Water Resource Summary

A Summary Prepared for the Town of Copake

March 2014

This summary provides information for land-use planning and decision-making as requested by the Town of Copake. It identifies many of the most critical aspects and locations of the town's water resources. The summary is based on information available to the New York State Department of Environmental Conservation (DEC) and the New York State Water Resources Institute at Cornell University. It was gleaned from various complementary, but not necessarily comprehensive, sources and should not be considered a complete inventory.

Central to the information in this document is the concept of watersheds. A **watershed** is the area of land from which water drains into a stream, river, lake or other waterbody. Precipitation flows over and through the landscape into intermittent streams, kills, creeks, rivers, aquifers, wetlands and floodplains of the Hudson Valley to form the watersheds of the Hudson River estuary, providing many necessities and vital benefits to human communities.

When these water resources are working with functioning and healthy ecosystems, they deliver clean drinking water, filter pollutants, comprise habitat for plants and animals, absorb floodwaters, and provide numerous recreation opportunities. Local municipalities play a critical role in restoring and maintaining the waters of the Hudson Valley for future generations. To do this, they must consider impacts to water resources during the local decision-making process.

To further support land-use and conservation planning efforts in the Town of Copake, this summary can be supplemented by complementary summaries of natural areas and habitat and climate resilience. These summaries are also being provided to Copake.

This document was created by the New York State Department of Environmental Conservation's Hudson River Estuary Program and the New York State Water Resources Institute at Cornell University. The Estuary Program protects and improves the natural and scenic Hudson River watershed for all its residents. It was created in 1987 and covers the river from the Troy dam to upper New York harbor.

The Estuary Program is funded by the New York State Environmental Protection Fund. The New York State Water Resources Institute at Cornell University seeks to foster an understanding of the critical connections between people and the state's waters. It also seeks to empower communities to make informed decisions about land use that minimize impacts to water resources, including drinking water supplies, floodplains, and aquatic habitats.

Additional information about water resources and the state of the Hudson Valley's waters can be found on DEC's webpages, starting with Clean Water for the Hudson River Estuary.

For more information about this summary or the Estuary Program, please contact:

Andrew Meyer, Shoreline Conservation Specialist

axmeyer@gw.dec.state.ny.us

New York State Department of Environmental Conservation

Hudson River Estuary Program

21 South Putts Corners Road

New Paltz, NY 12561

Phone: 845-256-3016 • Fax: 845-255-3649

Website: http://www.dec.ny.gov/lands/4920.html

The core mission of the Hudson River Estuary Program is to:

- *Ensure clean water*
- *Protect and restore fish, wildlife and their habitats*
- *Provide water recreation and river access*
- *Adapt to climate change*
- *Conserve world-famous scenery*

Table of Contents

List of Tables

List of Figures

Introduction

Effective conservation, of which watershed management is an important component, occurs across property and political boundaries and requires a broader view of natural landscapes than is often considered in municipal planning. This document will help to identify areas of your town where important resources exist and overlap. It is especially useful for supporting town planning through open space plans, comprehensive plans, natural resource inventories, and development of critical environmental areas. Communities can incorporate their summaries directly into local studies and plans or use the information to write their own documents. This summary goes hand in hand with the Habitat Summary and Climate Resiliency Summary, also provided by the Estuary Program. Together they provide critical information for local land-use decisions, including economic development and conservation.

If used to its fullest potential, this summary provides an objective inventory that can inform development review, resulting in a faster and cheaper process for all involved. Though this summary does not contain the detail needed for site planning, it is useful for environmental reviews in several ways. First, by identifying high-quality water resources on a townwide scale, it helps land-use decision-makers and applicants place a proposed site plan in the context of the larger watershed. Second, the town can ask applicants to address how proposed actions will affect water resources identified in the summary, potentially resulting in onsite restoration and mitigation projects (e.g. riparian buffer plantings or dam removal) that greatly benefit the community. When town representatives and applicants identify areas and issues of concern at the very beginning of the planning process—before time and money have been invested in plans that ultimately must be changed—the review process functions more smoothly and quickly. And third, the summary informs environmental review by highlighting areas that might need more detailed assessments. This summary is limited to existing information and, therefore, is not a substitute for on-the-ground surveys and assessments. However, it provides a starting point for recognizing high-quality water resources in your town, as well as water resources that should be considered for restoration efforts.

The summary is divided into three categories: watershed characteristics of the town, water quality standards and assessments, and the current status of water infrastructure in the town. These categories are further divided into several topics. Each topic begins with a description and an investigation of potential impacts to the region's water quality. Each then lists resources that can help municipalities improve the quality of water resources. Information specifically about Copake's water resources is contained in blue boxes for easy navigation. Links throughout this document will direct you to Internet resources, and there is a reference section at the end. External links and websites have been provided. All mentions of figures and tables are also internally linked. Finally, there are maps with information about the Town of Copake for many of the topics. When viewed as a pdf, these maps have layers that can be changed to include the most important components needed. These maps are not for jurisdictional or regulatory purposes; please contact your local DEC Environmental Permits staff with regulatory questions. Also, please note that some of the water resources identified in this document are protected by state or federal programs. We recommend the town continue to work with the DEC Region

4 Office in Schenectady and other appropriate agencies on issues involving regulated resources.

Limitations of Maps in this Summary

It is important that users of maps in this summary and of geographic information systems (GIS) data in general understand the limitations of maps and GIS information. GIS data originate from many different sources, produced at different times and for different purposes. They are often collected or developed from remote-sensed information (i.e., aerial photographs, satellite imagery) or derived from paper maps. For these reasons, GIS data can contain all the inaccuracies of the original data, in addition to any errors from converting it to digital GIS information. Therefore, maps created with GIS data are not a substitute for surveys and direct knowledge.

It is also important to emphasize that this summary contains the most current information available at the time, but new information is always being collected. Datasets contained here could change in important ways in the future. However, as the summary illustrates, using GIS to map information on a town-wide scale can help local decision-makers understand potential impacts, see patterns and relationships in their communities, and make better decisions.

Watershed Characteristics

Watersheds and Subwatersheds

A watershed is the area of land from which water drains into a stream, river, lake or other waterbody. Watersheds are divided by high points on the land, such as ridges, mountains, and hills (Figure 1). Management of water resources is ideally accomplished within a watershed context. The appropriate watershed scale changes depending on the land-use questions under consideration. Watershed planning units can encompass everything from the small watershed of two intermittent streams that drain an individual parcel, to the much larger Hudson River watershed, about 13,500 square miles. Both eventually flow to the Atlantic Ocean.

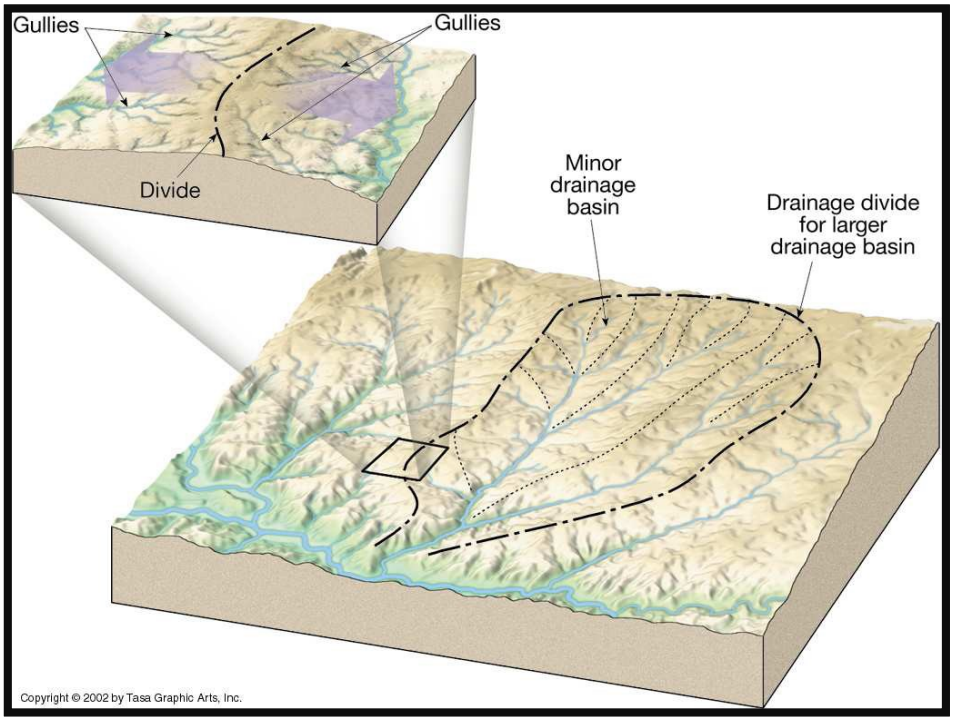


Figure 1: Watersheds are defined by the land that drains to a particular point in the landscape and are separated from one another by topographic divides. Smaller sub-watersheds are nested within larger watersheds.

Standard watershed boundaries for the entire U.S. have been created through the United States Geologic Survey's (USGS's) National Hydrography Dataset in a nested hierarchy by size. These regions each have a Hydrologic Unit Code (HUC). In this summary, we use size 12 HUC subwatershed boundaries delineated to encompass under 40,000 acres, or about 60 square miles each. These subwatersheds are the finest-scale data available for New York State through the USGS. They can be the most useful watershed units for municipalities because they often match the scale of the potential impacts and the authority of towns to eliminate or mitigate them.

There is a very strong relationship between land use and water quality in streams, wetlands, and other waterbodies. Land and water are connected through the interactions of water, soil, organisms, and chemical components. **Healthy watersheds, including both land and water resources, can recharge groundwater, reduce erosion and flooding impacts, minimize public infrastructure and water treatment costs, and be more resilient to climate change—all ecosystem services that directly benefit communities and cost less than the alternatives.** See the Environmental Protection Agency's (EPA) *Healthy Watersheds Initiative Fact Sheet* for more information.

Copake Information: Watersheds

Almost all of Copake is part of the Hudson River watershed. Streams and waterbodies in 99% of Copake flow into the Hudson River Estuary and then into the Atlantic Ocean. About 0.1% of the town, in the northeast corner, is in the Housatonic River watershed. Seventy-two percent of Copake is part of the Roeliff Jansen Kill watershed, which covers 150,000 acres of Columbia and Dutchess counties and a small piece of Massachusetts (Figure 2). The Roeliff Jansen Kill watershed is divided into 6 subwatersheds, with the *Headwaters Roeliff Jansen Kill*, *Bash Bish Bro*ok and *Punch Brook-Roeliff Jansen Kill* subwatersheds occurring within Copake (Figure 3). The northwestern 28% of Copake is in the Greater Stockport Creek watershed, including the *Loomis Creek-Claverack Creek* and *Headwaters Taghkanic Creek* subwatersheds. Taghkanic Creek flows into Claverack Creek along the border of the towns of Claverack and Greenport, and Claverack Creek flows into Stockport Creek close to the Hudson River in the Town of Stockport (Figure 2). The Greater Stockport Creek Watershed has an active watershed group, the Greater Stockport Creek Watershed Alliance (http://www.stockportwatershed.org/).

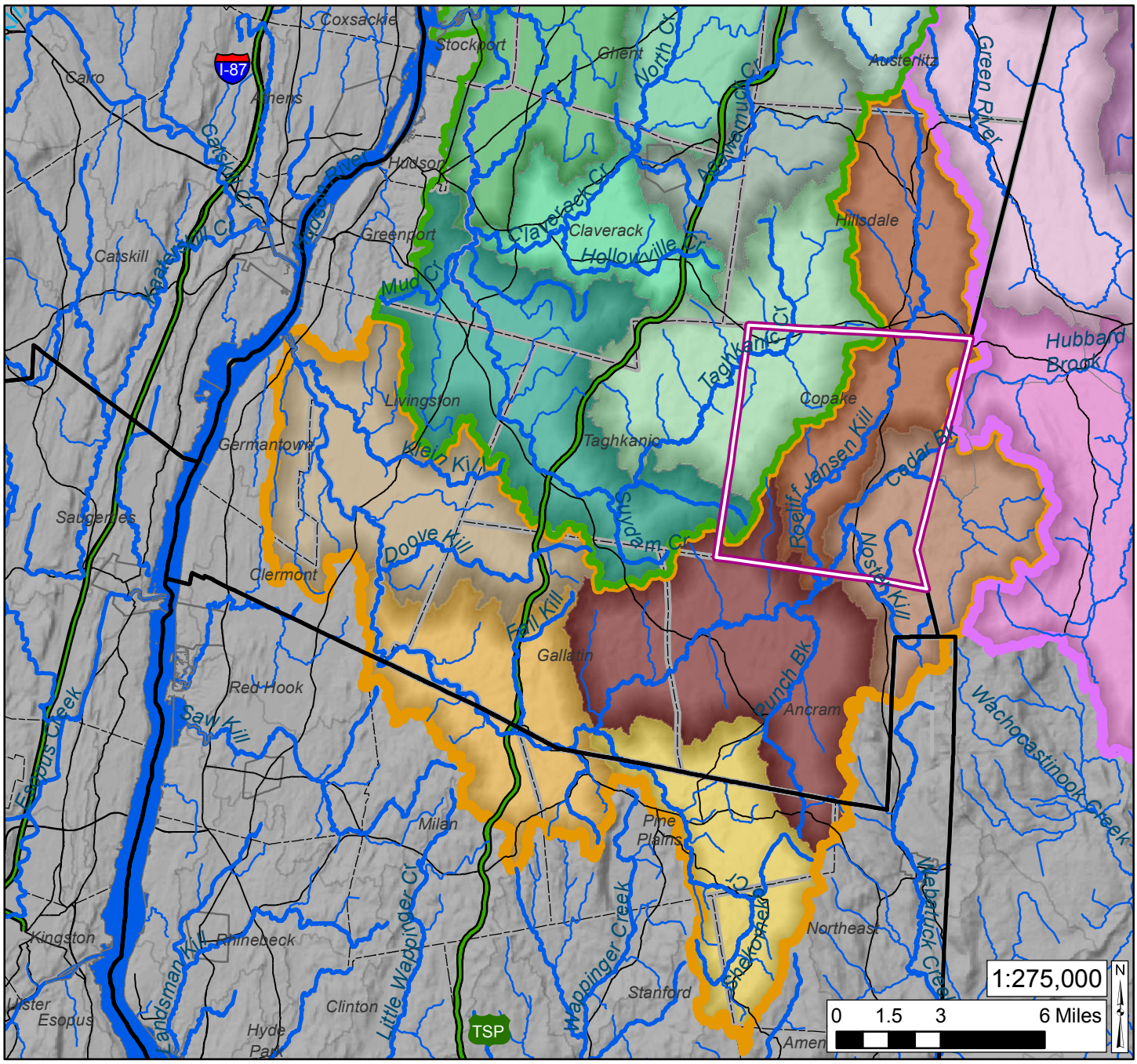
For many actions and plans related to water resources that are undertaken by towns, subwatersheds are the most appropriate ecological scale. Below is a list of the HUC 12 subwatersheds in and near Copake (Figure 3):

- Bash Bish Brook
- Headwaters Roeliff Jansen Kill
- Punch Brook-Roeliff Jansen Kill
- Headwaters Taghkanic Creek
- Loomis Creek-Claverack Creek
- Hubbard Brook (Housatonic River watershed)

A watershed is "that area of land, a bounded hydrologic system, within which all living things are inextricably linked by their common water course and where, as humans settled, simple logic demanded that they become part of a community."

- John Wesley Powell -

Figure 2: The Roeliff Jansen Kill and Greater Stockport Creek watersheds, Subwatersheds, and Major Streams in Copake, Columbia County, NY



Legend

- Copake
- Major stream
- Greater Stockport Creek Watershed
- Roeliff Jansen Kill Watershed
- Williams River/Housatonic River Watershed

This map shows streams and watersheds in and around the Town of Copake, Columbia County. The Roeliff Jansen Kill and Greater Stockport Creek watersheds are shown, which flow into the Hudson River. The Williams River/Housatonic watershed is also shown, which flows into the Housatonic River. This map was produced as part of a Water Resource Summary for the Town. For more information, please contact NYSDEC's Hudson River Estuary Program watershed specialists at (845) 256-3016.

Data Sources:

Northeast Aquatic Habitat Classification System (EPA, USGS, and TNC) (2010) for minor streams

USGS National Hydrography Dataset for major streams and all Hydrologic Unit Code 10 watershed and 12 subwatersheds (2008)

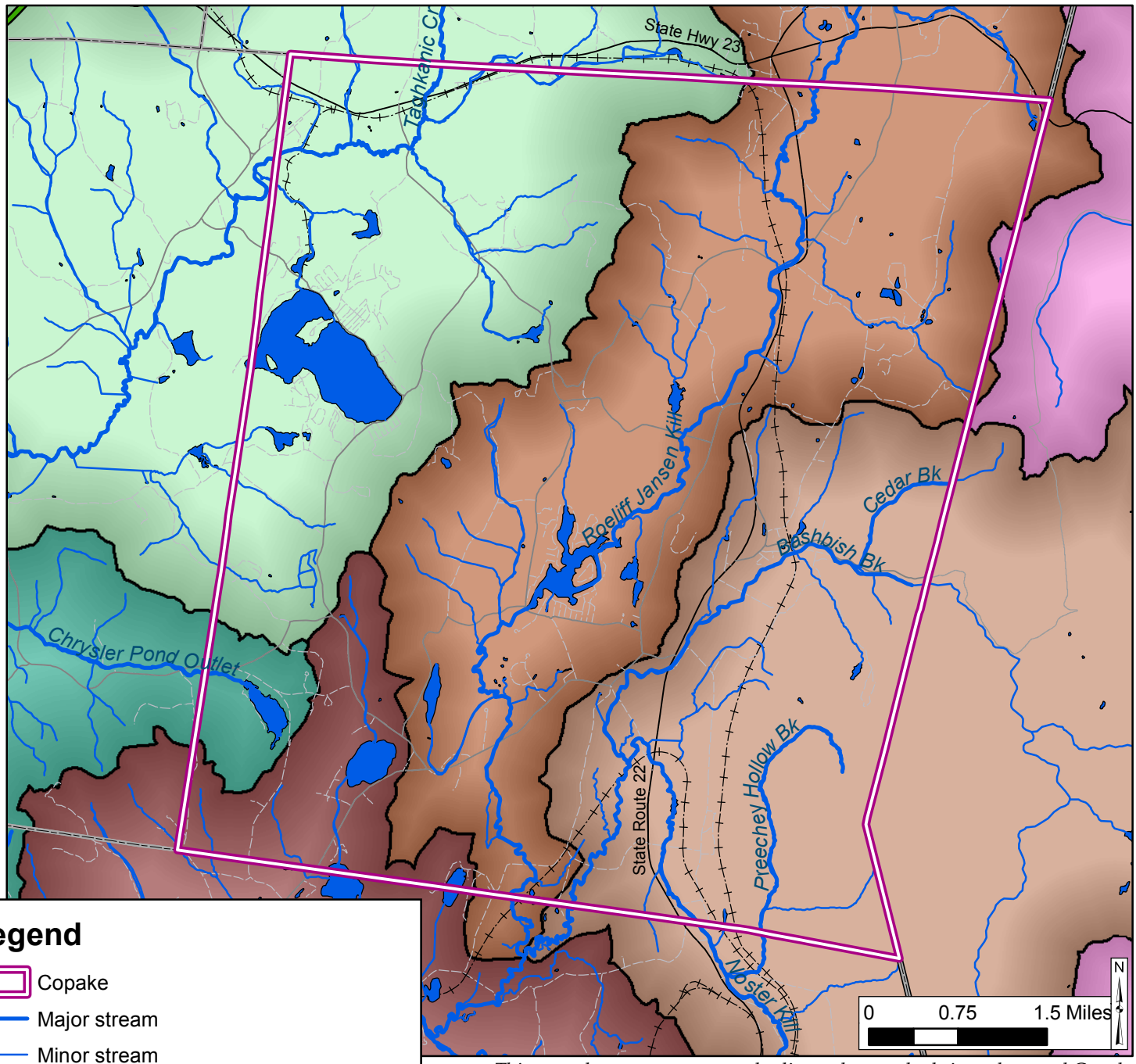
Map Created 2014

Hudson River Estuary

Water Resource Institute of New York State

Cornell University

Figure 3: Subwatersheds in Copake, Columbia County, NY



Legend

- Copake
- Major stream
- Minor stream
- Railroad (abandoned)
- Subwatershed boundary

Roeliff Jansen Kill watersheds

- Bash Bish Brook
- Headwaters Roeliff Jansen Kill
- Punch Brook-Roeliff Jansen Kill

Greater Stockport Creek watersheds

- Headwaters Taghkanic Creek
- Loomis Creek-Claverack Creek

Housatonic watersheds

- Hubbard Brook

This map shows streams, waterbodies and watersheds in and around Copake, Columbia County. Subwatershed boundaries are shown. Due to limitations of the available data, many intermittent and some perennial streams are missing. This map was produced as part of a Water Resource Summary for the Town. For more information, please contact NYSDEC's Hudson River Estuary Program watershed specialists at (845) 256-3016.

