2.1 Regional Setting

The Manor Kill watershed is located in the southeastern region of NY State (Figure 2.1.1). The majority of the 34.4 mile^2 Manor Kill watershed lies within the Town of Conesville, with a very small sliver in the Town of Gilboa. The Manor Kill is part of the Schoharie Watershed, which encompasses 316 miles^2, and receives waters from other creeks such as the Batavia Kill, West Kill and East Kill. The entire Schoharie basin (above reservoir) also includes the towns of Windham, Ashland, Jewett, Hunter, Prattsville, Roxbury and Lexington (Fig 2.1.2). Approximately 75% of the Schoharie Creek watershed is located within the Catskill Park.

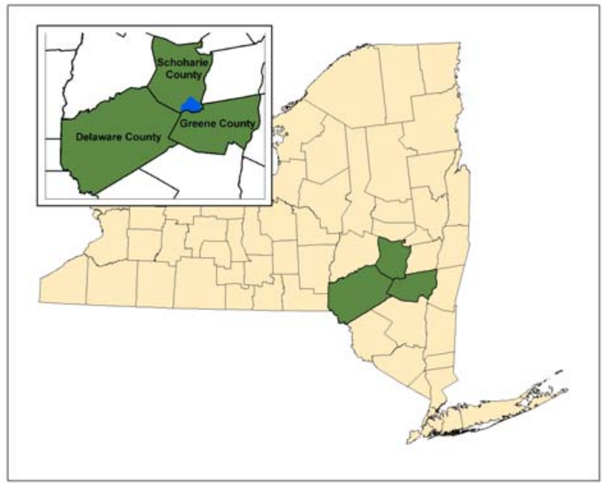


Figure 2.1.1 Schoharie Creek watershed counties

In 1885, the Catskill and Adirondack Forest Preserves were established by the NY State Assembly. An 1894 amendment to the New York State Constitution (now Article 14) directs "the lands of the State now owned or hereafter acquired, constituting the forest preserve as now fixed by law, shall be forever kept as wild forest lands. They shall not be leased, sold or exchanged, or be taken by any corporation, public or private, nor shall the timber thereon be sold, removed or destroyed" (NYS DEC, 2006).

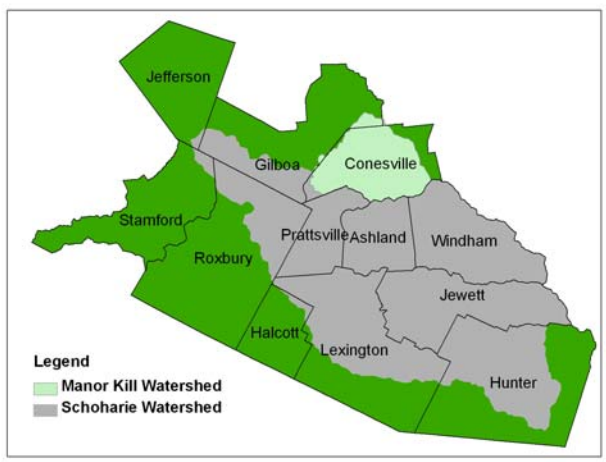


Figure 2.1.2. The Manor Kill's position within the Schoharie Basin.

In 1904, the Catskill Park was designated, establishing a boundary or 'blue line' around the Forest Preserve and private land as well. Over the years the Catskill Park grew, and now comprises roughly 700,000 acres, about half of which is public Forest Preserve. The Catskill and Adirondack Parks are nationally unique because they are a checkerboard of public and private land; a grand experiment in how nature and human society can coexist in a landscape (Catskill Center$_1$, 2006).

State Land historical marker

The Manor Kill and NYS Route 990V (which becomes Potter Hollow Mtn Rd) parallel each other through the Town of Conesville. This is a primary route through this rural section of Schoharie County.

A dominant characteristic of the Manor Kill watershed's regional setting is its location within the 2,000 square-mile New York City Watershed. The NYC Watershed is the largest unfiltered water supply in the U.S., providing 1.4 billion gallons of clean drinking water each day to over nine million residents in New York City and some smaller municipalities (nearly half the population of New York State) (Catskill Center$_2$, 2006).

The Schoharie Creek is dammed by the Gilboa Dam, creating the Schoharie Reservoir just outside the Catskill Park. The reservoir covers 1.9 mi^2, is 140' deep, and receives 80% of its water from the Schoharie Creek. The other 20% comes from local direct drainage basins, including the Manor Kill. At the reservoir, a portion of the water is transferred through the Shandaken portal to the Esopus Creek and Ashokan Reservoir. The Catskill system (Ashokan and Schoharie) provides approximately 40% of NYC's drinking water. The NYC Department of Environmental Protection (DEP) operates this drinking water supply under a Filtration Avoidance Determination (FAD) issued by the Environmental Protection Agency and the New York State Department of Health. Central to the maintenance of the FAD are a series of partnership programs between NYC and the upstate communities, as well as a set of rules and regulations written to protect water quality.

References

Catskill Center[1], 2006. About the Catskill Region. Available on web: www.catskillcenter.org/region.html (Accessed 12/20/06).

Catskill Center[2], 2006. New York City Watershed. Available on web: http://www.catskillcenter.org/atlas/nycwatershed/nycw_1watershedbasins.htm (Accessed 12/20/06).

NYC DEC, 2006. Catskill Forest Preserve. Available on web: www.dec.state.ny.us/website/dlf/publands/cats/index.html (Accessed 12/20/06).

2.2 History of the Manor Kill

Written by Beatrice Haskin Mattice, Conesville Historian - October 22, 2008

Conesville's Manorkill Creek flows westerly through the valley emptying into the Schoharie Creek in a spectacular waterfall. The Conesville-Gilboa town line is the center of the Schoharie Creek, now the Reservoir.

Settlers first came to the valley of the Manorkill in 1764. Earlier, in 1753, the British government appointed John Dies to survey the heavily wooded wilderness between the VanBergen Patent and Breakabeen on the Schoharie Kill. Apparently Dies found the land desirable for he then became connected with Ury Richtmyer and several others in the purchase of part of that land. Two patents were granted in 1754. The first patent became West Conesville (first called Strykersville), and Gilboa. The second patent was known as Dies's Manor and covered an area from the hamlets of Conesville (Stone Bridge) to Manorkill (The Manor). The creek was referred to as Diesman's Creek. In 1760, to bring settlers to the patent, Dies improved the Indian Trail over the mountain from Durham and early maps show this road as John Dies Road.

The earliest settlers made their homes along the creek. After the Revolution, people from over-crowded New England States poured into this area and settled on the hills. John Dies Road was once again improved and called the Susquehanna Turnpike. Thousands of people passed this way on their way west, traveling this turnpike. In 1836 the township was formed from parts of Broome, Schoharie County, and Durham, Greene County, and named Conesville. By 1850, the town had its highest number of residents. There were stores, schools, churches, taverns and small business of all kinds.

This was always an agricultural area. Large farms along the fertile Manorkill Creek prospered through the years, as well as smaller farms on the hills. Mills were always an important part of life in the Town of Conesville. Grist mills ground the farmers' buckwheat and rye flour and cornmeal; there were carding and knitting mills, furniture-making shops, cider mills, tanneries, and numerous saw mills, as the country was growing and everyone was building.

Barent Stryker is said to have built the first mill in the town at the mouth of the narrow gorge above the Falls. However, a very early write-up tells of the “Fanning Mill” somewhere in town before the Revolution.

Barent W. and Peter M. Stryker, sons of the Barent the first, built a once busy tannery in 1830 where raw hides were made into leather. The great hemlock forests that covered the sides of the mountains brought the tanning business to this area at an early period. The bark was rich in tannin that could convert hides into enduring and useful leather. Settlers who lived on the hill farms brought in load after load of hemlock bark to the tannery in Strykersville. They were paid $1 a load. The forests were soon stripped of hemlock and by about 1845 the business began to decline. The gaps left in the forests were soon covered with new growth—not hemlocks and pines, as the young seedlings do not thrive well under the sun, which beats down on a clearing. Instead, dense stands of hardwoods—birch, ash, maple and oak soon covered the mountains.

Gershom Stevens, Jr. built a mill on the lower Falls about 1835. This was still operating in the late 1800s.

In Strykersville there was a carding mill, a knitting mill and a sawmill. A large gristmill and sawmill was near the present concrete wall, just above the village. The foundation walls of the mill are still standing. The mills were destroyed by fire around 1900. An 1805 map shows another mill near Pangman Road.

In Stone Bridge, a water-powered sawmill was on the creek operating as early as 1847, where the town recreation field is today. The flood of 1874 destroyed this mill. (This flood was disastrous to this area; one man died, many homes and businesses were washed away).

Just up the Bearkill was a gristmill and sawmill in 1898; a steam-powered sawmill in the early 1900s; and a diesel operated sawmill in the 1960s. Still visible in 1980 was the dirt raceway of the original mills that led water from a dam upstream. Several miles up

Bearkill, a high sawmill wall is still standing on the Stanley Fancher place, operated by the Hawver family in the 1800s.

Back to the Manorkill Creek, across “the square” in Stone Bridge on Champlin Road was a dam and water wheel turning mill on a small stream that joins the Manorkill. Hand rakes and handles were manufactured from 1851 until 1875. One man in 1854 bought 24,280 broom handles at 8 ½ cents each, from this “Shoemaker Rake and Handle Factory”. This too was destroyed in the 1874 flood.

On up the valley, past South Mountain Road, on the former Freeland Case farm a sawmill was operating in the early 1800s. The remains of this mill dam can be seen where the creek comes near the road. The flood in 1874 also washed away this mill. The South Mountain Brook joins the Manorkill on the Bradley Case farm. On this brook, up a narrow gorge is a large formation of stonework that once was a sawmill operated by William E. Richtmyer in the 1800s. One old-timer said “There was awful strapping big pines up in there by this mill.”

Above Manorkill village was a mill dam near Schermerhorns, and another in a deep hollow in back of the house formerly owned by DeWitt. This is near the headwaters of the Manorkill. Mills on other Conesville streams included a busy gristmill in Dingmanville in the early 1800s; a mill on up South Mountain Brook; one on Toles Hollow where a high wall (12 feet by 8 feet wide) of the dam is still standing as well as iron gears as big as a wagon wheel; mill on Brand Road; another on the west branch of Bearkill on Leroy Road that was in operation before 1839; a mill on Robinson Road shown on a 1805 map; and on Bull Hill stream just out of West Conesville was the Morse cider, saw and planning mills that burned to the ground in 1913.

At one time, a drive through the Manorkill Valley showed grand farms with green meadows bordering the creek. Up until about 40 or 50 years ago, the farmers could clean out the creek on their land, thereby keeping it within its banks. One local contractor, Sam Bliss, did much of the creek repair in this area using a bulldozer. Since this is no longer allowed, much of the fertile valley farmland has been washed away or flooded and can no longer be used to grow hay and other crops.

The Manorkill Creek played an important roll in the settlement of this town. Today we have no water-powered mills along the Manorkill. This scenic and historic area remains one of the most rural sections of the state. Up until a few years ago this was exclusively a farming community. Small farms now have been divided into seasonal housing developments. A large percentage of residents now commute outside the town for employment. Many families have lived in these hills and valleys for over 200 years; others moved here with the last 25 years, moving their families out of the cities to enjoy our wholesome country living.

2.3 Physical Geography of the Manor Kill/Schoharie Watershed

Physical geography encompasses the physical elements and processes that comprise the earth's surface features and associated processes. These processes include: energy, air, water, weather, climate, landforms, soils, animals, plants, and the Earth itself. The study of physical geography attempts to explain the geographic patterns of climate, vegetation, soils, hydrology, and landforms, and the physical environments that result from their interactions.

Gilboa Dam at the Schoharie Reservoir
www.bearsystems.com

The Manor Kill watershed is located in the Appalachian Plateau physiographic province (Figure 2.3.1). The erosional characteristics of the sedimentary rock formations of the Appalachian Mountains are responsible for the characteristic valley and ridge topography of the Catskills. Durable layers of sandstone and conglomerate form ridges and less resistant limestone and shale underlie the Schoharie valley as it winds its way to the Mohawk River. During the height of glaciations, the Schoharie watershed was covered by an ice sheet up to a mile thick. Upon retreat, these ice sheets left a layer of unsorted and unconsolidated glacial debris, glacial till, ranging from clay particles to huge boulders. Following the retreat of the ice sheet, the landscape was covered with glacial tills and bedrock and was wiped clean of plants and animals, leaving a clean slate for the migration and colonization of the modern plant and animal communities. Today, the Schoharie watershed lies within the Northeastern Highlands ecoregion. This ecoregion is characterized by nutrient poor soils blanketed by northern hardwood and spruce fir forests.

Figure 2.3.1. Physiographic Regions of the United States, including the Appalachian Plateau (NASA Earth Observing System (EOS) Goddard Program Office).

Elevations in the Manor Kill basin of the watershed vary from a high of approximately 2,600 feet above sea level at High Knob in the North Eastern corner of the watershed, to a low point of 1,140 feet above sea level at the Schoharie reservoir. The average elevation of the watershed is approximately 1,808 feet above sea level. The Manor Kill starts as a palustrine forested wetland dropping approximately 160 feet in its first mile, but then reducing in slope to an average of 70 feet/mile to its approximate midway point. From this midway point to the reservoir, the stream slope drops approximately 45 feet/mile. The more notable high peaks (>= 2,500') that form the Manor Kill watershed basin are High Knob and Steenburg Mountain (Figure 2.3.2).

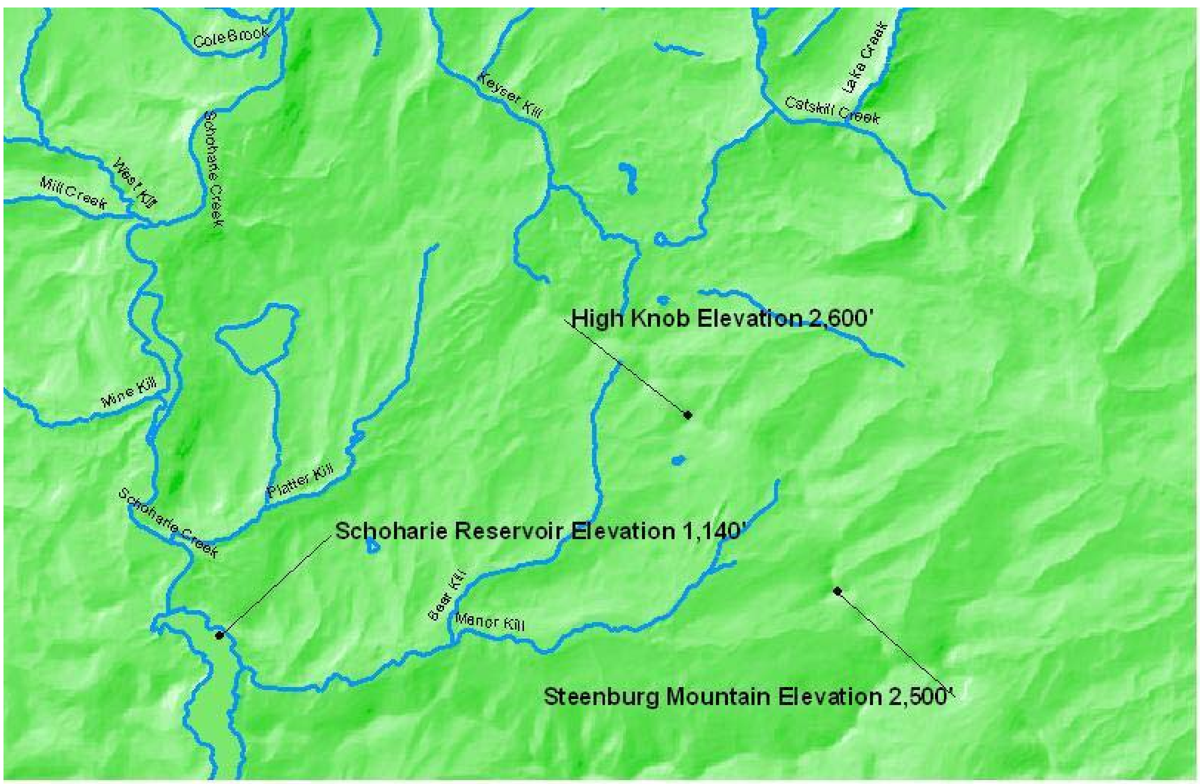


Figure 2.3.2 GIS Raster Image Showing Locations of High Knob and Steenburg Mountain

Traveling from north to south, the Bear Kill (6.15 m^2) is a large tributary that drains into the Manor Kill (Total drainage 34.4 m^2). The Manor Kill flows east to west for approximately 8 miles before exiting into the Schoharie reservoir where it turns north on its path to the Mohawk River. The entire Schoharie watershed (including reservoir) contains approximately 706 miles of stream.

Climate

The climate of the Manor Kill basin is primarily driven by the humid continental type, which dominates the northeastern United States. The average annual temperature for the area is 32.67˚ F and the area typically receives approximately 37.8" of rain/year (Table 2.3.1 and Figure 2.3.3). Due to up-sloping and down-sloping, the character of the mountaintop topography can affect the climate of the basin. Up-sloping occurs when air is lifted up over the mountains, the air expands, cooling and condensing into moisture, which takes the form of clouds and precipitation (Thaler, 1996). Down-sloping occurs when air sinking within a dome of high pressure or air that is forced downslope of a mountain range, warms up and loses moisture, as is shown by a drop in relative humidity (Thaler, 1996). These weather phenomena can be responsible for differences in cloud cover and precipitation between the Catskills and the surrounding area, and helps to explain the sometimes drastic variations in rainfall between Catskill basins (Figure 2.3.4).

Table 2.3.1. Average annual temperature, precipitation, snow fall and winter and summer temperatures for Conesville, NY. www.city-data.com

Average Annual Precipitation	37.8"
Average Annual Temperature	32.67 ˚ F
Average Winter Temperature	27.4 ˚ F
Average Summer Temperature	63.3 ˚ F
Seasonal Snowfall	68"

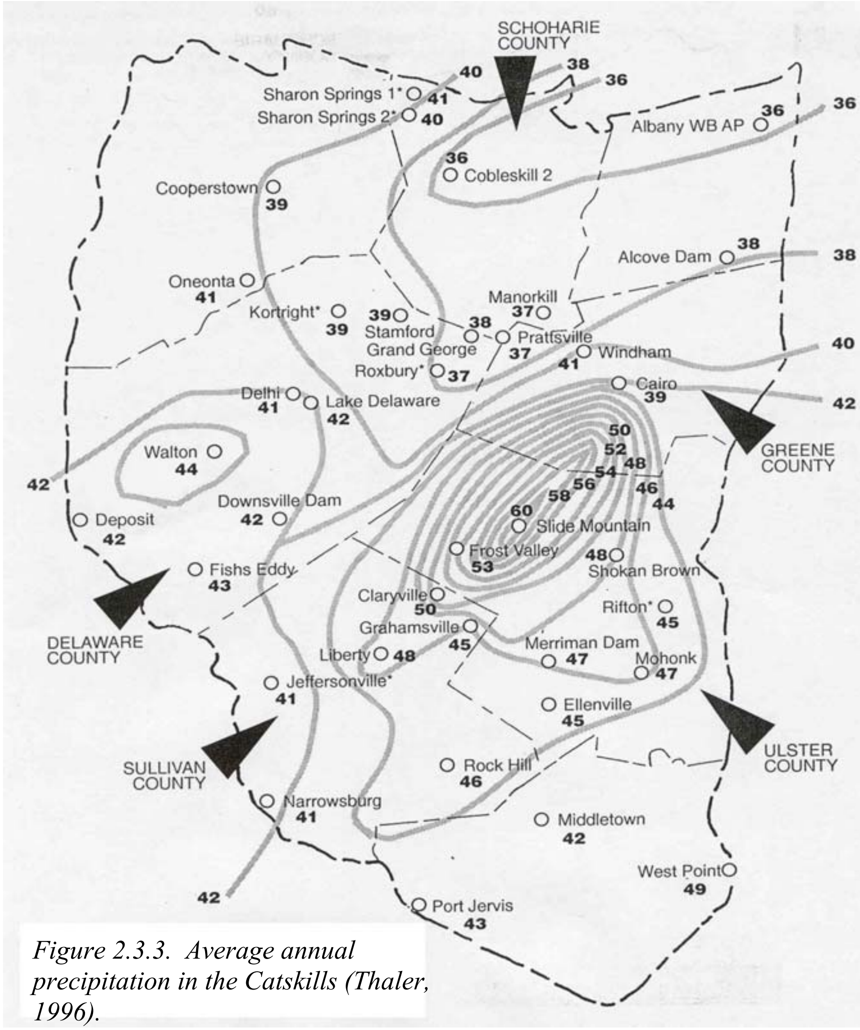
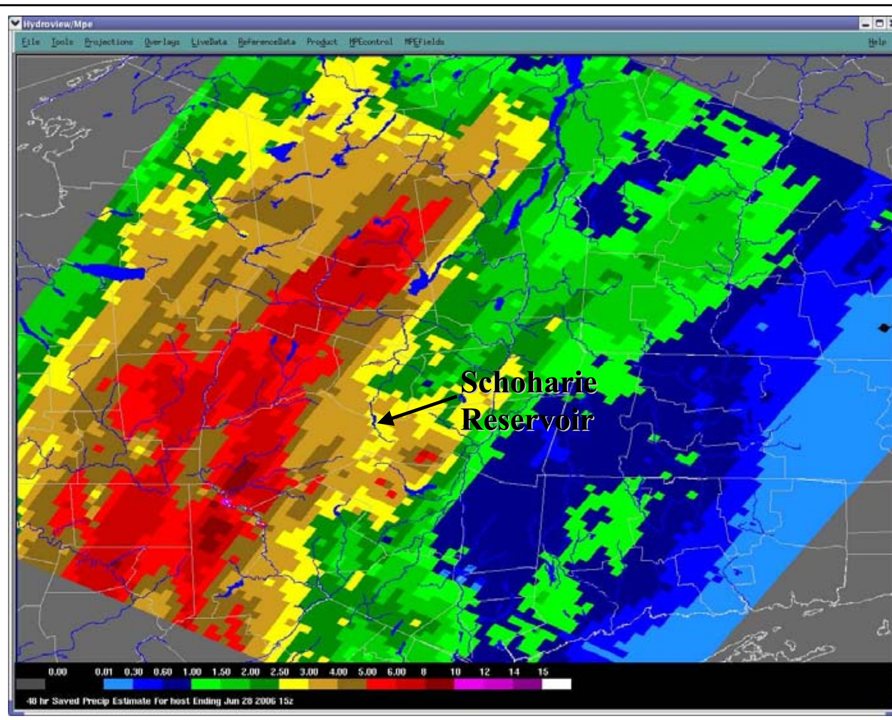


Figure 2.3.3. Average annual precipitation in the Catskills (Thaler, 1996).

Figure 2.3.4. Radar showing the rainfall intensity that caused the flooding in the Western Catskills in June 2006. The isolated pockets of heavy rain (dark red) within individual Valleys help explain why flood damages can be so dramatic from one basin to the next (National Weather Service Forecasting Office).



Global Climate Change Effects on the Watershed

Global warming will impact the Manor Kill basin in coming years. Greenhouse gases are trapping energy in our atmosphere that would normally be lost to space and causing global temperatures to rise. This warming is a natural phenomenon that provides enough heat to allow humans to thrive on earth, but the burning of fossil fuels, and the atmospheric concentration of other gases such as methane, has dramatically increased the rate of warming (Figure 2.3.5). Based on local data collected between 1952 and 2005, researchers have concluded that a broad general pattern of warming air temperatures, increased precipitation, increased stream runoff and increased potential evapotranspiration has occurred in the Catskills region (Burns et al., 2007). In coming years, there is no doubt that the effects of global warming will impact management decisions in the Manor Kill watershed.

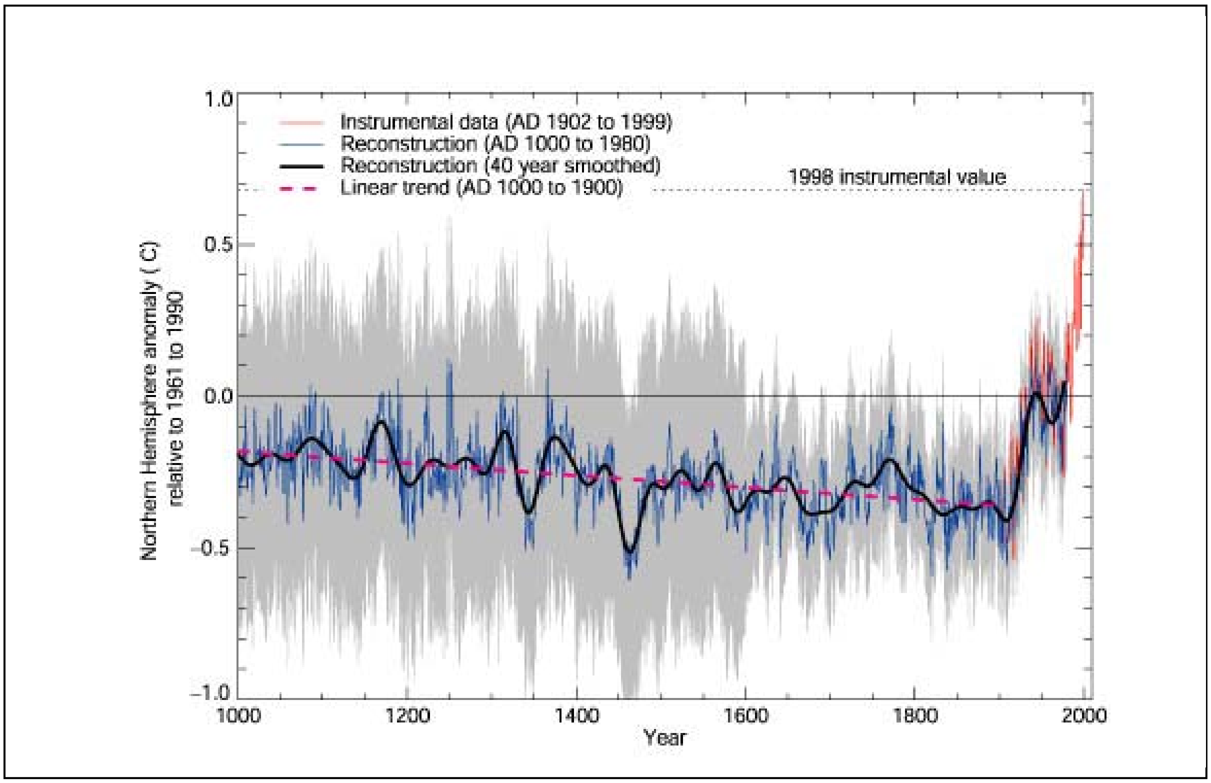


Figure 2.3.5. Millennial northern hemisphere temperature reconstruction, based upon ice core data, relative to actual temperatures recorded from 1902 through 1999. Despite large variation, the recent trend of rapid heating in the industrial era is apparent (National Climatic Data Center adapted from Mann et al., 1999).

With rising temperatures, air circulation, ocean currents, and rainfall patterns would change, causing generally violent weather. As a result, some regions of the world, including much of the United States, would experience droughts; other regions would become much wetter. Ecosystems all over the world would be disrupted, and some species might face extinction. Climate-related diseases such as malaria might attack areas where they are currently unknown (Girard 2005). Based upon current climatic trends, our climate may migrate to the extent that by the end of the century, summers in upstate New York may feel like Virginia (Figure 2.3.6) (Frumhoff et al., 2006). This climatic migration will have deleterious effects on plant and animal life, allowing new warmer climate species to thrive at the expense of our traditional plants and animals. The number of snow-covered days across the Northeast has already decreased, as less precipitation falls as snow and more as rain, and as warmer temperatures melt the snow more quickly. By the end of the century, the southern and western parts of the Northeast could experience as few as 5 to 10 snow-covered days in winter, compared with 10 to 45 days historically (Frumhoff et al., 2006). Decreased snowfall and increased rainfall would have negative effects on stream flows and the economy of Schoharie County and surrounding areas.

With the lack of snow fall, streams and groundwater will not receive a slow sustaining release of water through the winter and spring. Replacing the slow release will be more intense storms, which will sporadically dump large quantities of water into the system potentially causing damaging flooding (Figure 2.3.7). However, streams will return to base flow relatively quickly once the rain stops. Modeling predictions indicate that in the next century we will see more extreme stream flows that will cause streams to flow higher in winter, likely increasing flood risk, and lower in summer, exacerbating drought (Frumhoff et al., 2006). Changing the dynamic of the hydrologic cycle would also impact the NYC water supply system, forcing potential changes in operational measures.

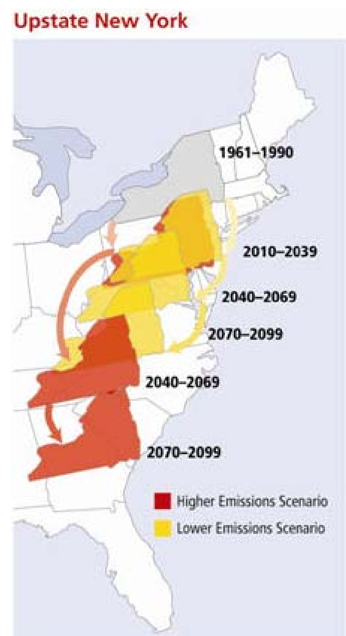


Figure 2.3.6. Projected climate "migrations" for Upstate, NY based on average summer heat index, under the lower (yellow) - and higher-emissions (rust) scenarios. Based on the average of the GFDL, HadCM3 and PCM model projections (Frumhoff et al., 2006).

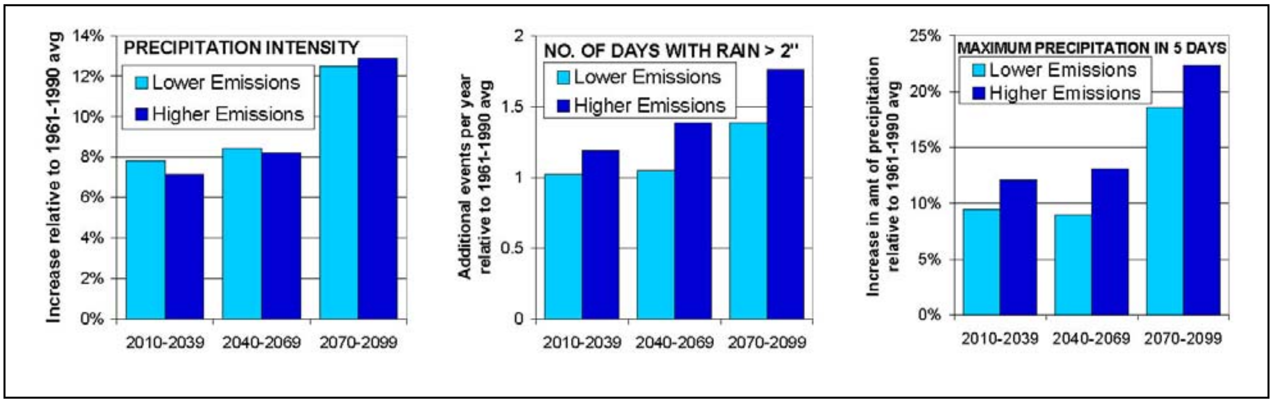


Figure 2.3.7. Projected increases in three indices of extreme precipitation: (1) precipitation intensity, (2) number of days per year with more than two inches of rain, and (3) maximum amount of precipitation to fall during a five day period each year (Frumhoff et al., 2006).

Due to a lack of a clear understanding of all of the coming impacts of climate change, stream managers need to employ the "no-regrets policy" with regard to their current management actions and policies. The no-regrets policy is the recognition that lack of certainty regarding a threat or risk should not be used as an excuse for not taking action to avert that threat, that delaying action until there is compelling evidence of harm will often mean that it is then too costly or impossible to avert the threat. Stream managers –including streamside landowners-- will need a basic understanding of how streams are formed and evolve to effectively adapt to coming changes. They will need to anticipate and compare the consequences of different management options, and will need to act conservatively: oversizing culverts and bridge spans, leaving larger buffers of undisturbed streamside vegetation, and consider limiting new development of infrastructure or personal property in areas where conditions indicate a high risk of the stream channel shifting across the floodplain. The humid continental climate has been an unquestionable asset to the historical development of the Manor Kill basin and its occupants and uses. With proper planning and implementation of the no-regrets policy, undoubtedly, the climate will continue its important role in Manor Kill basin life.

