## 3.4 Riparian Vegetation Issues in Stream Management



Mark McCarroll, 2003

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### 3.4.1 General Concepts of Riparian Vegetation Ecology and Management

**The role of the vegetation in maintaining a healthy stream**

Although people highly value the trees and plants along a stream for their contribution to the beauty of streamside landscape, the vegetation in a watershed, especially in the *riparian area* plays a critical role in providing for a healthy stream system. The riparian plant community serves to maintain the riverine landscape and moderate conditions within the aquatic ecosystem. As rainfall runs off the landscape, riparian vegetation slows the rate of runoff, captures excess nutrients carried from the land, protects the stream banks and floodplain from the erosive force of water, and regulates water temperature changes. The riparian plant community also provides food and cover to the terrestrial and aquatic fauna. Riparian vegetation plays a vital role in conserving soil moisture, ground water and atmospheric humidity.

**Vegetation's erosion and pollution prevention capabilities**

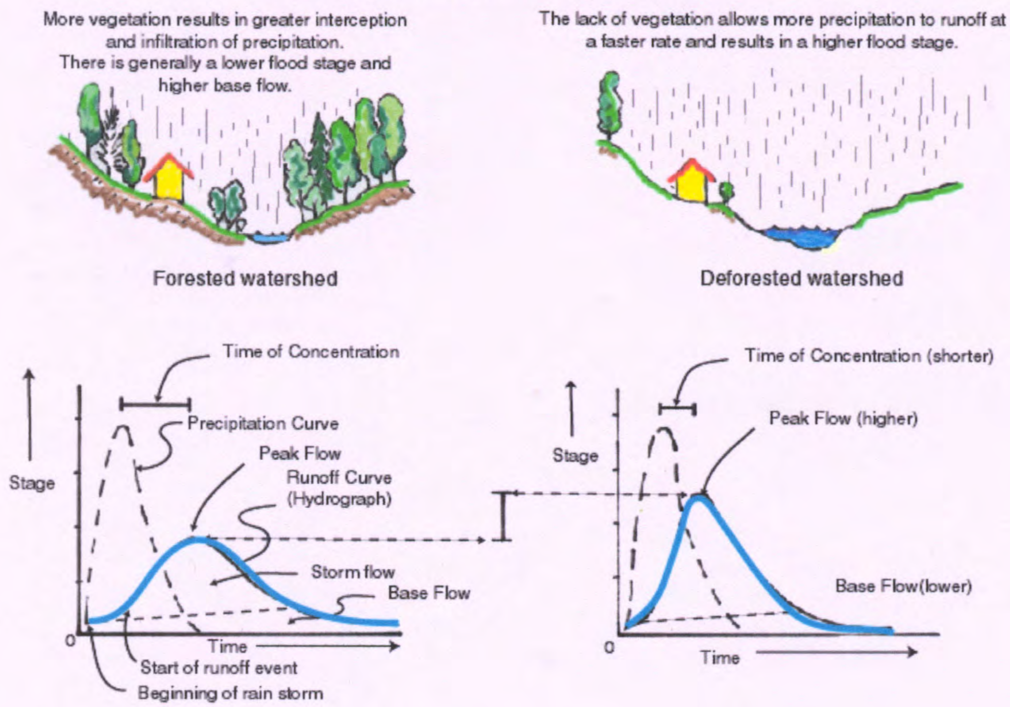
Riparian vegetation serves as a buffer for the stream against activities on upland areas. Most human activities, whether agriculture, development, or even recreation, can result in a disturbance or discharge which can negatively impact the unprotected stream. Riparian vegetation captures and stores pollutants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

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

**Vegetation's hydrologic influences**

Vegetation intercepts the rainfall and slows its runoff. This delay increases the amount of precipitation that infiltrates the soil and reduces overland runoff. This reduction and delay in runoff decreases the occurrence of destructive flash floods, lowers the height of the flood waters, and extends the duration of the runoff event. These benefits are generally most readily observed in forested watersheds like Broadstreet Hollow when compared with similar watersheds where urban development is the chief land use. The reduction in flood stage and duration typically means less disturbance to the stream banks and floodplains.

Figure 1: Comparison of Runoff on a Forested Watershed with a Deforested Watershed




**Ecological importance of vegetation in the riparian zone**

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

**Characteristics of a healthy riparian plant community**

A healthy riparian plant community should be diverse. It should have a wide variety of plants whether there are trees, shrubs, grasses or herbs. The age of the plants should be varied and there should be sufficient regeneration of new plants to ensure the future of the community. A diverse community provides a multitude of resources and the ability to resist or recover from disturbance. An important difference between an upland plant community and a riparian community is that the riparian community must be adapted to frequent disturbance from flooding. Many riparian plants, such as willow, alder, or poplar can regrow from stump sprouts or can reestablish their root system if up ended. Furthermore, the seed of these trees may have a greater ability to germinate and establish in depositional areas, such as gravel bars and lower flood benches.

