

Town of Caroline Natural Resources Inventory

Compiled by
Cornell Cooperative Extension
of Tompkins County

ACKNOWLEDGEMENTS

This natural resource inventory is a Caroline-specific, adapted, revised, and updated version of the [Tompkins County Natural Resources Inventory](#) (2001) with new sections added, used with permission from the Tompkins County Planning Department. The inventory was prepared by Nathan Revor and Hassan Saleem (Clean Energy Communities Planning Interns, Cornell Cooperative Extension of Tompkins County), and Osamu Tsuda, Climate Smart Communities Specialist Cornell Cooperative Extension of Tompkins County, in conjunction with Kristen Hychka (Research Specialist, Syracuse University Center for Sustainable Community Solutions/Environmental Finance Center) and Terry Carroll (Southern Tier NYSERDA Clean Energy Communities Coordinator, Cornell Cooperative Extension of Tompkins County). The original template of this document was created by Sky Hart from Cornell University. Feedback and proposed edits were provided by the Town of Caroline Watershed Committee. The data used in this natural resource inventory was the most up-to-date information available as of Fall of 2018, and much of it was provided by the Tompkins County GIS Division. Maps were prepared by Nathan Revor and Hassan Saleem, and the layout was created by Lois Nguyen (Graphic Design Intern, Cornell Cooperative Extension of Tompkins County).

Table of Contents

INTRODUCTION.....	6
CLIMATE CONDITIONS AND PROJECTIONS.....	11
SECTION 1: HYDROLOGY.....	14
WATER BODIES.....	15
WATERSHEDS.....	20
WETLANDS.....	25
FLOOD HAZARD AREAS.....	32
AQUIFERS.....	37
SECTION 2: GEOLOGY AND SOIL.....	41
SLOPE AND TOPOGRAPHY.....	42
BEDROCK GEOLOGY.....	47
SURFICIAL GEOLOGY.....	50
SOILS.....	53
SECTION 3: LAND USE AND PROTECTED LANDS.....	61
LAND USE AND LAND COVER.....	62
NATURAL HERITAGE SITES.....	67
UNIQUE NATURAL AREAS.....	70
PROTECTED OPEN SPACE.....	74
SCENIC RESOURCES.....	78
IMPLEMENTATION TOOLS.....	82

INTRODUCTION

What are Natural Resources in the Town of Caroline

The Town of Caroline, located in the southeast corner of Tompkins County, encompasses 54.89 square miles, 54.76 square miles of land and 0.13 square miles of water. There are several communities within the Town, including Brooktondale, Slaterville Springs, and Speedsville. This area is home to many important natural resources. Protecting and maintaining natural resources is important not only because of the intrinsic value of these resources but also because of their varied ecological functions that support all life. For example, keeping water clean is valuable as it supports aquatic life as well as other life that accesses the water, including humans, and water bodies can influence important abiotic factors of ecosystems such as soils. Preserving the water quality is essential to not just Caroline, but also to the downstream neighboring communities such as City of Ithaca. Natural resources also support a variety of recreational activities such as bird watching, hiking, fishing, boating, and simply enjoying the beauty of the Town as well as an active agriculture sector, both of which are foundations of the local economy. The 2006 Comprehensive Plan of Caroline acknowledges the unique scenic quality and sense of place derived “from the interrelationship among rural farmland, areas of undeveloped open space, and attractive hamlets.” In this vein, Caroline’s natural resources support an active agriculture sector, which is foundation to the local economy.

What is a Natural Resource Inventory?

In the simplest form, a Natural Resource Inventory (NRI) is a compilation of existing natural/ ecological resources, according to the New York DEC and Hudson River Estuary Program. Depending on the community, a natural resource inventory could also include historic resources. Oftentimes, the scope and level of detail is determined by the community preparing the document. While the simplest version is just a list of existing resources, the more complex NRIs could include detailed analysis of each existing resource. As the primary purpose of an NRI is to act as an informational source to community members and municipal officials, the secondary purpose of the document is to provide the building blocks for natural resource awareness in the local and regional comprehensive plans as well as building and zoning regulations. In other words, the NRI acts as a regional atlas that could be used when updating or developing local regulations.

The creation of this natural resource inventory also supports several of the objectives set forth in the Town of Caroline’s 2006 Comprehensive Plan for Open Space and Environmental Protection (page 10). These objectives are as follows:

- Preservation of existing protected open space, and pursuit of additional opportunities for public open space and recreational amenities, particularly close to population centers.
- Recreation on protected public open space that is safe and consistent with designated uses.
- Development concentrated away from environmentally sensitive areas, particularly Unique Natural Areas identified by the Tompkins County Environmental Management Council.
- Permanent protection of important natural features and open spaces, particularly of identified Unique Natural Areas.
- Landowner stewardship of natural features and open spaces.

- Preservation of water quality and quantity and protection against environmental degradation.

Why Should Natural Resources be Protected?

Protecting environmental quality is a matter of choices and tradeoffs. As Tompkins County becomes more developed, the Town faces increasing pressures to allow the development of homes, commercial properties, and new roads. There may be negative consequences from this pressure, including wildlife displacement, loss of recreation corridors and scenic vistas, surface and groundwater contamination, increased pervasiveness of invasive species, and increased erosion and flooding. The decisions to allow for development require the Town to determine where development should take place, what the environmental impacts of this development will be, whether these impacts are worth the result, and whether there are less harmful ways to develop. This document can serve as a guide for the Town and developers to consider the answers to these questions.

Since much development is irreversible, planning is very important. Long-term planning is one way to minimize the short-term exploitation of the resource base that results from “quick fixes” to localized problems and from competition for resources. Planning at the local, regional, and state levels provides individual municipalities with a rational system for guiding development with respect to the distribution and value of natural resources.

How Can Natural Resources be Protected?

This natural resource inventory identifies many of the natural resources within the Town. This is the first step in protecting those resources. Private landowners, government agencies, and conservation organizations can use this knowledge to protect the most important of these resources.

There are several major approaches to protecting natural resources. The following is a list of some of the types of options currently used in Tompkins County.

Non-Regulatory Tools

Acquisition

Acquisition with the goal of resource preservation is the surest way of protecting natural resources.

Informal Designations

Planning efforts can raise local awareness of the value and location of important natural resources. Goals for protecting natural resources can be defined in a community’s comprehensive plan. Natural resource protection can also be addressed in open space and recreation plans or in plans for a particular resource, such as a watershed protection plan. This will be discussed in further detail on page 75.

Educational Programs

Natural resource education programs are another way to help raise awareness of the impor-

tance of natural resources and interest in protecting those resources. Local examples include the Cayuga Nature Center's series of programs for children and adults and those of the Cayuga Lake Floating Classroom.

Regulatory Tools

There are also many regulatory tools available to local municipalities to control land use. Details on these regulatory tools are provided below on page 75. Not all of these tools may match the Town's current goals or capacity. These specific regulatory techniques for protecting resources include:

- Zoning and Subdivision Ordinances – used to protect the public health, safety, and general welfare.
- Local Wetlands Ordinances – regulate disturbance of wetlands beyond those covered under state and federal laws, such as small or isolated wetlands, and can add additional requirements for activities adjacent to wetlands.
- Buffer Requirements – establish minimum distances between a development and a selected natural feature.
- Clustering Requirements – place residential units on a portion of a site to protect a contiguous area of open space or unique feature.
- Performance Zoning – unlike traditional zoning, performance zoning determines whether a land use is permitted based on an assessment of potential impacts.
- Preservation Overlay Zones – geographic areas where more restrictive development regulations are enforced to protect valued natural resources.
- Park Dedications – require developers to contribute land, or cash in lieu of land, to provide for the open space and recreation needs of the subdivision's residents.
- Transfer of Development Rights – landowners in designated preservation areas may sell development rights to allow increased density in other areas of the community.
- Purchase of Development Rights – landowners in designated preservation areas may sell development rights for cash to a government or appropriate organization.

About the Organization of this Natural Resources Inventory

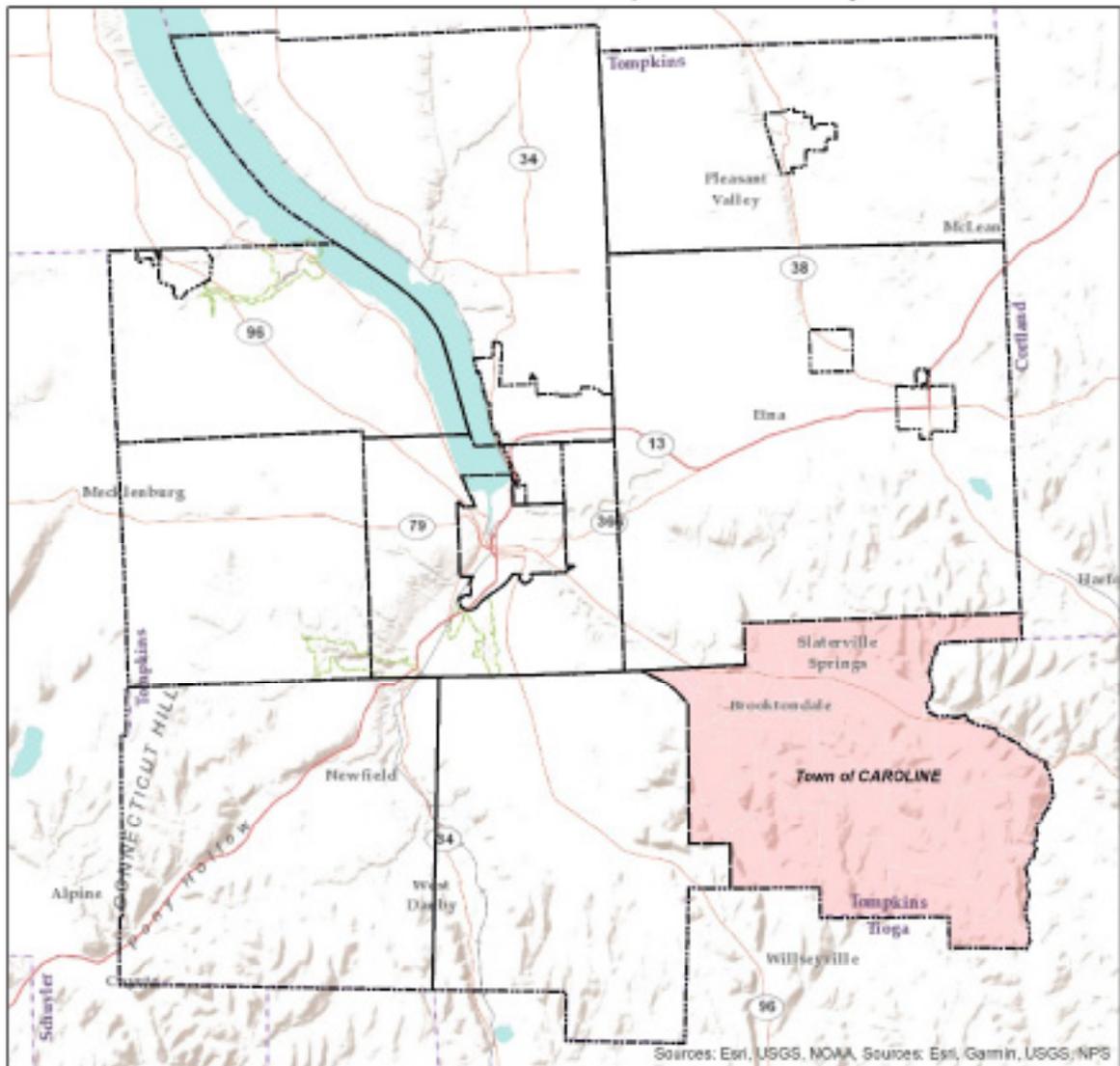
The Town of Caroline's Natural Resource Inventory begins with a summary of climate conditions and projections for the Town. The rest of the inventory is organized into three resource categories: hydrology and aquatic ecosystems, geology and soils, and land use and protected lands. An addition has been made titled "Implementation Tools" which lists the potential methods on preserving existing resources.

About the Data

Many of these data sets can be downloaded directly from the Cornell University Geographic Information Repository website (<http://cugir.mannlib.cornell.edu/>) and the New York State GIS Clearinghouse website (<http://gis.ny.gov/>). Some of these digital data sets can be purchased from the United States Geological Survey or the NYS Department of Environmental Conservation or downloaded from their websites. Some data sets have limitations and none of them are guaranteed

by their originators to be free of errors. Many are not intended to be used to review individual parcels, but are appropriate for larger-scale planning efforts. The Tompkins County GIS Division provided many of the GIS data sets necessary to produce this inventory. **All maps in this inventory are at a scale of 1:125,000, with the exception of the map on the following page, which is produced at a scale of 1:300,000 and shows the Town of Caroline's location within Tompkins County**

Location Within Tompkins County



0 2.5 5 10 Miles

 Tompkins County Municipal Boundaries

2019 Caroline NRI
 Created By: CCE-Tompkins
 Date Created: 1/25/2019
 Data Source: CUGIR, USGS
 Projection: NAD83_New_York_Central_ftUS

Map scale – 1:255,000

CLIMATE CONDITIONS AND PROJECTIONS

What is Climate Change?

Climate change refers to a change in typical or average weather in a region. Climate change has always been naturally occurring. However, human actions can also influence climate change, and since the mid-20th century, climate change has been occurring globally at an accelerated pace because of anthropogenic causes. The burning of fossil fuels (e.g. coal, oil, natural gas) is largely responsible for rapidly changing climate conditions since these fuels emit greenhouse gases that trap heat in the Earth's atmosphere. This results in changes to the average temperature and precipitation of regional climates around the world.

Why is Understanding Climate Change Important?

The changing climate is causing sea levels to rise as glaciers and polar ice melt, growing seasons to change as precipitation patterns and temperatures change, and an increase in extreme weather events including heat waves, droughts, and floods. This already impacts how and where we live, from farmers growing different crops to people leaving their no-longer-habitable homes. In addition, warmer temperatures can have adverse effects on health by increasing plants' pollen production and the formation of ground-level ozone, which in turn can worsen respiratory conditions such as asthma and allergies, and by creating a more hospitable environment for disease-carrying insects such as mosquitoes and ticks.

Climate Conditions and Projections in Caroline

New York State has a humid continental climate with an average temperature of 47.5°F and an average annual precipitation of 35 inches in the Southern Tier, where Caroline is located. The following table (Table 1) shows the range of predicted future changes in annual temperature, precipitation, and severe weather events in the Southern Tier.

Table 1: Baseline and Projected Changes in Climate Conditions and Severe Weather Events in the Southern Tier

	Baseline	2020s	2050s	2080s
Temperature	47.5°F	+1.8 to 3.8°F	+3.6 to 7.1°F	+4.2 to 11.6°F
Precipitation	35 inches	-4 to +9%	+2 to +15%	+3 to +16%
# of days per year with maximum temperature exceeding				
90°F	10	15 to 23	22 to 47	28 to 79
95°F	1	2 to 7	2 to 18	4 to 38
Heatwaves				
# per year	1	2 to 3	3 to 6	3 to 9
Average duration (days)	4	4 to 5	5	5 to 7
# of days per year with temperatures at or below freezing (32°F)				
	152	119 to 134	94 to 120	72 to 116
# of days per year with rainfall exceeding				
1 inch	6	6 to 7	7 to 8	8 to 8.5
2 inches	0.6	0.6 to 1	0.7 to 1	0.7 to 1

Source: NYSDEC, *Observed and Projected Climate Change in New York State: An Overview* (2015); baseline data is 1971-2000 NOAA data

The State's changing climate will negatively impact human health, the economy, and the environment. Warmer temperatures could hurt local economies by adversely affecting the ability to create maple syrup, grow apples, produce dairy, and participate in other agricultural activities. Extremely warm temperatures that occur as heat waves (defined as three or more consecutive days with maximum temperatures above 90°F) are a potentially deadly health hazard. These hotter temperatures in the summertime could also impact ecotourism in the region. In addition, both more frequent droughts and increased precipitation are predicted. Droughts hinder agricultural production and impact overall water use, while long, heavy rains will increase the chances of flash flooding and erosion, which can damage buildings, infrastructure, agriculture, and undeveloped lands. Lastly, the changing climate will permit the expansion of parasites such as ticks, which can carry Lyme disease, and invasive species, some of which are harmful to native species, ecosystems, and people.

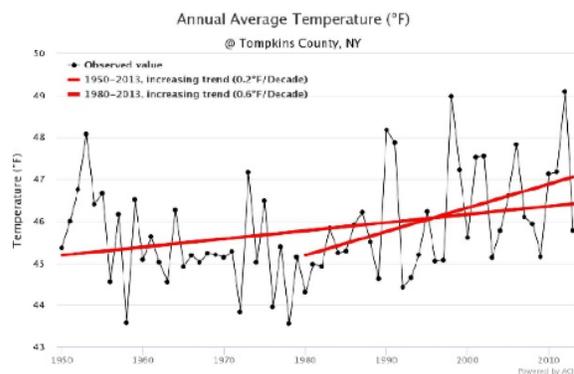


Chart 1: Historical Temperature Change

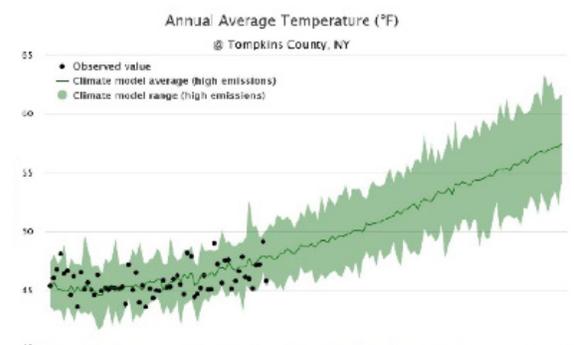


Chart 2: Tompkins Temperature Projection

Similar to the national level, records have shown a significant increase in temperature over time. According to the adjacent chart 1, the average temperature has increased by 2 degrees (F) between the years 1980 and 2010. According to the second chart, if emissions were to continue at the current high level, the average temperature in Tompkins County is expected to increase by approximately 6 degrees (F), from 48F to 54F between the 50-year period between 2020 and 2070 (Source: Climate Smart Farming)

Addressing Climate Change

To avoid facing the worst of these climate change projections, we can take measures to address climate change. These measures fall into two categories: mitigation and adaptation. Mitigation refers to the reduction of greenhouse gas emissions, while adaptation refers to changing our practices to match new or inevitable climate conditions (NASA). Examples of mitigation strategies include reducing energy use by taking actions such as turning off electronics when they are not in use or switching to energy efficient LED lightbulbs; switching to renewable energy sources such as solar or hydro power; reforestation to sustainably capture carbon dioxide emissions; and taking the bus, walking, biking, or carpooling instead of driving (NYS DEC). Examples of adaptation strategies include relocating facilities away from areas prone to flooding, creating cooling centers for people to take shelter in on extremely hot days, and reducing water use during droughts. Using a combination of mitigation and adaptation strategies at the individual, institutional, and

municipal levels is important. Climate change cannot be prevented entirely even if humans were to cease greenhouse gas emissions as the greenhouse gases currently in the atmosphere will remain there for decades or even centuries (NASA). Therefore, adaptation to a different climate is necessary. However, we can avoid experiencing the worst of the projections by reducing greenhouse gas emissions through mitigation strategies so that existing issues will not be exacerbated.

Resources and References

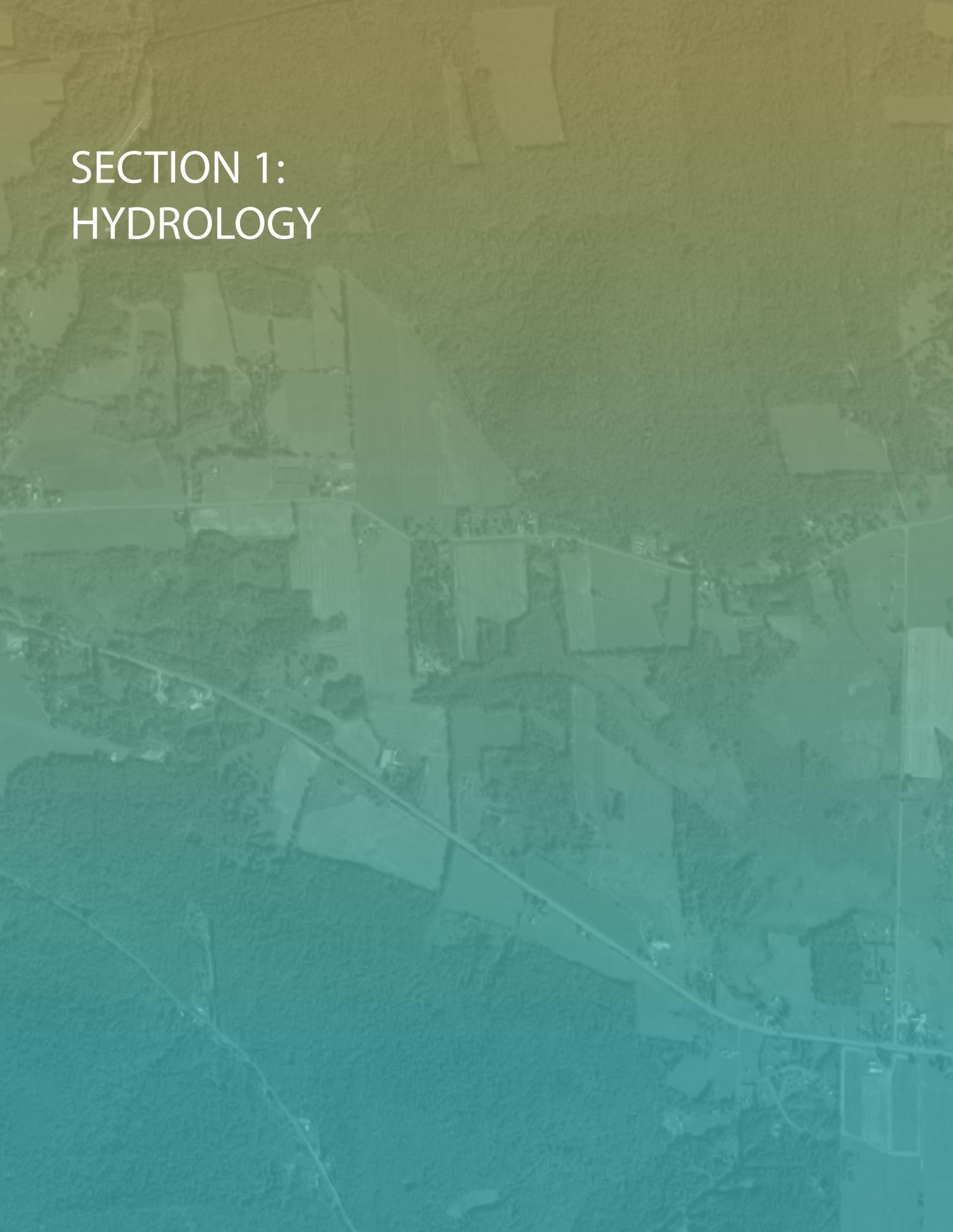
Climate Smart Farming, Cornell University: <http://climatesmartfarming.org/>

National Aeronautics and Space Administration (NASA), What Are Climate and Climate Change? <https://www.nasa.gov/audience/forstudents/5-8/features/nasa-knows/what-is-climate-change-58.html>

New York State Department of Environmental Conservation

Observed and Projected Climate Change in New York State: An Overview (2015). http://www.dec.ny.gov/docs/administration_pdf/climbkgncrra.pdf

Climate Change, <http://www.dec.ny.gov/energy/44992.html>

An aerial photograph of a rural landscape, showing a network of roads and agricultural fields. The image is overlaid with a vertical gradient that transitions from a dark brown at the top to a teal at the bottom. The text 'SECTION 1: HYDROLOGY' is positioned in the upper left corner in white, bold, sans-serif font.

SECTION 1: HYDROLOGY

WATER BODIES

Why Are Water Bodies Important?

Tompkins County is dominated by significant water bodies (lakes, ponds, rivers, and streams) that are critical to public health and the economic and environmental wellbeing of this area. In Caroline, these water bodies include Six Mile Creek and several perennial streams within the town boundaries. Caroline's economic and environmental activities dependent on the integrity of local water bodies and water supplies include agriculture, recreation, and real estate.

Although water supply is abundant in Caroline, certain activities can adversely affect the ecological balance within water bodies, impairing their current and potential economic and environmental functions. Threats to local water supplies include both point source pollution (originating from a single source, often as a pipe draining into a water body) and nonpoint source pollution (originating from multiple sources including: runoff from construction, agriculture, parking lots, and streets; on-site wastewater systems; and commercial and residential activities). Given Six Mile Creek's importance in feeding the City of Ithaca's municipal water supply, the impact of pollution can be felt by communities beyond Caroline itself.

How Are Water Bodies Regulated?

Federal and state agencies, such as the New York State Department of Environmental Conservation (DEC) and United States Army Corps of Engineers (Army Corps), require permits for activities that might affect or disturb a water body and/or its banks. The stringency of these permits corresponds with the DEC classification assigned to the water body (see Table 2) and may range from a general, or unified, permit to a permit tailored to the specific site and type of work conducted. Regulated activities might include streambank maintenance, construction, flood protection and mitigation, dredging, placing fill, and certain agricultural practices.

Commercial, industrial, and agricultural activities that discharge to a water body require a State Pollution Discharge Elimination System (SPDES) permit. This permit is required for a broad range of activities, including the discharge of wastewater, stormwater, or chemical and thermal emissions from municipal treatment plants, industrial plants, utilities, large subdivisions, apartment complexes, and confined animal feeding operations.

Prior to conducting stream-related work or discharging wastewater, the Region 7 Office of the DEC or the Army Corps Buffalo District should be contacted to obtain the necessary approvals and permits. Each of these agencies will automatically forward permit applications to the other, and each agency will contact the applicant if additional permits and/or paperwork are needed.

How Are Water Bodies Classified?

