

# Aquatic Biological Assessment of the Watersheds of Anne Arundel County, Maryland: 2013

Anne Arundel County, Maryland  
Department of Public Works  
Watershed, Ecosystem, and Restoration Services



# **Aquatic Biological Assessment of the Watersheds of Anne Arundel County, Maryland: 2013 Round Two—Year Five**

## **November 2013 - Final**

**Prepared for:**



**Anne Arundel County  
Department of Public Works  
Watershed, Ecosystem, and Restoration Services  
Ecological Assessment Program**

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## Abstract

The Anne Arundel County Department of Public Works' Watershed, Ecosystem, and Restoration Services Program assesses water resource quality using a comprehensive countywide biological monitoring and assessment program. The primary goals of the program are to document and track the ecological health of County streams and watersheds, identify the primary stressors on ecological health, and support natural resource management decision making as it relates to the intended uses of County waterbodies and State regulations. One intended use of all water bodies is the support of aquatic life. Assessment of the ability of a stream to support aquatic life can be accomplished for the entire County through probabilistic (random) site selection, sampling of biological specimens, and observations of the physical habitat and water quality. The County's assessment program was continued in 2013 with sampling in five primary sampling units; Cabin Branch, Lower Magothy River, Lyons Creek, Severn River, and Stocketts Run. The indicators used to assess the aquatic life in streams include the Maryland DNR Benthic Index of Biological Integrity (BIBI), the USEPA Rapid Bioassessment Protocol (RBP) physical habitat assessment, the MBSS Physical Habitat Index (PHI), and five water quality measures (temperature, dissolved oxygen, specific conductance, pH, and turbidity), as well as a detailed geomorphic assessment and classification using methods developed by Rosgen (1996). Each of these indicators was compared to established thresholds to determine narrative condition ratings. Three of the five sampling units had mean BIBI values that resulted in 'Poor' biological condition ratings, while the remaining two sampling units had mean BIBI values that resulted in 'Fair' ratings. Lyons Creek and Severn River were the only sampling units with physical habitat conditions rated as 'Supporting' by the RBP method, with the remaining three sampling units rated as 'Partially Supporting.' Using the PHI, all sampling units had 'Partially Degraded' physical habitat conditions. Approximately one-half of reaches (48 percent) were incised F or G type streams (32 percent and 16 percent, respectively). Water quality measurements were within COMAR standards for dissolved oxygen, temperature, and turbidity. Approximately one-fourth of the sites sampled (24 percent), spanning four of the five sampling units, recorded pH values that fell below state standards of 6.5 standard units. Elevated conductivity values were observed at approximately one-third of the sites sampled in 2013 (17 sites), throughout three sampling units. Comparisons of 2013 BIBI data to Round One data resulted in a statistically significant decrease in the average score for Stocketts Run and a statistically significant increase in the average score for Cabin Branch. Comparisons of physical habitat data showed a statistically significant increase in the average RBP score for Lyons Creek. Comparisons of 2013 PHI scores to Round One data also showed a statistically significant increase in the average score for Lyons Creek in addition to the Lower Magothy sampling unit.

## Acknowledgements

The principal authors of this document were Megan Crunkleton, Colin Hill, and Michael Pieper, all of KCI Technologies, Inc. They were assisted by KCI staff including Susanna Brellis and Katherine Myers. Environmental Services and Consulting and the Aquatic Resource Center completed benthic macroinvertebrate sample sorting and identification. County staff instrumental in program management and quality assurance are Janis Markusic and Christopher Victoria in the Department of Public Works, Watershed, Ecosystem, and Restoration Services. The appropriate citation for this report is:

Crunkleton, M.C., C. R.Hill, and M.J. Pieper. 2013. Aquatic Biological Assessment of the Watersheds of Anne Arundel County, Maryland: 2013. Anne Arundel County Department of Public Works, Watershed, Ecosystem, and Restoration Services, Annapolis, Maryland. 54 pp., plus Appendices.