**Photo 1. A healthy riparian community is densely vegetated, has a diverse age structure and is composed of plants that can resist disturbance**

## 3.4.2 Riparian Vegetation in Broadstreet Hollow

### Forest history and composition in Broadstreet Hollow

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

More recently, human activities have affected the forest either through the manipulation of regeneration for the maintenance of desirable species, the exploitation of the forest for wood and wood products or through development. Native American land management practices included the use of prescribed burning as a means of enabling the nut bearing oaks and hickories to remain dominant in the forest. European settlers contributing to the rising industrial economy in the 18$^{th}$ and 19$^{th}$ century greatly altered the landscape and forest cover through land clearing for agriculture, forest harvesting for construction materials, hemlock bark harvesting for the extraction of tannin. The land cover in Broadstreet Hollow began to revert to forest with the local collapse of these economies in the 20$^{th}$ century and the acquisition of much of the land by the state for the Catskill Reserve (Kudish, 2000).

Today, the Broadstreet Hollow watershed is largely forested. Upland forest cover types transition from the oak-ash-hickory forests at the bottom of the watershed, to a beech-maple forest in the middle elevations, to a maple-beech-birch in the headwaters. Balsam fir forest stands, remnant of the boreal, post-glacial forests and relatively unaffected by exploitation, can still be found at the crest of the watershed ridge. Riparian areas in Broadstreet Hollow are also largely forested, although the continuity of the forest is frequently interrupted by infrastructure, utility lines, residential land use and the remnants of past agricultural landuse.

**The riparian forest**

A riparian forest *community* typically is composed of those plant species that thrive in a wet or moist location and have the ability to resist or recover from disturbance. The riparian forest community generally is more extensive where a floodplain or wetland exists and the side slopes to the valley are more gently sloping. The plant associations found in forested floodplain communities may be exclusive to riparian areas, such as the case with the sycamore stands found at the confluence of Broadstreet Hollow and the Esopus Creek. Where the 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. From the vegetation assessment at Broadstreet Hollow, it was found that northern hardwood communities on steep slopes adjacent to the stream contained a mix of ash, poplar, elm, beech, yellow birch and some maple, whereas in upland northern hardwood communities, the yellow birch and maple became the dominant species. Soils, ground water and solar aspect may create conditions which allow the riparian forest species to occupy steeper slopes along the stream, as in the case where hemlock inhabits the steep, northfacing slopes along the watercourse.

Previous landuse has had a significant role in determining the type of vegetation found along the stream. Due to the steepness of the sides of the valley, the most intensive of development activities were confined to the valley floor along the stream. Pastures and fields were created from cleared forested floodplains. After abandonment, these old fields have experienced a consistent pattern of recovery, with species dominating the initial regrowth including sumac, dogwoods, aspens, hawthorns, and white pine. These species are succeeded by other light loving hardwood tree species such as ash, basswood and elm or in lower parts of the watershed, hickories, butternut, and oak. In various parts of the watershed, over mature orchard trees such as apple or pear can be found in old field regeneration. Hemlocks are largely confined to the steeper stream banks and slopes where cultivation or harvesting of hemlocks for bark was impossible. The large scale reforestation efforts of the 1940's resulted in the conversion of some abandoned farmland to white pine plantation as is evident at the base of Broadstreet Hollow. More recent housing construction has re-intensified activity along the stream and been accompanied by the introduction of non-native vegetation typical of household lawns and gardens.

**Natural disturbance and its effects on the riparian vegetation**

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

The flood of 1996 on Broadstreet Hollow created and reopened numerous high flow channels, reworked point bars, scoured floodplains and eroded formerly vegetated streambanks. Immediately following the flood, the channel and floodplains were scattered with woody debris and downed live trees. In the years since this event, much of the vegetation has recovered. Trees and shrubs flattened by the force of flood waters have re-established their form. Gravel bars and sites disturbed in previous flood events became the seedbed for herbs and grasses. Our recent assessment found numerous sites where young pioneer tree species such as poplar and shrubs like dogwood are succeeding this grass/herb community on gravel bars. This type of natural regeneration is possible where the stream is stable and the major flood events occur with sufficient interval to allow establishment. The effect of flood disturbance on the vegetation along stable stream reaches is short term and the recovery/disturbance regime can be cyclical. If the disturbance of floods and ice floes are too frequent, large trees will not have the opportunity to establish. Typically, the limit that trees can encroach upon the channel is defined by the area disturbed by the runoff event that achieves bankfull flow (expected to occur on average every 1.3 years). While shrubs like willow and alder, which reestablish themselves quickly after disturbance from stem and root sprouts, can grow in the bankfull channel, it is unadvisable to plant trees in this channel area.