Data Sources:
TNC Northeast Aquatic Habitat Classification for streams (2008)
USGS National Hydrography Dataset for streams, waterbodies and Hydrologic Unit Code 12 subwatersheds (2008)
NYS Office of CSCIC (2011) for road data

Map Created 2014

Hudson River Estuary
Water Resource Institute of New York State
Cornell University

Land Cover

Natural land cover and human land uses in a watershed strongly influence the health of the streams and other waterbodies into which they drain. Alteration and removal of natural cover (especially forests, floodplains and wetlands) can decrease water quality by adding pollutants and sediment to streams. These changes also limit a stream's natural ability to cope with nutrient input and increases in water quantity. Changes in natural land cover, including substantial increases in impervious cover and decreases in natural cover, can drastically alter stream health and hydrology. These changes can cause more water to reach a stream faster during storms and also decrease the baseflow in streams. When water can't infiltrate groundwater, streams lose an important source of water during dry periods. Taken together, these impacts can lead to "flashy" streams that carry much more water during storm events, and then run low or dry at other times of the year. When agricultural becomes a common land use in a watershed, another suite of stream alterations may occur, including water quality impairment from excess nutrients, sediment, and potentially pathogens.

Baseflow: The portion of stream flow comprising groundwater seepage. Streams are sustained by baseflow during dry times of the year.

In addition to current watershed land cover and use, other factors that can affect water quality include riparian (or streamside) condition and continuity, historical land uses, soils and geology, topography, the extent of wetlands, and point sources of pollution (Center for Watershed Protection, 2003). On a subwatershed scale, land uses and management practices within the riparian and floodplain corridor are likely important influences on stream health.

Although many towns in the Hudson Valley are rural communities without high-density development, it is important to note that building at higher densities is a valuable water resource protection strategy. To accommodate the same number of houses, denser development alters less natural land cover and creates less impervious cover than lower-density, sprawling development. Directing new development and growth to existing village centers uses land more efficiently, saves money, and is often the best option to protect water resources in the town. Locations and concentrations of developed land cover/land use, as well as of forest, wetland, and farmland can substantially impact water resources, both positively and negatively. Knowing where these land covers/land uses occur can help a town understand and anticipate general impacts to streams, lakes, and wetlands. Those indicators are the focus of land cover in this summary. See *Protecting Water Resources with Higher-Density Development* and the resource list at the end of the summary for more information on using higher-density development as one strategy for protecting water resources. Conservation subdivisions, a development strategy that can help identify and preserve natural areas in residential housing projects, can be good for water resources when used appropriately. See *Creating Open Space Networks* in the EPA's Green Communities toolbox for more information.

Another important tool for minimizing impacts from loss of natural cover and increases in impervious cover is the use of green infrastructure practices to manage stormwater; see the Green Infrastructure section below. Check the accompanying Habitat Summary for more discussion on minimizing impacts from development on habitats and water resources.

Information on land cover and land use comes from the National Land Cover Dataset (NLCD), which contains land cover and land-use information for the entire United States. **There are important limitations to the NLCD;** please see Appendix 1 for more information on NLCD data. Used appropriately, these data can be helpful for understanding patterns of land use in towns and for identifying areas of concern where land use could be impacting water resources.

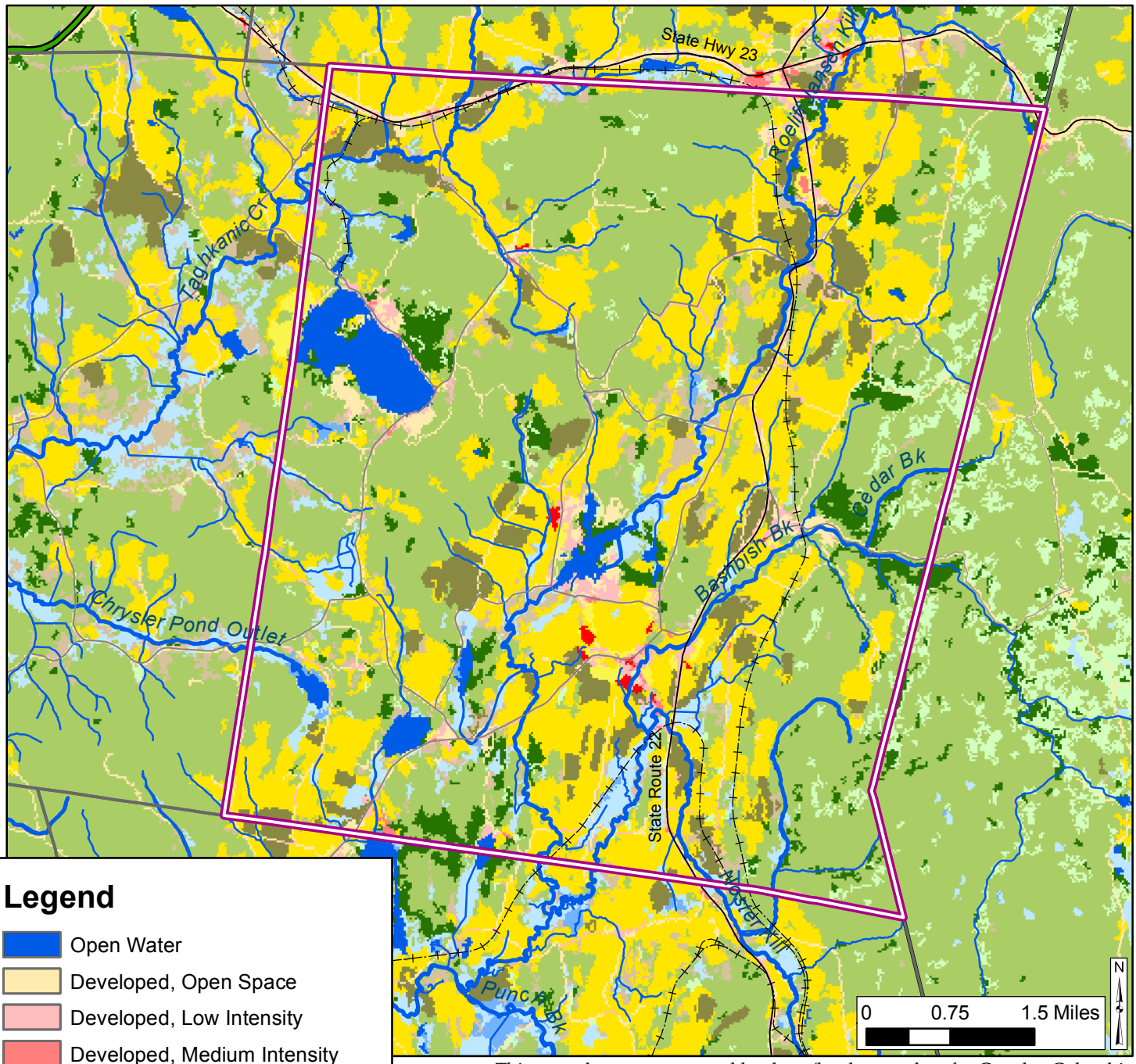
Copake Information: Land Use and Land Cover

Figure 4 shows land use/land cover data within Copake from the National Land Cover Database (NLCD). The Roeliff Jansen Kill (Roe Jan) valley flows runs north-south through the center of town, and most of the development and agriculture exists here. This same pattern exists along the Taghkanic Creek, in the northwestern portion of town. In between these ribbons are areas of large deciduous forests. The proximity of various land uses to streams or lakes can lead to significant water quality impacts, and in Copake, some of the highest intensity development is near Copake and Robinson lakes. For a summary of land cover and land use by subwatershed and for the town as a whole, see Table 1. The accompanying Habitat Summary also provides information on the significance and location of large forests, floodplain forests, wetlands and other habitats in the town.

The *Columbia County Hazard Mitigation Plan* notes that almost every town in Columbia County is losing farmland and forests to residential and commercial uses. Copake identified farmland-to-residential development as the overarching trend in the town. Residential development in former agricultural areas could be leading to a number of impacts to the habitats and water resources of the town commonly associated with sprawling forms of development, including habitat fragmentation, alteration of perennial and intermittent stream channels, water quality issues, loss or shrinking of riparian and wetland buffers, and others. Check the resources above for techniques to help address these impacts.

Copake's zoning code has many provisions regarding the land use and water resource patterns the Town wishes to promote. Copake's zoning code goals include: to protect and enhance wooded areas and waterways; to enhance the aesthetic aspects and maintain its present natural beauty; and to avoid a suburban pattern of development. The Town's Scenic Corridor Overlay Zone, flood district regulations, rural design and siting standards, and many other zoning components could be used to protect the town's water resources. Cluster subdivisions can be required by the Planning Board (§232-17), and flexible lot subdivisions are required for major subdivisions in the R zone outside the Scenic Corridor Overlay Zone. As part of a flexible lot subdivision, a conservation analysis is required. The information in this Water Resource Summary, as well as the accompanying Habitat and Climate Resiliency summaries, can provide information for these conservation analyses, and help the planning board make informed decisions regarding important resources in the town.

Figure 4: Land Cover and Land Use, including Forests, Farmland, and Impervious Cover, Copake, Columbia County, NY



Legend

- Open Water
- Developed, Open Space
- Developed, Low Intensity
- Developed, Medium Intensity
- Developed, High Intensity
- Barren Land (Rock/Sand/Clay)
- Deciduous Forest
- Evergreen Forest
- Mixed Forest
- Shrub/Scrub
- Grassland/Herbaceous
- Pasture/Hay
- Cultivated Crops
- Woody Wetlands
- Emergent Herbaceous Wetlands

This map shows streams and land use/land cover data for Copake, Columbia County. Land use and land cover information is not appropriate for site scale planning. This map was produced as part of a Water Resources Summary for the Town. For more information, please contact NYSDEC's Hudson River Estuary Program watershed specialists at (845) 256-3016.

Data Sources:
USGS National Hydrography Dataset (2008) for streams
USGS National Landcover Database (2006) for land use and land cover data

Map Created 2014

Hudson River Estuary
Water Resource Institute of New York State
Cornell University

Impervious Cover

Impervious surfaces are places where precipitation can't infiltrate the soil and recharge groundwater, resulting in increases in stormwater runoff. Conventional roofs, parking lots, driveways, sidewalks, and roads are common impervious surfaces. Impervious surface cover can be used within a watershed to look for changes to water quality from the associated increase in development. Research has found that increases in impervious cover are linked to degradation in water quality and aquatic habitat value and an increase in flooding problems (Walsh, et al., 2005).

Impervious Cover: Surfaces impenetrable to water, such as roads, conventional parking lots, and rooftops.

While the location and configuration of impervious surfaces in a watershed matter, research strongly suggests that a critical threshold of impervious cover exists (often about 10%), beyond which the probability of stream degradation greatly increases (National Research Council, 2008; Walsh, et al., 2005). And, in research undertaken in several small Dutchess County watersheds, impacts to nutrient levels in streams have been found in watersheds less than 5% impervious (Cunningham, et al., 2009). In the Hudson Valley, impacts associated with impervious cover, such as urban/storm runoff and municipal discharges, are a leading cause of impairment to the area's streams and lakes (Bureau of Watershed Assessment and Management, Division of Water, DEC, 2008). For more information on these impacts, see the Waterbody Impairment section in this summary. For more information on stormwater, see the Water Infrastructure section.

On a site-specific scale, there are many actions that homeowners and developers can take, and planning boards can encourage, to minimize impervious cover and promote best stormwater management practices. See *Protection Water Quality with Smart Growth Strategies and Natural Stormwater Management in Sussex County, Delaware* for a good introduction to site-specific actions for minimizing impervious cover. Check Appendix 1 for information on areas that have collected fine-scale impervious cover information.

Copake Information: Impervious Cover

As a whole, watersheds in Copake do not have high percentages of impervious surface cover (Table 1). Of the subwatersheds shown in Figure 3, the Loomis Creek-Claverack Creek has the highest average impervious cover, at 1.5%. Impervious cover could still be of concern in certain localized areas. The areas around Copake and Robinson lakes, as well as the hamlets of Copake and Copake Falls stand out as having the most impervious cover (Figure 5). Robinson Pond and Copake Lake are both considered *Impaired* by the DEC, and addressing the effects of impervious cover in their watersheds could help improve water quality (see Waterbody Impairment). In particular, urban/storm runoff is suspected to be a cause of impairment for Copake Lake. When impervious cover amounts are relatively low, as in most of Copake, other factors such as riparian and floodplain condition, forest and wetland cover, agriculture, and point-sources of pollution may become more important in addressing watershed-scale water quality issues.

Forest Cover

Forests are one of the most beneficial land covers for many reasons, and their benefits to water resources are well established. Conserving and managing forests is necessary to provide clean drinking water now and for future generations and critical habitat for numerous plants and animals. Research has shown that watersheds with greater percentages of forest cover can save significant drinking water treatment costs. For more information, see the EPA fact sheet The Economic Benefits of Protecting Healthy Watersheds.

More information on the value of local forests and the location of large forests in Copake can be found in the accompanying Habitat Summary. Helpful resources to guide forest management for water quality benefits include the Center for Watershed Protection's *Watershed Forestry Resource Guide*, which offers a summary of projects that explore links between forest cover and economic benefits to communities. The DEC Division of Lands and Forests' Forest Stewardship Program provides technical assistance and resources to private forest owners to guide them in their use and management of forest lands. Cornell Cooperative Extension's Forest Connect website also offers valuable information geared to private forest owners and elected officials. The *Municipal Official's Guide to Forestry in New York State* is a useful guide to promoting healthy forestry through local planning and zoning efforts.

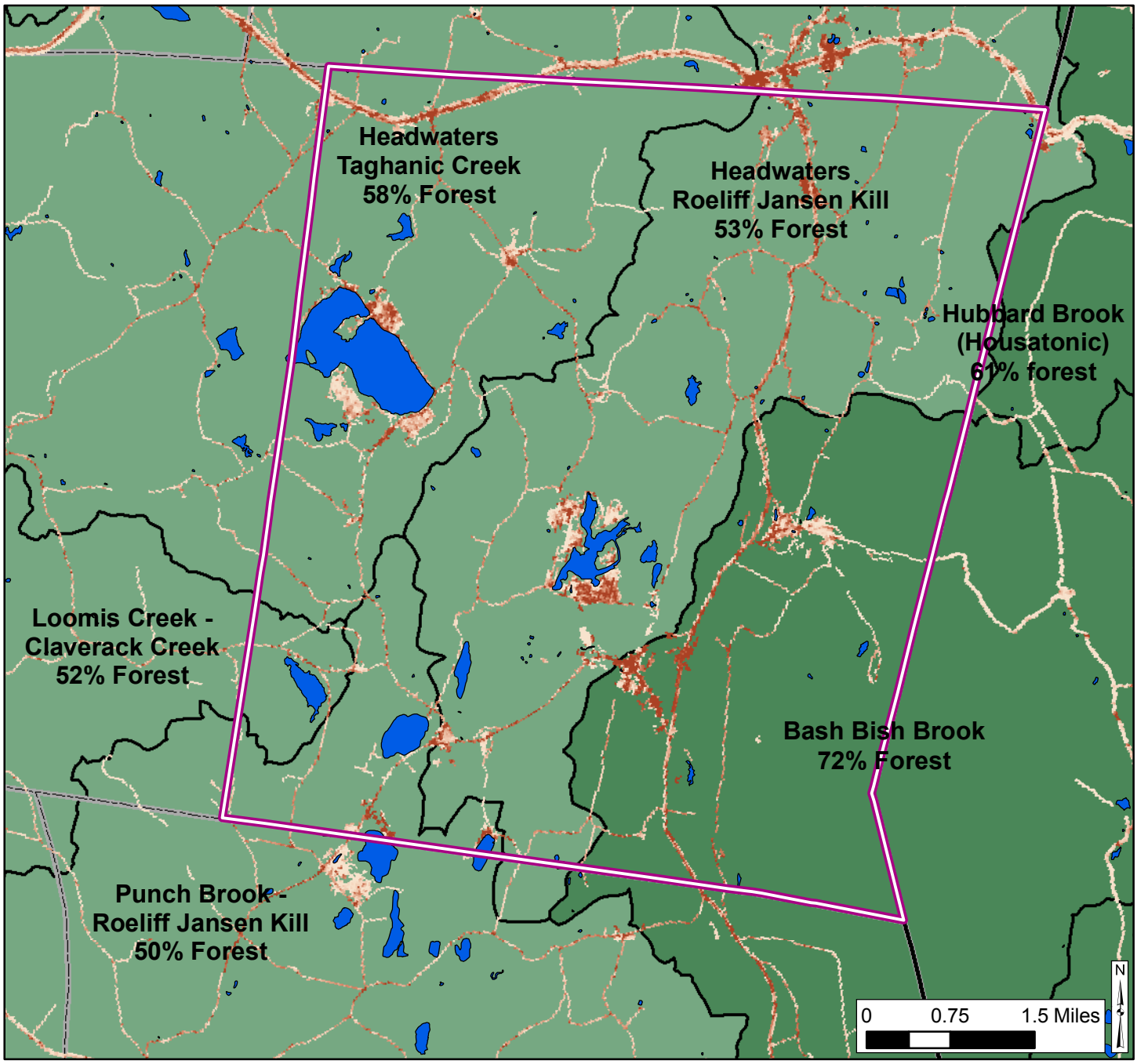
Copake Information: Forest Cover

Table 1 shows forest cover by subwatershed, which ranges from 50% to 72% in and around Copake (see also Figure 5). The importance of large forests, the landscape context of forests, forest connectivity and quality, and the value of forests for rare species are all addressed in the accompanying Habitat Summary.