The DEC has assigned most water bodies within the state a letter based on their existing or expected "best use." The most pristine waters are assigned a classification of AA, while the most degraded waters are assigned a classification of D. Table 2 details these classifications.

Table 2: NYSDEC Classifications of Fresh Surface Waters

Classes	Best Uses
D	Secondary contact recreation
C	Fishing
B	Bathing
A	Drinking (after chlorination and filtration)
AA	Drinking (after chlorination)

NOTE: (T) indicates that it may support a trout population, or (TS), that it may support trout spawning (TS)

Source: New York State Department of Environmental Conservation

Water Bodies in Caroline

Any stream classified as AA, A, or B, or C with a standard of T or TS is considered to be a protected stream. All streams and creeks in Caroline are classified as C or better (Table 3), and multiple – Boyer Creek, Six Mile Creek, West Branch Owego Creek, and Willseyville Creek (Table 3) - are classified highly enough to be designated as protected streams due to their importance as drinking water supplies or fish habitat. A NYS Protection of Waters Permit is necessary for the disturbance of the bed or banks of a protected stream and for the excavation of or the placement of fill in protected streams and their adjacent and contiguous marshes and wetlands.

Fish resources are a key factor in determining water body classifications because they are high on the food chain in aquatic habitats. As such, fish can be used as an indicator of the overall quality of an aquatic ecosystem. Some fish are highly vulnerable, both directly and indirectly, to changes in their environment. They can be directly affected by physical and chemical changes in the water and indirectly affected when changes in the environment affect their food sources or the temperature and turbidity of their habitat.

Reasons to Protect

There are many obvious benefits to protecting waterbodies and their surrounding banks/ riparian buffers; with the constantly changing climate conditions it is important to understand the critical role of natural water networks and how they can protect a community. The following is meant to be an incentive to encourage preservation and protection, and thus increase the community's resiliency to future climate related events.

Table 3: Caroline Water Bodies Classifications	Table 3: Caroline Water Bodies Classifications 2
Boyer Creek	C (T)
Six Mile Creek	A (T)
West Branch Owego Creek	C (T)
Willow Creek	C
Willseyville Creek	C (T)
Source: New York State Department of Environmental Conservation Environmental Resource Mapper	

As discussed above, waterbodies and their surroundings are fragile and can easily be affected by modifications to their structure. According to the Climate Impact Lab, the average temperature in New York State is projected to increase by 10 degrees (F) over the next 100 years. While Upstate New York might not have to worry much about sea level rise, the significant increase in temperature would not only trigger increasingly fluctuant weather patterns, but also precipitation at higher intensities. These more extreme weather patterns are already apparent throughout Upstate NY, as there has been a noticeable increase in precipitation between 5 - 10% every decade since 1960.

A study conducted by New York DEC and Delaware County Soil and Water Conservation District shows that any stream disturbance/ modification (such as stream bed sediment clearing, removal of vegetation along stream bank, man-made change in stream shape or size, etc.) can eventually lead to heavy erosion both upstream and downstream and thus cause flooding that could have otherwise been avoided. Thus, as communities can expect increased flooding events in the near future, it is important to understand how flooding can easily overwhelm any natural infrastructure that has been disturbed by human activity. While updating and improving infrastructure can help increase a community's safety, preserving waterbodies and their surroundings can be one of the most effective ways to improve a community's resilience.

Such resources can be preserved through multiple methods which are detailed in the Implementation Tools section of this document.

What can be done?

There are multiple option and methods to use this information. While being aware of the existing conditions and regulations is important, it is also necessary to understand how this information is used, especially for communities that might not have all the necessary resources. Therefore, this section aims to provide a better understanding in terms of how to apply the information in an effective and organized manner.

- **Developing Buffer Zones:** As the map depicts below, there are two different types

of streams, protected and non-protected. While it is important to note of all streams surrounding a parcel, it is especially important to note that DEC protected streams and waterbodies cannot be modified without a permit, even if the waterbody flows through private property. Therefore, this information can help developers, farmers, and municipal officials better understand where modifications can and cannot occur. The natural resources mapper is an interactive map that can provide further detail on DEC designated streams (<http://www.dec.ny.gov/gis/erm/>). In addition, as it is important to protect the buffer zone between streams and developed lands, there are numerous DEC grant programs that can be used to fund the development of buffer zones along streams and rivers (<https://www.dec.ny.gov/chemical/106345.html>)

- **Runoff mapping and floodplain delineation:** As runoff increase, it is necessary to understand where water sources originate and how they might be interconnected with other streams. As Tompkins County has been actively mapping ditches and culverts to better understand the watershed characteristics, the streams map is crucial in order to understand the behavior of water flow and thus the watershed which will be discussed further below. Additionally, stream maps can especially be effective when delineating a floodplain; having a better understanding of where the floodplain begins and ends is crucial information to better prepare for extreme weather events and develop land in a way that is most resilient to the changing weather patterns. More information on delineating floodplains and its uses can be found at the following link: <https://my.usgs.gov/confluence/display/cdi/Exploring+Methods+of+Floodplain+Delineation>

Maps and Data

The map on page 19 shows permanent streams – those that flow year-round - and their protection status in the Town of Caroline. Other maps in this document show intermittent (or seasonal) streams as well, which only flow when they receive water from upstream, groundwater, and/or precipitation. The data for this map comes from the New York State GIS Clearinghouse dataset entitled “[Water Quality Classifications - NYS](#),” last revised in May 2017.

Resources and References

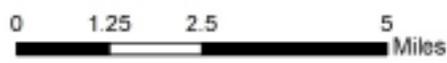
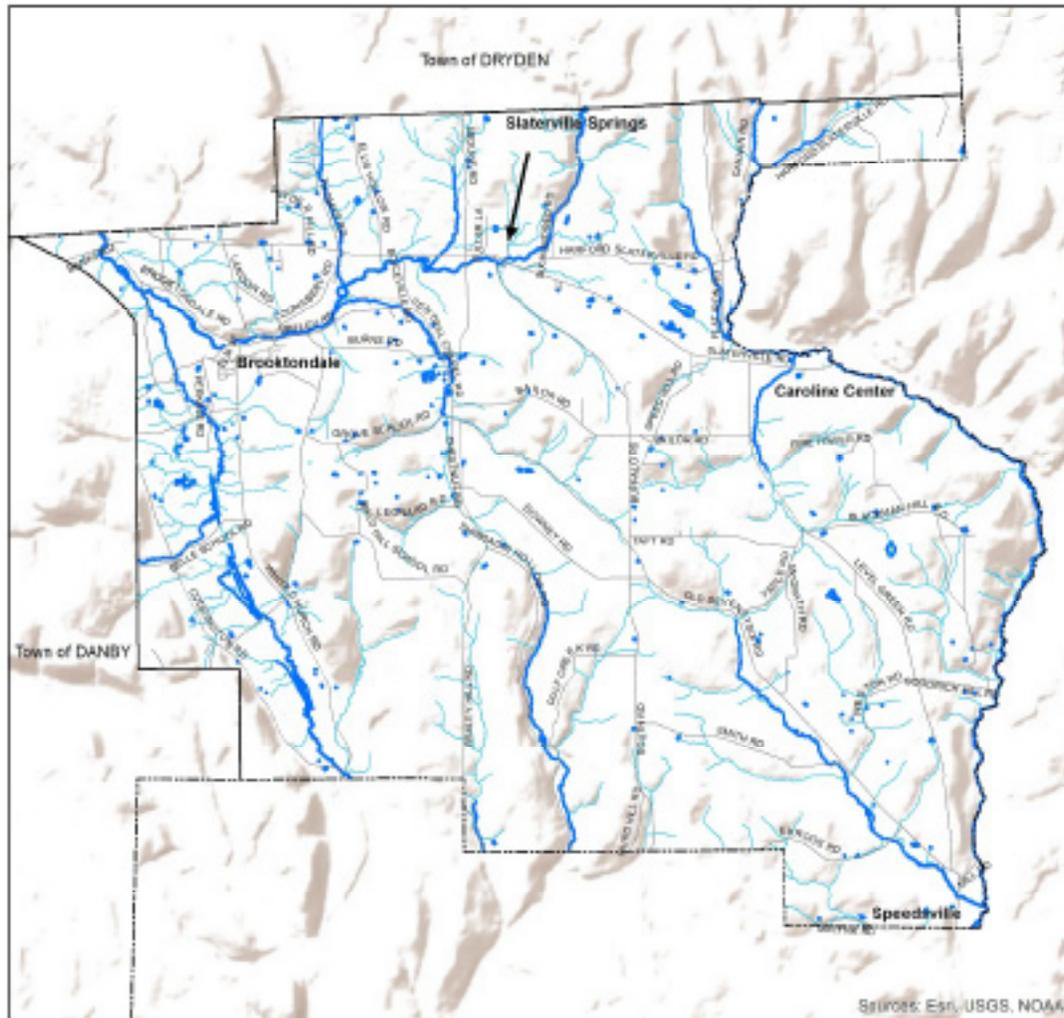
Army Corps of Engineers, Buffalo District, <http://www.lrb.usace.army.mil/>
Climate Impact Lab <http://www.impactlab.org/>

Delaware County Post-Emergency Stream Intervention : https://www.dec.ny.gov/docs/administration_pdf/streamnll.pdf

New York State Department of Environmental Conservation
DEC Regulations, Chapter X: Division of Water, <http://www.dec.ny.gov/regs/2485.html>
Protection of Waters: Disturbance of the Bed or Banks of a Protected Stream or Other Watercourse, <http://www.dec.ny.gov/permits/6554.html>

New York State GIS Clearinghouse, <http://gis.ny.gov/>
Tompkins County GIS Division, <http://www.tompkinscountyny.gov/gis>
Tompkins County Planning Department, <http://www.tompkinscountyny.gov/planning>
Tompkins County Soil and Water Conservation District, <http://www.tompkinscountyny.gov/swcd>
United States Environmental Protection Agency, “Streams,” <https://archive.epa.gov/water/archive/web/html/streams.html>

Caroline Streams



Tompkins Co. Municipal Boundaries

Caroline roads

Caroline roads

CLASS

Not Protected

DEC Protected



2019 Caroline NRI
 Created By: CCE-Tompkins
 Date Created: 1/25/2019
 Data Source: CUGIR, USGS
 Projection: NAD83_New_York_Central_ftUS

WATERSHEDS

What is a Watershed?

A watershed is the land area that contributes water to a given point, such as a stream or lake. Contributing sources of water for a watershed include (but are not limited to) springs, streams, seeps, ditches, culverts, marshes, wetlands, swamps, and ponds. Eventually, all surface water, some groundwater resources, and precipitation falling within a watershed drain into a single receiving water body such as a stream, river, lake, or wetland.

Watersheds exist at various scales within a hierarchical structure. Gullies and ravines trickle into streams, which in turn feed into larger streams or rivers. Each of these water bodies (gully, ravine, stream, etc.) drains its own particular watershed so that larger watersheds are comprised of several smaller watersheds. For example, the Six Mile Creek watershed flows into the Cayuga Inlet Watershed, which are both contained within the larger Cayuga Lake watershed. While the term watershed is often used interchangeably with “drainage basin”, the term drainage basin usually refers to a larger watershed such as the Susquehanna River Drainage Basin or the Lake Ontario Drainage Basin.

Why Are Watersheds Important?

Land use throughout a watershed (or the commercial, industrial, agricultural, and/or residential activities a land area can support) and the availability of reliable water sources within a watershed are directly related. That is, the land use in a particular area is often determined by the availability of reliable water supplies, and land use is a key determinant of the quality, quantity, and availability of local water resources. Because of this dynamic relationship between water and land use, the characteristics of the entire watershed must be considered when addressing water quality and water quantity issues, including such factors as the amount of impervious surface and effectiveness of local land management practices.

Additionally, the critical influence and impact of water on important ecological and economic systems (such as provision of drinking water, flooding, recreation, and future economic growth) make watersheds increasingly common management and planning units. State and federal agencies utilize and look favorably on water-related management and planning processes that also utilize the principles and concepts of watershed management.

How are Watersheds Regulated?

Though activities within a watershed can greatly influence the ecosystems they contain, many regulations apply to specific waterbodies or wetlands within a watershed and not the watershed itself.

Watersheds in Caroline

Caroline has three main watersheds: the Six Mile Creek Watershed, the West Branch Owego Creek Watershed, and the Catatonk Creek Watershed, with a small pocket of Cascadilla Creek Watershed in the northeast portion of the Town. The northwest watersheds (Six Mile Creek and Cascadilla Creek) drain into the Oswego River Basin and on the Lake Ontario while the south and east watersheds (Catatonk Creek and West Branch Owego) drain into the Susquehanna River and,

Table 4: Watersheds in Caroline

	Acres	Sq. Miles (approx.)	Drainage Basin
Six Mile Creek	33,403	52	Oswego River
Cascadilla Creek	8654	14	Oswego River
West Branch Oswego Creek	16,890	26	Susquehanna River
Catatonk Creek	25,266	39	Susquehanna River

Source: Tompkins County Planning Department

eventually, the Chesapeake Bay. Table 4 provides more information on the watersheds in Caroline.

Watershed Role with Changing Weather

As the temperature of Upstate New York increases and extreme weather patterns become more frequent, focusing on protecting and managing the watershed will not only increase resilience, but also protect community health from the harmful runoffs that are a result of increased high-volume precipitation. According to data from the Research Program on Climate Change, Agriculture, and Food Security, New York’s southern-tier and Central region will likely see up to an 80mm increase in precipitation between 2015 and 2050. With the increase in impervious surfaces such as roads, parking lots, and industrial lands, runoff will increase and contaminate the local water networks of waterbodies, increasing the probability of harmful algal bloom (Cayuga Watershed Intermunicipal Organization).

While there are programs such as the [Routine Monitoring Statewide Program](#) which monitors watershed throughout the state, there are direct actions that local governments can take to protect watersheds in their municipality. According to the [NYS Department of State Local Government Handbook](#), the following are potential actions a local government can take to preserve watersheds/ wetlands:

- 1) All wetlands that are smaller than 12.4 acres and that are not deemed of ‘unusual importance,’ are subject to the exclusive jurisdiction of the municipalities where the wetlands are located (ECL §24-0507).
- 2) Under ECL, §24-0501, a local government may enact a Freshwater Wetlands Protection Law to fully assume jurisdiction over all freshwater wetlands within its jurisdiction from DEC, provided its law is no less protective of wetlands than Article 24 of the ECL and provided that DEC certifies that the municipality is capable of administering the Act. There is also a limited opportunity for counties to assume wetlands jurisdiction if the local government declines.
- 3) Under ECL, § 24-0509, local governments can now adopt freshwater wetland regulations applying to wetlands already mapped and under the jurisdiction of DEC, provided that the local regulations are more protective of wetlands than the state regulations in effect. No pre-certification by DEC is required.”

In addition to the above, communities can protect critical waterbodies/ wetlands and thus watersheds through SEQURA by identifying them as unique natural areas; adopt local regulations in the comprehensive plan for stormwater control, ordinances for sediment and erosion control,

building and sanitary codes, floodplain regulation, and timber harvesting guidelines or other vegetation removal standards; and frequently monitoring local project processes for regulatory compliance (US EPA).

What Can Be Done?

While this section is intended to mainly provide information on what and where watersheds exist, there are several ways in which this information is applied. Below are some ideas on how to use this information:

- **Watershed Management Plan:** Algal bloom is a major issue that can be found throughout waterbodies in New York State. At the same time, there are no direct or primary causes to this issue, which makes solving the problem far more complicated. However, one common cause of algal bloom is the excess nutrients and nitrogen that results from direct runoff from agricultural lands. Thus, monitoring watersheds and making smarter and more sustainable land use decisions can drastically help reduce local and regional algal blooms. The Cayuga Lake Intermunicipal Organization, for example is attempting to solve the Cayuga Lake algal bloom through land use, zoning, and other regulatory tools that would reduce the amount of runoff that eventually enters the lake. On the other hand, watershed management is also possible on the municipal level. A municipal watershed management plan recommends strategies on how to improve water quality through proper land use practices as well as set guidelines on development. More information on a watershed management plan can be found at: <https://www.dec.ny.gov/chemical/103264.html>
- **Municipal Comprehensive Plan:** In addition to monitoring for contaminants, it is important to consider each watershed's intended use. In other words, while not all watersheds are intended for drinking purposes, it is important to understand that watersheds not only significantly affect public health, but also regional economies, especially those that rely on tourism. Thus, protecting the local watersheds should be promoted not only in environmental related documents, but also those that discuss the regional economies. A comprehensive plan is a perfect document to incorporate awareness around watershed management, as it can be used to show the interconnected relationship between watersheds and regional economies and well-being. The Hudson River Estuary Program is one example of tackling regional development from the watershed perspective. More information can be found at: <https://www.dec.ny.gov/lands/4920.html>

Map and Data

The map on page 24 shows the four watersheds in the Town of Caroline. This map shows both permanent and intermittent streams. The data for this map was provided by the Tompkins County GIS Division. A similar dataset is available from the Cornell University Geospatial Information Repository (CUGIR) under the name "[Watersheds, Tompkins County NY, 1991](#)," created in 1991.

Resources and References

Cayuga Lake Watershed Intermunicipal Organization, <http://www.cayugawatershed.org/>

Cayuga Lake Watershed Network, <http://www.cayugalake.org/>

Cornell Cooperative Extension of Dutchess County, Natural Resources, <http://ccedutchess.org/environment/natural-resources>

Cornell University Geospatial Information Repository (CUGIR), <https://cugir.library.cornell.edu/>

Dutchess County Department of Planning and Development, "Chapter 5: Water Resources of Dutchess County, NY," Natural Resources Inventory, 2010 (originally published in 1985), <http://www.co.dutchess.ny.us/CountyGov/Departments/Planning/nrichapfive.pdf>

NYS Local Government Handbook: https://www.dos.ny.gov/lg/publications/Local_Government_Handbook.pdf

Research Program on Climate Change, Agriculture, and Food Security: <http://www.ccafs-climate.org/data/>

State Wetland Managers Association: <https://www.aswm.org/>

Tompkins County GIS Division, <http://www.tompkinscountyny.gov/gis>

Tompkins County Planning Department, <http://www.tompkinscountyny.gov/planning>

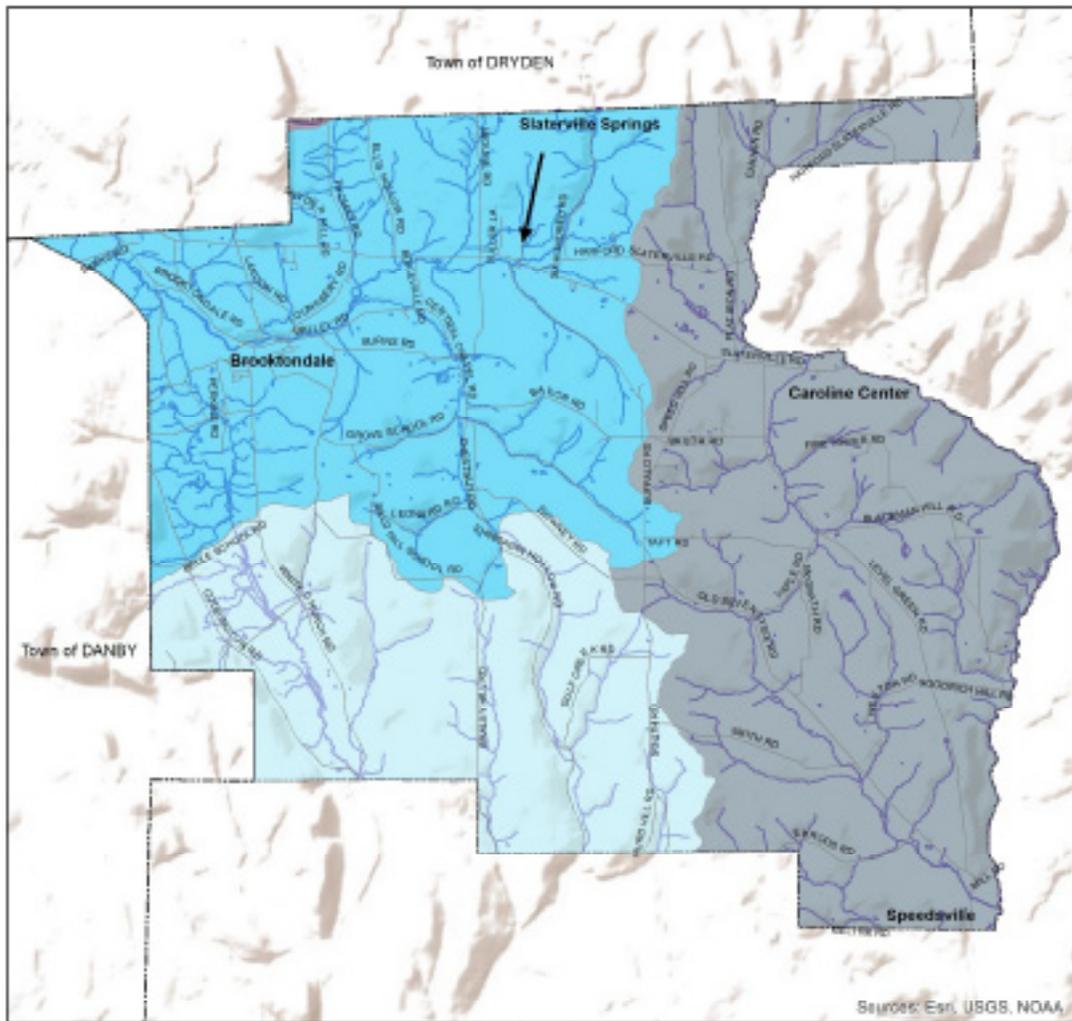
U.S. Department of Agriculture, Natural Resources Conservation Service, Hydrologic Unit Boundaries, https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/nra/nri/?cid=nrcs143_013728

U.S. Environmental Protection Agency

Surf Your Watershed, <https://cfpub.epa.gov/surf/locate/index.cfm>

Healthy Watersheds Protection, <https://www.epa.gov/hwp>

Caroline Watersheds



Source: Esri, USGS, NOAA



- Tompkins Co. Municipal Boundaries
- Caroline roads
- Streams

- WATERSHED**
- Cascadilla Creek
 - Catskill Creek
 - Six Mile Creek
 - West Branch Owego Creek



2019 Caroline NRI
 Created By: CCE-Tompkins
 Date Created: 1/25/2019
 Data Source: CUGIR, USGS
 Projection: NAD83_New_York_Central_fUS

WETLANDS

What is a Wetland?

Wetlands, according to the United States Army Corps of Engineers (Army Corps), are “those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, wet meadows, and similar areas.” According to the New York State Department of Environmental Conservation (DEC), “Freshwater wetlands are those areas of land and water that support a preponderance of characteristic wetlands plants that out-compete upland plants because of the presence of wetlands hydrology (such as prolonged flooding) or hydric (wet) soils. Freshwater wetlands commonly include marshes, swamps, bogs, and fens.” Wetlands such as swamps and marshes are often easily recognizable, but some wetlands, such as forested wetlands and wet meadows, are not obvious because they are dry during part of the year or do not have standing water.

Why Are Wetlands Important?

Wetlands are critical natural ecosystems and provide a variety of benefits such as:

- filtering harmful toxins, nutrients, and sediment from surface runoff;
- storing floodwaters and reducing the magnitude of flood events; and
- providing valuable habitat for a diverse array of flora and fauna, including many rare, threatened, or endangered species.

The recreational uses associated with wetlands are also very diverse and include birdwatching, hunting, and fishing, all of which provide direct economic benefits to local communities. Because wetlands are crucially important both economically and environmentally, they are highly regulated by the Army Corps and the DEC.

How Are Wetlands Regulated?

The Army Corps regulates wetlands under Section 404 of the Clean Water Act and issues wetland permits for the placement of fill or dredge materials and the construction of certain structures in waterways (navigable and non-navigable) and wetlands. Disturbances to wetlands must be mitigated in accordance with Army Corps regulations. The Army Corps permit required for activities within a wetland, and the amount of wetlands mitigation required, vary depending on the type of project proposed and the area of wetland impacted.

The DEC primarily regulates wetlands that are 12.4 acres (5 hectares) or larger in size under the Freshwater Wetlands Act. It protects smaller wetlands if they are considered to have unusual local importance. For any work occurring within a wetland or within 100 feet of a wetland boundary, the DEC requires that a wetlands permit be obtained.

Prior to conducting work in or near a wetland, the Regional DEC office or the Army Corps district office should be contacted to obtain the necessary approvals and permits. Each of these agencies will automatically forward permit applications to the other, and each agency will contact the applicant if additional permits and/or paperwork are needed. If permits are not obtained or wetlands are improperly altered, the Army Corps and the DEC have the authority to levy fines.

How Are Wetlands Classified?

The DEC classifies and ranks wetlands according to their respective functions, values, and benefits. Of the four classes of wetlands, Class I wetlands are the most valuable and are subject to the most stringent standards. For regulatory purposes, the Army Corps only classifies wetlands as regulated or not regulated based on the presence of wetland hydrology, hydric soils, and hydrophytic vegetation (wetland plants).

Wetlands' Role with Climate Change

As noted above, wetlands act as a key component to the ecosystem, not just for the municipality, but also for the entire region and watersheds associated with that region. According to the United States Environmental Protection Agency (EPA), wetlands are one of the most productive ecosystems that act as a “natural supermarket” for native species, as well as often act as a natural sponge to slow down and distribute flood runoff waters. The importance of wetlands is especially true for much of the developed and or agricultural areas of Upstate NY where the topography is relatively hilly or mountainous and the runoff rates are relatively high.

In terms of filtration, wetlands act as a vital resource to prevent contamination of drinking waters. While water treatment plants deal with direct waste from communities, most rural septic systems do not deal with ditch runoff waters which contain contaminants from roads, agriculture, and even landfills (NYS DEC). Unless this water enters a wetland, it can directly harm and pollute the local water system and resources. One direct effect of this contamination includes algal bloom in waterbodies from heightened nutrient levels (such as phosphates). This ultimately leads to a chain of events triggering public health and environmental issues, as well as direct and indirect negative impacts on local and regional economies. As our climate changes and with increased precipitation, preserving these wetlands will foster protection of both natural and public health.