Local geology and stream geomorphology may complicate the recovery process. A number of sites were found in Broadstreet Hollow where vegetation has not be able to reestablish itself on the high, steep bank failures created during the 1996 flood event. On these sites it will be necessary to understand the cause of the failure before deciding on whether to attempt planting vegetation to aid in site recovery. In these instances, the hydraulics of the flowing water, the morphological evolution of the stream channel, the geology of the stream bank, and the requirements and capabilities of the vegetation must be considered before attempting restoration. Since the geologic setting on these sites is partially responsible for the disturbance, the period required for natural recovery of the site would be expected to be significantly longer unless facilitated by restoration efforts.

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

Pests and diseases which attack vegetation can also affect changes in the ecology of the riparian area and could be considered a disturbance. The hemlock woolly adelgid (*Adelges tsugae*) is an insect which feeds on the sap of hemlocks (*Tsuga spp*.) at the base of the needles causing them to desiccate and the tree to take on a greyish color. The stress caused by this feeding can kill the tree in as little as 4 years and take up to 10 years where conditions enable the tree to tolerate the attack (McClure, 2001). This native insect of Japan was first found in the U.S. in Virginia in 1951 and has spread northward into the Catskills including Broadstreet Hollow (Adams, 2002).

**Photo 2. Hemlock woolly adelgid on the underside of a branch.**

In the eastern United States, the adelgid attacks eastern hemlock (*Tsuga canadensis*) and Carolina hemlock (*Tsuga carolinianna* Engelman) and can affect entire stands of hemlock. Once a tree is infested, population trends for the insect are typified by a fluctuating density of the insect with some hemlock regrowth occuring in periods when population densities are lower. This regrowth is stunted and is later attacked as the adelgid population increases. With each successive attack the reserves of the tree become depleted and eventually regrowth does not occur. The native predators of hemlock woolly adelgid have not offered a sufficient biological control, but recent efforts to combat the insect include the experimentation with an Asian lady beetle (*Pseudoscymnus tsugae* Sasaji). which has 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/

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

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

**Human disturbance and its effects on the riparian vegetation**

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

<u>Roadway and Utility line influences on riparian vegetation</u>
Due to the narrow valley and steepness of the sides of the valley, the alignment in Broadstreet Hollow Road closely follows the stream alignment. Approximately 85 percent of the road is within 60 feet of the stream. The use and maintenance of the roads impact the vigor of the riparian vegetation. From the vegetation assessment it was noted that where the road is close to the stream(less than 50 feet), the riparian vegetation is less vigorous. These narrow buffers receive the runoff of salt, gravel, and chemicals from the road that stunt vegetation growth or increase its mortality. Road maintenance activities also regularly disturb the soil along the shoulder and on the road cut banks. This

disturbance fosters the establishment of undesirable invasive plants. The linear gap in the canopy created by the roadway separates the riparian vegetation from the upland plant communities. This opening also allows light into the vegetative understory which may preclude the establishment of shade loving plants such as hemlock.

Utility lines parallel the roadway and cross the stream at various points requiring the utility company to cut swaths through the riparian vegetation at each crossing. Utility companies keep the vegetation cut, often to the ground, along the right of way. Although the right of way of the road and utility line sometimes overlap, at several locations along the stream, the utility right of way does not always run parallell with the road right of way, sometimes crossing through riparian areas. This further reduces the vigor of riparian vegetation and prevents the vegetation from achieving the later stages of natural succession.

Residential development influence

Residential landuse and the development of new homes can have a great impact on the watershed and the ecology of the riparian area. Houses require access roads and utility lines that frequently have to cross the stream. Homeowners, who 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. Following this clearing, the stream bank begins to erode, the stream becomes over-widened and shallow. The wide, shallow condition results in greater bedload deposition and increases stress on the unprotected bank. Eventually the stream alignment may change and begin to cause stream migration on the property of downstream landowners. Catskill stream banks require a mix of vegetation having a range of rooting depths such as grasses and herb which have a shallower rooting depth, shrubs with a medium root depth, and trees with deep roots. Grasses alone are insufficient to maintain bank stability in steeply sloping streams such as the Broadstreet Hollow.

Many people live close to the stream and have access to the water without destabilizing the bank. By carefully selecting the route from the house to the water's edge and locating the access at a point where the force of the water on the bank in high flow is lower, a landowner can minimize the disturbance to the 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.html A list of native trees and shrubs "Native Trees for Riparian Buffers in the Upper Connecticut River Valley of New Hampshire and Vermont" developed by this group is provided as an Appendix to this document.

