2.6 Riparian Vegetation Issues in Stream Management

General Concepts of Riparian Vegetation Ecology and Management

The role of vegetation in maintaining a healthy stream

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

As rainfall runs off the landscape, riparian vegetation slows the rate of runoff; captures excess nutrients carried from the land; protects stream banks and floodplains from the erosive force of water; and regulates water temperature changes. It also provides food and cover to terrestrial and aquatic fauna; and conserves soil moisture, ground water and atmospheric humidity.

Vegetation's erosion and pollution prevention capabilities

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

On bare soils, high stream flows can result in bank erosion and overbank flow can cause soil erosion and scour on the floodplain. The roots of vegetation along the bank hold the soil and shield against these erosive flows. On the floodplain, vegetation slows flood flows, reducing the energy of water and its potential to cause erosion and scour. Furthermore, as vegetation slows the water, the fine sediment and soil suspended in the water has more chance to settle on the floodplain (rather than carried be carried away by the stream).

Vegetation's hydrological influences

Vegetation intercepts rainfall and slows runoff, increasing the amount of precipitation that infiltrates the soil and reduces overland runoff. This helps to decrease the occurrence of destructive flash floods, lowers the height of flood waters, and extends the duration of the runoff event. These benefits are evident in forested watersheds such as the upper Rondout when compared to watersheds of similar size which have high levels of urban development (Fig.1). The reduction in flood stage and duration also results in fewer disturbances to the stream banks and floodplains.

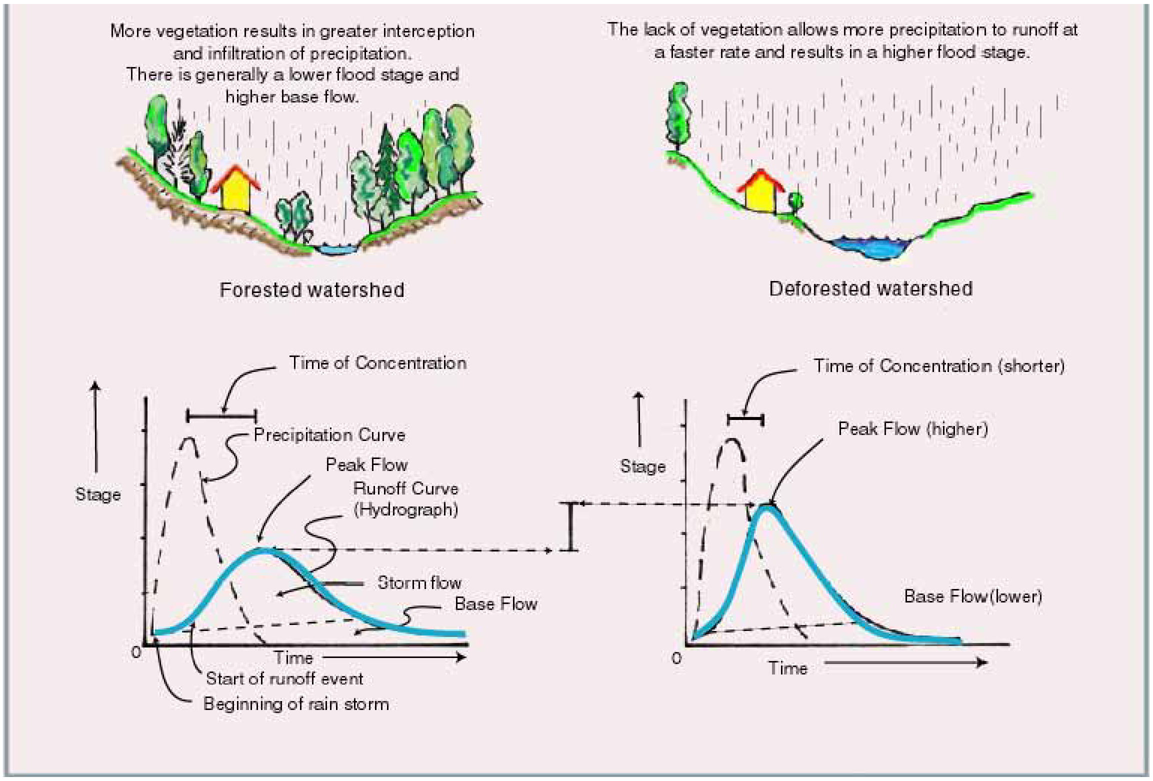

Figure 1 Comparison of Runoff on a Forested Watershed Versus a Deforested Watershed. Illustration by P. Eskeli 2002, from Watershed Hydrology, P.E. Black,1991, Prentice Hall, page 202, 214.