In addition to health concerns, wetlands are a crucial entity to local wildlife. While much of Upstate New York is fortunate to have a great deal of greenery throughout the state, wetlands are known to be the main habitat for the bottom of the food chain, which when affected or modified would create a domino effect for all other species that directly or indirectly rely on that food source (US EPA). This cycle involved dead leaves and other plant debris breaking down, becoming detritus which then feeds small aquatic insects, shellfish and small fish which ultimately are prey to larger aquatic and terrestrial animals. Rather than the high nutrient water directly entering and contaminating waterbodies, these resources are partially ingested by wildlife and the remainder enters the ground. Thus, it is reasonable to say that wetlands are crucial for all wildlife survival.

Unlike waterbodies, wetland borders can be difficult to delineate. The wetland map below therefore can be a useful tool to determine what parcels should and or do not need to be preserved, especially when overlaid and compared with other maps such as the flood or land cover map depicted below on page 36 and 65, respectively. Because wetlands are fragile ecosystems, a 100-foot buffer is legally established by the state around each individual wetland. The boundaries are determined based on three factors: existence of hydrophytic vegetation, hydric soil type, and standing water. In order to be designated as a wetland, usually two or more of the factors must

exist. While the map below may represent existing wetlands, their existence and size can continually fluctuate., especially with climate change. In order to have up to date maps, it is necessary for communities to actively be aware of the changing landscape. If a municipal official or community member believes they know of a wetland that is not mapped, the following manual can be used to identify potential new wetlands: https://www.dec.ny.gov/docs/wildlife_pdf/fwdelman.pdf

Mapped Wetlands in Caroline

While Caroline does not contain many waterbodies, the municipality does have many wetlands, especially in the northern part of the township. The map below depicts the Tompkins County Mapped Wetlands as well as those that are protected by the NYS DEC. According to the Caroline NRCP, due to climate change and increased precipitation, these wetlands are expected to grow and expand over the coming years. Thus, while wetlands tend to fluctuate in size and location, in general, areas that are low-lying can eventually become wetlands.

What Can Be Done?

- **Wetland Management Plans:** As wetlands are constantly changing and important ecosystems within the watershed, watershed management plans are often created by municipalities, which are intended as a guide for municipal officials and soil and water conservation districts to promote best practices in preserving these fragile ecosystems.
- **Wetland Restoration Plan:** While this document is similar to the wetlands management plan, this document is specifically intended for restoring wetlands. As they are fragile ecosystems, any modifications to the surrounding environment can negatively affect wetlands. As a result, over time there has been a significant loss in wetlands. And this document is specifically intended to help restore these crucial natural resources.
- **Water Quality Plan:** This document is specifically intended to preserve and or help create clean and reliable sources of water for communities. As previously mentioned, wetlands act as a runoff retention zone and most importantly a filter which eliminates all the toxins out of the water. Thus, this document acts as a guide as to how to take advantage of wetlands and improve water quality for the municipality.
- **Wildlife habitat management plan:** As explained above, wetlands are crucial for local wildlife survival. Thus, when considering development proposals, this document management plan can help determine the best land use practices. More information can be found at: <http://txmn.org/elcamino/files/2015/03/Developing-Your-Wildlife-Management-Plan.pdf>

Mapped Wetlands in Caroline

Caroline contains both National Wetlands Inventory wetlands (as mapped by the U.S. Fish and Wildlife Service) and additional NYSDEC Freshwater Wetlands (as mapped by the DEC), detailed in Table 5.

In 2015, a data analyst at the Cornell Wildlife Health Lab created more accurate wetlands maps for Tompkins County using 2012 LiDAR data. This data differs from the National Wetlands Inven-

Table 5: Wetlands In Caroline

	Acres of Wetlands	Percent of Municipality
2015 County-Mapped Wetlands	1366.93	3.88%
National Wetlands Inventory Wetlands	1536.76	4.36%
NYSDEC Freshwater Wetlands	971.35	2.76%

tory data (last updated in 2017) as the National Wetlands Inventory uses different remote sensing imagery to create their maps. However, the NYSDEC Freshwater Wetlands dataset has not been updated for over a decade and does not match up with the wetlands data released in 2015. Therefore, the NYSDEC Freshwater Wetlands dataset does not appear to be an accurate representation of Caroline’s wetlands. Because the 2015 County-mapped wetlands appear to be the most accurate and up-to-date representation of wetlands in Caroline, these wetlands are used in maps throughout this inventory.

Maps and Data

The map on page 31 shows the NYSDEC Freshwater Wetlands, National Wetlands Inventory Wetlands, and 2015 County-mapped wetlands. The map on the following page shows Caroline’s wetlands as mapped in 2015 in order to display a map with only the most up-to-date information. All subsequent maps in this document that display wetlands use the 2015 data. The NYSDEC wetlands data is available from CUGIR under the name “[New York State Regulatory Freshwater Wetlands](#),” last updated for Tompkins County in 1994. The National Wetlands Inventory data comes from the [U.S. Fish and Wildlife Service](#) and was last updated in 2017.

Although the Army Corps and the DEC create and periodically update wetlands maps, these maps are developed for use at a very broad scale (1:200,000) and are best used as an indicator that wetlands are present, and that an on-ground, site-specific investigation by a qualified wetland specialist (Army Corps Engineer, Tompkins County Soil and Water staff, or private consultant) is warranted. Many wetlands do not appear on wetland maps, so if land appears to be wet, or has typical wetland plants or soils, landowners should call the Army Corps or the DEC prior to altering the land to avoid wetland destruction and possible fines.

For questions about wetlands on active farmlands or the Wetlands Reserve Program (which makes payment to landowners for establishing wetland easements on their agricultural property), contact the USDA Natural Resources Conservation Service, Ithaca Office.

Resources and References

Cayuga Lake Watershed Network, Wetlands Maps Updated for Tompkins County, <http://www.cayugalake.org/wetlands-mapping-project.html>

Cornell University Geospatial Information Repository (CUGIR), <https://cugir.library.cornell.edu/>

Environmental Conservation Agency (EPA), Wetlands: <https://www.epa.gov/wetlands/why-are-wetlands-important>

Mitsch, W.J. and J.G. Gosselink (1986). Wetlands. New York: Van Nostrand Reinhold.

New York State Department of Environmental Conservation

Freshwater Wetlands Permits, <http://www.dec.ny.gov/permits/6058.html>

Freshwater Wetlands Mapping, <http://www.dec.ny.gov/lands/5124.html>

Freshwater Wetlands Program, <http://www.dec.ny.gov/lands/4937.html>

Tompkins County GIS Division, <http://www.tompkinscountyny.gov/gis>

Tompkins County Planning Department, <http://www.tompkinscountyny.gov/planning>

U.S. Army Corps of Engineers

Regulatory Program and Permits, <http://www.usace.army.mil/Missions/Civil-Works/Regulatory-Program-and-Permits/>

Buffalo District, <http://www.lrb.usace.army.mil/>

U.S. Department of Agriculture, Natural Resources Conservation Service

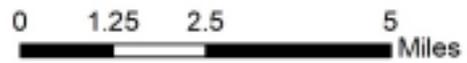
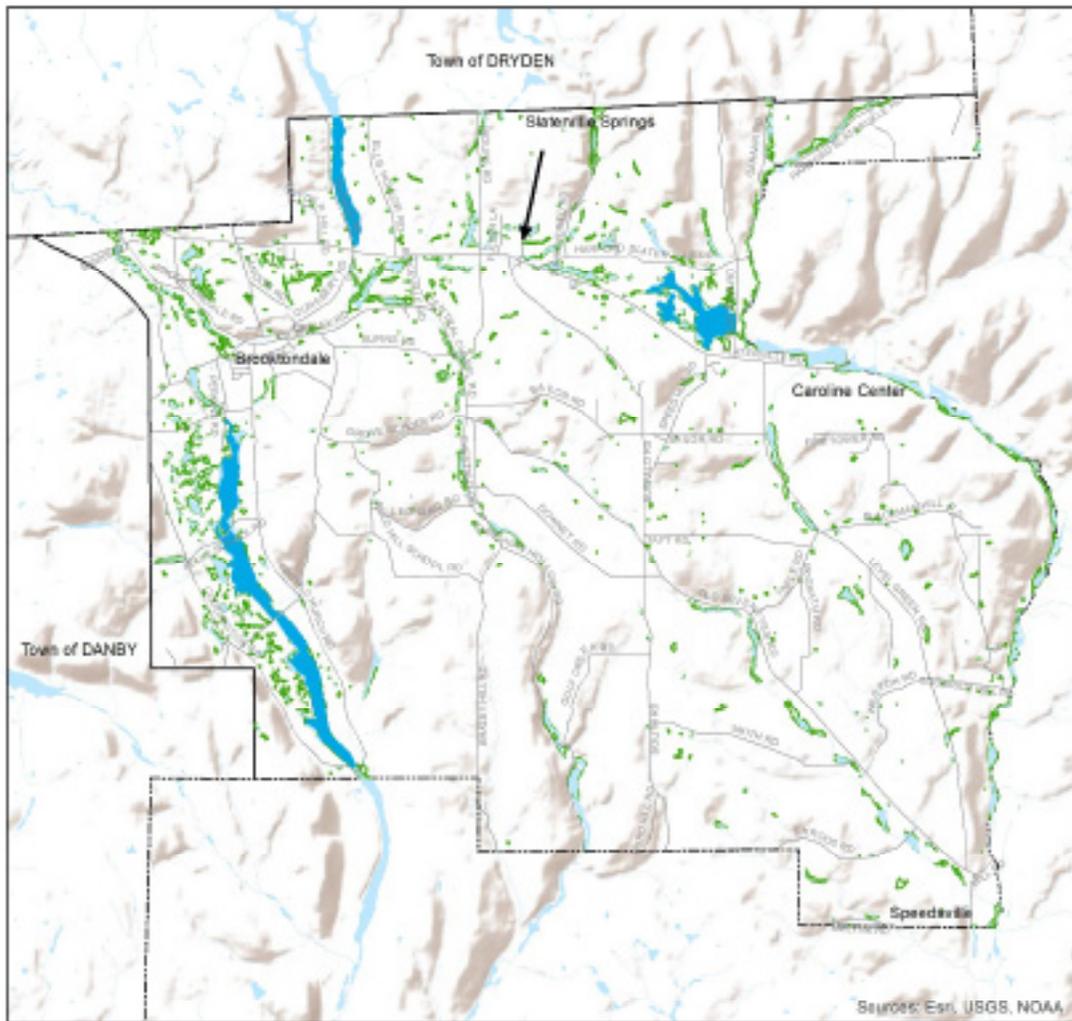
Ithaca Service Center, <https://offices.sc.egov.usda.gov/locator/app?service=action/1/ServiceCenterSummary/4/agencyToOfficeLink>

Wetlands, <https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/water/wetlands/>

Wetlands Reserve Program, <https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/easements/wetlands/>

U.S. Fish and Wildlife Service, National Wetlands Inventory, <https://www.fws.gov/wetlands/data/State-Downloads.html>

Caroline Wetlands

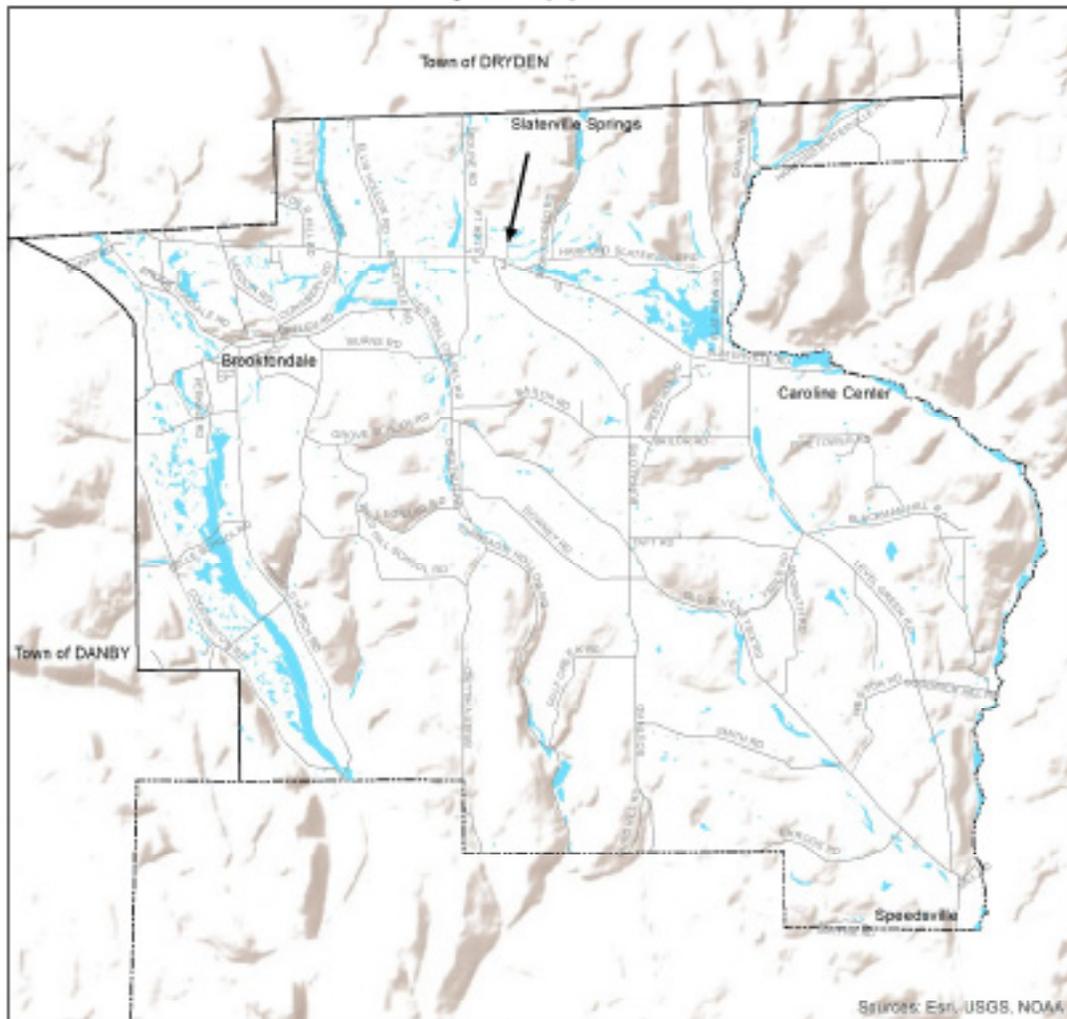


-  Tompkins Co. Municipal Boundaries
-  Caroline roads
-  DEC Mapped Wetlands
-  National Wetland Inventory Wetlands
-  Tompkins County Mapped Wetlands



2019 Caroline NRI
 Created By: CCE-Tompkins
 Date Created: 1/25/2019
 Data Source: CUGIR, USGS
 Projection: NAD83_New_York_Central_ftUS

2015 County Mapped Wetlands



0 1.25 2.5 5 Miles



-  Tompkins Co. Municipal Boundaries
-  Caroline roads
-  Tompkins County Mapped Wetlands

2019 Caroline NRI
 Created By: CCE-Tompkins
 Date Created: 1/25/2019
 Data Source: CUGIR, USGS
 Projection: NAD83_New_York_Central_ftUS

FLOOD HAZARD AREAS

What Are Flood Hazard Areas?

Flood Hazard Areas (FHA) are areas that the Federal Emergency Management Association (FEMA) has determined to be vulnerable to flooding. See Table 6 for a description of flood event frequencies.

Why Are Flood Hazard Areas Important?

Flood events are part of natural hydrological and seasonal cycles and may also occur more frequently as the global climate changes. The size and location of the areas, which are typically inundated during flood events, as well as the magnitude of the event, are significantly influenced by the total area of impervious surface (roads, parking lots, etc.) and wetlands within a watershed. Creation of or increases in impervious surfaces, diversion of water off the landscape (to ditches or nearby water bodies), and the loss of wetlands that help store and control floodwaters cause higher volumes and peak flows of stormwater runoff. It should also be noted that while floods can cause damage to infrastructure, the economy, and the environment, periodic inundation can benefit the habitat of certain flora and fauna species and add nutrients to agricultural lands located in flood areas.

Flood Hazard Areas in Tompkins County

FEMA produces paper Flood Insurance Rate Maps (FIRMs) to show areas subject to flooding as determined by historic, meteorological, and hydrological data, as well as open space conditions, flood control structures, and land use in the watershed at the time the FEMA study is conducted. These maps delineate Special Flood Hazard Areas, which are areas that “will be inundated by the flood event having a 1% chance of being equaled or exceeded in any given year,” commonly referred to as 100-year or base flood areas. These maps may also include the elevation of the base flood (100-year flood event), flood insurance risk zones, and areas subject to inundation by a 0.2%-annual-chance or 500-year flood event, all of which may be used to establish the National Flood Insurance Program’s (NFIP) flood insurance premiums.

Climate Change in Flood Hazard Areas

As most would expect, flood hazard areas are prone to increased risks of flooding over the course of time as weather patterns become more extreme. While Flood Hazard Area maps provided by FEMA can depict a great deal of areas that are threatened by flooding, it is important to note that most these maps and data are outdated, as FEMA does not consider the forecasted changes of climate change. As a result, the maps do not depict all areas that are actually affected by flooding. According to the National Weather Service, with current and forecasted weather patterns in New York State and the region’s relatively mountainous characteristics, streams that are only 6 inches deep could easily swell up to 10 feet deep in less than an hour. Additionally, with the fluctuating winter weather patterns, snowmelts can also contribute to serious flooding which could overwhelm streams, ditches and infrastructure that is not built to handle such high quantities of runoff. Such events could thus cause floods in unforeseen areas and lead to damage that is not covered by FEMA’s Flood Insurance Program. While there are multiple different approaches to mitigating these type of problems (as listed on page), it is up to individual communities to determine which areas might be most affected by extreme weather patterns.

According to the NYS DEC, flooding events in Upstate NY are expected to increase at a constant rate of 17% every decade. While this increase might sound modest for some, the implications of such increases not only means an overall increase in 100 and 500 year floods (maps depicted below), but also the geographical expansion of such flooding events. While avoiding such changes might not be possible, acquisition and preservation of these flood hazard areas determined by the community is highly encouraged. Additionally, forecasting how flooding could expand and affect land not currently designated as flood hazard areas using tools from the Army Corps of Engineers such as the Climate Impact Hydrology and HEC GeoHMS from ESRI could be extremely beneficial.

Additional tools and their descriptions can be found at the following links:

- Army Corps of Engineers (ACE): https://www.usace.army.mil/corpsclimate/Public_Tools_Dev_by_USACE/
- USACE Hydrology Tools: <http://www.hec.usace.army.mil/software/>
- ESRI Flood Planning: <https://solutions.arcgis.com/local-government/help/flood-planning/>

Maps and Data

FEMA publishes the data from paper FIRMs and Letters of Map Revision (LOMRs) online as a digital database called the National Flood Hazard Layer (NFHL). FEMA also offers Flood Risk Maps (FRM), Flood Risk Reports (FRR), and Flood Risk Databases (FRD) online to help community officials and the general public assess and visualize flood risk. The flood hazard boundary has an effective date of 1985. The age of the base data should be considered when using these maps for planning purposes.

The measurement used to estimate the frequency of a flood event can be confusing because a 100-year flood event is not a flood event that is likely to occur once every 100 years. Rather, it has a one percent chance of occurring or being exceeded during a one-year period, a 10% chance of occurring during a 10-year period, an 18% chance of occurring in a 20-year period, and so on. The following table shows the likelihood of occurrence of flood events during specified intervals of time.

Table 6: Likelihood of Experiencing at Least One Flood Event

Flood Event	In 1 year	In 10 years	In 20 years	In 25 years	In 30 years	In 50 years	In 100 years
10-year	10%	65%	88%	93%	96%	99%	99.99%
25-year	4%	34%	56%	64%	71%	87%	98%
50-year	2%	18%	33%	40%	45%	64%	87%
100-year	1%	10%	18%	22%	26%	39%	63%
500-year	0.2%	2%	4%	5%	6%	10%	18%

Source: *Water Courses* Vol. 5, Issue 1, Spring 1998. A Newsletter from Cornell Cooperative Extension and the Department of Soil, Crop and Atmospheric Sciences, Cornell University

Flood zones in Caroline are located along Six-Mile Creek, and on the eastern and south western borders of the municipality. While the central mass of Caroline is flood zone free, many of the ma-

ior hamlets such as Brooktondale, Slaterville Springs and Speedsville all lie in proximity to these zones. Only 100-year flood zones are present in Caroline.

The map on page 36 shows the 100-year flood zone in Caroline. The data for this map is available via the Tompkins County Open Data Portal under the name “[Floodzones](#).” To view FEMA maps, please visit their website at <https://msc.fema.gov/portal>. Because this 1985 data is outdated, new data should be collected in order to better evaluate flood hazards, especially as flooding becomes more frequent as a result of climate change.

What Can Be Done?

- **Flood Management Plan:** The purpose of this document is to explore emergency procedural actions for communities and better prepare them for future flooding events. While it is up to each individual municipality to create these documents, having such documents can be highly effective before, during and after flood events. Information in this section is meant to supplant these kind of documents and act as a reference.
- **FEMA Community Rating System:** By better understanding flood-hazard areas and preparing for future flooding events, municipalities can improve their FEMA Community Rating system score which would thus reduce the overall cost of flood insurance for all residents within the designated municipality (assuming enrollment). As this NRI provides the basic overview of flood hazard areas, it is the building blocks to helping prepare for future flooding events and educate governmental officials around existing flood hazard areas
- **Comprehensive Plan:** By fully understanding the existing flood hazard areas, municipalities can start considering projects that would make their community more resilient. Creating these long term goals and initiatives could then be incorporated into the municipal comprehensive plan. This would not only contribute to a more sustainable future, but would also increase the municipality’s chance of receiving funding for future resiliency/ infrastructure-related projects.
- **Storm water Management Plan:** By having clear delineation of flood hazard areas, municipalities can create a flood control plan, or a storm water management plan to protect residents in flood hazard areas from future flood damage. This would not only act as a roadmap to improving infrastructure and protecting existing natural resources, but would also clarify the future goal of the community.
- **Flood Preparedness Guide:** This is simply an informational factsheet that would act as a guide before, during, or after a flooding event. The fact sheet would have the basic emergency procedures on what to do and who to contact. This document can be designed for individual municipalities or even for the county.

Resources and References

Federal Emergency Management Act (FEMA)

Town of Caroline, Flood Map Service Center, <https://msc.fema.gov/portal/search?AddressQuery=caroline%20ny#searchresultsanchor>

National Flood Insurance Program, <https://www.fema.gov/national-flood-insurance-program>

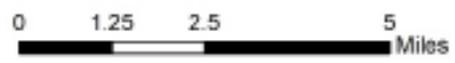
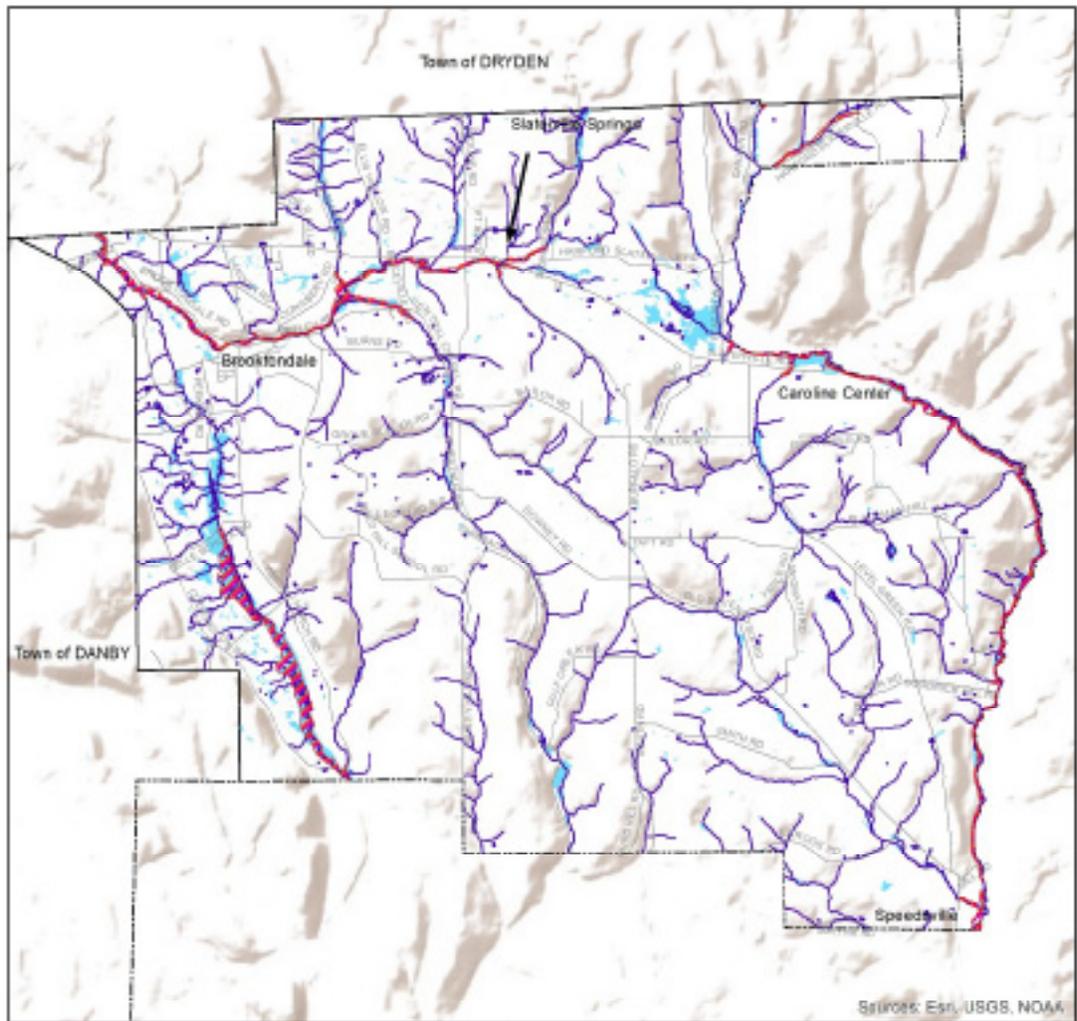
National Weather Service Temperature Map: <https://www.weather.gov/current>

Tompkins County GIS Division, <http://www.tompkinscountyny.gov/gis>

Tompkins County Open Data Portal, <https://tcdata-tompkinscounty.opendata.arcgis.com/>

Tompkins County Planning Department, <http://www.tompkinscountyny.gov/planning>

100-Year Flood Zones



-  Caroline roads
-  Streams
-  Tompkins County Mapped Wetlands
-  Tompkins Co. Municipal Boundaries
-  100 Year Flood Zone



2019 Caroline NRI
 Created By: CCE-Tompkins
 Date Created: 1/25/2019
 Data Source: CUGIR, USGS
 Projection: NAD83_New_York_Central_fUS

AQUIFERS

What Is An Aquifer?

