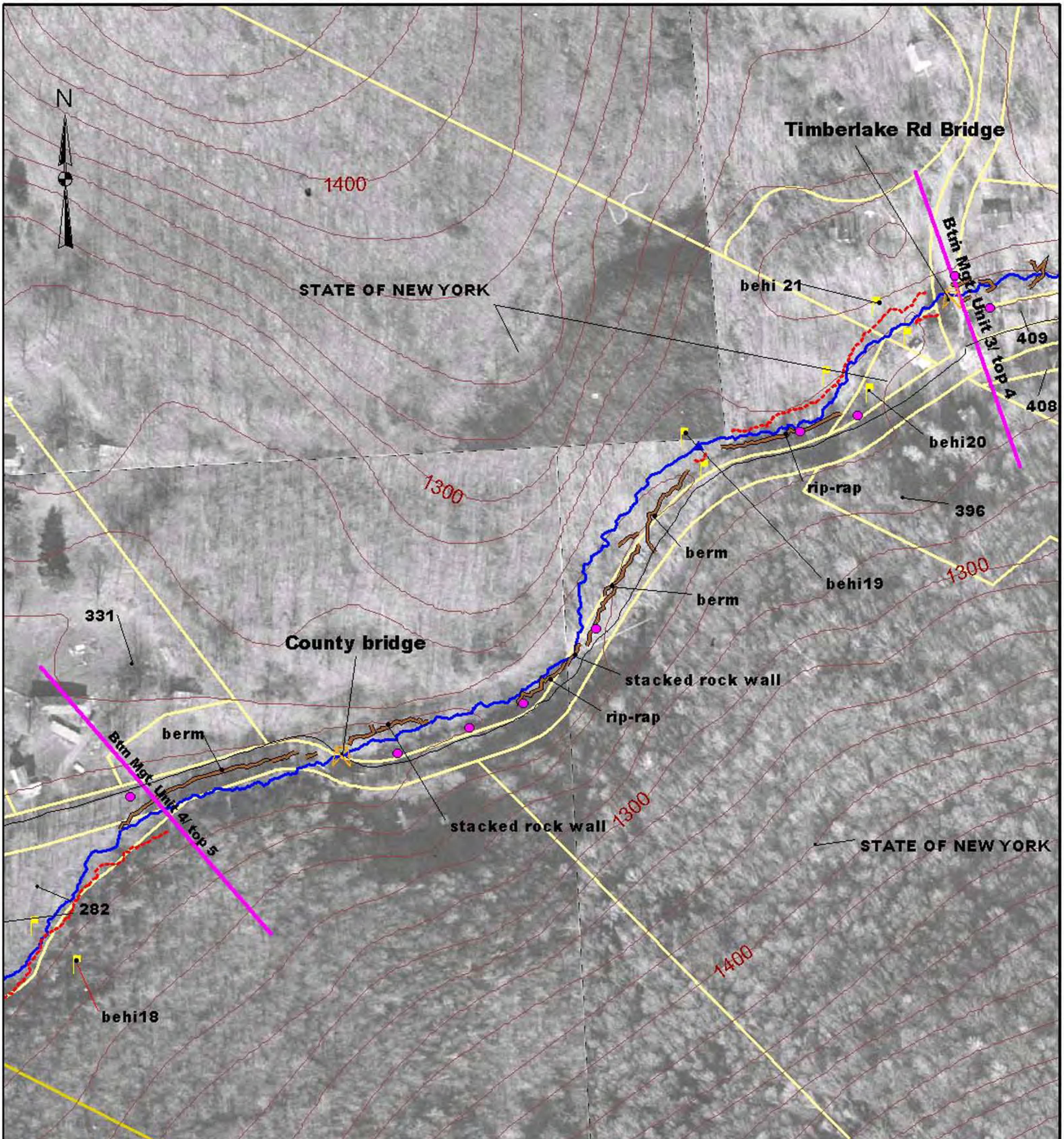


GIS Parcel, Contour and Wetland coverages are edited and provided by NYC DEP, 2000, UTM NAD 27, Zone 18 North, meters. Aerial Photography provided by UCSWCD & NYC DEP November 2001. All other coverages were developed using GPS in the UTM, Zone 18 North projection, NADCON (Conus), datum. GPS data collected 2001, by UCSWCD & NYC DEPSMP.

