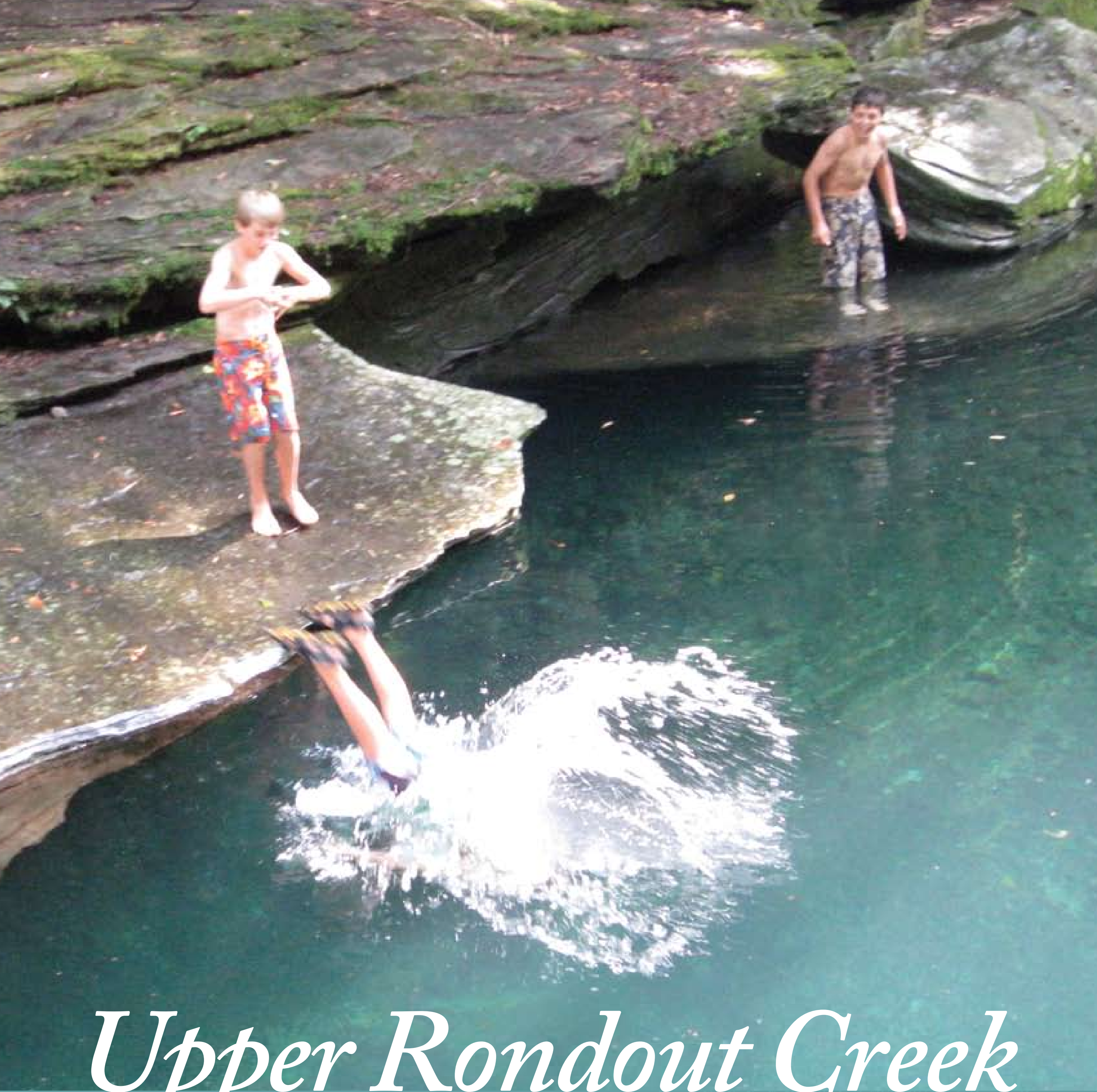


Upper Rondout Creek

Stream Management Plan

RONDOUT NEVERSINK
STREAM PROGRAM
SULLIVAN COUNTY SOIL & WATER CONSERVATION DISTRICT

Down Sugar Loaf Brook

Walking with the water down Sugar Loaf Brook
the sound of brook water is in our ears
rising and falling as it rushes along
cold from the mountain springs.
Watercress grows between the stones.
Deer have browsed on touch-me-nots
and cropped lush nettles along the bank.
Jack-in-the-pulpit has ripened its berries.
Small salamanders hide under the stones.
A brown woods wren keeps house in a brush heap.
Thrushes call in the cool deep woods.
We walk down Sugar Loaf Brook
pushing through windfalls, climbing over rocks.

We walk with the water but water never stops
to draw a breath or listen,
it is going on its journey.
We can't keep up with it.

—Inez George Gridley

Journey from Red Hill: Selected Poems 1931 to 1996 to...
OUTLOUD BOOKS 1997

Inez George Gridley (center, top row) first taught in a one-room school at Greenville, Ulster County.

Upper Rondout Creek

Stream Management Plan

RONDOUT NEVERSINK STREAM PROGRAM
SULLIVAN COUNTY SOIL & WATER CONSERVATION DISTRICT

Acknowledgments

THE RONDOUT CREEK PROGRAM TEAM IS PLEASED to release this summary of the *Upper Rondout Creek Stream Management Plan,* a guide for local residents, municipalities, interested organizations and agencies. We look forward to the improvements in the Rondout Creek's health that result from consideration of this resource management tool for the community.

The Rondout Creek Program Team gives special thanks to the streamside residents who assisted with the plan by providing valuable information in our public survey, sharing history, maps and photographs of the stream, and granting permission for our field crews to access the stream for data collection. Along the way, many landowners shared their direct experiences of living streamside over the years. Through our stream feature inventory, we developed a better understanding of stream conditions and trends, and look forward to implementing management recommendations that will lead to a healthier Rondout Creek.

Thanks to the partners involved in the writing of this plan: Mark Vian, Chris Tran, Jenn Grieser, and Dan Davis of NYC DEP, Laurie Machung, Jim Mayfield, Carol Smythe *(Neversink Historian)*, and Dave Gilmour *(Gilmour Planning)*. Thank you to the entire staff of Sullivan County Soil & Water Conservation District including Brent Gotsch, a master's candidate from SUNY Binghamton who prepared the document for final publication. Additional thanks to individuals who supported data collection and management efforts: Hanh Chu, SUNY Ulster interns Jasmine Ingersoll, Mark Dupre and Jesse Dallas, Martin Rosenfeld, and Eliot Jordon.

Working together to create a Stream Management Plan for a unique area like the Upper Rondout Creek, which crosses town and county lines, would not be possible without the helpful, active involvement and public support by the Town Supervisors of Denning and Neversink, Bill Bruning and Greg Goldstein, respectively. High-way Superintendents Dan Van Saders *(Denning)* and Preston Kelly *(Neversink)* contributed invaluable information from the field in their area of expertise. Thanks also go to the Rondout Creek Roundtable, Watershed Advisory Group participants, and the many additional volunteers for support and guidance in developmentof this plan. Your input helped produce what we believe will be a successful tool for addressing priorities for stream management along the Rondout.

This plan was adopted by resolution by the Towns of Neversink and Denning in November 2010.

KAREN RAUTER, *Stream Program Coordinator*
Rondout Neversink Stream Program
Grahamsville, NY
November 2010

Contents

Introduction

A Tool for Stream Management

The community process for local stream management planning is an emerging practice in creating a management tool to coordinate decision-making around common goals we identify together for the stream. This stream management plan was created cooperatively in the Upper Rondout Creek watershed community by residents, landowners, local leaders and area agency representatives. Its purpose is to identify common goals and priority management issues for the stream and its adjacent floodplains, forests and wetlands.

The residents of the Upper Rondout Creek valley — from the Peekamoose Gorge to the Rondout Reservoir — know the awesome power of the Creek. Over the past several centuries they learned how to harness that power, but also to keep out of its way when floodwaters roared, tumbling giant boulders down the streambed, leaving nothing but the foundations of homes.

Over generations, berms and revetment were installed, and in some reaches, the Creek was intentionally redirected in efforts to protect property and people. Abutments and numerous bridges — nine above the reservoir — were built to allow human settlement on both sides of the stream. Hardened road embankments edge in on the creek at many narrow points in the valley.

Floodplains and streamside wetlands were filled in some places while diversions to sluice water into floodplain ponds were created in others, and pastures and lawns have frequently been cleared along creek banks and terraces. NYS DEC has historically supplemented the native fisheries by introducing sport fish for recreation. Trees in the powerline rights-of-way — which frequently run along the stream banks — are regularly cut or removed.

DEREK VON BRIESEN/DVBPHOTOGRAPHY.COM

Each of these activities contributes to the overall picture of stream management in practice today on the Rondout Creek. Even with these human impacts, the stream remains relatively wild, and generally quite healthy. It shifts around within its floodplain during big floods, as those who remember the floods of 1928 or 1996 and many others will attest. The fishing is good, but local anglers will tell you it was better twenty years ago. The water quality is high for the most part, while recent landslides and ditch maintenance practices contribute to turbidity.

Everyone cools off during the dog days of July and August in the scour pools of the Rondout Creek. With the forests that have returned to the hillsides throughout the Catskills over the past century, water here is cooler and the banks more stable on many tributaries of the Rondout. This summer, *Yahoo News* included the "Blue Hole" on the main stem of the Rondout as one of the nation's top twenty swimming holes. So why does this Creek need a management plan?

In past years, most activities affecting the stream have taken place apart from one another Landowners manage their own stream banks and floodplains; highway superintendents manage road embankments and bridges; power companies clear their rights-of-way. When there are major problems, federal agencies such as Natural Resources Conservation Service or the Federal Emergency Management Agency bring resources to address immediate needs. NYS Department of Environmental Conservation requires a permit for certain activities in or near streams. The U.S. Army Corps of Engineers also has a similar permitting program.

Each of these players in stream management has their own objective, specific knowledge or area of expertise, and individual ideas about what needs to be done to keep their section of the stream healthy. No single force, however, holds responsibility for coordinating all of these isolated efforts. More importantly, streams are systems: what someone does on their own stream bank can create significant effects — good or bad — upstream or downstream. One action on the stream invariably affects — and sometimes compromises — the goals and interests and efforts of others.

We recognize the many benefits streams contribute to our community's quality of life, and also the many risks they pose. If we look at streams as a community resource, they might be better managed with a coordinated effort. This coordination requires an ongoing commitment, and the Upper Rondout Creek Stream Management Plan provides a framework to improve this effort. With a wealth of local knowledge about the Rondout Creek, many questions still remain:

- *How do we know whether the erosion we see along stream banks is just a natural part of the way streams evolve, or whether we are seeing excessive erosion and a stream system destabilized by past management decisions?*
- *Where there are problems, will the stream "fix" itself, and how long will that take? What further problems will likely result in the meantime?*
- *Do we need to change our management strategies, and undertake proactive projects to restore or protect stream channel stability?*
- *Large trees falling into the stream as a result of erosion can cause the stream to change course and act unpredictably, but will removing the wood destabilize the stream in a different way?*
- *Where should we invest our limited resources for restoration or protection?*
- *How can we know more reliably the condition of the fish community and the quality of the stream habitat?*
- *What is the trend in the overall ecological health of the Rondout Creek?*

In recent decades, advances have been made in the science of stream form and function. As part of the process of developing this plan, assessments and inventory of the condition of the stream were undertaken using state of the art methods, and the results of those assessments are described in this Plan. This documentation of baseline conditions in the Upper Rondout Creek will help us work toward answering these challenging questions and give us a measure of future conditions against the baseline to determine trends.

In late 2009, New York City Department of Environmental Protection (DEP) contracted Sullivan County Soil and Water Conservation District (SCSWCD) to develop and implement this stream management plan for the Rondout Creek Watershed. It represents the joint efforts of the Rondout streamside community, local leaders and representatives of agencies involved in different aspects of stream management. In addition to identifying our common goals, it identifies competing goals as well, and provides a road map for coordination among the many stakeholders — or those who rely on, work with, recreate in, and/or live by the waters of the Rondout Creek, including: local landowners concerned about erosion, flooding, the fishery and the beauty of the stream; the highway departments of the Towns of Denning and Neversink, Sullivan and Ulster Counties, who are responsible for managing the roads, bridges and culverts that residents and area emergency personnel use regularly; utilities that manage rights of way along the stream; anglers and tourists; and the downstream communities of the lower Hudson Valley and the City of New York, nine million residents who ultimately drink the Rondout Creek's waters.

The Rondout Creek Stream Management Plan summarizes the benefits, problems and needs of the entire creek and watershed sub-basin. The plan provides recommendations for long-term stream stewardship and protection of water quality that we can follow to individually and collectively reduce the risks of living in the Rondout Creek valley, improve the ecology of the stream and floodplain, and protect the many ways it is a valuable resource to everyone in the community.

This document is a summary of the comprehensive Stream Management Plan document (374 pages), available as a downloadable PDF at **www.catskillstreams.org.** Hard copies are available at the Rondout Neversink Stream Program field office at Neversink Town Hall (2nd floor), Denning and Neversink Town Halls, Daniel Pierce Library in Grahamsville, and Sundown Church Hall.

Local History

A Historical Tour of the Rondout

From Headwaters to the Reservoir

"My eyes had never before beheld such beauty in a mountain stream." John Burroughs wrote this in his sketch *A Bed of Boughs* on his first visit to Peekamoose and the headwaters of the Rondout Creek. He went on to say "If I were a trout, I should ascend every stream, until I found the Rondout." [1]

If we explore the Rondout's headwaters and follow the stream out towards civilization, it is an interesting journey through the history of the region's communities. This land that started in the stewardship of the Indians, and passed ownership to a relative few, was slow to be developed. It seems that it was 1849 when the bark peelers began leveling the massive hemlocks so they could peel the bark for the tanneries outside the area. Esther George[2] tells us "there were no tanneries in the area." The only tannery located on the Rondout Creek was far down the stream at Lackawack. Saw mills abounded and early maps often show the initials *SM* designating where a sawmill was operating.

But back to the stream itself and its source in the wilderness of Peekamoose, there fed by mountain brooks with plain names — Bear Hole, Stoney Cabin, High Falls Brook, Buttermilk Falls. These names do little to describe the exotic nature of the water as it came pounding down the steep mountainsides of Peekamoose Mountain. Even today, those exploring these streams come away with a sense of awe as to their majesty. The act of quenching a sudden thirst by kneeling by the stream and cupping one's hands for a drink of fresh mountain water is unique to the human experience. One can only imagine the first explorers of the area as they satisfied their thirst.

OPPOSITE: *"The Blue Hole, Peekamoose, N.Y." A postcard published by Krom Bros., circa 1910.*

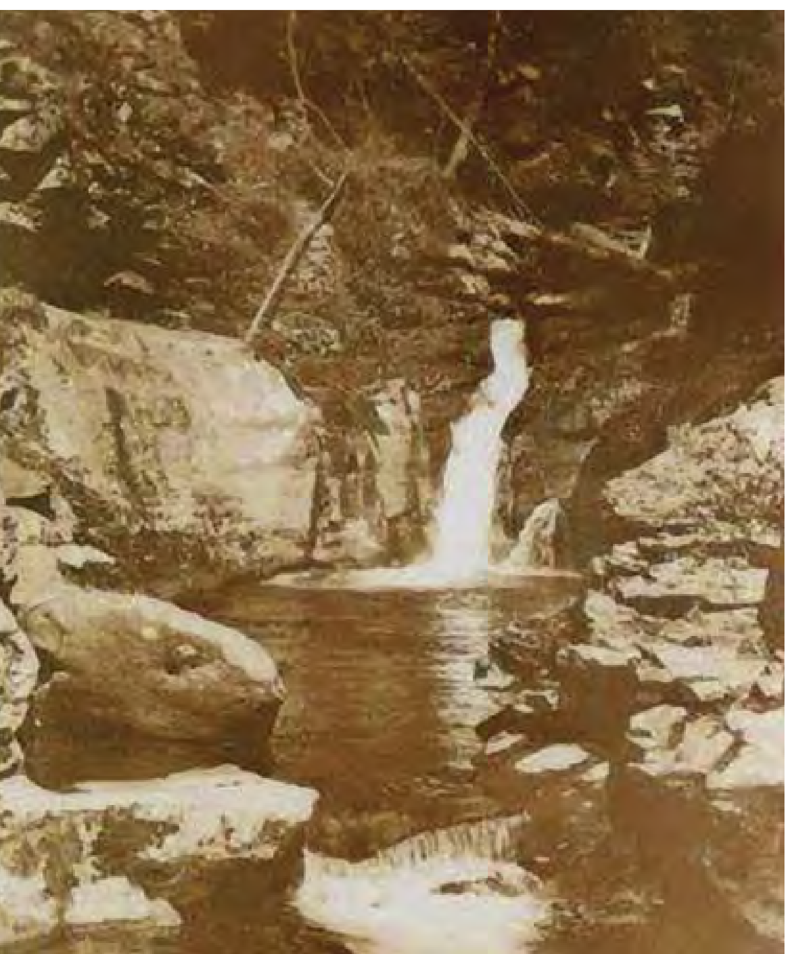
Climbing the mountainside to follow any of these streams is a tough hike into the past. The prize for those who explore the Bear Hole is reaching the section of the stream where a wide deep basin of water has been formed. There trout can be seen moving lazily in its deepest parts out of the way of all but the most determined angler. Who would know that the High Falls Brook once had a road that ran beside it all the way from Red Hill or that, in the middle of its descent, there lived a man by the name of Romaine Moe who farmed it in this very hardscrabble existence. Thus the midpoint on the High Falls Brook has been referred to as the "Main Moe" place. There were other families, too, who lived in the Peekamoose area eking out an existence before they settled elsewhere.

