Section 3. Watershed Characteristics

3.1 The Oswego River Basin

The Oneida Lake watershed is part of the Oswego River Basin (**Figure 2.3.1**). The Oswego River Basin in Central New York is a diverse system made up of many hydrologic components that flow together. Water flows from upland streams down to the Finger Lakes, then to low-gradient rivers and the New York State Barge Canal and eventually to Lake Ontario. (Cayuga Lake Preliminary Watershed Characterization 2000).

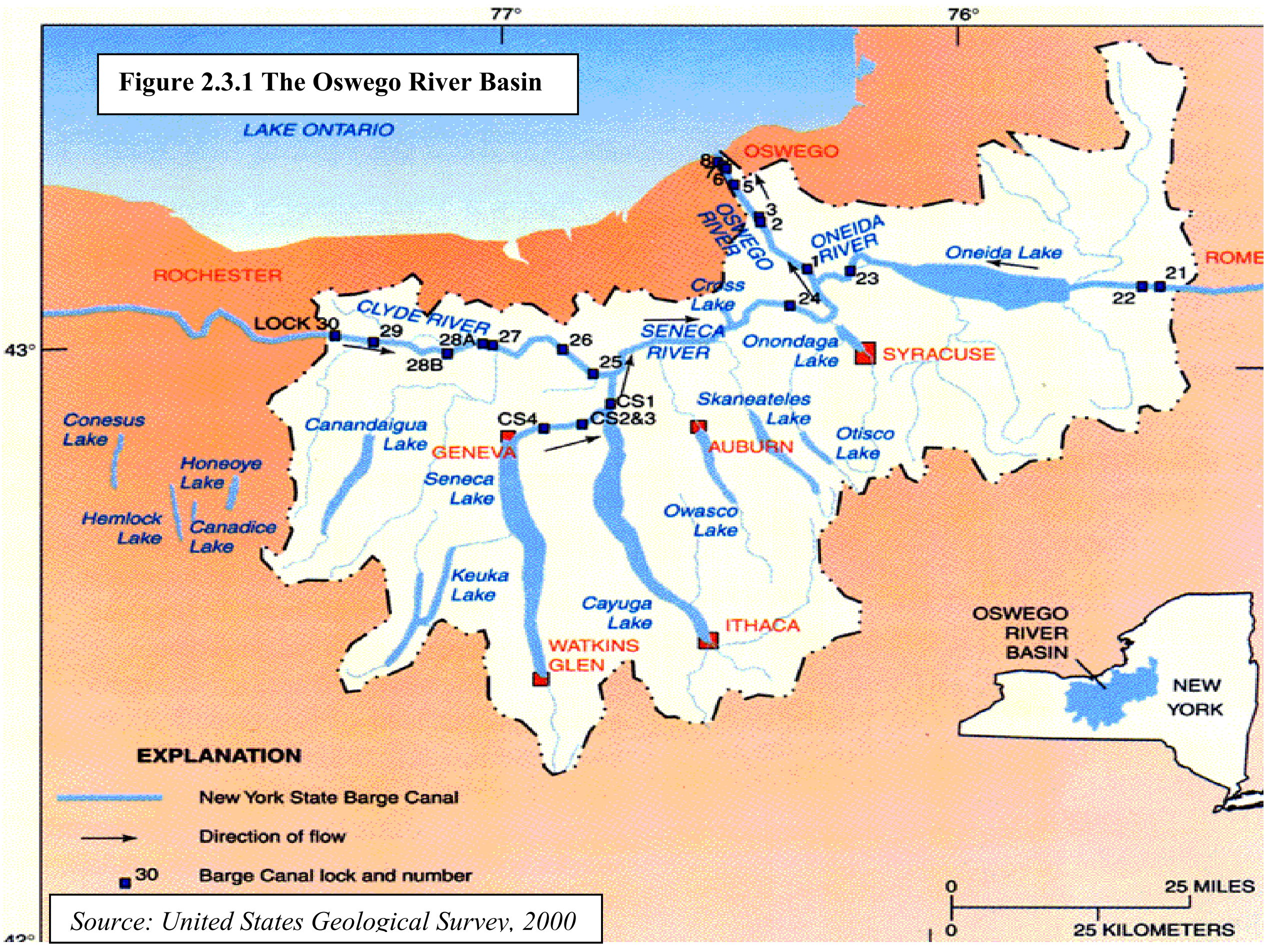

Figure 2.3.1 The Oswego River Basin

Source: United States Geological Survey, 2000

The Oswego River Basin drains an area of approximately 5,100 square miles and encompasses three physiographic regions: the Appalachian Uplands, the Tug Hill Uplands, and the Lake Ontario Plain (**Figure 2.3.2**). The Clyde/Seneca River-Oneida Lake trough is an "unofficial" geographic designation for the belt of lowlands that runs through the basin from west to east. The trough is key to understanding the Oswego River Basin flow system in its natural and human altered state.

The trough is a product of regional geology and glaciation. During the last Ice Age, glaciers carved out the erodible shales that lie between the Lockport Dolomite bedrock ridge to the north and the Onondaga Limestone bedrock ridge to the south. Subsequently, the trough was filled with a mixture of clay, silt, and gravel. The result was a very flat, low-lying area that encompasses many square miles of wetland. The New York State Barge Canal was constructed within the trough due to its exceptionally low gradient. As it is very difficult to move large volumes of water through this low gradient, the area posses a challenge to water resources management.

Surface water and groundwater flow from the upland watersheds of the basin to receiving rivers and lakes and then to the New York State Barge Canal along the western portion of the trough. In similar fashion, the uplands around Oneida Lake drain to the eastern end of the trough. The additive contribution of each stream and lake to the Barge Canal results in a bottleneck at the Three Rivers Junction (the confluences of the Seneca, Oneida, and Oswego Rivers). At this junction, 96 percent of the land area in the Oswego River Basin is represented. This is also the flattest, slowest moving stretch within the Oswego Basin. At times, the water discharged to the trough exceeds the channel capacity, resulting in flooding within Seneca, Cayuga, and Oneida Lakes, and along the Seneca and Oneida Rivers. Once the water reaches the Oswego River, downstream of Fulton, the gradient increases and the water has the potential to move more readily toward Lake Ontario (USGS 2000 and Cayuga Lake Intermunicipal Organization 2000).

