# Cayuga Lake Watershed Preliminary Watershed Characterization

## September, 2000

This report was prepared for the Town of Ledyard with funding provided by the New York State Department of State through the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.

This report was prepared by:
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Rochester, New York 14618
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Limnological Consultants:
EcoLogic
5891 Ridge Road
Cazenovia, New York 13035
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# Executive Summary

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**Acknowledgements**

The Cayuga Lake Watershed Management Plan Project is greatly indebted to the many individuals and organizations who contributed their time, expertise, and resources during the development of this Preliminary Watershed Characterization. Their tireless efforts will greatly benefit future protection of the Cayuga Lake Watershed for year to come. The Cayuga Lake Watershed Management Plan Project would like to thank all of the members of the Intermunicipal Organization, Technical Committee, Agricultural Committee, and the Education & Public Participation Committee for sharing their wide array of experience and technical skills. There is great appreciation for the time and efforts of all of the private citizens as well. The following organizations shared their personnel, data, meeting locations, and many other resources:

Atlantic States Legal Foundation
Cayuga County Cornell Cooperative Extension
Cayuga County Department of Health
Cayuga County Planning Department
Cayuga County Soil & Water Conservation District
Cayuga County Water Quality Management Agency
Cayuga Lake Watershed Network
Cayuga Lake Watershed Management Plan Intermunicipal Organization
Cayuga Nature Center
Central New York Regional Planning & Development Board
Cornell University Center for the Environment
Cortland County Planning Department
Cortland County Soil & Water Conservation District
Cortland County Water Quality Coordinating Committee
EcoLogic
Empire State Development Corporation
Farm Bureau
Genesee/Finger Lakes Regional Planning Council
Ithaca-Tompkins County Convention and Visitors' Bureau
Montezuma National Wildlife Refuge
Schuyler County Cornell Cooperative Extension, Planning and Community Development Division
Schuyler County Soil & Water Conservation District
Schuyler County Watershed Protection Agency
Seneca County Board of Supervisors
Seneca County Building Enforcement Office
Seneca County Department of Health
Seneca County Planning Department
Seneca County Tourism Promotion Agency
Seneca County Soil & Water Conservation District
Seneca County Water Quality Committee
Southern Tier Central Regional Planning and Development Board
Southern Tier East Regional Planning and Development Board
Tioga County Department of Economic Development and Planning
Tioga County Department of Environmental Health
Tioga County Soil & Water Conservation District
Tompkins County Cornell Cooperative Extension
Tompkins County Municipal Officials' Association
Tompkins County Planning Department
Tompkins County Soil & Water Conservation District
Tompkins County Water Resources Council
Town of Ledyard
New York State Department of Environmental Conservation, Division of Fish, Wildlife & Marine Resources
New York State Department of Environmental Conservation, Division of Water
New York State Department of Environmental Conservation Region 7
New York State Department of Environmental Conservation Region 8
New York State Department of Environmental Conservation, Wildlife Resources Center - New York Natural Heritage Program
New York State Department of Health
New York State Department of State, Division of Coastal Resources
New York State Office of Real Property Services
United States Geological Survey
United States Department of Agriculture – Natural Resource Conservation Service
Wells College

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## I. PURPOSE, OBJECTIVE AND FOCUS

The Cayuga Lake Preliminary Watershed Characterization Report is a working document developed to meet two objectives:

(1) Present the current state of scientific understanding of Cayuga Lake and its watershed with a focus on water quality of the lake and its tributaries. Physical, chemical, and biological conditions are discussed. Specific areas of potential concern and areas where more data are needed are highlighted
(2) Describe the multitude of activities underway by government, the private sector, and individuals to protect and improve this unique resource.

The overall goal is to provide a basis for understanding the state of the watershed.

This report is the first phase of the Cayuga Lake Watershed Management Plan. The process to develop a Management Plan for the lake began in 1998 when grant funds from New York Department of State, Division of Coastal Resources, Waterfront Revitalization Program were awarded to the Town of Ledyard and matched by local contributions and in-kind services. Additional funding was provided by the Empire State Development Corporation. Two multi-county planning agencies (Central New York Regional Planning and Development Board and Genesee/Finger Lakes Regional Planning Council) are providing administrative, technical, and in-kind support. The watershed management planning process requires several overlapping and interrelated phases: fact finding, public participation, and education.

An intermunicipal organization (IO) has been formed to foster participation by the many municipalities in the watershed and ensure that the plan reflects local priorities. IO membership is comprised of watershed municipalities (counties, cities, towns and villages). Approximately 66% of watershed municipalities have participated in IO activities to date. Twenty-nine of the 50 have signed a cooperative agreement. Non-municipal stakeholders participate via avenues such as membership on IO committees, the Cayuga Lake Watershed Network, and public information forums occurring throughout the project.

This report draws on many sources of data and information. Statistics have been compiled for the description of the watershed and potential sources of contamination. Historical data on Cayuga Lake and its tributaries date back to the early 1900s. Researchers at area universities have examined aspects of the lake and watershed. State agencies, notably the New York State Department of Environmental Conservation (NYSDEC) and the New York State Department of Health (NYSDOH), conduct monitoring programs to characterize water quality and the fish community and identify any impairment to designated uses. Additionally, the NYSDEC publishes the Priority Waterbodies List for each basin on a rotating basis in an attempt at characterizing the surface water bodies within that basin. The Cayuga Lake Watershed surface waters are dealt with in the 1996 Priority Waterbodies List for the Oswego-Seneca-Oneida River Basin. Two federal agencies, United States Geologic Survey (USGS) and the United States Environmental Protection Agency (USEPA), have included Cayuga Lake in research programs. Some long-term monitoring has been done by agencies such as the Soil and Water Conservation Districts (SWCD). Users of the resource, for public drinking water supply, wastewater disposal, or noncontact cooling water, monitor to meet permit requirements.

Draft sections of this report were reviewed by the Technical Committee of the IO, which includes representatives of the following: each County Water Quality Coordinating Committee (WQCC), New York State Department of State (NYSDOS), NYSDEC, Division of Water and Regional Water Engineers, Montezuma Wildlife Refuge, Cayuga Lake Watershed Network (CLWN), USGS, United States Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS), Wells College, Cornell University Center for the Environment, and the Atlantic States Legal Foundation. The main functions of the Technical Committee include data and information identification, technical education and public participation review, interim recommendation criteria and project review, and Preliminary Watershed Characterization input and review.

## II. FINDINGS AND CONCLUSIONS

Cayuga Lake has a rich history of research activities. Physical, chemical, and biological conditions of the lake and its tributary streams have been investigated for decades. The lake and its watershed remain the focus of several long-term monitoring initiatives. However, several important data gaps remain.

Cayuga Lake's water quality is generally very good. The lake is a valued and visible resource, serving as a public water supply and focal point for recreation. The fish community is diverse and productive. Overall, the tributary streams exhibit moderate to high water quality and habitat conditions that support a balanced biological community.

Despite the general conclusion that water quality of the lake and its tributary streams is high, a number of specific areas of concern are evident. These are summarized below, along with a discussion of additional data needed to identify specific priority areas and define effective remedial strategies.

- ***Fertilizers and pesticides*** have been detected in both tributary streams and the lake. Recent data provide direct evidence of chemical loss from the landscape and transport to the lake. Almost half of the land in the watershed is in active agriculture, and this land use contributes nitrate-nitrogen and pesticides (most notably, herbicides used in corn cultivation) to the lake. Using analytical methods with low detection limits, scientists from USGS and NYSDEC have documented trace concentrations of pesticides in the streams and lake. The chemicals are present at levels far below ambient water quality standards or guidelines based on toxicology and risk assessment. No exceedances of standards or guidelines developed to protect human health and the environment have been detected.

***Data Needs: Pesticides and Nitrates***

*Long-term effects of exposure to trace concentrations of many of these chemicals are unknown. It is important to continue to track these chemicals in all components of the ecosystem: water column, sediments, and throughout the food web.*

*Additional monitoring of pesticides in streams draining mixed land uses (agricultural and residential) is needed to further our understanding of the sources, fate, and significance of these chemicals. Stream monitoring must be designed to reflect the hydrologic cycle, the agricultural cycle, and the mix of land use and geology in the subwatersheds.*

*The potential for agricultural chemicals to be adsorbed to sediment particles and transported to the lake has not been fully assessed. Limited testing of lake sediments has not detected agricultural residues. However, testing has not been conducted in depositional areas of streams draining agricultural watersheds, nor in the lake at the mouths of tributaries.*

*Groundwater concentrations of pesticides and nitrates are not well documented. Since much of the watershed relies on groundwater, this data gap is significant.*

- ***Sediment*** is a significant water quality, habitat, and use impairment issue, particularly in the southern tributaries and southern Cayuga Lake. Destruction and fill of the extensive wetland areas in southern Cayuga Lake in the early 1900s has exacerbated this problem by removing a natural filtration process that captured sediment before it flowed into the lake. In the southern tributaries, the primary source of sediment appears to be streambank erosion, not runoff from construction sites or cultivated fields. The primary sources of sediment in other tributaries are not known and may differ based on land use and geology.

***Data Needs: Sediment***

*Before and after monitoring is lacking on tributaries where remedial measures such as streambank stabilization or stormwater controls has been implemented. Monitoring should occur over a range of hydrologic conditions, particularly high flow events.*

- ***Heavy metals*** are present in at elevated concentrations in sediments of Fall Creek and nearshore areas of southern Cayuga Lake. Heavy metals may enter the aquatic system from industrial discharges, stormwater runoff, or atmospheric deposition.

***Data Needs: Heavy Metals and Stormwater Quality***

*The quality of urban stormwater has not been assessed in the Cayuga Lake watershed. The concentration of heavy metals, phosphorus, sediment, petroleum compounds, and pathogens in stormwater is not characterized; moreover, the significance of this source in relation to other sources is not known.*

*There are no recent data characterizing chemical quality of precipitation (wetfall and dry fall) in the basin. This is important for load calculations as well as for general surveillance of acid precipitation.*

*Additional sampling of tributary sediment in subwatersheds and stream reaches with different mixes of land use might help identify factors contributing to the presence and concentration of heavy metals.*

- ***Phosphorus*** is the limiting nutrient for algal growth in Cayuga Lake as it is for most inland lakes in the Northeast. Recent monitoring data confirm that Cayuga Lake is mesotrophic, with moderate levels of primary productivity. However, the shallow areas at the northern and

- southern ends of the lake exhibit higher levels of phosphorus and productivity. Both of these segments are listed by New York State as priority areas, indicating water quality concerns. Phosphorus sources include the two wastewater treatment plants discharging to the southern lake basin and runoff from residential and agricultural areas. Septic systems are considered by NYSDEC to be significant sources of phosphorus to the northern segment.

**Data Needs: Phosphorus**

*Annual monitoring of a limited suite of limnological parameters will provide a basis for long-term trend analysis. These parameters include total phosphorus, soluble reactive phosphorus, total soluble phosphorus, dissolved oxygen profiles, chlorophyll a, Secchi disk transparency, and turbidity.*

*Biological parameters can provide information regarding trends as well. Species composition and abundance of the macroinvertebrate community (aquatic insects and worms found in the stream bed) of the tributary streams can be used to indicate water quality conditions and assess site-specific impacts of point and nonpoint discharges. Sampling tributaries in various geologic and land use settings can identify areas where the biological community is stressed.*

*A mathematical model would provide a tool for linking the inputs from the tributaries to the lake's water quality response.*

- ***Exotic species***. Because of its connections to the Great Lakes through the Seneca River, Cayuga Lake is vulnerable to invasion by nonindigenous species of plants and animals. There have been a number of exotic species invading Cayuga Lake over the years. Three recent invaders are a focus of special concern due to their potential to alter the food web. These organisms are the zebra and quagga mussel (*Dreissena polymorpha* and *Dreissena bugensis*) and a predatory cladoceran zooplankton (*Cercopagis pengoi).* The macrophyte Eurasian water milfoil (*Myriophyllum spicatum*) is another introduced species that has, until recently, been a nuisance in Cayuga Lake.

**Data Needs: Exotic Organisms**

*The impacts of exotic organisms on the food web and ecology of Cayuga Lake will be an important area of research. The macrophyte data illustrate the need for long-term monitoring to differentiate trends from year-to-year variability.*

- ***Pathogens and indicators.*** The presence of pathogenic microorganisms in the lake and its tributary streams is a potential area of concern. Pathogens originate from untreated or inadequately treated human sewage and wild and domestic animal waste. Human exposure to pathogens can occur from direct contact with or ingestion of contaminated waters. The potential presence and abundance of pathogenic microorganisms is assayed using indicator organisms such as coliform bacteria.

**Data Needs: Pathogens and Indicators**

*Measurements of pathogens and indicator organisms in Cayuga Lake are very limited. Storm event monitoring in the lake and streams could help define the importance of urban runoff as a source of pathogens. The importance of waterfowl as a source of microorganisms is not known.*

*Based on generalized geology and soils maps, there are large areas of the watershed with severe constraints to on-site wastewater disposal systems (septic systems). There has been no watershed-wide effort to characterize the performance of these individual systems and how leachate from septic systems contributes to nitrate, phosphorus, and pathogen levels. The experience of Cayuga County, which has a comprehensive inspection program, could serve as a guide.*

- Impacts of non-permitted, pre-permitted or unenforced uses

Data Needs: Sources

Additional field work could provide useful information on pre-permit and unpermitted underground storage tank sites, waste sites, junk yards and dumps, mines and wells. There is a need for better and more accurate recreational data including the impact of boating and fishing on water quality.

- *Floodplain delineation, management and mitigation.*. Water level management and flooding are important issues. The loss of wetlands and increase in impervious areas have altered the natural hydrology.

- Impacts of Cornell *Lake Source Cooling*

- *Native American territory* disputes

## III. THE NATURE OF THE BASIN

*The Watershed*

The Cayuga Lake watershed is part of the 5,100 square mile Seneca-Oneida-Oswego River watershed that drains to Lake Ontario (see Figure 1). The entire drainage basin of Cayuga Lake includes the basins of Seneca and Keuka Lakes. Outflow from these lakes enters Cayuga Lake at the extreme northern end via the Seneca-Cayuga Canal. However, because both Keuka and Seneca Lake Watersheds are undergoing a watershed management planning process with associated reports similar to this one, the Cayuga Lake Preliminary Watershed Characterization will concentrate on just the watershed that directly drains to Cayuga Lake.

The Cayuga Lake Watershed covers 785 square miles (United States Department of Interior, 1971). There are 44 municipalities and six counties that are all or partially in the watershed (see Map 2.1.1a and Figure 2). The watershed is home to over 120,000 people. For the purposes of this study the watershed has been broken down into 46 subwatersheds based on the major tributaries of Cayuga Lake (see Map 2.1.1a). The center of Cayuga Lake is located at latitude 42$^{o}$ 41’ 30" N and longitude 76$^{o}$ 41’ 20" W. Its average water-surface elevation is 382 feet above sea level.

Many factors enter into the use, type of pollutants, source of pollutants, and overall water quantity and quality in the Cayuga Lake Watershed. These include natural factors such as climate, topography, geology, soils, water resources, vegetation and wildlife. And they include human factors such as land use, demographics, economic development, tourism and recreation. The state and sustainability of the watershed depends on the interrelationship between the natural and human factors.


**Figure 2 Municipalities in the Cayuga Lake Watershed**

Tompkins County
- Town of Caroline
- Town of Danby
- Town of Newfield
- Town of Dryden
- Town of Ithaca
- Town of Enfield
- Town of Lansing
- Town of Ulysses
- Town of Groton
- City of Ithaca
- Village of Dryden
- Village of Trumansburg
- Village of Lansing
- Village of Cayuga Heights
- Village of Freeville

Schuyler County
- Town of Hector
- Town of Catharine*

Cortland County
- Town of Harford
- Town of Virgil
- Town of Cortlandville
- Town of Scott*
- Town of Homer

*Municipalities with small portion in watershed

Cayuga County
- Town of Summerhill
- Town of Genoa
- Town of Sempronius
- Town of Locke*
- Town of Venice
- Town of Ledyard
- Town of Scipio
- Town of Fleming
- Town of Aurelius
- Town of Springport
- Village of Aurora
- Village of Union Springs
- Village of Cayuga

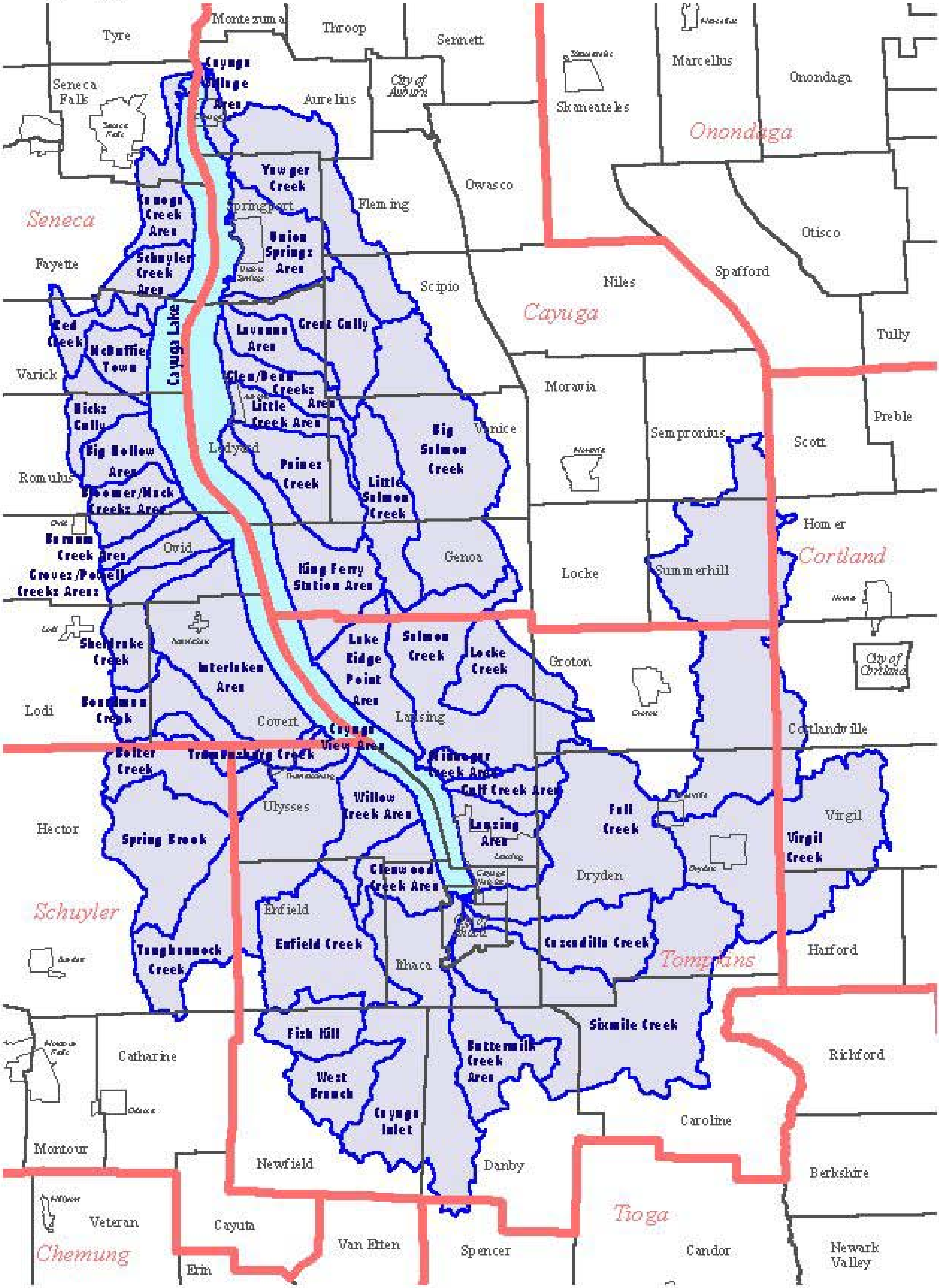
Tioga County
- Town of Spencer

Seneca County
- Town of Covert
- Town of Lodi
- Town of Ovid
- Town of Romulus
- Town of Fayette
- Town of Varick
- Town of Seneca Falls
- Village of Interlaken

*Climate*

The general climatic conditions of the watershed can be described as humid continental with warm summers and long, cold winters. The area lies on or near the major west to east track of cyclonic storms and hence is characterized by variety and frequent periods of stormy weather, particularly in the winter. Average daily air temperatures of 90$^{o}$ F or higher are rare. Average daily winter temperatures of 0$^{o}$ F or

# Cayuga Lake Watershed and Subwatersheds




This map was prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.

Source: Genesee/Finger Lakes Regional Planning Council, 1998.

Base Map: New York State Department of Transportation, February 1996.

1:369633

0 5 10 Miles

Prepared by Genesee/Finger Lakes Regional Planning Council, 19

less occur fewer than 15 times per year. The freeze-free season averages approximately 150 days. Annual precipitation ranges from approximately 25 inches to 45 inches per year with the average yearly precipitation approximately 35 inches per year. Generally the summer months are the highest average daily precipitation rates (Northeast Regional Climate Center).

One of the more persistent climatic features of the Cayuga Lake area is cloudiness, especially during the winter months. Ithaca averages about 175 cloudy days a year. The percentage of possible sunshine at Ithaca is less than 30% in November and December and increases to a maximum of 60% in June and July. Prevailing winds in the area are from the southwest during the summer and the northwest in the winter. Velocities in Ithaca average 7-10 mph from May through October and 11-12 mph during the colder months.

*Topography*

The Cayuga Lake Watershed is located in a glaciated valley with flat terrain and low relief characteristics in the northern portion and higher elevations with more hilly terrain with greater relief beginning near the northern third of the watershed and extending down to the southern end. The more dramatic increases in elevation and steeper slopes that define the gorges of the watershed begin on the eastern side near the towns of Springport and Scipio, while on the western side the same topographic effect begins further south near the Town of Ovid.

In the northern third of the watershed, elevations range from approximately 394 feet to 1050 feet above sea level. Elevations in the southern end of the watershed reach approximately 1804 feet above sea level. The higher elevations of Cayuga Lakes' southern tributaries combined with the "hanging valleys" produced by glaciation, have created steep gorges and scenic waterfalls.

The topography of the watershed was formed through uplift and erosion of the land surface that began approximately 200 million years ago with the draining of the inland sea which covered all of what is now New York. Periods of glacial advance and recession further modified the land surface by deepening and widening the Cayuga Lake Valley, and smoothing the surrounding hills. Recent erosion has further modified post-glacial stream channels and softened the land-surface topography left by the receding glaciers.

*Bedrock Geology*

Approximately 400 million years ago unconsolidated sediments were deposited in the Finger Lakes when the Western Oswego River Basin was still an inland sea. These unconsolidated sediments laid down in shallow inland seas, included clay, silt, sand, and calcium carbonate deposits, which were compressed into bedrock by the weight of overlying sediments. Later, periodic arid conditions dried up the inland waters, resulting in precipitation of mineral salts (gypsum and halite [rock salt]) within the unconsolidated clay and silt deposits. These deposits were later mined.

While the bedrock formations in the watershed are not of uniform composition, the formations can be separated into three general classes: (1) shale, siltstone, and sandstone, (2) carbonate rock, and (3) gypsum and salt-bearing shale. The shale, siltstone, and sandstone formations comprise the majority of bedrock formations in the watershed, present from the southern sections of the Towns of Fayette and Springport to the southern boundary of the watershed.

The carbonate rock and gypsum and salt-bearing shale classes are present in the northern end of the watershed. The carbonate rock class can be found in the northern half of the towns of Fayette and Springport and in the southern half of the towns of Aurelius and Seneca Falls as well as the Village of Seneca Falls. Carbonate rock, mostly limestone, are highly susceptible to groundwater contamination due to solution channels and sinkholes which can introduce surface contaminants.

*Surficial Geology*

The majority of the Cayuga Lake Watershed consists of glacial till of variable texture and thickness, most notably in the middle of the watershed east and west of the lake. The texture of the till varies but is predominantly poorly sorted, sand-rich silt and clay. Along the east and west borders of the lake from the Towns of Ledyard (east) and Fayette (west) to the Ithaca area, bedrock is either exposed or within several feet of the land surface.

On the east side of the lake, north of the Town of Summerhill is lacustrine (material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised) sand, and well-sorted, permeable quartz sand. To the south of Summerhill, and throughout the southern third of the watershed, areas of mixed clay, silt, sand and gravel (kame deposits) of variable texture and thickness are found. Kame deposits are also located throughout the southwestern portion of the watershed.

The most northern portion of the watershed is primarily lacustrine silt and clay, which has a low permeability and is up to 150 feet thick. At the very northern boundary of the watershed in the Montezuma Wildlife Refuge are wetland deposits that overlie calcium rich clays (marl) and lacustrine silt.

*Soils*

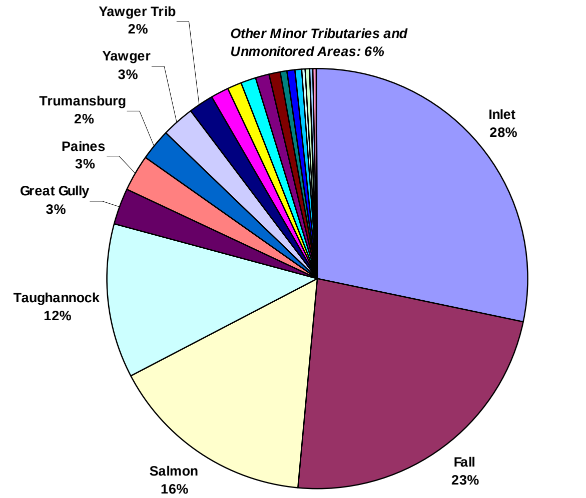
Soil is the product of the interaction among five major soil-forming factors: parent material, topography, plant and animal life, climate, and time (USDA, Soil Conservation Service). Most soils in the watershed formed after the last glacier receded from the area about 14,000 years ago. All soils have not reached the same stage of development, however, because various soil-forming/modifying factors influence the rate and depth of development.

The shape of the land surface, the slope, and the depth to the water table influence the formation of soils in the watershed. Since the area has a humid, temperate climate, these conditions tend to promote the development of moderately weathered, leached soils. The native forests, consisting of northern hardwoods and pine, influenced early soil formation. Humans have further modified the soils through clearing of forests, cultivation (mixing soil horizons through plowing), the addition of nutrients through fertilizers, and accelerated soil-erosion processes by removing vegetation and the root mat which would normally 'hold' soils in place. In geologic terms though, the soils in the watershed are relatively young.

*Surface water resources*

The dominant surface water feature of the basin is the lake itself. A network of more than 140 streams flows into the lake. Because of the topography of the watershed, many of these streams are small and intermittent. There are a few major streams that drain larger subwatershed areas and these are all found in the southern part of the watershed (Figure 3). The largest streams are Cayuga Inlet (which includes Six Mile, Cascadilla, Enfield and Buttermilk Creeks) and Fall Creek. Together, these two large streams drain just over half of the direct drainage (excluding the contribution from Seneca and Keuka Lakes), and contribute approximately 40% of the flow into the lake. Fall Creek and the Inlet flow into the southern end of Cayuga Lake. Salmon Creek (on the east side of the lake) is the next largest subwatershed. The watershed area of this stream is approximately 16% of the direct drainage area. Taughannock Creek (on the west side of the lake) is the next largest subwatershed representing approximately 9% of the direct drainage area.

**Figure 3**
**Drainage Areas of Subwatersheds**
**(Excludes Seneca and Keuka Lakes)**




*Groundwater resources*

Groundwater is precipitation that collects within the pores of soils or crevices and fractures in bedrock and can be used as a water supply. Many residents and businesses within the watershed access groundwater supplies through wells. According to USGS (Miller) the aquifers in the Cayuga Lake watershed with the greatest potential yield are located in the Cayuga Inlet, Fall Creek, and upper Salmon Creek Valleys. These are sand and gravel aquifers overlain by less permeable materials - silt, clay, or glacial till. Wells in these aquifers have the potential to yield from 5, to greater than 500 gallons per minute.

Groundwater quality depends on the composition of the soils and rocks. Because the watershed encompasses more than one geologic region, groundwater quality is variable. The northern region of limestone geology has well-buffered alkaline groundwater of relatively high quality and yield. Proceeding southward, groundwater quality reflects the sandstone and shale geology with higher concentrations of dissolved mineral salts and sulfur.

According to a report published by the USGS in 1975, calcium and sulfate concentrations were highest in the northern portion of the Cayuga Lake

Watershed. In the southern portion of the watershed, high chloride concentrations were detected in deeper wells. In the northern regions elevated chlorides in groundwater are a localized problem in the Seneca River and Barge Canal area near Mudlock.

*Terrestrial vegetation*

The Cayuga Lake watershed is located within the regional forest formation designated by the U.S. Forest Service as the Allegheny Section of the Northern Appalachian Highland Division which consist of Hemlock-White Pine, and Northern Hardwoods. The Allegheny Section is a broad forest type beginning at the northern edge of the Finger Lakes and continuing south, and covering most of the northern half of Pennsylvania.

The lower elevation segments of the Cayuga Lake Watershed, (in the northern part of the watershed), are part of the Lake Ontario lake-forest plain (dominant species include oak, hickory, and tulip poplar). In contrast, the higher elevation areas (which tend to be in the southern part of the watershed) are considered part of the more southern assemblage (sugar maple, beech, yellow birch, hemlock, and white pine). As a result of local variation in climate, the watershed contains species common to both forest types. Therefore, stand composition varies greatly with site, climate, and land-use history.

*Wildlife*

Based on the division of New York State into ecozones (zones that group living organisms that behave as a unit), nearly the entire watershed is within the Erie-Ontario Plain. Ecozones are determined by major physiographic (physical geographic) differences and are used to define and manage wildlife habitat on a broad scale.

The watershed contains a number of diverse habitats that support a wide array of wildlife. Forests and wetlands throughout the watershed, as well as agricultural lands and transitional areas, provide dwelling and feeding areas for various species of mammals, birds, reptiles and amphibians. The Montezuma National Wildlife Refuge, predominantly north of the watershed, provides habitats for a number of species. The refuge's primary purpose is to provide habitats for waterfowl, migratory birds, and endangered species. Nearly 75% of the refuge is classified as wetland, adding to the diversity of wildlife already present in the watershed. According to the NYSDEC's Natural Heritage Program (NYSDEC, 1999), there are two species of protected birds present in the watershed based on existing occurrences. They are the great blue herron and the short-eared owl. Game species present in the watershed include deer, coyote, opossum, rabbit, squirrel, hare, raccoon, red and gray fox, grouse, pheasant, woodcock, ducks, and geese.

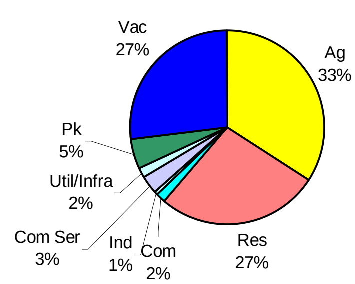
*Land use/Land cover*

Based on New York State Office of Real Property Services (NYSORPS) data (Figure 4), the single largest land use in the Cayuga Lake watershed is agriculture related (34 %), followed by residential (27 %), vacant (27 %), park lands (5 %), community service (3.2 %), commercial (1.6%), utility and infrastructure (1.6%), and industrial (0.6 %). However, 55% of the vacant land is classified as agricultural vacant.

Of the agricultural land in the watershed the largest portion (56.8%) is land usage related to livestock, followed by field crops (42.5%), vineyard (0.5%), orchard (0.1%), and nursery and greenhouses (0.1%). The highest percentage of residential land use by residential acreage in the watershed is low density residential (81%), followed by high density residential (9%), mobile homes and parks (9%), and low density seasonal residential (1%). Educational facilities account for over 79% of community service land use and over 2% of the overall land use in the watershed, largely due to the presence of Cornell University and Ithaca College.

The majority of the land cover in the watershed is classified as herbaceous planted/cultivated, which is vegetation that is planted, tilled, or subject to other intensive management or manipulation. This is largely due to agriculture (pasture, hay or row crops) but it includes lawns, parks and golf courses as well. The herbaceous planted/cultivated land cover is widely dispersed throughout the watershed, except for the southern end. Here the majority of the land

**Figure 4**
**Cayuga Lake Watershed Land Use By Acreage**



cover is categorized as natural forested upland or wetland where vegetation is dominated by trees generally forming greater than 25 percent canopy cover, or vegetation where the substrate (floor) is periodically saturated or covered with water (USGS, 1998).

*Population*

Portions of six counties and 44 municipalities lie within the Cayuga Lake Watershed. Between 1970 and 1990, the population of these municipalities grew 16.5%, with 8.9% of the increase taking place in the first decade. Only the Seneca County municipalities lost population (-8.1%) between 1970 and 1990. The Town of Spencer grew the fastest (50%). Tompkins County municipalities grew at a rate of 22% between 1970 and 1990. Each of the remaining counties' municipalities within the watershed grew between 11% and 16 % (USDC). As a whole, the population of the municipalities within the watershed is expected to increase by approximately 10,000 persons or 7% by 2010 (New York State Association of Regional Councils).

The Cayuga Lake watershed is predominantly rural in character. The combined population density for all of the municipalities in the watershed in 1990 was approximately 104 persons per square mile of land area. The greatest population density is at the southern end of the watershed in Tompkins County where Ithaca, the only city in the watershed, is located. Population density in Ithaca is 5,371.1 persons per square mile of land area. In contrast, the average population density for municipalities in Cayuga, Cortland, Schuyler, and Seneca counties is 62.1 persons per square mile of land area. When the City of Ithaca is excluded, the population density for the watershed is 82.9 persons per square mile of land area.

## IV. THE NATURE OF CAYUGA LAKE

*Lake Morphometry*

Cayuga Lake is the second largest of New York's Finger Lakes based on water volume and surface area. It is situated in a glacially carved valley at the northern edge of the Appalachian Uplands physiographic region of New York State. Average water surface elevation is 382 feet above mean sea level and maximum depth is 435 feet. The lake bottom extends well below sea level. The great depth of Cayuga Lake, second only to Seneca among the Finger Lakes, is attributed to rock scour from glaciation. The Cayuga Lake basin appears to have originated as a preglacial stream valley that was overdeepened by glacial erosion. Based on seismic surveys, bedrock may lie as much as 794 feet below sea level, and the rock basin has been infilled by as much as 741 feet of glacial and postglacial sediment.

Cayuga Lake is long and narrow, extending approximately 38 miles from Ithaca to the Seneca River outlet at Mudlock. Mean width is 1.75 miles. At its widest point, Cayuga Lake is 3.5 miles across. Volume is estimated at 331,080 million cubic feet at a lake elevation of 380.5 feet. Surface area is 66.4 sq. miles. The lake is relatively shallow at its northern end, deepens towards the south and has a relatively small, shallow shelf at its southern end. The deepest part of Cayuga Lake is a trough extending north from Myers Point to Long Point.

*Thermal Stratification and Mixing*

Cayuga Lake is a warm monomictic lake, meaning that there is one period of thermal stratification and one period of complete mixing each year. Considering winter as the beginning of the annual cycle, Cayuga Lake waters are cold and relatively uniform in temperature. Winds mix the lake waters from top to bottom, north to south.

As the sun's energy increases in spring, the lake gains heat and the upper waters begin to warm. Heating causes the water to expand and warmer, less dense water floats on top of the cooler water. More work is needed for winds to overcome density stratification and mix warmer water throughout the water column.

By June, Cayuga Lake waters stratify into three distinct layers: warm upper waters (epilimnion), cool lower waters (hypolimnion) and a middle transition layer (metalimnion). Density differences between the three layers are strong enough to prevent the winds from completely mixing the lake. During the summer, the lower waters remain isolated from the atmosphere.

By August, Cayuga Lake ceases to gain heat and the waters begin to cool. Heat loss continues through the fall. Eventually, the temperature of the upper water cools to the temperature of the lower waters, and thermal stratification breaks down. By early December of a typical year, the lake waters are again completely mixed.

The temperature difference between the surface and the deepest waters of Cayuga Lake can be 20 °C (36 °F) during the summer. Large-scale processes of

surface heat exchange and wind–induced mixing create these vertical temperature differences. Much less dramatic are differences in the horizontal dimension. Simultaneous measurements at different locations (same depth) reveal maximum temperature gradients in the range of 3°C (5.4°F).
These horizontal gradients are attributed to two mechanisms: localized input of heat and uneven heat distribution processes. Localized heat inputs can result from tributary inflows, effluent discharges, return of noncontact cooling water or microclimatic differences over the large lake. Uneven heat distribution can result from differences in wind energy across the lake surface or the effects of internal waves. Spatial temperature differences are most evident in spring and fall and diminish with increasing water depth.

*Water chemistry*

Cayuga Lake waters are moderately hard and well buffered, consistent with the predominance of calcareous parent material and soil in the watershed. Bicarbonate alkalinity is approximately 100 – 110 mg/l as $CaCO_3$. Major anions include chloride and bicarbonate, with relatively low amounts of sulfate; major cations include calcium and sodium, with relatively low concentrations of potassium and magnesium. Specific conductance, which is an indicator of total dissolved mineral salts, is consistently in the range of 380 – 480 μmhos/cm in the lake's open waters, away from the influence of tributary and wastewater inflows.

Chloride concentrations in surface waters reflect underlying geology, proximity to oceans, extent of road salting practices in the watershed, and any industrial or municipal discharge. Chloride concentrations in Seneca and Cayuga Lakes are elevated compared with the other Finger Lakes, and also compared with chloride concentrations in tributaries to these lakes. It appears that a small volume of groundwater with elevated concentration of sodium chloride may flow into Cayuga Lake.

Measurements of pH vary both diurnally (daily) and seasonally, but are consistently in the alkaline range. The highest pH values (in the range of 8.5 – 8.85) are measured in the upper waters during summer periods of algal activity as $CO_2$ is incorporated into biomass during photosynthesis. In the lower waters, where organic material is decomposed and $CO_2$ released, values between 7.2 and 7.9 have been reported.

*Trophic Status*

Phosphorus (P) is naturally present in all waters and is an essential nutrient for life. In most northeastern lakes, including Cayuga Lake, phosphorus is the limiting nutrient for algal growth. Because it is the limiting nutrient, the concentration of phosphorus in lake water is correlated with the abundance of algae. Given favorable light and temperature conditions, algal growth continues until the supply of phosphorus is depleted. The supply of phosphorus to Cayuga Lake depends on natural processes and human activities within the watershed.

Scientists and lake managers classify lakes according to their level of productivity (abundance of algae, plants, and other aquatic life forms and fish production) on a scale of trophic state. Oligotrophic lakes are nutrient-poor and low in productivity. Eutrophic lakes are well supplied with nutrients and support an abundance of algae and plants. Excessive algae will make a lake appear turbid or green, and diminish its attractiveness for recreational use. Decay of algae and aquatic plants reduces the concentration of dissolved oxygen in a lake's lower waters. Mesotrophic lakes are intermediate in nutrient supply and algal abundance.

Trophic state is assessed by several water quality measurements: phosphorus concentration, chlorophyll *a* (a plant pigment), dissolved oxygen concentrations through the water column, and water clarity (as measured by Secchi disk transparency or turbidity). Water quality monitoring programs of Cayuga Lake have included these parameters for decades. Ongoing programs continue to collect these data. Results of the monitoring indicate that Cayuga Lake is mesotrophic, exhibiting moderate levels of productivity.

However, the shallow southern and northern basins of the lake exhibit phosphorus concentrations and decreased water clarity conditions indicative of approaching eutrophic conditions. Plant and algal growth are more abundant. These shallow regions are affected by wastewater treatment plants, tributary streams, and waterfowl.

Dissolved oxygen (DO) concentrations are a significant factor affecting distribution, species composition, and abundance of the biological community. Variations in Cayuga Lake's DO concentrations occur seasonally and with depth. During the stratified period the lower waters remain isolated from atmospheric exchange and DO used up by aerobic organisms to decompose organic material is not replenished. The rate of DO depletion is an important indicator of trophic status. As algal biomass increases the rate of DO depletion increases and DO concentrations can decline in the lower waters. If DO falls below critical levels for aquatic life (4 – 5 mg/l) the habitat for cold water fishes such as salmonids is lost.

Cayuga Lake remains well-oxygenated throughout the stratified period. Dissolved oxygen levels remain above critical levels even in the deepest waters throughout the year. There have been no major changes in the DO levels since the earliest measurements obtained in 1910. This important finding is based on intensive investigations of the lake's water quality conducted by NYSDEC, USGS, and researchers from Cornell University. In contrast with other mesotrophic lakes, regeneration of P from bottom sediments is not an additional (internal) source of P. The well oxygenated hypolimnion and iron-rich sediments prevent diffusive flux (recycling) of soluble reactive phosphorus (SRP) to the hypolimnion from the bottom sediments.

*Pesticides and Other Organic Compounds*

Public suppliers of lake water are required by the NYSDOH to monitor for a comprehensive list of organic compounds. No organic contaminants have been detected in Cayuga Lake at concentrations exceeding water quality standards for human health.
The Bolton Point water supply (managed by the Southern Cayuga Lake Intermunicipal Water Authority) is included in a statewide survey for pesticides in water. In July 1997, Cayuga Lake water was tested for the presence of 47 pesticides using analytical techniques with very low limits of detection. Seven pesticides were detected in the sample collected at Bolton Point. Most of the analytes present are herbicides used on cornfields. Concentrations detected were well below any state or federal standard or guidance value developed to protect human health and the environment.

In 1998, research scientists from USGS and NYSDEC measured herbicides and breakdown products (metabolites) in storm flow samples of three tributaries to Cayuga Lake. The scientists sampled Cayuga Lake on two occasions after the storm. Results indicated that concentrations of herbicides were generally uniform throughout the north-south axis of the lake. In the summer, herbicide concentrations tended to be slightly higher in the upper waters. This pattern is a consequence of the timing of pesticide application with respect to the lake's thermal structure. Herbicides are typically applied after thermal stratification has developed in late spring. Streamflows transporting herbicides mix into the lake's warmer upper waters. Higher concentrations of chemicals were detected near mouths of tributaries draining agricultural areas.

*Sedimentation Rate and Sediment Quality*

The rate of sediment deposition in Cayuga Lake varies from south to north. Higher rates in the southern basin reflect the large hydrologic input from tributaries and the mixture of land use in the subwatersheds. The estimated sedimentation rate ranges from 0.2 – 1.6 cm/yr. (Yaeger 1999).

Only limited testing of the chemical quality of Cayuga Lake sediments has been conducted. Sediment testing is conducted throughout the Finger Lakes as part of the NYSDEC monitoring program; results will be released in early 2001. Recent testing of nearshore sediments in the southeastern region of Cayuga Lake detected concentrations of certain metals above regulatory guidelines. The NYSDEC "lowest effect level" thresholds for cadmium, copper, mercury, and nickel were exceeded in many samples. These thresholds are developed to protect aquatic biota living in sediment.
A second NYSDEC program classifies sediment into three classes (A, B, and C) depending on restrictions for disposal of dredged material. Class A is the lowest contaminant levels where disposal is unrestricted. Nearshore sediments in southern Cayuga Lake exceeded Class A thresholds for cadmium, copper, and mercury. Metals are part of the natural soil matrix, so their detection at low levels in sediments is to be expected. Elevated concentrations can reflect industrial inputs through effluent discharges, watershed runoff, and atmospheric deposition.

Sediments were also analyzed for organic compounds. Just as with the metals results, measured concentrations may be compared with regulatory guidelines established to protect designated uses of the lake ecosystem or to regulate disposal. Pesticides were detected in several of the nine sediment samples at concentrations exceeding thresholds for human health bioaccumulation, chronic toxicity for benthic (bottom) life, and wildlife bioaccumulation. The highest frequency of detectable pesticide results was associated with DDT and its breakdown products. Three samples of the top meter of sediment collected in nearshore areas exhibited elevated concentrations of polyaromatic hydrocarbons. These compounds are associated with fossil fuel combustion.

*Biological community*

Phytoplankton: Microscopic algae suspended in the water (phytoplankton) form the base of the food web in Cayuga Lake. The growth rate, abundance, and species composition of the phytoplankton community are affected by light, temperature, grazing pressure, and nutrient availability.

The phytoplankton community of Cayuga Lake is well-characterized. Annual succession dynamics dominate the observed variation in phytoplankton community structure. Four distinct periods are evident each year. In spring, the phytoplankton community is dominated (both numbers and biomass) by diatoms and cryptophytes. Chlorophyll *a* concentrations typically reach their annual maximum during this period. During a brief period in July large numbers of extremely small cyanophytes (blue-green algae) dominate the phytoplankton community in terms of numbers, but not biomass. From late summer through the fall mixing period, chlorophytes (green algae) dominate both numbers and biomass of the phytoplankton community. Blue-green algae gradually increase in importance over this period. During winter the community is dominated by cryptophytes.

Macrophytes: Rooted aquatic plants and algae (macrophytes) are a distinct feature of the shallow shelf areas at the southern and northern ends of Cayuga Lake. Aquatic macrophytes provide a number of important functions to lake ecosystems including stabilization, food, and habitat value. The presence of macrophytes in the littoral zone (the area between land and open water, which can also be described as that portion of the lake where rooted aquatic plants exist) is correlated with higher diversity and abundance of invertebrates, which are essential food sources for many life stages of organisms found in the lake. Macrophytes provide shelter and forage for waterfowl, invertebrates and fish. They provide habitat areas for insects and other organisms and for the spawning of many fish species. In addition, macrophytes provide habitat for young-of-the-year fish and adult sport fishes.

While important to the lake ecosystem, macrophytes can interfere with recreational uses of a lake if they become too abundant or if nuisance species dominate the flora. The species assemblage of macrophytes in Cayuga Lake has been documented at various intervals since the 1920s.

Significant changes in total biomass and species composition of macrophytes have occurred in the last decade. The abundance and dominance of *Myriophyllum spicatum* (eurasian watermilfoil), a nuisance exotic species which was dominant from the 1960s – 1980s have declined in the northern and southern study areas of Cayuga Lake. The precipitous decline in eurasian watermilfoil in the study areas has been accompanied by an increase in two native species, *Elodea canadensis* in the southern lake basin and *Vallisneria americana* in the northern shelf. This decline in dominance of eurasian watermilfoil was concurrent with the observation of the moth *Acentria ephemerella* feeding on the growing tips of this macrophyte.

In addition to herbivory, there are many environmental factors influencing the total biomass and species composition of macrophytes in Cayuga Lake. Significant storm events that deliver large amounts of sediment to the lake can affect light penetration and the littoral habitat. Invasion of lakes by the zebra mussel *Dreissena polymorpha* is associated with an increase in water clarity and expansion of littoral habitat . Zebra mussels entered Cayuga Lake through the Seneca River system and have spread from north to south. Finally, mechanical harvesting can influence the species composition along with abundance of macrophytes. Apparently, mechanical harvesting removes sufficient numbers of herbivorous larvae to suppress their effectiveness as a natural control for eurasian watermilfoil.

Zooplankton: The zooplankton community is another important component of the Cayuga Lake ecosystem. These small, motile, water column organisms graze on phytoplankton and are consumed by various life stages of fish. The Cayuga Lake zooplankton community is typical of a moderately productive north temperate lake.

Rotifers are the most abundant group, followed by cladocerans and copepods. Diversity and density of rotifers and cladocerans decreased with water depth. This pattern was reversed for copepods where the highest numbers of individuals and species were present at the deeper stations.

The zooplankton community of Cayuga Lake also includes a large number of the hypolimnetic crustacean *Mysis relicta*, the opossum shrimp. *Mysis relicta* is an important component of the Cayuga Lake food web. The species is a food source for juvenile lake trout , alewife, and smelt. Abundance of this zooplankton is considered by NYSDEC to be the facto limiting growth rate of juvenile lake trout.

Fish. The Cayuga Lake food web includes two interrelated assemblages of species, one in the shallow (littoral) zone and the second in the deep water (pelagic and profundal) zone. The littoral zone, defined as the region where light can penetrate to the sediment surface, extends from the shoreline to a water depth of approximately 20 ft. Because of the lake's shape, the littoral zone is primarily restricted to the northern and southern basins with only a narrow fringe along the eastern and western shorelines. Approximately 25% of the total surface area overlies depths of 20 ft. or less.

Most of the littoral zone is located in the northern basin, which is home to a warmwater fish community dominated by smallmouth bass. Other important predator fish in the littoral community include largemouth bass and northern pike. These species prey on yellow perch, pumpkinseeds, bluegills, rock bass, and minnows. Southern Cayuga Lake supports a spawning population of white suckers.

The deep water community is dominated by lake trout, rainbow trout, brown trout, and landlocked salmon as the top predators. Of these salmonids, only the lake trout is native to Cayuga Lake. Populations of the salmonids are maintained (or, in the case of rainbows, supplemented) by stocking. Juvenile salmonids prey on zooplankton, including *Mysis relicta*. Chiotti (1980) considers the quantity of this zooplankton to be the limiting factor for the growth and survival of stocked juvenile lake trout, Cayuga Lake's most important sport fishery. Older salmonids are piscivorous (fish eating) preying on alewives, rainbow smelt, white perch, and slimy sculpin.

The food web supporting the deep water community is relatively short: phytoplankton, zooplankton, alewife, and salmonids. A second energy pathway culminating with smelt begins with organic detritus, which is consumed by *Mysis relicta*, then by smelt. These generalized food webs do not reflect changes in food preferences with life stage and size.

Distribution of fish reflects thermal preferences, predator-prey relationships, and predictable migrations for spawning. Similar to feeding relationships, distribution is variable with life stage and season.

*Nuisance organisms*

The Great Lakes have been repeatedly invaded by plants and animals. Since the 1800s, at least 136 exotic aquatic organisms of all types: plants, fish, zooplankton, mollusks, and algae have been introduced. More than one-third have been introduced in the last 30 years, coinciding with opening of the St. Lawrence Seaway. Because of the hydrologic connection, many species introduced to the Great Lakes ultimately are found in the Finger Lakes.

Some nonindigenous species have long been part of the Cayuga Lake ecosystem. Rainbow smelt, alewife, white perch, common carp, and sea lamprey were introduced to Cayuga Lake as were rainbow trout and brown trout. Introduced plant species include eurasian watermilfoil, curly-leaf pondweed, and purple loosestrife. Eurasian watermilfoil *Myriophyllum spicatum* is highly visible to lake users.

Some of the most recent invaders to the ecosystem are among the most visible. *Dreissena polymorpha* (zebra mussel) and *Dreissena bugensis* (quagga mussel) have spread throughout the Great Lakes and their connecting waterways, the Finger Lakes, and many major river systems of the northeast. These mussels entered Cayuga Lake through the Seneca River in the early 1990s and have spread from north to south. By 1996, mussels were widely distributed throughout the lake, with dense populations in nearshore areas. Water suppliers, utilities, and other water users with intakes less than 10 m have found it necessary to employ control measures to minimize or prevent fouling. Proliferation of zebra mussels also diminishes the recreational suitability of the resource.

Long-term ecological effects of zebra mussels on lakes include increased water clarity and an enriched benthos (lake bottom). Mussels feed by filtering particles suspended in the water column where large quantities of organic material is pulled down from the water column to the benthos. One result is an increase in the diversity and production of all groups of benthic organisms. Periphytin and macrophytes benefit from the improved water clarity and, like zoobenthos, benefit from the increased nutrients and organic carbon found at the sediment surface. Many benthic macroinvertebrates benefit from the increased surface area created by the mussel shells. Production of benthic feeding fish can increase from the improved food supply. However, the increase in benthic production comes at the expense of the water column food web. This transfer of energy and nutrients from the water column to the benthos can lead to a fundamental shift in the food web.

Two exotic crustaceans, the predatory cladoceran zooplankton *Bythotrephes cederstroemi* (spiny waterflea) and *Cercopagis pengoi* (predatory waterflea) are recent invaders of the Great Lakes with the potential for altering the aquatic ecosystem. By October 1999, *Cercopagis* was confirmed present in Cayuga Lake, while *Bythotrephes* was not. Predation by these zooplankton on smaller cladocerans has the potential to affect the size distribution and composition of the phytoplankton community. These organisms may also affect fish populations by competing with young-of the-year fish for prey, or by becoming prey for older fish.

## V. HUMAN USES

Pollutants can enter water through direct, piped and channeled discharges – point sources, or they can enter groundwater, lakes, or streams from complex transport and delivery mechanisms within the lake watershed - nonpoint sources.

*Surface Runoff*

Overland flow, or stormwater as it is commonly called, is generated when the capacity of the soils and vegetation to absorb water from precipitation is exceeded and water runs across the surface of the land. In clay-rich soils, the water-retention capacity is low and runoff from these soils is generated quickly. In sandy soils, a larger portion of the precipitation infiltrates the land surface and recharges the underlying groundwater system, resulting in less runoff. Urban land contributes large amounts of contamination to water bodies via stormwater runoff.

Urban areas are characterized by a higher percentage of impervious surface coverage. Therefore, the ability of stormwater runoff to transport more pollutants is magnified. This can be seen in many of the subwatersheds, especially in the downstream portions of those subwatersheds. These include the following: Glenwood Creek Area (Town of Ithaca and Town of Ulysses), Lansing Area (Town and Village of Lansing, Cayuga Heights, Town of Ithaca), Big Salmon Creek/Little Salmon Creek/Salmon Creek/Locke Creek (Town of Lansing), Virgil Creek/Fall Creek (Village and Town of Dryden, Village of Freeville, Cayuga Heights, City and Town of Ithaca), Cascadilla Creek/Sixmile Creek/Buttermilk Creek/Cayuga Inlet/West Branch/Fish Kill/Enfield Creek (City and Town of Ithaca).

***Roadbank & Streambank Erosion***

In recognition of the role that roadbank and streambank erosion plays in the sedimentation rates in the Cayuga Lake Watershed a Roadbank & Streambank Inventory was done from May though August 2000.

*Roadbank Inventory*

The northwest portion of the watershed has relatively few problems with roadbank erosion with a few exceptions in Bloomer/Mack Creeks Area and the Sheldrake Creek subwatershed. The northeastern portion of the watershed has more significant roadbank erosion. Generally, the closer the road ditches are to the lake the more erosion is occurring mainly due to the steep gradients from the upland portions of the watershed down to the lake. This is demonstrated in the numerous road ditches classified as “very severe” in the King Ferry area. The same is true further south in the Lansing area. The southwestern portion of the watershed has some very severe erosion occurring along the road ditches in the Spring Brook, Taughannock Creek, Enfield Creek, and Willow Creek area. The large subwatersheds in the southern portion of the watershed with the exception of the Virgil, Cascadilla, and Buttermilk Creek subwatersheds have numerous road ditches classified as "very severe".

*Streambank Inventory*

The streambank data collected from the Cayuga Lake watershed displays various trends regarding erosion and sedimentation ultimately affecting water quality in the lake. Minor erosion is occurring along the western and eastern subwatersheds north of the Taughannock Creek subwatershed and the Salmon Creek subwatershed. The direct drainage basins on the southern end of the lake appear to pose little problems in regard to erosion. More appreciable erosion is apparent in the northeastern subwatersheds in Yawger Creek, Great Gully and Lavanna Area subwatersheds. Taughannock, Bolter, and Spring Brook subwatersheds also show a trend of appreciable erosion. The Salmon Creek major subwatershed (Salmon, Little Salmon, and Big Salmon Creeks) is classified as the low end of severe. The large subwatersheds on the southern end of the lake with the exception of the direct drainage basins are responsible for appreciable loads of sediment flowing into the lake. Fall, Virgil, and Sixmile Creeks are all categorized as moderately severe with a few very severe sites. The Cayuga Inlet is characterized as very severe and contains some of the highest stream ranks in the watershed.

*Underground and Above Ground Storage Tanks*

Chemical and petroleum products held in storage tanks can pose a significant threat to water quality. The average life of an underground storage tank in more acid soils (e.g. Tompkins County) is approximately 15 years. Leaking storage tanks can be significant sources of oil, fuel, and volatile organic compound (VOC) contamination. These contaminants may move into surface-water resources with groundwater flow. In the Cayuga Lake Watershed there are over 340 registered storage tanks sites, along with many more unknown tanks, containing petroleum and chemicals (NYSDEC, 1998a&b). These are dispersed throughout the watershed, but exist primarily in the southern part of the watershed.

*Hazardous Materials*

Any land use that results in the generation, use, or storage of materials classified as hazardous may be a source of contamination to ground and surface water. Hazardous materials are classified as substances that pose a danger to living organisms, materials, structures, or the environment by explosion or fire hazards, corrosion, toxicity to organisms, or detrimental effects. Based on NYSDEC data, there are several inactive hazardous waste sites in the watershed, most of these are along the southern end of the lake. These include an old chemical storage site which has leached into the groundwater and a low level radioactive site at Cornell, and a site in downtown Ithaca with buried coal tar and old city dumps.

*Hazardous Spills*

Hazardous spills can occur in a number of ways including leaking underground storage tanks, materials transfer, and materials transport. In the Cayuga Lake Watershed most spills have occurred in the southern portion, although there are many occurrences of spills throughout the watershed. Of the approximately 550 reported hazardous spills recorded in the watershed over the past 15 years, 360 were on land, 15 in sewers, 105 into groundwater, 60 directly into surface water, and 10 into the air (NYSDEC, 1998c).

*Industrial Sources*

There are over 600 industrial operations in the watershed. The categories of industrial sources include general industrial, industrial pipeline, material stockpiles, mining operations, transport and transfer stations, and well drilling operations. Other than wells and well drilling operations, most of the industrial operations are located in the southern portion of the watershed.

NYSDEC lists over 330 dry, brine, and gas development and extension wells in the watershed. These wells are fairly well dispersed throughout the watershed, with a pronounced concentration of over 70% in the northeast portion in the Aurelius, Fleming, and Springport area. These are mainly active gas wells. Approximately 5% of the wells in the watershed are brine wells, almost all of which are in the Town of Lansing. Approximately 18% of the wells in the watershed are dry wells, approximately 25% of which are plugged and abandoned.

Sand and gravel mining can pose a threat to water resources. Because of their relatively permeable nature, sand and gravel deposits are generally coincident with recharge areas. In order to mine these deposits, the topsoil is first removed, eliminating an important buffer zone between the ground surface and the underlying aquifer. Lowering the ground surface decreases the relative depth of the water table, thereby making it more susceptible to contamination from mining apparatus and vehicles. The loss of vegetation exposes sediment, making it more easily removable by wind and surface water runoff. Based on NYSDEC data, there are approximately 30 mines in the watershed. The vast majority of these (all but 3) are sand and gravel mines. The majority of the mines are in the southern and southeastern portions of the watershed.

There are two permitted discharges of noncontact cooling water to Cayuga Lake. AES-Cayuga (formerly known as Milliken Station) is a 387 megawatt, coal-fired power plant located 13 miles north of Ithaca on the eastern shore of the lake. This plant is permitted to circulate water at a rate of 10.67 cubic meters per second (169,000 gallons per minute). Water is drawn from a depth of 46 feet and returned to the surface. The temperature of the cooling water increases approximately 8.6 °C as it flows through the AES-Cayuga facility. The temperature of the water as it is returned to the lake is variable. It depends on the water temperature flowing in. At the intake the temperature of the lake fluctuates between 4 – 20 °C over the year. The temperature of the return flow is therefore 13 – 29 °C, which is almost always warmer than background conditions at the outfall.

A second noncontact cooling water discharge to Cayuga Lake has been permitted and will be on line in the summer of 2000. Lake Source Cooling (LSC) is a 29.4 megawatt heat exchange facility located on East Shore Drive in Ithaca. The LSC facility is permitted to circulate water at a peak rate of 2 cubic meters per second (32,000 gallons per minute). Actual flows will be variable, based on the demand for campus cooling, and will be much lower during winter. LSC draws water from a depth of 250 feet where it is cold year-round. The temperature of the water increases approximately 3.9 °C (winter) to 8.3°C (summer) as it flows through the heat exchange facility. During winter, the return flow will be approximately 8° C, which is warmer than the lake. During summer, the LSC return flow will be approximately 13° C, which is cooler than water in the shallow nearshore area where the water flows back to the lake. The outfall has a diffuser to insure rapid mixing of the return flow with lake water and minimize the plume of cooler or warmer water.

Potential environmental impacts of LSC have been the focus of research, monitoring, debate, regulatory scrutiny, and judicial review since 1994. The project reduces energy used in cooling by more than 80% and enables Cornell to accelerate replacing CFCs and aging equipment. The benefits of using the lake's cool water as a renewable resource have been weighed against potential adverse impacts of adding heat and circulating water from deep in the lake to the surface.

Of greatest concern has been phosphorus (P) transfer to the upper waters (the region of plant and algal growth) during the summer, when the lake waters do not naturally mix. LSC will not add phosphorus to the lake, but the transfer of phosphorus present in the lake's lower waters represents an additional source during the summer recreational season. Phosphorus is the limiting nutrient for algal growth in Cayuga Lake, and its transfer to the shallow southern lake, where concentrations are already elevated, has been a serious issue to the community. Phosphorus transfer by LSC is estimated at 2.9 kg P per day from May to October (assuming LSC is at its maximum permitted flow and concentrations in the lower waters are at their annual peak). For comparison, the two large tributaries to southern Cayuga Lake deliver 13.3 kg P per day during this period, and the two wastewater plants can discharge up to 45.4 kg P per day. During the remainder of the year the lake waters mix naturally.

The majority of scientists reviewing the LSC project concur with the conclusions of the Environmental Impact Statement that additional algal growth associated with phosphorus transfer of this magnitude will not be discernible. In fact, many reviewers concluded that transfer of cool, clear water from deep in Cayuga Lake will help improve water quality in the shallow southern lake basin. Others remain concerned that phosphorus in the lake's lower waters will be immediately available to the plant community and will stimulate algal growth near the outfall.

Because of the uncertainties associated with this innovative project and the current water quality conditions of southern Cayuga Lake, the LSC permit has a number of conditions for monitoring and assessment. There are "reopener" clauses in the 5-year permit requiring Cornell to take action if the LSC return flow causes water quality degradation. Cornell has committed to sharing their monitoring data with the community. Because of the level of concern regarding the LSC discharge, monitoring and assessment of its impacts will be reflected in the Cayuga Lake Watershed Management Plan.

*Commercial Sources*

Higher risk potential commercial sources of contamination in the watershed include airports and abandoned airfields, auto repair shops, boat yards and marinas, car dealerships/services, car washes, campgrounds, cemeteries, funeral homes and services, gasoline service stations, golf courses, hardware and lumber stores, horticultural practices including garden nurseries, and florists, laundromats and dry cleaners, print shops and publishing operations, medical institutions, railroad tracks and yards and veterinary services. There are approximately 50 auto repair shops in the watershed. These are dispersed throughout the watershed and are especially prevalent in the southern portion. There are approximately 25 boat yards and marinas in the watershed. These are fairly well dispersed, generally directly adjacent to the lake. There are approximately 40 car dealerships/services in the watershed, the majority of which are in the southern portion. There are approximately 170 cemeteries in the watershed. They are fairly well dispersed. There are approximately 55 gasoline service stations in the watershed. While there are gasoline service stations throughout the watershed, they tend to be most dense in and around the population centers in the southern portion of the watershed. There are approximately 15 horticultural operations in the watershed. They are fairly well dispersed. There are approximately 20 laundromats and dry cleaning operations throughout the watershed, the majority of which are in the southern portion.

*Municipal Sources*

Cayuga Lake is a public and private drinking water supply. Numerous communities and hundreds of households depend on the lake and its watershed as a drinking water source from both surface and ground waters. The largest public surface water supplies are located at the southern end of the watershed. These include a portion of the water system for the City of Ithaca, which draws water from Six Mile Creek, and the Southern Cayuga Lake Intermunicipal Water Commission at Bolton Point, which serves five municipalities and Cornell University. Other smaller surface water systems include the Village and Town of Seneca Falls and the Villages of Cayuga and Aurora. The majority of systems using groundwater have a retail population of less than 1,000. The only groundwater systems with a retail population over 1,000 are municipal systems located in Union Springs, and the Villages of Dryden, and Trumansburg.

Treated wastewater (effluent) from several municipal treatment plants is discharged to Cayuga Lake and its tributaries. A total of 15 million gallons of treated wastewater is permitted to flow into the lake and its tributaries each day from nine municipal treatment plants. Quality and quantity of the discharges remain relatively constant throughout the year, although higher flows tend to occur in the spring. The quantity and quality of wastewater (and other) discharges are closely regulated by NYSDEC to ensure that receiving water quality meets or exceeds standards associated with its designated use

The communities of Ithaca, Dryden, Cayuga Heights and Lansing recently submitted an application for funding assistance with upgrades and expansion of their municipal wastewater treatment systems. The intermunicipal proposal of August 1999 includes expansion of the service area into Lansing, with wastewater flows from the new service area directed to the Cayuga Heights plant. Excess flows from Cayuga Heights would be directed to the Ithaca Area Wastewater Treatment Plant, which serves the City and Town of Ithaca and the Town of Dryden. The flow capacity of this plant would be increased from 10 to 13 million gallons per day (mgd).

One element of the proposal is to increase the phosphorus removal capacities of both the Ithaca Area and Cayuga Heights treatment plants by adding filtration to the treatment process. Both plants currently hold a total phosphorus (TP) limit of 1.0 mg/l in their State Pollution Discharge Elimination System (SPDES) permit, consistent with the requirements of the International Joint Commission for wastewater treatment plants within the Great Lakes basin with a capacity greater than 1 mgd. Performance of the Ithaca Area Wastewater Treatment Plant is well below the 1 mg/l phosphorus (TP) limit, where average effluent concentrations are in the range of 0.5 – 0.6 mg/l. The Cayuga Heights plant has historically operated close to its permit limit of 1 mg/l for TP although improvements have been made in recent months as part of a 1998 wastewater improvement project.

NYSDEC policy for new discharges to lakes can require an effluent limit of 0.5 mg/l for TP, recognizing the central role of phosphorus in eutrophication of inland lakes. When existing plants request an increase in permitted flow, it is NYSDEC policy to hold the discharge to the existing mass limit for TP, thus reducing allowable concentration proportional to the flow increase.

With filtration, both Cayuga Heights and the Ithaca Area wastewater treatment plants will be able to meet or exceed a TP limit of 0.5 mg/l. Effluent concentrations from filtration can be 0.2 mg/l or less, depending on the amount of chemical addition and flow rates through the filters.

Outside of the few sewer districts there is extensive usage of septic systems. The highest densities of septic systems are in the southeast and southwest sides of the lower one third of the lake and the southern portion of the watershed. The effectiveness of on-site wastewater treatment is highly dependent on the soils, slopes, distance to surface and groundwater, and system use and maintenance. Much of the soils in the watershed have severe to very severe septic usage limitations. The NYSDEC Priority Waterbodies List (PWL) lists septic systems as a source of pollutants in segments of Cayuga Lake, Fall Creek, Lake Como, Cayuga Inlet, and Six Mile Creek.

Groundwater and surface water contamination from road salt application and storage occurs when the salt dissolves in precipitation and either infiltrates though topsoil into the water table or runs off into surface water. This can effect water quality including elevation of chloride levels. Important storage considerations include type of material, and type of storage. Most of the material used in the watershed is sand and salt. However, some municipalities use other materials such as cinders, IceBan, and calcium chloride. In the Cayuga Lake Watershed approximately 58% of deicing material is stored in enclosed facilities. Sixty-two percent of deicing material is stored on concrete, asphalt, shale or pavement. The rest is stored on the ground.

Important spreading considerations include ingredient ratio, amount per road mile, total amount per season, and total road miles. The average total amount of deicing material spread in the Cayuga Lake Watershed exceeds 30,000 tons per year (G/FLRPC).

Municipal waste landfills and dumps represent significant sources of metals, nutrients, pesticides, pathogens, and synthetic organic compounds. Based on NYSORPS data, municipal waste sites are fairly evenly dispersed throughout the watershed. Many of these sites were not properly sited or constructed. Their density is somewhat greater in the southern portion of the watershed, some of which are adjacent to the lake while others are close to tributaries.

*Agricultural Sources*

For the purposes of the Preliminary Watershed Characterization, agricultural sources were broken into two categories: plant agriculture and livestock. Plant agriculture was then further broken into the categories of field and truck crops, nursery and greenhouses, orchard, and vineyard. The livestock category includes cattle, calves, hogs; dairy products; poultry and poultry products; other livestock including donkeys and goats; aquatic farms; horse farms; sheep and wool; and fish, game and wildlife preserves.

Agriculture accounts for about 50% of the land use in the watershed when considering all categories including agricultural vacant land. Livestock farming accounts for over 20% of the land in the watershed. Plant agriculture accounts for over 15% of the land in the watershed. The vast majority of the livestock category is in dairy operations with a high density of these operations on the eastern side of the watershed. The primary plant agricultural category is in crop operations, much of which is for livestock feed. These operations are most dense in the eastern portion of the watershed as well (NYSORPS).

The primary agricultural nonpoint source pollutants are nutrients, sediment, animal wastes, salts, and pesticides. Agricultural activities also have the potential to directly impact the habitat of aquatic species through physical disturbances caused by livestock or equipment, or through the management of water. The PWL, which frequently has no quantitative backing particularly with regard to nutrient loading and pesticides, indicates nutrient loading from agriculture in the following tributaries to the lake: Yawger Creek, Big Salmon Creek, Little Salmon Creek, Dryden Lake, Lake Como, Fall Creek, Cascadilla Creek and Six Mile Creek. The PWL lists sediment as a type of pollutant in portions of the following tributaries to Cayuga Lake: Yawger Creek, Bolter Creek, Big Salmon Creek, Little Salmon Creek, Fall Creek, Lake Como, Cascadilla Creek, Cayuga Inlet, and Six Mile Creek. The PWL lists pesticides as a type of pollutant in Six Mile Creek and Cayuga Lake.

*Tourism and recreation*

The Cayuga Lake Watershed has numerous opportunities for residents and tourists to enjoy the amenities of the lake and the surrounding area. The natural resources of the area allow for water-based recreation including fishing, boating, and swimming. Cruises and charter boats also operate seasonally offering access to the water and activities for tourists. Marinas and boat launches are located along the lake with the largest concentration found at the southern end of the lake near Ithaca. The agricultural tradition of the watershed, that continues today, serves as the foundation for a number of "agri-tourism" businesses, most notably wineries. In addition, a rich cultural heritage is also present through museums and historic sites.

There are numerous federal, state and local parks, forests, sanctuaries, refuges, and wildlife management areas in the watershed providing areas for camping, hiking, picnicking, passive use. The northern part of the Cayuga Lake Watershed includes a small portion of the Montezuma National Wildlife Refuge. The City of Ithaca, at the southern end of the lake, complements the watershed's predominantly rural character. In addition to activities reserved for the warmer summer months, cross country skiing trails and local parks' winter programs offer tourists and residents year-round recreation opportunities.

## VI. REGULATORY/ PROGRAMMATIC ENVIRONMENT

*Federal*

The Clean Water Act (CWA) was passed in 1972 and signaled the creation of centralized federal legislation to protect and restore the biological, chemical, and physical properties of the nation's water. This protection was to be achieved though legislation requiring a permit for the discharge of pollutants, the encouragement of best management practices to control pollution, and funding for the construction of sewage and wastewater treatment plants and facilities. The act was amended five years later and placed more stringent controls on the discharge of toxic materials and allowed states to assume responsibility over federal clean water programs. The primary focus of the CWA and the 1977 amendments was the prevention of pollution discharges from point sources. In 1987 the act was again amended, this time to focus on nonpoint sources of pollution.

Phase I of the USEPA's storm water program was promulgated in 1990 under the CWA. Phase I relies on National Pollution Discharge Elimination System (NPDES) permit coverage to address storm water runoff from: (1) "medium" and "large" municipal separate storm water systems (MS4s) generally serving populations of 100,000 or greater, (2) construction activity disturbing 5 acres of land or greater, and (3) ten categories of industrial activity. In NYS NPDES permitting is under the purview of the NYSDEC, which issues a State Pollution Discharge Elimination System (SPDES) permit.

The Storm Water Phase II Final Rule was published on December 8, 1999. The permitting authority of the Storm Water Phase II Rule will be phased in over a 5-year period. The Phase II program expands the Phase I program by requiring additional operators of MS4s in urbanized areas and operators of small construction sites, through the use of NPDES permits, to implement programs and practices to control polluted storm water runoff.

Phase II is intended to further reduce adverse impacts to water quality and aquatic habitat by instituting the use of controls on the unregulated sources of storm water discharges that have the greatest likelihood of causing continued environmental degradation. The environmental problems associated with discharges from MS4s in urbanized areas and discharges resulting from construction activity.

Section 404 of the CWA establishes a program to regulate the discharge of dredged and fill material into waters of the United States, including wetlands. EPA and the Army Corps of Engineers (Corps) jointly administer the program. In addition, the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, and State resource agencies have important advisory roles. Activities in waters of the United States that are regulated under this program include fills for development, water resource projects (such as dams and levees), infrastructure development (such as highways and airports), and conversion of wetlands to uplands for farming and forestry.
The basic premise of the program is that no discharge of dredged or fill material can he permitted if a practicable alternative exists that is less damaging to the aquatic environment or if the nation's waters would be significantly degraded. In other words, when you apply for a permit, you must show that you have a) taken steps to avoid wetland impacts where practicable; b) minimized potential impacts to wetlands; and c) provided compensation for any remaining, unavoidable impacts through activities to restore or create wetlands.

The Safe Drinking Water Act (SWDA) was passed in 1974 to protect drinking water supplies from harmful contaminants. The legislation attempts to provide safe drinking water through primary drinking water regulations, underground injection control regulations, and protection of sole source aquifers. In 1986 the act was revised to speed up implementation and included additional provisions for regulating contaminants, filtration systems, distribution systems, and wellhead protection systems. The SWDA establishes both health-related (primary) and nuisance-related (secondary) standards for public drinking water. Under the original legislation, the EPA set primary standards for 25 contaminants. The 1986 amendments required the EPA to include an additional 48 contaminants, raising the total number of chemicals regulated in drinking water to 83. In August 1996, the act was amended to include a program that requires states to monitor and evaluate the quality of sources of drinking water supplies through a state-driven Source Water Assessment Program (SWAP). In addition, more stringent standards for drinking water and reporting of contaminant levels by water providers to their customers were also included.

In 1997, twenty-five years after the passage of the CWA, the Clean Water Action Plan (CWAP) was launched. The CWAP provides funding for programs developed by the EPA and USDA in conjunction with other federal agencies and state and local governments focusing on restoring and sustaining the quality and health of water resources.

The Environmental Quality Incentives Program (EQIP) is a USDA-NRCS initiative authorized by the 1996 Farm Bill that provides farmers with technical, financial, and educational assistance to address soil, water, and natural resource concerns in an environmentally beneficial and cost-effective manner. A conservation plan is required to receive EQIP funding. EQIP addresses natural resource concerns through the implementation of structural, vegetative, and land use practices such as manure management facilities, abandoned well capping, tree planting, filter strips, nutrient, pest, and grazing management, and wildlife habitat protection and enhancement. Agricultural producers enter into five-to-ten year contracts with federal funding limited to $10,000 per year with a maximum of $50,000 for the total contract.

At this time, Cayuga County is the only county in the watershed to receive EQIP funding. The three-year program is being overseen by the Cayuga County SWCD and exceeds $800,000 in funding for individual contracts with 62 farms in the watershed. The emphasis of the program is on developing and implementing Best Management Practices (BMPs) that reduce nutrient loading and sediment erosion. The Tompkins County SWCD is seeking EQIP funding for farms in the Fall Creek subwatershed. Other county SWCDs in the watershed have applied for EQIP funding every year, but have yet to receive any moneys.

The Agricultural Environmental Management (AEM) program assists farmers in identifying environmental issues on their farms and implementing measures to maintain their economic viability while simultaneously protecting natural resources. AEM involves a five-tier process of one-on-one consultation between farmers, members of agricultural agencies, and representatives of agri-business at the local level. Agricultural agencies involved in AEM include SWCDs, NRCS, Cornell Cooperative Extension, and the Farm Service Agency. Farmers voluntarily enter into these partnerships and remain the primary decision-maker throughout the AEM process.

In addition, the AEM program also addresses Animal Feeding Operations (AFOs). AFOs are agricultural operations where animals are raised and maintained in confined areas for 45 days or more in any 12-month period and where crops, vegetation, or other forage growths are not sustained over any portion of the lot or facility in a normal growing season. AFOs contribute to pollution through the carrying of nitrogen, phosphorus, pathogens, sediment, hormones, antibiotics, ammonia, and other harmful substances to water bodies.

AFOs are considered Concentrated Animal Feeding Operations (CAFOs) if they meet the standards of AFOs and there are more than 1,000 animal units at the facility or there are 301-1000 animal units and the facility directly discharges into a waterbody or through the confinement area via a manufactured conveyance. CAFOs are point sources of pollution under the National Pollution Discharge Elimination System (NPDES) and are regulated under Section 301 of the CWA.

The Cayuga County SWCD has received over $500,000 in funds through the Bond Act to work on animal waste management. In addition, the SWCD has received an EPA grant to demonstrate the use of drag hose applications in animal waste management. Several farms in the Cayuga Lake Watershed are currently receiving technical and financial assistance through this grant. Windmills have been installed on two animal waste pits to reduce the odor produced by these facilities. Currently, six rotational grazing programs have been developed, with four now implemented, for livestock operations in the watershed. Stream control plans have been developed for six sites in the watershed and will be implemented over the next year.

The Cortland County SWCD has applied for an implementation grant to institute BMPs on three farms in the Virgil Creek subwatershed after completing plans. Nutrient management programs are produced in combination with other programs as needed, most notably as part of the AEM BMPs. A nutrient management program has been developed and implemented for at least one farm in the Cortland County portion of the watershed.

According to the Seneca County SWCD, no requests for AEM plans have been requested from farms in the eastern portion of the county within the watershed. Private consultants currently design nutrient management programs for Seneca County farms. Many of these nutrient management programs began being developed and undertaken before CAFO/AFO regulations were mandatory. At this time, the Seneca County SWCD has received no requests for nutrient management program assistance.

Funding from the NYS Agricultural Non-Point Source Abatement and Control Grant Program is currently being sought to assist in the production of AEM plans for farms in the Taughannock Creek subwatershed at the southeastern end of the Town of Hector in Schuyler County. Three farms in Hector have received agricultural waste management plans that address manure storage design, silage leaks, barnyard pad runoff, and dairy operations in an attempt to reduce environmental risks as part of AEM plans. Nutrient management programs are done by private consultants throughout the county and if requested are produced for farms within the watershed.

Through AEM, the Tompkins, Cayuga, and Cortland SWCDs have completed surveys and worksheets for farms in the Fall Creek subwatershed. The Tompkins County SWCD has also completed surveys and worksheets for the Sixmile Creek and Salmon Creek subwatersheds. At present there are no major water quality problems and the current thrust is to assist farms in implementing BMPs to meet CAFO/AFO requirements. According to the Tompkins County SWCD, which administered the enabling grant, many of the farms have or are currently implementing portions of their Agricultural Waste Management Plans to meet compliance standards for CAFO/AFO regulations. Within the Fall Creek subwatershed over 120 farms covering approximately 43,000 acres were surveyed. Existing nutrient management programs are incorporated in the AEM plans. However, a comprehensive nutrient management program planning grant is currently being sought for the Tompkins County portion of the Cayuga Lake Watershed.

*State*

The NYDOS, Division of Coastal Resources provides financial and technical assistance and promotes initiatives at the local, regional, and state level to protect and enhance the coastal ecosystems and economies of New York State.

The NYSDEC attempts to enhance water quality through a number of activities including technical assistance for prevention, education, and monitoring and financial assistance for demonstration programs, improvement of existing facilities, and the construction of new ones. The NYSDEC provides technical assistance and funding through watershed management, dissemination of resources on best management practices, water quality monitoring, and assessing waterbodies throughout the state.

As part of the CWAP, the NYSDEC has developed the New York State Unified Watershed Assessment Program. Each of the watersheds within the state has been classified into one of four categories based on groundwater and surface water quality and impairments. The watersheds are then ranked according to the level of impairments and targeted for improvement based on these rankings. The Seneca-Oswego Basin is in Category I which includes watersheds in need of restoration (do not now meet, or face imminent threat of not meeting clean water and other natural resource goals).

NYSDEC requires that every point source discharger obtain a permit in order to legally discharge sanitary, industrial, or commercial wastewater. The permit is a comprehensive legal document, and all of its provisions and conditions are enforceable under the law. Under SPDES, NYSDEC reviews permit applications to develop the limits for types and quantities of pollutants in the effluent. The permit also includes the schedules and conditions under which discharges are allowed. Owners or operators of facilities must treat wastewater in order to meet the limits listed in their SPDES permit. In the case of municipal facilities, permits also require industries discharging into the municipal collection system to pre-treat their wastes. Compliance and self-monitoring reports are a major part of this program. Permits are reviewed and reissued every five years.

The State Environmental Quality Review Act (SEQRA) is a preventive measure that requires the completion of an Environmental Impact Assessment (EIA) and Environmental Impact Statement (EIS) for proposed state and local development. SEQRA requires investigation into alternative actions and the mitigation of harmful effects of the proposed development. Potential nonpoint source pollution can be remediated through revised design or other measures.

The NYSDOH monitors the impacts of NPS as it relates to the health of the citizens of New York through water quality monitoring and reporting programs. The New York Public Health Law includes statutes regulating the protection of public water supplies from contaminants due to source and nonpoint source pollution. The commissioner of the NYSDOH and commissioners of County DOH's determine violations and subsequent penalties.

As mentioned above, the 1996 amendments to the SWDA require states to evaluate the quality of sources of public drinking water. Beginning in 1998 and continuing through 2001, the NYSDOH will administer the SWAP to aid local and state efforts to develop and implement strategies to protect drinking water supplies from both point and nonpoint source pollutants. Under the enabling legislation and the SWAP, the NYSDOH is responsible for overseeing public water supply supervision and wellhead protection among other programs.

*County*

Each county in the watershed has an active water quality coordinating committee (WQCC) or, in Tompkins County, Water Resources Council (WRC). The purpose of these organizations is to integrate the diverse point/nonpoint source water quality pollution control and abatement programs of various county, regional, state, and federal agencies and organizations into a coordinated, comprehensive, and effective inter-agency approach at the county level.

WQCCs and WRCs provide a forum for involvement in water resources planning and management, and more efficient use of the limited resources available.

As stated earlier, each county has a SWCD responsible for implementing the NYS Agricultural Nonpoint Source Abatement and Control Program. The New York Soil and Water Conservation Law administered by the S&WCC requires owners of agriculture, livestock, or timber producing lands to apply to their respective county's SWCD for a soil and water conservation plan. The SWCD is obligated to produce such a plan upon request by the owner of the land, but there is no penalty for not implementing the plan upon its completion. The Agricultural Nonpoint Source Abatement and Control Program is often included as part of the agricultural environmental management program that produces such plans.

Other countywide ordinances, laws, plans, and programs that address NPS are also in place within the watershed. The *Cayuga County Sanitary Code* requires periodic inspection of all septic systems within the watershed. Septic system failure is a major health concern and results in human contact with possibly infectious organisms. In Seneca County a countywide drainage plan assists in the management of NPS through standards set to protect and enhance water. Through the 1994 *Watershed Protection Law of Schuyler County*, NPS management is attained through regulation and enforcement of sewage disposal and wastewater treatment systems throughout the county. Provisions are stipulated for the discharge and disposal of sewage and the design, construction, and certification of wastewater treatment facilities.

All five of the six counties in the watershed have planning boards or commissions responsible for conducting reviews and issuing approval for proposed development. The Tompkins County Planning Department, under provisions of their Charter, is responsible for reviewing development proposals. Although they do not have a planning board or commission at the county level, they do have a Planning Advisory Board that assumes the functions of a planning board. Cayuga, Cortland, Schuyler, and Tompkins Counties each have an environmental management council while Tioga County has a conservation board. These groups monitor and advise on issues related to development and sustaining/improving the environmental character of their respective counties. None of the counties in the watershed currently have sediment and erosion control laws or vegetation retention laws.

Countywide comprehensive plans are in place in Cortland, Schuyler, Tompkins, and Tioga Counties and Cayuga County currently has a land use plan. Seneca County has prepared a comprehensive plan, but at this time it is yet to be adopted. In addition to its comprehensive plan, Tioga County has a future land use plan and an agriculture and farmland protection plan. The *Tioga County Agriculture and Farmland Protection Plan* focuses on retaining and building upon the economic benefits of agriculture in the county through more viable farming practices. Tompkins County has an approved Farmland Protection Plan. Table 5.2 presents the county regulations and controls in the watershed that have an effect on the reduction of NPS in the watershed.

*Municipal*

Most of the programs, ordinances, and regulations directly related to NPS are administered, prepared, monitored, and enforced at the federal, state, and county levels. These programs involve a great deal of participation at the local level by municipal boards and elected officials, citizens, and businesses. While not always directly related to NPS, land use regulations and controls at the municipal level play an important part in controlling and reducing NPS.

Some municipalities do have committees and boards that include the reduction of NPS as part of their focus. The Town of Caroline in Tompkins County is the only municipality in the watershed with a committee that assesses and provides guidance on actions developed for watershed protection in the town. Conservation boards have been assembled and operate in the Village of Interlaken, Town of Ithaca, and Village of Trumansburg.

Municipal drainage plans are currently in place in the Village of Interlaken and Town of Newfield. The Village of Aurora and Town of Genoa each have sediment and erosion control laws. At present, the Village of Lansing has a drainage plan, sediment and erosion control laws, and vegetation retention laws included as part of its comprehensive plan.

Of the 40 municipalities in the Cayuga Lake Watershed that returned the *Municipal Land Use Regulation and Control Survey*, 27 have zoning, 17 have comprehensive plans, 26 have subdivision ordinances, and 23 have adopted other plans or ordinances (G/FLRPC).

*Other*

The Cayuga Lake Watershed Network (CLWN) is a community-based organization made up of citizens, businesses, associations, agencies, and local governments that advocates for a healthy and sustainable Cayuga Lake watershed. Anyone who lives, works, or plays in the watershed is invited to participate. The CLWN seeks to promote understanding of how to maintain and improve the ecological health, economic vitality, and overall beauty of the watershed environment. The CLWN provides education by encouraging individual stewardship throughout the watershed by raising awareness of watershed concerns, communication by providing an interactive, responsive forum that strives for the discovery and exchange of information, and leadership by acting as a proactive advocate for an economically sustainable and ecologically balanced watershed. Additionally, the Fall Creek Watershed Committee is made up of concerned citizens within that subwatershed.

## VII. FINDING OF DESIRED STATE (Public Participation Efforts)

Over the past three years there have been several planned opportunities for the public to voice their interests and concerns on issues affecting the Cayuga Lake Watershed. These events include the following:

- 1997 Finger Lakes-Lake Ontario Watershed Protection Alliance Conference
- Neighbors Around the Lake Watershed Mini-Conference I
- Cayuga Lake Watershed Network Stakeholder Survey
- Neighbors Around the Lake Watershed Mini-Conference II
- Intermunicipal Organization Water Quality Issues Identification

Although the composition of all the public input sessions were different, all included individuals who live, work, study, or recreate in the watershed. There are noticeable similarities in the issues, concerns, interests and visions that people have for the watershed including the following:

- Use of the land
- Quality of the water for uses such as drinking, fisheries, habitat, swimming, and recreation
- Economic and tourism sustainability
- Education
- Wastewater management
- Multiple uses of the lake
- Lake access
- Development pressure
- Stormwater runoff and erosion and sediment control
- Loading of nutrients, bacteria, chemicals, and metals
- Weed control
- Exotic species
- Water level

## VIII. NEXT STEPS

The Preliminary Watershed Characterization is part of the Cayuga Lake Watershed Management Plan process. The Characterization will act as the basis for both the existing state of the Cayuga Lake Watershed and potential implementation of the Findings. Additional locally driven work will commence toward the development of a consensus driven desired state of the Cayuga Lake Watershed along with a consensus driven Watershed Management Plan as a guide for implementation to get from the existing state to desired state.

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**Glossary of Acronyms**

**ACP**--- Agricultural Conservation Program
**ASCS**---Agricultural Stabilization and Conservation Service
**BOD**--- Biochemical Oxygen Demand
**BLM**--- Bureau of Land Management
**BMP---** Best Management Practice
**CBS---** Chemical Bulk Storage
**CCE**--- Cornell Cooperative Extension
**CERCLA**---Comprehensive Environmental Response, Compensation and Liability Act
**CLWN---**Cayuga Lake Watershed Network
**CNYRPDB**---Central New York Regional Planning & Development Board
**CPA**--- Conservation Priority Area
**CREP**---Conservation Reserve Enrollment Program
**CRP**--- Conservation Reserve Program
**CSGWPP**---Comprehensive State Ground Water Protection Program
**CSO---** Combined Sewage Overflow
**CWS**--- Community Water System
**CWA**--- Clean Water Act
**CWSRF**---Clean Water Act State Revolving Fund
**CZARA**---Coastal Zone Act Reauthorization Amendments
**DBP**--- Disinfection By-Products
**DOD**--- Department of Defense
**DOE**--- Department of Energy
**DOI**--- Department of Interior
**DOT**--- Department of Transportation
**DWSRF**---Drinking Water State Revolving Fund
**EPA**--- Environmental Protection Agency
**EPCRA**---Emergency Planning and Community Right-To-Know Act
**EIS**--- Environmental Impact Statement
**FIFRA**---Federal Insecticide, Fungicide and Rodenticide Act
**FOLA**---Federation of Lake Associations
**FSA**--- Farm Service Agency
**GIS**--- Geographic Information System
**G/FLRPC---**Genesee/Finger Lakes Regional Planning Council
**GWDR**---Ground Water Disinfection Rule
**IO---** Intermunicipal Organization
**IUP**--- Intended Use Plan
**IWI**--- Index of Watershed Indicators
**MCL**--- Maximum Contaminant Level
**MCLG**---Maximum Contaminant Level Goal
**MOSF---**Major Oil Storage Facility
**NCWS**---Non-Community Water System
**NEP**--- National Estuary Program
**NEPA**---National Environmental Policy Act
**NOAA**---National Oceanic and Atmospheric Administration
**NPDES**---National Pollutant Discharge Elimination System
**NPS**--- Nonpoint Source
**NRCS**---Natural Resource Conservation Service
**NYSDEC---**New York State Department of Environmental Conservation
**NYSDOS---**New York State Department of State
**NYSDOH---**New York State Department of Health
**NYSORPS**---New York State Office of Real Property Services
**OPRHP---**Office of Parks, Recreation, and Historical Preservation
**OSM**--- Office of Surface Mining
**PBS**--- Petroleum Bulk Storage

**PWL**---Priority Waterbodies List
**PWS**--- Public Water System
**RCRA**---Resource Conservation and Recovery Act
**RMP**--- Resource Management Plan
**SCS---** Soil Conservation Service
**SDWA**--Safe Drinking Water Act
**SDWIS**---Safe Drinking Water Information System
**SEQR---**State Environmental Quality Review Act
**SMP**--- State Management Plan
**SPDES---**State Pollution Discharge Elimination System
**SSA**--- Sole Source Aquifer
**STORET**---STOrage and RETrieval U.S. Waterways data system
**STP---** Sewage Treatment Plant
**SWAP**---Source Water Assessment Program
**SWCD---**Soil and Water Conservation District
**SWCP**---State Wetlands Conservation Plan
**SWP**--- Source Water Protection
**SWTR**---Surface Water Treatment Rule
**TMDL**---Total Maximum Daily Load
**TOT**--- Time-of-Travel
**TRI**--- Toxic Release Inventory
**UIC**--- Underground Injection Control
**USDA**---United States Department of Agriculture
**USEPA---**United States Environmental Protection Agency
**USGS**---United States Geological Survey
**UST**--- Underground Storage Tank
**UWA---** Unified Watershed Assessment
**WHP**--- Wellhead Protection Program
**WHPA**---Wellhead Protection Area
**WQCC---**Water Quality Coordinating Committee

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The Cayuga Lake Watershed Management Plan Project is greatly indebted to the many individuals and organizations who contributed their time, expertise, and resources during the development of this Preliminary Watershed Characterization. Their tireless efforts will greatly benefit future protection of the Cayuga Lake Watershed for year to come. The Cayuga Lake Watershed Management Plan Project would like to thank all of the members of the Intermunicipal Organization, Technical Committee, Agricultural Committee, and the Education & Public Participation Committee for sharing their wide array of experience and technical skills. There is great appreciation for the time and efforts of all of the private citizens as well. The following organizations shared their personnel, data, meeting locations, and many other resources:

Atlantic States Legal Foundation
Cayuga County Cornell Cooperative Extension
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Cayuga County Planning Department
Cayuga County Soil & Water Conservation District
Cayuga County Water Quality Management Agency
Cayuga Lake Watershed Network
Cayuga Lake Watershed Management Plan Intermunicipal Organization
Cayuga Nature Center
Central New York Regional Planning & Development Board
Cornell University Center for the Environment
Cortland County Planning Department
Cortland County Soil & Water Conservation District
Cortland County Water Quality Coordinating Committee
EcoLogic
Empire State Development Corporation
Farm Bureau
Genesee/Finger Lakes Regional Planning Council
Ithaca-Tompkins County Convention and Visitors' Bureau
Montezuma National Wildlife Refuge
Schuyler County Cornell Cooperative Extension, Planning and Community Development Division
Schuyler County Soil & Water Conservation District
Schuyler County Watershed Protection Agency
Seneca County Board of Supervisors
Seneca County Building Enforcement Office
Seneca County Department of Health
Seneca County Planning Department
Seneca County Tourism Promotion Agency
Seneca County Soil & Water Conservation District
Seneca County Water Quality Committee
Southern Tier Central Regional Planning and Development Board
Southern Tier East Regional Planning and Development Board
Tioga County Department of Economic Development and Planning
Tioga County Department of Environmental Health
Tioga County Soil & Water Conservation District
Tompkins County Cornell Cooperative Extension
Tompkins County Municipal Officials' Association
Tompkins County Planning Department
Tompkins County Soil & Water Conservation District
Tompkins County Water Resources Council
Town of Ledyard
New York State Department of Environmental Conservation, Division of Fish, Wildlife & Marine Resources
New York State Department of Environmental Conservation, Division of Water
New York State Department of Environmental Conservation Region 7
New York State Department of Environmental Conservation Region 8
New York State Department of Environmental Conservation, Wildlife Resources Center - New York Natural Heritage Program
New York State Department of Health
New York State Department of State, Division of Coastal Resources
New York State Office of Real Property Services
United States Geological Survey
United States Department of Agriculture – Natural Resource Conservation Service
Wells College

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Art Jacobson, Bureau of Wildlife, NYSDEC – Wildlife Resources Center
Clark Jillson, Cayuga County S&WCD
Betsy Landre, Finger Lakes Association
Michael Medovich, Southern Tier East Regional Planning & Development Board
Jim Skaley, Education, Public Participation & Outreach Committee
Linda Szeliga, USDA-NRCS
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Dan Winch, Tompkins County WRC
Cal Wysokowski, Tompkins County Area Development
Sara Young, Cayuga County Planning Department

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# Chapter 1. Project Background

# 1. Project Background

## 1.1 Purpose of Report

*The Cayuga Lake Preliminary Watershed Characterization Report has two purposes: (1) describe the current understanding of the state of the watershed; and (2) describe the history and status of the watershed management planning process.*

A watershed is drainage basin which includes the land and associated water resources (ground and surface water and wetlands) including streams which drain to larger streams, rivers, or lakes and eventually drains to another waterbody from one downstream location. A watershed management plan is a working document that describes the activities to be undertaken by government, the private sector, and individuals, which will result in the optimum use and enjoyment of the lake and surrounding land, by all members of society both now and in the future. A watershed management plan is also a process that requires several overlapping and interrelated phases that include fact finding, public participation and education. Just as no two watersheds are the same, no two watershed management planning processes are the same. However, what all the processes have in common is a need to understand the existing state of the watershed, a need to involve all of the interests in determining a desired state of the watershed, and a set of agreed upon implementation goals, objectives, and strategies that describe how the watershed will get from the existing state to the desired state.

The Cayuga Lake Watershed Management Plan process began in 1998 with several short-term goals. These goals included the following:

- Develop a Preliminary Watershed Characterization to provide the basis for the understanding of the state of the watershed
- Develop an intermunicipal organization which can bring all municipal governments within the watershed together, to work together
- Foster greater awareness and understanding about the Cayuga Lake Watershed
- Involve the citizens of the watershed in the development of Watershed Characterization and Watershed Management Plan

It is therefore the purpose of this Preliminary Watershed Characterization to both report on the progress of the process and the state of the understanding of the watershed. The process has included watershed information and data collection, synthesis, preliminary analysis, and findings, including the identification of information and data gaps. The process has also included education, public participation and the development of a structure for watershed-wide and intermunicipal cooperation. Within this document these two components can be separated into the technical portion and the description of the process.

The technical portion of this document is embodied in Chapters 2 through 6, which include the following categories:

- General Watershed Description
- Limnology
- Potential Sources of Contamination
- Programmatic and Regulatory Environment
- Subwatershed Description
- Watershed and Subwatershed Technical Findings

The technical portion of this document provides an understanding of the watershed and not necessarily the state of the watershed. It is meant to be a living document that provides a compendium of current data and information related to the Cayuga Lake Watershed that has been synthesized and analyzed to provide findings, guidance and identification of information gaps. Hopefully, as the data and information gaps are filled, a true state of the watershed will emerge.

The description of the process is embodied in Chapters 1, 7, and 8, which include the following categories:

- Project Background
- Public Perceptions in the Watershed
- Watershed Education

- Interim Recommendations

The description of the process gives a state of understanding of the watershed management plan process and the work that has been accomplished toward that end. This is a constantly evolving process that ultimately leads to a watershed management plan.

It is important to point out that within the Preliminary Watershed Characterization, the technical component and description of the process are interrelated. The technical component helps to drive awareness, and both affects and is affected by public perceptions and participation. The technical component begins to establish the existing state of the watershed. The description of the process helps to establish the desired state of the watershed. Together, the science embodied in technical component and the public participation embodied in the description of the process, can develop the goals, objectives and strategies to move from the existing state to the desired state of the watershed.

### 1.2 Project History

The Preliminary Cayuga Lake Watershed Characterization is the first phase of the Cayuga Lake Watershed Management Plan project. The project was initially funded by a grant to the Town of Ledyard from the New York State Environmental Protection Fund through the New York State Department of State Local Waterfront Revitalization Program. Additional funding for the Preliminary Watershed Characterization has been provided by the Empire State Development Corporation. Local and in-kind match has been provided by the Town of Ledyard, Cayuga Nature Center, Cornell Cooperative Extension of Cayuga and Tompkins Counties, Central New York Regional Planning & Development Board, Genesee/Finger Lakes Regional Planning Council, and the members of the Intermunicipal Organization, the Technical Committee, and the Education and Public Participation Committee.

### 1.3 Project Oversight

#### 1.3.1 Intermunicipal Organization

Mission Statement: *To create, modify, and implement a watershed management plan to allow local governments within the watershed to work together for the purposes of accessing dollars, cost savings, cost sharing, and efficiency of activities among municipalities. This plan when completed will prioritize water quality problems and solutions. The Intermunicipal Organization will provide direction for the regional planning boards and other staff, and oversee the entire project.*

Intermunicipal Organization (IO) membership is comprised of watershed municipalities (counties, cities, towns and villages) (see Table 1.2.1.1). Approximately 66% of watershed municipalities have participated in IO activities to date, with 28 of the 50 having signed the cooperative agreement developed by the IO (see Figure 1.3.1.1) (a few of the 50 municipalities are not expected to participate as their land area in the watershed is so small.). Generally the IO meets monthly with a set agenda.

The IO has defined organizational issues such as quorums, voting and committees. Committees that function under the IO include Technical, Membership and Education/Outreach/Public Participation Committees. Additionally, the goal is to form Finance and Agriculture Committees. Non-municipal stakeholders will participate via avenues such as membership on IO committees, the Cayuga Lake Watershed Network, and forums to occur throughout the project.

Table 1.2.1.1

| CAYUGA LAKE WATERSHED INTERMUNICIPAL ORGANIZATION ■ **MEMBERSHIP, PARTICIPATION AND AGREEMENT SIGNATORY STATUS -- ■ 4/26/0** | | | |
|---|---|---|---|
| **MUNICIPALITY** | **DESIGNATED REPRESENTATIVE/ ALTERNATE** | **NON-REP ATTENDEE** | **SIGNED CALL FOR COOP.** |
| **Cayuga County** | | Sara Young | |
| Aurelius (T) | Edward Ide | | Yes |
| Aurora (V) | Ken Zabriskie | | Yes |
| Cayuga (V) | Ronald Erickson | | Yes |
| Fleming (T) | Jim Young | | Yes |
| Genoa (T) | Don Franklin/Don Potter | | Yes |
| Ledyard (T) | Dave Morehouse/Sylvia Hurlbut | | Yes |
| Locke (T)* | Not participating at this time. | | |
| Scipio (T) | Chuck Howell | | Yes |
| Sempronius (T) | | | |
| Springport (T) | Robert Bower | | Yes |
| Summer Hill (T) | Deborah Davenport | | Yes |
| Union Springs (V) | Eli Shockey | John Dellonte | Yes |
| Venice (T) | Jack Rejman | | Yes |
| **Cortland County** | Sandra Price | | Yes |
| Cortlandville (T) | | | |
| Harford (T) | | Ed Drake | |
| Homer (T) | Not participating at this time. | | |
| Scott (T)* | Not participating at this time. | | |
| Virgil (T) | Ed Eaton | | Yes |
| **Schuyler County** | | | |
| Catharine (T)* | | | |
| Hector (T) | | | |
| **Seneca County** | Thomas Fox | | |
| Covert (T) | John Sipos | | Yes |
| Fayette (T) | Patrick Morrell | | Yes |
| Interlaken (V) | Barbara Stewart/Doug Burlew | | Yes |
| Lodi (T) | Not participating at this time. | | |
| Ovid (T) | | | |
| Romulus (T) | Raymond Zajac | | Yes |
| Seneca Falls (T) | Jeffrey Warrick | | Yes |
| Varick (T) | John Sipos | | Yes |
| **Tioga County*** | Not participating at this time. | | |
| Spencer (T)* | Not participating at this time. | | |
| **Tompkins County** | Dan Winch/Sharon Anderson/Kate Hackett | | Yes |
| Caroline (T) | | Fern DeLise | |
| Cayuga Heights (V) | Dave Allee/Dooley Kiefer | Ron Anderson | Yes |
| Danby (T) | | | |
| Dryden (T) | Deb Grantham | | Yes |
| Dryden (V) | | | |
| Enfield (T) | | | |
| Freeville (V) | Bruce Johnson | | Yes |
| Groton (T) | Teresa Robinson/Lyle Raymond | | Yes |
| Ithaca (C) | Larry Fabbroni | Gary Gleason, Jeff Soule | Yes |
| Ithaca (T) | Carolyn Grigorov | | Yes |
| Lansing (T) | Stephen Farkas/Katrina Greeley/Jerry Codner | | Yes |
| Lansing (V) | Lynn Leopold | | Yes |
| Newfield (T) | | | |
| Trumansburg (V) | | | |
| Ulysses (T) | Krys Cail/George Kennedy | | Yes |

* Municipalities with less than 3 sq. mi. in watershed

**Figure 1.3.1.1**

**CALL FOR COOPERATION**
**and**
**RESOLUTION TO ENDORSE A WATERSHED STUDY**
**FOR CAYUGA LAKE**

**WHEREAS**, the Intermunicipal Organization is being formed to create, modify and implement a watershed management plan to allow counties, towns, villages, and cities in the watershed to work together for the purpose of accessing dollars, cost savings, cost sharing and efficiency of activities among the municipalities, prioritize water quality issues, and

**WHEREAS**, the Intermunicipal Organization is made up of municipalities within the watershed to oversee the development of a watershed management plan, and

**WHEREAS**, this Board acknowledges the importance of water quality and natural resources of the Cayuga Lake Watershed, and

**WHEREAS**, the size of the watershed dictates that cooperation between varied user groups will be essential in protecting this natural resource,

**NOW THEREFORE, BE IT RESOLVED** that this Board of the Town/Village/City/County of: will participate in the efforts of the Intermunicipal Organization to: 1) define the structure of the Intermunicipal Organization; 2) promote scientific analysis of the watershed's resources in order to determine the state of the watershed; 3) develop an education and awareness program to educate local residents and stimulate their interest in protecting the watershed; 4) develop coalitions for cooperation and participation in projects relevant to the protection of the watershed; 5) prioritize water issues within the watershed; and 6) participate in solutions to water quality problems, including possible sources of funding.

**THIS IS TO CERTIFY** that the foregoing Resolution was duly adopted on , 1999.

is hereby appointed as the delegate to represent
Intermunicipal Organization

Signature and Title of Presiding Officer:

### 1.3.2 Technical Committee

The Technical Committee was formed by the IO to oversee the technical findings portion of the Watershed Management Plan project. The Technical Committee is comprised of a representative of the following: each County Water Quality Coordinating Committee, New York State Department of State (NYSDOS), New York State Department of Environmental Conservation (NYSDEC) Division of Water, NYSDEC Regional Water Engineers, Montezuma Wildlife Refuge, Cayuga Lake Watershed Network (CLWN), United States Geological Survey (USGS), United State Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), Wells College, Cornell University Center for the Environment, and the Atlantic Legal Services Foundation.

The main functions of the Technical Committee is data and information identification, technical education and public participation review, interim recommendation criteria and project review, and Preliminary Watershed Characterization and Watershed Management Plan development.

### 1.3.3 Education/Public Participation/Outreach Committee

The Education/Public Participation/Outreach Committee was formed by the IO to undertake activities that interface between the IO and the general public. The group consists of members of the IO and the CLWN. To date, the main task of the group has been overseeing the public review process for the draft Preliminary Watershed

Characterization. In addition to a series of three public meetings, which are co-sponsored by the Cayuga Lake Watershed Network and distributed throughout the watershed, comments are being solicited from citizen groups, professionals and municipal officials.

### 1.3.4 Agricultural Committee

The Agricultural Committee was formed by the IO and the Cayuga Lake Watershed Network to have agricultural input into the Watershed Management Plan process. The mission of the committee is as follows: *Since agriculture is recognized as a preferred land use in maintaining and protecting water quality, the mission of the Cayuga Lake Watershed Agricultural Committee will be to enhance agriculture through sound environmental stewardship and provide guidance for an agricultural program within the Cayuga Lake Watershed.*

Representatives of the following organizations developed the structure of the committee: County Soil & Water Conservation Districts, Natural Resource Conservation Service, and Cornell Cooperative Extension. These organizations agreed on a structure of individual county producer representation according to a percent of agricultural land in the watershed on the whole. It was a consensus of the group that the Committee should consist of 11 agricultural producers according to the following membership: Tompkins County (3), Cayuga County (3), Seneca County (2), Cortland County (1), Schuyler County (1), and one seat determined by the other ten committee members as at-large.

## 1.4 Scope and Statement of Goals and Objectives

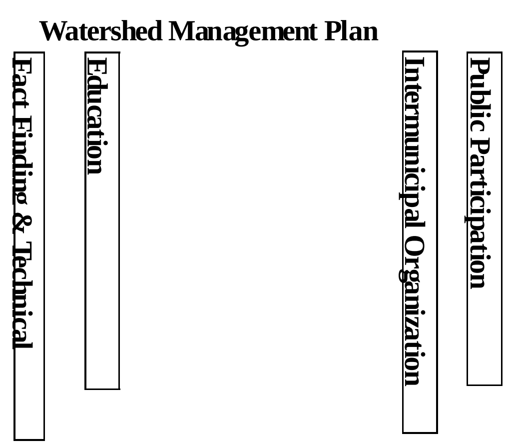
### 1.4.1 Project Scope

The project scope for Phase I (Preliminary Watershed Characterization) of the Cayuga Lake Watershed Management Plan includes the following:

- Develop and Coordinate an Intermunicipal Organization
- Hire Project Administrator
- Provide Forums for Public Participation
- On-going Public Education
- Prepare Contracts
- Undertake Project Scoping
- Prepare Draft Watershed Characterization
- Provide Measurable Results

### 1.4.2 Watershed Management Plan Project Goals and Objectives

The Cayuga Lake Watershed Management Planning Project has four major components: 1) the Intermunicipal Organization; 2) Technical Findings; 3) Education and Outreach; and 4) Public Participation. The goals and objectives of each component are listed below.




*Intermunicipal Organization (IO) Goals:*
To create, modify, and implement a watershed management plan to allow local governments within the watershed to work together for the purposes of accessing dollars, cost savings, cost sharing, and efficiency of activities among municipalities. This plan when completed will prioritize water quality problems and solutions. The Intermunicipal Organization will provide project and watershed direction.

*Intermunicipal Organization (IO) Objectives:*

- Form and maintain support of the IO
- Determine IO membership, committees, quorums, voting and mission
- Establish committees to help advise and work on critical areas of plan development

- Identify water quality issues of concern to the IO
- Conduct project review and oversight
- Provide assistance in the development of recommendations
- Assist with identifying and coordinating water-related programs throughout the watershed
- Facilitate watershed-wide communication
- Facilitate intermunicipal cooperation.

*Technical Findings Goals:*
To develop a Draft Preliminary Cayuga Lake Watershed Characterization report that focuses on the current state of Cayuga Lake, its tributaries and the surrounding land contributing to the water quality of the Lake. The report will include project background, related projects and processes in the watershed, a general description of the watershed, a description of the programmatic and regulatory environment, public perceptions of watershed issues, an analysis of the Lake's limnology and potential sources of contamination, and interim implementation recommendations.

*Technical Findings Objectives:*
- Delineate watershed and subwatershed
- Provide presentations to and input from technical stakeholders
- Form Technical Committee
- Develop geographical information database
- Undertake water quality data acquisition and development
- Select technical consultant
- Inventory potential sources of contamination
- Analyze and synthesize data and information
- Data and information gap identification
- Develop interim list of recommendations

*Education and Outreach Goals:*
To strengthen plan development and implementation by creating awareness and knowledge in the watershed about the watershed itself, about the Cayuga Lake Watershed Management Planning Project and the need for a Plan, as well as by fostering awareness and knowledge about water resource issues and the connection between human activities and water quality.

*Education and Outreach Objectives:*
- Develop, maintain and advertise a Cayuga Lake Watershed Management Plan website
- Develop and distribute printed materials about the project and water resource issues
- Hold workshops and seminars about the project and water resource and land use issues
- Develop and utilize presentations about the planning process and water issues
- Develop and circulate displays and exhibits about the project and water resource issues in the watershed
- Work with residents in the watershed to assess their individual impact and remedial or preventive actions they can take
- Utilize the media as a vehicle for fostering public awareness and involvement
- Maintain and update interested stakeholder mailing list.

*Public Participation Goals:*
To meaningfully involve non-municipal stakeholders and the general public in developing the Cayuga Lake Watershed Management Plan to ensure that it is locally accepted, supported and thereby implemented.
*Public Participation Objectives:*
- Hold public forums in multiple locations around the watershed to:
    - broaden knowledge of the planning project
    - broaden knowledge of the Cayuga Lake Watershed and its water quality
    - identify public perceptions as to water quality issues in the watershed
    - identify the public's vision for the future of the watershed
    - obtain public feedback on findings of the Draft Watershed Characterization
    - obtain public feedback on potential solutions to water quality problems in the watershed

  - obtain public feedback on draft recommendations
  - obtain public feedback on final recommendations
- Distribute plan drafts to interested stakeholders for their review and input
- Survey residents throughout the watershed about issues and solutions.

The process of getting from the existing (Characterization) to the desired state (implementation of the watershed management plan involves the recognition of differences between those states and the involvement of the watershed community. This involvement will allow for consensus on restoration and protection strategies which will be embodied in the watershed management plan (see Figure 1.4.1).

## 1.5 Related Projects and Processes in the Watershed

### 1.5.1 Cayuga Lake Watershed Network

The Cayuga Lake Watershed Network (CLWN) is a community-based organization made up of citizens, businesses, associations, agencies, and local governments that advocates for a healthy and sustainable Cayuga Lake Watershed. Anyone who lives, works, or plays in the watershed is invited to participate. The Network seeks to promote understanding of how to maintain and improve the ecological health, economic vitality, and overall beauty of the watershed environment. The Network provides education by encouraging individual stewardship throughout the watershed by raising awareness of watershed concerns; communication by providing an interactive, responsive forum that strives for the discovery and exchange of information; and leadership by acting as a proactive advocate for an economically sustainable and ecologically balanced watershed.

### 1.5.2 County Water Quality Coordinating Committees

The purpose of County Water Quality Coordinating Committees (WQCC) is to integrate the diverse point/nonpoint source water quality pollution control and abatement programs of various county, regional, state, and federal agencies and organizations into a coordinated, comprehensive, and effective inter-agency approach at the county level. WQCCs provide a forum for involvement in water resources planning and management, and more efficient use of the limited resources available. Table 1.5.2.1 summarizes the mission, function, membership, goals, objectives, and issues of each county's WQCC.

### 1.5.3 Academic Institutions

The academic institutions of high education in the watershed, as well as some outside the watershed, are carrying on research and other programs related to the Cayuga Lake Watershed. The institutions in the watershed include Cornell University, Ithaca College, and Wells College. Cornell University's Center for the Environment coordinates and facilitates watershed research and outreach at the University.

### 1.5.4 State and Federal Programs

New York State programs that relate to the Cayuga Lake Watershed are broadly discussed in Chapter 5. Programmatic Environment as they affect nonpoint source pollution management in the watershed. The state and federal agencies that have programs include the following:
New York State Department of Environmental Conservation
New York State Department of State
New York State Department of Health
New York State Department of Agriculture and Markets
United States Environmental Protection Agency
United States Department of Interior
United States Department of Agriculture
United States Geologic Survey
United States Army Corps of Engineers
United States Fish & Wildlife Service
Natural Resource Conservation Service

**Table 1.5.2.1**
**County Water Quality Coordinating Committtees**

| | Cayuga WQMA | Cortland WQCC | Seneca WQC | Tompkins WRC |
|---|---|---|---|---|
| **Mission** | The mission of the Cayuga County Water Quality Management Agency (WQMA) is to protect and improve the quality of water in Cayuga County. | Protect and improve the quality of water within Cortland County | To foster a coordinated inter-agency and public approach to protect and improve the water quality in Seneca County. | The purpose of the County Water Quality Strategy Plan is to promote education, policies and guidelines to protect and improve the quality of surface and ground water in Tompkins County |
| **Function** | The WQMA was established in November 1990 by the Cayuga County Legislature to provide a correlated approach to water quality management in Cayuga County. The agency's primary functions are to perform comprehensive planning of goals and implementation of strategies for water quality management programs by coalescing the efforts, activities, and responsibilities of member agencies; and to increase public awareness, and participation in water quality and quantity issues. | The CCWQCC was developed to provide for a coordinated a cooperative approach to water quality management in Cortland County. Water quality and nonpoint source pollution encompass a wide range of areas that no one department, agency or organization can adequately address on their own, Agencies from all levels of government and groups from the private sector are concerned with the nonpoint source water quality issue. A need existed for a pooling of resources and effort, closer working relationships, and awareness of the programs and mandates of all working toward the common goal of water quality enhancement. The CCWQCC serves this purpose and will further serve the residents of Cortland County by developing a coordinated county-wide water quality strategy. The CCWQCC will then monitor the implementation of the strategy, evaluate progress, continue to assess water quality conditions, and revise the strategy as needed. | To set overall direction for policy making by local government, and to identify problems that should be addressed and to target assistance. Other functions of the Committee include advisory, information sharing, and team-building. Assistance will be multi-disciplinary with technical expertise being provided to define problems and describe potential solutions. Educational assistance will afford an opportunity for public and private individuals to learn about water quality and quantity issues | The function of the Steering Committee is to act as a facilitator to implement the County Water Quality Strategy Plan by recommending policy changes to the County Board of Representatives and Municipalities as the need arises. It also acts as a coordinator of programs to reduce overlap and maximize the use of limited resources. The Steering Committee prepares a program document with specific goals and objectives and prioritizes tasks as part of its annual report to the Board of Representatives. It is the overall function of the Steering Committee to assure that the annual work plan is funded and implemented. The Steering Committee also invites representatives of various groups to participate in Task Groups. Minutes and information on the activities of the Steering Committee are distributed to all groups and agencies participating in the actions of the Committee as well as to public information sources such as Tompkins County Library and Cooperative Extension. |
| **Membership** | County S&WCD, County Health Department, County Planning Board, CCE, County EMC, City of Auburn, County Association of Towns, County Association of Villages, County Water Association | County S&WCD, County Health Department, County Planning, CCE, County Highway Department, Cortland Water Board, County Economic Development Committee, County EMC, County Farm Bureau, Local Government Representative, County Private Enterprise Representative | County S&WCD, Department of Economic Development & Planning, County Health Department, County CCE, Seneca County Pure Waters Association, Inc., Montezuma Wildlife Refuge, County Chamber of Commerce, County Farm Bureau, Member-at-Large (2) | County Planning Department, County Environmental Health, County S&WCD, CCE, Cornell University Water Resources Institute, Boulton Point Water System, USGS, NRCS, County EMC, County Agricultural and Farmland Protection Board or Agricultural Representative |
| **Membership** (Advisory) | NYS S&W Conservation Committee, NYSDEC Division of Water, ASCS, NRCS | NYS S&W Conservation Committee, NYSDEC, USDA-NRCS, USDA Farm Service Agency, USGS | NRCS – USDA, NYSDEC, NYS S&WC Committee, Farm Service Agency | |
| **Goal(s) & Objectives** | To establish and implement a coordinated water quality program, which identifies and addresses | Establish and implement a coordinated water quality program emphasizing local roles and responsibilities to | Public Education, Promote Sound Agricultural, Practices, County Household Hazardous Waste Collection, | Public Information Program, Water Quality Monitoring and Assessment, Technical Assistance for Implementing Water Quality Strategy Goals, Addressing Watershed Specific and County-Wide Issues, Address |

| | | | | |
|---|---|---|---|---|
| | nonpoint source pollution in Cayuga County | identify and address nonpoint source water pollution | Roadbank Stabilization, Coordination of Public Water and Sewer Supplies | Regional Watershed Issues |
| **Issues/ Concerns** | Stormwater Runoff – Agriculture, Stormwater Runoff – Construction/ Diffuse Urban Runoff, Stormwater Runoff – Hydraulic Modification, Illegal/Improper Disposal (including toxic or hazardous substances) | Stormwater Runoff/Infiltration (high) – construction, diffuse urban runoff, agriculture, hydromodification; Illegal/Improper Disposal/Storage (high); On-site Wastewater (high); Storage and Application of Deicing Agents (medium); Natural (medium) | | County-Wide: Lack of public awareness and understanding on water quality and nonpoint pollution, Lack of intermunicipal coordination and cooperation in reviewing projects affecting whole watersheds, Lack of coordination of local legislation and or agencies on project which affect watersheds or use of best management practices for stream corridors, Lack of adequate data on water quality and quantity to allow for adequate coordination and interpretation, Lack of watershed inventory information; County-Wide Problems: Sedimentation in the Lake from land and stream bank erosion, construction, highway maintenance and ditching and agricultural practices in the various watersheds, Surface and groundwater contamination by excess introduction of nutrients, road salts, and chemicals from point and nonpoint pollutant sources (e.g. application practices of road salt by highway departments, fertilization and spreading of manure by agriculture and excessive use of lawn chemicals), Discharge of on-site septage where it may impact ground or surface waters (especially in rapidly urbanizing areas or where soils are limiting), Impact and threats to public water supply and recreation by exotic species and pathogens entering watersheds and various aquatic eco-systems in the county (e.g. zebra mussels, Eurasian watermilfoil, giardia and cryptosporidium), Brownfield threats to groundwater from historic land use conditions or practices (e.g. industrial sites, municipal dumps, buried, abandoned petroleum tanks); Watershed Specific Concerns: Fall Creek (excess sediment, nitrogen, organic phosphorus, barnyards discharge, sewage overflow, storm water management, threats to public water supply), Six Mile Creek (heavy stream bank erosion, flooding, sedimentation, nitrogen and organic phosphorus loading, sewage overflow, stormwater management, threats to public water supply), Cayuga Lake (high levels of turbidity from storm events and algal blooms due to nutrient input, aquatic weed growth, possible threats to public water supply and filtration concerns, and limitations to recreational uses), Dryden Lake (agricultural runoff, excessive aquatic weed growth, threats to recreational uses), Salmon Creek (heavy loading of agricultural nutrients, flooding, stream bank erosion and sedimentation), Cascadilla Creek (heavy sediment loading, septic systems, stormwater management), Cayuga Inlet (streambank erosion, sedimentation and flooding); Groundwater Problems: Probable nitrate contamination<br>Seepage from inactive hazardous waste sites, Hazardous material spills impacting groundwater |

Source: Cayuga WQMA, Cortland County WQCC, Seneca County WQC, Tompkins County WRC

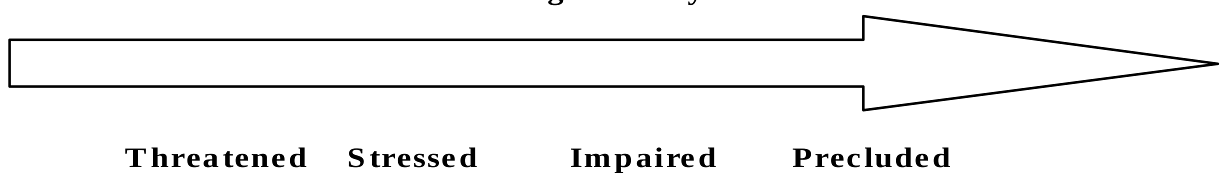
Specific programs of note include the following:

### 1.5.4.1 Priority Waterbodies List

Periodically, the NYSDEC Division of Water publishes a list of surface waters that either cannot be fully used as a resource, or have problems that can damage their environmental integrity. This list – The Priority Waterbodies List (PWL) – is used as a base resource for Division of Water program management. The listing of the PWL includes individual waterbody data sheets describing the conditions, causes, and sources of water quality problems in a given basin. The conditions use a scale of increasing severity ranging from threatened to stresssed to impaired to precluded (see Figure 1.5.4.1.1). Users of the information contained in the PWL are reminded of the following special considerations:

- The PWL is a reflection of priority waterbodies at a specific moment in time.
- In many cases, surface water systems are highly interrelated.
- Resolution potential can be noted as high, medium, or low. High resolution potential indicates that the water quality problem has been deemed to be worthy of the expenditure of available resources (time and dollar) because of the level of public interest and the expectation that the commitment of these resources will result in a measurable improvement in the situation. Medium resolution generally indicates that the resources necessary to address the problem are beyond what is currently available. Segments with low potential for resolution indicate water quality problems so persistent that improvements are expected to require an unrealistically high commitment of resources, not likely to become available (e.g. acid rain lakes).

**Figure 1.5.4.1.1**
**NYSDEC PWL Scale of Increasing Severity**




The latest PWL that includes the Cayuga Lake Watershed is called *The 1996 Priority Waterbodies List for the Oswego-Seneca-Oneida River Basin*. An overview of the Cayuga Lake Watershed portion can be seen on Table 1.5.4.1.1.

### 1.5.4.2 Unified Watershed Assessment and Watershed Restoration and Protection Strategies (NYSDEC, USDA & NRCS)

Unified Watershed Assessments provide a road map of priority areas to be addressed in 1999, 2000 and beyond. Watershed Restoration and Protection Strategies are described in the United States Clean Water Action Plan as response plans to restore those watersheds that do not meet clean water, natural resource, and public health goals and are most in need of restoration.

The Watershed Assessment began with selection of natural resource and water quality factors used to evaluate each 8-digit hydrologic unit code (HUC) watershed. The Cayuga Lake Watershed is part of the Oswego-Seneca-Oneida Rivers HUC. The initial assessment identified factors of concern for each watershed. Based on this information, each 8-digit HUC was categorized. The draft assessments and categorizations were reviewed with partners, stakeholders, and neighboring states.

Considering only the natural resource factors used in the assessment of the 8-digit HUCs, all watersheds were categorized as needing additional restoration (Category 1). Based on water quality factors used, less than half of the 8-digit HUC watersheds were categorized as needing additional restoration (Category 1). A unified watershed assessment for New York State was created by combining the highest priority watersheds from a natural resources perspective with the watershed identified as needing additional restoration based on water quality factors. The

**Table 1.5.4.1.1**
**Priority Waterbodies List**
**Cayuga Lake and Watershed**

| Name | Resolution Potential | Use Impairment(s) | Severity | Documentation | Type of Pollutant(s) | Source(s) of Pollutant(s) | County |
|---|---|---|---|---|---|---|---|
| Big Salmon Creek | Medium | Fishing* | Threatened | Some | Nutrients* | Agriculture* | Cayuga |
| | | Fish Propagation | Threatened | Some | Thermal Changes | Streambank Erosion | |
| | | Fish Survival | Threatened | Some | Silt (Sediment) | Roadbank Erosion | |
| | | Aesthetics | Stressed | Good | Water Level/Flow | | |
| | | Boating | Stressed | Poor | Oxygen Demand | | |
| | | | | | Pathogens | | |
| Cayuga Lake (Cayuga County Portion) | Medium | Water Supply | Stressed | Good | Nutrients* | On-Site Septic* | Cayuga |
| | | Bathing | Stressed | Some | Silt (Sediment)* | Agriculture | |
| | | Fishing | Impaired | Good | | Roadbank Erosion | |
| | | Fish Propagation | Stressed | Good | | Municipal | |
| | | Aesthetics | Impaired | Some | | Urban Runoff | |
| | | Boating* | Impaired | Some | | Acid Rain | |
| | | | | | | Streambank Erosion | |
| Cayuga Lake (Seneca County Portion) | Medium | Water Supply | Stressed | Some | Nutrients* | On-Site Septic* | Seneca |
| | | Bathing | Impaired | Some | Oxygen Demand | Acid Rain | |
| | | Fishing | Impaired | Some | Pesticides | Land Disposal | |
| | | Fish Propagation | Stressed | Good | Silt (Sediment) | Industrial | |
| | | Aesthetics | Impaired | Some | | Agricultural | |
| | | Boating* | Impaired | Some | | Streambank Erosion | |
| | | | | | | Municipal | |
| | | | | | | Urban Runoff | |
| | | | | | | Roadbank Erosion | |
| Cayuga Lake (Tompkins County Portion) | Medium | Water Supply | Threatened | Some | Silt (Sediment)* | Streambank Erosion* | Tompkins |
| | | Bathing | Stressed | Good | Nutrients | Urban Runoff | |
| | | Fish Propagation | Stressed | Some | | Agriculture | |
| | | Aesthetics | Stressed | Some | | Roadbank Erosion | |
| | | | | | | Construction | |
| Little Salmon Creek | Medium | Fishing* | Threatened | Some | Nutrients* | Agriculture* | Cayuga |
| | | Fish Propagation | Threatened | Some | Thermal Changes | Streambank Erosion | |
| | | Fish Survival | Threatened | Some | Silt (Sediment) | Roadbank Erosion | |
| | | Aesthetics | Stressed | Good | Water Level/Flow | | |
| | | | | | Oxygen Demand | | |
| | | | | | Pathogens | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Yawger Creek | High | Fish Propagation* | Impaired | Good | Silt (Sediment)*<br>Nutrients | Agriculture*<br>Streambank Erosion | Cayuga |
| Bolter Brook Trib | Medium | Fish Propagation*<br>Fish Survival | Threatened<br>Threatened | Some<br>Some | Silt (Sediment)*<br>Metals* | Resource Extraction*<br>Land Disposal* | Schuyler<br>Seneca |
| Black Brook | High | Fishing*<br>Aesthetics | Threatened<br>Stressed | Some<br>Some | Unknown Toxicity*<br>Nutrients | Land Disposal*<br>Agriculture<br>On-Site Septic | Seneca |
| White Brook | High | Fishing*<br>Aesthetics | Stressed<br>Stressed | Poor<br>Poor | Nutrients*<br>Oxygen Demand | Agriculture*<br>On-Site Septic | Seneca |
| Cascadilla Creek | Low | Fish Propagation<br>Aesthetics* | Threatened<br>Stressed | Some<br>Poor | Silt (Sediment)*<br>Nutrients | Streambank Erosion*<br>Urban Runoff<br>Agriculture<br>Roadbank Erosion<br>Construction | Tompkins |
| Cayuga Inlet | High | Fish Propagation* | Stressed | Some | Silt (Sediment)*<br>Unknown Toxicity<br>Nutrients | Agriculture*<br>Land Disposal<br>Roadbank Erosion<br>Construction<br>On-Site Septic<br>Urban Runoff<br>Streambank Erosion | Tompkins |
| Fall Creek | High | Water Supply<br>Bathing<br>Fish Propagation*<br>Fish Survival | Threatened<br>Threatened<br>Stressed<br>Stressed | Some<br>Poor<br>Some<br>Some | Silt (Sediment)*<br>Pathogens<br>Nutrients<br>Thermal Changes | Streambank Erosion*<br>On-Site Septic<br>Agriculture<br>Roadbank Erosion<br>Construction | Tompkins |
| Six Mile Creek | High | Water Supply*<br>Fish Propagation | Stressed<br>Stressed | Good<br>Some | Silt (Sediment)*<br>Aesthetics<br>Pesticides<br>Nutrients | Streambank Erosion*<br>Private<br>Storm Sewers<br>Roadbank Erosion<br>Industrial<br>Agriculture<br>On-Site Septic<br>Municipal<br>Urban Runoff<br>Hydromodification | Tompkins |

*Primary Use Impairment/Pollutant/Source
Source: NYSDEC, 1996

Oswego-Seneca-Oneida Rivers Basin is classified as a Category 1 and are scheduled for development of restoration and protection strategies in state fiscal year 2003.

**1.5.4.3 New York State Source Water Assessment Program** (New York State Department of Health 1999b)

Congress amended the Safe Water Drinking Water Act in 1996 and added a new program that requires states to evaluate the sources of water that are used to supply public drinking water. This new program is called the Source Water Assessment Program (SWAP). The New York State Department of Health (DOH) is implementing the program in New York State.

The Safe Drinking Water Act requires that each source of water (e.g. well, stream, lake, reservoir) used by a public water system be evaluated to identify possible contaminant threats to the source water quality. This evaluation is called a Source Water Assessment and the elements that will be completed for each source water assessment include delineation of the source water assessment area, completion of a contaminant inventory, and conducting a susceptibility analysis.

The DOH submitted a workplan as part of the Drinking Water State Revolving Fund's Intended Use Plan to the USEPA in October 1997 for initial work on the SWAP. Most of the SWAP efforts to produce assessments for public release will occur during the years 2000-2001.

**1.5.5 Related Watersheds**

Cayuga Lake is downstream of Keuka and Seneca Lake. Keuka Lake waters flow into Seneca Lake via the Keuka Lake Outlet. Seneca Lake waters flow into the extreme northern end of Cayuga Lake via the Seneca-Cayuga Canal. Therefore, the Keuka and Seneca Lake watersheds are considered part of the Cayuga Lake Watershed. However, because both Keuka and Seneca Lake Watersheds are undergoing a watershed management planning process with associated "state of the lake" reports, the Cayuga Lake Draft Preliminary Watershed Characterization will concentrate on just the watershed upstream of the northern end of Cayuga Lake. For information on the Keuka Lake Watershed Management Plan contact the Yates County Cornell Cooperative Extension at 315-536-5123. For information on the Seneca Lake State of the Lake Report contact the Seneca Lake Pure Waters Association at 315-789-3052.

# Chapter 2. General Description

## 2. General Description of the Watershed

### 2.1 Watershed and Subwatershed

#### 2.1.1 The Oswego River Basin

The Cayuga Lake Watershed is part of the Oswego River Basin. The Owego River Basin in Central New York State is a diverse system made up of many hydrologic components that flow together. Water flows from (1) upland streams down to, (2) the Finger Lakes, then to (3) low-gradient rivers and the New York Barge Canal , and (4) ultimately to Lake Ontario (see Figure 2.1.1.1). Within the Oswego River Basin, Cayuga Lake is downstream of Keuka and Seneca Lake. Keuka Lake waters flow into Seneca Lake via the Keuka Lake Outlet. Seneca Lake waters flow into the extreme northern end of Cayuga Lake via the Seneca-Cayuga Canal.

Figure 2.1.1.1 Location of the Oswego River in Central NY

The Oswego River Basin has an area of 5,100 square miles, and encompasses three physiographic provinces (see Figure 2.1.1.2). These include Appalachian Plateau (the area to the south of 1,000 foot contour); Tug Hill Plateau (the circular area to the northeast, within the 1,000 foot contour); and the Lake Ontario Plain (the area south of Lake Ontario). One additional, "unofficial" geographic area is significant in the flow regime of the Basin. This area is the "Clyde/Seneca River-Oneida Lake Trough", a belt of lowlands running from west to east within the 500-foot elevation contour – Cayuga and Seneca Lakes are also part of this trough due to extensive glacial deepening of these two Finger Lake valleys. The Trough is key to understanding the Oswego River Basin flow system in its natural and human-altered condition.

Figure 2.1.1.2 Generalized Land Surface Elevations in Owasco River Basin

The trough is a product of regional geology and glaciation. During and following the last Ice Age (ending about 14,000 years ago), glaciers carved out erodible shales which lie between the Lockport Dolomite bedrock "ridge" to the north and Onondaga Limestone bedrock "ridge" to the south and subsequently filled the trough with mixtures of clay, silt, sand, and gravel. The result was a very flat, low-lying area with many square miles of wetland, some of which are now farmed as muckland. The New York State Barge Canal was constructed within the trough, due to its exceptionally low gradient. Along the main stem of the canal, between Locks 27 and 24, the Canal surface elevation drops only 23 feet in 60 miles. Prior to the construction of the canal, the elevation change was about 0.4 feet/mile; with the canal, the elevation changes occur as steps at each of the canal locks. The very low gradient prior to and after canal construction poses a water-resources management challenge, because it is very difficult to move large volumes of water through such a low-gradient area.

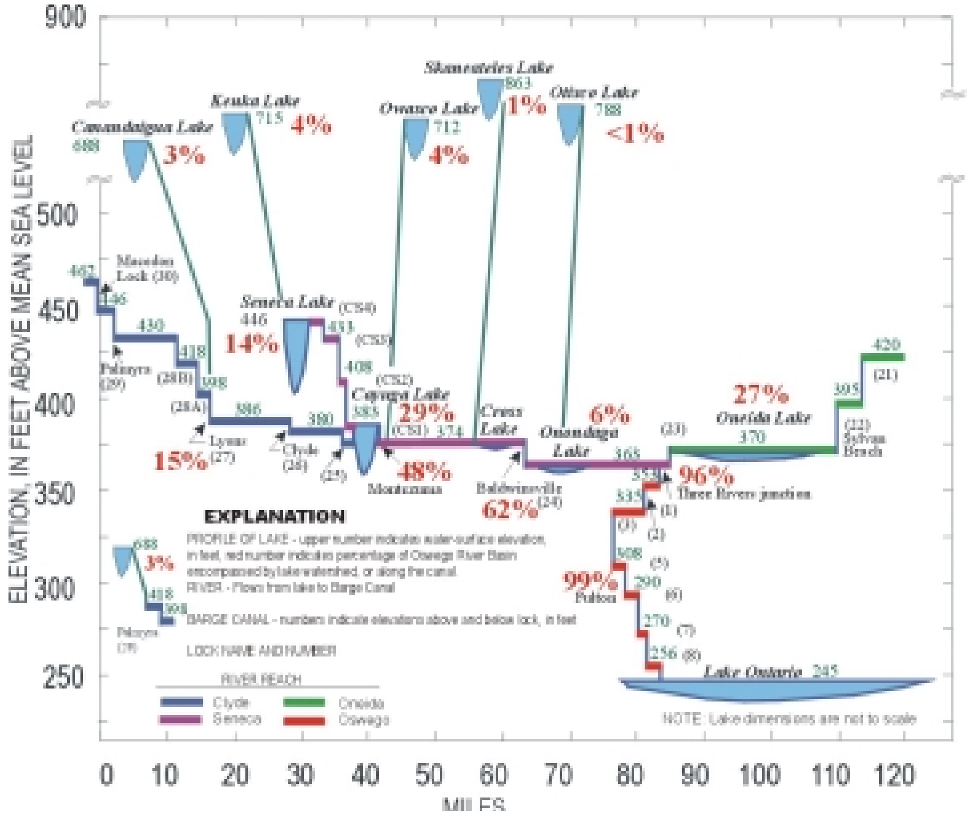


Figure 2.1.1.3. Water-feature elevations, lock location and number, and selected watershed areas.

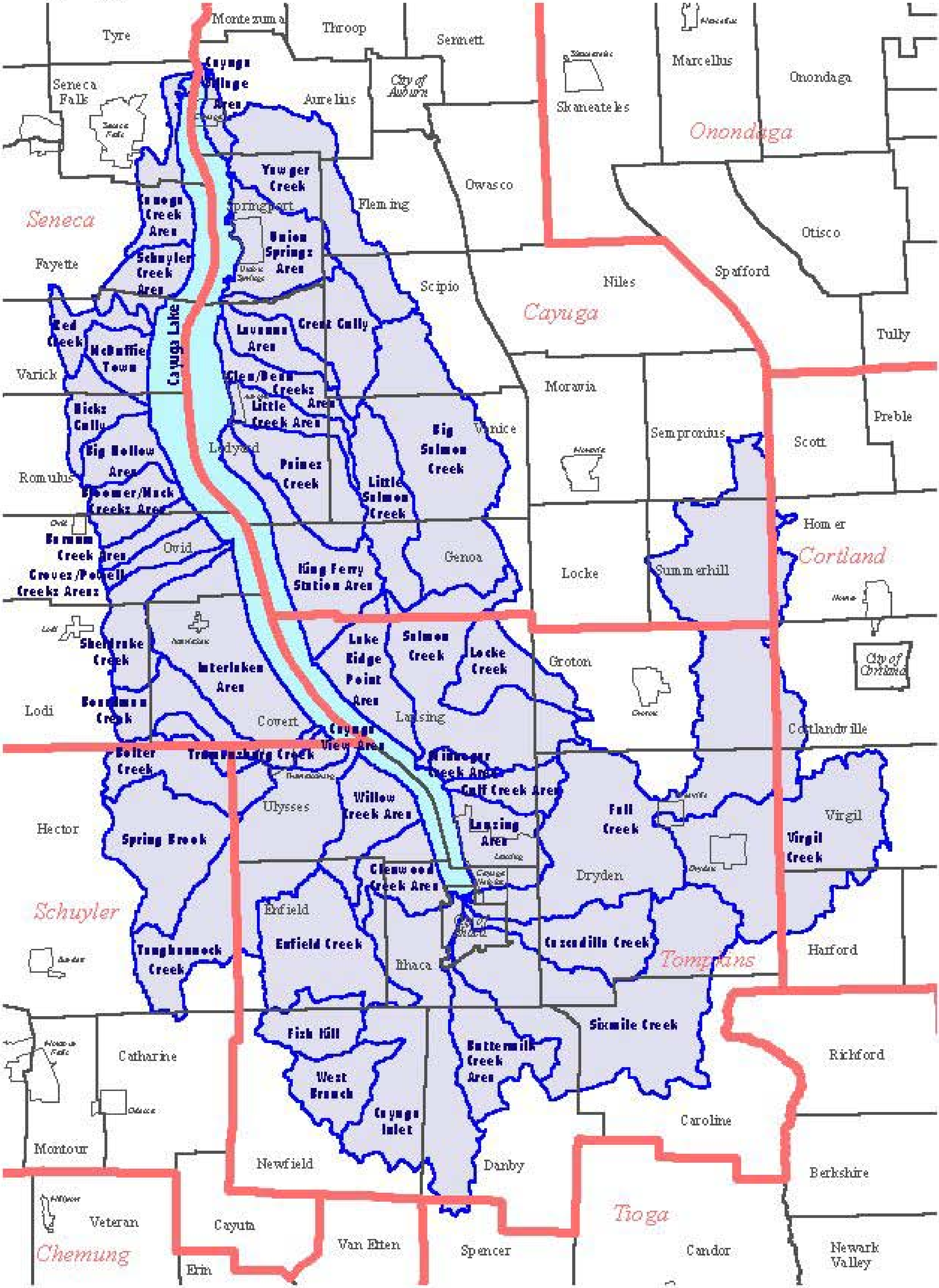
Surface water and groundwater flow from upland watersheds to receiving rivers and lakes and then to the New York State Barge Canal (see figure 2.1.1.3). As an example, the outlet of Keuka Lake is at a relatively high elevation in the western part of the basin (about 700 feet above sea level). Water flows from Keuka to Seneca Lake with a change in elevation of about 270 feet, and from the outlet of Seneca Lake the fall is only 60 feet to the northern end of Cayuga Lake. Water flows from Cayuga Lake to the Barge Canal through a gated-structure at Mudlock where the fall is only 9 feet. During some major storm-runoff periods the Barge Canal elevation near Montezuma, New York (just downstream of the Cayuga Lake outlet) has been higher than the Cayuga Lake elevation, and if the Mudlock gates were open, water would have flowed from the Barge Canal into Cayuga Lake.

Near Montezuma (just downstream of the Cayuga Lake outlet), 48 percent of the Oswego River Basin's 5,100 square miles is represented. Further down the trough, water is added from Owasco, Skaneateles, and Otisco Lake watersheds, which, like the neighboring Finger Lakes, are at higher elevations and drain readily to the trough. In a similar fashion, the uplands around Oneida Lake drain to the eastern end of the trough from the surrounding watershed. The additive contribution of each stream and Finger Lake to the Barge Canal results in a bottleneck at the Three Rivers junction (the confluence of the Seneca, Oneida, and Oswego Rivers). At this junction, fully 96 percent of the Oswego River Basin is represented, paradoxically, this is the flattest, slowest moving stretch within the Oswego Basin. At times, the water discharges to the trough exceed the channel capacity, resulting in flooding within the Seneca and Cayuga Lakes and along the Seneca and Oneida Rivers. Once the water reaches the Oswego River, downstream of Fulton, the gradient increases markedly to 118 feet in 29 miles (4 feet/mile), and water has the potential to move more readily toward Lake Ontario (Kappel, 1999).

### 2.1.2. The Cayuga Lake Watershed

The Cayuga Lake Watershed covers 785 square miles. There are 44 municipalities and six counties that are all or partially in the watershed (see Figure 2.1.2.1). The watershed is home to over 120,000 people. For the purposes of this study the watershed has been divided into 19 major subwatersheds (18 tributary-based subwatersheds and the remainder in direct drainage) (see Map 4.1.1) and then further broken down into 46 minor subwatersheds based on the major tributaries of Cayuga Lake (see Map 2.1.1a and Map 2.1.1b).

# Cayuga Lake Watershed and Subwatersheds



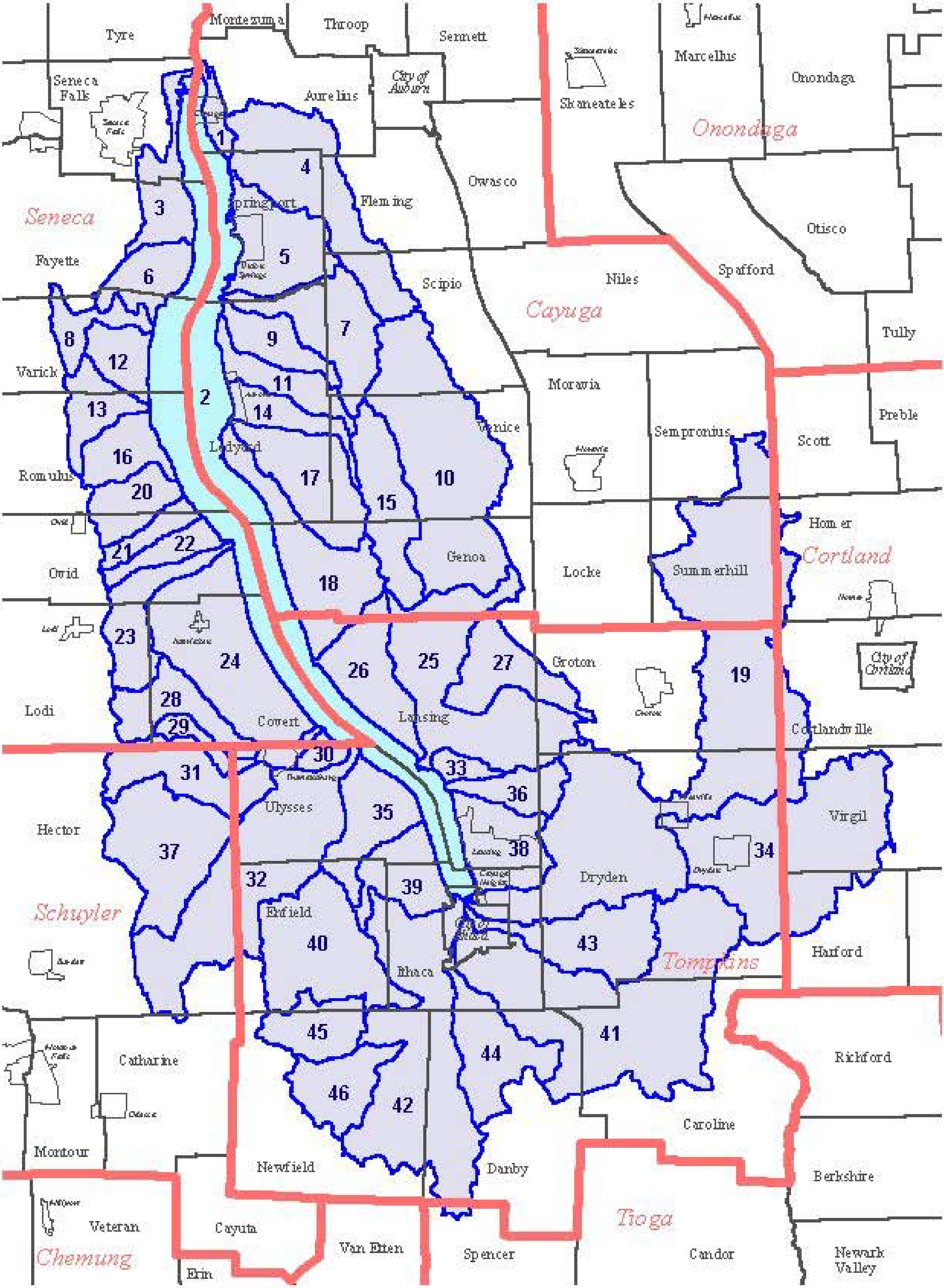

*This map was prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.*

*Source: Genesee/Finger Lakes Regional Planning Council, 1998.*

*Base Map: New York State Department of Transportation, February 1996.*

*Prepared by Genesee/Finger Lakes Regional Planning Council, 1*

# Cayuga Lake Watershed

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0 5 10 Miles

*This map was prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.*

*Source: Genesee/Finger Lakes Regional Planning Council, 1998.*

*Base Map: New York State Department of Transportation, February 1996.*

*Prepared by Genesee/Finger Lakes Regional Planning Council, 199*

# Cayuga Lake Subwatersheds

| | |
|---|---|
| 1 | Cayuga Village Area |
| 2 | Cayuga Lake |
| 3 | Canoga Creek Area |
| 4 | Yawger Creek |
| 5 | Union Springs Area |
| 6 | Schuyler Creek Area |
| 7 | Great Gully |
| 8 | Red Creek |
| 9 | Lavanna Area |
| 10 | Big Salmon Creek |
| 11 | Glen/Dean Creeks Area |
| 12 | McDuffie Town |
| 13 | Hicks Gully |
| 14 | Little Creek Area |
| 15 | Little Salmon |
| 16 | Big Hollow Area |
| 17 | Paines Creek |
| 18 | King Ferry Station Area |
| 19 | Fall Creek |
| 20 | Bloomer/Mack Creeks Area |
| 21 | Barnum Creek Area |
| 22 | Groves/Powell Creeks Areas |
| 23 | Sheldrake Creek |
| 24 | Interlaken Area |
| 25 | Salmon Creek |
| 26 | Lake Ridge Point Area |
| 27 | Locke Creek |
| 28 | Boardman Creek |
| 29 | Trumansburg Creek |
| 30 | Cayuga View Area |
| 31 | Bolter Creek |
| 32 | Taughannock Creek |
| 33 | Minnegar Creek Area |
| 34 | Virgil Creek |
| 35 | Willow Creek Area |
| 36 | Gulf Creek Area |
| 37 | Spring Brook |
| 38 | Lansing Area |
| 39 | Glenwood Creek Area |
| 40 | Enfield Creek |
| 41 | Sixmile Creek |
| 42 | Cayuga Inlet |
| 43 | Cascadilla Creek |
| 44 | Buttermilk Creek Area |
| 45 | Fish Kill |
| 46 | West Branch |

*Prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.*

*Source: Genesee/Finger Lakes Regional Planning Council, 1998.*

*Prepared by Genesee/Finger Lakes Regional Planning Council, 1999.*

The center of Cayuga Lake is located at latitude 42° 41' 30" N and longitude 76° 41' 20" W. Its altitude is 382 feet above sea level. Cayuga Lake is the longest, widest, and has the largest drainage basin and the most shoreline of the eleven Finger Lakes. It has a length of 38.2 miles, a mean width of 1.75 miles, a maximum depth of 435 feet and a shoreline of 95.3 miles. It takes over 10 years for water to cycle through its system.

The Cayuga Lake Watershed has excellent natural resources including wildlife, parks, fisheries, wetlands, and forests. The watershed is an important link in the waterfowl flyway of the Atlantic Coast. Seasonal use includes approximately 314 bird species, including many shorebirds and waders. There are seven state parks and numerous county/town parks which provide public access to the lake as well as preserve the integrity of various natural resources. The watershed is an important habitat for both warm and cold water fisheries including lake trout and four species of salmonoids. There is over 6,000 acres of high quality wetlands and thousands of acres of valuable forests which are important for timber, wildlife, recreation, and water quality.

The Cayuga Lake Watershed has excellent cultural and historical resources. There are many unique historical and Native American sites that provide insight into the customs and activities that shaped the local landscapes and communities. Many of these activities are closely linked to Cayuga Lake and its tributaries.

The Cayuga Lake Watershed has some of the richest, fertile agricultural soils in the nation. The watershed sustains a flourishing fruit and wine industry as well as hundreds of cash crop, beef, and dairy farms, including millions of dollars in cash receipts annually ($176,423,000 according to the 1992 Census of Agriculture).

**Figure 2.1.2.1**
**Municipalities in the Cayuga Lake Watershed**

| Tompkins County | Cayuga County |
|---|---|
| • Town of Carline | • Town of Summerhill |
| • Town of Danby | • Town of Genoa |
| • Town of Newfield | • Town of Sempronius |
| • Town of Dryden | • Town of Locke* |
| • Town of Ithaca | • Town of Venice |
| • Town of Enfield | • Town of Ledyard |
| • Town of Lansing | • Town of Scipio |
| • Town of Ulysses | • Town of Fleming |
| • Town of Groton | • Town of Aurelius |
| • City of Ithaca | • Town of Springport |
| • Village of Dryden | • Village of Aurora |
| • Village of Trumansburg | • Village of Union Springs |
| • Village of Lansing | • Village of Cayuga |
| • Village of Cayuga Heights | Tioga County |
| • Village of Freeville | • Town of Spencer |
| Schuyler County | Seneca County |
| • Town of Hector | • Town of Covert |
| • Town of Catharine* | • Town of Lodi |
| Cortland County | • Town of Ovid |
| • Town of Harford | • Town of Romulus |
| • Town of Virgil | • Town of Fayette |
| • Town of Cortlandville | • Town of Varick |
| • Town of Scott* | • Town of Seneca Falls |
| • Town of Homer | • Village of Interlaken |

* Municipalities with small portion in watershed

In the Cayuga Lake Watershed, tourism and recreational activities include day visit boats; power, sail, and personal watercraft; marina, launching, and boat services; bicycling tours; fishing tournaments and recreational fishing visits; waterfowl hunting visits; bird watching; swimming and camping; and public and private golf courses.

Cayuga Lake is a public and private drinking water supply. Numerous communities and hundreds of households depend on Cayuga Lake and its watershed as a drinking water source from both surface and ground waters.

**2.2 Climate**

The general climatic conditions of the Cayuga Lake Watershed area and summaries of temperature and precipitation data are given by the Northeast Regional Climate Center, Department of Soil, Crop, and Atmospheric Sci ences, Cornell University (Table 2.2.1). The climate is of the humid continental type with warm summers and long, cold winters. The area lies on or near the major west to east track of cyclonic storms and hence is charac terized by variety and frequent periods of stormy weather, particularly in the winter (Oglesby).
Average daily air temperatures at the Regional Climate Center of 90° F or higher are rare. Average daily winter temperatures of 0° F or less occur fewer than 15 times per year. The freeze-free season averages approximately 150 days. Annual precipitation ranges from approximately 25 inches to 45 inches per year with the average yearly

precipitation approximately 35 inches per year. Generally, the summer months have the highest average daily precipitation rates.

**Table 2.2.1**
**Climate**
Ithaca, NY

**Temperature Summary ($^{o}$ F)**

| | Normals | | | Daily Extremes | | Average Number of Days | | |
|---|---|---|---|---|---|---|---|---|
| **Month** | **Maximum** | **Minimum** | **Average** | **Hottest** | **Coldest** | **>=90** | **<=32** | **<=0** |
| Jan | 30.1 | 12.9 | 21.5 | 70 | -25 | 0 | 29 | 6 |
| Feb | 31.6 | 13.3 | 22.4 | 66 | -35 | 0 | 26 | 5 |
| Mar | 41.7 | 23.8 | 32.7 | 85 | -17 | 0 | 25 | 1 |
| Apr | 54.0 | 33.8 | 43.9 | 89 | 7 | 0 | 15 | 0 |
| May | 66.2 | 43.5 | 54.9 | 96 | 22 | 0 | 4 | 0 |
| Jun | 75.0 | 52.7 | 63.9 | 102 | 31 | 0 | 0 | 0 |
| Jul | 79.8 | 57.2 | 68.5 | 103 | 38 | 2 | 0 | 0 |
| Aug | 78.0 | 55.7 | 66.9 | 101 | 32 | 1 | 0 | 0 |
| Sep | 70.5 | 48.7 | 59.6 | 100 | 24 | 0 | 1 | 0 |
| Oct | 59.1 | 38.6 | 48.9 | 91 | 15 | 0 | 8 | 0 |
| Nov | 46.9 | 31.4 | 39.1 | 81 | -4 | 0 | 17 | 0 |
| Dec | 34.9 | 20.1 | 27.5 | 68 | -22 | 0 | 27 | 2 |
| Annual | 55.7 | 36.0 | 45.8 | 103 | -35 | 3 | 152 | 14 |

**Precipitation Summary (inches)**

| | | Monthly Extremems | | | | Daily Extremes | | Number of Days >= | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Month** | **Normal** | **Most** | **Year** | **Least** | **Year** | **Most** | **Year** | **0.01"** | **0.10"** | **1.00"** |
| Jan | 1.8 | 6.4 | 1978 | 0.4 | 1933 | 2 | 1915 | 15 | 5 | 0 |
| Feb | 2 | 4.3 | 1911 | 0.3 | 1968 | 1.7 | 1958 | 13 | 5 | 0 |
| Mar | 2.3 | 6.9 | 1936 | 0.3 | 1910 | 2.5 | 1900 | 14 | 6 | 0 |
| Apr | 2.9 | 8.2 | 1993 | 0.6 | 1915 | 2.1 | 1993 | 13 | 7 | 0 |
| May | 3.3 | 8.1 | 1984 | 0.3 | 1903 | 2.1 | 1944 | 13 | 8 | 0 |
| Jun | 3.8 | 11.8 | 1972 | 0.9 | 1927 | 3.6 | 1972 | 12 | 8 | 1 |
| Jul | 3.5 | 12.6 | 1935 | 0.9 | 1983 | 4.6 | 1935 | 11 | 7 | 1 |
| Aug | 3.4 | 8.7 | 1922 | 0.5 | 1923 | 4 | 1947 | 11 | 7 | 1 |
| Sep | 3.5 | 9.1 | 1977 | 0.7 | 1943 | 3.1 | 1924 | 12 | 7 | 1 |
| Oct | 3.3 | 8.4 | 1981 | 0.2 | 1963 | 5.1 | 1981 | 13 | 7 | 1 |
| Nov | 3.1 | 6.4 | 1963 | 0.6 | 1939 | 2.3 | 1926 | 14 | 7 | 0 |
| Dec | 2.6 | 5.8 | 1901 | 0.1 | 1928 | 2.4 | 1901 | 16 | 7 | 0 |
| Annual | 35.4 | 46.9 | 1958 | 25.5 | 1965 | 5.1 | 1981 | 157 | 81 | 5 |

**Snowfall Summary (inches)**

| | | Monthly & Daily Extremes | | | | Number of Days >= | | |
|---|---|---|---|---|---|---|---|---|
| **Month** | **Normal** | **Month** | **Year** | **Day** | **Year** | **0.1"** | **1.0"** | **3.0"** |
| Jan | 16.9 | 54 | 1978 | 15 | 1978 | 13 | 6 | 1 |
| Feb | 14.7 | 37.1 | 1972 | 21 | 1961 | 11 | 5 | 1 |
| Mar | 10.2 | 35.5 | 1956 | 16.5 | 1984 | 8 | 3 | 1 |
| Apr | 3.9 | 14.5 | 1983 | 9.5 | 1956 | 3 | 1 | 0 |
| May | 0.3 | 3.5 | 1966 | 2 | 1977 | 0 | 0 | 0 |
| ... | | | | | | | | |
| Oct | 0.5 | 6.5 | 1988 | 5 | 1988 | 0 | 0 | 0 |
| Nov | 5.4 | 17.8 | 1951 | 12 | 1968 | 4 | 2 | 0 |
| Dec | 15.4 | 48.1 | 1969 | 13 | 1969 | 11 | 6 | 1 |
| Seasonal | 67.3 | 122.2 | 1977 | | | 50 | 24 | 4 |

Source: Northeast Regional Climate Center, Department of Soil, Crop and Atmospheric Sciences, Cornell University, 1915-1999.

One of the more persistent climatic features of the Cayuga Lake area is cloudiness, especially during the winter months. Ithaca averages about 175 cloudy days a year. The percentage of possible sunshine at Ithaca is less than 30% in November and December and increases to a maximum of 60% in June and July (Oglesby). Prevailing winds in the area are from the southwest during the summer and the northwest in the winter.  Velocities in Ithaca average 7-10 mph from May through October and 11-12 mph during the colder months (Oglesby).

Cayuga Lake is located in a basin that opens into rather flat terrain at its north end but becomes progressively steeper toward the south.  On the east side of the lake this rise becomes an obvious feature about one-third of the lake's length from its northern terminus, and a similar rise occurs on the west side slightly farther south.  The upland plateau or shelf is at an elevation of 820-980 feet with hills beyond occasionally extending to about 1970 feet.  Wright (1969) has reviewed the available evidence and concluded that the shape of the basin probably exerts considerable influence on wind speed and direction in two ways.  First, the generally north-south orientation of the basin channels the prevailing winds along the long axis of the lake; second, downslope winds pouring cooler air into the basin occur during the warmer months at times when nighttime cooling is appreciable.  In the autumn the passage of this cool air over the warmer water surface often results in dense, local fogs.

.

North-south differences in local climate may be estimated by comparing data from Ithaca with that taken in Aurora, New York.  Comparing Ithaca and Aurora in terms of annual means through 1966 temperatures were respectively $46^{o}$ F and $44^{o}$ F, total precipitation 35.22 inches and 31.00 inches, and total evaporation for May through October 24.55 inches and 31.59 inches.  Annual average solar radiation from the period 1965-72 was significantly different between Aurora and Ithaca with the latter being 8% greater (Oglesby).

**2.3 Topography**

The Cayuga Lake Watershed is located in a glacial valley with flat terrain and low relief characteristics in the northern portion and higher elevations with steeper slopes on the east and west beginning near the northern third of the valley extending down to the southern end.  The more dramatic increases in elevations and steeper slopes that define the gorges of the watershed begin on the eastern side near the towns of Springport and Scipio, while on the western side the same topographic effect begins slightly further south near the Town of Ovid.  The corresponding Map 2.3.1 shows the elevations above sea level in 50-meter intervals for the watershed.

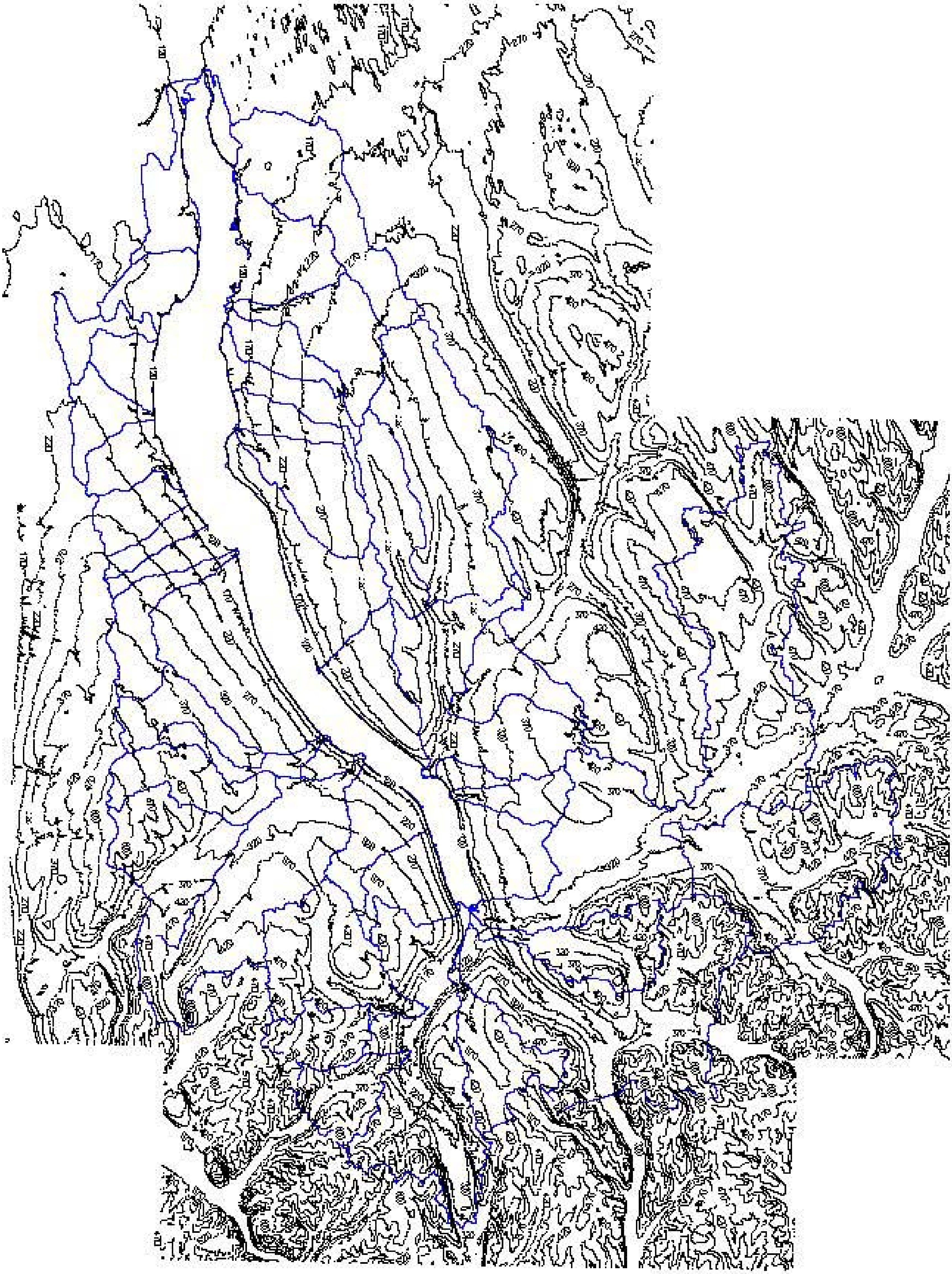
In the northern third of the watershed the elevations range from approximately 394 feet (120 meters) to 1050 feet (320 meters) above sea level.  Elevations of the gorges in the southern end of the watershed reach approximately 1804 feet (550 meters) above sea level.  The higher elevations of Cayuga Lake's tributaries than the lake itself combined with the steep gorges in the southern end produce a series of waterfalls.  The basin stretches from Cayuga and Seneca counties in the north to Schuyler, Tompkins, and Tioga counties in the south.  The valley widens to the east into Cortland County.  The eastern portion of the valley includes a thin extension to the north through the towns of Groton, Summerhill, Sempronius, and Locke in Cayuga County and the towns of Scott, Homer, and Cortlandville in Cortland County.

The topography of the watershed was formed through uplifting of the land that began approximately 200 million years ago. According to Oglesby, at that time drainage was to the south through the Susquehanna system.  The fluvial movements of the streams from their headwaters gradually eroded the northern portion of the basin.  During the Ice Age, two glaciations produced deep gorges and carried debris that formed the gorges of the southern end.  The retreat of the second glacier resulted in the reversal of drainage in the watershed from the south to the north.

**2.4 Bedrock Geology**

The sedimentary bedrock that underlies the Cayuga Lake Watershed originated between the Upper Silurian Period (approximately 420 million years ago) and the Upper Devonian Period (approximately 385 million years ago).  During this time the entire area was an inland sea whose depth varied from very shallow (salt flats) to very deep (limestone deposition).  While the depth varied over millions of years, the watershed was most often a shallow ocean where thousands of feet of mud were deposited to become the shale that underlies the watershed today.  After deposition, solidification, uplift, and erosion the bedrock was then subjected to periods of glaciation and additional erosion that further altered the landscape of central New York.  Today, most bedrock in New York State gently dips to the south resulting in younger bedrock being exposed in the south and older bedrock exposed in the north.

# Cayuga Lake Watershed Topography



This map was prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.

Source: United State Geological Survey and New York State Department of Environmental Conservation, 1999.
Genesee/Finger Lakes Regional Planning Council, 1998.

Base Map: New York State Department of Transportation, February 1996.

Contours at 50-meter intervals.

1:260496

0 5 10 Miles

Prepared by Genesee/Finger Lakes Regional Planning Council, 1999.

**Table 2.4.1**
**Bedrock Geology**

| System and Series (Age-millions of years ago) | | Formation - type | Location |
|---|---|---|---|
| | | | |
| Devonian | **Upper** | West Falls Group - Shale | Highest hills southwest part of watershed |
| | (370 M) | Sonyea/Genesee Group - Shales | Highest hills south and west of Ithaca |
| | **Middle** | Tully - Limestone | West and east shorelines (Taughannock Gorge and South Lansing areas wrapping west and east on hilltops) |
| | (380 M) | Hamilton Group - Shale | Central and near-north hilltops down to lakeshore further north |
| | | Onondaga - Limestone | Canoga (west) and Union Springs (east) |
| | **Lower** | Oriskany - Sandstone | Intermittent west, Union Springs and northeast |
| | (390 M) | Helderberg Group - Shale, Limestone, Dolostone | North and west of Canoga (west), north and east of Union Springs (east) |
| Silurian | **Upper** | Akron/Bertie - Limestone and Dolostone | Northern end of Lake and watershed (west and east) |
| | (410 M) | Syracuse Formation - Shale and evaporites (gypsum/salt) | Extreme northern end of watershed (west and east) |

Source: US Geological Survey - WRD, 1999.