Follow the Rondout through the area known as Bull Run and on to Sundown (once called Denning Falls). It is there that the East Branch of the Rondout meets the Rondout coming from Peekamoose. This mountain brook wends its way downward from the Greenville area. Natives refer to the East Branch as the Sundown Creek. It is here that a Methodist Church, a one-room school, a store/post office and a handful of residences are evident on an 1875 map of Town of Denning, Ulster County.

The first post office was established in Bull Run in 1889 with Jacob Coddington as postmaster. The second postmaster was Paul Sheley. The story is told that Sheley's widow became postmistress, didn't like the name Bull Run and hence the name Peekamoose came about. Sundown's first post office began in 1888 with Allen Dean as postmaster. Allen Dean was one of the fortunate ones who fought in the Civil War and returned home to tell about it.

Old-timers hunted and fished to feed their families. Once the area was opened up by the advent of the railroad, there were a few well-to-do individuals who purchased large tracts of land in the Peekamoose area. Certainly, the establishment of the Catskill Forest Preserve changed the area forever. Hunting, fishing, camping, and hiking for recreational purposes have been pursued since at least 1900. Today, this recreational aspect continues: it is even possible to see a group of visitor drumming with the Buttermilk Falls in the background.

Moving onward for a few miles and almost to Rondout Reservoir, there is a stream called the Sugar Loaf, which joins with the Rondout.



Buttermilk Falls, circa 1900..

The Sugar Loaf, too, has its source on Red Hill. This stream passes the sites of three one-room schools; one of which had the distinction of being the first approved school in the Town of Denning. It was down this same Sugar Loaf that an early story tells us of a long-gone Methodist Church that came tumbling down in an early flood.[3] The nearby community of Lowes Corners now exists only in memories.

Students, South Hill schoolhouse, 1904.

Eureka, Montela and Lackawack are the remaining communities that one could have seen along the stream where now the Rondout Reservoir waters rest. It was in Eureka where the Chestnut and the Rondout met that the Hornbecks, earliest documented settlers of the valley, made their home. Descendants of those first Hornbecks still make their home within walking distance of the foundation of that first log cabin. Eureka was more developed than many of the smaller communities previously mentioned here.

Montela, the middle village, straddled the Town of Neversink and Town of Wawarsing line. Its post office was established in 1886 in the Ulster County section with Frank Dixon as postmaster. One of the interesting stories to come out of the valley was the establishment of the County Line Hotel, which was located part in Neversink and part in Wawarsing. When the Town of Neversink became a "dry" township, a gentleman by the name of Frank Patruno moved his establishment to the County Line where he ran a bar on the "wet" side and cut hair on the "dry" side.

At the other end of the Reservoir, the village of Lackawack stood. Its first post office was established in 1835 with Alonzo Vail as postmaster. Lackawack was the most developed of the three communities. Its pride and joy was the Lackawack House run by John Shiels, proprietor and owner. It was commonplace for Tammany Hall politicians to travel from New York City by train to Ellenville. There, horse-drawn carriages conveyed travelers to this popular resort at Lackawack. The hotel was destroyed by fire in 1917.[4]

In 1976 the Town of Neversink and the Town of Wawarsing dedicated a plaque that memorialized the Upper Rondout Valley. It reads "People settled this valley over 200 years ago. They founded Eureka, Montela, and Lackawack. Most were farmers. A few were storekeepers. A tannery, lumber mill, excelsior mills, gristmill, carding and fulling mill, churches, cemeteries, post office and tourist accommodations were here. During the 1930s and 1940s, New York City constructed Rondout Reservoir. Its waters now rest on the sites of Eureka, Montela and Lackawack."

Contributed by Carol Smythe,
Town Historian, Neversink

Community Stakeholders

Saturday, July 25, 2009, marked the official start to community involvement in the Rondout Creek Stream Management Plan process. Sullivan County Soil and Water Conservation District (SCSWCD) and New York City Department of Environmental Protection (NYC DEP) representatives presented information on their current water resource programs and the different components of Stream Management Plans to the participants. Presentations were followed by a question and answer session that included passionate discussions that lead to very active participation throughout the planning process.

PUBLIC SUPPORT AND INPUT

Results from the July 25 session reinforced the fact that a critical component of this process is public support and input for the project. A professional consultant, Gilmour Planning, made a public opinion survey of streamside landowners along the Rondout Creek, Sundown (or East Branch Rondout) Creek, Sugarloaf Brook and the East, West and mainstem Neversink River. A Rondout Creek Roundtable of 20 local and regional committee members met three times (June, October and December, 2009) during the planning period to review the survey and its findings, and to offer insight about key concerns regarding the stream. Community informational meetings were held in Denning and Neversink in March to introduce the results of the 2009 stream assessment of the Rondout Creek.

Feedback from the public opinion survey helped guide key areas of interest for this management plan. Out of the 175 surveys sent out, SCSWCD received 76 (return rate of 43%); nearly two-thirds of the responses were from second homeowners. For detailed information about the results of the survey, please see the comprehensive Stream Management Plan document at **www.catskillstreams.org.**

General themes include 1) A desire for more flood planning and emergency preparation (67% of Rondout responses) and 2) A desire for more road/drainage infrastructure improvements and restored floodplain (48% of Rondout responses). These interests were reinforced when respondents were asked what type of technical assistance they need. For the Rondout, bank stabilization and floodproofing received the highest number of responses (19% and 15% respectively. In all, 84% of those responding said they would like to be contacted about technical help, with 55 providing specific name and contact information — a testament to value the streamside landowners place on their relationship to the Rondout Creek. A selection of written comments received on the survey is highlighted below:

- *I hope someone can do something about the flooding!*
- *High water = water in cellar.*
- *Significant threat to stream quality is home septic systems and abandoned automobiles in and near floodplain. Road runoff may also be contributing pollutants and sediments.*
- *I have been coming to the Sundown area for my whole life and have never worried about the creek before. We have had 2 serious flood incidents impacting our property over the last 8 years and are concerned now every time it rains. What is going on??*
- *Streams should be kept clean of debris and when erosion exists, stone walls need to be installed for strength and beauty.*
- *The most disturbing changes/symptoms that I have noted since 1972 (prop. acquisition) are: repeat flooding with mud in the water; more trash at streamside.*

In general, streamside landowners agreed that the Rondout Creek is an important feature of the area, despite the problems it sometimes presents. Survey respondents expressed a desire to see the stream maintain its healthy state for the benefit of streamside landowners, outdoor enthusiasts and wildlife.

Public interest in the planning project continued to rise as word circulated in the community. One resident took the initiative to host a Rondout

Developing a stream management plan for the Rondout brings landowners, professional staff and elected officials together — in formal committee meetings, neighborhood gatherings and educational site visits.

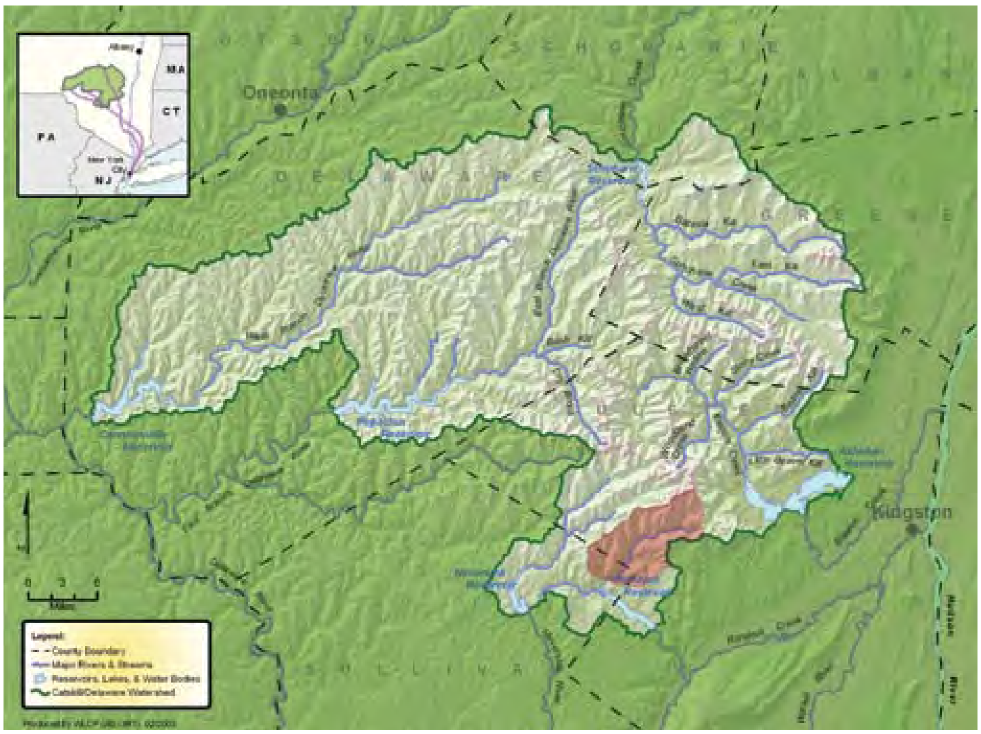
Watershed Landowners Association meeting to offer a forum for discussion about stream issues and how this important stakeholder group might coalesce in order to have appropriate representation in future planning (Watershed Advisory Group) meetings. This meeting provided the prod to recruit additional interested parties, resulting in a well-attended public meeting the following week which summarized survey and stream feature inventory results.

With the completion of the plan, the next phase was a review of the plan's recommendations by community members including streamside landowners, elected officials and the Watershed Advisory Group (WAG) — a formal extension from the initial roundtable gatherings, which has met three times to review the general recommendations in the Plan. These meetings were held in January and April and October of 2010 for guidance and input on the Rondout Stream Management Plan. The program team has incorporated revisions from all involved to adequately reflects stakeholders' concerns. Presentations were made at Town of Denning and Neversink Meetings in August to finalize the draft plan and begin its formal adoption and implementation.

The Watershed Advisory Group is currently evolving as the program field office establishes itself in the community. This group comprises twenty five local volunteer residents and involved agency representatives (listed on the inside back cover of this document). Committees will form by the end of 2010 to engage in the implementation of the Rondout, Neversink and Chestnut plans.

Town highway departments have important knowledge about the day-to-day challenges in stream management.

The Upper Rondout Creek

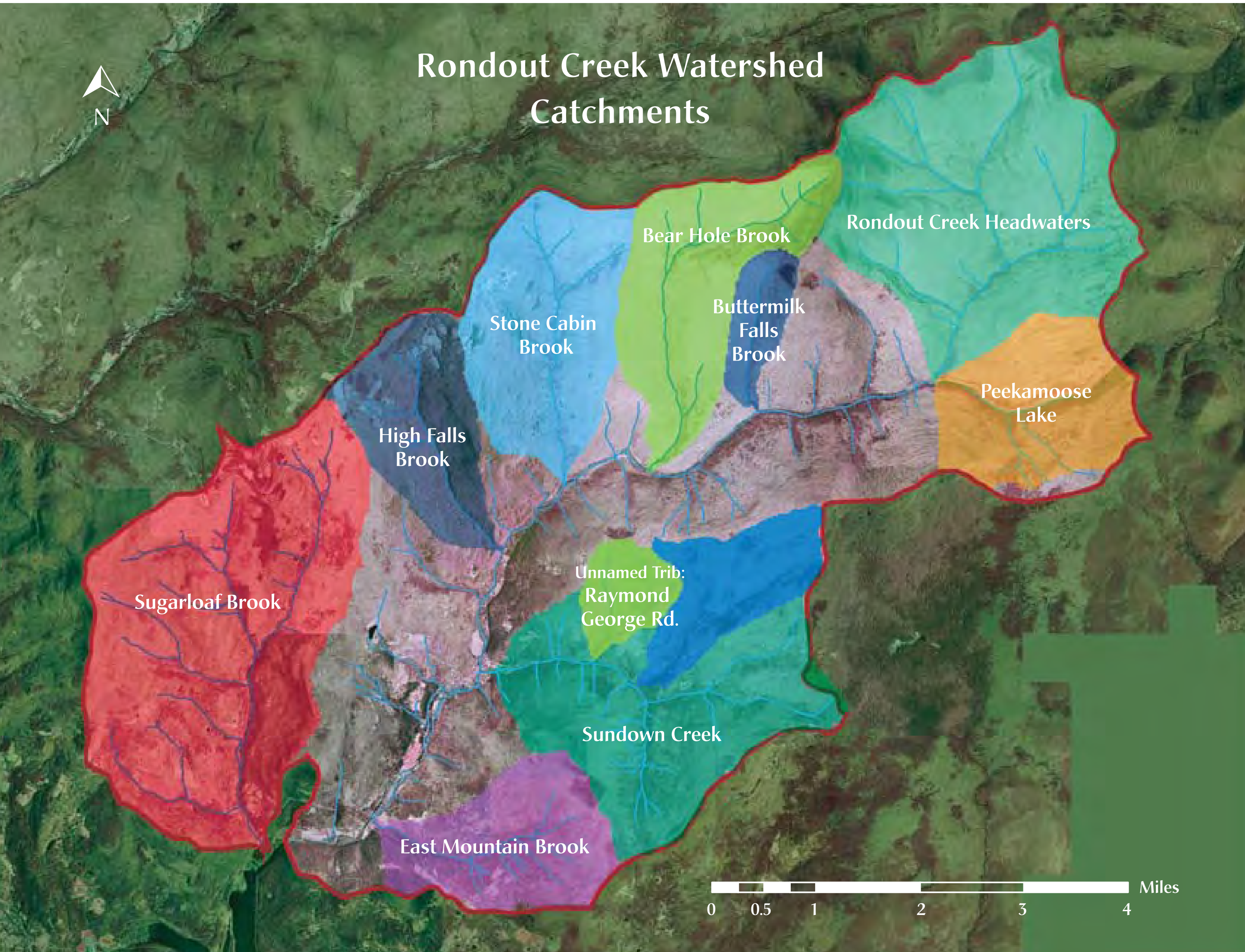


The Upper Rondout Creek watershed is located in the southern Catskill Mountain region of southeast New York State. The name "Rondout" comes from a fort which once resided at the mouth of the creek. The Upper Rondout Creek flows from the headwaters near Shandaken, running about 13 miles before entering the Rondout Reservoir in Neversink. The 48-square-mile watershed falls primarily in the towns of Denning in Ulster County, and Neversink in Sullivan County. A large portion of the Upper Rondout remains densely forested, mainly due to its status as New York State-owned preserve land; yet streamside areas in both towns are developed for a mix of purposes including municipal, residential and institutional.

The Upper Rondout Watershed is also located within the Catskill Forest Preserve, nearly 700,000 acres encompassing a patchwork of public and private lands and New York City Water Supply Watershed. At 2,000 square miles, this watershed is the largest unfiltered water supply in the United States, providing 1.4 billion gallons of clean drinking water daily to over nine million residents in New York City and some nearby municipalities (nearly half the population of New York State). The Upper Rondout is significant contributor to this water supply, highlighting the importance of conservation measures in this region.

The Rondout Reservoir is one of New York City's most important components in the water supply system. As the terminal (end-point) reservoir of the Delaware System, it accepts waters from the Cannonsville, Pepacton, and Neversink Reservoirs. These upland reservoirs are connected to the Rondout Reservoir by tunnels to three Tunnel Outlet facilities each of which houses a hydroelectric plant.

The Rondout Reservoir has a water surface area of 2,100 acres and a storage capacity of 50 billion gallons. The Reservoir is 7.2 miles long and about one-mile wide and is created by the Merriman



Dam — an earthen dam with a concrete core wall. The water from the Reservoir is diverted to the Delaware Aqueduct through the Rondout Effluent Chamber where water enters the building through one of 4 intake levels (to maximize water quality) and is regulated by a combination of 6 large valves. The Rondout Reservoir supplies more than 50% of the City's daily supply of water on average. The facility also makes small river releases into the lower Rondout Creek. Due to its location within the NYC Watershed, it is subject to the DEP rules and regulations written to protect water quality. The DEP offers a variety of watershed protection programs to encourage proper watershed management practices by landowners and municipalities.