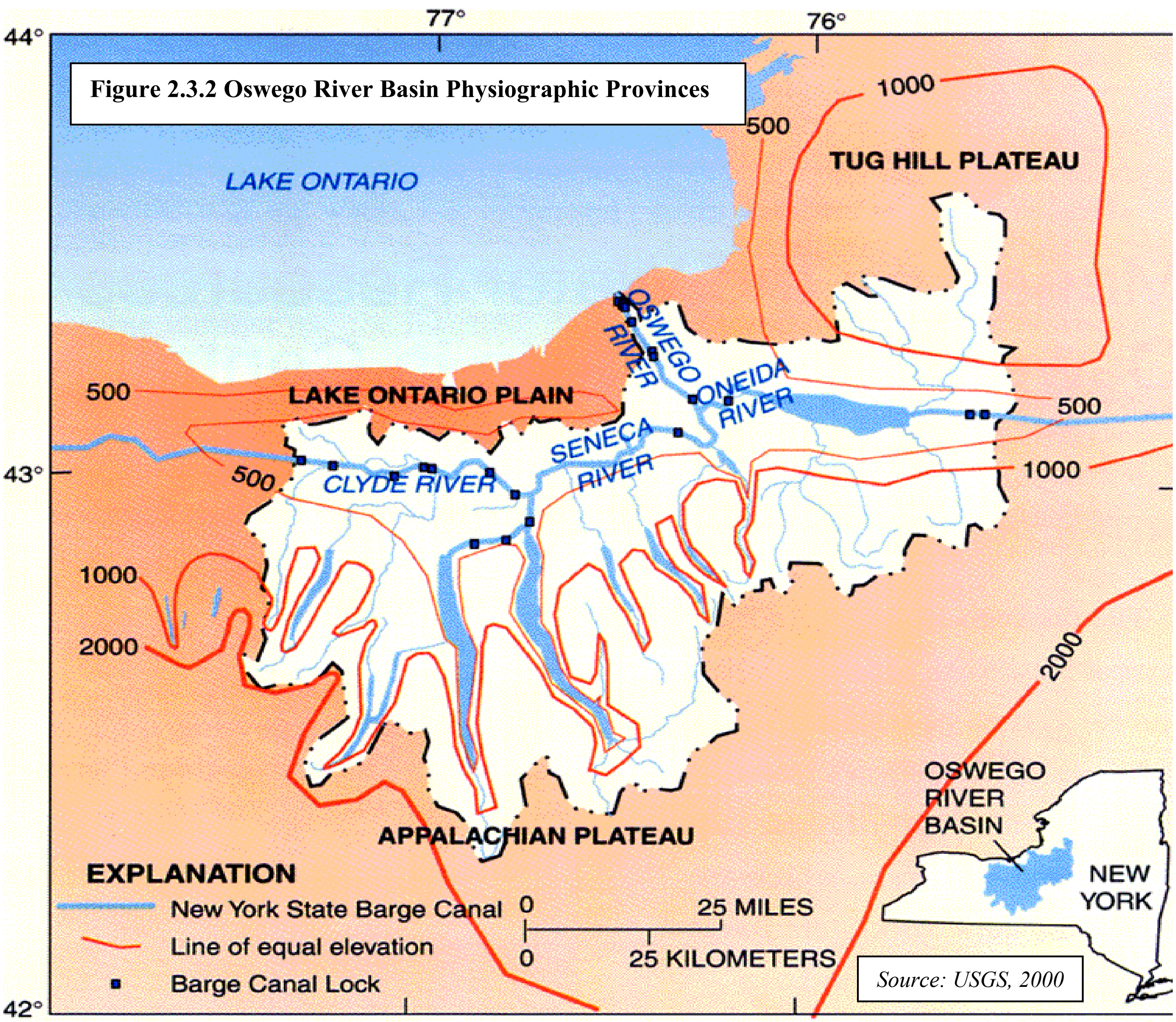

Figure 2.3.2 Oswego River Basin Physiographic Provinces

Source: USGS, 2000

3.2 The Oneida Lake Watershed

The Oneida Lake watershed comprises the eastern most part of the Oswego River Basin and contains 872,722 acres (approximately 1,364 square miles) of land draining parts of Lewis, Madison, Oneida, Onondaga, Oswego, and Cortland Counties (see Chapter I **Map 1.3.1** – Oneida Lake Watershed). The watershed contains portions of 69 municipalities and has a population of 262,164 based on the 2000 U.S. Census.

Oneida Lake is the largest waterbody within New York State. Located at 43˚ 12.5' N latitude and 75˚ 55' W longitude, Oneida Lake is approximately 11 miles northeast of Syracuse. It is 20.9 miles long and 5.5 miles at its widest point. The average depth is 22.3 feet. Many seasonal and permanent homes are located along the 54.7 miles of shoreline. Additional lake characteristics are described in Chapter II Section 2 *Oneida Lake Limnology and Its Ecology*.

The Oneida Lake watershed encompasses parts of the Appalachian Uplands, Tug Hill Uplands, and Lake Ontario Plain physiographic regions. The New York State Canal System traverses the Lake Plain Region as it flows east to west through the Oneida Lake watershed. For the purpose of this study, the watershed has been divided into seven subwatersheds based on the major tributaries of Oneida Lake (see Chapter II **Map 2.4.1** – Subwatersheds and Section 4.1 *Subwatershed Descriptions* for details). Water exits the watershed through the western end of Oneida Lake via the Oneida River where it eventually makes its way to Lake Ontario.

3.3 Land Forms

The Oneida Lake watershed encompasses parts of the Appalachian Uplands, Tug Hill Uplands, and Lake Ontario Plain physiographic regions (**Map 2.3.1** – Approximate Physiographic Regions). The Oneida Lake basin and its adjacent wetlands are located in the Lake Ontario Plain (Lake Plain) region. This area is also commonly referred to as the Erie-Ontario Lowlands or the Oneida Lake Plain. A description of each physiographic region follows.

3.3.1 Lake Ontario Plain

The Lake Ontario Plain is situated between the Appalachian Uplands to the south and the Tug Hill Uplands to the north. The Lake Plain is characterized by an expanse of low lying, flat land and meandering, slow-flowing streams. These lowlands are the remnants of Lake Iroquois, a glacial lake that existed approximately 12,000 years ago. Lake Iroquois was formed as the result of a glacial ice dam across the St. Lawrence River. Rising global temperatures at the end of the last ice age melted the ice dam. Surface water drained from all but the deepest depression on the lake bottom exposing the flat lakebed. The water filled depression is now known as Oneida Lake.

The outer areas of the Lake Plain to the south are characterized by steeper slopes, outwash terraces, and lacustrine benches among low, till-covered hills. The maximum elevation in this outer region is 820 feet (250 meters) above sea level (**Map 2.3.2** – Digital Elevation Model).

Because Oneida Lake serves as the primary point of drainage from upland watershed areas, the extreme lowlands in the Lake Plain region are susceptible to flooding.

3.3.2 Appalachian Uplands

The southern reaches of the Oneida Lake watershed are located in the Appalachian Uplands. A north-facing escarpment forms the border between the Lake Plain and Appalachian Upland regions. These southern uplands are characterized by a series of hills and valleys that follow a north-south direction. Many of the streams that drain into Oneida Lake from the south originate in this region. Chittenango Falls is an excellent example of the rapid flowing water and steep slopes found in the Appalachian Upland region. Within the Oneida Lake watershed, elevation in this region reaches over 2,000 feet (611 meters) above sea level in the Town of Fabius (**Map 2.3.2** – Digital Elevation Model).

3.3.3 Tug Hill Uplands

The Tug Hill Upland region is characterized by broad uplands and deep valley gorges. Marked by bold escarpments, elevations in this reach a maximum of 2,103 feet (641 meters) above sea level in the Town of Turin within the Oneida Lake watershed (**Map 2.3.2** – Digital Elevation Model). Just north of the watershed, the escarpment along the eastern edge of the Tug Hill Uplands drops approximately 1,500 feet to the Black River. The abundant gorges in the Tug Hill region were carved by rapidly flowing glacial runoff. Many of these gorges, locally referred to as "gulfs" reach depths up to 300 feet.

Additional information about the Tug Hill region is located in Chapter II Section 1.7.1, Chapter V Section 1.3.2 and dispersed throughout this report.

3.4 Bedrock Geology

The Oneida Lake watershed is underlain by bedrock with significant variation in its resistance to erosion (**Map 2.3.3** – Bedrock. *A larger version of this map (1'9"x1'5") is available for viewing at select agencies in your county. Contact CNY RPDB at 315-422-8276 for map locations. Maps can also be accessed on the Internet at http://www.cnyrpdb.org/oneidalake*). It ranges in age from Middle Ordovician (beginning approximately 460 million years ago) to Upper Devonian (beginning approximately 365 million years ago) geologic periods. The bedrock is youngest in the southern part of the watershed and grows older with distance northward. The bedrock pattern is very important because it affects the nature of landforms, groundwater, soils, and land use.

The Tug Hill Upland region has the oldest bedrock formations in the Oneida Lake watershed. The region largely contains erosion resistant sandstone of the Ordovician age. This deposit tilts westward and rests on limestone, siltstone, and a series of sandy shales. Primarily underlain by sandstone and other chemically unreactive materials, streams draining the Tug Hill Upland region tend to have minimal chemical impacts to the lake.

The Lake Plain region consists of slightly southward dipping Silurian aged deposits (dating from about 438 to 408 million years ago) composed of shale, dolomite, and sandstone units that are susceptible to erosion. East to west ridges of limestone are also present. Herkimer Sandstone, Lockport Dolomite, Cobleskill Limestone, Camillus Shale, and Vernon Shale are principally found in this region. Streams and roadcuts commonly expose the shale formations.

The Appalachian Uplands in the southern part of the watershed consist of slightly southward dipping Devonian aged formations. The bedrock in this region is the youngest in the Oneida Lake watershed and is mainly composed of shale formations from the Hamilton Group and Onondaga and Coeymans Limestones. In some places, nearly vertical limestone outcrops can be found. A thick section of erosion-resistant limestone (the Helderberg Group and Onondaga Formation) forms the escarpment where the Appalachian Uplands abruptly rise from the lowlands to the north.

Areas in the southern portion of the Oneida Lake watershed, including a large portion of the Cowaselon Creek subwatershed and along the deep valleys of the Appalachian Uplands, are composed of geologic units that have a significant impact on water chemistry. These highly erodible units (Vernon Shale, Syracuse Salt, Camillus Shale, and Bertie Limestone) contribute large amounts of dissolved minerals to surface waters draining the southern watershed region. In contrast, the northern half of the watershed largely contains erosion resistant bedrock that generally does not influence water quality.