References

Burns, D.A., Klaus, J. and McHale, M.R. 2007. Recent Climate trends and implications for water resources in the Catskill Mountain region, New York, USA. Journal of Hydrology (2007), doi:10.1016/j.jhydrol.2006.12.019.

Frumhoff, P., McCarthy, J., Melillo, J., Moser, S., Wuebbles, D. 2006. Climate Change in the U.S. Northeast: A Report of the Northeast Climate Impacts Assessment. Union of Concerned Scientists: Cambridge, MA. Available on web: http://www.northeastclimateimpacts.org.

Girard, James E. 2005. *Principles of Environmental Chemistry,* Jones and Bartlett Publishers, Inc.

Thaler, J.S. 1996. Catskill Weather. Purple Mountain Press, Fleischmanns, NY.

2.4 Hydrology and Flood History

Introduction

Hydrology is the study of the properties, distribution, and effects of water on the Earth's surface, in the soil and underlying rocks, and in the atmosphere. The hydrologic cycle includes all of the ways in which water cycles from land to the atmosphere (as water vapor and clouds) and back (as snow, rain and other forms of precipitation) (Figure 2.4.1).

Understanding the hydrology of the Manor Kill will assist us with making land use decisions that work within the constraints of the hydrologic cycle and won't exacerbate flooding or cause water quality impairment.

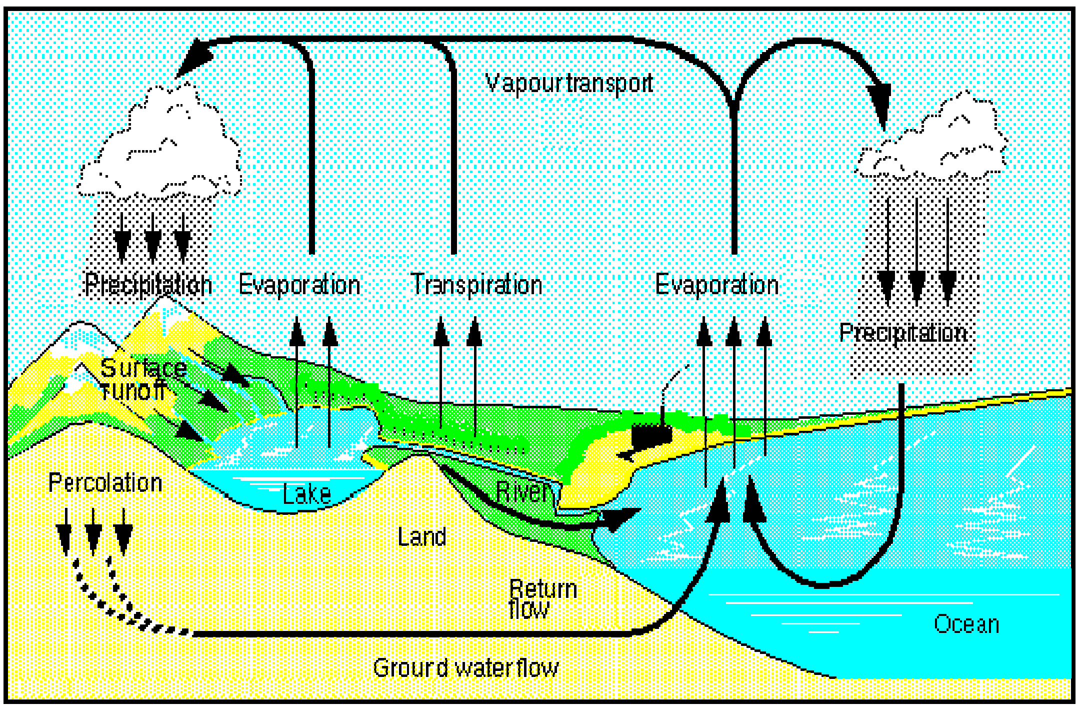


Figure 2.4.1. Graphic illustrating the hydrologic cycle.
(http://www.educ.uvic.ca/faculty/mroth/438/WEATHER/watercycle.html)

Water flowing through the Manor Kill reflects the integrated effects of all watershed characteristics that influence the hydrologic cycle. Characteristics include climate of the drainage basin (type and distribution patterns of precipitation and temperature regime), geology and land use/cover (permeable or impermeable surfaces and materials affecting timing and amount of infiltration and runoff, and human-built drainage systems), and vegetation (uptake of water by plants, protection against erosion, and influence on infiltration rates). These factors affect timing and amount of stream flow, referred to as the streams hydrologic regime. For example, a stream with an urbanized watershed where water will run off the hardened surfaces directly into the stream will have higher peak discharges following storms than a watershed, such as the Manor Kill, which is predominantly forested and agricultural and as a result allows a higher percentage of rain water to infiltrate before it reaches the stream, releasing it more slowly over time. Understanding the hydrology of a drainage basin is important to the stream manager because stream flow patterns affect aquatic habitat, flood behavior, recreational use, and water supply and quality.

Manor Kill Basics

Encompassing approximately 34.4 square miles, the Manor Kill is located primarily in Schoharie County, NY. The stream drains the town of Conesville, NY. The Manor Kill is typical of major streams within the Schoharie watershed in that it is a long, narrow watershed running east to west. This drainage pattern is controlled by the steep topography, formed in large part during the last period of glacial activity. Streams in the Schoharie valley are primarily perennial streams, that is, they flow year-round except in smaller headwater streams or in extreme drought conditions. The Manor Kill watershed averages approximately 36.8 inches of precipitation per year. This more damaging rainfall often comes in dramatic summer downbursts, remnants of autumn hurricanes, or late winter rain-on-snow events. Drainage density, or how much stream length is available to carry water off the landscape per unit area of watershed is about average for the Catskills, at 0.0016m/m2. Given the average drainage density, combined with steep mountainous slopes, and high precipitation, the system is relatively flashy, that is, stream water levels rise and fall quickly in response to storm events. This flashiness is somewhat mitigated by heavy forest cover throughout much of the watershed. Therefore, efforts to protect upland, as well as riparian, forest are important to reducing flooding impacts.

Stream flow Primer

There are two general categories of stream flow: storm flow (also called flood flow) and base flow, between which streams fluctuate over time. Storm flow fills the stream channel in direct response to precipitation (rain or snow) or snowmelt, whereas base flow is primarily groundwater fed and sustains stream flow between storms and during subfreezing or drought periods. A large portion of storm flow is made up of overland flow, runoff that occurs over and just below the soil surface during a rain or snowmelt event. This surface runoff appears in the stream relatively quickly and recedes soon after the event. The role of overland flow in the Manor Kill watershed is variable, depending upon the time of year and severity of storms or snowmelt events. In general, higher stream flows are more common during spring due to rain, snowmelt and combination events, and during hurricane season in the fall. During summer months, actively growing vegetation on the landscape draws vast amounts of water from the soil through evapotranspiration. This demand for groundwater by vegetation can significantly delay and reduce the amount of runoff reaching streams during a rain storm. During winter months, precipitation is held in the landscape as snow and ice, so precipitation events do not generally result in significant runoff to streams. However, frozen ground may increase the amount of overland flow resulting from a rain storm if the air temperature is above freezing, particularly in spring on north facing slopes. Subsurface storm flow, or interflow, comes from rain or snow melt that infiltrates the soil and runs down slope through the ground. Infiltrated water can flow rapidly through highly permeable portions of the soil or displace existing water into a channel by "pushing" it from behind. In the Schoharie valley, subsurface flow can occur fairly rapidly along layers of essentially impermeable glacial lake silt/clay deposits. Subsurface storm flow shows up in the stream following overland flow, as stream flow declines back toward base flow conditions.

Base flow consists of water that infiltrates into the ground during and after a rain storm, sustaining stream flow during dry periods and between storm flows. The source of base flow is groundwater that flows through unsaturated and saturated soils and cracks or layers in bedrock or other impermeable layers adjacent to the stream. In this way, streams can sustain flow for weeks or months between precipitation events and through the winter when the ground surface and all precipitation is otherwise frozen. Stable-temperature groundwater inputs keep stream water warmer than the air in winter and cooler than the air in summer – this is what enables fish and other aquatic life to survive in streams year-round.

Hydrologists use a hydrograph of a stream, a graph showing amount or depth of flow over time, to analyze flow patterns and trends such as flood frequency or drought cycles. A stream gage, a device that primarily measures water level, is necessary to monitor stream discharge and develop a hydrograph. The United States Geological Survey (USGS) maintains a network of stream gages throughout the country, with a gage located on the Manor Kill in the town of Conesville (Figure 2.4.2).

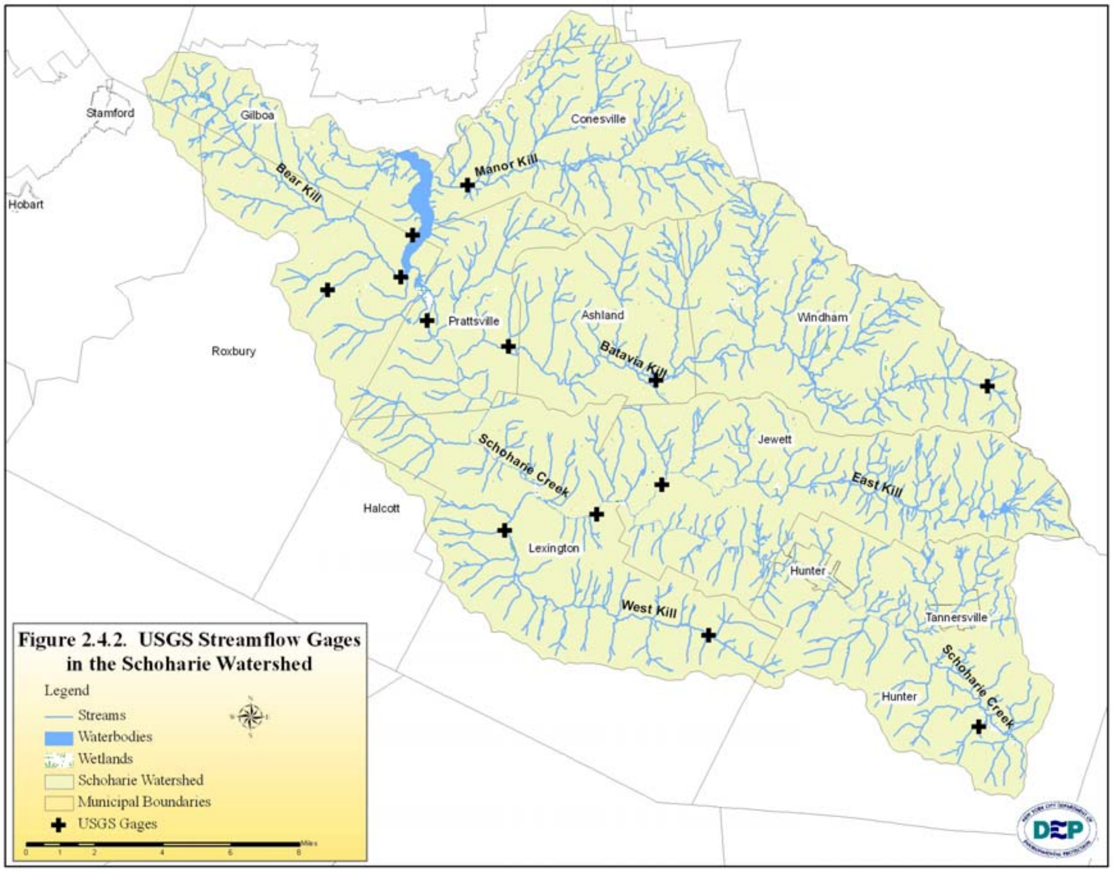


Figure 2.4.2. USGS Streamflow Gages in the Schoharie Watershed

These gages measure the stage, or height, of the water surface at a specific location, typically updating the measurement every 15 minutes. By knowing the stage we can calculate the magnitude of the discharge (flow), or volume of water flowing by that point, using a relationship developed by USGS called a rating curve. Using this rating curve, the magnitude of flow in the Manor Kill at the gage location can be determined at any time just by knowing current stage. Flow can also be calculated for any other stage of interest. Additionally, we can use the historic record of constantly changing stage values to construct a picture of stream response to rain storms, snow melt or extended periods of drought, to analyze seasonal patterns or flood characteristics.

The United States Geological Survey (USGS) maintains one continuously recording stream gage on the Manor Kill (established 1986, drainage area 32.4 mi2, USGS ID# 01350080). All gage information is available online at the USGS website: http://waterdata.usgs.gov/ny/nwis/uv/?site_no=01350080&PARAmeter_cd=00065,00060.

The Manor Kill gage has a long enough period of record to prepare a hydrograph covering several years for the stream (Figure 2.4.3). Each spike on the gage graph represents a peak in stream flow (and stage) in response to rain storms (Figure 2.4.3). Stream level rises (called the "rising limb" of the hydrograph) and falls as the flood recedes (called the "falling (or receding) limb" of the hydrograph). We can analyze long time periods to see seasonal trends or long-term averages for the entire length (period) of gage record. We can see the hydrograph for the gage shows higher flows in fall (hurricane season) compared to winter (water held in ice and snow), and higher flows in spring (snow and ice melt, with rain-on-snow events) compared to summer (drought conditions with vegetation using a lot of water). The highest flows of the year are generally associated with the hurricane season in the fall, followed by winter and spring snowmelt or rain-on-snow events. Overland flow accounts for most of water that causes the sharp peaks in the hydrograph.

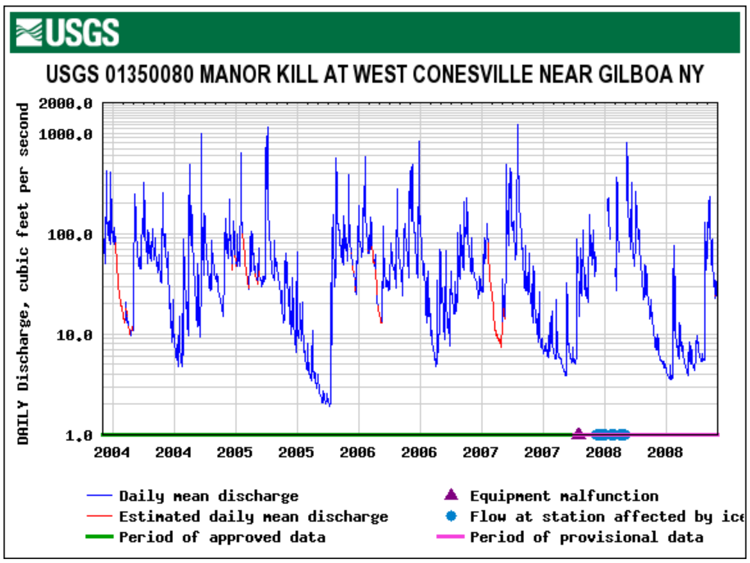
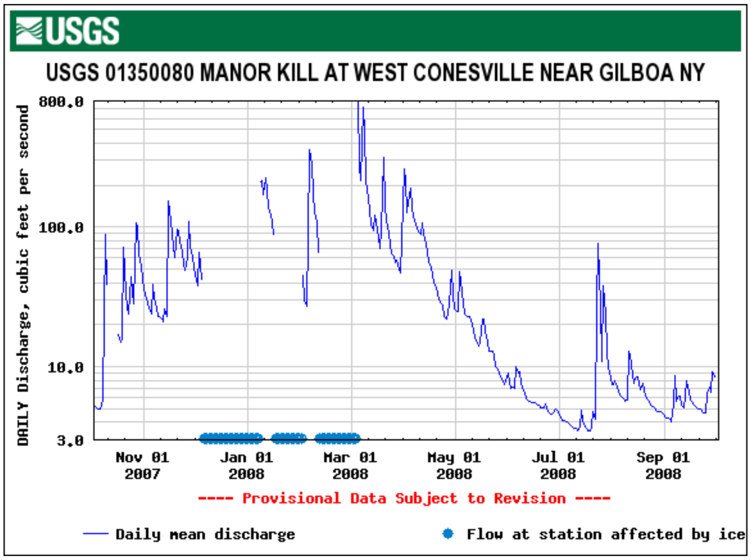


Figure 2.4.3. This hydrograph represents the daily average flow from 12/03 through 12/08.

We can analyze long time periods to see seasonal trends or long-term averages for the entire length (period) of gage record. We can see the hydrograph for the gage shows higher flows in fall (hurricane season) compared to winter (water held in ice and snow), and higher flows in spring (snow and ice melt, with rain-on snow events) compared to summer (drought conditions with vegetation using a lot of water) (Fig. 2.4.4). The highest flows of the year are generally associated with the occasional hurricane in the fall, followed by winter and spring



2.4.4. Hydrograph illustrating mean discharge per month.

snowmelt or rain-on-snow events. Overland flow accounts for most of water that causes the sharp peaks in the hydrograph. Stream flow always rises and peaks following the height of a precipitation event because it takes time for water to hit the ground and run off to the stream (this is known as lag time). Knowing storm timing, we could also calculate lag time for the Manor Kill at the gage location for particular storms or types of storms, and determine how the stream responds to storms both in timing and flood magnitude and recession. Through analysis of the long-term flow and flood records provided by the USGS, the town, its residents and resource managers can begin to better understand the cause/effect of various precipitation amounts on flooding.

Manor Kill Flood History

Flooding can be caused by excessive precipitation, rapid snowmelt, ice jams, beaver dams, or dam failure. Steep slopes make the area very prone to flash flooding. Slow moving thunderstorms often produce flash floods, particularly during summer months. Remnants of tropical storm systems can produce both flash floods and river flooding. Rapid thawing in the winter produces runoff from snowmelt and ice jams. Flooding can occur at any time of the year. According to Hazards of NY (HAZNY) reviews, Schoharie County is at high risk for flood potential (Schoharie County, 2006).

There was some historical documentation of an event that took place in 1874. It is remembered as follows:

"The village of Conesville was known as 'Stone Bridge' for many, many years because of the great arched stone bridge that stood where the present bridge crosses the Bearkill. This bridge was washed away in the flood of 1874. Before the stone bridge was

built the road (Susquehanna Turnpike*) closely followed the Manorkill Creek south of the village, crossed the Manorkill approximately by the Makely bridge, then recrossed the Manorkill and came on the present near Russell Germond's. These streams apparently were crossed by fording (driving through the water).''* (Whitbeck, 1995).

Though there is very limited detail to this event, it tells us that damaging floods did occur during this time period.

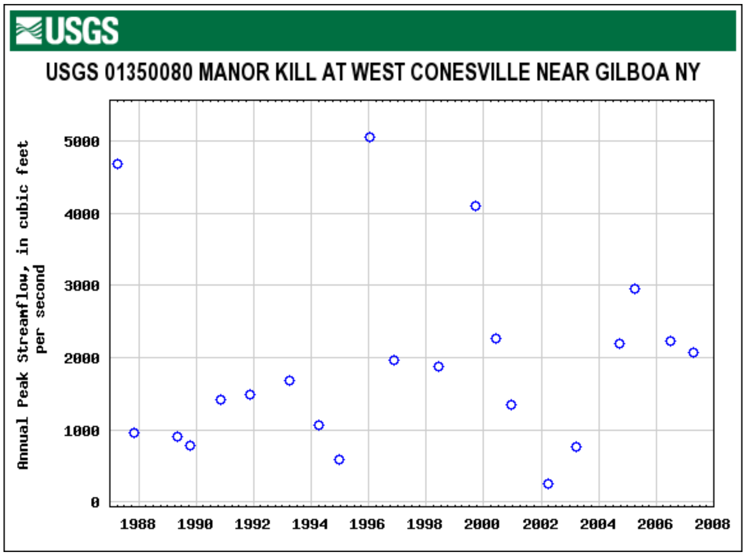


Figure 2.4.5. Peak stream flows recorded at the Manor Kill gage between 1987 and 2007.

Due to the relatively short period of record of the USGS gage (1986-2008) there is limited information regarding flood history specific to the Manor Kill. The highest recorded stream flow was recorded in 1996 (Figure 2.4.5 and Table 2.4.1). During spring of that year the flow gage recorded a maximum discharge of 5,050 cfs (Figure 2.4.5 and Table 2.4.1). Discharges above 4,000 were also recorded in April 1987 and September 1999 (Figure 2.4.5 and Table 2.4.1). These numbers are so far outside of the mean peak stream flow of 2,029.1 cfs for this 20 year time frame that they could easily be considered potential flood events. It is not clear what types of structural damage may have resulted during these periods of high flow, but it would have certainly resulted in heavy erosion and subsequent loss of fertile soils and possible crop damage.

Table 2.4.1. Peak Stream flow for Manor Kill 1987-2007 USGS

Schoharie County, New York
Hydrologic Unit Code 02020005
Latitude 42°22'37", Longitude 74°24'48" NAD27
Drainage area 32.4 square miles
Gage datum 1,255.95 feet above sea level NGVD29

Water Year	Date	Gage Height (feet)	Stream-flow (cfs)	Water Year	Date	Gage Height (feet)	Stream-flow (cfs)
1987	Apr. 04, 1987	9.76	4,680	1997	Nov. 09, 1996	5.94	1,970
1988	Oct. 28, 1987	4.17	955	1998	Jun. 14, 1998	5.77	1,870
1989	May 11, 1989	3.97	904	1999	Sep. 16, 1999	9.04	4,100
1990	Oct. 20, 1989	3.67	783	2000	Jun. 07, 2000	6.42	2,260
1991	Nov. 10, 1990	5.06	1,410	2001	Dec. 17, 2000	4.77	1,340
1992	Nov. 23, 1991	5.19	1,480	2002	Mar. 27, 2002	2.38	257
1993	Mar. 30, 1993	5.49	1,680	2003	Mar. 21, 2003	3.46[2]	756
1994	Apr. 14, 1994	4.24[2]	1,060	2004	Sep. 18, 2004	6.31	2,190
1995	Dec. 24, 1994	3.17	587	2005	Apr. 03, 2005	7.49	2,960
1996	Jan. 19, 1996	10.20	5,050	2006	Jun. 28, 2006	6.35	2,220
				2007	Apr. 16, 2007	6.10	2,070

The North Eastern United States has been experiencing more severe storms over the past several years, and Schoharie County has been taking steps to minimize risks to human populations. In April of 2004 the Schoharie County Emergency Management Department and the Federal Emergency Management Agency conducted a Flood Insurance Study. One of the products was Flood Insurance Rate Maps (FIRMs) that were developed for every town and village in Schoharie County (Figure 2.4.6). These maps help to illustrate flood prone areas which would experience inundation in the event of a 100 year flood event.

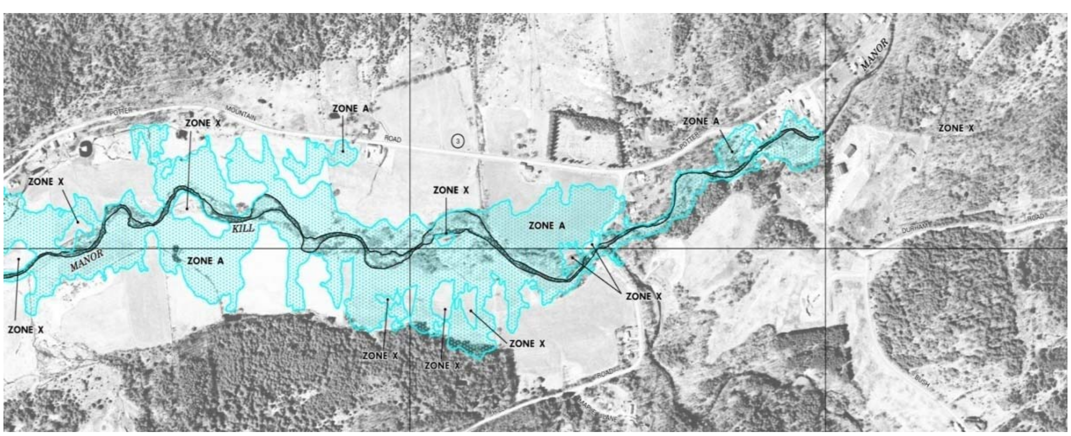


Figure 2.4.6. FIRM of Manor Kill illustrating base flood elevations near the head waters.

Implications of Manor Kill Flooding

The unique hydrology of the Manor Kill has consequences for how the stream corridor should be managed. Flood history and dynamics play a large role in determining the shape, or morphology, of stream channels and the hazards associated with land uses on the banks and in the floodplain. For example, applications for stream disturbance permits (from NYS DEC) typically increase following floods as landowners and municipalities attempt to repair damage caused by flooding. If we want to minimize impacts to property, infrastructure and other damages or inconvenience, it is critical that we understand and plan for flooding behavior. Historically, this "planning" has emphasized attempts to constrain and control stream channels, rather than working with processes we can measure and, to some extent, predict. The results are often costly and sometimes catastrophic, such as when berms or levees fail or bridges wash out. These "control" approaches typically result in ongoing maintenance costs that can draw valuable community resources away from other projects. With a better understanding of stream and floodplain processes, we can reduce these costs. For more information, see Section 3.2, Introduction to Stream Processes.

References

Schoharie County, 2006. Schoharie County Hazard Mitigation Committee and Schoharie County Planning and Development Agency, Schoharie County All Hazards Mitigation Plan.

Whitbeck, Lester E. & Anne, 1995. *The Sloughter's History of Schoharie County Bicentennial Edition 1795-1995.*

2.5 Manor Kill Watershed Geology

(Note: this is an adaptation of the Upper Esopus Creek and Upper Schoharie Watershed Management Plans' geology sections)

Introduction

Water flows across the landscape and sculpts the watershed. The geology (the earth material) of the watershed helps determine the nature of the streams that form, influences the stream's water quality, and the way the landscape erodes (Photo 2.5.1). In and around the Catskill Mountains, geology is the primary control on water quality. Jill Schneiderman, a professor of geology at Vassar College, notes in her book *The Earth Around Us: Maintaining a Livable Planet* that the bedrock and glacial sediments of the Catskills provide excellent filtration for maintaining high water quality (Schneiderman, 2003). However, the geology also periodically degrades the water quality. Where the stream erodes into very fine-grained (silt and clay) glacial deposits the water will become brown with the suspended sediment. This Section presents basic background information on Catskill and Manor Kill geology and discusses some of the important implications of the geology with respect to stream management. The intent is to provide just enough information to describe the geologic setting and history of the Manor Kill watershed. Specific recommendations pertaining to further characterization are presented at the end of this section. References are also provided for the reader interested in obtaining more detail on the geology of this region.

Photo 2.5.1. Streambank erosion into glacial mixed till along the Manor Kill.

Streams and glaciers sculpted these mountains out of rock that formed from ancient rivers. That is essentially the geologic story of the Catskill Mountains. These mountains and their river valleys are the ongoing result of water interacting with landscape geology under the force of gravity over millions of years. Knowing the geology of the landscape and stream corridor will help stream managers understand important conditions that control the stream's work (moving water and sediment out of the watershed) as well as significantly influencing water quality.

The nature of the bedrock – its composition and structure – determines how the stream valleys will form and what the sediment will be like. The Manor Kill flows in the northeastern quadrant of the Catskills. These mountains are composed of sedimentary rock. The broken bits of this rock, formed from layers of ancient river sediment, is the source of almost all of the stream sediment you see today - from clay to boulders. The reddish clays exposed in stream banks are ancient lake sediments eroded from the red siltstones and shales that often form the mountain slopes; the cobbles and boulders eroded from the thick-bedded sandstones that form the mountain cliffs. Much of this sediment that the stream is currently conveying was deposited during the most recent ice ages of 12,000 – 25,000 years ago, when the Catskills were mostly occupied by ice or the meltwater streams and lakes that followed the ice's retreat. The Manor Kill and all the streams that feed it water and sediment have inherited this geologic framework. The geology of the Manor Kill stream valley is typical of the complex geologic conditions that prevail in the Schoharie Creek basin, of which it is a part. The bedrock geology is straightforward, while the glacial geology provides the complexity that makes these basins unique in the Catskills.

Bedrock Geology

The bedrock geology of the Catskill Mountains and Manor Kill watershed exerts considerable control on the character of its valley slopes and streams (Photo 2.5.2). The sedimentary rock, primarily composed of alternating layers of sandstone and siltstone/shales, creates the characteristic Catskill stepped topography. The sandstones form the cliffs while the more easily erodible siltstones/shales tend to form the slopes. The mountain tops tend to be formed of conglomerate (gravelly sandstone). The sediments that form the middle-to-late Devonian (390 to 360 million years ago) bedrock are interpreted to be deposits of a vast deltaic

Photo 2.5.2. Bedrock exposed along the Manor Kill

river system, often called the "Catskill Delta" deposits (Isachsen et al, 2000) that drained the ancient high peaks of the Taconic mountain range. Titus (1998) has compared it to the Bangladesh river complex draining the Himalayas. The sandstone and conglomerate are made up of river channel sand and gravel, while the siltstones and shales are overbank and shallow fresh water silts and clays.

The Catskill Delta deposits were buried beneath younger sediments, and then uplifted as a plateau. Prior to and during the uplift, intersecting sets of vertical fractures formed in the Catskill rock. The following eras eroded away the overlying rock, and streams incised multiple channels into the slowly rising plateau. The following two publications are recommended for further detail on the Catskill bedrock geology: *Geology of New York: A simplified Account* (Isachsen, et al, 2000) and *The Catskills: A Geological Guide* (Titus, 1998).

Fisher, et al. (1970) mapped the bedrock of the area as part of the New York State Geological Survey Map and Chart Series. The mapped geologic formations that make up most of the watershed are the very similar Oneonta and Walton formations comprising sandstones, shales, and mudstones. The uppermost rocks in the sequence are conglomeratic sandstones of the Slide Mountain Formation.

The orientation of stream valleys is important, influencing the microclimate, average depth of snowpack and local hydrological regime in many ways. The Manor Kill's drainage is to the southwest, which is the norm (along with southeastern drainage patterns) for Catskill streams.

Modern stream deposits in the Catskill Mountains are principally derived from erosion of the well-bedded sedimentary Catskill bedrock. As a result, stream clasts (sediment particles and classes) have a low spherocity ("roundness"), typically forming platy or disk-like particle shapes. This platy shape affects the stability of the streambed in a number of ways. First, it allows the particles to *imbricate*, or stack up at an angle, forming an overlapping pattern like fish scales or roof shingles (Photo 2.5.3). Imbricated streambeds are thus generally more stable or "locked up," and all other things being equal, generally require a larger flow to mobilize the bed material than non-imbricated beds. However this same platy shape can also, under the right conditions, act like an airplane wing and be lifted by the stream flow more readily than would a spherical particle of similar weight. Once this occurs for even a few particles, the imbrication is compromised and significant portions of the streambed become mobile.

Photo 2.5.3. Example of imbricated Catskill stream sediment

Surficial Geology

Surficial geology is concerned with the material covering the bedrock. In the Catskills this surface material is principally soils and glacial deposits. The focus here is on a brief introduction to the glacial geology of the watershed and stream corridor. Features that are most likely to be encountered on the surface near the Manor Kill include bedrock, fluvial gravel, lacustrine sand, lacustrine silt and clay, kame moraine, kame deposits, and till (Catskill Center, 2001).

The most recent ice ages of the last 1.6 million years (Pleistocene Epoch) left their mark on the Catskill landscape. Vast continental ice sheets and smaller local mountain glaciers scoured the mountains and left thick deposits of scoured sediment in the valleys. The last ice sheet (the "Laurentide Ice Sheet") reached maximum thickness over the Catskills about 22,000 years ago (Isachsen, et al., 2000) and had fully retreated by 12,000 years ago. As measured on the scale of geologic time, this was a very recent event.

The most recent ice ages – the time that spanned the last 30,000 years or so – had giant continental-sized ice sheets flowing across the northern landscape (figure 2.5.1 a). The ice sheet covering Greenland is a modern day analog to those Pleistocene conditions (figure 2.5.1 b). The continental glaciers scoured and moved vast amounts of sediment across the landscape. Once the ice sheet started melting back into the Hudson River valley and to the north, smaller alpine glaciers formed in the mountains and further sculpted the landscape. The glaciers left a legacy that still profoundly influences hill slope and stream channel stability and water quality.

Figure 2.5.1. (a). Map of Laurentide ice sheet. (b). Photo of Greenland ice sheet in mountain terrain.