The Upper Rondout is nestled between the Neversink and Esopus basins, beginning as a small stream near Peekamoose and flowing just over 13 miles before entering the Rondout Reservoir in Neversink. Over its course, the stream drops approximately 610 ft. in elevation from Peekamoose Lake at nearly 1,450 ft., until it flows into the Rondout Reservoir at 840 ft. in elevation. The total watershed drainage area is approximately 48-square-miles, with an average stream valley slope of 1.2% across several peaks of the Catskill Mountain chain: Rocky, Peekamoose, Samson, Van Wyck, and Sugarloaf Mountains.

The Upper Rondout Creek was largely formed by the movement of the Hudson Valley glacier. As a portion of this glacier advanced up the Esopus Creek, an ice dam impounded water behind it. The ice dam diverted water away from the Esopus and into the Rondout Creek, resulting in the heavy erosion of what is now called Peekamoose Gorge. The Rondout continued to serve as a spillway for the Esopus basin, resulting in further erosion of the stream valley. Flows in the Rondout lessened as the glaciers fully retreated, and left the Rondout valley much larger than such a small stream would normally need.

Climate

The climate of the Rondout basin is primarily driven by the humid continental type, which dominates the northeastern United States. The average annual temperature for the area is 44.8° F and the area typically receives approximately 41 inches of rain/year. 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 cause differences in cloud cover and precipitation within the Catskills, and explains the drastic variations in rainfall between Catskill basins.

OPPOSITE: *Sub-basins of the Upper Rondout Creek.*

Weather Effects *on the Watershed*

Effects of global climate change are being watched by the people of the Rondout basin. As greenhouse gases trap energy in the atmosphere, global temperatures are on the rise. Based on local data collected between 1952 and 2005, researchers have concluded that a broad general pattern of warming air temperatures, increased precipitation, and increased stream runoff has occurred in the Catskills region (Burns et al., 2007).

Temperature increases will have effects on food production, plants, wildlife, invasive species, flooding, drought, snowfall and the cost of infrastructure maintenance and repair. 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 (Frumhoff et al., 2006). This climatic migration affects plant and animal life, giving new warmer climate species the ability thrive at the expense of established plants and animals. The number of snow-covered days across the Northeast is decreasing; less precipitation falls as snow and more as rain; and 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 the Catskills.

Lack of snow fall prevents streams and groundwater from receiving a slow sustaining release of water through the winter and spring. Instead of this, there will be more intense storms, sporadically dumping large quantities of water into the system potentially causing damaging flooding. 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 dynamics of the hydrologic cycle would also impact the NYC water supply system, forcing potential changes in operational measures. Since we do not have a clear understanding of all of the impacts of climate change, stream managers, towns and residents will benefit most from pro-active planning by working together with the with the best available information — in other words, preparedness.

The most effective planning will come from community stakeholders with a basic understanding of how streams are formed and evolve to effectively adapt to coming changes. This will likely call for training to anticipate and compare the consequences of different management options, and plan accordingly, for example, over-sizing culverts and bridge spans, leaving larger buffers of undisturbed streamside vegetation, and considering limiting new development of infrastructure or personal property in areas where conditions indicate a high risk of the stream channel shifting across the floodplain.

Introduction to Stream Processes

Ask anyone in the Rondout watershed, and they'll tell you that living around streams carries benefits and risks. Both the pleasures as well as the dangers of living near streams stem in part from their ever-changing nature. Icy spring flood-flows are exciting and beautiful as long as they don't creep up over their banks and run across your yard into the basement window, or suddenly tear out a stream bank and begin flowing down the only access road to your house. For many reasons, the relatively flat land in the floodplain of a stream is an inviting place to build a home or road — in fact it may be the only place — but as long-time residents of floodplains know only too well, it's not a matter of *if* they will see floodwaters, but *when*.

As changeable as streams are, there is something consistent about the way they change through the seasons, or even through an individual storm. With careful observation, we can begin to understand, and sometimes predict with accuracy, patterns in the way streams behave. Beyond this, we can learn to increase the stream's benefits to us, and to reduce the risks it poses.

This section of the management plan provides the reader a basic explanation of what stream scientists know about how streams "make themselves," why they take different forms in different settings, what makes them evolve. Based on this knowledge, the Plan offers recommendations for how we can manage them effectively to increase the benefits and reduce the risks they offer.

It's obvious that streams drain water off the landscape, but they also have to carry *bedload* — gravel, cobble, and even boulders — eroded from streambeds and banks upstream.

If you stand near the bank of a mountain stream during a large flood, you can feel the ground beneath your feet vibrate as gravel, cobble and boulders tumble against each other, pushed along by the force of the floodwaters down the streambed. As the water begins to rise in the channel during a major storm, at some point the force of the water begins to move the material on the bottom of the channel. The amount of water moving through the channel determines the bedload moving through it. As storm waters recede, this gravel and cobble stops moving.

To work with the stream effectively, it's important to understand how much water is coming from the landscape to the stream, at any particular point in the system. This is determined by:

- the climate: annual rainfall and temperatures
- the topography of the region
- the soils and bedrock geology
- the type of vegetation (or other land cover like roads and buildings) and its distribution across the landscape.

These characteristics also play key roles in determining the type and frequency of flood hazards in the region, the quality of the water, and the health of the stream and floodplain ecosystems.

The shape and size of a stream channel adapts itself to the amount of water and bedload it needs to carry. Within certain limits, the form, or *morphology*, of a stream is self-adjusting, self-stabilizing, self-sustaining. If the stream channel is changed to exceed those limits, it may remain unstable for a long time.

Over the period since the last glaciers retreated some 12,000 years ago, the Catskills streams have adapted their shape to regional conditions. Because the climate, topography, geology and vegetation of a region usually change only very slowly over time, the amount of water moving through a stream from year to year, or *streamflow regime,* is fairly consistent at any given location.(1) This stream flow regime, in turn, defines when and how much bedload will be moving through the stream channel from year to year. Together, the movement of water and bedload carve the form of the stream channel into the landscape. Because the streamflow regime is fairly consistent year after year, the form of the stream channel also changes relatively slowly, at least in the absence of human influence. Over the 120 centuries since glaciers covered the region, the stream and the landscape conditions evolved a dynamic balance.

However, as we make our mark on the landscape — clearing forest for pastures, or straightening a stream channel to avoid having to build yet another bridge — we frequently unintentionally alter that balance between the stream and its landscape. We may notice that some parts of the stream seem to be changing very quickly, while others remain much the same year after year, even after great floods. Why is this? Streams that are in dynamic balance with their landscape adapt a form that can pass the water and bedload associated with both small and large floods, regaining their previous form after the flood passes. This is the definition of stability. In many situations, however, stream reaches become unstable when some management activity has upset that balance, and altered the stream's ability to move its water and bedload effectively.

The amount of potential force the water has to move its rock is determined by its **slope** — the steeper the slope, the more force — and its **depth** — the deeper the stream, the more force. So, for example, if changes made to a stable reach of stream reduce its slope and/or depth, the stream may not be able to move the bedload supplied to it from upstream effectively. The likely result is that the material will deposit out in that section, and the streambed will start building up, or *aggrading*.

On the other hand, when we straighten a stream, we shorten it; this means that its slope is increased, and likewise its potential force to move its bedload. Road encroachment has narrowed and deepened many streams, with the same result: too much force, causing the bed of the stream to

An aggrading streambed builds up material because its slope or depth does not allow it to move downstream.

degrade and, ultimately, to become *incised,* like a gully in its valley. Both situations — aggradation and degradation — mean that the stream reach has become unstable, and both can lead to rapid bank erosion, as well as impairment of water quality and stream health. Worse yet, these local changes can spread upstream and downstream, causing great lengths of stream to become unstable.

The stream pattern we now see throughout the Catskills is the result of millions of years of landscape evolution: fractured bedrock, chiseled repeatedly by rivers, and then glaciers, and then rivers again, as glacial ages came and went, as valleys were eroded out of the mountains and washed out to sea. The material often settled out as the streams entered into local lakes, created where notches at the lower end of the valley were dammed by glacial ice. When the ice dams melted, the lakebed remained a fairly flat valley floor, poorly vegetated initially, through which the stream could meander from one side of the valley to the other.

As the streams shaped these flatter valleys, they flowed through, century after century, the resulting shape of the valleys in turn changed the streams. As valleys developed floodplains, the streams flowing through them became less steep, and their pattern and shape progressively adjusted to assume new stable forms, in balance with the new landscape.

In many settings, the story is even more complicated. The main valleys were widened out by glacial scouring, while in many small pockets, soil materials melting out of glaciers created complex local deposits of clay, sand, gravel, cobble and boulders, in diverse terrace forms throughout the valley. As the steeper streams coming off the mountains joined a more gently sloped channel running through the valley they often lose gradient, becoming wider and shallower at the delta.

As our climate warmed, grasses and then trees re-colonized this evolving valley floor. Vegetation returned to the floodplains, and the conditions that determine the balance between stream shape and the landscape changed once again. Stream banks that have a dense network of tree and shrub roots adding strength to the soil can better resist the erosive power of flood flows, and consequently a new stable stream form emerges; a new balance is struck between resistive and erosive forces. A dense mat of woody roots is essential if we want to maintain a stable stream bank. If streamside trees and shrubs are removed, we can expect the bank to soon begin eroding.

In the Catskills, a naturally stable stream will have trees and shrubs all along the stream bank to help hold the soil together.

If we want to maintain healthy, stable streams, then, we need to maintain a stable stream *morphology* and vigorous streamside, or *riparian,* vegetation.

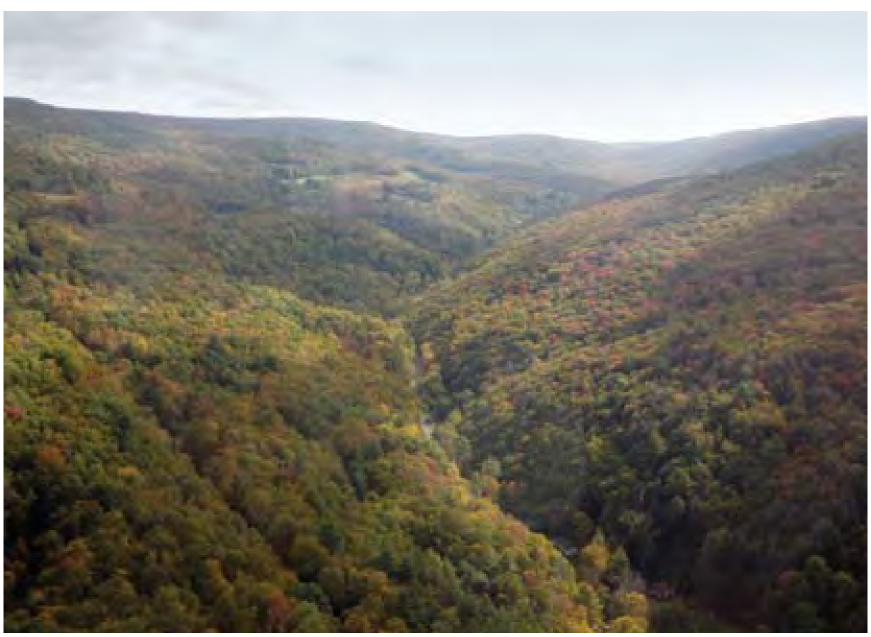
Stable streams regain their previous form after both a small or large flood and are less likely to experience bank erosion, water quality or habitat problems.

Stable streams are less likely to experience bank erosion, water quality and habitat problems. The management plans being developed for landowners by the Stream Management Program generally describe the current condition of the stream form and streamside vegetation throughout the watersheds they address, and then make recommendations for protecting healthy sections of stream and for restoring the stability of those sections that are at risk.

Land Use & Land Cover

98%
OF LAND IN
THE RONDOUT
WATERSHED
IS FORESTED

LAND USE AND LAND COVER OF A WATERSHED GREATLY INFLUENCE 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, reducing the recharge of groundwater into wells and streams.



A bird's eye view of the forested Upper Rondout valley.

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 water quality in 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 negative 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 toward degraded stream conditions.

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 appear 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 use of the Upper Rondout Creek 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 use categories. The table and figure opposite illustrates the categories and percentages of the different land use types present in the Upper Rondout Creek watershed.

The overwhelming majority (98%) of land use in the Rondout watershed is forested area. A large portion of this forest land is owned by the State of New York and under current state laws will remain undeveloped. Non-woody vegetation, including recreational fields, follows in a distant second at 172 acres (0.68%). Residential property is primarily rural housing, covering approximately 74 acres

TABLE 1 · Land Uses

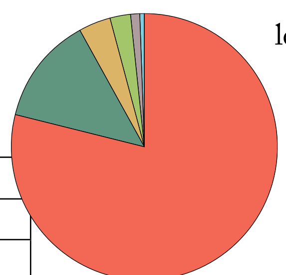
Land Use	Acres	Percent
Parks/Forest/Open Space	24, 878.72	98.02
Non-Woody Vegetation/Recreation	172.57	0.68
Rural Housing	74.02	0.29
Roads	36.52	0.14
Single Family Units	32.40	0.13
Urban (impervious/built up land)	27.16	0.11
Agriculture (Livestock)	24.27	0.096
Agriculture (Crops)	24.26	0.096
Low Density Housing	11.07	0.044
General Residential Housing	10.48	0.041
Mobile home	1.04	0.004
Industrial	0.37	0.001
Commercial Offices	0.20	0.00078
Total Acres	25, 293.08	100.00

Approximately 20,215 acres of the forest in the Rondout watershed is deciduous, totaling over 79% of the total land cover in the watershed *(Table 2)*. Over 13% of the landscape is covered by coniferous forest and over 4% by mixed forest. Livestock and crop agriculture occupy approximately 0.10% of the watershed each. Impervious surfaces, consisting of roads, residential, urban and industrial areas total around 0.76% of the watershed. Although the total impervious surface area is low in the Rondout watershed, it can have negative impacts on the stream. Proper land use planning to direct development and preserve sensitive areas can be utilized to maintain a manageable low level of impervious cover.

of the watershed. There is very little commercial and industrial activity in the Rondout watershed, combined they make up less than 1% of the land cover. The majority of the impervious surface in this area is made up of the network of roads which run through the landscape.

TABLE 2 · Land Cover

Land Cover	Acres	Percent
Deciduous Forest	20,214.99	79.64
Coniferous Forest	3,345.41	13.18
Mixed Forest	1,102.35	4.34
Grass/Herbaceous	62.85	0.25
Impervious Surface	27.16	0.11
Water	10.60	0.042



Recreation & Wildlife

Recreational Opportunities *on the Upper Rondout Creek*

The Rondout Creek watershed 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 towns, landscape and people. Recreation in and around these streams provides visitors and residents with key opportunities to reconnect with the natural world.

Catskill Forest Preserve

The Catskill Park is a mosaic of mountainous public and private lands in Ulster, Greene, Delaware, and Sullivan counties. The Upper Rondout Creek watershed falls entirely within the "Blue Line" of the Catskill Park and is protected within the New York State Land which makes up the Catskill Forest Preserve. This land is managed primarily by the New York State Department of Environmental Conservation (DEC) according to its classification in the *2008 Catskill Park State Land Master Plan*. In addition to the Catskill Forest Preserve, Vernooy Kill State Forest and Sundown Wild Forest also lie within the Upper Rondout Creek basin. The locations of various management areas, as well as general background information can be found in DEC's *Catskill Forest Preserve Map and Guide.* This information can be obtained at DEC's regional offices; locations are listed on DEC's website: **www.dec.state.us.**


USEPA

"If I were a trout, I should ascend every stream, until I found the Rondout." John Burroughs.

NYC DEP Land

Property owned by NYC DEP offers fishing, hiking, hunting, and trapping. Some parcels require an Access Permit in order to legally use the property, but as of May 2009, DEP updated its recreation rules to incorporate Public Access Areas where permits are not required. Visit: **www.nyc.gov** for recreation links to find Public Access Areas, apply for a permit or read additional information about using this property.

Fishing

NYSDEC has numerous public access fishing sites along the Upper Rondout Creek. Steep headwater streams like the Upper Rondout are renowned for supporting healthy fish populations of native trout. The portion of the stream running through Denning is stocked annually with brook trout by the NYSDEC. The fishing season is April 1 — October 15. A New York State Fishing License is required. The basic state catch limit of five trout is applied in the Upper Rondout; and as elsewhere, the practice of Catch and Release is voluntary.