A good source of additional geology information is the *Madison County Groundwater/Wellhead Protection Program Report* (1995) prepared by the Madison County Planning Department in cooperation with the Central New York Regional Planning and Development Board.

3.4.1 Areas of Geologic Significance

The Oneida Lake watershed contains several geologically significant landforms, including beach ridges, alluvial plains, gorges, waterfalls, and unique mineral deposits. The Chittenango Gorge is a unique geologic feature that stretches north from the Village of Cazenovia along the Chittenango Creek to the edge of the Village of Chittenango. The flow of water in the winding creek has been carving the steep sided, narrow gorge since glacial times. Chittenango Falls and other geologic formations characteristic of the Helderberg Escarpment can be seen along Route 13 between Cazenovia and Chittenango. The escarpment is the border between the Lake Plain and Appalachian Upland regions; its steep north-facing slope has nearly vertical outcrops of exposed limestone bedrock in some places. Local communities have recognized the unique physical character of this region and have taken steps to restrict development.

Other significant geologic areas, identified by the Oneida County Water Quality Coordinating Committee, include an area of mineral land near the Annsville-Camden border. This area contains significant deposits of sand that is suitable for use in abrasives and moulding. In addition, Point Rock Bridge on the East Branch of Fish Creek is noted for its vertical rock formations and deep, stream carved gorge. A similar area further down the East Branch of Fish Creek in the Towns of Lee and Annsville has also been identified as being geologically significant due to the deep, stream carved gorge. The Fall Brook Waterfall area in the Town of Annsville is noted for the presence of the large waterfall, the East Branch of Fish Creek, and the Fish Creek Gorge.

3.5 Soils

Soil characteristics of the Oneida Lake watershed are defined by glacial influences during the Pleistocene Epoch when a continental ice sheet several hundred feet thick covered the lake region. The parent materials from which today's soils are formed were deposited during periods of glacial advances and retreats. The most recent glacial retreat was about 10,000 years ago. Soils in this area are relatively young, closely related to the parent material in which they formed, and usually not seriously depleted of soluble nutrients. Agriculturally productive soils are found at well-drained, relatively level sites where the parent material is derived from limestone and glacial drift (Mills et al, 1978). Such soils are generally found in the Lake Plain region, valley floors, and the level areas of the Appalachian Uplands. In contrast, the Tug Hill Uplands in the northern Oneida Lake watershed are characterized by shallow, acidic soils most suitable for forests. General soils associations for the Oneida Lake watershed are shown in **Map 2.3.4** – General Soils Associations. (*A larger version of this map (1'9"x1'5") is available for viewing at select agencies in your county. Contact CNY RPDB at 315-422-8276 for map locations. Maps can also be accessed on the Internet at http://www.cnyrpdb.org/oneidalake*).

As described in *Oneida Lake* by Mills et al (1978) and *Soil* by DeLaubenfels (1966) there are six general categories of soils in the Oneida Lake watershed including:

- Limey soils on glacial till over rolling terrain (Appalachian Uplands). These rich lime soils are among the most productive soils in New York State.
- Limey soils on glacial lake sediments over level terrain (Lake Plain). These soils vary greatly in their drainage characteristics and are highly suitable for fruit and vegetable crops.
- Alluvial soils in valley bottoms (valleys of the Appalachian Uplands). These immature soils lack a well-developed profile, but do have a high potential for agricultural production.
- Deep acidic soils on glacial till over hilly terrain (the extreme southern tips of the watershed and eastern portion of the watershed extending up through Tug Hill). These deep, moderately well drained soils are derived from shale, sandstone, and slate. Consequently, these soils are prone to erosion and need to be heavily fertilized.
- Shallow acidic soils on glacial till over steep terrain (northern portion of the Lake Plain extending up through the Tug Hill Uplands). These stony, acidic, shallow soils are unsuited for agriculture and are almost entirely covered by forests.
- Coarse textured soil on sand and gravel (a portion of the Chittenango Creek subwatershed in the Lake Plain region). These shallow, acidic, excessively drained soils lack organic material, are unsuited for agriculture, and are subject to erosion.

In general, the largest concentrations of deep, productive soils are found in the southern half of the watershed. The Appalachian Uplands are characterized by highly productive, limestone soils formed in glacial till. Honeoye and Lima soils have good drainage and high lime content and can be found in the northern edge of the Appalachian Uplands. Lansing, Conesus, Mardin, and Volusia soils are located at the higher elevations of the region. Soil management efforts in the southern portion of the watershed are mainly restricted to improving natural drainage and controlling farmland erosion. Streams that flow into Oneida Lake from the south flow over Onondaga limestone through productive agricultural lands and concentrated population centers, and therefore tend to be nutrient-rich (Makarewicz and Lewis 2000).

Soils in the Lake Plain region are composed primarily of shale and sandstone overlain by glacial deposits. Soils in this area are typically flat, deep, have high lime content, and were formed in glacial till. Ontario, Hilton, Madrid, and Bombay soils are widespread on till plains and drumlins in the region. Niagara, Odessa, and Galen soils are examples of soils that formed in lacustrine and deltaic deposits of the lowlands. Organic soils formed in glacial outwash, commonly referred to as "muck" soils, are found in this region especially near the Village of Canastota. Palms and Edwards soils are examples. Soil management in the lowlands of the Lake Plain is generally restricted to improving natural drainage.

The soils in the northern part of the watershed are relatively shallow, particularly in the Tug Hill Upland region where the shallowest and most highly acidic soils in the entire watershed are located. In general, Tug Hill soils are derived from glacial till. Unlike the soils in the Appalachian Uplands, soils in the Tug Hill region tend to be wet, stony, shallow, sandy or steeply sloping. The soils in the region are poorly drained and the soil fertility decreases in the upland areas. These soils are generally unfit for agriculture and are dominated by forests. Streams that flow into Oneida Lake from the northern uplands flow over erosion resistant sandstone and are characteristically nutrient poor.

Map 2.3.5 Soil Erodibility K Factor shows soil erodibility within the Oneida Lake watershed (please note that soil erodibility data is not available for Lewis, Onondaga or Oswego Counties). The soil erodibility K factor indicates a soil's susceptibility to erosion. It is based on soil texture, organic matter content, permeability, and other factors inherent to soil type. The soil erodibility K factor can be used as a decision-making aid in choosing the most effective land management strategies. A low K value means that the soil is more resistant to erosion. Conversely, a soil with a high K value means that the soil is less resistant to erosion. However, the actual amount of soil lost due to erosion depends on the land use, management practices, slope, length of slope and other factors.

Additional soils information is found throughout this report. Please refer to Chapter II Section 4.1 for soils information specific to subwatershed regions and Chapter IV Section 2.3 for information on agricultural soils in the watershed.

3.6 Forests

The forest community in the Oneida Lake watershed reflects human activity as well as natural history. Land management practices, the introduction of non-native species, disease, and insect infestations have defined the current forest community that exists as private and public holdings. Regardless of ownership, forested lands improve the quality of life in the watershed by generating valuable renewable resources, improving water quality, providing opportunities for outdoor recreation, and providing a variety of wildlife habitats.

The once heavily forested southern areas of the watershed once served as a source of fuel and construction materials for early settlers. Large tracks of forested land were eventually cleared for agricultural use in Onondaga, Madison, and Cortland Counties. Much of the agricultural lands located in the southern portion of the watershed were later abandoned due to marginal productivity and have naturally reverted back to bushy stands of dogwood, thorn-apple, ash, and mixed hardwoods. In 1929, New York State initiated soil conservation and reforestation efforts on abandoned farmland and much of the land was replanted with coniferous species.

The majority of forested land in Oswego County is privately owned and commercially operated. Hardwood species are dominant, but significant softwood stands are common features of second and third growth areas in the County.

American elm and red maple are the dominant species found in the moist forest lands of the Lake Plain, while sugar maple and beach are the dominate species characterizing the forest canopy in areas of well-drained soils. Scattered patches of aspen, pitch pine, black, red and white oak, black gum, and yellow-poplar are also present throughout the Lake Plain region.

The area of heaviest tree cover is located in the northern half of the watershed where nearly two-thirds of the land is forested. Approximately 88 percent of the Tug Hill region forests are privately owned. Tug Hill's forests are an important resource of the timber industry and are a valuable component of the New York State economy.