Clear-cutting in Copake could be subject to NYSDEC permitting authority if it is within the 100 foot setback of a state-regulated wetland, though firewood collection and selective cutting might not need permits in this zone. Also, clear-cutting is subject to a Stormwater Pollution Discharge Elimination System (SPDES) general permit if it disturbs more than one acre, though on-going silviculture with a forest management plan is exempt. For general harvesting info see DEC's Timber Harvesting, and for more detailed information on timber harvesting and NYSDEC permits, see the stormwater permit Frequently Asked Questions. For more information on stormwater, see the Stormwater Management section of this summary. Permits may also be required from the NYSDEC and/or the Army Corps of Engineers for stream crossings.

For guidance on the regulation of specific sites and for the most up-to-date information, contact the NYSDEC for precise information. For questions regarding the protection of surface water resources, contact Steven Swenson (1-607-652-2645, stswenso@ gw.dec.state.ny.us) the NYSDEC biologist covering the Copake area.

Figure 5: Impervious Cover and Forest Cover in Copake, Columbia County, NY



Legend

Percent Impervious Cover

100% 0%

Subwatershed boundary

Percent forest cover by subwatershed

- 0 - 30
- 31 - 45
- 46 - 60
- 61 - 75
- 76 - 100

This map shows percent impervious cover, averaged in 30sq m grids, as well as percent forest cover averaged by subwatershed, for Copake, Columbia County. For both datasets, darker colors indicate higher percent cover values. **This map is not appropriate for site planning and is not a viable substitute for on-the-ground knowledge and site visits.** This map was produced as part of a Water Resource Summary for the Town. For more information, please contact NYSDEC's Hudson River Estuary Program watershed specialists at (845) 256-3016.

Data Sources:

USGS National Land Cover Database Land Cover and Percent Developed Imperviousness (2006) for forest cover and impervious cover

USGS National Hydrography Dataset for streams, waterbodies and Hydrologic Unit Code 12 subwatersheds (2008)

Map Created 2014

Hudson River Estuary

Water Resource Institute of New York State

Cornell University

Farmlands

Farms are a critical part of Hudson Valley communities and have many economic and social benefits. However, agriculture is also one of the biggest sources of negative impacts to water quality in the Hudson River Estuary watershed (Bureau of Watershed Assessment and Management, Division of Water, DEC, 2008). Together with urban/storm runoff, agriculture accounts for more than two-thirds of the documented negative impacts to streams. Farms can harm streams by polluting them with nutrients, pesticides, sediment and bacteria, or by altering stream channels and flow. The negative effects of agriculture on streams can be handled through best management practices that reduce soil erosion and reduce fertilizer and pesticide applications, which can make their way to streams and other waterbodies.

For information on minimizing the negative impacts of farmland on streams check local resources such as the Columbia County Soil and Water Conservation District and the USDA-Natural Resources Conservation Service. The Farmscape Ecology Program, based in Ghent, NY, provides many sources of information about agricultural ecology and on-farm biodiversity. Also, the Agricultural Environmental Management Program of the New York State Soil and Water Conservation Committee is an incentive-based program that offers practical, cost-effective and science-based information to help farms meet their business needs and conserve the state's natural resources.

Copake Information: Farmland

The subwatersheds in Copake vary from 12% to 35% agricultural land cover (see Table 1), including pasture/hay and cultivated crops. Within the boundary of the town, a third of the land is farmed. Agricultural practices may negatively affect Copake's streams and waterbodies (see the section below on Waterbody Impairment and Table 4), but agricultural impacts to streams and lakes are very dependent on the individual management of farms, so outreach to local farmers involving best management practices has an important role in improving water quality.

Table 1: Subwatersheds and Land Cover/Land Use in Copake, NY

Subwatershed	Area (square miles)	Impervious Surface (%) (mean % imperviousness)	Forest Cover (%)	Farmland (%) (including pasture/hay and cultivated crops)
Headwaters Taghkanic Creek	42.2	0.77	58	23.2
Loomis Creek-Claverack Creek	49.7	1.52	52.4	30.2
Punch Brook-Roeliff Jansen Kill	47.9	0.6	50	35.6
Headwaters Roeliff Jansen Kill	39.5	1.01	53.1	33.4
Bash Bish Brook	31.9	0.62	72.2	17.7
Hubbard Brook (Housatonic)	50.1	0.63	61.3	11.8
Town-wide	42.1	1.23	50	32.7

Aquifers

Aquifers are saturated underground areas that can yield usable amounts of water to wells and springs. Many Hudson Valley communities depend on drinking water extracted from aquifers through both municipal and private wells. Aquifers are critically important water resources for present and future generations who will need continued access to clean water. Groundwater, which includes aquifers and other underground water, is particularly important during dry periods of the year because it can be a constant source of water moving into streams and rivers. During dry periods, groundwater is often the dominant source of water in streams.

Base Flow: The portion of streamflow that comes from groundwater seepage. During dry periods base flow can make up the majority or the entirety of stream flow.

Aquifers can become polluted in many ways, including unintentional chemical spills, intentional addition of chemicals to the landscape, and improperly spaced or poorly functioning septic systems. Aquifer extraction and consumption that exceed recharge can result in wells running dry, with the associated expense of digging deeper wells or buying water. Excessive extraction can also harm aquatic organisms by changing the stream flows and water temperatures they rely on for survival and successful reproduction.

Protecting drinking water sources is important to ensure that sufficient high-quality water is available over time. NYS Department of Health's (DOH) Source Water Assessment Program has information on source water assessments; the Trust for Public Land's report *Protecting the Source* also outlines a process for protecting drinking water.

An important consideration with groundwater withdrawal and consumption is how and where it is discharged as wastewater. Septic systems return most of the withdrawn water as wastewater in the same location as its extraction. If groundwater is used by a community system, delivered to customers, and then discharged through a wastewater treatment plant to surface water, it is not returned in the same location, and is sometimes not even returned within the same watershed. Scientific understanding and information should be part of all decisions related to groundwater use and distribution to ensure long term availability of this critical service provided by the ecosystem.

An overlay district is one form of municipal aquifer protection. A district can help protect aquifers in several ways, including establishing buffer requirements around wells, requiring maintenance of wastewater treatment facilities (including septic systems), and identifying appropriate land uses in aquifer recharge areas. Examples of municipal aquifer protection in New York State are gathered in PACE Land Use Law Center's Gaining Ground database. Aquifer protection should be tailored to local needs. Contact a watershed specialist to help understand this resource.

USGS Aquifer Maps

Aquifers in the state were coarsely mapped by the USGS in partnership with DEC. Because the scale of the original aquifer maps is 1:250,000, they indicate only the general location of unconsolidated

aquifers; they are not intended for detailed site evaluations. See Appendix 1 for more information on the USGS aquifer maps.

Sources of data for groundwater information also include: well reports, published groundwater studies, unpublished consultant reports, well constructors, county health departments, and source water assessment reports. In addition, the organizations listed below can provide valuable information and services for protecting aquifers and other groundwater resources.

Other Sources of Aquifer Information

The New York Rural Water Association is a not-for-profit organization that helps public and private rural water and wastewater systems provide safe drinking water and protect the environment at an affordable cost to users. The association can help communities identify areas where groundwater protection is appropriate, look for potential conflicts between land use and groundwater resources, address wellhead or groundwater protection plans, assess wastewater treatment systems, and offer many other services. Contact them (Phone: 518-828-3155; e-mail: nyrwa@nyruralwater.org) for information on conducting a finer-scale analysis of your community's aquifer and groundwater resources.

Groundwater quality monitoring in New York State is done through a partnership between DEC's Division of Water and the USGS. The Ambient Groundwater Monitoring Program seeks to assess and report on the quality of the state's groundwater, identify long-term groundwater quality trends, characterize naturally occurring conditions, and establish an initial statewide comprehensive groundwater quality baseline. The Lower Hudson River drainage basin (which includes Copake) is undergoing a study during the next three years. Contact Scott Kishbaugh (sakashba@gw.dec.state.ny.us) for more information on the program or the locations of DEC's groundwater quality sampling.

Dutchess County's Waste and Wastewater Authority recently commissioned a countywide aquifer recharge rate analysis. In Dutchess County, rates can be used to calculate sustainable septic densities, helping to prevent aquifers from becoming contaminated through septic outflow too densely spaced. The report, *Dutchess County Aquifer Recharge Rates & Sustainable Septic System Density Recommendations*, is a useful document for towns interested in starting a similar process.

Copake Information: Aquifers

Figure 6 shows one class of known, mapped aquifers in Copake, according to USGS data. Mid-yield aquifers underlay many of the streams in town, including all of the Roeliff Jansen Kill and Taghkanic Creek. Certain land uses are inappropriate in areas that have been identified as important to a community's drinking water supply. Towns should seek to site land uses that are potentially harmful to groundwater supplies in the least sensitive areas. Development choices along the Roeliff Jansen Kill, Taghkanic Creek, and other streams should reflect the potential sensitivity of the aquifer.

The New York Rural Water Association prepared the Groundwater Resources Study and Protection Plan for the Town of Copake in 2009. This study is an in-depth, local resource for Copake on many water resource issues, including groundwater yield, groundwater sensitivity, and groundwater protection strategies. This study indicates that in certain locations (including the area surrounding Copake Lake and Robinson Pond and the hamlets of Copake and Copake Falls), density currently exceeds the recommended levels to minimize nitrate loading and to conserve base flow to streams. There are other areas that are less developed but current zoning allows development to exceed the recommended levels (including the areas north of Copake Lake, between the hamlet of Copake and Robinson Pond, and south and west of Copake Falls). The study also shows that highly and very highly sensitive hydrogeologic areas cover 33 percent of the town.

Public Drinking Water Supply

Public water systems provide drinking water to at least five service connections or serve an average of at least 25 people for 60 days of the year. The system type is based on the number of people served, the source of the water, and whether or not it serves the same people year-round. Community systems (C) provide drinking water to the same customers year-round; non-community systems (NC) do not. There are two types of non-community systems: transient non-community systems that serve different people for more than six months of the year and non-transient non-community systems (NTNC) that serve the same people more than six months of the year. Some systems that have less than five connections or service less than 25 people are classified as non-public systems (NP). See DOH's Drinking Water Program: Frequently Asked Questions for more information about the system types.

Information about public water systems and violations of drinking water regulations is available through the US EPA's Safe Drinking Water Information System (SDWIS).This includes violations and enforcement history from 1993 on.

Table 2: Public drinking water supplies in Copake (EPA)

Public Water System	Water System ID	Source Type	System Type*	Population Served
BERTS INN	NY1015331	1 well	NC	26
CAMP MAHICAN	NY1030035	1 well	NP	90
CAMP PONTIAC	NY1030032	3 wells	NC	500
CAMP WAUBEEKA	NY1012349	2 wells	NC	1,000
CAMPHILL VILLAGE USA INC	NY1009225	1 well, treatment plant (chlorination)	C	235
CHURCH STREET DELI	NY1030090	1 well	NC	75
COPAKE CAMPING RESORT	NY1012350	2 wells	NC	325
COPAKE DINER	NY1030144	1 well	NC	57
COPAKE GENERAL STORE	NY1030097	1 well	NC	26
COPAKE LAKE BOAT AND SKI, LLC	NY1030066	1 well	NC	25
COPAKE REC. PARK	NY1030182	1 well	NP	60
COPAKE SUNOCO	NY1030126	1 well	NC	25
CRARYVILLE AMERISTOP	NY1030247	1 well	NC	25
CREEKSIDE MANOR	NY1018154	2 wells	NP	22
DANCERS MARINE	NY1015353	1 well	NC	48
DEPOT DELI	NY1030101	1 well	NC	25
DUTCH TREAT	NY1015312	1 well	NC	41
HAMLET APARTMENTS	NY1030013	1 well	C	25
HILLOVER HEALTHY & FRESH	NY1030263	1 well	NP	20
HILLSDALE HOUSE	NY1015320	1 well	NC	65
LEBANON VALLEY CONCESSIONAIRES	NY1015329	1 well	NC	250
LINDEN VALLEY BED & BREAKFAST	NY1030001	1 well	NP	12
OLD CHATHAM COUNTRY STORE	NY1030118	1 well	NC	25
PLAST CAMP	NY1030033	5 wells	NP	600
ROELIFF JANSEN TOWN PARK/DAYCAMP	NY1030248	1 well	NP	60
SILVANUS LODGE	NY1012933	1 well	NC	25
ST. BRIDGETS OFA	NY1015315	1 well	NC	25
SWISS HUTTE	NY1016042	1 well	NC	75
TACONIC HILLS SCHOOL	NY1030076	2 wells, treatment plant	NTNC	2,500

		(hypochlorination)		
TACONIC MOBILE HOME PARK LLC.	NY1010856	1 well	C	40
TACONIC SHORES	NY1000237	2 wells, 2 treatment plants (hypochlorination)	C	950
TACONIC STATE PARK	NY1011777	2 wells	NC	600
TACONIC WAYSIDE INN	NY1012345	1 well	NC	50
THE GREENS RESTAURANT AT COPAKE CC	NY1030026	1 well	NC	50

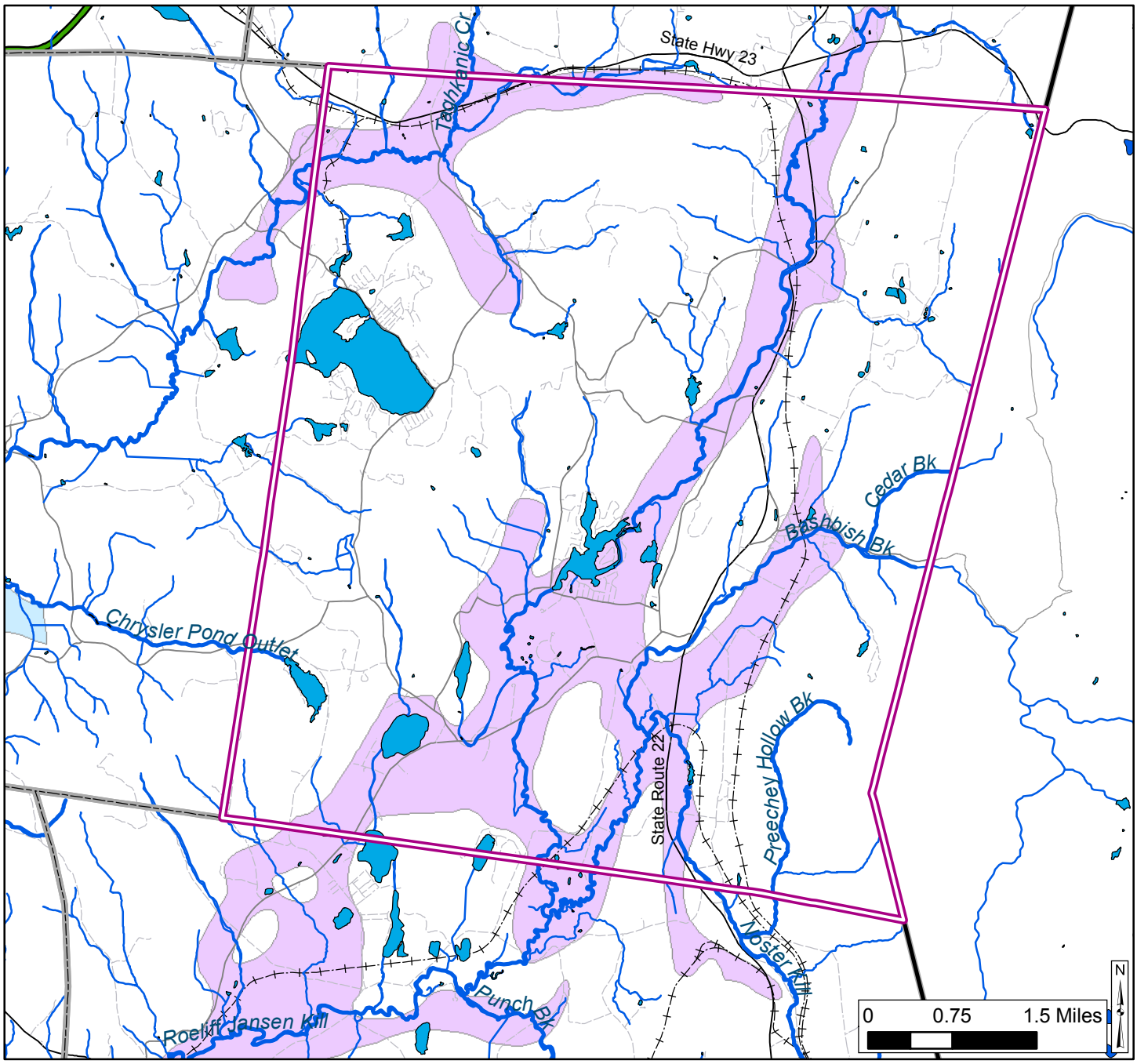
*C=community system, NC=non-community system, NTNC=non-transient non-community system, NP=non-public system

Copake Information: Public Drinking Water Supplies

The entire town uses groundwater as a source of drinking water, and Copake has recognized the importance of clean surface and groundwater to the town in its Comprehensive Plan. Copake has 27 public water supply systems, including four community systems (serving 1,250 people), 22 non-community systems, and one non-transient non-community system. There are also seven non-public systems (Table 2). The rest of the town is served by individual private wells.

