The Chestnut Creek Stream Management Plan

Volume I of II

Background, History and Watershed Description

March 2004

i. Foreword

It is the distinct pleasure of the Sullivan County Soil and Water Conservation District to release Parts I and II of the Chestnut Creek Stream Management Plan. After three years of teamwork by many dedicated individuals, the initial objectives of this undertaking have been reached, and the Management Plan has come together.

Part I of the Management Plan will be a “reference manual” complete with graphs, tables, pictures, and facts about the stream. It will serve as a guide for broad-based in-depth studies of Chestnut Creek and its tributaries. Part II will be a condensed “field manual” that will serve as a quick guide for general information and will be able to be utilized in the field for application of on the ground work.

It is the hope and desire of the Soil and Water Conservation District that this Management Plan will continue to grow and be updated with time. A plan such as this is never complete; it must be amended and updated continually as needs, suggestions, concerns, zoning, etc. change within the community.

We sincerely hope that this plan will serve as a valuable reference tool for many years to come!

Brian Brustman
District Manager
Sullivan County Soil & Water Conservation District
February 2004

Front cover photo of Hilltop Road Bridge, 2001.
Photo taken by Leslie Kirby, SCSWCD.

ii. Acknowledgements

The creation of the Chestnut Creek Management Plan has been enabled by the concentrated efforts of many people, working as a team, over the past three years. Firstly, we appreciate the efforts of Lori Kerrigan, Leslie Kirby, and Brian Brustman, Sullivan County Soil and Water Conservation District (SCSWCD) staff, who helped oversee much of the field effort and the project coordination, and drafted many sections of this management plan. We recognize the contribution of our current Technical Assistant and former AmeriCorps, Barbara Barone, as well as past AmeriCorps, Derrick Kelly and seasonal field crews, especially Christina Falk, for undertaking the tedious process of documentation and data collection.

We would also like to thank the NYC Department of Environmental Protection Stream Management Program (DEP SMP) staff for initiating this stewardship effort, and providing training and technical assistance and for their continued support, especially that of Sarah Miller, Beth Reichheld, Dan Davis, Phil Eskeli, and Beth Gelber. We wish to thank the Chestnut Creek Project Advisory Committee, a team of 35 who are identified in Section 2.0. We especially appreciate the participation of Russel Scheirer who has actively served as liaison to and representative of the landowners on the PAC, with co-representative Carol Smythe, Town Historian who volunteered time and information for the historical section of the plan.

We recognize local organizations such as the Beaver Dam Club, the Grahamsville Rod and Gun Club, Sullivan County Community College Geology Department, the NYS Department of Environmental Conservation (DEC) Fisheries and Habitat divisions, Cornell Cooperative Extension of Sullivan County (CCE) and DEP Division of Water Quality Control (Grahamsville), for their written contributions to the stream management plan.

We would like to acknowledge the Watershed Agricultural Council (WAC) for providing support for the Demonstration Restoration Project. We also recognize the cooperation of Town Supervisor Georgianna Lepke in helping make this effort a reality for the Chestnut Creek Watershed. We appreciate Gary VanValkenburg and the Town of Neversink Highway Department for lending equipment and operators for restoration projects along the Chestnut Creek. We want to thank Barbara Restaino, landscape architect, who also put in many volunteer hours to help design and implement the Demonstration Project. We are grateful for the advice and guidance of Natural Resources Conservation Service (NRCS) and CCE. We also thank Crystal Falls Farm for supplying so many of the materials needed for the project. We wish to acknowledge Integrated River Solutions (IRS) for the effort they have expended to better the restoration project.

A special thanks is extended to both IRS and Clear Creeks Consulting for providing recommendations and analysis for the stream management plan and management units. We recognize the contribution of the staff of the Sullivan County SWCD who showed great support for their colleagues throughout the development of the plan and the completion of the Grahamsville Town Hall demonstration project in Fall 2003 This stream management plan would not have been possible without its funders, and we thank the DEP SMP through the Water Resources Development Act of 1996 (WRDA), WAC, and the US Army Corps of Engineers under the Watershed Environmental Assistance Program.

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View of Chestnut Creek. Photo taken by Leslie Kirby, SCSWCD.

A. Introduction: What is a Stream Management Plan for Chestnut Creek?

Stream management is an emerging discipline that recognizes the importance of our local streams to our overall quality of life, and seeks to coordinate decision-making around common goals we collectively identify for the stream.

This stream management plan was created cooperatively by the Chestnut Creek watershed community, local leaders and agency representatives, and identifies common goals that many have for Chestnut Creek and its adjacent floodplains, forests and wetlands. In addition to identifying our common goals, it identifies competing goals as well, and provides a "road map" for coordination among the many "stakeholders". Stakeholders are those who rely on, work with, and/or live by the waters of Chestnut Creek, including: Town and County Highway Departments responsible for managing Chestnut Creek and its bridges and culverts, local landowners concerned about erosion, flooding and the beauty of the stream, anglers who seek out the rich trout fishery, and even the City of New York, which ultimately shares the creek's waters with the city's 9 million residents.

The Chestnut 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.

B. Purpose: Why Develop a Management Plan for Chestnut Creek?

The Chestnut Creek mainstem flows approximately 5 linear miles through the town of Neversink and the hamlet of Grahamsville before it empties into the Rondout Reservoir located in the Counties of Sullivan and Ulster, New York. The Chestnut Creek Watershed including several tributaries spans 20.9 square miles. Although relatively small compared to others in the Catskills, Chestnut Creek has an immense impact on quality of life to those who live along its banks.

Although the primary land use in the watershed is wild or managed forest, there are areas of agriculture, sand and gravel mining, as well as residential and commercial development along the State Route 55 corridor in the hamlets of Neversink, Curry, Unionville, and Grahamsville. Past and current land use and land management practices in rural areas and hamlets greatly affect water quality, stream bank erosion, sedimentation, flooding, infrastructure damage, and in-stream and stream-side (riparian) habitat. If managed well, effects to and from the stream environment should be minimal, if not mutually beneficial.

Relative to other watersheds in the region, conditions in the Chestnut Creek Watershed appear relatively good, though could nonetheless be improved to benefit local communities. In 1996, the five-mile main stem was included on New York State's Priority Waterbody List (PWL) due to evidence of water quality impairment. Problems identified included potential pathogens, an impaired biological community, and non-point source pollution. Some suspected causes include development along the lower half of the creek, road salt, and failing septic systems. Periodic flooding in the Chestnut Creek Watershed has caused identifiable stream bank erosion and infrastructure damage along the stream. There are also reaches where the channel or floodplain has been altered through the years causing disturbance to the stream's morphological characteristics, (its shape), and potential ongoing maintenance or disturbance issues.

The importance of developing a long-term stewardship plan for the Chestnut Creek Watershed, while important for the immediate community, is elevated by the Chestnut Creek's status as a primary feeder stream to the Rondout Reservoir. The Chestnut Creek is a terminal feeder in the Rondout Reservoir system (i.e., waters flow directly from Chestnut Creek into the reservoir, rather than into a larger river first). Rondout Reservoir is a Terminal Reservoir (waters flow directly from this reservoir to downstate) and one of six reservoirs west of the Hudson that contribute to the New York City drinking water supply system. Water quality in this reservoir is critical to maintaining high drinking water quality standards for upstate and downstate users.

In August 2000, New York City Department of Environmental Protection (DEP) contracted Sullivan County Soil and Water Conservation District (SCSWCD) to develop and implement a stream management plan for the Chestnut Creek Watershed. The planning process has helped foster and facilitate stronger partnerships and further cooperation and communication among local, state, city and federal agencies, landowners and various private organizations in the Chestnut Creek Watershed. The Chestnut Creek Stream Management Plan will serve as a basis for making targeted recommendations to aid development of solutions to issues identified in the watershed. Assessment is applied to the entire watershed to minimize potential for future problems that could result from site-specific analysis, and to support implementation of sound watershed and stream management practices in this watershed context.

The Chestnut Creek Stream Management Plan is an important tool that will provide a unique cooperative opportunity for citizens of the watershed to address property, infrastructure and recreational needs; for stream and resource managers to address environmental needs; for local governments to address infrastructure and planning needs; and finally for the City of New York and many downstate communities to continue to benefit from good quality drinking water.

C. Goals and Objectives for this Management Plan

1. Flooding and Erosion Threats: Document risks and outline a plan to reduce damage to private property and public infrastructure - roads, bridges, residential improvements and utility lines - from floodwaters and stream erosion;

2. Water Quality: Summarize known information and outline a plan to protect and improve water quality;

3. Ecological Health: Document current conditions and outline a plan to protect and enhance the integrity of stream and floodplain ecosystems, and of the unique communities of plants and animals that use the stream and floodplains as their home; and

4. Coordination: Provide a strategy for coordination of management activities among the various stakeholders, to ensure no one of the above goals is achieved at the expense of another.

1. Flooding and Erosion Threats

The risks associated with floods and their powerful erosive forces can affect an individual landowner or an entire community. To reduce these risks, this plan proposes to achieve the following objectives:

a) Conduct a watershed-wide survey of landowners to assess the history of flood damages, concerns and interests in the stream;

b) Conduct a physical survey and analysis of the stream channel and floodplain, to better understand how the stream is likely to behave in future flood events, as indicated by the physical form, or morphology, of the stream;

c) Identify, monument (for ongoing monitoring) and survey sites of bank erosion, assess their relative stability, and make recommendations for their treatment;

d) Identify those locations where improved or residential areas may be threatened by bank erosion, and make recommendations for their treatment; and

e) Assess bridge or culvert crossings that may be at risk from erosion of stream banks or streambeds, or otherwise unstable or threatened, and make prioritized recommendations for their treatment.

2. Water Quality

Potential impairments to water quality can come from many sources, and can affect both surface waters and ground water supplies for wells. To protect and improve ground and surface water supplies, this plan proposes to achieve the following objectives:

a) Determine the most significant sources of water quality impairment in Chestnut Creek from existing water quality monitoring data as available;

b) Identify likely sources of fine or coarse sediment from within the stream channel, and make recommendations for treatment;

c) Identify the most likely sources of

suspended sediment from upland areas, if any, and make prioritized recommendations for mitigation;

d) Identify potential sources of contamination from landfills or dumping areas in the stream corridor, and make recommendations for mitigation; and

e) Identify potential sources of contaminants from road runoff, and make recommendations for mitigation.

3. Ecological Health

The health of stream and floodplain ecosystems has come to be recognized as playing a key role in quality of life in our community – benefiting both stream function impacting our management goals, as well as providing aesthetic and recreational opportunities for enriching streamside living. Healthy streams that support a diversity of fish and insect species, healthy floodplains that support a variety of tree and shrub species, as well as wildlife that can only thrive along healthy streams are invaluable to water quality, stream stability, flood protection and cultural richness. To achieve the goal of optimizing stream and floodplain ecosystem integrity, this plan proposes the following objectives:

a) Characterize the status of stream ecosystem health in Chestnut Creek as a whole, using existing fish and insect population data as indicators of ecological community condition;

b) Survey local landowners' experience with the Chestnut Creek fishery, including their ideas about stocking practices and recreational opportunities;

c) Characterize current floodplain and riparian forest management practices in Chestnut Creek, and make recommendations for changes that can improve ecosystem integrity and floodplain function; and

d) Observe the state of riparian vegetation and make recommendations for further study and management of the riparian zone.

4. Coordination

Sometimes the goals and practices of one group can be at cross-purposes with others, but through better communication and coordination these potential conflicts can be minimized or avoided altogether. In addition, implementing common initiatives can be made more powerful by teaming up with like-minded stakeholders who may be working on similar initiatives in isolation or in a different location. To promote the goal of effective coordination among the many stakeholders, this plan proposes the following objectives:

a) Establish a Project Advisory Committee consisting of representatives of significant stakeholder groups to coordinate plan development and implementation;

b) Conduct a survey of Chestnut Creek residents to determine their concerns, interests and current stewardship practices;

c) Encourage and support streamside Landowners in Chestnut Creek to represent landowner interests, especially to the Project Advisory Committee during plan development;

d) Survey highway superintendents on their concerns, interests and current management practices and priorities;

e) Determine the needs of various stakeholder groups for technical assistance, information and education, and make recommendations for development of programs to meet those needs; and

f) Document baseline physical conditions of Chestnut Creek and adjacent floodplains that can be used as benchmarks to gauge progress toward collective goals of the Chestnut Creek community.

D. Guide to this Stream Management Plan

Plan Organization:

Volume I—*Reference Manual* for the Chestnut Creek Stream Management Plan is arranged by broad categories including watershed description, stakeholder information, watershed and stream specific recommendations, supporting data and other resource information. Background and history of the area are also provided to set the context for stream management in Chestnut Creek.

Volume II—*Field Manual* is intended to be a hands-on field guide for the surveyed 5-mile main stem, from the top of Chestnut Creek down to the mouth of the stream where it meets Rondout Reservoir and Pepacton Hollow and Red Brook tributaries. The main stem has been organized into Management Units (MUs) – stream reaches subdivided using physical stream characteristics, property boundaries, location of bridges and road infrastructure, and valley characteristics. Large portions of these data were gathered through a detailed stream assessment survey carried out in 2001 and a historic aerial photographic overlay analyzed to determine how stream and watershed conditions have evolved in the last 4 decades. These MU descriptions outline stream conditions (bed and banks), general streamside (riparian) vegetation condition, and proximity and arrangement of roads, bridges and culverts. Conditions and recommended practices were described with the objectives of flooding and erosion hazards, water quality, and stream ecology in mind. Detailed descriptions are provided for future projects or assessments. Each MU includes a companion map and summary tables for easy access of information.

Stream stewardship recommendations contain suggestions from the MU scale out to the watershed scale. This section provides guidance on techniques, information and funding sources, and strategies for implementing recommendations and keeping plan information up to date (Volume II, Section I. Chestnut Creek Stream Management Unit Descriptions, and Section II. Stream Stewardship Recommendations).

E. Methodology Used to Accomplish Goals

As discussed in the introduction and purpose, goals defined for this management plan are to identify and provide recommendations to reduce flood and erosion hazards and water quality impairments while supporting greater ecosystem health and stakeholder coordination. Information and methods used to meet these goals were gathered from many available sources and documented studies.

Information gathered to serve management planning goals is divided into two categories: 1) Summary and documentation of existing quantitative and narrative data, including existing mapping data, and 2) Watershed assessment field surveys to produce a new set of base maps to document current stream system condition.

1. Existing Information

Regional watershed geology, soils, topography, land use and land cover have a significant effect on the volume, timing and routing of water and sediments from adjacent uplands into a stream, and along the stream to the outlet of the watershed. These factors interact to profoundly affect the nature of stream systems and how resistant they are to disturbance. Existing information on natural watershed characteristics and historic and current land use practices was collected and compiled and additional information developed. This information was reviewed and evaluated to provide some understanding of how these characteristics may affect hydrologic and sediment regimes of the watershed, and the water quality, habitat and channel stability of Chestnut Creek and its tributaries.

Types of data collected and compiled for review and evaluation included existing GIS (Geographic Information System – spatial data) databases, topographic maps, soils maps, geology (bedrock and surficial), wetland and sensitive areas inventories, land use maps, water quality data, biological data, hydrologic and hydraulic data, historic and recent aerial photography, as well as published and unpublished technical reports and other management plans. Some of these categories are described in detail below.

Geology

To evaluate watershed-scale effects of geology on hydrologic and sediment regime and stream channel morphology of Chestnut Creek, the watershed map was overlain onto bedrock geologic maps, noting distribution of geologic formations, where changes in rock type occur, and the presence of structural boundaries.

Surficial geology maps of the Chestnut Creek watershed were obtained from the New York City Department of Environmental Protection (NYCDEP) GIS Database. Research by several regional geologists have aided in developing a picture of the geology of the Chestnut Creek watershed and influences on stream processes. (Gregg Erickson, Sullivan Co. Comm. College, http:/www.sullivan.suny.edu/academics/dept/scimath/gerickson/index.htm, and W.D. Davis, NYCDEP SMP Geologist)

Soils

Soil characteristics of the Chestnut Creek watershed were evaluated to determine potential effects on runoff and erosion hazard and potential for unstable hillslope and/or channel conditions. Soils maps of the Chestnut Creek watershed were obtained from the New York City Department of Environmental Protection GIS Database and the Soil Survey of Sullivan County, New York (1984).

Land Use and Land Cover

The Chestnut Creek stream corridor was evaluated relative to historic, current, and potential future land use and land cover. Particular attention was focused on land use, vegetation changes, and channel alterations that may have a significant influence on hydrologic and sediment regimes, hillslope processes and channel stability. Information on current land use and land cover (from aerial photographs and other remotely sensed data) was obtained from the NYCDEP GIS Database and revised based on information collected during the watershed field reconnaissance (described below). Historic aerial series was purchased by SCSWCD for 1963-2001.

A generalized history of land use activities, changes in vegetation patterns, as well as stream channel and floodplain alteration activities in Chestnut Creek watershed was developed from historic aerial photographs from 1963-2001, and from maps and plans obtained from records on file with the Sullivan County Soil and Water Conservation District. In addition, historical references and maps were obtained from the Neversink Historical Society and New York State Department of Transportation (DOT) in Monticello, NY. These records were supplemented with anecdotal information obtained through interviews with local officials and residents. Information on future land use potential was developed from zoning maps and master plans obtained from townships and the Sullivan County Planning Office.

100-Year Floodplains

Regulatory agencies and entities, such as town or county zoning and planning boards, State Emergency Management Office (SEMO) and Federal Emergency Management Agency (FEMA), use 100-year floodplain boundaries to assess risk in developable areas from major flooding, to regulate building in high risk areas, and to assess flood damages and funding needs for repair, rehabilitation and flood hazard mitigation following major floods. The approximate limits of the 100-year floodplain along the Chestnut Creek mainstem and its major tributaries were determined from the digital versions of the Flood Insurance Rate Maps (FIRM) produced by FEMA. The most recent FEMA historic flood studies conducted in the Chestnut Creek watershed were obtained for review and evaluation. These records were supplemented with anecdotal information obtained through interviews with local officials and residents to determine perceived flood risks and actual flood stages for major floods in the last several decades.

Biological Communities of the Chestnut Creek Watershed

Evaluating information and data from historic biological surveys can provide an understanding of how biological communities have changed with land use activities in a watershed. Certain biological communities, such as populations of certain fish species or benthic macroinvertebrates (aquatic insects) have been used as indicators of water quality or stream condition. As part of this assessment, available data was utilized to evaluate historic conditions and determine trends for biological communities along Chestnut Creek and its tributaries. Data compiled from biological surveys (macroinvertebrate and fish) conducted by state agencies (e.g. NYSDEC) were reviewed and evaluated. Data compiled from other investigations were also analyzed (Volume I, Section IV. B.4, Water Quality and Ecological Health).

Water Quality of the Chestnut Creek Watershed

Available data were utilized, to the extent practical, to evaluate historic conditions and determine trends for the water quality along Chestnut Creek and its tributaries (Volume I, Section IV.B.4, Water Quality and Ecological Health). Data compiled from water quality monitoring conducted by various agencies (e.g. NYSDEC and NYCDEP) were reviewed and evaluated.

2. Watershed Assessment

A complete watershed field reconnaissance to gather additional detailed current information on specific features of Chestnut Creek provided a set of base maps used to delineate Management Units and prioritize recommendations.

Following a watershed assessment protocol developed by the DEP Stream Management Program, including methods of stream classification developed by Rosgen (1996), current channel morphology was characterized, historic channel adjustments were researched, direction and rate of adjustment for specific reaches were estimated, and departure from a potential stable form analysis was conducted. The broad categories of data collection and analysis are described below. Please see Draft Watershed Assessment Protocol, Volume II, Section VI. Appendices for additional detail on office and field protocols.

Initial Watershed Assessment Office Procedures:

Watershed or Basin Morphometry

Watershed boundaries, drainage area, basin profile and cross-section, and drainage density have been determined from the NYC DEP GIS Database and United States Geological Survey (USGS) quadrangle topographic maps at 1:24,000 scale. This information, particularly drainage (or watershed) area, was used in more detailed watershed assessments described below.

Rosgen Level I Geomorphic Classification

Geomorphic characterization focused on classifying stream reaches of Chestnut Creek and selected tributaries into generalized stream types (i.e., A, B, C, D, etc.) described in A Classification of Natural Rivers (Rosgen, 1994). Stream reaches were classified based primarily on stream slope and valley type information gathered from USGS quadrangle maps and aerial photography. This task provided information that was useful in focusing field reconnaissance efforts, which provided verification of the initial reach classification.

Hydrology
United States Geological Survey Stream Gage Record Analysis

USGS records for the stream gage station on Chestnut Creek at Grahamsville, New York were analyzed to: 1) develop estimates for mean annual stream flow, 2) characterize seasonal variability in mean monthly streamflow, and 3) evaluate annual peak discharges for the periods of record (1939 – 1987, 1997 – 2002). In order to utilize this site for the watershed assessment, historic rating tables had to be updated. Necessary field measurements and analytical work was completed and rating tables were updated.

The most recent flood frequency analysis of maximum annual peaks was used to develop estimates for peak discharges for the 1.25-yr, 1.5-yr, 2-yr, 10-yr, 50-yr and 100-yr recurrence interval (RI) peak flows. This flood frequency curve can be used in a variety of applications for flow analysis in stream assessment, planning and management, some of which are described in sections below as appropriate.

Field Calibration of Bankfull Discharge and Channel Dimensions

Geomorphic stream assessments conducted for the Chestnut Creek watershed assessment included classification by stream morphology. An important step in this process involves correct and consistent identification of *bankfull* stage in the field. For detailed discussion of bankfull stage, see Volume I. Section III.C. Stream Morphology and Classification**.** The best way to ensure reliable bankfull identification is through the use of regional regression curves of drainage area and associated hydraulic geometry (channel width, depth, cross sectional area) to bankfull discharge developed from data gathered in the same physiographic region (or region with similar characteristics) as the project area. These curves provide critical data for checking estimates of bankfull channel dimensions in the field for use in stream classification, stability assessments or natural channel design. Information was obtained from on-going regional curve studies being conducted by NYCDEP Stream Management Program (Miller and Davis, 2003).

Elements of the Field-based Stream Assessment (from Watershed Assessment Protocol, NYCDEP Stream Management Program, 2000, see Appendix)**:**

1) Continuous delineation of channel morphology, characterized to Rosgen Level II, on the mainstem and major tributaries, with locations of classification cross-sections. A morphologic stream assessment was conducted along the mainstem of Chestnut Creek from its headwaters to the NYCDEP Water Portal from the Neversink Reservoir – just downstream from Grahamsville.

Using the regional relationships developed by DEP Stream Management Program in 2000 (briefly described in section above, with greater detail provided in Miller and Davis, 2003, and Miller and Powell, 2001 unpublished report available through DEP Stream Management Program), indicators of bankfull stage were defined and confirmed in the field at selected locations along both stream banks.

Classification to Rosgen Level II includes detailed assessment of streambed sediment using a "pebble count" procedure to determine reach D50 particle size (see Intro to Stream Processes Section C. 8., and Rosgen, 1996). Reach classification also requires a length of stream containing at least one pool and one riffle for accurate slope calculations. Stream classification for Chestnut Creek predominantly follows the Rosgen classification system with a few exceptions (see Intro to Stream Processes Section D). A number of reaches on Chestnut Creek contain very short sections of bedrock, which are included in reach pebble counts but due to low concentrations are not reflected in final sediment size distributions. Because locations of bedrock exposure still represent an important control on stream morphology, these sections were documented in stream typing as a double stream type, such as B1/B3. This reach would be predominantly a B3 (cobble), but would have section(s) of B1 (bedrock) too small to be broken out into a separate reach or reaches. Additional reach type splits may include borderline slope classification, such as B3/B3a, where "a" signifies an A channel slope with a B cross-section morphology.

2) Locations of hydraulic controls**,** including rock sills and banks, rip-rap placements, weirs, and bridge abutment.

3) Locations of natural and man-made drainage confluences, including tributary outfalls, stormwater and culvert outfalls, and road ditch outfalls. The majority of the discharge outfall locations were identified and mapped during the field reconnaissance. Location of all culverts, storm drain outfalls, landfills and dumping areas along the stream corridor were identified and mapped during the field reconnaissance. Though water quality at each outfall was not assessed directly, these locations were identified as potential locations of point sources of pollutants. A more detailed evaluation would be needed to confirm any problems areas.

4) Locations of problematic riparian vegetation, such as stands of invasive exotic species like Japanese knotweed (*Polygonum cuspidatum*)**.**

5) Locations of eroding banks, with initial characterization of bank erodibility hazard**;** *Level III - Assessment of Stream Condition* - Part of the Rosgen Level III assessment includes estimating potential for certain stream reaches or bank locations to either continue to experience instability problems, recover from disturbance, or stay in good condition. One set of measurements in this assessment is called the Bank Erodibility Hazard Index (BEHI), paired with the Stress in the Near Bank Region (SNR) (see Rosgen, 1996, for further description and detailed methods). These two methods provide a measure by which researchers can compare the relative severity of bank erosion and reach stability problems. Eroding banks noted during field assessments were monumented (for future monitoring), and surveyed to provide the data necessary to complete these analyses.

6) Location of potential reference reach locations for further assessment and monitoring**.**

7) Generalized field notes and photographic documentation provided categorical information to document existing conditions in Chestnut Creek and

two major sub-watersheds, Pepacton Hollow and Red Brook. This level of assessment provided useful tools for further detailed assessments and communication tools for summarizing classification and interpretation data with descriptive photos. Qualitative field notes kept during quantitative data collection provided invaluable information to the research team during data analysis and interpretation phases of watershed assessment. Digital photos were catalogued and stored associated with specific stream locations to enable researchers and the public to corroborate narrative descriptions with the visual evidence – in effect, demonstrating interpretation with real-life examples. The field research team obtained all notes and photographs during the project, many of which appear in Volume II. Section I. Chestnut Creek Stream Management Unit Descriptions. Selected photos and anecdotal notes were donated by the public for use in public meetings and historical interpretation.

Sub-Watershed Analysis

Physical features and current conditions of two of the major sub-watersheds of Chestnut Creek, Pepacton Hollow and Red Brook, were assessed as part of the management plan watershed assessment. Information was gathered from existing GIS databases, topographic maps, soil surveys and maps, geologic maps and reports, land use and land cover maps, as well as historic and recent aerial photography. Conducting a geomorphic characterization and field reconnaissance of the sub-watersheds yielded additional information on current conditions, though did not include the level of detail used to assess the mainstem.

II. Project Partners

A. Introduction

B. Chestnut Creek Stakeholders

C. Project Advisory Committee (PAC) Members List

Town Hall Stream Restoration Demonstration Project. Photo taken by Lori Kerrigan, SCSWCD.

II. Project Partners

A. Introduction

As described in the Introduction, the Chestnut Creek watershed became the focus of interest for a stream management planning effort in 1996, following inclusion of the five-mile main stem of Chestnut Creek on New York State's Priority Waterbody List (PWL) due to evidence of water quality impairment. In addition to impacts to the local community from development, periodic flooding and associated damages, and stream bank erosion, Chestnut Creek is a primary feeder stream to the Rondout Reservoir, a terminal reservoir in the New York City drinking water system. All of these concerns made Chestnut Creek a priority for inclusion in a wider strategy for cleaner water in the Catskills through the cooperative stream management process.

The Stream Management Program (SMP), a non-regulatory group of the NYC Department of Environmental Protection (DEP), partnered with the Sullivan County Soil and Water Conservation District (SCSWCD) to assess conditions of the main stem Chestnut Creek and several tributaries. This information was used to develop a plan for the long-term stewardship of Chestnut Creek. The SCSWCD recognized that to accomplish the broad set of goals and objectives described in the Introduction, greater communication was needed among the landowners and agencies that live near, work near, or enjoy the stream. When planning around any shared resource, there are many different points of view, regulations, concerns and management practices.

The SCSWCD established the Chestnut Creek Project Advisory Committee (PAC) in November 2000, with the first meeting in early 2001. Each member of the PAC brings a unique set of experiences, a different perspective, and history of the area. This diversity was essential to covering all management aspects of Chestnut Creek, and created a fertile ground for developing cooperation and setting common goals. The exchange of information in Chestnut Creek PAC meetings and in meetings with local residents has provided the backbone for creation of this Chestnut Creek Stream Management Plan. The PAC has met several times over the course of the project to review and discuss the information that has been collected, and to focus and redirect the work of the SCSWCD as needed to formulate this strategy.

In February 2001, the SCSWCD initiated a concentrated landowner outreach effort by mailing a Chestnut Creek landowner stream perception survey. This survey was mailed to 368 residents of the watershed. Survey results, along with concerns voiced in public meetings and other communications with local residents, are summarized in Volume I, Section IV.B.6. Landowner Concerns and Interests and Appendix.

Throughout the Project, the SCSWCD has been in close cooperation with local landowners. Landowners have been actively represented on the PAC, voting on restoration project selection and participating in riparian planting efforts at the demonstration project site at the Neversink Town Hall, Grahamsville, in Fall 2003.

Detailed stream characteristics collected on an intensive stream assessment field survey, comprise the framework for organization of the stream management plan. To accomplish this effort, in 2001 the DEP SMP funded and provided training for SCSWCD staff in stream surveying and assessment, and together undertook an extensive assessment of stability and condition of the stream corridor. These findings are reported in Volume II, Section I. Chestnut Creek Stream Management Unit Descriptions.

The Federal Emergency Management Agency (FEMA) favors counties and towns that have developed hazard mitigation plans. Having such a plan in place will enhance opportunities to receive FEMA funding in the case of a federally declared disaster. This plan can lay the groundwork for future plans and hazard mitigation grant projects.

B. Chestnut Creek Stakeholders

Many more groups than those who serve on the PAC have an interest in the Chestnut Creek. The following list was developed in 2000 during a planning session with PAC members from the Chestnut Creek and other regional groups involved in development of similar plans throughout the Catskills. These local, state, regional and federal agencies and groups may be users of the stream or its watershed, decision makers who will find the management plan useful in doing their job, potential funders of future projects, or local residents.

Local:
- Town of Neversink: Planning & Zoning Boards, Highway Departments, and Code Enforcement Officer
- Neversink Historical Society
- Catskill Mountain Chapter of Trout Unlimited (TU)
- Neversink Rod and Gun Club

County:
- Sullivan County Planning Department
- Sullivan County Department of Public Works (DPW)
- Sullivan County Highway Department
- Sullivan County Soil and Water Conservation District (SCSWCD)
- New York State Department of Transportation (NYS DOT), Sullivan County Resident Engineers

State/Regional:
- New York State Department of Environmental Conservation (NYS DEC): Regional Habitat Managers and Regional Foresters and Forest Rangers
- NYS Department of Health (DOH)
- Catskill Watershed Corporation (CWC)
- New York City Department of Environmental Protection (NYC DEP)
- NYS Emergency Management Office (SEMO)
- Watershed Agricultural Council (WAC)

Federal:
- United States Environmental Protection Agency (US EPA), Region 2
- US Army Corps of Engineers (US ACOE)
- Natural Resources Conservation Service (NRCS)
- Federal Emergency Management Agency (FEMA)

• US Fish and Wildlife Service (US FWS)

C. Project Advisory Committee Members List (PAC)

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III. Introduction to Stream Processes and Stream Ecology

A. Streams "101"

B. Stream and Riparian Ecology

C. Stream Morphology and Classification

D. Applying the Science of Stream Form and Function to Stream Management

Wolf Spider at Grahamsville Town Hall. Photo taken by Lori Kerrigan, SCSWCD.

III. Introduction to Stream Processes and Stream Ecology

For many people streams are beautiful features of our natural landscape. Residents of the Chestnut Creek watershed have told us that the sight and sounds of the creek enhances the quality of their lives here. But as all streamside landowners know, living streamside can bring as many dangers and challenges as it does pleasures. If we are to live in balance with our streams and water resources we need to understand more about how they function and why they are important to a healthy environment.

Part of the conflict between people and streams arises from the stream's ever-changing nature. As unpredictable as streams seem to be, there is something consistent about the way they change through the seasons, or even through an individual storm. If we take the time to observe them carefully, we can begin to understand the patterns in the way streams behave and, more importantly, what we might do in our individual roles as stream stewards and managers to increase the benefits and to reduce the risks they pose.

This section of the management plan is provided to offer the reader a basic explanation of how streams "create themselves": how they take different forms in different settings, what makes them evolve, and how we can manage them (and manage with them) more effectively.

A. Streams "101"

Chestnut Creek watershed is that area of land that contributes water to Chestnut Creek, in other words, the watershed land area "sheds water" to streams, which channel the water out of the landscape toward larger rivers and eventually the sea (Figure 1). The hydrologic cycle represents the collection of processes that determine routing of water through the atmosphere to the landscape and back. The amount and timing of water that flows through Chestnut Creek into Rondout Reservoir reflects the integrated net effect of all watershed characteristics that influence the hydrologic cycle.

The amount and timing of water a stream carries off the landscape is primarily determined by four landscape-scale characteristics:

Figure 1. Diagram of Chestnut Creek Watershed.

- climate of the region, specifically the amount of precipitation (rainfall or snowfall) and the temperatures the region typically sees throughout the course of a year;
- topography (landform relief, or the shape of the land and range of elevation change) of the region and especially the watershed;
- soils and bedrock geology; and
- type and distribution of vegetation and land use (like roads and buildings), across the landscape.

These characteristics also play key roles in determining water quality and health of stream and floodplain ecosystems.

1. Stream Hydrology and Stream Flow

To begin to effectively manage a stream, managers first need to understand how much water is delivered from the landscape to the stream at any particular point in the system. *Stream flow* (or discharge, the volume of water carried per unit time, usually measured in cubic feet per second) can vary widely, dependent on weather patterns and time of year. One can watch a stream swell and shrink over the course of a year or a single storm. Hydrologists use a stream hydrograph, or a graphical representation of stream flow over some period of time, to characterize the relationship between flow and time – for example, how long it might take rainfall to reach the stream after a storm starts, how long it takes for flood stage (water level) to drop once the storm is over, or at what rate does the stage fall in a drought period. In order to develop a hydrograph, hydrologists need active stream gages, or devices that measure the height of the water surface to calculate discharge. For more detailed information about stream gages and a picture of a hydrograph see Volume I, Section IV.B.2. Hydrology and Flood History.

While the primary focus of stream assessment, classification and restoration is typically on bankfull discharge and channel morphology, base flow and flood flow channels are also critical to health and function of stream systems. Base flow is that flow that sustains streams between storms and in times of drought. This flow is the most important factor in determining survival of species that require flowing water year round – fish, aquatic insects and certain water plants. A healthy stable stream has a distinct and defined thalweg, the deepest part of the stream, which will contain water even in lowest flow conditions, and generally in a continuous line. A disturbed or unstable stream may not have a discrete or continuous thalweg, and may even allow water to flow under the stream bed during drought periods, especially if the stream is very wide and shallow or has large sediment deposits.

The bankfull channel does not contain flood flows; this often defines what is considered a flood. Some stream types contain floodplain – that flat or gently sloping area adjacent to streams where water can spread out during a flood. Floodplains are actually a part of the stream channel, even though they may only have water flowing over them once a year or even less frequently. Floodplains can correspond to any size flood – the lowest active floodplain is often just referred to as the floodplain or floodplain bench (if very small or only in short sections along a streambank), whereas higher, inactive or abandoned floodplains can be referred to as terraces. Floodplain features are regulated according to the risk of flooding. The Federal Emergency Management Agency (FEMA) created Flood Insurance Rate Maps (FIRMs) showing 100-year and sometimes 500-year floodplains, simply the approximate boundary of the area that would be inundated during a 100-year or 500-year flood.

Base flow and flood flow channels, while not what we typically think of when considering shape and configuration of a stream, are nonetheless critical to stream function and must be considered in any stream restoration or management project. Too often one or both of these channels may be neglected – the result can be a lack of stream flow in summer if base flow is too slow and shallow to stay on top of the stream bed, or too much stream flow during floods if flood flow can't spread out on the floodplain to slow down and sink in.

2. Stream Formation

Streams not only drain water from the landscape, but also carry sediment (soil and rocks) in the form of *bedload* – sand, gravel, cobble, and even boulders – or *suspended load* – fine sand, silt or clay – eroded from streambeds, banks and hillsides upstream. As water begins to rise in the stream channel during a storm, at some point the force of water begins to move material on the channel bottom. As stormwaters recede, the force falls and sand, gravel and cobbles stop moving (Photo 1). You may observe these changes by noting elimination or addition of sediment deposits (small piles behind boulders or other obstructions, or larger piles called bars) in some places. On the other hand, though individual sediment particles may be removed and replaced through seasons and storm events, these deposits and bars often remain, maintaining similar shape and size over time. The amount of water moving through the channel, and particularly the way water energy is channeled and focused, determines size and amount of bedload moving through the system.

Photo 1. View looking upstream on Pepacton Hollow. Cobble in the stream bed.

In addition, the amount and distribution of bank erosion, scour and channel shape change through storms and seasons is highly correlated with type and amount of vegetation in floodplains and riparian areas. Two streams with similar sediment and rainfall patterns will show dramatically different shape and function if riparian vegetation is changed. In the Catskills, and especially in narrow valleys like Chestnut Creek, a naturally stable stream will have trees and shrubs all along the stream bank to help hold the soil together. If you take woody vegetation out and mow right down to the edge of the stream, you may be risking severe erosion problems.

The combination of vegetation, streamflow and bedload determines stream channel shape and size. Within natural limits, form, or morphology, of a stream is self-adjusting, self-stabilizing, and self-sustaining.

This consistency is due to the fact that the climate, geology, topography and vegetation of a region usually change very slowly over time. 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 unintentionally change that balance between the stream and its landscape. We may notice however that some parts of the stream seem to change very quickly, while others remain 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 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 or sections become unstable when some activity on or near the stream has upset that balance and altered the stream's ability to move its water and bedload effectively.

3. Stream Dynamics

The amount of force water exerts to move rock is determined by stream *slope* and *depth***.** The steeper the slope the more force and the deeper the depth the more force a stream has to move its water and bedload. For example, if changes made to a stable reach of stream reduce its slope and/or depth the stream may not be able to effectively move the bedload supplied to it from upstream. 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 cut down or, *degrade,* and ultimately to become *incised,* like a gully. Both situations – aggrading and degrading – 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 or downstream, causing great lengths of stream to become unstable.

B. Stream and Riparian Ecology

A stream can provide many community and ecological benefits such as visual beauty, clean drinking water, recreational opportunities, and increased land values. These benefits are dependent upon stream health. Stream health can be evaluated not only in terms of physical stability but also its ecological integrity.

1. Habitat: Inside and Out

Habitat, particularly *riparian* (streamside) and *aquatic* (in-stream) *habitat*, encompasses the many characteristics needed to sustain a diverse assembly of life forms; including fish, plants, and various aquatic and terrestrial animals that require the stream or riparian areas (Photo 2). Habitat, both aquatic and terrestrial, has physical properties (structure or shelter, temperature, and amount of light), biological properties (types of organisms and assemblages), and chemical properties (amounts and distribution of various chemical compounds such as oxygen or pollutants). Chemical and biological habitat properties of water are often referred to as water quality. Most often we discuss the habitat of an area in relation to its health, i.e., whether habitat is of good or poor quality will impact the health of plants and animals that are a part of it. In the most basic terms, a healthy habitat provides plenty of good food and shelter.

In-stream habitat in the mountainous northeast can be described as “coldwater habitat”. This is due to the major contribution of cold groundwater to stream *base flow* (stream flow between storms). Small, steep tributaries with extensive forest cover characterize pristine coldwater habitat in this region. These tributaries feed into slightly larger streams down towards the *mainstem* (the primary stream in the valley bottom). As water moves downstream it passes through a multitude of structural habitats, often referred to as microhabitats, including riffles, side channels or channel margin pools and flats. Food energy is added in the form of leaves and streamside plant material (Photo 3). Specialized organisms, such as macro-invertebrates (aquatic insects, primarily shredders in headwater streams) and micro-organisms (bacteria and other

Photo 2. Riparian vegetation in a stable reach on the Chestnut Creek.

Photo 3. Leaf pack available for food for benthic macro invertebrates.

microbes), eat and break up those leaves making the nutrients in them available for other organisms, like algae and other macro-invertebrates (filter-feeders or collectors in lower tributaries), downstream. Coldwater fish like trout, sculpin, and dace feed on these insects and other small fish. The ecologically healthy coldwater stream boasts a diversity of structure and species within and around the stream to sustain these cycles.

Riparian vegetation, or the assemblage of plants and trees along a stream, plays a significant role in sustaining in-stream health and habitat. As rainfall or snowmelt runs off the landscape, riparian vegetation slows the rate of runoff, captures excess nutrients and sediment carried from the landscape, protects stream banks and floodplains from the erosive force of water, and moderates water temperature changes. Thus, riparian vegetation can serve as a buffer for the stream against our activities in upland areas. Most of our activities, whether agriculture, development, or even recreation, can result in disturbance or negative effect on the unprotected (or "unbuffered") stream. Given the significant role riparian vegetation can play to improve the quality of streamside living it is important to understand how to protect those functions. For further discussion and actions see Volume I, Section IV.B.3. Riparian Vegetation Issues in Stream Management.

2. Water Quality

Water quality describes a suite of important habitat components for many organisms living in and around a stream. Water naturally contains a wide variety of ions (charged molecules) including minerals from rocks, soil and the atmosphere. These ions include sodium, calcium, chloride, sulfates, and nitrates, to name a few. Water can contain many other dissolved or suspended substances, such as sediment (clay or silt particles), algae, or other compounds both natural and human-made. Pollution occurs when human activities alter the quantities of these substances in water to a degree that creates a harmful imbalance – to some target species, for human use, or other natural ecological process. The term "water quality" refers to the types and amounts of substances in water and is meant to describe the extent to which a body of water is polluted.

Water quality typically becomes poorer as human activities and development increase in proximity to a stream, especially in the absence of efforts or practices to mitigate impacts. Salts, oils and sediment from roads and parking lots, bacteria and nitrates from failing septic systems, and pesticides from lawns or agricultural fields are just a few of the types and sources of stream pollution. Remote headwater streams with fewer potential pollution sources upstream will often have better water quality than more developed mainstem creeks.

Resource managers can evaluate water quality in a number of ways. We can measure concentrations of pollutants in a stream and compare these to a set of standards established by the New York State Department of Environmental Conservation (DEC) or other regulatory or scientific guidance agencies. These standards can be based on designated use of a stream, such as for drinking water or for recreation, or a set of target values for aquatic species of interest. We can also assess water quality by evaluating certain aspects of the biological community of the stream, such as species type and composition of fish or macro-invertebrate communities.

Significantly degraded water quality can dramatically impact species in a stream, from aquatic invertebrates, to fish, to birds and other animals that live in the riparian zone. The relationships between water quality and aquatic macro-invertebrates are very well established and reliable enough to use as water quality criteria. In fact, the DEC has developed a set of guidelines for sampling aquatic macro-invertebrates to assess water quality. NYCDEP maintains a stream macro-invertebrate sampling program in the Catskills water supply watershed, including Chestnut Creek, to compare with state-wide standards and other measures of water quality (Volume I, Section IV.B.4.c. Chestnut Creek Biomonitoring Results). Volunteer stream organizations can use these guidelines and sample streams themselves to submit for DEC review.

3. Conclusions

If stream managers and residents want to maintain healthy, stable streams, we need to maintain a stable stream *morphology* (channel shape) and vigorous streamside vegetation. Stable streams are less likely to experience bank erosion and habitat deficiencies, and streams with healthy, functioning riparian vegetation can maintain resilience from upland water quality threats. In the sections that follow, this Plan describes the current condition of stream form and streamside vegetation throughout Chestnut Creek. Volume II makes recommendations for protecting healthy sections of stream and for restoring stability of those sections that are at risk.

C. Stream Morphology and Classification

This section provides more technical information about the relationship between stream *form* (or *morphology*) and physical stream *function* (i.e., flood behavior and sediment transport). *Stream Formation,* Section III.A.2., describes how a stream's form, particularly slope and depth, determines its *hydraulics* and sediment transport function. We focused on slope and depth because they are easy to visualize and measure, and are often changed --intentionally or unintentionally-- by stream managers. There are, however, many other characteristics that share an influence on how a stream creates and maintains itself and determine whether a stream is stable or unstable in a given valley setting. Stream managers use a number of terms to define and describe stream form and function. These include:

1. Stream flow (Q)

Stream flow, also called *discharge*, is represented by a volume of water passing by a certain point in a stream in a set amount of time, or volume per unit time, usually cubic feet or cubic meters per second (cfs or cms). Stream flow changes constantly, naturally increasing or decreasing as inputs (from rainfall, snowmelt, springs or groundwater) and outputs (evaporation, downstream flow, infiltration into the ground from the stream bottom, or uptake from riparian vegetation) shift in balance through storm events or seasons. The typical pattern of stream flow over the course of a year is called the *stream flow regime.*

We can divide stream flow into two basic types for management discussions; *storm flow* and *base flow*. Storm flow appears in the stream channel in direct response to a precipitation or snow-melt event. Base flow is that source of water that sustains a stream throughout the year during drier conditions.

Sources of storm flow can be divided into three sub types:

Channel interception is simply precipitation that falls directly into the stream. Intercepted precipitation shows up on a storm water hydrograph immediately (i.e., becomes part of in-channel flow instantly), though comprises a very small amount of total stream flow. When the precipitation event stops, this input to stream discharge ceases.

Overland flow, or surface runoff, is the portion of precipitation or snow-melt that runs off over the land surface. Overland flow is not generated consistently over a watershed; it can vary with topography, vegetation type, land use or cover, and time of year. The amount of water that reaches the stream by overland flow is determined by characteristics of landscape materials (soils, etc.) and how long water sits on the surface. Relatively impermeable areas (exposed bedrock, frozen ground, clayey-soils, paved or compacted surfaces) will generate more runoff than more permeable areas (deep, coarse soils) due to how well water can infiltrate (penetrate) the material. Any landscape characteristic that affects the amount of time water is kept on the surface will also impact amount and timing of overland flow. Flat or densely vegetated landscapes slow runoff rate, allowing greater time for infiltration and producing less total runoff; steep or bare watersheds will produce very fast runoff in higher amounts, often called "flashy" watersheds. The speed at which overland flow appears on the stream flow hydrograph depends on the speed at which water runs over the landscape and how far it has to travel. The time it takes precipitation falling on the farthest point in the watershed to a point in the stream by overland flow is called "time of concentration".

Subsurface flow, or through flow, comes from rain or snow-melt that infiltrates and runs downslope through the soil. Subsurface flow speed depends on soil permeability, slope and the presence of fractures or other pathways in the soil. Subsurface flow typically shows up on a stream flow hydrograph after directly intercepted or overland flow, and sustains stream flow long after storm events have passed.

Certain specific stream discharge plays a more significant role in determining stream shape when compared to others. Very large floods may induce catastrophic changes in a stream — severely eroding banks and washing trees into the channel — but these major floods are relatively rare. Summer and winter base flow moves very little sediment, but occurs very frequently. Flows that have the greatest effect on channel shape are those that come fairly frequently, but which are still powerful enough to mobilize the gravel and cobble on the streambed. Flows that move sediment and occur fairly frequently will move the greatest amount of sediment over time, and therefore theoretically exert the greatest impact on stream morphology. *Bankfull flow*, recurring every 1 to 3 years on average, is often used in place of *channel-forming flow*, considered most responsible for defining stream form. This discharge is important for stream channel morphology and can be measured or calculated for most streams making it a useful management tool.

Height of water, or stream water surface level, is called *stage*. At flood stage, a stream overtops its banks or reaches some predetermined level associated with flood risks. *Bankfull stage* is associated with bankfull flow or discharge, and often corresponds with flood stage, or the point at which a stream breaks out onto the floodplain.

2. Slope (S)

Water surface slope, also discussed above, is one of two variables important in determining the force of moving water on stream beds and banks, and the potential for erosion, scour and bed sediment mobility. Slope typically refers to the average water surface slope at "current" discharge (the day a stream survey is conducted) for the purpose of classification. Other water surface slopes can be measured and used for flood calculations or sediment mobility estimates, such as bankfull slope.

3. Channel average depth (d)

Depth, also discussed above with regard to sediment transport, is measured from the streambed to the current water surface and used to calculate sediment transport capacity at a particular discharge. When used to compare one stream reach to another in *stream classification systems* (see below), the average depth at bankfull stage is used.

4. Channel width (w)

With average depth, stream channel *width* at the water surface determines *cross-sectional area* (Area = width x depth), usually measured perpendicular to flow direction. Stream width at bankfull stage is used in stream classification.

5. Channel roughness (n)

So far we've only talked about what gives the water force to erode the streambed and banks. There are also characteristics of the stream that slow water down, or resist the flow. One of these is bed or boundary *roughness*: it's harder for water to flow through a section of stream filled with boulders than through a reach with a clay bed with no obstructions. Roughness can also occur on floodplains in the form of trees or other coarse vegetation, which slow flowing water.

6. Sinuosity (k)

A different kind of roughness that slows water down has to do with whether the channel runs straight or has curves or bends (called *meanders*). When stream flow is slowed as it moves around a bend, we say the flow is encountering *form roughness*. The "curviness" of a stream is called *sinuosity*, measured as stream length divided by valley length. That is, if a stream runs completely straight down a mile long valley, both valley and stream are the same length, or k =1 mile /1 mile =

1. If a stream running down the same length of valley contains multiple *meanders* such that the stream channel is 1.5 miles in length, k = 1.5 miles /1 mile = 1.5.

7. Radius of curvature (Rc)

Radius of curvature is a measure of the "curviness" of the stream, but at a single curve. To find the radius of curvature, you measure the size of individual meanders, as if the bend were a perfect circle.

8. Sediment size (D50)

To classify or assess a stream reach using the Rosgen classification system, at least 100 bed surface sediment particles are randomly selected and measured, and the median sized particle (*D50*, meaning that 50% of the particles in the stream are smaller) is calculated. Specific size fractions (D50, D84, etc.) are used for classification, assessment or sediment mobility calculations.

9. Bank Cohesiveness

Due to the glacial history of the region, soils in the Catskills are extremely variable from place to place, and some soil types hold together better than others, or are more *cohesive*. Soil cohesiveness is a function of clay content in the soil. Roots of trees and shrubs can reach deep into the soil of a streambank, and the web of fine root fibers can add a tremendous amount of structural strength to banks and floodplains.

The "balance" that streams develop over time when they are not disturbed is the balance between the erosive forces of floodwaters and the strength of the bed and banks to resist that erosive power. This balance develops because streams will erode away their banks until, eventually, lengthening meanders reduces the slope, or the stream is widened and depth is decreased sufficiently, such that the cohesiveness of the soil and vegetation together just equal the erosive potential of floodwaters.

10. Sediment discharge (Qs)

Just as water flow in a stream is called *stream discharge*, stream transported silt and sand, gravel, cobble and even boulders, is called *sediment discharge*. Sediment discharge is measured as a weight, volume or size of sediment moving past a particular point over some interval of time, typically tons or kg per year. *Bedload* is sediment that moves (by rolling, bouncing or sliding) along the bottom of the channel (typically coarse sediment, gravel and larger), while *washload* or *suspended load* is sediment that is suspended in the water column (typically fine sediment, sand or smaller).

Measuring (or estimating) sediment discharge is one way to determine whether a stream is stable. If the amount of sediment coming into a reach of stream does not roughly equal the amount leaving the reach in the same time period, the form of the reach will have to change. Short or even medium term sediment transport imbalances do not necessarily constitute instability, however. A sudden increase in load or a very large discharge can temporarily change sediment dynamics in a reach, sometimes taking years to equalize. A stable stream is better equipped to mitigate and recover from these types of disturbances in shorter time frames.

11. Entrenchment

Entrenchment, as used in assessment and classification (Rosgen, 1996), is a quantitative expression of the degree to which a valley contains or confines a stream. Rosgen's *entrenchment ratio* compares stream width at bankfull flow with its width at twice the maximum depth at bankfull flow (also called the floodprone width). A large ratio of floodprone width to bankfull width indicates a stream that is not entrenched (i.e., the stream has access to a wide floodplain).

When a reach of stream is straightened or narrowed, it may cut down into its bed (degrade), so flood flows can not spill out onto the floodplain. When even large floods are confined to a narrow deep channel they can become very erosive and entrenched, potentially resulting in severe bank erosion or bed scour.

D. Applying the Science of Stream Form and Function to Stream Management

By carefully measuring and interpreting selected stream morphology characteristics, stream managers can get a fairly good idea about the relative stability of a stream, reach by reach, over its whole length.

Throughout this Plan you will find references to these different characteristics. By understanding the relationship between stream form and function, managers can prioritize severely unstable stream reaches for treatment, and can apply different management strategies more appropriately and cost effectively. Analysis of stream morphology can also make for more successful design of stream restoration projects; designers can identify and survey stable stream reaches and then use their form characteristics as *Reference Reaches* as part of a restoration design template.

Classifying Streams by Their Form

One useful tool for stream managers, developed by Dave Rosgen, is a system for stream reach classification based on channel form. Rosgen's system gives letter and number designations to different stream types, depending on the combination of five characteristics (discussed individually in sections above):

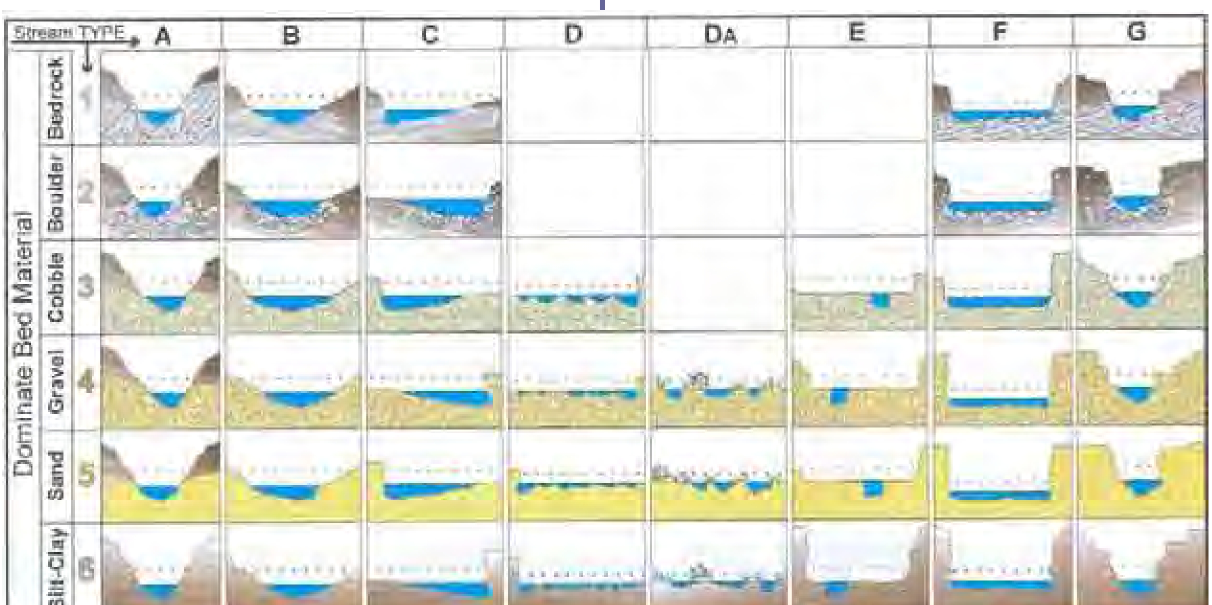
1) Entrenchment ratio, ER
2) Ratio of width to depth, w/d
3) Slope (water surface), s
4) Sinuosity, k
5) Sediment size (D50)

Different combinations of these characteristics result in a great number of different stream types, from A1 through G6 (Figure 2. Stream types from Rosgen). These letter/number designations provide a sort of shorthand for describing the form of a stream reach.

For example, a B3 stream type has a cobble dominated bed, a moderate amount of accessible floodplain, is greater than 12 times as wide as it is deep, is moderately sinuous, and drops between 2 and 4 feet for every 100 feet of stream length. How does a B3 differ from an F3? An F3 is more entrenched, meaning that it can't spill out onto its floodplain during storm flows, and it is also less steep, dropping less than 2 feet for every 100 feet of stream length. How is a B3 different from a G3? Though the G3 has similar slope, it is more entrenched, like the F3, but has a lower width-to-depth ratio.

Because locations of bedrock exposure represent an important control on stream morphology, these sections can be documented as a double stream type, such as B1/B3. A B1/B3 reach would be predominantly a B3 (cobble), but would have section(s) of B1 (bedrock) too small to be broken out into a separate reach or reaches. A B1 reach would be a bedrock dominated reach only. Additional reach types may include additional slope classification, such as B3a, where the “a” signifies an A channel slope with a B3 cross-section morphology, or B3/B3a where slope is borderline between B and A slope.

As discussed above, each of these different forms functions a little differently from the next, especially with regard to the stream’s ability to transport its sediment effectively. By classifying different stream types in a watershed, different management strategies can be applied appropriately to different sections of stream. Rosgen (1994) created a stream management table, which suggests how different stream forms can be interpreted with regard to a number of management issues. In the following sections, Chestnut Creek will be described in terms of these Rosgen stream types.



	A	B	C	D	DA	E	F	G
Entrchmnt.	< 1.4	1.4-2.2	> 2.2	n/a	> 4.0	> 2.2	< 1.4	< 1.4
W/D Ratio	< 12	> 12	> 12	> 40	< 40	< 12	> 12	< 12
Sinuosity	1-1.2	> 1.2	> 1.2	n/a	variable	>1.5	> 1.2	>1.2
Slope	.04-.099	.02-.039	< .02	< .04	< .005	< .02	< .02	.02-.039

Figure 2. Stream types from Rosgen, 1996.

IV. Chestnut Creek Watershed Description

A. Community History and Current Conditions

1. Background
2. Recreational Opportunities in Chestnut Creek
3. A History of the Beaver Dam Club
4. Grahamsville Rod and Gun Club

B. Physical Stream and Valley Characteristics

1. Geology
2. Hydrology and Flood History
3. Riparian Vegetation Issues in Stream Management
4. Water Quality
5. Public infrastructure Concerns and Interests
6. Landowner Concerns and Interests

Barn in Management Unit 2. Photo taken by Barbara Barone, SCSWCD.

IV. Chestnut Creek Watershed Description

A. Community History and Current Conditions

1. Background

In 1743, the first settlement in the Township of Neversink was created. The area, named Eureka, was situated where the Rondout and Chestnut streams flowed together. As more families arrived, the settlement grew. During the American Revolution (1775-1783), settlers were forced out of the area. The Town of Neversink remained unoccupied by white settlers until about 1788.[1]

Grahamsville, formerly called Chestnut Valley due to the vast number of Chestnut trees, was the site of a memorable battle in 1778, which led to the renaming of the town after Lieutenant John Graham (Photo 1). A more detailed account of the naming and development of the Town of Neversink can be found in Township of Neversink 1798-1998, by Loretta Ackerly. Also see Figure 2, Town of Neversink Timeline.

Before 1809, the area we now know as Sullivan County was included under Ulster County. The towns of Denning, Rockland, Fallsburg, Callicoon, Fremont and Liberty comprised an area designated "The Neversink Country". There are various interpretations of the origin of the name of the area, however the exact meaning of Neversink remains a mystery.[1] The word 'Neversink' may be derived from the Native American word, 'Mahackamack', the network of streams that flow through this region of the Catskills. One idea of what this word implies is, "a continual running stream which never sinks into the ground so as to become dry." Another interpretation would be that the water flows so quickly it never allows an object to reach its bottom, hence the object will 'never sink'.

On March 16, 1798, the "Town of Neversink" was formed under an act passed by the Ulster County Legislature. On March 27, 1809, Sullivan County was separated from Ulster County. Only a few years before the separation there were only four towns in the County; Neversink, Lumberland, Mamakating and Thompson. However, during and after this time other townships were formed and separated from Neversink, leaving what defines the "Town of Neversink" today.[1]

The combination of economic conditions and the coming of the reservoirs for provision of water to downstate New York have left Grahamsville, Neversink, Claryville, and Willowemoc as the communities in existence today. The towns committed to history are Neversink Flats,

Photo 1. Chestnut Valley-Grahamsville (http://www.catskillonline.com/history/neversink/, February 2003).

Bittersweet, Curry's Corners, Unionville, Eureka (Neversink's first settlement) and Montela.[1]

Lifestyles of the Past

During the late 1800's, the primary livelihood in the Town of Neversink was dairy farming, followed by lumbering and leather tanning. Chestnut Creek sustained two gristmill operations, a number of sawmills, a knife shop and several tanneries.[1]

It appears that the Chestnut Valley bottoms were at one time covered in hemlock forest, which is significant to stream and landscape evolution in the area. The leather tanning process required large quantities of tannin rich hemlock bark and dozens of vats for soaking. Forests cleared for agriculture provided a plentiful supply of bark.[3] Tanneries were often located on the creek because of their high demand for water. Tanneries in the vicinity of Grahamsville that utilized Chestnut Creek include Stoddard Hammond's (Reynolds) Tannery, Curry's Tannery, and Michael Walter's Tannery. The most successful years for Neversink tanneries were 1840-1870. Following the Civil War (1861-1865), demand for tanned leather declined and combined with steady depletion of hemlock forests, resulting in the decline of the tannery industry.

During the 1800's, each farm functioned as its own community, being almost entirely self-sufficient.[5] However, farmers often brought grain to local gristmills for flour. There were two gristmills located on Chestnut Creek. They utilized flowing water as a power source to operate large stone wheels to grind grain.[1] In MU 1, on

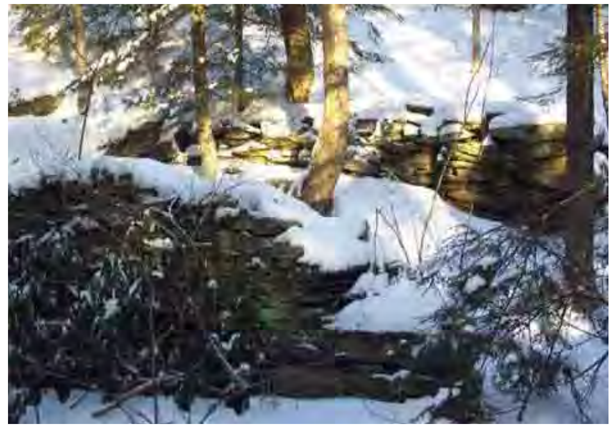


Photo 2. View of remnants of old grist mill below Crystal Falls. (Photo courtesy of Dean family).

Archie Dean's property, remnants of one of these mills resides at the bottom of Crystal Falls and serves as a reminder of the past (Photo 2). There was once a dam located above this mill which created a small pond. Chestnut Creek was once transported through a flume from the pond to the grist mill to turn the stone wheels.

A knife factory was also situated on Chestnut Creek next to the Methodist Church, which still stands in Grahamsville. There was a large turning wheel on the stream side of the building which used the flowing water to generate power for the factory. The knife factory burned to the ground in 1909.[1]

All of the above endeavors relied on the Chestnut Creek and employed numerous residents throughout the Town of Neversink. Thus, livelihoods of many have banked on the healthy function of Chestnut Creek throughout history.

The Turn of the Century

The Sullivan County Gazetteer and Business Directory (circa 1872-73) reports Neversink as a flourishing business district. Neversink was the center of trade for people throughout the County. However, with the coming of the railroad to Sullivan County in 1873, commercial opportunities diminished and a new lifestyle was to be adopted. Hotels and summer resorts attracting . Neversink was quick to pick up on the demand for this expanding industry and other areas of Sullivan County soon followed. The area became known for the clean air, water and country atmosphere that the summer resorts offered.[1]

By the end of the 19th century, farming remained the primary method of making a living, but boarding houses and business were beginning to spread.

The Reservoirs

The turn of the century not only brought changes to upstate New York, but had its impact on New York City as well. The population of downstate New York continued to expand due to the high rate of immigration. Clean drinking water became scarce as the main sources of New York water were depleted or polluted. The Board of Water Supply for the City of New York was formed in 1905 and enlisted to locate and plan a new water supply system. The Catskill Mountains were a prime source area due to the constant flow of clean water and sparsely populated forested landscape. Six reservoirs in New York City's West of Hudson River water supply, including Rondout Reservoir were constructed during the early and mid 1900's. These reservoirs were designed to deliver water through a series of aqueducts (Photo 3). The reservoirs were divided into two systems, the Catskill System which includes Schoharie and Ashokan Reservoirs, and the Delaware system which includes Cannonsville, Pepacton, Neversink, and Rondout reservoirs. Both systems deliver water through the East of Hudson River reservoir system to collection points prior to final delivery to New York City.

Photo 3. Catskill Aquaduct. October 3, 1923 (NYC DEP, 2003).

By 1939, the construction of the reservoirs was underway. Rondout Reservoir, into which Chestnut Creek empties, was completed in June of 1951 (Photo 4). Neversink Reservoir was in full operation by 1955.[1]

This was a time of hardship for the Town of Neversink. There are a variety of stories concerning the loss of homes and lives to construction of the dams and pipes, and the abrupt change forced upon the lifestyle and history of families

Photo 4. Rondout Reservoir, 2004.

throughout the area. More information concerning the social impacts the reservoirs had on the area can be found in Township of Neversink 1798-1998, by Loretta Ackerly. Many of the old timers who remain in the area still remember the time period when part of Chestnut Valley was flooded. In an interview with Archie Dean, he recalled relocating 2 barns, a silo, and 3 small bungalows outside of the reservoir area. One of the barns they removed still sits across from Mr. Dean's home in Grahamsville.

Floods

Neversink's history is marked with destructive natural disasters. Settling villages and hamlets along ever-flowing streams and rivers, such as Chestnut Creek, has contributed to massive flooding and flood damages over the past couple of centuries. Some people today can still recall the wrath that the Great Flood of 1928 released on Grahamsville and Eureka. As a result of the 1928 flood, three men drowned and several were injured, nearly 100 homes were washed away, numerous bridges were lost, 500 people were left homeless, the water supply to the area was polluted or destroyed, and acres of farmland and several hundred farm buildings were destroyed[2]

Floods have been documented in Chestnut Creek as far back as 1786. During a flood in Eureka in 1938, roads were damaged and landslides made escape to the hills difficult. The main road into town was flooded with three feet of water and damaged. One resident stated, "the waters rose with such great suddenness and the cars could scarcely be rushed to the hill before the flood was upon them."[2] Since the building of the reservoirs, there have been periods of high water, such as the flood of 1975 (Photo 5), but nothing has come close to the floods of the past. Some speculate that the reservoirs have 'tamed' the river by giving it a controlled outlet, while others feel that the next time we receive a 100-year storm there will be serious flooding.[1] For additional information about Chestnut Creek flood history and flooding behavior, see Section IV.B.2 Hydrology and Flood History.

2000 Census

Historically, farming was the most popular economic activity followed by tourism. Today, the labor force differs significantly according to the 2000 Census. The 2000 Census documented the Town of Neversink Population at 3,553 and a Total Employed Labor Force of 1,483. Agriculture is now at the bottom of a diverse list of employment[6] (Figure 1). About 27% of jobs are related to resources that may come from or end up in the Chestnut Creek watershed (quarries, road building, farming, fishing, etc.) influencing the natural landscape. Stream and resource related jobs may have increased in the management/professional category when considering such agencies as the

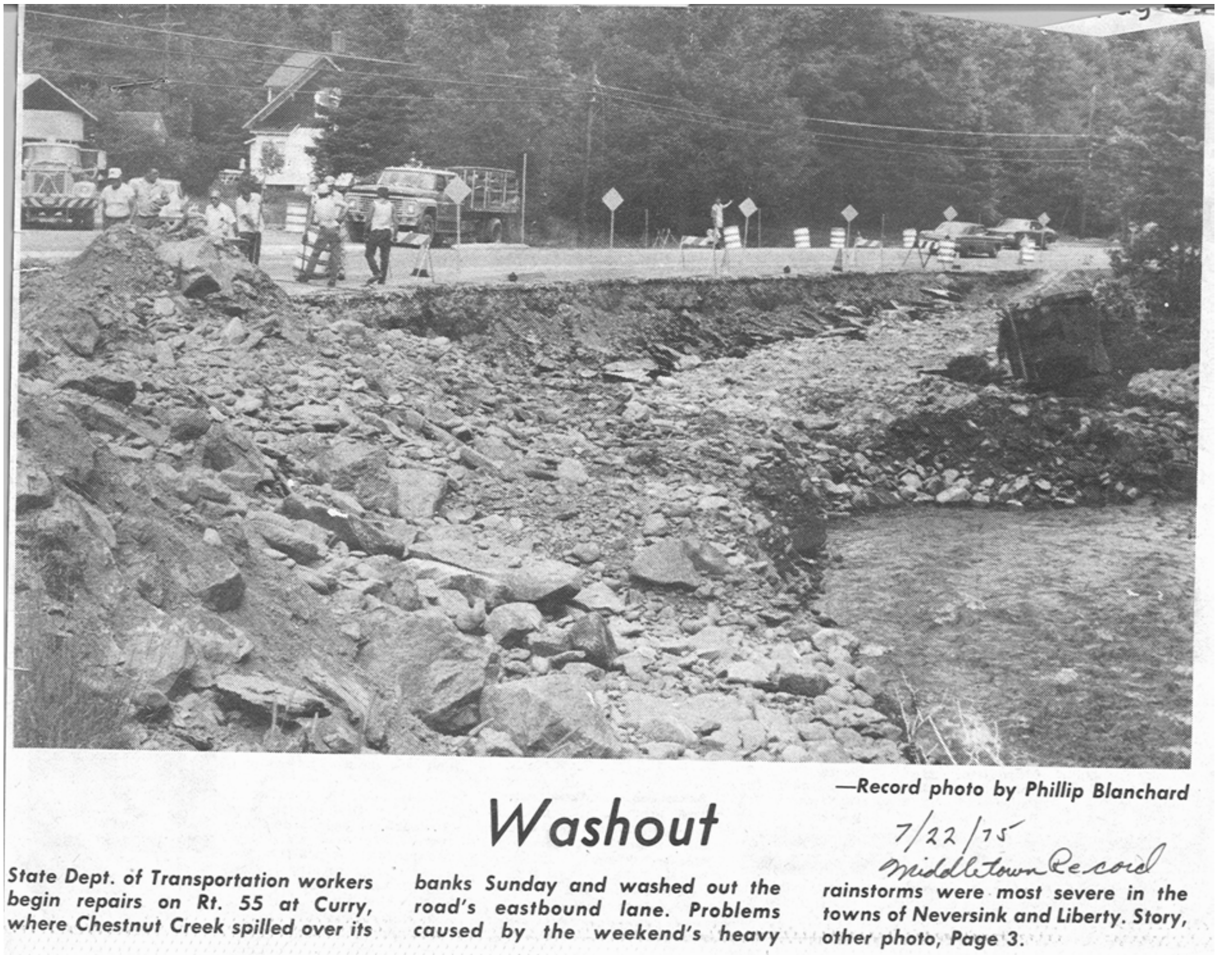


Photo 5. 1975 Flood (Middletown Record, 1975).

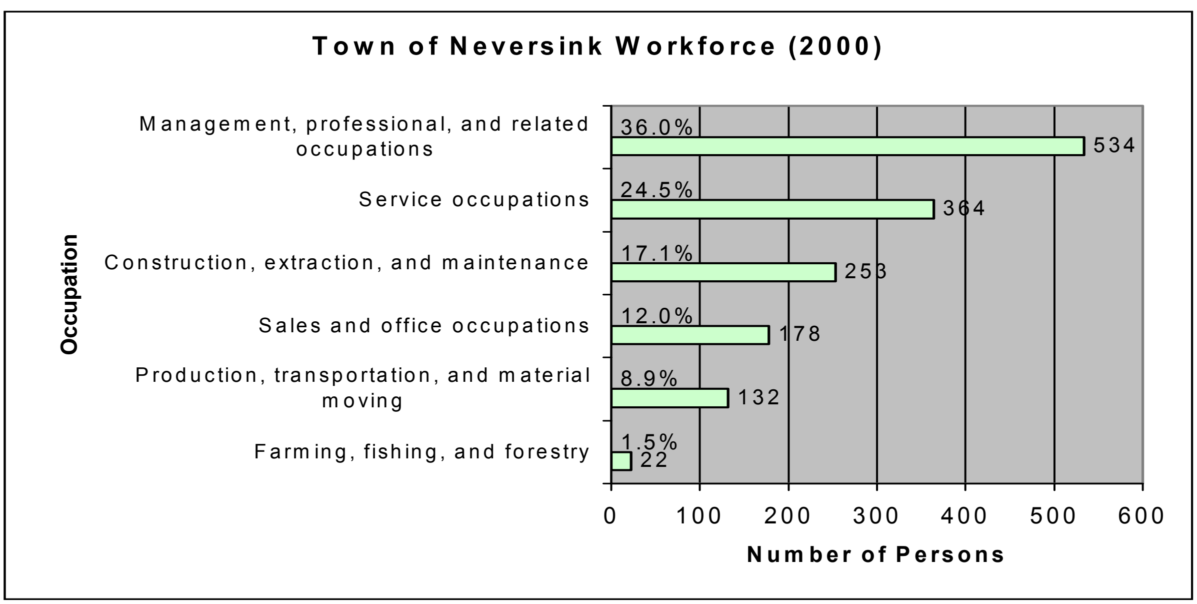


Figure 1. Breakdown of Occupations, Town of Neversink Census 2000.

Department of Environmental Protection (DEP) and the Sullivan County Soil and Water Conservation District (SCSWCD). These agencies as well as other resource jobs increase in opportunities as stream and resource partnerships grow.

2. Recreational Opportunities in Chestnut Creek

Chestnut Creek is also viewed differently for its benefits today than historically. Instead of utilizing the creek primarily for manufacturing leather, flour or other such products as in years gone by, it is valued more for the recreational opportunities it offers. The governing body of the Town of Neversink is continually brainstorming ways to beautify the town and demonstrate good stewardship. Chestnut Creek is a central part of the natural resource wealth of Neversink.

Fishing is a popular pastime associated with Chestnut Creek providing enjoyment for local residents and tourists. The Town of Neversink, the Grahamsville Rod and Gun Club and the Sullivan County Sportsman Association work together to fund a stream-stocking program, depositing trout at selected locations in Chestnut Creek every spring. For more information on stocking, see Volume I, Section IV.B.4. Water Quality and Ecological Health. The Grahamsville Rod and Gun Club has donated fishing poles to the Daniel Pierce Library for public use (Volume I, Section IV.A.4. Grahamsville Rod and Gun Club), while volunteers throughout the community are available to give guidance to those who need it. Georgiana Lepke, Town Supervisor, wishes for residents to take advantage of public access to Chestnut Creek behind the Town Hall for this purpose. Some of the fondest memories held by long time residents of the creek include learning to fish in the flowing waters as children.

Angler enthusiasts may prefer the reservoir for most fishing, depending on personal preference. Fishing in the reservoir can be relaxing, often involves a boat and calm waters, and larger fish. You are required to have a New York City DEP permit to fish in the reservoirs.

A Grahamsville Museum Committee has recently formed and is currently working on development of The Museum of Time and the Valleys. The mission of the museum is “To honor and preserve our history and share the heritage of our area including actively adding to the knowledge, understanding and appreciation of the history and value of the Rondout and Neversink Watersheds.” The museum is intended to be housed in the new addition of the Daniel Pierce Library and will eventually form partnerships with schools and other institutions to provide environmental education.

The Chestnut Creek Landowner Perspective Survey results in 2001 showed that Chestnut Creek is most valued for aesthetic purposes (Volume I, Section VI. Appendices). A walking trail is available, beginning at the Fairgrounds in Grahamsville, for year round use. Town Supervisor, Georgianna Lepke, hopes to incorporate Chestnut Creek’s ambience into weekend functions behind the Town Hall. A stage is situated adjacent to the Creek here, which local musicians can use to display their talent while residents relax along the stream bank.

Neversink Timeline

1740-Present

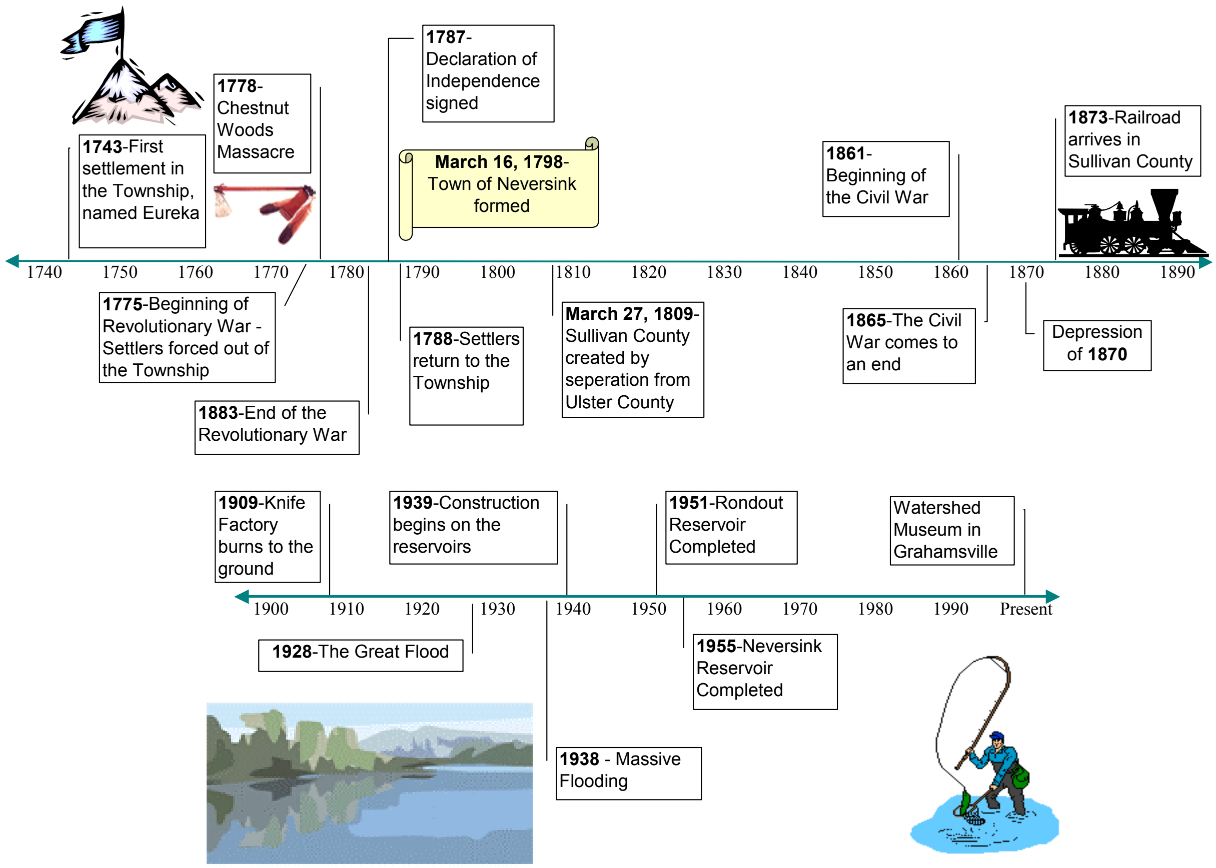


Figure 2. Town of Neversink Timeline. (Created with information derived from the sources below).

Sources

1. Ackerley, Loretta, 1998, '*Township of Neversink* 1798-1998'.
2. Ellenville, Ulster County, N.Y. Thursday August 11, 1938. *The Ellenville Journal.*
3. Richards, Matt, *Bark Tanning*, June 2000, http://www.braintan.com/barktan/1basics.htm, 2/10/2003
4. Schuetz, Annemarie. October 1999. *Watershed Museum may come to Neversink.* Times Harold Record.
5. Smythe, Carol. 2003. Personal Interview.
6. U.S. Census Bureau, Census 2000.
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3. A History of the Beaver Dam Club

By
Marilyn Shurter Cotesworth
September 7, 2003

According to a map, dated 1860, there was a man named Barney "Hots" Barefoot who owned a farm and sawmill near what is today the Beaver Dam Club lake. He sold the farm and sawmill in 1867 to Gerald Dubois. From that date until 1890 Mr. Dubois ran the sawmill located on Red Brook.

Local lore was "that each evening, after sawing and peeling operations had stopped, a family of beavers would swim down Red Brook and dam the stream, only to have the workmen tear down the dam the next day. This became a continuing nuisance until the mill owner finally surrendered to the beavers and decided to sell his land and sawmill."* Some men from Ellenville had been looking for land and a lake to buy with the intention of forming a club for fishing and hunting and they saw the potential in what the beavers had started and decided to buy the property. Thus, ten business and professional men from Ellenville purchased the Dubois acreage and farm. They also bought the adjoining land belonging to George B. and Nancy Childs on September 29, 1890 for $1,800. The deed to the Child's property states "the land being in the Town of Neversink Great Lot #4 Hardenbergh Patent," and mentions sections in the "Drowned Lands", part of a "Patent granted to Captain Johannis Ver Nooy in 1718 and said to extend to a place beyond Red Brook near Beaverdam."* The total land they eventually purchased is that which the Club owns today, consisting of approximately 277 acres with a lake of about 70 acres. These same ten men filed Certificate of Incorporation papers on August 2, 1890, naming the club for the industrious beavers that had originally dammed the stream. Thus the Beaver Dam Club, Inc. was officially formed. The road running between today's Route 42 and the Ulster Heights Road and through the Club property became the Beaver Dam Road. The Certificate of Incorporation from the State of New York specified, "the particular business and object of the Club is hunting & fishing and the propagation of game & fish, and acquiring of land, ponds & streams for said purpose". The deed names the ten as the Board of Trustees to manage the Club and the office of the Club was located in Ellenville, New York. The By-Laws of the Club adopted in 1890 showed they would have only 30 members, nine of them serving as the Board of Trustees who would then elect a President, Vice President, Secretary and Treasurer. It has always been a private club with its membership currently limited to 35.

Shortly after the Club was established a stone and earthen dam with a 50-foot long spillway was built to replace the beaver dam and to form the lake that exists today (Photo 1). A wooden bridge was built over the spillway for access to the far side of the lake.

Some time in the 1890's the members had a log clubhouse built and this still stands today exactly as it was built over 100 years ago, the only changes being porches that were soon added which encircled the building, and an upstairs loft which was built over one side porch. The Clubhouse consists of 6 bedrooms upstairs, and a large kitchen and meeting room on the first floor. A stone fireplace in the meeting room and the stone chimney had to be torn down in the late 1930's as it was threatening to pull the entire building over. The fireplace was replaced with a wood-burning stove. Behind the Clubhouse stood one shed for firewood and another one for ice, which was cut in the winter from the lake in large blocks, packed in sawdust and stacked in the shed. This supply was used for the farmhouse and Clubhouse iceboxes as well as those in some of the members' summer cottages. This practice continued until electricity reached the area. Over the years, twelve cottages were built on the Club property. Several of them are now over 70 or 80 years old and two of the oldest are still owned by the same families that originally built them. A few, after falling into disrepair or succumbing to fire, have been expanded or replaced. These 12 cottages are all that are now allowed, with the remainder of the property still being preserved in as pristine a manner as when it was originally purchased. Maintaining the quiet, peaceful atmosphere of the lake and its environs is what has kept the Club a special place all these years. The wonderful fishing lake that was envisioned by the founders became a reality and made the Club tremendously popular for its pickerel, perch and bullheads.

After the Clubhouse was built the members had a large, 8-slip boathouse constructed on the northwest side of the lake. It was one of the best loved features of the club, but unfortunately it only lasted until the 1960's when it was torn down by

Photo 1. Beaver Dam Pond

two members who claimed it was in disrepair, with neither the knowledge nor the approval of the other members. The boathouse, sadly, was never replaced.

The Clubhouse became a very important social center for the Club for over half a century. All six bedrooms were usually full on summer weekends until the 1940's. Many members would elect to stay at the Clubhouse for a week or so at a time. Before the automobile was in common use the trip to the club from Ellenville via the Ulster Heights Road in a two horse surrey or carriage took at least half a day. Members traveling such distances would spend the night in the Clubhouse in order to have time to hunt or fish.

Staying at the Club was made especially easy for the members due to the efforts of the Club caretakers. The land the Club had originally purchased came with a farmhouse and barn, (supposedly those of Barney "Hots" Barefoot), which was an ideal arrangement as the members had couples live in the farmhouse as full time caretakers. The Clubhouse had been built just to the west of the farmhouse so that it would be conveniently located near the caretaker's home. There were caretakers at the club until the 1990's. Most of them had dairy herds and farmed the land to earn a living, or were retired, but the man was responsible for maintaining the property, the buildings and the dam. He also supplied milk, eggs and vegetables to the members and tended the boats, cut the ice in the winter from the lake, and kept the hay cut in the fields in the summer. The caretaker's wife had to keep the Clubhouse clean and supply linens and other necessities for members staying there, at a cost of twenty five cents a night, raised to fifty cents a night in the 1940's. She was also responsible for providing mid-day dinners on Sundays for members and guests, and these were so popular it often took several sittings to serve everyone. There was a fish cleaning station on the back porch of the Clubhouse, where the caretaker cleaned "bullheads" early in the morning after late night fishing parties by members and their guests. The subsequent fried fish breakfasts were so good that nightly bullheading excursions became increasingly popular. The first known caretaker was Mr. Rampe. The last caretaker's wife to serve meals, in the mid 1940's was Mrs. Harold Deirfelter, who was famous for her chicken dinners and her hand churned vanilla custard ice cream.