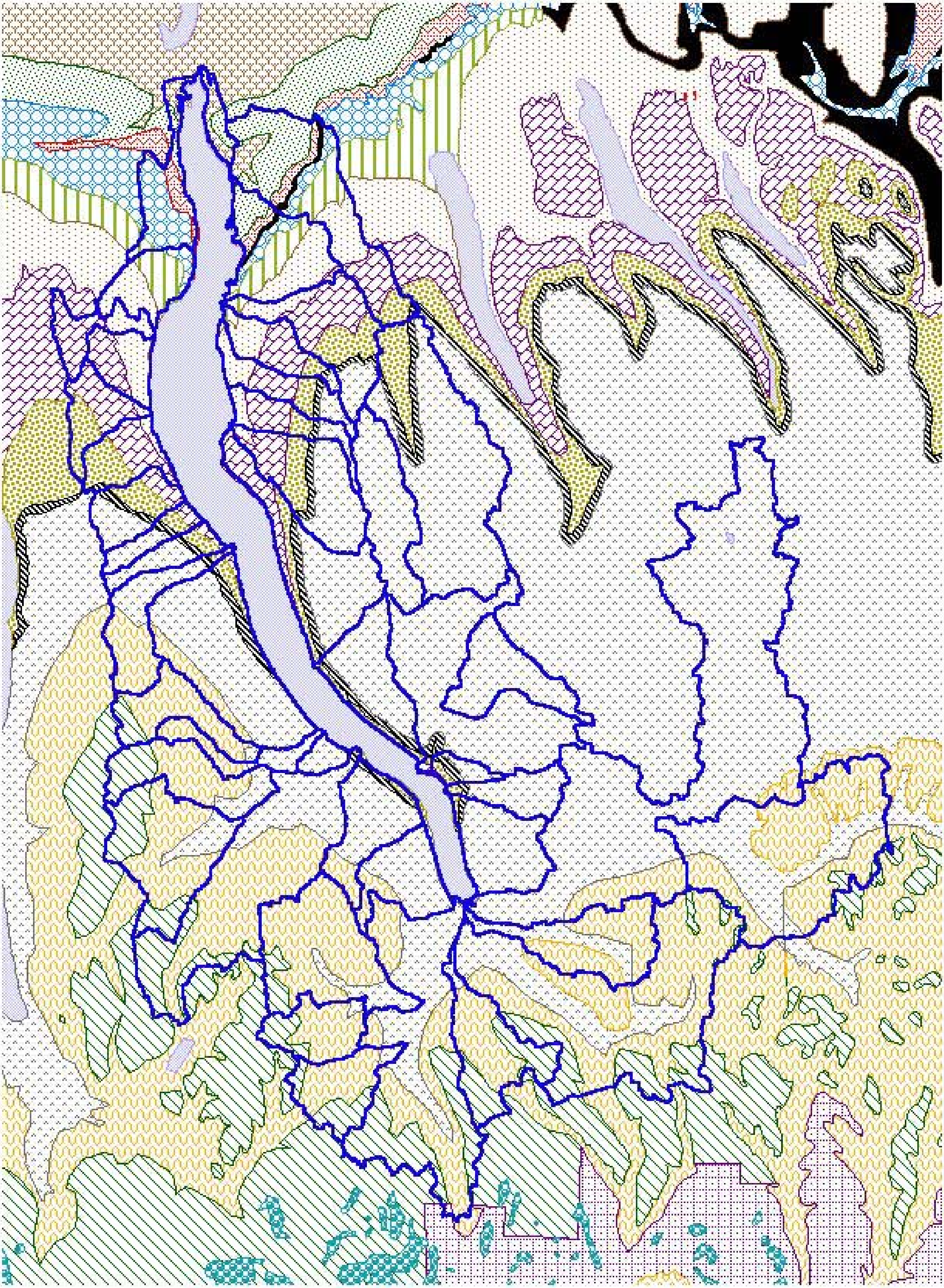
Beginning in the highest hills of the southwestern portion of the watershed is the youngest surficial bedrock from the Upper Devonian Period containing the West Falls Group of shale. The Sonyea and Genesee Groups of shale (with some siltstone) are found on the hilltops south and west of Cayuga Lake. Along the southern shoreline of the lake south of Taughannock Falls to the west and southern Lansing to the east, the Middle Devonian Tully Limestone rises to the north creating the lower falls at Taughannock gorge. The Hamilton Group of shale, a rather thick sequence of shale and limey-shale, caps the hilltops in the central and near-northern parts of the watershed. To the north of this area, Onondaga Limestone is first found along the lake's shoreline from Canoga on the west side to Union Springs on the east along with intermittent exposures of the Lower Devonian Oriskany sandstone which is more commonly found on the east side of the basin. Further north the Helderberg Group of shale, limestone, and dolostone is found. Near the northern end of the lake the Upper Silurian Akron/Bertie Group of limestone and dolostone is also found with some exposures of the Syracuse Formation at the extreme northern end of the watershed. Table 2.4.1 presents the periods in which the formations originated and a description of their general location within the watershed. Map 2.4.1 of the bedrock geology of the watershed displays the various formations according to group and material.

## 2.5 Surficial Geology

The majority of the Cayuga Lake Watershed consists of till of variable texture and thickness, most notably in the middle of the watershed to the east and west of the lake. The texture of the till varies but is predominantly poorly sorted, sand-rich diamict. Along the eastern border of the lake from the Town of Ledyard south of the Village of Aurora to the City of Ithaca lies bedrock that is either exposed or within one meter of the surface. Bedrock is also present in the watershed's southern portion extending from the central portion of the Town of Ithaca along the shared boundary of the towns of Newfield and Danby.

In addition, formations of bedrock are present in the eastern portion of the watershed in the Town of Summerhill extending east into the Town of Homer. North of the primary bedrock formation in Summerhill is lacustrine sand, a well-sorted, stratified arrangement of permeable quartz sand. To the south of the bedrock, and scattered throughout the southern third of the watershed, are areas of kame moraine of variable texture and thickness. Kame deposits are located throughout the southwestern portion of the watershed.

# Cayuga Lake Watershed
# Bedrock Geology



This map was prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.

Source: New York State Geological Survey, 1999.
Genesee/Finger Lakes Regional Planning Council, 1998.

Base Map: New York State Department of Transportation, February 1996.

1:381837

0 5 10 Miles

Prepared by Genesee/Finger Lakes Regional Planning Council, 19

# Cayuga Lake Watershed Bedrock Geology Materials

MESOZOIC INTRUSIVES

| | |
|---|---|
| KJk | Kimberlite and alnoite dike and diatreme |

WEST FALLS GROUP

| | |
|---|---|
| Dwm | Beers Hill Shale |
| Dwrg | Gardeau Formation |
| Dww | Upper Walton Formation |

SONYEA GROUP

| | |
|---|---|
| Ds | Cashaqua Shale |

GENESEE GROUP AND TULLY LIMESTONE

| | |
|---|---|
| Dg | West River Shale |
| Dt | Tully Limestone |

HAMILTON GROUP

| | |
|---|---|
| Dhld | Ludlowville Formation |
| Dhmo | Moscow Formation |
| Dhmr | Marcellus Formation |
| Dhsk | Skaneateles Formation |

ONONDAGA LIMESTONE AND TRISTATES GROUP

| | |
|---|---|
| Do | Oriskany Sandstone |
| Don | Onondaga Limestone |

HELDERBERG GROUP

| | |
|---|---|
| Dhg | Port Ewen Formation |

AKRON DOLOSTONE & COBLESKILL LIMESTONE & SALINA GROUP

| | |
|---|---|
| Sab | Akron Dolostone |
| Scy | Syracuse Formation |

| | |
|---|---|
| h20 | Water |

*Prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.*

*Source: New York State Geological Survey, 1999.*

*Prepared by Genesee/Finger Lakes Regional Planning Council, 1999.*

The northeastern portion of the watershed in the Towns of Seneca Falls and Fayette is primarily lacustrine silt and clay which has a low permeability and is up to 50 meters thick. At the very northern boundary in the Montezuma Wildlife Refuge are swamp deposits that overlie marl and lake silt. Till moraine can be found throughout the watershed particularly in the middle portion of the watershed on both sides of the lake mixed within areas of till. Map 2.5.1 of surficial geology in the watershed displays the location of various formations and materials.

## 2.6 Soils

### 2.6.1 Formation of Soils

Factors of Soil Formation

Soil is the product of the interaction among five major soil-forming factors: parent material, topography, plant and animal life, climate, and time (USDA, Soil Conservation Service). The relative importance of each factor varies from place to place. In some places one or two factors dominate and thus determine most of the properties of the soil.

*Parent Material*
Parent material is the unconsolidated earthy mass from which soils are formed. It determines the mineralogical composition of the soil and contributes largely to the chemical composition. It also influences to a great extent the rate at which soil-forming processes take place and the color of the soil. Most soils in the Cayuga Lake Watershed formed in different types of deposits resulting from glaciation. Glacial till is the most extensive source of parent material. Other, less extensive parent materials in the watershed are glaciolacustrine sediments and glaciofluvial (outwash) deposits. Some soils formed in more recent deposits of stream alluvium and in accumulations of organic material.

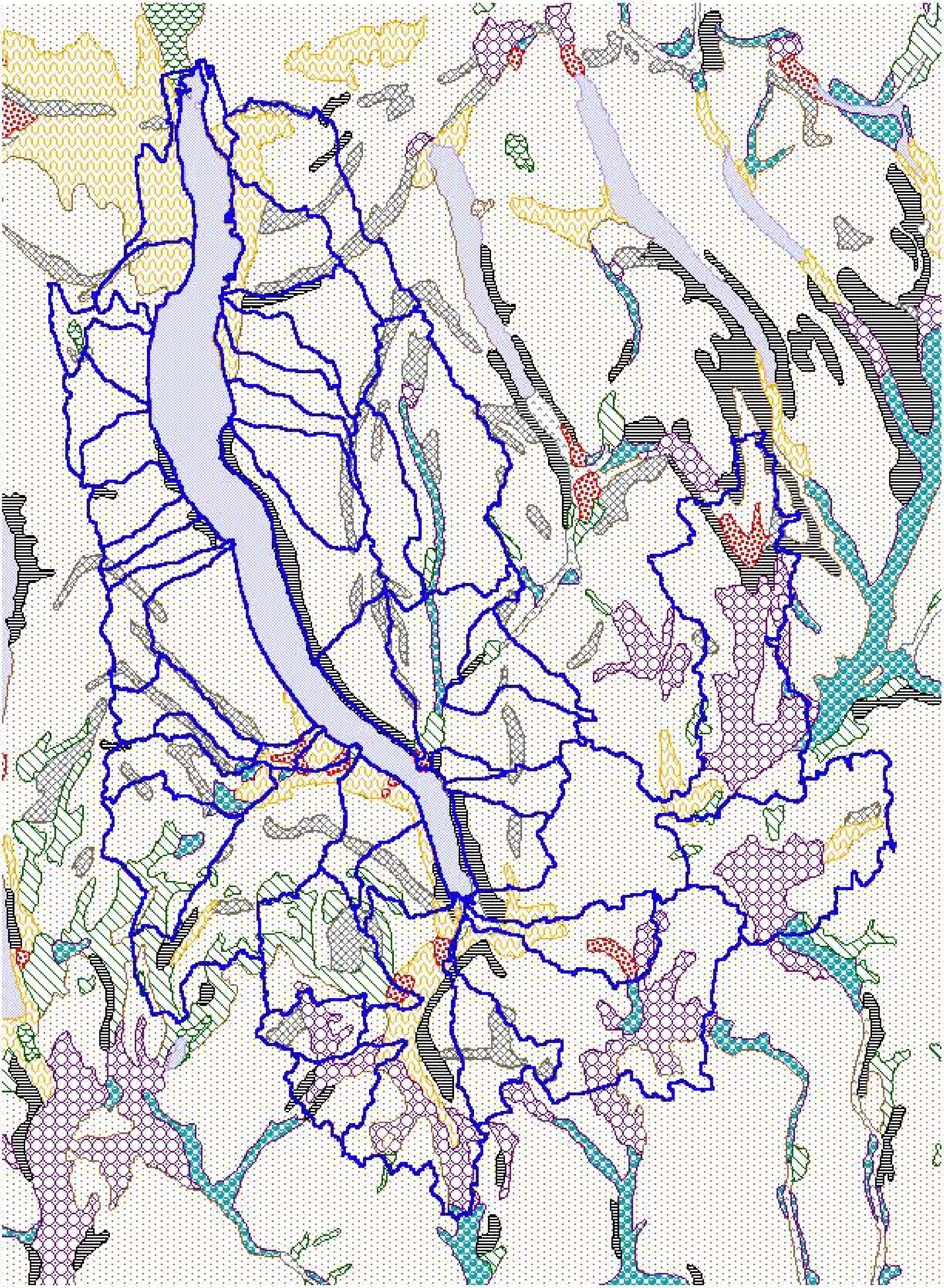
*Topography*
The shape of the land surface, the slope, and the position of the land surface in relation to the water table have influenced the formation of soils in the watershed. Soils formed in convex-sloping areas that accumulate little runoff, or where the rate of runoff is moderate or rapid, generally are well drained and have a bright-colored, unmottled subsoil. These soils are generally leached to a greater depth than the low-lying wetter soils in the same general area. In less sloping areas, where runoff is slower, the soils generally exhibit some evidence of wetness, such as mottling in the subsoil. In level areas or in slight depressions where the water table is at or near the surface for long periods, the soils show evidence of wetness to a marked degree. They have a dark-colored, thick organic surface layer and a strongly mottled or grayish subsoil. Some soils are wet because of a high water table or because they occupy a position on the landscape where water accumulates and is perched on impervious layers in the soil.

*Climate*
Climate, particularly temperature and precipitation, determines to a large degree the weathering of the soils and affects growth and kind of vegetation and the leaching and translocation of weathered materials. The Cayuga Lake Watershed has a humid, temperate climate, which tends to promote the development of moderately weathered, leached soils.

*Plant and Animal Life*
The living organisms that affect soil formation include plants, animals, bacteria, and fungi. Vegetation is generally responsible for the amount of organic matter and nutrients in the soil and the color of the surface layer. Earthworms and burrowing animals help keep the soil porous and more permeable to air and water. Their waste products cause aggregations of soil particles and improve soil structure. Bacteria and fungi decompose the vegetation, thus releasing nutrients for plant use.

In the Cayuga Lake Watershed, the native forests, consisting of northern hardwoods and pines, have influenced soil formation. Man has also influenced changes that occur in soils through clearing of the forests and cultivation of the land. He has added nutrients through fertilizers, mixed some soil horizons by plowing, and accelerated erosion in many areas.

# Cayuga Lake Watershed Surficial Geology



This map was prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.

Source: New York State Geological Survey, 1999.
Genesee/Finger Lakes Regional Planning Council, 1998.

Base Map: New York State Department of Transportation, February 1996.

1:378910

0 5 10 Miles

Prepared by Genesee/Finger Lakes Regional Planning Council, 19

# Cayuga Lake Watershed Surficial Geology Materials

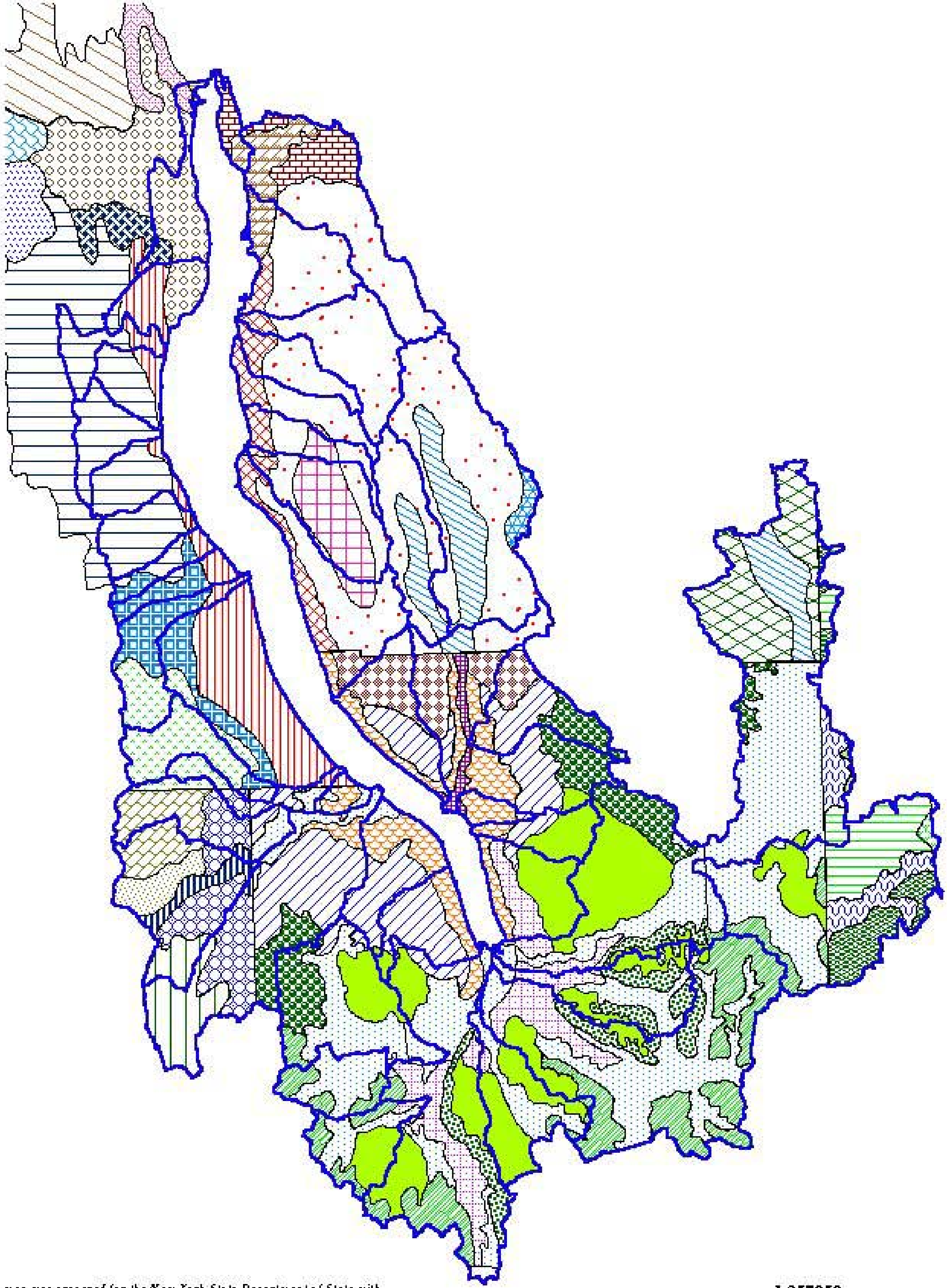
| | | |
|---|---|---|
| al | **Recent Alluvium** | Oxidized fine sand to gravel, permeable, generally confined to flood plains within a valley, in larger valleys may be overlain by silt, subject to flooding, thickness 1-10 meters. |
| alf | **Alluvial Fan** | Poorly stratified silt, sand, and boulders, fan shaped accumulations, at bottoms of steep slopes, generally permeable, thickness 1-10 meters. |
| h2o | **Water** | |
| k | **Kame Deposits** | Coarse to fine gravel and/or sand, includes kames, eskers, kame terraces, kame deltas, ice contact, or ice cored deposition, lateral variability in sorting, texture and permeability, may be firmly cemented with calcareous cement, thickness variable (10-30 meters). |
| km | **Kame Moraine** | Variable texture (size and sorting) from boulders to sand, deposition at an active ice margin during retreat, constructional kame and kettle topography, locally, calcareous cement, thickness variable (10-30 meters). |
| ls | **Lacustrine Sand** | Generally quartz sand, well sorted, stratified, usually deposited in proglacial lakes, but may have been deposited on remnant ice, generally a near-shore deposit or near a sand source, permeable, thickness variable (2-20 meters). |
| lsc | **Lacustrine Silt and Clay** | Generally laminated silt and clay, deposited in proglacial lakes, generally calcareous, low permeability, potential land instability, thickness variable (up to 50 meters). |
| og | **Outwash Sand and Gravel** | Coarse to fine gravel with sand, proglacial fluvial deposition, well rounded and stratified, generally finer texture away from ice border, permeable, thickness variable (2-20 meters). |
| pm | **Swamp Deposits** | Peat-muck, organic silt and sand in poorly drained areas, unoxidized, commonly overlies marl and lake silt, potential land instability, thickness 2-20 meters. |
| r | **Bedrock** | Exposed or generally within 1 meter of surface, in some areas saprolite is preserved. |
| t | **Till** | Variable texture (boulders to silt), usually poorly sorted sand-rich diamict, deposition beneath glacier ice, permeability varies with compaction, thickness variable (1-50 meters). |
| tm | **Till Moraine** | Variable texture (size and sorting), generally low permeability, deposition adjacent to ice, thickness variable (10-30 meters). |

*Prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.*

*Source: New York State Geological Survey, 1999.*

*Prepared by Genesee/Finger Lakes Regional Planning Council, 1999.*

# Cayuga Lake Watershed
# General Soil Associations



This map was prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.

Source: United States Department of Agriculture, Soil Conservation Service, 1965-1979.
Genesee/Finger Lakes Regional Planning Council, 1998.

Base Map: New York State Department of Transportation, February 1996.

1:357950

0 5 10 Miles

Prepared by Genesee/Finger Lakes Regional Planning Council, 19

# Cayuga Lake Watershed
# General Soil Associations

## HIGH LIME SOILS

### Developed on Glacial Till

Cazenovia-Ovid-Ontario: moderately shallow: Deep, well drained to somewhat poorly drained soils that have a moderately fine textured subsoil, and moderately shallow, well drained soils that have a medium-textured subsoil over limestone bedrock.

Honeoye-Lima: Deep, well drained and moderately well drained soils that have a medium-textured subsoil.

Lima-Kendaia: Deep, moderately well drained and somewhat poorly drained soils that have a medium-textured subsoil.

Cazenovia-Aurora: Deep and moderately deep, moderately well drained or well drained soils that have a moderately fine textured subsoil.

Ontario-Ovid: Deep, well drained to somewhat poorly drained soils that have a loam to silty clay loam subsoil.

Honeoye-Lima: Deep, well drained and moderately well drained soils that have a heavy silt loam to heavy loam subsoil.

Lima-Honeoye: Dominantly moderately well drained, silty soils on gently rolling to moderately steep topography.

### Developed on Glacial Till and Lake-Laid Materials

Hudson-Cayuga: Dominantly moderately well drained, heavy textured soils on moderate to steep slopes.

### Developed on Glacial Lake Sediments

Schoharie-Odessa: Deep, well drained to somewhat poorly drained, high-lime soils that have a fine textured subsoil.

Schoharie-Odessa: Deep, well drained to somewhat poorly drained soils that have a silty clay loam to clay subsoil.

Odessa-Lakemont: Deep, dominantly somewhat poorly drained soils that have a silty clay loam to silty clay subsoil.

### Developed on Lake-Laid Materials

Hudson-Rhinebeck: Moderately well drained and somewhat poorly drained, heavy-textured soils generally free of stones and gravel.

### Developed on Glacial Outwash

Palmyra: Well drained, light textured soils on stratified sand and gravel.

*Prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.*

*Source: United States Department of Agriculture, Soil Conservation Service, 1965-1979.*

*Prepared by Genesee/Finger Lakes Regional Planning Council, 1999.*

# Cayuga Lake Watershed General Soil Associations

## MEDIUM LIME SOILS

### Developed on Glacial Till

Lansing-Conesus: Deep, well drained and moderately well drained soils that have medium-textured subsoil.

Valois-Langford-Lansing: Well drained and moderately well drained, gently sloping to steep soils, some with fragipans. The main limitations of the soils are strong acidity, low fertility, and steepness.

Conesus-Appleton-Lansing: Dominantly sloping, deep, well drained to somewhat poorly drained, medium textured soils.

Conesus-Lansing: Deep, moderately well drained and well drained soils that have a heavy silt loam to heavy loam subsoil.

Darien-Angola: Deep and moderately deep, somewhat poorly drained soils that have a silty clay loam and clay loam subsoil.

Conesus-Lansing: Moderately well drained and well drained, medium-textured soils on gently rolling topography.

### Developed on Glacial Outwash Terraces and Kames

Langford-Howard: Deep, well drained, medium-lime soils that have a medium-textured subsoil over sand and gravel, and deep, moderately well drained or well drained, low-lime soils that have a medium-textured fragipan.

### Developed on Glacial Outwash and Till

Valois-Howard-Langford: Well drained, mainly steep soils with fragipans, and gently sloping, moderately well drained soils with fragipans.

Valois-Howard-Chenango: Dominantly gently sloping and sloping, deep, well drained and somewhat extensively drained, medium textured soils in valley and on plains.

Howard-Valois: Mainly well drained, light textured and medium-textured, gravelly soils on level, rolling, or steep topography.

### Developed on Glacial Lake Sediments

Dunkirk-Collamer: Deep, well drained and moderately well drained soils that have a silt loam to silty clay loam subsoil.

Dunkirk-Cazenovia: Moderately deep and deep, well drained and moderately well drained soils that have a silt loam to silty clay loam subsoil that overlies limestone.

Arkport-Claverack: Deep, dominantly well drained and moderately well drained soils that are loamy fine sand and fine sandy loam throughout or that have a loamy fine sand subsoil over silty clay or clay.

*Prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.*

*Source: United States Department of Agriculture, Soil Conservation Service, 1965-1979.*

*Prepared by Genesee/Finger Lakes Regional Planning Council, 1999.*

# Cayuga Lake Watershed General Soil Associations

## LOW LIME SOILS

### Developed on Glacial Till

Langford-Erie: Deep, moderately well drained and somewhat poorly drained soils that have a medium-textured fragipan.

Erie-Volusia-Langford: Gently sloping, somewhat poorly drained soils with fragipans.

Howard: Nearly level to sloping, well drained, gravelly soils on outwash terraces. Among the most favorable for agriculuture in County, and has several of the best dairy farms. Erosion and drainage are not a major problem.

Lordstown-Volusia-Mardin: Shallow or moderately deep soils over bedrock and somewhat poorly drained and moderately well drained soils with fragipans, on gently sloping to sloping areas.

Volusia-Mardin-Lordstown: Shallow or moderately deep soils over bedrock and somewhat poorly drained and moderately well drained soils with fragipans, on gently sloping to sloping areas.

Volusia-Mardin: Gently sloping and sloping, deep, somewhat poorly drained and moderately well drained, medium textured soils that have a fragipan; on uplands. This unit is mainly used for hay, pasture, woodland, and wildlife habitat. Many areas that were cleared for farming are idle or reverting to woodland. Drainage is that principle management requirement for crop production. Seasonal wetness and slow or very slow water movement through the fragipan are the main limitations for community development.

Mardin-Bath: Dominantly sloping and moderately steep, deep, moderately well drained and well drained, medium textured soils have a fragipan on uplands.

Erie-Mardin: Dominantly nearly level and gently sloping, deep, somewhat poorly drained and moderately well drained, medium textured soils that have a fragipan; on uplands.

Langford-Erie: Deep, moderately well drained and somewhat poorly drained soils that have a channery silt loam to channery loam fragipan.

Langford-Erie: Moderately well drained and somewhat poorly drained, medium-textured soils on rolling to moderately steep topography.

Erie-Langford: Dominantly somewhat poorly drained, silty soils on mild topography.

Volusia-Lordstown: Somewhat poorly drained and well drained soils on rolling to steep topography.

Lordstown-Mardin: Well drained and moderately well drained, shallow and deep soils on rolling to steep topography.

## ORGANIC MATERIAL

Muck-Peat-Fresh Water Marsh: Deep to shallow, very poorly drained organic soils.

*Prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.*

*Source: United States Department of Agriculture, Soil Conservation Service, 1965-1979.*

*Prepared by Genesee/Finger Lakes Regional Planning Council, 1999.*

## Table 2.6.1 General Soil Associations

| | High Lime | Medium Lime | Low Lime | Organic Material |
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| **Cayuga County** | | | | |
| Developed on Glacial Till | Cazenovia-Ovid-Ontario, moderately shallow: Deep, well-drained to somewhat poorly drained soils that have a moderately fine textured subsoil, and moderately shallow, well-drained soils that have a medium-textured subsoil over limestone bedrock. Dairying is the principle type of farming. The main crops are alfalfa, oats, and silage corn. Winter wheat, grain, corn, and dry field beans are important cash crops. If the major soils are used for residential or industrial sites, rock may need to be excavated. The limestone bedrock, however, will support most structures. The soils may have features desirable at sites used for developments, but they have severe limitations if used as disposal fields for septic-tank effluent (USDA 1971). | Lansing-Conesus: Deep, well drained and moderately well drained soils that have medium-textured subsoil. Dairying is the main type of farming in this association, and much of the acreage is in crops used to feed dairy cattle. A significant acreage is used for grain corn, winter wheat, and dry field beans. The soils are well suited or fairly well suited to most crops, including deep-rooted legumes, but they are susceptible to moderate or serious erosion unless measures are taken to protect them. The dominant soils have many properties favorable for industrial and residential sites. They have good depth, moderate to good drainage, and good bearing strength. In some places, slope is a limiting factor (USDA 1971). | Langford-Erie: Deep, moderately well drained and somewhat poorly drained soils that have a medium-textured fragipan. Dairying is the principle type of farming. Much of the crops grown are used to feed livestock. Some winter wheat and dry field beans are grown as cash crops. If the moderately steep to steep soils are cultivated, intensive measures are needed to control erosion. Season wetness and, in some places, the topography are the major limitations if the soils are used for industrial or residential sites. There are several limitations if the soils are used as drainage fields for septic tank effluent (USDA 1971). | |
| | Honeoye-Lima: Deep, well drained and moderately well drained soils that have a medium-textured subsoil. This association is on the gently sloping and rolling till plains that cover much of the southern part of Cayuga County. Much of the acreage is farmed intensively and is used for dairying and cash crop farming. The principle crops are grain corn, silage corn, winter wheat, dry field beans, alfalfa, and oats. Erosion is a moderate hazard on the gently sloping to steep soils. The major soils have many features that are favorable for industrial or residential sites. They will support most structures, but they have moderate to severe limitations if used as disposal fields for septic-tank systems (USDA 1971). | | | |
| | Lima-Kendaia: Deep, moderately well-drained and somewhat poorly drained soils that have a medium-textured subsoil. Most farms have dairy herds, and much of the acreage is used for hay crops, silage corn, and oats to feed dairy cattle. Winter wheat, dry field beans, and grain corn are important cash crops. The better drained soils of this association have some features that are favorable for industrial and residential sites. These soils commonly provide a good bearing surface for structures, but they have severe limitations if used as disposal fields for septic systems. The unconsolidated material that underlies these soils is suitable for hard fill, although it contains some large stones (USDA 1971). | | | |
| | Cazenovia-Aurora: Deep and moderately deep, moderately well drained or well drained soils that have a moderately fine textured subsoil. Dairying is the principle type of farming in this association. Hay crops, silage corn, grain corn, and oats are the main crops. Because of the proximity of the lake, this association is used to a considerable extent for residences. The entire lake shore is used for cottages and campsites, and many permanent | | | |

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| | residences have been built ton the slopes overlooking the lake. Slow permeability, shallowness to bedrock, and steep slopes severely limit the use of the soils as drainage fields for septic systems (USDA 1971). | | | |
| Developed on Glacial Lake Sediments | Schoharie-Odessa: Deep, well-drained to somewhat poorly drained, high-lime soils that have a fine textured subsoil. These heavy textured soils are difficult to work, and they tend to puddle if worked when they are too moist. Thus, they are better suited to hay crops than to crops that require intensive cultivation. Dairying is the principle type of farming, and most of the crops grown are used to feed dairy cattle. The soils of this association are high in clay content, and they are free of stones and gravel. They are highly susceptible to erosion, particularly in the more sloping areas. The dominant soils have many properties that make them poorly suited as sites for industrial and residential developments. Drainage is slow, and the soil material is highly plastic when wet. The varved silts and clays in the substratum have poor bearing surface for structures. These are severe limitations if these soils are used as drainage fields for septic-tank effluent (USDA 1971). | | | |
| Developed on Glacial Outwash Terraces and Kames | | Langford-Howard: Deep, well-drained, medium-lime soils that have a medium-textured subsoil over sand and gravel, and deep, moderately well drained or well drained, low-lime soils that have a medium-textured fragipan. Dairying is the principle type of farming, and much of the acreage is in silage corn, oats, and hay used to feed dairy cattle. The important cash crops are winter wheat, dry field beans, and grain corns. Areas that have mild relief are used intensively for crops, whereas terrace fronts and strongly rolling, morainic areas are generally in permanent pasture. Erosion is a serious hazard on the steeper slopes. The dominant soils have many features that are favorable for industrial and residential sites. They vary in suitability for use as drainage fields for septic-tank systems (USDA 1971). | | |
| **Cortland County** | | | | |
| Developed on Glacial Till | | Valois-Langford-Lansing: Well drained and moderately well drained, gently sloping to steep soils, some with fragipans. Farms in this general area are good for dairying, though not so highly productive as the farms in the valleys. The main limitations of the soils are strong acidity, low fertility, and steepness, The principle crops are corn grown for silage, oats, and grasses and legumes grown for hay and pasture. Some forest remain on the steep slopes (USDA 1957). | Erie-Volusia-Langford: Gently sloping, somewhat poorly drained soils with fragipans. In most of this area, impeded drainage, resulting from the fragipan, limits the use of the soils for crops. The fragipan restricts the depth to which roots can penetrate. Its is slowly permeable to water, and the soils remain wet and cold until late spring. The soils are medium acid to very strongly acid and are low in phosphorus but medium in potassium-supplying power; they are subject to erosion if used continually for intertilled crops. The soils that have a fragipan are difficult to drain, but drainage can be improved through the use of diversion ditches or terraces. Corn, alfalfa, oats, and grasses and | |

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| | | | legumes are grown. Most of the soils in this area are used for dairy farming; generally the steep areas are idle or in forest (USDA 1957). | |
| | | | Howard: Nearly level to sloping, well-drained, gravelly soils on outwash terraces. Among the most favorable for agriculture in County, and has several of the best dairy farms. Erosion and drainage are not a major problem. Little forest remains on these soils. The main crops are corn grown for grain or silage, oats, and alfalfa and mixtures of grasses and legumes grown for hay or pasture (USDA 1957). | |
| | | | Lordstown-Volusia-Mardin/Volusia-Mardin-Lordstown: Shallow or moderately deep soils over bedrock and somewhat poorly drained and moderately well drained soils with fragipans, on gently sloping to sloping areas. Wetness is a problem in some areas. Erosion is a hazard on the strongly sloping soils. More land in this general area has been abandoned for crops and reforested than in any of the other general areas. The main crops grown are corn for silage, small grains, hay, and pasture (USDA 1957). | |
| Developed on Glacial Outwash Terraces and Kames | | Valois-Howard-Langford: Well-drained, mainly steep soils with fragipans, and gently sloping, moderately well drained soils with fragipans. Most of the farms in this general area, especially those on gently sloping Howard soils, are good for dairying. The main limitations in the use of the soils are strong acidity, steepness, and only low to moderate natural fertility; also the Erie soils are limited by somewhat poor drainage. These limitations can be compensated for by using good management practices. The steep soils can be used for pasture, and the very steep soils, for forest. Most of the soils are used for growing corn for silage, oats, and grasses and legumes for hay and pasture. The soils respond well if lime and fertilizer are applied for the crops commonly grown.. They also respond well to management practices that increase the supply of readily decayable organic matter (USDA 1957). | | |
| **Schuyler County** | | | | |
| Developed on Glacial Till | | Conesus-Appleton-Lansing: Dominantly sloping, deep, well drained to somewhat poorly drained, medium textured soils. Much of this unit is cleared and farmed. Suitable for corn, dry beans, small grains, and alfalfa hay. Temporary seasonal wetness and slow water movement through the substratum are the main limitations of this soil for community development (USDA 1979). | Volusia-Mardin: Gently sloping and sloping, deep, somewhat poorly drained and moderately well drained, medium textured soils that have a fragipan; on uplands. This unit is mainly used for hay, pasture, woodland, and wildlife habitat. Many areas that were cleared for farming are idle or reverting to woodland. Drainage is that principal management requirement for crop production. Seasonal wetness and slow or very slow water movement through the fragipan are the main limitations for community development (USDA 1979). | |
| | | | Mardin-Bath: Dominantly sloping and moderately steep, deep, moderately well drained and well drained, medium textured soils have a fragipan; on uplands. More than half of this | |

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| | | | unit is forested. The remaining areas are cleared and are commonly idle or used for hay or pasture. Some areas have potential for row crops such as potatoes or corn, but slope and low natural fertility, and a short growing season limit many areas for crops. Slow or very slow water movement through the fragipan, temporary wetness, and slope are the primary limitations for community development (USDA 1979). | |
| | | | Erie-Mardin: Dominantly nearly level and gently sloping, deep, somewhat poorly drained and moderately well drained, medium textured soils that have a fragipan; on uplands. This unit is mainly used for crops, hay, pasture, woodland, and wildlife habitat. Many areas support dairy farms. Artificial drainage is the principal management requirement for crop production. Interceptor drains that divert surface runoff and subsurface seepage are needed in many areas. Seasonal wetness and slow or very slow water movement through the fragipan are the main limitations for community development (USDA 1979). | |
| Developed on Glacial Outwash Terraces and Kames | | Valois-Howard-Chenango: Dominantly gently sloping and sloping, deep, well drained and somewhat extensively drained, medium textured soils in valley and on plains. Most areas of this unit have been cleared and are used for farming. The less sloping areas of the major soils are well suited for corn, small grains, potatoes, and alfalfa. Droughtiness is a concern in some years, particularly in the gravelly Chenango soils. Some areas of the unit have good potential for community development, and most areas are excellent sources of water from wells. Slope and the high content of gravel fragments are the main limitations of this unit for most uses (USDA 1979). | | |
| **Seneca County** | | | | |
| Developed in Glacial Till | Ontario-Ovid: Deep, well drained to somewhat poorly drained soils that have a loam to silty clay loam subsoil. Dairying and general farming are the main farming enterprises. The main crops grown are alfalfa hay, winter wheat, kidney beans, and corn for silage and grain. The somewhat poorly drained soils that formed in lake-laid materials between the drumlins are heavy and difficult to work with. Erosion is a hazard on the moderately steep to steep slopes of the drumlins, and many areas on the sides of the drumlins have lost as much as 2 feet of soil. The drumlin areas of these soils are too steep to provide satisfactory sites for industrial development. The interdrumlin soils generally provide poor building sites because of their poor drainage and high clay content (USDA 1972). | Conesus-Lansing: Deep, moderately well drained and well drained soils that have a heavy silt loam to heavy loam subsoil. Dairying is the main farming enterprise on these soils, and most of the association is used to grow crops for dairy herds. Winter wheat and dry field beans are important cash crops. The medium texture, good depth, lack of strong acidity, and favorable topography of these soils result in high productivity and good response to proper management. The hazard of erosion is moderate on these flaggy and gravelly soils. The dominant soils are fairly well suited to community development. These soils, however, are moderately to severely limited as sites for septic tank disposal fields (USDA 1972). | Langford-Erie: Deep, moderately well drained and somewhat poorly drained soils that have a channery silt loam to channery loam fragipan. Dairying is the most important farming enterprise, and much land is in permanent pasture. The main crops are hay, oats, and corn for silage. Hazard of erosion is moderate. Most of the soils are severely limited for septic tank disposal fields (USDA 1972). | Muck-Peat-Fresh Water Marsh (Montezuma Marsh): Deep to shallow, very poorly drained organic soils. Muck is suitable for farming when it is diked and drained. The acreage that is cropped is used mainly for potatoes, some celery, and onions. Muck is severely limited for both industrial and residential development. The included small knolls of well drained upland soils are suitable for individual buildings or houses (USDA 1972). |
| | Honeoye-Lima: Deep, well drained and moderately well drained soils that have a heavy silt loam to heavy loam subsoil. General farming and dairying | Darien-Angola: Deep and moderately deep, somewhat poorly drained soils that have a silty clay loam and clay loam subsoil. General farming is the | | |

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| | are the main farm enterprises, and most of the soils are now farmed. Alfalfa, corn for silage and grain, winter wheat, and kidney beans are the main crops. The steep, shallow soils on the slopes above Cayuga Lake are not suited to crops and generally idle, abandoned, or forested. Erosion is a hazard in areas where slopes are more than 5 percent, and excessive erosion has been partly responsible for the abandonment of cropland on the steep slopes along the lakes (USDA 1972). | main farming enterprise. Corn, oats, and hay are grown to feed the dairy herds, but large quantities of corn for grain, winter wheat, kidney beans, and sugar beets are also produced. The soils of this association are limited mainly by their moderately fine texture, which makes them difficult to work if moisture content is not right, and by slow drainage, which necessitates artificial drainage in places. Hazard of erosion is greater then on some soils because of the moderately fine texture and slow permeability. This area is suitable for industrial development where somewhat poorly drained soils are not a limitation. The bedrock, which is close to the surface in many places, provides a good bearing surface for structures. Rural development is limited by the slowly permeable subsoil and the impervious shale bedrock, which severely restrict the operation of septic tank disposal fields (USDA 1972). | | |
| Developed on Glacial Lake Sediments | <u>Schoharie-Odessa</u>: Deep, well drained to somewhat poorly drained soils that have a silty clay loam to clay subsoil. Dairying is the main farming enterprise. A large acreage is used for rotation and permanent pasture. Hay, mainly alfalfa and mixtures of alfalfa and grasses, is grown on most of the acreage. Oats and corn for either grain or silage are also important crops. These soils are subject to erosion, even on the gentle slopes, because their high content of silt and clay reduces the rate at which water enters and moves through the soils. This area is not well suited to industrial and residential development, because of the slow drainage and the difficulty of working these clayey soils, particularly when they are wet. The dominant soils are severely limited as sites for septic tank disposal fields (USDA 1972). | <u>Dunkirk-Collamer</u>: Deep, well-drained and moderately well drained soils that have a silt loam to silty clay loam subsoil. Most crops commonly grown in this area are suited to these soils if they are properly managed. Dairying is an important farming enterprise, and a considerable part of the association is used to grow forage crops for dairy herds. Most of the acreage is in corn for grain and silage, oats, and hay, but winter wheat and field beans are important cash crops. Hazard of erosion is severe, even on relatively gentle slopes, because these soils are made up of uniform very fine sand and silt, free of gravel and surface stones. Engineering problems are encountered when these soils are subjected to the stresses imposed by industrial structures or roads. Limitations for septic tank disposal fields are moderate to severe (USDA 1972). | | |
| | <u>Odessa-Lakemont</u>: Deep, dominantly somewhat poorly drained soils that have a silty clay loam to silty clay subsoil. Dairying is the main farming enterprise. The somewhat poor and poor drainage of the dominant soils limits their use and make irrigation neither practical nor necessary. Erosion is generally not a hazard on this association. The somewhat poorly drained and poorly drained condition of these soils severely limits 80 to 90 percent of this association for industrial and residential development (USDA 1972). | <u>Dunkirk-Cazenovia</u>: Moderately deep and deep, well drained and moderately well drained soils that have a silt loam to silty clay loam subsoil that overlies limestone. General farming and dairying are the main farming enterprises. Most of the acreage farmed is in forage crops grown to feed dairy cattle, but winter wheat and field beans are important cash crops. Nearly level topography of these soils reduces the risk of soil loss through erosion. Where the slopes are more than 2 to 4 percent, however, these sandy and silty soils are highly erodible. The land is suitable for industrial and residential development (USDA 1972). | | |
| | | <u>Arkport-Claverack</u>: Deep, dominantly well drained and moderately well drained soils that are loamy fine sand and fine sandy loam throughout or that have a loamy fine sand subsoil over silty clay or clay. The association varies considerably in soils, topography, and drainage. It is not farmed intensively, and a considerable amount of acreage, especially in the southern part, is idle or abandoned. Many of the farms are small and some of them are | | |

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| | | part-time operations. Unprotected areas of these soils are subject to both soil blowing and erosion. Erosion is a special hazard during freezing and thawing. When saturated sands thaw at the surface, they slide down the slopes on the still-frozen subsoil. The present topography is partially the result of soil blowing. The physical properties of the dominant soils make the area suitable for development. The rolling topography and good drainage of the higher areas make them suitable for rural residential development. In those places the soils are generally only slightly limited for septic tank disposal fields (USDA 1972). | | |
| **Tompkins County** | | | | |
| Developed in Glacial Till | <u>Lima-Honeoye</u>: Dominantly moderately well drained, silty soils on gently rolling to moderately steep topography. Dairying and the production of winter wheat and field beans are the principle agricultural pursuits. Farms are medium sized. These soils make good building sites, but the underlying compact glacial till absorbs septic tank effluent very slowly and may cause trouble during wet periods or when the soils are frozen. The more nearly level areas are the most likely to cause difficulty (USDA 1965). | <u>Conesus-Lansing</u>: Moderately well drained and well-drained, medium-textured soils on gently rolling topography. The association is fertile and productive and is well suited to the crops commonly grown. Dairying is the type of farming. Hay, oats, and corn are common crops. Winter wheat and field beans are grown as well. The clayey subsoil and the compact substratum of limy glacial till interfere with sewage disposal (USDA 1965). | Langford-Erie: Moderately well drained and somewhat poorly drained, medium-textured soils on rolling to moderately steep topography. Dairying is the main type of farming, and most of the acreage in crops is in oats, corn for silage, and grass-legume hay. Field beans, winter wheat, and cabbage are grown to some extent. Sewage disposal is a problem on the fragipan soils because of low permeability. The dense fragipan makes good building foundations, but it also holds water unless adequate toe drains and outlets are provided (USDA 1965). | |
| | | | <u>Erie-Langford</u>: Dominantly somewhat poorly drained, silty soils on mild topography. The somewhat poor drainage of this association is the principle limitation in the use of these soils. Dairying is the main type of farming. Hay, oats, and short-season silage corn are the principle crops. Slow surface runoff, slow permeability, and slow internal drainage result in wetness and problems of sewage disposal (USDA 1965). | |
| | | | <u>Volusia-Lordstown</u>: Somewhat poorly drained and well-drained soils on rolling to steep topography. This association is less favorable for farming than most. The growing season is somewhat shorter, the region is less accessible, and the soils generally are somewhat less productive than equivalent low-lime soils. Slow drainage, a compact fragipan, and strongly acid reaction limit its use. Dairying is the main type of farming; oats and hay are the most important crop. Potatoes and silage corn are planted as well (USDA 1965). | |
| | | | <u>Lordstown-Mardin</u>: Well drained and moderately well drained, shallow and deep soils on rolling to steep topography. Where relief and depth are favorable, they can be used for farming. The soils in this association are generally too steep for anything except woodland, wildlife, and recreational uses (USDA 1965). | |
| Developed on Glacial | <u>Hudson-Cayuga</u>: Dominantly moderately well drained, heavy textured soils on moderate to steep | | | |

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| Till and Lake-Laid Material | slopes. Steep slopes and high erodibility limit the agricultural use of these soils. Intensive conservation practices are required to control water movement and to prevent excessive soil loss. Dairying is the main framing, but a considerable acreage on the west side of Cayuga Lake is used for grapes and tree fruits. Where the topography is favorable, the soils are will suited to the field crops, such as corn, oats, wheat, and legume-grass hay, commonly grown on dairy farms. They are especially well suited to alfalfa because of their high-lime status and very high potassium-supplying power. Many residences are located in this association along the shores of Cayuga Lake. The soils however, are not well suited to large buildings or structures unless the foundations can be placed in the underlying till or bedrock. Sewage disposal is a problem because of the slowly permeable clay in the subsoil (USDA 1965). | | | |
| Developed on Lake-Laid Material | <u>Hudson-Rhinebeck</u>: Moderately well drained and somewhat poorly drained, heavy-textured soils generally free of stones and gravel. The soils in this association are fertile and are generally limy in the subsoil, but they are somewhat difficult to work. They are highly erodible, even on gentle slopes, and favorable tilth is difficult to maintain. Sewage effluent is a problem if houses are built beyond existing municipal sewage systems (USDA 1965). | | | |
| Developed on Glacial Outwash | <u>Palmyra</u>: Well-drained, light textured soils on stratified sand and gravel. Where relief is favorable, these highly productive soils have few limitations for the crops commonly grown. The soils are permeable and absorb effluent from septic tanks readily. Consequently, there is a serious risk of septic tank effluent contaminating groundwater supplies. Sewage systems located on the low-lying alluvial soils may have backup problems during wet weather (USDA 1965). | | | |
| Developed on Glacial Outwash and Till | | <u>Howard-Valois</u>: Mainly well-drained, light textured and medium-textured, gravelly soils on level, rolling, or steep topography. Alluvial soils are not extensive in the Tompkins County portion of the watershed. The largest areas occur at the south end of the Lake and along the Cayuga Inlet. Small areas occur along Cascadilla, Fall, Trumansburg, Taughannock, and other smaller creeks. Some of the best farms in Tompkins County are located in this association. Dairying is the main type of farming, and most of the land is used to grow crops to feed dairy cattle. Corn, oats, and hay are the principle crops. The soils are generally well suited to use as building sites (USDA 1965). | | |

*Time*
Time is a passive soil-forming factor. The degree of profile development reflects the age of a soil, and it reflects the influence of other factors. In geological terms, the deposits from which the soils in the Cayuga Lake Watershed formed are relatively young. Most of the material was left after the last glacier melted 10,000 to 15,000 years ago. All the soils have not reached the same stage of development, however, because other soil-forming factors influence the rate and kind of development.

General Soil Associations

General soil associations for the watershed can be seen on Map 2.6.2.1 and associated Table 2.6.1. For descriptive purposes the soils of the watershed have been broken down by lime content, county, and the nature of soil development.

**2.7 Surface Water Resources**

Cayuga Lake is the second largest Finger Lake in volume and has the largest watershed while serving as the principal water resource for the watershed. The lake is 38.2 miles long with a maximum width of 3.5 miles and 95.3 miles of shoreline. The drainage basin or watershed is 785 square miles. Cayuga Lake drains through the Oswego River system to Lake Ontario. The primary users of surface water in the watershed are located at the southern end of the lake and include the City of Ithaca, Cornell University, and the Bolton Point Water System which serves the towns of Dryden, Ithaca, and Lansing, and the villages of Cayuga Heights and Lansing.

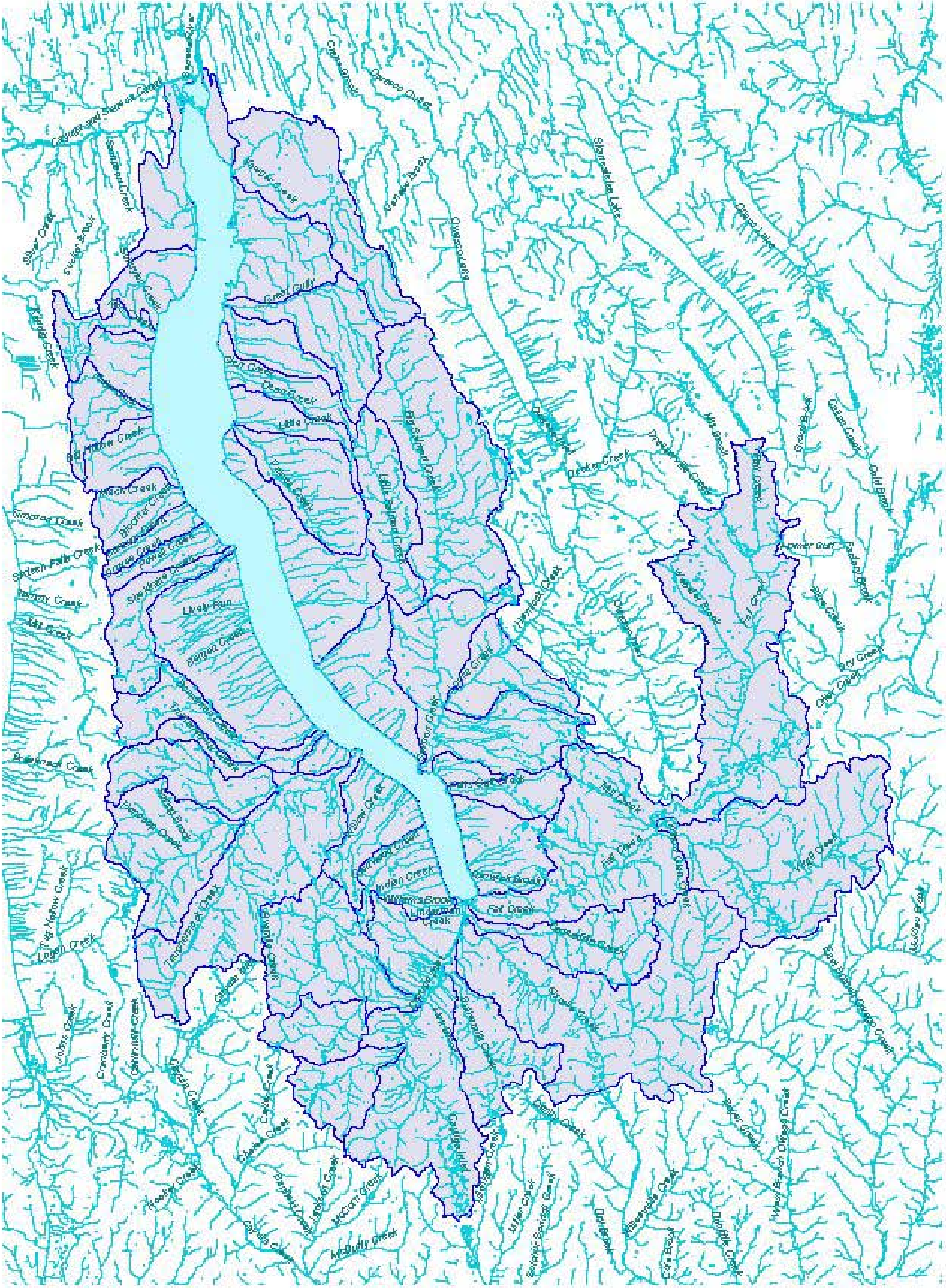
Figure 2.7.1. Mudlock

The control structure at Mud Lock, located at the north end of the lake, regulates the water level of Cayuga Lake. As part of the New York State Barge Canal System, the NYS Thruway Authority controls Mud Lock. According to Oglesby, “The general strategy is to draw the lake down in mid-December to minimize ice damage to shoreline structures and for maximizing storage during the period of heavy spring runoff” (Oglesby).

The quantity and quality of water in Cayuga Lake depends on the quality of water that drains into it from tributaries and runoff within the watershed. The watershed acts as a funnel for water from these inlets and overland runoff to the lake. For this report, the Cayuga Lake Watershed is made up of 46 subwatersheds that drain into the lake through streams. Map 2.7.1, Cayuga Lake Watershed Hydrography, displays the subwatersheds and their streams.

According to a report issued by the US Army Corps of Engineers, the largest tributary of Cayuga Lake “is Fall Creek with a drainage area of 128 square miles” (US ACE). Other principal tributaries of Cayuga Lake (and their drainage areas at mouth of stream) include Salmon Creek (89.2 square miles), Cayuga Inlet (86.7 square miles), Taughannock Creek (67 square miles), Sixmile Creek (49.6 square miles), Yawger Creek (24.9 square miles), Paines Creek (15.4 square miles – not taken at mouth), and Great Gully Creek (15 square miles).
Cayuga Lake is an “open” system and is therefore subject to contamination from point and non-point sources that enter the lake via runoff into tributaries or directly into the lake itself. These contaminants can result in waterborne diseases that afflict humans and the entire ecological system when exposed to contaminated surface water. The NYS Department of Health (NYSDOH) regulates municipal water systems, businesses, and other systems that serve five or more residences or 25 or more individuals. Regulation and enforcement of water quality standards by the NYSDOH is provided for under the NYS Sanitary Code Subpart 5-1. The NYSDEC also plays a prominent role through the permitting of

# Cayuga Lake Watershed Hydrography



This map was prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.

Source: New York State Department of Environmental Conservation, 1998.
Genesee/Finger Lakes Regional Planning Council, 1998.

Base Map: New York State Department of Transportation, February 1996.

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Prepared by Genesee/Finger Lakes Regional Planning Council, 1999.

| Table 2.7.1 Public Surface Water Systems in the Cayuga Lake Watershed | | | |
|---|---|---|---|
| System Location | Communities Served | Retail Population | Production (gallons/day) |
| *Cayuga County* | | | |
| Village of Cayuga | Village of Cayuga and portions of the Town of Aurelius north of the village along Rt. 90 | 600 | 1,710 |
| Wells College | Village of Aurora | 950 | 3,980 |
| *Cortland County* | No Public Surface Water Systems | | |
| *Schuyler County* | | | |
| *Seneca County* | | | |
| Seneca Falls | Town and Village of Seneca Falls | 7,400 | 3,500,000 |
| *Tioga County* | No Public Surface Water Systems | | |
| *Tompkins County* | | | |
| Bolton Point Water System | Towns of Dryden, Ithaca, and Lansing and Villages of Cayuga Heights and Lansing | 25,000 | 9,000,000 |
| Cornell University | Cornell University and City of Ithaca | 25,000 | 3,600,000 |
| City of Ithaca | City of Ithaca | 28,000 | 7,000,000 |

Sources: Cayuga County Health and Human Services Dept. - Environmental Health, Cortland County Health Dept. - Division of Environmental Health, Schuyler County Public Health Agency, Seneca County Public Health Dept., Tioga County Dept. of Environmental Health, Tompkins County Dept. of Health - Division of Environmental Health, 1999.

Two major pathogens that have been associated with animal waste are cryptosporidium parvum, and giardia lamblia. No safe and effective form of specific treatment for cryptosporidiosis has been identified to date. The parasite is transmitted by ingestion of oocysts excreted in the feces of infected humans or animals. The infection can therefore be transmitted from person-to-person, through ingestion of contaminated water (drinking water and water used for recreational purposes) or food, from animal to person, or by contact with fecally contaminated environmental surfaces. Giardiasis is an illness caused Giardia lamblia, a one-celled, microscopic parasite that lives in the intestines of people and animals. During the past 15 years, Giardia lamblia has become recognized as one of the most common causes of waterborne disease in humans.

The largest public surface water systems in the watershed are located at the southern end of the lake. The City of Ithaca's water system has the largest retail population at 28,000 and produces nine million gallons per day on average. The Bolton Point Water System, which serves five municipalities, and Cornell University also use large amounts of surface water in the basin and are located at the southern end of the lake. The Village and Town of Seneca Falls have a public water system that uses water directly from Cayuga Lake to supply a retail population of 7,400. The villages of Cayuga and Aurora are the only other two public water supply systems in the watershed that use surface water. There are no public surface water systems in the Cortland, Schuyler, or Tioga county portions of the watershed. Table 2.7.1 displays the location of public systems that use surface water from Cayuga Lake along with the communities served, retail population, and production in gallons per day.

Scattered throughout the Cayuga Lake Watershed are state regulated freshwater wetlands. Over time, many have been drained, filled, and fragmented leaving those that remain in small isolated pockets. The most significant concentrations are in the northern tip as part of the Montezuma National Wildlife Refuge, the Red Creek Subwatershed in the Town of Varick, and at the southern end in the Town of Danby. The locations of regulatory freshwater wetlands within the watershed are presented in Map 2.12.11.

**2.8 Groundwater Resources**

Ground water is water which moves from the land surface, infiltrates the soil, and fills pore spaces in unconsolidated materials (gravel, sand, silt, or clay) and/or fractures in bedrock. An aquifer is a locally or regionally connected zone of unconsolidated deposits and/or bedrock fractures which easily yields water to springs or wells.

Many residents, businesses, and others within the watershed access groundwater supplies through wells. There are five primary types of wells: dug, drilled, bored, jetted, and driven. Drilled wells are the deepest reaching depths of 750 to 300 feet. The majority of systems using groundwater have a retail population of less than 1,000. The only groundwater systems with a retail population over 1,000 are municipal systems located in located in Union Springs, the Village of Dryden, and Trumansburg. Table 2.8.1 presents public groundwater systems in the watershed and their corresponding retail populations where applicable.

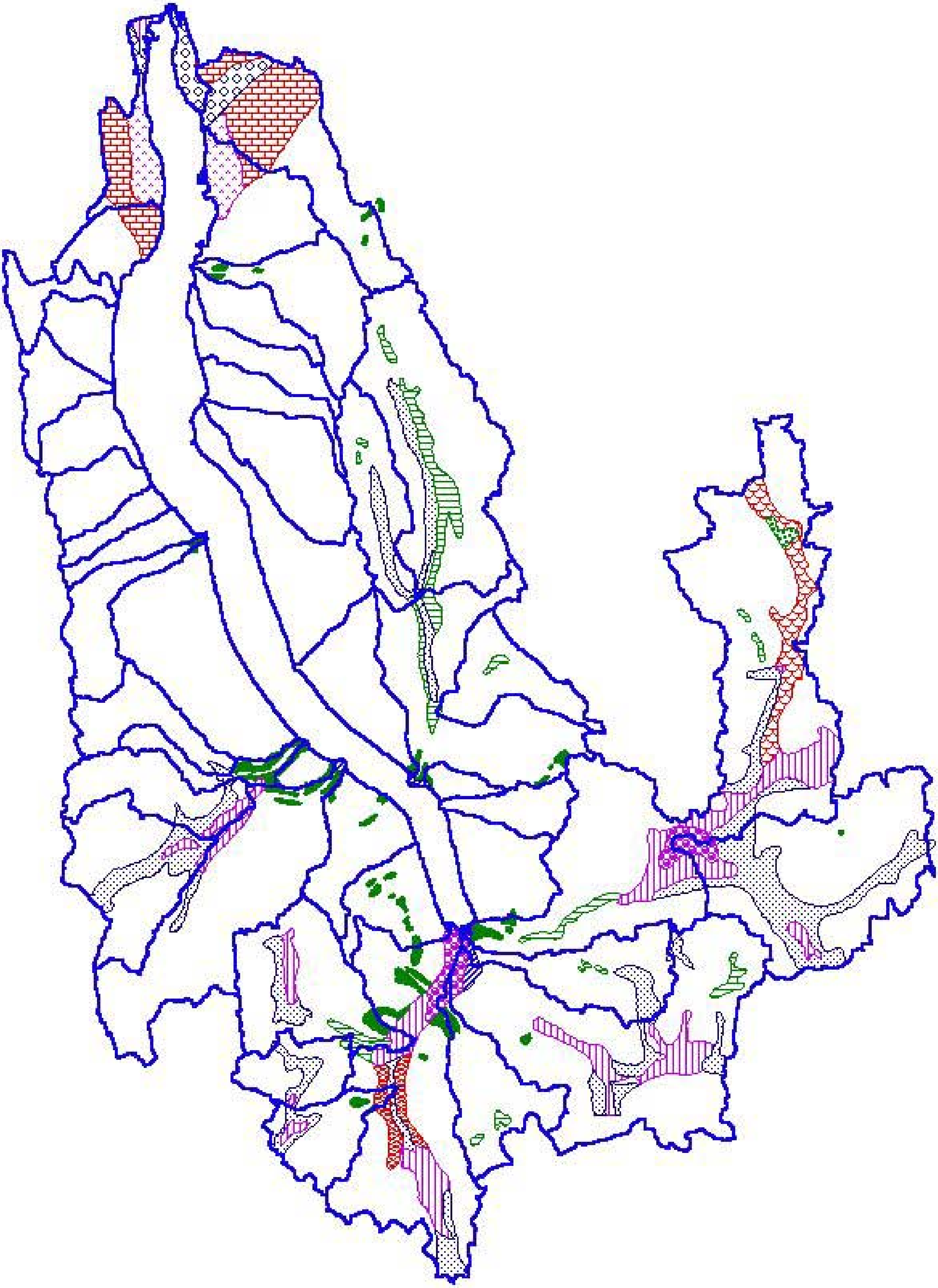
| **Table 2.8.1. Public Groundwater Systems in the Cayuga Lake Watershed** | |
|---|---|
| Name (Town) | Retail Population (persons unless otherwise noted) |
| *Cayuga County* | |
| Town of Genoa/King Ferry (Genoa) | 800 |
| Village of Union Springs (Springport) | 2,000 |
| *Cortland County* | |
| Elm Tree Golf Course (Virgil) | 100 |
| Trails End Campground (Virgil) | 75 |
| Virgil Elementary School (Virgil) | 150 |
| *Schuyler County* | |
| Blueberry Campground - seasonal (Hector) | 25 |
| Butternut Mobile Home Park (Hector) | 21 |
| Country Home Manor (Hector) | 50 |
| Potomac Campground - seasonal (Hector) | 25 |
| *Seneca County* | |
| Village of Interlaken (Covert) | 644 |
| *Tioga County* | |
| No Public Groundwater Systems | |
| *Tompkins County* | |
| 17 Railroad (Dryden) | 3 Businesses |
| A-1 Pizza (Dryden) | N/A |
| Annee T. Apartments (Dryden) | 8 Apartments |
| Arrowbrook Farm (Dryden) | 8 Apartments |
| B & B Mobile Home Park (Dryden) | 7 Sites |
| Bailey Mobile Home Park (Danby) | 14 Double Sites |
| Barangus Restaurant (Ulysses) | N/A |
| Beaconview Mobile Home Parks (Dryden) | 44 Sites |
| Big Al's Get-N-Go (Dryden) | N/A |
| Boxwood Apartments (Newfield) | 8 Apartments |
| Brook Woods Mobile Manor (Lansing) | 20 Sites |
| Brookside Apartments (Ulysses) | 8 Apartments |
| Brookside Mobile Home Park (Dryden) | 4 Sies |
| Brookview Apartments (Dryden) | 24 Apartments (50) |
| Buttermilk Apartments (Danby) | 9 Apartments |
| Caroline Elementary School (Caroline) | N/A |
| Cayuga Nature Center (Ulysses) | 100 |
| Cecil's Restaurant (Lansing) | N/A |
| Cedar View Golf Course (Lansing) | 49 |
| Central NY Spiritualist Camp (Dryden) | 20 |
| Chef Yeppi Presents (Ithaca) | N/A |
| Clover Land Mobile Home Park (Newfield) | 28 sites |
| CNG Transmission (Dryden) | 4 Homes, 2 Community Buildings |
| Collegeview North (Enfield) | 38 Sites |
| Common Ground Restaurant (Danby) | N/A |
| Congers Mobile Home Park (Dryden) | 114 Sites |
| Corning Apartments (Dryden) | 46 Apartments |
| Country Acres Mobile Home Park (Dryden) | 102 Sites |
| Country Garden Apartments (Dryden) | 20 Apartments |
| Country Garden Tea Room (Lansing) | N/A |
| Country Manor Estates Trailer Park (Dryden) | 14 Sites (24) |
| Country Meadows Apartments (Dryden) | 6 Apartments |
| Covenant Love Community School (Dryden) | N/A |
| Crooked Board Restaurant (Caroline) | N/A |
| Dalebrook Apartments (Caroline) | 4 Apartments, 1 Post Office |
| Deerfield Apartments (Dryden) | 6 Apartments |

| | |
|---|---|
| Deibler Apartments (Dryden) | 8 Buildings |
| Depot Apartments (Caroline) | 5 Apartments |
| Enfield Elementary School (Enfield) | N/A |
| Etna Mills Apartments (Dryden) | 15 Apartments |
| Fall Creek Parke Mobile Home Park (Dryden) | 38 Sites |
| Fallbrook Apartments (Groton) | 8 Apartments |
| Fenner Apartments Mobile Home Park (Lansing) | 8 Sites |
| Fountain Glow Apartments (Dryden) | 8 Apartments |
| Fountain Manor Apartments (Caroline) | 24 Apartments |
| Frazoni Apartments (Dryden) | 6 Apartments |
| Freeville Elementary School (Dryden) | N/A |
| Garden Trailer Park (Enfield) | 6 Sites |
| George Jr. Republic (Dryden) | N/A |
| German Cross Road Apartments (Dryden) | 9 Apartments |
| Glenwood Apartments (Ulysses) | 8 Apartments |
| Gray Haven Motel (Ithaca) | 49 |
| Green Acres Mobile Home Park (Caroline) | 12 Sites |
| Groton Golf & Recreation (Groton) | N/A |
| H & E Machine (Danby) | 80 |
| Hayts Trailer Park (Enfield) | 6 Sites |
| Hickory Stick Apartments (Ulysses) | 7 Apartments |
| Hill and Dale Apartments (Dryden) | 8 Apartments |
| Hillendale Golf Course (Enfield) | N/A |
| Hillside Apartments (Dryden) | 12 Buildings |
| Hillview Terrace Mobile Home Park (Danby) | 57 Sites |
| Holland Apartments (Dryden) | 14 Apartments |
| Hovlan Apartments (Lansing) | 14 Apartments |
| Iacovelli Apartments (Dryden) | 14 Apartments |
| ISA Breeders (Ulysses) | 30 |
| Island Grove Apartments (Dryden) | 11 Apartments |
| J & S Midline Mobile Home Park (Dryden) | 7 Sites |
| Jacksonville Apartments (Ulysses) | 8-9 Apartments (18) |
| J-A-M Mobile Home Park (Lansing) | 5 Sites |
| Jeslen Court Mobile Home Park (Groton) | 22 Sites (49) |
| Jewell Properties (Dryden) | 6 Apartments |
| Jim's Mobile Home Park (Newfield) | 16 Sites |
| Jim's Place (Caroline) | Convenience Store |
| Keith Lane (Dryden) | 8 Apartments |
| Knapp Apartments (Caroline) | 8 Apartments, 1 Single-family home |
| Kuma Restaurant (Enfield) | N/A |
| Lake Country Community Mobile Home Park (Dryden) | 149 Sites |
| Lake Ridge Point (Lansing) | N/A |
| Lake Road Apartments (Dryden) | 8 Apartments |
| Lakeview Golf Club (Dryden) | N/A |
| Lakeview Village Mobile Home Park (Lansing) | 30 Sites |
| Lansing Shore Apartments (Lansing) | 23 Apartments |
| Lansing Town Park (Lansing) | N/A |
| Lansingville Mobile Home Park (Lansing) | 10 Sites |
| Lehigh Crossing Apartments (Dryden) | 24 Apartments |
| Linda's Corner Diner (Lansing) | N/A |
| Little Creek Mobile Home Park (Dryden) | 100 Sites |
| LIU Apartments (Dryden) | 12 Apartments |
| Livery Restaurant (Caroline) | N/A |
| Longhouse Co-op (Ithaca) | 10 Units |
| Mandeville Apartments (Dryden) | 5 Apartments, 2 Cabins |
| Marion Apartments (Caroline) | 8 Apartments |
| Marquis Apartments (Dryden) | 17 Apartments |
| Matychak Apartments (Caroline) | 6 Apartments |
| McLean Elementary School (Dryden) | N/A |
| Meadowbrook Park (Newfield) | 240 Sites, 18 Apts. |
| Mott Road Mobile Home Park (Dryden) | 24 Sites (45) |
| Mountain View Manor Mobile Home Park (Caroline) | 17 Sites |
| Newfield Sunny's (Newfield) | 4 Businesses |
| Norman Apartments (Enfield) | 6 Apartments |

| | |
|---|---|
| Old 76 Club (Caroline) | N/A |
| Paradise Café (Ulysses) | N/A |
| Plantation Inn (Dryden) | N/A |
| Pleasant View Mobile Home Park (Dryden) | 49 Sites |
| Ponderosa Apartments (Enfield) | 5 Apartments |
| R. H. Treman Stae Park (Ithaca) | N/A |
| Rascal's Restaurant (Ulysses) | N/A |
| Red Barn Apartments (Caroline) | 6 Apartments |
| Rendano Apartments (Lansing) | 6 Apartments |
| Roman Village Restaurant (Groton) | N/A |
| Rose Inn (Lansing) | 34 |
| Sandy Creek Mobile Home Park (Enfield) | 85 Sites |
| Seabring Inn (Newfield) | N/A |
| Shady Grove Mobile Home Park (Dryden) | 18 Sites |
| Shagbark Apartments (Newfield) | 8 Apartments |
| Shelter Valley Mobile Home Park (Dryden) | 70 Sites |
| Siren's Restaurant (Groton) | N/A |
| Skyhook Apartments (Newfield) | 24 Apartments |
| Special Childrens' Center (Ulysses) | N/A |
| Spruce Row Campsite (Ulysses) | N/A |
| Stoney Brook Apartments (Enfield) | 14 Apartments |
| Sunrise Barn Apartments (Caroline) | 5 Apartments |
| Sunset Townhouses (Enfield) | 12 Apartments |
| Taughannock Falls State Park (Ulysses) | N/A |
| Teeter Trailer Park (Enfield) | 6 Sites |
| Thorpe Apartments (Dryden) | 5 Buildings |
| Town of Newfield | 900 |
| Tru Haven Apartments (Ulysses) | 15 Apartments |
| Ulysses Square (Ulysses) | N/A |
| Unity House (Dryden) | 10 Apartments |
| Upper Buttermilk Falls (Ithaca) | N/A |
| Valley Manor Mobile Home Park (Newfield) | 186 Sites |
| Village of Dryden (Dryden) | 2000 |
| Village of Trumansburg (Ulysses) | 2300 |
| Ward's Trailer Park (Newfield) | 70 Sites |
| Washington Heights Manufactured Home Park (Ulysses) | 13 Sites |
| Werninck Apartments (Dryden) | 10 Apartments |
| Werninck Subdivision (Dryden) | 48 |
| West Danby Water District (Danby) | 264 |
| White Apartments (Enfield) | 8 Apartments |
| White Tail Crossing Cottages (Lansing) | 4 Cottages |
| Willow Hill Mobile Court (Enfield) | 16 Sites |
| Willowood Campground (Newfield) | N/A |
| Wonderland Motel (Ithaca) | 80 |
| Xtra Mart (Dryden) | N/A |
| | N/A = not applicable |

Sources: Cayuga County Health and Human Services Dept. - Environmental Health, Cortland County Health Dept. - Division of Environmental Health, Schuyler County Public Health Agency, Seneca County Public Health Dept., Tioga County Dept. of Environmental Health, Tompkins County Dept. of Health - Division of Environmental Health, 1999.

# Cayuga Lake Watershed Maximum Yields to Individual Wells and Geologic Situations of Individual Aquifers



This map was prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.

1:358119

0 5 10 Miles

Source: United States Department of the Interior Geological Survey, 1974.
Genesee/Finger Lakes Regional Planning Council, 1998.

Base Map: New York State Department of Transportation, February 1996.

Prepared by Genesee/Finger Lakes Regional Planning Council, 1

# Cayuga Lake Watershed

## Maximum Yields to Individual Wells and Geologic Situations of Individual Aquifers

| | | |
|---|---|---|
| | <1 to 100 | Bedrock of moderate permeability overlain by till of low permeability |
| | 1 to 10 | Bedrock of low permeability overlain by sand and gravel. Best yields are obtained by wells drilled into rock but draining the thin saturated zone in sand and gravel at top of rock |
| | 1 to 150 | Bedrock of moderate permeability overlain by till or silt and clay |
| | 100 to 500 | Bedrock of high permeability with thick saturated zone overlain by till, sand and gravel, or silt and clay |
| | <1 to 100 | Sand or sand and gravel interbedded with silt and clay or till. Thin, saturated layers of moderately permeable material occurring at random |
| | 1 to 150 | Sand and gravel under water-table conditions but with thin saturated zone. May be necessary to drill into underlying bedrock to obtain adequate supply |
| | 5 to 250 | Sand and gravel of moderate transmissibility under water-table conditions |
| | 5 to 250 | Sand and gravel of moderate transmissibility under confined conditions, overlain by silt and clay |
| | 100 to 500 | Sand and gravel of high transmissibility under water-table conditions |
| | 100 to 500 | Sand and gravel of high transmissibility under confined conditions, overlain by silt and clay |
| | 250 to >1,000 | Sand and gravel of high transmissibility under water-table conditions |
| | 250 to >1,000 | Sand and gravel of very high transmissibility under confined conditions, overlain by silt and clay |

*Prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.*

*Source: United States Department of the Interior Geological Survey, 1974.*

*Prepared by Genesee/Finger Lakes Regional Planning Council, 1999.*

According to USGS (Miller) the unconsolidated aquifers in the Cayuga Lake watershed with the greatest potential yield are located in the Cayuga Inlet Valley and the Fall Creek Valley. These are confined sand and gravel aquifers overlain by less permeable materials -- silt, clay, or glacial till. Wells in these aquifers have the potential to yield from 5, to greater than 500 gallons per minute. A smaller, confined, valley-fill aquifer of lower yield potential lies southwest of the village of Trumansburg and is the back-up supply for the village.

Several small unconfined aquifers are found at the mouths of larger streams which enter Cayuga Lake and in the upper Salmon Creek valley. These aquifers have a potential yield of more than 100 gallons per minute. A few small unconfined aquifers lie northeast of Dryden and can yield between 10 and 100 gallons per minute. There are also several small kame terrace, outwash, or alluvial deposit unconfined aquifers adjacent to the large valley-fill aquifers and in the lower Salmon Creek valley. These aquifers yield generally less water than those described above, but can be enhanced if the aquifer is connected to surface water streams.

Elsewhere in the watershed, individual water supplies are generally from small unconsolidated deposits of varying yields or from bedrock. Bedrock aquifers in shale generally yield between 0.5 to 5 gallons per minute. Where limestone aquifers exist, these aquifers can yield from 10 to over 100 gallons per minute depending on whether karst development (natural widening of fractures) is present.

Natural water quality in the unconsolidated and bedrock aquifers vary by the aquifer source material, time of residence in the aquifer, and depth of the aquifer. Shallow aquifers generally yield softer water, but can be easily contaminated by land surface activities. Deeper aquifers generally have harder water, and can contain mineral salts and natural gas (methane and hydrogen sulfide). The potential for surface contamination in these aquifer is much less.

As with surface water, pollution from both point and non-point sources can contaminate groundwater making it unsafe for use by humans and animals. Because groundwater is stored in aquifers, water from precipitation and runoff can transmit pollutants into aquifers as it percolates through the pores of soils and sand and the cracks of bedrock eventually contaminating groundwater supplies. The chemical quality of groundwater is dependent on identifying and mitigating the effects of pollution, both from point and non-point surfaces. Those using groundwater from wells in agricultural areas need to be especially concerned with pesticide contamination through either accidental spills or improper disposal that allows pesticides to seep through soils or bedrock into drinking water supplies (USGS 1995).

According to a report published by the USGS (1975), calcium and sulfate concentrations were highest in the northern portion of the Oswego River Basin. In the southern portion of the watershed, high chloride concentrations were a problem, but only in deeper wells. High chloride concentrations in the northern end of the watershed were limited to the Seneca River and Barge Canal area near Mud lock. However, it should be noted that these characteristics may have changed given the age of the data.

### 2.9 Terrestrial Vegetation

The Cayuga Lake watershed falls completely within the regional forest formation designated as the Allegheny Section of the Northern Appalachian Highland Division of the Hemlock-White Pine Northern Hardwood Region (Braun 1950). This Allegheny Section is a broad forest type that begins at the northern edge of the Finger Lakes and continues south, covering most of the northern half of Pennsylvania and the southern half of New York. The U.S. Forest Service maps this area as the White Pine-Hemlock-Hardwood Forest Section (Lull 1968).

The watershed is located at the interface between the northern hardwoods (north of the Cayuga Lake to Lake Ontario) and the Yellow poplar- Tulip tree assemblage extending to the south (Lull 1968). As a result of local variation in microclimate, the Cayuga Lake watershed contains tree species common to both forest types. For example, northern red oak (*Quercus borealis*) is the most widely distributed hardwood, but other oaks (Quercus alba), hickory *(Carya glabra)*, and tulip trees (*Liriodendron tulpifera*) are present as well. In the northern or higher elevation areas, hardwoods typical of the beech-birch-maple region are common.

| Table 2.9.1 Area of Timberland by County, Geographic Unit, and Forest Type Group, 1993 | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (in thousands of acres) | | | | | | | | | | | | |
| | % of County in | White/ Red | Spruce/ | Loblolly / | Oak/ | Oak/ | Oak/Gum/ | Elm/Ash / | Northern | Aspen / | Total | Adjusted |
| | Watershed | Pine | Fir | Shortleaf | Pine | Hickory | Cypress | Red Maple | Hardwoods | Birch | Acres | Total Acres |
| Cayuga & Seneca | 33.0% | 0 | 5 | 0 | 0 | 34.3 | 0 | 62.4 | 103.6 | 10.2 | 215.5 | 71.1 |
| Cortland | 3.0% | 0 | 5.1 | 0 | 5 | 0 | 0 | 21.5 | 135.4 | 0 | 167 | 5.0 |
| Schuyler | 4.5% | 5.4 | 5.1 | 0 | 5.1 | 21.6 | 0 | 0 | 69.9 | 11.4 | 118.5 | 5.3 |
| Tioga | 0.5% | 32 | 4.9 | 0 | 0 | 20.9 | 0 | 0 | 121 | 5.3 | 184.1 | 0.9 |
| Tompkins | 59.0% | 10.4 | 4.9 | 0 | 15.8 | 20.5 | 0 | 18.5 | 87 | 0 | 157.1 | 92.7 |
| Source: Forest Statistics for New York: 1980-1993, USDA Forest Service, 1993 | | | | | | | | | | | | |

| Table 2.9.2 Area of Timberland by County, Geographic Unit, and Stand-Size Class, 1993 | | | | | | | |
|---|---|---|---|---|---|---|---|
| (in thousands of acres) | | | | | | | |
| | % of County in | | | Sapling & | Non- | | Adjusted |
| | Watershed | Sawtimber | Poletimber | Seedling | Stocked | Total | Total Acres |
| Cayuga & Seneca | 33.0% | 123.0 | 48.1 | 44.4 | 0.0 | 215.5 | 71.1 |
| Cortland | 3.0% | 84.8 | 30.1 | 52.0 | 0.0 | 166.9 | 5.0 |
| Schuyler | 4.5% | 59.4 | 42.4 | 16.8 | 0.0 | 118.6 | 5.3 |
| Tioga | 0.5% | 90.9 | 66.7 | 26.6 | 0.0 | 184.2 | 0.9 |
| Tompkins | 59.0% | 80.1 | 48.0 | 29.1 | 0.0 | 157.2 | 92.7 |
| Source: Forest Statistics for New York: 1980-1993, USDA Forest Service, 1993. | | | | | | | |

Other vegetation maps of the area consider the lower elevation segments of the watershed, which tend to be found in the northern portion, as part of the Lake Ontario lake plain forest (dominant species include chestnut (*Castanea dentata*), oaks, hickories and tulip tree). In contrast, the higher elevation areas (which tend to be found in the southern region of the watershed) are considered part of a more southern assemblage (sugar maples (*Acer saccharum*), beech (*Fagus grandifolia*), yellow birch (*Betula lutea*), hemlock (*Tsuga canadensis*) and white pine (*Pinus Strobus*) (Bray, 1930). Stand composition varies greatly with site and land-use history. On cool slopes, particularly after the selective cutting of conifers, northern hardwoods prevail.

Historically, terrestrial vegetation was quite different particularly in the amount of forested land. Original survey records provide a description of the character of the regional forest in the 1790s: "More than 97 percent of the landscape [of the Central Finger Lakes Region] was forested. Beech/maple/basswood was the predominant forest type throughout the region" (Marks, Gardescu, and Seischab 1992: 1).

The 1790 survey documented disturbance by wind, fire, beavers, and people on less than one percent of the land area. Western portions of the Cayuga Lake watershed were recorded as dominated by linden (*Tilia americana*), maple (*Acer saccharum*), oak (*Quercus rubra*), and ash (*Fraxinus americana*). Closer to Cayuga Lake the oaks and hickories became more prevalent. On the eastern side of the watershed, an oak-hickory association was common. Progressing south, pine (*Pinus strobus*) and oak groups increased, and a few areas of hemlock (*Tsuga canadensis*) and beech (*Fagus americana)* were recorded.
The present vegetation of the watershed bears little resemblance to the original cover. The forest vegetation of the upland areas has been profoundly modified by lumbering and fire in the earlier periods, and by urbanization in more recent times. Remnants of original forest cover remain in only a few places, preserved in state and local parks and wildlife refuges. These remnants indicate that the forest of the 1940's and 1950's was a hemlock-hardwood woodland in which hemlock *(Tsuga canadensis),* American beech *(Fagus grandifolia),* and sugar maple *(Acer saccharum) (*in that order) were the most abundant in the canopy. American beech far

| Table 2.9.3 Area of Timberland by County, Geographic Unit, and Cubic-Stand-Volume Class, 1993 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| (in thousands of acres) | | | | | | | | | |
| | % of County in | Stand-Volume-Class (cubic feet per acre) | | | | | | | Adjusted total |
| | Watershed | 0-499 | 500-999 | 1000-1499 | 1500-1599 | 2000-2499 | 2500+ | Total | cubic feet/acre |
| Cayuga & Seneca | 33.0% | 60.20 | 16.90 | 41.20 | 50.00 | 10.40 | 36.90 | 215.60 | 71.1 |
| Cortland | 3.0% | 56.20 | 22.80 | 12.20 | 18.00 | 43.60 | 14.10 | 166.90 | 5.0 |
| Schuyler | 4.5% | 32.60 | 22.00 | 21.10 | 10.20 | 16.30 | 16.30 | 118.50 | 5.3 |
| Tioga | 0.5% | 32.00 | 37.80 | 30.30 | 38.10 | 35.90 | 10.10 | 184.20 | 0.9 |
| Tompkins | 59.0% | 29.10 | 22.90 | 44.10 | 15.20 | 25.90 | 20.10 | 157.30 | 92.8 |
| Source: Forest Statistics for New York: 1980-1993, USDA Forest Service, 1993. | | | | | | | | | |

outnumbered other species in the subdominant layer and was well represented in all size classes (Braun 1950). Other prevalent species were black cherry *(Prunus serotina),* black birch *(Betula lenta),* yellow birch *(Betula alleghaniensis),* red maple *(Acer rubrum)* and white ash *(Fraxinus americana).* Tulip tree *(Liriodendron tulipifera),* cucumber magnolia *(Magnolia acuminata),* and basswood *(Tilia americana)* were also present. Herbaceous plants included spinulose wood fern *(Dryopteris spinulosa),* shining clubmoss *(Lycopodium lucidulum),* white wood sorrel *(Oxalis montana),* partridge berry *(Mitchella repens),* and Canada mayflower *(Maianthemum canadense).*

Presently, northward extensions of oak and oak-chestnut forests reach into New York State and are mainly established on gravelly soils in the valley head moraine belt south of the lake.

Diversity in topography and soils and the admixture of southern species give the watershed vegetation more variety than other areas typically mapped as this Hemlock-White Pine-Northern hardwoods region. The hemlock-beech and its variant, hemlock-beech red maple assemblages occupy the most mesic (average moisture conditions) habitat, while a more mixed type seems to be transitional between this and the hemlock-white oak (*Quercus alba*) white pine type of the warmer (southeast and southwest) slopes. The white pine-hemlock and hemlock-white pine-red maple (*Acer rubrum*) communities are developmental steps in which the large amount of white pine (which reproduces best in the open) is related to some site disturbance such as drought and fire (Braun, 1950).

The composition of the forest today can also be gauged through the countywide forest inventories by the US Forest Service. Forests of the northeastern and northwestern ends of the watershed in Cayuga and Seneca counties are made up of northern hardwoods including maple, beech and birch trees. The southern end of the lake, now mostly developed, was once filled with dense forests of northern hardwoods as well.

From the table it is apparent that Cayuga, Seneca, and Tompkins have the highest number of acres in forest. The total acres adjusted for the percentage of the county in the watershed is 175,000 acres. Based on the stand-size class of trees by county, the forests in the watershed are maturing and moving out of the early stages of succession. This has an impact on wildlife, particularly birds that inhabit the trees. The stand-size class for trees in counties in the watershed is provided above (Table 2.9.2)

While not an optimal measure of density, cubic-foot-stand-volume class can be used to compare the stocking or manner in which trees grow in an area against other areas. The areas of the watershed with the largest stand-volume class by county are located in the southern end of the watershed. A table of cubic-foot-stand-volume class is shown above (Table 2.9.3).

The highest average annual removals of growing stock trees in the watershed between 1979-1992 occurred in Tompkins County. During the same period, the highest number of removals as measured by board feet occurred in Cortland County. Schuyler County had the lowest number of removals as determined by both measures. While Cayuga and Seneca Counties had the largest quantity of trees in the watershed, these counties combined had the lowest number of removals. Displayed below (Table 2.9.4) are the average annual removals as measured by cubic feet growing stock and board feet of sawtimber. Total adjusted board feet of lumber removed in 6,448.

**Table 2.9.4 Average Annual Removals of Growing-Stock and Sawtimber Volume on Timberland by County, Geographic Unit, and Species Group, 1993**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | (in thousands of feet) | | | | |
| | | | Growing-Stock | | | Sawtimber | | |
| | % of County in | | (cubic feet) | | | (board feet) | | Adjusted |
| | Watershed | Softwoods | Hardwoods | All Groups | Softwoods | Hardwoods | All Groups | Board feet |
| Cayuga & Seneca | 33.0% | 37 | 651 | 688 | 189 | 2943 | 3132 | 1033.6 |
| Cortland | 3.0% | 74 | 2452 | 2526 | 205 | 9616 | 9821 | 294.6 |
| Schuyler | 4.5% | 0 | 261 | 261 | 0 | 1028 | 1028 | 46.3 |
| Tioga | 0.5% | 147 | 2147 | 2294 | 360 | 6285 | 6645 | 33.2 |
| Tompkins | 59.0% | 175 | 2396 | 2571 | 113 | 8431 | 8544 | 5041.0 |
| Source: Forest Statistics for New York: 1980-1993, USDA Forest Service, 1993. | | | | | | | | |

Large cattail (*Typha latifolia*) and iris (*Iris* sp.) marshes, and elm-silver maple swamps have developed in northern portions of the glacially filled valleys, notably in Montezuma Wildlife Refuge which is owned by the U.S. Fish and Wildlife Service. These vegetative communities are extensions of the vegetation association of the adjacent lake plain. Large wetland areas on the southern end of the lake existed in the past but have been filled for urban uses or parks.

Bogs occur frequently on the glaciated Allegheny Plateau. Black spruce (*Picea mariana*), tamarack (*Larix laricina*), and balsam fir (*Abies balsamea*) are constituents of the forest in this area. White pine, hemlock, red maple and sour gum (*Nyssa sylvatica*) may occupy the bog borders. *Chamaedaphne*, *Ledum*, and *Nemo phanthus* are common bog shrubs. Species of *Vaccinium*, *Viburnum*, *Spiraea* are often present in the bog border.

A unique quaking bog, Junius Bog, is located near Mays Point in the Montezuma National Wildlife Refuge (NWR). This quaking bog, approximately 25 to 35 acres in size, is intermediate between a bog and a fen, with a number of plants representative of both. The bog waters have thick marl deposits Johnson, 1985). Another example of a unique wetland within the Cayuga Lake watershed is Ringwood Bog near Freeville. The small 20-acre acidic bog (which is owned by Cornell University) is unusual since regional bog waters are typically neutral to basic pH, reflecting the underlying calcareous bedrock. Ringwood Bog has typical northern bog plants, such as sphagnum mosses, leatherleaf, black spruce, and some highbush blueberry (*Vaccinium corymbosum*).

The NYSDEC, Division of Fish, Wildlife and Marine Resources, Wildlife Resources Center, New York Natural Heritage Program has two listings for rare and endangered species in the watershed. They are existing occurrences and species known only from historical records. For terrestrial vegetation in the watershed 23 species are listed as rare, 3 species is listed as exploitably vulnerable, 12 species are listed as threatened, and 10 species are listed as endangered (NYSDEC, 1999). Based on the Users Guide to NY Natural Heritage Data, the data provided in the report (NYSDEC, 1999) is ecologically sensitive and should be treated in a sensitive manner. The report should not be released, distributed or incorporated in a public document. For additional information on rare and endangered species in the Cayuga Lake Watershed contact the NYSDEC, Division of Fish, Wildlife and Marine Resources, Wildlife Resources Center, New York Natural Heritage Program.

| Table 2.10.1 1997 Deer Take by Town and City for Municipalities in the Cayuga Lake Watershed, 1997. | | | | | |
|---|---|---|---|---|---|
| | **Buck Take** | **Total Take** | | **Buck Take** | **Total Take** |
| *Cayuga County* | | | *Seneca County* | | |
| Town of Aurelius | 46 | 95 | Town of Covert | 110 | 162 |
| Town of Fleming | 35 | 70 | Town of Fayette | 94 | 186 |
| Town of Genoa | 100 | 204 | Town of Lodi | 129 | 224 |
| Towne of Ledyard | 111 | 268 | Town of Ovid | 94 | 176 |
| Town of Locke | 74 | 162 | Town of Romulus | 113 | 268 |
| Town of Scipio | 76 | 135 | Town of Seneca Falls | 66 | 116 |
| Town of Sempronious | 56 | 98 | Town of Varick | 32 | 80 |
| Town of Springport | 73 | 124 | Seneca County Total | 638 | 1212 |
| Town of Summerhill | 48 | 111 | *Tioga County* | | |
| Town of Venice | 74 | 140 | Town of Spencer | 245 | 458 |
| Cayuga County Total | 693 | 1407 | Tioga County Total | 245 | 458 |
| *Cortland County* | | | *Tompkins County* | | |
| Town of Cortlandville | 139 | 196 | Town of Caroline | 244 | 483 |
| Town of Harford | 60 | 78 | Town of Danby | 285 | 540 |
| Town of Homer | 145 | 227 | Town of dryden | 336 | 643 |
| Town of Scott | 54 | 110 | Town of Enfield | 161 | 272 |
| Town of Virgil | 135 | 142 | Town of Groton | 119 | 340 |
| Cortland County Total | 533 | 753 | City of Ithaca | 178 | 303 |
| *Schuyler County* | | | Town of Ithaca | 1 | 1 |
| Town of Catharine | 158 | 292 | Town of Lansing | 180 | 408 |
| Town of Hector | 415 | 711 | Town of Newfield | 349 | 598 |
| Schuyler County Total | 573 | 1003 | Town of Ulysses | 142 | 228 |
| | | | Tompkins County Total | 1995 | 3816 |

Source: NYSDEC, Division of Fish, Wildlife, & Marine Resources, March 1998.

## 2.10 Wildlife

The Cayuga Lake Watershed contains a number of diverse habitats that support a wide array of wildlife. Forests and wetlands throughout the watershed, as well as agricultural lands and transitional areas, provide dwelling and feeding areas for various species of mammals, birds, reptiles and amphibians.

Based on the division of New York State into ecozones, nearly the entire Cayuga Lake Watershed is within the Erie-Ontario Plain. The ecozones are determined by major physiographic differences to provide a breakdown for the proper management of wildlife habitats by area. The land forms and local relief as they affect soils, climate, and vegetation determine the habitats contained in the ecozone and thus determine the species of wildlife that will reside in that ecozone.

The Montezuma National Wildlife Refuge at the northern end of the watershed encompassed approximately 36,000 acres and provides habitats for a number of species. The refuge's primary purpose is to provide habitats for waterfowl, migratory birds, and endangered species. In addition, nearly 75% of the refuge is classified as wetland, adding to the diversity of wildlife already present in the watershed.

The NYSDEC, Division of Fish, Wildlife and Marine Resources, Wildlife Resources Center, New York Natural Heritage Program has two listings for rare and endangered species in the watershed. They are existing occurrences and species known only from historical records. For wildlife in the watershed 2 species are listed as threatened, and 1 species is listed as endangered, and 5 species are listed as protected (NYSDEC, 1999). Based on the Users Guide to NY Natural Heritage Data, the data provided in the report (NYSDEC, 1999) is ecologically sensitive and should be treated in a sensitive manner. The report should not be released, distributed or incorporated in a public document. For additional information on rare and endangered species in the Cayuga Lake Watershed contact the NYSDEC, Division of Fish, Wildlife and Marine Resources, Wildlife Resources Center, New York Natural Heritage Program.

Table 2.10.2

| Mammals that Inhabit the Cayuga Lake Watershed | |
|---|---|
| Virginia Opossum | Red Fox |
| Masked Shrew | Gray Fox |
| Smoky Shrew | Bobcat |
| Pygmy Shrew | Woodchuck |
| Least Shrew | Eastern Chipmunk |
| Shorttail Shrew | Gray Squirrel |
| Starnose Mole | Red Squirrel |
| Hairytail Mole | Southern Flying Squirrel |
| Little Brown Myotis | Northern Flying Squirrel |
| Keen Myotis | Beaver |
| Indiana Myotis | Deer Mouse |
| Small-footed Myotis | White-footed Mouse |
| Silver-haired Bat | Southern Bog Lemming |
| Eastern Pipistrelle | Boreal Red-backed Vole |
| Big Brown Bat | Meadow Vole |
| Red Bat | Pine Vole |
| Hoary Bat | Muskrat |
| Raccoon | Meadow Jumping Mouse |
| Shorttail Weasel | Woodland Jumping Mouse |
| Longtail Weasel | Porcupine |
| Mink | Snowshoe Hare |
| River Otter | Eastern Cottontail |
| Striped Skunk | White-tailed Deer |
| Coyote | Water Shrew |
| Redback Vole | Norway Rat |
| Ermine | Least Weasel |

Source: *Integrating Forest Management Wildlife* , R.E. Chambers, School of Environmental Science & Forestry, Syracuse, NY.

Table 2.10.3

| Reptiles that Inhabit the Cayuga Lake Watershed | |
|---|---|
| Common Snapping Turtle | Northern Brown Snake |
| Stinkpot | Northern Redbelly Snake |
| Spotted Turtle | Eastern Garter Snake |
| Bog Turtle | Eastern Ribbon Snake |
| Wood Turtle | Northern Ringneck Snake |
| Map Turtle | Eastern Smooth Green Snake |
| Eastern Painted Turtle | Black Rat Snake |
| Eastern Spiny Softshell | Eastern Milk Snake |
| Coal Slink | Eastern Massasauga |
| Northern Water Snake | Timber Rattlesnake |
| Snapping Turtle | Northern Black Racer |
| Red-Bellied Racer | Smooth Green Snake |

Source: *Integrating Forest Management Wildlife* , R.E. Chambers, School of Environmental Science & Forestry, Syracuse, NY.

Table 2.10.4

| Amphibians that Inhabit the Cayuga lake Watershed | |
|---|---|
| Mudpuppy | Northern Spring Salamander |
| Jefferson Salamander | Northern Two-lined Salamander |
| Blue-Spotted Salamander | American Toad |
| Spotted Salamander | Northern Spring Peeper |
| Red-Spotted Newt | Gray Treefrog |
| Northern Dusky Salamander | Western Chorus Frog |
| Mountain Dusky Salamander | Bullfrog |
| Redback Salamander | Green Frog |
| Slimy Salamander | Wood Frog |
| Four-toed Salamander | Northern Leopard Frog |
| Pickerel Frog | Red-Backed Salamander |
| Spring Salamander | Spring Peeper |

Source: *Integrating Forest Management Wildlife* , R.E. Chambers, School of Environmental Science & Forestry, Syracuse, NY.

Small game species present in the watershed include deer, coyote, opossum, rabbit, squirrel, hare, raccoon, red and gray fox, grouse, pheasant, woodcock, ducks, and geese. The reported deer takes in towns in the watershed and the City of Ithaca in 1997 are provided in Table 4.10.1.

An inventory of the mammals, breeding birds, reptiles and amphibians that inhabit the forested riparian habitats of the Erie-Ontario Plain and the wetlands of the Montezuma NWR are provided in the Tables 4.10.2-5.

Table 2.10.5

**Birds Known to Inhabit or Frequent the Cayuga Lake Watershed by Abundance and Seasonal Occurrence**

| | | | |
|---|---|---|---|
| Acadian Flycatcher* (RS) | Black-crowned Night Heron* (FM,FS) | Common Black-headed Gull (Acl) | Forster's Tern (RM) |
| Alder Flycatcher* (FM,FS) | Black-legged Kittiwake (Acl) | Common Eider (Acl) | Fox Sparrow (FM,RW) |
| American Avoset (RM) | Blackpoll Warbler (FM) | Common Flicker | Franklin's Gull (Acl) |
| American Bittern* (UM,US) | Black-throated Blue Warbler* (FM,US) | Common Goldeneye (FM,FW) | Fulvous Whistling Duck (Acl) |
| American Black Duck* (AM,US) | Black-throated Gray Warbler (Acl) | Common Grackle* (AM,CS,UW) | Gadwall* (FM,US,RW) |
| American Coot* (AM,CP) | Black-throated Green Warbler* (FM,US) | Common Loon (CM,US,UW) | Glaucous Gull (UW) |
| American Crow* (AP) | Blue Grosbeak (Acl) | Common Merganser* (FM,RS,UW) | Glossy Ibis (RM) |
| American Goldfinch* (CM,CS,FW) | Blue Jay* (AP) | Common Moorhen* (US) | Golden Eagle (RM) |
| American Kestrel* (CP) | Blue-gray Gnatcatcher* (FM,FS) | Common Nighthawk* (UM,US) | Golden-crowned Kinglet* (FM,US,FW) |
| American Redstart* (CM,FS) | Blue-winged Teal* (FM,FS) | Common Raven (UP) | Golden-winged Warbler* (UM,RS) |
| American Robin* (AM,CS,UW) | Blue-winged Warbler* (FM,FS) | Common Redpoll (IW) | Grasshopper Sparrow* (UM,US) |
| American Swallow-tailed Kite (Acl) | Bobolink* (FM,FS) | Common Screech Owl | Gray Catbird* (CM,CS,RW) |
| American Tree Sparrow (FW) | Bohemian Waxwing (RW) | Common Snipe* (FM,US,RW) | Gray Jay (Acl) |
| American White Pelican (RM) | Bonaparte's Gull (FM) | Common Tern* (UM,US) | Gray Kingbird (Acl) |
| American Wigeon* (CM,RS,RW) | Boreal Chickadee (RW) | Common Yellowthroat* (CM,CS,RW) | Gray Partridge* (Introduced P) |
| American Woodcock* (FM,US,RW) | Brant (UM) | Connecticut Warbler (UM) | Gray-cheeked Thrush (UM) |
| Arctic Tern (Acl) | Broad-winged Hawk* (FM,US) | Cooper's Hawk (UM,UP) | Great Black-backed Gull (RS,UW) |
| Audubon's Warbler (Acl) | Brown Creeper* (FP) | Curlew Sandpiper (Acl) | Great Blue Heron* (CM,CS,RW) |
| Baird's Sandpiper (UM) | Brown Thrasher* (FM,FS) | Dark-eyed Junco* (CM,US,RW) | Great Crested Flycatcher* (FM,FS) |
| Bald Eagle* (UM,US,RW) | Brown-headed Cowbird* (AM,CS,UW) | Dickcissel (RM,RS,RW) | Great Egret (US) |
| Bank Swallow* (FM,US) | Buff-breasted Sandpiper (RM) | Double-crested Cormorant (FM,FS) | Great Horned Owl (CP) |
| Barn Swallow* (AM,CS) | Bufflehead (FM,FW) | Dovekie (Acl) | Greater Scaup (CM,CW) |
| Barred Owl* (UP) | Canada Goose* (AM,CP) | Downy Woodpecker* (CP) | Greater White-fronted Goose (RM) |
| Barrow's Goldeneye (RW) | Canada Warbler* (FM,US) | Dunlin (CM) | Greater Yellowlegs (FM) |
| Bay-breasted Warbler (FM) | Canvasback* (FM,RS,RW) | Eared Grebe (Acl) | Green-backed Heron* (CM,CS) |
| Belted Kingfisher* (CS,UW) | Cape May Warbler (FM) | Eastern Bluebird* (FM,FS,UW) | Green-talied Towhee (Acl) |
| Black Rail (Acl) | Carolina Wren* (FP) | Eastern Kingbird* (CM,CS) | Green-winged Teal* (FM,RS) |
| Black Scoter (RM) | Caspian Tern (UM) | Eastern Meadowlark* (FM,FS) | Gyrfalcon (Acl) |
| Black Tern* (UM,RS) | Cattle Egret (UM,US) | Eastern Phoebe* (CM,CS,RW) | Hairy Woodpecker* (FP) |
| Black Vulture (Acl) | Cedar Waxwing* (CP) | Eastern Screech-Owl (UP) | Harlequin Duck (Acl) |
| Black-and-white Warbler* (FM,US) | Cerulean Warbler* (UM,US) | Eastern Wood-Pewee* (CM,CS) | Harris' Sparrow (RW) |
| Black-backed Woodpecker (RW) | Chestnut-sided Warbler* (FM,FS) | Eurasian Wigeon (RM) | Henslow's Sparrow* (UM,US) |
| Black-bellied Plover (FM) | Chimney Swift* (CM,CS) | European Starling* (AP) | Herald Petrel (Acl) |
| Black-billed Cuckoo* (US) | Chipping Sparrow* (CM,CS,RW) | Eurpoean Goldfinch (Acl) | Hermit Thrush* (FM,US,RW) |
| Black-billed Magpie (Acl) | Cinnamon Teal (Acl) | Evening Grosbeak* (RS,IW) | Herring Gull (UW) |
| Blackburnian Warbler* (FM,US) | Clay-colored Sparrow (RS) | Field Sparrow* (CM,CS,RW) | Hoary Redpoll (Acl) |
| Black-capped Chickadee* (AP) | Cliff Swallow* (UM,US) | Fish Crow* (UP) | Hooded Merganser* (FM,US,UW) |
| Black-capped Petrel (Acl) | Common Barn-Owl* (RS) | Fork-tailed Flycatcher (Acl) | Hooded Warbler* (US) |
| Horned Grebe (CM,FW) | Mourning Dove* (FP) | Pine Grosbeak (IW) | Ruff (RM) |
| Horned Lark* (CM,US,FW) | Mourning Warbler* (UM,US) | Pine Siskin* (RS,IW) | Ruffed Grouse* (FP) |
| House Finch* (AP) | Mute Swan (Introduced P) | Pine Warbler* (UM,US) | Rufous-sided Towhee* (FM,FS,RW) |
| House Sparrow* (AP) | Myrtle Warbler* (CM,RS,RW) | Piping Pover (Acl) | Rusty Blackbird (FM,RW) |
| House Wren* (CS) | Nashville Warbler* (FM,US) | Praire Warbler* (UM,US) | Sabine's Gull (Acl) |
| Hudsonian Godwit (RM) | Northen Goshawk* (UM,RS) | Prothonotary Warbler* (UM,US) | Sanderling (UM) |
| Iceland Gull (UW) | Northern Bobwhite* (RP) | Purple Finch* (FM,US,UW) | Sandhill Crane (RM) |
| Indigo Bunting* (FM,FS) | Northern Cardinal* (CP) | Purple Gallinule (Acl) | Savannah Sparrow* (FM,FS,RW) |
| Kentucky Warbler* (RM,RS) | Northern Flicker* (CM,CS,RW) | Purple Martin* (UM,US) | Saw-Whet Owl |
| Killdeer* (CM,CS,RW) | Northern Gannet (Acl) | Purple Sandpiper (Acl) | Say's Phoebe (Acl) |
| King Eider (RW) | Northern Goshawk | Razorbill (Acl) | Scarlet Tanager* (CM,CS) |
| King Rail* (RS,RW) | Northern Harrier* (FM,US,UW) | Red Crossbill* (RS,IW) | Sedge Wren* (US) |
| Lapland Longspur (UW) | Northern Hawk-Owl (Acl) | Red Knot (UM) | Semipalmated Plover (FM) |
| Lark Bunting (Acl) | Northern Mockingbird* (FP) | Red Phalarope (RM) | Semipalmated Sandpiper (CM) |
| Lark Sparrow (Acl) | Northern Oriole* (CM,CS,RW) | Red-bellied Woodpecker* (FP) | Sharp-skinned Hawk* (FM,FP) |
| Laughing Gull (Acl) | Northern Parula* (FM,US) | Red-breasted Merganser (FM,RW) | Sharp-tailed Sparrow (RM) |
| Least Bittern* (UM,US) | Northern Pintail* (FM,RS,RW) | Red-breasted Nuthatch* (UP) | Short-billed Dowitcher (FM) |
| Least Flycatcher* (FM,FS) | Northern Rough-winged Swallow* (FM,FS) | Red-eyed Vireo* (CM,CS) | Short-eared Owl* (IW) |
| Least Sandpiper (CM) | Northern Saw-whet Owl* (UP) | Redhead* (CM,US,RW) | Slate-colored Junco* (FM,US,CW) |
| Least Tern (Acl) | Northern Shoveler* (CM,US) | Red-headed Woodpecker* (US,RW) | Snow Bunting (IW) |
| LeConte's Sparrow (Acl) | Northern Shrike (UW) | Red-necked Grebe (UM,UW) | Snow Goose (AM) |
| Lesser Black-backed Gull (RS,UW) | Northern Waterthrush* (FM,FS) | Red-necked Phalarope (UM) | Snowy Egret (US) |
| Lesser Golden-Plover (UM) | Northern Wheater (Acl) | Red-shouldered Hawk* (UM,US,RW) | Snowy Owl (IW) |
| Lesser Scaup (FM,RW) | Oldsquaw (UM,UW) | Red-tailed Hawk (CM,CS,FW) | Solitary Sandpiper (UM) |
| Lesser Yellowlegs (FM) | Olive-sided Flycatcher (UM) | Red-throated Loon (UM) | Solitary Vireo* (UM,US) |
| Lincoln's Sparrow (UM) | Orange-crowned Warbler (UM) | Red-winged Blackbird* (AM,AS,RW) | Song Sparrow* (CM,CS,UW) |
| Little Blue Heron (RS) | Orchard Oriole* (US) | Ring-billed Gull* (AM,AP) | Sora* (FM,FS) |
| Little Gull (Acl) | Oregon Junco (Acl) | Ring-Necked Duck (FM,RW) | Spotted Sandpiper* (CM,FS) |
| Loggerhead Shrike* (RS) | Osprey* (FM,US) | Ring-Necked Pheasant* (CP) | Stilt Sandpiper (UM) |
| Long-billed Dowitcher (UM) | Ovenbird* (CM,CS) | Rock Dove* (AP) | Summer Tanager (Acl) |
| Long-eared Owl* (UP) | Palm Warbler (FM) | Rose-breasted Grosbeak* (FM,CS,RW) | Surf Scoter (UM) |
| Long-tailed Jaeger (Acl) | Parasitic Jaeger (Acl) | Ross' Goose (Acl) | Swainson's Thrush* (UM) |
| Louisiana Waterthrush* (UM,CS) | Passenger Pigeon* (Extinct) | Rough-legged Hawk (TW) | Swamp Sparrow* (FM,FS,RW) |
| Magnolia Warbler* (FM,US) | Pectoral Sandpiper (CM) | Rough-Winged Swallow | Tennessee Warbler (FM) |
| Mallard* (AM, AP) | Peregrine Falcon* (UM) | Ruby-crowned Kinglet (FM,RW) | Thick-billed Murre (Acl) |
| Marbled Godwit (Acl) | Philadelphia Vireo (UM) | Ruby-throated Hummingbird* (FM,US) | Three-toed Woodpecker (Acl) |
| Marsh Wren* (UM,FS) | Pied-billed Grebe* (FM,CS,UW) | Ruddy Duck* (UM,RS,RW) | Tree Swallow* (AM,CS,RW) |
| Merlin (UM) | Pileated Woodpecker* (FP) | Ruddy Turnstone (UM) | Tricolored Heron (US) |
| Tufted Titmouse* (CP) | Western Kingbird (Acl) | White-winged Crossbill (RS,IW) | Worm-eating Warbler (RS) |
| Tundra Swan (UM,RW) | Western Meadowlark (Acl) | White-winged Scoter (UM) | Yellow Rail (Acl) |
| Turkey Vulture* (UM,US) | Western Sandpiper (UM) | Wild Turkey* (FP) | Yellow Warbler* (CM,CS) |
| Upland Sandpiper* (RM,US) | Western Tanager (Acl) | Willet (RM) | Yellow-bellied Flycatcher (UM) |
| Varied Thrush (Acl) | Whimbrel (RM) | Willow Flycatcher* (FM,FS) | Yellow-bellied Sapsucker* (FM,US,RW) |
| Veery* (CM,FS) | Whip-poor-will (UM,RS) | Wilson's Phalarope (UM) | Yellow-billed Cuckoo* (US) |
| Vesper Sparrow* (FM,US) | White-breasted Nuthatch* (CP) | Wilson's Warbler (FM) | Yellow-breasted Chat* (RS) |
| Virginia Rail* (FM,FS,UW) | White-crowned Sparrow (CM,RW) | Winter Wren* (UM,US,RW) | Yellow-crowned Night Heron (RM) |
| Warbling Vireo* (FM,FS) | White-eyed Vireo (RM,RS,Acl,W) | Wood Duck* (FM,FS,RW) | Yellow-headed Blackbird (Acl) |
| Water Pipit (UM) | White-rumped Sandpiper (UM) | Wood Stork (Acl) | Yellow-rumped Warbler* (UM,US,RW) |
| Western Grebe (Acl) | White-throated Sparrow* (CM,RS,UW) | Wood Thrush* (CM,CS) | Yellow-throated Vireo* (UM,US) |
| | | | Yellow-throated Warbler (RS,Acl,W) |

Key: * = Indicates at least one breeding record since 1890

Abundance: A = Abundant (seen every year), C = Common (seen every time), F = Fairly Common (usually seen), U = Uncommon (not seen every time, few individuals)

R = Rare (not seen every year, usually one individual), I = Invasion or Irruptive Species (wide yearly variation), Acl = Accidental (fewer than five records since 1950)

Seasonal Occurrence: P = Present all year, M= Migrant (spring and fall), S = Summer, W = Winter,

Introduced = Status uncertain or requiring periodic releases to maintain the population

Source: *Birds of the Cayuga Lake Basin, New York Annotated Check-List* , Dorothy W. Mellroy & Charles R. Smith, January 1992. Courtesy of Tompkins County Department of Planning and *Integrating Forest Management Wildlife* , R.E. Chambers, School of Environmental Science & Forestry, Syracuse, NY.

## 2.11 Fish Community

The Cayuga Lake food web includes two interrelated assemblages of species, one in the shallow (littoral) zone and the second in the deep water (pelagic and profundal) zone. The littoral zone is limited to the northern and southern lake basins and a narrow fringe along the lake margins where light reaches the bottom. Approximately 25% of the lake surface area overlies depths of 20 ft. or less.

Most of the littoral zone is located in the northern basin, which is home to a warmwater fish community dominated by smallmouth bass. Other important predator fish in the littoral community include largemouth bass and northern pike. These species prey on yellow perch, pumpkinseeds, bluegills, rock bass, and minnows. Southern Cayuga Lake supports a spawning population of white suckers.

The deep water community is dominated by lake trout, rainbow trout, brown trout, and landlocked salmon as the top predators. Of these salmonids, only the lake trout is native to Cayuga Lake. Populations of the salmonids are maintained (or, in the case of rainbows, supplemented) by stocking. Juvenile salmonids prey on zooplankotn, including *Mysis relicta*. Chiotti (1980) considers the quantity of this zooplankton to be the limiting factor for the growth and survival of stocked juvenile lake trout, Cayuga Lake's most important sport fishery. Older fish prey mainly on other fish; the alewife is the predominant forage species. Other prey species include rainbow smelt, trouthperch, and slimy sculpin.

Youngs and Ogelsby (1972) reported that the food web supporting the deep water community is relatively short: phytoplankton, zooplankton, alewife, and fish. A second energy pathway culminating with smelt begins with organic detritus, which is consumed by *Mysis relicta*, then by smelt. These generalized food webs do not reflect changes in food preferences with life stage and size.

Distribution of fish reflects thermal preferences, predator-prey relationships, and predictable migrations for spawning. Similar to feeding relationships, distribution is variable with life stage and season. The fish community is discussed in greater detail in Chapter 4. Limnology.

## 2.12 Land Use

Land use data for the purposes of this report is derived from the New York State Office of Real Property Services County Real Property Services (NYSORPS) database (New York State Office of Real Property Services, 1998) using the property classification codes. The NYSORPS classifies property into nine general divisions with subdivisions. The major divisions are as follows:

- Agricultural - Property used for the production of crops or livestock.
- Residential - Property used for human habitation. Living accommodations such as hotels and motels are in the Commercial category.
- Vacant Land - Property not in use, is in temporary use, or lacks permanent improvement.
- Commercial - Property used for the sale of goods and/or services.
- Recreation and Entertainment - Property used by groups for recreation, amusement, or entertainment.
- Community Services - Property used for the well being of the community.
- Industrial - Property used for the production and fabrication of durable and nondurable man-made goods.
- Public Services - Property used to provide services to the general public.
- Wild, Forested, Conservation Lands and Public Parks - Reforested lands, preserves, and private hunting and fishing clubs.

**Table 2.12.1a**
**Land Use**

| | Agriculture | Residential | Commercial | Industrial | Service Community | Infrastructure Utility | Park | Vacant | Total |
|---|---|---|---|---|---|---|---|---|---|
| Total Acreage | 187,807.91 | 147,952.14 | 8,953.47 | 3,209.34 | 17,755.21 | 8,872.91 | 27,710.02 | 147,873.41 | 550,134.41 |
| Percent Total Acreage | 34.14% | 26.89% | 1.63% | 0.58% | 3.23% | 1.61% | 5.04% | 26.88% | 100.00% |
| Tax Parcels | 1,557.00 | 27,907.00 | 1,693.00 | 105.00 | 904.00 | 472.00 | 683.00 | 8,775.00 | 42,096.00 |
| Percent Tax Parcels | 3.70% | 66.29% | 4.02% | 0.25% | 2.15% | 1.12% | 1.62% | 20.85% | 100.00% |

**Figure 2.12.1**
**Cayuga Lake Watershed County Percent**

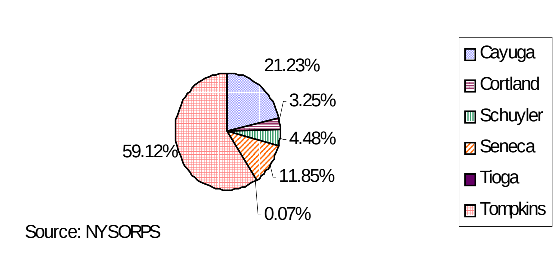



**Figure 2.12.2**
**Cayuga Lake Watershed Land Use By Acreage**

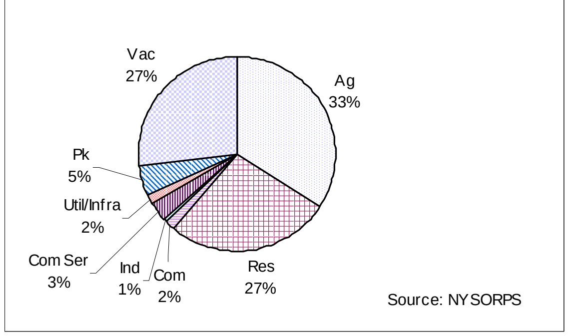
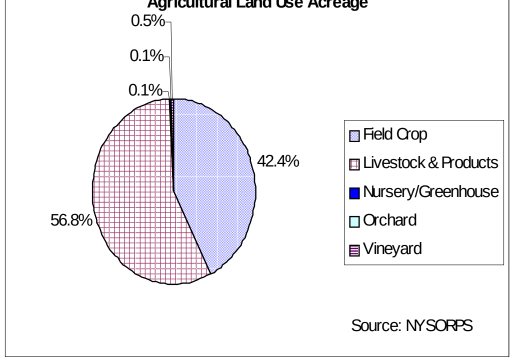



Table 2.12.1b

| Land Use Type | Acreage | Percent | Parcels | Percent |
|---|---|---|---|---|
| **Agriculture** | | | | |
| **Field Crop** | 79,717.91 | 42.4% | 817 | 52.47% |
| **Livestock & Products** | 106,650.58 | 56.8% | 718 | 46.11% |
| **Nursery/Greenhouse** | 206.80 | 0.1% | 5 | 0.32% |
| **Orchard** | 260.63 | 0.1% | 6 | 0.39% |
| **Vineyard** | 971.99 | 0.5% | 11 | 0.71% |
| | 187,807.91 | 100.0% | 1,557 | 100.00% |
| **Commercial** | | | | |
| **Accomodations** | 225.06 | 2.5% | 130 | 7.68% |
| **General Commercial** | 4,086.31 | 45.6% | 1,235 | 72.95% |
| **Rec. & Entertainment** | 4,642.10 | 51.8% | 328 | 19.37% |
| | 8,953.47 | 100.0% | 1,693 | 100.00% |
| **Industrial** | | | | |
| **General Industrial** | 1,098.26 | 34.2% | 71 | 67.62% |
| **Mining & Wells** | 2,111.08 | 65.8% | 34 | 32.38% |
| | 3,209.34 | 100.0% | 105 | 100.00% |
| **Community Service** | | | | |
| **Benevolent & Prof. Ass.** | 231.60 | 1.3% | 24 | 2.65% |
| **Cemeteries** | 516.92 | 2.9% | 152 | 16.81% |
| **Education** | 14,104.67 | 79.4% | 298 | 32.96% |
| **Government Offices** | 1,139.20 | 6.4% | 141 | 15.60% |
| **Health Care** | 526.15 | 3.0% | 33 | 3.65% |
| **Highway Garage** | 60.27 | 0.3% | 24 | 2.65% |
| **Waste Disposal** | 405.23 | 2.3% | 27 | 2.99% |
| **Military** | 343.82 | 1.9% | 4 | 0.44% |
| **Parking Lot** | 2.13 | 0.0% | 7 | 0.77% |
| **Police/Fire/Animal** | 134.91 | 0.8% | 50 | 5.53% |
| **Religious** | 290.31 | 1.6% | 144 | 15.93% |
| | 17,755.21 | 100.0% | 904 | 100.00% |
| **Park** | | | | |
| **Priv. Wildlife & For. Land** | 12,306.37 | 44.4% | 344 | 50.37% |
| **Public Park** | 4,736.04 | 17.1% | 178 | 26.06% |
| **Recreational** | 131.55 | 0.5% | 23 | 3.37% |
| **Public Forest Land** | 10,536.06 | 38.0% | 138 | 20.20% |
| | 27,710.02 | 100.0% | 683 | 100.00% |
| **Residential** | | | | |
| **High Density Residential** | 13,305.21 | 9.0% | 1757 | 6.30% |
| **Low Density Residential** | 119,539.59 | 80.8% | 23000 | 82.42% |
| **Low Density Seasonal** | 1,903.03 | 1.3% | 1072 | 3.84% |
| **Mobil Home** | 13,204.31 | 8.9% | 2077 | 7.44% |
| | 147,952.14 | 100.0% | 27906 | 100.00% |
| **Public Utility/Infrastructure** | | | | |
| **Airport** | 778.17 | 8.8% | 9 | 1.91% |
| **Power Transmission & Distribution** | 5,402.54 | 60.9% | 165 | 34.96% |
| **Railroad** | 121.05 | 1.4% | 195 | 41.31% |
| **Telephone** | 188.25 | 2.1% | 24 | 5.08% |
| **Water** | 2,304.40 | 26.0% | 68 | 14.41% |
| **Television/Radio** | 75.59 | 0.9% | 8 | 1.69% |
| **Automobile Related** | 2.91 | 0.0% | 3 | 0.64% |
| | 8,872.91 | 100.0% | 472 | 100.00% |
| **Vacant** | | | | |
| **Agricultural Vacant** | 81766.97 | 55.3% | 1388 | 15.82% |
| **Industrial Vacant** | 181 | 0.1% | 32 | 0.36% |
| **Vacant Land** | 65925.45 | 44.6% | 7355 | 83.82% |
| | 147873.42 | 100.0% | 8775 | 100.00% |

Source: NYS ORPS, Tompkins County Office of Real Property Services, 1999

**Figure 2.12.3**
**Agricultural Land Use Acreage**

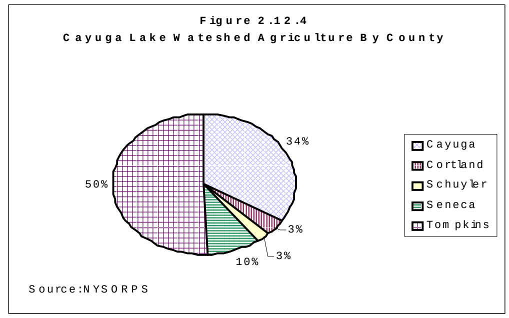



To analyze land use for this report the above noted general land use divisions and subdivisions have been used from the ORPS database along with the associated geographically referenced real property parcel centroid. The parcel centroid takes the form of a point, referenced to an actual location on the earth, that represents the visual center of each tax parcel. Using the parcel centroid along with the associated land use property classification allows for the following analysis of land use in the Cayuga Lake Watershed:

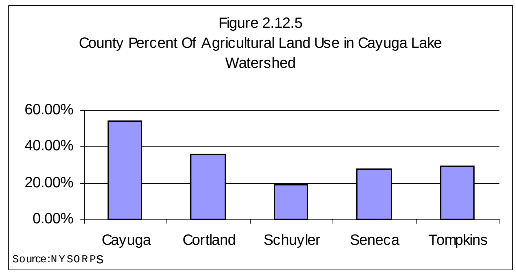
The Cayuga Lake watershed covers over 785 square miles of land area. Approximately 59% of the acreage of the watershed lies within Tompkins County, 21% in Cayuga County, 12% in Seneca County, 4.5% in Schuyler County, 3% in Cortland County and less than 0.5% in Tioga County (see Figure 2.12.1). The largest portion of land use within the watershed is agriculturally related (approximately 34%), followed by residential (approximately 27%), vacant (approximately 27%), park lands (approximately 5%), community service (approximately 3%), commercial (approximately 2%), utility and infrastructure (approximately 2%), and industrial (approximately 1%) (see Table 2.12.1 and Figure 2.12.2) (NYSORPS, 1998).

### 2.12.1 Land Cover

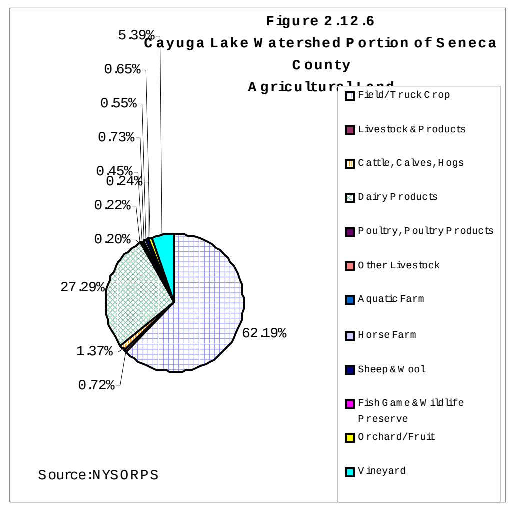
The majority of the land cover (see Map 2.12.1) in the watershed is classified as herbaceous planted/cultivated, which is vegetation that is planted, tilled, or subject to other intensive management or manipulation. In the Cayuga Lake Watershed this is largely due to agriculture (pasture, hay or row crops) but it includes lawns, parks and golf courses as well. The herbaceous planted/cultivated land cover is widely dispersed throughout the watershed, as is the majority of all the subwatersheds except for the southern end. Here the majority of the land cover is categorized as natural forested upland or wetland where vegetation is dominated by trees generally forming greater than 25 percent canopy cover, or vegetation where the substrate (floor) is periodically saturated or covered with water (USGS, 1998).



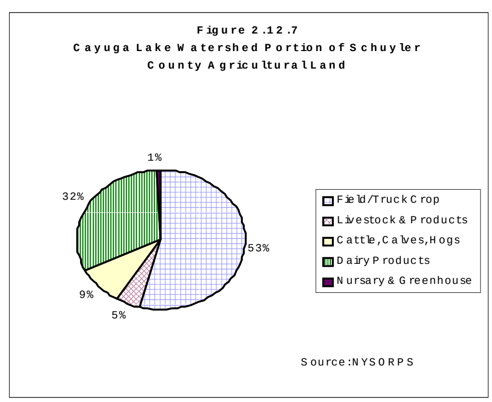

### 2.12.2 Agricultural Land Use




Agricultural land use includes field and truck crops, nursery and greenhouses, orchard, vineyard, and livestock and products. Livestock and products include the following: cattle, calves, hogs; dairy products; poultry and poultry products; other livestock including donkeys and goats; aquatic farms; horse farms; sheep and wool; and fish, game and wildlife preserves. Of the agricultural land in the watershed the largest portion (56.8%) is livestock and products, followed by field crops (42.5%), vineyard (0.5%), orchard (0.1%), and nursery and greenhouses (0.1%) (see Figure 2.12.3).

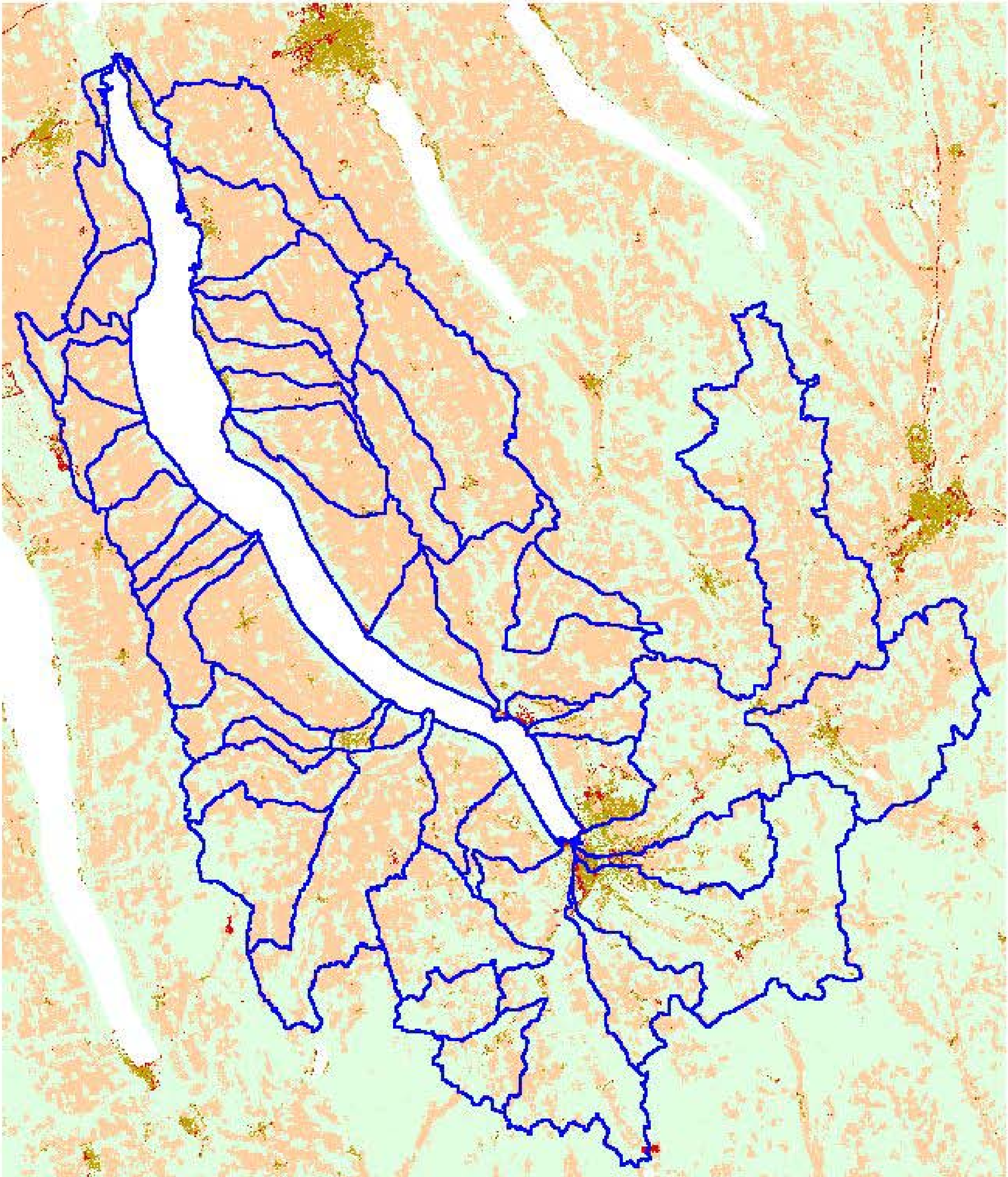



The contribution of agricultural land in the watershed by county is as follows: Tompkins County with 50%, followed by Cayuga County with 34%, Cortland County with 3%, Schuyler County with 3%, and Seneca County with 10% (see Figure 2.12.4). However, Cayuga County has the largest percentage of agricultural land use, approximately 54%, given the land area of the county in the watershed and the amount of land used for agriculture. This is followed by Cortland with approximately 36%, Tompkins with approximately 29%, Seneca with approximately 28% and Schuyler with approximately 19% (see Figure 2.12.5). These figures do not include the land use category of agricultural vacant, which is listed under vacant land use.




Agricultural land use is fairly well dispersed throughout the watershed with the exception of the south end of the lake (see Land Use Map 2.12.2 and 2.12.3). The two highest percentages of agricultural land use by acreage in the watershed is livestock and products (57%) and field crops (42%). These are followed by vineyard, orchard, and nursery and greenhouses (1%) (see Table 2.12.1). However, the type of agricultural land use is somewhat uneven around the watershed. On the west-side, of the portions of Seneca and Schuyler Counties that are in the watershed, there is a high percentage of agricultural land in field crops, with 62% and 54% respectively (see Figure 2.12.6 and Figure 2.12.7). Additionally, of the portion of Seneca County in the watershed, over 5% of the agricultural land is vineyard.

# Cayuga Lake Watershed
# Land Cover



This map was prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.

Source: U.S. Geological Survey, EROS Data Center, July 1998.
Genesee/Finger Lakes Regional Planning Council, 1998.

Base Map: New York State Department of Transportation, February 1996.

Land Cover

- Open Water
- Natural Forested Upland (non-wet) or Wetland
  Vegetation dominated by trees generally forming greater than 25 percent canopy cover, or vegetation where the substrate is periodically saturated or covered with water.
- Herbaceous Planted / Cultivated
  Vegetation that is planted, tilled, or subject to other intensive management or manipulation (pasture, hay, row crops, lawns, parks, golf courses).
- Low and High Intensity Residential
- High Intensity Commercial / Industrial / Transportation / Mining

1:370577

0 5 10 Miles

Prepared by Genesee/Finger Lakes Regional Planning Council, 1999.

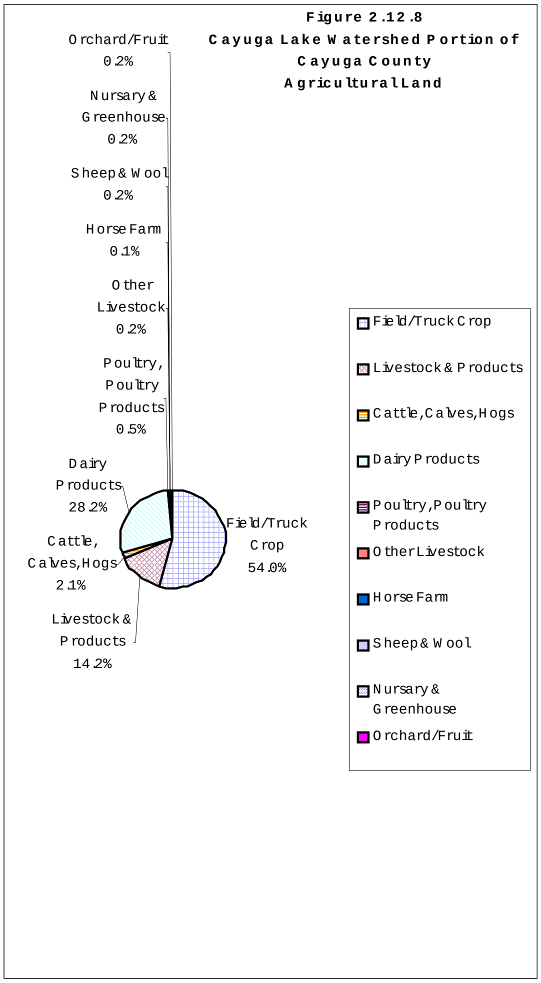


Figure 2.12.8
Cayuga Lake Watershed Portion of Cayuga County Agricultural Land

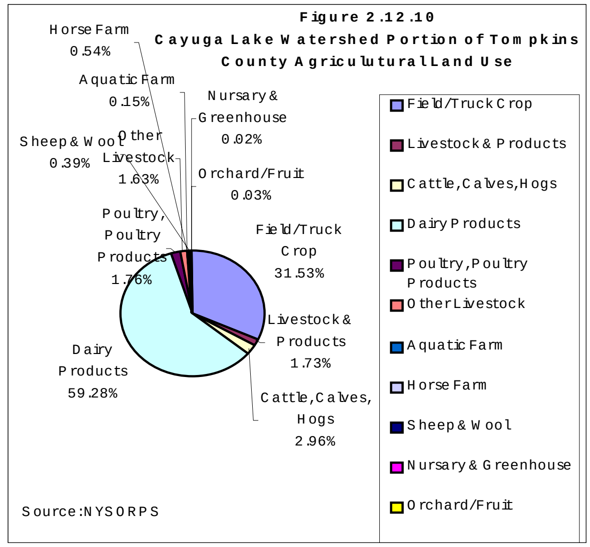


Figure 2.12.10
Cayuga Lake Watershed Portion of Tompkins County Agricultural Land Use

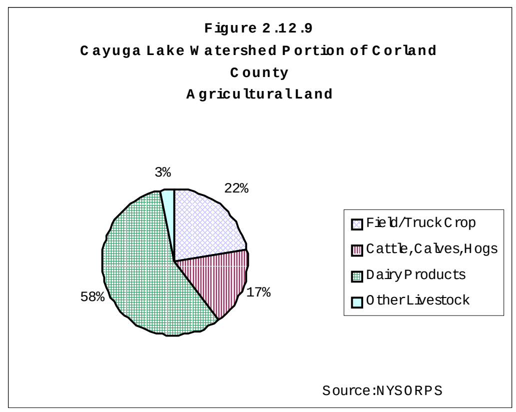


Figure 2.12.9
Cayuga Lake Watershed Portion of Corland County Agricultural Land

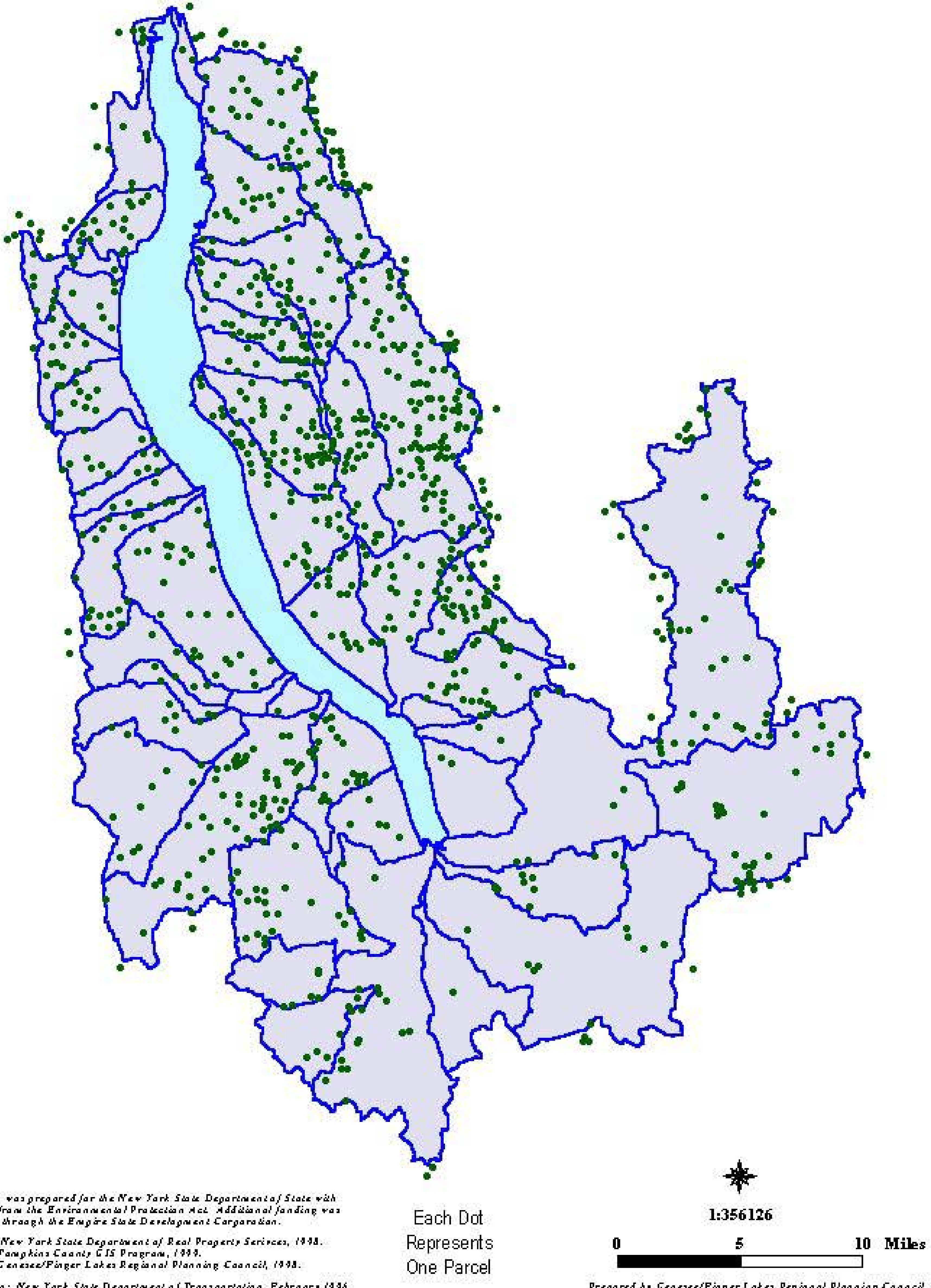
On the east side, of the portion of Cayuga County that is in the watershed, approximately 54% is field crops. However, the east side of the watershed shows a high percentage of livestock and products. In the portion of Cayuga County in the watershed, approximately 46% of the agricultural land is used for livestock and products, showing the highest density on the middle to east side of the watershed (moving away from the lake itself). Of that approximately 46%, or well over half of its land area is used for dairy products (see Figure 2.12.8). The same is true in the portion of Cortland County in the watershed, where approximately 75% of the agricultural land is used for livestock and products including 17% for cattle, calves and hogs, and 57% for dairy products (see Figure 2.12.9). This can be seen in the Six Mile Creek Agricultural Land Use Practices Report (Tompkins County S&WCD) and in Table 3.12.1. Of the 131 operations in the Fall Creek Subwatershed 84% (110) were livestock and products, 43% (56) of which were dairy products.

In the south end, of the portion of Tompkins County that is in the watershed, over 68% of the agricultural land use is livestock and products, including approximately 59% in dairy products (see Figure 2.12.10). Following the pattern of Cayuga and Cortland Counties above, most of the livestock and products land use is on the east side of Tompkins County. This can be seen in the Six Mile Creek Agricultural Land Use Practices Report (Mussell) and in Table 3.12.1. Of the 40 operations surveyed, 58% (23) were livestock and products.

### 2.12.3 Residential Land Use

Residential land use includes high-density residential, low-density residential, low density seasonal, and mobile homes and parks. High density residential includes three family year round residencies, multiple residencies on an individual parcel, and apartments. Low density residential includes one and two family year round residencies, rural residencies with acreage, and estates.

# Cayuga Lake Watershed Agriculture (Crops)




This map was prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.

Source: New York State Department of Real Property Services, 1998.
Tompkins County GIS Program, 1999.
Genesee/Finger Lakes Regional Planning Council, 1998.

Base Map: New York State Department of Transportation, February 1996.

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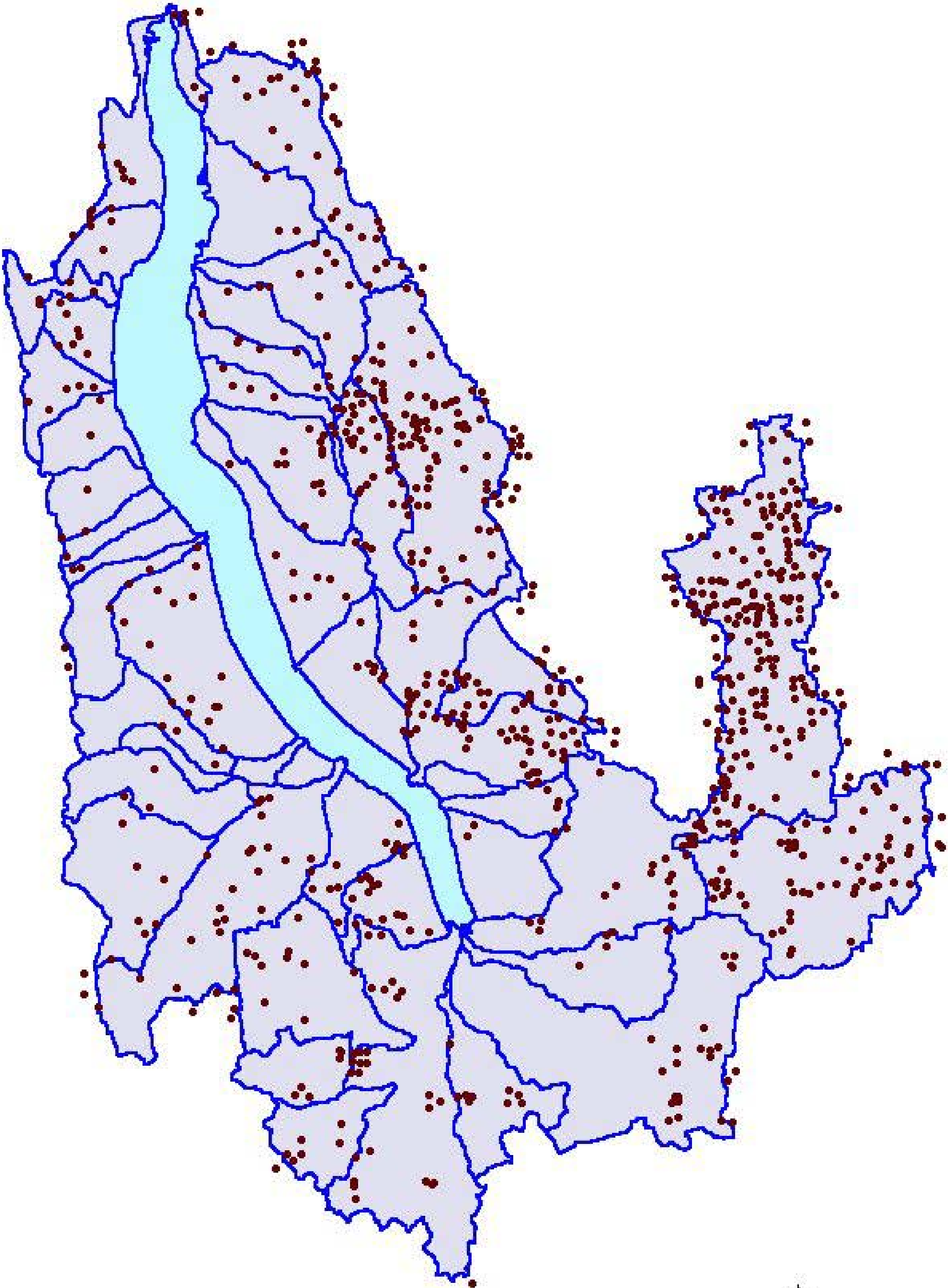
# Cayuga Lake Watershed Livestock and Products



This map was prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.

Source: New York State Department of Real Property Services, 1998.
Tompkins County GIS Program, 1999.
Genesee/Finger Lakes Regional Planning Council, 1998.

Base Map: New York State Department of Transportation, February 1996.

Each Dot Represents One Parcel

1:356633

0 5 10 Miles

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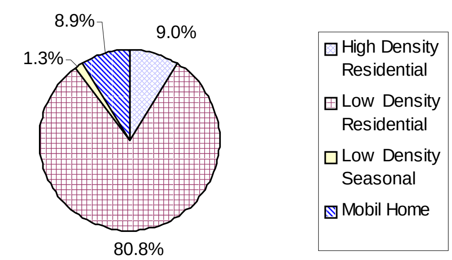
Residential land use in the watershed is fairly well dispersed (see Residential Land Use Maps 2.12.4, 2.12.5, 2.12.6). The highest percentage of residential land use by residential acreage in the watershed is low density residential (81%), followed by high density residential (9%), mobile homes and parks (9%), and low density seasonal residential (1%) (see Table 2.12.1 and Figure 2.12.11).

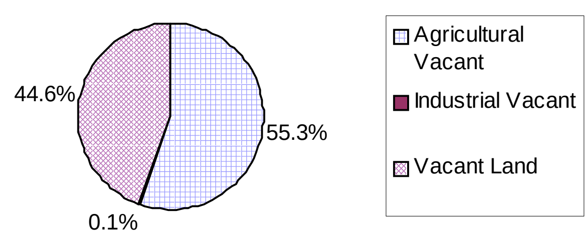
**Figure 2.12.11**
**Residential Land Use Acreage**




Source: NYSORPS

For obvious reasons the highest density of residential land use in the watershed is in the population centers, principally in the southern portion of the watershed near the City of Ithaca. This includes first and foremost the City of Ithaca, Village of Cayuga Heights, and Village of Trumansburg, followed by portions of the Towns of Ithaca, Ulysses, Enfield, Newfield, Danby, Caroline, Dryden and Lansing, and portions of the Villages of Lansing, Dryden, and Freeville. The vast majority of high-density residential land use is in and immediately around the City of Ithaca. Other smaller population centers, and therefore higher density residential land use, include the Village of Interlaken and portions of the Town of Seneca Falls on the west-side of the watershed, and the Villages of Cayuga, Union Springs, and Aurora on the eastern shores of the lake. Mobile homes and parks are dispersed throughout the watershed, but are generally not present in and around the population centers.

**Figure 2.12.12**
**Vacant Land Use Acreage**

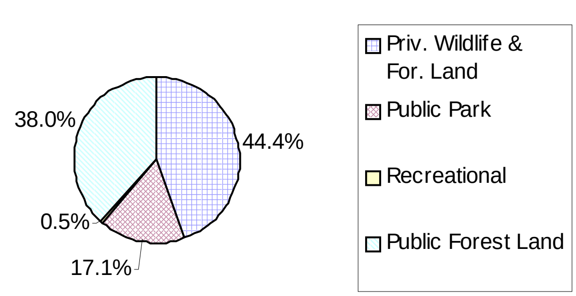



Source: NYSORPS

### 2.12.4 Vacant Land Use

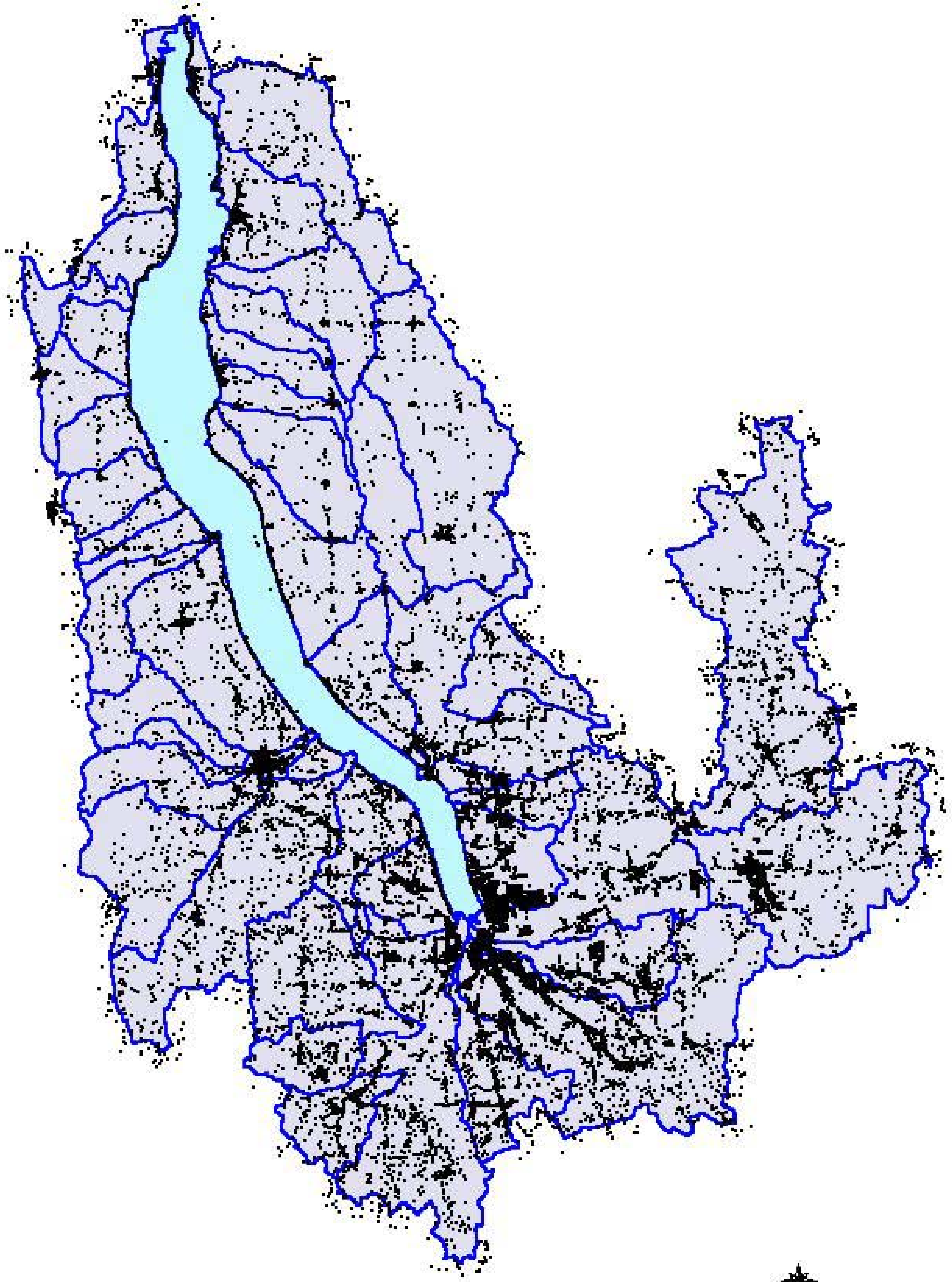
Vacant land use includes agricultural vacant land (55%) and general vacant land (45%) (see Table 2.12.1 and Figure 2.12.12). Agricultural vacant land can be productive and is generally considered as part of an operating farm. It does not have living accommodations and cannot be specifically related to any of the other divisions in the agriculture category. It is usually found when an operating farm is made up of a number of contiguous parcels. The general vacant land category consists of vacant residential (29 % of the general vacant land use category), vacant rural (67% of the general vacant land use category), vacant land located in commercial areas (4% of the general vacant land use category), and vacant land located in industrial areas (less than 1% of the general vacant land use category). Approximately 12% of the vacant rural land is categorized as abandoned agricultural land which is presently nonproductive and not part of an operating farm.

**Figure 2.12.13**
**Park Land Land Use Acreage**




Both vacant residential and vacant rural land use are widely dispersed throughout the watershed with the highest density of these categories in the southern end of the watershed. Vacant land located in commercial areas and vacant land located in industrial areas are generally located in the southern end of the lake in the

# Cayuga Lake Watershed
# Low Density Residential



*This map was prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.*

*Source: New York State Department of Real Property Services, 1998.*
*Tompkins County GIS Program, 1999.*
*Genesee/Finger Lakes Regional Planning Council, 1998.*

*Base Map: New York State Department of Transportation, February 1996.*

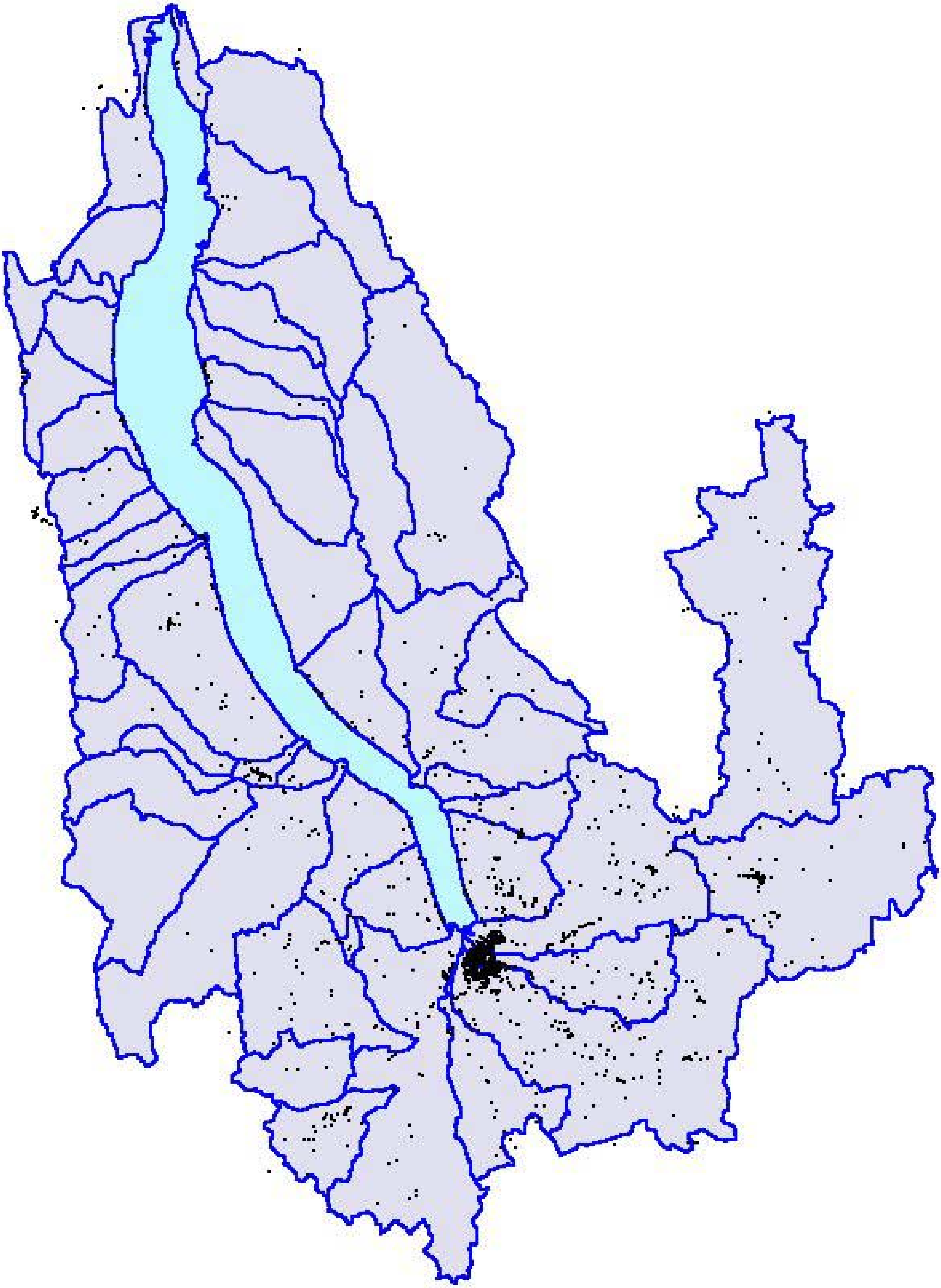
Each Dot Represents One Parcel

**1:356126**

**0 5 10 Miles**

*Prepared by Genesee/Finger Lakes Regional Planning Council, 19*

# Cayuga Lake Watershed
# High Density Residential



*This map was prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.*

*Source: New York State Department of Real Property Services, 1998.*
*Tompkins County GIS Program, 1999.*
*Genesee/Finger Lakes Regional Planning Council, 1998.*

*Base Map: New York State Department of Transportation, February 1996.*

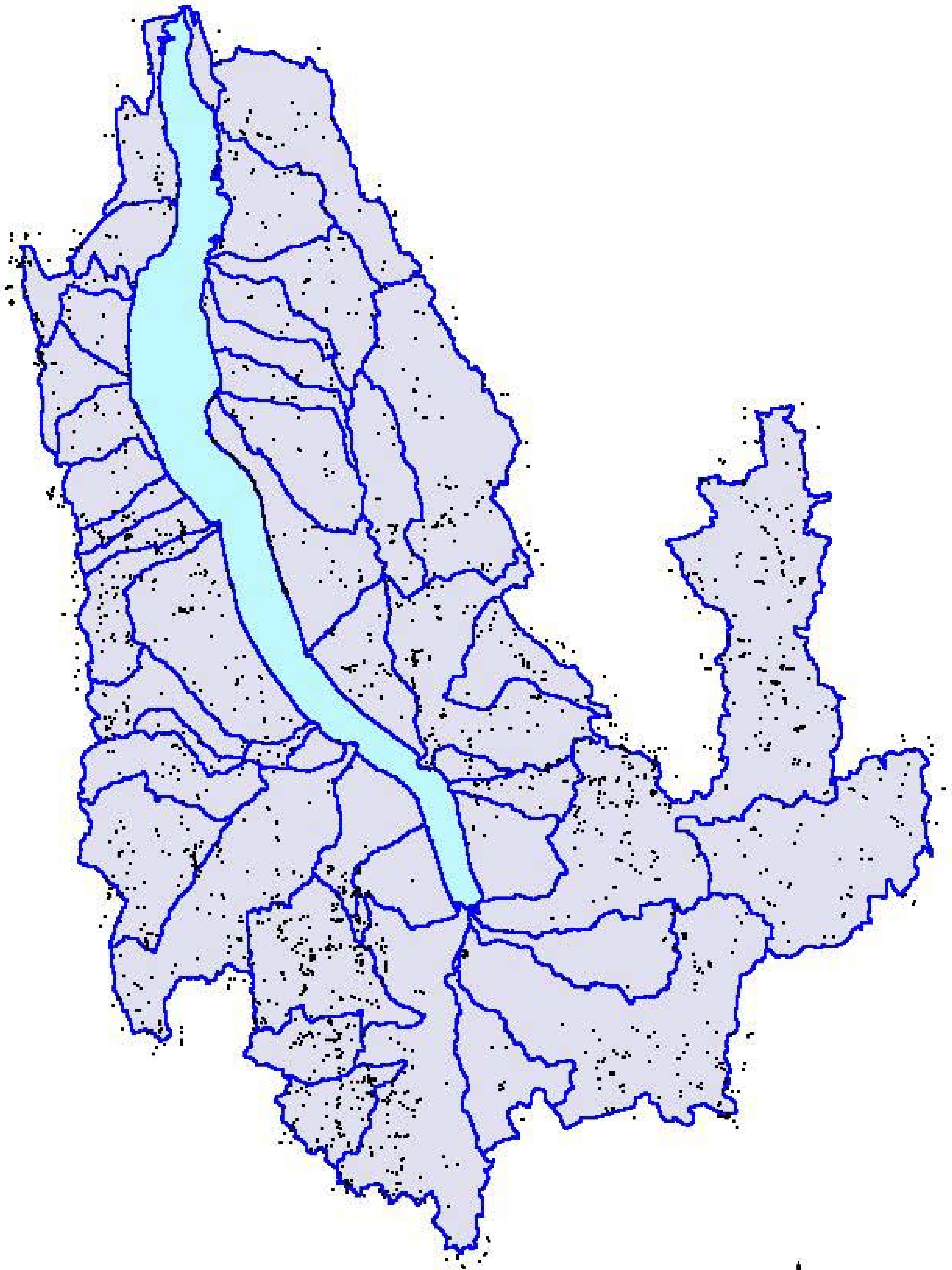
Each Dot Represents One Parcel

**1:356256**

**0 5 10 Miles**

*Prepared by Genesee/Finger Lakes Regional Planning Council, 19*

# Cayuga Lake Watershed
# Mobile Homes and Parks



This map was prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.

Source: New York State Department of Real Property Services, 1998.
Tompkins County GIS Program, 1999.
Genesee/Finger Lakes Regional Planning Council, 1998.

Base Map: New York State Department of Transportation, February 1996.

Each Dot Represents One Parcel

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0 5 10 Miles

Prepared by Genesee/Finger Lakes Regional Planning Council, 19

commercial and industrial portions of the watershed around the City of Ithaca and the adjacent towns and villages.

### 2.12.5 Park Land Use

Park land use includes private wildlife and forested land (44%), public forest land (38%), public park (17%), and recreational (1%) (see Table 2.12.1 and Figure 2.12.13). These are largely in the southern portion of the watershed (see Map 2.12.7). Almost all of the private wildlife and forested land is in the southern portion of the watershed with a good part of it owned by Cornell University.

Approximately 18% of the public forest land in the watershed is in Cayuga County. Only about 2% of it is in Cortland County. Both are largely New York State forest lands. Approximately 6% of the public forest land in the watershed is in Schuyler County, most of which is the federally designated Hector Land Use Area. Most of the remaining public forest land (74%) in the watershed is in Tompkins County, most of which is under New York State ownership. This accounts for the high percentage of natural forested upland or wetland land cover in the southern end of the watershed.

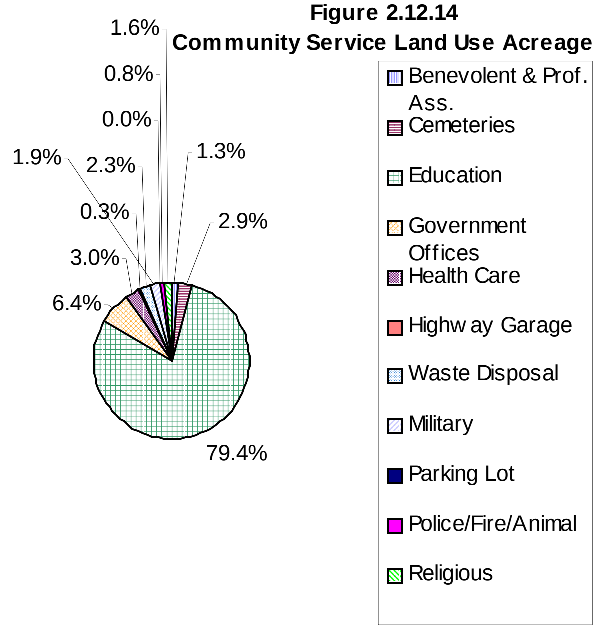
Generally, the public park land in Cayuga County is related to the Village of Cayuga. Most of the public park land in Seneca County is part of the Finger Lake National Forest. Park lands in Tompkins County include municipal parks (City of Ithaca, Town of Ithaca, Town of Dryden, Town of Lansing), county parks, and state parks (Robert Treman State Park and Taughannock State Park).

Most of the land classified as recreational in Seneca County is attributable to New York State parks. In Tompkins County land classified as recreational is attributable to municipal, county, and state ownership.

### 2.12.6 Community Service Land Use

Community services land use includes benevolent and professional associations, cemeteries, educational facilities, government offices, health care, highway garage, waste disposal, military, municipal parking lots, police/fire/animal control, and religious institutions. Educational facilities include colleges and universities, libraries, and schools. Health care includes homes for the aged, hospitals, and health facilities. Waste disposal includes landfills and dumps, sewage treatment and water pollution control facilities, waste and solid waste disposal.

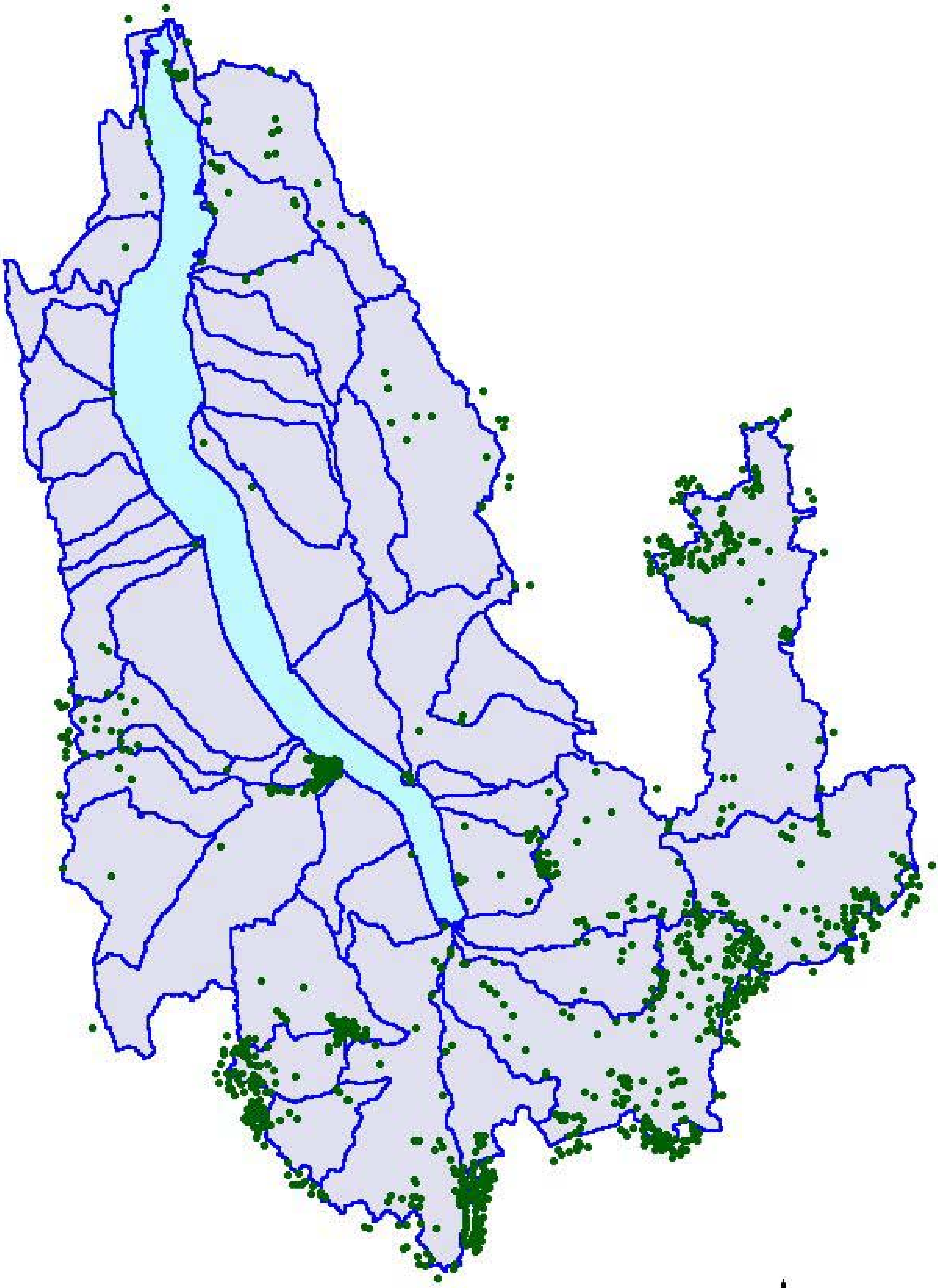
**Figure 2.12.14**
**Community Service Land Use Acreage**




Educational facilities accounts for over 79% of community service land use and over 2% of the overall land use in the watershed, largely due to the presence of Cornell University and Ithaca College. Therefore, the highest density of community service land use is in the southern portion of the watershed in the City and Town of Ithaca and the Villages of Cayuga Heights and Lansing. Other dense areas of community service land use include the Villages of Interlaken, Trumansburg, Freeville, and Aurora (Wells College). Otherwise community service land use is fairly evenly distributed in the watershed (see Map 2.12.8).

