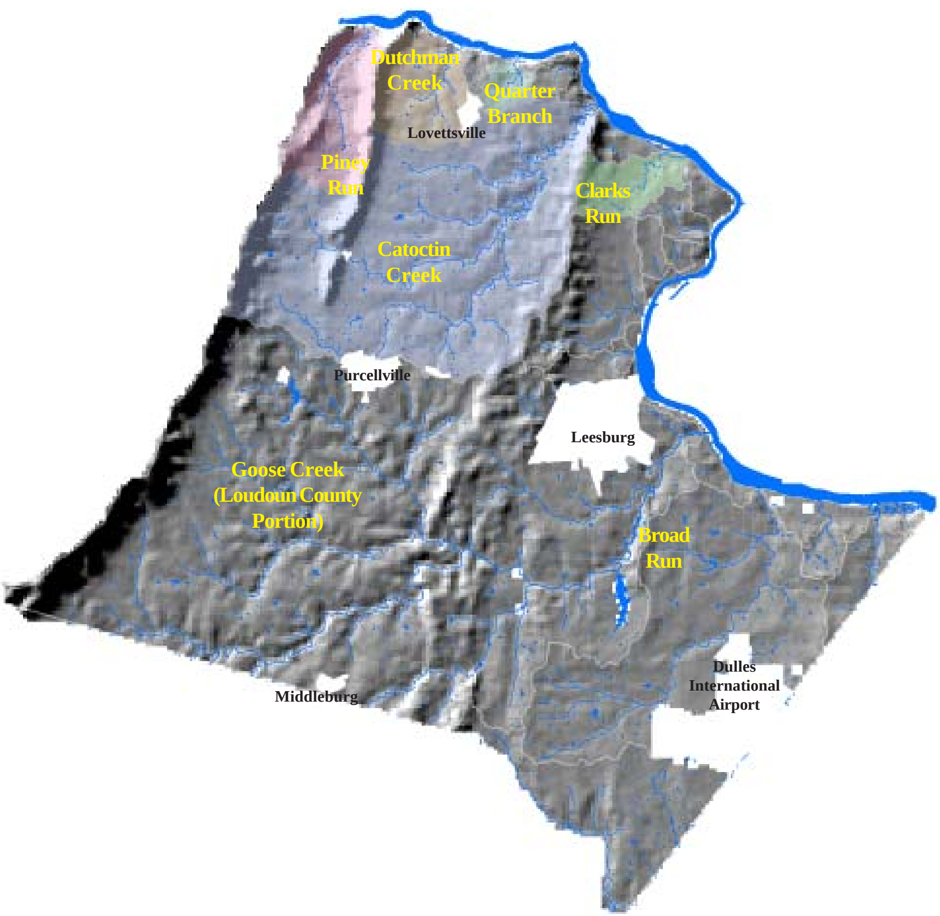
Loudoun County Baseline Biological Monitoring Survey (2004 – 2006)

Phase II: Clarks Run, Catoctin Creek, Quarter Branch, Dutchman Creek and Piney Run Conditions



Prepared for:
National Fish and Wildlife Foundation

Prepared by:
Department of Environmental Programs
Metropolitan Washington Council of Governments

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Phong Trieu, Katherine Levendosky, and John Galli

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Acknowledgments

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Executive Summary

Under Phase II of a proposed multi-phased study, Clarks Run, Catoctin Creek, Quarter Branch, Dutchman Creek and Piney Run were surveyed to systematically evaluate existing physical, chemical and biological stream quality conditions. Using COG's Rapid Stream Assessment Technique (RSAT), 16 strategically located and representative mainstem and tributary sites (totaling approximately five stream miles) were surveyed between October 2005 and April 2006. This report presents the findings of the RSAT survey, and provides valuable baseline data for assessing general stream conditions in the five preceding watersheds.

In addition, COG staff analyzed existing riparian buffer conditions under 35, 50, 100, and 200 foot width scenarios (on both sides of the stream) for the Catoctin Creek watershed. Using the Loudoun County stream geodata file and year 2005 Spot 5 satellite imagery within the ArcGIS platform, riparian buffer conditions were additionally classified into two generic forest and non-forest categories.

Major summary findings for each of the six RSAT categories (i.e., Streambank Stability, Channel Scouring/Sediment Deposition, Physical Aquatic Habitat, Water Quality, Riparian Habitat Conditions, and Biological Indicators (Benthic Macroinvertebrates)) and the riparian buffer condition analyses are presented herein by individual watershed.

1. Streambank Stability

Clarks Run

Overall, streambank stability in Clarks Run (78.8 percent) was rated as being in the good range (i.e., 71 - 80 percent). Neither moderate/severe or severe bank erosion conditions were observed. A total length of 356.4 feet of moderate streambank erosion, representing 7.6 percent of the total stream network length, was recorded. The associated calculated rate for the moderate streambank erosion category (i.e., 60-70 percent of the bank network is stable) is 401.2 linear feet per mile. The majority of the stream network survey length was observed to have slight or slight/moderate levels of streambank erosion. Corresponding lengths were 1,951.0 feet and 2027.0 feet, respectively. Not surprisingly, moderate streambank erosion conditions were generally associated with streambank outer bends.

Catoctin Creek

Mainstem Areas

The overall, mean streambank stability for the Catoctin Creek upper mainstem surveyed area was, at 75.4 percent, rated as being good. Specifically, mean bank stability for the North and South Fork mainstem areas were 74.2 and 76.0 percent, placing them in the good range. Streambank erosion survey totals were as follows: 1,343.7 linear feet of moderate erosion, 270.5 linear feet of moderate/severe erosion and 153.3 linear feet of severe bank erosion. The moderate/severe and severe streambank erosion condition totals were recorded in the North Fork, Hillsboro Road, and in the South Fork, Ketoctin Church Road, stream segments, respectively. In addition, of the four recent tree falls observed, two were documented within the North Fork mainstem. Erosional log jams were not recorded for either the upper North or South Fork mainstems.

Tributaries

Overall mean streambank stability for the seven Catoctin Creek tributaries surveyed was in the fair to excellent range. Mean bank stability for the upper tributaries, Hamilton Station Road and Talbot Farm tributaries (i.e., 70.8 and 74.5 percent, respectively), was rated as being good. Mean bank stability for the middle tributaries, Clover Mill Road tributary (62.7 percent), Richard Creek (63.8 percent) and Brens Creek (69.2 percent), was rated fair. The mean bank stability for the lower tributaries, Milltown Creek (80.0 percent) and EcoVillage Tributary (80.5 percent), was rated as being excellent. RSAT Catoctin Creek tributary streambank erosion summary results are as follows: 6,000 linear feet of moderate erosion (i.e., 61-70 percent of the streambank network is stable), 2,939.3 linear feet of moderate/severe erosion (i.e., 50-60 percent of the streambank network is stable) and 989.8 linear feet of severe erosion (i.e., less than 50 percent of the streambank network is stable). In addition, a total of eight recent tree falls were recorded - two each in the Hamilton Station Road tributary and two in Milltown Creek.

Quarter Branch and Dutchman Creek

Streambank stability for both Quarter Branch and Dutchman Creek was rated as being excellent (i.e., greater than 80 percent of the bank network is stable). Moderate/severe or severe erosion conditions were not observed at either survey site. RSAT Quarter Branch and Dutchman Creek streambank erosion survey results and totals are as follows: 1) Quarter Branch - 203 linear feet of moderate streambank erosion (i.e., 5.4 percent of the surveyed streambank network), 2) Dutchman Creek - 320 linear feet of moderate streambank erosion (i.e., 11.9 percent of the surveyed stream-bank network) and 3) two recent tree falls, both observed within Quarter Branch.

Piney Run

Overall mean streambank stability in Piney Run (i.e., 87.1 percent) was rated as being in the excellent range. Mean streambank stability for the middle and the lower mainstem areas surveyed was 89.2 and 85.0 percent, respectively. It should be noted that neither moderate/severe or severe streambank erosion conditions were observed during COG's Piney Run 2005 survey. However, streambank erosion levels in lower Piney Run increased noticeably from COG's 2000 and 2002 surveys. This has resulted in a six percent lower 2005 streambank stability rating for the lower mainstem. RSAT 2005 Piney Run streambank erosion survey results are as follows: zero linear feet of moderate/severe or severe erosion, 300 linear feet of moderate erosion, and no recent tree falls. One erosional log jam was recorded for the lower mainstem; whereas, none was recorded for the middle mainstem.

2. Channel Scouring/Sediment Deposition

Clarks Run

Large, unstable point bars were not observed in Clarks Run. Riffle embeddedness levels were rated as being good to excellent, and ranged from 23 to 60 percent. The overall mean embeddedness level of 42.7 percent was rated as being good. RSAT survey results also revealed a moderate level of in-channel sand deposition.

Catoctin Creek

Mainstem Areas

The observed mainstem riffle embeddedness levels, with the exception of South Fork at Piggott Bottom, were in the good category (i.e., 25-50 percent). Riffle embeddedness for the South Fork at Piggott Bottom Road was 80.7 percent (poor category). The overall mean embeddedness level for the three mainstem stream segments was 51.3 percent (fair). In addition, the relative level of in-channel sand deposition was generally in the high range for the South Fork (Piggott Bottom Road); whereas, it was in the moderate/high range for both the South Fork (Ketoctin Church Road) and North Fork (Hillsboro Road). The relatively low embeddedness levels in combination with low levels of in-channel sand deposits, suggests that sandy sediment loads are generally low and that such material is efficiently transported in these mainstem areas.

Tributaries

A total of seven large point bars were observed. Three of these (i.e., 43 percent) were unstable and were distributed evenly among the middle tributaries: Clover Mill Road tributary (one), Richard Creek (one) and Brens Creek (one). Riffle embeddedness levels varied, ranging from 63.3 percent (fair) to 15 percent (excellent). Upper Milltown Creek (63.3 percent) and middle Milltown Creek (15.0 percent) represented the two ends of this spectrum. The relative level of in-channel sand deposition varied from low for the Hamilton Station Road tributary and middle Milltown Creek to moderate/ high for upper Milltown Creek.

Quarter Branch and Dutchman Creek

Large point bars were not observed in Quarter Branch. A total of two large point bars, both of which were stable, were observed in the Dutchman Creek surveyed mainstem. Mean embeddedness levels in Quarter Branch, 55 percent, were rated as being fair (i.e., 51 - 75 percent). In contrast, the Dutchman Creek embeddedness levels were rated as being excellent, ranging from 10 to 25 percent.

Piney Run

A total of four large point bars were observed; two were classified as unstable (i.e., devoid of any vegetation), and both were located in the lower mainstem. Riffle embeddedness levels ranged from poor (i.e., 100 percent) to excellent (i.e., 10 percent). The overall mean mainstem embeddedness level of 34.1 percent was rated good.

3. Physical Aquatic Habitat

Clarks Run

The overall RSAT physical aquatic habitat condition rating for Clarks Run was good. Major contributing factors for this rating were low embeddedness levels (i.e., 42.7 percent = good), relatively deep mean riffle depths (i.e., greater than 2.5 inches deep) and excellent pool quality. Generally, the excellent pools were deep (i.e., greater than 22 inches), featured cobble and large gravel substrate, provided abundant overhead cover for fish, and were frequently associated with in-stream limestone rock outcrops.

Catoctin Creek

Mainstem Areas

RSAT physical aquatic habitat condition ratings were as follows: 1) Good - South Fork, (Piggott Bottom Road) and South Fork (Ketoctin Church Road), 2) Excellent - North Fork (Hillsboro Road). Major contributing factors for the good and excellent ratings were the presence of deeper pools and good, coarse-sized riffle substrate material.

Tributaries

RSAT physical aquatic habitat condition ratings for the upper, middle and lower tributaries were all good. With the exception of Richard Creek, pools were present in relatively high numbers and featured both good depth (i.e., >18 inches) and overhead cover for fish habitat. For Richard Creek, shallow pool depth (i.e., < 12 inches), suboptimal substrate composition (i.e., dominated by small sandy/silty material) and the lack of overhead cover for fish habitat, all contributed to the poor pool quality rating.

Quarter Branch and Dutchman Creek

RSAT physical aquatic habitat condition ratings for both Quarter Branch and Dutchman Creek were good. For Quarter Branch, the major contributing factors for its good rating included good pool quality (i.e., pools were >18 inches with abundant overhead cover for fish habitat) and good mean wetted perimeter (i.e., that portion of the bottom channel width at a riffle covered with water). For Dutchman Creek, the major contributing factors for the good rating included good riffle substrate quality (i.e., high levels of coarse substrate material such as cobble, rubble and gravel with little sand present) and very good quality pools.

Piney Run

The RSAT physical aquatic habitat condition rating for Piney Run was good. One of the major factors contributing to the overall good rating was excellent riffle substrate quality. In addition, the mean pool quality for both the middle and lower mainstem areas were rated as good and very good, respectively. It should be noted that for the lower mainstem, little has changed in the riffle substrate material composition since the 2000 and 2002 surveys. In contrast, pool quality and depth has dramatically improved, increasing from a poor to very good rating. No fish barriers were observed in any of the surveyed years.

4. Water Quality

Clarks Run

The mean TDS concentration, 240 mg/l, was in the poor range (i.e., >150 mg/l), but also reflects the higher level of dissolved solids associated with streams draining limestone parent material. Not surprisingly, pH (9.51) was within the alkaline range. The mean nitrate level of 3.8 mg/l is considered high (i.e., >3.0 mg/l). A 0.5 mg/l concentration is generally considered to be the upper threshold level for naturally occurring nitrate. Mean substrate fouling, 65 percent, was in the poor range (i.e., >50%). With regard to instantaneous dissolved oxygen (DO) levels, there were no violations of the Virginia Department of Environmental Quality (VADEQ) minimum 4.0 mg/l criterion. In fact, Clarks Run was observed to be well oxygenated, with a mean DO concentration of 12.83 mg/l. The overall RSAT water quality rating for Clarks Run was fair.

Catoctin Creek

Mainstem Areas

Levels of total dissolved solids (TDS) for the three mainstem stream segments ranged from fair (i.e., 101-150 mg/l) to good (i.e., 50-100 mg/l). The highest mean TDS concentration, 150 mg/l, was observed in the North Fork (Hillsboro Road). Nitrate concentrations were all within the upper moderate range (i.e., 1.1 - 2.9 mg/l). The highest (2.7 mg/l) and lowest (2.4 mg/l) mean nitrate concentration levels were observed in the North Fork (Hillsboro Road) and both South Fork stream segments, respectively. Mean substrate fouling levels were all in the poor to fair range. Mainstem RSAT water quality scores were all in the fair range.

Tributaries

Tributary TDS levels ranged from 50 mg/l (good) to 160 mg/l (poor). The highest mean TDS concentration, 160 mg/l, was recorded at the Hamilton Station Road tributary. Nitrate concentrations ranged from 1.6 mg/l up to 4.5 mg/l and fell within the moderate to high range. The highest nitrate concentration (4.5 mg/l) was observed at the Hamilton Station Road tributary. At the time of the survey, several horses occupied a paddock area and field that were in close proximity to the stream. Mean substrate fouling levels ranged from a low of 27 percent (fair) to a high of 68 percent (poor). Except for the two Milltown Creek stream segments, which were rated good (i.e., 5-6 points), overall RSAT water quality ratings for the tributaries were all fair.

Quarter Branch and Dutchman Creek

TDS levels were in the fair range for Quarter Branch (i.e., 101-150 mg/l) and in the good range for Dutchman Creek (i.e., 50-100 mg/l). Nitrate concentrations for Quarter Branch were high (i.e., >3.0 mg/l) and moderate for Dutchman Creek (i.e., 1.1-2.9 mg/l). Quarter Branch substrate fouling levels were excellent (i.e., < 11 percent of the bottom side of cobble-sized stones covered by organic film); whereas, Dutchman Creek's were fair (i.e., 21-50 percent of the bottom side of cobble-sized stones covered by organic film). The overall RSAT water quality ratings for Quarter Branch and Dutchman Creek were good and fair, respectively.

Piney Run

TDS levels for both Piney Run mainstem sites were in the good range (i.e., 50 - 100 mg/l). The nitrate concentration for the middle mainstem was low (i.e., 0.3 mg/l) and moderate (2.8 mg/l) for the lower mainstem. Mean substrate fouling levels were in the fair range at both locations, with the fouling level at the middle mainstem bordering on good.

5. Riparian Habitat Conditions

Clarks Run

The Clarks Run riparian habitat condition was rated as being in the lower good range. The overall mean canopy coverage observed along the survey reach was 82 percent, which is considered excellent. Riparian buffer vegetation composition was typically a mix of forest, grass and row crop (i.e., corn). The buffer was generally 200 feet wide or greater on both sides of the stream.

Catoctin Creek

Mainstem Areas

Riparian habitat conditions within the three surveyed Catoctin Creek mainstem areas were rated as being in the fair to excellent range. Mean canopy coverage ranged from a low of 58.3 percent to a high of 78.0 percent, averaging 65.4 percent (i.e., good). While portions of the riparian buffer zones contained mixed forest/grass or grass only (i.e., South Fork - Ketoctin Church Road) vegetation types, the vast majority of the steam corridors were comprised of mature hardwood forest. Riparian buffer widths were generally good to excellent, ranging from 100 (i.e., good range) to greater than 200 feet (i.e., excellent range).

Tributaries

RSAT riparian habitat condition ratings for the Catoctin Creek tributaries ranged from poor to good, with an overall fair rating. Mean canopy coverage ranged from poor (i.e., <50 percent) to good (i.e., 60-79 percent) with an overall fair (i.e., 50.3 percent) rating. In general, riparian vegetation consisted primarily of hardwood forest with some grass area intermixed. For the EcoVillage tributary, riparian vegetation was principally hardwood forest (optimal vegetation type). In sharp contrast, the Brens Creek buffer was predominately suboptimal grass vegetation. Mean riparian buffer widths for all tributary areas surveyed were generally rated as being good (i.e., >100 feet).

Quarter Branch and Dutchman Creek

Riparian habitat conditions within Quarter Branch and Dutchman Creek were rated as being in the fair to good range. Quarter Branch mean canopy coverage was 63 percent (good). Its riparian buffer zone widths were generally greater than 200 feet wide and consisted of hardwood forest. Dutchman Creek mean canopy coverage was 52 percent (fair), and its mean riparian buffer zone width was 170 feet. It also featured a mix of forest/grass vegetation types.

Piney Run

RSAT riparian habitat condition ratings for both Piney Run mainstem sites were good. The middle Piney Run riparian corridor included a wide, hardwood forest buffer (i.e., >200 feet wide) with good (i.e., 60-79%) canopy coverage. The riparian buffer along the lower Piney Run mainstem was generally well-forested and wide. This survey reach included a well-maintained, gravel surfaced road that paralleled the stream for most of its length. This effectively reduced the right bank buffer width to 20 to 30 feet.

6. Biological Indicators (Benthic Macroinvertebrates)

Clarks Run

Macroinvertebrate community conditions for the Clarks Run mainstem were excellent. The RSAT voucher total number of taxa collected was 29 (excellent). A total of twelve taxa from the pollution intolerant stonefly, flathead mayfly and cased caddisfly groups (i.e., Ephemeroptera, Plecoptera and Trichoptera - EPT) were present. This voucher included a stonefly family group (i.e., Capniidae) that is generally considered highly pollution intolerant. As for relative abundance for the EPT taxa groups, flathead mayflies, stoneflies and cased caddisflies were classified as 'scarce/common'. The relative abundance of roundhead mayflies was also observed to be 'scarce/common'. It should be noted that the relative abundance of moderately pollution tolerant cranefly larvae was 'common.'

Catoctin Creek

Mainstem Areas

Macroinvertebrate community conditions for the three Catoctin Creek mainstem survey areas were rated as being in the fair to excellent range. RSAT voucher total number of taxa results were as follows: 1) South Fork - Ketoctin Church Road, 26 (excellent), Piggott Bottom Road, 14 (fair), and 2) North Fork - Hillsboro Road, 22 (good). Taxa from the pollution intolerant stonefly, flathead mayfly and cased caddisfly groups (i.e., Ephemeroptera, Plecoptera and Trichoptera - EPT) were present at South Fork (Ketoctin Church Road) and North Fork (Hillsboro Road). Stonefly individuals were absent at South Fork (Piggott Bottom Road). However, both the flathead mayfly and cased caddisfly groups were present. As for relative EPT abundance at the three mainstem sites, stoneflies were classified as being 'common' in the South Fork (Ketoctin Church Road) and generally 'scarce' to absent elsewhere. In addition, the relative abundance of flathead mayflies were 'common' only at North Fork (Hillsboro Road) and 'scarce' at the other two mainstem sites. Cased caddisflies were 'scarce' in all three mainstem survey areas.

Tributaries

Macroinvertebrate community conditions for the Catoctin Creek tributaries surveyed were all rated excellent. RSAT voucher total number of taxa ranged from 27 to 40 (i.e., excellent range). Pollution intolerant taxa of stonefly, flathead mayfly and cased caddisfly groups were present in all tributary stream reaches. The relative abundance of the EPT individuals were generally 'scarce' to 'scarce/common' in all of the tributary stream segments. The single exception was Brens Creek, where stoneflies and cased caddisflies were 'common' in abundance.

Quarter Branch and Dutchman Creek

Macroinvertebrate community conditions for Quarter Branch and Dutchman Creek were rated excellent. The RSAT voucher total number of taxa collected for Quarter Branch and Dutchman Creek was 11 (fair) and 23 (good) taxa. As for the pollution intolerant stonefly, flathead mayfly and cased caddisfly groups, 11 taxa groups were collected in Dutchman Creek; whereas, only five were collected in Quarter Branch. It should be noted that the stonefly family group, Taeniopterygidae (generally considered highly pollution intolerant), were present in both streams. Dutchman Creek also included two other stonefly individuals, *Acroneuria sp.* and *Eccoptura sp.*, both highly pollution intolerant. The relative abundance of the mayflies, stoneflies and caddisflies (i.e., EPT taxa groups) generally fell into the 'scarce/common' to 'common' category for Dutchman Creek. Notably, net-spinning caddisflies and water pennies were both observed to be 'common/abundant'. As for Quarter Branch, stoneflies belonging to the family Capniidae were observed to be 'common/abundant'. Roundhead mayflies and cased caddisflies were observed to be 'scarce/common'. Flathead mayflies, generally considered more pollution intolerant than the roundhead mayflies, were absent from the survey. Cranefly larvae were also observed to be 'common' in relative abundance.

Piney Run

The macroinvertebrate conditions for both Piney Run mainstem reaches were excellent. Specifically, the RSAT voucher number of taxa collected for the middle and lower reaches totaled 19 (i.e., good) and 15 (i.e., fair), respectively. Pollution intolerant mayflies representing Heptageniidae and Isonychiidae families and stoneflies representing Perlidae family were present at both sites. Their relative abundances were observed to be in the 'scarce/common' to common/abundant' ranges. It should be noted that pollution intolerant cased caddisflies were not observed in the lower mainstem. In contrast, the highly pollution intolerant cased caddisfly, *Glossosoma sp.*, was observed to be 'scarce/ common' in the middle mainstem.

Catoctin Creek Riparian Buffer Analysis

Riparian Buffer Condition Result

In 2005, approximately 56 percent of the total 200 foot buffer area (i.e., 3,973.2 acres) was forested. The total land areas covered by a forested buffer within riparian buffer widths of 35, 50, 100 and 200 feet were 505.6, 690.3, 1,283.8 and 2,226.4 acres, respectively. The associated overall percent forest canopy coverage within the four buffer widths were 68.0, 68.0, 60.9, and 56.0 percent, respectively.

Non-Forested 35 Foot Wide Riparian Buffer

The COG analysis identified a number of areas lacking forest cover within the 35 foot buffer zone scenario (Table 32). Approximately 25 miles of mainstem and tributary streams do not meet the 35 foot forested riparian buffer. The Talbot Farm tributary has the greatest non-forested stream length, with 1.6 miles of its total 2.0 miles (i.e., 82.8 percent) lacking a 35 foot riparian buffer. In contrast, stream lengths lacking forest coverage within the 35 foot riparian buffer zone along the Catoctin Creek mainstem comprised only 1.3 miles of the total 18.1 mile stream length (i.e., 7.4 percent).

Potential Riparian Buffer Reforestation Areas

COG staff identified 271 potential sites for both riparian reforestation candidate and livestock exclusion sites within the 35 and 100 foot wide buffer areas. Of this total, 165 sites were identified for the 100 foot buffer scenario. For the Catoctin Creek mainstem-specific potential riparian buffer reforestation areas, the reader is referred to Appendix 6, Figures 1 through 3. A more extensive list for both the mainstem and tributary candidate sites can be found in Appendix 6, Tables 2 and 3.

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1.0 Introduction

1.1 Project Background

Loudoun County is currently the most rapidly developing jurisdiction in both the Washington Metropolitan Area (WMA) and the state of Virginia. In the year 2000, the county's human population was estimated to be 169,599. By 2005, it had increased by 50 percent to 255,518 people. Regional forecasts (MWCOG, 2005) predict an additional 161 percent in growth by the year 2030. Not surprisingly, significant development-related pressure is and will continue to be placed on Loudoun County's water resources. This is particularly the case for stream systems located within major growth corridors, such as Leesburg Pike (Route 7) and Mosby Highway (Route 50). In response, the Metropolitan Washington Council of Governments (COG) in partnership with the Loudoun Soil and Water Conservation District (LSWCD), has continued, using a phased approach, to comprehensively evaluate existing stream quality conditions. As part of this Phase II study, 16 representative mainstem and tributary sites strategically located within the Clarks Run, Catoctin Creek, Quarter Branch, Dutchman Creek and Piney Run watersheds were surveyed.

In addition, in an effort to provide a more accurate picture of the current state of the Catoctin Creek riparian buffer system, COG analyzed the percent forest and non-forest coverage by employing both 2005 Spot 5 satellite 'leaf-on' imagery data and the Loudoun County Office of Mapping stream geodata layer. It is expected that this riparian buffer data will complement the water chemistry and biological data generated and will be invaluable to Loudoun County in its efforts to develop and carry out total mean daily load (TMDL) implementation-related activities such as the prioritization of livestock exclusion areas.

COG's Rapid Stream Assessment Technique (RSAT) Level III survey (for characterizing existing stream conditions) was employed in the Phase II study. In addition, given Loudoun County's desire for additional channel morphology, a limited and modified Rosgen Level I and II stream morphology analysis was also performed. The total associated Phase II steam length surveyed by the RSAT method was approximately five miles. It should be noted that private landowners denied stream access to COG staff at two additionally proposed Catoctin Creek tributary RSAT sites.

It is expected that the baseline condition data generated by this study will provide needed guidance for possible future watershed protection, restoration, monitoring and resource management initiatives and actions. The Phase II study also builds upon the success of previous COG Loudoun County RSAT baseline watershed surveys (i.e., The Sugarland Run Phase I: Mainstem Survey (Galli and Corish, 1996), Sugarland Run Phase II: Tributaries Survey (Galli, Corish and Trieu, 1998), Talbot Farm Subwatershed (Trieu, Galli and Corish, 1998) and Phase I: Broad Run, Goose Creek, Limestone Branch, Catoctin Creek, Dutchman Creek and Piney Run Mainstem Conditions (Trieu, Galli, Dittman, Smith and Vatovec, 2003)).

1.2 Loudoun County - Major Watersheds

Clarks Run, Catoctin Creek, Quarter Branch, Dutchman Creek and Piney Run are five major watersheds in Loudoun County draining to the Potomac River (Figure 1). They vary tremendously in size, ranging from medium-sized second and third order streams (i.e., Clarks Run, Quarter Branch, Dutchman Creek and Piney Run) to much larger fourth order streams (i.e., Catoctin Creek). As seen in Table 1, drainage areas for the five study watersheds range from 2.9 up to 92.5 square miles.

Figure 1. Loudoun County Major Watersheds - Study Area

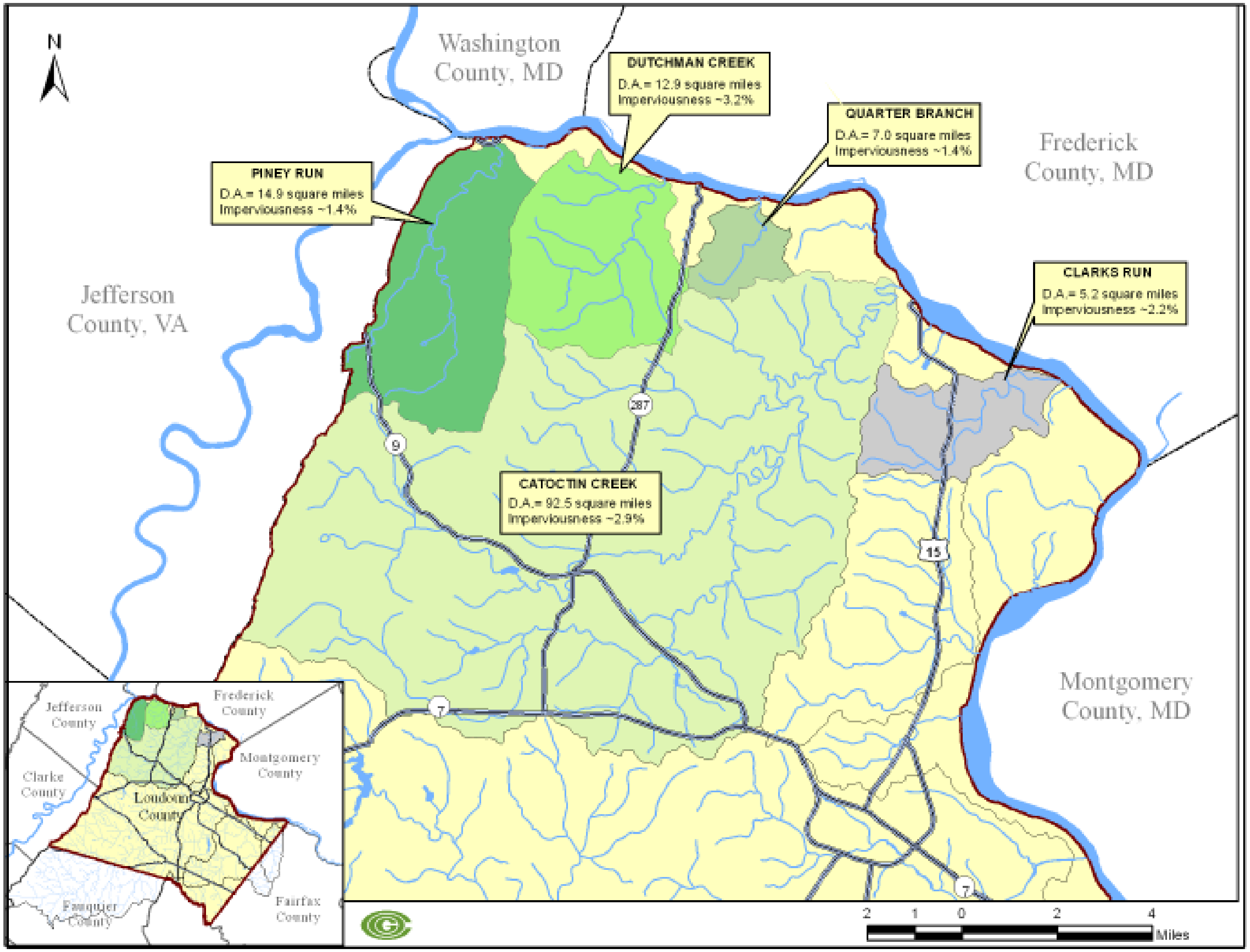


Table 1. Loudoun County Major Watershed - General Study Area Information

RSAT Stream Segment	Approx. Stream Segment Location	RSAT Survey Date	Drainage Area (mi^2)	Est. Existing Imperviousness (%)[1]	Stream Order[2]	Surveyed Stream Length	Stream Gradient	No. of RSAT Transects
Clarks Run								
Clarks Run	Saint Clair Lane	12/23/2005	5.2	2.0	2	2,345	0.43%	3
Total			**6.9**	**2.2**	**2**	**2,345**		**3**
Catoctin Creek								
Upper - North Fork	Hillsboro Road	3/9/2006	14.6	1.6	3	1,628	1.23%	3
Upper - South Fork	Ketoctin Church Road	2/9/2006	1.1	1.0	2	962	0.52%	3
Upper - South Fork	Piggott Bottom Road	2/9/2006	15.7	1.8	3	1,396	0.36%	3
Tributaries to Catoctin Creek								
Upper								
Hamilton Station Road Tributary	Hamilton Station Road	2/28/2006	2.1	5.2	1	3,170	0.63%	3
Talbot Farms Tributary	Clarkes Gap Road	2/28/2006	3.5	2.0	2	3,094	0.97%	3
Middle								
Clover Mill Road Tributary	Clover Mill Road	3/29/2006	1.6	1.3	1	1,312	1.14%	3
Richard Creek (Upper Brens Creek)	Purcellville Road	3/22/2006	4.0	2.1	2	1,273	1.18%	3
Brens Creek	Ash George Road	2/10/2006	8.4	2.9	2	1,496	0.33%	3
Lower								
Upper Milltown Creek	Bolington Road	3/9/2006	3.4	1.9	2	1,820	0.55%	3
Middle Milltown Creek	Milltown Road	3/22/2006	6.5	2.7	2	1,494	2.01%	3
Ecovillage Trib.	Taylortown Road	12/28/2005	1.1	1.9	2	2,241	1.12%	3
Total			**92.5**	**2.9**	**4**	**18,259**		**30**
Quarter Branch								
Quarter Branch	Quarter Branch Road	12/28/2005	2.7	2.4	2	1,871	1.34%	3
Total			**2.9**	**1.9**	**2**	**1,871**		**3**
Dutchman Creek								
Middle Dutchman Creek	Dutchman Creek Road	10/28/2005	2.5	2.1	3	1,343	0.74%	3
Total			**12.9**	**3.2**	**3**	**1,343**		**3**
Piney Run								
Middle - Piney Run	Arnold Lane	10/19/2005	8.3	1.8	2	1,692	0.59%	3
Lower - Piney Run	Branch River Road	10/19/2005	13.8	1.4	2	1,063	0.47%	3
Total			**14.9**	**1.4**	**3**	**2,755**		**6**

[1] Watershed impervious estimates extracted from RESAC 2000 Landsat 7 ETM imagery analysis for the WMA (COG and RESAC, 2003).
[2] Stream order determination made using 200-foot scale topographic maps.

The preceding watersheds, in their Loudoun County portion, are generally located within the Piedmont Plateau physiographic province. Clarks Run is also located within the Piedmont Plateau lowland province, but is underlain mainly by limestone conglomerates. Piney Run, Quarter Branch, Dutchman Creek and Catoctin Creek are located in the Piedmont upland province which is underlain by granodiorite and schist rock materials. It should be noted that the Catoctin Creek, Dutchman Creek and Piney Run extreme headwater areas extend into the Blue Ridge physiographic province which is associated with the Blue Ridge, Short Hill and Catoctin Mountains.

Climate for Loudoun County is generally referred to as being continental. Annual average precipitation is around 41 inches (NOAA, 2005). At the end of the year 2005, the total rainfall amount was 2.65 inches more than the annual average. The highest monthly rainfall total (i.e., 9.22 inches) was observed for October, when the RSAT stream survey was started.

The Loudoun County watershed imperviousness levels were estimated from the Washington Metropolitan Area 2000 imperviousness map, which was developed by the Mid-Atlantic Regional Earth Science Application Center (RESAC) using Landsat 7 Enhanced Thematic Mapper imagery data (COG and RESAC, 2003). Results (Table 1) indicated that watershed imperviousness ranged from approximately 1.4 percent (Piney Run) up to 3.2 percent (Dutchman Creek). The highest impervious level (i.e., 5.2 percent) was reported for the Hamilton Station Road tributary subwatershed (Catoctin Creek).

The mainstem and tributaries for Clarks Run, Catoctin Creek, Quarter Branch, Dutchman Creek and Piney Run are all designated by Virginia Department of Environmental Quality as Class III, non-tidal Piedmont zone streams. Major associated state water quality criteria are as follows: the minimum daily dissolved oxygen level can not fall below 4.0 mg/l, the pH range must fall between 6.0-9.0 and water temperature can not exceed 32 degrees Celsius (90^{o} Fahrenheit). These waters are also designated for the following uses: 1) recreational uses: swimming and boating; 2) the propagation and growth of balanced, indigenous populations of aquatic life, including game fish, which might reasonably be expected to inhabit them; 3) wildlife; and 4) the production of edible and marketable natural resources (e.g., fish and shellfish).

2.0 Study Design/Methods

2.1 Study Area

The 16 Rapid Stream Assessment Technique (RSAT) station locations (Figure 2) included both representative mainstem and tributary sites in Clarks Run, Catoctin Creek, Dutchman Creek, Quarter Branch and Piney Run. Importantly, each RSAT stream station featured a total of three transects (spaced on average approximately 500 to 700 feet apart), with an average total stream survey length of approximately 1,500 feet or longer. For RSAT study purposes, Catoctin Creek had its upper mainstem divided into respective North and South Forks similar to that of the 2002 study. Catoctin Creek tributaries were organized into the upper (i.e., above the confluence of the North and South Forks), middle (i.e., above the confluence of Brens Creek) and lower (i.e., below the confluence of Brens Creek) watershed portions. The Piney Run mainstem was also organized using a middle and lower mainstem approach. As for Clarks Run, Dutchman Creek and Quarter Branch, both middle and lower mainstem reaches were surveyed. Again, COG staff were denied access to two proposed Catoctin Creek tributary study sites (i.e., Featherbed Road and Waterford Down tributaries).

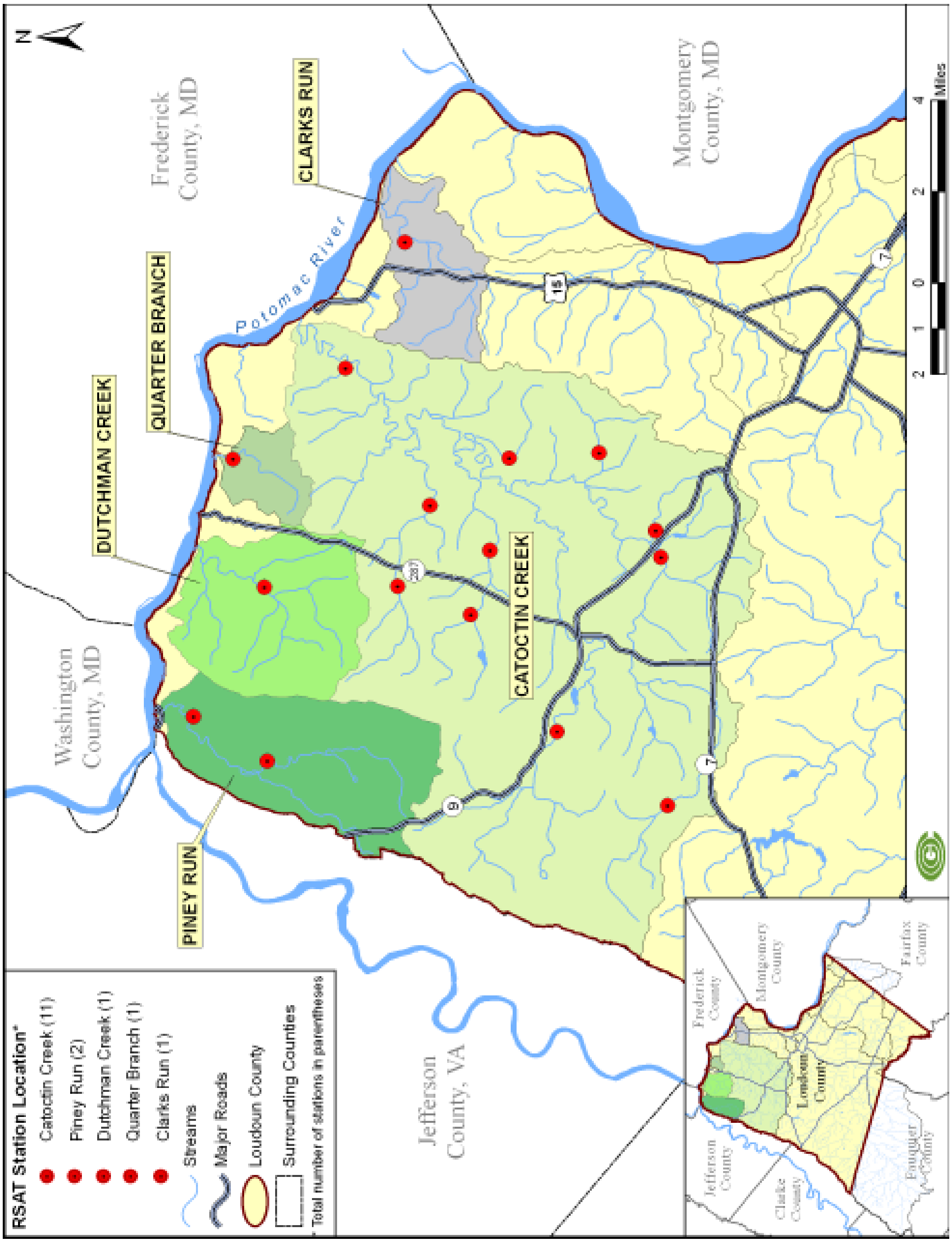


Figure 2. Loudoun County - General RSAT Transect Station Locations

Data collected from the 48 steam transects were used to evaluate overall stream quality conditions and to allow for comparisons between segments within a watershed. Each RSAT segment latitude/longitude location was registered using a Trimble Global Positioning System (GPS) GeoExplorer XT receiver. These GPS-derived latitude/longitude coordinates are included as Appendix 1.

2.2 RSAT Level III Survey

The Rapid Stream Assessment Technique (RSAT) was developed by COG in 1992 to provide a simple, rapid reconnaissance-level assessment of stream quality conditions. Since its inception, RSAT has undergone a series of revisions and upgrades. The RSAT Level III method used in this study features quantitative macroinvertebrate community metric calculations, greater use of hand-held water quality meters for enhanced baseflow water quality characterization, pebble counts and the capacity to assess both Piedmont and Coastal Plain streams. RSAT employs both a reference stream and an integrated numerical scoring and verbal ranking approach.

The following six standard RSAT survey evaluation categories were assessed to compute the overall RSAT stream evaluation scores: 1) Bank Stability, 2) Channel Scouring/Sediment Deposition, 3) Physical Instream Habitat, 4) Water Quality, 5) Riparian Habitat Condition and 6) Biological Indicators. The Level III evaluation included both 20-jab, with a D-frame 600 micron mesh kick net, best habitat streambed sampling for macroinvertebrate metric calculations and Fairfax County, Virginia (Department of Public Works and Environmental Services, Stormwater Planning Division) Stream Protection Strategy (SPS) macroinvertebrate Index of Biological Integrity (IBI) scoring of surveyed stream reaches. Sample metrics included: 1) taxa richness, 2) total number of Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa, 3) percent of EPT individuals, 4) percent of Trichoptera without Hydropsychidae, 5) percent of Coleoptera individuals, 6) Hilsenhoff's Family Biotic index, 7) percent dominant taxa, 8) Percent of Clingers and Percent of Plecoptera individuals, 9) Percent Shredders, and 10) Percent Predators. The following sections provide a brief overview of the types of field measurements and observations made for each of the preceding six RSAT evaluation categories. The reader is referred to Appendix 2 for RSAT Level III survey field data.

2.2.1 Bank Stability

One of the primary assessments of channel stability is overall bank stability which is evaluated through both a visual estimation of the percentage of bank length that is stable along each transect surveyed (expressed as a percentage) and a generalized approximation of the degree of erosion between transects (categorized verbally as stable, slight, slight/moderate, moderate, moderate/severe, or severe). To accurately document streambank channel conditions, COG staff employed the Trimble GEO-XT GPS receiver to register and georeference linear stream channel reaches that depicted the previous six channel streambank conditions. Additional observations factored into the bank stability evaluation include the stability of stream bend areas and the number of recent, large tree falls per stream mile. The relative erodibility of the soil material comprising the bottom one-third of the bank (the area most susceptible to erosion) is also considered.[1] Another factor considered in assessing channel stability is the degree of channel downcutting which is evaluated by a set of indicators that includes bank heights, exposed utility lines and nickpoints.[1]

[1] Relative erodibility describes the erosion potential and is classified as low, moderate or high. Low potential denotes predominantly clay-textured soils, bedrock, saprolite and rip-rap; moderate potential characterizes non-silt or non-clay dominant soil textures; and high potential describes predominantly silt-textured soils.

2.2.2 Channel Scouring/Sediment Deposition

A key factor in evaluating the degree of sediment deposition occurring along the stream channel is the mean embeddedness level of riffle substrate material.[2] Other important indicators of sediment load and transport include pool depths and the amount of silt and sand in pools; sand and silt deposits within run areas and along the tops of banks; and the number of large, unstable point bars. Point bars also provide insight into the degree of channel scouring. For example, point bars armored by cobble-sized materials generally reflect frequent, intense storm flows unlike point bars comprised of smaller, gravelly or sandy material. Scouring is also sometimes evidenced by riffle areas where lower-lying resistant streambed materials such as bedrock or clay have been exposed and the upper layers of loose substrate material have been stripped away.

2.2.3 Physical Instream Habitat

Two important criteria include the quality of both riffle substrate material and pools. For higher gradient Piedmont streams, the ideal riffle substrate includes a mix of cobble, rubble, coarser gravel with some larger boulder-sized stones and little sand. Cobble and rubble-sized materials should be the dominant and co-dominant materials present, respectively. Poor riffle substrate quality is generally associated with a very high and disproportionate amount of sand, silt and fine gravel. Small riffle substrate, such as sand and fine gravel provides limited habitat for macroinvertebrates and fish, is inherently unstable and generally supports a limited biological community. Individual pool quality is assessed relative to its value as fish habitat and is based on five factors: 1) size and maximum pool depth, 2) substrate composition, 3) amount and type of overhead cover, 4) amount and type of submerged cover and 5) proximity to key food producing areas such as the nearest upstream riffle area. Another criteria considered in evaluating physical instream habitat is the stream channel's wetted perimeter at riffle areas.[3] Diverse depths of flow and velocities through riffles are important to the sustainability of diverse macroinvertebrate communities. Additional factors considered in assessing overall physical instream habitat include: the degree to which riffles, runs and pools are equally represented; channel alteration or significant point bar formation; the riffle/pool ratio and the number of fish barriers (either partial or complete) present.[4]

[1] Mean bank heights of one to two feet for small first and second-order streams and two to three feet for third-order streams approximate reference conditions. Sewer lines are typically laid three to four feet below the bottom of the streambed; therefore, their exposure offers insight into the depth of downcutting that has occurred. A nickpoint is an erosional feature in the streambed, marked by an abrupt drop in elevation, which is caused by stream headcutting.

[2] Embeddedness is the amount of sand and/or silt that surrounds or covers larger riffle materials such as gravel, cobble, and rubble; it is expressed as a percentage.

[3] Wetted perimeter is the percentage of the bottom channel width at riffle areas that contains flowing water.

[4] Partial barriers denote any obstruction, which would likely prohibit or impede normal upstream-downstream fish movements during certain times of the year (e.g., low summer baseflow conditions). Complete barriers describe obstructions, which totally prevent the normal movement of fish throughout the year (e.g., a perched culvert, which features a three-foot-high vertical drop).

2.2.4 Water Quality

Two key RSAT indicators of baseflow water quality are substrate fouling and total dissolved solids (TDS). Substrate fouling provides a qualitative indirect measure of the chronic nutrient (primarily nitrogen) and organic carbon loading to a stream.[1] TDS levels often increase in response to the introduction of a variety of pollutants such as sewage from septic field/sanitary sewer line exfiltration, road salts, fertilizers, etc. Additional parameters measured include nitrate concentrations (which also provide indirect evidence of potential inputs such as sewage, chemical fertilizers and/or decaying organic matter), orthophosphate (a limiting macro-nutrient for algae), iron, copper, turbidity, water temperature, pH, dissolved oxygen (DO) and conductivity. Water clarity and odor are also documented. Baseflow water quality readings were taken using a Horiba U-10 water quality meter, Hach total dissolved solids (TDS) meter and Hach nitrate, orthophosphate, iron, sulfate, copper and fluoride pocket colorimeters.

2.2.5 Riparian Habitat

The quality of riparian habitat is evaluated based on 1) the width of the vegetated buffer zone on the left and right banks and the type of vegetation (a forested buffer rating highest) and 2) the percent canopy coverage (i.e., shading) over the stream.

2.2.6 Biological Indicators-Benthic Macroinvertebrate Biosurvey

Benthic macroinvertebrates are often used for biological monitoring because they are a ubiquitous diverse group of sedentary and relatively long-lived taxa, which often respond predictably to human watershed perturbations. Importantly, a stream's biological community normally responds to and is reflective of prevailing water quality and physical habitat conditions. The two principal factors considered in evaluating the benthic macroinvertebrate communities are: 1) the number of taxa present (i.e., species richness) and 2) the relative abundances (i.e., total number of individuals) of taxa present. Two types of macroinvertebrate samples were collected. For every survey reach, taxa were collected at each riffle transect area by compositing two one-square foot kick and two one-square foot jab samples. Representative individuals were preserved in ethyl alcohol and placed in the RSAT voucher collection. Sixteen RSAT stream segments and two Catoctin Creek tributaries with riffle areas present were also quantitatively sampled by compositing the 20-jab sample streambed area collected from all

Table 2. RSAT Scoring System

RSAT Evaluation Category	General Verbal Rating Categories and Associated Point Range			
	Excellent	Good	Fair	Poor
1. Bank Stability	9 - 11	6 - 8	3 - 5	0 - 2
2. Channel Scouring/Sediment Deposition	7 - 8	5 - 6	3 - 4	0 - 2
3. Physical In-Stream Habitat	7 - 8	5 - 6	3 - 4	0 - 2
4. Water Quality	7 - 8	5 - 6	3 - 4	0 - 2
5. Riparian Habitat Conditions	6 - 7	4 - 5	2 - 3	0 - 1
6. Biological Indicators	7 - 8	5 - 6	3 - 4	0 - 2
Verbal Ranking (based on total score: 42-50 pts = Excellent, 30-41 pts = Good, 16-29 pts = Fair, <16 pts = Poor)				

[1] Substrate fouling is defined as the percentage of the underside surface area of a cobble-sized stone (or larger) lying free on the streambed, which is coated with a biological film or growth.

representative available habitat. As previously stated, the 20-jab sample was used for Fairfax County, Virginia SPS macroinvertebrate IBI scoring evaluations. RSAT biological indicators scoring is based on both the taxa observed and collected as well as relative abundances over the entire survey reach.

An example of the RSAT scoring system has been included as Table 2. As seen in Table 2, the channel stability evaluation category was weighted slightly more heavily than the other five categories. This was done intentionally to reflect the major influence which the stream flow regime exerts on all six evaluation categories. For more detailed information regarding RSAT field protocols the reader is referred to Appendix A of "Technical Memorandum: Rapid Stream Assessment Technique (RSAT) Field Methods" (Galli, 1996a).

Measurement Via the Employment of a Laser Tech, Inc. Impulse 200 Laser Rangefinder

2.3 Channel Cross-Sections

As part of the channel morphology characterization portion of the study, COG staff established channel cross-section stations at seven selected RSAT representative transect mainstem locations. At each station location, cross-sectional elevational differences were recorded, via the employment of both an 11 foot-long fiberglass surveyor's rod and a Laser Tech Inc. Impulse® 200 Laser Rangefinder. Channel measurements were made to the nearest 100th of an inch. The following sixteen RSAT channel mainstem locations were selected:

- Clarks Run - Lower mainstem (Saint Clair Lane);
- Catoctin Creek - Upper south mainstem (Ketoctin Church Road and Piggott Bottom Road areas) and upper north mainstem (Hillsboro Road area);
- Catoctin Creek Tributaries - Hamilton Station Road tributary (Hamilton Station Road), Talbot Farm tributary (Clarkes Gap Road), Clover Mill Road tributary (Clover Mill Road), Richard Creek (Purcellville Road), Brens Creek (Ash George Road), upper Milltown Creek (Bolington Road), middle Milltown Creek (Milltown Road), and EcoVillage tributary (Taylortown Road);
- Quarter Branch - (Garnet Road);
- Dutchman Creek - Middle mainstem (Irish Corner Road); and
- Piney Run - Middle mainstem (Arnold Lane) and lower mainstem (Branchriver Road).

2.4 Modified Pebble Count Survey

A modified Wolman (1954) pebble count survey was performed at the previously mentioned 16 RSAT representative transect mainstem locations. The survey incorporated results from both the riffle substrate size distribution and the streambed materials observed within the 500-700 foot long RSAT transect station reach. The modified pebble count survey is a rapid procedure designed to qualitatively characterize the common substrate particle size within the given survey reach.

2.5 Modified Rosgen Level I and II-Stream Channel Morphology Characterization

Measurements to characterize Level I (e.g., Stream Type B, moderately entrenched, moderate gradient, riffle dominated channel with stable banks, width/depth ratio > 1.2, etc.) and Level II (e.g., bankfull width, mean depth, bankfull cross-section area, width/depth ratio, maximum depth of the bankfull cross-section, width of flood prone area, entrenchment ratio, water surface slope, etc.) conditions were performed employing a Laser Tech Incorporated Impulse® 200 Laser. For further Rosgen Level I and II method descriptions, the reader is referred to "*Applied River Morphology*" (Rosgen, 1996). For results of the Modified Rosgen Level I and II-Stream Channel Morphology Characterization, the reader is referred to Appendix 4**.**

2.6 Biological Monitoring

2.6.1 RSAT Macroinvertebrate Voucher Sample

RSAT Level III surveys were conducted in fall 2005 and spring 2006. For each RSAT riffle transect area, taxa were collected from representative riffle, run and pool habitat via the previously stated two one-square foot kick and two one-square foot jab protocol. A D-frame net with a 600-micron mesh was used to collect macroinvertebrates. In addition, macroinvertebrates were collected at each transect from the bottom side of 10 cobble-sized stones and included in the voucher collection.

Macroinvertebrate 20-Jab Best Habitat Sampling

2.6.2 20-Jab Best Habitat Macroinvertebrate Sampling

As part of the RSAT Level III evaluation, spring 2005 20-jab macroinvertebrate best habitat sampling was performed at the 16 RSAT stream sites. This collection is a quantitative survey that combines jabs from pool, run and riffle habitat sweep samples. Again, organisms were collected from these representative habitat areas using a 600-micron mesh D-frame net.

2.6.3 Taxonomy

RSAT voucher samples were identified in the field to the family level and preserved for laboratory identification to the lowest possible taxonomic level using the following taxonomic references: Harper and Hynes, 1971; Merritt and Cummins, 1996; Pennak, 1989; Stewart and Stark, 1993; Epler, 2001 and Wiggins, 1998. All preserved organisms collected via the 20-jab surveys were counted and identified by COG staff to the lowest possible taxonomic level. For aquatic insects, identification was, with few exceptions, to the genus level.

2.6.4 Macroinvertebrate Biosurvey Scoring

RSAT biosurvey scoring is based on the taxa observed and collected in the field as well as on the voucher collection for the entire survey reach. The 20-jab sampling scoring is based on the ten metrics currently employed by Fairfax County, Virginia SPS (Stribling et al., 1998) for Piedmont streams (i.e., 1) taxa richness, 2) total number of Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa, 3) percent of EPT individuals, 4) percent of Trichoptera without Hydropsychidae, 5) percent of Coleoptera individuals , 6) Hilsenhoff's Family Biotic index, 7) percent dominant taxa, 8) percent of clingers and percent of Plecoptera individuals, 9) percent shredders, and 10) percent predators). It should be noted that the SPS used these metrics to develop the Fairfax County Index of Biological Integrity (IBI) for Piedmont streams. This IBI was employed for Clarks Run, Catoctin Creek, Quarter Branch, Dutchman Creek and Piney Run biosurvey scoring.

2.7 Catoctin Creek Riparian Buffer Analysis

In 2002, Virginia Department of Environmental Quality (VADEQ) listed Catoctin Creek in its 303(d) stream impairment listing for fecal coliform bacteria. In an effort to reduce fecal coliform bacteria levels in Catoctin Creek in order to meet the requirements under the associated total mean daily loads (TMDL) implementation plan requirement, Loudoun County has examined various cost-effective bacteria reduction measures. Among the many approaches are the employment of water quality enhancing riparian buffers and greater exclusion of livestock from stream systems. In an effort to provide a more accurate picture of the current state of the Catoctin Creek riparian buffer system and assist Loudoun County in carrying out TMDL implementation-related activities to meet fecal coliform reduction goals, a preliminary assessment of existing forest canopy coverage, using four stream buffer width scenarios (i.e., 35, 50, 100, and 200 feet), was performed for the following mainstem and tributary areas:

- The entire Catoctin Creek mainstem, including the North and South Forks and the mainstem portion below the town of Waterford, Virginia; and
- Seven tributary mainstems - Hamilton Station Road tributary, Talbot Farm tributary, Clover Mill Road tributary, Richard Creek (tributary to Brens Creek), Brens Creek, Milltown Creek and EcoVillage tributary.

These buffer widths were chosen for the analysis based on: 1) Loudoun County implemented federal and state cost share riparian enhancement programs (which require landowners to set aside a minimum 35 foot wide riparian buffer area on each side of the stream in order to qualify); 2) the Chesapeake Bay Preservation Act (enacted by Virginia in 1988), which established a recommended minimum 100 foot wide riparian buffer; and 3) a buffer width of 200 feet (along each streambank), considered by many, as optimal for protecting water quality and related wildlife habitats.

The method used for analyzing riparian forest buffer widths included both digitizing the forest canopy coverage polygons from the SPOT 5 satellite that provided 2005 'leaf-on' 5-meter resolution condition imagery of the Catoctin Creek watershed, as well as limited groundtruthing. The procedure employed the digital stream network system (e.g., Loudoun County major drains geodata file) provided by the Office of Mapping. From this digital stream layer, a 35, 50, 100 and 200 foot stream buffer polygon digital layer was developed. Using this stream buffer polygon layer, as a 'cookie cutter', an image was extracted from the base SPOT Catoctin Creek watershed satellite imagery that represents each of the four riparian buffer width scenarios. Subsequently, the riparian buffer width image was classified (i.e., heads-up digitizing) for 'forest canopy' and 'non- forest canopy' conditions. Furthermore, areas denoted as 'non-forest canopy' coverage within the four riparian buffer widths were identified for potential reforestation sites. The following four part analyses were conducted:

1) Existing riparian forest buffer condition for four width scenarios: 35, 50, 100 and 200 feet (Appendix 6, Table 1);
2) Non-forested 35 foot wide riparian buffer condition to meet CREP minimum enrollment requirements (Note: due to limited resources, COG did not perform this analysis for the 50, 100 and 200 foot buffer width scenarios.); and
3) Potential riparian buffer reforestation area identification for both the 35 and 100 foot scenarios (Appendix 6, Table 2 and Table 3, respectively).

It should be noted that existing development, infrastructure or land features (i.e., steep slope) may preclude reforestation in some of these areas. It is also recognized that these areas will need to be groundtruthed and that the actual reforestation of these sites is incumbent upon approval of the landowner. Appendix 6 highlights the Catoctin Creek mainstem riparian buffer condition for the 100 foot width scenario and the centroid location for potential reforestation site opportunities within the 35 and 100 foot riparian buffer widths.

3.0 Results

3.1 Clarks Run

3.1.1 Streambank Stability, Relative Erodibility and Channel Downcutting

Clarks Run (Transect X-2) - Slight Streambank Erosion

Clarks Run (Upstream of X-3) - Moderate Streambank Erosion

Overall, streambank stability in Clarks Run (78.8 percent) was rated as being in the good range (i.e., 71 - 80 percent). As seen in Table 3 and Figure 3, neither moderate/severe nor severe bank erosion conditions were observed. A total of 356.4 feet of moderate streambank erosion, representing 7.6 percent of the total stream network length, was recorded. The associated calculated rate for the moderate streambank erosion category (i.e., 60-70 percent of the bank network is stable) is 401.2 linear feet per mile. The majority of the stream network survey length was observed to have slight or slight/moderate levels of streambank erosion. Corresponding lengths were 1,951.0 feet and 2027.0 feet, respectively. Not surprisingly, moderate streambank erosion conditions were generally associated with streambank outer bends.