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## 1 Introduction

Anne Arundel County, Maryland is bordered on the north by the Patapsco River, to the west by the Patuxent River, and to the east by the Chesapeake Bay. Anne Arundel County has approximately 1,500 miles of streams and rivers within its borders, all of which drain either directly or indirectly into the Chesapeake Bay. With a drainage area of 64,000 square miles, the Chesapeake Bay is the largest estuary in the United States (USEPA, 2004). The Chesapeake Bay provides habitat for many animal and plant species and is an important economic and recreational resource for more than 15 million people who live in the drainage basin. Increasing populations and development in the basin are intensifying point and nonpoint sources of pollutants and multiple other stressors that affect environmental conditions.

In order to protect these important resources and inform management decisions – not only for the streams and rivers of the County but ultimately the Chesapeake Bay – basic information regarding overall conditions must be understood. To more fully assess the condition of its watershed and stream resources, a Biological Monitoring and Assessment Program was initiated in the spring of 2004 by the Anne Arundel County Office of Environmental and Cultural Resources (now the Watershed, Ecosystem and Restoration Services Group of the Department of Public Works). The sampling program involves monitoring the biological health and physical condition of the County’s water resources to assess the status and trends at the stream level, the watershed level, and ultimately at the County level.

The County initiated the program, in part, to establish a baseline ecological stream condition for all of the County’s watersheds and to track changes in condition over time. The program is designed on a five-year rotating basis such that each of the County’s 24 watersheds or primary sampling units (PSU) will be sampled once every five years. In general, four to five PSUs are sampled each year with 10 sites sampled in each PSU. Table 1 illustrates the progress made to date within the countywide biological monitoring program. The first sampling rotation, Round 1, was completed in five years (2004-2008). Sampling efforts in 2013 mark the fifth, and final, year of Round 2 sampling with 50 randomly selected sites sampled throughout five sampling units (i.e., 10 per PSU).



**Table 1 - Summary of Bioassessment Progress**

Year	Number of Sites	Primary Sampling Unit (code and name)		
<b>Round 1</b>				
2004	50	03-Lower Patapsco 09-Severn Run	10-Severn River 18-Middle Patuxent	21-Ferry Branch
2005	50	11-Upper North River 12-Lower North River	15-Herring Bay 19-Stocketts Run	22-Lyons Creek
2006	40	05-Marley Creek 06-Bodkin Creek	07-Upper Magothy 24-Hall Creek	
2007	50	01-Piney Run 02-Stony Run	08-Lower Magothy 16-Upper Patuxent	17-Little Patuxent
2008	50	04-Sawmill Creek 13-Rhode River	14-West River 20-Rock Branch	23-Cabin Branch
<b>Round 2</b>				
2009	50	05-Marley Creek 12-Lower North River	14-West River 17-Little Patuxent	20-Rock Branch
2010	50	02-Stony Run 04-Sawmill Creek	15-Herring Bay 18-Middle Patuxent	21-Ferry Branch
2011	50	06-Bodkin Creek 07-Upper Magothy	09-Severn Run 11-Upper North River	16-Upper Patuxent
2012	40	01-Piney Run 03-Lower Patapsco	13-Rhode River 24-Hall Creek	
2013	50	08-Lower Magothy 10-Severn River	19-Stocketts Run 22-Lyons Creek	23-Cabin Branch

## 1.1 Purpose of Biological and Physical Habitat Assessment

The use of benthic macroinvertebrates as the basis of biological assessments offers many considerable advantages over other biological assemblages (e.g., fish, periphyton, herpetofauna). For instance, benthic macroinvertebrates are relatively sedentary and easy to sample in large numbers, they respond to cumulative effects of physical habitat alteration, point source pollution, and nonpoint source contaminants, and different aspects of the benthic assemblage change in response to degraded conditions (Barbour et al. 1999).

Physical habitat is also visually assessed at each sampling location to reflect current conditions of physical complexity of the stream channel, the capacity of the stream to support a healthy biota, and the potential of the channel to maintain normal rates of erosion and other hydrogeomorphic functions. Physical habitat of the stream channel can be affected by farming operations, increased housing density, and other urban-suburban developments; all of which may cause sedimentation, degradation of riparian vegetation, and bank instability, leading to reduced overall habitat quality (Richards et al. 1996).