The other community service land uses in the watershed are government offices (6%), health care (3%), cemeteries (3%), waste disposal (2%), military (2%), religious institutions (2%), benevolent and professional associations (1%), police/fire/animal control (1%), and highway garages and parking lots (less than 1%) (see Table 2.12.1 and Figure 2.12.14).

# Cayuga Lake Watershed
# Parks and Forest



*This map was prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.*

*Source: New York State Department of Real Property Services, 1998.*
*Tompkins County GIS Program, 1999.*
*Genesee/Finger Lakes Regional Planning Council, 1998.*

*Base Map: New York State Department of Transportation, February 1996.*

Each Dot Represents One Parcel

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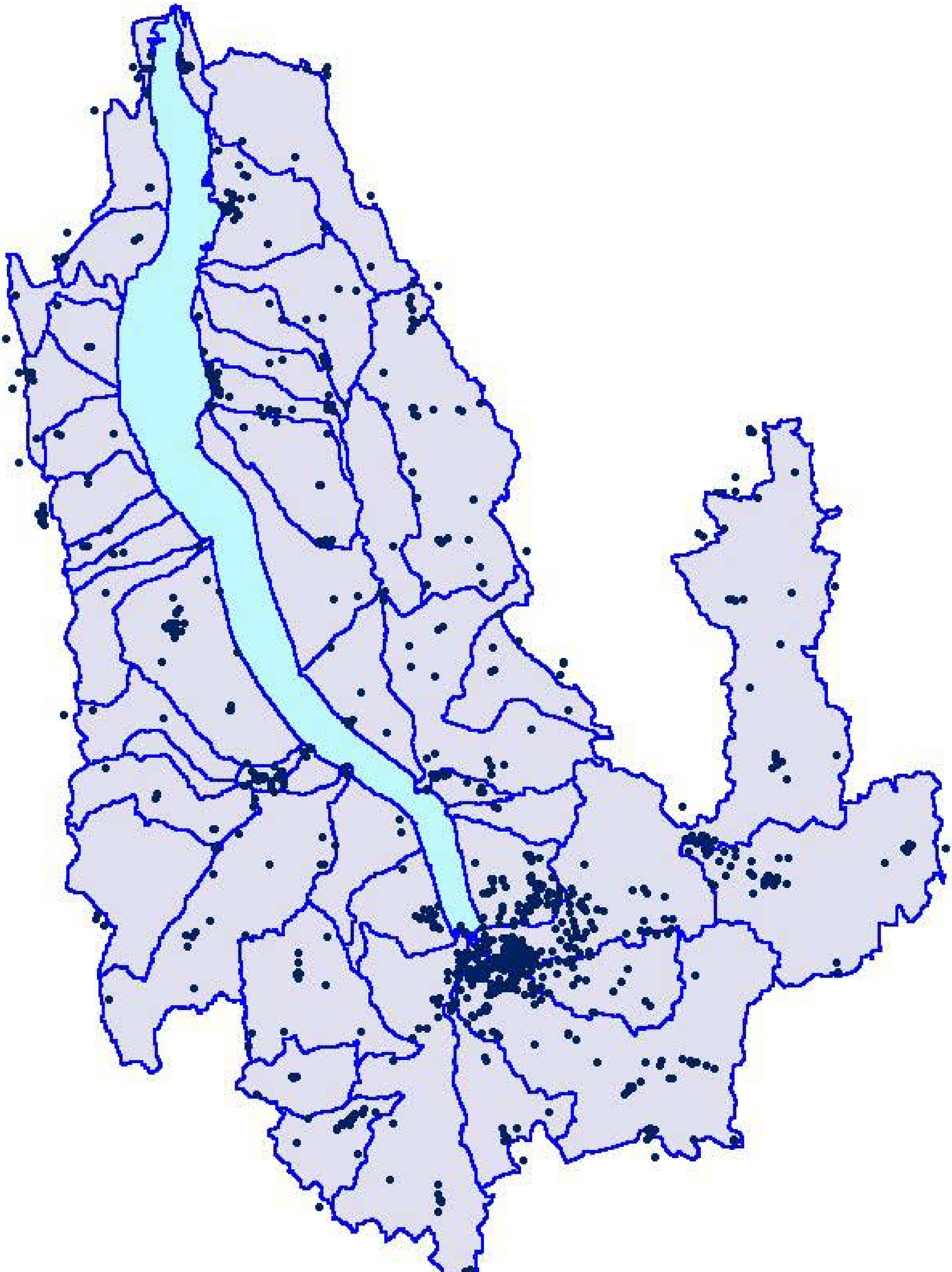
*Prepared by Genesee/Finger Lakes Regional Planning Council, 19*

# Cayuga Lake Watershed Community Services



This map was prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.

Source: New York State Department of Real Property Services, 1998.
Tompkins County GIS Program, 1999.
Genesee/Finger Lakes Regional Planning Council, 1998.

Base Map: New York State Department of Transportation, February 1996.

Each Dot Represents One Parcel

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0 5 10 Miles

Prepared by Genesee/Finger Lakes Regional Planning Council, 19

### 2.12.7 Commercial Land Use

Commercial land uses include accommodations, general commercial, and recreation and entertainment. Accommodations include hotels, motels, inns, and lodges. General commercial land use includes area shopping centers, autobody and tire shops, auto repair, auto dealers, auto service (including gas stations), retail, banks, office buildings, car wash, storage facilities, animal kennels and clinics, funeral homes, petroleum storage, grain and feed outlets, greenhouses, junkyards, lumber yards, and warehouse and distribution facilities. Recreation and entertainment include bars, bowling centers, camping facilities, cultural facilities, fairgrounds, golf courses, health spas, skating rinks, indoor and outdoor sports facilities, marinas, playgrounds, racetracks, restaurants, riding stables, social organizations, studios, theaters, and YMCAs.

It should be pointed out that some of the recreation and entertainment category is closely related to public park land use. Recreation and entertainment land use accounts for approximately 52% of the commercial land use category, followed by general commercial at approximately 46% and accommodations at approximately 3% (see Table 2.12.1 and Figure 2.12.15). Not surprisingly the highest density of commercial land use tends to run with the population centers and associated major transportation corridors in the southern portion of the watershed. Tompkins County accounts for approximately 80% of the recreation and entertainment, 88% of the general commercial, and 94% of the accommodations land use in the watershed (see Map 2.12.9).

**Figure 2.12.15**
**Commercial Land Use Agrage**

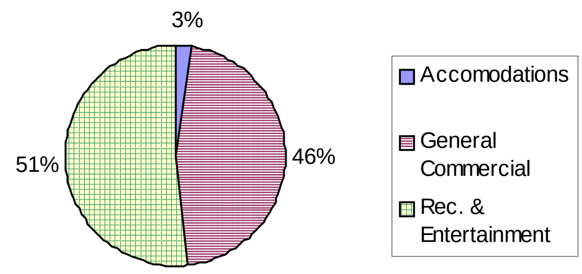
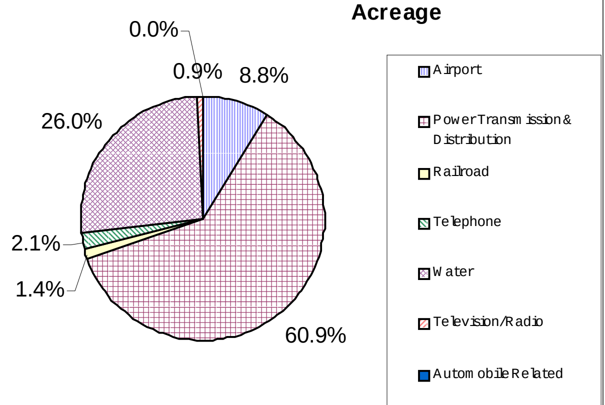


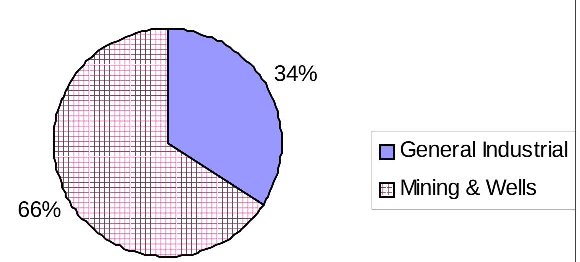

**Figure 2.12.16**
**Public Utility/Infrastructure Land Use Acreage**



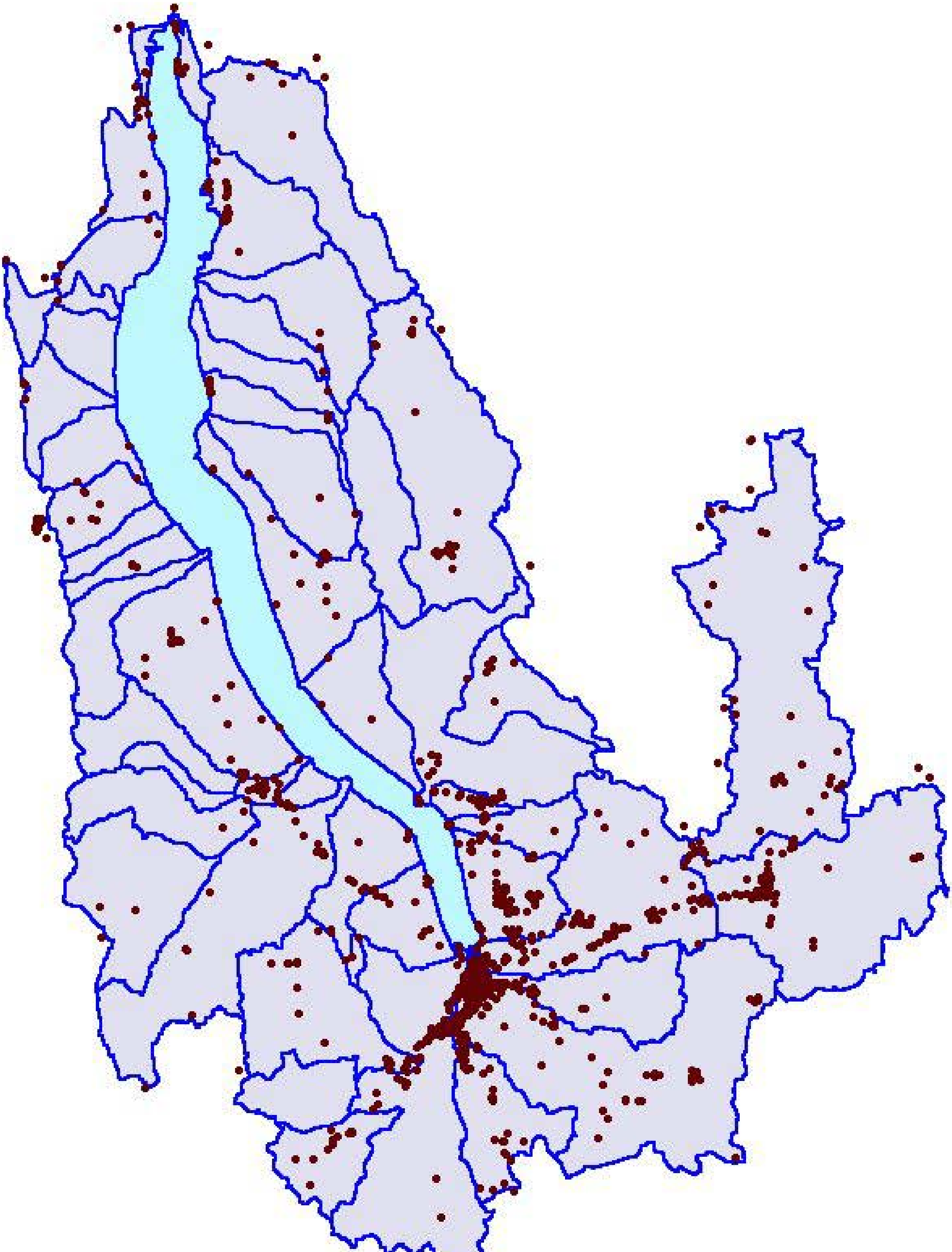

### 2.12.8 Public Utility and Infrastructure Land Use

Public utility and infrastructure land use include airports, power transmission and distribution, railroads, telephone, water supply and distribution, television and radio, and automobile related structures. In terms of land area, power transmission and distribution accounts for approximately 61% of the public utility and infrastructure land use category, followed by water supply and distribution (26%), airports (9%), telephone (2%), railroad (1%), television and radio (1%), and automobile related structures (places where automobiles can be housed) (less than 1%) (see Table 2.12.1 and Figure 2.12.16). This is another category of land use that tends to run with the major population center and associated transportation corridor in the southern portion of the watershed. Therefore, the vast majority of this land use in the watershed is in Tompkins County.

**Figure 2.12.17**
**Industrial Land Use Agreage**



# Cayuga Lake Watershed Commercial



This map was prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.

Source: New York State Department of Real Property Services, 1998.
Tompkins County GIS Program, 1999.
Genesee/Finger Lakes Regional Planning Council, 1998.

Base Map: New York State Department of Transportation, February 1996.

Each Dot Represents One Parcel

1:356256

0 5 10 Miles

Prepared by Genesee/Finger Lakes Regional Planning Council, 19

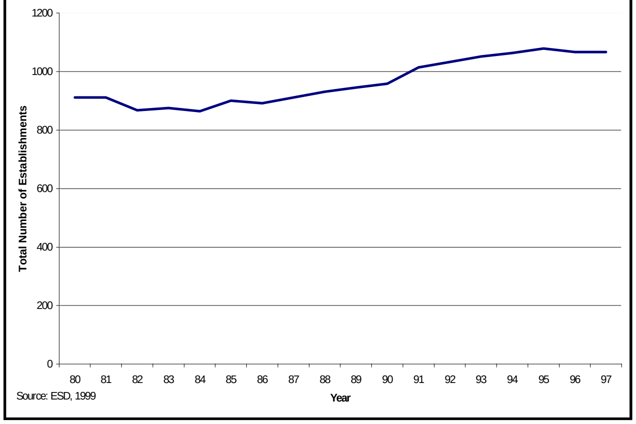
### 2.12.9 Industrial Land Use

Industrial land use includes general industrial and mines and wells. Most of the general industrial land use in the watershed involves manufacturing and processing. The vast majority of the mines and wells involves sand and gravel mining with a small percentage involving salt mining operations. Even though there are more industrial sites than mining sites, mining and wells account for approximately 66% of the land area versus 34% for industrial sites (see Table 2.12.1 and Figure 2.12.17). Most of the industrial land use is concentrated in the southern portion of the watershed with Tompkins County accounting for approximately 85% of the general industrial category and approximately 88% of the mining and well operations (see Industrial Land Use Map 2.12.10).

### 2.12.10 Tourism and Recreation

The Cayuga Lake Watershed has numerous opportunities for residents and tourists to enjoy the amenities of the lake and the surrounding area. The natural resources of the area allow for water-based recreation on and around the lake including the diverse landscape of the watershed that provides visitors a chance to enjoy the scenic beauty of Central New York and the largest of the Finger Lakes. The agricultural tradition of the watershed, that continues today, serves as the foundation for a number of "agri-tourism" businesses, most notably the Cayuga Lake wineries. In addition, a rich cultural heritage is also present through museums and historic sites.

Figure 2.13.1
Number of Tourism-Related Establishments
in the Cayuga Lake Watershed, 1980-1997.



Source: ESD, 1999

The northern part of the Cayuga Lake Watershed includes the Montezuma NWR. The eastern and western portions of the watershed are primarily agricultural and residential with business districts primarily along major roads and in the villages. The City of Ithaca, at the southern end of the lake, complements the watershed's predominantly rural character.

The road system around the lake includes (from the north end of the lake clockwise) Routes 5 & 20, Route 90, Route 34B, Route 34, and Route 89. At present, Route 90 has been designated by the NYS Office of Parks, Recreation, and Historic Preservation as a scenic byway. The other routes surrounding the lake are currently being studied for proposal as an encompassing scenic byway.

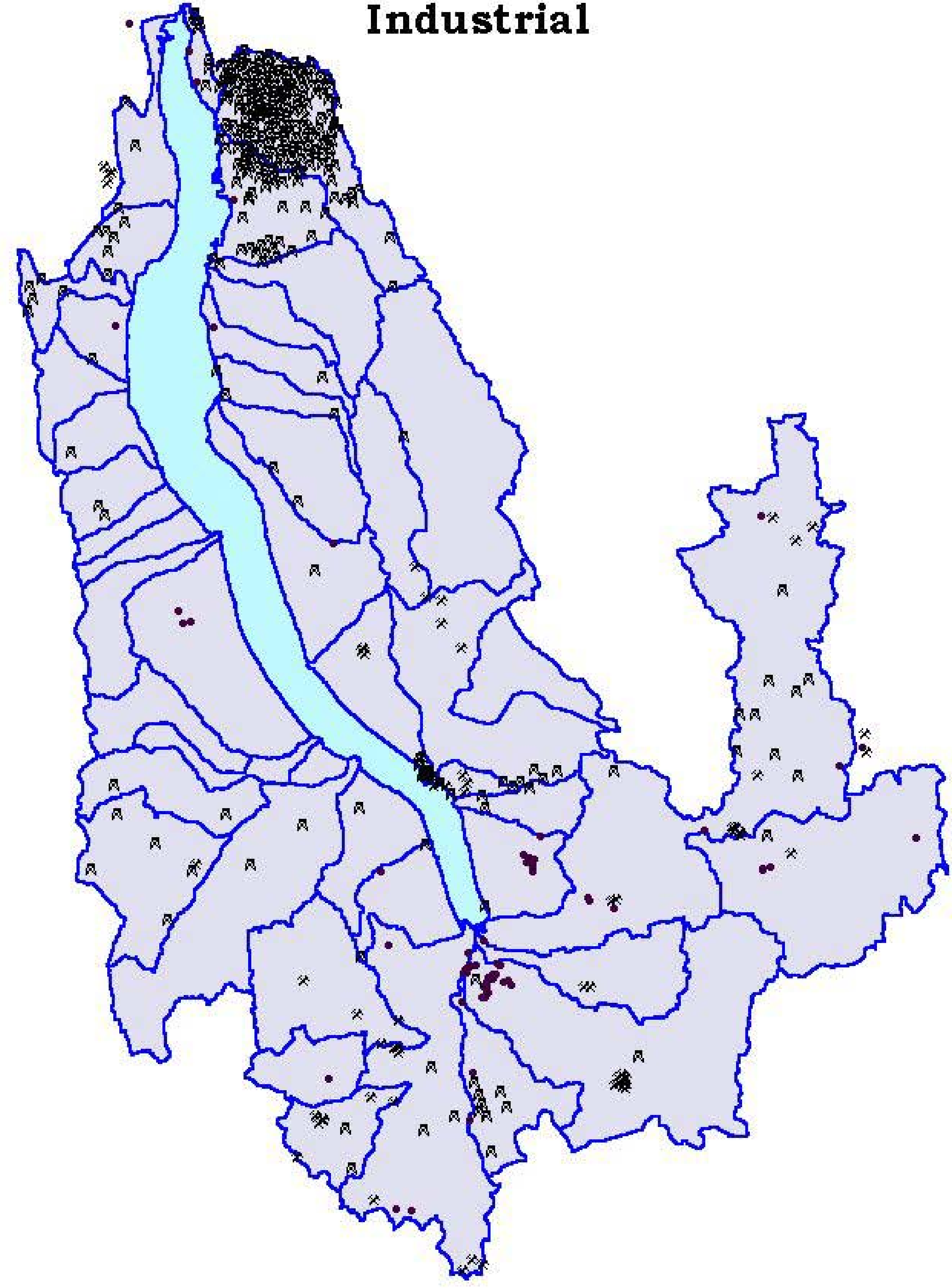
Cayuga Lake provides opportunities for a number of water sports including fishing, boating, swimming, and other activities during the summer. Cruises and charter boats also operate seasonally offering access to the water and activities for tourists. The surrounding area of the watershed provides areas for camping, hiking, picnicking, and relaxation. Marinas and boat launches are located along the lake with the largest concentration found at the southern end of the lake near Ithaca. In addition to activities reserved for the warmer summer months, cross country skiing trails and local parks' winter programs offer tourists and residents year-round recreation opportunities.

The numerous state and local parks in the watershed allow visitors to enjoy the scenic beauty of the watershed from numerous points. Among the state parks in the watershed are Cayuga Lake, Long Point, Taughannock Falls, Robert H. Treman, and Dean's Cove State Marine Park. Along with the parks, the Cayuga Nature Center, Cayuga Lake State Wildlife Management Area, Montezuma NWR, Fuertes Bird Sanctuary, Connecticut Hill State Wildlife Management Area, Finger Lakes National Forest, and other managed natural areas provide excellent opportunities for exploring and studying wildlife. The corresponding map provides a view of the locations of parks, campgrounds, marinas, and other tourism and recreation areas within the watershed.

The rural character of the watershed provides not only for a strong agricultural goods and services economy but also for complementary tourism and recreation related opportunities. As stated earlier, the most notable of these agri-businesses is the wineries throughout the watershed. The largest concentration of wineries can be found on the west

2.12.10

# Cayuga Lake Watershed
# Industrial



*This map was prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.*

*Source: New York State Department of Real Property Services, 1998.*
*Tompkins County GIS Program, 1999.*
*New York State Department of Environmental Conservation, Division of Mineral Resources, 1999.*
*Genesee/Finger Lakes Regional Planning Council, 1998.*

*Base Map: New York State Department of Transportation, February 1996.*

● General Industrial
⚒ Mine
Well

1:342510

0 4 8 Miles

*Prepared by Genesee/Finger Lakes Regional Planning Council, 1999.*

side of the lake along Route 89. In addition to tours of the vineyards and processing areas, some of the wineries also offer dining services or produce added business for lakefront restaurants and eateries. Other agri-businesses with tourism related spin-off include roadside produce stands, dairy, crop, and poultry farms, and museums such as the Rural Life Museum of Genoa Historical Association. Cornell University's Musgrave Research Farm and Cornell Plantations offer tours, displays, and exhibits of current research in agricultural sustainability and special populations of plants.
A plethora of cultural attractions can be found within the municipalities through their respective historical societies including local churches built in the early to mid-19$^{th}$ century that are renowned for their unique architectural styles. A number of Native American attractions including Cayuga Castle and other historical markers are also present. The Woman's Rights National Park, located in Seneca Falls, provide tributes to the women's right movement and attract tourists and visitors each year.

Cornell University, Ithaca College, Wells College, New York Chiropractic College, and Tompkins/Cortland Community College provide an arena for conferences and meetings as well as special events that residents and visitors to the watershed attend.

According to data provided by the Empire State Development Corporation, the number of tourism-related establishments (as defined by the US Travel Data Center) for the watershed as a whole increased between 1985 and 1990 (6%) and between 1990 and 1995 (13%). The number of employees in this industry increased between 1985 and 1990 (31%) but declined during the next five years (-4%). The increase in establishments but decrease in number of employees between 1990 and 1995 may be accounted for by the closing or layoffs of a few large employers and the opening of several smaller establishments that hire only a few workers. Figure 2.13.1 displays the changes in number of tourism-related establishments in the watershed between 1980 and 1997.

**2.13 Wetlands**

Wetlands form in a great variety of environments. Wetlands include such familiar areas as marshes, swamps and bogs. When the upper part of the soil is saturated with water at growing season temperatures, soil organisms consume the oxygen in the soil and cause conditions unsuitable for most plants. Such conditions also cause the development of soil characteristics (such as color and texture) of so-called "hydric soils." The plants that can grow in such conditions, such as marsh grasses, are called "hydrophytes." Together, hydric soils and hydrophytes give clues that a wetlands area is present.

The presence of water by ponding, flooding, or soil saturation is not always a good indicator of wetlands. Generally, the amount of water present in wetlands fluctuates as a result of rainfall patterns, snow melt, dry seasons and longer droughts. However, the presence of water greatly influences the soils and plant life found in wetlands. The water table is usually at or near the surface. The wetland area may be covered by shallow water all or part of the year or may not exhibit surface water.

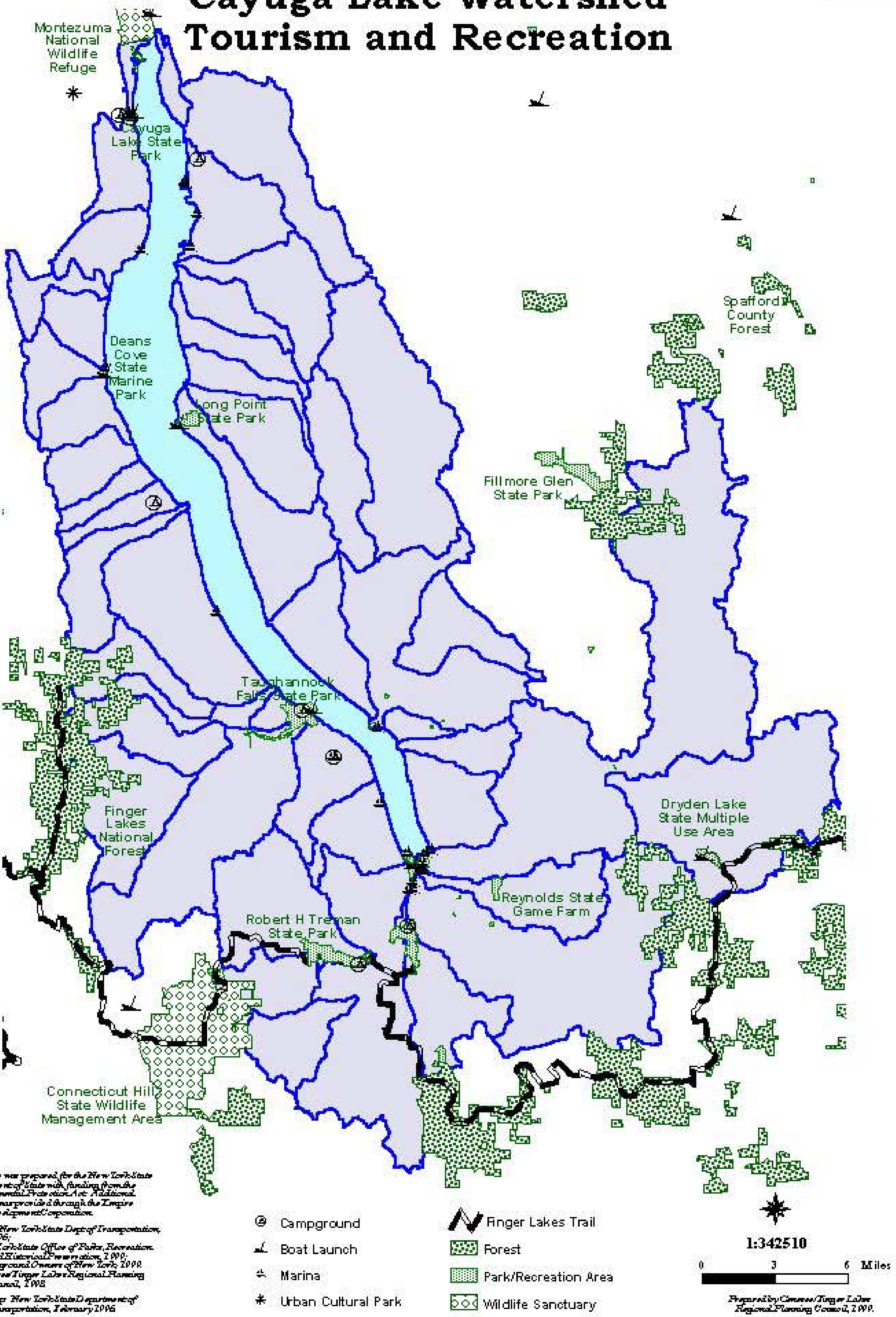
Wetlands provide many benefits, including food and habitat for fish and wildlife; flood protection; shoreline erosion control; natural products for human use; water quality improvement; and opportunities for recreation, education, and research. In New York State 60% of all wetlands have been lost from 1780 through 1980 (USEPA, 1999).

A variety of federal, state, and local regulations affect construction and other activities in wetlands and are in areas immediately adjacent to wetlands. In addition, the types, sizes, and locations of wetlands included in the regulations vary from law to law. The principle federal laws that regulate activities in wetlands are Sections 404 and 401 of the Clean Water Act, and Section 10 of the River and Harbors Act. Other federal laws include the National Environmental Policy Act, the Coastal Zone Management Act, and the Swampbuster provision of the Food, Agriculture, Conservation and Trade Act. The principal New York State regulations affecting development activities in and near wetlands in the Cayuga Lake Watershed include the Freshwater Wetlands Act and the Tidal Wetlands Act. Many local governments in New York also have provisions in ordinances and other regulations that affect projects proposed in or adjacent to wetlands (see Programmatic Environment Chapter).

There are approximately 6,575 acres of New York State Department of Conservation regulated freshwater wetlands in the watershed. This accounts for just over 1% of the land area in the watershed. As Map 2.12.11 indicates, these wetlands are fairly evenly dispersed throughout the watershed. The New York State Freshwater Wetlands Act

# Cayuga Lake Watershed Tourism and Recreation

2.12.11



protects freshwater wetlands and requires a 100 foot buffer around these wetlands. In the Cayuga Lake Watershed these are wetlands of 12.4 acres or greater in size, or smaller wetlands of unusual local importance. These wetlands have one or more of the following characteristics: a) lands and submerged lands commonly called marshes, swamps, sloughs, bogs, and flats supporting aquatic or semi-aquatic vegetation which depend upon seasonal or permanent flooding or sufficiently water logged soils to give them a competitive advantage; b) land and submerged lands containing remnants of any vegetation that is not aquatic or semi-aquatic that has died because of wet conditions over a sufficiently long period, provided that such wet conditions do not exceed a maximum seasonal water depth of six feet and provided further that such condition can be expected to persist indefinitely, barring human intervention; or c) land and water substantially enclosed by aquatic or semi-aquatic vegetation.

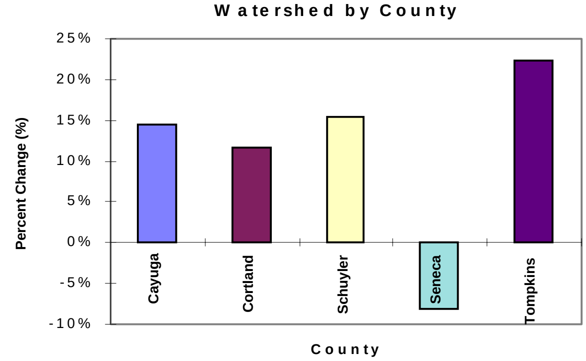
### 2.14 Demographic and Socio-Economic Profile

*The data presented in this analysis for these counties and municipalities are taken (except where otherwise noted) from the 1990 Census of Population and Housing. Because the Census Bureau's geographical study areas are not sensitive to watershed boundaries, the analysis provided herein is meant to serve as a general overview of the social and economic characteristics of the municipalities in the watershed; not the portions of these municipalities that fall within the Cayuga Lake Watershed. In some cases, only small portions of the municipalities analyzed lie within the watershed. Therefore, the validity of any projections made for only the portions of the municipalities that lie in the watershed will be limited.*

#### 2.14.1 Population

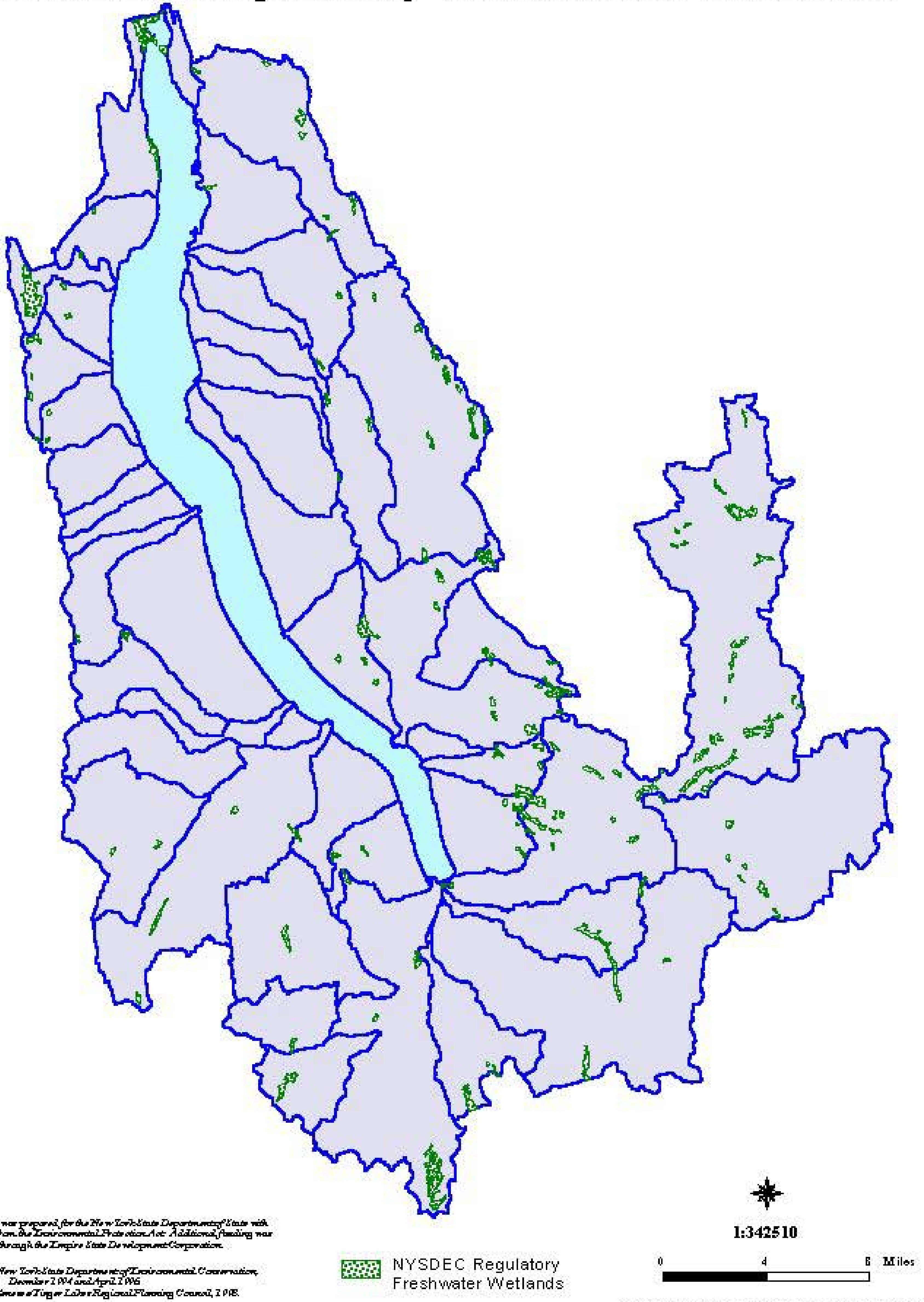
There are portions of six counties and 44 municipalities within the Cayuga Lake Watershed. The populations of the municipalities as of 1996 are shown in Map 2.14.1. From 1970 to 1990, the population of these municipalities has grown 16.5%. Between 1970 and 1980 the population increased 8.9% and the next decade saw a slightly smaller (7.0%) increase. Of the six counties, only the Seneca County municipalities within the watershed lost population (-8.1%) between 1970 and 1990. The Town of Spencer grew the fastest between 1970 and 1990 at a rate of 50%. In Tompkins County, the City of Ithaca, all of the towns, and all but one of the six villages are within the watershed. These municipalities grew at a rate of 22% between 1970 and 1990. Each of the remaining counties' municipalities within the watershed grew between 11% and 16 %. Figure 2.14.1 displays the percent change in population of municipalities in the watershed by county. The populations and changes by percent from 1970 to 1980 and 1980 to 1990 for each municipality in the watershed are presented in Table 2.14.1.

Figure 2.14.1
Percent Changes in Population between 1970 and 1990 for Municipalities in the Cayuga Lake Watershed by County




In 1997, the New York State Association of Regional Councils (NYSARC) published *New York State Population Projections through 2030.* To accomplish this, the nine regional planning councils and development boards of New York State each produced population projections for their respective regions. It is important to note that differing methodologies were used by the regional planning councils and development boards to arrive at the population projections used in this report. Projections were provided at the sub-county level for Cortland, Schuyler, Seneca, Tioga, and Tompkins counties, although these projections were never approved for use in Tompkins County. Cayuga County's growth rate was determined at the county level. For the purposes of this study, the Cayuga County growth rate was applied to each of its municipality's base year population (1990) to forecast changes in these populations between 1990 and 2010. The projected growth rates of municipal populations within the watershed by county are presented in Figure 2.14.2. According to these estimates, the combined population of the municipalities within the watershed will continue to experience growth but at a slower rate than that of the previous twenty years. The fastest growth is expected to

# Cayuga Lake Watershed
# NYSDEC Regulatory Freshwater Wetlands




*This map was prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.*

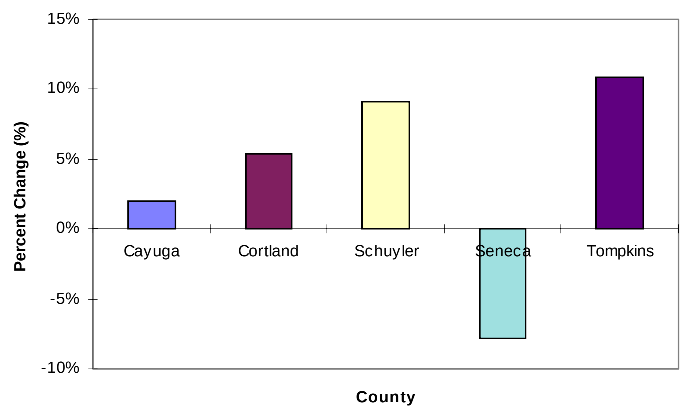
*Source: New York State Department of Environmental Conservation, December 1994 and April 1996*
*Genesee/Finger Lakes Regional Planning Council, 1998.*

*Base Map: New York State Department of Transportation, February 1996.*

*Prepared by Genesee/Finger Lakes Regional Planning Council, 1999.*

occur in the Tompkins County (10.9%), Tioga County (9.9%), and Schuyler County (9.1%) municipalities while the Cortland County (5.4%) and Cayuga County (2%) municipalities will also increase, but at a less substantial rate. Again, only the Seneca County municipalities are expected to decrease in population over the same period (-7.8%). As a whole, the population of the municipalities within the watershed is expected to increase by approximately 10,000 persons or 7% from 1990 to the end off the first decade of the upcoming century. The projected increases in population for all municipalities in the watershed are shown in Table 2.14.2.

**Figure 2.14.2**
**Projected Percent Changes in Population between 1990 and 2010 for Municipalities in the Cayuga Lake Watershed by County**



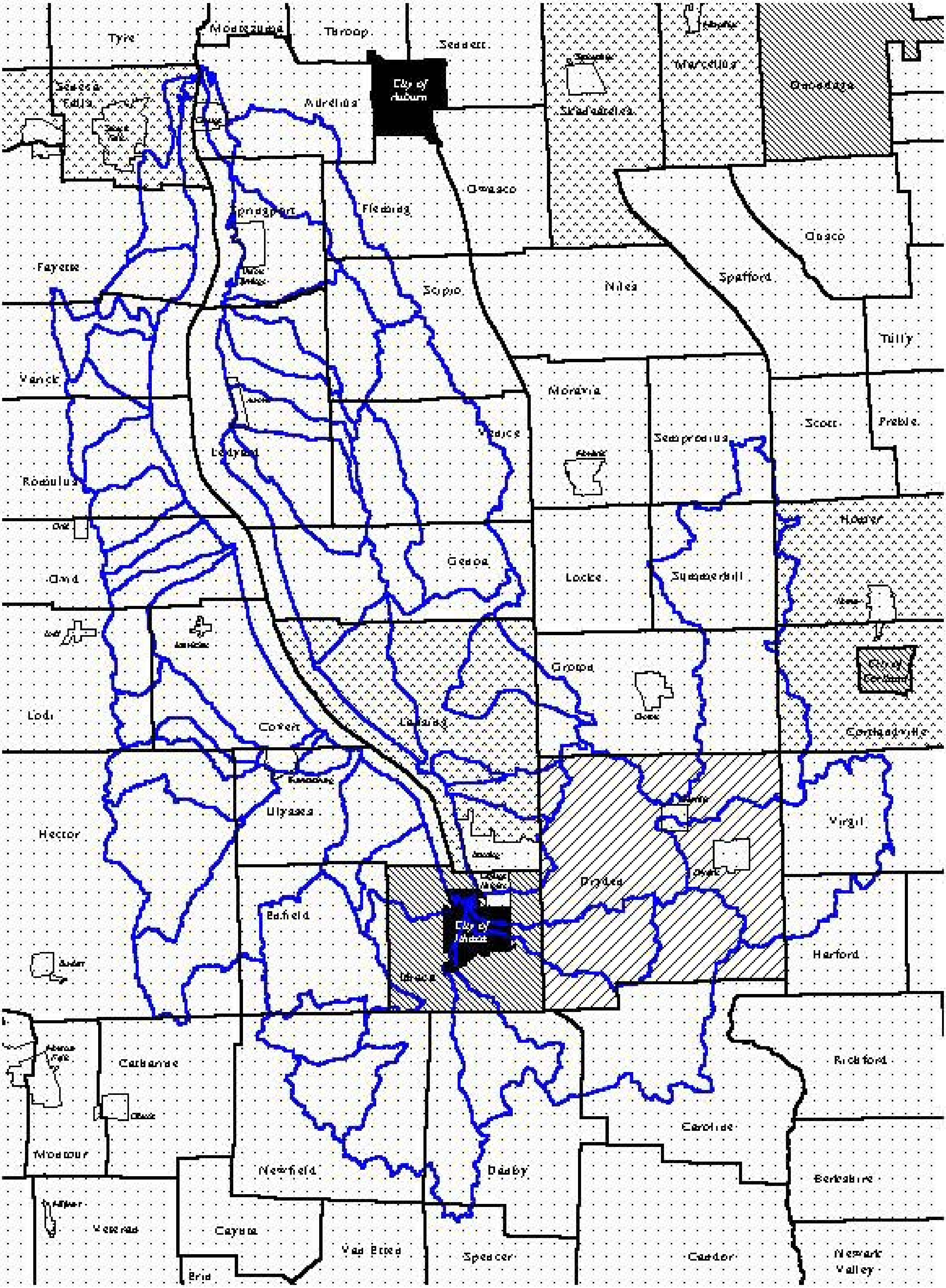

The combined population density for all of the municipalities in the watershed in 1990 was nearly 104 persons per square mile of land area. The greatest population density can be found at the southern end of the watershed in Tompkins County. The only city in the watershed (Ithaca) is located in Tompkins County and contributes greatly to an increased population density for both that particular county and the watershed as a whole. The City of Ithaca's population density is 5371.1 persons per square mile of land area. In contrast, the population density for the municipalities in Cayuga, Cortland, Schuyler, and Seneca counties combined is only 62.1 persons per square mile of land area. When the City of Ithaca is excluded, the population density for the watershed as a whole is only 82.9 persons per square mile of land area. The population densities for municipalities in the watershed are provided below in Table 2.14.3.

### 2.14.2 Housing

In 1990, the municipalities in the Cayuga Lake Watershed contained 63,515 housing units. Of these housing units, over two-thirds (69.1%) were in rural areas as defined by the Census Bureau. Farms constituted 2.6% (1,485 units) of all housing units in municipalities within the watershed. Only two towns in Schuyler County are in the watershed. However, located within the towns of Hector and Catharine were 57.8% of all the farms in Schuyler County. Of the 415 farms in Seneca County, 84% (347 farms) were in towns with at least some portion of the watershed within their boundaries. Cayuga County and Cortland County towns in the watershed comprised 51% and 38% of the total number of farms in their respective counties. Urban housing units constituted 31% of the total number of housing units in municipalities in the watershed. Urban housing units (as opposed to rural housing units) are in US Census Bureau defined Urbanized Areas. An Urbanized Area comprises one or more Central Places (usually a large city or cities) and the surrounding, densely settled land area called the Urban Fringe. The minimum population of an Urbanized Area is 50,000 persons. The City of Ithaca contained nearly 57% of all urban housing units in the watershed. No urban housing units were present in Cayuga, Schuyler, Seneca, or Tioga counties and the remaining urban housing units, all outside urbanized areas, were found in Cortland County. A breakdown of housing units by urban and rural classifications is provided in Table 2.14.4.

Housing units in towns in the watershed and the City of Ithaca had a 90.2% occupancy rate in 1990. Of all occupied housing units nearly 65% were owner occupied. Only seven of the municipalities analyzed had a lower owner occupancy rate than that of the study area as a whole. Over half (55%) of all renter occupied housing units in the study area were located in the City and Town of Ithaca, and Village of Lansing. The City of Ithaca alone contained approximately 37% of all the renter occupied units in municipalities within the watershed. In fact, over 70% of all housing units in the City of Ithaca were renter occupied. The presence of postsecondary institutions (namely Cornell University and Ithaca College) most likely accounts for the large number of renter occupied housing units in these municipalities. Compared to the average homeowner in the US, college students tend to be younger, more mobile, and lack the financial resources necessary to purchase a home. The total number of occupied housing units and the numbers of those that are owner or renter occupied are presented in Table 2.14.5.

# Cayuga Lake Watershed
# Population by Municipality




This map was prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.

Source: US Department of Commerce, Bureau of the Census, 1996 Estimates of Resident Population, 1997.
Genesee/Finger Lakes Regional Planning Council, 1998.

Base Map: New York State Department of Transportation, February 1996.

1996 Population

300 - 6000
6000 - 12000
12000 - 18000
18000 - 24000
24000 - 30000

1:401030

0 5 10 Miles

Prepared by Genesee/Finger Lakes Regional Planning Council, 1999.

In 1990, the vacancy rate for the towns and city in the watershed was 10.2%. Over half (51.2%) of all vacant housing units were for seasonal, recreational, or occasional use. Over 60% of seasonal, recreational, or occasional use housing units were located in the municipalities bordering the lake. It can be assumed that a number of the units falling within the classification of being for seasonal, recreational, or occasional use are homes and cottages used to enjoy the lake's recreational amenities. Of the remaining vacant housing units, 18.5% were for rent, 6.1% were for sale, and 24.3% were vacant for a reason other than those listed above. The Village of Lansing and the City and Town of Ithaca are home to the largest percentage of renters, and also contained 53.5% of all vacant housing units for rent in the study area. A breakdown of vacant housing units is provided below in Table 2.14.6.

According to the Census Bureau, over half (51.4%) of all housing units in municipalities within the watershed received their water from a public system or private company in 1990. Individual drilled wells provided water to 37.3% of the housing units in the study area over the same period. Individual dug wells and other sources provided water to the remaining housing units. Drilled wells were the primary source of water in the Cayuga, Cortland, Schuyler, and Tioga county municipalities in the watershed. Public systems and private companies were the primary sources of water for municipalities in Seneca and Tompkins counties. The sources of water for housing units in the study area are displayed in Table 2.14.7.

Within the study area, just over half (55%) of all housing units in municipalities in the watershed relied on septic tanks or cesspools for sewage disposal. Nearly all of the remaining housing units used public sewers, with approximately 1% of the remaining housing units disposing of sewage by some other means as defined by the Census Bureau. Septic tanks and cesspools were the primary means of sewage disposal in all of the counties in the watershed, with Tompkins County being the exception. Approximately 60% of the Tompkins County municipalities relied on public sewers for sewage disposal. The Towns of Danby and Ledyard were the only municipalities in the watershed to have no housing units using a public sewer. Only fourteen (or 32%) of the municipalities in the watershed had a majority of housing units using public sewers in 1990. Many of these were at the southern end of the lake including the City of Ithaca and the towns and villages surrounding it. Means of sewage disposal for municipalities in the watershed are detailed in Table 2.14.8.

### 2.14.3 Economic Profile

In 1990, the largest percentage of persons with incomes below the poverty level were found in the City of Ithaca. Nearly 40% of the population had incomes below the poverty level. This may be attributable to the large number of students who are enrolled in local colleges and universities and are not likely to be employed full time. There are areas of high and low poverty levels throughout the study area. A breakdown of the percent of population with incomes below the poverty level for the city and towns in the watershed is displayed in Table 2.14.9.

The highest per capita and median household income among all municipalities in the watershed could be found in the Village of Cayuga Heights. The median household income for the Village of Cayuga Heights was over 50% higher than the state average and the per capita income was almost 70% higher than the state average. As a whole, the Tompkins County municipalities exhibited the highest per capita and median household incomes in the watershed while the Schuyler County municipalities exhibited the lowest. Again, distribution of areas with high and low incomes scattered among municipalities within the various counties. Tables 2.14.10 and 2.14.11 present median household income and per capita income for the municipalities in the watershed.

Only two of the Seneca County municipalities in the watershed had more than 70% of their population in the labor force. Of the eight municipalities with less than 65% of the population in the labor force, five were in Seneca County. Two municipalities in Tompkins County did not have 65% or more of their populations in the labor force. They were the City and Town of Ithaca. As stated earlier, this may be attributable to the large number of college students, many of who may not be actively seeking employment. In 1990, only four municipalities in the watershed had unemployment rates higher than the state average. The lowest rates of unemployment were found at the southern end of the watershed in Tompkins County. The percentage of population in the labor force and unemployment rates for cities and towns in the watershed are displayed in Table 2.14.12.

To some degree, the level of education for an area represents the quality of the labor force and the potential for increased economic prosperity. As could be expected, the City of Ithaca and the municipalities surrounding it had the highest percentage of persons with a high school diploma or higher and the highest percentage of persons with a bachelor's degree or higher in the study area. Only five of the 44 municipalities in the watershed had a lower percentage of persons with a high school diploma or higher than the state average. However, only 13 of the municipalities in the watershed had a higher percentage of persons with a bachelor's degree or higher than the average for New York State. The percentage of persons with a high school diploma or higher and a bachelor's degree or higher are provided in Table 2.14.13.

Most of the major private employers in the watershed are located in the southern end of the watershed, and more particularly in the City of Ithaca and Town of Ithaca. Two of the three largest employers (Cornell University and Ithaca College) are institutions of higher education. The Wegmans, Tops, and P & C grocery stores employ approximately 1,000 persons and several manufacturing and high technology firms are also present . A list of employers in municipalities in the watershed with more than 100 employees is provided in Table 2.14.14.

Between 1985 and 1996 the number of persons employed by manufacturing firms decreased in all six counties in the Cayuga Lake Watershed. Simultaneously, retail trade and service employment rose over the same period in all six counties. With the exceptions of Seneca and Tioga counties, the number of full-time and part-time employees in each of the counties increased between 1985 and 1996. In some industries, the counties in the watershed experienced growth in employment between 1985 and 1990 only to see cutbacks in the total number of employees in those same industries between 1990 and 1996. A breakdown of employment by industry is presented in Table 2.14.15.

| Table 2.14.1 - Population Change: 1970 - 1990 | 1970 | 1980 | % Change | 1990 | % Change |
|---|---|---|---|---|---|
| **Cayuga County** | | | | | |
| Town of Aurelius | 2,158 | 2,316 | 7.3% | 2,357 | 1.8% |
| Village of Cayuga | 693 | 604 | -12.8% | 556 | -7.9% |
| Town of Fleming | 2,242 | 2,394 | 6.8% | 2,642 | 10.4% |
| Town of Genoa | 1,744 | 1,921 | 10.1% | 1,868 | -2.8% |
| Town of Ledyard | 814 | 943 | 15.8% | 1,050 | 11.3% |
| Village of Aurora | 1,072 | 926 | -13.6% | 687 | -25.8% |
| Town of Locke | 1,152 | 1,751 | 52.0% | 1,917 | 9.5% |
| Town of Scipio | 1,290 | 1,471 | 14.0% | 1,517 | 3.1% |
| Town of Sempronius | 649 | 733 | 12.9% | 796 | 8.6% |
| Town of Springport | 728 | 1,009 | 38.6% | 1,056 | 4.7% |
| Village of Union Springs | 1,183 | 1,201 | 1.5% | 1,142 | -4.9% |
| Town of Summerhill | 670 | 850 | 26.9% | 1,023 | 20.4% |
| Town of Venice | 1,261 | 1,268 | 0.6% | 1,315 | 3.7% |
| **Cortland County** | | | | | |
| Town of Cortlandville | 7,090 | 6,070 | -14.4% | 6,960 | 14.7% |
| Town of Harford | 748 | 855 | 14.3% | 886 | 3.6% |
| Town of Homer | 2,417 | 2,985 | 23.5% | 3,053 | 2.3% |
| Town of Scott | 805 | 1,193 | 48.2% | 1,167 | -2.2% |
| Town of Virgil | 1,692 | 2,053 | 21.3% | 2,172 | 5.8% |
| **Schuyler County** | | | | | |
| Town of Catharine | 1,886 | 1,932 | 2.4% | 1,991 | 3.1% |
| Town of Hector | 3,671 | 3,793 | 3.3% | 4,423 | 16.6% |
| **Seneca County** | | | | | |
| Town of Covert | 1,364 | 1,503 | 10.2% | 1,566 | 4.2% |
| Village of Interlaken | 733 | 685 | -6.5% | 680 | -0.7% |
| Town of Fayette | 2,352 | 2,829 | 20.3% | 2,856 | 1.0% |
| Town of Lodi | 934 | 850 | -9.0% | 1,068 | 25.6% |
| Town of Ovid | 2,359 | 1,888 | -20.0% | 1,671 | -11.5% |
| Town of Romulus | 4,253 | 2,440 | -42.6% | 2,507 | 2.7% |
| Town of Seneca Falls | 2,106 | 2,420 | -42.6% | 2,014 | -16.8% |
| Town of Varick | 1,700 | 1,868 | 14.9% | 2,161 | 15.7% |
| **Tioga County** | | | | | |
| Town of Spencer | 1,378 | 1,770 | 28.4% | 2,066 | 16.7% |
| **Tompkins County** | | | | | |
| City of Ithaca | 26,226 | 28,732 | 9.6% | 29,541 | 2.8% |
| Town of Caroline | 2,536 | 2,754 | 8.6% | 3,044 | 10.5% |
| Town of Danby | 2,141 | 2,449 | 14.4% | 2,858 | 16.7% |
| Town of Dryden | 7,616 | 9,946 | 30.6% | 10,906 | 9.7% |
| Village of Dryden | 1,490 | 1,761 | 18.2% | 1,908 | 8.3% |
| Village of Freeville | 664 | 449 | -32.4% | 437 | -2.7% |
| Town of Enfield | 2,028 | 2,375 | 17.1% | 3,054 | 28.6% |
| Town of Groton | 2,769 | 2,900 | 4.7% | 3,085 | 6.4% |
| Town of Ithaca | 12,490 | 12,852 | 2.9% | 14,340 | 11.6% |
| Village of Cayuga Heights | 3,130 | 3,170 | 1.3% | 3,457 | 9.1% |
| Town of Lansing* | 5,972 | 5,278 | -11.6% | 6,015 | 14.0% |
| Village of Lansing | N/A | 3,039 | N/A | 3,281 | 8.0% |
| Town of Newfield | 3,390 | 4,401 | 29.8% | 4,867 | 10.6% |
| Town of Ulysses | 2,697 | 2,944 | 9.2% | 3,295 | 11.9% |
| Village of Trumansburg | 1,803 | 1,722 | -4.5% | 1,611 | -6.4% |

Source: US Department of Commerce, Bureau of Census. 1970, 1980, & 1990.

*The 1970 census count for the Town of Lansing includes the Village of Lansing which is now counted separately.

| Table 2.14.2 - Projected Population Change: 1990 - 2010 | 1990 | 2000 | % Change | 2010 | % Change |
|---|---|---|---|---|---|
| **Cayuga County** | | | | | |
| Town of Aurelius | 2,357 | 2387 | 1.3% | 2405 | 0.7% |
| Village of Cayuga | 556 | 563 | 1.3% | 567 | 0.7% |
| Town of Fleming | 2,642 | 2676 | 1.3% | 2696 | 0.7% |
| Town of Genoa | 1,868 | 1892 | 1.3% | 1906 | 0.7% |
| Town of Ledyard | 1,737 | 1759 | 1.3% | 1772 | 0.7% |
| Village of Aurora | 687 | 696 | 1.3% | 701 | 0.7% |
| Town of Locke | 1,917 | 1942 | 1.3% | 1956 | 0.7% |
| Town of Scipio | 1,517 | 1536 | 1.3% | 1548 | 0.7% |
| Town of Sempronius | 796 | 806 | 1.3% | 812 | 0.7% |
| Town of Springport | 2,198 | 2226 | 1.3% | 2243 | 0.7% |
| Village of Union Springs | 1,142 | 1157 | 1.3% | 1165 | 0.7% |
| Town of Summerhill | 1,023 | 1036 | 1.3% | 1044 | 0.7% |
| Town of Venice | 1,315 | 1332 | 1.3% | 1342 | 0.7% |
| **Cortland County** | | | | | |
| Town of Cortlandville | 6,960 | 7,155 | 2.8% | 7,355 | 2.8% |
| Town of Harford | 886 | 907 | 2.4% | 929 | 2.4% |
| Town of Homer | 3,053 | 3,126 | 2.4% | 3,201 | 2.4% |
| Town of Scott | 1,167 | 1,195 | 2.4% | 1,224 | 2.4% |
| Town of Virgil | 2,172 | 2,233 | 2.8% | 2,295 | 2.8% |
| **Schuyler County** | | | | | |
| Town of Catharine | 1,991 | 2,212 | 11.1% | 2,246 | 1.5% |
| Town of Hector | 4,423 | 4,661 | 5.4% | 4,751 | 1.9% |
| **Seneca County** | | | | | |
| Town of Covert | 1,566 | 1,615 | 3.1% | 1,640 | 1.5% |
| Village of Interlaken | 680 | 739 | 8.7% | 734 | -0.7% |
| Town of Fayette | 2,856 | 2,869 | 0.5% | 2,906 | 1.3% |
| Town of Lodi | 1,068 | 1,100 | 3.0% | 1,106 | 0.5% |
| Town of Ovid | 1,671 | 1,451 | -13.2% | 1,462 | 0.8% |
| Town of Romulus | 2,507 | 1,921 | -23.4% | 1,933 | 0.6% |
| Town of Seneca Falls | 2,014 | 2,000 | -0.7% | 2,044 | 2.2% |
| Town of Varick | 2,161 | 1,567 | -27.5% | 1,570 | 0.2% |
| **Tioga County** | | | | | |
| Town of Spencer | 2,066 | 2,195 | 6.2% | 2,271 | 3.5% |
| **Tompkins County** | | | | | |
| City of Ithaca | 29,541 | 29,429 | -0.4% | 29,779 | 1.2% |
| Town of Caroline | 3,044 | 3,437 | 12.9% | 3,687 | 7.3% |
| Town of Danby | 2,858 | 3,027 | 5.9% | 3,277 | 8.3% |
| Town of Dryden | 10,906 | 11,969 | 9.7% | 12,769 | 6.7% |
| Village of Dryden | 1,908 | 2,037 | 6.8% | 2,057 | 1.0% |
| Village of Freeville | 437 | 471 | 7.8% | 491 | 4.2% |
| Town of Enfield | 3,054 | 3,291 | 7.8% | 3,641 | 10.6% |
| Town of Groton | 3,085 | 3,178 | 3.0% | 3,278 | 3.1% |
| Town of Ithaca | 14,340 | 14,832 | 3.4% | 15,632 | 5.4% |
| Village of Cayuga Heights | 3,457 | 4,073 | 17.8% | 4,093 | 0.5% |
| Town of Lansing | 6,015 | 6,911 | 14.9% | 7,711 | 11.6% |
| Village of Lansing | 3,281 | 3,633 | 10.7% | 3,883 | 6.9% |
| Town of Newfield | 4,867 | 5,391 | 10.8% | 5,641 | 4.6% |
| Town of Ulysses | 3,295 | 3,575 | 8.5% | 3,925 | 9.8% |
| Village of Trumansburg | 1,611 | 1,791 | 11.2% | 1,811 | 1.1% |

Source: US Department of Commerce, Bureau of Census. 1990 and New York State Association of Regional Councils. 1997.

| Table 2.14.3 - Population Density: 1990 | Land Area (Square Miles) | Population | Density |
|---|---|---|---|
| **Cayuga County** | | | |
| Town of Aurelius | 30.30 | 2,913 | 96.1 |
| Village of Cayuga | 0.60 | 556 | 926.7 |
| Town of Fleming | 21.80 | 2,642 | 121.2 |
| Town of Genoa | 39.70 | 1,868 | 47.1 |
| Town of Ledyard | 36.30 | 1,737 | 47.9 |
| Village of Aurora | 1.00 | 687 | 687.0 |
| Town of Locke | 24.40 | 1,917 | 78.6 |
| Town of Scipio | 36.70 | 1,517 | 41.3 |
| Town of Sempronius | 29.40 | 796 | 27.1 |
| Town of Springport | 21.50 | 2,198 | 102.2 |
| Village of Union Springs | 1.80 | 1,142 | 634.4 |
| Town of Summerhill | 25.90 | 1,023 | 39.5 |
| Town of Venice | 41.10 | 1,315 | 32.0 |
| **Cortland County** | | | |
| Town of Cortlandville | 48.6 | 6,960 | 143.2 |
| Town of Harford | 24.2 | 886 | 36.6 |
| Town of Homer | 50.4 | 3,053 | 60.6 |
| Town of Scott | 22.3 | 1,167 | 52.3 |
| Town of Virgil | 47.3 | 2,172 | 45.9 |
| **Schuyler County** | | | |
| Town of Catharine | 32.8 | 1,991 | 60.7 |
| Town of Hector | 102.5 | 4,423 | 43.2 |
| **Seneca County** | | | |
| Town of Covert | 31.2 | 1,566 | 50.2 |
| Village of Interlaken | 0.3 | 680 | 2266.7 |
| Town of Fayette | 65.9 | 2,856 | 43.3 |
| Town of Lodi | 33.7 | 1,068 | 31.7 |
| Town of Ovid | 30.6 | 1,671 | 54.6 |
| Town of Romulus | 37.8 | 2,507 | 66.3 |
| Town of Seneca Falls | 19.8 | 2,014 | 101.7 |
| Town of Varick | 32.3 | 2,161 | 66.9 |
| **Tioga County** | | | |
| Town of Spencer | 49 | 2,066 | 42.5 |
| **Tompkins County** | | | |
| City of Ithaca | 5.5 | 29,541 | 5371.1 |
| Town of Caroline | 55 | 3,044 | 55.3 |
| Town of Danby | 53.6 | 2,858 | 53.3 |
| Town of Dryden | 91.1 | 10,906 | 119.7 |
| Village of Dryden | 1.7 | 1,908 | 1122.4 |
| Village of Freeville | 1.1 | 437 | 397.3 |
| Town of Enfield | 36.9 | 3,054 | 82.8 |
| Town of Groton | 48 | 3,085 | 64.3 |
| Town of Ithaca | 27.3 | 14,340 | 525.3 |
| Village of Cayuga Heights | 1.8 | 3,457 | 1920.6 |
| Town of Lansing | 56.1 | 6,015 | 107.2 |
| Town of Newfield | 58.9 | 4,867 | 82.6 |
| Town of Ulysses | 33 | 3,295 | 99.8 |
| Village of Trumansburg | 1.2 | 1,611 | 1342.5 |

Source: US Department of Commerce, Bureau of Census. 1990.

## Table 2.14.4 - Housing Units: 1990

| | Total Numbe of Housing Units | Urban | | | Rural | | |
|---|---|---|---|---|---|---|---|
| | | Inside Urbanized Area | | Outside Urbanized Area | Farm | | Non-Farm |
| **Cayuga County** | | | | | | | |
| Town of Aurelius | 898 | - | | - | 57 | | 841 |
| Village of Cayuga | 246 | - | | - | - | | 246 |
| Town of Fleming | 1,048 | - | | - | 39 | | 1,009 |
| Town of Genoa | 897 | - | | - | 77 | | 820 |
| Town of Ledyard | 597 | - | | - | 50 | | 547 |
| Village of Aurora | 213 | - | | - | 3 | | 210 |
| Town of Locke | 702 | - | | - | 28 | | 674 |
| Town of Scipio | 631 | - | | - | 70 | | 561 |
| Town of Sempronius | 343 | - | | - | 23 | | 320 |
| Town of Springport | 522 | - | | - | 21 | | 501 |
| Village of Union Springs | 501 | - | | - | - | | 501 |
| Town of Summerhill | 402 | - | | - | 26 | | 376 |
| Town of Venice | 502 | - | | - | 69 | | 433 |
| **Cortland County** | | | | | | | |
| Town of Cortlandville | 3,127 | - | | 10 | 38 | | 3,079 |
| Town of Harford | 321 | - | | - | 2 | | 319 |
| Town of Homer | 1,092 | - | | - | 58 | | 1,034 |
| Town of Scott | 434 | - | | - | 10 | | 424 |
| Town of Virgil | 893 | - | | - | 37 | | 856 |
| **Schuyler County** | | | | | | | |
| Town of Catharine | 594 | - | | - | 21 | | 573 |
| Town of Hector | 2,071 | - | | - | 112 | | 1,959 |
| **Seneca County** | | | | | | | |
| Town of Covert | 846 | - | | - | 74 | | 772 |
| Village of Interlaken | 277 | - | | - | - | | 277 |
| Town of Fayette | 1,309 | - | | - | 69 | | 1,240 |
| Town of Lodi | 585 | - | | - | 58 | | 527 |
| Town of Ovid | 760 | - | | - | 48 | | 712 |
| Town of Romulus | 955 | - | | - | 34 | | 921 |
| Town of Seneca Falls | 910 | - | | - | 11 | | 899 |
| Town of Varick | 797 | - | | - | 48 | | 749 |
| **Tioga County** | | | | | | | |
| Town of Spencer | 832 | - | | - | 15 | | 817 |
| **Tompkins County** | | | | | | | |
| City of Ithaca | 10,075 | 10,075 | | - | - | | - |
| Town of Caroline | 1,223 | - | | - | 47 | | 1,176 |
| Town of Danby | 1,094 | - | | - | 47 | | 1,047 |
| Town of Dryden | 4,336 | 483 | | - | 81 | | 3,772 |
| Village of Dryden | 792 | - | | - | 3 | | 789 |
| Village of Freeville | 190 | - | | - | - | | 190 |
| Town of Enfield | 1,182 | - | | - | 32 | | 1,150 |
| Town of Groton | 1,118 | - | | - | 66 | | 1,052 |
| Town of Ithaca | 4,767 | 4,067 | | - | 9 | | 691 |
| Village of Cayuga Heights | 1,470 | 1,470 | | - | - | | - |
| Town of Lansing | 2,496 | 13 | | - | 51 | | 2,432 |
| Village of Lansing | 1,639 | 1,639 | | - | - | | - |
| Town of Newfield | 1,675 | - | | - | 23 | | 1,652 |
| Town of Ulysses | 1,383 | - | | - | 28 | | 1,355 |
| Village of Trumansburg | 674 | - | | - | - | | 674 |

Source: US Department of Commerce, Bureau of Census. 1990.

| Table 2.14.5 - Occupied Housing Units: 1990 | | | |
|---|---|---|---|
| | Occupied Housing Unit | Owner Occupied | Renter Occupied |
| **Cayuga County** | | | |
| Town of Aurelius | 820 | 713 | 107 |
| Village of Cayuga | 196 | 148 | 48 |
| Town of Fleming | 940 | 850 | 90 |
| Town of Genoa | 653 | 517 | 136 |
| Town of Ledyard | 360 | 300 | 60 |
| Village of Aurora | 186 | 118 | 68 |
| Town of Locke | 645 | 552 | 93 |
| Town of Scipio | 510 | 443 | 67 |
| Town of Sempronius | 272 | 234 | 38 |
| Town of Springport | 349 | 294 | 55 |
| Village of Union Springs | 435 | 306 | 129 |
| Town of Summerhill | 317 | 278 | 39 |
| Town of Venice | 433 | 345 | 88 |
| **Cortland County** | | | |
| Town of Cortlandville | 3,017 | 2,181 | 836 |
| Town of Harford | 292 | 251 | 41 |
| Town of Homer | 1,029 | 826 | 203 |
| Town of Scott | 381 | 362 | 19 |
| Town of Virgil | 736 | 592 | 144 |
| **Schuyler County** | | | |
| Town of Catharine | 503 | 419 | 84 |
| Town of Hector | 1,598 | 1,349 | 249 |
| **Seneca County** | | | |
| Town of Covert | 580 | 511 | 69 |
| Village of Interlaken | 258 | 185 | 73 |
| Town of Fayette | 979 | 850 | 129 |
| Town of Lodi | 376 | 322 | 54 |
| Town of Ovid | 616 | 483 | 133 |
| Town of Romulus | 756 | 472 | 284 |
| Town of Seneca Falls | 758 | 614 | 144 |
| Town of Varick | 622 | 515 | 107 |
| **Tioga County** | | | |
| Town of Spencer | 736 | 648 | 88 |
| **Tompkins County** | | | |
| City of Ithaca | 9,617 | 2,778 | 6,839 |
| Town of Caroline | 1,149 | 840 | 309 |
| Town of Danby | 1,050 | 809 | 241 |
| Town of Dryden | 4,091 | 2,938 | 1,153 |
| Village of Dryden | 753 | 458 | 295 |
| Village of Freeville | 158 | 111 | 47 |
| Town of Enfield | 1,106 | 836 | 270 |
| Town of Groton | 1,071 | 928 | 143 |
| Town of Ithaca | 4,476 | 2,340 | 2,136 |
| Village of Cayuga Heights | 1,406 | 795 | 611 |
| Town of Lansing | 2,304 | 1,678 | 626 |
| Village of Lansing | 1,508 | 428 | 1,080 |
| Town of Newfield | 1,901 | 1,485 | 416 |
| Town of Ulysses | 1,238 | 1,016 | 222 |
| Village of Trumansburg | 634 | 430 | 204 |

Source: US Department of Commerce, Bureau of Census. 1990.

| Table 2.14.6 - Vacant Housing Units: 1990 | | | | | |
|---|---|---|---|---|---|
| | Vacant Housing Unit | Vacant - For Rent | Vacant - For Sale | For Seasonal, ecreational, ccasional Us | All Other Vacant |
| **Cayuga County** | | | | | |
| Town of Aurelius | 78 | - | 5 | 39 | 34 |
| Village of Cayuga | 50 | 6 | 4 | 27 | 13 |
| Town of Fleming | 108 | 24 | 4 | 45 | 35 |
| Town of Genoa | 244 | 18 | 3 | 183 | 40 |
| Town of Ledyard | 237 | - | 8 | 212 | 17 |
| Village of Aurora | 27 | - | 3 | 13 | 11 |
| Town of Locke | 57 | 22 | 3 | 10 | 22 |
| Town of Scipio | 121 | 2 | 8 | 49 | 62 |
| Town of Sempronius | 71 | 4 | 5 | 39 | 23 |
| Town of Springport | 173 | - | 11 | 123 | 39 |
| Village of Union Springs | 66 | 5 | 6 | 26 | 29 |
| Town of Summerhill | 85 | 4 | 5 | 69 | 7 |
| Town of Venice | 69 | 2 | 5 | 32 | 30 |
| **Cortland County** | | | | | |
| Town of Cortlandville | 87 | 13 | 20 | 3 | 51 |
| Town of Harford | 29 | 6 | 3 | 2 | 18 |
| Town of Homer | 63 | 8 | 8 | 22 | 25 |
| Town of Scott | 53 | 5 | 6 | 33 | 9 |
| Town of Virgil | 157 | 9 | 7 | 114 | 27 |
| **Schuyler County** | | | | | |
| Town of Catharine | 91 | 2 | 4 | 75 | 10 |
| Town of Hector | 441 | 6 | 18 | 360 | 57 |
| **Seneca County** | | | | | |
| Town of Covert | 266 | 5 | 19 | 219 | 23 |
| Village of Interlaken | 19 | 5 | 2 | 2 | 10 |
| Town of Fayette | 330 | 14 | 11 | 288 | 17 |
| Town of Lodi | 209 | 3 | - | 182 | 24 |
| Town of Ovid | 144 | 5 | 8 | 102 | 29 |
| Town of Romulus | 199 | 30 | 6 | 120 | 43 |
| Town of Seneca Falls | 152 | 16 | - | 117 | 19 |
| Town of Varick | 175 | 16 | 2 | 138 | 19 |
| **Tioga County** | | | | | |
| Town of Spencer | 96 | - | 6 | 41 | 49 |
| **Tompkins County** | | | | | |
| City of Ithaca | 458 | 264 | 18 | 38 | 138 |
| Town of Caroline | 74 | 37 | - | 13 | 24 |
| Town of Danby | 44 | - | 9 | 20 | 15 |
| Town of Dryden | 245 | 152 | 19 | 20 | 54 |
| Village of Dryden | 39 | 16 | 8 | - | 15 |
| Village of Freeville | 32 | 5 | - | 6 | 21 |
| Town of Enfield | 76 | 32 | 6 | 11 | 27 |
| Town of Groton | 47 | - | - | - | 47 |
| Town of Ithaca | 291 | 152 | 29 | 32 | 78 |
| Village of Cayuga Heights | 64 | 18 | 16 | 4 | 26 |
| Town of Lansing | 192 | 31 | 22 | 51 | 88 |
| Village of Lansing | 131 | 82 | 10 | 17 | 22 |
| Town of Newfield | 87 | 39 | 6 | 12 | 30 |
| Town of Ulysses | 147 | 15 | 20 | 88 | 22 |
| Village of Trumansburg | 40 | 12 | 2 | 2 | 24 |

Source: US Department of Commerce, Bureau of Census. 1990.

| Table 2.14.7 - Source of Water by Housing Units: 1990 | Public System or Private Company | Individual Well (Drilled) | Individual Well (Dug) | Other Sources |
|---|---|---|---|---|
| **Cayuga County** | | | | |
| Town of Aurelius | 478 | 212 | 108 | 100 |
| Village of Cayuga | 240 | 2 | 2 | 2 |
| Town of Fleming | 718 | 234 | 65 | 31 |
| Town of Genoa | 311 | 391 | 106 | 89 |
| Town of Ledyard | 10 | 379 | 177 | 39 |
| Village of Aurora | 196 | - | 5 | 4 |
| Town of Locke | 279 | 344 | 20 | 59 |
| Town of Scipio | 7 | 357 | 193 | 74 |
| Town of Sempronius | 14 | 205 | 54 | 70 |
| Town of Springport | 91 | 298 | 73 | 70 |
| Village of Union Springs | 475 | 15 | 4 | 7 |
| Town of Summerhill | 6 | 339 | 35 | 22 |
| Town of Venice | 5 | 356 | 92 | 49 |
| **Cortland County** | | | | |
| Town of Cortlandville | 1,746 | 1,261 | 64 | 56 |
| Town of Harford | 34 | 249 | 27 | 11 |
| Town of Homer | 42 | 950 | 66 | 26 |
| Town of Scott | 56 | 298 | 41 | 39 |
| Town of Virgil | 118 | 693 | 45 | 37 |
| **Schuyler County** | | | | |
| Town of Catharine | 57 | 460 | 42 | 35 |
| Town of Hector | 440 | 1,037 | 328 | 266 |
| **Seneca County** | | | | |
| Town of Covert | 147 | 457 | 87 | 155 |
| Village of Interlaken | 263 | 8 | 3 | 3 |
| Town of Fayette | 209 | 772 | 220 | 108 |
| Town of Lodi | 7 | 390 | 106 | 82 |
| Town of Ovid | 112 | 446 | 95 | 107 |
| Town of Romulus | 499 | 260 | 91 | 105 |
| Town of Seneca Falls | 616 | 232 | 40 | 22 |
| Town of Varick | 98 | 363 | 132 | 204 |
| **Tioga County** | | | | |
| Town of Spencer | 4 | 744 | 48 | 36 |
| **Tompkins County** | | | | |
| City of Ithaca | 10,038 | 11 | 8 | 18 |
| Town of Caroline | 81 | 955 | 94 | 93 |
| Town of Danby | 110 | 891 | 54 | 39 |
| Town of Dryden | 1,118 | 2,857 | 301 | 60 |
| Village of Dryden | 762 | 28 | 2 | - |
| Village of Freeville | 17 | 140 | 15 | 18 |
| Town of Enfield | 44 | 959 | 103 | 76 |
| Town of Groton | 967 | 866 | 116 | 80 |
| Town of Ithaca | 4,135 | 542 | 45 | 45 |
| Village of Cayuga Heights | 1,470 | - | - | - |
| Town of Lansing | 746 | 1,436 | 209 | 102 |
| Village of Lansing | 1,636 | - | 6 | - |
| Town of Newfield | 230 | 83 | - | - |
| Town of Ulysses | 213 | 899 | 106 | 165 |
| Village of Trumansburg | 670 | 4 | - | - |

Source: US Department of Commerce, Bureau of Census. 1990.

## Table 2.14.8 - Sewage Disposal by Housing Units: 1990

| | Public Sewer | Septic Tank/ Cesspool | Other |
|---|---|---|---|
| **Cayuga County** | | | |
| Town of Aurelius | 138 | 740 | 20 |
| Village of Cayuga | 210 | 34 | 2 |
| Town of Fleming | 570 | 476 | 2 |
| Town of Genoa | 13 | 866 | 18 |
| Town of Ledyard | - | 582 | 15 |
| Village of Aurora | 198 | 15 | - |
| Town of Locke | 145 | 546 | 11 |
| Town of Scipio | 4 | 581 | 46 |
| Town of Sempronius | 14 | 328 | 1 |
| Town of Springport | 54 | 463 | 5 |
| Village of Union Springs | 446 | 55 | - |
| Town of Summerhill | 6 | 396 | - |
| Town of Venice | 4 | 493 | 5 |
| **Cortland County** | | | |
| Town of Cortlandville | 1,196 | 1,910 | 21 |
| Town of Harford | 5 | 312 | 4 |
| Town of Homer | 29 | 1,040 | 23 |
| Town of Scott | 6 | 415 | 13 |
| Town of Virgil | 119 | 760 | 14 |
| **Schuyler County** | | | |
| Town of Catharine | 10 | 575 | 9 |
| Town of Hector | 10 | 1,808 | 74 |
| **Seneca County** | | | |
| Town of Covert | 76 | 768 | 2 |
| Village of Interlaken | 267 | 10 | - |
| Town of Fayette | 9 | 1,287 | 13 |
| Town of Lodi | 7 | 562 | 16 |
| Town of Ovid | 79 | 654 | 27 |
| Town of Romulus | 487 | 453 | 15 |
| Town of Seneca Falls | 565 | 340 | 5 |
| Town of Varick | 93 | 683 | 21 |
| **Tioga County** | | | |
| Town of Spencer | 16 | 792 | 24 |
| **Tompkins County** | | | |
| City of Ithaca | 10,022 | 53 | - |
| Town of Caroline | 88 | 1,085 | 50 |
| Town of Danby | - | 1,081 | 13 |
| Town of Dryden | 1,003 | 3,283 | 50 |
| Village of Dryden | 746 | 46 | - |
| Village of Freeville | 165 | 25 | - |
| Town of Enfield | 33 | 1,124 | 25 |
| Town of Groton | 43 | 1,068 | 7 |
| Town of Ithaca | 3,929 | 805 | 33 |
| Village of Cayuga Heights | 1,462 | 8 | - |
| Town of Lansing | 281 | 2,167 | 48 |
| Village of Lansing | 1,514 | 125 | - |
| Town of Newfield | 395 | 1,560 | 33 |
| Town of Ulysses | 155 | 1,226 | 2 |
| Village of Trumansburg | 641 | 33 | - |

Source: US Department of Commerce, Bureau of Census. 1990.

| Table 2.14.9 - Percent of Population with Incomes Below the Poverty Level: 1989 | 1990 - % of Population Below Poverty Level |
|---|---|
| ***New York State*** | ***13.0%*** |
| **Cayuga County** | |
| Town of Aurelius | 7.2% |
| Village of Cayuga | 3.5% |
| Town of Fleming | 4.2% |
| Town of Genoa | 8.0% |
| Town of Ledyard | 14.7% |
| Village of Aurora | 1.3% |
| Town of Locke | 9.7% |
| Town of Scipio | 8.2% |
| Town of Sempronius | 7.0% |
| Town of Springport | 8.1% |
| Village of Union Springs | 6.5% |
| Town of Summerhill | 8.8% |
| Town of Venice | 9.2% |
| **Cortland County** | |
| Town of Cortlandville | 7.6% |
| Town of Harford | 15.6% |
| Town of Homer | 6.6% |
| Town of Scott | 5.6% |
| Town of Virgil | 7.2% |
| **Schuyler County** | |
| Town of Catharine | 14.2% |
| Town of Hector | 12.5% |
| **Seneca County** | |
| Town of Covert | 4.5% |
| Village of Interlaken | 9.1% |
| Town of Fayette | 4.4% |
| Town of Lodi | 9.0% |
| Town of Ovid | 7.8% |
| Town of Romulus | 11.4% |
| Town of Seneca Falls | 13.3% |
| Town of Varick | 10.3% |
| **Tioga County** | |
| Town of Spencer | 7.3% |
| **Tompkins County** | |
| City of Ithaca | 39.4% |
| Town of Caroline | 8.9% |
| Town of Danby | 6.5% |
| Town of Dryden | 10.3% |
| Village of Dryden | 10.9% |
| Village of Freeville | 8.0% |
| Town of Enfield | 14.3% |
| Town of Groton | 9.1% |
| Town of Ithaca | 12.2% |
| Village of Cayuga Heights | 17.6% |
| Town of Lansing | 6.3% |
| Village of Lansing | 14.7% |
| Town of Newfield | 12.4% |
| Town of Ulysses | 7.9% |
| Village of Trumansburg | 6.2% |

Source: US Department of Commerce, Bureau of Census. 1990.

| Table 2.14.10 - Median Household Income (MHI): 1989 | MHI | % of NYS MHI |
|---|---|---|
| ***New York State*** | ***$ 32,695*** | ***100%*** |
| **Cayuga County** | | |
| Town of Aurelius | $ 33,182 | 101.5% |
| Village of Cayuga | $ 34,688 | 106.1% |
| Town of Fleming | $ 37,443 | 114.5% |
| Town of Genoa | $ 30,967 | 94.7% |
| Town of Ledyard | $ 29,457 | 90.1% |
| Village of Aurora | $ 33,750 | 103.2% |
| Town of Locke | $ 29,886 | 91.4% |
| Town of Scipio | $ 31,970 | 97.8% |
| Town of Sempronius | $ 29,500 | 90.2% |
| Town of Springport | $ 34,130 | 104.4% |
| Village of Union Springs | $ 30,451 | 93.1% |
| Town of Summerhill | $ 27,460 | 84.0% |
| Town of Venice | $ 29,318 | 89.7% |
| **Cortland County** | | |
| Town of Cortlandville | $ 30,176 | 92.3% |
| Town of Harford | $ 28,056 | 85.8% |
| Town of Homer | $ 34,442 | 105.3% |
| Town of Scott | $ 33,393 | 102.1% |
| Town of Virgil | $ 32,841 | 100.4% |
| **Schuyler County** | | |
| Town of Catharine | $ 24,519 | 75.0% |
| Town of Hector | $ 26,970 | 82.5% |
| **Seneca County** | | |
| Town of Covert | $ 31,542 | 96.5% |
| Village of Interlaken | $ 27,031 | 82.7% |
| Town of Fayette | $ 33,574 | 102.7% |
| Town of Lodi | $ 27,344 | 83.6% |
| Town of Ovid | $ 26,159 | 80.0% |
| Town of Romulus | $ 28,110 | 86.0% |
| Town of Seneca Falls | $ 36,056 | 110.3% |
| Town of Varick | $ 31,154 | 95.3% |
| **Tioga County** | | |
| Town of Spencer | $ 33,448 | 102.3% |
| **Tompkins County** | | |
| City of Ithaca | $ 17,738 | 54.3% |
| Town of Caroline | $ 29,282 | 89.6% |
| Town of Danby | $ 34,500 | 105.5% |
| Town of Dryden | $ 33,176 | 101.5% |
| Village of Dryden | $ 31,121 | 95.2% |
| Village of Freeville | $ 32,639 | 99.8% |
| Town of Enfield | $ 29,659 | 90.7% |
| Town of Groton | $ 30,799 | 94.2% |
| Town of Ithaca | $ 32,303 | 98.8% |
| Village of Cayuga Heights | $ 51,034 | 156.1% |
| Town of Lansing | $ 33,969 | 103.9% |
| Village of Lansing | $ 29,655 | 90.7% |
| Town of Newfield | $ 28,281 | 86.5% |
| Town of Ulysses | $ 33,796 | 103.4% |
| Village of Trumansburg | $ 31,667 | 96.9% |

Source: US Department of Commerce, Bureau of Census. 1990.

| Table 2.14.11 - Per Capita Income (PCI): 1989 | | |
|---|---|---|
| | PCI | % of NYS PCI |
| ***New York State*** | ***$ 16,501*** | ***100%*** |
| **Cayuga County** | | |
| Town of Aurelius | $ 12,902 | 78.2% |
| Village of Cayuga | $ 11,557 | 70.0% |
| Town of Fleming | $ 15,825 | 95.9% |
| Town of Genoa | $ 11,534 | 69.9% |
| Town of Ledyard | $ 11,863 | 71.9% |
| Village of Aurora | $ 12,201 | 73.9% |
| Town of Locke | $ 10,803 | 65.5% |
| Town of Scipio | $ 12,910 | 78.2% |
| Town of Sempronius | $ 11,233 | 68.1% |
| Town of Springport | $ 12,811 | 77.6% |
| Village of Union Springs | $ 13,496 | 81.8% |
| Town of Summerhill | $ 9,517 | 57.7% |
| Town of Venice | $ 10,617 | 64.3% |
| **Cortland County** | | |
| Town of Cortlandville | $ 13,259 | 80.4% |
| Town of Harford | $ 9,743 | 59.0% |
| Town of Homer | $ 12,516 | 75.8% |
| Town of Scott | $ 11,685 | 70.8% |
| Town of Virgil | $ 12,457 | 75.5% |
| **Schuyler County** | | |
| Town of Catharine | $ 10,443 | 63.3% |
| Town of Hector | $ 11,307 | 68.5% |
| **Seneca County** | | |
| Town of Covert | $ 13,244 | 80.3% |
| Village of Interlaken | $ 12,640 | 76.6% |
| Town of Fayette | $ 12,790 | 77.5% |
| Town of Lodi | $ 12,167 | 73.7% |
| Town of Ovid | $ 11,476 | 69.5% |
| Town of Romulus | $ 10,333 | 62.6% |
| Town of Seneca Falls | $ 13,759 | 83.4% |
| Town of Varick | $ 12,883 | 78.1% |
| **Tioga County** | | |
| Town of Spencer | $ 11,458 | 69.4% |
| **Tompkins County** | | |
| City of Ithaca | $ 9,213 | 55.8% |
| Town of Caroline | $ 13,032 | 79.0% |
| Town of Danby | $ 15,600 | 94.5% |
| Town of Dryden | $ 14,826 | 89.8% |
| Village of Dryden | $ 13,389 | 81.1% |
| Village of Freeville | $ 12,134 | 73.5% |
| Town of Enfield | $ 12,064 | 73.1% |
| Town of Groton | $ 12,500 | 75.8% |
| Town of Ithaca | $ 19,743 | 119.6% |
| Village of Cayuga Heights | $ 27,818 | 168.6% |
| Town of Lansing | $ 15,641 | 94.8% |
| Village of Lansing | $ 18,801 | 113.9% |
| Town of Newfield | $ 12,309 | 74.6% |
| Town of Ulysses | $ 15,023 | 91.0% |
| Village of Trumansburg | $ 14,572 | 88.3% |

Source: US Department of Commerce, Bureau of Census. 1990.

| Table 2.14.12 - Labor Force and Unemployment: 1990 | % of Population in Labor Force | % of Labor Force Unemployed |
|---|---|---|
| ***New York State*** | ***63.6%*** | ***6.9%*** |
| **Cayuga County** | | |
| Town of Aurelius | 60.9% | 6.2% |
| Village of Cayuga | 70.1% | 5.1% |
| Town of Fleming | 66.3% | 4.9% |
| Town of Genoa | 70.5% | 6.5% |
| Town of Ledyard | 67.9% | 4.9% |
| Village of Aurora | 82.4% | 1.0% |
| Town of Locke | 74.1% | 5.3% |
| Town of Scipio | 71.8% | 4.1% |
| Town of Sempronius | 72.7% | 5.9% |
| Town of Springport | 69.9% | 8.7% |
| Village of Union Springs | 65.3% | 4.5% |
| Town of Summerhill | 74.2% | 4.2% |
| Town of Venice | 71.0% | 6.5% |
| **Cortland County** | | |
| Town of Cortlandville | 70.7% | 5.4% |
| Town of Harford | 73.9% | 4.0% |
| Town of Homer | 75.0% | 6.2% |
| Town of Scott | 76.2% | 5.7% |
| Town of Virgil | 75.1% | 7.7% |
| **Schuyler County** | | |
| Town of Catharine | 67.5% | 8.5% |
| Town of Hector | 67.6% | 5.4% |
| **Seneca County** | | |
| Town of Covert | 67.8% | 3.6% |
| Village of Interlaken | 58.6% | 6.2% |
| Town of Fayette | 64.9% | 5.9% |
| Town of Lodi | 70.1% | 7.2% |
| Town of Ovid | 56.5% | 2.4% |
| Town of Romulus | 57.3% | 6.6% |
| Town of Seneca Falls | 64.5% | 3.8% |
| Town of Varick | 72.6% | 6.8% |
| **Tioga County** | | |
| Town of Spencer | 65.9% | 4.1% |
| **Tompkins County** | | |
| City of Ithaca | 51.0% | 4.9% |
| Town of Caroline | 73.3% | 5.9% |
| Town of Danby | 79.4% | 5.1% |
| Town of Dryden | 74.9% | 5.2% |
| Village of Dryden | 72.7% | 3.8% |
| Village of Freeville | 70.9% | 2.2% |
| Town of Enfield | 75.9% | 5.9% |
| Town of Groton | 74.1% | 5.5% |
| Town of Ithaca | 70.3% | 3.9% |
| Village of Cayuga Heights | 57.8% | 2.2% |
| Town of Lansing | 75.2% | 3.9% |
| Village of Lansing | 68.4% | 1.4% |
| Town of Newfield | 74.7% | 2.3% |
| Town of Ulysses | 68.3% | 3.3% |
| Village of Trumansburg | 70.0% | 3.3% |

Source: US Department of Commerce, Bureau of Census. 1990.

| Table 2.14.13 - Educational Attainment of Persons 25 and Older: 1990 | % With High School Diploma or Higher | % With Bachelor's Degree or Higher |
|---|---|---|
| ***New York State*** | ***74.8%*** | ***23.1%*** |
| **Cayuga County** | | |
| Town of Aurelius | 72.8% | 14.1% |
| Village of Cayuga | 82.1% | 14.7% |
| Town of Fleming | 83.1% | 17.8% |
| Town of Genoa | 79.2% | 16.7% |
| Town of Ledyard | 77.7% | 22.0% |
| Village of Aurora | 93.8% | 54.0% |
| Town of Locke | 75.3% | 10.4% |
| Town of Scipio | 76.3% | 14.0% |
| Town of Sempronius | 74.7% | 11.6% |
| Town of Springport | 81.4% | 18.9% |
| Village of Union Springs | 81.1% | 21.8% |
| Town of Summerhill | 74.2% | 8.2% |
| Town of Venice | 81.2% | 16.3% |
| **Cortland County** | | |
| Town of Cortlandville | 77.0% | 21.1% |
| Town of Harford | 76.3% | 10.7% |
| Town of Homer | 83.0% | 15.3% |
| Town of Scott | 75.1% | 13.1% |
| Town of Virgil | 78.1% | 17.9% |
| **Schuyler County** | | |
| Town of Catharine | 78.5% | 9.3% |
| Town of Hector | 78.7% | 19.0% |
| **Seneca County** | | |
| Town of Covert | 83.7% | 19.3% |
| Village of Interlaken | 82.4% | 18.7% |
| Town of Fayette | 81.8% | 14.0% |
| Town of Lodi | 80.3% | 20.0% |
| Town of Ovid | 69.1% | 13.5% |
| Town of Romulus | 74.4% | 13.4% |
| Town of Seneca Falls | 84.0% | 16.6% |
| Town of Varick | 79.5% | 16.2% |
| **Tioga County** | | |
| Town of Spencer | 75.5% | 13.8% |
| **Tompkins County** | | |
| City of Ithaca | 86.7% | 50.2% |
| Town of Caroline | 81.5% | 31.7% |
| Town of Danby | 88.5% | 30.3% |
| Town of Dryden | 87.1% | 37.9% |
| Village of Dryden | 84.3% | 32.3% |
| Village of Freeville | 86.0% | 34.7% |
| Town of Enfield | 75.9% | 18.1% |
| Town of Groton | 77.7% | 14.9% |
| Town of Ithaca | 89.9% | 46.9% |
| Village of Cayuga Heights | 98.5% | 82.8% |
| Town of Lansing | 88.3% | 32.1% |
| Village of Lansing | 97.5% | 63.5% |
| Town of Newfield | 80.8% | 17.8% |
| Town of Ulysses | 89.5% | 33.2% |
| Village of Trumansburg | 89.3% | 38.0% |

Source: US Department of Commerce, Bureau of Census. 1990.

## Table 2.14.14 - Major Private Employers in the Watershed

| Employer | Town | Number Employed | |
|---|---|---|---|
| Cornell University | Ithaca | 8600 | Higher education |
| Goulds Pumps, Inc. | Seneca Falls | 1413 | Pumps and pumping equipment |
| Ithaca College | Ithaca | 1300 | Higher education |
| Borg Warner Automotive, Inc. | Lansing | 1115 | Automotive transmission systems |
| Cayuga Medical Center | Ithaca | 700 | Health care |
| Wegmans | Ithaca | 640 | Grocery stores |
| Emerson Power Transmission | Ithaca | 550 | Automotive drive chain components |
| NYS Electric and Gas | Dryden | 575 | Public Utilities |
| Axhiom IPD | Ithaca | 334 | Printer manufacturing |
| Wilcox Press, Inc. | Ithaca | 260 | Offset and web printing |
| MacKenzie-Childs | Aurora | 250 | Ceramic household goods |
| Cargill, Inc. | Lansing | 243 | Deicing salt |
| Seneca Knitting Mills Corporation | Seneca Falls | 240 | Hosiery |
| Tompkins County Trust Company | Ithaca | 224 | Banking |
| Tops Friendly Markets | Ithaca | 220 | Grocery stores |
| CBORD Group | Lansing | 207 | Software developemtn/technology |
| Challenge Industries, Inc. | Ithaca | 205 | Rehabilitation and training of disabled persons |
| Therm Inc. | Ithaca | 200 | Manufacturing (turbine blades) |
| P & C Food Market | Ithaca | 170 | Grocery store/retail |
| Wells College | Aurora | 160 | Higher education |
| Ithaca Journal | Ithaca | 155 | Printing/publishing |
| Thomas & Associates | Ithaca | 145 | Architecture/engineering |
| Boyce Thompson Institute | Ithaca | 138 | Research |
| Hi-Speed Checkweigher, Inc. | Dryden | 120 | Weighing and handling equipment |
| Genex Cooperative | Ithaca | 100 | Dairy cattle genetics |
| Ithaca Peripherals | Ithaca | 100 | Manufacturing |

Source: Central New York Regional Planning & Development Board, Genesee/Finger Lakes Regional Planning Council, Southern Tier Central Regional Planning & Development Board, Southern Tier East Regional Planning & Development Board and Tompkins County Area Development. 1998.

## Table 2.14.15 - Employees by Industry 1985, 1990, & 1996 for Respective Counties

**Cayuga County**

| | 1985 | 1990 | 1996 |
|---|---|---|---|
| Total Employment | 29,775 | 32,566 | 33,749 |
| Farm Employment | 1,868 | 1,722 | 1,613 |
| Non-Farm Employment | 27,907 | 30,844 | 32,136 |
| Private Employment | 23,000 | 25,083 | 26,681 |
| Agric, forestry, fishing, other | 256 | 303 | 422 |
| Mining | (L) | 19 | 17 |
| Construction | 1,222 | 1,909 | 1,691 |
| Manufacturing | 5,145 | 4,316 | 4,648 |
| Transport. & public utilities | 1,343 | 1,402 | 1,544 |
| Wholesale trade | 1,025 | 1,085 | 1,179 |
| Retail Trade | 5,282 | 6,071 | 5,530 |
| Finance, insurance, & real estate | 1,385 | 1,381 | 1,770 |
| Services | 7,333 | 8,597 | 9,880 |
| Government | 4,907 | 5,761 | 5,455 |
| Federal, civilian | 169 | 186 | 185 |
| Military | 275 | 265 | 183 |
| State and local | 4,463 | 5,310 | 5,087 |

**Schuyler County**

| | 1985 | 1990 | 1996 |
|---|---|---|---|
| Total Employment | 6,135 | 6,511 | 6,705 |
| Farm Employment | 663 | 517 | 439 |
| Non-Farm Employment | 5,472 | 5,994 | 6,266 |
| Private Employment | 4,475 | 4,879 | 5,196 |
| Agric, forestry, fishing, other | 109 | 75 | 95 |
| Mining | (L) | (L) | (L) |
| Construction | 280 | 403 | 403 |
| Manufacturing | 1,073 | 998 | 881 |
| Transport. & public utilities | 123 | 155 | 195 |
| Wholesale trade | 127 | 143 | 137 |
| Retail Trade | 960 | 1,152 | 1,265 |
| Finance, insurance, & real estate | 207 | 263 | 289 |
| Services | 1,593 | 1,686 | 1,928 |
| Government | 997 | 1,115 | 1,070 |
| Federal, civilian | 40 | 49 | 58 |
| Military | 62 | 60 | 42 |
| State and local | 895 | 1,006 | 970 |

**Cortland County**

| | 1985 | 1990 | 1996 |
|---|---|---|---|
| Total Employment | 21,724 | 25,480 | 24,937 |
| Farm Employment | 1,285 | 1,041 | 918 |
| Non-Farm Employment | 20,439 | 24,439 | 24,019 |
| Private Employment | 16,871 | 20,516 | 20,469 |
| Agric, forestry, fishing, other | 212 | 201 | 237 |
| Mining | (L) | (L) | (L) |
| Construction | 1,003 | 1,214 | 1,096 |
| Manufacturing | 4,483 | 5,914 | 4,517 |
| Transport. & public utilities | 509 | 436 | 562 |
| Wholesale trade | 540 | 504 | 575 |
| Retail Trade | 3,711 | 4,605 | 5,030 |
| Finance, insurance, & real estate | 874 | 1,073 | 1,356 |
| Services | 5,531 | 6,564 | 7,087 |
| Government | 3,568 | 3,923 | 3,550 |
| Federal, civilian | 96 | 107 | 101 |
| Military | 165 | 158 | 108 |
| State and local | 3,307 | 3,658 | 3,341 |

**Seneca County**

| | 1985 | 1990 | 1996 |
|---|---|---|---|
| Total Employment | 14,874 | 14,620 | 13,716 |
| Farm Employment | 883 | 707 | 620 |
| Non-Farm Employment | 13,991 | 13,913 | 13,096 |
| Private Employment | 9,468 | 9,626 | 10,689 |
| Agric, forestry, fishing, other | 87 | 101 | 149 |
| Mining | (L) | (L) | (L) |
| Construction | 553 | 803 | 687 |
| Manufacturing | 3,405 | 2,589 | 2,306 |
| Transport. & public utilities | 302 | 411 | 411 |
| Wholesale trade | 385 | 334 | 574 |
| Retail Trade | 1,898 | 2,110 | 2,510 |
| Finance, insurance, & real estate | 508 | 528 | 677 |
| Services | 2,322 | 2,743 | 3,368 |
| Government | 4,523 | 4,287 | 2,407 |
| Federal, civilian | 1,180 | 1,110 | 320 |
| Military | 759 | 722 | 92 |
| State and local | 2,584 | 2,455 | 1,995 |

**Tompkins County**

| | 1985 | 1990 | 1996 |
|---|---|---|---|
| Total Employment | 52,612 | 60,913 | 60,865 |
| Farm Employment | 1,141 | 915 | 779 |
| Non-Farm Employment | 51,471 | 59,998 | 60,086 |
| Private Employment | 46,644 | 54,174 | 53,915 |
| Agric, forestry, fishing, other | 1,027 | 1,087 | (D) |
| Mining | 295 | 286 | (D) |
| Construction | 1,719 | 2,145 | 1,753 |
| Manufacturing | 4,467 | 4,461 | 4,317 |
| Transport. & public utilities | 1,412 | 1,590 | 1,594 |
| Wholesale trade | 779 | 949 | 876 |
| Retail Trade | 7,370 | 8,546 | 8,461 |
| Finance, insurance, & real estate | 2,403 | 2,847 | 2,934 |
| Services | 27,172 | 32,263 | 32,605 |
| Government | 4,827 | 5,824 | 6,171 |
| Federal, civilian | 288 | 334 | 336 |
| Military | 350 | 339 | 242 |
| State and local | 4,189 | 5,151 | 5,593 |

**Tioga County**

| | 1985 | 1990 | 1996 |
|---|---|---|---|
| Total Employment | 19,306 | 19,027 | 18,349 |
| Farm Employment | 1,019 | 900 | 832 |
| Non-Farm Employment | 18,287 | 18,127 | 17,517 |
| Private Employment | 15,986 | 15,492 | 14,826 |
| Agric, forestry, fishing, other | 135 | 140 | (D) |
| Mining | 48 | 69 | (D) |
| Construction | 761 | 1,034 | 1,015 |
| Manufacturing | 8,002 | 5,982 | 4,730 |
| Transport. & public utilities | 352 | 285 | 376 |
| Wholesale trade | 463 | 649 | 667 |
| Retail Trade | 2,124 | 2,785 | 2,744 |
| Finance, insurance, & real estate | 609 | 554 | 844 |
| Services | 3,492 | 3,994 | 4,078 |
| Government | 2,301 | 2,635 | 2,691 |
| Federal, civilian | 80 | 79 | 108 |
| Military | 186 | 176 | 124 |
| State and local | 2,035 | 2,380 | 2,459 |

(L) Less than 10 jobs. Estimates are included in totals.

(D) Not shown to avoid disclosure of confidential information. Estimates are included in totals.

Source: US Department of Commerce, Bureau of Economic Analysis. 1996.

# Chapter 3. Potential Sources of Contamination

## 3.1 Introduction

All pollutants are categorized in two ways for the practical operation of water pollution abatement. The common categories are 1) the manner in which pollutants enter the water and 2) the way pollutants can be treated and removed from water.

Pollutants can enter water through direct, piped and channeled discharges – point sources, or they can enter groundwater, lakes, or streams from nonpoint sources. Nonpoint sources (see Table 3.1.1) considered to be major contributors to water pollution are: runoff from paved streets and parking lots, agricultural lands and construction sites; soil erosion from road cuts, streams and from logging or farm operations, and atmospheric deposition of acidic or toxic air pollutants.

Transported soil can be both a pollutant itself and a vehicle for carrying other pollutants which become attached to soil particles. For example, the soil contains phosphorus, but much of the phosphorus added to soil through the use of fertilizers also gets bound to the soil particles. When soil is disturbed (erosion), it may be transported by rivers and streams to the lake. The soil particles themselves may be considered a pollutant because they cause the lake water to become cloudy. The phosphorus in the transported soil may later become available to aquatic plants. Particles may also protect microbes from harm in nature or in disinfection of drinking water. This is why drinking water standards require very low turbidity (cloudiness).

Pollutants also can be classified by treatment technology as conventional, non-conventional or toxic. Conventional pollutants include organic materials that require oxygen to decompose (biodegradable). Wastes from sewage treatment plants, tanneries, paper mills, and food processing operations fall into this category, as do oil and grease. Inorganic sediments such as sand or silt are conventional pollutants – that is, these substances can be removed from wastewater with conventional treatment. Bacteria associated with the intestinal tract of humans (fecal bacteria, as indicated by the coliform group) are conventional pollutants and can easily be destroyed by disinfection with chlorine, ozone or ultraviolet light.

Non-conventional pollutants include excessive levels of nutrients, such as nitrogen and phosphorus, which require more advanced treatment to be removed from wastewater. These substances may come from many sources, including fertilizers, atmospheric deposition, and sewage.

Toxic pollutants such as heavy metals (chromium, lead), inorganic chemicals (salts, acids), and organic chemicals (pesticides, solvents) can damage human health, aquatic organisms, and the overall health of the ecosystem. Toxic effects can be acute, causing immediate death or impairment, or chronic, causing subtle damage that may not emerge until years after exposure. Toxics often persist in the environment, collecting either in water or in lake bottom sediments. Toxics can bioaccumulate in the tissues of organisms after repeated intake or exposure. Toxic concentrations can increase at higher levels in the food chain, called biomagnification (NYSDEC & Federation of Lake Associations)

## 3.2 Surface Runoff

Surface water flows within the watershed occur as overland runoff and as stream flow. Overland flow, or stormwater as it is commonly called, is generated when the capacity of the soils and vegetation to absorb water from precipitation is exceeded and water runs across the surface of the land. In clay-rich soils, the water-retention capacity is low and runoff from these soils is generated quickly. In sandy soils, a larger portion of the precipitation infiltrates the land surface and recharges the underlying groundwater system, resulting in less runoff.

Since precipitation-generated runoff is the major transport mechanism for nonpoint source pollution, a direct relationship exists between the timing and magnitude of precipitation events and the resulting level of nonpoint source pollution. Factors that affect the rate at which precipitation becomes runoff include the soil moisture conditions at the time of the precipitation event, vegetation type and density, and urbanization with its associated impervious surfaces. Of these factors, only the time of the precipitation event vary significantly with climate change. Therefore, climatic conditions preceding the precipitation event and the timing of the event are important factors in determining the amount of precipitation that will be available for the “first flush” of the watershed. Clearly, larger and more intense rain events carry more pollutants from the watershed into downgradient waters.

**Table 3.1.1**
**Nonpoint Sources of Pollution and Potential Impacts on Water Resources**

| Pollutant/ Associated Land Use | Impacts |
|---|---|
| **Sediment:** construction, urban runoff, gravel operations, agriculture, logging, hydromodification | **On Fisheries**:<br>• Decreases transmission of light, which affects plant production (food and cover), behavioral activities (nesting, feeding, mating), respiration, digestion, reproduction<br>• Increases surface water temperature, which decreases dissolved oxygen concentration in water<br>• Decreases spawning habitat (fills pools and nest sites)<br>• Transports absorbed contaminants<br>**On Water Supply**:<br>• Damages water treatment pumps, equipment<br>• Increases treatment costs<br>• Reduces reservoir volume<br>• Toxic substances may adhere to sediment<br>• Nutrients increase, which stimulates algae growth<br>• Decreases river bottom infiltration, which reduces well yields<br>**On Wetlands**:<br>• Reduces flood storage<br>• Increases peak discharges<br>• Alters habitat<br>**On Recreation**:<br>• Decreases clarity of water (public health and safety)<br>• Reduces aesthetic and recreational value<br>• Reduces sport fishing populations |
| **Phosphorus and Nitrogen**: urban development, gravel operations, agriculture, land disposal (sludge and septic systems), illegal waste disposal | **On Fisheries**:<br>• Promotes algae blooms, which inhibit aquatic plant growth<br>• Favors survival of less desirable species over more desirable (commercial and recreational) species<br>• Reduces dissolved oxygen levels through increased productivity and decay of organic matter<br>**On Water Supply**:<br>• Promotes algae blooms, which cause odors and poor taste<br>• Increases treatment costs<br>• Increases nitrate concentration (safe limit is 10 mg/l<br>**On Wetlands**:<br>• Alters wetland vegetation/habitat<br>**On Recreation**:<br>• Promotes eutrophication of lakes and streams<br>• Increases algae growth, which may create public health risks<br>• Decreases aesthetic value<br>• Degrades fishing and boating activities<br>• Reduces tourism and property values |
| **Metals**: urban runoff, mining, land disposal, natural deposits | **On Fisheries**:<br>• Accumulates in sediments, which poses risk to bottom feeders<br>• Bioaccumulates in fish tissue<br>• Affects reproductive rates and life spans of aquatic organisms<br>• Hinders photosynthesis in aquatic plants<br>**On Water Supply:**<br>• Increases treatment costs<br>• Forms deposits in pipes, which reduces carrying capacity<br>• Colors water, which leaves stains on fixtures, clothing<br>• Poses possible health hazard from toxic metals<br>**On Wetlands:**<br>• Bioaccumulates in existing food web |

| | |
|---|---|
| | • Hinders photosynthesis in aquatic plants<br>• Affects reproductive rates and life spans of wetland organisms<br>**On Recreation**:<br>• Reduces waterfront property values<br>• Restricts sport fishing if contamination is found in fish tissue |
| **Pesticides and Herbicides**: (agriculture, urban runoff, hydrologic/habitat modification, lawn and golf course care | **On Fisheries**:<br>• Accumulates in sediments, which poses risk to bottom feeders<br>• Bioaccumulates in fish tissue<br>• May kill fish and other aquatic organisms<br>• Hinders photosynthesis in aquatic plants<br>**On Water Supply:**<br>• Causes orders in water supply<br>• Carcinogenic effects cause public health risks<br>**On Wetlands**:<br>• Adversely impacts survival of wetland fauna and flora<br>**On Recreation**:<br>• Reduces waterfront property values<br>• Restricts sport fishing if contamination is found in fish tissue |
| **Pathogens** – Bacteria and Viruses: agriculture, urban runoff, land disposal, septic tanks (or illegal waste disposal), sludge | **On Fisheries**:<br>• Introduces disease-bearing organisms to aquatic life<br>• Closes shellfish areas<br>**On Water Supply**:<br>• Increases public health risks<br>• Increases treatment costs for drinking water supplies<br>**On Wetlands**:<br>• Results in loss of wetland recreation areas<br>• Introduces harmful organisms to aquatic life and food chain<br>**On Recreation**:<br>• Closes swimming area |
| **Thermal Energy**: construction, mining and gravel operations, logging, agriculture, urban runoff, hydrologic/habitat modification | **On Fisheries**:<br>• Reduces vigor and growth of fish<br>• Reduces resistance to disease<br>• Reduces dissolved oxygen and stream temperature increases<br>• Changes cold water sport fishery to warm water fishery<br>**On Water Supply**:<br>• Increased temperature accelerates pump/equipment corrosion<br>• Promotes biological activity, which produces odors and poor taste<br>• Creates a more favorable environment for pathogens<br>**On Recreation:**<br>• May stimulate growth of algae and aquatic plants, which reduces water clarity, aethetic value, sport fishing populations, and tourism |
| **Salts**: mining, urban runoff, contruction, road deicing | **On Fisheries**:<br>• Favors salt-tolerant species<br>• Fluctuations in salinity create stressful environment<br>• Destroys habitat and food source plants for some species<br>• Alters species composition of affected areas<br>**On Water Supply**:<br>• Reduces drinking water quality<br>**On Wetlands**:<br>• Alters wetland vegetation/species composition<br>• Destroys habitat and food sources for wetland animals<br>**On Recreation**:<br>• May cause skin/eye irrititations |

Source: Adapted from Massachusetts Department of Environmental Protection (1993)

Generally, the first inch of rainfall typically removes most of the pollutants from the watershed. Thus, as rainfall exceeds one inch, pollutant concentrations will decrease significantly, even though pollutant loadings will continue to slightly increase (Jeer, et al).

Urbanized land contributes large amounts of contamination to water bodies via stormwater runoff. Urban areas are characterized by a higher percentage of impervious surface coverage; thus, the ability of stormwater runoff to transport more pollutants is magnified. In the Cayuga Lake Watershed this can be seen in many of the subwatersheds, especially in the downstream portions of those subwatersheds. These include the following subwatersheds: Glenwood Creek Area (Town of Ithaca and Town of Ulysses), Lansing Area (Town and Village of Lansing, Cayuga Heights, Town of Ithaca), Big Salmon Creek/Little Salmon Creek/Salmon Creek/Locke Creek (Town of Lansing), Virgil Creek/Fall Creek (Village and Town of Dryden, Village of Freeville, Cayuga Heights, City and Town of Ithaca), Cascadilla Creek/Sixmile Creek/Buttermilk Creek/Cayuga Inlet/West Branch/Fish Kill/Enfield Creek (City and Town of Ithaca).

Urban developments tend to encroach on natural resources as well, allowing more and more people the opportunity to use lakes, rivers, beaches, and wetlands. Each natural habitat use has a one-time impact and a cumulative effect – many small impacts add up over time. Water-quality degradation caused by development also fragments existing habitats, restricting the territory available to plant and animal species and eliminating buffers between them and human use areas.

*Direct Inputs from Wetfall and Dryfall*
Nonpoint source inputs not only occur from the runoff of precipitation, but also from precipitation falling directly onto the land surface or the lake. Precipitation occurs as wet deposition (wetfall) of rain droplets and snow, and dry deposition (dryfall) of particulate matter. In the atmosphere, the mixture of gases, water vapor, particulate matter, and wind currents form a dynamic environment in which changes in chemical composition of precipitation frequently occur. Precipitation can carry increasing amounts of inorganic contaminants and sediments to groundwater and surface waters, particularly from heavily developed areas. Dissolved oxides of nitrogen and sulfur are frequently found in the atmosphere, and can be carried down in precipitation as acid rain. These compounds originate from automobile exhaust and power plant emissions, as well as from other minor sources. Precipitation also carries phosphorus.

### 3.3 Underground Discharges

"Underground discharge" is a broad term encompassing inputs from a variety of underground sources, much the same way that surface runoff encompasses inputs from a variety of above-ground sources. Included in this category are not only on-site wastewater systems (see Section 3.13), but also inputs from floor drains, dry wells, leaching catch basins, leaching chambers, or other structures. These potential sources may occur from a variety of land uses. Underground stormwater infiltration sites also contribute contaminants in the first flush of a watershed to groundwater.

### 3.4 Erosion and Sediment

Due to the nature of soils, sediment availability cannot be easily controlled. Influx of sediment into a waterbody is a natural process; however, human activities tend to accelerate sedimentation processes, thereby changing nature's intended schedule. Sediment in water bodies is derived from erosion of sloping lands, gullies and ditches, and streambanks. The most common factors influencing topsoil erosion include rainfall characteristics, soil properties, slope factors, land-cover conditions, and conservation practices. Impacts of sedimentation include reduction in water clarity, and water quality, reduced light transmission and, thus, reduced growth of aquatic vegetation, clogging of fish gills, and reduction in spawning area and aquatic habitat. Drainage patterns also change, thereby affecting downgradient waters. Water pollution hazards exist when available pollutants become detached from the soil matrix, and are transported to a receiving water body.

Construction projects, be they subdivision construction or individual home repairs and additions, are a major sources of sediment in the Cayuga Lake Watershed. These projects require a State Pollution Discharge Elimination System (SPDES) Permit for disturbance of over five acres of land in NYS. The sediment that is washed into surface waters from construction sites is regarded as the greatest single pollutant from nonpoint sources (USEPA, 1976).

Sediments, sedimentation rates and sediment chemistry of the watershed are discussed in Section 4.3. The PWL also indicates certain tributaries as use impaired partially because of silt (sediment). These include Yawger Creek, Bolter Creek, Big Salmon Creek, Little Salmon Creek, Dryden Lake, Lake Como, and Cascadilla Creek (see Chapter 6. Subwatershed Description).

### 3.4.1 Roadbank & Streambank Inventory Project

In recognition of the role that roadbank and streambank erosion plays in the sedimentation rates in the Cayuga Lake Watershed a Roadbank & Streambank Inventory was done from May though August 2000.

#### 3.4.1.1 Roadbank Inventory

##### 3.4.1.1.1 Methodology

A visual survey was performed on all roads in the watershed to obtain the information needed to rank the erosion potential of each road segment. The information gathered allows for a relative roadbank severity classification. All roads can be ranked according to their erosion potential.

Erosion in road ditches is categorized as moderate, severe, or very severe (1225 sites in the watershed). Those roads not listed in the three categories during this survey fall into the none category. The categorization reflected both subjective and objective standards. Ditch width and depth measurements were collected at representative problematic roadbank sites throughout the watershed. These measurements were used to calculate sediment loading from road ditches for the categories of moderate, severe and very severe. Calculations were taken from the USDA Engineering Field Manual, Chapter 3 Hydraulics, Exhibit 3-3 pp. 3-95. The parabolic shape was used since it most closely represents the shape of road banks.

Site locations where digitzed into a geographical information system. The collected data was then joined to the site locations for the purposed of mapping and analysis.

Very severe: implies cut, bare and collapsing banks, exposed roots, and “blow-out” holes in ditch bottoms and gully erosion with soil losses ranging from 97 to 188 tons per bankside mile. Soil loss is calculated for each representative site using a subjective average loss of 2 inches (.166 ft) over a parabolic wetted perimeter divided by three. An average figure of 144 tons of soil erosion per bank side mile is calculated and applied to determine the tons of soil loss over the miles of roads having very severe erosion. Usually “very severe” conditions were found to be on slopes greater than 8%.

Severe: bare banks, some collapsing of banks, some exposed roots, bare ditch bottoms and deposition of larger stones with soil losses ranging from 25 to 107 tons per bankside mile. Soil loss is calculated for each representative site using an subjective average loss of 1 inch (.083 ft) over a parabolic wetted perimeter divided by three. An average figure of 60 tons of soil erosion per bankside mile was calculated and applied to determine the tons of soil loss over the miles of roads having severe erosion. Usually, "severe" conditions occur in road ditches with slopes ranging from 5% to 8%.

Moderate: channel having the presence of vegetation for considerable length with evidence of some cutting and deposition. The range of soil loss for such conditions ranges from 10 to 55 tons per bankside mile. Soil loss is calculated for each representative site using an average loss of ½ inch (.042 ft) over a parabolic wetted perimeter divided by three. An average figure of 23 tons of soil erosion per bankside mile is calculated and applied to determine the tons of soil loss over the miles of roads having moderate erosion. This condition usually occurs on road ditches having slopes less than 5%.

For calculating sediment loading from road ditches that did not fall into the very severe, severe, or moderate categories, a base figure of 8.2 tons per mile is used. (equivalent to the scouring of ¼ inch of soil).

The following calculation shows the tons of soil loss per bankside mile per year for a given bank classified "very severe":

Soil Loss = (wp/3)(0.166 ft)(5280 ft)(.044 T/ft3)
Wp ( wetted perimeter) = (T + (8d2 / 3T),
where, T = ditch width and d = ditch depth.
(0.166 ft= 2 inches) (5280 ft = 1 mile)
(.044 T/ft3 = soil weight)

Using the soils handbook from USDA, NRCS, the weight for clay, silty, sands and sandy loams ranges from 65 to 110 pounds per cubic foot. An average weight of 87.5 pounds is converted to Tons per cubic foot. The method used to calculate erosion stemming from road ditch sources is intended as an indicator of relative severity. Its scope is limited, however, in that it does not account for soil losses from the road sub-surface (or surface on gravel or dirt roads) nor from exposed banks adjacent to the road ditches. Soil losses from the latter, in particular, can be very severe depending upon the steepness of the slopes.

Data collected in the field include the following: eroded distance, slope, depth, width, exposed roots, collapsing banks, washed out gravel, new dug/bare soil, vegetative cover, location relative to land use, and erosion class.

**3.4.1.1.2 Analysis**

The northwest portion of the watershed has relatively few problems with roadbank erosion with a few exceptions in Bloomer/Mack Creeks Area and the Sheldrake Creek subwatershed. The northeastern portion of the watershed has more significant roadbank erosion. Generally, the closer the road ditches are to the lake the more erosion is occurring mainly due to the steep gradients from the upland portions of the watershed down to the lake. This is demonstrated in the numerous road ditches classified as “very severe” in the King Ferry area. The same is true further south in the Lansing area. The southwestern portion of the watershed has some very severe erosion occurring along the road ditches in the Spring Brook, Taughannock Creek, Enfield Creek, and Willow Creek area. The large subwatersheds in the southern portion of the watershed with the exception of the Virgil, Cascadilla, and Buttermilk Creek subwatersheds have numerous road ditches classified as "very severe". Map 3.4.1 shows the moderate, severe and very severe sites. The following is a brief description of roadbank erosion in the subwatersheds of the Cayuga Lake Watershed:

Figure 3.1 Roadbank Erosion along Bergen Road

Barnum Creek - There are eleven sites sampled in this area, and all of them are classified as moderate.

Big Hollow Area - There are 12 sites in this subwatershed. Eight of the twelve are classified as moderate; 2 are classified as severe; and two are classified as very severe. The four road ditches not classified as moderate may be of some concern because they are all near the lake’s shore; therefore sediment has little distance to travel before it flows into the lake.

Big Salmon Creek - The road ditches in this subwatershed are in fairly good shape. There are only two sites in the severe category.

Bloomer/Mack Creeks Area - This direct drainage area has five road ditches considered to be in the severe category. This is a significant concern given they're proximity to the lake.

Boardman Creek - There are only seven areas documented for their eroded condition. Only one of them is considered to be severe.

Bolter Creek - The overall roadbank condition of this watershed is fairly good. Only seven sites were documented for their erosion, one of which is considered to be severe.

Buttermilk Creek Area - Road ditches in this subwatershed are slightly eroded. There are seven sites classified as severely eroded.

Canoga Creek Area - There are a few areas designated as moderately eroded..

Cascadilla Creek - There are a number of roadbank sites documented, but they are mostly in the moderate category. Four sites are classified as severe.

Cayuga Inlet - This subwatershed appears to have serious roadbank erosion. There are a number of road ditches documented as having moderate or severe erosion problems. Eight sites are considered very severe.

Cayuga View Area - Three roadbank sites are classified in this small subwatershed. Two are severe and one is moderately eroded. All three of these sites are located near the lakeshore.

Cayuga Village Area - This small subwatershed has only three sites documented. Two of them are classified as moderate and one is severe. The severely eroded one is located in close proximity to the lake.

Enfield Creek - There were 52 sites in this subwatershed documented for their erosion. Most of them are classified as moderate. Eleven of them are severe. There are three classified as very severe with a steep gradient along the road.

Fall Creek - The largest of the subwatersheds, Fall Creek has many sites documented for their roadbank erosion. Most of them are moderate, but quite a few are considered to be severe. Two sites were classified as very severe.

Fish Kill - The roadbank erosion in this subwatershed is fairly moderate given the number of sites classified and the relative size of the subwatershed. Most sites documented are considered to be moderate, but there are eight sites classified as severe.

Glen/Dean Creeks Area - A few road ditches in this area are classified as moderate. There are no severe or very severe sites. However, three of the moderate sites are located near the lake shoreline.

Glenwood Creek Area - There are a number of sites documented for their roadbank erosion in this subwatershed. Most of them are classified as moderate. Three are classified as severe, all of which are located on the shoreline.

Great Gully - Most of the sites are classified as moderately eroded. One is severe. One is very severe.

Groves/Powell Creeks Area - There are a few sites classified as moderate, but no sites were severe or very severe.

Gulf Creek - There are a few sites documented as moderate, all clustered in the middle of the subwatershed.

Hicks Gully - Only five sites are classified as moderate in this fairly large subwatershed.

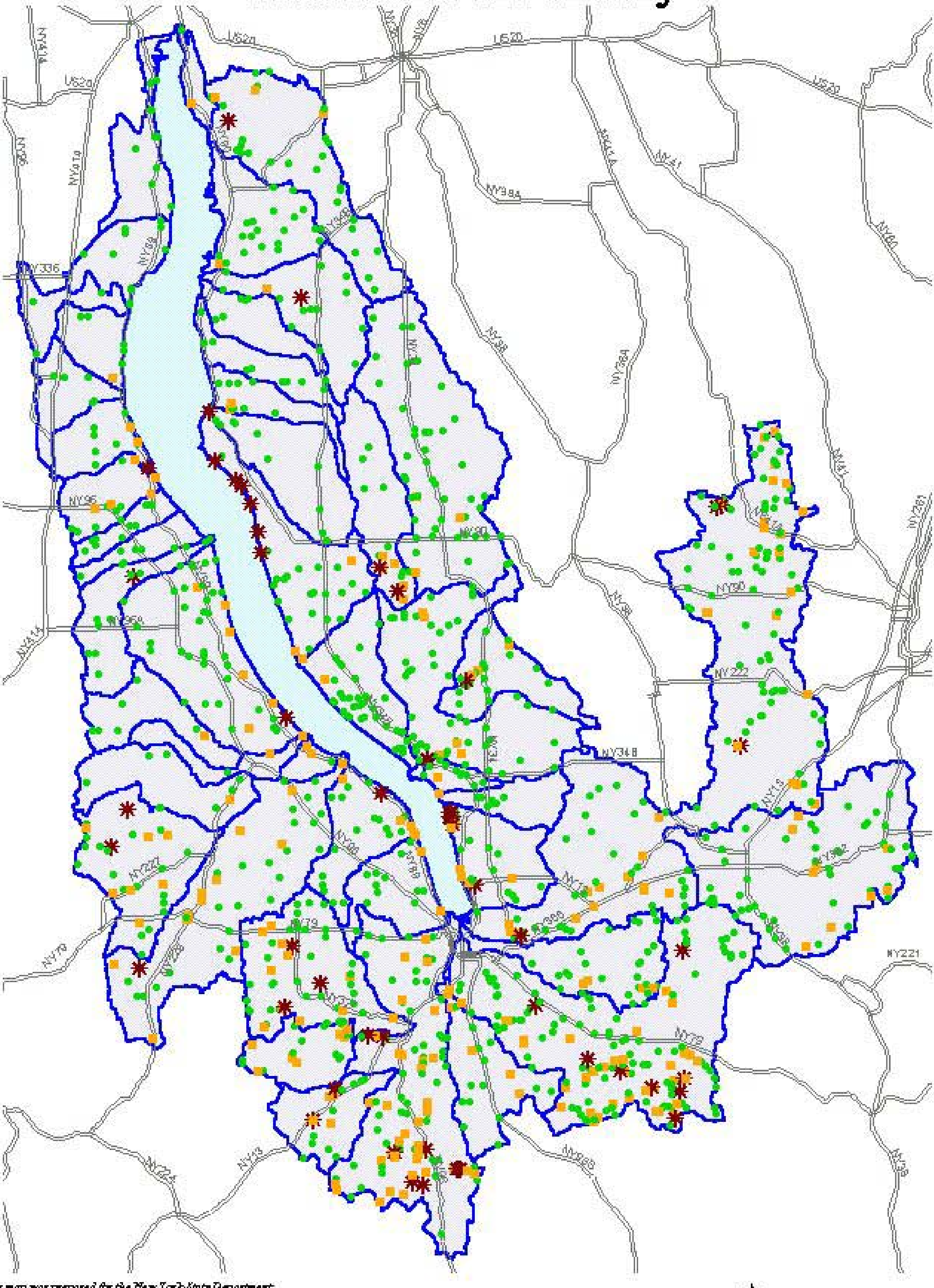
Interlaken Area - This large drainage area had numerous sites documented for the roadbank erosion, most of which were classified as moderate. There are seven sites designated as severely eroded, and most of these sites were located near the lake. There is one site on the lakeshore classified as very severe.

King Ferry Station Area - This drainage area has some significant erosion along the shoreline of the lake. There were numerous sites found to be moderately eroded, and a few classified as severe. Along the northern part of this subwatershed there are seven sites classified as very severe.

Lake Ridge Point Area - This drainage area has many roadbank sites classified as moderately eroded, some in close proximity to the lake. One site is classified as severe.

Lansing Area - This small subwatershed has some significant roadbank erosion problems. There are a few sites documented as moderately eroded and four severely eroded - two of which were located on the lakeshore. The

# Cayuga Lake Watershed Roadbank Inventory




*This map was prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.*

*Source: Genesee/Finger Lakes Regional Planning Council, 1998 and 2000.*

*Base Map: New York State Department of Transportation, February 1996.*

Erosion Class
- Moderate
- Severe
- Very Severe

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0 4 8 Miles

*Prepared by Genesee/Finger Lakes Regional Planning Council, 2000.*

concern in this area is the northwestern corner. There is a cluster of very severe road ditches located near the lakeshore.

Lavanna Area - This small subwatershed had only a few sites eroded enough to be classified as moderate. This area doesn't have any significant problems contributing to the sediment load emptying into the lake.

Little Creek Area - A few sites are classified as moderately eroded. Two sites are severe.

Little Salmon Creek - The northern half of this subwatershed has little to no problems with roadbank erosion. However, problems have been documented in the southern portion of this area. Five sites are classified as severely eroded. There were two sites classified as very severe.

Locke Creek - There are numerous sites documented as moderately eroded throughout this area. Three sites are classified as severe and one site is classified as very severe.

McDuffie Town - There are five sites classified as moderately eroded—three of them were located on the shoreline. There is one site designated as severe.

Minnegar Creek Area - This small subwatershed has some erosion concerns considering its size. There are numerous road ditches that are moderately eroded. There are two sites classified as severe, one of them located on the lakeshore.

Paines Creek - The road ditches in this subwatershed are not heavily eroded. There are a few sites classified as moderately eroded, but there are none classified as severe or very severe.

Red Creek - This small subwatershed had only two sites documented for their roadbank erosion.

Salmon Creek - Numerous sites had moderate erosion occurring along the roadbanks throughout the subwatershed. There are a few areas classified as severe - two in the northern portion and three near the outflow to the lake. Also nearby, there is one site designated as very severe.

Schuyler Creek - This subwatershed is located in a relatively flat area. Roadbank erosion does not appear to be a significant contribution to the sediment load entering the lake. There are a few sites classified as showing signs of moderate erosion, but there are no severe or very severe sites documented.

Sheldrake Creek - Many road ditches in this subwatershed are classified as moderately eroded. One site is classified as very severe

Sixmile Creek - The roadbanks in this major subwatershed are an area of concern. There are numerous sites documented as moderately eroded. Many sites are classified as severely eroded. Eight road ditches are classified as very severe.

Spring Brook - Numerous sites are classified as moderate. Seven sites are classified as severe. None of these seven are concentrated in any one area. There are two sites designated as very severe.

Taughannock Creek - Moderately eroded roadbanks are common throughout this subwatershed. There are many severely eroded road ditches, one of which is at the mouth of Taughannock Creek. Additionally there is a site classified as very severe near the headwaters of this subwatershed.

Trumansburg Creek - There are only three sites documented for their roadbank erosion in this small watershed; however, two of them are classified as severe. These two sites are also closer to the lake than the moderately eroded site.

Union Springs Area - Numerous moderately eroded roadbanks are scattered throughout this subwatershed. All of the designated sites are concentrated in the southern half of the subwatershed.

Virgil Creek - This major subwatershed has many moderately eroded roadbanks. They are not concentrated in any one area. Nine sites are classified as severely eroded. There are no roadbanks classified as very severe, but the total number of road ditches documented for their erosion was high.

West Branch - This small subwatershed had some significant roadbank erosion There are a few areas classified as moderately eroded. Five sites are classified as severe. Two sites are classified as very severe.

Willow Creek Area - There are many sites classified as moderately eroded, but the concern is near the lakeshore where there are four sites classified as severe. A very severe road ditch is located near the lakeshore.

Yawger Creek - This area's significant erosion is concentrated in the northern portion of the subwatershed, where three sites are classified as severe and one site is classified as very severe.

**3.4.1.2 Streambank Inventory**

**3.4.1.2.1 Methodology**

There are 140 tributaries in the Cayuga Lake Watershed. Data was taken from 1100 sites in the watershed. A visual survey was performed at several sites on each tributary to obtain the information needed to rank the erosion potential of each subwatershed and direct drainage. The information gathered is was fed into the stream factor equation in order to obtain a relative stream factor number. The higher the stream factor the greater the potential erosion problem. All subwatersheds and direct drainage areas were then ranked according to their erosion potential. The stream rankings for the Cayuga Lake Watershed ranged from 50 to 1350. For the purposes of analysis the following erosion classifications were developed based on the average of all stream ranks within a given subwatershed:
Minor - stream rank mean of 50-80
Appreciable - stream rank mean of 81-125
Severe - stream rank greater than 125
Low end of severe - stream rank of 125-250
Moderately severe - stream rank of 251-350
Very severe - stream rank of 351-1350

Site locations where digitized into a geographical information system. The collected data was then joined to the site locations for the purposed of mapping and analysis.

Stream Factor Equation = (Bottom material value + side slope condition value + vegetative condition value) + ((average velocity) X number of tributary miles in the watershed)

Stream Factor Variables:

Bottom Material: soil, gravel, or bedrock

Side Slope Condition: not eroded, partially eroded, or severely eroded

Vegetative Condition: heavily vegetated, sparsely vegetated, or no vegetation

Average Velocity: depth, bottom material, obstructions, meander, surface irregularities, vegetative cover, and channel size

Mannings Equation V = 1.49 r 2/3 s 1/2 / n

r = hydraulic radius
s = slope
n = basic roughness coefficient + modifying value for surface irregularity + modifying value for variations of cross sections + modifying value for obstructions + modifying value for vegetation + modifying value for meander

Tributary Miles: total length of longest branch of the tributary or average length of sampled tributaries for the direct drainage areas.

**3.4.1.2.2 Analysis**

The streambank data collected from the Cayuga Lake watershed displays various trends regarding erosion and sedimentation ultimately affecting water quality in the lake. Minor erosion is occurring along the western and eastern subwatersheds north of the Taughannock Creek subwatershed and the Salmon Creek subwatershed. The direct drainage basins on the southern end of the lake appear to pose little problems in regards to erosion. More appreciable erosion is apparent in the northeastern subwatersheds in Yawger Creek, Great Gully and Lavanna Area subwatersheds. Taughannock, Bolter, and Spring Brook subwatersheds also show a trend of appreciable erosion. The Salmon Creek major subwatershed (Salmon, Little Salmon, and Big Salmon Creeks) is on the low end of severe with stream ranks between 125-250. The large subwatersheds on the southern end of the lake with the exception of the direct drainage basins are responsible for appreciable loads of sediment flowing into the lake. Fall, Virgil, and Sixmile Creeks are all categorized as moderately severe with a few very severe sites. The Cayuga Inlet is characterized as very severe and contains some of the highest stream ranks in the watershed. Map 3.4.2 shows the Streambank Inventory sites and classifications. Map 3.4.3 shows the erosion classification by subwatershed. The following is a brief description of streambank erosion in the subwatersheds of the Cayuga Lake Watershed:

Barnum Creek
Sites Sampled: 4
Stream Rank
High: 89.1
Low: 43.3
Average: 64.9
Comments: No significant sites

Figure 3.2 Streambank Erosion in McDuffie Town Subwatershed

Big Hollow Area
Sites Sampled: 8
Stream Rank
High: 83
Low: 42.3
Average: 65.7
Comments: No significant sites

Big Salmon Creek
Sites Sampled: 48
Stream Rank
High: 712
Low: 87
Average: 189.5
Comments: There are some exceptions on some of the small tributaries flowing into the major stream, but for the most part the streambank erosion is relatively severe.

Bloomer/Mack Creeks Area
Sites Sampled: 11
Stream Rank
High: 89.1
Low: 38.5
Average: 58.2
Comments: No significant sites

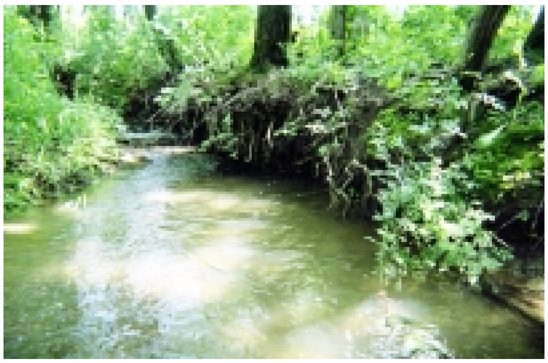
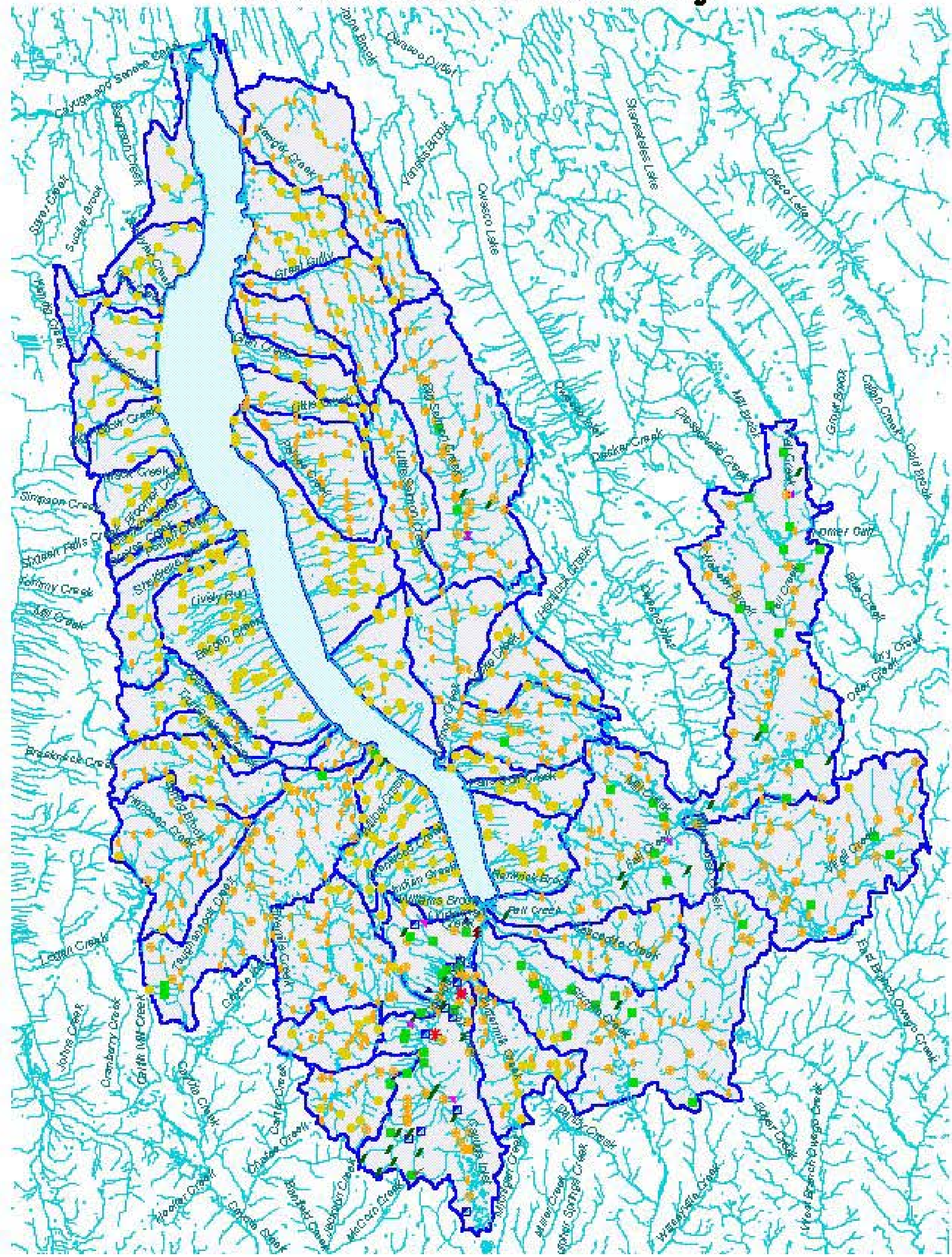


Figure 3.3 Streambank Undercutting along Minneger Creek

Boardman Creek
Sites Sampled: 12
Stream Rank
High: 99
Low: 50.5

# Cayuga Lake Watershed Streambank Inventory




Stream Rank

| | | | |
|---|---|---|---|
| 0 - 80 | 330 - 410 | 660 - 740 | 990 - 1070 |
| 80 - 160 | 410 - 490 | 740 - 820 | 1070 - 1150 |
| 160 - 250 | 490 - 580 | 820 - 900 | 1150 - 1230 |
| 250 - 330 | 580 - 660 | 900 - 990 | 1230 - 1320 |

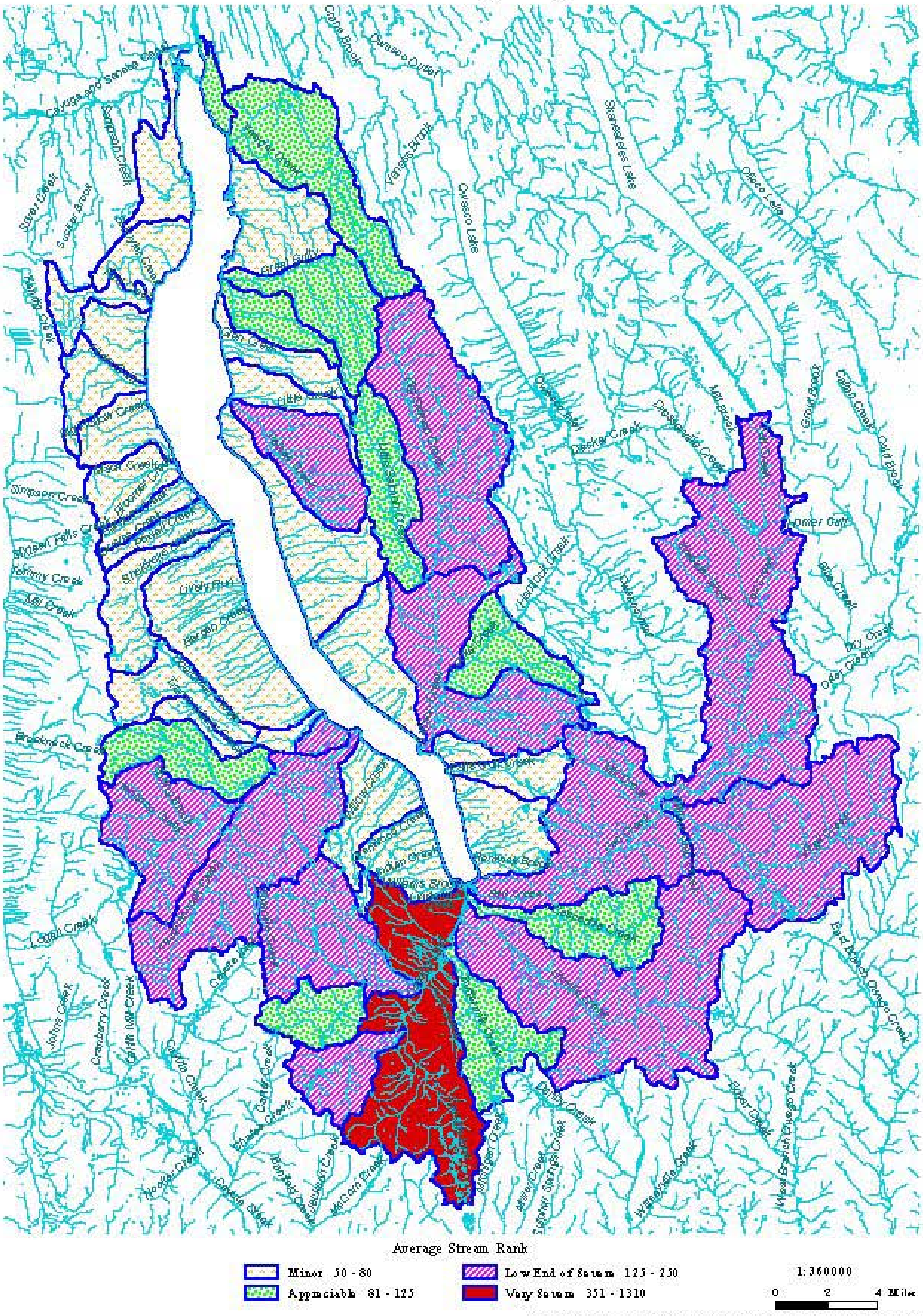
1:360000

0 2 4 Miles

*This map was prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.*

*Source: Genesee/Finger Lakes Regional Planning Council, 1998 and 2000.*
*Base Map: New York State Department of Transportation, February 1996.*
*Prepared by Genesee/Finger Lakes Regional Planning Council, 2000.*

# Cayuga Lake Watershed
# Streambank Inventory By Subwatershed

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*Source: Genesee/Finger Lakes Regional Planning Council, 1998 and 2000.*
*Base Map: New York State Department of Transportation, February 1996.*
*Prepared by Genesee/Finger Lakes Regional Planning Council, 2000.*

Average: 75
Comments: This subwatershed appears to have a few significant sites. Three sites had stream ranks in the appreciable category but none exceeded 100.

Bolter Creek
Sites Sampled: 19
Stream Rank
High: 151.9
Low: 55.5
Average: 101.3
Comments: Along the main stem of Bolter Creek a few sites were identified as problematic contributing to sedimentation in Cayuga Lake. The small tributaries feeding the main stream appear to be in good shape, but once they flow into Bolter Creek the condition of the streambanks decreases.

Buttermilk Creek Area
Sites Sampled: 28
Stream Rank
High: 233.4
Low: 59.5
Average: 119.5
Comments: Upstream, the tributaries tend to be in good shape with a few exceptions. However, when they flow into the main creek the condition of the streambanks becomes degraded.

Canoga Creek Area
Sites Sampled: 4
Stream Rank
High: 78.8
Low: 51.3
Average: 65
Comments: No significant sites

Cascadilla Creek
Sites Sampled: 20
Stream Rank
High: 174
Low: 63.3
Average: 111.5
Comments: Most of the stream ranks were over 100 with a few exceptions at the headwaters of various tributaries.

Cayuga Inlet
Sites Sampled: 78
Stream Rank
High: 1315.5
Low: 99.5
Average: 362
Comments: This subwatershed has the highest rank and therefore appears to need the most attention. No site sampled could be classified as minor.

Cayuga View Area
Sites Sampled: 5
Stream Rank
High: 176.6
Low: 97.3
Average: 130.8
Comments: This area is classified as severe. This may be caused by the steep gradients in the area.

Cayuga Village Area

Sites Sampled: 2
Stream Rank
High: 138.3
Low: 88.1
Average: 113.2
Comments: With only two sites sampled, it is hard to have an accurate account of the streambank erosion in this area.  However, one of the sites sampled showed signs of severe streambank erosion.

Enfield Creek

Sites Sampled: 38
Stream Rank
High: 260.3
Low: 72
Average: 131.4
Comments: The average was just high enough to classify the area as severe.  There were some exceptions with tributaries that weren't as severely eroded, but most of the sites showed signs of  severe streambank erosion.

Fall Creek

Sites Sampled: 84
Stream Rank
High: 762.7
Low: 101.8
Average: 234.8
Comments: This area is classified as severe, and not a single site sampled had a ranking of below 100. There appears to be major sediment loading to the lake from this subwatershed.

Fish Kill

Sites Sampled: 20
Stream Rank
High: 193.6
Low: 53.5
Average: 97.4
Comments: As a whole, the erosion occurring within the subwatershed isn't severe, but there are a few exceptions in some tributaries that may deserve attention.

Glen/Dean Creeks Area

Sites Sampled: 12
Stream Rank
High: 96
Low: 53.5
Average: 70.7
Comments: There wasn't much erosion evident, but there were a couple of sites that could be classified as appreciable.

Glenwood Creek

Sites Sampled: 20
Stream Rank
High: 87.5
Low: 35.25
Average: 60.37
Comments: No a significant sites

Great Gully

Sites Sampled: 23
Stream Rank
High: 192.8
Low: 77.3
Average: 112.1
Comments: Classified as appreciable, but certain tributaries in this subwatershed need more attention then others. Erosion increases after the tributaries join the main branch.

Groves/Powell Creeks Area
Sites Sampled: 13
Stream Rank
High: 92.5
Low: 44.8
Average: 65.5
Comments: No significant sites

Gulf Creek Area
Sites Sampled: 11
Stream Rank
High: 78
Low: 54
Average: 65.3
Comments: No significant sites

Hicks Gully
Sites Sampled: 7
Stream Rank
High: 87.1
Low: 58.9
Average: 70.8
Comments: Few significant sites

Interlaken Area
Sites Sampled: 42
Stream Rank
High: 84
Low: 34
Average: 53.9
Comments: No significant sites

King Ferry Station Area
Sites Sampled: 28
Stream Rank
High: 87.1
Low: 43.8
Average: 63.1
Comments: No significant sites

Lake Ridge Point Area
Sites Sampled: 15
Stream Rank
High: 85.6
Low: 41.1
Average: 65.3
Comments: No significant sites

Lansing Area

Sites Sampled: 16
Stream Rank
High: 84.3
Low: 41.3
Average: 64.9
Comments: No significant sites

Lavanna Area

Sites Sampled: 10
Stream Rank
High: 108.3
Low: 54.4
Average: 85.4
Comments: Some significant sites

Figure 3.4 Garbage in Willow Creek

Little Creek Area

Sites Sampled: 12
Stream Rank
High: 109.6
Low: 54.2
Average: 79.8
Comments: Some significant sites

Little Salmon Creek

Sites Sampled: 21
Stream Rank
High: 162.3
Low: 63.2
Average: 104.4
Comments: This subwatershed is part of the Salmon Creek major subwatershed, which has some significant streambank erosion problems.

Locke Creek

Sites Sampled: 17
Stream Rank
High: 138.2
Low: 55.7
Average: 86.8
Comments: This subwatershed should be considered an area of concern

McDuffie Town

Sites Sampled: 6
Stream Rank
High: 69.8
Low: 48
Average: 59.6
Comments: No significant sites

Minnegar Creek Area

Sites Sampled: 6
Stream Rank
High: 81.8
Low: 41.3
Average: 67.2
Comments: The erosion problems in this area are minimal.

Paines Creek

Sites Sampled: 31
Stream Rank
High: 225.9
Low: 73.7
Average: 131.9
Comments: Some sites in this area are highly eroded deserving some concern. There are some exceptions at the headwaters of some of the tributaries in this area.

Red Creek

Sites Sampled: 4
Stream Rank
High: 89
Low: 60.2
Average: 73.3
Comments: This is classified as minor.

Salmon Creek

Sites Sampled: 42
Stream Rank
High: 260.9
Low: 74.8
Average: 137.5
Comments: The major tributary in the subwatershed flows directly into the lake and most all of the sites sampled had significant erosion. This area is part of the Salmon Creek major subwatershed and should considered a subwatershed of concern.

Schuyler Creek

Sites Sampled: 10
Stream Rank
High: 67.6
Low: 42.8
Average: 56.8
Comments: Streambank erosion in this subwatershed is minimal.

Sheldrake Creek

Sites Sampled: 15
Stream Rank
High: 99.2
Low: 61.9
Average: 75
Comments: The erosion in this subwatershed is minimal.

Sixmile Creek

Sites Sampled: 55
Stream Rank
High: 375.1
Low: 76.5
Average: 205.5
Comments: Most of the sites sampled showed evidence of significant streambank erosion.

Spring Brook

Sites Sampled: 30
Stream Rank
High: 203.9

Low: 73.4
Average: 129.5
Comments: Most all of the tributaries showed signs of significant erosion with a few exceptions.

Taughannock Creek
Sites Sampled: 51
Stream Rank
High: 385.4
Low: 82.8
Average: 168.2
Comments: The erosion along the streambanks in this area is classified as severe. There were some exceptions along some of the small tributaries flowing into the main stem of Taughannock Creek, but the main stem didn't have a single ranking below 150.

Trumansburg Creek
Sites Sampled: 5
Stream Rank
High: 83.1
Low: 45.8
Average: 58.5
Comments: The streambank erosion in this area is minimal.

Union Springs Area
Sites Sampled: 23
Stream Rank
High: 118.4
Low: 53.7
Average: 79.6
Comments: Most of the tributaries are in fairly good shape, but there are some exceptions. A couple small tributaries, which flow directly into the lake, have stream ranks above 100.

Virgil Creek
Sites Sampled: 42
Stream Rank
High: 386.8
Low: 84.7
Average: 188.4
Comments: This ranking classifies the area's streambank erosion as severe. There are many sites with stream ranks greater than 150.

West Branch
Sites Sampled: 18
Stream Rank
High: 314.4
Low: 61.9
Average: 136.5
Comments: Many of the tributaries sampled near the headwaters were in fairly good shape, but as the sites got nearer to the mouth, the streambank erosion appeared significantly worse.

Willow Creek Area
Sites Sampled: 24
Stream Rank
High: 92.7
Low: 42.6
Average: 58.2
Comments: Streambank erosion in this area is minimal.

Yawger Creek

Sites Sampled: 39
Stream Rank
High: 244.2
Low: 70
Average: 123.5
Comments: Streambank erosion is classified as severe. There are a few exceptions with various tributaries, but most of the area has significant streambank erosion occurring.

### 3.5 State Pollution Discharge Elimination System (SPDES)

NYSDEC requires that every point source discharger obtain a SPDES permit in order to legally discharge sanitary, industrial, or commercial wastewater. The permit is a comprehensive legal document, and all of its provisions and conditions are enforceable under the law. Under SPDES, NYSDEC reviews permit applications to develop the limits for types and quantities of pollutants in the effluent. The permit also includes the schedules and conditions under which discharges are allowed. Owners or operators of facilities must treat wastewater in order to meet the limits listed in their SPDES permit. In the case of municipal facilities, permits also require industries discharging into the municipal collection system to pre-treat their wastes. Compliance and self-monitoring reports are a major part of this program. Permits are reviewed and reissued every five years (NYSDEC).

Section 4.2 and associated Tables 4.2.5 and 4.2.6 along with Map 4.2.1 discuss and illustrate permitted discharges to Cayuga Lake and its tributaries. A portion of these are municipal sewage treatment plants, which are discussed in Section 3.11.

Table 3.6.1
Bulk Storage

| Map Id | Owner | City State | Type |
|---|---|---|---|
| 414 | BROWN CYNTHIA A | WILLARD NY | Gasoline, Fuel, Liquid Petroleum Storage |
| 415 | GENERAL FUEL & SUPPLY CO | TRUMANSBURG NY | Gasoline, Fuel, Liquid Petroleum Storage |
| 416 | EHRHART, G W INC | TRUMANSBURG NY | Bottle Gas, Natural Gas Facility |
| 417 | LAMOREAUX-QUINN SERVICE | TRUMANSBURG NY | Gasoline, Fuel, Liquid Petroleum Storage |
| 418 | MESSENGER, RICHARD L | ITHACA NY | Gasoline, Fuel, Liquid Petroleum Storage |
| 419 | TOWN OF LANSING WATER DISTRICT | VESTAL, NY | Gasoline, Fuel, Liquid Petroleum Storage |
| 420 | WAINWRIGHT, EARL V JR | DRYDEN, NY | Gasoline, Fuel, Liquid Petroleum Storage |
| 421 | WAINWRIGHT, EARL V JR | DRYDEN, NY | Gasoline, Fuel, Liquid Petroleum Storage |
| 422 | APALICHIN OIL CO, INC | APALACHIN, NY | Gasoline, Fuel, Liquid Petroleum Storage |
| 423 | ANDREE, ROBERT P | ITHACA NY | Gasoline, Fuel, Liquid Petroleum Storage |
| 424 | ANDREE, ROBERT P | ITHACA NY | Gasoline, Fuel, Liquid Petroleum Storage |
| 425 | AGWAY PETROLEUM CORP | SYRACUSE NY | Gasoline, Fuel, Liquid Petroleum Storage |
| 426 | DONEY, FLOYD J | FAYETTEVILLE NY | Gasoline, Fuel, Liquid Petroleum Storage |
| 427 | OVERBAUGH, THOMAS G | TRUMANSBURG NY | Bottle Gas, Natural Gas Facility |

Source: NYSORPS

Table 3.6.2
Chemical Bulk Storage

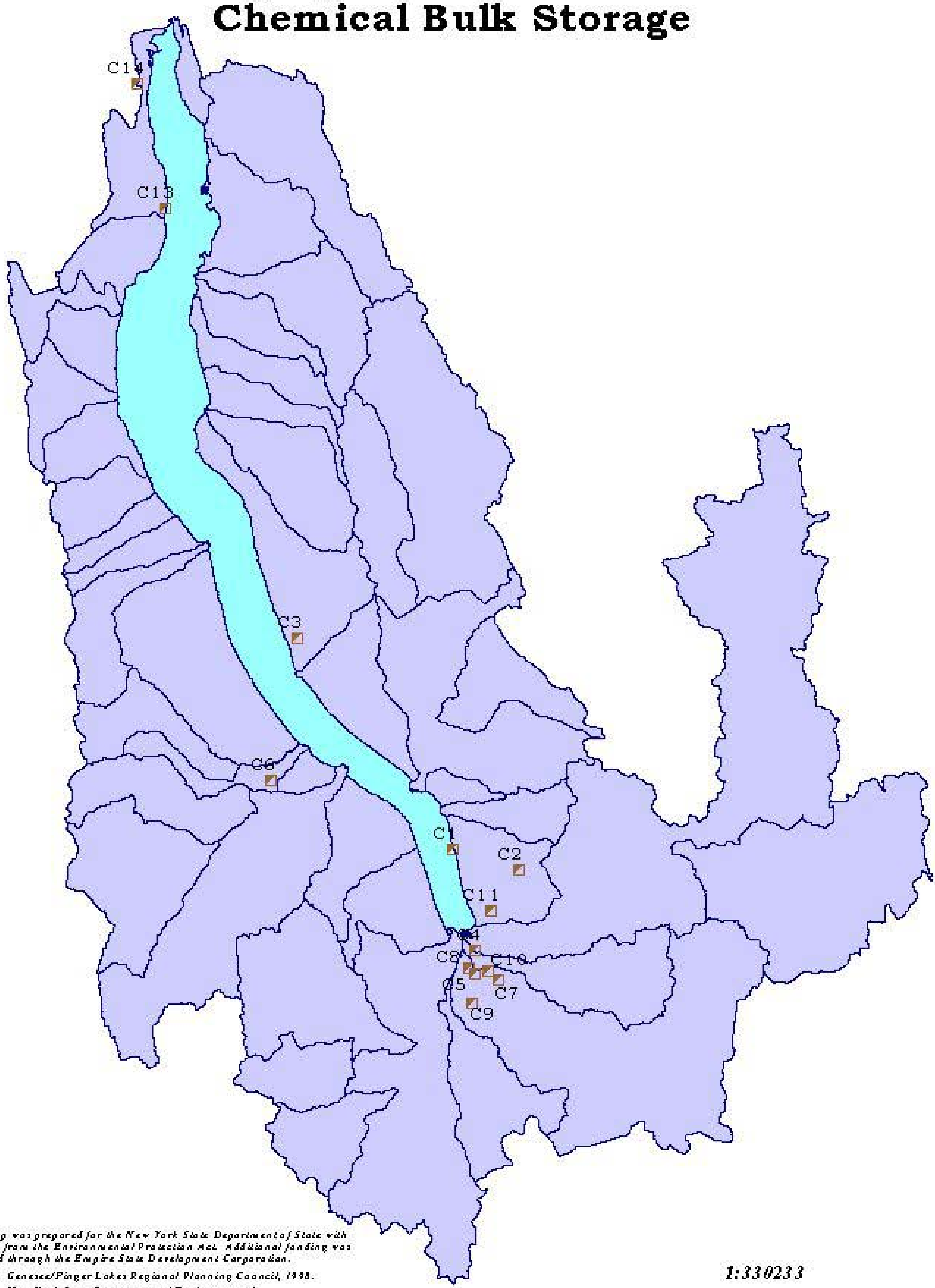
| Map Id | Site Name | Site City | Owner | Active Tanks | Site Type | Total Capacity (gals) |
|---|---|---|---|---|---|---|
| C1 | SOUTHERN CAYUGA LAKE INTERMUNICIPAL WATER COMM. | ITHACA | SOUTHERN CL INTERMUNICIPAL WATER COMM. | 7 | EF | 20288 |
| C2 | BORG WARNER AUTOMOTIVE MORSE TEC CORP | ITHACA | BORG WARNER AUTO MORSE TEC CORP | 1 | D | 12000 |
| C3 | MILLIKEN STATION | LANSING | NGE GENERATION,INC., NYSEG | 10 | E | 40750 |
| C4 | MORSE INDUSTRIAL CORP. | ITHACA | EMERSON POWER TRANS CORP. | 1 | D | 2000 |
| C5 | AGWAY ENERGY PRODUCTS | ITHACA | AGWAY PETROLEUM PRODUCTS | 0 | BC | 0 |
| C6 | VILLAGE OF TRUMANSBURG SEWAGE TREATMENT PLANT | TRUMANSBURG | VILLAGE OF TRUMANSBURG | 1 | E | 2000 |
| C7 | ITHACA (C) WATER TREATMENT PLANT | ITHACA | ITHACA (C) WATER TREATMENT PLANT | 4 | F | 9680 |
| C8 | WYLLIE DRY CLEANING INC. | ITHACA | WYLLIE DRY CLEANING INC. | 1 | I | 260 |
| C9 | ITHACA COLLEGE POOLS | ITHACA | ITHACA COLLEGE | 2 | G | 525 |
| C10 | CORNELL LAUNDRY INC | ITHACA | CORNELL LAUNDRY INC | 1 | I | 5000 |
| C11 | CASS PARK | ITHACA | CITY OF ITHACA | 2 | F | 775 |
| C13 | VILLAGE OF SENECA FALLS WATER TREATMENT PLANT | FAYETTE | SENECA FALLS (V) SENECA FALLS | 1 | F | 5500 |
| C14 | NEW YORK CHIROPRACTIC COLLEGE | SENECA FALLS | NEW YORK CHIROPRACTIC COLLEGE | 0 | G | 0 |

Site Type

| | |
|---|---|
| A | Chemical Distributor |
| B | Storage Terminal |
| C | Retail Gasoline Sales |
| D | Manufacturing |
| E | Utility |
| F | Municipality |
| G | School |
| H | Private Residence |
| I | Other |

Source: Adapted from NYSDEC

# Cayuga Lake Watershed Chemical Bulk Storage




This map was prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.

Source: Genesee/Finger Lakes Regional Planning Council, 1998.
New York State Department of Environmental Conservation, Division of Environmental Remediation, Bureau of Spill Prevention and Response, October 1, 1998.

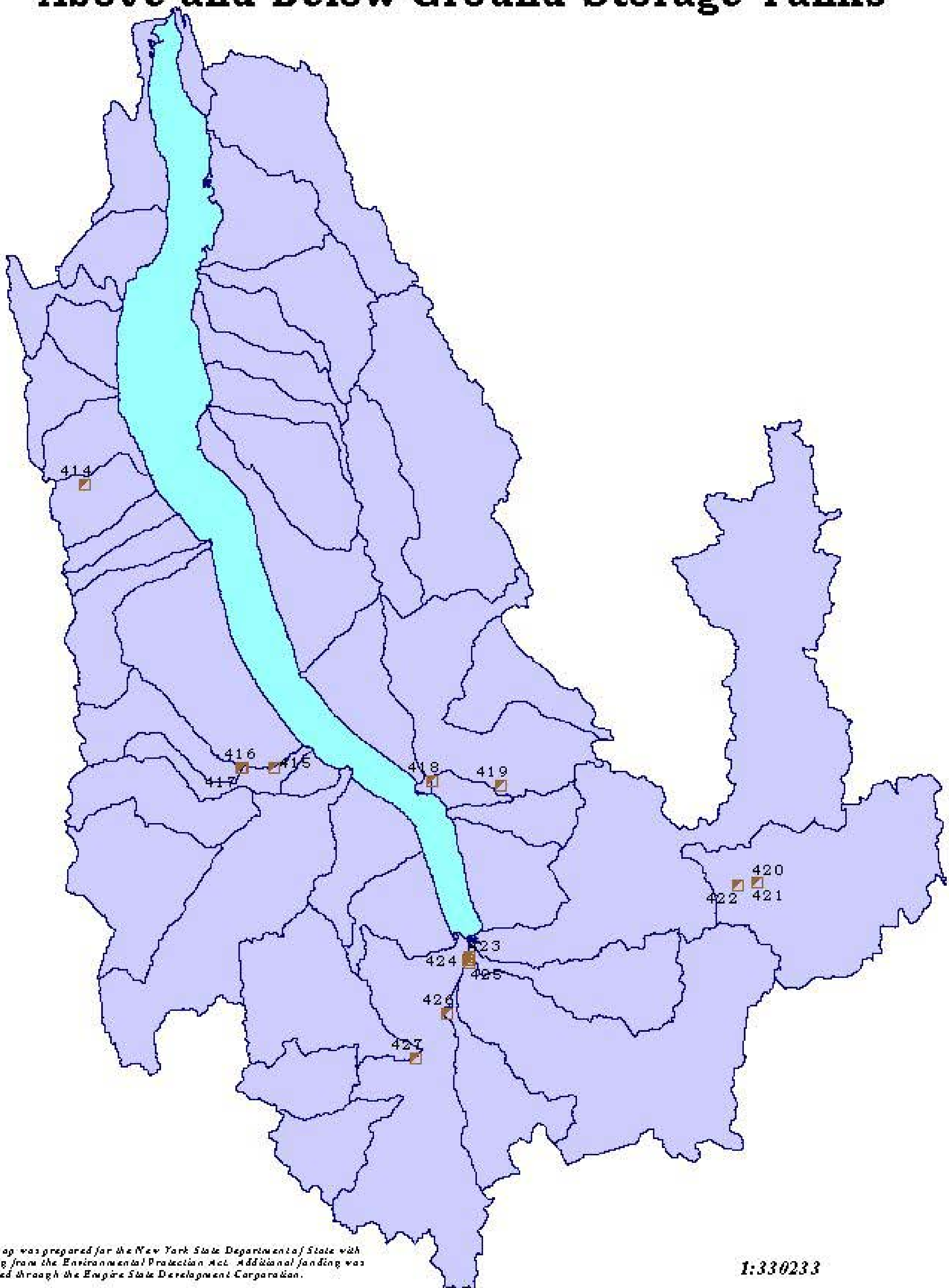
Base Map: New York State Department of Transportation, February 1996.

1:330233

0 4 8 Miles

Prepared by Genesee/Finger Lakes Regional Planning Council, 1999.