A predominate characteristic of the Tug Hill region is a large area of relatively unbroken forested land consisting of two main blocks: the upland core forest and the Oneida Lake forest. The upland core forest is dominated by sugar and red maple, American beech, and yellow birch, mixed with spruce-fir and hemlock. Outside of the core forest, conifer plantations exist, as well as abandoned agricultural fields and cutover areas in various stages of succession that will ultimately result in a mixed hardwood forest.

The Oneida Lake forest is dominated by red and sugar maple, but contains high concentrations of black cherry, eastern hemlock, and white pine. The wetland areas between the glacially deposited drumlins in this area are dominated by red maple. Red spruce and balsam fir are successful species in poorly drained areas where hardwood competition is not intense.

Approximately 25 percent of the total forested land area in the Tug Hill region is comprised of coniferous species including red spruce, balsam fir, hemlock, and white-pine. Naturally occurring coniferous forests exist around the rims of deep gorges and ravines, in the higher elevations of the upland core area, and in swampy woods. Much of the state-owned land in the Tug Hill region has been reforested as coniferous plantations consisting mostly of white pine, red pine, Austrian pine, jack pine, Scotch pine, Norway spruce, white spruce, and European larch.

Forest resource management shapes the way of life in the Tug Hill region and has a direct influence on water quality. Despite the fact that soils on Tug Hill are rated as "fair" regarding their potential for tree growth (due to wet, shallow, steep slope, or stony or sandy conditions), many activities in the area focus on the abundant woodlands. The total number of acres of harvested forest in the Oneida Lake watershed is currently unknown. The eastern and southern edges of the eastern core forest are divided into smaller, more developed parcels and private-property forestry information is difficult to compile. As more parcels of forestland are being managed privately, the ability to monitor the land becomes more difficult and thus increases the potential of impacting water quality.

However, an agreement for the sale of 45,000 acres of property in the East Branch of Fish Creek subwatershed was negotiated in 2002 between Hancock Timber Resource Group and The Nature Conservancy (TNC). Some of the land will be under a conservation easement, part will be managed as state forestland, and the remainder will be kept in timber management and will be available for a mix of private leased hunting and public access. Additional information about the Hancock land sale is presented in Chapter II Section 4.1.3.

A summary of timberland area ownership class and forest type for the five primary counties in the Oneida Lake watershed is provided in **Table 2.3.1** and **Table 2.3.2**. More information on Tug Hill, forestry resources, and the timber industry in the Oneida Lake watershed can be found in Chapter II Section 1.7.1, Chapter III, and other areas throughout this report.

Table 2.3.1 Area of Timberland by County and Ownership Class, 1993
(in thousands of acres)

	Misc. Federal	*State*	*County/ Municipal*	*Forest Industry*	*Other Private*	*Total*
Lewis County	7.7	72.1	7.7	118.1	350.6	556.2
Madison County	0	23.3	0.9	0	166.0	190.3
Oneida County	1.6	37.4	11.5	0	385.1	435.6
Onondaga County	0	10.1	0.1	0	214.4	224.5
Oswego County	< 50 acres	35.7	4.1	5.3	378.9	424.1

Source: Forest Statistics for New York: 1980 and 1993. USDA Forest Service. 1995.

Table 2.3.2 Area of Timberland by County and Forest Type, 1993
(in thousands of acres)

	White/ Red Pine	*Spruce/ Fir*	*Oak/ Pine*	*Oak/ Hickory*	*Elm/Ash/ Red/ Maple*	*Northern Hardwoods*	*Aspen/ Birch*	*Total Acres*
Lewis County	43.1	32.0	5.2	0	16.2	448.0	11.7	556.2
Madison County	14.9	22.9	0	4.2	17.4	126.2	4.7	190.3
Oneida County	61.9	10.7	5.3	21.7	53.9	260.2	21.8	435.6
Onondaga County	10.3	10.2	4.9	26.4	47.2	120.4	5.3	224.5
Oswego County	58.9	8.9	0	15.2	34.1	287.2	19.9	424.1

Source: Forest Statistics for New York: 1980 and 1993. USDA Forest Service. 1995.

3.7 Climate

The Oneida Lake watershed has a continental climate characterized by warm, dry summers and cold, snowy winters. Major climatic influences include topography, prevailing westerly wind direction, and proximity to Lake Ontario. Frost can be expected from early October until late May and the growing season is approximately 18 to 20 weeks long. Although serious droughts are rare, most growing seasons do experience periods of deficient soil moisture. Annual precipitation varies across the watershed with the greatest mean annual precipitation occurring in the northern portion of the watershed (approximately 52 inches/year) and the least in the southern region (approximately 38-40 inches per year).

In most years, the rate and distribution of precipitation in the watershed are sufficient for agriculture and domestic water supplies. Because the watershed is located in the Eastern Lake Ontario snowbelt, it is subject to significant lake effect snow events. Average seasonal snowfall in the Oneida Lake watershed varies from more than 200 inches in the Tug Hill region, between 159 and 200 inches in the eastern portion of Oswego County, and 115 inches in the City of Syracuse.

Lake effect snow is caused by the temperature contrast between the cold air moving over Lake Ontario and the warm water temperatures of the lake itself. As cold air flows over the warm water, the bottom layer of air over the surface of the water is heated from below. Since warm air is lighter and less dense than cold air, the heated air rises and cools. As it cools, the moisture that was picked up from the lake condenses and forms clouds. When enough moisture condenses out of the air, snow bands develop over the region downwind of Lake Ontario. The greater the temperature contrast between the cold air and the warm water, the heavier the resulting lake effect snow fall will be.

Historical climatic records of precipitation and air temperatures for the northeastern United States show a generally calm and cyclic seasonal weather pattern. Between 1890 and 1960, relatively few extreme departures from the norm were recorded. More recently, however, regional weather patterns have displayed frequent extremes, including droughts, floods, and periods of very cold or very warm temperatures. Such extreme conditions add to the difficulty of maintaining ideal hydrologic conditions in the watershed.

3.8. Hydrology

3.8.1 General Overview of Surface Water Resources in the Oneida Lake Watershed

The Oneida Lake watershed has an extensive surface water network. The watershed's surface water hydrology is displayed in **Map 2.3.6** – Surface Water Hydrology. (*A larger version of this map (1'9"x1'5") is available for viewing at select agencies in your county. Contact CNY RPDB at 315-422-8276 for map locations. Maps can also be accessed on the Internet at http://www.cnyrpdb.org/oneidalake*). Approximately 56 percent of the precipitation that falls in the watershed reaches the lake through surface inflow (Mills et al 1978). The rest is lost through evaporation, absorption by trees and plants, and groundwater recharge. The Tug Hill region in the northern portion of the watershed contributes approximately 67 percent of total surface inflows, in part, as a result of the large volume of snowfall. The average stored water equivalent of the core area snowpack is 16 inches. Water that is stored in the snowpack slowly recharges wetlands and streams throughout the winter months. The warmer temperatures in spring generate a more significant and rapid release to the lake.

Table 2.3.3 Tributary Discharge as a Percentage of Total Inflow to Oneida Lake

Scriba Creek	4 %
West Branch Fish Creek	21 %
East Branch Fish Creek	23 %
Wood Creek	6 %
Oneida Creek	7 %
Canaseraga Creek	1 %
Cowaselon Creek	4 %
Chittenango Creek	18 %
Ungaged Creeks	16 %
Total	100 %

Source: *Oneida Lake,* In: *Lakes of New York State*

Although surface inflow from the northern watershed region represents most of the total water volume entering the lake, the majority of the nutrients entering the lake are introduced from tributaries that flow through the nutrient rich farmlands and wetlands of the southern watershed (Mills et al 1999). The significant volume of surface inflow from the northern watershed helps to dilute nutrient levels in the lake. The tributary discharge to Oneida Lake is presented in **Table 2.3.3**.

Water flows out of Oneida Lake into the Oneida River, which is located at the western edge of the lake. Annual discharge to Lake Ontario from the Oneida River is estimated at 2.13 billion cubic meters per year (Mills et al 1978).

In addition to the streams, there are also numerous small lakes and ponds scattered throughout the Oneida Lake watershed. Many are concentrated in the northern watershed, especially the Tug Hill Uplands. Some of the watershed's larger lakes, Cazenovia, DeRuyter, and Tuscarora, are located in the southern half of the watershed in the Appalachian Upland region. A brief description of these and other lakes can be found in Chapter V Section 1.4 *Lake Associations*.