This was a period of accelerated erosion in the Catskills as the flowing ice sheet bulldozed sediment and "quarried" the bedrock. Glacial erosion broke the rock down into an entrained mixture of fragments ranging in size from boulders to clay. This mixture of saturated sediment was carried along by the ice and deposited as *till* (unsorted assemblage of glacial sediment) or as *stratified "drift"* if the sediment was subsequently sorted by melt-water streams. These glacial deposits filled in deep river ravines that once drained the landscape prior to the last glacier's advance over the mountains.

As the climate warmed and ice thinned, the landscape was deglaciated – lobes of the continental ice sheet melted back from the central Catskills in periodic stages (Dineen, 1986). As the ice sheet pulled back (and occasionally re-advanced as distinct "lobes" of flowing ice) alpine glaciers formed on some of the newly exposed peaks (e.g. Hunter and Panther Mountains). Meltwater from the decaying ice left a complex array of stream (outwash plain) and ice-contact (kame) sand and gravel deposits. Pro-glacial lakes formed where mountains, recessional moraines (deposits at former glacial margins) and ice impounded water and filled the valley floors with thick deposits of layered silt and clay. The extent of the pro-glacial lakes in the Catskills are inferred from elevations of "fossil" deltas from meltwater streams pouring into large valley filling lakes occur at an elevation up to 564 m (Rich, 1935), exposing a large proportion of the catchment to the accumulation of layered fine sediment. As climate fluctuated during the period of deglaciation, temporary readvances of ice from ice sheet lobes or alpine glaciers would leave till and other meltwater deposits on top of the earlier glacial material, resulting in the complex lateral and vertical distribution of glacial deposits observed today. After the ice fully retreated north, rainfall-runoff returned as the predominant sculptor of the landscape.

Glacial geology sets the geologic framework for most of the Manor Kill stream system, controlling such characteristics as depth of *alluvium* (water worked sediments), presence of non-alluvial boundary conditions (till and glacial lake sediments), sediment supply and stream channel slope and geometry. For example, glacial depositional features that partially fill river valleys, such as recessional moraines or kame terraces along the valley wall, influence valley slope and cause valley constriction, both of which limit where the river channel can occur. Also, locally complex *stratigraphy* of glacial till, glacial lake deposits and unconsolidated *fluvial* deposits in the stream bank profile significantly influences erosional process. Understanding the glacial geology in detail beyond the general level can help identify causes of stream erosion and water quality problems as well as assist in prioritizing where future stream stabilization or restoration actions may be most useful.

Hydrogeology

Though groundwater is not the subject of this Management Plan, its constructive role in maintaining base flow to the stream and cold water springs for thermal refugia, and its destructive role in hill slope failures should be addressed.

Given that much of the valley floor stratigraphy includes buried impermeable layers of glacial lake silt and clay and/or glacial till, groundwater circulating through the upper permeable coarse-grained alluvium is often perched and discharges as springs or base flow to the stream. Following periods of excess rainfall not only does the stream flow increase to or near flood stage, but the water table also increases and can flood basements. Much of the “flood” damage to basements in the Catskills is due to excess groundwater in these shallow groundwater systems and not directly from stream flooding.

The flow of groundwater through the complex glacial stratigraphy on the hill slopes is a major factor in the massive hill slope failures that impact stream channel conditions and water quality. The combination of stream erosion at the top of the hill slope, fluctuating groundwater levels, differential seepage from the slopes and saturated sediment can result in very long-lasting, deep-seated slope failures. Examples abound throughout the watershed (Photo 2.5.4). Every major rainfall-runoff event seems to generate new slope failures or reactivate older failures. Some of the chronic turbidity sources in the tributary streams are from these hill slope failure sources, which can release large volumes of sediment, especially during a storm or other high-water event.

Photo 2.5.4. Hillsope failure in the Manor Kill – notice fence posts moving down with slope.

Stream Channel Geology

Developing an effective stream corridor management plan that incorporates geologic boundary conditions requires an additional step beyond describing the geologic setting. Additional analysis is needed to characterize the surficial geology that forms the stream channel boundary by some of its sedimentologic conditions, specifically grain size distribution, cohesiveness, and consolidation.

The Manor Kill and its tributaries flow across a landscape characterized by *sedimentological heterogeneity* as a result of the complex distribution of glacial deposits and landforms. Stream channel stability and water quality vary in part as a function of this heterogeneity. By classifying the surficial geology along the stream corridor into mappable units that describe the potential for bed and bank erosion and entrainment of the stream channel material, recommendations for management of stream reaches can better reflect local geological considerations.

Rubin (1996) began this effort in the Stony Clove basin by classifying the glacial deposits into three sedimentologic units and mapping their distribution along the Stony Clove mainstem and tributary channels (GCSWCD, 2004). The following are the three key sedimentologic units that influence water quality and stream stability. They were first proposed Rubin (1996), and have been subsequently adapted for the development of stream management plans (GCSWCD, 2004; GCSWCD, 2005; GCSWCD, 2007; GCSWCD, 2007b; CCE, 2007).

Unconsolidated Deposits

Photo 2.5.5. Coarse fluvial sediment covers many of the Manor Kill's stream banks.

This general term is applied to all unconsolidated deposits regardless of whether they were deposited directly as post-glacial stream deposits, glacial *outwash* (proglacial fluvial sediments), reworked outwash, *kame terrace* deposits, *melt-out till*, *moraine* deposits or reworked *lodgement till* (Photo 2.5.5). The unit is composed of sand, gravel, cobbles, boulders and a small clay/silt fraction. The unconsolidated deposits are present in valley centers, typically ranging from four to twelve feet in thickness (Rubin, 1996). With the exception of a thin, weathered mantle often capping it, this is the uppermost geologic unit most commonly forming stream banks. Boulders specific to this geologic unit naturally drop out as stream banks are eroded, providing some aquatic habitat and diversity.

Lacustrine silt/clay

Photo 2.5.6. Clay lens exposed in the Manor Kill

This reddish or pinkish brown, finely-layered, silty-clay deposit floors significant portions of the Manor Kill and its tributaries. It was deposited *subaqueously* (from streams discharging into one or more glacial lakes) as a sediment blanket draped over underlying till or bedrock. Locally, it was also deposited in smaller impoundments associated with alpine glaciers and moraine dams. It is commonly exposed along the toe of the stream bank, sometimes in the channel bottom (often beneath a thin cover of coarse alluvium), and less frequently as long and/or large banks (Photo 2.5.6).

The fine, uniform grain size results in a very cohesive deposit that exhibits unique hydraulic and mechanical erosion characteristics. While the silts are easily entrained under high runoff events, many of the clay-rich deposits are resistant to hydraulic erosion. Susceptibility to erosion is largely dependent upon whether the layered silt/clay has been mechanically disturbed by geotechnical failures or human disturbance. The silt/clay unit tends to erode mechanically by slumping along rotational faults, subsequently losing its layered structure and cohesive strength. Within the silt and clay layers, strata of sand sometimes occur, creating the potential for piping and associated mechanical failures. When saturated it tends to be extremely soft, and in this physically and chemically-weakened condition is susceptible to creep and erosion.

Where vegetative cover is lost and large exposures of lacustrine silt/clays occur, revegetation is usually slow due to the poor drainage and rooting characteristics of the soil. A metal probe or stick can often be sunk into this unit to depths of between three and five feet, thus enabling identification even when it is covered by a thin cobble layer. Elongate troughs, scour holes and even deep potholes reflect its entrainment potential during scouring flows. Clear stream water contacting lake clays often results in an entire stream becoming turbid within 50 feet. In the Manor Kill watershed this lacustrine silt/clay, along with lodgement till, are primary sources for suspended sediment and turbidity problems, although they are less pronounced here than in the Upper Schoharie Creek or Upper Esopus Creek watersheds.

Lodgement Till

This is an over-consolidated (very dense), clay-rich, reddish brown deposit that is prevalent in the Manor Kill (Photo 2.5.7). This hard-packed silty clay with embedded pebbles, cobbles and boulders forms a number of steep banks in the drainage basin. Its dense, consolidated character is distinguished from the looser assemblage of mixed sediment sizes (silty sand-boulder) that comprises melt-out till found in moraines and along mountain sides. It is typically exposed in stream channels where overlying lake clay deposits have been

Photo 2.5.7. Lodgement till in the Manor Kill

removed by erosion, where streams have scoured into valley wall deposits or where they have breached morainal ridges.

Its relatively competent nature, especially compared to disturbed lacustrine sediment, make it significantly more resistant to hydraulic erosion. It is however, susceptible to mechanical erosion by mass failure of fracture bound blocks during saturation/desaturation and freeze/thaw cycles. This failed material is subsequently eroded by streamflows. Under conditions of high stream velocities and discharges, lodgement till is a contributor of sediment. However, where the stream (particularly in tributary valleys) is against the valley wall and the hill slope composed of lodgment till is saturated, long-lasting exposures can be chronic sources of suspended sediment into the stream well-after a storm event. Reaches in the Manor Kill and Bear Kill are subject to this phenomenon. Rain water and overland runoff contacting exposed banks can also readily entrain sediment from these units. For field mapping, a metal probe or stick can rarely be pushed into this unit more than 0.2 feet.

Bedrock Control

The presence of bedrock sills and banks is an additional geologic unit equally important in characterizing geology for stream corridor management (Photo 2.5.8). These hydraulic controls can represent natural limits to changes in the stream channel system caused by incision or lateral migration. An example is the occasional bedrock stream banks along the course of the Manor Kill, and the large amount of bedrock as the stream falls into the reservoir.

Figure 2.5.8. Lower Manor Kill contains a large amount of bedrock control.

In summary, the variable character of the Manor Kill is largely a reflection of the geologic bedrock control and complex glacial history of the valley. These geologic influences are evident in the sedimentological variation characterizing the topography and geomorphology of the stream channel boundary. The nature of these deposits makes them variably susceptible to stream erosion. In particular, the lacustrine and till sediments are sensitive to natural or man made disturbances which can have a long lasting negative effect on channel stability, water quality and stream ecology.

Stream Management Implications

The inclusion of geology in stream management consideration for the Manor Kill generally falls into four categories: fluvial erosion; hill slope erosion; water quality; and sediment supply.

Fluvial Erosion

There are different types or "styles" of stream bank erosion associated with the different geologic units the stream encounters. The prediction, prevention and/or treatment of the eroding stream bank must factor in the stream bank material composition and the underlying mechanism of failure. Observations made during this planning process and previous similar projects throughout the watershed indicate the following:

- Pro-glacial lake sediment erodes easily during storm events once exposed; however, if the "soft" silt and clay unit is overlain by coarser fluvial sediment (sand-boulder sized material) it is typically a short-lived exposure and the stream bank tends to get armored by the draping of the coarser sediment.
- Pro-glacial lake deposits that are undisturbed are much more resistant to erosion than those that have had their physical and chemical bonds weakened by mechanical action (including abrasion and displacement from hill slope failures).
- Glacial till tends to erode either as (a) mass slumping from saturated conditions or (b) translational fracture-bound failures forming high steep banks
- Coarse-grained, non-cohesive fluvial sediment will erode easily if not protected by dense roots or revetment.

Hill Slope Erosion

The mass wasting, or geotechnical failure of the valley hill sides when proximal to stream channels can result in chronic and excess fine and coarse sediment supply. This is a relatively common problem in the tributary valleys. Sediment entrainment occurs as a result of exposed glacial till or disturbed lake deposits to flood flows. In extreme situations, debris flows from these failures may block or cause the stream channel to adjust its planform. If the adjacent hill slope erosion is from a geotechnical failure in glacial till or pro-glacial lake sediment *and* the stream is actively eroding into the toe of the hill slope the problem is perpetuated by constantly activating the failure. Stream restoration or road construction/repair in these settings must first address whether the geotechnical failure can be resolved before dealing with the stream channel stabilization. Future construction or development activities in the Manor Kill tributary valleys should include geotechnical investigations and slope stability analyses to ensure that the proposed actions do not contribute to new slope failures or exacerbate existing failures.

Water Quality

The “muddy” or turbid water that follows a storm event carries the fine silt and clay particles initially deposited as glacial till or pro-glacial lake sediment. Fluvial and hill slope erosion of these fine sediment sources, along with re-suspension of fine sediment deposited in the stream bed are the primary cause of the turbid water conditions. The fact that the glacial till and glacial lake sediment is widely distributed throughout most of the watershed suggests that effective removal of the stream from contacting this material is impractical to consider. High levels of suspended sediment and associated turbidity have been and will be an ongoing water quality condition in the Manor Kill watershed, though not to the same degree as the Upper Schoharie or Upper Esopus Creek watersheds.

Sediment Supply

The mantle of glacial deposits over the landscape is the primary source material for all the coarse and fine sediment that the stream system conveys. At any given time along any given reach of stream most of the sediment observed has been in the stream system for a “long time.” However, it is important to determine where sediment recruitment takes place. Unanswered questions remain: why is there less turbidity in the Manor Kill than in other Catskill watershed systems? Are there localized sources in the watershed that lead to localized aggradation?

Recommendations

The following recommendations are presented as an initial scope for further investigation and development of products to improve the Manor Kill Stream Management Plan:

- Work with research and/or academic institutions to better characterize the lateral and vertical distribution of glacial deposits that influence stream channel condition and water quality.
- Continue to monitor previously mapped fine sediment sources along the Manor Kill, and implement a program to identify "new" exposures. The aim of this effort is to better characterize the temporal nature of fine sediment exposures and their contribution to water quality problems in the basin.
- Using (1) georeferenced data obtained during the Phase 2 geomorphic investigation, (2) available soils map and (3) further reconnaissance mapping develop a stream channel geologic map for the Manor Kill and its tributaries.
- Extend stream channel geologic and fine sediment source mapping into all tributary valleys not previously assessed, and include more detail on the tributaries so that the relative contribution of sediments from these sources can be determined and the potential benefits of management actions in the tributaries better elucidated.
- Support an investigation of the geotechnical and hydrogeologic processes controlling coupled hill slope and stream bank erosion in order to evaluate management feasibility.
- Develop a document that informs stream managers how to use this information when designing and implementing stream stabilization projects in the region.

References

Catskill Center, 2001. Catskill Communities: GIS Atlas. Catskill Center for Conservation and Development, Arkville, NY. Avalable on web: http://www.catskillcenter.org/atlas/geomorphology/geo_5_surficial.htm.

CCEUC. 2007. Upper Esopus Creek Management Plan. Cornell Cooperative Extension of Ulster County, Kingston, NY.

Dineen, R.J. 1986. Deglaciation of the Hudson valley between Hyde Park and Albany, NY in The Wisconsinan Stage of the First Geological District, Eastern New York, ed.

Fisher, D.W., Y.W. Isachsen, and L.V. Rickard. 1970. Geologic Map of New York State: Hudson-Mohawk Sheet. NYS Museum.

GCSWCD, 2003. Batavia Kill Stream Management Plan. Greene County Soil and Water Conservation District, Cairo, NY.

GCSWCD, 2004. The Stony Clove Stream Management Plan. Greene County Soil and Water Conservation District, Cairo, NY.

GCSWCD, 2005. West Kill Stream Management Plan. Greene County Soil and Water Conservation District, Cairo, NY.

GCSWCD, 2007. Schoharie Creek Management Plan. Greene County Soil and Water Conservation District, Cairo, NY.

GCSWCD, 2003. East Kill Management Plan. Greene County Soil and Water Conservation District, Cairo, NY.

Isachsen, Y.W. et al., editors. 2000. Geology of New York: A simplified account, 2nd ed. NYS Museum Educational Leaflet 28: 294 p.

Rich, J.L. 1935. Glacial geology of the Catskills. NYS Museum Bulletin 299, 180 p.

Rubin, P. 1996. Geologic Mapping of Sediment Sources. Draft NYCDEP memorandum.

Schneiderman, J.S. 2003. The Earth Around Us: Maintaining a Livable Planet. Boulder: Westview Press.

Titus, R. 1998. The Catskills: A geological guide. Purple Mountain Press. Flesichmanns, NY.

2.6 Wetlands and Floodplains

Primarily authored by the Schoharie County Soil and Water Conservation District

Wetlands are lands that are wet part or most of the year and include swamps, bogs, fens, salt marshes, and mangrove swamps. The land along rivers can also be classified as wetlands if they are flooded part of the year. Wetlands provide productive fish and wildlife habitat, with many species of waterfowl living and breeding within them. Destroying these areas endangers fish and wildlife populations. Wetlands are also purifiers that trap sediment and other pollutants. They act as sponges as well, holding back rain waters and reducing flooding and increasing groundwater recharge (Chiras, 2002).

Today, half of all coastal and inland wetlands have been drained or filled. The greatest losses of wetlands have occurred in California (91%), Ohio (90%), and Iowa (89%). Fortunately, the loss of wetlands has slowed dramatically in recent years. New laws prohibit further draining and filling. The federal government requires losses to be mitigated. That is, if wetlands must be lost due to development, steps must be taken to create new wetlands or prevent losses elsewhere.

Despite these changes, wetlands continue to be lost to development. Losses are particularly high in less developed nations, but the United States and Canada still experience unacceptably high losses. Further wetland drainage here or abroad must be viewed with caution. The impacts on wildlife and fish, stream flow, and water quality often far outweigh the benefits realized by converting them to other uses (Chiras, 2002).

Although wetlands serve a vital function to stream health by filtering out excess nutrients, they should not be considered the end all to assure optimum water quality. We must also make efforts to reduce the inputs of potential pollutants such as nitrogen, phosphorus, and other ubiquitous pollutants. The notion that BMPs, created wetlands, and other after-the-fact approaches will alone be sufficient is not supported by science or common sense (Cretaz, 2007).

Federally Designated Wetlands

The National Wetlands Inventory (NWI) of the U.S. Fish & Wildlife Service produces information on the characteristics, extent, and status of the Nation's wetlands and deepwater habitats (USFWS, 2006). According to the NWI maps there are at least 170 federally designated wetlands within the Manor Kill watershed totaling ~267.3 acres (Figure 2.6.1). Wetland types in the Manor Kill include Palustrine (97%) and Riverine (3%). The palustrine wetland system includes all nontidal wetlands dominated by trees, shrubs, emergent's, mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean derived salts is below 0.5 ppt. Wetlands lacking such vegetation are also included if they exhibit all of the following characteristics: are less than 8 hectares (20 acres); do not have an active wave-formed or bedrock shoreline feature; have at low water depth less than 2 meters (6.6 feet) in the deepest part of the basin; and have a salinity due to ocean-derived salts of less than 0.5 ppt.

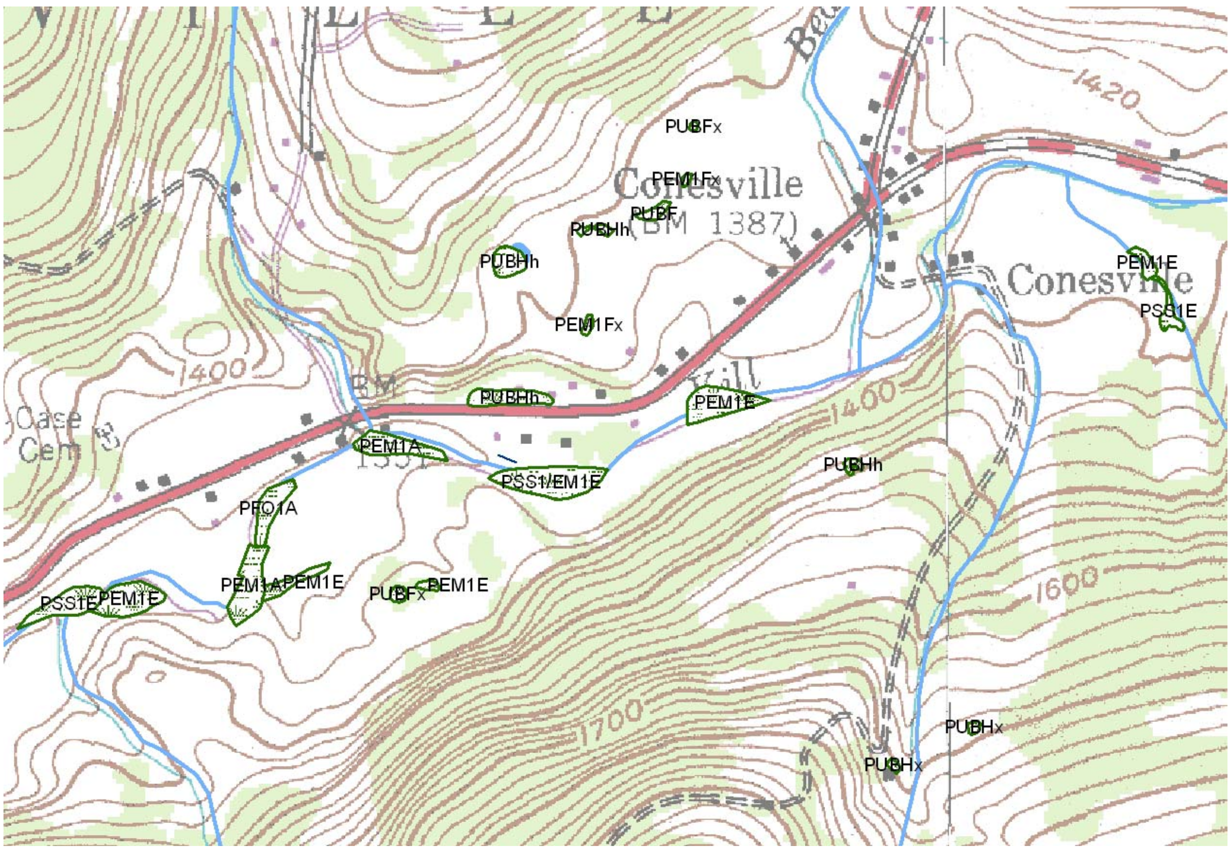


Figure 2.6.1. Example of Federally mapped wetlands around Conesville town center.

The riverine system includes all wetlands and deep water habitats contained in natural or artificial channels periodically, or continuously containing flowing water that forms a connecting link between the two bodies of standing water. Upland islands or palustrine wetlands may occur in the channel, but they are not part of the riverine System. Upland systems include all areas not defined as wetland or deep water habitats (USFWS1, 2006).

Currently the dominant wetland type in the Manor Kill watershed is Palustrine, Emergent (35%) (Table 2.6.1). Palustrine wetlands are vegetated wetlands including the small, shallow, permanent or intermittent water bodies often called ponds. Palustrine wetlands may be situated shoreward of lakes, river channels, or estuaries; on river floodplains; in isolated catchments; or on slopes. They may also occur as islands in lakes or rivers. Palustrine forested wetlands are characterized by woody vegetation that is 6 meters tall or taller. Palustrine emergent wetlands are characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens. This vegetation is present for most of the growing season in most years, and the wetlands are usually dominated by perennial plants. Palustrine unconsolidated bottom wetlands includes all wetlands and deep water habitats with at least 25% cover of particles smaller than stones (less than 6-7 cm), and a vegetative cover less than 30%. Riverine wetlands are confined within a channel and lack persistent emergent or woody vegetation. Riverine lower perennial wetlands have low velocity flows and fine substrates (USFWS1, 2006).

Table 2.6.1. National Wetland Inventory Classifications within the Manor Kill

NWI Code	NWI Wetland Classification	Acres	Percent of Total
PEM	Palustrine, Emergent	93.04	35%
PFO	Palustrine, Forested	49.62	19%
PSS	Palustrine, Scrub-Shrub	65.82	25%
PUB	Palustrine, Unconsolidated Bottom	48.73	18%
R2	Riverine, Lower Perennial	10.09	3%
	Total	267.3	100%

Federally designated wetlands are protected under the Clean Water Act, a 1977 amendment to the Federal Water Pollution Control Act of 1972, which set the basic structure for regulating discharges of pollutants to waters of the United States (USEPA, 2003). Section 404 of the Clean Water Act established a program to regulate the discharge of dredged and fill materials into waters of the United States, including wetlands. Activities in waters of the United States that are regulated under this program include fills for development, water resource projects (such as dams and levees), infrastructure development (such as highways and airports), and conversion of wetlands to uplands for farming and forestry (USEPA1, 2003).

New York State Designated Wetlands

The Freshwater Wetlands Act (FWA), Article 24 of the Environmental Conservation Law, provides NYS DEC and the Adirondack Park Agency (APA) with the authority to regulate freshwater wetlands in the state. The NYS Legislature passed the Freshwater Wetlands Act in 1975 in response to uncontrolled losses of wetlands and problems resulting from those losses, such as increased flooding. The FWA contains the following Declaration of Policy:

"It is declared to be the public policy of the state to preserve, protect and conserve freshwater wetlands and the benefits derived there from, to prevent the despoliation and destruction of freshwater wetlands, and to regulate use and development of such wetlands to secure the natural benefits of freshwater wetland, consistent with the general welfare and beneficial economic, social, and agricultural development of the state (ECL Article 24-0103)."

The FWA protects those wetlands larger than 12.4 acres (5 hectares) in size, and certain smaller wetlands of unusual local importance. The law requires DEC and APA to map those wetlands that are protected by the FWA. In addition, the law requires DEC and APA to classify wetlands. Outside the Adirondack Park, DEC classifies wetlands according to 6NYCRR Part 664, Wetlands Mapping and Classification Regulations from Class 1, wetlands which provide the most benefits, to Class IV, wetlands which provide the fewest benefits. Around every regulated wetland is a regulated adjacent area of 100 feet, which serves as a buffer area for the wetland from adjacent land uses (NYS DEC, 2003).

According to DEC maps, there are nine NYS DEC designated wetlands in the Manor Kill watershed covering 152.2 acres. Of these wetlands, 44.4% are Class 2, 44.4% are Class 3, and 11.1% are Class 4. Most of these wetlands reside in the town of Conesville.

Both Federal and NYS Designated Wetlands maps are available at County Soil & Water Conservation District Offices. It must be cautioned that these maps should only be used as guidance of wetland locations and boundaries. It is the responsibility of property owners to determine if wetland areas will be disturbed by proposed projects. Smaller wetlands which meet federal criteria may not have been mapped but are still protected by federal regulations. The NYS DEC offers wetland delineation services to landowners when they need more precise information, such as when they are planning to conduct work near a NYSDEC designated wetland area.

Floodplains

Floodplains are low lying areas along a stream that are subject to periodic flooding. Floodplains are formed by a river or stream, in the present climate, and receive water overflow whenever water level exceeds the tops of the banks, or bankfull discharge. Unfortunately, however, floodplains have been taken over by humans. The flatness of the land, their natural beauty, and the availability of the river/stream has attracted people since the beginning of time. Today more than 2,000 cities in the United States are located at least partially, on floodplains. Most of these cities experience flooding every 2 to 3 years. The U.S. Army Corps of Engineers, the Bureau of Reclamation, and the SCS have spent more than $15 billion on structural flood control projects (dams, levees, sea walls, etc.) since 1925. However, despite this enormous expenditure of tax money, property damage from flooding continues to rise. Annual costs increase considerably, from $3 billion in the early 1980s to more than $10 billion by 2000. More and more experts now believe that nonstructural flood controls like watershed protection and flood plain zoning are the most effective and economical strategies (Chiras 2002).

A floodplain is streamside land that gets periodically inundated by floodwaters. Floodplains are important because they temporarily store floodwaters, improve water quality, and provide important habitat for wildlife. Natural floodplains help reduce the heights of floods. During periods of high water, floodplains serve as natural sponges, storing and slowly releasing floodwaters. The floodplain provides additional "storage," reducing the velocity of the river and increasing the capacity of the river channel to move floodwaters downstream. Natural floodplains also help improve water quality. As water courses through the floodplain, plants serve as natural filters, trapping sediments and capturing pollutants (American Rivers, 2003)

One of the largest problems facing floodplain management is the disconnection of a stream from its floodplain. Management practices such as channelization, straightening, development, and loss of riparian vegetation may lead to stream channel incision or downcutting. As the stream incises it will lower the streambed elevation, no longer allowing floodwaters to spill out onto the floodplain. As a result flood velocity will increase causing stream bank degradation until a new floodplain is created at the lower streambed elevation. Building homes within the floodplain is incompatible with proper floodplain function. Many people want to live by streams but as they develop the floodplain, they often increase stream degradation by undertaking stream management activities to protect their property from flooding.

The Federal Emergency Management Agency (FEMA) performs hydrologic and hydraulic studies to produce Flood Insurance Rate Maps (FIRM), which identify flood-prone areas (FEMA, 2003). These studies analyze the data from local streamflow gages to predict how frequently different floods will occur, and to determine the magnitude of the benchmark “100-year flood”. This is the flow that has a statistical probability of recurring once every 100 years, but because it is a statistical prediction, based on historical record, “100-year floods” could be seen more or less frequently than every hundred years, especially if changes in climate or land use occur. An engineering model is then used to map the predicted boundaries of the 100-year flood on the floodplain. Towns then use these maps to help determine areas where the risk of flooding is high enough to warrant special precautions or review of land development. Towns are required to pass a floodplain protection ordinance that sets certain limits on building in the 100 year floodplain in order to participate in the National Flood Insurance Program.

Digital Flood Mapping Project

The NYSDEC Bureau of Program Resources and Flood Protection has developed new digitized floodplain maps, using topographic information derived from an airborne laser imaging technology called LIDAR (Light Detection and Ranging). LIDAR data, together with updated computer HEC models and digital aerial photography, enable engineers to produce extremely detailed and accurate maps. Modeling with this new data allows for flood contour lines indicating various depths of water under 100-year and other flood conditions. FEMA's new hardcopy Flood Insurance Rate Maps (FIRMs) are a vast improvement over their predecessors. One of the most obvious improvements is the inclusion of base map imagery utilizing the 2004 orthoimagery from New York's statewide orthoimagery program. A New York State Floodplain Management Map (NYSFMM) series has also been developed to provide floodplain managers, municipal planners, and other professionals with a tool for mitigation and planning. In addition to the information found on a FIRM, the NYSFMMs also contain department-set survey reference marks and flood depth contours (NYS DEC, 2006).

The new FIRM hardcopy maps are available for viewing at County Soil & Water Conservation District Offices and most town halls (Figure 2.6.2). Using GIS mapping software, Schoharie County Soil & Water Conservation District (SWCD) is able to overlay tax parcel boundaries with digital floodplain boundaries to asses if a property falls within a flood zone. This service is available to all interested. Floodplain maps of each management unit can be found in Section 4, Management Unit Summary and Recommendations.

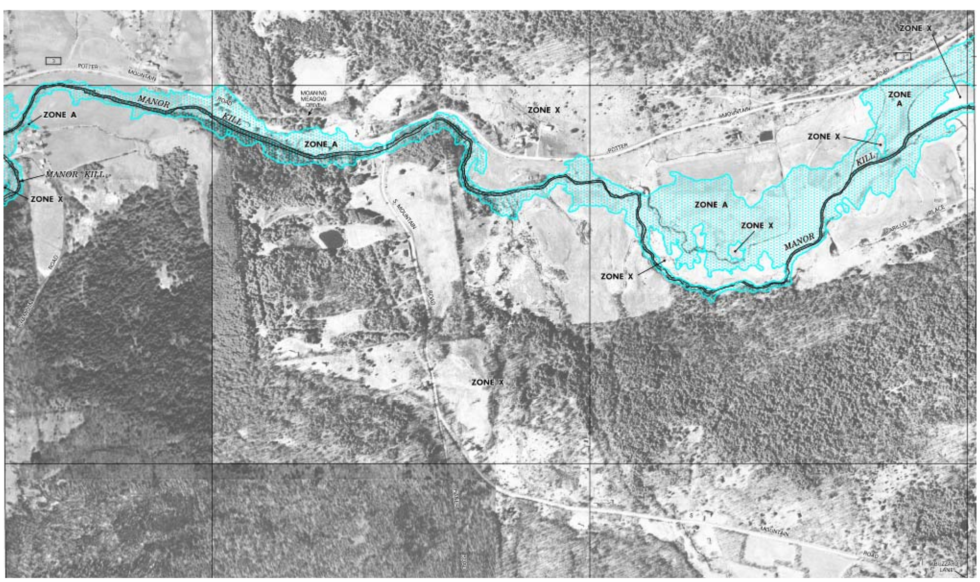


Figure 2.6.2. FIRM Map of Manor Kill Illustrating Areas at risk in 100 year flood event

References

American Rivers. 2003. The value of floods and floodplains. Available of web: http://www.amrivers.org/index.php?module=HyperContent&func=display&cid=1823.