# Cayuga Lake Watershed
# Above and Below Ground Storage Tanks




*This map was prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.*

*Source: Genesee/Finger Lakes Regional Planning Council, 1998.*
*New York State Department of Real Property Services, 1998.*
*Tompkins County GIS Program, 1999.*

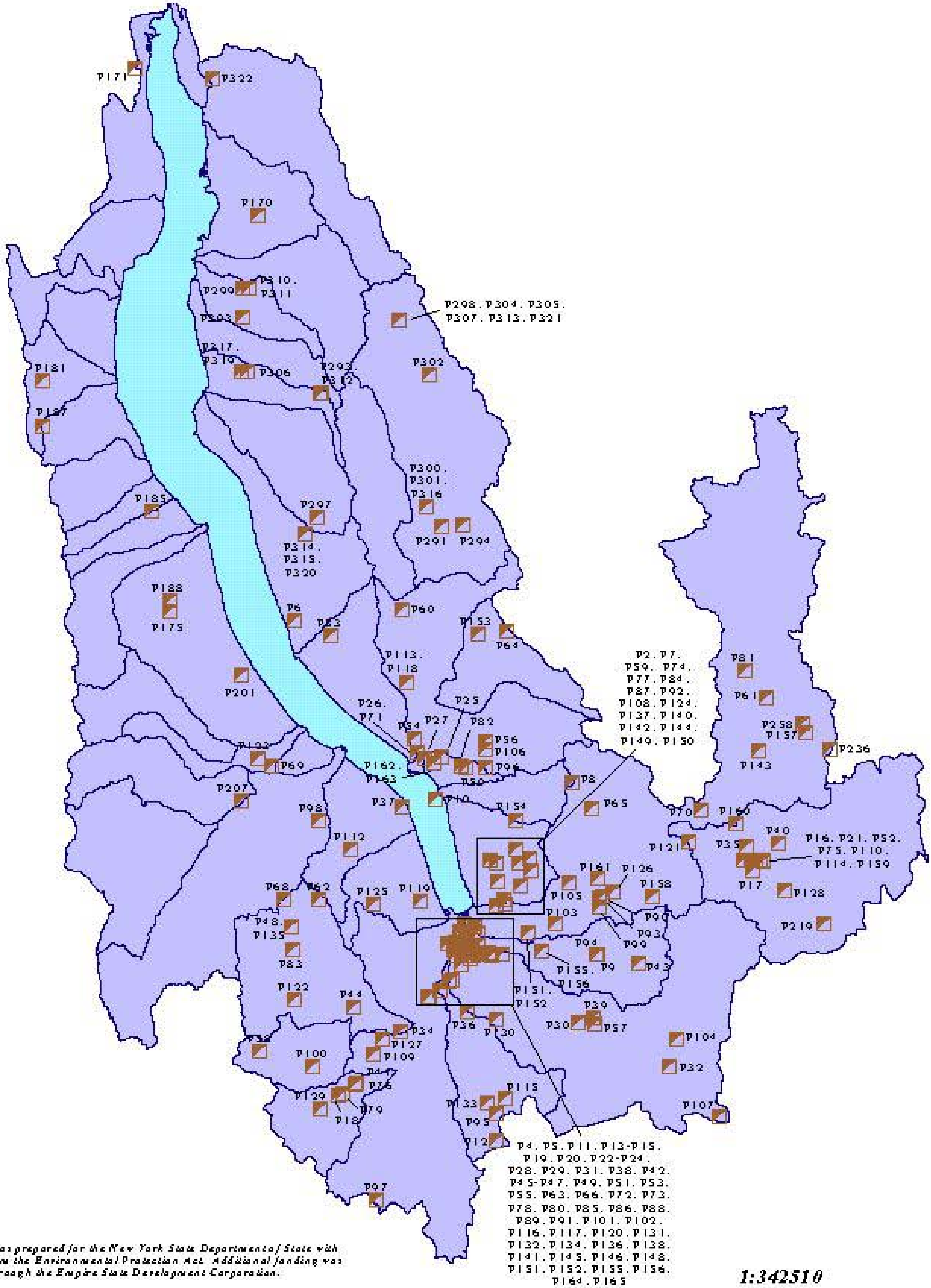
*Base Map: New York State Department of Transportation, February 1996.*

*1:330233*

**0 4 8 Miles**

*Prepared by Genesee/Finger Lakes Regional Planning Council, 1999.*

# Cayuga Lake Watershed Petroleum Bulk Storage




1:342510

0 4 8 Miles

*This map was prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.*

*Source: Genesee/Finger Lakes Regional Planning Council, 1998.*
*New York State Department of Environmental Conservation, Division of Environmental Remediation, Bureau of Spill Prevention and Response, October 1, 1998.*

*Base Map: New York State Department of Transportation, February 1996.*

*Prepared by Genesee/Finger Lakes Regional Planning Council, 1999.*

**Table 3.6.3**
**Petroleum Bulk Storage**

| Map Id | Site Name | Site Municipality | Site Type | Total Tanks | Site Status | Total Capacity |
|---|---|---|---|---|---|---|
| P2 | BORG-WARNER AUTOMOTIVE MORSETEC CORP | ITHACA | D | 19 | 1 | 56285 |
| P4 | EMERSON POWER TRANSMISSION | ITHACA | D | 15 | 4 | 17435 |
| P5 | AGWAY ENERGY PRODUCTS | ITHACA | AB | 8 | 1 | 130285 |
| P6 | MILLIKEN GENERATING STATION | LANSING | E | 11 | 1 | 99300 |
| P7 | TOMPKINS COUNTY AIRPORT | ITHACA | L | 3 | 1 | 4548 |
| P8 | CARGILL, INC. (CAYUGA MINE) | LANSING | L | 6 | 1 | 22825 |
| P9 | E.M. BORGER COMPRESSOR STATION | ITHACA | E | 3 | 1 | 19500 |
| P10 | LOCKHEED MARTIN CORP. | SOUTH LANSING | D | 2 | 1 | 2530 |
| P11 | ITHACA BOATING CENTER, INC. | ITHACA | BL | 2 | 1 | 8000 |
| P12 | WILBUR LUMBER CO. | ITHACA | D | 2 | 1 | 1275 |
| P13 | CITY OF ITHACA | ITHACA | E | 0 | 2 | 0 |
| P14 | BABCOCK HALL (136 TERRACE HILL) | ITHACA | L | 0 | 2 | 0 |
| P15 | GARAGE DE FRANCE INC. | ITHACA | C | 0 | 2 | 0 |
| P16 | WAINWRIGHT OIL CO. INC. | DRYDEN | L | 31 | 1 | 81985 |
| P17 | VILLAGE OF DRYDEN | DRYDEN | L | 2 | 1 | 2000 |
| P18 | NEWFIELD CENTRAL SCHOOL | NEWFIELD | H | 2 | 1 | 1300 |
| P19 | ITHACA JOURNAL | ITHACA | | 0 | 2 | 0 |
| P20 | CITY OF ITHACA | ITHACA | | 0 | 2 | 0 |
| P21 | TOWN OF DRYDEN HIGHWAY DEPARTMENT | DRYDEN | L | 4 | 1 | 11575 |
| P22 | ITHACA U-HAUL | ITHACA | BF | 0 | 2 | 0 |
| P23 | PATTERSONS SERVICE STATION OF ITHACA INC | ITHACA | B | 4 | 1 | 11250 |
| P24 | NICHOL BLOCK CORP. | ITHACA | F | 0 | 2 | 0 |
| P25 | LANSING ELEMENTARY SCHOOL | LANSING | H | 0 | 2 | 0 |
| P26 | LANSING SCHOOL BUS GARAGE | LANSING | H | 6 | 1 | 15650 |
| P27 | LANSING MIDDLE SCHOOL | LANSING | H | 0 | 2 | 0 |
| P28 | KWIK-FILL #A0033-038 | ITHACA | B | 6 | 1 | 34000 |
| P29 | TALLMADGE TIRE SERVICE | ITHACA | | 0 | 2 | 0 |
| P30 | CRISPELL AUTOMOTIVE, INC. | ITHACA | B | 2 | 1 | 24000 |
| P31 | EDDIE'S SUPER SERVICE | ITHACA | B | 0 | 2 | 0 |
| P32 | TOWN OF CAROLINE | BROOKTONDALE | L | 2 | 1 | 4000 |
| P33 | OLIVER FARM | LANSING | | 2 | 2 | 500 |
| P34 | LANDSTROM GRAVEL CO., INC. | NEWFIELD | DF | 8 | 1 | 25125 |
| P35 | CTC OF NY INC | DRYDEN | | 0 | 2 | 0 |
| P36 | BIG AL'S HILLTOP QUIKSTOP, INC. | ITHACA | BC | 4 | 1 | 15550 |
| P37 | WEST SHORE GAS AND GROCERY | ITHACA | B | 0 | 2 | 0 |
| P38 | BEVERLY J. MARTIN ELEMENTARY SCHOOL | ITHACA | H | 0 | 2 | 0 |
| P39 | VEHICLE MAINTENANCE CENTER | ITHACA | FH | 8 | 1 | 35600 |
| P40 | KENNETH R. ELLINWOOD | DRYDEN | J | 0 | 2 | 0 |
| P41 | NEWFIELD HIGHWAY DEPT. | NEWFIELD | F | 2 | 1 | 6000 |
| P42 | SUNOCO #0363-9127 | ITHACA | B | 2 | 1 | 30000 |
| P43 | NORMAN L. CHRISMER | ITHACA | J | 1 | 2 | 550 |
| P44 | AUSTIN PETROLEUM, INC. | FREEVILLE | BC | 2 | 1 | 20000 |
| P45 | MANHEIM'S CONVENIENCE | ITHACA | B | 0 | 2 | 0 |
| P46 | ITHACA SUNOCO | ITHACA | B | 4 | 1 | 28550 |
| P47 | MCGUIRE & BENNETT | ITHACA | | 0 | 2 | 0 |
| P48 | PARTNER MARKET | ITHACA | | 0 | 2 | 0 |
| P49 | L B TOWNSEND DISTR INC | ITHACA | | 0 | 2 | 0 |
| P50 | CORTLAND PAVING COMPANY INC. | LANSING | | 5 | 1 | 3800 |
| P51 | SUNOCO #0363-9119 | ITHACA | B | 2 | 1 | 30000 |
| P52 | XTRA MART #1617-DRYDEN | DRYDEN | B | 4 | 1 | 25000 |
| P53 | SENECA ST. SUPER SERVICE | ITHACA | B | 0 | 2 | 0 |
| P54 | DUTHIE PAINTING CO., INC. | LANSING | L | 0 | 2 | 0 |
| P55 | PAUL MANCINI & SONS, INC. | ITHACA | L | 3 | 1 | 1800 |
| P56 | WATCHTOWER FARMS-KINGDOM FARM | LANSING | I | 3 | 1 | 3000 |
| P57 | TOMPKINS COUNTY HIGHWAY DEPT. | ITHACA | FL | 4 | 1 | 24000 |
| P58 | PYRAMID MALL ITHACA | ITHACA | C | 1 | 2 | 275 |
| P59 | CAYUGA HEIGHTS FIRE DEPT. | ITHACA | F | 0 | 2 | 0 |
| P60 | FEDORKA FARMS | LANSING | I | 2 | 2 | 800 |
| P61 | CRISVALYN FARMS | BERKSHIRE | I | 2 | 1 | 1550 |
| P62 | JOHNNYS WHOLESALE, INC. | ITHACA | L | 1 | 2 | 1000 |
| P63 | TANANA OIL CORP. #416 | ITHACA | BC | 3 | 1 | 36000 |
| P64 | G & L TRUCKING, INC. | LOCKE | F | 1 | 1 | 20000 |
| P65 | BILL'S MOBIL SERVICE | ITHACA | BC | 3 | 1 | 12000 |
| P66 | EXPRESS MART #326 | ITHACA | B | 4 | 1 | 22550 |
| P68 | JUGHEAD'S PIZZA & SUB'S | TRUMANSBURG | | 0 | 2 | 0 |
| P69 | PAY-LO GAS CO. INC. | TRUMANSBURG | B | 3 | 1 | 24000 |
| P70 | THOMPSON LAB | FREEVILLE | HI | 2 | 1 | 1500 |
| P71 | KOHLENBERG AUTO WORKS | LANSING | BC | 5 | 1 | 22000 |
| P72 | STAR ENERGY & PETROLEUM, INC. | ITHACA | AB | 10 | 1 | 89250 |
| P73 | SOUTHSIDE FUEL CO. | ITHACA | | 0 | 2 | 0 |
| P74 | SWARTHOUT COACHES, INC. | ITHACA | F | 1 | 1 | 12000 |
| P75 | DRYDEN CENTRAL SCHOOL DISTRICT | DRYDEN | H | 2 | 1 | 11000 |
| P76 | R.J. WHYTE & SONS | FREEVILLE | B | 3 | 1 | 15000 |
| P77 | MOBIL S/S 08-EGT | ITHACA | B | 4 | 1 | 33000 |
| P78 | MOBIL S/S 08-EHJ | ITHACA | B | 4 | 1 | 30550 |
| P79 | COVERED BRIDGE MARKET | NEWFIELD | | 1 | 2 | 500 |
| P80 | JOHNNY ANTONELLI TIRE CO., INC. | ITHACA | L | 0 | 2 | 0 |
| P81 | SHIPHRAH FARM | GROTON | I | 1 | 1 | 10000 |
| P82 | C & Y CONVENIENCE STORE | LANSING | B | 4 | 1 | 20000 |
| P83 | TOWN OF ENFIELD HIGHWAY GARAGE | ITHACA | L | 4 | 1 | 5150 |
| P84 | BURIN'S SUNOCO | ITHACA | B | 0 | 2 | 0 |
| P85 | MONRO MUFFLER BRAKE, INC. | ITHACA | | 0 | 2 | 0 |
| P86 | HESS STATION #32464 | ITHACA | B | 4 | 1 | 42000 |
| P87 | NYNEX | ITHACA | E | 1 | 1 | 2000 |
| P88 | NYNEX | ITHACA | E | 2 | 1 | 4300 |
| P89 | NEW YORK TELEPHONE | ITHACA | E | 1 | 2 | 1000 |
| P90 | NICE-N-EASY | ITHACA | B | 2 | 1 | 20000 |
| P91 | JOHNSON BOAT YARD | ITHACA | BC | 4 | 1 | 3600 |
| P92 | TOMPKINS SENECA TIOGA BCES | TOMPKINS | | 0 | 2 | 0 |
| P93 | NEW YORK STATE POLICE | ITHACA | L | 1 | 1 | 3000 |
| P94 | ITHACA SHOPPING PLAZA | ITHACA | B | 0 | 2 | 0 |
| P95 | BENJAMIN'S ONE STOP, INC. | ITHACA | B | 5 | 1 | 18000 |
| P96 | HILLARD'S WRECKER & SERVICE | LANSING | | 0 | 2 | 0 |
| P97 | OMNI ELECTRO MOTIVE INC. | NEWFIELD | D | 1 | 1 | 10000 |
| P98 | NICE-N-EASY | JACKSONVILLE | B | 4 | 1 | 16000 |
| P99 | JOHN A. SWITZER | TRUMANSBURG | IJ | 2 | 1 | 1500 |
| P100 | AMERICAN POLYSTEEL FORMS | NEWFIELD | D | 1 | 1 | 10000 |
| P101 | PAOLANGELI CONTRACTOR | ITHACA | F | 3 | 1 | 2550 |
| P102 | MAGUIRE FORD LINCOLN-MERCURY | ITHACA | | 0 | 2 | 0 |
| P103 | VARNA INN & AUTO SERVICE | ITHACA | B | 4 | 1 | 17300 |
| P104 | MIDNIGHT SUN MARKET, INC. | SLATERVILLE | B | 0 | 2 | 0 |
| P105 | NYS ARMORY-DRYDEN | ITHACA | L | 2 | 1 | 6000 |
| P106 | LANSING RESIDENTIAL CENTER | LANSING | L | 6 | 1 | 21600 |
| P107 | MACCORMICK CENTER | BROOKTONDALE | L | 6 | 1 | 17000 |
| P108 | HOWARD JOHNSON | ITHACA | | 0 | 2 | 0 |
| P109 | VALLEY VIEW GROCERY | NEWFIELD | B | 2 | 1 | 17000 |
| P110 | APALACHIN OIL CO. INC. | DRYDEN | | 0 | 3 | 0 |
| P112 | CLOCK AND DECLOUX | ITHACA | A | 0 | 2 | 0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| P113 | BENSVUE FARMS | LANSING | I | 3 | 1 | 12000 |
| P114 | PETR-ALL CORP. | DRYDEN | B | 0 | 2 | 0 |
| P115 | TOWN OF DANBY | ITHACA | L | 3 | 1 | 3275 |
| P116 | CUDLIN'S USED CARS | ITHACA | | 0 | 2 | 0 |
| P117 | ITHACARE CENTER, INC. | ITHACA | L | 0 | 2 | 0 |
| P118 | NEDROW BROS. FARM | LANSING | I | 0 | 2 | 0 |
| P119 | LAKESIDE NURSING HOME, INC. | ITHACA | L | 1 | 1 | 2000 |
| P120 | KING SUB SHOPS | ITHACA | L | 0 | 2 | 0 |
| P121 | AGWAY ENERGY PRODUCTS | FREEVILLE | B | 1 | 1 | 10000 |
| P122 | XTRA MART #1601 - LANSING | LANSING | B | 4 | 1 | 32000 |
| P123 | FORMER LARRY GOW CHEVROLET PROPERTY | TRUMANSBURG | CL | 0 | 2 | 0 |
| P124 | UNITED STATES POSTAL SERVICE | ITHACA | L | 1 | 1 | 8000 |
| P125 | GENEX, INC. | ITHACA | IJ | 3 | 1 | 4500 |
| P126 | XTRA MART #1623 - FREEVILLE | FREEVILLE | B | 4 | 1 | 32000 |
| P127 | SUPERIOR DISPOSAL | NEWFIELD | F | 2 | 1 | 10500 |
| P128 | PLEASANT VIEW M.H.P. | DRYDEN | L | 0 | 2 | 0 |
| P129 | MOR-GAS | NEWFIELD | BC | 0 | 2 | 0 |
| P130 | FALL CREEK ELEMENTARY SCHOOL | ITHACA | H | 0 | 2 | 0 |
| P131 | WEST HILL SCHOOL | ITHACA | H | 0 | 2 | 0 |
| P132 | BELLE SHERMAN ELEMENTARY SCHOOL | ITHACA | H | 0 | 2 | 0 |
| P133 | DANBY | ITHACA | H | 0 | 2 | 0 |
| P134 | MARVIN J. FREEDMAN | ITHACA | D | 0 | 2 | 0 |
| P135 | VALLEY KORNER'S STORE | ITHACA | B | 3 | 1 | 15500 |
| P136 | ST. PAUL'S UNITED METHODIST CHURCH | ITHACA | L | 0 | 2 | 0 |
| P137 | TOMPKINS-SENECA-TIOGA BOCES | ITHACA | H | 3 | 1 | 1550 |
| P138 | WILLIAM T. PRITCHARD, INC. | ITHACA | C | 1 | 4 | 500 |
| P140 | KENDAL AT ITHACA | ITHACA | G | 2 | 1 | 5000 |
| P141 | PETE'S GROCERY | ITHACA | BC | 2 | 1 | 20000 |
| P142 | TOMPKINS COUNTY PUBLIC SAFETY BUILDING | ITHACA | L | 2 | 1 | 5000 |
| P143 | BIG AL'S GET-N-GO | FREEVILLE | B | 4 | 1 | 27000 |
| P144 | VILLAGE OF CAYUGA HEIGHTS DPW | ITHACA | L | 2 | 1 | 2000 |
| P145 | CORTLAND TIRE SERVICE, INC. | ITHACA | C | 2 | 4 | 550 |
| P146 | MONRO MUFFLER/BRAKE #16 | ITHACA | C | 0 | 2 | 0 |
| P148 | SUNNY'S CONVENIENCE STORE | ITHACA | BC | 2 | 1 | 15000 |
| P149 | RESEARCH PARK BLDG 1 | ITHACA | | 0 | 2 | 0 |
| P150 | EAST HILL FLYING CLUB | ITHACA | HL | 0 | 2 | 0 |
| P151 | H.H. LOVE FIELD BLDG | ITHACA | | 0 | 2 | 0 |
| P152 | CALDWELL FIELD | ITHACA | HI | 3 | 1 | 2285 |
| P153 | GLENN STRAUF | GROTON | | 0 | 2 | 0 |
| P154 | UNITED PARCEL SERVICE | LANSING | F | 3 | 1 | 10550 |
| P155 | POULTRY BLDG. EAST & WEST | ITHACA | HI | 0 | 2 | 0 |
| P156 | REYNOLDS GAME FARM | ITHACA | | 2 | 2 | 850 |
| P157 | AGWAY ENERGY PRODUCTS | MCLEAN | | 0 | 2 | 0 |
| P158 | MT. PLEASANT AGRONOMY COMPLEX | ITHACA | HI | 2 | 1 | 1500 |
| P159 | MAINTENANCE BUILDING | DRYDEN | H | 0 | 2 | 0 |
| P160 | RMS GRAVEL | DRYDEN | L | 6 | 1 | 17050 |
| P161 | SAUNDERS CONCRETE CO. | DRYDEN | F | 2 | 1 | 25000 |
| P162 | BENCHMARK NEW YORK - SOUTH LANSING | LANSING | L | 6 | 1 | 19325 |
| P163 | CAYUGA CRUSHED STONE INC. | LANSING | D | 6 | 1 | 21550 |
| P164 | NYS DOT | ITHACA | | 4 | 1 | 3050 |
| P165 | HANCOCK PLAZA PROPERTY | ITHACA | | 0 | 2 | 0 |
| P170 | MONTEZUMA NATIONAL WILDLIFE REFUGE | SENECA FALLS | L | 3 | 1 | 3000 |
| P171 | NEW YORK CHIROPRACTIC COLLEGE | SENECA FALLS | H | 0 | 2 | 0 |
| P175 | MOBIL S/S 08-P5E | INTERLAKEN | | 0 | 2 | 0 |
| P181 | COVERT FARMS | ROMULUS | | 0 | 2 | 0 |
| P185 | RICHARD COMPTON FARM | OVID | I | 3 | 1 | 3100 |
| P187 | SUNRISE FOOD STORE #16 | OVID | B | 4 | 1 | 26000 |
| P188 | INTERLAKEN AUTO SERVICE | INTERLAKEN | B | 3 | 1 | 12275 |
| P201 | U.S.BULK TRANSPORT,INC - MAXAM TRUCKING | INTERLAKEN | F | 2 | 1 | 12275 |
| P207 | CULVER FARMS INC | TRUMANSBURG | I | 1 | 2 | 800 |
| P219 | CORNELL T&R CENTER | DRYDEN | HI | 6 | 1 | 4945 |
| P236 | TUNISON LABORATORY | CORTLAND | L | 0 | 2 | 0 |
| P258 | CORTLAND WOOD PRODUCTS | CORTLAND | D | 2 | 1 | 12000 |
| P291 | JAMES COUNTRY CORNERS | GENOA | B | 2 | 1 | 20000 |
| P293 | TOWN OF VENICE | VENICE CENTER | L | 4 | 1 | 13350 |
| P294 | JOHN BERRY | GENOA | I | 1 | 1 | 10000 |
| P297 | FESSENDEN FARMS | KING FERRY | I | 3 | 1 | 2000 |
| P298 | DAVID B. WHITE (FARM) | SCIPIO CENTER | IJ | 1 | 2 | 300 |
| P299 | OSTERHOUDT FARMS | GENOA | I | 9 | 1 | 12830 |
| P300 | VENICE VIEW DAIRY INC. | VENICE CENTER | I | 4 | 1 | 12500 |
| P301 | CLEARVIEW FARM | GENOA | I | 0 | 2 | 0 |
| P302 | WALLCOURT | AURORA | | 0 | 2 | 0 |
| P303 | CAYUGA COUNTY HIGHWAY DEPT.(VENICE) | VENICE CENTER | F | 1 | 1 | 10000 |
| P304 | VENICE ENTERPRISE, INC. | VENICE CENTER | F | 1 | 1 | 10000 |
| P305 | GREENHILL FARMS | SCIPIO CENTER | I | 1 | 1 | 10000 |
| P306 | LEDYARD HIGHWAY DEPARTMENT | AURORA | L | 1 | 1 | 4000 |
| P307 | TOWN OF SCIPIO | SCIPIO CENTER | L | 2 | 1 | 8500 |
| P310 | WELLS COLLEGE | AURORA | H | 8 | 1 | 69300 |
| P311 | AURORA RESEARCH FARM | AURORA | HI | 2 | 1 | 2000 |
| P312 | HUNT'S SERVICE STATION | POPLAR RIDGE | BC | 2 | 1 | 2000 |
| P313 | SCIPEVILLE GARAGE | SCIPIO CENTER | | 2 | 1 | 1550 |
| P314 | WILCOX GENERAL STORE | KING FERRY | B | 2 | 1 | 5000 |
| P315 | AGWAY ENERGY PRODUCTS | KING FERRY | B | 0 | 2 | 0 |
| P316 | TOWN OF GENOA HIGHWAY DEPT. | GENOA | L | 1 | 2 | 1000 |
| P317 | AGWAY ENERGY PRODUCTS | AURORA | B | 0 | 2 | 0 |
| P319 | AURORA INN | AURORA | L | 1 | 1 | 2000 |
| P320 | JOHN DUNKLE | KING FERRY | I | 1 | 1 | 10000 |
| P321 | GARY M WHITTEN | SCIPIO CENTER | | 0 | 2 | 0 |
| P322 | AGWAY ENERGY PRODUCTS | CAYUGA | | 0 | 2 | 0 |

Site Status
1-Active
2-Inactive

Site Type
A- Storage Terminal/Petroleum Distributor
B-Retail Gasoline Sales
C-Other Retail
D-Manufacturing
E-Utility
F-Trucking/Transportation
G-Apartment Building
H-School
I-Farm
J-Private Residence
K-Airline
L-Other

Source: Adapted from NYSDEC

### 3.6 Underground and Above Ground Storage Tanks

Chemical and petroleum products held in storage tanks pose a significant threat to water quality. USEPA estimates that approximately one-third of all existing tanks nationwide are leaking (USEPA 1987). The average expected life span of steel tanks in acidic soils is approximately 15 years. At this point, corrosion may result in pinhole leaks that may discharge hundreds of gallons of fuel over several months. These leakage rates are small enough to go unnoticed to the tank owner, but are large enough to cause significant contamination problems.
Leaking underground storage tanks (USTs) (see Section 3.8 Hazardous Spills) can be significant sources of oil, fuel, and volatile organic compound (VOC) contamination. These contaminants may move into surface-water resources with groundwater flow. However, many of these compounds are volatile and will evaporate from the surface water system. The problems generated by leaky USTs are numerous. They include contamination of public and private drinking water wells, explosions and fires, and plume migration toward surface water bodies.

In the Cayuga Lake Watershed there are over 340 registered storage tanks sites containing petroleum and chemicals. As Map 3.6.1 indicates these are fairly well dispersed throughout the watershed, with a higher density in the population centers, especially at the southern end of the lake. Of the 340 registered sites, there are approximately 320 registered bulk petroleum sites with 650 tanks (see Table 3.6.3). One hundred eighty sites are active. Approximately 80 of the registered bulk petroleum storage tank sites are gasoline stations (see Section 3.10), 20 are manufacturing sites (see Section 3.9), 25 are school sites (see Section 3.11), and 25 are farm sites. Of the 164 farms surveyed in the Six Mile (Tompkins County S&WCD) and the Fall Creek (Mussell) subwatersheds, 40% (65) had either above ground or below ground petroleum storage tanks (see Table 3.12.1. There are over 15 chemical bulk storage sites in the watershed with 33 active tanks (see Table 3.6.2). Four of these are manufacturing sites, three are utilities,four are municipalities, and two are schools.

### 3.7 Hazardous Materials

Any land use that results in the generation, use, or storage of materials classified as hazardous may be a source of inorganic contamination to ground and surface water. Hazardous materials are classified as substances that pose a danger to living organisms, materials, structures, or the environment by explosion or fire hazards, corrosion, toxicity to organisms, or detrimental effects. Large-scale hazardous materials use and waste storage is regulated by federal, state, and local statute, but household use of small amounts of hazardous materials is rarely adequately regulated (see Table 3.13.1 Potentially Harmful Components of Common Household Products). Small-scale users may accidentally introduce contaminants to groundwater and surface water. There are many types of hazardous substances, often consisting of mixtures of more than one substance. These include the following:

**Table 3.7.1**
**Inactive Hazardous Waste Sites**

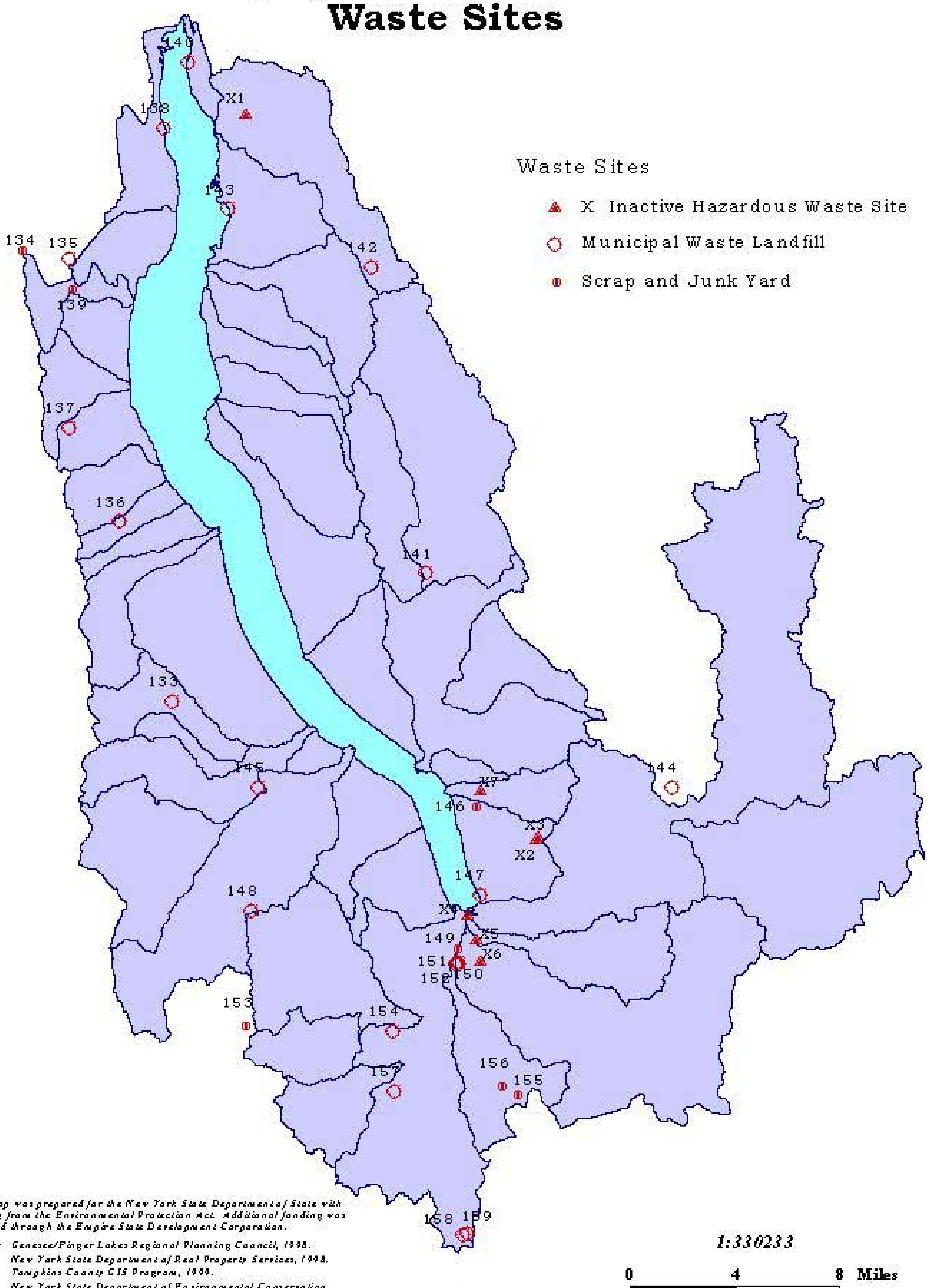
| Map Label | Site Name | S Class |
|---|---|---|
| X1 | Town Line Road Dump Site | 2a |
| X2 | Cornell Univ.-Radioactive Disposal Site | 3 |
| X3 | Cornell University; Chemical Disposal | 2 |
| X4 | City of Ithaca Fire Training School | D2 |
| X5 | NYSEG; Ithaca Court Street Coal Gas | 2 |
| X6 | Morse Industrial Corporation | 4 |
| X7 | Colonial Cleaners | 2 |
| X8 | Evans Chemetics, Div. of Hampshire Chem. | 2a |
| X9 | Evans Chemetics; Brewer Road Site | 4 |
| X10 | Gould Pumps Engineered Products Division | 4 |
| X11 | Tantalo Landfill | 2 |
| X12 | Sampson State Park | 2a |
| X13 | Seneca Army Depot | 2 |
| X14 | R.L. Sessler Scavenger Waste Disposal | 3 |
| X15 | NYSEG - Geneva Coal Gas (Former) | 2 |
| X16 | Seneca Meadows Landfill | 4 |

S Class
- 2 Significant threat to the public health or environment - action required
- 2a This temporary classification has been assigned to sites where there is confirmed disposal of a hazardous waste but for which there is inadequate data on hazardous waste impact to the environment and human health to assign them to the five classifications specified by law.
- 3 Does not present a significant threat to the environment or public health - action may be deferred
- 4 Site properly closed requires continued management
- D Delisted

Source: NYSDEC Inactive Hazardous Waste Sites

Explosives
Compressed gases
Flammable liquids
Flammable solids that burn readily, are water-reactive, or spontaneously combustible
Oxidizing materials that supply oxygen for the combustion of normally nonflammable materials
Corrosive materials, which may injure exposed flesh or cause disintegration of metal containers
Poisonous materials
Etiologic agents
Radioactive materials

# Cayuga Lake Watershed Waste Sites




This map was prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.

Source: Genesee/Finger Lakes Regional Planning Council, 1998.
New York State Department of Real Property Services, 1998.
Tompkins County GIS Program, 1999.
New York State Department of Environmental Conservation, Director of Hazardous Waste Remediation, 1999.

Base Map: New York State Department of Transportation, February 1996.

Prepared by Genesee/Finger Lakes Regional Planning Council, 1999.

There are several inactive hazardous waste sites in the watershed. As Map 3.7.1 and Table 3.7.2 indicate, most of these are along the southern end of the lake.

**3.8 Hazardous Spills**

Hazardous spills can occur in a number of ways including leaking underground storage tanks, materials transfer, and materials transport. If an underground storage tank develops a leak, which commonly occurs as the tank ages and corrodes, chemicals can migrate through the soil and reach groundwater, and in many cases, ultimately the surface water. Newer tanks are more corrosion-resistant, but they are not foolproof. Abandoned underground tanks pose another problem because their location often is unknown. Above ground storage tanks can also pose a threat if a spill or leak occurs and adequate barriers are not in place. Improper chemical storage, insufficient materials handling, and poor quality containers can be major threats to ground and surface water. Tanker trucks and train cars pose another chemical storage hazard.

Table 3.8.1 lists twelve categories of spills as follows: gasoline stations (see Section 3.10), passenger vehicle, commercial vehicle, tank truck, private dwelling (see Section 3.13), vessel, railroad car (see Section 3.9), non major facility > 1,100 gallons spilled, major facility > 400,000 gallons spilled, other commercial/industrial, other noncommercial/industrial, and unknown. It lists five potential resources affected as follows: on land, in sewer, groundwater, surface water, and air. Generally, surface water will ultimately be affected by all of these.

In the Cayuga Lake Watershed most spills have occurred in the southern portion, although there are many occurrences of spills throughout the watershed (see Map 3.8.1). Generally, with hazardous spills, it is important to consider the resource affected and the type of spill. Of the approximately 550 reported hazardous spills in the watershed in the last 15 years, 360 were on land, 15 in sewers, 105 into groundwater, 60 directly into surface water, and 10 into the air. Of the total spills in the watershed approximately 30 were at gasoline stations, one was major facility related, 7 were non-major facility related, 140 were other commercial/industrial related, 105 other noncommercial/industrial related, 10 were passenger vehicle related, 50 were commercial vehicle related, 20 tank truck related, 105 were at private dwellings, 2 were vessel related, and 80 were unknown (see Table 3.8.1) (NYSDEC).

**3.9 Industrial Sources**

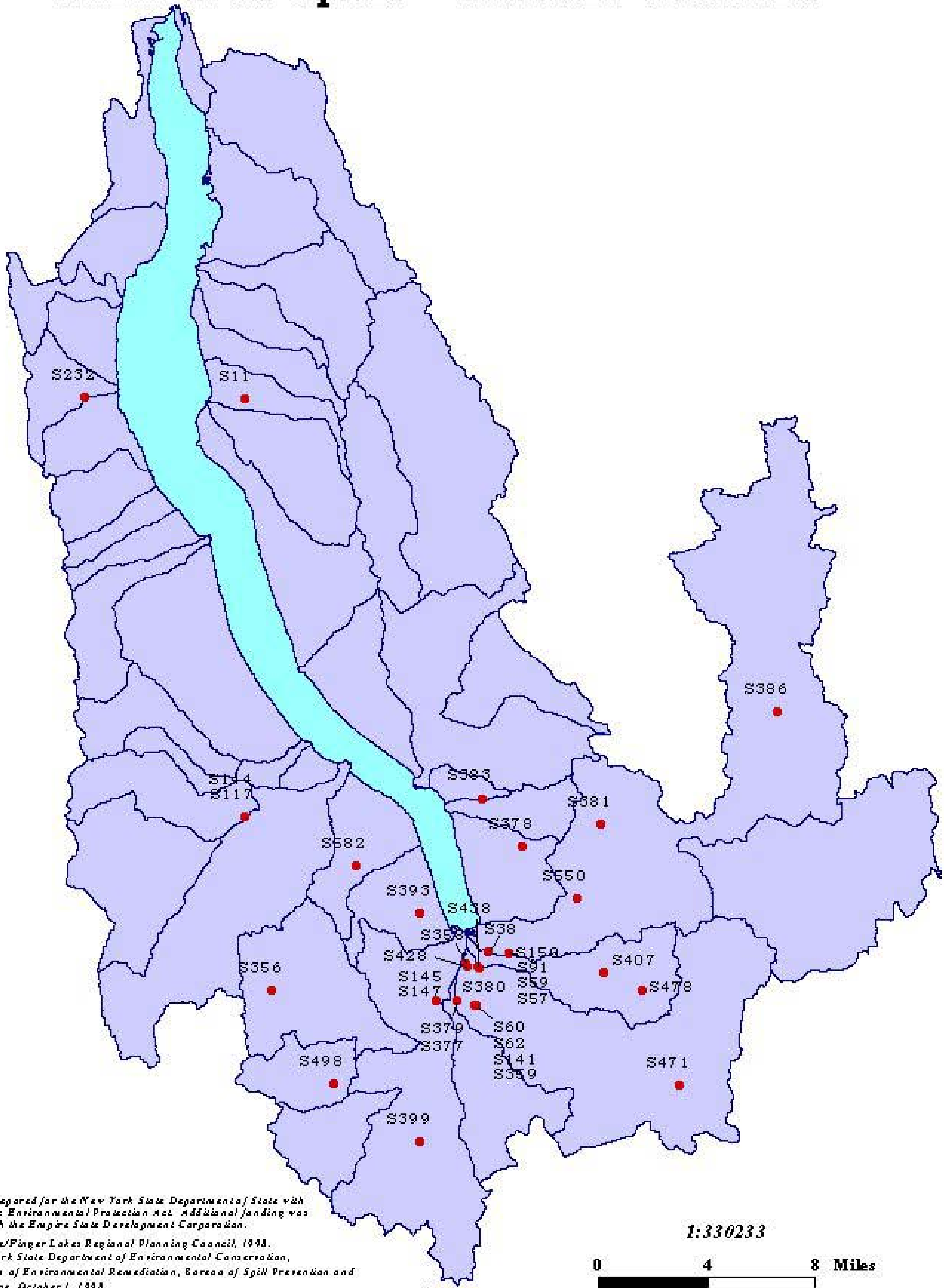
There are over 600 industrial operations in the watershed. The categories of industrial sources include general industrial, industrial pipeline, material stockpiles, mining operations, transport and transfer stations, and well drilling operations. As Map 3.9.1 indicates, other than wells and well drilling operations, most of the industrial operations are located in the southern portion of the watershed. Potential sources of contamination from industrial sources in the Cayuga Lake Watershed include the following categories:

*Material stockpiles* such as coal, metallic ores, phosphates and gypsum can include acid drainage and other hazardous and nonhazardous wastes. Based on NYSDEC information there is one materials stockpile operation in the watershed in Dryden.

*Transport and transfer stations* (trucking terminals and rail yards) include fuel tanks, repair shop wastes (see Automotive Repair), and other hazardous and nonhazardous wastes. There are over 130 of these operations in the watershed, most of which are storage warehouse and distribution operations. This category of industrial operation is fairly well dispersed throughout the region, with a good number of establishments on the northern, eastern and western portions of the watershed, even though the majority of them are in the southern portion of the watershed.

*Wells* – including operating and abandoned production and exploratory wells and dry wells
These can include the following contaminants: petroleum, brine (sulfates and chloride), metals, acids, minerals, sulfides, and other hazardous and nonhazardous chemicals. Poorly constructed wells can allow brackish water from lower formations to leak upward around the well casing into potable aquifers. Leaky production wells can allow oil to enter groundwater directly or through infiltration from the surface. Often wells are not properly capped, which can allow pollution from surface runoff or aquifer interconnection to contaminate drinking water aquifers and surface waters. Dry wells collect stormwater runoff and spilled liquids and are used for disposal. These wells sometimes contain contaminants such as used oil and antifreeze that may discharge into the water supply.

# Cayuga Lake Watershed
# Hazardous Spills - Gasoline Stations




This map was prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.

Source: Genesee/Finger Lakes Regional Planning Council, 1998.
New York State Department of Environmental Conservation, Division of Environmental Remediation, Bureau of Spill Prevention and Response, October 1, 1998.

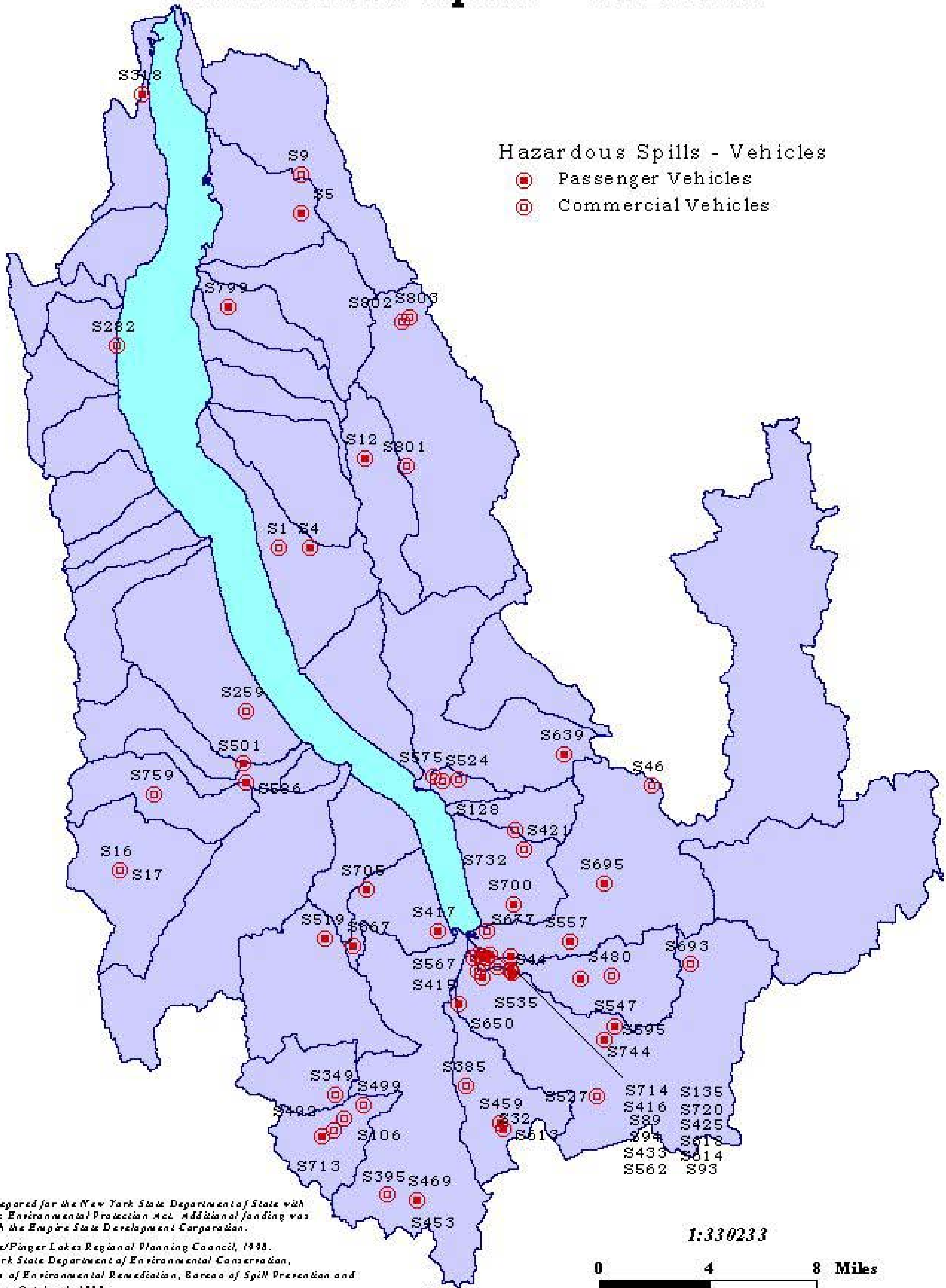
Base Map: New York State Department of Transportation, February 1996.

1:330233

0 4 8 Miles

Prepared by Genesee/Finger Lakes Regional Planning Council, 1999.

# Cayuga Lake Watershed Hazardous Spills - Vehicles



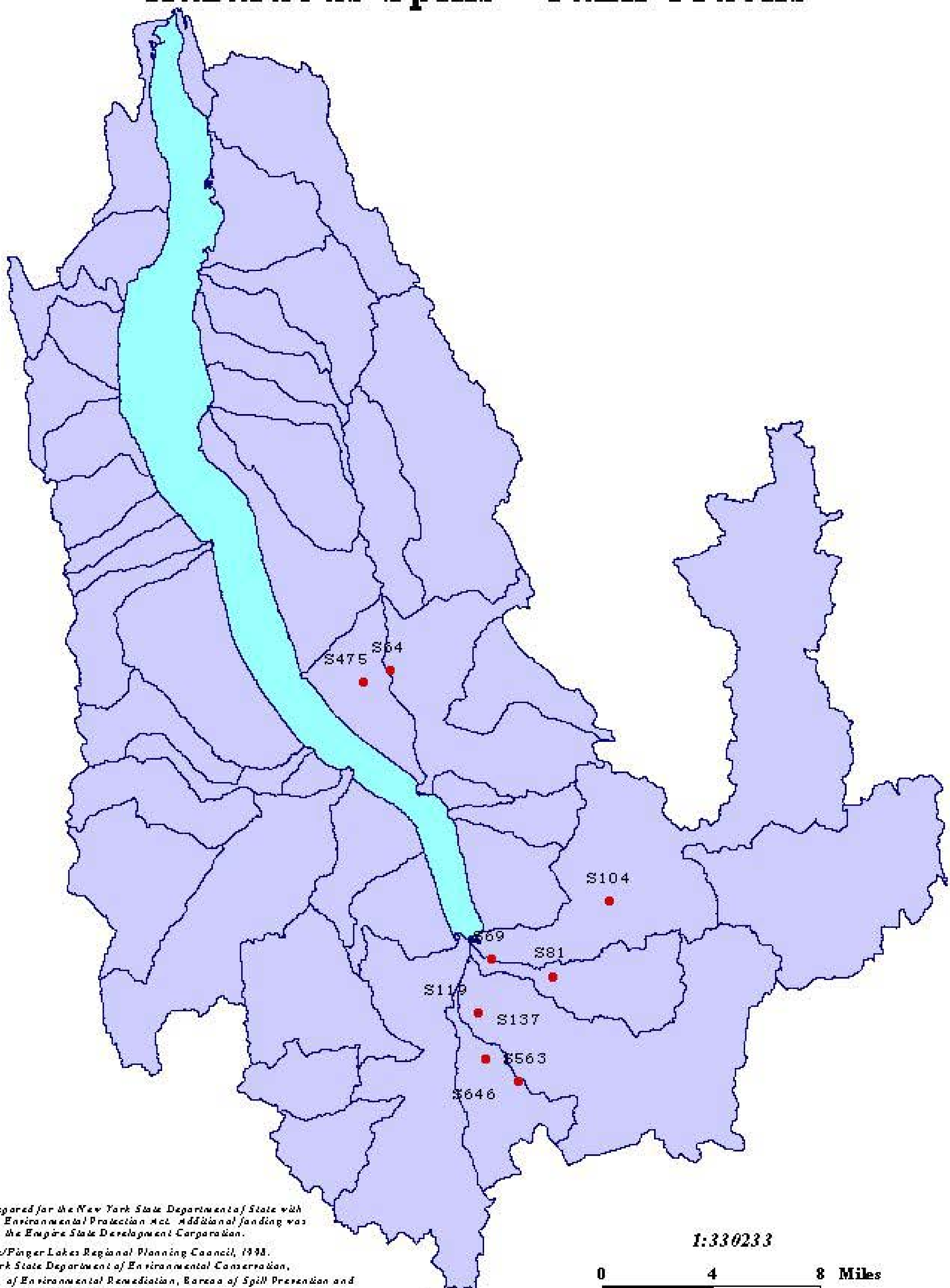

This map was prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.

Source: Genesee/Finger Lakes Regional Planning Council, 1998.
New York State Department of Environmental Conservation, Division of Environmental Remediation, Bureau of Spill Prevention and Response, October 1, 1998.

Base Map: New York State Department of Transportation, February 1996.

Prepared by Genesee/Finger Lakes Regional Planning Council, 1999.

# Cayuga Lake Watershed
# Hazardous Spills - Tank Trucks



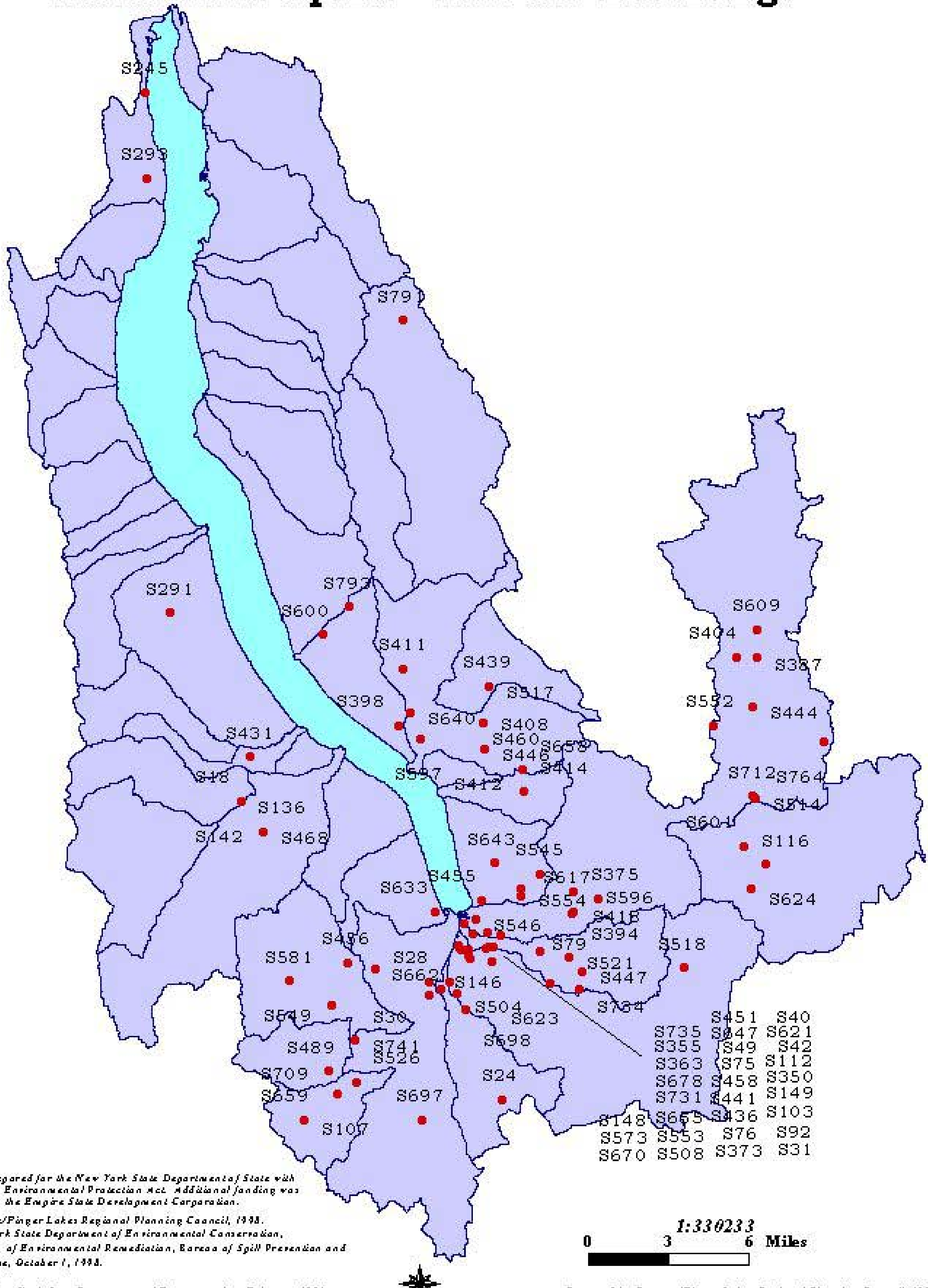

*This map was prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.*

*Source: Genesee/Finger Lakes Regional Planning Council, 1998.*
*New York State Department of Environmental Conservation, Division of Environmental Remediation, Bureau of Spill Prevention and Response, October 1, 1998.*

*Base Map: New York State Department of Transportation, February 1996.*

*Prepared by Genesee/Finger Lakes Regional Planning Council, 1999.*

# Cayuga Lake Watershed
# Hazardous Spills - Private Dwellings

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Source: Genesee/Finger Lakes Regional Planning Council, 1998.
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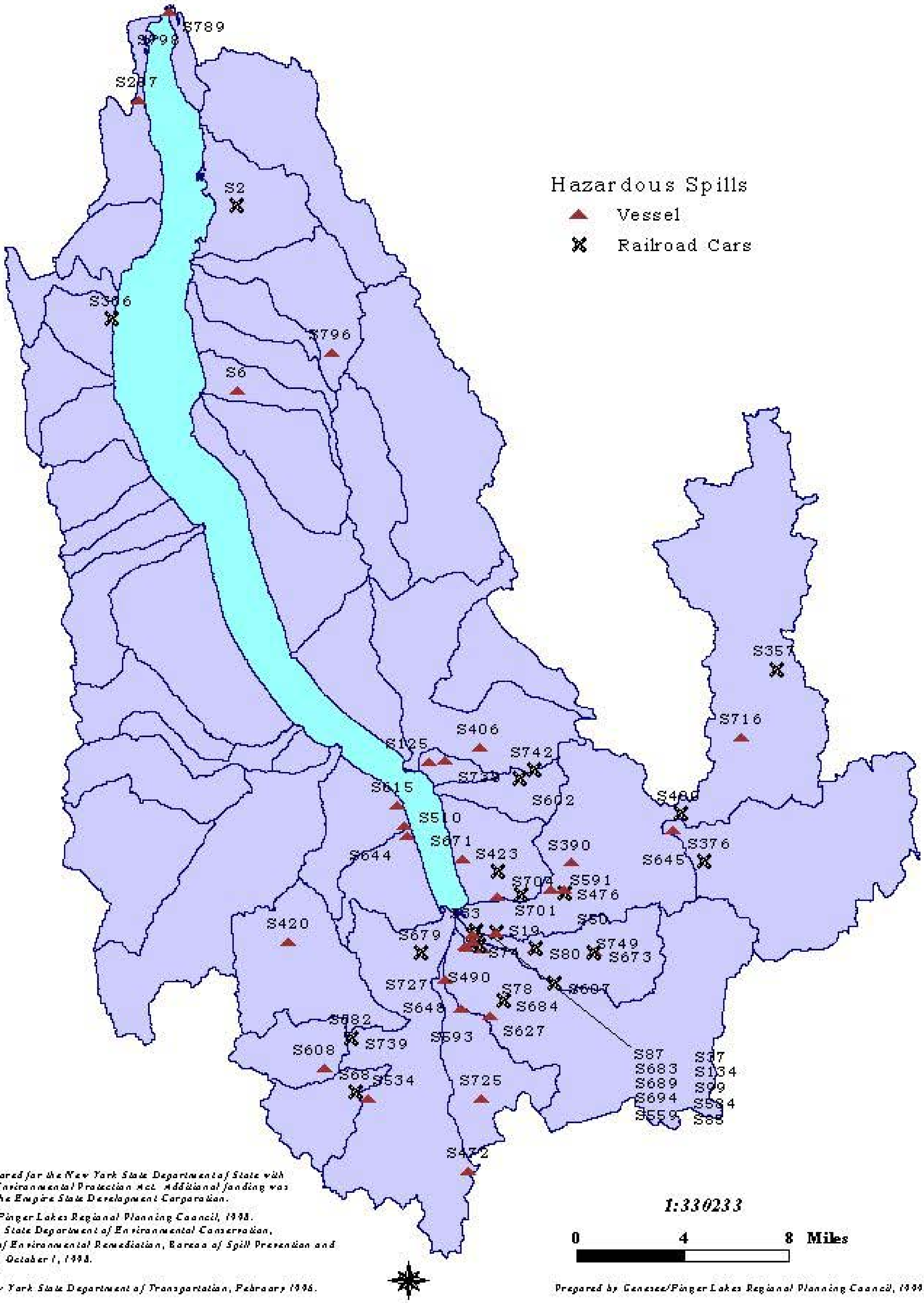
Base Map: New York State Department of Transportation, February 1996.

Prepared by Genesee/Finger Lakes Regional Planning Council, 1999.

# Cayuga Lake Watershed
# Hazardous Spills - Vessels and Railroad Cars



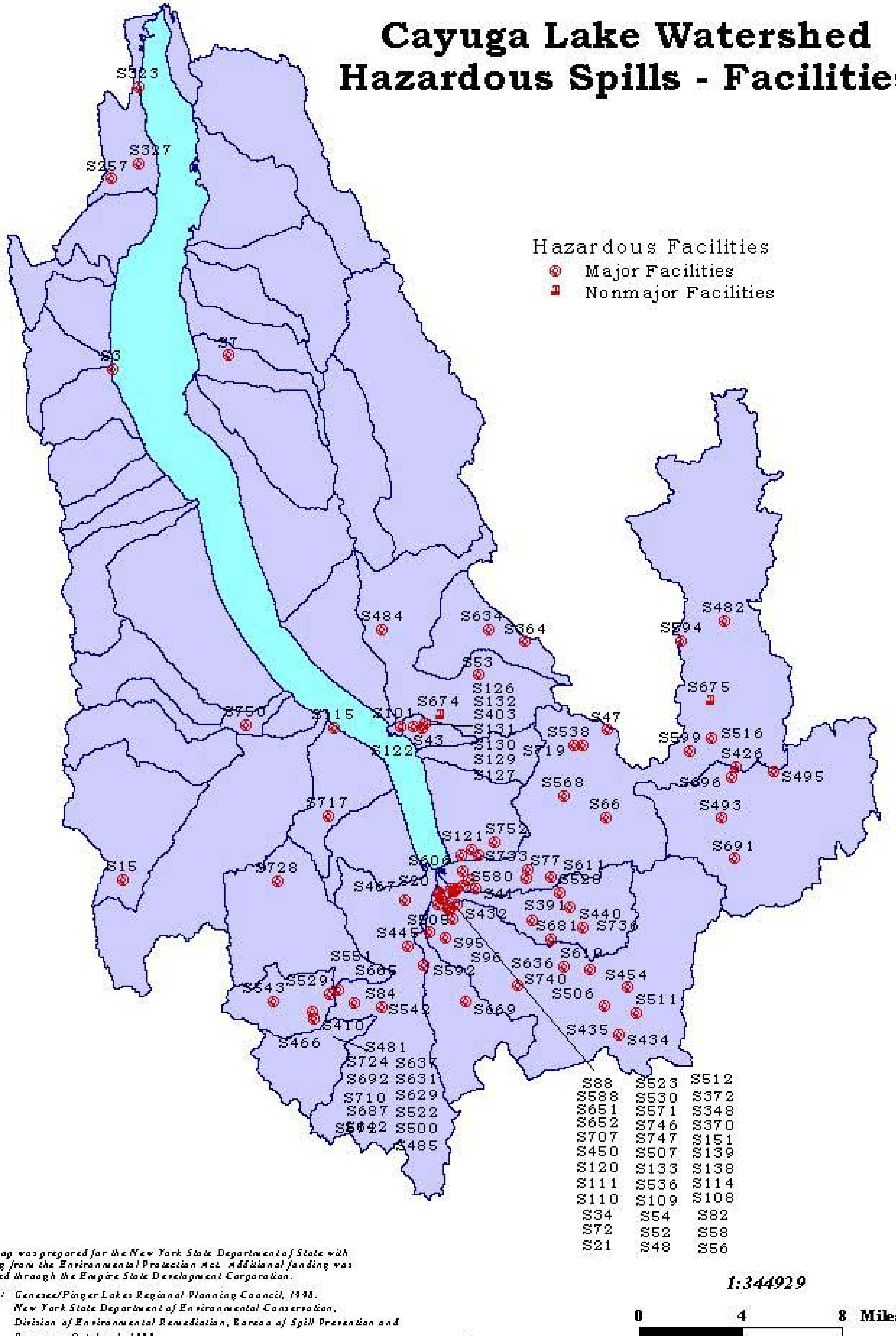

*This map was prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.*

*Source: Genesee/Finger Lakes Regional Planning Council, 1998.*
*New York State Department of Environmental Conservation, Division of Environmental Remediation, Bureau of Spill Prevention and Response, October 1, 1998.*

*Base Map: New York State Department of Transportation, February 1996.*

*Prepared by Genesee/Finger Lakes Regional Planning Council, 1999.*

# Cayuga Lake Watershed
# Hazardous Spills - Facilities

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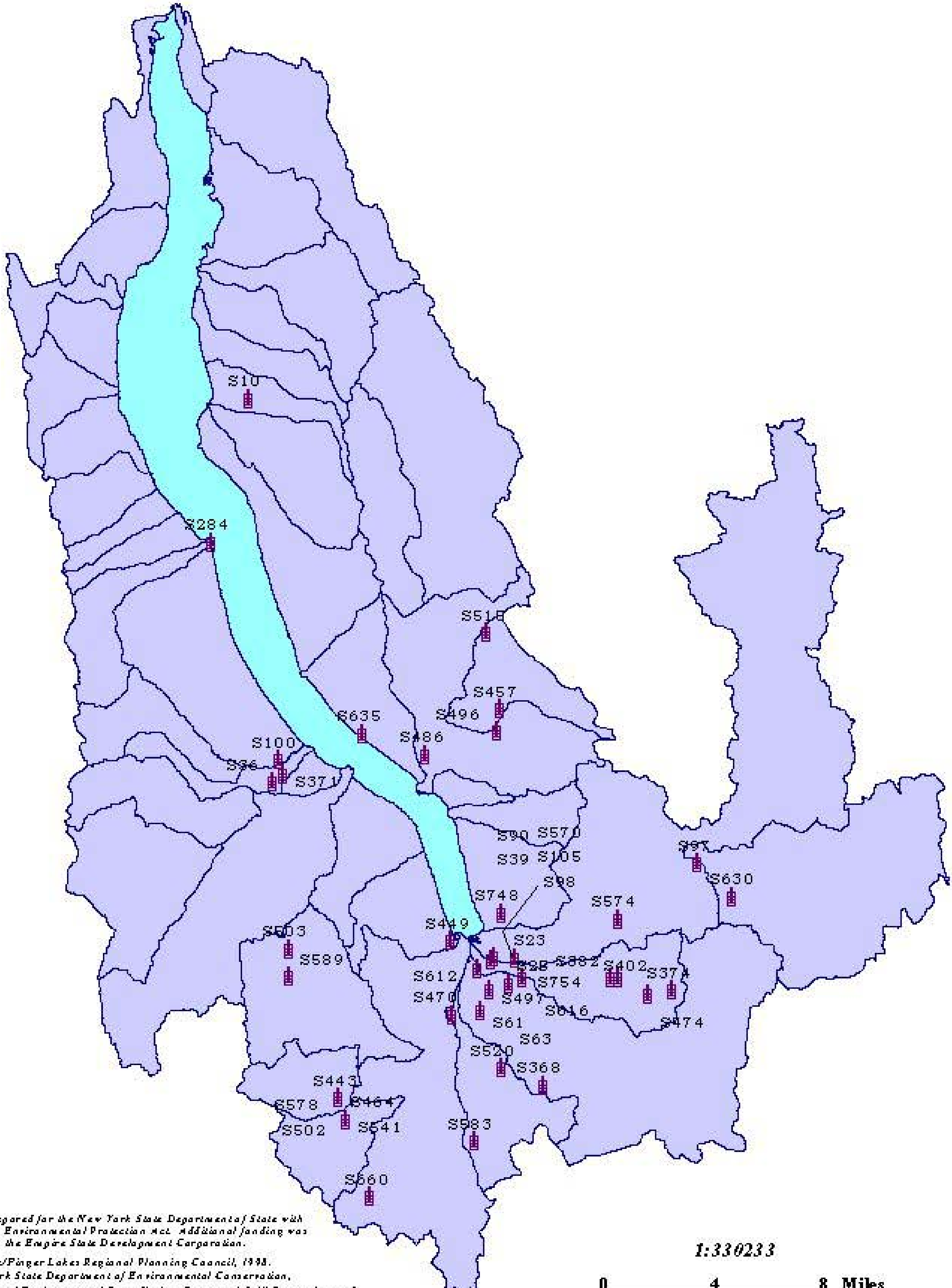
*Source: Genesee/Finger Lakes Regional Planning Council, 1998.*
*New York State Department of Environmental Conservation, Division of Environmental Remediation, Bureau of Spill Prevention and Response, October 1, 1998.*

*Base Map: New York State Department of Transportation, February 1996.*

*Prepared by Genesee/Finger Lakes Regional Planning Council, 1999.*

# Cayuga Lake Watershed
# Hazardous Spills - Other Commercial/Industrial

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*Source: Genesee/Finger Lakes Regional Planning Council, 1998.*
*New York State Department of Environmental Conservation,*
*Division of Environmental Remediation, Bureau of Spill Prevention and Response, October 1, 1998.*

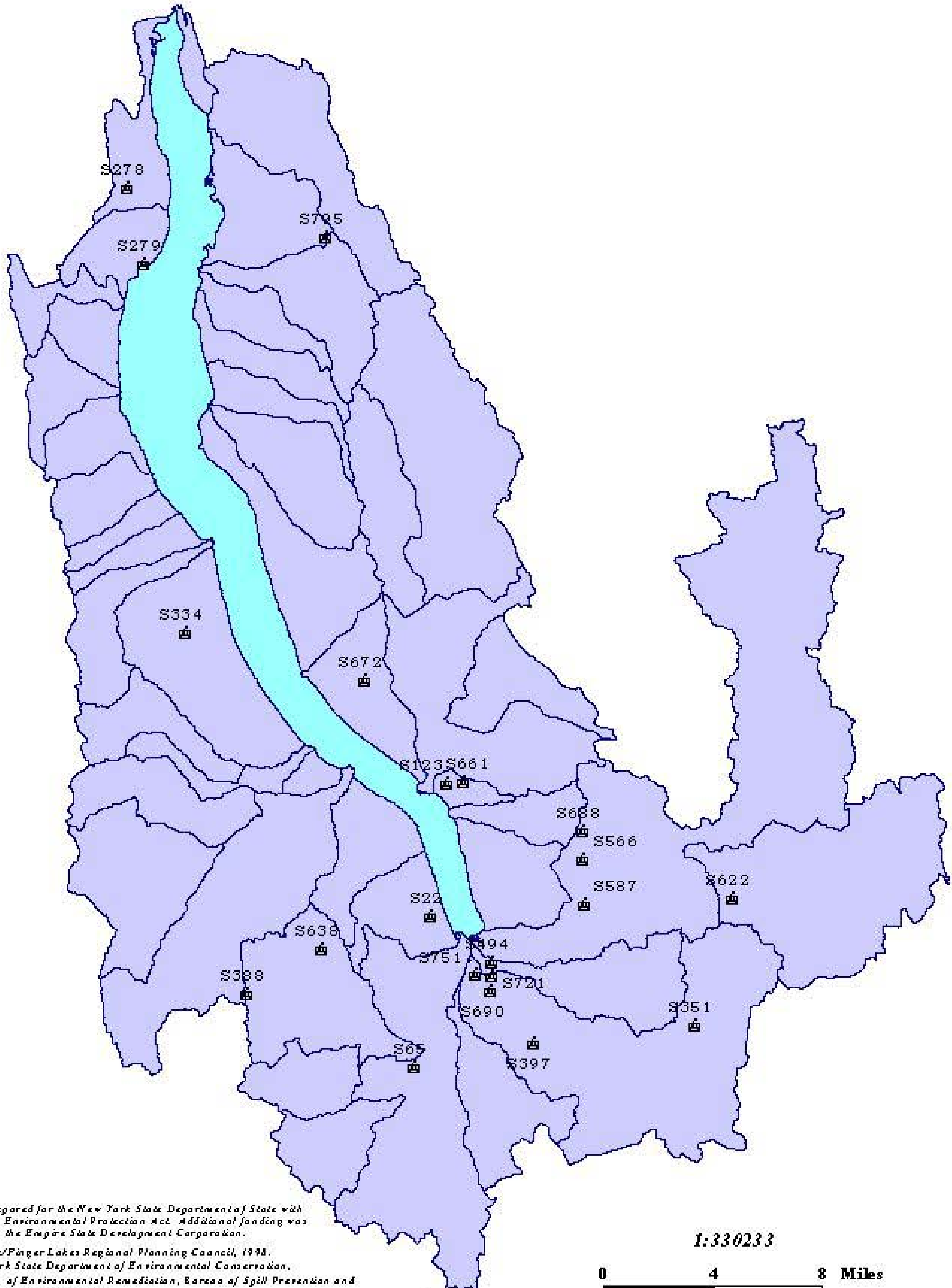
*1:330233*

0 4 8 Miles

*Base Map: New York State Department of Transportation, February 1996.*

*Prepared by Genesee/Finger Lakes Regional Planning Council, 1999.*

# Cayuga Lake Watershed
# Hazardous Spills - Other Non-Commercial/Industrial

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*New York State Department of Environmental Conservation, Division of Environmental Remediation, Bureau of Spill Prevention and Response, October 1, 1998.*

*Base Map: New York State Department of Transportation, February 1996.*

*Prepared by Genesee/Finger Lakes Regional Planning Council, 1999.*

**Table 3.8.1**
**Hazardous Spills**

| Map Id | Spill Date | Spill Name | Spill Street | Spill Municipality | Resource Effected | Waterbody | Spill Source |
|---|---|---|---|---|---|---|---|
| S1 | 3/5/93 | CLEAR VIEW ROAD | CLEARVIEW ROAD | KINGS FERRY | 1 | CAYUGA LAKE | 09 |
| S2 | 9/18/90 | SHRIMPTON'S TRAILER PARK | GROVE ST. | UNION SPRINGS | 1 | | 02 |
| S3 | 9/22/94 | WELLS COLLEGE | MAIN STREET | AURORA | 1 | CAYUGA LAKE | 02 |
| S4 | 4/23/92 | ITHACA GUN CO | RT 34 B | KING FERRY | 1 | | 01 |
| S5 | 10/14/94 | GILLESPIE CHEVROLET | RT 90 | UNION SPRINGS | 1 | | 01 |
| S6 | 11/16/95 | WELLS COLLEGE | RT 90 | AURORA | 1 | | 01 |
| S7 | 12/30/91 | RAFFERTY RESIDENCE | SHERWOOD RD | AURORA | 1 | | 08 |
| S8 | 8/22/95 | UNION SPRINGS ACADEMY | SPRING STREET | UNION SPRINGS | 1 | | 12 |
| S9 | 10/2/98 | WALDRON RD/POWERS RD | WALDRON RD/POWERS RD | SPRING PORT | 3 | | 07 |
| S10 | 9/25/87 | WELLS COLLEGE GOLF CRS. | WELLS COLLEGE GOLF COURSE | AURORA | 4 | | 01 |
| S11 | 4/27/93 | WELLS COLLEGE | WELLS COLLEGE ROUTE 90 | AURORA | 1 | | 02 |
| S12 | 10/29/93 | WEST COREY/COOK | WEST COREY/COOK RD | VENICE CENTER | 4 | LITTLE SALMON CREEK | 01 |
| S15 | 4/15/96 | BERGEN (JAMES) FARM | BERGEN ROAD | HECTOR | 1 | | 09 |
| S16 | 3/1/92 | FINGERLAKES NAT'L FOREST | CHICKEN COOP ROAD | HECTOR | 1 | | 12 |
| S17 | 6/1/91 | WILDLIFE PONDS | NAT'L FINGER LAKES FOREST | HECTOR | 4 | WILDLIFE POND | 12 |
| S18 | 4/7/88 | TAUGHANNOCK STATE PARK | ADMIN HQ BLDG. | TRUMANSBURG | 3 | | 02 |
| S19 | 5/23/88 | CORNELL | AGRONOMY COMPLEX MINEAH.R | ITHACA | 3 | | 02 |
| S20 | 3/18/94 | AGWAY RT 13 | AGWAY ENERGY PRODUCTS | ITHACA | 1 | | 01 |
| S21 | 11/23/87 | TOMPKINS CO. AIRPORT | AIR CARRIER RAMP | ITHACA | 1 | | 01 |
| S22 | 8/28/98 | HAYTS RD | AND RT.96 | ITHACA | 1 | | 07 |
| S23 | 4/21/94 | CORNELL-LIQUID NITROGEN | BAKER INSTITUTE-CORNELL | ITHACA | 5 | | 02 |
| S24 | 1/15/90 | T/DANBY HWY DEPT | BALD HILL RD | T/DANBY | 3 | | 02 |
| S25 | 8/12/94 | BEBEE LAKE - CORNELL UNIV | BEBEE LAKE - THURSTON AVE | ITHACA | 4 | BEBEE LAKE | 01 |
| S26 | 6/29/93 | BEEBEE LAKE -CORNELL | BEEBEE LAKE CORNELL CAMPU | ITHACA | 4 | BEEBEE LAKE | 12 |
| S27 | 6/12/87 | BOCES; ITHACA | BOCES; WARREN ROAD | ITHACA | 4 | STREAM | 02 |
| S28 | 10/3/87 | TOMPKINS CO. HWY. GARAGE | BOST ROAD. | ITHACA | 3 | | 02 |
| S29 | 12/2/97 | ITHACA TRANSPORTATION GA | BOSTICK RD | ITHACA | 1 | | 02 |
| S30 | 9/28/87 | TOMPKS CO. HIGHWAY GAR. | BOSTWICK ROAD | ITHACA | 3 | | 02 |
| S31 | 10/18/94 | CORNELL-RESEARCH PARK | BROWN RD. | ITHACA | 3 | | 01 |
| S32 | 1/27/93 | TOMPKINS CO. AIRPORT | BROWN RD.(CO. AIRPORT) | LANSING | 4 | | 01 |
| S33 | 11/8/93 | TOMPKINS COUNTY AIRPORT | BROWN RD.-NEAR T-AVIATION | LANSING | 2 | | 12 |
| S34 | 5/12/94 | BROWN ROAD | BROWN ROAD | LANSING | 1 | | 07 |
| S35 | 9/7/93 | BUFFALO AND MEADOW ST. | BUFFALO AND MEADOW ST. | ITHACA | 2 | | 07 |
| S36 | 10/18/89 | TRUMANSBURG CENT. SCHOOLS | BUS GARAGE | TRUMANSBURG | 1 | | 02 |
| S37 | 5/4/92 | CORNELL U. BUS GARAGE | BUS GARAGE-RT.366-CORNELL | ITHACA | 1 | | 02 |
| S38 | 8/22/91 | BUTTERMILK FALLS | BUTTERMILK FALLS - RT.13 | ITHACA | 1 | | 02 |
| S39 | 12/9/92 | CORNELL-CALDWELL FIELD | CALDWELL FIELD | ITHACA | 1 | | 01 |
| S40 | 9/16/96 | CORNELL UNIVERSITY | CALDWELL RD | ITHACA | 1 | | 02 |
| S41 | 8/15/97 | CORNELL UNIVERSITY | CALDWELL RD/PALM RD | ITHACA | 1 | | 01 |
| S42 | 8/5/94 | CORNELL ;POULTRY VIRUS BL | CALDWELL ST.-POULTRY VIRU | ITHACA | 1 | | 01 |
| S43 | 7/29/90 | CARGILL TRUCKING | CARGILL LOADING TOWER | LANSING | 1 | | 07 |
| S44 | 8/14/88 | CORNELL PAINT. | CASCIDILLA CREEK-CORNELL | ITHACA | 4 | CASCIDILLA CREEK | 01 |
| S45 | 7/13/88 | CORNELL STORM SEWER | CASCIDILLA CREEK-STEWART | ITHACA | 4 | CASCIDILLA CREEK | 12 |
| S46 | 4/5/97 | B AND B HUNTING CLUB | CASWELL RD | DRYDEN | 1 | | 12 |
| S47 | 11/14/94 | G & I HOMES | CASWELL RD | MCLEAN | 1 | | 07 |
| S48 | 11/3/94 | CENTRAL AVE.-NEAR OLIN LB | CENTRAL AVE.-OLIN LIBRARY | ITHACA | 1 | | 01 |
| S49 | 4/27/88 | CORNELL UNIVERSITY | CENTRAL HEAT PLANT RT 366 | ITHACA | 1 | | 02 |
| S50 | 10/16/92 | CAYUGA HEIGHTS FD PARKLOT | CHFD HANSHAW&PLEASANT GRO | VE CAYUGA HEIGHTS | 4 | | 02 |
| S51 | 9/25/94 | CORNELL-CHILLWATER #1 | CHILLWATER #1 -FOREST HME | ITHACA | 1 | | 12 |
| S52 | 6/20/88 | CORNELL (CLARK HALL) | CLARK HALL (CORNELL) | ITHACA | 4 | FALL CREEK | 01 |
| S53 | 12/1/93 | E.LANSING RD. & CO RT 152 | CO. RTE 152 | LANSING | 1 | | 07 |
| S54 | 7/16/91 | CORNELL-DRYWELL REMOVAL | CORNELL CAMPUS- SECTOR A | ITHACA | 3 | | 02 |
| S55 | 5/5/89 | CORNELL UNIV/MITCHELL ST | CORNELL QUARTERS | ITHACA | 1 | | 12 |
| S56 | 4/20/89 | CORNELL UNIV | CORNELL UNIV | ITHACA | 5 | | 02 |
| S57 | 8/14/87 | CORNELL UNIV. | CORNELL UNIV. | ITHACA | 3 | | 02 |
| S58 | 8/4/88 | CORNELL UNIVERSITY | CORNELL-FALL CREEK | ITHACA | 4 | FALL CREEK | 02 |
| S59 | 12/16/87 | CORNELL TRAINING FACILITY | COTTERILL LANE | DRYDEN | 3 | | 02 |
| S60 | 2/15/95 | ITHACA COLLEGE MAINT BLDG | CUDDINGTON ROAD | ITHACA | 1 | | 04 |
| S61 | 10/16/89 | ITHACA COLLEGE | DANBY RD. | ITHACA | 1 | | 02 |
| S62 | 7/22/86 | DANBY ROAD ITHACA COLLEGE | DANBY ROAD | ITHACA | 3 | | 02 |
| S63 | 12/29/89 | ITHACA COL.- FISCAL PLANT | DANBY ROAD - FISCAL PLANT | T/ITHACA | 1 | | 01 |
| S64 | 6/23/92 | DATES RD.- LANSING | DATES RD. | LANSING | 1 | | 02 |
| S65 | 11/30/93 | NYTEL | DECKER RD | ITHACA | 1 | | 07 |
| S66 | 6/24/87 | NYS ELEC. & GAS TRANSFORM | DEIBLER ROAD | DRYDEN | 1 | | 01 |
| S67 | 11/2/92 | BABBLING BROOK T-PARK | DEPOT RD. | NEWFIELD | 4 | | 12 |
| S68 | 3/17/88 | VALLEY MANOR MHP | DEPOT RD. | NEWFIELD | 3 | CAYUGA INLET | 01 |
| S69 | 4/25/96 | BEHIND TOMPKINS CO AIRPRT | DIRT RD (ETNA RD.) | LANSING | 1 | | 12 |
| S70 | 8/6/96 | CORNELL CAMPUS | DRYDEN ROAD | ITHACA | 1 | | 01 |
| S71 | 6/30/95 | DURLING ROAD | DURLING RD. | ULYSESS | 4 | TRIB TO TAUGHNAUK | 12 |
| S72 | 2/9/90 | J.A.G. TRANSPORTATION | E. STATE ST. | ITHACA | 1 | SIX MILE CREEK | 07 |
| S73 | 6/21/89 | WILCOX PRESS | E. STATE ST. | ITHACA | 5 | | 01 |
| S74 | 3/5/88 | PAY LO GAS STATION | EAST MAIN STREET | TRUMANSBURG | 1 | | 05 |
| S75 | 7/25/98 | CORNELL UNIVERSITY | ENGINEERING SCHOOL | ITHACA | 1 | | 01 |
| S76 | 12/14/92 | CORNELL UNIVERSITY-FLEET | FLEET GARAGE- | ITHACA | 1 | | 01 |
| S77 | 8/10/87 | LIDDLE LAB | FREESE ROAD | ITHACA | 1 | | 01 |
| S78 | 9/6/90 | REYNOLDS GAME FARM | GAME FARM RD. | T/ITHACA | 1 | | 02 |
| S79 | 8/16/94 | GAME FARM ROAD | GAME FARM ROAD | ITHACA | 1 | | 02 |
| S80 | 5/8/91 | POULTRY LAGOON | GAMEFARM RD. | T/ITHACA | 4 | CASCADILLA CREEK | 02 |
| S81 | 8/17/93 | GAMEFARM ROAD CORNELL | GAMEFARM RD. POULTRY BLDG | ITHACA | 1 | | 02 |
| S82 | 9/12/94 | CORNELL HEATING PLANT | HEATING PLANT-CORNELL | ITHACA | 1 | | 08 |
| S83 | 8/4/93 | HURD RD., DRYDEN | HEURD RD. | DRYDEN | 1 | | 12 |
| S84 | 3/17/93 | HOLIDAY LANE | HOLIDAY LN.&RT.34-96 | NEWFIELD | 1 | | 08 |
| S85 | 7/2/96 | CORNELL - BARTON HALL | HOY RD | ITHACA | 1 | | 02 |
| S86 | 2/26/97 | THERM INC | HUDSON ST EXT | ITHACA | 4 | 6 MILE CREEK | 12 |
| S87 | 5/16/97 | THERM INC | HUDSON ST EXT. | ITHACA | 1 | | 01 |
| S88 | 12/1/92 | THERM/ZYGLO PENETRANT | HUDSON ST. | ITHACA | 4 | | 01 |
| S89 | 9/5/89 | THERM INDUSTRY | HUDSON ST. EXT. | ITHACA | 1 | | 01 |
| S90 | 4/7/89 | HUMPHREY RESIDENTS | HUMPHERY RESIDENCE | ULYSSES | 5 | | 09 |
| S91 | 12/10/87 | CORNELL UNIVERSITY | HUMPHREY SERVICE CENTER | ITHACA | 1 | | 02 |
| S92 | 4/28/92 | CORNELL UNIV | HUNGERFORD HILL RD | ITHACA | 1 | | 01 |
| S93 | 8/1/96 | CORNELL UNIVERSITY FIELD | HUNGERFORD HILL ROAD | ITHACA | 1 | | 02 |
| S94 | 8/1/96 | CORNELL UNIVERSITY GAINES | HUNGERFORD HILL ROAD | ITHACA | 1 | | 02 |
| S95 | 6/27/90 | ITHACA COLLEGE | ITHACA COLLEGE-CAR WASH | ITHACA | 2 | SANITARY SEWER | 02 |
| S96 | 3/16/90 | ITHACA AGWAY PLANT | ITHACA PLANT-702 HANCOCK | ITHACA | 1 | | 04 |
| S97 | 9/26/97 | MIX BROTHER'S | JOHNSON ROAD | FREEVILLE | 1 | | 07 |
| S98 | 10/9/97 | CORNELL UNIVERSITY | JUDD FALLS RD | ITHICA | 3 | | 02 |
| S99 | 8/30/89 | CORNELL UNIV.-OID SHOP BD | JUDD FALLS RD. | T/ITHACA | 3 | | 02 |
| S100 | 10/5/90 | BOWERS FUEL CO. | KING ST. | TRUMANSBURG | 1 | | 04 |
| S101 | 3/3/88 | BOYNTON MIDDLE SCHOOL | LAKESHORE DRIVE | ITHACA | 1 | | 02 |
| S102 | 7/19/91 | TCE- LINDEN AVE. | LINDEN AVE | ITHACA | 3 | | 12 |
| S103 | 8/5/88 | CORNELL TANK LEAK | LOVE LAB | ITHACA | 3 | | 02 |
| S104 | 2/28/97 | PINKNY RD & | LOWER CREEK RD | DRYDEN | 1 | | 12 |
| S105 | 5/1/92 | CORNELL PCB OIL-TRANSFORM | M&SO GARAGE-CORNELL CAMP | ITHCA | 1 | | 02 |
| S106 | 7/30/98 | NEWFIELD CENTRAL SCHOOL | MAIN ST | NEW FIELD | 2 | | 02 |
| S107 | 9/2/93 | NEWFIELD SCHOOL | MAIN ST. | NEWFIELD | 3 | | 02 |
| S108 | 1/27/98 | CORNELL UNIVERSITY | MAPLE AVENUE | ITHACA | 1 | | 07 |
| S109 | 11/19/87 | CORNELL UNIVERSITY | MINEAH ROAD | MT PLEASANT (FREEVILLE) | 3 | | 02 |
| S110 | 5/4/90 | CORNELL UNIV.-BUTLER BUIL | MITCHELL ST.-BUTLER BUILD | ITHACA | 1 | | 02 |
| S111 | 9/18/92 | CORNELL- HIGH VOLTAGE LAB | MITCHELL ST.-HI VOLTAGE L | ITHACA | 1 | | 02 |
| S112 | 10/12/94 | CORNELL HIGH VOLTAGE LAB | MITCHELL STREET | ITHACA | 1 | | 01 |
| S113 | 9/30/91 | CORNELL AGRONOMY | MT. PLESANT FARM-MINEAH R | DRYDEN | 3 | | 02 |
| S114 | 11/1/92 | CORNELL-ELAVATOR LIFT | MVR BLDG.-NORTH WING- | ITHACA | 1 | | 02 |
| S115 | 4/19/89 | NORMAN SCOTT RESIDENCE | NORMAN SCOTT RESIDENCE | TRUMANSBURG | 1 | | 09 |
| S116 | 5/11/92 | DRYDEN FOOD MARKET | NORTH ST. | DRYDEN | 3 | | 05 |
| S117 | 10/22/93 | TAUGHANNOCK FALLS NYS PRK | NYS RTE 89-TAUGHANNOCK FL | TRUMANSBURG | 1 | | 02 |
| S118 | 10/27/89 | CORNELL UNIV-OLD SHOP BD. | OID SHOP BD.-JUDD FALL RD | T/ITHACA | 3 | | 02 |
| S119 | 9/21/90 | ITHACA COLLEGE | PHYSICAL PLANT DANBY RD. | ITHACA | 1 | | 02 |
| S120 | 6/10/98 | CORNELL UNIVERSITY | PLANTATIONS ROAD | ITHACA | 1 | | 07 |

| Map Id | Spill Date | Spill Name | Spill Street | Spill Municipality | Resource Effected | Waterbody | Spill Source |
|---|---|---|---|---|---|---|---|
| S121 | 4/21/92 | CAYUGA HTS. F.D. | PLEASANT HEIGHTS RD. | ITHACA | 1 | | 02 |
| S122 | 5/7/93 | CARGILL SALT MINES | PORTLAND AVE. | LANSING | 1 | | 07 |
| S123 | 9/14/96 | BENCHMARK NY | PORTLAND POINT RD | SOUTH LANSING | 1 | | 07 |
| S124 | 3/7/91 | CARGILL SALT | PORTLAND POINT RD. | T/LANSING | 3 | | 01 |
| S125 | 11/28/90 | GENERAL CRUSHED STONE | PORTLAND POINT RD. | T/LANSING | 1 | | 01 |
| S126 | 12/6/95 | CARGILL SALT | PORTLAND PT ROAD | LANSING | 1 | | 07 |
| S127 | 10/5/95 | CARGILL SALT MINE | PORTLAND PT. RD. | LANSING | 1 | | 07 |
| S128 | 6/12/95 | LANSING CRUSHED STONED | PORTLAND PT. RD. | LANSING | 1 | | 01 |
| S129 | 3/14/95 | MIX BROS. @ CARGILL | PORTLAND PT. RD. | LANSING | 1 | | 07 |
| S130 | 4/4/95 | CARGILL-HYDRAULIC OIL | PORTLAND PT. RD.- 150 TON | LANSING | 1 | | 01 |
| S131 | 5/15/97 | | PORTLAND PT. ROAD | LANSING | 1 | | 01 |
| S132 | 6/16/93 | CARGILL INC. | PRTLAND PT. RD. - QUARRY | LANSING | 1 | | 01 |
| S133 | 11/3/97 | CORNELL UNIVERSITY | RICE HALL | ITHACA | 1 | | 07 |
| S134 | 6/25/97 | CORNELL UNIVERSITY | ROUTE 366 | ITHACA | 1 | | 02 |
| S135 | 8/8/96 | CORNELL UNIVERSITY FARM S | ROUTE 366 | ITHACA | 1 | | 02 |
| S136 | 4/11/88 | TAUGHANNOCK STATE PARK | ROUTE 89 | ULYSSES | 3 | | 02 |
| S137 | 4/8/95 | ITHACA ABANDONED DRUMS | RT 96/NEAR TOMPKINS CO. | ITHACA | 1 | | 12 |
| S138 | 2/25/92 | CORNELL BUS GARAGE | RT. 366 BUS GARAGE | VARNA | 4 | | 07 |
| S139 | 10/30/95 | CORNELL UNIVERSITY | RT.366 | ITHACA | 1 | | 02 |
| S140 | 6/20/93 | TAUGHANNOCK FALLS BEACH | RTE. 89-TAUGHANNOCK PARK | ITHACA | 4 | CAYUGA LAKE | 12 |
| S141 | 10/4/91 | ITHACA CITY SCHOOL DIST. | SCHOOLBUS GARAGE-BOSTWICK | ITHACA | 3 | | 02 |
| S142 | 5/7/93 | TAUGHANNOCK FALLS | TAUGHANNOCK FALLS RT. 89 | TRUMANSBURG | 1 | | 02 |
| S143 | 7/9/90 | ITHACA BOATING CENTER | TAUGHANNOCK INLET | ITHACA | 4 | TAUGHANNOCK INLET | 12 |
| S144 | 3/28/88 | TAUGHANOCK ST. PARK | TAUGHANNOCK ST.PARK | ULYSESS | 3 | | 02 |
| S145 | 11/22/87 | EAST HILL FLYING CLUB | TOMPKINS CO. AIRPORT | ITHACA | 3 | | 01 |
| S146 | 3/16/87 | AVIS RENT-A-CAR | TOMPKINS COUNTY AIRPORT | ITHACA | 3 | | 01 |
| S147 | 10/19/89 | HERTZ CAR RENTAL | TOMPKINS COUNTY AIRPORT | ITHACA | 3 | | 01 |
| S148 | 9/5/90 | U.S. AIR - T.C. AIRPORT | TOMPKINS COUNTY AIRPORT | ITHACA | 1 | | 01 |
| S149 | 9/4/96 | CORNELL UNIV. TURKEY FARM | TURKEY HILL RD | ITHACA | 1 | | 02 |
| S150 | 12/15/87 | CORNELL TURKEY FARM | TURKEY HILL ROAD | ITHACA | 3 | | 01 |
| S151 | 3/28/90 | CORNELL UNIVERSITY | WILSON SYNCHITRON BUILD. | T/ITHACA | 1 | | 02 |
| S232 | 9/25/87 | ROMULUS (T) HGWY DEPT | 6004 CO RD 29 | ROMULUS | 3 | | 04 |
| S245 | 6/30/88 | CAYUGA LAKE STATE PARK | 2664 LOWER LAKE ROAD | SENECA FALLS | 3 | | 02 |
| S257 | 5/22/90 | JIM STEVENS GARAGE | 3678 RIDGE ROAD | FAYETTE | 1 | | 07 |
| S259 | 7/3/90 | THOMPSON (THERESA) RESIDE | 4298 EAST COVERT ROAD | COVERT | 1 | | 09 |
| S265 | 10/20/90 | SMITH (KATHY) RESIDENCE | 5440 ROUTE 96 | ROMULUS | 1 | | 09 |
| S278 | 7/22/91 | SUIT-KOTE | COUNTY ROAD 121 & SEYBOLT | FAYETTE | 1 | | 07 |
| S279 | 9/15/91 | CAYUGA LAKE | 4397 ROUTE 89 | FAYETTE | 4 | CAYUGA LAKE | 10 |
| S282 | 3/1/92 | KREUTTER (ERV) RESIDENCE | 5299 ROUTE 89 | ROMULUS | 1 | | 12 |
| S284 | 3/29/92 | DIAMOND PROPERTY/ HARTMAN | 7448 CO RT 153 | SHELDRAKE | 4 | SHELDRAKE CREEK | 09 |
| S287 | 6/8/92 | SENECA FALLS COUNTRY CLUB | 2800 ROUTE 89 | SENECA FALLS | 1 | | 01 |
| S291 | 9/2/92 | EAGENS MOBIL STA 08-P5E | MAIN STREET & MECHANIC ST | INTERLAKEN | 3 | | 05 |
| S293 | 11/27/92 | GAY DESARRO RESIDENCE | 3537 ROUTE 89 | SENECA FALLS | 1 | | 09 |
| S306 | 4/20/94 | BROWN (WILLIAM) PROPERTY | 5132 ROUTE 89 | ROMULUS | 1 | | 09 |
| S318 | 7/18/95 | MONTEVERDI (WILLIAM) HOME | ROUTE 89 & GARDEN STREET | SENECA FALLS | 1 | | 09 |
| S323 | 3/22/96 | CAYUGA LAKE STATE PARK | 2678 LOWER LAKE ROAD | SENECA FALLS | 1 | | 07 |
| S327 | 8/17/96 | ASHLEY PROPERTY | 3462 ROUTE 89 | SENECA FALLS | 1 | | 09 |
| S334 | 9/15/97 | CLINTON & LAKEVIEW ST | CLINTON & LAKEVIEW ST | INTERLAKEN | 1 | | 07 |
| S345 | 7/18/84 | 720 SOUTH MEADOW ST. | 720 MEADOW ST. | ITHACA | 3 | | 12 |
| S346 | 9/10/85 | VAN DOREN ROAD | 466 VAN DOREN CORNERS RD | ITHACA | 3 | DRINKING WELL | 12 |
| S347 | 3/25/86 | WALLACE STEEL | 105 CHERRY ST. | ITHACA | 4 | CAYUGA LAKE INLET | 12 |
| S348 | 5/10/86 | | STATE ST. & MEADOW ST. | ITHACA | 1 | | 08 |
| S349 | 5/19/86 | CARGILL SALT | 191 PORTLAND POINT RD. | LANSING | 3 | | 01 |
| S350 | 6/9/86 | STODDARD SOLVENT | 401 EDDY ST. | ITHACA | 1 | | 01 |
| S351 | 6/14/86 | | MIDLINE & HOLLISTER RD. | TOWN OF DRYDEN | 1 | | 08 |
| S352 | 7/8/86 | | 2175 HANSHAW RD. | DRYDEN | 3 | | 12 |
| S353 | 7/2/86 | | 1503 SLATERVILLE RD | ITHACA (T) | 3 | WELL | 12 |
| S354 | 7/11/86 | TIOGA & CASCADILLA ST. | N. TIOGA & CASCADILLA ST. | ITHACA | 2 | CASCADILLA CREEK | 12 |
| S355 | 8/26/86 | STATE ST. MOBIL | 540 W. STATE ST. | ITHACA | 3 | 1 | 05 |
| S356 | 9/9/86 | PHIL MESSENGER AUTO CNTR. | 341 RIDGE RD. OFF 34B | LANSING | 3 | | 05 |
| S357 | 9/19/86 | INDIAN CREEK FRUIT FARM | RT.96 OPPOSITE DEBOISE RD | ITHACA | 3 | | 02 |
| S358 | 9/29/86 | NY TELEPHONE, ITHACA | 720 W. COURT ST. | ITHACA | 3 | | 01 |
| S359 | 10/23/86 | NCR CORP., DANBY ROAD | 950 DANBY ROAD | ITHACA | 3 | | 01 |
| S360 | 1/30/87 | BES TECH AUTO | WEST SENECA & TAGONIC | ITHACA | 4 | | 01 |
| S362 | 3/9/87 | BOSTWICK ROAD | 919 BOSTWICK ROAD | ENFIELD | 3 | | 09 |
| S363 | 4/17/87 | NY TELEPHONE - TIOGA ST. | 212 N. TIOGA STREET | ITHACA | 3 | | 01 |
| S364 | 4/26/87 | COBB STREET - SHAFFLER | 643 COBB STREET | GROTON | 1 | | 01 |
| S365 | 4/27/87 | ELMIRA RD. - BELL | 614 ELMIRA ROAD | ITHACA | 3 | | 05 |
| S367 | 5/6/87 | MORSE INDUSTRIAL | 620 ARORA STREET | ITHACA | 1 | | 01 |
| S368 | 7/14/87 | RICHARD ROGERS RES. | 494 NEFFIN RD. | ITHACA | 1 | | 09 |
| S369 | 8/10/87 | VILLAGE OF GROTON | 201 CONGER BLVD. | DGROTON | 3 | | 02 |
| S370 | 9/24/87 | MORSE IND. | 620 S. AURORA ST. (96B) | ITHACA | 1 | | 07 |
| S371 | 9/28/87 | SMITH RESIDENT | 1 LAKE STREET | TRUMANSBURG | 1 | | 09 |
| S372 | 8/6/87 | CASCIDILLA CREEK | CASCIDILLA & N. TIOGA STS | ITHACA | 4 | | 05 |
| S373 | 10/14/87 | NY TELEPHONE | 720 W. COURT STREET | ITHACA | 3 | | 01 |
| S374 | 10/19/87 | FRENCH RESIDENCE | 292 HEINZ ROAD | ITHACA | 2 | ENFIELD CREEK | 08 |
| S375 | 10/30/87 | NYS POLICE TROOP C | 1296 DRYDEN ROAD | ITHACA | 3 | | 02 |
| S376 | 11/2/87 | COOK FARM (WELL) | 20 IRISH SETTLEMENT RD. | DRYDEN | 3 | | 09 |
| S377 | 11/6/87 | U-HAUL | 343 ELMIRA ROAD | ITHACA | 3 | | 01 |
| S378 | 12/12/87 | CORNELL UNIV. | 925 WARREN ROAD | ITHACA | 3 | | 02 |
| S379 | 12/14/87 | MONROE MUFFLER | 338 ELMIRA ROAD | ITHACA | 3 | | 01 |
| S380 | 12/19/87 | ITHACA JOURNAL | 123 WEST STATE STREET | ITHACA | 3 | | 01 |
| S381 | 12/29/87 | BILL'S MOBIL | 601 DRYDEN ROAD | ITHACA | 3 | | 05 |
| S382 | 1/2/88 | R. HUNT SERV. STATION | 222 ELMIRA ROAD | ITHACA | 1 | | 07 |
| S383 | 12/30/87 | LANSING HIGHWAY DEPT. | 29 AUBURN ROAD | LANSING | 3 | | 02 |
| S385 | 2/8/88 | H & E MACHINERY | 334 COMFORD ROAD | DANBY | 1 | | 01 |
| S386 | 1/20/88 | CRISPELL'S FARM | 369 LEVEL GREEN ROAD | CAROLINE | 3 | | 01 |
| S387 | 2/15/88 | MARSH RESIDENT | 489 CHAMBERLAIN ROAD | GROTON | 1 | | 09 |
| S388 | 3/7/88 | MITCHELL STREET ACCIDENT | 300 BLOCK OF MITHCELL ST. | ITHACA | 1 | | 07 |
| S389 | 3/8/88 | PATTERSON MOBIL | AURORA & BUFFALO STS. | ITHACA | 1 | | 12 |
| S390 | 4/7/88 | CAROLYN ADAMS | 384 ETNA RD. | ITHACA | 1 | | 08 |
| S391 | 4/4/88 | VARNA INN | 933 DRYDEN ROAD. | VARNA | 3 | | 05 |
| S392 | 3/11/88 | RITA MILLER | 255 HINES RD. | ENFIELD | 3 | | 12 |
| S393 | 4/14/88 | TOMKINS COMM. HOSPITAL | 1285 TRUMANSBURG RD. | ITHACA | 3 | | 02 |
| S394 | 4/25/88 | STALEY | 1143 DRYDEN RD. RT 366 | DRYDEN | 3 | | 01 |
| S395 | 4/25/88 | SWANSBOROUGH | 921 SHAFFER ROAD | NEWFIELD | 3 | | 09 |
| S397 | 6/6/88 | LRS LANSING EXCAVATION | 698 CODDINGTON RD | ITHACA | 4 | | 07 |
| S398 | 6/25/88 | BUSY BEE | BUSY BEE RT13 & RT38 | DRYDEN | 3 | | 05 |
| S399 | 7/1/88 | EAST HILL FLYING CLUB | 62 BROWN RD. | ITHACA | 3 | | 01 |
| S400 | 7/8/88 | CORNELL UNIVERSITY | H2O FILTRATION CALDELL RD | ITHACA | 4 | FALL CREEK | 02 |
| S401 | 8/8/88 | WELCH RESIDENCE | 110 SEVEN MILE DRIVE | ITHACA | 3 | | 09 |
| S402 | 10/25/88 | WILCOX TIRE CENTER | 233 ELMIRA RD. | ITHACA | 3 | | 01 |
| S403 | 11/29/88 | LAFAVE RESIDENCE | 167 RIDGE ROAD | LANSING | 1 | | 08 |
| S404 | 12/10/88 | HOPKINS RESIDENCE | 730 OLD STAGE ROAD | GROTON | 1 | | 09 |
| S406 | 1/14/88 | LANSING RESIDENTIAL CTR. | 270 AUBURN ROAD, RT. 34 | LANSING | 1 | | 02 |
| S407 | 2/7/89 | SPECIAL CHILDREN'S GARAGE | 210 ELMIRA ROAD | ITHACA | 3 | | 05 |
| S408 | 2/10/89 | NYS DIVISION OF YOUTH | 270 AUBURN ROAD, RT. 34 | LANSING | 4 | SALMON CREEK | 02 |
| S409 | 2/23/89 | BALADA RESIDENT | 983 TAUGHANOCK BLVD. | ITHACA | 3 | | 12 |
| S410 | 3/17/89 | CARGILL SALT | 191 PORTLAND POINT ROAD | LANSING | 1 | | 08 |
| S411 | 3/20/89 | JACK AVERY RESIDENT | 497 LANSING ROAD | LANSING | 4 | CAYUGA LAKE | 09 |
| S412 | 3/29/89 | NYS DIV. OF YOUTH | 270 AUBURN ROAD | LANSING | 1 | SALMON CREEK | 02 |
| S413 | 4/2/89 | SEWAGE-6 MILE CREEK | 300 BLOCK GUILES AVE | ITHACA | 4 | | 12 |
| S414 | 1/24/89 | OPLINGER RESIDENCE | 12 COLLINS ROAD | LANSING | 1 | | 09 |
| S415 | 5/6/89 | MIDAS SERVICE CENTER | 347 ELMIRA RD. | T/ITHACA | 1 | | 01 |
| S416 | 5/15/89 | NORMAN TIDD | 300 E. STATE ST. | ITHACA | 1 | | 07 |
| S417 | 5/31/89 | UNITED VAN LINES | 157 BUNDY PL. | T/ITHACA | 1 | | 07 |
| S418 | 6/20/89 | 7 TURKEY HILL RD. | 7 TURKEY HILL RD. | T/DRYDEN | 1 | | 09 |
| S420 | 7/5/89 | PRODTY TRUCKING | 138 ENFIELD RD. | T/ITHACA | 1 | | 09 |
| S421 | 1/10/88 | CORNELL UNIV-DRUG TESTING | 925 WARREN DR. | ITHACA | 1 | | 01 |
| S423 | 8/7/89 | COOKE TOYOTA CADILLAC | CINEMA RD. & UPTOWN RD. | T/LANSING | 1 | | 01 |
| S424 | 8/18/89 | LOERCH RESIDENCE | 214 BROOKTONDALE RD. | T/CAROLINE | 3 | WELL | 12 |

| Map Id | Spill Date | Spill Name | Spill Street | Spill Municipality | Resource Effected | Waterbody | Spill Source |
|---|---|---|---|---|---|---|---|
| S425 | 9/15/89 | CITY OF ITHACA - DPW | LAKE AVE. & ADAMS ST. | ITHACA | 4 | CASCADILLA CREEK | 02 |
| S426 | 10/14/89 | AVERY PARK | 7 DUTCHER RD. | DRYDEN | 1 | | 01 |
| S427 | 11/9/89 | K-MART-TTHACA | 744 S. MEADOW ST. | ITHACA | 3 | | 01 |
| S428 | 11/9/89 | HERKIMER PETROLEUM | 214 MEADOW ST. | ITHACA | 3 | | 05 |
| S429 | 11/13/89 | FISHKILL ROAD | 55-2 FISHKILL ROAD | T/NEWFIELD | 3 | | 12 |
| S431 | 11/30/89 | TRUMANSBURG MOBIL | MAIN & WASHINGTON ST. | TRUMANSBURG | 2 | SEWER | 05 |
| S432 | 12/12/89 | ITHACA FOREIGN CAR SER. | 501 W. STATE ST. | ITHACA | 2 | SIX MILE CREEK | 06 |
| S433 | 12/28/89 | 317 ITHACA RD. | 317 ITHACA RD. | T/ITHACA | 1 | | 09 |
| S434 | 1/6/90 | DELMADGE RESIDENCE | 100 GROVE SCHOOL RD. | BROOKTONDALE | 1 | | 09 |
| S435 | 2/3/90 | 688 VALLEY ROAD | 688 VALLEY ROAD | BROOKTONDALE | 4 | TRIB TO SIX MI. CR. | 09 |
| S436 | 2/6/90 | BISHOPS HARDWARE | 430 W. STATE ST. | ITHACA | 3 | | 01 |
| S438 | 2/13/90 | SENECA ST. CHEVRON | 201 W. SENECA ST. | ITHACA | 3 | | 05 |
| S439 | 3/9/90 | NENO RESIDENCE | 126 MUNSON RD. | T/LANSING | 1 | | 09 |
| S440 | 3/12/90 | CORNELIUS RESIDENCE | 1635 ELLIS HOLLOW RD. | T/ITHACA | 1 | | 09 |
| S441 | 3/19/90 | NYTEL | 721 W. COURT ST. | ITHACA | 3 | | 01 |
| S443 | 5/7/90 | CARGILL PLANT | 191 PORTLAND POINT RD. | T/LANSING | 1 | | 01 |
| S444 | 5/4/90 | NIAL SMITH & SONS | 136 CHAMPLIN RD. | T/GROTON | 4 | | 02 |
| S445 | 5/10/90 | MANHEIM CONVEINENT STORE | 614 ELMIRA RD. | ITHACA | 1 | | 05 |
| S446 | 4/26/90 | LANSING RES CTR | 270 AUBURN RD | LANSING | 1 | | 02 |
| S447 | 5/16/90 | CAPRANICA RESIDENCE | 1397 ELLIS HOLLOW RD. | T/ITHACA | 1 | | 09 |
| S448 | 5/11/90 | HOLENBECK RESIDENCE | 10 EVERGREEN ST. | DRYDEN | 1 | VIRGIL CREEK | 12 |
| S449 | 5/17/90 | 3IMROT RESIDENCE | 110 CAMPBELL AVE. | ITHACA | 1 | | 09 |
| S450 | 6/3/90 | A PLUS MINI MART | 112 S. MEADOW ST. | ITHACA | 1 | | 05 |
| S451 | 5/24/90 | BILL ZIKAKIS CHEV. INC. | 401 ELMIRA RD. | ITHACA | 3 | | 01 |
| S453 | 6/24/90 | SNYDER RESIDENCE | 920 SHAFFER RD. | T/NEWFIELD | 5 | | 09 |
| S454 | 6/25/90 | 2534 SLATTERVILLE RD. | 2534 SLATTERVILLE RD. | T/CAROLINE | 1 | | 09 |
| S455 | 7/2/90 | 107 CAYUGA PARK CIRCLE | 107 CAYUGA PARK CIRCLE | CAYUGA HEIGHTS | 1 | | 09 |
| S456 | 6/30/90 | SMITH RESIDENCE | 253 VANDORN RD. | T/ENFIELD | 1 | | 09 |
| S457 | 7/6/90 | AGWAY ENERGY | AGWAY PLANT-702HANCOCK ST | ITHACA | 1 | | 04 |
| S458 | 7/23/90 | SUNOCO- 214 MEADOW ST. | 214 MEADOW ST. | ITAHCA | 1 | | 05 |
| S459 | 8/2/90 | ABC CLEANING | 1754 DANBY RD. | DANBY | 1 | | 01 |
| S460 | 9/23/90 | WADELL RESIDENCE | 468 AUBURN RD. | T/LANSING | 1 | | 09 |
| S461 | 10/12/90 | GUNSALLUS RESIDENCE | 1453 ELMIRA RD. | T/NEWFIELD | 1 | | 02 |
| S462 | 11/6/90 | ALBANEESE RES. | 1324 ELMIRA RD. | T/NEWFIELD | 1 | | 09 |
| S464 | 12/4/90 | CARGILL INC. | 191 PORTLAND POINT RD. | T/LANSING | 1 | | 01 |
| S465 | 12/7/90 | KRANZ RESIDENCE | 372 ASBURY RD. | FREEVILLE | 1 | | 12 |
| S466 | 12/6/90 | CARGILL SALT | 191 PORTLAND PT. RD. | T/LANSING | 1 | | 07 |
| S467 | 12/17/90 | ARMSTRONG RESIDENCE | 141 WEST HAVEN RD. | ITHACA | 1 | | 08 |
| S468 | 12/26/90 | HOVENCAMP RESIDENCE | 5438 PODUNK RD. | TRUMANSBURG | 1 | | 09 |
| S469 | 12/15/90 | KELLY RESIDENCE | 360 TUPPER RD. | T/NEWFIELD | 1 | | 09 |
| S470 | 1/8/91 | ARG TRUCKING CORP. | 414 ELMIRA RD. | T/ ITHACA | 1 | | 01 |
| S471 | 2/6/91 | CAROLINE HIGHWAY DEPT. | 852 VALLEY RD. | BROOKTONDALE | 3 | | 02 |
| S472 | 2/18/91 | STATION RD | 6 STATION RD. | WEST DANBY | 1 | | 09 |
| S474 | 3/21/91 | MACDONALD RESIDENCE | 507 ELLIS HOLLOW CK. RD. | T/DRYDEN | 3 | | 09 |
| S475 | 3/26/91 | EAST HILL CAR WASH | 77 JUDD FALLS RD | T/ITHACA | 1 | | 12 |
| S476 | 4/3/91 | ANDREE PETRO. | 534 LOWER CREEK RD. | ITHACA | 1 | | 08 |
| S478 | 4/23/91 | BELL'S CONVENIENCE STORE | 614 ELMIRA RD. | ITHACA | 1 | | 05 |
| S479 | 4/22/91 | 226 LINDEN AVE. | 226 LINDEN AVE. | ITHACA | 3 | | 12 |
| S480 | 4/29/91 | FRONT OF 229 ELMIRA RD. | 227 ELMIRA RD. | ITHACA | 1 | | 06 |
| S481 | 5/2/91 | CARGILL SALT | 191 PORTLAND POINT RD. | T/LANSING | 1 | | 07 |
| S482 | 5/8/91 | 925 OLD WARREN RD. | 925 OLD WARREN RD. | T/LANSING | 4 | | 02 |
| S483 | 5/28/91 | MAYO RESIDENCE | 335 RIDGECREST RD. | T/ITHACA | 1 | | 12 |
| S484 | 5/31/91 | LOVELY RES. | 452 JERRY SMITH RD. | T/LANSING | 3 | | 09 |
| S485 | 6/11/91 | CARGILL | 191 PORTLAND PT. ROAD | LANSING | 4 | CAYUGA LAKE | 01 |
| S486 | 6/7/91 | CRATSLEYS RESIDENCE | 551 RIDGE RD. | LANSING,N.Y. | 1 | | 09 |
| S488 | 7/6/91 | CARGILL | 191 PORTLAND RD | LANSING | 1 | | 12 |
| S489 | 7/10/91 | CARGILL | 191 PORTLAND PT. RD | LANSING, | 1 | | 01 |
| S490 | 12/18/90 | ITHACARE | 115 SOUTH QUARRY STREET | ITHACA | 3 | 3 | 01 |
| S492 | 8/8/91 | BC BAGGING | 399 MAIN ST. EXTENSION | FREEVILLE | 1 | | 07 |
| S493 | 8/23/91 | DRYDEN SCHOOL | SCHOOL-15 MONTGOMERY ST. | DRYDEN ,N.Y. 13053 | 1 | | 02 |
| S494 | 8/27/91 | AURORA ST. | 600 S. AURORA ST. | ITHACA | 2 | | 06 |
| S495 | 9/3/91 | VAUGHN SHERMAN RESIDENT | 2219 GEE HILL RD. | DRYDEN | 1 | | 09 |
| S496 | 9/25/91 | 25 SEARLES RD. | 25 SEARLES RD. | LANSING | 3 | | 09 |
| S497 | 10/3/91 | ITHACA COLLEGE | ITHACA COLLEGE-953 DANBY | ITHACA COLLEGE | 1 | | 07 |
| S498 | 10/2/91 | C.ITHACA PUBLIC WORKS | 245 PIER RD. DPW BLDG. | ITHACA | 3 | | 02 |
| S499 | 10/1/91 | 67 MAIN ST.-TRUMANSBURG | 67 MAIN ST. | TRUMANSBURG | 1 | | 01 |
| S500 | 10/31/91 | CARGILL INC. | 191 PORTLAND PT. RD. | LANSING | 1 | | 07 |
| S501 | 11/6/91 | LAMEROUX-QUINN | RT. 96 & SENECA RD. | TRUMANSBURG | 1 | | 01 |
| S502 | 12/5/91 | CARGILL | 191 PORTLAND POINT RD. | LANSING | 1 | | 01 |
| S503 | 12/5/91 | MCGEE PROPERTY | 2169 MECKLENBURG RD | ITHACA | 1 | | 09 |
| S504 | 12/8/91 | 329 STONE QUARRY RD. | 329 STONE QUARRY RD. | ITHACA | 1 | | 09 |
| S505 | 12/11/91 | HESS-366 ELMIRA RD. | 366 ELMIRA RD. | ITHACA | 1 | | 06 |
| S506 | 12/9/91 | BARKER RESIDENCE | 960 SNYDER HILL RD | DRYDEN | 4 | | 09 |
| S507 | 12/31/91 | SENECA ST SUPER SERVICE | 201 WEST SENECA STREET | ITHACA | 1 | | 05 |
| S508 | 1/3/92 | PAUL MANCINI & SONS | 608 ELMIRA ROAD | ITHACA | 1 | | 01 |
| S509 | 1/8/92 | HURD BUILDING | 1858 TRUMANSBURG RD. | JACKSONVILLE | 3 | | 12 |
| S510 | 1/13/91 | 1263 TAUGHANNOCK BLVD. | 1263 TAUGHANNOK BLVD. | ITHACA | 1 | | 08 |
| S511 | 1/14/92 | 852 VALLEY RD. | 852 VALLEY RD | BROOKTONDALE | 1 | SIX MILE CREEK | 02 |
| S512 | 1/15/92 | ITHACA AGWAY | 702 HANCOCK ST | ITHACA | 1 | | 04 |
| S513 | 1/23/92 | 933 DRYDEN RD. | 933 DRYDEN RD. | ITHACA | 3 | | 12 |
| S514 | 1/29/92 | TOMPKINS COUNTY HOSPITAL | MAINT FAC. 101 DATES DR. | ITHACA | 1 | | 02 |
| S515 | 2/7/92 | O'BRIEN RESIDENCE | 100 SHARPSTEEN RD | GROTON | 1 | | 09 |
| S516 | 2/17/92 | COOPER RESIDENCE | 616 NORTHWOOD RD. | FREEVILLE | 1 | | 09 |
| S517 | 3/27/92 | 126 MUNSON RD. | 126 MUNSON RD. | LANSING | 3 | | 09 |
| S518 | 4/2/92 | 629 MIDLINE RD. - ZHALHER | 629 MIDLINE RD. | FREEVILLE | 1 | | 09 |
| S519 | 6/1/91 | CARPENTER RESIDENCE | 139 SOUTH APPLEGATE | ENFIELD | 1 | | 01 |
| S520 | 4/14/92 | ANDREE PETROLEUM | 103 NELSON ROAD | ITHACA | 1 | | 08 |
| S521 | 4/24/92 | COX RESIDENCE | 344 TURKEY HILL RD. | ITHACA | 1 | | 09 |
| S522 | 5/6/92 | CARGILL-PORTLAND PT. RD. | 191 PORTLAND PT. RD. | LANSING , N.Y. | 1 | | 07 |
| S523 | 6/1/92 | CAYUGA HEIGHTS | 410 E. UPLAND RD. | CAYUGA HEIGHTS | 2 | | 05 |
| S524 | 5/28/92 | CAYUGA CRUSHED STONE | 87 PORTLAND PT. RD. | LANSING | 1 | | 08 |
| S526 | 6/10/92 | USSBA-TRUMANSBURG | 74 MAIN ST. | TRUMANSBURG | 3 | | 01 |
| S527 | 6/15/92 | 1460 CODDINGTON RD. | 1460 CDDINGTON RD. | CAROLINE | 1 | | 09 |
| S528 | 7/2/92 | 11 BEECHNUT TERRACE | 11BEECHNUT TERRACE | ITHACA | 3 | | 09 |
| S529 | 7/14/92 | 287 MILLARD RD. | 287 MILLARD RD. | NEWFIELD | 1 | | 09 |
| S530 | 7/25/92 | EMERSON POWER TRANSFORMER | 620 S AURORA ST | ITHACA | 4 | SIX MILE CREEK | 01 |
| S531 | 7/31/92 | OLD GAS & ELECTRIC SITE | COURT & ALBANY ST. | ITHACA | 1 | | 02 |
| S532 | 8/17/92 | 80 PERUVILLE RD. | 80 PERUVILLE RD. | LANSING | 1 | | 12 |
| S533 | 7/27/92 | 196 COMFORT RD. | 196 COMFORT RD. | DANBY | 4 | | 12 |
| S534 | 8/27/92 | 54 OLD PAYNE RD. | 54 OLD PAYNE RD. | NEWFIELD | 1 | | 08 |
| S535 | 8/28/92 | CORNELL ORCHARD FACILITY | RT.266-CORNELL ORCHARD | ITHACA | 1 | | 02 |
| S536 | 8/29/92 | THURSTON AVE. | 410 THURSTON AVE. | ITHACA | 1 | | 09 |
| S538 | 9/29/92 | CHRITIE RESIDENCE-FREEVIL | 227 BONEPLAIN RD. | FREEVILLE | 1 | | 09 |
| S540 | 10/12/92 | 31 MAPLEWOOD RD.-BRASLER | 31 MAPLEWOOD RD. | ITHACA | 1 | | 09 |
| S541 | 10/13/92 | MINTEER RES | 180 BANK ST | NEWFIELD | 1 | | 08 |
| S542 | 10/20/92 | TOWER SERVICE-1472 ELMIRA | 1472 ELMIRA RD. | NEWFIELD | 3 | | 05 |
| S543 | 10/21/92 | MARTIN RESIDENCE | 635 TURNBULLS CORNERS RD. | NEWFIELD | 1 | | 09 |
| S545 | 11/9/92 | CORNELL UNIVERSITY | 159 SAPSUCKER WOODS RD. | ITHACA | 3 | | 02 |
| S546 | 4/11/92 | DEEB'S SERVICE STATION | 522 EAST SHORE RD. | ITHACA | 3 | | 05 |
| S547 | 11/4/92 | 344 TURKEY HILL RD. | 344 TURKEY HILL RD. | DRYDEN | 1 | | 09 |
| S548 | 11/24/92 | JOSEPH RESIDENCE | 1460 TRUMANSBURG RD. | ITHACA | 5 | | 12 |
| S549 | 12/23/92 | BABCOCK RESIDENCE | 758 ENFIELD RD {RT.327} | NEWFIELD | 1 | | 09 |
| S550 | 1/13/93 | NYS ARMORY -HENSHAW RD. | 1765 HENSHAW RD. | DRYDEN | 1 | | 02 |
| S551 | 2/8/93 | MILLIKEN STATION-LANSING | 228 MILLIKEN STATION | LANSING | 1 | | 01 |
| S552 | 2/25/93 | FREEVILLE | 440 STEVENS RD | FREEVILLE | 1 | | 01 |
| S553 | 3/27/93 | THERM INC. | 306 GILES ST. | ITHACA | 4 | SIX MILE CREEK | 01 |
| S554 | 3/29/93 | SOUTH WORTH RD | 423 SOUTH WORTH RD | DRYDEN | 4 | | 09 |
| S557 | 3/9/93 | FREESE RD-TRAILER PARK | 10 FREEZE RD. -LOT #3 | ITHACA | 1 | | 09 |
| S558 | 4/7/93 | VASSE RESIDENCE - DRYDEN | 2 GOODRICH WAY | DRYDEN | 1 | | 12 |
| S559 | 4/9/93 | MAGUIRE FORD-FIRE;T-BURG | 504 S.MEADOW | TRUMANSBURG | 5 | | 01 |
| S560 | 4/19/93 | C.BORD CO. | 61 BROWN RD. | ITHACA | 1 | | 01 |

| Map Id | Spill Date | Spill Name | Spill Street | Spill Municipality | Resource Effected | Waterbody | Spill Source |
|---|---|---|---|---|---|---|---|
| S561 | 4/21/93 | ANDRE PETROLEUM | 964 CAYUGA HEIGHTS ROAD | ITHACA | 1 | | 12 |
| S562 | 4/30/93 | SPECIAL CHILDREN'S CENTER | 210 ELMIRA | ITHACA | 1 | | 02 |
| S563 | 5/6/93 | 194 MUZZY RD. | 186-194 MUZZY RD. | DANBY | 1 | | 09 |
| S564 | 5/24/93 | THERM INC. | PENNSYLVANIA AVE. & KENDA | ITHACA | 4 | | 12 |
| S565 | 5/27/93 | CARGILL | 191 PORTLAND PT. RD. | LANSING | 1 | | 01 |
| S566 | 6/14/93 | 2027 HANSHAW RD. | 2027 HANSHAW RD. | DRYDEN | 1 | | 07 |
| S567 | 6/8/93 | 503 HANCOCK ST. | 503 HANCOCK ST. | ITHACA | 2 | | 02 |
| S568 | 6/16/93 | ALEXANDER BRIDGE-TAYLOR | RTE.26 NEAR ALEXANDER BRG | TAYLOR | 1 | | 08 |
| S569 | 6/16/93 | CASCADILLA ST | 803-805 CASCADILLA ST | ITHACA | 1 | | 01 |
| S570 | 6/17/93 | AMERSON POWER | 620 SOUTH AURORA ST | ITHACA | 1 | | 01 |
| S571 | 6/22/93 | 620 SOUTH AURORA ST. | 620 SOUTH AURORA ST. | ITHACA | 1 | | 07 |
| S572 | 6/25/93 | CITY OF ITHACA DPW | 245 PIER RD. | ITHACA | 3 | | 02 |
| S573 | 7/8/93 | ITHACA R CONSTRUCTION | ALBANY & CLINTON ST | ITHACA | 1 | | 02 |
| S574 | 7/15/93 | NICE AND EASY | 1321 DRYDEN ROAD | ITHACA | 1 | | 05 |
| S575 | 7/16/93 | 43 MYERS RD. | 43 MYERS RD. | LANSING | 1 | | 09 |
| S576 | 12/17/92 | 1834 DRYDEN RD. | 1834 DRYDEN RD. | DRYDEN | 1 | | 12 |
| S577 | 7/22/93 | NORTHWOOD APT. COMPLEX | 700 WARREN RD. | LANSING | 5 | | 01 |
| S578 | 7/29/93 | 191 PORTLAND PT. RD. | 191 PORTLAND PT. RD. | LANSING | 1 | | 07 |
| S580 | 8/6/93 | 602 WEST SENECA ST. | 602 W.SENECA ST. | ITHACA | 5 | | 01 |
| S581 | 8/23/93 | 20 HARVEY HILL RD. | 20 HARVEY RD. | ENDFIELD | 1 | | 09 |
| S582 | 10/28/93 | CLOCK & DEKLEW | 1609 TRUMANSBURG RD. | ITHACA | 3 | | 01 |
| S583 | 11/19/93 | 741 COMFORT RD. - DANBY | 741 COMFORT RD. | DANBY | 1 | | 08 |
| S584 | 11/28/93 | MORSE INDUSTRY | 620 AURORA ST | ITHACA | 4 | CAYUGA OUTLET | 01 |
| S585 | 11/29/93 | 30 ATWATER RD. - LANSING | 30 ATWATER RD. | LANSING | 4 | | 12 |
| S586 | 12/9/93 | 34 HALSEYVILLE RD. | 34-46 HALSEYVILLE RD.O | ENFIELD | 1 | | 09 |
| S587 | 12/10/93 | HANSHAW RD. | RT 13 & HANSHAW RD. | DRYDEN | 1 | | 06 |
| S588 | 1/5/93 | CARGILL SALT | 191 PORTLAND PT. RD. T79 | LANSING | 1 | | 07 |
| S589 | 1/25/94 | GOODRICH RESIDENCE | 139 ENFIELD CTR. TERRACE | ENFIELD | 1 | | 09 |
| S591 | 3/8/94 | S.P.C.A. - HANSHAW RD. | 1640 HANSHAW RD. | ITHACA | 1 | | 02 |
| S592 | 2/21/94 | PETER STRATAKOS | 362 WEST KING RD | ITHACA | 1 | | 09 |
| S593 | 3/8/94 | BIG AL'S HILLTOP QUICKSTO | 1103 DANBY RD. | ITHACA | 1 | | 05 |
| S594 | 3/22/94 | SALT RD | 579 SALT RD | GROTON | 1 | | 09 |
| S595 | 3/24/94 | 818 SNYDER HILL RD. | 818 SNYDER HILL RD. | ITHACA | 1 | | 08 |
| S596 | 3/29/94 | ADVANCE MOVING CO. | 500 LOWER CREEK RD | DRYDEN | 1 | | 01 |
| S597 | 3/31/94 | 194 LUDLOWVILLE RD. | 194 LUDLOWVILLE RD. | LUDLOWVILLE | 1 | | 09 |
| S598 | 4/4/94 | ITHACA/INLET ISLAND | 506TAUGHANNOCK FALLS BLVD | ITHACA | 1 | | 12 |
| S599 | 4/15/94 | FALL CREEK BRIDGE | RT.366-FALL CREEK BRIDGE | DRYDEN | 1 | FALL CREEK | 07 |
| S600 | 4/17/94 | COLE RESIDENCE | 1613 RIDGE RD | LANSING | 1 | | 09 |
| S601 | 11/2/93 | 6 F'VILLE RD. GTE- DRYDEN | 6 FREEVILLE RD. | DYRDEN | 3 | | 01 |
| S602 | 4/23/94 | COLLINS RD | 96 COLLINS RD | LANSING | 1 | | 09 |
| S603 | 4/26/94 | 1228 ELLIS HOLLOW RD. | 1228 ELLIS HOLLOW RD. | DRYDEN | 4 | | 09 |
| S606 | 5/11/94 | CASCADILLA TREE CARE | 629 HIGHLAND RD. | CAYUGA HEIGHTS | 4 | TRIB TO FALL CREEK | 01 |
| S607 | 5/13/94 | 413 SNYDER HILL RD. | 413 SNYDER HILL RD. | ITHACA | 4 | | 12 |
| S608 | 5/26/94 | CARGILL INC.- TANK REMOVA | 191 PORTLAND PT. RD. | LANSING | 1 | | 01 |
| S609 | 5/27/94 | 725 CHAMPLIN RD. - GROTON | 725 CHAMPLIN RD. | GROTON | 1 | | 09 |
| S611 | 6/16/94 | COOKE RESIDENCE | 38 DEERHAVEN ST. | ITHACA, N.Y. | 1 | | 09 |
| S612 | 6/30/94 | 191 PORTLAND PT. RD. | 191 PORTLAND PT.RD.-SHAFT | LANSINGT | 1 | | 01 |
| S613 | 6/26/94 | MONROE AUTO-1798 W.DANBY | 1798 WEST DANBY RD | NEWFIELD | 4 | | 01 |
| S614 | 7/14/94 | WEST VILLAGE APTS. COMPLX | 702 CHESNBUT ST. | ITHACA | 1 | | 01 |
| S615 | 7/18/94 | WEST SHORE GAS & GROCERY | 1400 TAUGHANNOCK BLVD. | ITHACA | 1 | | 01 |
| S616 | 7/18/94 | WATER ST.-CHLOROX SPILL | 202 WATER ST. | ITHACA | 1 | SIX MILE CREEK | 01 |
| S617 | 7/26/94 | 539 WARREN RD.- MAJERONI | 539 WARREN RD. | ITHACA | 1 | | 09 |
| S618 | 7/15/94 | EMERSON POWER TRNSMISSION | 620 S. AURORA ST. | ITHACA, N.Y. | 1 | | 01 |
| S619 | 7/22/94 | 150 BOSTWICK RD.-ITHACA | 150 BOSTWICK RD. | ITHACA | 1 | | 02 |
| S621 | 8/5/94 | JOHNSONS BOATYARD | 101 PIER RD. | ITHACA | 4 | CAYUGA LAKE | 01 |
| S622 | 8/14/94 | COOKS FARM | 114 IRIS SETTLEMENT ROAD | DRYDEN | 1 | | 08 |
| S623 | 8/16/94 | 355 SNYDER HILL RD. | 355 SNYDER HILL RD. | ITHACA | 1 | | 09 |
| S624 | 8/3/94 | 204;206;208 DRYDEN RD. | 204;206;208 DRYDEN RD. | ITHACA | 1 | | 01 |
| S626 | 8/27/94 | RYAN RESIDENCE | 44 N.LANSING SCHOOL RD. | LANSING | 3 | | 12 |
| S627 | 8/29/94 | 202 KING ST. - ITHACA | 202 KING ST. | ITHACA | 1 | | 02 |
| S628 | 8/24/94 | PARKWOOD VILLAGE TRAILER | 1871 HANSHAW | ITHACA | 1 | | 01 |
| S629 | 9/8/94 | CARGILL INC.- CAYUGA MINE | 191 PORTLAND PT. RD. | LANSING | 1 | | 01 |
| S630 | 9/9/94 | IRISH SETTLEMENT RD | 114 IRISH SETTLEMENT RD | DRYDAN | 1 | | 09 |
| S631 | 9/8/94 | CARGILL | 191 PORTLAND PT RD | LANSING | 1 | | 01 |
| S633 | 9/20/94 | GANETT HEALTH CENTER | 10 CENTRAL AVE | ITHACA | 1 | | 02 |
| S634 | 10/5/94 | NEWMAN RD. & VANOSTRAND | NEWMAN & VAN OSTRAND RD. | LANSING | 1 | | 01 |
| S635 | 10/6/94 | 107 ROSS RD. | 107 ROSS RD. | LANSING | 4 | TRIB /CAYUGA LAKE | 01 |
| S636 | 10/7/94 | 254 GENUG RD. | 254 GENUG RD. | ITHACA | 1 | | 09 |
| S637 | 10/21/94 | CARGILL - PORTLAND PT. R | 191 PRTLAND PT. RD. | LANSING | 1 | | 01 |
| S638 | 11/9/94 | 1959 MECKLENBURG RD. | 1959 MECKLENBURG RD. | ENFIELD | 1 | | 06 |
| S639 | 11/11/94 | 212 CHIPMAN RD. | 212 CHIPMAN RD. | GROTON | 1 | | 01 |
| S640 | 11/25/94 | 190 LANSINGVILLE RD. | 190 LANSINGVILLE RD. | LANSINGVILLE | 1 | | 09 |
| S641 | 11/26/94 | 190 LANSINGVILLE RD. | 190 LANSINGVILLE RD. | LANSING | 4 | | 12 |
| S642 | 12/12/94 | CARGILL T-4 WAREHOUSE | 191 PORTLAND PT. RD. | LANSING | 1 | | 01 |
| S643 | 12/12/94 | SWARTHOUT & FERRIS | 115 GRAHAM RD. | ITHACA | 1 | | 01 |
| S644 | 12/15/94 | 1283 TAUGHANOCK RD. | 1283 TAUGHANNOCK BLVD. | ULYSSES | 1 | | 12 |
| S645 | 1/10/95 | HARRIS DAYTON RES.-FREEVI | 30 JOHNSON ST. | FREEVILLE | 1 | | 04 |
| S646 | 1/9/95 | 110 CAMPBELL RD. - ZIMROT | 110 CAMPBELL RD. | ITHACA | 1 | | 09 |
| S647 | 1/12/95 | 700 S.MEADOW ST. -ITHACA | 700 S.MEADOW ST. | ITHACA | 3 | | 01 |
| S648 | 1/31/95 | NICHOL BLOCK CORP. | 327 ELMIRA RD. | ITHACA | 1 | | 01 |
| S650 | 1/19/95 | UHAUL- 343 ELMIRA RD. | 343 ELMIRA RD. | ITHACA | 1 | TRIB CAYUGA LAKE | 01 |
| S651 | 3/9/95 | A-PLUS;112 S.MEADOW ST. | 112 SOUTH MEADOW ST. | ITHACA | 1 | | 05 |
| S652 | 3/17/95 | A-PLUS | 112 SOUTH MEADOW | ITHACA | 1 | | 05 |
| S653 | 3/24/95 | ITHACA PUBLIC WORKS | CASCADILLA & ESTY ST. | ITHACA | 1 | | 12 |
| S654 | 4/3/95 | STORM SEWER DISCHARGE | CHERRY ST & CLINTON ST. | ITHACA | 2 | | 12 |
| S655 | 4/11/95 | 798 CASCADILLA ST. | 798 CASCADILLA ST. | ITHACA | 1 | | 01 |
| S656 | 4/23/95 | 123 COLLINS RD. | 123 COLLINS RD. | FREEVILLE | 1 | | 02 |
| S657 | 4/14/95 | 108 HORIZON DRIVE | 108 HORIZON DRIVE | LANSING | 3 | | 12 |
| S658 | 5/2/95 | 125 COLLINS RD. | 123 COLLINS RD. | LANSING | 1 | | 09 |
| S659 | 6/5/95 | 2080 ELMIRA RD. | 2080 ELMIRA RD. | NEWFIELD | 1 | | 09 |
| S660 | 6/5/95 | 47 TAGGERT RD. -COON RES. | 47 TAGGERT RD. | NEWFIELD | 1 | | 09 |
| S661 | 6/7/95 | CAYUGA CRUSHED STONE | 87 PORTLAND POINT RD | LANSING | 3 | UNNAMED POND | 07 |
| S662 | 6/8/95 | WILLOW HILL MOBIL COURT. | 146 SHEFFIELD RD.-LOT #30 | ENFIELD | 1 | | 09 |
| S663 | 6/28/95 | CASCADILLA GORGE -GREEN | COURT ST. & LYNN ST | ITHACA | 4 | CASCADILLA CREEK | 12 |
| S665 | 7/27/95 | NYSEG-MILLIKEN STATION | 228 MILLIKEN RD. | LANSING | 1 | | 01 |
| S666 | 6/19/95 | 363 ELMIRA RD. | 363 ELMIRA RD. | ITHACA | 1 | | 01 |
| S667 | 8/31/95 | 23 N. VAN DORN RD. | 23 N. VAN DORN RD. | ENFIELD | 4 | | 01 |
| S669 | 9/12/95 | 66 MUZZY RD. | 66 MUZZY RD. | ITHACA | 1 | | 09 |
| S670 | 9/20/95 | | 318-322 WEST STATE ST | ITHACA | 1 | | 05 |
| S671 | 10/12/95 | WILLIAM WHYTE RES | 1 SUNDOWN RD | ITHACA | 1 | | 09 |
| S672 | 10/15/95 | 74 WEST JERSEY HILL RD | 74 WEST JERSEY HILL RD | DANBY | 4 | LICKBROOK CREEK | 06 |
| S673 | 10/19/95 | GOODYEAR/COLE MUFFLER | 227 ELMIRA ROAD | ITHACA NY | 1 | | 01 |
| S674 | 10/18/95 | DEC INLET IN ITHACA | 122 COMMERCIAL AVE | ITHACA | 4 | INLET TO CAYUGA LK | 07 |
| S675 | 11/8/95 | GROTON HIGHWAY DEPARTMENT | 101 CONGER BOULEVARD | GROTON | 1 | | 01 |
| S676 | 12/11/95 | CAYUGA MEDICAL CENTER | 101 DATES DR | ITHACA | 1 | | 02 |
| S677 | 12/15/95 | | 30 RENWICK HIGHTS RD | ITHACA | 1 | | 09 |
| S678 | 12/18/95 | CORNELL UNIVERSITY | 726 UNIVERSITY AVE | ITHACA | 1 | | 02 |
| S679 | 12/22/95 | ASPHALT DRIVEWAY & LAWN | 100 WEST HAVEN ROAD | ITHACA | 1 | | 06 |
| S680 | 11/30/95 | ROAD CONSTRUCTION SITE | NORTH & SOUTH FULTON STRE | ITHACA | 1 | | 12 |
| S681 | 1/9/96 | | 1234 ELLIS HOLLOW RD | ITHACA | 1 | | 09 |
| S682 | 1/14/96 | MILLIKEN STATION | 228 MILLIKEN RD | LANSING | 1 | | 01 |
| S683 | 6/5/95 | ST. PAULS METHODIST CHURC | 402 N. AURORA | ITHACA | 1 | | 02 |
| S684 | 1/19/96 | RECIDENCE | 642 CODDINGTON ROAD | ITAHCA | 1 | | 09 |
| S685 | 2/7/96 | WOODCHUCK REASEARCH LAB | 925 WARREN RD | ITHACA | 1 | | 12 |
| S686 | 2/21/96 | BOLTER CREEK | 56D - CURRY RD | TRUMANSBURG | 4 | BOLTER CREEK | 12 |
| S687 | 3/6/96 | CARGILL SALT | 191 PORTLAND PT RD | LANSING | 1 | | 02 |
| S688 | 4/26/96 | DRAINAGE DITCH | 2254 HANSHAW RD | DRYDEN | 1 | | 06 |
| S689 | 4/30/96 | EMERSON POWER TRANSMISSIO | 620 SOUTH AURORA ST | ITHACA | 1 | | 01 |
| S690 | 4/30/96 | ITHACA COLLEGE | 953 DANBY RD | ITHACA | 1 | | 02 |
| S691 | 5/15/96 | ITHACA CITY SCHOOLS LOT | 400 LAKE ST | ITHACA | 1 | | 07 |
| S692 | 6/19/96 | | 191 PORTLAND POINT RD | LANSING | 1 | | 07 |

| Map Id | Spill Date | Spill Name | Spill Street | Spill Municipality | Resource Effected | Waterbody | Spill Source |
|---|---|---|---|---|---|---|---|
| S693 | 6/19/96 | | 811 MIDLINE ROAD | FREEVILLE | 1 | | 09 |
| S694 | 6/24/96 | CONVINENCE STORE | 201 W SENECA ST | ITHACA | 1 | | 05 |
| S695 | 7/8/96 | LYON RESIDENCE | 275 ETNA RD | DRYDEN | 1 | | 09 |
| S696 | 7/24/96 | CARGIL SALT | 191 CORTLAND POINT RD | LANSING | 1 | | 07 |
| S697 | 7/23/96 | TOMPKINS COUNTY AIRPORT | 72 BROWN RD | LANSING | 3 | | 01 |
| S698 | 9/8/96 | BIG AL'S | KING RD & DANBY RD. | ITHACA | 1 | | 05 |
| S699 | 9/16/96 | EMERSON POWER TRANSMISSIO | 620 SOUTH AURORA ST | ITHACA | 1 | | 01 |
| S700 | 9/18/96 | ITHACA COLLEGE | 101 CAMPUS SAFTY BLDG | ITHACA | 1 | | 01 |
| S701 | 10/11/96 | CAYUGA HTS FD | 194 PLEASANT GROVE RD | CAYUGA HTS | 1 | | 02 |
| S702 | 11/8/96 | 105 WINTHROP DR | 105 WINTHROP DR | ITHACA | 4 | UNKNOWN | 12 |
| S703 | 11/5/96 | JAMES INMAN RESIDENCE | 32 LOCKERBY RD | LANSING | 3 | | 12 |
| S704 | 11/10/96 | FINGER LAKES MARINA | 44 MARINA RD | LANSING | 4 | CAYUGA LAKE | 10 |
| S705 | 12/2/96 | DENNIS BOWERS GARAGE | 255 IRADELL RD | ENFIELD | 1 | | 02 |
| S706 | 12/16/96 | NYNEX | COURT & ALLEN ST | ITHACA | 1 | | 01 |
| S707 | 1/7/97 | ITHACA COURT BLDG | 120 EAST CLINTON | ITHACA | 1 | | 02 |
| S708 | 1/23/97 | IN A LITTLE BANK | BRICKYARD & LUDLOWVILLE | LANSING | 3 | | 12 |
| S709 | 2/8/97 | CARGILL SALT | 191 PORTLAND POINT RD | LANSING | 1 | | 01 |
| S710 | 3/6/97 | DPW STREETS & FACILITIES | 245 PIER RD | ITHACA | 3 | | 02 |
| S712 | 4/15/97 | MUKA RESIDENCE | 145 DASSANCE RD | NEWFIELD | 1 | | 09 |
| S713 | 5/8/97 | | 2021 ELLIS HOLLOW RD | ITHACA | 1 | | 09 |
| S714 | 5/20/97 | ALLEYWAY BETWEEN | 206 WILLIAMS/123 HIGHLAND | ITHACA | 5 | | 06 |
| S716 | 5/27/97 | TOWN OF GROTON HWY GARAGE | 101 CONGER BLVD | GROTON | 1 | | 02 |
| S717 | 6/5/97 | LOTT RESIDENCE | 445 SOUTH VANDORN RD | ENFIELD | 1 | | 09 |
| S718 | 6/10/97 | CAYUGA LAKE | 1105 TAUGHANNOCK BLVD | ULYESSES | 4 | CAYUGA LAKE | 12 |
| S719 | 7/14/97 | POLE #31 LINE #512 | 288 BEAN HIL RD | FREEVILLE | 1 | | 01 |
| S720 | 7/28/97 | WILLIAM T PRITCHARD | 304 SOUTH CAYUGA ST | ITHACA | 1 | | 01 |
| S721 | 8/21/97 | | GREEN ST & S AURORA ST | ITHACA | 1 | | 07 |
| S722 | 9/25/97 | BRIDGE | 120 E. CLINTON ST | ITHACA | 4 | SIX MILE CREEK | 12 |
| S723 | 10/14/97 | REBECCA GOLDING | 434 CENTRAL CHAPEL | BROOKENDALE | 1 | | 12 |
| S724 | 10/28/97 | CARGILL SALT | 191 PORTLAND POINT RD | LANSING | 1 | | 01 |
| S725 | 10/30/97 | DANBY FACILITY | 54 GUNDERMAN RD | DANBY | 1 | | 02 |
| S726 | 11/3/97 | CAYUGA INLET | 104 BUTTERMILK FALLS RD | ITHACA | 4 | CAYUGA CREEK | 12 |
| S727 | 11/13/97 | MONROE MUFFLER | 338 ELMIRA ROAD | ITHACA | 1 | | 05 |
| S728 | 11/19/97 | 2102 MECKLENBURG ROAD | 2102 MECKLENBURG ROAD | ENFIELD | 1 | | 07 |
| S730 | 12/8/97 | | 107 KIRK RD | FREEVILLE | 1 | | 09 |
| S731 | 12/18/97 | 311 DRYDEN HARTFORD RD | 311 DRYDEN HARTFORD RD | DRYDEN | 1 | | 09 |
| S732 | 12/12/97 | ITHACA OP GROUP | 10 ARROWWOOD DRIVE | ITHACA | 2 | | 01 |
| S733 | 12/24/97 | COUNTRY CLUB OF ITHACA | 189 PLEASANT GROVE ROAD | ITHACA | 1 | | 01 |
| S734 | 1/4/98 | RESIDENCE | 594 SNYDER HILL RD | ITHACA | 1 | | 09 |
| S735 | 1/27/98 | U HALL | 343 ELMIRA RD | ITHACA | 3 | | 02 |
| S736 | 2/2/98 | WALKER RESIDENCE | 225 ELDRIGE RD | LANSING | 1 | | 09 |
| S738 | 2/18/98 | CAYUGA CRUSHED STONE | 11 PORTLAND POINT RD | LANSING | 1 | | 01 |
| S739 | 2/18/98 | NYSEG | 228 MILLIKAN RD | LANSING | 2 | | 12 |
| S740 | 3/8/98 | WEBER RESIDENCE | 1028 CODDINGTON RD | ITHACA | 1 | | 09 |
| S741 | 3/12/98 | NYSEG | 228 MILLIKEN RD | LANSING | 1 | | 01 |
| S742 | 4/27/98 | | 152 SCOFIELD RD | FREEVILLE | 1 | | 12 |
| S743 | 4/23/98 | POTTER RESIDENCE | 23 MINEAH RD | FREEVILLE | 1 | | 09 |
| S744 | 7/1/98 | ITHICA CENTRAL SCHOOL BUS | 150 BOSTWICK RD | ITHICA | 1 | | 02 |
| S746 | 7/15/98 | CAYUGA STREET | 304 SO CAYUGA ST | ITHACA | 1 | | 01 |
| S747 | 7/24/98 | ITHACA COLLEGE | 953 DANBY RD | ITHACA | 2 | | 01 |
| S748 | 8/13/98 | AGWAY | 702 HANCOX ST | ITHACA | 1 | | 03 |
| S749 | 8/26/98 | C AND G TRANSMISSION | 219 ELLIS HOLLOW CREEK RD | ITHACA | 3 | | 01 |
| S750 | 8/27/98 | 24 SOUTH ST | 24 SOUTH ST | TRUMANSBURG | 1 | | 09 |
| S751 | 9/3/98 | CHUCK'S MOBIL | 540 WEST STATE ST | ITHACA | 1 | | 07 |
| S752 | 9/24/98 | DEWITT MIDDLE SCHOOL | 560 WARREN RD | ITHACA | 1 | | 02 |
| S754 | 10/2/98 | HIGH VOLTAGE LAB | 909 MITCHELL ST | ITHICA | 1 | | 02 |
| S755 | 10/8/98 | WOOLWORTHS DEPT STORE | 115 E. GREEN ST | ITHICA | 1 | | 12 |
| S759 | 7/5/89 | YAW, CLIFF | SEARSBURY & BURR ROAD | HECTOR | 3 | | 09 |
| S764 | 5/30/89 | SIDELINGER HOUSE | 3133 GRACIE RD | CORTLANDVILLE | 3 | | 09 |
| S784 | 6/30/87 | BARNARD/GENOA | 1025 RT 34 | GENOA | 3 | | 12 |
| S785 | 12/1/87 | WILCOX GENERAL STORE | RTE 34B & LEDYARD ROAD | LEDYARD | 3 | WELL | 05 |
| S788 | 6/26/91 | SCIPIO CENTER POST OFFICE | 3411 STATE ROUTE 34 | SCIPIO CENTER | 3 | | 02 |
| S789 | 2/7/92 | CHILSON RESIDENCE | 139 RIVER RD | CAYUGA | 1 | | 08 |
| S791 | 12/27/92 | 3351 RTE 34 | 3351 RT 34 | SCIPPIO CENTER | 1 | | 12 |
| S793 | 2/22/93 | MAHANEY RD | 215 MAHANEY RD | KING FERRY | 1 | | 09 |
| S795 | 1/27/94 | RT.90 & RT 34B | RT90 & RT 34B | KINGS FERRY | 1 | | 07 |
| S796 | 4/19/94 | TUREK FARMS | 1952 SHERWOOD RD | AURORA | 1 | | 08 |
| S798 | 2/16/95 | 139 RIVER ROAD | 139 RIVER RD | CAYUGA | 1 | | 08 |
| S799 | 12/14/95 | | 537 LEVANNA RD | AURORA | 1 | | 09 |
| S801 | 3/17/97 | HOME | 1777 INDIAN FIELD ROAD | GENOA | 1 | | 09 |
| S802 | 6/2/97 | REAR OF | 2694 CENTER RD | SCIPIO CENTER | 4 | | 05 |
| S803 | 4/7/98 | FIELD BEHIND RESIDENCE | 3454 ROUTE 34 | SCIPIO CENTER | 5 | | 09 |

Resource Affected
1-On Land
2-In Sewer
3-Groundwater
4-Surface Water
5-Air

Source Name
05 Gasoline Station
06 Passenger Vehicle
07 Commercial Vehicle
08 Tank Truck
09 Private Dwelling
10 Vessel
11 Railroad Car
04 Non Major Facility > 1,100 gal
03 Major Facility > 400,000 gal
01 Other Commercial/Industrial
02 Other Noncommercial/Industrial
12 Unknown

Source: NYSDEC

**Table 3.9.1**
**Industrial Process**

| Process | Toxic or Hazardous Components |
|---|---|
| Asphalt plants | Petroleum derivatives |
| Communications equipment manufacturers | Nitric, hydrochloric, and sulfuric acid wastes, heavy metal sludges, copper contaminated etchant, cutting oil and degreasing solvent, waste oils, corrosive soldering flux, paint sludge, waste plating solution |
| Electric and electronic equipment manufacturers and storage facilities | Cyanides, metal sludges, caustics, solvents, oils, alkalis, acids, paints and paint sludges, calcium fluorides sludges, methylene chloride, perchloroethylene, trichloroethane, anetone, methanol, toluene, PCBs |
| Electroplaters | Boric, hydrochloric, hydrofluoric and sulfuric acids; sodium and potassium hydroxide; chromic acid; sodium and hydrogen cyanide; metallic salts |
| Foundries and metal fabricators | Paint wastes, acids, heavy metals, metal sludges, plating wastes, oils, solvents, explosive wastes |
| Furniture and fixtures manufactures | Paints, solvents, degreasing sludges, solvent recovery sludges |
| Machine and metalworking shops | Solvents, metals, miscellaneous organics, sludges, oily metal shavings, lubricant and cutting oils, degreasers, metal marking fluids, mold-release agents |
| Paper mills | Metals, acids, minerals, sufides, other hazardous and nonhazardous chemicals, organic sludges, sodium hydroxide, chlorine, hypochlorite, chlorine dioxide, hydrogen peroxide |
| Petroleum production and storage companies, secondary recovery of petroleum | Hydrocarbons, oil-field brines |
| Plastics materials and synthetics producers | Solvents, oils, miscellaneous organics and inorganics, paint wastes, cynides, acids, alkalis, wastewater treatment sludge, cellulose esters, surfactant, glycols, phenols, formaldehyde, peroxides |
| Primary metal industries | Heavy metal wastewater treatment sludge, pickling liquor, waste oil, ammonia, scrubber liquor, acid tar sludge, alkaline cleaners, degreasing solvents, slag, metal dust |
| Public utilities | PCBs from transformers and capacitors, oils, solvents, sludges, acid solution, metal plating solutions, herbicides |
| Sawmills and planers | Treated wood residue (copper quinolate, mercury, sodium bazide), tanner gas, paint sludges, solvents, creosote, coating and gluing wastes |
| Stone, clay, and glass manufacturers | Solvents, oils and grease, alkalis, acetic wastes, asbestos, heavy metal sludges, phenolic solids or sludges, metal-finishing sludges |
| Welders | Oxygen, acetylene |
| Wood preserving facilities | Wood preservatives, creosote |
| Source: Adapted from EPA Seminar Publication EPA/625/R-93/002, 1993 | |

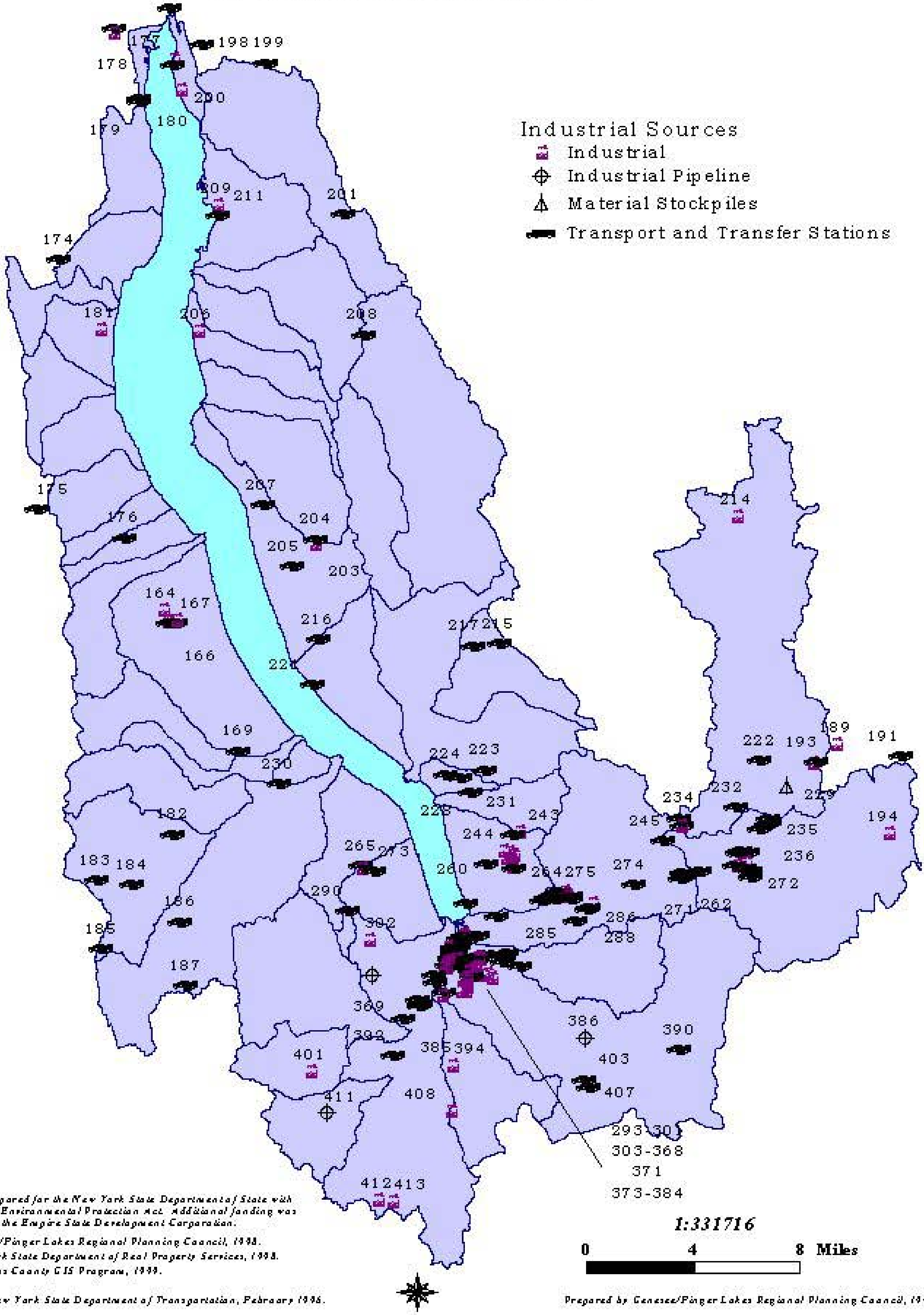
NYSDEC lists over 330 wells in the watershed. These include dry wells, brine wells, stratigraphic wells, and gas development and extension wells (see Table 3.9.1). As Map 3.9.1 indicates, these wells are fairly well dispersed throughout the watershed, with a pronounced density of over 70% in the northeast portion in the Aurelius, Fleming, Springport area. These are mainly active gas wells. Approximately 5% of the wells in the watershed are brine wells, almost all of which are in the Town of Lansing. Approximately 18% of the wells in the watershed are dry wells, approximately 25% of which are plugged and abandoned.

*Mines and mining operations*
The effect on downgradient waters depends on how long the mine has been in operation and the type of mined material. Abandoned mines are often used as wells and waste pits, sometimes simultaneously. In addition, mines are sometimes pumped to keep them dry; the pumping can cause an upward migration of contaminated groundwater.

Based on NYSDEC data, there are approximately 30 mines in the watershed (see Table 3.9.4). The vast majority of these (all but 3) are sand and gravel mines. As Map 3.9.2 indicates the majority of the mines are in the southern and southeastern portions of the watershed. Sand and gravel mining poses the greatest threat to water resources. Because of their relatively permeable nature, sand and gravel deposits are generally coincident with recharge areas. In order to mine these deposits, the topsoil is first removed, eliminating an important buffer zone between the ground surface and the underlying aquifer. Lowering the ground surface decreases the relative depth of the water table, thereby making it more susceptible to contamination from mining apparatus and vehicles. The loss of vegetation exposes sediment, making it more easily removable by wind and surface runoff.

*Industrial pipelines* include corrosive fluids, hydrocarbons, other hazardous and nonhazardous materials and wastes. Sewer pipes carrying wastes sometimes leak fluids into the surrounding soil and groundwater. Sewage consists of organic matter, inorganic salts, heavy metals, bacteria, viruses, and nitrogen (USEPA 1990). Other pipelines carrying industrial chemicals and oil brine have also been known to leak, especially when the materials transported through the pipes are corrosive. NYSDEC data indicates that there are three of these pipelines in the watershed (see Table 3.9.2).