RSAT streambank relative erodibility results (Figure 4) indicate that the bank material present at the Clarks Run site is primarily comprised of moderately erodible, loamy soils.

Stream channel downcutting results (Table 4 and Figure 5) revealed that mean bank heights in Clarks Run exceeded the expected or

Table 3. Clarks Run - Streambank Erosion Conditions

RSAT Stream Segment	Surveyed Stream Length (ft.)	Surveyed Streambank Network[1] Length (ft.)	Bank Erosion Conditions						No. of Recent Tree Falls[2]		No. of Erosional Log Jams	Mean Bank Stability (%)[3]
			Severe		Moderate/Severe		Moderate					
			(LF)	(LF/mi.)	(LF)	(LF/mi.)	(LF)	(LF/mi.)	No.	No./mi.		
Clarks Run												
Clarks Run	2,345.2	4,690.4	0.0	0.0	0.0	0.0	356.4	401.2	1.0	1.1	0.0	78.8

[1] Length to include both the left and right bank (i.e., twice the distance of the surveyed stream length).
[2] Tree fall interpretation: 0-1/mi. = Excellent, 2-3/mi. = Good, 4-5/mi = Fair, ≥6 = Poor.
[3] Mean bank stability interpretation: >80% = Excellent, 71-80% = Good, 50-70% = Fair, <50% = Poor.

Figure 3. Summary: Clarks Run - Bank Stability

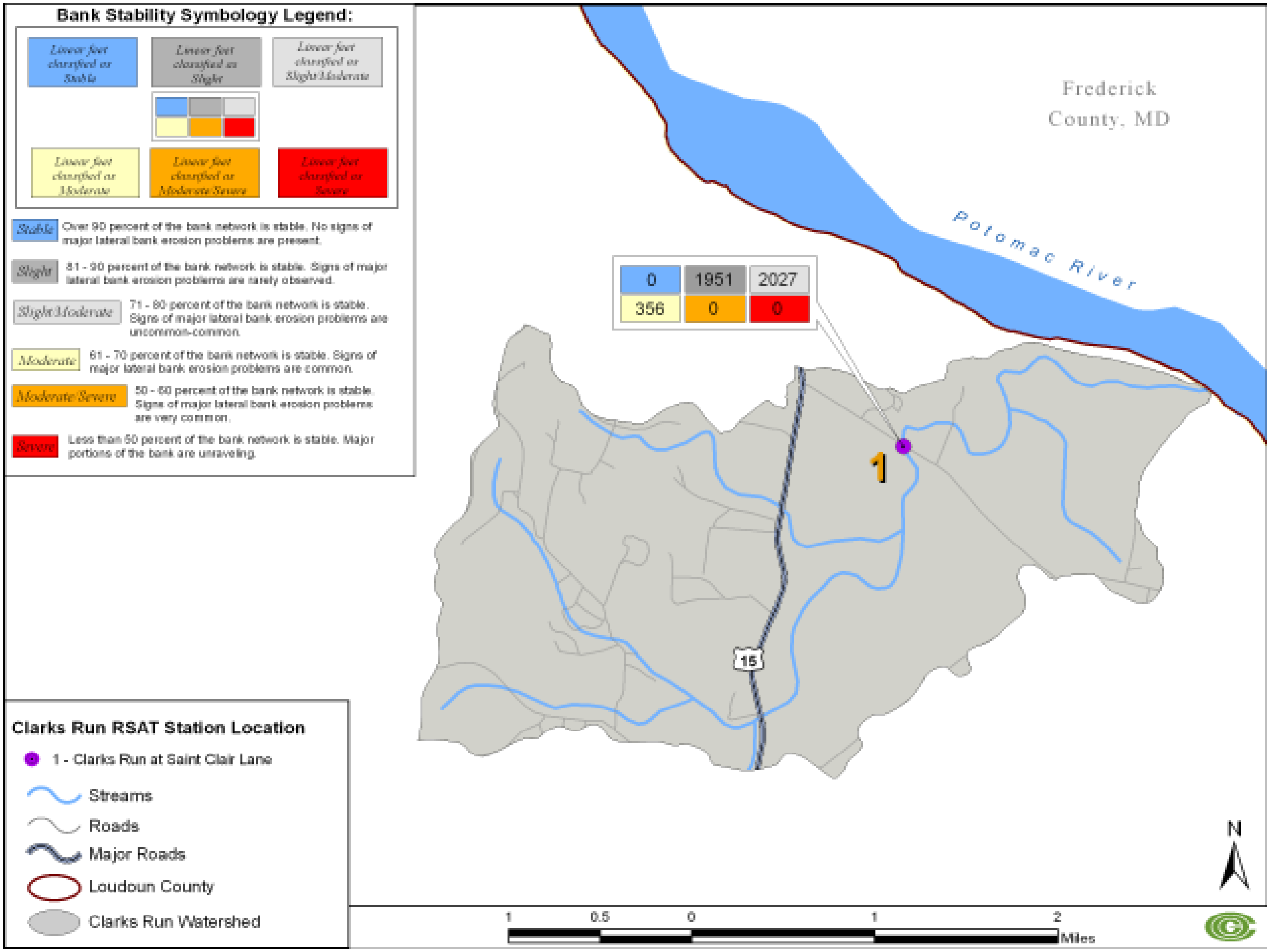


Figure 4. Summary: Clarks Run - Mean Streambank Stability and Relative Erodibility [1] (%)

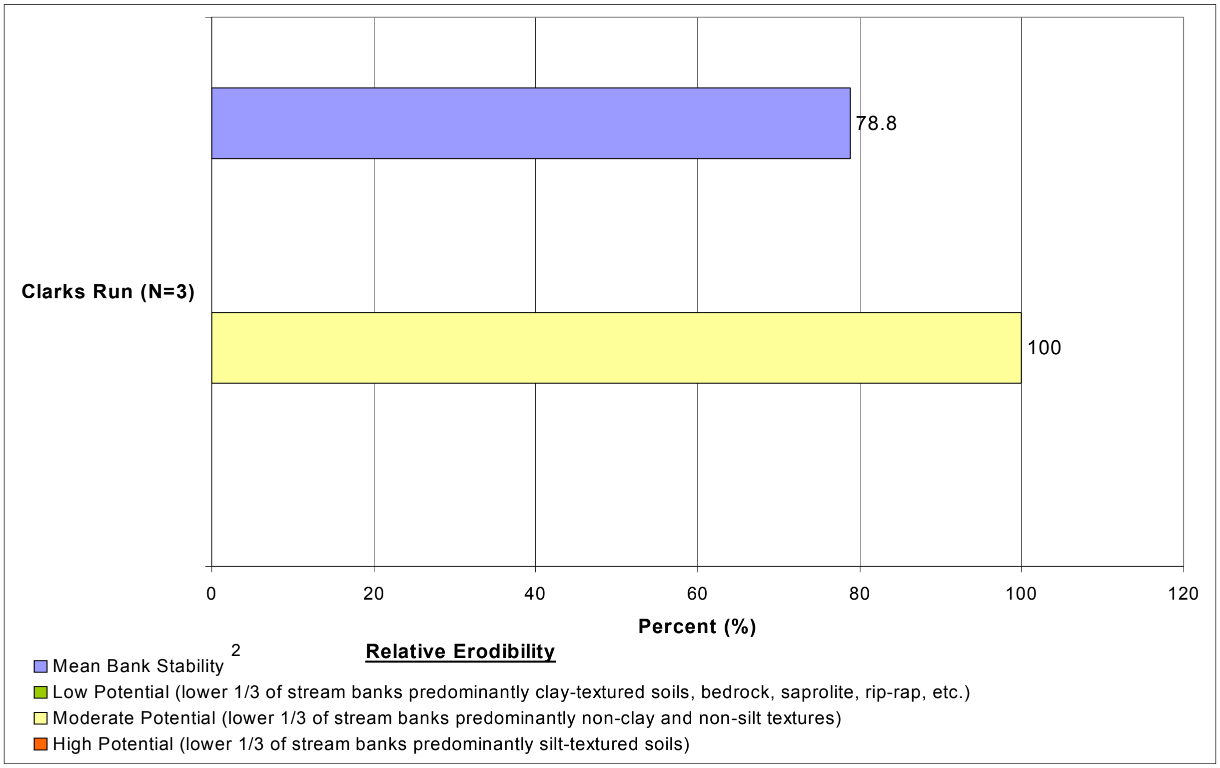
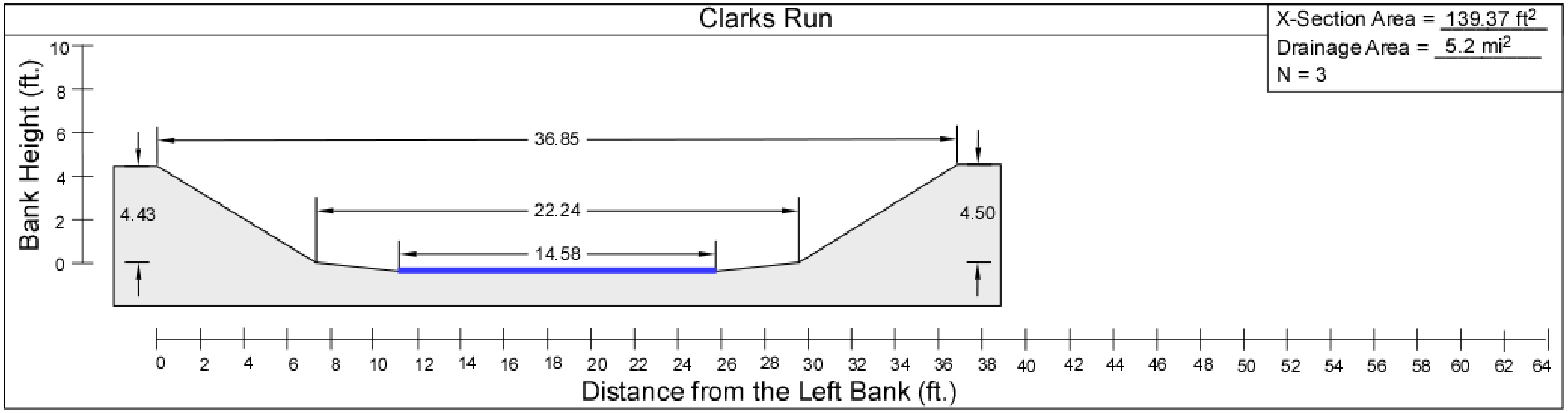


Table 4. Summary: Clarks Run - Stream Channel Downcutting

RSAT Stream Segment	Drainage Area (mi^2)	Surveyed Stream Length (ft)	Mean Bank Height R[3] (ft)	Mean Bank Height L[4] (ft)	Mean Bank Height (ft)	Expected Bank Height Range (ft)	Number of Nick Points
Clarks Run							
Clarks Run	5.2	2,345	4.5	4.4	4.5	2-3	0

[1] Total number of observations to determine average bank stability and relative erodibility appear in parentheses.
[2] Mean bank stability interpretation: >80% = Excellent, 71-80% = Good, 50-70% = Fair, <50% = Poor.
[3] Right bank looking downstream.
[4] Left bank looking downstream.

Figure 5. Representative Channel Cross-Sections[1] - Clarks Run Mainstem



[1] Top channel width, bottom channel width and wetted perimeter area depicted.

reference condition 2-3 foot height range by approximately 1.5 feet. The combination of the relatively wide stream channel cross-sectional area (i.e., 139.37 square feet) together with relatively tall bank heights suggests that there has been an appreciable amount of stream channel downcutting and widening.

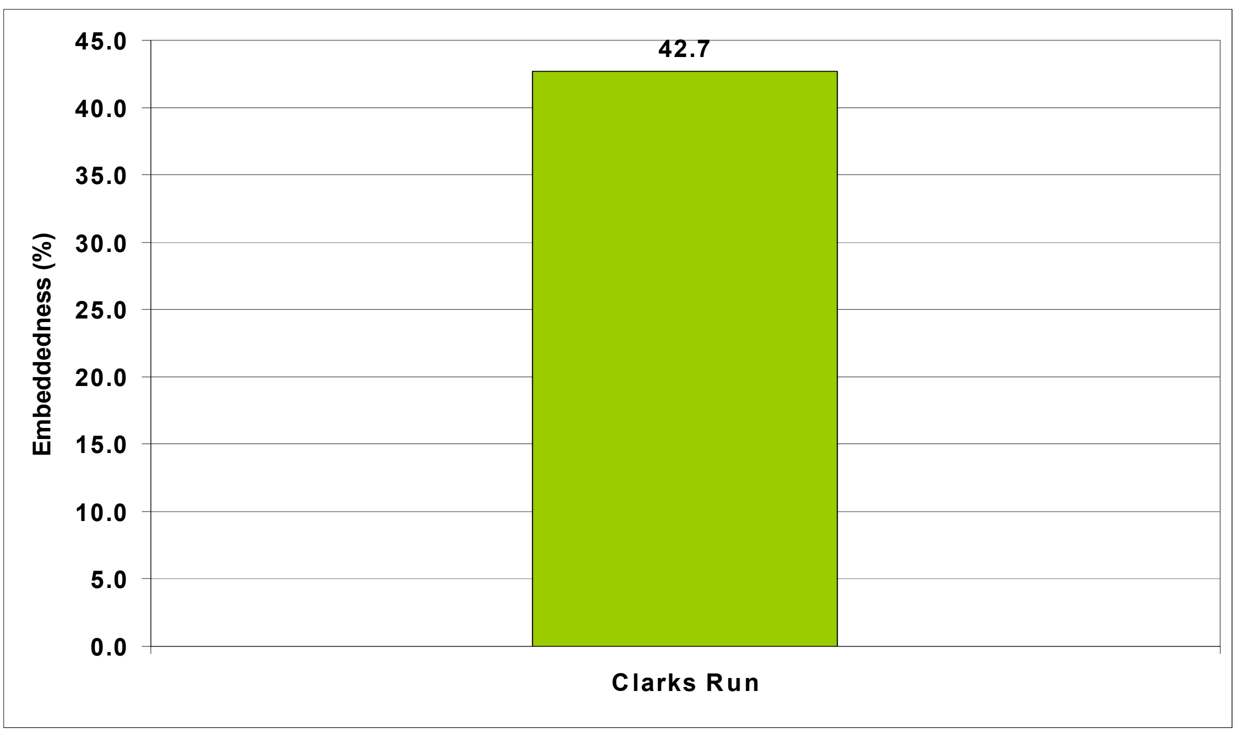
3.1.2 Channel Scouring and Sediment Deposition

Unstable large point bars were not observed in Clarks Run. Riffle embeddedness levels were rated as being good to excellent, and ranged from 23 to 60 percent. The overall mean embeddedness level of 42.7 percent was rated as being good (Figure 6). RSAT survey results also revealed a moderate level of in-channel sand deposition, suggesting that a significant amount of the sandy material is frequently deposited in this stream segment.

Table 5. Summary: Clarks Run - Channel Scouring/Sediment Deposition Conditions

RSAT Stream Segment	Surveyed Stream Length (ft.)	Percent Riffle Embbeddedness[1]		Large Point Bars				Relative Level of In-Channel Sand Deposits
		Observed Range	Mean	Total Number Observed	No. Unstable	Percent Unstable (%)	No.of Unstable/ Mile	
Clarks Run								
Clarks Run	2,345	23-60	42.7	0	0	0	0.0	Moderate

Figure 6. Clarks Run - Mean Riffle Embeddedness Levels[1]



[1] Riffle embeddedness rating scale: <25% = Excellent, 25-50% = Good, 51-75% = Fair, >75% = Poor.

3.1.3 Physical Aquatic Habitat

General physical aquatic habitat conditions for Clarks Run are summarized in Table 6 and Figure 7. As seen in Table 6, the general physical aquatic habitat condition for Clarks Run was rated as being good. Major contributing factors for the overall good rating include low embeddedness levels (i.e., 42.7 percent = good), relatively deep mean riffle depths (i.e., greater than 2.5 inches deep) and excellent pool quality (i.e., 5.0 points = excellent). Generally, the excellent pools were deep (i.e., greater than 22 inches), featured cobble and large gravel substrate and provided abundant overhead cover for fish. It should be noted that the excellent quality pools were frequently associated with instream limestone rock outcrops.

A total of two fish barriers were observed. Of the two, only one complete fish barrier was recorded in the survey. The blockage has a 0.6 foot vertical drop associated with the Saint Clair Lane road quadruple cell culvert. The other structure, classified as a partial barrier, was an abandoned beaverdam located immediately upstream of transect X-2. The beaverdam may preclude larger bodied fish from moving upstream.

Limestone Rock Outcropping and Associated Excellent Pool Habitat

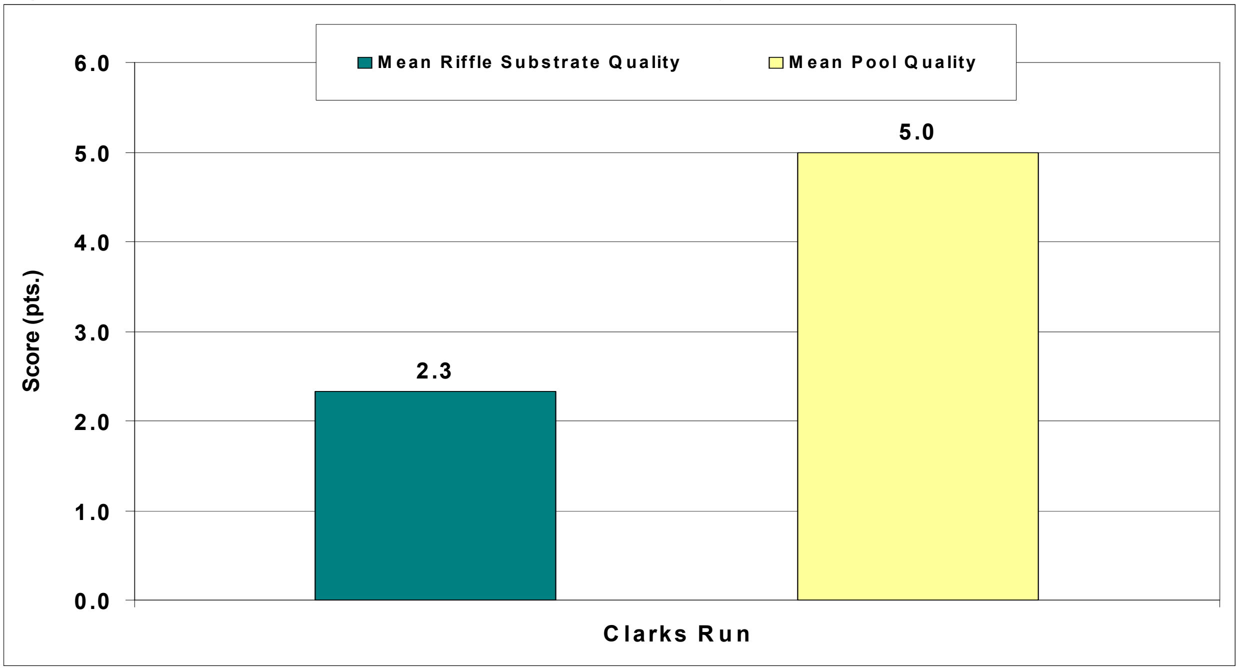
Complete Fish Barrier - Saint Clair Lane Road Culvert

Table 6. Summary: Clarks Run - General Physical Aquatic Habitat Conditions [1]

RSAT Stream Segment	Riffle Characteristics				Pool Characteristics				Fish Barriers		RSAT Physical Habitat Score (pts.)[6]
	No. of Riffles	Mean Riffle Depth (in.)	Mean Riffle Substrate Quality (pts.)[2]	Mean Riffle Embeddedness(%)[3]	No. of Pools	Mean Max. Depth (in.)	Mean Pool Quality (pts.)[4]	Riffle/ Pool Ratio[5]	Total Number	Per Mile	
Clarks Run											
Clarks Run	14	3.2	2.3	42.7	16	24.7	5.0	0.9	1	2	6

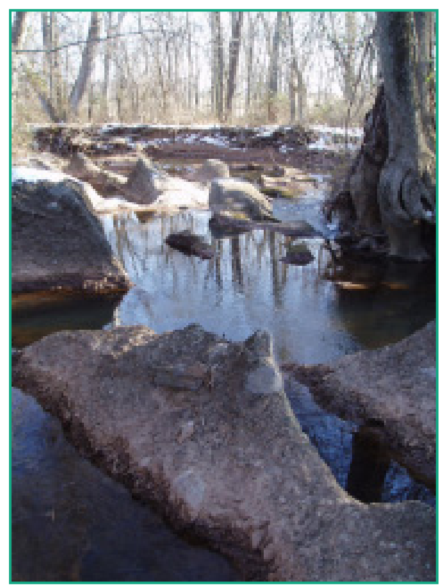
[1] Mean values shown are weighted means.
[2] Riffle substrate quality rating scale: 3.25-4.00 = Excellent, 2.50-3.24 = Good, 1.75 – 2.49 = Fair, 1.00- 1.74 = Poor.
[3] Riffle embeddedness rating scale: <25% = Excellent, 25-50% = Good, 51-75% = Fair, >75% = Poor.
[4] Quality pool point scale interpretation: 5 = Excellent, 4 = Very Good, 3 = Good, 2 = Fair, 1 = Poor.
[5] Riffle/pool ratio rating scale: 0.9-1.1:1 = Excellent, 0.70-0.89:1 or 1.11-1.3:1 = Good, 0.5-0.69 or 1.31-1.5:1 = Fair, 0.49:1< or >1.51:1 = Poor.
[6] RSAT Physical habitat rating scale: 6.5-8.0 = Excellent, 4.5-6.4 = Good, 2.5-4.4 = Fair, 1.0-2.4 = Poor.

Figure 7. Clarks Run - Mean Riffle Substrate[1] and Pool Quality[2]



3.1.4 Water Quality

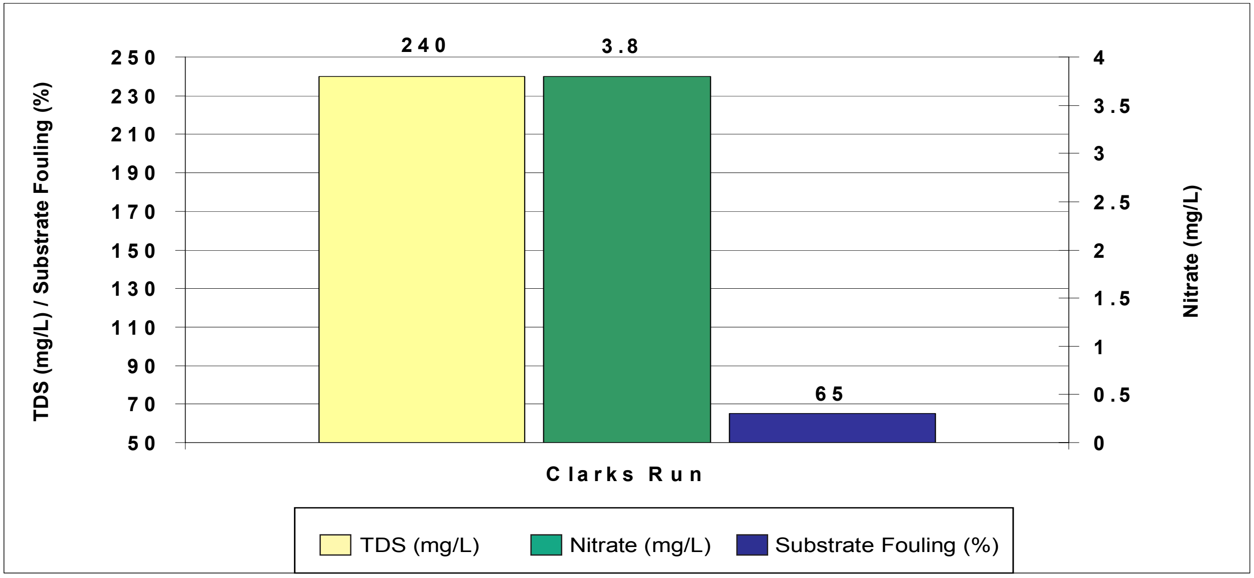
RSAT water quality grab sampling total dissolved solids (TDS), nitrate and mean substrate fouling summary results are presented in Figure 8. The instantaneous TDS concentration, 240 mg/l, is in the poor range (i.e., >150 mg/l). However, this high reading also reflects the higher level of dissolved solids associated with streams draining limestone parent material. Not surprisingly, pH (9.51) was within the alkaline range. The instantaneous nitrate level of 3.8 mg/l is considered high (i.e., >3.0 mg/l). Substrate fouling, 65 percent, was in the poor range (i.e., >50%). With regard to instantaneous dissolved oxygen (DO) levels, there were no violations of the Virginia Department of Environmental Quality (VADEQ) minimum 4.0 mg/l criterion. In fact, Clarks Run was observed to be well oxygenated, with a mean DO concentration of 12.83 mg/l. The overall RSAT water quality rating for Clarks Run was rated as being fair (i.e., 3 points).



In-stream Limestone Conglomerate Outcropping

[1] Riffle substrate quality point scale interpretation: 3.25-4.00 = Excellent, 2.50-3.24 = Good, 1.75-2.49 = Fair, 1.00-1.74 = Poor.
[2] Pool quality point interpretation: 4.5-5.0 = Excellent, 4.0-4.4 = Very Good, 3.0-3.9 = Good, 2.0-2.9 = Fair, 1.0-1.9 = Poor.

Figure 8. Clarks Run - Mean TDS[1], Nitrate[2] and Substrate Fouling[3]



3.1.5 Riparian Habitat Conditions

The Clarks Run riparian habitat condition was rated as being in the lower good range (i.e., 4 points). The overall mean canopy coverage observed along the survey reach was 82 percent, which is considered excellent. Riparian buffer vegetation was typically a mix of forest, grass and corn row crop. The buffer was generally 200 feet wide or greater on both sides of the stream.

Riparian Vegetation Type - Upstream of Transect X-2 - Grass and Corn Field

Table 7. Summary: Clarks Run - Riparian Habitat Conditions

RSAT Stream Segment	Surveyed Stream Length (ft.)	Number of Observations	Mean Canopy Coverage (%)[4]	Riparian Habitat Conditions	
				RSAT Score[5]	Verbal Ranking
Clarks Run					
Clarks Run	2,345.2	5	82.0	4	Good

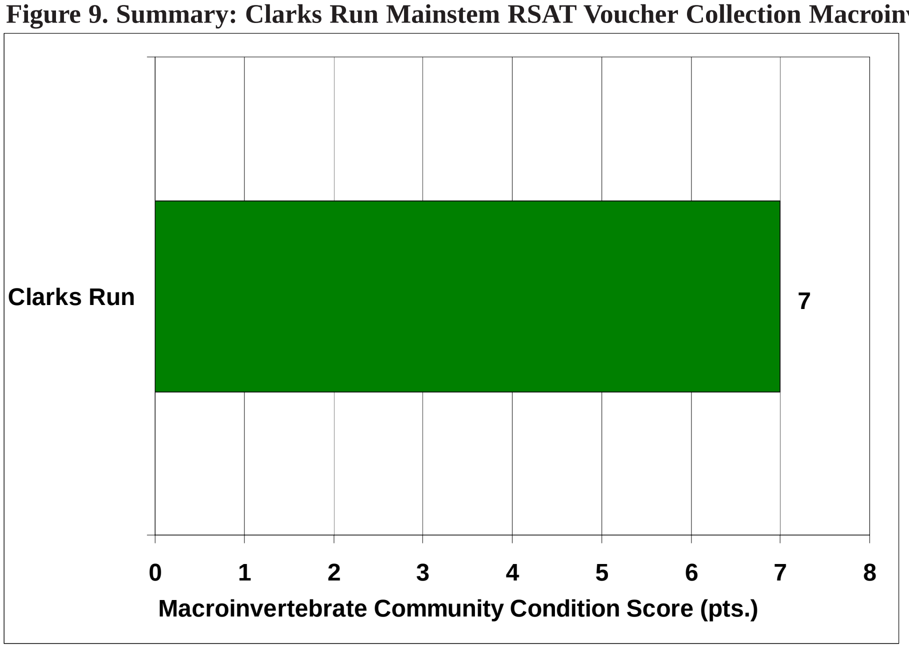
[1] TDS interpretation: <50 mg/L = Excellent, 50-100 mg/L = Good, 101-150 mg/L = Fair, >150mg/L = Poor.
[2] Nitrate interpretation: 0.0-1.0 mg/L= Low, 1.1-2.9 mg/L = Moderate, >3.0 mg/L = High.
[3] Substrate fouling interpretation: 0-10% = Excellent, 11-20% = Good, 21-50% = Fair, >50%=Poor.
[4] Mean canopy coverage interpretation: $\geq$ 80% = Excellent, 60-79% = Good, 50-59% = Fair, <50% = Poor.
[5] Riparian Habitat Condition Point Score Interpretation: 6.0-7.0 = Excellent, 4.0-5.9 = Good, 2.3-3.9 = Fair, 0-1.9 = Poor.

3.1.6 Biological Condition - Benthic Macroinvertebrate Survey

As seen in Figure 9, the macroinvertebrate community condition for the Clarks Run mainstem was excellent. The RSAT voucher total number of taxa[1] collected totaled 27, which is excellent. A total of twelve taxa from the pollution intolerant stonefly, flathead mayfly and cased caddisfly groups (i.e., Ephemeroptera, Plecoptera and Trichoptera - EPT) were present. The voucher also included the stonefly family group (i.e., Capniidae) considered to be highly pollution intolerant. The relative abundance of the EPT taxa groups (flathead mayflies, stoneflies and cased caddisflies) was observed to be 'scarce/common' (Figure 10). The relative abundance of roundhead mayflies was also observed to be 'scarce/common'. It should be noted that the relative abundance of moderately pollution tolerant cranefly larvae was 'common.'

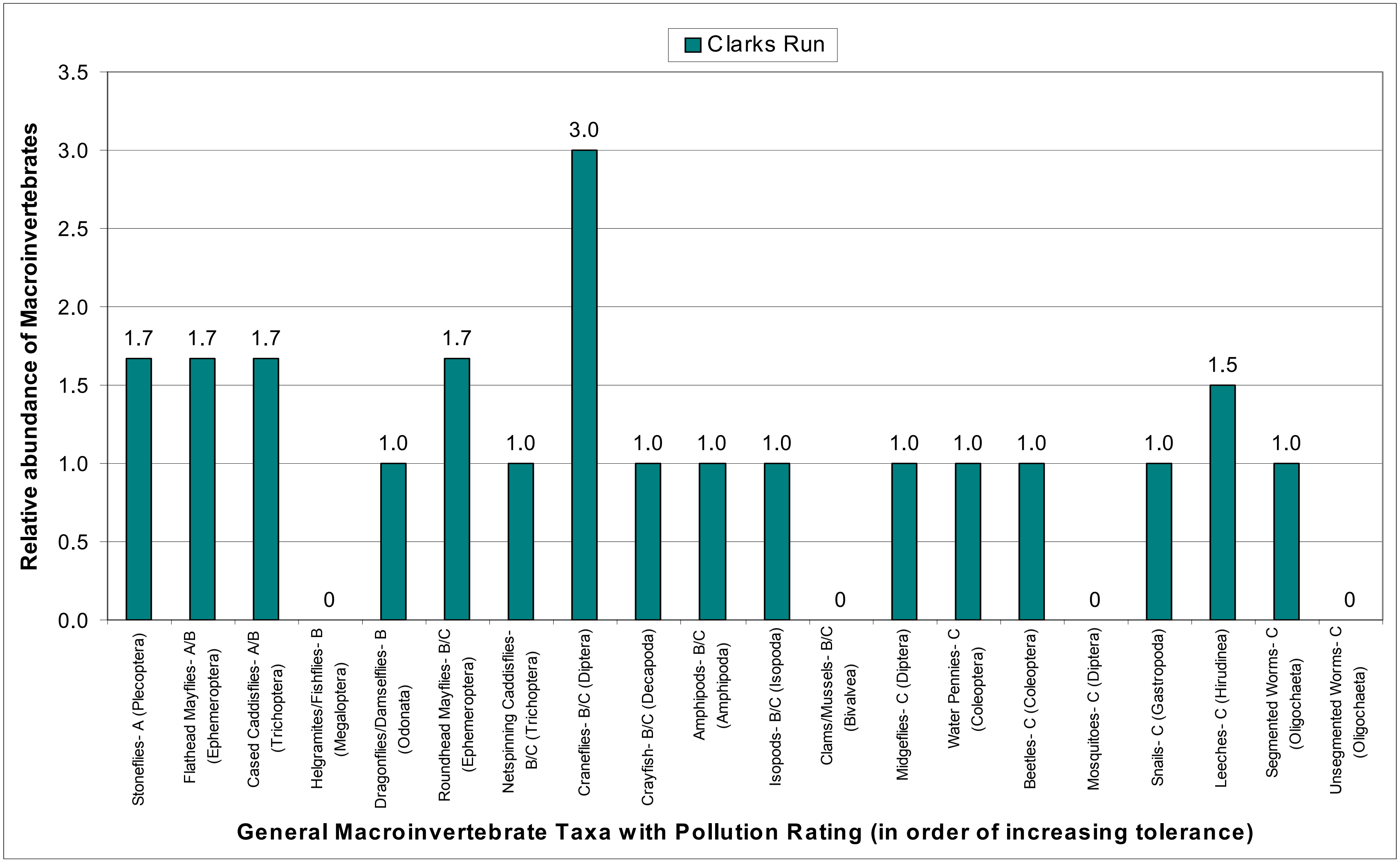
As part of the Level III RSAT survey, an additional spring qualitative 20-jab multiple/best habitat survey was performed. Results from the spring 2005 survey are summarized in Table 8. As seen in Table 8, the Clarks Run mainstem index of biotic integrity (IBI) score (80.8 points) fell just within the excellent range. One of the metrics used to score the IBI, taxa richness, totaled 21 (i.e., good = 16-24), which was the second lowest observed for the entire study. In addition, the two taxa with the highest number of individuals were represented by *Baetis sp.* (mayfly) and *Gammarus sp.* (scud). They are generally considered pollution tolerant taxa. It should be noted that, compared to the Piedmont freestone systems, benthic macroinvertebrate communities for limestone stream systems (like Clarks Run) have been shown to have lower taxa richness. However, such stream systems are likely to have higher numbers of individuals (e.g., *Baetis sp.* and *Gammarus sp.*) present. For additional results from this survey and the RSAT voucher collection, the reader is referred to Appendix 5.

Figure 9. Summary: Clarks Run Mainstem RSAT Voucher Collection Macroinvertebrate Condition[2]



[1] General RSAT voucher interpretation for taxa richness: >=25 = Excellent, 16-24 = Good, 8-15 = Fair, 0-7 = Poor.
[2] Macroinvertebrate scale interpretation: 7.0-8.0 pts. = Excellent, 5.0-6.9 pts. = Good, 2.1-4.9 pts. = Fair, 0.0-2.0 pts. = Poor.

Figure 10. Clarks Run Mainstems - Mean Relative Abundance of Observed Macroinvertebrates[1] and General Pollution Tolerance[2]



[1] Relative abundance interpretation: 0 = No Taxa Found, 0.1-0.9 = Scarce, 1.0-2.0 = Scarce/Common, 2.1-3.0 = Common, 3.1-4.0 = Common/Abundant, 4.1-5.0 = Abundant.
[2] Pollution tolerance rating: A = Intolerant, B = Moderately Tolerant, C = Tolerant.

Table 8. Summary: Clarks Run - 1m^2 Macroinvertebrate Sample Metrics and Fairfax County SPS IBI Score and Rating[1]

RSAT Stream Segment	Approx. Stream Segment Location	Total Number of Ind	Taxa Richness[2]	EPT Richness[3]	Percent EPT[4]	Percent Trichoptera w/o Hydropsychidae[5]	Percent Coleoptera[6]	Family Biotic Index[7]	Percent Dominance[8]	Percent Clingers + Percent Plecoptera[9]	Percent Shredder[10]	Percent Predators[11]	IMBI[12]	SPS Rating
Clarks Run														
Clarks Run	Saint Clair Lane	313	21.0	8.0	47.0	5.0	7.0	4.3	34.5	0.3	25.6	4.2	80.8	Excellent

[1] Scores and Rating were developed by Fairfax County Stream Protection Strategy.
[2] Taxa richness represents the total number of taxa collected and is interpreted by SPS as follows: >= 21 = Excellent, 13–20 = Good, 9-12 = Fair, 5-8= Poor, <5 = Very Poor.
[3] Counts the distinct taxa considered pollution intolerant within the groups of Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies). EPT taxa metrics are interpreted as follows: >7 = Excellent, 5-6 = Good, 4 = Fair, 2-3 = Poor, <=1 = Very Poor.
[4] Measures the abundance of generally pollution intolerant Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) relative to other often more tolerant individuals and is interpreted as follows: >16.6 = Excellent, 12.4-16.5% = Good, 8.3-12.3% = Fair, 4.1-8.2% = Poor, >1.9% = Very Poor.
[5] Measures the absence of generally pollution tolerant Hydropsychidae (caddisflies) relative to other more intolerant Caddisflies and is interpreted as follows: >0.79% = Excellent, 0.60-0.78% = Good, 0.40-0.59% = Fair, 0.39-0.20% = Poor, <0.20% = Very Poor.
[6] Measures the abundance of generally pollution tolerant Coleoptera (beetles) relative to other individuals and is interpreted as follows: >1.00% = Excellent, 0.75 – 0.99% = Good, 0.50-.74% = Fair, 0.25 – 0.49% = Poor and < 0.24% = Very Poor.
[7] The Family Biotic index measures the general tolerance/intolerance of the sample to organic nutrients and is interpreted as follows: 0.00-3.50 = Excellent, 3.51-5.50 = Good, 5.51-7.50 = Fair, 7.51-8.50 = Poor, > 8.51 Very Poor.
[8] Measures the percent of the most abundant taxa relative to the total taxa within the sample and represents community balance. It is interpreted as follows: <60% = Excellent, 61-68.5% = Good, 68.6-84.0% = Fair, 84.5-92.0%= Poor, >92.0% = Very Poor.
[9] Measures the percent of individuals whose habitat type is clingers plus the percent of sample that are stoneflies but are not clingers and is interpreted as follows: >3.28% = Excellent, 2.46-3.27% = Good, 1.63-2.45% = Fair, 0.84-1.62%= Poor, <0.84% = Very Poor.
[10] Measures the percent individuals that are shredders relative to all other feeding guild types and is interpreted as follows: >5.42% = Excellent, 4.10-5.41% = Good, 2.70-4.00% = Fair, 1.39-2.69% = Poor, <1.39% = Very Poor.
[11] Measures the percent individuals that are predators relative to all other feeding guild types and is interpreted as follows: >2.30% = Excellent, 1.52-2.00% = Good, 1.02-1.51% = Fair, 0.50-1.01% = Poor, <0.50% = Very Poor.
[12] SPS IBI score interpretation: 80-100 = Excellent, 60-79 = Good, 40-59= Fair, 20-39 = Poor, 0-19 = Very Poor.

3.1.7 RSAT Summary Stream Quality Ratings

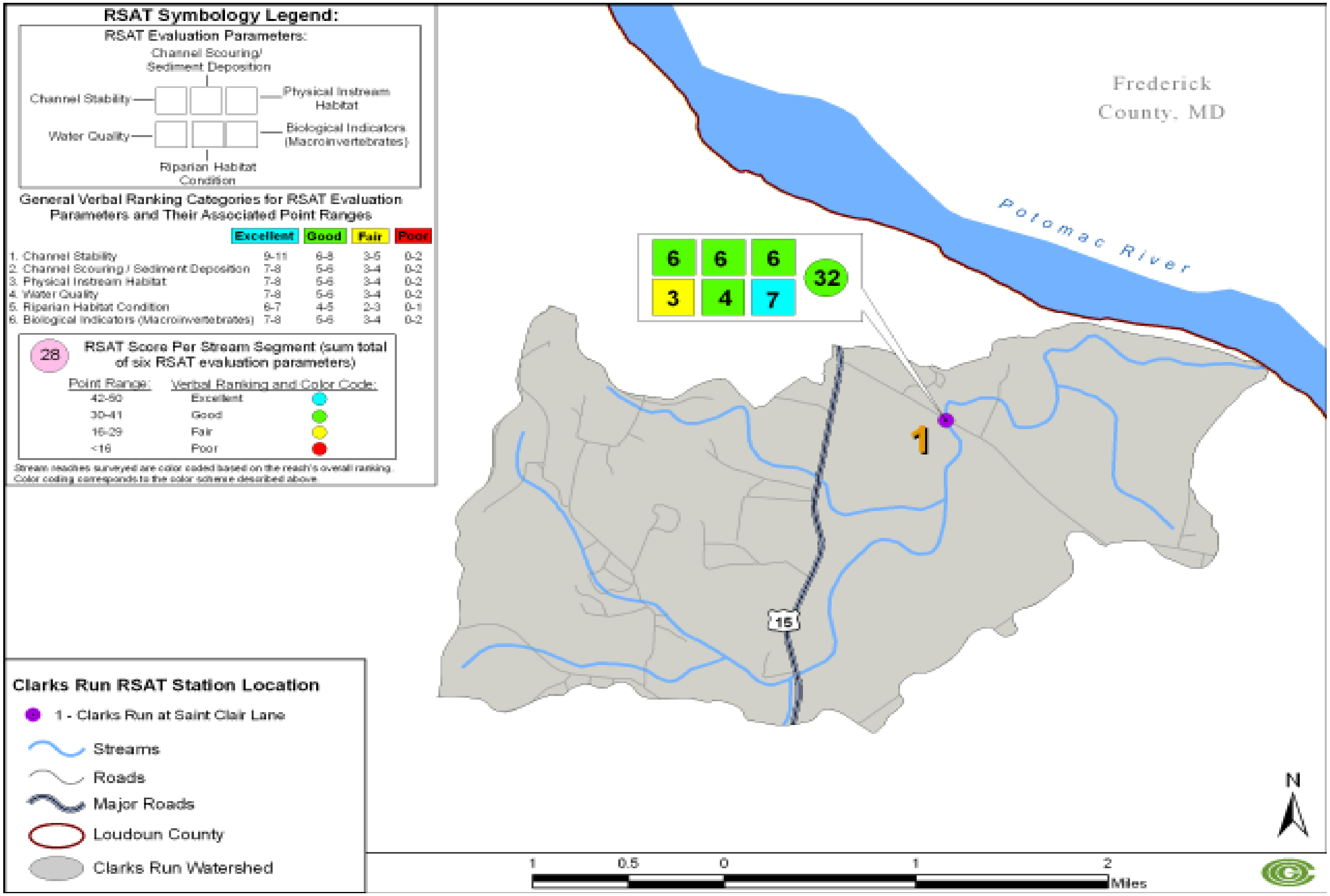
As seen in Table 9 and Figure 11, the overall RSAT stream quality rating for Clarks Run was good. It should be noted that the water quality category was rated fair and reflects the influence of the limestone conglomerate bedrock on the chemical characteristics of this stream system (e.g., high TDS levels due to high levels of dissolved calcium carbonate). Also, the riparian habitat conditions were rated as being good bordering on fair (a result of the less than desirable grass and row crop vegetation present). The only excellent rating given was for biological indicators.

Table 9. Clarks Run Study Summary: RSAT Ratings[1]

RSAT Stream Segment	Approx. Stream Segment Location	Bank Stability	Channel Scouring/ Deposition	Physical Instream Habitat	Water Quality	Riparian Habitat Conditions	Biological Indicators	RSAT Total Score[2]
Clarks Run								
Clarks Run	Saint Clair Lane	Good (6)	Good (6)	Good (6)	Fair (3)	Good (4)	Excellent (7)	**Good (32)**

[1] Actual point values are shown in parentheses.
[2] Total RSAT score interpretation: 42-50 = Excellent, 30-41 = Good, 16-29 = Fair, <16 = Poor.

Figure 11. Clarks Run Study Summary: RSAT Ratings



3.2 Catoctin Creek Watershed - North and South Forks, and Tributaries

3.2.1 Streambank Stability, Relative Erodibility and Channel Downcutting

Mainstem Areas

The overall, mean streambank stability for the Catoctin Creek upper mainstem surveyed area was, at 75.3 percent, rated as being good. Specifically, mean bank stability ratings for the North and South Fork mainstem areas were74.2 and 76.0 percent, placing them in the good range. As seen in Table 10 and Figure 13, streambank erosion survey totals were as follows: 1,343.7 linear feet of moderate erosion, 270.5 linear feet of moderate/severe erosion and 153.5 linear feet of severe bank erosion. The moderate/severe and severe streambank erosion condition totals were recorded in the North Fork at Hillsboro Road and in the South Fork at Ketoctin Church Road stream segments, respectively. In addition, of the four recent tree falls observed, two were documented within the North Fork mainstem. Erosional log jams were not recorded for either the upper North or South Fork mainstems.

It should be noted that the streambank erosion condition for the South Fork mainstem at Piggott Bottom Road was also assessed by COG in 2000. Unlike the 2000 survey, severe and moderate/severe erosion conditions upstream of transect X-2 were not observed in 2006. Rather, for that reach, the streambank erosion condition was classified as moderate. It was observed, during the 2006 survey, that a large tree fell back into the left bank (looking down stream); thereby, providing temporary bank protection.

South Fork Catoctin Creek Mainstem (Piggott Bottom Road, Upstream of X-2) - Moderate Streambank Erosion Condition and Tree Fall

RSAT relative streambank erodibility results (Figure 12) are as follows: 1) the bank soil material for the upper South Fork at Ketoctin Church Road stream segment consisted predominantly of moderate (i.e., loamy textured soils) with some high (i.e., silt or sand) and low (i.e., clay, rocky soil, etc.) erosion potential soil types, 2) the upper South Fork at Piggott Bottom Road stream segment consisted of primarily high erosion potential soil types (i.e., silt or sand); however, it also included some moderate and low potential erosion soil types (i.e., loamy textured soils, clay, rocky soil, etc.), and 3) the upper North Fork Hillsboro Road stream segment featured predominantly moderate (i.e., loamy textured soils) with some high (i.e., silt or sand) and low (i.e., clay, rocky soil, etc.) erosion potential soil types.

Stream channel downcutting results (Table 11), revealed the following: 1) the mean bank heights for both South Fork mainstem areas exceeded the expected reference condition bank height range by up to one foot, suggesting a slight amount of channel downcutting, and 2) the mean bank heights for the North Fork at Hillsboro Road fell within the expected or reference condition bank height range of 3-4 feet.

Tributaries

Overall mean streambank stability for the upper, middle and lower Catoctin Creek tributaries ranged from fair to good. Mean bank stability for upper Hamilton Station Road and Talbot Farm tributaries (i.e., 70.8 and 74.5 percent, respectively) were rated as being good. Mean bank stability for the middle Clover Mill Road tributary (i.e., 62.7 percent), Richard Creek (i.e., 63.8 percent) and Brens Creek (i.e., 69.2 percent) were rated as being fair. The mean bank stability for the upper Milltown Creek (i.e., 74.2 percent) was rated as being good; whereas, middle Milltown Creek (i.e., 80.0 percent) and EcoVillage Tributary (i.e., 80.5 percent) were rated as being excellent (Table 10). RSAT Catoctin Creek tributary streambank erosion summary results (Table 10 and Figure13) are as follows: 6,000.1 linear feet of moderate erosion (i.e., 61-70 percent of the streambank network is stable), 2,939.3 linear feet of moderate/severe erosion (i.e., 50-60 percent of the streambank network is stable) and 989.8 linear feet of severe erosion (i.e., less than 50 percent of the streambank network is stable). In addition, a total of eight recent tree falls were recorded - two each in the Hamilton Station Road tributary and two in middle Milltown Creek. It should be noted that the highest moderate bank erosion condition rate (i.e., 2,255.8 linear feet/mile) was observed in the EcoVillage tributary mainstem.

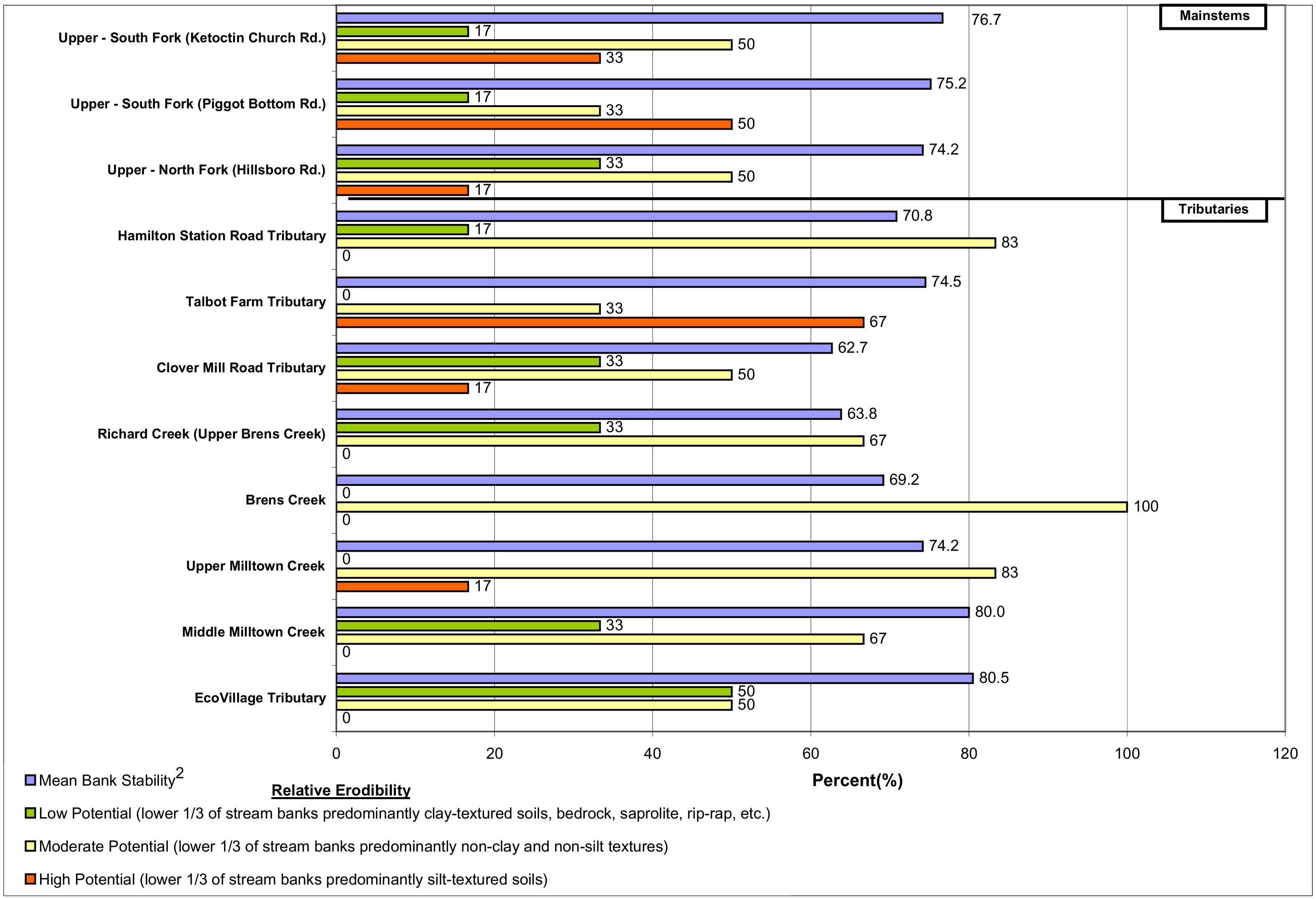
EcoVillage Tributary (X-1) - Stable Streambank

Table 10. Catoctin Creek - Streambank Erosion Conditions

RSAT Stream Segment	Surveyed Stream Length (ft.)	Surveyed Streambank Network[1] Length (ft.)	Bank Erosion Conditions: Severe (LF)	Severe (LF/mi.)	Moderate/Severe (LF)	Moderate/Severe (LF/mi.)	Moderate (LF)	Moderate (LF/mi.)	No. of Recent Tree Falls[2]: No.	No./mi.	No. of Erosional Log Jams	Mean Bank Stability (%)[3]
Catoctin Creek Mainstems												
Upper - North Fork (Hillsboro Rd.)	1,628.1	3,256.2	153.5	248.8	0.0	0.0	192.2	311.6	2.0	3.2	0.0	74.2
Upper - South Fork (Ketoctin Church Rd.)	962.2	1,924.3	0.0	0.0	270.5	742.2	536.4	1,471.8	1.0	2.7	0.0	76.7
Upper - South Fork (Piggott Bottom Rd.)	1,700.0	3,400.0	0.0	0.0	0.0	0.0	615.1	955.2	1.0	1.9	0.0	75.2
Upper - South Fork (Piggott Bottom Rd.) (2000)			80.0	124.2	80.0	124.2	400.0	621.2	0.0	0.0	0.0	81.3
Total[4]	**4,290.3**	**5,324.3**	**153.5**	**152.2**	**270.5**	**268.3**	**1,343.7**	**1,332.5**	**4.0**	**4.0**	**0.0**	**75.3[5]**
Tributaries to Catoctin Creek												
Upper												
Hamilton Station Road Tributary	3,169.7	6,339.4	0.0	0.0	492.1	409.9	2,165.0	1,803.2	2.0	1.7	1.0	70.8
Talbot Farm Tributary	3,094.2	6,188.3	256.6	218.9	901.2	768.9	552.5	471.4	1.0	0.9	0.0	74.5
Subtotal	6,263.9	12,527.7	256.6	218.9	1,393.3	587.2	2,717.6	1,145.4	3.0	1.3	1.0	**72.6[5]**
Middle												
Clover Mill Road Tributary	1,311.6	2,623.2	137.9	277.5	631.6	1,271.3	374.6	754.1	1.0	2.0	0.0	62.7
Richard Creek (Upper Brens Creek)	1,273.2	2,546.3	464.0	962.1	577.2	1,196.8	759.9	1,575.8	1.0	2.1	0.0	63.8
Brens Creek	1,496.2	2,992.4	131.4	231.8	337.2	594.9	107.2	189.1	1.0	1.8	0.0	69.2
Subtotal	4,081.0	8,162.0	733.2	474.3	1,545.9	1,000.1	1,241.8	803.3	3.0	1.9	0.0	**63.3[5]**
Lower												
Upper Milltown Creek	1,820.4	3,640.9	0.0	0.0	0.0	0.0	197.5	286.4	0.0	0.0	1.0	74.2
Middle Milltown Creek	1,494.3	2,988.5	0.0	0.0	0.0	0.0	427.3	755.0	2.0	3.5	0.0	80.0
EcoVillage Tributary	1,657.1	3,314.1	0.0	0.0	0.0	0.0	1,415.9	2,255.8	0.0	0.0	0.0	80.5
Subtotal	4,971.8	9,943.6	0.0	0.0	0.0	0.0	2,040.7	1,083.6	2.0	1.1	1.0	**77.1[5]**
Tributary Total	**15,316.7**	**30,633.3**	**989.8**	**170.6**	**2,939.3**	**506.6**	**6,000.1**	**1,034.2**	**8.0**	**1.4**	**2.0**	**72.0[5]**

[1] Length to include both the left and right bank (i.e., twice the distance of the surveyed stream length).
[2] Tree fall interpretation: 0-1/mi. = Excellent, 2-3/mi. = Good, 4-5/mi = Fair, ≥6 = Poor.
[3] Bank stability interpretation: >80% = Excellent, 71-80% = Good, 50-70% = Fair, <50% = Poor.
[4] Total excludes the Upper - South Fork (Piggott Bottom Road) (2000).
[5] Weighted mean.

Figure 12. Summary: Catoctin Creek - Mean Streambank Stability and Relative Erodibility[1] (%)



[1] Total number of observations to determine average bank stability and relative erodibility appear in parentheses.
[2] Mean bank stability interpretation: >80% = Excellent, 71-80% = Good, 50-70% = Fair, <50% = Poor.

With the exception of the Talbot Farm tributary, where soil types are predominantly highly erodible silt and sandy silt, streambank materials consisted primarily of moderately erodible soil types (i.e., non-clay and non-silt texture soils) with some high (i.e., silt and sand) and low (i.e., clay, rocky soils, etc.) erosion potential soils type.

Regarding tributary channel downcutting, with the exception of upper Milltown Creek, there has been some significant downcutting within the stream channels. Results in Table 11 and Figures 15-17 revealed that the mean streambank heights in the upper tributaries (i.e., Hamilton Station Road and Talbot Farm tributaries) exceeded the RSAT reference condition bank height range by as much as 1.8 feet. For the middle tributaries (i.e., Clover Mill Road tributary, Richard Creek and Brens Creek) mean streambank heights (i.e., 4.0, 3.6 and 4.4 feet, respectively) were up to 1.4 feet greater than the reference condition bank height range. As for the lower tributaries, mean bank heights for upper Milltown Creek (i.e., 2.3 feet) fell within the reference condition bank height range; whereas, the middle Milltown Creek and EcoVillage tributary mean streambank heights (i.e., 4.4 and 5.3 feet, respectively) were up to 3.3 feet higher than the reference condition.

Table 11. Summary: Catoctin Creek – Stream Channel Downcutting

RSAT Stream Segment	Drainage Area (mi^2)	Surveyed Stream Length	Mean Bank Height R[1] (ft)	Mean Bank Height L[2] (ft)	Mean Bank Height (ft)	Expected Bank Height Range (ft)	Number of Nick Points
Catoctin Creek							
Upper - North Fork (Hillsboro Rd.)	14.6	1,628	2.9	3.0	3.0	3-4	0
Upper - South Fork (Ketoctin Church Rd.)	1.1	962	3.1	2.9	3.0	1-2	0
Upper - South Fork (Piggott Bottom Rd.)	15.7	1,700	5.4	5.3	5.4	4-5	0
Upper - South Fork (Piggott Bottom Rd.) (2000)			5.7	6.1	5.9	4-5	0
Subtotal[3]		4,290	3.8	3.7	3.8		0
Tributaries to Catoctin Creek							
Upper							
Hamilton Station Road Tributary	2.1	3,170	3.8	3.8	3.8	1-2	0
Talbot Farm Tributary	3.5	3,094	4.1	5.3	4.7	2-3	0
Subtotal		6,264	4.0	4.6	2.8		0
Middle							
Clover Mill Road Tributary	1.6	1,312	4.0	3.9	4.0	2-3	0
Richard Creek (Upper Brens Creek)	4.0	1,273	3.2	4.0	3.6	2-3	0
Brens Creek	8.4	1,496	4.3	4.4	4.4	2-3	0
Subtotal		4,081	3.8	4.1	4.0		0
Lower							
Upper Milltown Creek	3.4	1,820	2.5	2.0	2.3	2-3	0
Middle Milltown Creek	6.5	1,494	4.7	4.1	4.4	2-3	0
EcoVillage Tributary	1.1	2,241	5.4	5.2	5.3	1-2	0
Subtotal		5,556	4.2	3.8	4.0		0
Total	**92.4**	**20,191**				**-**	**0**

[1] Right bank looking downstream.
[2] Left bank looking downstream.
[3] Subtotal excludes the Upper - South Fork (Piggott Bottom Road) (2000).

Major Findings

Mainstem Areas

- Of the total streambank network length surveyed, 20.6 percent fell into the moderate, moderate/severe, and severe erosion categories.
- South Fork (Ketoctin Church Road) - the calculated moderate/severe streambank erosion rate was 742.2 linear feet per mile, representing a mainstem high.
- South Fork (Piggott Bottom Road) - the stream channel cross-sectional area (Figure 14) (227.20 ft^2) is more than double that of the North Fork (Hillsboro Road) (98.82 ft^2). This suggests major downcutting and channel widening at the South Fork mainstem site. Note: drainage areas above both sites are comparable (Piggott Bottom Road = 15.7 square miles and Hillsboro Road = 14.6 square miles).
- South Fork (Piggott Bottom Road) - 2006 RSAT survey mean streambank stability was rated good (i.e., 72.5 percent) compared to the year 2000 excellent rating (i.e., 81.3 percent).
- North Fork (Hillsboro Road) - bank stability ranged from 45 (i.e., poor) to 93 percent (i.e., excellent), and included 153.5 linear feet of severe channel erosion with an associated rate of 248.8 linear feet/mile, representing a mainstem high.