Chiras, Daniel D., Reganold, J.P., Owen, O.S. 2002. Natural Resource Conservation, Management for a Sustainable Future, Prentice Hall.

Cretaz, Avril L., Barton, Paul K., 2007. Land Use Effects on Streamflow and Water Quality in the Northeastern United States. CRC Press.

FEMA. 2003. FEMA, Map Service Center. Federal Emergency Management Agency. Available on web: www.msc.fema.gov/prodover.shml.

NYSDEC. 2003. Programs to Conserve Wetlands. Available on web http://www.dec.state.ny.us/website/dfwmr/habitat/fwwprog4.htm.

NYSDEC. 2006. NYS DEC Floodplain Mapping Program Overview. Available of web: http://www.dec.state.ny.us/website/dow/wgit/fpm/index.html.

USEPA, 2003. Wetland Laws of the United States. United States Environmental Protection Agency, Washington, D.C. Available on web: http://www.epa.gov/owow/wetlands/laws/

USEPA1, 2003. Section 404 of the Clean Water Act: An Overview. United States Environmental Protection Agency, Washington, D.C. Available on web: http://www.epa.gov/owow/wetlands/facts/fact10.html.

USFWS. 2006. Information about National Wetland Inventory. US Fish & Wildlife Service, Division of Habitat and Resources Conservation, Arlington, VA. Available on web: http://www.nwi.fws.gov/aboutus.htm.

USFWS1. 2006. Wetlands and Deepwater Habitats Classification National Wetlands Inventory Mapping Code Description. US Fish & Wildlife Service, Division of Habitat and Resources Conservation, Arlington, VA. Available on web: http://wetlandsfws.er.usgs.gov/NWI/webatx/atx.html.

2.7 Riparian Vegetation Issues in Stream Management

General Concepts of Riparian Vegetation Ecology and Management

The Role of Vegetation in Maintaining a Healthy Stream

Although people value trees and plants along a stream for their contribution to the beauty of the streamside landscape, the vegetation in a watershed, especially in the *riparian* area, plays a critical role in providing for a healthy stream system. The riparian, or streamside, plant community serves to maintain the riverine landscape and moderate conditions within the aquatic ecosystem.

As rainfall runs off the landscape, riparian vegetation:

- Slows the rate of runoff
- Captures excess nutrients carried from the land
- Protects stream banks and floodplains from the erosive force of water
- Regulates water temperature changes

It also:

- Provides food and cover to terrestrial and aquatic fauna
- Conserves soil moisture, ground water and atmospheric humidity

Vegetation's Erosion and Pollution Prevention Capabilities

Riparian vegetation serves as a buffer for the stream against activities on upland areas. Most human activities whether agriculture, development, or even recreation, can result in a disturbance or *discharge* which can negatively impact the unprotected stream. Riparian vegetation captures and stores pollutants in overland flow from upland sources such as salts from roadways and excess fertilizer from lawns and cropland. The width, density, and structure of the riparian vegetation community are important characteristics of the buffer that can be used to define the level of its functionality.

On bare soils, high stream flows can result in bank erosion and overbank flow can cause soil erosion and scour on the floodplain. The roots of vegetation along the bank hold the soil and shield against erosive flows. On the floodplain, vegetation slows flood flows, reducing the energy of water. This reduction in energy will decrease the ability of water to cause erosion and scour. Furthermore, as vegetation slows the water, the soil suspended in the water is deposited on the floodplain.

Vegetation's Hydrologic Influences

Vegetation intercepts rainfall and slows runoff. This delay increases the amount of precipitation that infiltrates the soil and reduces overland runoff. A reduction and delay in runoff decreases the occurrence of destructive flash floods, lowers the height of flood waters, and extends the duration of the runoff event. These benefits are generally most readily observed in forested watersheds as opposed areas that have been deforested (Figure 2.7.1). The reduction in flood stage and duration typically means fewer disturbances to stream banks and floodplains.

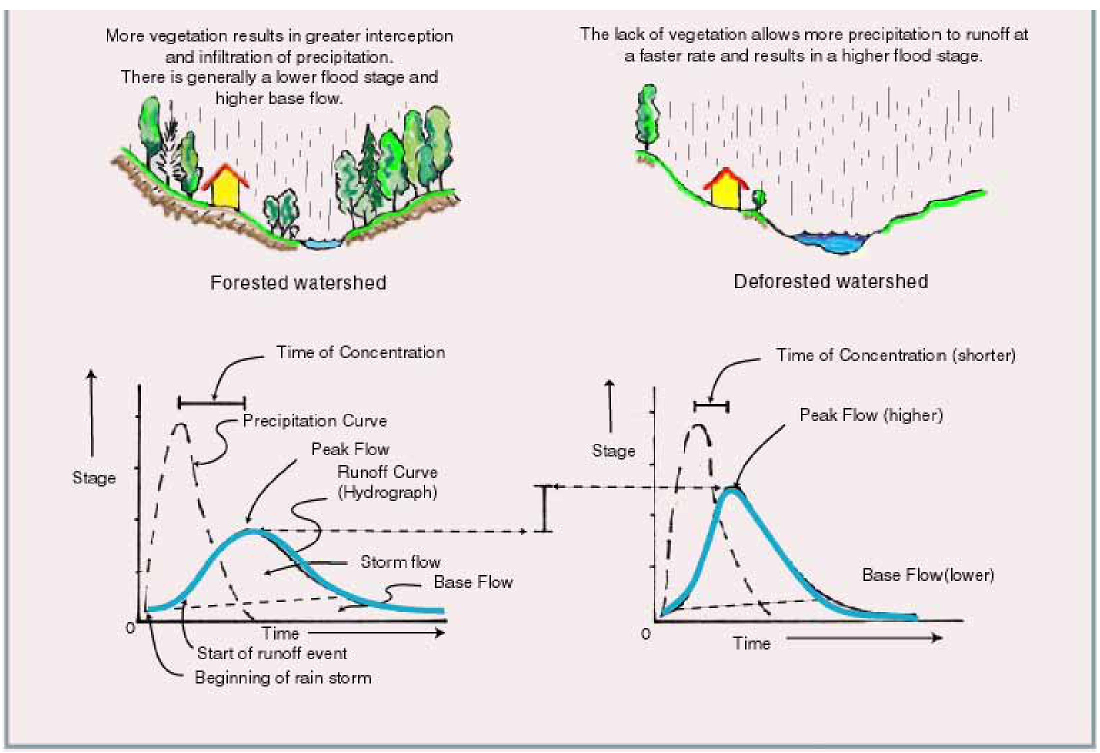


Figure 2.7.1. Comparison of Runoff on a Forested Watershed Versus a Deforested Watershed. Illustration by P. Eskeli 2002, from Watershed Hydrology, P.E. Black, 1991, Prentice Hall, page 202, 214.

Ecological Importance of Vegetation in the Riparian Zone

Vegetation along a stream also functions to provide the climate, habitat and nutrients necessary for aquatic and terrestrial wildlife. Trees shading a stream help maintain cool water temperatures needed by native fish populations. Low hanging tree branches and roots on undercut banks create cover for fish from predators such as birds and raccoons. Natural additions of organic leaf and woody material provide a food resource needed by terrestrial insects and aquatic macroinvertebrates (stoneflies, mayflies, etc.), the primary source of food for fish. Terrestrial wildlife depends upon vegetation for cover as they move from the upland community to the water's edge. A diverse plant community, one similar to the native vegetation of the Manor Kill, provides a wide range of conditions and materials needed to support a diverse community of wildlife. If the vegetation is continuous within the riparian zone along the length of a stream, a corridor is available for wildlife migration. Connectivity between the riparian and upland plant communities enhances the ability of upland and riparian plant and animal communities to thrive despite natural or human induced stress on either community.

Characteristics of a Healthy Riparian Plant Community

A healthy riparian plant community should be diverse. It should have a wide variety of plants including trees, shrubs, grasses or herbs (Figure 2.7.2). The age of the plants should be varied and there should be sufficient regeneration of new plants to ensure the future of the

Diverse Plant Types
(trees, shrubs, grasses, herbs)
+
Diverse Plant Ages
(young and old)
+
Disturbance-adapted, Moisture-loving Plants
(accustomed to flooding & ice floes)

=

Healthy Riparian Buffers

Figure 2.7.2. A healthy riparian community is densely vegetated, has a diverse age structure and is composed of plants that can resist disturbance.

community. A diverse community provides a multitude of resources and the ability to resist or recover from disturbance. An important difference between an upland plant community and a riparian community is that the riparian community must be adapted to frequent disturbance from flooding. Consequently, many riparian plants, such as willow, alder, or poplar can re-grow from stump sprouts or can reestablish their root system if up-ended. Furthermore, the seed of these trees may have a greater ability to germinate and establish in depositional areas, such as gravel bars and lower flood benches.

Riparian Vegetation of the Manor Kill

Forest History and Composition of the Manor Kill

Catskill mountain forests have evolved since the ice age reflecting the changes in climate, competition and human land use. The first of these changes was the result of the climatic warming that occurred after the ice age which enabled warm climate adapted plant communities to replace the cooler climate communities. Following the retreat of the glaciers, the forests of the Manor Kill basin gradually re-established and evolved from the boreal spruce/fir dominated forests, (examples of which can presently be found in Canada) to the maple-beech-birch northern hardwood forests (typical of the Adirondacks and northern New England) with the final transition of the lower elevations of the watershed to a southern hardwood forest dominated by oaks, hickory and ash (typical of the northern Appalachians). Dr. Michael Kudish provides an excellent documentation of evolution and site requirements of the region's forests in his book, The Catskill Forest: A History (Kurdish, 2000).

More recently, human activities have affected the forest either through the manipulation of regeneration for the maintenance of desirable species, the exploitation of the forest for wood and wood products or through development. Native American land management practices included the use of prescribed burning as a means of enabling the nut bearing oaks and hickories to remain dominant in the forest. European settlers contributing to the rising industrial economy in the 18^{th} and 19^{th} century greatly altered the landscape and forest cover through land clearing for agriculture, forest harvesting for construction materials, and hemlock bark harvesting for the extraction of tannin. Please refer to individual Management Unit descriptions for more detailed information about past activities that affected the streamside and floodplain vegetation.

Previous land uses have had a significant role in determining the types of vegetation found along the stream. Due to the steepness of the sides of the valley, the most intensive development activities were confined to the valley floor along the stream. Pastures and fields were created from cleared, forested floodplains. Abandoned old fields have experienced a consistent pattern of recovery, with species dominating the initial re-growth including sumac, dogwoods, aspens, hawthorns, and white pine. These species are succeeded by other light-loving hardwood tree species such as ash, basswood and elm or in lower parts of the watershed, hickories, butternut, and oak. Hemlocks are largely confined to the steeper stream banks and slopes where cultivation or harvesting of hemlocks for bark was impossible. More recent housing construction has re-intensified activity along the stream and been accompanied by the introduction of non-native vegetation typical of household lawns and gardens. While today the Manor Kill watershed is predominately forested (figure 2.7.3), agriculture and development activities are still concentrated along the valley floor, leaving the riparian area predominately herbaceous.

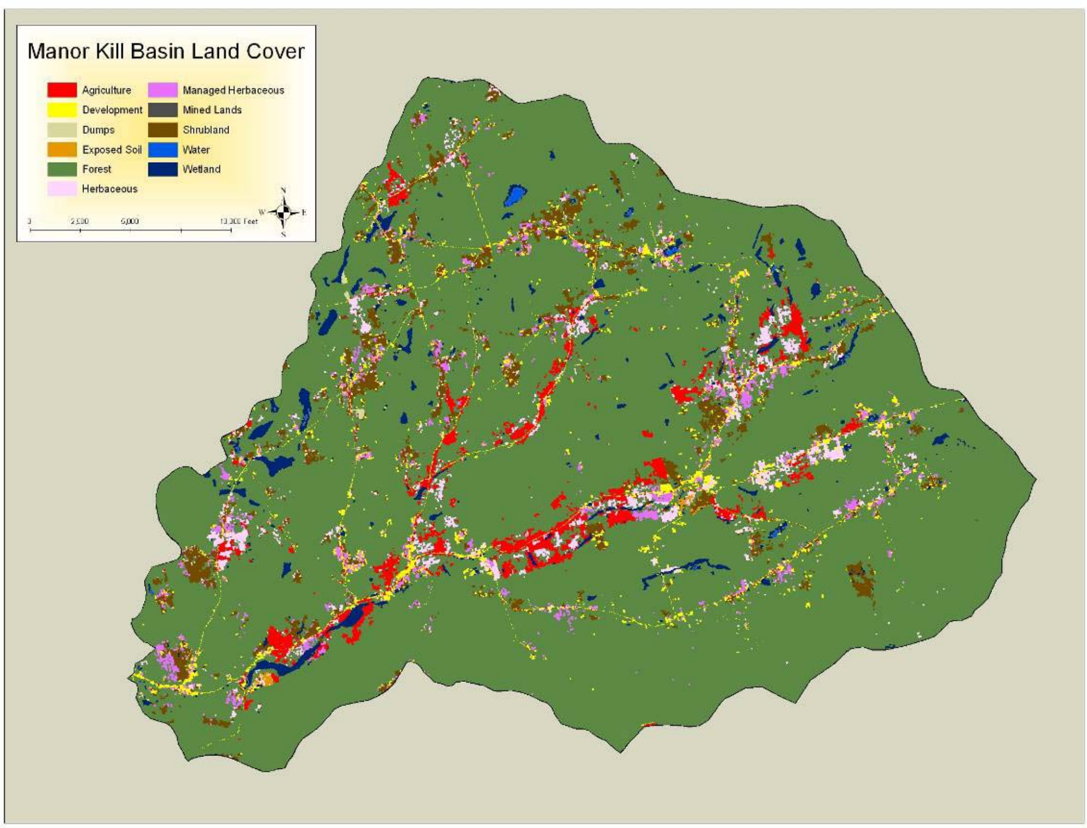


Figure 2.7.3 Manor Kill Basin Land Cover. The majority of land cover is forested (green), however agriculture (red) and herbaceous areas (pink) dominate stream corridors.

The Riparian Forest

Typically, a riparian forest community is composed of those plant species that thrive in a wet or moist location and have the ability to resist or recover from disturbance. Generally, the riparian forest community is more extensive where a floodplain or wetland exists and the side slopes to the valley are more gently sloping. The plant associations found in forested floodplain communities may be exclusive to riparian areas. Where the valley side slopes are steeper, the riparian community may occupy only a narrow corridor along the stream and then quickly transition to an upland forest community. From a vegetation assessment in a nearby watershed, it was found that northern hardwood communities on steep slopes adjacent to the stream contained a mix of ash, poplar, elm, beech, yellow birch and some maple, whereas in upland northern hardwood communities, the yellow birch and maple became the dominant species. Soils, ground water and solar aspect may create conditions that allow the riparian forest species to occupy steeper slopes along the stream, as in the case where hemlock inhabits the steep, northfacing slopes along the watercourse.

Natural Disturbance and its Effects on the Riparian Vegetation

Riparian vegetation is disturbed by the forces of nature and development activities of those who live near the stream. Sources of natural disturbance include damage due to floods, ice floes, and to a lesser extent, high winds, pest and disease epidemics, drought and fire. Deer herds can also alter the composition and structure of the vegetation due to their specific browse preferences.

Flood events have created and reopened numerous high flow channels, reworked point bars, scoured floodplains and eroded formerly vegetated streambanks in the Manor Kill. Immediately following these events, the channel and floodplains were scattered with woody debris and downed live trees. In the years since, much of the vegetation has recovered. Trees and shrubs flattened by the force of floodwaters have re-established their form. Gravel bars and sites disturbed in previous flood events became the seedbed for herbs and grasses. This type of natural regeneration is possible where the stream is stable and major flood events occur with sufficient interval to allow establishment. The effect of flood disturbance on vegetation along stable stream reaches is short term and the recovery/disturbance regime can be cyclical. If the disturbance of floods and ice are too frequent, large trees will not have the opportunity to establish. Typically, the limit that trees can encroach upon the channel is defined by the area disturbed by the runoff event that achieves bankfull flow (expected to occur on average every 1.3 years). While shrubs such as willow and alder or herbaceous plants such as sedges, which reestablish themselves quickly after disturbance, can grow in the bankfull channel, it is unadvisable to plant trees in this channel area.

Local geology and stream *geomorphology* may complicate the recovery process. A number of sites were found in the Manor Kill where vegetation has not been able to reestablish itself on the high, steep bank failures created during recent flood events. On these sites it will be necessary to understand the cause of the failure before deciding on whether to attempt planting vegetation to aid in site recovery. In these instances, the hydraulics of the flowing water, the morphological evolution of the stream channel, the geology of the stream bank, and the requirements and capabilities of the vegetation must be considered before attempting restoration. Since the geologic setting on these sites is partially responsible for the disturbance, the period required for natural recovery of the site would be expected to be significantly longer unless facilitated by restoration efforts.

The ice break up in the spring, like floods, can damage the established vegetation along the stream banks and increase mortality of the young tree and shrub regeneration. Furthermore, ice floes can cause channel blockages which result in erosion and scour associated with high flow channels and overbank flow. Typically this type of disturbance also has a short recovery period.

Pests and diseases that attack vegetation can also affect changes in the ecology of the riparian area and could be considered a disturbance. The hemlock woolly adelgid (*Adelges tsugae*) is an insect, which feeds on the sap of hemlocks (*Tsuga spp*.) at the base of the needles causing them to desiccate and the tree to take on a grayish color. Stress caused by this feeding can kill the tree in as little as 4 years or take up to 10 years where conditions enable the tree to tolerate the attack (McClure, 2001). This native insect of

Hemlock woolly adelgid on the underside of a branch.

Japan was first found in the U.S. in Virginia in 1951 and has spread northward into the Catskills (Adams, 2002).

In the eastern United States, the adelgid attacks eastern hemlock (*Tsuga canadensis*) and Carolina hemlock (*Tsuga carolinianna* Engelman) and can affect entire stands of hemlock. Once a tree is infested, population trends for the insect are typified by a fluctuating density of the insect with some hemlock re-growth occurring in periods when population densities are lower. This re-growth is stunted and later attacked as the adelgid population increases. With each successive attack tree reserves become depleted and eventually re-growth does not occur. The native predators of hemlock woolly adelgid have not offered a sufficient biological control, but recent efforts to combat the insect include experimentation with an Asian lady beetle (*Pseudoscymnus tsugae* Sasaji) which is known to feed on the adelgid. Initial experimental results have been positive, but large-scale control has yet to be attempted. The US Forest Service provides extensive information about this pest at its Northeastern Area "forest health protection" webpage: www.na.fs.fed.us.

With respect to stream management, the loss of hemlocks along the banks of the Manor Kill poses a threat to bank stability and the aquatic habitat of the stream. Wildlife, such as deer and birds, find the dense hemlock cover to be an excellent shelter from weather extremes. Finally, dark green hemlock groves along the stream are quiet, peaceful places that are greatly valued by the people who live along the Manor Kill. The Olive Natural Heritage Society, Inc. is monitoring the advance of the hemlock woolly adelgid in the Catskills and is working in cooperation with NYS DEC on testing releases of *Pseudosymnus tsugae*. Initial results of the monitoring suggested a possible link between the presence of hemlock woolly adelgid on a site and the degree to which people use or access the site. Due to the widespread nature of the infestation, the use of chemical pest control options such as dormant oil would most likely provide little more than temporary, localized, control. The use of pesticides to control adelgid is not recommended in the riparian area due to potential impacts on water quality and aquatic life.

Without a major intervention (as yet unplanned), it is likely that the process of gradual infestation and demise of local hemlock stands by woolly adelgid will follow the patterns observed in areas already affected to the south. Reports from Southern Connecticut describe the re-colonization of hemlock sites by black birch, red maple and oak (Orwig, 2001). This transition from a dark, cool, sheltered coniferous stand to open hardwood cover is likely to raise soil temperatures and reduce soil moisture for sites where hemlocks currently dominate vegetative cover. Likewise, in the streams, water temperatures are likely to increase and the presence of thermal refuge for cool water loving fish such as trout are likely to diminish. Alternatives for maintaining coniferous cover on hemlock sites include the planting of adelgid resistant conifers such as white pine as the hemlock dies out in the stand (Ward, 2001).

Human Disturbance and its Effects on the Riparian Vegetation

Although natural events disrupt growth and succession of riparian vegetation, human activities frequently transform the environment and, as a result, can have a long lasting impact on the capability of vegetation to survive and function. Presently, the most significant sources of human disturbance on riparian vegetation along the Manor Kill includes the construction and maintenance of roadway infrastructure, the maintenance of utility lines, the maintenance of agricultural fields, and the development of homes and gardens near the stream and its floodplain.

Roadway and Utility Line Influences on Riparian Vegetation

Due to the narrow valley and steepness of the valley walls, the alignment of Potter Hollow Mountain Road closely follows portions of the Manor Kill's stream alignment. Use and maintenance of the road right-of-way impacts the vigor of riparian vegetation. The narrow buffer of land between the creek and the road receives the runoff of salt, gravel, and chemicals from the road that stunt vegetation growth or increase its mortality. Road maintenance activities also regularly disturb the soil along the shoulder and on the road cut banks. This disturbance fosters the establishment of undesirable invasive plants. The linear gap in the canopy created by the roadway separates the riparian vegetation from the upland plant communities. This opening also allows light into the vegetative understory which may preclude the establishment of shade loving plants such as black cherry and hemlock.

Utility lines parallel the roadway and cross the stream at various points requiring the utility company to cut swaths through the riparian vegetation at each crossing, further fragmenting essential beltways for animal movement from streamside to upland areas. Although the road right-of-way and utility line sometimes overlap, at several locations along the stream, the right-of-way crosses through the riparian area separate from the road. This further reduces the vigor of riparian vegetation and prevents the vegetation from achieving the later stages of natural succession, typified by climax species such as sugar maple, beech and hemlock

Utility crossing.

Agricultural Influence on Riparian Vegetation

Agricultural land-use is often concentrated along the stream corridors due to the relatively flat, fertile landscape as well easy stream access for livestock. Often the native riparian trees and shrubs are replaced with herbaceous vegetation including pastures and hayfields; these fields being maintained to the edge of the streambank. Without the dense mat of roots under trees and shrubs to bind the soil together and without the woody material to reduce erosive forces, the rate of streambank erosion may be increased resulting in a loss of valuable topsoil. Additionally livestock, particularly cattle, favor riparian areas and will spend much time by the streambanks and in the water. The result is overgrazing that erodes bank soils. Trampling of riparian land during prolonged access by livestock results in soil compaction and physical damage to vegetation as well as allows for establishment of invasive plants.

Eroding bank along an agricultural field.

Planting a healthy riparian buffer with shrubs and trees and managing livestock access to the stream can help to stabilize streambanks while reducing water runoff and sedimentation, filtering nutrients from adjacent land uses and benefiting wildlife populations. Financial assistance is available to help protect environmentally sensitive land through programs such as the Conservation Reserve Enhancement Program (CREP) offered by the USDA's Farm Service Agency (FSA). CREP provides payments to participants who offer eligible land plus a cost-share of up to 50 percent of the eligible costs to install conservation practices. For more information on CREP or other conservation programs, contact you local FSA office or SCSWCD.

Residential Development Influence

Residential land use and development of new homes can have a great impact on the watershed and the ecology of the riparian area. Houses require access roads and utility lines that frequently have to cross the stream. Homeowners who love the stream and want to be close to it may clear trees and shrubs to provide access and views of the stream. Following this clearing, the stream bank begins to erode, the channel over-widens and shallows. The wide, shallow condition results in greater bedload deposition and increases stress on the unprotected bank. Eventually stream alignment may change and begin to cause erosion on the property of downstream landowners. Catskill stream banks require a mix of vegetation such as grasses and herbs that have a shallower rooting depth, shrubs with a medium root depth, and trees with deep roots. Grasses alone are insufficient to maintain bank stability in steeply sloping streams such as the Manor Kill.

Streamside development and limited riparian vegetation leads to compromised streambanks. This bank has been reinforced with riprap.

Many people live close to the stream and maintain access to the water without destabilizing the bank. By carefully selecting a route from the house to the water's edge and locating access points where the force of the water on the bank under high flow is lower, landowners can minimize disturbance to riparian vegetation and stream banks. Restricting access to foot traffic, minimizing disturbance in the flood prone area, and promoting a dense natural buffer provide property protection and a serene place that people and wildlife can enjoy. Additional information on concepts of streamside gardening and riparian buffers can be found at the following web site produced by the Connecticut River Joint Commission, Inc:

www.crjc.org/riparianbuffers.htm and www.catskillstreams.org. A list of native trees and shrubs "Native Trees for Riparian Buffers in the Upper Connecticut River Valley of New Hampshire and Vermont" developed by this group is provided in Appendix A. A list of native vegetation for the Catskill Mountain Region has been compiled using several sources, see Appendix A for this list or contact SCSWCD for more information.

Japanese Knotweed and Riparian Vegetation

Sometimes the attempt to beautify a home with new and different plants introduces a plant that spreads out of control and "invades" the native plant community. Invasive plants present a threat when they alter the ecology of the native plant community. This impact may extend to an alteration of the landscape should the invasive plant destabilize the geomorphology of the watershed (Malanson, 2002). The spread of Japanese knotweed (*Polygonum cuspidatum*), an exotic, invasive plant gaining a foothold in the Manor Kill, is an example of a plant capable of causing such a disruption. As its common name implies, Japanese knotweed's origins are in Asia, and it was brought to this county as an ornamental garden plant.

Japanese knotweed is quite recognizable throughout the year. The series of photographs in Figure 2.7.4 illustrate different stages of Japanese knotweed's growth throughout each season. This herbaceous, or non-woody, perennial goes through these

Figure 2.7.4. Stages of Japanese knotweed's growth throughout the growing season.

cycles every year. In the spring (generally late April, early May), new red, asparagus-like shoots sprout from last year's crown or from underground roots (*rhizomes*). By July, individual stems may reach 11 feet tall. Many thick, hollow stems are based at a crown.

The upper areas of the stems form a few branches that reach out like an umbrella from the crown. Each main stem and branch holds several large, nearly-triangular leaves. In August knotweed dons abundant clusters of small, white flowers that attract several pollinators, such as bees, wasps and Japanese beetles.

Knotweed seeds.

The numerous flowers turn into buckwheat-like seeds by late September, early October. Although some seeds may create small seedlings (Forman & Kesseli 2003), knotweed spreads more by their *rhizomes*.

Cold weather halts the growth of knotweed; once frost covers the land, knotweed drops its leaves and turns an auburn hue. These dead stems often remain standing for one or two years and then cover the ground, decaying slowly.


Knotweed following a frost.

The above ground portion dies back each fall and re-grows to a height of 6-9 feet tall each spring. The canopy of the dense stands of bamboo-like stalks, covered by large heart shaped leaves, blocks out almost all light from reaching the soil, thereby shading out other plants and leaving the soil bare.


Knotweed's leaf pattern.


Dense stand of knotweed.

Japanese knotweed spreads primarily by vegetative means. Often, earthmoving contractors, highway department crews or gardeners transfer small portions of the roots in fill or soil that gets dumped on or near a streambank. These roots then grow into a new plant that soon becomes a colony. Japanese knotweed is able to spread rapidly on disturbed sites and prefers the moist, open conditions of the stream edge and bank for colonization. Once knotweed has established itself in the riparian area, it is able to spread downstream after disturbances caused by beaver activity or by high flows scouring the streambank. Such disturbances often cause stems and rhizomes to break off and float downstream where fragments may establish themselves on streambanks that were previously unaffected by knotweed. Exposed streamside areas such as sediment deposits or disturbed banks with eroded soils lacking vegetation are particularly vulnerable to invasion by knotweed.

Although the impact of a Japanese knotweed invasion on the ecology of the riparian area is not fully understood, the traits of Japanese knotweed pose several concerns. Some of these concerns include:

- Knotweed appears to be less effective at stabilizing streambanks than deeper-rooted shrubs and trees, possibly resulting in more rapid bank erosion.
- The shade of its broad leaves and the cover by its dead litter limit the growth of native plants that provide food and shelter for associated native animals.
- Knotweed branches do not lean out over stream channels, providing little cooling from shade.
- Dead knotweed leaves (*detritus*) may alter food webs and impact the food supply for terrestrial and aquatic life.
- Large stands of knotweed impede access to waterways for fishing and streamside hiking.
- The presence of knotweed could reduce property value.
- Knotweed may alter the chemical make-up of the soil, altering soil microfauna and soil properties.

Japanese knotweed is very difficult to control. The broad use of herbicides, while potentially effective following a protocol of repeated treatments by a professional certified applicator, does present risks due to the threat the chemicals pose to water quality and the fragile aquatic ecosystem. Mechanical control, by cutting or pulling, is labor intensive and requires regular attention to remove any re-growth. Biological controls are untested. The first step for residents and those who manage land and infrastructure in the Manor Kill is to familiarize themselves with the appearance and habits of knotweed. Next, it is important for landowners and land managers to monitor its spread. Landowners should avoid practices that would destabilize the stream banks or weaken the natural riparian vegetation that can prevent its spread. Any fill material introduced to the riparian area should be tested for the presence of Japanese knotweed. Any Japanese knotweed roots pulled or dug up from your property should be disposed of in a manner that will prevent it from spreading or re-establishing itself.

Japanese knotweed colony along the Manor Kill.

During the 2008 stream feature inventory and assessment, the project team mapped the distribution of Japanese knotweed along the Manor Kill. During these mapping efforts, the size of a colony was estimated; however the map does not show the area covered by each colony, only the presence of a colony (Figure 2.7.5).

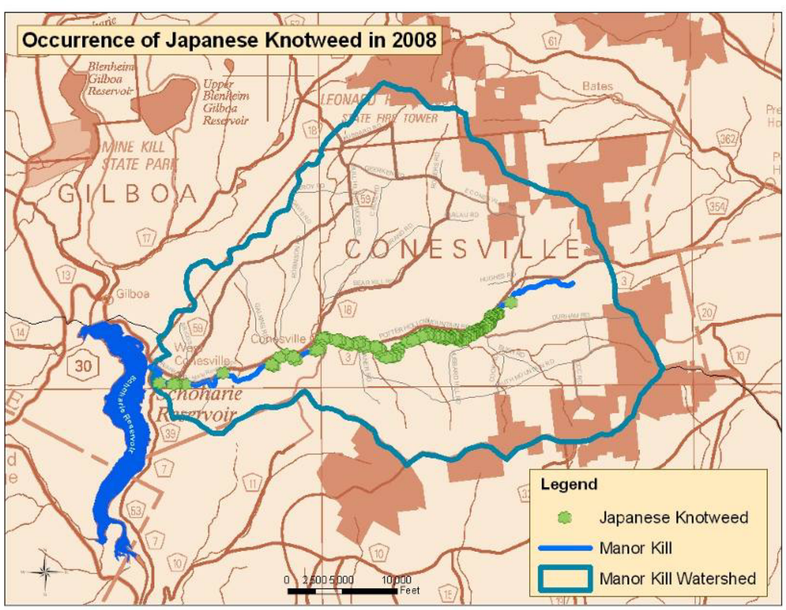


Figure 2.7.5. Japanese knotweed along the Manor Kill

In 2008, the first incidence of Japanese knotweed was observed in management unit #2; more than 800 feet downstream from the headwaters of the Manor Kill. The next occurrence was not for an additional 1500 feet further downstream. Knotweed had colonized many sites along the Manor Kill downstream of these stands, with 168 occurrences of knotweed affecting approximately 8,854 feet of stream banks (Figure 2.7.5). Approximately 36% of these occurrences were relatively small (less than 3 feet in length) and in the downstream portion of the Manor Kill, stands were sparse with 6 stands observed over 13,000 feet of stream. Without control efforts, Japanese knotweed is likely to continue to spread and fill in along the banks within a matter of a few years. It is critical to contain its spread and prevent invasion along unaffected stream banks. For more information about the specific quality and composition of a particular riparian area, please refer to individual Management Unit descriptions.