Hiking

Excellent hiking options abound in the Upper Rondout Creek watershed due to this large acreage of publicly-owned land. For more information, visit the Catskill Mountain Club website at **www.catskillmountainclub.org.**

Camping

The Peekamoose Valley campground, managed by NYS DEC, is a well known tourist location in the Catskills for outdoor enthusiasts. Situated just off County Rt. 42 and next to the Rondout Creek, these campsites provide the perfect location for enjoying a hike, a swim and a campfire. This campground also incorporates universally accessible features, including path to streamside picnic area, picnic tables, and fishing pier. **www.dec.ny.gov.**

Blue Hole

First discovered and named by the early 20th Century naturalist and Catskill native John Burroughs, the Blue Hole has become a popular swimming hole for locals and tourists alike. A recent article on *Yahoo Travel* named it as one of the nation's best swimming holes. There are a number of safety issues surrounding Blue Hole identified by the community. Traffic along the narrow road near Blue Hole becomes severely congested at the height of tourist season. Garbage and litter left behind by visitors has also been known to accumulate. Heavy use affects residents and also threatens the natural beauty of the area, which attracts people to the swimming hole in the first place. Balancing the need for access to Blue Hole with preserving its natural beauty is an ongoing challenge.

The Rondout's steep cold waters provide abundant habitat for the native and stocked trout prized by Catskill anglers.

Wildlife & Fisheries

The Rondout watershed is teeming with life. An amazing variety of habitats, people, plants, and animals are all interconnected in a fragile web of life, often called biodiversity. Every member is essential to keeping this web in balance. For example, the list of species required for the life cycle of a single tree may be in the hundreds or thousands. Moreover, the list of animals that utilize even a single fallen tree is in the thousands including squirrels, woodpeckers, grouse, bears, foxes, skunks, beavers, otters, mice, and shrews as well as worms, salamanders, beetles, ants, centipedes, sowbugs, and other insect larvae.

There are twice as many species of beetles that live on dead and dying wood as there are species of mammals, birds, reptiles, and amphibians in the entire world (Kyker-Snowman, 2003). The fallen tree provides critical habitat, steady moisture, and food for a multitude of mosses, fungi, trees, and vascular plants. If enough fallen trees are removed, the structure of the overall ecosystem would likely change.

Recognizing these relationships, many people work toward the protection and preservation of the ecosystem functions we receive from nature, including cleaner air through vegetation respiration, cleaner water through soil and wetland filtration, soil formation from forests, pollination of food crops from our native insects, natural flood water retention/groundwater recharge, and pest control from our native bats, birds, and insects (e.g. dragonflies/damselflies).

The benefits of a healthy and diverse ecosystem extend far beyond clean air and water and into the fabric of human health and quality of life. A few examples of this are the bees that pollinate about a trillion apple blossoms each year in New York State; micro-organisms that biodegrade much of our garbage as well as fallen leaves, sticks and other dead animal and plant matter; soil bacteria that turn nitrogen into nitrate fertilizer; and plants use up carbon dioxide and produce oxygen. One stunning example that affects us locally is forest fragmentation, which can increase white-footed mouse populations, which in turn increase the human risk of exposure to Lyme disease (Allan et al. 2003).

USEPA

The Rondout Reservoir is known for its active eagle nesting sites.

The plants and animals that inhabit the Rondout watershed are suited to the habitats provided by our temperate climate. The other major factor is human alteration of the landscape. Pre-European colonization of the watershed was predominantly forested with some small areas cleared by Native Americans for hunting. Early European settlers attempted to farm the land, but abandoned it soon after due to a short growing season, steep slopes and rocky and shallow soils. Between 1800 and the early 1900s gristmills, woolen mills, sawmills, the tanning industry, quarrying for bluestone, logging, furniture making, railroads and resorts cleared the Catskills of its forest cover. Since the early 1900s these industries have declined and areas that were previously cleared have grown back into forest, with approximately 98% of the Rondout basin's land cover being classified as forest in a 2001 NYCDEP analysis.

The reaction of wildlife has varied to the changing land uses. A few, such as the timber wolf, eastern cougar, New England cottontail and passenger pigeon were eliminated from the region (passenger pigeon is extinct worldwide); and some such as tiger beetle and timber rattlesnake are disappearing from the Catskills. Beaver, pileated woodpeckers, and bald eagles were once gone from this region due to over hunting, habitat loss, and pesticide poisoning respectively, but have since returned with reduced hunting pressure, an increase in second-growth forests and a ban on DDT. Some species, such as the bobcat, black bear, river otter and osprey are less common than they were prior to European colonization. However, other common species, such as the white tailed deer, raccoon, skunk, red fox, robin, and painted turtle are thriving.

Native pests often have native predators that control their populations. For example, the forest tent caterpillar *(Malacosoma disstria)* can cause a large amount of damage to Catskill forests. However, they tend to be controlled by a natural predator fly *(Sarcophaga aldrichi)* whose population explodes following increases of the catepillar's population, which helps to bring them back under control. A bacterial disease, known as "wilt" and cold, wet, weather conditions in early spring also helps.

The Upper Rondout, and many of its tributaries, are primarily cold water streams, meaning they provide suitable water temperatures for organisms, such as brook trout and sculpins, which require cold water (less than 72° F (22°C). Annually NYS DEC stocks the Rondout Creek with nearly 3,000 brook trout in the spring and stocks the Rondout Reservoir with over 4,400 brown trout in June.

RARE BIRDS

Common Name	Scientific Name	State Protection
Bald eagle	*Haliaeetus leucocephalus*	Threatened
Bicknell's Thrush	*Catharus bicknelli*	Special Concern Species
Peregrine Falcon	*Falco peregrinus*	Endangered

RARE INVERTEBRATES

Appalachian Tiger Beetle	*Cicindela ancocisconensis*	Unprotected

RARE PLANTS

Appalachian Firmoss	*Huperzia appressa*	Threatened
Blunt-lobe Grape Fern	*Botrychium oneidense*	Endangered
Button-bush Dodder	*Cuscuta cephalanthi*	Endangered
Hooker's Orchid	*Platanthera hookeri*	Endangered
Jacob's-ladder	*Polemonium vanbruntiae*	Rare
Nodding Pogonia	*Triphora trianthophora*	Endangered
Northern Monk's-hood	*Aconitum noveboracense*	Threatened
Northern Wild Comfrey	*Cynoglossum virginianum var. boreale*	Endangered
Squashberry	*Viburnum edule*	Threatened

Wildlife of Stream Corridors & Conservation Recommendations

Upper Rondout Watershed
Sullivan & Ulster County

In the Upper Rondout watershed, abundant streams with cobble beds, undercut banks, and streamside wetlands and forests are habitat for damselflies, dragonflies, stream salamanders, turtles, frogs and the threatened Northern Monk's-hood. Riparian forests are particularly important breeding habitat for birds such as the Louisiana waterthrush, Yellow warbler and Warbling 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 shrub land bird species, like the Veery, in decline in New York State as old farms revert to forests. Young forests are habitat for Canada warbler, while open shrub lands and dense thickets are preferred by Northern cardinals.

Many species, like Black-and-white warbler, 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.

Another species of bird that is common to the Rondout is the Bald eagle. Once nearing the brink of extinction, they have made an amazing comeback and are now off the endangered species list, though still listed as threatened. The abundance of fish (due to the purity of the water, abundant food, and health of the ecosystem) in the Rondout Creek and Rondout Reservoir makes it an ideal habitat for eagles. The New York City Department of Environmental Protection along with the New York State Department of Environmental Conservation have maintained and protected eagle nesting sites along the reservoir in order to encourage nesting pairs to continue to breed in the area. Viewing areas for eagles are also found along the reservoir.

Decaying logs provide the base of the food chain in forested mountain streams like the Rondout, encouraging natural habitat for a healthy fishery.

The Best Buffers

Stream managers can 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 tolerate human development if appropriate habitats exist, and unlike some grassland birds, do not require large habitat patches for breeding. Landowners who maintain shrubby thickets in 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.
- Stream managers are encouraged to learn to recognize the Appalachian tiger beetle and other declining and threatened species and report observations to the NY Natural Heritage Program.
- 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 a specific 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 can thrive if 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. Seeking to create a minimum 500 ft forested buffer around stream corridor wetlands will provide terrestrial habitat required by stream- and vernal pool-breeding amphibians to complete their life cycles, and to protect wetlands from adjacent land uses.
- If buffer widths of 30–100 ft are maintained, riparian forest canopies will provide enough shading and cooling of streams to maintain trout populations. These buffers need to be nearly continuous to be effective. 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 macroinvertebrates. In turn, aquatic macroinvertebrates are the major food source for most freshwater fish.
- A minimum 100 ft buffer is recommended to protect aquatic macroinvertebrate and fish abundance.

A healthy stream corridor is home to thousands of insects and amphibians who depend on a steady supply of fresh, clear water.

In addition to trout, there are a number of stream corridor species depend on the natural channel processes of a healthy stream to provide habitat during parts of their life cycles:

Stream salamanders are generally sensitive to siltation, scouring, nutrient enrichment, channelization, and diversion of water. Maintaining natural stream processes and riparian buffers protects salamander habitat.

There are only 10 rivers in NYS with populations of Appalachian tiger beetle. This beetle is typically found on riverside sand and cobble bars at the edges of forested streams where stream management practices maintain natural stream processes, including the natural flooding that prevent dense plant growth on cobble bars. Gravel mining and motorized vehicle use on sand and gravel bars can destroy beetle larvae.

Hydrology & Flood History

Understanding the dynamics of how the Upper Rondout streams carry rain and snow over time as runoff and stream flow (discharge) helps us to predict flood frequency and magnitude, and determine appropriate ways to manage the stream and watershed.

Estimated mean annual precipitation at the USGS gage near Lowes Corners, NY is approximately 50–60 inches per year, and often comes as late winter rain-on-snow events summer storms, or remnants of autumn hurricanes. Due to the steep side slopes of this watershed, stream levels can rise and fall relatively quickly during intense storm events. The watershed can also retain snowpack into the spring, often resulting in flash floods when rain melts existing snow. This flashiness can be mitigated by the heavy forest cover throughout much of the watershed, but is intensified in well-developed areas with impervious surfaces.

Rondout Statistics

Stream Flow

There are two general categories of streamflow: 1) storm and flood flow and 2) 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 streamflow 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 Rondout watershed is variable, depending upon time of year and severity of storms or snowmelt events.

Higher streamflows are 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. 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 Rondout 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 streamflow during dry periods and between storm flows. The source of base flow is

OPPOSITE: *High water on the Upper Rondout Creek, January 2010.*

groundwater that flows through unsaturated and saturated soils and cracks or layers in bedrock 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 process is what enables fish and other aquatic life to survive in streams year-round.

Sundown, April 2005.

Hydrologists use hydrograph of a stream to characterize the relationship between flow and timing. A *stream gage* is necessary to monitor stream discharge and develop a hydrograph. The United States Geological Survey (USGS) maintains two continuously recording stream gages on the Upper Rondout, one above the confluence with Red Brook at Peekamoose (drainage area 5.36 square miles, USGS ID# 01364959), and another near Lowes Corners just upstream from the confluence with Sugarloaf Brook (drainage area 38.3 square miles, USGS ID# 01365000). All gage information is available online at the USGS website at **http://waterdata.usgs.gov/ny/nwis/rt**.

The annual pattern of stream flow can be seen by looking at the flows from a single water year, such as the one displayed in Fig. 4. Fig. 5 displays the storm flow event associated with the remnants of Hurricane Tammy in October of 2005 at the Rondout gage at Peekamoose. As of September 2005, the gage was experiencing low flows due to drought-like conditions. As weather events dumped rain across the area, storm flow responded to the precipitation very rapidly. Stream flow increased from approximately 3–4 cubic feet per second (cfs) to nearly 400 cfs within 24 hours. Within another three days, this flow had dropped over 300 cfs and began to approach normal flow conditions. This storm was the highest recorded peak for this water year.

Rondout Flood History

The highest stream flow recorded over a 12-month period (usually from October 1 through September 30, or the "Hydrologic Water Year") is called annual peak stream flow. The beginning of the Water Year is chosen to represent the average "start" of the high flow season following the summer low flow period. The range of annual peak flows on Rondout hydrographs show the drama of the river that has been recorded since 1937.

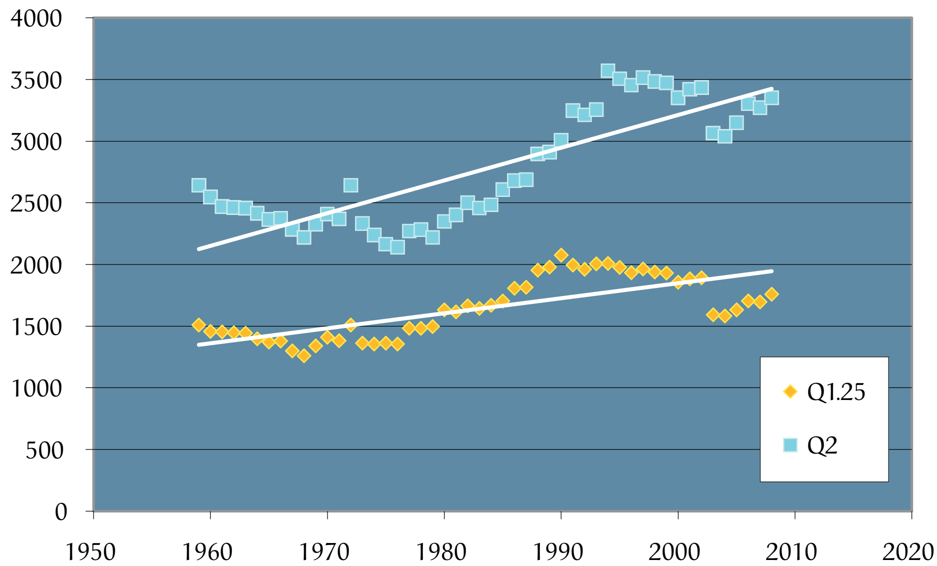
The prediction and evaluation of the likelihood of flooding is a useful tool to resource and land managers, as it allows for the appropriate planning of development and infrastructure, as well as anticipate potential property damage and safety issues. The USGS has developed a standard method for calculating flood frequency from peak flow data at stream gages, which is provided for public use upon request. This is accomplished by taking the long-term peak flow record and assigning a probability to each magnitude of flood event. Generally, the longer the period of record the more accurate the statistical probability assigned to each flow magnitude.

Since the Rondout gage near Lowes Corners has been established for 73 years, we can study historic records, interview knowledgeable individuals from the area, and look at photographic records from the watershed to help describe some major historical flood events and draw conclusions about the nature of flooding in the valley. In addition, we can evaluate gage records at nearby gages that have a sufficiently long record (30 years or more). Three examples are the Chestnut Creek at Grahamsville, Neversink River near Claryville, and Esopus Creek at Coldbrook. These gages are particularly useful because they surround the Upper Rondout near Lowes Corners, and represent similar hydrography and topography.

Sundown road conditions, flood of 1928.

Flooding occurs in response to excessive runoff associated with spring snowmelt, summer thunderstorms, remnants of fall hurricanes, and winter rain-on-snow events. Six of the fifteen major floods recorded at the Rondout Creek near Lowes Corners station occurred in early spring

50-YEAR TRENDS IN CHANNEL FORMING FLOWS
Lowes Corners Gage Station



Climate trends show an increase in the intensity and frequency of rainfall events that are large enough to fill the stream bank and change the stream channel's shape and size.

and are presumably associated with major snowmelt events from either spring thaw or rain-on-snow events. The largest recorded flood at this gage was a summer event.

The 1990s were generally a time without significant flooding events on the Rondout, as well as nearby Chestnut Creek. The years 2000–2006 were characterized by drought-like conditions with intervening wet conditions. High water events were typically limited to bankfull (or smaller) events. 2005 and 2010 were a particularly eventful years for the Rondout, producing an above bankfull event in both the spring and autumn. Predicting precisely when the next five year (or greater) flood will occur on the Rondout is impossible — the probability for a large flood, or a flood of any particular size, is the same each year — though weather and storm patterns can be used to anticipate conditions for a few months out.

The Riparian Community

Although people value trees and other plants along a stream for their contribution to the beauty of the landscape, the vegetation in a watershed — especially in the streamside or *riparian* area — plays a critical role in a healthy stream system. This streamside plant community maintains the riverine landscape and moderates 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; and regulates

water temperature changes. It also provides food and cover to animals and fish and other aquatic life; and conserves soil moisture, ground water and atmospheric humidity.

Riparian vegetation serves as a buffer for the stream against activities on upland areas. Most human activities like agriculture, development, or recreation can result in disturbances that can negatively impact the unprotected stream. Riparian vegetation captures and stores pollutants in overland flow from upland sources, such as salt from roadways and excess fertilizers from lawns and cropland. The width, density, and structure of the riparian vegetation community are important characteristics of the buffer and also affect how well it works in the watershed.