Geomorphic assessments are performed to obtain quantitative information regarding the stream's morphology. The morphological characteristics of a stream channel can provide insight into the impacts of past and present land use on stream stability and/or erosion potential, which can influence the resident biota.

*In situ* water chemistry parameters are measured at every site to supplement biological and physical data. Water chemistry data, while limited in the number of parameters tested, provides a general indication of the chemical conditions of a waterbody and may indicate the presence of water quality stressors.

The combined use of biological, physical, and chemical data is beneficial for detecting impairment and providing insight into the potential types of stressors and stressor sources. This allows prioritization of more detailed, diagnostic investigations based on the severity of observed biological responses.

## 2 Methods

### 2.1 Network Design

#### 2.1.1 Summary of Sampling Design

The sampling design uses a stratified random sampling approach, stratified by stream order. Details of the overall sampling program design, including the approach for the selection of sampling locations, can be found in *Design of the Biological Monitoring and Assessment Program for Anne Arundel County, Maryland* (Hill and Stribling, 2004). Stream assessment protocols including documented standard operating procedures (SOPs) for data collection, sample processing, taxonomic identification, and data management, the technical rationale behind the procedures, and the series of activities and reporting procedures that are used to document and communicate data quality are included in *Anne Arundel County Biological Monitoring and Assessment Program: Quality Assurance Project Plan* (Anne Arundel County, 2011). Documentation of data quality and method performance characteristics, including measurement and data quality objectives (MQOs and DQOs), are presented in Hill and Pieper (2011a).