For several years, NYCDEP, GCSWCD and Hudsonia have been collaborating on research efforts to gain a greater understanding of Japanese knotweed. In 2003, Hudsonia submitted a final draft of their report *Japanese Knotweed and Water Quality on the Batavia Kill in Greene County, New York: Background Information and Literature Review*. This report provided a review of available information on Japanese knotweed including the biology, ecology, history of its invasive spread, and methods of management (Talmage and Kiviat, 2003). Currently, the NYCDEP, GCSWCD and Hudsonia are working together on a project along the Batavia Kill to determine an effective treatment method for Japanese knotweed. Three experimental treatment methods are being tested for their effectiveness at managing stands of knotweed. These methods include: 1) frequent mowing, 2) limited excavation with planting of native species and a weed barrier around the trees, and 3) herbicide injection. This research is part of an effort to develop management recommendations for its future control. For more information on Japanese knotweed and for a link to Hudsonia's report, visit www.catskillstreams.org.

Japanese knotweed has established colonies along the Manor Kill and some of its' associated tributaries. Management of knotweed is a difficult task and careful consideration must be taken before determining how to manage individual knotweed stands or colonies on streamside properties. Besides understanding key characteristics about knotweed (e.g. how it spreads, what environments it prefers), it is also essential to recognize a few key concepts that apply to most invasive species. First and foremost, prevention is the best policy. Preventing the spread of knotweed is the most cost effective and time efficient approach to take, and may be achieved by: telling others about knotweed and warning them of its associated problems; keeping streambanks stable by allowing native trees and shrubs to grow and mature; and checking transported soil for any knotweed fragments.

It is critical to recognize that knotweed grows under diverse conditions and in varying locations, so there are different ways to approach its control. Before simply mowing down all the knotweed or spraying herbicides everywhere, one should first ask:

- How large is the stand of knotweed?
- Is it located near a waterway?
- What native plants exist nearby?

With answers to the questions above a customized approach may be taken, saving time and money by applying the most appropriate techniques.

Finally, someone wanting to control knotweed should understand that:

- **A disposal plan for all knotweed material is a must**; otherwise a new colony will just sprout somewhere else. This might include burning the material, burying it more than 6 ft. deep or letting it completely dry out.
- **Most treatments require multiple applications**. A one-time cutting or mowing of knotweed will not do anything besides stunt it temporarily and cause the rhizomes to extend underground faster towards more nutrients, possibly causing a higher rate of spread.
- **Revegetation with native species after treatment is necessary.** Leaving bare ground only promotes the reinvasion of knotweed. Rapid-growing, native trees and shrubs must be planted soon after removing knotweed in order to affect the most beneficial change.

Below are various treatment prescriptions depending on size of the knotweed stand, its proximity to a waterway and amount of surrounding vegetation. Please note that where bare ground exists after removing knotweed stems and roots, it is essential to revegetate the area with competitive (fast-growing) native trees and shrubs. This is especially critical if surrounding vegetation is limited or nonexistent. Otherwise re-establishment of knotweed is likely and control efforts are futile.

For *small* stands (less than 3ft^2):

- Cover with dark plastic.
- Frequent cutting, grubbing or pulling with safe disposal of knotweed stems.
- Herbicide injection of stems. PLEASE READ HERBICIDE CAUTION BELOW.

For *medium* stands (3ft^2 to 25ft^2):

- Frequent mowing (do not allow cut material to leave site).

For *large* stands (25ft^2+):
In some cases, the extent of a knotweed colony is so extensive that more harm (e.g. damage to soils) would be done in trying to eliminate the entire stand. For this reason control of expansion is the appropriate action.

- Frequent mowing around edges of stand (do not allow cut material to leave site).
- Herbicide injection of stems in edges of stand. PLEASE READ HERBICIDE CAUTION BELOW.

Herbicide Caution: Glyphosate (e.g. Rodeo, Roundup, Aquamaster) is the recommended active agent. When used with care and according to product labels, this herbicide does NOT negatively affect *un*touched plants and animals. Using an injection method is the highest recommendation because knotweed material is not cut therefore requiring no disposal. Also this method eliminates drift and targets only injected stems. Only certain herbicides, such as Rodeo and Aquamaster, should be used near a waterway. Please take care to wear appropriate protective equipment. Check with Cornell Cooperative Extension of Schoharie County at 518-234-4303 for information about the proper, safe and legal use of herbicides.

Assessment of the Current Condition of Riparian Vegetation

As part of the stream management planning process, physiognomic classes (e.g., deciduous open tree canopy, shrub land, herbaceous) were mapped and the riparian vegetation assessed for the Manor Kill watershed (methodology available in Appendix B). The purpose of this exercise was to provide the planning team with baseline information about communities present in the watershed, a description of the condition of vegetation in the riparian area, and to aid in the development of recommendations related to the management of riparian vegetation along the stream.

Mapping of Physiognomic Classes

Mapping of physiognomic classes was loosely based on the Vegetation Classification Standard produced by The Federal Geographic Data Committee. The mapping was based upon 2006 digital-ortho pictometry and was confined to the riparian and near adjoining upland areas within 300 feet of the mainstem of the Manor Kill. This classification was selected because it allows identification of locations, such as herbaceous or cobble deposits, where the combination of channel morphology and riparian vegetation would indicate the greatest cost-benefit from riparian buffer plantings and bio-engineered bank stabilizations.

Riparian vegetation (closed mixed), protects stream banks and water quality, and provides habitat and food sources for fish and wildlife.

The mapping exercise included the approximate delineation of the classes through the photo interpretation of 2006 digital orthophotography acquired from the Pictometry International Corporation. A physiognomic class GIS data layer was created using heads-up digitizing techniques with ESRI's Arcview software. The photo interpretation was field checked with class boundaries, and classifications were amended based upon field observations. The vegetation map resulting from this process is folded and included in the back of this section.

Summary of Findings

According to this ripairan vegetation assessment, herbaceous vegetation (approximately 459 acres) and deciduous closed tree canopy (approximately 91 acres) were the largest physiognomic classes within the 300 foot. buffer, while shrubland and mixed closed tree canopy occupied approximately 87 acres and 80 acres respectively. This predominance of herbaceous vegetation of the riparian area is a concern. While herbaceous cover is better than no cover at all, plants with a variety of rooting depths (herbs, shrubs and trees) provide more extensive stream bank protection. Forested land cover helps to provide a high degree of stability to the watershed by slowing storm runoff and helping to protect against stream bank erosion. Protection of forest communities as well as planting riparian vegetation near the stream will help ensure long-term stream stability, but the effectiveness of stream protection provided by vegetative communities differs based on their width, plant density, vegetation type and the stream's geomorphic characteristics.

Approximately 480 acres, or 52% of land area was considered to have inadequate vegetative cover; this included areas of herbaceous vegetation, bare soil and revetment. A streamside planting program is recommended to address these areas of inadequate vegetation.

Table 2.7.1 provides the results of the GIS vegetation assessment of the Manor Kill, including the area and percentage of each land cover type. Classes listed in italics contribute to the total area of inadequate vegetation.

Table 2.7.1. Summary of Physiognomic Vegetation Classification

Vegetation Classification	**Area (acres)**	**Percent**
Bare Soil	21.04	2.29%
Deciduous Closed Tree Canopy	90.90	9.91%
Deciduous Open Tree Canopy	35.16	3.83%
Evergreen Closed Tree Canopy	53.98	5.89%
Evergreen Open Tree Canopy	10.07	1.10%
Herbaceous Vegetation	458.81	50.02%
Impervious Surface	21.23	2.31%
Mixed Closed Tree Canopy	79.55	8.67%
Mixed Open Tree Canopy	1.10	0.12%
Revetment	0.42	0.05%
Shrubland	86.70	9.45%
Unpaved Road	9.46	1.03%
Water	48.81	5.32%
Total Area	917.23	
Inadequate Vegetation	480.27	52.36%

Riparian ecosystems are an important component of watershed protection and resource conservation. Therefore, it is important to maintain and improve the riparian vegetation along the Manor Kill and its' tributaries.

Manor Kill Streamside Planting

A streamside planting program is recommended for the Manor Kill. The findings from the mapping of physiognomic classes can be used to identify candidate stream reaches for inclusion in future streamside planting programs. There are three main steps to establish this type of program.

1. *Identify priority sites* using information gathered during riparian vegetation characterization analyses to identify potential planting sites where improvement of the riparian vegetation is likely to be both effective and successful.
2. *Develop treatment designs* for participating prioritized sites using primarily native plants that address landowner aesthetics, ecological enhancement and water quality improvement or protection.
3. *Install the designs* and document the planting process and results for program replication and general education/outreach.

To effectively carry out riparian planting projects, it is necessary to develop objective physical criteria for identifying and prioritizing eroding banks that may be stabilized with riparian vegetation plantings. It is also important to coordinate with streamside landowners by canvassing riparian landowners whose properties meet these objective criteria for their interest in participating in a project, and establishing a partnership with interested landowners. Technical assistance may then be provided to landowners to reestablish the riparian buffer on their property with native vegetation.

References:

Adams, M.S., Terzilla, D. & Baum, B.S. (2002) Community–based monitoring in the Catskills. In B. Onken, R. Reardon, J. Lashomb (Eds.), *Symposium on the hemlock wooly adelgid in eastern North America: February 5-7, 2002, East Brunswick, New Jersey* (pp. 100-105). New Brunswick, NJ: USDA Forest Service – Rutgers University.

Forman, J. & Kesseli, R.V. (2003). Sexual reproduction in the invasive species *Fallopia japonica* (Polygonaceae)[1]. *American Journal of Botany 2003*, 90, 586-592.

Kudish, M. (2000). *The Catskill forest: a history*. Fleischmanns, NY: Purple Mountain Press, Ltd.

Malanson, G.P. (1993). *Riparian landscapes*. Cambridge, UK: Cambridge University Press.

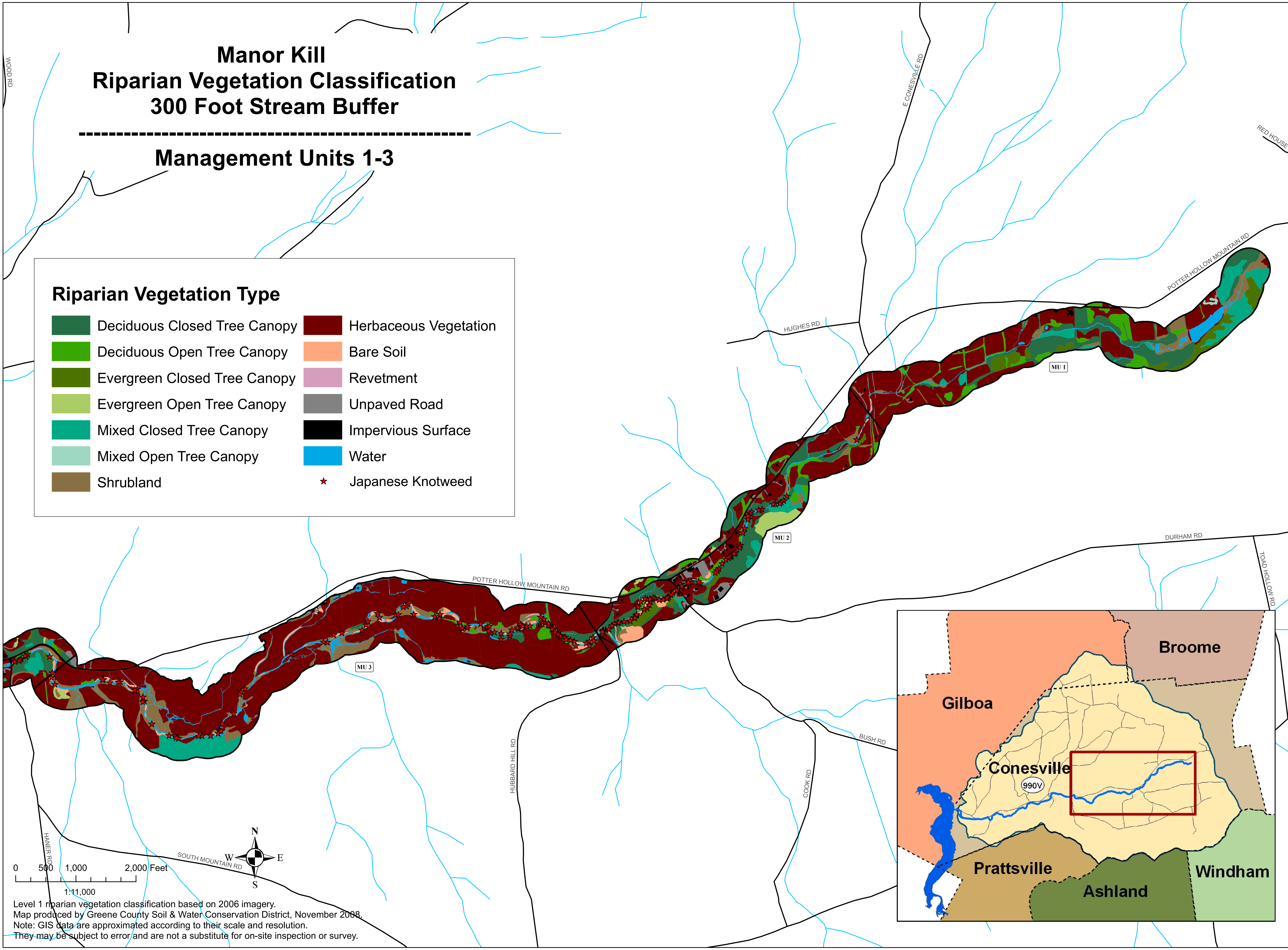
McClure, Mark S.and Carole A., and Cheah, S-J., 2002, Important mortality factors in the life cycle of hemlock wooly adelgid, *Adelges tsugae Annand* (Homoptera: Adelgidae). In B. Onken, R. Reardon, J.

Lashomb (Eds.), *Symposium on the hemlock wooly adelgid in eastern North America: February 5-7, 2002, East Brunswick, New Jersey* (pp. 13-22). New Brunswick, NJ: USDA Forest Service – Rutgers University.

Orwig, D.A. (2002). Stand dynamics associated with chronic hemlock woolly adelgid infestations in southern New England. In B. Onken, R. Reardon, J. Lashomb (Eds.), *Symposium on the hemlock wooly adelgid in eastern North America: February 5-7, 2002, East Brunswick, New Jersey* (pp. 36-46). New Brunswick, NJ: USDA Forest Service – Rutgers University.

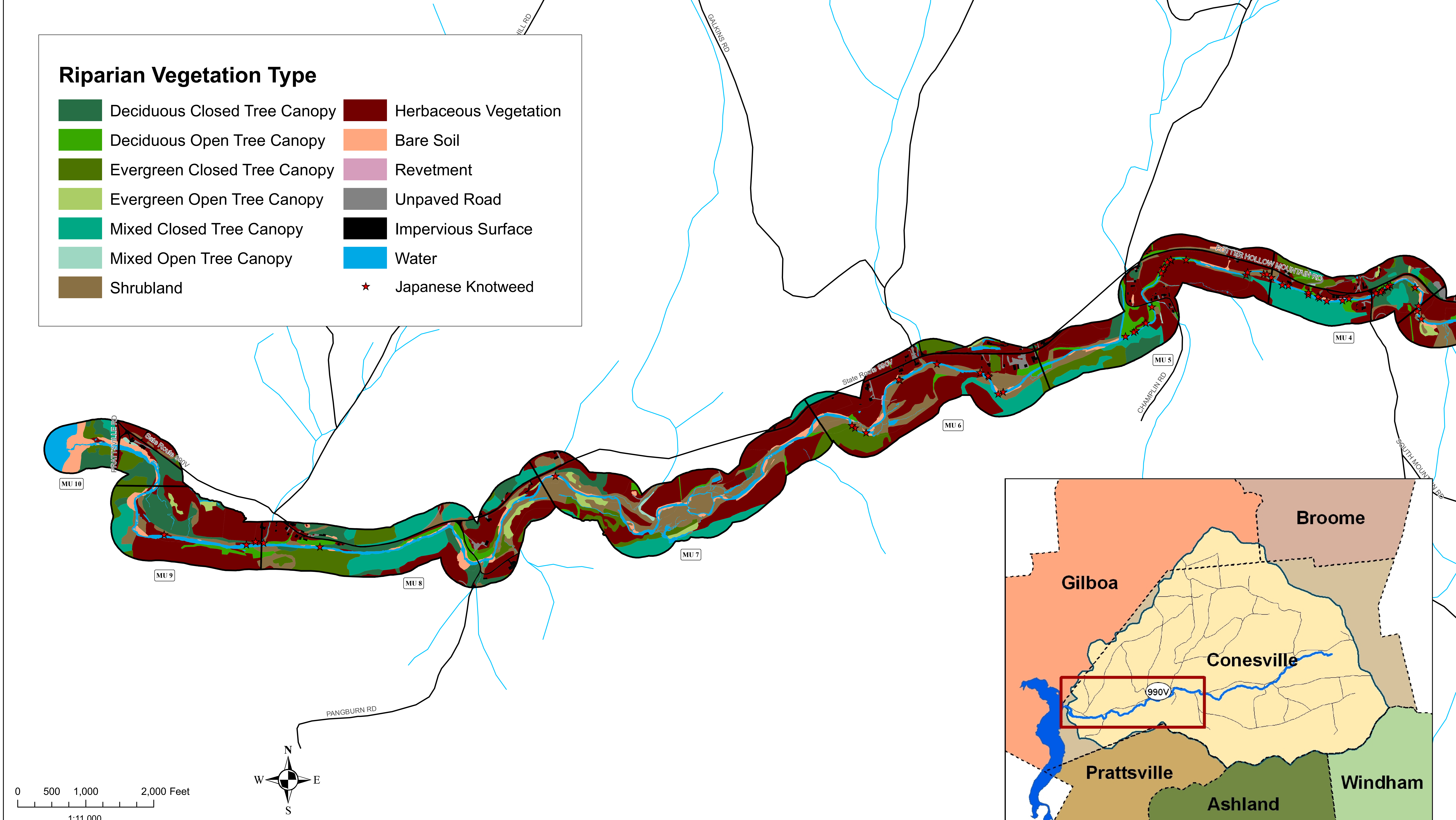
Talmage, E. & Kiviat, E. 2003. *Japanese knotweed and water quality on the Batavia Kill in Greene County, New York: background information and literature review*. Annandale, NY: Hudsonia Ltd.

Ward, J. (2002). Restoration of damaged stands: dealing with the after effects of hemlock woolly adelgid. In B. Onken, R. Reardon, J. Lashomb (Eds.), *Symposium on the hemlock wooly adelgid in eastern North America: February 5-7, 2002, East Brunswick, New Jersey* (pp. 118-126). New Brunswick, NJ: USDA Forest Service – Rutgers University.


Manor Kill
Riparian Vegetation Classification
300 Foot Stream Buffer
Management Units 1-3
Riparian Vegetation Type
Deciduous Closed Tree Canopy
Deciduous Open Tree Canopy
Evergreen Closed Tree Canopy
Evergreen Open Tree Canopy
Mixed Closed Tree Canopy
Mixed Open Tree Canopy
Shrubland
Herbaceous Vegetation
Bare Soil
Revetment
Unpaved Road
Impervious Surface
Water
Japanese Knotweed
WOOD RD
E CONESVILLE RD
RED HOUSE RD
HUGHES RD
POTTER HOLLOW MOUNTAIN RD
MU 1
MU 2
MU 3
DURHAM RD
TOAD HOLLOW RD
BUSH RD
COOK RD
HUBBARD HILL RD
HANER RD
SOUTH MOUNTAIN RD
N
S
E
W
0 500 1,000 2,000 Feet
1:11,000
Level 1 riparian vegetation classification based on 2006 imagery.
Map produced by Greene County Soil & Water Conservation District, November 2008.
Note: GIS data are approximated according to their scale and resolution.
They may be subject to error and are not a substitute for on-site inspection or survey.
Broome
Gilboa
Conesville
990V
Prattsville
Ashland
Windham

Manor Kill
Riparian Vegetation Classification
300 Foot Stream Buffer

Management Units 4-10



Level 1 riparian vegetation classification based on 2006 imagery.
Map produced by Greene County Soil & Water Conservation District, November 2008.
Note: GIS data are approximated according to their scale and resolution.
They may be subject to error and are not a substitute for on-site inspection or survey.

2.8 Land Use/Land Cover

Land use and land cover of a watershed have a great influence on water quality and stream stability. The watershed's land cover directly impacts stream hydrology by influencing the amount of stormwater runoff. Forests, natural meadows and wetlands naturally absorb rainwater, allowing a portion of it to percolate back into the ground. However, impervious surfaces such as pavement, parking lots, driveways, hard-packed dirt roads and rooftops increase the amount of rainfall that flows over land and reduces the amount of rainfall that percolates into the soil to recharge groundwater wells and streams.

Impervious cover is a major influence on streams and stream life due to the way it changes the amount and duration of stormwater that gets to the stream. Generally, the more impervious surface there is in a watershed, the less groundwater recharge (which supplies summer low flows), and the greater the magnitude of storm flows (and related erosion in streambeds). In addition to degrading streams, watersheds with a high percentage of impervious surfaces are prone to larger and more frequent floods, which cause property damage through inundation, as well as ecological harm resulting from lower base stream flows.

The literature has documented the deleterious effects impervious surfaces have on biota (Limburg and Schmidt, 1990; May et al., 2000; Wang et al., 2001; Roy et al., 2005), stream stability (Booth, 1990; CWP, 1998; White and Greer, 2005; Wohl, 2005) and instream water quality (Groffman et al., 2004 and Deacon et al., 2005). For example, impervious surfaces can raise the temperature of stormwater runoff, which in turn reduces the waters ability to hold dissolved oxygen and harms some game fish populations, while promoting excess algal growth. Field observation, research and hydrologic modeling suggest a threshold of 10% impervious surface in a watershed, after which there is marked transition to degraded stream conditions (CWP, 1998 and Booth, 2000).

Certain types of pollution problems are often associated with particular land uses, such as sedimentation from construction activities. There has been a vast array of research demonstrating that as land uses become more urbanized (built), biotic communities decline in health (Limburg and Schmidt, 1990; Schueler and Holland, 2000; May et al., 2000; Wang et al., 2001 and Potter et al. 2005). Concentrations of selected chemical constituents, including nitrate, in stream base-flow were strongly affected by the predominant land use in a large Hudson Valley study (Heisig, 2000). The decline of watershed forest cover below 65% percent marked a transition to degraded water quality (Booth, 2000). Based upon these results, land use/cover appears to be attractive attributes for long-term trend tracking. These results can then be correlated with in-stream water quality data and then used to focus best management practices towards the land uses with the greatest impact on water quality.

Land cover of the Manor Kill Watershed was analyzed using the LANDSAT ETM geographic information system (GIS) coverage (provided by the National Land Use Cover Data). To simplify the data, the 47 classifications assigned to the different types of land cover have been re-classified and grouped together under more general land cover categories. The chart below illustrates the categories and percentages of the different land cover types present in the Manor Kill watershed.

Table 2.8.1. Land Cover of Manor Kill Watershed

Land Cover Category	**Acres**	**Percentage**
Agriculture	175	.79%
Barren Land	2	.01%
Development	675	3%
Forested	17,642	80%
Herbaceous	159	.7%
Managed Herbaceous	2,265	10%
Open Water	37	.16%
Shrubland	35	.15%
Wetlands	1,082	5%
Total	22,072	100%

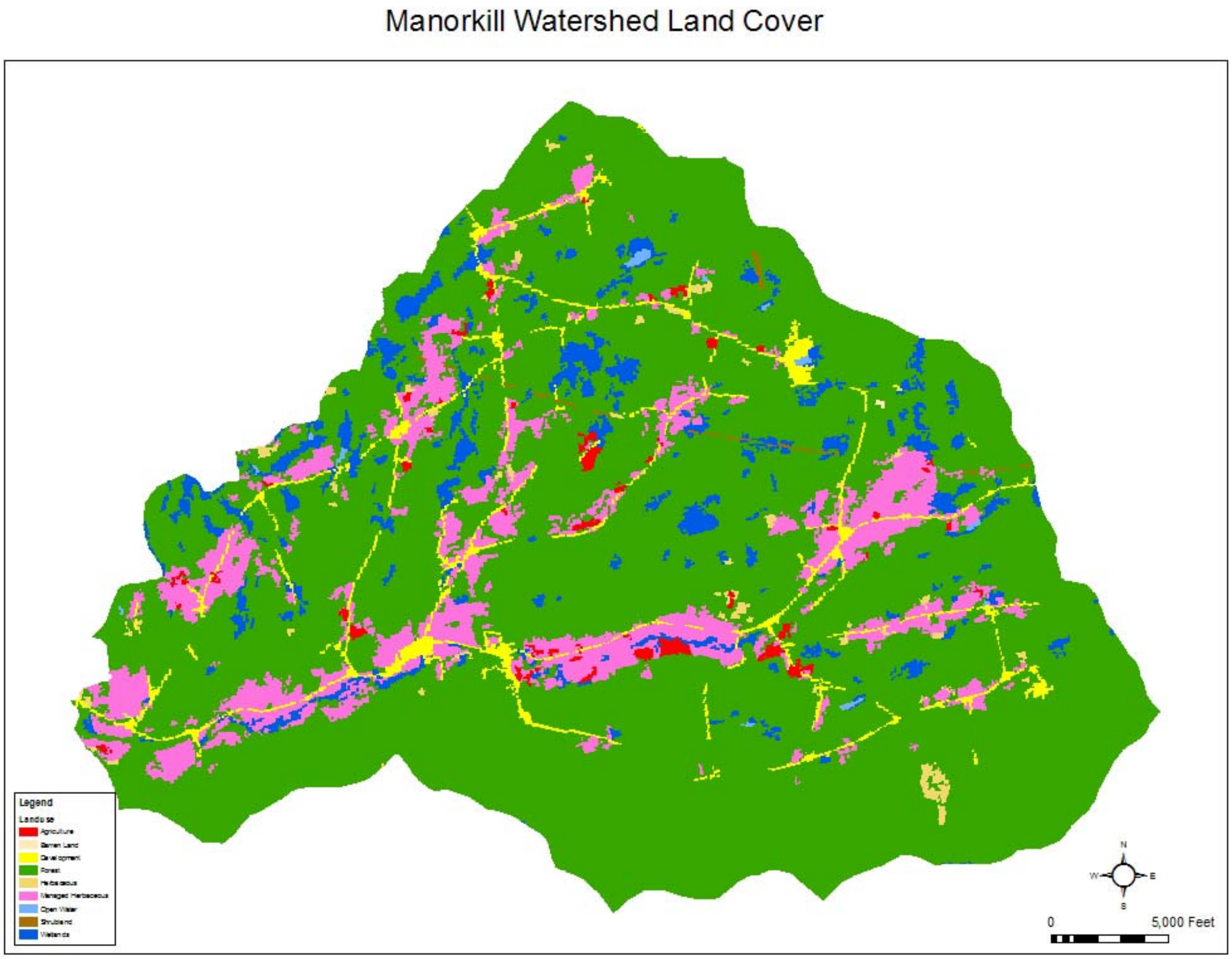


Figure 2.8.1. Land Cover of the Manor Kill Watershed 2001(NLCD).

The Manor Kill Watershed is predominately forested, with deciduous, coniferous and mixed forest comprising 80% of the total land area. Agriculture and cultivated herbaceous land cover coincides with farming activity—a predominant, yet declining land use in the watershed. Farming activities, primarily hay fields and small dairy operations are concentrated along the stream valleys. Along the Manor Kill, open pastures run adjacent to the stream for several miles.

Similar to agriculture, development is concentrated along the stream valleys. Along the Manor Kill there are three more densely built hamlets and lower-density residential scattered the length of the stream. Large expanses of mowed lawn were typical of the residential growth along the stream. Throughout the rest of the watershed, low-density, rural residential is the predominant development pattern.

With minimal development pressure, the small, natural resource-based economy of the area dictates much of the land use in the watershed. In additional to agriculture, logging is a common practice in the Manor Kill. There are several active and gravel mines, some located adjacent to the stream; and numerous in-active waste ground sites.

Protected Lands

Although outside of the Catskill Park, significant tracts of land in the Town of Conesville, particularly along the southern and eastern boundaries of the Manor Kill basin, are protected under public ownership. To determine the percentage of parcels within the Manor Kill basin that were protected, ownership and property use classifications as documented on records of the Schoharie County Real Property Tax Service Department, were analyzed.

In 2008, 13% of the lands in the Manor Kill watershed were protected as Forested, Conservation Lands. Of these, 10% was owned by New York State; 2.8% was owned by New York City; and .5% was owned by Schoharie County.

Table 2.8.2. Acreage and Percentage of Protected Land within the Manor Kill Watershed

Owner	**Acres**	**Percent**
City of New York	610	2.8%
Schoharie County	117	.5%
New York State Forest Lands	2,232	10%

References

Booth, D.B. 1990. Stream Channel Incision Following Drainage Basin Urbanization. Water Resources Bulletin Volume 26: 407-417.

Booth, D. 2000. Forest Cover, Impervious Surface Area, and the Mitigation of Urbanization Impacts in King County, Washington. Center for Urban Water Resources Management, University of Washington, Seattle, WA.

CWP. 1998. Rapid Watershed Planning Handbook: A Comprehensive Guide for Managing Urbanizing Watersheds. Center for Watershed Protection, Ellicot City, Maryland.

Deacon, J.R., Soule, S.A., and Smith, T.E. 2005. Effects of Urbanization on Stream Quality at Selected Sites in the Seacoast Region in New Hampshire, 2001-03. United States Geological Survey Investigations Report 2005-5103, 18 p.

Groffman, P.M., Law, N.L., Belt, K.T., Band, L.E., and Fisher, G.T. 2004. Nitrogen Fluxes and Retention in Urban Watershed Ecosystems. Ecosystems 7: 393– 403.

US EPA_5, 2003 - Land Use Planning: http://www.epa.gov/watertrain/protection/r2.html

Heisig, P. 2000. Effects of Residential and Agricultural Land Uses on the Chemical Quality of Baseflow of Small Streams in the Croton Watershed, Southeastern New York. Publication # WRIR 99-4173. United States Geological Survey, Troy, NY.

Limburg, K.E. and Schmidt, R.E. 1990. Patterns of Fish Spawning in Hudson River Tributaries: Response to an Urban Gradient?. Ecology Volume 71 (4): 1238 – 1245. 05).

May, C.W., Horner, R.R., Karr, J.R., Mar, B.W. and Welch, E.B. 2000. Effects of Urbanization on Small Streams in the Puget Sound Ecoregion. Watershed Protection Techniques, 2(4): 483-494.

Potter, P.M., Cubbage, F.W., and Schaberg, R.H. 2005. Multiple-scale landscape predictors of benthic macroinvertebrate community structure in North Carolina. Landscape and Urban Planning 71: 77-90.

Roy, A. H., Freeman, M. C., Freeman, B. J., Wenger, S. J., Ensign, W. E., Meyer, J. L. 2005. Investigating hydrologic alteration as a mechanism of fish assemblage shifts in urbanizing streams. Journal of the North American Benthological Society Volume 24 (3): 656-678.

Scheuler, T.R. and Holland, H.K. 2000. Housing Density and Urban Land Use as Indicators of Stream Quality. In: The Practice of Watershed Protection 2(4): 735-739.

Wang, L., Lyons, J., Kanehl, P. and Bannerman, R. 2001. Impacts of Urbanization on Stream Habitat and Fish Across Multiple Spatial Scales. Environmental Management Vol. 28(2): 255-266.

White, M.D. and Greer, K.A. 2005. The effects of watershed urbanization on the stream hydrology and riparian vegetation of Los Peñasquitos Creek, California. Landscape and Urban Planning, Volume 74(2): 125-138.

Wohl, E. 2005. Compromised Rivers: Understanding Historical Human Impacts on Rivers in the Context of Restoration. Ecology and Society 10(2): Article 2.

2.9 Wildlife and Fisheries

Primarily authored by the Schoharie County Soil and Water Conservation District

Water is an essential component to life on earth. Without it humans as well as most other species on this planet would cease to exist. Clean potable drinking water is a staple that helps to sustain a diverse collection of flora and fauna throughout the Schoharie Valley watershed. Human uses of land and water have had far-reaching impacts on natural ecosystems. In order to manage ecosystems for sustainable use, one must understand the basic physical, chemical, and biological components and functions of those systems. The interrelationships between ecosystems must be understood as well (Chiras and Rega, 2002).