Ecological importance of vegetation in the riparian zone

Streamside vegetation also functions to provide climate, habitat, and nutrients necessary for aquatic and terrestrial wildlife. Trees shading a stream help maintain cool water temperatures needed by native fish. Low-hanging branches and roots on undercut banks create cover for fish from predators such as birds and raccoons. Natural additions of organic leaf and woody material provide a food resource needed by terrestrial insects and aquatic macroinvertebrates (stoneflies, mayflies, etc.) – the primary source of food for fish.

Terrestrial wildlife depends upon vegetation for cover as they move from the upland community to the water's edge. A diverse plant community, one similar to the native vegetation of the upper Rondout, provides a wide range of conditions and materials needed to support a diverse community of wildlife. If 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 plan and animal communities to thrive despite natural or human induced stress on either community.

Characteristics of a healthy riparian plant community

A healthy riparian community is diverse, with a wide variety of plants, including trees, shrubs, grasses, and herbs (Fig. 2). The age of plant species are varied with a healthy regeneration rate so that new plants ensure the future of the community. Riparian communities are unique in that is that they must adapt to frequent disturbance from flooding. Consequently, many riparian plants including willow, alder, and poplar, can re-grow from stump sprouts or reestablish their root system if up-ended. Also, seeds from these species are adapted to thrive in gravel bars and lower flood benches, where they can sprout in sediment deposited there during high flows.

Diverse Plant Types
(trees, shrubs, grasses, herbs)

+

Diverse Plant Ages
(young and old)

+

Disturbance-adapted, Moisture-loving Plants
(accustomed to flooding & ice flows)

=

Healthy Riparian Buffers

Figure 2 A healthy riparian community is densely vegetated, has a diverse age structure and is composed of plants that can resist disturbance

Riparian Vegetation in the upper Rondout Watershed

Forest history and composition in the upper Rondout Watershed

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

More recently, human activities have affected the forest either through manipulation of forests through development or for maintenance of desirable species (high-grade wood) for wood products. Native Americans used prescribed burning as a means of allowing nut bearing oaks and hickories to establish dominance in the forests. European settlers in the 18th and 19th centuries contributed to a rising industrial economy by clearing vast areas of land for agriculture, harvest of construction materials, and hemlock bark harvesting for the extraction of tannin. The land cover in the upper Rondout began to revert to forest with the local collapse of these economies in the 20th century and the acquisition of much of the land by the State for the Catskill Forest Preserve (Kudish, 2000). Please refer to individual Management Unit descriptions in Section 4 for more detailed information about past activities that affected the streamside and floodplain vegetation of the watershed.

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

Figure 3 Primarily forested upper Rondout watershed

The Riparian Forest

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

Natural disturbance and its effects on riparian vegetation

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

The flood of 1996 on the upper Rondout created and reopened numerous high flow channels, reworked point bars, scoured floodplains and eroded formerly vegetated stream banks. Immediately following the flood, the channel and floodplains were scattered with woody debris and downed live trees. In the years since this event, much of the vegetation has recovered. Trees and shrubs, flattened by the force of floodwaters, have re-established their form. Gravel bars and sites disturbed in previous flood events became the seedbed for herbs and grasses. This type of natural regeneration is possible where the stream is stable and enough time passes between major flood events. Frequent floods and ice prevent large trees from establishing. In the area disturbed by runoff events that reach bankfull flow (expected to occur on average every 1.3 years). Ice flows can also cause channel blockages, resulting in erosion and scour associated with high flow channels and overbank flows. Typically this type of disturbance has a short recovery period.

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

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

Figure 4 Hemlock woolly adelgid on the underside of a Hemlock 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, their population fluctuates, allowing for some hemlock re-growth in periods when their density is low. But this re-growth is stunted and later attacked as the adelgid population increases. With each successive attack tree reserves become depleted and eventually regrowth does not occur. The native predators of hemlock woolly adelgid have not offered a sufficient biological control, but recent efforts to combat the insect include experimentation with an Asian lady beetle (*Pseudoscymnus tsugae* Sasaji) which is known to feed on the adelgid. Initial experimental results have been positive, but large-scale control has yet to be attempted. The US Forest Service provides extensive information about this pest at its Northeastern Area "forest health protection" webpage: www.na.fs.fed.us.