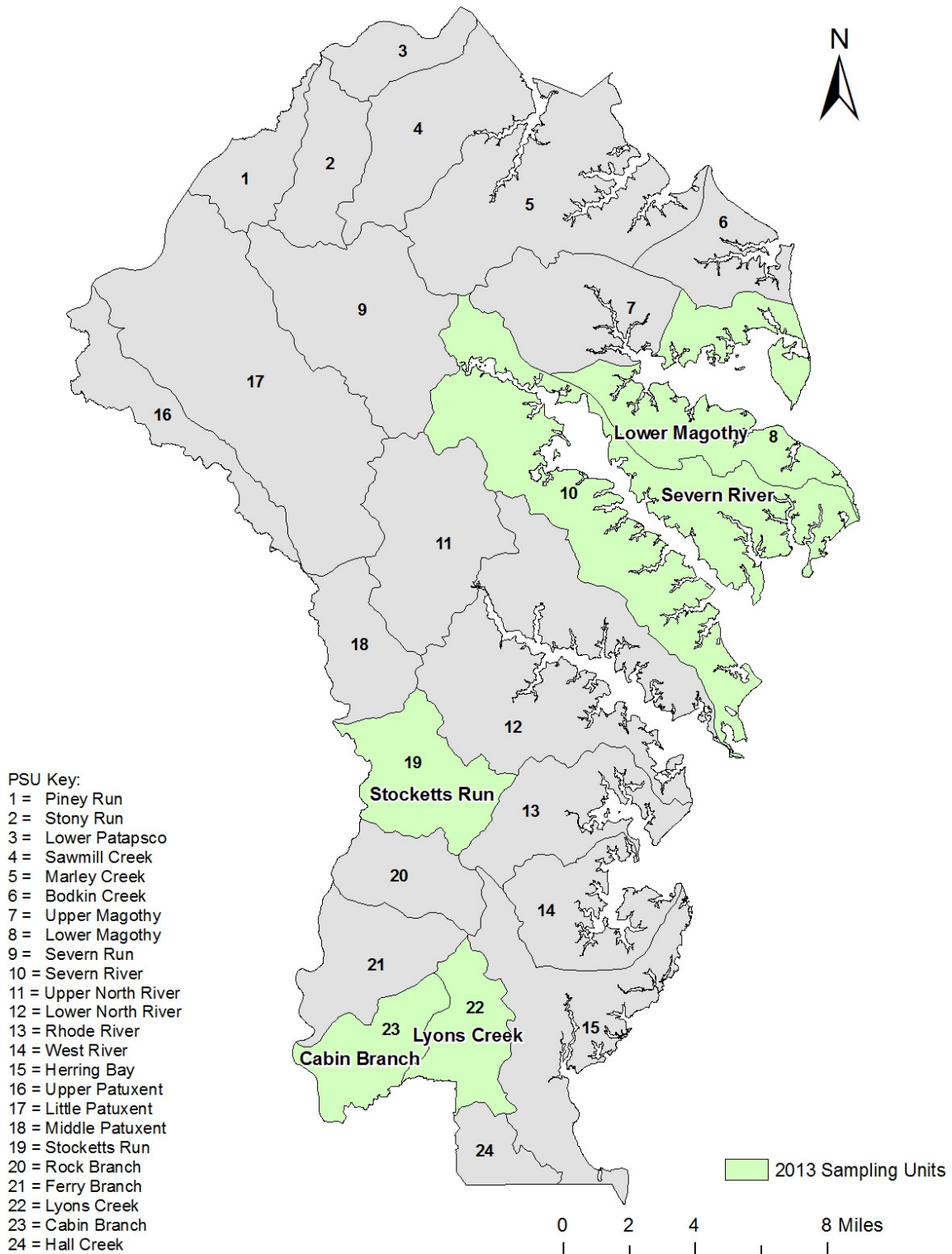
#### 2.1.2 Site Selection

The county was separated into 24 primary sampling units (PSUs) in which ten sites are randomly selected for sampling based on stream order stratification. In this approach, the number of sampling sites within each of the first through third order channel types, as defined by Strahler (1957), was proportional to the percentage of the total PSU stream length that each type comprised. The National Hydrologic Dataset (NHD) 1:100,000-scale stream layer was used in the selection. Four to five PSUs are sampled each year, so that all sampling units are assessed over a five-year period.

For 2013, ten randomly selected sites were chosen from each of the following PSUs (with PSU code); Cabin Branch (23), Lower Magothy River (08), Lyons Creek (22), Severn River (10), and Stocketts Run (19). Figure 1 shows the geographic distribution of PSUs assessed during this sampling period. A single site within each PSU was selected to conduct duplicate sampling for quality assurance/quality control purposes. Duplicate sampling reaches, or QC sites, were located immediately upstream of their paired sampling sites, and were first selected in the office and then assessed in the field to ensure that they had similar habitat characteristics and were not impacted by road crossings, confluences, or other unique stressors not present at the original sampling reach. Biological sampling, habitat assessments, and water quality measurements were repeated at the duplicate sites.

Sites were located in the field using a Trimble Pathfinder ProXT GPS unit coupled with a Panasonic Toughbook® field computer running ESRI's ArcPad mapping software and loaded with recent (2007), high-resolution aerial orthophotography layers and the same NHD stream layer that was used in the site selection process to ensure that the appropriate stream reach was sampled and surveyed. Since the targeted stream layer is based on coarse 1:100,000-scale mapping, pre-selected site coordinates are often several meters away from the actual stream channels. Consequently, the position of the reach mid-point was collected with a Trimble® GPS unit capable of sub-meter accuracy to ensure accurate final positioning of sampling locations. GPS data were recorded in the Maryland State Plane, NAD 1983 Feet coordinate system. The procedures performed at each site are described in detail in Section 2.2.

Figure 1 - 2013 Sampling Units



### 2.1.3 Alternate Sites

In addition to the primary sites, ten secondary (alternate) sites were also chosen at random for each sampling unit in case a primary sampling site was proven to be unsampleable (e.g. permission denied by landowner, no defined channel present, or channel is too deep or unsafe to sample). A total of 13 alternate sites were sampled during this sampling period (Table 2).