# Cayuga Lake Watershed
# Industrial Sources




*This map was prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.*

*Source: Genesee/Finger Lakes Regional Planning Council, 1998.*
*New York State Department of Real Property Services, 1998.*
*Tompkins County GIS Program, 1999.*

*Base Map: New York State Department of Transportation, February 1996.*

*Prepared by Genesee/Finger Lakes Regional Planning Council, 1999.*

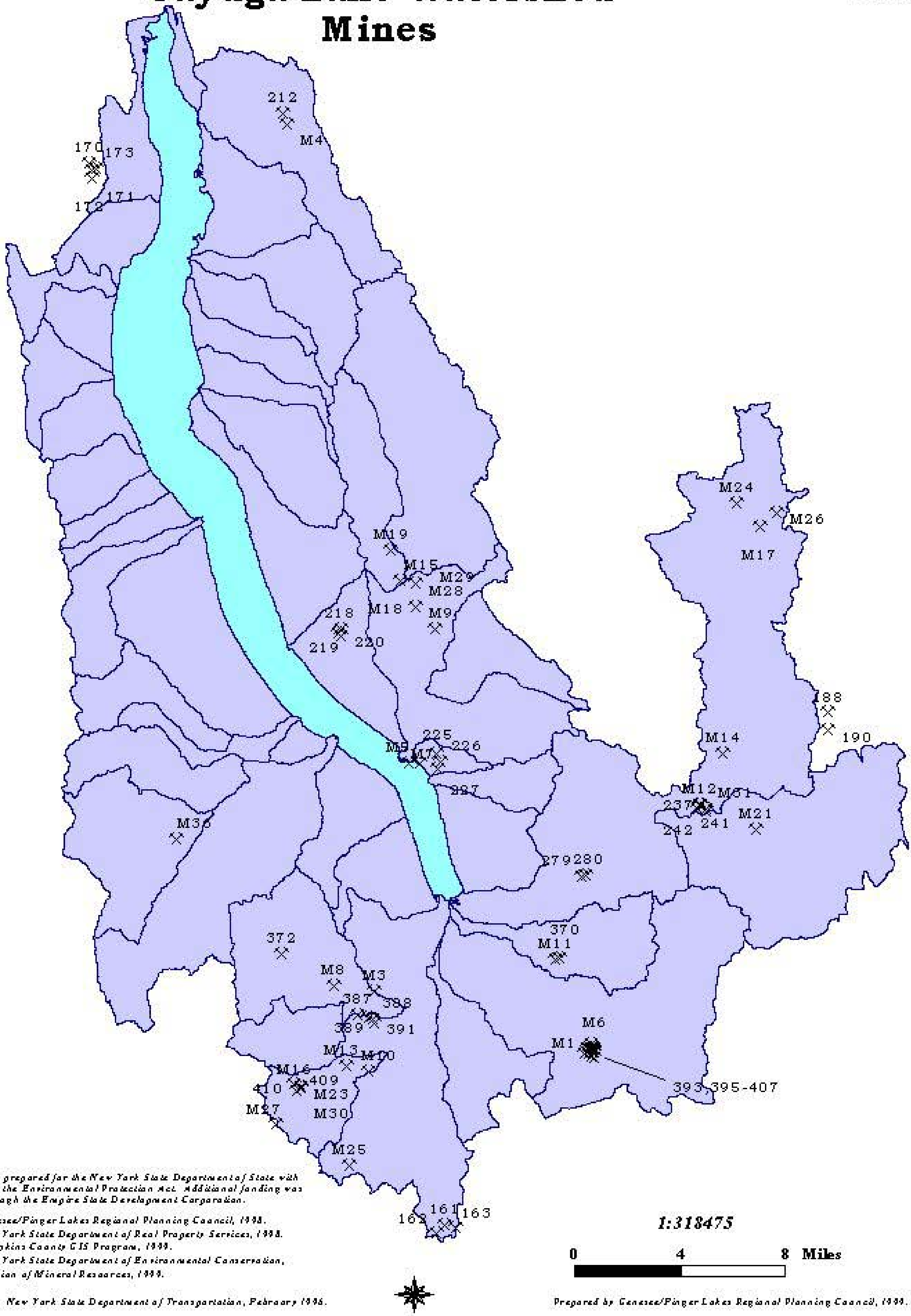
**Table 3.9.2**
**Industrial Sources**

| Map Id | Owner | Municipality State | Acres | Property Type | Property Classification |
|---|---|---|---|---|---|
| 164 | HIPSHOT PRODUCTS INC. | INTERLAKEN, NY | 10.20 | Manufacturing & Processing | Industrial |
| 165 | KEMPF JR FRANK B & | TRUMANSBURG NY | 0.29 | Manufacturing & Processing | Industrial |
| 166 | GRANT MARJORIE | TRUMANSBURG NY | 0.07 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 167 | ISA POULTRY FARM INC | ITHACA NY | 1.30 | Distribution Warehouse | Transport and Transfer Stations |
| 168 | C/O PINE TREE INC | INTERLAKEN NY | 2.20 | Manufacturing & Processing | Industrial |
| 169 | WEATHERBY ROBERT A | TRUMANSBURG NY | 49.10 | Warehouse | Transport and Transfer Stations |
| 174 | DINSMORE JAMES | SENECA FALLS NY | 0.24 | Multiple Use/Multipurpose | Transport and Transfer Stations |
| 175 | KOKE LLOYD | OVID NY | 0.32 | Distribution Warehouse | Transport and Transfer Stations |
| 176 | SWANK WILLIAM | OVID NY | 6.70 | Vacant Land | Transport and Transfer Stations |
| 177 | FINGER LAKES COCA COLA BOTTLING | ROCHESTER NY | 2.00 | Distribution Warehouse | Transport and Transfer Stations |
| 178 | RIDGEVIEW INC | NEWTON NC | 37.10 | Manufacturing & Processing | Industrial |
| 179 | MONTEVERDIWILLIAM A & GLADY'S | SENECA FALLS NY | 1.40 | Multiple Use/Multipurpose | Transport and Transfer Stations |
| 180 | MOREHOUSE JULIA B | SENECA FALLS NY | 0.55 | Distribution Warehouse | Transport and Transfer Stations |
| 181 | LAKESHORE WINERY INC | ROMULUS,NEW YORK | 52.43 | Manufacturing & Processing | Industrial |
| 182 | SPINGARN, RICHARD & PENNY | TRUMANSBURG, NY | 54.00 | Vacant Land | Transport and Transfer Stations |
| 183 | WIERNICKI, INC. | TRUMANSBURG, NY | 155.50 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 184 | FLETCHER, WILLIAM J. | TRUMANSBURG, NY | 0.93 | Distribution Warehouse | Transport and Transfer Stations |
| 185 | KELLY, DAVID & MARY | BURDETT, NY | 2.50 | Vacant Land | Transport and Transfer Stations |
| 186 | CONOVER, MICHAEL | MECKLENBURG, NY | 0.20 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 187 | J. WILLIAM KENNEY | TRUMANSBURG, NY | 7.21 | Distribution Warehouse | Transport and Transfer Stations |
| 189 | MONARCH MACHINE TOOL | CORTLAND NY | 46.37 | Manufacturing & Processing | Industrial |
| 191 | HENRY KEITH W | ELGINSC | 0.00 | Multiple Use/Multipurpose | Transport and Transfer Stations |
| 192 | DISTRIBUTOR DATA FORMS, INC. | CORTLAND NY | 2.53 | Manufacturing & Processing | Industrial |
| 193 | FERRO DENISE E | CORTLANDNY | 8.20 | Distribution Warehouse | Transport and Transfer Stations |
| 194 | JENNEY RICHARD C | CORTLAND NY | 0.00 | Multiple Use/Multipurpose | Industrial |
| 195 | HANFORD GEORGE & PATRICIA | FAIR HAVENNY | 0.00 | Manufacturing & Processing | Industrial |
| 196 | BEACON BAY ENTERPRISES | CAYUGA N Y | 7.80 | Cold Storage Facilities | Transport and Transfer Stations |
| 197 | CAYUGA BULK SERVICE INC | CAYUGA N Y | 4.90 | Trucking Terminal | Transport and Transfer Stations |
| 198 | CASLER MICHAEL & SUSAN | CAYUGA N Y | 1.00 | Distribution Warehouse | Transport and Transfer Stations |
| 199 | KELLY ALAN | AUBURN N Y | 6.40 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 200 | IDE EDWARD JR & LORI | CAYUGA N Y | 7.78 | Manufacturing & Processing | Industrial |
| 201 | WOOD WAYNE E. | UNION SPRINGS N Y | 4.50 | Vacant Land | Transport and Transfer Stations |
| 202 | MILLER BREWING CORP. | MILWAUKEE WI | 0.00 | Gas Wells | Well Drilling Operations |
| 203 | STOCKTON DALE-MAY ORIN | KING FERRY N Y | 9.50 | Manufacturing & Processing | Industrial |
| 204 | RANDALL RANDY & LINDA | GROTONNY | 0.00 | Distribution Warehouse | Transport and Transfer Stations |
| 205 | SALTONSTALL PETER & TACIE | KING FERRYNY | 5.30 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 206 | MAC KENZIE-CHILDS RICHARD | AURORANY | 42.00 | Manufacturing & Processing | Industrial |
| 207 | MYERS DAVID | GENOANY | 2.20 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 208 | BROWN MICHAEL | SCIPIO CENTERNY | 2.70 | Cold Storage Facilities | Transport and Transfer Stations |
| 209 | TRW INC. | UNION SPRINGSNY | 12.20 | Manufacturing & Processing | Industrial |
| 210 | CHURCHNY CONFERENCE | SYRACUSE,NY | 0.00 | Gas Wells | Well Drilling Operations |
| 211 | DONLON CHARLES & FRANCES | VESTALNY | 0.00 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 213 | MORGAN ARTHUR-DIENER,ER | TOLEDO, OH | 0.00 | Wells | Well Drilling Operations |
| 214 | CAYUGA COUNTY IDA | AUBURNNY | 2.60 | Manufacturing & Processing | Industrial |
| 215 | STRAUF, GLENN L & LINDA J | LOCKE NY | 6.06 | Trucking Terminal | Transport and Transfer Stations |
| 216 | COOK, RICHARD A | LANSING, NY | 1.10 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 217 | STRAUF, GLENN L & LINDA J | LOCKE, NY | 29.02 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 221 | BISHOP, SCOTT W | LANSING NY | 0.27 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 222 | CONVERSE, JUANITA D | MCLEAN NY | 0.75 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 223 | PAUSLEY, JOHN J | AUBURN, NY | 13.00 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 224 | BESEMER, THOMAS | LANSING NY | 5.90 | Trucking Terminal | Transport and Transfer Stations |
| 228 | OTTENSCHOT, MARTIN L | LANSING NY | 1.05 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 229 | POSO, JOHN R | DRYDEN NY | 0.45 | Coal Yards, Bins | Material Stockpiles |
| 230 | HILKER, WILLIS & SHIRLEY | ITHACA NY | 1.95 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 231 | JONES, RICHARD C JR | LANSING NY | 0.78 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 232 | BENICOR INC | ELMIRA NY | 46.95 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 233 | WESCOTT, DONALD | SHERBURNE, NY | 3.84 | Trucking Terminal | Transport and Transfer Stations |
| 234 | LA POINT, DAVID R | FREEVILLE, NY | 4.91 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 235 | HICKS, ERIC J & STEPHEN B | DRYDEN NY | 5.48 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 236 | LILLEY, ROBERT C | MARATHON NY | 1.92 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 238 | WHITE, PHILIP JR & MARY M | ITHACA NY | 1.07 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 239 | CLARK, BRIAN C & THOMAS W | DRYDEN NY | 2.75 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 240 | WHITE, PHILIP JR & MARY M | ITHACA NY | 0.00 | Manufacturing & Processing | Industrial |
| 243 | TOMPKINS COUNTY I D A | ITHACA NY | 9.03 | Manufacturing & Processing | Industrial |
| 244 | NEWBANY CORP | ATLANTA GA | 2.69 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 245 | WERNINCK, L & SONS SUPPLY | FREEVILLE NY | 2.20 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 246 | MAK INDUSTRIES INC | DRYDEN NY | 23.00 | Cold Storage Facilities | Transport and Transfer Stations |
| 247 | MAK INDUSTRIES INC | DRYDEN NY | 23.00 | Cold Storage Facilities | Transport and Transfer Stations |
| 248 | WHITMORE, FRED & SERRI | DRYDEN NY | 3.44 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 249 | TOMPKINS COUNTY I D A | ITHACA, NY | 40.82 | Manufacturing & Processing | Industrial |
| 250 | MAK INDUSTRIES INC | DRYDEN NY | 23.00 | Cold Storage Facilities | Transport and Transfer Stations |
| 251 | TOMPKINS COUNTY I D A | ITHACA, NY | 13.36 | Manufacturing & Processing | Industrial |
| 252 | B W TRANSMISSION & ENG COMPONENTS | ITHACA, NY | 26.49 | Manufacturing & Processing | Industrial |
| 253 | B W TRANSMISSION & ENG COMPONENTS | ITHACA, NY | 26.49 | Manufacturing & Processing | Industrial |
| 254 | TOMPKINS COUNTY I D A | ITHACA, NY | 11.67 | Manufacturing & Processing | Industrial |
| 255 | RENT A SPACE CORP | DRYDEN NY | 3.25 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 256 | KOCH, JAMES V & TERRY J | DRYDEN, NY | 0.00 | Manufacturing & Processing | Industrial |
| 257 | TOMPKINS COUNTY I D A | ITHACA, NY | 21.01 | Manufacturing & Processing | Industrial |
| 258 | RENT A SPACE CORP | DRYDEN NY | 1.96 | Manufacturing & Processing | Industrial |
| 259 | RENT A SPACE CORP | DRYDEN NY | 1.96 | Manufacturing & Processing | Industrial |
| 260 | MAY, MONTGOMERY | ITHACA, NY | 1.80 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 261 | RENT A SPACE CORP | DRYDEN NY | 0.00 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 262 | LORENZEN, ROBERT T | DRYDEN NY | 0.00 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 263 | TOMPKINS COUNTY I D A | ITHACA, NY | 7.54 | Manufacturing & Processing | Industrial |
| 264 | CORNELL UNIVERSITY | LANSING NY | 2.30 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 265 | DIRTY BIRD CO | ITHACA, NY | 7.10 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 266 | ROTUNDA, EUGENE D | FREEVILLE NY | 0.67 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 267 | MIX, DENNIS J & NATHAN | FREEVILLE, NY | 7.35 | Trucking Terminal | Transport and Transfer Stations |
| 268 | OSBURN, DAVID A ET AL | BERKSHIRE NY | 3.05 | Storage, Warehouse & Distribution | Industrial |
| 269 | RENT A SPACE CORP | DRYDEN NY | 1.37 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 270 | RENT A SPACE CORP | DRYDEN NY | 1.37 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 271 | CUTIA, RICHARD T | ETNA, NY | 10.87 | Cold Storage Facilities | Transport and Transfer Stations |
| 272 | SHERMAN, ROSS | DRYDEN, NY | 0.00 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 273 | TSELEKIS, GEORGE | ITHACA, NY | 1.31 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 274 | MARTIN, FRED A & DEANS | FREEVILLE NY | 8.83 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 275 | CAYUGA PARTNERS | E HILLS, NY | 11.85 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 276 | WILCOX, GENE & JEANNETTE | ITHACA NY | 1.00 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 277 | CAYUGA PRESS OF ITHACA | ITHACA NY | 2.23 | Manufacturing & Processing | Industrial |
| 278 | LUCENTE, ROCCO | ITHACA, NY | 33.04 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 281 | J C LEASING CO | ITHACA NY | 8.54 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 282 | TOMPKINS COUNTY I D A | ITHACA NY | 5.25 | Manufacturing & Processing | Industrial |
| 283 | J C LEASING CO | ITHACA NY | 8.54 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 284 | SCHUG, PETER & JOSEPHINE | ITHACA NY | 5.95 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 285 | LUCENTE, ROCCO | ITHACA, NY | 33.04 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 286 | TOMPKINS COUNTY I D A | ITHACA NY | 21.95 | Manufacturing & Processing | Industrial |
| 287 | LOWERY, JOHN C | ITHACA, NY | 1.38 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 288 | WATSON, MARK | DRYDEN, NY | 2.90 | Storage, Warehouse & Distribution | Transport and Transfer Stations |

| Map Id | Owner | Municipality State | Acres | Property Type | Property Classification |
|---|---|---|---|---|---|
| 289 | PRUDENCE, FRANK L & TONI | ITHACA NY | 2.16 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 290 | FISK,TERRANCE J & TERRY J | ITHACA NY | 1.52 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 291 | VILLAGE OF CAYUGA HGTS | ITHACA NY | 3.50 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 292 | BELLISARIO, NICHOLAS | ITHACA NY | 4.00 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 293 | STATE STREET ASC | ITHACA NY | 2.65 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 294 | CITY OF ITHACA | ITHACA NY | 2.50 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 295 | PAOLANGELI, FRANCIS J | ITHACA NY | 0.00 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 296 | PAOLANGELI, FRANCIS J | ITHACA NY | 0.00 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 297 | LANSING RESEARCH CORP | ITHACA NY | 0.28 | Manufacturing & Processing | Industrial |
| 298 | LANSING INSTRUMENT CORP | ITHACA NY | 0.18 | Manufacturing & Processing | Industrial |
| 299 | CITY OF ITHACA | ITHACA NY | 10.39 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 300 | ALBANESE, ANTHONY | ITHACA NY | 0.00 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 301 | BENJAMIN, HOYT D | ITHACA NY | 1.12 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 302 | RUMSEY, STANLEY | ITHACA NY | 0.00 | Manufacturing & Processing | Industrial |
| 303 | CORNELL UNIVERSITY | ITHACA, NY | 2.50 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 304 | GIORDANO, VINCENT | LANSING NY | 0.00 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 305 | GIORDANO, VINCENT | LANSING NY | 1.65 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 306 | FREEDMAN, MARVIN J | ITHACA NY | 1.15 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 307 | GIORDANO, VINCENT | LANSING NY | 0.00 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 308 | CORNELL UNIVERSITY | ITHACA NY | 1.79 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 309 | LIGUORI, DANIEL | ITHACA NY | 0.00 | Manufacturing & Processing | Industrial |
| 310 | RICK, GLENN | ITHACA NY | 0.50 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 311 | IRVING D BOOTH INC | ELMIRA NY | 0.00 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 312 | CORNELL UNIVERSITY | ITHACA NY | 1.00 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 313 | FREEDMAN, MARVIN & BERTHA | ITHACA NY | 0.34 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 314 | FRIENDS/TOMP CO PUBLIC LIBRARY | ITHACA NY | 0.00 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 315 | BENEDICT, VALENTINE | ITHACA NY | 0.00 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 316 | WATT, WILLIAM J | ITHACA NY | 0.00 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 317 | HAAG, MARK W | ITHACA NY | 0.00 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 318 | CORNELL UNIVERSITY | ITHACA NY | 0.00 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 319 | CORNELL UNIVERSITY | ITHACA NY | 0.45 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 320 | ZAHARIS, PETER | ITHACA NY | 0.31 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 321 | CHALLENGE INDUSTRIES | ITHACA NY | 0.59 | Manufacturing & Processing | Industrial |
| 322 | GOLDBERG FAMILY FUND | TRUMANSBURG, NY | 0.00 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 323 | POTOMAC CAPITAL INVEST. | ITHACA NY | 0.00 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 324 | MIX, SUSAN J | ITHACA, NY | 2.06 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 325 | COLTON, KATHRYN E TRUST | JAMESVILLE NY | 0.00 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 326 | DICKINSON, DONALD W | ITHACA NY | 0.51 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 327 | WILCOX PRESS INC | ITHACA NY | 2.29 | Manufacturing & Processing | Industrial |
| 328 | DICKINSON, DONALD W | ITHACA NY | 0.51 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 329 | WILCOX PRESS INC | ITHACA NY | 0.00 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 330 | WILCOX PRESS INC | ITHACA NY | 0.00 | Manufacturing & Processing | Industrial |
| 331 | WILCOX PRESS INC | ITHACA NY | 2.29 | Manufacturing & Processing | Industrial |
| 332 | GREEN STREET ASC INC | ITHACA NY | 0.00 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 333 | GREEN STREET ASC INC | ITHACA NY | 0.00 | Manufacturing & Processing | Industrial |
| 334 | AGWAY INC | SYRACUSE NY | 0.26 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 335 | WALLACE, NEIL | ITHACA NY | 5.62 | Manufacturing & Processing | Industrial |
| 336 | WALLACE, NEIL | ITHACA NY | 5.62 | Manufacturing & Processing | Industrial |
| 337 | GRANT, G EDWARD | HOMER NY | 1.14 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 338 | M A T PROPERTIES | ENDICOTT NY | 3.52 | Manufacturing & Processing | Industrial |
| 339 | BECKADAM, INC | OWEGO NY | 1.05 | Manufacturing & Processing | Industrial |
| 340 | MORGAN, MICHAEL & SUSAN D | ITHACA NY | 1.19 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 341 | CORNELL FEDERAL CREDIT UNION | ITHACA NY | 1.89 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 342 | MORGAN, MICHAEL & SUSAN D | ITHACA NY | 1.19 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 343 | WALLACE, NEIL | ITHACA NY | 1.27 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 345 | WALLACE, NEIL | ITHACA NY | 4.36 | Manufacturing & Processing | Industrial |
| 346 | WALLACE, NEIL | ITHACA NY | 4.36 | Manufacturing & Processing | Industrial |
| 347 | LUCENTE, DONALD J | ITHACA NY | 0.00 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 348 | WALLACE, NEIL | ITHACA NY | 4.36 | Manufacturing & Processing | Industrial |
| 349 | ITHACA URBAN RENEWAL | TRUMANSBURG NY | 0.69 | Manufacturing & Processing | Industrial |
| 350 | ITHACA URBAN RENEWAL | ITHACA NY | 0.80 | Manufacturing & Processing | Industrial |
| 351 | SCHWARTZ, FREDERICK E | ITHACA NY | 0.00 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 352 | ITHACA URBAN RENEWAL | ITHACA NY | 2.88 | Manufacturing & Processing | Industrial |
| 353 | EMERSUB IV INC | ITHACA NY | 31.00 | Manufacturing & Processing | Industrial |
| 354 | ITHACA URBAN RENEWAL | ITHACA NY | 1.48 | Manufacturing & Processing | Industrial |
| 355 | EMERSUB IV INC | ITHACA NY | 31.00 | Manufacturing & Processing | Industrial |
| 356 | EMERSUB IV INC | ITHACA NY | 31.00 | Manufacturing & Processing | Industrial |
| 357 | EMERSUB IV INC | ITHACA NY | 31.00 | Manufacturing & Processing | Industrial |
| 358 | EMERSUB IV INC | ITHACA NY | 31.00 | Manufacturing & Processing | Industrial |
| 359 | EMERSUB IV INC | ITHACA NY | 31.00 | Manufacturing & Processing | Industrial |
| 360 | EMERSUB IV INC | ITHACA NY | 31.00 | Manufacturing & Processing | Industrial |
| 361 | EMERSUB IV INC | ITHACA NY | 31.00 | Manufacturing & Processing | Industrial |
| 362 | THERM INC | ITHACA, NY | 22.84 | Manufacturing & Processing | Industrial |
| 363 | THERM INC | ITHACA, NY | 22.84 | Manufacturing & Processing | Industrial |
| 364 | THERM INC | ITHACA, NY | 22.84 | Manufacturing & Processing | Industrial |
| 365 | FISH, HAROLD A JR | ITHACA NY | 3.00 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 366 | EMERSUB IV INC | ITHACA, NY | 63.30 | Manufacturing & Processing | Industrial |
| 367 | EMERSUB IV INC | ITHACA NY | 31.00 | Manufacturing & Processing | Industrial |
| 368 | WEAVER, LAWRENCE E | ITHACA NY | 0.00 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 369 | MOBIL OIL CORP | DALLAS TX | 0.00 | Gas Pipeline | Industrial Pipeline |
| 371 | EMERSUB IV INC | ITHACA NY | 31.00 | Manufacturing & Processing | Industrial |
| 373 | IAL INC | ITHACA NY | 0.44 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 374 | AXIOHM IBP INC | ITHACA NY | 59.96 | Manufacturing & Processing | Industrial |
| 375 | AXIOHM IBP INC | ITHACA NY | 59.96 | Manufacturing & Processing | Industrial |
| 376 | AXIOHM IBP INC | ITHACA NY | 10.77 | Manufacturing & Processing | Industrial |
| 377 | AXIOHM IBP INC | ITHACA NY | 10.77 | Manufacturing & Processing | Industrial |
| 378 | AXIOHM IBP INC | ITHACA NY | 10.77 | Manufacturing & Processing | Industrial |
| 379 | PAN, MICHAEL & NANCY M | ITHACA NY | 1.22 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 380 | MANCINI REALTY | ITHACA, NY | 85.99 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 381 | EVAPORATED METAL FILMS | ITHACA NY | 0.00 | Manufacturing & Processing | Industrial |
| 382 | IACOVELLI BROS CONTR CO | ITHACA NY | 0.79 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 383 | LIGUORI, DANIEL F | ITHACA, NY | 1.50 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 384 | LIGUORI, DANIEL | ITHACA NY | 1.44 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 385 | SHELDRAKE, RAYMOND JR | ITHACA NY | 2.53 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 386 | TEXAS EASTERN PRODUCTS PIPELINE CO | HOUSTON TX | 0.00 | Gas Pipeline | Industrial Pipeline |
| 390 | BARD, BRUCE H | BROOKTONDALE NY | 0.90 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 392 | PARK, CHANG HO | FREEVILLE, NY | 2.43 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 394 | TOMPKINS COUNTY IDA | ITHACA, NY | 6.38 | Manufacturing & Processing | Industrial |
| 401 | BERRENBERG, JOHN & TERRI | NEWFIELD NY | 3.19 | Manufacturing & Processing | Industrial |
| 403 | ARSENAULT, L & MARION M | BROOKTONDALE NY | 80.45 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 407 | ARSENAULT, L & MARION M | BROOKTONDALE NY | 80.45 | Storage, Warehouse & Distribution | Transport and Transfer Stations |
| 408 | ENGELHART, MATTHEW | SPENCER NY | 26.90 | Manufacturing & Processing | Industrial |
| 411 | CNG TRANSMISSION CORP | CLARKSBURG, WV | 0.00 | Gas Pipeline | Industrial Pipeline |
| 412 | DERIDDER, J FRANKLIN | NEWFIELD NY | 60.40 | Manufacturing & Processing | Industrial |
| 413 | GERHART, TOM | NEWFIELD NY | 35.48 | Manufacturing & Processing | Industrial |

Source: NYSORPS

# Cayuga Lake Watershed Mines



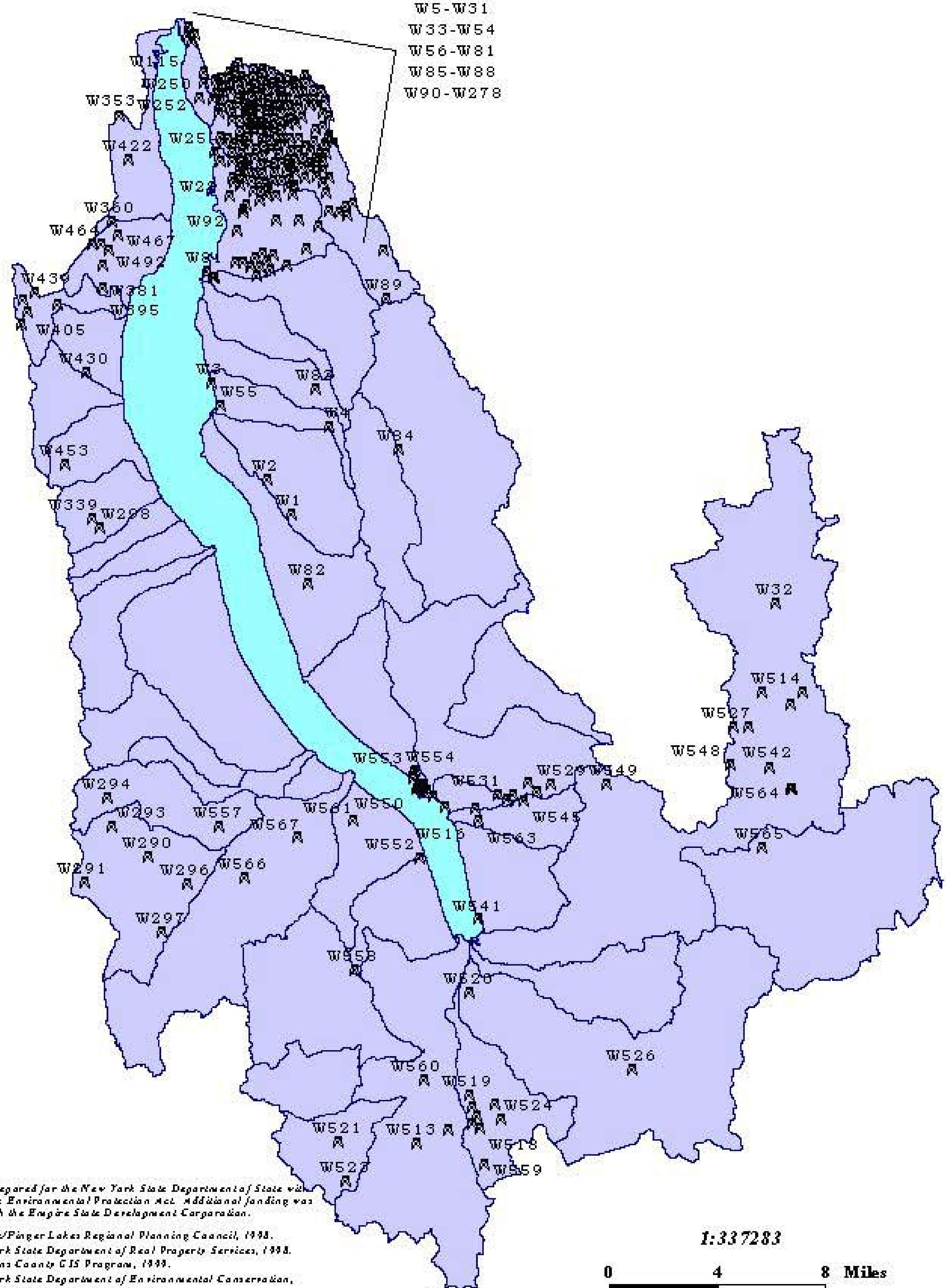

This map was prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.

Source: Genesee/Finger Lakes Regional Planning Council, 1998.
New York State Department of Real Property Services, 1998.
Tompkins County GIS Program, 1999.
New York State Department of Environmental Conservation, Division of Mineral Resources, 1999.

Base Map: New York State Department of Transportation, February 1996.

Prepared by Genesee/Finger Lakes Regional Planning Council, 1999.

# Cayuga Lake Watershed Wells




This map was prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.

Source: Genesee/Finger Lakes Regional Planning Council, 1998.
New York State Department of Real Property Services, 1998.
Tompkins County GIS Program, 1999.
New York State Department of Environmental Conservation, Division of Mineral Resources, 1999.

Base Map: New York State Department of Transportation, February 1996.

Prepared by Genesee/Finger Lakes Regional Planning Council, 1999.

**Table 3.9.3**
**Wells**

| Map Id | Well Type | Well Status | Well Municipality | Map Id | Well Type | Well Status | Well Municipality |
|---|---|---|---|---|---|---|---|
| W1 | DW | UN | LEDYARD | W52 | GE | AC | AURELIUS |
| W2 | DW | UN | LEDYARD | W53 | GE | AC | AURELIUS |
| W3 | SG | UN | LEDYARD | W54 | GW | AC | AURELIUS |
| W4 | DW | UN | VENICE | W55 | GW | AC | LEDYARD |
| W6 | DH | UN | AURELIUS | W56 | GD | AC | SPRINGPORT |
| W7 | GD | AC | SPRINGPORT | W57 | GE | AC | AURELIUS |
| W8 | GD | AC | SPRINGPORT | W58 | GE | AC | AURELIUS |
| W9 | GD | AC | AURELIUS | W59 | GE | AC | AURELIUS |
| W10 | GD | AC | AURELIUS | W60 | GD | AC | AURELIUS |
| W11 | GD | AC | AURELIUS | W61 | GE | AC | AURELIUS |
| W12 | GD | AC | AURELIUS | W63 | GE | AC | AURELIUS |
| W13 | GD | AC | AURELIUS | W66 | GW | AC | AURELIUS |
| W15 | GD | PA | SPRINGPORT | W67 | GW | AC | AURELIUS |
| W16 | GD | AC | SPRINGPORT | W68 | GD | AC | AURELIUS |
| W17 | GD | AC | SPRINGPORT | W69 | GD | AC | AURELIUS |
| W18 | GD | AC | SPRINGPORT | W70 | GE | AC | AURELIUS |
| W19 | GD | AC | SPRINGPORT | W71 | GE | AC | AURELIUS |
| W20 | DH | PA | AURELIUS | W72 | GE | AC | AURELIUS |
| W21 | GE | AC | SPRINGPORT | W73 | GE | AC | AURELIUS |
| W22 | GE | IN | SPRINGPORT | W74 | GE | AC | AURELIUS |
| W23 | GE | AC | SPRINGPORT | W76 | GE | AC | AURELIUS |
| W24 | GE | IN | SPRINGPORT | W78 | GE | AC | AURELIUS |
| W25 | GD | AC | SPRINGPORT | W79 | GD | AC | AURELIUS |
| W26 | GD | AC | SPRINGPORT | W80 | GD | AC | SPRINGPORT |
| W27 | GD | AC | SPRINGPORT | W81 | GD | AC | SPRINGPORT |
| W28 | GD | AC | SPRINGPORT | W82 | DW | PA | GENOA |
| W29 | GD | AC | AURELIUS | W83 | GW | AC | LEDYARD |
| W30 | GD | AC | AURELIUS | W84 | DW | PA | VENICE |
| W31 | GD | AC | FLEMING | W85 | GE | IN | SPRINGPORT |
| W32 | GW | AC | SUMMERHILL | W87 | GE | AC | AURELIUS |
| W33 | GD | AC | SPRINGPORT | W88 | GE | AC | SPRINGPORT |
| W34 | GD | AC | AURELIUS | W89 | DW | PA | SCIPIO |
| W35 | GD | AC | SPRINGPORT | W90 | GW | AC | SCIPIO |
| W36 | GE | AC | SPRINGPORT | W91 | GD | AC | SPRINGPORT |
| W37 | GE | AC | AURELIUS | W92 | DH | PA | SPRINGPORT |
| W39 | GD | AC | AURELIUS | W93 | GD | AC | SPRINGPORT |
| W40 | GE | AC | AURELIUS | W94 | GD | AC | SPRINGPORT |
| W41 | GE | AC | AURELIUS | W96 | GD | AC | SPRINGPORT |
| W43 | GE | AC | SPRINGPORT | W100 | GD | AC | AURELIUS |
| W44 | DH | PA | SPRINGPORT | W102 | GD | AC | SPRINGPORT |
| W45 | GD | AC | SPRINGPORT | W107 | GD | AC | AURELIUS |
| W46 | GD | AC | SPRINGPORT | W108 | GD | AC | SPRINGPORT |
| W47 | GE | AC | SPRINGPORT | W109 | GD | AC | SPRINGPORT |
| W48 | GD | AC | SPRINGPORT | W114 | GD | AC | AURELIUS |
| W49 | GW | AC | SPRINGPORT | W115 | GD | PA | AURELIUS |
| W50 | GD | IN | SPRINGPORT | W116 | GD | PA | AURELIUS |

| Map Id | Well Type | Well Status | Well Municipality | Map Id | Well Type | Well Status | Well Municipality |
|---|---|---|---|---|---|---|---|
| W51 | GD | AC | SPRINGPORT | W117 | GD | AC | AURELIUS |
| W118 | GD | AC | AURELIUS | W170 | GD | IN | SPRINGPORT |
| W119 | GD | PA | AURELIUS | W171 | GD | AC | SPRINGPORT |
| W120 | GD | AC | SPRINGPORT | W173 | GD | AC | AURELIUS |
| W121 | GD | AC | SPRINGPORT | W174 | GD | AC | SPRINGPORT |
| W122 | GD | AC | SPRINGPORT | W175 | GD | AC | AURELIUS |
| W123 | GD | AC | AURELIUS | W176 | GD | AC | AURELIUS |
| W124 | GD | AC | AURELIUS | W177 | GD | AC | AURELIUS |
| W125 | GD | AC | AURELIUS | W178 | GD | AC | SPRINGPORT |
| W126 | GD | AC | AURELIUS | W179 | GD | AC | SPRINGPORT |
| W127 | GD | AC | AURELIUS | W180 | GD | AC | SPRINGPORT |
| W128 | GD | AC | AURELIUS | W181 | GD | AC | SPRINGPORT |
| W129 | GD | AC | AURELIUS | W182 | GD | AC | SPRINGPORT |
| W130 | GD | AC | AURELIUS | W183 | GD | AC | SPRINGPORT |
| W131 | GD | AC | AURELIUS | W184 | GD | AC | SPRINGPORT |
| W132 | GD | AC | AURELIUS | W186 | GD | AC | SPRINGPORT |
| W133 | GD | AC | AURELIUS | W187 | GD | AC | SPRINGPORT |
| W134 | GD | AC | AURELIUS | W188 | GD | AC | SPRINGPORT |
| W135 | GD | AC | AURELIUS | W191 | GD | AC | SPRINGPORT |
| W136 | GD | AC | AURELIUS | W192 | GD | AC | AURELIUS |
| W137 | GD | AC | AURELIUS | W193 | GD | AC | AURELIUS |
| W138 | GD | AC | SPRINGPORT | W194 | GD | AC | AURELIUS |
| W139 | GD | AC | SPRINGPORT | W195 | GD | AC | SPRINGPORT |
| W140 | GD | AC | SPRINGPORT | W196 | GD | AC | SPRINGPORT |
| W141 | GD | AC | SPRINGPORT | W197 | GD | AC | SPRINGPORT |
| W142 | GD | AC | SPRINGPORT | W198 | GD | AC | AURELIUS |
| W143 | GD | AC | SPRINGPORT | W199 | GD | AC | FLEMING |
| W144 | GD | AC | SPRINGPORT | W200 | GE | IN | SPRINGPORT |
| W145 | GD | AC | SPRINGPORT | W201 | GD | AC | AURELIUS |
| W146 | GD | AC | SPRINGPORT | W202 | GD | AC | SPRINGPORT |
| W147 | GD | AC | SPRINGPORT | W203 | GD | AC | AURELIUS |
| W148 | GD | AC | SPRINGPORT | W204 | GD | AC | SPRINGPORT |
| W149 | GD | AC | SPRINGPORT | W205 | GD | AC | SPRINGPORT |
| W150 | GD | AC | SPRINGPORT | W207 | GD | AC | AURELIUS |
| W151 | GD | AC | SPRINGPORT | W208 | GD | AC | AURELIUS |
| W152 | GD | AC | SPRINGPORT | W209 | GD | AC | AURELIUS |
| W153 | GD | AC | SPRINGPORT | W210 | GD | AC | AURELIUS |
| W154 | GD | AC | SPRINGPORT | W212 | GD | AC | FLEMING |
| W155 | GD | AC | SPRINGPORT | W213 | GD | AC | FLEMING |
| W156 | GD | AC | SPRINGPORT | W214 | GD | AC | SPRINGPORT |
| W157 | GD | AC | SPRINGPORT | W215 | GD | AC | FLEMING |
| W158 | GD | AC | SPRINGPORT | W217 | GD | AC | SPRINGPORT |
| W159 | GD | AC | SPRINGPORT | W219 | GD | AC | FLEMING |
| W160 | GD | AC | SPRINGPORT | W220 | GD | AC | SPRINGPORT |
| W161 | GD | AC | SPRINGPORT | W221 | GD | AC | SPRINGPORT |
| W162 | GD | AC | SPRINGPORT | W222 | GD | AC | AURELIUS |
| W163 | GD | AC | SPRINGPORT | W223 | GD | AC | SPRINGPORT |
| W165 | GD | AC | AURELIUS | W224 | GD | AC | AURELIUS |
| W167 | GD | AC | SPRINGPORT | W226 | GD | AC | SPRINGPORT |

| Map Id | Well Type | Well Status | Well Municipality |
|---|---|---|---|
| W168 | GD | AC | FLEMING |
| W169 | GD | AC | SPRINGPORT |
| W229 | GD | AC | SPRINGPORT |
| W230 | GE | AC | SPRINGPORT |
| W231 | GD | AC | SPRINGPORT |
| W232 | GD | AC | SPRINGPORT |
| W233 | GD | AC | SPRINGPORT |
| W235 | GD | AC | SPRINGPORT |
| W236 | GD | AC | FLEMING |
| W238 | GE | AC | SPRINGPORT |
| W239 | GD | AC | FLEMING |
| W240 | GD | AC | AURELIUS |
| W241 | GD | AC | FLEMING |
| W244 | GD | AC | SPRINGPORT |
| W245 | GD | AC | SPRINGPORT |
| W246 | GD | AC | AURELIUS |
| W247 | GD | AC | FLEMING |
| W248 | GE | AC | FLEMING |
| W249 | GD | AC | AURELIUS |
| W250 | GD | AC | AURELIUS |
| W251 | GD | AC | AURELIUS |
| W252 | GE | AC | AURELIUS |
| W253 | GD | AC | AURELIUS |
| W255 | GD | AC | FLEMING |
| W256 | GD | AC | FLEMING |
| W257 | GD | AC | SPRINGPORT |
| W258 | GD | AC | FLEMING |
| W259 | GD | AC | FLEMING |
| W260 | GE | AC | FLEMING |
| W261 | GD | AC | FLEMING |
| W262 | GE | AC | SPRINGPORT |
| W263 | GD | AC | SPRINGPORT |
| W264 | GD | AC | SPRINGPORT |
| W265 | GE | AC | SPRINGPORT |
| W266 | GE | PA | SPRINGPORT |
| W267 | GD | AC | FLEMING |
| W268 | GD | AC | SPRINGPORT |
| W269 | GD | AC | SPRINGPORT |
| W270 | GD | AC | SPRINGPORT |
| W271 | GD | AC | SPRINGPORT |
| W272 | GD | AC | AURELIUS |
| W273 | GD | AC | SPRINGPORT |
| W274 | GD | AC | SPRINGPORT |
| W275 | GD | AC | AURELIUS |
| W276 | GD | AC | AURELIUS |
| W277 | GD | AC | AURELIUS |
| W278 | GD | AC | AURELIUS |
| W290 | DW | UN | HECTOR |
| W291 | DW | UN | HECTOR |
| W227 | GD | AC | SPRINGPORT |
| W228 | GD | AC | SPRINGPORT |
| W297 | DW | TA | HECTOR |
| W298 | DW | UN | OVID |
| W339 | DW | UN | OVID |
| W353 | GE | UN | SENECA FALLS |
| W360 | GD | AC | FAYETTE |
| W381 | GD | AC | FAYETTE |
| W395 | GD | AC | VARICK |
| W405 | GD | AC | VARICK |
| W422 | GD | IN | FAYETTE |
| W430 | GD | AC | VARICK |
| W432 | GD | AC | VARICK |
| W435 | GD | AC | VARICK |
| W439 | GD | AC | VARICK |
| W440 | GD | AC | VARICK |
| W453 | GW | PA | ROMULUS |
| W455 | GE | AC | FAYETTE |
| W464 | GD | AC | FAYETTE |
| W467 | GE | AC | FAYETTE |
| W492 | GD | AC | FAYETTE |
| W511 | DH | PA | FAYETTE |
| W512 | DH | PA | FAYETTE |
| W513 | DW | UN | NEWFIELD |
| W514 | DW | UN | GROTON |
| W515 | DW | UN | GROTON |
| W516 | DW | UN | LANSING |
| W517 | GW | PA | DANBY |
| W518 | DH | UN | DANBY |
| W519 | DW | UN | DANBY |
| W520 | DW | UN | ITHACA |
| W521 | DW | UN | NEWFIELD |
| W522 | DW | UN | DANBY |
| W523 | DW | UN | NEWFIELD |
| W524 | DW | UN | DANBY |
| W525 | DW | UN | DANBY |
| W526 | DW | UN | CAROLINE |
| W527 | DW | UN | GROTON |
| W529 | DW | UN | DRYDEN |
| W531 | GW | UN | LANSING |
| W537 | DH | UN | LANSING |
| W538 | DW | UN | LANSING |
| W539 | GD | UN | LANSING |
| W540 | DW | UN | LANSING |
| W541 | BR | UN | ITHACA |
| W542 | DW | UN | GROTON |
| W543 | DW | UN | GROTON |
| W544 | SG | UN | LANSING |
| W545 | DW | UN | LANSING |

| Map Id | Well Type | Well Status | Well Municipality |
|---|---|---|---|
| W293 | DW | UN | HECTOR |
| W294 | DW | UN | HECTOR |
| W296 | DW | PA | HECTOR |
| W549 | DW | UN | DRYDEN |
| W550 | BR | PA | LANSING |
| W551 | BR | PA | LANSING |
| W552 | BR | UN | ULYSSES |
| W553 | BR | PA | LANSING |
| W554 | BR | PA | LANSING |
| W555 | DW | PA | DANBY |
| W556 | DH | UN | DANBY |
| W557 | DW | UN | ULYSSES |
| W558 | DW | UN | ENFIELD |
| W559 | DW | UN | DANBY |
| W560 | DW | UN | NEWFIELD |
| W561 | DW | PA | ULYSSES |
| W563 | SG | PA | LANSING |
| W564 | DW | PA | GROTON |
| W565 | DW | PA | DRYDEN |
| W566 | | | ULYSSES |
| W567 | | | ULYSSES |
| W568 | | | DRYDEN |
| W569 | | | DRYDEN |
| W570 | BR | PA | LANSING |
| W571 | BR | PA | LANSING |
| W572 | BR | PA | LANSING |
| W573 | BR | PA | LANSING |
| W574 | BR | PA | LANSING |
| W575 | BR | PA | LANSING |
| W576 | BR | PA | LANSING |
| W577 | BR | PA | LANSING |
| W578 | BR | PA | LANSING |
| W579 | BR | PA | LANSING |
| W580 | BR | PA | LANSING |
| W581 | BR | PA | LANSING |
| W582 | BR | PA | LANSING |
| W583 | BR | PA | LANSING |
| W584 | BR | PA | LANSING |
| W585 | BR | PA | LANSING |

| Map Id | Well Type | Well Status | Well Municipality |
|---|---|---|---|
| W546 | DW | UN | LANSING |
| W547 | DW | PA | LANSING |
| W548 | DW | UN | GROTON |

DW - Dry Wildcat Straight Well
BR - Brine Straight Well
SG - Stratigraphic Straight Well
DH - Dry Hole Straight Well
GD - Gas Development Straight Well
GW - Gas Wildcat Straight
GDM - Gas Development Sidetracked Well
GE - Gas Extension Straight Well

| Map Id | Well Type | Well Status | Well Municipality | Map Id | Well Type | Well Status | Well Municipality |
|---|---|---|---|---|---|---|---|

AC - Active
UN - Unknown
PA - Plugged and Abandoned

Source: NYSDEC

*Industrial Processes* (see Table 3.9.1, Industrial Process). Most of the general industrial operations are classified as manufacturing and processing (see Table 3.9.2). The vast majority of them are in the southern portion of the watershed (Map 3.9.1).

Table 3.9.4a
Mines

Permitted Mines

| Map Id | Commodity Code | Mine Name | Total Acreage[1] | Reclaimed Acreage[2] | Net Affected Acres | Life of Mine Acres | Permittee Acres[3] | Recaimation Objective | Type of Permittee | Mine Status | Municipality |
|---|---|---|---|---|---|---|---|---|---|---|---|
| M1 | 30 | Brooktondale Pit | 53 | 0 | 53 | 59 | 90 | Lake | INDUSTRY | A | CAROLINE |
| M3 | 30 | Newfield Pit - Van Ostrand Road | 10 | 0 | 10 | 10 | 86 | Pasture Land | INDUSTRY | A | ENFIELD |
| M4 | 21 | Oakwood Quarry - Rt. 326 west of Ridge R | 43 | 0 | 43 | 225 | 235 | Basic | INDUSTRY | A | SPRINGPORT |
| M5 | 21 | Portland Point Quarry - Portland PointRD | 126 | 103 | 23 | 126 | 306 | Basic | INDUSTRY | A | LANSING |
| M6 | 30 | Perkins Road Mine - Perkins Road | 3 | 0 | 3 | 3 | 10 | Basic | TOWN | A | CAROLINE |
| M7 | 29 | Cayuga Salt Mine | 68 | 0 | 68 | 4951 | 4951 | RCL/B UG PLUG SHAFTS | INDUSTRY | A | LANSING |
| M8 | 30 | Bailey Pit - NYS Route 327 | 14 | 0 | 14 | 14 | 21 | Basic | INDUSTRY | A | ENFIELD |
| M9 | 30 | Twin Bridges Pit - Ludlowville Road | 21 | 10 | 11 | 21 | 96 | Basic | TOWN | E | LANSING |
| M10 | 30 | Tompkins Pit - Adams Road | 5 | 0 | 5 | 6 | 8 | Pasture land | TOWN | E | NEWFIELD |
| M11 | 31 | Finger Lakes Quarry, Ellis Hollow Road | 6 | 0 | 6 | 20 | 45 | Basic | INDUSTRY | A | DRYDEN |
| M12 | 30 | RMS GRAVEL - Bartlett Pit, Mott Road | 29 | 2 | 27 | 48 | 265 | Agricultural | INDUSTRY | A | DRYDEN |
| M13 | 30 | Taber Pit - NYS Route 13 | 3 | 0 | 3 | 16 | 135 | Agricultural use | INDUSTRY | A | NEWFIELD |
| M14 | 46 | Wolf Pit, 1 1/4 miles north of Rt 13Junc | 6 | 3 | 3 | 6 | 50 | RCL AC | INDUSTRY | A | DRYDEN |
| M15 | 30 | Center Road Gravel Mine | 7 | 0 | 7 | 12 | 167 | Basic | INDUSTRY | E | GENOA |
| M16 | 30 | Havlik Pit - Trumbulls Corners Road | 12 | 0 | 12 | 12 | 150 | Basic | TOWN | A | NEWFIELD |
| M17 | 30 | Ripley's Pit - NYS Route 41-A | 3 | 0 | 3 | 3 | 3 | Agricultural | TOWN | E | SUMMERHILL |
| M18 | 30 | Reeves Brothers Gravel Pit- Salmon Creek | 8 | 0 | 8 | 8 | 45 | Basic | INDUSTRY | E | GENOA |
| M19 | 30 | Genoa Sand and Gravel - Indian Field Rd. | 10 | 2 | 8 | 20 | 120 | Agricultural use | INDUSTRY | A | GENOA |
| M21 | 30 | Egypt Gravel Bank - Bradshaw Road | 3 | 0 | 3 | 3 | 85 | Equipment storage yard | TOWN | A | DRYDEN |
| M23 | 30 | Sayles Gravel Mine - NYS Route 13 | 7 | 0 | 7 | 16 | 28 | meadow | INDUSTRY | A | NEWFIELD |
| M24 | 30 | Branch Pit - Branch Road at Rt. 41-A | 4 | 0 | 4 | 4 | 4 | Agricultural | TOWN | E | SUMMERHILL |
| M25 | 30 | Edward Laine Farm Pit, Taggert Rd. | 2 | 0 | 2 | 4 | 190 | Agricultural | INDUSTRY | E | NEWFIELD |
| M26 | 30 | Reynolds pit - NYS Route 41-A | 8 | 0 | 8 | 8 | 107 | Agricultural | TOWN | A | SUMMERHILL |
| M27 | 30 | Mazourek Pit - NYS Route 13 | 4 | 0 | 4 | 4 | 649 | Agricultural | INDUSTRY | E | NEWFIELD |
| M28 | 30 | Salmon Creek Mine, Salmon Creek Road | 4 | 0 | 4 | 4 | 70 | building lot | INDUSTRY | A | LANSING |
| M29 | 30 | Blakley Road Mine - Blakley Road | 11 | 0 | 11 | 16 | 73 | Aricultural meadowland | INDUSTRY | A | GENOA |
| M30 | 30 | Newfield Mine - off NYS route 13 | 15 | 0 | 15 | 28 | 67 | meadow | INDUSTRY | A | NEWFIELD |
| M31 | 30 | South Mine - Hart Road | 9 | 0 | 9 | 121 | 123 | agricultural | INDUSTRY | A | DRYDEN |
| M36 | 30 | SWICK PIT | 5 | 0 | 5 | 10 | 111 | A | INDUSTRY | A | HECTOR |

Commodity Code
21 Limestone
29 Salt
30 Sand & Gravel
31 Sandstone
46 Glacial Till

[1] Total acres affected by mining since 1975
[2] Total acres reclaimed since 1975
[3] Total acres controlled by permittee

Source: NYSDEC

## 3.10 Commercial Sources

Based on field work designed to identify specific commercial sites that fall into the "high risk" categories listed below, potential sources of contamination have been separated into two major categories: General Commercial & Municipal Sources (Map 3.10.2) and Specific Commercial Sources (Map 3.10.1a through Map 3.10.1o).

General Commercial and Municipal Sources include "low risk" commercial, office building/institutional, and schools and government offices. The density of General Commercial and Municipal Sources can be seen on Map 3.10.2. They are dispersed throughout the watershed and largely follow a density pattern consistent with the major population centers. Therefore the density of general commercial sources increases at the extreme southern end of the lake. These general commercial sources are mainly retail establishments that may have potential contaminants in inventory but

Table 3.9.4b
Mines by Real Property Parcel

| Map Id | Parcel Acreage | Municipality |
|---|---|---|
| 161 | 101 | NEWFIELD, NY |
| 162 | 124 | NEWFIELD, NY |
| 163 | 133 | NEWFIELD, NY |
| 170 | 30 | FAYETTE NY |
| 171 | 60 | FAYETTE NY |
| 172 | 27 | FAYETTE NY |
| 173 | 12 | FAYETTE NY |
| 188 | 34 | HOMERNY |
| 190 | 80 | LITTLE YORK NY |
| 212 | 183 | EASTON PA |
| 218 | 33 | VESTAL, NY |
| 219 | 33 | VESTAL, NY |
| 220 | 33 | VESTAL, NY |
| 225 | 12 | MINNEAPOLIS MN |
| 226 | 102 | MINNEAPOLIS MN |
| 227 | 222 | LANSING NY |
| 237 | 145 | LANSING NY |
| 241 | 145 | LANSING NY |
| 242 | 145 | LANSING NY |
| 279 | 17 | SLATERVILLE SPGS NY |
| 280 | 20 | LANSING NY |
| 370 | 14 | SLATERVILLE SPGS NY |
| 372 | 1 | LANSING NY |
| 387 | 86 | LANSING NY |
| 388 | 14 | ITHACA NY |
| 389 | 14 | ITHACA, NY |
| 391 | 14 | ITHACA, NY |
| 393 | 79 | |
| 395 | 79 | |
| 396 | 79 | |
| 397 | 79 | |
| 398 | 79 | |
| 399 | 8 | |
| 400 | 79 | |
| 402 | 2 | |
| 404 | 11 | |
| 405 | 79 | |
| 406 | 12 | |
| 409 | 28 | |
| 410 | 39 | |

Source: NYSORPS

in most cases they are well packaged for sale. Otherwise these establishments have on-site systems similar to residential establishments if they are outside of sewer districts. However, the highest density of general commercial establishments is in areas of sewer districts.

Specific Commercial Sources include the following potential sources of contamination categories:

*Airports and abandoned airfields* include fuels, deicers, chlorinated solvents, automotive wastes, heating oil, and building wastes. These can be seen on the northwestern and southern portions of the watershed in the Town of Seneca Falls (on the watershed boundary) and in Ithaca.

*Auto repair shops* include waste oils, solvents, acids, paints, automotive wastes (gasoline, antifreeze, automatic transmission fluid, battery acid, engine and radiator flushes, engine and metal degreasers, hydraulic (brake) fluid and motor oils), and miscellaneous cutting oils. These are dispersed throughout the watershed and are especially prevalent in the southern portion of the watershed. There are approximately 50 auto repair shops in the watershed.

*Barber and beauty shops* include perm solutions, dyes, and miscellaneous chemicals contained in hair dyes. These tend to be in larger numbers in the southern end of the watershed. There are approximately 30 barber and beauty shops in the watershed, tending toward the southern portion.

*Boat yard and marinas* include diesel fuels, oil, septage from boat waste disposal areas, wood preservative and treatment chemicals, paints, waxes, varnishes, and automotive wastes. These are fairly well dispersed throughout the watershed, generally directly adjacent to the Lake. There are approximately 25 in the watershed.

*Bowling alleys* include epoxy and urethane-based floor finish. This is not a major commercial category in the watershed. There are approximately five in the watershed, all of which are in the southern portion.

*Car dealership/services* (especially those with service departments) include automotive wastes, waste oils, solvents, and miscellaneous wastes. There are approximately 40 of these in the watershed, the majority of which are in the southern portion.

*Car washes* include soaps, detergents, waxes, and miscellaneous chemicals. Detergents used in car washing can be a source of phosphorus. There are approximately eight car washes in the watershed, the majority in the southern portion.

*Campgrounds* include septage, gasoline, diesel fuel from boats, pesticides for controlling mosquitoes, ants, ticks, gypsy moths, and other pests, and household hazardous wastes from recreational vehicles. There are approximately 20 campgrounds in the watershed. They are fairly well dispersed.

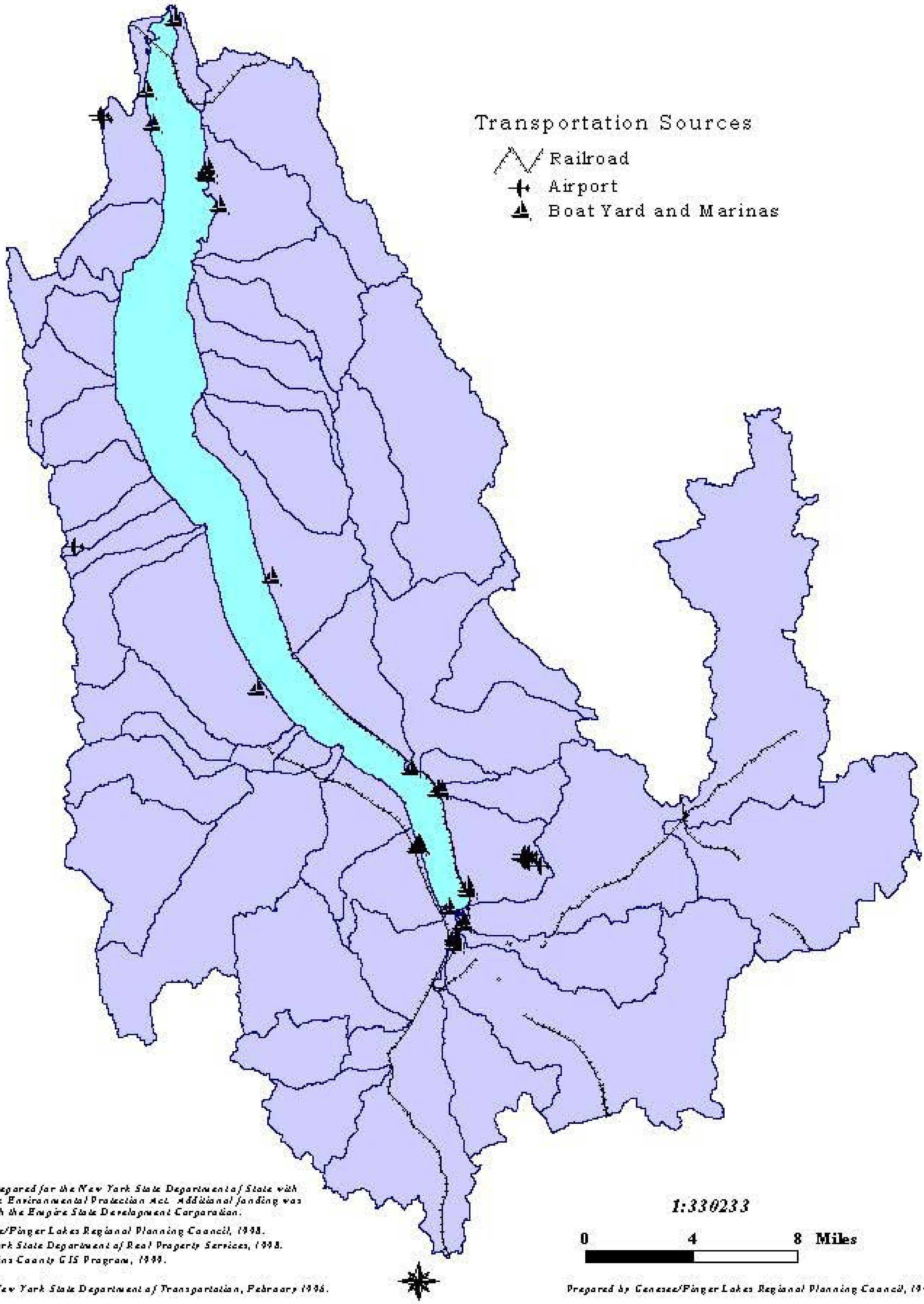
*Cemeteries* include leachate, and lawn and garden maintenance chemicals. There are approximately 170 cemeteries in the watershed. They are fairly well dispersed.

*Funeral homes and services* include formaldehyde, wetting agents, fumigants, and solvents. There are approximately 10 of these and they are fairly well dispersed within the watershed.

*Gasoline service stations* can be sources of petroleum hydrocarbons in groundwater – from underground storage facilities – and to surface waters via runoff if wastewater is not properly disposed. Improper disposal of used motor oil and antifreeze can lead to serious contamination of groundwater and downgradient surface waters. Seventy-five percent of leaky USTs identified nationally in 1994 were leaking gasoline. Typical constituents of a gasoline spill include benzene, toluene, xylene, 1-hexene, cyclohexane, n-hexane, and other aromatics (Jeer, et al, 1999). Potential sources of contamination from gasoline service stations include oils, solvents, and miscellaneous wastes. There are approximately 55 gasoline service stations in the watershed. While there are gasoline service stations throughout the watershed, they tend to be most dense in and around the population centers in the southern portion of the watershed.

*Golf courses* apply large amounts of fertilizers, herbicides, and pesticides in order to maintain a thick mat of short grass on greens and tees, with levels sometimes approaching or exceeding the amount used in agriculture. There are

# Cayuga Lake Watershed
# Specific Commercial Sources - Transportation



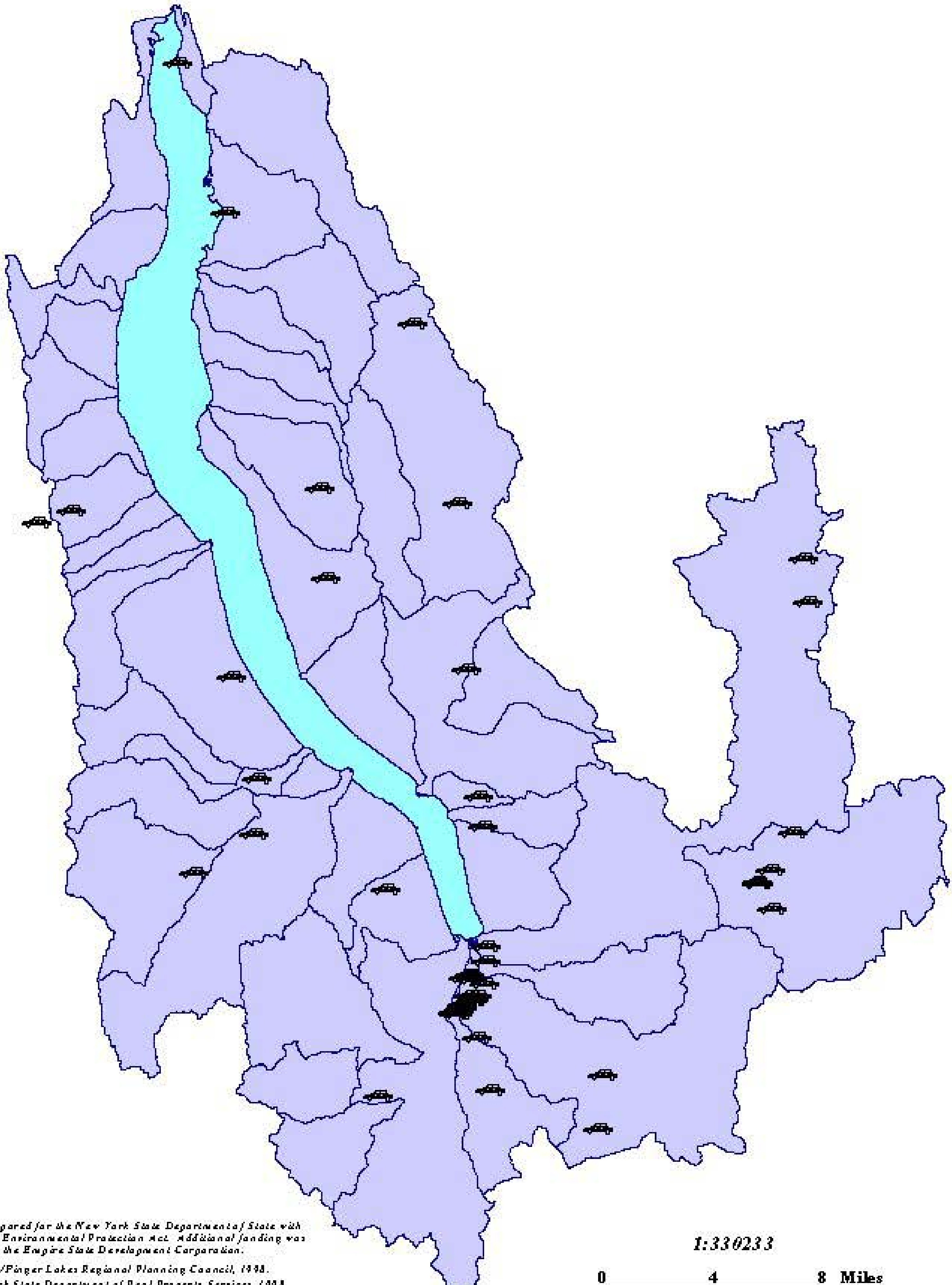

This map was prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.

Source: Genesee/Finger Lakes Regional Planning Council, 1998.
New York State Department of Real Property Services, 1998.
Tompkins County GIS Program, 1999.

Base Map: New York State Department of Transportation, February 1996.

Prepared by Genesee/Finger Lakes Regional Planning Council, 1999.

# Cayuga Lake Watershed
# Specific Commercial Sources - Auto Repair Shops



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Source: Genesee/Finger Lakes Regional Planning Council, 1998.
New York State Department of Real Property Services, 1998.
Tompkins County GIS Program, 1999.

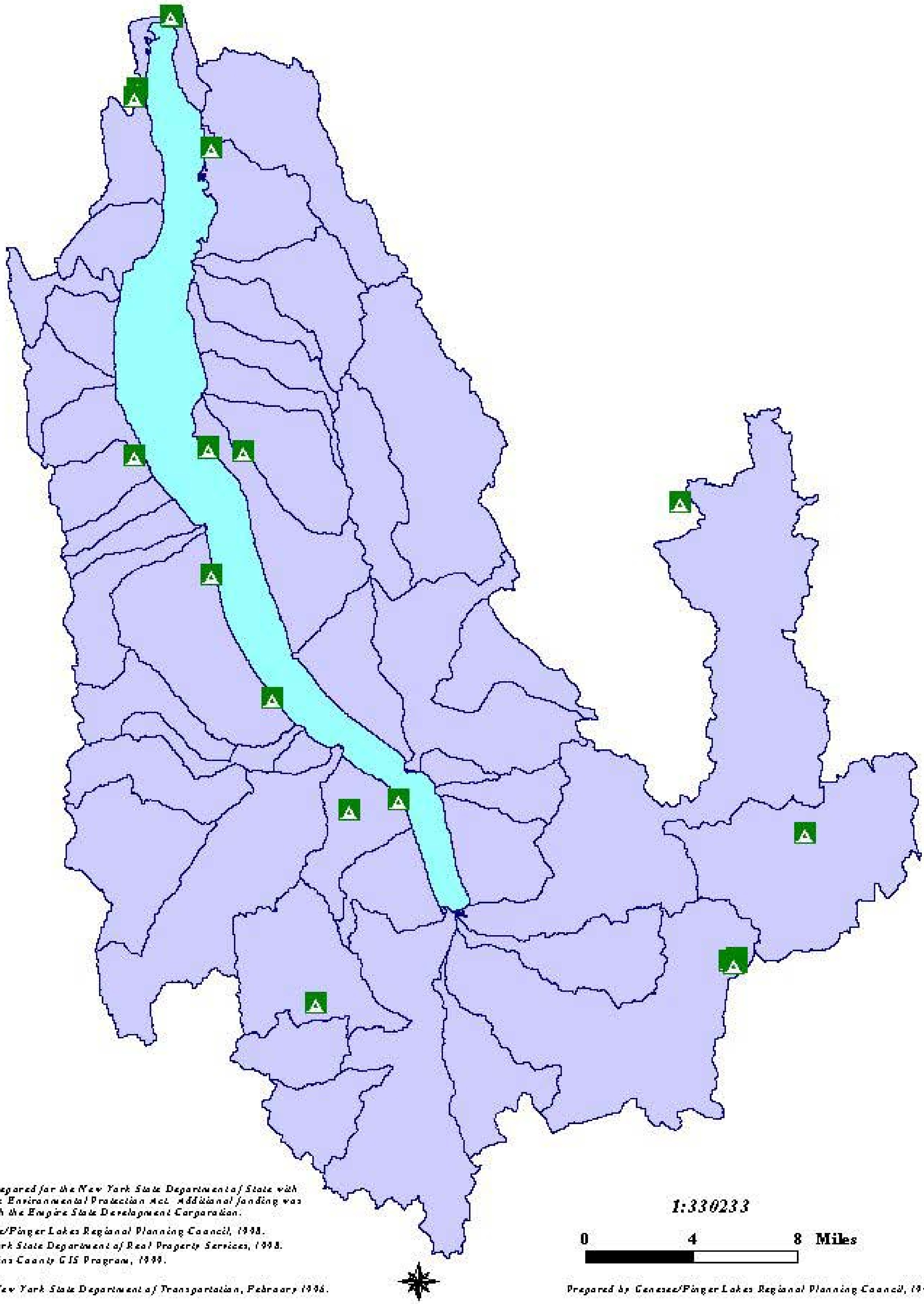
1:330233

0 4 8 Miles

Base Map: New York State Department of Transportation, February 1996.

Prepared by Genesee/Finger Lakes Regional Planning Council, 1999.

# Cayuga Lake Watershed
## Specific Commercial Sources - Campground

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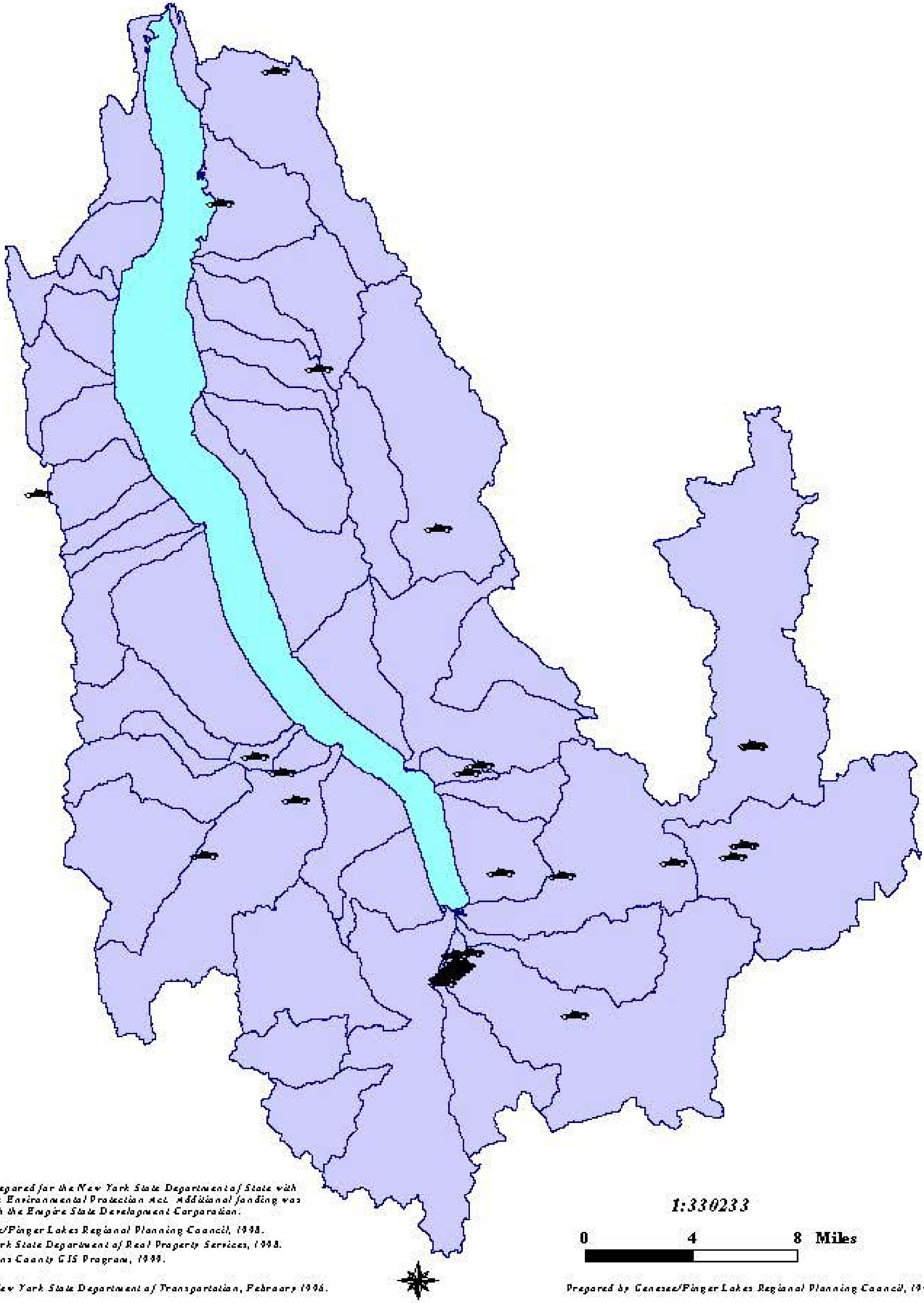
New York State Department of Real Property Services, 1998.
Tompkins County GIS Program, 1999.

Base Map: New York State Department of Transportation, February 1996.

Prepared by Genesee/Finger Lakes Regional Planning Council, 1999.

# Cayuga Lake Watershed
## Specific Commercial Sources - Car Dealership/Services



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Tompkins County GIS Program, 1999.

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0 4 8 Miles

Base Map: New York State Department of Transportation, February 1996.

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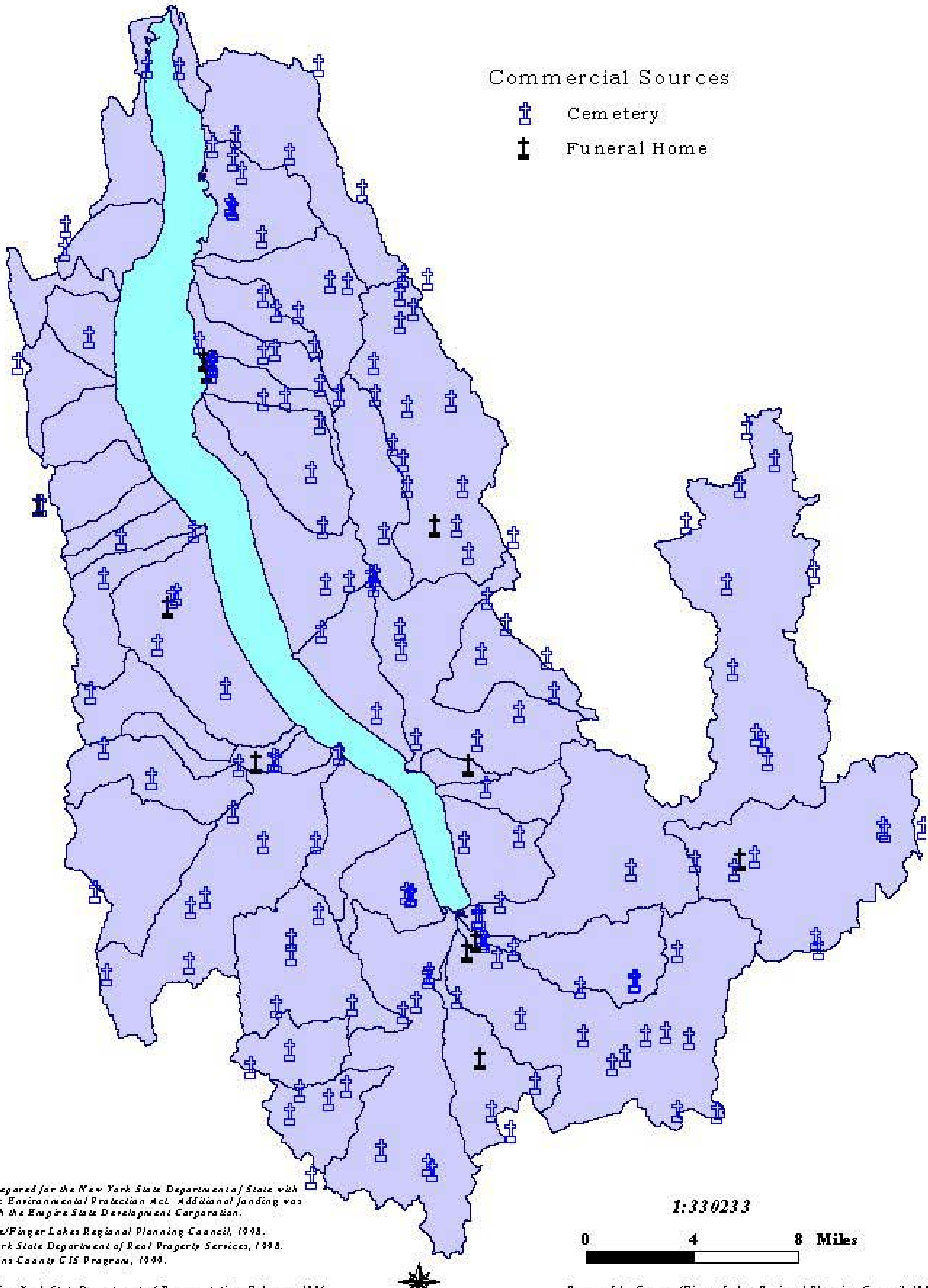
# Cayuga Lake Watershed
## Specific Commercial Sources - Cemetary & Funeral Homes

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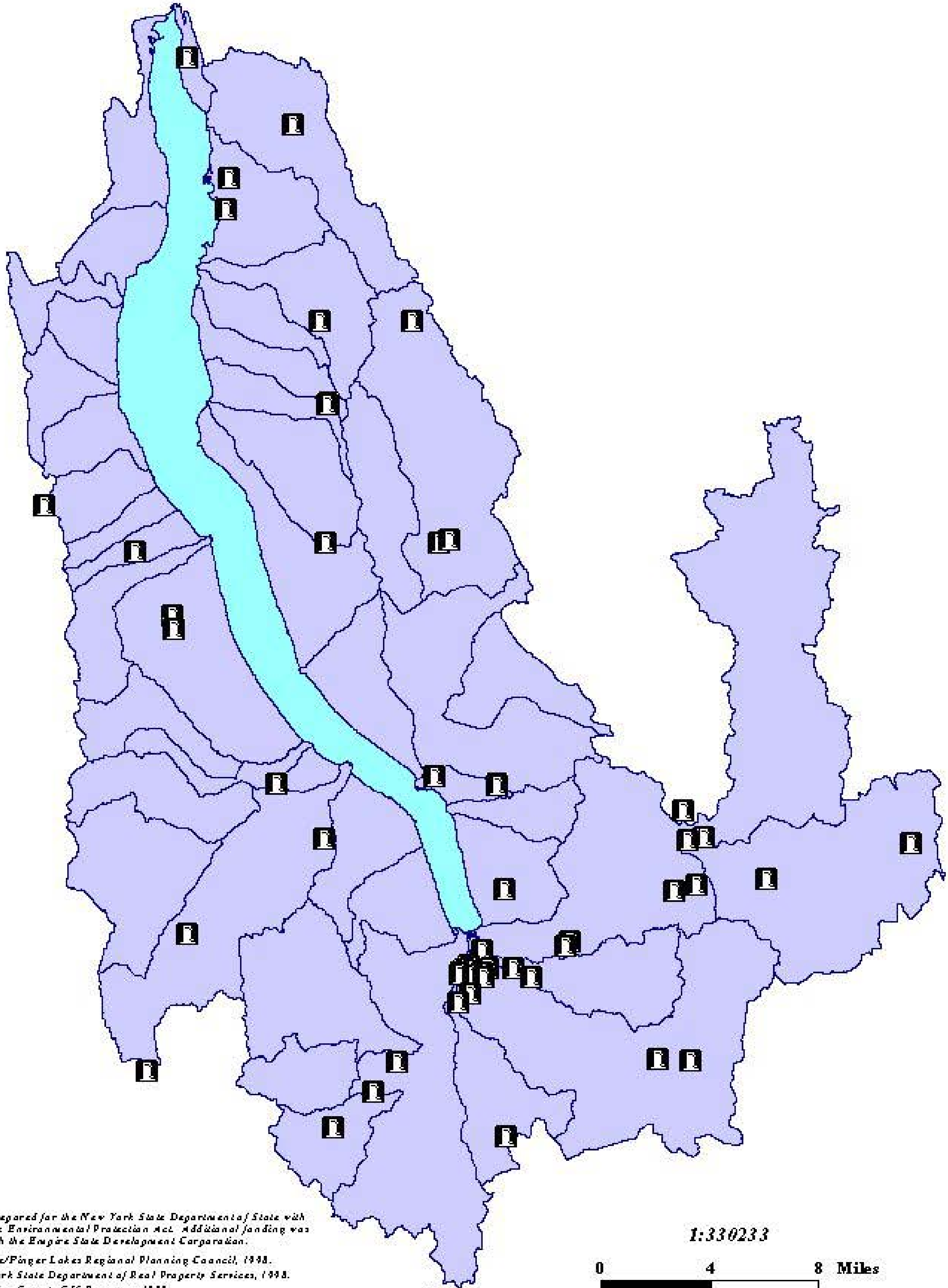
Tompkins County GIS Program, 1999.

Base Map: New York State Department of Transportation, February 1996.

Prepared by Genesee/Finger Lakes Regional Planning Council, 1999.

# Cayuga Lake Watershed
# Specific Commercial Sources - Gasoline Service Stations



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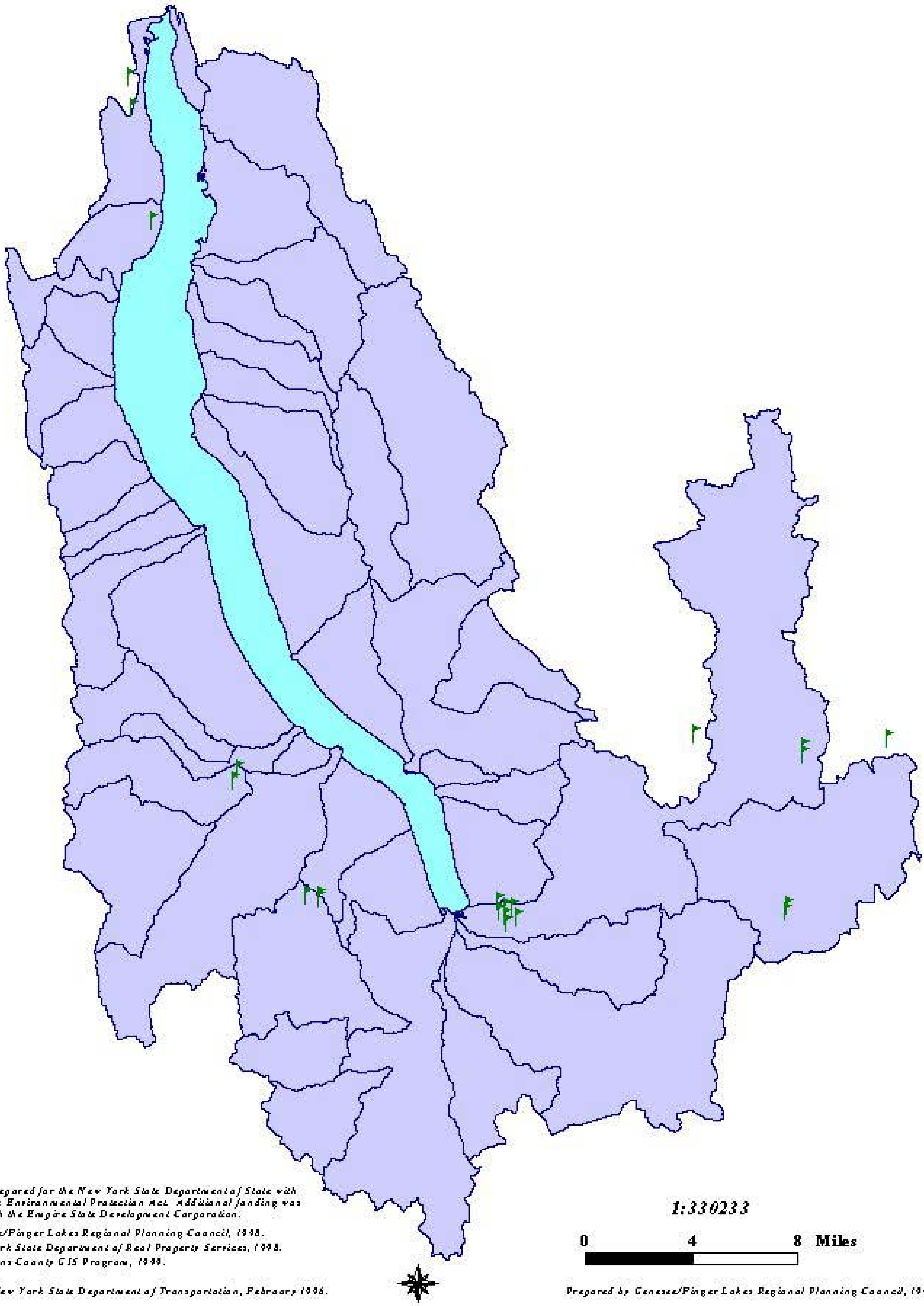
New York State Department of Real Property Services, 1998.
Tompkins County GIS Program, 1999.

Base Map: New York State Department of Transportation, February 1996.

Prepared by Genesee/Finger Lakes Regional Planning Council, 1999.

# Cayuga Lake Watershed
# Specific Commercial Sources - Golf Courses



This map was prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.

Source: Genesee/Finger Lakes Regional Planning Council, 1998.
New York State Department of Real Property Services, 1998.
Tompkins County GIS Program, 1999.

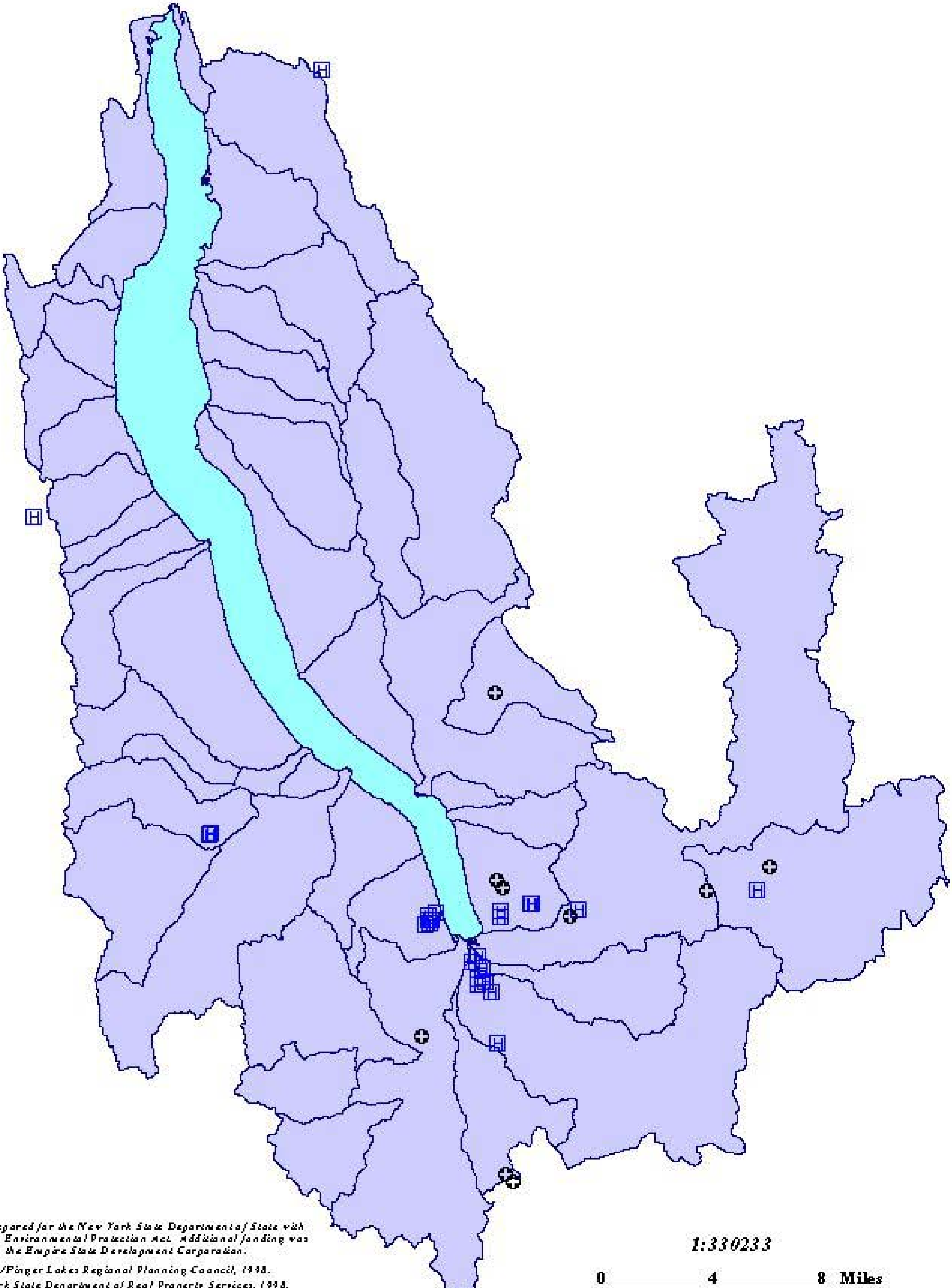
1:330233

0 4 8 Miles

Base Map: New York State Department of Transportation, February 1996.

Prepared by Genesee/Finger Lakes Regional Planning Council, 1999.

# Cayuga Lake Watershed
# Specific Commercial Sources - Medical and Veterinary Services



This map was prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.

Source: Genesee/Finger Lakes Regional Planning Council, 1998.
New York State Department of Real Property Services, 1998.
Tompkins County GIS Program, 1999.

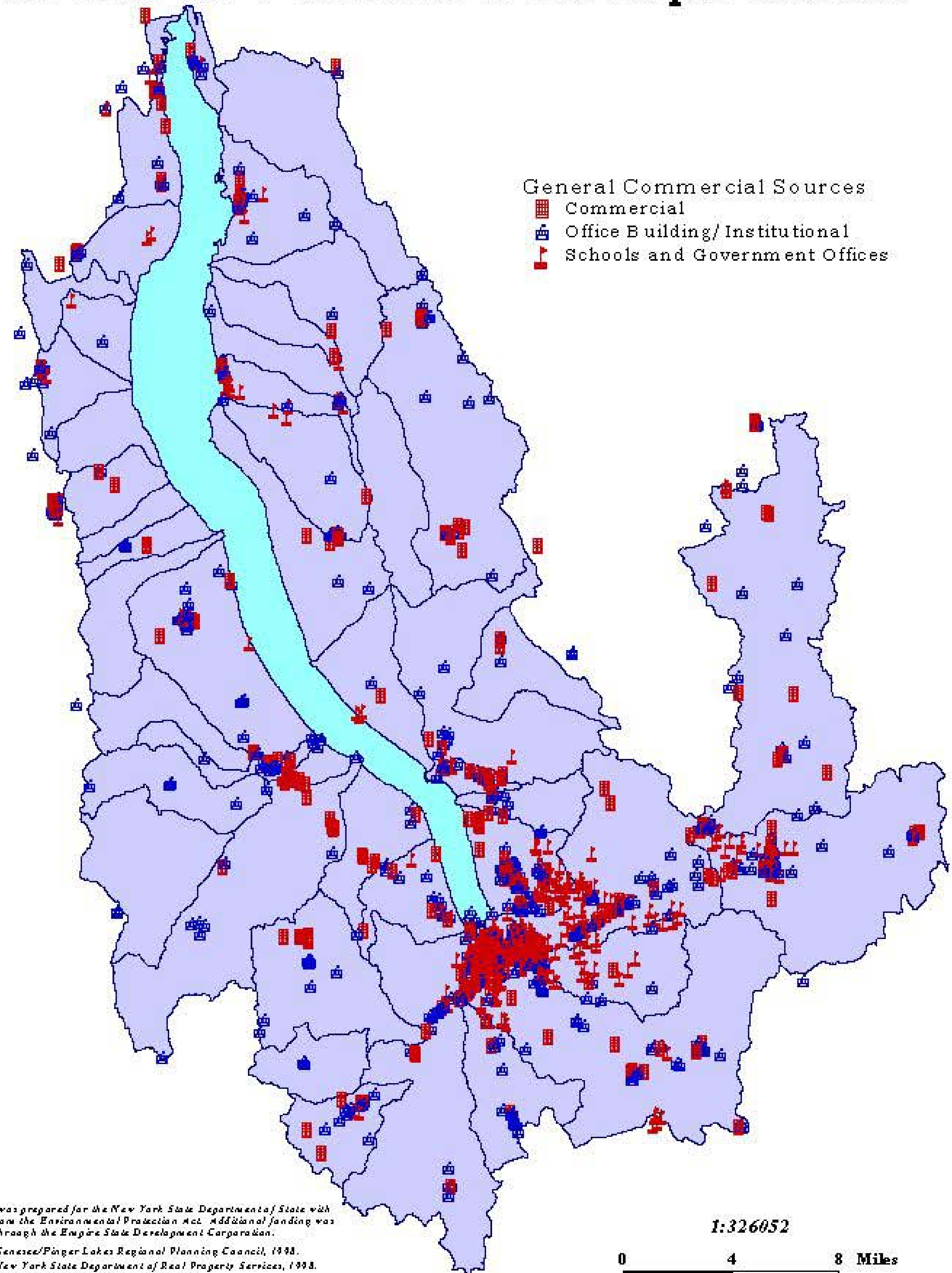
1:330233

0 4 8 Miles

Base Map: New York State Department of Transportation, February 1996.

Prepared by Genesee/Finger Lakes Regional Planning Council, 1999.

# Cayuga Lake Watershed
## General Commercial and Municipal Sources




*This map was prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.*

*Source: Genesee/Finger Lakes Regional Planning Council, 1998.*
*New York State Department of Real Property Services, 1998.*
*Tompkins County GIS Program, 1999.*

*Base Map: New York State Department of Transportation, February 1996.*

*Prepared by Genesee/Finger Lakes Regional Planning Council, 1999.*

approximately 20 golf courses in the watershed.  While there are golf courses throughout the watershed the majority of them are in the southern portion.

*Hardware/lumber stores* include hazardous chemical products in inventories, heating oil and forklift fuel from storage tanks, wood staining and treating products such as creosote.  There are approximately 15 commercial hardware and lumber operations in the watershed.  They can be found throughout the watershed and are most dense in the Ithaca area.

*Horticultural practices, garden nurseries, and florists* include herbicides, insecticides, fungicides, and other pesticides.  There are approximately 15 horticultural operations in the watershed.  They are fairly well dispersed.

*Laundromats and dry cleaners* include solvents (perchloroethylene, petroleum solvents, Freon), and spotting chemicals (trichloroethene, methylchloroform, ammonia, peroxides, hydrochloric acid, rust removers, amyl acetate), detergents, bleaches, and fabric dyes.  There are approximately 20 of these operations throughout the watershed the majority of which are in the southern portion.

*Medical institutions* include x-ray developers and fixers (may contain reclaimable silver, glutaldehyde, hydroquinone, phenedone, potassium bromide, sodium sulfide, sodium carbonate, thiosulfates, and potassium alum), infectious wastes, radiological wastes, biological wastes, disinfectants, asbestos, beryllium, dental acids, and miscellaneous chemicals.  There are approximately 25 medical institutions in the watershed the majority of which are in the southern portion.

*Print shops and publishing operations* include solvents, inks, dyes, oils, and photographic chemicals.  There are approximately 10 of these operations, the vast majority of which are in the Ithaca area.

*Railroad tracks and yards* include diesel fuel, herbicides for right-of-way, and creosote for preserving wood ties.  These tend to follow the railroad line along east side of the lake and in the southern portion of the watershed.

*Veterinary services* include solvents, infectious materials, vaccines, drugs, disinfectants (quaternary ammonia, hexachlorophene, peroxides, chlornexade, bleach) and x-ray developers and fixers.  There are approximately 10 of these in the watershed, the vast majority in the southern portion.

### 3.11 Municipal Sources

Potential sources of contamination from municipal sources in the Watershed include the following categories:

*Schools and government offices and grounds* including the use of solvents; pesticides; acids; alkalis; waste oils; machinery/vehicle servicing wastes; gasoline and heating oil from storage tanks; and general building wastes similar to household wastes (see Table 3.13.1, Potentially Harmful Components of Common Household Products).  Map 3.10.2 shows the distribution of office buildings, institutional buildings and schools and government offices.

*Park lands* including the use of fertilizers, herbicides and insecticides.  Parklands are distributed throughout tending toward the southern portion of the watershed (see Map 2.12.7).

*Public and residential areas* infested with mosquitoes, gypsy moths, ticks, ants and other pests which includes the use of pesticides.

*Highways, road maintenance depots and deicing operations*
These include the use of herbicides in highway rights-of-ways, road salt, road salt anti-caking additives, road salt anticorrosives, and automotive wastes.  Sources of contamination in road drainage include wet and dry deposition, soil erosion, street dirt and litter, and animal waste.  Rainwater falling on paved surfaces may become contaminated with nutrients, metals, oils and grease, salts and volatile organic compounds that have accumulated there.  Numerous studies have shown that metal (lead, copper, cadmium) loadings from paved surfaces are significant pollution sources.  Pollution from bridge maintenance is compounded by the fact that, since bridges are generally located over

Table 3.11.1

Road Deicing & Storage Inventory

| Map ID | MUNICIPALITY | COUNTY | DEICING | CONTRACT | MATERIAL: TYPE | MATERIAL: OTHER | MULTIPLE TYPES | RATIO | MIX | POLICY | MILES DEICED: PAVED | MILES DEICED: DIRT | RATE: PAVED | RATE: DIRT | TOTAL AMOUNT (Tons): WINTER 1996- | TOTAL AMOUNT (Tons): WINTER 1995- | STORED | STORED ON | FACILITY AGE (Yrs) | FACILITY TYPE | DUST CONTROL MATERIAL | MILES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D1 | Cayuga County Highway Dept. | Cayuga | Yes | Yes | Salt/Sand/IceBan | | Yes | 4:1 by Volume | Yes | | 520 | 0.00 | 500 lb Salt/1500 lb mix | | | | Enclosed | Ground | 10 | Poleshed | N/A | 0.00 |
| D12 | Town of Lansing | Tompkins | Yes | | Salt/Sand/IceBan | | Yes | 1:3 salt/sand , 6gal IceBan: 1 ton of sand | Yes | Slippery | 135 | 15.00 | 300-700 lbs./lane mi. | Sand only - 1 ton/lane mi. | 1200 | 2000 | Enclosed | Pavement | 8 | Poleshed | CaCl | 15.00 |
| D13 | Village of Dryden | Tompkins | Yes | | Salt/Sand | | Yes | 2:3 | Yes | Conditions | 12 | 0.00 | Conditions | -- | 270 | 280 | Enclosed | Pavement | 4 | Poleshed | None | 0.00 |
| D14 | Town of Venice | Cayuga | Yes | | Salt/Sand | | No | 1:4 | Yes | When roads start covering over | 44 | 25.00 | 1500-200 ton/yr. salt and sand | Varies, only if have to | 475 | 475 | Open | Ground | | | None | |
| D17 | Village of Trumansburg | Tompkins | Yes | | Salt/Sand | | No | 1:1 | Yes | 1" of snow | 11 | 0.00 | | | 145 | 120 | Enclosed | Pavement | 14 | Poleshed | None | 0.00 |
| D20 | City of Ithaca | Tompkins | Yes | | Salt/Sand | | Yes | 1:1 | Yes | Conditions | 72 | 0.00 | 200 lbs./ lane mi. | N/A | 2071 | 2842 | Enclosed | Pavement | 22 | Poleshed | None | 0.00 |
| D24 | Town of Dryden | Tompkins | Yes | | Salt/Sand | | No | | Yes | | 112 | 4.56 | | | | | Open | Ground | | | Calcium | 0.24 |
| D25 | Town of Covert | Seneca | Yes | | Salt/Sand | | No | 1:14 | Yes | Slippery | 30 | 14.00 | No Calibration | No Calibration | 100 | 150 | Open | Ground | | | Dust Oil, Calcium | 7.00 |
| D26 | Tompkins County Highway Dept. | Tompkins | Yes | | Salt/Sand | Ice Ban (testing only) | Yes | 1:19 salt/sand | Yes | Slippery | 215 | 0.00 | 500 lb/2 lane mi. | N/A | 5796 | 7381 | Enclosed | Pavement | 5 | | Water | 0.00 |
| D27 | Village of Aurora | Cayuga | Yes | | Salt/Sand | | No | 1:4 | Yes | Slippery | 4 | 0.00 | ~ 1 yard mix/mi. | | 5 | 5 | Open | Asphalt | 20 | Asphalt Tarp Covered | None | 0.00 |
| D28 | Town of Springport | Cayuga | Yes | | Salt/Sand | | No | 1:3 | Yes | Slippery | 33 | 3.70 | Hills, Curves, Intersections | Hills, Curves, Intersections | 171 | 158 | Open | Stone Floor | | | Salt brine | 3.70 |
| D29 | Town of Ledyard | Cayuga | Yes | | Salt/Sand | | No | 1:4 | Yes | 1.5" - 2" snow or ice | 42 | 0.00 | 5000 lbs./mi. | None | 96 | 112 | Enclosed | Pavement | 2 | Poleshed | Salt Brine | 10.00 |
| D3 | Town of Genoa | Cayuga | Yes | | Salt/Sand | | No | 1:4 | Yes | First sign that snow is sticking on state roads | 52 | 19.00 | varies: up to 400 lbs. of mix per mi. | Very little | 346 | 387 | Open | | | | CaCl | 10.00 |
| D32 | Village of Cayuga | Cayuga | Yes | | Salt | | No | 100% salt | N/A | Road becomes covered | 3 | 0.00 | Vary Low | | 85 | 85 | Enclosed | Ground | 5 | Poleshed | None | 0.00 |
| D35 | Town of Danby | Tompkins | Yes | | Salt/Sand/IceBan | Cinders | Yes | 1:7 | Yes | 1" snow or slippery | 30 | 30.00 | | | 203 | 312 | Open | Ground | | | CaCl | 20.00 |
| D36 | Town of Ulysses | Tompkins | Yes | | Salt/Sand | | Yes | 30/50 - 50/50 | Yes | Road becomes covered | 76 | 0.00 | 300-600 lbs./la mi. | N/A | 1500 | 1800 | Enclosed | Pavement | 5 | Poleshed w Paved Floor & Loading Area | None | 0.00 |
| D37 | Village of Union Springs | Cayuga | Yes | | Salt | | No | 100% salt | No | Conditions | 5 | 0.68 | | | 80 | | Enclosed | Pavement | 1 | Poleshed | None | 0.00 |
| D38 | NYSDOT | Tompkins | Yes | Yes | Salt/CaCl/IceBan | | Yes | N/A | No | | 383 | 0.00 | 225 lb salt/lm | -- | 5357 | 7226 | Enclosed | Pavement | 10 | Dome | None | 0.00 |
| D39 | Town of Ithaca | Tompkins | Yes | | Salt/IceBan | | Yes | 8 gal Ice Ban/Ton of Salt | Yes | 1" snow or slippery | 50 | 0.00 | 500 lbs./mi. | -- | 1500 | | Enclosed | Pavement | 15 | Poleshed | None | 0.00 |
| D41 | Town of Scipio | Cayuga | Yes | | Salt/Sand | | No | 1:5 | Yes | | 21 | 18.00 | | | 500 | 600 | Enclosed | Pavement | 2 | Poleshed | Salt brine calcium chloride | 10.00 |
| D42 | Town of Spencer | Tioga | Yes | | Salt/Sand | | No | 5:1 sand/salt | Yes | 1" snow or slippery | 32 | 30.00 | same | same | 350 | 350 | Enclosed | Pavement | | | Calcium chloride | 30.00 |
| D44 | Village of Cayuga Heights | Tompkins | Yes | | Salt/Sand | | | 95-100% salt | Yes | Police department | 21 | | varies | | 100 | 100 | Enclosed | Pavement | | Poleshed | | |
| D47 | Town of Summerhill | Cayuga | Yes | | Salt/Sand | #1A Stone/Salt | No | 4:1 sand/salt, #1A 7:1 stone/salt | Yes | Rain | 17 | 17.00 | 4:1 | 7:1 1A stone | 150 | 200 | Open | Ground | | | Calcium | 15.00 |

surface-water bodies, there is little opportunity for pollution attenuation to take place before runoff washes into water.

Groundwater and surface water contamination from road salt application and storage occurs when the salt dissolves in precipitation and either infiltrates though topsoil into the water table or runs off into surface water.  This can effect water quality including elevation of chloride levels. Municipal road maintenance and deicing storage operations include storage and spreading. Important storage considerations include type of material, and type of storage. Most of the material used in the watershed is sand and salt. However, some municipalities use other materials such as cinders, IceBan, and calcium chloride. In the Cayuga Lake Watershed 58% (29) of deicing material is stored in enclosed facilities. The rest (42%, 21) is stored in the open. Sixty-two percent (31) of deicing material is stored on concrete, asphalt, shale or pavement. The rest (38%, 19) is stored on the ground. Important spreading considerations include ingredient ratio, amount per road mile, and total amount per season, and total road miles. The average total amount of deicing material spread in the Cayuga Lake Watershed exceeds 30,000 tons per year (Table 3.11.1).

**Table 3.11.2**
**Additional Highway, Road Maintenance Depot, and Deicing Operations**

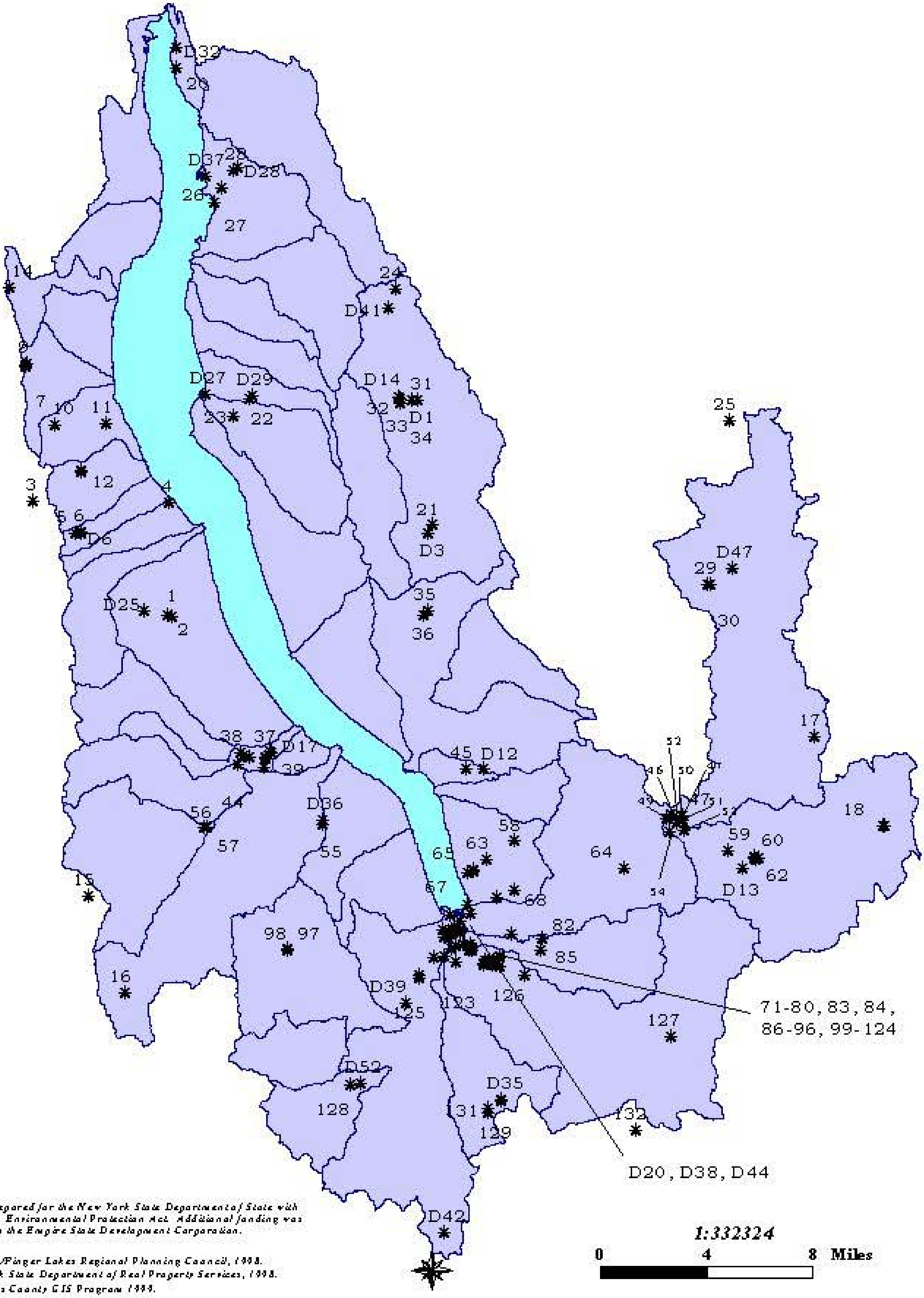
| Map ID | Municipality | Map ID | Municipality | Map ID | Municipality |
|---|---|---|---|---|---|
| 1 | VILLAGE OF INTERLAKEN | 49 | VILLAGE OF FREEVILLE | 97 | TOWN OF ENFIELD |
| 2 | TOWN OF COVERT | 50 | VILLAGE OF FREEVILLE | 98 | TOWN OF ENFIELD |
| 3 | VILLAGE OF OVID | 51 | VILLAGE OF FREEVILLE | 99 | CITY OF ITHACA |
| 4 | TOWN OF OVID | 52 | VILLAGE OF FREEVILLE | 100 | CITY OF ITHACA |
| 5 | TOWN OF OVID | 53 | VILLAGE OF FREEVILLE | 101 | CITY OF ITHACA |
| 6 | TOWN OF OVID | 54 | VILLAGE OF FREEVILLE | 102 | CITY OF ITHACA |
| 7 | COUNTY OF SENECA | 55 | TOWN OF ULYSSES | 103 | CITY OF ITHACA |
| 8 | COUNTY OF SENECA | 56 | TOWN OF ULYSSES | 104 | CITY OF ITHACA |
| 9 | COUNTY OF SENECA | 57 | COUNTY OF TOMPKINS | 105 | CITY OF ITHACA |
| 10 | TOWN OF ROMULUS | 58 | COUNTY OF TOMPKINS | 106 | CITY OF ITHACA |
| 11 | TOWN OF ROMULUS | 59 | VILLAGE OF DRYDEN | 107 | CITY OF ITHACA |
| 12 | TOWN OF ROMULUS | 60 | TOWN OF DRYDEN | 108 | CITY OF ITHACA |
| 13 | TOWN OF ROMULUS | 61 | TOWN OF DRYDEN | 109 | CITY OF ITHACA |
| 14 | TOWN OF VARICK | 62 | TOWN OF DRYDEN | 110 | CITY OF ITHACA |
| 15 | TOWN OF HECTOR | 63 | VILLAGE OF LANSING | 111 | CITY OF ITHACA |
| 16 | TOWN OF HECTOR | 64 | ETNA TOWN HALL | 112 | CITY OF ITHACA |
| 17 | USA TUNISON LAB OF | 65 | VILLAGE OF LANSING | 113 | CITY OF ITHACA |
| 18 | VIRGIL FIRE DISTRICT | 66 | VILLAGE OF LANSING | 114 | CITY OF ITHACA |
| 19 | VIRGIL FIRE DISTRICT | 67 | VILLAGE OF LANSING | 115 | ITHACA, CITY OF |
| 20 | CAYUGA VILLAGE OF | 68 | TOWN OF ITHACA | 116 | CITY OF ITHACA |
| 21 | GENOA TOWN OF | 69 | VILLAGE OF CAYUGA HGTS | 117 | CITY OF ITHACA |
| 22 | LEDYARD TOWN OF | 70 | CITY OF ITHACA | 118 | CITY OF ITHACA |
| 23 | LEDYARD TOWN OF | 71 | CITY OF ITHACA | 119 | CITY OF ITHACA |
| 24 | SCIPIO TOWN OF | 72 | CITY OF ITHACA | 120 | CITY OF ITHACA |
| 25 | SEMPRONIUS TOWN OF | 73 | CITY OF ITHACA | 121 | CITY OF ITHACA |
| 26 | UNION SPRINGS VILLAGE OF | 74 | CITY OF ITHACA | 122 | CITY OF ITHACA |
| 27 | UNION SPRINGS VILLAGE | 75 | STATE OF NEW YORK | 123 | CITY OF ITHACA |
| 28 | SPRINGPORT TOWN OF | 76 | CITY OF ITHACA | 124 | TOWN OF ITHACA |
| 29 | SUMMERHILL TOWN OF | 77 | CITY OF ITHACA | 125 | COUNTY OF TOMPKINS |
| 30 | SUMMERHILL TOWN OF | 78 | STATE OF NEW YORK | 126 | TOWN OF ITHACA |
| 31 | CAYUGA COUNTY OF | 79 | CITY OF ITHACA | 127 | TOWN OF CAROLINE |
| 32 | VENICE TOWN OF | 80 | CITY OF ITHACA | 128 | TOWN OF NEWFIELD |
| 33 | VENICE TOWN OF | 81 | U S A | 129 | TOWN OF DANBY |
| 34 | VENICE TOWN OF | 82 | NYS GAME FARM | 130 | TOWN HALL |
| 35 | TOWN OF LANSING | 83 | CITY OF ITHACA | 131 | TOWN OF DANBY |
| 36 | TOWN OF LANSING | 84 | STATE OF NEW YORK | 132 | TOWN OF CAROLINE |
| 37 | TOWN OF ULYSSES | 85 | NYS GAME FARM | | |
| 38 | VILLAGE OF TRUMANSBURG | 86 | COUNTY OF TOMPKINS | | |
| 39 | TOWN OF ULYSSES | 87 | CITY OF ITHACA | | |
| 40 | VILLAGE OF TRUMANSBURG | 88 | CITY OF ITHACA | | |
| 41 | VILLAGE OF TRUMANSBURG | 89 | US | | |
| 42 | VILLAGE OF TRUMANSBURG | 90 | CITY OF ITHACA | | |
| 43 | TOWN OF ULYSSES | 91 | TOWN OF ITHACA | | |
| 44 | VILLAGE OF TRUMANSBURG | 92 | HULL ESTATE | | |
| 45 | TOWN OF LANSING | 93 | CITY OF ITHACA | | |
| 46 | VILLAGE OF FREEVILLE | 94 | CITY OF ITHACA | | |
| 47 | VILLAGE OF FREEVILLE | 95 | ITHACA, CITY OF | | |
| 48 | VILLAGE OF FREEVILLE | 96 | CITY OF ITHACA | | |

Source: NYSORPS

As Map 3.11.1 and associated Tables 3.11.1 and 3.11.2 indicate road maintenance and deicing storage operations are widely dispersed throughout the watershed with the largest pocket of density at the southern end of the lake around the City of Ithaca. Other smaller pockets include the area near the Village of Trumansburg and the area associated with the Village of Freeville and Dryden. All of these are close to tributaries. In the case of the City of Ithaca, road deicing storage is close to the lake itself, however deicing material is stored in enclosed facilities. This is the case in all but one facility in the area around Trumansburg, Freeville, and Dryden. Other storage of concern is in the Village of Aurora, Town of Springport, Town of Covert, and the Town of Danby. These are all open storage piles. The Village of Aurora storage is close to the lake. The others are close to tributaries of the lake including the Town of Danby's storage near the Cayuga Inlet.

*Municipal sewage treatment*

# Cayuga Lake Watershed
# Road Maintenance & Deicing Storage




*This map was prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.*

*Source: Genesee/Finger Lakes Regional Planning Council, 1998.*
*New York State Department of Real Property Services, 1998.*
*Tompkins County GIS Program 1999.*

*Base Map: New York State Department of Transportation, February 1996.*

*Prepared by Genesee/Finger Lakes Regional Planning Council, 1999.*

Potential sources of contamination from municipal sewage treatment includes municipal wastewater, sludge, and treatment chemicals. Up to 95% of wastewater discharged from industrial and municipal treatment facilities consists of pure water. The remaining material consists of suspended materials, dissolved organic matter, microbiological pollutants such as bacteria, and nutrients such as phosphorus and nitrogen. The composition of wastewater depends on the chemical properties of the source water and on the materials added. Sewer pipes carrying wastes sometimes leak fluids into the surrounding soil and groundwater. Sewage consists of organic matter, inorganic salts, heavy metals, bacteria, viruses, and nitrogen (USEPA 1990). Other pipelines carrying industrial chemicals and oil brine have also been known to leak, especially when the materials transported through the pipes are corrosive.

Figure 3.1. Ithaca Area Wastewater Treatment Plant

There are eight permitted discharges for municipal wastewater in the watershed. Three of these discharge directly to the lake, four discharge to tributaries of the lake, and one discharges to groundwater (see Map 4.2.1 and Table 4.2.5). These are further discussed as state permitted discharges to the lake and its tributaries in Section 4.2.

Treated wastewater (effluent) from several municipal treatment plants is discharged to Cayuga Lake and its tributaries. As discussed in Chapter 4, a total of 15 million gallons of treated wastewater is permitted to flow into the lake and its tributaries each day from nine municipal treatment plants. These inputs are discharged in to an ecosystem (the lake or its tributary streams) where various chemical, physical, and biological processes act on substances present in the wastewater. These substances may be broken down by microorganisms, chemically altered (hydrolyzed), or deposited in sediments. Other materials are broken down by sunlight (photooxidized), die, or are consumed by animals and become part of the food web. Finally, the immense volume of Cayuga Lake acts to dilute the concentration of substances in wastewater.

The quantity and quality of wastewater (and other) discharges are closely regulated to ensure that receiving water quality meets or exceeds ambient standards associated with its designated use. Cayuga Lake is classified into four segments based on designated use for public water supply and recreation. Numerical or narrative limits on the concentrations of specific chemicals are promulgated to protect these uses. Regulatory agencies (in this case NYSDEC) issue discharge permits with chemical-specific limits. In most cases, these chemical-specific limits in the discharge permits to Cayuga Lake reflect best available technology for pollutant removals.

However, for certain substances and certain aquatic ecosystems technology-based limits may not be adequately protective of the designated use. More stringent limits are needed for substances of special concern or for receiving waters with a limited capacity to assimilate pollutants. Water quality based effluent limits are adopted instead, which require higher removals of specific substances. Water quality based effluent limits may be adopted for toxic chemicals that accumulate in the aquatic ecosystem (for example, mercury) or for nutrients that are not diluted below toxic thresholds (for example, ammonia). Phosphorus limits are a special case. As discussed in the limnology chapter, phosphorus is the limiting nutrient for algal growth and is therefore of special concern for ponded waters such as Cayuga Lake. The two treatment plants discharging to southern Cayuga Lake (Ithaca Area and Cayuga Heights) are applying for funding of filtration facilities to enable greater phosphorus removal.

*Storage treatment, and disposal ponds, lagoons, and other surface impoundments* include sewage wastewater, nitrates, other liquid wastes, and microbiological contaminants.

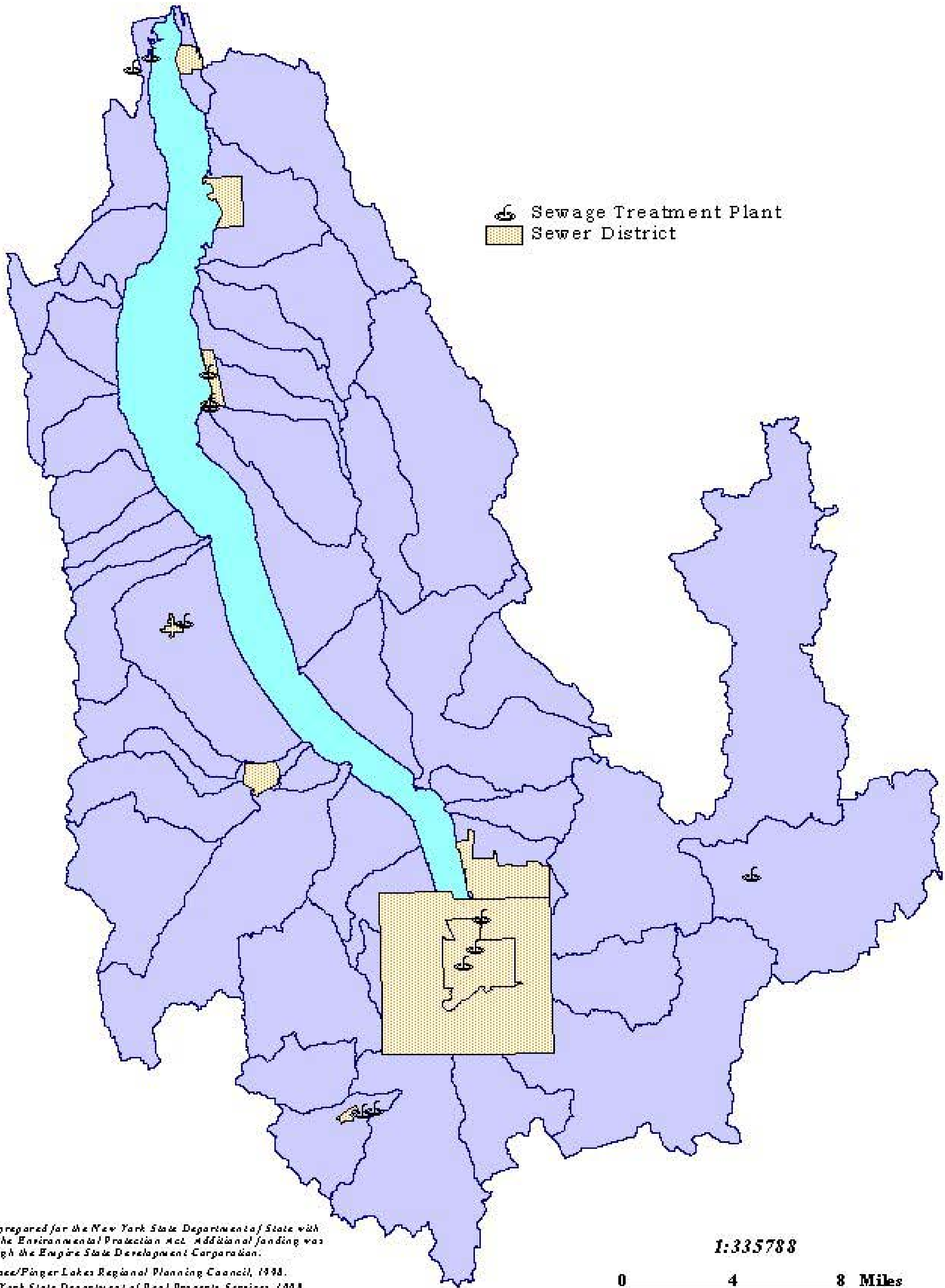
*Storm water drains and basins* (see Surface Runoff) including urban runoff, gasoline, oil, other petroleum products, road salt, and microbiological contaminants. Presently stormwater is not treated in the Cayuga Lake Watershed therefore it ultimately winds up in the surface and ground water.

*Recycling/reduction facilities* including residential and commercial solid waste residues. Tompkins County has a recycling operation at the southern end of the lake.

*Municipal waste landfills*

These represent significant sources of metals, nutrients, pesticides, pathogens, and synthetic organic compounds. Many household hazardous wastes end up in landfills. As landfill surfaces are typically devoid of vegetation, rainwater easily percolates down through the earth, encouraging the leaching of contaminants from refuse into

# Cayuga Lake Watershed
# Sewer Districts and Sewage Treatment Plants




This map was prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.

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New York State Department of Real Property Services, 1998.
Tompkins County GIS Program, 1999.

Base Map: New York State Department of Transportation, February 1996.

Prepared by Genesee/Finger Lakes Regional Planning Council, 1999.

**Table 3.11.3**
**Municipal Waste Sites**

| Map ID | Owner | City/State | Acres | Property Classification | Contaminant Classification |
|---|---|---|---|---|---|
| 133 | SEYMOUR RICHARD | INTERLAKEN NY | 94.90 | Landfills and Dumps | Municipal Waste Landfill |
| 134 | MITCHELLWALTER A JR | WATERLOO NY | 11.70 | Junkyards | Scrap and Junk Yards |
| 135 | TOWN OF FAYETTE-LANDFILL | FAYETTE NY | 21.60 | Landfills and Dumps | Municipal Waste Landfill |
| 136 | TOWN OF OVID | OVID NY | 16.30 | Solid Waste Disposal | Municipal Waste Landfill |
| 137 | TOWN OF ROMULUS | WILLARD NY | 13.20 | Landfills and Dumps | Municipal Waste Landfill |
| 138 | TOWNOFSENECA FALLS | SENECA FALLS NY | 0.22 | Waste Disposal | Municipal Waste Landfill |
| 139 | ZONAARMANDO | ROMULUS NY | 0.58 | Junkyards | Scrap and Junk Yards |
| 140 | CAYUGA VILLAGE OF | CAYUGA NY | 0.00 | Solid Waste Disposal | Municipal Waste Landfill |
| 141 | GENOA TOWN OF | GENOA N Y | 25.10 | Landfills and Dumps | Municipal Waste Landfill |
| 142 | SCIPIO TOWN OF | SCIPIO CENTER N Y | 7.40 | Landfills and Dumps | Municipal Waste Landfill |
| 143 | UNION SPRINGS VILLAGE OF | UNION SPRINGS NY | 4.10 | Waste Disposal | Municipal Waste Landfill |
| 144 | NEW YORK STATE | CORTLAND NY | 3.00 | Landfills and Dumps | Municipal Waste Landfill |
| 145 | VILLAGE OF TRUMANSBURG | TRUMANSBURG, NY | 3.46 | Landfills and Dumps | Municipal Waste Landfill |
| 146 | VOLBRECHT, CALVIN | LANSING NY | 1.96 | Junkyards | Scrap and Junk Yards |
| 147 | VILLAGE OF CAYUGA HGTS | ITHACA NY | 3.69 | Waste Disposal | Municipal Waste Landfill |
| 148 | TOWN OF ENFIELD | ITHACA, NY | 5.00 | Landfills and Dumps | Municipal Waste Landfill |
| 149 | CARPENTER, CARL T | ITHACA NY | 0.00 | Storage, Warehouse & Distribution | Scrap and Junk Yards |
| 150 | CITY OF ITHACA | ITHACA NY | 6.62 | Landfills and Dumps | Municipal Waste Landfill |
| 151 | CITY OF ITHACA | ITHACA NY | 6.62 | Landfills and Dumps | Municipal Waste Landfill |
| 152 | CITY OF ITHACA | ITHACA NY | 6.62 | Landfills and Dumps | Municipal Waste Landfill |
| 153 | TEETER, RICHARD C | NEWFIELD, NY | 100.00 | Junkyards | Scrap and Junk Yards |
| 154 | CASELLA WASTE MGMT NY INC | RUTLAND VT | 5.46 | Solid Waste Disposal | Municipal Waste Landfill |
| 155 | BARTHOLF, ROBERT G & PETRICOLA, J | ITHACA NY | 114.74 | Junkyards | Scrap and Junk Yards |
| 156 | DOBSON, RICK | ITHACA, NY | 16.66 | Junkyards | Scrap and Junk Yards |
| 157 | TOWN OF NEWFIELD | NEWFIELD, NY | 31.12 | Landfills and Dumps | Municipal Waste Landfill |
| 158 | TOMPKINS COUNTY | ITHACA NY | 9.10 | Landfills and Dumps | Municipal Waste Landfill |
| 159 | TOMPKINS COUNTY | ITHACA NY | 20.15 | Landfills and Dumps | Municipal Waste Landfill |

Source: NYSORPS, 1999

underlying groundwater or into nearby surface waters. Pollutant concentrations vary depending on the physical characteristics of the landfill design and of the underlying geology.
New landfills are required to have clay or synthetic liners and leachate systems to protect groundwater. Most older landfills, however, do not have these safeguards, Older landfills, were often sited over aquifers and in permeable soils with shallow water tables, enhancing the potential for leachate to contaminate ground water. Closed landfills can continue to pose a water contamination threat if they are not capped with an impermeable material before closure.

As Map 3.7.1 and associated Table 3.11.3 indicate, based on New York State Office of Real Property Services, municipal waste sites are fairly evenly dispersed throughout the watershed. Their density is somewhat greater in the southern portion of the watershed. As Map 3.7.1 indicates some of these are adjacent to the lake while others are close to tributaries.

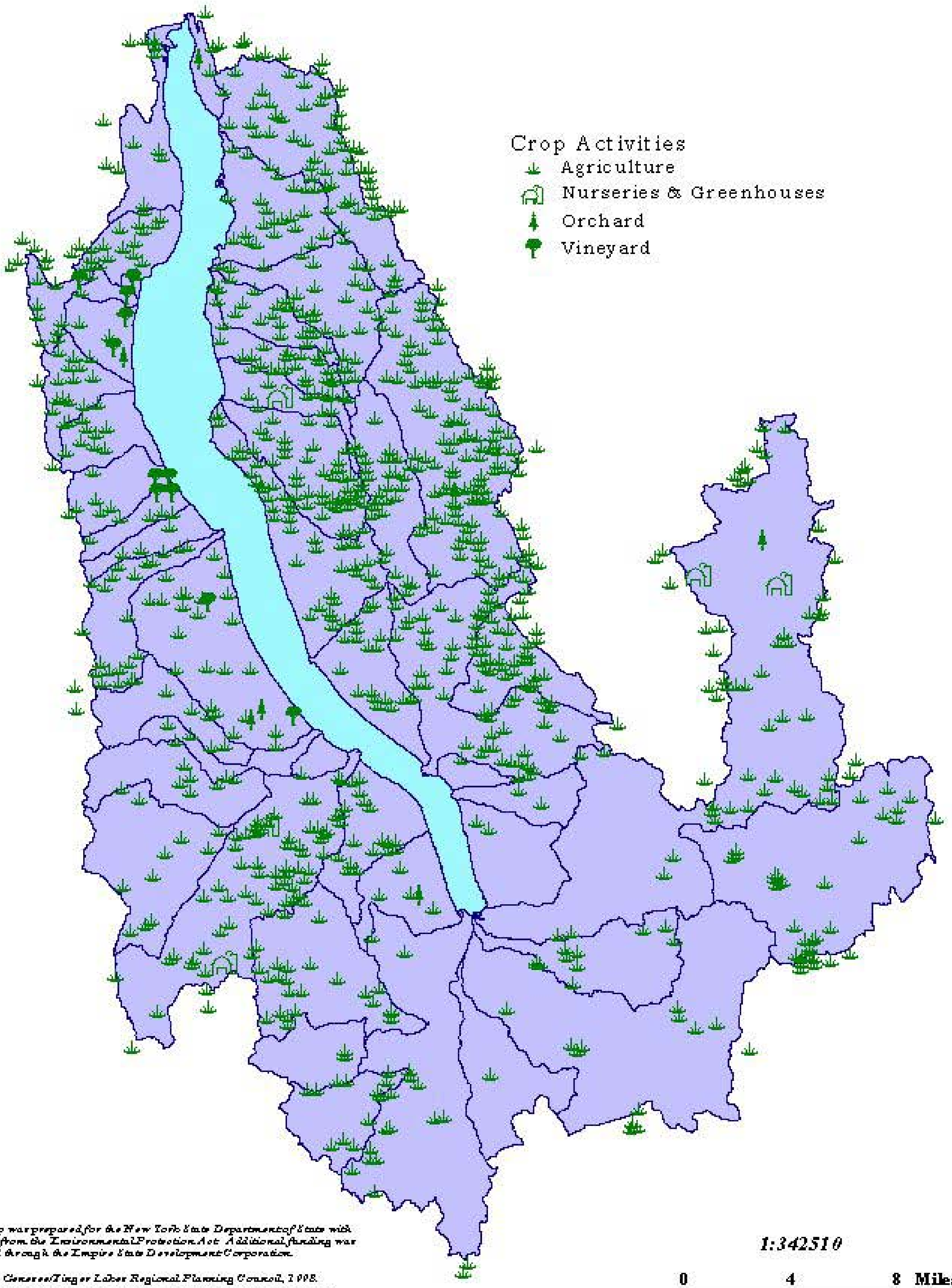
Open dumping and burning sites, closed dumps and scrap and junk yards including organic and inorganic chemicals, metals, oils, and wastes from household (see Potentially Harmful Components of Common Household Products) and business. As Map 3.7.1 indicate, there are approximately six known scrap and junk yards and they are mainly in the northwest and southern portions of the watershed.

### 3.12 Agricultural Sources

In the Cayuga Lake Watershed agricultural sources can be broken into two categories: plant agriculture and livestock and products. Plant agriculture can be further broken into the categories of field and truck crops, nursery and greenhouses, orchard, and vineyard. The livestock and products category includes cattle, calves, hogs; dairy products; poultry and poultry products; other livestock including donkeys and goats; aquatic farms; horse farms; sheep and wool; and fish, game and wildlife preserves.

Section 2.12.2 discusses agricultural land use in the watershed. Agriculture accounts for about 50% of the land use in the watershed when considering all agriculture categories including agricultural vacant land. Livestock and

# Cayuga Lake Watershed
# Crop Activities

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*Base Map: New York State Department of Transportation, February 1996.*

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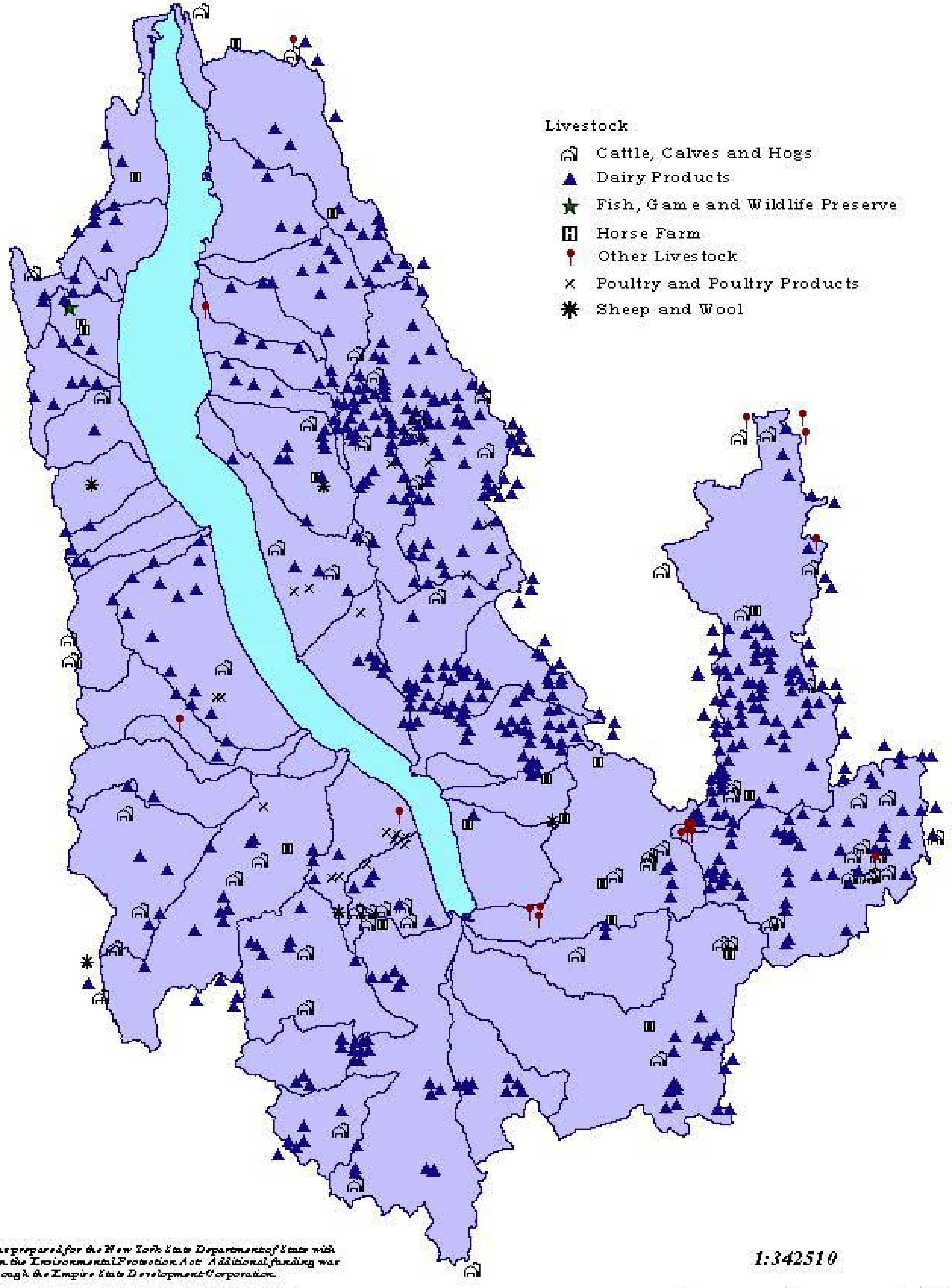
*Prepared by Genesee/Finger Lakes Regional Planning Council, 1999.*

# Cayuga Lake Watershed
# Livestock

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*Tompkins County GIS Program, 1999.*

*Base Map: New York State Department of Transportation, February 1996.*

*Prepared by Genesee/Finger Lakes Regional Planning Council, 1999.*

products accounts for over 20% of the land in the watershed. Plant agriculture accounts for over 15% of the land in the watershed. As map 3.12.2 indicates the vast majority of the livestock and products category is in dairy operations with a high density of these operations on the eastern side of the watershed. As Map 3.12.1 indicates the primary plant agricultural category is in crop operations, much of which is for livestock feed. These operations are most dense in the eastern portion of the watershed as well.

The primary agricultural nonpoint source pollutants are nutrients, sediment, animal wastes, salts, and pesticides. Agricultural activities also have the potential to directly impact the habitat of aquatic species through physical disturbances caused by livestock or equipment, or through the management of water. The effects of these pollutants on water quality are discussed below (USEPA 1993b):

*Nutrients*

Nitrogen (N) and phosphorus (P) are the two major nutrients from agricultural land that degrade water quality. Nutrients are applied to agricultural land in several different forms and come from various sources, including: Commercial fertilizer in a dry or fluid form, containing nitrogen (N), phosphorus (P), potassium (K), secondary nutrients, and micronutrients; Manure from animal production facilities including bedding and other wastes added to the manure, containing N, P, K, secondary nutrients, micronutrients, salts, some metals, and organics; Municipal and industrial treatment plant sludge, containing N, P, K, secondary nutrients, micronutrients, salts, metals, and organic solids; Municipal and industrial treatment plant effluent, containing N, P, K, secondary nutrients, micronutrients, salts, metals, and organics; Legumes and crop residues containing N, P, K, secondary nutrients, and micronutrients; irrigation water; and atmospheric deposition of nutrients such as nitrogen and sulfur.

Major nutrient data for Cayuga Lake is discussed in Section 4.2, Chemical Characteristics of Cayuga Lake. The PWL indicates nutrient loading from agriculture in the following tributaries to the lake: Yawger Creek, Big Salmon Creek, Little Salmon Creek, Dryden Lake, Lake Como, Fall Creek, Cascadilla Creek and Six Mile Creek. For the Cayuga County portion of the watershed nutrients were identified as the primary agricultural concern (Cayuga County SWCD, 2000). In identifying sources of nutrients on 54 farms the following worksheets were used: pathogens, manure storage and disposal, fertilizer management, milking center waste, silage, and barnyards. For each category, a scale of 1-4 was used, with 4 being a high concern, and 1 a lesser concern. Rankings were based on the total overall score (with a possible 24 points if a farm had 4s on all 6 worksheets). The data is summarized in Figure 3.12.1.

Figure 3.12.1
Farm Nutrient Worksheet Summary
Impact of the Environmental Quality Incentive Program
Cayuga County
Cayuga Lake Watershed

| | Pathogens | Manure | Milk Ctr. | Silage | Fertilizer | Barnyards |
|---|---|---|---|---|---|---|
| Total | 39 | 56 | 28 | 55 | 64 | 68 |
| Average | 1.77 | 1.93 | 1.75 | 2.29 | 1.36 | 2.62 |

Source: Cayuga Lake SWCD, 1999

Surface water runoff from agricultural lands to which nutrients have been applied may transport the following pollutants:

Particulate-bound nutrients, chemicals, and metals, such as phosphorus, organic nitrogen, and metals applied with some organic wastes; Soluble nutrients and chemicals, such as nitrogen, phosphorus, metals, and many other major and minor nutrients; Sediment, particulate organic solids, and oxygen-demanding material; salts; and bacteria, viruses, and other microorganisms.

Ground-water infiltration from agricultural lands to which nutrients have been applied may transport the following pollutants: soluble nutrients and chemicals, such as nitrogen, phosphorus, metals, and many other major and minor nutrients, and salts.

Surface water and ground water pollutants from organic matter and crop residue decomposition and from legumes growing on agricultural land may include nitrogen, phosphorus, and other essential nutrients found in the residue of growing crops.

All plants require nutrients for growth. In aquatic environments, nutrient availability usually limits plant growth. Nitrogen and phosphorus generally are present at background or natural levels below 0.3 and 0.05 mg/L, respectively. When these nutrients are introduced into a stream, or lake at higher rates, aquatic plant productivity may increase dramatically. This process, referred to as cultural eutrophication, may adversely affect the suitability of the water for other uses.

Increased aquatic plant productivity results in the addition to the system of more organic material, which eventually dies and decays. The decaying organic matter produces unpleasant odors and depletes the oxygen supply required by aquatic organisms. Excess plant growth may also interfere with recreational activities such as swimming and boating. Depleted oxygen levels, especially in colder bottom waters where dead organic matter tends to accumulate, can reduce the quality of fish habitat and encourage the propagation of fish that are adapted to less oxygen or to warmer surface waters. Highly enriched waters will stimulate algae production, with consequent increased turbidity and color. Furthermore, the increased turbidity results in less sunlight penetration and availability to submerged aquatic vegetation (SAV). Since SAV provides habitat for small or juvenile fish, the loss of SAV has severe consequences for the food chain.

a. Phosphorus

Phosphorus can also contribute to the eutrophication of both freshwater and estuarine systems. While phosphorus typically plays the controlling role in freshwater systems, in some estuarine systems both nitrogen and phosphorus can limit plant growth. Algae consume dissolved inorganic phosphorus and convert it to the organic form. Phosphorus is rarely found in concentrations high enough to be toxic to higher organisms. Although the phosphorus content of most soils in their natural condition is low, between 0.01 and 0.2 percent by weight, recent soil test results show that the phosphorus content of most cropped soils in the Northeast have climbed (Sims, 1992). Manure and fertilizers increase the level of available phosphorus in the soil to promote plant growth, but many soils now contain higher phosphorus levels than plants need (Killorn, 1980; Novais and Kamprath, 1978). Phosphorus can be found in the soil in dissolved, colloidal, or particulate forms.

Runoff and erosion can carry some of the applied phosphorus to nearby water bodies. Dissolved inorganic phosphorus (soluble reactive phosphorus) is probably the only form directly available to algae. Particulate and organic phosphorus delivered to waterbodies may later be released and made available to algae when the bottom sediment of a stream becomes anaerobic, causing water quality problems.

b. Nitrogen

All forms of transported nitrogen are potential contributors to eutrophication in lakes. In general, though not in all cases, nitrogen availability is the limiting factor for plant growth in aquatic ecosystems. Thus, the addition of nitrogen can have a significant effect on the natural functioning of aquatic ecosystems.

In addition to eutrophication, excessive nitrogen causes other water quality problems. Dissolved ammonia at concentrations above 0.2 mg/L may be toxic to fish, especially trout. Nitrates in drinking water are potentially dangerous, especially to newborn infants. Nitrate is converted to nitrite in the digestive tract, which reduces the oxygen-carrying capacity of the blood (methemoglobinemia), resulting in brain damage or even death. The U.S. Environmental Protection Agency has set a limit of 10 mg/L nitrate-nitrogen in water used for human consumption (USEPA, 1989).

Nitrogen is naturally present in soils but must be added to increase crop production. Nitrogen is added to the soil primarily by applying commercial fertilizers and manure, but also by growing legumes (biological nitrogen fixation) and incorporating crop residues. Not all nitrogen that is present in or on the soil is available for plant use at any one time. Organic nitrogen normally constitutes the majority of the soil nitrogen. It is slowly converted (2 to 3 percent per year) to the more readily plant-available inorganic ammonium or nitrate.

The chemical form of nitrogen affects its impact on water quality. The most biologically important inorganic forms of nitrogen are ammonium (NH4-N), nitrate (NO3-N), and nitrite (NO2-N). Organic nitrogen occurs as particulate matter, in living organisms, and as detritus. It occurs in dissolved form in compounds such as amino acids, amines, purines, and urea.

| Table 3.12.1 Agricultural Environmental Management Surveys for Selected Subwatersheds (Tompkins County SWCD) | | |
|---|---|---|
| | **Fall Creek Subwatershed** | **Six Mile Creek Subwatershed** |
| **Survey Coverage** | 126 | 26 active, 12 inactive properties |
| **Area Covered by Survey** | 43,031 acres | 7,056 acres |
| **Types of Operations** | | |
| **Dairy** | 48 | 5 |
| **Dairy Replacements** | 7 | 2 |
| **Beef** | 9 | 6 |
| **Cow-calf** | 8 | |
| **Stockers** | 2 | |
| **Other Livestock (Emu, Donkeys, and Mules** | 5 | |
| **Hay** | | 3 |
| **Cash Crop** | 7 | 9 |
| **Fruits and Vegetables** | 7 | |
| **Horses** | 18 | 8 |
| **Sheep** | 6 | 2 |
| **Goats** | 3 | |
| **Poultry** | 8 | |
| **Dairy Steers** | 1 | |
| **Aquaculture** | 1 | |
| **Golf Course** | 1 | |
| **Hardwoods** | | 2 |
| **Winery** | | 2 |
| **Bed & Breakfast** | | 1 |
| **Number of Livestock** | | |
| **Mature Dairy Cows** | 5,032 | 333 |
| **Replacement Heifers > 6 months** | 2,769 | |
| **Calves < 6 months** | 1,162 | |
| **Beef Cattle** | 669 | 304 |
| **Horses** | 215 | 123 |
| **Sheep** | 417 | 125 |
| **Pigs** | | 350 |
| **Goats** | | 2 |
| **Poultry** | 288 | |
| **All other livestock** | 9 | |
| **Fish (at any one time)** | 20 to 30,000 | |
| **Land Usage (acres)** | | |
| **Cropland** | 10,807 | |
| **Hay** | 7,090 | 2,671 (crop and hay) |
| **Pasture** | 3,866 | 1,592 |
| **Forest** | 2,514 | |
| **Other (swamp, brush, farmstead)** | 2,362 | |
| **Fruits/Vegetables** | 106 | |
| **Barnyards** | 49 farms have barnyards<br>Surface water can potentially run through 22 barnyards.<br>Roof water run off enters 35 barnyards | 8 farms have barnyards.<br>Surface water can potentially run through 4 barnyards.<br>Roof water enters 6 of the barnyards. |
| **Petroleum** | 50 farms store petroleum on the property. There are 56 above ground tanks, with only 2 farms having spill contaminant vessels.<br>There are 20 underground storage tanks, with only 2 with any spill contaminant. | 14 farms store petroleum on the property. There are 2 buried petroleum storage tanks. There are 27 above ground petroleum storage tanks on the farms, only 4 have any sort of spill containment. |
| **Manure Management** | 59 farms reported spreading manure. 12 farms have long term storage. 16 farms have some type of short term storage. 31 farms have no storage. | 12 farms spread manure, however only two spread daily. 20 properties have a stream on or within 50’ of the property. Of these 7 have crops within 50’ of the stream. Livestock have limited access to the stream on 6 farms |

| | | |
|---|---|---|
| **Silage Storage** | 17 farms store silage in upright silos<br>10 farms store silage in bulk silos<br>16 farms store silage in ag-bags | |
| **Fertilizer/Pesticide Applied By** | | |
| **Farmer** | 41 | |
| **Contractor** | 25 | |
| **Frequency of Soil Analysis** | | |
| **Yearly** | 7 | |
| **1-5 Years** | 15 | |
| **4-6 Years** | 14 | |
| **Other** | 12 | |

Nitrate-nitrogen is highly mobile and can move readily below the crop root zone, especially in sandy soils. It can also be transported with surface runoff, but not usually in large quantities. Ammonium, on the other hand, becomes adsorbed to the soil and is lost primarily with eroding sediment. Even if nitrogen is not in a readily available form as it leaves the field, it can be converted to an available form either during transport or after delivery to waterbodies.

*Sediment*

Chemicals such as some pesticides, phosphorus, and ammonium are transported with sediment in an adsorbed state. Changes in the aquatic environment, such as a lower concentration in the overlying waters or the development of anaerobic conditions in the bottom sediments, can cause these chemicals to be released from the sediment. Adsorbed phosphorus transported by the sediment may not be immediately available for aquatic plant growth but does serve as a long-term contributor to eutrophication.

Sediment is the result of erosion. It is the solid material, both mineral and organic, that is in suspension, is being transported, or has been moved from its site of origin by air, water, gravity, or ice. The types of erosion associated with agriculture that produce sediment are (1) sheet and rill erosion and (2) gully erosion. Soil erosion can be characterized as the transport of particles that are detached by rainfall, flowing water, or wind. Eroded soil is either redeposited on the same field or transported from the field in runoff.

Sediments from different sources vary in the kinds and amounts of pollutants that are adsorbed to the particles. For example, sheet and rill erosion mainly move soil particles from the surface or plow layer of the soil. Sediment that originates from surface soil has a higher pollution potential than that from subsurface soils. The topsoil of a field is usually richer in nutrients and other chemicals because of past fertilizer and pesticide applications, as well as nutrient cycling and biological activity. Topsoil is also more likely to have a greater percentage of organic matter. Sediment from gullies and streambanks usually carries less adsorbed pollutants than sediment from surface soils.

Soil eroded and delivered from cropland as sediment usually contains a higher percentage of finer and less dense particles than the parent soil on the cropland. This change in composition of eroded soil is due to the selective nature of the erosion process. For example, larger particles are more readily detached from the soil surface because they are less cohesive, but they also settle out of suspension more quickly because of their weight. Organic matter is not easily detached because of its cohesive properties, but once detached it is easily transported because of its low density. Clay particles and organic residues will remain suspended for longer periods and at slower flow velocities than will larger or more dense particles. This selective erosion can increase overall pollutant delivery per ton of sediment delivered because small particles have a much greater adsorption capacity than larger particles. As a result, eroding sediments generally contain higher concentrations of phosphorus, nitrogen, and pesticides than the parent soil (i.e., they are enriched).

Figure 3.12.2
Farm Sediment Worksheet Summary
Impact of the Environmental Quality Incentive Program
Cayuga County
Cayuga Lake Watershed

| | Streams | Soil Mgmt |
|---|---|---|
| Total | 89 | 101 |
| Average | 1.89 | 1.94 |

Source: Cayuga Lake SWCD, 1999

The PWL lists sediment as a type of pollutant in portions of the following tributaries to Cayuga Lake: Yawger Creek, Bolter Creek, Big Salmon Creek, Little Salmon Creek, Fall Creek, Lake Como, Cascadilla Creek, Cayuga Inlet, and Six

Mile Creek.  For the Cayuga County portion of the watershed sediments were identified as secondary agricultural concern (Cayuga County SWCD, 2000).  In identifying sources of nutrients on 54 farms the following worksheets were used: soil management and streambanks.  For each category, a scale of 1-4 was used, with 4 being a high concern, and 1 a lesser concern.  Rankings were based on the total overall score (with a possible 24 points if a farm had 4s on all 6 worksheets).  The data is summarized in Figure 3.12.2.

*Animal Wastes*

Animal waste (manure) includes the fecal and urinary wastes of livestock and poultry; process water (such as from a milking parlor); and the feed, bedding, litter, and soil with which they become intermixed. The following pollutants may be contained in manure and associated bedding materials and could be transported by runoff water and process wastewater from confined animal facilities: Oxygen-demanding substances;  Nitrogen, phosphorus, and many other major and minor nutrients or other deleterious materials; Organic solids;  Salts;  Bacteria, viruses, and other microorganisms; and Sediments.  Of the 164 farms surveyed in the Six Mile Creek (Mussell) and Fall Creek (Tompkins County S&WCD) subwatersheds 43% report spreading manure (see Table 3.12.1 and Appendix J).

Fish kills may result from runoff, wastewater, or manure entering surface waters, due to ammonia or dissolved oxygen depletion.  The decomposition of organic materials can deplete dissolved oxygen supplies in water, resulting in anoxic or anaerobic conditions. Methane, amines, and sulfide are produced in anaerobic waters, causing the water to acquire an unpleasant odor, taste, and appearance. Such waters can be unsuitable for drinking, fishing, and other recreational uses.
Solids deposited in waterbodies can accelerate eutrophication through the release of nutrients over extended periods of time.  Because of the high nutrient and salt content of manure and runoff from manure-covered areas, contamination of ground water can be a problem if storage structures are not built to minimize seepage.

Animal diseases can be transmitted to humans through contact with animal feces. Runoff from fields receiving manure will contain extremely high numbers of bacteria if the manure has not been incorporated or the bacteria have not been subject to stress.  Although there have been no existing beach closures reported by the Health Departments in the watershed, beach closure can result from high fecal coliform counts.

The method, timing, and rate of manure application are significant factors in determining the likelihood that water quality contamination will result. Manure is generally more likely to be transported in runoff when applied to the soil surface than when incorporated into the soil. Spreading manure on frozen ground or snow can result in high concentrations of nutrients being transported from the field during rainfall or snowmelt, especially when the snowmelt or rainfall events occur soon after spreading (Robillard and Walter, 1986).
When application rates of manure for crop production are based on N, the P and K rates normally exceed plant requirements (Westerman et al., 1985). The soil generally has the capacity to adsorb phosphorus leached from manure applied on land. As previously mentioned, however, nitrates are easily leached through soil into ground water or to return flows, and phosphorus can be transported by eroded soil.

Conditions that cause a rapid die-off of bacteria are low soil moisture, low pH, high temperatures, and direct solar radiation.  Manure storage generally promotes die-off, although pathogens can remain dormant at certain temperatures. Composting the wastes can be quite effective in decreasing the number of pathogens.

*Salts*

Salts are a product of the natural weathering process of soil and geologic material in the Cayuga Lake Watershed. They are present in varying degrees in all soils and in fresh water and ground waters.

In soils that have poor subsurface drainage, high salt concentrations are created within the root zone where most water extraction occurs. The accumulation of soluble and exchangeable sodium leads to soil dispersion, structure breakdown, decreased infiltration, and possible toxicity; thus, salts often become a serious problem on irrigated land, both for continued agricultural production and for water quality considerations. High salt concentrations in streams can harm freshwater aquatic plants just as excess soil salinity damages agricultural crops.  The movement and deposition of salts depend on the amount and distribution of rainfall and irrigation, the soil and underlying strata, evapotranspiration rates, and other environmental factors.  In humid areas, such as the Cayuga Lake Watershed, dissolved mineral salts have been naturally leached from the soil and substrata by rainfall. Soluble salts in saline and sodic soils consist of calcium, magnesium, sodium, potassium, carbonate, bicarbonate, sulfate, and chloride ions. They are fairly easily leached from the soil. Sparingly soluble gypsum and lime also occur in amounts ranging from traces to more than 50 percent of the soil mass.

Irrigation water, whether from ground or surface water sources, has a natural base load of dissolved mineral salts. As the water is consumed by plants or lost to the atmosphere by evaporation, the salts remain and become concentrated in the soil. This is referred to as the "concentrating effect."

The total salt load carried by irrigation return flow is the sum of the salt remaining in the applied water plus any salt picked up from the irrigated land. Irrigation return flows provide the means for conveying the salts to the receiving streams or groundwater reservoirs. If the amount of salt in the return flow is low in comparison to the total stream flow, water quality may not be degraded to the extent that use is impaired. However, if the process of water diversion for irrigation and the return of saline drainage water is repeated many times along a stream or river, water quality will be progressively degraded for downstream irrigation use as well as for other uses.

*Pesticides*

The term pesticide includes any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest or intended for use as a plant regulator, defoliant, or desiccant. The principal pesticidal pollutants that may be detected in surface water and in ground water are the active and inert ingredients and any persistent degradation products. Pesticides and their degradation products may enter ground and surface water in solution, in emulsion, or bound to soil colloids. For simplicity, the term pesticides will be used to represent "pesticides and their degradation products" in the following sections.

Along with agricultural use it should be noted that major pesticide use occurs in residential settings and golf course in the Watershed. Generally, for economic as well as environmental reasons farmers are more conservative with their use of pesticides. Additionally, new generations of pesticides have tended to decrease usage and have in-tern minimized off-site impacts.

Despite the documented benefits of using pesticides (insecticides, herbicides, fungicides, miticides, nematicides, etc.) to control plant pests and enhance production, these chemicals may, in some instances, cause impairments to the uses of surface water and ground water. Some types of pesticides are resistant to degradation and may persist and accumulate in aquatic ecosystems. Pesticide use can have adverse impacts on human health, particularly for farmers that may accidentally exposed to pesticides or may not be aware of the proper procedure of their application.

Pesticides may harm the environment by eliminating or reducing populations of desirable organisms, including endangered species. Sublethal effects include the behavioral and structural changes of an organism that jeopardize its survival. For example, certain pesticides have been found to inhibit bone development in young fish or to affect reproduction by inducing abortion.

Herbicides in the aquatic environment can destroy the food source for higher organisms, which may then starve. Herbicides can also reduce the amount of vegetation available for protective cover and the laying of eggs by aquatic species. Also, the decay of plant matter exposed to herbicide-containing water can cause reductions in dissolved oxygen concentration (North Carolina State University, 1984).

Sometimes the toxicity of a pesticide will increase in the presence of other pesticides or other chemical compounds. This is referred to as a synergistic effect, and it may be difficult to predict or evaluate. Bioconcentration is a phenomenon that occurs if an organism ingests more of a pesticide than it excretes. During its lifetime, the organism will accumulate a higher concentration of that pesticide than is present in the surrounding environment. When the organism is eaten by another animal higher in the food chain, the pesticide will then be passed to that animal, and on up the food chain to even higher level animals.

A major source of contamination from pesticide use is the result of normal application of pesticides. Other sources of pesticide contamination are atmospheric deposition, spray drift during the application process, misuse, and spills, leaks, and discharges that may be associated with pesticide storage, handling, and waste disposal.

The primary routes of pesticide transport to aquatic systems are (Maas et al., 1984):

1.Direct application;
2.In runoff;
3.Aerial drift;
4.Volatilization and subsequent atmospheric deposition; and
5.Uptake by biota and subsequent movement in the food web.

The amount of field-applied pesticide that leaves a field in the runoff and enters a stream primarily depends on:

1.The intensity and duration of rainfall or irrigation;
2.The length of time between pesticide application and rainfall occurrence;
3.The amount of pesticide applied and its soil/water partition coefficient;
4.The length and degree of slope and soil composition;
5.The extent of exposure to bare (vs. residue or crop-covered) soil;
6.Proximity to streams;
7.The method of application; and
8.The extent to which runoff and erosion are controlled with agronomic and structural practices.

Pesticide losses are generally greatest when rainfall is intense and occurs shortly after pesticide application, a condition for which water runoff and erosion losses are also greatest.

Analysis by Eckhardt (Eckhardt, et. al.) of stormwater samples collected from tributaries to Cayuga Lake shortly after application of atrazine and metolachlor to agricultural fields in June of 1998 indicate that the highest concentrations, and the bulk of the loads of the two herbicides in the three tributaries was transported during peak flows. Concentrations of metolachlor metabolites remained high after the flow peaked as the soils drained. In contrast, deethylatrazine concentrations, which are generally low, increased only slightly during stormflow, apparently because the parent compound (atrazine) degrades at a much slower rate than metolachlor. Far more metolachlor-ESA (a degradation compound) was transported than any other pesticide or degradate; this indicates that it is relatively stable and mobile in the hydrologic environment. The ratios of a metabolite concentration to that of other metabolites and the parent compound in stream-water samples showed that base flow in the tributaries before thestorm was enriched with metolachlor-ESA, but not with metolachlor or metolachlor-OA. After the storm, the ratio of metolachlor-OA to metolachlor-ESA to metolachlor increased markedly in the base flow; apparently metolachlor-OA that is formed in soils after pesticide application is readily leached but does not persist in ground water as much as metolchlor-ESA does. Water samples taken from Cayuga Lake in July, after the early-summer flush of pesticide residues in June, indicated fairly uniform concentrations of herbicides throughout the lake. The ratios of the three metabolites to their parent compounds were significantly higher in lake water than in the three tributaries, possibly as a result of (1) the inflow of ground water that enters the lake directly from adjacent agricultural land, and (2) the transformation of the parent compounds during their residence in the lake.

The rate of pesticide movement through the soil profile to ground water is inversely proportional to the pesticide adsorption partition coefficient or Kd (a measure of the degree to which a pesticide is partitioned between the soil and water phase). The larger the Kd, the slower the movement and the greater the quantity of water required to leach the pesticide to a given depth.

Pesticides can be transported to receiving waters either in dissolved form or attached to sediment. Dissolved pesticides may be leached to ground-water supplies. Both the degradation and adsorption characteristics of pesticides are highly variable.

In addition to use of pesticides and fertilizers, agricultural operations have gasoline and motor oils from chemical applicators, automotive wastes including gasoline, antifreeze, automatic transmission fluid, battery acid, engine and radiator flushes, engine and metal degreasers, hydraulic fluid and motor oils, and welding wastes.

The PWL lists pesticides as a type of pollutant in Six Mile Creek and Cayuga Lake (see Table 1.5.4.1.1 and Table 4.2.8). Other limnological findings of pesticide usage in the watershed are discussed in Section 4.3.2.

*Habitat Impacts*

The functioning condition of riparian-wetland areas is a result of interaction among geology, soil, water, and vegetation. Riparian-wetland areas are functioning properly when adequate vegetation is present to (1) dissipate stream energy associated with high water flows, thereby reducing erosion and improving water quality; (2) filter sediment and aid floodplain development; (3) support denitrification of nitrate-contaminated ground water as it is discharged into streams; (4) improve floodwater retention and ground-water recharge; (5) develop root masses that stabilize banks against cutting action; (6) develop diverse ponding and channel characteristics to provide the habitat and the water depth, duration, and temperature necessary for fish production, waterfowl breeding, and other uses; and (7) support greater biodiversity.

Improper livestock grazing affects all four components of the water-riparian system: banks/shores, water column, channel, and aquatic and bordering vegetation (Platts, 1990). The potential effects of grazing include:

Shore/banks
Shear or sloughing of streambank soils by hoof or head action.
Water, ice, and wind erosion of exposed streambank and channel soils because of loss of vegetative cover.
Elimination or loss of streambank vegetation.
Reduction of the quality and quantity of streambank undercuts.
Increasing streambank angle (laying back of streambanks), which increases water width, decreases stream depth, and alters or eliminates fish habitat.
Water Column
Withdrawal from streams to irrigate grazing lands.
Drainage of wet meadows or lowering of the ground-water table to facilitate grazing access.
Pollutants (e.g., sediments) in return water from grazed lands, which are detrimental to the designated uses such as fisheries.
Changes in magnitude and timing of organic and inorganic energy (i.e., solar radiation, debris, nutrients) inputs to the stream.
Increase in fecal contamination.
Changes in stream morphology, such as increases in stream width and decreases in stream depth, including reduction of stream shore water depth.
Changes in timing and magnitude of stream flow events from changes in watershed vegetative cover.
Increase in stream temperature.
Channel
Changes in channel morphology.
Altered sediment transport processes.
Riparian Vegetation
Changes in plant species composition (e.g., shrubs to grass to forbs).
Reduction of floodplain and streambank vegetation including vegetation hanging over or entering into the water column.
Decrease in plant vigor.
Changes in timing and amounts of organic energy leaving the riparian zone.
Elimination of riparian plant communities (i.e., lowering of the water table allowing xeric plants to replace riparian plants).

**3.13 Residential Sources**

Residential potential sources of contamination include the following categories:

*Common household maintenance and hobbies* including the use of common household products, wall and furniture treatments, and mechanical repair and other maintenance products (see Table 3.13.1, Potentially Harmful Components of Common Household Products)

*Lawn care and grounds management* including application of fertilizers, herbicides and other and pesticides also occur in residential areas, public parks, and golf courses, posing threats to natural water resources from grounds

| Table 3.13.1 Potentially Harmful Components of Common Household Products | |
|---|---|
| **Product** | **Toxic or Hazardous Components** |
| Antifreeze (gasoline or coolants systems) | Methanol, ethylene glycol |
| Automatic transmission fluid | Petroleum distillates, xylene |
| Battery acid (electrolyte) | Sulfuric acid |
| Degreasers for driveway and garages | Petroleum solvents, alcohols, glycol ether |
| Degreasers for engines and metal | Chlorinated hydrocarbons, tulene, phenols, dichloroperchloroethylene |
| Engine and radiator flushes | Petroleum solvents, ketones, butanol, glycol ether |
| Hydraulic fluid (brake fluid) | Hydrocarbons, fluorocarbons |
| Motor oils and waste oils | Hydrocarbons |
| Gasoline and jet fuels | Hydrocarbons |
| Diesel fuel, kersene, #2 heating oil | Hydrocarbons |
| Grease, lubes | Hydrocarbons |
| Rustproofers | Phenols, heavy metals |
| Car wash detergents | Alkyl benzene sulfonates |
| Car waxes and polishes | Petroleum distillates, hydrocarbons |
| Asphalt and roofing tar | Hydrocarbons |
| Paints, varnishes, stains, dyes | Heavy metals, toluene |
| Paint and lacquer thinner | Acetone, benzene, toluene, butyl acetate, methyl ketones |
| Paint and varnish removers, deglossers | Methylene chloride, toluene, acetone, xylene, ethanol, benzene, methanol |
| Paint brush cleaners | Hydrocarbons, toluene, acetone, methanol, glycol ethers, methyl ethyl ketones |
| Floor and furniture strippers | Xylene |
| Metal polishes | Petroleum distillates, isopropanol, petroleum naphtha |
| Laundry soil and stain removers | Hydrocarbons, benzene, trichloroethylene, 1,1,1-trichloroethane |
| Other solvents | Acetone, benzene |
| Rock salt | Sodium concentration |
| Refrigerants | 1,1,2-trichloro-1,2,2-trifluoroethane |
| Bug and tar removers | Xylene, petroleum distillates |
| Household cleaners, oven cleaners | Xylenols, glycol ethers, isopropanol |
| Drain cleaners | 1,1,1-trichloroethane |
| Toilet cleaners | Xylene, sulfonates, chlorinated phenols |
| Cesspool cleaners | Tetrachloroethylene, dichlorobenzene, methylene chloride |
| Disinfectants | Cresol, xylenols |
| Pesticides (all types) | Naphthalene, phosphorus, xylene, chloroform, heavy metals, chlorinated hydrocarbons |
| Photochemicals | Phenols, sodium sulfite, cyanide, silver halide, potassium bromide |
| Printing ink | Heavy metals, phenol-formaldehyde |
| Wood preservatives (creosote) | Penachlorophenols |
| Swimming pool chlorine | Sodium hypochlorite |
| Lye or caustic soda | Sodium hydroxide |
| Jewelry cleaners | Sodium cyanide |
| Source: Natural Resources Facts: Household Hazardous Wastes, Fact Sheet No. 88-3, Department of Natural Sciences, University of Rhode Island 1988 | |

upkeep. The potential water quality effects of these pollutants is discussed in the Agricultural Section above, although the application techniques may differ. An estimated 50 to 80 percent of homeowners apply some type of pesticides to their lawns, oftentimes with little regard for moderation.

*Swimming pools* including swimming pool maintenance chemicals which can contain free and combined chlorine; bromine; lodine; mercury-based, copper-based, and quaternary algicides; cyanuric acid; calcium or sodium hypochlorite; muriatic acid; and sodium carbonate.

*Underground storage tanks* containing home heating oil.

*On-Site Systems*
On-site systems are comprised of a tank and a leaching facility. The tank provides for some treatment and the separation of solids and liquids. The leaching facility serves to dispose of the liquid wastes. The USEPA estimates that one-third of all on-site systems in the United States do not operate in accordance with current health standards.

On-site systems are able to remove many of the dissolved and particulate materials present in sewage. Their primary function is to prevent wastewater from becoming a public health problem. By discharging wastewater below the ground surface, it is a popular belief that people are less likely to come in contact with harmful bacteria and viruses. Generally conventional on-site systems provide only minimal treatment of nitrogen; however, there are innovative/alternative wastewater disposal technologies that can remove nitrogen. After the effluent leaves the on-site system, nitrogen concentrations are above concentrations that can negatively affect water supplies and downgrade waters. Oftentimes plumes of elevated nitrogen levels can be found nearby.

Phosphorus and fecal coliform bacteria are two constituents of the effluent that are generally adequately removed as they pass through the soils immediately surrounding the on-site system. As the effluent percolates through, phosphate tends to adhere to soil particles. They can become a problem as sediment is carried into a tributary or directly into the Lake.

Bacteria are filtered out by the soils below the leaching structure as they are large enough to be trapped in the sediment pore spaces. Because virus are smaller then bacteria, the filtering action of the sediments is considered less efficient.

Another component of on-site system effluent is synthetic organic compounds (SOC). The SOCs most commonly identified as on-site system effluent include benzene, toluene, dichloromethene, and chloroform, and are the result of improper disposal of such things as paints, oil/grease, cleaners, and solvents. Conventional on-site systems are not designed to treat SOCs; therefore, these compounds can be expected to pass through the system into the soils beneath the facility or in the receiving groundwater. The fate and transport of the SOCs in the subsurface varies with the particular compound. For example, pesticides are likely to be found adsorbed to the soil particles beneath the on-site system, while chlorinated hydrocarbons like benzene and Trichloroethylene will be found in the groundwater, and possibly in the surface water.

On-site systems can fail for several reasons. The major observable symptoms of failure are: (1) backups of the wastewater at the source, (2) breakout or seepage of the wastewater onto the soil surface, and (3) groundwater contamination. These failure symptoms are likely to result in human contact with human excrement and possible exposure to infectious organisms capable of causing diseases, such as dysentery, infectious hepatitis, meningitis, typhoid, various types of diarrheal illnesses, and other diseases. For this reason, on-site system failure is a watershed-wide public health concern.

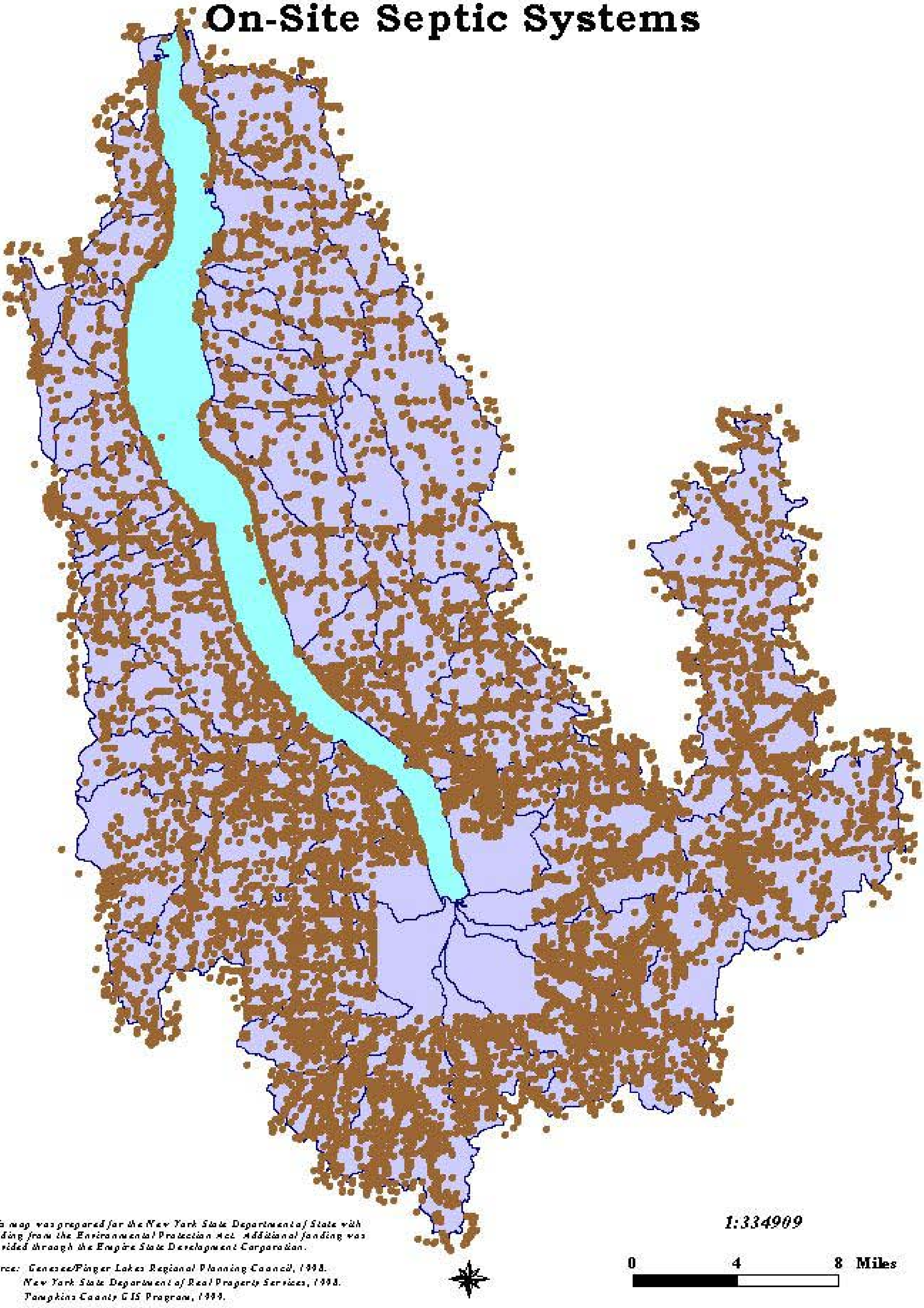
Failures of on-site systems are caused by the inability of the system to convey wastewater, either because the systems is flooded with groundwater or because the effluent does not percolate out of the system as rapidly as wastewater enters the system. High groundwater levels caused by fluctuations of the water table are the common cause of flooding of the on-site system, and the root of such problems is usually in the initial site evaluation and system design. The failure of effluent to percolate from the system may be caused by inadequate design in recognizing poorly draining soils or because of mismanagement of the system. To prevent flooding from high groundwater, a good engineering design establishes a suitable vertical buffer distance between the variable water table and the leaching structure so that maximum high water will be at a depth below the leaching structure. A sound program of operation and maintenance will help avert on-site system failure.

Commercially available on-site system cleaners containing synthetic organic chemicals have also contaminated groundwater. These cleaners also interfere with natural decomposition processes in on-site systems.

Outside of sewer districts in the Cayuga Lake Watershed there is extensive usage of on-site systems. The highest densities include the southeast and southwest sides of the lower one third of the lake and the southern portion of the watershed (see Map 3.13.1). Even though the least-dense county in terms of on-site systems is Cayuga, much of the soils have severe to very severe on-site system usage limitations, mainly due to infiltration rates. This is the case in middle and lower Seneca County as well. In Tompkins County the area of severe and very severe limitation to on-site systems due to soils is not as broad, although the on-site system usage is much denser than the other areas of the watershed. As map 3.13.2 indicates, this includes a swath of Hudson-Cayuga soils that runs up the west side of the lake in the Town of Ithaca and Ulysses, a swath of Hudson-Rhinebeck that runs north-south on the east side of the Town of Newville and the west side of the Town of Danby, pockets of Erie-Langford in the Towns of Enfield, Newfield, Danby, and Dryden. The PWL lists on-site systems as a source of pollutants in the following segments in the watershed: portions of Cayuga Lake, Fall Creek, Lake Como, Cayuga Inlet, and Six Mile Creek.

The only county in the Watershed routinely inspecting on-site systems is in Cayuga County. Table 3.13.2 shows a summary of the municipalities that have been inspected in Cayuga County within the Watershed.

# Cayuga Lake Watershed On-Site Septic Systems



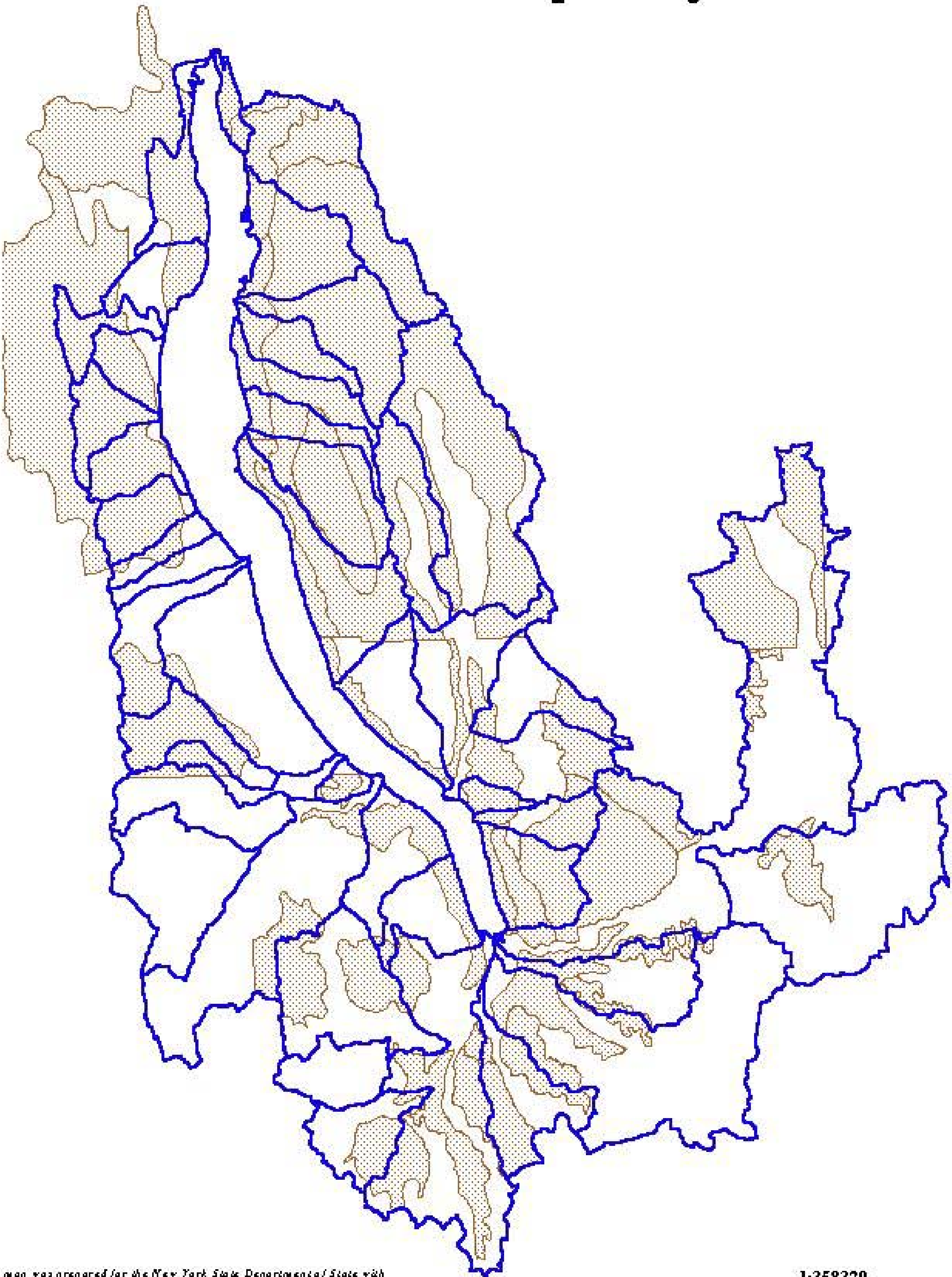

This map was prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.

Source: Genesee/Finger Lakes Regional Planning Council, 1998.
New York State Department of Real Property Services, 1998.
Tompkins County GIS Program, 1999.

Base Map: New York State Department of Transportation, February 1996.

Prepared by Genesee/Finger Lakes Regional Planning Council, 1999.