Aquifers are geologic formations beneath the Earth's surface that store and yield groundwater. One or more aquifers can lie beneath any given point on the Earth's surface; and the location, size, capacity, depth, and flow characteristics of an aquifer are directly related to the geology and hydrology of the particular aquifer and its recharge area. (See definition of recharge area below.)

Aquifers are usually described as confined or unconfined. Typically, confined aquifers are covered with, or consist of, less permeable substances such as clay or contiguous shale. Unconfined aquifers consist of unconsolidated materials such as sand and gravel, which allow substances to easily percolate from the surface to the aquifers below.

The uppermost boundary of surficial aquifers (those closest to the Earth's surface) is defined by the water table, which is where the spaces in unconsolidated sediments and the openings in bedrock are fully saturated. The spaces between soil and rock particles in the unsaturated zone, located above the water table, are only partially occupied by water. The water table rises and falls depending on the rates of groundwater recharge and discharge, the capacity of the aquifer, the rate of water use by plants on the surface (transpiration), and water withdrawals.

Aquifers can be replenished—or recharged—by the infiltration of precipitation and surface water runoff through soil, as well as by surface water resources such as streams, creeks, wetlands, and floodplains. The land area that contributes to this infiltration is called a recharge area. Recharge areas may replenish aquifers directly beneath them (as in the case of unconfined or surficial aquifers) or they may recharge aquifers far away (as in the case of confined aquifers).

Why Are Aquifers Important?

Aquifers are an important source of water for residential, commercial, and industrial uses. In Central New York, groundwater typically contributes more than half of the total annual flow to local streams and creeks.

Because aquifers are replenished by the infiltration of surface water, impervious surfaces (pavement from roads or parking lots, roofs, building footprints, etc.) decrease recharge areas and threaten aquifers by inhibiting infiltration of precipitation and surface water through the soil. Any contaminant contained in or near an aquifer and/or its recharge area may potentially contaminate the aquifer. Potential contaminants include bacteria and pathogens leaching from septic systems; gas, salt, and oil washed from parking lots; fertilizers; pesticides; hazardous or toxic waste spills; and petroleum or oil leaking from underground storage tanks.

Some groundwater migrates slowly and can take several years to decades or even centuries to move contaminants from the point of origin to the point of discharge. Once degraded, an aquifer can become unusable, and oftentimes remediation is not technologically or economically feasible. Moreover, because of groundwater and surface water interactions, contamination in an aquifer may eventually contaminate surface water as well.

The quantity of water contained within an aquifer and the aquifer's ability to serve as a reliable

supply of water must also be considered. Generally, an aquifer's geology, retention, and recharge characteristics determine the quantity of water available. When water is withdrawn at a rate faster than it is recharged, the aquifer can be depleted. Generally, this occurs when too many wells withdraw water from an aquifer.

The map below depicting aquifers and abandoned landfills can also be seen as a map that depicts area of concern for contamination. While it can be difficult to track the behavior of aquifers, the locational information depicted on the map can be used to better understand what areas can be preserved and protected to mitigate future contamination of these valuable resources. This is especially important with continuously increasing amounts of runoff from agricultural lands and urban impermeable surfaces which carry contaminants that could be harmful to both the environment and human health.

Aquifers in Caroline

The process of glaciation and the subsequent deposition of coarse sand and gravel deposits heavily influenced the location, size, and capacity of aquifers in Tompkins County. As a result, several small discontinuous local aquifers in Tompkins County were created that support limited numbers of wells while others supply vast quantities of water. The Town of Caroline has a large continuous aquifer across the northern and western portions of the municipality, with small pockets forming the eastern border. Smaller, disjointed aquifers form diagonals across the center. There are landfills located in proximity to some of these small aquifers.

Bedrock aquifers (interlayered sandstone, siltstone, and limestone) typically yield much less water than sand and gravel aquifers. Although bedrock aquifers may be sufficient to supply individual residential units and small farms, the water may be heavily mineralized and relatively unreliable.

What Can Be Done?

- **Groundwater Management Plan:** Groundwater is necessary for a community to exist. While most communities throughout the US rely on groundwater, it is not regularly discussed among municipal and planning officials. However, it is crucial to protect these natural resources for both the environment and public safety. This manual is intended to act as a guide for protecting as well as restoring damaged aquifers. Further information and guidance can be found at Global Water Partnership (<https://www.gwp.org/en/>). While the GMP is primarily used in developing countries with arid weather, much of the information can be useful to communities in developed countries as well, due to the increasing development and extreme weather patterns.
- **Aquifer Management Plan:** While this plan is similar to the GMP, this plan specifically guides developers and construction professionals on how to prevent any contamination of the existing aquifers. While one might assume construction firms would automatically take this responsibility, having this backup plan could protect municipalities from running into potential malpractices; in addition to the document providing clear guidance to the construction firm around its role and responsibilities (more information on this type of plan can be found at: <https://www.tceq.texas.gov/permitting/eapp/apps.html>)
- **State Environmental Quality Review Act (SEQRA):** While the primary role of SEQRA is to

help determine the environmental impacts of a specific project, aquifers are many times a primary concern as any physical modification can damage or contaminate these water sources. Thus, knowing the location of these aquifers and their designated classes can help determine their vulnerability to potential modifications and could help accelerate the SEQR process (more information can be found at: https://www.dec.ny.gov/docs/permits_ej_operations_pdf/dseqrhandbook.pdf)

Maps and Data

The following surficial aquifer map indicates the general location of aquifers in Caroline as well as abandoned landfills. The data for this map was provided by the Tompkins County GIS Division. Similar datasets containing aquifer data are available from the NYS GIS Clearinghouse under the names "[Primary Aquifers - 1:24,000](#)," "[New York State Aquifers](#)," and "[Unconsolidated Aquifers at 1:250,000](#)." This map is not intended to be used for detailed site evaluations as the determination of precise aquifer locations and characteristics requires additional evaluation.

Resources and References

Miller, T.S. (1990). Sand and Gravel Aquifers of Schuyler County, New York. U.S. Department of Energy, U.S. Geological Survey, Water-Resources Investigations Report 90-4073.

New York State GIS Clearinghouse, <http://gis.ny.gov/>

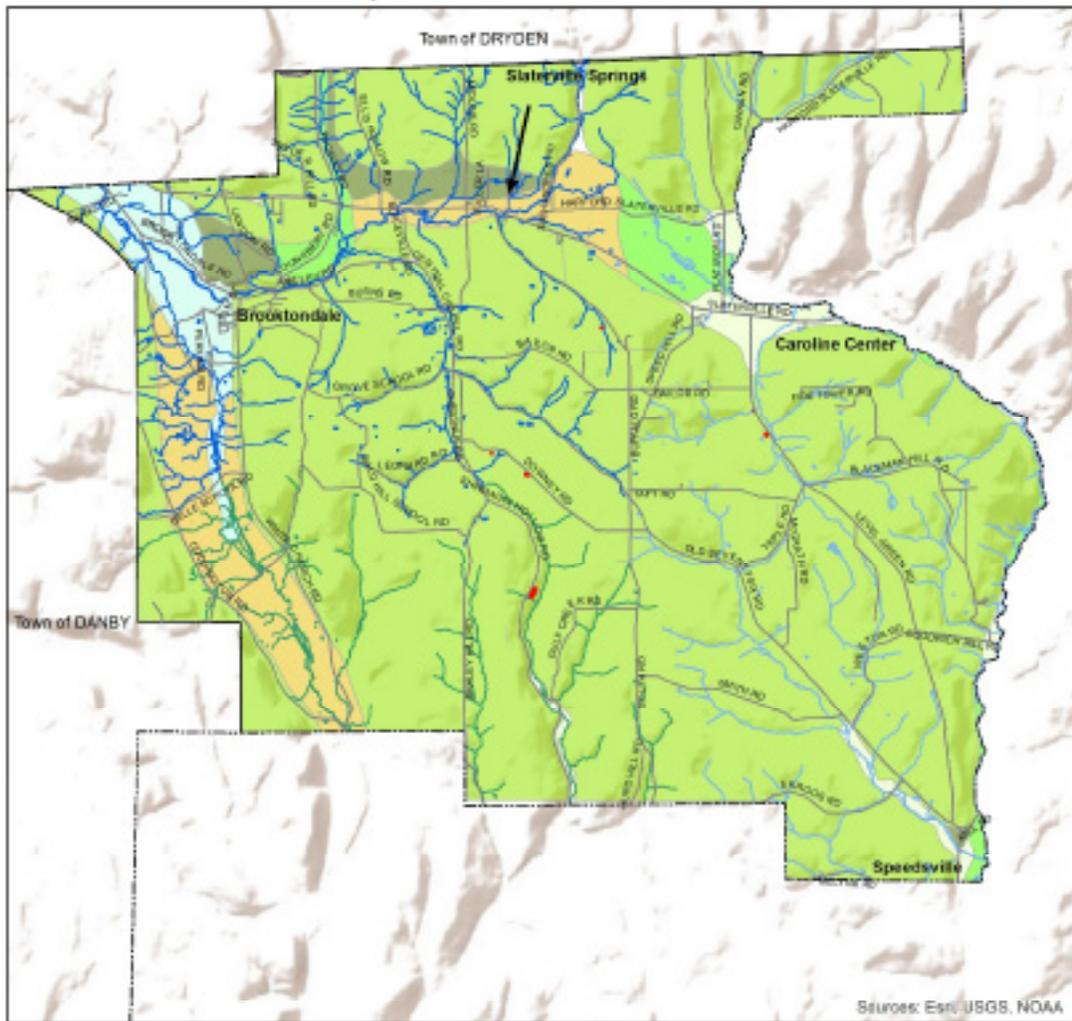
Tompkins County GIS Division, <http://www.tompkinscountyny.gov/gis>

Tompkins County Planning Department, <http://www.tompkinscountyny.gov/planning>

U.S. Geological Survey, New York Water Science Center, Ithaca Program Office, <https://ny.water.usgs.gov/about/offices/ithaca.html>

Winter, T.C., J.W. Harvey, O.L. Franke and W.M. Malley (1998). Ground Water and Surface Water: A Single Resource. USGS Circular.

Caroline Aquifer & Abandoned Landfills



0 1.25 2.5 5 Miles

— Caroline roads

--- Tompkins Co. Municipal Boundaries

■ Abandoned Landfills

WATERSHED

— Cascadilla Creek

— Cataonk Creek

— Owego Creek

— Sixmile Creek

AQUIFER

1 Alluvial S&G- unconfined

3 Outwash S&G- unconfined

4 Kame S&G- unconfined

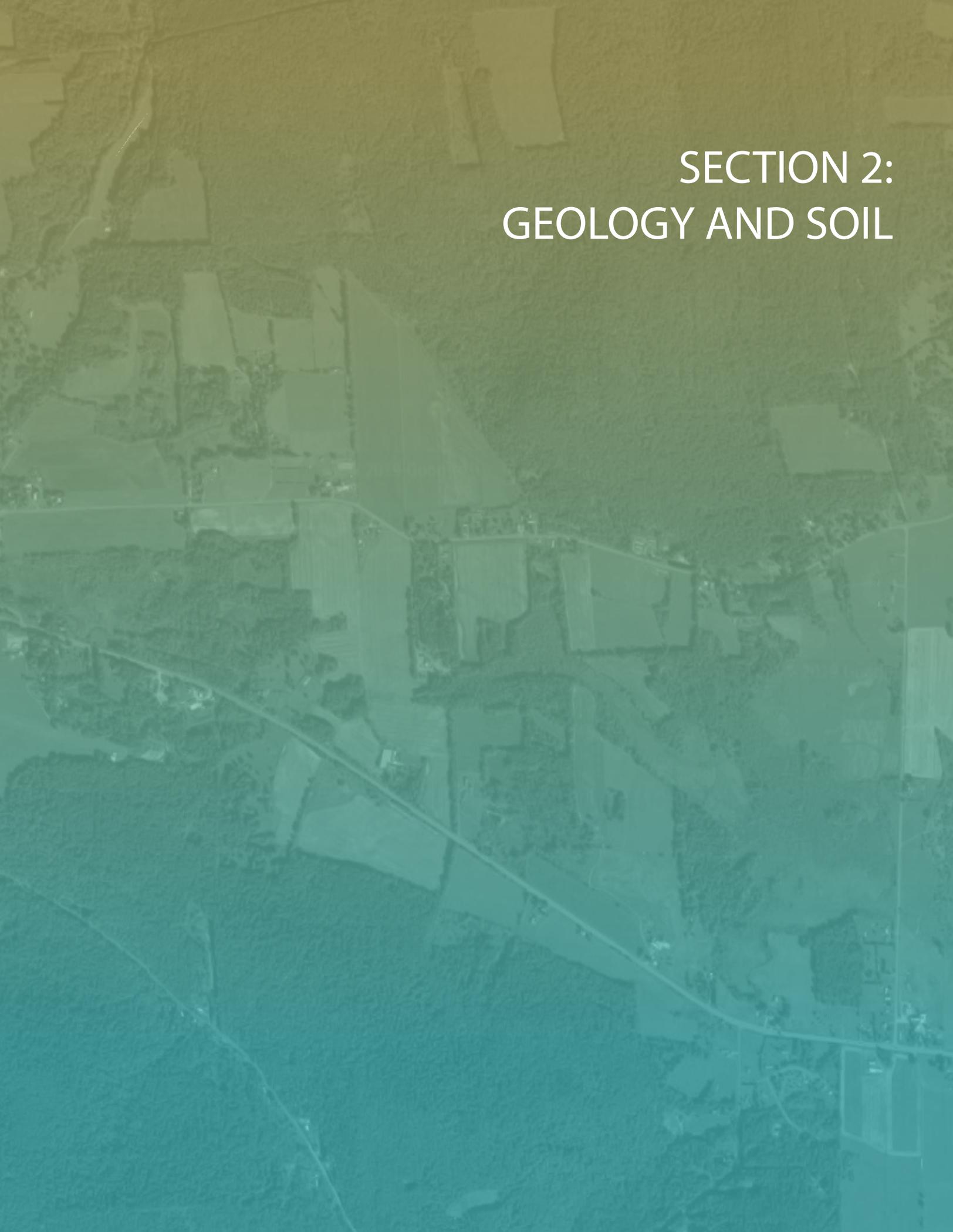
5 Sand and gravel- confined

7 Moraine

9 Till and/or bedrock

Compass rose showing N, S, E, W.

2019 Caroline NRI
 Created By: CCE-Tompkins
 Date Created: 1/25/2019
 Data Source: CUGIR, USGS
 Projection: NAD83_New_York_Central_fUS



SECTION 2:
GEOLOGY AND SOIL

SLOPE AND TOPOGRAPHY

What Are Slope and Topography?

Slope and topography describe the shape and relief of the land. Topography is a measurement of elevation, and slope is the change in that elevation over a certain distance. Topography may be measured with lines that connect points representing the same elevation; these are called topographic contours. Slope is measured by calculating the difference in the elevation from one point to another divided by the lateral distance between those points. Topographic data can also be used to create a model of the land's surface called a digital elevation model (DEM).

Why Are Slope and Topography Important?

Topography and slope should be considered when drawing up site plans for any construction project and most agricultural activities. Consideration of the slope of the land is important to reduce construction costs, to minimize risks from natural hazards such as flooding and landslides, to reduce erosion, and to minimize the impacts of proposed development on natural resources such as soils, vegetation, and water systems.

As described in Flood Hazard Areas, topography can play a major role in the amount of runoff during flash flooding. While there are many different types of topographies throughout the state, much of the Southern-tier is mountainous. This can create extremely dangerous situations for communities located along hillsides or in ravine settings, as runoff water accumulates in low elevations. As described above, flash floods can easily occur in streams and rivers located in valleys/ravines, even with moderate precipitation. As a result, communities located in these low lying area are most likely to be affected by extreme weather patterns. Thus it is important to consider topography when determining communities that are most vulnerable to flooding. The Map depicting slope and Hydrology on page 46 can be useful in helping determine the behavior of water during flooding and areas that might be prone to extreme runoff and potentially mudslides. Areas that are marked with dark blue and their surroundings are especially an area of concern, as water naturally flows downward and accumulates, thus triggering floods and mudslides.

Slope and Topography in Caroline

Tompkins County is characterized by diverse topography. The steepest parts of Caroline tend to be adjacent to streams, creeks. Much of Caroline is flat, it is suitable for development and agriculture. Table 7 summarizes the development potential of land based on its degree of slope.

Table 7: Development Potential Based on Degree of Slope

Degree of Slope	Development Potential
0% to 1%	Suitable primarily for agriculture that uses flood irrigation unless extensive drainage infrastructure is installed
1% to 3%	Suitable for most development
3% to 8%	Suitable for medium-density development
8% to 15%	Suitable for moderate to low-density residential development as well as pastures, forests, and vineyards
15% to 25%	Suitable for low-density residential development as well as pastures, forests, vineyards, and recreational uses
Over 25%	Recreational uses and open space

Sources: Anderson, L.T. (2000). *Planning the Built Environment*. New York: Routledge, and Lehigh Valley Planning Commission, *Steep Slopes: Guide and Model Regulations* (2008).

The highest point in Caroline is 602 meters (1975 feet) and the lowest point is 244 meters (800.5 feet).

What Can Be Done?

- **Runoff Calculation:** While the concept of runoff is quite simple, the behavior can be difficult to map. Often, runoff maps are created using software such as GIS to help determine where flood management and intervention is necessary. One of the key determining factors of runoff results is slope and is required to calculate the curve number which depicts the runoff.
- **Resilient Development and Infrastructure Planning:** FEMA often recommends avoiding physically modifying or developing slopes. These guidelines can be found at the link below. According to FEMA, developing slopes can drastically increase a community's vulnerability to natural disasters. Thus when conducting a feasibility analysis for a specific development project, it is important to conduct a Slope Risk Assessment. The guidance can be found at the same link below. It is important to keep in mind that increasing a community's risk to flooding by developing unstable slopes can directly negatively impact the municipality's FEMA Community Rating.

FEMA Slope Risk Assessment: https://www.fema.gov/media-library-data/1469794589266-f404b39e73fa7a1c5ffe4447636634d4/Elevation_Guidance_May_2016.pdf

Maps and Data

A hillshade map, which visualizes topography, is included on page 44 , and a map categorizing steepness of slope is included on page 45. A map showing slope with wetlands overlaid is included on page 46. The hillshade map was produced by Esri, the USGS, and NOAA at a scale of 1:70,000. The slope dataset was derived from the [Digital Elevation Model](#) created by the U.S. Geological Survey at a scale of 1:24,000.

Resources and References

Anderson, L.T. (2000). *Planning the Built Environment*. New York: Routledge.

Fakundiny, R. H., & Albanese, J. R. (2005). New York State Geological Survey (NYSGS). In P. Eisenstadt & L. E. Moss (Eds.), *The Encyclopedia of New York State*. Syracuse, NY: Syracuse University Press.

Lehigh Valley Planning Commission, *Steep Slopes: Guide and Model Regulations* (2008), <http://www.lvpc.org/pdf/SteepSlopes.pdf>

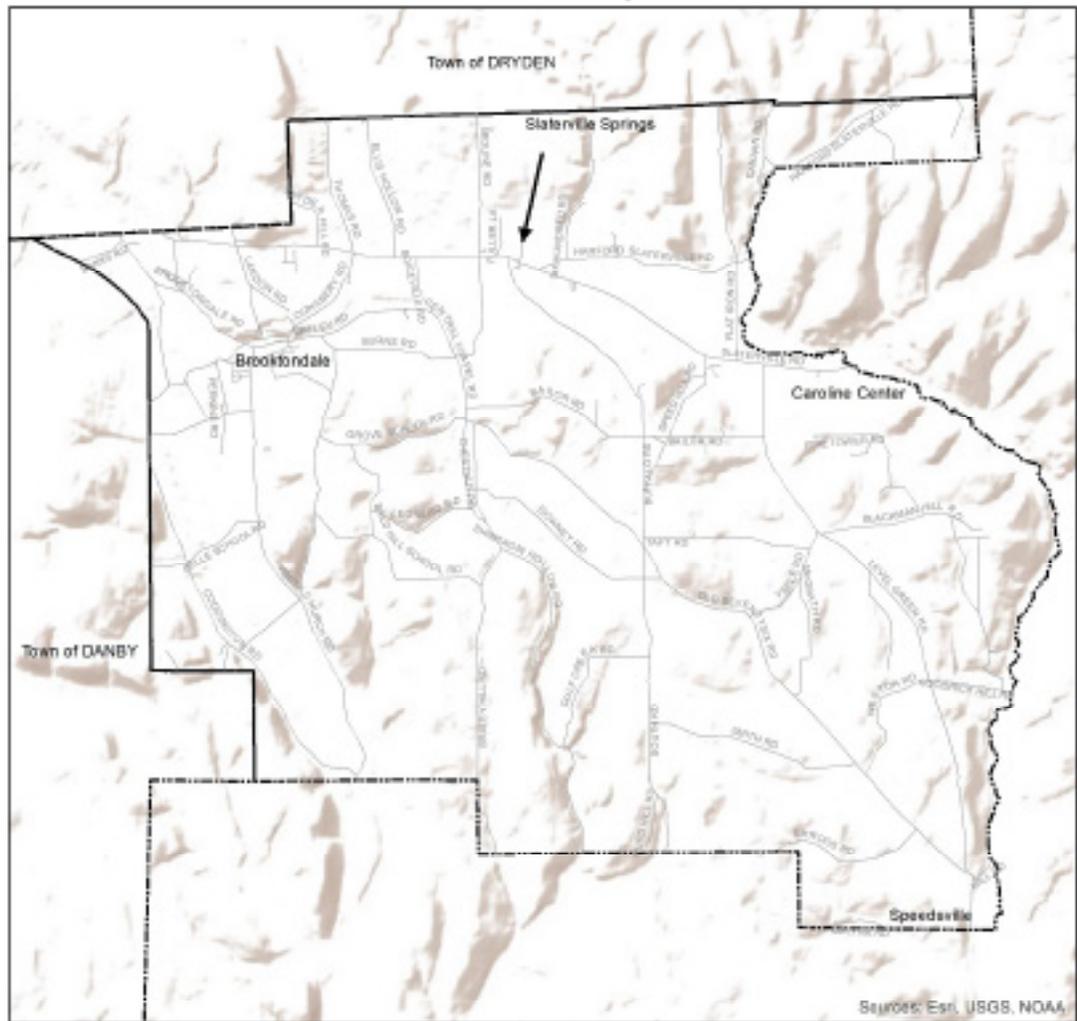
New York State GIS Clearinghouse, <http://gis.ny.gov/>

Tompkins County GIS Division, <http://www.tompkinscountyny.gov/gis>

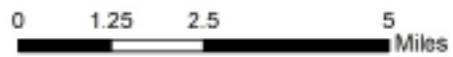
Tompkins County Planning Department, <http://www.tompkinscountyny.gov/planning>

U.S. Geological Survey, New York Water Science Center, Ithaca Program Office, <https://ny.water.usgs.gov/about/offices/ithaca.html>