According to the SDWIS, although none of the water supplies have had health-based violations, nearly all of the public water supplies have had monitoring violations over the past decade. 25 of the 27 public water supplies have had monitoring violations for coliform, and 23 have had monitoring violations for nitrate.

Figure 6: Mapped Aquifers in Copake, Columbia County, NY



This map shows streams, waterbodies and known aquifers for Copake, Columbia County. Aquifers were defined as "High Yield" (>100 gpm) and as "Mid Yield (10 to 100 gpm). **Aquifers were mapped at a very course scale (1:250,000) and are for general information only; this map should not be used at the site plan scale.** This map was produced as part of a Water Resources Summary for the Town. For more information, please contact NYSDEC's Hudson River Estuary Program watershed specialists at (845) 256-3016.

Legend

- Copake
- Unconfined, High Yield
- Unconfined, Mid Yield

Data Sources:
NYSDEC Bureau of Water Resources Management (2008) for aquifer data
USGS National Hydrography Dataset (2008) for streams and waterbodies

Map Created 2014

Hudson River Estuary
Water Resource Institute of New York State
Cornell University

Floodplains and Riparian Buffers

Floodplains and riparian buffers provide many critical functions for a healthy stream and its watershed. Successful stream management done on a watershed scale must include the condition and connection of a stream to its floodplain and shoreline. *Life at the Water's Edge: Living in Harmony with Your Backyard Stream* is an accessible document for private property owners that addresses floodplains, buffers, and other stream management concepts. CatskillStreams.org is a useful website for information on stream stewardship and links to many other projects dealing with connections between streams and watersheds. The Chemung County Soil and Water Conservation District created *Stream Processes, A Guide to Living in Harmony with Streams*, a very useful document that provides an overview of streams and stream processes in a watershed context.

Floodplain regulation: Local governments are the primary enforcers of floodplain regulations.

Floodplains

Floodplains are low-lying areas, often next to streams and rivers, which are inundated during heavy precipitation or snow melt events. They are naturally connected to streams but can extend far from a stream or river and aren't necessarily found alongside them. Flooding is a natural process and is one way a stream reacts to an increase in water coming into it. Streams of all sizes can have floodplains at various locations along their length. The total size of a floodplain and its distance from and connection to a stream can vary greatly with topography and other local conditions. Floodplains perform many important functions:

- Prevention of erosion
- Habitat for plants and wildlife
- Temporary storage of floodwaters
- Moderation of peak flows
- Maintenance of water quality
- Recharge of groundwater
- Recreational opportunities
- Aesthetic benefits

When left in a natural state, floodplains act as a type of natural infrastructure, providing a safety zone between people and the damaging waters of a flood. Building in floodplains increases the risk of property damage and loss of life. The location of floodplain boundaries can change over time and in response to changing weather patterns, changes in land use in and around the floodplain and in the surrounding watershed, obstructions in the floodway, stream projects (including dams and levees), and natural stream processes. For more information about changing flooding risk due to climate change, see the Estuary Program's *Climate Resiliency Summary for Copake.*

The Federal Emergency Management Administration (FEMA) has developed detailed floodplain maps for the National Flood Insurance Program. Flood insurance rate maps (FIRM) show areas estimated to have

a 1% chance or greater probability of being inundated in any given year (commonly referred to as a 100-year flood). Areas with 0.2% chance of flooding in a given year (500-year flood) are also included in FIRMs. While these maps can provide a valuable planning tool, it is important to note that FIRMs are only estimates based on the data and modeling technology available at the time of mapping. Due to the unpredictable nature of some kinds of floods, maps don't show many areas subject to flooding from localized drainage problems, including undersized culverts, ice jams, or sheet flooding down a slope.

Communities that adopt floodplain management ordinances in accordance with FEMA guidelines can qualify for federal flood insurance and many different kinds of disaster assistance. FEMA requires that local laws for flood damage prevention contain specific standards for any development in federally mapped Special Flood Hazard Areas (generally the 100-year floodplain). In partnership with federal and local governments, DEC's Bureau of Dams and Flood Protection provides technical assistance to communities for administration of local floodplain regulations, including a model local law for flood damage protection. More information is available through DEC's Floodplain Management resources or contact the bureau at 518-402-8185 or floodpln@gw.dec.state.ny.us.

Copake Information: Floodplains

Based on FIRM maps, 7% (3.1 sq miles) of Copake is within a 100-year floodplain. These flood hazard areas are situated in and along the Bash Bish Brook, Noster Kill and around Robinson Pond. There are no 500-year floodplains mapped in Copake. Floodplain maps for the Roeliff Jansen Kill can be found in the series of maps from the Town's Comprehensive Plan at http://townofcopake.org/site/wp-content/uploads/2013/11/Combined-Maps-For-Copake.pdf. See the accompanying Climate Resiliency Summary for information about the risks that flooding poses to communities, and opportunities to address those risks.

The most current FIRM maps that cover Copake have an effective date of 1985. FEMA has recently updated many flood hazard maps across the country to reflect physical changes in floodplains, new data, and modeling capabilities. However, at the time of this writing, no update has been scheduled for Columbia County.

The *Columbia County Multi-Jurisdictional Hazard Mitigation Plan* identifies 186 residential occupancy properties, 19 commercial occupancies and 9 critical infrastructure sites at risk for flood damage in Copake and over $35.6 million dollars in possible flood related losses.

Riparian Buffers

Riparian areas include streambanks, lakeshores, wetlands, and floodplains. A riparian buffer, also known as a stream buffer, is the vegetated area between a waterbody and human activity, often used to protect a stream from various detrimental influences. A healthy, vegetated riparian buffer helps improve stream health and water quality by:

Riparian: Ecosystems that occur along a waterbody–the transitional area influenced by the land and water.

- Filtering and slowing pollution runoff
- Preventing soil erosion
- Providing upland habitat
- Contributing essential nutrients to the food chain
- Providing woody debris for in-stream habitat
- Shading that keeps water temperatures down

Buffers can also help absorb and slow flood waters to protect human life and property. Varying buffer widths provide different functions to support human needs and ecosystems. As illustrated in Figure 7, riparian buffers of 300 feet or more provide the greatest opportunity for natural functions to benefit ecological and human communities. While narrower buffers could still provide viable functions and critical protections, in general, wider buffers provide better habitat connectivity and more protection to the water quality of streams and other waterbodies. Protecting existing buffers and restoring degraded ones can help protect streams.

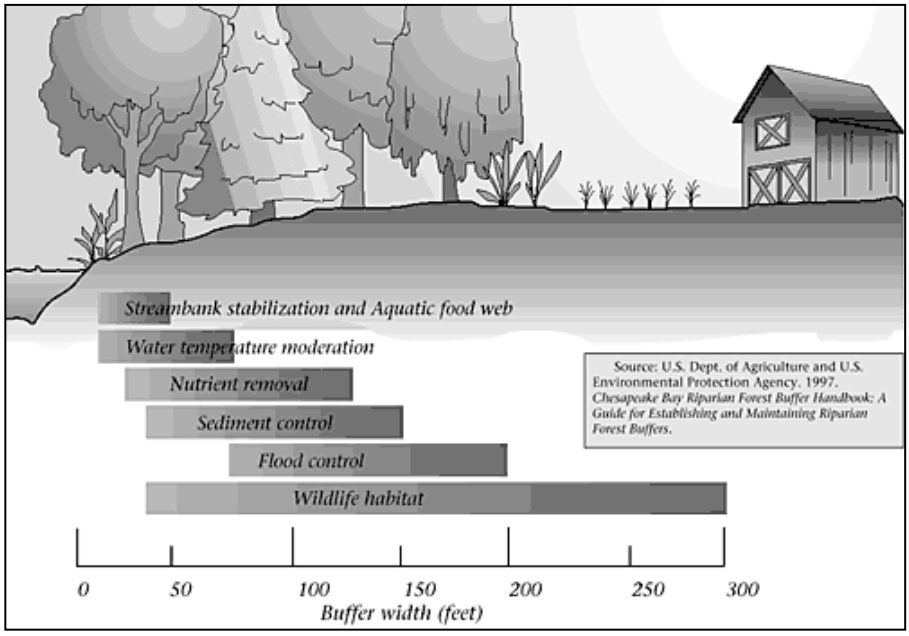


Figure 7: Buffer function based on width

Municipalities can protect buffers and floodplains by enacting local watercourse buffer ordinances and conservation overlays and by implementing buffer and floodplain protections through State Environmental Quality Reviews (SEQR). Municipalities can also encourage property landowners to allow native trees, shrubs and vegetation to grow along streams. More information on these techniques is available in DEC's handbook, *Conserving Natural Areas and Wildlife in Your Community: Smart Growth Strategies for Protecting the Biological Diversity of New York's Hudson River*

Valley. The Hudson Estuary Trees for Tribs initiative provides free native trees and shrubs and technical assistance for replanting riparian areas. In agricultural areas, the United States Department of Agriculture Conservation Reserve Enhancement Program offers support to increased conservation practices such as filter strips and forested buffers.

Copake Information: Riparian Buffers

Using a coarse estimation based on the land cover within 300 feet of Copake's mapped streams (but see the NLCD section in Appendix 1 for important limitations of the data) the riparian areas in Copake are 56% natural cover (32% forests, 6% shrub/scrub and 18% open water and wetlands), 35% agricultural (27% pasture, 7% cultivated) and 9% developed. The large proportion of agricultural cover might reveal opportunities for the community to assist farmers with the identification of best management practices to minimize the impact on streams. See the previous section on Farmlands for more resources.

More detailed studies are needed to identify specific opportunities for protection and restoration of riparian areas in Copake.

Water Quality Standards and Assessments

This section includes information on waterbody classification, assessment, and impairment. A waterbody's classification, along with its assessment results, provides an understanding of its health and can lead to the designation of a stream or waterbody as impaired. This summary is not a regulatory document; questions about the classification and impairment of specific streams should be directed to the appropriate DEC regional office. The maps displayed here show unofficial stream segment and waterbody information but are largely consistent with the official version.

The following information on water quality is collected and displayed for particular streams and waterbodies, but it's important to remember that stream management should occur in a watershed context. The effects of land use on streams and the effects of stream health on everything from habitat to real estate values highlight the critical connection between the two.

Waterbody Classification

DEC's classification of a waterbody designates the "best uses" that it should be supporting. Waterbodies are classified by the letters A, B, C, or D for freshwater. (For more information about classifications, see the DEC's webpage on Water Quality Standards and Classifications. For each class, the designated best uses are defined as follows:

- Class A, AA, A-S, or AA-S - water supply, primary and secondary contact recreation, and fishing
- Class B - primary and secondary contact recreation, fishing
- Class C – fishing, suitable for fish propagation and survival
- Class D - fishing

Waterbodies classified as A, B, or C may also have an associated standard of (T), indicating they are trout waters, or (TS), indicating they are trout spawning waters. For more information about the best uses designated for each classification, see DEC's Classifications-Surface Waters and Groundwaters webpage. DEC recognizes that some waterbodies have an existing quality that is better than their assigned classification and uses an anti-degradation policy to protect and maintain high-quality streams.

DEC also establishes water quality standards, specific to particular parameters and pollutants, to protect the uses associated with these classifications. Standards can be numerical or narrative. For example, dissolved oxygen has a numerical standard of no less than 7.0 mg/L in trout spawning waters. Turbidity has a narrative water quality standard, which states there should be "no increase that will cause a substantial visible contrast to natural conditions." Information on surface water and groundwater quality standards can be found at Surface Water and Groundwater Quality Standards. If waterbodies are not supporting the standards for their best uses, they may be listed on the Priority Waterbody List as Impaired (see Waterbody Impairment section below).

Activities allowed in and around waterbodies are regulated based on their classification and standard. C(T), C(TS), and all types of B and A streams (as well as water bodies under 10 acres located in the

course of these streams) are collectively referred to as "protected streams." They are subject to the stream protection provisions of the Protection of Waters regulations in Article 15.

On protected streams, DEC regulates their beds and banks, defined as the areas immediately adjacent to and sloping toward the stream, extending 50 feet or more (Figure 8). Activities that excavate, fill, or disturb these beds or banks require a DEC permit. See Protection of Waters: Disturbance of the Bed or Banks of a Protected Stream or Other Watercourse for more information. In situations where streams are unmapped in DEC databases, perennial streams share the classification of the receiving stream, while intermittent streams become Class D.

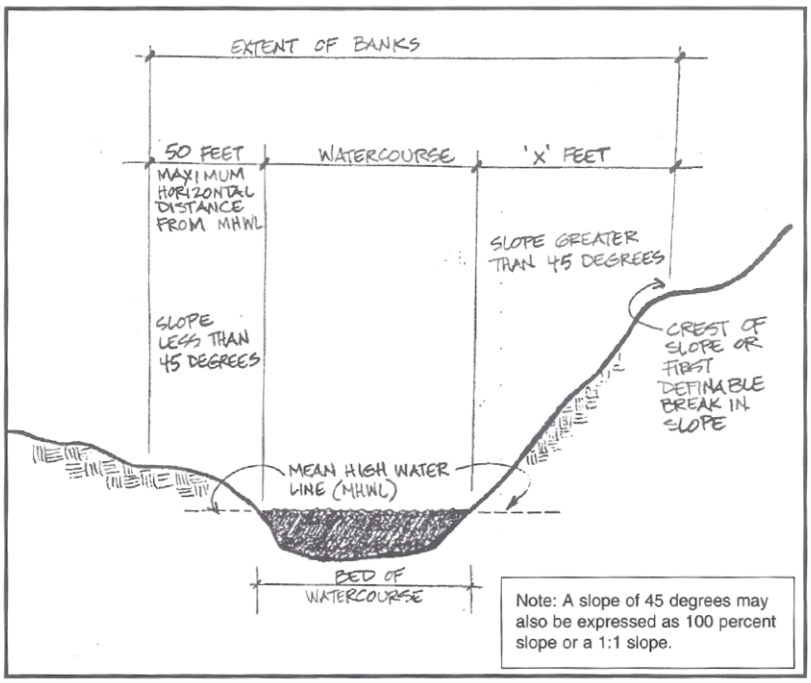


Figure 8: Visual representation of NYSDEC stream bank regulation (NYSDEC Protection of Waters: Application Procedures sample plans)

Article 15 also offers protection to navigable waters of the state. DEC permits are required for direct or indirect excavating or filling of navigable waters, which can include perennial streams and intermittent streams. This regulatory authority also covers estuaries, marshes, tidal marshes and other wetlands inundated at mean high water level or tide that are adjacent and contiguous at any point to any of New York State's navigable waters (Use and Protection of Waters: Excavation and placement of fill in navigable waters). DEC water quality certification permits and US Army Corps of Engineers (ACOE) permits may also be required for work involving streams; contact the DEC biologist responsible for applying state regulation in the protection of surface water resources for information regarding specific projects.

While the regulations stemming from stream classifications provide some level of protection from damage to streams' beds and banks, the lack of jurisdiction on "non-protected streams" shouldn't be misinterpreted to mean that the stream or river doesn't need local protection. There is scientific justification to protect all streams and rivers from pollution and damage to their channels. See the Sierra Club and American Rivers' Where Rivers Are Born for more information. Unprotected streams are often small, but these small streams run into larger ones, directly affecting their water quality. Ultimately, local tributaries flow into the Hudson River, and poor-quality tributaries negatively affect its health. Strong watershed

Stream protection from NYSDEC: Streams classified C(T) or higher and their beds and banks are regulated by NYSDEC. Wetlands contiguous to those streams may also be regulated.

protection must address all water resources in the watershed, not just those that meet certain classifications. Limitations in state regulations should be seen as an opportunity for local-level protection efforts. DEC encourages municipalities to go beyond state regulations and protect waterbodies through local measures.

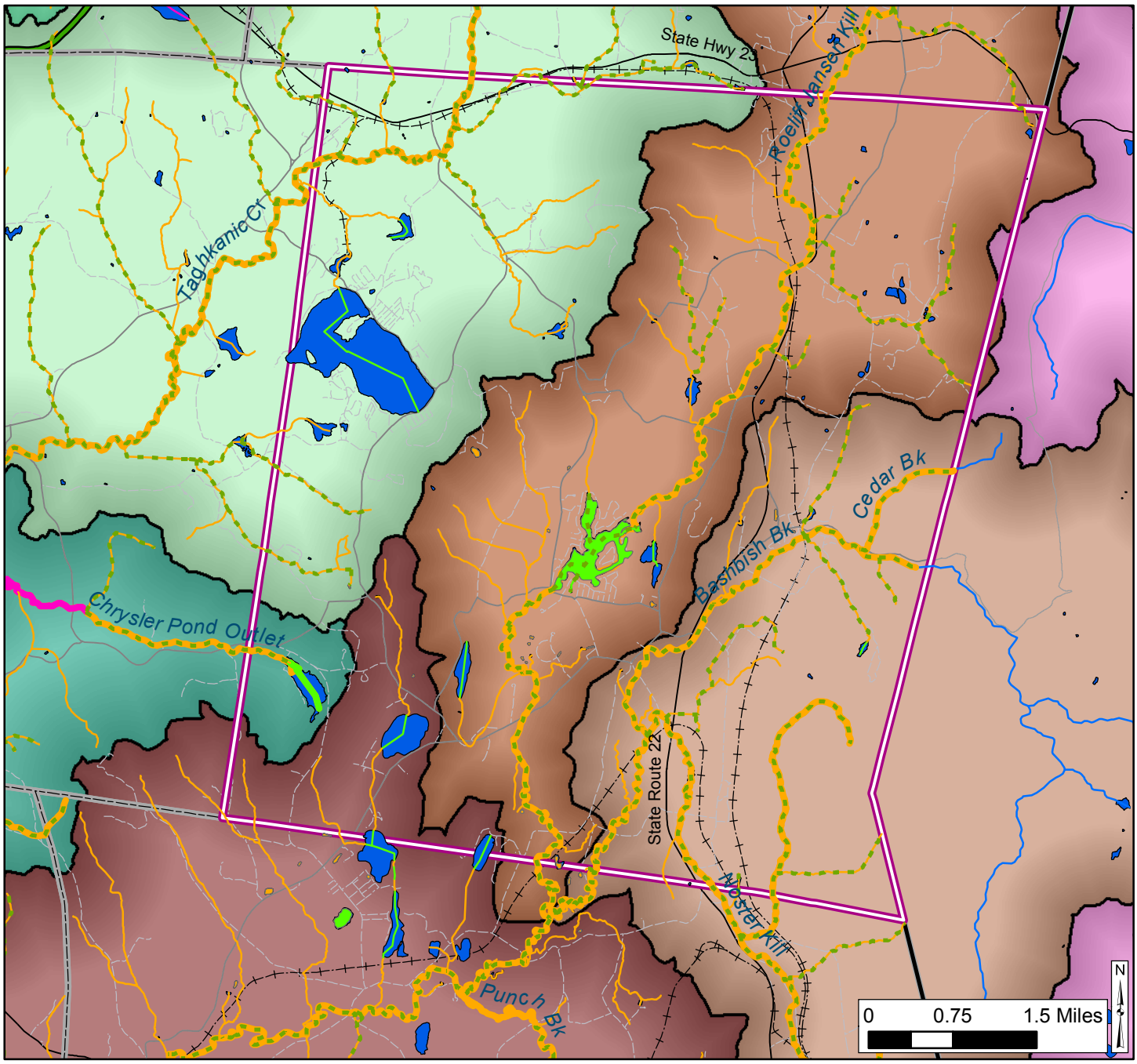
There are many options available for protecting streams at the local level. Multiple towns in the Hudson Valley have steep slope ordinances, clearing or grading ordinances and other land-use measures, which provide some protection from sediment and other pollutants entering streams. Several towns have gone one step further and enacted watercourse ordinances that help fill the void of critical stream, wetland and watershed protection. *Conserving Natural Areas and Wildlife in Your Community* is a reference for planning and implementing conservation on a municipal scale. There are several strategies for municipal stream protection in Chapter 5 of the book. For more information on neighboring communities that have enacted local protection measures, contact the Estuary Program's watershed specialists.