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 these erosive flows. On the floodplain, vegetation slows flood flows, reducing the energy of water and its potential to cause erosion and scour. As vegetation slows the water, the fine sediment and soil suspended in the water has more chance to settle on the floodplain (rather than be carried away by the stream).

Vegetation intercepts rainfall and slows runoff, increasing the amount of precipitation that infiltrates the soil and reduces overland runoff. This helps to decrease the occurrence of destructive flash floods, lowers the height of flood waters, and extends the duration of the runoff event. These benefits are evident in forested watersheds such as the Upper Rondout when compared to watersheds of similar size which have high levels of urban development. The reduction in flood stage and duration also results in fewer disturbances to the stream banks and floodplains.

Streamside vegetation also functions to provide climate, habitat, and nutrients necessary for aquatic and terrestrial wildlife. Trees shading a stream help maintain cool water temperatures needed by native fish. Low-hanging 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.

A healthy riparian community is diverse, with a wide variety of plants, including trees, shrubs, grasses, and herbs. The age of plant species are

DIVERSE PLANT TYPES
(trees, shrubs, grasses, herbs)

\+

DIVERSE PLANT AGES
(young and old)

\+

DISTURBANCE-ADAPTED, MOISTURE-LOVING PLANTS
(accustomed to flooding and ice flows)

=

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

varied with a healthy regeneration rate so that new plants ensure the future of the community. Riparian communities are unique in that they must adapt to frequent disturbance from flooding. Consequently, many riparian plants such as willow, alder, and poplar, can re-grow from stump sprouts or re-establish their root system if up-ended. Also, seeds from these species are adapted to thrive in gravel bars and lower flood benches, where they can sprout in sediment deposited there during high flows.

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 forest of the Upper Rondout watershed 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* (Kudish, 2000).

More recently, human activities have affected the forest both through development and harvesting of desirable species (high-grade wood) for wood products. Native Americans used prescribed burning as a means of encouraging nut bearing oaks and hickories to establish dominance in the forests. European settlers in the 18th and 19th centuries contributed to a rising industrial economy by clearing vast areas of land for agriculture, and harvesting construction materials and hemlock bark for the extraction of tannin. The land cover in the Upper Rondout began to revert to forest with the local collapse of these economies in the 20th century and the acquisition of much of the land by the State for the Catskill Forest Preserve (Kudish, 2000).

Prior land uses play a big role in what types of vegetation we find 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 primary-colonizer species dominating the initial regrowth including sumac, dogwood, aspen, hawthorn, 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, hickory, butternut, and oak. Hemlocks are largely confined to steeper stream banks and slopes where harvesting them 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. Today the Upper Rondout watershed is largely forested with a riparian area predominantly herbaceous.

The Riparian Forest

Typically, riparian forest communities consist of species that thrive in wet locations and have the ability to resist or recover from flood disturbances. Extensive riparian communities typically exist in floodplain or wetland areas where a gentle slope exists. Many of the species present in these plant communities are exclusive to riparian areas. In areas where a steep valley slope exists, the riparian community may occupy only a narrow corridor along the stream and then quickly transition to an upland forest community. Soils, ground water and available sunlight may create conditions that allow the riparian forest species to occupy steeper slopes along the stream, as in the case where hemlock inhabits the northfacing slopes along the watercourse.

Proximity to water means that these forests are subject to extreme forces of nature and human development. Natural disturbances include floods, ice floes, and to a lesser extent, high winds, pest and disease epidemics, drought, and fire. Large deer herds can also significantly alter the composition and structure of vegetation through browsing, leaving stands of mature trees with no understory.

The flood of 1996 on the Upper Rondout created and reopened numerous high flow channels, scoured floodplains and eroded formerly vegetated stream banks. Immediately following the flood, the channel and floodplains were scattered with woody debris and downed live trees. In the years since this event, 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 enough time passes between major flood events. Frequent floods and ice prevent large trees from establishing. in the area disturbed by runoff events that reach bankfull flow (expected to occur on average every 1.3 years). Ice flows can also cause channel blockages, resulting in erosion and scour associated with high flow channels and overbank flows. Typically this type of disturbance has a short recovery period.

Local geology and stream geomorphology may complicate the recovery process. A number of sites were found along Rondout Creek where vegetation has not been able to re-establish itself on bank failures created during recent flood events. On these sites, it will be necessary to understand the cause of the failure before deciding whether or not to attempt planting vegetation to aid in site recovery. In these instances, the hydraulics of flowing water, the morphological evaluation of the stream channel, the geology of the stream bank, and the requirements and capabilities of vegetation must be considered before attempting restoration.

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 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, the population fluctuates, allowing for some hemlock regrowth in periods when their density is low. But this regrowth is stunted and later attacked as the adelgid population increases. With each successive attack, tree reserves become depleted and eventually regrowth 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.**

Hemlock Woolly Adelgid, the invasive insect, attacks trees by feeding on sap at the base of the needles.

A loss of hemlocks along the banks of the Rondout Creek poses a threat to stream 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 Rondout Creek.

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*. 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 recolonization 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).

Other forest pests are on the brink of infesting the Catskills that pose even greater risks than the woolly adelgid. Emerald Ash Borer (*Agrilus planipennis;* EAB) and Asian Long-horned Beetle (*Anonplophora glabripennis;* ALB) are two particular insects that have ravaged forests elsewhere in the United States. EAB threatens the Catskills from the west as its makes its way from Michigan through Ohio, Pennsylvania and the southern tier of NY. Likewise ALB threatens to invade from the south (New York City) or east (Worchester, MA). The high level of tourism and second home ownership in the Catskills makes this area particularly vulnerable to the transport of these species. Together, these two pests could seriously impact the forests that comprise the livelihood of many creatures and humans. Statewide concerns about EAB and ALB have led to a recent ban on the movement of firewood within a 50 mile radius of where it was cut; quarantines are being updated regularly by New York State Department of Environmental Conservation.

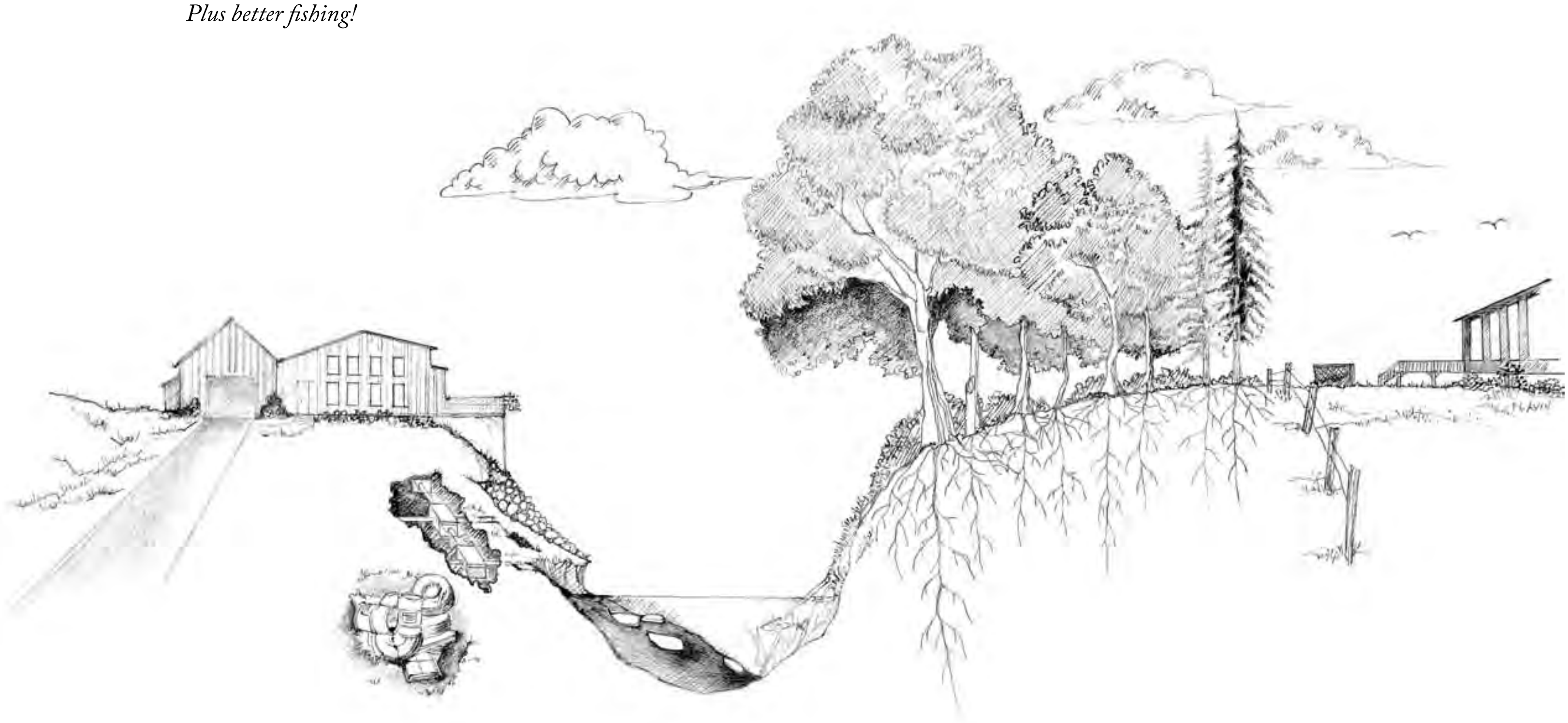
Although natural events disrupt growth and succession of riparian vegetation growth, human activities frequently transform the environment and, as a result, can have long lasting impact on the capability of vegetation to survive and function. Presently, the most significant sources of human disturbance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

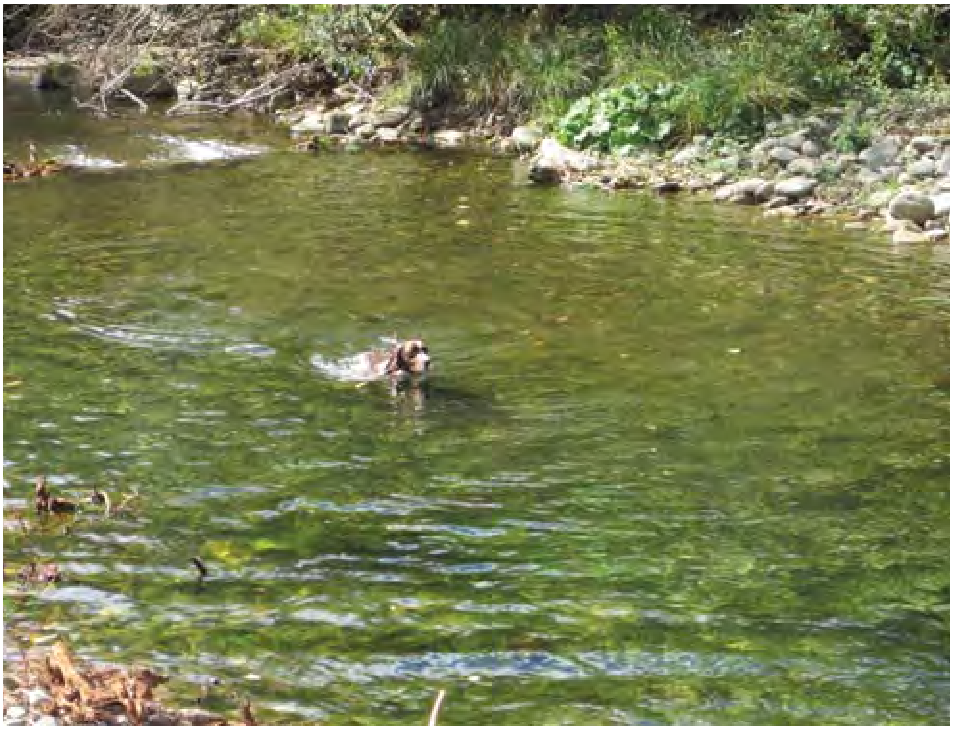
Due to narrow and steep valley walls, the alignment of Sullivan County Route 153/Sundown Road and Peekamoose Road closely follows the stream alignment of the Upper Rondout Creek. Use and maintenance of these roads has a significant impact on the riparian vegetation. The slim buffer of land between the creek and the road receives runoff containing salt, gravel, and chemicals from the road that stunt vegetation growth or increase mortality. This disturbance fosters the establishment of undesirable, invasive plants which establish more quickly than native vegetation in these areas. 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 native, 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.

Is your streamside buffer healthy?

A manicured lawn directly at the water's edge puts your property at risk for erosion. The deeper roots of native grasses, trees and shrubs stabilize the stream bank, filter and slow the creek waters, and provide safer conditions in the backyard. Plus better fishing!





Dog walking on the Rondout.

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 Rondout Creek.

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.

Invasive Plants & 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 (Melanson, 2002).

The spread of Japanese knotweed *(Fallopia japonica)*, an exotic, invasive plant gaining a foothold in many streams in the Catskills, is an example of a plant causing such a disruption. It shades out existing vegetation and form dense stands along the bank. Although the impact of a Japanese knotweed invasion on the ecology of the riparian area is not fully understood, the traits of this plant pose several concerns:

- Knotweed appears to be less effective at stabilizing streambanks than shrubs and trees with deeper roots, 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.
- Knotweed may alter the chemical make-up of the soil, altering soil microfauna and soil properties.

Japanese knotweed: first shoots emerge (spring); full bloom (summer) and dried stalks (after killing frost).

- Japanese knotweed is very difficult to control. One small fragment of stem or underground root can start a whole new stand, often spread by floods or inadvertent transport through fill or cutting. The broad use of herbicides, while partially effective, is not a viable option due to the threat 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. While Japanese knotweed colonizes nearly five continuous miles of stream banks in some areas of the Catskills, the Rondout Creek has primarily only one large stand and a few smaller, manageable stands.

Due to the low amount of Japanese knotweed along Rondout Creek and its tributaries, it is particularly important to prevent additional spread of the aggressive plant by ensuring that fill material introduced to the riparian area is clean from Japanese knotweed fragments; those conducting its removal dispose of it properly to prevent spreading or re-establishment; and planting stream banks with native vegetation, so that Japanese knotweed does not have a place to root.

As part of the stream management planning process, physiognomic vegetation classes (e.g., open-canopy forest, shrub-brush, herbaceous) were mapped and the riparian vegetation assessed for the Upper Rondout watershed. The purpose of this exercise was to provide the planning team with baseline information about plant communities present in the watershed, a description of the condition of vegetation in the riparian area, and 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 Rondout Creek. 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.

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.

TABLE 1
Vegetation Classes for the riparian corridor of the Rondout Creek.

Vegetation Classification	Area (acres)	Percent of Total Area
Deciduous Closed Tree Canopy	50.71	28.31 %
Mixed Closed Tree Canopy	29.77	16.62 %
Deciduous Open Tree Canopy	25.75	14.37 %
Evergreen Closed Tree Canopy	24.26	13.54 %
Herbaceous Vegetation	13.44	7.50 %
Shrubland	10.89	6.08 %
Bare Soil	7.71	4.30 %
Evergreen Open Tree Canopy	7.23	4.04 %
Impervious Surface	7.17	4.00 %
Unpaved Road	1.30	0.73 %
Mixed Open Tree Canopy	0.65	0.36 %
Water	0.22	0.12 %
Revetment	0.04	0.02 %
Total Area	179.14	100.00 %
Inadequate Vegetation	21.20	11.83 %

Summary of Findings

According to this riparian vegetation assessment, deciduous closed tree canopy (approximately 51 acres) and mixed closed tree canopy (approximately 30 acres) were the largest physiognomic classes within the 100 foot buffer, while deciduous open tree canopy and evergreen closed tree canopy occupied approximately 26 acres and 24 acres respectively (Table 1). Rondout Creek benefits greatly from this predominance of forest vegetation of the riparian area. 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. Only 21 acres, or 12% of land area was considered to lack healthy vegetative cover; this included areas of herbaceous vegetation, bare soil and revetment.

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 Rondout Creek and its tributaries. The Catskill Streams Buffer Initiative (CSBI) helps residential landowners add vegetation to protect property and preserve natural habitat along stream banks in the Catskill/Delaware watershed areas. The CSBI is a funded initiative of the Stream Management Program. In partnership with coordinators at county Soil and Water Conservation Districts, CSBI's environmental experts diagnose streamside-related problems and recommend solutions to effectively manage streamside property. By cultivating strong streamside buffers that use vegetation native to the Catskill region, CSBI assists landowners create streamside habitat, reduce stream bank erosion, and improve water quality. Applications for this program as well as broader watershed management and stream basics can be found at **www.CatskillStreams.org.**

OPPOSITE: *Threats to the Rondout Creek's high quality water are identified by collecting data and interpreting how human impacts, geology, and climate all contribute to stream health.*

Water Quality

Water Quality Measures

The purpose of this section is to provide a general understanding of water quality in the Rondout Creek. For the purposes of the NYC water supply, the Rondout watershed supplies good quality water with the exception of the time period following large storms in which in-stream turbidity and suspended solids are high. Streams in the Catskills have moved large amounts of suspended sediment during storms for thousands of years; and will continue to do so for thousands of years until all the glacial lake sediment and glacial till have been removed from the stream network.