# Cayuga Lake Watershed
# Severe to Very Severe Soil Limitations to Septic Systems



This map was prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.

Source: United States Department of Agriculture, Soil Conservation Service, 1965-1979.
Genesee/Finger Lakes Regional Planning Council, 1998.

Base Map: New York State Department of Transportation, February 1996.

1:358329

0 5 10 Miles

Prepared by Genesee/Finger Lakes Regional Planning Council.

**Table 3.13.2**
**Cayuga County Onsite System Inspection Program**

Aurelius

| | |
|---|---|
| Total | 729 |
| % Failed | 4% |
| % Seasonal | 12% |
| % System <5 years | 14% |
| System Type | |
| 6% | Unknown |
| 78% | Absorption Field |
| 9% | Absorption Bed |
| 4% | Drywell Septic Tank |
| 1% | Holding Tank |
| <1% | Drywell Only |
| 1% | Sand Filter |
| <1% | Privy |

Scipio (Within Cayuga Watershed)

| | |
|---|---|
| Total | 237 |
| % Failed | 6% |
| % Seasonal | 4% |
| % System <5 years | 13% |
| System Type | |
| 8% | Unknown |
| 82% | Absorption Field |
| 3% | Absorption Bed |
| 4% | Drywell Septic Tank |
| <1% | Holding Tank |
| <1% | Drywell Only |
| <1% | Sand Filter |
| <1% | Privy |

Venice

| | |
|---|---|
| Total | 529 |
| % Failed | 4% |
| % Seasonal | 7% |
| % System <5 years | 14% |
| System Type | |
| 9% | Unknown |
| 71% | Absorption Field |
| 3% | Absorption Bed |
| 14% | Drywell Septic Tank |
| 1% | Holding Tank |
| 1% | Drywell Only |
| <1% | Sand Filter |
| <1% | Privy |

Fleming (Within Cayuga Watershed)

| | |
|---|---|
| Total | 306 |
| % Failed | 5% |
| % Seasonal | 3% |
| % System <5 years | 12% |
| System Type | |
| 10% | Unknown |
| 69% | Absorption Field |
| 15% | Absorption Bed |
| 5% | Drywell Septic Tank |
| <1% | Holding Tank |
| <1% | Drywell Only |
| <1% | Sand Filter |
| <1% | Privy |

Genoa

| | |
|---|---|
| Total | 876 |
| % Failed | 4% |
| % Seasonal | 20% |
| % System <5 years | 9% |
| System Type | |
| 4% | Unknown |
| 71% | Absorption Field |
| 4% | Absorption Bed |
| 10% | Drywell Septic Tank |
| 6% | Holding Tank |
| 2% | Drywell Only |
| 1% | Sand Filter |
| <1% | Privy |

Springport (Not including properties within proposed sewer district)

| | |
|---|---|
| Total | 291 |
| % Saw Dye | 3% |
| % Seasonal | 12% |
| % System <5 years | 9% |
| System Type | |
| 2% Unknown | Unknown |
| 85% | Absorption Field |
| 4% | Absorption Bed |
| 4% | Drywell Septic Tank |
| <1% | Holding Tank |
| <1% | Drywell Only |
| 1% | Sand Filter |
| <1% | Privy |

Source: Cayuga County Health and Human Services Department, February, 2000

# Chapter 4. Limnology

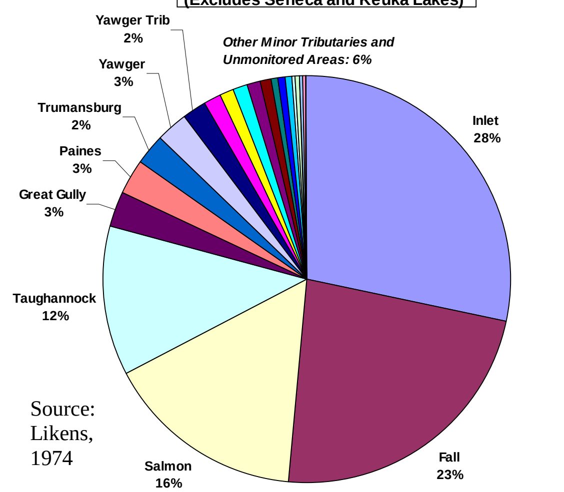
## Chapter 4: Limnology

### 4.1 Introduction

This chapter of the Cayuga Watershed Characterization Report is a compilation and analysis of water quality conditions in Cayuga Lake and its tributaries. Water quality and ecological conditions in Cayuga Lake are the result of complex physical, chemical, and biological processes. Important attributes of the lake ecosystem are determined by its geological history, climatic setting, hydrology, and land use patterns. Limnology, the science of freshwater lakes and streams, provides a framework for examining these processes and interpreting ambient conditions. The focus of Chapter 6 is on the interrelationships between water quality conditions and the health of the lake and its tributary streams from the perspectives of lake ecology and human use.

Multiple sources of data were reviewed to complete this limnological characterization of Cayuga Lake. Research and monitoring efforts date back to the early 1900s. Generations of students and faculty at area universities have examined aspects of the lake and watershed. State agencies, notably NYSDEC and NYSDOH, conduct ambient monitoring programs to characterize water quality and the fish community and identify any impairment to designated uses. Two federal agencies, USGS and EPA, have included Cayuga Lake in research programs.  Some long-term monitoring has been done by county and regional agencies such as the Soil and Water Conservation Districts. Users of the resource, for public drinking water supply, wastewater disposal, or noncontact cooling water, monitor to meet permit requirements.

**Figure 4.2.1**
**Drainage Areas of Subwatersheds**
**(Excludes Seneca and Keuka Lakes)**




Source: Likens, 1974

Each of the research or monitoring programs carried out on Cayuga Lake has been designed to meet specific objectives. A central task of the limnological characterization was to integrate the findings of the various investigations into an assessment of the “existing state” of water quality and ecological conditions. The “existing state” of Cayuga Lake was assessed by Professor Ray Oglesby of Cornell University using data through the mid-1970s.  His monograph on Cayuga Lake was included in the NYSDEC series on Lakes of New York State (Jay Bloomfield, editor, 1978).

There are several areas where additional data are needed to fully characterize the existing state of the resource. Some of the areas are specific water quality parameters; others are specific locations in the lake and tributaries. Data gaps are identified and discussed in terms of their potential significance to the baseline assessment of use attainment.

### 4.2 Watershed characteristics

#### 4.2.1 Subwatershed designations

As described earlier in this report, the Cayuga Lake watershed (direct drainage, excluding the Seneca River) has been divided into 45 subwatersheds that serve as the basic hydrologic unit of analysis. The subwatershed areas reflect major divisions of surface water hydrology.

#### 4.2.2 Hydrologic budget

Likens (1974) reported that more than 140 streams including small and intermittent streams discharge to Cayuga Lake. Cayuga Inlet (including Sixmile, Cascadillla, Enfield and Buttermilk Creeks) and Fall Creek together drain just over half of the total watershed area, excluding the contribution from Seneca and Keuka Lakes. Fall Creek and the Inlet flow into the southern end of Cayuga Lake. The proportional contribution of major subwatersheds to the total direct drainage area is shown in Figure 4.2.1.

**Figure 4.2.2**
**Water Flux for Subwatersheds, 1970 - 1971.**
**Source: Likens 1974**

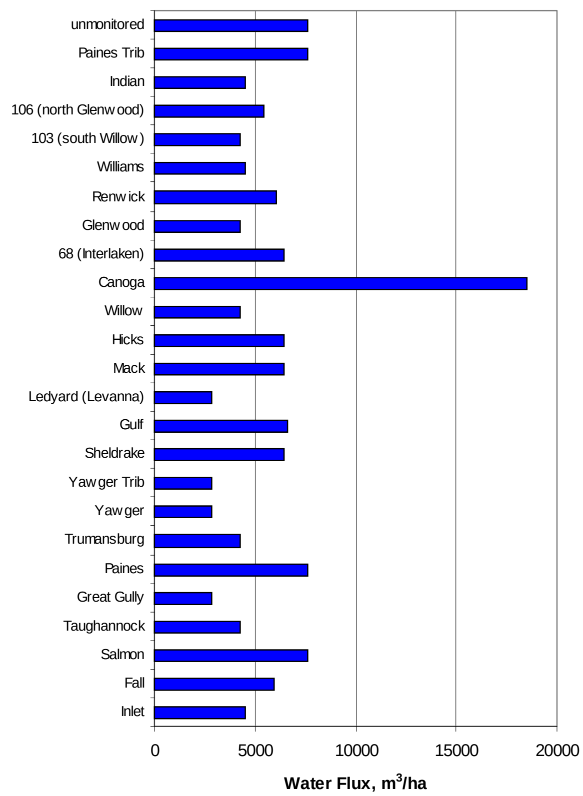
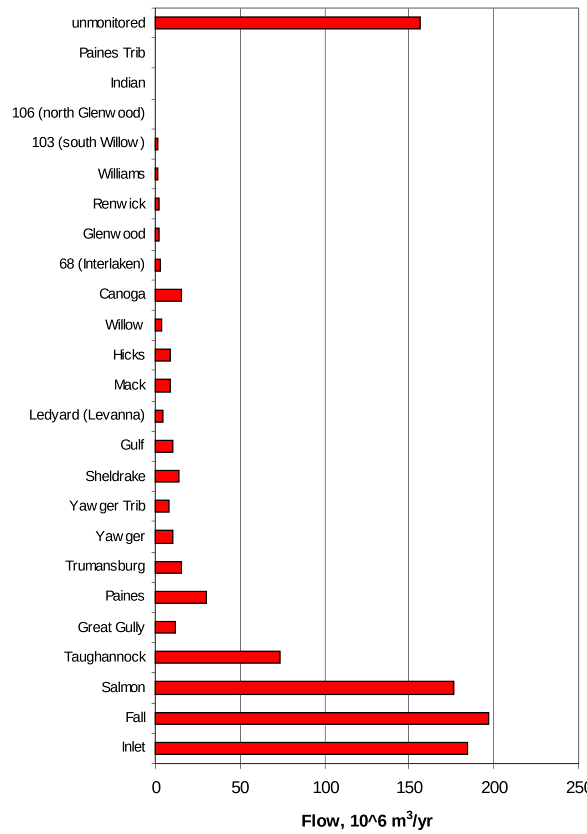



**Figure 4.2.3**
**Estimated Annual Water Flow for Subwatersheds**
**Based on 1970 - 1971 Data**




By estimating streamflow in a number of the tributaries, Likens calculated the water flux per unit drainage area in the subwatersheds (Figure 4.2.2). Note that most of the subwatersheds are within a relatively narrow range of water flux, with the exception of Canoga Creek. The high water yield per unit land area in this subwatershed probably reflects the underlying karst geology.

Coupling the drainage area and flux per unit area yields an estimated hydrologic budget for the subwatersheds for direct runoff into Cayuga Lake (Figure 4.2.3) and the proportional contribution of each subwatersheds to the total runoff into the lake (Figure 4.2.4). Note that there are some differences between the proportional contribution of runoff and the total drainage area. For example, the combined flow contribution of Fall Creek and Cayuga Inlet during this hydrologic year was approximately 41%, which is well below the combined drainage area of 51%. During 1970 – 1971, 91% of the hydrologic inflow to Cayuga Lake entered via runoff, and 9% fell directly onto the lake surface (Likens, 1974).

**Tributary Flows, 1970 - 1971**

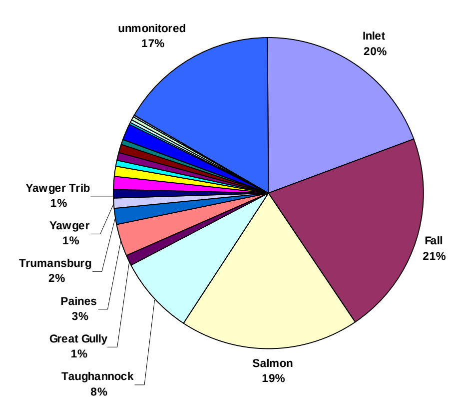



Figure 4.3.4. Source: Likens.

Discharge of a number of streams in the watershed has been gauged by USGS for various investigations (Table 4.2.1). These results are compiled and reported annually. Data are available from USGS and on their web site. However, only Fall Creek, Sixmile Creek, and Cayuga Inlet are currently part of the USGS monitoring program.

| **Table 4.2.1** Status of Stream Gauging in Cayuga Lake Watershed<br>Cayuga Watershed Characterization Report | | | | | |
|---|---|---|---|---|---|
| **Site** | **USGS Station** | **County** | **Drainage Area (sq. mi)** | **Datum (ft. above NGVD)** | **Period of Record** |
| **Active Flow Gauges** | | | | | |
| Cayuga Inlet near Ithaca | 04233000 | Tompkins | 35.2 | 437.16 | 3/3/37 - present |
| Six Mile Creek at Bethel Grove | 04233300 | Tompkins | 39.3 | Not listed | 3/9/95 - present |
| Fall Creek near Ithaca | 04234000 | Tompkins | 126 | 795.13 | 2/15/25 - present |
| ***Inactive Flow Gauges*** | | | | | |
| Fall Cr. Trib 7 at Stevens Corners | 04233632 | Tompkins | 0.52 | Not listed | 1975-1976 |
| Sixmile Creek near Ithaca | 04233310 | Tompkins | 42 | Not listed | 1967 - 1986 |
| Salmon Creek at Ludlowville | 04234018 | Tompkins | 81.7 | Not listed | 10/1/64 – 9/30/68 |
| Fall Creek at Freeville | 04233648 | Tompkins | 55.9 | Not listed | 1966 - 1982 |
| Virgil Creek at Freeville | 04233700 | Tompkins | 40.3 | 1015.99 | 8/1/73-10/31/75 |
| Virgil Creek at Mill St., Dryden | 04233676 | Tompkins | 20.7 | Not listed | 1966 - 1986 |
| Canoga Cr. At Canoga | 04234055 | Seneca | 3.2 | 395.76 | 10/1/64 – 9/30/68 |
| Yawger Creek Trib near Auburn | 042340588 | Cayuga | 1.76 | Not listed | 1976 - 1986 |
| Webster Bk at Summer Hill | 04233624 | Cayuga | 2.59 | Not listed | 1973 - 1975 |
| Cayuga Lake trib 8 near Jacksonville | 042340202 | Tompkins | 1.36 | Not listed | 1977 - 1986 |
| **Crest-Stage Gauge** | | | | | |
| Coy Glen Creek at Ithaca | 04233258 | Tompkins | 3.56 | 380 | 1972 - present |
| Cayuga Inlet at Ithaca | 04233255 | Tompkins | 86.7 | Not listed | 1971 - present |

### 4.2.2.1 Water level management and the rule curve

The Cayuga Lake watershed is part of the 5,100 square mile Seneca-Oneida-Oswego River watershed that drains to Lake Ontario. Cayuga Lake and its outlet, the Cayuga-Seneca Canal, are part of the New York State Canal System. The NYS Canal Corporation, a subsidiary of the NYS Thruway Authority, operates the Canal System. The entire system consists of four canals (Cayuga-Seneca Canal, Oswego Canal, and two segments of the Erie Canal) and the interconnected lakes and river reaches.

There are 22 locks within the basin with a fixed crest dam or movable dam serving as water level control structures. Seven of the locks are considered major control points, and the NYS Canal Corp. district office in Syracuse compiles data from each of the seven control points on a daily basis. Lock CS-1 (the Cayuga Seneca Canal) and CS-4 (outlet of Seneca Lake) are among the seven control points.

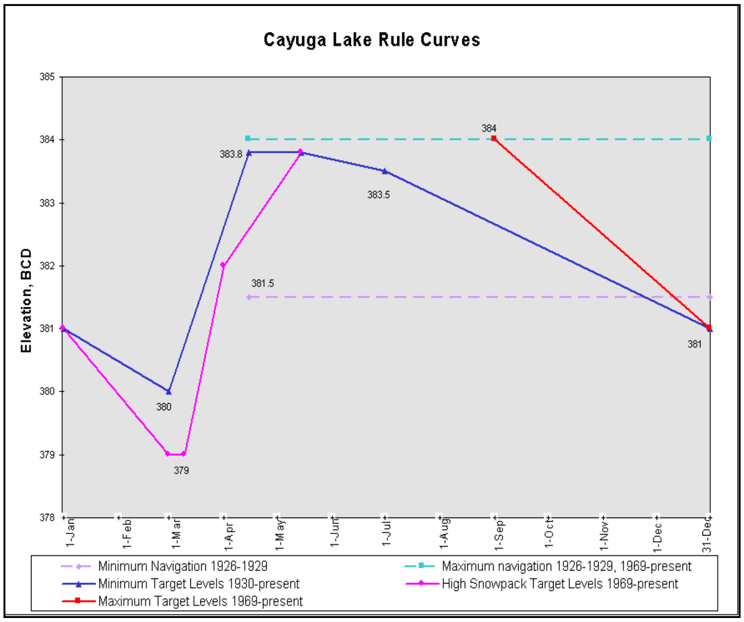



Figure 4.2.5. Cayuga Lake Rule Curve

Water levels are managed to balance multiple objectives: navigation, flood control, drinking water supply, recreational use, habitat, wastewater assimilation, and irrigation. The Finger Lakes represent a large amount of water storage capacity in the watershed, and lake level management is a critical tool for balancing water levels and flows throughout the system. Rule curves have been established for eight lakes in the basin (seven of the Finger Lakes plus Oneida Lake) to define monthly minimum and maximum acceptable water levels. These rule curves reflect a historical compromise to balance competing interests for target water levels. Rule curves establish the top and bottom of the curves to avoid severe flooding or severe drought conditions. Within the defined range, water levels are set considering navigation and public water supply as the highest priorities. The rule curve for Cayuga Lake is shown in Figure 4.2.5.

Water levels in Cayuga Lake are raised and lowered seasonally to protect recreational uses, increase storage capacity, and minimize the potential for flooding. At the close of the navigation season in the fall, water levels are drawn down to provide storage for spring snowmelt and runoff. Water levels are at their annual minimum in the winter and are allowed to rise slowly in the spring in anticipation of summer recreation and navigation needs. Summer water levels are a balance between the competing needs in the system with water supply and navigation given highest priority.

Water flows from Cayuga Lake to the Barge Canal through a gated structure at Mudlock. The elevation of the Lake is only nine feet above the Barge Canal at the outlet, which limits the ability of water resources managers to lower Cayuga Lake. The Barge Canal system is constructed in a physiographic region that is extremely flat; it is difficult to move large volumes of water through such a low-gradient area. The Seneca-Oneida-Oswego basin is vulnerable to flooding in the early spring, when snow is melting and evapotranspiration is at a minimum. Rainfall in the spring coupled with rising temperatures places the basin at risk of floods. These periodic floods can damage waterfront property and alter riparian habitat.

| **Table 4.2.2 Cayuga Lake Level Data** | |
|---|---|
| Period of Record | 1952-present |
| Record High (ft) | 387.8 (1993) |
| Record Low (ft) | 378.9 (1958) |
| Mean High, all years (ft) | 384.9 |
| Mean Low, all years (ft) | 380.3 |
| Mean High, 1990 – 1998 (ft) | 385.3 |
| Mean Low, 1990 – 1998 (ft) | 380.3 |
| Note: All water levels are reported as BCD (Barge Canal Datum) in feet. To convert to USGS elevation, subtract 1.43 at gauge. | |
| Source: Bob Heuschneider, NYS Canal Corp. | |

The level of Cayuga Lake has been continually monitored since 1952. Annual highs and lows recorded by the NYS Thruway Authority are summarized in Table 4.2.2. The spring flood of 1993, which delivered three times the water volume of 1972 Tropical Storm Agnes, is associated with the highest lake level of record. The lowest level of the period was recorded in 1958. There is no trend to higher water levels evident in the record.

### 4.2.3 Characterization of riparian zones and wetlands

Because of the topography of the watershed, many streams are short, first and second order, and steeply sloped. First order streams are those without tributaries, second order streams have one tributary. First and second order streams typically drain only limited watershed areas. The larger streams such as Fall Creek, the combined Inlet, and Salmon Creek are higher order (with many branching tributaries) and may have extensive wetland communities developed in lowland areas. Riparian vegetation has been altered throughout the watershed as land has been used for development or agriculture. The loss of riparian vegetation has removed an important buffer that serves to improve the quality of runoff water through sediment filtration and nutrient removal.

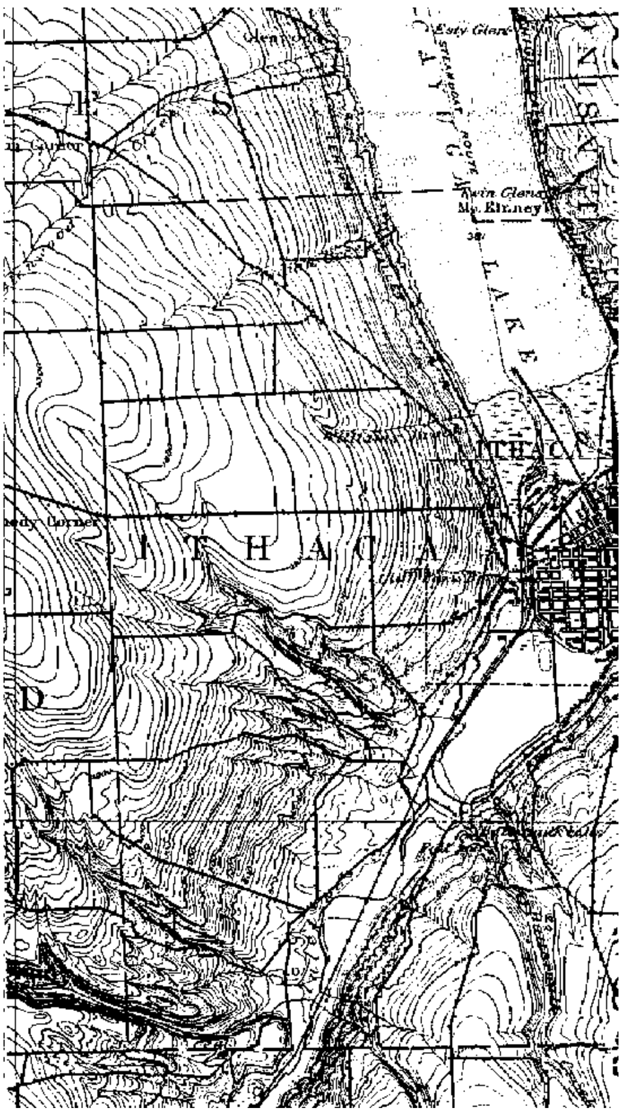



Figure 4.2.6. The southern end of Cayuga Lake from 1895 USGS topographic map (Ithaca West)

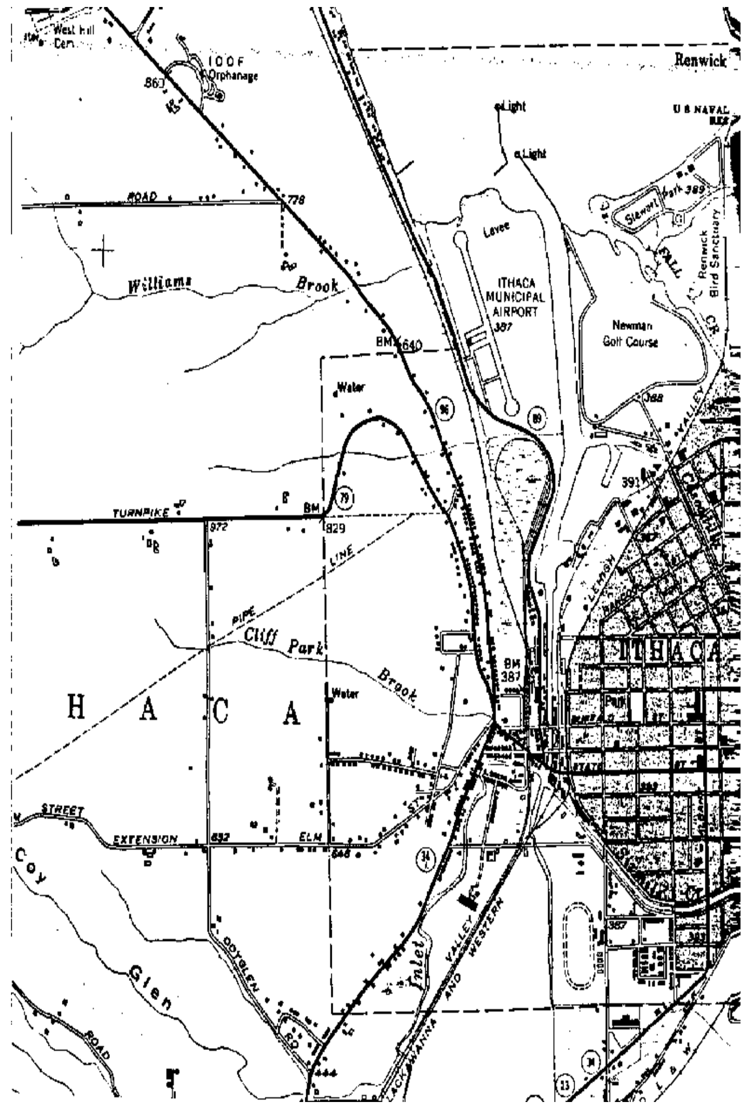



Figure 4.2.7 The southern end of Cayuga Lake from 1949 USGS topographic map (Ithaca West)

Efforts are underway to collect site-specific data describing riparian areas throughout the watershed. Toxics Targeting Inc. of Ithaca has visually inspected nearly 40 miles of streambanks along Fall Creek, Cascadilla Creek, Cayuga Inlet, Sixmile Creek, and the lake shoreline. Most sites were in the City of Ithaca. In summer 2000, GFLRPC conducted a streambank inventory throughout the watershed. Results of these investigations will help identify priority areas for protection and restoration.

Ichthyological Associates summarized the history of wetland filling at the southern end of Cayuga Lake as part of the Environmental Impact Statement for the Allan H. Treman State Marine Park Master Plan (New York State Office of Parks, Recreation and Historic Preservation 1996). In the early part of this century, the floodplain at the southern end of Cayuga Lake was an extensive wetland, as illustrated in the1895 topographic map (Figure 4.2.6). As the City of Ithaca developed, waterways were deepened to increase streamflow and reduce flooding. Dredged materials were deposited in the wetland and gradually began to fill it in. By the time the 1949 topographic map was published (Figure 4.2.7), all but remnants of the wetlands had been filled. By 1969 the Corps of Engineers had rerouted, widened and deepened Cayuga Inlet. Dredge material from the Inlet was used to extend the southwestern shoreline in an area that eventually became part of the Allan H. Treman State Marine Park.

Figure 4.2.8. Sediment plume in southern Cayuga Lake, spring 1993. Photo: Jon Reis

The extensive wetland served an important function in decreasing velocity and filtering sediment from water flowing into the southern lake through the large drainage areas of Fall Creek and the Inlet. Without the wetlands functioning as a filter, sediments lost from the erodible watersheds, streambanks, and streambeds of these large southern tributaries flow into the southern portion of the lake where they are deposited. Sediment plumes extend into the lake following storms (Figure 4.2.8).

### 4.2.4 Materials budgets

*Likens, 1970 – 1971*

Dr. Likens monitored water chemistry of 24 tributary streams, the inlet from Seneca Lake and the outlet of the entire Cayuga Lake watershed at Mudlock during his investigations of Cayuga Lake's water and materials budgets. Streams were sampled every two weeks for one year for anions and cations, suspended solids, and major nutrients.

There were distinct differences in water chemistry of the tributary streams. The calcium concentration of tributaries (plotted in Figure 4.2.9) varies three-fold. Minimum values were measured in first order creeks in shale geology at the southern end of the lake; maximum values were associated with larger higher order tributaries in the limestone geology of the

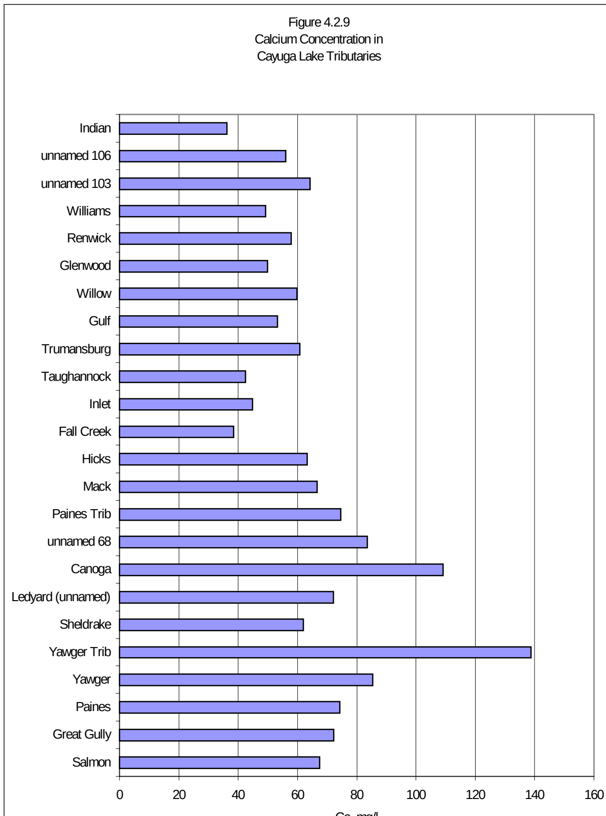
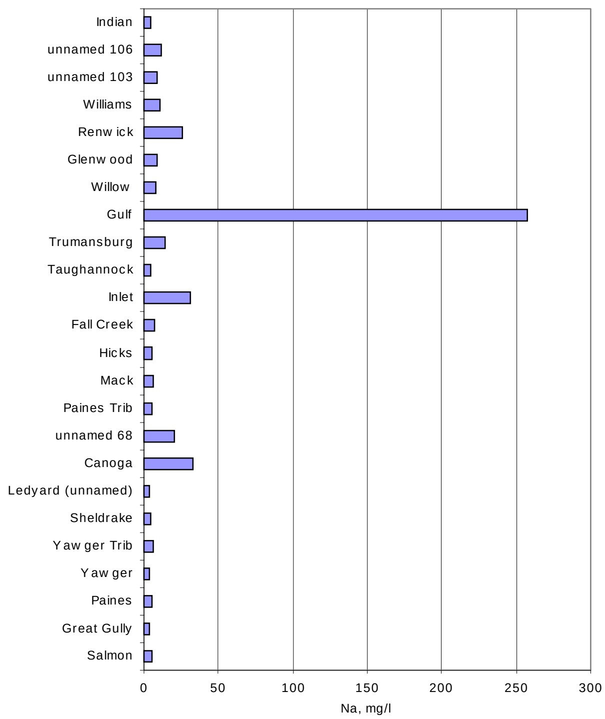



Figure 4.2.9. Annual mean calcium concentration, 1970 -1971.
Source: Likens 1974 a

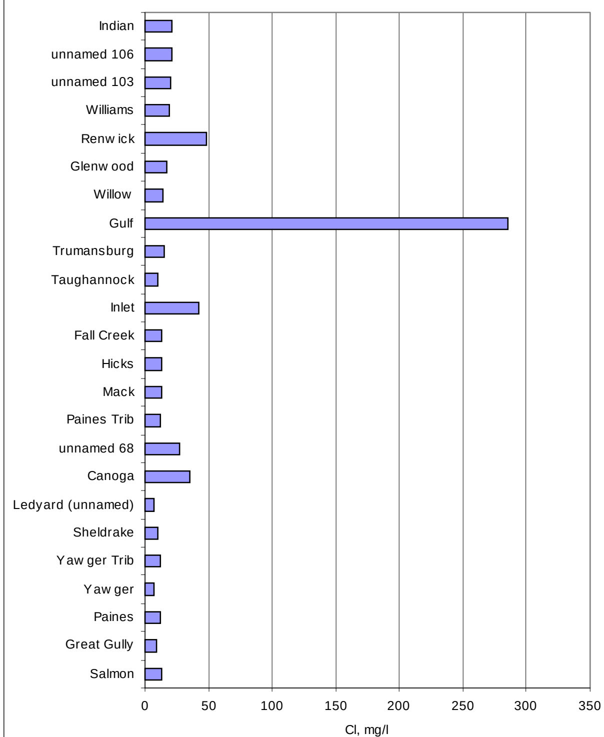
northern basin. Sodium and chloride concentrations (plotted in Figures 4.2.10 and 4.2.11) are also variable. The Gulf Creek data are outliers; at the time of Likens' work the discharge from the Cargill salt mine entered this creek. At the time of Likens' work (1970 – 1971) the Ithaca Wastewater Treatment Plant discharged to Cayuga Inlet upstream of the sampling site. The discharge of treated wastewater would have increased the chloride concentration in this stream.

**Figure 4.210. Sodium Concentration in Cayuga Lake Tributaries**




(Likens 1970-1971)

**Figure 4.2.11. Chloride Concentration in Cayuga Lake Tributaries**

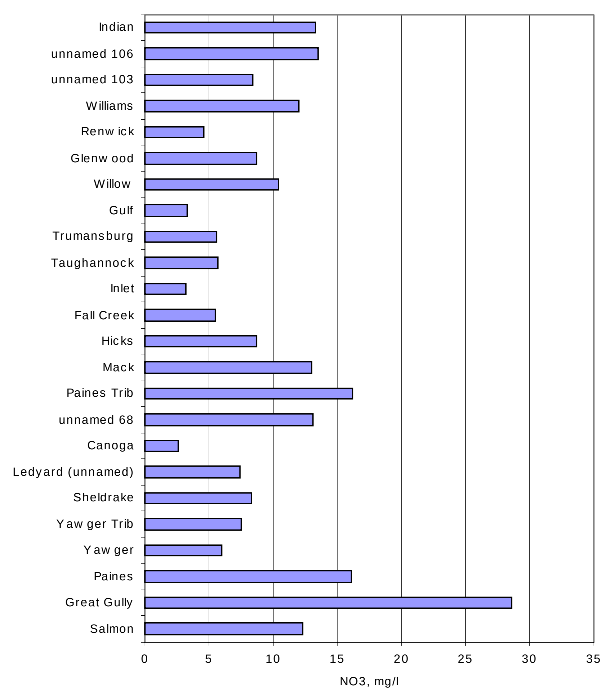



(Likens 1970-1971)

Nitrate data were variable, but high compared with other surface water streams of New York. Concentrations tended to be highest in tributaries draining agricultural areas (Figure 4.2.12). Likens noted a distinct annual pattern to the water chemistry data. Concentrations of calcium, magnesium, sodium, and chloride were inversely related to flow; minimum values were measured during spring runoff conditions. Nitrate concentrations were lowest during the growing season (April – September) when nitrate is incorporated into the vegetation and peaked in winter.

To examine the effect of geology on stream water quality, the 1970 – 1971 synoptic data were stratified into northern and southern tributaries. Mean concentrations of chloride, calcium, sodium, and nitrate were compared (Figure 4.2.13) and tested for significant differences. The analysis was completed both with and without Gulf Creek data. Only calcium concentrations were statistically different between the northern and southern tributaries (two-tailed student t, p=0.007).

**Figure 4.2.12. Nitrate Concentration in Cayuga Lake Tributaries**




(Likens 1970-1971)

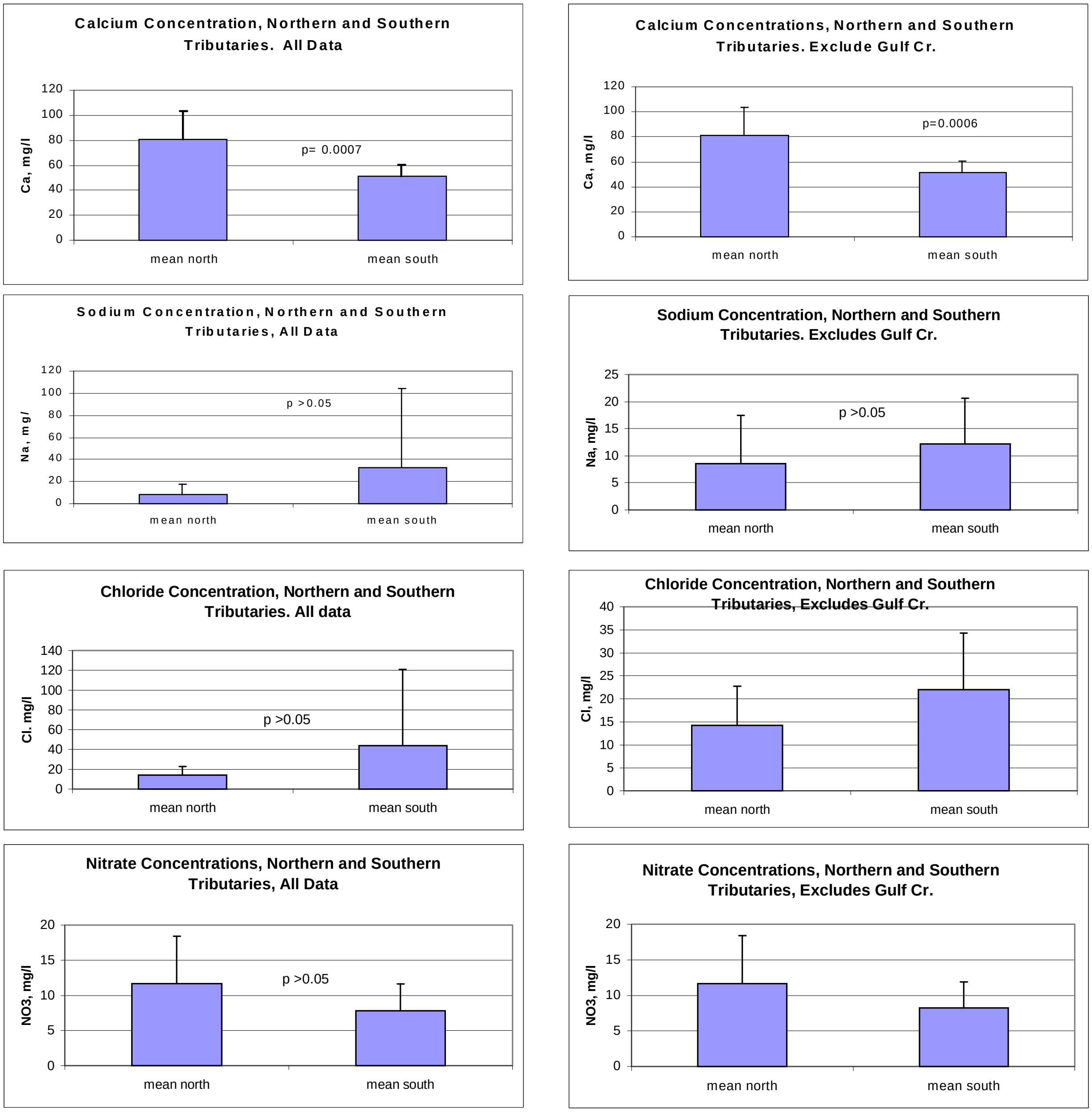



Figure 4.2.13. Comparisons of northern and southern tributaries to Cayuga Lake based on 1970 - 1971 data (Likens 1974 a,b) Student t test, 2 tailed, N=12 north and 12 south (with Gulf Cr)

Using his simultaneous flow and concentration measurements, Likens was able to estimate materials budgets for Cayuga Lake. Input from precipitation was calculated from data collected at a network of gauges located throughout the watershed. In Figure 4.2.14, the concentration, unit export (kg/ha) and load to Cayuga Lake of calcium, sodium, chloride, and nitrate are illustrated. The data are grouped by major tributary: Fall Creek, Cayuga Inlet, Salmon Creek, and Taughannock. Twenty minor tributaries are grouped together, as is the unmonitored portion of the direct drainage. Note that the total load to the lake factors in the size of the drainage area. The sodium and chloride unit export coefficients of the 20 minor tributaries are strongly influenced by the Gulf Creek data. Note, also, that the Inlet was the largest source of sodium and chloride to Cayuga Lake during the monitoring period. This pattern probably has changed with the relocation of the Ithaca WTP outfall from the Inlet channel to Cayuga Lake. The proportional contribution of the major tributaries to total loading of chloride, sodium, calcium and nitrate is plotted in Figure 4.2.15.

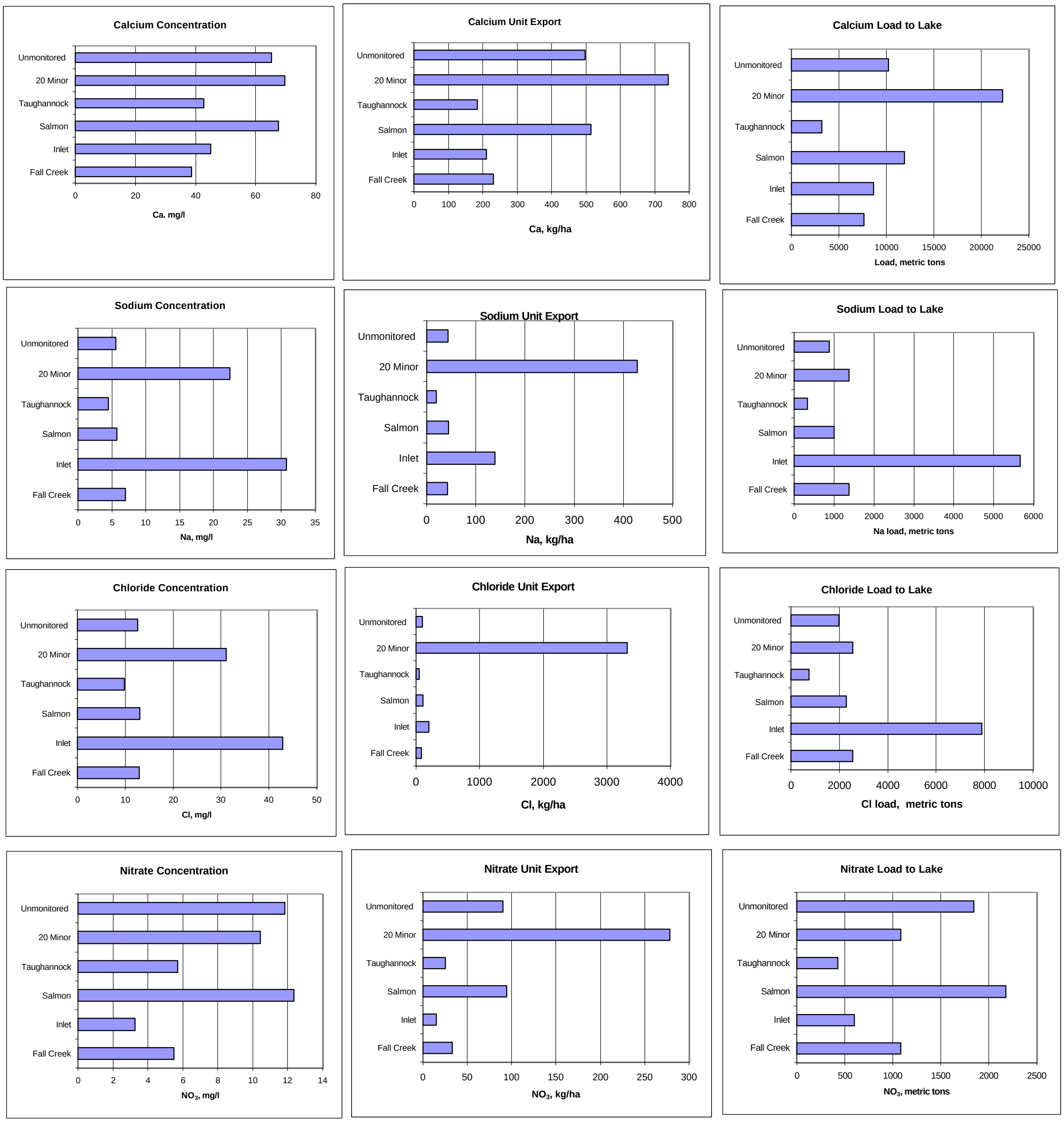
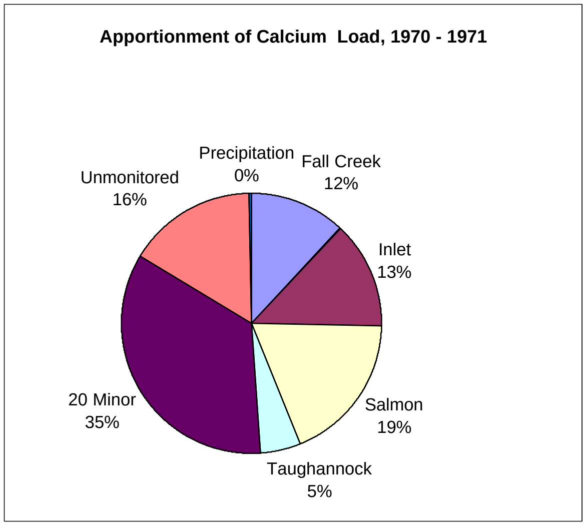
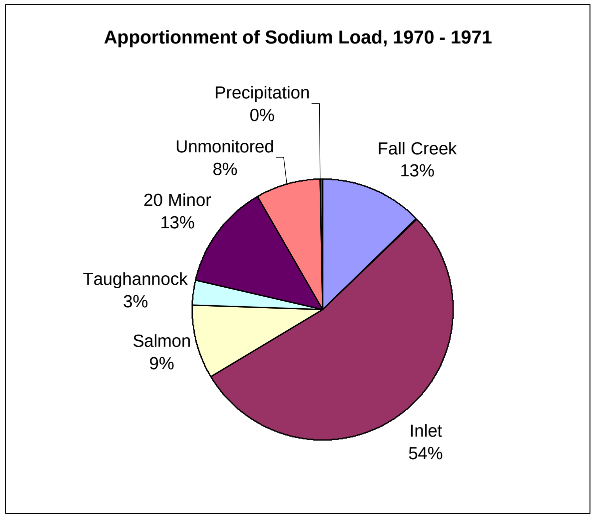
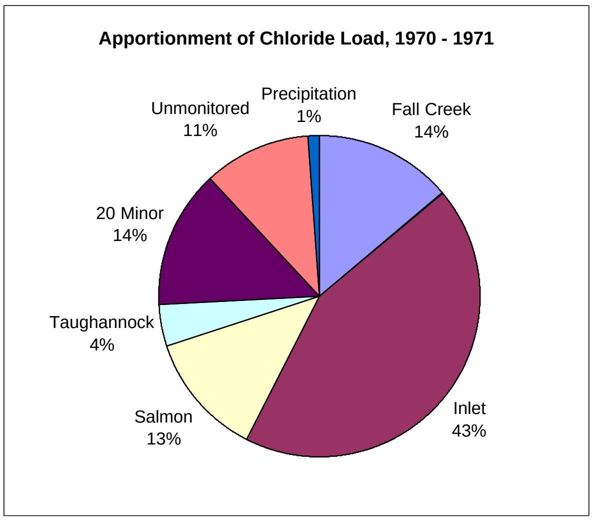



Figure 4.2.14. Average concentration of selected water quality parameters in tributaries to Cayuga Lake. 1970 - 1971 data
Source; Likens 1974 a,b

Note that industrial discharge of sodium chloride to Gulf Creek (one of 20 minor tributaries) has ben reduced since these data were collected.



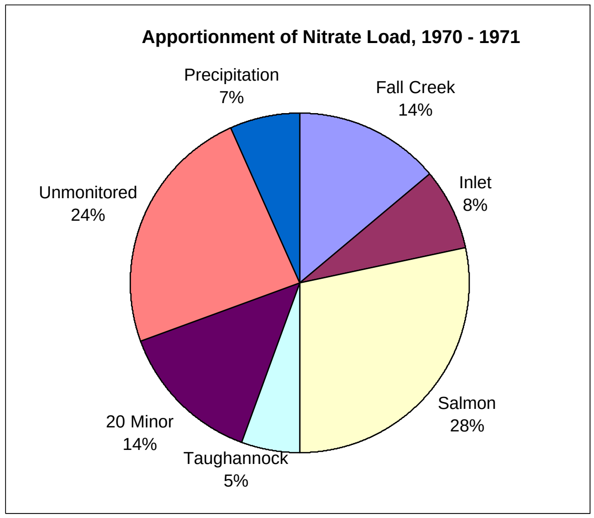




Figure 4.2.15. Apportionment of load of selected water quality parameters, Cauiga Lake tributaries.
Data from Likens 1974 a,b

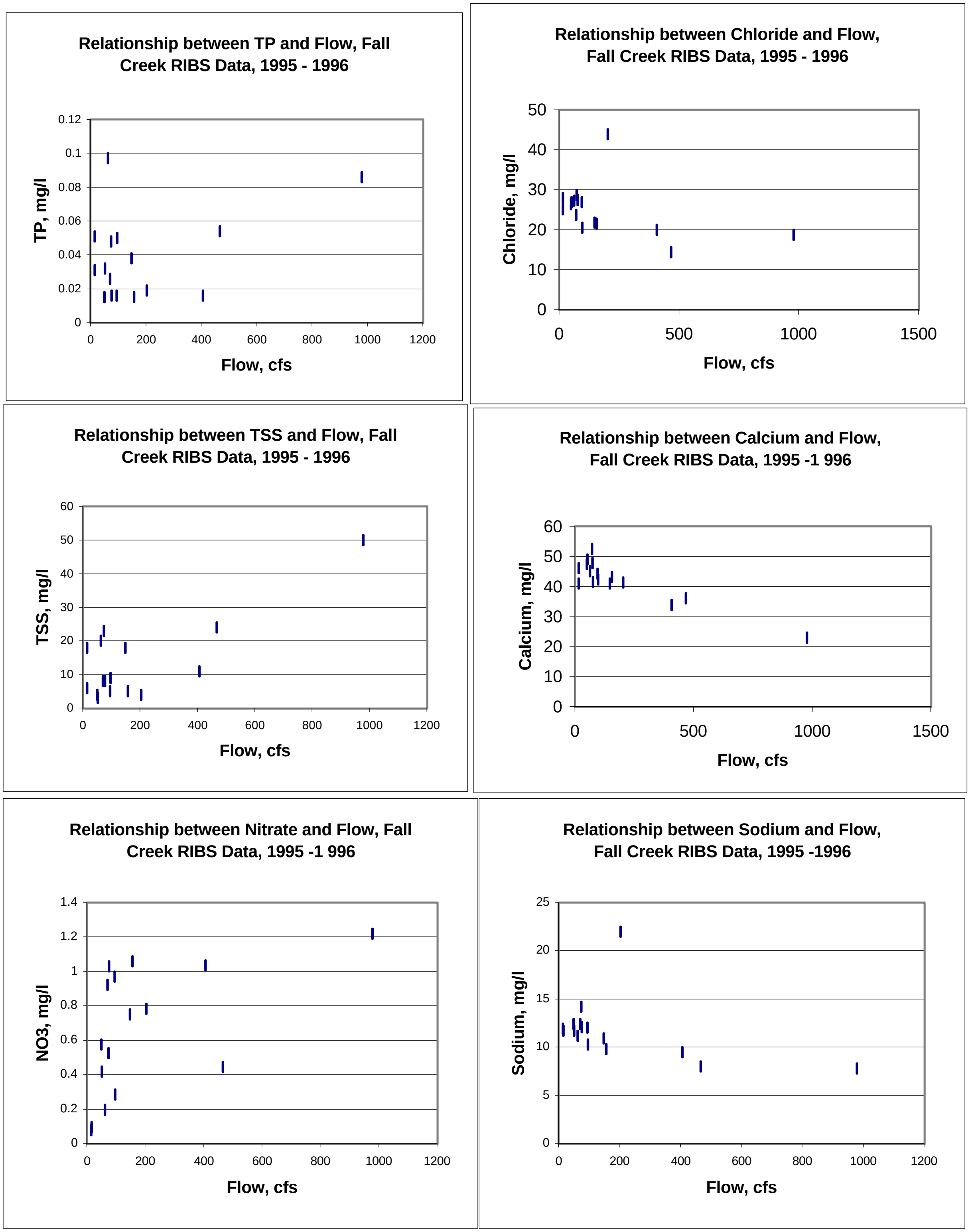



Figure 4.2.16. Results of NYSDEC Rotating Intensive Basin Survey (RIBS) sampling, Fall Creek 1995 - 1996

Although both soluble reactive phosphorus (SRP) and total phosphorus (TP) were included in Dr. Likens' monitoring program, these data have not been incorporated into this watershed characterization. Likens reported concentrations of TP and SRP that appear to be biased high compared with other measurements of Cayuga Lake waters. SRP and TP are reported in the range of hundreds of micrograms per liter in Likens' data set, compared with tens of micrograms per liter in samples collected by other investigators. In many cases the concentrations and loads of SRP were reported as higher than TP, which indicates an error. This data quality problem may reflect limitations in the analytical procedures. The lack of event sampling is another limitation to using this data set to characterize loads.

*Bouldin 1972 – 1975, 1987 - 1989*

As part of an interdisciplinary investigation of the impacts of agriculture on phosphorus transport, Dr. David Bouldin and his colleagues in the Cornell University Agronomy Department carried out a comprehensive monitoring program of Fall Creek and several of its subwatersheds. The major findings were published as Chapter 3 in Nitrogen and Phosphorus: Food Production, Waste and the Environment (Keith Porter, editor, Ann Arbor Science Publishers, Inc. 1975).

Bouldin estimated annual average flow weighted concentrations of phosphorus fractions in natural and agricultural watersheds. The biogeochemical fraction, defined as phosphorus which is transported independently of human activity, was estimated at 6 µg/l SRP and 15 µg/l total soluble P (TSP, excludes particulate material such as sediment eroded from streambanks). In an agricultural watershed, the net effect was estimated to increase the TSP concentration by 18 µg/l. Estimated concentration and loads of nutrients and suspended solids are summarized in Table 4.2.3.

Table 4.2.3 Summary of Load Estimates, Fall Creek at Forest Home, Based on D. Bouldin Investigations, 1972 – 1975

| Parameter | **Results, 1972 - 1975** |
|---|---|
| Suspended Solids Loading | 14,000 ( ± 2440) metric tons |
| SRP, weighted mean concentration | 18 µg/l |
| TSP, weighted mean concentration | 26 µg/l |
| TSP, weighted mean concentration from forested land use (biogeochemical) | 15 µg/l |
| TSP, increase due to agriculture | 18 µg/l |
| $NO_3$-N load | 5.5 ± 0.9 kg/ha |

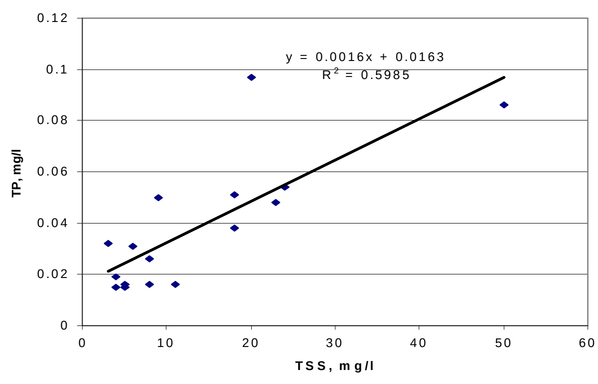
Monitoring of SRP, TSP, and NO3-N concentration in Fall Creek was repeated in 1987 – 1989 as part of the Tompkins County Aquatic Vegetation Control Program. Results of this effort were generally consistent with the earlier findings.

*NYSDEC RIBS Program, 1995 – 1996*

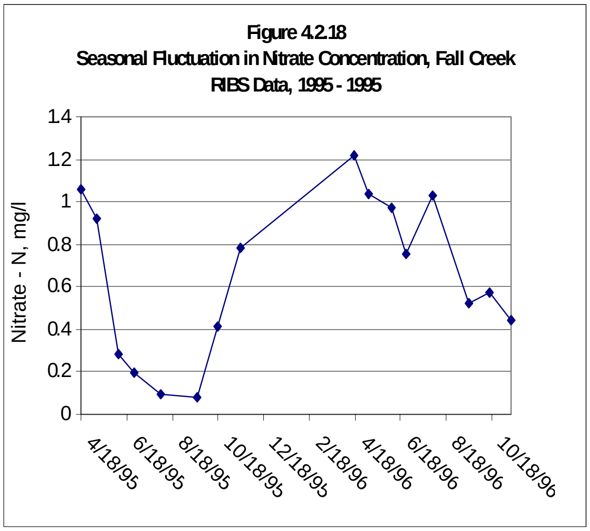
The NYSDEC Rotating Intensive Basin Survey (RIBS) program has one of its Intensive Network sites located in the Cayuga Lake watershed, Fall Creek in Ithaca one mile above its confluence with Cayuga Lake. In addition to this site, three tributaries are included in the Biological Screening Network: Little Salmon Creek in Little Hollow, Big Salmon Creek in Genoa, and Salmon Creek in

Figure 4.2.17

Relationship between Total Phosphorus and Suspended Solids, Fall Creek RIBS Data, 1995 - 1996



Ludlowville. Sites in the Intensive Network were monitored for a suite of physical and chemical parameters in 1995 –1996. . The RIBS program returns to each basin on a five-year rotation; the next sampling is scheduled for 2000 – 2001.




Fall Creek in Ithaca was sampled on 18 occasions between April 1995 and November 1996. Field parameters (water temperature, dissolved oxygen, pH, specific conductance, turbidity, and flow) were monitored and water samples collected for analysis of nutrients and solids, minerals and heavy metals. A subset of these results is plotted in Figure 4.2.16. Note the inverse relationship between minerals; concentrations of calcium, sodium and chloride are higher during low flows. In contrast, concentrations of TP and total suspended solids (TSS) vary directly with flow. There is a strong relationship between TSS and TP in Fall Creek (Figure 4.2.17). As evident in other data sets, nitrate exhibits a strong seasonal signal (Figure 4.2.18), concentrations are low during the growing season and highest in winter. The RIBS program did not collect any samples of Fall Creek in December, January, February or March. The lack of winter sampling results in a lower annual average nitrate concentration in Fall Creek as compared with previous investigations, however spring, summer, and fall data are relatively consistent (Table 4.2.4).

**Table 4.2.4**. Mean Nitrate N Concentration, Fall Creek, mg/l

| **Season** | **1970 – 1971 (Likens)** | **1972-1974 (Bouldin)** | **1987-1989 (Bouldin)** | **1995-1996 (NYSDEC RIBS)** |
|---|---|---|---|---|
| Winter | 1.47 | 1.4 | 1.73 | No samples |
| Spring | 1.35 | 1.19 | 1.35 | 1.06 |
| Summer | 0.46 | 0.4 | 0.69 | 0.55 |
| Fall | 0.63 | 0.61 | 0.68 | 0.47 |
| Annual Average | 0.98 | 0.9 | 1.11 | 0.65 |

USGS/NYSDEC Pesticide Monitoring

Fall Creek is included in the statewide pesticide monitoring network, a cooperative program of NYSDEC and USGS. This program uses analytical methods to accurately measure pesticides in trace concentrations. The sampling station is Fall Creek at the UGSG gauge in Forest Home (Town of Ithaca). Results of 34 sampling events between May 1997 and August 1998 have been published by USGS. Results indicate that measurable concentrations of herbicides are detected in Fall Creek (Table 4.2-5). The herbicides detected in Fall Creek are commonly applied during corn cultivation to control annual grasses and some broadleaf weeds. Concentrations detected in the stream are below ambient water quality standards to protect human health and the environment.
Cayuga Lake is also included in the statewide pesticide monitoring program and results of data collected at the Bolton Point water intake are discussed in Section 4.3.2.5. Pesticides detected in Fall Creek also are detected in Cayuga Lake.

In 1998, USGS and NYSDEC conducted a special June storm event monitoring program on three tributaries to Cayuga Lake: Salmon Creek, Yawger Creek and Paines Creek. Land use in the three subwatersheds is predominantly agricultural. The June storm event sampling was conducted shortly after application of the herbicides alachlor and metalochlor to agricultural fields. The highest concentrations were detected during peak flows (Eckhardt et al. 1999). Data are summarized in Table 4.2-6. Concentrations detected in the streams during this storm event were two or three orders of magnitude higher (100 to 1000 times higher) than detected in Fall Creek or Cayuga Lake.

After the storm, the researchers collected samples at transects in Cayuga Lake and determined that concentrations of herbicides were fairly uniform throughout the lake (see also discussion in section 4.3.2.5).

**Table 4.2.5. 1997-1998 NYSDEC/USGS Synoptic Sampling Results**
**Statewide Pesticide Survey: Fall Creek near Ithaca Gauge (Forest Home)**

| Pesticide Detected [1] | Number of Detectable Results | Maximum Concentration Detected (µg/l) | Data Qualifier [2] | Ambient Water Quality Criteria or Standard (µg/l) [3] |
|---|---|---|---|---|
| Alachlor | 8/34 | 0.010 | | 0.3 |
| Atrazine | 34/34 | 0.404 | | 3 |
| Diethylatrazine | 34/34 | 0.121 | E | 50 |
| Carbaryl | 3/34 | 0.032 | E | 29 |
| Cyanazine | 20/34 | 0.049 | | 1 |
| Diazonon | 1/34 | 0.003 | E | 0.08 |
| EPTC (ethyl di-n-propylthiocarbamate) | 1/34 | 0.002 | E | none |
| Metalochlor | 34/34 | 0.224 | | 50 |
| Pendimethalin | 1/34 | 0.008 | | 5 |
| Prometon | 9/34 | 0.020 | | 50 |
| Simazine | 16/34 | 0.017 | | 0.5 |

Notes:

1 Samples were analyzed for 47 pesticides on 34 sampling events between May 1997 and August 1998. Pesticides that were always less than the limit of detection are not reported.

2 Data qualifier of E signifies that the chemical was present below the method detection limit. Identity of the compound is confirmed; concentration is estimated.

3 Lowest value of federal maximum contaminant level, federal lifetime health advisory limit, NY maximum contaminant level, NY standard for Class GA waters, NY surface water quality standard.

4 Source: USGS Water Resources Report

**Table 4.2.6. Summary results of storm event monitoring of Paines, Yawger and Salmon Creeks, June 17, 1998**

| Herbicide and Metabolite | **Peak Concentration (µg/l)** |
|---|---|
| Atrazine | 15 |
| Atrazine metabolite | 6 |
| Metolachlor | 28 |
| Metolachlor metabolite | 20 |

*Permitted Discharges to Cayuga Lake and its Tributaries*

There are nine regulated municipal wastewater discharges to Cayuga Lake and its tributaries with a combined design flow slightly over 15 million gallons per day (Table 4.2.7). Two cooling water discharges are permitted, AES-Cayuga (formerly known as Milliken Station) and Cornell Lake Source Cooling (on line in summer, 2000).

| Table 4.2.7 Summary of Permitted Point Source Loads to Cayuga Lake and Tributaries | | | | |
|---|---|---|---|---|
| **Facility** | **Map ID** | **Type** | **Discharge Segment** | **Permitted Flow (mgd)** |
| Ithaca Area Wastewater Treatment Plant | 18 | Municipal wastewater | Class A segment, Cayuga Lake | 10 * |
| Cayuga Heights Wastewater Treatment Plant | 26 | Municipal wastewater | Class A segment, Cayuga Lake | 2 |
| Village of Union Springs | 27 | Municipal wastewater | Class A(T) segment, Cayuga Lake | 0.33 |
| Village of Aurora | 23 | Municipal wastewater | Paines Creek at confluence with Lake, Class D | 0.3 |
| Village of Trumansburg | 25 | Municipal wastewater | Trumansburg Creek, Class D | 0.25 |
| Village of Dryden and Village of Freeville | 24 | Municipal wastewater | Fall Creek, Class B | 0.27 (Dryden) 0.125 (Freeville) |
| Village of Interlaken | 6 | Municipal wastewater | Minors Creek, Class D | 0.1 |
| Town of Newfield | 22 | Municipal wastewater | Groundwater (Class GA) | 0.03 |
| Cayuga Lake State Park (seasonal) | 1 | Non-municipal wastewater | Class A (T) segment, Cayuga Lake | 0.0491 |
| Lodi Fire Hall | 4 | Non-municipal wastewater | Groundwater (Class GA) | 0.0015 |
| Happy Landing Restaurant., Interlaken | 3 | Non-municipal wastewater | Powell Creek (Class D) | 0.001 |
| Deerhead Inn, Seneca Falls | 2 | Non-municipal wastewater | Groundwater (Class GA) | <0.001 |
| Seneca Falls | 5 | Water filtration plant backwash | Class A(T) segment, Cayuga Lake | Not specified |
| Village of Cayuga | 9 | Water filtration plant backwash | Class B(T) segment, Cayuga Lake | Not specified |
| Southern Cayuga Lake Intermunicipal Water Authority (Bolton Point) | 12 | Water filtration plant backwash | Class AA(T) segment, Cayuga Lake | Not specified |
| Cornell University | 14 | Water filtration plant backwash | Fall Creek, Class B (5 outfalls, 1 is to groundwater) | Not specified |
| City of Ithaca | 28 | Water filtration plant backwash | Sixmile Creek, Class B | Not specified |
| * Ithaca Area Wastewater Treatment Plant has applied to NYSDEC for an increased discharge of 13 mgd. | | | | |
| mgd = million gallons per day | | | | |

The communities of Ithaca, Dryden, Cayuga Heights and Lansing have recently submitted an application to NYSDEC for funding assistance with upgrades and expansion of their municipal wastewater treatment systems. The funding program is the state's Clean Water Clean Air Bond Act. The intermunicipal proposal of August 1999 includes expansion of the service area into Lansing, with wastewater flows from the new service area directed to the Cayuga Heights Plant. Excess flows from Cayuga Heights would be directed to the Ithaca Area Wastewater Treatment Plant, which serves the City and Town of Ithaca and the Town of Dryden. The flow capacity of this plant would be increased from 10 to 13 mgd.

One element of the proposal is to increase the phosphorus removal capacities of both the Ithaca Area and Cayuga Heights treatment plants by adding filtration to the treatment process. Both plants currently hold a TP limit of 1.0 mg/l in their SPDES permit, consistent with the requirements of the International Joint Commission for wastewater treatment plants within the Great Lakes basin with a capacity greater than 1 mgd. Performance of the Ithaca Area Wastewater Treatment Plant is well below the 1 mg/l TP limit; average effluent concentrations are in the range of

0.5 – 0.6 mg/l. The Cayuga Heights plant has historically operated close to its permit limit of 1 mg/l for TP although improvements have been made in recent months based on TP concentration in effluent reported monthly to NYSDEC (Nick Hatala, Stearns & Wheler personal communication September 1999).

NYSDEC policy for new discharges to lakes can require an effluent limit of 0.5 mg/l for TP, recognizing the central role of phosphorus in eutrophication of inland lakes. When existing plants request an increase in permitted flow, it is NYSDEC policy to hold the discharge to the existing mass limit for TP, thus reducing allowable concentration proportional to the flow increase.

With filtration, both Cayuga Heights and the Ithaca Area wastewater treatment plants will be able to meet or exceed a TP limit of 0.5 mg/l. Effluent concentrations from filtration can be 0.2 mg/l or less, depending on the amount of chemical addition and flow rates through the filters.

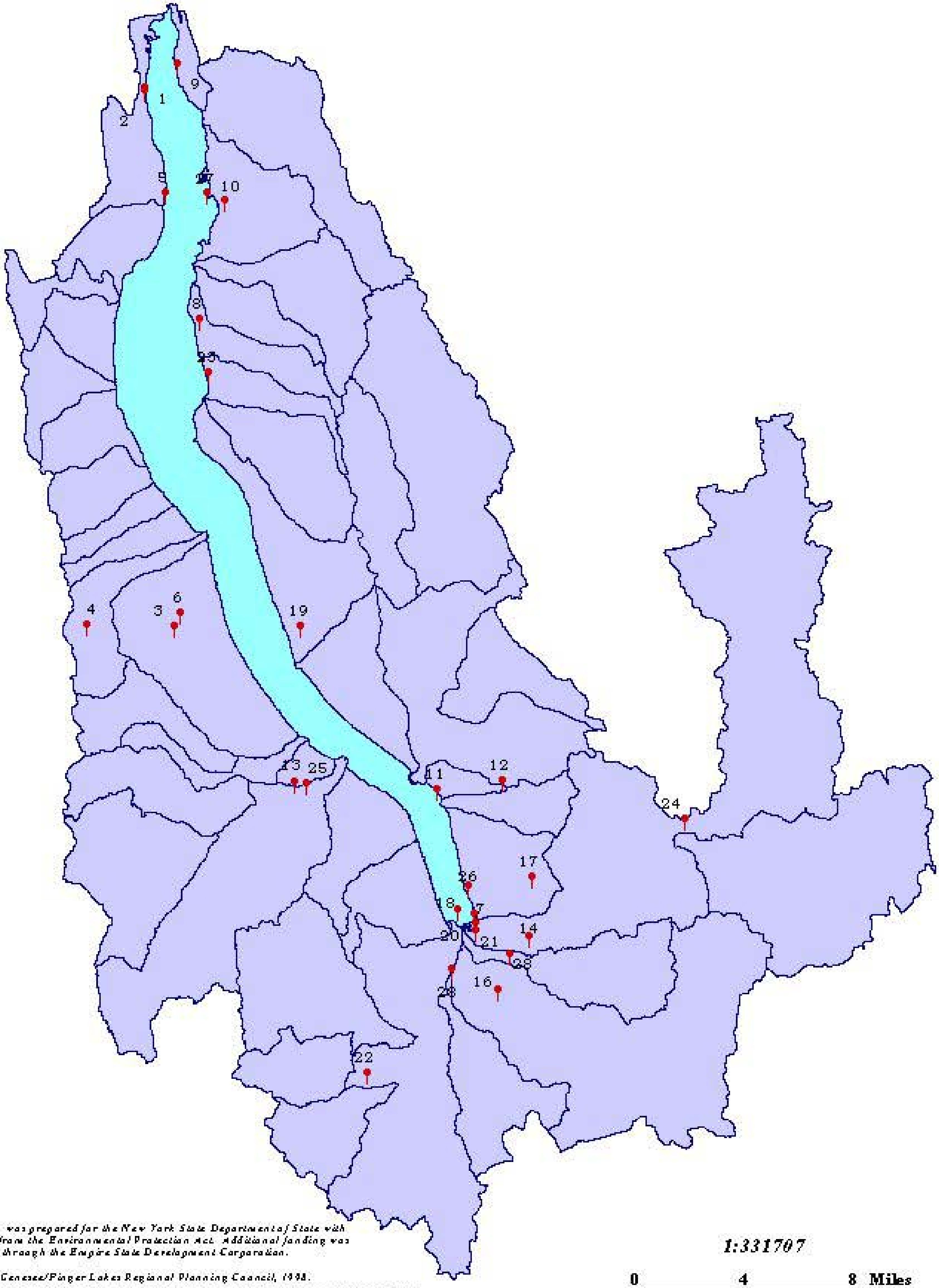
There are also a number of stormwater permit holders in the watershed discharging to surface water or groundwater (Table 4.2.8). Several municipal water filtration plants and Cornell University hold permits for the return of filtration backwash.

**Table 4.2.8 Summary of Permitted Industrial Discharges to Cayuga Lake and Tributaries**

| Facility Name and Location | Map ID | Discharge location(s) |
|---|---|---|
| AES Cayuga (formerly known as Milliken Station)<br>Noncontact cooling water, 218 mgd | 19 | Class AA (T) segment, Cayuga Lake |
| Cornell University Lake Source Cooling<br>Noncontact cooling water, 46 mgd (summer maximum) | 7 | Class A segment, Cayuga Lake |
| TRW Transportation, Union Springs | 10 | Unnamed tributary of Cayuga Lake, Class D |
| Mackenzie- Childs Ltd, Aurora | 8 | Groundwater, Class GA<br>Unnamed tributary to Cayuga Lake, Class C |
| Tompkins County Airport | 17 | Unnamed tributary (tributary 67) Class D |
| Cornell University, Ithaca | 28 | Cascadilla Creek, Class C (8 outfalls)<br>Fall Creek, Class B (7 outfallls)<br>Central Heating Plant (2 outfalls to Cascadilla Cr)<br>Harford Farm (11 outfalls, 8 are to groundwater) |
| Maguire, Trumansburg | 13 | Tributary to Taughannock Creek Class B(T) |
| Therm, Ithaca | 16 | Tributary to Six Mile Creek, Class C |
| Cargill, Portland Point | 11 | Cayuga Lake, Class AA(T)<br>Groundwater, Class GA |
| Agway Petroleum (Ithaca Bulk Plant) | 21 | Cayuga Inlet, Class C(T) |
| Evaporated Metal Films, Ithaca | 20 | Cayuga Inlet, Class C(T) |

The return of noncontact cooling water to southern Cayuga Lake by Cornell University's Lake Source Cooling facility has been an issue of concern to the community. The LSC system will not add chemicals to Cayuga Lake. Biofouling organisms will be controlled using mechanical methods and heat treatment during an annual maintenance shutdown. However, chemical impacts of LSC were a focus of the environmental impact investigations. During the period of thermal stratification, the transfer of water along with its dissolved and suspended substances represents a new "load" to the lake's upper waters. The potential ecological significance of this load depends on concentration

# Cayuga Lake Watershed
# State Pollutant Discharge Elimination System (SPDES) Permits




This map was prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.

Source: Genesee/Finger Lakes Regional Planning Council, 1998.
New York State Department of Environmental Conservation, Region 8, 1998.
New York State Department of Environmental Conservation, Region 7, 1999.

Base Map: New York State Department of Transportation, February 1996.

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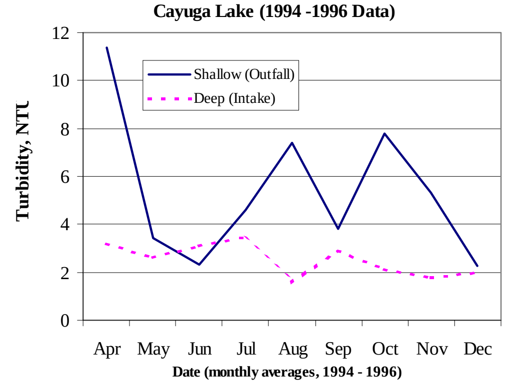
Prepared by Genesee/Finger Lakes Regional Planning Council, 1999.

gradients between the upper and lower waters; the mass of material transferred, and impacts of these substances on lake ecology and suitability for human use.

As described in the following sections of this report, water quality of Cayuga Lake is generally very good. The lake remains well oxygenated throughout the water column. Only small differences in concentrations of materials are detected between the upper waters (epilimnion) and lower waters (hypolimnion) during the annual period of thermal stratification, June through November. Differences in suspended sediment and phosphorus concentrations between the upper and lower waters were examined as part of the environmental assessment of the LSC project. These pollutants potentially affect the aesthetic quality of the lake and its suitability for use as a drinking water quality supply.

Based on turbidity and suspended solids measurements in the shallow and deep waters, the LSC return flow will almost always be lower in sediment than the upper waters of southern Cayuga Lake (Figure 4.2-19). The geological processes that created the gorges continue, and soils eroded from the watershed flow into the southern lake through the two major tributaries, Fall Creek and Cayuga Inlet. These natural processes are accelerated by urbanization. Sediment plumes are evident in the southern lake basin following storms. These elevated suspended sediment concentrations led New York State Department of Environmental Conservation to list southern Cayuga Lake on the statewide list of priority waterbodies.

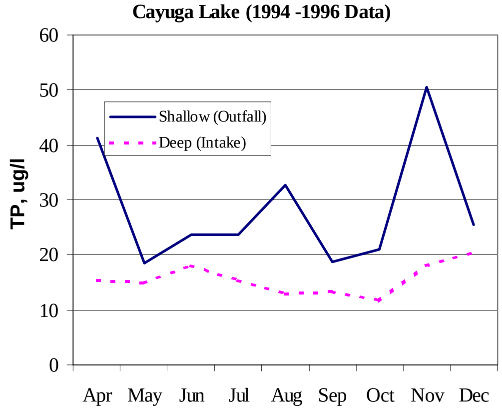
**Figure 4.2.19**
**Suspended Sediment**
**LSC Return Flow and Outfall Region**
**Cayuga Lake (1994 -1996 Data)**




Sterns and Wheeler, 1997

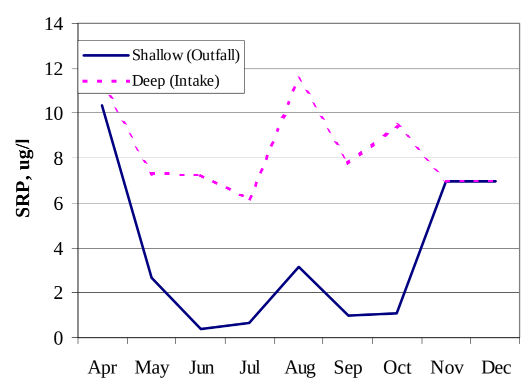
Similar to suspended solids, the concentration of total phosphorus in the LSC return flow will be below backgrounds concentration in the lake's upper waters (Figure 4.2-20). LSC will not add phosphorus to the lake, but the transfer of phosphorus present in the lake's lower waters represents an additional source during the summer recreational season. Phosphorus is the limiting nutrient for algal growth in Cayuga Lake, and its addition to the shallow southern lake, where concentrations are already elevated, was closely examined. Phosphorus transfer by LSC is estimated at 2.9 kg P per day from May to October (assuming LSC is at its maximum permitted flow and concentrations in the lower waters are at their annual peak). For comparison, the two

**Figure 4.2.20**
**Total Phosphorus**
**LSC Return Flow and Outfall Region**
**Cayuga Lake (1994 -1996 Data)**




Sterns and Wheeler, 1997

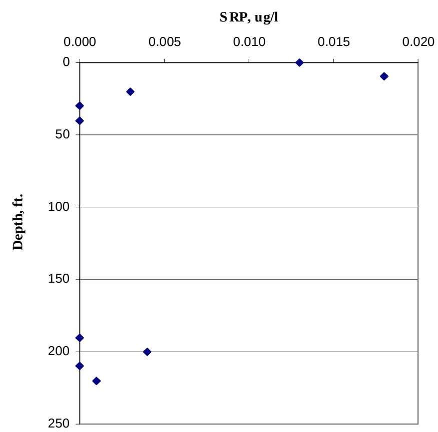
**Figure 4.2-21**
**Soluble Reactive Phosphorus**
**LSC Return Flow and Outfall Region**
**Cayuga Lake (1995 - 1996 Data)**




Sterns and Wheeler, 1997

large tributaries to southern Cayuga Lake deliver 13.3 kg P per day during this period, and the two wastewater plants can discharge up to 45.4 kg P per day. During the remainder of the year the lake waters mix naturally.

Figure 4.2-22
Soluble Reactive Phosphorus Profile 8/1/99
(City of Ithaca)




Sterns and Wheeler, 1997

The gradient in concentration of soluble reactive phosphorus (SRP) was also examined. Because Cayuga Lake is phosphorus limited, SRP concentration decreases in the upper waters during periods of algal growth. In contrast, SRP increases in the lower waters as algal cells are decomposed. The gradient in SRP concentration is plotted in Figure 4.2-21. Recent data collected by Dr. Jose Lozano of the City of Ithaca confirm the minimal SRP gradient with depth on Cayuga Lake (Figure 4.2-22).

The potential increase in algal abundance associated with the transfer of this mass of phosphorus was calculated. Results indicate that the effects will not be detectable. Planned improvements to the two wastewater treatment plants discharging to southern Cayuga Lake will reduce phosphorus input and concentration. As Cayuga Lake's concentration of phosphorus decreases, the amount of phosphorus transferred by LSC will decrease as well. Because of the uncertainties associated with this innovative project and the current water quality conditions of southern Cayuga Lake, the LSC permit has a number of conditions for monitoring and assessment. There are "reopener" clauses in the 5-year permit requiring Cornell to take action if the LSC return flow causes water quality degradation.

**4.2.5 Biological characteristics of tributaries**

There have been several investigations of macroinvertebrate communities of Cayuga Lake tributaries (Table 4.2.9). Direct comparisons of the findings are complicated by differences in collection technique, taxonomic level of identifications, and indices used to evaluate the data. Overall, the macroinvertebrate data indicate slight impairment of streams in urban and agricultural areas. The designation of impairment is based on a standard scale developed by NYSDEC.

According to Tom Chiotti, NYSDEC Fisheries Biologist, only Cayuga Inlet offers excellent habitat for salmonids based on substrate, stream cover, summer flows, and water temperatures. The other tributaries have various natural and human-induced restrictions to fish habitat. Several of the southern tributaries have impassable barrier falls close to the confluence with the lake. Water temperatures in the downstream segments are high during summer low flow periods. The lower reaches of Sixmile and Cascadilla Creeks are silted and open as they flow through the City of Ithaca (Chiotti 1980).

Salmon, Fall, and Taughannock Creeks are important spawning areas for smelt in the early spring. There is also some movement of rainbow trout into the lowest reaches of these tributaries, Fall Creek in particular, during high flow conditions in the spring. Smallmouth bass also spawn in Fall Creek below the Ithaca Falls. Yawger, Paines and Great Gully Creeks offer very limited spawning and nursery areas for rainbow trout due to their summer low flows and high temperatures (Chiotti 1980).

**4.2.6 Compliance with ambient water quality standards and guidance values**

The existing data indicate that tributaries to Cayuga Lake are in compliance with ambient water quality standards and guidance values, with minor exceptions. However, data are limited. There may be stream segments within the watershed where water quality does not meet ambient standards in place for the designated classification.

The RIBS monitoring program indicates that iron concentrations in Fall Creek are above the applicable ambient water quality standard. Elevated iron levels are attributed to natural geochemistry. The sampling station on Fall Creek is in the City of Ithaca below the falls. The RIBS program also detected seven heavy metals in Fall Creek sediments at concentrations above the assessment criteria. There are no federal or New York State standards in place for chemicals in sediment. The assessment criteria represent NYSDEC best professional judgment of the upper range of background (nonimpacted) levels. Assessment criteria for sediment metals are below levels that might adversely impact the environment.

#### 4.2.7 Subwatershed Description

A description of the major subwatersheds of the Cayuga Lake Watershed are given in Table 4.2.8 by drainage area, predominant land use, predominant potential source contaminant(s), limnological considerations, and PWL information. The major subwatershed can be seen on Map 4.2.2.

**Table 4.2.9.** Summary of Macroinvertebrate Sampling of Tributaries

| Stream | Investigator | Findings |
|---|---|---|
| Fall Creek in Ithaca | NYSDEC RIBS Program | Slightly impacted |
| Salmon Creek in Ludlowville | NYSDEC RIBS Program | Non-impacted |
| Big Salmon Creek in Genoa | NYSDEC RIBS Program | Non-impacted |
| Little Salmon Creek in Little Hollow | NYSDEC RIBS Program | Non-impacted |
| Cayuga Inlet | Dr. Barbara Peckarsky (Cornell University) | Impacted at fuel oil spill, recovery downstream and with time |
| Cascadilla Creek | Ichthyological Associates for Cornell University (Planning design and Construction) | Slightly impacted |
| Unnamed tributary downstream of Hillview Rd. Landfill (Cayuga Inlet drainage) | Tompkins County Solid Waste, various investigators | Slightly impacted in headwaters, non-impacted within short distance downstream |
| Paines Creek and Great Gully | Dr. Tom Vawter, Wells College and students | Seasonal and spatial variation in indices |

### 4.3 Lake Characteristics

#### 4.3.1 Physical Characteristics of Cayuga Lake

##### 4.3.1.1 Bathymetry

Cayuga Lake is the second largest of New York's Finger Lakes based on water volume and surface area. It is situated in a glacially carved valley at the northern edge of the Appalachian Uplands physiographic region of New York State. Water surface elevation is 116.4 m (382 ft.) above mean sea level and maximum depth is 132 m (435 ft.); the lake bottom extends well below sea level. The great depth of Cayuga Lake, second only to Seneca among the Finger Lakes, is attributed to rock scour from glaciation. The Cayuga Lake basin appears to have originated as a preglacial stream valley that was overdeepened by glacial erosion. Based on seismic surveys, bedrock may lie as much as 242 m (794 ft.) below sea level, and the rock basin has been infilled by as much as 226 m (741 ft.) of glacial and postglacial sediment (Mullins 1998).

**Table 4.2.10**
**Subwatershed Description**

| Watershed Characterization Subwatershed[1] | Major Subwatershed[2] | Drainage (HA)[2] | Predominant Land Use[1] | Predominant Potential Source Contaminants[1] | Limnological Considerations[1] | PWL Information[3] | | | | | | Other[1] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Segment Size | Description | Stream Classification | Use Impairment | Type of Pollutant(s) | Source(s) of Pollutant(s) | |
| Cascadilla Creek (43), Sixmile Creek (41), Buttermilk Creek Area (44), Cayuga Inlet (42), West Branch (46), Fish Kill (45), Enfield Creek (40) | Inlet | 40,979 | Residential, Community Services, Commercial, Industrial (downstream), Agriculture (upstream) | Bulk Storage, Waste Sites, Hazardous Spills, Industrial, Commercial, Deicing Storage, Septic (upstream) | Cayuga Inlet most important fish habitat. Sixmile Cr has good data on sediment loss. | Cascadilla Creek - 4 miles; Cayuga Inlet - 10 miles; Six Mile Creek - 19 miles | Cascadilla Creek - Lower section; Cayuga Inlet - Lower Cayuga Inlet; Six Mile Creek - Entire length of creek, including all major tribs | Cascadilla Creek and Cayuga Inlet - C, C(T); Six Mile Creek - A | Cascadilla Creek - Fish Propagation (T), Aesthetics (S); Cayuga Inlet - Fish Propagation (S); Six Mile Creek - Water Supply (S), Fish Propagation (S) | Cascadilla Creek - Silt (Sediment), Nutrients; Cayuga Inlet - Silt (Sediment), Unknown Toxicity, Nutrients; Six Mile Creek - Silt (Sediment), Aesthetics, Pesticides, Nutrients | Cascadilla Creek - Streambank Erosion, Urban Runoff, Agriculture, Roadbank Erosion, Construction; Cayuga Inlet - Agriculture, Land Disposal, Roadbank Erosion, Construction, On-site Systems, Urban Runoff, Streambank Erosion; Six Mile Creek - Streambank Erosion, Private, Storm Sewers, Roadbank Erosion, Industrial, Agriculture, On-site Systems, Municipal, Urban Runoff, Hydromodification | Densely Populated (downstream), Impervious Surfaces |
| Virgil Creek (34), Fall Creek (19) | Fall Creek | 33,111 | Residential, Agriculture (upstream), Commercial ,Community Services | Bulk Storage, Hazardous Spills, Industrial, Commercial, Deicing Storage, Agriculture | Fall Cr most monitored stream in watershed. Excellent historical data on phosphorus, nitrate, and sediment. NYSDEC intensive monitoring site for RIBS program | Dryden Lake - 104 acres; Fall Creek - 5 miles; Lake Como - 64 acres | Dryden Lake - Entire lake; Fall Creek - From mouth at Cayuga Lake to 5 miles upstream; Lake Como - Entire Lake | Dryden Lake - C; Fall Creek - B, A; Lake Como - B | Dryden Lake - Fishing (S), Boating (S); Fall Creek - Water Supply (T), Bathing (T), Fish Propagation (S), Fish Survival (S); Lake Como - Bathing (S), Fishing (I), Fish Survival (T), Aesthetics (I), Boating (I) | Dryden Lake - Nutrients; Fall Creek - Silt (Sediment), Pathogens, Nutrients, Thermal Changes; Lake Como - Nutrients, Water Level/Flow, Silt (Sediment), Pathogens, Oxygen Demand, Aesthetics | Dryden Lake - Agriculture, Other (golf course runoff); Fall Creek - Streambank Erosion, On-site Systems, Agriculture, Roadbank Erosion, Construction; Lake Como - On-site Systems, Roadbank Erosion, Agriculture, Streambank Erosion | Densely Populated (downstream), Impervious Surfaces |

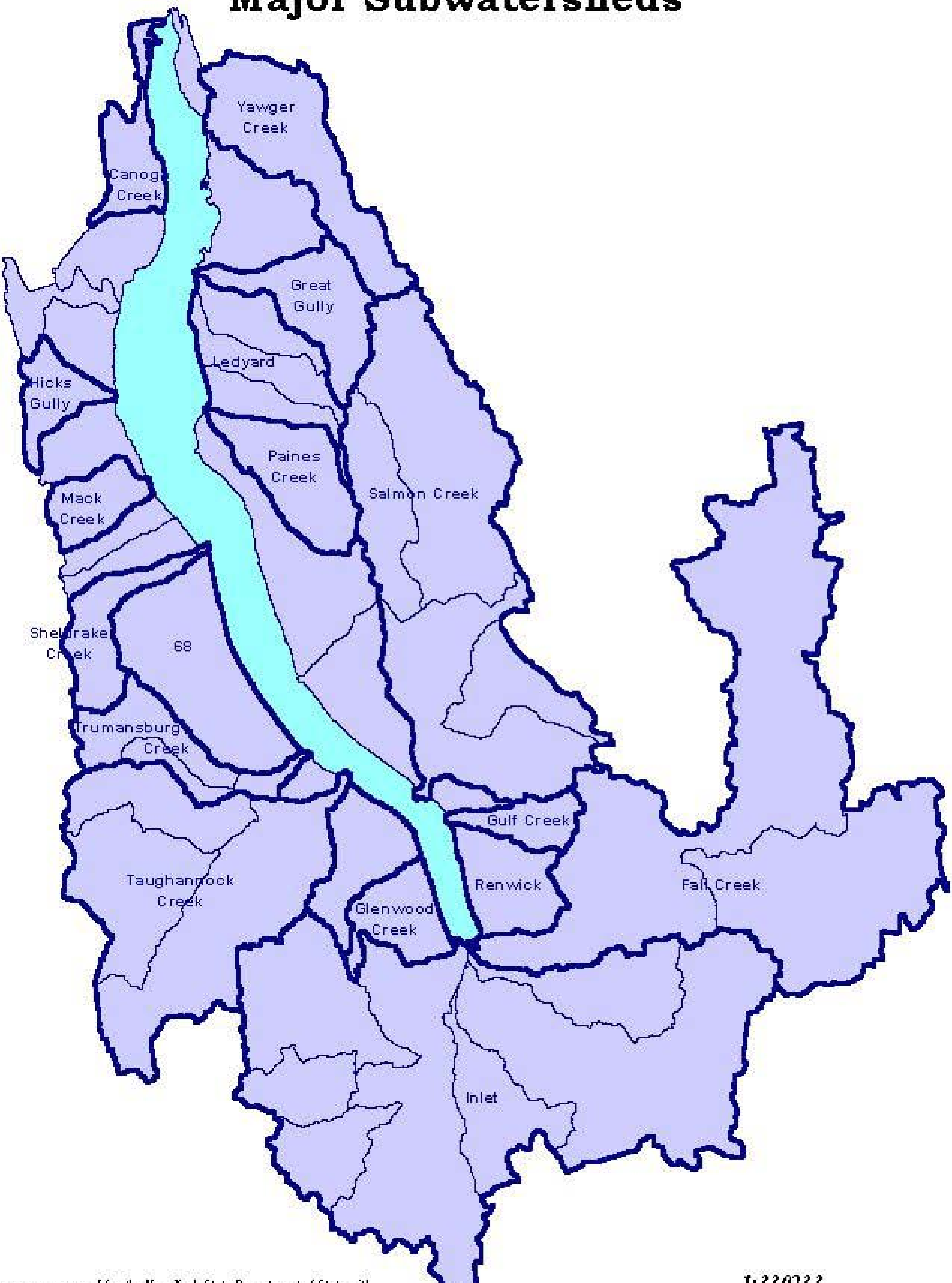
| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Big Salmon Creek (10), Little Salmon (15), Salmon Creek (25), Locke Creek (27) | Salmon Creek | 23,165 | Agriculture, Residential | Septic, Agriculture, Bulk Storage, Hazardous Spills, Industrial (mines), Deicing Storage | high nitrate concentration, documented pesticide runoff. | Big Salmon - 15 miles; Little Salmon - 7 miles | Big Salmon - Entire segment in Cayuga County; Little Salmon - Entire stream | Big Salmon, Little Salmon - C | Big Salmon - Fishing (T), Fish Propagation (T), Fish Survival (T), Aesthetics (S), Boating (S); Little Salmon - Fishing (T), Fish Propagation (T), Fish Survival (T), Aesthetics (S) | Big Salmon and Little Salmon - Nutrients, Thermal Changes, Silt (Sediment), Water Level (Flow), Oxygen Demand, Pathogens | Big Salmon and Little Salmon - Agriculture, Streambank Erosion, Roadbank Erosion | Populated (downstream), Impervious Surfaces) |
| Taughannock Creek (32), Spring Brook (37), Bolter Creek (31) | Taughannock | 17,224 | Agriculture, Residential, Commercial | Agriculture, Industrial (mines and wells) | | Bolter Creek - 0.3 miles; Bolter Creek Trib - 0.5 miles | Bolter Creek - From Schuyler County Rte 1 south for 1/4 mile; Bolter Creek Trib - Vicinity of Nat. Forest near Schuyler County line | Bolter Creek - C<D; Bolter Creek Trib - C | Bolter Creek - Fish Propagation (T); Bolter Creek Trib - Fish Propagation (T), Fish Survival (T) | Bolter Creek - Silt (Sediment); Bolter Creek Trib - Metals | Bolter Creek - Resource Extraction; Bolter Creek Trib - Land Disposal | |
| Yawger Creek (4) | Yawger Trib, Yawger Creek | 6,474 | Agriculture, Residential | Industrial (mines and wells), Septic, Agriculture | karstic limestone geology. Documented pesticide runoff | 15 miles | Entire creek in Springport (T) | C(TS) | Fish Propagation (I) | Silt (Sediment), Nutrients | Agriculture, Streambank Erosion | PWL segment |
| Great Gully (7) | Great Gully | 4,064 | Agriculture, Residential | Septic, Agriculture | elevated nitrate concentrations | | | | | | | |
| Paines Creek (17) | Paines Trib, Paines Creek | 3,991 | Agriculture | Septic, Agriculture | documented pesticide runoff | | | | | | | |
| Boardman Creek (28), Trumansburg Creek (29) | Trumansburg Creek | 3,572 | Residential, Park and Forest | Commercial, Hazardous Spills, Bulk Storage, Deicing Storage | | | | | | | | |
| Sheldrake Creek (23) | Sheldrake Creek | 2,142 | Residential, Agriculture | Agriculture | | | | | | | | |
| Gulf Creek Area (36) | Gulf Creek | 1,608 | Residential, Commercial | Septic, Hazardous Waste | Historically elevated chlorides from salt mining | | | | | | | Populated |
| Levanna Area (9), Glen/Dean Creeks Area (11), Little Creek Area (14) | Ledyard | 1,536 | Agriculture, Residential, Commercial, Community Service (Wells College) | Septic, Agriculture | | | | | | | | |
| Bloomer/Mack Creeks Area (20) | Mack Creek | 1,424 | Residential, Agriculture | Septic, Agriculture | | | | | | | | |
| Hicks Gully (13) | Hicks Gully | 1,349 | Agriculture | Septic, Agriculture | | | | | | | | |
| Willow Creek Area (35) | 103, Willow Creek | 1,137 | Residential | Septic, Agriculture | | | | | | | | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Glenwood Creek Area (39) | Indian, 106, Williams, Glenwood Creek | 1,108 | Residential, Commercial | Hazardous Spills, Commercial, Agriculture | Williams Br flows into important remnant wetland (Hogs Hole) in southern lake | | | | | | | Populated |
| Canoga Creek Area (3) | Canoga Creek | 829 | Residential | Septic, Agriculture, Waste Site, Hazardous Spills | water qualityand quantity reflect karstic geology | | | | | | | |
| Interlaken Area (24) | 68 | 510 | Agriculture, Residential | Septic, Agriculture, Commercial, Industrial | | | | | | | | |
| Lansing Area (38) | Renwick | 324 | Residential, Commercial, Community Service (University) | Bulk Storage, Waste Sites, Hazardous Spills, Industrial, Commercial, Deicing Storage | | | | | | | | Populated, Impervious Surfaces |
| Cayuga Village Area (1), Union Springs Area (5), Schuyler Creek (6), Red Creek (8), McDuffie Town (12), Big Hollow (16), King Ferry Station Area (18), Barnum Creek Area (21), Groves/Powell Creeks Area (22), Lake Ridge Point Area (26), Cayuga View Area (30), Minnegar Creek Area (33) | Unmonitored (Direct Drainage) | 20,640 | Mixed | Septic, Agriculture | | | | | | | | |

Use Impairment Severity
(I) Impaired
(S) Stressed
(T) Threatened

[1] Subwatershed Numbers From Cayuga Lake Preliminary Watershed Characterization (see Map 2.1.1b)
[2] Based on Likens
[3] NYSDEC, 1996

# Cayuga Lake Watershed
# Major Subwatersheds




This map was prepared for the New York State Department of State with funding from the Environmental Protection Act. Additional funding was provided through the Empire State Development Corporation.

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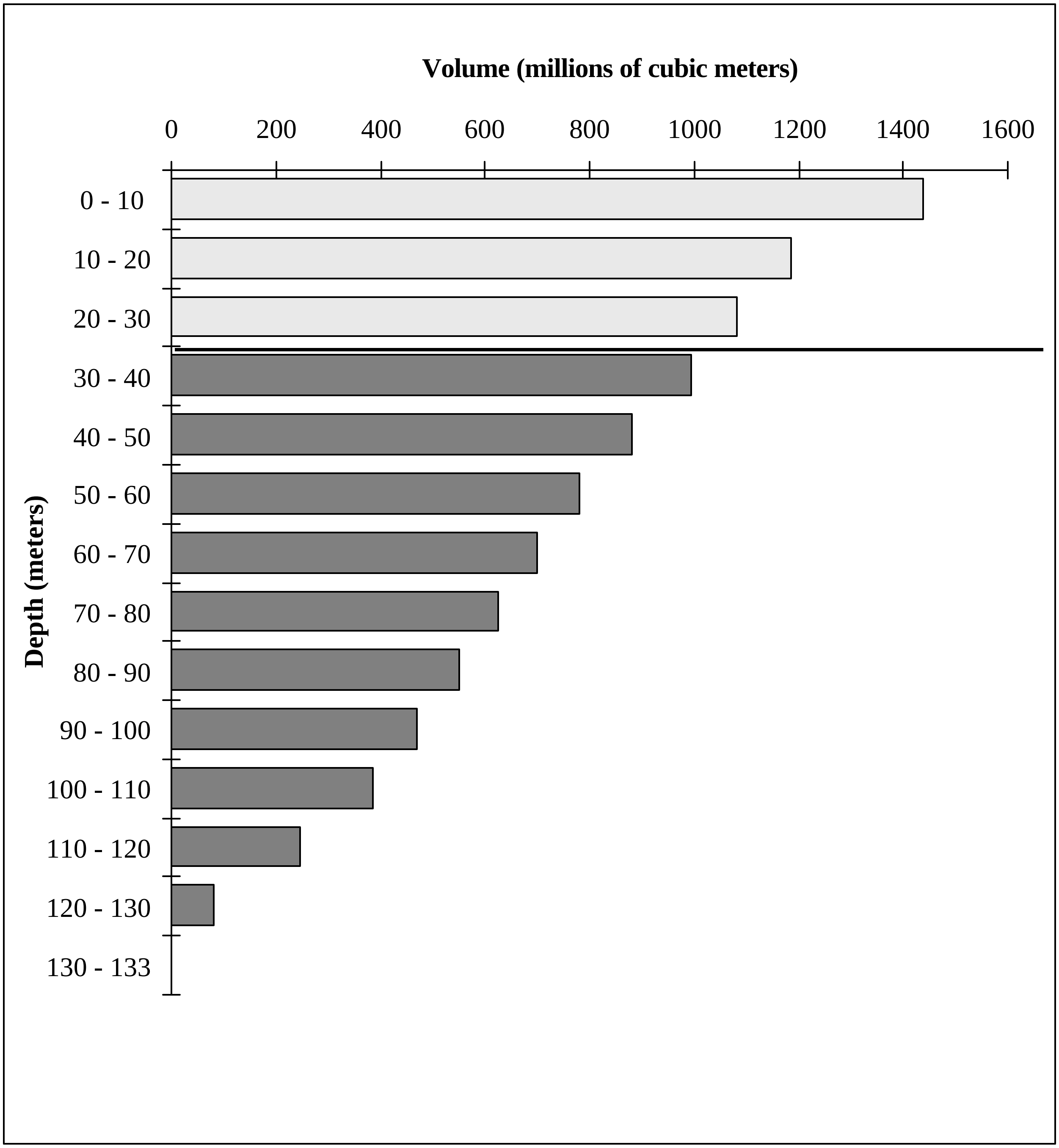
Source: Genesee/Finger Lakes Regional Planning Council, 1998.

Base Map: New York State Department of Transportation, February 1996.

Prepared by Genesee/Finger Lakes Regional Planning Council, 1999.




Note: Depth of epilimnion is 12-15 meters by late August. Size of metalimnion (which includes the thermocline) is variable.

$m^3$: cubic meters

**FIGURE 4.3.1**
**VOLUME OF CAYUGA LAKE WITH DEPTH, LATE SUMMER CONDITIONS**

Morphometric statistics for the Lake are summarized in Oglesby (1978). The Cayuga Lake basin is long and narrow, extending approximately 60 km (38 miles) from Ithaca in the southern basin to the Seneca River outlet. Mean width is 2.8 km (1.75 miles). At its widest point, Cayuga Lake is 5.6 km (3.5 miles) across. Volume is estimated at 9380 million cubic meters (331,080 million cubic ft.) at a lake elevation of 116 m. Surface area is 172.1 sq. km. (66.4 sq. miles).

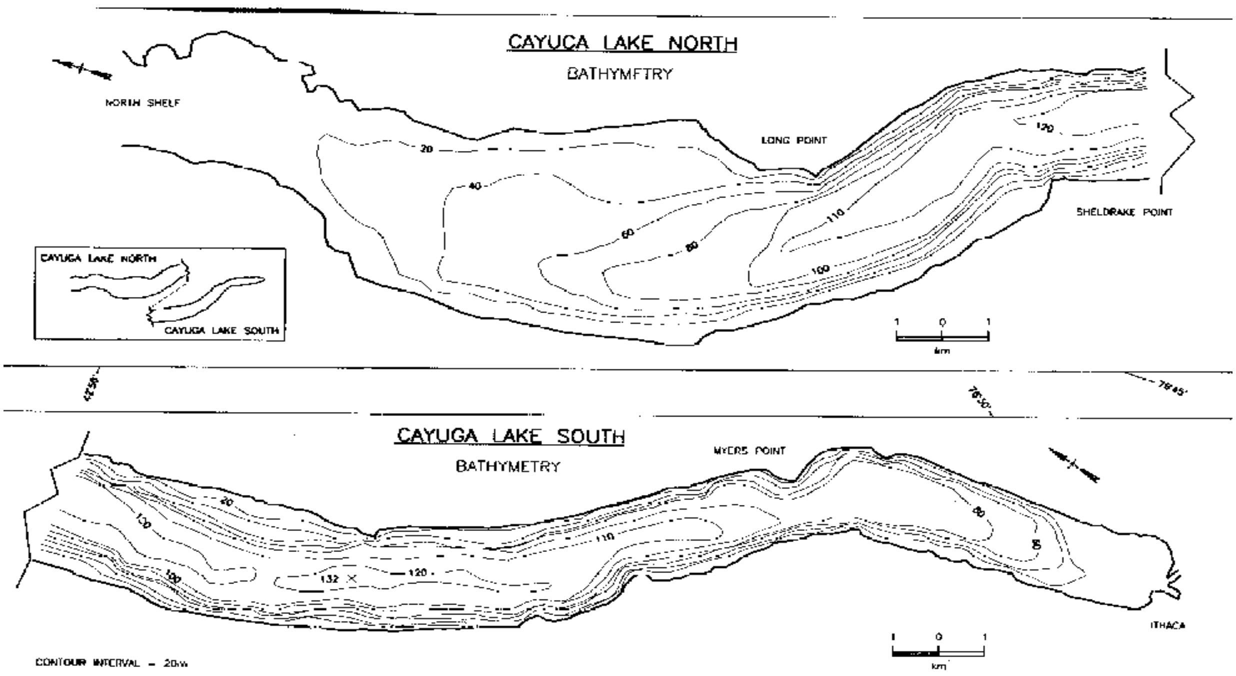



Figure 4.3.2 Bathymetric map of Cayuga Lake
Source: Edward Hinchey

Bathymetric data (depth and volume) for Cayuga Lake were first reported by Birge and Juday in 1912. These investigators used a base map surveyed by Cornell University engineering students and measured water depth with a steel sounding wire. Position of each depth measurement was controlled by transit instruments on shore and a sextant in the boat. Results of this early survey are plotted in Figure 4.3.1, which displays the water volume associated with each depth stratum. Note the large volume of deep water in Cayuga Lake. Median depth of the Lake is 40 meters (131 ft.); mean depth is 54.5 meters (179 ft.).

Between 1986 and 1988, Henry Mullins of Syracuse University and colleagues collected high-resolution seismic reflection profiles of the major Finger Lakes, including Cayuga Lake. The seismic reflection profiles allowed the researchers to quantify and map water depth, total sediment thickness, and depth to bedrock. They identified a sequence of six depositional events associated with the retreat of the Laurentide ice sheet that transported large volumes of fine-grained sediments into the Finger Lakes basins. The sediment deposits created the relatively flat lake bottom in the V-shaped basin.

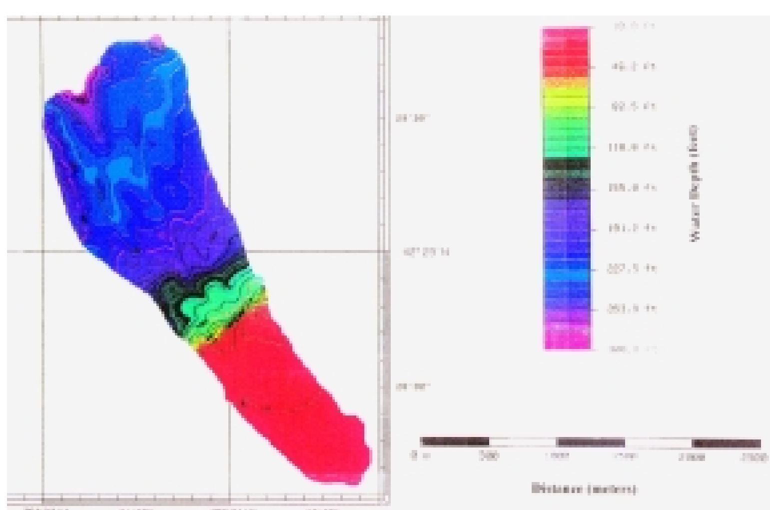


Figure 4.3.3. Lake Bottom

A bathymetric map of Cayuga Lake indicates that the lake is relatively shallow at its northern end, deepens towards the south and has a relatively small, shallow shelf at its southern end (Figure 4.3.2). The deepest part of Cayuga Lake is a trough extending north from Myers Point to Long Point.

A detailed bathymetric survey of southern Cayuga Lake was completed in 1996 to support design of the pipeline route for the Lake Source Cooling (LSC) intake. This survey was completed using differential-corrected Global Positioning System (GPS) technology coupled with side-scan sonar and hydroacoustics to map the lake bottom. Results are displayed in Figure 4.3.3.

**4.3.1.2 Hydraulic Retention Time**

The hydraulic retention time (water residence time) of a lake is defined as the average time water remains in the lake. In Cayuga Lake, various investigators have estimated hydraulic retention time between 5 – 12 years. This range in estimation reflects natural variability in weather conditions as well as the methodology of the estimate.

Several methods are used to estimate water residence time of a lake. The most accurate approach is to measure all the flows into and from a lake. Only in rare cases is this level of detail available. The most common method of calculating residence time is to assign a unit runoff coefficient to the watershed and estimate the volume of water entering the lake, then divide the volume of influent water by the lake volume. Recently, investigators from USGS have used tritium levels to estimate retention time of the Finger Lakes.

The work of Likens (1974) remains the most direct approach to estimating the water residence time in Cayuga Lake. He calculated the hydrologic budget for the period of August 1970 through July 1971 based on detailed measurements of precipitation, streamflow, discharge, and change in water surface elevation. Likens calculated that 18% of the Lake's volume flowed out to the Seneca River; which translated to an average hydraulic retention time of 5.1 years (100% lake volume / 18% per year =5.1years). However, this calculation included the inflow and outflow of the Seneca River, which enters Cayuga Lake close to the lake outlet. It is reasonable to assume that river waters do not mix south throughout the long lake. If the contribution of the Seneca River were excluded, the hydraulic retention time based on 1970 – 1971 data would be estimated at 7.4 years.

These values are about 50% smaller than hydraulic retention time estimates compiled by Wright (1969). The study period in 1970 – 1971 was relatively wet, which affects the estimates. Likens emphasized the theoretical nature of the flushing rate estimates, which are based on the total volume of the lake as if mixing were complete throughout the year. These calculations do not account for seasonal differences in hydrologic input, nor do they consider current patterns in the lake.

Oglesby (1978) estimated that the average hydraulic retention time of Cayuga Lake was 12.8 years, with a range of 8.1 to 24.1 years, based on 36 years of record of inflow and outflow data, excluding contribution of the Seneca River. Another estimate of Cayuga Lake's hydraulic retention time was prepared by Schaffner and Oglesby (1978) using detailed hydrologic calculations from Owasco Lake and assuming that unit runoff throughout the Finger Lakes was proportional to watershed size. This method yielded a retention time of 9.5 years. USGS estimated Cayuga Lake's hydraulic retention time at 10 years based on statewide runoff data (Michel and Kraemer 1995).

Investigators from USGS have used tritium, a radioactive isotope of hydrogen, to estimate hydraulic retention time in the Finger Lakes (Michel and Kraemer 1995). The concentration of tritium in rainfall peaked in the mid-1960's during atmospheric weapons testing. Tritium concentration in surface waters has decreased since this time period due to radioactive decay, mixing with older water masses, and dilution with rainfall with lower tritium concentration. Michel and Kraemer used this method to estimate hydraulic retention time of Cayuga Lake as 10 years. These results confirm that groundwater inflow to the lake is minimal.

**4.3.1.3 Heat Budget**

The temperature of Cayuga Lake reflects the net result of heat inputs, losses, and exchange. The sun is the ultimate natural source of heat to the lake, heating the water through shortwave solar radiation, longwave solar radiation and conduction of heat from the atmosphere to the water. Other heat inputs include municipal or industrial sources such as noncontact cooling water. There have been several attempts to estimate an annual heat budget for Cayuga Lake. An annual heat budget is an accounting of the total heat entering a lake between dates of its least and greatest heat content. Cayuga Lake contains the least heat in March and the greatest in August.

Early in the 20th century, Birge and Juday estimated a heat budget for Cayuga Lake based on isolated temperature data collected in winter and summer. Henson used this approach in the early 1950's, with similar findings. Two subsequent heat budgets were drawn using models of lakewide temperature and circulation. Both models were developed to quantify the thermal impacts of a proposed industrial cooling water discharge to Cayuga Lake. Sunderman et al (1968) developed a model of lake temperature as part of the environmental assessment of the Bell Station, and J. E. Edinger Associates, Inc. (1997) applied their model CE-QUAL-W2 to quantify potential lake-wide thermal impacts of Cornell Lake Source Cooling. The four estimated heat budgets are summarized in Table 4.3-1.

**Table 4.3.1. Heat Budgets developed for Cayuga Lake**

| Investigator | Years Used as Basis of Calculation | Annual Heat Budget * ($Btu/ft^2$) | Annual Heat Budget * ($J/m^2$) |
|---|---|---|---|
| Birge and Juday | 1910, 1911 | 144,000 | 1.6E+09 |
| Henson | 1950 -1953 | 137,000 | 1.6E+09 |
| Sunderam et al. | 1968 | 185,000 | 2.1E+09 |
| John E. Edinger Associates, Inc. | 1986 – 1995 | | |
| | Mean | 123,000 | 1.4E+09 |
| | Minimum | 115,000 | 1.3E+09 |
| | Maximum | 130,000 | 1.5E+09 |

Source: Stearns & Wheler 1997

* The annual heat budget is defined as the gain in heat storage in Cayuga Lake from the time of minimum heat storage (March) to the time of maximum heat storage (August).

$Btu/ft^2$ British thermal units per square ft.
$J/m^2$ joules per square meter

The annual heat budgets demonstrate periods during which the lake gains and loses heat. Monthly heat storage data (summarized in Table 4.3-2) indicate that, in an average year, the lake gains heat from March through mid-August and loses heat the remainder of the year. During the heating season, Cayuga Lake gains an average of 2.3 E+07 joules per square meter of lake surface per day (2,000 Btu per square foot per day). The net heat energy enters the lake surface primarily from solar radiation and is distributed through the water column by currents, seiche oscillations, and internal waves. On a long-term basis, the amount of heat gained by the lake each year is lost to the atmosphere during the prolonged period of winter mixing. There may, however, be disequilibrium in any given 12-month period.

With the exception of the Birge and Juday calculations, the heat budgets include the input from AES-Cayuga (formerly known as Milliken Station). AES Cayuga is a 387-megawatt (MW) coal-fired power plant located on the east shore of Cayuga Lake approximately 13 miles north of Ithaca. Cooling water is withdrawn at a depth of 14 m (46 ft.) through an intake located 183 m (600 ft.) offshore. The plant is permitted to reject heat at a maximum rate of 1.3 E+09 Btu/hr (2.42 watts/$m^2$-day) based on its permitted flow of 169,000 gallons/minute and an 8.3 °C (15 °F) heat rise through the condensers. On a cumulative annual basis, AES Cayuga is permitted to reject heat at 1.1 E+13 Btu/yr. AES Cayuga contributes approximately 15 $Btu/ft^2$/day, which is less than 1% of the natural heat gain (2,000 $Btu/ft^2$/day)

| Table 4.3.2 Monthly Heat Storage in Cayuga Lake per Unit Surface Area | | | |
|---|---|---|---|
| **Month** | **Average Heat Content (joules/m$^2$)** | **Minimum Heat Content (joules/m$^2$)** | **Maximum Heat Content (joules/m$^2$)** |
| January | 6.69E+08 | 5.82E+08 | 8.01E+08 |
| February | 5.39E+08 | 4.74E+08 | 6.29E+08 |
| March | 5.33E+08 | 4.16E+08 | 6.12E+08 |
| April | 7.01E+08 | 5.28E+08 | 7.86E+08 |
| May | 1.08E+09 | 9.48E+08 | 1.18E+09 |
| June | 1.50E+09 | 1.37E+09 | 1.63E+09 |
| July | 1.81E+09 | 1.68E+09 | 1.88E+09 |
| August | 1.93E+09 | 1.81E+09 | 1.98E+09 |
| September | 1.90E+09 | 1.85E+09 | 1.94E+09 |
| October | 1.69E+09 | 1.64E+09 | 1.75E+09 |
| November | 1.37E+09 | 1.31E+09 | 1.48E+09 |
| December | 9.89E+08 | 8.82E+08 | 1.12E+09 |
| Source: JEEAI, as presented in Stearns & Wheler 1997 | | | |

The JEEAI heat budget also includes heat rejected from Cornell's Lake Source Cooling project (LSC) which began operation in summer 2000. The LSC project is a second source of noncontact cooling water to Cayuga Lake. Water for LSC is drawn from a depth of 76 m (250 ft) through an intake located approximately 2 miles north of Stewart Park and circulated through a shoreline heat exchange facility. Plate and frame heat exchangers in this facility transfer chill from the lake water to a closed loop of water circulating from the Cornell University campus. Warmed water is returned to southern Cayuga Lake through a submerged multiport diffuser located approximately 500 ft offshore. Temperature of the return flow is relatively constant throughout the year as compared to the temperature of the shallow southern basin where the flow is returned. Temperature of the return flow will be 8.9 °C in winter and 13.3 °C in summer. Volume of the LSC return flow fluctuates in response to demand for campus cooling. The plate and frame heat exchanger is designed so that the circulating lake water system will never mix with the closed-loop campus chilled water system.

The two noncontact cooling water systems are compared in Table 4.3-3. The LSC system will add a daily maximum of 0.434 watts/m$^2$ to the lake surface during peak summer operating conditions and 0.07 watts/m$^2$ during winter when demand for campus cooling will be very low. As a basis for comparison, the sun can deliver 400 watts/m$^2$ to the lake surface during a clear summer day. The daily heat input from LSC is equivalent to heat from approximately 9 seconds of sunlight in summer (assuming 14 hours of sunlight) and 20 seconds during winter (assuming 9 hours of sunlight). On an annual basis, the LSC system represents approximately 8 percent of the heat load (to Cayuga Lake) from AES-Cayuga.

The effects of the LSC project on Cayuga Lake's thermal regime were examined at two scales: nearfield (in the region of the outfall) and lakewide. Near-field impacts were projected using the model CORMIX2, which simulates mixing of the return flow from the heat exchangers with ambient lake water (Jirka et al. 1996). The model projects dimensions of a "plume" of cooler or warmer water created in the region of the submerged outfall diffuser. The two-dimensional hydrothermal model CE-QUAL-W2 was used to simulate effects of LSC on Cayuga Lake's seasonal temperature structure. Site-specific data were used to define parameters, initialize the models, and (in the case of the lakewide model) verify model performance by comparing predicted and observed temperature profiles.

| **Table 4.3.3.** Comparison of Heat Loads, Noncontact Cooling Water Discharges to Cayuga Lake | | |
|---|---|---|
| **Permit Conditions** | **Cornell LSC** | **AES-Cayuga (*Formerly known as Milliken Station)*** |
| Heat input to Lake ($W/m^2$-day)<br>Summer<br>Winter | <br>0.434<br>0.07 | <br>2.42 |
| Btu/hr (peak summer) | $0.24 \times 10^9$ | $1.3 \times 10^9$ |
| Btu/yr (cumulative) | $0.09 \times 10^{13}$ | $1.1 \times 10^{13}$ |
| Average Heat Rejection ($MW_{thermal}$) | 29.4 | 387 |
| Depth of Intake | 76 m (250 ft) | 13.7 m (45 ft) |
| Depth of Return Flow/Distance Offshore of Outfall | 2.7 m (9 ft)/150m (500 ft) | **Surface**/At Shoreline |
| Recirculated Volume (peak flow) | 2 $m^3$/sec (32,000 gpm) | 10.6 $m^3$/sec (169,000 gpm) |
| Temperature of return flow | Ambient plus 7 – 15 degrees F (return flow temperature relatively constant at 48 – 56 °F) | Ambient plus 15 degrees F (return flow temperature is variable due to fluctuating temperature of intake water) |
| Recirculated volume (annual average flow) | 1.2 $m^3$/sec (19,200 gpm) | 10.6 $m^3$/sec (169,000 gpm) |
| $W/m^2$-day Watts per square meter per day<br>Btu/hr British thermalunits per hour<br>gpm Gallons per minute | | |
| Source: Cornell Utilities for LSC<br>NYSEG for Millken | | |

The CORMIX2 model projections assume that the LSC facility operates at its maximum permit capacity, 24 hours each day. In fact, flows through the system will vary in response to the demand for campus cooling. Actual flows will always be less. Projections indicate that the LSC return flow will have minimal impact on water temperature in southern Cayuga Lake (Stearns & Wheler 1997). Water temperatures are projected to return to within 2 °C of background within a short distance of the outfall diffuser. During most months, temperature returns to within 0.5 °C of ambient within several hundred meters of the outfall. The largest plume (a plume of cooler water) is projected to occur in August when the gradient between the temperature of the return flow and background conditions is greatest.

The lakewide model was used to simulate temperature regime, which included stratification and ice cover, over the ten-year period from 1986 – 1995. To apply CE-QUAL-W2, bathymetry was mapped onto a grid dividing Cayuga Lake into segments in two dimensions: with depth (vertical) and from south to north (longitudinal). The grid, with a total of 1103 model cells, was designed to provide more spatial resolution in the southern end and in the epilimnion. A continuous simulation of water temperature over the ten-year period was run using site-specific inputs of meteorological conditions and streamflow.

Model projections for 1995, the final year of the continuous simulation, were compared with field measurements recorded at 15-minute intervals by a series of thermistors suspended at 10-m intervals from the lake's surface to 70-

m depth. The string of thermistors was placed in the region of the proposed intake for LSC; predicted water temperature in this model segment was used as the basis for comparison. The model performed well, reproducing both the short-term variability associated with the lake's prominent seiches as well as the longer-term development of thermal structure. Root mean square (RMS) difference between predicted and observed temperature was always less than 2.4 $^{o}$C; 55% of RMS differences were less than 1 $^{o}$C.

Once model performance was established, it was used to simulate 10 years of thermal behavior with the LSC system online. This 10-year simulation period also provided an opportunity to examine whether there would be any thermal impacts that might carry over from year to year. Results indicate that lakewide impacts of LSC will be negligible. The maximum projected changes in water temperature are small (on the order of 0.08 $^{o}$C) and well below natural spatial and temporal variations. These subtle changes in water temperature are projected to occur in the region of the LSC intake. The greatest temperature changes are projected for shallow waters, and effects will be greatest in the winter. The project is projected to have no impact on the duration of stratification or ice cover.

Both the nearfield and lakewide models project that circulation of water and addition of heat by LSC will only slightly affect temperature in a very limited region of the lake. These temperature changes are well within the natural variability of the lake. Heat added to the lake will be lost to the atmosphere each winter during the prolonged period of complete mixing typical from December through May. There is projected to be no discernible impact on the spawning, nursery or migratory habitat for lake fishes and other aquatic life.

The potential impact of the Lake Source Cooling project on the phosphorus budget of southern Cayuga Lake has been an issue of concern to the community. Additional discussion of this issue is included in Sections 4.2.4 (permitted discharges) and 4.3.2.2 (materials budget).

#### 4.3.1.4 Stratification and Mixing

Deep lakes at temperate latitudes develop relatively predictable patterns of water temperature each year. Water temperatures vary with depth in response to seasonal changes in atmospheric temperatures and radiant heating. There are significant differences in the water temperature of Cayuga Lake during the stratified period (June through November), in both horizontal and vertical dimensions. Differences in the vertical dimension are pronounced, due to solar radiation to the lake surface, wind patterns, poor heat conductance of water, and depth and morphometry of the lake basin. Differences in the horizontal dimension are present, although less evident, due to tributary inflows, effluent discharges, return of noncontact cooling water, and localized microclimatic differences (Stearns & Wheler 1997).

Considering winter as the beginning of the annual cycle, Cayuga Lake water temperature and density are relatively uniform throughout the water column. Water reaches its maximum density at 4 °C (39 °F). Without density stratification, winds are able to mix the lake waters from top to bottom, north to south.

As the sun's energy increases in spring, the lake gains heat and the upper waters begin to warm. Heating causes the water to expand and warmer less dense water floats on top of the cooler water. More work is needed for winds to overcome density stratification and mix warmer water throughout the water column. Depending on meteorological conditions (in particular, solar radiation and wind) Cayuga Lake alternates between isothermal and weakly stratified conditions.

By June of a typical year, Cayuga Lake waters stratify into the three layers associated with classic thermal stratification: warm upper waters (epilimnion), cool lower waters (hypolimnion) and a transition layer between the two (metalimnion, which includes the thermocline). The thermocline is defined as the plane in the metalimnion exhibiting maximum rate of change in temperature with depth. Density differences during stratification are strong enough to impede wind-induced mixing between the epilimnion and hypolimnion; the hypolimnion remains isolated from the atmosphere. The extent of mixing in the spring influences the temperature of the hypolimnion for the rest of the year. In some years, the lake warms quickly and lower waters are isolated relatively early, leading to colder temperature in the hypolimnion. In years with cool, windy springs the lake stratifies later and the temperature of the bottom waters is warmer. The temperature of the hypolimnion varies between 4.1 °C and 5.5 °C (Oglesby, 1978).

Detailed thermal measurements of the hypolimnion obtained between 1994 – 1996 were consistent with this reported range (Table 4.3.4).

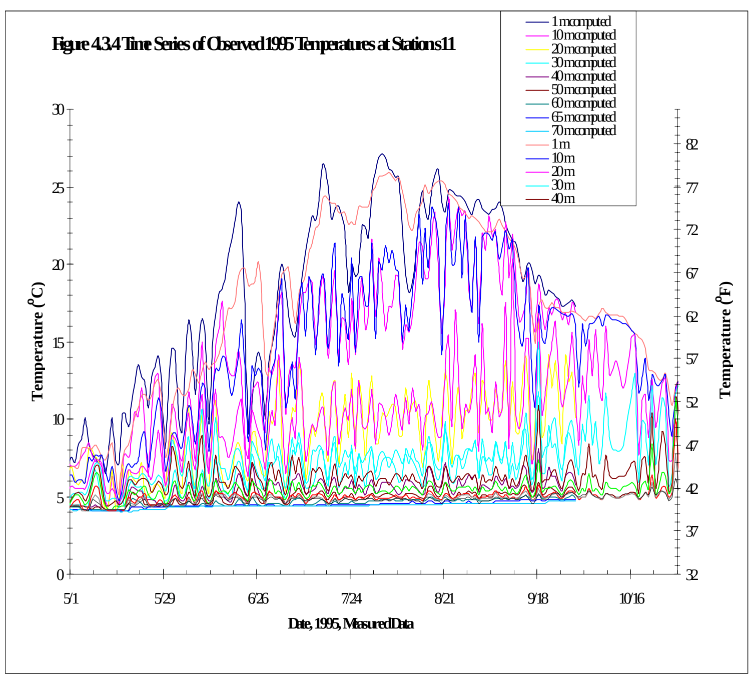
| Table 4.3.4. Water Temperature in Hypolimnion, Cayuga Lake | | | |
|---|---|---|---|
| | **1994** | **1995** | **1996** |
| Depth | 60 m | 70 m | 70 m |
| Period of Measurement | September - December | May - November | May - November |
| Mean Temp °C (°F) | 4.55 (40.2) | 5.0 (41) | 4.3 (39.7) |
| Maximum Temp °C (°F) | 5.97 (42.7) | 5.9 (42.6) | 5.5 (41.9) |
| Standard Deviation | 0.22 | 0.48 | 0.57 |
| Source: Stearns & Wheler 1997 | | | |

By August, Cayuga Lake ceases to gain heat and the waters begin to cool. The cooling process is manifested in a steady deepening of the epilimnion and gradual decrease in its temperature. As the epilimnion cools, the metalimnion warms due to wind-induced mixing of warmer surface waters deeper into the lake. Heat loss continues through the fall. Eventually, the temperature of the upper water cools to the temperature of the hypolimnion, and thermal stratification breaks down. There is no density impediment to complete mixing of the lake by winds. During most winters Cayuga Lake remains well mixed and essentially isothermal; stratification is rare and transient.

The annual thermal cycle of Cayuga Lake is illustrated in Figure 4.3.4. This is a plot of water temperature recorded every 15 minutes at 10-m depth intervals in southern Cayuga Lake. Note that on May 1, 1995 there was very little temperature difference between the depths; temperature varied from 4 – 7 °C. Warming of the upper waters is evident as the summer progressed. Water temperature at the surface was above 26°C by July, while the temperature below 50 – 60 meters remained relatively constant. Cooling was evident after August. In the late fall, distinctions between the water layers broke down as cooler water mixed deeper into the lake (Stearns & Wheler 1997)

#### 4.3.1.5 Hydrodynamic Motions (Currents, Seiches and Waves)

In Cayuga Lake, water moves primarily in response to winds. The long fetch of the lake and the steep-sided valley combine to channel winds down the lake surface. Wind action on the lake's surface causes circulation and mixing of the lake water. Three types of hydrodynamic motions are evident in response to the wind-induced turbulence created at the water surface: wind-induced drift current, internal seiche oscillations, and internal waves (Stearns & Wheler 1997).




Wind-induced drift current is created by wind blowing over the water surface, moving surface water in the direction of the wind at a rate two to three percent of the wind speed. A return current flows beneath the water surface in the direction opposite the wind. During unstratified conditions, the return current may be found at any depth in the water column.

During stratified conditions, the return flow is relatively shallow, restricted to the upper waters and metalimnion. The return flow moves at its highest velocity, half the velocity of the surface flow (one to one and one-half percent of wind speed), at the depth of the thermocline (Sunderam et al. 1969).

As the wind-induced drift current moves water in the direction of the wind, a slight tilt in the water surface is created. This tilt deepens the epilimnion and causes a slight depression in the metalimnion. In response, the metalimnion at the opposite end of the lake tilts upward. The tilt remains stable as long as the wind maintains its velocity and direction. When the wind stops or changes, the force maintaining the tilt is removed, causing the water to rock (oscillate) in the lake basin. These oscillations are called seiches.

Amplitude of the seiche oscillation in Cayuga Lake increases linearly towards the northern and southern ends of the lake. The effect of seiche activity on the lake's thermal structure is evident in Figure 4.3.4. Data measured at 10 and 20 meters show a pronounced periodicity in temperature. Note how the oscillations in temperature are dampened as the lake water deepens; only rarely are the temperature fluctuations so prominent in the shallow water evident at depths below 50 meters. Fluctuations in temperature of deeper water are more evident during fall when thermal stratification is weakening.

The third type of water motion in Cayuga Lake is the progressive internal wave, where all water moves through the same distance, differing only in phase. These waves are created by irregularities in the lake bottom profile or short-term atmospheric disturbances. Sunderam et al. (1969) reported the presence of internal waves in Cayuga Lake with a short period (5 minutes) during stratified conditions.

Two investigations of lake currents have been completed in recent years. As part of an environmental analysis of relocating the outfall of the Ithaca Area Wastewater Treatment Plant from Cayuga Inlet to southern Cayuga Lake, Dr. William Ahrnsbrak of Hobart William Smith Colleges installed a current meter near the proposed location. For the period between May – September 1985 lake currents in this region were very slow. The mean scalar current speed was 2.12 cm/sec. More than 50% of the observations had current speed less than 2 cm/sec and more than 80% of the observations had current speed less than 5 cm/sec (Ahrnsbrak 1986).

The current meter deployed in southern Cayuga Lake recorded water temperature as well. There were significant fluctuations in water temperature in southern Cayuga Lake that appear to be associated with movement of much colder water from deeper in the lake. Ahrnsbrak (1986) concluded that these incursions of lake water probably represent fairly complete flushing of the shallow southern lake basin. Based on the detailed temperature data collected in 1995, seiche activity is the likely explanation for the periodic abrupt changes in water temperature.

The second effort to quantify currents in Cayuga Lake was made as part of the environmental impact assessment and design phase of the LSC project. John E. Edinger Associates Inc. (JEEAI) applied the hydrodynamic model CE-QUAL-W2 to Cayuga Lake to examine any potential changes in the lake's temperature, mixing, or stratification. The model is constructed by dividing Cayuga Lake into a series of grid cells and tracking the transfer of water and heat between the cells. A ten-year simulation was run using site-specific streamflow and meteorological data from 1986 – 1995. Model performance was verified using the continuous 1995 temperature data measured in Cayuga Lake. Model accuracy for Cayuga Lake was confirmed through statistical comparisons of predicted and observed temperature data (Stearns & Wheler 1997).

Results of the hydrodynamic model can also be used to examine current velocity in each grid cell. LSC design engineers were interested in current velocity near the lake bottom along the route of the intake pipeline, to calculate the amount of anchoring required. Project scientists were interested in near-bottom currents in the region of the LSC intake to estimate potential for scour and entrainment of aquatic organisms. Results of the model simulation indicate that current velocity in the region of the LSC intake is on the order of 1.5 – 1.8 cm/sec. Higher velocities (in the range of 6 – 7 cm/sec) are typically northward (towards the lake outlet). A histogram of current velocity near the lake bottom at a depth of 75 m as predicted by the JEEAI model is included as Figure 4.3.5. Note that positive values are towards the north and negative values are towards the south.

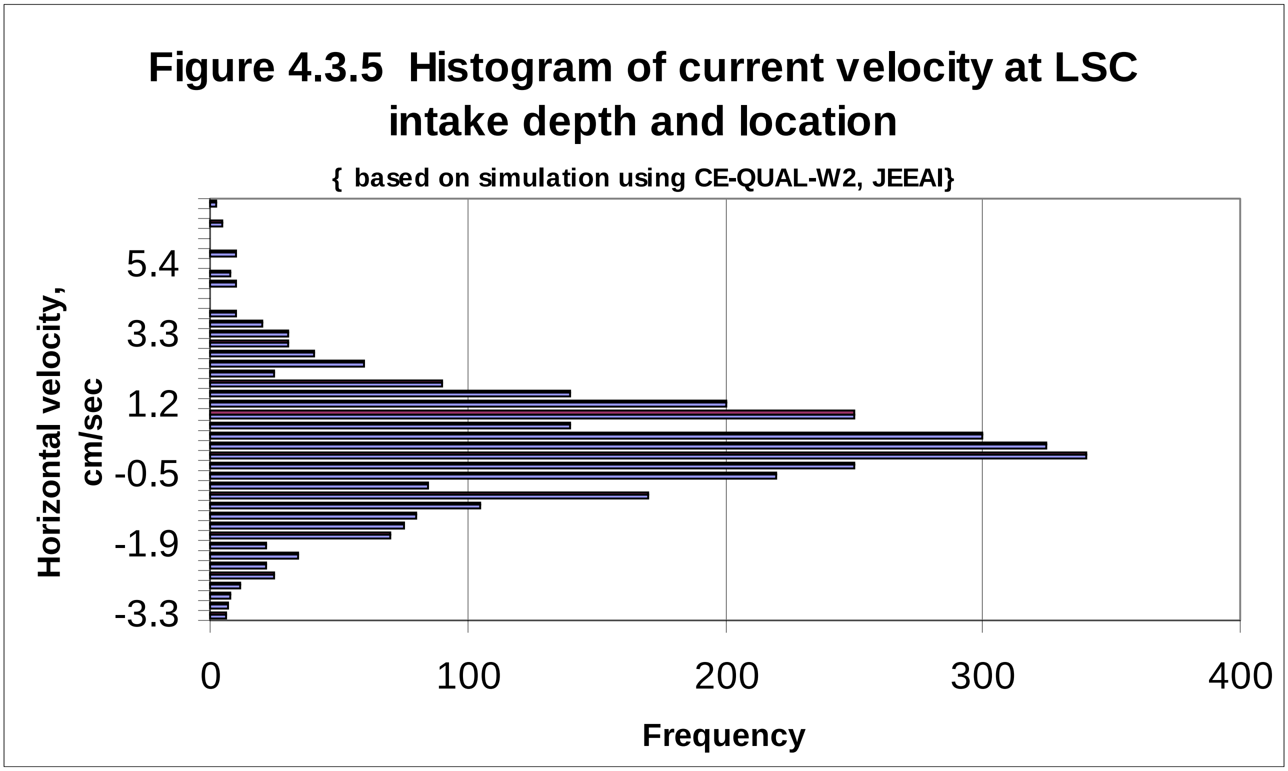


Figure 4.3.5 Histogram of current velocity at LSC intake depth and location
{ based on simulation using CE-QUAL-W2, JEEAI}
Horizontal velocity, cm/sec
5.4
3.3
1.2
-0.5
-1.9
-3.3
0
100
200
300
400
Frequency

#### 4.3.1.6 Light Penetration

Light penetration through the water column is one of the most important physical factors affecting distribution and abundance of phytoplankton and macrophytes (rooted aquatic plants and algae). Materials dissolved and suspended in water act to absorb and scatter incident radiation. As reported in Oglesby (1978) several investigators have measured light penetration through the water column of Cayuga Lake and used the results to calculate an extinction coefficient. Data on solar radiation and extinction coefficients were calculated by Peterson; a modified Table 17 from Oglesby (1978, pg. 46) is included as Table 4.3.5. The higher values of light extinction correspond to shallower light penetration through the water column. Light extinction in water is described by Beers Law, $I_z = I_0 * e^{-CZ}$ where $I_0$ is light intensity (irradiance) at the water surface, $I_z$ is irradiance at depth z, and c is the light extinction coefficient.

**Table 4.3.5** Light Extinction Coefficients Measured in 1968 – 1970

| **Month** | **Light Extinction Coefficient (N= number of observations)** |
|---|---|
| January | 0.250 (N=1) |
| February | 0.292 (N=1) |
| March | 0.250 (N=1) |
| April | 0.463 (N=2) |
| May | 0.301 (N=4) |
| June | 0.370 (N=3) |
| July | 0.854 (N=4) |
| August | 0.598 (N=10) |
| September | 0.403 (N=4) |
| October | 0.321 (N=2) |
| November | 0.286 (N=3) |
| December | No observations |
| Source: Ogelsby 1978 (pg. 46) | |

Additional measurements of light extinction were made during the environmental investigations for the LSC project. These data (summarized in Table 4.3.6) indicate that the light extinction coefficient is higher in shallower waters, where light is scattered by phytoplankton, than in deeper waters (Stearns & Wheler 1997).

Upstate Freshwater Institute measured wavelength-specific light extinction coefficients in June 1996 as part of the LSC field program. An underwater spectroradiometer (irradiance meter) was used to measure intensity of light of different wavelength through the water column.. Data are presented in two depth categories: the surface layer 0.5 – 4.5 m depth) and a subsurface layer (to 23 m). Approximately 98% of the surface illumination was attenuated within 4.5 m. Wavelengths between 500 and 600 nm had the lowest extinction coefficient; this portion of the visible spectrum penetrates deepest into the lake water.

**Table 4.3.6 Light Extinction Coefficients by Depth* Measured in 1996**

| **Date Sampled** | **0-10 m** | **11-20 m** | **21-30 m** | **Greater than 30 m** |
|---|---|---|---|---|
| 6/12/96 | 0.464 | 0.408 | 0.380 | Not measured |
| 6/20/96 | 0.721 | 0.386 | 0.340 | 0.236 |
| 7/24/96 (*near LSC Intake*) | 0.667 | 0.583 | Not measured | Not measured |
| 7/24/96 (*off Myers Point)* | 0.584 | 0.447 | 0.397 | Not measured |
| 8/21/96 *(1400 hours)* | 0.388 | 0.397 | 0.384 | Not measured |
| 8/21/96 *(1640 hours)* | 0.489 | 0.424 | 0.356 | 0.326 |

*Each reported extinction coefficient is the average of data obtained at 1 m depth intervals.

Unless specified, measurements were obtained in mid-basin, Southern Cayuga Lake near Station S-11.

Source. Stearns & Wheler 1997. Appendix C-2 (Volume 2)

Secchi disk transparency (SDT) is another measure of light penetration in water. SDT is easily measured and is used by lake managers as a rapid index of water clarity that is easily compared over time and among lakes. Historical SDT data for Cayuga Lake including 1910 measurements of Birge and Juday were compiled by Wright and compared with measurements he made in 1968. No statistically significant trend in SDT was detected when data were stratified into twoweek time periods by location.  However, when comparable data were available, SDT values measured after 1950 tended to be lower than values measured from 1910 – 1927 (Oglesby 1978).

SDT measurements in southern Cayuga Lake were obtained in 1994 – 1996 as part of the LSC field program. These data (summarized in Table 4.3.7) indicate that the lake water is more turbid closer to shore, as a result of tributary inflows and resuspension of bottom sediments.  The recent invasion of Cayuga Lake by the zebra mussel (*Dreissena polymorpha*) is likely to affect water clarity. These benthic organisms filter water and remove particles, thus increasing water clarity.

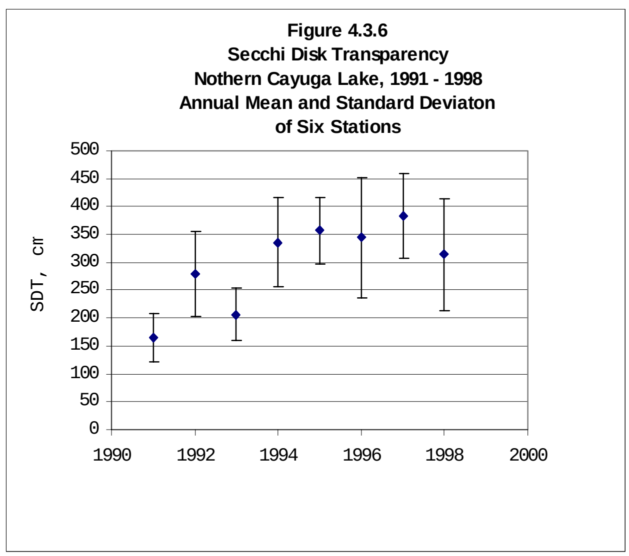
**Table 4.3.7** Recent Secchi Disk Transparency Data

| | **Southern Basin, Class A (nearshore)** | Southern Basin *Class A* **(mid-basin)** | **Northern basin Class B(T) (nearshore)** | **Northern basin Class A(T) (mid-basin)** |
|---|---|---|---|---|
| Years of measurement | 1994 – 1996, 1998 | 1994 – 1996, 1998 | 1991 – 1998 | 1991 – 1998 |
| Summer average SDT (meters) | 1.8 m (site P2) | 2.3 m (site S11/P4) | 2.7 m (site 1) | 3.4 m (sites 5 and 6) |
| Standard deviation | 0.52 | 0.82 | 0.90 | 1.3 |
| Number of observations N | 24 | 24 | 60 | 95 |
| Percent of observations at lake bottom | 0% | 0% | 48% | 6% |
| Program and reference | Lake Source Cooling Stearns & Wheler 1997 Cornell Utilities 1999 | | Makarewicz et al. 1999 Seneca County Aquatic Vegetation Control Program | |

The Seneca County Soil and Water Conservation District has routinely monitored SDT in a network of six shallow sites in the northern basin since 1991.  These data also demonstrate an improvement in water clarity after 1993 (Figures 4.3.6 and 4.3.7). The number of sites with light penetration to the lake bottom (sediment surface) has increased from less than 10% in 1991 – 1993 to greater than 50% after 1995.

#### 4.3.1.7 Sedimentation rate and sediment texture

Cayuga Lake sediments are mixtures of fluvial silts, sand, clay, gravel, shale fragments, and detrital organic material.  Sediment composition at any given site reflects the nature and proximity of tributary inflows coupled with the lake's hydrodynamic regime. Coarser texture sediments (larger particle size) tend to be present closer to the shoreline and near the mouths of tributaries. Preliminary analysis of sediment cores obtained in 1994 suggests that coarser sediments are being trapped in the shallow water complex of inlets and shelf (Karig et al. 1996).




Sediment deposition in the lake is variable along the north-south axis, with higher rates in the southern basin reflecting the large hydrologic input from tributaries and the mixture of land use in the

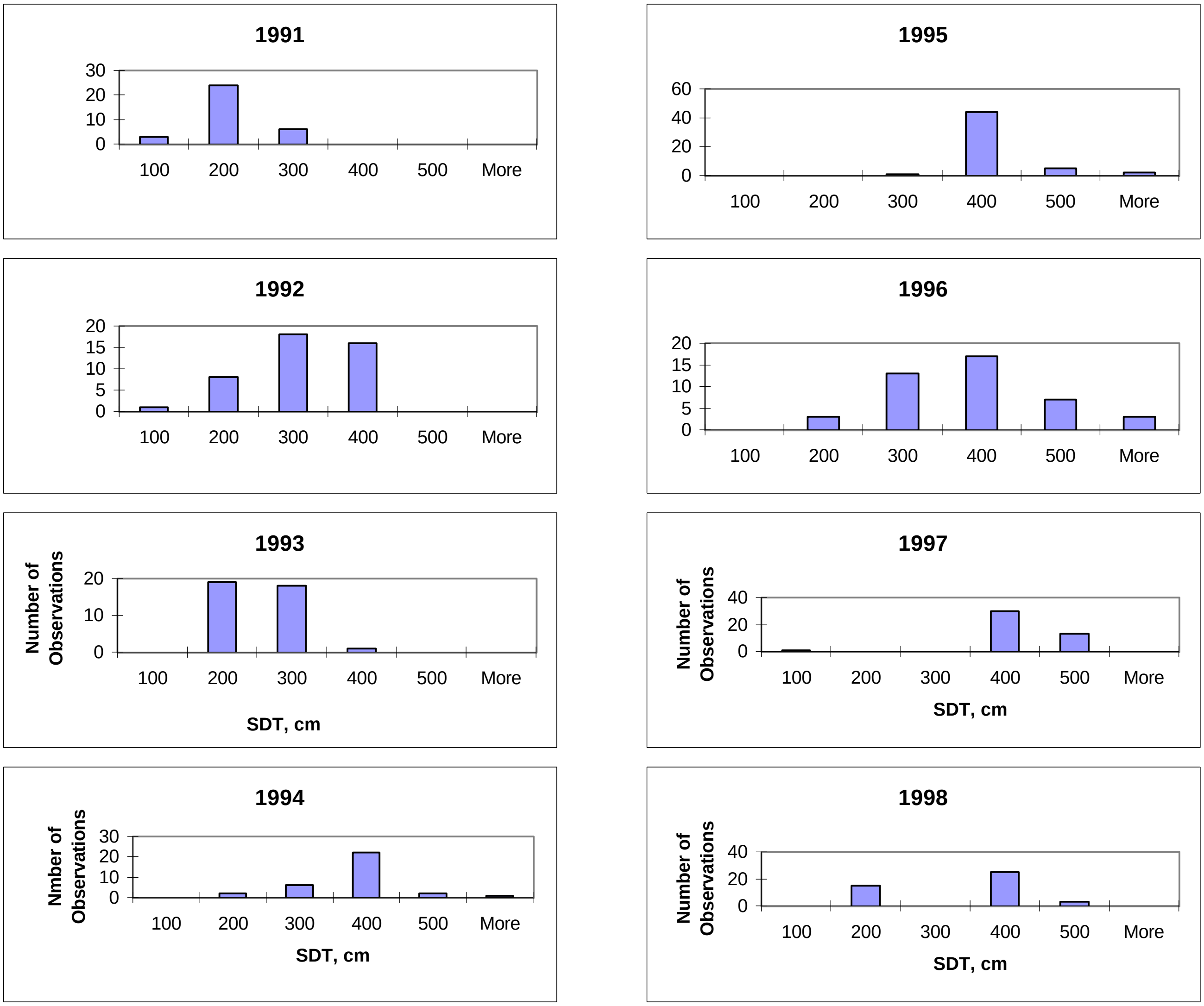



Figure 4.3.7. Histogram of Secchi disk transparency data, northern Cayuga Lake.

Source: Seneca County Soil and Water Conservation District subwatersheds. The estimated sedimentation rate ranges from 0.2 – 1.6 cm/yr (Yaeger 1999).

There have been several investigations of sediment quality in southern Cayuga Lake. The Environmental Measurements Laboratory of the U.S. Dept. of Energy and the Center for Climatic Research investigated the distribution of polycyclic aromatic hydrocarbons in lake sediment cores to assess changes in atmospheric transport and deposition in relation to fossil fuel combustion (Heit et al. 1986). The sediment cores were dated and peaks of polycyclic aromatic hydrocarbons were linked to forest clearing and coal combustion.

As part of the environmental impact assessment of the proposed Bell Station, New York State Electric and Gas collected sediment cores along the southeastern shoreline, in the region of Milliken Station (NUS 1973). In 1973, Al Vogel collected 33 samples of surficial sediments in the lake's littoral zone and analyzed them for texture (particle size distribution), pH, percent organic matter and major nutrients. He determined that littoral zone sediments are composed of 10 – 20% clay, 45 – 80% silt, and up to 80% sand (Vogel 1973).

Ludlam (1964) collected samples of Cayuga Lake sediments and determined that distinct banded pairs (varves) were present in core samples. The pairs of bands were approximately 2 cm thick in the top 1.5 m of lake sediment, and were considered to represent an annual deposition cycle.

A cooperative sediment coring effort was carried out in 1994. Researchers from USGS, Cornell University, Hobart William Smith Colleges, Tompkins County Water Quality Coordinating Committee, Syracuse University, and the U.S. Dept. of Energy participated in this effort. Cores were obtained throughout the lake and analyzed for geochemical composition, sediment texture, presence of microfossils, and sedimentation rate (dating). Results were presented at a symposium in October 1999.

### 4.3.2 Chemical Characteristics of Cayuga Lake

#### 4.3.2.1 Ionic composition, pH, alkalinity

Cayuga Lake waters are moderately hard and well buffered, consistent with the predominance of calcareous parent material and soil in the watershed. Bicarbonate alkalinity is approximately 100 – 110 mg/l as $CaCO_3$. Major anions include chloride and bicarbonate, with relatively low amounts of sulfate; major cations include calcium and sodium, with relatively low concentrations of potassium and magnesium (Figure 4.3.8). Specific conductance, which is an indicator of total dissolved salts, is consistently in the range of 380 – 480 μmhos/cm in the lake's open waters, away from the influence of tributary and wastewater inflows (Stearns & Wheler 1994). Measurements in 1969 indicated significant seasonal and spatial variability in specific conductance, attributed to tributary and groundwater inflows (Oglesby 1978). Specific conductance of the epilimnion increased from 475 μmhos/cm in July to nearly 600 μmhos/cm in October. Increases with depth were also noted.

Chloride concentrations in surface waters reflect underlying geology, proximity to oceans, extent of road salting practices in the watershed, and any industrial or municipal discharge. Chloride concentrations in Seneca and Cayuga Lakes are elevated compared with the other Finger Lakes, and also compared with chloride concentrations in tributaries to these lakes. Likens (1974) reported a significant chloride imbalance in Cayuga Lake; export of chloride from the lake was 95% higher than the sum of the influents. The data indicate a significant

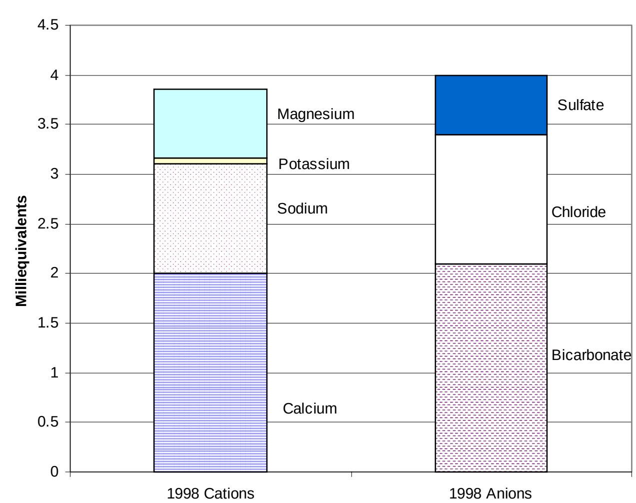
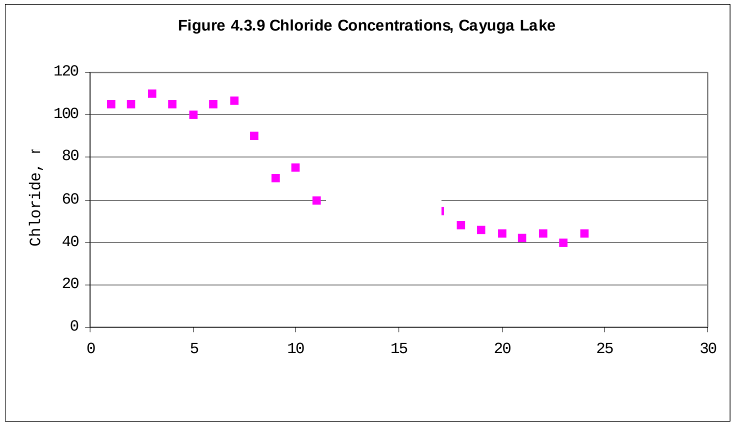



**Figure 4.3.8. Charge Balance, Cayuga Lake (1998 Data)**

source, or sources, of chloride within the lake basin.

Several hypotheses have been advanced to explain the elevated chloride levels. Berg (1966) considered that saline groundwater might enter Cayuga and Seneca Lakes, based on the depth of the lake bottoms. Wing et al. (1995) measured elevated sodium chloride (NaCl) concentrations in sediment pore water (concentrations as high as 30% NaCl) and concluded that the NaCl in interstitial water was due to intrusion of saline groundwater from underlying Silurian evaporites.




1965-85: Effler, et. al. 1989, 1994: Sterns & Wheler. 1997, 1999 Southern Cayuga Lake Intermunicipal Water Commission

However, the concentration of chlorides in Cayuga Lake have been decreasing since 1970 (Figure 4.3.9) which corresponds to the virtual elimination of an industrial discharge of chlorides from the salt mining operation at Portland Point. Effler et al. (1989) modeled Cayuga Lake chloride concentrations and concluded that concentrations would continue to decline to steady-state (approximately 32 mg/l by the year 2000) as lake water is gradually replaced by precipitation and runoff. Chloride levels in 1987 averaged 46 mg/l (Effler et al. 1989); in 1994 chloride averaged 41 mg/l (Stearns & Wheler 1997). Southern Cayuga Lake Intermunicipal Water Commission reported average chloride concentration of 44 mg/l between January and July 1999. Elimination of the point source of chlorides reduced ambient lake water concentrations since 1970. However, groundwater intrusion does appear to be a continuing source.

Measurements of pH vary both diurnally and seasonally, but are consistently in the alkaline range. The highest pH values (in the range of 8.5 – 8.85) are measured in the upper waters during summer periods of algal activity as $CO_2$ is incorporated into biomass during photosynthesis. In the lower waters, where organic material is decomposed and $CO_2$ released, values between 7.2 and 7.9 have been reported (Stearns & Wheler 1997).

**4.3.2.2 Major nutrients**

*Phosphorus*. In the vast majority of lakes in the Northeast, phosphorus is the most important nutrient limiting the growth of algae suspended in the water column. Given favorable light and temperature conditions, algal growth continues until the supply of phosphorus is depleted. Phosphorus has been established as the limiting nutrient for algal growth in Cayuga Lake (Peterson, Barlow and Savage, 1974). The supply of phosphorus to Cayuga Lake depends on natural processes and human activities within the watershed such as erosion, fertilization, and discharge of wastewater. Sources of wastewater are discussed in Chapter 3.

Scientists and lake managers classify lakes according to their level of productivity (abundance of algae, plants, and other aquatic life forms) on a scale of "trophic state". Oligotrophic lakes are nutrient-poor and low in productivity. Eutrophic lakes are well supplied with nutrients and support an abundance of algae and plants. Excessive algae will make a lake appear turbid or green, and diminish its attractiveness for recreational use. Decay of algae and aquatic plants reduces the concentration of dissolved oxygen in a lake's lower waters. Mesotrophic lakes are intermediate in nutrient supply and algal abundance.

Concentrations of phosphorus have been measured in Cayuga Lake and its tributaries at irregular intervals since the 1960s. Several fractions of phosphorus (P) have been measured: total phosphorus (TP), total soluble phosphorus (TSP) and soluble reactive phosphorus (SRP, equivalent to molybdate reactive phosphorus or MRP) are most common. These fractions of phosphorus are operationally defined by sample handling and analytical methodologies. TP is all the P in an unfiltered sample that reacts with the chemical reagent molybdate after the sample has been digested. It includes P incorporated into algal biomass or adsorbed to soil particles. TSP is all the P in a filtered (or centrifuged) sample that reacts with molybdate after digestion. SRP (or MRP) is all the P in a filtered sample that reacts with molybdate, without digestion. SRP includes dissolved inorganic P, some P associated with

TABLE 4.3.8

Historical Measurements of Summer and Winter Phosphorus Concentrations
Cayuga Watershed Characterization Report

| Year | Investigator | Station | Summer (June – September) | | | Winter | | |
|---|---|---|---|---|---|---|---|---|
| | | | **Average TP µg/l (0 – 10 m)** | **N** | **Std Error of mean** | **Average TP (Water Column)** | **N** | **Std Error of mean** |
| 1968 | Peterson | Myers Pt. | 20.2 | 19 | Not reported | Not measured | - | - |
| 1969 | Peterson | Myers Pt. | 15.3 | 22 | Not reported | Not measured | - | - |
| 1970 | Peterson | Myers Pt. | 14.0 | 32 | Not reported | Not measured | - | - |
| 1972 | EPA | Myers Pt. | 18.8 | 22 | 0.87 | 20.7 | 5 | 2.4 |
| 1973 | P. Godfrey | Myers Pt. | 14.5 | 88 | 0.71 | 22.2 | 3 | Not reported |
| 1994 | LSC | mid-southern lake basin | 22.4 | 12 | 8.4 | Not measured | - | - |
| 1995 | LSC | mid-southern lake basin | 16.3 | 12 | 1.0 | 15.7 | 15 | 1.6 |
| 1996 | LSC | mid-southern lake basin | 13.2 | 12 | 1.3 | 21.7 | 16 | 0.97 |
| 1998 | LSC | mid-southern lake basin | 17 | 7 | 1.9 | Data not available | - | - |
| 1991 | Makarewicz | Northern basin | 15.5 | 6 | 2.0 | Not measured | - | - |
| 1992 | Makarewicz | Northern basin | 9.1 | 9 | 1.1 | Not measured | - | - |
| 1993 | Makarewicz | Northern basin | 16.6 | 7 | 1.6 | Not measured | - | - |
| 1994 | Makarewicz | Northern basin | 9.1 | 8 | 2.5 | Not measured | - | - |
| 1995 | Makarewicz | Northern basin | 7.4 | 9 | 1.0 | Not measured | - | - |
| 1996 | Makarewicz | Northern basin | 13.1 | 9 | 1.4 | Not measured | - | - |
| 1997 | Makarewicz | Northern basin | 10.4 | 8 | 0.7 | Not measured | - | - |
| 1998 | Makarewicz | Northern basin | 11.5 | 8 | 3.5 | Not measured | - | - |

*References:*

*Peterson, Bruce. 1971. The role of zooplankton in the phosphorus cycle of Cayuga Lake. Ph.D. thesis, Cornell University. Ithaca, NY*

*Godfrey, Paul. 1977. Spatial and temporal variation in the phytoplankton in Cayuga Lake. Ph.D. thesis, Cornell University. Ithaca, NY*

*EPA. 1974. Report on Cayuga Lake: Cayuga, Seneca, and Tompkins Counties, New York. USEPA Region 2. Working paper 153. EPA National Eutrophication Survey.*

*Makarewicz, J. M. et al. Water quality of Cayuga Lake, 1991 – 1998. Prepared for Seneca County Soil and Water Conservation District.*

µg/l micrograms per liter
TP total phosphorus

small particles, and some organic P which reacts with molybdate. Most investigators consider SRP to represent biologically available P, that is, readily taken up by algal cells.

Results of P monitoring conducted through the 1970's are presented in Oglesby (1978). Additional data have been collected as part of graduate theses, special research programs, the Aquatic Vegetation Control Program, and in support of the environmental impact assessment of Cornell's LSC initiative. In May 1996, NYSDEC began a long-term monitoring program of 11 Finger Lakes for limnological parameters, including measurements of TP, TSP and SRP through the water column at the lakes' deepest point. Data from the NYSDEC monitoring program will be available in mid-2000.

Direct comparisons of historical and recent data are complex, even when equivalent fractions of P have been measured. The objectives and design of each monitoring program differ. Samples have been collected at various depths, stations, and time intervals. Three measures of P in Cayuga Lake are relevant to this analysis of trophic status and use impairment. First, summer average TP in the upper waters is used to assess compliance with NYSDEC guidance value for phosphorus in lakes, based on aesthetics. Second, TP concentration in the winter indicates the supply of TP throughout the water column and appears to be correlated to algal abundance the following summer (Dillon and Rigler 1974). Third, SRP profiles with depth indicate the uptake of phosphorus from the upper waters during algal growth, and any accumulation of SRP in the lower waters as algal cells are decomposed.

Summer average TP measured at a mid-lake station at one-meter depth is used as an index of a lake's trophic state and suitability for use in water supply and recreation. NYSDEC has adopted a guidance value for TP in lakes of 20 μg/l summer average (defined as the four months of June – September). This guidance value was derived from opinion survey data relating measured TP to perceived water quality for recreational use. Table 4.3.8 summarizes historical and recent TP data in the upper waters. Note that phosphorus concentrations are higher in the northern and southern basins as compared to the mid-lake station.

Winter or early spring TP data are also summarized in Table 4.3.8. The range of concentrations indicates that Cayuga Lake is mesotrophic, exhibiting moderate levels of primary productivity. The third index, phosphorus concentrations measured at discrete depths through the water column (profiles), is also typical of a mesotrophic lake. As summarized in Table 4.3.9 SRP concentrations are variable with depth. Concentration at any time is a dynamic balance between many biological and physical processes. Overall, the concentration of SRP in the upper waters tends to decrease as the lake warms each year, thermal stratification develops, and phytoplankton grow in the upper waters. The concentration of SRP in the lower waters tends to increase as algae settle through the water column and are decomposed.

As discussed below in the section on dissolved oxygen, Cayuga Lake remains well-oxygenated throughout the stratified period. Dissolved oxygen levels remain above 70% of saturation even in the deepest waters throughout the year. In contrast with other mesotrophic lakes, regeneration of P from bottom sediments is not an additional (internal) source of P. The well-oxygenated hypolimnion and iron-rich sediments prevent diffusive flux of SRP to the hypolimnion.

Table 4.3.9 Soluble Reactive Phosphorus (SRP), μg/l, Profiles Measured in Cayuga Lake, 1968 – 1969

| **Depth (m)** | **1968** | | | | | | | | | **1969** | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **July** | | **August** | | **Sept.** | **Oct** | | **Nov** | | **Jan** | **Feb** |
| | **1-2** | **15-16** | **1-2** | **19-20** | **19-20** | **16-17** | **29-30** | **11-14** | **26** | **21** | **17** |
| 00-09 | 2.1 | 3.7 | 2.1 | 1.3 | 1.0 | 1.0 | 1.4 | 1.8 | 4.7 | 12.2 | 11.4 |
| 10-19 | 3.5 | 3.3 | 2.0 | 3.2 | 2.6 | 1.2 | - | .6 | - | - | - |
| 20-29 | 3.2 | 4.5 | 3.5 | 4.0 | 1.4 | 1.3 | 2.1 | 5.7 | - | - | - |
| 30-39 | 4.5 | 5.4 | 5.8 | 6.0 | 5.7 | 3.1 | 2.0 | 7.3 | 6.1 | 16.0 | 12.7 |
| 40-49 | | 6.2 | 7.2 | 6.2 | 6.0 | 6.6 | 3.6 | 4.4 | 6.4 | 12.5 | 10.3 |
| 50-59 | | | 8.3 | - | - | 9.6 | 8.8 | 8.1 | - | - | 12.1 |
| 60-69 | | | 10.7 | 11.4 | 10.8 | 13.3 | - | 10.0 | 11.7 | 13.1 | 13.0 |
| 70-79 | | | 13.1 | 12.9 | 10.5 | - | 13.1 | 17.7 | 9.8 | 12.2 | 12.6 |
| 80-89 | | | | | 10.2 | 14.0 | 13.7 | 20.1 | - | - | - |
| 90-99 | | | | | 9.7 | | 17.9 | 21.9 | 13.4 | 12.7 | 11.6 |
| 100-109 | | | | | | | | | 15.9 | 12.9 | 12.7 |

Source: Ogelsby 1978 (pg. 52)
μg/l micrograms per liter

*Nitrogen*, another macronutrient for plant and algal growth, is detected at relatively high concentrations in Cayuga Lake. Oglesby reports that nitrate N is found consistently at all stations, all depths, throughout the year at an average concentration of 1 mg/l (Oglesby 1978). Data collected in 1994 for the LSC investigations were consistent with the historical data. Ammonia N concentrations are variable spatially in the lake, with elevated concentrations in regions of the southern lake basin directly affected by outfalls from the two wastewater treatment plants (Stearns & Wheler 1997; Moran 1984).

The ratio of nitrogen to phosphorus in lakes is used to predict the relative competitive success of phytoplankton groups. Nitrogen-fixing cyanobacteria (blue-green algae) are reported to be favored when the ratio of total N to total P decreases; nitrogen-fixing blue-greens are rare when the ratio exceeds 29:1 (Smith 1983). On a molar ratio basis, cyanobacteria generally comprise less than a few percent of phytoplankton biomass when the total N: total P ratio exceeds 65:1 (Howarth et al. 1988). The N:P ratio in Cayuga Lake is well over 100:1, indicating that nitrogen-fixing blue green algae are not favored. As discussed in the section on phytoplankton, cyanobacteria comprise only a small proportion of the algal community. The dominant species of cyanobacteria present in Cayuga Lake are not nitrogen-fixing organisms.

**4.3.2.3 Trace metals and micronutrients**

There are limited data on trace metals and micronutrients in Cayuga Lake. When substances are present in trace concentrations it can be difficult to differentiate ambient concentrations from contamination of sampling equipment or bottles, atmospheric deposition in the field or laboratory, or impurities in laboratory reagents. Based on an evaluation of historical data collected throughout the United States, limit of detection and contamination problems limit the quality of historical data for the metals cadmium, copper, lead, nickel, silver, zinc, and mercury (Windom et al. 1991). Analytical methods for monitoring metals in water and wastewater are inadequate for determining ambient concentrations of some metals in some surface waters (EPA Office of Water, October 1993).

Historical Cayuga Lake water column metals data (prior to the late 1980s) should be considered “estimated” due to these limit of detection and contamination problems. The NYSDEC Finger Lakes monitoring program analyzes water samples for selected metals. These data will be available in mid-2000.

The Southern Cayuga Lake Intermunicipal Water Commission operates the Bolton Point water supply. This agency serves the towns of Ithaca, Dryden, and Lansing and is a back-up supply to Cornell University and the City of Ithaca. The commission measures a suite of inorganic parameters in Cayuga Lake water as part of their permit-required monitoring of the public water supply. These data, summarized in Table 4.3.10, indicate that concentrations of metals in the water column are low.

Table 4.3.10 Summary of Monitoring Data for Inorganic Parameters, Bolton Point, 1994 - 1998

| Analyte | Mean Concentration (mg/l) | Number of Detectable Observations |
|---|---|---|
| Arsenic | <0.001 | 0 : 5 |
| Barium | 0.031 | 4 : 5 |
| Antimony | <0.003 | 0 : 3 |
| Beryllium | <0.002 | 0 : 3 |
| Cadmium | <0.001 | 0 : 5 |
| Chromium | <0.001 | 0 : 5 |
| Cyanide | <0.001 | 0 : 2 |
| Fluoride | 0.21 | 3 : 3 |
| Mercury | <0.0004 | 0 : 5 |
| Nickel | <0.01 | 0 : 3 |
| Nitrate | 1.29 | 3 : 3 |
| Selenium | <0.001 | 0 : 5 |
| Sodium | 25.5 | 5 : 5 |
| Sulfate | 28.5 | 20 : 20 |
| Thallium | < 0.005 | 0 : 3 |
| Source: Southern Cayuga Lake Intermunicipal Water Commission, Ithaca NY | | |

**4.3.2.4 Dissolved oxygen**

Dissolved oxygen (DO) concentrations are a significant factor affecting distribution, species composition, and abundance of the biological community. The founder of the science of limnology, G. Evelyn Hutchinson, concluded that a limnologist can learn more about the nature of a lake from a series of oxygen measurements than from any other type of chemical data (Hutchinson 1957). DO concentrations in Cayuga Lake are typical of those of a cold, deep, moderately productive lake (Ogelsby 1978). Variations in DO concentration occur seasonally and with depth.

When Cayuga Lake is stratified into layers of different temperature and density (thermal stratification) DO gradients develop through the water column. Concentrations of DO in the epilimnion (upper waters) are almost always near saturation levels due to atmospheric exchange. During daylight hours in summer, DO can be supersaturated as a result of photosynthesis. The epilimnion is isolated from the hypolimnion (deeper cooler layer) by the transition zone known as the metalimnion. As a consequence, the hypolimnion remains isolated from atmospheric exchange during stratification. The hypolimnion's supply of oxygen is used by aerobic organisms during decomposition of organic material and is not replenished. Oxygen concentrations in the hypolimnion gradually decrease with depth and as the stratified period progresses.

The rate of DO depletion is an important indicator of trophic status. As algal biomass increases the rate of DO depletion increases and DO concentrations can decline in the lower waters. If DO falls below critical levels for aquatic life (4 – 5 mg/l) the habitat for cold water fishes such as salmonids is lost. Cayuga Lake remains well-oxygenated throughout the stratified period. Dissolved oxygen levels remain above critical levels even in the deepest waters during the approximately six months of thermal stratification.

Temperature and DO profiles collected in late August 1995 are included as Figure 4.3-10 to illustrate the DO status of Cayuga Lake. Note the well-defined epilimnion to a depth of 10 m, and the supersaturated DO conditions. The metalimnion extends from the bottom of the epilimnion at 10 m to an approximate depth of 30 m. Below 30 m is the hypolimnion, where temperatures are cool and uniform. Note that DO concentrations remain close to 90% of saturation through the deepest waters.