Invasive plants and riparian vegetation

Sometimes the attempt 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). The spread of Japanese knotweed (*Fallopia japonica*), an invasive plant gaining a foothold in Broadstreet Hollow, is an example of a plant capable of causing such a disruption. As its common name implies, Japanese knotweed's origins are in Asia and it was brought to this county as an ornamental garden plant. This plant spreads rapidly on disturbed sites and finds the moist, open conditions of the stream edge and bank as a preferred site for colonization. After establishing itself on a site, Japanese knotweed will shade out the existing vegetation and form dense stands along the bank. The primary concern with this plant is that it will reduce the ability of a stream bank to resist erosion. Although the impact of a Japanese knotweed invasion on the ecology of the riparian area is still not fully understood, this plant may also displace other life dependent on the native vegetation for shelter, food or cover.

**Photo 3. Broad heart shaped leaf pattern of Knotweed**

It is believed that Japanese knotweed spreads primarily by vegetative means. Often, small portions of the roots are transferred in fill or soil that gets dumped on a stream bank by earthmoving contractors, highway department crews or gardeners. These roots then grow into a new plant which soon becomes a colony. Once in the riparian area, high flows scouring the bank may spread portions of the root downstream where it establishes new colonies on disturbed sites or sediment deposits. The above-ground portion dies back each fall and re-grows to a height of 6- 9 feet tall each spring. The canopy of the dense stands of bamboo-like stalks, covered by large heart shaped leaves, blocks out almost all light from reaching the soil, thereby shading out other plants and leaving the soil bare.

Japanese knotweed is very difficult to control. The use of herbicides, while partially effective, is not a viable option due to the threat the chemicals pose to water quality and the fragile aquatic ecosystem. Mechanical control, by cutting or pulling, is labor intensive and requires regular attention to remove any regrowth. Biological controls are untested. The first step for residents and those who manage land and infrastructure in Broadstreet Hollow is to familiarize themselves with the appearance and habits of knotweed. Next, it is important for landowners and land managers to monitor its spread. Landowners should avoid practices which would destabilize the stream banks or weaken the natural riparian vegetation which can prevent its spread. Any fill material introduced to the riparian area should be tested for the presence of Japanese knotweed. Any Japanese knotweed roots pulled or dug up from your property should be disposed of in a manner that will prevent it from spreading or re-establishing itself.

NYC DEP and Greene County Soil and Water Conservation District are supporting a review by Hudsonia of the state of the knowledge on Japanese knotweed with the intent to develop management recommendation for its future control.