This good water quality supporting multiple uses can most likely be attributed to the watershed's high percentage of forest cover. However, much of the developed land is adjacent to the stream, particularly roads. Future development in the stream corridor, with a resulting increase in impervious surface, may increase runoff and impair water quality.

Efforts to reduce or minimize impacts include direct measures such as remediating failing septic systems and upgrading sewer treatment plants (point sources of pollution); and indirect measures such as reducing stormwater inputs, carefully planning new infrastructure and planting riparian buffers. In areas where existing infrastructure is acting to destabilize the stream, or is threatened by erosion, stabilization techniques incorporating natural channel design can be employed. Reforesting the banks of the Rondout Creek and its tributaries, coupled with the protection of cold groundwater seeps, may help to lower summer water temperatures and enhance the fishery.

Additional benefits come from this attention to water quality by local landowners. For example, protecting and enhancing the fishery could also benefit the economy and aesthetic values of the region. Proper watershed management can also assist in protecting infrastructure, and reducing flood damages. Taken together, all these benefits can increase the quality of life of watershed residents, while providing high quality drinking water to the residents of New York City into the future.

Sediment: Silt and Clay

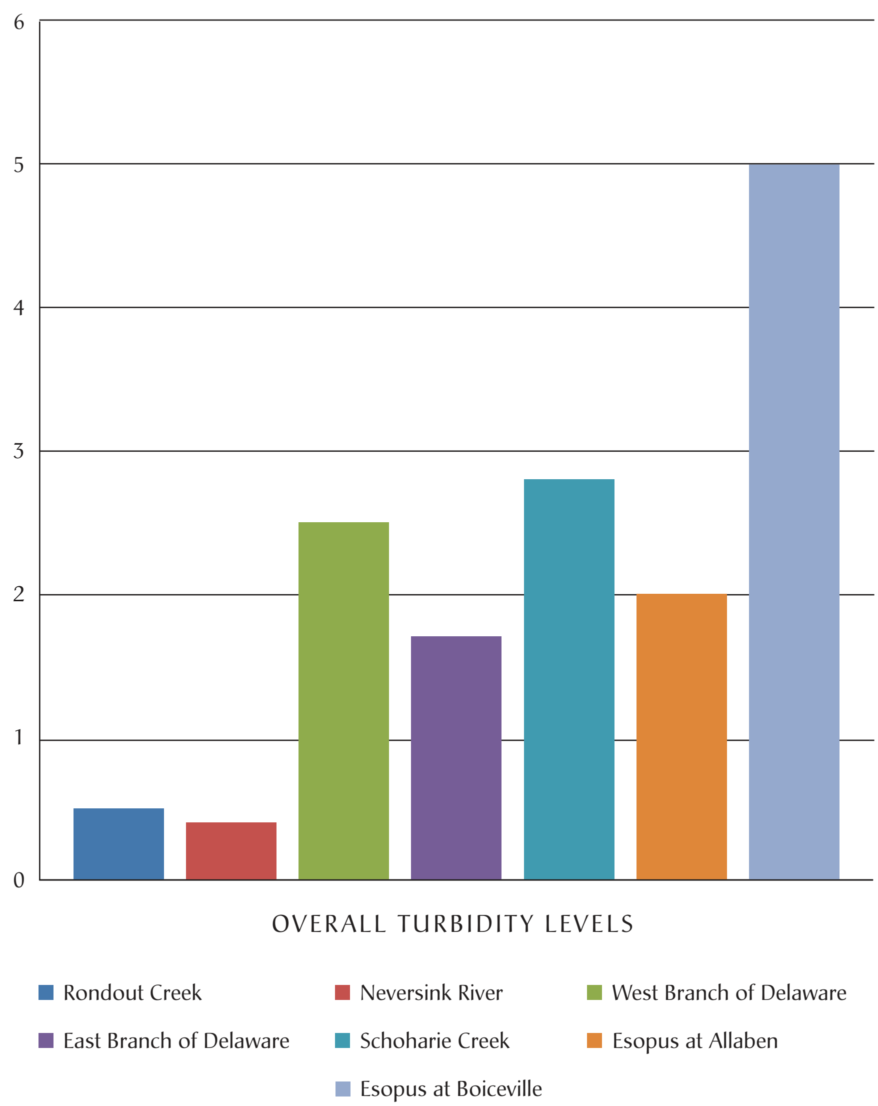
Silt and clay — buried in ice age deposits — are easily eroded into the stream and often, after a major storm, the streams run with a characteristic reddish brown color, which elevates in-stream turbidity. Although a certain percentage of this erosion is natural, disturbances to the steep slopes in the basin or other human interventions add to the problem and may be identified and addressed more easily. Infrastructure for protecting bridges, roads and buildings along the Rondout Creek can exacerbate the rates of erosion. This Plan offers recommendations for minimizing these efforts in a collaborative effort with the region's professional highway departments.

Fine sediments can settle on substrates used by colonizing algae and invertebrates and can fill the small spaces between gravel where fish lay their eggs. Transmission of light through the water can be reduced, which affects stream productivity through decreased photosynthesis. Turbid waters also become warmer as suspended particles absorb heat from sunlight, which can lead to falling levels of oxygen.

The median turbidity value for Rondout Creek near Lowes Corners based on data from 1987-2008 is 0.50 NTU. While Rondout Creek usually has fairly low turbidity values, storms can cause these numbers to increase by four orders of magnitude. For example, samples collected during storm events have had turbidities as high as 1600 NTU. Likewise the median value for total suspended solids is 0.55 mg/l, but during storm events has reached almost 3,000 mg/l.

In the case of Catskill stream turbidity, both hydrology (storm events) and geology are important determining factors. The hydrology and geology are natural factors that cannot be effectively managed. Therefore, management efforts can focus on preventing further human-induced water quality degradation through implementation of best management practices designed to reduce sediment impacts. The most effective plan includes both direct action (e.g. planting a riparian buffer) and future planning (e.g. reducing stormwater inputs and/or properly installing new infrastructure that supports stream stability).

MEDIAN TURBIDITY VALUES
for Selected Inflow Sites to Catskill–Delaware Reservoirs



Turbidity measures high during storm events when the Rondout Creek looks muddy because of escaping sediment from natural sources, January 2010.

Temperature

Water temperature is one of the most important variables in aquatic ecology. Temperature affects movement of molecules, fluid dynamics, and metabolic rates of organisms as well as a host of other processes. In addition to having its own potential "toxic" effect (i.e. when temperature is too high), temperature affects the solubility and, in turn, the toxicity of many other parameters. Generally the solubility of solids increases with increasing temperature, while gases tend to be more soluble in cold water (i.e. available O2 to fish).

In densely wooded areas where the majority of the streambed is shaded, heat transferred from the air and groundwater inputs drive in-stream temperature dynamics. However, in areas without shade, the water temperatures can rise much more quickly due to the direct exposure to the sun's radiation. Rock and blacktop also hold heat and can transfer the heat to the water (like hot coals in a grill). Annual fluctuation of temperature in a stream may drive many biological processes, for example, the emergence of aquatic insects and spawning of fish.

Even at a given air temperature, stream temperature may be variable over short distances depending on plant cover, stream flow dynamics, stream depth and groundwater inflow. Water temperatures exceeding 77° Fahrenheit cannot be tolerated by brook trout, and they prefer water temperatures less than 68° Fahrenheit (TU, 2006). The annual median water temperature of Rondout Creek from 1987 to 2008 was 8.0°C (46.4°F). The annual median temperature ranged from 6.5°C (43.7°F) (1988) to 11.0°C (51.8°F) (1990).

pH

For optimal growth, most species of aquatic organisms require a pH in the range of 6.5 to 8.0, and variance outside of this range can stress or kill organisms. Due to the acidity of rainfall in the northeast, maintaining this range is of concern. According to the NYSDEC (2004a), average pH of rainfall in New York ranges from 4.0 to 4.5. Annual (1987–2008) median pH values for the period of record for the Rondout Creek near Lowes Corners ranged from 6.28 to 7.05. The annual medians were generally slightly acidic, with annual medians being too coarse to differentiate between seasons and flow regimes.

Chloride

Chlorides are salts resulting from the combination of chlorine gas with a metal. Chlorine as a gas is highly toxic, but in combination with a metal such as sodium it becomes useful to plants and animals. Small amounts of chlorides are required for normal cell function in plants and animals. Common chlorides include sodium chloride ($NaCl$), calcium chloride ($CaCl2$) and magnesium chloride ($MgCl2$). Chlorides can enter surface water from several sources including geologic formations containing chlorides, agricultural runoff, industrial wastewater, effluent from wastewater treatment plants, and the salting of roads. Excess chloride can contaminate fresh water streams and lakes, negatively affecting aquatic communities. The major sources of chloride in the Rondout watershed are most likely geology and road salting. The annual median chloride concentrations are low across the board, ranging from2.75 mg/l to 4.3 mg/l. Annual medians are too coarse to tease out specific contributors. Annual chloride concentrations have been increasing, although by a relatively small degree.

I N T E R V E N T I O N   L E V E L S   M A P

Preservation | Passive Restoration | Assisted Restoration | Full Restoration

Figure 1

Rondout Creek Management Units 17 through 14: From a private bridge at the outfall of the Peekamoose Lake dam continuing downstream approximately 3.25 miles to the bridge at the trailer field in NYS DEC Peekamoose Valley Camping Area.

Figure 2

Rondout Creek Management Units 8–13 and Sundown Creek Management Units 18–20: From the trailer field downstream 3.1 miles under the Sundown Bridge on Peekamoose/ Sundown Road, including lower sections of Sundown Creek for 1.8 miles up Greenville Road.

Figure 3

Rondout Creek management units 7 through 1: Sundown Creek's entry into the Rondout Creek, downstream approximately 3.5 miles along Sundown Road until emptying into the Rondout Reservoir at the Route 55–A Bridge.

Summary of Management Unit Recommendations

This section contains observations of the condition of the Upper Rondout Creek made during a walkover assessment conducted in 2008-2009. Detailed descriptions and specific recommendations are presented for the stream length existing from the top of the watershed near Peekamoose Lake downstream to the Rondout Reservoir. New York State lands, which are in "forever wild" status, are not included.

The Rondout mainstem was organized into 17 Management Units (MUs) defined using physical stream characteristics, historical channel alignments, location of bridges and road infrastructure, and valley characteristics. The major tributaries, including the Rondout headwaters above Peekamoose Lake, will be inventoried in future assessments; the exception is the first portion of Sundown Creek (aka East Branch of the Rondout), which was included due to the predominant role it plays in conditions on the mainstem at the confluence. This section of Sundown Creek has been designated Management Unit 18.

These MU descriptions provide summary statistics, outline some of the historical conditions relating to current stream function, and describe current morphological conditions (bed and bank form), sediment transport dynamics, general streamside (riparian) vegetation condition, and proximity and arrangement of roads, bridges and culverts.

They also briefly address issues related to flood risks, in-stream habitat and water quality. These descriptions are meant to provide landowners and other stream managers information that might be useful in the management of their property for optimum stream health and to guide future policy and program development by regional decision-makers and agency personnel.

The stream feature inventory was conducted during 2008 and 2009. The following is a list of some of the features that were mapped using a handheld Global Positioning System (GPS) unit with 3–5 meter accuracy:

- Eroding banks
- Eroding beds (or head-cuts)
- Depositional bars — point, side, transverse (or diagonal), center bars
- Debris or log jams
- Culvert outfalls
- Revetment types — berms, walls, riprap, dumped stone, log cribbing
- Cross sectional locations
- Grade control features — including bedrock outcrops and dams
- Japanese knotweed colony locations
- Bridges and their abutments
- Clay exposures in the banks
- Spring seeps
- Tributaries

Photographs were taken of each feature significant to overall stream functioning. The information from this assessment was compiled within a series of Arcview Geographic Information Systems (GIS) software shapefiles maintained by the New York City Department of Environmental Protection (NYCDEP). Sample maps displaying important stream features are provided for each Management Unit.

In the summary table at the beginning of each Management Unit, the first entry is "Intervention Level". This refers to level of effort suggested for the management activities recommended for each unit. There are four categories ■ **Preservation** indicates that conditions are stable and healthy and should be protected as a reference model to guide management of other units ■ **Passive Restoration** indicates that there may be some instability of the channel bed, but it appears that the stream will recover from disturbance through self-correction and re-establish its stability without intervention, and that the appropriate management is to monitor the reach to track its evolution ■ **Assisted Restoration** indicates that there is sufficient channel instability to warrant active management (e.g., installation of soil bioengineering stabilization practices) but that major channel work is not necessary and management can be effective at the site scale ■ **Full Restoration** indicates that significant instability problems are present which will require intervention such as channel work to re-establish its effectiveness in transporting sediment.

While bank erosion occurs even in pristine settings, much of the bank erosion we see in the Rondout Creek and elsewhere in the Catskills is the result of past management practices on the stream, its floodplain and roads and bridges in the stream corridor. Since streams are integrated systems, a management decision in one reach has the potential to create disturbance up or downstream, and effective management requires that watershed communities coordinate these decisions in closer collaboration. For that reason, the recommendations in this section of the management plan consider conditions both at the site of the erosion and upstream and downstream of the site. In addition, the relative significance of each erosion site, its causes and the options for treatment all are best understood and addressed in the context of the entire watershed.

A Sample: Management Unit 7

The information in this section is meant to give landowners a sample of the information gathered and interpreted in the stream reach including their property. The *Summary Table of Management Unit Recommendations* offers information on all units. Detail on each unit is published in PDF at **www.catskillstreams.org** *(Click on Major Streams and Rondout Creek to find all related content).*

RONDOUT CREEK MANAGEMENT UNIT 7

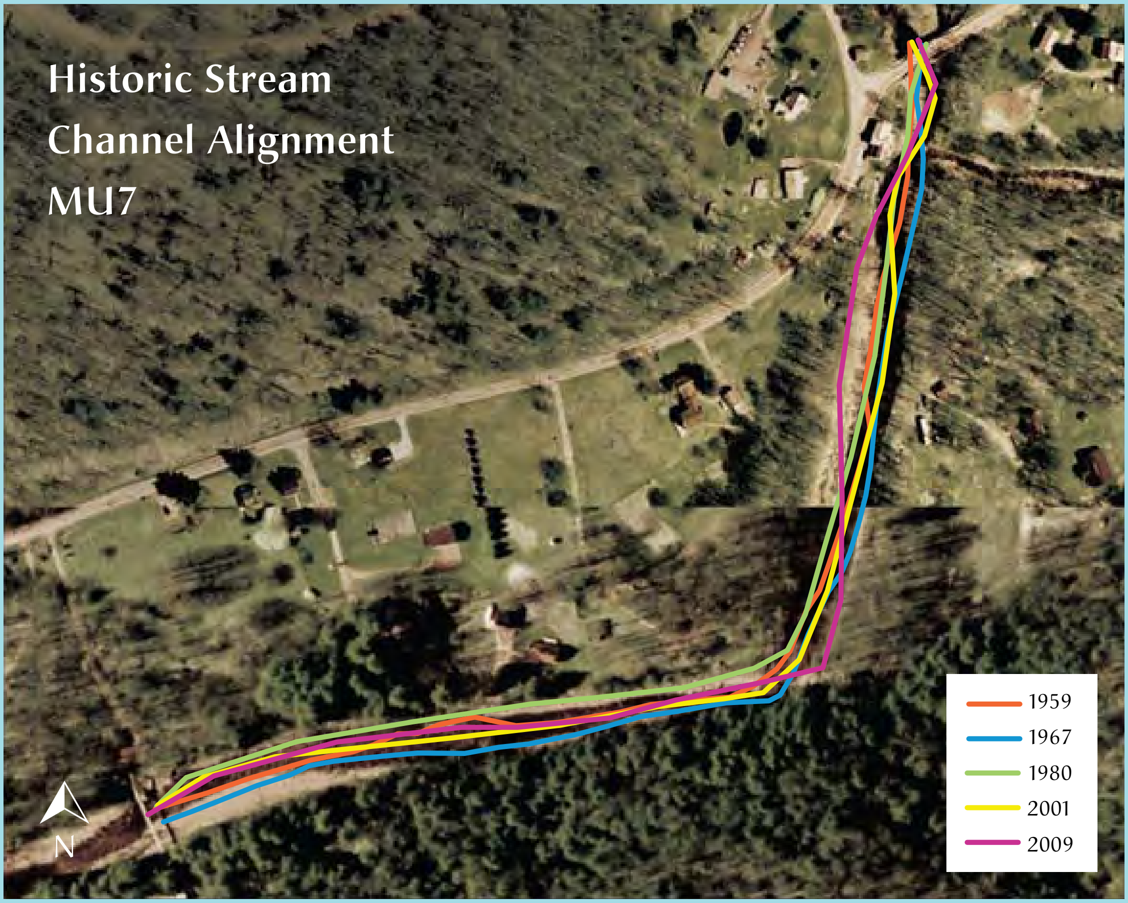
Between Station 16,300 and Station 18,500

STREAM FEATURE STATISTICS

- 9% of stream length is experiencing erosion
- 18% of stream length has been stabilized
- 2.34 acres of inadequate vegetation within the 100 ft. buffer
- 380 ft. of stream is within 50 ft. of the road
- 2 houses located within the 100–year floodplain boundary

This management unit begins at the Ulster County Route 42 bridge crossing in Sundown, continuing approximately 2,234 ft. to a foot bridge at the end of a private dirt road. The drainage area ranges from 33.3 mi2 at the top of the management unit to 26.3 mi2 at the bottom of the unit. The valley slope is 1.2%. The average valley width is 908.0 ft.