Tributaries

- Of the total streambank network length surveyed, 32.4 percent fell into the moderate, moderate/severe, and/or severe erosion condition categories.
- Over 27 percent of the middle tributary streambank network length exhibited moderate/severe and severe erosion; versus 2 and 13 percent for the upper and lower tributary networks.
- Over 41 percent of the surveyed streambank network for Hamilton Station Road tributary was classified as having moderate and moderate/severe erosion. Two of the total eight recent tree falls were recorded in this stream segment, as well as one of the two total erosional log jams.

Middle Tributary - Brens Creek - (X-2) - Severe Stream Bank Erosion

- Over 70 percent of the Richard Creek streambank network was characterized as having moderate, moderate/severe and severe channel erosion. The longest severe channel erosion section (i.e., 464 linear feet) was recorded at this site. The Richard Creek mean bank stability of 48 percent was the lowest recorded for any Phase II study stream area (Appendix 2, Table 2).
- For the lower tributaries, there were no areas exhibiting either moderate/severe or severe bank erosion conditions. These stream segments also boasted the highest mean bank stability - 77.1 percent (Table 10).

Figure 13. Summary: Catoctin Creek - Bank Stability

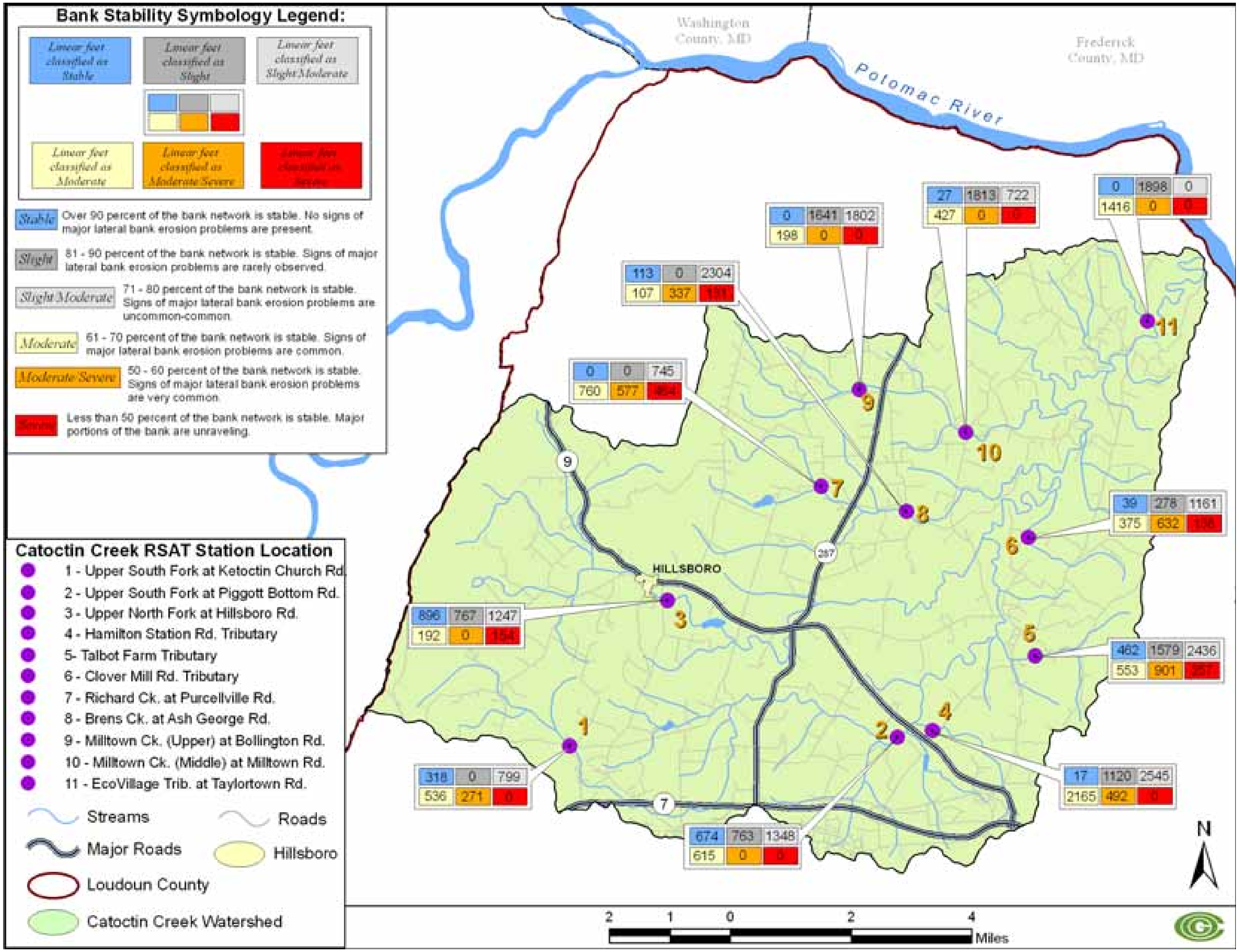
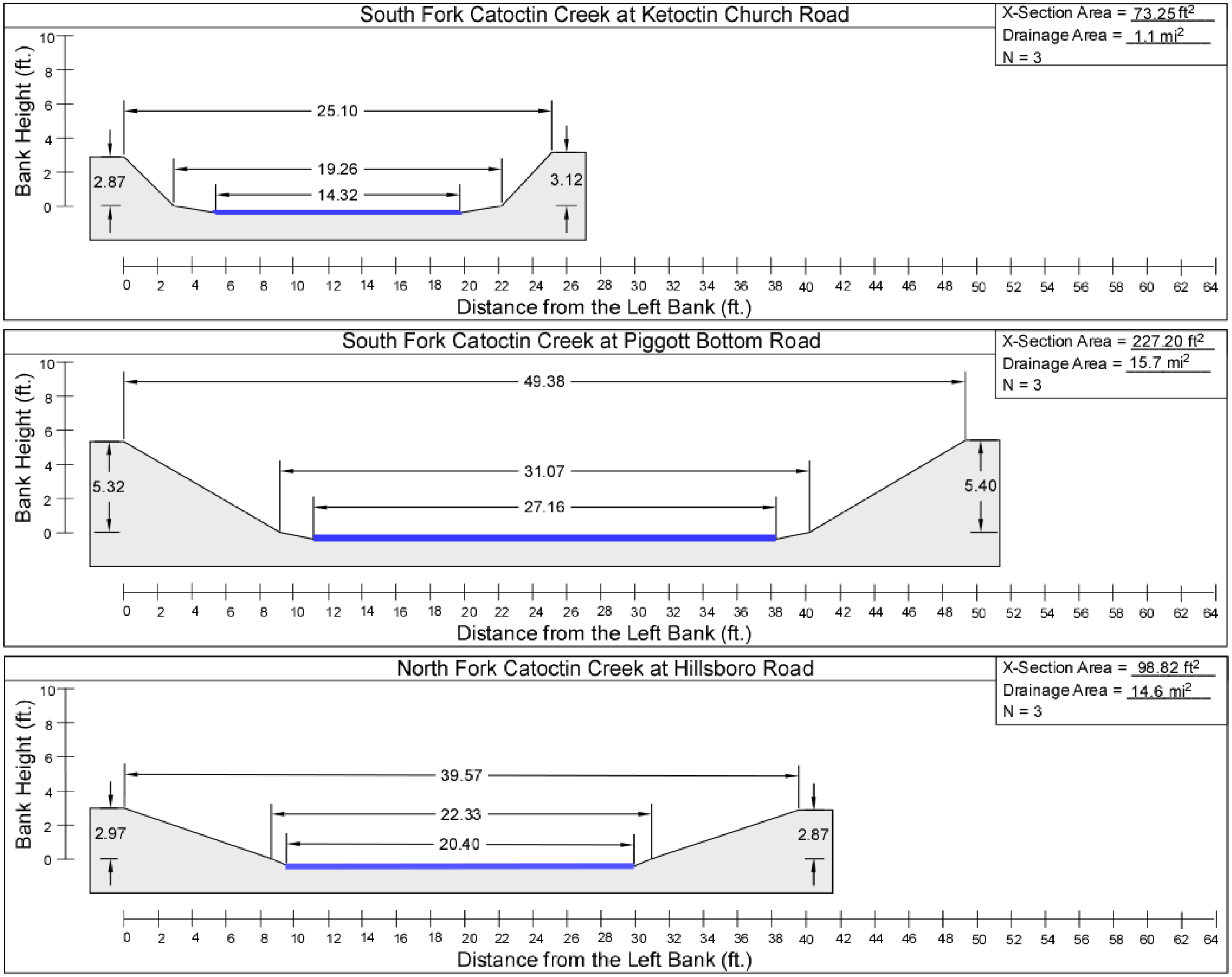
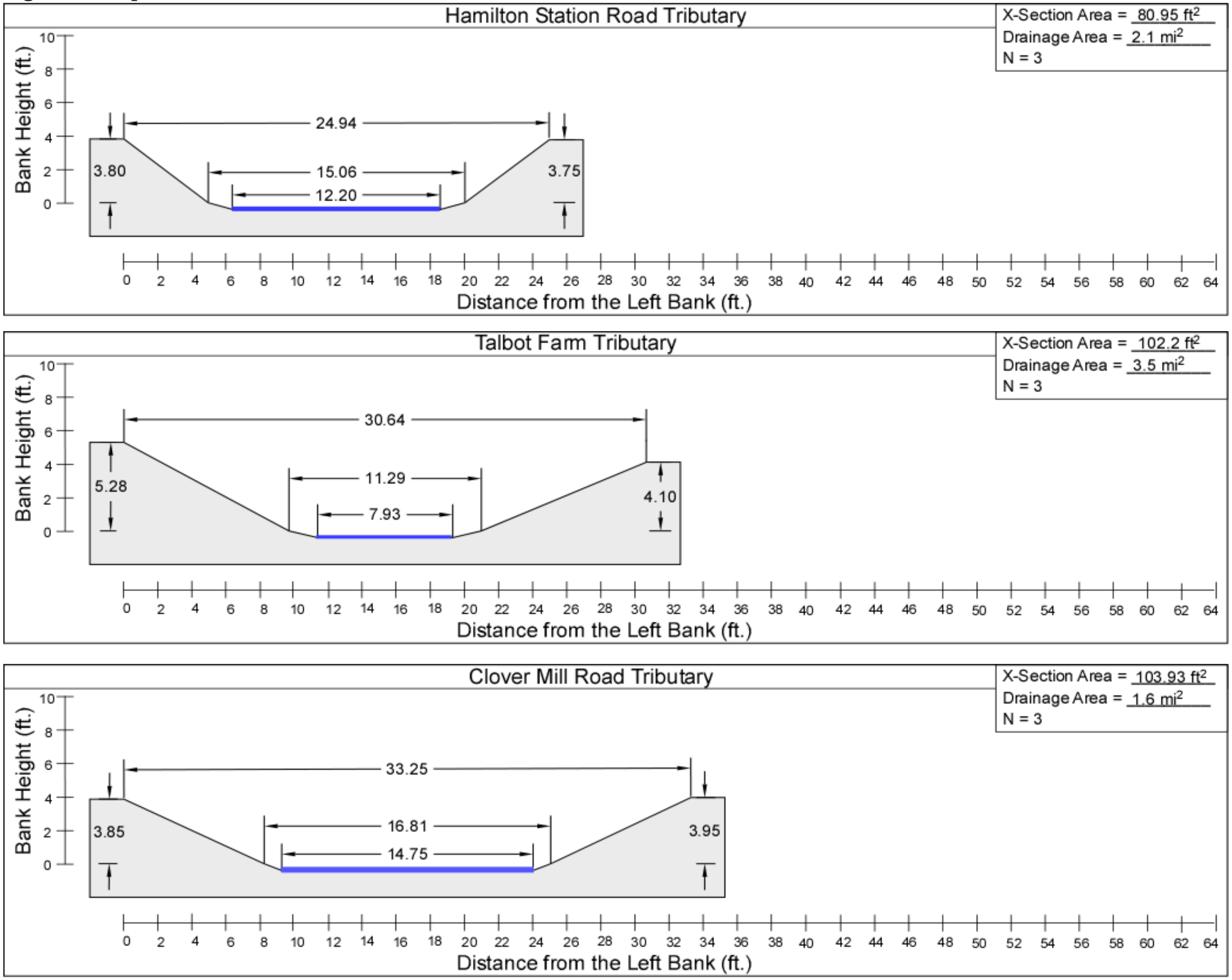


Figure 14. Representative Channel Cross-Sections[1] - Catoctin Creek Mainstems



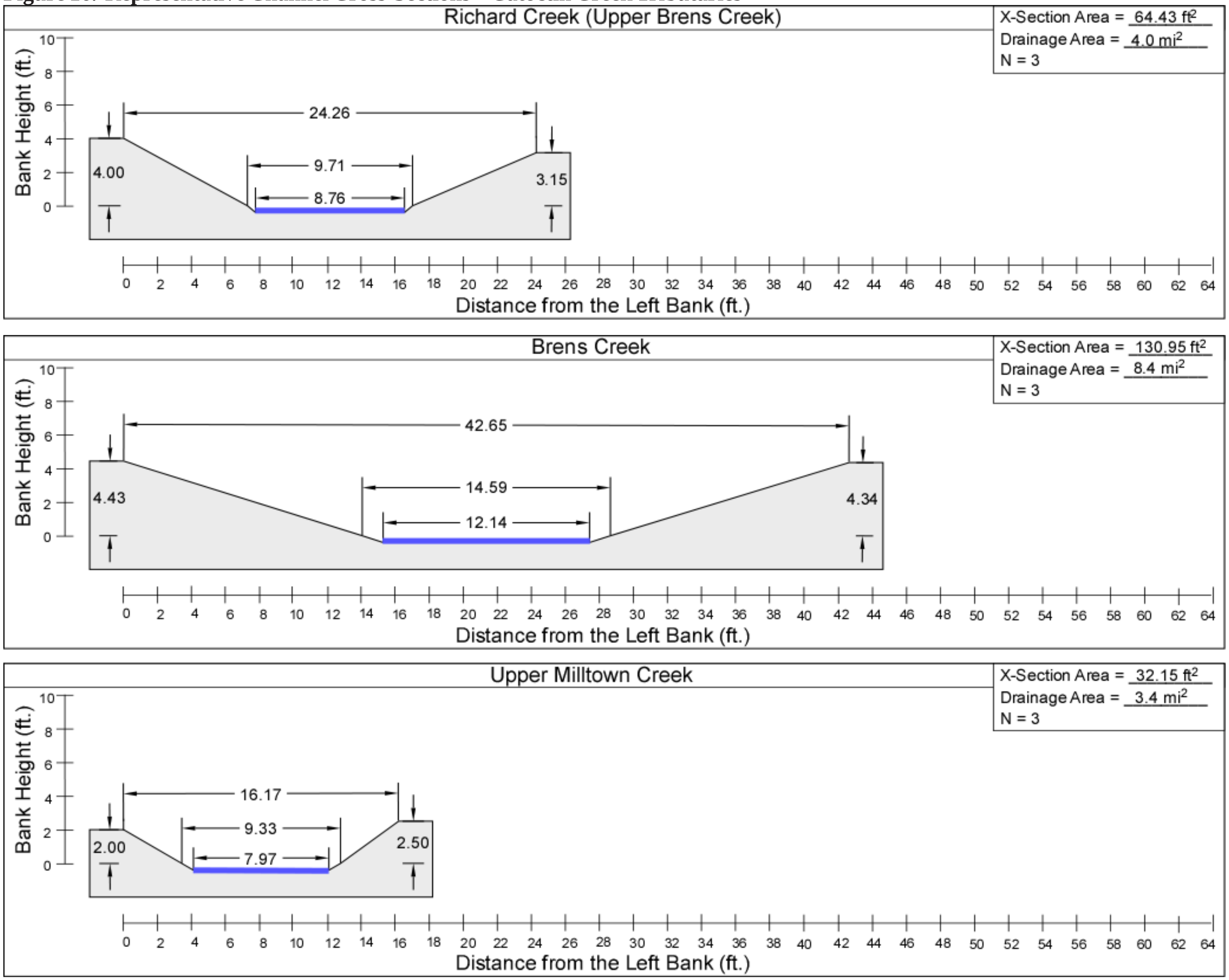
[1] Top channel width, bottom channel width and wetted perimeter area (heavy black line) depicted.

Figure 15. Representative Channel Cross-Sections[1] - Catoctin Creek Tributaries



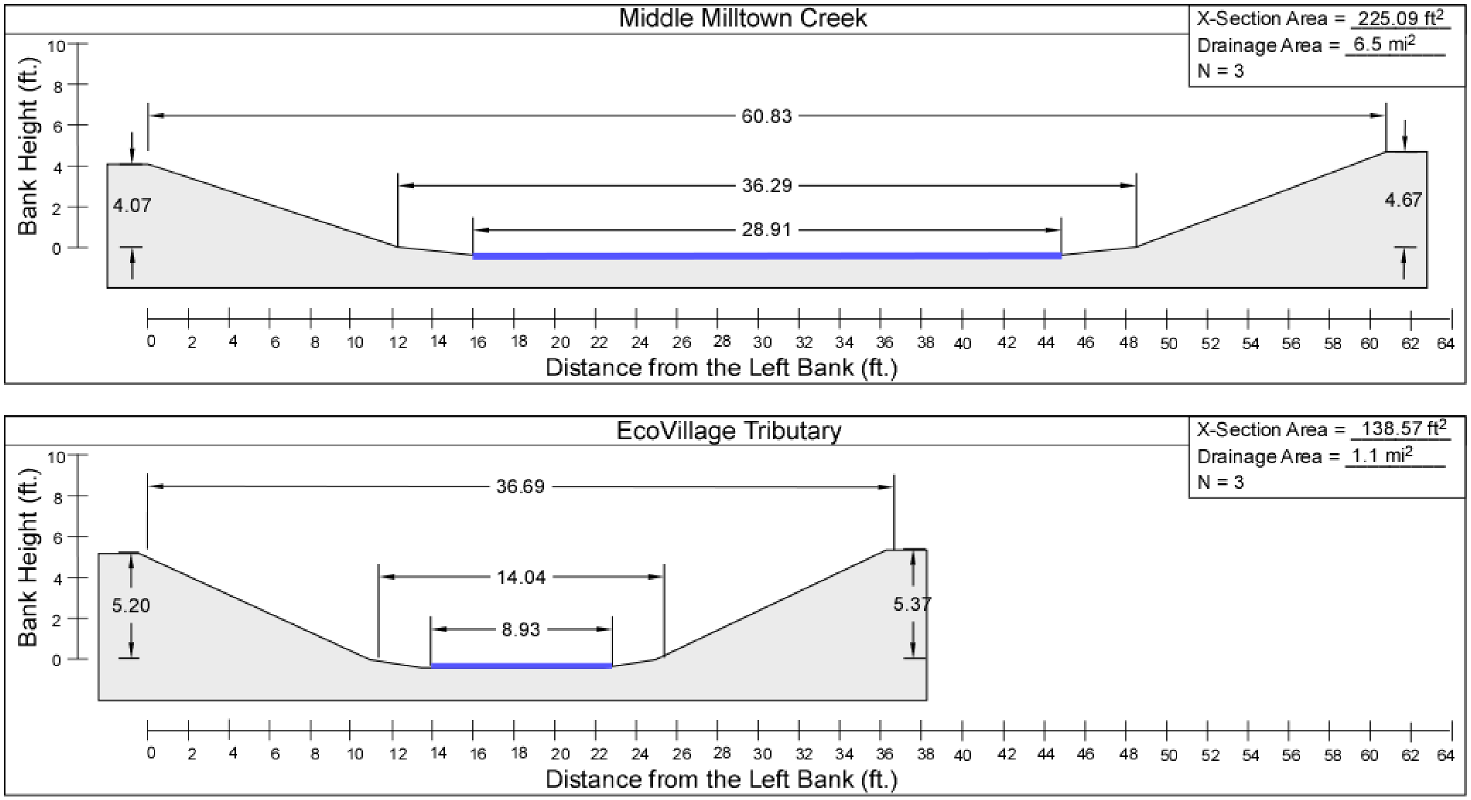
[1] Top channel width, bottom channel width and wetted perimeter area (heavy black line) depicted.

Figure 16. Representative Channel Cross-Sections[1] - Catoctin Creek Tributaries



[1] Top channel width, bottom channel width and wetted perimeter area (heavy black line) depicted.

Figure 17. Representative Channel Cross-Sections[1] - Catoctin Creek Tributaries



[1] Top channel width, bottom channel width and wetted perimeter area (heavy black line) depicted.

- The EcoVillage tributary cross-sectional area (i.e., 138.57 ft^2) is two to four times greater than those for the upper Milltown Creek (32.15 ft^2) or Richard Creek (64.43 ft^2). As depicted in Figure 17, the EcoVillage tributary stream channel is highly entrenched, with mean bank heights of 5.3 feet. These bank heights are on the order of three feet higher than the expected or reference stream bank height (i.e., typical bank height range for drainage areas between <2 mi^2 is approximately 1-2 feet). Note: the drainage area for the EcoVillage tributary is 1.1 mi^2; whereas, the upper Milltown Creek and Richard Creek drainage areas are 3.4 mi^2 and 4.0 mi^2, respectively.
- The largest cross-sectional area (i.e., Middle Milltown Creek, 225.09 ft^2) was almost twice that of Brens Creek (i.e., 130.95 ft^2) (Figures 16 and 17, respectively). Although both mean bank heights are similar (i.e., 4.4 feet) and both exceeded the expected or reference bank height range by 1.4 feet, the top and bottom channel widths for middle Milltown Creek are double those of Brens Creek. The preceding finding strongly suggests that major lateral channel erosion has occurred in Milltown Creek.

3.2.2 Channel Scouring and Sediment Deposition

Mainstem Areas

The observed mainstem riffle embeddedness levels (Table 12 and Figure 18), with the exception of South Fork at Piggott Bottom Road, were in the good category (i.e., 25-50 percent). Riffle embeddedness for the South Fork at Piggott Bottom Road was 80.7 percent (i.e., poor category). The

Table 12. Summary: Catoctin Creek – Channel Scouring/Sediment Deposition Conditions

RSAT Stream Segment	Surveyed Stream Length (ft.)	Percent Riffle Embbeddedness[3]		Large Point Bars				Relative Level of In-Channel Sand Deposits
		Observed Range	Mean	Total Number Observed	No. Unstable	Percent Unstable (%)	No.of Unstable/ Mile	
Catoctin Creek Mainstems								
Upper - North Fork (Hillsboro Rd.)	1,628	30-40	36.7	1	1	100	3.2	Low
Upper - South Fork (Ketoctin Church Rd.)	962	20-55	36.7	2	1	50	5.5	Low
Upper - South Fork (Piggott Bottom Rd.)	1,700	72-100	80.7	1	0	0	0.0	Moderate/High
Upper - South Fork (Piggott Bottom Rd.) (2000)			38.3	3	1	33	3.1	Low/Moderate
Total[1]	4,290	20-100	51.3[2]	4	2	50	2.5	
Tributaries to Catoctin Creek								
Upper								
Hamilton Station Road Tributary	3,170	20-35	26.7	0	0	0	0.0	Low
Talbot Farm Tributary	3,094	10-30	20.0	0	0	0	0.0	Low/Moderate
Subtotal	6,264	10-35	23.3[2]	0	0	0	0	
Middle								
Clover Mill Road Tributary	1,312	45-55	50.0	1	1	100	4.0	Moderate
Richard Creek (Upper Brens Creek)	1,273	35-85	56.7	1	1	100	4.1	Moderate
Brens Creek	1,496	23-38	32.0	1	1	100	3.5	Moderate
Subtotal	4,081	23-85	46.2[2]	3	3	100	3.9	
Lower								
Upper Milltown Creek	1,820	50-75	63.3	1	0	0	0.0	Moderate/High
Middle Milltown Creek	1,494	5-25	15.0	3	0	0	0.0	Low
EcoVillage Tributary	2,241	40-65	36.7	0	0	0	0.0	Low/Moderate
Subtotal	5,556	5-75	38.3[2]	4	0	0	0.0	
Tributary Total	**15,901**	**5-85**	**35.4[2]**	**7**	**3**	**43**	**1.0**	

[1] Total excludes the Upper - South Fork (Piggott Bottom Road) (2000).
[2] Weighted mean.
[3] Riffle embeddedness rating scale: <25% = Excellent, 25-50% = Good, 51-75% = Fair, >75% = Poor.

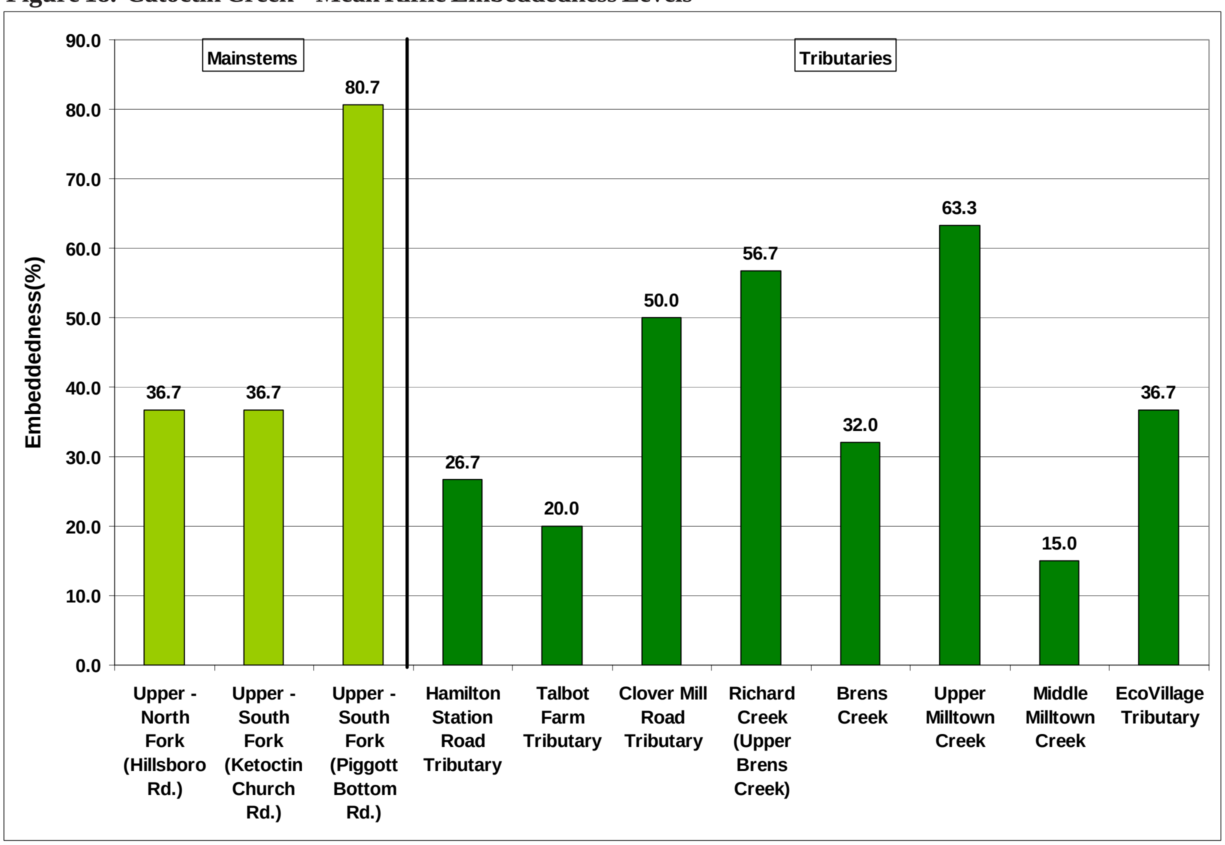
overall mean embeddedness level for the three mainstem stream segments was 51.3 percent (i.e., fair). In addition, the relative level of in-channel sand deposition was generally in the moderate/high range for the South Fork (Piggott Bottom Road); whereas, it was in the low range for both the South Fork (Ketoctin Church Road) and North Fork (Hillsboro Road). The relatively low embeddedness levels in combination with low levels of in channel sand deposits, suggests that sandy sediment loads are generally low and that such material is generally efficiently transported in these mainstem areas.

A total of four large point bars were observed in the surveyed mainstem areas (Table 12). Of these, two were unstable and were located between the South Fork (Ketoctin Church Road) and the North Fork (Hillsboro Road) areas.

Tributaries

With regard to the tributaries, seven large point bars were observed (Table 12). Three of these (i.e., 43 percent) were unstable and were distributed evenly among the middle tributaries: Clover Mill Road tributary, Richard Creek and Brens Creek. Riffle embeddedness levels for the tributaries varied, ranging from 15 percent (i.e., excellent) to 63.3 percent (i.e., fair). Middle Milltown Creek (i.e., 15.0 percent) and upper Milltown Creek (i.e., 63.3 percent) represented the two ends of this spectrum. The relative level of in-channel sand deposition varied from the low to moderate/high range with low for both Hamilton Station Road tributary and middle Milltown Creek and moderate/high for upper Milltown Creek.

Figure 18. Catoctin Creek – Mean Riffle Embeddedness Levels[1]



[1] Riffle embeddedness rating scale: <25% = Excellent, 25-50% = Good, 51-75% = Fair, >75% = Poor.

Major Findings

Mainstem Areas

- Mean riffle embeddedness levels for both the South Fork (Ketoctin Church Road) and North Fork (Hillsboro Road) were 36.7 percent (good).
- South Fork (Piggott Bottom Road) - riffle embeddedness rating range was fair (i.e., 51-75 percent) to poor (i.e., >75 percent) at all three transect locations. Compared to 2000 RSAT survey embeddedness levels (i.e., good range), 2005 levels were in the poor range.
- South Fork (Ketoctin Church Road) - lowest riffle embeddedness level recorded (i.e., 20 percent).

Tributaries

- The overall mean tributary riffle embeddedness level was 35.4 percent, which was in the good range (Table 12).
- Upper tributaries - mean riffle embeddedness was excellent (i.e., 23.3 percent) and there were no large unstable point bars.
- Middle tributaries - mean riffle embeddedness was good (i.e., 46.2 percent).
- Middle tributaries - the level of in-channel sand deposition was moderate for both riffle and run habitats.
- Lower tributaries - mean riffle embeddedness was good (i.e., 38.3 percent) and there were no large unstable point bars.

Point Bar Dominated By Large Stones

- Upper Milltown Creek - had the highest mean riffle embeddedness level - 63.3 percent (i.e., fair range). It should be noted that the stream segment above X-3 had been previously impacted by backwater from a beaverdam. Smaller-sized sediment particles, such as sand and silt were deposited into the riffle area upstream of this dam.
- Middle Milltown Creek - lowest mean riffle embeddedness observed - 15 percent (i.e., excellent range). A total of three large point bars were observed, but all were stable.

3.2.3 Physical Aquatic Habitat

Mainstem Areas

General physical aquatic habitat conditions for the upper South and North Fork mainstems are summarized in Table 13 and Figure 19. As seen in Table 13, RSAT aquatic habitat ratings were good for both the South Fork at Piggott Bottom Road and South Fork at Ketoctin Church Road, and excellent for the North Fork at Hillsboro Road. Major contributing factors for the good and excellent ratings included the presence of deeper pools, which featured very good overhead cover for fish, and generally, good riffle substrate material (i.e., material composition generally dominated by larger stone and gravel with minimal amounts of sand).

Table 13. Summary: Catoctin Creek - General Physical Aquatic Habitat Conditions[1]

RSAT Stream Segment	Riffle Characteristics				Pool Characteristics				Fish Barriers		RSAT Physical Habitat Score (pts.)[6]
	No. of Riffles	Mean Riffle Depth (in.)	Mean Riffle Substrate Quality (pts.)[2]	Mean Riffle Embedded-ness(%)[3]	No. of Pools	Mean Max. Depth (in.)	Mean Pool Quality (pts.)[4]	Riffle/ Pool Ratio[5]	Total Number	Per Mile	
Catoctin Creek Mainstems											
Upper - North Fork (Hillsboro Rd.)	9	5.7	4.0	36.7	10	21.6	3.0	0.9	0	0	7
Upper - South Fork (Ketoctin Church Rd.)	12	4.2	2.3	36.7	11	21.3	4.3	0.9	0	0	6
Upper - South Fork (Piggott Bottom Rd.)	4	6.0	2.5	80.7	7	36.0	4.0	0.6	0	0	5
Upper - South Fork (Piggott Bottom Rd.) (2000)	6	2.5	2.3	38.3	16	23.0	2.0	0.4	0	0	4
Total[7]	25	5.3	2.9	51.3	28	26.3	3.8	0.8	0	0	6
Tributaries to Catoctin Creek											
Upper											
Hamilton Station Road Tributary	21	4.3	2.3	26.7	25	26.0	3.3	0.8	0	0	5
Talbot Farm Tributary	20	4.9	3.7	20.0	15	22.7	3.7	1.3	0	0	7
Subtotal	41	4.6	3.0	23.3	40	24.3	3.5	1.1	0	0	6
Middle											
Clover Mill Road Tributary	11	2.7	2.0	50.0	17	28.7	4.0	0.6	2	8	5
Richard Creek (Upper Brens Creek)	9	3.8	3.0	56.7	12	16.0	1.7	0.8	0	0	4
Brens Creek	7	4.3	3.3	32.0	13	18.7	2.7	0.5	0	0	4
Subtotal	27	3.6	2.8	46.2	42	21.1	2.8	0.6	2	3	4
Lower											
Upper Milltown Creek	16	2.8	2.3	63.3	22	22.3	4.0	0.7	0	0	6
Middle Milltown Creek	8	3.3	3.7	15.0	6	28.0	4.0	1.3	0	0	7
EcoVillage Tributary	11	3.3	3.0	55.0	14	20.3	4.0	0.8	0	0	5
Subtotal	35	3.1	3.0	44.4	42	23.6	4.0	0.9	0	0	6
Tributary Total	103	3.7	2.9	39.8	124	22.8	3.4	0.9	2	1	5

Another factor that adds to the overall physical habitat quality is the ratio of wetted perimeter (that portion of the bottom channel at a riffle covered with water) to bottom channel width. This ratio provides insight into the available riffle habitat for fish, macroinvertebrates and other aquatic organisms. For the mainstems, the mean wetted perimeter generally covered more than 74 percent (i.e., good rating) of the bottom channel. It should be noted that fish barriers, either partial or complete, were not observed.

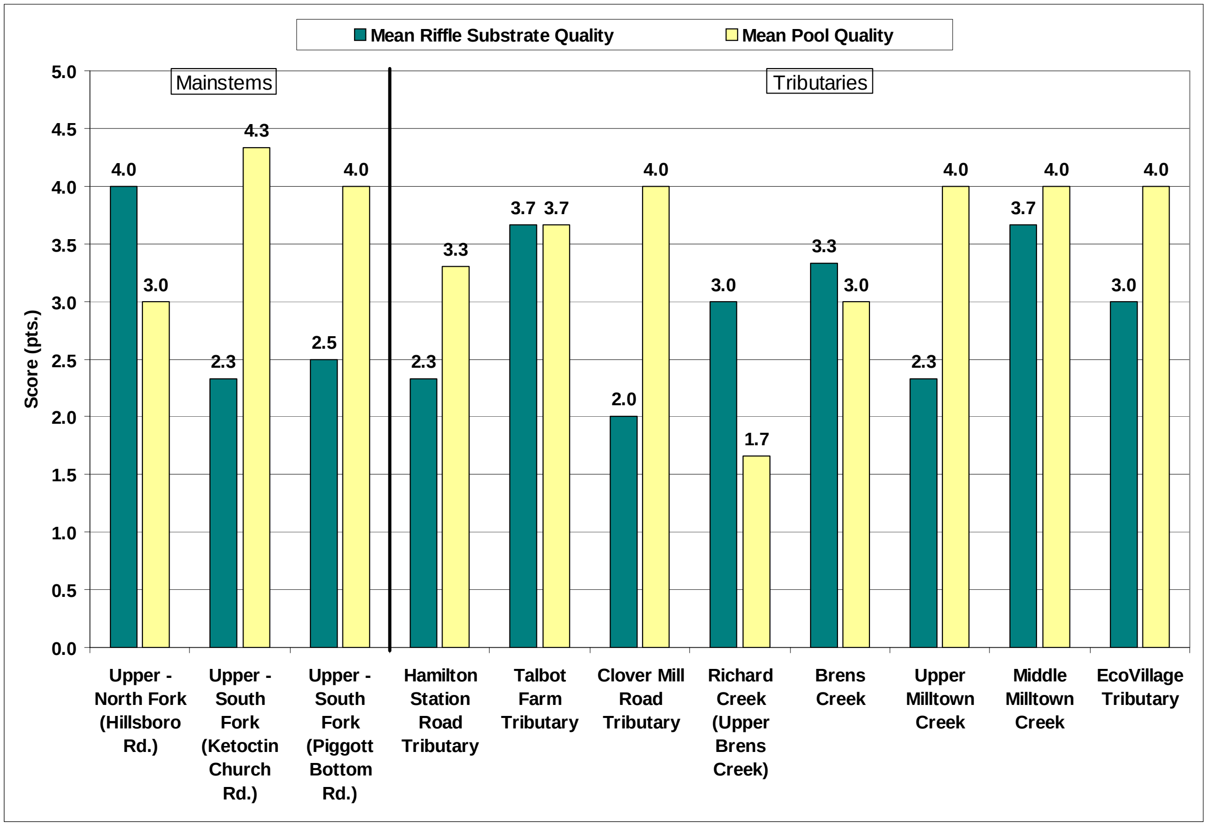
Tributaries

Mean RSAT aquatic habitat ratings for the upper, middle and lower tributaries were good. With the exception of Richard Creek, pools were present in relatively high numbers and featured both good depth (i.e., >18 inches) and overhead cover for fish habitat. For Richard Creek, shallow pool depth (i.e., < 12 inches), suboptimal substrate composition (i.e., dominated by small sandy/silty material) and the lack of overhead cover for fish habitat, all contributed to the poor pool quality rating.

The mean wetted perimeter widths, with the exception of EcoVillage tributary, were generally greater than 70 percent (i.e., good range). The EcoVillage tributary mean wetted perimeter width (i.e., 63 percent) was barely in the good range (i.e., 61 - 85 percent). Generally, as the wetted perimeter width narrows, habitat for aquatic organisms becomes more limited.

[1] Mean values shown are weighted means.
[2] Riffle substrate quality rating scale: 3.25-4.00 = Excellent, 2.50-3.24 = Good, 1.75 – 2.49 = Fair, 1.00- 1.74 = Poor.
[3] Riffle embeddedness rating scale: <25% = Excellent, 25-50% = Good, 51-75% = Fair, >75% = Poor.
[4] Pool quality point scale interpretation: 5 = Excellent, 4 = Very Good, 3 = Good, 2 = Fair, 1 = Poor.
[5] Riffle/pool ratio rating scale: 0.9-1.1:1 = Excellent, 0.70-0.89:1 or 1.11-1.3:1 = Good, 0.5-0.69 or 1.31-1.5:1 = Fair, 0.49:1< or >1.51:1 = Poor.
[6] RSAT Physical habitat rating scale: 6.5-8.0 = Excellent, 4.5-6.4 = Good, 2.5-4.4 = Fair, 1.0-2.4 = Poor.
[7] Total excludes the Upper - South Fork (Piggott Bottom Road) (2000).

Figure 19. Catoctin Creek - Mean Riffle Substrate[1] and Pool Quality[2]



Major Findings

Mainstem Areas

- The mean wetted perimeter generally covered more than 74 percent (i.e., good range) for the South Fork (Ketoctin Church Road).
- Mean wetted perimeter width was rated excellent (i.e., >80 percent) for the South Fork at Piggott Bottom Road (i.e., 87.4 percent) and North Fork at Hillsboro Road (i.e., 91.3 percent).
- South Fork (Ketoctin Church Road) - mean pool quality score (i.e., 4.3 points) was good. This was the highest score recorded for the Catoctin Creek watershed (Figure 19).
- South Fork (Piggott Bottom Road) - mean riffle embeddedness (i.e., 80.7 percent) was rated poor.
- South Fork (Piggott Bottom Road) - 2006 RSAT physical instream habitat was rated good (i.e., 5 points) compared to 2000 fair rating (i.e., 4 points). A major contributing factor to the 2006 good rating was the deeper pool habitats which provided greater overhead cover for fish.
- North Fork (Hillsboro Road) - riffle substrate composition was good (i.e., 4.0 points). Riffle substrate composition was predominantly larger cobble and rubble with little sand.

[1] Riffle substrate quality point scale interpretation: 3.25-4.00 = Excellent, 2.50-3.24 = Good, 1.75-2.49 = Fair, 1.00-1.74 = Poor.
[2] Pool quality point interpretation: 4.5-5.0 = Excellent, 4.0-4.4 = Very Good, 3.0-3.9 = Good, 2.0-2.9 = Fair, 1.0-1.9 = Poor

Tributaries

- The overall mean riffle substrate quality score (i.e., 2.9 points) was in the good range (Figure 19).
- With the exception of Richard Creek, mean pool quality scores were good to very good (i.e., 3 points and 4 points).
- Lower tributaries (i.e., Milltown Creek and EcoVillage tributary) - the mean pool quality score, was rated good (i.e., 4.0 points).
- Clover Mill Road tributary - mean substrate quality score (i.e., 2.0 points) was rated fair. This was the lowest for the Catoctin Creek watershed (Figure 19).
- Richard Creek - mean wetted perimeter width was rated excellent (i.e., >80 percent) at 90.2 percent.
- Richard Creek - mean pool quality score (i.e., 1.7 points) was rated poor (Figure 19). This was the lowest for the Catoctin Creek watershed.
- Talbot Farm tributary - pools were generally deep (i.e., >18 inches), with large substrate and good overhead cover for fish habitat.

Clover Mill Road Tributary (X-1) - Complete Fish Barrier

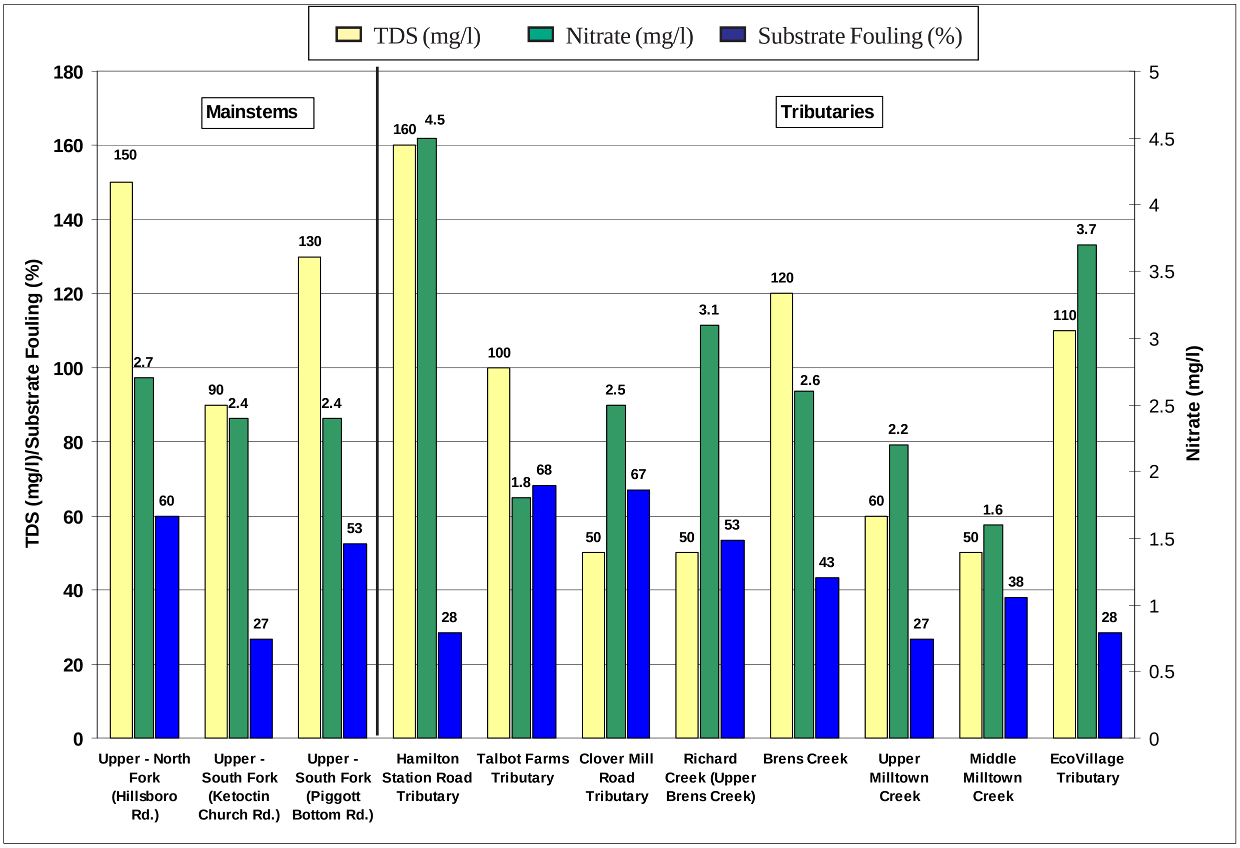
- Clover Mill Road tributary - two fish barriers, one partial and one complete, were observed. The partial barrier was associated to a natural cataract with a six inch drop. The complete barrier is associated with the perched Clover Mill Road culvert, which features a 15 inch vertical drop. It should be noted that fish were observed in the pool immediately downstream of the Clover Mill Road culvert.

3.2.4 Water Quality

Mainstem Areas

Upper South and North Fork Catoctin Creek mainstem RSAT water quality grab sampling total dissolved solids (TDS), nitrate and substrate fouling results are summarized in Figure 20. TDS levels for the three stream segments were all rated as being fair (i.e., 101-150 mg/l) to good (i.e., 50-100 mg/l). The highest TDS concentration, 150 mg/l, was observed in the North Fork (Hillsboro Road). Instantaneous nitrate concentrations were all within the upper moderate range (i.e., 1.1 - 2.9 mg/l). The highest (i.e., 2.7 mg/l) and lowest (i.e., 2.4 mg/l) nitrate concentration levels were observed in the North Fork (Hillsboro Road) and both South Fork stream segments, respectively. As a reference, 0.5 mg/l concentration is generally the upper threshold level for naturally occurring nitrate. Mean substrate fouling levels all fell within either the poor to fair range. Overall RSAT water quality scores were all in the fair range (i.e., 3-4 points).

Figure 20. Catoctin Creek - TDS[1], Nitrate[2] and Mean Substrate Fouling[3]



Tributaries

Tributary water quality, TDS levels ranged from 50 mg/l (i.e., good range) to 160 mg/l (i.e., poor range). The highest TDS concentration, 160 mg/l, was recorded at the Hamilton Station Road tributary. Nitrate concentrations ranged from 1.6 mg/l up to 4.5 mg/l and fell within the moderate to high range. The highest nitrate concentration (i.e., 4.5 mg/l) was observed at the Hamilton Station Road tributary. At the time of the survey, several horses occupied a paddock area and field that were in close proximity of the stream. Mean substrate fouling levels ranged from a low of 27 percent (i.e., fair range) to a high of 68 percent (i.e., poor range). Except for the two Milltown Creek stream segments which were rated good (i.e., 5-6 points), overall RSAT water quality scores for the tributaries were all in the fair range (i.e., 3-4 points). The reader is referred to Appendix 4, Table 1 for additional water quality grab sampling results.

Major Findings

Mainstem Areas

- Dissolved oxygen (DO) levels did not violate the minimum 4.0 mg/l Virginia Department of Environmental Quality water quality criterion.

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[1] TDS interpretation: <50 mg/L = Excellent, 50-100 mg/L = Good, 101-150 mg/L = Fair, >150mg/L = Poor.
[2] Nitrate interpretation: 0.0-1.0 mg/L= Low, 1.1-2.9 mg/L = Moderate, >3.0 mg/L = High.
[3] Substrate fouling interpretation: 0-10% = Excellent, 11-20% = Good, 21-50% = Fair, >50%=Poor.

- North Fork (Hillsboro Road), South Fork (Ketoctin Church Road) and South Fork (Piggott Bottom Road) - instantaneous orthophosphate concentrations were 0.54 mg/l, 0.45 mg/l and 0.23 mg/l, respectively. According to Dunne and Leopold (1978), 'Long-term eutrophication will usually be prevented if total phosphorus and orthophosphate levels are below 0.5 mg/l and 0.05 mg/l, respectively'.
- North Fork (Hillsboro Road) had the highest TDS (i.e., 150 mg/l), nitrate (i.e., 2.7 mg/l), and mean substrate fouling (i.e., 60 mg/l) levels observed for the three Catoctin Creek mainstem areas. Direct livestock (cattle) access to the stream is believed to be a major negative factor.
- South Fork (Ketoctin Church Road) - instantaneous TDS level, 90 mg/l, which was the lowest observed for the Catoctin Creek mainstems, was rated good bordering on fair. In addition, the lowest mean substrate fouling level was also observed for this stream segment.
- South Fork (Piggott Bottom Road) - 2000 and 2006 nitrate levels, 2.4 and 2.8 mg/l (i.e., moderate rating), respectively, are comparable and suggest that upstream cattle pasture areas with direct livestock access to the stream may be a major contributor.

Tributaries

- Dissolved oxygen (DO) levels did not violate the minimum 4.0 mg/l Virginia Department of Environmental Quality water quality criterion.
- Instantaneous copper and iron concentrations did not exceed water quality criteria to support aquatic life (i.e., copper concentrations did not exceed the Virginia Department of Environmental Quality water quality standard of 0.009 mg/l and iron concentrations did not exceed the U.S. Environmental Protection Agency's recommended water quality standard of 1.0 mg/l).
- Hamilton Station Road - the 4.5 mg/l nitrate concentration was the highest instantaneous level recorded during the Phase II study. As a reference, 0.5 mg/l concentration is generally the upper threshold level for naturally occurring nitrate.
- Talbot Farm tributary - mean substrate fouling level, 68 percent, was highest among all tributaries.
- Clover Mill Road tributary - moderate nitrate (i.e., 2.5 mg/l) and poor substrate fouling (i.e., 67 percent) levels were recorded. Direct livestock access to the stream was observed throughout the surveyed area.
- Richard Creek - high nitrate (i.e., 3.1 mg/l) and poor substrate fouling (i.e., 53 percent) levels were recorded. A private small automobile salvage yard and an active livestock pasture/paddock area with direct stream access were observed immediately upstream of the surveyed reach.
- Upper Milltown Creek - the lowest mean substrate fouling level (i.e., 27 percent) was recorded at the site.
- EcoVillage tributary - instantaneous nitrate level, 3.7 mg/l (i.e., high range), was the second highest level observed among all the tributaries. It should be noted that the large one-acre plus lot, subdivision, which both surrounds EcoVillage and similarly drains to the tributary, had very well manicured "green" lawns.

- With the exception of the EcoVillage tributary, direct livestock access to the streams was commonly observed.

3.2.5 Riparian Habitat Conditions

Mainstem Areas

Riparian habitat conditions within the three surveyed Catoctin Creek mainstem segment areas were in the good to excellent range. As seen in Table 14, mean canopy coverage ranged from a low of 58.3 percent to a high of 78.0 percent, averaging 65.4 percent (good). While portions of the riparian buffer zones contained mixed forest/grass and/or grass only (i.e., South Fork - Ketoctin Church Road) vegetation types, the vast majority of the stream corridors were comprised of mature hardwood forest. Riparian buffer widths were generally rated good to excellent, ranging from 100 (i.e., good) to greater than 200 foot widths (i.e., optimal or excellent condition).

South Fork Catoctin Creek Mainstem (Piggott Bottom Road, X-2) - Good Riparian Habitat Conditions

Table 14. Summary: Catoctin Creek - Riparian Habitat Conditions

RSAT Stream Segment	Surveyed Stream Length (ft.)	Number of Observations	Mean Canopy Coverage (%)[1]	Riparian Habitat Conditions	
				RSAT Score[2]	Verbal Ranking
Catoctin Creek Mainstems					
Upper - North Fork (Hillsboro Rd.)	1,628.1	5	78.0	6	Excellent
Upper - South Fork (Ketoctin Church Rd.)	962.2	6	58.3	4	Good
Upper - South Fork (Piggott Bottom Rd.)	1,700.0	5	60.0	5	Good
Upper - South Fork (Piggott Bottom Rd.) (2000)		5	54.0	4	Good
Total[3]	**4,290.3**	**16**	**62.6[4]**	**5.0[4]**	**Good**
Tributaries to Catoctin Creek					
Upper					
Hamilton Station Road Tributary	3,169.7	8	49.0	3	Fair
Talbot Farm Tributary	3,094.2	5	24.0	2	Fair
Subtotal	**6,263.9**	**13**	**36.5[4]**	**3.0[4]**	**Fair**
Middle					
Clover Mill Road Tributary	1,311.6	5	70.0	3	Fair
Richard Creek (Upper Brens Creek)	1,273.2	4	35.0	2	Fair
Brens Creek	1,496.2	7	34.3	1	Poor
Subtotal	**4,081.0**	**16**	**46.4[4]**	**2.0[4]**	**Fair**
Lower					
Upper Milltown Creek	1,820.4	5	32.0	2	Fair
Middle Milltown Creek	1,494.3	6	68.0	5	Good
EcoVillage Tributary	2,241.5	6	75.0	5	Good
Subtotal	**5,556.2**	**17**	**58.3[4]**	**4.0[4]**	**Good**
Tributary Total	**15,901.1**	**46**	**47.1[4]**	**3.0[4]**	**Fair**

[1] Mean canopy coverage interpretation: $\geq$80% = Excellent, 60-79% = Good, 50-59% = Fair, <50% = Poor.
[2] Point Score Interpretation: 6.0-7.0 = Excellent, 4.0-5.9 = Good, 2.3-3.9 = Fair, 0-1.9 = Poor.
[3] Total excludes the Upper - South Fork (Piggott Bottom Road) (2000).
[4] Weighted mean.

Tributaries

RSAT riparian habitat condition scores for the Catoctin Creek tributaries ranged from poor (i.e., 0.0-1.9 points) to good (i.e., 4.0-5.9 points), with an overall fair rating (i.e., 3.0 points). Mean canopy coverage ranged from poor (i.e., <50 percent) to good (i.e., 60-79 percent) with an overall fair (i.e., 50.3 percent) rating. In general, riparian vegetation consisted primarily of hardwood forest with some grass area intermixed. For the EcoVillage tributary, riparian vegetation was principally hardwood forest (i.e., optimal vegetation type). In sharp contrast, Brens Creek was dominated by less than optimal grass vegetation. Mean riparian buffer widths for all tributary areas surveyed were generally rated as being good (i.e., >100 feet).

Major Findings

Mainstem Areas

- South Fork (Ketoctin Church Road) - lowest mainstem mean canopy coverage (i.e., 58.3 percent). A large gap in the canopy coverage upstream of transect X-2, was associated with both severe channel erosion and tree falls.
- South Fork (Piggott Bottom Road) - riparian zone vegetation was predominately hardwood forest. This riparian buffer zone was generally greater than 200 feet in width (i.e., excellent range).
- North Fork (Hillsboro Road) - highest mainstem mean canopy coverage, at 78.0 percent (i.e., good range). Riparian buffer zone vegetation was also primarily hardwood forest and generally greater than 200 feet wide.

Tributaries

- Talbot Farms tributary- lowest tributary mean canopy coverage (i.e., 24.0 percent, poor range). It should be noted that recent beaver cuttings above transect X-2 have greatly reduced the number of young willow trees (i.e., *Salix sp.*) in this stream reach.
- In the middle tributaries, riparian buffer widths were generally wide (i.e., > 100 feet). However, the majority of the vegetation present was either the suboptimal forest/grass mix, or in the case of Brens Creek, grassland.
- Brens Creek - lowest tributary riparian habitat condition score, 1 point (i.e., poor).
- Upper Milltown Creek - canopy coverage condition was rated poor at 30 percent. Stream reach upstream of transect X-3 is associated with an abandoned beaverdam area, comprised of wetland emergent plants with few trees.
- Middle Milltown Creek - recent adjacent homeowner activity had removed the majority of the understory trees and shrubs, as well as unwanted exotic and invasive plants.
- EcoVillage tributary - highest tributary mean canopy coverage (i.e., 75.0 percent). Riparian buffer zone widths were greater than 200 feet (i.e., excellent).

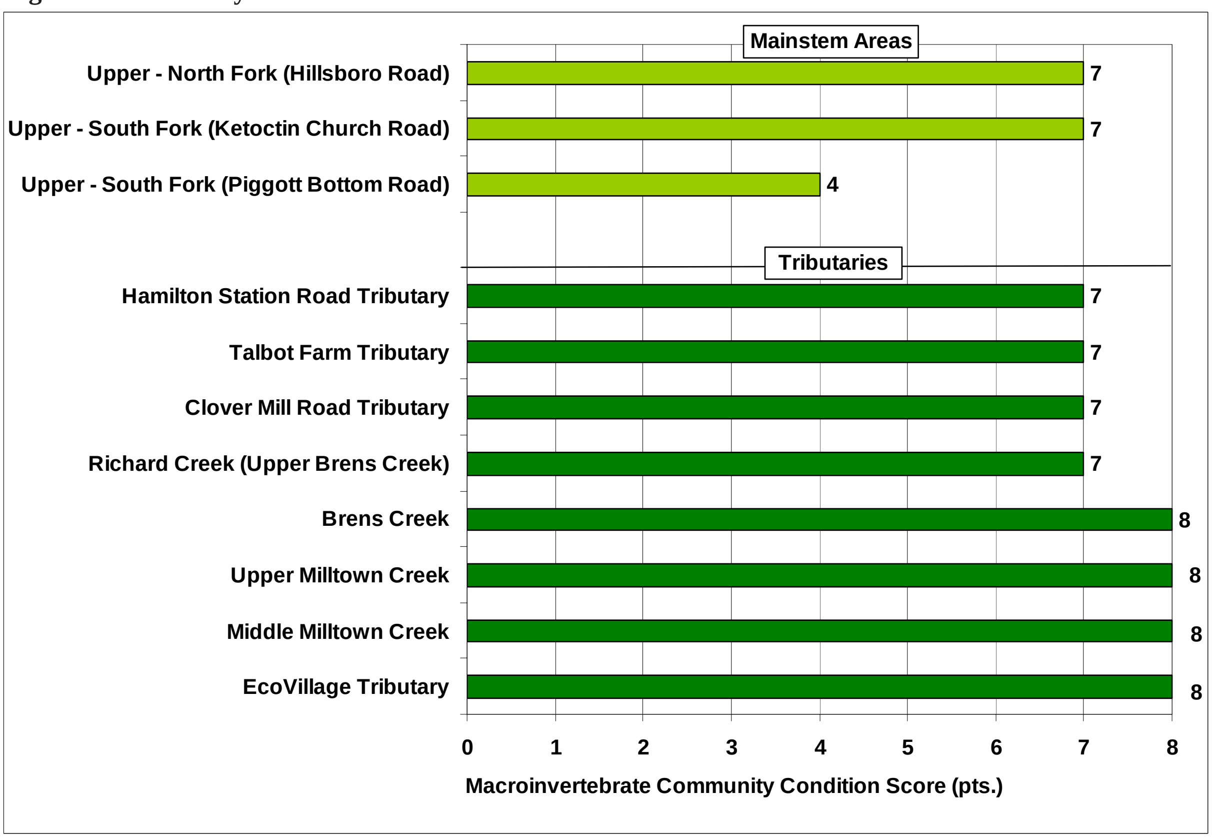
3.2.6 Biological Condition - Benthic Macroinvertebrate Survey

Mainstem Areas


Stonefly - Perlidae Family - Pollution Intolerant - Collected at Middle Milltown Creek

As seen in Figure 21, macroinvertebrate community conditions for the three Catoctin Creek mainstem areas were in the fair to excellent range. RSAT voucher total number of taxa[1] results were as follows: 1) South Fork - Ketoctin Church Road, 26 (excellent), Piggott Bottom Road, 14 (fair), and 2) North Fork - Hillsboro Road, 22 (good). Taxa from the pollution intolerant stonefly, mayfly and caddisfly groups (i.e., Ephemeroptera, Plecoptera and Trichoptera - EPT) were present at South Fork (Ketoctin Church Road) and North Fork (Hillsboro Road). Stonefly individuals were absent at South Fork (Piggott Bottom Road). However, both the flathead mayfly and cased caddisfly groups were present. As for relative abundance

Figure 21. Summary: Catoctin Creek Mainstem RSAT Voucher Collection Macroinvertebrate Condition[2]



[1] General RSAT voucher interpretation for taxa richness: >=25 = Excellent, 16-24 = Good, 8-15 = Fair, 0-7 = Poor.
[2] Macroinvertebrate scale interpretation: 7.0-8.0 pts. = Excellent, 5.0-6.9 pts. = Good, 2.1-4.9 pts. = Fair, 0.0-2.0 pts. = Poor.

for the EPT at the three stream reaches, stonefly relative abundance was classified as being 'common' in the South Fork (Ketoctin Church Road) and generally 'scarce' to absent elsewhere (Figure 22). In addition, the relative abundance of flathead mayflies were 'common' only at North Fork (Hillsboro Road) and 'scarce/common' at the other two stream segments. Cased caddisflies were 'scarce/common' in all three mainstem survey areas.