Caroline Slope



Source: Esri, USGS, NOAA

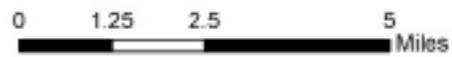
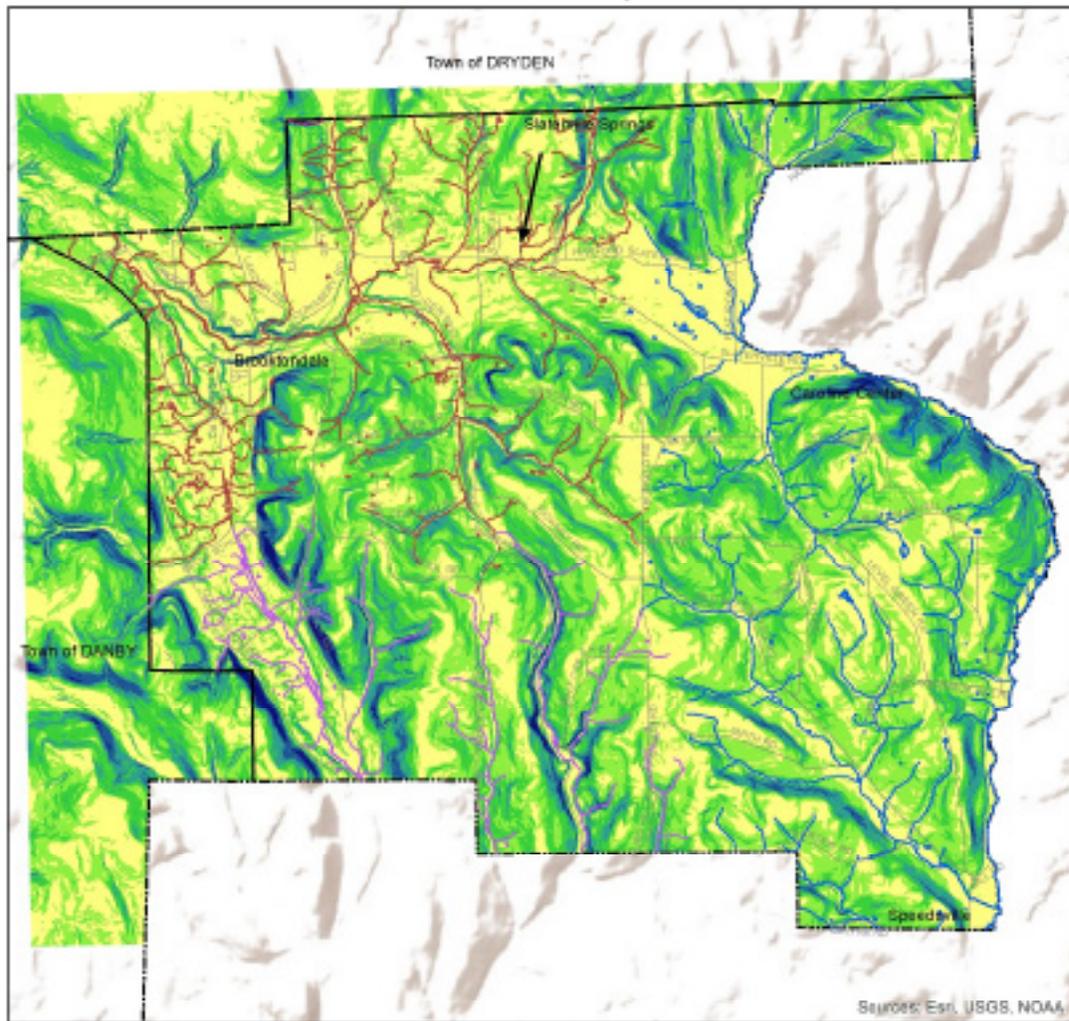


-  Tompkins Co. Municipal Boundaries
-  Caroline roads



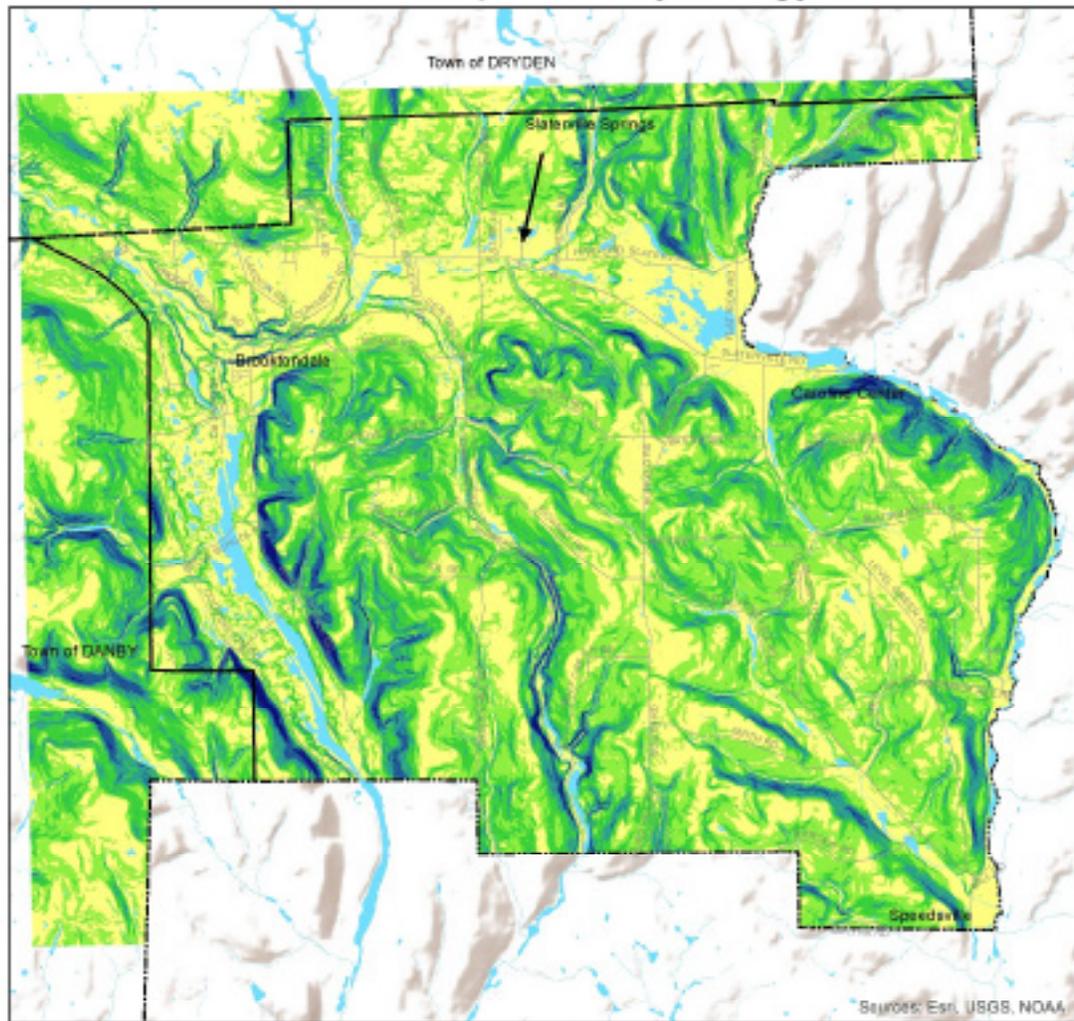
2019 Caroline NRI
Created By: CCE-Tompkins
Date Created: 1/25/2019
Data Source: CUGIR, USGS
Projection: NAD83_New_York_Central_fUS

Caroline Slope



2019 Caroline NRI
 Created By: CCE-Tompkins
 Date Created: 1/25/2019
 Data Source: CUGIR, USGS
 Projection: NAD83_New_York_Central_fUS

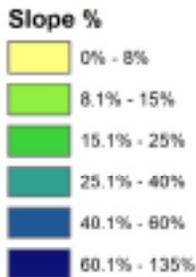
Caroline Slope with Hydrology



Source: Esri, USGS, NOAA



- Tompkins Co. Municipal Boundaries
- Caroline roads
- Water



2019 Caroline NRI
 Created By: CCE-Tompkins
 Date Created: 1/25/2019
 Data Source: CUGIR, USGS
 Projection: NAD83_New_York_Central_fUS

BEDROCK GEOLOGY

What Is Bedrock Geology?

Bedrock geology describes the basic rock formations that underlie soils and unconsolidated materials (see Surficial Geology section). Bedrock occasionally protrudes through these materials or may be exposed alongside roads and creek beds. These rocks, formed millions of years ago, constitute the foundation of materials and topography in a region. Bedrock is found beneath the soils and may, in Tompkins County, be buried beneath glacial till, composed of rock fragments of various sizes that were released from glaciers as they receded.

Why Is Bedrock Geology Important?

In Tompkins County, the depth to bedrock is relatively shallow, sometimes only 5 to 10 feet below the surface of the soil. Shallow depth to bedrock significantly impacts the location, development, maintenance, and cost of public services, such as sewers, water supply systems, and roads. Construction feasibility and costs for private investments, such as building foundations, septic tanks, and private roads, are partially dependent on the depth to bedrock. Shallow bedrock may also be subject to frost heaving and deformation. Determination of bedrock qualities must be made on a site-specific basis.

How Was Bedrock Formed?

Approximately 550 million years ago, the land that is now Tompkins County and the surrounding region was submerged under an ancient sea. Over the course of 325 million years, layers of sediment (sand, mud, salt, and lime) were deposited on the lake bottom and slowly hardened into beds of sedimentary rocks that we now know as sandstone, shale, and limestone.

Bedrock Geology in Caroline

There are three major groupings of bedrock in Caroline. The formations found within a group are shown in parentheses. The following are listed from oldest to youngest formations:

Genesee Group (Dg): This grouping of limestone, shale, and siltstone is what makes up about 8.95% of the land in Caroline, mostly in the northwestern areas like Brooktondale and Slaterville Springs.

Sonyea Group (Ds): These siltstones and shales can be found between 200 and 1,000 feet in elevation and is the most common bedrock in Caroline, making up about 46.10% of the land.

West Falls Group (Dwm, Dww): These shales and siltstones can be found at elevations between 1,100 and 1,600 feet and make 44.95% of the municipality, mostly in central and southern Caroline.

What Can Be Done?

Solid Waste and Landfill Management: Sanitary landfills are a crucial part of proper land use management. While the location of a landfill is partially determined based on the municipal officials and residents, it is also determined based on the underlying bedrock geology. If the landfill is not placed on the proper surface, the liquids leaching from the landfills could diffuse and contaminate the regional aquifers as well as the soils which could create dangerous living conditions for the local residents. More information on landfill management can be found at USGS: <https://pubs.usgs.gov/wri/1973/0050/report.pdf>

Maps and Data

The New York State Geological Survey has produced a geographic data set of bedrock geology. The Bedrock Geology map was created at a scale of 1:2,500,000, and depicts general locations of various rock formations; it should not be used for any site-specific analyses. This dataset is available via the Tompkins County Open Data Portal under the name "[Bedrock](#)."

For more detail on New York State Bedrock formations, go to the following website: <http://www.nysm.nysed.gov/data/bedrock.txt>

Resources and References

Fakundiny, R. H., & Albanese, J. R. (2005). New York State Geological Survey (NYSGS). In P. Eisenstadt & L. E. Moss (Eds.), *The Encyclopedia of New York State*. Syracuse, NY: Syracuse University Press.

Tompkins County GIS Division, <http://www.tompkinscountyny.gov/gis>

Tompkins County Open Data Portal, <https://tcddata-tompkinscounty.opendata.arcgis.com/>

Tompkins County Planning Department, <http://www.tompkinscountyny.gov/planning>

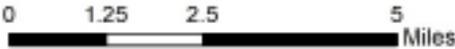
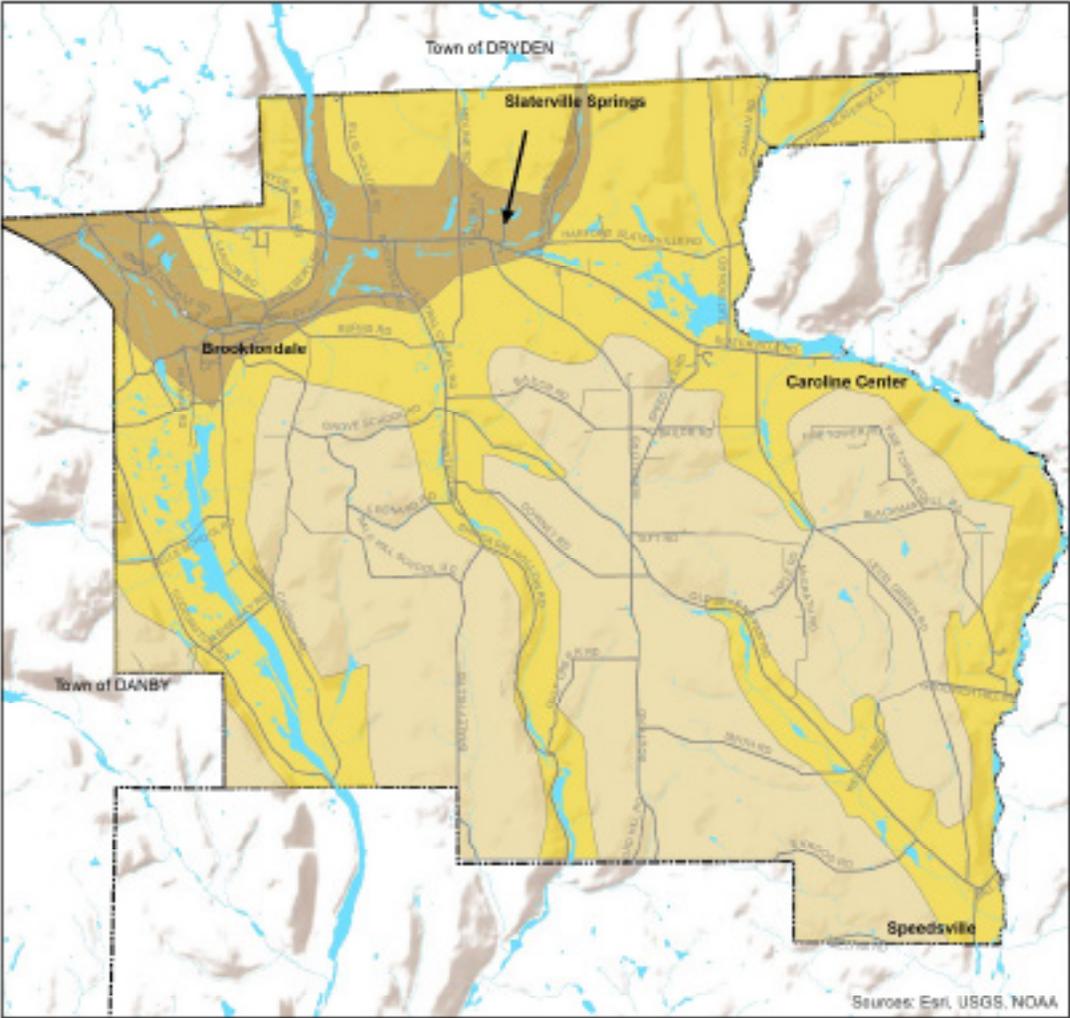
U.S. Geological Survey

National Geologic Map Database, <https://ngmdb.usgs.gov/Geolex/search>

New York Water Science Center, Ithaca Program Office, <https://ny.water.usgs.gov/about/officeithaca.html>

Von Englen, O.D. (1961). *The Finger Lakes Region: Its Origin and Nature*. Ithaca, NY: Cornell University Press.

Caroline Bedrock Geology



- Tompkins Co. Municipal Boundaries
 - Caroline roads
 - Water
- Bedrock Type**
- Beers Hill Shale (Dwm)
 - Cashaqua Shale (Ds)
 - Ithaca Formation (Dg)



2019 Caroline NRI
 Created By: CCE-Tompkins
 Date Created: 1/25/2019
 Data Source: CUGIR, USGS
 Projection: NAD83_New_York_Central_fUS

SURFICIAL GEOLOGY

What Is Surficial Geology?

Surficial geology describes the rocks and unconsolidated materials that lie between bedrock and the surface of the land. In the Finger Lakes region, glaciers that receded 12,000 to 25,000 years ago deposited these materials. When the glaciers receded, the rock and debris frozen within the ice were left behind in various formations depending upon how fast or slow the glacier receded. These formations contain various sized particles and are classified by the shape of formation, the thickness, and the type and size of particles found.

Why Is Surficial Geology Important?

Surficial geology is important because the characteristics of materials below the earth's surface influence the feasibility of constructing buildings and roads. Surficial deposits commonly determine soil composition and therefore may affect agricultural viability. This information can also be used to better understand the runoff, as permeability can vary depending geological composition and soil type (discussed in further detail below on page 57).

Additionally, while it is important to consider how the geological characteristics can handle flooding, it is also important to consider how different surfaces can be affected by droughts. While Upstate New York is fortunate to not be threatened by water scarcity, that does not mean that the ground is consistently saturated. Thus, as the community develops it is important to preserve and protect as many surfaces that are more permeable and can handle variant weather patterns. The map that depicts soil drainage (page 58) can be a useful tool to determine future land uses.

Surficial Geology Deposits in Caroline

There are five types of surficial geology deposits in Caroline:

1. **Lacustrine Sands** are well sorted (particles are of similar size) and stratified sand deposits that settled out when lakes were formed by the melting glaciers. Deposits found today range from 6 to 60 feet in thickness.
2. **Outwash Sand and Gravel** is coarse to fine gravel mixed with sand. Location is restricted to valley bottoms and stream terraces. These deposits are of variable thickness of five to 65 feet.
3. **Recent Deposits** range from fine sands to gravels and are generally confined to floodplains within a valley. They may be subject to frequent flooding and, in larger valleys, may be overlain by silt. Deposits range from 3 to 30 feet in thickness.
4. **Till** deposits are poorly sorted (particles of varying sizes) material of variable texture such as clay, silt-clay, or boulder clay that were deposited beneath the glacial ice. Permeability of these deposits varies with the amount of compaction. Thicknesses vary from 3 to 160 feet.
5. **Kame Moraines** are glacial deposits that range in size from boulders to sand deposited during glacial retreat. These deposits are found in thicknesses of 30 to 100 feet.

Table 8: Surficial Geology of Caroline

Type of Surficial Geology Deposit	Percent of Municipality
Lacustrine Sands	0.02%
Outwash Sand and Gravel	6.52%
Recent Deposits	0.15%
Till	69.53%
Kame Moraines	23.78%

What Can Be Done?

As mentioned above, this information can be used to determine runoff as well as development potential. However, this information is also often used for the following:

- **Flood Hazard Assessment:** As the surficial geology can tell much about runoff, that also means that it can tell how water will behave during a torrential downpour and thus predict how that could affect local residents within the vicinity of existing waterbodies and streams. Municipalities throughout the US use surficial geology data to better predict their community's vulnerability to floods.
- **Predicting and mapping contamination flow:** While surficial geology can help predict the flow of runoff, it can also help predict how contamination could spread. As the porosity can vary among each geological formation, knowing these characteristics can help municipalities and engineering professionals map out how a poisonous or hazardous spill spreads and whether or not remediation needs to take place.

More information on the technical analysis can be found at the following link: http://repository.azgs.az.gov/uri_gin/azgs/dlio/1456

Maps and Data

The following map shows the surficial geography of the Town of Caroline. The dataset is available from the Tompkins County Open Data Portal under the name "[Surficial Geology](#)."

Resources and References

Fakundiny, R. H., & Albanese, J. R. (2005). New York State Geological Survey (NYSGS). In P. Eisenstadt & L. E. Moss (Eds.), *The Encyclopedia of New York State*. Syracuse, NY: Syracuse University Press.

Tompkins County GIS Division, <http://www.tompkinscountyny.gov/gis>

Tompkins County Open Data Portal, <https://tcddata-tompkinscounty.opendata.arcgis.com/>

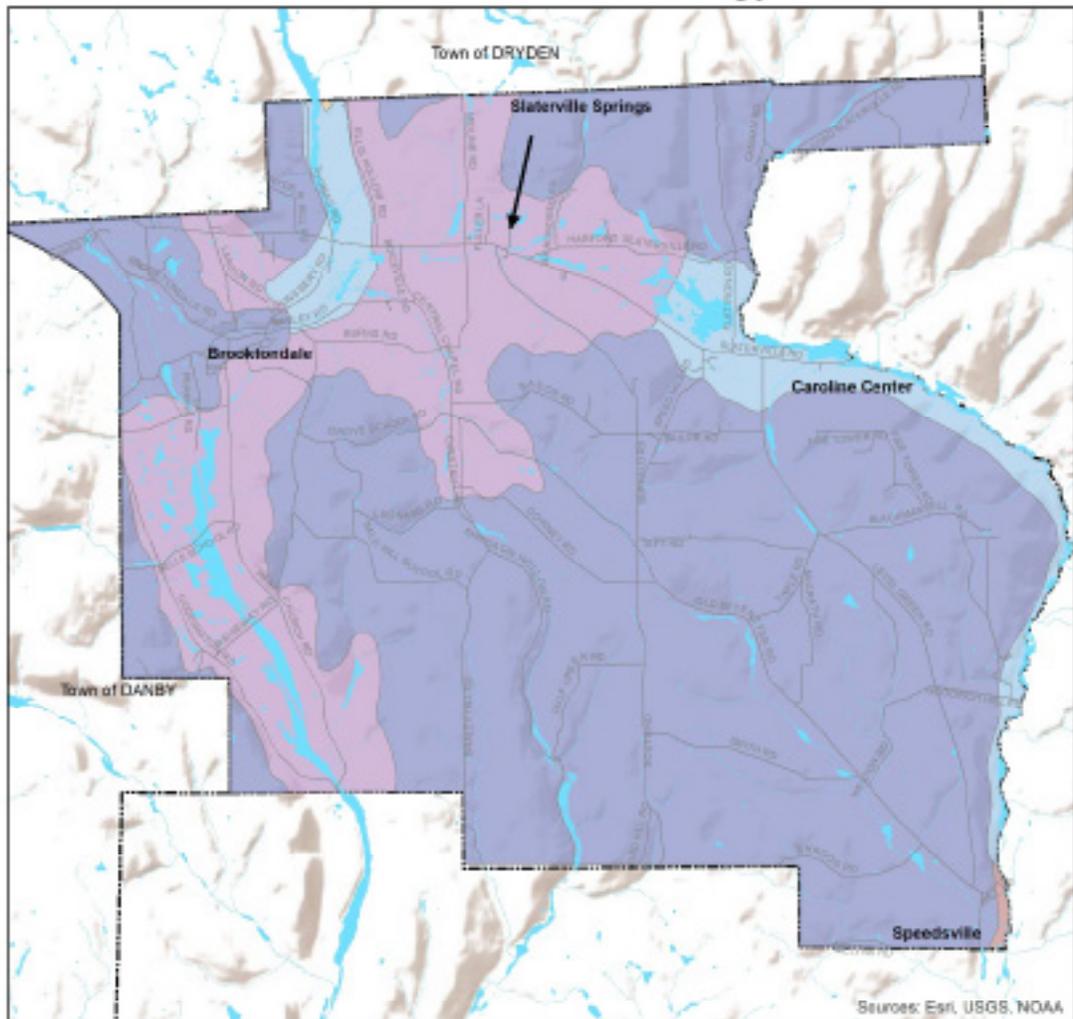
Tompkins County Planning Department, <http://www.tompkinscountyny.gov/planning>

U.S. Geological Survey

National Geologic Map Database, <https://ngmdb.usgs.gov/Geolex/search>

New York Water Science Center, Ithaca Program Office, <https://ny.water.usgs.gov/about/officeithaca.html>

Caroline Surficial Geology



Sources: Esri, USGS, NOAA

Tompkins Co. Municipal Boundaries

Caroline roads

Water

Surficial Geology Type

Kame Moraine

Lacustrine Sand

Outwash sand and gravel

Recent Deposits

Till

0 1.25 2.5 5 Miles



2019 Caroline NRI
 Created By: CCE-Tompkins
 Date Created: 1/25/2019
 Data Source: CUGIR, USGS
 Projection: NAD83_New_York_Central_fUS

SOILS

What Are Soils?

Soil is a mixture of mineral particles, organic matter, water, and air. Soils are often described in terms of their primary texture (e.g., sand, silt, and clay).

Why Are Soils Important?

Soils affect a variety of human activities from agriculture to the engineering and construction of roads, buildings, and sewage disposal systems. They are critical in determining the productivity and viability of agricultural operations. The United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) evaluates soils in terms of their capability to support agriculture. These range from Class I soils, which are productive and easy to work, to Class VIII soils, which are not suitable for growing crops, pasture, or trees for profit.

Planning boards, elected officials, zoning officers, developers, etc., can use soil maps to identify areas suitable for future development of homes, industry, agriculture, and recreation. For example, a soil map may indicate poorly drained areas, which should not be used for residential development because of the need for costly drainage facilities and because they may be sites of existing or potentially restored wetlands. Soil maps can also be used to assess the likelihood of finding suitable sites for individual, on-site, sewage disposal systems.

Classification of Soils

NRCS (and its predecessor, the Soil Conservation Service) is the agency responsible for preparation of maps showing soil series containing soils that share common profiles. Soil series are further divided into soil types that share common physical features, general properties that affect the use of the soil, and properties that limit suitability for cultivation.

Rhinebeck, Niagara, Hudson, Dunkirk, and Collamer series soils can support hay, oats, corn, small grains, small fruits, and some vegetables. These soils can also be used as pasture. Trees that grow well with this soil include sugar maples, red oaks, black cherries, basswood, hickories, and hemlocks.

Volusia, Mardin, and Lordstown series soils are often cleared but idle. Much of these soils are reverting to brush and trees. These soils can be used to support silage corn, small grains, hay, and pasture. Some farmers have grown potatoes in this soil on sloping areas. Wooded areas on these soils support sugar maple, beech, white ash, black cherry, and hemlock.

Wayland, Palmyra, Howard, and Chenango series soils can support hay, corn, small grains, vegetables, fruits, and nursery stock. Chenango series soils can also be used for growing grapes. All of these soils make good pasturelands. Woodlots on these soils often have sugar maples, red maples, American beech, eastern hemlocks, white pines, and black cherries.

In addition to being evaluated in terms of agricultural viability, soil types have been assessed by the NRCS in terms of their suitability for various types of development. Soil characteristics that are considered in this assessment are depth to seasonal high water table, depth to bedrock, flood potential, and permeability. Depth to seasonal high water table affects both building foundation

and septic system siting. A seasonal high water table can cause flooding in basements or cause a septic system to malfunction. A high water table can also affect the ability of a soil to support weighty structures.

Permeability and soil types

As described above in Surficial Geology, all surficial characteristics, including soil types can have a major impact on determining the characteristics of flooding as well as the structural stability of the surrounding lands. Soil types also determine land use such as agricultural, urbanized, and conserved lands, which also have major effects on the volume of runoff and thus the contamination of local and regional aquifers, wetlands, and waterbodies.

Soils can be broken down into four Hydric Soil Categories (HSC) based on their permeability. The list below was originally retrieved from the Engineering Division of the Natural Resource Conservation Service, United States Department of Agriculture, Technical Release-55 and can be a useful description in determining the characteristics of local soils:

Group A is sand, loamy sand or sandy loam types of soils. It has low runoff potential and high infiltration rates even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sands or gravels and have a high rate of water transmission.