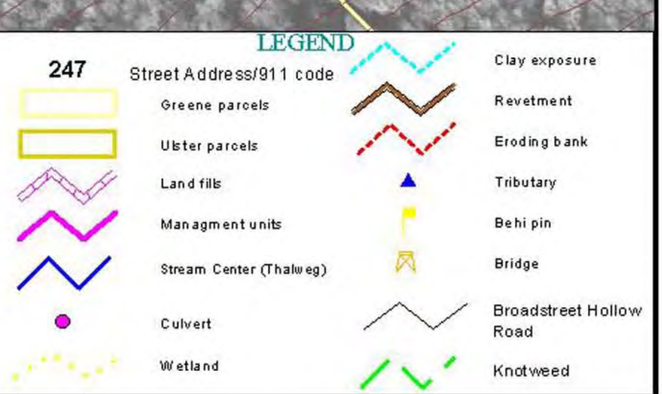
Note: G.I.S. data are approximate according to their scale and resolution. Data may be subject to error and are not a substitute for on-site inspection or survey. Parcel coverages are based on Ulster County Real Property tax maps 2000 and may not reflect actual surveyed property boundaries.

Broadstreet Hollow Management Unit 4

Contour Interval 20 feet

50 0 50 100 150 200 Feet

Scale 1:2,400



Broadstreet Hollow Management Unit 4

General Description:

Management Unit 4 (MU4), is located in Greene County, NY, beginning at County Bridge 3-20124-0 on Timberlake Road, and extending approximately 1,660 feet downstream to about 300 feet below County Bridge 3-20122-0 (Photos 1 and 2). The Jay Hand Hollow, the stream that runs along Timberlake Road, enters the main Broadstreet Hollow stream in the upstream half of MU4. At the bottom of the unit, the stream bends, or *meanders*, away from the road into the top of MU5. The stream runs very close to the road for most of the length of MU4[1&2].

Photo 1. Looking upstream near the bottom of MU4, old mill race and dam wall at left, Broadstreet Hollow Road at right.

MU4 is characterized by generally poor conditions, or *instability*, caused primarily by its proximity to the road and resulting bank conditions. This unit has several hundred feet of eroding bank and over 1,000 feet of stream bank stabilization and hardening measures, or *revetments*[3].

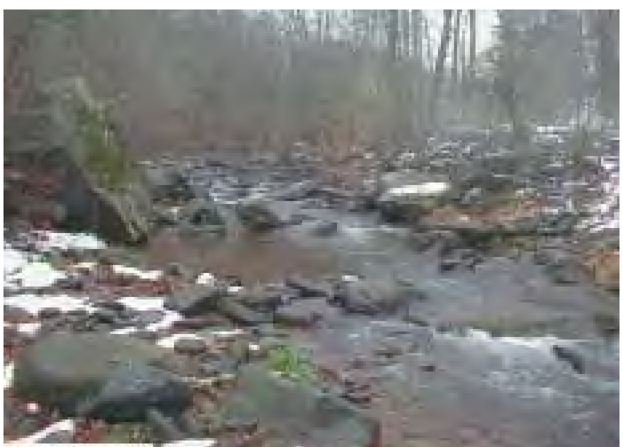


Photo 2. Looking upstream, near the middle of MU4, with steep valley wall to the left, and material stockpiles and plow side-cast berms to the right along Broadstreet Hollow Road.

The structural shape, or *morphology*, of the stream (i.e., slope, width and depth) changes dramatically and frequently in this unit, creating many smaller sections, or *reaches*. Each reach functions to move water and sediment differently than its up- and down-stream neighbors. Management units with so many small, changing reach types produce complex interactions, making solutions to instability problems and overall management more challenging.

The valley in MU4 is somewhat narrow compared to other MUs, and the stream shape is predominantly *entrenched*, with road fill close all along the left bank (looking downstream) and high banks and valley walls along much of the other bank. Typically stable stream types associated with this type of valley are relatively narrow and fairly steep, primarily with *riffles* and *pools* interspersed with some small waterfalls ("steps"), and stream banks formed into low benches, or *discontinuous floodplains*, that function as small overflow areas during floods. MU4 actually maintains some areas with these discontinuous floodplains on the banks near the road, and for much of its length on the opposite bank as well, with the notable exceptions of rip-rap, stacked rock wall and eroding bank areas. These floodplain benches increase the resiliency of MU4, enabling the stream in this unit to handle flood flows more efficiently, reducing potential for further instability and increasing potential for faster recovery from disturbance.