Results for the Level III RSAT qualitative 20-jab multiple/best habitat survey performed in spring 2005 are summarized in Table 15. The Catoctin Creek index of biotic integrity (IBI) score ratings were all within the good to excellent range. South Fork at Ketoctin Church Road was rated excellent (i.e., 90.0 points); whereas, both the South Fork at Piggott Bottom Road (i.e., 73.2 points) and North Fork at Hillsboro Road (i.e., 76.0 points) areas were rated as being good. For additional results from this survey and the RSAT voucher collection, the reader is referred to Appendix 5.

Tributaries

Macroinvertebrate community conditions for the Catoctin Creek tributaries surveyed were all rated excellent. RSAT voucher total number of taxa ranged from 20 to 31 (i.e., good to excellent rating). Pollution intolerant taxa of stonefly, mayfly and caddisfly groups (i.e., Ephemeroptera, Plecoptera and Trichoptera (EPT), respectively) were present in all tributary stream reaches. The relative abundance of the EPT individuals were generally 'scarce' to 'common' in all of the tributary stream segments. The single exception was Brens Creek, where stoneflies, mayflies and cased caddisflies were all 'common' in abundance.

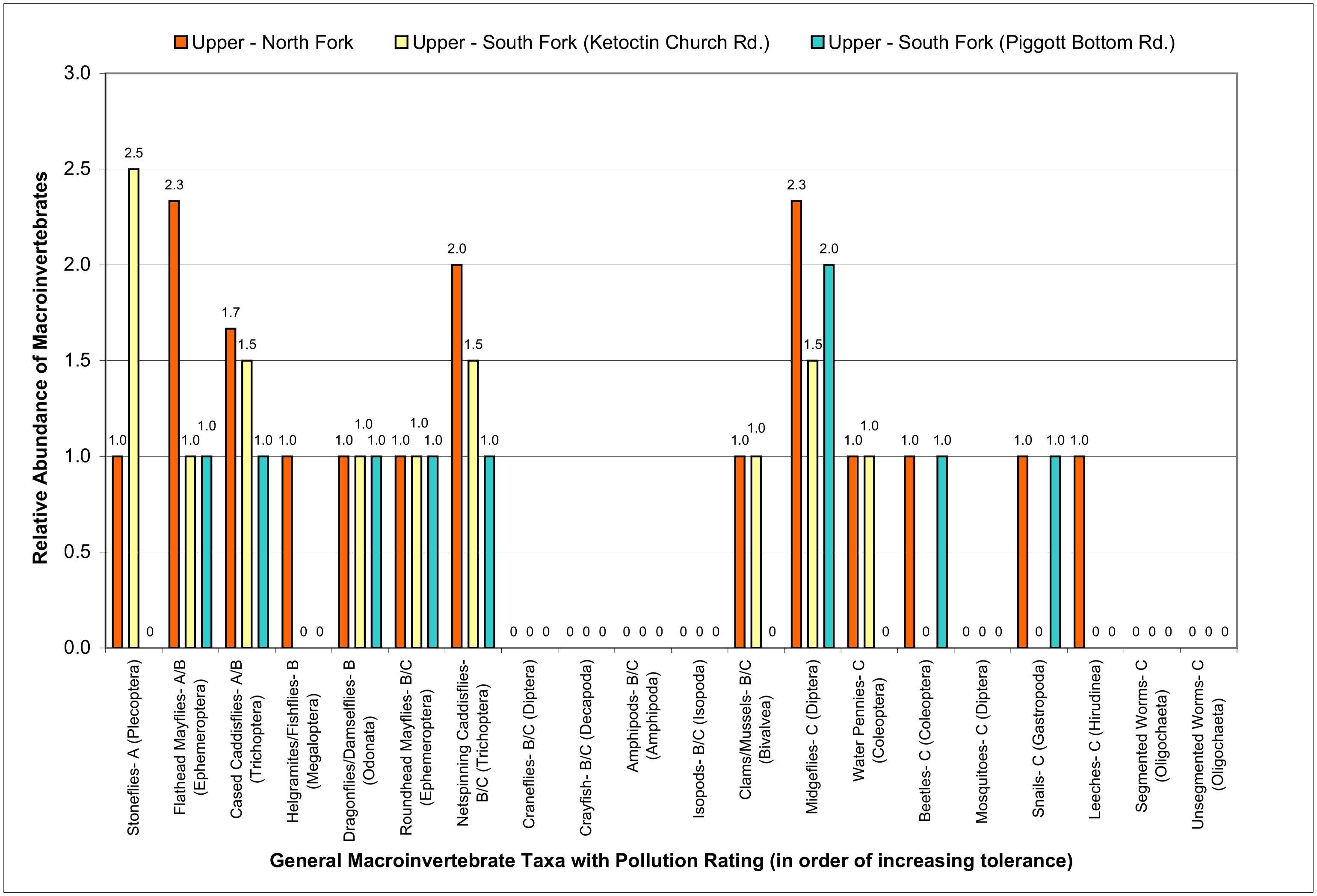
Catoctin Creek Level III RSAT tributary survey results (performed in spring 2005) are shown in Table 15. As seen in Table 15, with the exception of Richard Creek, which received a good IBI verbal rating, all of the tributaries had IBI scores in the excellent range. It should be noted that Brens Creek and upper Milltown Creek had the highest possible IBI score, (i.e., 100 percent). Other highlights included a total of 19 EPT taxa collected at each of the following tributary segments: Hamilton Station Road tributary, Middle Milltown Creek and EcoVillage tributary. For additional results from this survey and the RSAT voucher collection, the reader is referred to Appendix 5.

Major Findings

Mainstem Areas

- South Fork (Ketoctin Church Road) - a total of 13 stonefly taxa (pollution intolerant) collected from both the 20-jab (five) and the RSAT voucher (eight) samples that includes one taxa, *Acronueria sp.*, that is highly pollution intolerant.
- South Fork (Ketoctin Church Road) - the relative abundance of the stonefly group, represented by the Capniidae family (pollution intolerant) was 'common'.
- South Fork (Piggott Bottom Road) - in both the 20-jab and the RSAT voucher, the family group with the highest number of individuals present were Chironomidae (midgeflies), generally considered to be pollution tolerant.
- South Fork (Piggott Bottom Road) - both the 2000 and 2006 IBI ratings, although still in the good range (i.e., 60-79 points) declined from 73.2 to 64.1 points, respectively.
- North Fork (Hillsboro Road) - in the RSAT voucher sample, the relative abundance of

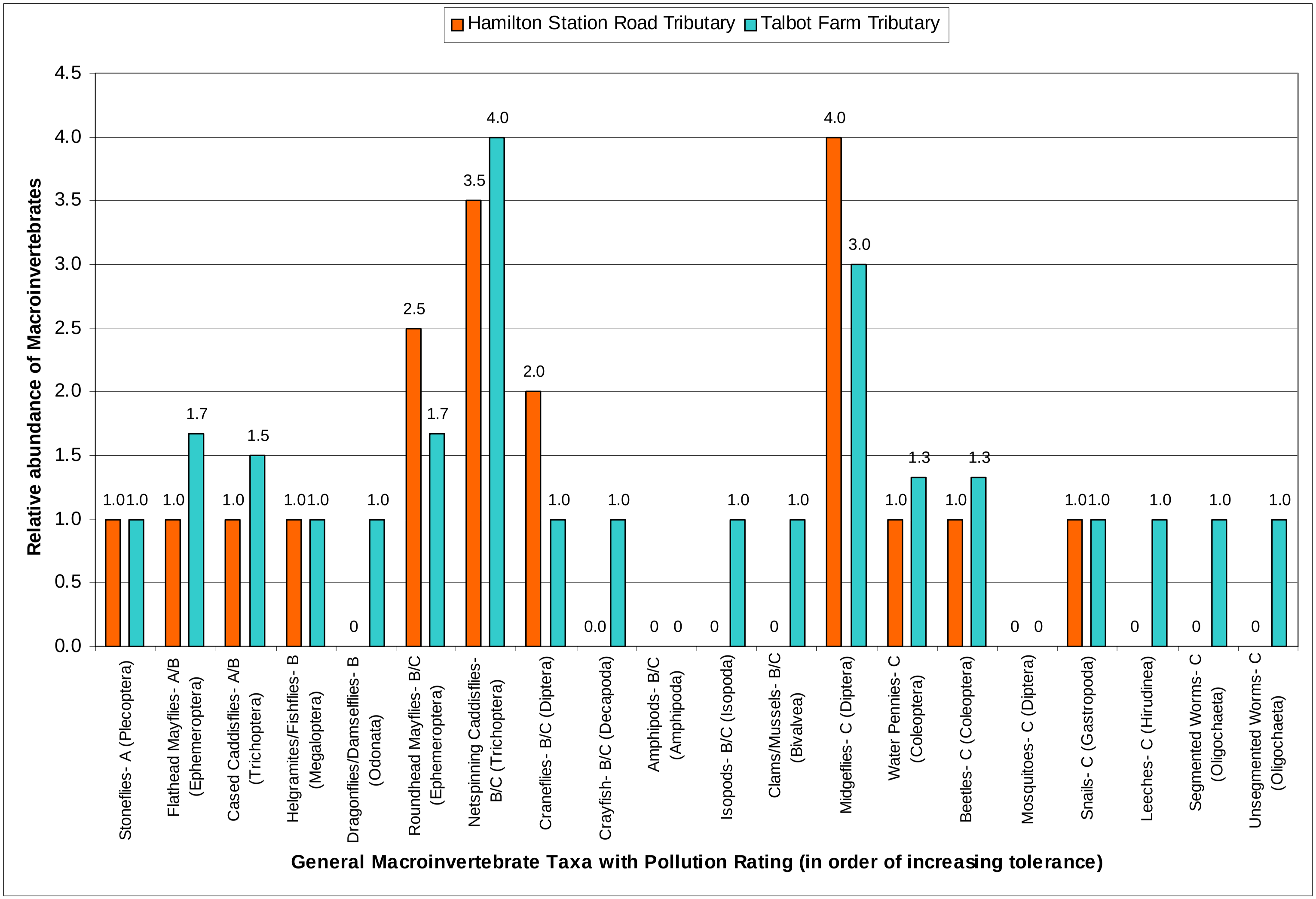
Figure 22. Catoctin Creek Mainstems - Mean Relative Abundance of Observed Macroinvertebrates[1] and General Pollution Tolerance[2]



[1] Relative abundance scores were averaged for each reach. Relative Abundance interpretation: 0 = No Taxa Found, 0.1-0.9 = Scarce, 1.0-2.0 = Scarce/Common, 2.1-3.0 = Common, 3.1-4.0 = Common/Abundant, 4.1-5.0 = Abundant.

[2] Pollution Tolerance Rating: A = Intolerant, B = Moderately Tolerant, C = Tolerant.

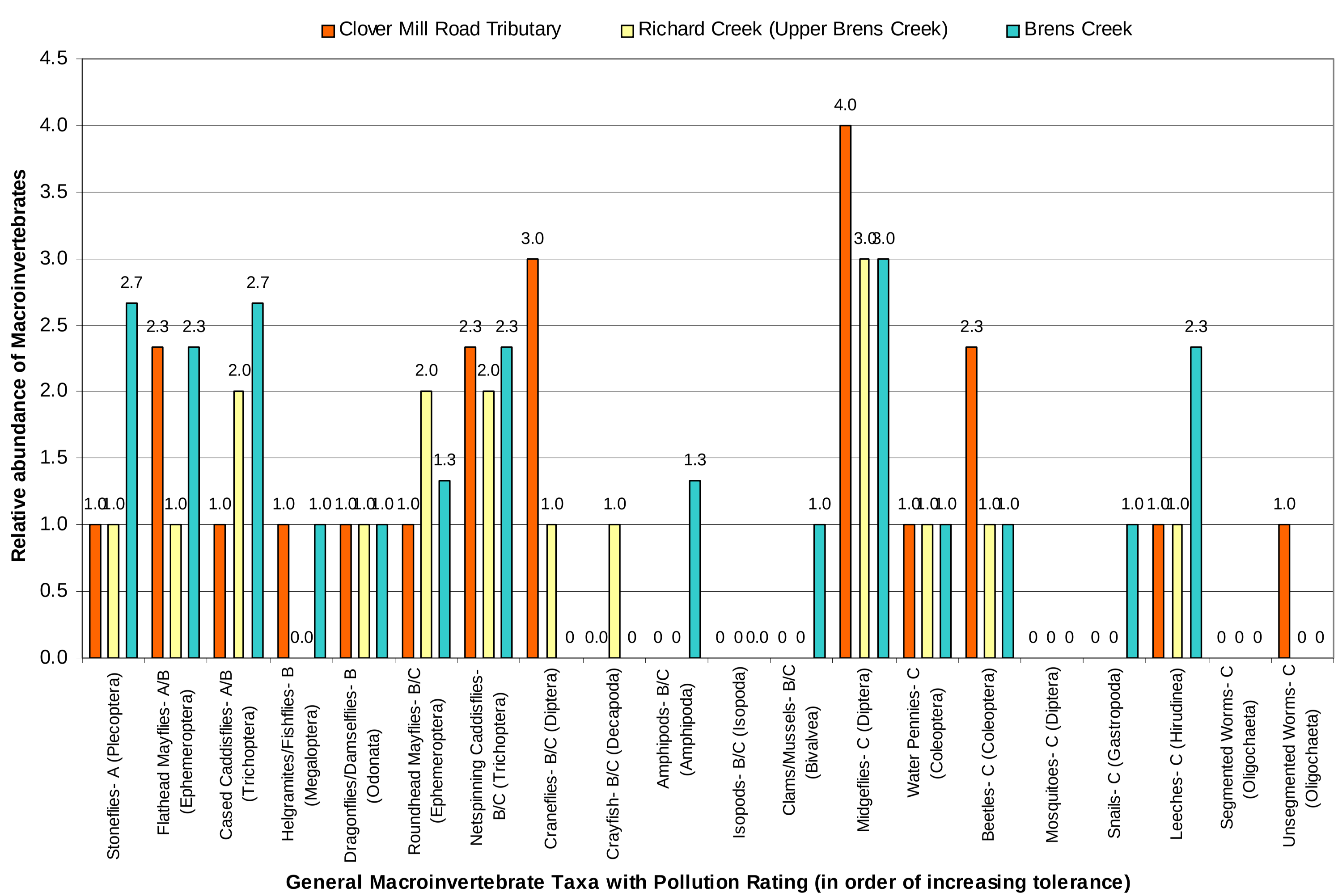
Figure 23. Catoctin Creek Upper Tributaries - Mean Relative Abundance of Observed Macroinvertebrates[1] and General Pollution Tolerance[2]



[1] Relative abundance scores were averaged for each reach. Relative Abundance interpretation: 0 = No Taxa Found, 0.1-0.9 = Scarce, 1.0-2.0 = Scarce/Common, 2.1-3.0 = Common, 3.1-4.0 = Common/Abundant, 4.1-5.0 = Abundant.

[2] Pollution Tolerance Rating: A = Intolerant, B = Moderately Tolerant, C = Tolerant.

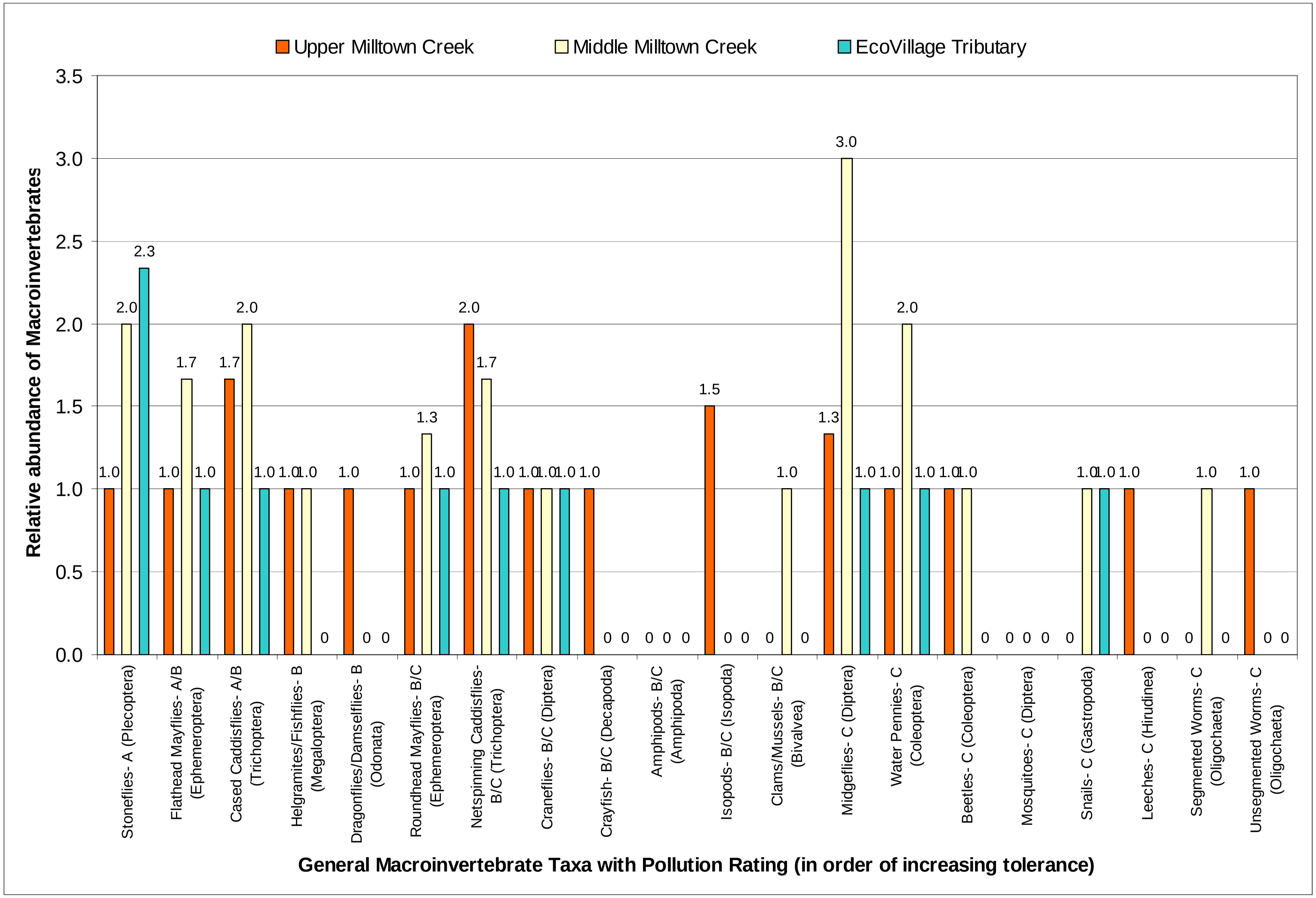
Figure 24. Catoctin Creek Middle Tributaries - Mean Relative Abundance of Observed Macroinvertebrates[1] and General Pollution Tolerance[2]



[1] Relative abundance scores were averaged for each reach. Relative Abundance interpretation: 0 = No Taxa Found, 0.1-0.9 = Scarce, 1.0-2.0 = Scarce/Common, 2.1-3.0 = Common, 3.1-4.0 = Common/Abundant, 4.1-5.0 = Abundant.

[2] Pollution Tolerance Rating: A = Intolerant, B = Moderately Tolerant, C = Tolerant.

Figure 25. Catoctin Creek Lower Tributaries - Mean Relative Abundance of Observed Macroinvertebrates[1] and General Pollution Tolerance[2]



[1] Relative abundance scores were averaged for each reach. Relative Abundance interpretation: 0 = No Taxa Found, 0.1-0.9 = Scarce, 1.0-2.0 = Scarce/Common, 2.1-3.0 = Common, 3.1-4.0 = Common/Abundant, 4.1-5.0 = Abundant.

[2] Pollution Tolerance Rating: A = Intolerant, B = Moderately Tolerant, C = Tolerant.

Table 15. Summary: Catoctin Creek - 1m^2 Macroinvertebrate Sample Metrics and Fairfax County SPS IBI Score and Rating[1]

RSAT Stream Segment	Approx. Stream Segment Location	Survey Date	Total Number of Ind.	Taxa Richness[2]	EPT Richness[3]	Percent EPT[4]	Percent Trichoptera w/o Hydropsychidae[5]	Percent Coloeoptera[6]	Family Biotic Index[7]	Percent Dominance[8]	Percent Clingers + Percent Plecoptera[9]	Percent Shredder[10]	Percent Predators[11]	IMBI[12]	SPS Rating
Catoctin Creek															
Upper - North Fork	Hillsboro Road	4/21/2005	77	16.0	5.0	26.0	1.3	2.6	4.3	45.5	0.0	1.3	3.9	76.0	**Good**
Upper - South Fork	Ketoctin Church Road	4/21/2005	161	30	14.0	48.4	6.2	23.6	4.2	14.9	3.7	0.6	10.6	90.0	**Excellent**
Upper - South Fork	Piggott Bottom Road	4/20/2005	211	23.0	5.0	15.6	1.4	14.7	5.3	42.7	0.0	0.0	7.1	73.2	**Good**
Upper - South Fork	Piggott Bottom Road	4/21/2000	298	18.0	7.0	4.4	0.3	52.1	6.3	1.7	0.5	0.7	0.3	64.1	**Good**
Tributaries to Catoctin Creek															
Upper															
Hamilton Station Road Tributary	Hamilton Station Road	5/6/2005	277	38.0	19.0	62.1	10.1	14.4	3.9	20.2	6.1	5.4	7.9	97.9	**Excellent**
Talbot Farm Tributary	Clarkes Gap Road	5/6/2005	217	33.0	15.0	52.1	6.0	10.6	3.9	17.1	3.7	3.7	9.2	94.4	**Excellent**
Middle															
Clover Mill Road Tributary	Clover Mill Road	6/10/2005	517	32.0	7.0	67.5	1.0	1.2	4.0	51.6	0.0	1.7	11.6	80.5	**Excellent**
Richard Creek	Purcellville Road	6/2/2005	532	27.0	3.0	22.7	0.6	16.7	4.7	42.1	1.1	0.4	16.5	77.0	**Good**
Brens Creek	Ash George Road	5/11/2005	391	32.0	16.0	66.5	10.0	7.7	3.6	21.0	6.1	9.2	8.7	100.0	**Excellent**
Lower															
Upper Milltown Creek	Boilington Road	6/6/2006	452	40.0	16.0	58.2	1.5	12.8	4.2	18.4	11.7	11.3	16.6	100.0	**Excellent**
Middle Milltown Creek	Milltown Road	5/11/2005	344	36.0	19.0	60.2	3.5	13.1	4.0	27.3	4.9	2.6	11.0	93.8	**Excellent**
EcoVillage Tributary	Taylortown Road	6/10/2005	390	38.0	19.0	65.4	3.3	12.6	3.6	19.5	1.5	6.7	10.0	93.5	**Excellent**

[1] Scores and rating were developed by Fairfax County Stream Protection Strategy.

[2] Taxa richness represents the total number of taxa collected and is interpreted by SPS as follows: >= 21 = Excellent, 13–20 = Good, 9-12 = Fair, 5-8= Poor, <5 = Very Poor.

[3] Counts the distinct taxa considered pollution intolerant within the groups of Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies). EPT taxa metrics are interpreted as follows: >7 = Excellent, 5-6 = Good, 4 = Fair, 2-3 = Poor, <=1 = Very Poor.

[4] Measures the abundance of generally pollution intolerant Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) relative to other often more tolerant individuals and is interpreted as follows: >16.6 = Excellent, 12.4-16.5% = Good, 8.3-12.3% = Fair, 4.1-8.2% = Poor, >1.9% = Very Poor.

[5] Measures the absence of generally pollution tolerant Hydropsychidae (caddisflies) relative to other more intolerant Caddisflies and is interpreted as follows: >0.79% = Excellent, 0.60-0.78% = Good, 0.40-0.59% = Fair, 0.39-0.20% = Poor, <0.20% = Very Poor.

[6] Measures the abundance of generally pollution intolerant Coleoptera (beetles) relative to other individuals and is interpreted as follows: >1.00% = Excellent, 0.75 – 0.99% = Good, 0.50-.74% = Fair, 0.25 – 0.49% = Poor and < 0.24% = Very Poor.

[7] The Family Biotic index measures the general tolerance/intolerance of the sample to organic nutrients and is interpreted as follows: 0.00-3.50 = Excellent, 3.51-5.50 = Good, 5.51-7.50 = Fair, 7.51-8.50 = Poor, > 8.51 Very Poor.

[8] Measures the percent of the most abundant taxa relative to the total taxa within the sample and represents community balance. It is interpreted as follows: <60% = Excellent, 61-68.5% = Good, 68.6-84.0% = Fair, 84.5-92.0%= Poor, >92.0% = Very Poor.

[9] Measures the percent of individuals whose habitat type is clingers plus percent of sample that are stoneflies but are not clingers and is interpreted as follows: >3.28% = Excellent, 2.46-3.27% = Good, 1.63-2.45% = Fair, 0.84-1.62%= Poor, <0.84% = Very Poor.

[10] Measures the percent of individuals that are shredders relative to all other feeding guild types and is interpreted as follows: >5.42% = Excellent, 4.10-5.41% = Good, 2.70-4.00% = Fair, 1.39-2.69% = Poor, <1.39% = Very Poor.

[11] Measures the percent of individuals that are predators relative to all other feeding guild types and is interpreted as follows: >2.30% = Excellent, 1.52-2.00% = Good, 1.02-1.51% = Fair, 0.50-1.01% = Poor, <0.50% = Very Poor.

[12] SPS IBI score interpretation: 80-100 = Excellent, 60-79 = Good, 40-59= Fair, 20-39 = Poor, 0-19 = Very Poor.

netspinning caddisflies (moderately pollution tolerant) was 'common'.

- North Fork (Hillsboro Road) - A total of only 77 individuals were collected in the 20-jab sample survey in April 2006. Therefore, the index of biotic integrity results for this stream segment should be viewed with caution.

Tributaries

- With the exception of Richard Creek and Clover Mill tributary, the number of mayfly (Ephemeroptera), stonefly (Plecoptera) and caddisfly (Trichoptera), also referred to as EPT, taxa present in the 20-jab survey were greater than seven, which is rated as being excellent.
- Talbot Farm tributary - netspinning caddisflies (moderately pollution tolerant) were 'common/abundant'.
- Hamilton Station Road tributary - midgeflies (pollution tolerant) were 'common/abundant'.

Midgefly - Chironomidae Family - Pollution Tolerant - Collected At All Tributary Stream Segments

- Clover Mill Road tributary - IBI score of 80.5 points was borderline excellent/good. The EPT taxa was verbally rated as being excellent with seven total taxa present.
- Richard Creek - the number of mayfly (Ephemeroptera), stonefly (Plecoptera) and caddisfly (Trichoptera) taxa present totaled three (i.e., poor category) in the 20-jab survey.
- Brens Creek - the relative abundance of stoneflies (highly pollution intolerant) was 'common'.
- Upper Milltown Creek - caddisfly individuals from the Glossosomatidae family (highly pollution intolerant), *Glossosoma sp.*, were collected. Although few individuals were present, these tortoise-case makers are associated with cool, well oxygenated streams.
- Middle Milltown Creek - stonefly individuals from the Perlidae family (highly pollution intolerant), *Agnetina sp.*, were present in high numbers for the 20-jab sample.
- EcoVillage tributary - flathead mayfly individuals from the Heptageniidae family (highly pollution intolerant), *Leucrocuta sp.*, were collected. These individuals occupy riffle habitats in cool, well oxygenated streams.

Flathead Mayfly - Heptageniidae Family (Highly Pollution Intolerant), *Leucrocuta sp.*, collected from Middle Milltown Creek

3.2.7 RSAT Summary Stream Quality Ratings

Mainstem Areas

A summary of the six RSAT evaluation categories employed for evaluating overall stream quality in the Catoctin Creek and its surveyed tributary segments is presented in Table 16 and Figure 26. As seen in Table 16, with the exception of the South Fork (Piggott Bottom Road) site, all of the Catoctin Creek mainstem areas received a good overall rating. For the South Fork (Piggott Bottom Road) site, the overall stream quality rating was fair. In addition it should be noted that in the RSAT 2000 survey South Fork at Piggott Bottom Road was rated good, bordering on fair.

Tributaries

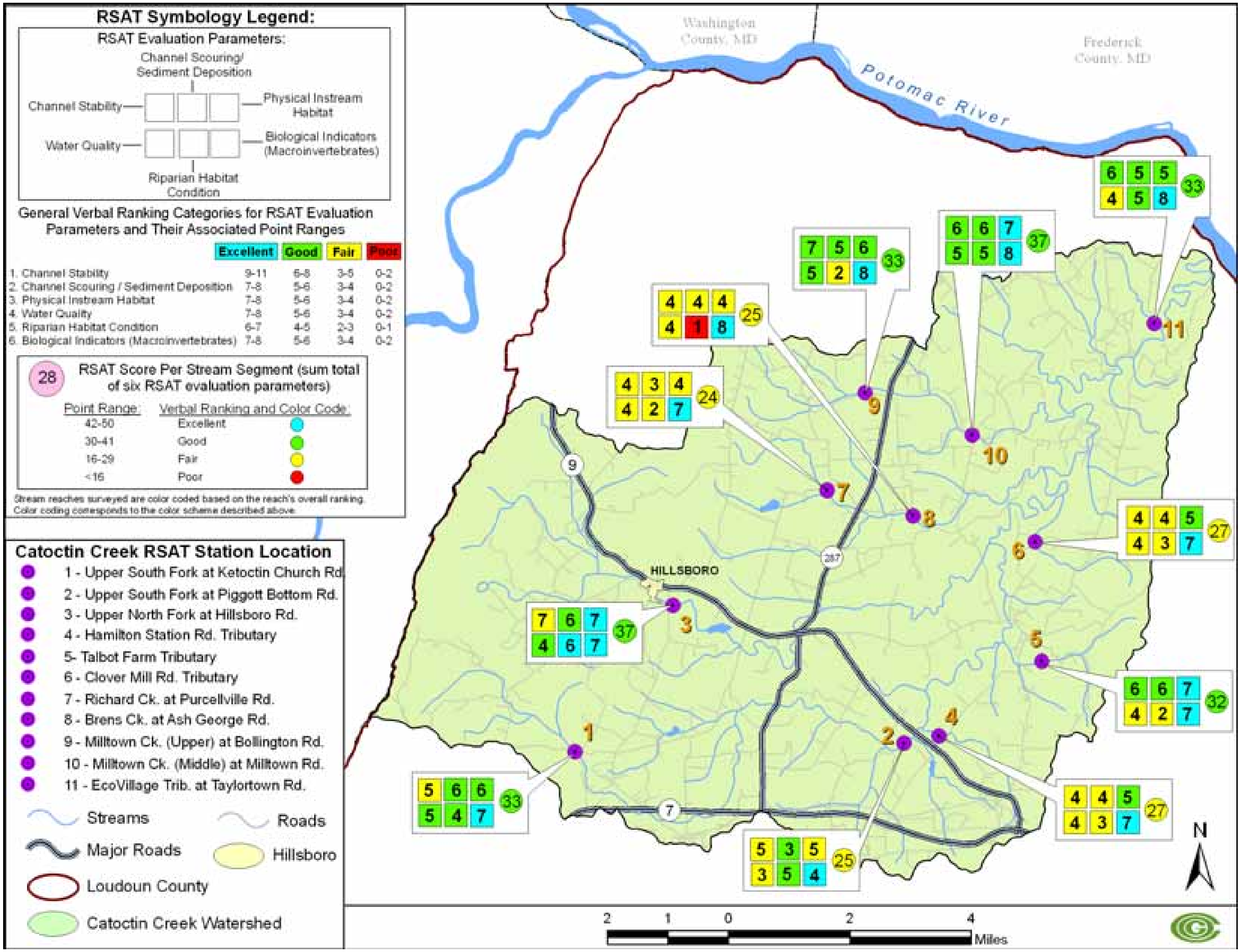
Of the eight tributary stream segments surveyed, four (i.e., Hamilton Station Road and Clover Mill Road tributaries, Richard Creek, and Brens Creek) were rated fair. The remaining four (i.e., Talbot Farm tributary, upper Milltown Creek, middle Milltown Creek and EcoVillage tributary) were rated good.

Table 16. Catoctin Creek Study Summary: RSAT Ratings[1]

RSAT Stream Segment	Approx. Stream Segment Location	Bank Stability	Channel Scouring/ Deposition	Physical Instream Habitat	Water Quality	Riparian Habitat Conditions	Biological Indicators	RSAT Total Score[2]
Catoctin Creek Mainstems								
Upper - North Fork	Hillsboro Road	Good (7)	Good (6)	Excellent (7)	Fair (4)	Excellent (6)	Excellent (7)	**Good (37)**
Upper - South Fork	Ketoctin Church Road	Fair (5)	Good (6)	Good (6)	Good (5)	Good (4)	Excellent (7)	**Good (33)**
Upper - South Fork	Piggott Bottom Road	Fair (5)	Fair (3)	Good (5)	Fair (3)	Good (5)	Fair (4)	**Fair (25)**
Tributaries to Catoctin Creek								
Upper								
Hamilton Station Road Tributary	Hamilton Station Road	Fair (4)	Fair (4)	Good (5)	Fair (4)	Fair (3)	Excellent (7)	**Fair (27)**
Talbot Farm Tributary	Clarkes Gap Road	Good (6)	Good (6)	Excellent (7)	Fair (4)	Fair (2)	Excellent (7)	**Good (32)**
Middle								
Clover Mill Road Tributary	Clover Mill Road	Fair (4)	Fair (4)	Good (5)	Fair (4)	Fair (3)	Excellent (7)	**Fair (27)**
Richard Creek (Upper Brens Creek)	Purcellville Road	Fair (4)	Fair (3)	Fair (4)	Fair (4)	Fair (2)	Excellent (7)	**Fair (24)**
Brens Creek	Ash George Road	Fair (4)	Fair (4)	Fair (4)	Fair (4)	Poor (1)	Excellent (8)	**Fair (25)**
Lower								
Upper Milltow n Creek	Bollington Road	Good (7)	Good (5)	Good (6)	Good (5)	Fair (2)	Excellent (8)	**Good (33)**
Middle Milltow n Creek	Milltow n Road	Good (6)	Good (6)	Excellent (7)	Good (5)	Good (5)	Excellent (8)	**Good (37)**
EcoVillage Tributary	Taylortow n Road	Good (6)	Good (5)	Good (5)	Fair (4)	Good (5)	Excellent (8)	**Good (33)**

[1] Actual point values are shown in parentheses.
[2] Total RSAT score interpretation: 42-50 = Excellent, 30-41 = Good, 16-29 = Fair, <16 = Poor.

Figure 26. Catoctin Creek Study Summary: RSAT Ratings



3.3 Quarter Branch and Dutchman Creek Watersheds

3.3.1 Streambank Stability, Relative Erodibility and Channel Downcutting

Overall streambank stability results are summarized in Table 17 and Figures 27 and 28. Streambank stability for both Quarter Branch and middle mainstem portion of Dutchman Creek was rated as being excellent (i.e., greater than 80 percent of the bank network is stable). Moderate/severe or severe erosion conditions were not observed at either surveyed site. RSAT Quarter Branch and Dutchman Creek streambank erosion survey results and totals (Table 17, Figures 27 and 28) are as follows: 1) Quarter Branch - 203 linear feet of moderate streambank erosion (i.e., 5.4 percent of the surveyed streambank network at a rate of 286.2 linear feet per mile), 2) Dutchman Creek - 320 linear feet of moderate streambank erosion (i.e., 11.9 percent of the surveyed streambank network at a rate of 629.6 linear feet per mile) and 3) two recent tree falls both observed within Quarter Branch stream channel (i.e., at a rate of 2.8 tree falls per mile). It should be noted that both tree falls were associated with short (i.e., less than 50 linear feet) moderate erosion condition stream bend areas.

Quarter Branch (X-2) - Stable Streambank

RSAT soil texture survey results (Figure 27) revealed that: 1) the bank material for Quarter Branch is comprised of moderately erodible soil types (i.e., loamy textured soils) and 2) the bank material for Dutchman Creek (middle mainstem) is comprised of low erodibility potential soil types (i.e., predominantly clay-textured soils, bedrock, rip-rap, etc.), though soils with moderate and high erodibility potentials are also present.

Table 17. Summary: Quarter Branch and Dutchman Creek - Streambank Erosion Conditions

RSAT Stream Segment	Surveyed Stream Length (ft.)	Surveyed Streambank Network[1] Length (ft.)	Bank Erosion Conditions: Severe (LF)	Severe (LF/mi.)	Moderate/Severe (LF)	Moderate/Severe (LF/mi.)	Moderate (LF)	Moderate (LF/mi.)	No. of Recent Tree Falls[2] No.	No./mi.	No. of Erosional Log Jams	Mean Bank Stability (%)[3]
Quarter Branch												
Quarter Branch	1,871.2	3,742.4	0.0	0.0	0.0	0.0	202.9	286.2	2.0	2.8	0.0	81.7
Dutchman Creek												
Dutchman Creek	1,342.5	2,685.0	0.0	0.0	0.0	0.0	320.2	629.6	0.0	0.0	0.0	81.8

[1] Length to include both the left and right bank (i.e., twice the distance of the surveyed stream length).
[2] Tree fall interpretation: 0-1/mi. = Excellent, 2-3/mi. = Good, 4-5/mi = Fair, $\geq$6 = Poor.
[3] Bank stability interpretation: >80% = Excellent, 71-80% = Good, 50-70% = Fair, <50% = Poor.

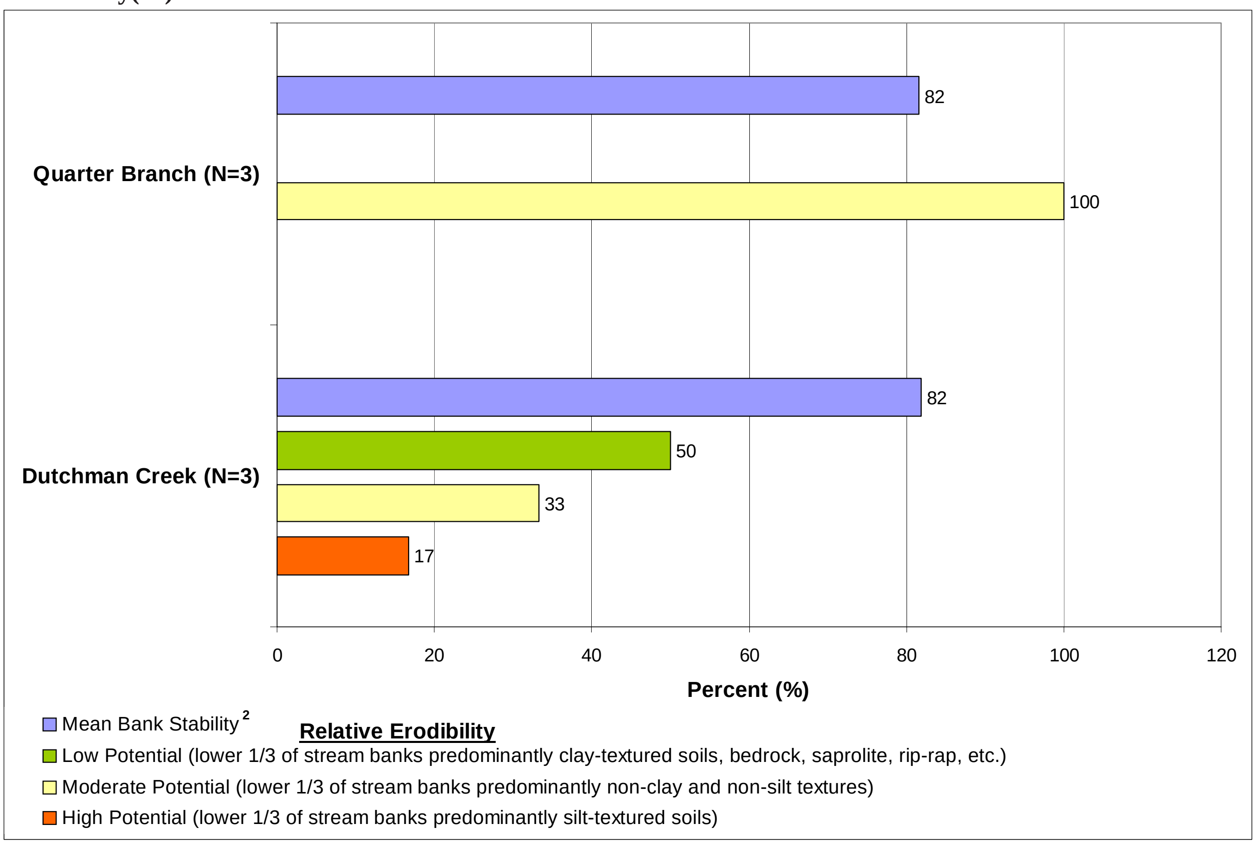
Stream channel downcutting results (Table 18 and Figure 29) revealed that mean streambank heights for both Quarter Branch and Dutchman Creek exceed the expected or reference condition bank heights by as much as one foot. Representative channel cross-sectional areas for Quarter Branch and Dutchman Creek were 209.79 square feet and 192.11 square feet, respectively. The combined higher than expected streambank heights and large channel cross-sectional areas suggest that both Quarter Branch and Dutchman Creek stream channels have, in the past, experienced a moderate level of channel downcutting and widening. It should be noted that, for Quarter Branch, further channel downcutting may be limited by the frequent presence of in-channel bedrock out-crops.

Major Findings

Quarter Branch

- Bank stability ranged from 72 (i.e., good) to 90 percent (i.e., excellent).
- Mean streambank stability was 81.7 percent and was rated as being excellent.
- There were no areas exhibiting either moderate/severe or severe bank erosion conditions.

Figure 27. Summary: Quarter Branch and Dutchman Creek - Mean Streambank Stability and Relative Erodibility(%)[1]



[1] Total number of observations to determine average bank stability and relative erodibility appear in parentheses.
[2] Mean bank stability interpretation: >80% = Excellent, 71-80% = Good, 50-70% = Fair, <50% = Poor.

Figure 28. Summary: Quarter Branch and Dutchman Creek - Streambank Stability Condition

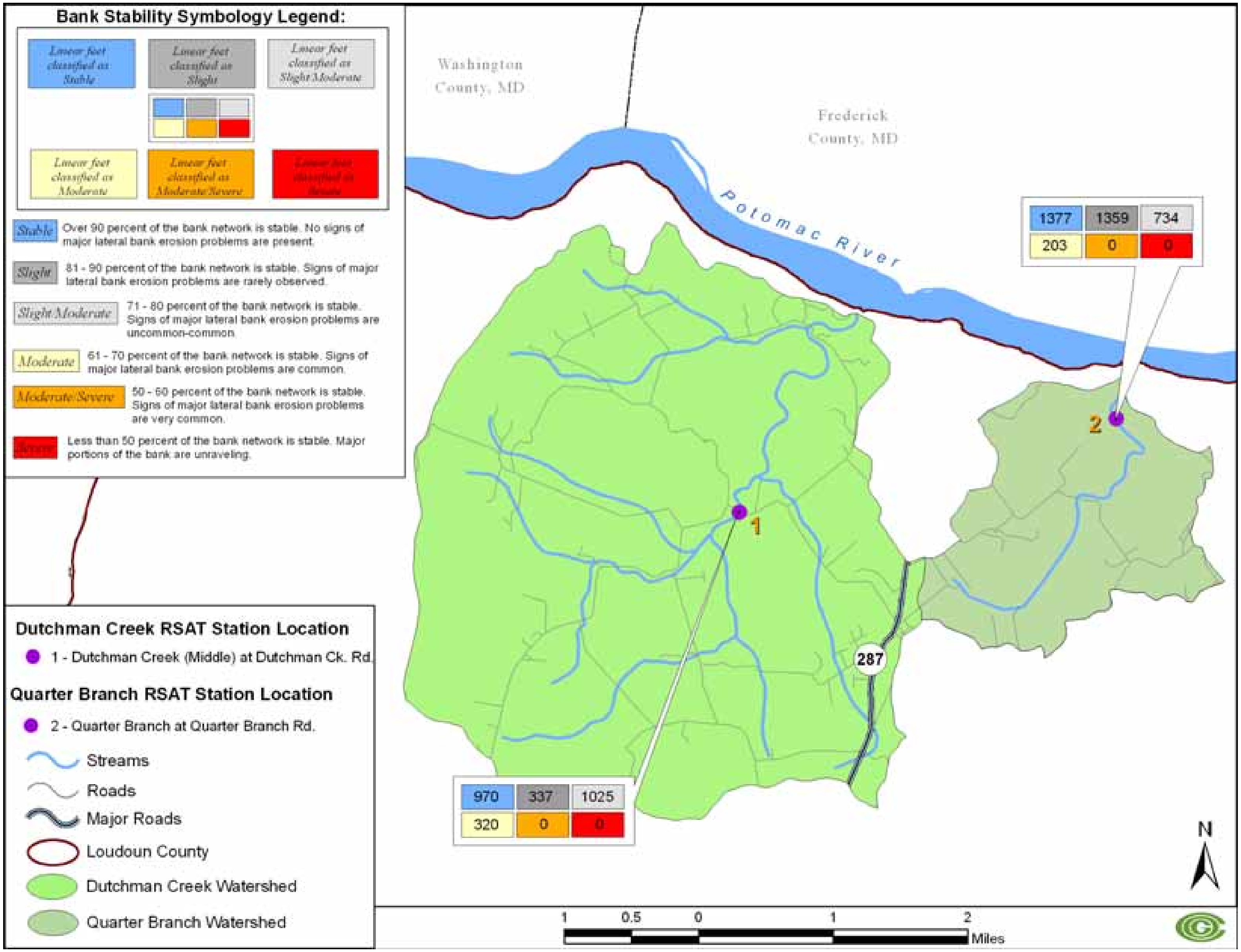
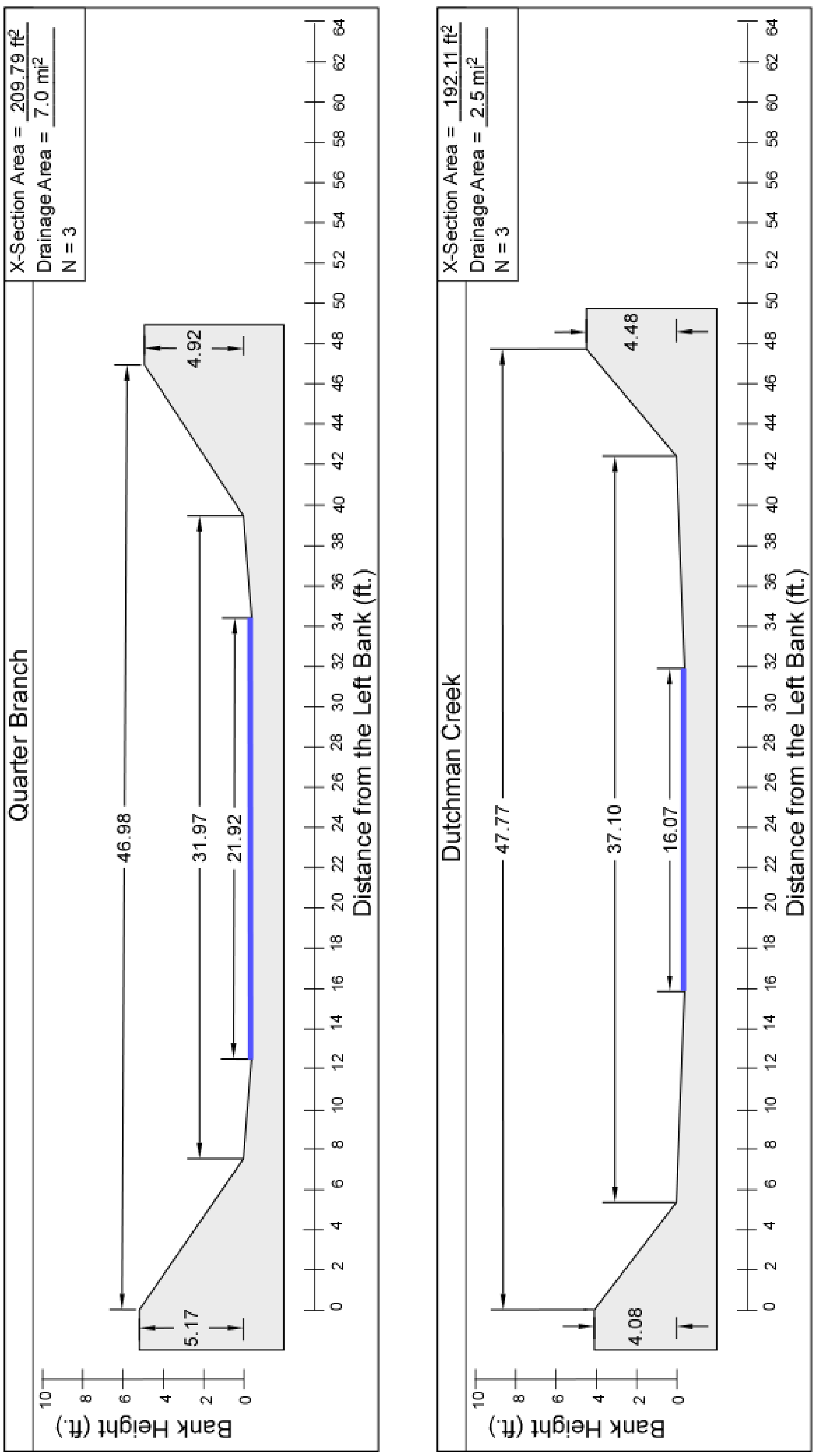


Figure 29. Quarter Branch and Dutchman Creek Mainstem - Representative Channel Cross-Sections[1]



[1] Top channel width, bottom channel width and wetted perimeter area (heavy blue line) depicted.

Table 18. Summary: Quarter Branch and Dutchman Creek - Stream Channel Downcutting

RSAT Stream Segment	Drainage Area (mi²)	Surveyed Stream Length	Mean Bank Height R[1] (ft)	Mean Bank Height L[2] (ft)	Mean Bank Height (ft)	Expected Bank Height Range (ft)	Number of Nick Points
Quarter Branch							
Quarter Branch	7.0	1,871	3.9	3.4	3.6	2-3	0
Dutchman Creek							
Dutchman Creek	2.5	1,343	3.7	3.6	3.7	2-3	0

Dutchman Creek

- Bank stability ranged from 65 (i.e., fair) to 95 percent (i.e., excellent).
- Mean streambank stability was 81.8 percent and rated excellent.
- Moderate/severe or severe bank erosion conditions were not observed.
- No recent tree falls were observed.
- 142 linear feet of actively eroding streambank (moderate erosion condition) was observed in the vicinity of Cypress Knoll Lane.

Dutchman Creek (Transect X-3) - Stable Streambank

3.3.2 Channel Scouring and Sediment

Channel Deposition

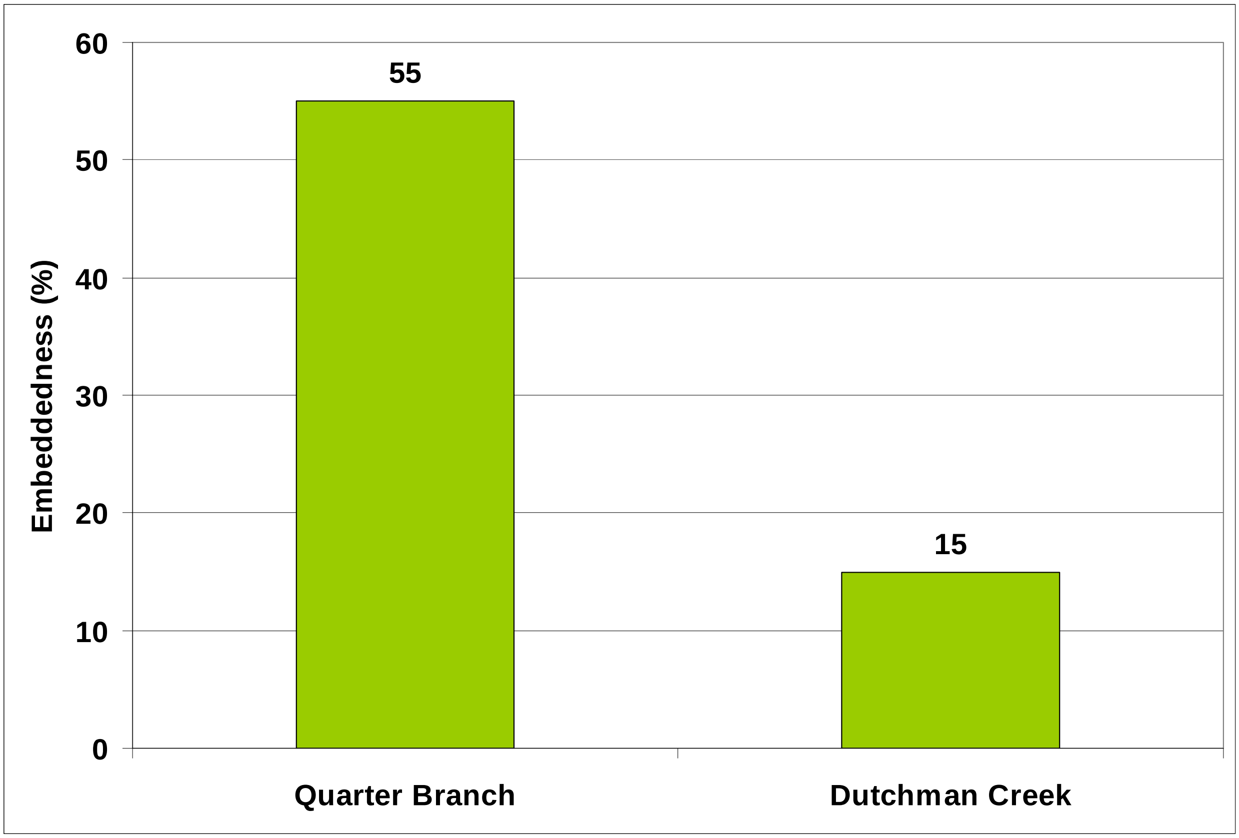
Table 19 summarizes the channel scouring and sediment channel deposition for Quarter Branch and Dutchman Creek. As seen in Table 19, large point bars were not observed in Quarter Branch. A total of two large stable point bars were observed in Dutchman Creek. Mean embeddedness levels in Quarter Branch (Figure 30) were rated as being fair (i.e., 51 - 75 percent). In contrast, the Dutchman Creek embeddedness levels were excellent, ranging from 10 to 25 percent.

Table 19. Summary: Quarter Branch and Dutchman Creek - Channel Scouring/Sediment Deposition Conditions

RSAT Stream Segment	Surveyed Stream Length (ft.)	Percent Riffle Embbeddedness		Large Point Bars				Relative Level of In-Channel Sand Deposits
		Observed Range	Mean	Total Number Observed	No. Unstable	Percent Unstable (%)	No.of Unstable /Mile	
Quarter Branch								
Quarter Branch	1,871	50-60	55.0	0	0	0	0.0	Moderate
Dutchman Creek								
Dutchman Creek	1,343	10-25	15.0	2	0	0	0.0	Low

[1] Right bank looking downstream.
[2] Left bank looking downstream.
[3] Riffle embeddedness rating scale: <25% = Excellent, 25-50% = Good, 51-75% = Fair, >75% = Poor.

Figure 30. Quarter Branch and Dutchman Creek - Mean Riffle Embeddedness Levels[1]



Major Findings

Quarter Branch

- Mean riffle embeddedness throughout the survey ranged from 50-60 percent, which fell within the good and fair range.
- There was a noticeable amount of sand deposition within riffle, pool and run habitat areas.

Dutchman Creek

- Riffle embeddedness levels fell within the excellent to good categories (10-25 percent) throughout the survey.
- Below transect X-2, riffle and pool substrate featured coarser-sized rubble, cobble and boulder material with little sand.

[1] Riffle embeddedness rating scale: <25% = Excellent, 25-50% = Good, 51-75% = Fair, >75% = Poor.

3.3.3 Physical Aquatic Habitat

General physical aquatic habitat conditions for Quarter Branch and Dutchman Creek are summarized in Table 20 and Figure 31. As seen in Table 20, the RSAT physical aquatic habitat conditions for both Quarter Branch and Dutchman Creek were good. For Quarter Branch, the major factors contributing to its good rating included good pool quality (i.e., pools generally >18 inches with abundant overhead cover for fish) and good mean wetted perimeter. For Dutchman Creek, the major factors contributing to its good rating included good riffle substrate quality (i.e., high levels of coarse substrate material such as cobble, rubble and gravel with little sand present) and very good quality pools.

Quarter Branch - Riffle/Pool Sequence With In-Stream Bedrock Outcrops

Major Findings

Quarter Branch

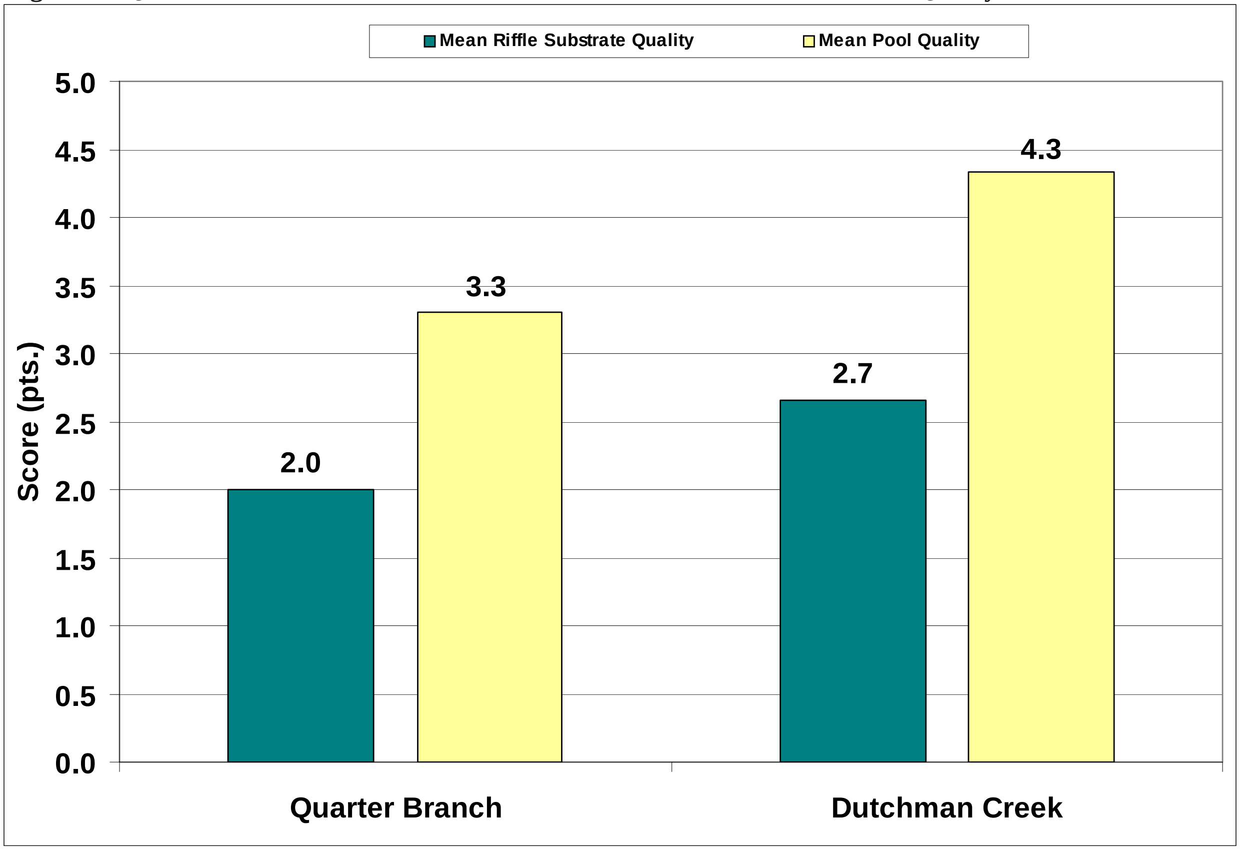
- Maximum pool depth was 20 inches. However, several shallow pools (i.e., approximately 12 inches deep) were present. As previously mentioned, the bedrock streambed limits the formation of deeper pools.
- The substrate material composition consisted of small cobble, gravel, rubble, and bedrock with a noticeable amount of sand.
- No fish barriers were observed.