Group B is silt loam or loam. It has a moderate infiltration rate when thoroughly wetted and consists chiefly or moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures.

Group C soils are sandy clay loam. They have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine structure.

Group D soils are clay loam, silty clay loam, sandy clay, silty clay or clay. This HSG has the highest runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface and shallow soils over nearly impervious material.

As for the soil types that exist in the Town of Caroline, the table below shows which soils belong to which Hydrologic Soil Groups:

Soil Name	Hydrologic Soil Group
Rhinebeck-Niagara-Hudson-Dunkirk-Collamer	C/D
Volusia-Mardin-Lordstown	D
Wayland-Palmyra-Howard-Chenango	B/D

NOTE for Dual Category: The first letter applies to the drained condition/ and the second to the undrained condition.

The above can help determine not just the permeability of the soil, but also the characteristics

of erosion due to precipitation. Volumes of silt and sand can determine the soil’s erosion factor; higher volume of silt and sand means higher erosion, and thus higher possibilities of landslides. With this information, the soil types map on page 57 can be useful when determining what areas are most suitable for development and or conservation.

What Can Be Done?

As there are similarities between surficial geology and soil types, this data can be used for similar purpose. However, this data is additionally applicable to the following as well:

- **Soil Management Plan:** As soil can be a valuable resource, especially for agricultural purposes, it is important to maintain high protection standards when making modifications to a property. A soil management plan can achieve just that by directing and guiding municipal and contract workers to mitigate any potential accident that could lead to soil contamination. At the same time, the soil management plan can also help municipal officials to decide how to develop their municipality as well as determine what parcels should be designated as agricultural land. More Information can be found at: https://www.waterboards.ca.gov/rwqcb2/board_info/agendas/2015/November/Hamilton-Square/Soil_Management_Plan.pdf
- **Drought Planning:** While flooding is and will continue to be a major issue with climate change, droughts will also be another issue that communities will incur. While the idea around drought planning is to help communities prepare for future droughts within their municipality and throughout the region, the soil and its behavior during these events is a major factor in determining a community’s resilience. While it is impossible to change a soil type, communities can modify existing land uses and land cover to better prepare for future extreme weather events.

The following link can be useful for drought planning: <https://drought.unl.edu/drought-planning/PlanningHome.aspx>

Soils are mapped at various levels of detail, the two most common being general soil maps and soil surveys.

General soil maps show soil associations that share a characteristic landscape and pattern of soils. The soils within any one association may be somewhat similar, but they commonly differ in many important characteristics. These maps are suitable for planning large areas such as multi-county regions and large drainage basins. A general soil map for Caroline is included on page 57. The data used to create this map comes from the [U.S. Department of Agriculture’s Natural Resources Conservation Service’s Soils Division’s U.S. General Soil Map](#), downloaded in 2015. A summary of soil types in Caroline is included in Table 9.

Table 9: Soil Types in Caroline

Soil Type	Percent of Land in Municipality
Rhinebeck-Niagara-Hudson-Dunkirk-Collamer	0.18%
Volusia-Mardin-Lordstown	77.56%
Wayland-Palmyra-Howard-Chenango	22.26%

Soil survey maps are more detailed. The area of soil delineated on these maps can be as small as one or two acres. These maps can be used for planning at the county or municipal level. This soil

data is available via the U.S. Department of Agriculture's Natural Resources Conservation Service's Soils Division.

Also included are a map of drainage based on soil type (see page 58), a map of prime agricultural soils (see page 59), and a map of hydric soils. The soil drainage map is derived from the U.S. General Soil Map. The data for the prime agricultural soils and hydric soils were provided by the Tompkins County GIS Division.

Soil drainage refers to a soil's ability to retain water and is influenced by soil texture and organic content. The soil drainage map classifies Wayland-Palmyra-Howard-Chenango as soils that drain well; Rhinebeck-Niagara-Hudson-Dunkirk-Collamer as soils that drain moderately well; and Volusia-Mardin-Lordstown as somewhat poorly drained. Water and urban land are categorized as "somewhat excessively drained." Most of Caroline consists of Volusia-Mardin-Lordstown soil and is thus mostly categorized as somewhat poorly drained.

According to the USDA, prime agricultural land "is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is available for these uses." This land is determined based on soil quality, the length of the growing season, and moisture supply. Most of Caroline does not qualify as prime agricultural land, either as-is or if drained.

Lastly, hydric soils are soils that lack oxygen for an extended period of time due to saturation or flooding, such as soils in wetlands. Hydric soils can be naturally or artificially produced.

Resources and References

Cornell Cooperative Extension, Cornell Small Farms Program, Soil Drainage, <http://smallfarms.cornell.edu/plan-your-farm/accessing-evaluating-land/evaluating-land-tutorial/know-your-soils/soil-drainage/>

Tompkins County GIS Division, <http://www.tompkinscountyny.gov/gis>

Tompkins County Planning Department, <http://www.tompkinscountyny.gov/planning>

Tompkins County Soil and Water Conservation District, <http://www.tompkinscountyny.gov/swcd>

U.S. Department of Agriculture, Natural Resources Conservation Service, Soil Division

Hydric Soils – Introduction, https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/use/hydric/?cid=nrcs142p2_053961

Official Soil Series Descriptions (OSDs), https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/class/data/?cid=nrcs142p2_053587

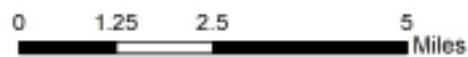
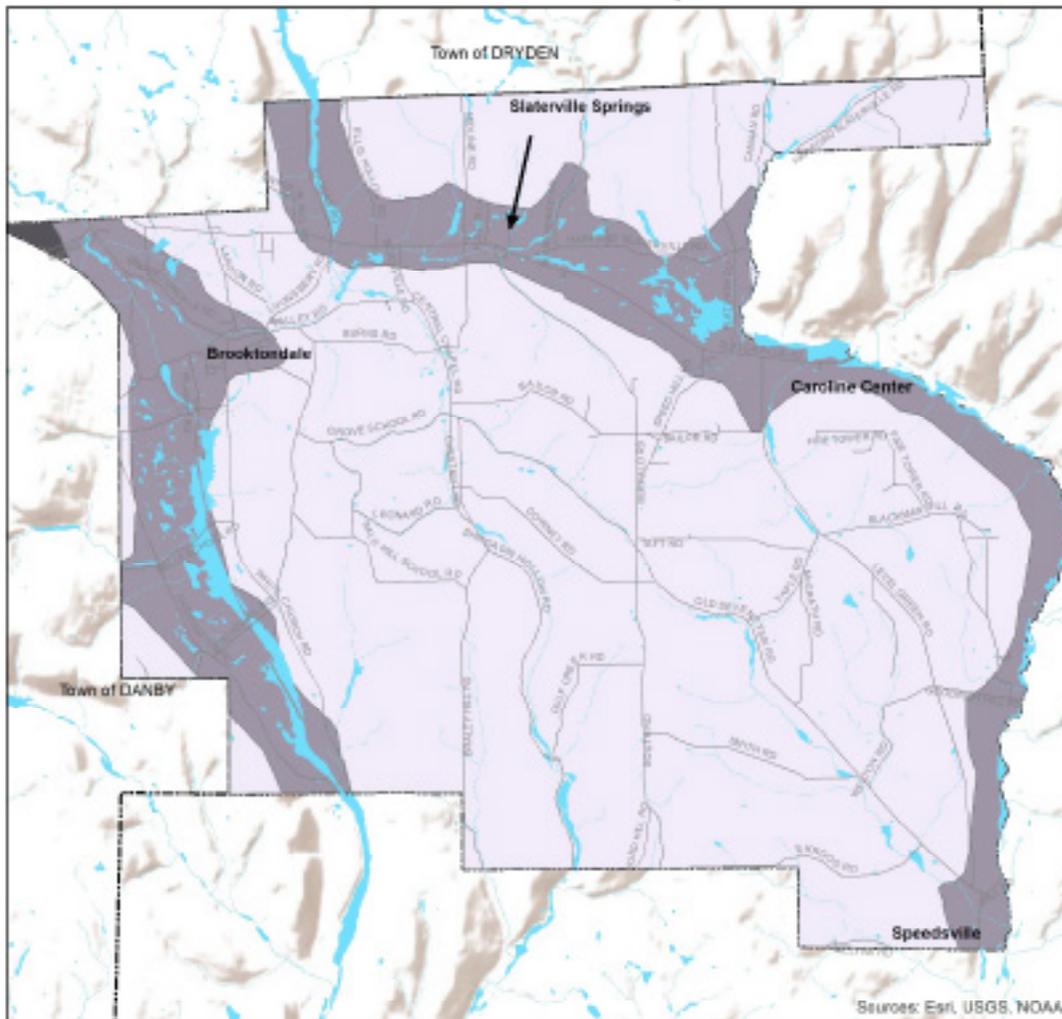
U.S. General Soils Map, <https://gdg.sc.egov.usda.gov/GDGOrder.aspx?order=QuickState>

U.S. Department of Agriculture, Soil Conservation Service, & Cornell University Agricultural Experiment Station. (1965). Soil Survey: Tompkins County, New York (1961 No. 25). Washington, D.C.: U.S. Government Printing Office.

US Department of Agriculture National Engineering Handbook Par 630 Chapter 7: <https://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17757.wba>

USDA Web Soil Survey: <https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx>

Caroline Soil Map

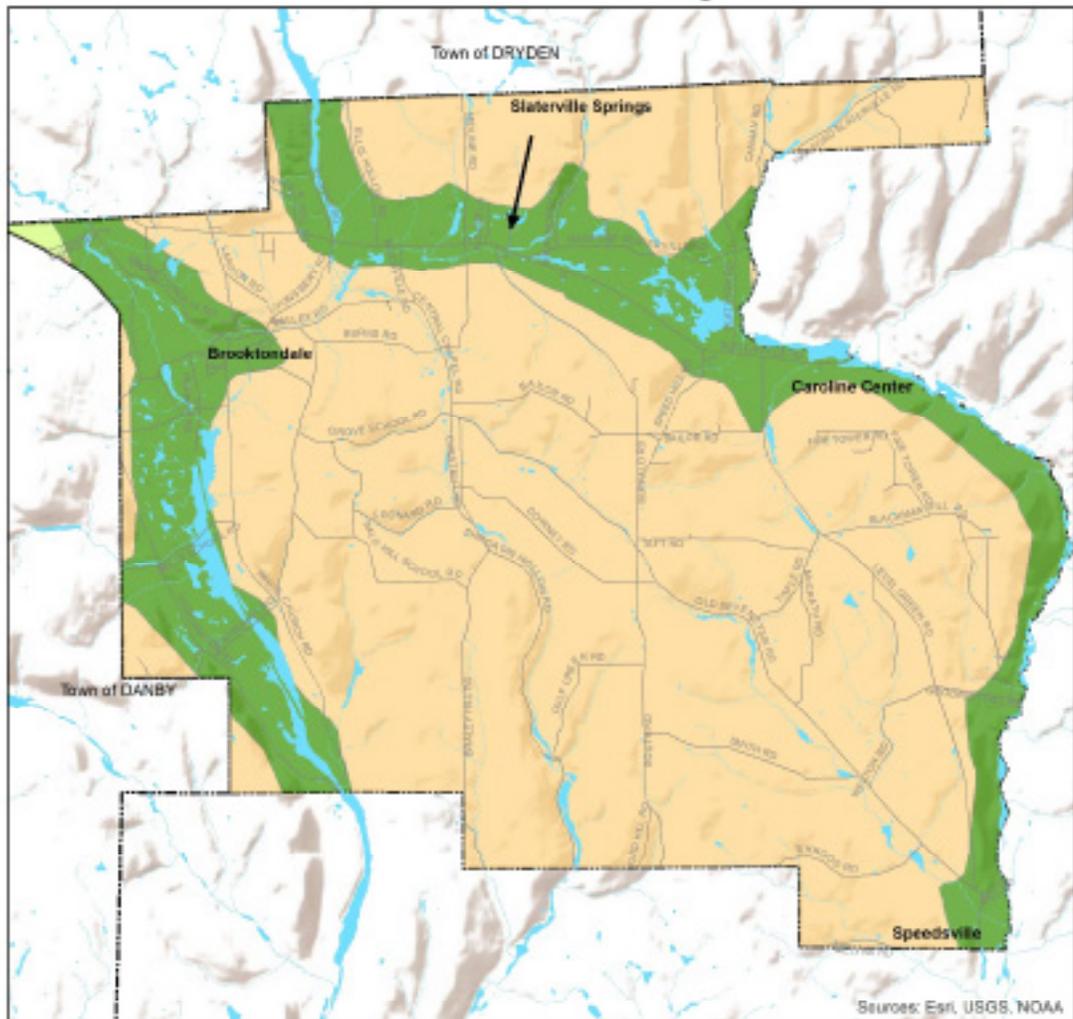


- Tompkins Co. Municipal Boundaries
- Caroline roads
- Water
- Soil Type**
- Rhinebeck-Niagara-Hudson-Dunkirk-Collamer (s5987)
- Volusia-Mardin-Lordstown (s5975)
- Wayland-Palmyra-Howard-Chenango (s5983)



2019 Caroline NRI
 Created By: CCE-Tompkins
 Date Created: 1/25/2019
 Data Source: CUGIR, USGS
 Projection: NAD83_New_York_Central_ftUS

Caroline Soil Drainage



0 1.25 2.5 5 Miles

-  Tompkins Co. Municipal Boundaries
-  Caroline roads
-  Water
- Drainage**
-  Somewhat poorly drained
-  Moderately well drained
-  Well drained



2019 Caroline NRI
 Created By: CCE-Tompkins
 Date Created: 1/25/2019
 Data Source: CUGIR, USGS
 Projection: NAD83_New_York_Central_fUS

Caroline Prime Farm Land



Sources: Esri, USGS, NOAA

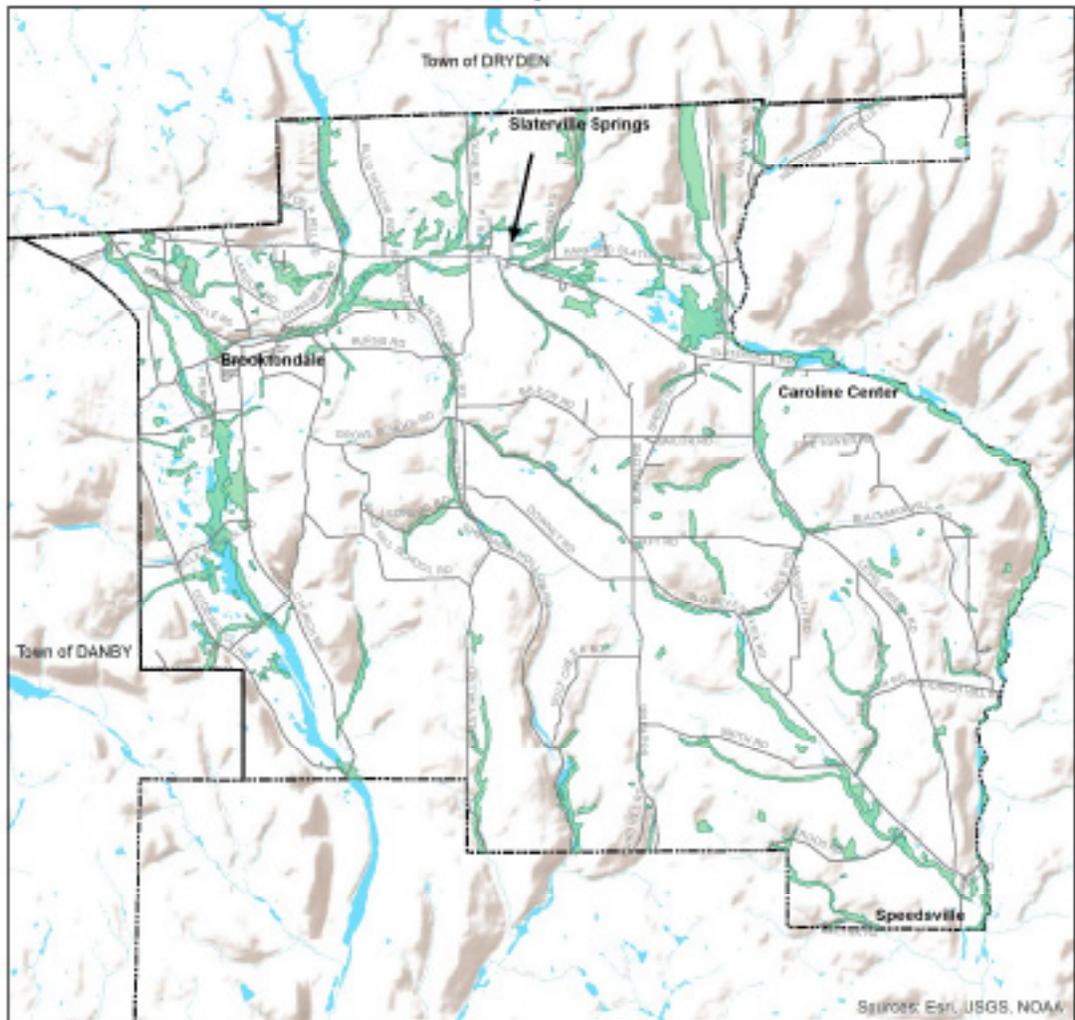


- Prime Farmland
- Prime Farmland if Drained
- Caroline roads
- Water
- Tompkins Co. Municipal Boundaries



2019 Caroline NRI
 Created By: CCE-Tompkins
 Date Created: 1/25/2019
 Data Source: CUGIR, USGS
 Projection: NAD83_New_York_Central_fUS

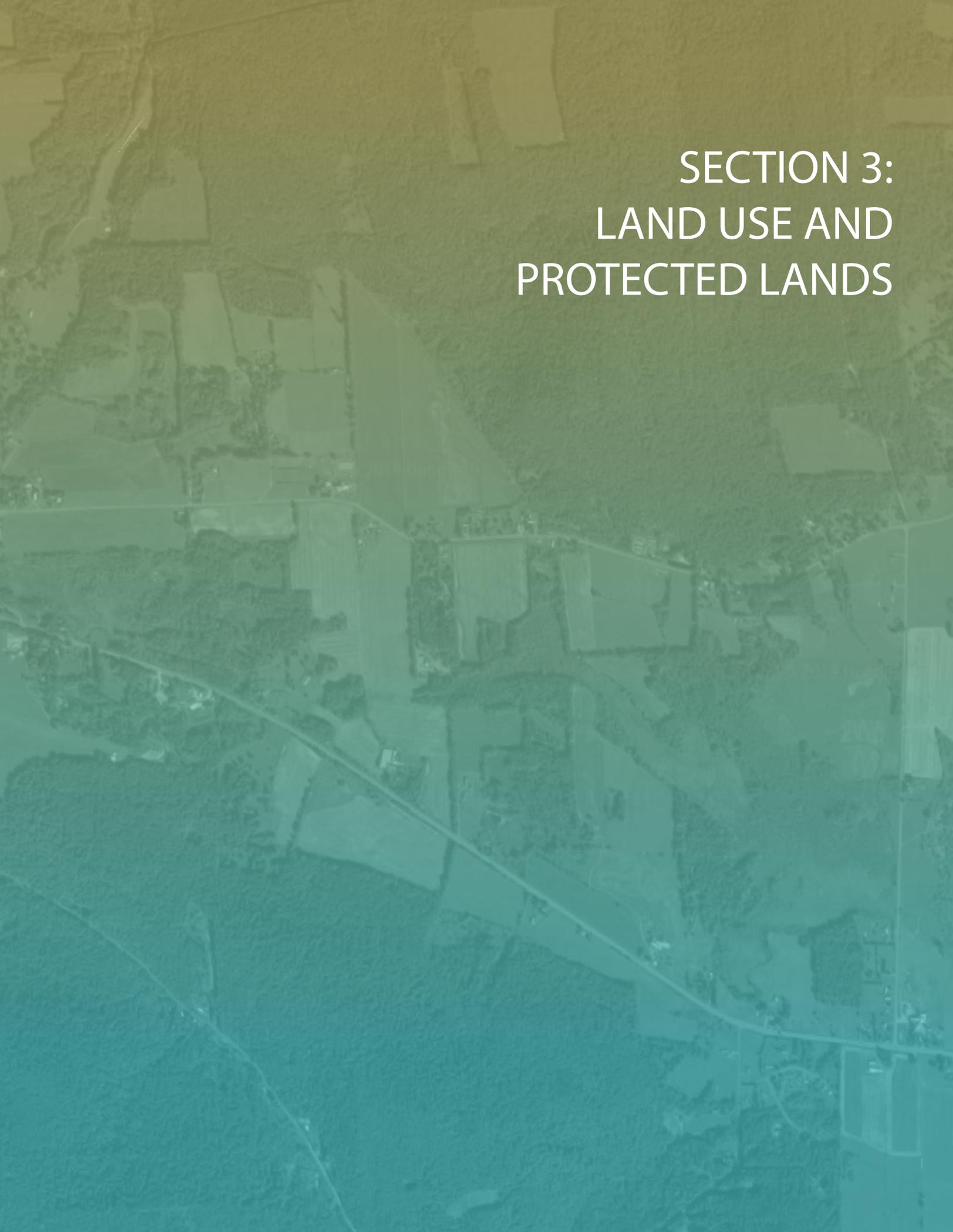
Caroline Hydric Soils



- HydricSoils_Caroline
- Caroline roads
- Water
- Tompkins Co. Municipal Boundaries



2019 Caroline NRI
 Created By: CCE-Tompkins
 Date Created: 1/25/2019
 Data Source: CUGIR, USGS
 Projection: NAD83_New_York_Central_fUS



SECTION 3:
LAND USE AND
PROTECTED LANDS

LAND USE AND LAND COVER

What Are Land Use and Land Cover?

Land use refers to how humans use the landscape and includes categories such as residential development and agriculture. Land cover refers to the physical cover of the land, whether natural or manmade. These categories range from forests and wetlands to impervious surfaces and cleared fields.

Why Are Land Use and Land Cover Important?

The current land use and land cover information enables communities to identify existing land use patterns, and, consequently, make better informed decisions concerning proposed land uses, development suitability analyses, and comprehensive planning. These data provide a static picture of development patterns and may be used as a benchmark for future land use and land cover analyses. In addition to future development patterns, this data may also be used for historical analyses when old data becomes available in Geographic Information System (GIS) format.

As previously discussed, due to increasing extreme weather patterns, it is important for a community to carefully plan development and future land use to prevent any unnecessary disturbance to the area. It is also helpful to consider how the land cover will change with the increasing temperatures and how, as a result, land use and development can be affected. According to the USDA, native tree species such as the Sugar Maple are projected to migrate north between now and 2100. In addition to changing species, the density of forests is expected to thin-out over time, causing less ground stability and thus increased potential for landslides. Between 2000 and 2050, the northeast is expected to have an overall decline in forest and cropland by 7 and 6% respectively. While it is not possible to predict exactly how the land cover will change over time, it is possible to forecast change by referring to and cross-comparing current with historical land cover maps.

Because land use and land cover can directly be controlled by government, updating land use and zoning laws according to current projections can have a drastic positive impact on both the well-being of the community and environment. Historical Land cover data can be retrieved from the USDA website (<https://datagateway.nrcs.usda.gov/>). The maps below are also useful as they depict the present land uses. As developed and agricultural land uses increase, it is vital to fully understand current land cover characteristics and agricultural lands and identify the changing trends of the municipality.

By comparing current land covers and FEMA flood maps, it is possible to see how changing land cover has influenced the behavior of flooding. Also, by overlaying soil types with land cover, it is possible to determine the parcels that should be protected versus those that can potentially be developed without causing disturbance to current wildlife corridors or floodplains.

Land Use and Land Cover in Caroline

Land use and land cover data from 2015 have been mapped into a single GIS coverage, Land Use and Land Cover (LULC), which form a basis for comprehensive study of the land surface in Tompkins County. Individual classes are grouped into main categories. The data for the Town of Caroline is as follows:

Agricultural Districts

Agricultural Districts provide the framework to limit unreasonable local regulation on farm practices, to limit public agencies' ability to acquire farmland by eminent domain and to limit the use of public funds to construct facilities that encourage development of farmland. Also, benefit assessments, special ad valorem levies, or other rates and fees for financing of improvements such as water, sewer or non-farm drainage may not be imposed upon land used in agricultural production and within an New York State Certified Agricultural District. Much of the town of Caroline is designated as an agricultural district by New York State.

Table 10: Land Use and Land Cover by Category

Category	Percentage of Total Area Including Water Bodies	Percentage of Total Land Area	Examples of Individual Classes
Agriculture	13.35%	13.39%	Cropland, pastures
Barren or Disturbed	0.33%	0.33%	Vegetation has been cleared but no development
Commercial	0.16%	0.16%	Retail stores, offices
Inactive Agriculture	3.85%	3.86%	Agricultural land not in use
Industrial, Transportation, and Transmission	0.27%	0.27%	Utilities, pipelines, highways, railroads
Public/Institutional	0.20%	0.20%	Educational facilities, cemeteries, public works
Recreation	0.13%	0.13%	Golf courses, ball fields, parks
Residential	4.36%	4.37%	High, medium, and low density residential
Water	0.29%	—	Natural lakes, ponds
Wetlands	3.01%	3.02%	NYSDEC or national wetlands
Vegetative Cover	74.05%	74.27%	Forests, brush

What Can Be Done?