After the late 1940's the members' use of the Clubhouse changed. What had always been a popular weekend or vacation destination became less desirable following the war. The bedrooms at the Clubhouse were rarely used after the 1950's when members could easily drive to the Club and get back home quickly. So the Clubhouse became a place for the business meetings and the annual social functions of the Club or as a spot to sit awhile on a day trip. The lure of "catching the big one", however, still draws the fishing enthusiasts to the lake all summer long, and in the winter ice fishing is popular. In the fall hunters roam the property looking for pheasant, deer and wild turkeys.

Most of the members now live in Sullivan or Ulster Counties or other locations in New York, and a few are from New Jersey, Delaware, Florida, and Ohio. The current

Officers of the Club are Herbert DeWitt, Jr., President; Craig Wilhelm, Vice President; Jim Cotesworth, Secretary and Harold Buley, Treasurer. Many of the memberships have been handed down from one generation to the next, so the Club has become an important part of family tradition for those members and their families. In 1990, and in 2000, special 100th and 110th year anniversary parties were held to commemorate the founding.

The Club's unifying theme over the last 113 years has been just what the founding members stated in the Certificate of Incorporation in 1890 – "the business of the Club is hunting & fishing" and that is what it's members have loved about the Beaver Dam Club ever since.

Sources

*"A Brief History of the Ulster Heights Area";

**"History of Sullivan County" by J.E. Quinlan;

Beaver Dam Club documents;

Remembrances by Mae Potter Shurter, now 98 years old who spent 90 summers at the Club and whose father, Frank J. Potter became a member in the 1890's and was Club president for the better part of 50 years.

4. Grahamsville Rod & Gun Club

The following is the contribution of local residents:

This club is believed to be one of the oldest such organizations in the State of New York.

Grahamsville Rod & Gun Club was organized for the protection, propagation and conservation of fish and game and to foster and promote good sportsmanship. To further these ends some of the activities in which the club participates include: stocking the Chestnut and its tributaries with trout; releasing white rabbits and pheasants in the Tri Valley area; providing fishing poles that area youth can use for fishing local streams with the cooperation of the Daniel Pierce Library; holding a local “big buck” contest; sponsoring youngsters at the DeBruce Conservation Camp; working with the Sullivan County Federation of Sportsman and the Fish and Wildlife Coalition for Youth of the Hudson Valley each fall to put on a Youth Outdoor Expo; and participating in the Neversink Agricultural Society's Fair at Grahamsville and the Sportsman's show at the Sullivan County Museum in Hurleyville. The club's main fund raising activity is the sale of knives.

Meetings are held the first Thursday after the first Wednesday of the month at the Grahamsville First Aid Squad building. The club owns four boats for members' use.

The club is a member of the Sullivan County Federation of Sportsman and New York State Conservation Counsel, Inc.

Some early members of the club, that Jack and Ray Denman could recall, included: Bill Weizman, Bruce Denman, Jack Denman, Ken Roosa, Jack Donaldson, Roger Banta, Tony Rojt, Cal Crary, Harrison Krom, Art TerBush, Harry Cole, Miles Gillett, Harry Moore, John Jones, John Knight, Chan Dayton, Sam Anderson and Clarence Krum.

Chestnut Valley Rod and Gun Club (Previous Name of the Grahamsville Rod and Gun Club)

Some of My Early Memories
By Jack Denman

1943-44-45

Meetings were held over Mark Slater's shop, which was later converted to Roger Banta's store and workshop. Now owned and operated as an antique store - (I believe, at any rate it's still there.) On the East side of the second story was a two position 50ft 22 rifle range and competition took place on a regular basis among members and some local clubs.

The club distributed trout to many of the local streams and stocked a lot of feeder streams to the Chestnut that the State didn't get to. In those years these streams ran full year round, today many dry up. As the fish grew they would seek bigger water, that was the theory.

The club worked with the State on various stocking programs and was allowed voice in the County and State on sportsman's issues.

I recall fundraisers in the form of trap shoots, turkey shoots etc. being held several years at Art Akerley's farm behind where Bob Botsford lives now - all fields then. Also was held on the hill behind Bruce Denman's on the level below Bonnell's farm. A 22 shot shell mini - trap shoot was held at the Grahamsville Fair for several years.

About 1946 the club purchased the Odd Fellows hall, I believe from Mark Slater. Fred Akerley held the mortgage and made the sale possible - Art Akerley's father. Now serious money had to be raised.

Alton Carney, my great uncle, was running the Roscoe Theater at the time and he agreed to bring over and show his first run movies every Saturday night. So Grahamsville now had a movie house with good shows followed by food and dancing (locals provided music) once a week year round.

It was great. Downtown Grahamsville was jammed on Saturday nights and I recall good times by all. Some more than others as they made regular trips outside to their cars for a nip or two. Kids take this all in. Neversink was dry - on the inside at least.

The junior members, such as me, did the grunt work. Setting up chairs, dishes, cleaning, etc.

The rifle team was now expanded to five or six positions and we joined a league that included, Port Jervis, Matamorus, Old Falls, Newburgh, Middletown and West Point. We regularly shot at all these places and they came here. The upstairs range was a bit shaky for prone shooting and proved a challenge if somebody was walking around. We were used to it and could cope but visitors complained it was unfair advantage - maybe we did have some prearranged walking, timed correctly. All in good fun.

The first year that the DeBruce Conservation Camp opened, I was sponsored and attended. I was there for a few days and I kept observing a racoon in a cage that wasn't given much care - it was a stinky matted hair animal. I turned it loose. I was snitched on and was given K. P. duty for the remainder of my stay. Bummer! I packed my bag and left for home. They caught up to me down the road and explained that this wouldn't look good for camp. K.P. would be forgiven - so I went back and completed the two weeks. It was a great experience and I enjoyed it, many of the things taught have stayed with me always.

Getting back to the club. I went away to college in 1950 so I lost contact with happenings. I did shoot for the team on several occasions later on. I had won the individual champion trophy for a couple years and could improve the score sheet. Then I went in the Army so I don't know what happened after that. I do recall hearing that Fred Akerley took the building back for the mortgage. No ill will on anybody's part - T.V. had come on the scene and the people just weren't coming out.

B. Physical Stream and Valley Characteristics

1. Geology

a. Introduction
b. Physiography
c. Chestnut Creek Geology

Rock formation at Crystal Falls. Photo taken by Derrick Kelly, WAC, courtesy of Archie Dean.

B. Physical Stream and Valley Characteristics

1. Geology

a. Introduction

In a landscape that has not been changed by human activities, the streams of a region reflect the climate, geology, and biology of that region. For instance we know that the Catskill High Peak region has higher rain/snowfall amounts than the western and northern Catskills, and as a result, for a given watershed drainage area, streams are generally larger in the High Peaks than elsewhere in the Catskills (Miller and Davis, 2002). Likewise, the large amount of forest cover in the Catskills affects the amount of rain and snowfall that will run off the landscape to become streamflow, and therefore the shape and size (morphology) of stream channel required to handle the runoff. Similarly, the geology of the Catskill Mountains exerts a clear influence on the landscape and stream valley and channel morphology. This section describes the basic geology of Chestnut Creek watershed.

b. Physiography

The Catskill Mountains are a dissected plateau of mostly flat-lying sedimentary rocks cut into by streams and ice flow over millions of years. The mountains are at the northeastern extreme of the Alleghany Plateau, a physiographic province (a land area with fairly uniform physical characteristics) that extends from Tennessee along the western border of the Appalachians (Rich, 1935).

There are many descriptions of the boundaries of the Catskills (Rich, 1935; Thaler, 1996; Isachson et al, 2000). A useful definition is Rich's description of the escarpments that comprise this mountainous region: Northeastern Escarpment (Blackhead Range); Eastern Escarpment (Wall of Manitou); the Central Escarpment (Indian Head to Utsayantha); and the Southern Escarpment (Slide Mountain to Ashokan High Point) (Figure 1). Chestnut Creek is located at the western end of the Southern Escarpment.

c. Chestnut Creek Geology

Two episodes in the geologic history of New York are represented by the landscape and rocks in Chestnut Creek watershed. Unconsolidated sediments are mostly remnants of Pleistocene glaciation, during which an ice sheet covered this region until about 12,000 years ago. Bedrock in the region represents an earlier stretch of geologic history, the Devonian period about 370 million years ago, during which huge amounts of sediment were being deposited by ancient rivers in this region from uplifting mountains to the east.

Unconsolidated Sediments

Much of Chestnut Creek watershed is covered with a layer of unconsolidated sediment. These deposits are mostly glacial sediments. There are basically two primary kinds of glacial sediment in Chestnut Creek watershed: glacial till and stratified "drift". Glacial till ("t" on the surficial geology map, Figure 2) is the material that is deposited either at the base of the glacier or along glacier margins. Glacial till is typically an unsorted assemblage of sediment that can range in

Figure 1. Catskill Mountains, N.Y.

size from clay to boulders. This material can be very compact, almost rock-like in its consolidation. This is often referred to as lodgement till, as it is "lodged" into place at the base of flowing ice. Till can also be a loose assemblage of material that is formed along ice margins, or melts out of the base of the ice. A lot of the valley walls are covered by weathered and partly eroded bouldery glacial till. Till also is deposited as a veneer of compacted sediment across the valley floors. There are several reaches of Chestnut Creek that are thick with boulders where the stream has incised into bouldery till, see Figure 2.

When glacier ice stagnated and melted in place, vast amounts of meltwater transported and reworked till into "stratified drift" deposits comprising layers of silt, sand, gravel and cobble. These deposits are present in glacial outwash (old meltwater stream deposits) , kames and kame terraces, deltas into glacial lakes, and glacial lake deposits. According to the NYS surficial geology map (Cadwell, 1986) Chestnut Creek's glacial deposits are principally till and kame-type deposits. In some of the mapped kame deposits (k) there are extensive layers of sand, which are locally mined.

There are also older river sediments (gravel and cobble layers) that were deposited in meltwater streams that eventually became the Chestnut Creek. According to mapped glacial geology there are no silt-clay glacial lake deposits as are often found in the Esopus and Schoharie Creek watersheds. Along the course of Chestnut Creek, the stream has incised into these ancestral river and glacial deposits which comprise the streambank and streambed material.

Bedrock

Bedrock exposed in the Chestnut Creek watershed, (in hillsides, along the creek bed and in road cuts) is Upper Devonian in age, which means it was deposited around 360-374 million years ago. Most of the exposed rocks are in the Walton Formation ("r" on the surficial map), which is composed of alternating layers of sandstone, shale, mudstones and, at higher elevations, conglomerate. These rocks were all formed by deposition from moving water (rivers and streams), but they differ in the size of particles within them. Conglomerates have particles that are typically sand to gravel size, sandstones have sand-sized particles, and shales and mudstones have silt/clay-sized particles. Particle size is an indication of the energy of moving water; bigger particles indicate higher energy which carries away finer sediments leaving courser deposits behind. That means conglomerates formed from fast moving river sediments while shales and mudstones formed from floodplain or basin deposits.

Rock typically exposed in the Chestnut Creek channel are inter-bedded sandstones and shales/mudstones. More resistant sandstone layers tend to form steeper, bedrock-controlled sections with minor falls and cascades, while less erosion resistant shales and mudstones tend to form lower-gradient plane bed reaches of the stream.

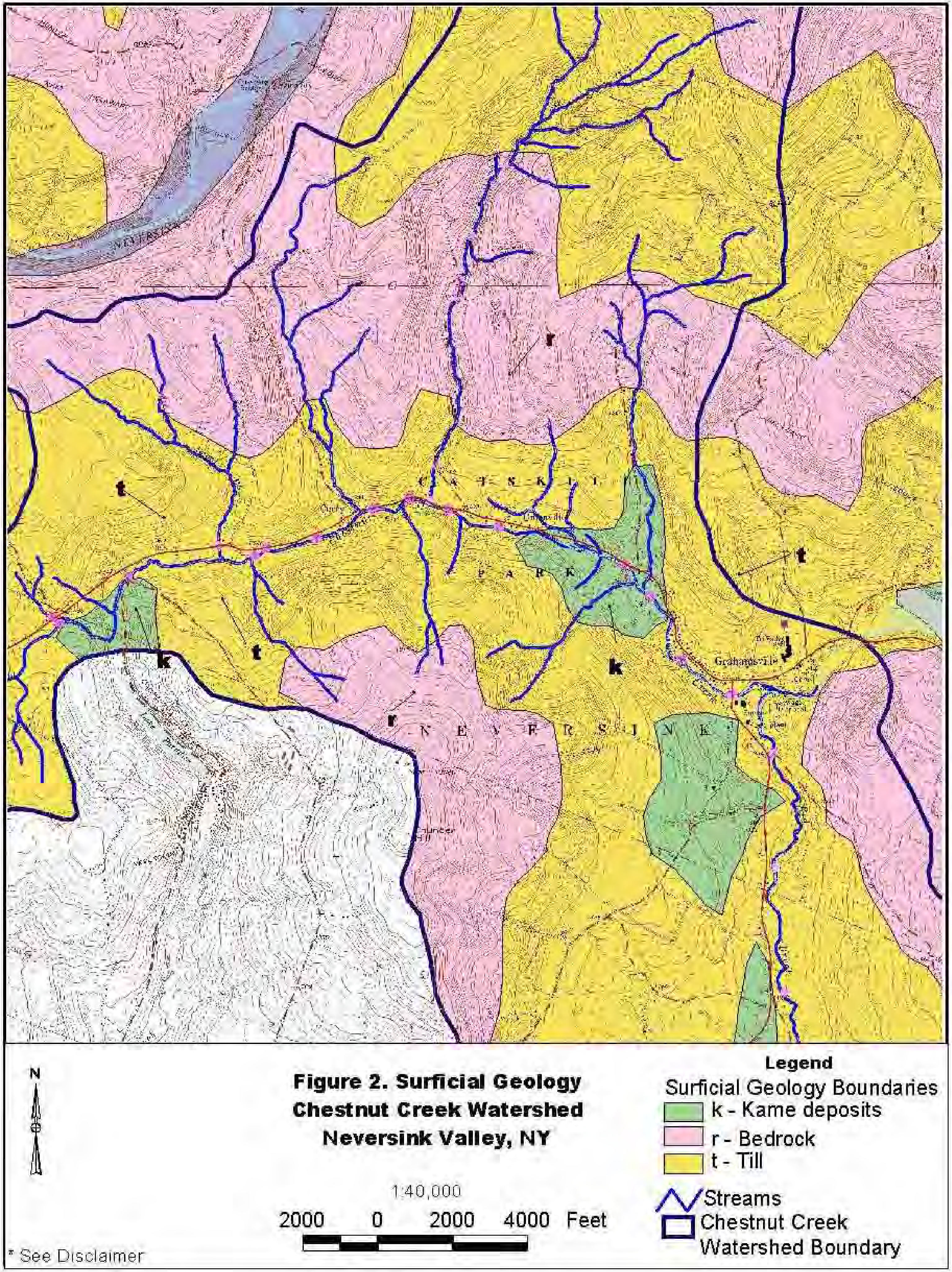

Figure 2. Surficial Geology Chestnut Creek Watershed Neversink Valley, NY

* See Disclaimer

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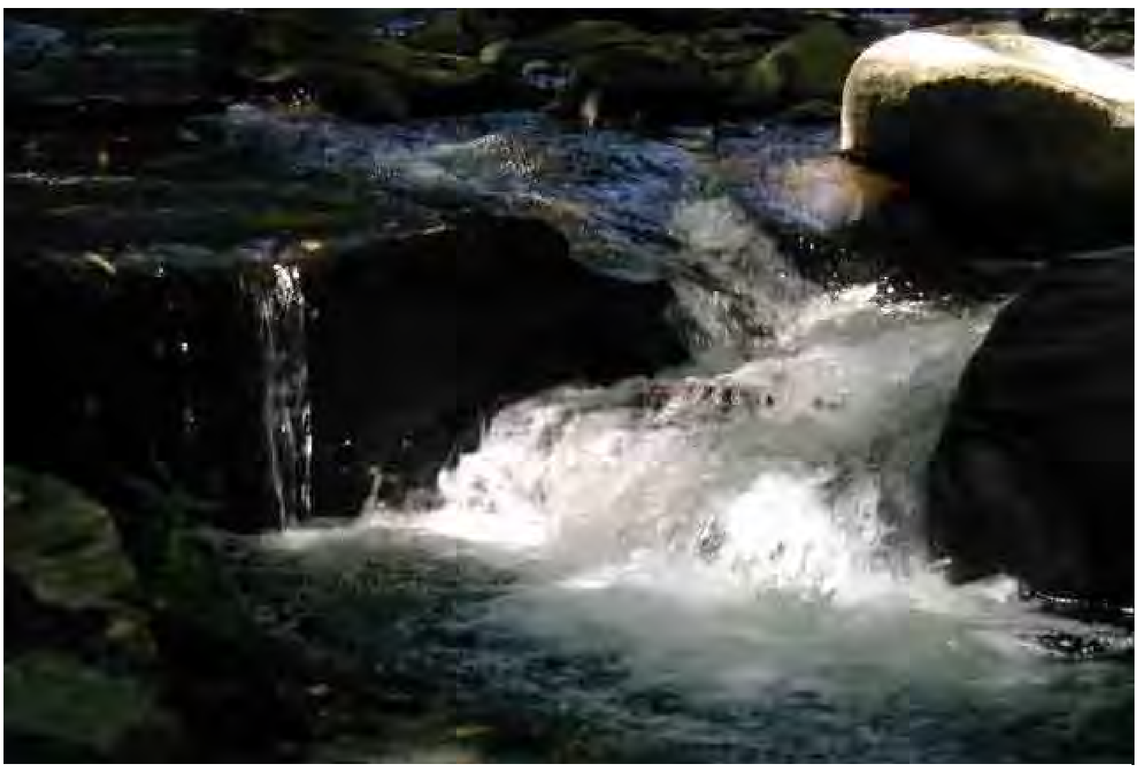
2. Hydrology and Flood History

a. Introduction
b. Chestnut Creek Statistics
c. Streamflow
d. Chestnut Creek Flood History
e. Conclusion



Chestnut Creek. Photo taken by Lori Kerrigan, SCSWCD.

2. Hydrology and Flood History

a. Introduction

Hydrology, the study of water cycles in the landscape, includes a characterization of how the watershed and stream network cycle rain and snow over time as runoff and streamflow. By studying these characteristics we can gain some insight into how the watershed reacts to flood events, and learn more about human interaction with the dynamic Chestnut Creek system.

b. Chestnut Creek Statistics

According to the United States Geological Survey (USGS), the Chestnut Creek drainage encompasses 20.9 square miles of watershed area and empties into the Roundout Reservoir (www.USGS.gov). Streams in Chestnut Creek basin are primarily perennial streams, that is, they flow year-round except in extreme drought conditions. The drainage pattern in the watershed is dendritic (branching tree-like form), typical of Catskill Mountain watersheds otherwise uncontrolled by geologic factors.

c. Streamflow

There are two general categories of streamflow of interest to stream managers: storm flow (flood flow) and base flow. For additional information, see Volume I, Section III.C. Introduction to Stream Processes and Ecology. Storm flow appears in the channel in direct response to precipitation (rain or snow) and/or snowmelt, whereas base flow sustains streamflow between storms or during subfreezing periods. A large portion of storm flow is made up of overland flow; the runoff that occurs over and slightly below the soil surface during a rain or snowmelt event. This surface runoff appears in the stream relatively quickly and recedes soon after the precipitation event. The role of overland flow in the Chestnut watershed is variable, depending upon the time of year and severity of the storm or snowmelt. In general, higher streamflows are more common during spring due to rain and snowmelt events, and during hurricane season in the fall. During the summer months, vegetation has the highest demand for water, which delays and reduces the amount of runoff reaching streams during a rain storm. During the winter months, water is held in the landscape as snow and ice, so precipitation events do not generally result in significant runoff to streams. However, a sudden thaw or "rain on snow" event produces runoff that is not taken up by vegetation, and that can't sink into the ground (if frozen), so these events can produce significant flooding.

USGS maintains a continuous recording stream gage on the Chestnut Creek in Grahamsville, which provides invaluable stream flow information. The stream gage (USGS ID. # 01365500) is located in Grahamsville, just downstream from the confluence of Red Brook with Chestnut Creek, and drains 20.9 square miles of watershed area. This gage measures stage, or height, of the water surface at a specific location, updating the measurement every 15 minutes. These values can be converted to a flow magnitude (the USGS develops this relationship, called a "rating curve", for each of its stream gages), or the volume of water flowing by that point, usually measured in cubic feet per second (cfs). This way, the flow in the Chestnut Creek at this location can be determined at any time just by knowing the current stage. Additionally, we can make use of the historic record of constantly changing stage values to construct a picture of the response of the stream to rain storms, snow melt or extended periods of drought, to analyze seasonal patterns or flood characteristics.

As an example of what we can learn from gage data, compare two graphs for Chestnut Creek gage over the period from July 31, 2003 through August 7, 2003 (Figures 1 & 2). These graphs are called "hydrographs", and usually show a change in stream stage or flow over time. Figure 1 illustrates changes in stage during one week in the summer of 2003, showing the response of the stream stage for each of the rain storm events. Changes in stream flow, or discharge, clearly reflect stream response to storm events during the same time period in Figure 2. Each spike on the graph represents an increase in stream flow in response to rain storms – stream level rises (called the "rising limb" of the hydrograph) and falls as the flood recedes (called the "falling or receding limb" of the hydrograph).

We can see there was probably a rain storm around late August 3 that resulted in the stream rising about half a foot, and increasing in discharge by more than 60 cfs, from less than 20 cfs to about 80 cfs. We can also see that the stream recovered somewhat from this storm during the next day, but was hit by another storm before it could drop all the way back to its previous level. The stream always rises and peaks following the precipitation event, because it takes time for precipitation to hit the ground and run off to the stream. Knowing the timing of a rain storm, we could also calculate the response time of Chestnut Creek at the gage location, and determine how the stream responds to the rain storm both in timing as well as in magnitude of the resulting flood.

We can also analyze a longer time period to see seasonal trends or long-term averages for the entire length (period) of the gage record. The daily average flow annual hydrograph for August 2002 through August 2003 shows higher flows than average during this period of time, comparing median values from 50 years of record (purple line) with daily flows of this particular year period (blue line) (Figure 3). Stream flow was affected by ice from January through March 2003, so there is a corresponding gap in data during the period in which stage could not be measured. We can see the long term record shows higher flows in fall (hurricane season) compared to winter (water held in ice and snow), and higher flows in spring (snow and ice melt) compared to summer (drought conditions with vegetation using a lot of water). Though this year was wetter than average, we can see a similar overall seasonal pattern comparable to the long-term record.

d. Chestnut Creek Flood History

Annual peak streamflow is the highest instantaneous stream flow recorded for a particular 12-month period (usually from October 1 through September 30, or the "hydrologic Water Year"). Most peak flows for the Chestnut Creek gage from 1939 through 2001 occurred during the months of December, March, and April, though peak flow can occur at any time during the year (Figure 4). The range of

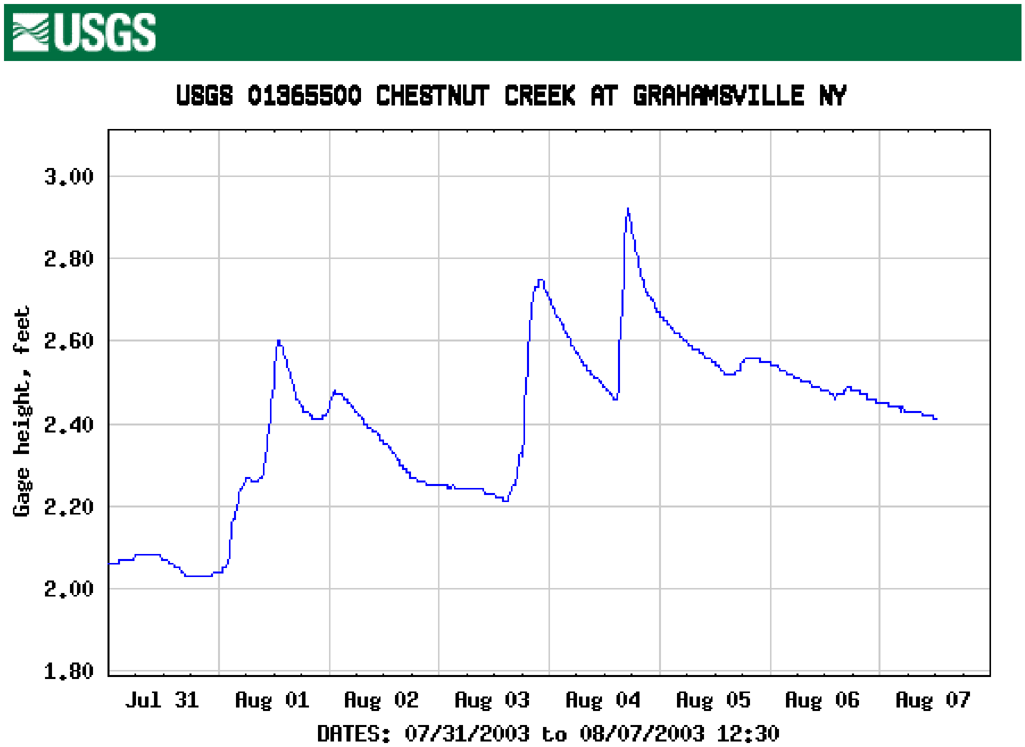


Figure 1. Stream gage height hydrograph for USGS 01365500, Chestnut Creek at Grahamsville, from July 31, 2003 to August 7, 2003. Source: USGS.gov

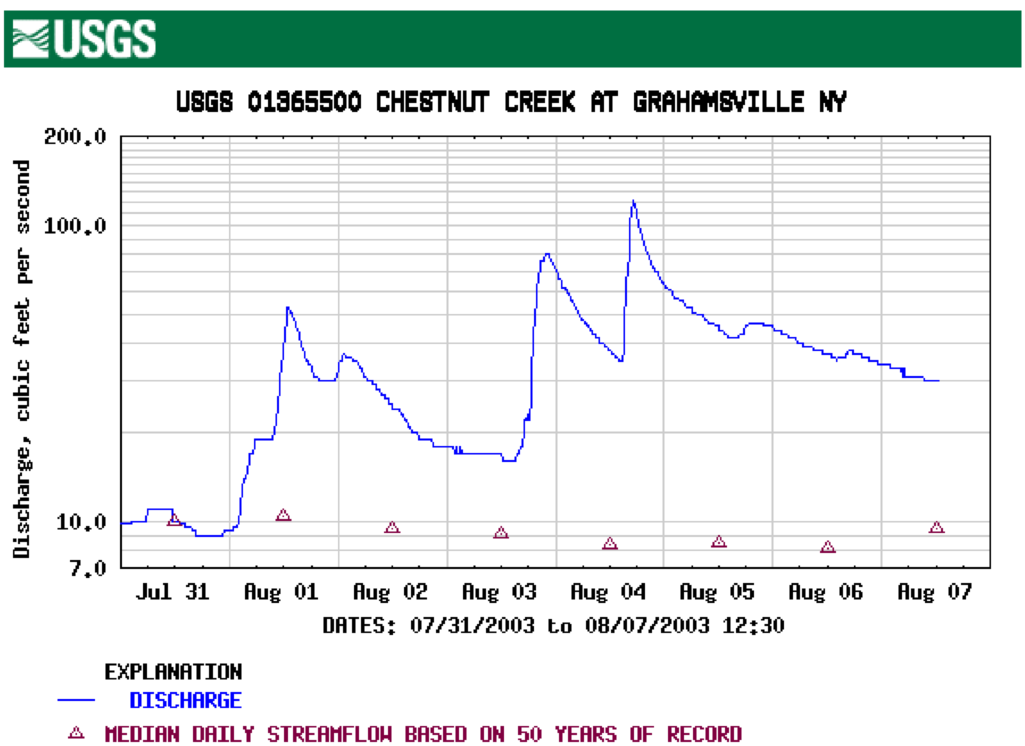


Figure 2. Stream discharge (cfs) hydrograph for USGS 01365500, Chestnut Creek at Grahamsville, from July 31, 2003 to August 7, 2003. Source: USGS.gov

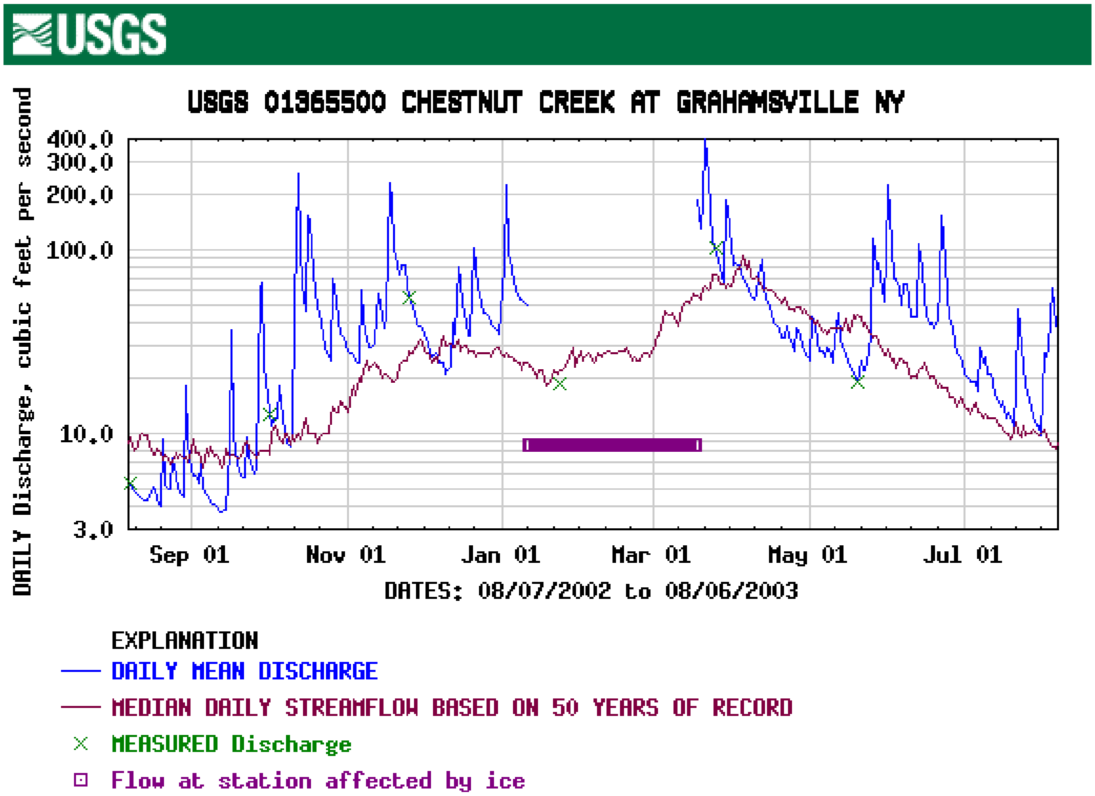


Figure 3. Daily discharge of Chestnut Creek from August 1, 2002 to August 1, 2003. Source: USGS.gov

annual peak flows shows the dramatic range of floods that have been recorded on Chestnut Creek in the last 60 years, and can assist stream managers in estimating the range of future flood behavior.

Stream flows that exceed stream channel capacity or a certain stage are called floods. Flooding can occur in response to runoff associated with spring snowmelt, summer thunderstorms, fall hurricanes, and winter rain-on-snow events, and can range from minor events to raging torrents that wipe out bridges and carve new channels. USGS has a standard method for creating a flood frequency distribution from flood peak data for a gage.

Flood frequency distribution shows flood magnitudes for various degrees of probability (likelihood). This value is most often converted to a number of years, the "recurrence interval" or "return period", for example, the flood with 20% chance of occurring or being exceeded in any single year corresponds to what is commonly referred to as a "5 year flood" (just divide 1 by the % probability to get the recurrence interval in years). This simply means that on average, for the period of record, this magnitude of flood will occur about once every 5 years. This probability is purely statistical; the probability remains the same year to year over time for a particular size flood, but many years may go by without one, or it may occur several times in one year.

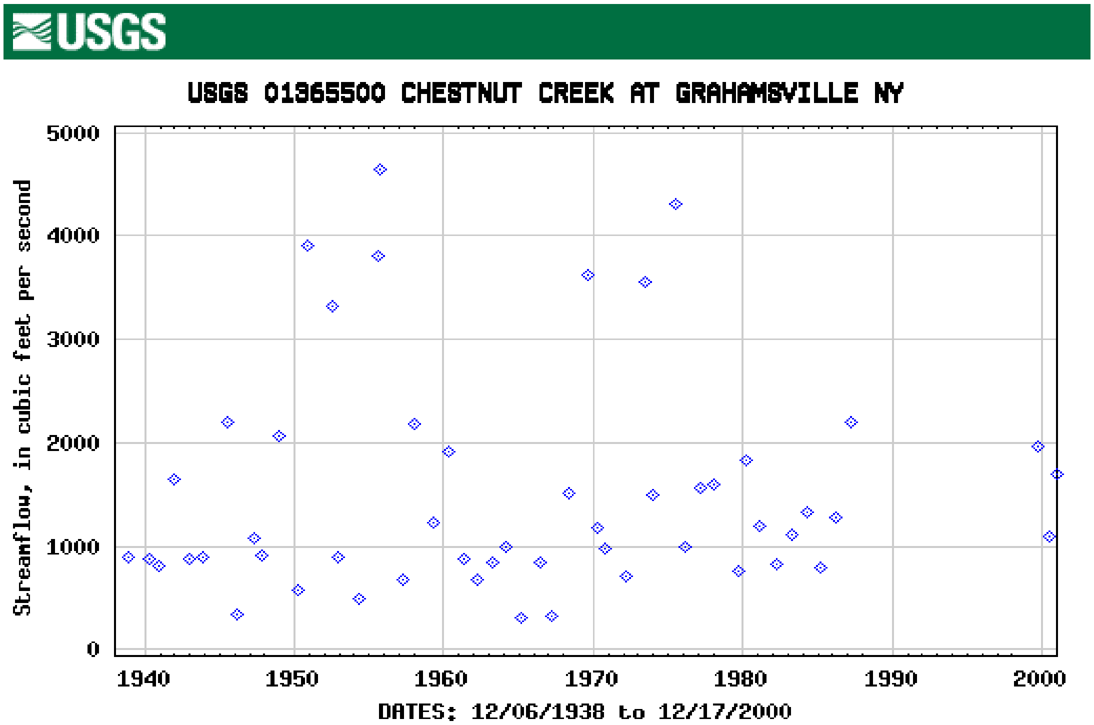


Figure 4. Annual maximum stream flow at USGS 01365500, Chestnut Creek at Grahamsville, for the period of record, 1939 - 2001. Source: www.usgs.gov

e. Conclusion

By studying the information recorded by the USGS gaging station on Chestnut Creek we can gain some insight into how the stream reacts to flood and drought events. Many agencies rely on evaluation of the likelihood of stream flooding in order to effectively manage the resource, plan developments or anticipate infrastructure or property damages and reconstruction needs.

3. Riparian Vegetation Issues in Stream Management

a. Natural Disturbance and its Effects on Riparian Vegetation
b. Human Disturbance and its Effects on Riparian Vegetation
   i. Roadway and Utility line influences on riparian vegetation
   ii. Residential development influence
c. Invasive Plants and Riparian Vegetation
d. Forest History and Composition in Chestnut Creek

Photo taken by Lori Kerrigan, SCSWCD.

3. Riparian Vegetation Issues in Stream Management

Streamside vegetation provides numerous benefits to water quality, to local landowners, and to aquatic and terrestrial plants and animals. Riparian buffers facilitate stream stability and function by providing rooted structure to protect against bank erosion and flood damage. Vegetated riparian zones act as a buffer against pollution and the adverse impacts of human activities. Streamside forests also reduce nutrient and sediment runoff, provide food and shelter, and moderate fluctuations in stream temperature. Finally, they improve the aesthetic quality of the stream community.

The extent of benefits depends on width of the riparian zone and its species diversity (Photo 1). For example, benefits addressed by a 25 foot buffer may be beneficial in a several ways including bank stability, while a buffer over 200 feet includes a whole range of water quality and ecological benefits. In addition, a buffer that contains a variety of species and types (trees, grasses, shrubs, herbs) offers the best protection. An area with diverse species would be more likely to continue to function properly than a simpler community if one species was eliminated (more discussion will follow with the issue of wooly adelgid and Eastern hemlock). Whereas, if only one or a few species covers a streambank and disease or pests attack it, the buffer would quickly disappear. In addition, different types of plants offer a variety of root depth and strength to stabilize stream banks in shallow to deep soils.

Photo 1. A healthy riparian community is densely vegetated, has a diverse age structure and is composed of plants that can resist disturbance. View upstream from XS-56.

Native plants in the riparian zone share a common characteristic; they have the ability to resist or recover from disturbance, namely from repeated inundation by floodwaters. The riparian forest community generally is more extensive where a floodplain exists and valley walls are more gently sloping. Where valley side slopes are steeper, the riparian community may occupy only a narrow corridor along the stream and then transition to an upland forest community. Soils, ground water and solar aspect may create conditions that allow the riparian forest species to occupy steeper slopes along the stream, as in the case where hemlock inhabits the steep, north facing slopes along the watercourse.

The following section introduces the basic threats to this important ecological area. This section also presents more detailed information about the past and present condition of Chestnut Creek's riparian vegetation.

a. Natural Disturbance and its Effects on Riparian Vegetation

Natural disturbances can greatly affect the vigor of streamside vegetation. These natural disturbances include floods, ice or debris floes, and to a lesser extent, high winds, pest and disease epidemics, drought and fire. Deer herds can also alter the composition and structure of vegetation due to their specific browse preferences.

The effect of flood disturbance on vegetation along stable stream reaches is short term and the recovery/disturbance regime can be cyclical. Following a large flood, the channel and floodplains can be scattered with woody debris and downed live trees (Photo 2). In following years, much of the vegetation recovers. Trees and shrubs flattened by the force of floodwaters re-establish their form. Gravel bars and sites disturbed in previous flood events become the seedbed for herbs and grasses. This type of natural regeneration is possible where the stream is stable and major flood events occur with sufficient interval to allow re-establishment. If floods and ice floes are too frequent, large trees do not have the opportunity to establish.

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

Sometimes, stream managers may seek to

Photo 2. View showing channel wide debris jam.

speed or augment the recovery process, but local geology and stream geomorphology may complicate this process. Hydraulics of flowing water, morphological evolution of the stream channel, geology of the stream bank, and the requirements and capabilities of vegetation must be considered before attempting restoration. Since geologic setting on these sites is partially responsible for the disturbance, the period required for natural recovery of the site would be expected to be significantly longer unless facilitated by restoration efforts.

Pests and diseases that attack vegetation also impact the riparian area. In the eastern United States, the wooly adelgid (*Adelges tsugae*) attacks eastern hemlock (*Tsuga canadensis*) and Carolina hemlock (*Tsuga carolinianna* Engelman) and can affect entire stands of hemlock, an important riparian species (Photo 3). The stress caused by the adelgid's feeding can kill a tree in as little as 4 years (McClure, 2001). Once a tree is infested, insect density fluctuates with hemlock regrowth. This regrowth is stunted and is later attacked as the adelgid population increases. With

Photo 3. Hemlock wooly adelgid appear as fuzzy white spots on underside of the branch.

each successive attack the reserves of the tree become depleted and eventually regrowth does not occur.

With respect to stream management, loss of hemlocks along the banks of Chestnut Creek poses a threat to bank stability and in-stream habitat. Wildlife find excellent cover from harsh weather within dense hemlock stands. Finally, dark green hemlock groves are quiet, peaceful places that are greatly valued by people who live in the valley. Without a major intervention (as yet unplanned), it is likely that the process of gradual infestation and the demise of local hemlock stands will result in re-colonization by black birch, red maple and oak (Orwig, 2001). This transition from a dark, cool, sheltered coniferous stand to open deciduous hardwood cover is likely to raise soil temperatures and reduce soil moisture for sites where hemlocks currently dominate the vegetative cover. Likewise, in streams, water temperatures are likely to increase and the presence of thermal refugia for cold water fish species such as trout are likely to diminish.

Many obstacles inhibit natural resource managers from controlling or even containing the wooly adelgid. Due to the widespread nature of the infestation it is unlikely that use of chemical pest control options such as dormant oil would provide little more than temporary localized control. Use of pesticides to control adelgid is not recommended in the riparian area due to the impact on water quality and aquatic life. 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 Morgantown office "forest health protection" webpage: http://www.fs.fed.us/na/morgantown/. Other alternatives for maintaining coniferous cover on hemlock sites include planting adelgid resistant conifers such as white pine as the hemlock dies out in the stand (Ward, 2001).

b. Human Disturbance and its Effects on Riparian Vegetation

The distinction between natural and human disturbances is important to understand. While the effects of floods, ice floes, pests and disease can cause some widespread damage to riparian vegetation; most often the effects are temporary. In time, vegetation regenerates and repopulates streambanks. On the contrary, human activities frequently significantly transform the environment and, as a result, can have a longer lasting impact on the capability of vegetation to survive and function (Photo 4). Human disturbances include construction and maintenance of

Photo 4. View of eroded left bank on DEP property. Material undercut and slumping.

roadway infrastructure, development of homes and parking lots, and introduction of non-native species in the riparian zone.

i. Roadway and Utility line influences on riparian vegetation

Use and maintenance of impervious surfaces, such as roads, impact the vigor of riparian vegetation. Narrow buffers that run between roads and streams receive runoff containing salt, gravel, and chemicals from the road that stunt vegetation growth or increase stress and mortality. Road maintenance activities also regularly disturb the soil along the shoulder and on road cut banks, welcoming undesirable invasive plants. The linear gap in the canopy created by roadway and utility lines separates riparian vegetation from upland plant communities. This opening also allows light into the vegetative under story which may preclude the establishment of shade loving plants such as black cherry and hemlock.

ii. Residential development influence

Residential land use and development of new homes may have the greatest 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 also love the stream and want to be close to it, may clear all the trees and shrubs along the stream to provide access and views of the stream, replacing natural conditions with an unnatural mowed lawn that provides no benefits to stream health or local wildlife. Following this clearing, the stream bank may begin to erode and the stream may become over-widened and shallow. This wide, shallow condition results in greater bedload deposition and increases stress on the unprotected bank. Eventually, stream alignment may change and begin to cause stream migration impinging on the property of downstream landowners. Catskill stream banks require a mix of vegetation having a range of rooting depths such as grasses and herbs which have a shallower rooting depth, shrubs with a medium root depth, and trees with deep, thick roots. Grasses alone are insufficient to maintain bank stability in most cases.

Many people live close to the stream and have access to the water without destabilizing the bank. By carefully selecting a route from the house to the water's edge and locating access at a point where the force of water on the bank in high flow is lower, a landowner can minimize disturbance to riparian vegetation and the stream bank. Restricting access to foot traffic, minimizing disturbance in the flood prone

area, and promoting a dense natural buffer provide property protection and a serene place that people and wildlife can enjoy. Additional information on concepts of streamside gardening and riparian buffers can be found at the following web site produced by the Connecticut River Joint Commission, Inc:
http://www.crjc.org/riparianbuffers.htm.
Riparian gardeners must know the appropriate species for streamside areas to identify species that are tolerant of frequent inundation and the force of high flows.

Photo 5. Broad heartshaped leaf pattern of Knotweed (Janet Novak, 2001).

c. Invasive Plants and Riparian Vegetation

Sometimes attempts to beautify a home with new and different plants will introduce a plant that spreads out of control and "invades" the native plant community. Invasive plants present a threat when they alter the ecology of the native plant community. This impact may extend to an alteration of the landscape should the invasive plant destabilize the geomorphology of the watershed (Malanson, 2002). A few invasives, Japanese knotweed (*Fallopia japonica*) and multiflora rose (*Rosa multiflora*) are currently gaining a foothold along Chestnut Creek. Though many invasives are also exotic (non-native), certain native plants may take over if introduced inappropriately.

As its common name implies, Japanese knotweed's origins are in Asia, and it was brought to this county as an ornamental garden plant (Photo 5). This plant grows and spreads rapidly on disturbed sites and prefers moist, open conditions common to developed or cleared stream edges and banks. After establishing itself on a site, Japanese knotweed shades out existing vegetation and forms large, dense stands. Stream managers suspect that knotweed roots do not provide the same high level of bank stabilization as do native tree, shrub and grass roots, especially if knotweed is the only species present. In addition, ecologists fear that this plant may also displace local wildlife dependent on native vegetation for shelter, food or cover. The canopy of dense stands of bamboo-like stalks, covered by large heart shaped leaves, blocks out almost all light from reaching the soil, thereby shading out other plants and leaving the soil between plants bare that would otherwise contain grasses or herb species in a natural vegetative community.

Most researchers believe that Japanese knotweed spreads primarily by vegetative means. Often, earthmoving contractors, highway department crews or gardeners transfer small portions of roots in fill or soil that get dumped on a stream bank or other construction project. These roots initiate growth of a new colony. Another means of spread occurs when high flows scouring the bank move roots downstream where they can establish new colonies on disturbed sites or sediment deposits.

NYC DEP and Greene County Soil and Water Conservation District (GCSWCD) are currently supporting Hudsonia to review the state of the science on Japanese knotweed and to conduct basic research to understand its growth habits, with the intent to develop management recommendations for its future control.

Another invasive, Multiflora rose (a thorny perennial shrub with compound leaves) was introduced to the area in the 1930's (Photo 6). This plant was promoted as a 'living fence' to farmers, because its arching stems can take root at the tip, forming dense thickets. The plant's persistent seeds provide an edible resource, and thick stems provide shelter to pheasant, quail, and songbirds. In recent years the rose has been planted along highways to serve as a crash barrier.

Although the white, spring-blooming Multiflora rose has some uses and attraction, landowners are quickly learning about its negative characteristics. Since it adapts to a wide range of soil, moisture, and light conditions, Multiflora rose spreads quickly and forms impenetrable thickets that thwart native species growth and attempts to control it. Multiflora rose is most commonly spread by seed through birds and other wildlife, thriving in fields, forest edges, stream banks, and roadsides. Disturbed areas are particularly vulnerable to invasion by multiflora rose, which impedes natural succession by preventing native species establishment.

Photo 6. Multiflora rose compound leaf (Samuel Roberts Noble Foundation, Inc. 2003).

Japanese knotweed and Multiflora rose are very difficult to control. Herbicides, while partially effective, are not a viable option in many locations due to the threat these 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 regrowth. The first step for residents and those who manage land and infrastructure is to familiarize themselves with the appearance and habits of invasive species such as these. Next, it is important for landowners and land managers to monitor its spread. Landowners should avoid practices that would destabilize stream banks or weaken natural riparian vegetation that can prevent invasives from spreading. Any fill material introduced to the riparian area should be tested for the presence of these species or obtained from a reliable source. Any Japanese knotweed or Multiflora rose roots pulled or dug up from your property should be disposed of in a manner that will prevent it from spreading or re-establishing itself such as burning or deep burial.

The following sections describe how various natural and human disturbances have influenced the state of riparian vegetation that we see today along the Chestnut Creek. Recognizing some historic influences is helpful in order to more fully understand present conditions.

d. Forest History and Composition in Chestnut Creek

Catskill mountain forests have evolved since the last ice age, reflecting changes in climate, competition and human land use. Upon icemelt, plants adapted to warmer temperatures began to migrate north, replacing those species with a cold weather preference. The forests of Chestnut Creek gradually re-established and evolved from boreal spruce/fir dominated forests, (examples of which can presently be found in Canada) to maple-beech-birch northern hardwood forests (typical of the Adirondacks and northern New England) with the final transition of lower elevations of the watershed to a southern hardwood forest dominated by oaks, hickory and ash (typical of the northern Appalachians).

One of the earliest recorded natural disturbances was the March 20th blowdown in 1797. Regional high winds felled trees from Delaware county, to the Towns of Rockland and Neversink (Kudish, 2000). There have been several serious floods in the Chestnut Creek area in the past. One of the most massive occurred in 1928 and is still remembered by residents of the Town of Neversink (Volume I, Section IV.A. Community History and Current Condtions). While not as ferocious as the Great Flood of 1928, the flood of 1975 damaged roads, homes and seriously eroded many stream banks.

More recently, human activities have affected forests either through manipulation of regeneration for maintenance of desirable species, exploitation of the forest for wood and wood products or through clearing for development. Native American land management practices included the use of prescribed burning as a means of enabling nut bearing oaks and hickories to remain dominant in the forest. In response to the rising industrial economy, European settlers altered the landscape and forest cover through land clearing for agriculture, forest harvesting for construction materials, and hemlock bark harvesting for the extraction of tannin. These activities may have allowed the migration of some southern hardwood species (e.g. sycamore, shagbark hickory, gray dogwood) travelling up the Hudson Valley. Land cover in Chestnut Creek began to revert back to forest with the local collapse of these economies in the 20th century (Kudish, 2000) (Volume I, Section IV.A. Community History and Current Conditons).

Although a specific assessment of the condition of vegetation along Chestnut Creek was not conducted, stream managers made important observations during the stream assessment survey of the mainstem of Chestnut Creek and Red Brook and Pepacton Hollow tributaries. A series of historic aerial photographs from 1963-2001 supplement field observations. See Volume II, Section I. Chestnut Creek Stream Management Unit Descriptions for specific trend observations.

The Chestnut Creek riparian area can be characterized as a mix of small wooded buffers with mature trees, shrubs, and herbaceous plants, mowed lawns with scattered trees and shrubs, and reaches along steep hillslopes and terraces with

Photo 7. View looking downstream from below XS-124. Mowed lawn is shown on the left, densely vegetated riparian buffer is shown on the right.

mature forest (Photo 7). In riparian areas where wooded buffers are present, the width varies from 25 feet to 350 feet. On average, these areas are less than 100 feet wide. Japanese knotweed and Multiflora rose occupy a small portion of the Creek's streambanks, though they have potential for continued spread. Wooly adelgid is infesting hemlocks in the upper reaches of Chestnut Creek.

Where riparian functions are not limited by human activities, vegetation along Chestnut Creek generally appears to support conditions for a stable stream. This does not mean that there is no room for improvement. Many reaches have adjacent parking lots, equipment storage areas, and roads with little or no space for buffers. Along developed properties riparian vegetation has been affected by clearing, routine yard maintenance, and other land use activities. Although floodplain vegetation was deemed as adequate for providing general stability watershed wide, areas with a relatively low rooting depth to bank height provide minimal vegetative stability.

Various beneficial or potentially harmful riparian characteristics within each individual management unit were documented during the 2001 Stream Assessment Survey (Tables 1 & 2). For a more detailed description of riparian condition in a particular unit, please refer to its specific section (Volume II, Section I. Chestnut Creek Management Unit Descriptions and Volume II, Section II. A. Watershed Recommendations for Best Management Practices).

Table 1. Summary of beneficial riparian characteristics by Management Unit. (2001 Stream Assessment Survey, SCSWCD personnel)

MU#	Floodplain Vegetation/Forests	Small Wooded Buffers	Steep Hillslopes with Mature Forests
MU1		x	x
MU2	x		
MU3			x
MU4			x
MU5		x	x
MU6		x	
MU7	x		
MU8		x	
MU9		x	

Table 2. Summary of potentially harmful riparian characteristics by Management Unit. (2001 Stream Assessment Survey, SCSWCD personnel)

MU#	Mowed Lawns, Scattered Trees	Adjacent Roads & / or Parking Lots	Wooly Adelgid	Japanese Knotweed	Multiflora Rose
MU1	x		x		
MU2	x				x
MU3					
MU4	x	x		x	
MU5	x	x		x	
MU6	x	x			x
MU7	x				
MU8		x			
MU9		x			

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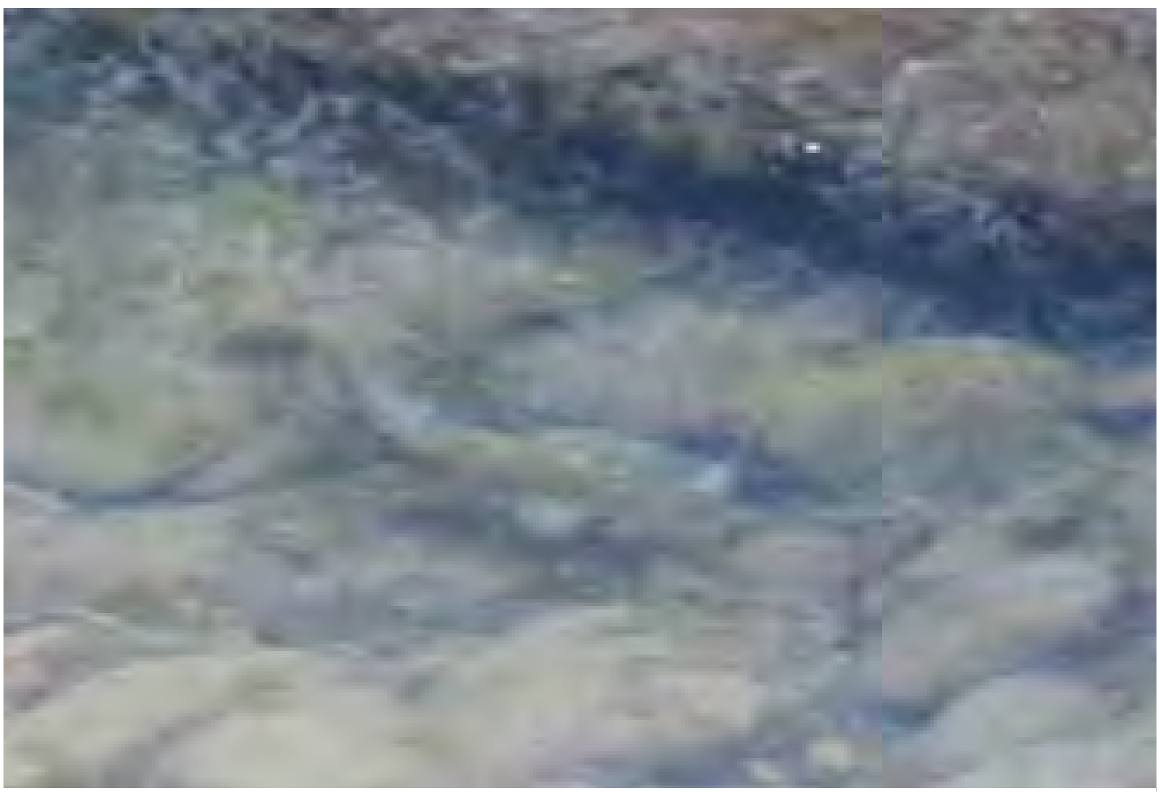
4. Water Quality and Ecological Health

a. Chestnut Creek Fisheries Management
b. Chestnut Creek Surface Water Monitoring
c. Chestnut Creek Biomonitoring Results



Brown trout sighted in Chestnut Creek. Photo taken by Derrick Kelly, WAC.

4. Water Quality and Ecological Health

a. Chestnut Creek Fisheries Management

Setting

Chestnut Creek (H-139-14-48) is a tributary to the Rondout Creek (entering Rondout Reservoir), with its source located in the Sullivan County hamlet of Neversink. There are 11 identified perennial (flow year round) or intermittent (flow only following storms or snowmelt) tributaries to the mainstem Chestnut Creek.

All waters of the State have a classification and standard designation based on existing or expected best usage of each water or waterway segment. The classification AA or A is assigned to waters used as a source of drinking water. Classification B indicates a best usage for swimming and other contact recreation. Classification C is for waters supporting fisheries and suitable for non-contact activities. Waters with classifications, A, B, and C may also have a standard of (T), indicating that it is able to support a trout population, or (TS) indicating that it supports trout spawning. Special requirements apply to sustain these waters that support these valuable and sensitive fisheries resources. Chestnut Creek has a legal classification/standard of A(T) from mouth to source, as listed in New York State Conservation Rules and Regulations (6 NYCRR Part 862, item 470).

Fisheries

Fish species historically collected from Chestnut Creek include:

Brook trout (*Salvelinus fontinalis*) (wild)
Brown trout (*Salmo trutta*) (both wild and hatchery origin)
Slimy sculpin (*Cottus cognatus*)
Longnose dace (*Rhinichthys cataractae*)
Blacknose dace (*Rhinichthys atratulus*)
White sucker (*Catostomus commersoni*)
Common shiner (*Notropis cornutus*)
Chain pickerel (*Esox niger*)

Chestnut Creek is currently managed as a stocking-supplemented brown trout stream for a length of 1.9 miles, from just downstream of Grahamsville upstream to Clark Road off State Route 55 (Photo 1). The Department of Conservation (DEC), Region 3, has assigned a stocking scheme to Chestnut Creek based on fish survey results and knowledge of fishing pressure. There are two basic management types;
"A" (higher quality) with consistently good year-round trout habitat, good trout growth rates, OR high wild trout biomass.
"B" (lower quality) with one or more of: evidence of low fertility, habitat deficiency, high non-trout population

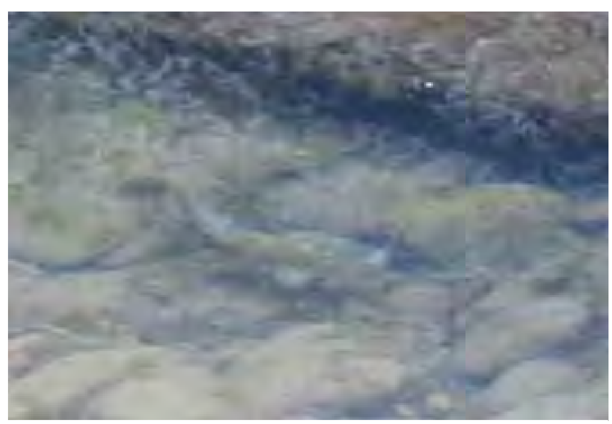


Photo 1. Brown trout sighted in Chestnut Creek upstream from Grahamsville.

density, unstable flows or high summer water temperatures, or poor or irregular growth and survival. Chestnut Creek is managed as a class B(s) trout fishery, indicating a lower grade trout stream (in the stocked section), managed by supplemental stocking ("s") of trout. The management target of supplemental stocked trout streams in New York State is an average trout catch rate of 0.5 fish/hr.

A lower grade trout stream is defined as one with evidence of low fertility, and/or habitat deficiency, and/or high non-trout density, and/or unstable flows or high summer temperatures which all result in poor or irregular growth and survival. Additionally, wild trout biomass will be less than 41 lbs./acre. The wild trout biomass in the stocked section of the Chestnut Creek was estimated to be 27.9 lbs./acre in 1990, the year of the last Department fisheries survey.

The current stocking policy calls for a first increment of 600 brown trout yearlings to be stocked in mid-April, followed by a second increment of 150 brown trout spring yearlings to be stocked in May. That policy has been modified to include a stocking of 72 larger two-year-old brown trout in mid-April, since these fish are a relatively recent management option from the State hatchery system.

Wild brown trout of five different year classes (0, 1, 2, 3, and 5) were collected in 1990, as well as brook trout of two different year classes (1 and 2). Although specific spawning habitats have not been documented by the Department of Environmental Conservation (DEC) in this system, it is likely that brook and brown trout spawn both in the Chestnut Creek proper as well as in the perennial tributaries.

Future Management Recommendations

Future management activities by the DEC may include:

1. An updated assessment of fishing pressure (important component in stocking policy calculation)

2. Routine fisheries surveys

3. Habitat protection as authorized under Environmental Conservation Law Article 15 (protection of bed and banks of protected waters)

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b. Chestnut Creek Surface Water Monitoring

Water quality in Chestnut Creek has been monitored and tested for many years as part of the NYCDEP Stream Monitoring Program. Parameters of interest to surface water quality for drinking water supplies include conductivity, chloride, turbidity, fecal coliform, dissolved oxygen and phosphorous. Prior to 2002, DEP collected samples twice a month year round, above and below the outfall of the Grahamsville Wastewater Treatment Plant (WWTP) (these sites are labeled "Chestnut Above" and "Chestnut Below", respectively, on the graphs below, see Figure 1). Following an evaluation of the sampling program, the frequency was changed to once a month for "Chestnut Above" and twice a month for "Chestnut Below." For comparative purposes, data are also presented from other streams in the Rondout Reservoir watershed that are monitored by DEP. These include:

- Red Brook, which largely follows Route 42 and flows into Chestnut Creek just upstream from the Grahamsville WWTP sampling sites (Red Brook monitoring ceased on 1/1/02 due to programmatic changes at DEP);

- Rondout Creek, a major tributary flowing directly into Rondout Reservoir;

- Sugarloaf Brook, which flows into Rondout Creek just upstream from the reservoir; and

- Sawkill Brook (also known as Trout Creek), which flows directly into the reservoir.

New York State Routes 55 and 42 run through the Chestnut and Red Brook watersheds, respectively. These roads generally run close to the streams, and the narrow valleys in the Chestnut Creek and Red Brook watersheds have relatively high density of housing and other development compared to Rondout Creek, Sugarloaf and Sawkill Brooks. In contrast, these latter three streams have heavily forested, largely undeveloped watersheds.

This report shows annual medians for selected water quality variables, plotted against time for monitored streams in the Rondout Reservoir watershed. The median is a statistic that expresses the "typical" condition of something. In this sense it is similar to the "average." However, the average may be strongly skewed by extreme values (such as might occur briefly during a flood) and so is considered a poor statistic to use for water quality data. The median is simply the value in the center of a data set, that is, half of the sample values are higher, and half lower. One drawback of the median is that it does not show data from extreme events (mainly floods in this case); maximum values are thus stated in the text as appropriate. The median is useful as a "broad brush" characterization of water quality, and is useful for comparing different streams. An alternative to using either the median or the average would be to show all the data points, but this can be very "noisy" and difficult to interpret, especially for long-term datasets such as this. The time period chosen, 1987-2002, was the period for which DEP has final data available in computer files ("final" means the data have been carefully checked and have passed quality control measures).

Conductivity describes the ability of water to conduct electricity, and is dependent on levels of dissolved minerals and other chemicals. It may be a fairly good indicator of human impacts on water quality. "Pristine" sites with little human impact normally have low conductivity (though local geology can add minerals to the water), while more developed sites have higher conductivity. There are no legal standards or scientific guidance values for conductivity. Conductivity is simple and inexpensive to measure, and so is often used to compare different sites, and an unusually high conductivity value at a site might indicate some form of contamination. Likely causes of elevated conductivity in this area are road salt runoff, leaching of pesticides and fertilizers from lawns and gardens, and septic system leachate.

The more developed watersheds of Chestnut Creek and Red Brook show high conductivity compared to the heavily forested basins of Rondout, Sawkill, and Sugarloaf (Figure 1). However, even the relatively high conductivity values for Chestnut and Red Brook are low compared to streams in heavily developed basins, which may have conductivity values in the hundreds or thousands of micromhos/cm. The Grahamsville WWTP has little impact on conductivity. Road salt runoff may be one of the primary causes of the elevated conductivity, as suggested by chloride concentrations shown in Figure 2 (chloride is a chemical in road salt that imparts

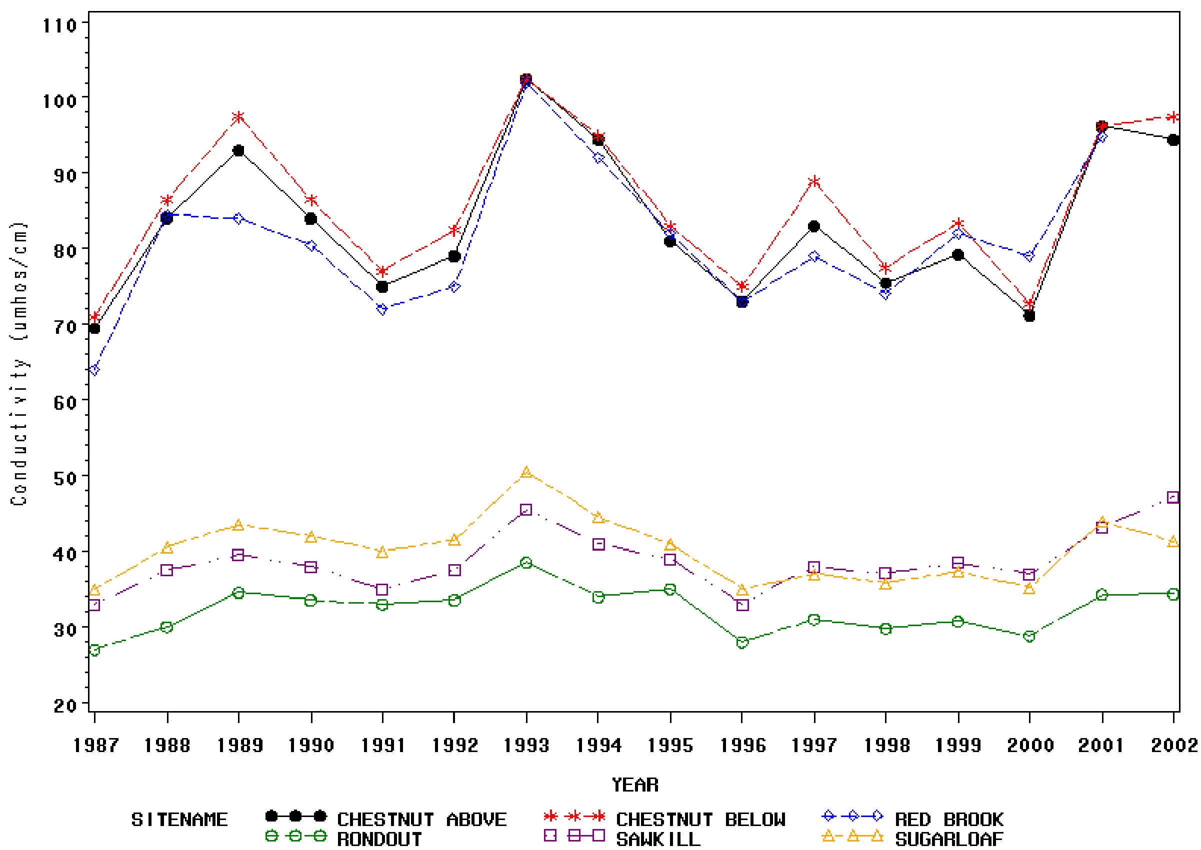


Figure 1. Median conductivity in Chestnut and surrounding streams.

conductivity to water). The Grahamsville WWTP has little impact on chloride concentrations. As with conductivity, even the relatively high chloride concentrations in Chestnut and Red Brook are not an issue. For these streams, the maximum chloride concentration allowed under NYS DEC Environmental Conservation Rules and Regulations is 250 mg/L (milligrams per liter). Median values for all sampled streams in the Rondout Reservoir basin are consistently less than 10% of the limit (Figure 2), and the maximum concentration measured during this time period was 38 mg/L (data not shown).

Turbidity measures how "cloudy" water appears. It is defined by EPA as "a principal physical characteristic of water and is an expression of the optical property that causes light to be scattered and absorbed by particles and molecules rather than transmitted in straight lines through a water sample." Turbidity can be caused by sediment (such as silt, clay, and sand), algae, or other materials suspended in the water. Turbidity does not necessarily relate to how much sediment is in the water; some sites might have a strong correlation between sediment and turbidity, while others would have a very weak correlation. Turbidity is measured in nephelometric units, or NTU. Values can range from less than 1 NTU to over 1000 NTU. Pristine sites commonly have values in the low single digits. There is no numerical standard for stream turbidity generated by human activities under State law, but there must be "No increase that

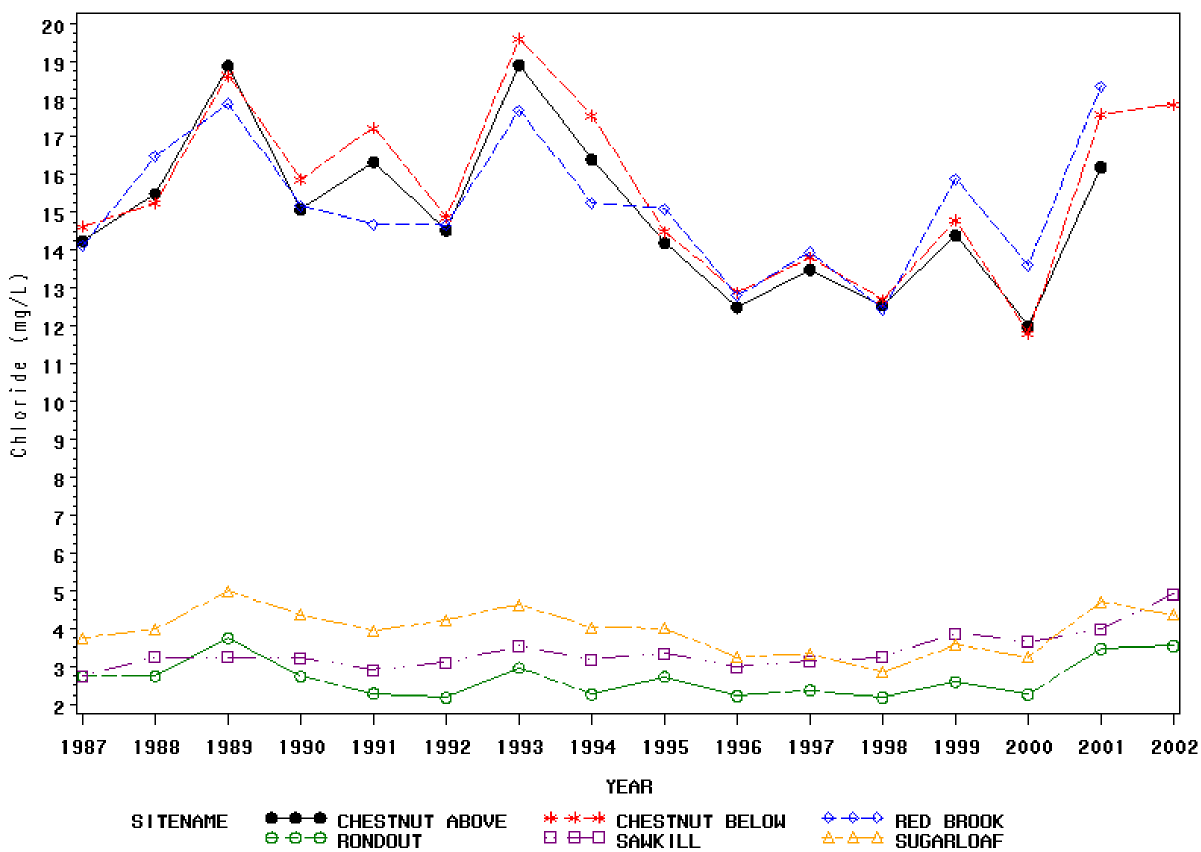


Figure 2. Median chloride concentration in Chestnut and surrounding streams.

will cause a substantial visible contrast to natural conditions" between upstream and downstream locations from a project site (this is called a "narrative standard").

Median turbidity values in Chestnut Creek are similar to other streams in the Rondout Reservoir watershed (Figure 3). The medians are all below 2 NTU, which generally is considered good water quality. The maximum value measured in Chestnut Creek during this time period was 134, though higher values have probably occurred but were not measured.

Fecal coliform bacteria, which can be from animal or human sources, are measured to determine if there is contamination of the water by fecal material, and if the degree of contamination is sufficient to cause concern and warrant further investigation. The New York State regulatory limit states: "The monthly geometric mean, from a minimum of five examinations, shall not exceed 200 CFU/100 mL" (colony forming units per100 milliliters of water; these are the units used to count coliform bacteria in water samples).

Based on DEP's twice-monthly sampling, Chestnut Creek coliform values are typically well under 100 CFU/100 mL (Figure 4). (Note: DEP also monitors the effluent from the WWTP as part of its WWTP monitoring program, but those data were not considered for this report.) There

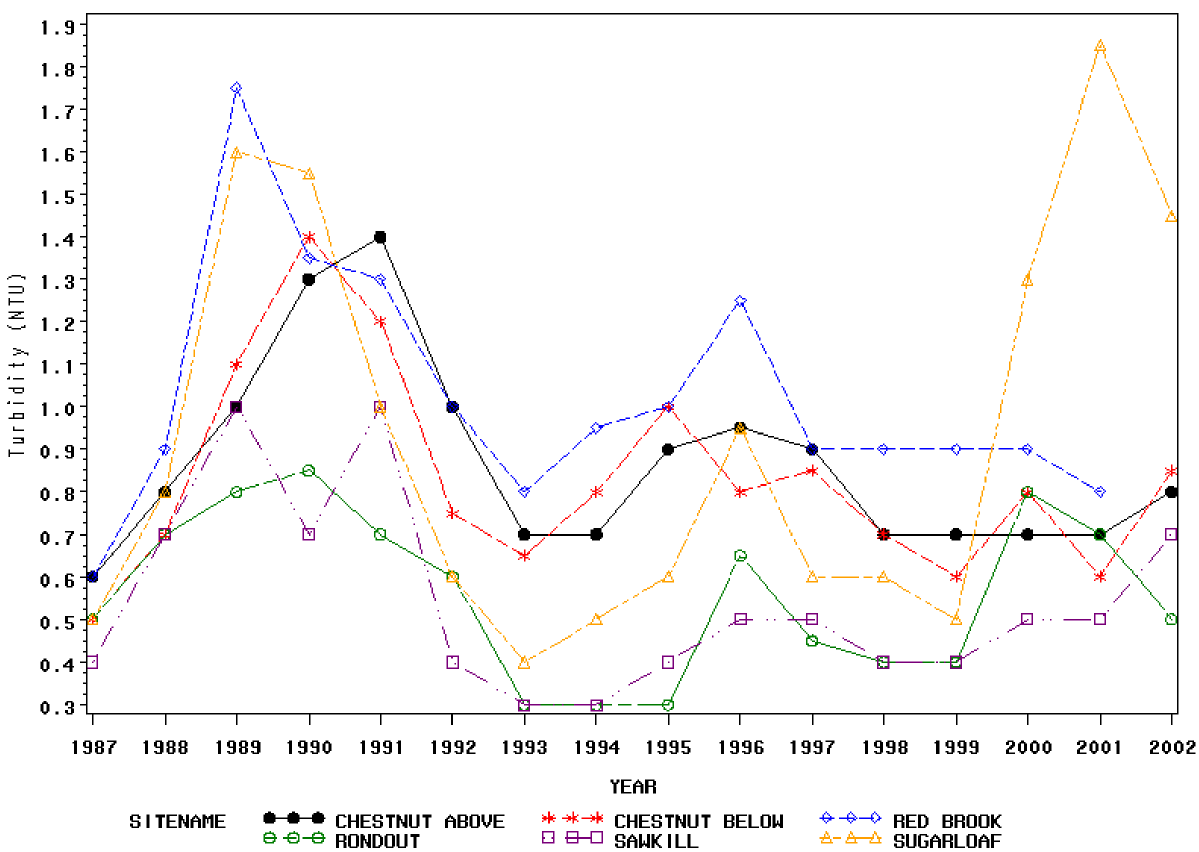


Figure 3. Median turbidity in Chestnut and surrounding streams.

is little impact of the WWTP on the stream, with median values above and below differing by no more than about 15 CFU. Chestnut Creek and, to a lesser extent Red Brook, do have somewhat elevated fecal coliform concentrations compared to the other monitored streams, but as previously noted, the median values are below the 200 CFU limit. Individual values in the 600 to 1000 CFU range have been measured at all monitored sites in the Rondout Reservoir watershed, including the relatively pristine sites on Rondout Creek, the Sawkill, and Sugarloaf Brook. These high values usually occur during high-flow events and normally don't last very long; DEP has done follow-up sampling a day after a high value was recorded and found the levels have fallen significantly, often close to the median values.

Fish and other aquatic life need oxygen to live just like terrestrial animals. Oxygen gas dissolves in water, and its concentration can be measured. According to NYS regulations: For cold waters suitable for trout spawning, the dissolved oxygen (DO) concentration shall not be less than 7.0 mg/L from other than natural conditions. The annual medians for Chestnut Creek and surrounding streams are well above the minimum allowed (Figure 5), and review of the data shows minimum individual measurements of 7.5 mg/L or higher at all sites. Dissolved oxygen concentrations are similar among all sampled streams (Figure 5), though the more heavily developed Chestnut Creek and Red Brook show lower DO content.

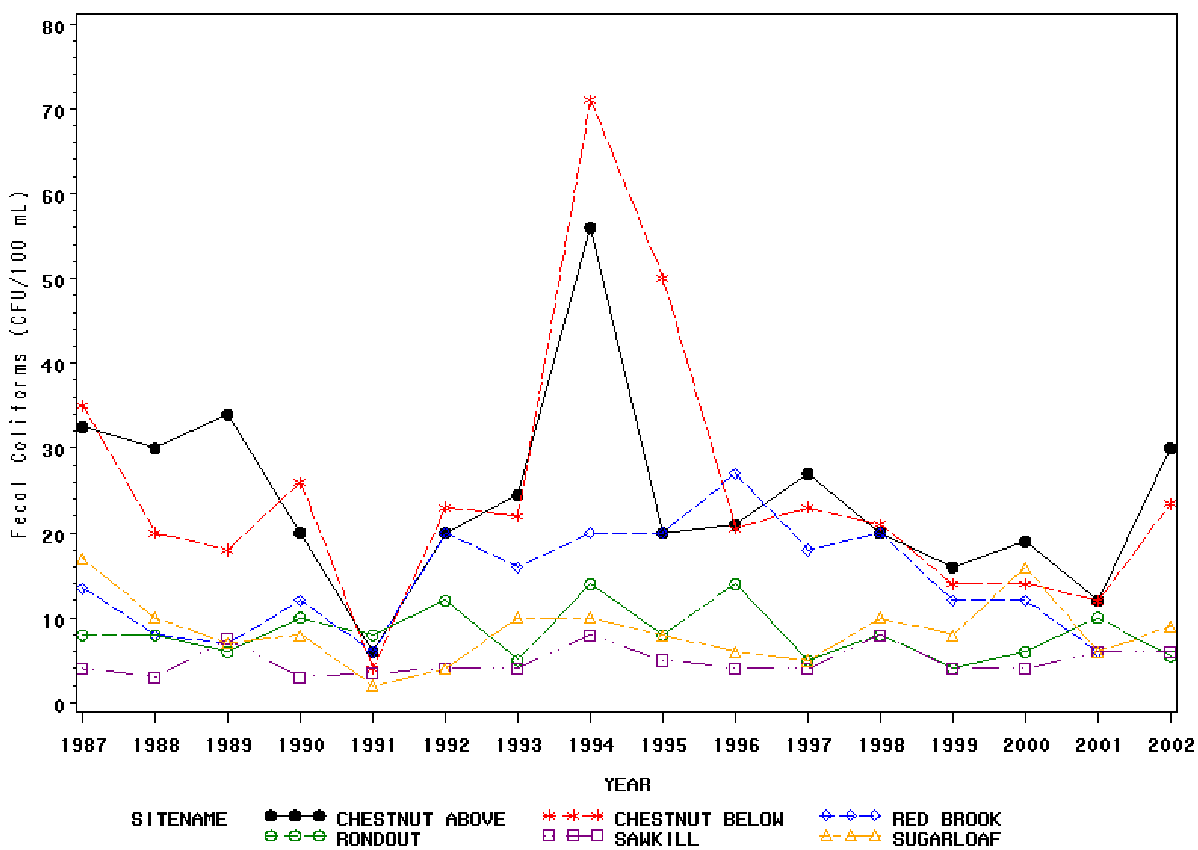


Figure 4. Median fecal coliform concentrations in Chestnut and surrounding streams.

Phosphorus is a nutrient that can promote growth of algae in water bodies. Common sources include runoff of fertilizer (including manure applied to fields), wastewater treatment plants, and failing septic systems. Some phosphorus also occurs naturally. There is no legal standard for phosphorus. There is a scientific guidance value of 50 micrograms/L (a microgram is one millionth of a gram) for streams, representing the phosphorus concentration below which there should not be problems with algal growth. Median total phosphorus concentrations in Chestnut Creek are well below the guidance value (Figure 6). Phosphorous concentrations are generally higher below the Grahamsville WWTP than above it, but the median concentrations below the plant are less than half the guidance value. Furthermore, in the last few years the differences in Total Phosphorus (TP) concentration above and below the plant have become almost negligible, due largely to the construction of a new WWTP in 1999, which utilizes phosphorus removal technology.

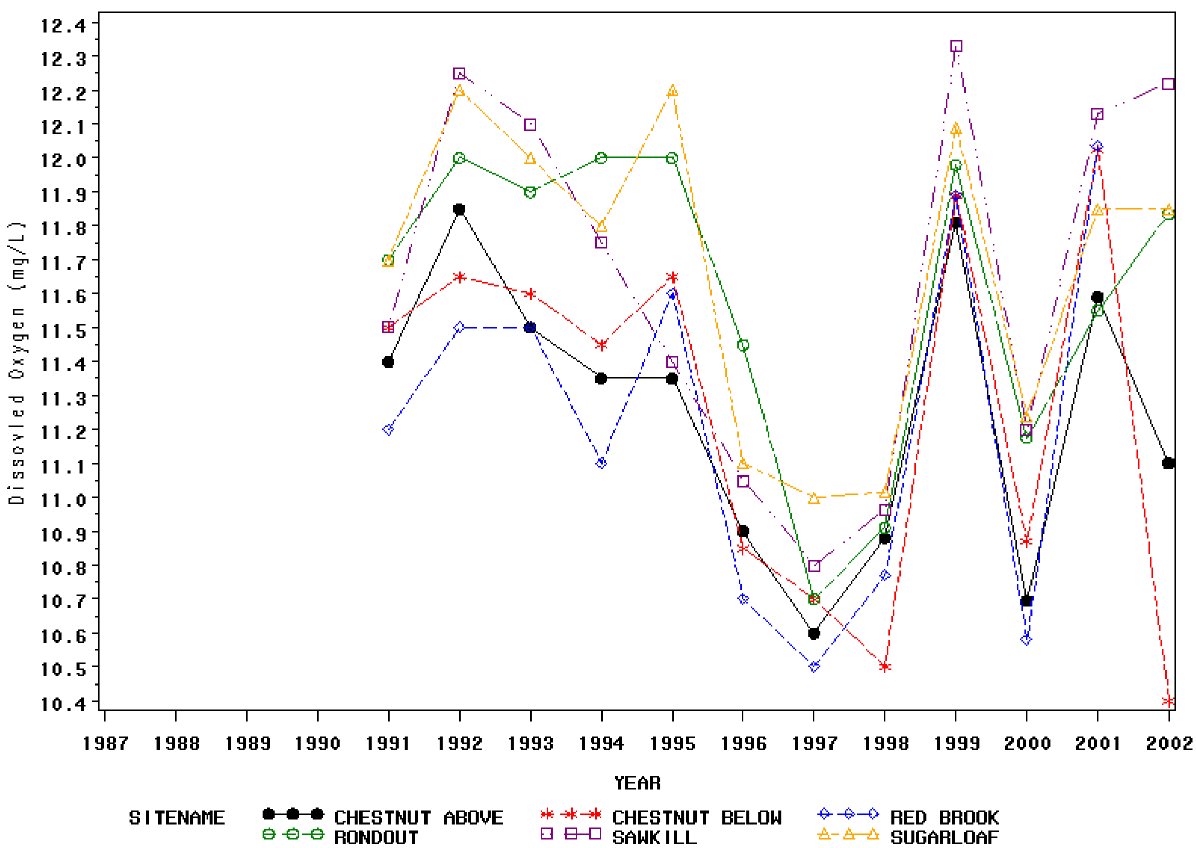


Figure 5. Median dissolved oxygen concentration in Chestnut and surrounding streams.