Table 20. Summary: Quarter Branch and Dutchman Creek - General Physical Aquatic Habitat Conditions

RSAT Stream Segment	Riffle Characteristics				Pool Characteristics				Fish Barriers		RSAT Physical Habitat Score (pts.)[5]
	No. of Riffles	Mean Riffle Depth (in.)	Mean Riffle Substrate Quality (pts.)[1]	Mean Riffle Embeddedness (%)[2]	No. of Pools	Mean Max. Depth (in.)	Mean Pool Quality (pts.)[3]	Riffle/Pool Ratio[4]	Total Number	Per Mile	
Quarter Branch											
Quarter Branch	10	3.9	2.0	55.0	8	17.3	3.3	1.3	0	0	5
Dutchman Creek											
Dutchman Creek	6	3.9	2.7	15.0	7	33.2	4.3	0.9	0	0	5

[1] Riffle substrate quality rating scale: 3.25-4.00 = Excellent, 2.50-3.24 = Good, 1.75 – 2.49 = Fair, 1.00- 1.74 = Poor.
[2] Riffle embeddedness rating scale: <25% = Excellent, 25-50% = Good, 51-75% = Fair, >75% = Poor.
[3] Quality pool point scale interpretation: 5 = Excellent, 4 = Very Good, 3 = Good, 2 = Fair, 1 = Poor.
[4] Riffle/pool ratio rating scale: 0.9-1.1:1 = Excellent, 0.70-0.89:1 or 1.11-1.3:1 = Good, 0.5-0.69 or 1.31-1.5:1 = Fair, 0.49:1< or >1.51:1 = Poor.
[5] RSAT Physical habitat rating scale: 6.5-8.0 = Excellent, 4.5-6.4 = Good, 2.5-4.4 = Fair, 1.0-2.4 = Poor.

Figure 31. Quarter Branch and Dutchman Creek - Mean Riffle Substrate[1] and Pool Quality[2]



Dutchman Creek

- Mean riffle embeddedness, at 15 percent, was rated excellent.
- Maximum pool depth was measured at 43 inches and provided abundant fish habitat-related overhead cover.
- No fish barriers were observed.

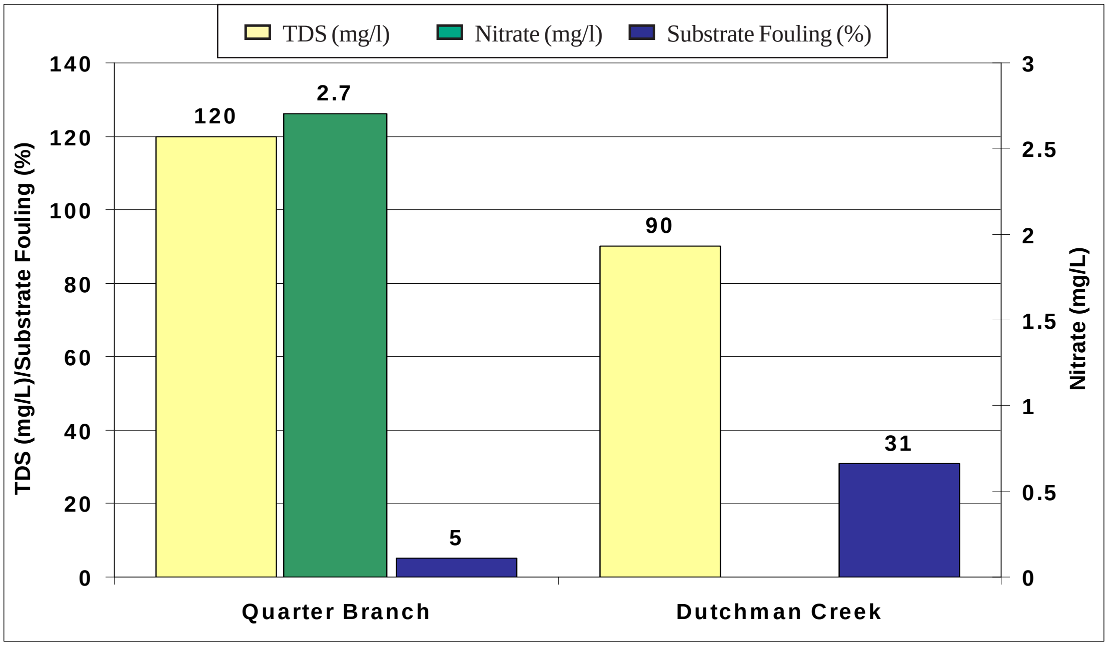
3.3.4 Water Quality

Quarter Branch and Dutchman Creek RSAT water quality grab sampling summary total dissolved solids (TDS), nitrate, and substrate fouling results are presented in Figure 32. As seen in Figure 32, TDS levels were in the fair range for Quarter Branch (i.e., 101-150 mg/l) and in the good range for Dutchman Creek (i.e., 50-100 mg/l). Nitrate concentrations for Quarter Branch were high (i.e., >3.0 mg/l) and moderate for Dutchman Creek (i.e., 1.1-2.9 mg/l). Quarter Branch substrate fouling levels were excellent (i.e.,< 11 percent of the bottom side of cobble-sized stones covered by organic film); whereas, Dutchman Creek's were fair (i.e., 21-50 percent of the bottom side of cobble-sized stones covered by organic film). The overall RSAT water quality ratings for Quarter Branch and Dutchman Creek were good and fair, respectively.

---

[1] Riffle substrate quality point scale interpretation: 3.25-4.00 = Excellent, 2.50-3.24 = Good, 1.75-2.49 = Fair, 1.00-1.74 = Poor.
[2] Pool quality point interpretation: 4.5-5.0 = Excellent, 4.0-4.4 = Very Good, 3.0-3.9 = Good, 2.0-2.9 = Fair, 1.0-1.9 = Poor.

Figure 32. Quarter Branch and Dutchman Creek - TDS[1], Nitrate[2] and Mean Substrate Fouling[3]



Major Findings

Quarter Branch

- The instantaneous TDS level (120 mg/l) was in the fair range.
- The instantaneous nitrate concentration (4.0 mg/l) was in the high range.
- Mean substrate fouling (5 percent) was in the excellent range.
- The instantaneous orthophosphate concentration was 0.19 mg/l. According to Dunne and Leopold (1978), 'long-term eutrophication will usually be prevented if total phosphorus and orthophosphate levels are below 0.5 mg/l and 0.05 mg/l, respectively.'
- The instantaneous copper concentration, 0.06 mg/l, exceeded the Virginia Department of Environmental Quality (VADEQ) 0.009 mg/l standard for protecting aquatic life.

Middle Dutchman Creek

- The instantaneous TDS level (90 mg/l) was in the good range.
- The instantaneous nitrate level (2.7 mg/l) was in the moderate range.
- Mean substrate fouling (31 percent) was in the fair range.
- The instantaneous orthophosphate concentration was 0.54 mg/l.
- The instantaneous copper concentration, 0.67 mg/l, exceeded the VADEQ 0.009 mg/l standard for protecting aquatic life.

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[1] TDS interpretation: <50 mg/L = Excellent, 50-100 mg/L = Good, 101-150 mg/L = Fair, >150mg/L = Poor.
[2] Nitrate interpretation: 0.0-1.0 mg/L= Low, 1.1-2.9 mg/L = Moderate, >3.0 mg/L = High.
[3] Substrate fouling interpretation: 0-10% = Excellent, 11-20% = Good, 21-50% = Fair, >50% = Poor.

3.3.5 Riparian Habitat Conditions

As seen in Table 21, riparian habitat conditions within Quarter Branch and Dutchman Creek were rated as being in the good to fair range. Quarter Branch mean canopy coverage was 63 percent (i.e., good). Its riparian buffer zone widths were generally greater than 200 feet wide and consisted of hardwood forest. Dutchman Creek mean canopy coverage was 52 percent (i.e., fair) and its mean riparian buffer width was approximately 170 feet. It also featured a mix of forest/grass vegetation types.

Dutchman Creek (Transect X-2) - Grassed Riparian Buffer/Cypress Knoll Lane Development

Major Findings

Quarter Branch

- The only major canopy gap was associated with the VEPCO stream crossing.

Dutchman Creek

- Major canopy gaps were present along the left streambank (looking downstream) section located behind the houses at Cypress Knoll Lane. Mixed forest/grass vegetation dominated this riparian buffer area for approximately 500 linear feet.

Quarter Branch (Above Transect X-3) - Poor Tree Canopy/ VEPCO Crossing

Table 21. Summary: Quarter Branch and Dutchman Creek - Riparian Habitat Conditions

RSAT Stream Segment	Surveyed Stream Length (ft.)	Number of Observations	Mean Canopy Coverage (%)[1]	Riparian Habitat Conditions	
				RSAT Score[2]	Verbal Ranking
Quarter Branch					
Quarter Branch	1,871.2	6	63.3	5	Good
Dutchman Creek					
Dutchman Creek	1,342.5	5	52.0	3	Fair

[1] Mean canopy coverage interpretation: $\geq$ 80% = Excellent, 60-79% = Good, 50-59% = Fair, <50% = Poor.
[2] Point Score Interpretation: 6.0-7.0 = Excellent, 4.0-5.9 = Good, 2.3-3.9 = Fair, 0-1.9 = Poor.

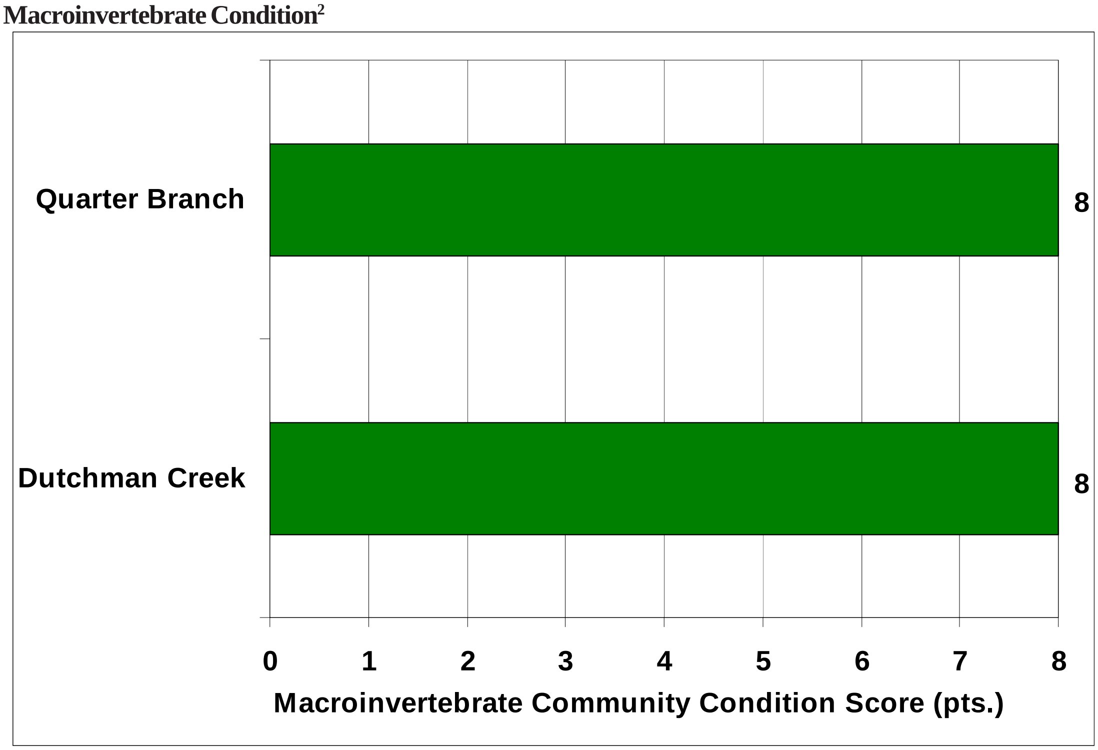
3.4.6 Biological Condition - Benthic Macroinvertebrate Survey

As seen in Figure 33, macroinvertebrate community conditions for Quarter Branch and Dutchman Creek were excellent. The RSAT voucher total number of taxa[1] collected for Quarter Branch and Dutchman Creek was 10 (i.e., fair) and 23 (i.e., good) taxa, respectively. As for the pollution intolerant stonefly, mayfly and caddisfly groups (i.e., Ephemeroptera, Plecoptera and Trichoptera - EPT), 11 taxa groups were collected in Dutchman Creek; whereas, only five were collected for Quarter Branch. It should be noted that individuals from the stonefly family group, Taeniopterygidae (generally considered highly pollution intolerant), were present in both streams. Dutchman Creek also included two other highly pollution intolerant stonefly taxa, *Acroneuria sp.* and *Eccoptura sp.*

Dutchman Creek - *Eccoptura sp.*, A Highly Pollution Intolerant Stonefly

In Quarter Branch, stoneflies belonging to the family Capniidae were observed to be 'common/abundant.' Roundhead mayflies and cased caddisflies were observed to be 'scarce/common.' Flathead mayflies, generally considered more pollution intolerant than the roundhead mayflies, were absent from the survey. Cranefly larvae were also observed to be 'common' in relative abundance. Dutchman Creek mayfly, stonefly and caddisfly relative abundances (i.e., EPT taxa groups) generally fell into the 'scarce/common' to 'common' categories (Figure 34). Notably, net-spinning caddisflies and water

Figure 33. Summary: Quarter Branch and Dutchman Creek Mainstem RSAT Voucher Collection Macroinvertebrate Condition[2]



[1] General RSAT voucher interpretation for taxa richness: >=25 = Excellent, 16-24 = Good, 8-15 = Fair, 0-7 = Poor.
[2] Macroinvertebrate scale interpretation: 7.0-8.0 pts. = Excellent, 5.0-6.9 pts. = Good, 2.1-4.9 pts. = Fair, 0.0-2.0 pts. = Poor.

pennies were both observed to be 'common/ abundant'.

As part of the Level III RSAT survey, an additional spring 2005 qualitative 20-jab multiple/best habitat survey was performed. Results for the Level III RSAT survey are summarized in Table 22. As seen in Table 22, both Quarter Branch and Dutchman Creek index of biotic integrity (IBI) scores (i.e., 100.0 and 90.1 points, respectively) were excellent. The total taxa richness (i.e., 32 and 44, respectively) as well as the EPT taxa richness (i.e., 17 and 21, respectively) were rated excellent (i.e., taxa richness >20 = excellent; EPT taxa richness >7 = excellent). Specifically, for Quarter Branch, five highly pollution intolerant taxa were represented by *Nemoura sp.* (P), *Suwallia sp.* (P), *Dolophilodes sp.* (T), *Glossosoma sp.* (T), and *Rhyacophila sp.* (T). The number of individuals from these five taxa represented almost 40 percent of the total number of individuals collected. In Dutchman Creek, there were four taxa (i.e., *Leucrocuta sp.* (E), *Agnetina sp*. (P), *Dolophilodes sp.* (T), and *Glossosoma sp*. (T)) considered highly pollution intolerant and they represented five percent of the total number of individuals collected. For additional results from this survey and the RSAT voucher collection, the reader is referred to Appendix 5.

Dutchman Creek - Commonly Collected Water Pennies (Psephenus sp.)

Major Findings

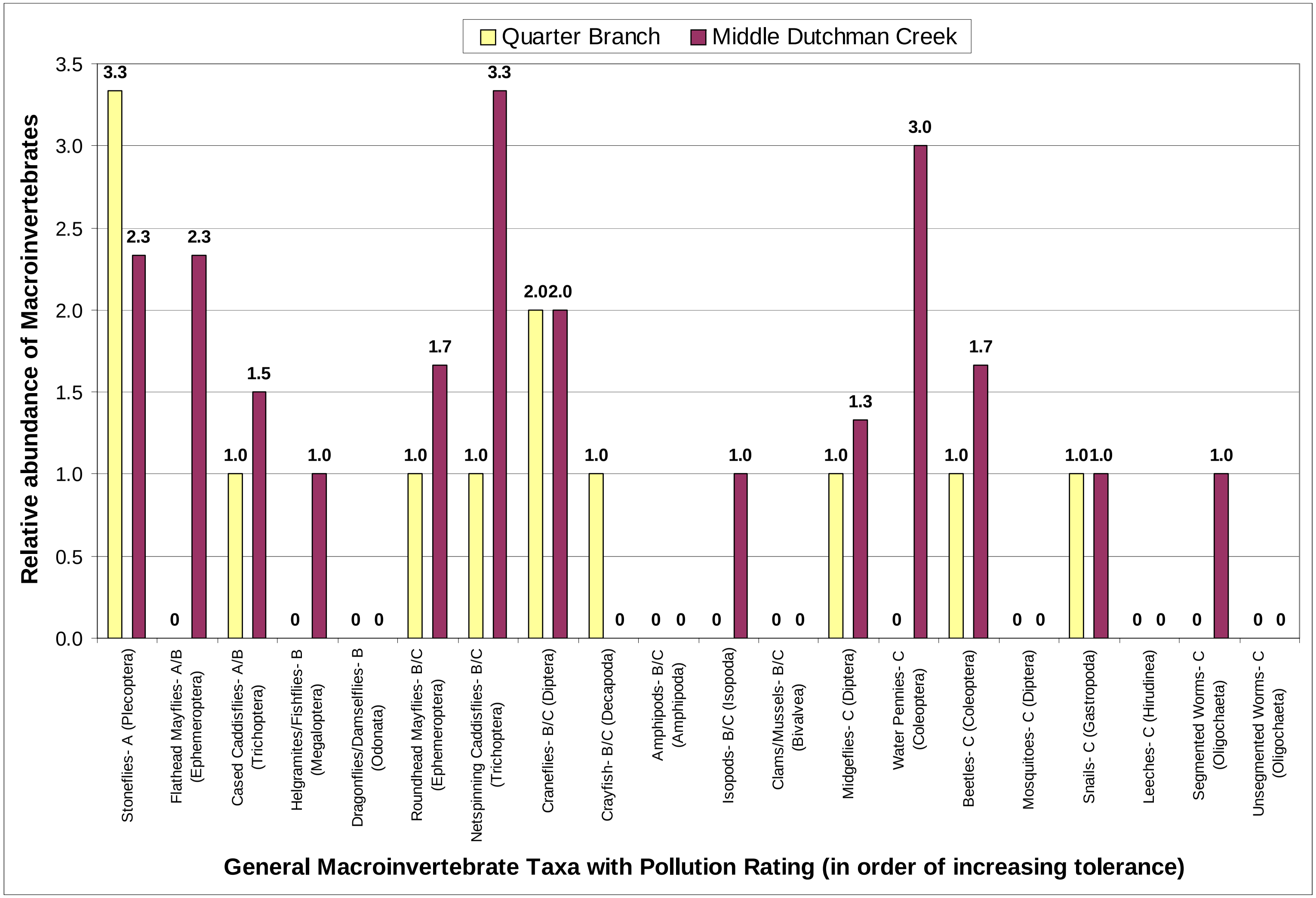
Quarter Branch

- RSAT voucher sample - the relative abundance of midgeflies, beetles, and snails, generally considered highly pollution tolerant, was 'scarce/common' (Figure 34).
- RSAT voucher sample - the relative abundance of pollution tolerant craneflies (*Tipula sp.*) was 'common' (Figure 34).
- Level III RSAT survey - the percent of EPT taxa individuals relative to the total number of taxa collected, 76.1 percent, was the highest for the entire study (Table 22).
- Level III RSAT survey - the ten metrics, used to score the index of biological integrity (IBI), were all rated as being excellent (Table 22).
- Level III RSAT survey - *Dolophilodes sp.* (T) number of individuals totaled 138 or almost 30 percent of the total number of individuals collected. As previously mentioned, these individuals are highly pollution intolerant (Table 22).

Dutchman Creek

- RSAT voucher sample - the relative abundance of midgeflies, beetles, snails, and segmented worms, generally considered highly pollution tolerant, was 'scarce/common' (Figure 34).
- RSAT voucher sample - water pennies (*Psephenus sp.*) and aquatic riffle beetles, were 'common'. These taxa are generally considered pollution tolerant (Figure 34).

Figure 34. Quarter Branch and Dutchman Creek Mainstems - Mean Relative Abundance of Observed Macroinvertebrates[1] and General Pollution Tolerance[2]



[1] Relative abundance scores were averaged for each reach. Relative Abundance interpretation: 0 = No Taxa Found, 0.1-0.9 = Scarce, 1.0-2.0 = Scarce/Common, 2.1-3.0 = Common, 3.1-4.0 = Common/Abundant, 4.1-5.0 = Abundant.

[2] Pollution Tolerance Rating: A = Intolerant, B = Moderately Tolerant, C = Tolerant.

Table 22. Summary: Quarter Branch and Dutchman Creek - 1m^2 Macroinvertebrate Sample Metrics and Fairfax County SPS IBI Score and Rating[1]

RSAT Stream Segment	Approx. Stream Segment Location	Total Number of Ind	Taxa Richness[2]	EPT Richness[3]	Percent EPT[4]	Percent Trichoptera w/o Hydropsychidae[5]	Percent Coloeoptera[6]	Family Biotic Index[7]	Percent Dominance[8]	Percent Clingers + Percent Plecoptera[9]	Percent Shredder[10]	Percent Predators[11]	IMBI[12]	SPS Rating
Quarter Branch														
Quarter Branch	Quarter Branch Road	461	32	17	76.1	31.0	1.3	3.7	28.6	13.9	10.2	6.7	100.0	Excellent
Dutchman Creek														
Dutchman Creek	Dutchman Creek Road	470	44	21	57.2	8.5	11.1	3.8	14.7	4.0	0.2	9.1	90.1	Excellent

[1] Scores and rating were developed by Fairfax County Stream Protection Strategy.

[2] Taxa richness represents the total number of taxa collected and is interpreted by SPS as follows: >= 21 = Excellent, 13–20 = Good, 9-12 = Fair, 5-8= Poor, <5 = Very Poor.

[3] Counts the distinct taxa considered pollution intolerant within the groups of Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies). EPT taxa metrics are interpreted as follows: >7 = Excellent, 5-6 = Good, 4 = Fair, 2-3 = Poor, <=1 = Very Poor.

[4] Measures the abundance of generally pollution intolerant Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) relative to other, often more tolerant, individuals and is interpreted as follows: >16.6 = Excellent, 12.4-16.5% = Good, 8.3-12.3% = Fair, 4.1-8.2% = Poor, >1.9% = Very Poor.

[5] Measures the absence of generally pollution tolerant Hydropsychidae (caddisflies) relative to other more intolerant Caddisflies and is interpreted as follows: >0.79% = Excellent, 0.60-0.78% = Good, 0.40-0.59% = Fair, 0.39-0.20% = Poor, <0.20% = Very Poor.

[6] Measures the abundance of generally pollution intolerant Coleoptera (beetles) relative to other individuals and is interpreted as follows: >1.00% = Excellent, 0.75 – 0.99% = Good, 0.50-.74% = Fair, 0.25 – 0.49% = Poor and < 0.24% = Very Poor.

[7] The Family Biotic index measures the general tolerance/intolerance of the sample to organic nutrients and is interpreted as follows: 0.00-3.50 = Excellent, 3.51-5.50 = Good, 5.51-7.50 = Fair, 7.51-8.50 = Poor, > 8.51 Very Poor.

[8] Measures the percent of the most abundant taxa relative to the total taxa within the sample and represents community balance. It is interpreted as follows: <60% = Excellent, 61-68.5% = Good, 68.6-84.0% = Fair, 84.5-92.0%= Poor, >92.0% = Very Poor.

[9] Measures the percent of individuals whose habitat type is clingers plus percent of sample that are stoneflies but are not clingers and is interpreted as follows: >3.28% = Excellent, 2.46-3.27% = Good, 1.63-2.45% = Fair, 0.84-1.62%= Poor, <0.84% = Very Poor.

[10] Measures the percent of individuals that are shredders relative to all other feeding guild types and is interpreted as follows: >5.42% = Excellent, 4.10-5.41% = Good, 2.70-4.00% = Fair, 1.39-2.69% = Poor, <1.39% = Very Poor.

[11] Measures the percent of individuals that are predators relative to all other feeding guild types and is interpreted as follows: >2.30% = Excellent, 1.52-2.00% = Good, 1.02-1.51% = Fair, 0.50-1.01% = Poor, <0.50% = Very Poor.

[12] SPS IMBI score interpretation: 80-100 = Excellent, 60-79 = Good, 40-59= Fair, 20-39 = Poor, 0-19 = Very Poor.

- Level III RSAT survey - a total of twenty-one EPT taxa were collected. This was among the highest EPT taxa richness for the entire study (Table 22).
- Level III RSAT survey - only the percent shedder metric, 0.2 percent, received a very poor rating (i.e., <1.39 percent = very poor). All other IBI metrics received an excellent rating (Table 22).

3.4.7 RSAT Summary Stream Quality Ratings

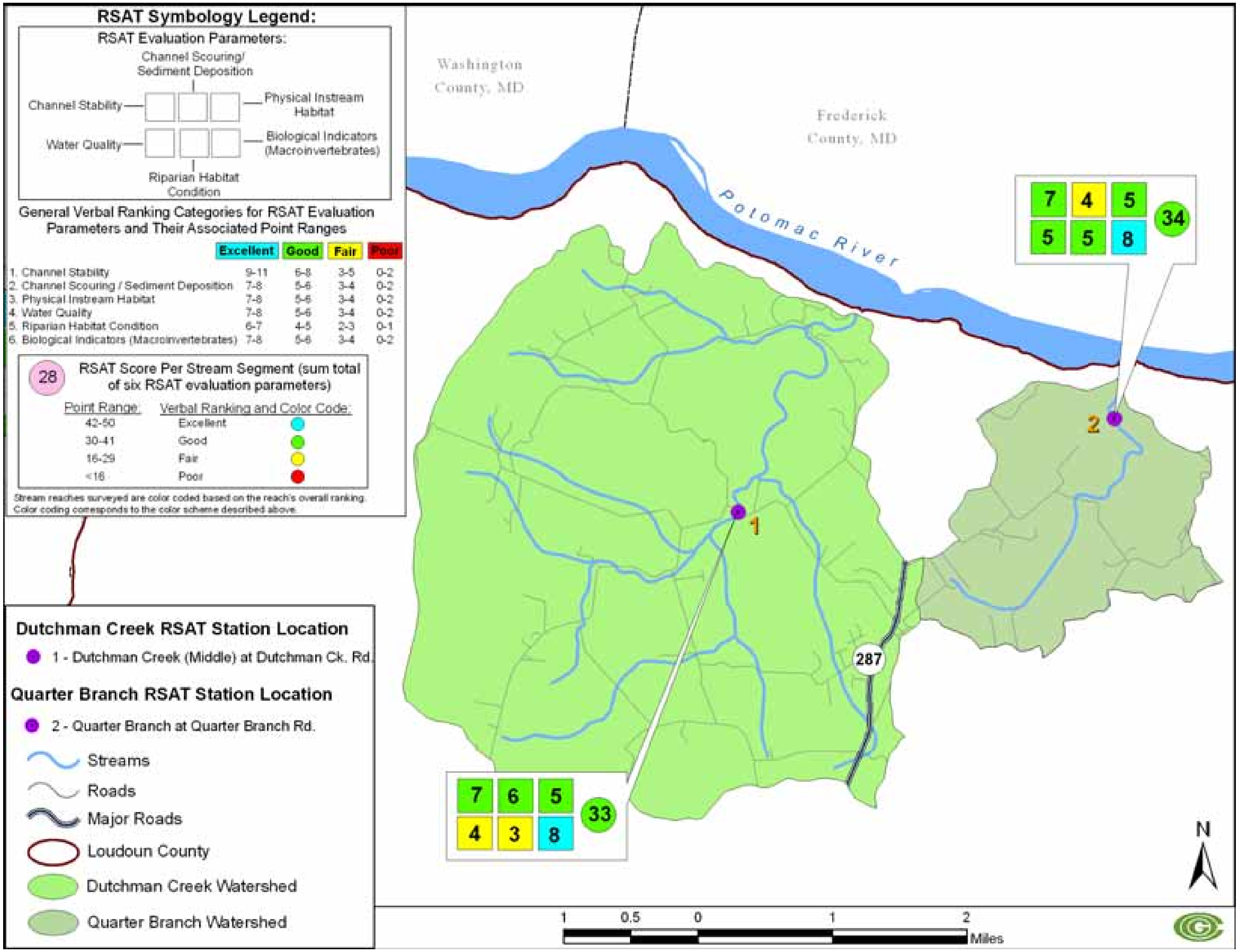
As seen in Table 23 and Figure 35, the overall RSAT stream quality rating for both Quarter Branch and Dutchman Creek was good. Specifically, the biological indicators category was rated excellent. It should be noted that for Dutchman Creek, the water quality and riparian habitat conditions categories were rated fair. For Quarter Branch, the channel scouring/deposition category was rated fair.

Table 23. Quarter Branch and Dutchman Creek Study Summary: RSAT Ratings[1]

RSAT Stream Segment	Approx. Stream Segment Location	Bank Stability	Channel Scouring/ Deposition	Physical Instream Habitat	Water Quality	Riparian Habitat Conditions	Biological Indicators	RSAT Total Score[2]
Quarter Branch								
Quarter Branch	Quarter Branch Road	Good (7)	Fair (4)	Good (5)	Good (5)	Good (5)	Excellent (8)	**Good (34)**
Dutchman Creek								
Dutchman Creek	Dutchman Creek Road	Good (7)	Good (6)	Good (5)	Fair (4)	Fair (3)	Excellent (8)	**Good (33)**

[1] Actual point values are shown in parentheses.
[2] Total RSAT score interpretation: 42-50 = Excellent, 30-41 = Good, 16-29 = Fair, <16 = Poor.

Figure 35. Quarter Branch and Dutchman Creek Study Summary: RSAT Ratings



3.4 Piney Run Watershed

3.4.1 Streambank Stability, Relative Erodibility and Channel Downcutting

Middle Piney Run (Transect X-1) - Stable Streambank

Streambank stability results are summarized in Table 24, and Figures 36 and 37. Overall, the mean streambank stability in the Piney Run mainstem (i.e., 87.1 percent) was rated as being in the excellent range (i.e., >80.0 percent of the bank network is stable). Mean streambank stability for the middle and the lower mainstem areas surveyed was 89.2 and 85.0 percent, respectively. It should be noted that neither moderate/severe nor severe streambank erosion conditions were observed during COG's 2005 survey. However, moderate streambank erosion levels in lower Piney Run increased noticeably from earlier COG 2000 and 2002 surveys. This has resulted in a six percent lower 2005 streambank stability rating for the lower mainstem. RSAT 2005 Piney Run streambank erosion survey results (Table 24 and Figure 36) are as follows: zero linear feet of moderate/severe or severe erosion, 300 linear feet of moderate erosion, and no recent tree falls. One erosional log jam was recorded for the lower mainstem; whereas, none was recorded for the middle mainstem.

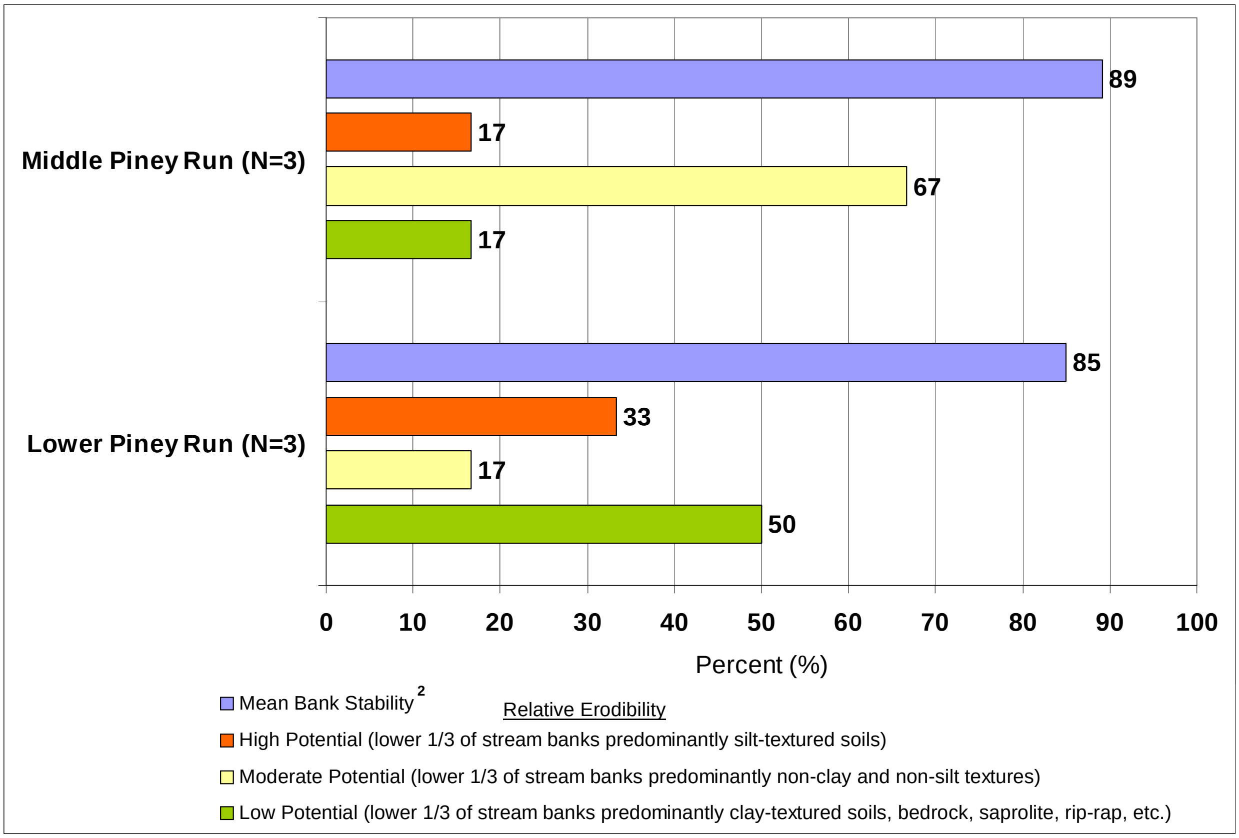
Regarding the relative erodibility of existing streambank material, RSAT streambank soil texture results for Piney Run (Figures 36) revealed that bank material for the middle mainstem survey area consisted primarily of moderately erodible soil types (i.e., generally silty/sandy soils) while the bank material at the lower mainstem survey area consisted primarily of soils that are far less erodible (i.e., predominately clay soils with intermittent areas of exposed bedrock). It should be noted that a relatively small amount of highly erodible soils (i.e., soils with high silt and sand contents) were also present.

Table 24. Piney Run - Streambank Erosion Conditions

RSAT Stream Segment	Surveyed Stream Length (ft.)	Surveyed Streambank Network[1] Length (ft.)	Bank Erosion Conditions						No. of Recent Tree Falls[2]		No. of Erosional Log Jams	Mean Bank Stability[3] (%)
			Severe		Moderate/Severe		Moderate					
			(LF)	(LF/mi.)	(LF)	(LF/mi.)	(LF)	(LF/mi.)	No.	No./mi.		
Piney Run												
Middle Piney Run	1,692.1	3,384.2	0.0	0.0	0.0	0.0	54.7	85.3	0.0	0.0	0.0	89.2
Lower Piney Run	1,200.0	2,400.0	0.0	0.0	0.0	0.0	245.5	540.1	0.0	0.0	0.0	85.0
Total	2,892.1	5,784.2	0.0	0.0	0.0	0.0	300.2	274.0	0.0			87.1[4]
Lower Piney Run (2002)	1,200.0	2,400.0	0.0	0.0	60.0	132.0	20.0	44.0	0.0	0.0	0.0	91.3
Lower Piney Run (2000)	1,200.0	2,400.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	94.0

[1] Length to include both the left and right bank (i.e., twice the distance of the surveyed stream length)
[2] Tree fall interpretation: 0-1/mi. = Excellent, 2-3/mi. = Good, 4-5/mi = Fair, ≥6 = Poor.
[3] Mean bank stability interpretation: >80% = Excellent, 71-80% = Good, 50-70% = Fair, <50% = Poor.
[4] Weighted Mean

Figure 36. Summary: Piney Run - Mean Streambank Stability and Relative Erodibility [1] (%)



Stream channel downcutting results (Table 25) revealed that both the middle and lower mainstem sites were very close to the expected or reference condition bank height range. Figure 38 shows the representative channel cross-sections with cross-sectional areas of 117.1 square feet and 120.4 square feet for the middle and lower mainstems, respectively.

Table 25. Summary: Piney Run – Stream Channel Downcutting

RSAT Stream Segment	Drainage Area (mi^2)	Surveyed Stream Length	Mean Bank Height R[3] (ft)	Mean Bank Height L[4] (ft)	Mean Bank Height (ft)	Expected Bank Height Range (ft)	Number of Nick Points
Piney Run							
Middle Piney Run	8.3	1,692	3.9	3.4	3.6	2-3	0
Lower Piney Run (2005)	13.8	1,200	3.7	3.6	3.7	2-3	0
Total	14.9	2,892	3.7[5]	3.5[5]	3.6[5]	-	0.0
Lower Piney Run (2002)	13.8	1,200	3.3	2.5	2.9	2-3	0
Lower Piney Run (2000)			2.8	2.8	2.8		0

[1] Total number of observations to determine average bank stability and relative erodibility appear in parentheses.
[2] Mean bank stability interpretation: >80% = Excellent, 71-80% = Good, 50-70% = Fair, <50% = Poor.
[3] Right bank looking downstream.
[4] Left bank looking downstream.
[5] Weighted Mean

Figure 37. Summary: Piney Run - Streambank Stability

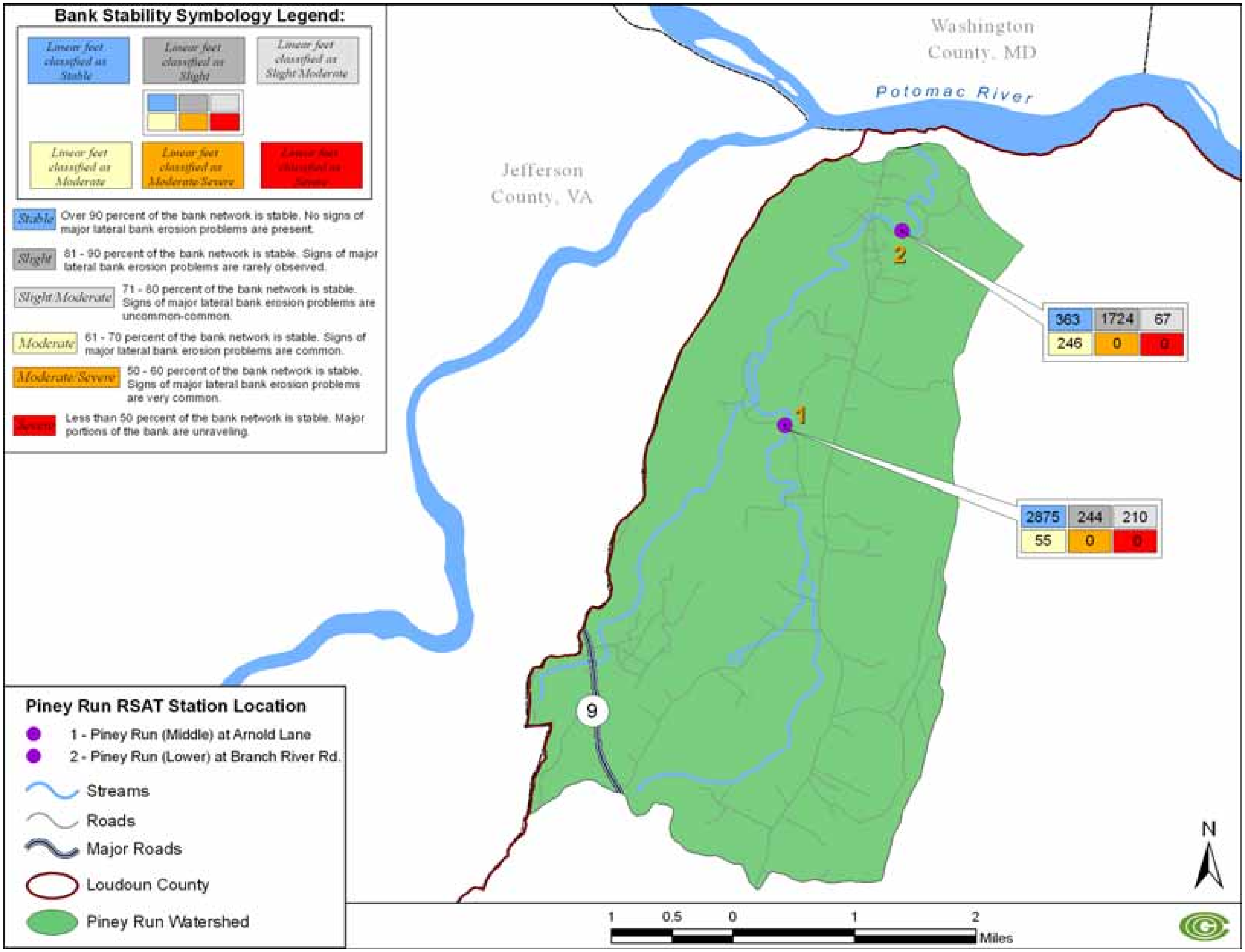
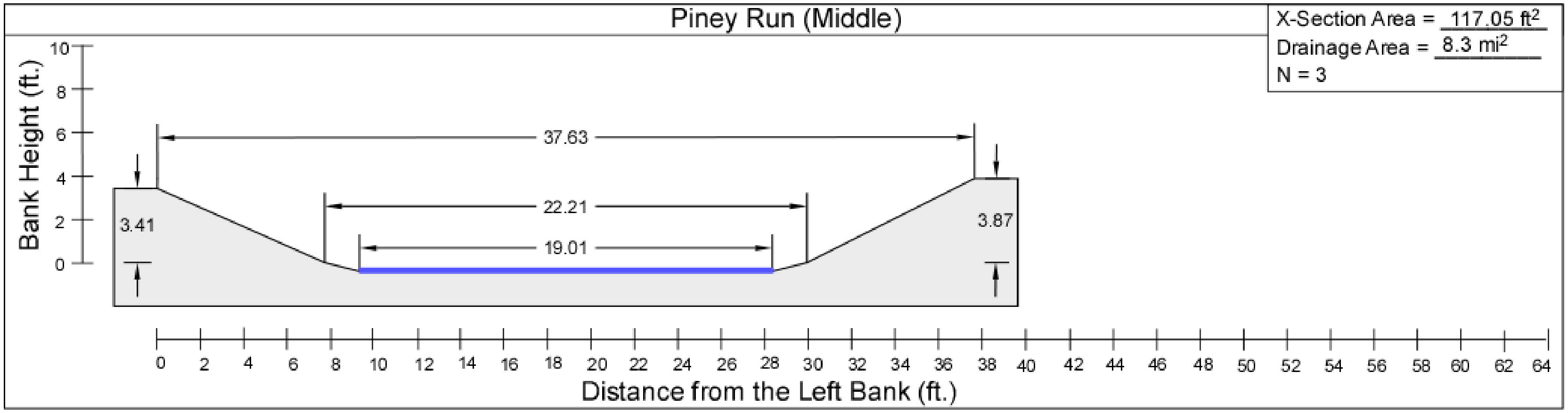
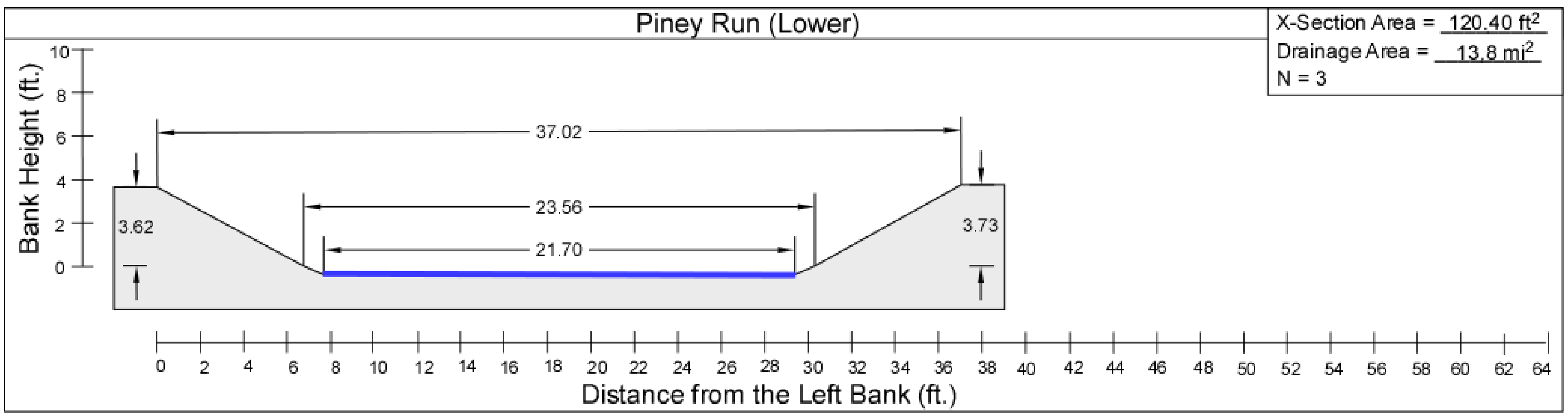


Figure 38. Piney Run Mainstem - Representative Channel Cross-Sections[1]





[1] Top channel width, bottom channel width and wetted perimeter area depicted.

Major Findings

Middle Mainstem

- Over 84 percent of the total streambank network length was classified as being stable (Figure 37).
- Moderate streambank erosion (i.e., 55 linear feet total) represented less than one percent of the total streambank network (i.e., 3,384.2 feet) surveyed. No areas of moderate/severe or severe streambank erosion conditions were observed (Figure 37).
- At transect X-3, the stream channel was markedly wider (i.e, almost twice the width of transect X-2).

Lower Mainstem

- Over 87 percent of the streambank network length was classified as being stable or exhibiting slight erosion.
- Moderate streambank erosion conditions were observed in the vicinity of transect X-2 located downstream of a major log jam.
- The calculated rates for the moderate/ severe and moderate streambank erosion categories were 0.0 and 540.1 linear feet/ mile versus 132.0 and 44 linear feet/mile for the 2000 middle mainstem.

Lower Piney Run (X-2) - Major Log Jam

3.4.2 Channel Scouring and Sediment Deposition

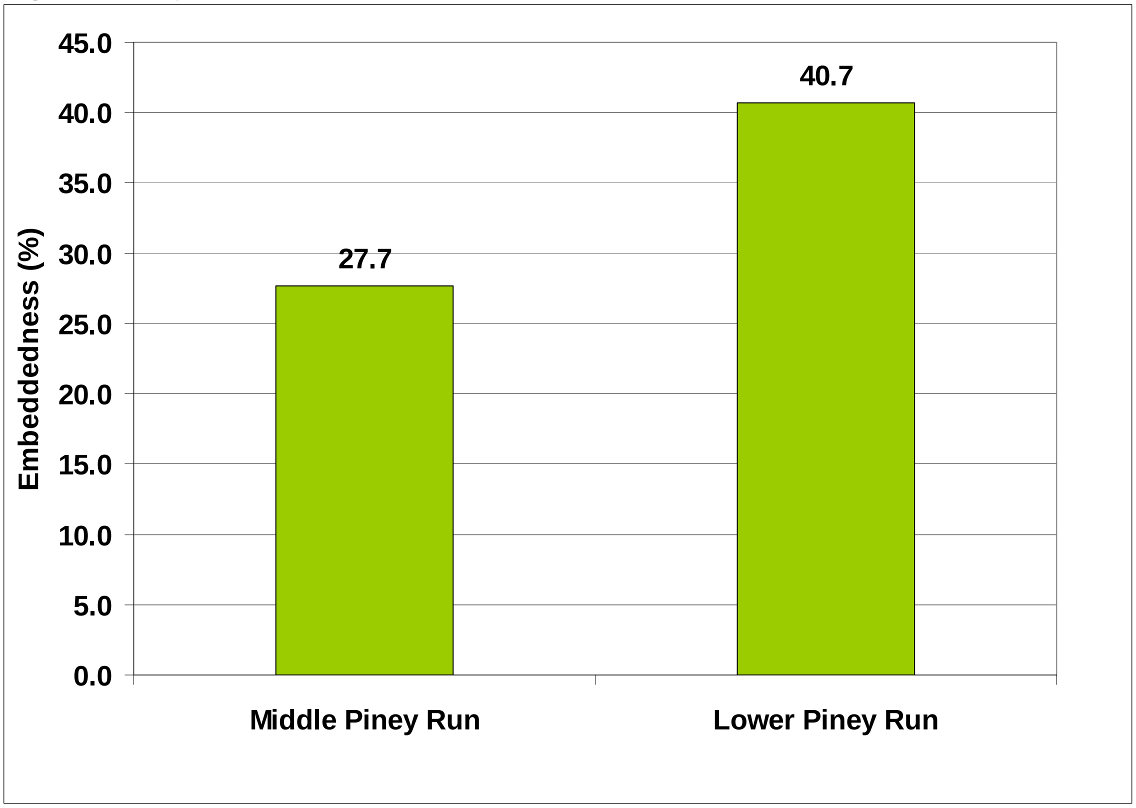
A total of four large point bars were observed; two were classified as unstable (i.e., devoid of any vegetation), and both were located in the lower mainstem (Table 26). Riffle embeddedness levels ranged from poor (100.0 percent) to excellent (10.0 percent). The overall mean mainstem embeddedness level of 34.1 percent was rated good (Table 26).

Table 26. Summary: Piney Run – Channel Scouring/Sediment Deposition Conditions

RSAT Stream Segment	Surveyed Stream Length (ft.)	Percent Riffle Embbeddedness		Large Point Bars				Relative Level of In-Channel Sand Deposits
		Observed Range	Mean	Total Number Observed	No. Unstable	Percent Unstable (%)	No.of Unstable /Mile	
Piney Run								
Middle Piney Run	1,692	10-48	27.7	2	0	0	0.0	Low
Lower Piney Run (2005)	1,200	10-100	40.7	2	2	100	8.8	Low
Total	2,892	0.0	34.1[2]	4	2	100	8.8	-
Lower Piney Run (2002)	1,200	10-66	36.7	3	1	33	4.4	Low
Lower Piney Run (2000)		10-57	31.5	4	2	50	8.7	Low

[1] Riffle embeddedness rating scale: <25% = Excellent, 25-50% = Good, 51-75% = Fair, >75% = Poor.
[2] Weighted means.

Figure 39. Piney Run – Mean Riffle Embeddedness Levels[1]



Major Findings

Middle Mainstem

- No unstable point bars were observed.
- Mean riffle embeddedness = 27.7 percent (i.e., good).
- The level of in-channel sand deposition was low (Table 26).

Lower Mainstem

- Material composition of the two unstable point bars observed included small, easily entrained sand and pea-sized gravel. Both point bars were mostly devoid of vegetation.

Lower Piney Run (Upstream of X-2) - Unstable Large Point Bar

- Mean riffle embeddedness = 40.7 percent (i.e., good). There appears to have been a slight increase in riffle embeddedness since the 2000 and 2002 surveys (i.e., 31.5 and 36.7 percent, respectively).

[1] Riffle embeddedness rating scale: <25% = Excellent, 25-50% = Good, 51-75% = Fair, >75% = Poor.

3.4.3 Physical Aquatic Habitat

General physical aquatic habitat conditions for Piney Run are summarized in Table 27 and Figure 40. As seen in Table 27, the RSAT physical aquatic habitat condition rating for Piney Run was good. One of the major factors contributing to the overall good rating was excellent riffle substrate quality. In addition, the mean pool quality at the middle and lower mainstem areas was rated good and very good, respectively. It should be noted that for the lower mainstem, little has changed in the riffle substrate material composition since the 2000 and 2002 surveys. In contrast, pool quality and depth have dramatically improved, increasing from a poor to very good rating. It should be noted that the 2000 and 2002 surveys coincided with a prolonged and severe drought period, 1999 through 2002. No fish barriers were observed in any of the surveyed years.

Table 27. Summary: Piney Run - General Physical Aquatic Habitat Conditions [1]

RSAT Stream Segment	Riffle Characteristics				Pool Characteristics				Fish Barriers		RSAT Physical Habitat Score (pts.)[6]
	No. of Riffles	Mean Riffle Depth (in.)	Mean Riffle Substrate Quality (pts.)[2]	Mean Riffle Embedded-ness(%)[3]	No. of Pools	Mean Max. Depth (in.)	Mean Pool Quality (pts.)[4]	Riffle/ Pool Ratio[5]	Total Number	Per Mile	
Piney Run											
Middle Piney Run	19	3.1	3.7	27.7	16	19.3	3.7	1.2	0	0	6
Lower Piney Run (2005)	8	3.8	3.3	40.7	7	22.0	4.3	1.1	0	0	6
Total	27	3.4[1]	3.5[1]	34.2[1]	23	20.7[1]	4.01	1.2[1]	0	0	6
Lower Piney Run (2002)	5	2.6	3.0	36.6	6	15.8	1.3	0.83	0	0	5
Lower Piney Run (2000)	5	3.1	3.3	31.5	12	12.3	1.7	0.42	0	0	5

Major Findings

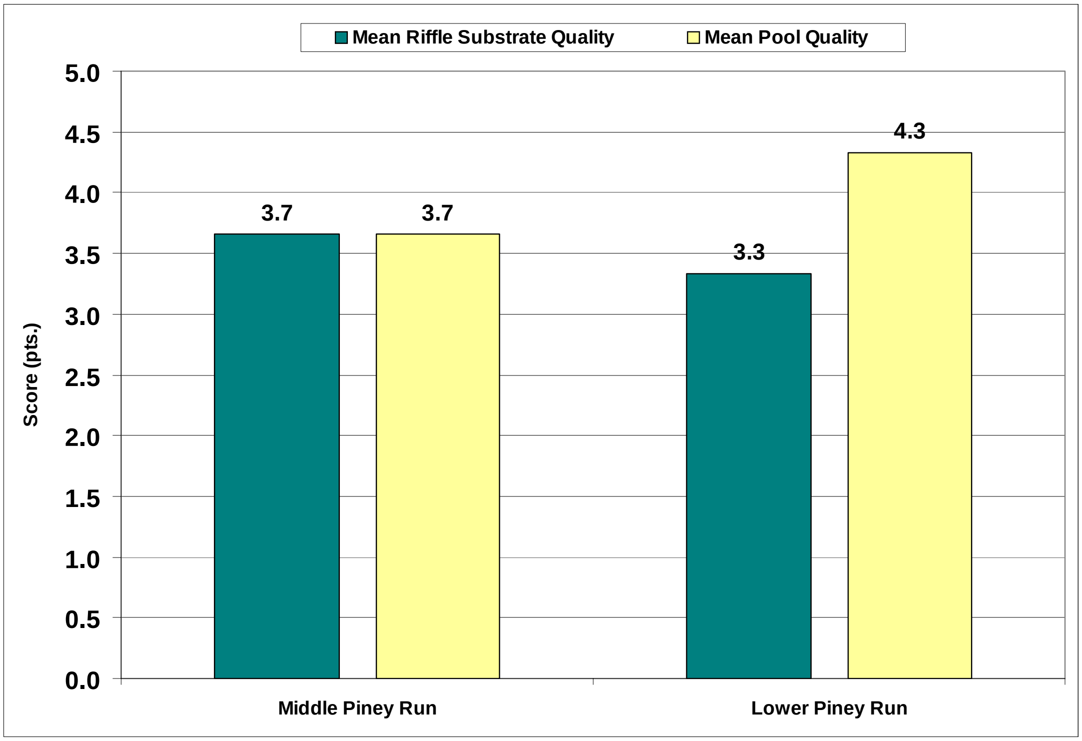
Middle Mainstem

- Below transect X-2, instream habitat is predominantly deep, long run-type habitat, featuring a small gravel and sandy bottom.
- Pools were moderately deep (i.e., >15 inches), with large rubble and boulder-sized substrate which provide excellent overhead cover for fish.

Middle Piney Run (Downstream of X-2) - Instream Run Type Habitat

[1] Mean values shown are weighted means.
[2] Riffle substrate quality rating scale: 3.25-4.00 = Excellent, 2.50-3.24 = Good, 1.75 – 2.49 = Fair, 1.00- 1.74 = Poor.
[3] Riffle embeddedness rating scale: <25% = Excellent, 25-50% = Good, 51-75% = Fair, >75% = Poor.
[4] Quality pool point scale interpretation: 5 = Excellent, 4 = Very Good, 3 = Good, 2 = Fair, 1 = Poor.
[5] Riffle/pool ratio rating scale: 0.9-1.1:1 = Excellent, 0.70-0.89:1 or 1.11-1.3:1 = Good, 0.5-0.69 or 1.31-1.5:1 = Fair, 0.49:1< or >1.51:1 = Poor.
[6] RSAT Physical habitat rating scale: 6.5-8.0 = Excellent, 4.5-6.4 = Good, 2.5-4.4 = Fair, 1.0-2.4 = Poor.

Figure 40. Summary: Piney Run - Mean Riffle Substrate[1] and Pool Quality[2]



- Optimal aquatic habitat conditions were observed including: 1) mean riffle depth, at 3.1 inches, 2) excellent mean wetted width perimeter (i.e., >80 percent of the bottom channel width covered with water) and 3) excellent riffle substrate material composition comprised of large cobble, gravel and rubble-sized stones with little sand.
- Maximum pool depths, reaching 36 inches, contributed to the excellent pool quality rating.
- 2005 riffle substrate material composition was similar to that of the 2000 and 2002 surveys, and consisted primarily of a good mix of cobble, rubble, gravel, and boulder with very little sand.