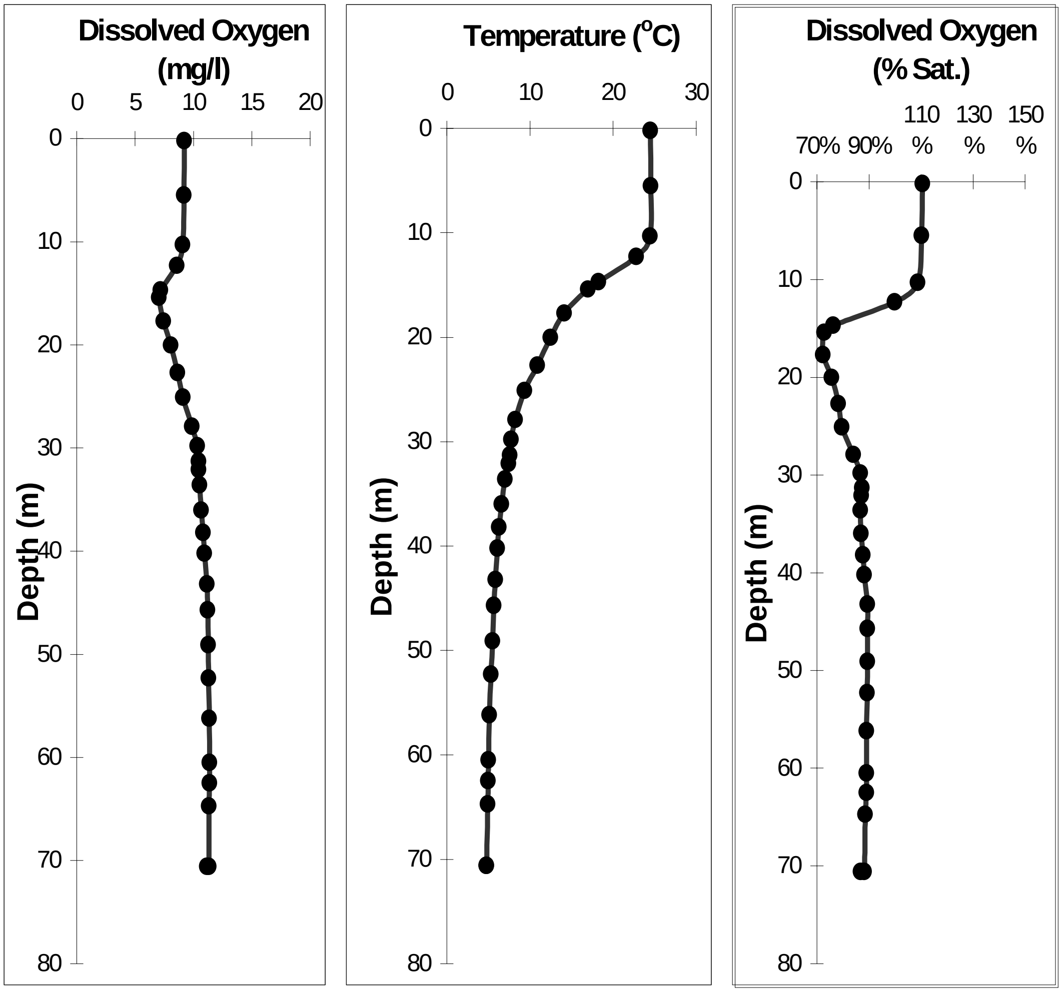
When the lake mixes again late in the year, DO is replenished throughout the water column. Concentrations remain near saturation at all depths until the following summer when the sun's energy once again drives thermal stratification.

There have been no major changes in the DO levels since the earliest measurements obtained in 1910. This important finding is based on intensive investigations of the lake's water quality conducted by NYSDEC, USGS, and researchers from Cornell University.

**4.3.2.5 Concentrations of organic compounds (including pesticides)**

Public suppliers of lake water are required by the NYS Dept. of Health to monitor for a comprehensive list of inorganic chemicals, organic chemicals, particulate matter, and microbiological organisms (pathogens and indicator organisms). In addition to the routine required monitoring, Cayuga Lake is included in several special statewide investigations of pesticides in water. These special investigations are notable for the use of analytical methods with extremely low limits of detection. Pesticide compounds are precisely and accurately measured at concentrations in the part per trillion or nanogram per liter range ($10^{-9}$).

The Bolton Point water supply (managed by the Southern Cayuga Lake Intermunicipal Water Authority) is included in the NYSDEC/USGS statewide survey for pesticides in water. Results of five synoptic surveys of 64 surface water sites throughout NY conducted between May 1997 and July 1998 have been published by USGS. Filtered samples were tested for the presence of 47 pesticides using the analytical techniques with very low limits of detection. Eight pesticides have been detected in the samples collected at Bolton Point (Table 4.3.11). Most of the analytes present are herbicides used on cornfields. Concentrations detected were below any state or federal standard or guidance value developed to protect human health and the environment (Philips et al. 1998).




mg/l: milligrams per liter
% Sat.: percent saturation

FIGURE 4.3.10
DO, TEMPERATURE, AND PERCENT SATURATION PROFILES WITH DEPTH, SOUTHERN CAYUGA LAKE, 8/22/95

| **Table 4.3-11. 1997-1998 NYSDEC/USGS Synoptic Sampling Results<br>Statewide Pesticide Survey: Bolton Point Water Intake** | | | | |
|---|---|---|---|---|
| **Pesticide Detected [1]** | **Number of Detectable Results** | **Maximum Concentration Detected (µg/l)** | **Data Qualifier [2]** | **Ambient Water Quality Criteria or Standard (µg/l) [3]** |
| Simazine | 5/5 | 0.031 | | 0.5 |
| Prometon | 3/5 | 0.004 | E | 50 |
| Metolachlor | 5/5 | 0.066 | | 50 |
| Diethylatrazine | 5/5 | 0.107 | E | 50 |
| DCPA | 1/5 | 0.001 | E | 50 |
| Cyanazine | 5/5 | 0.022 | | 1 |
| Alachlor | 2/5 | 0.003 | E | 0.3 |
| Atrazine | 5/5 | 0.178 | | 3 |

Notes:

5 Samples were analyzed for 47 pesticides on five dates (5/6/97, 7/2/97, 9/9/97, 2/3/98, 7/17/98). Pesticides that were always less than the limit of detection are not reported.

6 Data qualifier of E signifies that the chemical was present below the method detection limit. Identity of the compound is confirmed; concentration is estimated.

7 Lowest value of federal maximum contaminant level, federal lifetime health advisory limit, NY maximum contaminant level, NY standard for Class GA waters, NY surface water quality standard.

Source: USGS Water Resources Report

| **Table 4.3-12. 1997-1998 NYSDEC/USGS Synoptic Sampling Results<br>Statewide Pesticide Survey: Cayuga Lake off Taughannock Park** | | | | |
|---|---|---|---|---|
| **Pesticide Detected [1]** | **Number of Detectable Results** | **Maximum Concentration Detected (µg/l)** | **Data Qualifier [2]** | **Ambient Water Quality Criteria or Standard (µg/l) [3]** |
| Alachlor | 2/3 | 0.005 | | 0.3 |
| Atrazine | 3/3 | 0.239 | | 3 |
| Diethylatrazine | 3/3 | 0.104 | E | 50 |
| Cyanazine | 3/3 | 0.033 | | 1 |
| Metalochlor | 3/3 | 0.120 | | 50 |
| Prometon | 2/3 | 0.006 | E | 50 |
| Propanil | 1/3 | 0.004 | | 7 |
| Simazine | 2/3 | 0.028 | | 0.5 |

Notes:

8 Samples were analyzed for 47 pesticides in 8/96, 9/97 and 7/98. Samples were collected at a 2-m depth. Pesticides that were always less than the limit of detection are not reported.

9 Data qualifier of E signifies that the chemical was present below the method detection limit. Identity of the compound is confirmed; concentration is estimated.

10 Lowest value of federal maximum contaminant level, federal lifetime health advisory limit, NY maximum contaminant level, NY standard for Class GA waters, NY surface water quality standard.

Source: USGS Water Resources Report

NYSDEC and USGS also cooperative on an annual pesticide monitoring program including the 11 Finger Lakes, Oneida Lake, and Onondaga Lake. Cayuga Lake samples were collected at a 2-m depth at the NYSDEC sampling station off Taughannock State Park. Results of the 1996, 1997, and 1998 pesticide testing have been released by USGS. These data (summarized in Table 4.3.12) indicate that the pesticides present in the 2-m depth samples are generally consistent with the Bolton Point monitoring data. The major pesticides in both data sets are herbicides used in corn cultivation (atrazine, alachlor, metalochlor, diethylatrazine and cyanazine).

In June 1998, USGS and NYSDEC measured two herbicides in stormflow samples of three tributaries to Cayuga Lake (see section 4.2.4). Researchers then sampled Cayuga Lake at 12 cross-sections on two consecutive weeks one month after the storm. Results of this program indicated that concentrations of atrazine and metolachlor were generally uniform throughout the lake. Atrazine concentration ranged from 0.2-0.6 μg/l; metolachlor was detected at 0.05-0.3 μg/l. Concentration of the two herbicides was more uniform in the hypolimnion. Concentrations in the epilimnion appeared more responsive to changes in seasonal loading. Higher concentrations of chemicals were detected near mouths of tributaries draining agricultural areas (Eckhardt et al. 1999)

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**4.3.2.6 Sediment chemistry**

Sediment testing is conducted throughout the Finger Lakes as part of the NYSDEC monitoring program. Results will be available in mid-2001.

Chemical composition of sediments in southern Cayuga Lake was assayed as part of the Lake Source Cooling field investigations to determine environmental impacts associated with dredging to install the intake and outfall pipes. Sediment cores were analyzed for presence and concentration of heavy metals and organic compounds that might affect water quality during excavation, or limit disposal options for dredged material.

Results of the sediment testing were compared to guidelines adopted by New York State Dept. Environmental Conservation (NYSDEC). Regulatory guidelines have been developed to protect four uses of surface water resources: human health, wildlife health and reproduction, benthic and water column organisms (acute toxicity) and benthic and water column organisms (chronic toxicity). A separate NYSDEC guidance document provides disposal options based on chemical content of sediments to be removed.

Two rounds of sediment sampling were completed for this project. Surficial sediments were collected in 1994 as part of the feasibility screening for the Lake Source Cooling proposal. Additional sampling was completed in 1996 to support permit acquisition and design of best management practices during construction. The two rounds used different analytical laboratories and different sediment core depths.

Sediment samples were collected by box core on July 21 and 22, 1994 in the nearshore region where sediments will be excavated to install pipelines and in the region of the LSC intake structure. The box core sampled the upper 20 cm of the sediment profile. These samples were analyzed for Target Compound List analytes (as provided in Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA] [1980]), total organic carbon, and acid volatile sulfides (AVS) in order to evaluate the chemical quality of the material.

Concentrations of cobalt, copper, lead, nickel, and zinc ranged from 1.16 micromoles per gram (μmol/g) to 1.35 μmol/g. Acid volatile sulfides were analyzed as well, because their relationship to concentrations of metals is an indicator of the potential for exposure of benthic organisms to potentially toxic concentrations of some divalent metals. When the ratio of metals to AVS is greater than one, biological toxicity may occur (DiToro et al. 1991). The molar ratios of total metal to AVS were calculated and range from 0.0711 to 0.0653. The AVS calculations indicate that the potential for toxicity to benthic and water column organisms from the metals detected in the Cayuga Lake sediments in 1994 is low.

Additional testing of sediment chemistry was completed in 1996. The specialty laboratories used in the 1996 sampling program applied analytical techniques designed to detect chemicals at trace concentrations. Sediment samples were collected by split spoon and hand core on June 18, 19, and 20, 1996. Split-spoon core samples were taken to a depth of 2 - 3 m based on anticipated dredging depths for each section of the excavation. The hand core samples were taken to a depth of 1 m, selected to represent 60 to 100 years of sedimentation (assuming a sedimentation rate of 1.0 - 1.6 cm/yr). These sediments would likely reflect any elevated concentrations of contaminants associated with industrial activity and/or atmospheric deposition.

Results of the sediment sampling for metals are summarized in Table 4.3.13. Complete results can be found in appendices C-12 and C-15 (volume IV) to the Environmental Impact Statement prepared for the LSC project (Stearns & Wheler 1997). Metals are part of the natural soil matrix, so their detection at low levels in sediments is to be expected. Elevated concentrations can reflect industrial inputs through effluent discharges, watershed runoff, and atmospheric deposition.

Risks associated with exposure to metals (inorganic compounds) are addressed in NYSDEC guidance with two separate thresholds for protection: the "lowest effect level" and the "severe effect level." The severe effect level corresponds to acute toxicity thresholds for aquatic organisms, while the lowest effect level "indicates a level of sediment contamination that can be tolerated by the majority of benthic organisms, but still causes toxicity to a few species" (NYSDEC 1994a).

Table 4.3.13 Summary of Cayuga Lake Sediment Metal Data, 1994 – 1996

| Analyte | Number of Samples | Mean (mg/kg) dry weight | Median (mg/kg) dry weight | Maximum (mg/kg) dry weight | Number of Observations over Guidance Value Derived for Various Receptors and Disposal Options | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Lowest Effect Level | Severe Effect Level | Class A Threshold | Class B Threshold |
| Cadmium | 16 | 0.54 | 0.71 | 0.8 | 5 | 0 | 5 | 0 |
| Chromium | 16 | 19.62 | 14.05 | 75.7 | 3 | 0 | na | na |
| Copper | 16 | 15.49 | 16.05 | 30.8 | 8 | 0 | na | na |
| Lead | 16 | 25.35 | 17 | 123 | 2 | 1 | 8 | 0 |
| Mercury | 16 | 0.16 | 0.17 | 0.227 | 7 | 0 | 2 | 1 |
| Nickel | 16 | 19.27 | 18.1 | 46.6 | 9 | 0 | 8 | 0 |
| Arsenic | 16 | 4.41 | 4.1 | 9.1 | 1 | 0 | na | na |
| Silver | 16 | 0.67 | 0.88 | 0.99 | 0 | 0 | na | na |
| Zinc | 16 | 69.44 | 64.95 | 143 | 4 | 0 | na | na |

The NYSDEC published guidelines for managing sediment materials in its 1994 Interim Guidance: Freshwater Navigational Dredging (NYSDEC 1994b). These guidelines provide a sediment classification system and associated disposal options that are based on measured chemical concentrations. Class A sediments are considered "clean" and suitable for most uses, including in lake disposal. Class B sediments are moderately contaminated with organic and/or inorganic compounds that have the potential for negative environmental and human health impacts. Class C sediments are considered hazardous and must be disposed of as hazardous waste.

Data presented in Table 4.3.13 indicate that nearshore sediments in the southeastern region of Cayuga Lake contain concentrations of certain metals above regulatory guidelines. The NYSDEC "lowest effect level" thresholds for cadmium, copper, mercury, and nickel were exceeded in many samples. Class A sediment thresholds for cadmium, copper, and mercury were exceeded as well.

Because these sediments were to be disturbed during dredging, the LSC project team estimated the potential for contaminants adsorbed to soil particles to be released into the water column. The amount of metals released and their biological availability depends in the nature of the disturbance and the properties of the lake water such as pH, alkalinity, temperature, dissolved and particulate organic carbon, and hardness. The acid volatile sulfide (AVS) results discussed above indicate that AVS levels prevent biological availability of sediment metals to benthic organisms. However, as sediments are disturbed and come into contact with the well-oxygenated water column the metal sulfides will become oxidized. Each metal sulfide oxidizes at a different rate, and each solubilized metal has a unique affinity for repartitioning onto solid phase particulates in the water column and sediment surface (Stearns & Wheler 1997).

The chemical equilibrium model MINEQL+ (Schecher and McAvoy 1992) was used to evaluate speciation of metals potentially mobilized from the Cayuga Lake sediments. Trace metals in lake water are largely associated with carbonate complexes in a high alkalinity hard water lake such as Cayuga. Most metals exhibit relatively low concentrations of the aquo (uncomplexed) form. Results of this analysis (summarized in Stearns & Wheler 1997 pg. 2.3.5.18) indicate that the majority of trace metals mobilized from the sediments during dredging would not be in a biologically available form. Exceptions include zinc (100% uncomplexed) and silver (30% uncomplexed). Dredging was conducted using closed-bucket techniques to minimize exchange with the overlying water column, and sediments were removed from the lake for disposal.

Sediments were analyzed for organic compounds; results are summarized in Table 4.3.14. Just as with the metals results, measured concentrations may be compared with regulatory guidelines established to protect designated uses of the lake ecosystem or regulate disposal. Pesticides were detected in several of the nine sediment samples at concentrations exceeding thresholds for human health bioaccumulation, chronic toxicity for benthic life, and wildlife bioaccumulation. The highest frequency of detectable pesticide results was associated with DDT and its breakdown products. Three samples of the top meter of sediment collected in nearshore areas exhibited elevated concentrations of polyaromatic hydrocarbons. These compounds are associated with fossil fuel combustion.

The New York State Department of Health monitors fish for the presence and concentration of metals and organic compounds. No contaminants have been detected in Cayuga Lake fish at concentrations above human health guidelines.

### 4.3.3 Biological Characteristics

#### 4.3.3.1 Phytoplankton

Microscopic algae suspended in the water column (phytoplankton) form the base of the food web in Cayuga Lake.

A number of researchers have studied various aspects of the Cayuga Lake phytoplankton community since completion of the first comprehensive biological survey in the early part of this century (Birge and Juday 1914). Oglesby’s (1978) monograph on Cayuga Lake provides a comprehensive review of species composition, biomass, and annual succession of phytoplankton through the early 1970s. The Lake Source Cooling environmental impact statement (Stearns & Wheler 1997) summarizes historical data and findings of field investigations conducted from 1994 – 1996. The objective of this section of the watershed characterization report is to describe the current status of the phytoplankton community from the perspective of trends and use impairment.

Phytoplankton growth rate, abundance, and species composition are affected by the availability of light and nutrients and the temperature of the water. Other factors such as grazing by organisms in the water column and benthos also affect the phytoplankton community. In Cayuga Lake, phosphorus is the limiting nutrient for algal growth. Other essential nutrients include carbon, hydrogen, oxygen, nitrogen, sulfur, (needed in relatively large supply) and silica, iron, manganese, copper, zinc, molybdenum and cobalt (needed in trace amounts).

Cornell graduate student Paul Godfrey completed a detailed evaluation of spatial and temporal variation of the Cayuga Lake phytoplankton based on extensive sampling in 1972 – 1973 (Godfrey 1977). He concluded that annual succession dynamics dominated the observed variation in phytoplankton community structure. Four distinct periods were clearly evident in the annual data. In spring, the phytoplankton community was dominated (both numbers and biomass) by diatoms and cryptophytes. Chlorophyll *a* concentrations typically reached their annual maximum during this period. During a brief period in July large numbers of extremely small cyanophytes (blue-green algae) dominated the phytoplankton community in terms of numbers, but not biomass. From late summer through the fall mixing period, chlorophytes (green algae) dominated both numbers and biomass of the phytoplankton community. Blue-green algae gradually increased in importance over this period. During winter the community was dominated by cryptophytes.

TABLE 4.3.14

Summary of Organic Compounds in Cayuga Lake Sediments, 1996 LSC Data *
Cayuga Watershed Characterization Report

| Analyte | Number of Samples (1996) | Samples with Detectable Results | Highest Concentration | | Number of Observations over Guidance Value Derived for Various Receptors and Disposal Options | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | (µg/g organic carbon) | (µg/g total solids) | Human health (bioaccumulation) | Benthic (acute) | Benthic (chronic) | Wildlife (bioaccumulation) | Class A Sediment |
| aldrin | 9 | 2 | 0.1133 | 0.0021 | 1 | 0 | 0 | 0 | 0 |
| alpha-BHC | 9 | 1 | 0.100 | 0.0027 | 0 | 0 | 0 | 0 | 0 |
| beta-BHC | 9 | 3 | 0.16296 | 0.0044 | 0 | 0 | 0 | 0 | 0 |
| delta-BHC | 9 | 2 | 0.18889 | 0.0051 | 0 | 0 | 0 | 0 | 0 |
| gamma-BHC | 9 | 1 | 0.111 | 0.003 | 0 | 0 | 0 | 0 | 0 |
| BHC (total) | 9 | 4 | 0.563 | 0.0152 | 2 | 0 | 1 | 0 | 0 |
| alpha-chlordane | 6 | 0 | Non detect | Non detect | 0 | 0 | 0 | 0 | 0 |
| gamma-chlordane | 6 | 1 | 0.03843 | 0.00088 | 0 | 0 | 0 | 0 | 0 |
| chlordane (total) | 9 | 1 | 0.03843 | 0.00088 | 1 | 0 | 1 | 1 | 0 |
| 4,4’ DDD | 9 | 7 | 0.5424 | 0.00922 | 7 | 0 | 0 | 0 | 1 |
| 4,4’ DDE | 9 | 5 | 0.2553 | 0.00434 | 5 | 0 | 0 | 0 | 0 |
| 4,4’ DDT | 9 | 5 | 0.08519 | 0.0023 | 5 | 0 | 0 | 0 | 0 |
| dieldrin | 9 | 3 | 0.1056 | 0.001901 | 1 | 0 | 0 | 0 | 0 |
| endosulfan I | 9 | 1 | 0.09630 | 0.0026 | 0 | 0 | 1 | 0 | 0 |
| endosulfan II | 9 | 3 | 0.03704 | 0.001 | 0 | 0 | 1 | 0 | 0 |
| endosulfan sulfate | 9 | 0 | Non detect | Non detect | 0 | 0 | 0 | 0 | 0 |
| endrin | 9 | 3 | 0.08384 | 0.00093 | 0 | 0 | 0 | 0 | 0 |
| heptachlor | 6 | 1 | 0.10370 | 0.0028 | 1 | 0 | 1 | 1 | 0 |
| heptachlor epoxide | 6 | 1 | 0.07407 | 0.002 | 1 | 0 | 0 | 1 | 0 |
| methoxychlor | 9 | 4 | 0.17778 | 0.0048 | 0 | 0 | 0 | 0 | 0 |
| Total PCB | 9 | 0 | Non detect | Non detect | 0 | 0 | 0 | 0 | 0 |
| toxaphene | 9 | 0 | Non detect | Non detect | 0 | 0 | 0 | 0 | 0 |
| acenaphthene | 3 | 3 | 3.5529 | 0.0604 | 0 | 0 | 0 | 0 | 0 |
| phenanthrene | 3 | 3 | 37.1176 | 0.6310 | 0 | 0 | 0 | 0 | 0 |
| fluoroanthene | 3 | 3 | 56.5294 | 0.96100 | 0 | 0 | 0 | 0 | 0 |
| benzo(a)pyrene | 3 | 3 | 36.5882 | 0.6220 | 3 | 0 | 0 | 0 | 0 |
| Bis(2-ethylhexyl)phthalate | 3 | 3 | 12.444 | 0.2240 | 0 | 0 | 0 | 0 | 0 |
| Total PAH | 3 | 3 | 140.8471 | 2.3944 | 0 | 0 | 0 | 0 | 2 |
| mirex | 3 | 0 | Non detect | Non detect | 0 | 0 | 0 | 0 | 0 |

Seasonal succession of the phytoplankton community was evaluated again in 1994 - 1996 and the findings were remarkably consistent with the data set collected more than two decades earlier. Diatoms and dominated the community in the spring, green algae were increasingly important as the summer progressed, peaking in late August Blue-green algae comprised a significant fraction of the community in terms of numbers by late July and August, but were a negligible fraction of the total algal biomass. Crypotophytes became increasingly dominant as the fall advanced. (Figure 4.3.11).

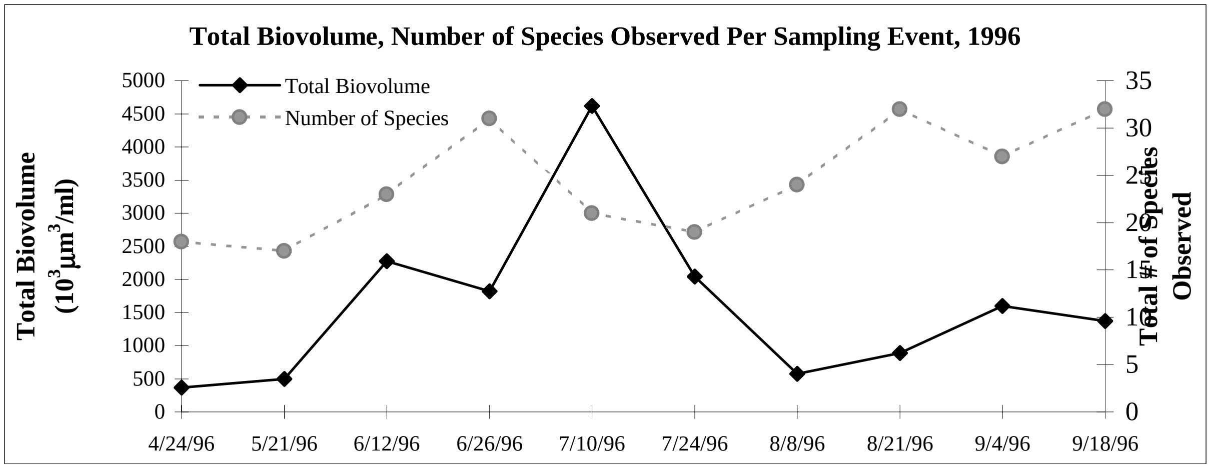
According to Oglesby (1978), the most complete investigations of phytoplankton species assemblages had been performed by Godfrey, Barlow and Dahlberg. Direct comparisons of data gathered by the three investigators are not meaningful due to differences in methods used to collect, preserve, identify, and count the samples and in the taxonomic skills of the investigators. Oglesby considered the Godfrey data set to be most representative of conditions in Cayuga Lake. The phytoplankton species reported by Godfrey as relatively important over the course of his investigation are summarized in Table 4.3.15. Also noted in this table are the findings of the phytoplankton survey work completed in 1994 – 1996 by Dr. William Schaffner for the Lake Source Cooling environmental impact assessment. Dr. Schaffner concluded that the species composition and community structure of the 1994 – 1996 phytoplankton assemblage were generally consistent with the historical Cayuga Lake data (Schaffner, 1997).

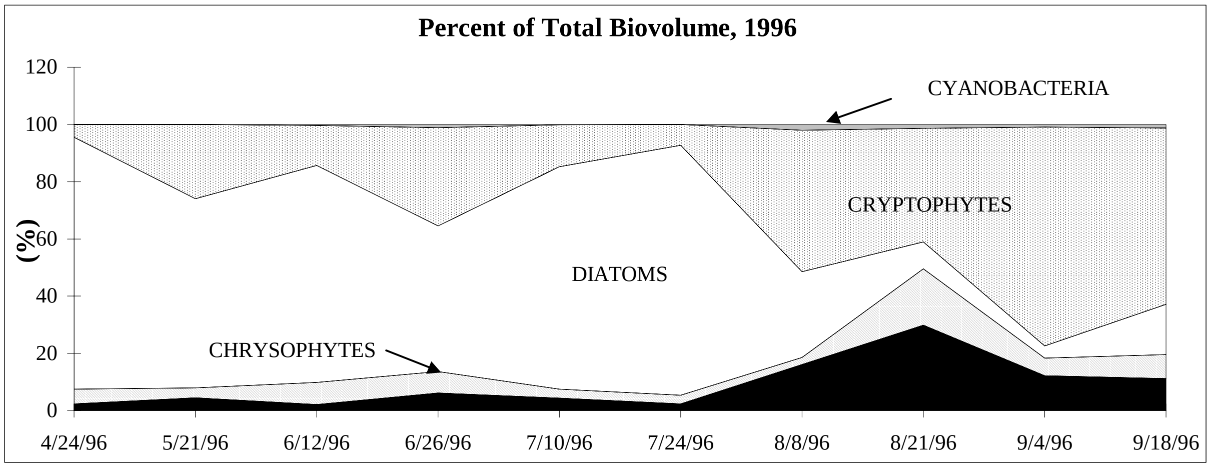
Another index of phytoplankton abundance is chlorophyll *a*, a photosynthetic pigment present in algal cells. Summer average chlorophyll *a* concentration is used as one index of a lake's trophic status, or degree of enrichment by nutrients. Lake managers use summer average chlorophyll a as an indicator of use impairment; for example, NYSDEC derived their guidance value for phosphorus in lakes to correspond to a low frequency of perceived "algal greenness". Upper waters, summer average chlorophyll *a* concentrations less than 6 μg/l correspond to a low frequency of perceived use impairment. When summer average chlorophyll *a* exceeds 13 μg/l more than 50% of lake users would perceive definite algal greenness and find at least slight impairment in use (NYSDEC Fact Sheet, Ambient Water Quality Value for Protection of Recreational Uses, Oct. 22, 1993). The summer averaging period is defined as the four months from June 1 – September 30 to encompass the major recreational period for New York lakes.

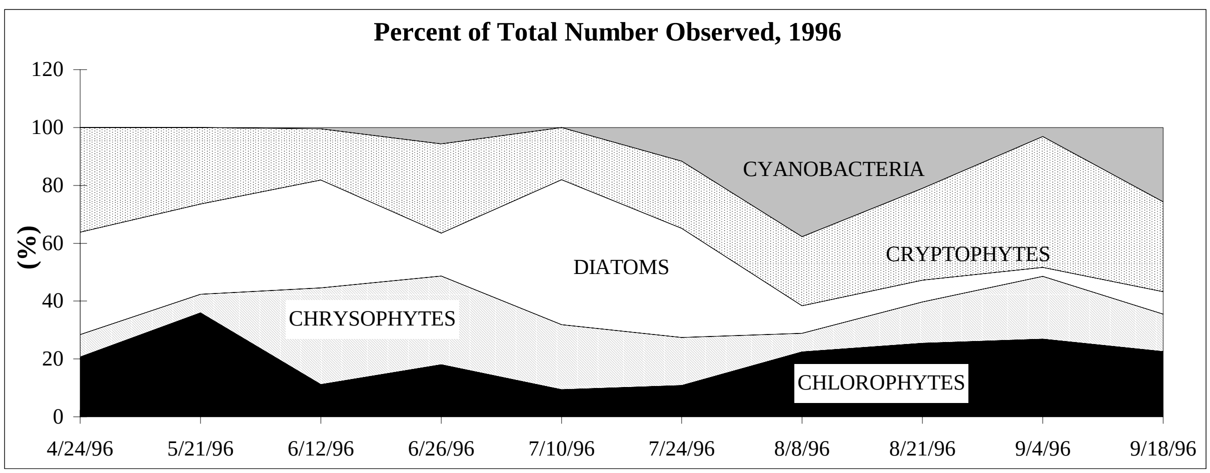
**Table 4.3.16** Summer Average Chlorophyll *a* Concentration, Cayuga Lake

| **Year** | **Chlorophyll a (μg/l)** | **Standard Error** | **Location** | **Reference** |
|---|---|---|---|---|
| 1968 - 1970 | 4.8 | Not reported | Myers | Peterson, B. 1971 |
| 1970 | 3.7 | Not reported | Myers | Peterson, B. 1971 |
| 1972 | 10.3 | 0.2 | Myers | Godfrey, P. 1977 |
| 1973 | 8.2 | 0.2 | Myers | Godfrey, P. 1977 |
| 1974 | 8.1 | 0.2 | Myers | EPA 1974 |
| 1977 | 8.6 | Not reported | Myers | Ogelsby and Schaffner 1978 |
| 1978 | 6.5 | Not reported | Myers | Ogelsby and Schaffner 1978 |
| 1994 | 4.1 | 1.1 | Southern basin | Stearns & Wheler 1997 |
| 1995 | 4.8 | 1.0 | Southern basin | Stearns & Wheler 1997 |
| 1996 | 3.4 | 0.96 | Southern basin | Stearns & Wheler 1997 |
| 1998 | 5.1 | 0.25 | Southern basin | Cornell Utilities 1999 |
| 1991 - 1998 | 4.0 | 0.66 | Northern basin | Makarewicz et al. 1999 |

Similar to other water quality parameters of the Cayuga Lake ecosystem, chlorophyll *a* has been assayed by a number of investigators over the past decades. Measurements fluctuate over the annual cycle; maximum values tend to occur in the spring and minimum values in the winter. Summer average chlorophyll *a* data for Cayuga Lake are summarized in Table 4.3.16. These data represent samples of the upper waters collected during the months of June – September. Note that in recent years the chlorophyll *a* data are consistently below the 6 μg/l threshold for perceived




Data are averages of duplicate samples.
mm3/ml: cubic micrometers per milliliter

FIGURE 4.3.11
SEASONAL PHYTOPLANKTON
SUCCESSION, 1996
Source: Stearns & Wheler 1997

| Table 4.3.15 Summary of phytoplankton species present in Cayuga Lake, 1972 – 1974 (Godfrey 1977) and 1994 – 1996 (Schaffner 1997) | | |
|---|---|---|
| **Phytoplankton** | **Present in 1972 – 1974** | **Present in 1994 – 1996** |
| **CHLOROPHYTA** | | |
| *Actinastrum* | No | Yes |
| *Ankistrodesmus* | Yes | Yes |
| *Arthrodesmus* | No | Yes |
| *Carteria* | Yes | Yes |
| *Chlamydomonas* | Yes | Yes |
| *Closteriopsis* | Yes | Yes |
| *Closterium* | No | Yes |
| *coccoids* | Yes | Yes |
| *Coelastrum* | Yes | Yes |
| *Coronastrum* | No | Yes |
| *Cosmarium* | Yes | Yes |
| *Crucigenia* | No | Yes |
| *Dictyosphaerium* | No | Yes |
| *Dimorphococcus* | Yes | No |
| *Eudorina* | No | Yes |
| *Francia* | No | Yes |
| *Gloeocystis* | No | Yes |
| *Golenkinia* | Yes | Yes |
| *Gonium* | No | Yes |
| *Kirchneriella spp.* | Yes | Yes |
| *Lagerheimia* | Yes | Yes |
| *Micractinium* | No | Yes |
| *Nannochloris* | Yes | Yes |
| *Oocystis pusilla/parva* | Yes | Yes |
| *Oocystis spp.* | Yes | Yes |
| *Pediastrum* | Yes | Yes |
| *Scenedesmus bijuga* | Yes | Yes |
| *Scenedesmus spp.* | Yes | Yes |
| *Schroederia* | No | Yes |
| *Selenastrum minutus* | Yes | Yes |
| *Selenastrum spp.* | Yes | Yes |
| *Sphaerocystis* | Yes | Yes |
| *Staurastrum* | Yes | Yes |
| *Treubaria* | No | Yes |
| *Tetraedron* | Yes | Yes |
| *Tetraspora* | No | Yes |
| **EUGLENOPHYTA** | | |
| *Euglena* | No | Yes |
| *Phacus* | No | Yes |
| *Trachelmonas* | No | Yes |
| **CHRYSOPHYTA** | | |
| *Biocoeca* | Yes | No |
| *Chromulina* | Yes | Yes |
| *Chrysococcus* | No | Yes |
| *Chrysochromulina* | No | Yes |
| *colonial flagellate* | Yes | Yes |
| *coccoid* | Yes | Yes |
| *Dinobryon* | Yes | Yes |
| *Erkenia* | No | Yes |

| | | |
|---|---|---|
| *Flagellate w/spines* | Yes | Yes |
| *u flagellates* | Yes | Yes |
| *uu flagellates* | Yes | Yes |
| *Mallomonas* | No | Yes |
| *Ochromonas* | Yes | Yes |
| *Uroglenopsis americana* | No | Yes |
| **DIATOMS** | | |
| *Achnanthes* | No | Yes |
| *Amphipora* | No | Yes |
| *Asterionella formosa* | Yes | Yes |
| *Cosinodiscus/Stephanodiscus* | Yes | Yes |
| *centrics* | Yes | Yes |
| *Cymbella* | No | Yes |
| *Diatoma* | Yes | Yes |
| *Eunotia* | No | Yes |
| *Fragilaria* | Yes | Yes |
| *Melosira* | No | Yes |
| *Meridion* | No | Yes |
| *Navicula* | No | Yes |
| *Nitzschia* | Yes | No |
| *Opephora* | No | Yes |
| *pennates* | Yes | Yes |
| *Rhizosolenia* | No | Yes |
| *Synedra* | Yes | Yes |
| *Tabellaria* | Yes | Yes |
| **CRYPTOPHYTA** | | |
| *Chroomonas/Rhodomonas* | Yes | Yes |
| *Cryptomonas spp.* | Yes | Yes |
| **CYANOPHYTA** | | |
| *Anabaena* | Yes | Yes |
| *Aphanizomenon* | Yes | No |
| *coccoid* | Yes | Yes |
| *Chrococcus* | Yes | Yes |
| *Coelosphaerium* | Yes | No |
| *Gomphosphaeria* | Yes | Yes |
| *Lyngbya* | Yes | No |
| *Merismopedia* | Yes | Yes |
| *Microcystis* | Yes | Yes |
| *Oscillatoria* | No | Yes |
| **PYRROPHYTA** | | |
| *Ceratium* | Yes | Yes |
| *Glenodinium* | Yes | No |
| *Peridiniales* | Yes | Yes |

use impairment. It is likely that the reduction in chlorophyll a concentration is a direct result of the invasion of the lake by zebra mussels.

### 4.3.3.2 Macrophytes (rooted aquatic plants and algae)

Aquatic macrophytes provide a number of important functions to lake ecosystems including stabilization, food, and habitat value. Macrophytes physically stabilize soft sediments with their root structure and help dissipate the energy of wind and wave action with their stems and leaf structure. Macrophyte beds act as traps for inorganic and organic particulate materials (Foote and Kadlec 1988; Barko et al. 1991). Aquatic vegetation also provides food for other aquatic organisms; in addition to the phytoplankton, macrophytes capture photosynthetic energy and serve as a base to the aquatic and terrestrial food web. For example, *Vallisneria americana* is an important food source for waterfowl.

The presence of macrophytes in the littoral zone is correlated with higher diversity and abundance of invertebrates, which are essential food sources for many life stages of organisms found in Cayuga Lake. Macrophytes provide shelter and forage for waterfowl, invertebrates and fish. They provide habitat areas for insects and other organisms and for the spawning of many fish species. In addition, macrophytes provide habitat for young-of-the-year fish (Dewey and Jennings 1992) and adult sport fishes (Savino and Stein 1989; Crowder and Cooper 1982).

While important to the lake ecosystem, macrophytes can interfere with recreational uses of a lake if they become too abundant or if nuisance species dominate the flora. The species assemblage of macrophytes in Cayuga Lake has been documented at various intervals since the 1920s. Beginning in 1987 (south end) and 1990 (north end), a comprehensive program has been carried out each year to estimate the species composition and biomass of macrophytes. The program is led by Robert L. Johnson of Cornell University's Department of Ecology and Evolutionary Biology, with funding through the Finger Lakes Lake Ontario Watershed Protection Alliance (funding source, NYSDEC) and the Hatch Program (funding source, U.S. Dept. of Agriculture).

The shallow shelf areas at the southern and northern ends of Cayuga Lake represent the vast majority of the lake's littoral zone, which is the habitat for macrophytes. The littoral, or shoreline, zone is defined as the shallow area extending from the water's edge to the maximum depth of light penetration. Because of the steeply sloped basin, the long axis of Cayuga Lake provides only limited littoral habitat. According to data presented in Oglesby (1978) approximately 20% of the lake surface area overlies water of 5 m or less. The majority of this littoral zone (more than 80% of the total) is at the northern end of the lake, north of Union Springs.

The macrophyte species currently found in Cayuga Lake are listed in Table 4.3.17. The number of species present in Cayuga Lake (16 species as of 1998) is comparable to other New York lakes (see, for example, Auer et al. 1996). As discussed in Oglesby (1978) the number of macrophyte species present has fluctuated over time: 21 species were reported in southern Cayuga Lake in 1921, 18 in 1942 – 1943, and 10 in 1970.

Significant changes in total biomass and species composition of macrophytes have occurred over the 12-year study period (Figure 4.3.12). The abundance and dominance of *Myriophyllum spicatum* (eurasian watermilfoil), a nuisance exotic species, have declined in the northern and southern study areas of Cayuga Lake. The precipitous decline in eurasian watermilfoil in the study areas has been accompanied by an increase in two native species, *Elodea canadensis* in the southern lake basin and *Vallisneria americana* in the northern shelf.

It is very interesting to note the fluctuations in total biomass and the contrast between the two regions of the lake. In the northwest area, total biomass was high from 1987 – 1998 and eurasian watermilfoil dominated the flora. Total biomass fell to low levels in the early 1990's accompanied by a decline in eurasian watermilfoil. As biomass has recovered since 1994, *Vallisneria americana* is the dominant species. In contrast, total biomass was relatively low in southern Cayuga Lake in the early part of the record, and increased in 1991 – 1993. 1994 and 1995 were low, but total plant biomass has recovered in recent years. Peak biomass in the northern study area has always been higher than in the southern lake. The one consistent signal lakewide is the decline in dominance of eurasian watermilfoil and the renewed success of native species. This decline in dominance of eurasian watermilfoil was concurrent with the observation of the moth *Acentria ephemerella* feeding on apical meristematic tissue of this macrophyte (Gross et al. 1999 in review).

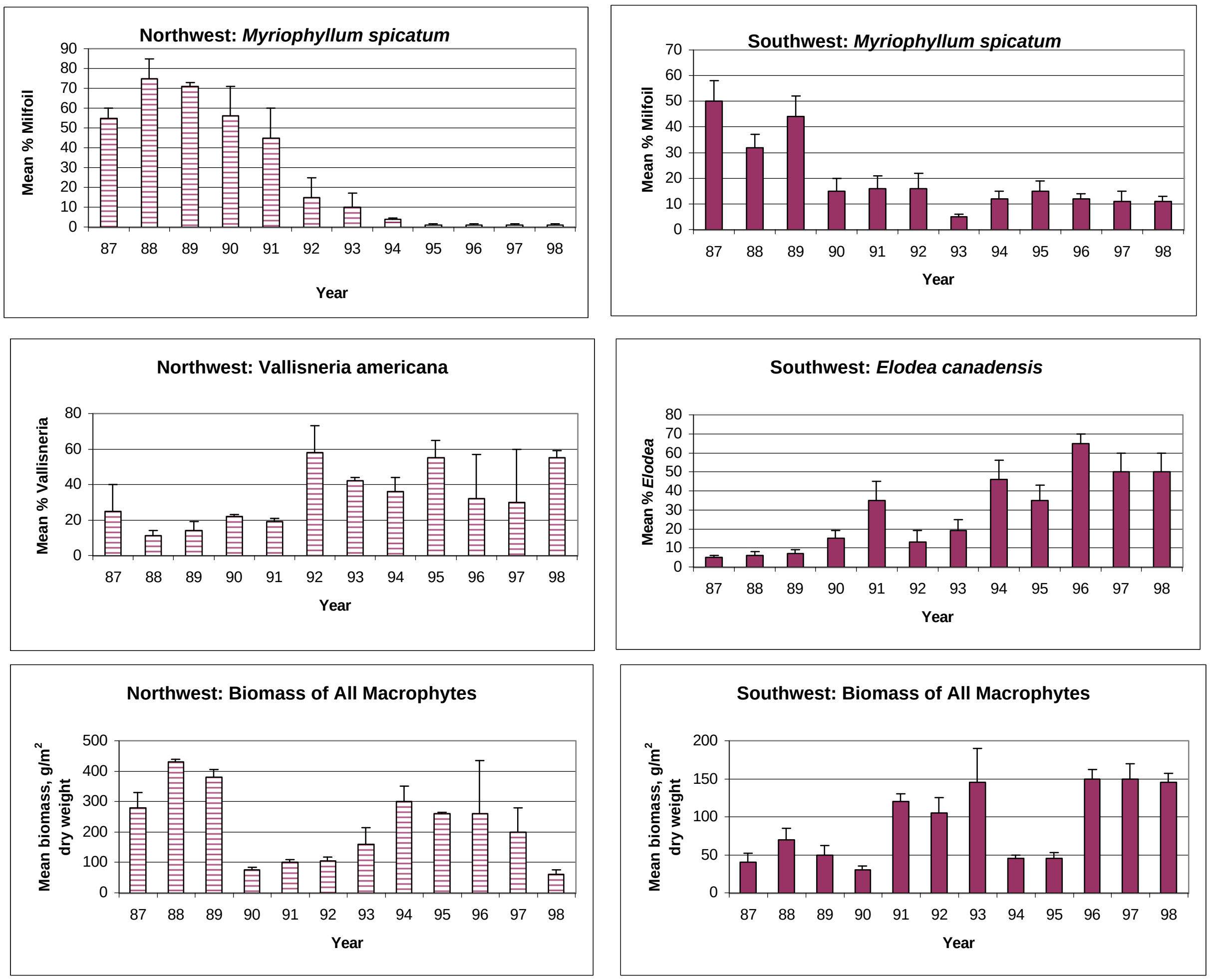



Figure 4.3.12. Relative abundance of selected species and total biomass of macrophytes, northern and southern basins, Cayuga Lake

Source: Robert L. Johnson, P. J. Van Dusen, J.A. Toner and N. G. Hairston, Jr. 1999. Eurasian water milfoil biomass associated with insect herbivores in New York. Submitted for review, Journal of Aquatic Plant Management

| Table 4.3.17 Macrophyte species present in Cayuga Lake | | |
|---|---|---|
| **Scientific name** | **Common Name** | **Distribution** |
| **Ceratophyllum demersum** | Coontail | North, south |
| *Chara vulgaris* | Muskgrass | North, south |
| *Elodea canadensis* | Elodea, Canadian waterweed | North, south |
| *Heteranthera dubia* | Water stargrass | North, south |
| *Myriophyllum spicatum* | Eurasian Watermilfoil | North, south |
| *Najas minor* | Brittle naiad | North |
| *Najas flexilis* | Bushy naiad | North, south |
| *Potomogeton pectinatus* | Sago pondweed | North, south |
| *Potomogeton pusillus* | Slender pondweed | North, south |
| *Potomogeton richardsonii* | Clasping-leaf pondweed | North, south |
| *Potomogeton zosteriformis* | Flat-stemmed pondweed | North, south |
| *Potomogeton vaginatus* | Bigsheath pondweed | South |
| *Potomogeton crispus* | Curlyleaf pondweed | North, south |
| *Vallisneria americana* | Eelgrass, wild celery | North, south |
| *Ranunculus trichophyllus* | White water buttercup | South |
| *Zannichellia palustris* | Horned pondweed | South |
| Sources:<br>Robert L. Johnson, Cornell University. June 1997. Project Completion Report for the Seneca County Soils and Water Conservation District.<br>Tompkins County Planning Dept. Oct. 1998. Project Completion Report for the Finger Lakes- Lake Ontario Watershed Protection Alliance. | | |

Additional sampling and experiments have focused on the role of this aquatic lepidopteran larva in the observed shift in species composition. Johnson and his colleagues (Elisabeth Gross and Nelson Hairston, Jr.) have developed experimental evidence that the shift in dominance from *Myriophyllum spicatum* to *Elodea canadensis* may be explained by the preference of larval *Acentria ephemerella* for feeding on meristematic tissue of *Myriophyllum spicatum* (Johnson et al. 1998a). In laboratory and mesocosm studies these researchers have demonstrated that the larval stage of *Acentria ephemerella* clearly prefer *Myriophyllum spicatum* over *Elodea canadensis*.

Grazing on the apical meristematic tissue (the growing tip) prevents milfoil from elongating towards the water surface, thus eliminating a major advantage this species has held over native flora. More desirable native species of submersed macrophytes have been able to outcompete milfoil and now comprise a significant fraction of the flora. These native species do not elongate towards the water surface and form a canopy; consequently, there is less perceived impairment of the resource for recreational and aesthetic uses.

In addition to herbivory, there are many environmental factors influencing the total biomass and species composition of macrophytes in Cayuga Lake. Significant storm events that deliver large amounts of sediment to the lake can affect light penetration and the littoral habitat. For example, the number of macrophytes present in southern Cayuga lake dropped from 11 to 5 following tropical storm Agnes in June 1972. Biomass decreased by 44 – 100%. By the following summer, eurasian watermilfoil had greatly increased its relative dominance of the macrophyte community (Oglesby et al. 1976).

Invasion of lakes by the zebra mussel *Dreissena polymorpha* is associated with an increase in water clarity and expansion of littoral habitat (Fahnenstiel et al. 1995). Zebra mussels invaded Cayuga Lake through the Seneca River system and have spread from north to south. Recall that Secchi disk transparency data for northern Cayuga Lake collected by Seneca County Soil and Water Conservation District shows an increase in water clarity concurrent with the mussel invasion. By 1996, significant numbers of zebra mussels were present throughout the lake.

Finally, mechanical harvesting can influence the species composition along with abundance of macrophytes. Survey work performed by Robert Johnson and colleagues at Cornell University suggest an association between lakes intensively managed to control eurasian watermilfoil and low abundance of herbivores (Johnson et al. 1998b).

Apparently, mechanical harvesting removes sufficient numbers of herbivorous larvae to suppress their effectiveness as a natural control for *Myriophyllum spicatum*.

### 4.3.3.3 Zooplankton (including *Mysis relicta*)

The zooplankton community is another important component of the Cayuga Lake ecosystem; these small, motile, water column organisms graze on phytoplankton and are consumed by various life stages of fish. Oglesby (1978) has reviewed historical data extending back to 1910 describing the abundance and species composition of zooplankton and concluded that the Cayuga Lake community is typical of a moderately productive north temperate lake.

**Table 4.3.18. Zooplankton taxa found in Cayuga Lake, Summer 1994**

| | |
|---|---|
| **ROTIFERA** | **CALANOIDA** |
| *Asplanchna priodonta* | *Senecella calanoides* |
| *Brachionus sp.* | *Diaptomus minutus m.* |
| *Cephalodella sp.* | *Diaptomus minutus f.* |
| *Collotheca sp.* | *Diaptomus oregonensis m.* |
| *Conochilus unicornis* | *Diaptomus oregonensis f.* |
| *Filinia longeseta* | *Diaptomus spp. CI-CV* |
| *Gastropus hytopus* | *Diaptomus spp. NI-NVI* |
| *Kellicottia longispina* | |
| *Keratella cochlearis* | **CYCLOPOIDA** |
| *Keratella quadrata* | *Cyclops scutifer m.* |
| *Ploesoma sp.* | *Cyclops scutifer f.* |
| *Polyarthra spp.* | *Cyclops vernalis m.* |
| *Synchaeta sp.* | *Cyclops vernalis f.* |
| *Trichocerca multicrinis* | *Diacyclops bicuspidatus m.* |
| | *Diacyclops bicuspidatus f.* |
| **CLADOCERA** | *Mesocyclops edax m.* |
| *Bosmina longirostris* | *Mesocyclops edax f.* |
| *Camptocercus rectirostris* | *Cyclopoid sp. m.* |
| *Ceriodaphnia* | *Cyclopoid sp. f.* |
| *Chydorus* | *Cyclopoid CI-CV* |
| *Daphnia galeata* | *Cyclopoid NI-NV* |
| *Daphnia retrocurva* | |
| *Diaphanosoma brachyurum* | **AMPHIPODA** |
| *Eubosmina coregoni* | *Diporia affinis* |
| *Holopedium gibberum* | |
| *Leptodora kindtii* | |
| *Ilyocryptus sp.* | **MYSIDACEA** |
| *Polyphemus pediculus* | *Mysis relicta* |
| *Sida crystallina* | |

Source: Stearns & Wheler 1994

The most recent zooplankton data were collected between June and September 1994 at three stations extending from shallow southern Cayuga (station P2, depth 4m), two miles north (station P4, depth 65 m) to a site off Myers Point (station R, depth 90 m). Dr. William Schaffner analyzed samples as part of the Lake Source Cooling environmental assessment. A total of 37 species were identified in the collections, 21 at P2, 19 at P4 and 25 at R (Table 4.3.18). Oglesby (1978 pg. 89) includes a list of zooplankton species found during field sampling in the early 1970s by Chamberlain and Dahlberg. The species lists are relatively consistent, with a few notable exceptions. The rotifer *Ascomorpha sultans*, dominant in the early 1970's community, was not found in 1994. Both Chamberlain and Dahlberg listed the cyclopoid copepod *Tropocyclops parsinus* and the rotifer *Notholca acuminata* as abundant in the 1970's; these organisms were not present in the 1994 samples. In 1994 the deeper sites had significant numbers of the cyclopoid copepod *Diacyclops*, which was not part of the zooplankton community two decades earlier.

Rotifers were the most abundant group at all sites, followed by cladocerans and copepods. Diversity and density of rotifers and cladocerans decreased with water depth (i.e. the highest numbers of species and individuals were present at the shallowest station P2). This pattern was reversed for copepods; the highest numbers of individuals and species were present at the deepest station R. Abundance of the major taxa present in the 1994 samples is plotted in Figure 4.3.13.

The zooplankton community of Cayuga Lake also includes a large number of the hypolimnetic crustacean *Mysis relicta*, the opossum shrimp. Due to their unique behavioral adaptations, *Mysis relicta* can be difficult to capture using traditional plankton sampling techniques. Their presence and abundance in the zooplankton community can be easily underestimated. These small pelagic crustaceans migrate vertically through the water column over each 24-hour day. During daylight hours, the animals are found at or near the bottom of lakes. In very deep waters, *Mysis relicta* are suspended in the lower regions of the hypolimnion during the day (Brownell 1970; Robertson, Powers, and Anderson 1968; Holmquist 1959). As daylight fades, the animals begin to ascend to shallower depths to feed. This daily migration behavior enables *Mysis relicta* to forage high in the water column during the night making the animals less visible to predators. During the daytime, when light penetrates further into the water column, *Mysis relicta* avoid visual predators by traveling to the deeper, darker waters. In addition to offering protection from predators, the lower temperatures of the deep water may minimize metabolic costs. The benthos also provides an additional food source.

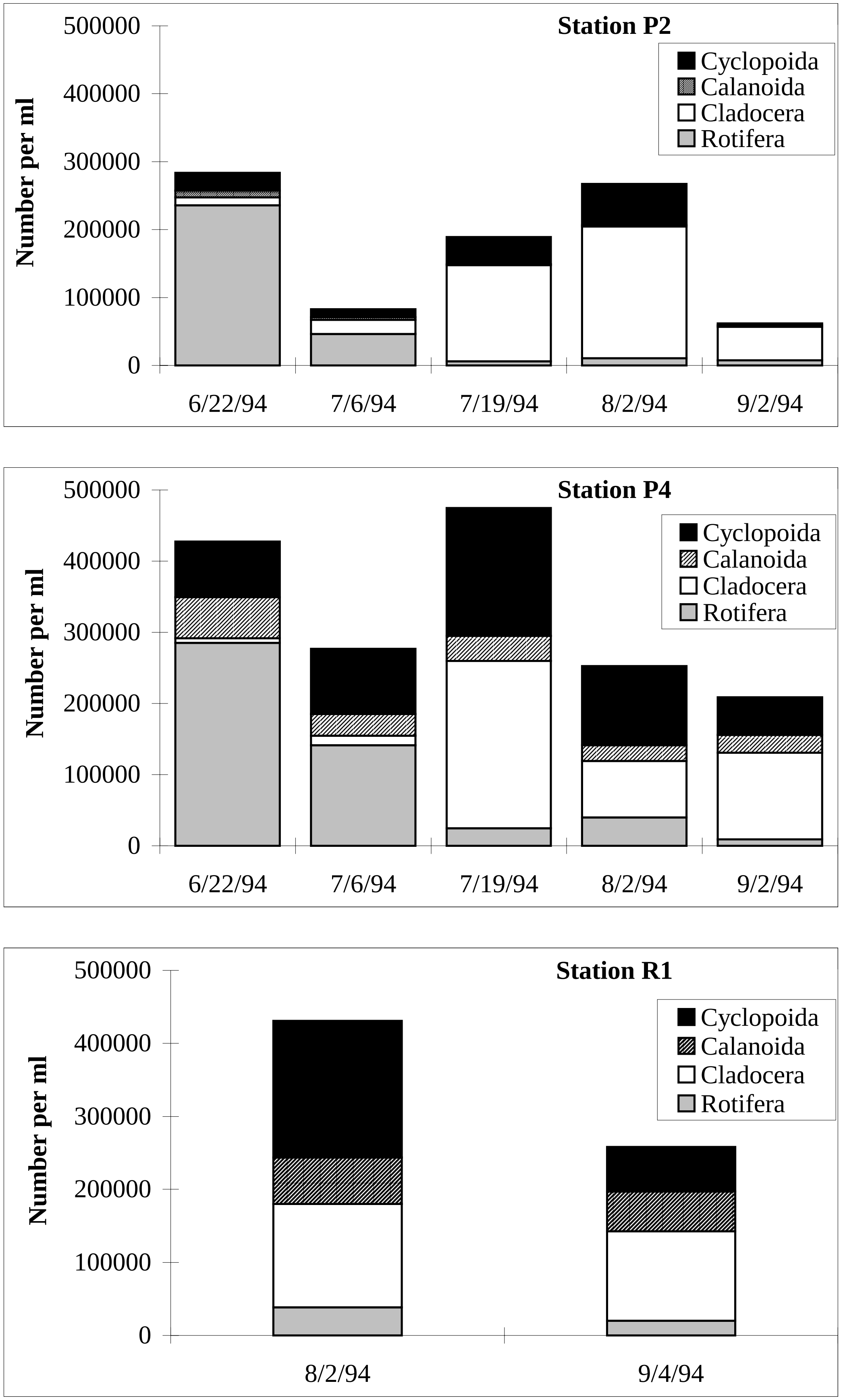



Figure 4.3.13 : Zooplankton densities at stations P2, P4 and R1, Cayuga Lake, New York,
Summer 1994.  Source: Stearns & Wheler 1994

*Mysis relicta* is an important component of the Cayuga Lake food web. The species is a food source for juvenile lake trout (*Salvelinus namaycush*), alewife (*Alosa psuedoharengus*), and smelt (*Osmerus mordax*) (Brownell 1970). Chiotti (1980) considers that abundance of *Mysis relicta* limits growth rate of juvenile lake trout. *Mysis relicta* is an opportunistic omnivore feeding on detritus, benthic invertebrates, phytoplankton and zooplankton (Lasenby, Northcote, and Furst 1986).

Because of the potential vulnerability of this organism to entrainment by a deep-water intake, *Mysis relicta* was a focus of environmental investigations of Cornell's Lake Source Cooling project. Field investigations were carried out from 1994 – 1996 to define the distribution and abundance of *Mysis relicta* in Cayuga Lake, expand the scientific understanding of the animal's life history, and assess the effectiveness of artificial light as a means to keep the animal from being drawn into the intake. Dr. Lars Rudstam of Cornell's Biological Field Station at Shackleton Point on Oneida Lake was the lead investigator. Investigations were conducted using high frequency hydroacoustics and nets.

Significant findings of these investigations are as follows (Stearns & Wheler 1997):

*Life History*

- The Cayuga Lake population of *Mysis relicta* is composed of two overlapping generations or cohorts. Each cohort has a generation time of 18 to 24 months. The animals are released as 3 to 4 mm juveniles between October and April, and reach sexual maturity in July to October of the following year. Thus, at any one time, there are three cohorts that overlap in size: the winter cohort, the yearling (age one), and the adults. Some females may also spawn a second time in the summer.

- The summer growth rate is estimated at 1 to 1.5 mm/month or 0.033 to 0.050 mm/day. Winter growth rate is approximately one-third to one-half of the summer value, thus retarding growth and sexual maturity to maintain an 18- to 24-month cycle.

- The average length at sexual maturity for the species is 12 to 14 mm for males and 14 to 16 mm for females. Males die shortly after mating. Individuals can reach sexual maturity in 13 to 16 months, and females have a gestation time of 2 to 3 months before releasing young. Life span in Cayuga Lake is 16 to 24 months.

*Distribution and Abundance*

- *Mysis relicta* are distributed throughout all suitable habitats in Cayuga Lake. Due to patchiness in distribution, variance between samples collected in different regions of the lake is high. The animals are not significantly more abundant in the southern basin as compared with the rest of Cayuga Lake. For example, based on an intensive survey completed in spring 1996 lakewide abundance of *Mysis relicta* was 86 organisms per square meter of lake surface (N= 58, standard deviation = 64). In southern Cayuga Lake, abundance was estimated at 103 organisms/$m^2$ (N=36, st.dev = 57).

- The pigments in the eyes of the Cayuga Lake *Mysis relicta* population are most sensitive to light of wavelength 520 nm (Rudstam and Lowe, unpublished data 1996). This finding, coupled with measured wavelength-specific light extinction coefficients, has enabled researchers to estimate the depth to which the critical wavelengths of light penetrate into Cayuga Lake. This calculated light level is correlated with the depth at which *Mysis relicta* are found during daylight conditions.

- Daily variations in irradiance, and perhaps seasonal illumination patterns, dictate the depth to which *Mysis relicta* descend. During summer conditions, organisms were off the bottom at water depths of 70 m to 90 m. During the spring survey, the animals were suspended off the bottom at water depths between 50 and 65 m. These water depths correspond to a light intensity in the range of $10^{-4}$ lux.

- Diurnal migrations were tracked to estimate the swimming speed of *Mysis relicta* through the water column. Based on detailed data from an August 1995 survey, the organisms can swim at a rate of 36 – 60 meters per hour.

*Effectiveness of Light*

- In a series of experiments conducted in 1995 and 1996, investigators demonstrated that artificial light is an effective deterrent to *Mysis relicta.* Increasing wattage excluded the organism to a greater distance from the light source. The intake for Lake Source Cooling has been designed with sufficient illumination to repel the animals from a region corresponding to the induced flow field around the LSC intake. The potential for entrainment is therefore greatly reduced.

**4.3.3.4 Macroinvertebrates (zoobenthos)**

Benthic invertebrates spend all or most of their life cycle in or on the lake sediments. The most common taxa are crustaceans, insect larvae, oligochaetes, and mollusks. These organisms convert particulate detritus they use as a food source into protein that can be used for other animals in the food web. Benthic invertebrates exhibit spatial zonation along gradients related to depth of the overlying water. In general, benthic communities are more dense and diverse in shallower water, probably due to the higher quantities of nutrients and higher diversity of microhabitat created by macrophytes (Thorpe and Covich 1991). There are exceptions; littoral areas that are drawn down or experience significant ice scour or wave action tend to have lower diversity and abundance of benthic organisms.

Benthic macroinvertebrates (the benthos) of Cayuga Lake have been sampled at irregular intervals since Birge and Juday collected two samples in 1918. Oglesby (1978) summarized investigations of 1918, 1952 – 1953 and 1972. Additional sampling of the benthos was completed in 1994 as part of the Lake Source Cooling environmental investigations. All samples were collected in late July or early August.

Based on the analysis presented in Oglesby (1978), species composition and abundance of the major benthic invertebrate taxa in the profundal zone have remained relatively consistent over time. Quantitative comparisons are difficult to draw, as sampling methodologies and locations have changed with the objectives of each investigation. Benthic invertebrates tend to be distributed in a non-random (patchy) manner. Replicate samples were not collected in 1918 and 1972. Additional complexity is introduced by changes in taxonomy.

Given these caveats, a comparison of dominant species and density of benthic organisms is summarized in Table 4.3.19. The deepest station (station R) from the 1994 survey is included as most comparable to the earlier stations. The abundance of organisms was higher in 1994 than in the earlier surveys, although the 1972 sampling by Dahlberg might have produced comparable numbers had oligochaetes been enumerated.

Data from all five stations sampled in 1994 by Dr. Mills for the Lake Source Cooling investigations are graphed in Figure 4.3.14. Note the much greater abundance of organisms in the shallower samples.

**4.3.3.5 Fish community**

*The primary data source for this section of the Watershed Characterization Report is the Environmental Impact Statement prepared for Cornell University Lake Source Cooling (Stearns & Wheler 1997). The principal author of the section is Myriam Ibarra, co-author Elizabeth Moran. Lars Rudstam of Cornell University provided extensive review.*

Cayuga Lake contains two relatively distinct fish communities: the cold water community utilizing the extensive region of deep, well-oxygenated hypolimnion, and the warm water community utilizing the littoral zone and epilimnion. Historically, a total of 57 fish species have been reported within Cayuga Lake. Of these, 11 are believed to be no longer present due to habitat changes or competition from introduced species. The current fish community includes 46 species (Table 4.3.20) (Chiotti 1980).

| Table 4.3.19 Comparison of Benthic Macroinvertebrate Sample Results | | | | | |
|---|---|---|---|---|---|
| **Date of Collectio n** | **Station** | **Depth** | **Investigator** | **Taxa** | **Abundance (organisms / m²)** |
| July 28, 1918 | King Ferry | 113 m | Birge and Juday | Chironomus | 3863 |
| | | | | *Pontoporeia* | 710 |
| | | | | Oligochaetes | 1288 |
| | | | | **Sum** | **5861** |
| July 23, 1952 | Taughannock | 98-105 m | Henson | Pontoporeia | 1459 |
| | | | | Oligochaetes | 2525 |
| | | | | Pisidium | 460 |
| | | | | Heterotrissocladius | 325 |
| | | | | Ostracods | 98 |
| | | | | **Sum** | **4867** |
| August 6, 1953 | Taughannock | 98-105 m | Henson | Pontoporeia | 949 |
| | | | | Oligochaetes | 7593 |
| | | | | Pisidium | 221 |
| | | | | Heterotrissocladius | 161 |
| | | | | Ostracods | 304 |
| | | | | **Sum** | 9228 |
| July 25, 1972 | King Ferry | Est 100 m | Dahlberg | *Pontoporeia* | 2016 |
| | | | | Chironomids (including *Heterotrissocladius* | 66 |
| | | | | Oligochaetes | Not enumerated |
| | | | | sum | >2082 |
| July 25, 1972 | Taughannock | Est 100 m | Dahlberg | *Pontoporeia* | 4506 |
| | | | | Chironomids (including *Heterotrissocladius* | 20 |
| | | | | Oligochaetes | Not enumerated |
| | | | | **Sum** | **>4526** |
| July 22, 1994 | Meyers | 90 m | Mills for LSC | Pontoporeia | 1765 |
| | | | | Oligochaetes | 3187 |
| | | | | *Chironomids* | 184 |
| | | | | Ostracods | 7084 |
| | | | | **Sum** | **12,220** |

Source: Ogelsby 1978 pg 96
Stearns & Wheler 1997

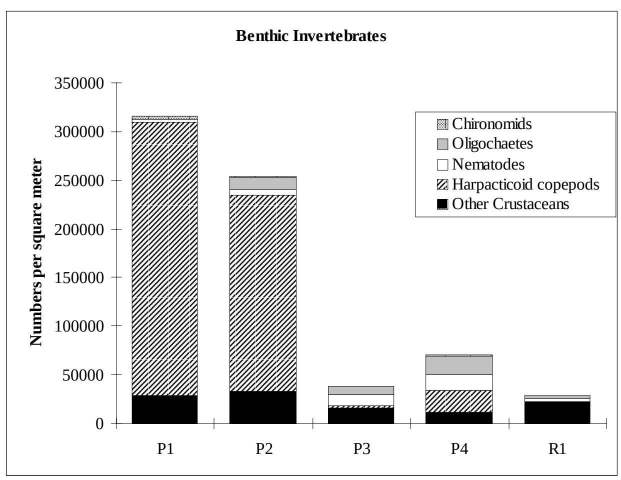



Figure 4.3.14 Abundance of benthic macroinvertebrates, Cayuga Lake, July 22, 1994. Source: Sterns & Wheler, 1994

### 4.3.3.5.1 Deep Water Fish Community

As discussed in Section 4.1, Physical Characteristics, approximately half of the volume of Cayuga Lake is deeper than 40 meters. The deep water supports a thriving fish community including water column (pelagic) and bottom oriented (benthic) species. The fish community is dominated by four salmonid species as the top predators: lake trout, rainbow trout, brown trout, and landlocked Atlantic salmon. Only the lake trout is native to Cayuga Lake; the other three salmonid species have been introduced. As described in the Strategic Fisheries Management Plan for Cayuga Lake (Chiotti 1980), the populations of all four salmonids are maintained by

| **Table 4.3.20** Fish Species Present in Cayuga Lake | | |
|---|---|---|
| **Family** | **Species (Scientific Name)** | **Species (Common Name)** |
| Petromyzontidae | *Petromyzon marinus* | sea lamprey |
| Acipenseridae | *Acipenser fulvescens* | lake sturgeon |
| Lepisosteidae | *Lepisosteus osseus* | longnose gar |
| Amiidae | *Amia calva* | bowfin |
| Anguillidae | *Anguilla rostrata* | american eel |
| Clupeidae | *Alosa psuedoharengus* | alewife |
| | *Dorosoma cepedianum* | gizzard shad |
| Cyprinidae | *Cyprinus carpio* | common carp |
| | *Cyprinella analostanus* | satinfin shiner |
| | *Notropis hudsonius* | spottail shiner |
| | *Notemigonus crysoleucas* | golden shiner |
| | *Rhinicthys atratulus* | blacknose dace |
| | *Rhinicthys cataractae* | longnose dace |
| | *Semotilus atromaculatus* | creek chub |
| | *Semotilus corporalis* | fallfish |
| Catostomidae | *Catostomus commersoni* | white sucker |
| | *Hypentelium nigricans* | northern hog sucker |
| | *Moxostoma sp.* | redhorse |
| Ictaluridae | *Ameiurus nebulosus* | brown bullhead |
| | *Ictalurus punctatus* | channel catfish |
| | *Notorus flavus* | stonecat |
| Esocidae | *Esox lucius* | northern pike |
| | *Esox niger* | chain pickerel |
| Osmeridae | *Osmerus mordax* | rainbow smelt |
| Salmonidae | *Coregonus artedi* | cisco |
| | *Coregonus clupeaformis* | lake whitefish |
| | *Oncorhynchus mykiss* | rainbow trout |
| | *Salmo salar* | Atlantic salmon |
| | *Salmo trutta* | brown trout |
| | *Salvelinus namaycush* | lake trout |
| Percopsidae | *Percopsis omiscomaycus* | troutperch |
| Gasterosteidae | *Culaea inconstans* | brook stickleback |
| Cottidae | *Cottus cognatus* | slimy sculpin |
| Percichthyidae | *Morone americana* | white perch |
| | *Morone chrysops* | white bass |
| **Family** | **Species (Scientific Name)** | **Species (Common Name)** |
| Centrarchidae | *Ambloplites rupestris* | rock bass |
| | *Lepomis gibbosus* | pumpkinseed |
| | *Lepomis macrochirus* | bluegill |
| | *Micropterus dolomieui* | smallmouth bass |
| | *Micropterus salmoides* | largemouth bass |
| | *Pomoxis nigromaculatus* | black crappie |
| | *Pomoxis annularis* | white crappie |
| Percidae | *Etheostoma olmstedi* | tesselated darter |
| | *Perca flavescens* | yellow perch |
| | *Percina caprodes* | logperch |
| | *Stizostedion vitruem* | walleye |

Source: Chiotti, 1977, 1980, personal communication 1999 stocking. Stocking is needed due to failure of natural reproduction or high mortality of early-life stages.

Distribution of fishes in the water column is a result of species and size-specific responses to temperature, light, and predator-prey interactions. Distribution consequently varies with size and life stage of fish, time of day, and time of year. Juvenile salmonids prey on zooplankton while adult salmonids are largely piscivorous, eating alewives, rainbow smelt, troutperch, and slimy sculpin. Deep water species migrate to streams and littoral areas to spawn and, when water temperatures are low, to feed. At some times of the year (usually late fall through early spring when the lake is isothermal) deep water species can be found in littoral regions of the lake.

Daytime and nighttime hydroacoustical surveys were conducted to estimate distribution and abundance of the deep water fish community as part of the field investigations for Cornell's Lake Source Cooling initiative. Surveys were conducted in April, August, and October. High-frequency hydroacoustical equipment was applied; this technology uses split-beam sound waves to determine the target strength of individual fish and then applies the target strength of an individual fish to the total integrated echo response to estimate the absolute abundance of fish. Gill nets were set to confirm the hydroacoustical findings.

Results of the hydroacoustical surveys demonstrate that most fish are found in upper waters during the stratified period (Figures 4.3.15 ). Fish are more abundant closer to shore than towards the middle of the lake, and smaller fish are found at shallower depths. Few fish (less than 3% of the total biomass) were found in water deeper than 50 m in August or October. A subtle difference between night and day distribution was observed. Although the acoustical signal was concentrated in the top 40 m during day and night surveys, fish were generally found higher in the water column during the day. Two peaks of distribution were evident in the day surveys. One layer of schooling fish was present in shallow water (less than 10 m). A higher number of non-schooling (dispersed) fish was found at 40 m. The majority of the larger fish (which were presumably salmonids based on their size) were found below 20 m during both the August and October surveys.

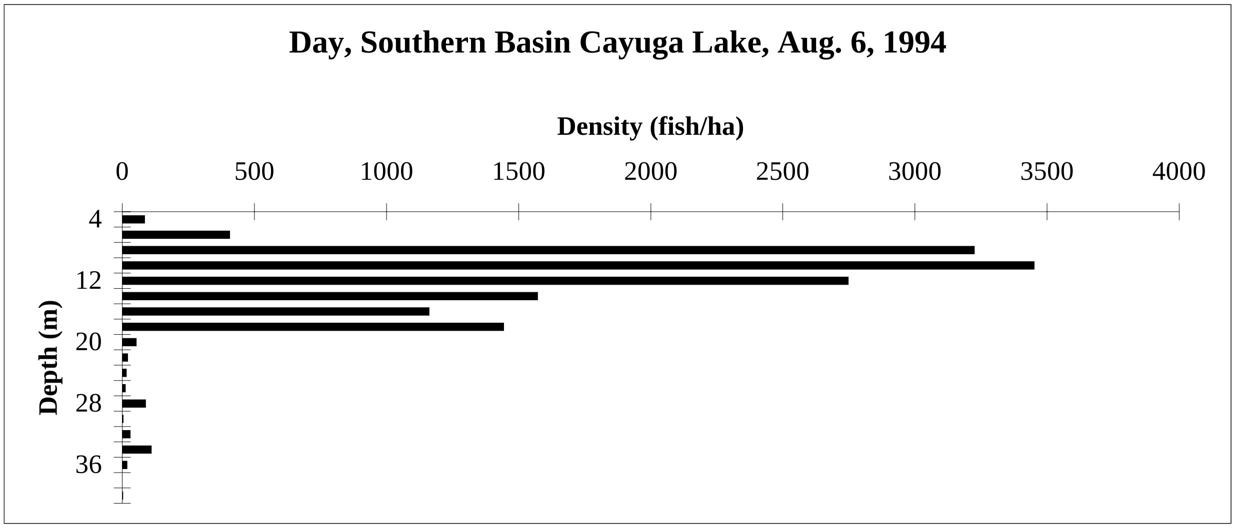
Based on the presence of some fish at the depth of the LSC intake during winter, the intake has been screened. This will prevent drawing fish into the cooling waterloop.

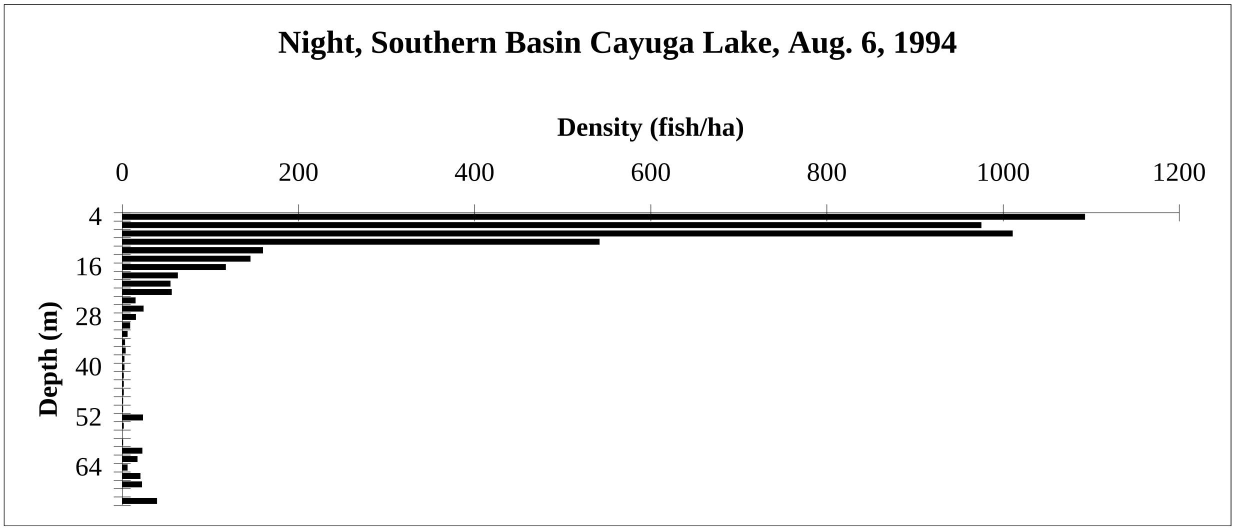
The April survey detected fish deeper in the water column, consistent with the limited historical data regarding winter distribution. Approximately 60% of the fish were present at depths shallower than 40 m during the April survey when the lake was isothermal. In contrast, recall that close to 90% of fish were at water depths shallower than 40 m during the April and October surveys when the lake was thermally stratified. Another one-third of the population was located between 40 and 60 m during the April survey and the remaining 7 % was found below 60 m.

The strength of hydroacoustical signal provided an indication of the size of fish detected during the April survey. Fish smaller than alewife and rainbow smelt formed the majority of the population to 20 m, and rapidly diminished with increasing water depth. Alewives and smelt formed an increasing percentage of the population as depth increased. Fish larger than alewife and smelt, including salmonids, were concentrated from 40 to 60 m, slightly deeper than the peak of 20 – 40 m during the stratified period.

Several graduate student theses have examined the depth distribution of Cayuga Lake fishes over portions of the annual cycle, and discussed the observations with respect to thermal preferences, predator-prey relationships, and reproductive behavior. Galligan (1951) focused on the distribution of lake trout and alewife. His data were collected using gill nets set during various seasons (primarily summer), depths, and locations in Cayuga Lake. He drew the following conclusions from his field program:

- During summer months, lake trout are most abundant in a relatively narrow band between 24 and 30 m. Distribution of this fish is consistent across size and age class.
- As the water cools in the fall, lake trout move towards shallower water.
- Distribution of the alewife is markedly similar to the distribution of lake trout.
- Alewives move to shallower waters to spawn (peak spawning period is late June-early July). Large schools can be observed in the evenings in near-shore areas.
- Beginning in October and November, alewives are found deeper in the lake. No alewives were found in water less than 13 m during winter sampling events.



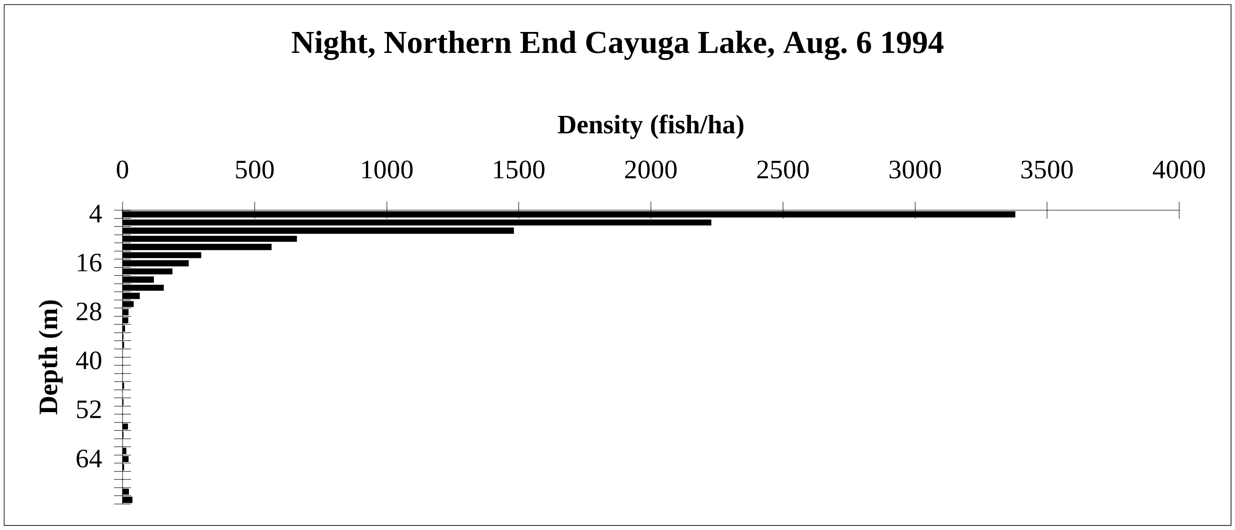




Figure 4.3.15 Fish densities, Cayuga Lake, New York, August 1994

Cayuga Watershed Characterization Report

Source: Stearns & Wheler 1997.

Another graduate student examined life history and distribution of the alewife in Cayuga Lake and concluded as follows (Rothschild 1962):

- Population of the alewife in Cayuga Lake fluctuates greatly from year to year.
- Mature alewives move into littoral areas in early summer, spawning takes place in mid-summer.
- Alewives are positively phototactic (attracted to light) except when exhibiting spawning behavior
- Young-of-year alewives are present in net catches by late August. They remain inshore into fall, but are recruited into the offshore (pelagic) population as fall progresses

Finally, Gibson (1981) used hydroacoustics and limited gill-netting to document depth distribution, temperature preference, and schooling behavior of Cayuga Lake alewife. He concluded that schools of alewives move progressively deeper in the lake as the water cools in the fall. Distribution appeared generally consistent with the upper limit of the thermocline and associated deep layers of *Mysis relicta* and other planktonic organisms. However, there appeared to be a well-defined limit to the depth distribution of the alewife; no fish were detected at water depths below 75 m.

Table 4.3.21 summarizes information on temperature preferences and summer distribution of Cayuga Lake cold water fishes. Table 4.3.22 provides a summary of reproductive biology.

*Lake Trout*

The dominant sport fishery in Cayuga Lake is for lake trout. Despite the fact that the lake trout is native to Cayuga Lake, the species is no longer able to reproduce naturally within the lake. The lack of reproductive success is manifested in the "Cayuga Syndrome" an early life mortality syndrome evident in salmonids in several Finger Lakes and Great Lakes. Several days after hatching, close to 100% of the swim-up fry die during yolk absorption. Various explanations for the mortality have been advanced including contamination by chemicals or infectious diseases (Fynn-Aikins et al. 1998). The hypothesis with the strongest experimental support is that the mortality is due to thiamin deficiency in the parent (brood) stock of salmonids caused by consumption of forage fish that contain thiaminase (Fisher et al. 1995). The Cayuga Syndrome is found in Finger Lakes with alewife and rainbow smelt, both of which contain the enzyme thiaminase.

**Table 4.3.21 Thermal Preferences, Deep Water Fishes**

| Species | Preferred Temperature |
|---|---|
| lake trout | 10 °C |
| rainbow trout | young > 19 °C |
| | adult 15 °C |
| brown trout | 10 – 18 °C |
| Atlantic salmon | 10 – 13 °C |
| yellow perch | young 15 – 20 °C |
| | adult 15 – 16 °C |
| alewife | young 15 – 20 °C |
| | adult 11 – 14 °C |
| smelt | larvae: 10 – 14 °C |
| | adult 7 – 12 °C |
| troutperch | 14 – 18 °C |
| slimy sculpin | < 6°C |

Sources: Smith 1985, Brandtt et al. 1980

The lake trout population has been maintained through a stocking program that started as early as 1897 (Chiotti 1980). Abundance has fluctuated due to variations in stocking rates and the abundance of forage fish. Relatively high stocking rates and high recruitment allowed a rapid increase of the lake trout population in the 1950's. The fishery was less productive in the 1970's (Chiotti 1980), but recovered again in the 1980's (Bishop 1992). Since the 1980's, 72,000 yearling equivalents have stocked annually in the lake. However, in the late 1980's, there was an inverse relationship between adult densities and growth rates of juveniles. This suggests that the lake trout population in Cayuga Lake is approaching carrying capacity (Bishop 1992).

| Table 4.3.22 Spawning Requirements, Deep Water Fishes | | | | |
|---|---|---|---|---|
| **Fish Species** | **Habitat** | **Spawning Period** | **Temperature (°C)** | **Reproductive Population** |
| lake trout | Lake, 30 – 50 m | Sept. – Oct | 10 ° | no |
| rainbow trout | Streams, gravel | April – June | 10 – 15 ° | yes |
| brown trout | Streams, gravel | Nov. - Jan | 4-8 ° | no |
| Atlantic salmon | Streams, rocky | Oct. – Nov | 6 – 8 ° | no |
| cisco | Lake, rocky shoals | Late fall | Ice forming | yes (limited) |
| alewife | Lake shores | May – Aug | 10 – 21 ° | yes |
| smelt | Streams, crevices | Feb. – March | 9 ° | yes |
| troutperch | Streams, rocky | Feb. – march | 19 ° | yes |
| slimy sculpin | Lake-streams, crevices | April – May (streams) | 2 – 13 ° | yes |
| sea lamprey | Streams, riffles | April – Aug. | 10 – 21 ° | yes |

Sources: Smith 1985, Becker 1983, Scott and Crossman 1973, Chiotti 1980

The lake trout spends most its life in deep water. The preferred temperature of lake trout is about 10 °C. (Youngs and Oglesby 1972; Chiotti 1980). In the Great Lakes, this species is most abundant between 30 and 90 m. The fish mostly stay on or near the lake bottom, but a few may occur in the open water offshore (Becker 1983). In Cayuga Lake, the NYSDEC samples the lake trout population in August using gill nets set below the thermocline, typically between 30 and 55 m (Bishop 1992).

Lake trout smaller than 25 cm feed primarily on the hypolimnetic crustacean *Mysis relicta* (Youngs and Oglesby 1972) and occasionally on the benthic amphipod *Diporeia affinis*, sculpin, and small alewives. Fish larger than 25 cm prey mostly on alewives (Youngs and Oglesby 1972, Chiotti, Sage, and Emerson 1977, Bishop 1992), especially during the summer months. Slimy sculpin, rainbow smelt and troutperch are also part of the diet. Lake trout prey on smelt during the spring when the surface waters are cool and smelt congregate near the mouths of tributaries to spawn. As the trout get larger, the proportion of alewives in the diet increases (Chiotti, Sage, and Emerson 1977). This finding is consistent with observations of lake trout in the Great Lakes (Stewart et al. 1983).

*Rainbow Trout*

Another important sport fish in Cayuga Lake is the rainbow trout, an introduced species. Rainbow trout is one of the most tolerant of the salmonids to a wide range of temperatures. Juveniles prefer to be at about 19° C (Rand et al. 1993). In Lakes Michigan and Superior, rainbow trout prefer shoal water that is 4.6 to 10.7 m deep (15 to 35 ft) (Becker 1983). Little is known of their distribution in Cayuga Lake, but extensive movement in the lake is suspected (Youngs and Oglesby 1972).

The first introduction of rainbow trout to Cayuga Lake in the 1800's was apparently unsuccessful. Introductions between 1954 and 1958 led to the establishment of a self-sustaining population in Cayuga Inlet and Salmon Creek. The population has apparently been stable since 1965 (Chiotti 1980). However, the wild populations are not large enough to provide a strong lakewide fishery. The limiting factor for more natural reproduction is the availability of nursery areas in tributaries. For this reason NYSDEC has been stocking Cayuga Lake with rainbow trout since 1975. In the 1980's, some 40,000 yearlings were stocked annually and accounted for 30 to 40 percent of the harvested fish.

Rainbow trout spawn in the spring in tributaries to Cayuga Lake. Younger and mostly male spawners migrate to the streams in the fall and remain there until spring when the majority of spawners join them. Migrant fish have been trapped in the Cayuga Inlet fishway from October to April (Boreman 1974). Spawning occurs on gravely substrate, usually in riffles. The juveniles reside in the stream up to three years, migrate to the lake where they stay for two years, and then return to spawn in their stream of origin (Youngs and Oglesby 1972). Less than 10 percent of the females and even fewer males survive to spawn the following year.

Rainbow trout in the Great Lakes feed on aquatic and terrestrial insects, zooplankton, and macroinvertebrates; as they grow larger, they eat progressively more rainbow smelt and alewives (Rand et al. 1993). Food habits of the Cayuga Lake rainbow trout population have not been examined, but there is no reason to believe that they would differ greatly from those found in the Great Lakes.

*Brown Trout*
Brown trout were first introduced to Cayuga Lake in 1917 (Chiotti, Sage, and Emerson 1977). A recreational fishery is maintained by annual stocking of 15,000 yearlings. There are no published data on distribution of brown trout in Cayuga Lake. Because their preferred temperature is 10 to 18.3 °C (Becker 1983), brown trout probably inhabit the metalimnion Cayuga Lake. Young brown trout feed on zooplankton and benthic invertebrates. Adults feed mostly on fish.

*Landlocked Atlantic Salmon*
Landlocked salmon were re-introduced to the lake in 1957, and small populations are maintained by stocking. Throughout the 1980's, about 15,000 yearlings and 270,000 spring fingerlings were stocked annually in tributaries. Apparently, relatively low proportions of these fish return to spawn in the tributaries. Most of the catch occurs in the lake. In recent years, Cayuga Lake has supported a popular fishery for the landlocked salmon (Chiotti, personal communication, November 1996).

*Alewife*
The alewife is the most important forage species for salmonids in Cayuga Lake. It is not known whether the alewife invaded the lake through the canal system, was introduced by anglers, or has been present since the last glacial recession (Youngs and Oglesby 1972). Mills et al. (1993) report that the alewife was discovered in Lake Ontario in 1873, and either expanded through the canal system from the Atlantic drainage or was native in the Great Lakes, but its numbers were depressed by salmonids.

Thermal distribution of the alewife differs significantly between day and night and between young and adults. Mature individuals move inshore from June to August. During spawning, they crowd the shore, and during the winter they may be found at depths up to 75 m. They also tend to move inshore at night and return to deeper waters during the day. After spawning, they move to the sublittoral waters. In Lake Michigan, young alewives prefer temperatures greater than 15 °C, while adults are most abundant at 11 to 14 °C (Brandt, Maguson, and Crowder 1980). Rothschild (1962) reported that alewives in Cayuga Lake attain a maximum length of 15 cm (6 inches) and a maximum life span of five to six years.

Janssen and Brandt (1980) investigated vertical distribution and feeding habits of alewives over the 24-hour cycle in Lake Michigan. A vertical migration was documented. Adult alewives concentrated near the bottom (in 50 m of water) during the day, and migrated to mid-water depths at night. The upper limit of vertical migration was closely linked to the distribution o *Mysis relicta* and to the depth of the thermocline during stratified periods (Janssen and Brandt 1980). Alewife appears to avoid the steep thermal gradient associated with the thermocline (O'Gorman 1997).

Bergstedt and O'Gorman (1989) have documented winter distribution of the alewife in Lake Ontario near Oswego. Just as in Cayuga Lake, alewife moves deeper into the water column as the thermocline deepens in the fall. Results indicate that alewives are pelagic during the winter period, and are distributed in a stratum 40-80 m below the water surface. Distribution of the fish was quite uniform between the survey dates, suggesting little migration during winter. Warmer water habitat was available deeper than 40-80 m in Lake Ontario during the winter survey, but alewives were not common below 100 m depth. The preferred depth of 40-80 m is consistent with the distribution of alewife in its native oceanic environment, when southerly migration each winter leads the species to warmer water (Bergstedt and O'Gorman 1989; O'Gorman personal communication 1997).

The young alewife feeds almost exclusively on zooplankton, while the older fish also include *Mysis relicta* and *Diporeia affinis* in their diet (Hewett and Stewart 1989). In Lake Michigan, adult alewives closely followed *Mysis relicta* migrations at night and preyed on them (Janssen and Brandt 1980). Larger alewives also appear to be effective predators of the early life stages of many fishes, especially those with pelagic larvae, such as yellow perch and the coregonines, including cisco and whitefish (Crowder 1980; Eck and Wells 1987). In Cayuga Lake during the fall, the alewife reportedly feeds on the water column invertebrates *Bosmina*, *Daphnia*, and *Diaptomus*.

Hennick (1973) examined the growth rate of alewife and its relationship to zooplankton biomass and water temperature. Alewives were collected in experimental gill nets, set vertically at a station just north of Salmon Creek at Myers Point. He concluded that the growth rate of yearling alewives could be explained by fluctuations in food supply.

*Rainbow Smelt*

Rainbow smelt were introduced to Cayuga Lake in 1920. Populations remained low until the mid-1940's, when there was a marked increase of spawners. In Cayuga Lake, smelt are found at depths between 20 and 45 m in the summer. In the fall they move to shore, and during winter, they are found inshore at water depths of about 15 m. During stratification, young-of-year smelt are above the thermocline, where temperatures are 8 to 15 °C, segregated from older fish, which remain below the thermocline where temperatures are less than 10 °C (Lantry and Stewart 1993). Optimum temperatures for smelt are 6.1 to 13.3 °C (Becker 1983). Smelt spawn in March and April in all tributary streams. Three southern tributaries (Fall, Salmon, and Taughannock Creeks) support a popular dip netting fishery for the spring spawning run (Chiotti 1980).

In Cayuga Lake, young smelt prey primarily on *Mysis relicta* and secondarily on *Diporeia affinis* (Youngs and Oglesby 1972). Adult smelt are highly cannibalistic and also prey heavily on young alewives, which move offshore during the fall (Becker 1983).

*Troutperch*

Troutperch are native to Cayuga Lake, where they occur in shallow to intermediate depths. During the day, their preferred temperature is 7 °C and at night they expand their range to 15 to 16 °C (Brandt, Magnuson, and Crowder 1980). Troutperch probably migrate to spawn in tributary streams to Cayuga Lake from May to July (Smith 1985).

Young troutperch consume zooplankton, and older individuals eat *Mysis relicta*, *Diporeia affinis*, and chironomids. Lake trout, other salmonids, yellow perch, and northern pike prey on troutperch (Becker 1983).

*Slimy Sculpin*

This cold water species is typically distributed below the thermocline in Cayuga Lake, but also occurs in cooler tributaries. Although there is information on the reproductive habits of the population in Cayuga Inlet, little is known about the biology of the lake's population (Smith 1985). Sculpin are preyed upon by lake trout and probably by other salmonids as well (Youngs and Oglesby 1972, Chiotti, Sage and Emerson 1977). The fish feeds primarily on insect larvae; however, the stomachs of a few large individuals have been found with small fish and fish eggs (Koster 1936, cited in Smith 1985). In Lake Michigan, they also feed on *Diporeia affinis* and *Mysis relicta* (Kraft and Kitchell 1986).

*Cisco*

Ciscoes are native fishes whose population declined after the establishment of the alewife in Cayuga Lake (Youngs and Oglesby 1972). They are found in waters 25 to 43 m deep and are usually below the thermocline in the summer. In the fall, ciscoes move into shallow areas and spawn when ice is forming along the shores. Ciscoes are zooplanktivores throughout their lives.

#### 4.3.3.5.2 Shallow Water Fish Community

Due to its morphology Cayuga Lake has a relatively small area of littoral habitat to support the warm water fish community. The majority of habitat is found at the extended shelf on the northern end of the lake; the small shelf in the southern lake provides additional habitat. These areas are home to warm water fish assemblages. Dominant predators include smallmouth bass, largemouth bass, and northern pike. These fish prey on yellow perch, pumpkinseed, bluegill, rock bass, and various minnows. With the exception of largemouth bass, all these fish are indigenous. Largemouth bass were introduced with construction of the canal system. In the southern end, there is a population of white sucker that spawn in Cayuga Inlet and other southern tributaries. Reproductive requirements of the common littoral fishes are summarized in Table 4.3.23.

| Table 4.3.23 Spawning Requirements, Littoral Fishes | | | |
|---|---|---|---|
| **Fish Species** | **Habitat** | **Spawning Period** | **Temperature** |
| Smallmouth bass | Gravel | May – July | 17 – 18 °C |
| Largemouth bass | Vegetation | May – June | > 15 °C |
| Northern pike | Vegetation | March – April | 10 °C |
| Chain pickerel | Vegetation | April – May | 8 - 11°C |
| Yellow perch | Vegetation | April – May | 7 – 11 °C |
| Black crappie | Vegetation | May - July | 20 °C |
| Bluegill | Gravel | May – July | >21 °C |
| Golden shiner | Vegetation | May - August | >20 °C |
| Rock bass | Gravel | April – June | 20-23 °C |
| Pumpkinseed | Vegetation | May – August | >15 °C |
| White sucker | Gravel | April – June | 5 – 12 °C |
| Carp | Vegetation | May - August | 17 °C |
| Brown bullhead | Crevices | May - June | 17 °C |
| Spottail shiner | Sand | June - July | Undocumented, probably 15-. 20 °C |
| Tesselated darter | Undersides of rocks | April | Undocumented, probably. 5 - 10 °C |

Sources: Smith 1985, Becker 1983, Scott and Crossman 1973

*Smallmouth Bass*
A large population of smallmouth bass provides an excellent fishery at the northern end of the lake (Youngs and Oglesby 1972). Spawning takes place in the southern tributaries from May to July. Tag return data suggest extensive movement of smallmouth bass in the lake. Smallmouth bass are found at 2 to 9 m along the shore and in the autumn to depths of 13 m. The fish prefer temperatures of 20 to 27 °C; waters below 10 °C make the fish lethargic. In the winter, smallmouth bass seek refuge among rocks and ledges where they remain semidormant until spring (Becker 1983).

Smallmouth bass are opportunistic predators. Small fish eat zooplankton. As they grow, their diet shifts to insects, crayfish, frogs, and a variety of small fish, particularly yellow perch (Smith 1985).

*Other Species*
Historically, largemouth bass, chain pickerel, northern pike, yellow perch and bullhead have been less abundant than smallmouth bass in Cayuga Lake. In the past, these warm water fishes were objects of small local fisheries. They prefer warm weedy areas in the lake. Draining and filling of wetlands in the northern and southern ends of the lake have been detrimental to the habitat and populations of these fish. Active fisheries currently exist for largemouth bass, smallmouth bass, yellow perch and white crappie.

The southern end of the lake has a relatively large population of white suckers. These benthic feeders spawn in Cayuga Inlet in late April and May. Another common benthic feeder is the common carp.

An important species in Cayuga Lake is the sea lamprey. Like the alewife, the sea lamprey is considered an exotic species that may have invaded the lake through the canal system; however, there are scientists who believe it to be a relict of the last ice age and glacial retreat. Lamprey is a parasite of all large fish in the lake, but particularly of trout (Youngs and Oglesby 1972). Since 1969, the sea lamprey population has been partially controlled by removal of spawning adults at the fishway in Cayuga Inlet. A lampricide treatment applied in 1986 in Cayuga Inlet appears to have reduced the population of sea lamprey.

#### 4.3.3.6 Exotics

The invasion of ecosystems by nonindigenous (exotic) species has become a problem worldwide (Enserink 1999). Travel and trade have facilitated introductions of species of plants and animals into new environments. Most imports die quickly, but an estimated one species in ten survive in the new environment. An even smaller percentage of the invaders (less than 1%) actually thrive and can outcompete native species; in many cases, invasive species alter the processing of energy and nutrients throughout the food web. Biological invasions are the second largest cause of the loss of biodiversity, second only to habitat destruction.

The Great Lakes have been repeatedly invaded by plants and animals. Since the 1800s, at least 136 exotic aquatic organisms of all types: plants, fish, zooplankton, mollusks, and algae have been introduced. More than one-third have been introduced in the last 30 years, coinciding with opening of the St. Lawrence Seaway. Because of the hydrologic connection, many species introduced to the Great Lakes ultimately are found in the Finger Lakes.

Some nonindigenous species have long been part of the Cayuga Lake ecosystem. Rainbow smelt, alewife, white perch, common carp, and sea lamprey were introduced to Cayuga Lake as were rainbow trout and brown trout. Introduced plant species include eurasian watermilfoil, curly-leaf pondweed, and purple loosestrife. Eurasian watermilfoil *Myriophyllum spicatum* is highly visible to lake users. As discussed in the section on macrophytes, abundance and dominance of this macrophyte have declined precipitously in recent years. The decline was concurrent with the discovery of herbivory by another nonindigenous species, *Acentria ephemerella*. Experiments with biological control of the purple loosestrife are underway; two leaf-eating beetles and a flower-feeding weevil are being tested for their effectiveness in controlling the spread of this wetland plant.

The water chestnut, *Trapa natans,* is a nonindigenous nuisance species of macrophyte. It has been present in Sodus Bay of Lake Ontario for a number of years and was recently detected in the Seneca and Oswego Rivers and the western area of Oneida Lake. Montezuma wetland at the northern end of Cayuga Lake is vulnerable to invasion by this species.

Some of the most recent invaders to the ecosystem are among the most visible. *Dreissena polymorpha* (zebra mussel) was first detected in Lake St. Clair in 1986. This small freshwater mussel has spread throughout the Great Lakes and their connecting waterways, the Finger Lakes, and many major river systems of the northeast. Zebra mussels entered Cayuga Lake through the Seneca River in the early 1990s and have spread from north to south. By 1996, zebra mussels were widely distributed throughout the lake, with dense populations in nearshore areas. Water suppliers, utilities, and other water users with intakes less than 10 m have found it necessary to employ control measures to minimize or prevent fouling.

A closely related species *Dreissena bugensis*, quagga mussel, was identified in Cayuga Lake in 1994 (Mills et al. 1995). Quagga mussels thrive in the same water quality conditions as zebra mussels except that their reproductive temperature limit is lower (8 °C as compared to 12 °C for the zebra mussel) and their preferred temperature range is wider (4 – 20 °C as compared to 12 – 20 °C for zebra mussel). The shape of the shells is different; quagga mussels are more rounded and appear to be better adapted for softer substrates (Mills et al. 1993).

In Lake Ontario, quagga mussels are more abundant than zebra mussels in deeper water. According to Mills (1996a) quagga mussels are displacing zebra mussels at depths greater than 25 m and their numbers are increasing. Mills (1996b) expects that quagga mussels will ultimately be the more dominant species in the Great Lakes and Finger Lakes. Native mollusks (clams and snails) are outcompeted in the presence of dreissenid mussels.

Long-term effects of zebra mussels on lakes include increased water clarity and an enriched benthos. Mussels feed by filtering particles suspended in the water column; large quantities of organic material is pulled down from the water column to the benthos. One result is an increase in the diversity and production of all groups of benthic organisms. Periphytin and macrophytes benefit from the improved water clarity and, like zoobenthos, benefit from the increased nutrients and organic carbon found at the sediment surface. Many benthic macroinvertebrates benefit from the increased surface area created by the mussel shells. Production of benthic feeding fish can increase from the improved food supply.

Two exotic crustaceans, the predatory cladoceran zooplankton *Bythotrephes cederstroemi* (spiny waterflea) and *Cercopagis pengoi* (predatory waterflea) are recent invaders of the Great Lakes with the potential for altering the aquatic ecosystem. By October 1999, *Cercopagis* was confirmed present in Cayuga Lake, while *Bythotrephes* was not. Predation by these zooplankton on smaller cladocerans has the potential to affect the size distribution and composition of the phytoplankton community. These organisms may also affect fish populations by competing with young-of the-year fish for prey, or by becoming prey for older fish.

Two exotic fish have recently been confirmed in the Great Lakes and may eventually find their way to Cayuga Lake. The round goby, *Neogobius melanostomus*, is an aggressive bottom-dwelling fish considered a voracious feeder. A native of the Caspian Sea, the goby was probably introduced in ballast water and is now found throughout the Great Lakes and in major river basins of the Midwest. The goby can take over prime spawning sites and will compete with native fish for habitat. The river ruffe (*Gymnocephalus cernuus*) is a small spiny perch with a high reproductive rate. This fish has been found in Lake Superior and connecting waterways.

The National Invasive Species Act of 1996 is the federal legislation to address the issue of nonindigenous species. This bill reauthorizes and expands the original 1990 legislation. A key provision is management of ballast waters, which limits the discharge of water from overseas ecosystems.

#### 4.3.3.7 Pathogens and indicator organisms

Pathogens (disease causing microorganisms) originate from untreated or inadequately treated human sewage and wild and domestic animal waste. Pathogens can enter Cayuga Lake from point and nonpoint sources such as stormwater runoff and septic tank leachate. Human exposure to pathogens can occur from direct contact with or ingestion of contaminated waters. Elevated concentrations are more likely to occur in nearshore areas and at the mouths of tributaries, since microorganisms die once introduced to the aquatic environment.

The potential presence and abundance of many pathogenic microorganisms (including viruses) are assayed using indicator organisms such as coliform or streptococcal bacteria. Indicator organisms are easily measured by standardized protocols and their presence and abundance are correlated with the presence and abundance of pathogens. When the abundance of indicator organisms indicates that pathogens may be present over acceptable threshold levels, human use of the resource for drinking or water contact recreation may be restricted. Other pathogens such as *Giardia* and *Crypotsporidia* are assayed using direct measurements.

Existing data on pathogens and indicator organisms in Cayuga Lake are relatively limited. Distribution of microorganisms in the lake is extremely variable in time and space, and conditions in other areas or time periods cannot be inferred from the few results available

Monitoring for pathogens and indicator organisms is required of public water suppliers as part of their Dept. of Health permit. Concentrations of microorganisms in the intake water for the water treatment plants are consistently low.

Wastewater treatment plants discharging to the Lake and tributaries monitor their effluent for indicator organisms to comply with SPDES permit requirements. Effluent from the wastewater treatment plants is disinfected on a year-round basis. The treatment plants are in compliance with their requirement to maintain fecal coliform bacteria concentrations less than 200 cells per 100 ml (the standard for water contact recreation).

Monitoring is also required for bathing beaches Cayuga County Health Department routinely monitors bathing beaches for fecal coliform bacteria. According to Eileen A. O'Connor, Environmental Health Director, no beaches on Cayuga Lake have been closed in recent history. 1994 – 1998 monitoring data for four beach areas (at two water depths) are presented in (Table 4.3.24).

Tompkins County Health Dept. occasionally monitors the area around Stewart Park for fecal coliform bacteria. Because there is no public swimming beach at this park, monitoring is not conducted on a routine basis. Monitoring has occasionally demonstrated elevated levels of fecal coliform bacteria in nearshore areas. The relative contribution of waterfowl, urban stormwater, and effluent from the wastewater treatment plants is not known.

A microbial source tracking study was done on nearby Owasco Lake (Samadpour, 1999). Genetic fingerprinting data from a total of 335 E. coli isolates from 11 sampling stations (site samples) and various sources of microbial pollution in the Owasco Lake Watershed were analyzed.

| **Table 4.3.24** Results of Cayuga County Health Dept. Monitoring for Fecal Coliform Bacteria, 1994 – 1998 | | |
|---|---|---|
| Location and Date | **Fecal Coliform Bacteria (cells/100 ml)** | |
| | **Sample at 18 inches** | **Sample at 60 inches** |
| ***Wells College Dock (Aurora)*** | | |
| 7/30/98 | 20 | 2 |
| 7/15/98 | 11 | 18 |
| 6/23/98 | 15 | 12 |
| 8/6/97 | 30 | 44 |
| 7/16/97 | 41 | 20 |
| 7/1/97 | 23 | 31 |
| 7/9/96 | 11 | 8 |
| 6/20/96 | 380 | 10 |
| 7/26/95 | 670 | 160 |
| 8/8/94 | 327 | <10 |
| ***Frontenac Park*** | | |
| 7/30/98 | 51 | 45 |
| 7/15/98 | 22 | 71 |
| 6/23/98 | 29 | |
| 8/6/97 | 123 | 76 |
| 7/1/97 | 35 | 54 |
| 8/14/96 | 41 | 5 |
| 6/27/96 | 100 | 10 |
| 8/16/94 | 83 | 167 |
| 8/8/94 | 345 | 227 |
| **Harris Park** | | |
| 7/15/98 | 13 | 54 |
| 6/23/98 | 31 | 29 |
| 8/6/97 | 175 | 210 |
| 6/30/97 | 120 | |
| 6/27/96 | 44 | |
| 8/14/96 | <10 | |
| 7/13/95 | 10 | 7 |
| **Camp Gregory** | | |
| 7/30/98 | 66 | 15 |
| 7/15/98 | 21 | 18 |
| 6/23/98 | 16 | 11 |
| 8/8/94 | 5600 | 2800 |
| 8/16/94 | 100 | |
| 7/18/94 | 173 | 27 |

Source: Cayuga County Health Dept. March 1999

The sampling stations included four of the major tributaries to the lake, the Owasco Outlet, and four lake sites (beaches). The tributaries had 60 E. coli strains analyzed with 42% matching to known sources. The major sources matched to agriculture (cows) and wildlife (waterfowl and deer). The minor sources matched to humans and pets. The beaches and Owasco Outlet had 119 E. coli strains analyzed with 38% matching to known sources. The major sources matched to wildlife (largely waterfowl). The intermediate sources matched to agriculture. The minor sources matched to humans and pets.

### 4.3.4 Compliance with ambient water quality standards and guidance values

In New York, the DEC classifies surface waters according to their designated “best use”. Cayuga Lake is classified into four distinct segments, reflecting differences in the lake’s morphometry (shape and depth of the basin) and water quality.  South of McKinneys Point, Cayuga Lake is Class A, with a designated best use for water supply (with filtration).  The main, deep body of the lake is Class AA (T), with a designated best use for water supply (without filtration). The T designation indicates that the waters support a salmonid fish community. Another Class A (T) segment begins at the northern shelf. The northernmost segment of the lake, including the Seneca-Cayuga Canal and the lake outlet, is Class B (T) with a designated best use for water contact recreation. These segments are displayed in Figure 4.3.16

Each designated use has an associated set of ambient water quality standards and guidance values designed to protect the ecological community and human uses associated with the use. These standards and guidance values are based on the best available scientific information relating water quality to human health and ecological integrity.

Monitoring data are used to evaluate whether water quality supports the designated use of the surface water resource, by comparing measured values to ambient water quality standards and guidance values. When monitoring detects adverse water quality conditions, that may affect a designated use, DEC adds the lake or stream to its list of "priority waterbodies" (the PWL). Waterbodies are ranked on a scale of increasing severity: *Threatened* (conditions indicate potential impairment to best use), *Stressed* (evidence of adverse water quality conditions), *Impaired* (designated use only partially met), and *Precluded* (designated use not met).

Two segments of Cayuga Lake are included on the NYSDEC 1998 305(b) Report. Southern Cayuga Lake in Tompkins County {5000 acres of Class A and a portion of the Class AA (T) segments} is considered "threatened" by silts. The affected use is water supply, and the primary source is identified as streambank erosion. 6000 acres of the Class A (T) segment northern Cayuga Lake, Seneca and Cayuga Counties, is considered "impaired" by nutrients. The affected use is recreational, boating and swimming, and the primary source is listed as on-site septic systems.

A subset of the PWL is the 303d list, named for the section of the federal Clean Water Act requiring states to report to EPA those waterbodies requiring a watershed approach to water quality protection or restoration. A watershed approach examines all point and nonpoint sources of nutrients and develops an integrated strategy for improvement. In April 1998, New York added Cayuga Lake to the 303d list, noting a need for additional information.

Overall, the waters of Cayuga Lake are in compliance with applicable ambient water quality standards and guidance values developed to protect the designated use. There are gaps; however, data we have examined show that the lake supports its designated uses. The standards and associated data supporting this statement are summarized in Table 4.3.25. Recent improvements in water clarity in northern Cayuga Lake are documented in the Secchi disk transparency data of Seneca County Soil and Water Conservation District (refer to Figures 4.3.6 and 7). The improved water clarity, a likely result of the zebra mussel invasion, may alter the listing of this water segment on the next revision of the PWL.

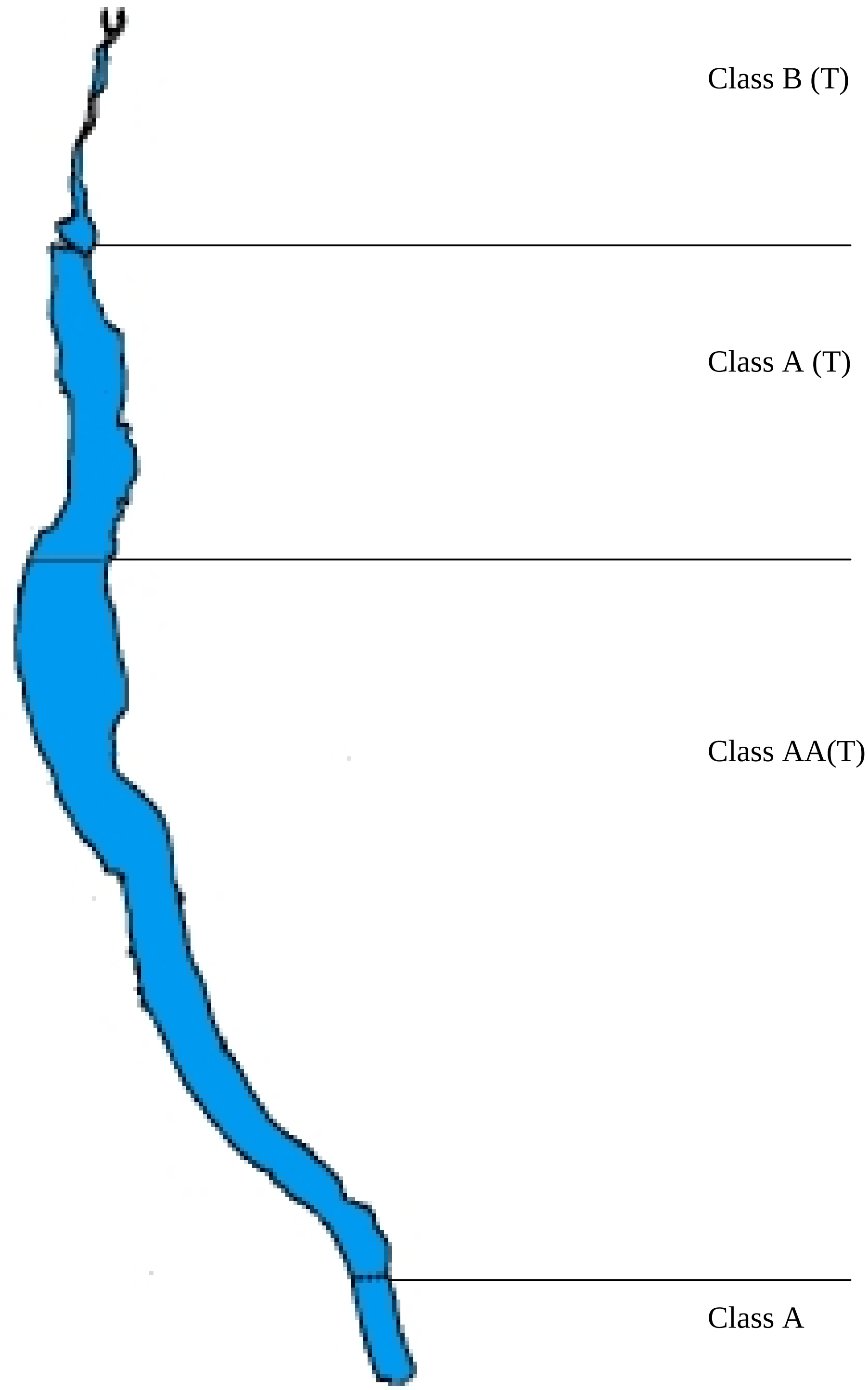



Figure 4.3.16. Classification segments of Cayuga Lake

<u>TABLE 4.3.25</u>

Regulatory Compliance, Cayuga Lake Waters
Cayuga Watershed Characterization Report

| **Parameter** (units) | **NYSDEC Standard** | **Reported Data** |
|---|---|---|
| **pH** (standard units) | Shall not be less than 6.5 nor more than 8.5 | Upper water summer pH occasionally exceeds 8.5 |
| **Dissolved Oxygen** (mg/l) | Minimum daily average 5.0 mg/l, at no time shall DO be < 4.0 mg/l | No violations throughout water column |
| **Dissolved Solids** (mg/l) | Shall be kept as low as practicable to maintain the best usage of waters but in no case shall it exceed 500 mg/l. | No violations |
| **Fecal Coliform** (cells/100 ml) | The monthly geometric mean, from a minimum of five examinations, shall not exceed 200 cells/100ml. | Limited data available at required temporal frequency. Occasional single measurements exceed 200 cells/100 ml |
| **Ammonia-N** (mg/l) | Varies with pH and temperature. | Elevated NH3 in mixing zone at IAWWTP outfall. Occasional exceedance chronic toxicity, no exceedance acute toxicity. |
| **Arsenic** * (1) (µg/l) | 190 µg/l | Required monitoring at water intakes; No violations |
| **Cyanide** * (µg/l) | 5.2 µg/l (Free CN) | Limited data No violations |
| **Nitrite-N** (µg/l) | 100 µg/l (Warm water fishery) 20 µg/l (Cold water fishery) | Limited data No violations |
| Organic compounds | Variable for individual compounds | No violations |

| **Parameter** (units) | **NYSDEC Standard** (at hardness = 150 mg/l) | **Reported Data** |
|---|---|---|
| **Copper** (µg/l) | 0.96 exp (0.8545 [ln (ppm hardness)] - 1.702)<br>Standard: 12.7 µg/l | Required monitoring at water intakes;<br>No violations |
| **Mercury** (µg/l) | 0.2 µg/l | Required monitoring at water intakes;<br>No violations |
| **Lead** (µg/l) | {1.46203 -[(ln hardness) 0.145712)]} exp (1.273 [ln harness)] - 4.297<br>Standard: 4.88 µg/l | Required monitoring at water intakes;<br>No violations |
| **Cadmium** (µg/l) | 0.85 exp (0.7852 [ln (ppm hardness)] - 2.715)<br>Standard: 2.88 µg/l | Required monitoring at water intakes;<br>No violations |
| **Zinc** (µg/l) | exp (0.85 [ln (ppm hardness)] + 0.50)<br>Standard: 117 µg/l | Required monitoring at water intakes;<br>No violations |
| **Chromium** (µg/l) | 0.86 exp (0.819 [ln (ppm hardness)] + 0.6848)<br>Standard: 248 µg/l | Required monitoring at water intakes;<br>No violations |
| **Iron** (µg/l) | 300 µg/l | Required monitoring at water intakes;<br>No violations |
| **Nickel** (µg/l) | 0.997 exp (0.846 [ln (ppm hardness)] + 0.0584)<br>Standard: 73 µg/l | Required monitoring at water intakes;<br>No violations |
| **Total Phosphorus** (µg/l) | None in amounts that will result in growths of algae, weeds, and slimes that will impair the waters for their best usages. Guidance value of 20 mg/l, *upper waters summer average.* | Mid-lake stations in compliance<br><br>Southern, nearshore TP close to upper limit of guidance |
| **Secchi Disk Transparency (m** | NYSDOH guidance for bathing beaches 1.2 m June - Aug. | Limited data, no violation<br>Mid-lake data in compliance |

# Chapter 5. Programmatic Environment

**5. Programmatic and Regulatory Environment (Description of Federal, State, County, and Municipal Roles Affecting Nonpoint Source Pollution (NPS) Management)**

**5.1 Federal**

The Clean Water Act was passed in 1972 and signaled the creation of federal legislation to protect and restore the biological, chemical, and physical properties of the nation's water. This protection was to be achieved though legislation requiring a permit for the discharge of pollutants, the encouragement of best management practices to control pollution, and funding for the construction of sewage and wastewater treatment plants and facilities. The act was amended five years later and placed more stringent controls on the discharge of toxic materials and allowed states to assume responsibility over federal clean water programs.

The primary focus of the Clean Water Act (CWA) and the 1977 amendments was the prevention of pollution discharges from point sources. In 1987 the act was again amended, this time to focus on nonpoint sources of pollution (NPS). The Section 319 Nonpoint Source Management Program was enacted to aid states, territories and tribal lands in reducing NPS. This is accomplished through technical and financial assistance, training, education, and the monitoring of projects aimed at curbing NPS. In addition, the EPA has requested that funding provided under section 106 of the act for water quality program assistance grants be used by states, territories, and tribal lands for the inclusion and development of programs that reduce NPS. In 1996, Section 319 funding was used in place of Clean Lakes Program (Section 314 Federal Water Pollution Control Act) funding to provide technical and financial assistance for restoring public lakes.

Phase I of the USEPA's storm water program was promulgated in 1990 under the CWA. Phase I relies on National Pollution Discharge Elimination System (NPDES) permit coverage to address storm water runoff from: (1) "medium" and "large" municipal separate storm water systems (MS4s) generally serving populations of 100,000 or greater, (2) construction activity disturbing 5 acres of land or greater, and (3) ten categories of industrial activity. In NYS NPDES permitting is under the purview of the NYSDEC, which issues a State Pollution Discharge Elimination System (SPDES) permit.

The Storm Water Phase II Final Rule was published on December 8, 1999. The permitting authority of the Storm Water Phase II Rule will be phased in over a 5-year period. The Phase II program expands the Phase I program by requiring additional operators of MS4s in urbanized areas and operators of small construction sites, through the use of NPDES permits, to implement programs and practices to control polluted storm water runoff.

Phase II is intended to further reduce adverse impacts to water quality and aquatic habitat by instituting the use of controls on the unregulated sources of storm water discharges that have the greatest likelihood of causing continued environmental degradation. The environmental problems associated with discharges from MS4s in urbanized areas and discharges resulting from construction activity.

Section 404 of the CWA establishes a program to regulate the discharge of dredged and fill material into waters of the United States, including wetlands. EPA and the Army Corps of Engineers (Corps) jointly administer the program. In addition, the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, and State resource agencies have important advisory roles. Activities in waters of the United States that are regulated under this program include fills for development, water resource projects (such as dams and levees), infrastructure development (such as highways and airports), and conversion of wetlands to uplands for farming and forestry.

The basic premise of the program is that no discharge of dredged or fill material can he permitted if a practicable alternative exists that is less damaging to the aquatic environment or if the nation's waters would be significantly degraded. In other words, when you apply for a permit, you must show that you have a) taken steps to avoid wetland impacts where practicable; b) minimized potential impacts to wetlands; and c) provided compensation for any remaining, unavoidable impacts through activities to restore or create wetlands.

Regulated activities are controlled by a permit review process. An individual permit is usually required for potentially significant impacts. However, for most discharges that will have only minimal adverse effects, the Army Corps of Engineers often grants up-front general permits. These may be issued on a nationwide, regional, or state basis for particular categories of activities (for example, minor road crossings, utility line backfill, and bedding) as a means to expedite the permitting process.

Section 404(f) exempts some activities from regulation under Section 404. These activities include many ongoing farming, ranching, and silviculture practices. Farmers who own or manage wetlands are directly affected by two important Federal programs: (1) Section 404 of the CWA, which requires individuals to obtain a permit before discharging dredged or fill material into waters of the United States, including most wetlands, and (2) the Swampbuster provisions of the Food Security Act, which withholds certain Federal farm program benefits from farmers who convert or modify wetlands. Together, these two programs have helped to reduce the rate at which wetlands are converted to agriculture and other uses.

Also passed in 1972, the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) provides for the control of the distribution, sale, and use of pesticides. Enforcement is accomplished through the regulations requiring users of pesticides to register at the time of purchase. Amendments to the law now require that persons applying pesticides be certified to reduce accidents and misuses that may result in increased NPS.

The Safe Drinking Water Act was passed in 1974 to protect drinking water supplies from harmful contaminants. The legislation attempts to provide safe drinking water through primary drinking water regulations, underground injection control regulations, and protection of sole source aquifers. In 1986 the act was revised to speed up implementation and included additional provisions for regulating contaminants, filtration systems, distributions systems, and wellhead protection systems.

The Safe Water Drinking Act establishes both health-related (primary) and nuisance-related (secondary) standards for public drinking water. Under the original legislation, the EPA set primary standards for 25 contaminants. The 1986 amendments required the EPA to include an additional 48 contaminants, raising the total number of chemicals regulated in drinking water to 83.

In August 1996, the Safe Water Drinking Act was amended to include a program that requires states to monitor and evaluate the quality of sources of drinking water supplies. In addition, more stringent standards for drinking water and reporting of contaminant levels by water providers to their customers were also included. Other amendments passed in 1996 included financial assistance to communities attempting to upgrade or replace existing water treatment facilities and train and certify water treatment plant operators. The 1996 amendments also granted states the authority to require public water suppliers with over 10,000 customers to annually disclose the levels of contaminants in public water.

The Safe Drinking Water Act is important in that it not only protects the water humans consume directly, but also water used for agriculture and the production of livestock. The identification and control of NPS is a major consideration in attaining the standards set by the EPA to ensure the quality of water used for drinking and agricultural purposes.

In 1990 under the Authority of Section 6217(g) of the Coastal Zone Act Reauthorization Amendments (CZARA), the EPA issued *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters*. This document is intended to serve as a compilation of technical measures that states should include in their coastal NPS control programs.

The management measures outlined therein are not designed to replace existing programs, but rather to compliment existing programs through updated technical documentation and the introduction of newly developed management measures. Management measures are defined in the CZARA as:

> economically achievable measures for the control of … nonpoint sources of pollution, which reflect the greatest degree of pollutant reduction achievable through the application of the best available nonpoint pollution control practices, technologies, processes, siting criteria, operating methods, or other alternatives. (Section 6217(g)(5))

The guidance provided is an attempt to focus on nonpoint sources that are regarded as large contributors to reduced water quality in coastal areas. The management measures apply to five main sources of NPS that threaten water quality throughout the nation. The five main sources are:

1. Agricultural runoff
2. Urban runoff
3. Forestry (silviculture) runoff
4. Marinas and recreational boating
5. Hydromodification (channelization and channel modifications, dams, and streambank and shoreline erosion)

Management measures are also included for wetlands, vegetated treatment systems, and riparian areas as applicable to NPS. The EPA has recognized that the most effective means of controlling NPS include measures aimed at controlling point source pollution as well. The overlap between point and nonpoint sources is substantial in many instances.

In 1997, twenty-five years after the passage of the CWA, the Clean Water Action Plan (CWAP) was launched. As part of President Clinton's Clean Water Initiative, the CWAP provides funding for programs developed by the EPA and USDA in conjunction with other federal agencies and state and local governments focusing on restoring and sustaining the quality and health of water resources. The CWAP is based upon four primary elements:

1. Watershed Approach – more effective means of planning and managing water resources compared to approaches based on political boundaries.
2. Stricter Standards – tighter controls and enforcement of NPS regulations as they relate to water quality at the federal and state levels.
3. Stewardship – greater public and private involvement in the planning and management of natural resources and their protection from NPS at the state and local levels.
4. Informed Citizens and Officials – increase the monitoring and reporting of water quality and the effects of NPS with greater involvement of state and local officials and agencies.

The Natural Resource Conservation Service (NRCS) is the US Department of Agriculture's primary agency responsible for NPS prevention. The NRCS provides technical assistance through fact sheets, information bulletins, and other reports on agricultural best management practices.

The Environmental Quality Incentives Program (EQIP) is a USDA NRCS initiative authorized by the 1996 Farm Bill that provides farmers with technical, financial, and educational assistance to address soil, water, and natural resource concerns in an environmentally beneficial and cost-effective manner. A conservation plan is required to receive EQIP funding. EQIP addresses natural resource concerns through the implementation of structural, vegetative, and land use practices such as manure management facilities, abandoned well capping, tree planting, filter strips, nutrient, pest, and grazing management, and wildlife habitat protection and enhancement. Agricultural producers enter into five-to-ten year contracts with federal funding limited to $10,000 per year with a maximum of $50,000 for the total contract.

At this time, Cayuga County is the only county in the Cayuga Lake Watershed to receive EQIP funding. The three-year program is being overseen by the Cayuga County SWCD and exceeds $800,000 in funding for individual contracts with 62 farms in the watershed. The emphasis of the program is on developing and implementing BMPs that reduce nutrient loading and sediment erosion. The Tompkins County SWCD is seeking EQIP funding for farms in the Fall Creek subwatershed. Other county SWCDs in the Cayuga Lake Watershed have applied for EQIP funding every year, but have yet to receive any moneys at this time.

The US Fish and Wildlife Service (USFWS) is partners in the National Wildlife Refuge System which protects wildlife (including rare and endangered species) and wetlands and other habitats from NPS. Additionally, the USFWS provides education programs to hunters and anglers on NPS pollution and assists farmers in preventing animals from accessing streams where their waste would contaminate water supplies.

These various programs and laws provide the foundation for states to develop, administer, regulate, and enforce programs that improve water quality by controlling NPS. At this time, it appears that the primary role of the federal government as related to NPS is the development and availability of technical and financial assistance for reducing the associated impacts of NPS on water quality. Implementation and enforcement of measures designed to curb and control NPS are delegated to the states to administer as they see fit. The specific delegation of programs enabled by the above legislation to departments and agencies within New York State are discussed below.

**5.2 State**

The NYDOS, Division of Coastal Resources provides financial and technical assistance and promotes initiatives at the local, regional, and state level to protect and enhance the coastal ecosystems and economies of New York State. This report is funded through the NYDOS, Division of Coastal Resources' Local Waterfront Revitalization Program. Technical assistance includes information and data on programs including CZARA, GIS data, and land use.

The NYDOS has a tremendous influence on land use regulation in New York State. While New York is a "home rule" state, the enabling legislation for the development of land use regulations and the process for developing, implementing, and appealing decisions based on them is the product of the NYSDOS.

The NYSDEC attempts to reduce NPS through a number of activities including technical assistance for prevention, education, and monitoring and financial assistance for demonstration programs, improvement of existing facilities, and the construction of new ones.

The NYSDEC provides technical assistance and funding for programs aimed at preventing NPS through watershed management, dissemination of resources on best management practices, water quality monitoring, and assessing waterbodies throughout the state.

The NYSDEC has developed the New York State Unified Watershed Assessment Program. Each of the watersheds within the state has been classified into one of four categories based on groundwater and surface water quality and impairments. The watersheds are then ranked according to the level of impairments and targeted for improvement based on these rankings. Section 17-0301 of the New York Environmental Conservation Law (NYECL) establishes water quality standards and classifications of waterbodies in relation to these standards. Section 17-0101 requires "the use of all known available and reasonable methods to prevent and control the pollution of the waters of the state" to guarantee the quality of water in New York State waterbodies meets acceptable standards based on these classifications. The NYSDEC also oversees implementation of the FIFRA and groundwater protection.

The State Environmental Quality Review Act (SEQRA) is a preventive measure that requires the completion of an Environmental Impact Assessment (EIA) and Environmental Impact Statement (EIS) for proposed state and local development. SEQRA requires investigation into alternative actions and the mitigation of harmful effects of the proposed development. Potential NPS can be remediated through revised design or other measures.

The New York Environmental Conservation Law (NYECL) contains several other provisions relating to the implementation, monitoring, and enforcement of measures aimed at eliminating or reducing NPS. The NYECL establishes enforcement of penalties pertaining to the discharge of matter if such discharge violates the standards set in section 17-0101 regarding water quality and the endangerment of fisheries set in sections 17-0503, 11-1301 (1)(a), 71-01-919 (1)(b), 71-0923, and 71-0925. None of these sections apply exclusively to NPS, but NPS is considered to be in violation of all.

The Agricultural Environmental Management (AEM) program assists farmers in identifying environmental issues on their farms and implementing measures to maintain their economic viability while simultaneously protecting natural resources. AEM involves a five-tier process of on-on-one consultation between farmers, members of agricultural agencies, and representatives of agri-business at the local level. Agricultural agencies involved in AEM include SWCDs, NRCS, Cornell Cooperative Extension, and the Farm Service Agency. Farmers voluntarily enter into these partnerships and remain the primary decision-maker throughout the AEM process.

AEM is designed to provide a system for planning and implementing environmentally suitable farming practices through the following steps or tiers:

- Tier 1 – Farmers complete a survey that includes questions regarding current farm activities, future activities or plans, and areas of possible environmental concern. Where no concerns are identified, the AEM process ends and the farmer's good stewardship is documented.

- Tier 2 – Areas for environmental concern identified in the Tier 1 survey are further detailed through the completion of a corresponding worksheet. Technical assistance in completing the worksheet is often provided by a local agricultural agency. Through the worksheet, the need for a management plan is determined. If the related environmental concerns can be easily remedied the farmer's good stewardship is documented and the AEM process ends.

- Tier 3 – A plan to remedy the specific environmental concerns identified in Tiers 1 and 2 is developed and completed. The plan takes into account the economic concerns of the farmer as well as environmental concerns resulting from current agricultural processes. Existing waste management, nutrient management, and conservation plans may be included in the AEM plan.

- Tier 4 – The plan developed in Tier 3 is implemented through Best Management Practices (BMPs) to reduce nonpoint source pollution. Agricultural agency staff provide technical, educational, and (when available) financial assistance to farmers in implementing these BMPs.

- Tier 5 **–** On-going evaluation of the AEM program at the individual farm, county, watershed, and state level is conducted to insure that environmental concerns related to nonpoint source pollution and the economic viability of agriculture production are addressed.

The Cornell Cooperative Extensions throughout New York, NYS Agriculture and Markets, NYSDEC, NYSDOH, NYS Department of State, NYS Soil and Water Conservation Committee, County SWCDs, USDA NRCS, and US EPA developed the AEM tiered-approach.

In addition, the AEM program also addresses Animal Feeding Operations (AFOs). AFOs are agricultural operations where animals are raised and maintained in confined areas for 45 days or more in any 12-month period and where crops, vegetation, or other forage growths are not sustained over any portion of the lot or facility in a normal growing season. AFOs contribute to pollution through the carrying of nitrogen, phosphorus, pathogens, sediment, hormones, antibiotics, ammonia, and other harmful substances to water bodies.

AFOs are considered Concentrated Animal Feeding Operations (CAFOs) if they meet the standards of AFOs and there are more than 1,000 animals at the facility or there are greater than 300 animals and the facility directly discharges into a waterbody or through the confinement area via a man-made conveyance. CAFOs are point sources of pollution under the National Pollution Discharge Elimination System (NPDES) and are regulated under Section 301 of the CWA.

The Cayuga County SWCD has received over $500,000 in funds through the Bond Act to work on animal waste management. In addition, the SWCD has received an EPA grant to demonstrate the use of drag hose applications in animal waste management. Several farms in the Cayuga Lake Watershed are currently receiving technical and financial assistance through this grant. Windmills have been installed on two animal waste pits to reduce the odor produced by these facilities. Currently, six rotational grazing programs have been developed, with four now implemented, for livestock operations in the watershed. Stream control plans have been developed for six sites in the watershed and will be implemented over the next year.

The Cortland County SWCD has applied for an implementation grant to institute BMPs on three farms in the Virgil Creek subwatershed after completing Tier 3 plans. Nutrient management programs are produced in combination with other programs as needed, most notably as part of the AEM BMPs. A nutrient management program has been developed and implemented for at least one farm in the Cortland County portion of the watershed.

According to the Seneca County SWCD, no requests for AEM plans have been requested from farms in the eastern portion of the county within the watershed. Private consultants currently design nutrient management programs for Seneca County farms. Many of these nutrient management programs began being developed and undertaken before

CAFO/AFO regulations were mandatory. At this time, the Seneca County SWCD has received no requests for nutrient management program assistance.

Funding from the NYS Agricultural Non-Point Source Abatement and Control Grant Program is currently being sought to assist in the production of AEM plans for farms in the Taughannock Creek subwatershed at the southeastern end of the Town of Hector in Schuyler County. Three farms in Hector have received agricultural waste management plans that address manure storage design, silage leaks, barnyard pad runoff, and dairy operations in an attempt to reduce environmental risks as part of AEM Tier 3 plans. Nutrient management programs are done by private consultants throughout the county and if requested are produced for farms within the Cayuga Lake Watershed.

Through AEM, the Tompkins, Cayuga, and Cortland SWCDs have completed Tier 1 surveys and Tier 2 worksheets for farms in the Fall Creek subwatershed. The Tompkins County SWCD has also completed Tier 1 surveys and Tier 2 worksheets for the Sixmile Creek and Salmon Creek subwatersheds. At present there are no major water quality problems and the current thrust is to assist farms in implementing BMPs to meet CAFO/AFO requirements. According to the Tompkins County SWCD, which administered the enabling grant, many of the farms have or are currently implementing portions of their Agricultural Waste Management Plans to meet compliance standards for CAFO/AFO regulations. Within the Fall Creek subwatershed over 120 farms covering approximately 43,000 acres were surveyed. Existing nutrient management programs are incorporated in the AEM plans. However, a comprehensive nutrient management program planning grant is currently being sought for the Tompkins County portion of the Cayuga Lake Watershed.

There are no farms present in the Tioga County portion of the Cayuga Inlet subwatershed.

The NYS Agricultural and Markets Law, Article 25AA-Agricultural Districts provides local owners with the ability to propose their farmland be designated as an agricultural district to “conserve, protect, and encourage the development and improvement” of their land for “production of food and agricultural products.” The Agricultural Districts provision of the law takes precedent over local regulations that may limit or otherwise obstruct the use of these designated districts for agricultural production purposes. Large portion of the Cayuga Lake Watershed are designated as agricultural districts including a large portion of the western side of the watershed throughout Seneca County and the Town of Hector. On the eastern side, Cayuga County agricultural districts extend along the lake east of the cottages located on the lake and within the Cortland County portion of the watershed. Cortland County Agricultural District 1 includes the towns of Virgil and Harford, while Agricultural District 2 encompasses the Town of Cortlandville, other portions of Homer, and the Town of Scott. The majority of the two agricultural districts within Tompkins County are located in the watershed as well.

In addition, the NYS Department of Agriculture and Markets provides administrative support to the Soil & Water Conservation Committee (SWCC) which in turn provides guidance to the county Soil & Water Conservation Districts (SWCD). SWCD’s receive guidance from the SWCC in administering the NYS Agricultural Nonpoint Source Abatement and Control Program and planning and implementing agricultural environmental management programs. The Agricultural Nonpoint Source Abatement and Control Program funds the Graze New York Program which assists farmers in select counties to implement more intensive grazing, practices. Four of the six counties (Cayuga, Cortland, Tioga, and Tompkins) in the program are within the Cayuga Lake Watershed.

The NYS Department of Health (DOH) monitors the impacts of NPS as it relates to the health of the citizens of New York through water quality monitoring and reporting programs. The New York Public Health Law includes statutes regulating the protection of public water supplies from contaminants due to source and nonpoint source pollution. The commissioner of the NYSDOH and commissioners of County DOH’s determine violations and subsequent penalties.

As mentioned above, the 1996 amendments to the SWDA require states to evaluate the quality of sources of public drinking water. Beginning in 1998 and continuing through 2001, the NYSDOH will administer the Source Water Assessment Program to aid local and state efforts to develop and implement strategies to protect drinking water supplies from both point and nonpoint source pollutants. Under the enabling legislation and the Source Water Assessment Program, the NYSDOH is responsible for overseeing public water supply supervision and wellhead protection among other programs.

**5.3 County**

The counties in the Cayuga Lake Watershed each have a committee or council responsible for providing guidance and monitoring of issues related to county water quality and resources. Each of the groups consists of members from various agencies including planning, DOH, SWCD, and others. Table 5.1 lists the appropriate water quality agency or committee for the counties in the Cayuga Lake Watershed. NPS is an oft-discussed topic among the committees, agencies, and councils. Studies and reports conducted in each county have monitored and assessed NPS to assist in developing guidance for controlling NPS.

| **Table 5.1<br>County Water Quality and Resource Groups** |
|---|
| Cayuga County Water Quality Management Agency |
| Cortland County Water Quality Coordinating Committee |
| Schuyler County Water Quality Coordinating Committee |
| Seneca County Water Quality Committee |
| Tioga County Water Quality Coordinating Committee |
| Tompkins County Water Resources Council* |

*Includes a Policy and Technical Committee

As stated earlier, each county has a SWCD responsible for implementing the NYS Agricultural Nonpoint Source Abatement and Control Program. The New York Soil and Water Conservation Law administered by the SWCC requires owners of agriculture, livestock, or timber producing lands to apply to their respective county's SWCD for a soil and water conservation plan. The SWCD is obligated to produce such a plan upon request by the owner of the land, but there is no penalty for not implementing the plan upon its completion. The Agricultural Nonpoint Source Abatement and Control Program is often included as part of the agricultural environmental management program that produces such plans.

Other countywide ordinances, laws, plans, and programs that address NPS are also in place within the Cayuga Lake Watershed. The *Cayuga County Sanitary Code* requires periodic inspection of all septic systems within the watershed. Septic system failure is a major health concern and results in human contact with possibly infectious organisms. In Seneca County a countywide drainage plan assists in the management of NPS through standards set to protect and enhance water.

Through the 1994 *Watershed Protection Law of Schuyler County*, NPS management is attained through regulation and enforcement of sewage disposal and wastewater treatment systems throughout the county. Provisions are stipulated for the discharge and disposal of sewage and the design, construction, and certification of wastewater treatment facilities.

All five of the six counties in the watershed have planning boards or commissions responsible for conducting reviews and issuing approval for proposed development. The Tompkins County Planning Department, under provisions of their Charter, is responsible for reviewing development proposals. Although they do not have a planning board or commission at the county level, they do have a Planning Advisory Board that assumes the functions of a planning board. Cayuga, Cortland, Schuyler, and Tompkins Counties each have an environmental management council while Tioga County has a conservation board. These groups monitor and advise on issues related to development and sustaining/improving the environmental character of their respective counties. None of the counties in the watershed currently have sediment and erosion control laws or vegetation retention laws.

Countywide comprehensive plans are in place in Cortland, Schuyler, Tompkins, and Tioga Counties and Cayuga County currently has a land use plan. Seneca County has prepared a comprehensive plan, but at this time it is yet to be adopted. In addition to its comprehensive plan, Tioga County has a future land use plan and an agriculture and farmland protection plan. The *Tioga County Agriculture and Farmland Protection Plan* focuses on retaining and building upon the economic benefits of agriculture in the county through more viable farming practices. Tompkins County has an approved Farmland Protection Plan. Table 5.2 presents the county regulations and controls in the watershed that have an effect on the reduction of NPS in the watershed.

**Table 5.2**
**County Land Use Regulation and Control Form**

| | Comprehensive Plan | Drainage Plan | Sediment & Erosion Control Laws | Vegetation Retention Laws | Other County Plans | Other County Ordinances | Planning Board/ Commission | Conservation Board | Environmental Management Council | Other County Boards and Committees |
|---|---|---|---|---|---|---|---|---|---|---|
| Cayuga County | No | No | No | No | Yes(Land Use) | Yes | Yes | No | Yes | Yes (WQMA) |
| Cortland County | Yes | No | No | No | No | No | Yes | No | Yes | Yes (WQCC) |
| Schuyler County | Yes | No | No | No | Yes(Water Quality) | Yes(Watershed Protection) | Yes | No | Yes | Yes (WQCC) |
| Seneca County | No* | Yes | No | No | No | No | Yes | No | No | Yes (WQC) |
| Tioga County | Yes | No | No | No | Yes(Ag & Future Use) | No | Yes | Yes | No | Yes (WQCC) |
| Tompkins County | Yes | No | No | No | Yes | Yes | No | No | Yes | Yes (WRC)** |

* Prepared but not adopted
** In addition to the Tompkins County WRC, there is also a Policy & Technical Committee
Source: Genesee/Finger Lakes Regional Planning Council, 1999

WQMA = Water Quality Management Agency
WQCC = Water Quality Coordinating Committee
WQC = Water Quality Committee
WRC = Water Resources Council

## 5.4 Municipal

Most of the programs, ordinances, and regulations directly related to NPS are administered, prepared, monitored, and enforced at the federal, state, and county levels. These programs involve a great deal of participation at the local level by municipal boards and elected officials, citizens, and businesses. While not always directly related to NPS, land use regulations and controls at the municipal level play an important part in controlling and reducing NPS.

Some municipalities do have committees and boards that include the reduction of NPS as part of their focus. The Town of Caroline in Tompkins County is the only municipality in the watershed with a committee that assesses and provides guidance on actions developed for watershed protection in the town. Conservation boards have been assembled and operate in the Village of Interlaken, Town of Ithaca, and Village of Trumansburg.

Municipal drainage plans are currently in place in the Village of Interlaken and Town of Newfield. The Village of Aurora and Town of Genoa each have sediment and erosion control laws. At present, the Village of Lansing has a drainage plan, sediment and erosion control laws, and vegetation retention laws included as part of its comprehensive plan.

Of the 40 municipalities in the Cayuga Lake Watershed that returned the *Municipal Land Use Regulation and Control Survey*, 27 have zoning, 17 have comprehensive plans, 26 have subdivision ordinances, and 23 have adopted other plans or ordinances. Table 5.3 provides a matrix of the various municipal land use regulations and controls in the Cayuga Lake Watershed. These regulations and controls provide avenues for implementing future programs aimed at improving water quality through increased NPS management.

**Table 5.3**
**Municipal Land Use Regulation and Control Form**

| | Zoning | Comprehensive Plan | Subdivision Ordinance | Drainage Plan | Sediment & Erosion Control Laws | Vegetation Retention Laws | Other Plans | Other Ordinances | Planning Board | Board of Appeals | Municipal Board | Conservation Board |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Cayuga County* | | | | | | | | | | | | |
| Town of Aurelius | Yes | No | No | No | No | No | No | No | Yes | Yes | Yes | No |
| Village of Aurora | Yes | Yes | Yes | No | Yes | No | No | Yes | Yes | Yes | Yes | No |
| Village of Cayuga | Yes | No | Yes | No | No | No | Yes | Yes | Yes | Yes | Yes | No |
| Town of Fleming | Did not yet return survey | | | | | | | | | | | |
| Town of Genoa | No | No | No | No | Yes | No | Yes | Yes | No | Yes | Yes | No |
| Town of Ledyard | Yes | No | No | No | No | No | No | Yes | Yes | Yes | Yes | No |
| Town of Locke | Refused to complete | | | | | | | | | | | |
| Town of Scipio | Yes | No | No | No | No | No | No | No | Yes | Yes | Yes | No |
| Town of Sempronius | No | No | No | No | No | No | No | Yes | Yes | Yes | Yes | No |
| Town of Springport | Yes | No | No | No | No | No | No | No | Yes | Yes | Yes | No |
| Town of Summer Hill | No | No | Yes | No | No | No | Yes | Yes | Yes | Yes(Variance Board) | Yes | No |
| Village of Union Springs | Yes | Yes | Yes | No | No | No | No | No | Yes | Yes | Yes | No |
| Town of Venice | No | No | No | No | No | No | No | No | No | No | Yes | No |
| *Cortland County* | | | | | | | | | | | | |
| Town of Cortlandville | Did not yet return survey | | | | | | | | | | | |
| Town of Harford | Yes | Do not Know | No | No | No | No | Yes | Yes | Yes | Yes | Yes | No |
| Town of Homer | Yes | Yes | Yes | No | No | No | Yes | No | Yes | Yes | Yes | No |
| Town of Scott | Yes | No | Yes | No | No | No | Yes | No | Yes | Yes | Yes | No |
| Town of Virgil | Yes | No | Yes | No | No | No | No | Yes | Yes | Yes | Yes | No |
| *Schuyler County* | | | | | | | | | | | | |
| Town of Catharine | Yes | Yes | Yes | No | No | No | No | No | Yes | Yes | Yes | No |
| Town of Hector | No | No | No | No | No | No | No | Yes | No | No | Yes | No |
| *Seneca County* | | | | | | | | | | | | |
| Town of Covert | No | No | Yes | No | No | No | No | Yes | Yes | No | Yes | No |
| Town of Fayette | Yes | Yes | Yes | No | No | No | No | No | Yes | Yes | Yes | No |
| Village of Interlaken | No | No | No | Yes | No | No | No | Yes | No | No | Yes | Yes |
| Town of Lodi | No | No | No | No | No | No | No | No | Yes | No | No | No |
| Town of Ovid | No | No | No | No | No | No | No | No | No | No | Yes | No |
| Town of Romulus | No | Yes | No | No | No | No | No | Yes | Yes | No | No | No |
| Town of Seneca Falls | Did not yet return survey | | | | | | | | | | | |
| Town of Tyre | Yes | No | No | No | No | No | No | No | No | No | No | No |
| Town of Varick | Yes | No | Yes | No | No | No | No | Yes | Yes | Yes | Yes | No |
| *Tioga County* | | | | | | | | | | | | |
| Town of Spencer | No | No | Yes | No | No | No | No | No | Yes | No | Yes | No |
| *Tompkins County* | | | | | | | | | | | | |
| Village of Cayuga Heights | Yes | Yes | Yes | No | No | No | No | Yes | Yes | Yes | No | No |
| Town of Caroline | Did not yet return survey | | | | | | | | | | | |
| Town of Danby | Yes | Yes | Yes | No | No | No | No | No | Yes | Yes | Yes | No |
| Town of Dryden | Yes | Yes | Yes | No | No | No | No | No | Yes | Yes | Yes | No |
| Village of Dryden | Yes | Yes | Yes | No | No | No | No | No | Yes | Yes | Yes | No |
| Town of Enfield | No | No | Yes | No | No | No | No | No | Yes | No | Yes | No |
| Village of Freeville | Yes | Yes | Yes | No | No | No | No | Yes | Yes | Yes | Yes | No |
| Town of Groton | Yes | Yes | Yes | No | No | No | No | Yes | Yes | Yes | Yes | No |
| City of Ithaca | Yes | Yes | Yes | No | No | No | Yes | Yes | Yes | Yes | Yes(Common Council) | No |
| Town of Ithaca | Yes | Yes | Yes | No | No | No | Yes | Yes | Yes | Yes | Yes | Yes |
| Town of Lansing | Yes | Yes | Yes | No | No | No | No | Yes | Yes | Yes | Yes | No |
| Village of Lansing | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | No |
| Town of Newfield | No | No | Yes | Yes | No | No | No | No | No | No | Yes | No |
| Village of Trumansburg | Yes | Yes | Yes | No | No | No | No | Yes | Yes | Yes | Yes | Yes |
| Town of Ulysses | Yes | Yes | Yes | No | No | No | No | No | Yes | Yes | Yes | No |

Source: Genesee/Finger Lakes Regional Planning Council, 1999

# Chapter 6. Watershed and Subwatershed Technical Findings

**Chapter 6. Watershed and Subwatershed Technical Findings**

**6.1 Overview**:

Cayuga Lake's water quality is generally very good. The lake supports its designated best use as a public drinking water supply and recreational resource; the fish community is diverse and productive. Overall, the tributary streams exhibit moderate to high water quality and habitat conditions that support a balanced biological community.

Cayuga Lake has been well characterized and is the focus of several significant long-term monitoring initiatives. There is much less information available to characterize the tributaries. A few long-term tributary monitoring programs are in place; most are directed at the southern tributaries.

Despite the conclusion that water quality is high, a number of specific areas of concern are evident:

- ***Agricultural chemicals*** such as nitrate-nitrogen and pesticides and metabolites are detected in both tributary streams and the lake. While there are no exceedances of ambient water quality standards associated with human health or ecosystem protection, these data provide direct evidence of losses from agricultural lands and transport to the lake.

- ***Sediment*** is a significant water quality, habitat, and use impairment issue, particularly in the southern tributaries and southern Cayuga Lake. Destruction and fill of the extensive wetland areas in southern Cayuga Lake in the early 1900s has exacerbated this problem by removing a natural filtration process that captured sediment before it flowed into the lake. In the southern tributaries, the primary source of sediment appears to be streambank erosion, not runoff from construction sites or cultivated fields. The primary sources of sediment in other tributaries are not known and may differ based on land use and geology.

- ***Heavy metals*** are present in sediments of Fall Creek at concentrations exceeding the NYSDEC assessment criteria, which represent the upper limit of background levels. Seven heavy metals (chromium, copper, iron, lead, manganese, nickel and zinc) were detected during 1995 – 1996 monitoring. Nearshore sediments of Cayuga Lake also exhibit elevated concentrations of some heavy metals. These data suggest the need for improved stormwater management.

- ***Phosphorus*** is the limiting nutrient for algal growth in Cayuga Lake as it is for most inland lakes in the Northeast. Ambient concentrations measured in the deep portion of the lake confirm that Cayuga Lake is mesotrophic, with moderate levels of primary productivity. A phosphorus guidance value for lakes has been adopted by NYSDEC to protect recreational uses. Cayuga Lake meets the NYSDEC total phosphorus guidance value of 20 μg/l, summer average upper waters, measured at a mid-lake station. However, phosphorus concentrations in the southern, Class A segment of Cayuga Lake occasionally exceed the 20 μg/l guidance value. There is strong evidence that these elevated concentrations reflect sediment-borne phosphorus as well as phosphorus in the discharges of the two wastewater treatment plants.

- ***Urban runoff.*** Stormwater runoff from developed areas carries sediment and contaminants including salts to the streams ultimately to Cayuga Lake.

- ***Pathogens and indicators.*** The presence of pathogenic microorganisms in the lake and its tributary streams is a potential area of concern. Pathogens originate from untreated or inadequately treated human sewage and wild and domestic animal waste. Human exposure to pathogens can occur from direct contact with or ingestion of contaminated waters. The potential presence and abundance of pathogenic microorganisms is assayed using indicator organisms such as coliform bacteria.

- ***Exotic species***. Because of its connections to the Great Lakes through the Seneca River, Cayuga Lake is vulnerable to invasion by nonindigenous species of plants and animals. There have been a number of exotic species invading Cayuga Lake over the years. Three recent invaders are a focus of special concern due to their potential to alter the food web. These organisms are the zebra and quagga mussel (*Dreissena polymorpha* and *Dreissena bugensis*) and a predatory cladoceran zooplankton (*Cercopagis pengoi).* The macrophyte eurasian water milfoil (*Myriophyllum spicatum*) is another introduced species that has, until recently, been a nuisance in Cayuga Lake.

- Impacts of Cornell ***Lake Source Cooling***
- ***Native American territory*** disputes

Specific areas of concern for the tributary watersheds are summarized in Table 6.1. A similar table for the lake is presented as Table 6.2.

**Table 6.1. Summary of Areas of Concern, Tributary Subwatersheds**

| Parameter | Location | Use Affected | Primary Cause | Potential for Improvement |
|---|---|---|---|---|
| Sediment | Fall Creek,<br>Cayuga Inlet,<br>Sixmile Creek,<br>Yawger Creek,<br>Cascadilla Creek | Fishing,<br>fish propagation,<br>water supply | Streambank erosion,<br>agriculture,<br>urban runoff | Moderate. Requires field investigations to identify causes and contributing factors. In some areas only viable solution may be riparian greenbelt to allow natural meanders. Requires watershed –wide commitment to land use and riparian zone management |
| Phosphorus | Salmon Creek | Water clarity, aesthetics | Agriculture | Moderate |
| Nitrate | Great Gully<br>Paines Brook<br>Salmon Creek<br>Mack Br<br>Williams Cr<br>Indian Creek | Potential water supply | Agriculture | Unknown. Highly dependent on mix of agriculture and practices in watershed. |
| Petroleum products | Trumansburg Ck<br>Cayuga Inlet | Benthos<br>Fish propagation<br>Fish tainting | Spills | Moderate – high<br>(natural flushing and breakdown_ |
| Pesticides | Salmon Creek,<br>Paine Brook,<br>Yawger Creek<br><br>(other locations not surveyed) | Presently, none detected over limits of concern. Could affect drinking water use. | Agriculture | Highly dependent on mix of agriculture and practices in watershed. |
| Heavy metals in sediment | Fall Creek (confirmed)<br><br>Cayuga Inlet (likely based on land use) | Chronic toxicity to vulnerable biota<br><br>Bioaccumulation | Urban runoff | High. Controls on point sources (including air emissions) more stringent.<br><br>Sedimentation buries more contaminated sediments |
| Pathogens and Indicators | Unknown | Water consumption, contact recreation | Stormwater, on-site systems | Unknown, likely moderate |

| Table 6.2 Summary of Areas of Concern, Lake | | | | |
|---|---|---|---|---|
| Parameter | Location | Use Affected | Primary Cause | Potential for Improvement |
| Sediment | Mouths of tributaries, particularly southern lake | Aesthetics (water clarity and enhanced habitat for macrophytes) Drinking water | Streambank erosion, agriculture, urban runoff | Difficult. Requires watershed –wide commitment to land use and riparian zone management |
| Exotic species | Lakewide | Ecological integrity, fishing, swimming, aesthetics | Entrance through Seneca River | Difficult to control. Requires technical and regulatory controls throughout Great Lakes, public education |
| Phosphorus | Lakewide, particularly in southern and northern basins | Water clarity, aesthetics | Southern: treated wastewater<br><br>Northern: on-site systems | Reductions in municipal point source loading are planned.<br><br>Controls on nonpoint sources are more difficult |
| Pesticides and metabolites | Lakewide | Presently, none detected over limits of concern. Could affect drinking water use and fish bioaccumulation. | Agriculture | Highly dependent on mix of agriculture and practices in watershed. |
| Metals in sediment | Spatial extent of problem is unknown. Nearshore southern lake data show exceedances of some criteria. | Biological availability of metals appears to be low based on AVS.<br><br>Minimal potential for release into water column, based on water chemistry and equilibrium partitioning models. | Historical industrial use, atmospheric deposition | High. Controls on point sources (including air emissions) more stringent.<br><br>Sedimentation buries more contaminated sediments |
| Pathogens and indicators | Existence or spatial extent of problem is unknown. | Ingestion, primary water contact recreation | Unknown relative contribution of urban stormwater, waterfowl. | Depends on sources |

**6.2 Data Needs**

There are data gaps that limit our ability to draw conclusions regarding the status of the lake and its watershed. These data gaps exist for both the lake and the tributary watersheds. The listing does not reflect an assessment of priorities.

### 6.2.1 Data Needs: Subwatersheds

- Baseline characterization of water quality and loading

  Likens' 1970 – 1971 work represents the only synoptic survey of baseline water quality of all tributaries to Cayuga Lake. These chemical profiles provide important insights regarding quality of waters draining individual subwatersheds and total external loading to the Lake. There have been significant changes to loads of several subwatersheds over the last three decades; for example, salt loading to Gulf Creek has been greatly reduced, and the outfall of the Ithaca Area Wastewater Treatment Plant has been relocated from Cayuga Inlet. It is therefore recommended that a synoptic survey be conducted over at least one full year.

  Monitored parameters should include: calcium, sodium, chloride, magnesium, potassium, sulfate and total alkalinity, total suspended solids, total P, total soluble P, soluble reactive P, pesticides and metabolites, and nitrate N. The sampling program should be conducted for at least one full year, with concentrated sampling during high flow events. Based on existing data, seasonal, event-driven, and land use activities in the subwatersheds all affect external loading.

  *Need for seasonal sampling*

  Many of the monitored parameters exhibit strong seasonal concentrations that reflect biogeochemical processes, human activities on the landscape, and the hydrologic cycle.

  *Need for event sampling*

  Based on the Fall Creek data set, most of the annual loading of sediment and phosphorus to Cayuga Lake occurs during high flow events. Sampling during high flows will greatly reduce the standard error of estimates of annual loading.

  *Need for sampling to be linked to agricultural activities in the subwatersheds*

  The July 1998 low level pesticide sampling of Yawger Creek, Salmon Creek and Paine Brook conducted by Dave Eckhardt and colleagues of USGS illustrates the need to consider major land use activities in the watershed in designing a monitoring program.

  *Need for additional flow monitoring*

  Load estimates require accurate gauging in the watershed. Several gauging stations have been installed throughout the watershed and operated for various periods to meet specific program objectives. Only Cayuga Inlet, Fall Creek, and Sixmile Creek are currently gauged for flow. These stations monitor flow from approximately 204 square miles of the 785 square mile direct drainage. Reactivating the gauge at Salmon Creek would monitor an additional 81.7 square miles.

  *Need for monitoring in various geological and land use settings*

  The Cayuga Lake watershed has diverse geological and land use settings, and the results from one area may not be transferable to regions with different geology soils and land use.

  *Need for subwatershed modeling*

  An assessment of which tributaries contribute disproportionate loads of sediment, phosphorus, nitrate, and pesticides to Cayuga Lake would help identify priority areas for remediation. Data are not yet sufficient to define these resource-based priorities for Cayuga Lake.

- Atmospheric deposition

  There are no recent data characterizing chemical quality of precipitation (wetfall and dry fall) in the basin. This is important for load calculations as well as for general surveillance of acid precipitation.

- Septic system performance

  Based on generalized geology and soils maps, there are large areas of the watershed with severe constraints to on-site wastewater disposal systems (septic systems). There has been no watershed-wide effort to characterize the performance of these individual systems and how leachate from septic systems contributes to nitrate, phosphorus, and pathogen levels. The experience of Cayuga County, which has a comprehensive inspection program, could serve as a guide.

- Macroinvertebrate screening of tributaries

  Species composition and abundance of the macroinvertebrate community can be used to indicate water quality conditions and assess site-specific impacts of point and nonpoint discharges. Sampling tributaries in various geologic and land use settings can identify areas where the biological community is stressed.

- Effectiveness of mitigating measures (Best Management Practices) in reducing export of sediment and nutrients from subwatersheds

  Before and after monitoring is lacking on tributaries where remedial measures such as streambank stabilization or stormwater controls has been implemented. Monitoring should occur over a range of hydrologic conditions, particularly high flow events.

- Riparian zones and wetlands

  There is a need to identify wetlands and riparian areas that are most critical for protecting water quality and floodplains.

- Ecological and human health effects of trace concentrations of agricultural herbicides and other pesticides

  Herbicides used in cultivation of corn have been detected at low concentrations in monitored tributaries and in the lake. Concentrations are at least one order of magnitude below the most stringent water quality criteria or standard. Additional assessment of human health and ecological impacts of these trace concentrations of chemicals is needed. The potential for agricultural chemicals to be adsorbed to sediment particles and transported to the lake has not been fully assessed. Limited testing of lake sediments has not detected agricultural residues. However, testing has not been conducted in depositional areas of streams draining agricultural watersheds, nor in the lake at the mouths of tributaries.

- Watershed sources of heavy metals detected in Fall Creek sediments

  The 1995 –1 996 RIBS sampling program conducted by NYSDEC detected seven heavy metals above the assessment criteria, defined as the upper range of background levels but below thresholds that might cause adverse impacts. Nearshore sediments in southern Cayuga Lake also contained levels of some heavy metals above thresholds of ecological concern. Based on land use patterns and data from other areas, urban stormwater is the likely source of these heavy metals in Fall Creek. Additional sampling of tributary sediment in subwatersheds and stream reaches with different mixes of land use might help identify factors contributing to the presence and concentration of heavy metals.

- Urban stormwater monitoring

  The quality of urban stormwater has not been assessed in the Cayuga Lake watershed. The concentration of metals, phosphorus, sediment, petroleum compounds, and pathogens in stormwater is not characterized; moreover, the importance of this source in relation to other sources is not known.

- Floodplain delineation, management and mitigation

  Water level management and flooding are important issues. The loss of wetlands and increase in impervious areas have altered the natural hydrology.

- Underground storage tanks

Underground storage tank permit data is provided in Chapter 3. However, additional field work could provide useful information on pre-permit and unpermitted storage sites.

- Junk yards and dumps

  Data is provided in Chapter 3 for known inactive hazardous waste sites and permitted waste sites. However, additional field work would provide useful information on unpermitted waste sites, junk yards and dumps.

- Mines and wells

  Data is provided in Chapter 3 for permitted mines and wells. However, additional field work would provide useful information on unpermitted mines and wells and the status of permitted mines and wells.

- Recreation

  There is a need for better and more accurate recreational data including the impact of boating and fishing on water quality. This could be provided through a recreation inventory.

- Land use

  Development of a high resolution digital land use coverage would lead to a better understanding of the role of nonpoint sources and the impact of land use on the quality of water in the lake and its tributaries.

- Soils

  Development of a high resolution digital soils coverage would lead to a better understanding of the physical nature of the watershed along with the role of nonpoint sources and the impact of land use on the quality of water in the lake and its tributaries.

- The role and status of the quality of groundwater in the watershed.
- Groundwater by usage - number of individuals on private wells, number of individuals using groundwater (and surface water) for irrigation.
- The impact of water quality on economic indicators such as tourism and property tax.
- Source of nonpoint source pollutants
- Seneca-Cayuga Canal

**6.2.2 Data Needs: Lake**

There are specific areas of research and monitoring where additional information would further characterize the lake's water quality and ecological status. These are noted below.

- Trophic status indicators

  Annual monitoring of a limited suite of limnological parameters will provide a basis for long-term trend analysis. These parameters include total phosphorus, soluble reactive phosphorus, total soluble phosphorus, dissolved oxygen profiles, chlorophyll *a*, Secchi disk transparency, and turbidity. Biological parameters can provide information regarding trends as well.

- Ecological effects of sedimentation

Visual evidence and limited sampling confirm the periodic sediment plumes in southern Cayuga Lake following storms. The ecological effects of high suspended solids carry contaminants and nutrients to the lake. Physical burial of plant and animal habitat is likely. Finally, the importance of sediment-borne phosphorus to Cayuga Lake's trophic status is not well understood. This issue has implications for the relative value of investment in point and nonpoint source reduction.

- Significance of low-level pesticides to human health and lake ecology

  Using analytical methods with low detection limits, investigators from USGS and NYSDEC have documented trace concentrations of pesticides in Cayuga Lake and its tributary streams. The chemicals are present at levels far below ambient water quality standards or guidelines based on toxicology and risk assessment. It is important to continue to track these chemicals in all components of the ecosystem: water column, sediments, and throughout the food web.

- Pathogens and indicator organisms

  Measurements of pathogens and indicator organisms in Cayuga Lake are very limited. Storm event monitoring in the lake and streams could help define the importance of urban runoff as a source of pathogens. The importance of waterfowl as a source of microorganisms is not known.

- The significance of exotic species

  Because of its connections to the Great Lakes through the Seneca River, Cayuga Lake is vulnerable to invasion by nonindigenous species of plants and animals. The impacts on the food web and ecology of the Lake will be an important area of research.

- Water quality modeling

  A mechanistic mathematical model of Cayuga Lake would provide a tool for linking the inputs from the tributaries to the lake's water quality response.

# Chapter 7. Public Perceptions & Education

## 7. Public Perceptions & Education

### 7.1 Public Perceptions – Watershed Issues

Over the past three years there has been several planned opportunities for individuals from the public to voice their interests and concerns on issues effecting the Cayuga Lake Watershed. This chapter summarizes public input on issues important to them within the watershed. Although the composition of all the public input session were different, all included individuals who live, work, study, or recreate in the watershed. There are noticeable similarities in the issues, concerns, interests and visions that people have for the watershed.

#### 7.1.1 1997 Finger Lakes-Lake Ontario Watershed Protection Alliance (FL-LOWPA) Conference

NYS Department of Environmental Conservation staff facilitated a session at the Finger Lakes - Lake Ontario Water Planning Alliance (FL-LOWPA) Conference on Visioning for the Future of Cayuga Lake. Developing a vision meant to take a long-term, seventh generation approach to looking at the watershed. The objective was to get people to share their view of what the watershed should be in the future; the overall goal or vision. The process used to develop this vision included: an overview of the Ecosystem Approach to Watershed Management; individual time to brainstorm elements of the vision; round robin responses from the participants; an opportunity to clarify, combine and evaluate responses, developing the vision (vision statement); determining next steps; and a process check.

Since time was limited and there were over fifty people participating, the process ended at the "clarify, combine and evaluate responses" step, and no vision statement was developed. The combined, clarified categories for developing the vision were completed and are as follows:

- land use planning
- quality of water/natural resources
- fisheries/habitat
- environmentally aware and responsible public
- quality of life
- effective, inclusive community decision-making
- quantity of water
- economic revitalization and sustainability
- cultural diversity

All the above categories were to be included in some manner in a future vision statement for the Cayuga Lake Watershed.

#### 7.1.2 Neighbors Around Cayuga Lake Watershed Mini-Conference I

Building on the information and the process used at the FL-LOWPA Conference, further visioning was done at the first Neighbors Around Cayuga Lake Watershed Mini-conference held at Cayuga Nature Center in 1997. This was a gathering of over 100 individuals who had interests in the Cayuga Lake Watershed either as property owners, businesses, agencies and organizations, and/or other interested parties.

Groups worked through a visioning process that resulted in several proposed vision statements and at least, components of a vision statement. Many of the mini-conference attendees had not participated in the visioning session at the FL-LOWPA conference and required time to discuss the future of the watershed. Proposed draft vision statements and components for visions included:

*"Create a long-term dynamic vision through a continuing process of public involvement that guides*
*-land use planning*
*-public education and involvement*
*-environmental management decisions*
*-economic development*
*on a cooperative, intermunicipal basis throughout the watershed; in order to protect and enhance the natural, social, cultural and economic environments of the Cayuga Lake Watershed on a sustainable basis."*

*"We seek:*
*A lake as aesthetic resource for mental and spiritual health; cohesive and consistent land use planning and management; individually and politically healthy watershed ecosystem; public awareness education; access to lake; awareness of impact of watershed on lake ecosystem; environmentally sensitive commercial and agricultural operations."*

Other Vision components

-Water quality standards
-Safe drinking water
-Educated public
-Protected "viewsheds"
-Waste water management
-Positive tax incentives to preserve water quality
-Tourism and other economic development
-Organizing effort to deal with lake issues (education, communication, and collaboration)
-Support for multiple uses of lake (supply, recreation, access, agriculture, etc.)
-Public awareness and involvement
-Zero impact from new development on water quality
-Maintain and improve the quality of life in the watershed (economic, environmental, social)

### 7.1.3 Cayuga Lake Watershed Network Stakeholders Survey

During the fall of 1998, a phone and written survey was conducted at the request of the Cayuga Lake Watershed Network and funded by FL-LOWPA, to determine what issues were of importance to a variety of stake holders in the Cayuga Lake watershed. The survey was undertaken, in order to discover priorities and concerns of the various constituencies and geographic areas within the watershed. Approximately 300 individuals, in a weighted sample answered questions from the perspective of the entity they were representing and then as individuals. The most relevant issues concerning the watershed as identified by watershed stakeholders in **rank** order were:

**Responding as Representatives**
1) Water quality
2) Public Health Issues
3) Land Use and Development
4) Tourism
5) Preservation of Open Space
6) Invasive Plants and animals
7) Economic Development
8) Access to the lake
9) Lake water levels
10) Motorized recreational vehicles
11) Recreational activities

**Responding as Individuals**
1) Water quality
2) Public Health Issues
3) Preservation of Open Space
4) Land use and development
5) Invasive plants and animals
6) Economic development
7) Tourism
8) Access to the lake
9) Lake water levels
10) Motorized recreational vehicles
11) Recreational activities

The entire Cayuga Lake Watershed Network Survey of Cayuga Lake Watershed Stakeholders is included in Appendix H.