Copake Information: Waterbody Classification

In Copake, 7.5% of streams (6 miles) are class B streams, and 55% (44 miles) are class C(T) or C(TS). The remaining 37.5% of streams are class C and not subject to New York State's stream protection provisions of the Protection of Waters regulations. See the accompanying Habitat Summary for information about the value of both cold water trout streams and warm water streams.

For the Town of Copake, Steven Swenson (1-607-652-2645, stswenso@gw.dec.state.ny.us) is the NYSDEC biologist responsible for applying state regulation in the protection of surface water resources. Contact him for questions regarding stream classifications.

Figure 9: Waterbody Classifications in Copake, Columbia County, NY



This map shows streams and their NYSDEC classification, waterbodies, and watersheds for Copake, Columbia County. See the accompanying summary for a description of stream classifications. Perennial streams that are not shown take on the classification of the waterbody they flow into. This is an unofficial version, however the stream segments are largely consistent with the official regulations. **This map is not appropriate for regulatory purposes, for the most recent information contact NYSDEC Region 4.** This map was produced as part of a Water Resource Summary for the Town. For more information, please contact NYS DEC's Hudson River Estuary Program watershed specialists at (845) 256-3016.

Data Sources:

NYSDEC (2010) for stream classifications

USGS National Hydrography Dataset for waterbodies and Hydrologic Unit Code 12 subwatersheds (2008)

Map Created 2014

Legend

- Copake
- T and TS streams (trout, trout spawning)

NYSDEC Stream Classification

- A
- B
- C
- D

Hudson River Estuary

Water Resource Institute of New York State

Cornell University

Waterbody Assessments

Lake Assessments

Lakes, ponds, and reservoirs are monitored through the Lake Classification and Inventory Program and through the Citizens Statewide Lake Assessment Program (CSLAP). The first program is conducted by DEC staff, and the second is directed by DEC but run by volunteers from lake associations. Contact Program Manager Scott Kishbaugh (sakishba@gw.dec.state.ny.us) for more information about these programs and to find detailed information regarding lakes, ponds, and reservoirs in town.

Diet for a Small Lake: The Expanded Guide to New York State Lake and Watershed Management is a compendium of information about the ecology, monitoring, and management of lakes and watersheds in New York State. The guide is written for both lake residents and professionals.

Copake Information: Lake Monitoring

Both Copake Lake and Robinson Pond have been monitored through the Citizens Statewide Lake Assessment Program (CSLAP). CSLAP is a citizen monitoring program and is primarily focused on monitoring to evaluate lake conditions and impacts associated with lake eutrophication. For Copake Lake, the 2000 Interpretive Summary is the most recent report summarizing the water quality information, and the 2012 Lake Water Quality Summary is the most current for Robinson Pond. The Copake Lake summary includes several paragraphs of both in-lake and terrestrial land use management discussions that could be useful to the town. DEC continues to sample these lakes. Contact David Newman at DEC (djnewman@gw.dec.state.ny.us) for the most up-to-date information on the state's lake water quality information in Copake. Taconic Shores Property Owners Association commissioned a study on water quality impacts of Robinson Pond and the upper Roe Jan in 2012 (Sutherland 2013). This study provides more local water quality data and offers recommendations to address water quality problems.

The water quality information in these monitoring summaries of Copake Lake and Robinson Pond note the importance of the surrounding land use and tributary water quality, and strongly suggest that a watershed perspective is needed to appropriately deal with the suspected causes of the known impacts.

Stream Assessments - Biomonitoring

Benthic macroinvertebrates, including aquatic insects, worms, clams, snails, and crustaceans, can be used to assess and monitor the water quality of a stream. In this way, biological monitoring, or biomonitoring, provides an excellent indicator of overall water quality at a particular site because macroinvertebrates are sensitive to many environmental impacts and are less mobile than fish. Biomonitoring can integrate the chemical, physical, and biological features of a stream, providing a more comprehensive characterization than each of these measures alone. Stream biomonitoring represents an important measure of overall water quality; identifying healthy stream segments is key to protecting

them. Caution is warranted to avoid impacting these healthy, non-impacted streams through land-use disturbances and activities. Once streams are impacted, restoring them can be extremely difficult and expensive.

Biomonitoring uses the abundance and kinds of aquatic organisms as a measure of waterbody health.

DEC Stream Biomonitoring Unit Data

DEC measures and characterizes waterbody health in two basic ways—best uses and stream biomonitoring. For more information on waterbody characterization based on best uses, see the next section, Waterbody Impairment. While best uses characterize stream health for its effect on human uses, stream biomonitoring is a good measure of stream health through aquatic ecology. DEC's Stream Biomonitoring Unit conducts biomonitoring sampling throughout New York State.

Based on the number and kinds of macroinvertebrates, each sample receives a Biotic Assessment Profile (BAP) score. A BAP score integrates several community characteristics to calculate single water quality score. BAPs range from 0 to 10, with 10 being the healthiest, and are divided into four water quality impairment categories:

- Severe - BAP score from 0 to 2.5
- Moderate - BAP score from 2.5 to 5
- Slight - BAP score from 5 to 7.5
- Non-impacted - BAP score from 7.5 to 10

Biomonitoring sites are selected for a number of reasons. See Appendix 1 for more information on DEC's selection criteria. Regional trends in biomonitoring data in New York State were published in the 30 Year Biological Trends Report, which covers 1972-2002. Stream biomonitoring data is also available to the public. Contact the Estuary Program's watershed specialists for help obtaining the data.

Wadeable Assessments by Volunteer Evaluators (WAVE)

DEC's Division of Water and the Estuary Program have started a citizen monitoring program using biomonitoring results to understand stream health. Citizen monitors visit a stream and collect and identify stream organisms. WAVE data will be included in federal and state water quality reports and will be used to focus DEC assessments and local restoration efforts to where they are most needed. WAVE could be particularly useful in *Unassessed* waterbodies (see Figure 11). To learn more about the program and volunteer opportunities, visit the Estuary Program's Volunteer Opportunities in the Hudson River Estuary, or contact WAVE Coordinator Alene Onion at (amonion@gw.dec.state.ny.us).

Copake Information: Stream Biomonitoring (NYSDEC)

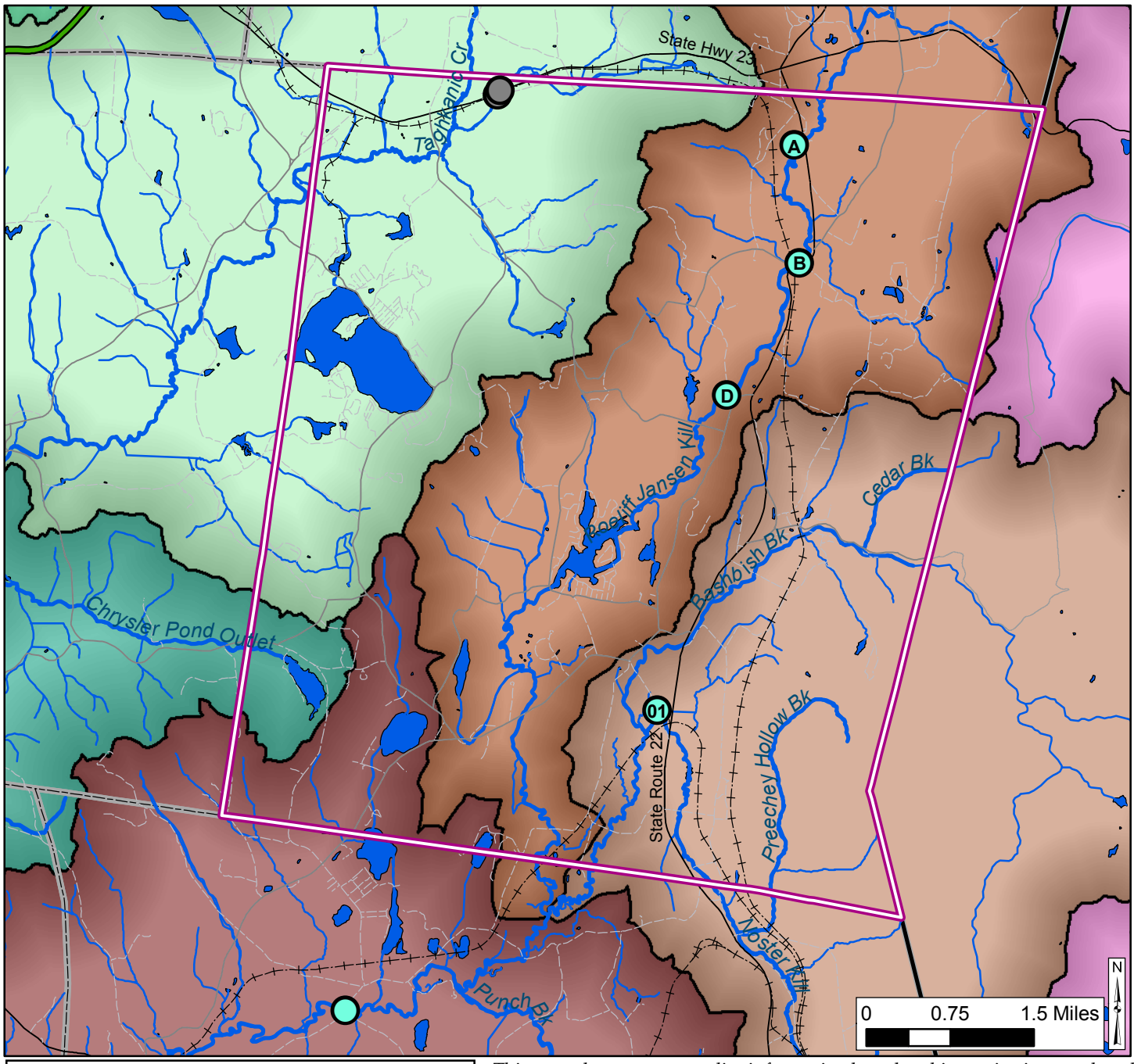
There are four sites in Copake that have been sampled by the NYSDEC Stream Biomonitoring Unit, including three on the Roeliff Jansen Kill and one on the Noster Kill (Table 4 and Figure 10). The most recent biomonitoring samples indicate that there are *Slight Impacts* to water quality at each location. A sampling site in Ancram downstream of Copake on the Roeliff Jansen Kill also showed *Slight Impacts* when it was last sampled in 1992.

The NYSDEC WAVE program has sampled two locations in Copake, both in 2013 and both along the Taghkanic Creek, close to State Hwy 23. Biomonitoring information gathered at the locations was inconclusive; more sampling needs to be conducted to give a BAP score to the stream segments at these locations. Copake's Comprehensive Plan shows the town's interest in evaluating and monitoring the health of the town's streams, lakes and other waterbodies, and more WAVE samples could help the town achieve that goal.

Table 3: DEC Stream Biomonitoring Unit Data in Copake, NY

Stream	Site	Year	Score	Water Quality Category
Roeliff Jansen Kill	A	1993	7.00	Slight impacts
		1994	7.64	Non-impacted
		1997	6.34	Slight impacts
Roeliff Jansen Kill	B	1997	8.86	Non-impacted
		2008	7.07	Slight impacts
Roeliff Jansen Kill	D	1993	5.84	Slight impacts
		1994	6.43	Slight impacts
		1997	7.37	Slight impacts
Noster Kill	01	2007	6.26	Slight impacts

Figure 10: Biomonitoring Samples in Copake, Columbia County, NY



Legend

Copake

Biomonitoring scores

(category of most recent sample)

- Non-impacted
- Slight
- Moderate
- Severe
- No Conclusion (WAVE project sample)

This map shows water quality information based on biomonitoring results taken at particular locations in Copake, Columbia County. See the accompanying summary for a description of biomonitoring results and sites labeled on the map. This map was produced as part of a Water Resource Summary for the Town. For more information, please contact NYSDEC's Hudson River Estuary Program watershed specialists at (845) 256-3016.

Data Sources:

New York State Department of Environmental Conservation, Division of Water, Stream Biomonitoring Unit for biomonitoring results (up to 2011)
except NYSDEC Division of Water WAVE program for WAVE results (2013)
USGS National Hydrography Datase for streams, waterbodies and Hydrologic Unit Code 12 watersheds (2008)
Map Created 2014

Hudson River Estuary

Water Resource Institute of New York State

Cornell University

Waterbody Impairment

The Waterbody Inventory/Priority Waterbodies List (WI/PWL) is a document that lists New York State waterbodies and information about their water quality. It is published by the DEC Division of Water. The WI/PWL categorizes rivers and streams, lakes and reservoirs, and estuaries and indicates whether they are meeting their "best uses" based on their DEC classification (see previous section on Waterbody Classification).

Waterbody Inventory/Priority Waterbodies List: is the best way to access the state's information on water quality. Access it at Lower Hudson River Basin WI/PWL

There are two components to the WI/PWL: the Waterbody Inventory and the Priority Waterbodies List. The Waterbody Inventory (WI) is a comprehensive list of water quality information for waterbodies in the state. The Priority Waterbodies List (PWL) is a subset of waterbodies from this inventory that experience water quality impacts that can range from possible threats and minor impacts to impairment of designated best uses. Impairment is determined from DEC's monitoring (including biomonitoring, see the previous Stream Assessment-Biomonitoring section) and other available information. Impaired waters that do not meet applicable water quality standards are considered for inclusion on the state's Clean Water Act Section 303(d) List and reported to Congress.

To better assess water quality at a regional scale, most waterbodies are divided into segments based on classification, size, and land use or character. These segments can be categorized as:

- Impaired Waters,
- Waters with Minor Impacts,
- Threatened Waterbodies,
- Waterbodies with Impacts Needing Verification,
- Waterbodies with No Known Impacts, or
- Unassessed Waterbodies.

Waterbodies characterized as Impaired, Waters with Minor Impacts, or Threatened Waterbodies are assigned to the Priority Waterbodies List. These water quality categories are used by DEC to determine whether a waterbody will be included on the federal 303(d) list of impaired waters, and if it needs a Total Maximum Daily Load (TMDL) to be developed to support restoration. The WI/PWL is available on the DEC website. The Lower Hudson River Basin WI/PWL is the section covering the Hudson River estuary watershed.

Copake Information: Waterbody Impairment

There is a variety of impairment categories in Copake. For streams, Bash Bish Brook and the Roeliff Jansen Kill downstream of Robinson Pond and their tributaries are meeting their best uses and are listed as having *No Known Impact* (Table 4, Figure 11). The Roeliff Jansen Kill upstream of Robinson Pond *Needs Verification* and the Taghkanic Creek and tributaries are *Unassessed*. For ponds and lakes in the town, Shaver Pond has *No Known Impacts*, Copake Lake and Robinson Pond are *Impaired* for recreation and stressed for several other uses, and the other ponds in town are *Unassessed*. Several water-quality issues are suspected as sources for the impairment in Copake Lake and Robinsons Pond, including on-site/septic systems, urban/storm runoff and agricultural runoff. These issues are addressed and management resources are offered elsewhere in this Summary (see the Other Sources of Aquifer Information, Post-Construction Stormwater Management and Green Infrastructure, and Farmlands sections). Table 4 lists the details of the documented reasons for the impairment status of these two waterbodies.

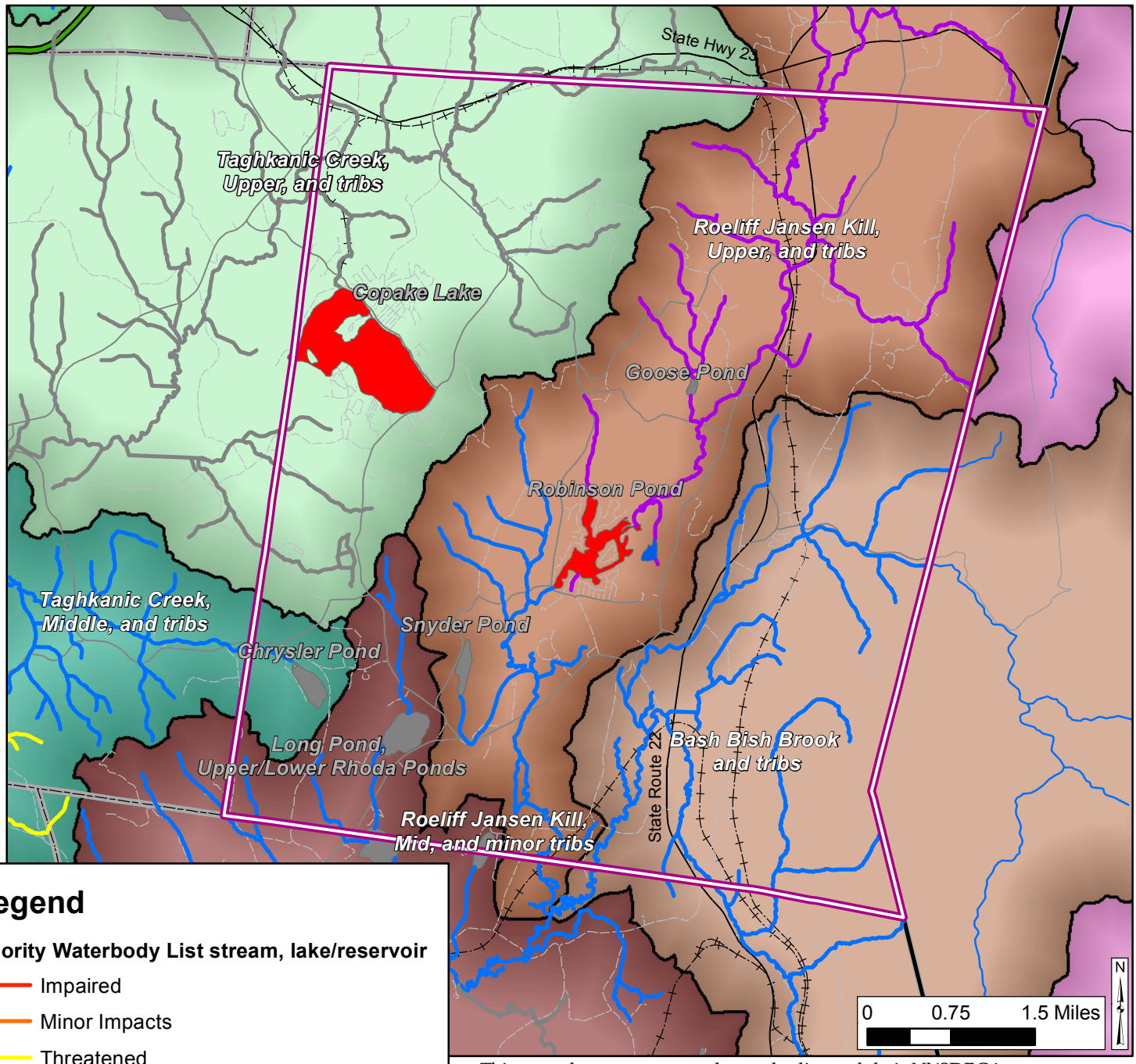
Given that many of the tributaries to the Taghkanic Creek and Roeliff Jansen Kill, as well as many of the ponds in the town, are not considered protected waterbodies by NYSDEC regulations (see previous Waterbody Classification section), the town should consider water quality protection measures to maintain these as healthy streams.