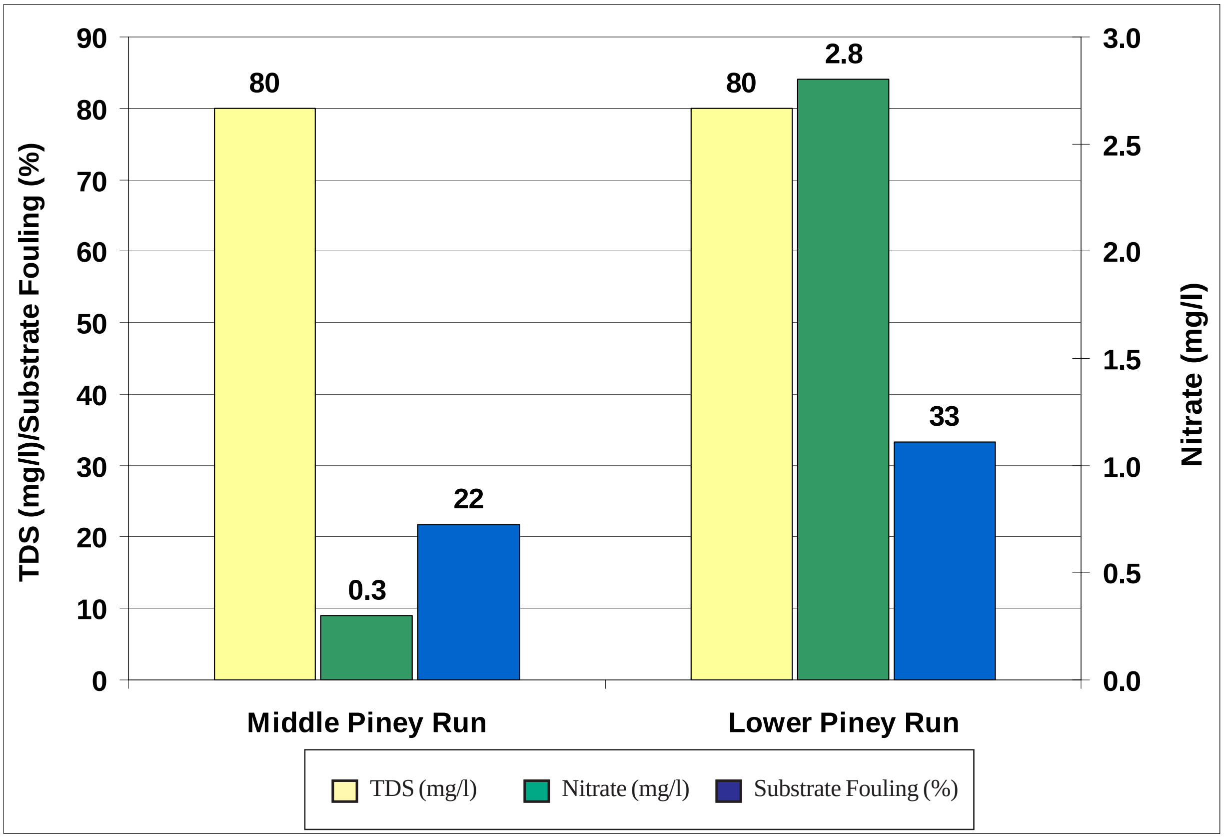
Lower Piney Run (X-1) - Looking Downstream - Riffle to Pool Sequence Habitat

[1] Riffle substrate quality point scale interpretation: 3.25-4.00 = Excellent, 2.50-3.24 = Good, 1.75-2.49 = Fair, 1.00-1.74 = Poor.
[2] Pool quality point interpretation: 4.5-5.0 = Excellent, 4.0-4.4 = Very Good, 3.0-3.9 = Good, 2.0-2.9 = Fair, 1.0-1.9 = Poor.

3.4.4 Water Quality

RSAT total dissolved solids (TDS), nitrate and substrate fouling summary results are presented in Figure 41. TDS levels for both Piney Run mainstem sites were in the good range (i.e., 50 - 100 mg/l). The nitrate concentration for the middle mainstem was low (i.e., 0.3 mg/l) and moderate (i.e., 2.8 mg/l) for the lower mainstem. Mean substrate fouling levels were in the fair range (i.e., 21-50 percent of the bottom side of cobble-sized stones covered by organic film) at both locations, with the fouling level at the middle mainstem bordering on good.

Figure 41. Piney Run - Mean TDS[1], Nitrate[2] and Substrate Fouling[3]



Major Findings

Middle Mainstem

- The instantaneous dissolved oxygen (DO) reading (i.e., 7.1 mg/l) did not violate the Virginia Department of Environmental Quality (VADEQ) minimum 4.0 mg/l standard.
- The lowest substrate fouling level (i.e., 5 percent) was recorded at transect X-1.
- The copper concentration, 0.11 mg/l, exceeded the VADEQ 0.009 mg/l limit criterion for protecting aquatic life.

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[1] TDS interpretation: <50 mg/l = Excellent, 50-100 mg/l = Good, 101-150 mg/l = Fair, >150 mg/l = Poor.
[2] Nitrate interpretation: 0.0-1.0 mg/l= Low, 1.1-2.9 mg/l = Moderate, >3.0 mg/l = High.
[3] Substrate fouling interpretation: 0-10% = Excellent, 11-20% = Good, 21-50% = Fair, >50% = Poor.

Lower Mainstem

- The instantaneous DO level (i.e., 7.6 mg/l), did not violate the VADEQ minimum of 4.0 mg/l standard.
- The copper concentration, 0.21 mg/l, exceeded the VADEQ 0.009 mg/l limit criterion for protecting aquatic life.
- The orthophosphate concentration was 0.21 mg/l. According to Dunne and Leopold (1978), 'long-term eutrophication will usually be prevented if total phosphorus and orthophosphate levels are below 0.5 mg/l and 0.05 mg/l, respectively.'

3.4.5 Riparian Habitat Conditions

The RSAT riparian habitat condition ratings for both Piney Run mainstem sites were good. As seen in Table 28, the middle Piney Run riparian corridor included a wide, hardwood forest buffer (i.e., >200 feet wide) with good (i.e., 60-79%) canopy coverage. Similarly, the riparian buffer along the lower Piney Run mainstem was generally well-forested and wide. However, this survey reach included a well-maintained, gravel surfaced road that paralleled the stream for most of its length. Although both sides of the road are bordered by hardwood forest, the riparian buffer along the right bank (looking downstream) has been effectively reduced to a width of 20 to 30 feet.

Middle Piney Run (X-3) - Good Tree Canopy Over the Stream

Table 28. Summary: Piney Run - Riparian Habitat Conditions[1]

RSAT Stream Segment	Surveyed Stream Length (ft.)	Number of Observations	Mean Canopy Coverage (%)	Riparian Habitat Conditions	
				RSAT Score[2]	Verbal Ranking
Piney Run					
Middle Piney Run	1,692.1	4	70.0	5	Good
Lower Piney Run (2005)	1,200.0	5	42.0	4	Good
Total	**2,892.1**	**9**	**56.0[3]**	**4.5[3]**	**Good**
Lower Piney Run (2002)	1,200.0	7	53.6	5	Good
Lower Piney Run (2000)	1,200.0	8	55.0	5	Good

[1] Mean canopy coverage interpretation: ≥ 80% = Excellent, 60-79% = Good, 50-59% = Fair, <50% = Poor.
[2] Riparian Habitat Condition Point Score Interpretation: 6.0-7.0 = Excellent, 4.0-5.9 = Good, 2.3-3.9 = Fair, 0-1.9 = Poor.
[3] Weighted mean.

Major Findings:

Middle Mainstem

- The riparian buffer at transect X-2 was wide (i.e., >200 feet), but was primarily dominated by grass, with little hardwood forest.
- A significant gap in the stream canopy was observed at transect X-2, resulting from both mowing and the Arnold Lane Road bridge.

Lower Mainstem

- The recent tree fall at transect X-2 has created a significant gap in the stream canopy.

3.4.6 Biological Condition - Benthic Macroinvertebrate Survey

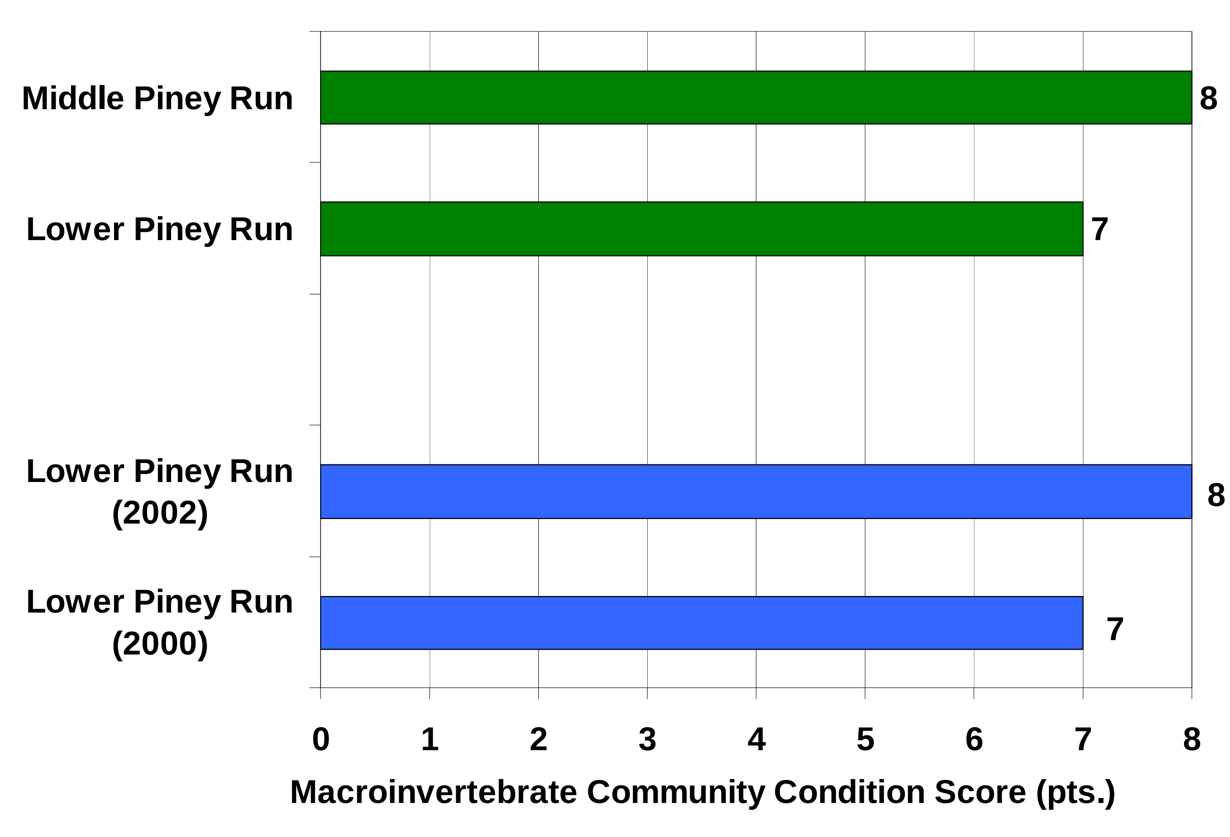
As seen in Figure 42, the macroinvertebrate conditions for both Piney Run mainstem reaches were rated excellent (i.e., 7-8 points). Specifically, the RSAT voucher number of taxa[1] collected for the middle and lower reaches totaled 19 (i.e., good) and 15 (i.e., fair), respectively. Pollution intolerant mayflies representing Heptageniidae and Isonychiidae families and stoneflies representing Perlidae family were present at both sites. Their relative abundances were observed to be in the 'scarce/common' to common/abundant' ranges. It should be noted that pollution intolerant cased caddisflies were not observed in the lower mainstem. In contrast, the highly pollution intolerant cased caddisfly, *Glossosoma sp.*, was observed to be 'scare/common' in the middle mainstem.

Middle Piney Run - Highly Pollution Intolerant Caddisfly, *Glossosoma sp.*

As part of the Level III RSAT survey, an additional spring 2005 qualitative 20-jab multiple/best habitat survey was performed. As seen in Table 29, the macroinvertebrate community index of biological integrity (IBI) was rated excellent (i.e., 80-100 points) for both the middle and lower mainstems. Taxa richness, one of the ten metrics used to determine the IBI score and rating was observed to be excellent, ranging from 35 at the lower mainstem up to 44 at the middle mainstem. Another metric, the Ephemeroptera (E, mayflies), Plecoptera (P, stoneflies) and Trichoptera (T, caddisflies) taxa richness was also rated excellent, ranging from 18 at the lower mainstem to 21 at the middle mainstem. In comparing lower mainstem taxa richness between the three IBI surveyed years (i.e., 2000, 2002 and 2005), the 2005 taxa richness increased by almost 45 percent. In addition, there was a slight increase in EPT taxa richness from 2000 to 2005. For additional biological RSAT voucher and 20-jab survey results, the reader is referred to Appendix 5.

[1] General RSAT voucher interpretation for taxa richness: >=25 = Excellent, 16-24 = Good, 8-15 = Fair, 0-7 = Poor.

Figure 42. Summary: Piney Run Mainstem RSAT Voucher Collection Macroinvertebrate Conditions[1]



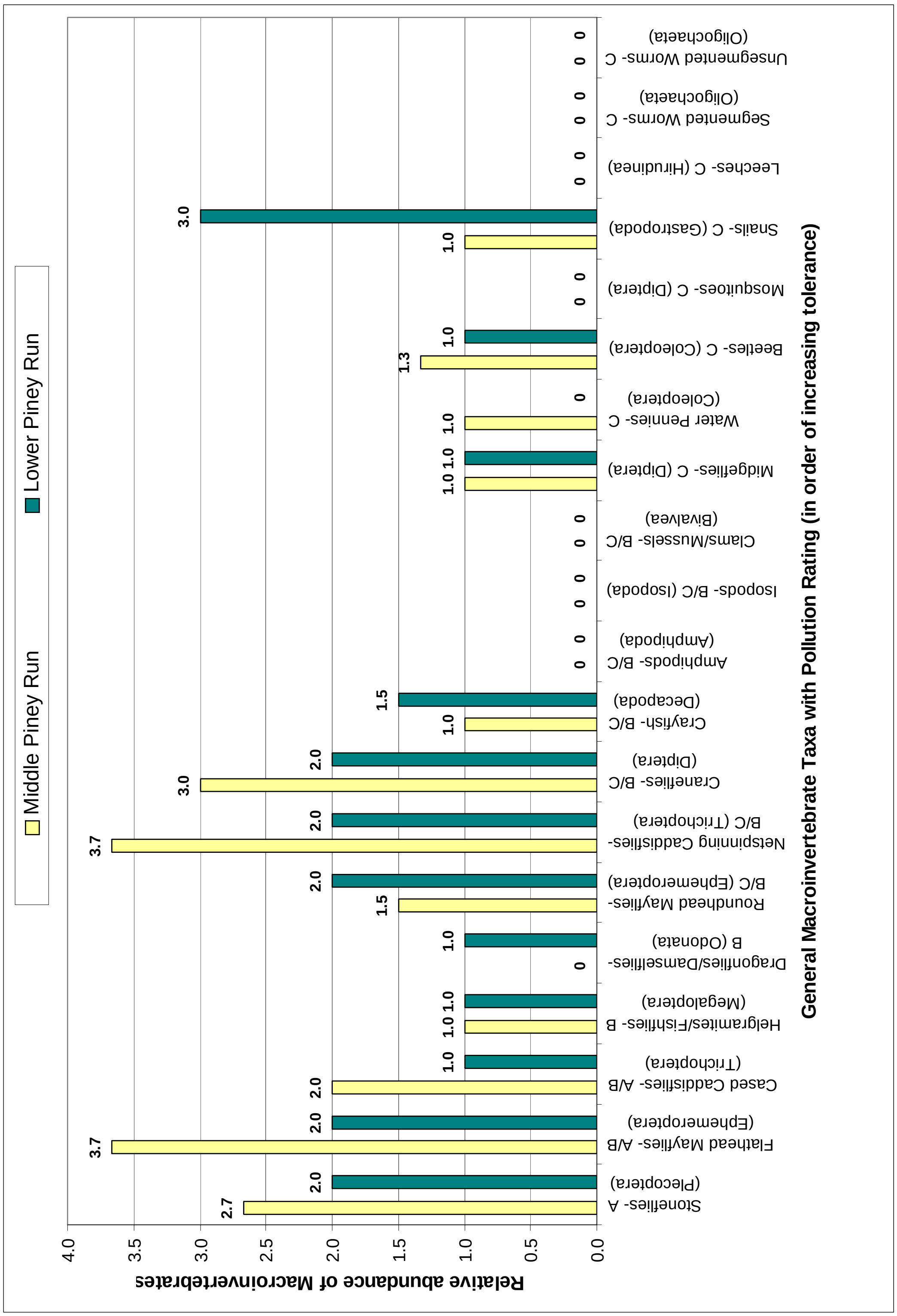
Major Findings:

Middle Mainstem

- The highly pollution intolerant stonefly taxa (Plecoptera), *Pteronarcys sp.*, was collected in the RSAT Level III macroinvertebrate survey. Individuals belonging to this genus generally have an instream larval stage life cycle of 2-4 years. Such a life cycle requires stable physical aquatic habitat (e.g., cold/cool stream temperatures with well oxygenated riffles, and cobble or larger-sized riffle material etc.).
- *Baetisca sp.*, a mayfly infrequently observed in the Washington Metropolitan Area, was collected in the RSAT voucher collection.
- The relative abundance of pollution tolerant groups (i.e., midgeflies, beetles, and aquatic worms) was 'scarce/common', excluding riffle beetles which were observed to be 'common/abundant'.
- Of the 21 EPT taxa collected in the 20-jab sample, six were classified as highly pollution intolerant. The six EPT taxa representatives included one mayfly (E), *Drunella sp.*; two stoneflies (P), *Acroneuria sp.* and *Agnetina sp.;* and three caddisflies (T), *Glossosoma sp.*, *Dolophilodes sp.* and *Rhyacophila sp.*

[1] Macroinvertebrate scale interpretation: 7.0-8.0 pts. = Excellent, 5.0-6.9 pts. = Good, 2.1-4.9 pts. = Fair, 0.0-2.0 pts. = Poor.

Figure 43. Piney Run Mainstems - Mean Relative Abundance of Observed Macroinvertebrates[1] and General Pollution Tolerance[2]



[1]Relative abundance interpretation: 0 = No Taxa Found, 0.1-0.9 = Scarce, 1.0-2.0 = Scarce/Common, 2.1-3.0 = Common, 3.1-4.0 = Common/Abundant, 4.1-5.0 = Abundant.
[2] Pollution tolerance rating: A = Intolerant, B = Moderately Tolerant, C = Tolerant.

- *Triaenodes sp.,* a caddisfly that builds a spiralling retreat made of plant material, was collected in the 20-jab sample. Generally, these individuals are extremely rare in Washington Metropolitan Area streams.

Lower Piney Run - Moderately Pollution Tolerant Cranefly Larva, *Tipula sp.*

Lower Mainstem

- The relative abundance of pollution intolerant stonefly, flathead mayfly individuals was 'scarce/ common'. Cased caddisflies were present, but were 'scarce' in the RSAT voucher collection.
- Moderately pollution tolerant cranefly individuals were 'common' in relative abundance in the RSAT voucher collection.
- Highly pollution tolerant snails and limpets were 'common' in relative abundance; whereas, midgeflies and aquatic beetles, excluding riffle beetles, were observed to be 'scarce' in the RSAT voucher collection.
- In the RSAT Level III 20-jab sample, of the 18 EPT taxa collected, five were classified as highly pollution intolerant. The five EPT taxa representatives included individuals from mayfly (E) (i.e., *Drunella sp.)*; and four caddisflies (T) (i.e., *Micrasema sp.*, *Agapetus sp.*, *Dolophilodes sp.* and *Rhyacophila sp.)* groups. These individuals prefer cool stream temperatures and well oxygenated waters.

Lower Piney Run - Plant Material Case Retreat and Caddisfly, *Micrasema sp.*

- *Micrasema sp.* are case building caddisflies which construct their retreats from plant materials. They are often found in riffles where year round stream temperatures are often cool to cold.
- In the 20-jab sample, the mayfly, *Ephemerella sp.*(to include *E. septentrionalis,* a highly pollution intolerant individual that is infrequently collected within the WMA) made up 33 percent of the 255 total individuals collected. These individuals are considered pollution intolerant.
- The highly pollution intolerant stonefly (Plecoptera), *Pteronarcys sp.*, first observed in 2000, continued to be present in 2005.
- The presence of *Pteronarcys sp.,* in addition to ten other highly pollution intolerant taxa in both the middle and lower mainstems, strongly suggests that these taxa are present throughout the Piney Run mainstem.

Stonefly (*Pteronarcys sp*.) Collected in the Piney Run 2006 RSAT Level III Survey

Table 29. Summary: Piney Run - 1m² Macroinvertebrate Sample Metrics and Fairfax County SPS IBI Score and Rating[1]

RSAT Stream Segment	Approx. Stream Segment Location	Total Number of Ind	Taxa Richness[2]	EPT Richness[3]	Percent EPT[4]	Percent Trichoptera w/o Hydropsychidae[5]	Percent Coleoptera[6]	Family Biotic Index[7]	Percent Dominance[8]	Percent Clingers + Percent Plecoptera[9]	Percent Shredder[10]	Percent Predators[11]	IMBI[12]	SPS Rating
Piney Run														
Middle - Piney Run	Arnold Lane	535	44	21	65.4	5.6	5.0	3.2	12.3	9.7	0.7	13.6	91.1	Excellent
Lower - Piney Run	Branch River Road	255	35	18	65.9	11.8	1.6	2.9	33.7	3.9	2.7	16.1	93.5	Excellent
Lower (2002)		232	28	18	78.4	4.7	1.3	3.3	36.7	57.3	4.7	12.9	97.0	Excellent
Lower (2000)		312	24	16	40.1	21.8	6.1	4.4	3.2	16.7	5.4	2.2	93.0	Excellent

[1] Scores and rating developed by Fairfax County Stream Protection Strategy (FC SPS).

[2] Taxa richness represents the total number of taxa collected and is interpreted by SPS as follows: >= 21 = Excellent, 13–20 = Good, 9-12 = Fair, 5-8= Poor, <5 = Very Poor.

[3] Counts the distinct taxa considered pollution intolerant within the groups of Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies). EPT taxa metrics are interpreted as follows: >7 = Excellent, 5-6 = Good, 4 = Fair, 2-3 = Poor, <=1 = Very Poor.

[4] Measures the abundance of generally pollution intolerant Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) relative to other often more tolerant individuals and is interpreted as follows: >16.6 = Excellent, 12.4-16.5% = Good, 8.3-12.3% = Fair, 4.1-8.2% = Poor, >1.9% = Very Poor.

[5] Measures the absence of generally pollution tolerant Hydropsychidae (caddisflies) relative to other more intolerant Caddisflies and is interpreted as follows: >0.79% = Excellent, 0.60-0.78% = Good, 0.40-0.59% = Fair, 0.39-0.20% = Poor, <0.20% = Very Poor.

[6] Measures the abundance of generally pollution tolerant Coleoptera (beetles) relative to other individuals and is interpreted as follows: >1.00% = Excellent, 0.75 – 0.99% = Good, 0.50-.74% = Fair, 0.25 – 0.49% = Poor and < 0.24% = Very Poor.

[7] The Family Biotic index measures the general tolerance/intolerance of the sample to organic nutrients and is interpreted as follows: 0.00-3.50 = Excellent, 3.51-5.50 = Good, 5.51-7.50 = Fair, 7.51-8.50 = Poor, > 8.51 Very Poor.

[8] Measures the percent of the most abundant taxa relative to the total taxa within the sample and represents community balance. It is interpreted as follows: <60% = Excellent, 61-68.5% = Good, 68.6-84.0% = Fair, 84.5-92.0%= Poor, >92.0% = Very Poor.

[9] Measures the percent of individuals whose habitat type is clingers plus percent of sample that are stoneflies but are not clingers and is interpreted as follows: >3.28% = Excellent, 2.46-3.27% = Good, 1.63-2.45% = Fair, 0.84-1.62%= Poor, <0.84% = Very Poor.

[10] Measures the percent of individuals that are shredders relative to all other feeding guild types and is interpreted as follows: >5.42% = Excellent, 4.10-5.41% = Good, 2.70-4.00% = Fair, 1.39-2.69% = Poor, <1.39% = Very Poor.

[11] Measures the percent of individuals that are predators relative to all other feeding guild types and is interpreted as follows: >2.30% = Excellent, 1.52-2.00% = Good, 1.02-1.51% = Fair, 0.50-1.01% = Poor, <0.50% = Very Poor.

[12] SPS IBI score interpretation: 80-100 = Excellent, 60-79 = Good, 40-59= Fair, 20-39 = Poor, 0-19 = Very Poor.

3.4.7 RSAT Summary Stream Quality Ratings

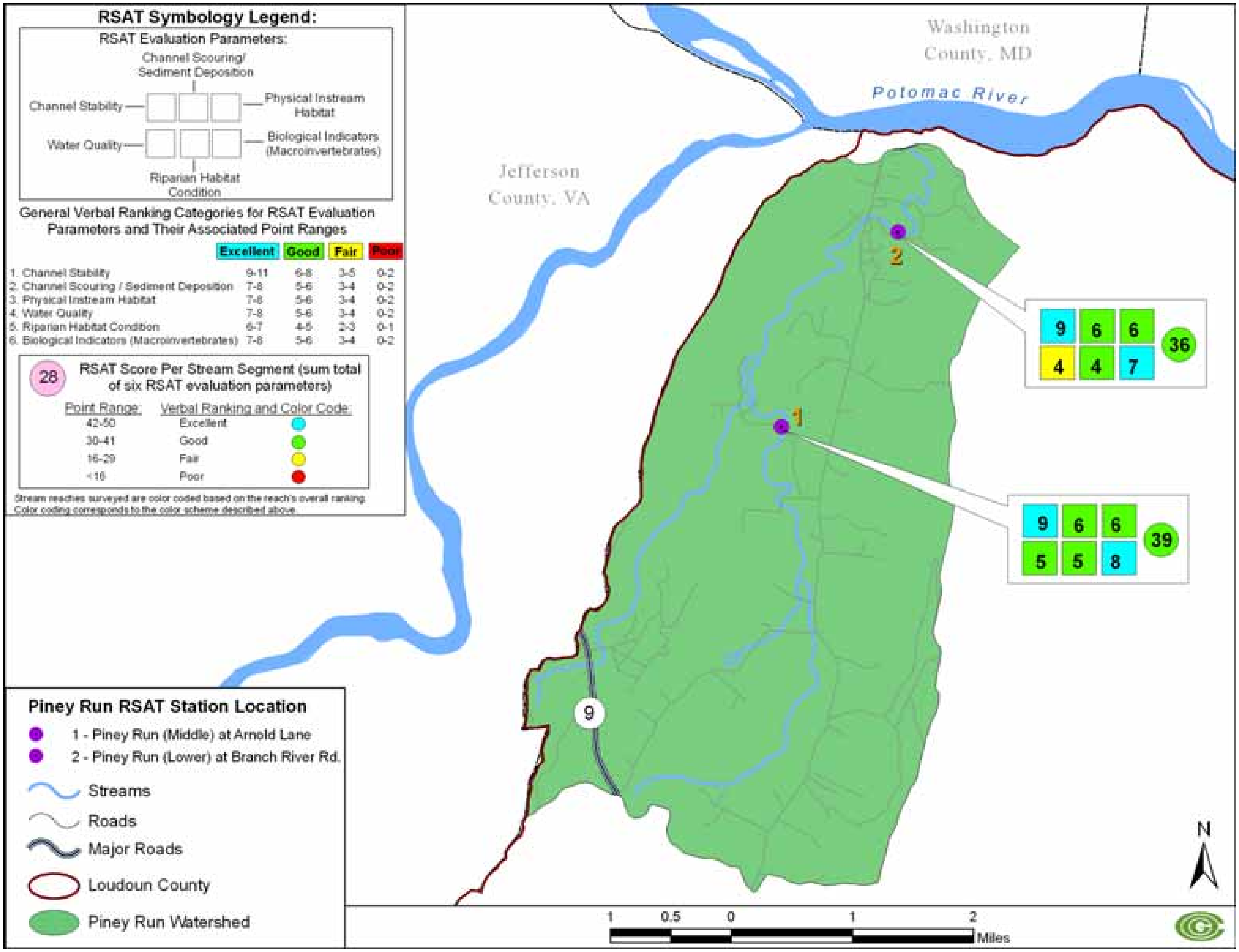
As seen in Table 30 and Figure 44, the overall RSAT stream quality rating for both middle and lower Piney Run mainstems was good. It should be noted that the major categories that contributed to the overall good rating were bank stability and biological indicators, both of which were rated as being excellent. The only category with a fair rating was water quality and that was found in the lower mainstem.

Table 30. Piney Run Study Summary: RSAT Ratings[1]

RSAT Stream Segment	Approx. Stream Segment Location	Bank Stability	Channel Scouring/ Deposition	Physical Instream Habitat	Water Quality	Riparian Habitat Conditions	Biological Indicators	RSAT Total Score[2]
Piney Run								
Middle Piney Run	Arnold Lane	Excellent (9)	Good (6)	Good (6)	Good (5)	Good (5)	Excellent (8)	**Good (39)**
Lower Piney Run -05	Branch River Road	Excellent (9)	Good (6)	Good (6)	Fair (4)	Good (4)	Excellent (7)	**Good (36)**
Lower Piney Run -02	Branch River Road	Excellent (9)	Good (6)	Good (5)	Fair (4)	Good (5)	Excellent (8)	**Good (37)**
Lower Piney Run -00	Branch River Road	Excellent (10)	Good (5)	Good (5)	Good (5)	Good (5)	Excellent (7)	**Good (37)**

[1] Actual point values are shown in parentheses.
[2] Total RSAT score interpretation: 42-50 = Excellent, 30-41 = Good, 16-29 = Fair, <16 = Poor.

Figure 44. Piney Run Study Summary: RSAT Ratings



3.5 Catoctin Creek Riparian Buffer Analysis

As previously stated, Catoctin Creek's Virginia Department of Environmental Quality 303(d) impairment listing for fecal coliform bacteria and associated total maximum daily loads (TMDL) implementation plan requirement have led Loudoun County to examine various cost-effective bacteria reduction measures. Included among this mix are the employment of water quality enhancing riparian buffers and the greater exclusion of livestock from the stream system. In an effort to provide Loudoun County with timely Catoctin Creek watershed-specific riparian corridor data, COG staff performed a remote-sensed imagery analysis to determine the existing riparian buffer conditions along 84 stream miles (i.e., approximately 62 percent of the total).

Importantly, under the Chesapeake Bay Preservation Act (CBPA), the recommended minimum riparian buffer width for Virginia State waters is designated to be 100 feet. As part of the Virginia Agricultural Best Management Practice, Conservation Reserve Enhancement Program (CREP), there is a 35 foot minimum riparian buffer width requirement. Furthermore, many studies have shown that wider riparian buffers generally provide a broader more sustainable range of water quality/quantity and wildlife habitat benefits (Mayer et al., 2005; Castelle et al., 1994; Palone and Todd, 1997; and Wenger, 1999). Incorporating these recommended and minimum riparian buffer width guidelines, COG staff conducted the following four part Catoctin Creek riparian buffer analysis:

1) Existing riparian forest buffer condition for four width scenarios: 35, 50, 100 and 200 feet;
2) Non-forested 35 foot wide riparian buffer condition to meet CREP minimum enrollment requirement (Note: due to limited resources, COG did not perform this analysis for the 50, 100 and 200 foot buffer width scenarios.); and
3) Potential riparian buffer reforestation area identification for both the 35 and 100 foot scenarios (Appendix 6, Tables 2 and 3, respectively).

3.5.1 Riparian Buffer Condition Results

In 2005, approximately 56 percent of the total 200 foot buffer area (i.e., 3,973.2 acres) was forested. The total land areas covered by a forested buffer within riparian buffer widths of 35, 50, 100 and 200 feet were 505.6, 690.3, 1,283.8 and 2,226.4 acres, respectively. The associated overall percent forest canopy coverage within the four buffer widths were 68.0, 68.0, 60.9, and 56.0 percent, respectively. Additional riparian forest buffer results are presented in the following sections and summarized in Table 31 and Figure 45.

Mainstem Areas

The percent forested buffer coverage within the 35, 50, 100 and 200 foot buffer widths along Catoctin Creek mainstem areas were 70.6, 71.3, 63.6 and 60.3 percent, respectively. The riparian forest buffers along the North Fork and South Fork mainstems have consistently lower levels of forested buffer coverage than the buffers along the Catoctin Creek mainstem (i.e., the percent canopy coverage within the 50 foot buffer width along the North Fork and South Fork was 65.1 and 61.7 percent, respectively, versus 92.2 percent for Catoctin Creek). It should be noted that the Catoctin Creek mainstem (downstream of Waterford, Virginia) is designated as a Virginia Scenic River, and must maintain its rather extensive undeveloped riparian buffer network to meet National Wild and Scenic Rivers Act eligibility requirements.

Tributaries

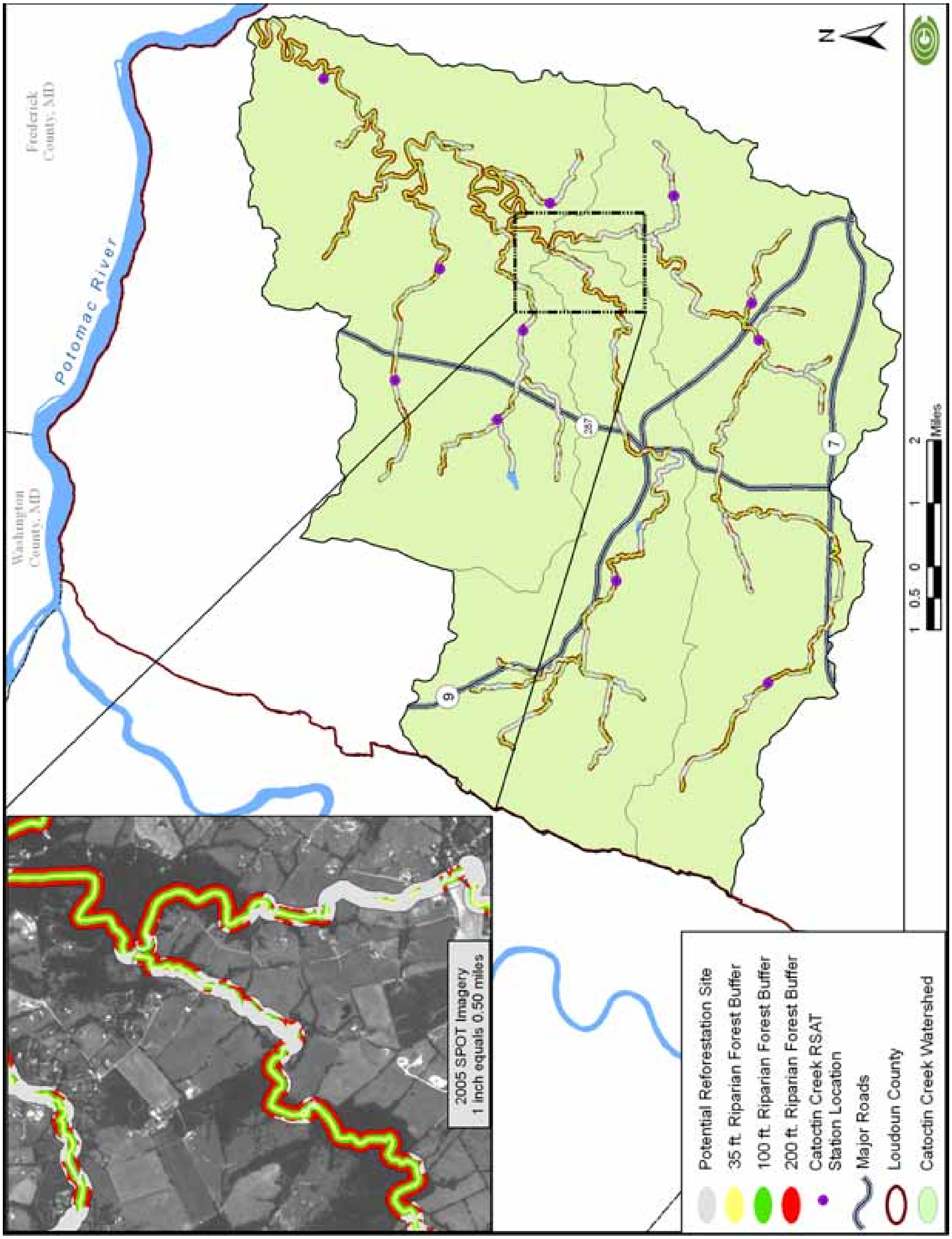
The percent riparian forest buffer coverage within the Catoctin Creek tributary stream system under the 200 foot buffer width scenario ranged from 15 to 60 percent. The Talbot Farm tributary has the least robust forest buffer, with only 15 percent of its total riparian buffer (i.e., 95.2 acres) covered by forest. In contrast, 60 percent of Milltown Creek's total 200 foot buffer area (i.e., 336.1 acres) is forested. Overall, the average percent forested buffer coverage for the CBPA recommended 100 foot minimum buffer was 54 percent. For the optimal 200 foot forest buffer condition, 45 percent of the riparian buffer zone was forested.

Table 31. Catoctin Creek: Summary - 2005 Riparian Forest Buffer Acreage And Percent Cover[1]

Watershed	Total Watershed Area		35 ft. Buffer			50 ft. Buffer			100 ft. Buffer			200 ft. Buffer		
			Total Buffer Area	Forested Area within Buffer	%35 ft. Buffer Covered by Forest Canopy	Total Buffer Area	Forested Area within Buffer	%50 ft. Buffer Covered by Forest Canopy	Total Buffer Area	Forested Area within Buffer	%100 ft. Buffer Covered by Forest Canopy	Total Buffer Area	Forested Area within Buffer	%200 ft. Buffer Covered by Forest Canopy
	Acres	Sq-Mi	Acres	Acres		Acres	Acres		Acres	Acres		Acres	Acres	
Catoctin Creek Mainstems														
North Fork Catoctin Creek	14,910.6	23.30	167.2	108.9	65.1%	238.4	152.4	65.1%	473.8	279.9	59.1%	933.8	474.8	50.8%
South Fork Catoctin Creek	17,426.8	27.23	227.6	137.2	60.3%	279.7	172.7	61.7%	644.2	319.6	49.6%	1,089.1	550.8	50.6%
Mainstem Catoctin Creek	8,228.3	12.86	152.5	140.6	92.2%	217.4	199.7	92.2%	431.6	385.8	89.4%	844.0	704.0	83.4%
Subtotal	40,565.8	63.4	547.3	386.7	70.6%	735.5	524.8	71.3%	1,549.6	985.3	63.6%	2,867.0	1,729.6	60.3%
Tributaries to Catoctin Creek														
Upper														
Hamilton Station Road Tributary	1,388.3	2.17	14.8	11.0	74.8%	21.1	15.3	72.2%	42.2	27.2	64.6%	84.2	44.7	53.1%
Talbot Farm Tributary	2,347.8	3.67	16.6	3.2	19.5%	23.7	4.7	19.9%	47.5	9.0	19.0%	95.2	14.2	15.0%
Subtotal	3,736.0	5.84	31.4	14.3	45.5%	44.9	20.0	44.5%	89.7	36.2	40.4%	179.3	59.0	32.9%
Middle														
Clover Mill Tributary	1,560.3	2.44	18.8	8.8	46.9%	26.8	12.2	46.9%	53.1	21.5	40.4%	104.6	34.9	33.4%
Brens Creek	7,083.5	11.07	85.2	46.6	54.7%	121.5	65.4	54.7%	241.8	120.4	49.8%	477.8	196.2	41.1%
Subtotal	8,643.8	13.51	104.0	55.4	53.3%	148.3	77.6	52.4%	294.9	141.8	48.1%	582.4	231.1	39.7%
Lower														
Milltown Creek	5,527.1	8.64	59.5	48.0	80.6%	84.9	66.2	80.6%	169.3	117.5	69.4%	336.1	201.8	60.0%
EcoVillage Tributary	737.3	1.15	1.3	1.2	94.8%	1.9	1.7	94.8%	3.9	3.0	75.7%	8.4	5.0	58.9%
Subtotal	6,264.5	9.79	60.8	49.2	80.9%	86.8	67.9	78.2%	173.3	120.5	69.5%	344.5	206.7	60.0%
Total	**59,210.1**	**92.52**	**743.5**	**505.6**	**68.0%**	**1,015.5**	**690.3**	**68.0%**	**2,107.4**	**1,283.8**	**60.9%**	**3,973.2**	**2,226.4**	**56.0%**

[1] Buffer widths shown include both sides of the stream.

Figure 45. Catoctin Creek: 2005 Riparian Buffer Condition



3.5.2 Non-Forested 35 Foot Wide Riparian Buffer

The COG analysis identified a number of areas lacking forest cover within the 35 foot buffer zone (Table 32). As shown in Table 32, approximately 25 miles of mainstem and tributary streams do not meet the 35 foot forested riparian buffer. The Talbot Farm tributary has the greatest non-forested stream length, with 1.6 miles of its total 2.0 miles (i.e., 82.8 percent) lacking a 35 foot riparian buffer. In contrast, stream lengths lacking forest coverage within the 35 foot riparian buffer zone along the Catoctin Creek mainstem comprised only 1.3 miles of the total 18.1 mile stream length (i.e., 7.4 percent). As previously mentioned, it should be noted that existing development, infrastructure or land features (e.g., steep slope) may preclude reforestation in some of these areas. It is also recognized that these areas will need to be additionally groundtruthed and that the actual reforestation of these sites is incumbent upon approval of the landowner.

Table 32. Catoctin Creek: Summary - 35 Foot Width Riparian Buffer Scenario

Watershed	Total Stream Length	35 ft. Buffer		
		Stream Length With Forested Buffer	Stream Length Without Forested Buffer	% Stream Length Without Forested Buffer
	Miles	Miles	Miles	
Catoctin Creek Mainstems				
South Fork Catoctin Creek	23.2	14.8	8.4	36.3%
North Fork Catoctin Creek	19.8	13.2	6.6	33.2%
Mainstem Catoctin Creek	18.1	16.7	1.3	7.4%
Subtotal	61.1	44.7	16.3	26.7%
Tributaries to Catoctin Creek				
Upper				
Hamilton Station Road Tributary	1.7	1.4	0.4	21.5%
Talbot Farm Tributary	2.0	0.3	1.6	82.8%
Subtotal	3.7	1.7	2.0	53.9%
Middle				
Clover Mill Tributary	2.2	1.1	1.1	51.6%
Brens Creek	10.1	5.6	4.4	43.9%
Subtotal	12.3	6.7	5.6	45.3%
Lower				
Milltown Creek	7.0	5.8	1.2	16.7%
EcoVillage Tributary	0.2	0.2	0.0	0.0%
Subtotal	7.2	6.0	1.2	16.4%
Total	84.2	59.2	25.1	29.8%

3.5.3 Potential Riparian Buffer Reforestation Areas

In an attempt to assist Loudoun County in reducing fecal bacteria levels and meeting the TMDL implementation requirements, COG staff identified a total of 271 potential sites for riparian reforestation and/or livestock exclusion within the 35 and 100 foot wide buffer areas. Of this total, 165 sites were associated with the 100 foot buffer scenario. For the Catoctin Creek mainstem-specific potential riparian buffer reforestation areas, the reader is referred to Appendix 6, Figures 1 through 3. A more extensive list for both the mainstem and tributary candidate sites can be found in Appendix 6, Tables 1 and 2. Note: the sites have been organized from largest to smallest acreages within the mainstem and tributary stream reaches.

Figures 46 and 47 provide representative examples for the 35 and 100 foot wide buffer scenarios. As seen in figure 46, a 0.56 mile long section of South Fork Catoctin Creek (immediately downstream of Old Wheatland Road) was identified as a potential riparian reforestation site. A 35 foot minimum riparian buffer zone could be established in this pasture area, along with fencing to eliminate direct livestock access to the stream, by working with the landowner and using federal reimbursement and state cost-share riparian buffer enhancement incentive programs (e.g., Conservation Reserve Enhancement Program). For additional site specific information, the reader is referred to South Fork Catoctin Creek (ID #21) in Appendix 6, Table 1.

Figure 46. South Fork Catoctin Creek: Mainstem - Riparian Buffer Immediately North of Old Wheatland Road

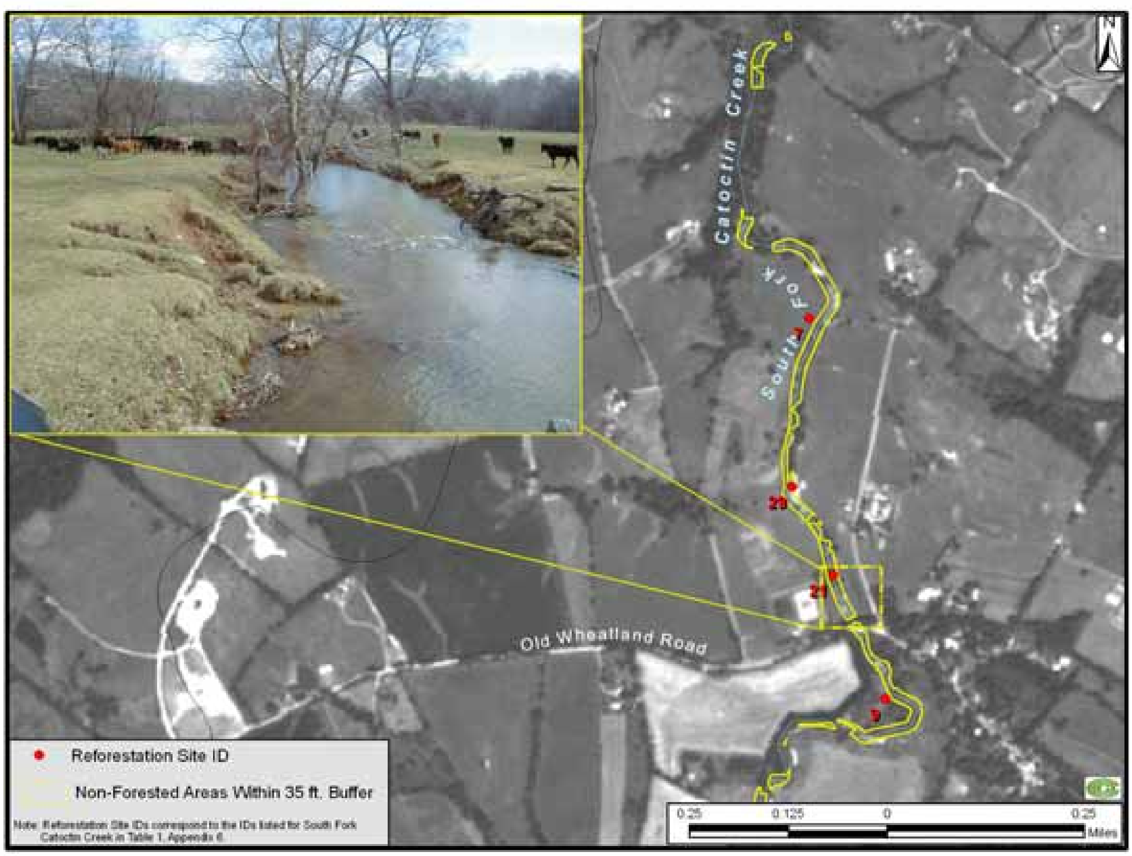


Figure 47 provides a second representative non-forested riparian buffer area example. The mainstem of Brens Creek, near the Ash George and Rehobeth Church Road intersection, flows adjacent to a power line easement area. There is an opportunity at this location to work with VEPCO to create an approximately 100 foot wide riparian forested buffer area. The associated stream length is 0.53 miles. For additional site specific information, the reader is referred to Brens Creek (ID #4) in Appendix 6, Table 2.

Figure 47. Catoctin Creek Tributary - Brens Creek (Ash George Road In The Vicinity of Rehobeth Church Road)

4.0 Study Recommendations

It is recognized that Loudoun County is currently the most rapidly developing jurisdiction in both the Washington Metropolitan Area (WMA) and the state of Virginia. Population growth in the County is projected to grow from the 2000 census estimate of 169,599 to 462,100 by 2030 (United States Census 2000 data). Concurrently, the number of households[1] is projected to increase from the 2000 estimate of 59,900 to 163,900 (COG, 2004). This growth will greatly increase pressure on the County's current undeveloped areas and associated aquatic ecosystems. Where development occurs, it should be done in a well-planned, environmentally sensitive manner. It is also recognized that the creation of a comprehensive environmental database is a critical first step for the proper protection, restoration and management of the County's water resources. Listed below are COG staff's study recommendations.

General Recommendations

1) Loudoun County should seriously consider employing environmental overlay zones, special protection area (SPA) designations and other appropriate land use management measures for protecting high quality, sensitive watersheds, such as Quarter Branch, Dutchman Creek and Piney Run.

2) Conduct additional RSAT-type surveys, so as to provide a comprehensive stream quality picture for the 12 major Loudoun County watersheds and their tributaries. It is also recommended that quantitative watershed stream assessment surveys be repeated approximately every 3-5 years. The exception being "sensitive" streams which should be surveyed at least once per year (i.e., Quarter Branch, Dutchman Creek and Piney Run).

3) As a companion piece to the macroinvertebrate database, perform County-wide baseline fisheries surveys for the 12 major Loudoun County watersheds..

4) Based on the 2006 RSAT Loudoun County macroinvertebrate community assemblage results, a summertime, continuous stream temperature monitoring survey for Quarter Branch, Dutchman Creek and Piney Run is strongly recommended. The recommended 2-3 year long survey would provide critically needed companion data for better determining both the coldwater fisheries potential and appropriate water use classification of these systems.

5) Establish a permanent RSAT-type monitoring station network (with strategically located channel cross-section bank pins) for the 12 major watersheds, recommended by COG for annual surveys.

Clarks Run - Saint Clair Lane Quadruple Concrete Box Culvert - Complete Fish Blockage

[1]Household, or occupied housing unit, projections are based on increases in new house construction.

6) Building upon COG's Loudoun County provisional fish blockage list that has been compiled since 1997, develop a comprehensive inventory for the 12 major watersheds. This inventory should, at a minimum, include blockage type, location, height, and ownership information. In addition, the data should be fully integrated into the County's GIS geodatabase.

Upper Brens Creek - Nixon Road - Direct Livestock Access To Stream

7) Given their ecological significance and water quality benefits, comprehensive watershed-specific riparian corridor analyses (which, at a minimum, examines buffer widths and vegetation types), similar to the recent COG Catoctin Creek riparian buffer analysis are needed. It is further recommended that these analyses employ the most recent 'leaf-on' aerial imagery. Results from the riparian corridor analyses will enable Loudoun County Soil and Water Conservation District (LSWCD), the Virginia Department of Forestry (VDOF) and the Natural Resources Conservation Service (NRCS) to both better identify additional potential reforestation areas, and to work more closely with landowners to restore riparian corridors and to limit direct livestock access.

8) Expand the County's current reimbursement and/or cost-share riparian buffer enhancement incentive program to include residential property owners who can provide a minimum 0.5 acre riparian reforestation or wetland creation.

9) The County's major watershed digital stream layer currently lacks the resolution needed for stream-related surveys. A higher resolution digital stream hydrography layer should be developed, at a sub-subwatershed level, to allow for accurate mapping of all stream channel-related conditions.

10) As a means of better assessing and integrating stream survey results, the County should develop a comprehensive landuse/landcover database, derived from remote sensing data, which can be regularly updated (i.e., every five years). It is further recommended that a county-wide impervious surface data layer and tracking system be developed to monitor annual impervious surface changes at the subwatershed level. In addition, the County should explore the feasibility of acquiring light detection and ranging (LIDAR) to generate topographic data for the entire County (e.g., every five years), including stream channel elevation data.

11) Develop a County-wide "Stream Protection Strategy" (SPS) similar to the ones which currently exist in both Fairfax County, VA and Montgomery County, MD, and which feature both protection and restoration measures and bench marks.

12) Regarding quantitative macroinvertebrate sampling, a 20-jab collection protocol similar to the one currently employed by the Maryland Biological Stream Survey is recommended. It is also recommended that, wherever possible, macroinvertebrate identification be taken down to the lowest taxonomic level possible (i.e., genus level or lower).

13) Continue to encourage, train and employ citizen volunteers to routinely monitor the health of County streams.

14) Loudoun County should seriously consider reinstituting the River and Stream Corridor Overlay District (RSCOD), which established minimum riparian buffer widths. It is further recommended that the County's minimum of 100 feet riparian buffer be strictly enforced. Finally, for all construction sites, require that perimeter-type erosion and sediment control features (such as silt fence, super silt fence, sediment traps and berms) be in place prior to land grading in and along stream corridors.

Upper Brens Creek - Complete Fish Blockage - Recent Nixon Road Culvert Replacement Project

15) Where applicable, for new development and redevelopment areas, strategically implement Low Impact Development (LID) technologies for stormwater runoff control.

16) All future County road culvert projects (i.e., both new and /or replacement ones) should incorporate fish passage features into their designs.

17) The County should continue to work with local farmers on nutrient management and should encourage greater participation in programs such as the Small Grain Cover Crop for Nutrient and Residue Management.

Watershed - Specific Recommendations

Clarks Run

A) Upstream of Saint Clair Lane - The County should work with landowner(s) to implement federal reimbursement and state cost-share riparian buffer enhancement incentive programs (e.g., such as Conservation Reserve Enhancement Program (CREP)) for the establishment of 100 foot minimum riparian buffers. Note: cropland in this area encroaches to the top of the streambank.

Clarks Run - Upstream of Saint Clair Lane - Cropland Within A Foot Of The Stream

B) Downstream of Saint Clair Lane - As a targeted “High Priority Area” for implementation of the state cost-share Virginia Agricultural Best Management Practice (BMP) programs, the County should work with watershed residents, who qualify, to fence off the stream and eliminate direct livestock access to stream.

C) Saint Clair Lane Culvert - Modify the existing fish blockage to allow the upstream and downstream movement of residential fishes. It is further recommended that riffle grade control structures, similar to the ones employed as part of the Woodrow Wilson Bridge Replacement mitigation effort, be employed where possible.

Catoctin Creek

Mainstems

A) South Fork Mainstem (Ketoctin Church Road) - Establish a permanent RSAT-type monitoring station (with cross-sectional bank pins) upstream of Ketoctin Church Road.

B) South Fork Mainstem (Ketoctin Church Road) - Reevaluate the Ketoctin Church Road culvert to determine if the structure meets current design criteria for safely passing high frequency stormflows.

C) South Fork Mainstem (Piggott Bottom Road) - Establish a permanent RSAT-type monitoring station. This stream site has been RSAT surveyed by COG twice (2002 and 2006), and it is also a former Catoctin Creek bacterial total maximum daily load (TMDL) monitoring location.

D) South Catoctin Creek (Alder School Road) - Reevaluate the Ketoctin Church Road culvert to determine if the structure meets current design criteria for safely passing high frequency stormflows.

South Fork Catoctin Creek - Alder School Road Culvert

E) North Fork (Hillsboro Road) - Establish a permanent RSAT-type mainstem monitoring station. This site is in close proximity to the Loudoun Watershed Watch Catoctin Creek bacterial total maximum daily load (TMDL) monitoring site.

Tributaries

A) Hamilton Station Road tributary - Based on the high nitrate level reading (i.e., 4.5 mg/l), it is recommended that additional monitoring be performed to determine if high nitrate levels are a chronic problem.

B) Talbot Farm tributary (approximately 200 feet upstream of Clarkes Gap Road) - Work with landowner(s) to stabilize approximately 500 feet of moderate/severe streambank. As a companion piece, work with the landowner(s) to reforest the riparian corridor.

C) Talbot Farm tributary - It was observed that beaver(s) had extensively felled many young trees that were planted during the 1998 LCSWCD reforestation project. It is recommended that the remaining trees be caged and/or that the beaver(s) be trapped and relocated to allow for the further establishment of the riparian buffer vegetation.

D) Clover Mill Road tributary - The County should work with multiple landowners to introduce Federal reimbursement and State cost-share riparian buffer enhancement incentive programs to eliminate direct livestock access to the stream and establish the minimum riparian buffer.

E) Richard Creek (Purcellville Road) - Work with landowner to remove and appropriately discard salvaged automobile and parts from the stream corridor.

F) Richard Creek (Purcellville Road) - Work with landowner(s) to establish a 100 foot minimum forested riparian buffer.

G) Richard Creek (Purcellville Road) - Perform a dam safety inspection for the small pond located along the left bank (looking downstream) near transect X-1.

H) Brens Creek (Ash George Road area) - Work with landowner(s) to stabilize 200 feet of moderate/severe streambank erosion. In addition, stabilize the stream crossing area currently used by the Virginia Electrical Power Company (VEPCO) to access their utility poles.

Brens Creek - Ash George Road - Moderate/Severe Streambank Erosion

I) Brens Creek - Work with landowner(s) to establish a 100 foot minimum forested riparian buffer for a 2,000 foot long stream section near the Ash George and Rehobeth Church Road intersection.

J) Upper Milltown Creek (Ash George Road) - The County should work with multiple landowners to introduce Federal reimbursement and State cost-share riparian buffer enhancement incentive programs to plant wetland plants within the area near the intersection of Bolington Road and Breezy Meadow Lane.

K) Middle Milltown Creek (Milltown Road) - Establish a permanent RSAT-type monitoring station in the mainstem. This site is in close proximity to a former Catoctin Creek bacterial total maximum daily load (TMDL) monitoring location.

L) EcoVillage Tributary (Taylortown Road) - Work with landowner(s) to establish a minimum 100 foot forested riparian buffer along the lowermost stream section.

Piney Run

A) Establish a permanent RSAT-type monitoring station in the middle and lower mainstems. The lower mainstem site has been RSAT surveyed by COG three times (2000, 2002 and 2006).

B) As previously stated in the 2003 COG report, Loudoun County, together with the Virginia Department of Fish and Inland Game, should evaluate the recreational trout fishing potential for both the middle and lower mainstem portions of Piney Run.

Quarter Branch

A) Perform RSAT-type monitoring, with an electro-fishing survey component, for the upper mainstem portions of Quarter Branch.

Dutchman Creek

A) Middle Dutchman Creek - Work with landowners along Cypress Knoll Lane to establish a 400-foot long, 100 foot minimum forested riparian buffer.

B) Middle Dutchman Creek - Establish a permanent RSAT-type monitoring station in the mainstem. This stream site has been RSAT surveyed by COG twice (2002 and 2006), and it is also in close proximity to a former Catoctin Creek bacterial total maximum daily load (TMDL) monitoring location.