3.8.2 General Overview of Groundwater Resources in the Oneida Lake Watershed

Summary

Appropriate geologic settings combined with a suitable climate result in the Oneida Lake watershed having a wealth of groundwater resources throughout much of its several thousand square miles of watershed. An extensive system of aquifers was created when thick layers of unconsolidated deposits were laid down by glaciers during their retreat, approximately 10,000 years ago. These deposits overtop underlying bedrock aquifers of sedimentary rock formed millions of years earlier. Precipitation is the ultimate source of the groundwater recharging these aquifers. The Oneida Lake watershed receives an average of 35 inches of precipitation each year, with considerably higher amounts originating in the northern watershed and Tug Hill Uplands as lake-effect snowfall. These groundwaters are not static reservoirs. Rather, a growing body of evidence indicates that significant quantities of groundwater flow centrally from the northern and southern watersheds and discharge along the shallow shorelines of Oneida Lake. Lake waters then outflow along the western lakeshore into the Oneida River and on towards Lake Ontario. Despite the overall abundance of groundwater, dry wells and limitations on groundwater availability are arising more frequently. This is due to spatial variability in aquifer yield, seasonal and interannual fluctuations in precipitation recharge, and complications associated with land use, overwithdrawal, and groundwater contamination as development pressures increase, particularly in the southern portion of the watershed. The following overview of groundwater resources was compiled by Rebecca Schneider, Department of Natural Resources, Cornell University.

Geologic Setting

Aquifers in the Oneida Lake watershed include both unconfined and confined aquifers (**Map 2.3.7** – Potential Yields From Unconsolidated Aquifers). Unconfined aquifers are water-bearing rock formations in which the upper boundary of the water surface is at atmospheric pressure, like the surface of a pond or lake only underground. This is in contrast to confined aquifers in which the water-bearing rock is overlain by an impermeable formation that generally puts the groundwater under pressure. As a result of this overburden of weight, as well as other factors, water will often rise up in a well that penetrates into a confined aquifer. Within this framework, the Oneida Lake watershed aquifers are comprised of two basic types, sedimentary bedrock aquifers overlain by unconsolidated glacial deposits. The unconsolidated glacial deposits comprise the most heavily used aquifers, depending on the local water yield which in turn is controlled by the thickness and texture of the till material. Throughout the basin, the glacial till averages 30 feet in depth, thinning on steep slopes with accumulations of 50 feet on the hilltops and 200 feet in some of the lowlands. Coarse-grained stratified deposits consist of sand and gravel left behind from the glacial meltwater rivers. Such deposits form the highest water yielding aquifers because of their high porosities, upwards of 20 to 30 percent. Surficial deposits of highly sorted sand, free of gravel or clays, are found scattered throughout the basin, and especially throughout the Tug Hill Uplands and underlying the Rome Sand Plains. Mixed deposits of unsorted sand, gravel, clay and silt have much lower porosities and therefore lower water yields. They are found predominantly along the northern extent of the Appalachian Uplands, called the Valley Heads Moraine, in the southern half of the Oneida Lake watershed. These moraines are more than 500 feet thick. There are less extensive beds, less than 100 feet thick, deposited as concentric bands in and around the Tug Hill Uplands.

Consolidated sedimentary bedrock, formed some 350-500 million years ago, underlies the entire watershed. Most sedimentary rocks have a considerably higher ability to store and transmit water than igneous or most metamorphic rock types and this foundation therefore contributes to the wealth of Oneida's groundwater reserves. There are seven main water-bearing units, although these are considerably more uniform in water bearing properties than the overlying deposits. These seven units occur as a series of stacked layers with a gentle incline toward the south of 50 feet per mile. Bedrock layers in the southern half of the watershed consist, respectively, of a layer of upper shale laid over a layer of limestone, another layer of middle shale, and a layer of dolomite. However, because of the incline and historical patterns of erosion, each lower layer successively approaches the surface as one moves northward through the watershed. Oneida Lake itself sits within the outcropping of the fifth layer of sand-shale and the northern half of the watershed is underlain by the sixth layer of sandstone and the bottom-most layer of lower shale.

These bedrock aquifers provide a better source of water than till or clay and silt but are much poorer than the sand, gravel or mixed deposits. "Safe water yield" is an estimate of the rate at which water can be withdrawn from a well or aquifer without depleting the supply so much that subsequent withdrawal is impacted. An evaluation of the water yield from 270 wells drilled into bedrock in the mid-1970's throughout the watershed indicated that significant yields were only possible from the limestone (25 gallons per minute or gpm), sandstone shale (32 gpm) and the middle shale (20 gpm) units (Kantrowitz 1970). Yields lower than 10 gpm for the remaining four bedrock units made them less practical for most uses. A current map of water yield by aquifer, developed by the Herkimer-Oneida Counties Comprehensive Planning Program, is in general agreement with the Kantrowitz findings and provides useful guidance for development planning (**Map 2.3.7** – Potential Yields From Unconsolidated Aquifers).

Precipitation and Runoff Patterns

Superimposed on the geologic setting and aquifer capacity is the availability of water itself. All water in the basin arises from precipitation. Although the average 35 inches of precipitation is fairly evenly distributed throughout the year, the actual amount moving into the ground as recharge varies considerably among seasons. Much of the winter precipitation originates as snowfall and is stored as snowpack, prevented from infiltration by air temperatures and the frozen soil surfaces. Recharge is concentrated during March and April snowmelt and this influx helps to maintain a high water table through early summer. Plant transpiration and soil evaporation result in considerably reduced recharge during the summer and early fall. It is at this time that the most frequent occurrence of dry wells occurs.

Several factors contribute to an increasing incidence of low water availability being reported. Precipitation varies temporally and drought conditions have been occurring more frequently in recent years. Precipitation also varies spatially across the watershed. Snowfall in the Tug Hill Uplands benefits from moisture-filled air flowing from Lake Ontario to the west and as a result the snowpack is the highest documented east of the Rocky Mountains. The average annual snowpack of 7 feet is several feet higher than occurs in the southern half of the watershed. The amount of snow and rain that actually becomes groundwater recharge is furthermore strongly influenced by land use patterns. In the northern watershed, most of the landscape is covered with a matrix of evergreen-dominated forests pockmarked by an abundance of pocket wetlands. The forested landscape and numerous wetlands foster snowpack retention late into the year, wetland depression-focused recharge, and infiltration of precipitation back into the ground. In contrast, slightly less precipitation falls throughout the southern half of the watershed and much less as snowfall. Evaluation of 1994 land use maps (U.S. Geological Survey) indicates that the southern half contrasts sharply with the northern half and is dominated by agricultural and suburban development expanding from the nearby city of Syracuse. Such land uses are characterized by more impervious surfaces, more compacted soils, and less vegetated surfaces. These are not conducive to groundwater recharge but rather encourage runoff to streams. As a result of this lack of recharge, combined with over-withdrawal and increased drought, groundwater is becoming more limited in availability throughout the southern watershed.

Groundwater Quality

There is no comprehensive monitoring or data collection program available by which to assess groundwater quality (or quantity for that matter) throughout the Oneida Lake watershed. Some information is available through the U.S. Geological Survey, which has monitored two wells within the watershed for at least a decade as a source of data for the New York State Department of Environmental Conservation. Other information is sparse, with isolated gray literature reports and Web reports describing possible point sources of groundwater contamination from various landfills and numerous other activities.

Broadscale testing of private wells conducted several decades ago indicated that groundwater quality throughout the watershed appeared to be overall good, largely as a result of the aquifer geology and limited human impacts throughout the northern watershed (Kantrowitz 1970). Many of the reported problems associated with groundwater quality were those of inconvenience or unpleasant taste and not of contaminants that are harmful to human health. In the northern half of the watershed, water quality particularly maintained a generally excellent level. In a few isolated areas, natural beds of salt had resulted in brine to salty groundwater that is not fit for consumption.

More recently, groundwater contamination appears to be an increasing problem. S. Winkley, of the New York Rural Water Association, recently identified several areas within the four counties bordering Oneida Lake as having a high potential for groundwater nitrate contamination. The watershed Counties of Madison and Oneida were among approximately 22 counties identified as having the highest nitrate groundwater contamination potential in New York State (http://www.nyruralwater.org/aquafacts/spring2001/3.shtml).