Table 4: Stream Segments and Impacted Uses in Copake, NY (from the Waterbody Inventory/Priority Waterbody List, DEC DOW 2008)

Stream Segment	ID	Waters Index Number	Class	Water Quality	Uses Impacted	Pollutants	Pollutant Source	303(d) List	Notes
Bash Bish Brook and Tribs	1308-0021	H-188-59	C(TS), C(T), C	No Known Impact	No use impairment	n/a	n/a	No	Biomonitoring in 2002 in Copake Falls showed non-impacted water quality and diverse fauna
Taghkanic Creek, Middle, and Tribs	1310-0051	H-204-3-8	C(T)	No Known Impact	No use impairment	n/a	n/a	No	Biomonitoring in 2002 in New Forge showed non-impacted water quality and diverse fauna
Taghkanic Creek, Upper, and Tribs	1310-0052	H-204-3-8	C(TS), C(T), C	Unassessed	Unknown				
Roeliff Jan Kill, Mid, and Minor Tribs	1308-0011	H-188	C(TS), C	No Known Impact	No use impairment	n/a	n/a	No	Biomonitoring in 1992, 1997, and 1998 in New Forge showed non-impacted water quality
Roeliff Jan Kill, Upper, and Tribs	1308-0002	H-188	C(TS), C(T), C	Need Verification	*Stressed:* Aquatic life	*Suspected:* Nutrients *Possible:* Dissolved oxygen/oxygen demand, pathogens	*Suspected:* On-site/septic systems, agriculture	No	Aquatic life and recreational uses in this segment may experience minor impacts, but this needs to be verified.
Chrysler Pond	1310-0055	H-204-3-8-22-P105	B	Unassessed	Unknown				
Copake Lake	1310-0014	H-204-3-8-32-P108a	B	Impaired	*Impaired:* Recreation *Stressed:* Aquatic life, aesthetics	*Known:* Algal/weed growth (aquatic vegetation) *Suspected:* Nutrients (phosphorus) *Possible:* Dissolved oxygen/oxygen demand	*Known:* Habitat modification *Suspected:* On-site/septic systems, urban/storm runoff *Possible:* Agriculture	No	Phosphorus consistently exceeds the state guidance value for impacted/stressed recreational uses. Transparency measurements occasionally fail to meet recommended levels for swimming beaches. It may be appropriate to consider the lake impaired due to aquatic weed growth, but more recent sampling is needed to verify nutrient levels before listing it on the 303(d) List for phosphorus.

Goose Pond	1308-0024	H-188-64-P904	C	Unassessed	Unknown				
Long Pond, Lower/Upper Rhoda Ponds	1308-0018	H-188-55-P887, P888, P889	B	Unassessed	Unknown				
Miller Pond	1308-0019	H-188-56-P891	B	Unassessed	Unknown				
Robinson Pond	1308-0003	H-188-P902	B(T)	Impaired	*Impaired:* Recreation *Stressed:* Public bathing, aesthetics, aquatic life	*Known:* Algal/weed growth (aquatic vegetation), nutrients (phosphorus) *Possible:* Dissolved oxygen/oxygen demand	*Known:* Habitat modification *Suspected:* Agriculture, on-site/septic systems	Yes, Part 3a	Phosphorus consistently exceeds the state guidance value for impacted/stressed recreational uses. Transparency measurements occasionally fail to meet recommended levels for swimming beaches. The lake is included on Part 3a of the 303(d) List as a Water Requiring Verification of Impairment, however assessments suggest that the suspected impairments are verified and it is recommended that it be moved to Part 1 of the List, indicating a waterbody with an impairment requiring TMDL development.
Shaver Pond	1308-0023	H-188-63-P903	B	No Known Impact	No use impairment	n/a	n/a	No	Phosphorus levels in the lake rarely exceed the state guidance values indicating impacted/stressed recreational uses. Transparency measurements meet the recommended minimum for swimming beaches.
Snyder Pond	1308-0022	H-188-60-P901	B	Unassessed	Unknown				

Figure 11: Waterbody Impairment Information from the Priority Waterbodies List for Copake, Columbia County, NY



Legend

Priority Waterbody List stream, lake/reservoir

- Impaired
- Minor Impacts
- Threatened
- Threatened (Possible)
- Need Verification
- No Known Impact
- UnAssessed
- Impaired
- Minor Impacts
- Threatened
- Threatened (Possible)
- Need Verification
- No Known Impact
- UnAssessed

This map shows streams and waterbodies and their NYSDEC impact assessments from the Waterbody Inventory/Priority Waterbody List for Copake, Columbia County. These segments don't necessarily align with watershed boundaries. See Table 4 in the accompanying summary for a description of stream assessments and their impairment. **This map is not appropriate for regulatory purposes, for the most recent information contact NYSDEC Region 4.** This map was produced as part of a Water Resource Summary for the Town. For more information, please contact NYSDEC's Hudson River Estuary Program watershed specialists at (845) 256-3016.

Data Sources:

NYSDEC, Division of Water (2008) for Waterbody Inventory/Priority Waterbody List assessments

USGS National Hydrography Dataset (2008) for waterbodies and Hydrologic Unit Code 12 subwatershed boundaries

Map Created 2014

Hudson River Estuary

Water Resource Institute of New York State

Cornell University

DRAFT Stream Condition Index

The NYSDEC Hudson River Estuary Program, with help from NYSDEC Division of Water and New York Natural Heritage Program staff, has created a draft Stream Condition Index that assembles information on stream health in the Hudson River Estuary watershed. The Stream Condition Index is in draft form and should be appropriately used. The Draft Index will become more useful as data and scientific information becomes available and is added in. Equally important is that the Draft Index is one measure of stream health, and is no substitute for site specific monitoring information. See Appendix 1 for more information on the Draft Index.

The Stream Condition Index uses a framework outlined in the EPA's *Identifying and Protecting Healthy Watersheds* report, released in 2012. The document illustrates the benefit of making small investments to prevent healthy places from becoming impaired, as compared to the alternative strategy of restoring waters after they become impaired through expensive programs and substantial efforts. It also incorporates the importance of watershed management and outreach in water quality protection. The Hudson River Estuary Program's Draft Stream Condition Index seeks to identify healthy waters, including healthy watersheds.

The Draft Index is a GIS-based accumulation of stream quality information at a fine scale. It combines several different measures of stream quality into one value. The Draft Index includes:

- percent natural cover in active river areas and floodplain complexes,
- percent impervious cover upstream,
- predicted brook trout abundance,
- density of dams,
- distance without aquatic barriers, and
- density of infrastructure crossings.

Some of the measures are related to information provided elsewhere in this Resource Summary, including percent natural cover, percent impervious cover, density of dams, and distance without aquatic barriers. By combining these into one score, the Draft Stream Condition Index evaluates aspects of streams' geomorphology, hydrology, landscape condition, biological integrity, and habitat.

The Draft Index adds value to New York State's Waterbody Inventory (see previous Waterbody Impairment section) by providing a complimentary measure of stream quality. The Draft Index identifies the likely highest quality waters among the numerous streams that are currently grouped in the *No Known Impact* category in the State's Waterbody Inventory. In stream segments that are categorized as *Impaired*, the finer-scale Draft Index can help identify the areas to focus restoration effort as well as stream segments that might remain high quality, helping to prioritize where effort and money should be spent. And lastly, in streams that are currently *Unassessed* in the State's Waterbody Inventory, the Draft Index can identify the areas that have high quality attributes and are likely high quality stream reaches.

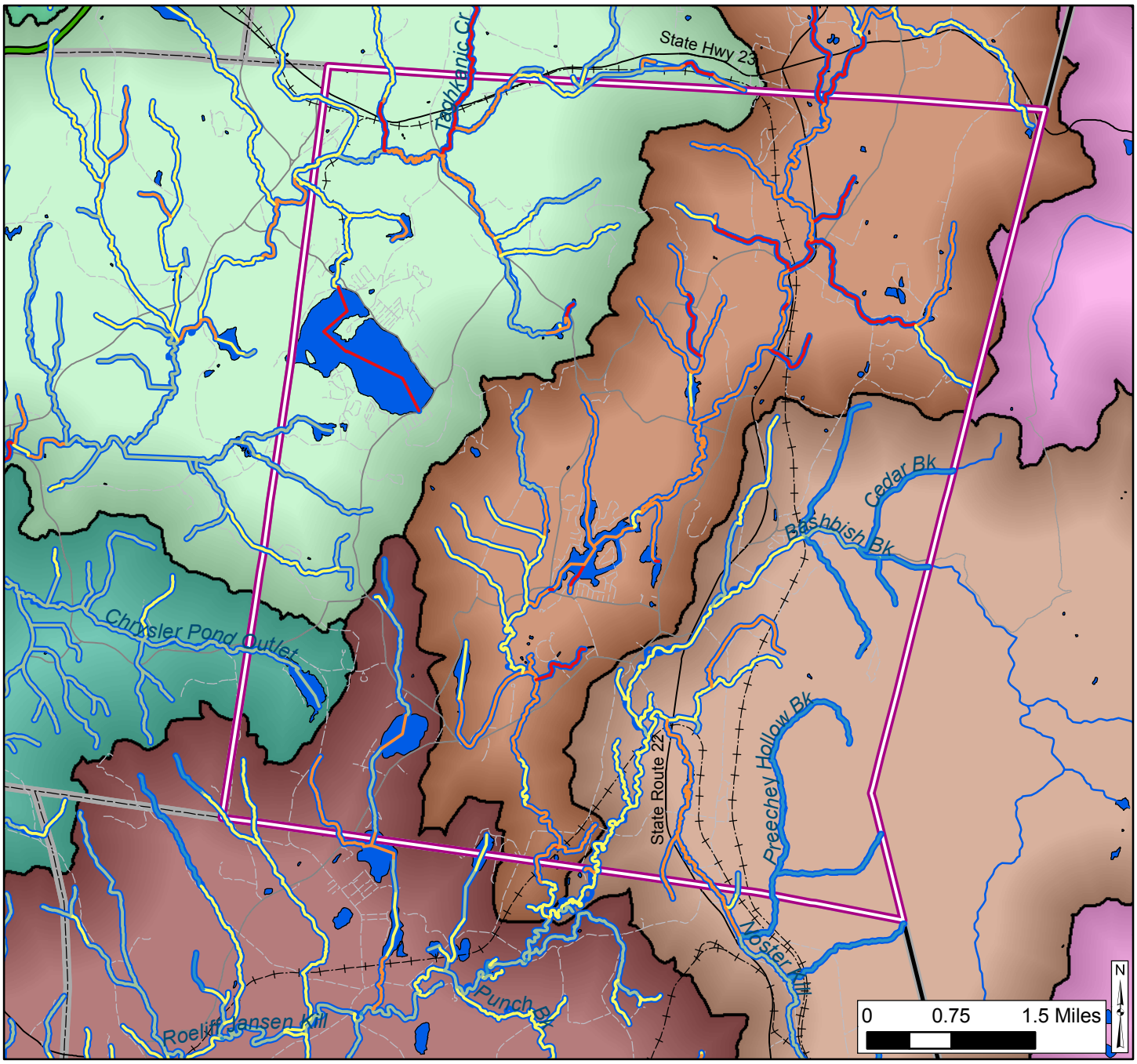
The Draft Index will improve over the coming years with the addition of agricultural land use, point sources of pollution, and predicted biological assessment profiles based on collected biomonitoring samples. The Hudson River Estuary Program is using the Draft Index in outreach efforts, such as this Resource Summary, because it synthesizes several stream health measures into one value, giving the town one way to compare various streams.

Copake Information: DRAFT Stream Condition Index

Copake has 80 miles of streams that were included in the Draft Stream Condition Index and 20 miles of stream receive a rating of high or highest quality (Figure 12). The 9 miles of streams with the highest Index value are headwater tributaries to the Bash Bish Brook, Noster Kill, and one tributary that flows into Upper Rhoda Pond. These areas scored highly in most of the components of the Index, though they are part of a relatively short network of connected streams between known aquatic barriers (such as dams) and received few points in this category. The highest quality streams from the Draft Index are in stream segments that have no known impact according to the Waterbody Inventory, supporting the stream health information provided in that document (see Figure 11). Maintaining these areas as high quality streams is important, and raising the quality of nearby streams might be a justified and attainable management goal.

Copake should plan appropriately to ensure that average streams don't slip into poorer quality categories. Thirty-six miles of streams in Copake receive a low or lowest score. Much of the mainstem of the Roeliff Jansen Kill and Taghkanic Creek, several tributaries to those streams, and Copake Lake, Robinson Pond and Upper Rhoda Pond receive below-average Index scores. These streams generally receive low scores for the small amount of natural cover in their watersheds, limited aquatic connectivity, and the density of dams in their watershed.

Figure 12: DRAFT Stream Condition Index in Copake, Columbia County, NY



Legend

Copake

Stream Condition Index (draft)

- Highest
- High
- Average
- Low
- Lowest

This map shows the NYSDEC Hudson River Estuary Program's draft Stream Condition Index for streams in Copake, Columbia County. The draft Stream Condition Index synthesizes several stream health measures into one value, giving the town one way to compare among the various streams in town. This map was produced as part of a Water Resource Summary for the Town. For more information, please contact NYSDEC's Hudson River Estuary Program watershed specialists at (845) 256-3016.

Data Sources:

NYSDEC Hudson River Estuary Program(2013) for draft Stream Condition Index

USGS National Hydrography Dataset (2008), waterbodies and Hydrologic Unit Code 12 subwatersheds

Map Created 2014

Hudson River Estuary

Water Resource Institute of New York State

Cornell University

Water Infrastructure

Stormwater Management

Municipal Separated Storm Sewer System (MS4)

A Municipal Separated Storm Sewer System (MS4) is a stormwater collection and conveyance system owned by a state, city, town, village, or other public entity that is not part of a sewage treatment plant or combined sewer system. The MS4 program provides a regulatory framework for municipalities to better manage stormwater and nonpoint source pollution. Regulated MS4 areas are "urbanized areas" (areas with at least 50,000 people and at least 1,000 people per square mile as determined by the US Census), and also include other designated areas.

Currently the MS4 program is in Phase II, which the Environmental Protection Agency (EPA) issued in 1999. Regulated MS4s are required to obtain a State Pollutant Discharge Elimination System (SPDES) permit (GP-0-10-002) from DEC and develop a stormwater management program. For more information, see the DEC's Stormwater MS4 Permit and Forms webpage.

Municipalities with regulated MS4 areas are required to implement and report on six Minimum Control Measures:

- Public education/outreach
- Public participation/involvement
- Illicit discharge detection and elimination
- Construction site runoff control
- Post-construction runoff control
- Pollution prevention/good housekeeping

More information from the EPA about the MS4 regulatory program can be found at Stormwater Discharges From Municipal Separate Storm Sewer Systems, and information about the state program can be found at the DEC's Stormwater webpage.

Copake Information: Stormwater Management (MS4)

Even in rural areas, stormwater management is important for maintaining water quality, including that of high-quality streams. Although the Town of Copake, along with the rest of Columbia County, is not currently designated as an MS4, the six minimum control measures and other strategies could be useful for protecting water quality.

Construction Stormwater Management

The SPDES General Permit for Stormwater Discharges from Construction Activity (GP-0-10-001) must be obtained by the owner or operator of a construction project if the project disturbs one acre or more of

land. As part of this permit, the owner/operator must complete a Stormwater Pollution Prevention Plan (SWPPP). For more information, see the DEC's Stormwater Permit for Construction Activities webpage.

Planning boards can also review SWPPPs submitted with site plans. All SWPPPs should describe the erosion and sediment controls that will be used on-site during construction, based on the technical information in the NYS Standards and Specifications for Erosion and Sediment Control.

The SWPPPs may also be required to describe the post-construction stormwater management practices that will be implemented, based on the standards in the NYS Stormwater Management Design Manual. Generally, post-construction stormwater management is required if projects disturb five acres or more for single-family residential projects or one acre or more for multi-family or commercial projects. See General Permit for Stormwater Discharges Appendix B for details on where post-construction stormwater management is required. For more information on post-construction stormwater management, see the Green Infrastructure section below.

If sites are located within the watershed of a 303(d) listed waterbody impaired by pollutants related to construction activity such as sediment or nutrients, then single family residential projects that disturb one acre or more of land will also require a SWPPP with post-construction stormwater management.

Copake Information: Stormwater Management (Construction)

In the Town of Copake, Robinson Pond is designated as a waterbody impaired by pollutants related to construction activities, so Stormwater Pollution Prevention Plans (SWPPPs) describing post-construction stormwater management are required for all development projects that disturb one or more acres of land and discharge directly into the waterbody. In the rest of the town, SWPPPs describing post-construction stormwater management are required for single-family residential projects that disturb five or more acres and multi-family or commercial projects that disturb one or more acres.