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Table 1. Catoctin Creek - Locations of Potential Riparian Reforestation Sites within 35 ft. Riparian Buffer Cont'd

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Table 2. Catoctin Creek - Locations of Potential Riparian Reforestation Sites within 100 ft. Riparian Buffer Cont'd

Table 2. Catoctin Creek - Locations of Potential Riparian Reforestation Sites within 100 ft. Riparian Buffer Cont'd

Table 1. RSAT Transect Location

Watershed	Name	Location	VAHUC5	VAHUC6	Transect	Longitude	Latitude
Clarks Run	Clarks Run	Saint Clair Lane	PL-C	PL04	X-1	-77.51981438	39.23898876
					X-2	-77.51837015	39.24093763
					X-3	-77.51960508	39.24281230
Catoctin Creek	Upper South Fork	Ketoctin Church Road	PL-B	PL02	X-1	-77.75043673	39.16002674
					X-2	-77.74991744	39.15920631
					X-3	-77.74894138	39.15851983
	Upper South Fork	Piggott Bottom Road	PL-B	PL02	X-1	-77.65058000	39.15911000
					X-2	-77.64814000	39.15994000
					X-3	-77.64756000	39.16125000
	Upper North Fork	Hillsboro Road	PL-B	PL02	X-1	-77.71986881	39.19393548
					X-2	-77.71721255	39.19396415
					X-3	-77.71548956	39.19421875
	Hamilton Station Road Tributary	Hamilton Station Road	PL-B	PL02	X-1	-77.63362214	39.16367570
					X-2	-77.63566016	39.16269301
					X-3	-77.63745271	39.16368458
	Talbot Farm Tributary	Clarkes Gap Road	PL-B	PL02	X-1	-77.60287562	39.18152776
					X-2	-77.60685273	39.18096943
					X-3	-77.61033704	39.18044617
	Clover Mill Road Tributary	Clover Mill Road	PL-B	PL03	X-1	-77.60749132	39.20929396
					X-2	-77.60731953	39.21154783
					X-3	-77.60647096	39.21217897
	Richard Creek (Upper Brens Creek)	Purcellville Road	PL-B	PL03	X-1	-77.67078885	39.22070480
					X-2	-77.66995651	39.21951560
					X-3	-77.66882413	39.21900821
	Brens Creek	Ash George Road	PL-B	PL03	X-1	-77.64706282	39.21617422
					X-2	-77.64513776	39.21552544
					X-3	-77.64386674	39.21491833
	Upper Milltown Creek	Bolington Road	PL-B	PL03	X-1	-77.66878919	39.24334738
					X-2	-77.66678069	39.24393385
					X-3	-77.66482703	39.24424882
	Middle Milltown Creek	Milltown Road	PL-B	PL03	X-1	-77.63131462	39.23613793
					X-2	-77.62954583	39.23535729
					X-3	-77.62779445	39.23512029
	EcoVillage Tributary	Trillium Glen Lane	PL-B	PL03	X-1	-77.57554280	39.26551649
					X-2	-77.57415010	39.26361413
					X-3	-77.57224568	39.26292355
Quarter Branch	Quarter Branch	Garnet Road	PL-A	PL01	X-1	-77.60486415	39.29392321
					X-2	-77.60696878	39.29558455
					X-3	-77.60845851	39.29696777
Dutchman Creek	Middle Dutchman Creek	Irish Corner Road	PL-A	PL01	X-1	-77.66448775	39.28498865
					X-2	-77.66381935	39.28563640
					X-3	-77.66193176	39.28616676
Piney Run	Middle Piney Run	Arnold Lane	PL-A	PL01	X-1	-77.73219847	39.28330084
					X-2	-77.73109300	39.28501973
					X-3	-77.73095127	39.28754813
	Lower Piney Run	Branchriver Road	PL-A	PL01	X-1	-77.71667000	39.31061000
					X-2	-77.71558000	39.30988000
					X-3	-77.71393000	39.30918000

Table 1. Clarks Run and South Fork Catoctin Creek RSAT Field Data[1]

Stream: Clarks Run | Survey Date: 12/23/2005 | RSAT Score: 32

Reach: Saint Clair Lane

Transect Number	Top Channel Width (ft)	Bottom Channel Width (ft)	Wetted Perimeter (ft)	Mean Riffle Depth (in)	Mean Bank Height R (ft)	Mean Bank Height L (ft)	Mean Bank Stability R & L (%)	Bank Material Type R	Bank Material Type L	Substrate Material Composition	Mean Riffle Embeddedness (%)	Mean Substrate Fouling Level (%)	Riparian Veg. Type R	Riparian Veg. Type L	Buffer Width R	Buffer Width L	Max. Pool Depth (in)	Pool Habitat Quality
x-1	38.1	23.1	20.5	3.0	5.1	4.8	77.5	Cl/Sl	Sl/S	G,C,R,S	23	65	F	F/G	201	34	24	Excellent
x-2	38.9	20.1	10.1	4.0	4.8	4.6	82.5	Sl/S	Cl/L	G,C,S,Cl	45	65	F	G	137	200	28	Excellent
x-3	33.5	23.6	13.2	2.5	3.6	3.9	76.5	S	Cl/S	G,S,Bd,C,R	60	65	G	G	200	200	22	Excellent
Average	**36.9**	**22.2**	**14.6**	**3.2**	**4.5**	**4.4**	**78.8**				**42.7**	**65.0**			**179.3**	**144.7**	**24.7**	

Table 2. Catoctin Creek and Tributary RSAT Field Data[1]

Stream: South Fork Catoctin Creek | Survey Date: 2/9/06 | RSAT Score: 33

Reach: Ketoctin Church Road

Transect Number	Top Channel Width (ft)	Bottom Channel Width (ft)	Wetted Perimeter (ft)	Mean Riffle Depth (in)	Mean Bank Height R (ft)	Mean Bank Height L (ft)	Mean bank Stability R & L (%)	Bank Material Type R	Bank Material Type L	Substrate Material Composition	Mean Riffle Embeddedness (%)	Mean Substrate Fouling Level (%)	Riparian Veg. Type R	Riparian Veg. Type L	Buffer Width R	Buffer Width L	Max. Pool Depth (in)	Pool Habitat Quality
x-1	28.1	22.4	11.3	4.8	3.1	3.2	68.5	S/L	L	G,S,C,R,B	35	25	F	F	100	100	28	Excellent
x-2	28.7	20.7	19.7	4.5	2.8	3.3	68.0	Cl/Sl	Sl/S	G,S,C,Cl	55	20	F	F	200	150	18	Very Good
x-3	18.5	14.7	11.9	3.4	3.5	2.2	93.5	S/Sl	Sl	R,G,C,B,S	20	35	F	G	200	150	18	Very Good
Average	**25.1**	**19.3**	**14.3**	**4.2**	**3.1**	**2.9**	**76.7**				**36.7**	**26.7**			**166.7**	**133.3**	**21.3**	

Stream: South Fork Catoctin Creek | Survey Date: 2/9/06 | RSAT Score: 24

Reach: Piggott Bottom Road

Transect Number	Top Channel Width (ft)	Bottom Channel Width (ft)	Wetted Perimeter (ft)	Mean Riffle Depth (in)	Mean Bank Height R (ft)	Mean Bank Height L (ft)	Mean bank Stability R & L (%)	Bank Material Type R	Bank Material Type L	Substrate Material Composition	Mean Riffle Embeddedness (%)	Mean Substrate Fouling Level (%)	Riparian Veg. Type R	Riparian Veg. Type L	Buffer Width R	Buffer Width L	Max. Pool Depth (in)	Pool Habitat Quality
x-1	50.2	22.3	21.1	6.0	6.1	5.5	68.0	Sl/Cl	S/Sl	S,G,C,R,Cl,B	72	45	G/F	F	200	200	36	Good
x-2	44.3	30.9	28.4	6.0	5.1	5.5	87.5	S/Sl	Sl/S	G,S,C,R,B	70	60	F	F	200	200	36	Excellent
x-3	53.6	40.0	32.0		5.0	5.0	70.0	S/Sl	Sl/S		100		F	F	200	200	36	Very Good
Average	**49.4**	**31.1**	**27.2**	**6.0**	**5.4**	**5.3**	**75.2**				**80.7**	**52.5**			**200.0**	**200.0**	**36.0**	

[1] Total score interpretation - 42-50 pts. = Excellent, 30-41pts. = Good, 16-29 pts. = Fair, <16 pts. = Poor.

Table 2. Catoctin Creek and Tributary RSAT Field Data[1] Cont'd

Stream: North Fork Catoctin Creek — Survey Date: 3/9/06 — RSAT Score: 37

Reach: Hillsboro Road

Transect Number	Top Channel Width (ft)	Bottom Channel Width (ft)	Wetted Perimeter (ft)	Mean Riffle Depth (in)	Mean Bank Height R (ft)	Mean Bank Height L (ft)	Mean bank Stability R & L (%)	Bank Material Type R	Bank Material Type L	Substrate Material Composition	Mean Riffle Embeddedness (%)	Mean Substrate Fouling Level (%)	Riparian Veg. Type R	Riparian Veg. Type L	Buffer Width R	Buffer Width L	Max. Pool Depth (in)	Pool Habitat Quality
x-1	36.0	26.0	25.0	6.0	2.5	3.0	81.0	S/Cl	Sl/S	C,R,B,S,G	30	50	F	F	200	200	27.6	Excellent
x-2	43.2	22.5	22.0	4.0	3.1	3.4	59.0	Cl/S	S/Sl	C,G,R,S,B	40	65	F	F/G	200	200	25.2	Good
x-3	39.5	18.5	14.2	7.0	3.0	2.5	82.5	S/Cl	Sl/S	B,C,G,S,R	40	65	F	F	200	200	12	Poor
Average	**39.6**	**22.3**	**20.4**	**5.7**	**2.9**	**3.0**	**74.2**				**36.7**	**60.0**			**200.0**	**200.0**	**21.6**	

Stream: Hamilton Station Road Tributary — Survey Date: 2/28/06 — RSAT Score: 28

Reach: Hamilton Station Road

Transect Number	Top Channel Width (ft)	Bottom Channel Width (ft)	Wetted Perimeter (ft)	Mean Riffle Depth (in)	Mean Bank Height R (ft)	Mean Bank Height L (ft)	Mean bank Stability R & L (%)	Bank Material Type R	Bank Material Type L	Substrate Material Composition	Mean Riffle Embeddedness (%)	Mean Substrate Fouling Level (%)	Riparian Veg. Type R	Riparian Veg. Type L	Buffer Width R	Buffer Width L	Max. Pool Depth (in)	Pool Habitat Quality
x-1	21.1	13.9	6.0	5.0	4.8	4.1	67.5	Sl/Cl	Sl/S	G,C,R,Bd,S	20	35	G	G	200	60	20	Fair
x-2	19.2	9.9	9.5	4.0	3.3	4.0	73.5	S/L	Sl/S	G,C,S,R	35	30	F/G	F	200	160	28	Very Good
x-3	34.5	21.4	21.1	4.0	3.2	3.3	71.5	Sl/L	Cl/Sl	G,C,S	25	20	F/G	F	200	200	30	Very Good
Average	**24.9**	**15.1**	**12.2**	**4.3**	**3.8**	**3.8**	**70.8**				**26.7**	**28.3**			**200.0**	**140.0**	**26.0**	

Stream: Talbot Farms Tributary — Survey Date: 2/28/06 — RSAT Score: 31

Reach: Clarkes Gap Road

Transect Number	Top Channel Width (ft)	Bottom Channel Width (ft)	Wetted Perimeter (ft)	Mean Riffle Depth (in)	Mean Bank Height R (ft)	Mean Bank Height L (ft)	Mean bank Stability R & L (%)	Bank Material Type R	Bank Material Type L	Substrate Material Composition	Mean Riffle Embeddedness (%)	Mean Substrate Fouling Level (%)	Riparian Veg. Type R	Riparian Veg. Type L	Buffer Width R	Buffer Width L	Max. Pool Depth (in)	Pool Habitat Quality
x-1	31.2	10.5	10.0	3.6	5.2	5.4	70.5	Sl/S	L/Sl	G,C,R,S,B	20	55	G	F/G	200	200	18	Good
x-2	30.1	8.6	5.0	5.0	4.0	6.2	84.0	Sl/S	S/Sl	C,G,R,S	10	75	F/G	G	200	200	24	Excellent
x-3	30.7	14.7	8.8	6.0	3.1	4.3	69.0	S/Sl	Sl	C,G,Bd,R,S	30	75	G	G	200	10	26	Good
Average	**30.6**	**11.3**	**7.9**	**4.9**	**4.1**	**5.3**	**74.5**				**20.0**	**68.3**			**200.0**	**136.7**	**22.7**	

[1] Total score interpretation - 42-50 pts. = Excellent, 30-41pts. = Good, 16-29 pts. = Fair, <16 pts. = Poor.

Table 2. Catoctin Creek Tributary RSAT Field Data[1]

Stream: Clover Mill Road Tributary — Survey Date: 3/29/06 — RSAT Score: 27

Reach: Clover Mill Road

Transect Number	Top Channel Width (ft)	Bottom Channel Width (ft)	Wetted Perimeter (ft)	Mean Riffle Depth (in)	Mean Bank Height R (ft)	Mean Bank Height L (ft)	Mean bank Stability R & L (%)	Bank Material Type R	Bank Material Type L	Substrate Material Composition	Mean Riffle Embeddedness (%)	Mean Substrate Fouling Level (%)	Riparian Veg. Type R	Riparian Veg. Type L	Buffer Width R	Buffer Width L	Max. Pool Depth (in)	Pool Habitat Quality
x-1	36.5	19.2	17.9	3.0	4.3	3.5	67.5	S/SI	S/L	C,G,S,R	50	68	F/G	F/G	200	200	36	Excellent
x-2	33.5	16.3	15.0	2.4	3.6	3.9	62.5	SI/S	SI/Cl	G,C,S,R,Bd,	55	60	F/G	F/G	200	200	25	Fair
x-3	29.7	14.9	11.3	2.7	4.0	4.2	58.0	SI/S	L/S	G,C,S,Bd,R	45	73	F/G	F/G	200	200	25	Excellent
Average	**33.3**	**16.8**	**14.8**	**2.7**	**4.0**	**3.9**	**62.7**				**50.0**	**67.0**			**200.0**	**200.0**	**28.7**	

Stream: Richard Creek (Upper Brens Creek) — Survey Date: 3/22/06 — RSAT Score: 24

Reach: Purcellville Road

Transect Number	Top Channel Width (ft)	Bottom Channel Width (ft)	Wetted Perimeter (ft)	Mean Riffle Depth (in)	Mean Bank Height R (ft)	Mean Bank Height L (ft)	Mean bank Stability R & L (%)	Bank Material Type R	Bank Material Type L	Substrate Material Composition	Mean Riffle Embeddedness (%)	Mean Substrate Fouling Level (%)	Riparian Veg. Type R	Riparian Veg. Type L	Buffer Width R	Buffer Width L	Max. Pool Depth (in)	Pool Habitat Quality
x-1	35.8	10.2	8.3	3.5	3.2	4.9	61.5	SI/S	S/Cl	G,S,C,R	85	55	G	F/G	197.6	200	13	Poor
x-2	21.2	8.2	8.0	3.5	4.6	3.8	68.0	SI/S	Cl/S	G,C,R,S,B	50	55	G	F/G	200	200	18	Good
x-3	15.9	10.8	10.0	4.5	1.7	3.3	62.0	Cl/S	L	C,G,Bd,S,B	35	50	G	F	200	200	17	Poor
Average	**24.3**	**9.7**	**8.8**	**3.8**	**3.2**	**4.0**	**63.8**				**56.7**	**53.3**			**199.2**	**200.0**	**16.0**	

Stream: Brens Creek — Survey Date: 2/10/06 — RSAT Score: 25

Reach: Ash George Road

Transect Number	Top Channel Width (ft)	Bottom Channel Width (ft)	Wetted Perimeter (ft)	Mean Riffle Depth (in)	Mean Bank Height R (ft)	Mean Bank Height L (ft)	Mean bank Stability R & L (%)	Bank Material Type R	Bank Material Type L	Substrate Material Composition	Mean Riffle Embeddedness (%)	Mean Substrate Fouling Level (%)	Riparian Veg. Type R	Riparian Veg. Type L	Buffer Width R	Buffer Width L	Max. Pool Depth (in)	Pool Habitat Quality
x-1	39.0	12.5	11.5	4.3	4.1	4.6	79.5	SI/S	SI/S	G,C,R	35	50	G	G	100	200	17	Excellent
x-2	41.0	19.3	14.1	3.7	4.7	3.6	60.0	SI/S	SI/S	G,C,S,Cl	38	35	G	G	200	200	24	Fair
x-3	48.0	12.0	10.8	4.9	4.2	5.1	68.0	SI/S	Cl/S	C,G,B,R,S	23	45	G	G	200	200	15	Fair
Average			**12.1**	**4.3**	**4.3**	**4.4**	**69.2**				**32.0**	**43.3**			**166.7**	**200.0**	**18.7**	

[1] Total score interpretation - 42-50 pts. = Excellent, 30-41pts. = Good, 16-29 pts. = Fair, <16 pts. = Poor.

Table 2. Catoctin Creek Tributary RSAT Field Data[1]

Stream: Upper Milltown Creek — Survey Date: 3/9/06 — RSAT Score: 33

Reach: Bollington Road

Transect Number	Top Channel Width (ft)	Bottom Channel Width (ft)	Wetted Perimeter (ft)	Mean Riffle Depth (in)	Mean Bank Height R (ft)	Mean Bank Height L (ft)	Mean bank Stability R & L (%)	Bank Material Type R	Bank Material Type L	Substrate Material Composition	Mean Riffle Embeddedness (%)	Mean Substrate Fouling Level (%)	Riparian Veg. Type R	Riparian Veg. Type L	Buffer Width R	Buffer Width L	Max. Pool Depth (in)	Pool Habitat Quality
x-1	14.0	6.5	6.0	3.0	1.5	1.7	71.5	SI/S	SI/S	G,S,C	75	20	F	G	125	200	23	Good
x-2	17.0	9.8	6.4	3.0	3.0	2.4	75.0	CI/S	SI/S	G,C,S	65	30	F/G	F/G	100	200	18	Fair
x-3	17.5	11.8	11.5	2.5	3.0	1.9	76.0	CI/L	S/SI	G,C,R,S	50	30	F/G	F/G	200	200	26	Very Good
Average	**16.2**	**9.3**	**8.0**	**2.8**	**2.5**	**2.0**	**74.2**				**63.3**	**26.7**			**141.7**	**200.0**	**22.3**	

Stream: Middle Milltown Creek — Survey Date: 3/22/06 — RSAT Score: 36

Reach: Milltown Road

Transect Number	Top Channel Width (ft)	Bottom Channel Width (ft)	Wetted Perimeter (ft)	Mean Riffle Depth (in)	Mean Bank Height R (ft)	Mean Bank Height L (ft)	Mean bank Stability R & L (%)	Bank Material Type R	Bank Material Type L	Substrate Material Composition	Mean Riffle Embeddedness (%)	Mean Substrate Fouling Level (%)	Riparian Veg. Type R	Riparian Veg. Type L	Buffer Width R	Buffer Width L	Max. Pool Depth (in)	Pool Habitat Quality
x-1	69.1	27.0	16.9	3.2	6.0	5.2	68.5	SI/S	L/S	R,C,B,G,Bd	5	20	F	F/G	100	87	36	Very Good
x-2	53.7	40.3	29.7	3.4	4.5	3.5	85.0	L	SI/L	C,G,R,S,B	25	55	F/G	F/G	200	200	21	Very Good
x-3	59.7	41.6	40.2	3.2	3.5	3.5	86.5	SI/S	SI/S	C,R,G,S,B	15	39	F/G	F	200	188	27	Very Good
Average	**60.8**	**36.3**	**28.9**	**3.3**	**4.7**	**4.1**	**80.0**				**15.0**	**38.0**			**166.7**	**158.3**	**28.0**	

Stream: EcoVillage Tributary — Survey Date: 12/28/2005 — RSAT Score: 33

Reach: Taylortown Road

Transect Number	Top Channel Width (ft)	Bottom Channel Width (ft)	Wetted Perimeter (ft)	Mean Riffle Depth (in)	Mean Bank Height R (ft)	Mean Bank Height L (ft)	Mean bank Stability R & L (%)	Bank Material Type R	Bank Material Type L	Substrate Material Composition	Mean Riffle Embeddedness (%)	Mean Substrate Fouling Level (%)	Riparian Veg. Type R	Riparian Veg. Type L	Buffer Width R	Buffer Width L	Max. Pool Depth (in)	Pool Habitat Quality
x-1	38.8	8.9	7.7	3.4	5.3	4.8	84.0	S/L	S/Cl	G,S,R,B,C,B	65	35	F	F	200	200	24	Excellent
x-2	41.4	18.2	10.8	3.2	6.3	5.1	90.0	S/L	S/Cl	S,B,G,C,R	60	25	F	F	200	200	12	Fair
x-3	29.9	15.1	8.3	3.2	4.5	5.7	67.5	S/Cl	SI/S	R,C,G,S,B,B	40	25	G	F	200	200	25	Excellent
Average	**36.7**	**14.0**	**8.9**	**3.3**	**5.4**	**5.2**	**80.5**				**55.0**	**28.3**			**200.0**	**200.0**	**20.3**	

[1] Total score interpretation - 42-50 pts. = Excellent, 30-41pts. = Good, 16-29 pts. = Fair, <16 pts. = Poor.

Table 3. Quarter Branch and Dutchman Creek RSAT Field Data[1]

Stream: Quarter Branch						Survey Date: 12/28/2005					RSAT Score: 34							
Reach: Quarter Branch Road																		
Transect Number	Top Channel Width (ft)	Bottom Channel Width (ft)	Wetted Perimeter (ft)	Mean Riffle Depth (in)	Mean Bank Height R (ft)	Mean Bank Height L (ft)	Mean bank Stability R & L (%)	Bank Material Type R	Bank Material Type L	Substrate Material Composition	Mean Riffle Embeddedness (%)	Mean Substrate Fouling Level (%)	Riparian Veg. Type R	Riparian Veg. Type L	Buffer Width R	Buffer Width L	Max. Pool Depth (in)	Pool Habitat Quality
x-1	41.3	23.8	13.0	4.5	3.7	6.7	68.5	S	S	G,C,S,R,Bd	55	5	F	F	200	200	20	Excellent
x-2	50.6	35.7	24.3	4.0	4.9	4.8	90.0	S/L	S/L	G,S,R,C,Bd	60	5	F	F	200	200	20	Good
x-3	49.0	36.4	28.5	3.2	6.2	4.0	86.5	S/L	S/L	G,S,Bd,R,C	50	5	F	F	200	200	12	Fair
Average	**47.0**	**32.0**	**21.9**	**3.9**	**4.9**	**5.2**	**81.7**				**55.0**	**5.0**			**200.0**	**200.0**	**17.3**	

Stream: Dutchman Creek						Survey Date: 10/28/2005					RSAT Score: 33							
Reach: Dutchman Creek Road																		
Transect Number	Top Channel Width (ft)	Bottom Channel Width (ft)	Wetted Perimeter (ft)	Mean Riffle Depth (in)	Mean Bank Height R (ft)	Mean Bank Height L (ft)	Mean bank Stability R & L (%)	Bank Material Type R	Bank Material Type L	Substrate Material Composition	Mean Riffle Embeddedness (%)	Mean Substrate Fouling Level (%)	Riparian Veg. Type R	Riparian Veg. Type L	Buffer Width R	Buffer Width L	Max. Pool Depth (in)	Pool Habitat Quality
x-1	41.1	31.4	10.2	4.0	4.8	3.6	76.5	Sl/L	S/Cl	C,G,R,B,S	10	10	F	G	200	200	20.4	Good
x-2	56.9	44.1	11.5	3.7	5.0	4.6	75.0	Sl/S	S/Cl	C,G,S,R	25	18	F/G	G	200	200	43.2	Excellent
x-3	45.3	35.8	26.5	4.1	3.6	4.1	94.0	S/Cl	RIP-	R,B,C,G,S	10	65	F	F	125	80	36	Excellent
Average	**47.8**	**37.1**	**16.1**	**3.9**	**4.5**	**4.1**	**81.8**				**15.0**	**31.0**			**175.0**	**160.0**	**33.2**	

[1] Total score interpretation - 42-50 pts. = Excellent, 30-41pts. = Good, 16-29 pts. = Fair, <16 pts. = Poor.

Table 4. Piney Run RSAT Field Data[1]

Stream: Middle Piney Run						Survey Date: 10/19/2005					RSAT Score: 39							
Reach: Arnold Lane																		
Transect Number	Top Channel Width (ft)	Bottom Channel Width (ft)	Wetted Perimeter (ft)	Mean Riffle Depth (in)	Mean Bank Height R (ft)	Mean Bank Height L (ft)	Mean bank Stability R & L (%)	Bank Material Type R	Bank Material Type L	Substrate Material Composition	Mean Riffle Embeddedness (%)	Mean Substrate Fouling Level (%)	Riparian Veg. Type R	Riparian Veg. Type L	Buffer Width R	Buffer Width L	Max. Pool Depth (in)	Pool Habitat Quality
x-1	39.4	19.3	10.5	3.5	3.4	4.5	87.5	SI/S	C/S	C,G,S	48	5	F	F	73	200	12	Good
x-2	22.0	11.4	11.4	3.7	4.4	2.4	91.0	S/SI	SI/S	C,G,S	25	35	F/G	F/G	200	200	22	Fair
x-3	51.5	36.0	35.2	2.0	3.8	3.3	89.0	SI/S	SI/S	S,R,G,B,S	10	25	F	F	200	200	24	Good
Average	**37.6**	**22.2**	**19.0**	**3.1**	**3.9**	**3.4**	**89.2**				**27.7**	**21.7**			**157.7**	**200.0**	**19.3**	

Stream: Piney Run (Lower)						Survey Date: 10/19/2005					RSAT Score: 36							
Reach: Branch River Road																		
Transect Number	Top Channel Width (ft)	Bottom Channel Width (ft)	Wetted Perimeter (ft)	Mean Riffle Depth (in)	Mean Bank Height R (ft)	Mean Bank Height L (ft)	Mean bank Stability R & L (%)	Bank Material Type R	Bank Material Type L	Substrate Material Composition	Mean Riffle Embeddedness (%)	Mean Substrate Fouling Level (%)	Riparian Veg. Type R	Riparian Veg. Type L	Buffer Width R	Buffer Width L	Max. Pool Depth (in)	Pool Habitat Quality
x-1	34.4	25.6	22.2	5.0	3.5	3.4	93.5	RIP-	L	C,R,G,B,S	10	45	F,ROA	F	10	200	12	Good
x-2	33.3	22.1	20.0	2.4	4.3	4.5	75.5	SI	S/Cl	G,S,C,R,B	100	30	F,ROA	F	15	200	18	Excellent
x-3	43.4	22.9	22.9	4.1	3.4	3.0	86.0	L	SI/S	C,R,B,S,G	12	25	G/R	F	20	200	36	Excellent
Average	**37.0**	**23.6**	**21.7**	**3.8**	**3.7**	**3.6**	**85.0**				**40.7**	**33.3**			**15.0**	**200.0**	**22.0**	

[1] Total score interpretation - 42-50 pts. = Excellent, 30-41pts. = Good, 16-29 pts. = Fair, <16 pts. = Poor.

Table 1. Water Quality Summary - Instantaneous Baseflow Water Chemistry (October 2005 - March 2006)

RSAT Stream Segment	Approx. Stream Segment Location	RSAT Survey Date	Water Temp (C)	DO (mg/l)	pH	TDS (mg/l)	Conductivity (ms/cm)	Turbidity (NTU)	Nitrate-Nitrogen (mg/L)	Phosphate (mg/L)	Iron (mg/L)	Copper (mg/L)
Catoctin Creek												
Upper - South Fork	Ketoctin Church Road	2/9/2006	3.1	15.00	7.6	90	0.116	10	2.4	0.54	0.00	0.06
Upper - South Fork	Piggott Bottom Road	2/9/2006	4.2	14.62	8.0	130	0.178	6	2.4	0.45	0.00	0.02
Upper - North Fork	Hillsboro Road	3/9/2006	5.9	12.85	7.8	150	0.124	1	2.7	0.23	0.03	0.15
Average			**4.4**	**14.16**	**7.8**	**123**	**0.139**	**6**	**2.5**	**0.41**	**0.01**	**0.08**
Tributaries to Catoctin Creek												
Upper												
Hamilton Station Road Tributary	Hamilton Station Road	2/28/2006	3.8	14.59	7.1	160	0.223	0	4.5	0.01	0.09	0.11
Talbot Farms Tributary	Clarkes Gap Road	2/28/2006	5.3	13.92	7.2	100	0.138	0	1.8	0.33	0.10	0.13
Average			**4.6**	**14.26**	**7.2**	**130**	**0.181**	**0**	**3.2**	**0.17**	**0.10**	**0.12**
Middle												
Clover Mill Road Tributary	Clover Mill Road	3/29/2006	9.9	11.44	7.0	50	0.148	2	2.5	0.30	0.30	0.17
Richard Creek (Upper Brens Creek)	Purcellville Road	3/22/2006	9.0	11.67	7.0	50	0.127	2	3.1	0.40	0.15	0.09
Brens Creek	Ash George Road	2/10/2006	2.8	15.01	7.6	120	0.149	3	2.6	0.29	0.13	0.12
Average			**7.2**	**12.71**	**7.2**	**73**	**0.141**	**2**	**2.7**	**0.33**	**0.19**	**0.13**
Lower												
Upper Milltown Creek	Bolington Road	3/9/2006	9.4	12.18	7.6	60	0.099	0	2.2	0.12	0.09	0.11
Middle Milltown Creek	Milltown Road	3/22/2006	4.2	13.28	6.8	50	0.140	0	1.6	0.54	0.04	0.15
Ecovillage Trib.	Taylortown Road	12/28/2005	6.4	12.57	8.6	110	0.162	0	3.7	0.32	0.07	0.17
Average			**6.7**	**12.68**	**7.7**	**73**	**0.134**	**0**	**2.5**	**0.33**	**0.07**	**0.14**
Piney Run												
Middle - Piney Run	Arnold Lane	10/19/2005	11.5	7.05	8.9	80	0.142	0	0.3	0.08	0.05	0.11
Lower - Piney Run	Branch River Road	10/19/2005	14.7	7.56	8.5	80	0.133	0	2.8	0.21	0.13	0.21
Average			**13.1**	**7.31**	**8.7**	**80**	**0.138**	**0**	**1.6**	**0.15**	**0.09**	**0.16**
Dutchman Creek												
Middle Dutchman Creek	Dutchman Creek Road	10/28/2005	10.1	11.60	8.7	90	0.141	3	2.7	0.53	0.00	0.06
Quarter Branch												
Quarter Branch	Quarter Branch Road	12/28/2005	2.9	14.48	9.4	120	0.165	3	4.0	0.19	0.04	0.67
Clarks Run												
Clarks Run	Saint Clair Lane	12/23/2005	3.1	12.83	9.5	240	0.311	9	3.8	0.06	0.00	0.03
Average			**6.6**	**12.54**	**8.0**	**105**	**0.156**	**2**	**2.7**	**0.29**	**0.08**	**0.15**

Table 1. Modified Rosgen Level I and II - Stream Channel Morphology Characterization Results

RSAT Stream Segment	Approx. Stream Segment Location	Drainage Area (mi^2)	Stream Order	Surveyed Stream Length	Stream Gradient	Entrenchment Ratio[1]	Width/ Depth Ratio[2]	Sinuosity[3]	RSAT Segment Slope (%)[4]	Common Channel Material	Stream Type Classification	
Clarks Run												
Clarks Run	Saint Clair Lane	5.2	2	2,345	0.43%	1.12	21.9	1.1	0.43%	Cobble	F	F3
Catoctin Creek												
Upper - South Fork	Ketoctin Church Road	1.1	2	962	0.52%	1.10	13.3	1.2	0.52%	Cobble	F	F3
Upper - South Fork	Piggott Bottom Road	15.7	3	1,396	0.36%	1.27	18.1	1.2	0.36%	Gravel	F	F4
Upper - North Fork	Hillsboro Road	14.6	3	1,628	1.23%	1.40	19.3	1.1	1.23%	Cobble	B	B3
Total		**92.4**		**3,986**								
Tributaries to Catoctin Creek												
Upper												
Hamilton Station Road Tributary	Hamilton Station Road	2.1	1	3,170	0.63%	1.19	20.7	1.3	0.63%	Gravel	F	F4
Talbot Farms Tributary	Clarkes Gap Road	3.5	2	3,094	0.97%	1.30	14.8	1.2	0.97%	Gravel	F	F4
Middle												
Clover Mill Road Tributary	Clover Mill Road	1.6	1	1,312	1.14%	1.23	15.4	1.1	1.14%	Gravel	F	F4
Richard Creek (Upper Brens Creek)	Purcellville Road	4.0	2	1,273	1.18%	1.19	12.2	1.3	1.18%	Sand	F	F5
Brens Creek	Ash George Road	8.4	2	1,496	0.33%	1.50	15.2	1.2	0.33%	Gravel	B	B4
Lower												
Upper Milltown Creek	Bolington Road	3.4	2	1,820	0.55%	1.18	13.7	1.3	0.55%	Sand	F	F5
Middle Milltown Creek	Milltown Road	6.5	2	1,494	2.01%	1.13	38.6	1.0	2.01%	Cobble	F	F3
EcoVillage Trib.	Taylortown Road	1.1	1	2,241	1.12%	1.20	14.9	1.6	1.12%	Cobble	F	F3
Quarter Branch												
Quarter Branch	Quarter Branch Road	2.7	2	1,871	1.34%	1.08	32.3	1.0	1.34%	Bedrock	F	F2
Dutchman Creek												
Middle - Dutchman Creek	Dutchman Creek Road	2.5	3	1,343	0.74%	1.08	31.6	1.0	0.74%	Gravel	F	F4
Piney Run												
Middle - Piney Run	Arnold Lane	8.3	2	1,692	0.59%	1.13	33.8	1.1	0.59%	Cobble	F	F3
Lower - Piney Run	Branch River Road	13.8	2	1,063	0.47%	2.00	27.8	1.0	0.47%	Cobble	B	B3
Total		**14.9**		**2,755**								

[1] Entrenched = <1.4; Moderately Entrenched = 1.4 – 2.2; Slightly Entrenched = > 2.2
[2] Width /Depth Ratio Interpretation: Very Low to Low = < 12; Moderate to High = > 12; Very High = > 40
[3] Sinuosity Interpretation: Low = < 1.2; Moderate to High = > 1.2; Very High = > 1.5
[4] Channel slope calculated from reach riffle-to-riffle measurements (Rosgen, 1996).

Table 1. Clarks Run - Macroinvertebrate Functional Feeding Group[1] and Pollution Tolerance Values[2]

Order	Taxa	Common Name	Tolerance Alpha	Feeding Functional Groups
Plecoptera	1. Allocapnia sp.	Stonefly	A/B	Shredder
	2. Paracapnia sp.	Stonefly	A	Shredder
	3. Perlidae	Stonefly	A	Predator
Ephemeroptera	4. Baetis sp.	Mayfly	B	Collector
	5. Caenis sp.	Mayfly	B/C	Collector
	6. Centroptilum sp.	Mayfly	A/B	Collector
	7. Ephemerellidae	Mayfly	A	Collector
	8. Euryophella sp.	Mayfly	B	Scraper
	9. Leptophlebiidae	Mayfly	A/B	Collector
	10. Paraleptophlebia sp.	Mayfly	A/B	Collector
	11. Stenonema sp.	Mayfly	B	Scraper
Trichoptera	12. Cheumatopsyche sp.	Caddisfly	B	Filterer
	13. Chimarra sp.	Caddisfly	B	Filterer
	14. Cyrnellus sp.	Caddisfly	B/C	Filterer
	15. Hydatophylax sp.	Caddisfly	A/B	Shredder
	16. Hydropsyche sp.	Caddisfly	B	Filterer
	17. Ptilostomis sp.	Caddisfly	B	Shredder
Anisoptera	18. Boyeria sp.	Dragonfly	A/B	Predator
Zygoptera	19. Argia sp.	Dragonfly	B/C	Predator
	20. Calopteryx sp.	Damselfly	B	Predator
Coleoptera	21. Peltodytes sp.	Crawling Water Beetle	B	Shredder
	22. Psephenus sp.	Water Penny	B	Scraper
	23. Stenelmis sp.	Riffle Beetle	B	Scraper
Diptera	24. Antocha sp.	Cranefly	B	Collector
	25. Chironomini	Midge	B	Collector
	26. Orthocladinae	Midge	B	Collector
	27. Simulium sp.	Blackfly	B/C	Filterer
	28. Tabanus sp.	Horsefly	B	Predator
	29. Tanypodinae	Midge	B	Predator
	30. Tanytarsini	Midge	B	Collector
	31. Tipula sp.	Cranefly	B	Shredder
Lepidoptera	32. Lepidoptera	Aquatic Butterfly	B	Shredder
Decapoda	33. Cambaridae	Crayfish	B	Shredder
Amphipoda	34. Gammarus sp.	Scud	B	Shredder
Isopoda	35. Asellidae	Sowbug	B/C	Collector
Gastropoda	36. Ancylidae	Limpet	B/C	Scraper
	37. Physella sp.	Snail	B/C	Scraper
Hirudinea	38. Hirudinea	Leech	C	Predator
Oligochaeta	39. Oligochaeta	Aquatic Worm	B/C	Collector

[1] A number assigned to an individual or its group describing the degree to which that individual or group tolerates organic pollution.
[2] Feeding adaptations that classify the nutritional processing method performed by different aquatic insects (Merritt and Cummins, 1984).

Table 2. Clarks Run - Macroinvertebrate RSAT Voucher Collection - Relative Abundance [1]

Order	Taxa	Pollution Tolerance Value[2]	Clarks Run
Plecoptera	Allocapnia sp.	A/B	1.7
	Paracapnia sp.	A	1.7
Ephemeroptera	Caenis sp.	B/C	1.0
	Centroptilum sp.	A/B	1.7
	Ephemerellidae	A	1.0
	Paraleptophlebia sp.	A/B	1.0
	Stenonema sp.	B	1.7
Trichoptera	Cheumatopsyche sp.	B	1.0
	Chimarra sp.	B	1.0
	Cyrnellus sp.	B/C	1.0
	Hydatophylax sp.	A/B	1.7
	Hydropsyche sp.	B	1.0
	Ptilostomis sp.	B	1.0
Zygoptera	Calopteryx sp.	B	1.0
Coleoptera	Psephenus sp.	B	1.0
Diptera	Antocha sp.	B	3.0
	Chironomini	B	1.0
	Orthocladinae	B	1.0
	Tabanus sp.	B	1.0
	Tipula sp.	B	3.0
Decapoda	Cambaridae	B	1.0
Amphipoda	Gammarus sp.	B	2.0
Isopoda	Asellidae	B/C	1.0
Gastropoda	Ancylidae	B/C	1.0
	Physella sp.	B/C	1.0
Hirudinea	Hirudinea	C	1.5
Oligochaeta	Oligochaeta	B/C	1.0
Total Taxa[3]			**27**

[1] Relative abundance scores were averaged for each mainstem reach. Relative abundance interpretation: 0.1-0.9 = Scarce, 1.0-2.0 = Scarce/Common, 2.1-3.0 = Common, 3.1-4.0 = Common/Abundant, > 4.0 = Abundant.

[2] Pollution Tolerance Rating: A = Intolerant, B = Moderately Tolerant, C = Tolerant.

[3] Taxa Richness Interpretation: >=25 = Excellent, 16-24 = Good, 8-15 = Fair, <8 = Poor.

Table 3. Clarks Run - Macroinvertebrate 1m² Collection - Number of Individuals

Order	Taxa	Tolerance Alpha	Total Number of Individuals
Plecoptera	1. Perlidae	A	1
Ephemeroptera	2. Baetis sp.	B	108
	3. Caenis sp.	B/C	2
	4. Euryophella sp.	B	22
	5. Leptophlebiidae	A/B	2
	6. Stenonema sp.	B	8
Trichoptera	7. Cheumatopsyche sp.	B	1
	8. Hydropsyche sp.	B	3
Anisoptera	9. Boyeria sp.	A/B	2
Zygoptera	10. Argia sp.	B/C	2
	11. Calopteryx sp.	B	4
Coleoptera	12. Peltodytes sp.	B	3
	13. Stenelmis sp.	B	19
Diptera	14. Chironomini	B	2
	15. Orthocladinae	B	30
	16. Simulium sp.	B/C	12
	17. Tanypodinae	B	4
	18. Tanytarsini	B	6
Lepidoptera	19. Lepidoptera	B	1
Amphipoda	20. Gammarus sp.	B	76
Oligochaeta	21. Oligochaeta	B/C	5
Total Taxa			**313**

[1] Pollution Tolerance Rating: A = Intolerant, B = Moderately Tolerant, C = Tolerant.
Note: a blank cell indicates the macroinvertebrate group was not found during the 1m² sampling.

Table 4. Catoctin Creek and Tributaries - Macroinvertebrate Functional Feeding Group[1] and Pollution Tolerance Values[2]

Order	Family	Taxa	Common Name	Tolerance Alpha	Feeding Functional Groups
Plecoptera	Capniidae	1. Allocapnia sp.	Stonefly	A/B	Shredder
		2. Capnia sp.	Stonefly	A	Shredder
		3. Unknown	Stonefly	A	Shredder
	Nemouridae	4. Amphinemoura sp.	Stonefly	A/B	Shredder
		5. Nemoura sp.	Stonefly	A	Shredder
		6. Unknown	Stonefly	A/B	Shredder
		7. Prostoia sp.	Stonefly	B	Shredder
		8. Shipsa rotunda	Stonefly	A	Shredder
	Perlidae	9. Acronueria sp.	Stonefly	A	Predator
		10. Agnetina sp.	Stonefly	A	Predator
		11. Eccoptura sp.	Stonefly	A/B	Predator
		12. Ostrocerca sp.	Stonefly	A/B	Shredder
		13. Perlesta sp.	Stonefly	B	Predator
		14. Unknown	Stonefly	A	Predator
		15. Unknown	Stonefly	A	Predator
	Perlodidae	16. Clioperla sp.	Stonefly	A	Predator
		17. Isoperla sp.	Stonefly	A/B	Predator
		18. Unknown	Stonefly	A	Predator
	Taeniopterygidae	19. Taenionema sp.	Stonefly	A/B	Shredder
		20. Taeniopteryx sp.	Stonefly	A/B	Shredder
Ephemeroptera	Ameletidae	21. Ameletus sp.	Mayfly	A	Collector
	Baetidae	22. Acentrella sp.	Mayfly	B	Collector
		23. Acerpenna sp.	Mayfly	B	Collector
		24. Unknown	Mayfly	B	Collector
		25. Baetis sp.	Mayfly	B	Collector
		26. Centroptilum sp.	Mayfly	A/B	Collector
	Caenidae	27. Caenis sp.	Mayfly	B/C	Collector
	Ephemerellidae	28. Attenella sp.	Mayfly	A/B	Collector
		29. Ephemerella sp.	Mayfly	A/B	Collector
		30. Eurylophella sp.	Mayfly	B	Scraper
		31. Timpanoga sp.	Mayfly	A/B	Collector
		32. Serratella sp.	Mayfly	A/B	Collector
	Ephemeridae	33. Ephemera sp.	Mayfly	A/B	Collector
	Heptageniidae	34. Leucrocuta sp.	Mayfly	A	Scraper
		35. Stenacron sp.	Mayfly	B	Scraper
		36. Stenonema sp.	Mayfly	B	Scraper
	Isonychiidae	37. Isonychia sp.	Mayfly	A/B	Filterer
	Leptophlebiidae	38. Habrophlebiodes sp.	Mayfly	B	Collector
		39. Leptophlebia sp.	Mayfly	B	Collector
		40. Paraleptophlebia sp.	Mayfly	A/B	Collector
Trichoptera	Glossosomatidae	41. Glossosomma sp.	Caddisfly	A	Scraper
	Hydropsychidae	42. Cheumatopsyche sp.	Caddisfly	B	Filterer
		43. Diplectrona sp.	Caddisfly	A/B	Filterer
		44. Hydropsyche sp.	Caddisfly	B	Filterer
	Leptoceridae	45. Triaenodes sp.	Caddisfly	B	Shredder
	Limnephilidae	46. Hydatophylax sp.	Caddisfly	A/B	Shredder
		47. Ironoquia sp.	Caddisfly	A/B	Shredder
	Philopotamidae	48. Chimarra sp.	Caddisfly	B	Filterer
		49. Dolophilodes sp.	Caddisfly	A	Filterer
		50. Wormaldia sp.	Caddisfly	A	Collector, Filterer
	Phryganidae	51. Ptilostomis sp.	Caddisfly	B	Shredder
	Polycentropodidae	52. Polycentropus sp.	Caddisfly	B	Filterer
	Uenoidae	53. Neophylax sp.	Caddisfly	A/B	Scraper

[1] A number assigned to an individual or its group describing the degree to which that individual or group tolerates organic pollution.
[2] Feeding adaptations that classify the nutritional processing method performed by different aquatic insects (Merritt and Cummins, 1984).

Table 4. Catoctin Creek and Tributaries- Macroinvertebrate Functional Feeding Group[1] and Pollution Tolerance Values[2] Cont'd

Order	Family	Taxa	Common Name	Tolerance Alpha	Feeding Functional Groups
Megaloptera	Corydalidae	54. Corydalus sp.	Dobsonfly	B	Predator
		55. Nigronia sp.	Alderfly	B	Predator
Anisoptera	Aeshnidae	56. Boyeria sp.	Dragonfly	A/B	Predator
		57. Epiaeschna sp.	Dragonfly	A/B	Predator
	Gomphidae	58. Dromogomphus sp.	Dragonfly	B	Predator
		59. Gomphus sp.	Dragonfly	B	Predator
		60. Hagenius sp.	Dragonfly	B	Predator
		61. Stylogomphus sp.	Dragonfly	A	Predator
Zygoptera	Calopterygidae	62. Calopteryx sp.	Damselfly	B	Predator
	Coenagrionidae	63. Argia sp.	Damselfly	B/C	Predator
		64. Unknown	Damselfly	B/C	Predator
		65. Enallagma sp.	Damselfly	B/C	Predator
	Lestidae	66. Lestes sp.	Damselfly	C	Predator
Coleoptera	Dryopidae	67. Helichus sp.	Beetle	B	Scraper
	Dytiscidae	68. Dytiscus sp.	Beetle	B	Predator
		69. Hydaticus sp.	Beetle	B	Predator
		70. Hydroporus sp.	Beetle	B	Predator
		71. Hydrovatus sp.	Beetle	B	Predator
	Elmidae	72. Dubiraphia sp.	Riffle Beetle	B	Scraper
		73. Gonielmis sp.	Riffle Beetle	B	Scraper
		74. Macronychus sp.	Riffle Beetle	B	Scraper
		75. Optioservus sp.	Riffle Beetle	B	Scraper
		76. Oulimnius sp.	Riffle Beetle	A/B	Scraper
		77. Stenelmis sp.	Riffle Beetle	B	Scraper
	Gyrinidae	78. Dineutus sp.	Whirligig Beetles	B	Predator
		79. Gyrinus sp.	Whirligig Beetles	B	Predator
	Haliplidae	80. Peltodytes sp.	Crawling Water Beetle	B	Shredder
	Hydrophilidae	81. Dibolocelus sp.	Beetle	B	Collector
		82. Hydrophilus sp.	Beetle	B	Collector
	Psephenidae	83. Psephenus sp.	Water Penny	B	Scraper
	Staphylinidae	84. Unknown	Beetle	B	Collector
	(blank)	85. Unknown	Beetle	B	Predator
Diptera	Ceratopogonidae	86. Bezzia sp.	Biting Midges	B	Predator
		87. Ceratopogonodae	Biting Midges	B	Predator
		88. Culicoides sp.	Biting Midges	C	Predator
	Chironomidae	89. Chironomini	Midge	B	Collector
		90. Diamesinae	Midge	B	Collector
		91. Orthocladiinae	Midge	B	Collector
		92. Tanypodinae	Midge	B	Predator
		93. Tanytarsini	Midge	B	Collector
	Culicidae	94. Anopheles sp.	Mosquito	C	Collector
	Dixidae	95. Dixella sp.	Midges	B/C	Collector
	Empididae	96. Hemerodromia sp.	Daggerfly	B	Predator
	Muscidae	97. Unknown	Fly	B/C	Predator
	Simuliidae	98. Prosimulium sp.	Blackfly	B/C	Filterer
		99. Simulium sp.	Blackfly	B/C	Filterer
	Tabanidae	100. Chrysops sp.	Horsefly	B/C	Predator
		101. Tabanus sp.	Horsefly	B	Predator
	Tipulidae	102. Antocha sp.	Cranefly	B	Collector
		103. Dicranota sp.	Cranefly	B	Predator
		104. Dicranota sp.	Cranefly	B	Predator
		105. Hexatoma sp.	Cranefly	B	Predator
		106. Leptotarsus sp.	Cranefly	B	Shredder

[1] A number assigned to an individual or its group describing the degree to which that individual or group tolerates organic pollution.
[2] Feeding adaptations that classify the nutritional processing method performed by different aquatic insects (Merritt and Cummins, 1984).

Table 4. Catoctin Creek and Tributaries- Macroinvertebrate Functional Feeding Group[1] and Pollution Tolerance Values[2] Cont'd

Order	Family	Taxa	Common Name	Tolerance Alpha	Feeding Functional Groups
		107. Pedicia sp.	Cranefly	B	Shredder
		108. Tipula sp.	Cranefly	B	Shredder
Lepidoptera	Unknown	109. Unknown	Aquatic Butterfly	B	Shredder
Hemiptera	Corixidae	110. Corixidae	Water Boatman	B	Predator
		111. Hesperocorixa sp.	Beetle	B	Predator
	Gerridae	112. Gerris sp.	Water Strider	B	Predator
	Velidae	113. Microvelia sp.	Water Strider	B	Predator
Decapoda	Cambaridae	114. Unknown	Crayfish	B	Shredder
		115. Orconectes sp.	Crayfish	B	Shredder
Gastropoda	Ancylidae	116. Unknown	Limpet	B/C	Scraper
	Physidae	117. Physella sp.	Snail	B/C	Scraper
	Planorbidae	118. Unknown	Snail	B/C	Scraper
Hirudinea	Hirudinea	119. Unknown	Leech	C	Predator
Oligochaeta	Oligochaeta	120. Unknown	Aquatic Worm	B/C	Collector
Pelecyoda	Sphaeriidae	121. Unknown	Clam	B/C	Filterer
	Unionidae	122. Unknown	Clam	B/C	Predator
Nematomorpha	Nematomorpha	123. Unknown	Horse Hair	C	Collector
Amphipoda	Gammaridae	124. Unknown	Scud	B	Shredder
		125. Gammarus sp.	Scud	B	Shredder

[1] A number assigned to an individual or its group describing the degree to which that individual or group tolerates organic pollution.
[2] Feeding adaptations that classify the nutritional processing method performed by different aquatic insects (Merritt and Cummins, 1984).

Table 5. Catoctin Creek and Tributaries - Macroinvertebrate RSAT Voucher Collection - Relative Abundance [1]

Order	Taxa	Pollution Tolerance Value[2]	Catoctin Creek										
			Mainstem			Tributaries							
			South Fork		North Fork	Hamilton Station Tributary	Talbot Farm Tributary	Clover Mill Road Tributary	Richard Creek	Brens Creek	Milltown Creek		EcoVillage Tributary
			Ketoctin Church Road	Piggott Bottom Road	Hillsboro Road	Hamilton Station Road	Clarks Gap Road	Clover Mill Road	Purcellville Road	Ash George Road	Milltown Road	Bolington Road	Taylortown Road
			2/9/2006	2/9/2006	3/9/2006	2/28/2006	2/28/2006	3/29/2006	3/22/2006	2/10/2006	3/9/2006	3/9/2006	12/28/2005
Plecoptera	Acronueria sp.	A						1.0				1.0	
	Allocapnia sp.	A/B	3.5		1.0	1.0				2.7	2.0		2.3
	Amphinemoura sp.	A/B										1.0	
	Capnia sp.	A				1.0							
	Clioperla sp.	A	1.0		1.0								
	Eccoptura sp.	A/B	1.0								2.0		2.0
	Nemoura sp.	A							1.0				
	Nemouridae	A/B	1.0										
	Ostrocerca sp.	A/B	1.0		1.0								
	Perlodidae	A					1.0						
	Prostoia sp.	B				1.0				2.7		1.0	
	Shipsa rotunda	A										1.0	
	Taenionema sp.	A/B	2.5		1.0	1.0				2.7	1.0	1.0	
	Taeniopteryx sp.	A/B	1.0							2.7			1.0
Ephemeroptera	Acerpenna sp.	B									1.0	1.0	
	Ameletus sp.	A					1.0		1.0				1.0
	Attenella sp.	A/B							1.0				
	Baetidae	B						1.0	1.0		1.0		
	Baetis sp.	B	1.0									1.0	
	Caenis sp.	B/C		1.0		1.0		1.0	2.0			1.0	1.0
	Centroptilum sp.	A/B				1.0	1.0						
	Ephemera sp.	A/B								1.0			
	Ephemerella sp.	A/B			1.0		1.5	1.0		1.3	1.0	1.0	
	Eurylophella sp.	B					1.0				1.3		1.0
	Isonychia sp.	A/B	1.0		1.0	2.5		1.0		1.0		1.0	
	Leptophlebia sp.	B	1.0						1.0				1.0
	Paraleptophlebia sp.	A/B									1.0		
	Stenacron sp.	B					1.0						
	Stenonema sp.	B	1.0	1.0	2.3	1.0	1.7	2.3	1.0	2.3	1.5	1.0	1.0
	Timpanoga sp.	A/B				1.0							

[1] Relative abundance scores were averaged for each mainstem reach. Relative abundance interpretation: 0.1-0.9 = Scarce, 1.0-2.0 = Scarce/Common, 2.1-3.0 = Common, 3.1-4.0 = Common/Abundant, > 4.0 = Abundant.

[2] Pollution Tolerance Rating: A = Intolerant, B = Moderately Tolerant, C = Tolerant.

Table 5. Catoctin Creek and Tributaries- Macroinvertebrate RSAT Voucher Collection - Relative Abundance [1] Cont'd

Order	Taxa	Pollution Tolerance Value[2]	Catoctin Creek										
			Mainstem			Tributaries							
			South Fork		North Fork	Hamilton Station Tributary	Talbot Farm Tributary	Clover Mill Road Tributary	Richard Creek	Brens Creek	Milltown Creek		EcoVillage Tributary
			Ketoctin Church Road	Piggott Bottom Road	Hillsboro Road	Hamilton Station Road	Clarks Gap Road	Clover Mill Road	Purcellville Road	Ash George Road	Milltown Road	Bolington Road	Taylortown Road
			2/9/2006	2/9/2006	3/9/2006	2/28/2006	2/28/2006	3/29/2006	3/22/2006	2/10/2006	3/9/2006	3/9/2006	12/28/2005
Trichoptera	Cheumatopsyche sp.	B	1.5	1.0	2.0	3.5	1.0	2.3	1.0	1.0	1.7	1.0	1.0
	Chimarra sp.	B	1.0		2.0	1.0	4.0	1.0	2.0	2.3	1.7	2.0	1.0
	Diplectrona sp.	A/B										1.0	1.0
	Glossosomma sp.	A			1.0								
	Hydatophylax sp.	A/B	1.5							1.0	1.0		
	Hydropsyche sp.	B		1.0	1.0	3.5	1.0	2.3	1.0	2.3	1.0	1.0	
	Ironoquia sp.	A/B							1.0				
	Neophylax sp.	A/B	1.5		1.7	1.0	1.0	1.0	2.0	2.7	2.0	1.7	1.0
	Polycentropus sp.	B										1.0	1.0
	Ptilostomis sp.	B	1.0	1.0			1.0				1.0		1.0
Megaloptera	Corydalus sp.	B			1.0			1.0		1.0	1.0	1.0	
	Nigronia sp.	B				1.0						1.0	
Anisoptera	Boyeria sp.	A/B	1.0										
	Dromogomphus sp.	B								1.0			
	Epiaeschna sp.	A/B								1.0			
	Gomphus sp.	B		1.0									
	Hagenius sp.	B			1.0								
	Stylogomphus sp.	A	1.0			1.0			1.0				
Zygoptera	Argia sp.	B/C					1.0						
	Calopteryx sp.	B		1.0			1.0	1.0	1.0		1.0		
	Coenagrionidae	B/C	1.0				1.0						
	Lestes sp.	C							1.0				
Coleoptera	Dibolocelus sp.	B					1.0						
	Dytiscus sp.	B										1.0	
	Helichus sp.	B		1.0									
	Hydrophilus sp.	B				1.0							
	Hydrovatus sp.	B					1.0						
	Optioservus sp.	B			1.0	1.0					1.0	1.0	
	Oulimnius sp.	A/B					1.0						
	Peltodytes sp.	B				1.0	1.0		1.0				

[1] Relative abundance scores were averaged for each mainstem reach. Relative abundance interpretation: 0.1-0.9 = Scarce, 1.0-2.0 = Scarce/Common, 2.1-3.0 = Common, 3.1-4.0 = Common/Abundant, > 4.0 = Abundant.

[2] Pollution Tolerance Rating: A = Intolerant, B = Moderately Tolerant, C = Tolerant.

Table 5. Catoctin Creek and Tributaries- Macroinvertebrate RSAT Voucher Collection - Relative Abundance [1] Cont'd

Order	Taxa	Pollution Tolerance Value[2]	Catoctin Creek										
			Mainstem			Tributaries							
			South Fork		North Fork	Hamilton Station Tributary	Talbot Farm Tributary	Clover Mill Road Tributary	Richard Creek	Brens Creek	Milltown Creek		EcoVillage Tributary
			Ketoctin Church Road	Piggott Bottom Road	Hillsboro Road	Hamilton Station Road	Clarks Gap Road	Clover Mill Road	Purcellville Road	Ash George Road	Milltown Road	Bolington Road	Taylortown Road
			2/9/2006	2/9/2006	3/9/2006	2/28/2006	2/28/2006	3/29/2006	3/22/2006	2/10/2006	3/9/2006	3/9/2006	12/28/2005
	Psephenus sp.	B	1.0		1.0	1.0	1.3	1.0	1.0	1.0	2.0	1.0	1.0
	Stenelmis sp.	B				1.0	1.3	2.3	1.0	1.0	1.0	1.0	
Diptera	Antocha sp.	B				1.0	1.0						
	Chironomini	B	1.5	1.0	1.0	1.0	3.0		3.0		1.0		1.0
	Chrysops sp.	B/C			1.0								
	Diamesinae	B			1.0					1.0			
	Dicranota sp.	B				2.0							
	Dicranota sp.	B							1.0				
	Hexatoma sp.	B	1.0				1.0	3.0	1.0			1.0	
	Leptotarsus sp.	B	1.0										
	Orthocladiinae	B	1.5	2.0	2.0	4.0	3.0	4.0	1.0	3.0	3.0	1.3	1.0
	Prosimulium sp.	B/C	1.0		1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
	Tabanus sp.	B								1.0			
	Tanypodinae	B			1.0		1.0				1.0		
	Tipula sp.	B		1.0		1.0		1.0				1.0	1.0
Lepidoptera	Lepidoptera	B						1.0					
Hemiptera	Corixidae	B		1.0									
	Hesperocorixa sp.	B				1.0							
Decapoda	Orconectes sp.	B							1.0				
Amphipoda	Gammaridae	B										1.5	
	Gammarus sp.	B								1.3	1.0		
Pelecyoda	Sphaeriidae	B/C	1.0	1.0						1.0		1.0	
Gastropoda	Ancylidae	B/C					1.0						1.0
	Physella sp.	B/C				1.0	1.0			1.0		1.0	1.0
Hirudinea	Hirudinea	C		1.0			1.0	1.0	1.0	2.3	1.0		
Oligochaeta	Oligochaeta	B/C							1.0			1.0	
Total Taxa[3]			26	14	22	28	30	20	26	26	26	31	20

[1] Relative abundance scores were averaged for each mainstem reach. Relative abundance interpretation: 0.1-0.9 = Scarce, 1.0-2.0 = Scarce/Common, 2.1-3.0 = Common, 3.1-4.0 = Common/Abundant, > 4.0 = Abundant.

[2] Pollution Tolerance Rating: A = Intolerant, B = Moderately Tolerant, C = Tolerant.

[3] Taxa Richness Interpretation: >=25 = Excellent, 16-24 = Good, 8-15 = Fair, <8 = Poor.

Table 6. Catoctin Creek and Tributaries - Macroinvertebrate 1m² Collection - Number of Individuals

			Catoctin Creek										
			Mainstem			Tributaries							
			South Fork		North Fork	Hamilton Station Tributary	Talbot Farm Tributary	Clover Mill Road Tributary	Richard Creek	Brens Creek	Milltown Creek		EcoVillage Tributary
			Ketoctin Church Road	Piggott Bottom Road	Hillsboro Road	Hamilton Station Road	Clarks Gap Road	Clover Mill Road	Purcellville Road	Ash George Road	Milltown Road	Bolington Road	Taylortown Road
Order	Taxa	Tolerance Alpha	4/21/2005	4/21/2005	4/21/2005	5/6/2005	5/6/2005	6/10/2005	6/2/2005	5/11/2005	6/6/2005	5/11/2005	6/10/2005
Plecoptera	Acronueria sp.	A	1										
	Agnetina sp.	A									34		3
	Allocapnia sp.	A/B			2								
	Amphinemoura sp.	A/B	1			11	4					6	
	Capniidae	A					2						1
	Clioperla sp.	A			1								
	Eccoptura sp.	A/B	1			1							2
	Isoperla sp.	A/B	1			2	2			1	2		
	Ostrocerca sp.	A/B			3								
	Perlesta sp.	B							6	23	17	7	
	Perlidae	A				3						4	
	Perlidae	A	2										
	Taenionema sp.	A/B			3								
Ephemeroptera	Acentrella sp.	B									1		5
	Baetis sp.	B	1			56	18	8		82	32	94	49
	Caenis sp.	B/C	6		1	7	2			27	2	8	1
	Ephemerella sp.	A/B	2		22	3				1		12	
	Eurylophella sp.	B		1		13	16			3		3	6
	Habrophlebiodes sp.	B				11	2						19
	Isonychia sp.	A/B	8		8	1		36		2		4	
	Leucrocuta sp.	A										9	4
	Paraleptophlebia sp.	A/B		1		3				1	11	2	76
	Stenacron sp.	B				1				1		3	4
	Stenonema sp.	B	24		18	11	5	6	4	6	24	23	28
	Timpanoga sp.	A/B									1		
	Serratella sp.	A/B				8	14	1		45	10	12	2
Trichoptera	Cheumatopsyche sp.	B	10	18	6	5	12	267	112	8	83	4	37
	Chimarra sp.	B	6	3	6	2	4	5	3	38	1	8	2
	Diplectrona sp.	A/B								1			2
	Dolophilodes sp.	A				7							8
	Glossosomma sp.	A			1						2		3
	Hydatophylax sp.	A/B					1			1			
	Hydropsyche sp.	B	11	10	2	9	23	24		20	33	4	3

[1] Pollution Tolerance Rating: A = Intolerant, B = Moderately Tolerant, C = Tolerant.
Note: a blank cell indicates the macroinvertebrate group was not found during the 1m² sampling.