Biological Energy within the Stream Environment

Organisms that live within the stream environment can be divided into three categories based on the function they perform: producers, consumers, and predators. Aquatic plants are the producers that provide energy to the stream community through photosynthesis and include diatoms, algae, and macrophytes (larger plants). Bacteria also provide energy through the decomposition of organic matter. Consumers, including invertebrates (insects) and fish, use the energy provided by these plants and microbes. Lastly, predators (fish, birds, mammals) feed on consumer groups for their energy requirements (Chiras and Rega, 2002). These components make up the building blocks of the food web, a complex arrangement which is the essence of all life on earth. Any time there is a change in the availability of one of the components within the schematic of the food web; species within the habitat have one of two choices. One choice is to adapt to the change and redirect their efforts towards other ways to survive with the potential to include abandoning the habitat. The other is to succumb to localized extinction which might be the case if the species is a "specialist" feeder or is limited to a very small "home range" habitat. This is what has prompted fish and wildlife experts to identify what are known as "keystone" species. Keystone species are species that are a critical component to other species within their niche. Once a keystone species is extirpated from a habitat, the symbiotic ties are cut, and that usually means drastic consequences for one or more other species within the habitat.

Biological Energy along the Stream Banks

Riparian areas serve as transitional zones, or ecotones, and have been defined as "zones of direct interaction between terrestrial and aquatic ecosystems" (Gregory et al., 1991). Today, riparian areas are recognized as being transportation corridors, high producers of timber and forage, key habitats for a diversity of wildlife, major components of quality fisheries habitat, prime recreational areas, and areas critical to the overall management of any watershed (Kohler and Hubert, 1999). Frequent disturbance and a shallow water table provide conditions favorable to a riparian plant community dominated by mesic, early successional species (e.g. alder, cottonwood, and willow) and differ markedly from upslope or adjacent plant communities (Gregory et al, 1991). From watershed and fisheries management perspectives, riparian areas provide many important services. Streamside vegetation plays a role in controlling channel morphology. Not only do roots stabilize otherwise easily eroded stream banks, but pieces of large woody debris recruited into the stream from the riparian zone retain sediments that would otherwise be flushed into the stream (Speaker et al., 1984). Large woody debris in conjunction with fluvial processes also creates a diversity of meso-and microhabitats important to stream fishes (Keller and Swanson 1979). Riparian areas also serve to moderate environmental conditions experienced by stream biota including: decreased temperature variations by shade relief, promoting recharging of the aquifer by slowing movement of water within the floodplain, control of non-point source pollution by filtering out sediments from adjacent lands, and reducing nutrient loadings into the aquatic system.

Terrestrial Species that benefit from a Healthy Stream

There are many land dwelling species that need a healthy stream environment to thrive in the wild. Several mammals like beaver, muskrat, shrew, mouse, white tail deer, coyote and black bear to name a few are known to inhabit the Schoharie Valley. There are also countless species of birds that use this region as a home range as well as part of their migratory route up and down the eastern seaboard. The Great Blue Heron (*Ardea Herodias Linnaeus*) for instance, is a large bird that calls the Manor Kill with its diverse landscapes and bordering wetlands home (Photo 2.9.1). The Great Blue Heron has earned federally protected status. The reasons that this bird has obtained protected status are numerous. One of the more significant threats faced by Great Blue Herons is the loss of habitat. New York State has lost over half of its wetlands since colonization. More recently, loss of wetlands in the Lake Plains portion of the state have been offset as agricultural lands revert back to wetlands, although net losses of wetlands in the Hudson Valley continue (NYNHP 2008).

Photo 2.9.1. Great Blue Heron (photo by: Lee Karney)

The Great Blue Heron is just one of many species that would suffer a severe setback in its life history if water quality in its habitat were to become negatively impacted. Eastern Bluebirds which are a member of the thrush family do not eat birdseed. Bluebirds eat insects and native fruits produced by black cherry, winterberry holly, red-osier dogwood, blueberry, sumac, wild grape, bittersweet, and Virginia creeper. This drives home the importance of these native plant species in or near wetlands and stream environments in Schoharie County. There are literally dozens of species of birds, mammals, reptiles, and amphibians that inhabit streamside and wetland habitats in Schoharie County. The Northern Leopard Frog (*Rana pipiens*) is another example of a species that is at risk when its habitat is altered (Photo 2.9.2). This amphibian was once the most abundant and widespread frog species in North America. Massive declines beginning in the 1970s have significantly reduced their numbers earning them threatened status. Scientists have not determined the

Photo 2.9.2. Northern Leopard Frog - an aquatic species that requires a healthy stream habitat.

cause of the declines, but it is likely a combination of ecological factors: pollution, deforestation, and water acidity (http://animals.nationalgeographic.com/animals/amphibians/northern-leopard-frog.html).

Living organisms in streams are part of complex food webs as well. External inputs include light, nutrients, and course particulate organic matter (CPOM) (allochthonous material) from riparian areas. Organic matter is produced in the stream (autochochthonous material) from the growth and reproduction of photosynthesizing algae, bacteria, and plants. Decomposing bacteria and fungi process CPOM into other components, and in turn, stream bacteria and algae are consumed by macroinvertebrates. Various species of fish consume plants, macro-invertebrates, and other fish (Cretaz 2007). This is to say that impacts to the streamside environment can and will have direct impacts to the food web within the stream. This is why when biologists conduct a biological monitoring study they use the presence or absence of fish as well as macroinvertebrates as indicators of stream condition. These indicator species tell watershed managers if something is amiss within the stream environment. Usually the macroinvertebrates will succumb first to a less than desirable aquatic environment followed by the most sensitive fish species like sculpin and trout (Photo 2.9.3). All of these factors, as well as a detailed physical and chemical analysis, help indicate if human intervention is required. DEC has conducted species diversity studies on the Manor Kill for both fish and invertebrate populations. Most recently the State University of New York at Cobleskill conducted electro fishing studies to determine species diversity within the Manor Kill (Photo 2.9.4). They also completed kick net sampling of benthic invertebrates to determine overall condition of the watershed with regards to water quality (Photo 2.9.5).

Photo 2.9.3. Brown trout caught in Manor Kill during 2007 sampling.

Photo 2.9.4. College Students conducting fish sampling on Manor Kill April 2007.

Photo 2.9.5. Stonefly's captured during April 2007 macro-invertebrate study on

Historically, brown and brook trout occur throughout the Manor Kill (Figure 2.9.1). Results of the 2007 fish study were tabulated and compared with historic data from the NYS Dept. of Environmental Conservation (Table 2.9.1). The data collected in the study will be used to compare changes in salmonid distribution in Schoharie County coldwater streams (Nichols, 2007). These techniques allow watershed managers to view biotic changes over a long time frame which may help identify areas if, where, and when changes should be implemented.

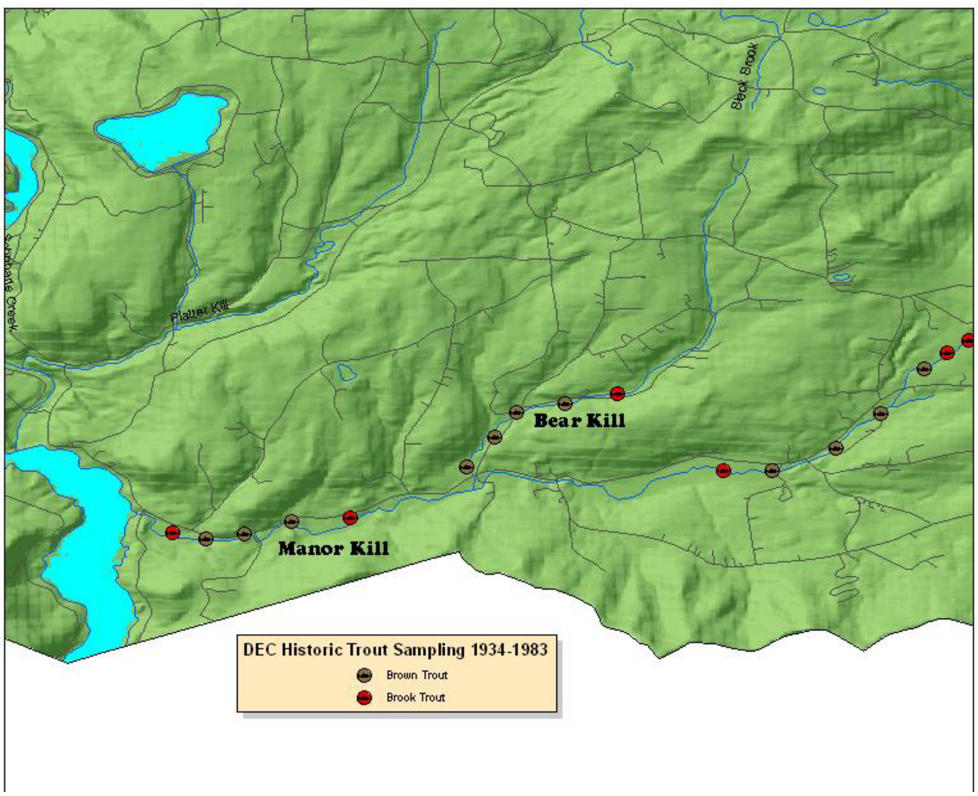


Figure 2.9.1. Map illustrating DEC historic sampling data for two species of trout in two bodies of water in Conesville NY. Created by SUNY Cobleskill.

Table 2.9.1 Manor Kill Fish Species Composition 1934-2008					
Date	SiteName	Species	Date	SiteName	Species
8/3/1934	COOPER	white sucker	9/3/1996	NYS DEC	Eastern Eastern Blacknose Dace
8/3/1934	COOPER	brown trout	9/3/1996	NYS DEC	Brown Bullhead
8/3/1934	COOPER	brook trout	9/3/1996	NYS DEC	Slimy Sculpin
8/3/1934	COOPER	Eastern Blacknose Dace	9/3/1996	NYS DEC	Creek Chub
8/3/1934	COOPER	creek chub	9/3/1996	NYS DEC	Common Shiner
8/11/1955	WFS	Eastern Blacknose Dace	9/3/1996	NYS DEC	Slimy Sculpin
8/11/1955	WFS	creek chub	9/3/1996	NYS DEC	Creek Chub
8/11/1955	WFS	brown trout	9/3/1996	NYS DEC	Eastern Eastern Blacknose Dace
8/11/1955	WFS	common shiner	9/3/1996	NYS DEC	Common Shiner
8/11/1955	WFS	white sucker	9/3/1996	NYS DEC	Eastern Eastern Blacknose Dace
8/10/1961	DIETSCH	brown trout	9/3/1996	NYS DEC	White Sucker
8/10/1961	DIETSCH	creek chub	9/3/1996	NYS DEC	White Sucker
8/10/1961	DIETSCH	white sucker	4/13/2007	Nichols 17	Slimy Sculpin
8/10/1961	DIETSCH	Eastern Blacknose Dace	4/13/2007	Nichols 17	Brook Trout
8/10/1961	DIETSCH	common shiner	4/13/2007	Nichols 17	Brown Trout
7/15/1968	R FIELDHOUSE	common shiner	4/13/2007	Nichols 18	Eastern Blacknose Dace
7/15/1968	R FIELDHOUSE	white sucker	4/13/2007	Nichols 18	Common Shiner
7/15/1968	R FIELDHOUSE	creek chub	4/10/2008	MK1	Longnose Dace
7/15/1968	R FIELDHOUSE	brook trout	4/10/2008	MK1	Eastern Blacknose Dace
7/15/1968	R FIELDHOUSE	brown trout	4/10/2008	MK1	White Sucker
7/15/1968	R FIELDHOUSE	Eastern Blacknose Dace	4/10/2008	MK1	Common Shiner
7/15/1968	R FIELDHOUSE	common shiner	4/10/2008	MK3	Brown Trout
7/15/1968	R FIELDHOUSE	brown trout	4/10/2008	MK3	Brook Trout
7/15/1968	R FIELDHOUSE	Eastern Blacknose Dace	4/10/2008	MK3	Longnose Dace
7/15/1968	R FIELDHOUSE	white sucker	4/10/2008	MK3	Eastern Blacknose Dace
7/15/1968	R FIELDHOUSE	creek chub	4/10/2008	MK3	White Sucker
7/15/1968	R FIELDHOUSE	Eastern Blacknose Dace	4/10/2008	MK4	Slimy Sculpin
7/15/1968	R FIELDHOUSE	white sucker	4/10/2008	MK4	Longnose Dace
7/15/1968	R FIELDHOUSE	creek chub	4/10/2008	MK4	Eastern Blacknose Dace
7/15/1968	R FIELDHOUSE	slimy sculpin	4/10/2008	MK4	White Sucker
7/15/1968	R FIELDHOUSE	brook trout	4/10/2008	MK4	Common Shiner
7/15/1968	R FIELDHOUSE	white sucker	4/10/2008	MK5	Brown Trout
7/15/1968	R FIELDHOUSE	brown bullhead	4/10/2008	MK5	Slimy Sculpin
7/15/1968	R FIELDHOUSE	Eastern Blacknose Dace	4/10/2008	MK5	Longnose Dace
7/15/1968	R FIELDHOUSE	brook trout	4/10/2008	MK5	Eastern Blacknose Dace
7/15/1968	R FIELDHOUSE	common shiner	4/10/2008	MK5	Creek Chub
7/15/1968	R FIELDHOUSE	brown trout	4/10/2008	MK6	Brown Trout
7/15/1968	R FIELDHOUSE	brown trout	4/10/2008	MK6	Brook Trout
7/15/1968	R FIELDHOUSE	creek chub	4/10/2008	MK6	Slimy Sculpin
8/15/1983	K SANFORD	creek chub	4/10/2008	MK6	Longnose Dace
8/15/1983	K SANFORD	longnose dace	4/10/2008	MK6	Eastern Blacknose Dace
8/15/1983	K SANFORD	brown trout	4/10/2008	MK6	Common Shiner
8/15/1983	K SANFORD	brook trout	4/10/2008	MK6	White Sucker
8/15/1983	K SANFORD	Eastern Blacknose Dace	4/10/2008	MK7	Common Shiner
8/15/1983	K SANFORD	common shiner	4/10/2008	MK7	Brown Trout
8/15/1983	K SANFORD	brown trout	4/10/2008	MK7	Slimy Sculpin
8/15/1983	K SANFORD	white sucker	4/10/2008	MK7	Creek Chub
8/15/1983	K SANFORD	common shiner	4/10/2008	MK7	Eastern Blacknose Dace
8/15/1983	K SANFORD	Eastern Blacknose Dace	4/10/2008	MK7	White Sucker

8/15/1983	K SANFORD	SCULPIN	4/18/2008	MK8	Brown Trout
8/15/1983	K SANFORD	creek chub	4/18/2008	MK8	Brook Trout
8/15/1983	K SANFORD	longnose dace	4/18/2008	MK8	Slimy Sculpin
8/15/1983	K SANFORD	brown trout	4/18/2008	MK8	White Sucker
8/15/1983	K SANFORD	Eastern Blacknose Dace	4/18/2008	MK8	Eastern Blacknose Dace
9/3/1996	NYS DEC	Brown Trout	4/18/2008	MK8	Creek Chub
9/3/1996	NYS DEC	Brown Trout	4/18/2008	MK9	Brown Trout
9/3/1996	NYS DEC	Brown Trout	4/18/2008	MK9	Brook Trout
9/3/1996	NYS DEC	Brook Trout	4/18/2008	MK9	Slimy Sculpin
9/3/1996	NYS DEC	Longnose Dace	4/18/2008	MK9	Eastern Blacknose Dace
9/3/1996	NYS DEC	Longnose Dace	4/18/2008	MK10	Brook Trout
9/3/1996	NYS DEC	Brown Bullhead	4/18/2008	MK10	Eastern Blacknose Dace
9/3/1996	NYS DEC		4/18/2008	MK10	Creek Chub

Fish and Wildlife Conservation Recommendations for the Manor Kill, Schoharie County, October 2008

The Manor Kill Watershed contains a high degree of biological diversity with a species assemblage that is typical of the Schoharie Valley. Forests with features such as talus slopes, cliffs, and mature stands are habitat for plants and animals adapted to these conditions. The large, unfragmented nature of the forests creates favorable habitat for wide-ranging animals (such as black bear and bobcat) and wildlife that prefer forest interiors. It is likely that forests of the Manor Kill watershed are important breeding areas for raptors such as broad-winged hawk, Northern goshawk, and sharp-shinned hawk. Forests that occur adjacent to the stream create habitat for a wide range of small mammals, including rarely seen moles, voles, and shrews, and fox, weasel, mink, beaver, and muskrat. The change in elevation from stream valley floor to mountain peaks, and the presence of both evergreen and deciduous forests contribute to the watershed's biodiversity.

In the Manor Kill watershed, abundant streams with cobble beds, undercut banks, and streamside wetlands and forests are habitat for damselflies, dragonflies, stream salamanders, turtles, and frogs. The wood turtle lives almost exclusively in and near streams, while spotted turtles might be found in streamside wetlands. Riparian forests are particularly important breeding habitat for birds such as the Louisiana water thrush and yellow-throated vireo. Stream corridors are the preferred foraging habitat for the many bat species that are likely to occur in the watershed.

Grassy fields, open woods, and shrubby patches make important contributions to biodiversity of the watershed. These open and scrubby areas can provide nesting habitat for the wood turtle and shrub land bird species that are declining in New York State as old farms revert to forests. Young forests are habitat for American woodcock, and ruffed grouse, while open shrub lands and dense thickets are preferred by brown thrasher. A list of other bird species known to utilize habitats within the Manor Kill watershed can be seen below (Table 2.9.2). Many species, like American woodcock, require a complex of different habitats to complete breeding, foraging, overwintering, and migration portions of their life cycles. As a result, maintaining connectivity between the stream and the adjacent uplands is very important for biodiversity conservation.

Schoharie County is fortunate to have the Schoharie County Bluebird Society, which was formed in 1983.The Blue Bird Society has been very instrumental in bringing this New York State bird back to the fore from a time when its numbers were very low. Bluebirds nest in open fields or orchards which the Manor Kill watershed has an abundance of. The fate of the bluebird in Schoharie County was realized by one man. Ray Briggs remembered "a time when he could count almost as many bluebirds as robins". Then something changed: fewer and fewer bluebirds returned in the spring. They disappeared from Mr. Brigg's farm. Their numbers dropped all over the United States. By the 1970s many young people had never seen a bluebird (www.highlightskids.com). There are many reasons this happened, one being the lack of cavities for nesting, like old apple trees, and rotted fence posts. The trees had been cut down and the wooden fence posts replaced with metal. They were also competing with invasive cavity nesters like the English sparrow. There was also a lack of food availability because the fields that used to provide them with as source for insects had been developed, or pesticides were applied to eliminate the insects. By placing, monitoring, and managing nest boxes all over Schoharie County, the county now fledges more bluebirds than any other county in the state (www.highlightskids.com). This is an example of how a species can experience significant decline because of natural and non-natural impacts on its habitat. It also exemplifies how thoughtful human intervention can reverse those trends.

Table 2.9.2. Observed Breeding Bird Species known to inhabit stream and wetland areas in Conesville, NY (http://www.dec.ny.gov/cfmx/extapps/bba/index.cfm).

Common Name	Scientific Name	Common Name	Scientific Name
Turkey Vulture	*Cathartes aura*	Brown Creeper	*Certhia americana*
Canada Goose	*Branta canadensis*	House Wren	*Troglodytes aedon*
Common Merganser	*Mergus merganser*	Winter Wren	*Troglodytes troglodytes*
Bald Eagle	*Haliaeetus leucocephalus*	Eastern Bluebird	*Sialia sialis*
Red-tailed Hawk	*Buteo jamaicensis*	Veery	*Catharus fuscescens*
Ruffed Grouse	*Bonasa umbellus*	Hermit Thrush	*Catharus guttatus*
Wild Turkey	*Meleagris gallopavo*	Wood Thrush	*Hylocichla mustelina*
Killdeer	*Charadrius vociferus*	American Robin	*Turdus migratorius*
Rock Pigeon	*Columba livia*	Gray Catbird	*Dumetella carolinensis*
Mourning Dove	*Zenaida macroura*	European Starling	*Sturnus vulgaris*
Black-billed Cuckoo	*Coccyzus erythropthalmus*	Cedar Waxwing	*Bombycilla cedrorum*
Yellow-billed Cuckoo	*Coccyzus americanus*	Yellow Warbler	*Dendroica petechia*
Barred Owl	*Strix varia*	Chestnut-sided Warbler	*Dendroica pensylvanica*
Chimney Swift	*Chaetura pelagica*	Magnolia Warbler	*Dendroica magnolia*
Ruby-throated Hummingbird	*Archilochus colubris*	Yellow-rumped Warbler	*Dendroica coronata*
Belted Kingfisher	*Ceryle alcyon*	Black-throated Green Warbler	*Dendroica virens*
Yellow-bellied Sapsucker	*Sphyrapicus varius*	Blackburnian Warbler	*Dendroica fusca*
Downy Woodpecker	*Picoides pubescens*	Prairie Warbler	*Dendroica discolor*
Hairy Woodpecker	*Picoides villosus*	Black-and-white Warbler	*Mniotilta varia*
Northern Flicker	*Colaptes auratus*	American Redstart	*Setophaga ruticilla*
Pileated Woodpecker	*Dryocopus pileatus*	Ovenbird	*Seiurus aurocapilla*
Eastern Wood-Pewee	*Contopus virens*	Louisiana Waterthrush	*Seiurus motacilla*
Alder Flycatcher	*Empidonax alnorum*	Mourning Warbler	*Oporornis philadelphia*
Least Flycatcher	*Empidonax minimus*	Common Yellowthroat	*Geothlypis trichas*
Eastern Phoebe	*Sayornis phoebe*	Scarlet Tanager	*Piranga olivacea*

Great Crested Flycatcher	*Myiarchus crinitus*	Chipping Sparrow	*Spizella passerina*
Eastern Kingbird	*Tyrannus tyrannus*	Field Sparrow	*Spizella pusilla*
Blue-headed Vireo	*Vireo solitarius*	Savannah Sparrow	*Passerculus sandwichensis*
Warbling Vireo	*Vireo gilvus*	Song Sparrow	*Melospiza melodia*
Red-eyed Vireo	*Vireo olivaceus*	White-throated Sparrow	*Zonotrichia albicollis*
Blue Jay	*Cyanocitta cristata*	Dark-eyed Junco	*Junco hyemalis*
American Crow	*Corvus brachyrhynchos*	Northern Cardinal	*Cardinalis cardinalis*
Tree Swallow	*Tachycineta bicolor*	Rose-breasted Grosbeak	*Pheucticus ludovicianus*
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	Indigo Bunting	*Passerina cyanea*
Bank Swallow	*Riparia riparia*	Bobolink	*Dolichonyx oryzivorus*
Cliff Swallow	*Petrochelidon pyrrhonota*	Red-winged Blackbird	*Agelaius phoeniceus*
Barn Swallow	*Hirundo rustica*	Eastern Meadowlark	*Sturnella magna*
Black-capped Chickadee	*Poecile atricapillus*	Common Grackle	*Quiscalus quiscula*
Tufted Titmouse	*Baeolophus bicolor*	Brown-headed Cowbird	*Molothrus ater*
Red-breasted Nuthatch	*Sitta canadensis*	Baltimore Oriole	*Icterus galbula*
White-breasted Nuthatch	*Sitta carolinensis*	Purple Finch	*Carpodacus purpureus*
American Goldfinch	*Carduelis tristis*	House Finch	*Carpodacus mexicanus*
House Sparrow	*Passer domesticus*		

Management Recommendations

Stream managers should consider the following general recommendations to maintain and protect important stream corridor habitats:

- Limit disturbance and protect both small and large stream corridor wetlands that provide significant habitat for amphibians, reptiles, and breeding birds in the watershed;
- Most shrub land breeding birds are relatively tolerant of human development if appropriate habitats exist, and unlike some grassland birds, do not require large habitat patches for breeding. While open lands should not be created at the expense of

mature, unfragmented forests, agricultural and suburban landowners who maintain shrubby thickets in the uplands adjacent to stream corridors can support shrub land birds;

- Where possible, plant native species appropriate to the pre-existing or predicted ecological community for a site;
- Riparian buffer widths can be established to conserve habitat function, in addition to water quality, hydrologic, and geomorphic functions. It is particularly important to maintain habitat connectivity needed by wildlife to complete their life cycles. To evaluate connectivity, consider the needs of indicator species, or species of conservation concern in the watershed.
- The forest area within 300 ft of the forest edge is considered "edge" habitat. Edge habitats support increased densities of deer and invasive plants, and are avenues for nest predators to enter forests. A minimum 300 ft forested stream buffer will protect forest health and provide better breeding habitat for forest wildlife;
- Riparian forests at least 50 acres in size with an average total width of at least 300 ft can provide forest interior habitat and should be highly valued. Breeding bird diversity increases substantially between 300 and 1,500 ft from the stream's edge;
- Most of the amphibian and reptile observations in this watershed are within or near stream corridors. Seek to create a minimum 500 ft forested buffer around stream corridor wetlands to provide terrestrial habitat required by stream- and vernal pool-breeding amphibians to complete their life cycles, and to protect wetlands from adjacent land uses;
- Buffer widths of 30-100 ft should be maintained for riparian forest canopies to provide enough shading and cooling of streams to maintain trout populations. These buffers need to be nearly continuous. Some studies suggest 80% of banks along a stream supporting trout populations must have forests at least 30 ft wide to provide sufficient shade for trout;
- Minimum buffers of 50-100 ft are often recommended to protect aquatic communities. Large woody debris deposited into streams provides important shelter for fish, and in particular for trout. At a minimum, a 50 ft buffer appears necessary to maintain sufficient woody debris inputs to streams. Riparian vegetation provides

leaves and other forms of litter that feed macro invertebrates. In turn, aquatic macro invertebrates are the major food source for most freshwater fish. A minimum 100 ft buffer is recommended to protect aquatic macro invertebrate and fish abundance.

References

Chiras, D. and Rega, J.P. 2002. Natural resource conservation: management for a sustainable future, 8th Edition. Pearson Prentice Hall, Upper Saddle River, N.J.

Cretaz, Avril L., Barten, Paul K. 2007, *Land Use Effects on Streamflow and Water Quality in the Northeastern United States,* CRC Press.

Gregory, S.V., F.J. Swanson, W.A. McKee, K.W. Cummins. 1991. An ecosystem perspective of riparian zones. BioScience. 41(8):540-550.

Keller, E. A., and F. J. Swanson. 1979. *Effects of Large Organic Material on Channel Form and Fluvial Processes* 4:361-380.

Kohler, Christopher C., Hubert, Wayne A, 1999, *Inland Fisheries Management in North America*, American Fisheries Society.

New York National Heritage Program Conservation Guides:

http://www.acris.nynhp.org

Nichols, Peter M., 2007, *Geographic Information Systems to show Trout Presence in Selected Streams in Schoharie County, New York.* Dept. of Fisheries & Wildlife SUNY Cobleskill, NY.

Speaker, R., Moore, K., and Gregory, S.V. 1984. *Analysis of the process of retention of organic matter in stream ecosystems.* International Association of Theoretical and Applied Limnology 22:1835-1841.

Information on Schoharie County Bluebird Society can be found at:

http://www.highlightskids.com/Science/Stories/SS0302_mrBluebird.asp

Information on bird species indigenous to the Manor Kill watershed can be found at:

http://www.dec.ny.gov/cfmx/extapps/bba/index.cfmttp://

2.10 Recreational Opportunities

Primarily authored by the Schoharie County Soil and Water Conservation District

Schoharie County is a diverse landscape offering many opportunities for outdoor recreation. The natural and cultural heritage of this region is inextricably linked to the unique high quality streams that course through its mountains and valleys. These resources play a defining role in the character of its landscape. Recreation in and around these streams provide visitors and residents with many opportunities to reconnect with the natural world.

Schoharie County Forest Preserves

Schoharie County is home to several New York State Parks each offering its own unique setting and types of recreation. A few of these State Parks are within the Manor Kill Watershed (Figure 2.10.1). The New York State Department of Environmental Conservation (DEC) manages lands in the forest preserve according to its classification in the Catskill Park State Land Master Plan (NYSDEC, 1985). Management recommendations are based on specific land characteristics and its capacity to withstand certain uses. These public uses include Wild Forest, Wilderness, Intensive Use, and Administrative Use. DEC's Catskill Forest Preserve Map and Guide graphically depict the locations of these different management areas and uses. This information can be obtained by visiting the DEC's Regional office for your area of interest. A listing of DEC offices as well as the areas they cover can be found at www.dec.ny.gov. There is also an interactive map on the site that illustrates locations of state parks throughout Schoharie and

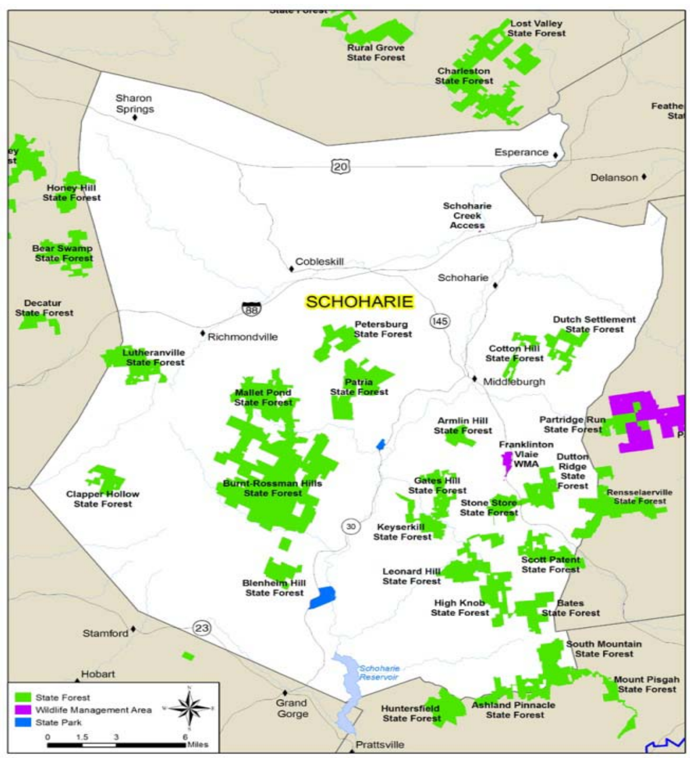


Figure 2.10.1 Schoharie County State Parks and Forest Preserves

surrounding counties (Figure 2.10.2). This map can be accessed directly through the following web address: http://www.dec.ny.gov/docs/lands_forests_pdf/cpslmpmap.pdf .