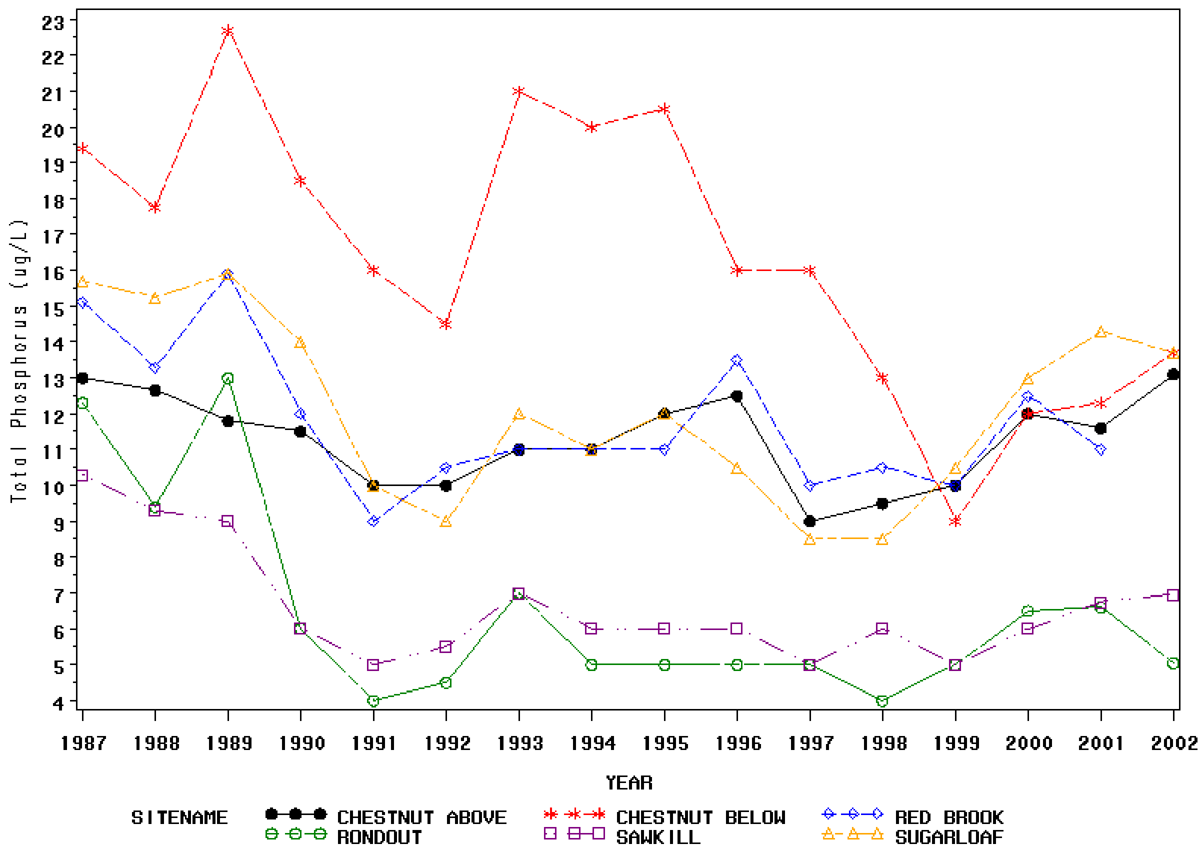


Figure 6. Median phosphorus concentration in Chestnut and surrounding streams.

c. Chestnut Creek Biomonitoring

One of the ways NYCDEP monitors water quality in streams is by sampling and identification of stream benthic macroinvertebrates (animals without backbones visible to the naked eye) in accordance with NYSDEC stream biomonitoring protocols. These protocols, derived from USEPA Rapid Bioassessment methods, require qualitative sampling of invertebrates from riffle habitats in streams. Randomly generated subsamples of 100 organisms are taken from raw samples often consisting of several hundred organisms. These organisms, primarily insect larvae, are sent to a contractor for identification to the genus or species level. When the 100 organisms in the subsample are identified and counted, four metrics are calculated:

- species richness, or the total number of different taxa (species classification groups) in the subsample,
- EPT richness, or the total number of different taxa from the mayfly (***E****phemeroptera*), stonefly (***P****lecoptera*), and caddisfly (***T****richoptera*) orders,
- biotic index, an average score reflecting the overall pollution tolerance of the sub sampled benthic community, and
- percent model affinity, or the similarity of the subsample to an "ideal" stream benthic macroinvertebrate community in New York State.

The four metric scores are averaged resulting in a final water quality score which falls into one of four narrative categories: severely impacted (0-2.5), moderately impacted (2.5-5), slightly impacted (5-7.5), and non-impacted (7.5-10). While this program samples and identifies aquatic biota rather than the water itself, a long history of this work in the U.S. and around the world leads scientists to accept that the community present is a reflection of water quality.

DEP's primary sampling site on Chestnut Creek is 315, located just below the outfall of the Grahamsville WWTP (Figure 1).

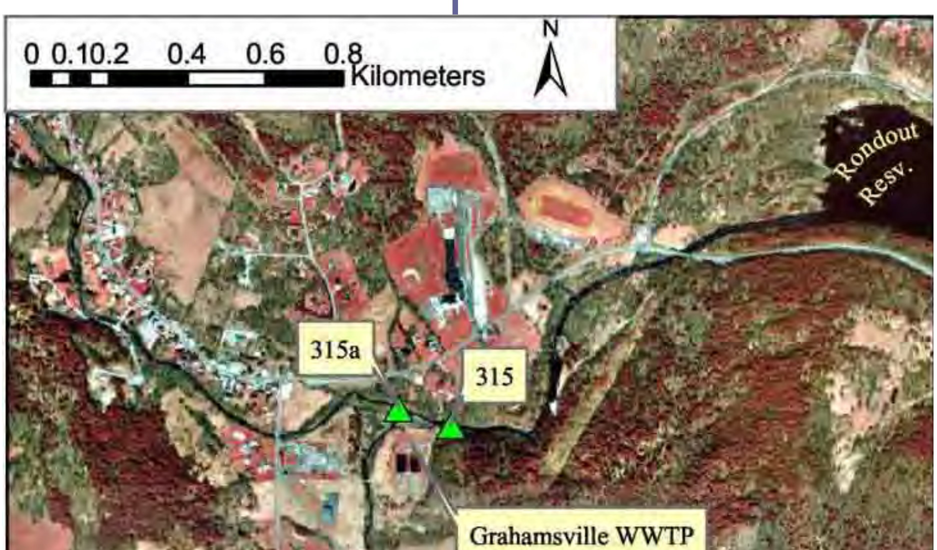


Figure 1. Aerial photograph of the vicinity of Grahamsville, N.Y. showing the locations of DEP stream biomonitoring sites on Chestnut Creek in relation to the Grahamsville Wastewater Treatment Plant. (streamflow from left to right)

This site was sampled in 1996, 1999, and 2000. In 2000, a site above the WWTP, 315a, was sampled in order to assess whether or not the macroinvertebrate community in the stream was being altered as a result of the discharge from the plant. The upgrade to microfiltration at the Grahamsville WWTP was functionally complete in March of 1997. Increases in water quality scores at site 315 after the 1996 sample could be attributable in part to this upgrade, but insufficient data are available to reliably support this assertion. Samples collected in 2001 have not yet been fully processed.

Chestnut Creek appears to exhibit excellent water quality with a healthy assemblage of aquatic invertebrates according to this sampling regime. Four converted metric scores and final water quality scores are reported for all fully processed samples (Table 1). All final water quality scores from samples collected on Chestnut Creek after 1996 are well into the range of non-impacted, although a few of the species richness scores fell below the 7.5 slightly/non-impacted threshold. While final scores at the upstream site appear a bit lower than at the downstream site, since the latest available final scores indicate no impact to water quality, the difference between the two sites is not considered environmentally significant. A review of water quality data collected by DEP's Hydrology group at the same sites in 1999 and 2000 did not find statistically significant differences in pH, dissolved oxygen, temperature, or specific conductance.

Table 1. Converted metric and final water quality scores from samples collected on Chestnut Creek, Sullivan County, N.Y.

Site	Sample Date	Species Richness	EPT Richness	Biotic Index	Percent Model Affinity	Final Water Quality Score
315	9/9/96	5.88	7.27	7.13	8.90	7.29
315	9/10/99	8.33	8.00	7.56	9.47	8.39
315 (sample replicate)	9/10/99	10.00	8.50	7.84	8.54	8.72
315	9/14/00	7.35	9.50	7.98	9.36	8.55
315 (sample replicate)	9/14/00	8.89	10.00	7.58	9.42	8.97
315a	9/14/00	6.47	8.00	7.86	9.23	7.89
315a (sample replicate)	9/14/00	6.47	8.50	7.93	8.25	7.89

5. Public Infrastructure Concerns and Interests

a. Concerns by Management Unit
b. General Concerns

6. Landowner Concerns and Interests

Mohr Bridge. Photo taken by Lori Kerrigan, SCSWCD.

5. Public Infrastructure Concerns and Interests

Sullivan County Soil and Water Conservation District (SCSWCD) staff interviewed Dean Smith of the State Highway Department, Charles Burgio of the Sullivan County Bridge Unit, and Gary VanValkenburg of the Town of Neversink Highway Department in order to document their interests and concerns about public infrastructure along Chestnut Creek. Where possible, information collected was divided among the management units to which it pertained. General concerns are listed at the end of the document. Also see Table 1 for more bridge information.

a. Concerns by Management Unit

MU1

No specific information provided.

MU2

No specific information provided.

MU3

No specific information provided.

MU4

Kelly Road Bridge – This bridge has a good span, able to handle high flows. Pilings were drilled into bedrock during construction. The bridge is currently in good condition.

Scott Brook Culvert – This culvert is a six-foot diameter reinforced pipe. It has experienced erosion of the embankment behind its wingwalls. The gravel bar upstream of the pipe should be removed. The above should be strictly maintenance work.

MU5

A few of landowners in MU5 have complained to Dean Smith about erosion and flooding problems on their property. However, the State Highway Department has not viewed most of these problems as serious enough to address with public funds to date.

Riprap in Chestnut Creek across from Maschio's failed in 1975 and was replaced immediately because Route 55 was washed out. Another riprapped area upstream of the Covered Bridge is experiencing undercutting action and shifting of the stream. The stream bank on the highway side is falling into the Creek and a gravel bar is forming.

Mohr's Bridge - This bridge is located across from Maschio's Restaurant concerns the Highway Department because the abutment closest to the road is being undercut. If Mohr's Bridge collapses it may cause damage to Route 55 and will be addressed as deemed necessary.

Covered Bridge - This bridge is owned by the Agricultural Society. The Town uses the bridge for access to town property which the town leases for 3 months out of the year. The County paid for the Town's labor to repair the bridge in Summer 2003.

Storm water runoff from the Fairgrounds is being funneled beneath the upstream wingwall of the Covered Bridge on the Fairgrounds side, which undercuts the wingwall and causes damage. During the interview, Gary VanValkenburg inquired of SCSWCD staff whether removing the gravel bar along the Fairgrounds would be helpful, and suggested cutting the trees that are about to fall into the stream to prevent log jams.

Hilltop Road Bridge – This bridge is built out of timber. Depending on whether it becomes infested with ants/termites, it may need to be replaced in the near future. The facing and gabions were installed in 1991. Charles Burgio stated that the opening of this bridge is narrower than those upstream and downstream. The narrow opening could cause a restriction in high flow conditions. The bridge is currently in good structural condition.

Clark Road Bridge – This bridge has a timber deck and rail. It has been posted by the state for annual inspection due to its 22 ton weight limit. Posting generally refers to the weight limit, and posted bridges generally require annual inspections (others usually get biennial inspection). Bridges not posted are assumed to be able to carry all legal limits. The bridge was originally built in 1965 and rebuilt in 1995 and is currently in excellent condition.

MU6

Storm water drainage was a concern for Dean Smith. In the fall of 2003 the State Highway Department extended and improved the drainage system near the Methodist Church. Problems with ice build up, which prevents drainage, have often been encountered in MU6. Storm water runoff drains naturally into the stream through town until you reach the firehouse. From the firehouse to the light at the 42/55 intersection, the runoff collects on the street. Drainage must be improved here as well.

Culvert outfalls have been difficult to locate and replace. A culvert in MU6 was recently plugged and to find the outfall, the State Highway Department brought in a truck full of water, dumped it into the basin and used food coloring to find the culvert's outfall. An in ground pool and trees made replacement impossible. After the outflow was unplugged by hand digging, it still worked efficiently, so the Highway Department continues to rely on what exists.

River Road Bridge – Originally built in 1933, this bridge was replaced in 1940, widened in 1954, and completely rebuilt in 1996. There have been no problems with this bridge since 1996.

Davis Lane Bridge – The state inspects this bridge every year because it has been posted due to its weight limit. There is a meander upstream of this bridge and the stream has shifted. The state assigns alignment ratings to bridges ranging from 1 to 7, 7 being the best. The state alignment rating of this bridge with the stream is 3 out of 7. Otherwise, everything (riprap, etc.) is in good condition.

MU7

The State Highway Department has recently increased drainage at the 42/55 intersection due to ice build up problems. A steep eroding slope exists on DEP property past the blinking light in Grahamsville. During construction fill material was dumped on these slopes and the State Highway Department believes that this is the material that slid into the stream and the slope is now stabilizing.

MU8-Pepacton Hollow

Gary VanValkenburg observes that Pepacton Hollow, along with Denman

Mountain and Gillette Road, all suffer from repeated erosion towards the town road and have had riprap wash out. The Town of Neversink Highway Department plans to replace Pepacton Hollow culvert in 2004 because the culvert is undersized and becomes plugged repeatedly.

MU9-Red Brook

There is a lot of water coming off the mountain near Ackerly Road, which contributes to Red Brook. Since the drainage network is insufficient, this runoff causes erosion near the town road.

Big Hollow Road provides easy access to Chestnut Creek by proximity to the stream bank and has been utilized for illegal dumping. This is a problem that is continually cleaned up by the Town.

South Hill Road Bridge – Charles Burgio, of the Sullivan County Bridge Unit, has written a 5 year plan, which includes all 400 bridges that the County is responsible for. The only bridge noted for replacement in this plan that is situated in the Chestnut Creek watershed is South Hill Road Bridge, which crosses Red Brook, a tributary to Chestnut Creek. Either the bridge will be replaced or it will receive new beams and a rail.

Table 1. Chestnut Creek Road Crossings. Width vs. Channel Bankfull Width Up and Downstream.

Chestnut Creek Road Crossings	Conveyance bridge/ culvert	Span width/ diameter	Upstream X.S.	BFW	Downstream X.S.	BFW
Benton Hollow Road	culvert	7.3' d.	XS 29	13'	XS 32-33	14'--19'
Slater Road	culvert	15' d.	XS 75-76	23'--24'	XS 77-78	27'--20'
Scheirer driveway	bridge	38.5'	XS 79	32'	XS 80-81	29'--26'
Kelly Road	bridge	23.3'	XS 83	21'	XS 84-85	21'--29'
Mohr driveway	bridge	23.9'	XS 104-105	33'--25'	XS 107-C1	30'--36'
Clark Road	bridge	30.2'	XS 109-110	36'--30'	XS 112-XS1	31'--37'
Hilltop Road	bridge	22.6'	XS 116-117	40'--41'	XS 117.3-118	38'--36'
Covered Bridge	bridge	37.8'	XS 134-135	50'--48'	XS 136-137	51'--66'
Davis Lane	bridge	57.4' combined openings	XS 139-141	56'-45' (split channel)	XS 146-147	40'--50'
River Road	bridge	42.9'	XS 153-155	47'--51'	XS 0301-0302	44'--46'
NYS Route 42	bridge	65.8'	XS 164-165	40'--37'	XS 168-169.5	37'--36'

b. General Chestnut Creek Infrastructure Concerns

Drainage

The original drainage system in the Town of Neversink was constructed in the 1920's, and to this point the State Highway Department has been replacing sections and extending the system a piece at a time. Water from sump pumps in homes can no longer discharge into the sanitary sewer line, so many now discharge directly into catch basins for the storm sewers. No private pump lines are connected directly into storm sewer lines with a "T" as this could lead to clogging in the future.

The water table under Route 55 adjacent to the bridge over Chestnut Creek near the Rondout Reservoir is so close to the surface it is causing the road to heave following freeze/thaw conditions. There has been much under drainage installed by the State in this area without complete success. A test hole was bored in the road and water gushed out like a geyser indicating water beneath the road is under pressure. This section of road should be torn out when the bridge is replaced in 2007 to install proper drainage.

Gary VanValkenburg agreed that runoff increases with development. As development expands, culverts must be increased in size to accommodate runoff.

Highways

When the reservoirs were constructed, Route 55 had to be relocated because it ran along the bottom of the valley that would become part of Rondout Reservoir. Confusion developed about ownership and maintenance of Highways running through the Town of Neversink. Route 42 is owned and maintained by the State. Route 55 is maintained by a combination of entities. The State maintains Route 55 from Liberty to West Shields Road in Neversink, the County maintains Route 55 from West Shields Road to Wagner Road, and the State resumes the responsibility from Wagner Road on. In areas where NYC owns Route 55, (from in front of Tri-Valley School to the County Line), the State maintains Route 55. The Town maintains the roads along the tributaries to Chestnut Creek.

Bridges

The State is responsible for maintenance of 3 bridges in Chestnut Creek Watershed; the bridge over the outlet from the Neversink Reservoir, the bridge over Chestnut Creek in Grahamsville that carries Route 42, and the bridge over Chestnut Creek that carries Route 55 just before the Creek enters the Rondout Reservoir.

There was a legal battle over the Chestnut Creek Bridge (Route 55 near the Rondout Reservoir) concerning whether the City or the State should pay for its replacement. The dispute went to the Attorney General's office and it was found that the city should pay for the replacement. The Chestnut Creek Bridge is scheduled for replacement in 2007.

The County began inspecting all the Bridges in Sullivan County in 1948. The County Bridge Unit is responsible for the maintenance and repair of 400 bridges in Sullivan County. Due to lack of county funding and personnel, the state currently inspects the 250 County Bridges that span over 20 feet every other year, unless posted. The State submits a bridge report, along with a hydraulic vulnerability assessment of the 250 County Bridges that span over 20 feet to the County Bridge Unit. The County inspects the other 150 bridges that span less than 20 feet. The County hopes to establish a 2 year inspection plan like the State in the near future for those bridges less than 20 feet. The last time an inspection was performed by the County was in 1999.

When a bridge needs replacement, the County Bridge Unit performs their own watershed study. The County has replaced most of the Bridges in the Chestnut Creek watershed in recent years, accomplishing a great deal of work. The only bridge in the Chestnut Creek Watershed slated for replacement within the next 5 years is South Hill Road Bridge. The other bridges are currently in good structural condition.

Ditches (Road Drainage)

The State Highway Department now leaves vegetation intact during construction as much as possible and provides seed and mulch after road work is completed. They are interested in a hydroseeder, if funding becomes available, to alleviate the problem of seed immediately washing off exposed banks. The Highway Department is not in favor of paving ditches and gutters because it increases water velocity, increases erosion and heats up the water which is harmful to aquatic habitat. In addition, some infiltration occurs in well-vegetated and maintained road side ditches, reducing size and timing of flood peaks.

The Town usually cleans ditches in the spring and summer to allow adequate time for vegetation to establish. The town seeds everything with a premix suitable for the area, and also expressed an interest in hydroseeding if the cost to operate it was not too high.

Culverts

Town:

The Town crew goes into the field when it is raining to check that the culverts are functioning and not plugged. This is in part why the Town experiences minimal flood damage. When paving roads, the Town checks all culverts and replaces those that are not in excellent condition. The Town replaced a 4' culvert with a 5' culvert on Cummings Road in 2003. Gary VanValkenburg always upsizes when the Town can afford it because it minimizes risks of damage during flood events. Most property damage occurs after bursts of heavy rainfall because increased precipitation in a short amount of time causes more runoff and pressure on the culvert drainage network.

The Town has been using smooth plastic culverts because they have a better flow, fewer freezing problems, are easier to unplug. Metal corrugated pipes allow for sediment deposition. Gary VanValkenburg does not know how long the plastic pipes last because they have not been installing them that long, but it appears that they should outlast the metal pipes. They could experience sun damage and deterioration on the ends, or debris may wear the culvert lining. According to the Town Highway Department most of the large culverts (more than 5' in diameter) are still adequate, with the exception of the pipe that schedule to be replaced on Pepacton Hollow Road in summer 2004.

State:

According to the State culvert inspection program, culverts over 5' in diameter are inspected about once every 3 years. Smaller culverts are not looked at unless they are plugged or the road is sinking or some other problem occurs about which the Highway Department is notified. The State has begun using plastic culverts, but galvanized ones are preferred when the culverts are close to the road surface because galvanized culverts support more weight. The State does not have enough staff to examine streambeds or culverts on a more frequent basis. However, the Culvert program has a construction department in addition to the maintenance department, so during the winter the construction department has extra time to inspect large pipes.

Snow Removal

Responsibility for snow plowing is divided between the State/County portions of Route 55. The Town Highway Department is responsible to remove snow from the Town Roads. The State is conservative with spreading sand and salt because their trucks have limited capacity. Current watershed rules and regulations prohibit use of chemicals near the reservoir so only a combination of salt and sand is used on the roads in the Chestnut Creek Watershed.

Sand and Salt Storage

Town:

Sand and salt for road ice control in the Chestnut Creek Watershed is stored at the Town of Neversink Highway Department in Grahamsville. New York City DEP funded construction of a new building for storage, but it only holds 1/3 of the winter supply. Gary VanValkenburg has not had a problem getting the sand through the winters to date. However, he buys sand by bid, and is not sure if the next lowest bid will be reliable. He would like to put an addition on the building or install a filling elevator so he would be able to stockpile the material higher. The Highway Department could then utilize the full height of the building that already exists, which would be most cost effective and not require any additional building.

6. Landowner Concerns and Interests

Landowners have made a significant contribution to the development of the stream management plan for Chestnut Creek. Landowners have provided historical information and photos, participated in Project Advisory Committee (PAC) meetings and answered survey questions to communicate their concerns and opinions (see Appendix for Landowner Perspective Survey). The information collected through this process has helped the SCSWCD to identify and address the most unstable reaches and important issues of Chestnut Creek. The following section summarizes concerns expressed by landowners throughout the stream management planning process. Comments are reported by Management Unit (MU1-MU9).

MU1

A major concern held by landowners in MU1 is that other landowners are not removing debris from Chestnut Creek, and its headwaters, which could lead to flooding.

MU2

No specific comments were received.

MU3

No specific comments were received.

MU4

The landowners that responded in MU4 identified the fallen trees and woody debris (log jams) in the stream channel as their prevailing concern. According to some, debris jams have been a problem for over 17 years, and have become worse in recent years. Other worries include pollution from upstream runoff, flooding of property, streambank erosion and the time and money required for proper stream care. Most landowners in MU4 report that flooding has been a relatively minor problem in this Management Unit. Brown Trout have been sighted and are thought to be breeding near the old town barn below Grey's woodworking. Several pairs were sighted in 2003. Debris jams in this area are a concern not only for flooding and erosion threats they might pose but also as a potential barrier to fish migration.

MU5

Leading concerns for residents of MU5 include stream bank erosion and pollution from upstream runoff and dumping. Other issues included flooding of property, impaired fishing, removal of trees and woody debris and government regulation of private property rights. Aggradation of gravel, especially where tributaries enter the mainstem, was a common concern. Most landowners reported flooding as a minor problem, however one resident noted damage to their home and property due to an increased flow of water onto the property during high flow events. Another resident went into detail about trees, which have fallen into the stream as a result of bank erosion, causing more debris to accumulate because they are not removed.

MU6

Stream bank erosion was the most voiced concern for landowners in MU6. Other concerns about the stream include flooding of property, pollution from upstream runoff and dumping, time and money required for proper stream care, government regulation of private property rights, the effect of chemicals on fish, impaired fishing, washout of roads and bridges, removal of trees and woody debris, and difficulty obtaining permits for stream work. Flooding was identified as a relatively minor problem in MU6, however, a few flooding related incidents were reported. One resident explained that the stream ran through their barn on one occasion and the barn had to be removed. Another resident complained of a nearby culvert being plugged with debris, resulting in frequent flooding of the road during storms.

MU7

No specific comments were received.

MU8-Pepacton Hollow

The number one concern of landowners in MU8 is erosion of stream banks. One landowner included additional comments stating the erosion is a result of the meandering stream changing direction due to the drains from the road collecting runoff from the other side for flood control and releasing it under higher pressure than it would otherwise into Chestnut Creek. Other concerns include impaired fishing, government regulation of private property rights, removal of trees and woody debris, nuisance wildlife, flooding of property, and cleanup of the dump. Flooding was considered a relatively minor problem and some residents stated that conditions have improved.

MU9-Red Brook

Of the three landowners that responded from MU9, stream bank erosion, removal of trees and woody debris and government regulation were the primary concerns. Also included were flooding of property and pollution from dumping. Flooding is considered a minor problem. Red Brook fisheries play an important role for the community especially for the historic Beaver Dam Club with property including the upper reaches of the stream (Volume I, Section IV.A.3. A History of the Beaver Dam Club).

Other Tributaries

For the Chestnut Creek Management Plan, we have decided to group opinion survey results of the smaller tributaries together until we have the resources to scientifically survey them. The two top concerns of Tributary landowners were stream bank erosion and the time and money required for proper stream care. Other concerns included government regulation of private property rights, flooding of property, groundwater connection to private wells, pollution, nuisance wildlife, difficulty obtaining permits for stream work, removal of trees and woody debris, the effect of logging on the watershed and the stream, and road washouts. One resident of Denman Mountain explained how during Hurricane Floyd, the road at the base of the guardrail eroded into the stream. Flooding ranges from a frequent problem to never a problem. One resident claimed they are unable to utilize their property during high flow periods due to flooding.

Unknown MU

A few landowners submitted surveys anonymously, making it difficult to assign the results to a specific MU. Among these responses there was a consensus that stream bank erosion is the number-one concern. Remaining issues range from impaired fishing to washout of roads and bridges. Flooding has been a minor to frequent problem. Most landowners throughout the watershed considered fishing in Chestnut Creek to have remained consistent or to have improved in recent years.

Generally, if high waters have affected property and roads, erosion of stream banks seemed to be of highest concern in those areas. Where flooding has not presented a problem, concerns focus on trees and woody debris in the immediate/ upstream area and pollution from upstream runoff and dumping. It is apparent that portions of Chestnut Creek require a long-term solution of proper stream stewardship to not only promote a more stable stream, but also to reduce the overall cost of stream maintenance and the number of stream work permits required every year. Landowners have expressed an interest in learning more about these long-term solutions and how to implement them.

VI. GLOSSARY OF TERMS

GLOSSARY OF STREAM AND FLOODPLAIN TERMS

Note: where a word within a definition is italicized, it is defined elsewhere within the glossary

aggradation - The process by which *sediment* and deposition causes a streambed elevation to increase, or fill in. The channel becomes more shallow by filling in with *sediment*. An aggrading stream will typically show a *bank height ratio* of less than 1.0.

aquatic habitat – Physical attributes of the stream channel and *riparian area* that are important to the health of all or some life stages of fish, aquatic insects and other stream organisms. Attributes include water quality (temperature, pH), *riparian* vegetation characteristics (shade, cover, density, species), stream bed *sediment* characteristics, and *pool*/*riffle* spacing**.**

backwater – An area in or along a stream where water has been held back by an obstruction, constriction or dam.

bankfull flow or discharge – typically recurs every 1 – 3 years. These floods are frequent and powerful enough to mobilize *gravel* and *cobble* on the streambed. Bankfull flow is considered most responsible for defining the stream form and is also referred to as channel forming flow.

Bank Erodibility Hazard Index (BEHI) – An index for predicting *erosion potential* on selected stream banks, usually associated with a *monitoring cross-section* for measurement of actual *erosion* rates over time (Rosgen, 1996).

bank height ratio-The ratio of height of bank to *bankfull* height, used in stream assessment to determine whether a stream is stable-bank height and *bankfull* height will be the same in a stable stream.

bar, mid-channel, point, side, lateral, etc. **-** a location within the stream channel in which sediment accumulates occupying a significant portion of the channel (vs.localized *sediment* deposits behind small obstructions).

base flow –The typical groundwater fed, low flow for a given stream between periods of no rainfall.

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.

berm – A mound of earth or other materials, usually linear, constructed along streams, roads, *embankments* or other areas. Berms are often constructed to protect land from flooding or eroding, or to control water drainage (as along a road-side ditch). Some berms are constructed as a byproduct of a stream management practice whereby stream bed *sediment* is pushed out of the channel and mounded on (and along the length of) the stream bank - these berms may or may not be constructed for flood control purposes; some are simply piles of excess material. These berms often interfere with other stream processes such as *floodplain* function, and can exacerbate flood-related *erosion* or stream *instability*.

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 *sediment*.

boulder – In the context of *stream assessment surveys*, a boulder is stream *sediment* that measures between 256 mm and 4096 mm (about 10 inches to 13.3 feet).

channel, stream– A defined waterway with definite bed and banks, which periodically or continuously contains flowing water.

channel forming flow—see *bankfull* flow.

channelization — The re-alignment of rivers involving straightening, widening, reshaping, entrenching or altering the slope. Often this work is accompanied by stream bank stabilization, grade control or berm construction.

cobble – In the context of *stream assessment surveys*, cobble material is *sediment* that measures between 64 mm and 256 mm (about 2.5 inches to 10 inches).

confluence – The location of the joining of two separate streams, each with its own *watershed*.

corridor—The area of land along a stream between the valley walls including floodplains, riparian areas, and terraces.

convergence – The downstream end of a split channel, where the stream merges back to one channel; the two channels having the same *watershed*.

cross-section (see also monitoring cross-section) – In the context of *stream assessment surveys*, a *cross-section* is a location on a stream channel where stream *morphology* is measured perpendicular to the stream flow direction (as if taking a slice through the stream), including width, depth, height of banks and/or *terraces*, and area of flow.

culvert – A closed conduit for the free passage of surface drainage water. In Chestnut Creek, culverts are typically used by the Town and County 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 main Chestnut Creek stream. Culverts are also used by landowners to route roadside drainage ditch water under their driveways to reduce or prevent *erosion*.

degradation – The process by which a stream *reach* or channel becomes deeper by eroding downward into its bed over time, also called "*downcutting*", either by periodic episodes of bed scouring without filling, or by longer term transport of *sediment* out of a *reach* without replacement. A degrading stream will typically show a *bank height ratio* greater than 1.0.

demonstration stream restoration project (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.

destabilized (see also instability, unstable) – Describing a section of stream that has been made *unstable*, by natural or human activity.

discharge (stream flow) – The amount of water flowing in a stream, measured as a volume per unit time, usually cubic feet per second (cfs).

discontinuous floodplains (see also floodplain) – A series of small *floodplains*, formed as a series of small benches along stream banks. These *floodplain* features, typically seen in steeper mountain streams, are not connected sequentially following the valley floor, but still provide the critical *floodplain* functions of reducing water *velocity* and enhancing *sediment* deposition and infiltration (water sinking into the ground rather than running straight to the stream).

downcutting—see *degradation*

drainage area – see *watershed.*

dumping site – For the purposes of the stream assessment survey, these are areas in the stream or on the *floodplain* where refuse or other non-natural or non-biodegradable materials were documented. A dumping site is not necessarily an actively used area, and may be the result of material washing downstream.

embankment – A linear structure, usually of earth or *gravel*, constructed so as to extend above the natural ground surface. Similar to a *berm*, but usually associated with *road fill* areas, and extending up the hillside from the road, or from the stream up to the road surface.

entrenched – In stream classification (see s*tream type*), entrenchment (or entrenchment ratio) is defined by stream *cross-sectional* shape in relation to its *floodplain* and valley shape, and has a specific numerical value that in part determines stream type. For example, if this number is less than 1.4, the stream is said to be highly entrenched, if between 1.4 and 2.2 it is mildly entrenched, and greater than 2.2 it is not entrenched. Entrenchment ratio is used with other stream shape data to determine *stream type*, and define baseline data for future *monitoring* (Rosgen, 1996).

ephemeral– Referring to a stream that runs only in direct response to rain and whose channel is above the water table.

equilibrium (see also stable) – The degree to which a stream has achieved a balance in transporting its water and *sediment* loads over time without aggrading (building up), degrading (cutting down), or migrating laterally (eroding its banks and changing course).

erosion - The wearing away, detachment, and movement of the land surface (*sediment*), by running water, wind, ice, or other geological agents, including such processes as gravitational creep or *slumping*. In streams, erosion is a natural process, but can be accelerated by poor stream management practices.

erosion potential – The amount of *erosion* that may be expected under given climatic, topographic, soil, and cultural conditions.

fascines – A *bioengineering* method using bundles of small branches of willow or other *riparian* tree species, tied together and laid into shallow trenches along a stream to stabilize and revegetate stream bank areas.

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 by 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*. Vegetation on floodplains greatly improves their functions.

floodplain connection - the stream's ability to access the land area adjacent to its active *channel* during higher flows in order for the stream system to function properly and dissipate energy or *velocity*.

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

gabions – Large wire-mesh baskets filled with rock material used to *harden* or *stabilize* road *embankments* and sometimes stream banks.

Geographic Information System (GIS) - Desktop software with a graphical user interface that allows loading and querying, analysis and presentation of spatial and tabular data that can be displayed as maps, tables and charts. The maps in the Chestnut Creek stream management plan were produced with a GIS, and can be updated as new information becomes available.

geomorphic - Pertaining to the form of the earth or of its surface features.

Global Positioning System (GPS) - A satellite based positioning system operated by the U.S. Department of Defense (DOD). When fully deployed, GPS will provide all-weather, worldwide, 24-hour position and time information.6 The *stream assessment survey* done for the Chestnut Creek stream management plan included the use of a GPS unit to document the locations of all mapped stream features. This information was added to the *GIS* to produce the maps.

gravel – In the context of *stream assessment survey*, gravel is *sediment* that measures between 2 mm and 64 mm (about 0.08 inches to 2.5 inches).

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.

head-cut – A marked change in stream bed slope, as in a step or waterfall, that is unprotected or of greater height than the stream can maintain. This location, also referred to as a knick point, moves upstream, eventually reaching an *equilibrium* slope.

headwater - the uppermost portion or beginnings of a stream**.**

hydraulic - Relating to the flow or conveyance of water through a channel; movement or action caused by water**.**

impervious surface – A surface which will not permit water to pass through, such as concrete or asphalt.

inboard – Referring to a roadside ditch that is between the road and adjacent hillside, on the higher or uphill side of the road.

incised - The lowering of the streambed due to downcutting and removal of bed material by the stream, referring to a stream that has degraded such that the *bank height ratio* is greater than 1.0.

instability (see also unstable) - An imbalance in a streams capacity to transport *sediment* and maintain its channel shape, pattern and profile.

invasive plants – Species that aggressively compete with and replace native species in natural habitats.

Japanese Knotweed (see also invasive plants) – An *invasive plant*, not native to the Catskill region, that colonizes disturbed or wet areas, especially stream banks, road-side ditches and *floodplains*. This plant out-competes natives and other beneficial plants, and may contribute to *unstable* stream conditions.

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

leaching – The process by which chemical or mineral materials are removed from a physical *matrix* (such as soil, or mixed *sediment* materials) by water running through and creating a solution of those chemicals.

left bank – The left stream bank as looking or navigating downstream. This is a standard used in *stream assessment surveys*.

mass wasting –The fall or slide of a hillslope which results in the rapid or slow movement of soil organic debris and rock down slope. See *erosion*.

matrix – The framework material within which other materials are lodged or included. For example, *cobbles* could be embedded in a matrix of *sand* and fine *gravel*.

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

meander – Refers both to a location on a stream channel that is curved (a "meander bend"), and to the process by which a stream curves as it passes through the landscape (a "meandering stream").

meander width ratio—The quantitative expression of confinement (lateral containment of rivers) and is determined by the ratio of belt width/*bankfull* width.

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

monitoring cross-section – For the purposes of the Chestnut Creek stream management plan, this is a location where metal rebar rods have been used to permanently locate an actively eroding stream bank. At this site, detailed data have been gathered to document the stream condition. The site is permanently marked to enable future measurements that, when compared to the existing condition, provide information about the stream's change. Measuring change over time is considered '*monitoring*,' and this information provides early warning to stream managers about important but perhaps visually imperceptible changes in the stream.

monumented – Refers to a location, usually a *cross-section*, that is marked with a permanent or semi-permanent marker, or "monument", to enable future *monitoring* at the same place.

morphology, stream morphology – The physical shape, or form, of a landscape or stream channel, that can be measured and used to analyze stream or landscape condition, type or behavior.

multiflora rose (see also invasive plants) – An *invasive plant*, not native to the Catskill region, that colonizes disturbed or wet areas such as fields, forest edges, stream banks, and roadsides. This plant spreads quickly and forms impenetrable thickets that exclude native species. It impedes succession and out competes other plants for soil nutrients.

native material – *Sediment* material with a local or on-site source, as in material pushed up out of a stream channel to armor the banks.

non-quarried, or natural boulders – *Boulder*-sized rock material, either *native* or imported material, not harvested from a quarry. This material has been used in the past in stream bank stabilization, usually harvested directly from the stream or from nearby hillsides.

nutrient – The term "nutrients" refers broadly to those chemical elements essential to life on earth, but more specifically to nitrogen and phosphorus in a water pollution context. In a water quality sense nutrients really deal with those elements that are necessary for plant growth, but are likely to be **limiting** -- that is, where used up or absent, plant growth stops.

pathogen – Disease-causing agent, especially microorganisms such as bacteria, protozoa, and viruses.

planform – Horizontal stream pattern, including sinuosity, meander radius, and belt width, as seen in plan view (from above).

pool – A small section of stream characterized by having a flat or nearly flat water surface compared to the average *reach* slope (at low flow), and deep and often asymmetrical *cross-sectional* shape.

perennial -A stream that runs all year long, regardless of precipitation patterns.

reach – A section of stream with consistent or distinctive *morphological* characteristics.

reference reach, stable reference reach – 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 – Any structural measure undertaken to stabilize a road *embankment*, stream bank or hillside.

riffle – A small section of stream characterized by having a steep water surface slope compared to the average *reach* slope (at low flow), and a shallow and often uniform *cross-sectional* shape.

right bank – The right stream bank as looking or navigating downstream. This is a standard used in *stream assessment surveys*.

riparian (area, buffer, vegetation, 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.

riprap – 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* control.

road fill (see also *embankment*) – Typically *gravel*- and *sand*-sized material used to elevate the level of the road, control the road grade, or provide a buffer for the road grade from stream *erosion*.

runoff – The portion of precipitation (i.e., rainfall) that reaches the stream channel over the land surface.

sand – In the context of *stream assessment surveys*, sand material is *sediment* that measures between 0.063 mm and 2 mm (up to 0.08 inches).

sediment, stream bed 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 deposition (in the stream bed or on the *floodplain*).

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

silt – In the context of *stream assessment surveys*, silt material is *sediment* that measures between 0.0039 mm and 0.063 mm.

sinuosity - The ratio of stream length to valley length, or the ratio of valley slope to channel slope.

slump – The product or process of mass-wasting when a portion of hillslope slips or collapses downslope, with a backward rotation (also a rotational failure).

stable (see also equilibrium) – A stable stream is defined as maintaining the capacity to transport water and *sediment* loads over time without aggrading (building up), degrading (cutting down), or migrating laterally (eroding its banks and changing course). Stable streams resist flood damage and *erosion*, and provide beneficial *aquatic habitat* and good water quality for the particular setting.

stability – In stream channels, the relative condition of the stream on a continuum between *stable* (in *equilibrium* or balance) and *unstable* (out of *equilibrium* or balance). Stream stability assessment seeks to quantify the relative *stability* of stream *reaches*, and can be used to rank or prioritize sections of streams for management.

stacked rock wall – A *boulder revetment* used to line stream banks for stabilization. Stacked rock walls can be constructed on a steeper angle than *rip-rap*, so they take up less of the stream *cross-section*, provide a wider road surface, and provide less surface area for solar heating, allowing stream temperature to remain cooler relative to banks lined with *rip-rap*. These features can be augmented with *bioengineering* to enhance *aquatic habitat* and *stability* functions.

stage – In streams, stage refers to the level or height of the water surface, either at the current condition (i.e., current stage), or referring to another specific water level (i.e., flood stage).

stream assessment, stream assessment survey – The methods and summary information gathered in a stream *reach* or series of *reaches*, primarily focused on stream *morphology*. Stream assessment for the Broadstreet Hollow included detailed characterization and mapping of stream channel patterns, *cross-section* shapes and slope.

stream flow (discharge) – The amount of water flowing in a stream, measured as a volume per unit time, usually cubic feet per second (cfs).

stream stability restoration (design, project) – An *unstable* portion of 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 (that is, to a shape that may allow the stream to transport its water and *sediment* load over time without dramatic changes in its overall shape).

stream type – As defined by Rosgen (1996), one of several categories defined in a stream classification system, based on a set of delineative criteria in which measurements of channel parameters are used to group similar *reaches*.

substrate - The bottom material of a waterway.

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 – *Sediment* carried in the water column (above the stream bed), including *clay*, *silt* and sometimes fine *sand*. These materials contribute to *turbidity*.

terrace – A level area in a stream valley, above the active *floodplain*, that was deposited by the stream but has been abandoned as the stream has cut downward into the landscape. These areas may be inundated (submerged) in higher floods, but are typically not at risk in more common floods.

thalweg – The line followed by the majority of the stream flow. 1 In *stream assessment*, this location is used as a reference location for surveys and other measurements, and is most often associated with the deepest point in the stream *cross-section* (stream channel that would still have water flowing in it at even the lowest flow conditions).

toe – The bottom, or base, of a stream bank or *embankment*.

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. Streams with high turbidity are often referred to as being "turbid".

unstable (see also instability) – Describing a stream that is out of balance in its capacity to transport *sediment* and maintain its channel shape, pattern and profile over time.

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

watershed – A unit of land on which all the water that falls (or emanates from springs) collects by gravity and runs off via a common outlet (stream).

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)—see *summer base flow*--Winter base flow is generally higher due to lower rates of evapo-transpiration during vegetative dormancy.

Sources

1. ArcView GIS: The Geographic Information System for Everyone. Environmental Systems Research Institute, Inc. 1996.
2. Black, P., Watershed Hydrology, 1991, Prentice-Hall Inc., Englewood Cliffs, NJ.
3. GPS Pathfinder Office: Getting Started Guide. Trimble Navigation Limited. 1999.
4. Helms, J., Dictionary of Forestry,1998, Society of American Foresters, Bethesda, MD.
5. Lo, S. 1992. Glossary of Hydrology. Water Resourced Publications, PO Box 2841, Littleton, CO.
6. New York Guidelines for Urban Erosion and Sediment Control, USDA SCS, 1972.
7. Soil Conservation Society of America. Resource Conservation Glossary. 1982.
8. Rosgen, D.L. 1996. Applied River Morphology.

VI. Appendices

A. Chestnut Creek Landowner Survey, 2001.

B. Landowner Survey Results.

C. Chestnut Creek News meeting minutes.

Fishing on the Chestnut Creek has generally

☐ Improved in recent years. The reason is

____

☐ Deteriorated in recent years. The reason is

____

☐ Remained consistent (please explain)

☐ I don't fish

☐ Other (please explain)

____

_

***Decisions* about how streams are managed on *private property* should**

☐ Rest with landowners

☐ Rest with the County Soil and Water Districts

☐ Rest with the town highway department

☐ Rest with the county highway department

☐ Be shared between landowners and local government

☐ Rest with the federal government

- ☐ FEMA
- ☐ Army Corps of Engineers
- ☐ Natural Resources Conservation Service
- ☐ U.S. Fish and Wildlife

☐ Don't know

☐ Other (please explain)

____

The main financial responsibility for management of streams on *private property* should

☐ Rest with landowners

☐ Rest with the County Soil and Water Districts

☐ Rest with the town highway department

☐ Rest with the county highway department

☐ Rest with the federal government

- ☐ FEMA
- ☐ Army Corps of Engineers
- ☐ Natural Resources Conservation Service
- ☐ U.S. Fish and Wildlife

☐ Be shared between landowners and government

☐ Don't know

☐ Other (please explain)________________________________

I would be interested in a stewardship program involving Chestnut Creek

☐ I would like to attend a summer community information- sharing day

☐ I would like to attend a stream walk

☐ I would be supportive of a school based event

☐ I would like to volunteer for field work assistance

If anything has been omitted that you feel is a concern in the Watershed area, please feel free to express it here____

I would be interested in participating in a Chestnut Creek Landowners Meeting to insure that landowner concerns and knowledge are represented in the development of a management strategy.

☐ Yes ☐ No

I would be willing to represent my neighbors in the landowners association on the Project Advisory Committee of the management plan.

☐ Yes ☐ No

Name (optional)________________________________

Address____

_

Phone____

For more information contact:

Sullivan County Soil & Water Conservation District

64 Ferndale-Loomis Road Liberty, NY 12754

Phone (845) 292-6552 Fax (845)295-9073 e-mail

scswcd@ln4web.com

Chestnut Creek

Landowner Perspective Survey

I live in the Chestnut Creek Watershed

☐ Year round ☐ Mostly on weekends

☐ Primarily in the summer season

One of these tributaries or the Chestnut Creek runs along or through my property

☐ The Chestnut mainstem

☐ Pepacton Hollow

☐ Denman Mountain

☐ Red Brook

☐ Scott Brook

☐ Davis Lane

☐ Other________________

I enjoy the Chestnut Creek on my property for

(check all that apply to you)

☐ Walking along the stream

☐ Camping along the stream

☐ The view

☐ Watching the wildlife, birds

☐ Hunting along the stream

☐ Source of gravel or rock materials

☐ Fishing

☐ Swimming

☐ Household water supply

☐ Lawn or garden water supply

☐ Area to dispose of grass clippings and brush

Conditions on the Chestnut Creek in my area are generally

- ☐ Excellent, need no change in management
- ☐ Good, but could use some improved management
- ☐ Fair, need much more management
- ☐ Poor, need urgent management

I've lived here ____years.

While I've lived here, flooding along the Chestnut Creek

- ☐ Has been a frequent problem
- ☐ Has been a relatively minor problem
- ☐ Has never been a problem
- ☐ Has gotten worse
- ☐ Has gotten better

My main concerns about the stream include (check all that apply to you)

- ☐ Streambank erosion
- ☐ Flooding of property
- ☐ Impaired fishing
- ☐ Groundwater connection to my well
- ☐ Pollution from upstream runoff, dumping
- ☐ Nuisance wildlife (e.g., mosquitos)
- ☐ Difficulty obtaining permits for streamwork
- ☐ Removal of trees & woody debris from immediate/upstream area
- ☐ Time and money required for proper stream care
- ☐ Government regulation of private property rights
- ☐ Getting enough water for my lawn and garden
- ☐ Washout of roads and bridges
- ☐ Other (please explain)

____

I personally have been affected by flooding
(Check all that apply to you)

☐ Never ☐ Once ☐ A number of times
☐ Extensively

- ☐ Damage to my home
- ☐ Washout of road access
- ☐ Washout of bridge access
- ☐ Erosion of stream banks
- ☐ Other (please explain)____________

____

The best way to solve flooding problems is to

- ☐ Clean gravel and cobble out of the stream
- ☐ Restore natural channels and floodplains
- ☐ Straighten the stream
- ☐ Clear trees and brush away from the channel
- ☐ Build berms and levees
- ☐ Build more flood control structures
- ☐ Keep buildings out of the floodplain
- ☐ Maintain wetland storage in headwater valleys
- ☐ Other (please explain)

____

Some people think that rip-rap (large rock placed on the streambank) is the best way to treat bank erosion.

Others say that rip-rap just deflects the erosion downstream, creates poor fish habitat and destroys the natural function and look of the stream.

I think rip-rap

- ☐ Is the only reliable way to treat bank erosion
- ☐ Is rarely a good way to treat bank erosion
- ☐ Is the treatment of last resort to be used when other bank stabilization measures cannot be used
- ☐ Other (please explain)

____
____

Survey Result

		Percent of TotaL
SumOfYear Round	31	73.81%
SumOfMostly on Week ends	3	7.14%
SumOfPrimarily in t	4	9.52%
SumOfWalking	24	57.14%
SumOfCamping	2	
SumOfThe View	25	
SumOfWatching	22	
SumOfHunting	2	
SumOfFishing	15	
SumOfSwimming	7	
SumOfHousehold wa	1	
SumOfLawn or gard	6	
SumOfArea to dispose	2	
SumOfSource of gravel	1	
CountOf2 Other	0	

Survey Results

	Count		Percent of Total
Excellent	11		26.19%
Good	16		38.10%
Fair	11		26.19%
Poor	4		9.52%
Ave years	28		
less 5	-1	less 5	2.38%
5-10:	-7	5-10:	16.67%
10-20:	-6	10-20:	14.29%
20 +	-23	20 +	54.76%
A frequent problem	5		11.90%
Relatively minor problem	20		47.62%
Never been a problem	9		21.43%
Has gotten worse	2		4.76%
Has gotten better	1		2.38%
Streambank erosion	27		64.29%
Flooding of property	11		26.19%
Impaired fishing	6		14.29%
Groundwater connection to well	4		9.52%
Pollution from upstream runoff	14		33.33%
Nuisance wildlife	4		9.52%
removal	20		47.62%
fDifficulty obtaining permits for stre	4		9.52%
Time and money required for proper	10		23.81%
Government regulation of private pro	14		33.33%
Getting enough water for my lawn an	0		0.00%
Washout of roads and bridges	7		16.67%
Other	7		16.67%
Never affected by flooding	20		47.62%
Once	8		19.05%
A number of times	9		21.43%
Extensively	0		0.00%
Damage to my home	5		11.90%

Washout of road access	5	11.90%
Washout of bridge access	3	7.14%
Erosion of stream banks	13	30.95%
Clean gravel out of stream	13	30.95%
Restore natural channels	14	33.33%
Straighten the stream	5	11.90%
Clear trees and brush away	11	26.19%
Build berms and levees	4	9.52%
Build more flood control structures	6	14.29%
Keep buildings out of floodplain	7	16.67%
Maintain wetland storage in headwat	3	7.14%
Other	4	9.52%
Rip rap is the only reliable way	10	23.81%
is rarely a good way	4	9.52%
a last resort	18	42.86%
Fishing has improve	4	9.52%
Reason	3	7.14%
Has deterioriated in recent years	9	21.43%
Reason	5	11.90%
Remained consisten	3	7.14%
Don't fish	19	45.24%
Other	2	4.76%
Rest with landowners	3	7.14%
County Soil and Water districts	3	7.14%
town highway dept	1	2.38%
county highway dept	1	2.38%
Shared between landowners and lo	23	54.76%
Federal government	6	14.29%
FEMA	2	4.76%
Army Corps of Engineers	4	9.52%
NRCS	2	4.76%
US Fish and Wildlife	1	2.38%
don't know	8	19.05%
other	5	11.90%

rest with landowners	3	7.14%
County Soil and Water district	7	16.67%
town highway dept	4	9.52%
county highway dept	4	9.52%
Shared between landowners and loca	11	26.19%
federal government	7	16.67%
FEMA	2	4.76%
Army Corps of Engineers	4	9.52%
NRCS	1	2.38%
US Fish and Wildlife	2	4.76%
don't know	7	16.67%
other	10	23.81%

Community Info share	16	38.10%
Stream walk	11	26.19%
school based event	10	23.81%
volunteer:	3	7.14%

Other Comments	8	19.05%

Landowner Association	25	59.52%	Project Advisory Committee	4	9.52%

CHESTNUT CREEK NEWS

The Chestnut Creek Watershed

The Chestnut Creek mainstem flows 5 linear miles through the town of Neversink and the hamlet of Grahamsville before it empties into the Rondout Reservoir. Its tributaries span over 21 square miles and include the 3.5 mile Pepacton Hollow, whose headwaters originate on Denman Mountain, and the 8 mile Red Brook, which originates in the Town of Fallsburg. Over three hundred people own land within the watershed.

Informational Meeting Held

On the evening of February 22, 2001, about 30 riparian landowners braved snowy conditions to attend an informational meeting hosted by the Sullivan County Soil and Water Conservation District (SCSWCD) at the Neversink Town Hall. The Soil and Water District, the Town of Neversink and NYC DEP's Stream Management Program are embarking on a multi-year project - A Stream Management Plan - for the Chestnut Creek and its tributaries.

Brian Brustman, District Manager, welcomed the group and gave a general introduction to stream issues encountered by the District in their work. After heavy stream flows, the District is often called by landowners about stream bank erosion. Usually, the District works on a site-by-site basis, but this often only fixes a problem temporarily. Les Kirby, SCSWCD Project Technician gave a slide presentation about natural channel stability. A naturally stable channel is able to transport the sediment and water moving through the stream, without building up in the channel, or down-cutting the stream banks. He explained that Project staff will be doing an assessment in the stream beginning this summer. Lori Kerrigan, SCSWCD Project Coordinator described the process that will be used to create a community-based stream management plan.

The project seeks input from streamside landowners regarding flooding and erosion problems, and other information about your experience living near the stream.

Beth Gelber, DEP Project Manager, explained that like the Catskill system's Ashokan Reservoir, the Rondout Reservoir is a "Terminal Basin" for the City's Delaware system - it collects water from other reservoirs (Neversink, Cannonsville, Pepacton) for distribution into the rest of the supply system. Since water in the Rondout has less time for impurities to settle out, it is of special interest to DEP.

During the question and answer session, an attendee mentioned his prompt attention to woody debris deposited by storm flows in order to protect the stream bank. Others reported that they didn't have any immediate problems with eroding stream banks. A question was asked about landowner liability for District staff, and landowner permission to access private property. The District covers all liability for Project staff in the field. Any requests to the District by landowners regarding property access will be honored.

Project Advisory Committee

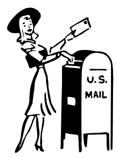
A Project Advisory Committee (PAC) is being formed, made up of local officials such as Town Highway, Town Planning, County Department of Public Works, and County Planning. The landowners will be asked to select two representatives to sit on the PAC at an upcoming public meeting. The Project Advisory Committee will meet several times during the year to review the stream assessment underway by the District, and make recommendations.

Follow-Up Meeting
At an upcoming public meeting to be held this summer, we encourage you to bring your photos and other archives of the Chestnut Creek. We will use a scanner to create images and maps that contain your photos.

What is proposed for the Stream Management Plan?
The Stream Management Plan will include an inventory of historical and present conditions related to water quality, flooding, and stream ecology. The plan may include recommendations to direct local, state, and federal resources toward the long-term protection of water quality in the Chestnut Creek and its tributaries. The management plan seeks to promote and encourage stewardship of the Chestnut Creek by the community of Grahamsville, the Tri-valley Central School, and other community groups. The plan also includes a restoration demonstration project based on the principles of natural channel restoration.

Other cooperative Stream Management plans are underway with the Soil and Water Conservation Districts in Greene, Ulster and Delaware counties, on the Batavia Kill, Stony Clove, Broadstreet Hollow, and West Branch Delaware River.

Landowner Survey
In order to begin communicating directly with landowners in the Chestnut Creek watershed, we have enclosed a survey that we hope you will fill out and send back to us at your earliest convenience. Thanks for your time and concern.



County and Local Officials participate in Stream Management Planning Workshop
On March 1st and 2nd, representatives from Sullivan County Planning and Public Works Departments and the Town of Neversink participated in a multi-county workshop that focused on the goals of stream management plans being developed by the Soil and Water Districts throughout the Catskills, and identified methods to involve and inform local communities. The group agreed that this newsletter might be a helpful way to convey information to you, the community of the Chestnut Creek watershed.

Daniel Pierce Library Lecture Series, at the Grahamsville Methodist Church

On May 18, 2001, at 7:30 PM, as a part of a ten lecture series, funded by the Catskill Watershed Corporation, Lori Kerrigan, Project Coordinator for the Chestnut Creek Stream Management Project will give a slide presentation about the Chestnut Creek Management Plan at the Grahamsville Methodist Church. The presentation will be advertised in the local paper.
All are welcome to attend.

Field Season (2002)

This field season we have been concentrating mostly on the tributaries to the Chestnut Creek, to get a more complete picture of what is happening in the whole watershed. We have covered the entire mainstem length of Red Brook and Pepacton Hollow tributaries with the G.P.S. unit (Global Positioning System) and the digital camera. By using photographic documentation and locating these areas with the G.P.S. unit, we are able not only to see what is happening, but where it is happening. When this information is linked to a map, we can pick a point and access the photos and data that are relevant to this area to better answer your questions.

SCSWCD Project Technician , Les Kirby gathers GPS satellite points.

We have contracted with consultants to help us analyze our data to determine what additional field information remains to be gathered, and where we should concentrate our efforts.

We will also be asking for input from the Project Advisory Committee (PAC) this fall. This will provide us with a wealth of information from a local prospective. We will be asking the community to elect 2 landowners as representatives to the committee this fall and will of course have a public gathering at the Town Hall for all to participate.

What is a Stable Stream Reach?

During the winter of 2002, the Chestnut Creek stream team organized and analyzed the field data, collected previously, to determine stream types and stability for each *reach* or continuous sections of the same type of stream. *Stream stability* is defined as the ability of the stream segment to move all of the water and all of the sediment produced by its watershed, with minimum rates of erosion, over time. A naturally stable stream reach is one that has survived flood after flood without excessive rates of streambed or stream bank erosion. A *reference reach* of a stream indicates a well functioning stream section. The SWCD will survey and use a reference reach as a template, or blueprint, for restoration of degraded sections of the Chestnut Creek, or when replacement or maintenance of infrastructure is required.

A stable reach of a similar type and can be used to model other less stable areas.

The Chestnut Creek *Stream Management Plan* will identify areas of instability and stream bank erosion and make recommendations for treatment based on their relative severity. A demonstration project will be constructed according to "natural channel design" principles, using the dimensions of a stable reach as a reference or template/ blueprint.

Sullivan County
Soil and Water Conservation District
64 Ferndale - Loomis Road
Liberty, NY 12754

Chestnut Creek News

For the past 2 years, the Sullivan County Soil and Water Conservation District has been engaged in the development of a stream management plan for the Chestnut Creek.

Throughout this time, the Chestnut Creek Project Team has been measuring stream channel stability - the channel dimensions such as slope, width, depth, sinuosity - that will enable the SWCD to map the condition of the stream in different sections or reaches.

Stream channel stability assessment is important because the physical processes that shape channels have consequences for public (bridges and roads) and private property loss, flood protection, fish habitat, and water quality.

Stream Watch at Tri-Valley School

Last May, the Catskill Center for Conservation and Development held a *Stream Watch* program for 30 students at Tri-Valley Central High School. The students learned about pH, riparian vegetation, stream flow, temperature, and macro-invertebrates, the components of a healthy stream including vertebrates – a major food supply for fish. At the end of the week they sampled a small tributary of the Chestnut Creek that flows near the school. They found an abundance of aquatic critters from stoneflies and mayflies to crayfish. This educational program will continue with the Tri-Valley School next year.

Students measuring stream flow, and sampling

Streamside Landscaping Workshop

On Saturday, July 27, 2002, 48 residents of the Catskill region attended a free streamside landscaping workshop cosponsored by the Stony Clove Creek and Broadstreet Hollow Landowners Associations. The focus was on the benefits of using native vegetation and planting techniques to prevent and remediate excessive stream bank erosion, enhance stream and floodplain ecosystems and attract particular birds, butterflies and other wildlife. The workshop also described programs available to help fund the design and implementation of these landscaping plans. For a list of native riparian plants and wildlife, please call or Email us.

AmeriCorps Joins the Chestnut Project

In December 2001, Derrick Kelly joined the District's Stream Management project staff as an AmeriCorps* member serving a 12 month term. Derrick is a native of Liberty. Derrick graduated from SUNY Oneonta in 2001 with a Bachelor's degree in Environmental Science. Last winter, his help was essential as the Project team began to analyze a great deal of data collected in the stream last summer. This summer he has spent plenty of time in the field, assisting the Project Technician with GPS mapping and photo documentation of the creek and its tributaries. We want to thank Derrick for his hard work, dedication, and good humor! A new AmeriCorps member will be joining the team in 2003!

*AmeriCorps is the national domestic service corps established in 1993. Members receive technical training and professional experience while accomplishing specific tasks at their Host Sites. Americorps members receive a weekly stipend and an Educational Award following their term of duty.

NYS DOT, 1929 Cloth Maps

We were able to get copies of old cloth highway maps from 1929 that are still updated and used by NYS DOT. We are in the process of scanning these maps into our computer files and aligning them with our existing files so they can be overlain to show any major changes in the stream over the years. Some changes the maps display are the historic relocation of the Chestnut Creek for Route 55 construction and the original location of the stream along the highway. We have talked to many landowners who have given us many valuable historical accounts of changes in and along the creek. We look forward to scanning or copying any photos, old news articles or historic maps that are available.

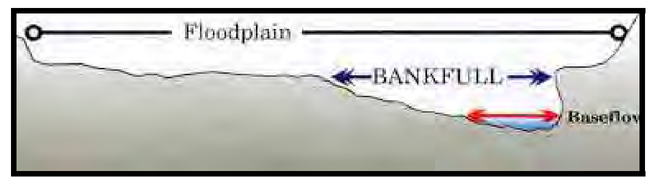
Sizing up a Stream

All of our stream channel measurements are based on the theory of ***bankfull discharge.***

Bankfull discharge is associated with a common stream flow, like a spring flood, that occurs approximately every other year. Bankfull discharge is also the flow in which the sediment transported by the stream, shapes the channel dimensions.

We use the bankfull stage as a benchmark flow level at which we measure the channel's shape or morphology.

The term "bankfull" is somewhat of a misnomer – for some streams, bankfull flow fills the channel to the top of the banks at the level of the flood plain, i.e., the banks are full. Other streams don't have a distinct flood plain, such as steep mountain streams, this common flow is expressed by a different characteristic level or stage.



Rosgen, Dave 1996. (Figure 2-7; p. 2-10)

Changes in the watershed that affect the quantity, or timing of stream flows are activities such as vegetation removal, roads, soil compaction, diversions, urban development, or drainage alteration.

Streams need to be considered often, not only in their current state but also in terms of their future, similarly, it's essential that restoration goals are compatible with the current and future stream type.

Developing A Successful Watershed Association

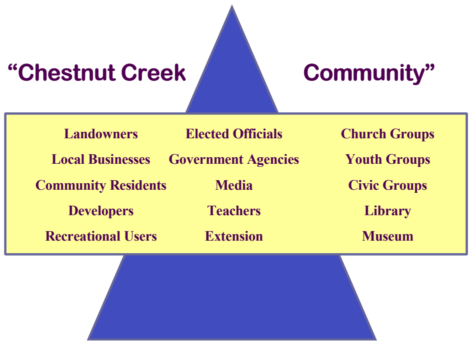
With your participation, a watershed association can become an influential voice in your community. Come find out how.

On Sunday, September 22nd at the Phoenicia Elementary School from 2:00-3:30pm, Robin Ulmer of the Boquet River Association, in the Adirondacks, NY, will be speaking about how their watershed association has influenced the local decision-making about their river and ultimately improved the overall health of the stream.

Ms. Ulmer has directed the Boquet River Association for nearly 12 years. Previously, she was a Peace Corps volunteer, an educator at all levels, conducted research for alternative energy and alternative agricultural cooperatives.

This event is being co-sponsored by the Stony Clove Creek & the Broadstreet Hollow Landowner Association. These two Associations are being developed locally in Ulster and Greene Counties in response to the Management Plans that are being formulated by the Conservation Districts and the Department of Environmental Protection. Please RSVP to Amy at (518) 622-3620 or amy@gcswcd.com Drop-ins welcomed.

Sullivan County Soil and Water Conservation District
64 Ferndale-Loomis Road
Liberty, NY 12754
Email: SCSWCD@IN4WEB.COM
Phone: 845-292-6552 ext. 105
Fax: 845-295-9073



__Community Participation__ The attendants were broken into groups according to the "Management Unit" their property is located in. Each group had a facilitator who helped get the discussion rolling by asking questions concerning Chestnut historical events, concerns and problem areas of the stream, and recreational values and ideas for future community events.

The most predominant historical influence in the watershed was determined to be the construction of the reservoirs. Floods and the damage they have caused were discussed, specifically the floods of 1928, 1938, and 1975. A suggestion made by one group was that the reservoirs might have actually helped with the flooding.

The most frequent concern expressed was that of erosion on personal property. In addition to the sites previously assessed and ranked by the Project Advisory Committee, areas such as erosion and aggradation of gravel and cobble above River Road Bridge, downstream of Davis Lane and Slater Rd, sites on Pepacton Hollow and Red Brook were also recorded as problematic areas.

The Creek was valued most highly for aesthetic purposes. Controversy over fish stocking was noted and questions rose as to whether it hurts the native fish or if there is ample habitat for the native inhabitants to reproduce and sustain a healthy population. It seemed lack of fishing results from an absence of public access to Chestnut Creek, however the majority at the meeting expressed that the reservoirs were also valued for fishing purposes.

Sullivan County Soil and Water
Conservation District
64 Ferndale-Loomis Road
Liberty, NY 12754

Chestnut Creek News

Thank-you to those who attended and the rest of the Chestnut Community for their support and ideas!

Streamside planting volunteers needed!
Another project meeting is to be scheduled this summer.

Sullivan County Soil & Water
Conservation District
64 Ferndale-Loomis Road
Liberty, NY 12754
Email: SCSWCD@IN4WEB.COM
Phone: 845-292-6552 ext. 105
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Chestnut Watershed Public Meeting at Neversink Fire House

On Thursday, May 1, 2003, a meeting was held for the Chestnut Creek Watershed Landowners from 7pm-9pm in the Grahamsville Fire Hall. The purpose of the meeting was to discuss the progress of the Chestnut Creek Management Plan and to collect input from residents regarding their stream related needs, along with their vision of the past, present and the future of stewardship of the Chestnut Creek. Project Partners include the SCSWCD, the Town of Neversink, NYCDEP, and the US Army Corps of Engineers, and the Chestnut Watershed Project Advisory Committee (PAC).

The meeting was attended by a number of Neversink residents who were eager to participate and share their experiences. A special thank you to all the residents who brought pictures to be scanned into the Chestnut Creek archives!

Lori Kerrigan, SCSWCD project coordinator, started off the meeting with a short PowerPoint presentation. Lori proposed ways of organizing the Management Plan that would meet the multi-objective needs of the Watershed.

- Organize resources and contacts
- Investigate and address stream related questions and concerns
- Address permitting issues and funding sources
- Include local history of the stream
- Conduct riparian or streamside vegetation assessment
- Summarize geological and hydrological characteristics
- Include fisheries & recreation information
- Divide recommendations into manageable sections

Chestnut Watershed Management Units

The results of the stream assessment were presented and revealed that Chestnut Creek is for the most part a healthy stream with over 60% of the bank remaining untouched. However, unstable areas do exist. With the information provided by the Chestnut Community we will be able to further evaluate and make recommendations for these sites.

In order to facilitate the organization and prioritization of issues along the stream the Chestnut Watershed Project Team has mapped the condition of the stream in different sections or reaches, called Management Units. Nine Management Units (MU) that were determined according to the following criteria:

Topography	*Geology*
Stream Types	*Vegetation*
Land use	*Population Density*

Within these management units, stable and unstable sections of stream along with historically significant information and landowner concerns are being noted. Several project sites have been prioritized by the Chestnut Watershed Project Advisory Committee as significant community sites, important to the general health of the stream, or repeated problem areas. The following 3 sites were voted highest priority by the PAC. Further assessment of these sites is underway along with the development of designs and plans for the areas:

- Covered Bridge area erosion
- Town Hall bank stabilization and planting
- Pepacton culvert replacement

As funding becomes available, we will prioritize additional sites. Recommendations will be made for

Erosion-left bank behind Town Hall parking lot-view looking downstream with dry hydrant visible in the background

all sites in the Stream Management Plan, with resources and contact information.

Chestnut Creek Management Plan

The Sullivan County Soil and Water Conservation District has been engaged in collecting data and information for the development of a stream management plan for the Chestnut Creek. Now it is time to begin to assemble the Plan. To carry out this task, we need input from you, residents of the Chestnut Creek Watershed. The goals of the Plan, determined last year were to:

- Reduce Flood Risk & Property Damage
- Enhance Fisheries
- Improve Water Quality
- Stream Restoration Projects
- Protect Drinking Water
- Promote Good Stewardship.

Kate Schmidt of the Cornell Cooperative Extension, talked about ways that the community could become more involved in the process. She stressed the importance of good streamside stewardship and the development of a Chestnut Watershed Association that could assist the Project Advisory Committee in keeping abreast of current local issues.

Chestnut Creek News

What's New?

Sullivan County Soil and Water Conservation District (SCSWCD) would like to announce the Demonstration Stream Restoration project at the Town of Neversink, Town Hall in Grahamsville, N.Y., in cooperation with Town Supervisor, Georgianna Lepke, the NYC Department of Environmental Protection, Stream Management Program (DEP SMP), and the Watershed Agricultural Council (WAC). The project will consist of 300 feet of native Catskill flora, planted as a streamside buffer for the Chestnut Creek, along with the repair of two eroded areas along the banks behind the Town Hall. The project is set to commence in September, dependent on the weather.

The Town Hall project site was selected as one of the top ranked sites by the Chestnut Project Advisory Committee (PAC). Some of the other projects proposed require additional site evaluation and preparation and therefore will be considered next year, as funding allows.

Project Details

The project is intended to stabilize the stream, act as a bio-filter for overland runoff and provide an educational forum on best management practices along local streams in this region. The native Catskill plant roots will help to anchor the soils along the stream, and the foliage will provide shade for fish habitat, with the added benefit of flowers and berries to attract birds and butterflies to the Town's amphitheatre and fishing park. The eroded areas along the stream will be remedied by restructuring an already existing low "bankfull" bench that has been scoured by a piece of riprap that was dislodged during a storm event. The low bank, or bench, provides a much needed flood-overflow feature for the stream. This bankfull bench allows small storm flows to dissipate energy by spreading out laterally, in the same manor as a larger storm flow would temporarily spread out over the adjacent floodplain to reduce its velocity.

Small signs identifying the plants species accompanied by an informational pamphlet will be developed in cooperation with the Town and the DEP. In addition, the Catskill Center, through the Catskill Stream and Watershed Education Program with the TriValley School, is attempting to incorporate this site into their curriculum for stream assessment and monitoring, as well as instruction on proper care for streamside habitat.

The Players

The project site planting has been laid out by SCSWCD, with local landscape architect, Barbara Restaino. Georgianna Lepke has provided us with design ideas and support for the preservation of the stream's natural ecosystem. Planning and technical assistance have been provided by Douglas DeKoskie of Integrated River Solutions, Cornell Cooperative Extension (CCE), Natural Resources Conservation Service (NRCS), WAC and DEP SMP staff. Funding for this project has been provided through an ongoing grant with the NYC DEP SMP and WAC. We would also like to thank Gary VanValkenburg of the Town Highway Department for his support.

What can you do?

Volunteers are welcome to assist in the site planting phases to be conducted mid to late September. For more information or to volunteer your assistance please contact SCSWCD at 845-292-6552 ext. 111.

Sullivan County Soil and Water Conservation District
64 Ferndale-Loomis Road
Liberty, NY 12754
Phone: 845-292-6552 ext. 5 Fax: 845-295-9073 email:
scswcd@in4web.com

The Chestnut Creek Stream Management Plan

Volume II of II

Management Units, Resources and Recommendations

March 2004

i. Foreword

It is the distinct pleasure of the Sullivan County Soil and Water Conservation District to release Parts I and II of the Chestnut Creek Stream Management Plan. After three years of teamwork by many dedicated individuals, the initial objectives of this undertaking have been reached, and the Management Plan has come together.

Part I of the Management Plan will be a “reference manual” complete with graphs, tables, pictures, and facts about the stream. It will serve as a guide for broad-based in-depth studies of Chestnut Creek and its tributaries. Part II will be a condensed “field manual” that will serve as a quick guide for general information and will be able to be utilized in the field for application of on the ground work.

It is the hope and desire of the Soil and Water Conservation District that this Management Plan will continue to grow and be updated with time. A plan such as this is never complete; it must be amended and updated continually as needs, suggestions, concerns, zoning, etc. change within the community.

We sincerely hope that this plan will serve as a valuable reference tool for many years to come!

Brian Brustman
District Manager
Sullivan County Soil & Water Conservation District
February 2004

Front cover photo of Crystal Falls, Neversink, New York courtesy of Archie Dean.
Photo taken by Derrick Kelly, WAC.

ii. Acknowledgements

The creation of the Chestnut Creek Management Plan has been enabled by the concentrated efforts of many people, working as a team, over the past three years. Firstly, we appreciate the efforts of Lori Kerrigan, Leslie Kirby, and Brian Brustman, Sullivan County Soil and Water Conservation District (SCSWCD) staff, who helped oversee much of the field effort and the project coordination, and drafted many sections of this management plan. We recognize the contribution of our current Technical Assistant and former AmeriCorps, Barbara Barone, as well as past AmeriCorps, Derrick Kelly and seasonal field crews, especially Christina Falk, for undertaking the tedious process of documentation and data collection.

We would also like to thank the NYC Department of Environmental Protection Stream Management Program (DEP SMP) staff for initiating this stewardship effort, and providing training and technical assistance and for their continued support, especially that of Sarah Miller, Beth Reichheld, Dan Davis, Phil Eskeli, and Beth Gelber . We wish to thank the Chestnut Creek Project Advisory Committee, a team of 35 who are identified in Section 2.0. We especially appreciate the participation of Russel Scheirer who has actively served as liaison to and representative of the landowners on the PAC, with co-representative Carol Smythe, Town Historian who volunteered time and information for the historical section of the plan.

We recognize local organizations such as the Beaver Dam Club, the Grahamsville Rod and Gun Club, Sullivan County Community College Geology Department, the NYS Department of Environmental Conservation (DEC) Fisheries and Habitat divisions, Cornell Cooperative Extension of Sullivan County (CCE) and DEP Division of Water Quality Control (Grahamsville), for their written contributions to the stream management plan.

We would like to acknowledge the Watershed Agricultural Council (WAC) for providing support for the Demonstration Restoration Project. We also recognize the cooperation of Town Supervisor Georgianna Lepke in helping make this effort a reality for the Chestnut Creek Watershed. We appreciate Gary VanValkenburg and the Town of Neversink Highway Department for lending equipment and operators for restoration projects along the Chestnut Creek. We want to thank Barbara Restaino, landscape architect, who also put in many volunteer hours to help design and implement the Demonstration Project. We are grateful for the advice and guidance of Natural Resources Conservation Service (NRCS) and CCE. We also thank Crystal Falls Farm for supplying so many of the materials needed for the project. We wish to acknowledge Integrated River Solutions (IRS) for the effort they have expended to better the restoration project.

A special thanks is extended to both IRS and Clear Creeks Consulting for providing recommendations and analysis for the stream management plan and management units. We recognize the contribution of the staff of the Sullivan County SWCD who showed great support for their colleagues throughout the development of the plan and the completion of the Grahamsville Town Hall demonstration project in Fall 2003 This stream management plan would not have been possible without its funders, and we thank the DEP SMP through the Water Resources Development Act of 1996 (WRDA), WAC, and the US Army Corps of Engineers under the Watershed Environmental Assistance Program.

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2. Riparian Land Use and Public Infrastructure
3. History of Stream and Floodplain Work
4. Channel Stability and Sediment Supply
5. Riparian Vegetation
6. Restoration and Management Recommendations

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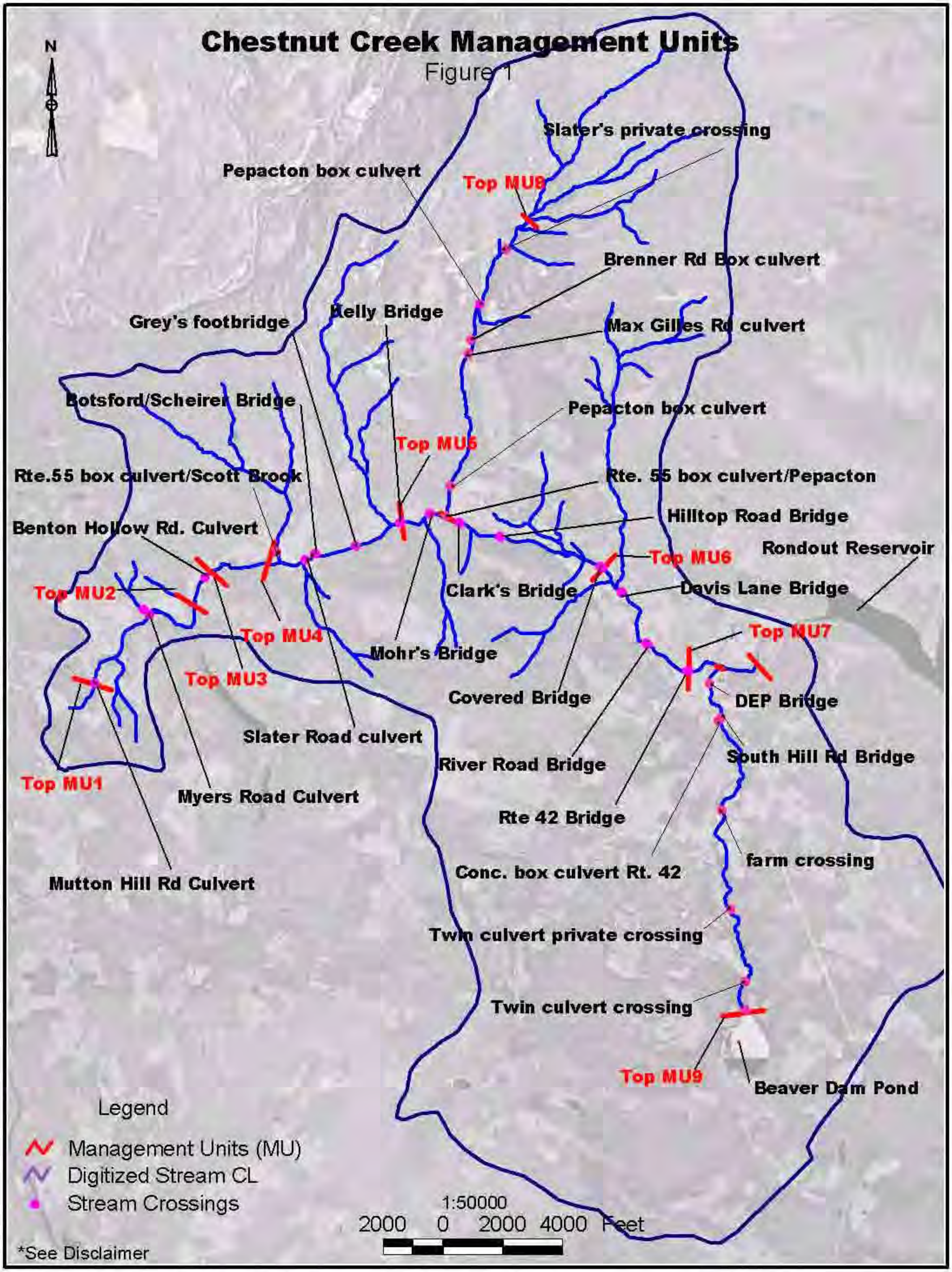
I. Chestnut Creek Stream Management Unit Descriptions

Introduction

In this section of the Plan, landowners will find the descriptions of their immediate "stream neighborhood". The following sections provide detailed maps and descriptions of stream and infrastructure features documented as part of the Stream Assessment Survey conducted in 2001.

The main stream, as well as the main tributaries of Pepacton Hollow and Red Brook, have been organized into *Management Units* (MUs). The MUs were created by using physical stream characteristics, property boundaries, location of bridges and road infrastructure, and valley characteristics. The MU descriptions and companion maps outline stream conditions (its bed and banks), general streamside (riparian) vegetation condition, and proximity and arrangement of roads, bridges and culverts. Conditions and recommendations are organized by management objectives in the areas of Infrastructure and Private Property near the stream, History of Stream Work conducted previously, Exposed Banks and Sediment Supply to the stream, and Riparian Vegetation. These descriptions provide guidance and suggestions for specific projects or assessments in these categories, as well as for additional monitoring that might provide further detail to define specific problems.

This section provides a useful reference for the extent of current problems at a localized stream reach scale, with specific recommendations for action, and references to other sections of the plan for further information or resources



Chestnut Creek Management Units
Figure 1
N
Slater's private crossing
Pepacton box culvert
Top MU8
Brenner Rd Box culvert
Grey's footbridge
Kelly Bridge
Max Gilles Rd culvert
Botsford/Scheirer Bridge
Pepacton box culvert
Top MU5
Rte.55 box culvert/Scott Brook
Rte. 55 box culvert/Pepacton
Hilltop Road Bridge
Benton Hollow Rd. Culvert
Top MU6
Rondout Reservoir
Top MU2
Clark's Bridge
Davis Lane Bridge
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River Road Bridge
South Hill Rd Bridge
Top MU1
Myers Road Culvert
Rte 42 Bridge
farm crossing
Conc. box culvert Rt. 42
Mutton Hill Rd Culvert
Twin culvert private crossing
Twin culvert crossing
Top MU9
Beaver Dam Pond
Legend
Management Units (MU)
Digitized Stream CL
Stream Crossings
1:50000
2000 0 2000 4000 Feet
*See Disclaimer

Chestnut Creek Management Unit and Stream Assessment Survey Metadata and Disclaimer

Aerial Photography, and GIS Parcel, Contour, Stream and Wetland coverages are edited and provided by NYC DEP, 2000, UTM NAD 27, Zone 18 North, meters. 2001 & 2002 Stream Assessment Survey coverages were developed by SCSWCD using GPS in the UTM, Zone 18 North projection, NADCON (Conus), datum. Cross section locations, stream type and MU boundaries have been digitized and are approximate. Many themes have been edited to reflect changes or improve accuracy.

Disclaimer Note: G.I.S. data are approximate according to their scale and resolution. Data may be subject to error and are not a substitute for on-site inspection or survey. Parcel coverages are based on Sullivan County Real Property tax maps 2000 and may not reflect actual surveyed property boundaries.

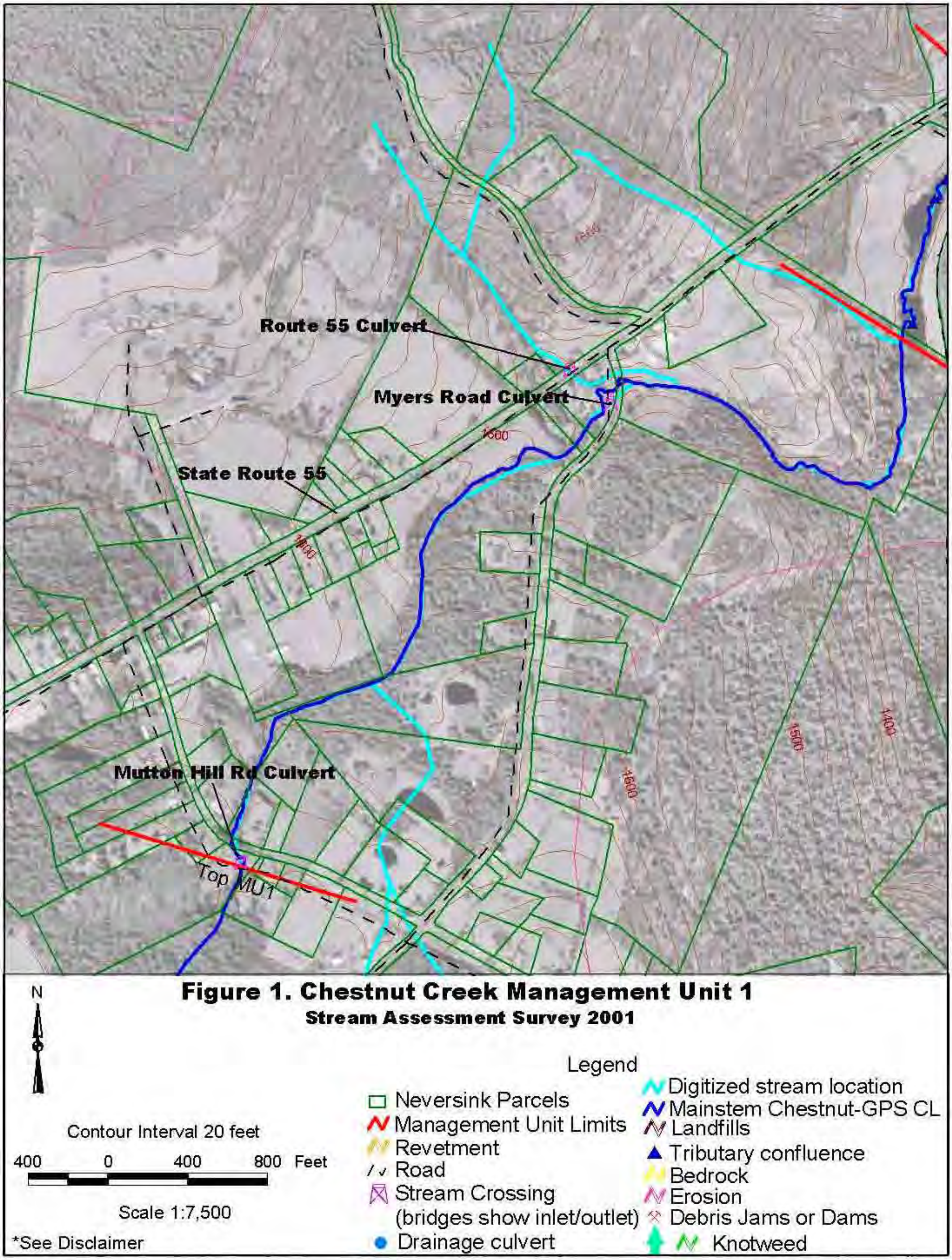

Figure 1. Chestnut Creek Management Unit 1
Stream Assessment Survey 2001

A. Chestnut Creek Management Unit 1

1. Summary Description

This section is intended to summarize the overall character and condition of Management Unit 1 (MU1). Subsequent sections will discuss specific issues (e.g., *riparian* land use and public infrastructure, *channel stability*, etc.) in greater detail.

This unit has two sections (see MU1 general map, Figure 1). The upstream section is approximately 450 linear feet (0.085 miles) in length, beginning at the *culvert* where the stream crosses Mutton Hill Road (Photo 1). This section was assessed using a field-based stream assessment method (Methodology used to accomplish goals, Volume I, Section I.E), and will be the focus of more detailed description below. The downstream section extends approximately 5,000 feet (0.947 miles) to the top of Management Unit 2, just downstream from the *confluence* of a small, unnamed *tributary*, where the stream moves from the largely forested setting that characterizes MU1 to the open grassy *wetland* characterizing MU2. The last few hundred feet of MU1 contain a large forested wetland (Photo 2).

Photo 1. View looking upstream toward culvert under Mutton Hill Road. Laid-up stone walls on both banks, small pump on right bank.

Photo 2. Looking upstream from MU2, trees and grassy flood-plain typical of this type of channel.

The downstream section of MU 1 was assessed using remotely sensed data sources (primarily aerial photographs). The *drainage areas* at the upstream and downstream ends of the upstream section of MU1 are 0.12 and 0.14 square miles, respectively. The drainage areas at the upstream and downstream ends of the downstream section are 0.14 and 0.84 square miles, respectively.