### 3.4.3. Assessment of the Current Condition of Riparian Vegetation in Broadstreet Hollow

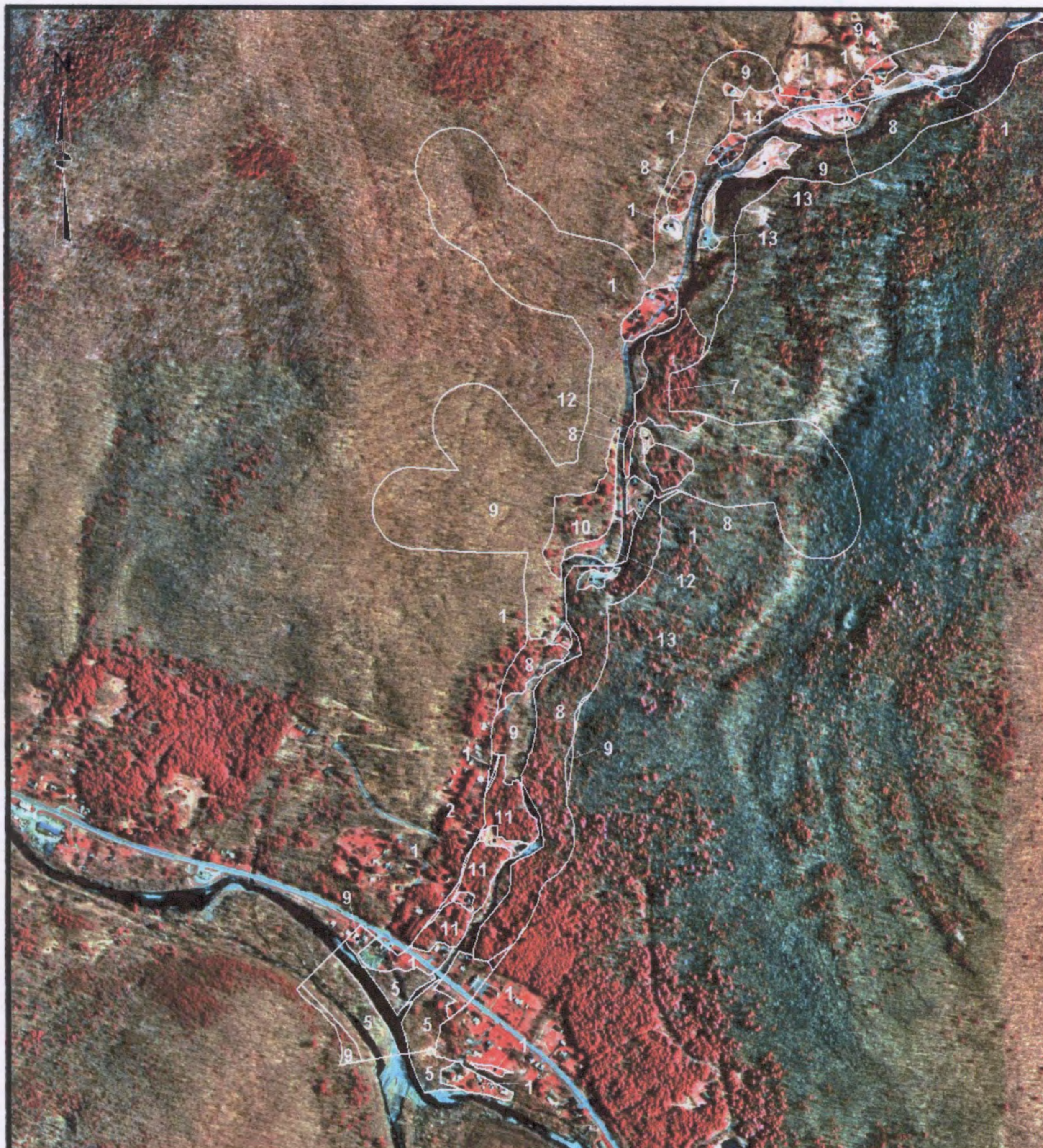
As part of the stream management planning process, ecological communities were mapped and the riparian vegetation assessed for the Broadstreet Hollow watershed. The purpose of this exercise was to provide the planning team with baseline information about the ecological communities present in the watershed, a description of the functional condition of the vegetation in the riparian area, and recommendations related to the management of the riparian vegetation along the stream.

#### Mapping of ecological communities and land use

Mapping of the ecological communities was loosely based on the classification, Ecological Communities of New York State, Second Edition (NYSDEC, 2002), produced by the New York Natural Heritage Program of the NYS Department of Environmental Conservation. The mapping was confined to the riparian and near adjoining upland areas within 300 feet of the mainstem of the Broadstreet Hollow and the Timberlake tributary. This classification was selected because it:

- defines the structure of the community (whether the community is made up of grasses, shrubs or trees),
- describes the stage of successions ( provides information about the evolution of the community),
- enables the mapping of communities that have been significantly altered, such as lawns and pastures,
- informs users about the capacity of the vegetation to provide for a stable stream environment, and
- specifically defines ecological communities as they are found in New York State.

The mapping exercise included the approximate delineation of the communities through the photointerpretation of infra-red digital orthophotography acquired by New York State in the mid-1990's. An ecological community GIS data layer was created using heads-up digitizing techniques with ESRI’s Arcview and Image Analyst softwares. The photo interpretation was field checked with community boundaries and classification amended based upon field observations. The results of the classification are shown the set of maps shown on the next two pages.



# Figure 2. Ecological Communities and Land Use (Lower Watershed)

Delineation of ecological communities from photo interpretation of color infra-red digital orthophotography (1994-99 series) with a 1 meter ground resolution. Verified through a windshield survey and the functional condition assessment Fall 2002.

**Broadstreet Hollow**

300 0 300 600

Feet

Ecological communities (and land use)

| | | | |
|---|---|---|---|
| 1 | residential/commercial | 9 | n. hardwood (hwd) |
| 2 | lawn | 10 | pine/n. hwd |
| 3 | impervious surface | 11 | pine plantation |
| 4 | lawn/ imp. surface | 12 | successional n. hw |
| 5 | floodplain forest | 13 | suc. old field |
| 6 | bare ground | 14 | suc. shrubland |
| 7 | hemlock | 15 | water |
| 8 | hemlock/n. hardwood | 16 | sewage treatment |


# Figure 3. Ecological Communities and Land Use (Upper Watershed)

Delineation of ecological communities from photo interpretation of color infra-red digital orthophotography (1994-99 series) with a 1 meter ground resolution. Verified through a windshield survey and the functional condition assessment Fall 2002.