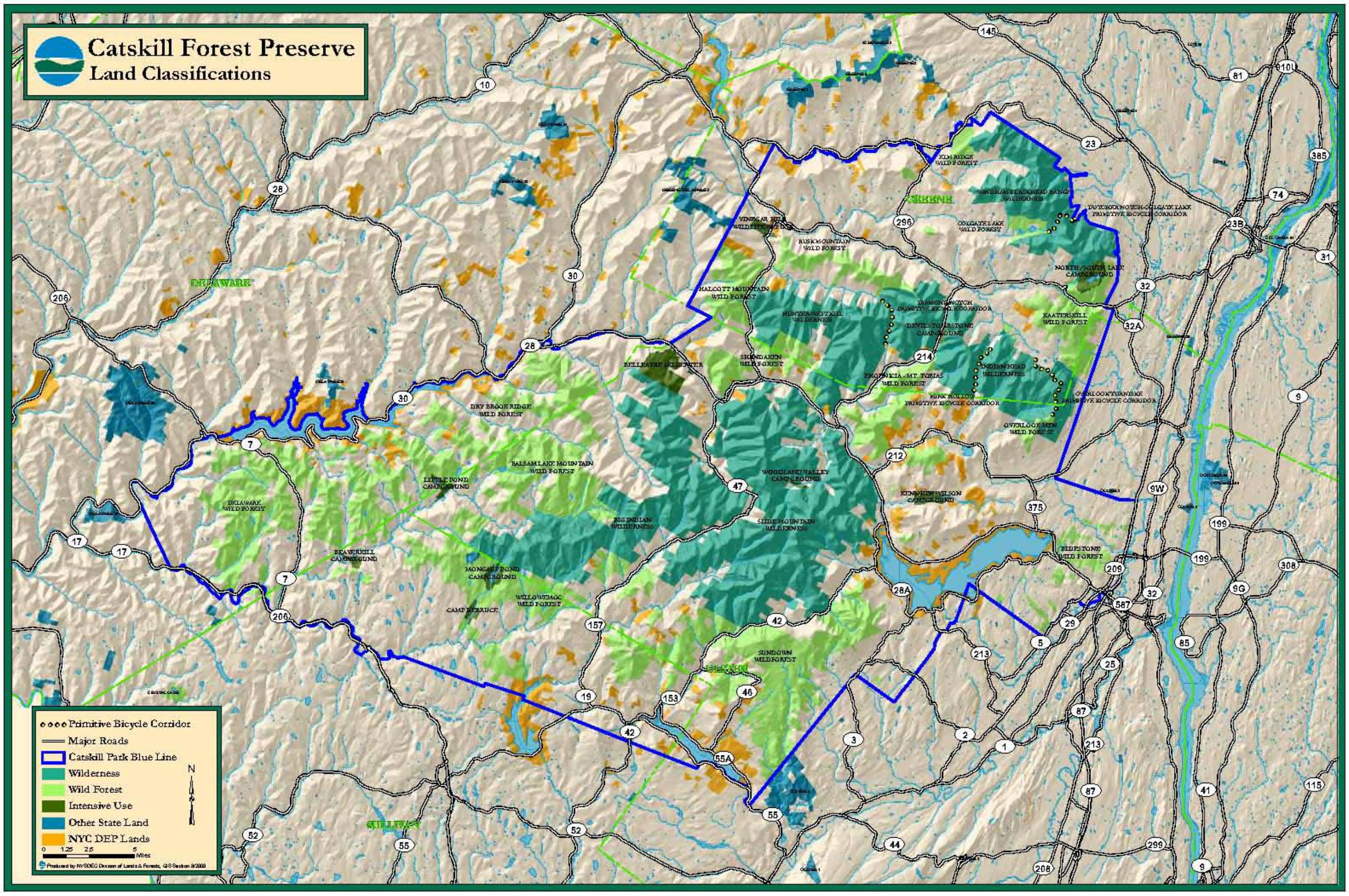


Figure 2.10.2 DEC Map Illustrating Forest Preserve Areas in the Catskill Forest Preserve Program

Some of these State forests may provide hunting, fishing, snowmobiling, skiing, camping, or hiking, opportunities. For more information about DEC recreation available at certain state parks, you can access their website at: http://www.dec.ny.gov/index.html.

NYCDEP Recreational Land

Areas in and around the Manor Kill watershed contain a diverse variety of habitats for wildlife. In addition to private forested land, there are several state forests nearby that can provide tremendous hunting, fishing, and hiking opportunities. Many of these areas are private property of the New York City Department of Environmental Protection (NYCDEP). However, special permits are issued for recreational activities within these protected areas. A list of types of activities allowed as well as accessible locations can be found on DEP's website at www.nyc.gov/dep (Table 2.10.1). Moreover, within the DEP website, detailed maps may be accessed which will give a more detailed description of the Wildlife Management Unit WMU (Figure 2.10.3).

Table 2.10.1 NYSDEP Wildlife Management Units within the Manor Kill Watershed Providing Recreational Activities with Special Permits

Map #	Area	Town	Location	WMU+	Hike	Fish	Hunt	Acres
37	Road 7 Unit	Gilboa	NYC Road7	4R	No	No	No	148
38	Bull Hill Unit	Conesville	Bull Hill Rd.	4G	Yes	Yes	Yes	90
39	Hubbard Hill Unit	Conesville	E. Conesville Road	4G	Yes	No	Yes	290
40	Hubbard Hill South Unit	Conesville	Hubbard & Bearkill Roads	4G	Yes	No	Yes	110
41	Bearkill Unit	Conesville	Bearkill Road	4G	Yes	No	Yes	115
42	Manorkill Unit	Conesville	Potter Mountain Road	4G	Yes	No	Yes	240
43	West Conesville Unit	Conesville	Bull Hill Road	4G	Yes	No	Yes	245
44	Macumber Road Unit	Conesville & Prattsville	Macumber Road	4R	Yes	No	Yes	142
45	Bluebird Road Unit	Conesville	South Mountain & Bluebird Roads	4R	Yes	No	Yes	222

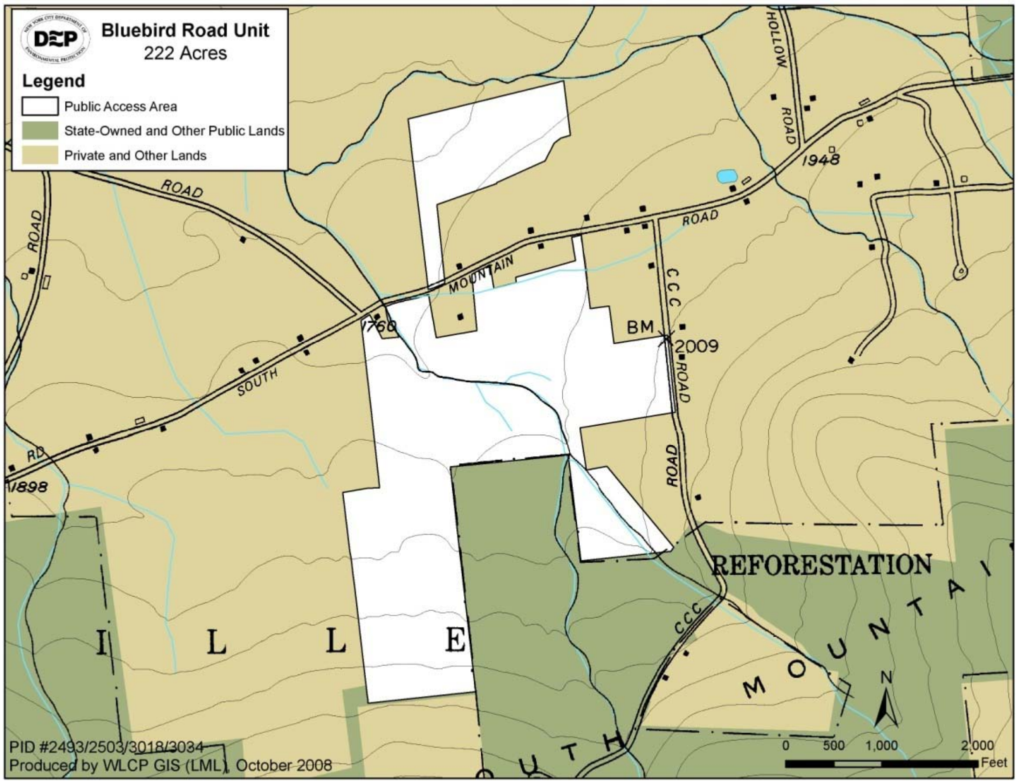


Figure 2.10.3 DEP Map Illustrating Wildlife Management

Hiking

The Long Path which runs almost parallel to the Manor Kill for a distance is a 347.35-mile (559 km) long distance hiking trail running from the George Washington Bridge in Fort Lee, New Jersey to Altamont, New York, in the Albany Area (Figure 2.10.4). It offers hikers an incredible diversity of environments to pass through, from suburbia and sea-level salt marshes along the Hudson to wilderness and boreal forest on Catskill summits 4,000 feet (1219 m) in elevation.

From Huntersfield the trail makes its way via a combination of roads, woodlots and field edges to Schoharie Reservoir and then enters the county of the same name. First stop is Mine Kill State Park and its waterfall, then the trail crosses through the woods to Lansing Manor at the Blenheim-Gilboa Power Project. It dips down into the Schoharie Creek valley and crosses to Eminance and Patria state forests on the other side, then up NY 30 to Vroman's Nose, a popular local hike.

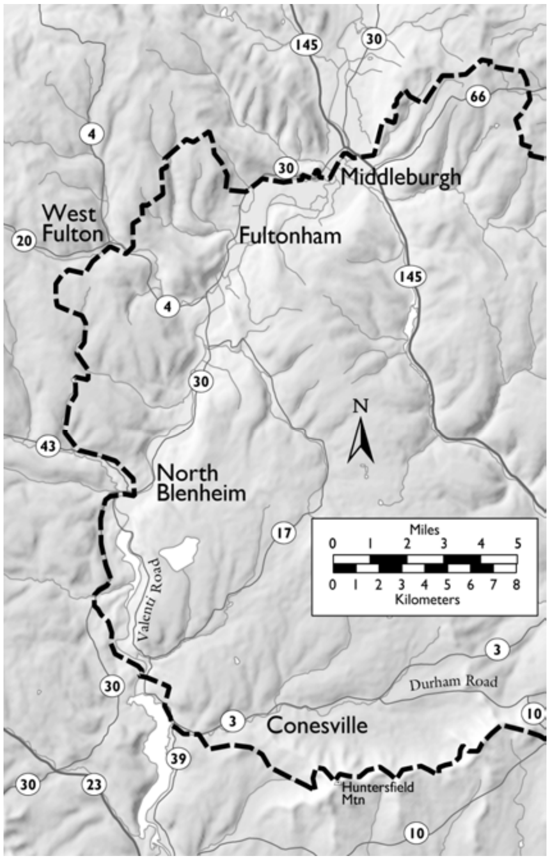


Figure 2.10.4 Map Illustrating Long Path Route through Conesville and North Blenheim, Schoharie Co.

The Long Path is currently under the purview of the Trail Conference, which divides it geographically into three sections:

- The Long Path South Committee for the areas south of the Catskills
- The existing Catskill Trails Committee for the Catskills
- The Long Path North Committee.

Throughout most of its length, whether on or off the road, the Long Path is indicated by a 2-by-4-inch (5 by 10 cm) aqua blaze. In some areas where blazes have not been repainted in some time, older light blue blazes may be found; but the distinctive "parakeet" aqua (sometimes referred to, incorrectly, in some guidebooks as teal) indicates the Long Path, and only the Long Path.

Parakeet Aqua Long Path Paint Blaze

Fishing

Although the DEC ceased stocking the Manor Kill in the mid to late 1990s, there remains a strong population of game fish. Native Brook Trout and Brown Trout populations have been captured by local anglers as well as during fish surveys conducted by the State University of New York at Cobleskill and the NYSDEC. This is indicative of good trout habitat being found throughout scattered portions of the Manor Kill watershed including the Bear Kill. Currently there is no public access fishing easements on the Manor Kill except by special permit on DEP properties (see above). Trout fishing season in New York is open from April 1st through October 15th. To view more information on the fishing season for these and other species of fish in New York State, see the Freshwater Fishing Guide at: http://www.dec.ny.gov/outdoor/fishing.html.

References

NYSDEC. 1985 Catskill Park State Land Master Plan. New York State Department of Environmental Conservation (DEC), Albany, NY.

2.11 Stakeholders

When discussions first began about the development of the Manor Kill Management Plan, local stakeholders were quick to show their interest in the proposal. On May 22, 2007 an informal meeting was scheduled by GCSWCD and SCSWCD to inspect a stream side property in the hamlet of Manor Kill. Over 20 local residents came out to learn more about the Stream Management Plan process and express their support for the project.

In late summer of 2007, it was agreed that DEP and GCSWCD, with cooperation from the SCPD and SCSWCD would complete the Manor Kill Management Plan. Shortly thereafter, the Town of Conesville was awarded funding from the Catskill Watershed Corporation's Schoharie Watershed Impact Statement Program. The grant project proposed to develop a Generic Environmental Impact Statement (GEIS) to assess the impact of future development on water quality in the Manor Kill Watershed. The two projects were designed to compliment each other and provide Conesville with a comprehensive assessment of both the stream corridor and the entire Manor Kill Watershed.

With the stream management plan development process well-established from previous projects, and the concerns of regional stakeholders already recorded, efforts were made to ensure that local stakeholders had ample opportunity to learn about the project and get involved. Input from local residents, elected officials and community organizations were solicited to ensure that the final products would be well-supported. Direct outreach was provided at monthly Town Board and Planning Board meetings. Additionally, three subsequent public meetings held in October 2007, February 14 and April 2008 were held to solicit local input for the SMP and the GEIS.

A selection of the comments received at meetings are highlighted below:

- fond memories of the stream when it was in better condition

- opportunity for outdoor recreation
- erosion of streamside properties
- costs of repairing flood-damaged infrastructure
- loss of farmland due to moving stream bed

In general, stakeholders agreed that the Manor Kill was an important feature of the Town, despite its associated problems. There was an expressed desire to see the stream return to a healthy state for the benefit of streamside landowners, outdoor enthusiasts and wildlife. All of the stakeholders listed in Table 2.11.1 have an interest in maintaining the Manor Kill as a well-functioning natural resource, and many of them have direct management influence over it. With the completion of the plan, the next phase will include review of the plan's recommendations by the community, stakeholders and the Watershed Committee. The plan will then be revised to ensure that it adequately reflect stakeholders' concerns, and then presented to the various municipalities and agencies for formal adoption and implementation.

Table 2.11.1. Stakeholder groups within the Manor Kill Basin

Landowners	Federal Emergency Management Agency
Town of Conesville	NYC Department of Environmental Protection
Town of Conesville and Schoharie County Highway Departments	NYS Department of Environmental Conservation
Schoharie County Soil & Water Conservation District	US Environmental Protection Agency
Greene County Soil &Water Conservation District	NYS Department of Transportation
Schoharie County Planning Department	Army Corps of Engineers
Local businesses,	Private Utility Companies
Community Organizations (Trout Unlimited, Rod-And-Gun Club, Schoharie River Center)	NY State Emergency Management Office

Occurring simultaneously with the initiation of the Manor Kill project were the activities Schoharie Turbidity Task Force. This project was designed to develop a turbidity reduction strategy for the Schoharie basin. The project included the surveying of stakeholder interests to better understand the challenges that turbidity poses to various interest groups (i.e. local residents, fishermen, water supply, local officials, highway crews, etc.). In addition, the group recommended the hosting of a "turbidity summit" to present turbidity concerns within the

Schoharie basin, recommend possible best management practices to reduce turbidity and to gather input from ~ 100 attendees. Final turbidity reduction recommendations were completed in early 2008 and are available at www.catskillstreams.org/majorstreams_sc.html.

Schoharie Turbidity summit break-out session (1 of 3), January 27, 2007.

The Turbidity Task Force continues to provide bi-annual educational programs—the watershed summit and the watershed tour—for local stakeholders. These outreach programs are aimed at local decision-makers in particular, to identify and enable the implementation of better stream management practices.

2.12 Agency Contacts and Program Resources

Technical Assistance

A wealth of information and assistance is available to local municipalities, landowners, and businesses in the Catskill/Delaware watershed. Services are wide ranging through a variety of programs. Although funding and grant opportunities may not always be a possibility, the organizations listed below offer a variety of solutions for water quality, infrastructure, and property protection. Please do not hesitate to contact these resources with questions and requests. Many of these organizations also offer grant and other funding opportunities. Please see the grant resources list at the end of this section for more information on monetary support (Table 2.12.1).

Soil & Water Conservation Districts (SWCD)

With a conservation district in each county, these local entities provide a variety of services to its local constituency. Most districts focus on offering agricultural assistance with best management practices (BMPs) through design, installation, and oversight. These BMPs include water management such as diversions, barnyard management systems, manure storages, grazing systems, and animal water systems. Other services include riverfront revitalization, plant materials supply, environmental education, permit assistance, flood mitigation, and stream restoration. The SWCDs are often a good starting place for information and assistance. If they cannot help you, they can most likely point you in the right direction.

Greene: Executive Director
(518) 622-3620

Schoharie: Executive Director
(518) 234-4092

Delaware: Executive Director
(607) 865-7161/7090

New York City Department of Environmental Protection (NYC DEP)

http://nyc.gov/html/dep/html/drinking_water/index.shtml

The Bureau of Water Supply works closely with landowners to achieve goals in an environmentally sensitive manner. NYC DEP has a variety of programs that assist landowners with the management of their property and streams. Please see below for a brief description of the various programs.

Land Acquisition: In 1997, the DEC issued a permit that allowed the DEP to acquire land for the purpose of watershed protection. The acquisition of land is one of the best ways to ensure the ongoing prevention of pollution and to prevent future water quality problems from occurring as a result of adverse development close to critical natural features and reservoir intakes. Purchase of land at fair market value or placement in an easement is negotiated only from willing sellers. Interested parties should contact the Land Acquisition Program @ 1-800-575-LAND or (845) 340-7837.

Stream Management: DEP's Stream Management Program was established in 1992, and formalized in 1996, as one of the watershed community partnership programs included in the 1996 Watershed Memorandum of Agreement. Its mission is to establish long-term stewardship of streams through a watershed-scale, community-based, geomorphic approach, and the development of Stream Management Plans for priority sub-basins in the NYC Water Supply West-of-Hudson (WOH) watersheds. Essential to achieving this goal is the provision of technical assistance to local municipalities, landowners, and businesses within the watershed. Staff members also offer training and educational programs regarding these topics. Concerns or requests for service should be made to the Stream Management Program at (845) 340-7850.

Land Management: The Land Management Program develops land resource management plans for DEP properties, conducts a recreational review, and develops basin plans, incorporating specific property by property uses and stewardship. In addition, the DEP implemented a public access program that of august, 2006 had made 65% of acquired lands in the Schoharie basin available for recreational purposes like hiking, hunting, and fishing. For additional information call (845) 340-7862.

The DEP also oversees a number of other programs like the watershed agricultural and watershed forestry programs, sewer and septic maintenance, economic development, and watershed education through the Catskill Watershed Corporation (CWC). Please see the CWC description below for more details.

New York State Department of Environmental Conservation (NYS DEC)

http://www.dec.ny.gov

Many water related programs are offered by the NYS DEC. The agency has various divisions, which handle watershed assessment and management, environmental education, fisheries, and flood protection. Information about the DEC stocking schedule, fishing licensing, and access points is available at http://www.dec.ny.gov/outdoor/fishing.html or by calling (607) 652-7366 for Region 4.

To receive information regarding any flooding issues and the National Flood Insurance Program, see http://www.dec.ny.gov/lands/24267.htmlor call (518) 402-8141 about flood control projects or (518) 402-8146 about flood plain management.

In addition to the above services, the DEC is also the regulatory agency for the state of New York's waterways. Having classified Catskill streams, the DEC requires a Protection of Waters Permit for disturbing the bed or banks of a stream. Please contact the following for direction and advice.

Greene/Delaware/Schoharie Bureau of Habitat
65561 St Hwy 10
Stamford, NY 12167
(607) 652-7366

U.S. Army Corps of Engineers (ACOE) New York District

www.nan.usace.army.mil/index.htm

The Army Corps of Engineers has a variety of duties related to stream management. If a municipality or landowner wishes to install a water-related structure, dredge or fill a stream, or affect a wetland area, ACOE will often assign a field technician to visit the sight in order to evaluate the need for a federal permit. ACOE also offers engineering designs and other technical expertise. In addition, they are available for planning, designing, and constructing flood control projects. For a field technician contact the office listed below:

Delaware/Greene/Schoharie: (518) 273-7420

Catskill Watershed Corporation (CWC)

www.cwconline.org

The CWC is a not-for-profit corporation with a dual goal: to protect the water resources of the New York City Watershed west of the Hudson River while preserving and strengthening communities located in the region. Although the CWC is mainly a source of funding (see grant information section), they can also provide technical assistance. Pertinent programs for Catskill/Delaware stream stakeholders include the Stormwater Controls for New Construction, Stormwater Retrofit, Septic System Rehabilitation and Replacement, and Alternate Design Septic Program. For more information call (845) 586-1400.

The Septic Rehab and Replacement program, administered by The Catskill Watershed Corporation (CWC) reimburses permanent residents 100 percent of eligible costs of repairing or replacing a failed septic system. Non-primary residents are reimbursed 60 percent of eligible costs. Eligible systems must be a one or two family residence or home-business combination using less than 1,000 gallons per day, and be located in the NYC Watershed in Delaware, Greene, Schoharie, Sullivan or Ulster Counties. The septic system must be located within 150-feet of a watercourse or within 500 feet of a reservoir or reservoir stem in the West-of-Hudson (WOH) Watershed. This program does not pay for new septic systems serving newly constructed home; or for new or repaired systems intended for commercial or institutional use (CWC, 2006).

The Septic Maintenance program is intended to extend the life of septic systems serving one and two family households in the West-of-Hudson Watershed. This program is open to homeowners anywhere in the NYC WOH watershed, who have had a new, or replacement septic system installed after January 21, 1997, and at least three years ago. This program reimbursed homeowners for up to 50% of the eligible cost for septic system inspections and pump-outs.

Watershed Agricultural Council (WAC)

www.nycwatershed.org

WAC offers the Watershed Agricultural Program and the Watershed Forestry Program. WAC subcontracts with local, state, and federal agricultural assistance agencies, Cornell University, and the private sector to provide planning, education, training, engineering, scientific, and administrative support.

Watershed Agricultural Program (WAP)

WAP strives to protect the high water quality from agricultural nonpoint source pollution through the planning and implementation of Best Management Practices (BMPs) on farms. Using traditional and non-traditional BMPs, WAP strives to offer a variety of alternatives to farmers that promote the health of their land and the stream. Some specific programs are Whole Farm Planning, the Conservation Reserve Enhancement Program, Nutrient Management Planning, and Small Farm Program. Call (607) 865-7790 or email info@nycwatershed.org with questions or requests.

Conservation Reserve Enhancement Program (CREP)

This program is available to current agricultural landowners or landowners who may not currently farm land, but whose property has a history of agricultural use. CREP is a program for promoting the health of streamside vegetation by providing rental payments for buffer lands that are taken out of production, as well as 100% funding for tree/shrub planting. This program also helps landowners implement stream fencing and livestock watering facilities and other BMPs.

Watershed Forestry Program (WFP)

The Watershed Forestry Program is a voluntary partnership between New York City and the upstate forestry community that maintains well-managed forests as a preferred land use for watershed protection. In 2001, forests covered approximately 85% of the Schoharie basin land area, and a majority of this forest land is privately owned and managed by thousands of individual landowners. To promote forest stewardship and encourage long-term investment in private forestry, the Forestry Program offers cost-sharing to landowners for developing 10-year forest management plans written by qualified professional foresters.

Participating landowners must own at least 10-acres of forest land in the watershed. The Forestry Program also offers a variety of cost-sharing, technical assistance and other incentive programs to both loggers and landowners for implementing certain forestry practices that protect water quality, such as properly installing new timber harvest roads and stream crossings or remediation of existing forest roads that have documented erosion problems. Owning a watershed forest management plan is actually a prerequisite for many of these programs. Forest landowners may also attend a variety of educational workshops and other training events that are periodically sponsored throughout the watershed. For more information, call (607) 865-7790 or email forest@catskill.net.

National Rural Water Association

www.nrwa.org

The National Rural Water Association is a non-profit federation of State Rural Water Associations. Their mission is to provide support services to State Associations who have more than 22,000 water and wastewater systems as members. See description below for New York state contact information.

New York Rural Water Association

http://www.nyruralwater.org/technical_assistance/technical.cfm

New York Rural Water Association (NYRWA) is a not-for-profit group organized in 1979 with the goal of promoting the development, improvement, and sound operation of rural drinking water and wastewater systems throughout New York State. New York Rural Water Association recently expanded its scope to offer training, technical, and administrative assistance to rural communities on solid waste management matters as well. Contact (518) 828-3155, or visit nyruralwater.org.

Federal Emergency Management Agency (FEMA)

http://www.fema.gov/ www.msc.fema.gov

FEMA is the federal government agency responsible for administering emergency and disaster relief, recovery, planning and preparedness programs across the United States and territories. While FEMA's most apparent role is emergency response and recovery, its role in risk reduction through the establishment of building codes and administration of insurance programs, like the national flood insurance program, provide protection against losses of life and property in the case of an emergency or natural disaster. Based in Washington, FEMA operates regional offices across the United States including the Region II office in New York City, covering New York State. FEMA works in cooperation with other federal agencies and State and local emergency response entities such as the State Emergency Management Office (NYS SEMO) and county Emergency Management officials (please see below). FEMA provides training to state and local officials on most aspects of their work including emergency response, disaster response planning, hazard mitigation planning, code interpretation and enforcement. Following a Presidentially declared disaster, FEMA's assistance can be available to state and local government, private individuals, and businesses.

Floods are the most common disaster that would require FEMA involvement with Catskill watershed communities. To protect against flood damages and the loss of life associated with flood events, FEMA provides the following types of assistance:

- Administration of the National Flood Insurance Program (NFIP). Through this program FEMA prepares flood insurance rate maps (FIRMs) that define where floodwaters are likely to cause damage to property. These maps provide communities with a tool to prevent losses through the limitation of building and flood plain modification within these flood zones (Maps provided at FEMA's Map Service Center where you can access the most current FIRM maps: www.msc.fema.gov).
- Management of hazard mitigation programs that help communities identify and modify situations and places at risk during flood events. This would include the development of hazard mitigation plans prepared by communities to help the community reduce or avoid threats to life or property during flood events.
- Following flood events that are declared by the President to be a disaster for a specific county, FEMA typically provides assistance for temporary housing, clean-up, repairs to private structures and repairs to public infrastructure. The availability of this assistance depends on the magnitude of the disaster and the types of losses incurred by the county and its residents. The Small Business Administration also can provide assistance with low interest loans to private business. FEMA programs are modified frequently and therefore the type and level of assistance will vary from event to event.
- FEMA plays its most important role as a coordinator of response and information in times of a disaster.

To contact the FEMA Region II office, please call (212) 680-3600.

New York State Emergency Management Office (NYS SEMO)

www.semo.state.ny.us

As stated above, the New York State Emergency Management Office is the state entity for pre- and post disaster assistance. Like FEMA, the state office provides planning and resources through cooperation with local governments, volunteer organizations like Red Cross, and the private sector. Where FEMA is primarily involved immediately after a disaster event, SEMO provides long-term recovery solutions. The state agency is more involved in the day to day planning and preparation for disaster response. Below are summaries of some of SEMO's major programs.

Mitigation: This may be one of SEMO's most influential programs by providing preventative assistance to communities within the Catskills. Mitigation efforts intend to reduce negative impacts of floods and other major disasters by preparing pre-disaster planning. This program also aims to identify potential threats and repeatedly damaged structures and to offer positive solutions to reduce future losses and protect against the loss of life and property. It is the intention that preventative efforts will greatly reduce the cost of recovery and will also reduce the loss of property. SEMO manages a Hazard Mitigation Grant program available to communities that prepare hazard mitigation plans. Communities preparing the plan are eligible for grant program funds to implement hazard mitigation projects following Presidentially declared disasters within New York State. Individuals living in communities with plans may benefit from the program through the reduction in flood insurance rates.

Disaster Recovery Assistance: Recognizing that not all disasters can be prevented, this program aims to provide local assistance for faster recovery by coordinating public assistance funds, disaster housing assistance, individual family grants, and small business administration assistance.

Other Emergency Assistance: SEMO also provides a variety of services during times of emergency. These services include state of the art communications, information dissemination, and emergency operation coordination. Call the Emergency Coordination Center at (518) 929-2200 with questions or requests.

Schoharie County Emergency Management Office

For assistance with flood damage and all related emergencies contact the Schoharie County Emergency Management office at: 518 295-2276

Judith L. Warner, Director: judithwarner@co.schoharie.ny.us

Cornell Cooperative Extension (CCE)

www.cce.cornell.edu

Cooperative Extension builds partnerships and coalitions with individuals, communities, organizations, government agencies, and businesses around issues of mutual concern; develops local leaders who use CCE knowledge to inform decisions; promotes youth development through 4-H clubs and other experiences; strives to help participants make informed choices using the best knowledge available; connects learners with educational resources found in locations throughout the world; consults with individuals and groups on multiple topics; provides resources via technologies such as the World Wide Web, satellite, and compressed video.

Greene:	(518) 622-9820	*Schoharie*:	(518) 234-4303
	greene@cornell.edu	schoharie@cornell.edu	
Delaware:	(607) 865-6531		
	delaware@cornell.edu		

Natural Resources Conservation Service (NRCS)

www.nrcs.usda.gov

NRCS puts nearly 70 years of experience to work in assisting owners of America's private land with conserving their soil, water, and other natural resources. Local, state and federal agencies and policymakers also rely on their expertise. They deliver technical assistance based on sound science and suited to a customer's specific needs. Cost shares and financial incentives are available in some cases. Most work is done with local partners.

NRCS's partnership with local conservation districts serves almost every county in the nation, and the Caribbean and Pacific Basin. Participation in our programs is voluntary. Please see below for local contact information.

Greene: Ghent Service Center (518) 828-4385

Schoharie: Cobleskill Service Center (518) 234-4092

Delaware: Walton Service Center (607) 865-4005

United States Geological Survey (USGS)

ny.water.usgs.gov

The USGS provides the Nation with reliable information about the Earth to minimize the loss of lives and property from natural disasters, to manage biological, water, mineral, and energy resources, to enhance and protect the quality of life, and to contribute to wise economic and physical development. The USGS provides a variety of assistance related to the four main categories of biology, geography, geology, and water. The water division is broken down into ground water, surface water, and water quality. Individuals can find a multitude of data throughout the website, search various resource databases, and view a number of maps. For more information call the Troy office at (518) 285-5600.

Catskill Forest Association (CFA)

www.catskillforest.org

The Catskill Forest Association is a non- profit organization dedicated to enhancing all aspects of the forest in New York's Catskill region. CFA offers educational programs at all levels, from one-on-one site visits at landowner properties to group woods-walks, workshops and seminars. School-based activities include classroom visits and teacher training such as the Watershed Forestry Institute. CFA is also active in advocating for proper forest management, as well as promoting the economic development of viable markets for a variety of forest products. For more information, email cfa@catskill.net or call (845) 586-3054.

Catskill Center for Conservation and Development (CCCD)

www.catskillcenter.org

The Catskill Center is a non-profit organization working to protect the cultural, historic, and natural resources of the Catskill Mountains. The CCCD has a few integrated program areas:

Land Conservation & Natural Resource Protection: This program identifies, monitors, and engages in effective actions to protect and preserve sensitive, ecologically significant, aesthetically, or recreationally critical lands and waters.

Community Outreach and Planning Assistance: This program provides technical support to rural communities in the Catskills on grant-writing, planning, land use, zoning, subdivision, community empowerment, main street revitalization, regional forums, conferences and workshops, producing reports and publications, and public policy development.

Education: This program consists of a curriculum entitled The Catskills: A Sense of Place, which is a series of five modules on the water resources, geography and geology, ecosystems, human history, and culture and arts of the Catskills. A Sense of Place is designed to give children a better awareness, understanding, and appreciation of the distinctive features of our area. In addition, The Center has partnered with Hudson Basin River Watch to support advanced water quality monitoring efforts by adult volunteer groups. Lastly, they host a hike, lecture, and recreation series for our membership and the general public throughout the year. Visit their website at catskillcenter.org or call (845) 586-2611.

Trout Unlimited (TU)

www.tu.org

Trout Unlimited's mission is to conserve, protect and restore North America's trout and salmon fisheries and their watersheds. TU accomplishes this mission on local, state and national levels with an extensive and dedicated volunteer network. Local TU members have been active in many aspects of stream management planning throughout the Catskill/ Delaware watershed. Not only do they participate in public meetings, legislative activities, and volunteer events, but TU has also funded research projects such as the "Economic

Impact Assessment of the Beaverkill-Willowemoc Trout Fishery" to promote improved trout habitats and stream health. Please contact the following local chapters for further information:

Clearwater Chapter Trout Unlimited 518-399-5550

http://www.clearwatertu.org/index.html

ESRI Environmental Conservation Program (CSP)

www.conservationgis.org/aaesrigrants.html

This program provides donations and discounts of GIS software, data, books, and training. It offers free on-line live workshops. The overall goal of the ECP is to support conservation groups in acquiring, learning, and using GIS tools and methods. ECP has a particular focus on appropriate levels of technology for locally sustainable programs. Its goal is not to throw out one-off donations into a vacuum with no forethought, but to build permanent, locally based support structures that provide ongoing evolutionary growth in GIS skills. Email ecp@esri.com for detailed information.

Enviormental Study Team At The Schoharie River Center

www.schoharierivercenter.org

This is a not for profit organization that provides award-winning youth development programs which provide local youth with an opportunity to learn through hands-on training how to be good stewards of our fresh water resources. The students undergo advance training in chemistry, biology, forestry, archeology, stream and terrestrial ecology.