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

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

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

To learn more about these species and the threats they pose, view:
APHIS fact sheets for general information about invasive forest pests:

http://www.aphis.usda.gov/publications/plant_health/content/printable_version/fs_invspec_forest_health.pdf
For ALB:
http://www.aphis.usda.gov/publications/plant_health/content/printable_version/faq_alb_mass_regarea.pdf
for EAB:
http://www.aphis.usda.gov/publications/plant_health/content/printable_version/EAB-GreenMenace-reprint-June09.pdf

Human disturbance and its effects on riparian vegetation

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

Due to narrow valley and steepness of valley walls, the alignment of Sullivan County Route 153/Sundown Road and Peekamoose Road closely follows the stream alignment of the upper Rondout Creek. Use and maintenance of these roads has a significant impact on the riparian vegetation. The narrow buffer of land between the creek and the road receives runoff containing salt, gravel, and chemicals from the road that stunt vegetation growth or increase mortality. 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 which establish more quickly than native vegetation in these areas. The linear gap in the canopy created by the roadway separates the riparian vegetation from the upland plant communities. This opening also allows light into the vegetative understory which may preclude the establishment of native, shade-loving plants such as black cherry and hemlock.

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

Residential Development Influence

Residential land use and development of new homes can have a great impact on the watershed and the ecology of the riparian area. Houses require access roads and utility lines that frequently have to cross the stream. Homeowners who love the stream and want to be close to it may clear trees and shrubs to provide access and views of the stream. Following this clearing, the stream bank begins to erode, the channel over-widens and shallows. The wide, shallow condition results in greater bedload deposition and increases stress on the unprotected bank. Eventually stream alignment may change and begin to cause erosion on the property of downstream landowners.

Catskill stream banks require a mix of vegetation such as grasses and herbs that have a shallower rooting depth, shrubs with a medium root depth, and trees with deep roots. Grasses alone are insufficient to maintain bank stability in steeply sloping streams such as the Rondout Creek.

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

Invasive Plants and Riparian Vegetation

Sometimes the attempt to beautify a home with new and different plants introduces a plant that spreads out of control and "invades" the native plant community. Invasive plants present a threat when they alter the ecology of the native plant community. This impact may extend to an alteration of the landscape should the invasive plant destabilize the geomorphology of the watershed (Melanson, 2002).

The spread of Japanese Knotweed (*Fallopia japonica*), an exotic, invasive plant gaining a foothold in many streams in the Catskills, is an example of a plant causing such a disruption. As its common name implies, Japanese knotweed's origins are in Asia. It shades out existing vegetation and form dense stands along the bank (Fig. 5 a-c). Although the impact of a Japanese knotweed invasion on the ecology of the riparian area is not fully understood, the traits of Japanese knotweed pose several concerns. Some of these concerns include:

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

Figure 5, (a), (b), and (c)   Stages of Japanese knotweed's growth throughout the growing season

Japanese knotweed is very difficult to control. One small fragment of stem or underground root can start a whole new stand, often spread by floods or inadvertent transport through fill or cutting. The broad use of herbicides, while partially effective, is not a viable option due to the threat chemicals pose to water quality and the fragile aquatic ecosystem. Mechanical control, by cutting or pulling, is labor intensive and requires regular attention to remove any re-growth. Biological controls are untested. While Japanese knotweed colonizes nearly five continuous miles of stream banks in some areas of the Catskills, the Rondout Creek has primarily only one large stand and a couple other small, manageable stands.

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

Assessment of current condition of riparian vegetation

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

Mapping of physiognomic classes

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

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

Summary of Findings

According to this riparian vegetation assessment, deciduous closed tree canopy (approximately 51 acres) and mixed closed tree canopy (approximately 30 acres) were the largest physiognomic classes within the 100 foot buffer, while deciduous open tree canopy and evergreen closed tree canopy occupied approximately 26 acres and 24 acres respectively (Table 1). Rondout Creek benefits greatly from this predominance of forest vegetation of the riparian area. Forested land cover helps to provide a high degree of stability to the watershed by slowing storm runoff and helping to protect against stream bank erosion. Protection of forest communities as well as planting riparian vegetation near the stream will help ensure long-term stream stability, but the effectiveness of stream protection provided by vegetative communities differs based on their width, plant density, vegetation type and the stream's geomorphic characteristics. Only 21 acres, or 12% of land area was considered to lack healthy vegetative cover; this included areas of herbaceous vegetation, bare soil and revetment.

Table 1. Summary of Physiognomic Vegetation Classification for the riparian corridor of the Rondout Creek mainstem.

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

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

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