Recommendations for Management Unit 7	
Intervention Level	Assisted self-recovery from Stn 17400 to Stn 18000 to address bed deposition and bank erosion
Stream Morphology	Conduct hydraulics study of management unit. Address overwidened channel in the middle of the management unit contributing to bedload deposition, increasing stress on an eroding bank.
Riparian Vegetation	Improve vegetative cover at revetment in vicinity of confluence of EB Rondout; install bioengineering practices at Stn 17400 to Stn 18500
Infrastructure	Monitor condition of stream barbs at Stn 18300
Aquatic Habitat	Conduct fish habitat and population study
Flood Related Threats	Develop strategy for addressing "berm" piles on right bank, berms on left, at Stn 18200; Install bioengineering practices to mitigate bank erosion, Stn 17400 to Stn 18000. Conduct an updated hydraulics study of the management unit (flood study).
Water Quality	Address fine sediment entrainment from bank erosion at Stn 17400 to Stn 18000
Further Assessment	Conduct detailed geomorphic and hydraulic assessment of reach from Stn 17400 to Stn 18500; Monitor and evaluate condition and function of stream barbs at Stn 18300, and of rip-rap at Stn 16300.



This map shows how the course of the Rondout Creek has changed over the past 50 years.

Rondout Creek Management Unit Recommendations

MU 1– 6	MU1	MU2	MU3	MU4	MU5	MU6
INTERVENTION LEVEL						
Preservation	X					
Passive						remainder
Assisted		3050–2400	6600	X	X	
Full						15600–14400, 12000–9600
STREAM MORPHOLOGY						
Reduce entrenchment						
Monitor stream characteristics						
Evaluate sediment transport dynamics					X	
Establish single channel						15600–14400
Address overwidened channel						
Detailed geomorphic assessment						X
RIPARIAN VEGETATION						
Improve vegetation						
Install bioengineering		3050–2400	5500		9000–8600	15600–14400
Woody vegetation plantings		X	5500		X	
Monitor vegetation						
Invasive species removal				X		15600–14400
Interplant revetment					X	
INFRASTRUCTURE						
Improve outfall protection for piped outfalls						
Set back berms						
Upgrade revetment						
Monitor changes in channel profile						
Monitor stream barbs & rip-rap						
Stabilize road embankments				X	X	X
AQUATIC HABITAT						
Fisheries population & habitat study	X	X	X	X	X	X
FLOOD RELATED THREATS						
Evaluate integrity & impact of existing berms						X
Address "berm" piles						
Restore sediment conveyance						
Support development of new FIRMs				X	X	
Reduce sheet flow through floodplain			X			

MU1–6 continued	MU1	MU2	MU3	MU4	MU5	MU6
WATER QUALITY						
Evaluate potential for mitigation for water quality impacts						X
Address fine sediment entrainment						
Identify turbidity sources					East Mtn. Brook	
FURTHER ASSESSMENT						
Hydraulics assessment						
Complete SFI in Rondout Creek headwaters						
Complete SFI in High Falls Brook						
Investigate stability of pond						
Evaluate unname trib as source of bedload						
Monitor bed aggradation upstream of constrictions		X	X	X		
Monitor debris jams		X	X			

MU 7–18	MU7	MU8	MU9	MU10	MU17	MU18[1]
INTERVENTION LEVEL						
Preservation						
Passive				26700		
Assisted	18000–17400	22000	X	25800	52200	3200, 1500, 1200–1000, 350–150
Full		19300–18800				
STREAM MORPHOLOGY						
Reduce entrenchment						
Monitor stream characteristics			Balace Rd.			
Evaluate sediment transport dynamics		X	X			
Establish single channel		19300–18800				
Address overwidened channel	middle of MU					
Detailed geomorphic assessment	18500–17400					

[1] This management unit is for the Sundown Creek.

* MU11–16 are not included in this summary table, because they lie within Catskill Park State Land on land designated "forever wild".

** Specific numbers indicate station position along the stream where recommendation does not apply to entire management unit. LB = Left Bank, RB = Right Bank

MU 7–18 continued	MU7	MU8	MU9	MU10	MU17	MU18[1]
RIPARIAN VEGETATION						
Improve vegetation	conf with Sundown Creek	20200, 19300–18800		X		X
Install bioengineering	18500–17400		X	25800	52200	X
Woody vegetation plantings					LB: 51200 –51800	
Monitor vegetation			Balace Rd.			
Invasive species removal						
Interplant revetment						
INFRASTRUCTURE						
Improve outfall protection for piped outfalls						X
Set back berms			X			lower half
Upgrade revetment					X	
Monitor changes in channel profile		newly installed stacked-rock wall				
Monitor stream barbs & rip-rap	18300 & 16300					
Stabilize road embankments						
AQUATIC HABITAT						
Fisheries population & habitat study	X	X	X	X	X	X
FLOOD RELATED THREATS						
Evaluate integrity & impact of existing berms			X	X		X
Address "berm" piles	18200					
Restore sediment conveyance						
Support development of new FIRMs						
Reduce sheet flow through floodplain						
WATER QUALITY						
Evaluate potential for mitigation for water quality impacts						X
Address fine sediment entrainment	18000–17400					
Identify turbidity sources						
FURTHER ASSESSMENT						
Hydraulics assessment	X	X	X	X		X
Complete SFI in Rondout Creek headwaters					X	
Complete SFI in High Falls Brook				X		
Investigate stability of pond			24160			
Evaluate unname trib as source of bedload		22200				
Monitor bed aggradation						
Monitor debris jams						

Water Quality Projects

The multi-faceted nature of Stream Management Planning requires a coordinated effort among all those interested in stream health for the most effective outcome. Sullivan County Soil & Water Conservation District is the local contracting agency with the mandate and technical experience to coordinate and conduct stream assessments, design and implement stream management best management practices, and implement the recommendations of these plans. Implementation projects include the involvement of streamside landowners, residents, town officials, county agencies and departments, teachers, students, and recreationists. The Rondout Neversink Stream Management Program is operated as a field office of the District working in close and constant coordination with representatives of the town, county and state agencies, and community organizations that serve these Basins and the resident landowners. Through public meetings and planning sessions, natural resource assessments, documentation of stream management concerns and recommendations, and education and outreach activities, the Stream Management Program operates on multiple tracks to establish a comprehensive watershed conservation partnership within the community.

Conservation Partnerships
IN ACTION

The Rondout Neversink Stream Management Program, staffed with full-time coordinators and seasonal interns, is based on the second floor of the Neversink Town Hall. A Watershed Advisory Group was formed

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OPPOSITE: *Sullivan County Soil & Water Conservation District hydroseeds a bare bank sediment source in the Town of Denning April 2010 (above); the critical area stabilized with new vegetative growth by October (below).*

in 2009 to lead the outreach and implementation of the Rondout Stream Management Plan, and plans for the Neversink River and Chestnut Creek in future years. An Annual Action Plan identifies the implementation priorities for the year. This chapter illustrates the types of projects geared to improving water quality and stream stewardship, both in the short and long terms — that Stream Management Plan promotes in the Rondout watershed.

Critical Area Seeding

Towns of Denning and Neversink

As part of an important collaboration to manage the interface between roads, infrastructure and the stream network, the project team visited various "hot spots" to understand points of concern for town and county highway departments, which resulted in recommendations included in the comprehensive Stream Management Plan.

Undersized bridges and culverts and road encroachments can provide the point at which a stream begins to unravel, leading to negative consequences upstream and downstream that often extend well beyond the rights-of-way associated with the infrastructure (i.e. into private property). On the other hand, properly-sized bridges and culverts and well-managed stream-road intersections can house a stream and road network that co-exists without adverse impacts.

Due to this critical relationship, the Program Team met with each of the four primary infrastructure managers (*Neversink Highway Department, Denning Highway Department, Ulster County Department of Public Works and Sullivan County Department of Public Works*) in autumn 2009.

Since then, Sullivan County Soil and Water Conservation Districts makes a hydroseeder available to Denning and Neversink to address critical areas such as roadside ditches and steep slopes which contribute to sediment during heavy rainfall and high water events.

Rondout Creek Stream Restoration Demonstration

Ulster County Highway Garage at Sundown, Town of Denning

OBJECTIVES

- Stabilize exposed streambank to reduce entrainment of fine sediment
- Reduce sediment runoff from entering the stream by improving existing stormwater BMPs and/or implementing supplemental stormwater BMPs
- Provide buffer for activities at highway garage storage yard
- Improve stream and riparian habitat.

GOALS

- Site grading to improve functionality of existing stormwater BMPs
- Re-shaping the exposed northern face and top of bank
- Establishing streambank toe protection and bioengineered treatments on bank and in buffer area on top of bank
- Installation of slot drains and various other stormwater BMPs as applicable to reduce sediment runoff.

Plan: provide a buffer for activities at highway garage storage yard.

Sunset Farm, Town of Neversink

OBJECTIVES

- Improve stream system stability by re-establishing proper channel geometry and appropriate bedload conveyance
- Protect public health and safety by stabilizing a failing road embankment along a primarily emergency access route for dozens of residents
- Reduce entrainment of fine sediment from the road embankment and failing streambanks for improved water quality
- Minimize private property loss along active hay field
- Improve fish habitat: increase passage and improve temperature conditions at baseflow, increase pool holding capacity in primary channel, increasing rearing habitat in backwaters.

GOALS

- Establish a primary channel thread with appropriate sediment conveyance

Plan: Re-establish proper stream channel to protect a road embankment critical to the community.

- Divert the downstream portion of an existing drainage channel, which bisects the farm field, away from the road embankment to connect with the proposed primary channel
- Fill the channel against the road embankment to the floodplain elevation
- Use extensive bioengineering and vegetative planting treatments at all applicable areas including the proposed channel, existing drainage channel, and restored floodplain areas to minimize the use of rock revetment and rock structures, as appropriate. Bioengineering treatments will be provided by means of a preliminary bioengineering design prepared by NRCS.

Catskill Streams Buffer Initiative

Backyard Stream Buffer, Town of Denning

The Rondout Stream Management Plan recommends exploring with landowners the benefits of protection and restoring forested riparian buffers, which will promote a mature vegetation community along the bank and in the floodplain and reduce threats of serious bank erosion while helping to improve aquatic habitat. The rooting structure of trees help form a dense mat of roots to bind the soil together, while the multi-stemmed nature of most native shrubs create friction in waters moving over the floodplain further reducing stream's energy and its erosive power. A plan is drawn up to achieve the goals of the landowner to increase vegetation in the buffer while retaining some access for recreation; gardening and other compatible activities.

OBJECTIVES

- Reduce amount of erosion and property loss
- Reduce water velocity over floodplain
- Increase riparian buffer area and reduce the amount of land that is mowed
- Increase wildlife habitat, especially for song birds
- Remove the two mature trees blocking the channel

GOALS

- Remove large woody debris causing obstruction to flow
- Plant a 25-foot vegetative buffer to establish strong root growth of native plants adapted to thrive in riparian corridor
- Remove invasive species such as barberry and supplement with native species
- Encourage attendance at educational opportunities that increase knowledge about stream stewardship

Plan: Reduce erosion and property loss.

Education & Outreach

Invasive Species Awareness

Native plants in the backyard stream buffer play a vital role in stream health, as does early detection of invasive species that put stream banks at risk.

Invasive species threaten the vitality of riparian buffers. Although Rondout Creek is far less impacted by the presence of the invasive Japanese knotweed than many of the other basins within the West of Hudson watershed, Japanese barberry appears to be the most widespread invasive plant within the riparian area. Other invasive plant species are present, but limited in extent. Of greater concern may be the potential impact of forest pests such as Emerald Ash Borer and Asian Longhorned Beetle. Coordination and communication are imperative to effective, efficient management of and education about invasive species. The first step to tackling this prevention effort is to remove invasive species that have not gained a strong foothold yet and eradicating them, and through outreach and education to watershed residents about detecting and preventing those which have not yet been introduced.

This exhibit was built for the Grahamsville community's annual Old Time Fair to showcase native plants of the Rondout Neversink watershed by incorporating quotations from 19th century author John Burroughs as he traveled the Catskill Mountains. A companion card educates about invasive species to be on the watch for in the region.

The balsam fir is a native plant in high elevations at the Rondout and Neversink headwaters. Quilters from Red Brook and Pepacton Hollow partnered with the field office to produce balsam sachets which bring the message of stream stewardship to landowners at local events such as craft fairs and community events.

Time and talent provided by area quilters gave the Old Time Fair exhibit true Grahamsville style.

Priority Recommendations

Earlier sections of this Stream Management Plan (smp) gave site-specific recommendations for management of the Rondout Creek stream system. Presented here are the top ten recommendations for more comprehensive, voluntary programs and tasks to enhance and improve stream management activities along the Rondout Creek. This list represents the priorities chosen by the Towns of Denning and Neversink and the target audiences of the Rondout watershed to address their stream management needs at this point in time. All recommendations are voluntary (non-regulatory) and will evolve over time as projects are completed and further input, priorities and needs of the participating communities are identified.

Rondout Neversink Stream Program
Initiatives

The recommendations that follow involve the coordination among streamside landowners, residents, town officials, county agencies and departments, teachers, students, and recreationists. Through a funded five-year contract with NYC DEP, Sullivan County Soil & Water Conservation District established a Field Office in January 2010 to guide this effort. A Watershed Advisory Group meets quarterly and in sub-committees to carry out annual action plans to address these plan recommendations.

Invasive Species: Early Detection & Rapid Response

Emerald Ash Borer

Recommended: that an effective early detection & rapid response protocol to prevent the spread of all invasive species be implemented through collaboration among private landowners, recreational users and local, county and state agencies.

While invasive species with the stream and riparian environments are first priority, the Project Team could remain active in efforts to universally address invasive species because devastation from infestations in the forests of the Panther Mountain (i.e., Emerald Ash Borer, Asian Longhorned Beetle) will have serious consequences to overall stream health.

The Emerald Ash Borer, left and the katydid, right, shown at same life size scale.

Selective Stream Gravel Management

Recommended: that an independent stream scientist be funded to create a guidance document with recommendation on how, when and where to scientifically manage problematic gravel deposits with the Rondout Creek watershed.

Numerous concerns have been expressed regarding current policies and regulations restricting gravel removal. It is the Stream Management Program's role to investigate these issues by advancing discussion with the appropriate regulatory agencies.

Identify Locations of Potential Water Quality Impairments

Recommended: that a review existing water quality data take place to identify the most significant water quality impairments and the locations of potential water quality impairments including, sources of pollution from upland areas and within the stream channel (i.e., significant glacial lack clay exposures), and sources of contaminants from road runoff and households.

Potential impairments to water quality can come from many non-point sources affecting both surface and ground water supplies.

Stream Stability Restoration

Recommended: Secure funding commitments for additional unfunded restoration projects on the Rondout Creek as discussed in individual management segments.

In this Plan, the Project Team identified a number of reaches which are strongly recommended for restoration. Additional restoration sites should be prioritized, ranked and continuing funding sought.

Watershed Assessment of Major Rondout Creek Tributaries

Recommended: that a watershed assessment be conducted of those Rondout Creek tributaries that contribute a majority of the total Rondout Creek discharge and a significant portion of the total sediment load.

A study of the tributaries can identify long-term chronic fine sediment sources, erosion hazards, dump sites and other potential water quality impairments and associated treatment opportunities, followed by recommendations for restoration practices.

Debris Management

Recommended: that a protocol be developed for the inventory of floodplain debris and assistance to municipalities and communities in debris management.