## Broadstreet Hollow

300 0 300 600

Feet

Ecological communities (and land use)

1 residential/commercial
2 lawn
3 impervious surface
4 lawn/ imp. surface
5 floodplain forest
6 bare ground
7 hemlock
8 hemlock/n. hardwood
9 n. hardwood (hwd)
10 pine/n. hwd
11 pine plantation
12 successional n. hw
13 suc. old field
14 suc. shrubland
15 water
16 sewage treatment

Summary of Findings

The table following the maps shows the summary of the area and percent of the total area for each ecological community identified within 300' and within 50' of watercourses of the watershed. The northern hardwood forest type (1200 acres) and the northern hardwood forest associated with hemlock forest (75 acres) are the largest communities followed by the residential landuse (40 acres). If only the area within 50 feet of the stream is considered then the relative proportion of each community in the area does not change dramatically. This predominance of the hardwood forest cover helps to provide a high degree of stability to the watershed. Storm runoff is slowed by the forest cover and the stream banks in much of the watershed have some woody vegetation to protect against bank erosion. Protection of the forest communities near the stream will help ensure long-term stream stability. Residential landuse and the development of new homes do not appear so extensive that it can cause widespread stream system instability.

**Table 1. Summary of Area and Percent of Area for Each Ecological Community Within 300 and 50 feet of the Stream**

| | 300 foot buffer | | 50 foot buffer | | |
|---|---|---|---|---|---|
| **Ecological Community** | **Area (acres)** | **Percent of Total Area** | **Area (acres)** | **Percent of Total Area** | **Difference (50'-300')** |
| northern hardwood | 1197 | 87.7% | 202.7 | 88.4% | +0.7 |
| northern hardwood /hemlock | 75 | 5.5% | 15.1 | 6.6% | +1.1 |
| residential | 41 | 3% | 4.4 | 1.9% | -1.1 |
| floodplain forest | 12 | 0.9% | 0.9 | 0.4% | -0.5 |
| pine plantation | 9 | 0.7% | 0.8 | 0.3% | -0.4 |
| pine/n. hwd | 8 | 0.6% | 3.0 | 1.3% | +0.7 |
| successional old field | 8 | 0.6% | 0.8 | 0.3% | -0.3 |
| hemlock forest | 6 | 0.4% | 0.5 | 0.2% | -0.2 |
| lawn | 4 | 0.3% | 0.2 | 0.2% | -0.1 |
| lawn and impervious surface | > 1 | > 0.1% | >0.1 | >0.1% | 0 |
| successional n. hardwood | 3 | 0.2% | 0.8 | 0.4% | +0.2 |
| Bare ground | 1 | 0.1% | 0 | 0% | -0.1 |
| Total | 1364 | 100% | 229.2 | 100% | 0 |

Although this mapping is useful for general understanding of the land cover and landuse of the watershed, due to their small scale, these aerial photographs are not appropriate for describing the condition of the vegetation near the stream or on its floodplains. Therefore, it was recommended that a ground survey and assessment of the streamside vegetation be performed to provide a more complete picture of its condition and effect on stream stability.

## Riparian Vegetation Functional Condition Assessment

For the Broadstreet Hollow stream management plan, it was decided that the assessment of the riparian vegetation should describe the condition of the vegetation in terms of its ability to maintain or create proper stream conditions. A trial assessment was conducted using a methodology recognized as being relatively simple to undertake and as providing results that are easily communicated to landowners. The "Proper function condition" assessment created by the Bureau of Land Management for use in the Western United States (BLM, 1998) provides the investigator with a checklist and rating system for defining the extent to which the vegetation is performing its role. A riparian area is considered to be in proper functioning condition when adequate vegetation, landform, or large woody debris is present to:

- dissipate stream energy associated with high waterflow, thereby reducing erosion and improving water quality
- filter sediment, capture bedload, and aid floodplain development
- improve flood water retention and ground-water recharge
- develop root masses that stabilize streambanks against cutting action
- develop diverse ponding and channel characteristics to provide the habitat and water depth, duration and temperature necessary for fish production
- support greater biodiversity

The assessment ranks the vegetation at a point along the stream as having one of following four levels of functionality:

- proper functional condition,
- functional-at-risk,
- non functional,
- unknown.

As an example, the assessment would consider whether the vegetation on the stream bank consisted of plants or plant communities that have root masses capable of withstanding high-stream flow events. Using a series of such questions related to the vegetation's capacity, the assessment can be used to identify weak points or "stressors" which, if addressed, could improve the functional condition of the system.

This assessment will be conducted at a later date as a trial of the protocol, and will eventually be expanded for the entire watershed. This trial was conducted from the reference reach site at the top of the mainstem, to a point just below the confluence of the Timberlake tributary to the mainstem. The procedure included the completion of the question form with the rating and description of the limiting factors on the site, the diagramming of a cross section of the riparian area including bank features and all vegetation communities, and photographing of upstream and downstream conditions. The investigator then walked downstream until there was a major change in either the vegetative communities on either bank, or a change in the landform, or a change in the intensity of development that might influence the functional condition rating. Cross-

The graphic below (Figure 4) shows the location and functional condition rating for each of the ten cross sections completed in this pilot study. Discussion of the results will be grouped by the various rating classes.