Land use along the stream corridor through both sections is predominantly forest along adjacent hillslopes, with some residential development. *Riparian* areas in the upstream section are maintained in generally well-vegetated, narrow residential woodland, including hemlock and birch (Photo 3). The downstream section is also primarily forested along the southern (right) bank. There is little impervious area in the stream corridor in this unit. Storm water runoff is conveyed

Photo 3. View looking upstream toward private foot bridge and waterfall from below XS-5. As seen here, riparian, or stream side vegetation plays an important role in the health of the stream and aquatic ecosystem.

predominantly as sheet flow through both cleared and forested areas, with culvert crossings at road locations.

An analysis of a series of historic aerial photographs covering the period 1974-2001 indicates that routine channel maintenance has not been widespread through MU1, except in the immediate vicinity of Route 55, Mutton Hill and Meyers roads (Aerial Photos 4, 5, 6, 7, 8, & 9). The stream crosses through culverts under two roads and runs along a private road behind the Crystal Falls Farm quarry.

The landowner carefully maintains the upstream section of MU1, primarily with hand-worked stone on one or both banks throughout most of this section (Photo 10).

Photo 10. View looking upstream from private foot bridge. Both banks are laid-up walls.

Photo 4. 1974 Aerial Photograph of the upstream section of MU1.

Photo 5. 1985 Aerial Photograph of the upstream section of MU1.

Photo 6. 2001 Aerial Photograph of the upstream section of MU1.

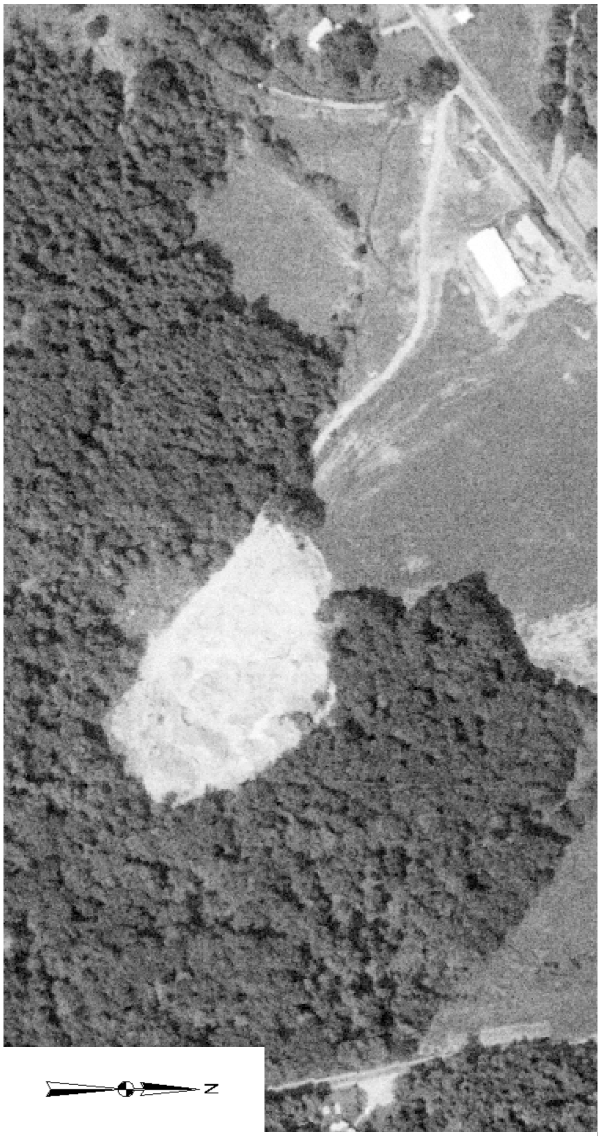

Photo 7. 1974 Aerial Photograph of the downstream section of MU1.

Photo 8. 1985 Aerial Photograph of the downstream section of MU1.

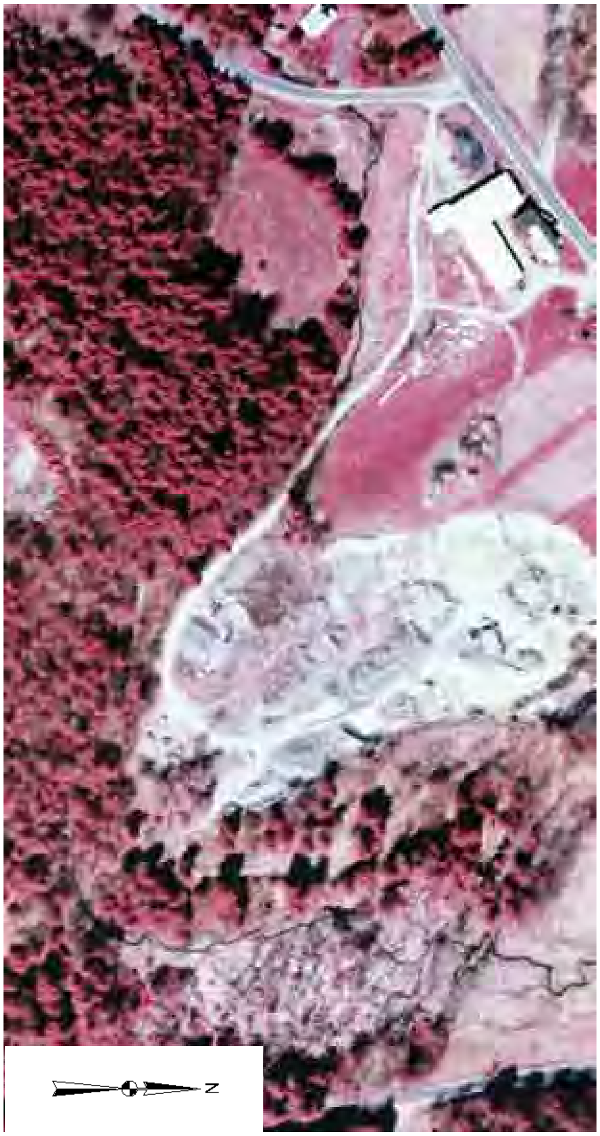

Photo 9. 2001 Aerial Photograph of the downstream section of MU1.

Much of the stonework is maintained with special attention to preserving riparian trees, adding to the stability of MU1, particularly in especially narrow sections near the top and in the vicinity of a private bridge crossing with a high, built step (Photo 11). These channel modifications have resulted in a somewhat confined channel with a low width/depth ratio (from 8 to 20 feet), but with very low *entrenchment* despite the steep slope (from 2% to nearly 8% slope in some sections) (Introduction to Stream Processes and Ecology, Volume I, Section III).

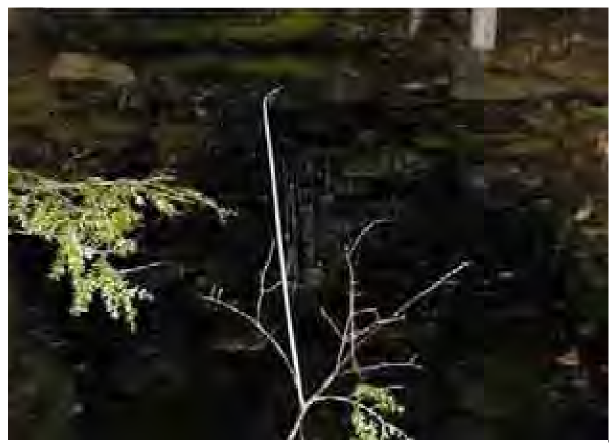

Photo 11. View looking upstream toward small step/ pool waterfall below private bridge.

Because of ongoing channel modifications and maintenance, the *stream types* in the upstream section are not typical of what would be expected in this setting under natural conditions, though the current configuration appears to be functioning well. The stream is very small in this *headwaters* location, with *bankfull* channel cross sectional area between 2.5 and 4.5 square feet (Photo 12). As such, the adjacent *floodplain* and riparian areas are not as susceptible to flood inundation problems, though may be more susceptible to ongoing stability problems due to the

Photo 12. View looking upstream toward XS-10 from XS-11.

typically "flashy" nature (rapid rise and fall of *stage* during floods) of headwaters areas and the steep slope in this section.

2. Riparian Land Use and Public Infrastructure

There are 22 parcels within the stream *corridor* along MU1 that include predominantly private residences and undeveloped areas. As noted above, development of the riparian corridor has historically been light, with some residential development and clearing of forested areas especially along the *left bank* throughout the downstream section, though fairly consistent riparian corridors are evident in the entire aerial photographic series.

Maintenance of public infrastructure is always a concern for local municipalities. The Chestnut Creek crosses under Mutton Hill and Myers Roads in MU1 and is conveyed by use of culverts (Photos 13 & 14).

There is one small unnamed tributary that enters the Chestnut above Myers Road through a small culvert under Route 55.

Photo 13. Tributary through culvert, Mutton Hill Rd.

Photo 14. Tributary through culvert under Meyers Rd.

No further information or assessment of these culverts was obtained.

Volume as well as water quality of runoff is a function of the size and characteristics of the land area each system drains. For example, land areas with a high percentage of *impervious surfaces* tend to generate considerably more runoff than areas that are predominantly forest or lawn. Size and land use characteristics of areas draining to identified outfalls (culverts), as well as potential for storm water retrofit opportunities were not evaluated as part of the initial assessment. However, a review of aerial photographs indicates MU1 has very little impervious surface presently, though the trend of expanding residential developments shown in the aerial photo series could continue, potentially adding impervious area to this unit depending on stormwater management strategies implemented in development designs.

3. History of Stream and Floodplain Work

As noted Chestnut Creek appears to have been managed at some time in the past in the vicinity of road crossings and expanding development. Channel work to remove *gravel* deposits and maintain flood conveyance has been routine in the past, commonly used throughout Chestnut Creek to maintain infrastructure. Development of the riparian corridor along Chestnut Creek has historically involved floodplain fill and/or the construction of flood *berms* to protect structures placed in these areas – the presence of this kind of development in MU 1 cannot be assessed from aerial photos, there were no berms in the upstream section. Filling floodplain areas to accommodate development on private as well as public land is still a common practice in the Chestnut Creek watershed.

General impacts of traditional approaches to stream management have been addressed in the Watershed Recommendations for Best Management Practices, Volume II, Section II.A of this plan. Specific impacts and management considerations in relation to the assessment of MU1 are included with this section of the plan.

4. Channel Stability and Sediment Supply

During the 2001 Stream Corridor Survey, MU1 was divided into 9 *reaches* on the basis of the Level II – Morphologic Description (Rosgen, 1996). The largest portion (47%) of this unit includes moderately entrenched channel types B and Ba (MU1 Stream Type & Cross Sections location map, Figure 2). With a low width to depth ratio (i.e., 11 – 16) and mature vegetation on the banks these types of channels tend to be very *stable* and are generally effective at moving *sediment* transported from upstream reaches. Although mature trees and shrubs provide lateral control along much of the management unit, channel maintenance activities in the upstream portion have left all of the reaches in this unit with moderate to low width to depth ratios making them more efficient at moving sediment (Photo 15), though not necessarily prone to severe *downcutting*, especially in reaches with coarser sediment in the lower reaches of the upstream section (Photo 16).

Highly entrenched reaches (i.e. F-types)

Photo 15. View looking upstream from XS-6 at narrow, well forested gravel and cobble bed stream.

Photo 16. View looking upstream toward XS-9 and large boulder in stream bed.

account for 9% of the total length. Because they lack a floddplain area (i.e., an area adjacent to the channel where floodwaters can spread out and reduce the energy against the streambed and banks), entrenched reaches experience considerable stress during storm flow and tend to be more susceptible to stability problems, particularly bank *erosion* and bed scour or *degradation*. In addition, these types of channels route storm flow quickly to downstream reaches where they can contribute to channel instability and flooding.

Morphological data collected along the reaches is summarized in Table 1 and illustrated in Figure 2. As can be discerned in the aerial photographs, the channel *planform*, or stream pattern, along this management unit is characterized by relatively low *sinuosity*, though shows a few truncated *meanders*. The greatest alteration in meander geometry appears to be associated with road locations, though does not appear to have changed appreciably since the 1970s. What

Table 1 - Summary of Morphological Data for Reaches along Management Unit 1 .

Reach	Length (ft)	Area (ft^2)	Width (ft)	Mean Depth (ft)	W/D	Ent.	Slope (ft/ft)	Stream Type
1	123	2.7-4.6	3.1-4.4	0.9-1.1	4	2.7-2.9	0.039	E4b
2	13	4.1	5.6	0.7	8	1.4	0.110	A3a+
3	31	4.3	7.5	0.6	13	1.5	0.021	B4
4	19	3.9	8.8	0.4	20	1.1	0.044	F4a
5	13	3.0	6.5	0.5	14	2.4	0.041	C4b
6	182	2.8-4.6	5.6-8.6	0.4-0.5	11-18	1.5-2.2	0.068	B4a
7	23	2.5	4.2	0.6	7	1.9	0.047	A3
8	26	3.9	6.9	0.6	12	3.3	0.071	E3a
9	20	3.0	7.1	0.4	17	1.3	0.030	F3b

alteration has occurred has likely been the result of minor channel adjustments to accommodate the roads, some development of properties along the stream corridor, and periodic channel maintenance at culverts and stream crossings.

The effects of the channel maintenance and natural adjustments are most evident between the 1974 and 2001 aerial photographs. Apparent from the imagery is slight alignment changes near the culvert at Myers Road and some shifting of the channel south away from the road constructed to serve the Crystal Falls Farm quarry just upstream from the large meander bend near the bottom of the unit. This change has been gradual judging by the aerial photo series, associated with increased usage of land and road in the quarry area. The smaller channel area near the top of MU1 can only be seen as the line of riparian trees, apparent in each of the four photos, and appears not to have changed appreciably in the last 30 years.

As pointed out in Introduction to Stream Processes and Ecology, Volume I, Section III, natural streams are composed of three distinct flows that include: a *baseflow* or low flow channel, which provides habitat for aquatic organisms; a *bankfull* channel, which is critical for maintaining sediment transport; and a floodplain, which effectively conveys flows greater than the bankfull discharge (i.e., 1 – 3-year peak flow).

Standard engineering practice includes designing channels to convey large storm flows (e.g., 25-, 50-, or even 100-year peak flows) without overtopping adjacent streambanks. While enlarging the channel to improve its ability to convey storm flows may seem logical, in fact this approach usually creates channels that have poor habitat, are ineffective at transporting sediment, and require constant maintenance. These engineered channels are generally designed to convey all flows (baseflow, bankfull flow, and flood flow) in a single channel that is relatively straight, very wide and trapezoidal in *cross-sectional area*, with a uniform profile.

In these altered channels, baseflow is usually very shallow or may actually flow beneath the *substrate* because it is spread out over such a large surface area. The uniform profile replaces the typical *riffle-pool* sequence with a continuous shallow riffle or run that provides no cover for fish to avoid predation or strong flushing currents. A very wide, shallow channel is less efficient at moving sediment under bankfull flow conditions. As a consequence, sediment (e.g., *sand, gravel, cobble*) tends to accumulate, developing lateral and/or mid-channel bars along these altered reaches. Ironically, the accumulation of sediment and the development of bars significantly reduce the channel's capacity to convey the large storm flows for which it was designed.

The 2001 Stream Assessment Survey conducted by SCSWCD did not contain enough detail in the downstream section to show large areas of *aggradation,* though some shifting in channel pattern is evident in the vicinity of the Myers Road culvert. The upstream section did not show any pattern of ongoing aggradation, though could be at higher risk for degradation due to low width to depth ratios and high bank height ratios.

Hand-stacked rock walls and *rip-rap* currently provide lateral control along the channel in the upstream section, and mature riparian vegetation provides lateral control throughout MU1. These lateral controls appear to have maintained the current channel planform through the last several decades, the notable exceptions being in locations near the stream crossing, where riparian coverage is inadequate, and the channel can therefore be seen in the aerial photographs.

Lateral control along the majority of the management unit in the downstream section is provided by mature trees and shrubs. Preliminary observations indicate that most of the channel along this management unit is laterally stable (i.e., bank erosion rates are low). Bank height to bankfull ratios along the upstream section of this unit ranged from an estimated 1.0 to nearly 2.0, confirming that a significant length of the channel is *incised,* even though entrenchment ratios show low entrenchment. Rosgen (2002) notes that bank to bankfull height ratio is a good measure of vertical stability, as well as an indicator of sediment supply potential. Because this upper section is well maintained, and there is a significant grade control at the private foot bridge within this section (Photo 9), any continued downcutting will not likely result in large-scale instability or increased sediment supply.

Debris jams and other channel obstructions can cause problems by deflecting storm flows into stream banks and trapping sediment, which initiates the development of gravel bars and reduces channel capacity. At the time of the Assessment Survey debris jams were not a significant problem along the reaches in this unit.

As part of the Assessment Survey *monumented cross-sections* were installed in a number of locations along Chestnut Creek to monitor stream bank erosion and streambed changes (e.g., aggradation) in specific reaches of concern. Due to the generally stable condition within the upstream section of this unit, no monitoring cross sections were installed. The downstream section was not assessed to the level of detail to determine site-specific erosion, and no monitoring will be done in this section.

Evaluating reaches along Chestnut Creek to determine whether they are contributing to sediment problems in the Chestnut Creek/Rondout Reservoir System was a component of the Assessment Survey. Preliminary results of the field work indicate that there are few actively eroding banks or mid-channel bars (as noted above) that could provide a source of sediment to downstream reaches. Where they accumulate, sediments can reduce channel capacity and contribute to localized channel stability problems, as may be the case in the vicinity of the Myers Road culvert.

Sediment eroded from the reaches along Chestnut Creek is generally coarse (i.e., sand, gravel and cobble). Unlike other watersheds where exposed *silt* or clay deposits are a water quality concern because they contribute very fine material to the suspended load, these coarser sediments tend to move as bed load and settle out quickly after storms. As a consequence, sediment eroded from the streambed and stream banks along this management unit does not appear to directly affect water quality within the Chestnut Creek/Rondout Reservoir System.

5. Riparian Vegetation

The riparian area along Management Unit 1 can be characterized as: reaches adjacent to developments or cleared areas with scattered trees and shrubs; reaches with small wooded buffers of mature trees, shrubs, and herbaceous plants; and reaches along steep hillslopes and/or terraces with mature forest. In riparian areas where small wooded buffers are present, their width varies from 75 feet to 2000 feet. Along developed properties, the riparian vegetation has been affected by clearing, routine maintenance, or other land use activities. Properties along the stream corridor with the lowest percent of riparian vegetation and buffer include primarily the left bank along most of the downstream section of the unit, though the right bank typically contains large expanses of wooded area. The notable exception to this is the section of stream downstream from the culvert at Myers Road where the aerial photographs indicate very little riparian vegetation, and no woody vegetation, along both sides of the stream. The upstream section contains well-wooded, though somewhat narrow, riparian areas along both banks.

The presence of two problem *invasive* exotic species, *multi-flora rose* and *Japanese Knotweed*, was not found in this management unit. These species have caused problems elsewhere in the Chestnut Creek, primarily leading to bank instability and crowding out native vegetation that has ecological as well as stability benefits.

Of perhaps future ecological significance is the presence of Hemlock Wooly Adelgid. This insect pest was noted on the underside of Hemlock needles in this headwaters section of the Chestnut Creek. Hemlock Wooly Adelgid causes approximately a 90% mortality rate within 5 years of infection. See the Riparian Vegetation Issues in Stream Management section for more information on sighting and dealing with Wooly Adelgids (Also see Riparian Vegetation Management Recommendations, Volume II, Section II. A.1).

6. Restoration and Management Recommendations

As presented previously, the Chestnut Creek Management Plan will be utilized to guide and facilitate stakeholders in their efforts to correct stream channel instability problems, restore and maintain natural floodplain functions, control runoff from developed areas to reduce pollutant loadings from channel and upland sources, restore and protect in-stream habitat, and reduce the need for future channel maintenance.

This section includes specific restoration and management recommendations for Management Unit 1 for the Chestnut Creek Watershed. The SCSWCD, NYCDEP, and other agencies and organizations will be working with the community to implement restoration and management strategies outlined in this Management Plan. Stream and upland area projects must be integrated to avoid potential conflicts in their respective objectives. Therefore, this section also includes comments and recommendations regarding integration of proposed strategies in upland areas, in particular floodplain management and storm water management practices.

Restoration and Management Recommendations Management Unit 1

1. Implement storm water management for properties with the highest percent impervious surface along the corridor including the quarry and any other significant impervious areas identified during the field reconnaissance recommended below. Storm water management facilities should be designed to provide water quality management for the first half-inch of runoff and quantity management that reduces the peak discharge runoff rate for the 1 – 3-year storm flows.

2. Evaluate the potential for reconstructing the channel and/or augmenting riparian vegetation along the historically active reach below the culvert at Myers Road. Evaluate the culvert at road crossing to determine the best method for reducing scour and improving sediment transport and conveyance of bankfull and flood flows, if this is determined to add to channel instability in this area. Install flow diverting structures (e.g., rock vanes, J-Hook vanes, etc.) at key points along the channel to reduce stress in the near bank region.

3. Stabilize banks and provide long-term lateral control by reestablishing bank vegetation composed of native trees, shrubs and grasses along the left bank in the downstream section.

4. Research the extent of Wooly Adelgid infestation, develop and implement a strategy for control.

5. Maintain or increase vegetative buffer in area of the quarry to control sediment runoff contribution to the stream.

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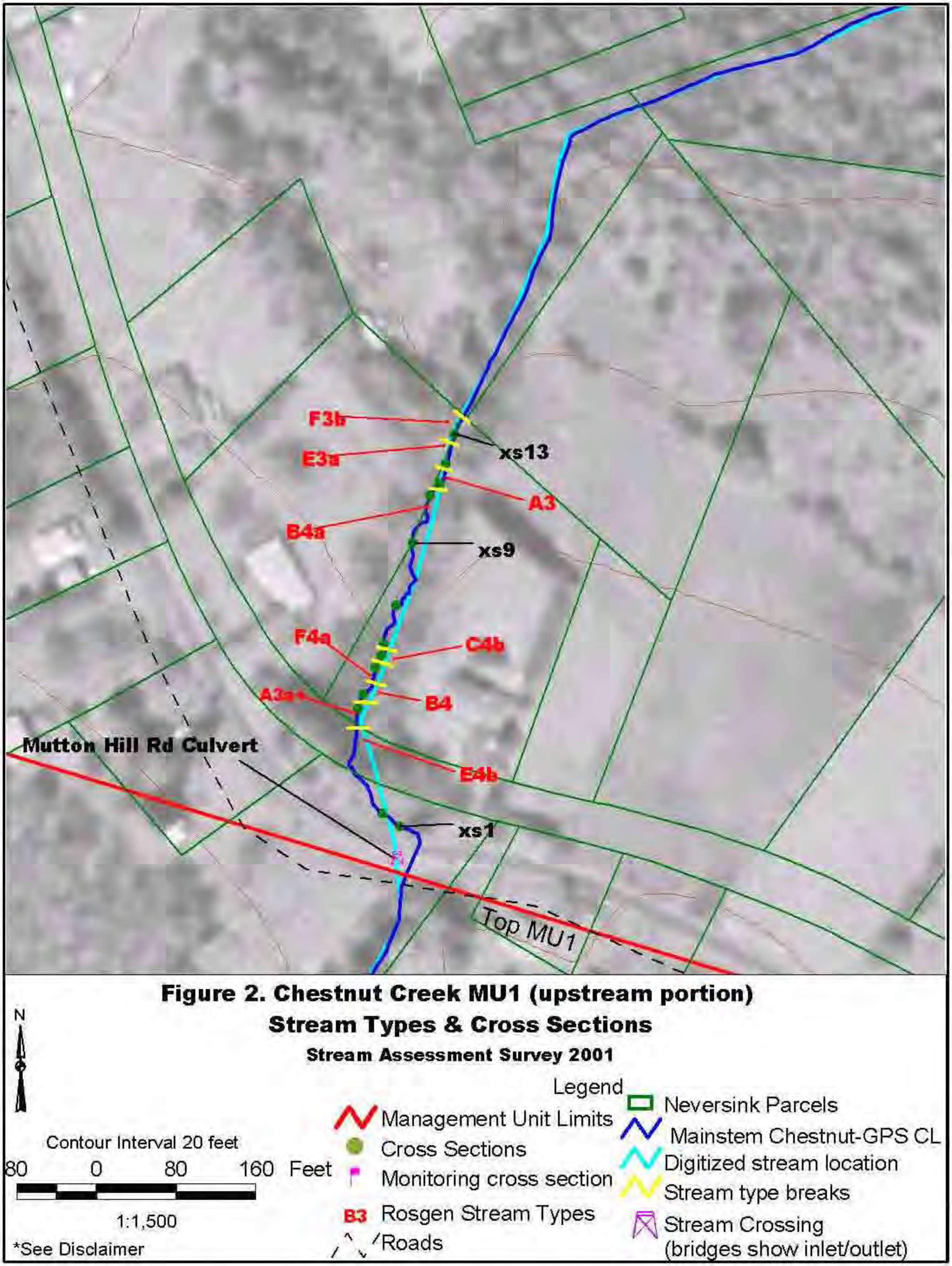

Figure 2. Chestnut Creek MU1 (upstream portion)
Stream Types & Cross Sections
Stream Assessment Survey 2001

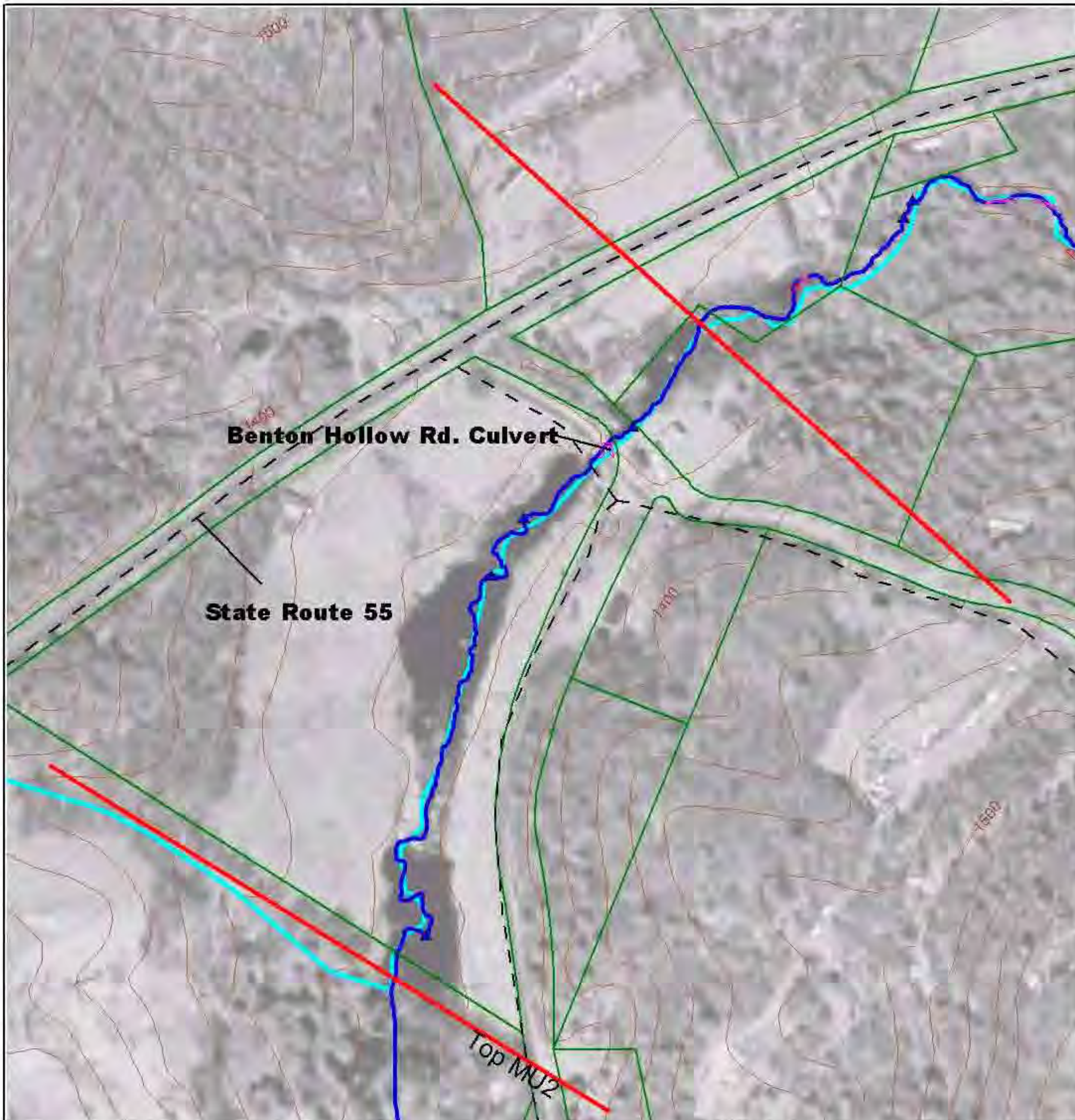

Figure 1. Chestnut Creek Management Unit 2

Stream Assessment Survey 2001

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Contour Interval 20 feet

100 0 100 200 300 400 Feet

Scale 1:3,000

*See Disclaimer

Legend

Neversink Parcels
Management Unit Limits
Revetment
Road
Stream Crossing (bridges show inlet/outlet)
Drainage culvert
Digitized stream location
Mainstem Chestnut-GPS CL
Landfills
Tributary confluence
Bedrock
Erosion
Debris Jams or Dams
Knotweed

B. Chestnut Creek Management Unit 2

1. Summary Description

This section is intended to summarize the overall character and condition of Management Unit 2 (MU2). Subsequent sections will discuss specific issues (e.g., riparian land use and public infrastructure, channel stability, etc.) in greater detail.

MU2 is approximately 1600 feet (0.30 miles) in length and includes the segment of Chestnut Creek from approximately 950 feet up valley to 300 feet down valley of the Benton Hollow Road culvert crossing. The *drainage area* at the upstream and downstream ends of the management unit is 0.84 and 1.21 square miles, respectively, without the introduction of any major *tributaries* (MU2 general map, Figure 1).

MU2 begins at the transition of the *corridor* from a forested wetland setting to a grass dominated meadow (Photo 1). The *channel* is narrower, less steep, and has a greater *sinuosity* and *floodplain* connection than upstream and downstream units. Channel materials consist of *sand* and *gravel*, which deviate from connecting units dominated by coarser sediments. *Sediments* are stored in the form small side channel *bars*, however the general minimal occurrences of the formations as well as vegetative characteristics indicate that the reach is effective at moving supplied sediment. The floodplain connection serves an important function for the inventoried *stream types*. The physical condition of the channel is generally *stable*, however it is suspected that the unit is susceptible to disturbance if the vegetative structure does not remain intact (Introduction to Stream Processes and Ecology, Volume I, Section III).

Photo 1. View looking upstream toward XS-17.

Land use along the corridor is primarily noncultivated fields with a few homes located along Neversink and Benton Hollow Roads. Vegetation along the corridor is predominantly grassland meadow along the head of the unit and along the channel in wetter areas. Vegetative communities transition to shrubs and larger trees between the Benton Hollow Road culvert and the start of Management Unit 3. Impervious surfaces include Neversink and Benton Hollow Roads and two residential properties along the adjacent hill slopes and floodplain. One particular residence located along the downstream outlet of the culvert was constructed in close proximity to the channel and is potentially located within the 100-year floodplain. Although privately owned, only a small percentage of the land area contains impervious surfaces or is maintained as lawn.

An analysis of a series of historic aerial photographs covering the period 1974-2001 documents the stability of the reach and consistent land use. The area has remained grassland meadow with dense vegetation and minimal change in land use and riparian structure in the 30-year record. There was considerable evidence of channel lateral adjustment through the series, but deemed consistent with the stream types present. (Aerial Photos 2, 3, & 4).

The 1995 aerial photo and the 2000 map backdrop show the area of Management Unit 2 inundated with water. Although the causes of the increased stage have not been investigated, it is presumably caused by a high flow event, a downstream channel or debris blockage, or beaver damming.

Field inventories, as well as information obtained from interviews with residents and town officials indicate that MU2 has required minimal recent maintenance activity.

As documented in following management units, downstream units of Chestnut Creek have been substantially modified by development within the stream corridor. These modifications have degraded habitats through a variety of means, including the fragmentation and destruction of habitat by road construction and development, and the introduction of invasive plants, such as Japanese knotweed and multiflora rose. These invasive species, as well as the anthropogenic modifications to the *riparian* corridor have jeopardized important secondary corridor benefits; including critical habitat, food, shade for the stream, filtering mechanism for pollutants in runoff, and travel ways for wildlife. The ability to support present and future wildlife populations, including

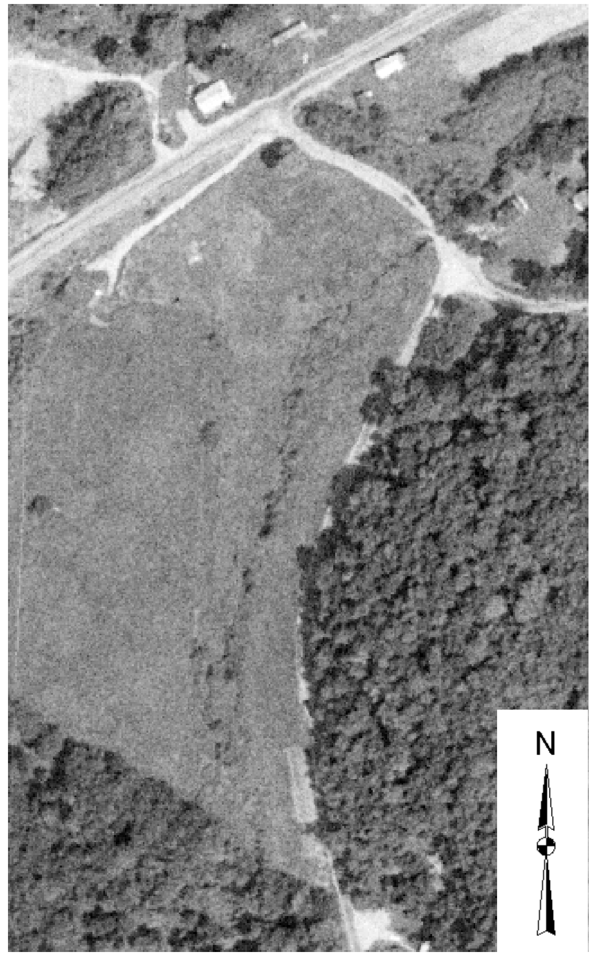


Photo 2. 1974 Aerial Photograph of Management Unit 2.

Photo 3. 1995 Aerial Photograph of Management Unit 2.

Photo 4. 2001 Aerial Photograph of Management Unit 2.

riparian habitat critical for migratory birds, waterfowl, and other river dependant species will be heavily dependant upon the management of riparian lands. Therefore, the focus of concern for MU 2 is for the preservation of the current healthy riparian community, which will in turn assist in preserving the general physical stability of the unit (Riparian Vegetation Issues in Stream Management, Volume I, Section IV.B.3, and Riparian Vegetation Management Recommendations, Volume II, Section II.A.1).

2. Riparian Land Use and Public Infrastructure

There are five privately owned land parcels in within the stream corridor along MU2. The land may have been historically cleared for agricultural purposes leaving the corridor without larger tree species that dominate corridors along both upstream and downstream units. Current land use along the corridor is primarily non-cultivated fields with a few residences located along Neversink and Benton Hollow Roads. Vegetation along the corridor is predominantly grassland meadow at the head of the unit and along the channel in wetter areas. Vegetation species transitions to shrubs and larger trees below the culvert at the connection with the downstream unit. As stated, impervious surfaces include the Neversink and Benton Roads and two homes containing ancillary structures along adjacent northern hill slope and lower southern floodplain. One particular residence in the floodplain and is located at the outlet of the culvert in close proximity to the channel. Although privately owned, only a small percentage of the land area contains impervious surface or is maintained as lawn.

The current stream corridor through MU 2 is sparsely populated and displayed only minor anthropogenic impact from the private residence. The potential for population growth along the unit generates concern for proper planning and land use. In comparison, historic development and continued encroachment have been noted along lower portions of Chestnut Creek. Several management units have displayed impacts both at the management unit level, and throughout the entire main stem.

In general, the volume as well as the water quality of the runoff is a function of the size and characteristics of the land area each system drains. For example, land areas with a high percentage of impervious surfaces tend to generate considerably more runoff than areas that are predominantly forest. The impacts become more pronounced when applied to areas containing small amounts of development as an initial condition.

Maintenance and public infrastructure is generally a concern for local municipalities. The Chestnut Creek flows through one culvert under Benton Hollow Road in the lower portion of the unit (Photo 5). The construction of the road and culvert may affect the conveyance of

Photo 5. View looking upstream at culvert under Benton Hollow Road.

flows from the upstream drainage. As stated, the relative size (hydraulic opening) and elevation of the road base in relation to the floodplain, presents a management concern. Inspection of the culvert, in combination with assessments of upstream and downstream channel geometries or *planform*, determined that the width of the culvert opening is significantly less than the *bankfull* channel widths of surrounding reaches. This condition can generate a backwater effect above the culvert and potentially lead to sedimentation, accumulated channel debris and accelerated channel migration upstream of the structure and possibly affect the channel and properties downstream as well.

Management of the current culvert configuration should include field inspections of debris blockages at the culvert as well as evidence of upstream flood elevations after storm events. Scheduled replacement and future improvements should incorporate *geomorphic* considerations of stream shape and condition for both the upstream and downstream reaches. Design considerations should include the natural slope break of the valley surrounding the reach, potential for channel aggradation or degradation, and protection/enhancement of the current floodplain connection, as well as the size and placement of the structure.

As pointed out in the Introduction to Stream Processes and Ecology, Volume 1, Section III, natural streams are composed of three distinct flows that include: a *base flow* or low flow channel, which provides habitat for aquatic organisms; a bankfull channel, which is critical for maintaining sediment transport; and a floodway or floodplain, which effectively conveys flows greater than the bankfull discharge (i.e., 1 – 3-year peak flow).

It is standard engineering practice to design bridge and culvert crossings so that they can safely convey large storm flows (e.g., 25-, 50-, or even 100-year peak flows) without overtopping the structure and associated roadway. In addition, the channel immediately upstream and downstream of bridges is commonly reconstructed (i.e., channelized) so that it contains those same storm flows without overtopping the adjacent streambanks. While enlarging the channel to improve its ability to convey storm flows may seem logical, in fact this approach usually creates channels that have poor habitat, are ineffective at transporting sediment, and require constant maintenance. These engineered channels are generally designed to convey all flows (base flow, bankfull flow, and flood flow) in a single channel that is relatively straight, very wide, and trapezoidal in *cross-sectional area*, with a uniform profile.

In these altered channels, baseflow is usually very shallow or may actually flow beneath the *substrate* because it is spread out over such a large surface area. The uniform profile replaces the typical *riffle-pool* sequence with a continuous shallow riffle or run that provides no cover for fish to avoid predation or strong flushing currents. A very wide, shallow channel is less efficient at moving sediment under bankfull flow conditions. As a consequence, sediment (e.g., *sand, gravel, cobble*) tends to accumulate, developing lateral and/or mid-channel bars along these altered reaches. Ironically, the accumulation of sediment and the development of bars significantly reduce the channel's capacity to convey the large storm flows for which it was designed. The stream through MU2 seems to have had very little alteration and hence has maintained a natural channel that transports sediment well and should be preserved as such.

3. History of Stream and Floodplain Work

As noted, many of the other MUs along the Chestnut Creek appear to have been managed at some time in the past in the vicinity of road crossings and expanding development. Channel work to remove gravel deposits and maintain flood conveyance has been routine in the past, commonly used throughout Chestnut Creek to maintain infrastructure. Development of the riparian corridor along Chestnut Creek has historically involved floodplain fill and/or the construction of flood *berms* to protect structures placed in these areas.

The 2001 Stream Assessment Survey revealed no evidence in MU2 of floodplain filling, berms or channel maintenance other than for the historic construction Benton Road. Further, the assessment of the historical aerial photography of MU 2 did not reveal any significant stream channel *stabilization*, modification, or maintenance although the central portion of the Management Unit appears to have been straightened at some point prior to 1974. Management of the reach including any future floodplain work should incorporate natural channel design principles with the understanding of the stream types present.

General impacts of traditional approaches to stream management have been addressed in the Watershed Recommendations for Best Management Practices, Volume II, Section II of this plan. Specific impacts and management considerations in relation to the assessment of MU 2 are included with this section of the plan.

4. Channel Stability and Sediment Supply

During the 2001 Stream Assessment Survey, MU2 was divided into five reaches on the basis of the Level II – Morphologic Description (Rosgen, 1996). The largest portion (67.5%) of this unit includes slightly and moderately entrenched channel types C5 and C4. Mature grasses provide lateral control along the majority of these reaches (Photo 6). Slightly and moderately entrenched reaches benefit from the rooted structure and stability of vegetation, exemplified by much of MU2. The large, well-vegetated floodplain in these reaches can assist in reducing the energy of the higher flows, dissipating velocity of the water, in addition reducing erosion and sediment

Photo 6. View looking upstream at XS-34.5.

inputs into the system. Several small stable areas containing side channel ponding were noted through the reach providing additional habitat benefits (Photo 7) (Stream Processes and Ecology, Volume I, Section III).

Photo 7. View of pollywogs in side channel.

The E5 stream type represents 29% of the channel in MU2. This channel type is typically riffle-pool sequenced with high meander-width ratios, high sinuosity, and low width/depth ratios and very low slope. The channel slopes of E stream types vary considerably but are typically very flat in these settings, narrow and relatively deep channels with long grasses and dense low growing shrubs along their channel perimeter and floodplain (Photo 8). The healthy vegetation through the unit facilitates trapping sediment from entering the system as well as assisting in stabilizing the bed and banks through the unit. The banks in these reaches are composed of very fine sediment, such as sand, silt and finer gravels. These materials can be moved and eroded easily, unless they remain well vegetated. In general, these reaches remain stable unless stream banks are disturbed and/or

Photo 8. View looking upstream from bend downstream of XS-16.

significant changes in vegetative structure occurs.

Highly *entrenched* reaches (i.e. F-types) account for 3.5% of the total length at the very bottom of the unit transitioning into MU3. Because they lack a floodplain area (i.e., an area adjacent to the channel where floodwaters can spread out and reduce the energy against the streambed and banks), entrenched reaches experience considerable stress during storm flow and tend to be more susceptible to stability problems, particularly bank erosion and bed scour or *degradation*. In addition, these types of channels route storm flow quickly to downstream reaches, further contributing to channel instability and flooding. A summary of morphological data collected through the unit is summarized in Table 1 and illustrated in Figure 2, Stream Type and Cross Section map.

The majority of the stream channel bed material in MU2 is composed of sand material, with gravels more prevalent in the lower reaches. The 2001 Stream Assessment Survey inventoried channel

Table 1 - Summary of Morphological Data for Reaches along Management Unit 1

Reach	Length (ft)	Area (ft^2)	Width (ft)	Mean Depth (Ft)	W/D	Ent	Slope (ft/ft)	Stream Type
1	437	12.8	11.2	1.2	9.69	3.15	.0044	E5
2	416	10.4	12.6	0.9	17.01	2.43	.0043	C5
3	26	10.5	8.6	1.2	7.17	2.10	.0004	E5
4	661	11.5	13.8	0.8	18.54	2.42	.0081	C4
5	56	13.2	33.5	0.4	85.00	1.5	.0105	F4

contained lateral bars. A majority of the bars are vegetated with grasses and are considered natural occurrences for the current channel morphology. In general, the unit is considered in balance with its current sediment regime.

Preliminary observations indicate that the majority of the channel along this management unit is laterally stable (i.e., bank erosion rates are low). Mature grasses and shrubs provide lateral control along the majority of the management unit. There are two small sections of only a few linear feet cut low bank (Photo 9). The erosion appears local and within a natural range for this stream type and should require little or no intervention.

Photo 9. View looking upstream at XS-17 towards left bank at outside of meander bend, stream flow left to right.

A component of the 2001 Stream Assessment Survey included evaluating the reaches along Chestnut Creek to determine the relative contribution to sediment problems in the Chestnut Creek/ Rondout Reservoir System. The sediments eroded from the reaches along Chestnut Creek are generally coarse (i.e., sand, gravel and cobble). Unlike other watersheds where exposed silt or clay deposits are a water quality concern because they contribute very fine material to the suspended load, these coarser sediments tend to move as bed load and settle out quickly after storms. The preliminary results of the fieldwork indicate that although MU 2 contains fine sediment through its bed and banks, it currently has minimal impact to the overall sediment supply of the Chestnut Creek, due to the small amount of inventoried erosion and bed stability of these stream types in the presence of healthy riparian vegetation.

5. Riparian Vegetation

Vegetated streamside or *riparian* zones act as a buffer against pollution and are therefore very important in mitigating the adverse impacts of human activities. Vegetated buffers facilitate stream stability and function by providing rooted structure to protect against bank erosion and flood damage. Streamside vegetation also reduces nutrient and sediment runoff, provides organic matter that can be used by aquatic life, while providing shade to dampen fluctuations in stream temperature (Photo 10).

The stream assessment conducted in 2001 did not investigate specific riparian plant species or density, other than to note areas of insufficient or stressed vegetation that could affect stream stability, flooding or erosion threats, water quality or aquatic habitat for fisheries. Based on these general, qualitative observations, the riparian vegetation in MU 2 appears to be generally sufficient to provide the benefits of a healthy riparian area. The riparian area Management Unit 2 is generally stable and consists of a wide variety of grasses, shrubs and flowering plants. The vegetation appears well established, and able to resist moderate disturbance during large storm events.

Many of the species seen in this area are native, however reed canary grass, a highly competitive species, was noted. This species may crowd out native vegetation which have ecological as well as stabilizing benefits. Healthy diverse native plant communities appear to inhibit the growth of the invasive species. Management for the reach should include a more detailed inventory and assessment of the non-native species, and consider methods for eradication (Riparian Vegetation Issues in Stream Management, Volume I, Section IV.B.3, and Riparian Vegetation Management Recommendations, Volume II, Section II. A.1).

Photo 10. View looking downstream at XS-34.5.

6. Restoration and Management Recommendations

As presented previously, the Chestnut Creek Management Plan will be utilized to guide and facilitate stakeholders in their efforts to correct stream channel instability problems, restore and maintain natural floodplain functions, control runoff from developed areas to reduce pollutant loadings from channel and upland sources, restore and protect in-stream habitat, and reduce the need for future channel maintenance.

This section includes specific restoration and management recommendations for Management Unit 2 for the Chestnut Creek Watershed. The SCSWCD, NYCDEP, and other agencies and organizations will be working with the community to implement the restoration and management strategies outlined in this Management Plan. It is critical that stream and upland area projects be integrated to avoid potential conflicts in their respective objectives. Therefore, this section also includes comments and recommendations regarding the integration of proposed strategies in upland areas, in particular floodplain management and storm water management practices.

Restoration and Management Recommendations Management Unit 2

1. Promote protection and preservation of the current riparian areas. Implement strategies to educate riparian landowners on the benefits of preserving the current riparian area and limiting land use changes.

2. Promote protection of the current stream channel. Implement strategies to educate adjacent landowners on the benefits of sustaining naturally functioning stable stream reaches.

3. Consider efforts to promote land use planning within the corridor to protect the existing resource. Techniques for assessment could include “build-out” analyses that could effectively model the existing conditions and create comparisons between future proposed land use changes relative to stormwater runoff, water quality, habitat, erosion, and flooding threats. Analyses could be coordinated with further assessment of the current morphology and the developed understanding of the sensitivity of the stream corridor. These scenarios could be further quantified and paired with stakeholder expectations and uses of the resource.

4. Evaluate the existing culvert crossing for the ability to convey both bankfull and flood flow, as well as proper sediment transport. Additionally, any design modification should reduce scour and provide for fish passage.

5. Perform stabilization techniques only where necessary using best management practices which promote and maintain a naturally functioning stream channel. Stabilization techniques should only include methods which assist in the natural recovery of the localized sections and which will benefit the reach.

6. Continue to assess, inventory and identify invasive plant species within MU2 and consider methods of eradication to prevent future establishment and potential dispersal into downstream areas.

7. Continue with efforts NYC DEP and the USGS have initiated developing a monitoring strategy in selected areas to document the channel stability, fish population and aquatic habitat for comparison purposes, as well as for inclusion into a local stable reference reach database for use on potential project areas within the Chestnut Creek watershed.

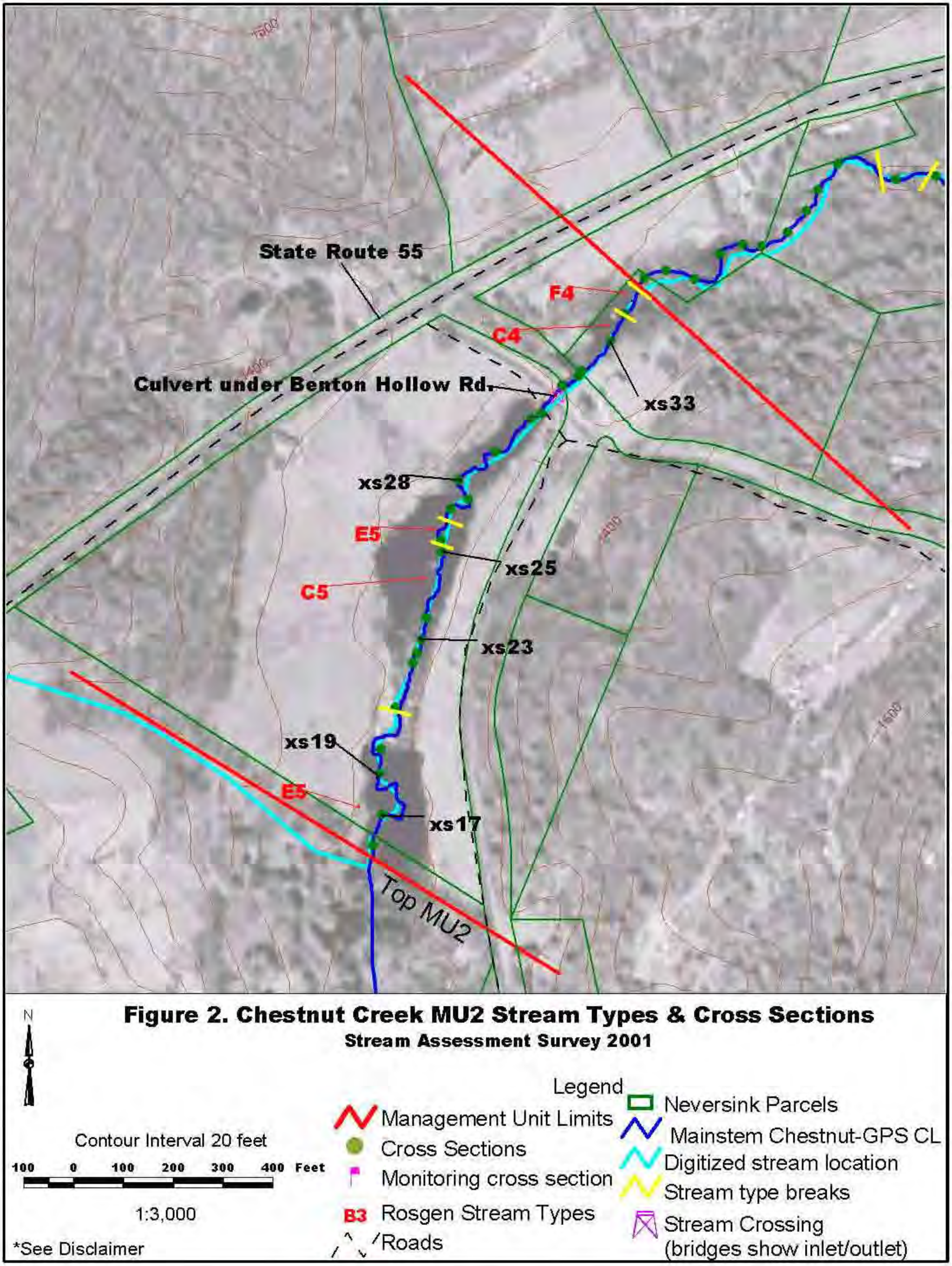


Figure 2. Chestnut Creek MU2 Stream Types & Cross Sections
Stream Assessment Survey 2001

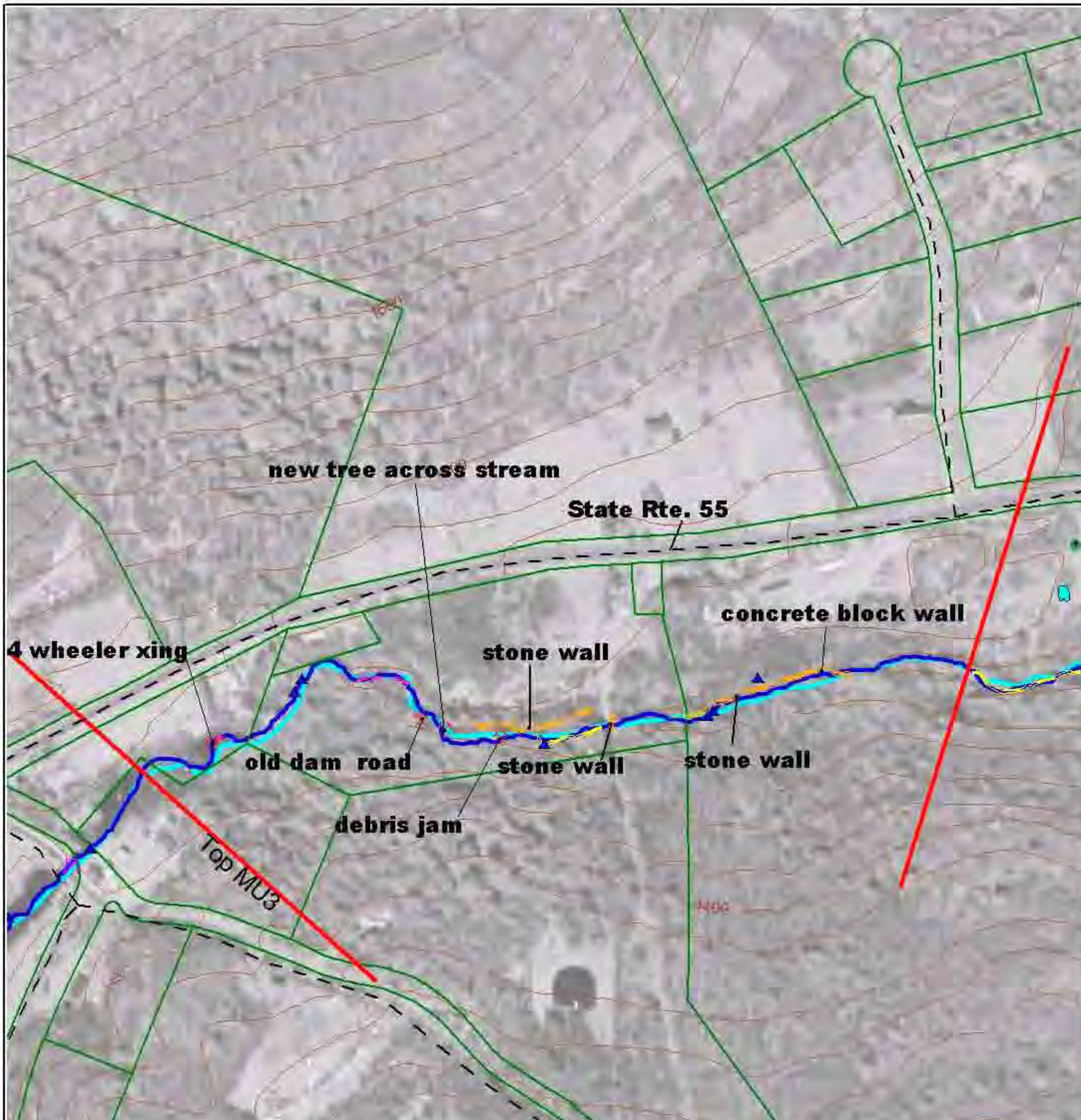
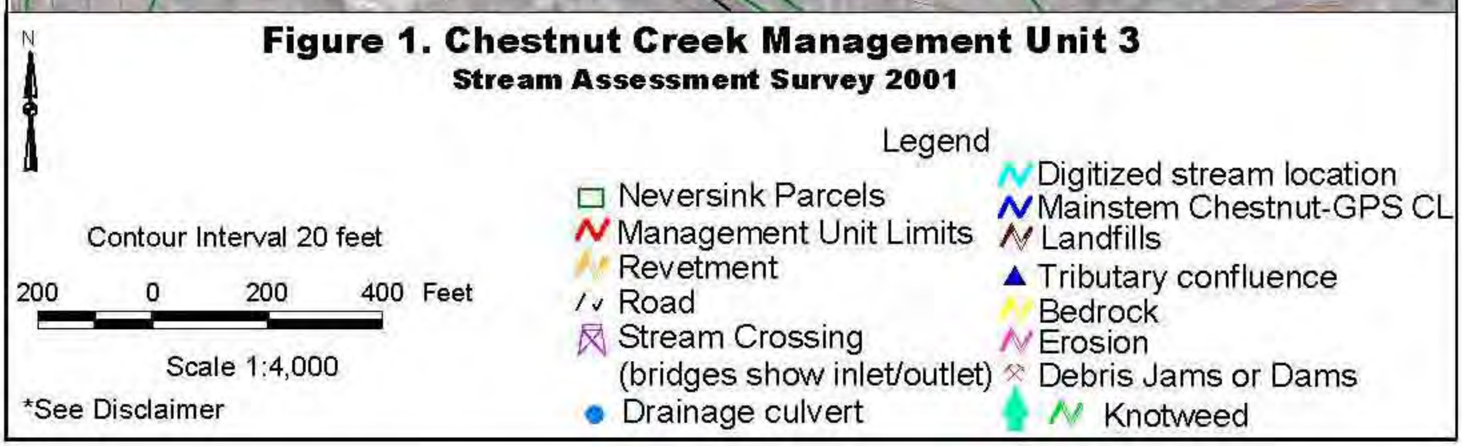


Figure 1. Chestnut Creek Management Unit 3
Stream Assessment Survey 2001



C. Chestnut Creek Management Unit 3

1. Summary Description

This section is intended to summarize the overall character and condition of Management Unit 3 (MU3). Subsequent sections will discuss specific issues (e.g., *riparian* land use and public infrastructure, channel *stability*, etc.) in greater detail.

MU3 is approximately 2400 linear feet (0.46 miles) in length and includes the segment of Chestnut Creek from approximately 300 feet downstream of Benton Hollow Road culvert, to approximately 450 feet upstream of Scott Brook (Photo 1). The drainage area at the upstream and downstream ends of the management unit is 1.21 and 1.49 square miles, respectively, without introduction of any major tributaries and only a few small springs (MU3 General map, Figure 1).

Land use along the stream corridor is predominantly forest along adjacent hillslopes located within six privately owned parcels. The parcels contain several small, scattered private residences situated along the northern banks of the active stream channel. Although privately owned, only a small percentage of the land area is maintained as lawn or contains impervious surface. This section of Chestnut Creek has had minimal anthropogenic influences.

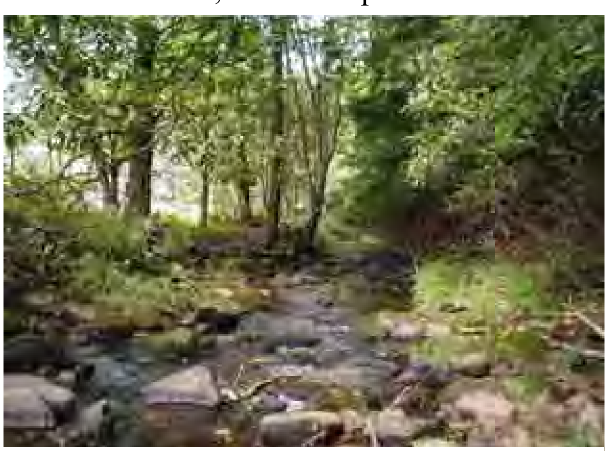


Photo 1. Looking downstream from above XS-52.

An analysis of a series of historic aerial photographs covering the period 1963-2001 documents the stability of the reach and consistent land use. The area remained forested with dense vegetation covering the stream channel and minimal change in land use or *riparian* structure in nearly 30 years. There was no evident change in channel *planform,* or stream pattern, through the aerial series. Aerial photos 2, 3, & 4 taken in 1974, 1985, and 2001 illustrate greatest contrast.

Field inventories, as well as information obtained from interviews with residents and town officials, indicate that MU3 has undergone minimal maintenance activity. Relatively minimal stream stabilization has is occurred along stream channel within the management unit. Efforts by landowners to protect property resulted in 50 feet of concrete block wall near the downstream end of MU3. Almost 700 feet of stone wall was also inventoried. Although perceived to be a result of historic land clearing, and not for flood mitigation, the stone wall may act as an unnaturally high, hardened bank during periods of high flow. These stone walls may constrict and entrench the channel and accelerate water velocities potentially causing unforeseen erosion or other problems both locally and downstream.

The general physical character of the corridor along MU 3 varies in physical

Photo 2. 1974 Aerial Photograph of MU3.

Photo 3. 1985 Aerial Photograph of MU3.

shape or *morphology*, floodplain function, and riparian habitat. From field observation and the aerial photographic series, current vegetative communities seem to be significantly healthier than other downstream units, transitioning from MU2 sand bed, grass dominated corridor through Benton Hollow Road culvert, to a the top of MU3 becoming a forested corridor, consisting of larger mature hardwoods and Hemlocks through the unit (Photo 5). The stream channel becomes less connected to its historic floodplain with coarser *sediment* within the channel boundary.

Photo 4. 2001 Aerial Photograph of MU3.

As documented in following management unit descriptions, downstream units of Chestnut Creek have been substantially modified by development within the stream corridor. These modifications have degraded habitats through a variety of means, including the fragmentation and destruction of habitat by road construction and development, and the introduction of *invasive* plants, such as *Japanese knotweed* and *multiflora rose*. These invasive species, as well as the anthropogenic modifications to the riparian corridor have jeopardized important secondary corridor benefits;

Photo 5. View looking downstream at XS-55. Shows a forested riparian habitat.

including critical habitat, food, shade for the stream, filtering mechanism for pollutants in runoff, and travel ways for wildlife. The ability to support present and future wildlife populations, including riparian habitat critical for migratory birds, waterfowl, and other river dependant species will be heavily dependant upon the management of riparian lands. Therefore, the focus of concern for MU3 is for the preservation of the current healthy riparian community, which will, in turn, assist in preserving the general physical stability of the unit.

2. Riparian Land Use and Public Infrastructure

There are six known property parcels in MU3, which contain or are bounded by the stream corridor. The current stream corridor through MU3 is currently sparsely populated and displays only minor anthropogenic impact. There were no culvert or bridge crossings, stormwater outfalls, or known underground stream crossings documented in the 2001 Stream Assessment Survey . However, as outlined in downstream units, historic development and continued management activities have negatively affected stream corridor potential in the lower Chestnut Creek. This development and encroachment has resulted in undesirable impacts both at the Management Unit level, and has potential impacts throughout the entire system.

3. History of Stream and Floodplain Work

Efforts by streamside landowners to protect property have resulted in revetment through approximately 1.1% of the channel through this unit. A single concrete block wall measuring 54 feet was documented running along the channel's left bank. During the assessment in 2001 the wall was failing and much of the stream bank was exposed to erosive forces. The concrete wall appears to have failed by the water *eroding* the bank behind the revetment. Piled stone wall along the stream channel banks, possible from agricultural land clearing, accounts for 14% of the altered bank. An assessment of the historical aerial photography of MU3 did not reveal any further significant stream channel stabilization, modification, or maintenance.

General impacts of traditional approaches to stream management have been addressed in the Watershed Recommendations for Best Management Practices, Volume II, Section II.A of this plan. Specific impacts and management considerations in relation to the assessment of MU 7 are included with this section of the plan.

4. Channel Stability and Sediment Supply

Following the 2001 Stream Assessment Survey, MU3 was divided into thirteen *reaches* on the basis of the Level II – *Morphologic* Description (Rosgen, 1996). (MU3 Stream Types and Cross Sections map, Figure 2).

The overall physical structure of the reach changes primarily by the varied encroachment of high banks along the active channel. The impingements of the high banks create multiple *entrenchment* changes over relatively short segments.

The largest portions of this unit include slightly and moderately *entrenched* C and

B channel types (Photo 6 shows C-type, Photo 7 shows B-type). Mature trees and shrubs provide lateral control along the majority of these reaches. Slightly and moderately entrenched reaches benefit from the deep-rooted structure and stability of mature vegetation.

Highly entrenched reaches (i.e., F-types) account for 28% of the total length. Because they lack a wide floodprone area, entrenched reaches experience considerable stress during storm flow and tend to be more susceptible to stability problems, particularly bank *erosion* and bed scour or *degradation*. In addition, these types of channels route storm flow quickly to downstream reaches where they can contribute to channel instability and flooding. The stream types tend to shift multiple times throughout the unit, which could indicate an imbalance and should be monitored. The morphological data collected through the unit is summarized in Table 1 and illustrated in Figure 2.

Photo 6. View looking downstream at XS-41, C-type stream.

Photo 7. View looking downstream from right bank towards left bank at XS-44, B-type stream.

The majority of the stream channel bed material in MU3 is composed of gravel, with 150 feet of the stream bed consisting of bedrock in one continuous section.

The 2001 Stream Assessment Survey identified several debris jams and other dam-like structures, both human-made and natural (Photo 8). Debris jams and other channel obstructions may cause problems by trapping sediment, which initiates and/or accelerates the development of gravel bars and reduces channel capacity. Debris jams can cause an increase in flood stage and result in bank erosion. Alternately, small blockages that don't span the entire channel width, can create and maintain beneficial physical habitat, as well as assist in controlling stream channel *incision* and degradation. Although the current debris jam appears stable, regular monitoring can detect a potential future problem. The monitoring should include an inventory of the debris jam to include the potential future problems such as risk of sudden release of the sediment and debris.

The 2001 Stream Assessment Survey documented approximately 490 feet (10.2%) of channel containing mid-channel and lateral bars. The majority of the bars are vegetated with grasses and shrubs and considered natural occurrences for the current channel morphology. With exception to the debris jams and dams, MU3 is considered in balance with its

Table 1 - Summary of Morphological Data for Reaches along Management Unit 3.

Reach	Length (ft)	Area (ft^2)	Width (ft)	Mean Depth (ft)	W/D	Ent	Slope (ft/ft)	Stream Type
1	731	15.8	20.2	0.8	27.0	3.1	.014	C4
2	99.5	19.2	16.4	1.2	13.8	1.4	.018	B4
3	218.5	21.1	24.2	0.9	27.5	2.4	.016	C4
4	330	22.2	36.3	0.6	59.0	1.0	.039	F4b
5	391.5	21.2	23.7	0.9	26.5	1.8	.037	B1
6	83	19.9	17.9	1.1	16.0	7.3	.021	C4b
7	30	17.2	19.1	0.9	21.0	1.2	.029	F4b
8	220	17.3	15.8	1.1	14.0	1.9	.027	B4
9	90	22.5	17.9	1.3	14.0	1.1	.020	F4b
10	122	16.1	14.5	1.1	13.0	4.8	.023	C4b
11	172	16.8	18.1	0.9	20	1.2	.030	F3b
12	87	22.4	18.2	1.2	15	1.6	.020	B4
13	31	20.6	18.8	1.1	17	1.0	.030	F4b

current sediment regime, meaning that it transports sediment sufficiently to neither degrade nor aggrade its stream channel.

A number of physical constraints were inventoried within the unit, both natural and human-made. These include stonewalls, concrete blocks, and natural topography, which laterally control the unit alignment. Exposed moss covered bedrock currently provides grade control along a portion of the unit (Photo 9), thereby preventing channel degradation.

Photo 8. View looking upstream from below XS-47. Sediment has accumulated due the debris jam shown above.

Preliminary observations indicate that most of the channel along this management unit is laterally stable (i.e., bank erosion rates are low) which includes areas along high banks (Photo 10). Mature trees and shrubs also provide lateral control along the majority of the management unit. The 2001 Stream Assessment Survey determined that 117 feet (2.4%) of the streambanks are actively eroding. The erosion occurs in three small sections ranging from 15-50 linear feet and mostly consists of slightly undercut areas along low banks (Photo 11). The erosion appears local in nature, should require little or no intervention, and potentially adds to the fish and wildlife habitat.

A component of the stream assessment included evaluating the reaches along Chestnut Creek to determine the relative

Photo 9. View of bedrock, looking upstream from below XS-48.

Photo 10. View looking upstream towards dam at XS-46.

Photo 11. View looking downstream at XS-54.

contribution to sediment problems in the Chestnut Creek/Rondout Reservoir System. The sediments eroded from the reaches along Chestnut Creek are generally coarse (i.e., sand, gravel and cobble). Unlike other watersheds where exposed *silt* or clay deposits are a water quality concern because they contribute very fine material to the suspended load, these coarser sediments tend to move as bed load and settle out quickly after storms. The preliminary results of the fieldwork indicate that MU3 currently has minimal impact to the overall sediment supply of the Chestnut Creek. Debris jams that seem to be collecting sediment should be evaluated and addressed in order to maintain sediment transport capacity.

5. Riparian Vegetation

The riparian area in Management Unit 3 is generally stable and consists of mature trees and shrubs (Photo 12). Vegetated riparian zones act as buffers against pollution and are therefore very important in mitigating the adverse impacts of human activities. Forested riparian buffers facilitate stream stability and function by

Photo 12. View looking upstream at XS-53, with cobble bed.

providing rooted structure to protect against bank erosion and flood damage. Streamside forests also reduce nutrient and sediment runoff, provide organic matter that can be used by aquatic animals, while providing shade to dampen fluctuations in stream temperature. Wide forested riparian buffers protect streams from runoff and generally provide better habitat than narrow buffers.

6. Restoration and Management Recommendations

As presented previously, the Chestnut Creek Management Plan will be utilized to guide and facilitate stakeholders in their efforts to correct stream channel instability problems, restore and maintain natural floodplain functions, control runoff from developed areas to reduce pollutant loadings from channel and upland sources, restore and protect in-stream habitat, and reduce the need for future channel maintenance.

This section includes specific restoration and management recommendations for Management Unit 3, as well as a general discussion of the approach to stream corridor restoration and management recommended for the Chestnut Creek Watershed. The SCSWCD, NYCDEP, and other agencies and organizations will be working with the community to implement the restoration and management strategies outlined in this Management Plan. It is critical that stream and upland area projects be integrated to avoid potential conflicts in their respective objectives. Therefore, this section also includes comments and recommendations regarding the integration of proposed strategies in upland areas, in particular floodplain management and storm water management practices.

Restoration and Management Recommendations Management Unit 3

1. Promote protection and preservation of the current riparian areas. Implement strategies to educate riparian landowners on the benefits of preserving the current riparian area and limiting land use changes.

2. Promote protection of the current stream channel. Implement strategies to educate adjacent landowners on the benefits of sustaining naturally functioning stable stream reaches.

3. Evaluate the existing failing *revetment* for replacement with an adequate stabilization structure which will maintain and promote a naturally function stream channel. Any stabilization technique should incorporate *bioengineering* and/or re-vegetation.

4. Perform stabilization techniques only where necessary using best management practices which promote and maintain a naturally functioning stream channel. Stabilization techniques should only include methods which assist in the natural recovery of the localized sections and which will benefit the reach.

5. Promote floodplain protection, which is critical in maintaining stream stability in moderately entrenched reaches.

6. Monitor the areas containing debris jams and channel blockages for changes in channel stability.

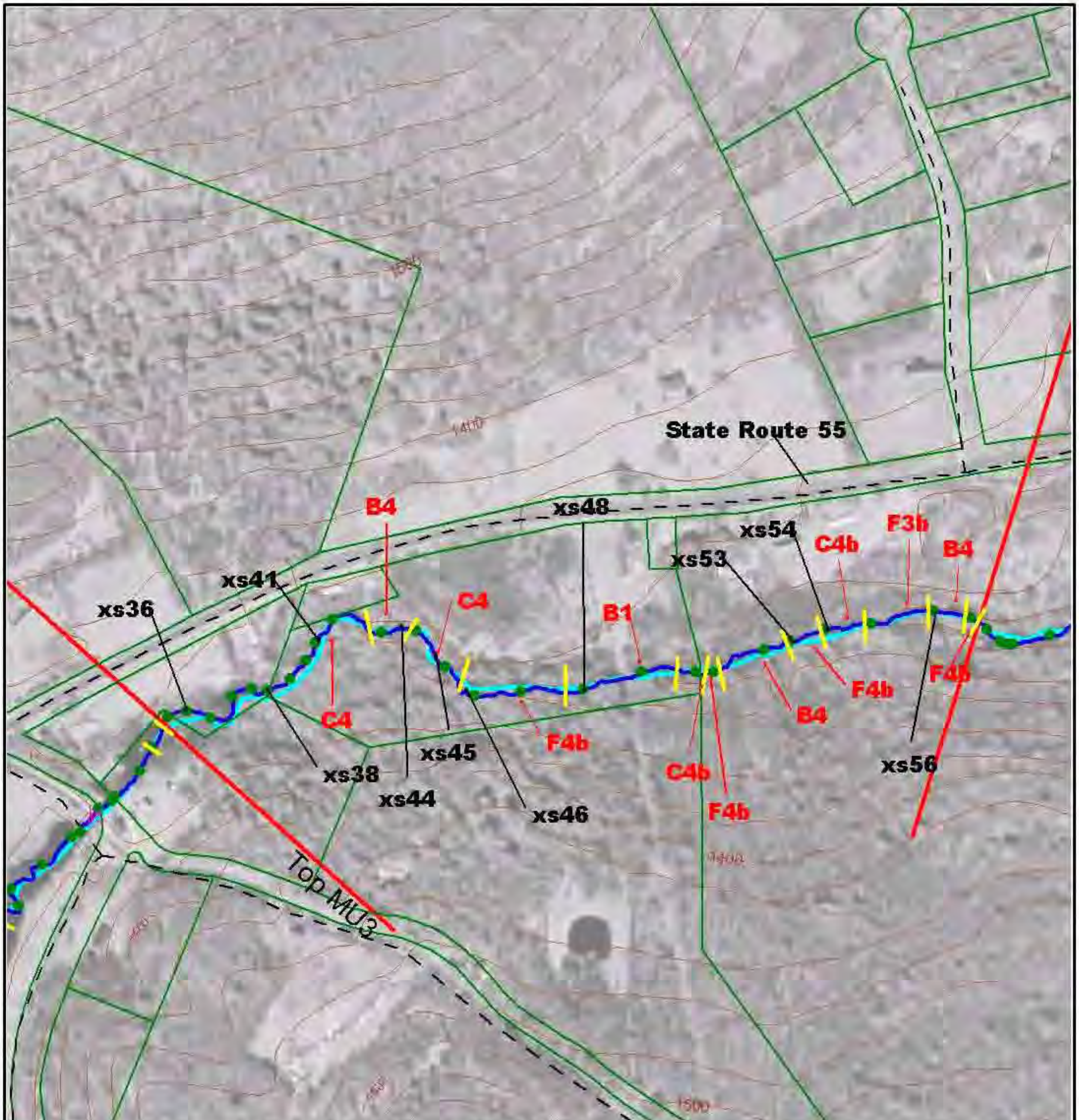


Figure 2. Chestnut Creek MU3 Stream Types & Cross Sections

Stream Assessment Survey 2001

Contour Interval 20 feet

200 0 200 400 Feet

1:4,000

*See Disclaimer

Legend

- Management Unit Limits
- Cross Sections
- Monitoring cross section
- B3 Rosgen Stream Types
- Roads
- Neversink Parcels
- Mainstem Chestnut-GPS CL
- Digitized stream location
- Stream type breaks
- Stream Crossing (bridges show inlet/outlet)

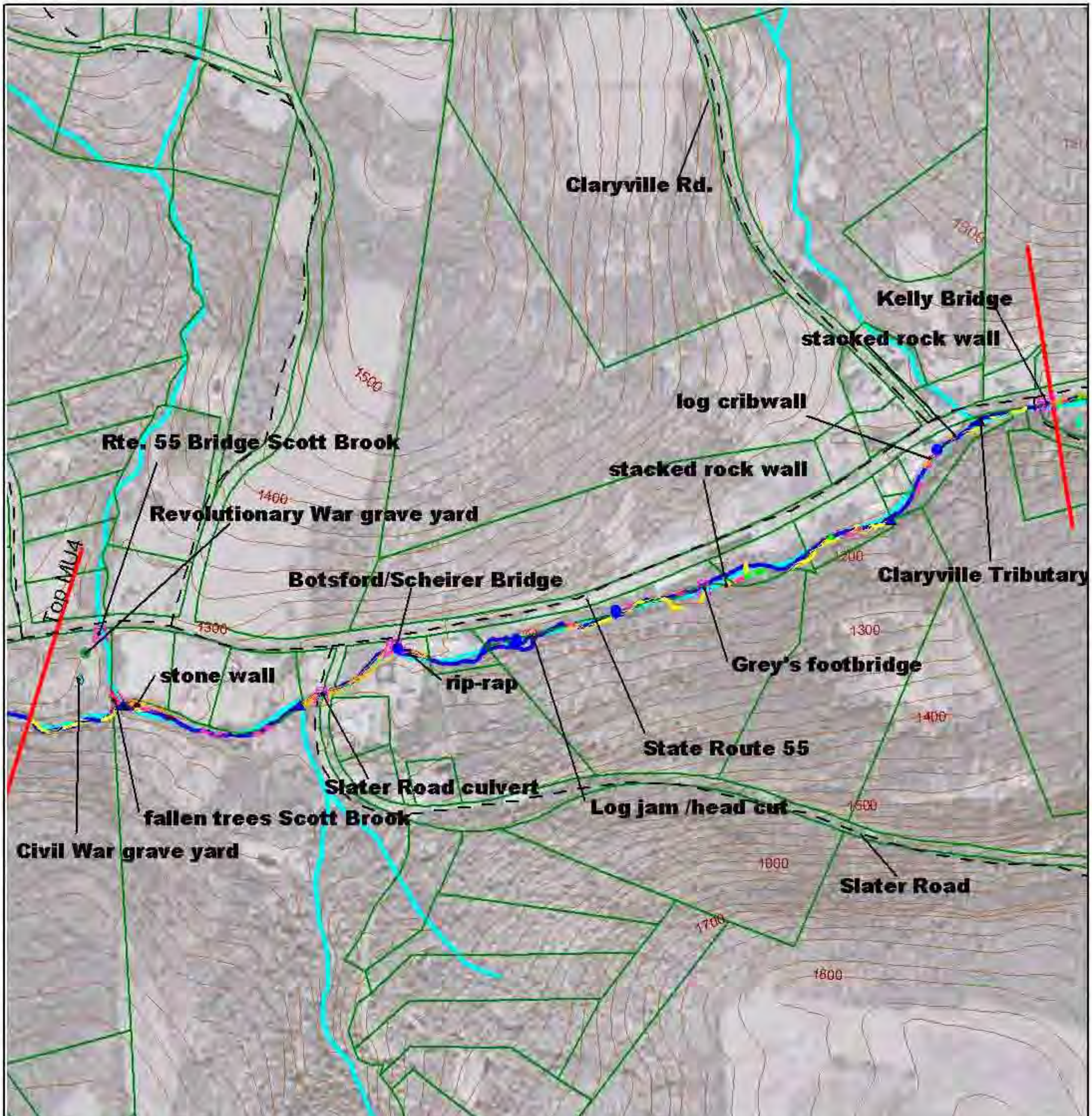


Figure 1. Chestnut Creek Management Unit 4

Stream Assessment Survey 2001

N

Contour Interval 20 feet

400 0 400 800 Feet

Scale 1:7,500

*See Disclaimer

Legend

- Neversink Parcels
- Management Unit Limits
- Revetment
- Road
- Stream Crossing (bridges show inlet/outlet)
- Drainage culvert
- Digitized stream location
- Mainstem Chestnut-GPS CL
- Landfills
- Tributary confluence
- Bedrock
- Erosion
- Debris Jams or Dams
- Knotweed

D. Chestnut Creek Management Unit 4

1. Summary Description

This section is intended to summarize the overall character and condition of Management Unit 4 (MU4). Subsequent sections will discuss specific issues (e.g., *riparian* land use and public infrastructure, channel *stability*, etc.) in greater detail.

This unit is approximately 5450 linear feet (1.03 miles) in length and includes the segment of Chestnut Creek from approximately 450 feet upstream of the *confluence* with Scott Brook to a point immediately downstream of the Kelly Rd Bridge (MU4 General map, Figure 1). The drainage areas at the upstream and downstream ends of the management unit are 1.49 and 4.75 square miles, respectively (Photos 1, 2, & 3).

Land use along the stream corridor is predominantly forest along adjacent hillslopes with a number of residences and businesses situated along the *floodplain*. The *riparian* area on private residential land fronting on Route 55 and Slater Road is generally maintained as mowed lawn with scattered trees and shrubs. The riparian area adjacent to private businesses fronting on Route 55 is mostly parking lots, material and equipment storage areas, and small strips of mowed lawn. Although privately owned, a significant portion of the corridor along the adjacent hillslopes and terraces is maintained as forest. Storm water runoff from yards is conveyed predominantly as *sheet flow*. The parking lots and equipment storage areas drain to

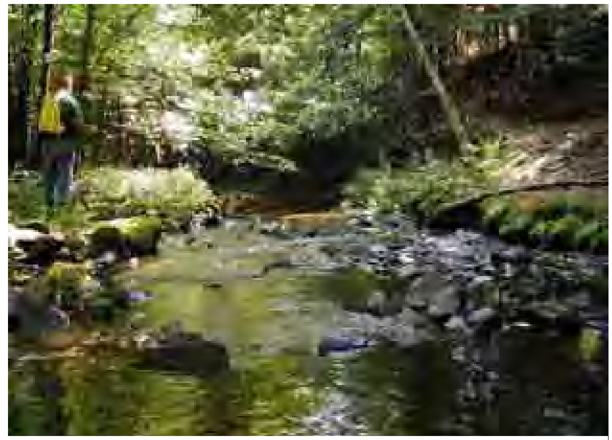


Photo 1. Cross section 58– view looking downstream behind Revolutionary War graveyard.

Photo 2. Cross section 63– view looking downstream.

Photo 3. View looking upstream -Rt. 55 to the right of view.

the creek via sheet flow and storm drainage culverts.

It appears that this section of Chestnut Creek was straightened and *channelized* at some time in the past. An analysis of a series of historic aerial photographs covering the period 1974-2001 indicates that routine channel maintenance occurred until recently (Aerial Photos 4, 5, 6, 7 & 8).

Revetment present, as well as information obtained from interviews with residents and town officials indicates that MU4 has been the focus of periodic maintenance activity. The banks have been armored along sections of the management unit. Efforts by landowners to protect property have resulted in approximately 14% of the channel length through this unit undergoing some type of alteration (e.g., *riprap*, stacked rock wall, and log cribwall). These protective measures appear to have been relatively successful in some areas, while less successful in other areas. It is evident that portions of the floodplain have been filled to accommodate development. These channel and floodplain modifications have resulted in a confined channel with a high width/depth ratio, low *sinuosity* and a relatively steep gradient. As such the creek and adjacent floodplain are more susceptible to stability and flooding problems (Public Infrastructure and Landowner Concerns and Interests, Volume I, Section IV.B.5).

2. Riparian Land Use and Public Infrastructure

There are 24 developed properties within the stream *corridor* along MU4 that include private residences and businesses as well as historically significant areas . The residential properties include homes and ancillary structures, such as garages and sheds. The commercial properties include businesses such as Grey's Woodworks that have large buildings for manufacturing wood products and storage of lumber, storage yards for finished products, offices, and parking lots. Other businesses include an auto repair shop and a septic contractor which are housed in large buildings with adjacent parking lots and equipment storage areas. There is also a gas station and deli. The historic properties include Revolutionary War and Civil War cemeteries.

Maintenance of infrastructure is a concern for local municipalities as well as landowners. There are four stream crossings and four drainage culverts in MU4. The stream crossing at Slater Road culvert is a 9 x 15 foot corrugated metal elliptical pipe (Photo 9). The cross-section of the culvert is narrower than the *bankfull* channel upstream and downstream of the culvert. Downstream landowners have reported erosion and maintenance problems. According to residents, an old culvert in the same location had been

Photo 9. View looking downstream at inlet of culvert under Slater Road.

Photo 4. 1974 Aerial Photograph of the upstream section of MU4.

Photo 5. 2001 Aerial Photograph of the upstream section of MU4.

Photo 6. 1974 Aerial Photograph of the downstream section of MU4.

Photo 7. 1995 Aerial Photograph of the downstream section of MU4.

Photo 8. 2001 Aerial Photograph of the downstream section of MU4.

placed to direct streamflow towards the center of the channel. The old culvert was replaced in the mid to late 1980's with a new culvert that was shorter and placed at a skew relative to the stream channel. This skewed position resulted in storm flows being directed against the downstream *meander* bend contributing to *erosion* of the banks. In 1996, the Town repaired the culvert and stabilized 50 feet of banks downstream of the crossing. Subsequently, the landowner placed additional *riprap* along downstream sections.