- **Calculating Runoff Curve Number:** While soil data and surficial geological data both can be used to help calculate runoff, it is crucial to also use land cover data as well. The reason for this is that land cover often determines how well the water can be absorbed (by the plants) and whether or not the water would be retained by the existing vegetation. If the land is barren and has relatively low levels of vegetation, that usually means that water will not be retained. Whereas, lush forests, wetlands, and grasslands are more likely to be well drained.
- **Suitability Assessment:** Often development suitability assessment is determined based on multiple factors such as economic and physical characteristics of the site. In terms of physical characteristics, land cover is a major factor in determining its potential use. For example, grassland that is well drained is going to have more potential in terms of develop-ability. On the other hand, wetlands obviously are not going to be prime investment real estate. Land cover also helps municipal officials how to enforce zoning and other land use regulatory tools. More information can be found at: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/?cid=nrcs143_008438
- **Open Space Planning:** The basic idea of open space planning is to determine what undeveloped lands should remain undeveloped. While this is a version of preservation, open space planning specifically concentrates on land that provides a sense of openness

as well as greenery within the community. Public lands such as municipal or even state park are considered a version of open space. More information on this topic can be found at the following link: <https://www.dec.ny.gov/lands/98720.html>

- **Invasive Species Management Plan:** As an initiative developed by the USDA to combat invasive species, the document is meant to provide a strategized approach to monitoring and controlling new and foreign species. The national management plan (can be accessed below) has created a method on how to identify invasive species and produce regional and or municipal ISMPs and develop a strategy to help control the spread of these invasive species. As much of New York State is experiencing the impact of these invasive species, it will become more important to develop a systematic strategy as the climate continues to change.

National Management Plan: <https://www.doi.gov/sites/doi.gov/files/uploads/2016-2018-nisc-management-plan.pdf>

Example: State of PA Invasive Species Management Plan: http://www.docs.dcnr.pa.gov/cs/groups/public/documents/document/dcnr_002854.pdf

Example: Municipality of Whistler CA Invasive Species Management Plan: https://www.whistler.ca/sites/default/files/related/rmow_ismp_2014_1.pdf

- **Zoning:** Zoning is the primary regulatory tool that directly impacts the characteristics of land use and thus land cover. While existing land uses are usually the primary concern to municipal officials and developers, land cover is many times also a major factor which determines a parcel's develop-ability, as mentioned above. More information of this topic can be found at the following link: https://www.dos.ny.gov/lg/publications/Rural_Resource_Survey.pdf

Maps and Data

The map on page 65 shows land use/land cover in Caroline. Data for this map was provided by the Tompkins County GIS Division and was last updated in 2015. Although the 2015 data is not available online, the 2012 data is available from CUGIR under the name "Land Use and Land Cover, Tompkins County NY 2012." For more information on the Land Use Land Cover Project methodology, contact the Tompkins County Planning Department.

Resources and References

Cornell Cooperative Extension, ulster.cce.cornell.edu/agriculture/farmland-access-protection/agricultural-districts

Cornell University Geospatial Information Repository (CUGIR), <https://cugir.library.cornell.edu/>

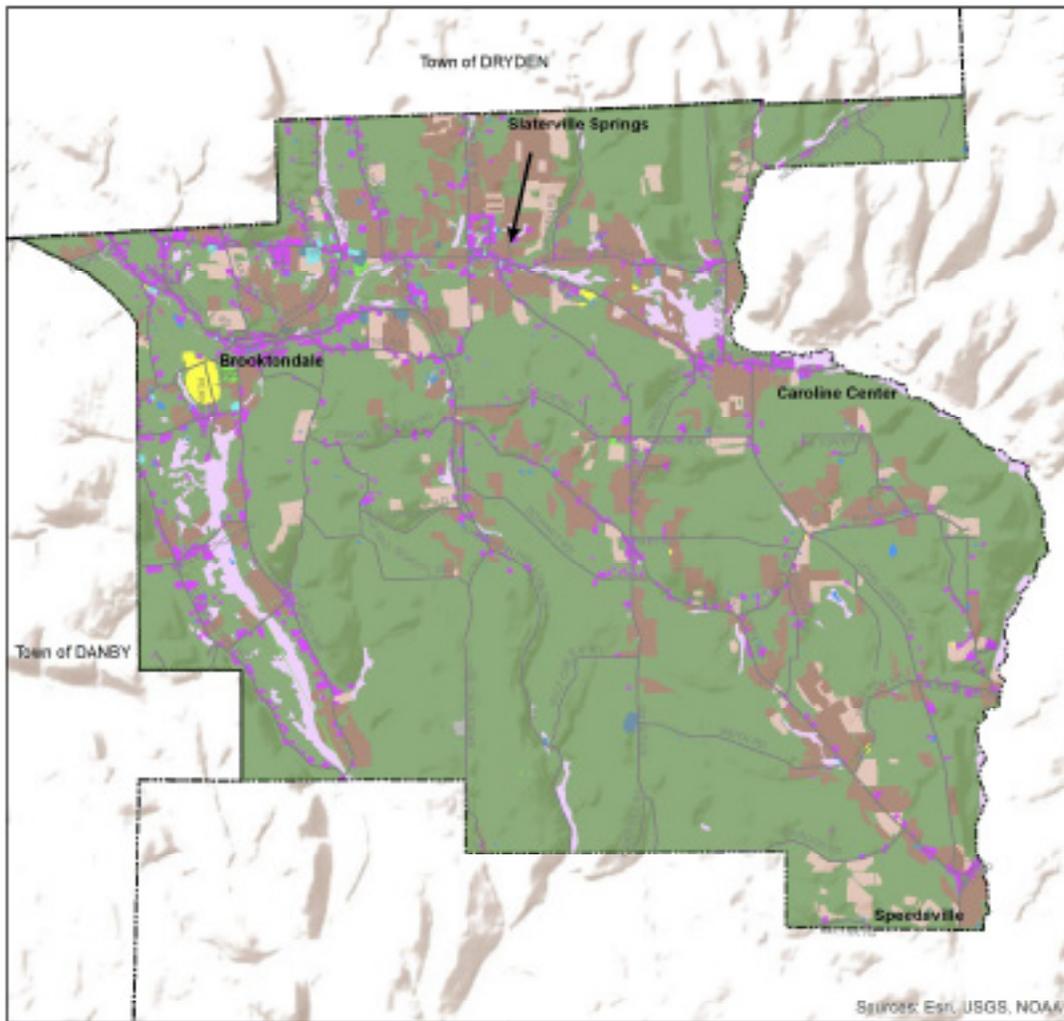
Cornell University Institute for Resource Information Systems (IRIS), <http://iris.css.cornell.edu/index.html>

Tompkins County GIS Division, <http://www.tompkinscountyny.gov/gis>

Tompkins County Planning Department, <http://www.tompkinscountyny.gov/planning>

US Department of Agriculture, <https://www.fs.usda.gov/ccrc/topics/species-distribution-models>

Caroline Land Use/ Land Cover

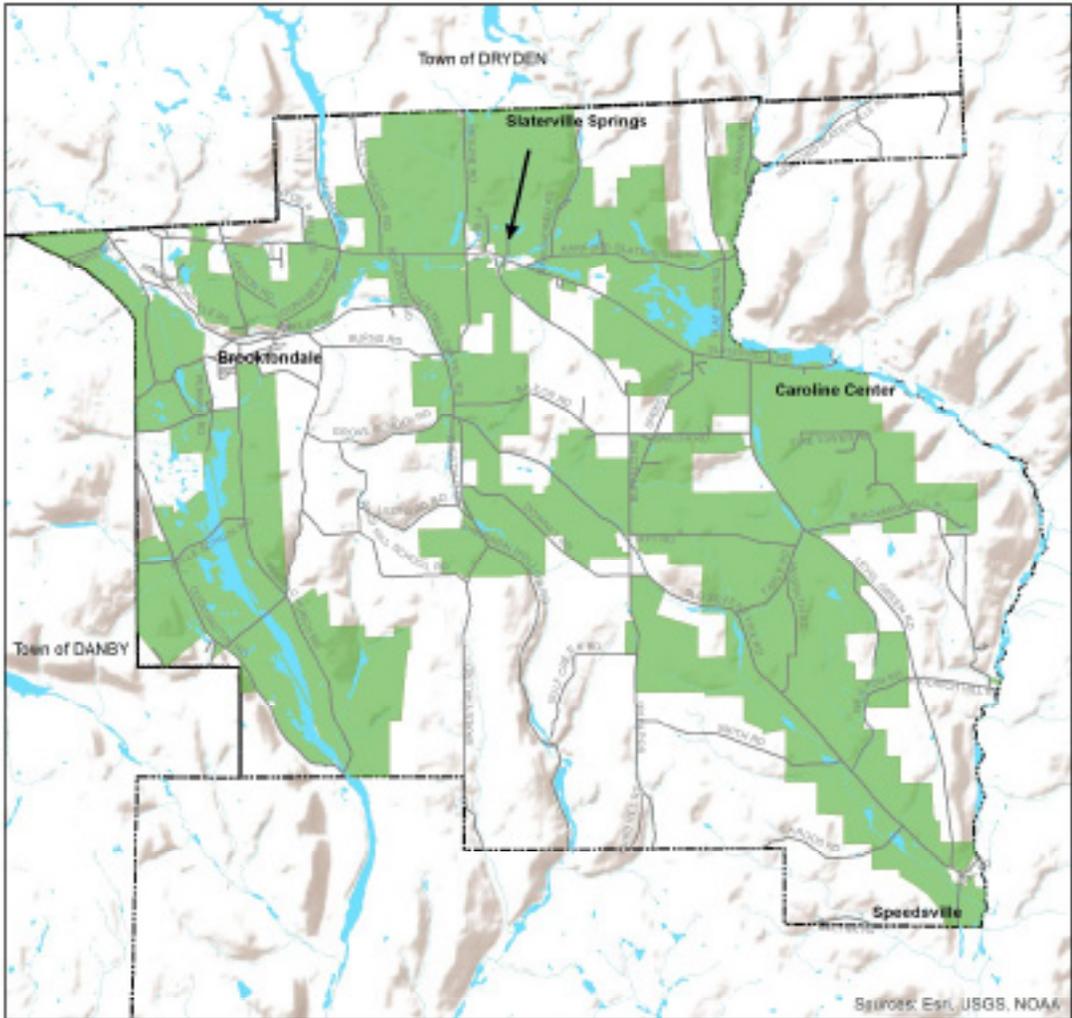


- | | |
|--|----------------------|
| Tompkins Co. Municipal Boundaries | Public/Institutional |
| Land Use & Land Cover | Recreation |
| Agriculture | Residential |
| Barren or Disturbed | Vegetative Cover |
| Commercial | Water |
| Inactive Agriculture | Wetlands |
| Industrial, Transportation, Transmission | Caroline roads |



2019 Caroline NRI
 Created By: CCE-Tompkins
 Date Created: 1/25/2019
 Data Source: CUGIR, USGS
 Projection: NAD83_New_York_Central_ftUS

Caroline Agricultural Districts



-  Tompkins Co. Municipal Boundaries
-  Caroline roads
-  Water
-  Agricultural Districts



2019 Caroline NRI
 Created By: CCE-Tompkins
 Date Created: 1/25/2019
 Data Source: CUGIR, USGS
 Projection: NAD83_New_York_Central_fUS

NATURAL HERITAGE SITES

What Is a Natural Heritage Site?

A Natural Heritage Site is a point or area representing specific natural resource information documented by the New York Natural Heritage Program. The goal of this program, a joint venture of the New York State Department of Environmental Conservation (DEC) and The Nature Conservancy (TNC) since 1985, is to compile and maintain an up-to-date inventory of the location and status of New York State's rarest animal and plant species and its ecological communities. As of 2017, the Natural Heritage Program monitors the status of 802 rare plant species, 466 rare animal species, and 179 ecological community types in New York State.

Why Are Natural Heritage Sites Important?

The databases maintained by the New York Natural Heritage Program can assist in identifying threatened or endangered species and ecological communities in Tompkins County. This knowledge can be incorporated into planning, conservation, and natural resources management to help conserve the plants, animals, and ecological communities that represent the County's natural heritage. Though not a requirement of the State Environmental Quality Review Act (SEQRA), the Natural Heritage Program will search its databases upon request for proposed actions subject to SEQRA review.

Natural Heritage Sites in Caroline

Currently, the Natural Heritage Program databases lists 2 significant ecological community types in Caroline. For information concerning the data, or to request site specific information, contact the New York Natural Heritage Program.

What Can Be Done?

- Natural Heritage Plan: Similar to open space planning, the natural heritage plan is intended towards how to preserve existing natural heritage sites. One might consider this more as a land preservation plan. The Town of Rochester NY has a NHP at the following link: <http://townofrochester.ny.gov/files/2018/04/2018-Natural-Heritage-Plan.pdf>
- Natural Heritage Inventory: similar to a Natural Resource Inventory, a natural heritage inventory lists the different natural heritage sites and provides detailed descriptions and analysis. However, unlike a natural heritage plan, this does not act as a guide to preserving these sites.

Maps and Data

The map on page 69 shows significant natural communities and rare plants and animals in the Town of Caroline. This data was provided by the following source: New York Natural Heritage Program, SUNY College of Environmental Science and Forestry. January, 2018. Element Occurrence Spatial Data Set. Albany, New York.

Information on the status and distribution of rare and endangered animals and plants, and the best examples of New York State's ecological communities, is collected, stored, and analyzed in databases maintained by the Natural Heritage Program. This information has been assembled from historical records and collections maintained by scientific institutions such as the New York

State Museum, and from field surveys by staff from the New York Natural Heritage Program and other scientific groups.

Neither site-specific nor comprehensive surveys for rare species and significant natural communities have been conducted for the entire state. Therefore, these data cannot be relied on as a definitive statement of the presence or absence of rare species or significant ecological communities, and cannot be substituted for on-site surveys that may be required for environmental assessment.

Resources and References

New York Natural Heritage Program, SUNY College of Environmental Science and Forestry. January, 2018. Element Occurrence Spatial Data Set. Albany, New York.

New York State Department of Environmental Conservation

Division of Fish and Wildlife, <http://www.dec.ny.gov/about/634.html>

Division of Marine Resources, <http://www.dec.ny.gov/about/796.html>

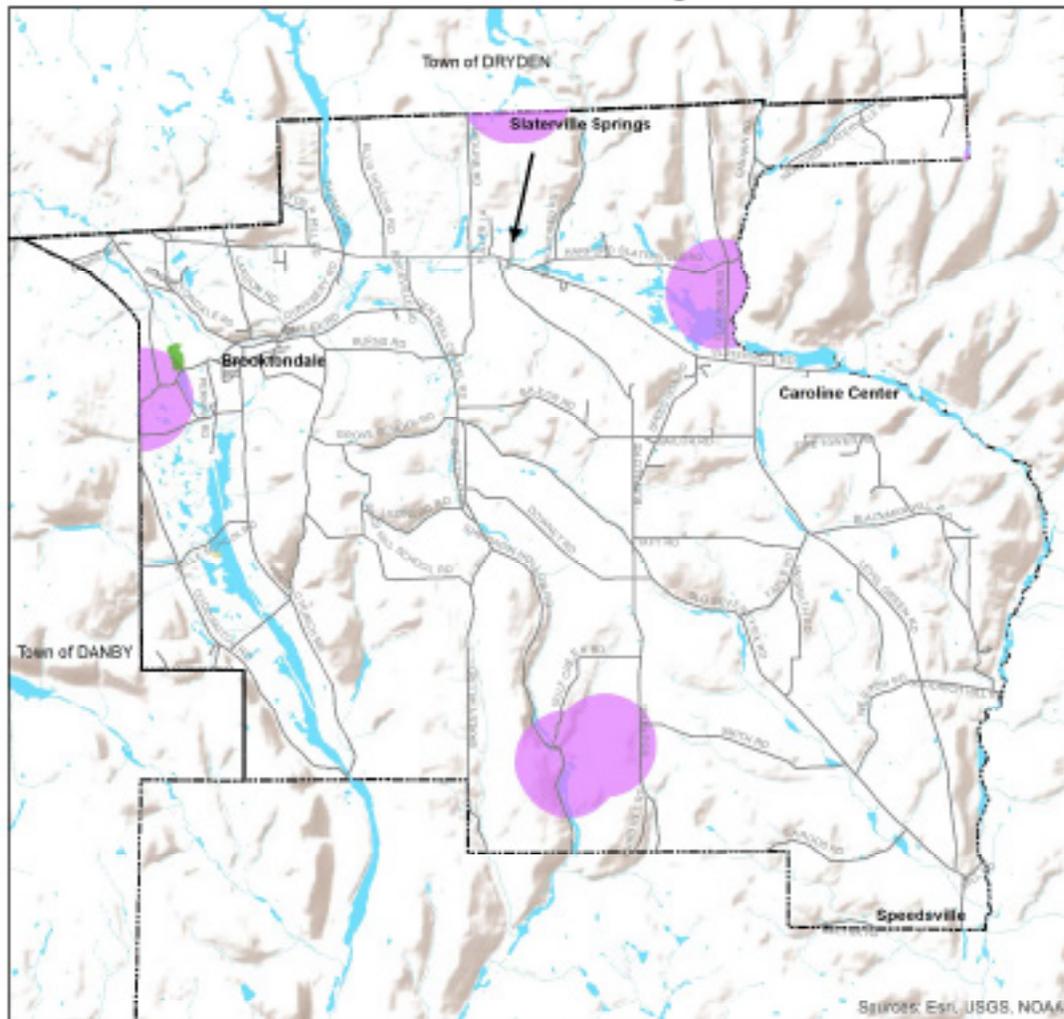
List of Endangered, Threatened and Special Concern Fish & Wildlife, Species of New York State, <http://www.dec.ny.gov/animals/7494.html>

New York Natural Heritage Program, <http://www.dec.ny.gov/animals/29338.html>

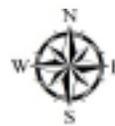
Tompkins County GIS Division, <http://www.tompkinscountyny.gov/gis>

Tompkins County Planning Department, <http://www.tompkinscountyny.gov/planning>

Caroline Natural Heritage Sites



- Hemlock-Northern Hardwood Forest
- Rich Sloping Fen
- Rare Plants And Animals
- Caroline roads
- Water
- Tompkins Co. Municipal Boundaries



2019 Caroline NRI
 Created By: CCE-Tompkins
 Date Created: 1/25/2019
 Data Source: CUGIR, USGS
 Projection: NAD83_New_York_Central_ftUS

UNIQUE NATURAL AREAS

What Is a Unique Natural Area?

The Unique Natural Areas (UNAs) of Caroline are sites with outstanding environmental qualities, as defined by the Tompkins County Environmental Management Council, that are deserving of special attention for preservation and protection. UNAs include such natural features as gorges, woods, swamps, fens, cliffs, and streams. They lie on both publicly and privately owned lands, and anyone wishing to visit a site on private land must obtain permission from the owner or owners.

Why Are Unique Natural Areas Important?

Unique Natural Areas are recognized because of the outstanding qualities that render them “unique” within Tompkins County. Often, the characteristics that make a site unique are extremely vulnerable to a wide range of both direct and indirect impacts and may be compromised by disturbing the site. For this reason, the UNA Inventory incorporates an array of data that can be utilized in planning efforts to help identify and mitigate potential impacts to a UNA.

What Are the Criteria for a Unique Natural Area?

At least one of five criteria must be met to classify an area as a UNA:

1. **Important Natural Community:** the site includes a state-designated wetland, a designated natural area/preserve, historical botanical/zoological characteristics, important teaching characteristics, an old-growth forest, a plant or animal community type that is rare or scarce in the County, diverse flora or fauna, a birding site, and/or a wilderness character.
2. **Quality of Example:** the site is considered the best representative, for example, of an ecosystem, plant community, or animal community of high quality within the County. These sites typically contain especially large individuals, dense populations, and/or a particularly diverse mixture of species.
3. **Rare or Scarce Plants or Animals:** the site contains plant or animal species that have been recognized as rare or scarce at a national, state, or local level; has critical migration, reproductive, or feeding habitat for rare or scarce animal species; and/or has reports of large mammals.
4. **Geological Importance:** the site includes a rare or outstanding example of geological features or processes and/or a paleontological site.
5. **Aesthetic/Cultural Qualities:** the site contains acknowledged outstanding natural or scenic beauty as viewed from within or from a distance, has recreational value, is designated as urban greenspace, and/or has cultural/historic/archeological significance.

Unique Natural Areas in Caroline

The Town of Caroline contains seventeen UNAs amounting to 8158 acres, or 23.15% of the municipality. Table 11 provides more information about the UNAs in Caroline.

Table 11: Unique Natural Areas In Caroline

UNA Name	Acres	% of municipality
Thomas Road Wetlands	186.69	0.53%
Six Mile Creek Woods	34.14	0.10%
Brooktondale Gorge	9.14	0.03%
Willseyville Beaver Ponds	278.32	0.79%
Caroline Depot Natural Woods	256.37	0.73%
The Narrows	17.24	0.05%
White Rock Gorge	177.03	0.50%
Deputron Hollow	781.26	2.22%
White Church	222.35	0.63%
Willseyville Swamp		
Six Mile Creek Valley	1468.9	4.17%
Staterville Wildflower Preserve	1109.15	3.15%
Caroline Pinnacles	504.6	1.43%
Shindagin Hollow	1978.6	5.61%
Belle School Road Fen	20.5	0.06%
Bald Mountain Laurel Woods	264.91	0.75%
Bald Hill Woods	443.75	1.26%
Eastmann Hill	405.08	1.15%
Total	8158.03	23.15%

What Can Be Done?

- **Land Use and Zoning:** While the term Unique Natural Areas is specific to Tompkins County, the concept of UNAs can be applied to almost any municipality or county in New York State. Even though UNAs are not enforceable or implementable by law, they can potentially have an impact on decisions around land use changes and development. In other words, because UNAs can have many beneficial aspects to the community’s health, economy, and aesthetics, preservation of these sites and their surroundings can play in the community’s interests.
- **Unique Natural Area Inventory:** According to the Tompkins County Environmental Management Council, a UNA Inventory is a compilation of all existing sites that are deemed worthy of being considered unique by the municipality. Similar to a NRI, a UNA Inventory not only lists each existing site, but also describes and analyzes the them in detail. It is also important to note that while the UNA Inventory analyzes the sites, the document does NOT provide recommendations. Rather it is to be used as a resource to help supplement other existing planning related documents.

Maps and Data

The following map shows the location and names of the seventeen UNAs in Caroline. The data for this map was provided by the Tompkins County GIS Division and was last updated in 2017.

Information available for each UNA includes the reason for selecting the site, special land use information, adjacent land use data, vulnerability of the site, vegetation cover types, ecological communities, rare, threatened or endangered species, geologic and water features, slope, and soils. This information is available from the Town of Caroline and the Tompkins County Planning Department.

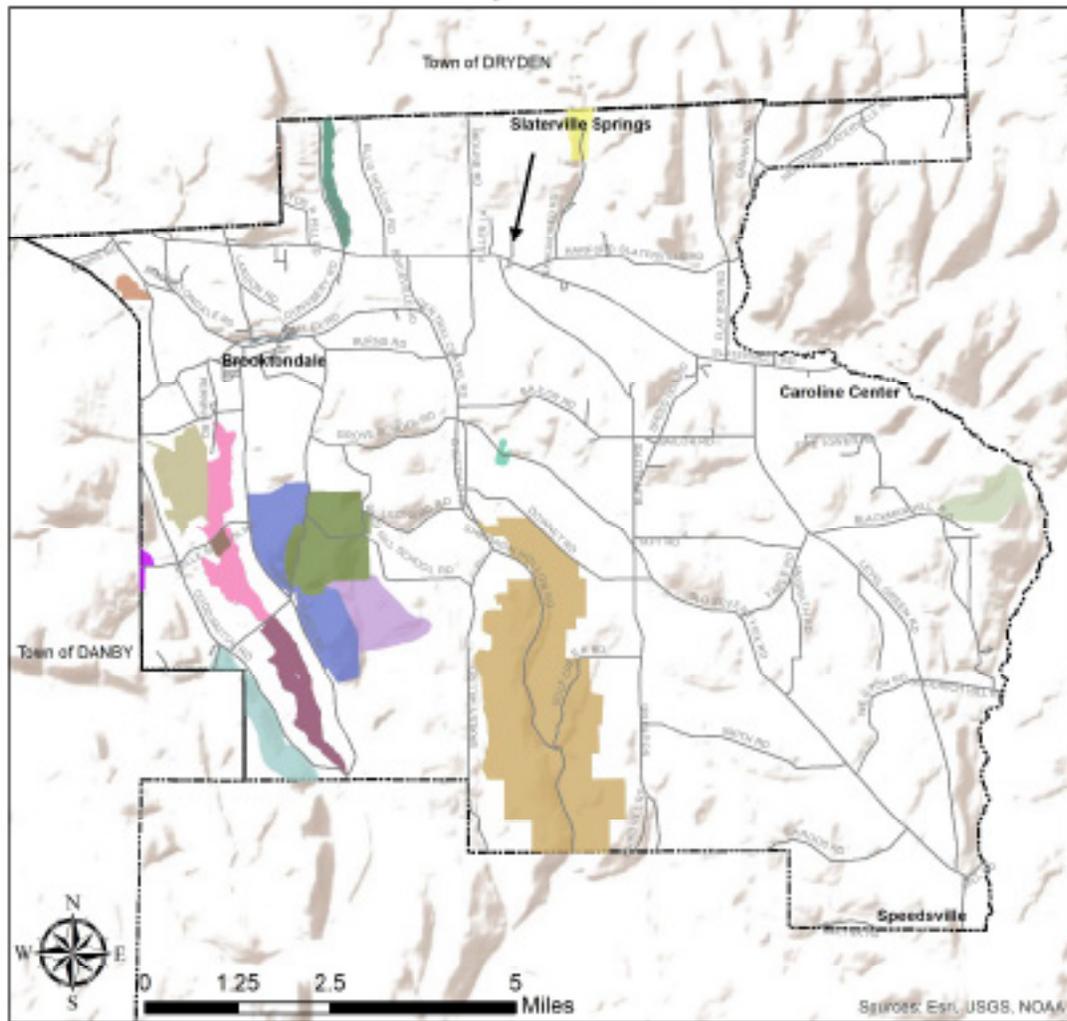
Resources and References

Tompkins County GIS Division, <http://www.tompkinscountyny.gov/gis>

Tompkins County Planning Department, <http://www.tompkinscountyny.gov/planning>

Tompkins County Unique Natural Areas, <http://www.tompkinscountyny.gov/emc/educational-materials>

Caroline Unique Natural Areas



- | | | |
|-------------------------------------|---------------------------------|---|
| — Caroline roads | Caroline Pinnacles | Slaterville Wildflower Preserve (old 600) |
| ▭ Tompkins Co. Municipal Boundaries | Deputron Hollow | The Narrows |
| Bald Hill Woods | Eastman Hill | Thomas Road Wetlands |
| Bald Mountain Laurel Woods | Polson Preserve and Snyder Hill | White Church-Wilseyville Swamp |
| Belle School Road Fen | Shindagin Hollow | White Rock Gorge |
| Brookfordale Gorge | Six Mile Creek Valley, Ithaca | Wilseyville Beaver Ponds |
| Caroline Depot Woods | Six Mile Creek Woods, Caroline | |

2019 Caroline NRI
 Created By: CCE-Tompkins
 Date Created: 1/25/2019
 Data Source: CUGIR, USGS
 Projection: NAD83_New_York_Central_ftUS

PROTECTED OPEN SPACE

What Is Protected Open Space?