Post-Construction Stormwater Management and Green Infrastructure

The NYS Stormwater Design Manual provides information on how to select, locate, size, and design stormwater management practices to comply with NYS standards for post-construction stormwater management. It also includes a planning process to follow when managing stormwater in new development and redevelopment projects.

Green Infrastructure: Weaves natural processes into the built environment, providing stormwater management, as well as flood mitigation, air quality management, groundwater recharge, and more.

This process includes:

1. Site planning to preserve natural features and reduce impervious surface cover,
2. Calculating the amount of runoff that will be produced on-site

(based on a typical storm),
3. Reducing runoff by implementing green infrastructure and other stormwater management practices that allow stormwater to infiltrate on-site,
4. Using standard stormwater management practices to treat the rest of the stormwater that is produced, and
5. Designing volume and peak rate control practices, where required.

Green infrastructure practices maintain or restore stormwater's natural flow patterns at a site by allowing runoff to infiltrate into the soil. On a regional scale, green infrastructure includes preserving and restoring natural landscape features, along with reducing impervious surface cover. At the site scale, green infrastructure includes practices that capture stormwater runoff, such as rain gardens, vegetated swales, green roofs, pervious pavement, and rain barrels. These practices allow water to soak into the soil, be used by plants, or be reused. For more information and a full list of green infrastructure practices, see Chapter 5 of the NYS Stormwater Management Design Manual.

Green infrastructure and other stormwater practices that reduce runoff should be able to infiltrate the full volume of stormwater produced by the site being developed (the calculation from Step 2, known as the Water Quality Volume). If that can't be done, the designer must provide justifications and identify the specific site limitations. The rest of the stormwater volume should be treated by standard stormwater practices (described in Chapter 6 of the NYS Stormwater Management Design Manual.

At the municipal scale, it is important to ensure that local laws don't restrict green infrastructure practices. The New York State Better Site Design Code and Ordinance Worksheet is a useful tool to assess potential barriers to green infrastructure.

The Estuary Program's Green Infrastructure Examples website has regional examples of green infrastructure demonstration sites, including several practices in Columbia County. Other helpful resources include the Columbia County Soil and Water Conservation District and Cornell Cooperative Extension for Columbia and Greene Counties.

Copake Information: Stormwater Management (Green Infrastructure)

The revised NYSDEC Stormwater Management Design Manual (2010) increased the importance of implementing green infrastructure practices for new development. The Town of Copake Planning Board should understand green infrastructure practices and regulations because these practices are strongly encouraged for developments that require post-construction stormwater management. Different practices are appropriate for different sites, and it's essential that these practices are sized/designed correctly, constructed appropriately, and well-maintained.

The Roeliff Jansen Community Library is a great local example of multiple green infrastructure practices, including porous concrete and a vegetated swale.

SPDES Permits and Wastewater

DEC recognizes that point-source pollution is still a significant concern in New York State. To ensure permit compliance, DEC wants to be involved early in the process of planning new facilities or upgrading existing ones. New York State uses the State Pollutant Discharge Elimination System (SPDES) to control wastewater and stormwater discharges in accordance with the Clean Water Act. The NYS program regulates discharges to groundwater and surface water. For more information about types of SPDES permits and their discharge classes, see the *DOW 1.2.2 Administrative Procedures and the Environmental Benefits Permit Strategy for Individual SPDES Permits*.

SPDES permit compliance status information is available from the EPA's Enforcement and Compliance History Online (ECHO). ECHO is a web-based tool that provides public access to permit, inspection, violation, enforcement action, and penalty information from the past three years. ECHO offers the most comprehensive way of searching for SPDES locations and information about individual SPDES permitted facilities. The easiest way to access data on this web site is to enter a zipcode into the search tool in the upper left of the opening webpage. Each resulting pinpoint on the map can be clicked on for individualized information.

New York Water Environment Association (NYWEA) is another good information source dealing with wastewater treatment at the municipal level. Together with DEC, they have created the *Handbook on Wastewater Management for Local Representatives*. NYWEA updated the handbook in January of 2013.

Copake Information: SPDES and Wastewater

There are eight regulated SPDES discharges within Copake (see Table 5: SPDES Permits in the Town of Copake, NY). While all of these are private/commercial/institutional (P/C/I) facilities, two are state significant minor facilities (Class 09 discharges) and six have non-significant minor permits (Class 02 discharges). Non-significant minor permits cover facilities that have minimal water quality risk and do not contain limitations for priority pollutants or other toxics. Significant minor facilities contain or have the potential to contain toxics and require routine inspection, monitoring, and/or submission of Discharge Monitoring Reports. The two state significant minor facilities are Catamount Crest Resort Hotel and Golf Course Road Sewage Works Facility.

Table 5: SPDES Permits in the Town of Copake, NY

Facility Name	SPDES Permit	Discharge Class	Discharge Class*
CATAMOUNT CREST RESORT HOTEL	NY0268569	09	P/C/I State Significant Minor
GOLF COURSE ROAD SEWAGE WORKS FACILITY	NY0261092	09	P/C/I State Significant Minor
CAMPHILL VILLAGE	NY0241695	02	P/C/I Nonsignificant Minor
CATAMOUNT CREST RESORT HOTEL	NY0268569	02	P/C/I Nonsignificant Minor
FILIPOVITS APARTMENTS	NY0223486	02	P/C/I Nonsignificant Minor
ISLAND AT COPAKE SEWAGE WORKS	NY0191787	02	P/C/I Nonsignificant Minor
LAKESHORE SEWAGE WORKS	NY0212628	02	P/C/I Nonsignificant Minor
SWISS HUTTE RESTAURANT & COUNTRY INN	NY0069426	02	P/C/I Nonsignificant Minor

*P/C/I=private/commercial/institutional

Dams and other Aquatic Barriers

Stream barriers, such as dams and culverts, can isolate and severely limit the range of aquatic species and other organisms that use stream corridors. Just as many forest-dwelling species are negatively impacted by forest fragmentation from roads and structures, stream barriers disconnect streams and decrease available habitat. Historically, as mills and road crossings were added to the streams of the Hudson Valley, dams and culverts blocked off and cut up the habitat for organisms like the native brook trout. Stream barriers can also have serious effects on local flooding and water quality. Streams flowing into undersized culverts can flood upstream, and in some cases, overtake and washout a road during heavy precipitation or snowmelt events.

The impact of aquatic barriers on plants and animals (especially fish, mussels, amphibians and reptiles) can result in the disappearance of local populations, potentially leading to global extinction of some of our indigenous and rare mussel species (DEC 2008, DEC 2010). Currently, it's estimated that the Northeast has an average of 7 dams and 106 road-stream crossings per 100 miles of river (Anderson and Olivero Sheldon 2011). The Hudson River watershed has over 2,300 dams (DEC Inventory of Dams 2009).

Impacts from aquatic barriers can include:

- flooding hazards due to plugged culverts and impounded water;
- decreased navigational and recreational uses;
- altered sediment and nutrient processes;
- changes in water quality (e.g. water temperature);
- reduced dispersal of young animals resulting in increased competition and reduced gene flow;
- lost access to important, upstream habitats;
- increased road kills from increased attempts to cross the road; and
- increased hazard to motorists because of animal road crossings.

The New York State Inventory of Dams and the National Hydrography Dataset both record some dam information, but many dams, especially small ones, are missing or not collected in these datasets. Assessments done by the Estuary Program in trial watersheds indicate that perhaps twice as many barriers exist than are recorded in the NYS Inventory of Dams. It is important to note that "dams" can be defined in many ways. The Water Resource Summary is concerned with artificial structures that eliminate or negatively affect the movement of aquatic and semi-aquatic organisms such as migratory and resident fish, mussels, and amphibians, whereas the NYS Inventory of Dams uses size and hazard thresholds to define and track dams.

Culvert datasets do not exist on any standard, county-, or state-wide scale in New York. For this reason, the accompanying map does not include culverts, though they can be a critical source of aquatic fragmentation. The Estuary Program is collecting information on both kinds of aquatic barriers in the Hudson Valley. Check with the Estuary Program's watershed specialists for the most recent information.

In the planning phase of stream work, owners should consult with the ACOE and DEC for permit requirements. For the best watershed management, ecological considerations should be applied to all road crossings, not just those that are under DEC or ACOE jurisdictions. Information is available on DEC's Stream Crossings: Guidelines and Best Management Practices website.

Culverts at Road Crossings

Every time a road crosses a stream, river or estuary, there is the potential for changes in the water's natural flow to create a barrier to aquatic and riparian organisms. Roads that cross streams and are installed and maintained to have as little impact as possible on the hydrology and floodplain of the stream, as well as the plants and animals that use it are preferred. Bridges, open-bottom arches and similar structures that completely span the waterway and associated floodplain/riparian area usually have the least impact on the stream. The *New Hampshire Stream Crossing Guidelines* provide useful information on the best culvert designs and installations, and the *Massachusetts River and Stream Crossing Standards* is an example of strong road-stream intersection standards.

Stream Processes, A Guide to Living in Harmony with Streams (Chemung County Soil and Water Conservation District 2006) anticipates many of the positive and negative issues associated with barrier mitigation and removal.

Dam Replacement or Removal

Dams can be aquatic barriers, and can be a hazard to public safety as well as an insurance liability. See Information for Dam Owners, for common problems involving dam maintenance, as well as the *Owners Guidance Manual for the Inspection and Maintenance of Dams in New York State* for an introduction to the responsibilities of dam owners.

Many dams are currently unwanted and unused, presenting opportunities for stream restoration and habitat connectivity. However, dam removal is a complex endeavor, and should not be undertaken without first contacting a stream professional. There are many reasons why a dam removal could harm the in-stream biodiversity and hydrology, including facilitating the spread of invasive species and releasing potentially contaminated sediment into the stream. *Dam Removal and Barrier Mitigation in New York State: Preliminary Guidance for Dam Owners and Project Applicants* is a useful guide to a well-planned dam removal process.

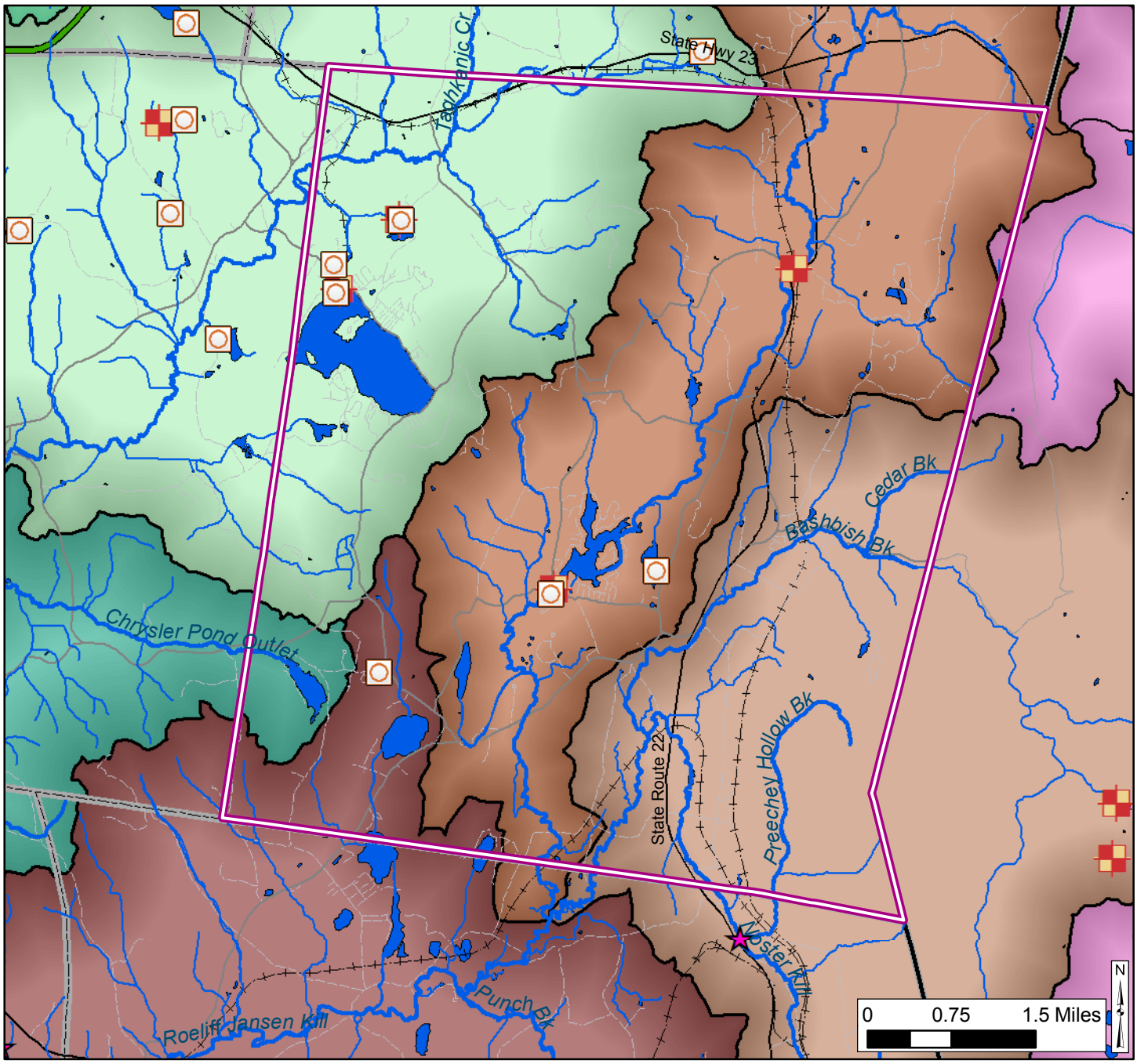
Copake Information: Aquatic Connectivity

Figure 13 shows the known aquatic barriers in and near Copake. Many small dams and all the culverts are missing from the map. There is likely a culvert almost everywhere a road crosses a stream, though some streams are spanned with bridges. Small dams and culverts have the potential to be just as important to aquatic connectivity as the inventoried dams in Figure 13. Given the limitations to the existing datasets, our understanding of aquatic connections—well-connected networks or highly-fragmented networks—is limited. American eel migrate from the Atlantic Ocean into streams in Copake, and need to pass freely under many roads on their way. See the accompanying Habitat Summary for information on migratory fish runs in the town. In new development projects, or in planned replacement projects, the town should emphasize designing and installing culverts that do not act as aquatic barriers or flooding constriction points.

Just upstream of Copake on the Noster Kill, in the Town of Ancram, a culvert has been identified as a biologically important barrier by the Hudson River Estuary Program (see Figure 13). Both brook trout and American eel could benefit if this barrier was mitigated. It is a priority for engineering and ecological study, and mitigation if appropriate.

Bridges and open bottom box and arch culverts are the preferred type of crossing structure. In DEC Region 4, which covers Columbia County, culverts need to be sized to accommodate a Q50 storm event and must be embedded 20%. The DEC also strongly encourages culverts that span the bank-full width or greater to minimize potential stream constriction.

Figure 13: Known Barriers to Aquatic Connectivity in Copake, Columbia County, NY



Legend

- Copake
- Estuary Program priority barrier for mitigation
- NYSDEC Inventory of Dams
- National Hydrography Dataset dams

This map shows documented human-made barriers to movement of fish, mussels and other aquatic organisms that rely on free-flowing, connected streams in Copake, Columbia County. The map shows known locations of dams based on two potentially duplicative datasets; but many dams are missing. Also, this map doesn't show nearly all culverts, though they can present serious barriers to many species when not sized and placed correctly and likely exist at the majority of places where a road crosses a stream. This map was produced as part of a Water Resource Summary for the Town. For more information, please contact NYSDEC's Hudson River Estuary Program watershed specialists at (845) 256-3016.

Data Sources:

NYSDEC (2009) and National Hydrography Dataset (2008) for dam locations
The Nature Conservancy and Estuary Program (2013) for priority aquatic barriers
USGS National Hydrography Dataset (2008) for streams, waterbodies and Hydrologic Unit Code 12 subwatersheds
Map Created 2014

Hudson River Estuary
Water Resource Institute of New York State
Cornell University

References and Resources

Watershed Characteristics

Watersheds

- Environmental Protection Agency, Healthy Watersheds Initiative Fact Sheet, http://water.epa.gov/polwaste/nps/watershed/ecoben_factsheet.cfm
- USGS National Hydrography Dataset, http://nhd.usgs.gov/

Land Cover

- Center for Watershed Protection. 2003. Impacts of Impervious Cover on Aquatic Systems. Watershed Protection Research Monographs No.1 p. 158. http://clear.uconn.edu/projects/TMDL/library/papers/Schueler_2003.pdf
- Ecology and Environment, Inc. 2008. Columbia County Multi-Jurisdictional Hazard Mitigation Plan. Columbia County Emergency Management Office, 85 Industrial Tract Hudson, NY 12534. p. 127. http://www.columbiacountyny.com/documents/misc/columbia_hazard_mitigation_plan.pdf
- Environmental Protection Agency, Office of Sustainable Communities Smart Growth Program. 2006. Protecting Water Resources with Higher-Density Development. p. 45. http://www.epa.gov/dced/pdf/protect_water_higher_density.pdf
- Environmental Protection Agency, Green Communities document, Creating Open Space Networks: http://www.epa.gov/greenkit/pdfs/envdev1.pdf
- Environmental Protection Agency, Greenkit toolbox: http://www.epa.gov/greenkit/index.htm
- United State Geologic Survey, Multi-Resolution Land Characteristics Consortium. 2013. National Land Cover Database. http://www.mrlc.gov/

Impervious Cover

- Cunningham M.A., C.M. O'Reilly, K.M. Menking,, D.P. Gillikin, K.C. Smith, C.M Foley, S.L Belli, A.M. Pregnall, M.A. Schlessman, and P. Batur. 2009. The Suburban Stream Syndrome: Evaluating Land Use and Stream Impairments in the Suburbs. Physical Geography. 30, 3, p. 269-284.
- Environmental Protection Agency. 2009. Protecting Water Quality with Smart Growth Strategies and Natural Stormwater Management in Sussex County, Delaware. EPA-NOAA Smart Growth Implementation Assistance for Coastal Communities for Sussex County, Delaware. http://www.epa.gov/dced/pdf/2009_0106_sussex_county.pdf
- National Research Council, Committee on Reducing Stormwater Discharge Contributions to Water Pollution. 2008. Urban Stormwater Management in the United States. Water Science and Technology Board, Division of Earth and Life Studies of the National Research Council. National Academies Press, Washington D.C., p. 529. http://www.epa.gov/npdes/pubs/nrc_stormwaterreport.pdf
- NYSDEC Bureau of Watershed Assessment and Management, Division of Water. 2007. The Lower Hudson River Basin Waterbody Inventory and Priority Waterbodies List. p. 238 plus Appendices. http://www.dec.ny.gov/chemical/36740.html

- Walsh C.J., A.H. Roy, J.W. Feminella, P.D. Cottingham, P.M Groffman, and R.P Morgan III. 2005 The Urban Stream Syndrome: Current Knowledge and the Search For A Cure. Journal of the North American Benthological Society, 24(3):706-723 p. 18.