A privately owned bridge is located at the Botsford/Scheirer Property (Photo 10) approximately 380 feet downstream of the Slater Road culvert. The bridge appears to be in good condition, and consistent with the bankfull channel width in the immediate upstream and downstream cross sections. However, landowners have reported maintenance problems and development of a mid-channel bar downstream of the bridge as well as a gravel bar along the right bank upstream of

Photo 10. View looking downstream at private crossing below Slater Rd. Channel is split with a center island. The banks and island are well-vegetated with willows, but stream seems to be choked into the right bank.

and through the bridge opening. The reason for the sediment deposits is not conclusive. However, reports of improper alignment of the upstream culvert crossing, presence of a debris jam downstream, ongoing maintenance creating overwidened conditions and sediment deposition appear to be inhibiting the stream's ability to transport its sediment. Reduction or changes in hydraulic opening under a bridge can cause ongoing maintenance problems and potentially result in higher stress on the bridge or structure. Evaluation of bridge alignment could benefit redesign and maintenance of the bridge and stream in this reach.

The County bridge at Kelly Road (CBN: 386, BIN: 3229170) was built in 1979 (Photo 11). In appears that the bridge was designed to convey larger, less frequent storm flows, probably the 25-year event. The bridge is subject to a biennial inspection by NYSDOT, which indicates that the decking, abutments, and wing walls are in good condition with no significant changes in scour. The bankfull cross sectional width both upstream and downstream of the bridge are only slightly larger than the span of the bridge itself.

Photo 11. Looking downstream at Kelly Road Bridge.

A privately owned footbridge is located at the rear of Grey's Woodworks approximately 1600 feet downstream of the bridge at the Botsford/Scheirer Property and was not evaluated as it does not appear to be more than a primitive foot crossing and does not exert any hydraulic control on the stream.

As noted above, storm drainage culverts conveys storm water runoff from parking lots and equipment/materials storage areas directly to the creek. Three storm drainage culverts were identified in this management unit during the 2001 Stream Assessment Survey (Photo 12).

The volume as well as the water quality of the runoff is a function of the size and characteristics of the land area each system drains. For example, land areas with a high percentage of impervious surfaces tend to generate considerably more runoff than areas that are predominantly forest or lawn. The size and land use characteristics of the areas draining to the outfalls identified, as well as the potential for storm water retrofit opportunities was not evaluated as part of the initial assessment. However, a review of the aerial photographs indicates that the properties along the corridor with the highest percent impervious surfaces include Grey's Woodworks, the auto repair, and septic contractor properties, as well as a portion of the Town Highway Facility on the opposite side of Route 55. Recent improvements, working with the NYC DEP, have incorporated storm water management into their plans for dealing with parking area runoff.

A planned extension of the existing sanitary sewer system may enable residents, currently using on-site treatment

Photo 12. Storm drain outfall behind Zanetti's along Route 55.

and disposal systems to connect to DEP's Grahamsville Sewage Treatment Plant. Four extensions to the existing sanitary sewer system are being planned, three of them emanating out of Grahamsville. One of the extensions being planned will extend along Rte 55 west for approximately 1.5 miles from Clark Road to Armstrong Road, upstream of Scott Brook. In some places the sewer alignment will be close to Chestnut Creek. Depending on its ultimate location, the installation of the sewer system could impact a significant length of the riparian area along the creek. In addition, it may be necessary to install lateral extensions across the creek to serve properties on the opposite side of the creek from the sewer main. Current construction specifications, which require that sanitary sewer lines be installed a minimum of three feet below the streambed should minimize the potential for the laterals to create a situation similar to the sewer crossing grade drop caused at Davis Lane discussed in MU6. Careful planning of the main sewer alignment can reduce impacts to the riparian area along Chestnut Creek.

3. History of Stream and Floodplain Work

As noted Chestnut Creek appears to have been straightened and *channelized* at some time in the past. Channel work to remove gravel deposits and maintain flood conveyance has been routine until recently. Development of the riparian corridor along Chestnut Creek historically involved *floodplain* fill. Filling floodplain areas to accommodate development on private as well as public land is still a common practice in the Chestnut Creek watershed. Maintenance of public infrastructure and the extension of public services have required periodic encroachments on the channel and floodplain.

Efforts by the Town, as well as landowners focused on protecting infrastructure and property have involved the installation of *riprap* (Photo 13), stacked rock walls, and a log cribwall along 14% of the channel length through

Photo 13. View looking upstream– rip-rap on left bank– Rt. 55 is on the right side of the picture.

this management unit. These protective measures appear to have been relatively successful in some areas, while less successful in other areas. For example, a section of a log cribwall installed near the downstream end of the unit is failing (Photo 14).

Photo 14. Beginning of log crib wall on left bank view from right bank near bottom of MU4, before the entry of the Claryville Road tributary.

General impacts of traditional approaches to stream management have been addressed in the Watershed Recommendations for Best Management Practices, Volume II, Section II.A of this plan. Specific impacts and management considerations in relation to the assessment of MU 4 are included with this section of the plan.

4. Channel Stability and Sediment Supply

During the 2001 Stream Assessment Survey, MU4 was divided into ten *reaches* on the basis of the Level II – *Morphologic* Description (Rosgen, 1996). Stream classification for Chestnut Creek predominantly follows the Rosgen classification system with a few exceptions (see Intro to Stream Processes Volume I, Section III.D, and Watershed Assessment, Volume I, Section I.E.2). Three reaches in MU4 (#8, 9, and 10) contain very short sections of bedrock, though these reaches are otherwise dominated by cobble-sized sediment. Because locations of bedrock exposure still represent an important control on stream morphology, these sections were documented as a double stream type, such as B1/B3. A B1/B3 reach would be predominantly a B3 (cobble), but would have section(s) of B1 (bedrock) too small to be broken out into a separate reach or reaches. Additional reach type splits may include borderline slope classification, such as B3/B3a, where "a" signifies an A channel slope with a B cross-section morphology.

The largest portion (62%) of this unit includes moderately *entrenched* channel B-types. With a low width to depth ratio (i.e., 11 – 16) and mature vegetation on the banks these types of channels tend to be very stable and are generally effective at moving sediment transported from upstream reaches (MU4 Stream Type & Cross Section map, Figure 2).

Highly entrenched reaches (i.e. F-types) account for 38% of the total length. Because they lack a floodplain area (i.e., an area adjacent to the channel where floodwaters can spread out and reduce the energy against the streambed and banks), entrenched reaches experience considerable stress during storm flow and tend to be more susceptible to stability problems, particularly bank *erosion* and bed scour or *degradation*. In addition, these types of channels route storm flow quickly to downstream reaches where they can contribute to channel instability and flooding. The *morphological* data collected along the reaches is summarized in Table 1 and illustrated in Figure 2.

As evident in the current aerial photographs, the channel *planform*, or stream pattern, along this management unit is characterized by low *sinuosity* and *meanders* with large radii of curvature. The altered meander geometry is the result of channel straightening to accommodate development of properties along the stream corridor and periodic channel maintenance. For example, a significant portion of the upper reaches of Chestnut Creek are confined between the commercial properties on left floodplain along Route 55 and steep hillslopes adjacent to the right banks and terraces.

An analysis of a series of historic aerial photographs covering the period 1974 – 2001 indicates that routine channel maintenance activities and subsequent natural channel adjustments are on-going. The effects of the channel maintenance and natural adjustments are most evident in the 1974 and 1995 aerial photographs. Prior to 1985 most channel and floodplain work appears to have been confined to the upper reaches in the vicinity of Slater Road. However, by 1995 it is evident that a considerable amount of work had occurred along the reaches to the rear of the commercial properties along Route 55.

A standard approach to channel maintenance involves excavating channels that convey large storm flows (e.g., 25-, 50-, or even 100-year peak flows) without overtopping the adjacent streambanks. While enlarging the channel to improve its ability to convey storm flows may seem logical, in fact this approach usually creates channels that have poor habitat, are ineffective at transporting sediment, and require constant maintenance.

Table 1 - Summary of Morphological Data for Reaches along Management Unit 4. The last reach in MU4 is shared with the first reach in MU5.

Reach	Length (ft)	Area (ft^2)	Width (ft)	Mean Depth (ft)	W/D	Ent	Slope (ft/ft)	Stream Type
1	350	18.3	18.4	1.02	18.8	1.77	0.038	B1a
2	162	17	20.8	0.9	26	2.05	0.058	B1/4a
3	37	16.6	17	1.0	17	1.8	0.033	B4
4	379	24.9	23.9	1.06	23	1.27	0.022	F3b
5	492	24.3	21.3	1.2	19	1.68	0.034	B3
6	270	30.9	23.5	1.33	18.9	1.3	0.030	F3b
7	619	32	26.8	1.25	23	1.28	0.024	F3b
8	2356	36.8	25.2	1.5	17.2	1.6	0.027	B
9	426	38.9	29.3	1.3	22	1.35	0.024	Fb
10	646	41.7	26.2	1.6	17	1.4	0.015	F1/F3

As pointed out in the Introduction to Stream Processes and Ecology, Volume I, Section III, natural streams are composed of three distinct flows that include: a *baseflow* or low flow channel, which provides habitat for aquatic organisms; a bankfull channel, which is critical for maintaining sediment transport; and a floodplain, which effectively conveys flows greater than the bankfull discharge (i.e., 1 – 3-year peak flow). However, the engineered channels routinely constructed during channel maintenance activities are generally designed to convey all flows (baseflow, bankfull flow, and flood flow) in a single channel that is relatively straight, very wide and trapezoidal in *cross-sectional area*, with a uniform profile.

In these altered channels, baseflow is usually very shallow or may actually flow beneath the *substrate* because it is spread out over such a large surface area. The uniform profile replaces the typical *riffle-pool* sequence with a continuous shallow riffle or run that provides no cover for fish to avoid predation or strong flushing currents. A very wide, shallow channel is less efficient at moving sediment under bankfull flow conditions. As a consequence, sediment (e.g., *sand, gravel, cobble*) tends to accumulate, developing lateral and/or mid-channel bars along these altered reaches. Ironically, the accumulation of sediment and the development of bars significantly reduce the channel's capacity to convey the large storm flows for which it was designed. The reduced channel capacity places considerable stress on adjacent streambanks under storm flow conditions. The resulting bank erosion and lateral migration widens the channel further, undercutting and toppling bank trees that can create debris jams.

Debris jams and other channel obstructions can cause problems by trapping sediment which initiates and/or accelerates the development of gravel bars and reduces channel capacity. Subsequent bed erosion and removal of the deposited gravel contributes sediment to downstream reaches. The 2001 Assessment Survey identified the largest debris jam, located at the upstream end of the Grey/Mickelson Property, has contributed to *aggradation* along approximately 800 feet of stream channel (Photo 15). The accumulated material has flattened the channel gradient and reduced channel capacity thereby contributing to flooding of adjacent properties as well as bank erosion in this area. Immediately downstream of the jam the streambed drops sharply in a step. A *headcut* or sharp step in the stream bed, tends to continue to erode, moving the entire step upstream as it cuts into the bed and into the fine sediment accumulated behind the debris jam. Information obtained from interviews with residents and town officials indicates that this and the surrounding area has been an on-going maintenance problem for more than 17

Photo 15. Debris jam and *head cut* behind Grey's Woodworking just upstream of XS180.

years.

Historic bed *degradation* and floodplain fill contribute to the current entrenched situation along Reaches 1, 4, 6, 7, 9 and 10. Exposed bedrock currently provides grade control along a significant portion of the unit, thereby preventing further widespread channel degradation (Photo 16).

Photo 16. View looking towards left bank at bedrock stream bed MU4.

Preliminary observations indicate that the most of the channel along this management unit is laterally stable. Lateral control along the majority of the management unit is provided by mature trees and shrubs. The 2001 Stream Assessment Survey determined that there is a moderate amount of erosion however, 926 feet (17%) of the streambanks are actively eroding (Photo 17). Bank to bankfull height ratios along this unit ranged from 1.1– 5.5, confirming that a significant length of the channel is *incised*. Rosgen (2002) notes that bank to bankfull height ratio is a good measure of vertical stability, as well as an indicator of *sediment* supply potential. Results of the

Photo 17. Eroded right bank – view looking upstream near the bottom of MU4.

stability assessment show that the banks along the actively eroding areas have very high bank erosion potential, meaning that the potential for continued bank erosion, loss of trees and channel migration and bank erosion potential is very high compared to other sites. Because the channel is cutting into terraces and fill slopes in some areas they will continue to be a significant source of sediment for downstream reaches.

As part of the Assessment Survey, *monumented* cross-sections were installed in a number of locations along Chestnut Creek to monitor stream bank erosion and streambed changes (e.g., aggradation) in specific reaches of concern. Accordingly, two Bank Erosion Hazard Indexing cross-sections (BEHI) were established and surveyed as BEHI 1,2 & 3 (MU4 Stream Type Cross Section map, Figure 2) in MU4, upstream and downstream of the confluence with Scott Brook (Photos 18 & 19). The cross-sections will be resurveyed and compared to the initial surveys to document the rate at which stream bank/ bed changes occur. Data obtained from these surveys will also allow estimates of

Photo 18. Monitoring cross section 2, left bank above the confluence of Scott Brook with the Mainstem Chestnut Creek. Tree roots and rocks are providing some protection and good habitat.

Photo 19. Monitoring cross section 3, below confluence of Scott Brook with the Mainstem Chestnut Creek. Stream flow is from left to right.

sediment loadings to be developed.

Evaluating the reaches along Chestnut Creek to determine whether they are contributing to sediment problems in the Chestnut Creek/Rondout Reservoir System was a component of the Assessment Survey. The preliminary results of the field work indicate that the actively eroding banks and mid-channel bars noted above are a source of sediment to downstream reaches. Where they accumulate, these sediments may reduce channel capacity and can contribute to localized channel stability problems.

The sediment eroded from the reaches along Chestnut Creek are generally coarse (i.e., sand, gravel and cobble). Unlike other watersheds where exposed *silt* or *clay* deposits are a water quality concern because they contribute very fine material to the *suspended sediment* load, these coarser sediments tend to move as bed load and settle out quickly after storms. As a consequence, sediment eroded from the streambed and stream banks along this management unit does not appear to directly affect water quality within the Chestnut Creek/Rondout Reservoir System.

5. Riparian Vegetation

The riparian area along Management Unit 4 can be characterized as: reaches adjacent to parking lots and equipment storage areas with narrow or no buffers; reaches with mowed lawns and scattered trees and shrubs; and reaches along steep hillslopes and terraces with mature forest. In riparian areas where narrow buffers are present, their width is generally less than 50 feet. Along developed properties, the riparian vegetation has been affected by clearing, routine yard maintenance, and other land use activities. The properties along the stream corridor with the lowest percent of riparian vegetation and buffer include the upper reaches where private residences front along Slater Road and Route 55 and in the middle reaches and lower reaches to the rear of the commercial properties.

During the Assessment Survey *Japanese knotweed,* an *invasive species*, was sighted along the banks in this management unit. It occupied a total of 120 feet on both the left and right banks in two separate locations. Invasive, exotic, non-native plants such as these crowd out the natural flora of the area and generally provide little streambank stabilization or habitat benefit (see Riparian Vegetation Issues in Stream Management Volume I, Section IV.B.3., and Riparian Vegetation Management Recommendations, Volume II, Section II.A.1.).

6. Restoration and Management Recommendations

As presented previously, the Chestnut Creek Management Plan will be utilized to guide and facilitate stakeholders in their efforts to correct stream channel instability problems, restore and maintain natural floodplain functions, control runoff from developed areas to reduce pollutant loadings from channel and upland sources, restore and protect in-stream habitat, and reduce the need for future channel maintenance.

This section includes specific restoration and management recommendations for Management Unit 4, as well as a general discussion of the approach to stream corridor restoration and management recommended for the Chestnut Creek Watershed. The SCSWCD, NYCDEP, and other agencies and organizations will be working with the community to implement the restoration and management strategies outlined in this Management Plan. It is critical that stream and upland area projects be integrated to avoid potential conflicts in their respective objectives. Therefore, this section also includes comments and recommendations regarding the integration of proposed strategies in upland areas, in particular floodplain management and storm water management practices.

Restoration and Management Recommendations Management Unit 4

1. Repair and stabilize the worst erosion sites along MU4 and the tributaries draining to the Unit.

2. Implement storm water management for the properties with the highest percent impervious surface along the corridor, including the Town Highway Facility and the commercial properties along Route 55, and any other significant impervious areas identified during the field reconnaissance recommended below. The storm water management facilities should be designed to provide water quality management for the first half-inch of runoff and quantity management that reduces the peak discharge runoff rate for the 1 – 3-year storm flows.

3. Evaluate the potential for reconstructing the channel along the historically active reaches from upstream of the Slater Road culvert to a point below the debris jam and gravel deposits at the rear of Grey's Woodworks, in combination with recommendations 4, below.

4. In combination with recommendation 3, above, evaluate the Slater Road culvert and Botsford/Scheirer bridge to determine the best method for reducing bank erosion and improving sediment transport under

bankfull and flood flow conditions. Suggest planting water-hearty shrubs to anchor the existing stream banks along lawn-kept areas.

5. Convert existing F-types and unstable B-types to stable B-type channels by removing existing debris jams, removing midchannel bars, and reconstructing overwide and entrenched channels with lower width/depth ratios and wider floodplain area.

6. Establish a better angle of repose on unstable banks and lower the bankfull to bank height ratio by grading high, vertical banks. Stabilize the banks and provide long-term lateral control by reestablishing bank vegetation composed of native trees, shrubs and grasses.

7. Install flow diverting structures (e.g., rock vanes, J-Hook vanes, etc) at key points along the channel, as an alternative option to bank armor, to reduce stress in the near bank region in conjunction with detailed assessments to maintain channel morphology and stability.

8. Work with landowners to establish a wooded buffer zone along reaches with little or no woody vegetation.

9. Initiate a knotweed eradication and control program along this unit.

10. Monitor areas with debris jams and channel blockages for changes in channel stability and threat to infrastructure.

11. Evaluate failing revetment for replacement with stabilization structure to maintain naturally functioning channel. Should include bioengineering and/or re-vegetation.

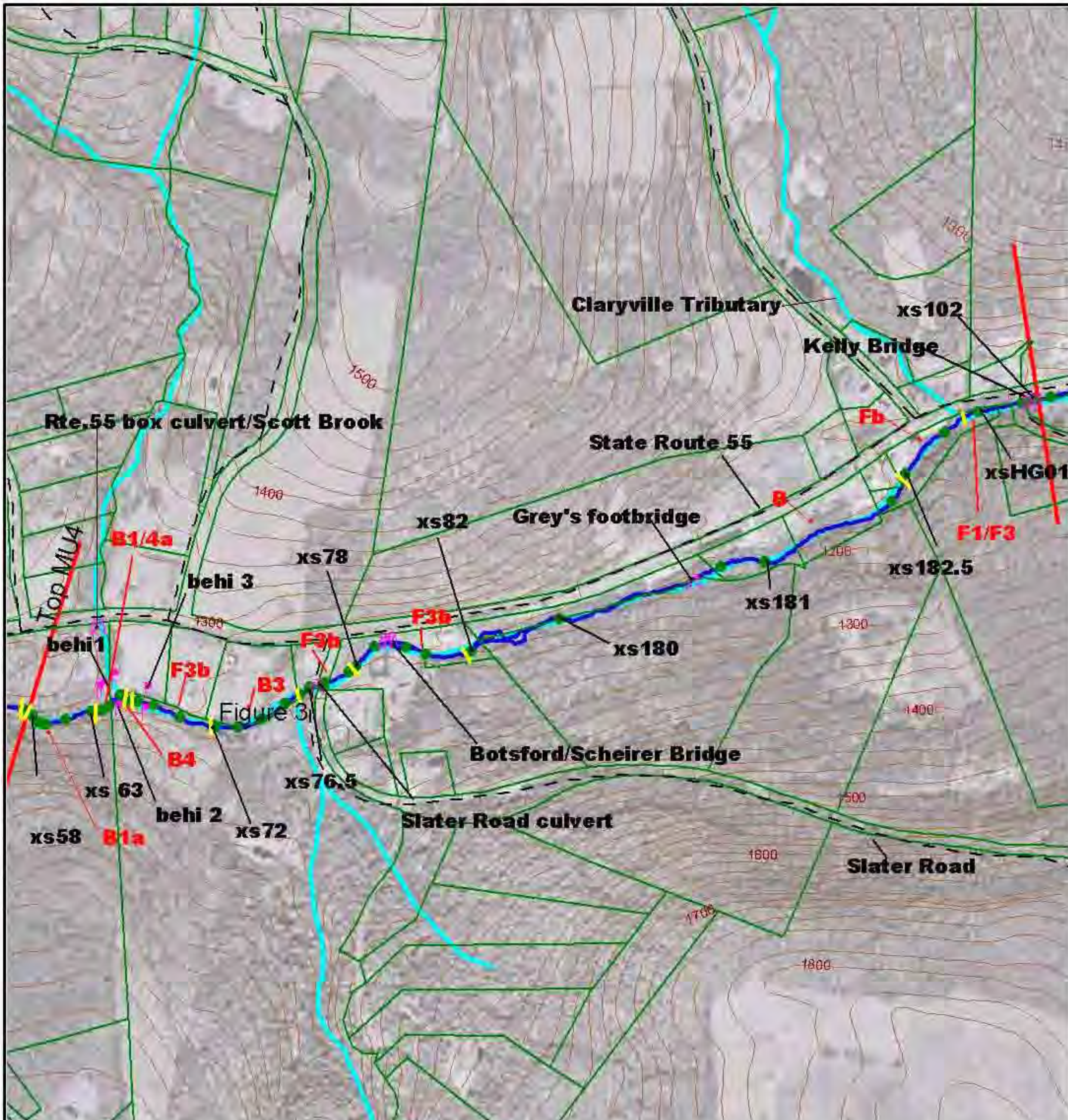


Figure 2. Chestnut Creek MU4 Stream Types and Cross Sections

Stream Assessment Survey 2001

N

Contour Interval 20 feet

300 0 300 600 Feet

1:7,500

*See Disclaimer

Legend

- Management Unit Limits
- Cross Sections
- Monitoring cross section
- B3 Rosgen Stream Types
- Roads
- Neversink Parcels
- Mainstem Chestnut-GPS CL
- Digitized stream location
- Stream type breaks
- Stream Crossing (bridges show inlet/outlet)

N

Figure 1. Chestnut Creek Management Unit 5

Stream Assessment Survey 2001

Contour Interval 20 feet

500 0 500 1000 Feet

Scale 1:11,500

*See Disclaimer

Legend

- Neversink Parcels
- Management Unit Limits
- Revetment
- Road
- Stream Crossing (bridges show inlet/outlet)
- Drainage culvert
- Digitized stream location
- Mainstem Chestnut-GPS CL
- Landfills
- Tributary confluence
- Bedrock
- Erosion
- Debris Jams or Dams
- Knotweed

E. Chestnut Creek Management Unit 5

1. Summary Description

This section is intended to summarize the overall character and condition of Management Unit 5 (MU5). Subsequent sections will discuss specific issues (e.g., *riparian* land use and public infrastructure, channel stability, etc.) in greater detail.

This unit is approximately 8015 linear feet (1.50 miles) in length and includes the segment of Chestnut Creek from immediately downstream of the Kelly Bridge to a point immediately downstream of the Covered Bridge at the Town Park and Fairgrounds (Photo 1). The drainage areas at the upstream and downstream ends of the management unit are 4.75 and 9.45 square miles, respectively (MU5 General map, Figure 1).

Land use along the stream corridor is predominantly forest along adjacent hillslopes with a number of residences, the Town Highway Facility as well as the Town Park and Fairgrounds situated near the *floodplain*. Although the riparian areas on private land are generally maintained as mowed lawn with scattered trees and shrubs, a significant portion of the corridor is owned by NYCDEP and maintained as forest. Storm water runoff from yards is conveyed predominantly as *sheet flow.* The parking lot/equipment storage area at the Highway Facility and the parking lots and tennis courts at the Park drain to the creek via sheet flow and vegetated swales.

Photo 1. Looking downstream upstream at the historical Covered Bridge at the Town of Neversink, Agricultural Society Fairgrounds along Route 55, at bottom MU 5.

This section of Chestnut Creek appear to have been straightened and *channelized* at some time in the past. An analysis of a series of historic aerial photographs covering the period 1974-2001 indicates that routine channel maintenance occurred until recently (Aerial Photos 2, 3 & 4).

Field evidence, as well as information obtained from interviews with residents and town officials indicates that MU5 has been the focus of periodic maintenance activity. (For more information see Public Infrastructure and Landowner Concerns and Interests, Volume I, Section B). The banks have been armored along sections of the management unit. Efforts of the Town and landowners to protect infrastructure and property have resulted in approximately 10% of the channel length through this unit undergoing some type of alteration (e.g., *riprap, gabion*, and concrete *revetment).* These protective measures appear to have been relatively successful in some areas, while less successful in other areas. Gravel flood *berms* are present along some *reaches*. In addition, it is evident that portions of the floodplain have been filled to accommodate development. These channel

Photo 2. 1974 Aerial Photograph of Management Unit 5.

Photo 3. 1995 Aerial Photograph of Management Unit 5.

Photo 4. 2001 Aerial Photograph of Management Unit 5.

and floodplain modifications have resulted in a confined channel with a moderate to high *width/depth ratio*, low *sinuosity* and a relatively steep gradient. As such the creek and adjacent floodplain are more susceptible to stability and flooding problems.

2. Riparian Land Use and Public Infrastructure

There are 41 developed properties within the stream corridor along MU5 that include private residences with ancillary structures, the Town Highway Facility, and the Town Park and Fairgrounds. As noted above, development of the riparian corridor has historically involved floodplain fill and/or the construction of flood berms to protect structures placed in these areas. The Town Highway Facility property includes the old maintenance shop, storage sheds, and a large parking lot and equipment storage area that covers most of the property. The Town Park and Fairgrounds includes several large buildings, storage sheds, athletic fields, tennis courts, a swimming pool, and several large parking lots.

Maintenance of public infrastructure is always a concern for local municipalities. There are two drainage culverts and four bridges in MU5. The bridge names from top of MU5 to the bottom are Clark Road, Mohr's, Hilltop Road, and the Covered Bridge. The County bridge at Clark Road (CBN: 319, BIN: 3357090) was rebuilt in 1995 (Photo 5). The new bridge was designed to convey the 25-year storm flow. Bridge inspections in 2000 and 2001 indicate that the decking, abutments, and wingwalls for this structure are in satisfactory condition.

Photo 5. Looking downstream at Clark Road Bridge.

Photo 6. Failing left abutment (on photo right) attached to concrete wall at Mohr's Bridge, stream flow from right to left.

Photo 7. Looking downstream at concrete wall on left bank tied into edge of Route 55 and Mohr's Bridge.

Although privately owned, the bridge at the Mohr Property provides emergency access for several landowners. The bridge was originally used as access for the local school before the present day Tri-Valley School was established in 1950. The bridge is currently in poor condition. The bridge span was measured to be less than the *bankfull width* immediately both up and downstream of the structure. The left abutment (looking downstream) is also located in the *thalweg* or deepest part of the active stream channel which can be seen in Photo 7. This puts significant stress on the structure as well as the stream channel in the vicinity of the bridge as evidenced by the large scour hole that has undermined the left abutment (Photo 6). Approvals were obtained from NYSDEC in 1998 to repair the failing abutment. The concrete wall that runs along the left bank adjacent to Route 55 is attached directly to the failing abutment (Photo 7). If the bridge is not repaired or replaced the factors contributing to its failure may ultimately affect the structural integrity of the concrete wall.

Hilltop Road Bridge also a County bridge (CBN: 340, BIN: 3357180) was built in 1967 (Photo 8). The bridge width from bank to bank, is smaller than the immediate up and downstream cross sections. This narrow span may contribute to backwater conditions and scour through the bridge opening. Flood damage to the foundation and wingwalls occurred during a severe thunderstorm in July 1995. A general permit was issued for repairs that included removal of gravel and debris deposits, replacing riprap, new toe footings and base protection. Bridge inspections in

Photo 8. View looking downstream at Hilltop Road Bridge, gabion revetment can be seen on left of photo.

Photo 9. Looking upstream right bank Covered Bridge and Fairgrounds. Archive photo obtained from NYS DEC of repair work conducted on wingwall scour in 1991.

2000 and 2001 indicate minor scour erosion was evident. However, the decking, abutments, and wingwalls for this structure are in satisfactory condition.

The historic Covered Bridge was built in 1976 as a bicentennial community project (see Photo 1). Inspected by NYSDOT as a County bridge (BIN: 5524660), it provides access to the Town Park and Fairgrounds and an emergency access to Davis Lane. Although the cross-sectional area of the bridge opening is adequate to pass the bankfull discharge, the relatively narrow span may contribute to backwater conditions and scour through the bridge opening, as the width from bank to bank is smaller than the up and downstream bankfull cross sectional width. During the 2001 Stream Assessment Survey, scour was noted along the right abutment (looking downstream). The bridge wingwall was repaired in 1991 (Photo 9). Bridge inspections in 2000 and 2001 indicated that additional repair work was required. Repairs planned for 2003 were conducted.

At the bottom of MU5, below the Covered Bridge, (actually located at the top of MU6) the town maintains a dry hydrant, (located on the map with a drainage culvert symbol). As with many rural communities, streams provide a critical source of water for fighting fires. To provide a readily available supply of water, dry hydrant facilities are maintained by the Fire Department at key points of access along Chestnut Creek. These facilities can only function if the water in the area of the pump intake is deep enough to accommodate continuous pumping without being drawn down during an emergency. As designed currently, gravel and other debris tend to accumulate in these areas reducing water depth and available pump volume. Standard practice has been to routinely remove these accumulated gravels to maintain proper function of the facility. An alternative design for dry hydrants that significantly reduces the need for maintenance should be addressed, suggestions are presented in the Recommendations section at the end of MU5.

As noted above, storm drainage conveys storm water runoff from streets and parking lots directly to the creek (Photo 10). Two storm drain outfalls were identified in this management unit during the 2001 Assessment Survey.

Photo 10. rip-rap along left bank and Rt. 55 with 2' diameter culvert from the road – below Mohr's bridge.

The volume as well as the water quality of the runoff is a function of the size and characteristics of the land area each system drains. For example, land areas with a high percentage of impervious surfaces tend to generate considerably more runoff than areas that are predominantly forest or lawn. The size and land use characteristics of the areas draining to the outfalls identified, as well as the potential for storm water retrofit opportunities was not evaluated as part of the initial assessment. However, a review of the aerial photographs indicates that the properties along the corridor with the highest percent impervious surfaces include the Town Highway Facility, a private residence along Route 55 at Hilltop Road, and the Town Park and Fairgrounds. These properties do not have storm water management facilities for controlling runoff.

A planned extension of the existing sanitary sewer system may enable existing residences, currently using on-site treatment and disposal systems to connect to DEP's Grahamsville Sewage Treatment Plant. Four extensions to the existing sanitary sewer system are being planned, three of them emanating out of Grahamsville. One of the extensions being planned will extend along Rte 55 west for approximately 1.5 miles from Clark Road to Armstrong Road, upstream of Scott Brook. In some places the sewer alignment will be close to Chestnut Creek. Depending on its ultimate location, the installation of the sewer system could impact a significant length of the riparian area along the creek. In addition, it may be necessary to install lateral extensions across the creek to serve properties on the opposite side of the creek from the sewer main. Current construction specifications, which require that sanitary sewer lines be installed a minimum of three feet below the streambed should minimize the potential for the laterals to create a situation similar to that at Davis Lane, where an unnatural grade change imposed by the sewer crossing may adversely affect the stream (see MU6 description). Careful planning of the main sewer alignment can reduce impacts to the riparian area along Chestnut Creek.

3. History of Stream and Floodplain Work

As noted Chestnut Creek appears to have been straightened and channelized at some time in the past. Channel work to remove gravel deposits and maintain flood conveyance has been routine until recently. Development of the riparian corridor along Chestnut Creek historically involved floodplain fill and/or the construction of flood berms to protect structures placed in these areas. Filling floodplain areas to accommodate development on private as well as public land is still a common practice in the Chestnut Creek watershed. Efforts by the Town, as well as landowners focused on protecting infrastructure and property have involved the installation of *riprap, flood berms, gabions,* and *concrete revetment* along 20% of the channel length through this management unit (Photos 11, 12 & 13). Maintenance of public infrastructure and the extension of public services have required periodic encroachments on the channel and floodplain.

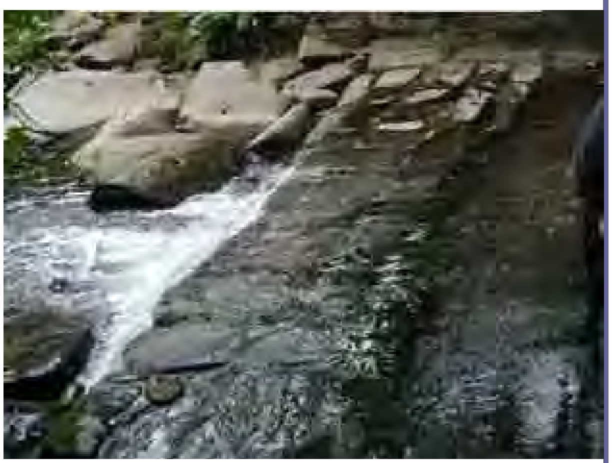


Photo 11. Rock and cement bed/elevation control – looking toward right bank below Clark Road Bridge.

Photo 12. Left channel riprap looking upstream several hundred feet above covered bridge opposite fairgrounds.

Photo 13. Rip-rap on right bank below Clark Rd. Bridge – view looking upstream at end of bridge opposite from Route 55.

General impacts of traditional approaches to stream management have been addressed in the Watershed Recommendations for Best Management Practices, Volume II, Section II.A of this plan. Specific impacts and management considerations in relation to the assessment of MU5 are included with this section of the plan.

4. Channel Stability and Sediment Supply

During the 2001 Stream Corridor Survey, MU5 was divided into twelve *reaches* on the basis of the Level II – *Morphologic* Description (Rosgen, 1996). Stream classification for Chestnut Creek predominantly follows the Rosgen classification system with a few exceptions (see Intro to Stream Processes Volume I, Section III.D, and Watershed Assessment, Volume I, Section I.E.2). Five reaches in MU5 (#1, 7, 8, 9, and 10) contain very short sections of bedrock, though these reaches are otherwise dominated by cobble or gravel-sized sediment. Because locations of bedrock exposure still represent an important control on stream morphology, these sections were documented as a double stream type, such as B1/B3. A B1/B3 reach would be predominantly a B3 (cobble), but would have section (s) of B1 (bedrock) too small to be broken out into a separate reach or reaches. Additional reach type splits may include borderline slope classification, such as B3/B3a, where "a" signifies an A channel slope with a B cross-section morphology.

The largest portion (68%) of this unit includes moderately *entrenched* channel types B3 and B1 with a moderate width to depth ratio (i.e., 18-30). These types of channels tend to be resilient to disturbance and recover well from impact. B-types are generally effective at moving sediment transported from upstream reaches. Although mature trees and shrubs provide lateral control along the majority of the management unit, channel maintenance activities have left all of the reaches in this unit with moderate to high width to depth ratios making them less efficient at moving sediment.

Highly entrenched reaches (i.e. F-types) account for 32% of the total length. Because they lack a floodprone area (i.e., an area adjacent to the channel where floodwaters can spread out and reduce the energy against the streambed and banks), entrenched reaches experience considerable stress during storm flow and tend to be more susceptible to stability problems, particularly bank erosion and bed scour or *degradation*. In addition, these types of channels route storm flow quickly to downstream reaches where they can contribute to channel instability and flooding. The morphological data collected along the reaches is summarized in Table 1 and illustrated in Figure 2.

As evident in the current aerial photographs, the channel *plan form* along this management unit is characterized by low sinuosity and *meanders* with large radii of curvature. The altered meander geometry is the result of channel straightening to accommodate Route 55, development of properties along the stream corridor, and periodic channel maintenance. For example, a significant portion of the upper reaches of Chestnut Creek is confined between Route 55 along the left banks and floodplain, terraces and steep hillslopes adjacent to the right banks. Both left and right banks are developed in this area.

Information obtained from interviews with residents indicates that landowners along the middle reaches have altered the location of the stream over the years. An analysis of a series of historic aerial photographs covering the period 1974 – 2001 indicates that routine channel maintenance activities and subsequent natural channel adjustments has been on-going. The effects of the channel maintenance and natural adjustments are most evident in the 1974 and 1977 aerial photographs. Apparent from the imagery is a consistent down valley migration of the meander bend upstream of the Black property, located upstream of the Covered Bridge near the entry of a small tributary which bounds the upstream side of their property. A noticeable straightening of the same meander occurred between 1977 and 1985 possibly from a chute cutoff during a high flow event or as a result of channel

Table 1 - Summary of Morphological Data for Reaches along Management Unit 5. The first reach is shared with last reach in MU4. The last reach in MU5 is shared with the first reach in MU6.

Reach	Length (ft)	Area (ft^2)	Width (ft)	Mean Depth (ft)	W/D	Ent	Slope (ft/ft)	Stream Type
1	646	41.7	26.2	1.6	17	1.4	0.015	F1/F3
2	447	43.2	29.4	1.35	20	1.5	0.025	B3
3	582	44.5	34	1.3	26	1.27	0.020	F3
4	109	35.4	24.5	1.4	18	1.5	0.020	B3
5	275	42.9	29.7	1.4	21	1.2	0.015	F3
6	334	68.3	36.5	1.9	20	1.6	0.020	B3
7	658	62	38.7	1.6	25	1.2	0.010	F1/F4
8	951	62.7	39.7	1.6	25	1.55	0.020	B1/B4
9	352	60.5	38.5	1.6	24	1.4	0.015	F1/F3
10	1332	66	38.6	1.7	23	1.7	0.020	B1/B3
11	247	70	40	1.8	22	1.3	0.020	F3
12	2926	70.5	44.9	1.64	30	1.74	0.020	B3

maintenance activities. The *meander* continued to migrate in a down valley direction between 1995 and 2001 moving progressively closer to the Black's residence. The largest change in channel plan form occurred along the meander bend adjacent to the tennis courts, just upstream of the Covered Bridge adjacent to the Town Fairgrounds. In this area the bend location shifted 60 feet between 1974 and 2001. The meander bend adjusted several times through the photo series, most noticeably with the shift from a well-developed point bar evident in 1977 to a mid-channel bar existing currently.

Historic bed degradation, floodplain fill, and the construction of gravel flood berms contributed to the current entrenched situation along Reaches 1, 3, 5, 7, 9 and 11. Exposed bedrock currently provides grade control along a significant portion of the unit, thereby preventing further channel degradation. However, field observations and the aerial photographic record indicate that aggradation is an on-going process throughout this management unit. Mid-channel and lateral bars have developed along many of the reaches. The overwide condition (i.e., high width to depth ratio) of the channel along a number of reaches is likely a result of historic channel maintenance.

As pointed out in Introduction to Stream Processes and Ecology, Volume I, Section III.A, natural streams are composed of three distinct flows that include: a *baseflow* or low flow channel, which provides habitat for aquatic organisms; a bankfull channel, which is critical for maintaining sediment transport; and a floodplain, which effectively conveys flows greater than the bankfull discharge (i.e., 1 – 3-year peak flow).

Standard engineering practice to designs channels that convey large storm flows (e. g., 25-, 50-, or even 100-year peak flows) without overtopping the adjacent streambanks. While enlarging the channel to improve its ability to convey storm flows may seem logical, in fact this approach usually creates channels that have poor habitat, are ineffective at transporting sediment, and require constant maintenance. These engineered channels are generally designed to convey all flows (baseflow, bankfull flow, and flood flow) in a single channel that is relatively straight, very wide and trapezoidal in *cross-sectional area*, with a uniform profile.

In these altered channels, baseflow is usually very shallow or may actually flow beneath the substrate because it is spread out over such a large surface area. The uniform profile replaces the typical *riffle-*pool sequence with a continuous shallow riffle-run that provides no cover for fish to avoid predation or strong flushing currents. A very wide, shallow channel is less efficient at moving sediment under bankfull flow conditions. As a consequence, sediment (e.g., *sand, gravel, cobble*) tends to accumulate, developing lateral and/or mid-channel bars along these altered reaches. Ironically, the accumulation of sediment and the development of bars significantly reduce the channel's capacity to convey the large storm flows for which it was designed. The 2001 Stream Assessment Survey conducted by SCSWCD showed that approximately 2825 feet (35%) of channel is affected by aggradation.

Lateral control along 20% of channel length is currently provided by riprap, gabions, and concrete revetment. These protective measures appear to have been relatively successful in some areas, while less successful in other areas. For example, the banks along the rear of the Black Property in the middle reaches of this unit had been rip rapped during previous maintenance attempts. Currently riprap has been dislodged, fallen into the channel and is inappropriately redirecting higher flows and scouring stream banks (Photo 14).

Mature trees and shrubs provide sp,e lateral control along the management unit. The 2001 Stream Assessment Survey determined that 2040 feet (12.7%) of the

Photo 14. Dislodged riprap in the channel.

Photo 15. Looking downstream towards eroded left bank and fallen Sycamore trees near Fairground area-monitoring cross section 6.

streambanks are actively eroding (Photo 15). Bank to bankfull height ratios along this unit ranged from 1.1 – 3.6, confirming that a significant length of the channel is *incised.* Rosgen (2002) notes that bank to bankfull height ratio is a good measure of vertical stability, as well as an indicator of sediment supply potential. Stability assessment resulted in banks along the actively eroding areas to be rated very high in terms of bank erosion potential, meaning that the potential for continued bank erosion, loss of trees and channel migration is very high compared to other sites. In fact, as meander bends and bars continue to develop lateral erosion and meander migration will accelerate. Because the channel is cutting into terraces and fill slopes in some areas they may continue to be a significant source of sediment for downstream *reaches*.

Debris jams, dams and other channel obstructions can cause problems by deflecting storm water into stream banks and trapping sediment that initiates the development of gravel bars and reduces channel capacity, and scouring the bed and banks. At the time of the 2001 Stream Assessment Survey debris jams were not a significant problem along the reaches in this unit, although subsequent visits have shown new trees undercut and fallen (Photo 15). A number of man-made structures were observed including; a log sill and several rock check dams (Photos 16, 17 & 18). It was not clear whether these structures are negatively affecting channel stability and/or sediment transport.

As part of the 2001 Assessment Survey *monumented* cross-sections were installed in a number of locations along Chestnut Creek to monitor stream bank erosion and streambed changes in specific reaches of

Photo 16. Rock check dam, between Clark Road Bridge and Hilltop Road Bridge.

Photo 17. Just below Covered Bridge MU5, Wood Weir serving dry hydrant in downstream MU (see MU6 for more detail).

Photo 18. Log sill located just above Covered Bridge.

concern (Bank Erosion Hazard Index, BEHI, and Bank Monitoring Cross–section, BMX, to observe aggradation) Accordingly, four cross-sections were established and surveyed in MU5 along the reaches upstream of the Covered Bridge adjacent to the Town Fairgrounds (Photos 19, 20, 21 & 22, MU5 Stream Type Cross Section map, Figure 2). Three of the sites were established to monitor lateral erosion (BEHI 4,5&6) and one along a section that appears to be aggrading (BMX 1). The cross-sections will be resurveyed and compared to the initial surveys to document the rate at which stream bank and streambed changes occur. Data obtained from these surveys will also allow estimates of sediment loadings to be developed.

Photo 19. Monitoring cross section 4 at eroded left bank view from right opposite tennis courts at Fair-ground.

Photo 20. Monitoring cross section 5, view looking at right bank, tennis courts in background beyond tree, approximately 200’ downstream of monitoring cross section 4.

Photo 21. Monitoring cross section 6, approximately 200’ eroded right bank, downstream of monitoring cross section 5.

Photo 22. Aggradation monitoring cross section 1, just upstream Covered Bridge.

Evaluating the reaches along Chestnut Creek to determine whether they are contributing to sediment problems in the Chestnut Creek/Rondout Reservoir System was a component of the Assessment

Survey. The preliminary results of the fieldwork indicate that the actively eroding banks and mid-channel bars noted above may be a source of sediment to downstream reaches. Where they accumulate, these sediments may reduce channel capacity and contribute to localized channel stability problems.

The sediments eroded from the reaches along Chestnut Creek are generally coarse (i.e., *sand, gravel and cobble*). Unlike other watersheds where exposed *silt* or *clay* deposits are a water quality concern because they contribute very fine material to the suspended sediment load, these coarser sediments tend to move as *bed load* and settle out quickly after storms. As a consequence, sediment eroded from the streambed and stream banks along this management unit does not appear to directly affect water quality within the Chestnut Creek/Rondout Reservoir System.

5. Riparian Vegetation

The riparian area along Management Unit 5 can be characterized as: reaches adjacent to roads and parking lots with little or no buffer; reaches with mowed lawns and scattered trees and shrubs; reaches with small wooded buffers of mature trees, shrubs, and herbaceous plants; and reaches along steep hillslopes and terraces with mature forest. In riparian areas where small wooded buffers are present, their width varies from 75 feet to 250 feet. In general these areas are less than 100 feet wide. Along developed properties, the riparian vegetation has been affected by clearing, routine yard maintenance, and other land use activities. The properties along the stream corridor with the lowest percent of riparian vegetation and buffer include the Town Highway Facility in the upper reaches and the private residences fronting along Route 55 in the middle reaches.

The results of the 2001 Assessment Survey indicate that control of *multiflora rose* has been a problem along some areas. *Japanese knotweed*, an *invasive species*, was sighted along the banks in this management unit. It occupied a total of 110 feet on both the left and right banks in three separate locations. Invasive, exotic plants such as this crowd out the natural flora of the area and generally provide little streambank stabilization or habitat (Riparian Vegetation Issues in Stream Management, Volume I, Section IV.B.3).

6. Restoration and Management Recommendations

As presented previously, the Chestnut Creek Management Plan will be utilized to guide and facilitate stakeholders in their efforts to correct stream channel instability problems, restore and maintain natural floodplain functions, control runoff from developed areas to reduce pollutant loadings from channel and upland sources, restore and protect in-stream habitat, and reduce the need for future channel maintenance.

This section includes specific restoration and management recommendations for Management Unit 5, as well as a general discussion of the approach to stream corridor restoration and management recommended for the Chestnut Creek Watershed. The SCSWCD, NYCDEP, and other agencies and organizations will be working with the community to implement the restoration and management strategies outlined in this Management Plan. It is critical that stream and upland area projects be integrated to avoid potential conflicts in their respective objectives. Therefore, this section also includes comments and recommendations regarding the integration of proposed strategies in upland areas, in particular floodplain management and storm water management practices.

Restoration and Management Recommendations Management Unit 5

1. Assess small tributaries and springs that feed the mainstem in MU5. Prioritize projects along mainstem and tributaries. Repair and stabilize the worst erosion sites along mainstem and the tributaries draining to MU5.

2. Implement storm water management for the properties with the highest percent impervious surface along the corridor, including the Town Highway Facility and the Town Park and Fairgrounds, and any other significant impervious areas identified during the field reconnaissance recommended below. The storm water management facilities should be designed to provide water quality management for the first half-inch of runoff and quantity management that reduces the peak discharge runoff rate for the 1 – 3-year storm flows.

3. Convert the existing F and unstable B reaches to stable B channels by removing existing mid-channel bars, removing poorly sited and/or poorly functioning check dams, removing gravel flood berms, and reconstructing these overwide and entrenched channels with lower width/ depth ratios and wider floodprone areas.

4. Evaluate the potential for removing all or a portion of the paving and fill along the Town Highway Facility Property in order to reestablish a wooded buffer zone and floodplain area.

5. Repair or replace the bridge at the Mohr's Property. If the bridge is replaced it should be designed to convey the 25-year storm and have a cross-section and width that effectively conveys the bankfull discharge without causing scour or deposition.

6. Evaluate the potential for reconstructing the channel along the historically active reaches from upstream of the Black Property to the tennis courts at the Town Park.

7. Evaluate the Covered Bridge to determine the best method for reducing scour and improving sediment transport and conveyance of bankfull and flood flows.

8. Establish a better angle on unstable banks and lower the bankfull to bank height ratio by removing gravel flood berms and grading high, vertical banks.

9. Stabilize the banks and provide long-term lateral control by reestablishing bank vegetation composed of native trees, shrubs and grasses.

10. Provide grade control structures (e.g., cross vanes) at key points along the channel to maintain bed stability as an alternative to bank armoring, after conducting on-site inspections and full assessment at problem areas.

11. Install flow-diverting structures (e.g., rock vanes, J-Hook vanes, etc) at key points along the channel to reduce stress in the near bank region as an alternative to bank armoring, after conducting on-site inspections and detailed assessment at problem areas.

12. Initiate a knotweed eradication and control program along this unit.

13. Reconstruct problematic dry hydrant sites utilizing cross vanes to provide low maintenance facilities.

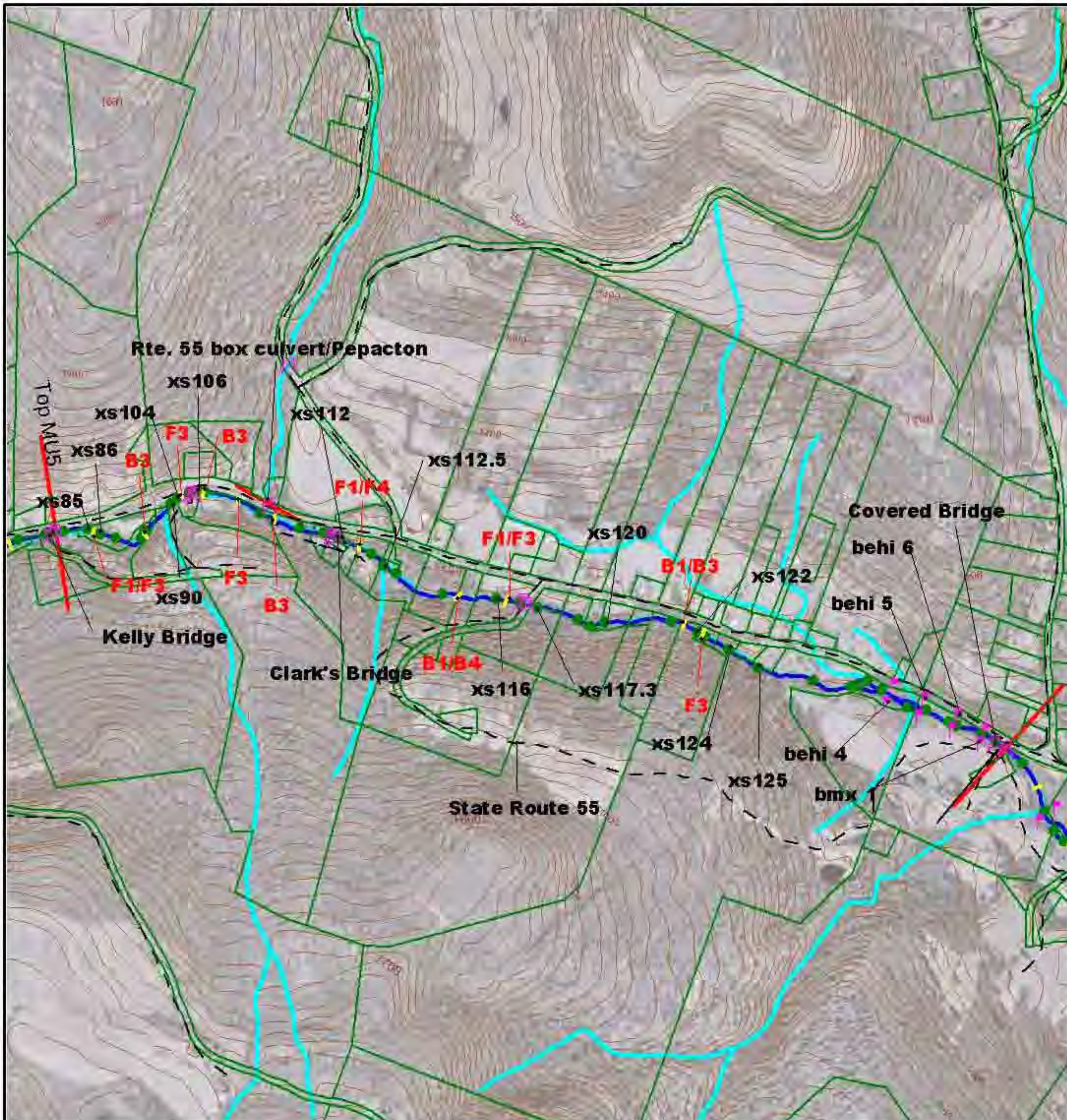


Figure 2. Chestnut Creek MU5 Stream types & Cross Sections

Stream Assessment Survey 2001

Legend

- Management Unit Limits
- Cross Sections
- Monitoring cross section
- B3 Rosgen Stream Types
- Roads
- Neversink Parcels
- Mainstem Chestnut-GPS CL
- Digitized stream location
- Stream type breaks
- Stream Crossing (bridges show inlet/outlet)

N

Contour Interval 20 feet

300 0 300 600 900 1200 Feet

1:12,000

*See Disclaimer

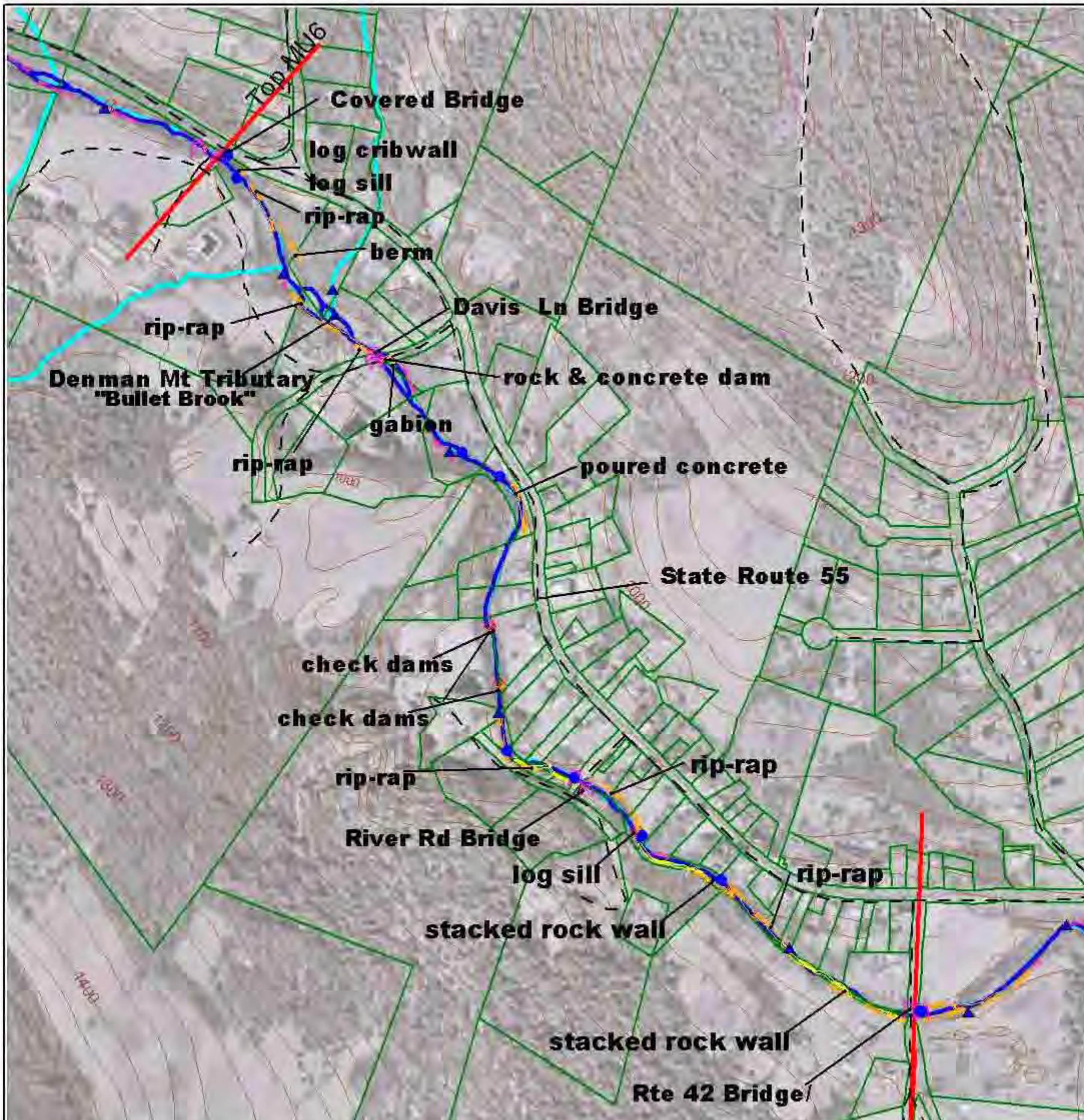


Figure 1. Chestnut Creek Management Unit 6

Stream Assessment Survey 2001

N

Contour Interval 20 feet

300 0 300 600 Feet

Scale 1:7000

*See Management Unit Disclaimer

Legend

- Neversink Parcels
- Management Unit Limits
- Revetment
- Road
- Stream Crossing (bridges show inlet/outlet)
- Drainage culvert
- Digitized stream location
- Mainstem Chestnut-GPS CL
- Landfills
- Tributary confluence
- Bedrock
- Erosion
- Debris Jams or Dams
- Knotweed

F. Chestnut Creek Management Unit 6

1. Summary Description

This section is intended to summarize the overall character and condition of Management Unit 6 (MU6). Subsequent sections will discuss specific issues (e.g., *riparian* land use and public infrastructure, channel stability, etc.) in greater detail.

This unit is approximately 5370 linear feet (1.02 miles) in length and includes the segment of Chestnut Creek from immediately downstream of the Covered Bridge, through the Hamlet of Grahamsville, to the Route 42 Bridge (Photo 1). The drainage areas at the upstream and downstream ends of the management unit are 9.45 and 12 square miles, respectively (MU6 General map, Figure 1).

Because of its location in the heart of the hamlet, the stream corridor along MU6 is the most heavily developed and maintained of the management units. Land use includes a mix of homes, businesses, and government buildings. Although most of the structures front along Route 55, the *riparian* areas on private land are maintained as mowed lawn with scattered trees and shrubs along the more densely developed sections of the creek (Photos 2 & 3). The land around public buildings is predominantly parking lots and mowed lawn. Storm drainage conveys storm water runoff from these parking lots, as well as from streets, directly to the creek.

This section of Chestnut Creek is reported to have been straightened and *channelized*

Photo 1. View looking downstream from cross section 136, Fairgrounds on right of photo, several hundred feet below Covered Bridge.

Photo 2. Looking upstream at cross section 151, half-way between Davis Lane and River Road bridges.

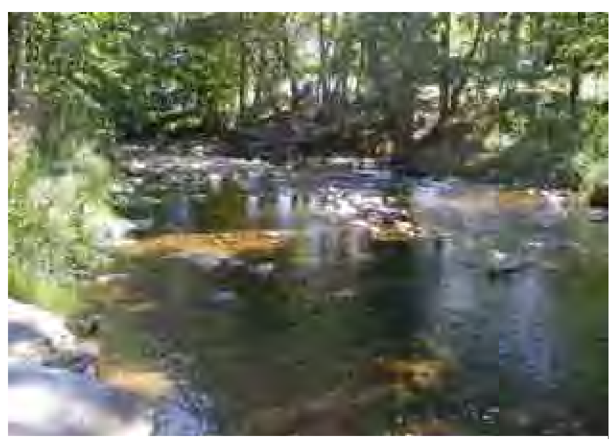


Photo 3. Reach-view looking downstream from left bank at cross section 161 behind fire house.

at some time in the past from information obtained from an historic 1929 DOT highway map. An analysis of a series of historic aerial photographs covering the period 1963-2001 verifies that any channel modifications occurred prior to 1963. The aerial photographic record also indicates that routine channel maintenance occurred until recently (Aerial Photos 4, 5 & 6).

Field evidence, as well as information obtained from interviews with residents and town officials indicates that MU6 has been the focus of significant maintenance activity. The bed and banks have been armored along many sections of the management unit. Efforts of the Town and landowners to protect infrastructure and property have resulted in nearly 25% of the channel length through this unit undergoing some type of alteration (e.g., *riprap*, *gabion*, and concrete *revetment*). These protective measures appear to have been relatively successful in some areas, while less successful in other areas. Gravel flood *berms* are common along the stream corridor. In addition, it is evident that portions of the *floodplain* have been filled to accommodate development. These channel and floodplain modifications have resulted in a confined channel with a high width/depth ratio, low *sinuosity* and a relatively steep gradient. As such the creek and adjacent floodplain are more susceptible to stability and flooding problems.

2. Riparian Land Use and Public Infrastructure

According to tax maps for 2000, there are 53 developed properties within the stream corridor along MU 6 that include a mix of homes, businesses, and government buildings. As noted above, development

Photo 4. 1963 Aerial Photograph of Management Unit 6.

Photo 5. 1977 Aerial Photograph of Management Unit 6.

Photo 6. 2001 Aerial Photograph of Management Unit 6.

of the riparian corridor has historically involved *floodplain* fill and/or the construction of flood *berms* to protect structures placed in these areas. Recent development has continued these practices. For example, an expansion of the Town Hall was completed in 2001. Although the original structure was already located in the *floodplain*, the expansion has placed the structure and its associated parking lot much closer to the creek, which could pose a threat to both the building and the creek. Construction of the new Post Office in 1999 required placing as much as two feet of fill in the floodplain and resulted in a parking lot and loading dock that are in very close proximity to the creek. Sketches included with the permit application for the Post Office indicate that a flood berm existed along this *reach* of stream prior to the filling of the floodplain. Fill brought the rest of the site to the level of the flood berm.

Maintenance of public infrastructure is always a concern for local municipalities. There are two bridges in MU6, one on Davis Lane (CBN: 70, BIN: 3357040) built in 1953 (Photo 7) and the other on River Road (CBN: 92, BIN: 3357080) built originally in 1933 and rebuilt after flooding in 1996 damaged it (Photo 8). Although bridge inspections in 2000 and 2001 indicate that the decking, abutments, and wingwalls for both structures are in satisfactory condition, inspection reports, as well as the historic aerial photographs and information obtained from residents and town officials indicate that the stream reaches in the vicinity of the bridges have had on-going *aggradation* problems. Large gravel bars were observed upstream and downstream of the bridges during the 2001 Assessment Survey (Photos 8 & 9).

Photo 7. Looking downstream at right span of Davis Lane Bridge.

Photo 8. Looking downstream at River Road Bridge, just above Town Hall. Note the cobbles that are deposited upstream of the bridge in the foreground of the photo.

Photo 9. Looking downstream at left bank cross section 141 at end of center bar and split channel upstream of Davis Lane Bridge.

As pointed out in Introduction to Stream Processes and Ecology, Volume I, Section III, natural streams are composed of three distinct flows that include: a *baseflow* or low flow channel, which provides habitat for aquatic organisms; *a bankfull* channel, which is critical for maintaining sediment transport; and a *floodplain*, which effectively conveys flows greater than the bankfull discharge (i.e., 1 – 3-year peak flow).

Standard engineering practice designs bridges so that they can safely convey large storm flows (e.g., 25-, 50-, or even 100-year peak flows) without overtopping the bridge and associated roadway. In addition, the channel immediately upstream and downstream of bridges is commonly reconstructed (i.e., *channelized*) so that it contains those same storm flows without overtopping the adjacent stream banks. While enlarging the channel to improve its ability to convey storm flows may seem logical, in fact this approach usually creates channels that have poor habitat, are ineffective at transporting sediment, and require constant maintenance. These engineered channels are generally designed to convey all flows (baseflow, bankfull flow, and flood flow) in a single channel that is relatively straight, very wide, trapezoidal in *cross-sectional area*, with a uniform profile.

In these altered channels, base flow is usually very shallow or may actually flow beneath the *substrate* because it is spread out over such a large surface area. The uniform profile replaces the typical *riffle*-pool sequence with a continuous shallow riffle-run that provides no cover for fish to avoid predation or strong flushing currents. A very wide, shallow channel is less efficient at moving sediment under bankfull flow conditions. As a consequence, sediment (e.g., *sand, gravel, cobble*) tends to accumulate, developing lateral and/or mid-channel bars along these altered reaches. Ironically, the accumulation of sediment and the development of bars initially reduces the channel's capacity to convey the large storm slows for which it was designed. Bar development is the stream's way of reducing width, increasing effective depth and improving sediment transport capacity and velocity. Eventually, improves flood conveyance improves by reducing further inappropriate deposition, if allowed to continue to equilibrium. This process can take years, so maintenance is often required before the stream can reach a stable balance.

The Davis Lane Bridge was designed to convey the 25-year storm flow. The channel width in the vicinity of the bridge is 3 times wider than the *reaches* upstream and downstream. The high width to depth ratio of the channel and the presence of the bridge center pier has contributed to *aggradation* problems and large mid-channel bars have developed upstream and downstream of the bridge (Photo 10). These decrease stream effective width, enabling greater sediment transport capacity, reduced by over widening.

Another significant factor contributing to problems in this area was the effect of the sanitary sewer crossing downstream of the bridge on channel slope through this reach (Photo 11). In the 1950's, a sanitary sewer lateral was installed across Chestnut Creek immediately downstream of the Davis Lane Bridge to serve the Fairgrounds. After the sewer line was exposed by a

Photo 10. Looking downstream from top of Davis Lane Bridge at split channel below grade control at high flow. Right channel dry in 2001 at low flow. Center bar with cobbles and willow can be seen.

Photo 11. Looking upstream towards Davis Lane Bridge concrete grade control structure over sewer line.

storm in the 1960's it was reinforced with a grouted riprap encasement. The elevation of the original sewer line and subsequent encasement significantly raised the streambed in this reach. This resulted in an extremely flat channel gradient in the vicinity of the bridge upstream, which has undoubtedly contributed to the on-going aggradation problems previously mentioned. The combination of the high width to depth ratio, flat gradient, and center pier of the bridge ensures that material transported from upstream will routinely accumulate in this reach.

The River Road Bridge is also affected by aggradation. However, in this case the problem appears to be the result of a loss of stream energy due to a sharp (120°) meander bend and overwidend reach upstream of the bridge (Photo 12). In addition, the bridge span is narrower than the width of the channel along the reaches upstream and downstream. These factors cause water to back up on the upstream side of the bridge. Under this *backwater* condition, the flow velocity along the upstream reach drops reducing the stream's ability to transport its sediment load. As a result material accumulates along the upstream reach. Water backed up above the bridge during floods tends to form scouring eddies near the banks as the water rushes under the bridge, contributing to bank erosion and further widening of the channel.

At the top of MU6, located below the Covered Bridge, the town maintains a dry hydrant, (located on the map with a drainage culvert symbol). As with many rural communities, streams provide a critical source of water for fighting fires in

Photo 12. Looking downstream at rip rap along sharp curve and culvert on right bank, along River Road upstream of bridge. Flow hits directly into bank near culvert.

the Chestnut Creek Valley. To provide a readily available supply of water, dry hydrant facilities are maintained by the Fire Department at key points of access along Chestnut Creek (Photo 13). These facilities can only function if the water in the area of the pump intake is deep enough to accommodate continuous pumping without being drawn down during an emergency. As designed currently, gravel and other debris tend to accumulate in these areas reducing water depth and available pump volume. Standard practice has been to routinely remove these accumulated gravels to maintain proper function of the facility. An alternative design for dry hydrants that significantly reduces the need for maintenance should be addressed, possibly using structures suggested in the Recommendations at the end of MU6.

As noted above, storm drainage conveys storm water runoff from streets and parking lots directly to the creek. Eight storm drain culverts were identified in this management unit during the 2001 Stream Assessment Survey (Photo 14). The volume as well as the water quality of the runoff is a function of the size and characteristics of the land area each system drains. For example, land areas with a high percentage of impervious surfaces tend to generate considerably more runoff than areas that are predominantly forest or lawn. The size and land use characteristics of the areas draining to the outfalls identified, as well as the potential for storm water retrofit opportunities was not evaluated as part of the initial assessment. However, a review of the aerial photographs indicates that the properties along the corridor with the highest percent impervious surfaces include the Agriculture Center, Bank, Town Hall, Post Office, and Fire Hall. None of these properties have storm water management facilities for controlling runoff.

A planned extension of the existing sanitary sewer system may enable existing residences, currently using on-site treatment and disposal systems to connect

Photo 13. Dry hydrant (out of order, removed) and eroded bank behind Town Hall parking lot-view looking toward left bank & Town Hall from center of stream. (flow left to right)

Photo 14. Culvert in left bank abutment on upstream side of River Road Bridge, view looking downstream from the center of the stream.

to DEP's Grahamsville Sewage Treatment Plant. Four extensions to the existing sanitary sewer system are being planned, three of them emanating out of Grahamsville. One of the extensions being planned will extend along Rte 55 west for approximately 1.5 miles from Clark Road to Armstrong Road, upstream of Scott Brook. In some places the sewer alignment will be close to Chestnut Creek. Depending on its ultimate location, the installation of the sewer system could impact a significant length of the riparian area along the creek. In addition, it may be necessary to install lateral extensions across the creek to serve properties on the opposite side of the creek from the sewer main. Current construction specifications, which require that sanitary sewer lines be installed a minimum of three feet below the streambed should minimize the potential for the laterals to create a situation similar to that at Davis Lane, there is an unnatural grade change imposed by the sewer crossing may adversely that may adversely affect the stream. Careful planning of the main sewer alignment can reduce impacts to the riparian area along Chestnut Creek.

3. History of Stream and Floodplain Work

As noted Chestnut Creek appears to have been straightened and channelized at some time in the past. Channel work to remove gravel deposits and maintain flood conveyance has been routine until recently. Development of the riparian corridor along Chestnut Creek historically involved floodplain fill and/or the construction of flood berms to protect structures placed in these areas. Filling floodplain areas to accommodate development on private as well as public land is still a common practice in the Chestnut Creek watershed. Efforts by the Town, as well as landowners focused on protecting infrastructure and property have involved the installation of riprap, flood berms, gabions, stacked rock walls, and concrete revetment along 25% of the channel length through this management unit (Photos 12, 15 & 16). Maintenance of public infrastructure and the extension of public services have resulted in periodic encroachments on the channel and floodplain.

Photo 15. Bedrock streambed, starting approximately 200' upstream from Route 42 Bridge-view looking upstream from center of stream, stacked rock wall on left of photo.

Photo 16. Concrete wall with box culvert along Route 55 between River Road and Fire House.

General impacts of traditional approaches to stream management have been addressed in the Watershed Recommendations for Best Management Practices, Volume II, Section II.A of this plan. Specific impacts and management considerations in relation to the assessment of MU6 are included with this section of the plan.

4. Channel Stability and Sediment Supply

During the 2001 Stream Corridor Survey, MU6 was divided into ten reaches on the basis of the Level II – Morphologic Description (Rosgen, 1996). Stream classification for Chestnut Creek predominantly follows the Rosgen classification system with a few exceptions (see Intro to Stream Processes Volume I, Section III.D, and Watershed Assessment, Volume I, Section I.E.2). Three reaches in MU5 (#8, 9, and 10) contain very short sections of bedrock, though these reaches are otherwise dominated by cobble-sized sediment. Because locations of bedrock exposure still represent an important control on stream morphology, these sections were documented as a double stream type, such as B1/B3. A B1/B3 reach would be predominantly a B3 (cobble), but would have section(s) of B1 (bedrock) too small to be broken out into a separate reach or reaches. Additional reach type splits may include borderline slope classification, such as B3/B3a, where "a" signifies an A channel slope with a B cross-section morphology.

The largest portion (36%) of this unit includes moderately *entrenched* channel types B-types. With mature vegetation on the banks these types of channels tend to be very stable and are generally effective at moving sediment transported from upstream reaches. Highly entrenched reaches (i.e., F-types) account for 30% of the total length. Approximately 28% of the unit includes reaches in transition from one stream type to another (i.e., B3/F3 and F3/B3c). Because they lack a floodprone area (i.e., an area adjacent to the channel where floodwaters can spread out and reduce the energy against the streambed and banks), highly entrenched reaches experience considerable stress during storm flow and tend to be more susceptible to stability problems, particularly bank erosion and bed scour or *degradation.* In addition, these types of channels route storm flow quickly to downstream reaches where they can contribute to channel instability and flooding. The remaining reaches are C-types, which make up 10% of the total length. Although these channel types are generally stable, woody vegetation is critical to maintaining bank stability. In addition, they are susceptible to stability problems where sediment loads are high. The *morphological* data collected along the reaches is summarized in Table 1 and illustrated in Figure 2.

The general cross-section and *meander* geometry along this management unit is typical of streams that have been channelized and straightened. As evident in the current aerial photographs, the channel *planform* is characterized by low sinuosity and truncated meanders with large radii of curvature. It appears that the reaches in this unit have undergone a series of alterations and adjustments over time that have included flooding impacts, gravel removal and channelization, floodplain alteration, and natural adjustments.

Table 1 - Summary of Morphological Data for Reaches along Management Unit 6. The first reach in MU6 is shared with last reach in MU5.

Reach	Length (ft)	Area (ft^2)	Width (ft)	Mean Depth (ft)	W/D	Ent	Slope (ft/ft)	Stream Type
1	2926	70.5	44.9	1.64	30	1.74	0.020	B3
2	541	70.8	66	1.1	60	2.2	0.020	C3
3	896	67.2	45.3	1.5	30.2	1.9	0.015	B3c
4	312	76.3	36.9	2.1	17.3	1.2	0.014	F3
5	487	81.2	51	1.6	31.9	1.4	0.017	B3c
6	269	66.3	49	1.4	35	1.2	0.012	F3
7	866	80.6	51	1.6	31.9	1.4	0.015	F3/B3c
8	596	82.9	39	2.1	18.5	1.3	0.017	F1/3
9	546	91.4	44.4	2.1	21	1.7	0.013	B3c/B1c
10	414	64.8	40	1.6	25	1.0	0.013	F1/3

Historic bed degradation, floodplain fill, and the construction of gravel flood berms contributed to the current entrenched situation along Reaches 4, 6, 7, 8 and 10. Exposed bedrock currently provides grade control along a significant portion of the unit, thereby preventing further channel degradation. However, field observations and the aerial photographic record indicate that aggradation has been and continues to be a problem along the upper and middle reaches. Information obtained from interviews with residents indicates that aggradation has been an on-going problem in the vicinity of the Davis Lane and River Road Bridges.

As noted above, large mid-channel bars have developed upstream and downstream of the Davis Lane Bridge. The overwidend condition of the channel is likely a result of historic channel maintenance. Although the high width to depth ratio of the channel and the bridge center pier have contributed to the development of the gravel bars, encasement of the sanitary sewer downstream of the bridge has contributed to the problem as well. Analysis of the data from the longitudinal profile field survey shows that the slope of the reach upstream of the bridge is 0.018. When measured through the bridge to a point downstream of the sewer line the slope is also 0.018. However, when measured through the bridge to the top of the sewer line the channel slope is only 0.0012. The combination of the high width to depth ratio, center pier, and the extremely flat gradient significantly affects sediment transport in this reach. Unnaturally high meander geometry (i.e., a tight bend), a high width to depth ratio, and an undersized bridge are the principal contributors to the aggradation problems at the River Road Bridge.

Although eroding banks were observed in some locations, preliminary observations indicate that most of the channel along this management unit is laterally stable (i.e., bank erosion rates are considered low at 4%). Lateral control along one-fourth the channel length is currently provided by rip-rap, gabions, stacked rock, and concrete revetment. These protective measures appear to have been relatively successful in some areas, while less successful in other areas. For example, the banks along the rear of the Town Hall have been rip-rapped during previous maintenance attempts. Currently rip rap has been dislodged, fallen into the channel and is diverting storm flows (Photo 17). Residents have expressed concerns about the riprap revetment on the sharp bend upstream of the River Road Bridge. The riprap was installed in the 1970's to protect the road along the right floodplain. Some of the riprap has been dislodged and scattered along the channel by storm flows during the intervening years.

Mature trees and shrubs provide lateral control along the majority of the management unit. Only 4% of the stream banks exhibited active erosion. Results of the stability assessment show that the banks along the actively eroding areas have high to very high bank erosion potential. In addition, bank to bankfull height ratios along this reach ranged from 1.0 – 2.5, confirming that a significant length of the channel is *incised*. Rosgen (2002) notes that bank to bankfull height ratio is a good measure of vertical stability, as well as an indicator of sediment supply potential.

Photo 17. Dislodged riprap at left bank behind Town Hall parking lot-view looking downstream with dry hydrant partially visible in the background.

Debris jams and other channel obstructions can cause problems by deflecting storm flows into stream banks and trapping sediment which initiates the development of gravel bars and reduces channel capacity. At the time of the 2001 Stream Assessment Survey debris jams were not a significant problem along the reaches in this unit. However, a number of man-made structures were observed including; a wood weir forming a pool for a dry hydrant, and several rock check dams (Photo 18). It was not clear whether these structures are negatively affecting channel stability and/or sediment transport.

As part of the 2001 Stream Assessment Survey *monumented* cross-sections were installed in a number of locations along Chestnut Creek to monitor stream bank erosion and streambed changes (e.g., aggradation) in specific reaches of concern. Two cross-sections were

Photo 18. Wood weir behind Town Hall.

established and surveyed in MU6, one along the reach between the Covered Bridge and Davis Lane and a second along the reach downstream of the Davis Lane Bridge. The cross-sections will be resurveyed and compared to the initial surveys to document the rate at which streambed and stream bank changes occur. Data obtained from these surveys will also allow estimates of sediment loadings to be developed.

Evaluating the reaches along Chestnut Creek to determine whether they are contributing to sediment problems in the Chestnut Creek/Rondout Reservoir System was a component of the Assessment Survey. The preliminary results of the field work indicate that the actively eroding banks and mid-channel bars noted above may be a source of sediment to downstream reaches. Where they accumulate, these sediments may reduce channel capacity and can contribute to localized channel stability problems.

The sediments eroded from the reaches along Chestnut Creek are generally coarse (i.e., sand, gravel and cobble). Unlike other watersheds where exposed silt or clay deposits are a water quality concern because they contribute very fine material to the suspended load, these coarser sediments tend to move as bed load and settle out quickly after storms. As a consequence, sediment eroded from the streambed and stream banks along this management unit does not appear to directly affect water quality within the Chestnut Creek/Rondout Reservoir System.

5. Riparian Vegetation

The riparian area along MU6 can be characterized as a mix of small wooded buffers with mature trees, shrubs, and herbaceous plants; mowed lawns with scattered trees and shrubs; and roads and parking lots with mowed lawn. In riparian areas where wooded buffers are present, their width varies from 25 feet to 350 feet. In general these areas are less than 100 feet wide. With the exception of the reaches in the immediate vicinity of Davis Lane, River Road, and Route 42, the riparian vegetation along the right floodplain (looking downstream) has been least affected by clearing, routine yard maintenance, and other land use activities. The properties along the stream corridor with the lowest percent of riparian vegetation and buffer include the Bank, Town Hall, Post Office, and Fire Hall. The results of the Assessment Survey indicate that control of multiflora rose has been a problem in some areas. Japanese knotweed did not appear to be a problem in this management unit. For more information, see Riparian Vegetation Issues in Stream Management, Volume I, Section IV.B.3.

6. Restoration and Management Recommendations

As presented previously, the Chestnut Creek Management Plan will be utilized to guide and facilitate stakeholders in their efforts to correct stream channel instability problems, restore and maintain natural floodplain functions, control runoff from developed areas to reduce pollutant loadings from channel and upland sources, restore and protect in-stream habitat, and reduce the need for future channel maintenance.

This section includes specific restoration and management recommendations in Management Unit 6 for the Chestnut Creek Watershed. The SCSWCD, NYCDEP, and other agencies and organizations will be working with the community to implement the restoration and management strategies outlined in this Management Plan. It is critical that stream and upland area projects be integrated to avoid potential conflicts in their respective objectives. Therefore, this section also includes comments and recommendations regarding the integration of proposed strategies in upland areas, in particular floodplain management and storm water management practices.

Restoration and Management Recommendations Management Unit 6

1. Repair and stabilize the worst erosion sites along the tributaries draining to MU6.

2. Implement storm water management for the properties with the highest percent impervious surface along the corridor, including the Agriculture Center, Bank, Town Hall, Post Office, Fire Hall, and any other significant impervious areas identified during the field reconnaissance. The storm water management facilities should be designed to provide water quality management for the first half-inch of runoff and quantity management that reduces the peak discharge runoff rate for the 1 – 3-year storm flows.

3. Convert the existing F-types and unstable transition reaches to stable B-types channels by removing existing mid-channel bars, removing poorly sited and/or poorly functioning check dams, removing gravel flood berms, and reconstructing these overwide and entrenched channels with lower width/depth ratios and wider floodprone areas.

4. Reconstruct the channel in the vicinity of the Davis Lane Bridge by removing the mid-channel bars upstream and downstream of the bridge, narrowing the width to depth ratio, steeping the slope by reinstalling the sanitary sewer line downstream of the bridge under current construction specifications, and constructing a W-Weir to direct bankfull flows through one opening, while allowing flood flows to pass through both openings.

5. Evaluate the River Road Bridge to determine the best method for improving sediment transport and conveyance of bankfull and flood flows.

6. Reconstruct the River Road reach to provide a larger radius of curvature and install rock vanes to divert flow away from the reconstructed banks.

7. Establish a better angle on unstable banks and lower the bank to bankfull height ratio by removing gravel flood berms and grading high, vertical banks. Stabilize the banks and provide long-term lateral control by reestablishing bank vegetation composed of native trees, shrubs and grasses.

8. After conducting detailed assessments consider providing grade control structures (e.g., cross vanes), upon field assessment, at key points along the channel to maintain bed stability as opposed to traditional bank hardening methods.

9. Install flow diverting structures (e.g., rock vanes, J-Hook vanes, etc.) at key points along the channel to reduce stress in the near bank region as opposed to traditional bank hardening methods, again in conjunction with detailed assessments.