Photo 3. Looking upstream into Jay Hand Hollow, at the confluence with the main Broadstreet Hollow stream. Flow in the main stream is from right to left.

Jay Hand Hollow, the largest side stream, or *tributary*, in the valley, enters the main Broadstreet Hollow stream near the top of the unit [1](Photo 3). *Confluence* areas (where two streams join) tend to be unstable by nature's design, as the smaller stream delivers pulses of floodwater and sediment to the main stream. Eroding banks in the main stream opposite the confluence are a common feature, and do not necessarily indicate systemic instability, but are worthy of monitoring to assess changes or increased erosion, especially if instability conditions are locally common.

I. Flooding and Erosion Threats

A. Infrastructure and Private Property

MU4 has five property (land parcel) owners, for six parcels; three of them contain or are bounded by the stream. Two parcels are owned by the State of New York. One seasonal house, at 339 Broadstreet Hollow Road, is located between the Broadstreet Hollow Road and the stream, just downstream of the Timberlake Road Bridge. Stream assessment data for 2001 shows the Broadstreet Hollow Road centerline ranges from 0 (at the bridges) to 100 feet in distance from the deepest part of the stream channel, or stream *thalweg*[1&2].

Photo 4. Looking upstream into the top of MU4 at the Timberlake Road bridge, County BIN 3-20124-0.

The span under County Bridge 3-20124-0 (Timber Lake Road, at the top of MU4) is approximately 24 feet, compared to the average natural stream channel width both upstream and downstream from the bridge location of approximately 33 feet (Photo 4).

County Bridge 3-20122-0 (Broadstreet Hollow Road, at the bottom of MU4), though constructed at a more appropriate width of approximately 30 feet, is still narrower than the average local stream width of approximately 38 feet (Photo 5). Additionally, due to the valley and road configuration, this bridge was built into a sharp turn in the road to accommodate stream flow direction, but still crosses the stream at an angle. The result is that the stream is directed into the right abutment (looking downstream) during high flow, increasing potential for bridge structural instability and stream bed scour.

A bridge that is too narrow can result in maintenance problems, both of the bridge itself as well as the stream channel and banks both upstream and downstream of the bridge. Constriction at a bridge can cause water to back up during floods, which can lead to increased erosion both upstream of the bridge, as the water swirls, or *eddies*, behind it, and as the water rushes through and eddies around the banks just downstream[3&5]. Also, constriction raises flood level, or stage, upstream of the bridge, increasing the risk of inundation of the road, which can cause road damage or access restrictions.

Photo 5. Looking downstream near the bottom of MU4, at inlet of County bridge 3-20122-0, Broadstreet Hollow Road at right of stream. .

Both of these bridges show some evidence of such bank erosion both upstream and downstream of the bridge structure, as well as subsequent attempted bank revetment work to address this ongoing instability. Both of these bridges will likely have maintenance problems over time, unless they are reconstructed to accommodate the natural width of the stream[8]. Addressing stream bank stability separate from amending the bridge will likely only offer a temporary fix.

MU4 Culverts

Six culverts were found in MU4 during the *stream assessment survey* conducted in 2001. Two of them had flowing water and two were wet at the time of the survey, during the lowest yearly flow, or *summer base-flow*, condition. This indicates some groundwater supply and shows the stream is spring fed year round, even during drought conditions in summer, 2001. Culvert function under flooding conditions was not documented.

The culverts in MU4 provide road crossings for roadside ditch drainage. Culvert inlets were not surveyed as part of the stream assessment, so culvert inlet condition is unknown. Culvert outlets are generally in good condition; with no apparent immediate threat to stream bank or road fill stability, and currently enter the stream at a low angle, reducing negative erosive impacts to stream stability. Some culverts, especially in the middle of the unit, could benefit from additional vegetation at their outlets to dissipate energy of concentrated water flow, and encourage sediment deposition and nutrient or road runoff reduction, or attenuation (see also water quality discussion below).

B. History of Stream Work

Approximately 1,220 feet, or 36%, of the stream banks in MU4 have been altered or hardened (Table 1)[3].

Table 1. Altered Banks* Broadstreet Hollow MU4.[2]
*length of both stream banks combined

Revetment Type	Linear Feet	Percent of Unit
rip-rap	310	9
stacked rock wall	210	6
berm	695	21
Total revetment	**1,215**	**36%**

Approximately 310 feet, or 9% of the stream bank in MU4 has been rip-rapped with medium to large boulders, either *non-quarried natural boulders* from outside the stream, or local (*native*) material from the stream channel itself (this type of revetment is an older method, not practiced currently). This rip-rap is generally older, and vegetated with some trees between the boulders (Photo 6).