Catskillstreams.org

www.catskillstreams.org

Well-informed living along Catskill streams begins with understanding stream basics and the important environmental functions and services streams provide, and the relationships among these functions. With this foundation, visitors can view stream stewardship from three stream locations: instream, streamside or watershed community. This website also includes a watershed-based navigation and information of the major watersheds in the Catskills, resource library, watershed plans, and a community calendar of events.

Table 2.12.1. Funding Sources and Agency Contacts

Name	Focus	Due Date	Contact	Award Example	Notes/Priority	on-the-	research	planning	< $20K	$20K to	> $100K	Range
Natural Resources Conservation Service												
Conservation on Private Lands http://www.nfwf.org/AM/Template.cfm?Section=Browse_All_Programs&CONTENTID=3971&TEMPLATE=/CM/ContentDisplay.cfm	Projects that engage private landowners, primarily farmer and ranchers, on the ground project.		NRCS District Conservationist Tom Lacko 518 234-4092 thomas.lacko@ny.usda.gov		Partnership with NRCS or local conservation districts, priority given to landscape, watershed scale projects integrating agriculture, forestry, and ranching that benefit fish and wildlife.	X			X	X	X	10K-150K
Emergency Watershed Protection http://www.nrcs.usda.gov/programs/ewp/factsheet.html	Projects support such work as clearing debris from clogged waterways, restoring vegetation, and stabilizing river banks.	on-going	Highland Service Center 845-883-7162		The measures that are taken must be environmentally and economically sound and generally benefit more than one property owner.	X						
National Oceanic and Atmospheric Administration												
Community-based Restoration http://www.nmfs.noaa.gov/habitat/restoration/projects_programs/crp/index.html	Provides funds for small-scale locally driven habitat restoration projects that foster natural resources stewardship within communities.		Robin Bruckner robin.bruckner@noaa.gov 301-713-0174	Provides funding to implement on-the-ground habitat restoration projects to benefit marine, estuarine and riparian habitats.		X			X	X	X	14K-8 mil.
Federal Emergency Management Agency												
Flood Mitigation Assistance http://cfpub.epa.gov/fedfund/list1.cfm?prog_num=31	Program helps states and communities identify and implement measures to reduce or eliminate the long-term risk of flood damage to homes and other structures.	established by states	Public Assistance Branch, Recovery Division FEMA,DHS 500 C Street, SW Washington, DC 20472 202-646-4262		Two types offered: planning and project grants for National Flood Insurance Program (NFIP) participating communities.	X		X				
U.S. Fish and Wildlife Service												
North American Wetlands Conservation Act Grants http://www.fws.gov/birdhabitat/Grants/index.shtm	Standard and small grants programs help deliver funding to on-the-ground projects through the protection, restoration, or enhancement of an array of wetland habitats.		Standard–David Buie 703-358-2266 Small-Keith Morehouse 703-358-1888	See award examples at: http:/birdhabitat.fws.gov/nawca/grants.htm				X	X	X	X	small=<75K standard=75K-36.2mil.
Partners for Fish and Wildlife http://ecos.fws.gov/partners/viewContent.do?viewPage=home	Restoring former and degraded wetlands, native grasslands, stream and riparian areas, and other habitats to conditions as natural as feasible.	on-going	Carl Schwartz 607-753-9699	The program has partnered landowners to restore wetlands, prairie grassland, and in-stream aquatic and riparian habitat.	Provides technical and financial assistance to landowners interested in voluntarily restoring or otherwise improving native fish & wildlife habitat on their lands.	X			X	X		<25K

Table 2.12.1. Funding Sources and Agency Contacts, Continued

Name	Focus	Due Date	Contact	Award Example	Notes/Priority	on-the-ground	research	planning	< $20K	$20K to	> $100K	Range
Cooperative State Research, Education, and Extension Service												
National Integrated Water Quality http://www.usawaterquality.org/integrated	Supports integrated research, education, and extension projects, as well as, extension/education projects to address water quality issues at the watershed scale.		Mike O'Neill National Program Leader, Water Quality 202-205-5952 moneill@csrees.usda.gov	See award examples at: http:/www.usawaterquality.org/projects	Grant awards to be made to four-year degree granting institutions.		X			X	X	85K-1.3 mil.
State Emergency Management Office												
http://www.semo.state.ny.us	Provides leadership, planning, education, and resources to protect lives, property and the environment.	on-going	State Emergency Coordination Center 518-292-2200 postmaster@semo.state.ny.us			X		X	X	X	X	
Catskill Watershed Corporation												
Catskill Fund for the Future http://www.cwconline.org/programs/econ_dev/econ_dev.html	Funds will be used to make loans and rants to businesses and organizations proposing environmentally responsible projects.	rolling basis	Michael Triolo, Economic Development Director, triolo@cwconline.org Phil Sireci, sireci@cwconline.org	Delhi received money for establishment of Riverwalk Community Park (purchase of riparian property and development of a village riverfront area with canoe access.	This fund program includes a variety of grant and loan programs.	X		X	X	X	X	
Septic System Rehabilitation and Replacement http://www.cwconline.org/programs/septic/rehab.html	This program reimburses homeowners for repairing or replacing damaged septic tanks.		Leo LaBuda labuda@cwconline.org John Jacobson jjacobson@cwconline.org 845-586-1400		Limited to properties in the five-county West-of-Hudson Watershed whose septic systems or property centroids lie within 100 feet of a watercourse. 60% and 100% of eligible costs for non-primary and primary landowners, respectively.	X			X			60%-100% of costs

Table 2.12.1. Funding Sources and Agency Contacts, Continued

Name	Focus	Due Date	Contact	Award Example	Notes/Priority	on-the-ground	research	planning	< $20K	$20K to	> $100K	Range
Catskill Watershed Corporation continued												
Stormwater Controls for New Construction http://www.cwconline.org/programs/strm_wtr/strm_wtr.html	Program to design and construct runoff and erosion control measures.		Thomas De John Professional Engineer tdejohn@cwconline.org	One project will improve stormwater collection and treatment on Railroad Ave., a project intended to decrease pollution and nutrient loading and reduce flow to the village's wastewater treatment plant.		X					X	
Stormwater Retrofit http://www.cwconline.org/programs/strm_wtr/strm_wtr.html	Program to provide funds for stormwater management needed to correct or reduce existing erosion, polluted runoff or other problems associated with stormwater.		Thomas De John Professional Engineer tdejohn@cwconline.org		Projects to implement stormwater BMPs that reduce erosion and/or pollutant loading associate with conditions existing on/or before January 21, 1997 are eligible to apply.	X						
Public Education http://www.cwconline.org/programs/pub_edu/pe.html	Projects that would increase awareness of the region's environment, its natural beauty, and human history.		Diane Galusha galusha@cwconline.org	Tri-Valley Central School, Grahamsville, water monitoring equipment to expand the agricultural and environmental studies programs to include water quality examinations; Ernest Myer School, to bring Streamwatch.		X			X			$750 to $10K
Local Technical Assistance Program http://www.cwconline.org/programs/tech/tech.html	Program addresses projects that enhance pollution prevention management plans or regulations intended to reduce existing /potential erosion and/or pollutant loading or improve the vitality of watershed communities		Thomas De John Professional Engineer tdejohn@cwconline.org	New Program	Preference given to projects that involve municipalities with commitment to adopting management plans, local law, or study recommendations.			X	X	X		<$50K

2.12.1. Funding Sources and Agency Contacts, Continued

Name	Focus	Due Date	Contact	Award Example	Notes/Priority	on-the-ground	research	planning	< $20K	$20K to	> $100K	Range
National Fish & Wildlife Foundation												
Bring Back the Natives http://www.nfwf.org/AM/Template.cfm?Section=Browse_All_Programs&TEMPLATE=/CM/ContentDisplay.cfm&CONTENTID=4095	Funds on-the-ground efforts to restore native aquatic species to their historic range. Can involve riparian habitat restoration, moving streams toward stability and supporting native aquatic communities.	two-decision cycles/year	Corey Grace 415-778-0999 corey.grace@nfwf.org		Projects involving sensitive or listed aquatic species. Does not fund basic research or monitoring.	X				X	X	
Native Plant Conservation Initiative http://www.nfwf.org/AM/Template.cfm?Section=Stewardship&TEMPLATE=/CM/ContentDisplay.cfm&CONTENTID=3966	Projects that protect and enhance, and/or restore native plant communities on public and private land, including protection and restoration, information and education, and inventory and assessment.	two-decision cycles/year	Ellen Gabel 202-857-0166 ellen.gabel@nfwf.org		There is a strong preference for "on-the-ground" projects that involve local communities and citizen volunteers in the restoration of native plant communities. Projects that include a pollinator conservation component are also encouraged.	X	X					10K-50K
Five-Star Restoration Matching Grants Program http://www.nfwf.org/AM/Template.cfm?Section=Browse_All_Programs&TEMPLATE=/CM/ContentDisplay.cfm&CONTENTID=4502	Supports community-based wetland, riparian, and coastal habitat restoration projects that build diverse partnerships and foster local natural resource stewardship through education, outreach and training activities.		Amanda Bassow 202-857-0166 amanda.bassow@nfwf.org	The Mahopac High School will create a half-mile of wetlands along SEAC Creek in front of Mahopac High School by re-contouring the stream corridor and planting native trees and shrubs. The project will serve as a local example of ecological restoration and will be designed as an outdoor classroom for student educational use.	Preference will be given to projects that: Are part of a larger watershed or community stewardship effort; include specific provisions for long-term management, monitoring, and protection; and demonstrate the value of innovative, collaborative approaches to restoring the nation's waters.	X						5K-20K
Watershed Agricultural Council												
NYC Watershed Forestry Program http://www.nycwatershed.org/	Provides cost-sharing incentives and technical assistance to watershed forest landowners to promote forest management planning and to help establish streamside buffers.	rolling assistance	Watershed Forestry Program 607-865-7790 1-800-662-1220 info@nycwatershed.org		Assistance from this program could be used to establish additional grants from matching programs that require existing challenge funds and partnerships.			X	X			

Table 2.12.1. Funding Sources and Agency Contacts, Continued

Name	Focus	Due Date	Contact	Award Example	Notes/Priority	on-the-ground	research	planning	< $20K	$20K to	> $100K	Range
The Conservation Fund												
Kodak American Greenways Award http://www.conservationfund.org/?article=2372	Small grants to stimulate the planning and design of greenways in communities throughout America.	03-01 to 06-01 each year	American Greenways Program 703-525-6300 postmaster@conservationfund.org	North American Water Trails received grant money for its development, enjoyment and stewardship or recreational water trails.	Grants used for appropriate expenses needed to complete greenway project including planning, technical assistance, legal and other costs.			X	X			
ESRI Conservation Program												
Software/Training Donations	Provides donations and discounts of basic GIS software and books.	on-going	grant@esri.com		Does not provide hardware or cash.							
Conservation Program http://www.conservationgis.org/aaesrigrants.html Resource Conservation District Grant Programs http://www.esri.com/grants/esri/conservation.html	Provides donations and discounts of GIS software, data, books, and training.	on-going	ecp@esri.com rcdgrant@esri.com.		Does not provide hardware or cash.							
Tech Grants												
http://www.techfoundation.org	TechFoundation is committed to bringing financial resources, technology solutions and management expertise to non-profits to strengthen the social sector.		techgrants@techfoundation.org 617-354-7500	Colorado Environmental Coalition www.ourcolorado.org	Awardees selected for focus on projects that will bring quality technology resources.	X		X	X			
Earthwatch Institute												
Research Program http://www.earthwatch.org/research	Supports field research worldwide in biological, physical, social, and cultural sciences.	on-going	Earthwatch Institute 1-800-776-0188 info@earthwatch.org	Monitor water quality. Inventory, monitoring, or restoration of watershed environments.	Grants cover cost of maintaining volunteers and research field staff not PI salaries, capital equipment, or overhead.				X	X	X	
Toshiba America Foundation												
www.toshiba.com/taf/apply.html	Contribute to projects designed by classroom teachers to improve science and math education.	on-going	212-596-0620 foundation@tai.toshiba.com	MS received grant for earth science students to conduct a water quality study in their area.		X			X	X		

2.13 Stream-related Activities and Permit Requirements

NYS DEC Permit Requirements

Certain kinds of human activities can have a detrimental impact on water resources. The policy of New York State is to preserve and protect lakes, ponds, rivers and streams, as set forth in the Environmental Conservation Law (ECL) Title 5 of Article 15. To implement this policy, the New York State Department of Environmental Conservation created the Protection of Waters Regulatory Program.

All waters of the State have a classification and standard designation based on existing or expected best usage of each water or waterway segment. The classification AA or A is assigned to waters used as a source of drinking water. Classification B indicates a best usage for swimming and other contact recreation. Classification C is for waters supporting fisheries and suitable for non-contact activities. Classification D, the lowest classification standard, reflects a best usage for fishing.

Waters with classifications, A, B, and C may also have a standard of (t), indicating that it is able to support a trout population, or (ts) indicating that it supports trout spawning. Special requirements apply to sustain these waters that support these valuable and sensitive fisheries resources. The Schoharie Creek and most of its tributaries have a classification and standard of C(t) or higher, and as such are subject to the stream protection provision of the Protection of Waters regulation.

A Protection of Waters Permit is required for disturbing the bed or banks of a stream with a classification and standard of C(t) or higher. For example, 1) the construction of a bridge or placement of a culvert to allow access across a stream; 2) any type of stream bank protection, e.g. placement of rip-rap, or other revetment; 3) lowering stream banks to establish a stream crossing (i.e. creation of a ford); 4) using equipment to remove debris in a stream, all require a permit.

Some examples of activities which are exempt from the requirement to obtain a Protection of Waters permit would be: 1) agricultural activities involving the crossing and recrossing of a stream by livestock or rubber tired farm equipment at an established crossing; or 2) removal of fallen tree limbs or trunks where material can be cabled and pulled from the stream without disruption of the stream bed or banks, using equipment placed on or above the stream bank. There are occasions when permits from other state or local agencies are required; county or town permits, flood plain permits or other approvals may be necessary. The appropriate offices should be consulted. There is no charge for the Protection of Waters Permit. For permit applications and any questions regarding the permit process contact:

NYSDEC Region 4
Bureau of Habitat
65561 St Hwy 10
Stamford, NY 12167
(607) 652-7741
http://www.dec.ny.gov/permits/6042.html

Living Streamside in the Manor Kill:

Frequently Asked Questions about Working In/Near the Stream

Everyone wants their stream to look and be healthy. Stream health can be measured ecologically by the plants and animals that live in it, but also by its riparian (streamside) buffer area and the stability of its bed and banks. A stable stream is one that does not undergo accelerated erosion. This means the stream does not move laterally (the banks remain stable) or vertically (the stream bed does not build up or cut down) over short periods of time. Streams are very sensitive to anthropogenic (man-made) disturbances, and if stream related projects do not take the necessary precautions, a stable stream can quickly become unstable. Experience has shown that many stream related projects (such as flood control or stream bank stabilization) that have been performed in the past have done far more harm than good to the nation's waterways. Studies that have focused on some of these projects have contributed to the development of new technology to better work with the natural ability of streams to remain stable over time.

Following are answers to some of the questions most commonly asked by homeowners about activities they are considering undertaking that may impact the health and stability of streams. Where you may need more information, contacts are provided. Please contact your local Soil and Water Conservation District office for site-specific information.

We have also noted those activities that may not be beneficial to overall stream health. This information constitutes some of the best professional guidance available today.

If you seek to:

1) Construct a private bridge for vehicles or foot-traffic over the stream, or install a culvert under a driveway or along a stream

Resource Guidance: Efforts should be made to avoid widening or narrowing the stream beyond its naturally stable width. Often, you can observe stable conditions in a reach nearby. Each stream has a stable set of dimensions (width, depth and cross sectional area), which are necessary to maintain effective sediment and water transport. Widening or narrowing can lead to stream instability that could also eventually undermine the bridge. To minimize the potential for erosion or other problems, try to locate a bridge at a narrow and straight reach, and not on a bend. A bridge functions much better than a culvert as a stream crossing, so bridges are preferable to culverts wherever possible. A bridge should span the entire stream to reduce potential erosion damages and prevent debris from catching on the bridge in a flood. If a culvert is absolutely necessary, the size and placement are critical to maintaining stream stability and ensuring the culvert stays in place and minimizes impact on fish passage. DEC's Habitat Unit staff can advise you on size and placement. Multiple culverts (two or more) are rarely permitted.

Permits: Depending on the specific conditions of a stream crossing (bridge or culvert) project, permits are required from the Army Corps of Engineers (ACOE), the New York State Department of Environmental Conservation (DEC) and the New York City Department of Environmental Protection (DEP). An ACOE permit is required when more than 25 cubic yards of fill material will be used below the "ordinary high water mark" (the approximate yearly flood level). Because the streambed or banks will be disturbed, stream crossing construction requires an Article 15 Stream Disturbance Permit from the DEC. Depending upon whether or not there are any drainage features (streams or wetlands) on the property that will be involved as a result of the project, it may require a Crossing, Piping and Diversion Permit (DEP). Also, if the bridge is part of new construction that involves disturbance of more than 1 acre, it must be reviewed under the DEC stormwater State

Pollution Discharge Elimination System (SPDES) program. If the project will disturb more than 2 acres, it may need a Stormwater Pollution Prevention Permit (SPPP) from DEP.

Contacts: Start by contacting the DEC Habitat Unit staff to determine which state permits are needed. In Region 4 (Greene, Schoharie and Delaware Counties), contact Jerry Fraine at 607-652-7366. For DEC Stormwater permits in Region 4 contact Peter Freehafer at 518-357-2381 and at DEP, contact Joe Damrath at 845-340-7234.

2) Divert water from a stream

Resource Guidance: Any diversion of water from a stream, especially during warmer summer months, can negatively impact downstream ecology by reducing the amount of cool water available to aquatic life. This condition can be especially urgent when streamflows are naturally at their lowest levels and trout are in survival-mode. Improper installation of pumps or waterlines can also disturb the streambed or banks, and potentially initiate erosion problems that can worsen over time and move up and downstream to neighboring properties. Finally, water taken from the stream for use nearby will eventually return to the stream, often warmer or containing substances (i.e., lawn chemicals, salts, oils or soap from cars or driveways) that may further stress fish and other aquatic life, or reduce water quality for downstream users.

Permits: Any diversion must be reviewed by DEC.

Contacts: Contact the DEC Habitat Unit. In Region 4 (Greene, Schoharie and Delaware Counties), contact Jerry Fraine at 607-652-7366.

3) Pave or repave a driveway near a stream

Resource Guidance: By not allowing water to slow down and percolate into the ground, impervious surfaces (i.e., pavement and buildings) and associated land drainage improvements that occur from development can accelerate rain runoff into streams, changing the amount and timing of water they receive and in effect delivering it all in one big "gush". Generally, by the time a watershed exceeds approximately 10% impervious land cover, the streams that capture the runoff are already impaired. A particular concern is localized streambed or bank erosion that a poorly drained impervious surface can encourage. Localized scour and erosion problems can, quickly or slowly, move upstream or downstream and cause your property or a neighbor's property to erode. Designing "stream friendly" drainage for existing or new impervious surfaces can reduce stream damages from stormwater runoff.

Permits: A DEC Article 15 stream disturbance permit may be required. Seek DEC guidance if the impervious surface is within 50 feet of the stream. If the disturbance is more than 1 acre, it must be reviewed under the DEC stormwater State Pollution Discharge Elimination System (SPDES) program as well. If the project will disturb more than 2 acres, it may need a Stormwater Pollution Prevention Permit (SPPP) from DEP. New driveways being paved for the first time will be required to have a setback from the stream under DEP's regulations.

Contacts: Start by contacting the DEC Habitat Unit to determine what state permits are needed. In Region 4 (Greene, Schoharie and Delaware Counties), contact Jerry Fraine at 607-652-7366. For DEC Stormwater permits, in Region 4, contact Peter Freehafer at 518-357-2381, and at DEP, contact Joe Damrath at 845-340-7234.

4) Cut or trim streamside (riparian) vegetation on the streambank

Resource Guidance: Stable streambanks in the Catskills usually require woody vegetation. Shrub and tree roots provide holding power for streambank soils that cannot be achieved solely by grasses or herbs. For a more thorough discussion on the role of vegetation in stabilizing streambanks, see Section 2.7. To maximize stream bank stability as well as ecological and aesthetic benefits of riparian vegetation, discontinue mowing and allow a buffer of vegetation to grow, or plant woody vegetation.

If you are removing a log jam (a pile of trees that have fallen into the stream and are trapping more trees and stream sediment): this requires technical assistance to ensure that the removal process does not initiate new erosion areas upstream or downstream. These jams can cause considerable property damage. While biologically they may actually be beneficial to the stream, resource management agencies understand the property damage they can cause, and will work with you towards the most beneficial solution. If you are removing individual trees, they must be cut up into smaller pieces and removed from the stream so they will not get caught further downstream and cause or worsen another log or debris jam. If the log jam or falling trees are not on your property, but are causing damage to your property, you must coordinate with your neighbor.

Permits: The DEC will require an Article 15 Stream Disturbance Permit if the project will disturb the bed or banks of the stream.

Contacts: Seek technical assistance from the DEC Habitat Unit. In Region 4 (Greene, Schoharie and Delaware Counties), contact Jerry Fraine at 607-652-7366. DEP Stream Management Program staff can provide assistance, contact Beth Reichheld at 845-340-7838, or contact your local Soil and Water Conservation District: Schoharie County SWCD, Peter Nichols at 518 234-4092.

5) Stabilize an eroding streambank

Resource Guidance: Streambank stabilization is a common need in the Schoharie valley. As the management plan has revealed, there are eroding streambanks that threaten water quality, private property and public and private infrastructure (i.e., bridges, culverts and roads). Care should be taken in designing stabilization work to ensure that you don't over-widen, narrow, or encroach upon the stream. Borrowing fill material from nearby gravel bars in the stream should be avoided (see FAQ #7). Seek technical assistance to identify the set of causes of your streambank instability problem so the solution can addresses these causes, and seek a solution that does not transfer the erosion problem up or downstream. The agencies referenced below can advise you on streambank stabilization projects. Neighboring properties may need to be involved to properly address the erosion concern.

Permits: Streambank stabilization will require a DEC Article 15 Stream Disturbance Permit. An ACOE permit is required when more than 25 cubic yards of fill material will be used below the "ordinary high water mark" (the approximate yearly flood level); the DEC can advise you about determining these limits.

Contacts: Seek technical assistance from the DEC Habitat Unit. In Region 4 (Greene, Schoharie and Delaware Counties), contact Jerry Fraine at 607-652-7366. DEP Stream Management Program staff can provide assistance, contact Beth Reichheld at 340-

7838, or contact your local Soil and Water Conservation District: Schoharie County SWCD, Peter Nichols at 518 234-4092.

6) Build a house or other structure

Resource Guidance: Siting a new home near a stream can define your enjoyment of that stream and relationship to it. Proper location for homes and facilities must consider stream flooding behavior, no matter how high above or far back from the stream the location may appear during low flows. Because some areas on the FEMA floodplain maps may contain errors due to stream channel migration or infrastructure changes over time, technical assistance is necessary to identify approximate floodplain boundaries, and design your site in as "stream friendly" a manner as possible. Give the stream area to flood, and to move (because a slow rate of erosion is a natural stream adjustment process), so you'll be able to enjoy living streamside, as well as reducing home maintenance costs from streambank erosion or flood inundation.

Permits: Of course, many permits are needed for new construction, and listing them is beyond the scope of this guidance document. If the house or structure is within 50 ft of a streambank, contact DEC to determine if an Article 15 stream disturbance permit is needed. If the house or driveway will be within 100 ft. of a perennial (flows all year round) stream, you'll need an Individual Stormwater Permit (DEP). If your project is to construct a single family residence and it will disturb more than 1 acre of land, you must submit a notice of intent to work and an erosion control plan to the DEC under their Stormwater State Pollution Discharge Elimination System (SPDES) program. If your project will disturb more than 2 acres, you'll need a Stormwater Pollution Prevention Permit (DEP). You will also need to follow State and local regulations, and should contact your Town code enforcement officer. In many communities, the building inspector serves in this capacity.

Contacts: For DEC Article 15 permits: In Region 4 (Greene, Schoharie and Delaware Counties), contact Jerry Fraine at 607-652-7366. For DEC Stormwater permits, in Region 4, contact Peter Freehafer at 518-357-2381, and for DEP permits: Joe Damrath, 845-340-7234. Contact your Town clerk for the number of the local code enforcement officer, and/or building inspector.

7) Extract gravel from the stream

Resource Guidance: There is a common belief that cleaning gravel from streams is necessary to improve flood conveyance capacity and reduce flooding. Others wish to use skimmed stream gravel for construction-related projects. Proponents of gravel mining should reflect on stream processes including the concept that a stream must effectively be able to move both water and sediment delivered from its watershed to maintain its shape and provide optimum water quality and aquatic habitat. Therefore, any stream channel alterations should consider the impact not only on moving water, but also on sediment (the gravel) transport, to ensure these qualities of a functioning stream are preserved. Excavating gravel usually disturbs the sensitive balance the stream maintains between its slope (steepness) and the amount and size of sediment it can move. Gravel mining reduces the amount of bed material available in the stream system, as a result the stream begins to erode its bed and banks in efforts to bring its sediment load back into balance with its slope and the amount of water in the stream. Gravel mining typically results in accelerated erosion and deposition processes that harm fish habitat. If you are removing gravel to increase flood conveyance capacity, please bear in mind that this has been found to be a damaging practice. If you are excavating gravel for construction-related projects, a non-stream source should be considered.

Permits: DEC rarely permits gravel removal. Any removal will require a DEC Article 15 Stream Disturbance Permit. An ACOE permit is required when more than 25 cubic yards of fill material will be used below the "ordinary high water mark" (the approximate yearly flood level). The DEC can advise you about the need for an ACOE permit.

Contacts: Start by contacting the DEC Habitat Unit to determine what state permits are needed. In Region 4 (Greene, Schoharie and Delaware Counties), contact Jerry Fraine at 607-652-7366. You can also seek technical assistance from the DEP and/or your local Soil and Water Conservation District: Schoharie County SWCD, Peter Nichols at 518 234-4092, and the DEP Stream Management Program, contact Beth Reichheld at 845-340-7838.

Additional Frequently Asked Questions

From: A Guide to Living in Harmony with Streams by the Chemung County SWCD, *http://www.chemungcountyswcd.com/Tire%20Page.htm*

Who owns the streambed?

New York State is the sovereign owner of the beds of "navigable waters" in the state. This ownership gives the state the right to control the bed and to ensure that navigable waterways shall forever remain public highways. A stream and any contiguous wetlands may be classified as "navigable" if it is large enough for operation of a canoe or larger boat. For information about state ownership of a waterway and the activities for which state approval is required, contact the Lands Underwater program of the NYS Office of General Services (http://www.ogs.state.ny.us/realEstate/permits/luwfaq.html). As a general rule, the ownership and therefore control of the bed of non-navigable streams or other non-navigable bodies of water is vested in the proprietors of the adjoining uplands, unless their deed provides otherwise. In other words, if you own the bank of a non-navigable stream, you probably own the streambed and are referred to as a riparian owner. Regardless of who owns a stream, various government entities retain police power over activities that may impact navigation, public safety, the environment, or the rights of other property owners. Owning a stream does not give you the right to do whatever you please with it.

Who owns the water in a stream?

In New York State, water in a stream is not "owned" by anyone. The relevant question is: Who has the right to use water in a stream? Water rights and water laws vary from state to state. New York follows the riparian rights doctrine developed under common law. Common law means that the rules were not enacted by the legislature, but were developed by the courts through the decisions they hand down. Riparian rights doctrine allows the owners of land bordering on a watercourse to withdraw a "reasonable" amount of water. The courts have generally held that domestic use or use on the land is "reasonable," while removal of water from the riparian property is "unreasonable." Because all landowners along a stream have "riparian rights," none can use the water so as to deprive the others of their rights. If a water use interferes with the "reasonable" use of another riparian owner, the aggrieved party must go to court to protect his/her rights.

Who is responsible for the stream?

Restoration of stream problems is generally the responsibility of the private landowner. Although various government agencies have regulatory jurisdiction over how a stream is managed, it is not their job to come and "fix" your stream. Government highway departments generally limit their stream work to that needed for protection of roads, bridges, and culverts. Other government resources are more likely to be available to assist with a project that restores a degraded stream system, rather than one designed for localized protection of private property. For information about stream maintenance and restoration assistance, contact the Schoharie County Soil and Water Conservation District (518 234-4092). Responsibility for a stream does not give you the right to do whatever you consider necessary to "fix" its problems. Assume that every stream is regulated unless you determine otherwise.

Liability

Common Law is that body of law developed from judicial decisions, based on custom and precedent. As such, it is constantly changing by extension or by interpretation. The central point of common law is damage. The owner of a bridge, hydraulic structure, or other stream project has a legal obligation to protect adjacent landowners from damages due to changes in natural drainage that result from that project. Anyone claiming such damage may file suit in court.

If flooding occurs or gets worse after a stream has been modified (by diverting flow, modifying the channel, constructing a bridge, etc.), is the person who made the modification liable for damages?

Yes, quite possibly. Courts have, according to common law, followed the adage "use your own property in such a manner as not to injure that of another." This means that no landowner, public or private, has a right to use his/her land in a way that substantially increases flood or erosion damages on adjacent lands. A municipality or property owner may thus be liable for construction, improvements, or modifications that they should reasonably have anticipated to cause property damage to adjacent property. The lack of proper planning, design, and execution thereof, may be considered a clear indication of the lack of good faith and hence negligence with regard to damages that subsequently occurred.

May someone be held liable for failing to remedy a natural hazard that damages adjacent property?

Sometimes. Courts have generally not held governmental units and private individuals responsible for naturally occurring hazards such as stream flooding or bank erosion that damage adjacent lands. In keeping with this principle, a municipality would not be liable for failure to restrain waters between banks of a stream or failure to keep a channel free from obstruction that it did not cause. However, a small number of courts have held that government entities may need to remedy hazards on public lands that threaten adjacent lands. In addition, land owners and governments are liable if they take actions that increase the hazards.

Can liability arise from failure to reasonably operate and maintain a bridge, drainage structure, dam, or flood control structure?

Possibly. The owner of a dam or other water control structure is responsible for inspecting and maintaining it. Where there is a duty to act and the risk of not acting is reasonably perceived, then failure to take appropriate actions may be considered negligent conduct.

May a regulatory agency be liable for issuing a regulatory permit for an activity that damages other private property?

Yes, quite possibly. In fact a careful analysis of hundreds of cases in which the lawsuit involved permitting indicates that a municipality is vastly more likely to be sued for issuing a permit for development that causes harm than for denying a permit based on hazard prevention regulations. The likelihood of a successful lawsuit against a municipality for issuing a permit increases if the permitted activity results in substantial flood, erosion or physical damage to other private property owners.

How safe is safe enough? Municipalities regularly issue permits for activities that are in compliance with existing laws, but might still be at risk of damage.

For example, floodplain development regulations generally apply only to areas mapped as the 100-year floodplain. Yet significant flooding and erosion damages can and do occur outside of these regulated flood-prone areas. Some municipalities address this additional risk by attaching conditions to their approvals for those projects with identified risks. These conditions can clearly state that the municipality is not obligated to fix personal property in the event of damage. One Town granted approval for a driveway bridge that met all applicable standards, but attached material clearly warning the applicant about the hazards of driving through floodwaters, the risk that emergency vehicles may be unable to reach the house during floods, the potentially high maintenance costs, and the potential liability for the owner if the project results in damage to other property.

May governmental units be held liable for refusing to issue permits in floodways or high-risk erosion areas because the proposed activities could damage other lands?

No. In general, landowners have no right to make a "nuisance" of themselves. Courts have broadly and consistently upheld regulations that prevent one landowner from causing a nuisance or threatening public safety.

What precautions can be taken to avoid liability?

Be "reasonable." The overall issue, in most instances, is the "reasonableness" of an action by the community or property owner. Due to advances in technology and products, there is an increasingly high standard of care for "reasonable conduct." The "act of God" defense is seldom successful because even rare flood events are now predictable. As a precaution, technical assistance from stream professionals should be obtained prior to implementing any stream project. Because a well-designed project is less likely to damage other lands, this reduces the potential basis for legal action. And if you are sued, the best defense is a well-documented record showing "due diligence." That is, that you have done sufficient analysis and design to demonstrate the adequacy of the project with "a reasonable degree of certainty."