11. Reconstruct problematic dry hydrant sites utilizing cross vanes to provide low maintenance facilities.

12. Evaluate the extent of multi-flora rose and evaluate an invasive vegetation eradication and control program.

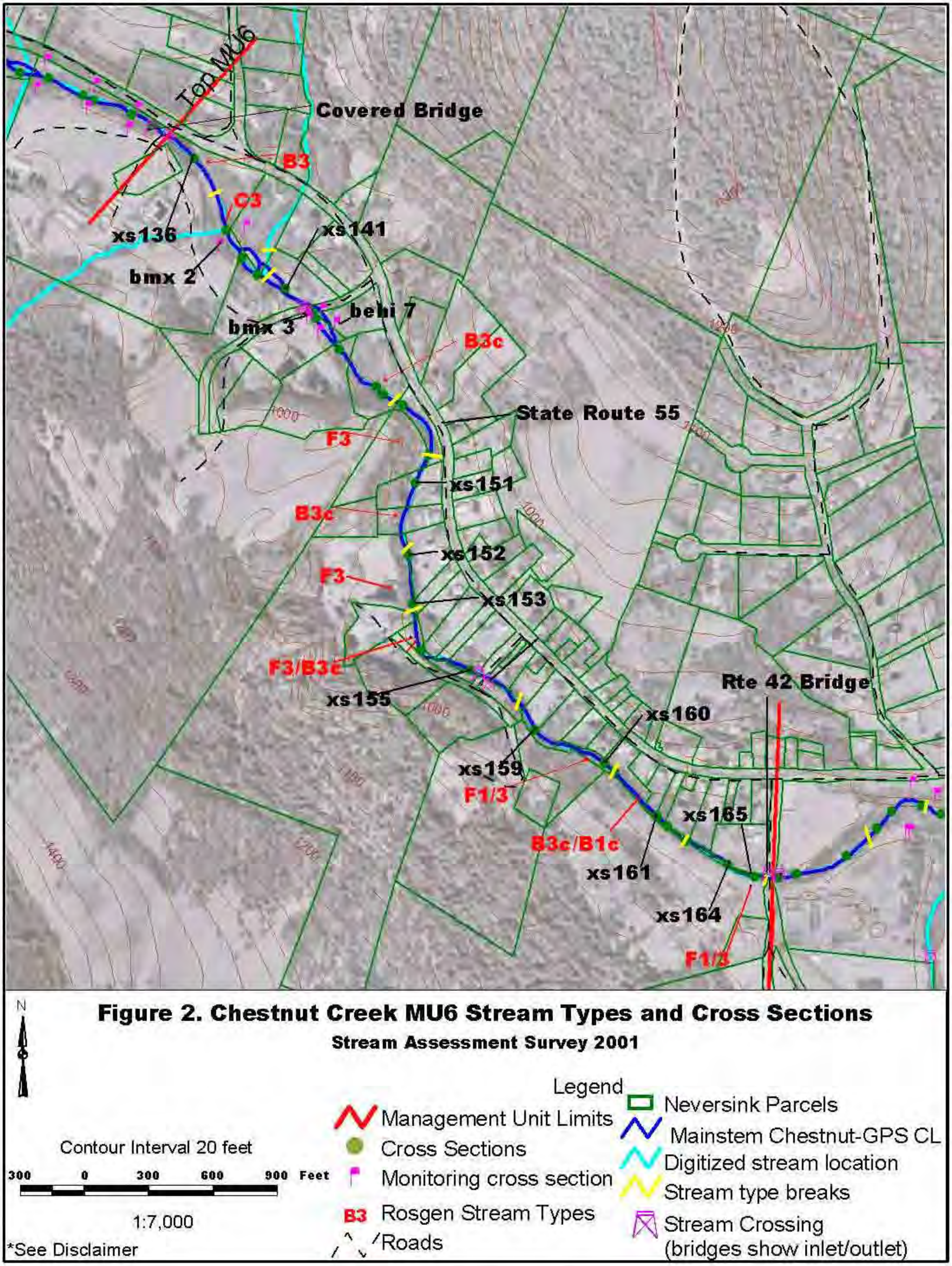


Figure 2. Chestnut Creek MU6 Stream Types and Cross Sections

Stream Assessment Survey 2001

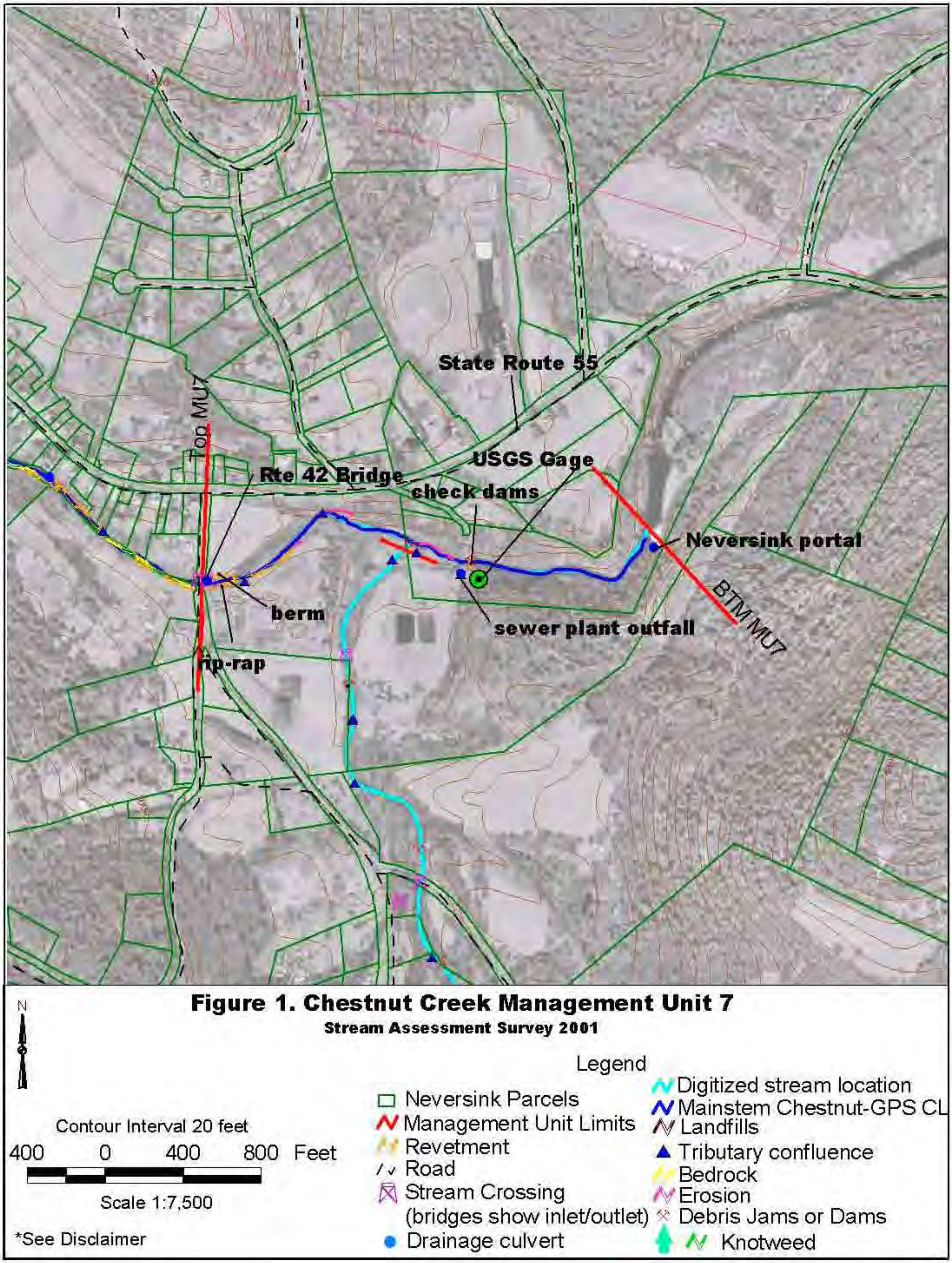


Figure 1. Chestnut Creek Management Unit 7

Stream Assessment Survey 2001

G. Chestnut Creek Management Unit 7

1. Summary Description

This section is intended to summarize the overall character and condition of Management Unit 7 (MU7). Subsequent sections will discuss specific issues (e.g., *riparian* land use and public infrastructure, channel *stability*, etc.) in greater detail.

MU7 is approximately 3200 linear feet (0.61 miles) in length and includes the segment of Chestnut Creek immediately downstream of New York State Route 42 Bridge (BIN: 1025010) to NYC DEP Portal from the Neversink Reservoir (Photos 1 & 2). *Drainage area* at the upstream and downstream ends of the management unit is 12.1 and 21.1 square miles, respectively, and includes direct flow from Red Brook, NYCDEP Portal, and effluent discharge from the Grahamsville Waste Water Treatment Plant (Photo 3). A USGS stream gaging station (#01365500 Chestnut Creek at Grahamsville) is located along Chestnut Creek approximately 600 ft. downstream of the confluence with Red Brook (MU7 General map, Figure 1).

The stream corridor along MU 7 varies in channel shape or *morphology*, floodplain function, riparian habitat and channel stability. Vegetative community and riparian areas were documented as being significantly healthier than other local units. In general, moving from the upstream unit, the channel becomes less *entrenched* with a flatter channel *slope* and a wider average channel width.

Photo 1. View looking downstream at Route 42 Bridge, cobble bar under bridge with main channel flowing into right abutment armed with riprap.

Photo 2. NYC DEP water portal from the Neversink Reservoir, emptying into the Chestnut Creek on the outskirts of Grahamsville, NY.

Photo 3. Tributary from sewer plant outfall on NYC DEP property above USGS gaging station, Grahamsville, NY.

Consequently, gravel and finer sediment are more prevalent, with *sedimentation* and *channel migration* becoming more of a management concern. These materials take the form of numerous *sediment bars* located throughout the unit (Introduction to Stream Processes and Ecology, Volume I, Section III).

A number of natural constraints and human-made modifications were inventoried within the unit during the 2001 Stream Assessment Survey. These include traditional applications consisting of placed rock revetment, such as *riprap*, floodplain *berms*, and grade control structures such as check dams and weirs, as well as sewer and bridge crossings. Channel alignment has been historically constrained by high terraces, in areas along both banks. In the center of the unit, the stream channel currently impinges along the toe of a high bank along State Route 55, on NYCDEP property, resulting in severe erosion and *mass wasting* (Photo 4 & Appendix Projects Ranking).

Photo 4. Steep eroded left bank on DEP property, along Route 55-view looking downstream toward road & left bank from XS-170.

2. Riparian Land Use and Public Infrastructure

According to tax maps for 2000, there are 6 properties located within 150' of the stream in MU7 that include several small residential parcels, the Grahamsville Rural Cemetery, the Grahamsville Waste Water Treatment Plant, Power plant and property owned and operated by NYCDEP including the Grahamsville Laboratory, and a new NYCDEP Police Precinct. In comparison, the riparian corridor through MU7 is significantly less developed than MU6.

MU7 currently contains one bridge at State Route 42, located at the top of the unit. There is evidence of an historical bridge which was located downstream near the USGS gaging station. This bridge crossed Chestnut Creek toward Route 55 and but was removed in the late 1980's.

Historical aerial photographic assessment was performed to assess the natural changes and historic modifications to the stream channel and floodplain within MU7. Field assessments and historical documentation can be combined with interpretation of the imagery in order to develop a causal analysis relating to the current channel stability and morphology. MU7 was assessed using remotely sensed imagery from 1963-2001 (Aerial Photos 5, 6 & 7).

Landowners in the area have reported that the stream channel through the State Route 42 Bridge was repositioned during reconstruction in 1996 (Landowner Concerns and Interests, Volume I, Section IV.B.6). The 2001 inventory documented

Photo 5. 1963 Aerial Photograph of Management Unit 7.

Photo 6. 1977 Aerial Photograph of Management Unit 7.

Photo 7. 2001 Aerial Photograph of Management Unit 7.

a large gravel bar had formed under the opening of the structure (Photo 8). Gravel deposition can result from inadequate bridge width or location over the bankfull channel width. Reduction of the *hydraulic* opening under a bridge causes ongoing maintenance problems as well as potentially results in higher stress along the bridge abutments. Field surveys verified that the deepest part of the stream channel currently runs directly into and along the right bridge abutment (see Photo 1). Evaluation of the bridge alignment and width over the bankfull channel width would be beneficial to both the longevity of the bridge and the integrity of the stream.

Photo 8. Cobble bar under Route 42 bridge along left abutment.

Bridges and culverts which have been constructed without proper consideration of *fluvial* (stream) processes can have negative impacts on stream systems and result in ongoing maintenance problems for structures themselves. These impacts are most commonly associated with inadequate sizing of the bankfull width and alignment of the bridge opening. Bridges with inadequate openings results in a loss of stream function and increase potential for numerous impacts upstream and downstream of the structures.

Storm water runoff from yards and parking lots is conveyed predominately as *sheet flow*. The volume as well as the water quality of the runoff is a function of the size and characteristics of the land area each system drains. For example, land areas with a high percentage of impervious surfaces tend to generate considerably more runoff than areas that are predominately forest or lawn. The size and land use characteristics of the areas draining to the outfalls identified, as well as the potential for storm water retrofit opportunities was not evaluated as part of the initial assessment. However, a review of the aerial photographs indicates that the properties along the corridor with the highest percent impervious surfaces include the DEP Facilities and the Waste Water Treatment Plant. These properties do not have storm water management facilities for controlling runoff (Riparian Vegetation Issues in Stream Management, Volume I, Section IV.B.3, and Riparian Vegetation Management Recommendations, Volume II, Section II. A.1).

3. History of Stream and Floodplain Work

Traditionally, activities to straighten, widen, build up or deepen stream channels have been undertaken to increase floodwater conveyance and attempt to protect eroding streambanks throughout Chestnut Creek watershed. Similar to upstream units, a number of modifications to the stream and floodplain in MU7 were inventoried during the 2001 Stream Assessment Survey. Review of historic aerial imagery displayed a number of channel modifications and revealed expected corridor responses. Most evident was channel work performed between 1963 and 1974 where the channel in MU7 appeared to have been mechanically straightened and widened. Extensive areas of vegetation appear to have been removed.

Typically the practice of over-widening causes a decrease in stream velocity, which results in excessive sediment deposition, a reduction in *riffle/pool* complexes, and a loss of habitat. Channel braiding and extensive random gravel deposition were evident in later imagery. Further review of imagery from 1995 revealed that it took nearly 20 years for the floodplain to re-vegetate and to develop a single narrower channel.

General impacts of traditional approaches to stream management have been addressed in Stream Stewardship Recommendations, Volume II, Section II. Specific impacts and management considerations in relation to the assessment of MU7 are included with this section of the plan as well. Use of riprap around bridges is a common practice and usually is specified in design and construction due to hydraulic considerations and erosive forces created by the bridge opening during storm flows. The Route 42 Bridge has a continuous section of riprap along the right bank of the channel. Riprap begins at the bridge outlet and continues nearly 600 feet downstream (Photo 9). The purpose for the extent of the original installation was not established during the initial site investigation. Several impacts have potentially resulted from revetment placement, which includes redirection of stream flow toward the high bank area and increased entrenchment. Additionally, the stream channel in MU7 seems to be

Photo 9. End of rip-rap on right bank, downstream of Route 42 Bridge – on DEP property – view looking upstream from the center of the stream.

reducing channel slope by increasing belt width through erosion and lateral migration. This process is prevented by riprap, but is potentially amplified or transferred to the downstream areas.

Entrenchment in an upper *reach* is exacerbated by a floodplain *berm* located along the left bank. The berm is over 100 feet in length and is presumably constructed from sediment excavated from the channel bottom. Streamside berms are typically constructed to prevent infrastructure damage and flooding, however the purpose of this modification was not investigated during initial assessment. These embankments typically increase peak flood elevation and stream velocities, which result in increased erosive forces. Stream systems *entrenched* within floodplain berms are prone to channel degradation and other associated instabilities.

Berms such as these generally do not offer much, if any, protection from flooding. They can cause stream entrenchment and higher flood height or *stage* locally by preventing floodwaters from flowing over the floodplain, cutting off an important function of these flat areas. Floodplains function to reduce flood velocity, increase absorption of floodwaters, encourage deposition of silt and fine sediments (keeping them from being washed further downstream) and decrease flood stage in downstream areas. Small, low, *discontinuous floodplain* benches perform important floodplain functions in small mountain streams. Removal or restructuring of some of these bermed areas should be considered to add floodplain functions to this area and reduce erosion and instability problems. Setting berms back from the stream provides a compromise solution, if berm materials are necessary either for stockpiles or flood inundation protection.

A common practice in the past for controlling erosion of stream beds, is the installation of cross channel check dams constructed of concrete, steel sheet piling, gabion baskets or other materials. MU7 contains two structures acting as check dams with apparently different purposes. Approximately 140 feet downstream of State Route 42 Bridge is a low head check dam structure (Photo 10). This structure generates a one-foot grade drop in channel invert below the structure. The nature of this check dam was not determined during the initial inventory, but these structures are frequently used to address stream channel *incision*, or to raise base stream flow elevation for easier water withdrawal. The structure may contain a sanitary sewer lateral, which were inventoried in upstream units, and should be investigated. Typical impacts of stream channel check dams include a local reduction of stream slope, increased deposition and increased bank erosion. Sediment transport through

Photo 10. Stone and cement bed-grade control-view looking upstream towards Route 42 Bridge.

Route 42 Bridge may be affected by the check dam. Often a stream will migrate around a check dam requiring ongoing maintenance. Use of extensive riprap discussed above may have been implemented to prevent loss of this check dam.

The second structure is a v-notched weir located at the USGS gaging station, 1,400 feet downstream from State Route 42 Bridge (Photo 11). The effects of this structure independently were not evident from the assessment, however the combination of these structures and the

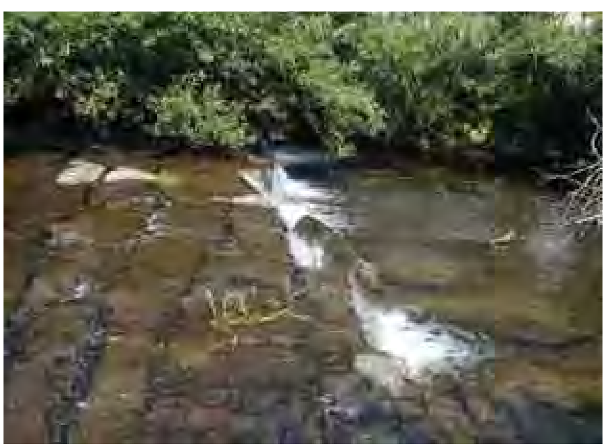


Photo 11. Stone step weir on DEP property at USGS gage.

apparent instability of the high bank between them will need to be incorporated in future analysis, restoration and management of MU7.

Channel modifications appear to have occurred in MU 7 prior to 1963, associated with unstable areas. The channel was braided throughout many sections along the length of MU 7, particularly upstream of the failing DEP bank. Braiding could be a direct result of previous channel maintenance or in combination with prior flood events. Historic peak flow data shows several large flood events occurring in the 1950's, with the largest flow of 4,640 cfs recorded on October 15, 1955. The riparian corridor consisted of a thin strip of vegetation along MU 7 channel banks and floodplain from State Route 42 Bridge to the sewer outfall. Below the outfall the buffer looks to be continuous through the end of the unit (see Hydrology and Flood History, Volume I, Section IV. B.2, & Aerial Photos 5, 6 & 7).

The 1974 and 1977 imagery displayed many of the same channel and floodplain features present in 1963. Most evident was apparent *channelization* and widening between 1963 and 1974. Virtually all riparian vegetation was removed from the floodplain in the upper half of unit above the sewer outfall. Extensive sediment braiding and random gravel deposition increased throughout the area during this time period.

Gravel *bar* formations increased in size from 1974 to 1977 with the apparent tendency of the channel to become more defined, however no established vegetation was documented on these formations. Extensive sediment formed at Chestnut's confluence with Red Brook, denoting reduced transport capabilities of Chestnut Creek and potential instabilities located within Red Brook. Large spread bar formations were present upstream of the historical bridge remains.

By 1985 the stream had redeveloped into a more defined, single thread channel with increasing amounts of riparian vegetation. There were no visible central depositional features noted and a small number of side channel point bars. By 1995, side channel point bars had become completely vegetated, with a single thread stream channel. The lower bridge crossing had been removed. The high bank was completely vegetated. Limited bar formation around and in front of the DEP high bank was noted, however formations just downstream Red Brook Tributary were inventoried.

High flows in the period between 1995 and 2001 have exposed a large section of erosion along the high bank, removing all vegetation from its face. Data from the Chestnut Creek gage station, located within MU 7, was unavailable for this time period, however nearby stream gages revealed large storm events occurring in both 1996 and 1999. Migration of channel and bank lines was clearly evident as well as a channel shift up valley along the lower portion of the *meander*. This migration may have reduced the local slope and therefore increased deposition in the area of the bank. The 2001 aerial further displayed a down valley meander migration of nearly 60 feet. This migration directs flows into the face of the bank further threatening its stability.

4. Channel Stability and Sediment Supply

During the 2001 Stream Corridor Survey, MU7 was divided into 5 reaches on the basis of the Level II – Morphologic Description (Rosgen, 1996). The largest percentage of channel is of the C stream type, which makes up 56% of the units total length MU7. The C channel types are generally stable and common in the lower, flatter portions of many local watersheds. These stream types are highly dependent on woody vegetation for maintaining stability. In addition, they are susceptible to stability problems where sediment loads are high, as is the case in this unit. The second largest portion (23%) of this unit includes highly entrenched F *stream types*. Because they lack a floodprone area, entrenched reaches experience considerable stress during storm flow and tend to be more susceptible to stability problems, particularly bank erosion and bed scour or degradation. In addition, these types of channels route storm flow quickly to downstream reaches where they can contribute to channel instability and flooding. Moderately entrenched channel types B3, and B1 comprise the remaining portion of the unit (22%). With mature vegetation on the banks, these types of channels tend to be very stable and are generally effective at moving sediment transported from upstream reaches.

The 2001 Stream Assessment Survey in documented nearly 450 feet of the stream bank actively eroding and failing in MU7. This erosion occurs in three sections on both the left and right banks as well as the high bank of concern. Areas with minimal vegetation along the bank as well as high bank height to bankfull height ratios tend to experience increased bank stress and erosion rates.

Sediment supply varies within the unit. Storage of sediment in the form of both sidebars and central bars is evident throughout the entire unit. A number of these bars are vegetated, however some areas indicate recent or ongoing deposition. Cobble and gravel comprise the predominant substrate within the bankfull channel and bar formations. Also a small amount of exposed bedrock has been identified below the bridge at Route 42 and below the gage. The morphological data collected along MU7 is summarized in Table 1 in order progressing downstream from the Route 42 Bridge. Also see Stream Type and Cross Section location map, Figure 2.

Information obtained from interviews with residents and town officials paired with field inventories identified actively eroding DEP high bank as the primary concern in MU 7. The stream bank is currently located within 20 feet of the state highway, amplifying the priority for concern. Estimations using aerial photography that more than 73,000ft^3 of sediment has been eroded from this single bank in six years between 1995 and 2001. The high eroded bank is currently over 100 feet long and 30 feet high (see Public Infrastructure and Landowner Concerns and Interests, Volume I, Section IV.B).

Evaluating reaches along Chestnut Creek to determine whether they are contributing to sediment problems in the Chestnut Creek/Rondout Reservoir System was a component of the 2001 Stream Assessment Survey. The preliminary results of the fieldwork indicate that the actively eroding banks and mid-channel bars noted above are a source of sediment to downstream reaches. Where they accumulate, these sediments may reduce channel capacity and contribute to localized channel stability problems.

Sediments eroded from reaches along Chestnut Creek are generally coarse (i.e., sand, gravel and cobble). Unlike other watersheds where exposed silt or clay deposits are a water quality concern because they contribute very fine material to the suspended load, these coarser sediments tend to move as bed load and settle out quickly after storms. As a consequence, sediment eroded from the streambed and stream banks along this management unit does not appear to directly affect water quality within the

Table 1 - Summary of Morphological Data for Reaches along Management Unit 7 .

Reach	Length (ft)	Area (ft^2)	Width (ft)	Mean Depth (ft)	W/D	Ent	Slope (ft/ft)	Stream Type
1	567	59.1	37.0	1.6	23	1.6	0.016	B3c
2	363	81.5	47.6	1.7	30	3.4	0.009	C3
3	135	82.3	74.0	1.1	67	1.9	0.023	B
4	1421	70.5	33.8	2.1	16	4.1	0.014	C
5	311	124.0	65.8	1.9	35	1.1	0.006	F

Chestnut Creek/Rondout Reservoir System.

Planform, or stream pattern, through MU7 was derived from current aerial photography. MU7 is characterized by an average radius of curvature of 260 feet and an average meander length of 558 feet. The belt width of MU7 ranges from 55 feet to 480 feet. *Sinuosity* or curvature of the channel is 1.17, which is slightly lower than expected for contributing stream types within the particular valley setting.

Sinuosity measurements from historical aerial photography show a continual increase in value from 1974 to present. As previously mentioned, the upper section of MU7 had undergone channelization work in the early 1970's. The stream channel appears to be continuing to make adjustments as a result of that work over 30 years ago. Sinuosity values have increased in the upper section from 1.02 to 1.14, with a corresponding increase in channel length of over 180 feet, illustrating that the stream is attempting to regain its natural form.

<u>High Bank Failure</u>

General cross-section and meander geometry along this management unit is typical of streams that have undergone extensive anthropogenic impact. MU7 has been affected by erosion and reduced sediment transport during large storm events, and more prevalent lateral migration. Again this type of migration becomes a problem erosion threatens infrastructure or property. Numerous factors contribute to current migration in the unit including geology, riparian vegetation, flooding and anthropogenic impacts.

The high bank of concern is located 800 feet downstream of State Route 42 Bridge on NYCDEP property. The bank is 38 feet in height at its center and over 100 feet long. The bank at its center is uniform in slope with a bank angle of approximately 42 degrees. Bank configuration in 2001 was considered over-steepened, in comparison to upstream and downstream areas of the same terrace formation and is presently located less then 20 feet from Rt. 55. It has been estimated using aerial photography that more than 73,000 ft^3 of sediment has been eroded from this single bank in the six years between 1995 and 2001. No protective vegetation existed on the bank top, face, or toe of the bank (Photos 12 & 13).

Suspected cause of failure was initialized by sediment *entrainment* from water flowing parallel to the bank, causing erosion by removal of soil particles at the bank toe. Field evidence revealed the soil

Photo 12. Monitoring cross section, DEP 2, eroded left bank.

Photo 13. Monitoring cross section, DEP 1, left toe of eroding bank close up of Photo 9, stream flow left to right.

composition of the bank is distinctly different from materials in other local banks. Interviews with local residents and town officials indicate that bank material is composed of tailings from construction of the water portal from the Neversink Reservoir, which enters into Chestnut Creek just downstream. The bank soil composition was characterized as homogeneous fine sediment, with limited stratification, again not typical of other more resistant native materials found in other local banks.

Field inspections revealed slumped grass from the top of the bank along the bank toe indicating active erosion and slumping. The 2001 Stream Assessment Survey included establishment of monitoring cross sections, two of which were placed in the area of the high bank, to verify this process. The bank was evaluated using a *Bank Erosion Hazard Index (BEHI)* scoring system, which evaluated parameters such bank height, vegetation rooting depth and density, bank surface protection, angle and materials. The bank was rated with an extreme potential for erosion, which is the highest applied score in the entire Chestnut Creek mainstem.

Historically, the bank material has been unable to withstand the near bank stress imposed by flow in the channel. Further compounding the risk of continued bank failure is a lack of suitable bank protection along the bank toe, exacerbated by current stream alignment. Apparent from historic imagery is the trend of increasing sinuosity and channel length in the area of the high bank through lateral migration at the bank, and a channel avulsion downstream. The 2001 aerial photo further displayed down valley migration of the meander leading into the area of the bank, directing flows into the face of the bank. The effect of this migration is suspected to have reduced local slope, and increased deposition in the area of the bank, ultimately accelerating erosion into and at the bank.

In general, current channel configuration and channel inefficiencies may tend to lead to further erosion at the high bank. Without treatment, the bank failure will likely continue both upstream and downstream. This current trend amplifies priority for remediation of this bank. To be successful, any stabilization scheme must deal with this imbalance either by reducing velocities, increasing bank erosion resistance, and/or removing or re-directing the force. Sediment transport inefficiencies should be examined and addressed in any remediation effort. Permanent treatment of the bank should be performed in conjunction with channel improvements both upstream and downstream. An immediate temporary stabilization effort should be considered along the bank toe to prevent further failure and potential catastrophic damage to the adjacent highway.

5. Riparian Vegetation

Streamside assessment conducted in 2001 did not investigate specific streamside (riparian) plant species or density, but recorded areas with insufficient or stressed vegetation that could affect stream stability, flooding or erosion threats, water quality or aquatic habitat.

The majority of MU7 has good vegetative cover except in areas where the channel runs fairly close to a roadway. Stream types present indicate that riparian condition is extremely important to current stream channel stability. Riparian condition throughout the reach varied in relation to length, bankfull stage and topography.

The upper half of MU7 contains primarily deciduous brush (willows and alder) with grass understory, at moderate to high

Photo 14. Reach-view looking upstream from XS-170 on DEP property.

densities (Photo 14). A large area containing maintained fields exists along the upper portion of the unit on the right floodplain. The lower section of the unit consists of more dense mature stands of deciduous trees along both floodplains. Although floodplain vegetation was deemed adequate to provide general stability, areas with a relatively low rooting depth to bank height provided minimal vegetative stability. Historical aerial photograph analysis shows an increasing density of riparian vegetation from 1997 to present.

6. Restoration and Management Recommendations

As presented previously, the Chestnut Creek Management Plan will be utilized to guide and facilitate stakeholders in their efforts to correct stream channel instability problems, restore and maintain natural floodplain functions, control runoff from developed areas to reduce pollutant loadings from channel and upland sources, restore and protect in-stream habitat, and reduce the need for future channel maintenance (see Project Partners, Volume I, Section II).

The following discussion includes specific restoration and management recommendations for Management Unit 7, as an approach to stream corridor restoration and management recommended for the Chestnut Creek Watershed. The SCSWCD, NYCDEP, and other agencies and organizations will be working with the community to implement the restoration and management strategies outlined in this Management Plan. It is critical that stream and upland area projects be integrated to avoid potential conflicts in their respective objectives

Restoration and Management Recommendations Management Unit 7

1. Relocate and stabilize the stream channel in the area of the high eroding bank. (See following section)

2. Perform further assessment of the Red Brook tributary to determine the extent of erosion and potential sources of excess sediment to the mainstem of the Chestnut Creek in Management Unit 7.

3. Implement and/or improve on storm water management for the properties with the highest percent impervious surface along the corridor, including the DEP Facilities and the Waste Water Treatment Plant. The storm water management facilities should be designed to provide water quality management for the first half-inch of runoff and quantity management that reduces the peak discharge runoff rate for the 1 – 3-year storm flows.

4. Assess the potential effects of the check dams on channel stability, sediment transport, habitat improvement, and fish passage. Remove poorly sited and/or poorly functioning check dams, with attention to promoting multi-objective restoration.

5. Evaluate the potential for increasing the riparian buffer between the NYCDEP facilities and Chestnut Creek in order to establish a functioning wooded buffer zone and floodplain area. Stabilize the banks and provide long-term lateral control by reestablishing bank vegetation composed of native trees, shrubs and grasses.

6. Evaluate the potential of replacing or modifying stabilized areas (riprap), as needed with alternative stabilization techniques including bioengineered vegetation and vane/log style structures. These techniques can prove to be more aesthetically pleasing, promote physical habitat, and facilitate other multiple secondary benefits.

8. Evaluate the State Route 42 Bridge for the ability to convey both bankfull and flood flow, as well as proper sediment transport. Design modification should reduce scour and provide for fishery passage.

9. Assess the local condition and stream width at remaining abutments from the historical bridge. Evaluate bankfull width accommodation and the potential for removing the abutments if necessary to improve flood conveyance, aesthetics, and potential liability.

10. Establish a better angle on unstable banks and lower the bank to bankfull height ratio by grading high, vertical banks. Stabilize the banks and provide long-term lateral control by reestablishing bank vegetation composed of native trees, shrubs and grasses.

11. Provide grade control structures (e.g., cross vanes) at key points along the channel to maintain bed stability as an alternative to bank armoring, after conducting on-site inspections and detailed assessment at problem areas.

12. Install flow diverting structures (e.g., rock vanes, J-Hook vanes, etc) at key points along the channel, as an alternative

option to bank armor, to reduce stress in the near bank region after conducting on-site inspections and detailed assessment at problem areas.

13. Continue to monitor the reach for the establishment of knotweed and establish an eradication and control program as needed.

High Bank Area Management Recommendations

The Summary and Description of MU7 represents an initial investigation of causes and risks associated with the high bank failure. Recommendations for channel relocation combined with bank stabilization techniques are based on the obvious risk to public infrastructure (State Rt. 55) and human welfare, as well as site assessments which identified a high probability for further bank failure. Immediate temporary stabilization is recommended to give program partners time to analyze potential restoration alternatives, seek available resources, and identify project objectives and constraints. Any temporary stabilization efforts should be planned so as they can be incorporated into a final restoration project. The final restoration project should consider utilizing a multi-objective approach toward project implementation, which could effectively include many additional benefits outlined within this plan.

The Sullivan County SWCD, the Town of Neversink, NYCDEP, NYSDEC, and NYSDOT and should work with consulting engineers trained in geomorphology and natural channel design to evaluate existing high bank instability.

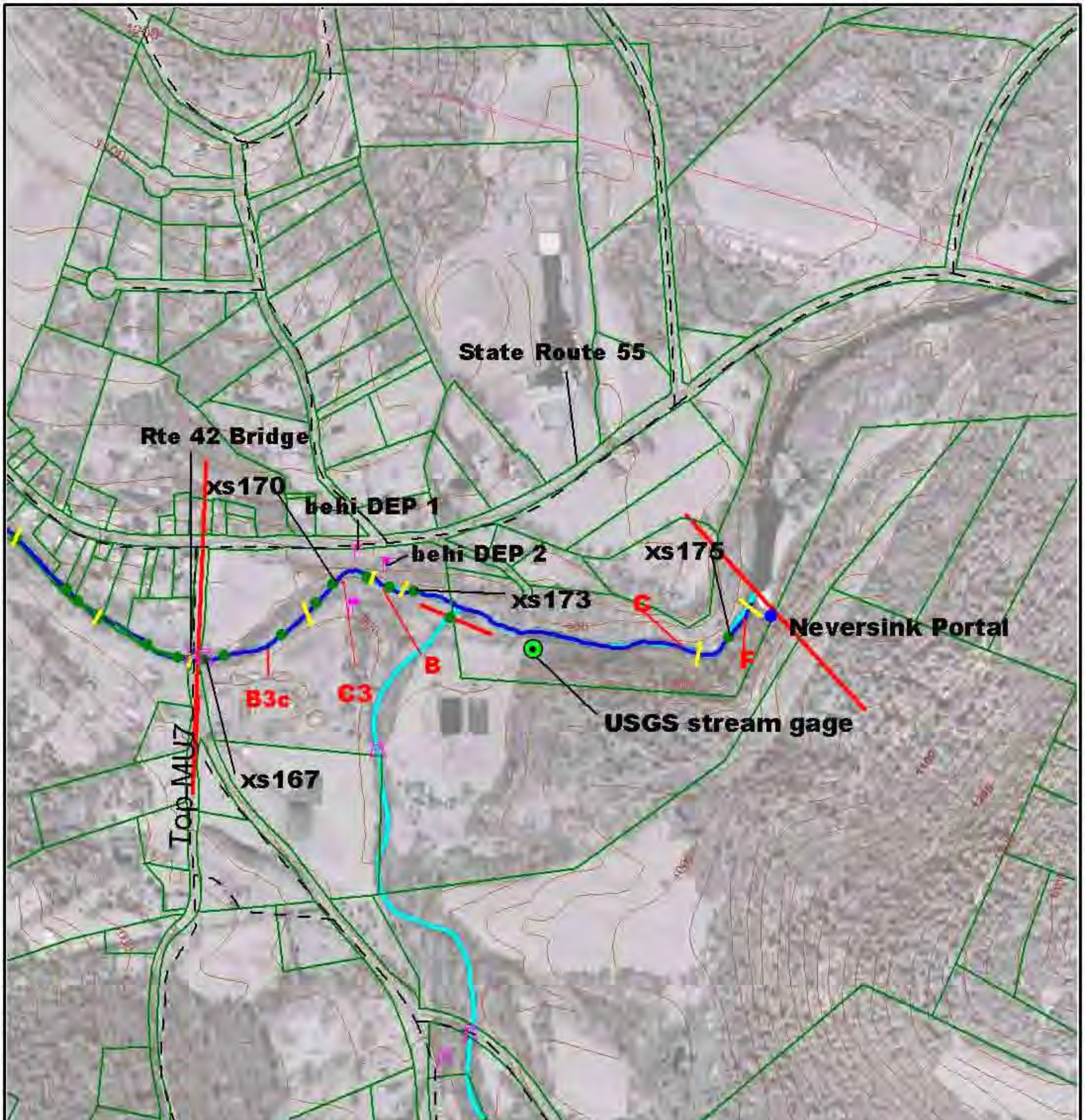


Figure 2. Chestnut Creek MU7 Stream Types & Cross Sections

Stream Assessment Survey 2001

Contour Interval 20 feet

300 0 300 600 900 Feet

1:7,000

*See Disclaimer

Legend

- Management Unit Limits
- Cross Sections
- Monitoring cross section
- B3 Rosgen Stream Types
- Roads
- Neversink Parcels
- Mainstem Chestnut-GPS CL
- Digitized stream location
- Stream type breaks
- Stream Crossing (bridges show inlet/outlet)

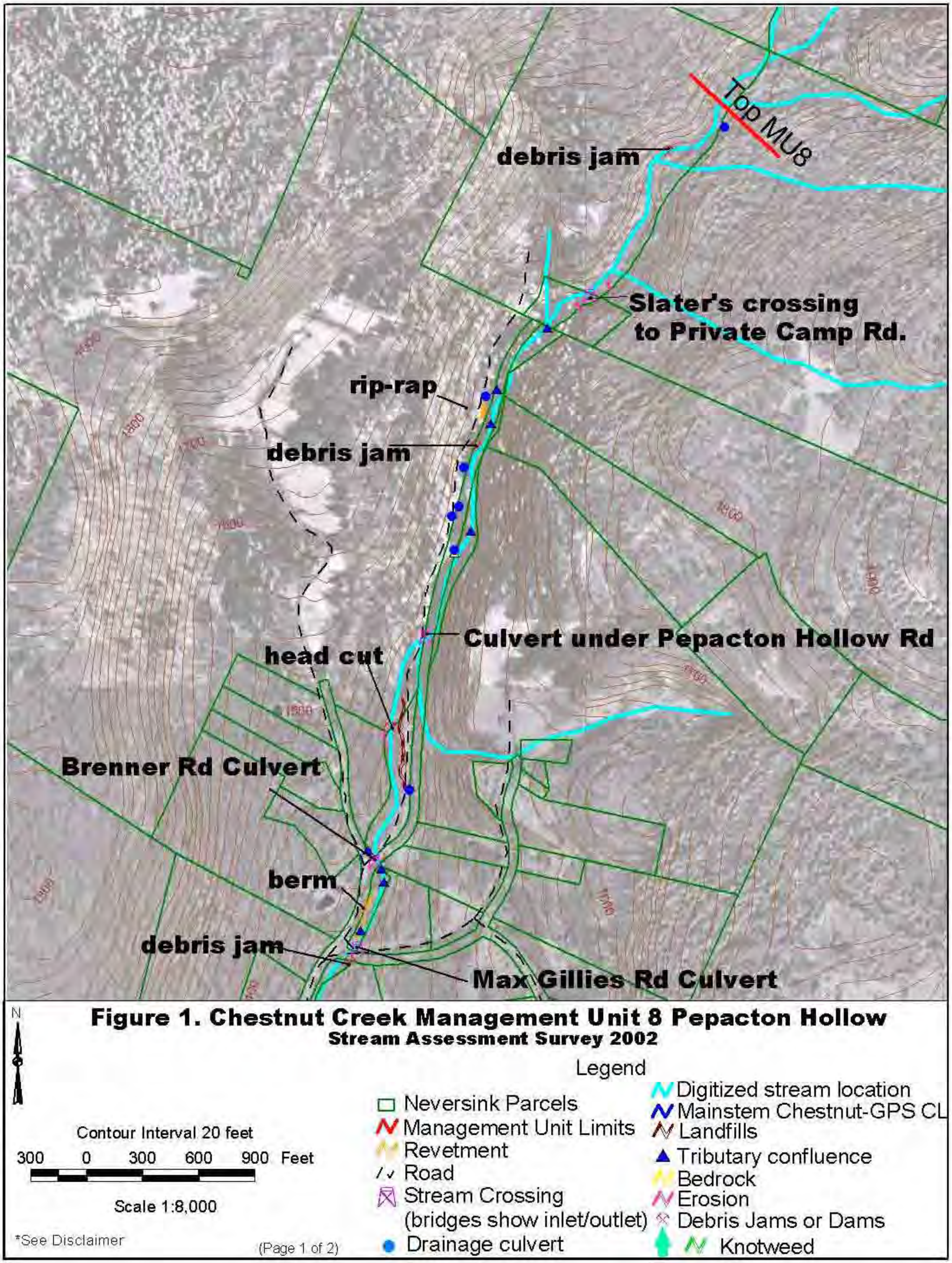


Figure 1. Chestnut Creek Management Unit 8 Pepacton Hollow
Stream Assessment Survey 2002

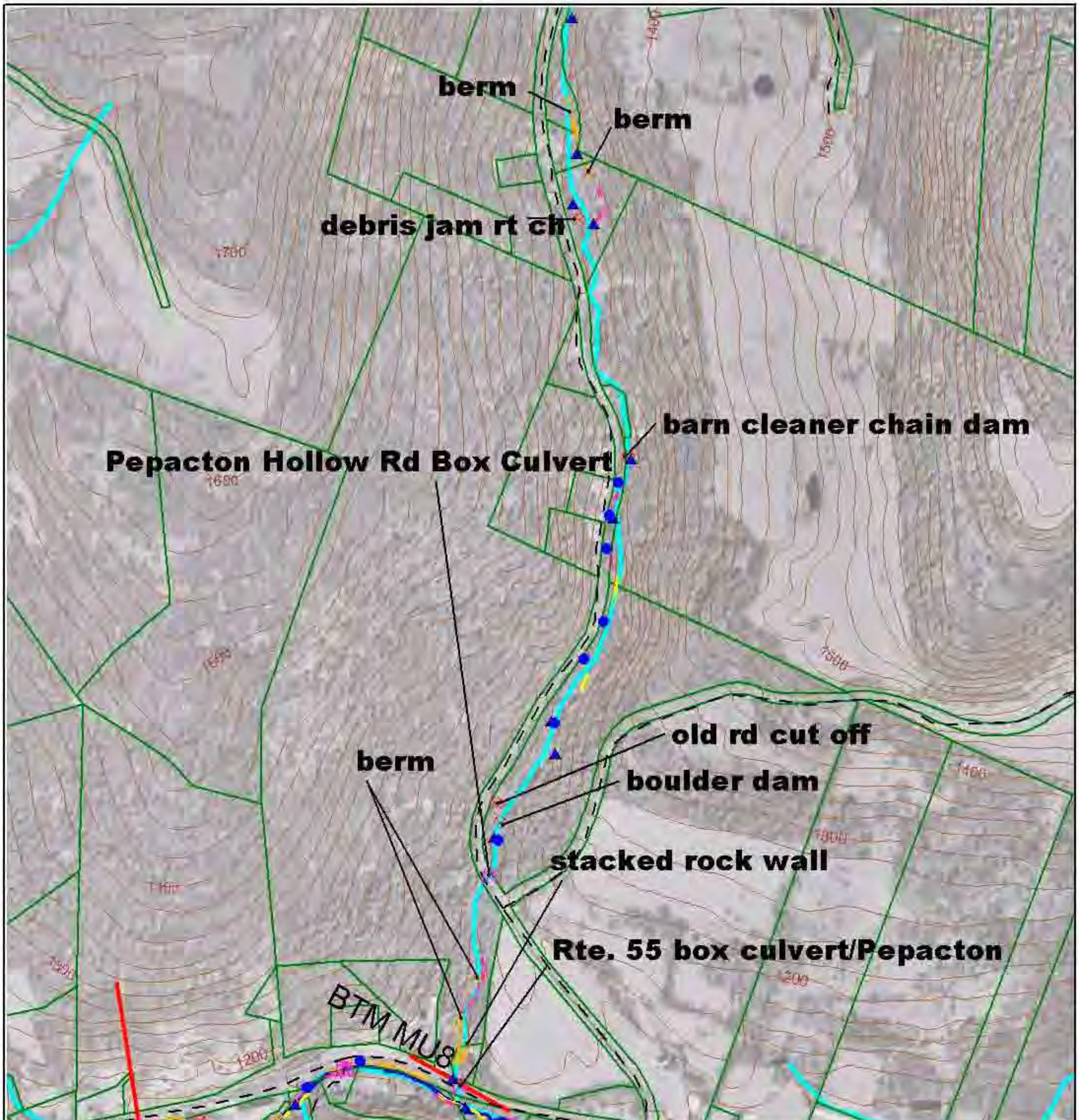


Figure 2. Chestnut Creek Management Unit 8 Pepacton Hollow

Stream Assessment Survey 2002

N

Contour Interval 20 feet

300 0 300 600 900 Feet

Scale 1:8,000

Legend

- Neversink Parcels
- Management Unit Limits
- Revetment
- Road
- Stream Crossing (bridges show inlet/outlet)
- Drainage culvert
- Digitized stream location
- Mainstem Chestnut-GPS CL
- Landfills
- Tributary confluence
- Bedrock
- Erosion
- Debris Jams or Dams
- Knotweed

*See Disclaimer

H. Chestnut Creek Management Unit 8

Background

This section is intended to summarize the overall character and condition of the Pepacton Hollow *tributary* to the Chestnut Creek *mainstem* Management Unit 8 (MU 8). Subsequent sections will discuss specific issues (e.g., riparian land use and public infrastructure, channel stability, etc.) in greater detail.

In the summer of 2002, a stream inventory and assessment was conducted along Pepacton Hollow, MU8 (Methodology used to Accomplish Goals, Volume I, Section I.E). The inventory integrated photographic documentation throughout the management unit with the *GPS* (Global Positioning System) location of multiple physical attributes. Components were incorporated into a *GIS* (Geographical Information Systems) database and used in conjunction with various base maps to assess the corridor. The purpose of the assessment and the following description is to document current condition of the stream corridor as well as identify potential problem areas that could negatively impact both Pepacton Hollow and Chestnut Creek and as well as stable *reference* areas that could be used to model ideal stream conditions for the watershed. Although the assessment was not as intensive as in management units along the main stem of Chestnut Creek, the inventory was used to create a summary description as well as generate prospective recommendations. The goal of the following description and summary is to facilitate future planning and integrated data collection efforts (MU8 General map, Figures 1 & 2).

1. Summary Description

MU 8 is approximately 11,270 linear feet (2.14 miles) in length and includes the stream corridor along the Pepacton Hollow tributary, beginning approximately 1300 feet above the end of Pepacton Hollow Road to the *confluence* with Chestnut Creek. Pepacton Hollow watershed collects 7 small tributaries, which combine to form the 3.55 square mile sub-basin. The confluence of Pepacton Hollow and Chestnut Creek is located in the Town of Neversink, downstream of Clark Road Bridge and upstream of Hilltop Road Bridge.

The headwaters above MU8 contain 26,300 feet (5.0 miles) of stream channel, which drain 1.9 square miles along Denman Mountain hillside. The *headwater* section of Pepacton Hollow includes various types of *entrenched* stream channels, which are dominated by large cobbles and boulders (Photo 1). The headwater section of Pepacton Hollow drops 880 feet in elevation over its length, which equates to a channel slope of 3.5

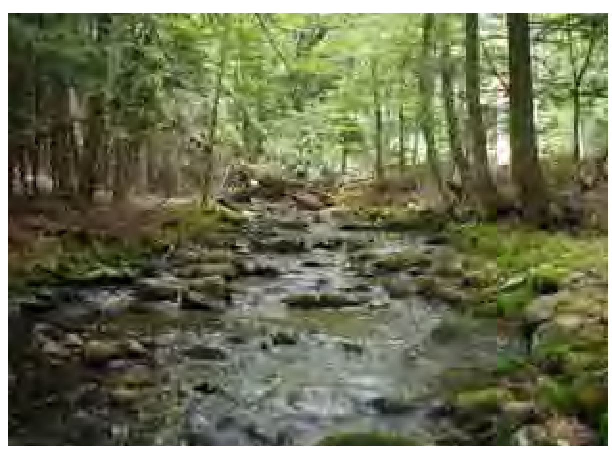


Photo 1. Reach view looking upstream.

percent.

Four small *perennial* tributaries totaling nearly 6,700 feet (1.26 miles) and numerous small *ephemeral* watercourses enter Management Unit 8 before its confluence with Chestnut Creek (Photo 2). The stream channel in Management Unit 8 falls nearly 460 feet in elevation, corresponding to an average channel slope of 4 percent. The drainage is primarily forested, with private residential structures mainly fronting along highways in the *basin*. Natural valley confinement, as well historic road construction, has greatly influenced the historic channel behavior.

Field evidence and review of map data revealed the upper portion of the stream channel is steep in slope, and confined in a narrow valley. Many sections of the channel impinge on steep side slopes causing high potential for *mass wasting*

Photo 2. View looking up steep tributary on the side of a hill, which flows to the left bank of mainstem Pepacton Hollow along Camp Road.

and bank failures. Failures can occur in response to relatively small lateral channel adjustments. A number of small perennial tributaries flowing down these slopes were inventoried, showing evidence of potential *erosion* and instability upstream (Photo 3). Confluence instability was marked by irregular accumulations of *sand* and *gravel* at tributary mouth extending into mainstem Pepacton Hollow. The channel contained a substantial volume of woody debris and included a number of areas with the potential to form debris jams.

Photo 3. View looking upstream at left bank and confluence with another tributary downstream of Photo 2 (on right side of the photo) that flows under Camp Road. Significant erosion.

Historical channel work and concern for public infrastructure were discussed during the planning process. Further information obtained from interviews with residents documented concern for impacts from flooding and public infrastructure, stream bank erosion, and excessive woody debris. A particular area of concern was the uppermost large culvert structure in which recent storms have overtopped and caused damage to the road (Photo 4) (Public Infrastructure Concerns and Interests, Volume 1, Section IV.B.5, and Infrastructure Recommendations, Volume II, Section II.A.2).

Photo 4. Recent storms have overtopped the road at this culvert, causing damage to the road. FEMA funding replaced guardrail seen in photo, 2002.

Numerous streamside *berms* were inventoried during initial assessment. Berms consist primarily of side cast materials from the stream channel. One dumping area was inventoried along the unit and apparently functions as a *floodplain* berm.

2. Riparian Land Use and Public Infrastructure

According to tax maps for 2000, there are thirty-one known properties in MU8, which contain or are bounded by the stream. Private property containing residential structures account for the predominant development within the corridor. Relative density residential structures is minimal in comparison with other management units. Although most of the private residential structures front along roadways within the basin, and are not in direct contact with the channel and corridor, they have potential influence on the quality of the resource.

The current stream corridor through MU8 is sparsely populated and showed evidence of only minor anthropogenic impact from the private residences. Potential for growth along Pepacton Hollow is limited by steep adjacent slopes but nonetheless generates concern for proper planning and land use. In comparison, historic development and continued encroachment have been noted along the mainstem of Chestnut Creek. Chestnut Creek management units have displayed these impacts both at the unit level and throughout the entire main stem. In general, volume as well as water quality of the runoff is a function of the size and characteristics of the land area each system drains. For example, land areas with a high percentage of impervious surfaces tend to generate considerably more runoff than areas that are predominantly forest. Impacts become more pronounced when applied to areas containing small amounts of development as an initial condition.

Six stream crossings, as well as fourteen culverts including those for stormwater, roadside drainage and tributary outfalls were inventoried along Pepacton Hollow corridor in MU8. Crossings include a private bridge to the Slater property (Photo 5) located at the top of Pepacton Hollow Road, and three structures which are maintained by the Town of Neversink Highway Department. The box culvert under Pepacton Hollow Road (Photo 6) is County owned and maintained, and is subject to NYSDOT biennial inspections. A single culvert, stream crossing Route 55, is maintained by NYSDOT. Inspection and maintenance records for these structures have yet to be reviewed.

During the planning process and public meetings, concern was raised by

Photo 5. View looking downstream toward Slater Bridge and Camp Road.

Photo 6. Looking upstream at County box culvert Pepacton Hollow Rd.

stakeholders regarding the existing 6.5-foot diameter culvert crossing under Pepacton Hollow Road (Photos 7 & 8). Local residents reported on several occasions floodwater crested the road and caused substantial damage throughout the area. Floodwaters kept landowners from their homes and/or landlocked from other access roads. Site inspections and the 2001 Stream Assessment Survey, noted the culvert pipe crossing under the roadway is of insufficient size to pass bankfull discharge. Several problems can directly result from an undersized culvert in this location. A backwater condition

Photo 7. Culvert crossing under Pepacton Hollow Road.

Photo 8. Looking at culvert (top of photo) under Pepacton Hollow Rd. right stream bank, stream flow right to left.

can occur when the culvert pipe is unable to carry the volume of water delivered to it during a storm event. This can cause floodwater to re-route around and over the culvert pipe causing damage to the roadway and erosion at its re-entrance point with the stream channel. Backwater conditions can also cause sedimentation upstream of the culvert and lead to streambank erosion as lateral forces on the bank are increased (Landowner Concerns and Interests, Volume I, Section IV.B.6).

Undersized culverts are more susceptible to upstream debris blockages, increasing potential for the stream to divert around the culvert during high flow events. Constriction that an undersized culvert can place on the stream channel can cause an increase in stream velocities through the culvert, causing stream bank erosion downstream of the culvert.

The stream channel itself appears fairly stable and in relatively good physical condition in the vicinity of the culvert. Improvements throughout the area can only benefit by correcting the road crossing and culvert first. In the area surrounding the culvert, there is well-established mature riparian vegetation that is providing sufficient streambank protection and overhead cover for fisheries habitat. Disturbance of this vegetation should be minimized during any re-construction of the bridge area or stream channel. SCSWCD has partnered with the Town of Neversink and NYC DEP to help remedy this site (Stream Stewardship Recommendations, Volume II, Section II).

As pointed out in the Introduction to Stream Processes and Ecology Section Volume I, Section III.A, natural streams are composed of three distinct flows that include: a *base flow* or low flow channel, which provides habitat for aquatic organisms; a *bankfull* channel, which is critical for maintaining sediment transport; and floodplain, which effectively conveys flows greater than the bankfull discharge (i.e., 1 – 3-year peak flow).

Standard engineering practices design bridge and culvert crossings so that they can safely convey large storm flows (e.g., 25-, 50-, or even 100-year peak flows) without overtopping the structure and associated roadway. In addition, the channel immediately upstream and downstream of bridges is commonly reconstructed (i.e., channelized) so that it contains those same storm flows without overtopping the adjacent streambanks. While enlarging the channel to improve its ability to convey storm flows may seem logical, in fact this approach usually creates channels that have poor habitat, are ineffective at transporting sediment, and require constant maintenance. These engineered channels are generally designed to convey all flows (base flow, bankfull flow, and flood flow) in a single channel that is relatively straight, very wide, and trapezoidal in cross-sectional area, with a uniform profile.

In these altered channels, baseflow is usually very shallow or may actually flow beneath the substrate because it is spread out over such a large surface area. The uniform profile replaces the typical *riffle-pool* sequence with a continuous shallow riffle-run that provides no cover for fish to avoid predation or strong flushing currents. A very wide, shallow channel is less efficient at moving sediment under bankfull flow conditions. As a consequence, sediment (e.g., *sand, gravel, cobble*) tends to accumulate, developing lateral and/or mid-channel bars along these altered reaches.

3. History of Stream and Floodplain Work

Development of the riparian corridor in Chestnut Creek watershed historically involved floodplain fill and/or construction of flood berms to protect structures placed in these areas. Filling floodplain areas to accommodate development on private as well as public land is still a common practice in the Chestnut Creek watershed. Efforts by landowners to protect property have resulted in modification of approximately 9.5% of the channel through this MU8.

Three types of revetment were found in MU8. Riprap was found in two locations (Photo 9), totaling 90 feet, and a stacked rock wall measuring 160 feet was also inventoried. Berms made of side-cast channel material totaling 830 feet were found in five locations along Pepacton Hollow (Photo 10). The purpose of the berms was not determined, but seem to be a historic remnant of management for flooding. These berms have kept the stream from utilizing its natural floodplain.

Photo 9. View looking downstream at riprap on right bank.

Floodplain berms such as these generally do not offer much, if any, protection from flooding, and can result in higher flood stages by preventing floodwaters from flowing over the floodplain. In situations where berms create higher flow velocities and channel stresses, channel erosion and down cutting can occur. Floodplains function to reduce flood velocity, increase absorption of floodwaters, encourage deposition of silt and fine sediments (keeping them from being washed further downstream) and decrease flood stage, in downstream areas.

Small, low, *discontinuous floodplain* benches perform an important floodplain functions in small mountain streams. Removal or restructuring of some of these bermed areas should be considered to add floodplain function to this area and reduce potential erosion and instability problems. Setting berms back away from the active stream can provide a compromise solution, if flood protection is required. Further assessment should be performed in the area of the berm as well as upstream and downstream. Assessment should quantify the degree of disconnection of the stream from its floodplain to determine impacts of the berm to the channel and quantify the benefits of removal or redesign.

Photo 10. Looking at undercut right bank and berm, stream flow left to right.

The Stream Assessment along Pepacton Hollow identified an area of floodplain which contains a 500-foot long section of dumped refuse and discarded litter. The area contains a mix of glass and metal waste and is located immediately adjacent to the active stream channel (Photo 11). There are large trees growing through the debris, indicating that it has remained relatively stable and has been present for some time. Several site inspections have been made by SCSWCD, the Town and NYC DEP, but have not revealed any contaminants leaching from the site. Although the area may not currently contribute to impaired water quality, it does remain an aesthetic concern.

4. Channel Stability and Sediment Supply

Although the 2002 Stream Assessment did not include morphological stream surveys or channel evaluations, some general assessments can be made from the inventory and remotely sensed data. The stream channel in MU8 contains several general channel types. *Stream types* range from entrenched to moderately entrenched and have predominantly moderate width to depth ratios with relatively low sinuosity (Introduction to Stream Processes and Ecology, Volume I, Section III).

Photo 11. View showing old dumping site along Pepacton Hollow stream bank. Stream flow is left to right.

Channel materials such as large cobble and gravels were identified as the dominant sediment size, with isolated areas of bedrock totaling 240 feet. *Bar* formations were frequently noted and consisted of predominantly small side channel formations. Several sections containing recently deposited central bars indicated potential for localized channel aggradation (Photo 12 & 13). Aggradation is caused by the stream flow not having force to move the available sediment through the system, allowing it to deposit along the channel bottom. If total stream energy is less than the energy required to transport the sediment provided, the streambed will aggrade. Several areas were inventoried where the active channel had recently aggraded to nearly the elevation of the active floodplain, completely reducing channel capacity (Photo 13). Sand and fine gravel were

Photo 12. View looking downstream at aggradation.

Photo 13. Looking upstream at mid-channel bar in left branch of split channel.

inventoried along the mouths of several tributaries, which is typical at a stream confluence by nature's design.

Preliminary observations indicate the majority of the channel along this management unit is laterally stable (i.e., bank erosion rates are low). Mature trees and shrubs in combination with natural rock armoring provide lateral control along the majority of the management unit (Photo 14). The 2002 Stream Assessment documented approximately 830 feet of streambank erosion, which equates to 3.7% of the channel length. Erosion occurs in nine sections along the corridor ranging

Photo 14. Looking downstream at wooded stable reach with large boulders.

from 11 ft. to nearly 175 ft. in length. These occurrences seem to be random in distribution along the entire streams length and vary in type and scale. Many eroded areas included undercut banks causing large trees to fall into the stream (Photo 15).

Photo 15. Looking downstream at major debris jam on right branch of split channel.

The upper reaches of MU 8 contain two primary areas of erosion totaling more than 1850 square feet. Streambank heights generally range between 10 ft. and 15 ft. through the area. One additional area along Camp Road contains a steep eroding bank approximately 70 ft. in height (Photo 16). Stream bank erosion is more extensive in areas where the stream channel impinges against steep, natural hill slopes. Erosion in these areas has caused larger bank failures and mass wasting from the displacement of material along the toe of these slopes.

The lower reaches of Management Unit 8 contain five primary areas of erosion totaling 9,340 square feet of exposed streambank. Severe mass wasting was observed along a 40 ft. tall, 150 ft. long section of streambank. A number of smaller eroding banks were identified where undercutting of the banks have caused large trees to fall into the stream channel (Photo 17).

The 2002 Stream Assessment documented a number of areas containing debris jams and channel blockages. Although wood recruitment is a natural and necessary process for mountain stream stability, current volume likely exceeds natural rates. Some areas were documented with debris jams spanning the entire active channel. These blockages are seemingly affecting the capacity to move the water, sediment and smaller debris (Photo 18).

Debris jams and other channel obstructions may cause problems by trapping sediment, which initiates and/or accelerates development of gravel bars and further reduces channel capacity. Subsequent bed erosion and removal of the deposited gravels contributes sediment imbalance to downstream reaches. Alternately, small blockages can create and maintain beneficial physical habitat (Photo 18), as well as assist in controlling stream channel incision and degradation. Extent and effect of wood debris should be quantified and compared to indices that provide information on quantity and include stream types present. Further annual monitoring of the area for continued growth and potential impact would be an effective management strategy for woody debris, jams and channel impacts. Streambank erosion should be further measured and quantified and compared to other physically similar local streams. This could be further quantified for management purposes by evaluating stream types and natural sensitive areas within the corridor as well as assist in prioritizing enhancement opportunities.

Photo 16. Shows very steep eroding right bank along the upper reaches of Pepacton Hollow along Camp Road.

Photo 17. Eroding right bank and fallen trees, incised section, along Camp Road.

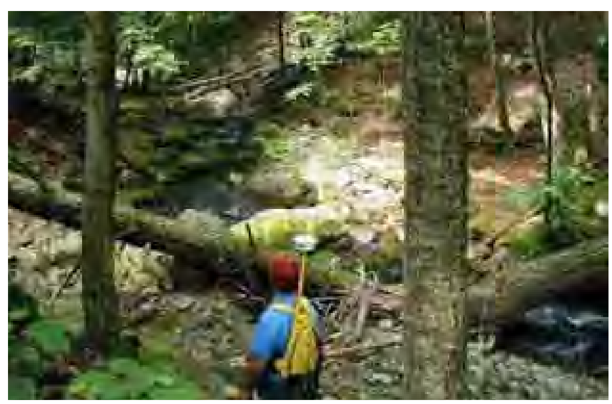


Photo 18. View looking downstream from left bank at steam wide debris jam.

Evaluating reaches along Chestnut Creek to determine whether they are contributing to sediment problems in the Chestnut Creek/Rondout Reservoir System was a component of the Assessment Survey. The preliminary results of the fieldwork indicate that the actively eroding banks and mid-channel bars noted above are a source of sediment to downstream reaches. Where they accumulate, these sediments can reduce channel capacity and contribute to localized channel stability problems.

Sediments eroded from reaches along Chestnut Creek are generally coarse (i.e., sand, gravel and cobble). Unlike other watersheds where exposed silt or clay deposits are a water quality concern because they contribute very fine material to the suspended load, these coarser sediments tend to move as bed load and settle out quickly after storms. As a consequence, sediment eroded from the streambed and stream banks along this management unit does not appear to directly affect water quality within the Chestnut Creek/Rondout Reservoir System.

An historical aerial photographic assessment was performed to assess natural changes and historic modifications to the stream channel and floodplain within MU 8. Field assessments and historical documentation can be combined with interpretation of the imagery in order to develop a causal analysis relating to current channel stability and morphology. MU 8 was assessed using imagery from 1977, 1985, and 2001 (Aerial Photos 20-22).

It is evident from the aerial imagery that land use and general riparian density appears not to have changed significantly over the period covered by the aerial series.

5. Riparian Vegetation

Vegetated *riparian* zones act as a buffer against pollution and are therefore very important in mitigating adverse impacts of human activities. Forested riparian buffers facilitate stream *stability* and function by providing rooted structure to protect against bank erosion and flood damage (Photo 19). Streamside forests also reduce nutrient and sediment runoff and provide organic matter that can be used by aquatic life, while providing shade to dampen fluctuations in stream temperature. Wide riparian buffer areas protect streams from runoff and generally provide better habitat for plants and animals than narrow buffers (Introduction to Stream Processes and Ecology, Volume I, Section III).

Photo 19. View looking upstream from inlet end of culvert under Pepacton Hollow Road at intersection with Brenner Road.

The 2002 Stream Assessment did not investigate specific streamside (riparian) plant species or density, other than to note areas of insufficient or stressed vegetation that could affect stream stability, flooding or erosion threats, water quality or aquatic habitat for fisheries. Riparian areas appeared generally stable and consisted of mature vegetation. The riparian areas in Pepacton Hollow are largely forested, although the community of the forest is frequently interrupted by infrastructure including the adjacent roadway (Pepacton Hollow Road) and multiple stream crossings. The riparian width is limited by the presence of the roadway and may restricts the amount of filtration and stabilization that a larger stream buffer may more readily provide.

Due to the narrow valley and relative steepness of the side slopes, the alignment of Pepacton Hollow Road closely follows the stream alignment. GIS coverages of the stream and roadway alignments were use to analyze the influence of the infrastructure on the width of the riparian areas. Various widths were applied to the alignments and used to estimate the percentage of stream channel located immediately adjacent to the roadway. Approximately 71% of the stream channel is located within 100 ft. of Pepacton Hollow Road. Additionally, 23% of the stream channel is located within 50 ft. of the roadway.

Although the relatively narrow width of the valley floor and the encroachment of Pepacton Hollow Road do not facilitate an extensive area for riparian establishment, the effectiveness of the existing buffer is extremely important. The buffer receives runoff of salt, gravel, and chemicals from the road, which can impact vegetative establishment and growth. Road maintenance activities also regularly disturb the soil along the shoulder and on the road cut banks. This disturbance can lead to the establishment of undesirable

Photo 20. 1974 Aerial Photograph of Management Unit 8.

Photo 21. 1985 Aerial Photograph of Management Unit 8.

Photo 22. 2001 Aerial Photograph of the upstream section of Management Unit 8.

invasive plants or add stress to the established plants.

6. Restoration and Management Recommendations

As presented previously, the Chestnut Creek Management Plan will be utilized to guide and facilitate stakeholders in their efforts to correct stream channel instability problems, restore and maintain natural floodplain functions, control runoff from developed areas to reduce pollutant loadings from channel and upland sources, restore and protect in-stream habitat, and reduce the need for future channel maintenance.

This section includes specific restoration and management recommendations for Management Unit 8, as well as a general discussion of the approach to stream corridor restoration and management recommended for the Chestnut Creek Watershed. The SCSWCD, NYCDEP, and other agencies and organizations will be working with the community to implement the restoration and management strategies outlined in this Management Plan. It is critical that stream and upland area projects be integrated to avoid potential conflicts in their respective objectives. Therefore, this section also includes comments and recommendations regarding the integration of proposed strategies in upland areas, in particular floodplain management and storm water management practices.

Restoration and Management Recommendations Management Unit 8

1. Promote protection and preservation of the current riparian areas. Implement strategies to educate riparian landowners on the benefits of preserving the current riparian area and limiting land use changes.

2. Evaluate the existing riparian areas located between the stream channel and roadway. Identify specific sites and prescribe treatments in areas which could benefit or enhance the existing riparian function.

3. Promote protection of the current stream channel. Implement strategies to educate adjacent landowners on the benefits of sustaining naturally functioning stable stream reaches.

4. Evaluate the existing revetment for replacement with an adequate stabilization structure which will maintain and promote a naturally function stream channel. Any stabilization technique should include bioengineering and/or re-vegetation.

5. Perform further morphological assessment along Pepacton Hollow to determine the character, stability, extent of erosion, and potential sources of excess sediment to the areas within Management Unit.

6. Extend assessments beyond the upstream limits of the MU8 into the headwaters of Pepacton Hollow to include all major tributaries.

7. Evaluate the existing floodplain berms to quantify the degree of floodplain disconnection, impacts of the berm to the

channel and evaluate quantify the benefits of removal or redesign.

8. Continue with evaluations in the floodplain area containing the dumped refuse. Consider removing the visible waste from the surface in order to prevent future entrainment of the waste and partially restore the aesthetic quality of the area.

9. Consider excavation and disposal of the waste material from the old dump site to improve both aesthetics of the area, stream stability and water quality.

10. Evaluate the existing bridge and culvert crossings for the ability to convey both bankfull and flood flow, as well as proper sediment transport. Additionally, any design modification should reduce scour and provide for fishery passage during varying flow periods.

11. The culvert under Pepacton Hollow Road should be replaced with a suitable size crossing capable of providing adequate passage of base flow, bankfull flow and flood flow. Effort should be made to enhance the stability of the upstream and downstream reaches using adequate stabilization structure which will maintain and promote a naturally function stream channel.

12. Conduct further morphological stability assessments through the areas containing potentially eroding streambanks. Determine the significance, rate, and magnitude of the disturbance and consider stabilization and/or restoration if deemed necessary.

13. Perform stabilization techniques only where necessary using best management practices which promote and maintain a naturally functioning stream channel. Stabilization techniques should only include methods which assist in the natural recovery of the localized sections and which will benefit the reach.

14. Promote floodplain protection, which is critical in maintaining stream stability in moderately entrenched reaches.

15. Continue to assess, inventory and identify invasive plant species and determine a plan to remediate.

16. Monitor the areas containing debris jams and channel blockages for changes in channel stability and threat to infrastructure. Initiate an assessment to document the source and magnitude of the large woody debris to include the effects from localized erosion. Treatment recommendations should target the reduction of debris at its source.

19. Initiate a monitoring strategy in selected areas to document the channel stability for comparison purposes, as well as for inclusion into a local reference reach database for use on potential project areas within the Chestnut Creek watershed.

20. Monitor the areas containing debris jams and channel blockages for changes in channel stability and threat to infrastructure.

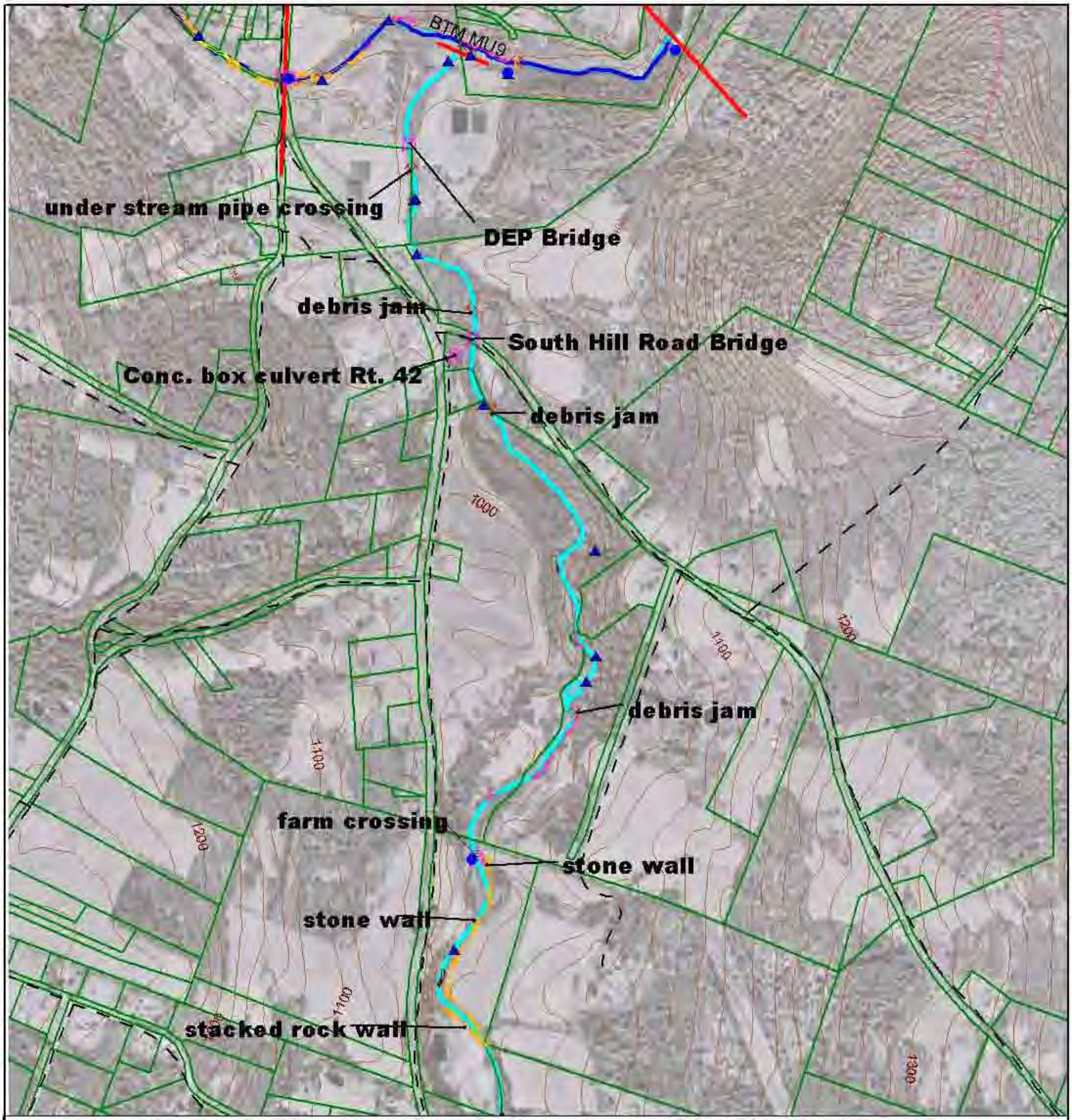


Figure 1. Chestnut Creek Management Unit 9 Red Brook

Stream Assessment Survey 2002

Contour Interval 20 feet

400 0 400 800 1200 Feet

Scale 1:10,000

*See Disclaimer

(Page 1 of 2)

Legend

- Neversink Parcels
- Management Unit Limits
- Revetment
- Road
- Stream Crossing (bridges show inlet/outlet)
- Drainage culvert
- Digitized stream location
- Mainstem Chestnut-GPS CL
- Landfills
- Tributary confluence
- Bedrock
- Erosion
- Debris Jams or Dams
- Knotweed

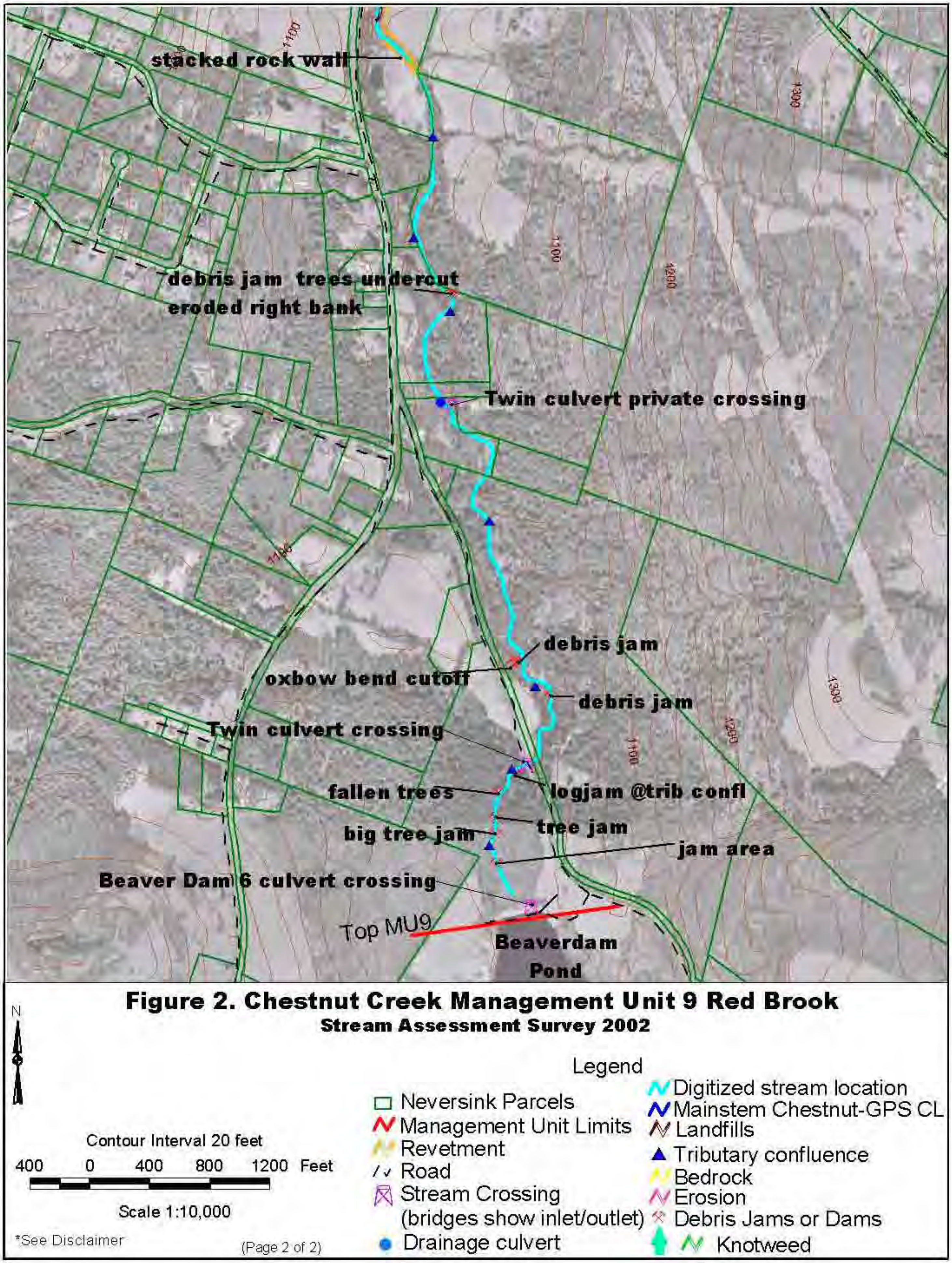


Figure 2. Chestnut Creek Management Unit 9 Red Brook
Stream Assessment Survey 2002

I. Chestnut Creek Management Unit 9

Background

This section is intended to summarize the overall character and condition of the Red Brook *tributary* to the Chestnut Creek *mainstem*, Management Unit 9 (MU 9). Subsequent sections will discuss specific issues (e.g., *riparian* land use and public infrastructure, channel stability, etc.) in greater detail.

In the summer of 2002, a stream inventory and assessment was conducted along Red Brook, MU9 by District staff. The inventory integrated photographic documentation throughout the management unit with the *GPS* (Global Positioning System) location of multiple physical attributes. The components were incorporated into a *GIS (*Geographic Information System) database and used in conjunction with various base maps to assess the corridor (MU 9 General maps Figures 1 & 2, Photo 1). The purpose of the assessment and the following description is to document the current condition of the stream corridor as well as identify both potential problem areas that could negatively impact Red Brook and Chestnut Creek, and *reference* areas that could be used to model ideal stream conditions for the *watershed*. Although the assessment was not as intensive as for the management units along the mainstem of Chestnut Creek, the inventory was used to create a summary description as well as generate prospective recommendations. The goal of the following description and summary is to facilitate future planning and integrate data collection efforts with other agencies, organizations and landowners.

Photo 1. Reach view looking upstream from private bridge.

1. Summary Description

MU9 is approximately 13,850 linear feet (2.62 miles) in length and includes the stream corridor of Red Brook tributary beginning at the outlet of Beaver Dam Pond (Photo 2) to its confluence with Chestnut Creek. The *headwaters* of Red Brook begin in the Town of Fallsburg where stream flow originates from a *wetland* area. Stream flow continues

Photo 2. Beaver Dam Pond outfall. Six Culverts, looking upstream.

nearly 2.7 miles passing through two more wetland areas before entering Beaver Dam Pond. A single channel flows north, from a six *culvert* outlet at the dam, to its *confluence* with Chestnut Creek at MU7 in Grahamsville. The *drainage area* of Red Brook headwaters to the top of MU9 at Beaver Dam Pond is 3.65 square miles. An additional 5.21 square miles of drainage area is gained between Beaver Dam Pond and the mouth of Red Brook at Chestnut Creek with the introduction of five tributaries. The largest tributary to confluence with Red Brook enters from the west, upstream of the Route 42 crossing.

The drainage is primarily covered in forest, with agricultural land uses more prevalent in flatter sections of the *basin*. Agricultural land use begins near the middle of the drainage and extends to the confluence. Farm fields and pastures are maintained directly adjacent to the stream corridor throughout this area. Structural development primarily includes a mixture of private residences with several municipal and public buildings located in the lower portion of the MU.

Field inventories were used to characterized the stream *channel* in the upper portion of the basin as a low gradient channel with sediment consisting predominantly of finer *sand* and *gravel*. Although a natural process, excessive *bar* formations documented throughout the area, raised concern for potential channel instability. The area was found to be forested with ample vegetation for maintaining general physical stream *stability*. Vegetation was providing substantial overhead cover, which generates numerous benefits including decreased water temperature for fisheries habitat (Riparian Vegetation Issues in Stream Management, Volume 1, Section IV.B.3).

The lower portion of the tributary was characterized by a steeper channel slope, less floodplain connection and larger channel materials. The inventory documented a number of potential issues including floodplain disconnection resulting from historic stream alterations; reduced riparian buffer widths from development, and potential areas contributing to increased stormwater runoff.

During the planning process and public meetings, concern was raised by stakeholders (Landowner Concerns & Interests, Volume 1, Section IV.B.6) regarding excessive woody debris (see definition for large organic debris creating debris jams within the unit. Further information obtained from interviews with residents documented concern for impacts from streambank *erosion*, excessive woody debris, and habitat impacts from infrastructure and channel processes.

2. Riparian Land Use and Public Infrastructure

According to tax maps for 2000, there are nineteen known property owners in MU 9, holding twenty-one parcels which are contained or bounded by Red Brook. Private property containing residential structures account for the primary development within the corridor. Relative density of the residential structures is minimal in comparison with other management units. Although most private residential structures front along the roadways within the basin, and are not in direct contact with the channel and corridor, they have potential influence on the quality of the resource.

The current stream corridor through MU9 is sparsely populated and displayed only minor anthropogenic impact from the private residences. The potential for growth along Red Brook generates concern for proper planning and land use. In comparison, historic development and continued encroachment have been noted along the mainstem Chestnut Creek. Chestnut Creek management units have displayed these impacts both at the management unit level, and throughout the mainstem as a whole. In general, the volume as well as the water quality of the runoff is a function of the size and characteristics of the land area each system drains (Introduction to Stream Processes and Ecology, Volume I, Section III). For example, land areas with a high percentage of *impervious surfaces* tend to generate considerably more runoff than areas that are predominantly forest. The impacts become more pronounced when applied to areas containing small amounts of development as an initial condition.

Land around public buildings near the confluence with Chestnut Creek is predominantly parking lot and mowed lawn. Storm drainage probably conveys storm water *runoff* from these parking lots directly to Red Brook and Chestnut Creek. Storm water retrofit opportunities were not evaluated as part of the initial assessment, however the review of aerial photographs indicates that the properties along the corridor with the highest percent impervious surfaces include the Grahamsville Wastewater Treatment Plant the Powerplant and property owned and operated by NYCDEP at the Grahamsville Laboratory. All structures and parking lots are located at the confluence of Red Brook and Chestnut Creek and are located directly adjacent to the stream corridor.

Seven stream crossings and one spring drainage culvert were inventoried within the stream corridor of MU9. These bridges and culverts are located on both the mainstem of Red Brook and one along Route 42 on a tributary draining to Red Brook. The crossings include the private NYCDEP Bridge (Photo 3) and the County bridge at South Hill Road (CBN:216,BIN:3356140) built in 1947 (Photo 4). Biennial Inspection conducted for the NYS DOT indicates that the South

Photo 3. DEP bridge over Red Brook.

Photo 4. View looking at South Hill Road Bridge.

Hill Road bridge has settled over time, causing some cracking. Debris along the has blocked all of the right side and the deck exhibits longitudinal, transverse cracking and fatigue prone welds. The report also indicated that the waterway opening was undersized to pass higher *stream flows*.

There is a private farm culvert crossing, two double culverts, one on Beaver Dam Road which appears to be having difficulty transporting sediment indicated by the presence of sand bars, however, no further studies have been conducted at this site (Photo 5). There is also another double culvert at a private crossing in which one of the culvert pipes is smaller and elevated to an overflow height seemingly to assist the larger culvert at higher flows (Photo 6). There is a six culvert outlet crossing at the mouth of the Beaver Dam pond (see Photo 2) and one small culvert that feeds an intermittent spring.

There is single “hanging” box culvert, located on an unnamed tributary crossing State Route 42, just upstream of the tributary’s confluence with Red Brook upstream of the South Hill Road Bridge (Figure 2). The base of the culvert is severely scoured and weathering, as the stream flow passing through its narrow confines has created a scour pool at the outlet (Photo 7). Project stakeholders voiced concern regarding the current condition of the channel at the outlet as well as the potential barrier to fish migration. Local anglers have expressed that Brown trout exist both upstream and downstream of the structure, though whether upstream fish are resident is unknown. The stream channel below the outlet has developed a large scour *pool* resulting in a three to four foot elevation

Photo 5. Looking upstream at twin culvert Beaver Dam Road crossing.

Photo 6. Looking downstream at double culvert Over-flow culvert is indicated by white arrow.

Photo 7. View from mid channel looking upstream. Scour pool at outlet of Route 42 box culvert. Eroding right bank 10’ high.

difference in grade between the outlet invert and *base flow* of Red Brook. A potential causes for the elevation difference is excess channel scour produced by the *hydraulic* condition developed through the culvert. The steep slope of the culvert, lining and geometry are the suspected causes of this condition. Another potential cause of the grade difference is channel *incision* along the main stem of Red Brook leaving a perched condition, possibly a *headcut,* or downcutting, upstream migration, at the culvert. This scenario should be evaluated both for the immediate migration issue, as well as a possible indicator of local channel processes of Red Brook. The culvert bottom has begun to deteriorate revealing rebar supports along the bottom of the culvert and stress cracks in State Route 42 from culvert instability.

3. History of Stream and Floodplain Work

Development of the riparian corridor along Chestnut Creek Watershed historically involved floodplain fill and/or the construction of flood *berms* to protect structures placed in these areas. Filling floodplain areas to accommodate development on private as well as public land is still a common practice in the Chestnut Creek watershed. Efforts by landowners to protect property have resulted in modification of approximately 6% of the channel through this unit with various types of *revetment*.

Two types of revetment were found in MU 9. Several *stacked rock wall*s totaling approximately 340 feet we inventoried as well as a stone berm comprised of dumped fieldstone (Photo 8), which measured 1340

Photo 8. View looking upstream at dumped field stone on right bank.

feet. The purpose of the berm was not investigated, but it is suspected to be a historic remnant of land clearing for agricultural production and a protective measure from flooding (Community History and Current Conditions, Volume 1, Section IV.A). The berm is currently well vegetated with a large number of deciduous trees growing through the stones. The continuous makeup of the berm prevents flood flow from utilizing the undeveloped natural floodplain.

Floodplain berms such as these generally do not offer much, if any, protection from flooding, and can result in higher flood height (or stage) by preventing floodwaters from flowing over the floodplain. In situations where berms create higher flow *velocities* and channel stresses, channel erosion and down cutting can occur. Floodplains function to reduce flood velocity, increase absorption of floodwaters, encourage deposition of *silt* and fine sediments (keeping them from being washed further downstream) and decrease flood *stage*, in downstream areas.

Removal or restructuring of some of these bermed areas should be considered to add floodplain function to this area and reduce potential erosion and instability problems. Setting berms back away from the active stream can provide a compromised solution, if flood protection is required. Further assessment should be performed in the area of the berm as well as upstream and downstream. The assessment should quantify the degree of disconnection of the stream from its floodplain, impacts of the berm to the channel and evaluate the benefits of removal or redesign.

4. Channel Stability and Sediment Supply

Although the stream inventory conducted in 2002 did not include morphological stream surveys or channel evaluations, some general assessments can be made from the inventory and remotely sensed data. The stream channel in MU 9 primarily contains two general channel types. The upper watershed appears to have greater floodplain connection and a lower channel slope (Hydrology and Flood History, Volume 1, Section IV.B.2). Channel materials such as sands and gravels were identified as the dominant sediment size. Bar formations are more common as well as substantial woody debris located in the channel boundary. Progressing downstream, average channel slopes increase with predominantly larger channel sediment.