Photo 6. Native boulder rip-rap on left bank along Broadstreet Hollow Road, sparsely vegetated with trees. Flow in the stream is from left to right.

Photo 7. Old mill race and dam wall, right bank upstream of County bridge 3-20122-0. Flow is from right to left.

stacked rock wall or stone wall revetment. One wall, approximately 150 feet in length, is at the site of an old mill dam, and does not provide any necessary stream bank protection (Photo 7).

The other walls, totaling about 60 feet, stabilize the stream bank and road fill in a short section just downstream of County bridge 3-20122-0 (Photo 8), and in the middle the unit between a rip-rapped and a bermed section where the road and stream are in closest proximity.

MU4 also has several berms, comprising approximately 690 feet, or 20% of the bank length, which appear to be a combination of fill material stockpiled by the road, snow plow side-cast berms and berms constructed to protect the road or road fill from flooding or erosion. These berms consist of a variety of materials, from mossy cobble vegetated with small trees (likely constructed to protect the road from inundation, primarily in the lower portion of MU4 along the right bank below County bridge 3-20122-0) to crushed stone and bank run, with buried trees (likely stockpiles and snow plow side-cast berms, primarily in the middle portion of MU4)[1&2].

Photo 8. Looking upstream toward County bridge 3-20122-0, showing short section of stacked rock wall at left, with large tree, along Broadstreet Hollow Road.

Unfortunately, berms such as these generally do not offer much, if any, protection from flooding, and can cause stream entrenchment and higher flood 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 height, or *stage*, in downstream areas. The majority of Broadstreet Hollow stream floodplains consist of small, low, discontinuous floodplain benches that perform the important floodplain functions in small mountain streams. Because MU4 is particularly entrenched and confined, with little floodplain storage, removal or restructuring of some of these bermed areas should be considered to add floodplain function to this area and reduce erosion and instability problems[3]. Setting berms back from the stream provides a compromise solution, if berm materials are necessary either for stockpiles or flood inundation protection.

C. Exposed Banks

Stream assessment conducted in 2001 revealed approximately 460 feet (14%) of eroding stream bank in MU4, in two sections less than 50 feet long on the left bank (on the road side of the stream, looking downstream) and one section greater than 400 feet long on the right bank, beginning at the Timberlake Road bridge (Photos 9, 10 and 11). All three eroding banks have been monumented at a representative location for future monitoring (locations designated as "monitoring cross-sections" numbered 19, 20 and 21) to determine erosion rates and priority for potential restoration[3]. These sites have been assessed and ranked based on calculation of a *Bank Erodibility Hazard Index* (BEHI) rating using data collected at the time of the stream assessment survey in 2001[4].

Photo 9. Eroding left bank along Broadstreet Hollow Road, opposite the Jay Hand Hollow confluence with the main stream (flow from left to right). Pink flag marks the location of monitoring cross-section 19.

Monitoring cross section 19 (the downstream-most section) received a moderate BEHI ranking. This monitoring cross section was installed to track erosion on the road side of the stream associated with the confluence with the Jay Hand Hollow. Monitoring cross-sections 20 and 21 were installed in different locations along the same long bank on the opposite side of the stream from the road. Both received high BEHI rankings, indicating they have a higher potential for future erosion, though this area of erosion does not currently threaten houses or infrastructure.

Photo 10. Eroding right bank at wooded terrace, monitoring cross-section 20, stream flow is from right to left.

Photo 11. Eroding right bank at sparsely wooded terrace on NYS DEC land, monitoring cross-section 21, stream flow is from right to left.

Minor bank erosion at the left bank just downstream from the Timberlake Road bridge was noted, but was not monumented for further monitoring (Photo 12). While this section does not currently threaten any structures or the road, this area is just upstream of a residential lawn area, and probably represents eddy erosion associated with the bridge.

Photo 12. Low eroding left bank, just downstream from Timberlake Road bridge near the top of MU4, stream flow is from left to right.

This section should be visually monitored, as it may represent a potential future risk to stream stability and clearly indicates an imbalance in this reach[3&8]. Additionally, this area could benefit from additional riparian vegetation to improve bank stability and prevent ongoing property damage[7].