Forest Cover

- Center for Watershed Protection's Watershed Forestry Resource Guide, 2008, http://www.forestsforwatersheds.org/forests-and-drinking-water/
- Cornell Cooperative Extension's Forest Connect, http://www2.dnr.cornell.edu/ext/forestconnect/
- Environmental Protection Agency. Economic Benefits of Healthy Watersheds, http://water.epa.gov/polwaste/nps/watershed/upload/economic_benefits_factsheet3.pdf
- New York Planning Federation, NYSDEC, and Empire State Forest Products Association. 2005. The Municipal Official's Guide to Forestry in New York State. p. 31. http://www2.dnr.cornell.edu/ext/info/pubs/management/MunicipalOfficialsGuide ToForestry.pdf
- NYSDEC Division of Lands and Forests, Forest Stewardship Program, http://www.dec.ny.gov/lands/45934.html
- NYSDEC Division of Lands and Forests, Timber Harvesting webpage, http://www.dec.ny.gov/lands/5242.html
- NYSDEC SPDES general permit frequently asked questions, http://www.dec.ny.gov/docs/water_pdf/constrfaq.pdf

Farmlands

- Agricultural Environmental Management, http://www.nys-soilandwater.org/aem/index.html
- Columbia County Soil and Water Conservation District, http://www.ccswcd.org/
- Farmscape Ecology Program, http://hawthornevalleyfarm.org/fep/
- NYSDEC Bureau of Watershed Assessment and Management, Division of Water. 2007. The Lower Hudson River Basin Waterbody Inventory and Priority Waterbodies List. p. 238 plus Appendices. http://www.dec.ny.gov/chemical/36740.html

Aquifers

- Dutchess County Aquifer Recharge Rates & Sustainable Septic System Density Recommendations, http://www.co.dutchess.ny.us/CountyGov/Departments/Planning/16891.htm
- EPA's Safe Drinking Water Information System (SDWIS), http://www.epa.gov/enviro/facts/sdwis/search.html
- New York Rural Water Association, http://www.nyruralwater.org/
- New York Rural Water Association, 2009, Groundwater Resources Study and Protection Plan for the Town of Copake, http://townofcopake.org/site/wp-content/uploads/2013/10/GroundwaterCopake.pdf
- NYSDEC Division of Water and USGS's Ambient Groundwater Monitoring Program, http://www.dec.ny.gov/lands/36117.html

- NYSDOH Drinking Water Program: Frequently Asked Questions, http://www.health.ny.gov/environmental/water/drinking/faq_def.htm
- NYSDOH Source Water Protection Program, http://www.health.ny.gov/environmental/water/drinking/upstate.htm
- PACE Land Use Law Center's Gaining Ground database entries on Aquifer Protection in New York, http://landuse.law.pace.edu/SPT--BrowseResources.php?ParentId=410
- Trust for Public Land, Protecting the Source; Land Conservation and the Future of America's Drinking Water. 2004. p. 56. http://www.health.ny.gov/environmental/water/drinking/upstate.htm
- USGS's New York Water Science Center, ny.water.usgs.gov, and a map of Hudson Valley places with finer-scale aquifer information can be found at ny.water.usgs.gov/projects/bgag/aquifer.maps/aquifer1.maps.html

Floodplains and Riparian Buffers

- Army Corps Of Engineers National Flood Risk Management Risk Reduction Program, http://www.nfrmp.us/index.cfm
- The Association of State Floodplain Managers, http://www.floods.org/
- Catskill Streams www.catskillstreams.org and a primer on riparian buffers and links to more in-depth information at http://www.catskillstreams.org/stewardship_streamside_rb.html
- Chemung County Soil and Water Conservation District. 2006. Stream Processes, A Guide to Living in Harmony with Streams. p. 74. http://www.chemungcountyswcd.com/PDF/Soil%20&%20Water%20Guide.pdf
- Ecology and Environment, Inc. 2008. Columbia County Multi-Jurisdictional Hazard Mitigation Plan. Columbia County Emergency Management Office, 85 Industrial Tract Hudson, NY 12534. p. 127. http://www.columbiacountyny.com/documents/misc/columbia_hazard_mitigation_plan.pdf
- Emergency Watershed protection program –NRCS (floodplain easements and funding towards repair of watershed impairments) http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/landscape/ewpp)
- Environmental Protection Agency, Life at the Water's Edge, Living in Harmony with Your Backyard Stream. p. 12. http://www.epa.gov/ecopage/aquatic/lifedge.pdf
- Federal Emergency Management Agency, National Flood Insurance Program, http://www.fema.gov/national-flood-insurance-program
- Flood Smart- the official site of the National Flood Insurance Program, http://www.floodsmart.gov/floodsmart/
- Hudson Estuary Trees for Tribs (offers free trees and shrubs for streamside planting), http://www.dec.ny.gov/lands/43668.html
- NYSDEC, Floodplain Management (helps to implement state floodplain mapping and assists communities with the NFIP), http://www.dec.ny.gov/lands/24267.html
- New York State Floodplain and Stormwater Managers Association - http://ny.floods.org/
- Strong, Karen. 2008. Conserving Natural Areas and Wildlife in Your Community: Smart Growth Strategies for Protecting the Biological Diversity of New York's Hudson River Valley. New York Cooperative Fish and Wildlife Research Unit at Cornell University for NYSDEC Hudson River Estuary Program. p. 101. http://www.dec.ny.gov/lands/50083.html

- USDA Conservation Reserve Enhancement Program, https://www.fsa.usda.gov/FSA/webapp?area=home&subject=copr&topic=cep

Water Quality Standards and Assessments

Waterbody Classification

- American Rivers: Where Rivers Are Born: The Scientific Imperative for Defending Small Streams and Wetlands http://www.americanrivers.org/assets/pdfs/reports-and-publications/Where_Rivers_Are_Born804d.pdf
- NYSDEC information about water standards and classifications: http://www.dec.ny.gov/chemical/23853.html
- NYSDEC information about best uses for waterbodies: http://www.dec.ny.gov/regs/4592.html
- NYSDEC information on surface water and groundwater quality standards: http://www.dec.ny.gov/regs/4590.html
- NYSDEC information on the Protection of Waters Program (Article 15): http://www.dec.ny.gov/permits/6042.html
- NYSDEC information on Protection of Waters: Application Procedures: **http://www.dec.ny.gov/permits/6333.html**
- NYSDEC information on Protection of Waters: Disturbance of the Bed or Banks of a Protected Stream or Other Watercourse: http://www.dec.ny.gov/permits/6554.html
- NYSDEC information on protection for streams, wetlands and other waterbodies: http://www.dec.ny.gov/regs/4438.html#15885
- Strong, Karen. 2008. Conserving Natural Areas and Wildlife in Your Community: Smart Growth Strategies for Protecting the Biological Diversity of New York's Hudson River Valley. New York Cooperative Fish and Wildlife Research Unit at Cornell University for NYSDEC Hudson River Estuary Program. p. 101. http://www.dec.ny.gov/lands/50083.html

Waterbody Assessment

- NYSDEC Stream Biomonitoring Unit: http://www.dec.ny.gov/chemical/23847.html
- NYSDEC Stream Biomonitoring Unit, Division of Water. 2004. 30 Year Trends in Water Quality of Rivers and Streams in New York State Based on Macroinvertebrate Data 1972-2002. NYSDEC. p. 389. http://www.dec.ny.gov/chemical/78979.html
- NYSDEC information about the volunteer opportunities including WAVE (Wadeable Assessments by Volunteer Evaluators) www.dec.ny.gov/lands/72898.html
- New York Federation of Lake Associations, Inc. 2009. Diet for a small lake: the expanded guide to New York State lake and watershed management. 2d ed. / NYSFOLA in cooperation with the New York State Department of Environmental Conservation: NYSFOLA: (http://www.dec.ny.gov/chemical/82123.html

- Sutherland, James W. 2013. Robinson Pond and the Roeliff Jansen Kill Tributary The 2012 Water Quality Program: A Summary of Physical, Chemical and Biological Monitoring. report prepared for the Taconic Shores Property Owners Association. p. 102.

Waterbody Impairment

- NYSDEC Bureau of Watershed Assessment and Management, Division of Water. 2007. The Lower Hudson River Basin Waterbody Inventory and Priority Waterbodies List. p. 238 plus Appendices. http://www.dec.ny.gov/chemical/36740.html

Draft Stream Condition Index

- Environmental Protection Agency. 2012. Identifying and Protecting Healthy Watersheds: Concepts, Assessments, and Management Approaches. US EPA Office of Water, Office of Wetlands, Oceans, and Watersheds. p. 296. http://water.epa.gov/polwaste/nps/watershed/hw_techdocument.cfm

Water Infrastructure

Stormwater Management

- Center for Watershed Protection. 2010. New York State Stormwater Management Design Manual. Center for Watershed Protection for NYSDEC. pp.642. http://www.dec.ny.gov/chemical/29072.html
- Columbia County Soil and Water Conservation District: http://www.ccswcd.org/
- Cornell Cooperative Extension for Columbia and Greene Counties: http://www.ccecolumbiagreene.org/
- EPA information on the Stormwater Discharges from Municipal Separate Storm Sewer Systems (MS4s) program: http://cfpub.epa.gov/npdes/stormwater/munic.cfm.
- Hudson River Estuary Program green infrastructure example: http://www.dec.ny.gov/lands/58930.html
- NYSDEC Codes and Ordinance Worksheet for Development Rules in New York State: http://www.dec.ny.gov/docs/remediation_hudson_pdf/cownys.pdf
- NYSDEC Green Infrastructure Examples Roeliff Jansen Community Library Porous Concrete: http://www.dec.ny.gov/lands/79020.html
- NYSDEC information on the Stormwater MS4 permits and forms: http://www.dec.ny.gov/chemical/43150.html
- NYSDEC information about stormwater: http://www.dec.ny.gov/chemical/8468.html
- NYSDEC information on the stormwater permit for construction activities: http://www.dec.ny.gov/chemical/43133.html
- NYSDEC information on General Permit for Stormwater Discharges: http://www.dec.ny.gov/docs/water_pdf/gpsconspmt10.pdf (Appendix B)
- NYSDEC Standards and Specifications for Erosion and Sediment Control: http://www.dec.ny.gov/chemical/29066.html

SPDES Permits and Wastewater

- EPA Enforcement and Compliance History Online (ECHO): http://www.epa-echo.gov/echo/
- New York Water Environment Association (NYWEA): www.nywea.org
- NYSDEC information on State Pollution Discharge Elimination System: http://www.dec.ny.gov/permits/6054.html
- NYWEA and Environmental Finance Center at Syracuse University. 2013. Wastewater Management Handbook for Local Representatives, Second Edition. p. 187.
- http://www.nywea.org/images/temp/Wastewaterhandbook013013.pdf

Dams and other Aquatic Barriers

- Anderson, M.G. and Olivero Sheldon, A. 2011. Conservation Status of Fish, Wildlife, and Natural Habitats in the Northeast Landscape: Implementation of the Northeast Monitoring Framework. The Nature Conservancy, Eastern Conservation Science. pp.292 http://www.conservationgateway.org/ConservationByGeography/NorthAmerica/UnitedStates/edc/Documents/Conservation-Status-of-Fish-Wildlife-and-Natural-Habitats.pdf
- Chemung County Soil and Water Conservation District. 2006. Stream Processes, A Guide to Living in Harmony with Streams. p. 74. http://www.chemungcountyswcd.com/PDF/Soil%20&%20Water%20Guide.pdf
- NYSDEC Inventory of Dams is available at: http://www.dec.ny.gov/lands/4991.html
- NYSDEC information on Stream Crossings: Guidelines and Best Management Practices: http://www.dec.ny.gov/permits/49066.html
- NYSDEC information for dam owners: http://www.dec.ny.gov/lands/66952.html
- NYSDEC Division of Water. 1987. An Owner's Guidance Manual for the Inspection and Maintenance of Dams in New York State. p. 126. http://www.dec.ny.gov/lands/4991.html
- NYSDEC New York Barrier Mitigation Forum of the New York State Nonpoint Source Hydrologic and Habitat Modification Workgroup. 2010. Dam Removal and Barrier Mitigation In New York State, Final Draft Guidance for Dam Owners and Project Applicants. pp.50. http://www.dec.ny.gov/docs/remediation_hudson_pdf/damremoval.pdf
- NYSDEC Nonpoint Source Coordinating Committee—Hydrologic and Habitat Modification Workgroup. 2008. A strategy for removing or mitigating dams in New York State and lessons learned in the Upper Susquehanna Watershed. Prepared by USFWS, 3817 Luker Road Cortland, New York 13045. 37pp. http://www.fws.gov/northeast/nyfo/fwc/UpperSus/UpperSusqDam%20ReportFinalMay08.pdf
- River and Stream Continuity Partnership. 2011. Massachusetts River and Stream Crossing Standards Developed by the River and Stream Continuity Partnership. p. 28. http://www.streamcontinuity.org/pdf_files/MA%20Crossing%20Stds%203-1-11%20corrected%203-8-12.pdf
- USGS National Hydrography Dataset: http://nhd.usgs.gov/
- University of New Hampshire. 2009. New Hampshire Stream Crossing Guidelines. p. 48. http://des.nh.gov/organization/divisions/water/wetlands/documents/nh-stream-crossings.pdf

Appendix1: Mapping and Background Information

Landcover

The National Land Cover Dataset (NLCD, http://www.mrlc.gov/) has land cover and land use information for the entire United States at a 30 square meter resolution. Each 30X30m square is given a land cover/land use class. For impervious cover, the values of each square represent the proportion of urban impervious surface estimated for that cell. Accuracy assessments are underway for the 2006 dataset (used in this summary), but the 2001 NCLD was found to have a country-wide accuracy of about 80%, with variations by geography and by identified class. **It is critical to note that the NLCD dataset is most reliable at regional scales and has important limitations at the subwatershed scale. It should not be used for site planning and is not a viable substitute for on-the-ground knowledge and site visits**—the data is not necessarily accurate at particular locations in the town, and does not collect information on many important habitat types. Read more about the applications and limitations on the NLCD factsheet (http://pubs.usgs.gov/fs/2012/3020/). Used in an appropriate manner, the land cover/land use data can be a useful tool to understand patterns of land use in towns and to identify areas of concern where land use could be impacting water resources.

Aquifers

Aquifers were mapped by the USGS in partnership with the NYSDEC in New York State in the mid-1980s. They show significant unconsolidated aquifers: those that consist of sand and gravel and yield large supplies of water to wells. Bedrock aquifers, although significant in some areas, were not addressed. Because the scale of the original aquifer maps is 1:250,000, these maps indicate only the general location of the unconsolidated aquifers; **they are not intended for detailed site evaluations**. Determination of the precise location of aquifer boundaries or of well yields may require additional data, according to authors of the source maps. Figure 4 is included as a general indication of where aquifers have been identified.

Figure 4 shows two classes of aquifers:

- UNCONFINED AQUIFER, Mid Yield (10 to 100 gallons per minute) - Sand and gravel with saturated zone generally less than 10 ft thick. Thicker deposits with less permeable silty sand and gravel may also be included. Yields in areas adjacent to streams may exceed 100 gal/min through pumping-induced infiltration, but these areas are too small to show at 1:250,000 scale.
- UNCONFINED AQUIFER, High Yield (More than 100 gallons per minute) - Sand and gravel of high transmisivity with saturated thickness greater than 10 ft. Many such areas are associated with a surface water source that can provide pumping-induced recharge

There are a limited number of places in the Hudson Valley where aquifers have been mapped at a 1:24000 scale, a much finer scale. Information on these locations and this project can be found on the

USGS's New York Water Science Center (ny.water.usgs.gov) website, and a map of these locations can be found here: ny.water.usgs.gov/projects/bgag/aquifer.maps/ aquifer1.maps.html.

Impervious Cover

NLCD impervious cover information is not fine-scale enough to be useful at the site plan scale, determining impervious cover amounts and locations on particular parcels or projects. It is possible to collect impervious cover information at a more useful scale for planning at the subwatershed or finer scale. Several counties have undertaken their own, fine-scale, impervious cover mapping that will enable them to direct watershed management actions to the parts of communities that need it most. Contact a watershed specialist at the Hudson River Estuary Program for more information.

Stream Assessments-Biomonitoring

The Stream Biomonitoring Unit chooses sample sites to meet several goals: characterizing regional reference sites, monitoring long-term sites, assessing unassessed waters, and monitoring sites that are of departmental, regional and/or public interest. Sites are also selected randomly within a region to provide a more unbiased dataset. Targeted sites make up approximately 60% of sites, while random sites comprise 40%.

DRAFT Stream Condition Index

The Draft Stream Condition Index combines several important measures of stream health into one metric, but leaves out many other important considerations. It should be used in concert with understanding of the site and other sources of stream health information.

The metrics used include percent natural cover in active river areas and floodplain complexes, percent impervious cover upstream, predicted brook trout abundance, density of dams, distance without aquatic barriers, and density of infrastructure crossings. Percent natural cover is based on the active river area (a dataset created by The Nature Conservancy that encompasses much of the area that streams interact with outside of the channel) and large floodplain complexes. We used percent natural landcover from NLCD 2001 for these two datasets. We also used impervious cover in all upstream catchments based on NLCD 2006 data. For these three datasets, stream segments were scored based on the percent of the stream's catchment with natural cover. The USGS created a brook trout abundance model, and we attributed the predicted brook trout values to the stream segments covered under that model. Upstream tributaries not modeled were given the value of the nearest downstream stream with a value. The Draft stream condition index also includes a measure of the density of dams within the streams' HUC 12 watershed. The number of known dams from the NYS Inventory of Dams within the watershed was standardized by the watershed acreage and attributed to the stream segments. We also looked at known aquatic barriers, with information coming from the NYS Inventory of Dams as well as field-verified habitat fragmenting culverts, though this last dataset is very incomplete. A stream's score was based on length of the unfragmented stream network. Lastly, we incorporated a measure of the density of man-made infrastructure for each stream segment. Road and railroad crossings and dams were accumulated for each stream segment, and then divided by the length of the segment. For more information about the Draft Stream Condition Index, please contact the watershed specialists at the Hudson River Estuary Program.