Preliminary observations indicate that most of the channel along this management unit is laterally stable (i.e., bank erosion rates are low). Mature trees and shrubs provide lateral control along the majority of the management unit. The inventory assessment documented 560 feet of the streambank erosion, which equates to 2% of the channel length. The erosion is located primarily in the upper watershed and occurs in four sections ranging from 85 ft. to nearly 200 ft in length (Photo 9). The exposures consist mainly of moderately undercut banks, located along areas with generally low bank heights. One bank, approximately 30 ft. - 40 ft. in height was inventoried, which potentially could be introducing a considerable volume of sediment to the stream system (Photo 10). Minimal information was collected along this bank. It is recommended that the relevant data be collected to determine the rate and magnitude of the failure as well as potential future impacts. In general, stream bank erosion in MU 9 seems to be less than other management units along Chestnut Creek.

Photo 9. View looking at 30’-60’ eroded right bank. Lack of vegetation on top of cobble/gravel/sand. Fallen trees at base of bank.

The 2002 Assessment documented a number of areas containing debris jams and channel blockages (Photo 11). The areas were located exclusively in the upper watershed below the Beaver Dam Pond

Photo 10. View looking at erosion and undercut trees on right bank.

Photo 11. View looking upstream at river wide log jam on Red Brook, can cause stream instability.

outfall. These debris jams and other channel obstructions cause problems by trapping sediment, which initiates and/or accelerates the development of gravel bars and reduces channel capacity. Subsequent bed erosion and removal of the deposited gravels contributes sediment to downstream reaches. Alternately, small blockages can create and maintain beneficial physical habitat (Photo 12), as well as assist in controlling stream channel

Photo 12. View looking at smaller debris jam on Red Brook, can add to habitat.

incision and *degradation*. Extent of wood debris should be quantified and compared to standards that provide information on quantity and include the association of the *stream types* present. Annual *monitoring* of the area for additional debris and potential impact would be effective management strategy woody debris, jams and channel impacts.

An analysis of a series of historic aerial photographs was performed to assess the natural changes and historic modifications to the stream channel and floodplain within MU 9. Field assessments and historical documentation can be combined with interpretation of the imagery in order to develop a causal analysis relating to the current channel stability and morphology. MU 9 was assessed using imagery from 1977, 1985, and 2001 (Aerial Photos 13, 14, & 15).

Aerial imagery shows land use and general riparian density has not changed significantly over the photographic series. Visual in the aerial series, the agricultural areas (seen on bottom left) have an extremely narrow riparian buffer in

Photo 13. 1977 Aerial Photograph of MU 9.

Photo 14. 1985 Aerial Photograph of MU 9.

Photo 15. 2001 Aerial Photograph of MU 9.

comparison to downstream areas (top center) which are wider and have increased density.

5. Riparian Vegetation

Vegetated riparian zones act as a buffer against pollution and are therefore very important in mitigating the adverse impacts of human activities (, Riparian Vegetation Issues in Stream Management, Volume 1, Section IV.B.3). Forested riparian buffers facilitate stream stability and function by providing rooted structure to protect against bank erosion and flood damage (Photo 16). Streamside forests also reduce *nutrient* and sediment runoff, provide organic matter that can be used by aquatic life, while providing shade to dampen fluctuations in stream temperature (Photo 17). Wide riparian buffer areas protect streams from runoff and generally provide better habitat for plants and animals than narrow buffers.

The 2002 Stream Assessment conducted on Red Brook did not investigate specific streamside (riparian) plant species or density, other than to note areas of insufficient or stressed vegetation that

Photo 16. View shows diverse riparian buffer and larger cobble towards the end of a side bar.

Photo 17. Forested buffer provides shade and habitat for the stream.

could affect stream stability, flooding or erosion threats, water quality or *aquatic habitat* for fisheries. Based on these general, qualitative observations, riparian vegetation in MU 9 appears to be generally sufficient to provide the benefits of a healthy riparian area. Riparian areas appeared generally stable and consisted of mature vegetation. Several isolated areas including several maintained agricultural fields and areas along developed areas near the mouth of Red Brook (Grahamsville Wastewater Treatment Facility, NYCDEP Laboratories, and the Powerplant Substation) have the potential for increasing the quantity and quality of the existing riparian area by providing for larger forested buffer areas adjacent to the stream.

6. Restoration and Management Recommendations

As presented previously, the Chestnut Creek Management Plan will be utilized to guide and facilitate stakeholders (Stream Related Activities & Funding Sources & Agency Contacts, Volume 2, Section V) in their efforts to correct stream channel instability problems, restore and maintain natural floodplain functions, control runoff from developed areas to reduce pollutant loadings from channel and upland sources, restore and protect in-stream habitat, and reduce the need for future channel maintenance.

This section includes specific restoration and management recommendations for Management Unit 9, as well as a general discussion of the approach to stream *corridor* restoration and management recommended for the Chestnut Creek Watershed. The SCSWCD, NYCDEP, and other agencies and organizations will be working with the community to implement the restoration and management strategies outlined in this Management Plan. It is critical that stream and upland area projects be integrated to avoid potential conflicts in their respective objectives. Therefore, this section also includes comments and recommendations regarding the integration of proposed strategies in upland areas, in particular floodplain management and storm water management practices.

Restoration and Management Recommendations Management Unit 9

1. Promote protection and preservation of currently healthy riparian areas. Implement strategies to educate riparian landowners on the benefits of preserving the current riparian area and limiting land use changes.

2. Promote protection of currently stable stream channel. Implement strategies to educate adjacent landowners on the benefits of sustaining naturally functioning *stable* stream reaches.

3. Evaluate the existing revetment for potential replacement with adequate

stabilization structures where needed which will maintain and promote a naturally functioning stream channel. Any stabilization technique should include *bioengineering* and/or re-vegetation.

4. Consider efforts to promote land use planning within the corridor to protect the existing resource. Techniques for assessment could include "build-out" analyses that could effectively model the existing conditions and create comparisons between future proposed land use changes relative to stormwater runoff, water quality, habitat, erosion, and flooding threats. Analyses could be coordinated with further assessment of the current *morphology* and the developed understanding of the sensitivity of the stream corridor. These scenarios could be further quantified and paired with stakeholder expectations and uses of the resource.

5. Evaluate opportunities to assess stormwater impacts and retrofit or improve stormwater controls. Implement and/or improve on storm water management for the properties with the highest percent impervious surface along the corridor, including the DEP Facilities and the Wastewater Treatment Plant (also see MU7)

6. The storm water management facilities should be designed to provide water quality management for the first half-inch of runoff and quantity management that reduces the peak *discharge* runoff rate for the 1 – 3-year storm flows.

7. Perform further morphological assessment along the Red Brook tributary to determine the character, stability, extent of erosion, and potential sources of excess sediment to the areas within MU 9.

8. Evaluate the existing floodplain berm to quantify the degree disconnection of from its floodplain, impacts of the berm to the channel and evaluate quantify the benefits of removal or redesign.

9. Evaluate the existing bridge and culvert crossings for the ability to convey both *bankfull* and flood flow, as well as proper sediment transport. Additionally, any design modification should reduce scour and provide for fish passage.

10. Evaluate the existing bridge and culvert crossings for the ability to facilitate fish passage during varying flow periods. Specific attention should be placed on the Route 42 box culvert, on the tributary to Red Brook, where it is recommended that fisheries biologists examine potential migration barrier and assist with project designers to recommend potential enhancements.

11. Perform stabilization techniques only where necessary using best management practices which promote and maintain a naturally functioning stream channel. Stabilization techniques should only include methods which assist in the natural recovery of the localized sections and which will benefit the reach.

12. Work with landowners to establish and maintain a wooded buffer zone along reaches which contain little or no woody vegetation. Targeted areas should include the developed areas near the mouth of Red Brook including properties owner or operated by the Grahamsville Wastewater Treatment Facility, NYCDEP

Laboratories, and the Powerplant Substation.

13. Initiate an assessment to inventory and identify *invasive* plant species and a plan to remediate.

14. Monitor the areas containing debris jams and channel blockages for changes in channel stability and threat to infrastructure. Initiate an assessment to document the source and magnitude of the large woody debris to include the effects from upstream pond and wetland areas. Treatment recommendations should target the reduction of debris at its source.

15. Initiate a monitoring strategy in selected areas to document the channel stability for comparison purposes, as well as for inclusion into a local reference reach database for use on potential project areas within the Chestnut Creek watershed.

J. Management Units for Unsurveyed Tributaries to Chestnut Creek

Upland tributaries contribute flow, sediment and other materials to mainstem Chestnut Creek. Tributaries also provide valuable habitat areas for migrating species of fish and other animals, and source areas for healthy riparian communities. These areas are therefore important in any long-term study or plan for mainstem Chestnut Creek. Many smaller tributaries and headwater areas are steep, in narrow, largely undeveloped forested valleys, and/or owned by New York State. For this reason, assessments for Chesnut Creek were begun on mainstem and larger tributary streams in which active management is of greater short-term importance.

Several major tributaries to Chestnut Creek/Rondout Watershed including Scott Brook and Claryville Road (unnamed) tributary entering Chestnut Creek in MU4, and Denman Mountain "Bullet" Brook entering Chestnut Creek in MU6 have not been assessed beyond information collected through interviews within the community. Both remotely sensed data analysis and field reconnaissance should be conducted to assess and document existing conditions in each of these major sub-watersheds from their headwaters to confluence with Chestnut Creek.

Existing aerial photographic records, landuse and cover maps, geologic and soils maps and topographic maps should first be analyzed to determine areas where additional assessments may be recommended (e.g., locations where roads and streams are in close proximity, highly developed or cleared areas, road crossing areas, etc.). If possible, new aerial flights should be commissioned or procured to enable the most up to date analysis. All remotely sensed data should be geo-referenced (locations attached to coordinates on the ground so layers of information can be compared directly) and combined into existing Geographic Information System (GIS) databases held by Sullivan County Soil and Water Conservation District and New York City Department of Environmental Protection. These databases should be reviewed and updated periodically with the latest surveyed, satellite or photographic information.

Field reconnaissance should focus on verifying existing land use activities and land cover, identifying and documenting unstable conditions in upland and riparian areas, and characterizing stream channel morphology and condition, as well as identifying sources of point and non-point source pollution. Mapping and photographic documentation should include location with a GPS (Global Positioning System) hand-held unit and conversion to GIS map data.

II. Stream Stewardship Recommendations

A. Watershed Recommendations for Best Management Practices

1. Riparian Vegetation Management Recommendations
2. Infrastructure Recommendations
3. General Recommendations for the Chestnut Creek Watershed
4. Water Quality Monitoring for Fisheries Recommendations

B. Management Unit (MU) Summary of Recommendations

Photo of Rondout Reservoir taken by Barbara Barone, SCSWCD.

A. Watershed Management Recommendation Summary

1. Riparian Vegetation Management Recommendations

Decision-makers would benefit from a more detailed assessment of the vegetation along the Chestnut Creek. This would help facilitate a prioritization process for addressing the most at-risk riparian areas. Individual riparian management programs aimed at different public sectors, e.g. landowners, highway departments, municipal officials would enable projects of different scale and scope to be spearheaded simultaneously.

The current state of all healthy, functioning riparian areas throughout the Chestnut Creek Watershed should be minimally be maintained, if not augmented. Any additional clearing or damage to these areas reduces valuable source populations and ecosystems that help sustain the general riparian character of Chestnut Creek.

Streamside landowners should consider enhancing the riparian zone by leaving a strip of lawn un-mown and planting supplemental diverse, native grasses, herbs, shrubs, and trees. Education programs and training sessions may be offered to enhance this effort.

Additional riparian vegetation may be added in areas currently occupied by impervious surfaces in the watershed. For instance, a wooded buffer zone may be established on a portion of the paved area near the Town Highway Facility (Volume II, Section II.B, Management Unit (MU) Summary of Recommendations, Tables 1-4).

Additional opportunities to rehabilitate impervious surfaces to augment riparian vegetation should be investigated and a program initiated to target these areas. Residents of and visitors to the watershed should be aware of invasive plants and be encouraged to point them out to resource managers. The sooner an invasive species is spotted, the easier and cheaper it is to address. One way to prevent an invasion is by the deliberate evaluation of soil used as fill for gardening, and highway, road, and culvert replacement projects. Soil and fill material can easily be contaminated with seeds or rhizomes of many different invasive plants, which can quickly establish new colonies. (see "Invasive Threats" section).

Especially where Japanese knotweed and Multiflora rose exist, resource managers and residents should note the rate of expansion. If a colony appears to be expanding rapidly, a resource manager should be notified so property owners can receive advice and assistance to contain it. Bare soil resulting from invasive species removal must be subsequently revegetated to prevent re-establishment of unwanted species in disturbed areas. This is a crucial step to preventing the reinvasion of these problematic species. Monitoring of invasives should continue after the implementation of any control program; most control measures require multiple treatments, sometimes over a few years.

Addressing the issue of woolly adelgid infestation requires information and close collaboration. Land managers, municipalities, and landowners can work together to determine the extent of infestation and the proper plan of action.

This is not an exhaustive list of recommendations about daily life next to the stream. If you have any questions or suggestions, please do not hesitate to contact the Sullivan County Soil and Water Conservation District at 845-292-6552.

a. Recommended Riparian Vegetation Management Concepts and Practices

Following is a set of general concepts for the public and local government for improving stream conditions through the enhancement of riparian vegetation (See Landowner Guide for additional information):

<u>Riparian buffers: Wider is better</u>

Anyone who owns property bordering a stream should leave as much room as possible for a vegetative buffer between their home or outbuildings and the stream. This vegetation should include a closely spaced mixture of trees, shrubs and ground cover. Native plants are suggested because they require less maintenance and are able to reproduce on their own and adjust to regional climate and conditions.

When determining the location of new construction, such as homes, access roads, or outbuildings, the site plan should allow for a setback of at least 100' from the stream. At least half of this distance should be vegetated buffer. The set back should be significantly (3 to 4 times) greater if there are development limitations present, such as a flood plain, steep slopes or sensitive soils. This larger setback will enable the stream to migrate with reduced risk of damage to the structures from floods or landslides.

If there is insufficient space available for a wide riparian buffer, then property owners should make the best of what is available. Assess the quality of the buffer and consider all the components necessary for a healthy riparian zone. Are there trees, shrubs and ground cover? Is there space and light for more plants? Would the addition of organic material improve the quality of the soil and the vigor of the vegetation? Watch the stream during high flow events, like during spring snow melt. Where is bankfull, the point where the flow begins to spread out on the floodplain? Any planting effort should start here and work back from the stream. The stream will maintain a general channel without any permanent vegetation. Before attempting to plant on a bank next to the stream make sure to seek the advice of the Soil and Water Conservation District or a local nursery. Disturbing the bank - even with the best of intentions - can accelerate erosion. The best time for planting is the early spring, but trees and shrubs can be planted in the early fall during their dormant season. Mulch and weed your plants; use tree tubes to protect young seedlings from deer browse. Remember to water new vegetation until it becomes well established, especially in periods of drought conditions.

Identify which plants naturally grow along the banks of the stream and use them as a guide to what should be planted. Native plant nurseries are an expanding business in the Catskills and are becoming increasingly popular. Their plants are typically very well adapted to conditions in this area. Any plant that is planted on or near the floodplain should be able to withstand moist soil conditions and periodic inundation. Conservation plants suitable for wet areas are also available from the Soil and Water Conservation District.

Protecting Riparian Buffers: Watch for Knotweed, Hemlock Woolly Adelgid, and Multiflora Rose

As a hardy, highly competitive and quickly growing invasive plant already present in the valley, Japanese knotweed threatens to colonize many of the disturbed banks along Chestnut Creek. The first step toward preventing the spread of knotweed is knowing how to identify the plant and monitoring stream banks for its presence (see Vol. I, Sect. IV,B.3: Riparian Vegetation Issues In Stream Management). Watch along the edge of the stream for young plants attempting to take root in sand and gravel deposits. Pulling the plant - including the roots - can be accomplished while it is tender after first frost in the fall or when it first emerges in the spring. Cutting the plant back frequently in the summer can reduce its vigor by reducing its ability to make and store food. Preventing the conditions which enable establishment of new colonies is also very important. Refrain from disturbing the stream bank and avoid dumping fill and garden material on the stream bank or in the floodplain. Even a small piece of Japanese knotweed stem or root can become a full plant if given the chance, so be careful to dispose of any knotweed in the garbage. Perhaps the best weapon against the invasion of knotweed is a dense, vigorous riparian plant community. Knotweed does not like shade.

Hemlock Woolly Adelgid has been reported in Chestnut Creek Watershed (see Vol.I, Sect.IV,B.3: Riparian Vegetation Issues In Stream Management). If there are hemlocks growing on your property, become familiar with the appearance of the adelgid and check the lower branches of your trees for the insect. Participate in a local monitoring program and stay abreast of any trial efforts to combat the insect. Any pure stands of hemlock located on steep slopes along the stream are areas of primary concern. Planting other types of trees or encouraging natural regeneration on these sites through thinning may eventually be necessary to ensure future stream bank stability. Woolly Adelgid infestation causes rapid mortality (in as few as 5 years) and can decimate entire stands of trees faster than natural regeneration can replace them.

Multiflora Rose has presented a problem along several sections on Chestnut Creek. Multiflora Rose spreads quickly, is highly adaptable to a wide array of conditions, and impedes natural succession. This thorny shrub is difficult to eliminate. As with knotweed, pulling the plant and root mass after first frost, cutting the plant frequently throughout the summer season, and refraining from streambank disturbance can reduce the vigor and colonization of Multiflora Rose.

Conserve Riparian Corridors and Connections to Upland Communities

Animals use streamside vegetation communities as corridors to move up and down the valley. Similarly, fish need cover along the stream to migrate to and from spawning locations and cool water refuge without falling prey to predators. Exposed areas therefore become barriers to passage.

Limiting access points to the stream to narrow stretches of less than 20 - 30 feet will help maintain the integrity of the riparian corridor. Likewise, riparian connections to the upland community should be conserved to enable animals to access the stream. Even though plants don't move, their genetic material moves as their seeds pass across the upland - riparian interface by wind, gravity and animals. Roadways and lawns that separate the riparian community from the upland plant community break these linkages and make the riparian community vulnerable to competition from invasive plants as well as slowing the recovery of vegetation from disturbance events such as floods.

b. Specific Program Recommendations

Streamside Vegetation Improvement Along Roads

Roads along the stream, such as Rte. 55, frequently encroach on the stream's floodplain or floodprone area, and affect the streamside vegetation. The road isn't likely to be relocated, but efforts can be made to mitigate the impact of the road's encroachment on the riparian vegetation community by supplemental plantings and improved care of existing vegetation. The Town Highway Department has worked in cooperation with this planning effort and is aware of the value of this vegetation in reducing long term infrastructure maintenance costs from failing road embankments and plugged road culverts. Stakeholders and sponsors of this planning effort should continue to work in cooperation with the Town Highway Department to identify and prescribe specific sites for action and provide funding or assistance for plantings either as buffers or as bioengineering/ biotechnical stabilization projects. A similar program should be developed for the eradication of Multiflora Rose and Japanese Knotweed along roadways. Sites are suggested in each Management Unit and in the Management Unit Recommendations Summary Table (Volume II, Section II. B. Management Unit Summary of Recommendations).

Conservation of Riparian Vegetation Along Utility Lines

Like roadways, utility lines also impact riparian vegetation and can reduce its vigor. Stakeholders and sponsors of this plan should work in cooperation with the major utilities to prepare a plan for maintenance of utility lines at stream crossings and other places where lines pass through riparian vegetation. Whenever possible, such as when poles are replaced or new spurs are established, location of the utility lines away from streams should be considered. A first step might entail review of the rights of way and mapping of specific locations where the lines intersect with streamside vegetation. A review of specifications for maintenance of vegetation near utility lines may provide managers with a set of innovative practices that enable the utilities to mitigate the impact of the lines on riparian vegetation and the stream.

Streamside Gardening Program

Streamside gardening is an alternative to traditional landscaping and the extensive use of lawns as well as exotic trees and shrubs. Streamside gardening promotes the use of native plants that provide multiple benefits, including: improved wildlife habitat, soil and bank stability, and the aesthetics of a natural streamside landscape. Streamside gardening generally does not include the use of pesticides and results in reduced labor required for mowing. Streamside gardening also promotes landscape designs that allow views and access to the stream without opening up the stream bank to erosion. Because stream side gardening is a relatively new concept, education and examples of successful gardens would assist the public to understand and consider adopting streamside gardening practices.

Stakeholders and sponsors of the planning effort should consider the funding of streamside gardening training for landowners in the valley and establishing a program for the provision of professional advice and material for the planning and creation of streamside gardens. This program might provide incentives for supporting innovative conservation practices and would result in the creation of local gardens that could act as models for the extension of these practices to additional streamside landowners of Chestnut Creek.

<u>Japanese Knotweed Control Program</u>

NYC DEP and Soil and Water Conservation Districts in the Catskill region should cooperate on the development of a joint task force to research, monitor and manage Japanese knotweed within water supply watersheds including Chestnut Creek. The effort would establish a program researching the ecology of Japanese Knotweed and testing various management prescriptions. The findings of this research would be applied to management programs throughout the Catskill watersheds. An initial phase of the effort would entail an education and awareness program to inform landowners of the appearance, habits and impact of Japanese Knotweed. The program also would work with NYS DEC and NYC DEP Land Management Program to ensure that public lands in Chestnut Creek are included in management efforts.

2. Infrastructure Recommendations

Management of roads, bridges, culverts and roadside drainage presents an important opportunity for collaboration between area stream managers working on Chestnut Creek. Town and county highway departments may be able to make use of resources available through programs administered by other Project Advisory Committee (PAC) members to reduce impacts of infrastructure maintenance on the stream, and in turn can lower infrastructure maintenance costs. The following recommendations are initial proposals to begin discussion of public infrastructure and stream issues, and summarize conversations between highway department staff and the NYC DEP and SCSWCD.

a. Road-side ditches

Ditches are periodically cleaned (scraped out and re-shaped) to increase stormwater conveyance and reduce the possibility that culverts through which they discharge will become clogged with debris. The raw soil of recently cleaned roadside ditches, however, can introduce significant amounts of fine sediment (silts and clay) turbid stormwater into the stream during storms. Road crews may not have the resources to adequately re-vegetate (seed) following ditch cleaning.

Recommendation

Develop programs to provide road maintenance crews with additional resources for seeding newly cleaned roadside ditches with native ground-cover appropriate for protection. Make application to the Catskill Watershed Corporation's Stormwater Retrofit Grants program for funds to purchase hydroseeding equipment.

b. Culvert outfalls

Culvert outfalls create point sources of discharge, collected from diffuse sources of runoff from roads or other impervious surfaces. These outfalls can discharge significant amounts of concentrated pollutants (salt, oil, and sediment) into the stream. Other outfalls may produce intermittent heavy flows that physically disturb soil and plants at the outfall. Additionally, outfalls over bare revetment (rip rap, concrete, etc.) or falling from a distance may cause additional stress due to water heating or added erosive power. Road crews may not have the resources to improve treatment practices at these outfalls.

Recommendation

Identify and prioritize the most critical outfalls with regard to point-source discharges and substrate stability, and which offer opportunities for mitigation. Vegetation can break the fall of concentrated water, cools water by shading, filters out pollutants, and stabilizes soil and streambed. Make application to the Catskill Watershed Corporation's Stormwater Retrofit Grants program for funds to install best stormwater management practices.

c. Utilities

Power and telephone lines that pass through trees are at risk of being downed by falling branches during high winds. Consequently, utility managers frequently trim branches above and around where the lines pass through the trees. The understory is also frequently cleared in the right-of-way. Excessive trimming, however, can stress the health of trees and shrubs, reducing the energy available for maintaining root mass. When these trees and shrubs are also along streambanks, and playing a critical role in streambank stability along a road embankment, protection of the utility lines and protection of roads can be at cross-purposes. Both are critical public safety concerns.

Recommendation

Identify locations where utility line right-of-ways pass through vegetation that is critical to bank stability. Develop management prescriptions for minimizing stress to these trees resulting from trimming streamside vegetation. Develop strategies and programs to replant these areas with tree and shrub species which require less maintenance, and seek resources to implement these strategies and programs. This should also be implemented along roads, since stressed vegetation can not hold embankments as well, which could result in increased sediment in runoff from road ditches.

d. Snow removal

Snow removal on roads in narrow valleys like the Chestnut Creek presents serious difficulties for road crews, especially during heavy snowfalls. Sidecast snow, which often contains a good amount of road gravel and soil, can result over time in the burying of tree roots and lower trunks, which in turn can severely stress many species of trees. When these trees are also playing a critical role in maintaining streambank stability along road embankments, snow removal sidecast may be increasing road embankment maintenance costs. Melting sidecast snow can also introduce a significant volume of fines and salts to the stream.

Recommendation

Identify critical road embankment/ streambank locations and develop strategies to strengthen riparian vegetation through planting of native species combinations that are both hardy to having their "feet" buried, and which can serve to trap fine sediment. Seek funding to implement these strategies.

e. Bridge and culvert maintenance

Repair and reconstruction of bridges, culverts and abutments represents a significant expenditure for towns and county highway departments. The design of bridges and culverts can also dramatically affect stream functions like sediment transport and stability, both upstream and downstream. The limits of bridge right-of-ways constrain the ability of engineers to incorporate into bridge designs stream channel stabilization and restoration practices on private property. Coordination between maintenance/ engineering staff and other stream managers on the PAC represents opportunities to bring additional resources into the process of bridge maintenance or replacement.

Recommendations

Develop arrangements to institutionalize coordination on bridge repair/replacement between town and county highway personnel and stream management personnel. Actively seek resources to incorporate natural channel design practices into bridge repair/replacement plans.

f. Revetment maintenance

In narrow valleys like Chestnut Creek, road maintenance includes maintenance of significant lengths of revetted embankments and streambanks, and these represent a significant expenditure for town and county highway departments. Revetted streambanks can have significant impacts on stream biological and hydraulic functions.

Recommendations

Consider, where appropriate, dumped rock revetments for upgrade to stabilization practices that permit wider shoulders, incorporate biostabilizing materials, and increase protection of both the toe of the revetment and of adjacent reaches. Seek the necessary resources to implement these upgrades, as advised by town and county highway managers.

3. General Recommendations for Chestnut Creek Watershed

a. Follow-up Assessment

The 2001 Stream Assessment Survey was a good initial effort at providing information for evaluating channel stability, flooding, and water quality problems in the Chestnut Creek Watershed. However, additional work needs to be conducted in order to complete the evaluation. The following outline includes recommendations for additional field studies and evaluation components.

1. Conduct a field reconnaissance:

a. Identify, map, and photo-document existing land use activities, identify and document unstable conditions in upland and riparian areas, characterize stream channel morphology and condition, and identify point and non-point pollution sources in the remaining Chestnut Creek subwatersheds.

b. Determine the effect that problems identified in subwatershed areas may be having on mainstem reaches to which they drain.

c. Evaluate land areas draining to storm drain outfalls identified during the 2001 Stream Assessment Survey. Identify potential storm water retrofit opportunities.

2. Resurvey monumented cross-sections and overlay them with the initial surveys to determine rates of lateral and vertical erosion. Prioritize these sites for management.

3. Evaluate man-made structures (e.g., wood weirs, rock check dams, etc.) identified during the 2001 Stream Assessment Survey to determine if they are having a negative effect on channel stability and/or sediment transport. If so, recommend corrective measures.

4. Prioritize mainstem and subwatershed problems identified during the 2001 Stream Assessment Survey and the Follow-up Field Reconnaissance.

5. Identify and prioritize restoration and management projects to address problems identified along the mainstem and in the subwatersheds.

b. Stream Corridor Management

Traditional approaches to managing streams and floodplains in the U.S. and other developed countries have included filling floodplains to accommodate new development and channelizing streams and constructing flood berms to protect existing properties in the floodplain. Riparian and streamside vegetation is routinely impacted by mechanical removal and spraying with herbicides for preparation of riparian land for cultivation or grazing; maintenance of power line, utility, and road rights-of-way; maintenance of public parks, recreation and open space areas; maintenance or expansion of yards in residential areas or for parking adjacent to businesses.

Experience has demonstrated that these types of channel and floodplain “improvements” often have unintended consequences, in that they result in a loss of flood storage capacity and prevent floodwaters from spreading out across the floodplain. These alterations to normal stream-floodplain interactions convey passing floodwaters more rapidly to downstream areas, increasing peak flood stage and increasing the energy of the flood downstream. The result is decreased channel stability, increased channel migration, increased bank and bed erosion on neighboring properties, increased damage to property and adjacent utilities, increased maintenance costs, increased loss of land, and degraded in-stream habitat.

The effects of riparian and streamside vegetation removal include increased bank erosion and lateral migration, increased channel width and decreased depth, increased water temperature, lowered water tables, increased velocity of flows in overbank areas, reduced trapping of sediments in floodplain areas, increased damage to property and adjacent utilities, increased maintenance costs, increased loss of land, and decreased fish and wildlife habitat.

This traditional approach to stream and floodplain management has been practiced throughout the Catskills with predictable results. The following recommendations are put forth to assist the Town of Neversink in its efforts to correct the flooding and channel stability problems that this approach has caused in the Chestnut Creek Watershed. They are also intended to encourage the Town to work with all stakeholders to develop an approach to managing Chestnut Creek that will minimize the potential for more serious consequences developing as the population of the watershed continues to grow.

1. Watershed/Stream/Floodplain Corridor: Ordinances and/or Land Use Covenants

To minimize the potential for future flooding and channel instability problems, current land use practices involving stream channels, floodplains and riparian vegetation should be modified.

a. The Town of Neversink should work with the Sullivan County SWCD, NYCDEP, NYSDEC and consulting engineers trained in geomorphology and natural channel design to evaluate its existing Flood Damage Prevention ordinances. Questions/issues for consideration by the evaluation team should include:

- Do the ordinances, as written and currently enforced, provide the intended level of protection indicated in its Purpose Section? Particular emphasis should be placed on evaluating the effectiveness of Section 27-2. Purpose, Subsection C – "Control the alteration of natural floodplains, stream channels and natural protective barriers which are involved in the accommodation of floodwaters"; Subsection D – "Control filling, grading, dredging and other development which may increase erosion or flood damages"; and Subsection E – "Regulate the construction of flood barriers which will unnaturally divert floodwaters or which may increase flood hazards to other lands". These sections should be evaluated from a geomorphic perspective.

- The evaluation may determine that amendments to existing ordinances and/or plans, review and enforcement policies and procedures are necessary. If so, the Evaluation Team should assist in developing the necessary additional management measures.

- Existing Flood Insurance Rate Maps are over thirty years old. Given the changes in land use as well as channel and floodplain modifications that have occurred since the maps were completed, should the maps be updated?

- Although Flood Insurance Rate Maps are valuable planning tools, they were not intended to be used for evaluating effects of alterations to individual properties on channel and floodplain hydraulics. The Town should request that a detailed flood study be conducted for the mainstem Chestnut Creek for use in evaluations of proposed site-specific alterations to the channel and/or floodplain.

- Should restrictions be placed on the disturbance or removal of riparian trees and shrubs, except as needed to restore or improve natural channel and floodplain function, control multiflora rose and noxious weeds, or conduct emergency maintenance activities?

b. In addition to the ordinances, the Town of Neversink could establish protective covenants for particularly sensitive areas that would be voluntarily agreed to in writing by all participating landowners. These covenants would control and restrict certain land use activities in areas prone to flooding and areas immediately adjacent to stream channels.

2. Channel Maintenance Procedures

It is recognized that even after the mainstem and subwatershed restoration projects have been completed some channel maintenance will be necessary over the long-term. However, landowners should forgo conducting their own channel maintenance work. In anticipation of future maintenance needs, the Town of Neversink, in collaboration with the Sullivan County SWCD, NYCDEP, and NYSDEC should develop procedures for conducting emergency flood restoration work and routine maintenance that is based on the recommendations in this Plan and geomorphic principles and natural stability concepts.

3. Joint Review and Evaluation of Public Projects

The Town of Neversink, in collaboration with Sullivan County SWCD, NYCDEP, and NYSDEC should review and evaluate the proposed extension of any public services along the stream corridor. For example, the proposed extension of the existing sanitary sewer system should be reviewed and evaluated to ensure that the proposed alignment of the sewer main, as well as proposed laterals are designed to minimize impacts to Chestnut Creek and adjacent riparian areas.

The following list of questions were adapted from the Pennsylvania Natural Stream Channel Design Guidelines, and include a series of questions/issues that need to be answered, refined, and documented for effective evaluation and future restoration projects. Further, this document should be utilized in planning for restoration of the proposed unstable or eroding sites within the Chestnut Creek Watershed. They are as follows:

Site specific questions:

- What are the causes of the observed problems?
- Are there relationships between channel stability and watershed changes?
- How does the project support the overall vision for watershed health?
- Is the project compatible with concurrent or planned activities within the watershed?
- Can priorities be established? Project goals?
- Is there a sequence of interventions that make sense?
- What are the treatment options?
- What is the cost/benefit ratio?

- What kinds of risks are associated with each alternative?
- What are the environmental impacts of each alternative?
- What are the short term and long term multiple benefits of the project?
- What are the long-term maintenance requirements?
- What types of data are needed to support the objectives of the project?
- What data exists to support your project, and what data gaps exist?
- What types of monitoring data should be collected?
- What site constraints exist?
- Will the project significantly reduce risk to public health and safety and/or fish and wildlife resources?
- Is this an emergency stabilization project?
- For emergency projects, encourage natural channel design alternatives to hard engineering stabilization.

A clear description of the project objectives and scope of work, including the approach to data collection and analysis and plans to evaluate all proposed alternatives should be outlined.

B. Management Unit (MU) Summary of Recommendations

The Chestnut Creek Management Plan will be utilized to guide and facilitate stakeholders in their efforts to correct stream channel instability problems, restore and maintain natural floodplain functions, control runoff from developed areas to reduce pollutant loadings from channel and upland sources, restore and protect in-stream habitat, and reduce the need for future channel maintenance. This section presents an approach to stream corridor restoration and management recommended for the Chestnut Creek Watershed and includes specific restoration and management recommendations organized by Management Units.

The SCSWCD, NYCDEP, and other agencies and organizations will be working with the community to implement restoration and management strategies outlined in this Management Plan. Stream and upland area projects must be integrated to avoid potential conflicts in their respective objectives. Therefore, this section also includes comments and recommendations regarding integration of proposed strategies in upland areas, in particular floodplain management and storm water management practices (see Tables 1 - 4).

For a detailed description of the recommendations, see Volume II, Chestnut Creek Management Units.

Table 1: Summary of all recommendations corresponding with Management Unit (MU)

MU Recommendations	MU1	MU2	MU3	MU4	MU5	MU6	MU7	MU8	MU9
Stabilize banks and provide long-term lateral control by reestablishing bank vegetation composed of native trees, shrubs, and grasses.	X			X	X	X	X	X	
Evaluate the presence and extent of knotweed and multi-flora rose, and evaluate an invasive exotic vegetation eradication and control program.				X	X	X	X	X	X
Research the extent of Wooly Adelgid infestation, develop and implement a strategy for control.	X								
Promote protection and preservation of current healthy riparian areas.		X	X					X	X
Implement strategies to educate riparian landowners on the benefits of preserving the current riparian area and limiting land use changes.		X	X					X	X
Work with landowners to establish a wooded buffer zone along reaches with little or no vegetation.				X	X	X	X		X
Evaluate the potential for removing a portion of the paving and fill along the Town Highway Facility Property.					X				
Evaluate the potential for increasing the riparian buffer between the NYCDEP facilities and Chestnut Creek.							X		
Evaluate the potential of replacing or modifying stabilized areas (riprap), as needed with alternative stabilization techniques including bioengineered vegetation and vane/log style structures.							X	X	X
Implement storm water mgmt for properties w/ highest percent impervious surface along corridor.	X			X	X	X	X		X

Table 2: Summary of all recommendations corresponding with Management Unit (MU)

MU Recommendations	MU1	MU2	MU3	MU4	MU5	MU6	MU7	MU8	MU9
Evaluate reconstructing channel along historically active reach.	X			X	X				
Provide grade control structures at key points along channel to maintain bed stability.					X	X	X		
Reconstruct problematic dry hydrant sites to provide low maintenance facilities.					X	X			
Assess affects of check dams on channel stability, sediment transport, habitat and fish passage. Remove poorly functioning check dams.							X		
Promote protection of current stable stream channel. Implement strategies to educate landowners on benefits of stable stream reaches.		X	X					X	X
Evaluate failing revetment for replacement with stabilization structure to maintain naturally functioning channel. Should include bioengineering and/or re-vegetation.				X					
Perform stabilization only where necessary using BMPs which promote and maintain a naturally functioning channel.		X	X					X	X
Promote floodplain protection, which is critical in maintaining stability in moderately entrenched reaches.		X	X					X	
Monitor areas w/ debris jams and channel blockages for changes in channel stability and threat to infrastructure.		X	X	X				X	X
Initiate monitoring strategy in selected areas to document channel stability for comparison purposes, and inclusion into a local reference reach database.		X						X	X

Table 3: Summary of all recommendations corresponding with Management Unit (MU)

MU Recommendations	MU1	MU2	MU3	MU4	MU5	MU6	MU7	MU8	MU9
Convert the existing F and unstable B reaches to stable B channels.					X	X			
Repair and stabilize the worst erosion sites along mainstem and tributaries draining to MU.				X	X	X			
Evaluate potential for removing all or portion of paving and fill along old Town Highway Building to reestablish wooded buffer zone and floodplain area.					X				
Establish a better angle of repose on unstable banks and lower bank to bankfull height ratio, by grading high, vertical banks.				X	X	X	X		
Install flow diverting structure (e.g, rock or J-Hook vanes, etc) at key points along channel to reduce stress in near bank region as an alternative to bank hardening revetment..				X		X	X		
Evaluate culvert at road crossing to determine best method to reduce scour, improve sediment transport and conveyance of bankfull and flood flows. If this adds to channel instability install flow diverting structures.	X	X		X	X				X
Repair or replace bridge at Mohr Property. If replaced, should be designed to convey 25-year storm, have X.S. area and width that conveys bankfull discharge without causing scour or deposition.					X				
Evaluate Covered Bridge to determine best method for reducing scour, improving sediment transport, conveyance of bankfull and flood flows.					X				

Table 4: Summary of all recommendations corresponding with Management Unit (MU)

MU Recommendations	MU1	MU2	MU3	MU4	MU5	MU6	MU7	MU8	MU9
Reconstruct channel by Davis Lane Bridge, removing bars, narrowing width to depth ratio, steepening slope by reinstalling sewer line under current specs, and construct a W-Weir to direct bankfull flows through one opening, allowing flood flows to pass through both openings.						X			
Evaluate the River Road Bridge to determine the best method for improving sediment transport and conveyance of bankfull and flood flows.						X			
Reconstruct River Road reach to provide a larger radius of curvature and install rock vanes to divert flow away from the reconstructed banks.						X			
Evaluate existing bridge and culvert crossings for ability to facilitate fish passage during varying flow periods.							X	X	X
Assess local condition surrounding remaining abutments of the historical bridge. Evaluate potential for removing abutments to improve flood conveyance, aesthetics, and reduce potential liability.							X		
Relocate and stabilize the stream channel in the area of the high eroding bank.							X		
Consider efforts to promote land use planning within the corridor to protect the existing resource.		X							X
Extend assessments beyond upstream limit of MU to the headwaters, including major tributaries.								X	X
Evaluate existing berms to quantify the degree of disconnection from its floodplain, impacts to the channel and evaluate and quantify benefits of removal or redesign.								X	X

III. Amending and Updating the Plan

As dynamic as nature and the Chestnut Creek itself, this Stream Management Plan should ideally evolve with the goals and values of the community, the policy makers and those policies that affect stream management. In order to ensure that the Plan continues to be useful to the community, the Plan needs ongoing maintenance and updating in the years ahead.

First, we recommend that the Chestnut Creek Project Advisory Committee (PAC) continue as an organization, meeting at least biannually to review progress towards implementing the plan and address new issues. A member of the PAC should be selected to serve as a Coordinator to set up meetings and ensure changes get implemented. The Neversink Town Board naturally plays a central role in keeping the Management Plan current because the residents of the Chestnut Creek neighborhood have first hand knowledge of changes and needs in the watershed. A member of this organization should be selected to work with the PAC representative to ensure meetings are held and changes or updates are made to the plan to best serve the community.

Agenda for ongoing meetings could include:

- Updating resource and contact information;

- Review of recommendations in the Plan and identification of projects to implement or pursue;

- Updating technical assistance and grants available for stream work and stewardship, and documenting those sources both sought and received, to avoid redundancy;

- Evaluation of progress toward implementing Plan recommendations (List of accomplishments or projects completed);

- Identification of obstacles to implementation and development of strategies for overcoming these obstacles;

- Identification of emerging issues that may require new recommendations to be included in the Plan;

- Identification of recommendations that are not practicable, or are no longer relevant;

- Review of demonstration project monitoring information, monitoring cross section data, and any landowner ongoing monitoring of specific sites;

- Amendment and reproduction of the Plan, as needed.

As on-going active members of the PAC, the Sullivan County Soil and Water Conservation District (SCSWCD), the NYC DEP Stream Management Program (NYC DEP SMP) and the New York State Department of Environmental Conservation (NYS DEC) should also provide assistance to these groups, both within the PAC and as needed, and especially to the Town of Neversink, in cooperation with which most programs or projects are most likely to be implemented. These agencies should proactively provide other members with up-to-date information regarding funding and other resources available for stream-related activities, as well as changing regulations, guidance on best management practices (BMPs), workshops and important contact information.

As members of the Project Advisory Committee change over time, other members should orient new members to the effort that went into the development of the Stream Management Plan, including its goals and strategies. As policies change and other issues arise that impact management of the stream, these changes should be reflected, where necessary, as amendments to the Management Plan.

IV. Stream-related Activities and Permit Requirements

NYS DEC Permit Requirements

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

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

Waters with classifications, A, B, and C may also have a standard of (T), indicating that it is able to support a trout population, or (TS) indicating that it supports trout spawning. Special requirements apply to sustain these waters that support these valuable and sensitive fisheries resources. Chestnut Creek has a legal classification/ standard of A(T) from mouth to source, as listed in New York State and as such is subject to the stream protection provision of the Protection of Waters regulation.

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

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

For Sullivan County:

NYSDEC Region 3
Bureau of Habitat
21 South Putt Corners Rd
New Paltz, NY 12561-1696
(845) 256-3054194

Living Streamside in the Chestnut Creek Watershed

Frequently Asked Questions about Undertaking Various Projects Near the Stream

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

Following are answers to some of the questions most commonly asked by homeowners about activities they are considering undertaking that may impact the health and stability of streams. Where you may need more information, contacts are provided. Please contact your local Soil and Water Conservation District office for site-specific information. We have also noted those activities that may not be beneficial to overall stream health. This information constitutes some of the best professional guidance available today.

If you seek to:

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

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

Permits

Depending on the specific conditions of a stream crossing (bridge or culvert) project, permits are required from the Army Corps of Engineers (ACOE), the New York State Department of Environmental Conservation (DEC) and the New York City Department of Environmental Protection (DEP). An ACOE permit is required when more than 25 cubic yards of fill material will be used below the "ordinary high water mark" (the approximate yearly flood level). Because the streambed or banks will be disturbed, stream crossing construction requires an Article 15 Stream Disturbance Permit from the DEC. Depending upon whether or not there are any drainage features (streams or wetlands) on the property that will be involved as a result of the project, it may require a Crossing, Piping and Diversion Permit (DEP). Also, if the bridge is part of new construction that involves disturbance of more than 1 acre, it must be reviewed under the DEC stormwater State Pollution Discharge Elimination System (SPDES) program. If the project will disturb more than 2 acres, it may need a Stormwater Pollution Prevention Permit (SPPP) from DEP.

Contacts

Start by contacting the DEC Habitat Unit staff to determine which state permits are needed.. In Region 3 (Ulster and Sullivan Counties), contact Jack Isaacs at 845-256-3087. For DEC Stormwater permits in Region 3 contact Patrick Ferracane, at 914-322-1835, X357. At DEP, contact Brenda Drake at 845-657-2390.

2) Divert water from a stream:

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

Permits

Any diversion must be reviewed by the DEC.

Contacts

Contact the DEC Habitat Unit. In Region 3 (Ulster and Sullivan Counties), contact Jack Isaacs at 845-256-3087.

3) Pave or repave a driveway near a stream:

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

Permits

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

Contacts

Start by contacting the DEC Habitat Unit to determine what state permits are needed. In Region 3 (Ulster and Sullivan Counties), contact Jack Isaacs at 845-256-3087. For DEC Stormwater permits, in Region 3 contact Patrick Ferracane, at 914-322-1835 X357. At DEP, contact Brenda Drake at 845-657-2390.

4) Cut or trim streamside (riparian) vegetation on the stream bank:

Resource Guidance: Stable stream banks in the Catskills usually require woody vegetation. Shrub and tree roots provide holding power for stream bank soils that can't be beaten by grasses or herbs. For a more thorough discussion on the role of vegetation in stabilizing stream banks, see Chestnut Creek Stream Management Plan Riparian Vegetation Management. To maximize stream bank stability as well as ecological and aesthetic benefits of streamside, or riparian, vegetation, discontinue mowing and allow a buffer of vegetation to grow, or plant woody vegetation.

If you are removing a log jam (a pile of trees that have fallen into the stream and are trapping more trees and stream sediment): this requires technical assistance to ensure that the removal process does not initiate new stream erosion in an upstream or downstream direction. These jams can cause considerable property damage. While biologically they may actually be beneficial to the stream, resource management agencies understand the property damage they can cause, and will work with you towards the most beneficial solution.

If you are removing individual trees, they must be cut up into smaller pieces and removed from the stream so they won't get caught further downstream and cause or worsen another log or debris jam. If the log jam or falling trees are not on your property, but are causing damage to your property, you must coordinate with your neighbor.

Permits

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

Contacts

Seek technical assistance from the DEC Habitat Unit. In Region 3 (Ulster and Sullivan Counties), contact Jack Isaacs at 845-256-3087. DEP Stream Management Program staff can provide assistance, contact Beth Reichheld at 845-340-7512, or contact your local Soil and Water Conservation District.

5) Stabilize an eroding streambank:

Resource Guidance: Stream bank stabilization is a common need in the Chestnut Creek valley. As the management plan has revealed, there are eroding stream banks along the Chestnut Creek Stream that threaten water quality, private property and public and private infrastructure (i.e., bridges, culverts and roads). Care should be taken in designing the work to ensure that you don't over-widen the stream, narrow or encroach upon the stream, and that you do not borrow from nearby gravel bars in the stream for fill material. Seek technical assistance to identify the set of causes of your stream bank instability problem so that the solution addresses the causes, and seek a solution that does not transfer the erosion problem up- or downstream. The agencies referenced below can advise you. Neighboring properties may need to be involved.

Permits

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

Contacts

Start by contacting the DEC Habitat Unit to determine what state permits are needed. In Region 3 (Ulster and Sullivan Counties), contact Jack Isaacs at 845-256-3087. DEP Stream Management Program staff can provide assistance, contact Beth Reichheld at 845-340-7512, or contact your local Soil and Water Conservation District.

6) Build a house or other structure:

Resource Guidance: Siting a new home near a stream can define your enjoyment of that stream and relationship to it. Proper location for homes and facilities must consider stream flooding behavior, no matter how high above or far back from the stream the location may appear during low flow. Because floodplain maps are not available in the Chestnut Creek valley, seek technical assistance to identify approximate floodplain boundaries, and design your site in as "stream friendly" a manner as possible. Give the stream room to flood, and to move (because a slow rate of erosion is a natural stream adjustment process), so you'll be able to enjoy it, as well as reduce home maintenance costs from stream erosion or flood inundation.

Permits

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

Contacts

For DEC Article 15 permits: In Region 3 (Ulster and Sullivan Counties), contact Jack Isaacs at 845-256-3087. For DEC Stormwater permits, in Region 3 contact Patrick Ferracane, at 914-322-1835, X357. For DEP permits: Brenda Drake, 845-657-2390. Contact your Town clerk for the number of the local code enforcement officer, soil and water conservation district, and/or building inspector.

7) Extract gravel from the stream:

Resource Guidance: There was a common belief that cleaning gravel from streams is necessary to improve flood conveyance capacity and reduce flooding. Others wish to use the gravel for construction-related projects where clean gravel is needed. These are the considerations you should weigh: The stream must effectively be able to move both water and sediment delivered from the mountains to maintain its shape and provide optimum water quality and aquatic habitat. Therefore, any activity in a stream channel should consider its impact not only on moving water, but also on moving sediment (the gravel) to ensure these qualities of a functioning stream are preserved. Excavating gravel usually disturbs the sensitive balance that the stream maintains between its slope (steepness) and the amount and size of sediment it can move. If you are removing gravel to increase flood conveyance capacity, please consider that this has been found to be a damaging practice and if the stream is left to its own devices, the channel will eventually restore itself by moving accumulated gravels through and restoring its own flood conveyance capacity. If you are excavating gravel for construction-related projects, a non-stream source should be considered.

Permits

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

Contacts

Start by contacting the DEC Habitat Unit to determine what state permits are needed. In Region 3 (Ulster County), contact Jack Isaacs at 845-256-3087. You can also seek technical assistance from the DEC, your local Soil and Water Conservation District, and the DEP Stream Management Program; contact Beth Reichheld at 845-340-7512.

V. Funding Sources and Agency Contacts

Technical Assistance

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

Soil & Water Conservation Districts (SWCD)

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

Greene:
Executive Director
(518) 622-3620

Ulster: Executive Director
(845) 883-7162 ext. 5

Sullivan:
District Manager
(845) 292-6552

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

New York City Department of Environmental Protection (NYC DEP)

www.nyc.gov/dep

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

Land Acquisition: In 1997, the DEC issued a permit that allowed the DEP to acquire land for the purpose of watershed protection. The acquisition of land is one of the best ways to ensure the ongoing prevention of pollution and to prevent future water quality problems from occurring as a result of adverse development close to critical natural features and reservoir intakes. Purchase of land at fair market value or placement in an easement is negotiated only from willing sellers. Interested parties should contact the Land Acquisition Program @ (845) 340-7540.

Stream Management: DEP's Stream Management Program was established after the 1996-snowmelt flood to address the systemic challenges to overall water quality in the Catskill/Delaware watershed. Its mission is to establish long-term stewardship of the streams through a watershed-scale, community-based, geomorphic approach. Essential to achieving this goal is the provision of technical assistance to local municipalities, landowners, and businesses within the watershed. The stream management staff is available for consultation on property and infrastructure protection through natural channel design. Staff members also offer training and educational programs regarding these topics. Concerns or requests for service, should be made to the Stream Management Program @ (845) 340-7517.

Land Management: This program aims towards good stewardship of the natural resources in the West of Hudson watershed. Providing good stewardship is critical to the success of any water quality protection program. The Land Management Program develops land resource management plans for DEP properties, conducts a recreational review, and develops basin plan, incorporating specific property by property uses and stewardship. In addition, the DEP has implemented a public access program, making 50% of acquired lands available for recreational purposes like hiking, hunting, and fishing. For additional information call (845) 340-7541.

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

New York State Department of Environmental Conservation (NYS DEC)

www.dec.state.ny.us

Many water related programs are offered by the NYS DEC. The agency has various divisions, which handle watershed assessment and management, environmental education, fisheries, and flood protection. Information about the DEC stocking schedule, fishing licensing, and access points is available at http://www.dec.state.ny.us/website/dfwmr/fish/index.html or by calling (845) 256-3161 for Region 3.

To receive information regarding any flooding issues and the National Flood Insurance Program, see http://www.dec.state.ny.us/website/dow/bfp/gisfpm/gisfpm.htm or call (518) 402-8141 about flood control projects or (518) 402-8146 about flood plain management.

In addition to the above services, the DEC is also the regulatory agency for the state of New York's waterways. Having classified Catskill streams, the DEC requires a Protection of Waters Permit for disturbing the bed or banks of a stream. If you are in DEC Region 3, please contact the following individuals for direction and advice.

Ulster/Sullivan:
Bureau of Habitat
21 South Putt Corners Rd
New Paltz, NY 12561-1696
(914) 256-3054

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

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

The Army Corps of Engineers has a variety of duties related to stream management. If a municipality or landowner wishes to install a water-related structure, dredge or fill a stream, or affect a wetland area, ACOE will often assign a field technician to visit the sight in order to evaluate the need for a federal permit. ACOE also offers engineering designs and other technical expertise. In addition, they are available for planning, designing, and constructing flood control projects. For a field technician in Region 3 contact the office listed below:

Sullivan/ Ulster County: (212) 264-0182

Catskill Watershed Corporation (CWC)

www.cwconline.org

The CWC is a not-for-profit corporation with a dual goal: to protect the water resources of the New York City Watershed west of the Hudson River, while preserving and strengthening communities located in the region. Although the CWC is mainly a source of funding (see grant information section), they can also provide technical assistance. Pertinent programs for Catskill/Delaware stream stakeholders include the Stormwater Controls for New Construction, Stormwater Retrofit, Septic System Rehabilitation and Replacement, and Alternate Design Septic Program. For more information call 10(845) 586-1400.

Watershed Agricultural Council (WAC)

www.nycwatershed.org

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

Watershed Agricultural Program (WAP)

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

Conservation Reserve Enhancement Program (CREP)

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

Watershed Forestry Program (WFP)

The Watershed Forestry Program is a voluntary partnership between New York City and the upstate forestry community that maintains well-managed forests as a preferred land use for watershed protection. Forests cover more than 75% of the total watershed land area, and a similar majority of this forestland is privately owned and managed by thousands of individual landowners. To promote forest stewardship and encourage long-term investment in private forestry, the Forestry Program offers cost-sharing to landowners for developing 10-year forest management plans written by qualified professional foresters. Participating landowners must own at least 10 acres of forest land in the watershed. The Forestry Program also offers a variety of cost-sharing, technical assistance and other incentive programs to both loggers and landowners for implementing certain forestry practices that protect water quality, such as properly installing new timber harvest roads and stream crossings or remediating existing forest roads that have documented erosion problems. Owning a watershed forest management plan is actually a prerequisite for many of these programs. Forest landowners may also attend a variety of educational workshops and other training events that are periodically sponsored throughout the watershed. For more information, call (607) 865-7790 or email forest@catskill.net.

National Rural Water Association

www.nrwa.org

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

New York Rural Water Association

www.nyruralwater.org/tech_assistance.shtml

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

Federal Emergency Management Association (FEMA)

http://www.fema.gov/

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

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

- Administration of the National Flood Insurance Program (NFIP). Through this program FEMA prepares flood insurance rate maps (FIRMs) that define where floodwaters are likely to cause damage to property. These maps provide communities with a tool to prevent losses through the limitation of building and flood plain modification within these flood zones.

- Management of hazard mitigation programs that help communities identify and modify situations and places at risk during flood events. This would include the development of hazard mitigation plans prepared by communities to help the community reduce or avoid threats to life or property during flood events.

- Following flood events that are declared by the President to be a disaster for a specific county, FEMA typically provides assistance for temporary housing, clean-up, repairs to private structures and repairs to public infrastructure. The availability of this assistance depends on the magnitude of the disaster and the types of losses incurred by the county and its residents. The Small Business Administration also can provide assistance with low interest loans to private business. FEMA programs are modified frequently and therefore the type and level of assistance will vary from event to event.

- FEMA plays its most important role as a coordinator of response and information in times of a disaster.

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

New York State Emergency Management Office (NYS SEMO)

www.nysemo.state.ny.us

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

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

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

Other Emergency Assistance: SEMO also provides a variety of services during times of emergency. These services include state of the art communications, information dissemination, and emergency operation coordination.

Call the Emergency Coordination Center at (518) 457-2200 with questions or requests.

Cornell Cooperative Extension (CCE)

http://www.cce.cornell.edu/

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

Greene: (518) 622-9820
greene@cornell.edu

Ulster: (845) 340-3990
ulster@cornell.edu

Sullivan: (845) 292-6180
Sullivan@cornell.edu

Delaware: (607) 865-6531
delaware@cornell.edu

Natural Resources Conservation Service (NRCS)

www.nrcs.usda.gov/

NRCS puts nearly 70 years of experience to work in assisting owners of America's private land with conserving their soil, water, and other natural resources. Local, state and federal agencies and policymakers also rely on our expertise. They deliver technical assistance based on sound science and suited to a customer's specific needs. Cost shares and financial incentives are available in some cases. Most work is done with local partners. NRCS's partnership with local conservation districts serves almost every county in the nation, and the Caribbean and Pacific Basin. Participation in our programs is voluntary. Please see below for local contact information.

Greene: Ghent Service Center
(518) 828-4385

Ulster: Highland Service Center
(845) 883-7162

Sullivan: Liberty Service Center
(845) 292-6471

Delaware: Walton Service Center
(607) 865-4005

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

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

Catskill Center for Conservation and Development (CCCD)
www.catskillcenter.org/
The Catskill Center is a non-profit organization working to protect the cultural, historic, and natural resources of the Catskill Mountains. The CCCD has a few integrated program areas:

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

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

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

Visit their website at catskillcenter.org or call (845) 586-2611.

Trout Unlimited (TU)

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

Ashokan-pepacton 559:
(845) 254-5904

Catskill Mountain 028:
(845) 339-5938

Columbia Green Rvw 569:
(518) 943-6728

ESRI Environmental Conservation Program (ECP)

http://www.conservationgis.org/aaesrigrants.html

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

See Tables 1 and 2 for a list of government, private, and non-profit contacts and sources.

Table 1. Government Sources and Contacts.

Name	Focus	Due Date	Contact	Award Example	Notes/ Priority	on-the-ground	research	planning	<$20K	$20K to $100K	>$100K	range
Environmental Protection Agency												
Five-Star Restoration Program	Projects include strong on-the-ground wetland, riparian, or coastal habitat restoration component and education, outreach, and community stewardship components.	Jan/Feb	John Pai, 202-566-1350, pai.john@ epa.gov	Westchester County Department of Planning received $9,500 to complete restoration activities at Echo Bay in Five Island Park and Blind Brook. Students from local high schools and colleges willl complete on the ground restoration.	Projects involving only research, monitoring or planning are not eligible for funding.	X			X			5K-20K
http://www.epa.gov/owow/wetlands/restore/5star/												
Water Quality Cooperative Agreements	This program supports new approaches to meeting stormwater, sanitary sewer, and combined sewer outflows, biosolids, and pretreatment requirements, as well as enhancing state capabilities.	accepted on a rolling basis	U.S. EPA, Office of Wastewater Management, Baron Benroth, 202-564-0672, benroth.barry@ epa.gov		Eligible projects include research, investigations, experiments, training, demonstrations, surveys, and studies related to the causes, effects, extent, and prevention of pollution.		X		X	X	X	10K-500K
http://www.epa.gov/owm/cwfinance/waterquality.htm												

Wetlands Program Development	Projects that promote the coordination and acceleration of research, investigations, experiments, training, demonstrations, surveys, and studies relating to the causes, effects, extent, prevention, reduction, and elimination of water pollution.	determined annually	Region 2, Kathleen Drake, drake.kathleen@epa.gov, 212-637-3817	NY DEC received grant money to implement the Great Swamp watershed conservation plan, promote local participation, perform hydrological studies, assess wetland communities, produce species inventories, conduct education and outreach activities, and promote land protection with an emphasis on fens and bogs.	Priority given to projects addressing three priority areas: Developing a comprehensive monitoring and assessment program; improving effectiveness of compensatory mitigation; and refining protection of vulnerable wetlands and aquatic resources.		X	X		X	X	20K-313K

http://www.epa.gov/fedrgstr/EPA-WATER/2002/August/Day-26/w21670.htm
http://yosemite.epa.gov/water/grant.nsf/EPA%20Regions?OpenView&Start=1&Count=100&Expand=2.2#2.2

Natural Resource Conservation Service

Conservation on Private Land	Projects that engage private landowners, primarily ranchers and farmers, on the ground projects.	December	Eastern Regional Office, Director Conservation Education, Tom Kelsh 202-857-0166		Partnerships with NRCS or local conservation districts, priority given to landscape, watershed scale projects integrating agriculture, forestry, and ranching that benefit fish and wildlife.	X			X	X		4K-100K

http://www.nfwf.org/programs/nrcsnacd.htm

Emergency Watershed Protection	Projects support such work as clearing debris from clogged waterways, restoring vegetation, and stabilizing river banks.	on-going basis	Liberty Service Center, 845-292-6471		The measures that are taken must be environmentally and economically sound and generally benefit more than one property owner.	X						

http://www.nrcs.usda.gov/programs/ewp/factsheet.html

Name	Focus	Due Date	Contact	Award Example	Notes/ Priority	on-the-ground	research	planning	<$20K	$20K to $100K	>$100K	range
National Oceanic and Atmospheric Administration												
Community-based Restoration	Provides funds for small-scale, locally driven habitat restoration projects that foster natural resource stewardship within communities.	on-going basis	Robin Bruckner, Robin.Bruckner@noaa.gov, 301-713-0174	Provides funding to implement on-the-ground habitat restoration projects to benefit marine, estaurine and riparian habitats.		X			X	X	X	14K-8mil
http://www.nmfs.noaa.gov/habitat/restoration/projects_programs/crp/index.html												
Federal Emergency Management Association												
Flood Mitigation Assistance (FMA)	Program helps states and communities identify and implement measures to reduce or eliminate the long-term risk of flood damage to homes and other structures.	established by states	26 Federal Plaza, New York, New York 10278, 212-680-3600		two types offered: planning and project grants for National Flood Insurance Program (NFIP) participating communities.	X		X				
http://cfpub.epa.gov/fedfund/search1.cfm												
U.S. Fish and Wildlife Service												
North American Wetlands Conservation Act Grants	Standard and Small Grants programs help deliver funding to on-the-ground projects through the protection, restoration, or enhancement of an array of wetland habitats	on-going basis	Standard- David Buie, 301-497-5870, Small- Keith Morehouse, 703-358-1888, General Office Number, 703-358-1784		The act requires that U.S. and Canadian partners focus on these three activities; Mexican partners may also develop training, educational, and management programs and conduct sustainable use studies.			X	X	X	X	small=<50K standard= 50K-1mil
http://birdhabitat.fws.gov/NAWCA/grants.htm												

Partners for Fish and Wildlife	Focuses on restoring former and degraded wetlands, native grasslands, stream and riparian areas, and other habitats to conditions as natural as feasible.	on-going basis	Sally J. Valdes, 703-358-2201	The program has partnered landowners to restore wetlands, prairie grassland, and in-stream aquatic and riparian habitat. In addition, the program has reopened stream habitat for fish and other aquatic species by removing barriers to passage.	Provides technical and financial assistance to landowners interested in voluntarily restoring or otherwise improving native habitats for fish and wildlife on their lands.	X			X	X		<25K

http://partners.fws.gov/

State Emergency Management Office

	Provides leadership, planning, education, and resources to protect lives, property and the environment.	on-going	Chief of Recovery, 518 457-7082, postmaster@ semo.state.ny.us			X		X	X	X	X	

http://www.nysemo.state.ny.us/

Table 2. Private, Non-Profit Sources and Contacts.

Name	Focus	Due Date	Contact	Award Example	Notes/ Priority	on-the-ground	research	planning	<$20K	$20K to $100K	>$100K	range
Catskill Watershed Corporation (CWC)												
Catskill Fund for the Future	Funds will be used to make loans and grants to businesses and organizations proposing environmentally responsible projects.	accepted on a rolling basis	Michael Triolo, Economic Development Director, triolo@cwonline.org	Delhi received money for establishment of Riverwalk Community Park (purchase of riparian property and development of a village riverfront area with canoe access).	This fund program includes a variety of grant and loan programs.	X		X	X	X	X	2k-500k
http://www.cwonline.org/econ_dev/ed_index.htm												
Septic System Rehabilitation and Replacment	This program reimburses homeowners for repairing or replacing damaged septic tanks.	within 30 days of completion of repair and replacement	Leo LaBuda, labuda@cwonline.org; John Jacobson, jacobson@cwonline.org; Kirsten Miller, kmiller@cwonline.org; 845-586-1400		Program limited to homeowners in areas highly sensitive to water quality, as identified on NYCDEP maps.	X			X			60% and 100% of eligible costs for non-primary and primary landowners, respectively.
http://www.cwconline.org/programs/septic/septic.htm												
Sand and Salt Storage Facilities	This program is meant to upgrade or replace buildings used for storing road de-icing materials to prevent salt and other substances from leaching into groundwater or nearby streams.	determined annually	Mimi McGiver, Staff Engineer, mcgiver@cwonline.org			X			X			
http://www.cwonline.org/programs/sandsalt/sandsalt.htm												

Alternate Design Septic Program	This CWC program pays eligible costs of septic system installation added solely due to requirements of the watershed regulations.	accepted on a rolling basis	Leo LaBuda, labuda@cwconline.org; Mimi McGiver, mcgiver@cwconline.org; 845-586-1400			X			X			
http://www.cwconline.org/programs/septic/alt_septic.htm												
Stormwater Controls for New Construction	Program to design and construct runoff and erosion control measures.		Elizabeth Mastrianni, Professional Engineer, emastrianni@cwconline.org	One project will improve stormwater collection and treatment on Railroad Avenue, a project intended to decrease pollution and nutrient loading and reduce flow to the village's wastewater treatment plant.		X					X	
http://www.cwconline.org/programs/strm_wtr/strmwtr_controls.htm												
Stormwater Retrofit	Program to provide funds for stormwater management needed to correct or reduce existing erosion, polluted runoff or other problems associated with stormwater.	accepted on a rolling basis	Elizabeth Mastrianni, Professional Engineer, emastrianni@cwconline.org		Projects to implement stormwater BMPs that reduce erosion and/or pollutant loading associated with conditions existing on or before January 21, 1997 are eligible to apply.	X						
http://www.cwconline.org/programs/strm_wtr/strmwtr_retro.htm												

Name	Focus	Due Date	Contact	Award Example	Notes/ Priority	on-the-ground	research	planning	<$20K	$20K to $100K	>$100K	range
Catskill Watershed Corporation (CWC)												
Community-Wide Stormwater Infrastructure Assessment and Planning Program	Program to conduct detailed and comprehensive assessments of existing community stormwater infrastructure with the goal of identifying and prioritizing potential areas for Stormwater BMP's for funding.	annual application deadline is November 1	Elizabeth Mastrianni, Professional Engineer, emastrianni@cwconline.org	Grantees receive funds for locating existing stormwater infrastructure and the compilation of a GIS database identifying each individual structure with an associated description, operational status and repair needs.	Projects which propose benificial project outcomes in the three categories of Public Value, Water Quality Protection Value and Local Commitment .		X	X	X			
http://www.cwconline.org/programs/strm_wtr/strmwtr_retro.htm												
Public Education	Projects that would increase awareness of the region's environment, and its natural and human history.		Diane Galusha, Education Coordinator, galusha@cwconline.org	Tri-Valley Central School, Grahamsville, water monitoring equipment to expand the agricultural and environmental studies programs to include water quality examinations; Ernest Myer School, to bring Streamwatch.	Projects must highlight importance of City's water supply system and role of watershed residents as stewards; ecology of the region and diversity of aquatic and vegetative life; and/or the development of the city's water system.	X			X			$750 to $10K
http://www.cwonline.org/programs/pub_edu/pe.htm												

National Fish & Wildlife Foundation

General Challenge	Projects that address priority actions promoting fish and wildlife conservation and the habitats on which they depend, work proactively to involve other conservation and community interests.	year round, two decision cycles	NE Regional Office: Director, Tom Kelsch, 202-857-0166	Tioga County SWCD received $9,700 to restore 8 acres of former floodplain to benefit fish and wildlife habitat along the Catatonk Creek.	Goods and services that are exchanged for cash are ineligible.	X			X	X	X	10K-150K
http://www.nfwf.org/programs/guidelines.htm												
Bring Back the Natives	Projects that benefit native aquatic species in their historic range. BBN projects involve riparian habitat restoration, moving streams towards stability, and supporting native aquatic communities.	December & March	Cynthia Johnson, 303-289-0526, bbn@nfwf.org		BBN will not fund basic research or monitoring.	X				X	X	21K-450K
http://www.nfwf.org/												
Native Plant Conservation Initiative	Projects that protect, enhance, and/or restore native plant communities on public and private land, including protection and restoration, information and education, and inventory and assessment.	Twice a year, December 1 & July 15	Caroline Cremer, caroline.cremer@nfwf.org, 202-857-0166	Indiana Dunes Natl. Lakeshore and Natl. Park Service received funds to protect the unique floristic features of the western-most extent to the Great Marsh in Indiana. Project with eradicate invasive species, erect deer exclosures, and propagate and outplant white cedar and various orchids on 6 acres of wetland.	A special emphasis is placed on larger projects that demonstrate a landscape-level approach and produce lasting, broad-based results on the ground.	X	X				X	
http://www.nps.gov/plants/nfwf/index.htm												

Name	Focus	Due Date	Contact	Award Example	Notes/ Priority	on-the-ground	research	planning	<$20K	$20K to $100K	>$100K	range
Watershed Agricultural Council												
NYC Watershed Forestry Program	Provides cost-sharing incentives and technical assistance to watershed forest landowners to promote forest management planning and to help establish streamside buffers.	rolling assistance	Collin Miller, collinmiller@ catskill.net, Watershed Agricultural Council, 607-865-7790		Assistance from this program could be used to establish additional grants from matching programs that require existing challenge funds and partnerships.			X	X			
http://www.nycwatershed.org/												
The Conservation Fund												
Kodak American Greenways Award	Small grants to stimulate the planning and design of greenways in communities throughout America.	March 1 & June 1 of each calendar year	American Greenways Program Coordinator, The Conservation Fund, greenways@conservationfund.org, 703-525-6300	North American Water Trails received grant money for its development, enjoyment and stewardship of recreational water trails, also known as "blueways".	Grants used for appropriate expenses needed to complete greenway project including planning, technical assistance, legal and other costs.			X	X			up to 2,500
http://www.conservationfund.org/?article=2372												
ESRI Conservation Program												
Software/ Training Donation	Our grant program provides donations and discounts of GIS software, data, books, and training.	on-going	ecpgrant@esri.com for full application before asking questions of individuals	Grantees receive conference passes, web-based training passes, live training days, ESRI press books, software and software upgrades.	Does not grant hardware or cash.	X	X					

Conservation Program	Our grant program provides donations and discounts of GIS software, data, books, and training.	on-going	email rcdgrant@esri.com for detailed information	Initial RC&D Grant-Bundle will include ArcView GIS software, a Getting to Know ArcView text book with exercises and tutorial, and an ArcUSA CD containing digital data for the US.	Does not grant hardware or cash.	X	X					

http://www.esri.com/library/whitepapers/pdfs/consprgm.pdf

TechGrants

	TechFoundation is committted to bringing financial resources, technology solutions and management expertise to nonprofits to strengthen the social sector.	March	Kathleen Sherwin, Manager, External Affairs, 617-354-7595, info@techfoundation.org	Colorado Environmental Coalition, www.ourcolorado.org	Awardees selected for focus on projects that will bring quality technology resources to nonprofits and show that effectively deployed technology can have a great impact on the ability of a nonprofit to achieve their mission.	X		X	X	X		5K-35K

www.techfoundation.org

Earthwatch Institute

Research Program	Project monitors water quality in lakes, streams, wetlands and agricultural areas. Projects involved the inventory, monitoring or restoration of watershed environments.	on-going	800-776-0188, 978-461-0081, research@earthwatch.org	Projects monitor water quality in lakes, streams, wetlands and agricultural areas. Projects involve the inventory, monitoring or restoration of watershed environments.	Grants cover cost of maintaining volunteers and principal research staff in field. Grants cannot be used for PI salaries, capital equipment, or overhead costs.		X		X	X	X	7K-130K

http://www.earthwatch.org/research/index.html

Name	Focus	Due Date	Contact	Award Example	Notes/ Priority	on-the-ground	research	planning	<$20K	$20K to $100K	>$100K	range
Toshiba America Foundation												
	contribute to the quality of science and mathematics education in U.S. communities by investing in projects designed by classroom teachers to improve science and mathematics education	accepted year round	Toshiba America Foundation, 212-596-0620, foundation@ tai.toshiba.com	Chimacum Middle School received money for 7th and 8th grade earth science students to conduct a water quality study in their area. After the study, students will make recommendations to local agencies.		X			X	X		$2.1K - $24K

www.toshiba.com/taf/apply.html

VI. GLOSSARY OF TERMS

GLOSSARY OF STREAM AND FLOODPLAIN TERMS

Note: where a word within a definition is italicized, it is defined elsewhere within the glossary

aggradation - The process by which *sediment* and deposition causes a streambed elevation to increase, or fill in. The channel becomes more shallow by filling in with *sediment*. An aggrading stream will typically show a *bank height ratio* of less than 1.0.

aquatic habitat – Physical attributes of the stream channel and *riparian area* that are important to the health of all or some life stages of fish, aquatic insects and other stream organisms. Attributes include water quality (temperature, pH), *riparian* vegetation characteristics (shade, cover, density, species), stream bed *sediment* characteristics, and *pool*/*riffle* spacing**.**

backwater – An area in or along a stream where water has been held back by an obstruction, constriction or dam.

bankfull flow or discharge – typically recurs every 1 – 3 years. These floods are frequent and powerful enough to mobilize *gravel* and *cobble* on the streambed. Bankfull flow is considered most responsible for defining the stream form and is also referred to as channel forming flow.

Bank Erodibility Hazard Index (BEHI) – An index for predicting *erosion potential* on selected stream banks, usually associated with a *monitoring cross-section* for measurement of actual *erosion* rates over time (Rosgen, 1996).

bank height ratio-The ratio of height of bank to *bankfull* height, used in stream assessment to determine whether a stream is stable-bank height and *bankfull* height will be the same in a stable stream.

bar, mid-channel, point, side, lateral, etc. **-** a location within the stream channel in which sediment accumulates occupying a significant portion of the channel (vs.localized *sediment* deposits behind small obstructions).

base flow –The typical groundwater fed, low flow for a given stream between periods of no rainfall.

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.

berm – A mound of earth or other materials, usually linear, constructed along streams, roads, *embankments* or other areas. Berms are often constructed to protect land from flooding or eroding, or to control water drainage (as along a road-side ditch). Some berms are constructed as a byproduct of a stream management practice whereby stream bed *sediment* is pushed out of the channel and mounded on (and along the length of) the stream bank - these berms may or may not be constructed for flood control purposes; some are simply piles of excess material. These berms often interfere with other stream processes such as *floodplain* function, and can exacerbate flood-related *erosion* or stream *instability*.

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 *sediment*.

boulder – In the context of *stream assessment surveys*, a boulder is stream *sediment* that measures between 256 mm and 4096 mm (about 10 inches to 13.3 feet).

channel, stream– A defined waterway with definite bed and banks, which periodically or continuously contains flowing water.

channel forming flow—see *bankfull* flow.

channelization — The re-alignment of rivers involving straightening, widening, reshaping, entrenching or altering the slope. Often this work is accompanied by stream bank stabilization, grade control or berm construction.

cobble – In the context of *stream assessment surveys*, cobble material is *sediment* that measures between 64 mm and 256 mm (about 2.5 inches to 10 inches).

confluence – The location of the joining of two separate streams, each with its own *watershed*.

corridor—The area of land along a stream between the valley walls including floodplains, riparian areas, and terraces.

convergence – The downstream end of a split channel, where the stream merges back to one channel; the two channels having the same *watershed*.

cross-section (see also monitoring cross-section) – In the context of *stream assessment surveys*, a *cross-section* is a location on a stream channel where stream *morphology* is measured perpendicular to the stream flow direction (as if taking a slice through the stream), including width, depth, height of banks and/or *terraces*, and area of flow.

culvert – A closed conduit for the free passage of surface drainage water. In Chestnut Creek, culverts are typically used by the Town and County 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 main Chestnut Creek stream. Culverts are also used by landowners to route roadside drainage ditch water under their driveways to reduce or prevent *erosion*.

degradation – The process by which a stream *reach* or channel becomes deeper by eroding downward into its bed over time, also called "*downcutting*", either by periodic episodes of bed scouring without filling, or by longer term transport of *sediment* out of a *reach* without replacement. A degrading stream will typically show a *bank height ratio* greater than 1.0.

demonstration stream restoration project (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.

destabilized (see also instability, unstable) – Describing a section of stream that has been made *unstable*, by natural or human activity.

discharge (stream flow) – The amount of water flowing in a stream, measured as a volume per unit time, usually cubic feet per second (cfs).

discontinuous floodplains (see also floodplain) – A series of small *floodplains*, formed as a series of small benches along stream banks. These *floodplain* features, typically seen in steeper mountain streams, are not connected sequentially following the valley floor, but still provide the critical *floodplain* functions of reducing water *velocity* and enhancing *sediment* deposition and infiltration (water sinking into the ground rather than running straight to the stream).

downcutting—see *degradation*

drainage area – see *watershed.*

dumping site – For the purposes of the stream assessment survey, these are areas in the stream or on the *floodplain* where refuse or other non-natural or non-biodegradable materials were documented. A dumping site is not necessarily an actively used area, and may be the result of material washing downstream.

embankment – A linear structure, usually of earth or *gravel*, constructed so as to extend above the natural ground surface. Similar to a *berm*, but usually associated with *road fill* areas, and extending up the hillside from the road, or from the stream up to the road surface.

entrenched – In stream classification (see s*tream type*), entrenchment (or entrenchment ratio) is defined by stream *cross-sectional* shape in relation to its *floodplain* and valley shape, and has a specific numerical value that in part determines stream type. For example, if this number is less than 1.4, the stream is said to be highly entrenched, if between 1.4 and 2.2 it is mildly entrenched, and greater than 2.2 it is not entrenched. Entrenchment ratio is used with other stream shape data to determine *stream type*, and define baseline data for future *monitoring* (Rosgen, 1996).

ephemeral– Referring to a stream that runs only in direct response to rain and whose channel is above the water table.

equilibrium (see also stable) – The degree to which a stream has achieved a balance in transporting its water and *sediment* loads over time without aggrading (building up), degrading (cutting down), or migrating laterally (eroding its banks and changing course).

erosion - The wearing away, detachment, and movement of the land surface (*sediment*), by running water, wind, ice, or other geological agents, including such processes as gravitational creep or *slumping*. In streams, erosion is a natural process, but can be accelerated by poor stream management practices.

erosion potential – The amount of *erosion* that may be expected under given climatic, topographic, soil, and cultural conditions.

fascines – A *bioengineering* method using bundles of small branches of willow or other *riparian* tree species, tied together and laid into shallow trenches along a stream to stabilize and revegetate stream bank areas.

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 by 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*. Vegetation on floodplains greatly improves their functions.

floodplain connection—the stream's ability to access the land area adjacent to its active *channel* during higher flows in order for the stream system to function properly and dissipate energy or *velocity*.

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

gabions – Large wire-mesh baskets filled with rock material used to *harden* or *stabilize* road *embankments* and sometimes stream banks.

Geographic Information System (GIS) - Desktop software with a graphical user interface that allows loading and querying, analysis and presentation of spatial and tabular data that can be displayed as maps, tables and charts. The maps in the Chestnut Creek stream management plan were produced with a GIS, and can be updated as new information becomes available.

geomorphic— Pertaining to the form of the earth or of its surface features.

Global Positioning System (GPS) - A satellite based positioning system operated by the U.S. Department of Defense (DOD). When fully deployed, GPS will provide all-weather, worldwide, 24-hour position and time information.6 The *stream assessment survey* done for the Chestnut Creek stream management plan included the use of a GPS unit to document the locations of all mapped stream features. This information was added to the *GIS* to produce the maps.

gravel – In the context of *stream assessment survey*, gravel is *sediment* that measures between 2 mm and 64 mm (about 0.08 inches to 2.5 inches).

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.

head-cut – A marked change in stream bed slope, as in a step or waterfall, that is unprotected or of greater height than the stream can maintain. This location, also referred to as a knick point, moves upstream, eventually reaching an *equilibrium* slope.

headwater– the uppermost portion or beginnings of a stream.

hydraulic—Relating to the flow or conveyance of water through a channel; movement or action caused by water.

impervious surface – A surface which will not permit water to pass through, such as concrete or asphalt.

inboard – Referring to a roadside ditch that is between the road and adjacent hillside, on the higher or uphill side of the road.

incised - The lowering of the streambed due to downcutting and removal of bed material by the stream, referring to a stream that has degraded such that the *bank height ratio* is greater than 1.0.

instability (see also unstable) - An imbalance in a streams capacity to transport *sediment* and maintain its channel shape, pattern and profile.

invasive plants – Species that aggressively compete with and replace native species in natural habitats.

Japanese Knotweed (see also invasive plants) – An *invasive plant*, not native to the Catskill region, that colonizes disturbed or wet areas, especially stream banks, road-side ditches and *floodplains*. This plant out-competes natives and other beneficial plants, and may contribute to *unstable* stream conditions.

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

leaching – The process by which chemical or mineral materials are removed from a physical *matrix* (such as soil, or mixed *sediment* materials) by water running through and creating a solution of those chemicals.

left bank – The left stream bank as looking or navigating downstream. This is a standard used in *stream assessment surveys*.

mass wasting –The fall or slide of a hillslope which results in the rapid or slow movement of soil organic debris and rock down slope. See *erosion*.

matrix – The framework material within which other materials are lodged or included. For example, *cobbles* could be embedded in a matrix of *sand* and fine *gravel*.

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

meander – Refers both to a location on a stream channel that is curved (a "meander bend"), and to the process by which a stream curves as it passes through the landscape (a "meandering stream").

meander width ratio—The quantitative expression of confinement (lateral containment of rivers) and is determined by the ratio of belt width/*bankfull* width.

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

monitoring cross-section – For the purposes of the Chestnut Creek stream management plan, this is a location where metal rebar rods have been used to permanently locate an actively eroding stream bank. At this site, detailed data have been gathered to document the stream condition. The site is permanently marked to enable future measurements that, when compared to the existing condition, provide information about the stream's change. Measuring change over time is considered '*monitoring*,' and this information provides early warning to stream managers about important but perhaps visually imperceptible changes in the stream.

monumented – Refers to a location, usually a *cross-section*, that is marked with a permanent or semi-permanent marker, or "monument", to enable future *monitoring* at the same place.

morphology, stream morphology – The physical shape, or form, of a landscape or stream channel, that can be measured and used to analyze stream or landscape condition, type or behavior.

multiflora rose (see also invasive plants) – An *invasive plant*, not native to the Catskill region, that colonizes disturbed or wet areas such as fields, forest edges, stream banks, and roadsides. This plant spreads quickly and forms impenetrable thickets that exclude native species. It impedes succession and out competes other plants for soil nutrients.

native material – *Sediment* material with a local or on-site source, as in material pushed up out of a stream channel to armor the banks.

non-quarried, or natural boulders – *Boulder*-sized rock material, either *native* or imported material, not harvested from a quarry. This material has been used in the past in stream bank stabilization, usually harvested directly from the stream or from nearby hillsides.

nutrient – The term "nutrients" refers broadly to those chemical elements essential to life on earth, but more specifically to nitrogen and phosphorus in a water pollution context. In a water quality sense nutrients really deal with those elements that are necessary for plant growth, but are likely to be **limiting** -- that is, where used up or absent, plant growth stops.

pathogen – Disease-causing agent, especially microorganisms such as bacteria, protozoa, and viruses.

planform –Horizontal stream pattern, including sinuosity, meander radius, and belt width, as seen in plan view (from above).

pool – A small section of stream characterized by having a flat or nearly flat water surface compared to the average *reach* slope (at low flow), and deep and often asymmetrical *cross-sectional* shape.

perennial -A stream that runs all year long, regardless of precipitation patterns.

reach – A section of stream with consistent or distinctive *morphological* characteristics.

reference reach, stable reference reach – 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 – Any structural measure undertaken to stabilize a road *embankment*, stream bank or hillside.

riffle – A small section of stream characterized by having a steep water surface slope compared to the average *reach* slope (at low flow), and a shallow and often uniform *cross-sectional* shape.

right bank – The right stream bank as looking or navigating downstream. This is a standard used in *stream assessment surveys*.

riparian (area, buffer, vegetation, 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.

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* control.

road fill (see also *embankment*) – Typically *gravel*- and *sand*-sized material used to elevate the level of the road, control the road grade, or provide a buffer for the road grade from stream *erosion*.

runoff – The portion of precipitation (i.e., rainfall) that reaches the stream channel over the land surface.

sand – In the context of *stream assessment surveys*, sand material is *sediment* that measures between 0.063 mm and 2 mm (up to 0.08 inches).

sediment, stream bed 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 deposition (in the stream bed or on the *floodplain*).