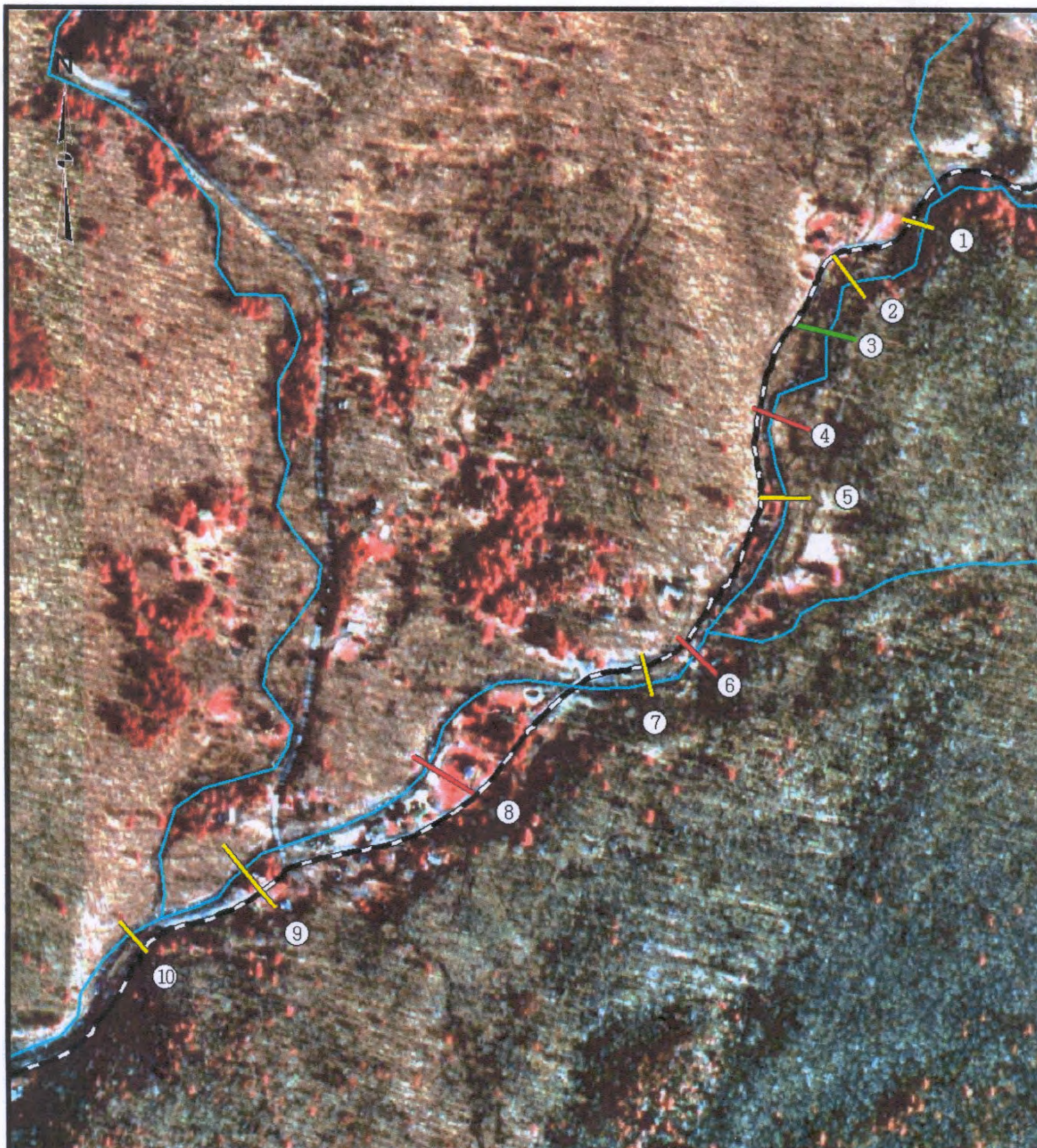



**Figure 4. Riparian Vegetation Functional Condition Assessment Cross Section Locations and Ratings**

Properly Functioning Condition - Only cross section number 3 achieved this high rating. This site has a wide vegetation buffer (over 50 feet on both sides), an established and unconfined floodplain, and plenty of woody debris to provide additional resistance during high flow conditions. The vegetation is diverse in its composition and structure resulting in a densely rooted soil profile. There is also adequate regeneration on this site to ensure that it will continue to aid in the maintenance of stable stream conditions.