Develop protocol to ensure responsible floodplain management, including annual clean-up efforts, prevention of illegal dumping, and flood event debris management. The Program Team may need to explore issues of landowner liability for managing large woody debris, the most common form of this problem. Removal of large woody debris would focus on areas that pose a flood hazard to infrastructure and a threat to human welfare.

Knotweed-Free Areas & Spread Prevention

Recommended: that a knotweed-free area be established for educating the public, highway departments and general contractors about the threats of Japanese knotweed colonization and avoiding the spread of this invasive plant.

The community can promote being "knotweed-free" and maintain this status. Outreach efforts can provide education about avoiding the spread of Japanese knotweed.

Flood Hazard Education Sessions

Recommended: that the Towns of Denning and Neversink, working with local and state agencies, support periodic training sessions on flood related issues; and that the audience include municipal leaders, code enforcement staff, planning boards, landowners, realtors, lending institutions and others.

Knowing how to properly manage floodplains is crucial to continued safety and economic sustainability. NYSDEC and the New York State Department of State (NYSDOS) have established education programs geared to local municipalities. Better understanding of flood damage potential, stormwater implications, the NFIP, and use of Federal Insurance Rate Maps will empower local officials to make informed decisions.

Flood Response Technical Resources

Recommended: that trained professionals be identified to coordinate with town officials to provide timely on-site guidance for stream modifications immediately following flooding. Guidelines for work on flood damaged streams with minimal stream disturbance during post-flood response would greatly reduce risk of further instability.

Improving communication and response time among stream managers and permitting agencies can provide for the necessary time-sensitive review and guidance on a regional basis during planning, funding, permitting and construction phases of flood remediation. The existing approach to flood management of patching flood damage with little interagency coordination and stream process knowledge wastes limited funding, may leave localities more vulnerable to future floods and may create liability for already devastated communities.

Stream Stewardship Educational Workshops

Recommended: that the Sullivan and Ulster County Soil and Water Conservation Districts host workshops targeted to various audience groups to foster long-term stream stewardship ethic.

Workshops can address topics such as basic stream processes and functions. Another area of potential interest indicated by the Streamside Landowner Survey includes the status of wetlands and fishery in the basin. Education can contribute to growing community awareness of threats posed to the watershed by invasive species.

For a complete list of General Recommendations in the Rondout Stream Management Plan see the comprehensive document at **www.catskillstreams.org**.

Glossary

AGGRADATION The process by which streams are raised in elevation by the deposition of material eroded and transported from other areas. The opposite of degradation.

ALLUVIUM Loose unconsolidated gravel, sand and finer sediments deposited by flowing water.

AVULSION A rapid change in channel direction when a stream suddenly breaks through its banks typically bisects an overextended meander arc (oxbow cutoff).

BACKEDDY SCOUR Erosive action of water in streams by excavating and transporting bed and bank materials downstream caused by swirling water and reverse current created when water flows past an obstacle.

BACKWATER An area in or along a stream where water has been held back by an obstruction, constriction or dam. Condition in which the surface water movement is slowed by downstream flow impediments.

BANKFULL STAGE The elevation at which flooding occurs on a floodplain.

BASE FLOW The sustained low flow of a stream, usually resulting from groundwater inflow to the stream channel rather than surface water runoff.

BASIN, DRAINAGE an area in which the margins dip toward a common center or depression, and toward which surface and subsurface channels drain. The common depression may allow free drainage of water from the basin as in a stream, or may be the end point of drainage as in a lake or pond.

BED MATERIAL The composite mixture of substrate of which a streambed is composed.

BEDLOAD The amount and size of stream bed material or substrate that is mobilized by tractive and erosive forces measured or calculated at a specific discharge and are transported by jumping, rolling or sliding on the bed layer of the stream. Contrast to Suspended Load.

BIOENGINEERING The use of live vegetation, either alone or in combination with harder materials such as rock or (dead) wood, to stabilize soils associated with stream banks or hillslopes. Roots stabilize the soil, while stems, branches and foliage slow high velocity water, reducing erosion and encourage deposition of fine sediments.

BUFFER ZONE/BUFFER STRIP An area of permanent vegetation between waterways and adjoining land uses designed to intercept and filter out pollution before it reaches the surface water resources.

CHANNEL CROSS-SECTION The physical measurements (width and depth) across the channel and floodplain.

CHANNEL MIGRATION Lateral or longitudinal (down-valley) migration of the stream channel within the valley by the process of erosion and deposition.

CHANNELIZATION The modification of a natural river channel; may include deepening, widening, straightening, or altering of the slope, to accelerate conveyance or increase drainage of wet areas.

CONFLUENCE The meeting or junction of two or more streams, each with its own watershed.

CULVERT A closed conduit for the free passage of surface drainage water used to control water running along and under the road, and to provide a crossing point for water from road side drainage ditches to the stream, as well as for routing tributary streams under the road to join the mainstem.

DEGRADATION The process by which a stream reach or channel becomes deeper by eroding downward into its bed over time, also called "downcutting."

DEMONSTRATION STREAM RESTORATION PROJECT OR DEMONSTRATION PROJECT A stream stability restoration project that is designed and located to maximize opportunities for monitoring of project success, public and agency education about different stream restoration techniques, and interagency partnerships funding and cooperation.

DEPOSITION Accumulation of sediment on the channel bed or banks.

DISCHARGE OR STREAM FLOW The amount of water flowing in a stream, measured as a volume per unit time, usually cubic feet per second (cfs).

EDDY A circular current or a current of water running contrary to the main current, usually resulting from an obstruction.

ENTRENCHMENT Flood flows in an entrenched stream are contained within the stream banks or adjacent terraces. Flood flows in a stream that is not entrenched are spread out over a floodplain.

EPHEMERAL Referring to a stream that runs only in direct response to rain or snow events and whose channel is above the water table.

EROSION The wearing away of the land surface by detachment and movement of soil and rock fragments during a flood or storm or over a period of years through the action of water, wind, or other geological process.

FLOOD STAGE The gage height at which the stream begins to overflow its banks.

FLOODPLAIN The portion of a river valley, adjacent to river channel, which is covered with water when river overflows its banks at flood stage. The floodplain usually consists of sediment deposited b the stream, in addition to riparian vegetation. The floodplain acts to reduce the velocity of floodwaters, increase infiltration (water sinking into the ground rather than running straight to the stream—this reduces the height of the flood for downstream areas), reduce stream bank erosion and encourage deposition of sediment.

FLOODWAY The stream channel and those parts of the floodplain adjoining the channel that are required to carry and discharge the floodwaters or flood flow of the stream.

FLUVIAL 1. Of or pertaining to a river or rivers. 2. Existing, growing, or living in or about a stream. 3. Produced by the action of a stream or river, as in fluvial plain.

FLUVIAL GEOMORPHOLOGY The study of the formation of landforms by the action of flowing water.

HARDENING Any structural revetment that fixes in place an eroding stream bank, embankment or hillside by using hard materials, such as rock, sheet piling or concrete, that does not allow for revegetation or enhancement of aquatic habitat. Rip-rap and stacked rock walls are typically considered to be hardening measures, though some revegetation of these areas is possible.

HEADCUTTING The process by which the stream is actively eroding the streambed downward (degrading, incising, downcutting) to a new base level.

HEADWATER The upstream area in a stream system or area where streams originate.

HYDROLOGIC CYCLE The natural pathway water follows as it changes between liquid, soil, and gaseous states. The cyclic transfer of water vapor from the Earth's surface via evapotranspiration into the atmosphere, from the atmosphere via precipitation back to the earth, and through runoff into stream, rivers, lakes, and ultimately into the oceans.

IMPERVIOUS SURFACE Surfaces, such as roads, parking lots, and roofs, whose properties prevent the infiltration of water and increase the amount of stormwater runoff in a watershed.

IMPOUNDMENT A body of water, such as a pool, lake or reservoir, formed by confining a stream or other surface flow.

INSTABILITY An imbalance in the capacity of the stream to transport sediment and maintain its channel shape, pattern and profile.

INTERMITTENT STREAM A stream that only flows for part of the year and is marked on topographic maps with a line of blue dashes and dots.

INVASIVE PLANTS Species that aggressively compete with and replace native species in natural habitats.

LARGE WOODY DEBRIS Any woody material, such as from trees or shrubs, that washes into a stream channel or is deposited on a floodplain area. This debris provides important aquatic habitat functions, including nutrient sources and micro-habitats for aquatic insects and fish. Large woody debris is especially influential to stream morphology in small streams, though may be detrimental in the vicinity of structures and infrastructures.

LATERAL MIGRATION The movement of a channel across its floodplain by bank erosion. The outside banks of meanders move laterally across the valley floor and down the valley.

MACROINVERTEBRATES Stream-dwelling insects and crustaceans without a backbone that can be viewed without magnification. Examples include crayfish, leeches, water beetles and larva of dragonflies, caddisflies, and mayflies. Macroinvertebrates are an important food source for many species of fish.

MAINSTEM The common outlet or stream, into which all of the tributaries within a watershed feed.

MEANDER Bend or curve in a stream channel.

MONITORING The practice of taking similar measurements at the same site, or under the same conditions, to document changes over time.

MORPHOLOGY The form (dimension, pattern, and profile) and structure of the stream channel.

NATIVE VEGETATION Vegetation indigenous to an area and adapted to local conditions.

NON-POINT SOURCE Extensive or disperse source of pollution. Examples include agriculture, lawns, parking lots, roads, and septic systems.

NUTRIENT The term "nutrient" refers broadly to those chemical elements essential to life on earth, but more specifically to nitrogen and phosphorus in a water pollution context.

PEAK FLOW The highest discharge achieved during a storm event.

PERENNIAL STREAM A stream that normally contains flowing water at all times regardless of precipitation patterns.

POINT SOURCE Source of pollution from a single, well-defined outlet. Examples include wastewater treatment outfalls, combine sewer overflows, and industrial discharge pipes.

POOL Deep, flat, areas in the stream created by scour, with slow currents at low flow. Usually pools occur on the outside of a meander bend between two riffles or the bottom of a step. Pools generally contain fine-grain bed materials, such as sand and silt. Natural streams often consist of a succession of pools and riffles.

REACH A section of a stream with consistent or distinctive morphological characteristics.

REFERENCE REACH/SITE A stable portion of a stream that is used to model restoration on an unstable portion of stream. Stream morphology in the reference reach is documented in detail, and that morphology is used as a blueprint for design of a stream stability restoration project.

REVETMENT A facing stone, rootwads, cut trees, or other durable material used to protect a stream bank or hillside.

RIFFLE A reach of stream that is characterized by shallow, fast-moving water broken by the presence of rocks. Most invertebrates will be found in riffles.

RIPARIAN CORRIDOR/ZONE The area of land along stream channels, within the valley walls, where vegetation and other landuses directly influence stream processes, including flooding behavior, erosion, aquatic habitat condition, and certain water quality parameters.

RIPARIAN BUFFER An undisturbed, vegetated strip of land adjacent to a water course.

RIP-RAP Broken rock cobbles, or boulders placed on earth surfaces, such as a road embankment or the bank of a stream, for protection against the action of water; materials used for soil erosion.

RUNOFF The portion of rainfall or snowmelt that moves across the land surface into streams and lakes.

SCOUR Erosive action of water in streams by excavating and transporting bed and bank materials downstream.

SEDIMENT Material such as clay, sand, gravel, and cobble that is transported by water from the place of origin (stream banks or hillsides) to the place of destination (in the stream bed or on the floodplain).

SEDIMENTATION OR SILTATION The deposition of sediment.

SHEET FLOW Water, usually storm runoff, flowing in a thin layer over the ground surface; also one form of overland flow.

SIDE CHANNEL A secondary channel of the stream.

SINUOSITY The relative curviness of a stream channel. Quantified as the total stream length divided by valley length, or the ratio of valley slope to channel slope.

STABLE CHANNEL State in which a stream develops a stable dimension, pattern and profile such that, over time, channel features are maintained and the stream system neither aggrades nor degrades (Rosgen, 1996).

STREAM STABILITY RESTORATION DESIGN PROJECT An unstable portion of a stream that has been reconstructed, using morphology characteristics obtained from a stable reference reach in a similar valley setting, that returns the stream to a stable form (a shape that may allow the stream to transport its water and sediment load over time without dramatic changes in its overall shape).

SUMMER BASE-FLOW Stream discharge primarily from groundwater (not from surface runoff). Typically this is the lowest flow of the year, occurring in late summer, or following extended periods of drought.

SUSPENDED SEDIMENT OR SUSPENDED SEDIMENT LOAD The soil particles lifted into and transported within the streamflow for a considerable period of time at the velocity of the flow, free from contact with the stream bed. These materials contribute to turbidity.

THALWEG Literally means "valley view" and is the deepest point of a cross section of stream channel.

TRIBUTARY A stream that feeds into another stream; usually the tributary is smaller in size than the main stream (also called "mainstem"). The location of the joining of the two streams is the confluence.

TURBIDITY A measure of opacity of a substance; the degree to which light is scattered or absorbed by a fluid.

UNDERCUTTING The process by which the lower portion or "toe" of the stream bank is eaten away by erosion leaving a concave, overhanging section of stream bank. Often occurs on banks at the outside of stream bends.

VELOCITY In streams, the speed at which water is flowing, usually measured in feet per second.

WATER QUALITY A term used to describe the physical, chemical, and biological characteristics of water with respect to its suitability for a particular purpose.

WATERSHED Area that drains to a common outlet. For a stream, it is all the land that drains to it or its tributaries. Also called a basin, drainage basin, or catchment. A sub-basin or sub-watershed is a discriminate drainage basin within a larger watershed, typically defined for planning or modeling purposes. The size of a watershed is termed as its drainage area.

WETLAND An area that is saturated by surface water or ground water with vegetation adapted for life under those soil conditions, as in swamps, bogs, fens, and marshes.

WINTER BASE FLOW Stream discharge primarily from groundwater (not from surface runoff). Winter base flow is generally higher due to lower rates of evapotranspiration during vegetative dormancy.

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Watershed Advisory Group & Community Members

BOB ANGYAL
New York State Department of Environmental Conservation

FRANK BROOKS
Ulster County Department of Public Works

BILL BRUNING
Town of Denning Supervisor

BRIAN BRUSTMAN
Sullivan County Soil & Water Conservation District

GARY CAPELLA
Ulster County Soil & Water Conservation District

LINDA COMANDO
Tri-Valley Townsman

BRENDA DEVORE
Town of Neversink

BRIAN DRUMM
New York State Department of Environmental Conservation

DERMOT DOWD
Sullivan County Department of Public Works

DENNIS DOYLE
Ulster County Planning Department

MIKE FLAHERTY
New York State Department of Environmental Conservation

DAVID FORSHAY
Town of Neversink

WILLIAM GAUDETTE
Town of Neversink

GREG GOLDSTEIN
Town of Neversink Supervisor

JERRY GOTSCH
Watershed Agricultural Council Forest Plan Landowner

JOHN GREEN
New York City Department of Environmental Protection

JENNIFER GRIESER
New York City Department of Environmental Protection

ROBERT HAYES
Tri-Valley Central School Agriculture Teacher

MARGARET HELTHALER
Grahamsville Resident

NATE HENDRICKS
Catskill Watershed Corporation

PRESTON KELLY
Superintendent of Highways, Town of Neversink

AMANDA LAVALLE
Ulster County Department of the Environment

GEORGIANNA LEPKE
Town of Neversink

JENNIFER MALL
Sullivan County Planning Department

JIM & CHERYL MARION
Grahamsville Residents

ED MCANDREW, P.E.
Sullivan County Department of Public Works

GARY MILLER
New York State Department of Environmental Conservation

JOY ANN MONFORTE
Town of Denning

ED MUES
Town of Denning

KIRK PETERS
Ulster County Department of Public Works

CHARLES PIERA
Hamlet of Sundown

MERRILL PIERA
Hamlet of Sundown

MIKE POGUE
New York State Department of Environmental Conservation

KAREN RAUTER
Sullivan County Soil & Water Conservation District

BETH REICHHELD
New York City Department of Environmental Protection

LISA SCHICK
Sullivan County Soil & Water Conservation District

CAROL SMYTHE
Neversink Town Historian

BEN SNYDER
Frost Valley YMCA

JAMES STANGEL
Town of Neversink Planning Board Chair

IRA STERN
New York City Department of Environmental Protection

BOB TAYLOR
Sullivan County Soil & Water Conservation District

DANIEL VAN SADERS
Superintendent of Highways, Town of Denning

MARK VIAN
New York City Department of Environmental Protection

JILL WEYER
Sullivan County Planning Department

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RONDOUT NEVERSINK STREAM PROGRAM
SULLIVAN COUNTY SOIL & WATER CONSERVATION DISTRICT

P.O. Box 256 · 273 Main Street *(2nd floor)*
Grahamsville, NY 12740
Tel 845–985–2581
Fax 845–985–7950
Email info@rondoutneversink.org

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