One measure of groundwater quality that is particularly relevant in the Oneida Lake watershed is the amount of dissolved solids that are present. The total dissolved solids are reflected in the hardness of the water. Calcium and magnesium combine with carbonate to form an insoluble precipitate that clogs water heaters, pipes, and interferes with detergents. Dissolved iron and manganese cause staining of bathroom fixtures and laundry. EPA recommends a total dissolved solid content of less than 500 ppm and measurements from wells across the Oneida basin range from 80 to over 3,040 ppm. Actual content of these ions appears to be strongly related to underlying geology and to outcrop patterns of the bedrock units.

Additional information about drinking water supplies in the Oneida Lake watershed is located in *Chapter IV Section 4 Water Supply Systems*. Information about regulations that help to protect groundwater supplies (Safe Drinking Water Act, Clean Water Act, Resource Conservation and Recovery Act, Federal Insecticide, Fungicide and Rodenticide Act, and others) is presented in *Chapter V Institutional and Regulatory Influences*. Site-specific groundwater information is available from the 1995 report *Madison County Groundwater/Wellhead Protection Program Report*, prepared by the Madison County Planning Department.

Groundwater Linkages with Oneida Lake

Groundwater throughout the Oneida Lake watershed does not occur as stagnant reservoirs. Instead there is a growing body of evidence that suggests there are local and regional scale flows of groundwater that differ in their rates of movement. Overall, the general flow paths in the southern watershed probably move northward towards Oneida Lake and northwesterly toward the Oneida River outflow. Groundwater underlying the northern watershed moves either westward into Lake Ontario or southward into Oneida Lake.

Ongoing research by faculty of Cornell University working at the Cornell Biological Field Station at Shackelton Point indicate groundwater seepage along the Oneida Lake shoreline links the lake to human activities in the watershed. Groundwater seepage was found to flow at rates of several gallons per day per square yard of shoreline surface with higher rates discharging along the northern and eastern shorelines. Peak inflows following rainfall or snowmelt can be considerably higher. These findings suggest that the northern half of Oneida's watershed represents a critical source of groundwater to the lake, probably resulting from the higher snowpack development and greater recharge across its landscape. Furthermore, higher flow rates were documented as much as 300 ft from the shoreline edge, suggest that groundwater seepage may underlay considerably more of the Oneida Lake bed. Patterns of lake water recharging the groundwater were documented along several miles of shoreline adjacent to the Oneida Creek outflow.

However preliminary data on groundwater quality along the southern shoreline indicates this inflowing seepage is considerably higher in dissolved nitrate than found in nearby Chittenango Creek. It may be that the greater quantity and cleaner quality of groundwater from the northern watershed balances contaminant inputs from the southern portion, helping to maintain Oneida Lake's high water quality. However additional research would be needed to confirm this hypothesis.

A recent study by S. Komor of the U.S. Geological Survey using chlorofluorocarbon dating of well water along the northwestern part of the watershed indicated some wells were tapping into groundwater that was several decades old (S. Komor, pers. comm.). This finding suggests that some of the groundwater seeping into the lake may be relatively older and not necessarily reflective of the human impacts that have occurred in the watershed in more recent years.

Management Responsibility and Planning Recommendations

Currently management for Oneida's groundwater is being conducted relatively independently by different agencies and in different geographic jurisdictions. There is no comprehensive monitoring or planning program. A broader, more integrated approach needs to be taken to adequately protect this resource. Critical stakeholders involved with groundwater usage who should be represented in any planning activity include private residents on wells, small water system operators, well drillers, the County Departments of Health, university researchers, local town governments, staff of the New York State Dept. of Environmental Conservation, and staff of the U.S. Geological Survey, and Environmental Protection Agency. A longer-term planning horizon also is needed to protect Oneida's groundwater resources. Groundwater aquifers can be rapidly depleted or contaminated but take a long time to replenish. Finally, a comprehensive water resource management program needs to recognize the tight linkages between groundwater, stream and lake waters, and human activities on the land.

3.9 Flora and Fauna

Geology, topography, soil, climate, and land use patterns influence the distribution of flora and fauna. From uplands to lowlands, the Oneida Lake watershed provides diverse habitats that sustain a healthy and productive assemblage of plant and animal species.

Diverse topography and soil types throughout the watershed have produced great variations in the composition and location of vegetative communities. The wet soils along the lakeshore support vegetative species that have adapted to flooding such as black gum and yellow poplar. Elm, black ash, beech, and red maple are typically found growing in soils with better drainage. Conifer stands are frequently found along the north shore of the lake while a variety of mosses, ferns, and wildflowers are found in the mixed stands of beech, birch, maple, hemlock, oak, and dogwood near the vicinity of Verona Beach and the south shore.

Wetlands throughout the watershed provide suitable breeding habitat for the mallard, wood duck, hooded merganser, and black duck, and resting and feeding habitat for migratory waterfowl.

Populations of waterfowl are increasing due, in part, to the growing number of wetlands created by beaver activity.

Common wildlife species found throughout the watershed include woodchuck, beaver, red fox, white-tailed deer, cottontail rabbit, and gray squirrel. Common bird species include woodpeckers, hawks, and warblers. Great Blue Herons and Ospreys are often spotted in proximity to the lake. In the *Integrating Timber and Wildlife Handbook* (1983), Robert E. Chambers notes the presence of mammals, birds, reptiles, and amphibians in New York State based upon regional ecological characteristics. **Table 2.3.4** lists the mammals, reptiles, and amphibians that inhabit the Tug Hill Upland, Lake Ontario Plain, and Appalachian Upland regions.

TABLE 2.3.4 MAMMALS, REPTILES AND AMPHIBIANS THAT INHABIT THE TUG HILL UPLAND, LAKE ONTARIO PLAIN, AND APPALACHIAN UPLAND REGIONS

MAMMALS			
Virginia Opossum	Small-footed Myotis	Southern Bog Lemming	White-footed Mouse
Masked Shrew	Silver-haired Bat	Boreal Red-backed Vole	Striped Skunk
Smoky Shrew	Eastern Pipistrelle	Red Fox	Coyote
Longtail Shrew	Big Brown Bat	Gray Fox	Meadow Vole
Northern Water Shrew	Red Bat	Bobcat	Yellownose Vole
Pygmy Shrew	Hoary Bat	Woodchuck	Pine Vole
Least Shrew	Black Bear	Eastern Chipmunk	Muskrat
Shorttail Shrew	Raccoon	Gray Squirrel	Beaver
Starnose Mole	Fisher	Red Squirrel	Deer Mouse
Hairytail Mole	Shorttail Weasel	Southern Flying Squirrel	Porcupine
Little Brown Myotis	Longtail Weasel	Northern Flying Squirrel	Showshoe Hare
Keen Myotis	Mink	Meadow Jumping Mouse	Eastern Cottontail
Indiana Myotis	River Otter	Woodland Jumping Mouse	White-tailed Deer
REPTILES			
Eastern Painted Turtle	Common Snapping Turtle	Northern Redbelly Snake	Black Rat Snake
Stinkpot	Eastern Spiny Softshell	Eastern Garter Snake	Eastern Milk Snake
Spotted Turtle	Coal Skink	Eastern Ribbon Snake	Eastern Massasauga
Bog Turtle	Northern Water Snake	Northern Ringneck Snake	Timber Rattlesnake
Wood Turtle	Queen Snake	Northern Black Racer	
Map Turtle	Northern Brown Snake	Eastern Smooth Green Snake	
AMPHIBIANS			
Eastern Hellbender	Northern Dusky Salamander	Northern Two-Lined Salamander	Western Chorus Frog
Mudpuppy	Mountain Dusky Salamander	Four-Toed Salamander	Bullfrog
Jefferson Salamander	Redback Salamander	Longtail Salamander	Green Frog
Blue-spotted Salamander	Slimy Salamander	American Toad	Mink Frog
Spotted Salamander	Northern Spring Salamander	Northern Spring Peeper	Wood Frog
Red-Spotted Newt	Northern Red Salamander	Northern Leopard Frog	Gray Treefrog
Source: R. E. Chambers (1983) Integrating Timber and Wildlife Handbook			Pickerel Frog

3.9.1 Tug Hill Uplands

Areas of wooded wetlands, shrublands, and agricultural fields sustain a healthy and productive assemblage of wildlife species. Big game animals, such as white-tailed deer, use the deciduous forests during the warmer months while moving into the coniferous stands to find winter refuge. Fur-bearing animals such as the beaver, mink, muskrat, otter, and fisher occupy the wetlands and forested waterways. Low lying wetlands also support significant populations of waterfowl, snowshoe hare, and many species of amphibians and reptiles. Forest fringe areas provide excellent habitat for numerous songbird species, woodcocks, ruffed grouse, and many other small mammals. Trout and other cool water fishery species abound in the waters that flow from Tug Hill. Several species of rare plants and animals have been documented by the New York Natural Heritage Program including bird's-eye primrose, large-leaf aster, soft fox sedge, rock cress, Jacob's ladder, and the raven.