II. Water Quality

A. Sediment

The three eroding banks in MU4 may cause an increase of muddy water or *turbidity* in this reach from fine sediment (*silt* and *clay*) coming from stream bank and bed material, though stream assessment conducted in 2001 did not reveal any *clay exposures* in MU4[4]. Vegetation would help reduce bank erosion at these eroding bank areas and potentially intercept sediment-laden runoff, although vegetation alone will not be adequate to stabilize these banks, and may offer only temporary protection without further restoration.

An additional source of suspended sediment to the Broadstreet Hollow in MU4 is road and road ditch runoff. These sources may be reduced through seeding of roadside ditches with native grasses and forbes, and may be addressed along the stream and road together as part of an integrated stormwater management effort. Additionally, augmenting riparian vegetation at culvert outfall locations could help encourage sediment deposition and reduce suspended sediment loading to the main stream[7].

B. Landfills/Dumping Sites

Stream assessment conducted in 2001 did not reveal any current *dumping sites* in or near the stream in MU4 that could contribute to water quality impairment.

C. Other Water Quality Issues

Investigation of other possible sources of contamination was not part of the stream assessment conducted in 2001. However, no evidence was found for *nutrient* or *pathogen* contamination in the stream (i.e., odors or discolored water). Any road runoff roadside ditches and culverts that may contain salts or other pollutants was not specifically investigated, but lack of well-vegetated streamside or *riparian buffer* areas could reduce the capacity of the stream banks to assimilate, or slow the input of, contaminants to the stream, especially at culvert outfalls[7]. Over a third of the stream banks in MU4 are either hardened (with some kind of revetment) or actively eroding, and have insufficient riparian vegetation to provide full benefits of bank stability, pollutant uptake and other habitat advantages.

III. Stream Ecology

A. Aquatic Habitat and Populations

No specific aquatic habitat or population monitoring was conducted in MU4 as part of the stream assessment survey in 2001. However, as part of the stream restoration demonstration project completed in MU3 in 2000, fish and aquatic insect population data have been gathered yearly since 1998 within the stable reference reach (MU1), the project site (MU3) and the control reach (MU17). These data show the Broadstreet Hollow self-supports, without stocking, populations of all three common trout species (rainbow, brook and brown) as well as a healthy and diverse community of aquatic insects[9]. The impact that stream bed and bank instability has on these aquatic organisms or their communities is unknown.

B. Riparian Vegetation

The stream assessment conducted in 2001 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 trout species. Based on these general observations, riparian vegetation throughout MU4 is insufficient to provide the full benefits of a healthy riparian zone. As mentioned above, the road is at most 100 feet from the stream thalweg throughout MU4, and over a third of the bank length is hardened or eroding. The area between the stream in the road is commonly narrow, and generally steep, making vegetation both more difficult to support as well as more important for maintaining stream bank and road fill stability and preserving other riparian vegetative benefits. Existing riparian vegetation between the road and the stream can be stressed by ongoing road runoff, snowplow side-cast, and ongoing maintenance of revetments. Under-vegetated areas in the vicinity of rip-rap, berms, stacked rock walls and road fill sections in this reach should be vegetated with a mixture of native riparian species, including trees, shrubs and grasses, to improve shade, cover and water temperature conditions for aquatic habitat[9], as well as to improve bank stability and reduce the need for bank stabilization work that could cause or increase stream ecosystem disturbances[3].

The west side of the stream, opposite the road (the right bank) contains generally more healthy riparian vegetation, excepting the reach below the Timberlake Road bridge and below County bridge 3-20122-0, though both of these areas do support some vegetation. This reach would benefit from additional native trees and shrubs to protect property and improve bank stability, particularly in the vicinity of the lower bridge[3&7].

No *Japanese Knotweed* [7], a non-native, *invasive* plant was noted in this unit at the time of the assessment survey, though source populations of this plant have been documented upstream, increasing the potential for colonization of disturbed or under-vegetated areas in MU4.

[1]Broadstreet Hollow Management Unit 4 Map
[2]Broadstreet Hollow Management Unit 4 Workbook.
[3]Stream Bank Stabilization Methods and Alternatives
[4]BEHI Monitoring Cross Section Workbooks and BEHI Score Summary
[5]Stream Dynamics Discussion
[6]Attachment ___: USGS
[7]Riparian Vegetation Management
[8]Stream Stability Restoration Projects, Techniques and Contact Information
[9]Habitat Requirements for Trout
[10]Broad Street Hollow Geology