Table 6. Catoctin Creek and Tributaries - Macroinvertebrate 1m² Collection - Number of Individuals Cont'd

Order	Taxa	Pollution Tolerance Value	Catoctin Creek										
			Mainstem			Tributaries							
			South Fork		North Fork	Hamilton Station Tributary	Talbot Farm Tributary	Clover Mill Road Tributary	Richard Creek	Brens Creek	Milltown Creek		EcoVillage Tributary
			Ketoctin Church Road	Piggott Bottom Road	Hillsboro Road	Hamilton Station Road	Clarks Gap Road	Clover Mill Road	Purcellville Road	Ash George Road	Milltown Road	Bolington Road	Taylortown Road
			4/21/2005	4/21/2005	4/21/2005	5/6/2005	5/6/2005	6/10/2005	6/2/2005	5/11/2005	6/6/2005	5/11/2005	6/10/2005
	Ironoquia sp.	A/B				1	1						
	Neophylax sp.	A/B	4		6	18	7				3	1	
	Triaenodes sp.	B									1	2	
	Wormaldia sp.	A										1	
Megaloptera	Corydalus sp.	B			1			1					
	Nigronia sp.	B	2		1								
Anisoptera	Boyeria sp.	A/B		2		1	2		3	1	1	1	
	Gomphus sp.	B		1	1				2				
	Hagenius sp.	B			1				1				
	Stylogomphus sp.	A	1										
Zygoptera	Argia sp.	B/C	1						4		1	1	
	Calopteryx sp.	B		3		11	4	3	7	6	6		10
	Enallagma sp.	B/C		2				1					
Coleoptera	Coleoptera	B				1							
	Dineutus sp.	B					1		43				
	Dubiraphia sp.	B									2		
	Gonielmis sp.	B				1				3	1	6	1
	Gyrinus sp.	B						2					
	Helichus sp.	B	2	1					3		1	1	
	Hydaticus sp.	B				1	1	1					
	Hydroporus sp.	B					1		1			1	4
	Macronychus sp.	B		4		1		1	20	5	10	1	
	Optioservus sp.	B	1		3	2				3			
	Psephenus sp.	B	22		2	3	8	2		6	2	8	19
	Staphylinidae	B						1					
	Stenelmis sp.	B	13	26	1	31	12	19	22	13	42	28	25
Diptera	Anopheles sp.	C											1
	Antocha sp.	B			1		3	6	5		3		
	Bezzia sp.	B									2		
	Ceratopogonodae	B										1	
	Chironomini	B	4	9	2	7	37	37	224	15	23	30	19
	Chrysops sp.	B/C			1								
	Culicoides sp.	C									1		

[1] Pollution Tolerance Rating: A = Intolerant, B = Moderately Tolerant, C = Tolerant.
Note: a blank cell indicates the macroinvertebrate group was not found during the 1m² sampling.

Table 6. Catoctin Creek and Tributaries - Macroinvertebrate 1m² Collection - Number of Individuals Cont'd

Order	Taxa	Pollution Tolerance Value	Catoctin Creek										
			Mainstem			Tributaries							
			South Fork		North Fork	Hamilton Station Tributary	Talbot Farm Tributary	Clover Mill Road Tributary	Richard Creek	Brens Creek	Milltown Creek		EcoVillage Tributary
			Ketoctin Church Road	Piggott Bottom Road	Hillsboro Road	Hamilton Station Road	Clarks Gap Road	Clover Mill Road	Purcellville Road	Ash George Road	Milltown Road	Bolington Road	Taylortown Road
			4/21/2005	4/21/2005	4/21/2005	5/6/2005	5/6/2005	6/10/2005	6/2/2005	5/11/2005	6/6/2005	5/11/2005	6/10/2005
	Diamesinae	B	1	1	1		6	4					1
	Dicranota sp.	B		1							3		1
	Dixella sp.	B/C											3
	Hemerodromia sp.	B					1						
	Hexatoma sp.	B	5	1	1	1	2	16	8	2	4	8	2
	Muscidae	B/C						1					
	Orthocladiinae	B	18	90	60	33	11	16	2	10	25	17	2
	Pedicia sp.	B							1				
	Prosimulium sp.	B/C			4								
	Simulium sp.	B/C		3		4	1	3	13	27	47	16	4
	Tanypodinae	B	1		1	1	4	24	6	1	4		13
	Tanytarsini	B			1	2	7	3	25	1	1	9	
	Tipula sp.	B	1					7			3	1	21
Lepidoptera	Lepidoptera	B			1								
Hemiptera	Gerris sp.	B											1
	Hesperocorixa sp.	B						1					
	Microvelia sp.	B						1					3
Decapoda	Cambaridae	B				1			1	3			4
Amphipoda	Gammaridae	B						2					
	Gammarus sp.	B				2				32	3		
Pelecyoda	Sphaeriidae	B/C	8	19						3		1	
	Unionidae	B/C	1										
Gastropoda	Physella sp.	B/C						8	3		2		1
	Planorbidae	B/C		1					1		1		
Hirudinea	Hirudinea	C		5			2	7	7				
Oligochaeta	Oligochaeta	B/C	2	8		1	1	3	5		7	7	
Nematomorpha	Nematomorpha	C		1									
	Total		161	211	77	277	217	517	532	391	452	344	390

[1] Pollution Tolerance Rating: A = Intolerant, B = Moderately Tolerant, C = Tolerant.
Note: a blank cell indicates the macroinvertebrate group was not found during the 1m² sampling.

Table 7. Quarter Branch and Dutchman Creek - Macroinvertebrate Functional Feeding Group[1] and Pollution Tolerance Values[2]

Order	Family	Taxa	Common Name	Tolerance Alpha	Feeding Functional Groups
Plecoptera	Capniidae	1. Allocapnia sp.	Stonefly	A/B	Shredder
	Chloroperlidae	2. Suwallia sp.	Stonefly	A	Predator
	Nemouridae	3. Nemoura sp.	Stonefly	A	Shredder
	Perlidae	4. Perlesta sp.	Stonefly	B	Predator
	Perlodidae	5. Isoperla sp.	Stonefly	A/B	Predator
	Taeniopterygidae	6. Taeniopteryx sp.	Stonefly	A/B	Shredder
Ephemeroptera	Baetidae	7. Acentrella sp.	Mayfly	B	Collector
		8. Baetis sp.	Mayfly	B	Collector
	Caenidae	9. Caenis sp.	Mayfly	B/C	Collector
	Ephemerellidae	10. Euryophella sp.	Mayfly	B	Scraper
	Heptageniidae	11. Stenonema sp.	Mayfly	B	Scraper
	Leptophlebiidae	12. Paraleptophlebia sp.	Mayfly	A/B	Collector
Trichoptera	Glossosomatidae	13. Glossosoma sp.	Caddisfly	A	Scraper
	Hydropsychidae	14. Cheumatopsyche sp.	Caddisfly	B	Filterer
		15. Hydropsyche sp.	Caddisfly	B	Filterer
		16. Diplectrona sp.	Caddisfly	A/B	Filterer
	Limnephilidae	17. Hydatophylax sp.	Caddisfly	A/B	Shredder
	Philopotamidae	18. Dolophilodes sp.	Caddisfly	A	Filterer
		19. Chimarra sp.	Caddisfly	B	Filterer
	Rhyacophilidae	20. Rhyacophila sp.	Caddisfly	A	Predator
	Uenoidae	21. Neophylax sp.	Caddisfly	A/B	Scraper
Zygoptera	Calopterygidae	22. Calopteryx sp.	Damselfly	B	Predator
Coleoptera	Dryopidae	23. Helichus sp.	Beetle	B	Scraper
	Dytiscidae	24. Hydroporus sp.	Beetle	B	Predator
	Elmidae	25. Stenelmis sp.	Riffle Beetle	B	Scraper
Diptera	Ceratopogonidae	26. Stilobezzia sp.	Biting Midges	B	Predator
	Chironomidae	27. Unknown	Midge	B	Collector
		28. Chironomini	Midge	B	Collector
		29. Tanypodinae	Midge	B	Predator
		30. Tanytarsini	Midge	B	Collector
		31. Orthocladinae	Midge	B	Collector
	Simuliidae	32. Simulium sp.	Blackfly	B/C	Filterer
	Tipulidae	33. Tipula sp.	Cranefly	B	Shredder
Decapoda	Cambaridae	34. Unknown	Crayfish	B	Shredder

[1] A number assigned to an individual or its group describing the degree to which that individual or group tolerates organic pollution.
[2] Feeding adaptations that classify the nutritional processing method performed by different aquatic insects (Merritt and Cummins, 1984).

Table 8. Quarter Branch and Dutchman Creek - Macroinvertebrate RSAT Voucher Collection - Relative Abundance [1]

Order	Taxa	Pollution Tolerance Value[2]	Quarter Branch	Dutchman Creek
			12/28/2005	10/28/2005
Plecoptera	Acroneuria sp.	A		1.0
	Eccoptura sp.	A/B		2.3
	Taeniopteryx sp.	A/B	1.0	1.0
	Allocapnia sp.	A/B	3.3	
Ephemeroptera	Caenis sp.	B/C		1.7
	Ephemera sp.	A/B		1.0
	Isonychia sp.	A/B		1.7
	Paraleptophlebia sp.	A/B		1.0
	Stenonema sp.	B		2.3
	Baetidae	B	1.0	
Trichoptera	Cheumatopsyche sp.	B		1.0
	Chimarra sp.	B		3.3
	Hydropsyche sp.	B	1.0	2.0
	Neophylax sp.	A/B	1.0	
Megaloptera	Nigronia sp.	B		1.0
Coleoptera	Oulimnius sp.	A/B		1.0
	Psephenus sp.	B		3.0
	Stenelmis sp.	B	1.0	1.7
Diptera	Antocha sp.	B		1.0
	Chironomidae	B	1.0	1.3
	Chironomini	B		1.0
	Hexatoma sp.	B		1.0
	Leptotarsus sp.	B		1.0
	Orthocladiinae	B		1.0
	Tipula sp.	B	2.0	2.0
Decapoda	Cambaridae	B	1.0	
Gastropoda	Physella sp.	B/C	1.0	
Oligochaeta	Oligochaeta	B/C		1.0
Total Taxa[3]			**10**	**23**

[1] Relative abundance scores were averaged for each mainstem reach. Relative abundance interpretation: 0.1-0.9 = Scarce, 1.0-2.0 = Scarce/Common, 2.1-3.0 = Common, 3.1-4.0 = Common/Abundant, > 4.0 = Abundant.

[2] Pollution Tolerance Rating: A = Intolerant, B = Moderately Tolerant, C = Tolerant.

[3] Taxa Richness Interpretation: >=25 = Excellent, 16-24 = Good, 8-15 = Fair, <8 = Poor.

Table 9. Quarter Branch and Dutchman Creek - Macroinvertebrate 1m^2 Collection - Number of Individuals

Order	Taxa	Pollution Tolerance Value[1]	Quarter Branch Garnet Road 5/12/2005	Dutchman Creek Irish Corner Road 6/10/2005
Plecoptera	Agnetina sp.	A		14
	Isoperla sp.	A/B	15	1
	Perlesta sp.	B	3	3
	Perlidae	A		1
	Nemoura sp.	A	44	
	Suwallia sp.	A	2	
Ephemeroptera	Acentrella sp.	B	31	1
	Attennella sp.	A/B		1
	Baetis sp.	B	92	15
	Caenis sp.	B/C	3	2
	Centroptilum sp.	A/B		1
	Ephemeridae	A/B		1
	Habrophlebiodes sp.	B		9
	Isonychia sp.	A/B		61
	Leucrocuta sp.	A		6
	Paraleptophlebia sp.	A/B	6	2
	Procloeon sp.	B		1
	Serratella sp.	A/B		6
	Stenonema sp.	B	7	34
	Euryophella sp.	B	5	
Trichoptera	Cheumatopsyche sp.	B	1	69
	Chimarra sp.	B		37
	Dolophilodes sp.	A	132	2
	Hydropsyche sp.	B	2	35
	Neophylax sp.	A/B	5	
	Chimarra sp.	B	2	
	Glossosoma sp.	A	1	1
	Hydatophylax sp.	A/B	1	
	Rhyacophila sp.	A	2	
	Diplectrona sp.	A/B	6	
Megaloptera	Corydalus sp.	B		1
	Nigronia sp.	B		1
Anisoptera	Gomphus sp.	B		1
Zygoptera	Argia sp.	B/C		1
	Calopteryx sp.	B	4	
Coleoptera	Gyrinus sp.	B		1
	Microcylloepus sp.	A/B		1
	Psephenus sp.	B		3
	Stenelmis sp.	B	3	45
	Gonielmis sp.	B		2
	Helichus sp.	B	1	
	Hydroporus sp.	B	2	
Diptera	Antocha sp.	B		18
	Chironomidae	B	2	

[1] Pollution Tolerance Rating: A = Intolerant, B = Moderately Tolerant, C = Tolerant.
Note: a blank cell indicates the macroinvertebrate group was not found during the 1m^2 sampling.

Table 9. Quarter Branch and Dutchman Creek - Macroinvertebrate 1m^2 Collection - Number of Individuals Cont'd

Order	Taxa	Pollution Tolerance Value[1]	Quarter Branch	Dutchman Creek
			Garnet Road	Irish Corner Road
			5/12/2005	6/10/2005
	Chironomini	B	5	44
	Diamesinae	B		16
	Dicranota sp.	B		1
	Orthocladiinae	B		4
	Probezzia sp.	B		1
	Simulium sp.	B/C	6	1
	Tanypodinae	B	2	16
	Tanytarsini	B	36	2
	Tipula sp.	B	1	
	Stilobezzia sp.	B	1	
	Orthocladinae	B	37	
Hemiptera	Microvelia sp.	B		1
Decapoda	Cambaridae	B	1	1
Gastropoda	Physella sp.	B/C		2
Oligochaeta	Oligochaeta	B/C		4
	Total		**461**	**470**

[1] Pollution Tolerance Rating: A = Intolerant, B = Moderately Tolerant, C = Tolerant.
Note: a blank cell indicates the macroinvertebrate group was not found during the 1m^2 sampling.

Table 10. Piney Run - Macroinvertebrate Functional Feeding Group[1] and Pollution Tolerance Values[2]

Order	Family	Taxa	Pollution Tolerance Value	Common Name	Feeding Functional Groups
Plecoptera	Nemouridae	1. Amphinemura sp.	A/B	Stonefly	Shredder
	Perlidae	2. Acronueria sp.	A	Stonefly	Predator
		3. Agnetina sp.	A	Stonefly	Predator
		4. Perlesta sp.	B	Stonefly	Predator
		5. Unknown	A	Stonefly	Predator
	Perlodidae	6. Isoperla sp.	A/B	Stonefly	Predator
	Pteronarcyidae	7. Pteronarcys sp.	A/B	Stonefly	Shredder
Ephemeroptera	Baetidae	8. Acentrella sp.	B	Mayfly	Collector
		9. Acerpenna sp.	B	Mayfly	Collector
		10. Unknown	B	Mayfly	Collector
		11. Baetis sp.	B	Mayfly	Collector
		12. Procloeon sp.	B	Mayfly	Collector
	Baetiscidae	13. Baetisca sp.	B	Mayfly	Collector
	Caenidae	14. Caenis sp.	B/C	Mayfly	Collector
	Ephemerellidae	15. Attenella sp.	A/B	Mayfly	Collector
		16. Drunella sp.	A	Mayfly	Scraper
		17. Ephemerella sp.	A/B	Mayfly	Collector
		18. Timpanoga sp.	A/B	Mayfly	Collector
	Heptageniidae	19. Stenacron sp.	B	Mayfly	Scraper
		20. Stenonema sp.	B	Mayfly	Scraper
	Isonychiidae	21. Isonychia sp.	A/B	Mayfly	Filterer
	Leptophlebiidae	22. Paraleptophlebia sp.	A/B	Mayfly	Collector
Trichoptera	Brachycentridae	23. Micrasema sp.	A	Caddisfly	Filterer
	Glossosomatidae	24. Agapetus sp.	A	Caddisfly	Scraper
		25. Glossosoma sp.	A	Caddisfly	Scraper
	Hydropsychidae	26. Cheumatopsyche sp.	B	Caddisfly	Filterer
		27. Hydropsyche sp.	B	Caddisfly	Filterer
	Leptoceridae	28. Triaenodes sp.	B	Caddisfly	Shredder
	Philopotamidae	29. Chirmarra sp.	B	Caddisfly	Filterer
		30. Dolophilodes sp.	A	Caddisfly	Filterer
	Psychomyiidae	31. Psychomyia sp.	A/B	Caddisfly	Collector
	Rhyacophilidae	32. Rhyacophila sp.	A	Caddisfly	Predator
	Uenoidae	33. Neophylax sp.	A/B	Caddisfly	Scraper
Megaloptera	Corydalidae	34. Corydalus sp.	B	Dobsonfly	Predator
		35. Nigronia sp.	B	Alderfly	Predator
Anisoptera	Aeshnidae	36. Boyeria sp.	A/B	Dragonfly	Predator
	Corduliidae	37. Macromia sp.	A/B	Dragonfly	Predator
	Gomphidae	38. Dromogomphus sp.	B	Dragonfly	Predator
		39. Unknown	A	Dragonfly	Predator
		40. Hagenius sp.	B	Dragonfly	Predator
		41. Stylogomphus sp.	A	Dragonfly	Predator
Zygoptera	Calopterygidae	42. Calyoptryx sp.	B	Damselfly	Predator
Coleoptera	Dryopidae	43. Helichus sp.	B	Beetle	Scraper
	Elmidae	44. Dubiraphia sp.	B	Riffle Beetle	Scraper
		45. Macronychus sp.	B	Riffle Beetle	Scraper
		46. Optioservus sp.	B	Riffle Beetle	Scraper

[1] A number assigned to an individual or its group describing the degree to which that individual or group tolerates organic pollution.
[2] Feeding adaptations that classify the nutritional processing method performed by different aquatic insects (Merritt and Cummins, 1984).

Table 11. Piney Run - Macroinvertebrate Functional Feeding Group[1] and Pollution Tolerance Values[2] Cont'd

Order	Family	Taxa	Pollution Tolerance Value	Common Name	Feeding Functional Groups
		47. Oulimnius sp.	A/B	Riffle Beetle	Scraper
		48. Stenelmis sp.	B	Riffle Beetle	Scraper
	Psephenidae	49. Psephenus sp.	B	Water Penny	Scraper
Diptera	Blephariceridae	50. Blephāricera sp.	A	Net-winged midges	Scraper
	Ceratopogonidae	51. Dasyhelea sp.	B	Biting Midges	Collector
	Chironomidae	52. Chironomini	B	Midge	Collector
		53. Orthocladiinae	B	Midge	Collector
		54. Tanypodinae	B	Midge	Predator
		55. Tanytarsini	B	Midge	Collector
	Empididae	56. Hemerodromia sp.	B	Daggerfly	Predator
	Tipulidae	57. Antocha sp.	B	Cranefly	Collector
		58. Leptotarsus sp.	B	Cranefly	Shredder
		59. Tiupla sp.	B	Cranefly	Shredder
Decapoda	Cambaridae	60. Unknown	B	Crayfish	Shredder
Amphipoda	Gammaridae	61. Gammarus sp.	B	Scud	Shredder
Gastropoda	Ancylidae	62. Unknown	B/C	Limpet	Scraper
Oligochaeta	Oligochaeta	63. Unknown	B/C	Aquatic Worm	Collector

[1] A number assigned to an individual or its group describing the degree to which that individual or group tolerates organic pollution.
[2] Feeding adaptations that classify the nutritional processing method performed by different aquatic insects (Merritt and Cummins, 1984).

Table 12. Piney Run - Macroinvertebrate RSAT Voucher Collection - Relative Abundance [1]

Order	Taxa	Pollution Tolerance Value[2]	Middle	Lower
			Arnold Lane	Branchriver Road
			10/19/2005	10/19/2005
Plecoptera	Acronueria sp.	A	2.7	2.0
Ephemeroptera	Baetisca sp.	B	1.0	1.0
	Isonychia sp.	A/B	1.5	1.5
	Stenacron sp.	B		2.0
	Stenonema sp.	B	3.7	2.0
Trichoptera	Cheumatopsyche sp.	B	3.7	2.0
	Chirmarra sp.	B	2.0	
	Glossosoma sp.	A	1.0	
	Hydropsyche sp.	B	3.0	1.0
	Neophylax sp.	A/B	2.0	
Megaloptera	Nigronia sp.	B	1.0	
Anisoptera	Stylogomphus sp.	A	1.0	1.0
Coleoptera	Helichus sp.	B	1.0	1.0
	Optioservus sp.	B	1.3	
	Oulimnius sp.	A/B		1.0
	Psephenus sp.	B	1.0	
	Stenelmis sp.	B	1.3	1.0
Diptera	Leptotarsus sp.	B		1.0
	Orthocladiinae	B	1.0	1.0
	Tanytarsini	B	1.0	
	Tiupla sp.	B	3.0	2.0
Decapoda	Cambaridae	B	1.0	
Gastropoda	Ancylidae	B/C		3.0
	Total Taxa[3]		**19**	**15**

[1] Relative abundance scores were averaged for each mainstem reach. Relative abundance interpretation: 0.1-0.9 = Scarce, 1.0-2.0 = Scarce/Common, 2.1-3.0 = Common, 3.1-4.0 = Common/Abundant, > 4.0 = Abundant.

[2] Pollution Tolerance Rating: A = Intolerant, B = Moderately Tolerant, C = Tolerant.

[3] Taxa Richness Interpretation: >=25 = Excellent, 16-24 = Good, 8-15 = Fair, <8 = Poor.

Table 13. Piney Run - Macroinvertebrate 1m² Collection - Number of Individuals

Order	Taxa	Pollution Tolerance Value[1]	Piney Run	
			Middle	Lower
			Arnold Lane	Branchriver Road
			5/11/2005	5/11/2005
Plecoptera	Acronueria sp.	A	6	
	Agnetina sp.	A	7	
	Amphinemura sp.	A/B		1
	Isoperla sp.	A/B		5
	Perlesta sp.	B	26	
	Perlidae	A	12	3
	Pteronarcys sp.	A/B	1	1
Ephemeroptera	Acentrella sp.	B	8	
	Acerpenna sp.	B	5	
	Attenella sp.	A/B	8	4
	Baetidae	B		4
	Baetis sp.	B	41	6
	Caenis sp.	B/C	4	
	Drunella sp.	A	26	1
	Ephemerella sp.	A/B	22	86
	Isonychia sp.	A/B	45	1
	Paraleptophlebia sp.	A/B	1	
	Procloeon sp.	B	5	
	Stenacron sp.	B	2	
	Stenonema sp.	B	26	20
	Timpanoga sp.	A/B	2	
Trichoptera	Agapetus sp.	A		4
	Cheumatopsyche sp.	B	50	15
	Dolophilodes sp.	A	2	4
	Glossosoma sp.	A	23	
	Hydropsyche sp.	B	53	11
	Micrasema sp.	A		10
	Neophylax sp.	A/B	4	10
	Psychomyia sp.	A/B		1
	Rhyacophila sp.	A	1	1
	Triaenodes sp.	B	1	
Megaloptera	Corydalus sp.	B	2	
	Nigronia sp.	B	9	1
Anisoptera	Boyeria sp.	A/B	4	
	Dromogomphus sp.	B		1
	Gomphidae	A	1	1
	Hagenius sp.	B		1
	Macromia sp.	A/B		2
	Stylogomphus sp.	A	1	
Zygoptera	Calyoptryx sp.	B	3	4
Coleoptera	Dubiraphia sp.	B	2	
	Helichus sp.	B	1	
	Macronychus sp.	B	7	4
	Optioservus sp.	B	4	

[1] Pollution Tolerance Rating: A = Intolerant, B = Moderately Tolerant, C = Tolerant.
Note: a blank cell indicates the macroinvertebrate group was not found during the 1m² sampling.

Table 13. Piney Run - Macroinvertebrate 1m² Collection - Number of Individuals Cont'd

	Psephenus sp.	B	1	
	Stenelmis sp.	B	12	
Diptera	Antocha sp.	B	12	3
	Blephariccera sp.	A		4
	Chironomini	B	66	3
	Dasyhelea sp.	B		3
	Hemerodromia sp.	B		1
	Orthocladiinae	B	15	28
	Tanypodinae	B	1	1
	Tanytarsini	B	9	
Decapoda	Cambaridae	B	2	
Amphipoda	Gammarus sp.	B		5
Oligochaeta	Oligochaeta	B/C	2	5
	Total Taxa		**535**	**255**

[1] Pollution Tolerance Rating: A = Intolerant, B = Moderately Tolerant, C = Tolerant.

Figure 1. Catoctin Creek Mainstem Non-Forested Areas Within 100 Foot Buffer - Confluence to Milltown Road

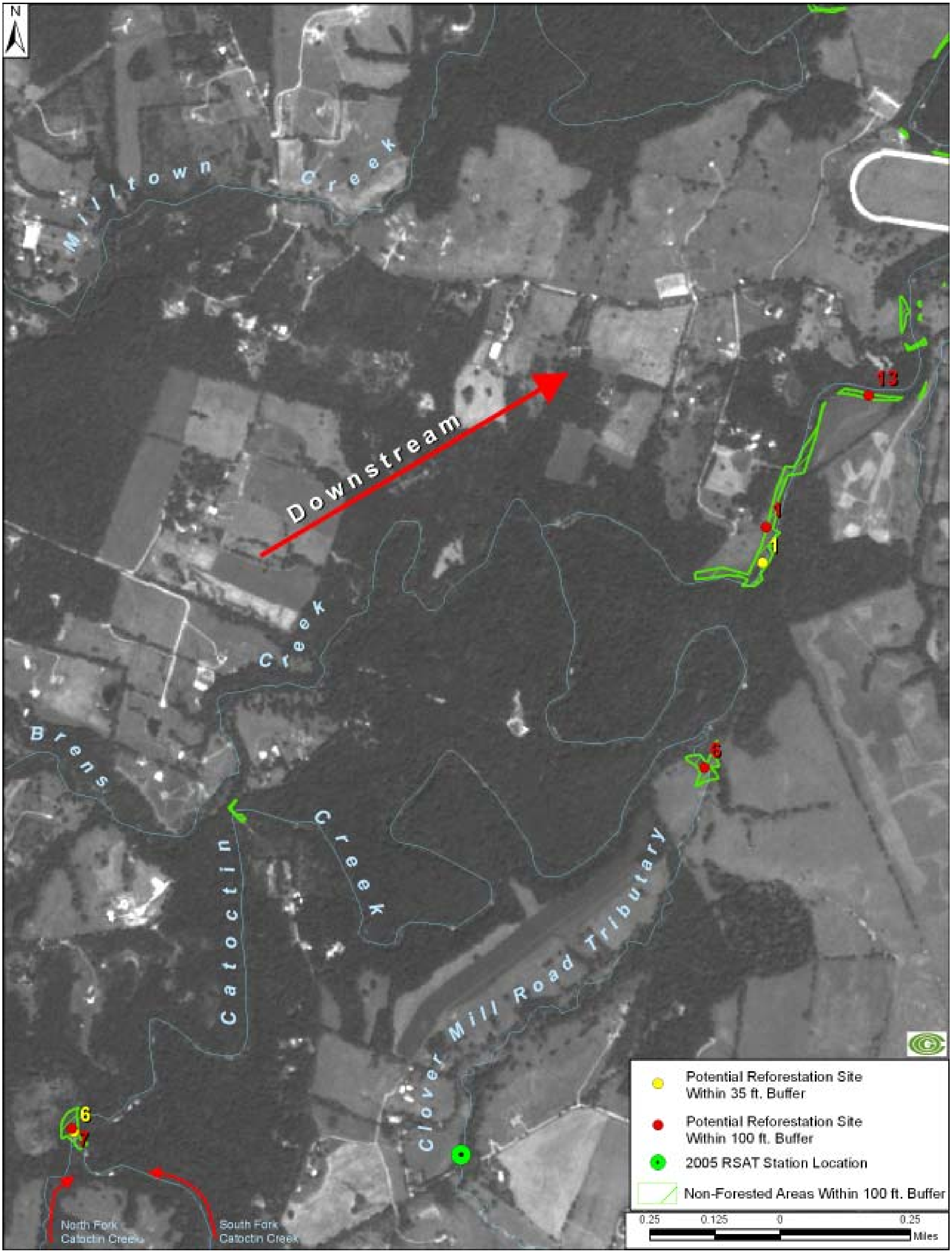

Figure 2. Catoctin Creek Mainstem Non-Forested Areas Within 100 Foot Buffer - Milltown Road to Taylorstown Road

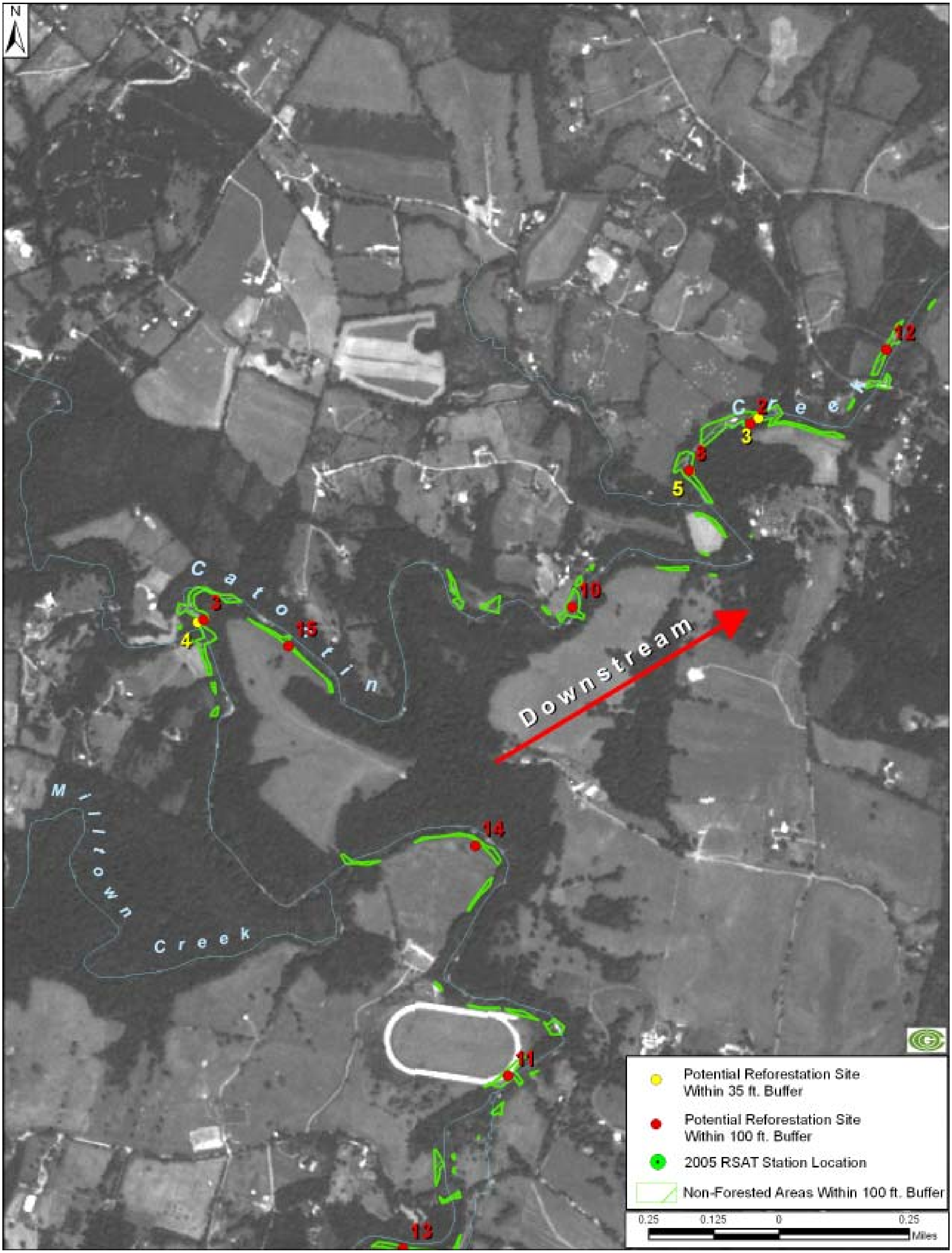

Figure 3. Catoctin Creek Mainstem Non-Forested Areas Within 100 Foot Buffer - Taylorstown Road to Potomac River

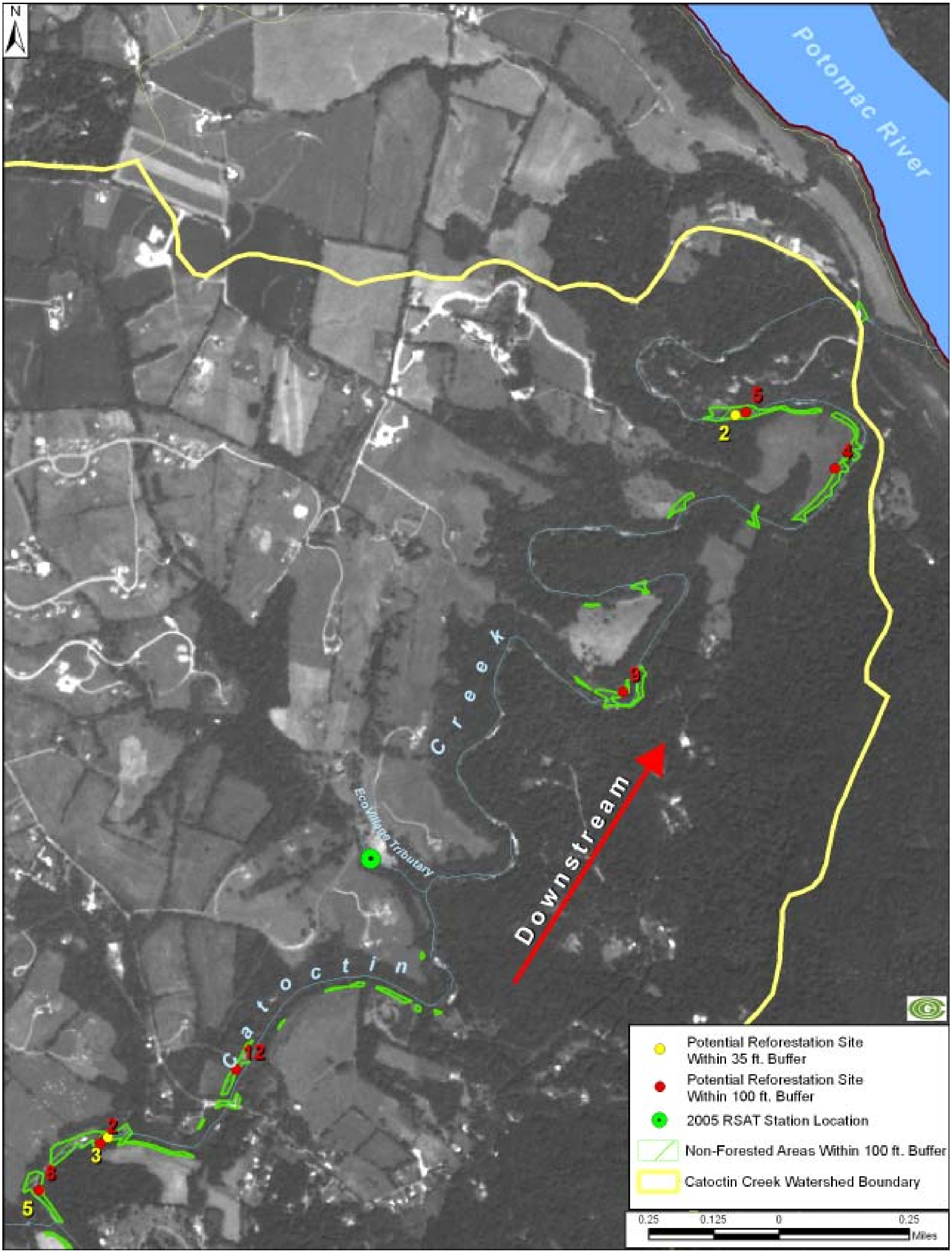

Table 2. Catoctin Creek - Locations of Potential Riparian Reforestation Sites within 35 ft. Riparian Buffer[1]

ID	Stream	Square Feet	Acres	Latitude	Longitude
1	South Fork Catoctin Creek	305,422.6	7.01	39.153085	-77.657263
2	South Fork Catoctin Creek	202,096.3	4.64	39.185611	-77.618817
3	South Fork Catoctin Creek	191,075.9	4.39	39.167341	-77.703929
4	South Fork Catoctin Creek	176,760.3	4.06	39.175855	-77.637235
5	South Fork Catoctin Creek	126,906.2	2.91	39.177240	-77.773848
6	South Fork Catoctin Creek	124,811.5	2.87	39.172902	-77.770421
7	South Fork Catoctin Creek	102,332.6	2.35	39.196745	-77.616714
8	South Fork Catoctin Creek	99,588.6	2.29	39.178308	-77.631307
9	South Fork Catoctin Creek	81,781.4	1.88	39.189628	-77.614845
10	South Fork Catoctin Creek	70,521.9	1.62	39.163880	-77.714761
11	South Fork Catoctin Creek	67,571.6	1.55	39.146819	-77.664535
12	South Fork Catoctin Creek	55,738.7	1.28	39.180853	-77.628589
13	South Fork Catoctin Creek	55,342.1	1.27	39.149925	-77.655830
14	South Fork Catoctin Creek	55,056.9	1.26	39.158083	-77.638452
15	South Fork Catoctin Creek	52,157.5	1.20	39.161360	-77.641683
16	South Fork Catoctin Creek	51,423.1	1.18	39.168523	-77.671959
17	South Fork Catoctin Creek	48,713.6	1.12	39.162911	-77.752717
18	South Fork Catoctin Creek	47,822.7	1.10	39.163761	-77.755932
19	South Fork Catoctin Creek	47,157.0	1.08	39.142073	-77.714774
20	South Fork Catoctin Creek	43,567.1	1.00	39.142506	-77.722738
21	South Fork Catoctin Creek	43,510.2	1.00	39.191953	-77.616105
22	South Fork Catoctin Creek	42,257.3	0.97	39.148778	-77.741080
23	South Fork Catoctin Creek	40,333.2	0.93	39.146886	-77.654473
24	South Fork Catoctin Creek	39,602.0	0.91	39.170203	-77.681756
25	South Fork Catoctin Creek	38,374.4	0.88	39.153336	-77.638848
26	South Fork Catoctin Creek	38,345.7	0.88	39.168787	-77.699043
27	South Fork Catoctin Creek	38,215.3	0.88	39.170031	-77.684906
28	South Fork Catoctin Creek	32,660.7	0.75	39.144175	-77.728317
29	South Fork Catoctin Creek	32,628.7	0.75	39.193604	-77.617081
30	South Fork Catoctin Creek	29,885.3	0.69	39.169951	-77.675207
31	South Fork Catoctin Creek	28,892.4	0.66	39.162995	-77.721147
32	South Fork Catoctin Creek	27,487.3	0.63	39.163443	-77.719368
33	South Fork Catoctin Creek	25,812.1	0.59	39.144064	-77.725165
34	South Fork Catoctin Creek	25,514.6	0.59	39.209180	-77.620686
35	South Fork Catoctin Creek	25,464.3	0.58	39.160054	-77.652318
36	South Fork Catoctin Creek	25,061.2	0.58	39.170040	-77.678281
37	South Fork Catoctin Creek	24,481.8	0.56	39.145197	-77.732025
38	South Fork Catoctin Creek	23,223.7	0.53	39.169917	-77.673280
39	South Fork Catoctin Creek	23,005.0	0.53	39.149862	-77.700074
40	South Fork Catoctin Creek	22,450.2	0.52	39.146903	-77.668126
1	North Fork Catoctin Creek	387,691.3	8.90	39.181596	-77.685147
2	North Fork Catoctin Creek	204,459.5	4.69	39.202095	-77.626074
3	North Fork Catoctin Creek	161,323.0	3.70	39.215292	-77.760249
4	North Fork Catoctin Creek	159,279.1	3.66	39.195432	-77.753596
5	North Fork Catoctin Creek	152,282.4	3.50	39.188108	-77.706942
6	North Fork Catoctin Creek	141,792.9	3.26	39.220719	-77.750281
7	North Fork Catoctin Creek	117,252.4	2.69	39.192091	-77.749642
8	North Fork Catoctin Creek	116,721.2	2.68	39.194614	-77.649941
9	North Fork Catoctin Creek	107,524.8	2.47	39.195620	-77.768488
10	North Fork Catoctin Creek	105,876.7	2.43	39.200904	-77.738138
11	North Fork Catoctin Creek	72,047.2	1.65	39.193274	-77.671523
12	North Fork Catoctin Creek	44,292.8	1.02	39.212337	-77.746526
13	North Fork Catoctin Creek	42,317.5	0.97	39.215960	-77.744835
14	North Fork Catoctin Creek	32,367.9	0.74	39.224370	-77.750411
15	North Fork Catoctin Creek	27,008.6	0.62	39.201001	-77.732043
16	North Fork Catoctin Creek	26,590.9	0.61	39.208565	-77.745293

[1]Please note that existing development, infrastructure such as roads, or land features may preclude the reforestation of some of the highlighted potential reforestation areas. In addition, it is also recognized that these areas will need to be groundtruthed and that actual reforestation of these sites is incumbent upon approval of the landowner.

Table 2. Catoctin Creek - Locations of Potential Riparian Reforestation Sites within 35 ft. Riparian Buffer Cont'd

ID	Stream	Square Feet	Acres	Latitude	Longitude
17	North Fork Catoctin Creek	25,597.5	0.59	39.210242	-77.746563
18	North Fork Catoctin Creek	25,052.4	0.58	39.218028	-77.744224
19	North Fork Catoctin Creek	23,925.0	0.55	39.187689	-77.702969
20	North Fork Catoctin Creek	23,456.0	0.54	39.209840	-77.745485
21	North Fork Catoctin Creek	22,528.1	0.52	39.199200	-77.633377
1	Catoctin Creek Mainstem	37,654.1	0.86	39.226045	-77.596886
2	Catoctin Creek Mainstem	31,909.8	0.73	39.274079	-77.558308
3	Catoctin Creek Mainstem	30,651.9	0.70	39.253880	-77.580618
4	Catoctin Creek Mainstem	25,095.1	0.58	39.248092	-77.600608
5	Catoctin Creek Mainstem	23,765.8	0.55	39.252391	-77.583036
6	Catoctin Creek Mainstem	22,316.8	0.51	39.210073	-77.621371
1	Hamilton Station Rd. Tributary	52,288.1	1.20	39.163105	-77.632436
2	Hamilton Station Rd. Tributary	34,237.8	0.79	39.161590	-77.623530
3	Hamilton Station Rd. Tributary	22,623.7	0.52	39.163189	-77.634420
1	Talbot Farms Tributary	277,504.2	6.37	39.181380	-77.611411
2	Talbot Farms Tributary	178,599.9	4.10	39.182528	-77.596601
3	Talbot Farms Tributary	58,270.4	1.34	39.184241	-77.591029
4	Talbot Farms Tributary	47,645.9	1.09	39.181520	-77.602177
1	Clover Mill Tributary	106,226.0	2.44	39.203927	-77.596834
2	Clover Mill Tributary	104,685.4	2.40	39.207521	-77.605909
3	Clover Mill Tributary	60,838.4	1.40	39.205553	-77.601350
4	Clover Mill Tributary	59,324.0	1.36	39.218900	-77.599304
5	Clover Mill Tributary	42,091.0	0.97	39.212230	-77.606630
1	Featherbed Road Tributary	88,174.5	2.02	39.232083	-77.590468
1	Brens Creek	354,578.6	8.14	39.208870	-77.665749
2	Brens Creek	105,759.6	2.43	39.215990	-77.647045
3	Brens Creek	103,474.7	2.38	39.207403	-77.684387
4	Brens Creek	99,240.4	2.28	39.220320	-77.674977
5	Brens Creek	99,188.4	2.28	39.221036	-77.672007
6	Brens Creek	99,114.6	2.28	39.214185	-77.642969
7	Brens Creek	93,347.5	2.14	39.216383	-77.659779
8	Brens Creek	88,375.6	2.03	39.217841	-77.684470
9	Brens Creek	78,682.0	1.81	39.215659	-77.653176
10	Brens Creek	75,955.7	1.74	39.216468	-77.631836
11	Brens Creek	53,062.0	1.22	39.207310	-77.679927
12	Brens Creek	52,853.7	1.21	39.219906	-77.616293
13	Brens Creek	47,321.9	1.09	39.218898	-77.679867
14	Brens Creek	41,354.5	0.95	39.226041	-77.676065
15	Brens Creek	33,364.3	0.77	39.213417	-77.638332
16	Brens Creek	27,966.3	0.64	39.223347	-77.674693
17	Brens Creek	27,188.0	0.62	39.221456	-77.627141
18	Brens Creek	24,485.3	0.56	39.231445	-77.679041
19	Brens Creek	22,273.2	0.51	39.217382	-77.664442
1	Milltown Creek	92,533.4	2.12	39.235806	-77.612377
2	Milltown Creek	67,060.3	1.54	39.242957	-77.680965
3	Milltown Creek	46,491.6	1.07	39.243855	-77.666723
4	Milltown Creek	43,586.8	1.00	39.243135	-77.668854
5	Milltown Creek	39,001.1	0.90	39.243753	-77.644670
6	Milltown Creek	35,333.9	0.81	39.244248	-77.683600
7	Milltown Creek	27,942.1	0.64	39.244710	-77.651790

Table 3. Catoctin Creek - Locations of Potential Riparian Reforestation Sites within 100 ft. Riparian Buffer[1]

ID	Stream	Square Feet	Acres	Latitude	Longitude
1	South Fork Catoctin Creek	948,124.6	21.77	39.177437	-77.634112
2	South Fork Catoctin Creek	884,722.7	20.31	39.153343	-77.657225
3	South Fork Catoctin Creek	695,452.8	15.97	39.174855	-77.772076
4	South Fork Catoctin Creek	618,649.1	14.20	39.167013	-77.705007
5	South Fork Catoctin Creek	599,451.6	13.76	39.186008	-77.618553
6	South Fork Catoctin Creek	583,519.0	13.40	39.195154	-77.616754
7	South Fork Catoctin Creek	454,393.9	10.43	39.142562	-77.719858
8	South Fork Catoctin Creek	450,113.4	10.33	39.159973	-77.640350
9	South Fork Catoctin Creek	331,650.9	7.61	39.169405	-77.673700
10	South Fork Catoctin Creek	248,987.2	5.72	39.170051	-77.683644
11	South Fork Catoctin Creek	243,748.6	5.60	39.150713	-77.700111
12	South Fork Catoctin Creek	234,762.9	5.39	39.146808	-77.663676
13	South Fork Catoctin Creek	219,007.7	5.03	39.162671	-77.752725
14	South Fork Catoctin Creek	209,596.9	4.81	39.144649	-77.730132
15	South Fork Catoctin Creek	209,454.9	4.81	39.189498	-77.614810
16	South Fork Catoctin Creek	207,092.5	4.75	39.164372	-77.756411
17	South Fork Catoctin Creek	203,465.8	4.67	39.163903	-77.714763
18	South Fork Catoctin Creek	187,771.3	4.31	39.146957	-77.654534
19	South Fork Catoctin Creek	173,099.5	3.97	39.150011	-77.655927
20	South Fork Catoctin Creek	163,252.9	3.75	39.154224	-77.638790
21	South Fork Catoctin Creek	147,732.0	3.39	39.169730	-77.677854
22	South Fork Catoctin Creek	116,403.7	2.67	39.166493	-77.665706
23	South Fork Catoctin Creek	111,655.4	2.56	39.159525	-77.654644
24	South Fork Catoctin Creek	110,708.1	2.54	39.148846	-77.741002
25	South Fork Catoctin Creek	108,304.9	2.49	39.156939	-77.698377
26	South Fork Catoctin Creek	102,207.6	2.35	39.146921	-77.667831
27	South Fork Catoctin Creek	101,518.2	2.33	39.168744	-77.699079
28	South Fork Catoctin Creek	93,131.6	2.14	39.170659	-77.688255
29	South Fork Catoctin Creek	84,505.1	1.94	39.162958	-77.721244
30	South Fork Catoctin Creek	84,208.7	1.93	39.163475	-77.719361
31	South Fork Catoctin Creek	73,040.0	1.68	39.152360	-77.745754
32	South Fork Catoctin Creek	66,684.5	1.53	39.164779	-77.711812
33	South Fork Catoctin Creek	63,963.4	1.47	39.144532	-77.704543
34	South Fork Catoctin Creek	62,869.4	1.44	39.143837	-77.707710
35	South Fork Catoctin Creek	62,650.8	1.44	39.159956	-77.652328
36	South Fork Catoctin Creek	61,117.9	1.40	39.201644	-77.617907
37	South Fork Catoctin Creek	57,335.0	1.32	39.173056	-77.640390
38	South Fork Catoctin Creek	52,224.4	1.20	39.164070	-77.698619
39	South Fork Catoctin Creek	45,294.8	1.04	39.202761	-77.618173
40	South Fork Catoctin Creek	40,520.4	0.93	39.209161	-77.620553
41	South Fork Catoctin Creek	38,535.0	0.88	39.161052	-77.699154
42	South Fork Catoctin Creek	36,379.8	0.84	39.169268	-77.698104
43	South Fork Catoctin Creek	36,163.5	0.83	39.159843	-77.699260
44	South Fork Catoctin Creek	30,209.8	0.69	39.147865	-77.735692
45	South Fork Catoctin Creek	28,430.9	0.65	39.155169	-77.700198
46	South Fork Catoctin Creek	27,368.2	0.63	39.189195	-77.617154
47	South Fork Catoctin Creek	23,295.1	0.53	39.170471	-77.692090
1	North Fork Catoctin Creek	1,116,885.4	25.64	39.181635	-77.685182
2	North Fork Catoctin Creek	639,047.5	14.67	39.216050	-77.760917
3	North Fork Catoctin Creek	500,898.9	11.50	39.202019	-77.626196
4	North Fork Catoctin Creek	485,425.5	11.14	39.191497	-77.750037
5	North Fork Catoctin Creek	469,192.6	10.77	39.200842	-77.738651
6	North Fork Catoctin Creek	459,835.6	10.56	39.195431	-77.753496
7	North Fork Catoctin Creek	433,442.3	9.95	39.220454	-77.750260
8	North Fork Catoctin Creek	407,522.5	9.36	39.188119	-77.706801
9	North Fork Catoctin Creek	380,949.7	8.75	39.194553	-77.649717

[1]Please note that existing development, infrastructure such as roads, or land features may preclude the reforestation of some of the highlighted potential reforestation areas. In addition, it is also recognized that these areas will need to be groundtruthed and that actual reforestation of these sites is incumbent upon approval of the landowner.

Table 3. Catoctin Creek - Locations of Potential Riparian Reforestation Sites within 100 ft. Riparian Buffer Cont'd

ID	Stream	Square Feet	Acres	Latitude	Longitude
10	North Fork Catoctin Creek	350,847.7	8.05	39.196033	-77.768864
11	North Fork Catoctin Creek	328,666.4	7.55	39.193103	-77.672006
12	North Fork Catoctin Creek	318,908.0	7.32	39.209076	-77.745270
13	North Fork Catoctin Creek	145,318.0	3.34	39.187211	-77.702264
14	North Fork Catoctin Creek	138,737.7	3.18	39.199424	-77.746649
15	North Fork Catoctin Creek	131,091.8	3.01	39.216018	-77.744833
16	North Fork Catoctin Creek	126,830.5	2.91	39.206757	-77.623060
17	North Fork Catoctin Creek	119,915.5	2.75	39.212359	-77.746493
18	North Fork Catoctin Creek	116,955.3	2.68	39.184032	-77.693223
19	North Fork Catoctin Creek	112,742.3	2.59	39.224433	-77.750473
20	North Fork Catoctin Creek	110,435.7	2.54	39.206317	-77.745668
21	North Fork Catoctin Creek	83,842.2	1.92	39.218023	-77.744292
22	North Fork Catoctin Creek	80,744.3	1.85	39.200931	-77.732120
23	North Fork Catoctin Creek	75,691.2	1.74	39.195836	-77.724140
24	North Fork Catoctin Creek	75,202.3	1.73	39.193814	-77.660611
25	North Fork Catoctin Creek	71,581.6	1.64	39.191459	-77.643330
26	North Fork Catoctin Creek	63,744.4	1.46	39.197212	-77.746999
27	North Fork Catoctin Creek	63,636.2	1.46	39.206047	-77.742079
28	North Fork Catoctin Creek	55,174.4	1.27	39.196623	-77.759657
29	North Fork Catoctin Creek	52,696.2	1.21	39.194114	-77.717052
30	North Fork Catoctin Creek	52,626.7	1.21	39.199206	-77.727025
31	North Fork Catoctin Creek	46,699.4	1.07	39.194401	-77.654963
32	North Fork Catoctin Creek	44,113.3	1.01	39.182914	-77.682041
33	North Fork Catoctin Creek	37,796.5	0.87	39.187142	-77.680373
34	North Fork Catoctin Creek	34,180.1	0.78	39.199143	-77.633361
35	North Fork Catoctin Creek	32,994.8	0.76	39.209770	-77.752263
36	North Fork Catoctin Creek	32,673.5	0.75	39.220506	-77.743122
37	North Fork Catoctin Creek	32,609.8	0.75	39.195000	-77.722083
38	North Fork Catoctin Creek	32,389.9	0.74	39.208694	-77.750819
39	North Fork Catoctin Creek	32,088.9	0.74	39.193658	-77.712306
40	North Fork Catoctin Creek	30,698.4	0.70	39.185049	-77.681265
41	North Fork Catoctin Creek	29,253.6	0.67	39.192691	-77.641779
42	North Fork Catoctin Creek	26,512.5	0.61	39.210864	-77.757497
43	North Fork Catoctin Creek	26,313.8	0.60	39.208942	-77.755479
44	North Fork Catoctin Creek	22,437.4	0.52	39.183614	-77.697608
45	North Fork Catoctin Creek	22,187.1	0.51	39.196901	-77.762687
1	Catoctin Creek Mainstem	189,428.2	4.35	39.227034	-77.596774
2	Catoctin Creek Mainstem	116,756.7	2.68	39.253721	-77.580897
3	Catoctin Creek Mainstem	91,445.2	2.10	39.248158	-77.600405
4	Catoctin Creek Mainstem	85,330.0	1.96	39.272622	-77.554738
5	Catoctin Creek Mainstem	74,580.2	1.71	39.274164	-77.557951
6	Catoctin Creek Mainstem	52,321.9	1.20	39.220329	-77.598923
7	Catoctin Creek Mainstem	52,234.3	1.20	39.210169	-77.621446
8	Catoctin Creek Mainstem	49,405.7	1.13	39.252402	-77.583073
9	Catoctin Creek Mainstem	45,334.1	1.04	39.266370	-77.562285
10	Catoctin Creek Mainstem	36,004.3	0.83	39.248579	-77.587224
11	Catoctin Creek Mainstem	34,259.3	0.79	39.235535	-77.589401
12	Catoctin Creek Mainstem	33,005.9	0.76	39.255803	-77.576036
13	Catoctin Creek Mainstem	27,427.4	0.63	39.230717	-77.593124
14	Catoctin Creek Mainstem	22,340.1	0.51	39.241922	-77.590625
15	Catoctin Creek Mainstem	22,169.0	0.51	39.247444	-77.597366
1	Hamilton Station Road Tributary	238,834.5	5.48	39.163038	-77.632732
2	Hamilton Station Road Tributary	178,310.8	4.09	39.161708	-77.623840
3	Hamilton Station Road Tributary	102,232.1	2.35	39.155679	-77.616555
4	Hamilton Station Road Tributary	34,943.9	0.80	39.157890	-77.620285
5	Hamilton Station Road Tributary	22,219.7	0.51	39.159837	-77.621412

Table 3. Catoctin Creek - Locations of Potential Riparian Reforestation Sites within 100 ft. Riparian Buffer Cont'd

ID	Stream	Square Feet	Acres	Latitude	Longitude
1	Talbot Farms Tributary	1,012,555.1	23.25	39.181661	-77.610247
2	Talbot Farms Tributary	638,297.2	14.65	39.182963	-77.595210
1	Clover Mill Tributary	548,985.1	12.60	39.204624	-77.598810
2	Clover Mill Tributary	297,573.9	6.83	39.207463	-77.605771
3	Clover Mill Tributary	165,915.4	3.81	39.218889	-77.599271
4	Clover Mill Tributary	119,996.7	2.75	39.212443	-77.606370
5	Clover Mill Tributary	68,566.1	1.57	39.214861	-77.602400
6	Clover Mill Tributary	65,560.9	1.51	39.210327	-77.607545
7	Clover Mill Tributary	39,160.5	0.90	39.203235	-77.592386
1	Featherbed Road Tributary	350,112.9	8.04	39.231198	-77.590702
1	Brens Creek	1,029,741.2	23.64	39.208791	-77.665999
2	Brens Creek	738,455.5	16.95	39.219074	-77.679613
3	Brens Creek	642,250.2	14.74	39.215941	-77.656896
4	Brens Creek	630,052.1	14.46	39.215185	-77.645368
5	Brens Creek	357,395.6	8.20	39.220522	-77.671403
6	Brens Creek	295,189.8	6.78	39.207413	-77.684425
7	Brens Creek	228,037.1	5.24	39.216523	-77.631854
8	Brens Creek	145,411.2	3.34	39.219806	-77.616526
9	Brens Creek	132,633.9	3.04	39.207308	-77.680052
10	Brens Creek	125,120.2	2.87	39.225992	-77.676091
11	Brens Creek	110,154.7	2.53	39.207257	-77.676427
12	Brens Creek	103,417.3	2.37	39.231511	-77.679113
13	Brens Creek	102,151.5	2.35	39.217143	-77.663946
14	Brens Creek	83,274.5	1.91	39.223337	-77.674647
15	Brens Creek	81,823.4	1.88	39.221528	-77.626501
16	Brens Creek	63,401.3	1.46	39.213469	-77.638175
17	Brens Creek	50,086.7	1.15	39.233470	-77.681400
18	Brens Creek	40,554.8	0.93	39.214047	-77.661173
19	Brens Creek	32,066.4	0.74	39.230237	-77.677750
20	Brens Creek	23,491.7	0.54	39.213865	-77.633548
1	Milltown Creek	468,857.5	10.76	39.244250	-77.664340
2	Milltown Creek	319,859.6	7.34	39.235934	-77.612319
3	Milltown Creek	315,055.7	7.23	39.243408	-77.681945
4	Milltown Creek	194,228.8	4.46	39.243856	-77.645339
5	Milltown Creek	150,361.7	3.45	39.244623	-77.650976
6	Milltown Creek	131,647.8	3.02	39.238620	-77.632538
7	Milltown Creek	104,130.0	2.39	39.247147	-77.688658
8	Milltown Creek	89,124.1	2.05	39.244684	-77.638077
9	Milltown Creek	59,185.8	1.36	39.242257	-77.634907
10	Milltown Creek	48,758.0	1.12	39.233857	-77.623643
11	Milltown Creek	42,646.8	0.98	39.234402	-77.620816
12	Milltown Creek	33,322.6	0.76	39.239933	-77.632741
13	Milltown Creek	32,933.2	0.76	39.244649	-77.654836
14	Milltown Creek	24,874.9	0.57	39.235031	-77.625910
1	Tributary 3 to Catoctin Creek	63,834.1	1.47	39.247559	-77.601910
2	Tributary 3 to Catoctin Creek	46,278.8	1.06	39.248748	-77.604031
3	Tributary 3 to Catoctin Creek	29,085.3	0.67	39.256532	-77.615063
4	Tributary 3 to Catoctin Creek	25,441.1	0.58	39.257017	-77.617613
1	Tributary 2 to Catoctin Creek	59,488.0	1.37	39.253172	-77.586002
2	Tributary 2 to Catoctin Creek	57,169.5	1.31	39.254733	-77.588255
3	Tributary 2 to Catoctin Creek	39,492.3	0.91	39.258235	-77.590649
4	Tributary 2 to Catoctin Creek	33,130.7	0.76	39.256879	-77.590664
1	EcoVillage Tributary	25,501.6	0.59	39.261858	-77.570946