The Tug Hill Tomorrow Land Trust publication, *Tug Hill: A Four Season Guide to the Natural Side*, illustrated and edited by Robert McNamara, is an excellent, non-technical aid to identifying a variety of species and habitats in the Tug Hill region.

3.9.2 Lake Ontario Plain

A large, concentrated block of forest cover, interspersed with several wooded wetlands, is located along the north shore of Oneida Lake. Hemlock and white pine are the major species. The mixed deciduous and coniferous tree species provide cover, nesting areas, and a primary food source (seeds, cones, and tender leaves) for a variety of birds and mammals including warblers, kinglets, woodpeckers, and porcupines. Fruit bearing shrubs of the understory provide an additional source of food for deer, snowshoe hare, and ruffed grouse seeking shelter during the winter months. The dense forest canopy creates a moist forest floor that is suitable for a variety of salamanders, reptiles, and small rodents. These, in turn, serve as food for resident predator species including hawks, owls, and foxes. The forested wetlands provide habitat for moles, shrews, woodcock, snowshoe hare, ruffed grouse, deer, beaver, and numerous other species of mammals, birds, and amphibians.

The shores and marshes of Oneida Lake provide habitat for a broad assemblage of waterfowl during migration and for breeding including mallards, black ducks, great blue herons, red-breasted mergansers, and blue-winged teal. The open waters of Oneida Lake provide suitable habitat for coots, scaups, goldeneyes, buffleheads, and oldsquaws. Fairly large populations of geese, ducks, and mergansers are common to the Oneida Lake area and are known to breed and nest in the wetland areas.

Uncommon bird species that use Oneida Lake for a migration stopover or for breeding include common tern, osprey, bald eagle, double-crested cormorant, and common loon. Since 1984, when double-crested cormorants were first observed on Oneida Lake, resident and migrating cormorants populations have dramatically increased, reaching controversial levels significantly impacting the Oneida Lake fishery. Additional information is provided in Chapter II Section 2.4.6 *Cormorants*.

Oneida Lake and its shoreline also serve as resting and feeding areas for loons, grebes, herons, gulls, sandpipers, and plovers. Frenchman and Dunham Islands in Oneida Lake provide excellent wildlife habitat for waterfowl and migratory birds. These, and other small islands in the lake, are highly productive areas that are home to several gull and tern populations, provide spawning and hatching shelter for fish populations, and provide a substantial food source for feeding birds, waterfowl, and other forms of wildlife.

3.9.3 Appalachian Uplands

The active farm and pasturelands in the southern areas of the watershed serve an important role for wildlife by providing open areas and food. Many species of wildlife come out of the forest to visit these openings for sunshine and warmth. Pastures are often the first areas free of snow and the first to green up in the spring, replenishing the food source. Cultivated croplands provide corn and other food for wildlife. Deer, squirrel, Canada goose, and crow are among the many wildlife species that take advantage of farm fields.

Shrublands are areas of dense thickets comprised of shrubs, saplings, grasses and flowering plants and are common in the fringe areas between the active farmlands and forestlands. The converging habitat types (open/sheltered) and variety of food sources (seeds, fruits, grasses) available in shrubland areas attract of wildlife species and contribute to the diversity of the overall landscape. Field-side shrubland is characterized by tall grasses and provide ideal habitat for birds, such as woodcock, and small mammals, such as mice and voles. Not surprising, aerial predators, such as hawks and owls are also attracted to open shrubland areas.

3.9.4 Rare, Threatened and Endangered Species

Changes in land use patterns have the potential to threaten the health, well being, and in some cases, the survival of several plant and wildlife species. Conversion of grassy areas, open fields, and hedgerows to more intensively used agricultural areas, for example, posse a threat for white-tailed deer, wild turkey, and ring necked pheasant populations throughout the watershed that depend on these areas for food and habitat. The draining and filling of wetlands for farming, industry, and housing also poses a threat to many waterfowl species, while channelization and sedimentation contributes to the loss of critical habitat areas for many species of aquatic plants and fish.

Despite changes in land use patterns, the Oneida Lake watershed is home to a number of rare, threatened and endangered animals and plants, and significant natural communities. The common tern, a colonial waterbird that nests on Oneida Lake, is listed as a threatened species in New York State. Their populations are greatly affected by shorebirds, owls, and mammals preying on their chicks and eggs. Cornell University and the NYS DEC restoration efforts have included enhancing the common tern nesting habitat, reducing predation by gulls on young, and minimizing competition for nesting sites. As a result, the common tern population has increased and over 400 pairs now nest on Oneida Lake.

Habitat for the northern harrier and red-shouldered hawk, two species on the NY State Threatened Species List, has been identified in Madison County and is found throughout the

Oneida Creek subwatershed. Habitat for the loggerhead shrike, on the NY State Endangered Species List, is found in the Oneida Creek subwatershed as well. Specialized habitat for the Chittenango ovate amber snail and the American hart's tongue fern, both on the United States Threatened Species List are found in specific areas of Madison County.

The endangered Chittenango ovate amber snail is located exclusively within the Chittenango Creek subwatershed. NYS DEC and the SUNY College of Environmental Science and Forestry are managing a program to protect this species, which is located primarily in the Chittenango Falls State Park.

The American hart's tongue fern, a plant found on the United States Threatened Species List, is found in the Cowaselon Creek subwatershed because it requires humid, shady, moist dolomitic limestone outcrops for its habitat.

The Nature Conservancy lists the bobcat, red spruce, blackburnian warbler, eastern pearlshell mussel, moose, fisher, goshawk, marten, and brook trout as species of note in the Tug Hill region. In the Rome Sand Plains, the red-shouldered hawk, fisher, spotted turtle, wild blue lupine, frosted elfin, grass pink orchid, and Nashville warbler are species of note.

Additional information can be found in **Appendix E** that contains a NY Natural Heritage Program report that was generated for the Oneida Lake watershed.

3.10 Wetlands

3.10.1 Wetlands in the Oneida Lake Watershed

Wetlands are found throughout the Oneida Lake watershed but are especially concentrated in the Lake Plain region, an area characterized by a high water table and flooding. Wetland types found in the Oneida Lake watershed vary from forested, seasonally flooded swamps to open marshes of grasses, sedges, and other low growing species. Riparian habitat can be found along perennial streams and rivers in the watershed. However, some of the secondary streams and tributaries (the lower Chittenango and Cowaselon Creek subwatersheds for example) have been channelized and no longer have characteristics of riparian areas.

Deer, hare, squirrel, beaver, muskrat, mink, raccoon, and fox are commonly found in wetlands throughout the watershed. Typical tree species growing in wetland areas include red maple, black ash, American elm, red ash, hemlock, and tamarack. Common shrubs include various willows, speckled alder, spicebush, buttonbush, dogwoods, holly, highbush cranberry, and golden rod. Several species of Typha and freshwater Sparina are typically found growing in the marshes. Other common plants include rushes, grasses, sedges, and other species that are adapted to seasonal flooding.

The preservation, protection, and conservation of wetlands is a priority because of the benefits they provide. Wetlands provide excellent habitat for migratory waterfowl and serve as wintering yards for many animal species that utilize the low growing vegetation for cover and a year-round food source. In addition to providing habitat for plants and animals, wetlands also act as sedimentation areas and filtering basins to remove impurities, thereby enhancing water quality. By slowing runoff and temporarily storing excess surface water, wetlands protect downstream areas from flooding. Under certain hydrological conditions, wetlands can recharge groundwater and augment surface water flow. Wetlands adjacent to waterbodies also provide spawning and nursery grounds, supply food, and lend protection to fish and other aquatic species. As an added benefit, wetlands provide excellent recreational, aesthetic, and educational opportunities.