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

silt – In the context of *stream assessment surveys*, silt material is *sediment* that measures between 0.0039 mm and 0.063 mm.

sinuosity - The ratio of stream length to valley length, or the ratio of valley slope to channel slope.

slump – The product or process of mass-wasting when a portion of hillslope slips or collapses downslope, with a backward rotation (also a rotational failure).

stable (see also equilibrium) – A stable stream is defined as maintaining the capacity to transport water and *sediment* loads over time without aggrading (building up), degrading (cutting down), or migrating laterally (eroding its banks and changing course). Stable streams resist flood damage and *erosion*, and provide beneficial *aquatic habitat* and good water quality for the particular setting.

stability – In stream channels, the relative condition of the stream on a continuum between *stable* (in *equilibrium* or balance) and *unstable* (out of *equilibrium* or balance). Stream stability assessment seeks to quantify the relative *stability* of stream *reaches*, and can be used to rank or prioritize sections of streams for management.

stacked rock wall – A *boulder revetment* used to line stream banks for stabilization. Stacked rock walls can be constructed on a steeper angle than *rip-rap*, so they take up less of the stream *cross-section*, provide a wider road surface, and provide less surface area for solar heating, allowing stream temperature to remain cooler relative to banks lined with *rip-rap*. These features can be augmented with *bioengineering* to enhance *aquatic habitat* and *stability* functions.

stage – In streams, stage refers to the level or height of the water surface, either at the current condition (i.e., current stage), or referring to another specific water level (i.e., flood stage).

stream assessment, stream assessment survey – The methods and summary information gathered in a stream *reach* or series of *reaches*, primarily focused on stream *morphology*. Stream assessment for the Broadstreet Hollow included detailed characterization and mapping of stream channel patterns, *cross-section* shapes and slope.

stream flow (discharge) – The amount of water flowing in a stream, measured as a volume per unit time, usually cubic feet per second (cfs).

stream stability restoration (design, project) – An *unstable* portion of 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 (that is, to a shape that may allow the stream to transport its water and *sediment* load over time without dramatic changes in its overall shape).

stream type – As defined by Rosgen (1996), one of several categories defined in a stream classification system, based on a set of delineative criteria in which measurements of channel parameters are used to group similar *reaches*.

substrate— The bottom material of a waterway.

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 – *Sediment* carried in the water column (above the stream bed), including *clay*, *silt* and sometimes fine *sand*. These materials contribute to *turbidity*.

terrace – A level area in a stream valley, above the active *floodplain*, that was deposited by the stream but has been abandoned as the stream has cut downward into the landscape. These areas may be inundated (submerged) in higher floods, but are typically not at risk in more common floods.

thalweg – The line followed by the majority of the stream flow. 1 In *stream assessment*, this location is used as a reference location for surveys and other measurements, and is most often associated with the deepest point in the stream *cross-section* (stream channel that would still have water flowing in it at even the lowest flow conditions).

toe – The bottom, or base, of a stream bank or *embankment*.

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. Streams with high turbidity are often referred to as being "turbid".

unstable (see also instability) – Describing a stream that is out of balance in its capacity to transport *sediment* and maintain its channel shape, pattern and profile over time.

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

watershed – A unit of land on which all the water that falls (or emanates from springs) collects by gravity and runs off via a common outlet (stream).

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

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winter base flow—Stream discharge primarily from groundwater (not from surface runoff)—see *summer base flow*-- Winter base flow is generally higher due to lower rates of evapo-transpiration during vegetative dormancy.

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VII. Appendices

A. Stream Assessment 2001 summary of Stream Type data.

B. Draft Watershed Assessment Protocol, NYCDEP.

C. PAC Project Site ranking questionnaire.

D. PAC Project Site ranking results.

E. Chestnut Creek Demonstration Restoration Project Site Report.

1. Location map for Town Hall Demonstration Restoration Project Site, 2003.
2. Cornell Soil Sample Nutrient Analysis Results, Town Hall planting site, Neversink, NY.
3. Catskill species Planting List.
4. Topographic survey of Project Site.
5. "As Built" Planting Plan.

F. Chestnut Creek Demonstration Restoration Project Site Planting Plan and Eroded Bank specifications.

G. Riparian Buffer Monitoring Plan for the Town Hall Demonstration Restoration Site.

Chestnut Creek Stream Assessment Survey, 2001 - Summary of Data							
LP stn	Feature break	Distance (feet)	Cross Sections included	Notes	Slope	Stream type	Management Unit/Reach #
0-123	tp to tp	123'	1,2		0.039	E4b	MU1/ R 1
123-136	tp to tp	13'	3		0.110	A3a+	MU1/ R2
136-167	tp to tp	31'	4		0.021	B4	MU1/ R 3
167-186	tp to tp	19'	5		0.044	F4a	MU1/ R 4
186-199	tp to tp	13'	6		0.041	C4b	MU1/ R 5
199-381	tp to tp	182'	7,8,9,10		0.068	B4a	MU1/ R 6
381-404	tp to tp	23'	11		0.047	A3	MU1/ R 7
404-430	tp to tp	26'	12		0.071	E3a	MU1/ R 8
430-450	tp to tp	20'	13		0.030	F3b	MU1/ R 9
Begin Curry							
0-437	tr to tr	437'	16-19	Begin Curry	0.0044	E5	MU2/R1
437-853	tr to tr	416'	20,22,23,24,25		0.0043	C5	MU2/R2
853-879	tr to tr	26'	26		0.0004	E5	MU2/R3
879-1540	tr to tr	661'	27,27.5,28,29,29.5,29.6,32,33,34		0.0081	C4	MU2/R4
1540-1596	tr to tp	56'	34.5		0.0105	F4	MU2/R5
1596-2327	tp to tp	731'	35.5-42		0.014	C4	MU 3/R-1
2327-2426.5	tp to tp	99.5'	43/44		0.018	B4	MU 3/R-2
2426.5-2665.5	tp to tp	218.5'	45	top of dam	0.016	C4	MU 3/R-3
2665.5-2887	tp to tp	330'	46,47	btm of step	0.039	F4b	MU 3/R-4
2887-3198	tp to tp	391.5'	48,49		0.037	B1	MU 3/R-5
3198-3281	tp to tp	83'	50		0.021	C4b	MU 3/R-6
3281-3311	tp to tp	30'	51		0.029	F4b	MU 3/R-7
3311-3501	tp to tp	220'	52		0.027	B4	MU 3/R-8
3501-3591	tp to tp	90'	53		0.020	F4b	MU 3/R-9
3591-3713	tp to tp	122'	54		0.023	C4b	MU 3/R-10
3713-3885	tp to tp	172'	55		0.030	F3b	MU 3/R-11
3885-3972	tp to tp	87'	56		0.020	B4	MU 3/R-12
3972-4003	tp to tp	31'	57		0.030	F4b	MU 3/R-13
4003-4353	tp to tp	350'	58,59,60,61,62,63	Bedrock Control-cascade	0.038	B1a	MU 4/R-1
4353-4515	tp to tp	162'	64,65	BEHI 2 cascade	0.058	B1/4a	MU 4/R-2
On Scott Brook Tributary	tp to tp	at 4500 LP sta.	66	BEHI 1 Scott Brook	N/A	F	Tributary
4515-4552	tp to tp	37'	67		0.033	B4	MU 4/R-3
4552-4931	tp to tp	379'	68,69,70	BEHI 3	0.022	F3b	MU 4/R-4
4931-5423	tp to tp	492'	72,73,74,75		0.034	B3	MU 4/R-5
5423-5693	tp to tp	270'	76,76.5,76.6,76.7,77	Slater Bridge/Culvert	0.030	F3b	MU 4/R-6
5693-6312	tp to tp	619'	78,79,79.1,79.2,79.3,80,81	includes Scheirer/Botsford Bridge	0.024	F3b	MU 4/R-7
6312-8668	tp to tp	2356'	82,180,180.5,181,182		0.027	B	MU 4/R-8
8668-9094	tp to tp	426'	182.5, 183		0.024	Fb	MU 4/R-9
On Claryville, unnamed trib	tp to tp	bxs extent of bridge	96,97,98,99	Claryville Bridge and Tributary	N/A	F/B	Tributary
9094-9740	tp substrate change	646'	HG01,83,84,101,102, 85	Kelly Bridge	0.015	F1/F3	MU 4&5/R-10&1

Chestnut Creek Stream Assessment Survey, 2001 - Summary of Data							
LP stn	Feature break	Distance (feet)	Cross Sections included	Notes	Slope	Stream type	Management Unit/Reach #
9740-10215	tp substrate change	447'	86, 87, 88		0.025	B3	MU 5 / R-2
10070-10652	tp substrate change	582'	89, 90, 104		0.020	F3	MU 5 / R-3
10652-10761	tp substrate change	109'	105,106	Includes Mohrs Bridge	0.020	B3	MU 5 / R-4
10761-11036	tp substrate change	275'	107		0.015	F3	MU 5 / R-5
11036-11370	tp substrate change	334'	cxs01		0.020	B3	MU 5 / R-6
11370-12028	tp substrate change	658'	108, 109, 110, 111, 112	Includes Clark's Bridge (111 not surveyed)	0.010	F1/F4	MU 5 / R-7
12028-12979	tp substrate change	951'	xs-1, 112.5, 113, 114, 115		0.020	B1/B4	MU 5 / R-8
12979-13331	tp substrate change	352'	116		0.015	F1/F3	MU 5 / R-9
13331-14663	tp substrate change	1332'	117,117.1,117.3,118,119,120,121	Includes Hilltop Bridge	0.020	B1/B3	MU 5 / R-10
14663-14910	tp substrate change	247'	122		0.020	F3	MU 5 / R-11
14910-17836	tp substrate change	2926'	123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134.135,136,BEHI 7, BMX 3		0.020	B3	MU 5 &6/ R-12&1 Break below Covered Brg
17836-18377	tp to tp	541'	137,138,139		0.02	C3	MU 6 / R-2
18377-19273	tp to tp	896'	141,144,145,147,148		.01 / .02	B3c	MU 6 / R-3
On Bullet Brook Tributary	tp to tp	at 18314 LP sta	140	On Bullet Brook	N/A	C	Tributary
19273-19594	tp to tp	312'	149		0.014	F3	MU 6 / R-4
19594-20081	tp to tp	487'	150,151		0.017	B3c	MU 6 / R-5
20081-20350	tp to tp	269'	152,153		0.012	F3	MU 6 / R-6
20350-21216	tp to tp	866'	154,155	monumented xs 0301-0303-behi @ xs 0303	0.015	F3/B3c	MU 6 / R-7
21216-21812	tp to tp	596'	159,160		0.017	F1 / 3	MU 6 / R-8
21812-22358	tp to tp	546'	160.5,161,162		0.013	B3c/B1c	MU 6 / R-9
22358-22772	tp to tp	414'	163,164,165		0.013	F1/ 3	MU 6 / R-10
22772-23339	tp to tp	567'	168,168.5		0.016	B3c	MU 7 / R-1
23339-23702	tp to tp	363'	169.5,170,171	BEHI DEP 1	0.009	C3	MU 7 / R-2
23702-23837	tp to tp	135'	172	BEHI DEP 2	0.023	B	MU 7 / R-3
23837-25258	tp to tp	1421'	173		0.014	C	MU 7 R-4
On Red Brook Tributary	tp to tp	N/A	174		N/A	C	Tributary
25258-25569	tp to tp	311'	175		0.006	F	MU 7 / R-5

DRAFT

Watershed Assessment Protocol

NYCDEP Stream Management Program

Prepared by M. A. Vian

v.4.26.02

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Table of Contents

1.0 Introduction

This reconnaissance protocol is intended to aid in the development of subbasin-scale Stream Management Plans by providing baseline information on the condition of the stream system. These plans will summarize assessments and surveys of stream hydrology and hydraulics, the condition of biota in the stream and riparian ecosystem, point- and non-point sources of pollution and flood risks associated with unstable channel morphology. They will also anticipate potential future development within each sub-basin on the basis of local land-use patterns, regulations and landscape conditions, with the goal of providing local decision-makers with information they can use to determine the impacts on community flood risk, ecosystem function and water quality that might result from future development. Finally, these plans will make recommendations on what management strategies and practices might be implemented to remediate current problems, mitigate potential negative impacts of future development, and enhance ecosystem function and quality of life for the local community.

2.0 Purpose

The purpose of this reconnaissance protocol is fourfold. First, it is meant to provide for the field researcher a general inventory of conditions throughout the stream corridor, by defining the focus of observation during the assessment. This baseline inventory may include, but is not necessarily limited to, conditions that affect hydraulic function, particularly sediment transport function (such as bedrock sills and banks, cultural and natural grade controls, berms, and riprap or other revetment placements), potential sources of water quality impairment (especially eroding banks, clay exposures, or exposed septic leach fields or other hazards), "buffer" functionality of riparian vegetation (including locations of functional reference riparian communities, locations where riparian vegetation management is warranted to improve ecosystem function, and occurrences of invasive exotic vegetation of significant consequence to stream stability and ecosystem function), infrastructure (including road crossings, bridge abuttments, culverts and outfalls, and utility lines or poles), and other features such as tributary confluences, springs, wells or diversions. This inventory may be used to define and prioritize further assessment and scope the issues that will be addressed in the management plan.
Second, this protocol is meant to support quantitative and comprehensive verification of the

Rosen Level I geomorphic classification performed in the office prior to field work, and to add field-verified Level II and Level III classification detail to this classification (Rosgen 1996). This classification will allow general management interpretations regarding channel morphology on a watershed-wide basis.

Third, this protocol is meant to provide data to support ground-truthing of subsequent characterization of the vegetative community structure of riparian areas from remotely-sensed data. Characterizing the structure of the riparian vegetation will support analysis of the capacity of the riparian "buffer" to mitigate potentially deleterious water quality impacts from upland land uses. In addition, riparian classification will define the role of vegetation in the cohesion of stream bank soils and the integrity of the stream and riparian ecosystems. This analysis should lead to recommendations for where improvement of buffer functionality might be most critical or effective, and locations of reference riparian vegetative communities within the watershed.

The fourth purpose of this protocol is to support analysis that would determine, for certain reach types and conditions, the extent to which channel geometry and stream bank stability departs from its potential stable form[1]. This will allow determination of locations for which restoration of stable channel geometry is required, or alternatively where bioengineered bank stabilization would be sufficient to reasonably assure future stability. In this regard, the protocol represents a "first cut" to identify where further assessment is warranted, both of potential stable reference reaches and reaches where instability is indicated. Reference reaches will subsequently be surveyed in greater detail and over time to verify their stability and to provide data on the range of values they exhibit in variables such as facet dimensions, Bank Erodibility Hazard Index (BEHI) scores (Rosgen 1996), measures of bed aggradation and degradation, bank erosion rates, and substrate size distribution. Stable channel geometry derived from these reaches can be used in the design of channel stability restoration projects. Unstable reaches will be subsequently surveyed in greater detail to allow comparison to the stable ranges of these same variables

[1] This approach assumes that for any valley setting, a variety of channel morphologies might be found, and that some of these forms, in that setting, convey the range of water and sediment discharges supplied by the landscape in a manner which allows them to maintain their morphology with relatively little change from year to year (stable forms), while others are less effective and are likely to evolve relatively rapidly through a sequence of channel forms due to vertical and/or lateral adjustments (unstable forms). For any valley setting, there are a discrete number of potential stable forms.

exhibited by reference reaches, and among themselves to characterize their relative severity and support the prioritization of their remediation.

This paper presents office, field data collection, data plotting, data analysis, and administrative procedures for conducting this reconnaissance.

3.0 Outcomes

The product of this reconnaissance study is a comprehensive stream corridor map which features:

1) **Continuous delineation of channel morphology**, characterized to Rosgen Level II class types on the mainstem (and, where practicable, on major tributaries) with locations of classification cross-sections;

2) **Locations of hydraulic controls,** including bedrock sills and banks, rip-rap or other revetment, weirs, and bridge abuttments;

3) **Locations of natural and man-made drainage confluences**/divergences, including tributary inlets, springs, stormwater and culvert outfalls, and roadside ditch outfalls, stream diversions and split channels;

4) **Locations of problematic riparian vegetation**, such as stands of invasive species like Japanese knotweed (*Polygonum cuspidatum*)**;**

5) **Locations of transects along which changes in riparian vegetation community structure has been documented** for use in subsequent ground-truthing of office characterization of the riparian buffer using remotely-sensed data (optional);

6) **Locations of eroding banks, with initial classification of bank erodibility hazard;**

7) **Locations of potential reference reach sites** for further assessment and monitoring**;**

8) **Locations of infrastructure within the stream corridor or intersecting the stream channel,** such as bridges and abuttments, road crossings, wells or other utilities**.**

4.0 Procedures

4.1 Office Procedures.

Preparation of base maps. Reference maps (scale approximately = 1:2400) should be prepared prior to field work which can be annotated in the field with the location of features identified. These maps should include:

a. Recent aerial photography.

b. Historic channel alignments from historic aerial photography. Note on maps where these indicate both significant laterally instability and stability (the latter as potential reference reach sites).

c. Elevation contour lines

d. Characterization of significant valley slope and confinement breaks.

i. Valley slope can be calculated from contour line crossings.

ii. Valley confinement can be interpreted from contours, or alternatively, a preliminary estimate of entrenchment ratio can be roughly calculated at regular intervals along the stream to cue field observation of changes in floodplain width. Using 100 yr (or preferably, 50 yr) floodplain boundaries from a flood study, the ratio of floodplain width to bankfull width (as predicted from regionally developed relationships of hydraulic geometry to drainage area) can be calculated. The objective is to cue field observation of changes in floodplain width.

e. Line coverage of the stream network. This coverage should be classified to Rosgen Level I, using the protocol described in "Procedure for Rosgen Level I Stream Classification" (NYCDEP, 2001), attached as Appendix ().

f. Drainage area and expected bankfull channel cross-sectional area, identified from regionally derived hydraulic geometry curves and displayed at:

i) points both immediately upstream and downstream of all significant confluences on the mainstem and major tributaries to be assessed, or

ii) if there is greater than 10% change in drainage area between confluence points, at points identified along the stream network such that there is no more than a 10% increase in drainage area between points, or

iii) at all cross-over reaches, as identified from aerial photography.

Drainage area at these points can be determined through computer-based GIS analysis (as in NYCDEP, 2001 above), by planimeter, or developed manually through delineation of drainage basins on USGS topographic maps, overlaying gridded tracing paper, counting the grid squares in each drainage area, and multiplying the number of grid cells by the area represented by each cell at the scale of the map. Use the most locally-verified hydraulic geometry curves available (describing bankfull channel dimensions as a function of drainage area) to obtain values for the predicted cross-sectional area.[2]

g. Property boundaries, with owners' names.

h. Locations of benchmarks at bridges referenced in bridge surveys. These will be identified in the field, and tied into the longitudinal profile survey and monitoring cross-section resurveys to estimate scour at the bridges.

4.2 Field Procedures

The following field procedures should be performed in a specific sequence. In general, the assessment is conducted in a series of iterative steps, to the detail necessary and practicable given the management objectives and resources available.

The preliminary GPS reconnaissance (Section 4.2.1) is intended to provide sufficient inventory of conditions in the stream corridor to determine 1) the scope and intensity of subsequent assessments, and 2) the general scope of the stream management plan. Following preliminary reconnaissance, the field researcher should analyze the data collected, and divide the study area into preliminary management segments. Integrate this analysis with data available from other agencies and the public into a preliminary report, and request review of the report by partnering agencies, public officials, and area residents to determine the appropriate level and focus of effort for each segment with

[2] For the Catskill Region, see Miller and Davis, 2001.

regard to subsequent assessment and research. The more detailed subsequent components of the protocol can be initially conducted in high priority reaches, or comprehensively, as is appropriate to the geographic scale of the project.

Where further morphological characterization is warranted,[3] it will be useful to first develop hydraulic geometry functions, *specific to the stream under investigation,* describing the relationship of drainage area to bankfull cross-sectional area (See Section 4.2.2b). This function should be created using survey data from reference cross-sections identified for this purpose during the preliminary reconnaissance on the basis of relatively clear bankfull field indicators. Because slope and roughness will influence local cross-sectional area, the longitudinal profile should be surveyed prior to the survey of these hydraulic geometry reference sections, and Wolman pebble counts should be conducted at these locations. These data should also be used in quality control measures in the field identification of bankfull stage at these reference sections (see Section). These data on slope and relative roughness can also be added to the plot of drainage area and cross-sectional area (see Figure XXX), to allow explanation of variation around the regression line in terms of these additional variables.

Add detail on goal of each assessment component.

4.2.1 Preliminary reconnaissance and GPS procedures.

For all locations field-identified using Global Positioning System (GPS) technology, use standard GPS survey practice, (e.g., Leick, 1995). If GPS points are offset from actual features, record compass bearing and distance to feature.

a. Navigate with GPS and/or aerial photography base maps to target area(s)

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[3]There are many management concerns that warrant geomorphic characterization. For a detailed discussion, see Rosgen (1996, chapters 3 and 8), and Dunne and Leopold (1978, chapters 14-18).

identified in office protocol as top of furthest upstream reach to be classified. Monument top of study area if not already monumented. Position monument in a retrievable location, sufficently back into the floodplain such that the monument will not be lost to bank erosion or hidden by deposition. Map the location of the monument on field maps, GPS the monument coordinates and photodocument.

Walking downstream:

b. Establish cross-section locations for Level II classification and record coordinates (see below). Identify and establish temporary monuments or flags at the riffle or step, flag bankfull stage, and identify whether the cross-section will be used as a reference section to construct a stream-specific hydraulic geometry curve (see Section 4.2.2b, below) and label monument / flag with:

i) sequential cross-section numbering (eg., BSHX1, BSHX2...etc.),

ii) indication if the section is a reference section.

c. Record coordinates of stormwater and culvert outfalls, road ditch outfalls into stream.

d. Record coordinates of top and bottom points of hydraulic controls: rock sills and banks, rip-rap placements, weirs, bridge abutments, centers and benchmarks at crossings.

e. Record coordinates of approximate upstream and downstream extents of eroded banks. This can be accomplished with two points or as a line feature recording the upslope extent of the failure or along the bankfull intercept. Document height sufficiently to roughly determine area of exposure; this will be used later to determine if a full survey is warranted at the site. Establish endpoints of cross-section at the failure (see below), monument and record coordinates. Photodocument, ideally with compass bearing. Visually assess the cause of failure, and determine a Bank Erodibility Hazard Index (Rosgen 1996) rating representative of the reach as a whole. Characterize water quality threat, in terms of sources of turbidity. Document approximate distances to structures or infrastructure where a threat is evident.

f. Record coordinates of occurrences of problematic bank vegetation (eg., invasive exotics like Japanese knotweed (*Polygonum cuspidatum*) or locations of insufficient vegetation).

g. Photodocument all GPSed points and identify location on reference maps.

h. Habitat (this section under development)

Following preliminary reconnaissance, analyze the data collected, and divide the study area into preliminary management segments. Integrate this analysis with data available from other agencies and the public into a preliminary report, and request review of the report by partnering agencies, public officials, and area residents to determine the appropriate level and focus of effort for each segment with regard to subsequent assessment and research.

4.2.2 Profile and cross-section survey procedures. Survey both the long profile and cross-sections into a clearly identified common benchmark, preferably point of known elevation. This can be accomplished at bridge crossings along the profile. The profile should include classification cross-section bankfull stage locations and/or endpoint monuments in each of the monitoring cross-sections to tie them into the same reference elevation. Recorded survey data should enable determination of actual elevations, and sufficient notes should be associated with each measurement to clearly identify the feature being surveyed as well as relevant site data. The data recorder should be continually comparing measured data to the observed site condition, and the data recorder should produce field plots as a quality control check. Use standardized survey field sheets to record measurements (see Appendix ( ) for options). Each traverse should include two turning points.

a. Survey longitudinal profile. Beginning at the top of the study area survey elevations of water surface at edge of water. Use thalweg stationing for distance measurements. Survey elevation at:

i. bankfull stage flags

ii. monitoring cross-section endpoint monuments

iii. water surface, at edge of water, at cross-section stations

iv. water surface, at edge of water, at upstream extent of pools

Water surface slope measurements for stream segment classification and quality control calculations using Manning's Equation are taken from top-of-pool to top-of-pool, as a surrogate for energy grade at bankfull discharge. For slope calculations used in stream classification, the reach limits should be chosen to most accurately reflect the energy grade slope through the section being classified. While it is acknowledged that feature boundaries (e.g., riffle/pool transition) may vary somewhat with stage, pools are identified as features with less than reach average slope, and riffles as features with greater than average slope. Further, a pool ideally contains control at downstream end that runs the full width of the channel, so as to create a single water surface elevation across the channel at low flow (but not necessarily perpendicular to flow; i.e., the control can be transverse).

Cross-sections, general. The cross-section should include the entire channel (bank to bank) and the adjacent floodplain and terraces on both sides of the channel, and be established perpendicular to the direction of bankfull flow. The cross-section should extend on both the right and left banks so as to include some area beyond "floodprone stage," which is defined as the elevation at twice maximum bankfull depth (Rosgen 1996), to enable classification based on entrenchment ratio. The suggested sequence is to identify the cross-section location, identify bankfull stage, survey bankfull elevation, survey thalweg elevation, calculate floodprone elevation, identify floodprone stage, establish cross-section endpoints beyond floodprone stage, and survey cross-section.

Survey each cross-section including not fewer than ten stations spaced at major grade breaks. Optional: Record cross-section bearing. Use a standardized cross-section field sheet (see Appendix ( ) for optional electronic data recorder) and follow general guidelines in Harrelson, et al., 1994, Chapter 6. The station and elevation of bankfull stage, current left and right edge of water surface, and thalweg should be surveyed into the cross-section. Photo document.

Select cross section stations that are representative of the feature and the reach, relatively uniform longitudinally and generally symmetrical in cross-section. The frequency of classification cross-sections will depend on the resources available for the effort; where resources permit, every riffle section should be surveyed in riffle/pool streams, and at least every other cross over feature should be surveyed in step/pool streams. If reach classification boundaries are determined subjectively and riffles are skipped, minimally:

i) survey cross-sections at the top and bottom riffles of the reach;

ii) at intervening riffles, determine bankfull width and floodprone width, as described below, to ensure that entrenchment ratios and width/depth ratios have not changed.

In step-pool stream architecture, locate cross-section through the top of the step, where the bed is controlling the pool above, taking care to avoid including bed elevations in the pool above or below the step. Where possible, avoid areas that are affected by debris jams or other channel obstructions, overly wide relative to the rest of the channel, where the planform or profile changes abruptly, or the cross-section is extremely asymmetric or transverse (such that a cross section perpendicular to bankfull flow contains sections in pool features above or below the cross over feature).

Identify bankfull stage using methods described in Harrelson, et al., 1994. Identify bankfull indicators along the reach adjacent to the cross-section. Use similar morphological features to establish the estimated bankfull elevation at the cross-section. Survey cross-section and determine cross-sectional area. Compare to predicted cross-sectional area from regional hydraulic geometry curves.

If cross-sectional area departs more than 50% from the expected regional or local value, estimate velocity using bankfull discharge from applicable regional curves, and evaluate whether the velocity is reasonable (4-12 fps) in the context of local hydraulic and roughness conditions. This percentage may have to be increased for first- and second-order headwater steams, where high upland slopes and thin soils may produce higher runoffs and therefore larger discharges and cross-sectional areas, and where supply of material typically has a larger D50, and the effective discharge is larger.

b. Survey hydraulic reference section cross-sections at thalweg cross-over reaches. These cross-sections are surveyed at locations throughout the sub-basin where field indicators of bankfull stage are relatively clear, and are used to created hydraulic geometry curves specific to the hydrologic regime in that sub-basin that can guide identification of bankfull where field indicators are less clear. They represent a subset of the classification cross-sections (below) and are surveyed following the same subsequent procedures. Prepare a stream-specific hydraulic geometry curve from these surveys before flagging and surveying the cross-sections where bankfull stage is less-easily identifiable.

When plotting the reference hydraulic geometry curves, coding the individual data points on these curves to represent both slope and D50 of the bed material particle size distribution will facilitate interpretation of the variation of bankfull cross-sectional area from the mean. (This will also be useful later at cross-sections locations with poor bankfull stage indicators.) Evaluate the reach for conditions that might explain the residual. For instance, for larger than expected cross-sectional areas, look for:

i) low water surface slope,

ii) high width/mean depth ratio,

iii) high roughness from bed or bank materials, channel form or vegetation

Where the residual cannot be explained by evident hydraulic conditions, re-evaluate identification of bankfull elevation and conduct a Wolman Pebble Count directly at the cross-section following Harrelson, et al., 1994.

During data review for quality control, use the relationships between relative roughness (d/D84) and friction factor (u/u*) and between friction factor and Manning's "n" value, given in Rosgen 1998, pp 188-189, to solve for discharge using Manning's Equation.

Determine the difference between current water surface elevation and bankfull elevation at clear bankfull indicators, and use this as a rough guide in determining bankfull elevation at subsequent cross-sections. Recognize that water-surface slope and bankfull slope can diverge, and that the difference in their elevation will change with changes in drainage area, channel width to depth ratio, roughness, and slope.

c. Survey reach classification cross-sections at thalweg cross-over reaches.

Survey each classification cross-section, recording station and elevation, including not fewer than ten stations spaced at major grade breaks. Record cross-section bearing. Use a standardized cross-section field sheet (see Appendix ( ) for optional electronic data recorder) and follow general guidelines in Harrelson, et al., 1994, Chapter 6. The station and elevation of bankfull stage, current left and right edge of water surface, and thalweg should be surveyed into the cross-section. Photo document.

d. Survey BEHImonitoring cross-sections to determine stress in the near-bank region (SNR) ratio (Rosgen, 1996) using the procedures above, but detailing the bank profile to allow for long-term monitoring of changes due to erosion or failure. At each eroding bank to be monitored, establish two cross-sections:

i) at the longitudinal station where the combined BEHI score and SNR appear to be most extreme (often near the head of a pool) and

ii) at a location that appears to be representative of local bank conditions in general.

For these purposes, SNR ratio is expressed as

$$A_{nb}/A_{bf}$$

where A_{nb} is cross-sectional area in the third of the channel nearest the bank at bankfull stage (determined by dividing bankfull width into thirds), and A_{bf} is total bankfull channel area. A high SNR ratio will, therefore, be evidenced by the most extremely asymmetric channel, where the thalweg is closest to the eroding bank. Establish permanent rebar monuments in a retrievable location on left and right cross-section endpoints and record coordinates. Monuments should be located sufficently back into the floodplain such that they will not be lost to bank erosion or hidden by deposition, and will include at least floodprone stage on both left and right extents.

The bank profile should capture undercut banks, depth of rooted vegetation, sand lenses or other relevant soil or sediment strata, and any other features related to erosion potential. This survey can be accomplished in a number of ways:

i) using a total station and prism;

ii) stretching a tape or cable at a recoverable elevation using control pins on the right and left banks, precisely locating a rod at a recoverable station along the tape/cable near the base of the eroding bank, measuring perpendicularly from the rod back to the bank profile, recording the rod reading at each perpendicular with the distance to each bank feature and the rod height to the tape/cable, and finally converting these measurements to stations and elevations to add into the cross section survey.

f. Measure width between bridge piers and abuttments at bankfull stage. To determine the stage at which to measure distance between piers or abuttments, measure the difference between water surface and bankfull elevations at the cross-sections immediately upstream and downstream of the bridge. Average the two differences and measure this distance up from water surface at the bridge. If bridge construction documents include an as-built survey at the bridge, establish the location of the as-built survey and resurvey the cross-section to determine bed aggradation/degradation since construction.

4.2.3 Bed surface material characteriztion. Perform a modified Wolman pebble count following procedures given in Harrelson, et al., 1994 with the following exceptions:

a. No pebble count is performed on “A” and “Aa” type reaches (where slope> 0.4)

b. For all other stream types, establish reach boundaries using top-of-pool endpoints used in slope calculations. Aggregate adjacent reaches with the same

Level I stream types into a single reach. Divide each reach into ten equal intervals, locate the long profile station at the midpoint of each interval, and measure ten particles along transects spanning the bankfull channel at each of these stations. Alternatively, divide the thalweg length of the reach by 10, define a random start from the top of the reach, and determine stations by adding the interval.

c. Additional 100-count pebble counts should be conducted in riffle areas at all reference sections and BEHI locations with slopes < .02. If resources permit, riffle pebble counts can be conducted at remaining reaches. These data can be used to determine a dimensionless shear stress ratio that characterizes flow competence after Olsen, et al. (1998), defined as

$$J_e = J_o / J_c$$

where J_e = entrainment ratio; J_o = average boundary shear stress and J_c = critical shear stress for the D84 of the bed surface material.

4.2.4 Riparian vegetation characterization ground truthing procedures. Characterize riparian vegetation at randomly selected cross-section locations (the number will depend on the cover types found at each transect; minimally every category of cover should be encountered at least once, categories= forest, shrub/brush, grass, cropped, or impervious). Extend, from the reach classification cross-section, a transect for characterization of riparian vegetation for 50m in both directions from center of channel, with 0-station at center of channel, and record changes in vegetative community type (with station) along the transect starting at the stream bank.

5.0 Analysis

Following quality control verification, the field data derived from the above assessment can compiled analysis using a Geographic Information System, such as ArcView. Figures (X-Y) and Table (x) demonstrate how the data may be displayed and analyzed.

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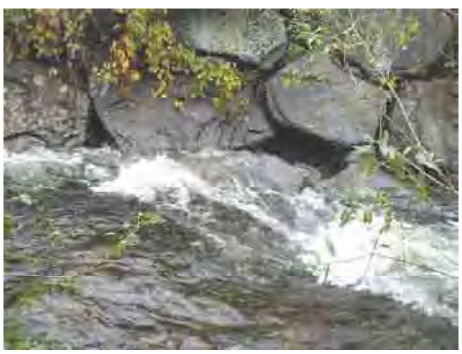
Chestnut Creek Stream Management Project Sites Detailed Descriptions

In November 2002, SCSWCD put together a list and description of potential project sites noted during the 2001 Stream Assessment Survey. The Chestnut Creek Project Advisory Committee (PAC) was asked to vote on these sites to determine a Demonstration Restoration Site for the Stream Management Plan 2003. The following information was sent to the PAC and a meeting held to vote on the project site:

1. Covered Bridge *BIN# 5524660 (abutments reinforced 2003, by Neversink Agricultural Society and Town)*

Crack in downstream right wing wall of Covered Bridge

Crack in upstream right wing wall of Covered Bridge and 14 inch undercut



Split channel with riprap on right bank being undermined upstream of covered bridge, within 20' of Route 55

Description: ***(See Management Unit 5)***

Built as 1976 bicentenial, historically significant, provides access to Fair Grounds,
Scour and erosion along bridge abutment and wingwall (14" undercut)—is this a threat?
1929 map-channel straightened (uncertain when), "cleaned", moved away from road
Upstream trees falling into stream as channel migrates, providing material to constriction flow
1963 aerial photograph shows more sinuous channel than currently
1991Neversink Agricultural Society gained a permit to repair failed abutment
NYSDOT conducts Biennial bridge inspection and Scour report, 2001 bridge failed scour report
Runoff from parking lot scouring behind wooden wingwall

Recommendations:

Complete historical aerial overlay to assess erosion rate and direction, as well as changes in plan form geometry at Covered Bridge, upstream to riprap near tennis courts.
Begin assessment of the bridge and upstream area to determine changes in meander patterns
Potential for "assisted" restoration
Review of existing reports and designs as provided by Town
A W-weir structure could redirect the stream and protect the bridge from future repairs as well as reduce gravel build-up

2. Town Hall Vegetation and Dry Hydrant *(chosen as project site 2003, see Demonstration Project Report)*


Dislodged riprap behind Town Hall


Eroded left bank and lack of vegetation behind Town Hall

Description: ***(See Management Unit 6)***

Located on Chestnut Creek
Minor erosion along left bank near Town Hall Parking
Lack of vegetation and parking area "sheeting action" of rain runoff may affect water temperatures and bank stability
Riprap dislodged – may loose some bank along parking lot
Dry Hydrant not functioning; potentially filled with sediment, and lack of accessible water
Is this the best location for the hydrant since the Town Hall addition?

Recommendations:

Potential assisted restoration project (possible cross vane to reduce bank erosion, provide scour pool for dry hydrant.) This could stabilize the bank and make a dry hydrant viable.
Add bioengineering to increase riparian buffer and anchor existing or replaced riprap

3. **Pepacton Hollow Culvert Overflow (Gaurdrail replaced 2002, newly sized culvert purchased 2003)**

Looking upstream at culvert under Pepacton Hollow Rd.

Erosion under guardrail above outlet end of culvert (2001)

Description: ***(See Management Unit 8)***

Located along Pepacton Hollow Road
Town maintained culvert pipe
Potential for floods that continue to damage the roadway and cause stream channel erosion
Flood water has crested the road and has caused substantial damage on several occasions—most recently in 1997 and 2000
FEMA money has been used to replace the guardrail and resurface the road
Culvert has not been upgraded
Logs jam the upstream culvert invert *(Continued next page)*

Recommendations*:*

Replace culvert with properly sized and angled culvert to fit the bankfull stage height and direction of stream flow. This could avert future rebuilding and maintenance after every high flow event

4. Box culvert under Rt. 42, (off of South Hill Road, on tributary to Red Brook)


Undercut box culvert and scour pool under Rte 42, on tributary of Red Brook

Description: ***(See Management Unit 9)***

Located on a tributary to Red Brook
Downstream end of undercut culvert with deep scour pool
Potentially limiting fish passage
Possibly installed in 1929, no maintenance records obtained for the structure to date
Stream often goes subsurface in the summer months
Small areas of back eddy scour downstream
Operated by NYSDOT--- are there any immediate plans for work in this area?
Possible threat to Route 42

Recommendations:

Set up permanent BEHI monitoring station at culvert outlet to determine rate of scour
Monitor cracking in Route 42 pavement over culvert
Determine bankfull width above and below structure to see if the width is adequate
Determine natural slope of stream without structure present and the change caused by the hanging culvert

5. Head Cut Erosion/ Debris Jam (above Grey's Woodworks)


Head cutting erosion, center island, debris jam near back lot of Grey's Lumber

Description: ***(Management Unit 4)***

Located on Chestnut Creek Along Rt. 55, near Grey's Woodworking
Severe debris jam in channel, split channel around central gravel bar
Evidence of head-cut working upstream through left channel
Flooding issue with upstream landowner, landowner believes area has aggraded

Recommendations:

Begin monitoring the site
Potential removal of blockage and regrading the slope.

6. Mohr's Bridge/ Route 55 (Across from Maschio's Restaurant)


Concrete crib wall along Rte. 55 attached to failing abutment

View looking upstream at Miller's Bridge

Description: ***(Management Unit 5)***

The left bridge abutment is partially undercut and leaning toward the stream channel,
The upstream wing wall is showing signs of erosion
This abutment is directly attached to a concrete wall that lines the left bank near Rte 55
Local NYS DOT is concerned that a bridge failure will affect the highway
There is only one house accessed by this bridge

Recommendations:

An inspection of the structure by the bridge engineer
to determine its safety and anticipated design life.
Possible replacement of structure designed and
built to accommodate the stream flow and protect the road.

7. Scott Brook and Chestnut Confluence

Scott Brook failing bank with fallen trees at Chestnut confluence

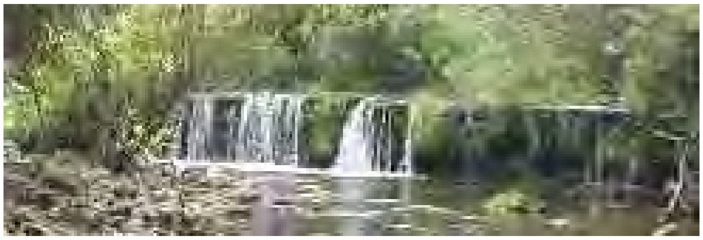
Description: ***(Management Unit 4 at confluence)***

Located on Scott Brook at the confluence with Chestnut Creek
Severely eroded high bank with undercut fallen trees
Potentially large sediment supply available
On private property – no roads or structures threatened
SCSWCD has monumented cross section to monitor bank erosion rate

Recommendations:

Determine rate of erosion from cross section monitoring
Determine if bioengineering can stabilize bank
Determine cause of erosion

8. Davis Lane Bridge *BIN# 3357040* Sewer Crossing



Looking upstream at eroded sewer line structure below Davis Lane Bridge

Description: ***(Management Unit 6)***

A double opening bridge crossing Chestnut Creek at Davis Lane
A stone structure, over a DEP sewer line, is scouring the stream bed downstream (+/-5' drop)
Upstream and downstream of the bridge, the Creek is divided into two distinct channels.
The stream appears to be fairly "stable"
There is well-developed streamside vegetation with mature willow stands
Is this a barrier to fish passage?

Recommendations *(Davis Lane Bridge Sewer Crossing Continued)*:

Sewer line should be reconstructed the proper under the streambed to be in accordance with current standards
Any stream channel work through this area would be best applied during future efforts to repair the bridge structure
A W-weir could be used to aid in directing stream flow properly through the double chambered bridge during high flow events

9. **Route 42 Bridge (adjacent to NYC DEP offices)**


Route 42 bridge Grahamsville, overwidend channel with cobble filling in (right bank) / bridge abutment in main flow of water (left bank).

Description: ***(Management Unit 7)***

Located on Chestnut Creek
Structure had past problems and was re-built in 1991
Landowners reported stream was moved when bridge repaired
Stream thalweg now located along abutment
No current sign of scour or erosion

Recommendations:

Recommend monitoring (use as-built survey to determine aggradation rate)
Model bridge opening with gravel bar for flood risk/damage when maintenance is needed.

10. Eroded Bank on NYCDEP property

Looking downstream at high eroding bank DEP property

Looking at eroding bank with BEHI XS

View from Route 55 top of RB looking Downstream

Description: ***(Management Unit 7)***

Located on Chestnut Creek along Route 55
High bank constructed from tunnel spoils
Stream causing erosion along several hundred feet portion (+40' in height)
Highway along the top of the bank is threatened
Potential source of turbidity/ sediment loading
Well-established adjacent floodplain
Appears stable upstream and downstream

Recommendations being conducted by Sullivan County Soil and Water Conservation District:

Historical aerial overlay to assess erosion rate and direction, as well as changes in plan form geometry
SCSWCD has 2 monumented cross sections in place to monitor erosion rate

Some Possible Solutions:

Move meander to historic location, with installation of natural design structures etc.
Construct a Bankfull bench and use geomorphically-based rock structures to assist channel realignment
Vegetate high bank; stop mowing to edge of fence

Chestnut Creek Project Advisory Committee (PAC) Survey Results November 2002
Demonstration Restoration Site (in order of priority top to bottom):

1. Covered Bridge
2. Town Hall
3. Pepacton Hollow
4. Debris Jam/ headcut behind Grey's Lumber
5. Mohr's Bridge
6. Scott Brook confluence
7. Davis Lane sewer crossing
8. DEP eroded high bank
9. Route 42 bridge on Chestnut Creek
10. Route 42 box culvert on tributary to Red Brook

Chestnut Creek
Town Hall Demonstration Site
Project Report

Sullivan County Soil & Water
Conservation District
64 Ferndale-Loomis Road
Liberty, NY 12754
November 12, 2003

Chestnut Creek-
Town Hall Project Site, 2003

Location of Demonstration/ Restoration site (stream flow left to right)

N

1:1200

60 0 60 120 Feet

Site Description

The Chestnut Creek Demonstration Restoration Project site is located directly behind the Town of Neversink Town Hall, in the hamlet of Grahamsville at 273 Main Street. The Sullivan County Soil and Water Conservation District (SCSWCD) identified a scoured bank that allowed riprap to slip into the channel, which was directing the force of the high flows towards the unstable bank (Photo 1). The left stream bank on the Town's property was also afflicted with an invasive species, multiflora rose. In the Town's effort to remove this species, the bank was left under-vegetated and therefore more susceptible to erosion, increased water temperatures in the stream and pollutants from overland runoff (Photo 2). The bank was also susceptible to re-establishment of multiflora rose. A dry hydrant, which no longer functioned, was located at the site and sat on top of an eroded area (Photo 3). If the bank was left unprotected, it may have continued to scour towards the parking lot. The Project Advisory Committee to the Chestnut Creek Stream Management Program voted this site as a top priority for the location of the Demonstration Restoration site.

Photo 1. Erosion – left bank behind Town Hall. View looking downstream, dislodged riprap visable in right front corner of photo.

Photo 2. Top of bank before construction. Damaged Black Cherry on right, dry hydrant shown in the distance; both were removed.

Site Preparation

In September 2003, SCSWCD staff visited the Town Hall site and removed the existing Multiflora Rose. They accomplished this by digging around the base of each plant and removing as much of the roots and stems as possible. Plants and roots were removed from the site and disposed of in a manner that will prevent them from regenerating. Holes

Photo 3. Dry hydrant behind Town Hall parking lot. View looking toward left bank from center of stream.

Photo 4. Dislodged riprap removed from the creek and keyed into the eroded bank to create a bankfull bench on September 26, 2003.

were filled with topsoil to the original ground elevation. If needed, the site will be assessed for use of DEP-approved herbicides in the spring.

The hollow Cottonwood and dying Black Cherry tree were removed from the site in the beginning of September 2003.

Project Construction

On September 26, 2003 construction at the Town Hall Demonstration Site began. It was not necessary to divert water from the jobsite because construction was occurring mostly on the upper portions of the bank.

1.) A stacked rock wall was constructed of medium sized flat native stones as support under the dislodged rip rap that was relocated.

2.) The dislodged riprap was removed from the creek and keyed into the stream bank horizontally over the stacked

Photo 5. View looking downstream from swale towards stacked rock bankfull bench with new shrubs and native plants.

Photo 6. Swale expanded and filled with cobble; September 26, 2003.

Photo 7. View looking downstream from parking lot. Shows completed swale and planted buffer.

rock wall (Photo 4&5). Soil was placed to build a bankfull bench modeled on the upstream bench at reference monitoring cross-section XS 03-01.

3.) The non-functioning dry hydrant was removed and the bank was graded. An area of about 25' in width was left unplanted for emergency access to the stream at this location.

4.) The existing runoff swale from the parking lot was expanded and filled with cobble four feet in depth to improve percolation from parking area runoff (Photos 6&7).

Photo 9. October 16, SCSWCD and DEP volunteers planting at Town Hall Demonstration

5.) The sod layer along top of bank where the riparian buffer would be planted was removed with the excavator.

6.) On October 14 & 15, 2003 top soil and peat moss was imported to the site as a soil test revealed organic matter at the site was only 1 percent. The remaining vegetation was weeded from the bed and the topsoil/compost was spread and graded (Photo 8).

Photo 8. Topsoil/compost distributed at site. View looking downstream from parking lot; October 15, 2003.

7.) Quick growing rye seed was applied to the lower banks to protect the initial restoration work until sections of the low bank is planted in the spring.

8.) On October 16, 17 & 20, 2003 planting and mulching was conducted on the top of the bank under the supervision of Landscape Architect Barbara

Photo 10. Looking downstream at extent of completed riparian buffer, from just above willow tree. Project ends at tree line property boundary in background.

Restaino. Native trees, shrubs and herbaceous materials were planted on the left bank, adjacent to the Town Hall parking lot, over approximately a 300’ x 10’ to 15’ area, as a riparian buffer (Photo 9). Many volunteers helped prepare this project including AmeriCorps, Natural Resource Conservation Service, Watershed Agricultural Council, SCSWCD, Neversink residents, Catskill Watershed Association, Cornell Cooperative Extension.

9.) As additional native plants that were hard to locate have arrived through October, they have also been planted.

10.) All of the planted vegetation was sprayed with an organic deer repellent, which will serve as an invisible fence through the winter.

11.) Ample rainfall throughout the month has kept the plants well watered, and although there have been several frosts, the temperature have remained mild, giving the young plants a chance to establish their roots.

Photo 11. Looking upstream towards River Road Bridge at extend of completed riparian buffer, from just below willow tree. Project ends by Norway Spruce before picnic table in background.

Operation and Maintenance

Under the Operation and Maintenance Agreement signed by Town of Neversink, NYC DEP, SCSWCD, the SCSWCD will maintain the riparian buffer and associated stream bank work for three years after installation is complete. This will include replacement or modification as needed to maintain and/or repair stream bank rock and bench work for three years after installation due to acts of nature. SCSWCD shall also monitor the success of the entire project for a period of three years after installation. After the first 3 years have lapsed from project installation, the Town of Neversink will assume ownership of maintenance.

According to the O&M signed on September 30, 2003, the NYC DEP will provide funding and technical assistance for replacement or modification as needed to maintain and/or repair stream bank rock and bench work for three years after installation due to acts of nature *(barring such actions as human negligence)*. NYC DEP also agrees to provide funding to maintain the riparian buffer vegetation, including purchase of supplemental vegetation needed to complete the project during the spring 2004, and mulch for the first three years.

Cornell Nutrient Analysis Laboratories

New York State College of Agriculture and Life Sciences • A Statutory College of the State University
804 Bradfield Hall, Cornell University, Ithaca, NY 14850 • Telephone 607/255-4540 FAX 607/255-1644

I D E N T I F I C A T I O N

LAB ID	SAMPLED	RECEIVED	REPORTED	COUNTY	BAG #	SAMPLE ID	AGENTS PHONE
6872-29 (N)	/ /	09/09/03	09/12/03	SULL	268842	CHESTNUTCR	(845)292-6180

A D D R E S S E S

REPRESENTATIVE	GROWER	COOPERATIVE EXTENSION AGENT
PETER CAREY CCE OF SULLIVAN CTY 64 FERNDALE-LOOMIS RD LIBERTY NY 12754	SULLIVAN CO SOIL & WATER CONS 64 FERNDALE-LOOMIS RD LIBERTY NY 12754	MARIANNA QUARTARARO CCE-SULLIVAN COUNTY 64 FERNDALE-LOOMIS ROAD LIBERTY NY 12754

B A C K G R O U N D I N F O R M A T I O N

SITE	CROP	TURFGRASS	TREES AND SHRUBS	AMENDMENTS
Environment: MOST SUN	Crop Code: PER	Species :	Age/ht/dia: 0/ 8/ 0	Manure Type:
Drainage : EXCEL	Variety : ALG & SAG	Cut Height:	Location : UNF. LAWN	Manure, #/M:
Texture : SANDY	Recommend: PREPLANT	Clippings :	Top Prune : NONE	Compost, in:
Topography : PLAIN	Month : 9	Irrigation:	Tree Type : FULL SIZE	Lime, #/M :
		Irr. Rate :	Growth :	Sulfer, #/M:

S O I L T E S T R E S U L T S

		Very Low - Low + - Medium + - High + Excess
pH	6.3	***
PHOSPHORUS (P #/A)	13	**
POTASSIUM (K #/A)	65	*****************************
MAGNESIUM (Mg #/A)	65	**
CALCIUM (Ca #/A)	1480	***********************************

Aluminum (Al #/A):	21	Zinc (Zn #/A):	7.8	Salts (mmho/cm):	0.070
Iron (Fe #/A):	2	Organic Matter (%):	1.1	Salts (K x 100000):	7
Manganese (Mn #/A):	38	Nitrate (NO3-N #/A):	11		

L I M E A N D F E R T I L I Z E R R E C O M M E N D A T I O N S

CROP: PERENNIALS (PER)

-------- Recommendations per acre --------		----- Recommendations per 1000 sq ft ------		---- Recommendations per 100 sq ft ----	
Lime (T/A):	0	Lime (#/M):	0	Lime (#/100 SQ FT):	0
Nitrogen (N #/A):	90-110	Nitrogen (N #/M):	2.1-2.5	Nitrogen (#/100 SQ FT):	0.21-0.25
Phosphate (P2O5 #/A):	70	Phosphate (P2O5 #/M):	1.6	Phosphate (#/100 SQ FT):	0.16
Potash (K2O #/A):	200	Potash (K2O #/M):	4.6	Potash (#/100 SQ FT):	0.46

CLIENT COMMENTS: PLANT MID-SEPT ASAP W/ PER & SHRUBS/LRG TREES FLOO

1ST YEAR. PERENNIALS (PER)

1. IF AN ANALYSIS RESULT IS NOT REFFERED TO SPECIFICALLY IN THE RECOMMENDATIONS OR COMMENTS THEN LEVELS ARE CONSIDERED NORMAL.
2. ALWAYS WATER IN SEED OR PLANTS AFTER SOWING OR PLANTING.
3. APPLY 2 LB OF 10-10-10 PER 100 SQ FT OF GARDEN. RAKE IN.
4. CONSIDER INCORPORATING COMPOSTED MANURE TO INCREASE ORGANIC MATTER IN SOIL

Abbreviation key: lb = pound, # = pound, T = tons, A = acres, M = 1000, N = nitrogen, and SQ FT = square feet.

Maintain a good sampling program and keep a record of all nutrient analyses and recommendations.

PLANT LIST

KEY	BOTANICAL NAME	COMMON NAME	#	SIZE
		TREES AND SHRUBS		
AL	AMELANCHIER LAEVIS	SERVICEBERRY/SHADBUSH	1	7 - 8'
CC	CERCIS CANADENSIS	EASTERN REDBUD	1	8 -10'
CA	CLETHRA ALNIFOLIA	SUMMERSWEET	14	3 GAL.
CF	CORNUS X CONSTELLATION	FLOWERING DOGWOOD HYB.	1	7 - 8'
CS	CORNUS SERICEA	RED OSIER DOGWOOD	8	5 GAL.
IV	ILEX VERTICILLATA	WINTERBERRY	6	5 GAL.
LB	LINDERA BENZOIN	SPICEBUSH	1	5 GAL.
QB	QUERCUS BICOLOR	SWAMP WHITE OAK	1	8 -10'
RA	RHUS AROMATICA 'GRO-LO'	AROMATIC SUMAC	7	3 GAL.
SC	SALIX COTTETII	DWARF WILLOW	11	3 GAL.
		GRASSES AND FERNS		
AP	ADANTIUM PEDATUM	MAIDENHAIR FERN	12	1 GAL.
CL	CHASMANTHUS LATIFOLIA	RIVER OAT GRASS	21	2 GAL.
MS	MATTEUCHIA STRUTHIOPTERIS	OSTRICH FERN	20	2 GAL.
OR	OSMUNDA REGALIS	ROYAL FERN	30	2 GAL.
OC	OSMUNDA CINNAMONAE	CINNAMON FERN	20	2 GAL.
PV	PANICUM VIRGATUM	SWITCH GRASS	30	3 GAL.
PA	POLYSTICHUM ACROSTICHOIDES	CHRISTMAS FERN	12	1 GAL.
		SHADE AREA WILDFLOWERS		
CP	CLEMATIS PANICULATA	SWEETAUTUMN CLEMATIS	2	1 GAL.
DC	DICENTRA CUCULLARIA	DUTCHMAN'S BREECHES	10	1 QT.
DE	DICENTRA EXIMA	WILD BLEEDING HEART	12	1 QT.
GM	GERANIUM MACULATUM	CRANESBILL	15	PLUGS
IC	IRIS CRISTATA	CRESTED IRIS	30	RHIZOMES
PR	POLEMOMIUM REPTANS	CREEPING JACOBS LADDER	10	1 QT.
PF	POLYGONATUM FALCATUM	SOLOMON'S SEAL	20	RHIZOMES
TC	TIARELLA CORDIFOLIA	FOAMFLOWER	15	1 QT.
		MEADOW /STREAMSIDE WILDFLOWERS		
AT	AMSONIA TABERNAEMONTANA	BLUE MILKWEED	50	PLUGS
AN	ASTER NOVAE-ANGLIAE	NEW ENGLAND ASTER	25	PLUGS
BA	BAPTISIA ALBA	WHITE FALSE INDIGO	30	RHIZOMES

CR	CAMPANULA CORDIFOLIA	ROUNDLEAVED BELLFLOWER	30	PLUGS
CG	CHELONE GLABRA	TURTLEHEAD	30	PLUGS
EF	EUPATORIUM FISTULOSUM	JOE-PYE WEED	50	RHIZOMES
HD	HELIANTHUSDIVARICATUS	WOODLAND SUNFLOWER	40	RHIZOMES
IR	IRIS VERSICOLOR	BLUEFLAG IRIS	100	RHIZOMES
---	LILIUM SUPERBUM	TURK'S CAP LILY	50	BULBS
LS	LOBELIA SIPHILITICA	GREAT BLUE LOBELIA	40	PLUGS
LC	LOBELIA CARDINALIS	CARDINAL FLOWER	20	PLUGS
MD	MONARDA DIDYMA	BEEBALM	60	RHIZOMES
MF	MONARDA FISTULOSA	WILD BERGAMOT	30	RHIZOMES
PH	PHYSOSTEGIA VIRGINIANA	OBEDIENT PLANT	40	RHIZOMES
PM	PHLOX MACULATA	MEADOW PHLOX	20	PLUGS
RL	RUDBECKIA LACINATA	CUTLEAF CONEFLOWER	50	PLUGS
TP	THALICTRUM PUR. 'ALBA'	MEADOW RUE	25	PLUGS
VN	VERNONIA NOVEBORACENSIS	NEW YORK IRONWEED	30	PLUGS

Chestnut Creek
Town Hall
Demonstration Site
Planting Plan and Eroded Bank Repair Specifications

Sullivan County Soil & Water
Conservation District
64 Ferndale-Loomis Road
Liberty, NY 12754
September 9, 2003

Chestnut Creek
Town Hall Demonstration Site

PROJECT NARRATIVE

I. Site Description

The proposed project site is located directly behind the Town of Neversink, Town Hall that is in the hamlet of Grahamsville at 273 Main Street. A scoured bank has allowed rip rap to slip into the channel, which is now directing the force of the high flows towards this unstable bank. The left stream bank near on the Town's property has also been afflicted with an invasive species, multiflora rose. In the Town's effort to remove this exotic species the bank has been left under-vegetated, and therefore more susceptible to erosion, increased water temperatures in the stream and pollutants from overland runoff. The bank may also be susceptible to re-establishment of multiflora rose, a highly competitive invasive species, unless proper care is taken. If the bank is left unprotected, it could threaten the parking lot as it continues to scour and fail.

II. Project Description

A. Project Goals:
The goal of this proposed project is to restore the low bench that was scoured near the dislodged rip rap, by rebuilding a "bankful bench" in this area. This will be done in conjunction with planting native flora, used as bioengineering, that will stabilize the stream bank, provide a bio-filter for overland water flow, along with beautification and an educational forum at the Town's fishing park and amphitheatre.

B. Scoured Bank
The bank stabilization project, approximately 20'+/- length, would involve the building of a bench to repair the eroded area described above. The low, bankful bench will be modeled on the upstream reference XS 03-1, just below River Road Bridge. The existing dislodged rip rap would be used to create a stacked rock wall type structure infiltrated with topsoil. The channel shape and slope would match the adjacent cross sections for bankfull width and area. A quick-growing annual cover grass will be used on the new bank to help stabilize and protect it over the winter and until spring floods recede and the bank can be planted with more permanent vegetation.

C. Riparian Buffer
Native trees, shrubs and herbaceous material will be planted on the left bank, adjacent to the Town Hall, over approximately a 300'x 10' to 15' area, as a riparian buffer. This bioengineering will help stabilize the stream bank. An added benefit to this project is that the vegetation will act as a biofilter, whereas the roots and organic matter filter runoff water from the paved surfaces, before it runs into the stream. This native vegetation will also enhance the park-like setting of the Town Hall for the Town of Neversink.

D. Educational Aspects
The project, located in the center of Grahamsville, will be designed based on natural river processes and planted with species that are native to the Catskill Region and North East

in order to provide an educational function to the site. Small signs identifying the plants species accompanied by an informational pamphlet will be developed in cooperation with the Town and the DEP. The Catskill Center, in their yearly Stream Watch program with the TriValley School, will be working on incorporating this site into their curriculum for stream assessment and monitoring, as well as instruction on proper care required for stream side habitat.

III. Project Time Frame

The bankful bench, at the worst eroded area, is planned for construction during the 2003 field season. It is projected that stream bank work will take place in September during the period between the 12^{th} and the 30^{th} and seeded with a cover crop immediately to protect the bank.

The initial planting shall be done between September 2003 and December 2003. Additional planting material are being ordered now, to be secured for supply materials required for a timely supplemental spring planting (before June 2004). This will offset the costs and insure that the required plant material will be available. Species identification signs will be designed and installed with the associated informational pamphlet by June 2004.

Chestnut Creek
Town Hall Demonstration Site

Project Schedule for Eroded Bank

1.) Water to be diverted away from jobsite as necessary

2.) A stacked rock wall constructed of medium sized flat native stones will be constructed as support below dislodged rip rap

3.) Dislodged rip rap will be keyed into stream bank horizontally over stacked rock wall and soil will be placed to build bankfull bench modeled on the upstream bench at reference monitoring cross-section 03-1.

4.) Rip rap to be reinstalled vertically along lower face of bench, keyed in to match the existing bench upstream.

5.) Perform seeding with quick growing rye upon completion of project to protect initial restoration work and perform bioengineering (VRSS, willow plantings, etc.) tasks in fall and spring.

Chestnut Creek
Town Hall Demonstration Site
Riparian Buffer
Tree, Shrub and Herbaceous Plant Establishment

1.) SITE PREPARATION: This shall consist of eradication of all existing multi-flora rose on the site. The multi-flora rose has been cut down by the Town and yet is still viable and growing. The following method will be used to assist:

> Dig around the base of each plant and remove as much of the roots and stems as possible. Plants and roots shall be removed from the site and disposed of in a manner that will prevent them from regenerating. Holes shall be filled with topsoil to the original ground elevation. If needed, the site will be assessed for use of DEP-approved herbicides in the spring

2.) Dead or dying and invasive trees will be cut and removed from the site (1 Black cherry, 1 Cottonwood).

3.) All shrubs shall be live containerized stock of minimum 2-3 gallon size. Trees shall be live containerized stock minimum 5 feet tall. Herbaceous material will be obtained in both 2" plugs, potted and seeds. Quantities shall be as listed on site plans.

4.) Trees and shrubs shall be planted in clusters according to the attached plan layout. Individual shrubs shall be planted on an average of 5-10 feet apart in each cluster. Quantities shall be as listed on site plans.

5.) Herbaceous material will be planted in clusters at a distance appropriate to provide for optimal spacing required for the individual plant at maturity (minimum 6" for smaller species). Quantities shall be as listed.

6.) Planting holes shall be dug to a minimum of twice the diameter of the individual containers or root balls. Plants shall not be buried below the level of the top of the root mass. All plastic containers, strings, and wire shall be removed prior to plant placement in the hole. Holes shall be backfilled using original soil minus any large stones and debris. Organic matter in the form of compost and/or topsoil will be adding where deemed necessary. The site will be mulched to hold moisture and protect from frost damage.

7.) Seeding will be done during dormancy. Due to high water flow this fall, only the top portion of the bank will be planted immediately. The low bank areas will be planted in the late spring (by June 15) as well as planting additional smaller herbaceous plants, as needed to supplement the fall planting.

8.) Small, educational identification signs will be acquired and installed by June 2004 along with the development of the associated informational pamphlet

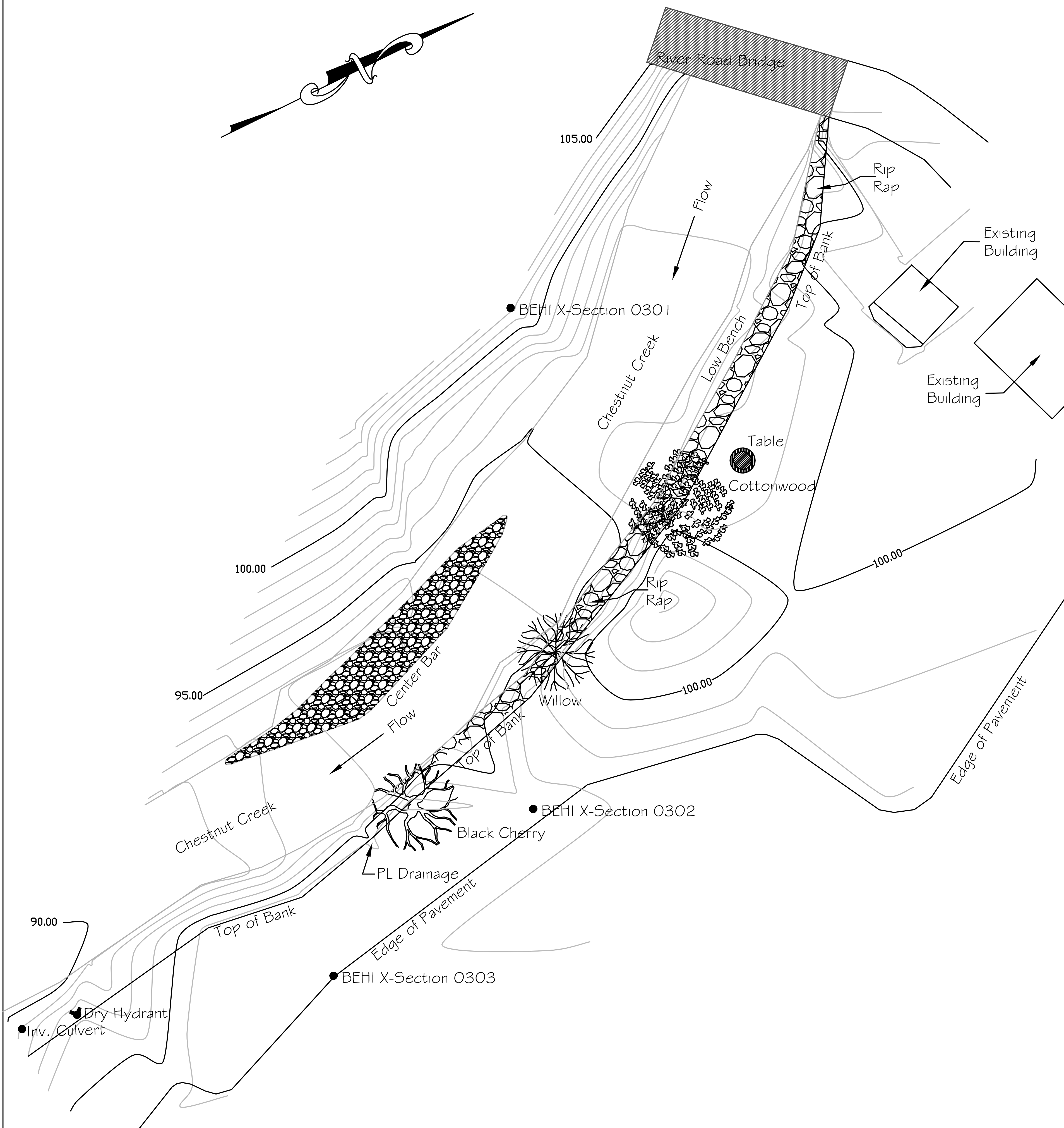
VI. Project Monitoring

Baseline data has been collected at the Town Hall demonstration site. These data include long profile, 3 monumented cross sections (XS 03/1-3), pebble counts, a topographic survey, photo documentation, and existing flora identification. The upstream XS 03-1 is being used as a reference site. A control reach is being sought on the adjacent property just downstream of the restoration site (pending permission).

Upon completion, as-built survey will be conducted and the site will be monitored for a three-year period in accordance with the monitoring plan developed by SCSWCD and approved by NYC DEP SMP. A report on the status of the project will be provided to the DEP and the Town to include recommendations for any modification to management of the riparian buffer or eroded bank.

VII. Project Sponsors

This project is being sponsored by the Sullivan County Soil and Water Conservation District, (SCSWCD), who is serving as the project administrator. Funding for the plant material is being provided through a riparian buffer grant obtained by SCSWCD through WAC. Additional funds and O&M will be supplied through Chestnut Creek Stream Management contract with New York City Department of Environmental Protection, (NYC DEP) the Town of Neversink will contribute equipment and operators through the Highway Dept. upon availability, Geomorphic consultant is Integrated River Solutions of Port Ewen, N.Y., Landscape Architectural Consultant, Barbara Restaino. NRCS and Cornell Cooperative Extension have also provided technical support for this project.



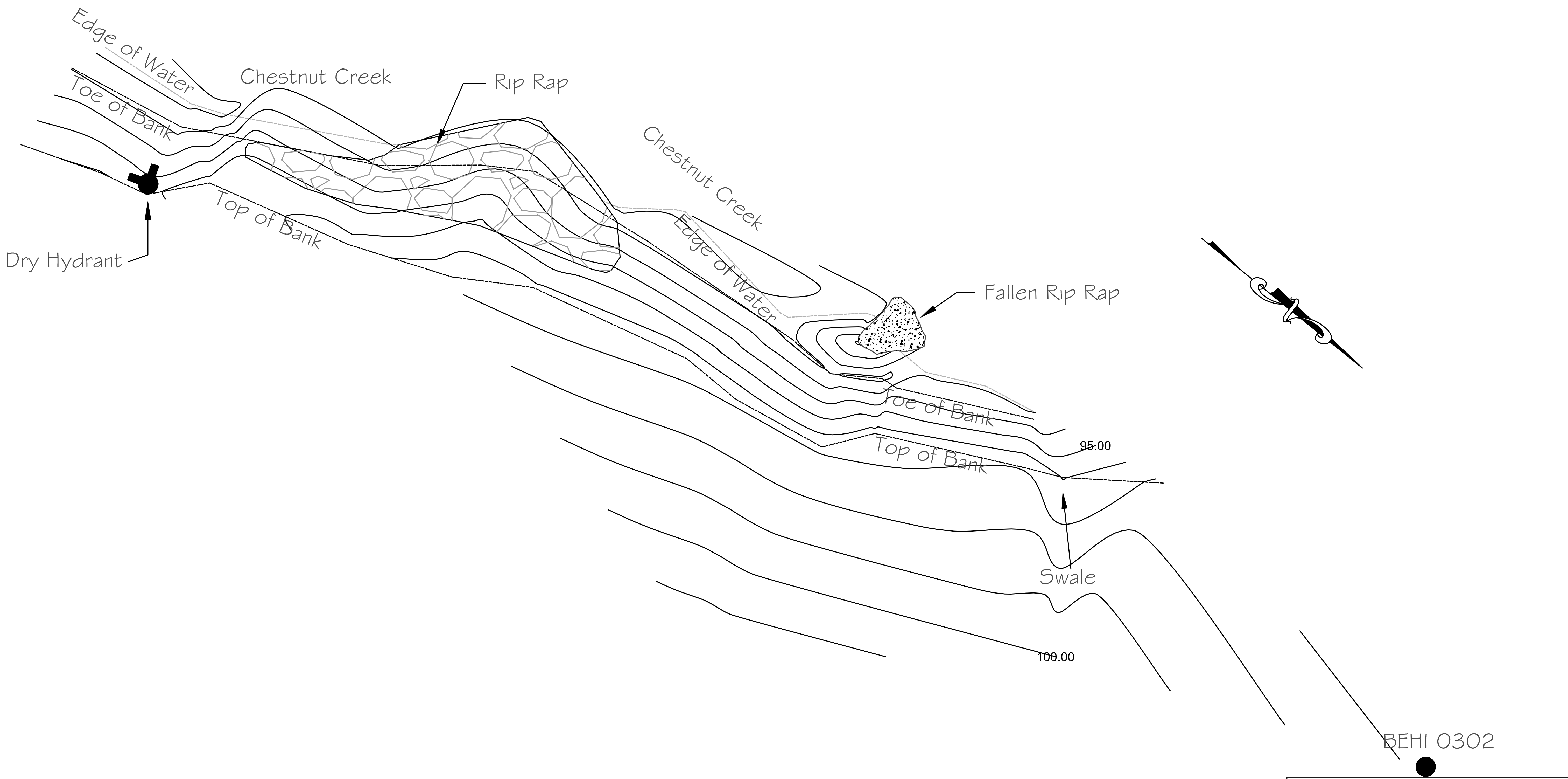
HORIZONTAL SCALE IN FEET

1" = 30'

Chestnut Creek Stream Restoration Project
Town Hall Planting
Sullivan Co., NY

Sullivan County Soil & Water Conservation District

		Date	
Designed	Stream Team	9-03	Approved by
Drawn	BAB	9-03	Title District Manager
Traced			Title
Checked			Sheet No. 2 of ___ Drawing No.



HORIZONTAL SCALE IN FEET
1" = 10'

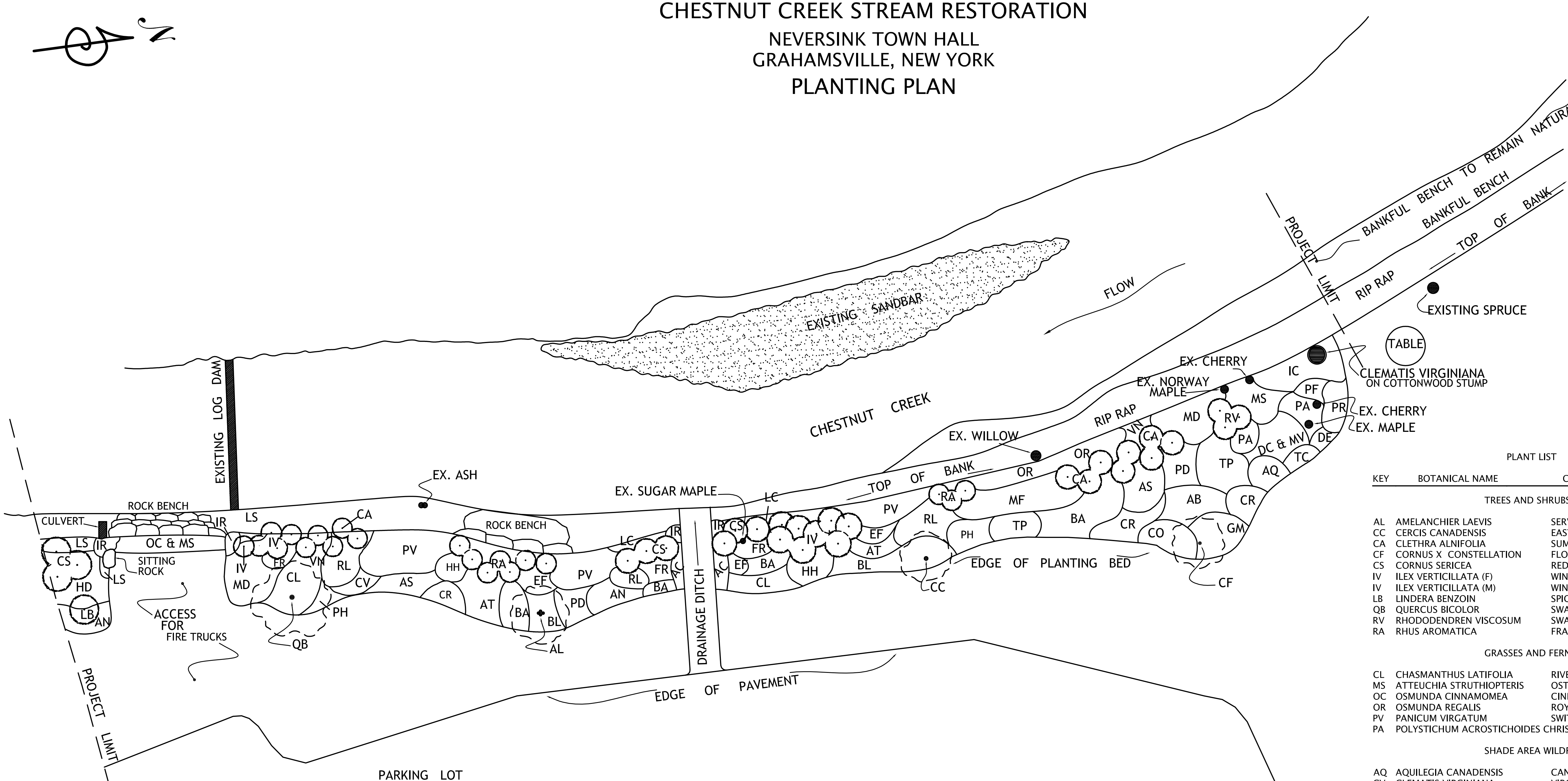
Chestnut Creek Stream Restoration Project
Rip Rap Improvement
Exisiting Site View
Sullivan Co., NY

Sullivan County Soil & Water Conservation District

Designed BAB/LK	Date 9-03	Approved by	
Drawn BAB	9-03	Title District Manager	
Traced		Title	
Checked		Sheet No. 1 of	Drawing No.

CHESTNUT CREEK STREAM RESTORATION

NEVERSINK TOWN HALL
GRAHAMSVILLE, NEW YORK
PLANTING PLAN



PLANT LIST

KEY	BOTANICAL NAME	COMMON NAME	#	SIZE
	TREES AND SHRUBS			
AL	AMELANCHIER LAEVIS	SERVICEBERRY/SHADBUSH	1	7 - 8'
CC	CERCIS CANADENSIS	EASTERN REDBUD	1	7 - 8'
CA	CLETHRA ALNIFOLIA	SUMMERSWEET	14	3 GAL.
CF	CORNUS X CONSTELLATION	FLOWERING DOGWOOD	1	8 - 10'
CS	CORNUS SERICEA	RED OSIER DOGWOOD	9	5 GAL.
IV	ILEX VERTICILLATA (F)	WINTERBERRY	10	3 GAL.
IV	ILEX VERTICILLATA (M)	WINTERBERRY	2	2 GAL.
LB	LINDERA BENZOIN	SPICEBUSH	1	3 GAL.
QB	QUERCUS BICOLOR	SWAMP WHITE OAK	1	8 -10'
RV	RHODODENDREN VISCOSUM	SWAMP AZALEA	3	3 GAL.
RA	RHUS AROMATICA	FRAGRANT SUMAC	12	2 GAL.
	GRASSES AND FERNS			
CL	CHASMANTHUS LATIFOLIA	RIVER OAT GRASS	12	2 GAL.
MS	ATTEUCHIA STRUTHIOPTERIS	OSTRICH FERN	18	1 GAL.
OC	OSMUNDA CINNAMOMEA	CINNAMON FERN	10	1 GAL.
OR	OSMUNDA REGALIS	ROYAL FERN	14	1 GAL.
PV	PANICUM VIRGATUM	SWITCH GRASS	30	1 GAL.
PA	POLYSTICHUM ACROSTICHOIDES	CHRISTMAS FERN	12	1 GAL.
	SHADE AREA WILDFLOWERS			
AQ	AQUILEGIA CANADENSIS	CANADA COLUMBINE	30	PLUGS
CV	CLEMATIS VIRGINIANA	VIRGIN'S BOWER	2	1 GAL.
DC	DICENTRA CUCULLARIA	DUTCHMAN'S BREECHES	10	1 QT.
DE	DICENTRA EXIMA	WILD BLEEDING HEART	12	1 QT.
GM	GERANIUM MACULATUM	CRANESBILL	15	PLUGS
IC	IRIS CRISTATA	CRESTED IRIS	30	RHIZOMES
MV	MERTENSIA VIRGINICA	VIRGINIA BLUEBELLS	20	RHIZOMES
PR	POLEMONIUM REPTANS	CREEPING JACOBS LADDER	10	1 QT.
PF	POLYGONATUM FALCATUM	SOLOMON'S SEAL	13	RHIZOMES
TC	TIARELLA CORDIFOLIA	FOAMFLOWER	22	1 QT.

MEADOW /STREAMSIDE WILDFLOWERS

AT	AMSONIA TABERNAEMONTANA	BLUE MILKWEED	50	PLUGS
AC	ANEMONE CANADENSIS	MEADOW ANEMONE	6	1 GAL.
AS	ASCLEPIAS TUBEROSA	BUTTERFLY WEED	30	PLUGS
AN	ASTER NOVAE-ANGLIAE	NEW ENGLAND ASTER	25	PLUGS
AB	ASTER NOVI-BELGII	NEW YORK ASTER	20	PLUGS
BA	BAPTISIA AUSTRALIS	WILD INDIGO	30	RHIZOMES
BL	BAPTISIA LACTEA	WHITE FALSE INDIGO	30	RHIZOMES
CR	CAMPANULA ROTUNDIFOLIA	ROUNDLEAVED BELLFLOWER	25	PLUGS
CO	COREOPSIS VERTICILLATA	THREADLEAF COREOPSIS	25	PLUGS
EF	EUPATORIUM FISTULOSUM	JOE-PYE WEED	25	RHIZOMES
FR	FILIPENDULA RUBRA	QUEEN OF THE PRAIRIE	10	RHIZOMES
HD	HELIANTHUS DIVARICATUS	WOODLAND SUNFLOWER	40	RHIZOMES
HH	HELIOPSIS HELIANTHOIDES	SUNFLOWER HELIOPSIS	20	RHIZOMES
IR	IRIS VERSICOLOR	BLUE FLAG IRIS	10	1 GAL.
----	LILIUM SUPERBUM	TURK'S CAP LILY	50	BULBS
LC	LOBELIA CARDINALIS	CARDINAL FLOWER	24	PLUGS
LS	LOBELIA SIPHILITICA	GREAT BLUE LOBELIA	24	PLUGS
MD	MONARDA DIDYMA	BEEBALM	24	RHIZOMES
MF	MONARDA FISTULOSA	WILD BERGAMOT	12	RHIZOMES
PD	PENSTEMON DIGITALIS	TALL WHITE BEARDTONGUE	25	PLUGS
PH	PHYSOSTEGIA VIRGINIANA	OBEDIENT PLANT	30	RHIZOMES
RL	RUDBECKIA LACINATA	CUTLEAF CONEFLOWER	50	PLUGS
TP	THALICTRUM SPP.	MEADOW RUE	24	PLUGS
VN	VERNONIA NOVEBORACENSIS	NEW YORK IRONWEED	30	PLUGS

CHESTNUT CREEK STREAM RESTORATION
NEVERSINK TOWN HALL
GRAHAMSVILLE, NEW YORK
PLANTING PLAN

RESTAINO DESIGN, P.C.
LANDSCAPE ARCHITECTS

P.O. BOX 778 TEL: 845-985-0202
GRAHAMSVILLE, NY 12740 FAX: 845-985-0066

DRAWN BY: DCM DATE: 5/3/04 NOT TO SCALE

Monitoring Protocol for Riparian Buffer Planting Projects

A stream restoration project takes time, effort and corresponding funds to carry out. It is important to those involved in the process, as well as those affected by the project, to determine the success of the project. In order to do this, follow up monitoring and data collection must be applied.

Why use a monitoring protocol?

If the decision is made to monitor a project site, a protocol should be designed to ensure the data is collected in a consistent way. It is better to classify data in the field than back in the office to minimize misjudgment. Also, baseline information is key to monitoring, especially number, type, and size of plants. This can be accomplished by filling out a survey immediately after the project has been completed.

Project Summary

The left bank of Chestnut Creek located behind the Town Hall suffers from erosion and failed riprap. The Creek has scoured an area around a large piece of riprap located near the left bank and continues to erode the property. The town uses the area to hold fishing lessons and other leisure activities. A project has been designed to meet the needs of the town as well as preserve the bank from further erosion. The total length of the project is almost 400 feet. A bench will be built on approximately 45 feet of bank downstream of the bridge to create a flood plain. A vegetation restoration project is planned to stabilize bench and surrounding area. The estimated time it will take for the vegetation to provide the desired functions is 3 years. These functions include wildlife habitat, soil and nutrient storage, and decreased erosion. In the first year there is a minimal of 60% survival rate expected.

Monitoring Protocol: Town Hall Project

Reporting Mechanism

Two monitoring sheets have been assembled for the Town Hall site as a reporting mechanism. The first is to be used for the initial survey, which will include a range of site information including slope, soil type, and details about planted and established plants. The second is to be used the following three years by the Sullivan County Soil and Water Conservation District personnel to monitor changing characteristics of the site.

When and How to use the Monitoring Sheets

- The site should be evaluated twice a year (spring and fall) and after high flow events.

- General Description: Record the success of vegetation in stream bank stabilization, soil preservation, etc. Determine visually (compare photographs) or by measuring the bench width to top of bank.

- Evaluate plant growth, diversity, competition, damage and mortality. Use ID codes and place in charts.

- Management Recommendations: Determine what plants should be added in the late fall or early spring. What else could improve the success of the native species; different care, eradicate invasives?

- Protocol Revision Recommendations: If there are problems with the current monitoring strategy place your concerns here.

Riparian Buffer Monitoring Protocol

Project Name:	Town Hall	Date:	
Watershed:	Rondout	Last monitored:	
Project Width:		Township:	Neversink
Project Length:		Team:	

General Description of riparian buffer, stream bank, and stream condition:

Weather:	currently	in last month	in last 6 months
rain			
frost			
snow			
air temp F			

Plot Characteristics

Slope

Aspect South

Soil Type TkA - gravelly loam, 0 to 3 percent slope

CODES

BRUSH COMPETITION (BRUSH)		GRASS COMPETITION (GRASS)	
Code	**Description**	**Code**	**Description**
0	No brush within 2', no shading	0	No sod w/in 2'
1	Brush within 2', shading < 25%	1	Sod w/in 12"
2	Brush within 2', shading 25%-50%	2	Sod w/in 6"
3	Brush within 2', shading > 50%	3	Sod to stem

VEGETATION DAMAGE (DAM)

Code	**Description**	**Code**	**Description**	**Code**	**Description**
ad	animal damage	bl	broken leader	ml	multiple leader
bd	bark damage	cl	crooked leader	ms	multiple stems
bt	bent top	dt	dead top	ot	other
bb	broken stem	di	diseased/sick	rt	rot
bw	browse	dl	dead leader	to	broken top
bc	bud collar damage				

* = code available above. For species list (SPP), refer to "As Built" on attached pages.

SURVEY OF VEGETATION

Zone 1 - Bankful Area

Since this area was not included in the planting, it is not necessary to monitor the vegetation at this time.

Zone 2 - Top of Bank / Floodplain

Wildflowers

*SPP	NUMBER	AVE HT	*BRUSH	*GRASS	*DAM	Alive/Dead?

Grass

*SPP	NUMBER	AVE HT	*BRUSH	*GRASS	*DAM	Alive/Dead?

Shrubs

*SPP	NUMBER	AVE HT	CALIPER	*BRUSH	*GRASS	*DAM	Alive/Dead?

Trees

*SPP	AVE HT	DBH	*BRUSH	*GRASS	*DAM	Alive/Dead?

Other: Weeds and invasives.

SPP	NUMBER	AVE HT	% COVER

Management Practices (how often the site was watered, how often deer repellant was applied, how often the site was weeded)

Management Recommendations (add plants, remove invasives, trim existing, etc.):

Protocol Revision Recommendations (problems with current monitoring strategy):