In Tompkins County, some open space is protected by various public and private organizations, namely the Finger Lakes Land Trust, the Nature Conservancy, Cornell University, the National Audubon Society, and the Cayuga Nature Center. Reasons for protecting land range from protection of species and natural resources to preserving land for research. New York State also protects land as State Forests, Parks, and Wildlife Management Areas.

New York State Parks in Caroline

New York State owns public lands throughout the state. Because they are owned by the State, all citizens have access to the lands. These lands include state forests, state parks, and wildlife management areas. State forests are managed by the DEC and include reforestation areas, multiple-use areas, unique areas, and state nature and historic preserves. State forests can be used for recreational purposes or for managing ecosystem health and protecting rare, threatened, and endangered species. State parks serve similar purposes but are not limited to forest ecosystems.

Parks are managed by the New York State Office of Parks, Recreation, and Historic Preservation, primarily for recreation and tourism. These lands often contain outstanding natural or historic resources. Permitted uses, such as hunting, fishing, biking, camping, ATV, and snowmobile and horseback riding, vary from park to park.

In Caroline, there are three state forests, no state parks, and no wildlife management areas.

Potato Hill State Forest is a 915 acre space that includes trails, campsites, and a pond as well as habitats for various flora and fauna. It is a popular place for nature observation, snowmobiling, birdwatching, fishing, and other outdoor activities.

Shindagin Hollow State Forest is a 5,266 acre space in the southern parts of Caroline. Activities here include hiking, birdwatching, camping, mountain biking, and nature watching.

Hammond Hill State Forest is a 3,618 acre site with some parts in the northeastern parts of Caroline. It has a 16-mile trail system that is maintained cooperatively among the NYSDEC, Cayuga Nordic Ski Club, Cayuga Nature Center, Friends of Hammond Hill, and the Town of Dryden.

What Are the Finger Lakes Land Trust Preserves and Conservation Easements?

The Finger Lakes Land Trust Preserves and Conservation Easements are tracts of land protected by a private, non-profit organization, the Finger Lakes Land Trust (FLLT). Each of the FLLT's preserves and conservation easements is monitored by volunteers. Preserves are areas of significant natural resources that are owned outright by the FLLT, while conservation easements are voluntary agreements that allow a landowner to limit the type or amount of development on their property while retaining private ownership of the land. The easement is signed by the landowner, who is the easement donor, and the FLLT, who is the party receiving the easement. Both preserves and easements are managed by the FLLT to help preserve the natural integrity of the Fin-

ger Lakes Region, and, in the case of its nature preserves, for education, research, and quiet forms of recreation, such as hiking and bird watching.

Finger Lakes Land Trust Preserves and Conservation Easements in Caroline

The only Finger Lakes Land Trust Preserve in Caroline is the Goetchius Wetland Preserve. It is the site of a wetland restoration partnership and spans roughly 80 acres. In total, the Land Trust holds 28 easements on approximately 1,674 acres of land throughout Tompkins County.

Why Are These Preserves, Conservation Easements, Natural Areas, and State Lands Important?

Nature preserves, conservation easements, natural areas, and state lands protect important landscapes from development and uses that may damage their natural features. These lands protect key plant and animal species and their habitats, protect watersheds and the quality of water in the area, and provide recreational opportunities to everyone. Most importantly, open space can act as a retention and relief zone for excess water during flood events. They also add economic value to their surrounding areas by providing areas for recreation, enhancing tourism and increasing land values. In addition, they provide important educational opportunities for teaching about botany, natural history, entomology and cultural history. Although municipal governments do not have direct control of these lands, they may be able to use them in their planning efforts to create greenways, biological corridors, and recreational trails.

New York State WMAs and Forests are also utilized for logging. Logging in State Forests are monitored by the DEC to ensure that trees of varying sizes and ages are left for future generations. The focus of logging activities in WMAs is to manage habitat and provide a diversity of vegetation types and wildlife species.

What Can Be Done?

Connecting Wildlife Corridors: As preservation has been one of the main topics throughout this NRI, it is important to consider the connectivity of protected undisturbed natural lands. While this connectivity is primarily intended for the wellbeing of wildlife, it is also intended for the healthy development of these natural lands. While increasing protected natural lands is one way of improving wildlife habitat, connecting it could be a more efficient way of insuring wildlife protection. This way of preserving land can especially be effective when concentrating preservation around streams and waterbodies, as those are usually areas that act as the main food source for wildlife. Thus, the map depicted below could be a helpful tool in planning for future preservation and development goals. More information can be found at: <https://www.nwf.org/Our-Work/Habitats/Wildlife-Corridors>

Public Open Space Planning: While preserving rural and natural open space can be beneficial, it is also important to note that smaller, community centered, and green open space is another important aspect to consider when planning for future development. According to the EPA open and

green space includes parks, community gardens, school yards, and even cemeteries. While these natural open spaces help beautify a community, they also help improve the real estate value as well as the public health. More information can be found at the following link: <https://www.epa.gov/G3/green-streets-and-community-open-space>

Maps and Data

The map on page 77 shows state parks, the Finger Lakes Land Trust's Lauman Preserve, Cayuga Nature Center properties, archaeological sites, community parks, and municipal parks. This data is available from the Tompkins County Open Data Portal under the name "[GenForestPark](#)." Additional GIS data on Important Bird Areas was provided by the National Audubon Society of New York. There are no Cornell Natural Areas or Nature Conservancy Preserves in the Town of Caroline.

For a map of this information, in paper or digital format, contact the Tompkins County Planning Department. For information on Finger Lakes Land Trust Preserves and Conservation Easements, contact the Finger Lakes Land Trust. For information on the Nature Conservancy Preserves, contact the Nature Conservancy. For information on Cornell Natural Areas, contact the Cornell Botanic Gardens.

Resources and References

Cornell University, Cornell Botanic Gardens, Natural Areas, <http://www.cornellbotanicgardens.org/our-gardens/natural-areas>

Finger Lakes Land Trust
Find a Preserve, <http://www.fllt.org/learntheland/preserves/>
About the Finger Lakes Land Trust, <http://www.fllt.org/about/>

The Nature Conservancy, Places and Preserves, Central & Western New York, <https://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/newyork/places-preserves/central-western-new-york-preserves.xml>

New York State Department of Environmental Conservation
State Forests, <http://www.dec.ny.gov/lands/40672.html>
Wildlife Management Areas, <http://www.dec.ny.gov/outdoor/7768.html>

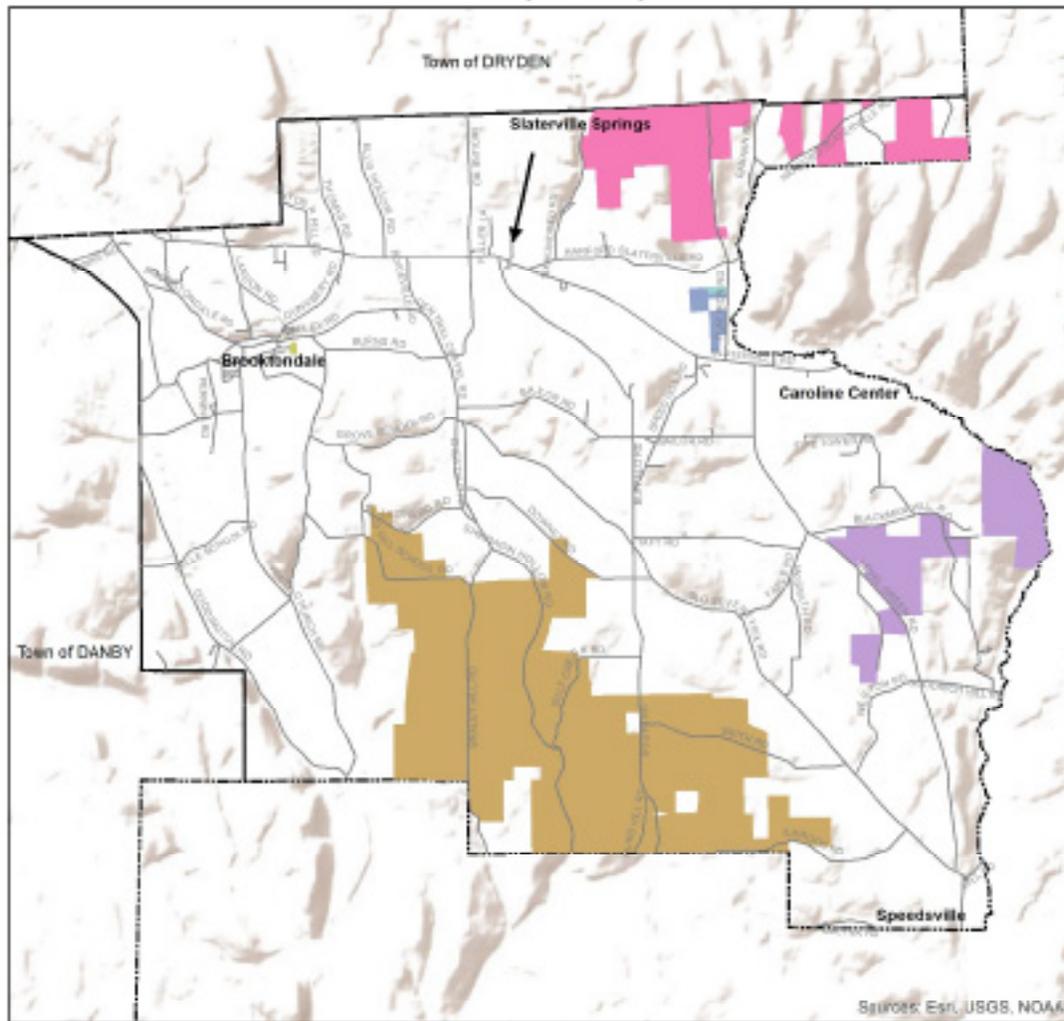
New York State Department of Parks, Recreation and Historic Preservation, <https://parks.ny.gov/>

Tompkins County GIS Division, <http://www.tompkinscountyny.gov/gis>

Tompkins County Parks and Trails Network, Tompkins County Planning Department in conjunction with the Town of Caroline and the Tompkins County Tourism Program, <https://ithacatrails.org/>

Tompkins County Planning Department, <http://www.tompkinscountyny.gov/planning>

Caroline Open Space



Source: Esri, USGS, NOAA



- Tompkins Co. Municipal Boundaries
- Caroline roads
- Open Space Name**
- Brooktondale Park
- Goetchius
- Goetchius Preserve
- Hammond Hill State Forest
- Potato Hill State Forest
- Shingdoin Hollow State Fo
- Speedsville Commons



2019 Caroline NRI
 Created By: CCE-Tompkins
 Date Created: 1/25/2019
 Data Source: CUGIR, USGS
 Projection: NAD83_New_York_Central_FTUS

SCENIC RESOURCES

What is a Scenic Resource?

A scenic resource is an “area of intense visual appeal,” both natural and human made. In 2007, Tompkins County created an inventory of scenic resources based on public input. This process resulted in categorization of scenic resources into three categories: Distinctive Views, Noteworthy Views, and Characteristic Views. Distinctive views are those that “make a clear, unmistakable impression;” noteworthy views are those that “are worthy of attracting attention, and are better than many of the scenic views in the County;” and characteristic views are scenic views that are seen frequently that are characteristic of the County.

Scenic Resources in Caroline

The Town of Caroline has 28 documented views, some of which were selected as Distinctive, Noteworthy, or Characteristic Views. These 28 views comprise 4.7% of all views in the County. Of the 25 Distinctive Views in the County, two are in Caroline. Distinctive views are determined to “make a clear, unmistakable impression” on the viewer, and are supposed to be the best views in Tompkins County. These are each documented below.



Distinctive View 8: View from White Church Road
Source: Tompkins County Scenic Resources Inventory (2007), page 7



Distinctive View 9: View from Level Green Road
Source: Tompkins County Scenic Resources Inventory (2007), page 7



Noteworthy View 9: Along Coddington Rd

Source: Tompkins County Scenic Resources Inventory (2007), page 15

Noteworthy views are “worthy of attracting attention” and constitute some of the better views within the county. Of the 30 Noteworthy Views, three are located in Caroline. They are documented on this page.



Noteworthy View 10: Along Bailor Road

Source: Tompkins County Scenic Resources Inventory (2007), page 15



Noteworthy View 11: Along Creamery Road

Source: Tompkins County Scenic Resources Inventory (2007), page 16

Characteristic Views were discussed more generally. These views were grouped out of the remaining inventory, though some views remained uncategorized. The inventory lists 45 examples across ten categories. There are two total Characteristic Views in the Town of Caroline. There are also 19 “Uncategorized” views. All of these can be found on the map on page __.

Why are Scenic Resources Important?

Scenic resources contribute to the day-to-day quality of life of Caroline residents, as well as attract visitors to the area. They are a large part of what makes this region such a beautiful and desirable place to live, work, and visit. Documenting where these resources are makes it easier to protect and manage them. Scenic views can be protected through measures such as zoning ordinances.

What Can Be Done?

Scenic Resources Protection Plan: This document’s main purpose is to guide a municipality to protect the existing scenic resources. As it is quite unrealistic to preserve the entire area that is within the scenery, a viewshed analysis is usually conducted to evaluate the most and least visible areas from a specific point. Through this analysis, a list of parcels is compiled, prioritized based on the most to least visible within the viewshed. Finally, the plan produces a roadmap for the designated community on how to acquire and preserve each parcel. More information on this topic can be found at the following link: <https://www.dec.ny.gov/permits/91750.html>

Environmental Impact Review: During the process of an environmental impact review, and especially with SEQR, viewshed is an integral part to determining whether a project might have an impact on the existing scenery. The scenery can be considered for all projects ranging from placement of a cellular tower to the construction of a salt mine. Whether or not the scenic impact is major or minor, it is up to the municipal and potentially state to decide whether or not the impact is significant enough to delay or potentially even ban the project. More information on this topic can be found at the following link which provides mitigation measures around scenic/visual impact: https://www.dec.ny.gov/docs/permits_ej_operations_pdf/vispolfinaldraftoct18.pdf

Maps and Data

The map on page 81 shows the locations of Distinctive, Noteworthy, and Characteristic Views in the Town of Caroline, as well as views that were inventoried but did not fall under any of these three categories. Data was provided by the Tompkins County GIS Division.

Resources and References

Tompkins County

Protecting Our Scenic Resources (2010), http://www.tompkinscountyny.gov/files2/planning/nri/documents/ScenicResourcesProtectionDec2010_000.pdf

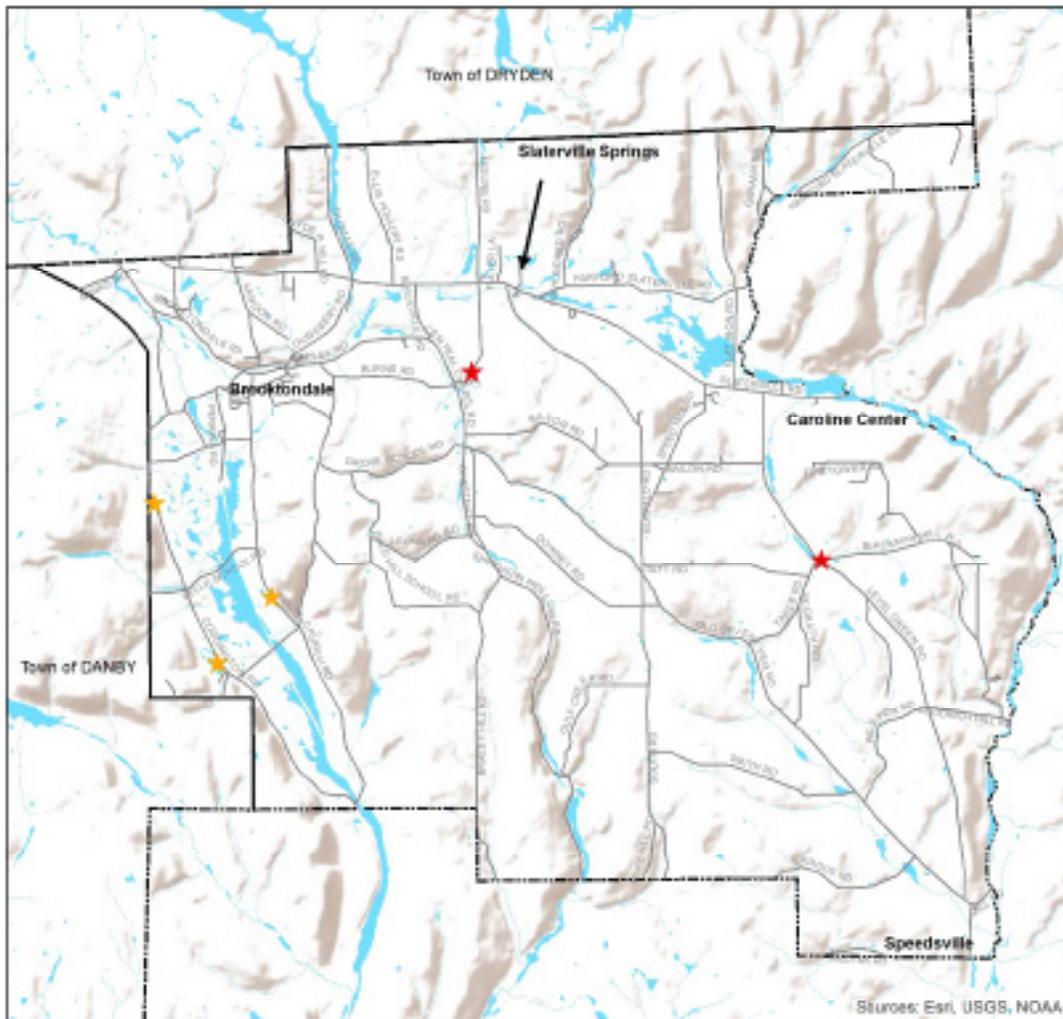
Scenic Resources, http://www.tompkinscountyny.gov/planning/nri-scenic_resources

Tompkins County Scenic Resources Inventory (2007), prepared by Peter J. Smith & Company, Inc., <http://www.tompkinscountyny.gov/files2/planning/nri/documents/TCSRReportJan17.pdf>

Tompkins County GIS Division, <http://www.tompkinscountyny.gov/gis>

Tompkins County Planning Department, <http://www.tompkinscountyny.gov/planning>

Caroline Scenic Resources



- ★ Distinctive Views
- ★ Noteworthy Views
- Tompkins Co. Municipal Boundaries
- Caroline roads
- Water



2019 Caroline NRI
 Created By: CCE-Tompkins
 Date Created: 1/25/2019
 Data Source: CUGIR, USGS
 Projection: NAD83_New_York_Central_ftUS

IMPLEMENTATION TOOLS

Once parcels have been identified, the following tools are meant to help municipal officials implement actions that they believe are necessary to protect the community and environment to prepare for the effects of climate change. While the primary goal of this document is meant to help communities identify potential areas of interest within municipal boundaries, this section is meant to provide supplemental assistance to guide communities towards a more sustainable future.

Since the Town of Caroline is not too large, it is possible to consider parcels on an individual basis. While there is no specific method to identifying specific parcels, having an overview of the general process can of land evaluation can be useful before proceeding.

The main activities in a land evaluation are as follows:

1. Initial consultations, concerned with the objectives of the evaluation, and the data and assumptions on which it is to be based
2. Description of the kinds of land use to be considered, and establishment of their requirements
3. Description of land mapping units, and derivation of land qualities
4. Comparison of kinds of land use with the types of land present
5. Economic and social analysis
6. Land suitability classification (qualitative or quantitative)
7. Presentation of the results of the evaluation.

List from *A Framework for Land Evaluation*, 4.2

Assuming that the economic and social analysis is conducted separately, there are many ways to conduct a land suitability analysis. This can be done using the evaluation instruction manual provided by the Food and Agricultural Organization of the United Nations: <http://www.fao.org/docrep/x5310e/x5310e00.htm#Contents>

Once parcels have been evaluated and selected, the following methods could be used to preserve or protect the parcels.

- **Transfer or Purchase of Development Rights**

When development rights are transferred, the development potential of a site becomes its own good that can be bought and sold by the owner and sold to an individual land owner or developer who wishes to build on another property at higher density that the zoning allows.

A transfer of development rights for multiple parcels can also be coupled with cluster zoning ordinance. This would allow for property owners to earn back some of the value of their land that they will forego by not developing it and will accommodate residential or commercial growth without sprawling into properties with ecological or historic significance.

Source: https://www.dos.ny.gov/lg/publications/Transfer_of_Development_Rights.pdf

- o *Advantages:*
 - Properties remain on tax rolls
 - The program does not create a financial shortfall for the landowner
 - No direct expenditure of municipal funds to purchase property.
- o *Disadvantages:*
 - A transfer of development rights program necessitates ongoing administration and careful oversight

- **Conservation Easement**

Conservation easements are used to protect wildlife, ecosystems, natural habitats, wetlands, and other valuable ecological resources while maintaining a property's private ownership. As a result, the properties do not have to be purchased outright by a public organization in order to preserve the parcel.

Easements would be permanent, legally binding, and would prevent or strictly regulate future development that would occur on the property. This assessment would thus be the compensation to the landowner who would have the monetary loss by conserving his/her land. If the two parties (land owner and governmental agency) agree upon a price for the easement, the governmental agency would then purchase these rights which would subsequently enforce the agreement made in the easement.

Source: <http://www.dec.ny.gov/lands/41156.html>

- o *Advantages:*
 - Straight forward
 - Future modifications that enhance quality or public use do not require the consent of a private owner.
 - Ultimate ownership control of property
- o *Disadvantages:*
 - Local government must take direct expenditure
 - Property is removed from tax rolls
 - Acquisition is likely to be subject to public debate

- **Private Acquisition by Non-Profit Conservation Groups**

Non-profit conservation groups, such as land trusts, can be a vital resource for preserving scenic, historic, and ecological resources. In New York State, 90 land trusts are at work preserving land throughout the state, in both rural and urban areas. Mission based organizations often have extensive experience writing grants, and if their sole mission is acquisition and maintenance, they may be able to expedite the acquisition process through sharp negotiation skills and legal expertise. It will be important for the municipality to be vigilant in vetting the mission of each organization to ensure that the ecological resource will be treated in a way to enhance its quality.

Less than fee-simple acquisition is a more common technique used to protect natural resources. The acquisition of conservation easements (through purchase or donation from a willing seller) is used by land trusts and municipalities to restrict the type and amount of development permitted on a particular parcel of land. The Purchase of Development

Rights on agricultural lands is an example of a conservation easement program.

o *Advantages:*

- No direct acquisition expense for the municipality.
- No direct maintenance expense for the municipality.

o *Disadvantages:*

- Private Ownership
- Property removed from tax rolls.

• **Zoning**

While zoning is another tool that could be used to protect natural resources, unfortunately the town of Caroline does not have any zoning in place. However, as population increases in the region, the municipality might consider implementing a zoning ordinance to control development.

o *Advantages:*

- Property owners maintain the value of their property
- Properties maintain their historic and ecological significance

o *Disadvantages:*

- Some developers may forgo development due to stringent review requirements

• **Performance Zoning:**

Performance zoning is an alternate technique to conventional zoning. While conventional zoning has static standards for designated areas, performance zoning regulates the design and location of development based on land's suitability and geographical orientation. Once the criteria for performance is developed, a municipality can use this as a tool to guide development and protect important natural resources. At the same time, land owners and developers would have greater flexibility to meet their zoning requirements.

o *Advantages:*

- Utilizes existing characteristics of property and conserves energy use.
- Can be customized based on each property.
- Can be controlled by municipality to protect specific lands.
- Encourages mixed use development and in general more variety in use
- Does not need to be consistently modified

o *Districts*

- Eliminates districts and a sense of uniformity which can be difficult for a community to handle
- Could give developer too much authority and power which might create conflicting situations within the community
- Could potentially be a complex system to manage, especially for municipalities with limited resources and staff.

• **Impact Fee**

An impact fee is imposed by the municipal government. The fee is for developers who want to build or modify the local land use and thus permanently change the existing

landscape. While this can be extremely useful in urban settings, this could also be used in rural communities to protect natural resources. The fees received from the developer could be then used to fix or mitigate any damage caused by the development.

- o Advantages
 - No cost to municipalities
 - Can be controlled to protect certain areas
- o Disadvantages
 - Discourages development and investment

Sources:

Food and Agricultural Organization of the United Nations: <http://www.fao.org/docrep/x5310e/x5310e05.htm#4.3%20kinds%20of%20land%20use%20and%20their%20requirements%20and%20limitations>

New York State Division of Local governmental Services: https://www.dos.ny.gov/lg/publications/Transfer_of_Development_Rights.pdf

New York State Department of Environmental Conservation: <http://www.dec.ny.gov/lands/41156.html>