Appalachian Uplands

Wetlands are not as abundant in the Appalachian Upland region as compared to the northern two-thirds of the watershed. However, two well-known wetlands that are located in the Appalachian Upland region include Madison County's Nelson Swamp, located along Chittenango Creek in the Towns of Nelson, Cazenovia and Fenner, and Peterboro Swamp, located along Oneida Creek in the Town of Smithfield. Both wetlands provide numerous benefits to the watershed such as wildlife habitat and recreation opportunities.

The NYS DEC has designated Nelson Swamp as a Unique Area due to its unique and uncommon environmental values within the rapidly changing landscape of Central New York. The NYS DEC in cooperation with the Nelson Swamp Citizens Advisory Committee prepared a Nelson Swamp Stewardship Management Plan. The plan aims to ensure the protection and sustainability of the area's ecosystems while providing multiple use benefits that are compatible with the well being of the area's sensitive resources. Additional information about the Nelson Swamp Unique Area Stewardship Management Plan is available on the Internet (http://www.dec.state.ny.us/website/dlf/publands/ump/reg7/nelswp.pdf).

Lake Ontario Plain

There are a substantial number of wetlands in the lowlands surrounding Oneida Lake, especially to the north. These wetlands occupy the clay-rich regions that were once an arm of glacial Lake Iroquois. To the south of the lake, a large portion of the Lake Plain wetlands has been drained for agricultural purposes. Over 5,000 acres of muck (organic soils) in the lower Cowaselon Creek area have been extensively drained and converted to agricultural land (Madison County Local Working Group 1997). However, some of the acreage is now reverting back to wetlands, and there is big potential for additional wetland restoration in the lower Cowaselon, Chittenango and Oneida Creek subwatersheds.

Wetlands are located in the northern portions of the Chittenango, Cowaselon, and Oneida Creek subwatersheds. The Canastota Muckland, Cicero and Black Creek Swamps, Pine Plains Marsh, and North Chittenango Swamp are located in the northern portion of Madison and Onondaga Counties. Cicero Swamp, located southwest of Oneida Lake, is approximately five square miles. The NYS DEC maintains a Wildlife Management Area there that serves as a popular location for bird watching, cross-country skiing, snowshoeing, hunting, fishing, and trapping. Toad Harbor Swamp, a highly productive, 3.8 square mile wetland complex, and Big Bay Swamp (2.6 square miles) are both located along the northwestern shore of Oneida Lake in Oswego County.

Verona Swamp in Oneida County, although dissected by highways and railroads, still contains several large and relatively undisturbed mature swamp forests. A deep stream drains the silver maple, red ash, white cedar forest, and surrounding mixed coniferous, deciduous stands. Local outdoor enthusiasts enjoy canoeing, hiking, bird watching and hunting in this area. The Vienna

Wetland is a productive streamside wetland where tussock sedge meadows, pondweeds, elodea, and wild celery are found. The alder meadows and mature upland forests that surround the area enhance habitat diversity. The Rome Sand Plains Resource Management Area contains numerous wetlands. The unique peat bog and pine barren ecology results in an important biological, geological and cultural resource. Additional information about the Rome Sand Plains is found in Chapter II Section 4.1.7.

Tug Hill Uplands
Wetlands are located throughout the Tug Hill Upland region. They are dispersed throughout the forest landscape, but the greatest concentrations are the headwater areas in the upland core forest. The headwaters of the East Branch of Fish Creek are located in the core forest of Tug Hill. This area is a large, uninterrupted tract that contains streams, swamps, marshes, and beaver ponds that provide valuable habitat for a variety of wildlife. Fisher, mink, otter, and muskrats can be found in and around the wetlands, along with waterfowl and amphibians.

Many wetlands on Tug Hill occupy swales between small hills and adjacent to streams. The most common wetland type in the Tug Hill region is the shrub swamp, dominated by alder. These moist, shaded thickets provide habitat for moles, shrews, woodcock, snowshoe hare, ruffed grouse, deer, beaver, and numerous other species of mammals, birds, and amphibians.

In addition to providing habitat for plants and animals, wetlands in the Oneida Lake watershed also filter out pollutants and reduce flooding by storing excess surface water. This is an important feature in the Tug Hill Upland region because of the large snow pack that accumulates during the winter months. At times, heavy rains can combine with high springtime temperatures to cause the snow pack to melt rapidly, causing streams to swell. Wetlands slow the release of snowmelt and spring rains, reducing the volume of water moving down the tributaries at any one time.

3.10.2 Wetland Threats

A significant threat to the wetlands of the Oneida Lake watershed is commercial and residential development. The impacts from urbanization have degraded wetlands near the lake as well as in upland areas. Reduced wetland acreage has reduced the potential for runoff retention of urban and agricultural pollutants, and has reduced water storage capacity during periods of excessive precipitation. Stormwater problems in the watershed are also more prevalent due to the conversion of wetlands to urban and agricultural land. Wetland losses reduce the ability of the watershed to store water and consequently increase the region's susceptibility to high water damage. Another threat to wetlands in the Oneida Lake watershed is a non-native plant called purple loosestrife. This plant thrives in marshes and ditches, out-competes indigenous flora, and makes wetlands less suitable for wildlife habitat.

3.10.3 NYS DEC Regulated Wetlands

NYS DEC regulated wetlands are located throughout the Oneida Lake watershed (**Map 2.3.8** – NYS DEC Regulated Wetlands). Title 6 of the Official Compilation of Codes, Rules, and Regulations of the State of New York (6 NYCRR), Part 664.5 establishes four ranked regulatory classifications of wetlands based on the degree of benefits supplied, which depend upon many factors including vegetative cover, ecological associations, special features, hydrological and pollution control features, distribution, and location. Class I wetlands have the highest rank, and the ranking descends through Classes II, III, and IV. Class I wetlands provide the most critical of the state's wetland benefits, Class II wetlands provide important wetland benefits, Class III wetlands provide wetland benefits, and Class IV wetlands provide some wildlife, open space, and other benefits. The DEC regulates wetlands that are at least 12.4 acres (5 hectares) in size. Activities within these wetland areas and within a 100-foot buffer are subject to state regulations. Activities that are subject to regulation are addressed in detail in 6 NYCRR Part 663. Wetlands between 1 and 12.4 acres are regulated by the federal government through the U.S. Army Corps of Engineers. Additional information about wetland regulation can be found in Chapter V *Institutional and Regulatory Influences*.

3.10.4 Wetlands Reserve Program

The Wetlands Reserve Program (WRP) is a voluntary program offering landowners across the nation the opportunity to protect, restore, and enhance wetlands on their property. Landowners are provided technical and financial support from the United States Department of Agriculture Natural Resources Conservation Service (USDA NRCS). Under the program, permanent easements, 30-year easements, and 10-year restoration cost-share agreements are offered for wetlands and associated uplands. The program offers payment, based on the agricultural value, for wetlands that have previously been drained and converted to agricultural uses and pays up to 100% reimbursement for restoration costs. In all cases, the landowner retains ownership and responsibility for the land, including any property taxes based on its re-assessed value as wetland or non-agricultural land. The landowner controls access to the land, the right to hunt, fish, trap, and pursue other appropriate recreational uses, and may sell or lease land enrolled in the Wetlands Reserve Program. Further information about the Wetland Reserve Program is available in Chapter V Section 2.7 or by contacting your local NRCS office or USDA Service Center.

3.10.5 Great Swamp Conservancy, Inc.

The Great Swamp Conservancy Inc. (GSC) is a non-profit, volunteer-based organization that seeks to foster environmental education, preserve biological diversity, and conserve and manage natural resources in the southeast watershed of Oneida Lake. The GSC publishes a bimonthly newsletter called the "The Marsh Lander" that documents progress and informs the public on local and regional environmental issues. The Canastota Muckland/WRP project focuses on preserving the rural character and bio-diversity of 10,000 acres in the Cowaselon Creek subwatershed. The Great Swamp Conservancy has worked closely with the NRCS and U.S. Fish and Wildlife Service (FWS) to negotiate conservation easements with landowners in this area. In 1999 the GSC approved an agreement with the US Fish and Wildlife Service. The Montezuma National Wildlife Refuge and the Partners for Fish and Wildlife Program became formal partners in addressing the need for habitat restoration throughout the Canastota Muckland project area. Breeding, nesting, and brooding areas have been provided for waterfowl, terns, and other species that use Oneida Lake. Additional information about the Great Swamp Conservancy, Inc. can be obtained from http://gscincny.tripod.com/.