**Photo 4. Example of Properly Functioning Condition**

At Risk Condition - Six of the ten cross sections (numbers 1,2,5,7,9 and 10) were rated as functional-at risk. At half of these sites, the proximity of the road, stress on the vegetation associated with road maintenance, and its encroachment on the width of the vegetative buffer has created a condition that has affected the vigor and function of the riparian vegetation buffer. At site 5, the proximity of disturbance associated with an abandoned residence, the invasion of Japanese knotweed (this colony may be the source of many of the downstream knotweed colonies) and the resulting weakened vegetation on the right bank threatens the stability of the stream at this location.

**Photo 5. Example of At Risk Condition**

At site 1 and 2 the width of the riparian buffer on the right bank is insufficient to provide for the long-term stability of the stream. At each of the "At Risk" sites either an extension of the buffer or protection of the buffer from road encroachment will reduce the stress and improve the functional condition to a “Properly Functioning Condition” rating.

Nonfunctioning Condition- Three cross sections (numbers 4, 6, and 8) were rated as non-functional. At two of these cross-sections (number 4 and 6) the stream was confined by the road and the width of the vegetation buffer was less than five feet. Riprap and log cribbing on the right bank that had been placed to protect the road was in poor condition and was in need of maintenance. Replacement or integration of this revetment with vegetation to protect the bank in place of rock would improve the functional condition to at least the “At Risk” rating. The vegetation on the left bank at cross section 4 was also severely affected by the utility line which parallels the stream. Tree clearing and brush control crews left only a narrow strip of vegetation between the left bank of the stream and the utility line. Cross-section 8 was the stream restoration project site where the woody vegetation has yet to achieve a size and density where it will aid in maintaining stream stability. Areas of this site will need supplemental planting for it to meet the properly functioning condition rating. Plant species diversity at this site was low and the impact of residential dwellings may continue to affect the rating at this reach.

**Photo 6. Example of Nonfunctioning Condition**

The results of this assessment compare favorably with the geomorphic assessment. First, the selection of the cross-section locations based on changing vegetation or landform conditions was consistent with changes in stream type. The characterization of the vegetation into the four functional rating groups was also generally consistent with the relative stability of the geomorphic classification of the stream at each cross section. For example the Proper function condition cross-section was located in a B3 stream type, a type which is generally considered to be stable if supported by vegetation. Most of the the cross sections receiving an “At Risk” or “Nonfunctioning” rating were located on F or D stream types where the lack of vegetation may be contributing to the over widening of the stream from a B stream type to a F stream type.

This functional condition approach to vegetation assessment will be conducted on the remainder of the watershed at a later date.

**Riparian Glossary**

Community - for the purpose of ecological community classification, community is defined as a variable assemblage of interacting plant and animal populations that share a common environment.

Riparian area - that transitional area of land abounding a stream where water has a significant influence on the land and its vegetative cover. A more specific functional definition states that riparian areas are " three dimensional ecotones of interaction that include terrestrial and aquatic ecosystems, that extend down into the groundwater, up above the canopy, outward across the floodplain, up the near-slopes that drain the water, laterally into the terrestrial ecosystem and along the water course at variable width" (NRC, 2002).

Riparian buffer – A belt of vegetation, either naturally or artificially established, along a watercourse which protects both the water from the effects of adjoining landuse and the land along the stream from the disturbance and erosion associated with storm events. Riparian buffers filter and store nutrients and sediment from overland flow, provide bank stability, aquatic habitat, wildlife habitat, forest products, recreational opportunities and aesthetics. The width of a riparian buffer should be a minimum of 50 feet and may vary based upon the size of the local topography, hydrology, ecology and management objective.

Riparian plant community - the assemblage of trees, shrubs, herbs and grasses found near and dependent on the moist conditions found near the stream. Plants in this community are typically especially adapted to withstand periods of inundation, saturated soils, and the erosive force associated with storm runoff events.

Color infra-red digital orthophotograph - is a color aerial photograph in which the infra-red reflectance of ground surfaces and vegetation is captured in the photograph. The digital orthophotograph is an aerial photograph which has been converted to a digital image, referenced to its location on the earth and had the distortions due to photography and the terrain removed from the image to enable a more accurate registration. The resulting image enables the interpreter to differentiate between objects or land covers and to accurately map their location on the earth.

Bioengineering – the science and practice of using vegetative materials, such as live cuttings and rooted plants imbedded in the ground to provide the main structural and mechanical support to slope protection systems. Bioengineering (or soil bioengineering) is slightly different from biotechnical stabilization, the practice of integrating mechnical elements (or structures) with biological elements (or plants) to arrest or prevent slope failures (Gray, 1996).

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