### 7.1.4 Neighbors Around Cayuga Lake Mini-Conference II

As part of the Neighbors Around Cayuga Lake Mini-Conference II, held in November 1998, Cayuga Lake Watershed residents participated in a session to provide input on the Cayuga Lake Watershed Management Plan and planning process. Participants were provided with information from a panel representing the Town of Ledyard, Central New York Regional Planning and Development Board, Genesee/Finger Lakes Regional Planning Council, and the Cayuga Lakes Watershed Network about the Cayuga Lake Watershed Management Plan project, timeline, process, and partners. Written materials about the management plan and process were also provided to participants.

In small groups, participants were asked to individually identify and write down any (and all) issues, concerns, interests and passions they had regarding the Cayuga Lake Watershed. They were then asked to identify their top three issues. Participants shared their issues/interests within their small groups until all issues were recorded. Only unique issues were recorded and all issues, concerns, interests and passions were recorded even if not identified as a top three on a persons list (the overall group list was exhaustive of all individual lists in group). Since only unique issues were recorded, the subtle differences of wording or meaning were not necessarily recorded. Forty-three watershed residents provided input. Categories for responses were created post facto from all group lists to assist in organizing responses and clarifying narrative.

The issues were not prioritized of ranked in any manner for each person had there own concerns and interests, and the object of this session was to help identify issues in the watershed so they could be addressed in the Cayuga Lake Watershed Characterization and ultimately in the Management Plan. The public has many other opportunities throughout the process to prioritize issues within the watershed; at future public participation sessions, when reviewing drafts of the Characterization and Plan, and locally within their municipality.

Issues identified by individuals at the Neighbors Around Cayuga Lake Watershed public participation session as important to them:

<u>Land Use Issues</u>
A range of issues of concern surfaced in the area of land use including urban and rural sprawl, unplanned development, changes in the natural environment (specifically diminishing forests and wetlands), decrease in farm land, need for changes in land use planning, and others. People suggested that there needs to be changes in the way planning occurs for land use in the future. Specifically, of concern was: the need for model land use planning; land use planning to protect the environment and the rural communities; small municipalities needing help in planning; planning for open space, natural areas, and habitat protection; concern that there be smart land use and growth control within the watershed in the future; and that planning be based on science.

<u>Water Management Issues</u>
A wide variety of issues focused on the actual management of water within the watershed. These included everything from various water permitting processes and agencies, to methods used to manage stormwater runoff. Specific named issues included: concerns about water permitting processes looking individually (case by case) and not cumulatively; the need for taking into account total daily maximums; there needs to be a watershed view for permitting; urban and rural stormwater management; use of traditional engineering methods instead of other methods for water management; the limitation of the lake to dilute pollutants; issues over regulations that affect business and individual property owners within the watershed; shoreline and riparian corridor protection; implementation of best management practices for water management; and watershed-wide regulation and enforcement.

<u>Erosion and Siltation</u>
Participants had concerns about erosion control in the Cayuga Lake tributaries. Siltation, especially at the South end of Cayuga Lake was a big issue. Erosion associated with stormwater runoff and the resulting sedimentation were identified as concerns in the watershed. How issues of erosion, siltation, sedimentation and stormwater runoff were addressed was also of concern to the public. Using traditional engineering methods only and not looking holistically at these issues was much discussed. The need for other methods to control erosion was of interest to participants.

### 7.1.5 Intermunicipal Organization Water Quality Issues Identification

As part of the Cayuga Lake Watershed Management Plan process, the Intermunicipal Organization Water Quality Issues Identification Session was held in March 1999. The session was split into two parts: visioning and specific issues, impairments and sources of data.

#### 7.1.5.1 Part 1: Visioning

Participants were asked imagine that they return to the Cayuga Lake Watershed after an absence of 20 years. The watershed management plan is in place. Each person was asked to name three specific attributes of the lake or watershed (water quality related) that they would like to see. Responses were clustered into broad categories (human uses, lake ecology, control of inputs, and tools).

Each respondent was asked to rank the issues as Priority 1, 2 or 3. The data summary includes a total score for each comment based on the priorities. Priority 1 was assigned 3 points, Priority 2, 2 points and Priority 3, 1 point. These results are included in the "weighted rank" column next to each specific comment.

From the rankings, it is clear that protection and improvement of the lake as a recreational resource (swimming and aesthetic) and a source of high quality drinking water are the highest priorities. Public access to the lake is also a high priority.

**7.1.5.2 Part 2: Specific Issues, Impairments, and Sources of Data**

As the second exercise, each of the four tables (southern lake and watershed, mid-lake and watershed, northern lake and watershed, and lake-wide, watershed-wide) focused on identifying specific water quality issues. Guided by a facilitator at each table, the groups created a matrix of sources of pollution, type of pollutant, water quality impacts, uses affected, and any data sources for documentation.

Whenever possible, the group identified the specific location in the lake or watershed where the pollution source was an issue. Maps of the specific lake and watershed segments were marked with numbered dots. The numbers correspond to the numbered responses presented in the tables.

The following series of tables records the specific responses provided during the meeting.

**Table 7.1.5.1 Part 1: Visioning**

| Category | Subcategory | Weighted Rank | Comment |
|---|---|---|---|
| Human uses: Recreational<br><br>*(total 63 points)* | Swimming<br><br>17 | 11 | Swimming at Stewart park in Ithaca |
| | | 1 | Clean safe swimming at the south end of the lake |
| | | 2 | Swimming everywhere in Cayuga Lake |
| | | 3 | Swimming at Stewart Park and other public beaches |
| | Recreation<br>4 | 2 | More recreational use available in watershed |
| | | 2 | Health condition of lake for recreation |
| | Access<br><br>19 | 15 | Improved public access |
| | | 2 | Development of access with sensitivity to fragile systems |
| | | 2 | Unrestricted access for all recreational needs (i.e. access to lake and minimal growth of weeds) |
| | Aesthetic<br><br>12 | 3 | Reduced algae blooms |
| | | 3 | Much less weed growth for all recreational uses |
| | | 2 | Increased post-storm transparency |
| | | 2 | Preservation of aesthetics/scenic beauty |
| | | 2 | Aesthetic beauty of lake preserved, including tranquility |
| | Noise<br>5 | 2 | Less noise from watercraft |
| | | 3 | Noise pollution from jet skis for example |
| | Fishing<br>6 | 3 | Excellent fishing opportunities |
| | | 1 | Pan fishing with public access (for children etc) |
| | | 2 | Fish at Fall Creek |
| Human uses: Water supply<br>*(total 23 points)* | Drinking water quality<br>23 | 19 | High quality drinking water source |
| | | 2 | Less sediment in lake for municipal water use |
| | | 2 | Protection of public drinking water sources |
| Human Uses: Economics<br><br>(*total 8 points*) | Economics<br><br>7 | 3 | Sustainable economics |
| | | 2 | Economic development: develop a plan to help use the lake to improve the economy |
| | | 2 | Quality of life among agricultural and urban sector |
| | Land ownership<br>1 | 1 | Native Americans don't get control of 64000 acres around north end of Cayuga Lake |

***Part 1: Visioning***

| Category | Subcategory | Weighted Rank | Comment |
|---|---|---|---|
| Lake Ecology<br><br>*(total 50 points)* | Water Quality (not specific to any use)<br><br>18 | 5 | Lake quality maintained as it is now, no degradation |
| | | 7 | Improved water quality |
| | | 1 | Find no pollution in Cayuga Lake basin |
| | | 2 | Improved protection of ground and surface water |
| | | 3 | Lake in near pristine condition |
| | Natural resources<br><br>17 | 3 | Natural resource for all |
| | | 3 | Clean water providing healthy watershed dependent ecosystems and good human drinking water |
| | | 4 | The ecosystem within the lake is healthy |
| | | 2 | Cleaner environment |
| | | 1 | Healthy lake for flora and fauna |
| | | 3 | All tributaries healthy |
| | | 1 | Beaver control |
| | Control of weeds<br><br>7 | 3 | Reduce/eliminate the seaweed in the lake |
| | | 2 | Reduced algae and other weeds in the lake and good fishing |
| | | 2 | Clean water and fewer weeds |
| | Exotic species<br><br>3 | 2 | Elimination of exotic species such as milfoil and control of vegetation in general |
| | | 1 | No new non-native species and a noticeable reduction in previously established ones |
| | Fish community<br><br>5 | 1 | Re-appearance of the sturgeon in deep water |
| | | 1 | A healthy fishery and ecosystem |
| | | 2 | Salmon fishing in Salmon Creek |
| | | 1 | Fish spawning in Fall Creek and Cayuga Inlet |
| Tools for Preservation<br><br>*(total 12 points)* | Open space and scenic vistas<br><br>12 | 5 | Preservation of open space (agriculture and public lands) |
| | | 3 | Maintain scenic vistas via land use regulation, planning |
| | | 1 | Aesthetics of more open areas for the general public |
| | | 3 | Significant tracts of open space in the full variety of habitats are preserved, both in the watershed and along the majority of the lakeshore. |

***Part 1: Visioning***

| **Category** | **Subcategory** | **Weighted Rank** | **Comment** |
|---|---|---|---|
| Management and regulatory tools<br><br>*(total 17 points)* | Water level and flooding<br><br>7 | 1 | Flood control (water level management) to help reduce erosion |
| | | 1 | Manage lake levels appropriately for recreational use |
| | | 2 | Flood-prone areas are under better control |
| | | 3 | Water supply systems improved to allow better water level management |
| | Regulation of shoreline construction 1 | 1 | No further construction on the lake perimeter and some buildings gone. |
| | Implementation funding 1 | 1 | $ to implement plan |
| | Land use planning<br><br>8 | 3 | Controls on development |
| | | 1 | Better land management |
| | | 2 | Balanced management plan |
| | | 1 | Zoning and health laws enforced, septic systems etc. |
| | | 1 | Use of best management practices and land use planning that considers and protects the environment long-term |
| *Control of Inputs*<br><br>*(total 28 points)* | Wastewater management<br><br>11 | 3 | Properly running wastewater treatment plants |
| | | 2 | Programs for residual sewage |
| | | 2 | Municipal water system and sewer around the lake |
| | | 1 | Control of wastewater discharges from public or private sources (no pathogens) |
| | | 2 | No lake-related industry potentially damaging to the lake |
| | | 1 | Regional wastewater treatment programs |
| | Agricultural<br><br>5 | 3 | Agriculture thriving in the southern basin, with reduced sediment and nutrients |
| | | 1 | Progress for agricultural runoff |
| | | 1 | Preservation of agricultural economy with controlled erosion and sedimentation |
| | Erosion and sedimentation<br><br>11 | 3 | Less sedimentation pollution of south end |
| | | 2 | Control erosion |
| | | 3 | Beach areas no longer eroded |
| | | 1 | Reduced sedimentation |
| | | 2 | Sediment control from runoff |
| | Nonpoint sources 1 | 1 | Lawn care, fertilizer, herbicides |

**Table 7.1.5.2 Part 2: Specific Water Quality Issues**
***Group 1: Northern Basin, Northern Watershed***

| SOURCE | TYPE | ISSUE | USE | DATA |
|---|---|---|---|---|
| (1) Nonpoint source of TCE | Volatile organic compound | Drinking water | Drinking water | County health and DEC |
| (2) Water level drawdown | Water level management | Biotic habitat | Habitat alteration | DEC, DOT |
| (3) Inadequately treated domestic sewage | Nutrients, bacteria, oxygen demand | Smell and bacteria | Aesthetic<br>Water supply | Bridgeport |
| (4) Canoga Creek area | Sediment | Turbidity | Water supply | Treatment plant reports |
| (5) Agriculture and residential runoff | Nutrients in water | Weeds, water clarity | Boating, drinking water | |
| (6) Exotic species (rudd and zebra mussel) | Transplanting | Water quality and filtration of microorganisms | Food chain | Dave McNeil at Brockport |
| (7) Septic systems | Nutrients, bacteria, oxygen demand | Water quality, algae, aquatic vegetation | Navigation | Ray Oglesby |
| (8) Marinas | Organic chemicals gas/oil etc. | Toxic substances | Water quality<br>drinking<br>swimming | Visual observation |
| (9) Stormwater runoff | Road-side ditches | Turbidity | Water quality<br>drinking<br>swimming | Visual observation |

***Part 2: Specific Water Quality Issues, Group 2: Mid-Lake, Mid-Watershed***

| SOURCE | TYPE | ISSUE | USE | DATA |
|---|---|---|---|---|
| (1) Stewart Park | Runoff from Fall Creek | Water is filthy and polluted | Swimming | |
| (2) Sewage treatment plant | Effluent running to lake | Affects aquatic life in streams | Aquatic life | DEC |
| (3) North end | Nutrients and possibly pathogens | Water fowl | Drinking and recreation | None |
| (4) Hog farms | Nutrients (nitrogen), odors | Nutrient loading and aquifer | Recreation and drinking water | None |
| (5) Building marina | Scenic, safety | More cars, sewage | Neighboring properties, cove | |
| (6) Deans Cove Stream | Sediment | Sediment loading | Recreation and drinking | |
| (7) Milfoil | Introduction of exotic species | Recreational use, disruption of ecosystem | Swimming, boating | |
| (8) Zebra mussels | Introduction of exotic species | Drinking water intakes | Drinking water, recreation | |
| (9) Lamprey eels | Depletion of fish supply | Fish community | Fishing, recreation | |

***Part 2: Specific Water Quality Issues, Group 3: Southern Lake, Southern Watershed***

| SOURCE | TYPE | ISSUE | USE | DATA |
|---|---|---|---|---|
| (1) Rapid storm runoff | Sediments and nutrients | Lack of transparency, lack of infiltration, increased sedimentation, aesthetics (smelly) | Swimming<br>Boating<br>Drinking<br>Fishing | USGS<br>Cornell LSC<br>Milliken |
| (2) Wastewater treatment plants | Biochemical oxygen demand. Phosphorus and nitrogen, pathogens | Algae blooms<br>Transparency<br>Weed growth | Fishing<br>Recreation<br>Drinking water | |
| (3) Oil spills (Jacksonville leak, Fall Creek and Inlet spills) | Petroleum products | Ground and surface water quality, ecosystem degradation, fish productivity, general ecosystem health | Fishing<br>Recreation<br>Drinking water | |
| (4) Private septic systems | Bacteria<br>Nutrients<br>Chemicals<br>Pathogens | Groundwater pollution | Drinking water | |
| (5) Abandoned landfills (Trumansburg area, Cornell low-level radioactive, etc.) | Heavy metals, petroleum | Surface water and groundwater (localized in watershed), wildlife | Drinking water<br>General water quality,<br>Environmental health | |
| (6) Lawn and garden overuse of pesticides and fertilizers | Pesticides and fertilizers | Water quality<br>Turbidity<br>Wildlife | Drinking water<br>Recreation<br>Wildlife | |

***Part 2: Specific Water Quality Issues, Group 4: Lake-Wide, Watershed-Wide***

| SOURCE | TYPE | ISSUE | USE | DATA |
|---|---|---|---|---|
| (1) Sediment streams and agricultural runoff (south end) | Nutrients<br>Pathogens<br>Pesticides<br>Sediment./fill-in | Degraded water quality<br>Clarity decrease | Recreational use<br>Human health<br>Drinking water<br>Fishing | USGS<br>Health depts. |
| (2) Treatment plant | Phosphorus<br>Nitrogen<br>Metals<br>Coliform<br>Giardia and Cryptosporidia<br>Viruses<br>Pathogens | Drinking water source<br>Recreational use<br>Metals in fish | Drinking<br>Swimming<br>Recreational use | Special project (Coliform data not that great)<br>Treatment plant (age and efficiency) |
| (3) Lake level | Erosion and sedimentation<br>Inundated septics<br>Water supply systems<br>Salt water<br>Concentrate contaminants<br>Mosquitoes | Increased turbidity<br>Affect water supply issues (including algae due to septics)<br>Recreational use<br>Access to homes | Recreation<br>Navigation<br>Drinking water<br>Fish population | Canal Corp<br>Citizens around the lake |
| (4) Camps in floodway with unregulated septic systems | Pathogens<br>Nitrogen<br>Phosphorus<br>Coliform | Similar to wastewater treatment plants | Swimming<br>Boating<br>Drinking water<br>Public health<br>Insects | Cayuga County DOH<br>Other health departments?<br>Smaller political subdivisions (code enforcement people?) |
| (5) Industrial use of the lake | Thermal<br>Ionic (chlorides) | Temp. degradation, biosides, phosphorus transfer | Swimming,<br>Fishing<br>Drinking | NSDEC, SPDES permits, reports. |
| (6) Commercial and residential development around the lake | Runoff<br>Impervious surfaces<br>Infrastructure (bring in water and sewer)<br>Erosion | Degraded water quality in lake<br>Loss of natural infiltration<br>Loss of open space | Open space<br>Lack of public access<br>Increased noise pollution<br>General water quality<br>Decreased agriculture | Building permits<br>Zoning boards<br>Home Builders Associations<br>Remote sensing<br>Aerial photos (historical) |

### 7.2 Education Activities

As part of, or in association with the Cayuga Lake Watershed Management Plan the following education activities have taken place:

#### 7.2.1 Educational Display for Water Quality Issues

Three educational displays was designed and constructed to increase awareness of water quality issues in the Cayuga Lake Watershed. A display titled “Drains to the Lake” brought to light the various aspects of non-point source pollution, erosion, stormwater management, and others watershed issues were represented. The display also shows the Cayuga Lake watershed boundaries and gives interesting facts about the watershed. The display can be used throughout the watershed at businesses, banks, municipal offices, fairs, festivals and other events to educate and inform the public.

#### 7.2.2 Cayuga Lake Watershed Fact Sheet

The Cayuga Lake Watershed Fact Sheet includes an overview of lake facts, economic resources, natural resources, cultural/historical resources, public and private drinking water, geographic/political, and pollution and impairments in the watershed (see Appendix D).

#### 7.2.3 Local Government Workshops

The Genesee/Finger Lakes Region Planning & Zoning Workshop is held twice a year in May and November. Training sessions are held throughout the day on land use and environmental issues (see Appendix D). Municipal priority issues in the Cayuga Lake Watershed have been addressed through this Workshop since 1998.

#### 7.2.4 Cayuga Lake Watershed Intermunicipal Organization/Network Bus Tour

As part of the Cayuga Lake Watershed Management Plan process and educational bus tour of the watershed was held in October 1999. Representatives of the Intermunicipal Organization and Cayuga Lake Watershed Network were part of the following agenda:

Lake Source Cooling – Stewart Park, Ithaca - Bob Bland, Cornell University
Ithaca Waste Water Treatment Plant – Ithaca, New York - Jose Lozano, City of Ithaca
Silt Dam – Roxy Johnson, City of Ithaca
Cayuga Lake Watershed Management Plan – David Zorn, G/FLRPC
Lake Sampling in Cayuga Lake – Joe Makarewicz, SUNY Brockport
Manure Handling, Patterson Farm, Sandy Huey, Cayuga County SWCD
Cayuga Lake Pesticide Research, Dave Eckhardt, USGS
Hydrology of the Cayuga Lake Watershed – Mud Lock - Bill Kappel, USGS
West side of Cayuga Lake

#### 7.2.5 Cayuga Lake Watershed Management Plan Internet Web Site

The Cayuga Lake Watershed Management Plan Internet Web Site was developed at the beginning of the project in 1998. It is maintained on a regular basis and is now at www.cayugawatershed.org

#### 7.2.6 Cayuga Lake Watershed Management Plan Brochure

The Cayuga Lake Watershed Management Plan brochure (Appendix D) was developed in 1998 to educate people about the Cayuga Lake Watershed Management Plan project.

# Chapter 8. Interim Recommendations

## 8. Interim Recommendations

The ultimate goal of the Cayuga Lake Watershed Management Planning process is to develop and implement recommendations for restoring, protecting, and enhancing water quality in the Cayuga Lake Watershed. During the first two years of the Watershed Management Plan process "interim" lists of implementation recommendations for projects of watershed-wide significance and impact was developed for the New York State Department of State.

The process included the following steps:

- Technical Committee development and Intermunicipal Organization approval of Evaluation Criteria
- Solicitation of recommendations from each municipality, county, and county water quality coordinating committee
- Joint Technical Committee/Intermunicipal Organization review
- Intermunicipal Organization review and approval

### 8.1 Evaluation Criteria

#### 8.1.1 1999 Evaluation Criteria

The following evaluation criteria is used as a description of each numbered column of the Evaluation Matrix where the numbers below are directly related to the numbers in the columns of the Evaluation Matrix (see Table 8.3.1):

1. Might this project be implemented on other areas of the lake or contributing watersheds?

- This could allow for demonstration projects and/or model development
- This could allow for watershed-wide integration of many related individual projects
- If the project needs can not be identified elsewhere in the watershed will its impact be as significant as more watershed-wide projects
- Is it an innovative project
- What is the likelihood of success or degree of failure

2. Does the problem to be addressed have an existing solution? (A proven remediation technology but just lacks funding?)(i.e., Best Management Practices documentation/implementation plans exist, versus a unique problem, where data collection and analysis are required prior to devising a remediation approach.)

- Use of existing models assist with implementation efficiency and effectiveness

3. Does the project have a means of being evaluated -- proving that the $'s were invested correctly. (This begins the process of establishing a baseline of data from which to evaluate cost/benefits.)

- Projects can be evaluated based on the target of mitigation and the technical description of the application or on historical data of existing applications already in the field if applicable.

4. Operation and maintenance consideration

- What is the cost of operating and maintaining the project in subsequent years
- What is the degree of assurance that maintenance will be covered throughout the life span of the project

5. Does the project address an identified impairment

- Use existing means to rank. One of the means presently available is the 1996 Priority Waterbodies List(PWL)*. In the future the Cayuga Lake Watershed Characterization can be used.

6. Does the project address potential human use of the lake and the watershed (e.g. bathing, fishing, boating, drinking, aesthetic enjoyment, wastewater disposal, power generation, cooling, access, transportation, tourism, recreation)

- Without solid data how does the project potentially effect human use of the lake and watershed

7. Does the project address potential lake and watershed ecology (e.g. wildlife habitat, fisheries)
- Without solid data how does the project potentially effect the lake and watershed ecology

8. Does the project potentially benefit/degrade the general quality of the lake, or the watershed feeding the lake?
- a project might exacerbate existing water quality concerns, for example downstream
- a project might benefit water quality but not have lake-wide/watershed-wide impact
- a project might potentially have watershed-wide impact

9. Capital expenditure limit? (spreading the wealth, versus all the eggs in one or a few baskets?)
- The approximate cost of the project would be considered but not ranked within the other criteria. A determination would be made after project ranking how to proceed given the proposed approximate cost.

10. Actual use consideration (swimming, power generation, access, boating, drinking, fishing/fisheries, wildlife habitat, aesthetics, waste disposal, cooling, transportation, tourism, recreation)
- Projects impacts on uses of the lake and the watershed
- Because of lack of data at the present time this could be considered outside of the project ranking scheme. As more data becomes available this category can be used for the purposes of ranking
- PWL* information should be considered

11. Funding considerations.
- Consider outside of the project ranking scheme.
- Has other funding sources been applied to previously?
- Has all other possible sources of funding been exhausted.

*Periodically, the NYSDEC Division of Water publishes a list of surface waters that either cannot be fully used as a resource, or have problems that can damage their environmental integrity. This list – The Priority Waterbodies List (PWL) – is used as a base resource for Division of Water program management. The listing of the PWL includes individual waterbody data sheets describing the conditions, causes, and sources of water quality problems in a given basin. Users of the information contained in the PWL are reminded of the following special considerations:

- The PWL is a reflection of priority waterbodies at a specific moment in time.
- In many cases, surface water systems are highly interrelated.
- Resolution potential can be noted as high, medium, or low. High resolution potential indicates that the water quality problem has been deemed to be worthy of the expenditure of available resources (time and dollar) because of the level of public interest and the expectation that the commitment of these resources will result in a measurable improvement in the situation. Medium resolution generally indicates that the resources necessary to address the problem are beyond what is currently available. Segments with low potential for resolution indicate water quality problems so persistent that improvements are expected to require an unrealistically high commitment of resources, not likely to become available (e.g. acid rain lakes).

PWL information for Cayuga Lake and many of its tributaries are in Chapter 1.5.4.1 and associated Table 1.5.4.1.1. Information includes name of waterbody, resolution potential, use impairment(s), severity, documentation, type of pollutant(s), and source(s) of pollutant(s).

**8.1.2 2000 Evaluation Criteria**

1. What is the overall positive long-term impact on the watershed and/or lake**
- This could allow for demonstration projects and/or model development
- Might this project be implemented on other areas of the lake or contributing watersheds?

- This could allow for watershed-wide integration of many related individual projects
- If the project needs can not be identified elsewhere in the watershed will its impact be as significant as more watershed-wide projects
- What is the likelihood of success or degree of failure

2. Does the problem to be addressed have an existing solution? ** (A proven remediation technology but just lacks funding?)(i.e., Best Management Practices documentation/implementation plans exist, versus a unique problem, where data collection and analysis are required prior to devising a remediation approach.)

- Use of existing models assist with implementation efficiency and effectiveness

3. Does the project have a means of being evaluated -- proving that the $'s were invested correctly.** (This begins the process of establishing a baseline of data from which to evaluate cost/benefits.)

- Projects can be evaluated based on the target of mitigation or enhancement and the technical description of the application or on historical data of existing applications already in the field if applicable.

4. Operation and maintenance consideration

- What is the cost of operating and maintaining the project in subsequent years
- What is the degree of assurance that maintenance will be covered throughout the life span of the project

5. Does the project address an identified impairment**

- 1996 Priority Waterbodies List (PWL)*.
- Cayuga Lake Preliminary Watershed Characterization
- Other

6. Does the project address potential human use of the lake and the watershed (e.g. bathing, fishing, boating, drinking, aesthetic enjoyment, wastewater disposal, power generation, cooling, access, transportation, tourism, recreation)

7. Does the project address potential lake and watershed ecology (e.g. wildlife habitat, fisheries)

8. Does the project potentially benefit/degrade the general quality of the lake, or the watershed feeding the lake?

- a project might exacerbate existing water quality concerns, for example downstream

9. Capital expenditure limit? (spreading the wealth, versus all the eggs in one or a few baskets?)

- The approximate cost of the project would be considered but not ranked within the other criteria. A determination would be made after project ranking how to proceed given the proposed approximate cost.

10. Actual use consideration (swimming, power generation, access, boating, drinking, fishing/fisheries, wildlife habitat, aesthetics, waste disposal, cooling, transportation, tourism, recreation)**

- Projects impacts on uses of the lake and the watershed
- PWL* information should be considered
- Cayuga Lake Preliminary Watershed Characterization should be considered

11. Funding considerations.

- Consider outside of the project ranking scheme.
- Has other funding sources been applied to previously?
- Has all other possible sources of funding been exhausted.

12. Amount of criteria met

*Periodically, the NYSDEC Division of Water publishes a list of surface waters that either cannot be fully used as a resource, or have problems that can damage their environmental integrity. This list – The Priority Waterbodies List (PWL) – is used as a base resource for Division of Water program management. The listing of the PWL includes individual waterbody data sheets describing the conditions, causes, and sources of water quality problems in a given basin. Users of the information contained in the PWL are reminded of the following special considerations:

- The PWL is a reflection of priority waterbodies at a specific moment in time.
- In many cases, surface water systems are highly interrelated.
- Resolution potential can be noted as high, medium, or low. High resolution potential indicates that the water quality problem has been deemed to be worthy of the expenditure of available resources (time and dollar) because of the level of public interest and the expectation that the commitment of these resources will result in a measurable improvement in the situation. Medium resolution generally indicates that the resources necessary to address the problem are beyond what is currently available. Segments with low potential for resolution indicate water quality problems so persistent that improvements are expected to require an unrealistically high commitment of resources, not likely to become available (e.g. acid rain lakes).

PWL information for Cayuga Lake and many of its tributaries are attached. Information includes name of waterbody, resolution potential, use impairment(s), severity, documentation, type of pollutant(s), and source(s) of pollutant(s).

**Scores for Criteria 1, 2, 3, 5, 10 will be both aggregated with all Criteria and shown separately for Bond Act, EPF and Section 319 related projects

***Final qualitative ranking – the IO has the option to rerank all projects based on a qualitative consideration of overall positive impact on the watershed.

## 8.2 Implementation Recommendations

### 8.2.1 1999 Implementation Recommendations

The following implementation recommendations were submitted to the Intermunicipal Organization (see Appendix I for project description):

1. Conduct Suitability Analysis for Open Space Acquisition
2. Conduct a Source Water Assessment to Improve Lake-Source Drinking Water Quality
3. Increase Public Education and Participation in Lake and Water Quality Management
4. Assess Climate-Related Impacts, Land Use, and Effects on Water Quality
5. EQIP Funding for Cayuga Lake (Cayuga County)
6. Town of Ulysses Safe Drinking Water Project
7. Streambank Stabilization Within Cayuga Lake Watershed (Seneca County)
8. Comprehensive Nutrient Management Planning (Tompkins County)
9. Streambank Stabilization and Debris Removal (Tompkins County)
10. Aquifer Research and Monitoring
11. Location and Identification of Farmstead Dumps
12. Highway Department Stormwater Education
13. Manure Handling
14. Trophic State of Cayuga Lake
15. Ithaca/Cayuga Heights/Lansing Area Wastewater Collection and Treatment System Improvements
16. Development of Natural Trail
17. Watershed Planning and Streambank Restoration in Subwatersheds of Fall Creek Watershed
18. Six Mile Creek Restoration

### 8.2.2 2000 Implementation Recommendations

The following implementation recommendations were submitted to the Intermunicipal Organization (see Appendix I for project description):

1. Biomonitoring of Four Major Tributaries of Northern Cayuga Lake: Yawger Creek, Great Gully, Paine's Creek and Salmon Creek
2. Water Remediation
3. Cayuga Lake Road: Hydrologic Modification
4. Ithaca/Cayuga Heights/Lansing Area Wastewater Collection And Treatment System Improvements
5. Ag Nutrient Management in Seneca County
6. Proposed Water System Improvements Village of Interlaken
7. High resolution-multispectral remote-sensing chlorophyl-$\alpha$ quantitation
8. Six Mile Creek Riparian Buffer Restoration Program
9. The Trophic State of Cayuga Lake
10. Defining a Source Water Assessment Program (SWAP) for the Cayuga Lake Watershed and the Hydrological, Ecological and Environmental Conditions of Watersheds Undergoing Socio-Economic Changes Affecting Land and Water Use
11. Stream Restoration at the Barrile Site in the Town of Caroline

## 8.3 Ranking

Ranking of submitted implementation recommendations was done by a ranking committee that was made up of representatives of the Cayuga Lake Watershed Management Plan Technical Committee and the Intermunicipal Organization. The rankings (see Table 8.3.1 and 8.3.2) was then submitted to and approved by the Intermunicipal Organization.

**Table 8.3.1**
**1st Year Interim Recommendations Evaluation Matrix**
5, 3, 1 Ranking - 5 best, 1 worst)

| Project | 1)Implement Watershed-Wide | Standard Deviation | 2) Existing Tools | Standard Deviation | 3) Can Project Be Evaluated | Standard Deviation | 4) Operation & Maintenance Consideration | Standard Deviation | 5) Addresses Identified Impairment | Standard Deviation | 6) Addresses Human Use | Standard Deviation | 7) Addresses Lake/Watershed Ecology | Standard Deviation | 8) Benefit to Lake/Watershed | Standard Deviation | **Average Score** | **Average Deviation** | 9) Capital Expenditure Amount | 10) Benefiting Use(s) | 11) Funding Considerations | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 4 1 5 5 5 2 5 4 1 | 1.74 | 5 5 5 5 5 5 5 4 5 | 0.33 | 5 3 4 5 5 5 5 2 5 | 1.12 | 4 4 5 5 2 5 1 5 | 1.55 | 5 5 4 5 5 5 5 4 5 | 0.44 | 5 5 4 5 5 4 5 5 5 | 0.44 | 5 5 4 5 5 4 5 5 5 | 0.44 | 5 5 4 5 5 4 5 4 5 | 0.50 | **4.46** | 0.49 | $ 3,000,000.00 | 4 1 | Big bang for $/ 2 rankings indicated endorse | BA |
| 6 | 4 5 1 4 1 1 5 5 3 | 1.79 | 4 3 4 5 4 5 3 4 5 | 0.78 | 4 1 4 4 4 1 3 3 5 | 1.39 | 4 5 5 5 5 1 1 3 | 1.77 | 4 3 5 5 5 1 5 5 5 | 1.39 | 5 5 5 4 5 5 4 5 5 | 0.44 | 4 3 1 5 5 4 4 5 3 | 1.30 | 5 3 1 5 5 4 4 4 3 | 1.30 | **3.85** | 0.33 | $ 3,400,000.00 | 3 4 | | SDW part of Bond Act |
| 5 | 4 5 4 5 5 1 5 5 3 | 1.36 | 4 5 4 5 5 5 4 5 5 | 0.50 | 4 3 4 5 3 4 4 2 3 | 0.88 | 4 3 5 3 2 4 1 3 | 1.25 | 5 3 3 5 5 4 5 3 3 | 1.00 | 4 1 3 5 5 2 5 2 1 | 1.69 | 5 3 3 5 4 3 5 3 1 | 1.33 | 5 5 3 5 3 4 5 4 1 | 1.36 | **3.76** | 0.28 | $ 200,000.00 | 2 3 | Support letter | SWAP & Bond Act |
| 9 | 4 5 3 5 3 5 5 5 3 | 0.97 | 4 5 3 3 5 5 5 5 3 | 0.97 | 5 1 3 5 5 1 5 1 3 | 1.86 | 4 3 5 5 4 5 1 1 | 1.69 | 5 5 3 5 5 5 1 4 3 | 1.41 | 4 1 3 5 3 2 5 3 3 | 1.30 | 5 3 3 5 3 4 5 4 1 | 1.32 | 5 3 3 5 3 4 5 5 3 | 1.00 | **3.76** | 0.25 | $ 100,000.00 | 4 4 | | SWAP & Bond Act |
| 8 | 4 5 3 5 5 5 5 5 3 | 0.88 | 4 5 3 3 5 4 5 5 3 | 0.93 | 5 3 5 5 3 2 4 1 1 | 1.64 | 4 2 5 3 2 1 1 5 | 1.64 | 5 5 5 5 5 2 2 5 3 | 1.36 | 3 3 3 5 5 4 5 4 1 | 1.32 | 5 3 3 5 4 2 5 4 1 | 1.42 | 5 5 2 5 3 2 5 5 3 | 1.36 | **3.75** | 0.21 | $ 500,000.00 | 2 4 | | BA |
| 7 | 4 5 3 5 3 5 5 5 3 | 0.97 | 4 5 4 4 5 5 5 5 3 | 0.73 | 4 1 3 5 5 1 5 3 3 | 1.58 | 3 2 4 5 4 5 1 1 | 1.64 | 4 5 4 5 5 5 1 4 3 | 1.32 | 3 1 3 5 3 2 5 2 3 | 1.32 | 5 3 3 5 3 4 5 4 1 | 1.32 | 5 3 3 5 3 4 5 4 3 | 0.93 | **3.72** | 0.26 | $ 158,400.00 | 4 4 | | SWAP & Bond Act |
| 13 | 4 5 3 5 5 5 5 5 3 | 0.88 | 4 5 3 4 5 3 5 5 3 | 0.93 | 4 3 3 4 5 4 5 1 5 | 1.30 | 5 3 5 1 1 1 1 1 | 1.83 | 5 5 3 5 5 2 1 4 3 | 1.50 | 4 3 3 5 5 2 5 4 1 | 1.42 | 5 3 3 5 3 2 5 4 1 | 1.42 | 5 5 3 5 3 3 5 4 3 | 1.00 | **3.68** | 0.26 | $ 300,000.00 | 2 2 | | BA |
| 14 | 4 3 2 5 5 2 5 2 3 | 1.33 | 4 3 2 5 4 2 5 4 3 | 1.13 | 5 1 2 5 5 2 3 2 5 | 1.66 | 5 2 4 5 4 3 1 1 | 1.64 | 5 3 2 5 5 4 5 4 1 | 1.48 | 5 3 2 5 5 4 5 4 1 | 1.48 | 5 5 2 5 4 5 5 4 3 | 1.09 | 5 5 2 5 3 5 5 4 3 | 1.17 | **3.68** | 0.19 | $ 790,250.00 | 3 2 | Other funding sources | BA |
| 12 | 4 5 3 5 3 5 3 5 5 | 0.97 | 4 3 2 5 5 5 3 5 5 | 1.17 | 5 3 2 3 5 2 3 1 5 | 1.48 | 4 2 4 3 1 3 1 1 | 1.30 | 5 5 4 5 5 3 3 4 5 | 0.87 | 5 1 2 2 2 2 3 3 1 | 1.22 | 5 3 3 5 3 4 3 4 5 | 0.93 | 5 5 2 5 5 4 3 5 5 | 1.12 | **3.62** | 0.16 | $ 50,000.00 | 3 3 | Use existing models, do on watershed-wide basis | BA |
| 18 | 4 5 2 5 3 5 4 3 | 1.13 | 4 5 4 5 3 5 5 3 | 0.89 | 5 1 2 4 2 5 1 3 | 1.64 | 4 2 3 3 5 1 3 | 1.29 | 5 3 3 5 3 1 4 5 | 1.41 | 3 1 2 2 2 5 4 3 | 1.28 | 5 5 2 5 3 5 4 5 | 1.16 | 5 5 2 5 3 5 3 5 | 1.25 | **3.60** | 0.15 | $ 110,000.00 | 2 2 | Ongoing | SWAP & Bond Act |
| 10 | 4 3 3 5 3 5 5 4 5 | 0.93 | 4 5 3 5 4 2 1 5 5 | 1.48 | 5 1 5 5 5 2 1 1 5 | 2.00 | 4 3 3 5 5 1 1 3 | 1.55 | 5 3 5 2 1 2 1 3 1 | 1.59 | 5 5 5 2 5 5 5 5 3 | 1.13 | 5 1 3 5 1 1 5 4 5 | 1.87 | 5 3 3 1 2 2 5 3 3 | 1.32 | **3.46** | 0.27 | $ 65,000.00 | 3 2 | | BA |
| 2 | 4 5 4 5 5 3 4 5 5 | 0.73 | 3 3 3 4 3 3 1 4 3 | 0.87 | 3 1 3 5 5 2 3 1 3 | 1.45 | 3 3 3 2 4 1 1 5 | 1.39 | 3 3 3 4 5 4 1 3 3 | 1.09 | 4 3 2 5 5 3 4 4 5 | 1.05 | 3 3 3 5 5 3 4 4 3 | 0.87 | 4 3 3 5 3 3 4 4 3 | 0.73 | **3.44** | 0.23 | $ 100,000.00 | 2 4 | | BA |
| 11 | 4 5 3 5 2 5 4 5 3 | 1.12 | 4 3 3 1 2 3 4 4 3 | 1.00 | 5 3 3 2 4 2 4 1 5 | 1.39 | 4 3 3 2 5 1 1 1 | 1.51 | 5 3 4 2 2 4 1 4 3 | 1.27 | 5 3 3 1 2 4 3 5 1 | 1.50 | 5 3 2 3 2 3 3 4 1 | 1.17 | 5 5 2 4 2 3 3 5 3 | 1.24 | **3.17** | 0.15 | $ 75,000.00 | 4 3 | This is phase 1 | BA |
| 3 | 4 5 4 5 5 3 4 5 5 | 0.73 | 3 3 3 3 5 4 1 4 5 | 1.24 | 3 1 2 5 5 3 1 1 1 | 1.67 | 2 2 5 2 2 1 1 5 | 1.60 | 1 1 2 5 5 3 1 3 3 | 1.58 | 5 3 1 5 5 3 4 4 1 | 1.59 | 3 1 1 5 4 3 3 4 1 | 1.48 | 4 3 1 5 4 3 3 4 3 | 1.12 | **3.14** | 0.26 | $ 75,000.00 | 4 4 | | BA |
| 17 | 4 5 2 5 5 5 4 1 | 1.55 | 3 3 5 1 5 3 5 3 | 1.41 | 4 1 2 1 1 1 1 3 | 1.16 | 4 2 1 4 1 1 1 | 1.41 | 4 5 3 5 5 1 4 3 | 1.39 | 3 1 2 1 2 1 3 3 | 0.93 | 3 3 2 5 4 3 4 3 | 0.92 | 4 3 2 5 4 3 4 3 | 0.93 | **2.98** | 0.23 | $ 15,000.00 | 2 4 | Falls under 9 | |
| 4 | 4 5 4 5 3 4 3 5 5 | 0.83 | 4 3 4 5 4 2 1 5 3 | 1.33 | 4 1 1 3 4 3 1 1 1 | 1.36 | 3 2 3 3 4 1 1 3 | 1.07 | 3 1 1 4 2 3 1 3 1 | 1.17 | 5 1 1 5 2 2 2 4 1 | 1.67 | 5 3 1 5 3 4 3 4 1 | 1.48 | 4 3 1 5 4 4 3 5 3 | 1.24 | **2.97** | 0.19 | $ 75,000.00 | 3 2 | | BA |
| 1 | 4 3 4 5 1 2 4 5 3 | 1.33 | 3 3 4 5 3 2 1 4 1 | 1.36 | 4 1 2 0 3 2 1 1 3 | 1.27 | 4 4 3 2 2 1 1 1 | 1.28 | 2 1 1 4 1 2 1 3 1 | 1.09 | 4 1 2 3 5 3 4 2 1 | 1.39 | 3 1 2 3 1 2 5 3 1 | 1.32 | 4 3 2 5 1 3 5 4 3 | 1.32 | **2.59** | 0.06 | $ 25,000.00 | 3 2 | | Bond Act (BA) |
| 16 | 1 1 1 1 1 4 1 3 1 | 1.13 | 1 1 5 1 3 4 1 3 3 | 1.51 | 4 1 5 1 5 1 1 1 3 | 1.81 | 1 1 1 1 2 1 1 1 | 0.35 | 1 1 1 1 1 1 1 3 1 | 0.67 | 3 1 1 1 5 3 1 3 1 | 1.45 | 1 1 1 1 1 1 1 1 1 | 0.00 | 1 1 1 1 1 1 1 1 1 | 0.00 | **1.62** | 0.61 | | 3 3 | | BA |

**Table 8.3.2**
**Cayuga Lake Watershed Management Plan**
**2nd Year Interim Recommendations**
**Ranking Matrix**
**Scoring 1 through 5 (1 low, 5 high)**

**Quantitative Scoring**

| Project # | Criteria 1 *Overall Inpact*** | | | | | *SD* | Criteria 2 *Existing Solution*** | | | | | *SD* | Criteria 3 *Means of Evaluation*** | | | | | *SD* | Criteria 4 *O & M* | | | | | *SD* | Criteria 5* *Identified Impairment*** | | | | | *SD* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | 4 | 5 | 4 | 5 | 5 | 0.55 | 5 | 5 | 3 | 5 | 5 | 0.89 | 5 | 5 | 3 | 5 | 3 | 1.10 | 3 | 5 | 5 | 5 | 5 | 0.89 | 5 | 5 | 0 | 5 | 5 | 2.24 |
| 7 | 1 | 5 | 5 | 4 | 4 | 1.64 | 3 | 5 | 5 | 4 | 5 | 0.89 | 3 | 4 | 5 | 5 | 5 | 0.89 | 1 | 3 | 5 | 4 | 2 | 1.58 | 4 | 5 | 5 | 4 | 5 | 0.55 |
| 8 | 3 | 4 | 5 | 4 | 5 | 0.84 | 4 | 5 | 5 | 4 | 5 | 0.55 | 1 | 5 | 5 | 5 | 3 | 1.79 | 1 | 2 | 3 | 5 | 2 | 1.52 | 4 | 5 | 5 | 4 | 5 | 0.55 |
| 11 | 1 | 5 | 3 | 4 | 5 | 1.67 | 3 | 5 | 5 | 4 | 5 | 0.89 | 2 | 5 | 0 | 4 | 5 | 2.17 | 3 | 5 | 3 | 4 | 3 | 0.89 | 4 | 5 | 5 | 4 | 5 | 0.55 |
| 1 | 3 | 4 | 5 | 4 | 5 | 0.84 | 3 | 2 | 5 | 2 | 5 | 1.52 | 5 | 4 | 5 | 3 | 5 | 0.89 | 3 | 5 | 3 | 4 | 5 | 1.14 | 4 | 5 | 5 | 4 | 5 | 0.55 |
| 9 | 3 | 4 | 5 | 4 | 3 | 0.84 | 3 | 4 | 5 | 4 | 5 | 0.84 | 3 | 4 | 5 | 4 | 4 | 0.71 | 3 | 4 | 3 | 4 | 3 | 0.67 | 4 | 4 | 5 | 4 | 5 | 0.55 |
| 5 | 4 | 5 | 5 | 3 | 5 | 0.89 | 5 | 5 | 4 | 3 | 5 | 0.89 | 3 | 3 | 0 | 3 | 2 | 1.30 | 3 | 3 | 5 | 3 | 1 | 1.41 | 5 | 5 | 5 | 3 | 5 | 0.89 |
| 3 | 1 | 5 | 1 | 4 | 3 | 1.79 | 4 | 5 | 4 | 4 | 5 | 0.55 | 1 | 3 | 0 | 4 | 3 | 1.64 | 4 | 4 | 3 | 4 | 5 | 0.89 | 4 | 5 | 5 | 4 | 5 | 0.55 |
| 2 | 1 | 4 | 0 | 5 | 2 | 2.07 | 4 | 5 | 4 | 4 | 5 | 0.55 | 1 | 5 | 5 | 4 | 3 | 1.67 | 4 | 5 | 5 | 4 | 2 | 1.22 | 4 | 5 | 0 | 5 | 4 | 2.07 |
| 10 | 2 | 5 | 3 | 5 | 1 | 1.79 | 2 | 5 | 2 | 5 | 1 | 1.87 | 4 | 4 | 2 | 5 | 1 | 1.64 | 2 | | 1 | 5 | 1 | 1.89 | 3 | 4 | 5 | 5 | 3 | 1.00 |
| 6 | 1 | 1 | 0 | 1 | 1 | 0.45 | 2 | 5 | 4 | 1 | 5 | 1.82 | 1 | 1 | 1 | 3 | 1 | 0.89 | 1 | 1 | 5 | 4 | 1 | 1.95 | 1 | 1 | 0 | 2 | 1 | 0.71 |

| Project # | Criteria 6 *Address Human Use* | | | | | *SD* | Criteria 7 *Address Ecology* | | | | | *SD* | Criteria 8 *Benefit/ Degrade WQ* | | | | | *SD* | Criteria 9* *Use Consideration*** | | | | | *SD* | Quantitative Sum | Average Deviation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | 4 | 5 | 0 | 5 | 5 | 2.17 | 4 | 5 | 0 | 5 | 4 | 2.07 | 4 | 5 | 4 | 5 | 5 | 0.55 | 5 | 5 | 3 | 5 | 5 | 0.89 | 193.0 | 1.57 |
| 7 | 3 | 5 | 5 | 4 | 5 | 0.89 | 3 | 5 | 5 | 5 | 5 | 0.89 | 3 | 4 | 5 | 5 | 3 | 1.00 | 3 | 5 | 5 | 5 | 5 | 0.89 | 189.0 | 1.52 |
| 8 | 4 | 5 | 5 | 4 | 4 | 0.55 | 4 | 5 | 5 | 4 | 5 | 0.55 | 4 | 5 | 5 | 4 | 5 | 0.55 | 3 | 5 | 5 | 4 | 5 | 0.89 | 189.0 | 1.36 |
| 11 | 4 | 5 | 3 | 4 | 5 | 0.84 | 4 | 5 | 3 | 4 | 5 | 0.84 | 4 | 5 | 5 | 4 | 5 | 0.55 | 3 | 5 | 3 | 4 | 5 | 1.00 | 182.0 | 1.54 |
| 1 | 4 | 4 | 5 | 4 | 3 | 0.71 | 4 | 4 | 5 | 3 | 5 | 0.84 | 3 | 3 | 5 | 3 | 3 | 0.89 | 4 | 4 | 5 | 3 | 5 | 0.84 | 181.5 | 1.41 |
| 9 | 3 | 5 | 5 | 4 | 5 | 0.89 | 3 | 5 | 5 | 4 | 5 | 0.89 | 3 | 3 | 5 | 4 | 3 | 0.89 | 3 | 3 | 5 | 4 | 5 | 1.00 | 180.5 | 1.30 |
| 5 | 4 | 5 | 5 | 3 | 3 | 1.00 | 4 | 5 | 5 | 3 | 3 | 1.00 | 4 | 5 | 3 | 3 | 5 | 1.00 | 5 | 5 | 5 | 3 | 5 | 0.89 | 176.0 | 1.49 |
| 3 | 3 | 5 | | 4 | 4 | 0.82 | 4 | 5 | | 4 | 4 | 0.50 | 4 | 5 | 4 | 4 | 5 | 0.55 | 4 | 5 | 0 | 4 | 5 | 2.07 | 162.5 | 1.53 |
| 2 | 4 | 5 | 5 | 5 | 5 | 0.45 | 3 | 3 | 0 | 3 | 3 | 1.34 | 3 | 3 | 0 | 4 | 5 | 1.87 | 4 | 5 | 0 | 4 | 2 | 2.00 | 156.0 | 1.69 |
| 10 | 3 | 5 | 5 | 5 | 3 | 1.10 | 3 | 4 | 5 | 5 | 3 | 1.00 | 3 | 4 | 5 | 5 | 3 | 1.00 | 3 | 4 | 5 | 5 | 1 | 1.67 | 155.0 | 1.66 |
| 6 | 4 | 5 | 5 | 3 | 3 | 1.00 | 1 | 1 | 0 | 1 | 1 | 0.45 | 1 | 1 | 0 | 2 | 3 | 1.14 | 1 | 1 | 0 | 2 | 2 | 0.84 | 82.0 | 1.06 |

**Qualitative Scoring/Comments/Considerations**

| Project # | Criteria 10 *Capital Expenditure Limit* | | | | Criteria 11 *Funding Considerations* | | | | Criteria 12 *# Criteria Met* | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | 3 | | Reasonable - multi-million | 1 | High impact on southern end of lake, big bucks for big problem | 1 | | 5 | 10 | | 11 |
| 7 | 4 | 5 | 44,000 Good to fit into satellite imaging in the future | 3 | Nice idea, but not enough "bang" for the money, method development rather than a proven tool? | 5 | Good match | 3 | 11 | ok | |
| 8 | 4 | | 100,000 | 1 | Buffer strip improvements, good utility, pilot project? | 5 | | 4 | 10 | | 11 |
| 11 | 4 | | 250,000 | 3 | Small area project and impact, again this type of project rated higher than expected | 5 | Budget high | 5 | 11 | | 11 |
| 1 | 5 | 5 | 38,000 Budget info lacking | 4 | Northeastern watershed assessments, good as initial survey, fairly cheap | 3 | ok | 1 | 10 | ok | 11 |
| 9 | 4 | | 34,000 | 5 | Good for monitoring P improvements - already in other programs? - provides some baseline assessment | 4 | | 5 | 11 | ok | 11 |
| 5 | 4 | | 885,000 Creates new problem | 1 | High impact on reducing NPS loads from Seneca City | 3 | | 4 | 11 | | 11 |
| 3 | 5 | | 10,000 Good project - length | 5 | Small area impact, pilot project? Overall surprised it ranked this high | 1 | | 5 | 10 | | 11 |
| 2 | 3 | | 177,000 Too high budget | 1 | Clean-up of local drinking water supply - doesn't address source of TCE or cleanup | 2 | | 2 | 10 | | 9 |
| 10 | 3 | | 700,000 | 1 | Good for SWAP assessment, but the rest of project is questionable add on, although it facilitates public involvement | 4 | | 1 | 10 | ok | 4 |
| 6 | 2 | | Not in our realm | 1 | Not even a subwatershed project - impact on lake minimal, capital fund request | 1 | | 1 | 2 | | 3 |

For explanation of all criteria refer to Evaluation Criteria
* Refer to PWL for Cayuga Lake and Cayuga Lake Tributaries
** Scores will be both aggregated with all criteria and shown separately for Bond Act, EPF and Section 319 related projects

Appendix A
Road Deicing & Storage Survey

Survey Form and Data Dictionary not available in digital format.

Appendix B
Land Use Regulation and Controls and Sewer District Survey

Land Use Regulation and Control Information Form not available in digital format

Appendix C
Public Forums

Public Forums announcement brochures not available in digital format.

Appendix D
Education/Outreach Tools

Cayuga Lake Watershed Fact Sheet available in digital format on the Cayuga Lake Watershed Management Plan Web Site at www.cayugawatershed.org

Genesee/Finger Lakes Local Government Workshop brochures not available in digital format. Information on the Workshop can be found at www.gflrpc.org

**Appendix E**
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**Appendix F**
**Glossary of Terms**

**Adsorption.** The adhesion of one substance to the surface of another.

**Aeration.** A process that involves pumping or lifting water from a lake bottom (hypolimnion) for exposure to the atmosphere, with the oxygenated waters being returned back to the bottom.

**Agricultural Conservation and Stabilization Service.** Federal government agency that works with farmers to improve the efficiency of agricultural operations and protect the long-term condition of the farmers' soil and water resources.

**Agricultural Management Practices.** Practices whose goals are to maintain soil fertility, increase farm productivity, and reduce pollutant loading in receiving waters. Pollutants from agricultural sources that can be controlled through the use of management practices include sediment, nutrients, pesticides, and pathogens.

**Algae.** Microscopic plants, considered primary producers in the lake food web, capable of photosynthesis.

**Algal blooms.** Massive growths of phytoplankton, commonly occurring in lakes in the spring. When the phytoplankton are profuse, the water may be stained bright green or blue and the lake rendered unfit for swimming or drinking.

**Alluvium.** A general term for unconsolidated material deposited by a stream or other body of running water.

**Animal unit.** A unit of measurement for any animal feeding operation calculated by adding the following numbers: the number of slaughter and feeder cattle multiplied by 1.0, plus the number of mature dairy cattle multiplied by 1.4, plus the number of swine weighing over 25 kilograms (approximately 55 pounds) multiplied by 0.4, plus the number of sheep multiplied by 0.1, plus the number of horses multiplied by 2.0.

**Aquatic herbicides.** Chemicals, such as Diquat and 2,4-D, used to eradicate aquatic plants.

**Aquifer.** A water-bearing rock unit (unconsolidated or bedrock) that will yield water in a usable quantity to a well or spring.

**Artesian aquifer.** Groundwater that rises to an elevation above the water-bearing unit from which it is released, as a result of a confining layer. In common usage, artesian usually means discharging above the land surface.

**Backflow prevention device**: A safety device used to prevent water pollution or contamination by reventing flow of water and/or chemicals in the opposite direction of that intended (ASAE, 1989).

**Baseflow.** Sustained or fair-weather flow of a stream.

**Bedding plane**. In bedrock a fracture that is parallel to the bedrock unit, usually found where two bedrock units of different origins (i.e., shale and limestone) are in contact. Potentially a zone of water movement.

**Bedrock.** The massive formations that underlie the soil and other unconsolidated surficial materials.

**Best Management Practices.** A series of approved practices that can be used to address specific pollution problems. Examples include changes in land use activities, a ban on pesticides, or following design standards for installing a septic system.

**Best use.** A series of classifications designating the most desired use of the water and bordering lands. 14 classifications are used, ranging from AA (source of water supply for drinking, culinary, or food processing purposes) to II (waters which constitute the Interstate Sanitation District).

**Bioaccumulate.** The process by which toxic pollutants (such as heavy metals, inorganic chemicals, and organic chemicals) amass in the tissues of organisms after repeated intake or exposure.

**Biochemical Oxygen Demand (BOD).** The consumption of oxygen caused by decomposition or metabolism of biodegradable organic compounds by microbes.

**Biodegradation.** The metabolic breakdown of materials into simpler components by living organisms.

**Bog/Marsh/Swamp.** Land that has less than 10.0 percent stocking with live trees and which characteristically supports low, generally herbaceous or shrubby vegetation, and which is intermittently covered with water during all seasons; includes tidal areas that are covered with brackish water during high tides.

**Buffer strips.** Strips of land along water courses that contain natural and (or) planted grasses, plants and trees that filter out sediment and increase uptake of nutrients in runoff.

**Clean Water Act.** National environmental law enforced by the United States Environmental Protection Agency (USEPA) that regulates water pollution.

**Cluster septic systems.** Method of waste disposal where wastewater is transported via small-diameter sewers to a drainfield, mound or sand filter which is used by several residences. Used where site conditions prohibit the use of on-lot systems.

**Coliform.** Bacteria group often involved in contamination of water. Can be associated with the intestinal tract of humans (fecal coliform) or from feces and decaying lake matter (total coliform). Coliform can also be an indicator organism and not necessarily a pathogen.

**Combined Sewage Overflow (CSO).** A water drainage pipeline that receives surface runoff as well as sanitary or industrial wastewater.

**Composting**. A controlled process of degrading organic matter by microorganisms

**Cone of depression.** The drawdown of the water table caused by the withdrawal of water by a well. Usually a circular depression (cone) but may vary in shape dependent on the properties of the material from which the water is being taken.

**Confined aquifer.** An aquifer bounded by materials having a distinctly lower hydraulic conductivity than the aquifer itself.

**Conservation easements.** A legal document that restricts the type and amount of development that may take place on a parcel of land. They are often developed for open space preservation, historic preservation, protection of natural habitats, and preservation of areas for public recreation or education.

**Contaminant plume.** An elongated and mobile column or band of a pollutant moving through the subsurface.

**Cover crops.** Grasses and other close-growing crops grown on fields during the winter to provide soil protection between harvest and spring plowing. Cover crops are also used to enrich soils.

**Crop rotation.** Growing different crops in a sequential pattern on the same field. Crops that conserve soil and nutrients, alternated with those that deplete them provide opportunities for maintaining soil productivity, reducing soil erosion, and re- ducing fertilizer usage. Rotations may prevent the build-up of large pest populations that can occur when single crops are grown continuously on a field.

**Cropland.** Land that currently supports agricultural crops including silage and feed grains, bare farm fields resulting from cultivation or harvest, and maintained orchards.

**Cubic-foot stand-volume class.** A classification of forest land based on net cubic-foot volume of all live trees per acre.

**Denitrification.** The chemical or biochemical reduction of nitrate or nitrite to gaseous nitrogen, either as molecular nitrogen or as an oxide of nitrogen

**Dense Non-Aqueous Phase Liquids (DNAPLs).** Organic compounds more dense than water that tend to sink to the bottom of a water column.

**Deposition.** The accumulation of material dropped because of a slackening movement of the transporting material water or wind.

**Detention basin.** A constructed holding area for stormwater runoff. Basins can protect streams and lakes from sediment and other pollutants derived from up-gradient land use activities. The removal rate for particulate pollutants depends on the volume of runoff, length of time provided for sedimentation, and the settleability characteristics of the particulate matter. Artificial marshes can be incorporated within the basins to provide additional biological removal of pollutants.

**Dilution.** A lowering of the concentration of a chemical constituent in a water column through mixing with a less concentrated water column.

**Discharge area.** An area in which water is lost from the zone of saturation.

**Dissolved oxygen.** The quantity of oxygen dissolved in the water. In lakes, the amount of oxygen dispersed in the water helps determine the degree of stratification, and the potential for depletion of oxygen, fish and other aquatic organisms. Dissolved oxygen is affected by temperature (as water temperature decreases, increasing amounts of oxygen can be dissolved in water), time of day (photosynthetic plants create oxygen during the day, and use oxygen at night), and pollution (*aerobic* bacteria and other organisms require oxygen for the consumption of wastes).

**Diversion.** A channel, embankment, or other man-made structure constructed to divert water from one area to.

**Drainage basin.** Used interchangeably with *catchment* or *watershed*. The term can also imply a larger area containing several watersheds or *sub-basins*.

**Drainage class** (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

*Excessively drained.*---Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

*Somewhat excessively drained.*---Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

*Well drained.*---Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

*Moderately well drained.*---Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

*Somewhat poorly drained.*---Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

*Poorly drained.*---Water is removed so slowly that the soil is saturated period- ically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

*Very poorly drained.*--- Water is removed from the soil so slowly that free water remains at or on the surface during the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients, as for example is "hillpeats" or "climatic moors."

**Drainage, surface.** Runoff, or surface flow of water, from an area.

**Drawdown.** A technique that involves manipulating the water level of a lake to expose rooted aquatic vegetation and sediments to freezing and drying conditions, which serves to affect the growth of plants. Can also be used in the context of surface water in defining rule curves and safe yields.

**Dredging.** Form of sediment removal that involves clearing bottom sediment from a lake to increase the depth, control nuisance aquatic vegetation, control nutrient release from sediments, and to remove toxic substances.

**Drumlin.** A low, smooth, elongated oval hill, mound, or ridge of compact glacial till. The longer axis is parallel to the path of the glacier and commonly has a blunt nose pointing in the direction from which the ice approached.

**Ecosystem.** A group of living organisms that behave as a unit.

**Effluent.** Wastewater that flows into receiving water by way of a domestic or industrial point source.

**Eluviation.** The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

**Environmental Impact Statement (EIS).** A report containing a description of some proposed action, the environmental setting, potential environmental impacts, ways to minimize the impacts, and reasonable alternatives. The EIS also serves as a public disclosure of the record used by an agency in its environmental decision-making process.

**Eolian soil material.** Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

**Epilimnion.** Surface layer of lake

**Erosion.** The wearing away of the land surface by running water, wind, ice , or other geologic agents and by such processes as gravitational creep.

*Erosion* (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

*Erosion* (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the actions of man or other animals or of a catastrophe in nature, for example, fire, that exposes a bare surface.

**Esker** (geology). A narrow, winding ridge of stratified gravelly and sandy drift deposited by a stream beneath a glacier.

**Eutrophic.** A stage of nutrient availability and biological productivity, the natural result of the aging of a lake. The highest stage of nutrient availability is hyper-eutrophic.

**Eutrophication.** The process of natural lake aging, nutrient enrichment, and basin fill-ing. Human activities that increase nutrient and sediment loadings to a lake are called *cultural eutrophication*.

**Evaporation.** Conversion of water from the liquid phase to the gaseous phase.

**Evapotranspiration.** The combined loss of water from water bodies (evaporation) and plants (transpiration – plant uptake, consumption and release of soil water through leaves).

**Fallow.** Allowing cropland to lie idle, either tilled or untilled, during the whole or greater portion of the growing season.

**Fecal coliform.** A type of bacteria whose natural habitat is the colon of warm-blooded mammals, such as man. The presence of this type of bacteria in water, beverages, or food is usually taken to mean that the material is contaminated with solid human waste.

**Fertility, soil.** The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

**Fertilizer.** Any organic or inorganic material of natural or synthetic origin that is added to a soil to supply elements essential to plant growth.

**Field capacity**. The soil-water content after the force of gravity has drained or removed all the water it can, usually 1 to 3 days after rainfall

**Filter (see buffer) strips.**

**First flush.** Stormwater runoff, usually early in the storm, that contains the majority of accumulated sediments and chemical constituants (pollutants) derived from the upstream watershed.

**Fish habitat.** The zone where environmental conditions are spatially uniform and ideal for supporting fish life.

**Flocculate.** Phosphorus located in the water column, assisting in algal growth.

**Flooding.** The temporary covering of soil with water from overflowing streams, runoff from adjacent slopes, and tides. Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; *November-May*, for example, means that flooding can occur during the period November through May. Water standing for short periods after rainfall or commonly covering swamps and marshes is not considered flooding.

**Floodplain.** The area that borders a water body and is subject to flooding on a periodic basis.

**Forest land.** Land that is at least 10 percent stocked with trees of any size, or that formerly had such tree cover and is not currently developed for a nonforest use. The minimum area for classification of forest land is one acre. The components that make up forest land are timberland and all noncommercial forest land.

**Forest-type group.** A classification of forest land based on the species forming a plurality of live-tree stocking. A combination of forest types that share closely associated species or site requirements are combined into the following major forest-type groups (the descriptions apply to forests in this state):

a) *White/red pine*. Forests in which eastern white pine, red pine, or eastern hemlock, singly or in combination, make up the plurality of the stocking; common associates include red maple, oak, sugar maple, and aspen.

b) *Spruce/fir*. Forests in which red, white, black, or Norway spruces, balsam fir, northern white-cedar, tamarack, or planted larch, singly or in combination, make up a plurality of the stocking; common associates include white pine, red maple, yellow birch, and aspens.

c) *Hard pine* (also called loblolly/shortleaf pine). Forests in which eastern redcedar or pitch pine, singly or in combination, make up a plurality of the stocking; common associates include white pine, paper birch, sugar maple, and basswood.

d) *Oak/pine*. Forests in which hardwoods (usually hickory or upland oaks) make up a plurality of the stocking and in which pines or eastern redcedar contribute 25 to 50 percent of the stocking.

e) *Oak/hickory*. Forests in which upland oaks, hickory, yellow-poplar, black locust, sweetgum, or red maple (when associated with central hardwoods), singly or in combination, make up a plurality of the stocking and in which pines or eastern redcedar make up less than 25 percent of the stocking; common associates include white ash, sugar maple, and hemlock.

f) *Oak/gum/cypress*. Bottomland forests in which tupelo, blackgum, sweetgum, oaks, or southern cypress, singly or in combination, make up a plurality of the stocking and in which pines makes up less than 25 percent of the stocking; common associates include cottonwood, willow, ash, elm, hackberry, and maple.

g) *Elm/ash/red maple* (also called elm/ash/cottonwood). Forests in which elm, willow, cottonwood, or red maple (when growing on wet sites), singly or in combination, make up a plurality of the stocking; common associated include white ash, sugar maple, aspens, and oaks.

h) *Northern hardwoods* (also called maple/beech/birch). Forests in which sugar maple, beech, yellow birch, black cherry, or red maple (when associated with northern hardwoods), singly or in combination, make up a plurality of the stocking; common associated include white ash, eastern hemlock, basswood, aspens, and red oak.

i) *Aspen/birch*. Forests in which aspen, paper birch, or gray birch, singly or in combination, make up a plurality of the stocking; common associates include red maple, white pine, red oaks, and white ash.

**Fragipan**. A loamy, brittle substance horizon low in porosity in content of organic matter and low in moderate in clay but high in silt or very fine sand. A fragipan appears cemented and restricts roots. When dry, it is hard or very hard and has a higher bulk density than the horizon or horizons above. When moist, it tends to rupture suddenly under pressure rather than to deform slowly.

**Freshwater.** Water containing only small quantities (generally less than 1,000 mg/L) of dissolved minerals.

**Freshwater Wetlands Act.** Law passed in 1975 that regulates the use and development of the State's freshwater wetland resources for the purpose of preserving, protect- ing, and conserving the wetlands and the benefits derived from them. Provides for the regulation of all wetlands over 5 hectares (12.4 acres) in size, and for smaller ones if they have been determined by the DEC to be of unusual ecological importance.

**Geographic Information (GISs).** Software that is used for digitizing and accessing hydrologic information.

**Glacial drift** (geology). Rock and associated materials (sorted and unsorted) which is transported and deposited by glacial processes.

**Glacial outwash** (geology). Gravel, sand, and silt, commonly stratified, deposited from melt water as it flows from glacial ice.

**Glacial till** (geology). Unassorted, nonstratified, compact glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

**Glaciofluvial deposits** (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

**Glaciolacustrine deposits** (geology). Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes by water originating mainly from the melting of glacial ice. Many are interbedded or laminated.

**Grab sample.** Type of water sample usually taken from either the surface alone, or the bottom waters alone. They can be collected by hand, or with specialized collection devices that minimize surface layer contamination and maximizes reproducibility. They involve a discrete sample time, which can be latter aggregated as a composite sample.

**Grade**. (1) The slope of a road, channel, or natural ground. (2) To finish the surface of a canal bed, roadbed, top of embankment, or bottom of excavation.

**Gravel.** Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

**Gravelly soil material.** Material from 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.5 centimeters) in diameter.

**Grazing unit.** An area of public or private pasture, range, grazed woodland, or other land that is grazed as an entity.

**Ground cover.** Maintenance of a vegetative cover for silviculture (forestry) activities in order to reduce sediment and nutrient runoff from an activity site as well as control weeds.

**Ground water** (geology). Water filling all the unblocked pores of underlying material below the water table, which is the upper limit of saturation.

**Ground water divide.** A ridge in the water table or potentiometric surface from which ground water moves away at right angles in both directions. The line of highest hydraulic head in the water table or potentiometric surface.

**Growing-stock trees.** Live trees of commercial species classified as sawtimber, poletimber, saplings, or seedlings; that is, all live trees of commercial species except rough and rotten trees.

**Growing-stock volume.** Net volume, in cubic feet, of growing-stock trees 5.0 inches d.b.h. and larger from a 1-foot stump to a minimum 4.0-inch top diameter outside bark of the central stem, or to the point where the central stem breaks into limbs. Net volume equals gross volume less deduction for cull.

**Gully.** A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

**Habitat.** A zone where environmental conditions are rather uniform spatially.

**Hardpan.** A hardened cemented soil horizon, or layer. The soil material is sandy, loamy, or clayey, and is cemented by iron oxide, silica, calcium carbonate, or other substance.

**Hardwater.** Water that is high in calcium, magnesium, and (or) other minerals. In lakes, hard water can cause “whiting events”, when changes in water pH causes the calcium to precipitate from the water column.

**Herbaceous.** A vascular plant that does not develop woody tissue

**Herbicides.** Chemical compounds, applied in either liquid or granular form, used to kill undesired rooted vegetation and restrict further vegetation growth.

**Herding.** The guiding of a livestock herd to desired areas or density of distribution.

**Hazardous Waste.** The Resource Conservation and Recovery Act (RCRA) defines hazardous waste as a solid waste that may cause an increase in mortality or serious illnes or pose a substantial threat to human health and the environment when improperly treated, stored, transported, disposed of, or otherwise managed, A waste is hazardous if it exhibits characteristics of ignitability, corrosivity, reactivity, and/or toxicity.

**Holding pond.** A reservoir, pit, or pond, usually made of earth, used to retain polluted runoff water for disposal on land.

**Hydraulic conductivity.** The capacity of a rock to transmit water; expressed as the volume of water that will move in unit time under a unit hydraulic gradient through a unit area measured at right angles to the direction of flow.

**Hydraulic gradient.** The slope of the water table or potentiometric surface; that is, the change in water level per unit of distance along the direction of maximum head decrease. Determined by measuring the water level in several wells.

**Hydraulic head.** In ground water, the height above a datum plane (such as sea level) of a column of water. In a ground water system, it is composed of elevation head and pressure head.

**Hydrogeology.** The science of the interactions between water and geologic materials.

**Hydrologic budget.** A mass balance expression of hydrologic inputs and outputs (precipitation, condensation, evapotranspiration, surface and ground water storage, gains and losses, etc.)

**Hydrologic cycle.** An abstraction of water's movement, in solid, liquid and gaseous states, through the atmosphere, lithosphere, and biosphere.

**Hydrology.** The science of water. It describes the movement, distribution, chemistry, and occurrence of water.

**Hypolimnion.** Bottom layer of lake.

**Idle farmland.** Former cropland or pasture that has not been tended for within the last 2 years and has less than 10 percent stocking with live trees (established seedlings or larger trees), regardless of species.

**Igneous rock.** A rock that solidified from molten or partly molten material.

**Impervious soil.** A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

**Incineration**. The controlled process by which solids, liquid, or gaseous combustible wastes are burned and changed into gases; the residue produced contains little or no combustible material.

**Industrial and commercial land.** Supply yards, parking lots, factories, etc.

**Inert**. A substance that does not react with other substances under ordinary conditions.

**Infiltration.** The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

**Infiltration capacity.** The maximum rate at which water can infiltrate into a soil under a given set of conditions.

**Infiltration rate.** The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

**In-lake control techniques.** Treatment actions that are conducted in the lake itself. There are four major types of in-lake control techniques. *Physical techniques* alter the physical structure of the land or water, examples being sediment dredging, aquatic plant harvesting, and the construction of stormwater sediment traps. *Chemical techniques* involve the use of chemicals that either change the behavior of the lake or poison some of the lakes' plants and animals. *Biological techniques* consist of introducing or removing specific types of plants and/or animals. *Institutional techniques* involve methods that focus on society, including regulating the actions of individuals by law.

**Insecticide.** A pesticide compound specifically used to kill or control the growth of insects.

**Integrated pest management.** A technique that uses two or more control methods to minimize pesticide pollution of surface or ground waters and provide an economic control of pests.

**Irrigation.** Application of water to soils to assist in production of crops. Methods of irrigation are---
*Basin*.---Water is applied rapidly to nearly level plains surrounded by levees or dikes.
*Controlled flooding*.---Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.
*Corrugation*.---Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.
*Furrow*.---Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.
*Sprinkler*.---Water is sprayed over the soil surfaces through pipes or nozzles from a pressure system.
*Subirrigation*.---Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

**Kame** (geology). An irregular, short ridge or hill of stratified glacial drift.

**Karst.** A landscape or region characterized by rock dissolution (generally in limestone).

**Kettle** (geology). A depression in the ground surface formed by the melting of an ice block buried in glacial drift.

**Lacustrine deposit** (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

**Lagoon.** A reservoir or pond built to contain water and animal wastes until they can be decomposed either by aerobic or anaerobic action.

**Lake plain.** An area dominated by low-lying relief that formed at the bottom of a glacial lake during part of the glacial period.

**Lake stratification, also thermal stratification.** During ice-free season, lake are warmer at the top and colder at the bottom. Deeper lakes tend to exhibit a warm layer of water of uniform temperature at the surface, a region of water exhibiting rapid temperature decrease beneath, and a uniformly cold layer of water at the bottom.

**Land trust.** A private, not-for-profit group, controlled by local citizens, that acquires land or interests in land for the protection of open space, recreation, or resource lands. There are currently over 25 land trusts in New York State.

**Land use planning.** A method of watershed regulation where a program is developed in order to effectively manage growth and development within the watershed.

**Leachate.** Liquids that have percolated through a soil and that contain substances in solution or suspension.

**Leaching.** The removal of soluble material from soil or other material by percolating water.

**Legume.** A member of a large family that includes many valuable food and forage species, such as peas, beans, peanuts, clovers, alfalfas, sweet clovers, lespedezas, vetches, and kudzu.

**Light Non-Aqueous Phase Liquids (LNAPLs).** Organic compounds less dense than water that tend to float or pool at the surface of a waterbody or water table, and migrate in the direction of water flow.

**Light textured soil.** Sand and loamy sand.

**Limestone**. A rock that is formed chiefly by accumulation of organic remains (as shells and coral), consists mainly of calcium carbonate.

**Liming.** The process by which calcium-based products are added to acidified lakes or their surrounding watershed to bring the pH closer to neutral and to restore the alkalinity levels to buffer future acidic inputs.

**Limiting nutrients.** Those nutrients that restrict or limit algal growth when not sufficiently present or utilized. In most lakes, either phosphorus or nitrogen serve as the limiting nutrient.

**Limnologist.** A scientist involved in the study of freshwaters.

**Limnology.** The study of freshwaters--- lakes, ponds, reservoirs, streams and wetlands.

**Littoral zone.** The area between land and open water, can also be described as that portion of the lake where rooted aquatic plants exist. One of the three important habitats of a lake, consisting of the shoreline. This zone is very similar ecologically to terrestrial habitats, and is very productive and rich in diversity.

**Livestock.** Domestic animals.

**Load.** The quantity (i.e., mass) of a material that enters a waterbody over a given time interval.

**Loam.** Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

**Losing stream.** A stream or reach of a stream that contributes water to the zone of saturation.

**Macronutrient.** Nutritional necessities of algae, required and available in larger amounts (the classic examples are carbon, nitrogen, phosphorus, hydrogen, sulfur, oxygen)

**Macrophyte.** Rooted aquatic plants in the lake ecosystem that grow and propagate by photo-synthesis.

**Management practices.** Techniques implemented in order to improve the quality of a certain area. In a lake environment, techniques implemented to improve water quality.

**Manure.** The fecal and urinary defecations of livestock and poultry; may include spilled feed, bedding litter, or soil.

**Medium textured soil.** Very fine sandy loam, loam, silt loam, or silt.

**Mesotrophic.** An intermediate stage of nutrient availability and biological productivity. Less nutrient-rich than eutrophic but more than oligotrophic.

**Metamorphic rock.** Rock of any origin altered in mineralogical composition, chemical composition, or structure by heat, pressure, and movement. Nearly all such rocks are crystalline.

**Mineral soil.** Soil that is mainly mineral material and low in organic material. Its bulk density is greater than that of organic soil.

**Mineralized water.** Water containing dissolved materials in concentrations large enough to affect the use of the water for some purposes. A concentration of 1,000 mg/L of dissolved solids is used commonly as the lower limit for mineralized water.

**Mining and waste land.** Surface mining, gravel pits, dumps.

**Mixing zone.** The transition boundary between the fresh groundwater and saltwater zones. Also used to describe the transition zone where a pollutant load mixes with the receiving water.

**Moderately coarse textured (moderately light textured) soil.** Sandy loam and fine sandy loam.

**Moderately fine textured (moderately heavy textured) soil.** Clay loam, sandy clay loam, and silty clay loam.

**Monitoring program.** Strategy which uses and analyzes water quality data to build a representation of conditions present in the lake.

**Monomictic**. Monomictic lakes have one period of complete mixing each year, separated by one period of thermal stratification. Cayuga Lake typically mixes completely from late November through early June. Thermal stratification develops in June and persists through November.

**Mooring regulations.** Restrictions on the number, size, and location of docks, or the materials to construct them. These restrictions help to reduce overcrowding and strain on the lake ecosystem.

**Moraine** (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Types are terminal, lateral, medial, and ground.

**Morphology**

**Soil -** The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

**Lake** – Lake morphological characteristics such as depth and shape (e.g. bathymetry).

**Mottling, soil.** Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance--- *few, common, and many*; size--- *fine, medium, and coarse*; and contrast--- *faint, distinct, and prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

**Muck.** Dark colored, finely divided, well decomposed organic soil material mixed with mineral soil material. The content of organic matter is more than 20 percent.

**National Forest lands.** Federal lands legally designated as National Forests or purchase units and other lands administered as part of the National Forest System by the USDA Forest Service.

**Nonpoint source pollution.** Type of pollution involving complex transport and delivery mechanisms within the lake watershed. Unlike point source pollution, where the pollutants are discharged directly to the lake of tributaries. Thus, this pollution is much more difficult to control.

**Nutrient, plant.** Any element taken in by a plant, essential to its growth, and used by it in the production of food and tissue. Plant nutrients are nitrogen, phosphorus, potassium calcium, magnesium, sulfur, iron, manganese, copper, boron, zinc, and perhaps other elements obtained from the soil; and carbon, hydrogen, and oxygen obtained largely from the air and water.

**Outwash, glacial.** Stratified sand and gravel produced by glaciers and carried, sorted, and deposited by water that originated mainly from the melting of glacial ice. Glacial outwash is commonly in valleys on landforms known as valley trains, outwash terraces, eskers, kame terraces, kames, outwash fans, or deltas.

**Outwash plain.** A land form of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

**Overland flow.** The flow of rainwater or snowmelt over land surface toward receiving waters.

**Pan**. A compact, dense layer in a soil. A pan impedes the movement of water and the growth of roots. The word "pan" is commonly combined with other words that more explicitly indicate the nature of the layer; for example, *hardpan, fragipan, claypan, plowpan, and traffic pan*.

**Parent material.** The great variety of unconsolidated organic and mineral material in which soil forms. Consolidated bedrock is not yet parent material by this concept.

**Pasture.** Grazing lands planted primarily to introduced or domesticated native forage species that receives periodic renovation and/or cultural treatments such as tillage, fertilization, mowing, weed control, and irrigation. Not in rotation with crops.

**Peat.** Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture.

**Pelagic zone.** The open water portion of a lake.

**Percolation.** The downward movement of water through the soil.

**Permeability.** The quality that enables the soil to transmit water or air, measures as the number of inches per hour that water moves through the soil. Terms describing permeability are *very slow* (less than 0.06 inch), *slow* (0.06 to 0.20 inch), *mod-erately slow* (0.2 to 0.6 inch), *moderate* (0.6 to 2.0 inches), *moderately rapid* (2.0 to 6.0 inches), *rapid* (6.0 to 20 inches), and *very rapid* (more than 20 inches).

**Pesticide.** A chemical compound used to eliminate or control insects which may include herbicides.

**pH.** A number used by chemists to express the acidity of solutions, including water. A pH value lower than 7 indicates an acidic solution, a value of 7 is neutral, and a value of higher than 7 indicates an alkaline solution. Most ground waters in the United States have pH values ranging from about 6.0 to 8.5.

**Phosphorus.** An element which is an essential macronutrient for plant growth. Phosphorus is often the limiting nutrient for freshwater lakes in New York State.

**Phosphorus budget.** A biogeochemical cycle that accounts for the major sources of phosphorus to a lake (soil erosion, transport by streams, human waste) and from the lake (withdrawals, surface and groundwater outflows).

**Phosphorus inactivation.** A method of removing phosphorus from the water column in order to limit algal growth. A chemical is added to the water in order to bind with phosphorus present in the bottom sediments, minimizing the release of biolog- ically available phosphorus from sediments when oxygen is depleted from the hypolimnion.

**Phosphorus precipitation.** A method of removing phosphorus from the water column in Order to limit algal growth. Certain chemicals (usually alum salts) are added to the lake that will bind the phosphorus in the water column and sink it to the lake bottom.

**Photic zone.** The zone of a lake between the lake surface and the depth where light is about 1 percent of surface levels.

**Photosynthesis.** The process by which plants convert the sun's energy into biomass or chemical energy. The primary way that energy enters the lake ecosystem.

**Phytoplankton.** The scientific designation for the class of organisms known as algae and some bacteria (e.g. cyanobacteria) which are the base of the food chain.

**Pieziometric surface.** The level to which water would rise if a well were installed at a particular depth.

**Piezometer.** A nonpumping well used to observe the elevation of the water table or the potentiometric surface.

**Plankton.** Microscopic plants and animals that drift with the movement of the water and are a major source of food for aquatic life.

**Planning basins.** Watershed boundaries for major rivers.

**Plume.** A relatively concentrated mass of emitted chemical contaminants spreading in the environment.

**Point source pollution.** Form of pollution where the pollutants are discharged directly ("pipe" discharge) to a lake or its tributaries.

**Poletimber stand.** A stand-size class of forest land that is stocked with at least 10 percent of minimum full stocking with live trees with half or more of such stocking in poletimber or sawtimber trees or both, and in which the stocking of poletimber exceeds that of sawtimber.

**Poletimber tree.** A live tree of commercial species meeting regional specifications of soundness and form and at least 5.0 inches in d.b.h., but smaller than a sawtimber tree.

**Pollutant.** Any particle or substance that disturbs the operation of an ecosystem.

**Pollution.** Any activity that causes an impairment in the environment.

**Polychlorinated biphenyls (PCBs).** Synthetic organic compounds that can accumulate in the bodies of fish and other organisms and cause death with enough exposure. Probable human carcinogen.

**Poorly graded.** Refers to soil material consisting mainly of particles or nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

**Porosity.** The volume of openings in a rock. When expressed as a fraction, porosity is the ratio of the volume of openings in the rock to the total volume of the rock.

**Potable water.** Water that is suitable for drinking.

**Potentiometric surface.** An imaginary surface representing the level to which water will rise in a well.

**Primary wastewater treatment.** The first step in the treatment process, involving screens to remove the larger floating solids (such as sticks, seeds, rags, or paper). Skimming tanks remove excess oil or grease, and settling or sedimentation basins remove settleable suspended matter such as sand, gravel, and some organic solids.

**Producers.** Organisms, such as phytoplankton, that provide energy for other members of the food web. Photosynthetic organisms are classified as producers.

**Profile, soil.** A vertical section of the soil extending through all its horizons and into the parent material.

**Public access.** The principle that non-resident visitors have full admittance to use a lake. Restricting public access is one of the techniques frequently discussed as a method to protect water quality.

**Recharge.** The water that infiltrates the water table. Recharge is the leftover precipitation after losses to surface runoff and evapotranspiration.

**Recharge area.** The area where water reaches the saturated zone by surface infiltration.

**Recreation site.** Parks, campgrounds, playing fields, tracks, etc.

**Regolith.** The unconsolidated mantle of weathered rock and soil material on the earth's surface; the loose earth material above the solid rock. Soil scientists regard as soil only the part of the regolith that is modified by organisms and other soil-building forces. Most engineers describe the whole regolith, even to a great depth, as "soil".

**Relief.** The elevations or inequalities of a land surface, considered collectively.

**Removals.** The net growing-stock volume harvested or killed in logging, cultural Operations (such as timber stand improvement) or land clearing, and the net growing-stock volume neither harvested nor killed but growing on land that was reclassified from timberland to noncommercial forest land or nonforest land during the period between surveys. The volume is decided by the number of growing seasons to produce average annual removals.

**Request for Proposals (RFPs).** A problem statement and a detailed scope of proposed services to be provided by a consultant.

**Residence time.** Also called Detention time. The inverse of flushing rate, which is the time it takes a lake to complete one full exchange of water.

**Respiration.** The process that photosynthetic plants undertake, when oxygen is used to burn up the chemical fuels that were produced during photosynthesis. As a result, carbon dioxide and water are produced.

**Retention basin.** Much like a detention basin, where water is stored and pollutants are removed through sedimentation.

**Rill.** A steep sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

**Riparian area.** Vegetated ecosystems along a waterbody through which energy, materials, and water pass. Riparian areas characteristically have a high water table and are subject to periodic flooding and influence from the adjacent waterbody.

**Riprap.** Rock and stone rubble used as a blanket or liner to prevent erosion in highly susceptible areas. This practice is used on sites that are subjected to large volumes of water that cannot be stabilized with less expensive vegetative measures.

**Rock fragments.** Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

**Root zone**. The part of the soil that is, or can be, penetrated by plant roots

**Runoff.** The precipitation discharged in stream channels from a drainage area. The water that flows off the land surface without sinking in is called surface runoff; that which enters the ground before reaching surface streams is called ground-water runoff or seepage flow from ground water.

**Salinity.** The concentration of dissolved solids or salt in water.

**Salmonid.** A class of fish, including lake trout and brown trout, best suited for a deep, cold water portion of oligotrphic lake with a small littoral zone.

**Sand.** As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

**Sandstone.** Sedimentary rock containing dominantly sand-size particles.

**Sapling.** All live trees 1.0 through 4.9 inches d.b.h.

**Sapling/seedling stand.** A stand-size class of forest land that is stocked with at least 10 percent of minimum full stocking with live trees with half or more of such stocking in saplings or seedlings or both.

**Saturated.** When referring to soil, the maximum amount of water that can be held either when the soil is frozen or the spaces between the soil particles are filled with water. Any additional seepage over saturated soil will result in runoff.

**Saturated zone.** The zone (below the unsaturated zone) where interconnected openings contain only water.

**Sawtimber stand.** A stand-size class of forest land that is stocked with at least 10 percent of minimum full stocking with all live trees with half or more of such stocking in poletimber or sawtimber trees or both, and in which the stocking of sawtimber is at least equal to that of poletimber.

**Sawtimber tree.** A live tree of commercial species at least 9.0 inched d.b.h. for softwoods or 11.0 inches for hardwoods, containing at least one 12-foot sawlog or two noncontiguous 8-foot sawlogs, and meeting regional specifications for freedom from defect.

**Secchi disk.** A 20cm steel or heavy plastic disk, composed of alternating black and white quadrants, used to measure the transparency of lakes. The transparency is considered the average of the depths at which the disk first disappears from view, and first reappears, respectively.

**Secondary wastewater treatment.** This intermediate step is used to reduce high oxygen demand before the wastewater is discharged into a lake or stream. Filtration and biological and chemical processes are used to remove a high percentage of organic matter from the wastewater.

**Sediment.** The deep water bottom or suspended material that may be rocky, sandy, or muddy.

**Sediment basins.** Depressions that can be constructed to protect lakes and streams from upstream land use activities. Stormwater is detained and released at a controlled rate, which can be modified to optimize sedimentation.

**Sediment removal.** Management technique that involves dredging bottom sediment from a lake to increase the depth, control nuisance aquatic vegetation, control nutrient release from sediments, and to remove toxic substances.

**Sedimentary rock.** Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

**Sedimentation.** The process or act of depositing sediment.

**Seedling.** A live tree less than 1.0 inch d.b.h. and at least 1 foot tall.

**Seepage**. Water escaping through or emerging from the ground along an extensive line or surface as contrasted with a spring, where the water emerges from a localized spot.

**Septic leachate detector.** A hand held fluorometer that can locate effluent plumes and domestic waste water in lakes. When the probe is submersed in lake water in front of a shoreline home, a response can be noted if human sewage, detergents, or whiteners are detected. Also known as a septic snooper.

**Septic tank mound.** An alternative method to the septic tank-leach field system, used in areas where soil conditions are not well suited for subsurface soil absorption. An above-ground mound is created with fill material, usually a porous sandy soil. Wastewater from the tank is allowed to seep through the soil in the mound, which then filters back through the ground. Clay barriers around the mound serve to reduce the seepage of wastewater to the surrounding ground.

**Septic tank sand filter.** Used in area where soils are unsuitable for conventional drain fields. The wastewater filters from the septic tank to a second tank, which periodically releases the water through a sand filter. The filter is lined with clay or plastic to prevent wastewater leakage, and the filtrate is collected and piped to a disinfection unit.

**Septic tank.** The most common on-site system for the treatment and disposal of domes-tic wastewater from individual residences, involving the transport of wastewater from a residence to a buried tank. Perforated pipes then transport the wastewater to a subsurface drainage system where it percolates into the soil.

**Settleable solids**. Solids in a liquid that can be removed by stilling a liquid. Settling times of 1 hour (APHA/AWWA/WPFC, 1975) or more are generally used

**Sewer system.** A replacement for small scale treatment systems such as on-lot septic tanks and cluster systems. Used at many larger lake communities, most involve pumping or carrying the outflow of septic tanks to a treatment facility or large interceptor sewer.

**Shale.** Sedimentary rock formed by the hardening of a clay deposit.

**Sheet flow.** Water, usually storm runoff, flowing in a thin layer over the ground surface.

**Silage.** A fodder crop that has been preserved in a moist, succulent condition by partial fermentation; such crops include corn, sorghums, legumes, and grasses

**Silt.** As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

**Siltstone.** Sedimentary rock made up of dominantly silt-sized particles.

**Silviculture.** A branch of forestry dealing with the cultivation and management of trees in order to produce a crop resource on a continuing basis.

**Sinkhole.** A depression in a landscape where limestone has been locally dissolved.

**Slope.** The inclination of the land surface form the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

**Sludge.** The material resulting from chemical treatment of water or coagulation.

**Soil.** A natural, three-dimensional body at the earth's surface that is capable of support-ing plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

**Soil profile.** A vertical section of the soil from the surface through all its horizons, including C horizons.

**Soil separates.** Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recog- nized in the United States are as follows: *very coarse sand* (2.0 millimeters to 1.0 millimeter); *coarse sand* (1.0 to 0.5 millimeter); *medium sand* (0.5 to 0.25 millimeter); *fine sand* (0.25 to 0.10 millimeter); *very fine sand* (0.10 to 0.05 millimeter); *silt* (0.05 to 0.002 millimeter); and *clay* (less than 0.02 millimeter).

**Soil survey.** A general term for the systematic examination of soils in the field and in laboratories; their description and classification; the mapping of kinds of soil; the interpretation of soils according to their adaptability for various crops, grasses, and trees; their behavior under use or treatment for plant production or for other purposes; and their productivity under different management systems.

**Solubility.** The relative capacity of a substance to dissolve in liquid. Sugar has a high solubility in water, whereas gold has a low solubility in water.

**Stand.** A group of forest trees growing on forest land.

**Stand-size class.** A classification of forest land based on the size class (that is, seedlings, saplings, poletimber, or sawtimber) of all live trees in the area.

**Stocking.** The degree of occupancy of land by trees, measured by basal area and/or number of trees in a stand compared with the basal area and/or number of trees required to fully use the growth potential of the land (or the stocking standard). In the Eastern United States this standard is 75 square feet of basal area per acre for trees 5.0 inches d.b.h. and larger, or its equivalent in numbers of trees per acre for seedlings and saplings. Two categories of stocking are used in this report: all live trees and growing- stock trees. The relationships between the classes and the percentage of the stocking standard are: nonstocked (0 to 9); poorly stocked (10 to 59); moderately stocked (60 to 99); fully stocked (100 to 129); and overstocked (130 to 160).

**Stones.** Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

**Storage.** Available capacity for temporarily removing water from circulation.

**Stratified.** Arranged in strata, or layers. The term refers to geologic material. Layers in soils that result from the processes of soil formation are called horizons; those in- herited from the parent material are called strata.

**Strip cropping.** A means of reducing soil erosion on tilled cropland. The intent is to Break the length of slope into segments by laying out strips across the natural slope of the land. Strips of close-growing crops or meadow grasses are planted between tilled row crop strips to serve as sediment filters or buffer strips in controlling erosion. The strips increase water infiltration, retain soil particles, and reduce velocity of runoff.

**Strip mine.** Area devoid of vegetation due to current or recent general excavation.

**Structure, soil.** The arrangement of primary soil particles into compound particles or aggregates that are separated from adjoining aggregates. The principal forms of soil structure are--- *platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or sub-angular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

**Sublimation.** The process by which a solid vaporizes directly to a gas.

**Subsoil.** Technically, the B horizon; roughly, the part of the solum below plow depth.

**Subsurface layer.** Technically, the A2 horizon. Generally refers to a leached horizon lighter in color and lower in content of organic matter than the overlying surface layer.

**Surface soil.** The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon".

**Surface water.** All water whose surface is exposed to the atmosphere.

**Suspended sediment**. The very fine soil particles that remain in suspension in water for a considerable period of time

**Taxonomy.** The identification of living organisms.

**Temperature profile.** The temperature of a water column at specific points. Used in lake profiling to determine the degree of stratification, and the potential for depletion of oxygen, fish and other aquatic organisms.

**Terminal moraine.** A belt of thick glacial drift that generally marks the termination of important glacial advances.

**Terrace** (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea. A stream terrace is frequently called a second bottom, in contrast with a flood plain, and is seldom subject to overflow. A marine terrace, generally wide, was deposited by the sea.

**Terraces.** Earth embankments, channels or a combination ridge and channel construct-ed across the slope of a field to control runoff. They are generally applied where contouring, strip cropping and reduced tillage operations do not offer adequate protection from soil erosion and are most practical on deep soils. By breaking the length of slope into smaller segments and intercepting the flow of runoff, terraces effectively reduce soil erosion and the transport of sediment off-site. In reducing the volume and velocity of runoff, water is retained on the land for moisture conservation.

**Tertiary wastewater treatment.** The third step in treatment is used to significantly reduce nutrient concentrations in the wastewater. These advanced treatment processed usually involve a combination of chemical (alum or iron salt addition), biological (biological treatment columns), and physical (filtration and/or settling) techniques. This may provide more than 90% removal of phosphorus.

**Texture, soil.** The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

**Thermocline.** The region of rapid temperature decline in a lake, related to the trans-parency of the lake water and how exposed the lake is to the wind. A clear lake will have a deeper thermocline than a turbid lake. A wind-exposed lake will have a deeper thermocline than a protected lake.

**Thin layer.** Otherwise suitable soil material too thin for the specified use.

**Till.** A compact, unsorted and unstratified mixture of clay, silt, sand, gravel, and boulders deposited directly by glaciers.

**Till plain.** An extensive flat to undulating area underlain by glacial till.

**Tillage.** The operation of implements through the soil to prepare seedbeds and rootbeds, control weeds and brush, aerate the soil, and cause faster breakdown of organic matter and minerals to release plant foods.

**Tilth**. The physical condition of the soil as related to its ease of tillage, its fitness as a seedbed, and its impedance to seedling emergence and root penetration.

**Timberland.** Forest land producing or capable of producing crops of industrial wood (more than 20 cubic feet per acre per year) and not withdrawn from timber utilization (formerly known as commercial forest land).

**Time of travel.** The amount of time it takes for water to reach a well or stream from a certain distance.

**Topographic map.** A map that shows contours of elevation above sea level.

**Topography.** The relative positions and elevations of the natural or man-made features of an area that describe the configuration of its surface.

**Topsoil** (engineering). Presumably a fertile soil or soil material, or one that responds to fertilization, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

**Toxicity.** A gauge of how detrimental a substance is to a living organism. Toxic effects can either be *acute* (causing immediate death or impairment) or *chronic* (causing subtle damage that may not show up until years after exposure).

**Transmissivity.** The rate of groundwater flow through a unit area of an aquifer under a hydraulic gradient of 1.

**Transpiration.** The process by which trees, shrubs, and grasses in a watershed draw water out of the soil and emit water vapor to the air.

**Transportation right-of-way.** Land associated with highways and railroads.

**Tree class.** A classification for the quality or condition of trees for sawlog production.Tree class for sawtimber trees is based on their current condition. Tree class for poletimber trees is a prospective determination—a forecast of their potential quality when they reach sawtimber size (11.0 inches d.b.h. for hardwoods, 9.0 inches d.b.h. for softwoods)

**Trenches.** An infiltration practice that provides an opportunity for surface water to filter runoff through the surface soil. A trench involves infiltration through uncovered soil.

**Trickling filter.** A fixed bed of rock over which wastewater is applied for aerobic bio-logical treatment. Slimes form on the rocks and treat the wastewater. A distrib- utor system continues dosing the filter beds, and the treated wastewater is collect- ed by an underdrain system.

**Trophic state classifications.** Using the Trophic State Index, a value is determined that classifies a water sample as being either oligotrophic (low-nutrient), mesotrophic (average nutrients), or eutrophic (high-nutrient). Oligotrophic lakes often provide an excellent drinking water supply, while eutrophic lakes often support excellent warmwater fisheries.

**Turbidity.** A water chemistry parameter, caused by suspended materials such as clay, silt, algae, and other materials that cause light to be scattered and absorbed, not transmitted in straight lines through water. It has a major influence on Secchi disk transparency and therefore the clarity of the lake.

**Turn over**. The upper layer cools down in the fall, until the lake reaches uniform temperature. The thermal barrier to mixing is gone and the lake will mix, or turn over, from top to bottom. This process is called fall overturn. In the spring, the ice melts and the lake again becomes one uniform temperature and mixes, called spring overturn.

**Unconfined aquifer.** An aquifer that contains both an unsaturated and a saturated zone (i.e., an aquifer that is not full of water) and does not have a confining layer at its top.

**Underground Storage Tanks (USTs).** A tank with at least 10 percent of its volume beneath the ground, including attached pipes.

**Unsaturated.** When referring to soil, any sample that has still has the capability to hold more water without experiencing runoff.

**Unsaturated zone.** The subsurface zone, usually starting at the land surface, that contains both water and air.

**Upland** (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

**Use impairment.** When referring to a lake, a "problem" in the complete functioning of the lake ecosystem.

**Valley fill.** In glaciated regions, material deposited in stream valleys by glacial melt water. In nonglaciated regions, alluvium deposited by heavily loaded streams emerging from hills or mountains and spreading sediments onto the lowland as a series of adjacent alluvial fans.

**Vegetative cover.** A management technique that involves growing grasses, trees or shrubs in areas where slope and soils are particularly vulnerable to erosion and runoff damage. Because permanent protection is provided, it is an effective control for most pollutants, especially sediments.

**Volatile Organic Compounds (VOCs).** A category of volatile organic compounds with relatively high vapor pressures.

**Waste**. Material that has no original value or no value for the ordinary or main purpose of manufacture or use; damaged or defective articles of manufacture; or superfluous or rejected matter or refuse.

**Water table.** The upper limit of the soil or underlying rock material that is wholly saturated with water.
*Water table, apparent*. A thick zone of free water in the soil. An apparent water table is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.
*Water table, artesian*. A water table under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole.
*Water table, perched*. A water table standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

**Watershed.** The area that consists of all the land, streams, rivers, lakes, and other water bodies that contributes water to the lower end of that watershed at its point of discharge.

**Weathering.** All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in dis- integration and decomposition of the material.

**Weir.** A device for measuring or regulating the flow of water.

**Well graded.** Refers to a soil or soil material consisting of particles well distributed over a wide range in size or diameter. Such a soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

**Wetland.** An area with some open water and much shoreline and emergent vegetation. The water in a wetland may be only a few inches deep.

**Zone of aeration.** Also called the unsaturated zone. The portion of the subsurface between the water table and the ground surface.

**Zone of saturation.** The portion of the subsurface that is saturated with groundwater.

**Zoning.** A method by which local governments can protect natural resources by using regulations to control land use activities. Through zoning, an area is divided into districts. The local government then established laws that govern the use of land with these districts.

**Zoning variances.** A method that can be developed in some areas to facilitate unusual landscape features, such as steep hillsides, scenic vista, erosive sites, and natural drainage that may restrict development.

**Zooplankton.** The primary consumers of the lake food web. Small, microscopic animals that drift with the movement of the water.

**Appendix G**
**Glossary of Acronyms**

**ACP**--- Agricultural Conservation Program
**ASCS**---Agricultural Stabilization and Conservation Service
**BOD**--- Biochemical Oxygen Demand
**BLM**--- Bureau of Land Management
**BMP---** Best Management Practice
**CBS---** Chemical Bulk Storage
**CCE**--- Cornell Cooperative Extension
**CERCLA**---Comprehensive Environmental Response, Compensation and Liability Act
**CLWN---**Cayuga Lake Watershed Network
**CNYRPDB**---Central New York Regional Planning & Development Board
**CPA**--- Conservation Priority Area
**CREP**---Conservation Reserve Enrollment Program
**CRP**--- Conservation Reserve Program
**CSGWPP**---Comprehensive State Ground Water Protection Program
**CSO---** Combined Sewage Overflow
**CWS**--- Community Water System
**CWA**--- Clean Water Act
**CWSRF**---Clean Water Act State Revolving Fund
**CZARA**---Coastal Zone Act Reauthorization Amendments
**DBP**--- Disinfection By-Products
**DOD**--- Department of Defense
**DOE**--- Department of Energy
**DOI**--- Department of Interior
**DOT**--- Department of Transportation
**DWSRF**---Drinking Water State Revolving Fund
**EPA---** Environmental Protection Agency
**EPCRA**---Emergency Planning and Community Right-To-Know Act
**EIS**--- Environmental Impact Statement
**FIFRA**---Federal Insecticide, Fungicide and Rodenticide Act
**FOLA**---Federation of Lake Associations
**FSA**--- Farm Service Agency
**GIS**--- Geographic Information System
**G/FLRPC---**Genesee/Finger Lakes Regional Planning Council
**GWDR**---Ground Water Disinfection Rule
**IO---** Intermunicipal Organization
**IUP**--- Intended Use Plan
**IWI**--- Index of Watershed Indicators
**MCL**--- Maximum Contaminant Level
**MCLG**---Maximum Contaminant Level Goal
**MOSF---**Major Oil Storage Facility
**NCWS**---Non-Community Water System
**NEP**--- National Estuary Program
**NEPA**---National Environmental Policy Act
**NOAA**---National Oceanic and Atmospheric Administration
**NPDES**---National Pollutant Discharge Elimination System
**NPS**--- Nonpoint Source
**NRCS**---Natural Resource Conservation Service
**NYSDEC---**New York State Department of Environmental Conservation
**NYSDOS---**New York State Department of State
**NYSDOH---**New York State Department of Health
**NYSORPS**---New York State Office of Real Property Services
**OPRHP---**Office of Parks, Recreation, and Historical Preservation
**OSM**--- Office of Surface Mining

**PBS**--- Petroleum Bulk Storage
**PWL**---Priority Waterbodies List
**PWS**--- Public Water System
**RCRA**---Resource Conservation and Recovery Act
**RMP**--- Resource Management Plan
**SCS---** Soil Conservation Service
**SDWA**--Safe Drinking Water Act
**SDWIS**---Safe Drinking Water Information System
**SEQR---**State Environmental Quality Review Act
**SMP**--- State Management Plan
**SPDES---**State Pollution Discharge Elimination System
**SSA**--- Sole Source Aquifer
**STORET**---STOrage and RETrieval U.S. Waterways data system
**STP---** Sewage Treatment Plant
**SWAP**---Source Water Assessment Program
**SWCD---**Soil and Water Conservation District
**SWCP**---State Wetlands Conservation Plan
**SWP**--- Source Water Protection
**SWTR**---Surface Water Treatment Rule
**TMDL**---Total Maximum Daily Load
**TOT**--- Time-of-Travel
**TRI**--- Toxic Release Inventory
**UIC**--- Underground Injection Control
**USDA**---United States Department of Agriculture
**USEPA---**United States Environmental Protection Agency
**USGS**---United States Geological Survey
**UST**--- Underground Storage Tank
**UWA---** Unified Watershed Assessment
**WHP---** Wellhead Protection Program
**WHPA**---Wellhead Protection Area
**WQCC---**Water Quality Coordinating Committee

Appendix H
Cayuga Lake Watershed Network Survey of Cayuga Lake Watershed Stakeholders

Not available in digital format.

**Appendix I**
**Interim Recommendation Project Description**

1999 Project Descriptions not available in digital format.

**Year 2000 Project Descriptions**

**Project 1**

A_ProjectTitle:

Biomonitoring of Four Major Tributaries of Northern Cayuga Lake: Yawger Creek, Great Gully, Paine's Creek and Salmon Creek

B_Principal_Investigator: Niamh O' Leary, Ph.D.; A. Thomas Vawter, Ph.D.

B_Affiliation: Wells College

B_FirstName: Niamh

B_MiddleName:

B_LastName: O' Leary

B_StreetAddress: Wells College

B_City: Aurora

B_State: NY

B_Zip: 13026

B_Email: noleary@wells.edu

B_AreaCode: 315

B_Exchange: 364

B_PhoneNumber: 3279

C_ProjectCategory: Research

C_ProjectCategory_other:

D1_addresses_impairment: yes

Impairment:
Impairment of water supply by a variety of pollutants from agricultural and urban run-off, as well as streambank erosion. Likely pollutants include sediments, pathogens, pesticides and nutrients.

D2_solution: yes

D3_watershed_wide: yes

D4_human_use: yes

D5_lake_ecology: yes

D6_watershed_ecology: yes

E_description:
This project will establish a means by which routine biomonitoring of four major tributaries (Yawger Creek, Great Gully, Paine's Creek and Salmon Creek)of northern Cayuga Lake can be achieved. Under the guidance of Wells College faculty, students enrolled in environmentalstudies courses and engaged in independent research at Wells College will monitor the tributaries for two groups of organisms--macroinvertebrates and coliforms. The species distribution
within macroinvertebrate communities is an indicator of overall water quality; coliforms are indicators of specific pathogens in the water. The aim of this project is to accumulate an appreciable volume of reliable baseline data on the water quality in these tributaries, and to establish a means by which changes in the quality of the water can be detected. The data will be made accessible to others in the watershed via a web page. Data collection will begin in the fall of 2000 for an initial period of 2 years. Consistent, long-term monitoring, as is proposed here, is required to determine the degree of impairment of waterbodies accurately, and to allow a means by which their impairment or degradation can be tracked. Ultimately this project will be expanded to include or coordinate with efforts in other subwatersheds of Cayuga Lake.

F_impact_on_management:
Development and implementation of an effective Cayuga Lake Watershed Management Plan requires accurate knowledge of the water quality status of the lake and its tributaries. This project would provide a consistent, reliable, and long-term source of water quality data for tributaries in the northern region of the Cayuga Lake Watershed, a region that has not received as much attention as the southern end due to the latter's higher population density and relative wealth of educational and research institutions with the resources and the personnel to conduct monitoring.

G1_impact_on_watershed:
This project will serve as a model for combining the educational needs of an environmental studies program with the data needs of the surrounding watershed and, as such, could be relatively easily emulated by other educational institutions or, in modified form, by volunteer service organizations. Once it is established, the pilot project at Wells could serve as a coordinating "umbrella" for these other, similar projects.

G2_solution:
The Cayuga Lake Watershed Draft Preliminary Watershed Characterization identifies the need for baseline water quality and loading characterization of subwatersheds. The use of macroinvertebrates and coliforms as indicators of water quality in streams is well established. Standard methods allow calculation of water quality indices that allow comparisons among streams within the watershed and elsewhere.

G3_evaluation:
The success of this project will be evidenced by the accumulation of high quality data on the coliform flora and macroinvertebrate communities of the chosen tributaries and the insertion of these data in an accessible database for use by the Intermunicipal Organization and other interested parties.

G4_operation_maintenance:
Long-term maintenance of this program during the academic year will be integrated into the regular activities of Wells College faculty and students. The project will, however, require summer stipends for faculty and students and funds for the purchase of some expendable biomonitoring supplies. The current proposal is for a 2-year pilot program.

G5_identified_impairment:
The diversity of pollutants that have lead to the placement of Cayuga Lake and its tributaries on the DEC 1996 Priority Waterbodies List would be adequately monitored in this project using the proposed indicators. In addition, the Cayuga Lake Watershed Draft Preliminary Watershed Characterization Report identifies Yawger Creek, Great Gully, Paine's

Creek and Salmon Creek as likely to be impaired to a greater or lesser extent by pollutants in run-off and erosion. Several data gaps do exist, however, for the chosen tributaries, and these gaps would be addressed by the study proposed here.

G6_human_use:
Yes. According to the Cayuga Lake Watershed Draft Preliminary Watershed Characterization Report, the recreational use and potential drinking water use of the tributaries in question are likely to be affected by pollutants in run-off and erosion. Thus accurate quantification of the extent of these problems via biomonitoring is warranted.

G7_lake_watershed_ecology:
The biomonitoring proposed here will help us identify potential ecological problems in the subwatershed studied. Only problems identified through monitoring can be addressed by remediation

G8_benefit_degrade:
The project will be of benefit to the general quality of the lake and its watershed as it will provide a means by which best management plans for water quality can be evaluated. Three will be no negative effects on water quality.

G9_use_consideration:
According to the NYS DEC 1996 Priorities Waterbodies List, the uses of Cayuga Lake and its tributaries are restricted by the pollutants and pathogens, which would be effectively monitored in this study. Data collected in this project would lead to effective targeting of remediation practices to broaden actual use of the waterbodies.

G10_expenditure_limits:
The 2-year proposed duration of the pilot project will require $28,000 for summer stipends, and $10,000 for supplies.

G11_funding_considerations:
Wells College will cover most of the costs of the project by paying the salaries of the principal investigators for the 9 months of the academic year and by providing laboratory space, equipment, computer facilities and other elements of infrastructure

G12 number of criteria met: 11

H1_real_cost:
NYS DOS (Clean Water/Clean Air Bond Act): We will be requesting $38,000 for a 2-year biomonitoring pilot program.

Wells College Environmental Studies Program: Additional salaries, supplies and overhead for biomonitoring September to May for 2 years.

H2_cost_specifics:
Summer stipends for students and principal investigators: $28,000
Supplies: $10,000
Total: $38,000

H3_continued_funding: yes

**Project 2**

A_ProjectTitle: Water Remediation

B_Principal_Investigator:

Doug Field, Village Trustee; Melinda Kostreva, Clerk/Treas; John Reid, Engineer, R&D Engineering

B_Affiliation: Village of Union Springs

B_FirstName: Edward

B_MiddleName: C.

B_LastName: Trufant

B_StreetAddress: 26 Chapel Street

B_City: Union Springs

B_State: NY

B_Zip: 13160

B_Email: n/a

B_AreaCode: 315

B_Exchange: 889

B_PhoneNumber: 7341

C_ProjectCategory: Implementation

C_ProjectCategory_other:

D1_addresses_impairment: yes

Impairment:
There are trace levels of Volatile Organic Compounds, Cis-1,2-Dichloroethene and Trichloroethene in the public drinking water supply.

D2_solution: yes

D3_watershed_wide: no

D4_human_use: yes

D5_lake_ecology: yes

D6_watershed_ecology: yes

E_description:
The Village of Union Springs has undertaken a Water Remediation Project to eliminate the presence of Volatile Organic Contaminants in the public water supply. Levels of the VOCs Cis-1,2-Dichloroethene and Trichloroethene are

above New York State Department of Health regulations and pose a health concern for all Village and 280 Town of Springport residents. Our engineers have proposed to correct this problem by installing a tower air stripper unit.

The design of the project has been initiated so that when approval is received and funding obtained, the project can commence immediately under the following schedule:
- Finalize design and permits - 1 to 30 days following approval
- Project construction - 30 to 150 days following approval
- Project closeout - 150 to 200 days following approval

F_impact_on_management:

The project will correct urgent problems with the Village water system that threaten the public health and continued economic vitality of the regions. A safe drinking water supply is essential in providing a healthy, liveable neighborhood for residence and activities.

Additionally, the VOCs detected in the groundwater will travel to tributaries and finally into the lake. They will not remain contained and thereby have a watershed-wide effect.

G1_impact_on_watershed:
Provide a safe municipal water supply and address a groundwater contamination problem.

G2_solution: Yes, installation of a Tower Air Stripper Unit.

G3_evaluation: Yes, ongoing State and County mandated water sample analysis.

G4_operation_maintenance:
The Village of Unions Springs has operated a public water supply system since the 1930s. The funding is an expected part of the municipal budget and financed completely through user fees.

G5_identified_impairment: Yes, cleans a contaminated municipal water supply.

G6_human_use: Yes, drinking water.

G7_lake_watershed_ecology: Yes, extent of VOCs moving offsite unknown.

G8_benefit_degrade: Yes, eliminates VOCs from groundwater reducing the amount traveling to tributaries and the lake.

G9_use_consideration: Yes, drinking water.

G10_expenditure_limits: Total Project Cost = $177,000.00

G11_funding_considerations:
Denied HUD CCI funding. Submitted funding request of $100,000. to New York State Department of State Quality Communities Demonstration Program.

G12_funding criteria met: Nine.

H1_real_cost:
The project's component tasks and costs are as follows:
1. Vertical air stripper 35,000.00
2. Booster pump 7,000.00
3. Stripper enclosure (bldg.) 30,000.00
4. Piping modifications 20,000.00
5. Electrical & instrumentation 15,000.00
6 Site Work 10,000.00

7. Engineering, Legal,
Administrative & Contingency 60,000.00

TOTAL COST 177,000.00

H2_cost_specifics: $6,000.00 projected maintenance and operation costs

H3_continued_funding: no

**Project 3**

A_ProjectTitle: Cayuga Lake Road: Hydrologic Modification

B_Principal_Investigator: Phil Griswold

B_Affiliation: Seneca County Soil and Water Conservation District

B_FirstName: Phil

B_MiddleName:

B_LastName: Griswold

B_StreetAddress: 12 North Park Street

B_City: Seneca Falls

B_State: NY

B_Zip: 13148

B_Email: PG@NYSENECSFA.FSC.USDA.GOV

B_AreaCode: 315

B_Exchange: 568-4568

B_PhoneNumber: 4366

C_ProjectCategory: Implementation

C_ProjectCategory_other:

D1_addresses_impairment: no

Impairment:
This project will potentially address the impairments listed in the 1996 PWL List. Those being: Water Supply, Bathing, Fishing Fish Propagation,Aesthetics and boating.

D2_solution: yes

D3_watershed_wide: yes

D4_human_use: yes

D5_lake_ecology: yes

D6_watershed_ecology: yes

E_description:
An area along Cayuga Lake Road in the Town of Romulus exhibits a severe erosion problem. Installation of rock rip/rap and drop structures are the recommended corrective measures for this site. If funded, this project could begin within 30 days.

F_impact_on_management:
When completed, this project will correct a severe erosion problem in the above mentioned area as well as reduce the amount of sediment entering Cayuga Lake.

G1_impact_on_watershed:
This project will reduce sedimentation in Cayuga Lake. This project will also be a demonstration project targeting Highway Superintendents
and local legislatores in the benifits of proper road bank management.

G2_solution:
Yes. Installation of rock rip-rap and drop structures is a widely accepted best management practice. All construction will be to USDA Natural Resources Conservation Service specifications.

G3_evaluation:
This project will not be evaluated from a scientific standpoint. The project will result in tangible benifits however. Stabilization of the road bank will result in reduced maintainance costs to the Town of Romulus.

G4_operation_maintenance:
Long term maintainence cost will be minimal. These costs will be the responsibility of the Town of Romulus Highway Department.

G5_identified_impairment:
Yes. Cayuga Lakes use impairments are listed as Water Supply, bathing, fishing, fish propagation, aesthetics and boating. Two types of pollution listed are nutrients and sedimnent. This project will potentially reduce the inputs of these pollutants to Cayuga Lake.

G6_human_use:
Yes. Reduction of sediment and nutrient inputs to the lake could potentially improve the condition of the lake within the affected area. This would potentially reduce the above mentioned use impairments.

G7_lake_watershed_ecology:
Yes. The reduction of erosion and the resulting nutrient and sediment loading to the lake can potentially improve the ecology of the watershed and the lake.

G8_benefit_degrade:
The project will potentially benefit the quality of both the watershed and the lake by reducing nutrient and sediment loading to the lake.

G9_use_consideration:
The project will potentially improve all the listed use impairments listed in the 1996 Priority Waterbodies List.

G10_expenditure_limits:

The total project cost will be $10,000. The Town of Romulus and the Seneca County SWCD will provide aproximately $5,000 in in-kind services.

G11_funding_considerations:
Funding for this project has been requested from two sources:
The Great Lakes Basin Program and the 1999 Water Quality Coordinating Committee Mini Grants Level III program.

G11_funding_considerations:

H1_real_cost:
$5,000 Materials to be purchased
$4,850 Personnel and equipment costs (in-kind)
$150 Educational materials
total $10,000

Funding for this project will again be requested from the Great Lakes Basin Program.

H2_cost_specifics: No maintenance and operation costs are anticipated.

H3_continued_funding: no

**Project 4**

A_ProjectTitle: ITHACA/CAYUGA HEIGHTS/LANSING AREA WASTEWATER COLLECTION AND TREATMENT SYSTEM IMPROVEMENTS

B_Principal_Investigator: Lawrence P. Fabbroni,P.E.,L.S.,

B_Affiliation: Assistant Superintendent DPW, City of Ithaca Water & Sewer Division

B_FirstName: Lawrence

B_MiddleName: Peter

B_LastName: Fabbroni

B_StreetAddress: 510 First Street

B_City: Ithaca

B_State: NY

B_Zip: 14850

B_Email: larryf@ci.ithaca,ny.us

B_AreaCode: 607

B_Exchange: 272

B_PhoneNumber: 1717

C_ProjectCategory: Implementation

C_ProjectCategory_other: Approximately, $4.2million local funds have been spent to date.

D1_addresses_impairment: yes

Impairment:
Nutrients south end of lake summer exceedance of 20 ug/l average.  failing septic systems, raw sewage overflows, and lack of total secondary treatment in the Six Mile Creek, Cascadilla Creek, Fall Creek, and Salmon Creek Watersheds emptying into Cayuga Lake representing approximately 50% of flow into Cayuga Lake.

D2_solution: yes

D3_watershed_wide: yes

D4_human_use: yes

D5_lake_ecology: yes

D6_watershed_ecology: yes

E_description:
See last year's description.
This joint municipal project involving six municipalities on the southern end of Cayuga Lake, bordering tributaries that contribute over 50% of the flow into Cayuga Lake, addresses water quality impacts related to phosphorus discharges directly into the lake at the two wastewater plant discharges. The total regional plan will abate health concerns and water quality impacts related to failing on-site systems on the lake and within tributary areas of Six Mile Creek, Cascadilla Creek, Fall Creek, and Salmon Creek. Likewise, all known existing sewer system raw sewage overflows that occur within the wastewater collection systems or at plant bypasses to the Flood Channel, Six Mile Creek, Cascadilla Creek, Fall Creek, Salmon Creek, and Cayuga Lake will be mitigated. This project provides municipal wastewater treatment service to currently unsewered areas in the Town of Lansing, Village of Lansing, and Town of Dryden while providing a solution to all groundwater contamination problems! of on-site systems and treatment deficiencies of existing larger scale in-ground or package plants. The area has prepared and submitted a Unified Engineering plan accepted by DEC as sufficient for Bond Act applications. The area has spent $4.2million local money on improvements thus far. The projects will be implemented in 2000-2002 if adequate grants are received to move forward expeditiously.

F_impact_on_management:
This project is just part of a more inclusive City of Ithaca and neighbors effort to eliminate point and non-point source pollution in the same watersheds. These collective improvements will compliment the balance of the watershed protection efforts directed to soil and stream bank stabilization, farm management practices, etc. The state of sewage treatment systems will be dramatically improved at the south end of Lake Cayuga. These collective improvements will effect the greatest integrated environmental package of improvements ever to support urbanization and protect the water quality of waters discharging to Cayuga Lake.

G1_impact_on_watershed:
The tertiary phosphorus removal systems will implement best available filter technology that could prove to be applicable at any other treatment facility discharging to Cayuga Lake or its tributaries. The current permitted loading of phosphorus of 100+ pounds per day is expected to be reduced to no more than 50 pounds per day even with the expanded treatment capacity at the Ithaca wastewater palnt to 13MGD and expanded service area in Lansing and Dryden.

G2_solution:
The phosphorus removal systems are up and down flow filter systems some with continuous backwashing and high rate settling filters all currently being evaluated for the most cost-effective solution to meet target phosphorus removals. The sewer collection upgrades and extensions are proven technology with much data comiled through engineering facility plans and infiltration inflow studies.

G3_evaluation:

Yes! Phosphorus discharges at the two plants are currently monitored so before and after data will be available. The City is cooperating with multiple agencies in gathering nutrient information before and after these improvements and Cornell Lake Source Cooling to evaluate impacts on the southern Lake basin. The recorded bypassing os secondary treatment at the Cayuga heights Plant will be eliminated. The overflow odf raw sewage to tributaries will be eleiminated. Discharges of package plants will be eliminated. Failing septic systems will be eliminated. All these improvements are absolute and verifiable.

G4_operation_maintenance:
Operating and maintenance costs added to the improvements will be funded through user rates without the need for additional outside funding beyond help with the first cost capital expenses. The City has had successful user charge systems in place since 1906. Cayuga Heights has had similar systems succefully in place since building their plant in 1954. The surrounding Town and Villages involved all have viable financial plans associated with sewer districts to sustain O&M funding.

G5_identified_impairment:
Yes!PWL#0705-0040 Water clarity in the southern Cayuga Lake is reduced due to inflows of sedimant from the watershed and from algal particulates generated with the lake basin. Uses of this water segment are considered impaired due to the high turbidity. Swimming at Stewart Park has been precluded for more than 20 years, and the NYSDEC notes that macrophyte growth is suppressed, thus limiting fish habitat. Recent USGS estimates of the sedementation rate in the southern Cayuga Lake document the accelarated deposition of solids over the past several decades. The state guidance value for total P (summer average
20 micrograms per liter) is exceeded in this water segment.

G6_human_use:
Reliability of wastewater collection and treatment at the plants will increase, reducing potential for overflows, periods of diminished treatment, and dramatically reducing point source phosphorus contributions to the lake in critical dry flow periods. The projects will enhance human uses of the Lake and its tributaries by eliminating bqacteriological concerns, protecting the Class AA recreational and drinking water supplu portion of the Lake, and lowering the nutrient levels contributing to algae growth and resulting decaying odors.

G7_lake_watershed_ecology:
The southern basin of the Lake will support a wider range of fish sizes. Southern Cayuga Lake is calssified as Class A, with designated best use for water supply following treatment. This region of Cayuga Lake is heavily used for boating and other water contact recreation. The Allen H. Treman State Marine Park is located in the water segment affected by the proposed project. Cayuga Lake supports two distinct fish communities: a littoral zone warm water community and a cold water community dominated by lake trout, rainbow trout, brown trout, and landlocked salmon. Rainbow trout and salmon travel through shallow southern Cayuga Lake on their annual spawning migrations to the southern tributaries.

G8_benefit_degrade:
The benefits are numerous and great to the Lake and watersheds contributing 50% of the flow to Cayuga Lake as elaborated above. The phosphorus removal technologies will greatly help to reduce point source nutrients contributed to the Lake. Elimination of raw sewage overflows, incomplete treatment, and package plant point discharges will reduce laods of pathogens, nitrates, and phosphorus to local surface waters and groundwater. There is no conceivably degradation
as construction disturbances will be totally mitigated through a Stormwater Management Plan.

G9_use_consideration:
See 7 above. With the dramatic decrease of pathogens, nitrogen , and phosphorus contribtuions to the lake in a manner than can be sustained and regulated, the complementary efforts going on the the watersheds to reduce non-point source pollution will improve the fishery, boating, drinking, and swimming opportunities along the southern part of the lake and its shore line.

G10_expenditure_limits:
The project costs projected in our 1999 submission was $19,510,000 with $8,061,000 being funded locally. We had been succesful in receiving $7.4 million in Bond Act Funds in September 1998. This was actually increaded to a toal of $7,513,920 in the latest grant awards to the Finger Lakes in April 2000. Our $4 million dollar project given the highest

rating in the 1999 rankings by the technical group and I/O, a Score of 317, HAS NOT BEEN FUNDED TO DATE. This was submitted as part of a larger regional package for Bond Act Funding in August 1999. A revised total budget of $26million includes more enhanced treatment and some more financial assistance for sewer and I/I work. This request through the I/O would increase of previous request to the
I/O from $4 million to $7 million. We have some indication this is the highest rated project in the Fingerlakes but that Albany would like to
wait until this next cycle to award additional funds. Local funding in the end even if we were to recieve additional funds form the Bond ACt would approach $11.5 million. We have spent $4.2 million of this already. The Watershed inclusion of this project in your management plan and priorities is essential to its funding and more all inclusive results and success.

G11_funding_considerations:
See 10 above. The local communities have a $26 million+ improvement program outlined for wastewater improvements. The current total request through the I/O for additional Bond Act funds is $7 million, including the $4 million not acted upon from the I/O top 1999 priority
for interim recommendation to the Department of State. The $7 million will further help Lansing with sewer construction, Cayuga heights and the Ithaca Plant owned by the City and Town of Ithaca, and Town of Dryden and with overflow and I/I problems in the interceptor conveyance system. No other outside funding other than low interest EFC revloving fund loans is available. The support of this project and inclusion in the Cayuga Lake Watershed Management Plan is essential to its successful funding for major improvements to one of the few urban areas discharging to a Finger Lake. Grant funds have been lacking for major wastewater improvements identified over twenty-five years ago to adequately serve the Ithaca region.

G11_funding_considerations: All criteria are met in multiple ways.

H1_real_cost:
$26million +, State Bond Act $14.5 million ($7.5 received to date)
local funding $11.5 million ($4.2+ spent to date)

H2_cost_specifics:

The Cayuga Heights Plant and the Ithaca Plant owned by the City and Town of Ithaca and Town of Dryden have combined operational budgets of $2.7million per year. The increased cost of treatment will be adsorbed in the user charges that Cayuga Heights has had a system for since 1954 and the City has had a system for since 1906.

The sewer collection system is funded annually for the six municipalities at over $2 million per year. The costs to the part of the system with replacement interceptors will actually be less. The costs where sewers will replace septic systems and package plants will be covered in sewer district costs.

H3_continued_funding: no

**Project 5**

A_ProjectTitle: Ag Nutrient Management in Seneca County

B_Principal_Investigator: Phil Griswold, Neil LeRoux

B_Affiliation: Seneca County SWCD, USDA Natural Resources Conservation Service

B_FirstName: Phil

B_MiddleName:

B_LastName: Griswold

B_StreetAddress: 12 N. Park St.

B_City: Seneca Falls

B_State: NY

B_Zip: 13148

B_Email: PG@nysenecafa.fsc.usda.gov

B_AreaCode: 315-568-4315-568-4315

B_Exchange: 568

B_PhoneNumber: 4366

C_ProjectCategory: Implementation

C_ProjectCategory_other:

D1_addresses_impairment: yes

Impairment:
This project will address the impairments listed in the 1996 PWL list. Those being: Water Supply, Bathing, Fishing, Fish Propagation, Aesthetics, and Boating

D2_solution: yes

D3_watershed_wide: yes

D4_human_use: yes

D5_lake_ecology: yes

D6_watershed_ecology: yes

E_description:
41 Livestock Farms have been identified in the portion of the Cayuga Lake Watershed that lies within the boundries of Seneca County. These farm operations contain approximatley 5000 animal units and utilize 15,447 acres of farm land. Many of these operations are located within a close proximity to the varius tributaries or to Cayuga Lake itself. 29 of these farms were identified as Dairy Farms. The goal of this prject is to provide funding to create Comprehensive Nutrient Management Plans to these farms as well as provided funding as needed to construct Best Management Practices, mainly manure storage facilities.

F_impact_on_management:
This project would reduce nutrient and possibly pathogen loading to many of the tributaries of Cayuga Lake.

G1_impact_on_watershed:
Reduced Nutrient,Sedimnent and possibly pathogen loading reaching the Cayuga Lake.

G2_solution:
Yes. The implementation of Comprehensive Nutrient Management Plans, and construction manure storage and other manure management facilities are proven best management practices.

G3_evaluation:
This project can possibly be evaluated useing long term water qulality monitoring.

G4_operation_maintenance:
Long term operation and maintenance will be the responsibility of the individual farmer.

G5_identified_impairment:
Yes. The potential reduction of Nutrient and sediment loading that this project can potentially accomplish, may address the impairments listed in the PWL. A common complaint, aquatic vegeatation can be reduced.

G6_human_use:
Yes. The potential reduction in Nutrient and Sediment loading can enhance all potential human uses of the lake. A reduction in Aquatic vegetation and algal growth will enhance human uses of the lake.

G7_lake_watershed_ecology:
Yes. The potential reduction in Nutrient and Sediment loading can address potential watershed and lake ecology.

G8_benefit_degrade:
This project will benefit the gereral quality of the lake and its tributaries. It will reduce use impairments listed in the PWL.

G9_use_consideration:
This project will potentially improve all of the listed use impairments listed in the PWL.

G10_expenditure_limits:
The total cost to accomplish all of the goals of this project is $885,000.00

G11_funding_considerations:
Funding for portions of this project has been requested from 2 sources in the past:
-AG Non-Point Source Program (Ag and Markets)
-EQUIP

G11_funding_considerations:

H1_real_cost:
$885,000 Comprehensive Nutrient Management plans for 41 Livestock operations and construction of manure mangagement facilities in 20 of 29 dairy operations.

Funding Sources would be:

-EQUIP
-AG Nonpoint Program (Ag and Markets)

H2_cost_specifics:
Operation and Maintenance costs will be the reposibility of individual farmer/recipients.

H3_continued_funding: no

**Project 6**

A_ProjectTitle: Proposed Water System Improvements Village of Interlaken

B_Principal_Investigator: Resource Associates Cortland, N. Y. 13045

B_Affiliation:

B_FirstName: Barbara

B_MiddleName: B.

B_LastName: Stewart

B_StreetAddress: PO 130 3683 Clinton St.

B_City: Interlaken

B_State: NY

B_Zip: 14847

B_Email: bbs2@cornell.edu

B_AreaCode: 607

B_Exchange: 532

B_PhoneNumber: 4917

C_ProjectCategory: Implementation

C_ProjectCategory_other:

D1_addresses_impairment: yes

Impairment:
our off shore wells have gone dry twice in 2 years, forcing us to use water from cayuga lake.

D2_solution: yes

D3_watershed_wide: no

D4_human_use: yes

D5_lake_ecology: yes

D6_watershed_ecology: yes

E_description:
there are 3 parts: emergency artificial recharge, placement of a permanent mechanism to allow us to remove water from cayuga lake in case of a water emergency.
booster station improvements: install a new water storage tank, this would allow us to pump at the night rate. as our engery rates are very high this would be a significant help in keeping our usage rates current at least with no increase. modifications to the booster pumps would help provide additional water flow to the system in case of fire needs.
and part 3 concerns the current water tank, at this time we are not going to take direct action. we are considerating a replacement tank sometime in the future.

F_impact_on_management:
with some of the modifications in place, it would be our hope that we would not have to use the lake water, cayuga. which we feel is a direct impact. an indirect positive would be the reduced use of high cost electricity.

G1_impact_on_watershed: reduced use of lake water

G2_solution: if we have a drought, our lake shore well would go dry again.

G3_evaluation: na

G4_operation_maintenance:
hopefully with grant monies that will allow for improvements, we will be able to better manage these areas.

G5_identified_impairment: no

G6_human_use: no

G7_lake_watershed_ecology:
the additional tank would allow a much more efficient use of water from our well that is fed by an aquafer. hopefully we would not need the emergency recharge system.

G8_benefit_degrade: benefits the quality of the lake/aquafer by more efficient use of the natural resource.

G9_use_consideration:

G10_expenditure_limits:

G11_funding_considerations:

G11_funding_considerations:

H1_real_cost:
part1:emergency artifical recharge  $38,461
part 2: booster station improvements  $145,000
part 3:  if we need tank in the future  $326, 167

H2_cost_specifics: non avalible at this time

H3_continued_funding: no

**Project 7**

**A**. Project Title: **HIGH RESOLUTION-MULTISPECTRAL REMOTE-SENSING CHLOROPHYL-α QUANTITATION**

**B.** Principal Investigator(s), Affiliation(s), Contact Information:  (Provide name of primary contact person, address, phone no., and e-mail address)

Jose Lozano, City of Ithaca Environmental Laboratories
525 Third St., Ithaca NY 14850
(607) 273- 8381, Fax (607) 273-8433
e-mail: JLL13@cornell.edu

**C.** Project Category:  Implementation, Planning, Education, Research, Other (specify):
Planning and Research

**D.** Please respond to the following questions.  (Each may be expanded in Section E – Project Description):

1. Does the project address an identified impairment to the watershed?  Yes or No (indicate one)
If so, what is that impairment? Yes, Nutrients load

2. Does the problem identified have an existing solution? Yes or No (indicate one): Yes, BMPs implementation at the most critical locations
3. Can the project be implemented on a watershed-wide basis (either now or in the future)?
   Yes or No (indicate one): Yes, Once implemented it will be an economical and easily implemented measurement of the overall water quality of the lake
4. Does the project address human uses of the watershed? Yes or No (indicate one): Yes, Recreational, Fisheries, Drinking Water.
5. Does the project address lake ecology? Yes or No (indicate one): Yes, It provides a measurement of the trophic state of the lake
6. Does the project address watershed ecology? Yes or No (indicate one): Yes, it allows to locate and identify the worst areas in which nutrients are being discharged into the lake.

**E.** Project Description. (In 150 words or less, describe what the project is; why, where, how and when it will be done; and project readiness):

The concentration of chlorophyl-α is one of the best indicators of the trophic state of waterbodies. The large scale resolution studies, using remote sensing quantitation, have proven this to be the case. The application of this methodology at a small-scale resolution is proposed here.

Silt and nutrients loading in Cayuga Lake have been identified as the most probable cause for impairment in Cayuga Lake. The simultaneous upgrading of the two major wastewater treatment plants and several stream bank stabilization projects in Cayuga Lake, offer a unique opportunity to study the improvement in the water quality and ecology at Cayuga Lake, using "conventional" water-quality parameters and remote-sensing quantitation of chlorophyl-α at a meter scale resolution.

Project Objectives: Establish baseline water quality conditions in the Lake and tributaries for:

i) Chlorophyl-α by multiprobe sensing and laboratory analysis calibration

ii) Phosphorous (P), Ammonia ($NH_3$), Total Dissolved Solids (TDS), Dissolved Oxygen (DO), and Temperature (T), GPS location, and Depth

**F.** Briefly describe the overall impact of the project in terms of watershed management.

The measurements of chlorophyll alpha will be useful in several ways, (i) it will allow the characterization of the main areas in the lake receiving the largest nutrient loads, (ii) it will allow the targeting of these most important areas for priority remediation, and (iii) it will provide a quantitative measurement of how well best management practices, and which ones, are performing.

G. Describe the project in relation to the Evaluation Criteria (summarized numerically below – refer to Evaluation Criteria section for more detail).

**1.** What is the overall positive long-term impact on the watershed and/or lake?

Provides a quantitative measurement of the overall water quality of the lake. Not a localized evaluation, but a lake wide, practical way to measure the entire lake's overall health.

**2.** Does the problem to be addressed have an existing solution?

Yes, the implementation of BMP's for both point and non-point pollution sources

**3.** Does the project have a means of being evaluated? What means will you use?

The project has a specific outcome, the ditribution and concentration of Chlorophyl alpha in the Lake. This will be calibrated by direct laboratory assays by independent laboratories, as well as the peer-review of the technical Watershed Group based at the Cornell Center for the Environment.

**4.** Operation and maintenance consideration.

Annual calibration assays will be conducted, after the two year sampling seasons.

**5.** Does the project address an identified impairment?

Yes, Nutrients loading into Cayuga Lake and the data gaps that exist in the precise localization of these sources.

**6.** Does the project address potential human use of the lake and the watershed?

Yes, Drinking water, recreation, and fisheries

**7.** Does the project address potential lake and watershed ecology?

Yes, It provides a measurement of the trophic state of the lake

**8.** Does the project potentially benefit/degrade the general quality of the lake, or the watershed feeding the lake?

It will benefit the lake's ecology by improving the identification of prioritary areas in the lake. It would also (i) allow the characterization of the main areas in the lake receiving the largest nutrient loads, (ii) allow the targeting of these most important areas for priority remediation, and (iii) it will provide a quantitative measurement of how well best management practices, and which ones, are performing.

**9.** Capital expenditure limit.

Estimated In-Kind Contribution: Staff cost per year (includes the use of two certified environmental laboratories): $14,212.00 per year +Sampling and Analysis Total Cost: $4,112.25 per year + Equipment & supplies

$15,000.00 (HydroLab multiprobe $12,000.00, Geographic Positioning System $5,000.00) that gives a TOTAL LOCAL MATCHING FUNDS: $35,324.25

The Ithaca Area Waste Water Treatment Facility has funded $10,000.00 for the purchase of a vessel. Funding from a 2001 RFP to the Finger Lakes –Lake Ontario Watershed Protection Alliance, FL-LOWPA, will be used for the purchase of sampling equipment. This proposal has been endorsed by the Tompkins County Water Resources Council.

(FY 2000-01 Project Budget: Itemized Expenses: Samplers $3,000.00, + Boat $20,000.00, + Supplies $8,000.00 to give a TOTAL COST: $44,000.00)

**10.** Actual use consideration.

Planning agencies as well as Conservation offices and researchers will derive useful information from the measurements. This is a long-term lake wide, practical assessment tool to measure Cayuga Lake water quality.

**11.** Funding considerations.
This proposal will seek funding from the NSF, USDA, NYS-DOS or NASA.

**H.** Budget

- Provide real cost of the project and identify funding source(s).

A tentative estimate of the project's budget is indicated next.
Budget Request: bimonthly sub-meter resolution, multispectral-resolution remote sensing fly-over info sets over Cayuga Lake ($150,000.00???), four sets of multiprobe chlorophyl-α sensors ($32,000.00), laboratory analysis of chlorophyl-α field reference samples (15,000.00), Overhead expenses (15%).Total = 297,000+15%

- Provide cost specifics of maintenance and operation.

These will be derived from the third and subsequent years of operation, taking in consideration three annual measurements (sub-meter resolution, multispectral-resolution remote sensing fly-over info sets over Cayuga Lake (50,000???) and field calibration measurements of Chlorophyll Alpha ($5,000)

- Will the project require continued funding? Yes or No (indicate one)

Yes, remote sensing and field calibration ($55,000/year)

**Project 8**

**A.** Project Title: SIX MILE CREEK RIPARIAN BUFFER RESTORATION PROGRAM

**G.** Principal Investigator(s), Affiliation(s), Contact Information: (Provide name of primary contact person, address, phone no., and e-mail address)

APPLICANT MUNICIPALITY: Caroline, City of Ithaca, & Town of Ithaca
CONTACT PERSON: Jose Lozano
Environmental Laboratories, City of Ithaca
525 Third St., Ithaca NY 14850
PHONE: (607) 273-6381 FAX: (607) 2738433
e-mail: jll13@cornell.edu

**H.** Project Category: Implementation, Planning, Education, Research, Other (specify):
All these categories will be addressed in this project

**I.** Please respond to the following questions. (Each may be expanded in Section E – Project Description):

7. Does the project address an identified impairment to the watershed? Yes or No (indicate one)
   If so, what is that impairment?
   <u>Siltation, Habitat degradation, Fisheries, Drinking Water</u>
8. Does the problem identified have an existing solution? Yes or No (indicate one)
   <u>Yes, Stream Riparian Buffers Restoration</u>
9. Can the project be implemented on a watershed-wide basis (either now or in the future)?
   Yes or No (indicate one) <u>Yes, the project is a multi jurisdictional cooperation</u>
10. Does the project address human uses of the watershed? Yes or No (indicate one)
    Yes, Drinking Water and recreational uses
11. Does the project address lake ecology? Yes or No (indicate one)
    <u>Yes, it aims at decreasing the silt load at the south end of the lake</u>
12. Does the project address watershed ecology? Yes or No (indicate one)
    Yes, Improving fish habitat at a Class A Trout Stream and reducing the silt load at the south end of the Lake

**J.** Project Description. (In 150 words or less, describe what the project is; why, where, how and when it will be done; and project readiness)

This is an implementation and management program of riparian buffers, designed to decrease silt and nutrients loading to improve water quality and habitat in the Six Mile Creek Watershed. One of the most important impairments of Six Mile Creek is the high silt loading, the associated habitat degradation and the lack of an effective riparian buffer zone management program.

Six Mile Creek, the source of drinking water for the City of Ithaca and a Class A trout stream, is part of the Cayuga Lake Watershed, a priority waterbody located in the Seneca-Oneida Watershed (Category 1 NYS-Unified Watershed Assessment). The Six Mile Creek Management Program has been endorsed by the Cayuga Lake Inter-municipal Organization, the Tompkins County Water Resources Council, the Town of Caroline, and the City of Ithaca.

If this riparian corridor restoration and management program is funded, a critical component of the intermunicipal stakeholders partnership effort will be accomplished and the benefits of riparian buffers would be realized at Six Mile Creek, beyond the basic streambank stabilization already funded by the NYS Clean Air - Clean Water Bond Act.

In partnership with the Center for the Environment, Cornell University we are setting a testing node for end-users (planners, elected officials, watershed stakeholders) of a user-friendly comprehensive water resources modeling program. It will have the ability to answer 'what if' questions pertaining the land use, as well as water resource designated uses, quality, and quantity.
The Six Mile Creek Stakeholders group will be the pilot study for the presentation and simulation of “what-if” scenarios of the effect of riparian buffers have on water quality and stream health.

Twelve sites at Six Mile Creek have been documented in terms of macroinvertebrates, fish, chlorophyll ∝, water quality parameters, and land cover – usage. The effect of the riparian buffer restoration program will be followed and used to educate the end-users about the benefits of a healthy riparian corridor.

**K.** Briefly describe the overall impact of the project in terms of watershed management.

Improving fish habitat at a Class A Trout Stream and reducing the silt load at the south end of the Lake this proposal also organizes a multi jurisdictional, multi disciplinary partnership. This partnership includes citizens groups, municipal and federal government, and state and federal agencies. The experience gained during the implementation of this proposal would be easily applied to other areas in the watershed.
The cooperation between the DEC and the Six Mile Creek partnership has now been expanded to work on the Cayuga Lake Inlet restoration project. In a joint effort, these two teams will develop the stream restoration projects simultaneously at the Inlet and at Six Mile Creek.

**L.** Describe the project in relation to the Evaluation Criteria (summarized numerically below – refer to Evaluation Criteria section for more detail).

**12.** What is the overall positive long-term impact on the watershed and/or lake?
Siltation reduction, habitat improvement (Fish, forest, and wildlife), drinking water quality protection.

**13.** Does the problem to be addressed have an existing solution?
Yes, the implementation of a steambank restoration program (already funded by 175,000 for Six Mile Creek, ~200,000 for the Inlet), and the restoration of riparian buffer corridors.

**14.** Does the project have a means of being evaluated? What means will you use?
Yes, Monitoring for water quality and bioassessment is an integral part of the program. Not only before and after, but also upstream and downstream od the target areas.

**15.** Operation and maintenance consideration.
The schedule for maintenance is indicated below:

**16.** Does the project address an identified impairment?

| Time Since Installation | Inspection Interval |
|---|---|
| 2 Months | 2 weeks (4 total) |
| 6 Months | 1 month (5 total) |
| 2 Years | 6 months (3 total) |

Yes, Silt and nutrient load at the south end of Cayuga Lake

**17.** Does the project address potential human use of the lake and the watershed?
Six Mile Creek is the drinking water source for the City Ithaca; Fisheries, recreational uses will also benefit from the implementation of the riparian buffer restoration program.

**18.** Does the project address potential lake and watershed ecology?
Yes. The silt and nutrient load is a prioritary impairment in Cayuga Lake watershed.

**19.** Does the project potentially benefit/degrade the general quality of the lake, or the watershed feeding the lake?
Yes, the benefits are direct, by addressing one of the main impairments in the watershed, the reduction of silt load and fisheries habitat improvement is expected to have an immediate beneficial impact on the watershed.

**20.** Capital expenditure limit.
The total cost of the project as follows:

| | |
|---|---|
| Total Project Costs: | $487,300.00 |
| Local Match: | $232,200.00 |
| State Assistance Requested: | $100,000.00 |

**21.** Actual use consideration.

The present proposal -Six Mile Creek Stream Corridor Restoration Program- is part of a wider management plan for this watershed. Already funded by the NYS Clean Air - Clean Water Bond Act, the streambank stabilization of Six Mile Creek is already underway.

This stream is also part of a Source Water Assessment Program currently under consideration for funding. This SWAP proposal was prepared in partnership with Dr. Pete Loucks's team at CfE, Cornell University. In this SWAP proposal, all the Cayuga Lake Watershed would be evaluated.

The implementation of Six Mile Creek Watershed Management plan has the highest priority in the Tompkins County Water Quality Strategy Plan. The Six Mile Creek Management Plan has also been endorsed by the Cayuga Lake Watershed Inter-municipal Organization.

Six Mile Creek is a tributary to Cayuga Lake. Both are in the 303(d) priority waterbodies list. The Six Mile Stream Corridor Restoration Program is helping to restore the recreational use of Cayuga Lake, also contributing to protect and improve fisheries by decreasing silt loading

**22.** Funding considerations.
This proposal is seeking funding from the US Forest Service (487,300).
The local match has been secured already. It was provided by the City of Ithaca Planning Department ($200,000). The difference is acconted for in staff and other in-kind contributions

**H.** Budget

- Provide real cost of the project and identify funding source(s).

The total cost of the project as follows:

| | |
|---|---|
| Total Project Costs: | $487,300.00 |
| Local Match: | $232,200.00 |
| State Assistance Requested: | $100,000.00 |

This proposal is seeking funding from the US Forest Service (487,300).
The local match has been secured already. It was provided by the City of Ithaca Planning Department ($200,000). The difference is acconted for in staff and other in-kind contributions

- Provide cost specifics of maintenance and operation.

The maintenance costs are considered here as an independent source of funding. The members of the Six Mile Creek partneship, by incorporating the maintenance of riparian buffers into their annual work programs and local ordinances will create the continuity required by the successful upkeep of riparian buffer corridors.

- Will the project require continued funding? Yes or No (indicate one)

After the three year project duration, the funding, although required for maintenance, will come for an independen source. Please see previous paragraph.

**Project 9**

**A.** Project Title:

The Trophic State of Cayuga Lake
As affected by a Reduction of Phosphorous and Silt Loading

**M.** Principal Investigator(s), Affiliation(s), Contact Information: (Provide name of primary contact person, address, phone no., and e-mail address)

Jose Lozano, City of Ithaca Environmental Laboratories
525 Third St., Ithaca NY 14850
(607) 273- 8381, Fax (607) 273-8433
e-mail: JLL13@cornell.edu

**N.** Project Category: Implementation, Planning, Education, Research, Other (specify)

**Planning and Research**

**O.** Please respond to the following questions. (Each may be expanded in Section E – Project Description):

13. Does the project address an identified impairment to the watershed? Yes or No (indicate one)
    If so, what is that impairment? Yes, Silt and Phosphorus load to Cayuga Lake
14. Does the problem identified have an existing solution? Yes or No (indicate one) Yes, the upgrading of the largest waste water treatment plants and streambank stabilization.
15. Can the project be implemented on a watershed-wide basis (either now or in the future)?

Yes or No (indicate one) Yes, the implementation in a lake-wide basis of this type of project will benefit the watershed, of particular interest are septic systems performance and sources of sediment

16. Does the project address human uses of the watershed? Yes or No (indicate one) Yes, it addresses the protection of drinking water.
17. Does the project address lake ecology? Yes or No (indicate one) Yes. The assessment of the trophic state of Cayuga Lake provides the means to plan an effective management plan for Cayuga Lake.
18. Does the project address watershed ecology? Yes or No (indicate one) Yes. The trophic state is one of the best indicators of the ecological status of Cayuga

**P.** Project Description. (In 150 words or less, describe what the project is; why, where, how and when it will be done; and project readiness)

The simultaneous upgrading of the wastewater treatment plants and the stream bank stabilization projects provides a unique opportunity to study the effect of the reduction of phosphorous and silt loading on the trophic state of the South end of Cayuga Lake

The objectives of the project are

1. – Establish the Phosphorous baseline of Cayuga Lake, upon nutrient and silt loadings reduction on Cayuga Lake before and after the wastewater treatment plants upgrade and streambank stabilization projects. The objective of this study is to characterize the Phosphorus baseline after a reduction in nutrients and silt loading to Cayuga Lake.

2. - Bacteriological assessment (Total and Fecal Coliforms)

In order to evaluate if there are improvements of the water quality, in terms of bacteriological density on the lake by farm run-off and storm over-flows, the density of Total and Fecal coliforms in the lake will be determined in bi-monthly samplings.

**Q.** Briefly describe the overall impact of the project in terms of watershed management.

The results of this proposal will establish the general health status of Cayuga Lake and allow for the planning of remediation strategies. It will also provide data to formulate successful grant proposals for the actual implementation of the Cayuga Lake Management Plan. The data derived for this project will be of great value in accomplishing a quantitative way to assess the performance of implemented best management practices. It will also provide the information required to evaluate the placement of Cayuga Lake in the waterbodies lists that determine funding priorities, i.e., The Unified Watershed Assessment and Restoration Priorities of New York State. It can also have an impact on the placement of Cayuga Lake in the 303(d) List.

**R.** Describe the project in relation to the Evaluation Criteria (summarized numerically below – refer to Evaluation Criteria section for more detail).

**23.** What is the overall positive long-term impact on the watershed and/or lake?

Provides a quantitative assessment tool for watershed management and determination of funding priorities when requesting State or Federal funds for the implementation of the Cayuga Lake Management plan.

**24.** Does the problem to be addressed have an existing solution?

Yes, the lack of up to date information will help to plan a better management plan

**25.** Does the project have a means of being evaluated? What means will you use?

Yes, the direct product of the work will be the peer-reviewed assessment of the trophic state of Cayuga Lake.

**26.** Operation and maintenance consideration.
The sampling and analysis of data is the main cost. The Operation/Maintenance costs are only a minimal part. They are restricted to equipment maintenance and operation.

**27.** Does the project address an identified impairment?
The need for up-to-date information, and the need of a monitoring program have been established in the preliminary assessment. The data gaps identified in the preliminary characterization report are addressed by this proposal.

**28.** Does the project address potential human use of the lake and the watershed?
Yes, it has a direct effect the water quality of the like by providing a quantitative measurement.

**29.** Does the project address potential lake and watershed ecology?
Yes, by gauging the trophic state of the lake, we gain a valuable planning tool.

**30.** Does the project potentially benefit/degrade the general quality of the lake, or the watershed feeding the lake?
The potential benefits are substantial. See section F, above.

**31.** Capital expenditure limit.

**BUDGET**

STAFF: SUBTOTAL per year: $10,306.00

SAMPLING & ANALYSIS: SUBTOTAL $4,112.25 per year

SUBTOTAL Equipment and Supplies Total: $49,000.00 (First year)

TOTAL: First Year $63,418.25 per year

LOCAL MATCHING FUNDS:

STAFF SUBTOTAL: $10,306.00 per year

SAMPLING AND ANALYSIS SUBTOTAL COST: $4,112.25 per year

EQUIPMENT AND SUPPLIES TOTAL: $15,000.00 (First year)

TOTAL LOCAL MATCHING FUNDS: $29,418.25

TOTAL COST : $34,000.00

**32.** Actual use consideration.
The information derived from this study will be available to all Cayuga Lake stakeholders. Planning departments and local government officials will have access to information useful in decision making.

**33.** Funding considerations.
The present proposal is funded by the monitoring program undertaken by the Town and City of Ithaca, as well as Dryden through the Special Joint Sub-committee, SJS, at the Ithaca Waste Water Facility. The total matching funds, $39,418.00, has been allocated to the purchase of a sampling vessel, and monitoting equipment. The staff in the project has given the backing required for this project by the SJS endorsement of a monitoring program for Cayuga Lake. This proposal is seeking the endorsement of the IO to be able to seek funding from the NYS Department of State.

**H.** Budget

- Provide real cost of the project and identify funding source(s).
  The total cost of this project is $63,000.00 during the first year, $34,000.00 will be the amount requested, for the first year, by the present request for endorsement.
  The cost of the project in each of the two more years of the duration of the project is $20,000.

- Provide cost specifics of maintenance and operation.

  The project will require funding during three years. Each year $10,000.00 will be allocated to maintenace and operation.

- Will the project require continued funding? Yes or No (indicate one)

  Yes, we are requesting funding for three years. The start-up costs are quite high, in relation to the operation/maintenance costs of the second and subsequent years. It can be said that it makes good financial sense to run the monitoring program for at least three years.

**Project 10**

**A.** Project Title:
Defining a Source Water Assessment Program (SWAP) for the Cayuga Lake Watershed and the Hydrological, Ecological and Environmental Conditions of Watersheds Undergoing Socio-Economic Changes Affecting Land and Water Use.

**S.** Principal Investigator(s), Affiliation(s), Contact Information: (Provide name of primary contact person, address, phone no., and e-mail address)

- Daniel P. Loucks, Professor, Civil and Environmental Engineering, Cornell University
- Mark B. Bain, Associate Professor, Natural Resources, Cornell University
- Rolf J. Pendall, Assistant Professor, City & Regional Planning, Cornell University
- Tammo S. Steenhuis, Professor, Agriculture and Biological Engineering, Cornell University
- Jose Lozano, Director, Environmental Laboratories, City of Ithaca
  Contact: J Lozano JLL13@cornell.edu 525 Third St., Ithaca NY 14850, Phone (607) 273-8381, FAX (607) 273-8433.

**T.** Project Category: Implementation, Planning, Education, Research, Other (specify)
Planning, Education, and Research

**U.** Please respond to the following questions. (Each may be expanded in Section E – Project Description):

19. Does the project address an identified impairment to the watershed? Yes or No (indicate one)
    If so, what is that impairment? Yes, the lack of a drinking water source assessment

20. Does the problem identified have an existing solution? Yes or No (indicate one)
    Yes, the development of the objectives of this proposal will provide an assessment of the drinking water sources in Cayuga Lake.
21. Can the project be implemented on a watershed-wide basis (either now or in the future)?
    Yes or No (indicate one)
    Yes, the coverage of the present SWAP program includes all the Cayuga Lake watershed.
22. Does the project address human uses of the watershed? Yes or No (indicate one)
    Yes. Drinking Water
23. Does the project address lake ecology? Yes or No (indicate one)
    Yes. The ecological good health of the Lake will be the best SWAP.
24. Does the project address watershed ecology? Yes or No (indicate one)

Yes, this proposal also has a community-participation-based objective: to develop a suite of improved computational tools that will allow stakeholder groups to work effectively with professionals in specifying management strategies for watershed development and water quality protection.

**V.** Project Description. (In 150 words or less, describe what the project is; why, where, how and when it will be done; and project readiness)

The objective of this proposal is to conduct a detailed diagnostic study of Land Use, Hydrology, Limnology and Bioassessment of Cayuga Lake and the streams tributaries of Cayuga Lake in order to establish a Source Water Assessment Program. Emphasis is placed on Phosphorus and Sediments loading in Cayuga Lake for TMDL development, since the New York State Department of Environmental Conservation (NYS DEC) has placed Cayuga Lake on the Water Bodies Priority List indicating the need to study Phosphorus and Sediments Loadings. Data will be compiled from existing sources (EPA,USGS, Tompkins County, City of Ithaca, Bolton Point, Lake Source Cooling Project) and/or collected for one year. Other water quality parameters (pH, T, TDS, DO) are also included. Cayuga Lake is one of the Finger Lakes, located in the Great Lakes Basin. Cayuga Lake and the Finger Lakes are clasified by the NYS DEC as prioritary watersheds. The impared uses identified for Cayuga Lake are swimming, and because of the heavy siltation, fisheries are also impacted.

**W.** Briefly describe the overall impact of the project in terms of watershed management.

This proposal is primarily driven by the research objective: to better understand and predict the socioeconomic processes taking place in urbanizing watersheds and the water quality and ecological impacts resulting from these processes. The proposal also has a community-participation-based objective: to develop a suite of improved computational tools that will allow stakeholder groups to work effectively with professionals in specifying management strategies for watershed development and water quality protection. If such strategies are to help protect water quality, open space, and other valued environmental attributes, these tools must be able to simulate the multiple interdependent impacts of alternative watershed land use and water management policies and practices.

Through such understanding and tools our objective is to fill the major data and technology gaps that currently limit the usefulness of a watershed management approach for establishing and implementing Source Water Assessment Programs (SWAPs) and Total Maximum Daily pollutant Load (TMDL) requirements.

**X.** Describe the project in relation to the Evaluation Criteria (summarized numerically below – refer to Evaluation Criteria section for more detail).

**34.** What is the overall positive long-term impact on the watershed and/or lake?

Changes in a watershed's land use and cover will impact that watershed's hydrology. Both land use and hydrology will impact the watershed's water quality and ecology. Section 303(d) of the Clean Water Act requires states to identify pollution-impaired water bodies and develop plans to reduce pollutant loads

Development of TMDLs requires a broad understanding of point and nonpoint pollutant sources, the processes that influence their magnitude, timing, attenuation, transformation and transport to water bodies, and how they affect aquatic and riparian (flood plain) biota.

**35.** Does the problem to be addressed have an existing solution?

Yes. The processes to develop SWAP or TMDLs programs tend to be highly site-specific. In their efforts to comply with the Clean Water Act, local environmental planning agencies and/or watershed authorities are challenged by frequent lack of data, information and modeling tools. This proposal addresses these data gaps.

**36.** Does the project have a means of being evaluated? What means will you use?

All the questions formulated in this proposal will require the development, calibration, verification and then application of predictive models. Having these models will allow us together with the stakeholders in the three watersheds to analyze and simulate relationships among

- alternative land use or urbanization patterns including sprawl, farming and forestry practices,
- total amounts of point and nonpoint source pollutants generated and their fate and transport through the watershed.

- the socio-economic, environmental and ecological impacts of the time series of pollutant loadings resulting from alternative land and water management policies and practices.

**37.** Operation and maintenance consideration.
Not applicable

**38.** Does the project address an identified impairment?
Drinking water, and information data gaps

**39.** Does the project address potential human use of the lake and the watershed?
Yes, Land use, stormwater runoff, and planning

**40.** Does the project address potential lake and watershed ecology?

Yes, given that the main objective of this proposal is the detailed diagnostic study of Land Use, Hydrology, Limnology and Bioassessment of Cayuga Lake and the streams tributaries in order to establish a Source Water Assessment Program.

**41.** Does the project potentially benefit/degrade the general quality of the lake, or the watershed feeding the lake?
Yes. Emphasis is placed on Phosphorus and Sediments loading in Cayuga Lake for TMDL development.

**42.** Capital expenditure limit.
Approximately $700,000 for the proposed three year duration of the project.

**43.** Actual use consideration.
We intend to address the research questions outlined above in the combined Cascadilla-Fall-Six Mile Watersheds flowing into Cayuga Lake in south central New York. These contain areas that have been urbanized since at least the 1800s; suburban areas developed in the 1950s to 1990s; and still-rural areas that represent important visual, ecological, and hydrologic resources for their watersheds. These rural areas are experiencing residential development, and employment decentralization also seems likely in the coming several decades. Recent developments have led to an increase in rural households with relatively high incomes and high values on open space. The new residents are both concerned and ready to do something about open space preservation. They have formed land trusts, voted for municipal open-space purchases, and advocated local zoning changes and growth management programs.

**44.** Funding considerations.
This proposal will seek funding from the federal SWAP program, the US EPA, and the NYS – DOS.

**H.** Budget

- Provide <u>real</u> cost of the project and identify funding source(s).
Approximately $700,000 for the proposed three year duration of the project. This proposal will seek funding from the federal SWAP program, the US EPA, and the NYS – DOS.

- Provide cost specifics of maintenance and operation.
Not applicable.

- Will the project require continued funding? Yes or No (indicate one)

The total cost of the project, during the proposed three years, is approximately $700,000.00

**Project 11**

<u>A. Project Title: Stream Restoration at the Barrile Site in the Town of Caroline</u>

**B.** Mr. Donald Barber
Town of Caroline Supervisor
108 Landon Road
Ithaca, NY 14850
(607) 539-3395

**C.** Implementation of Best Management Practices on the Six Mile Creek to address sedimentation, drinking water, and nutrient and pathogen concerns.

**D.** 1.) Yes (1996 Priority Waterbodies List: water supply, fish propagation; Tompkins County Water Quality Strategy Plan: sedimentation and nutrients)
2.) No
3.) Yes
4.) Yes
5.) Yes
6.) Yes

**E. Project Description**

The project is located along the main corridor of Six Mile Creek, a major tributary of Cayuga lake. The project site is located in the Town of Caroline in Hamlet of Slaterville Springs, starting at the Crispell farm extending to the State Road 79 bridge. The area of concern totals approximately 3,000 feet in length. Previous work at the site includes gravel removal and straightening of the stream corridor, which increased the speed and velocity of the stream, causing 80-100 feet of streambank erosion on each of six properties (one farm and five homes).

Due to this erosion, septic systems at this site are currently located within 50 feet of the streambank. Further encroachment of the stream could have extreme negative impacts on other local sources of drinking water (private wells) and pathogen loading in the Six Mile and Cayuga Lake watersheds.

Restoration of this area would reinstate the natural curvature of the streams by installing rock weirs, rock veins, and rootwads in and along the streambank and streambed (using large stones); and securing streambanks using bioremediation and buffer strips installation. To ensure the longevity of this work, project construction will also lower the slope of and stabilize the streambanks and streambeds.

The project will begin pending award of financial resources.

**F. Overall Impact on Watershed Management**

This project has the potential to dramatically impact watershed management in the Six Mile Creek and Cayuga Lake watersheds in terms of improving overall water quality including sources of drinking water. This would be accomplished by:

- reducing sedimentation by stabilizing streambanks and streambeds and installing buffers trips,
- implementing best management practices (bioremediation and buffer strips),
- reducing potential nutrient and pathogen pollution of public and private drinking water sources, and
- creating terrestrial and aquatic habitat by remediation and via the stream restoration techniques employed.

Additionally, this restoration will reduce nutrient, pathogens, and sedmemtnation in the Six Mile Creek watershed and the Cayuga Lake watershed, identified in the Cayuga Lake Watershed Primary Characterization as pollutants of concern.

**G. Project Description for Evaluation Criteria**

1.) This project: will lead to increased water quality in Six Mile Creek and Cayuga Lake watersheds; provides a model project for homeowner and farmers that could be transferred to similar conditions around Tompkins County and the Cayuga Lake watershed; offers a more environmentally friendly approach to stream restoration problems that integrates the principles of stream mechanics; and considers contiguous properties affected by these conditions rather than just individual properties.

2.) Although work has been conducted previously at this site on several occasions, that work was not successful because it looked at short-term, site specific approach to creek management. The proposed solution of stream restoration (modeled after the Dave Rosgen techniques) takes a more natural and long-term approach to stream management and has been successfully employed in other areas of the country and New York State, including Greene County. Steuben and Chemung Counties are also beginning to use this approach. All work will be conducted to the specifications of the USDA National Resource Conservation Service.

3.) Measuring progress at this site could include evaluating the amount of sedimentation in the settling ponds upstream of the Six Mile Creek drinking water reservoir and at the gauging station at German Cross Road (the gauging station provides historical data for sedimentation and nutrients); the amount of erosion at the area of concern (feet of property lost); and the creation of wildlife habitat and aquatic and terrestrial species (macroinvertebrates, fish, birds, ungulates, etc.)

4.) The site will require periodic monitoring and maintenance for the first 2-3 years after project construction. Once the necessary maintenance and structural corrections have been made at the site and vegetation has been established, the project is considered final and permanent and will require little to no maintenance thereafter. Any unanticipated costs incurred after the repositioning and establishment of vegetation will be the responsibility of the Town of Caroline.

5.) This project addresses many identified impairments including:

- **1996 Priority Waterbodies List** (water supply, fish propagation)
- **Cayuga Lake Watershed Preliminary Characterization** (sedimentation, nutrients and pathogen loading)
- **Tompkins County Water Quality Strategy Plan** (sedimentation, nutrients)
- **Town of Caroline Watershed Committee** (flood mitigation, private property loss, sedimentation, water quality)

6.) This project could dramatically impact drinking water sources for the Town of Caroline; the City of Ithaca, both of which depend on Six Mile Creek for drinking water. To some extent, this project would improve drinking water sources (Cayuga Lake) for other watershed residents as well. Additionally, this project could address recreation impairments at the southern end of Cayuga Lake due to sedimentation (primarily drinking, swimming, fishing, aesthetics, tourism).

7.) This project directly affects the ecology of the Six Mile Creek watershed ecology by enhancing existing aquatic and terrestrial habitat using rock weirs, cross veins, and rootwads which cause water to pool as well as bioremediation and buffer strips. This is critical for Six Mile Creek as it is a DEC-identified trout stream.

This project also indirectly addresses the ecology of the Cayuga Lake watershed, particularly the ecology of the southern end of the Cayuga Lake, by reducing sedimentation and enhancing aquatic habitat.

8.) This project benefits both the Six Mile Creek watershed and the Cayuga Lake watershed by reducing sedimentation and preventing conveying problems downstream, implementing Best Management Practices, providing a model for construction and habitat creation that can be used elsewhere in these watersheds, taking a more natural and environmentally-friendly approach to stream restoration, considering several contiguous properties rather than taking a property-by-property approach, and protecting drinking water resources from nutrient and pathogen loading.

9.) This project addresses the actual use impairments identified by the 1996 Priority Waterbodies List, the Cayuga Lake Watershed Preliminary Characterization, the Tompkins County Water Quality Strategy Plan, and the Caroline Watershed Committee including drinking water supply, swimming, fishing, and aesthetics.

10.) The approximate cost of the total project would be $250,000.00, including all in kind services donated for the project and long-term maintenance and monitoring of the construction at the project site.

11.) Additional sources of funding for the project might include: State Bond Act, Tompkins County Flood Hazard Mitigation, the State Environmental Protection Fund, Great Lakes Commission, and Clean Water Act Section 319 Funds.

12.) The proposed action addresses all of the stated criteria to some degree, including all environmental considerations.

H. Budget

- The total costs for the project are approximately $250,000 to $300,000. Additional sources of funding for the project might include: State Bond Act, Tompkins County Flood Hazard Mitigation, the State Environmental Protection Fund, Great Lakes Commission, and Clean Water Act Section 319 Funds.
- Long-term operation and maintenance of the project include some repositioning of rock weirs and plant material in the first two years following completion of project construction. Once vegetation is established at the site, monitoring and maintenance of the site will be minimal.
- Once project construction is completed and vegetation is established, no additional funding should be required for the project.

Appendix J
Agricultural Environmental Management Surveys

Not available in digital format.

We are relying on your municipality for valuable information. In our work on the Cayuga Lake Watershed Management Plan we are once again requesting the location of sewer districts and sewage treatment plants (STPs). Please fill out the fax back form below along with a map of your sewer district and STP if applicable.

1. Part or all of this municipality is in a sewer district: Yes No

2. The sewer district and the municipal boundary is the same: Yes No

3. Part of municipality is in sewer district of a larger, intermunicipal sewer district: Yes No

4. If Yes to Question 3 what is the sewer district and what is the name of the lead municipality:

5. If part or all of municipality is in sewer district what is the location of STP:

6. Using the enclosed map please indicate the border of the sewer district and the location of the STP. If you can not use the enclosed map but prefer to supply map of sewer district and STP please do so.

7. What is the type of STP:

8. Municipality Name:

9. Sewer District Name:

10. Contact Person:

11. Contact Information (Address, Phone, Fax, Email):