**Table 2 - Field Sampling - Alternate Sites Chosen**

Original Site	Alternate Site	Reason
R2-08-01	R2-08-11A	Completely within storm sewer system
R2-08-02	R2-08-12A	Completely within storm sewer system
R2-08-03	R2-08-13A	Permission denied
R2-08-06	R2-08-14A	No stream present
R2-08-09	R2-08-17A	Completely within SWM facility
R2-10-09	R2-10-11A	Overlapped with R2-10-03
R2-19-09	R2-19-11A	Permission denied
R2-19-01	R2-19-16A	Permission denied
R2-23-02	R2-23-12A	Permission denied
R2-22-05	R2-22-12A	Permission denied
R2-22-06	R2-22-19A	Permission denied
R2-22-04	R2-22-21A	Permission denied
R2-22-07	R2-22-27A	Permission denied

## 2.2 Field and Laboratory Procedures

### 2.2.1 Benthic Macroinvertebrate Sampling and Processing

Benthic macroinvertebrate samples were collected during the Spring Index Period (March 1st to May 1st) following the sampling protocols in the Quality Assurance Project Plan (QAPP), which closely mirrors MBSS procedures (DNR, 2010). The approach was used to sample a range of the most productive habitat types within the reach. In this multi-habitat sampling approach, a total of twenty jabs are distributed among the most productive habitats present within the 75-meter reach and sampled in proportion to their dominance within the segment using a D-frame net. The most productive stream habitats are riffles followed by, rootwads, rootmats and woody debris and associated snag habitat; leaf packs; submerged macrophytes and associated substrate; and undercut banks. Less preferred habitats include gravel, broken peat, and clay lumps located within moving water and detrital or sand areas in runs.

All sorting and identification of the subsampled specimens was conducted by Environmental Services and Consulting, LLC<sup>1</sup>. Benthic macroinvertebrate samples were processed and subsampled according to the County QAPP and based on the methods described by Caton (1991). Subsampling is conducted to standardize the sample size and reduce variation caused by samples of different size. In this method, the sample is spread evenly across a gridded tray (30 total grids) and each grid is picked clean of organisms until a minimum count of 100 is reached. If the initial count exceeds 120 organisms, the sample is further subsampled using a gridded petri dish until the final count is between 100 and 120 organisms. If

<sup>1</sup> Address: 516 Roanoke St, Christiansburg, VA 24073

there were any samples containing greater than 120 organisms after taxonomic identification and enumeration, a post-processing subsampling procedure was conducted using an Excel spreadsheet application (Tetra Tech, 2006). This post-processing application is designed to randomly subsample all identified organisms within a given sample to a desired target number. Each taxon is subsampled based on its original proportion to the entire sample. In this case, the desired sample size selected was 110 individuals. This allows for a final sample size of approximately 110 individuals ( $\pm 20$  percent) but keeps the total number of individuals below the 120 maximum.

Taxa were primarily identified to the genus level for most organisms. Groups including Oligochaeta and Nematomorpha were identified to the family level while Nematoda was left at phylum. Individuals of early instars or those that may be damaged were identified to the lowest possible level. Chironomidae were further subsampled depending on the number of individuals in the sample and the numbers in each subfamily or tribe. Most taxa were identified using a stereoscope. Temporary slide mounts were used to identify Oligochaeta to family with a compound scope. Chironomid sorting to subfamily and tribe was also conducted using temporary slide mounts. Permanent slide mounts were then used for final genus level identification. Results were logged on a bench sheet and entered into a spreadsheet for data analysis.

## 2.2.2 Stream Physical Habitat Assessment

Each biological monitoring site was characterized based on visual observation of physical characteristics and various habitat parameters. Both the EPA's Rapid Bioassessment Protocol (RBP) habitat assessment for low gradient streams (Barbour et al., 1999) and the Maryland Biological Stream Survey's (MBSS) Physical Habitat Index (PHI; Paul et al., 2003) were used to visually assess the physical habitat at each site. Both assessment techniques rely on subjective scoring of selected habitat parameters. To reduce individual sampler bias, both assessments were completed as a team with discussion and agreement of the scoring for each parameter. In addition to the visual assessments, photo-documentation of the condition of each assessment reach was performed. Photographs were taken from three locations within the sampling reach (downstream end, mid-point, and upstream end) facing in the upstream and downstream direction, and also facing in the upstream, downstream, left bank, and right bank directions at the cross section location, for a total of ten photographs per site. Additional photographs were occasionally taken to document important or unusual site features.

The RBP habitat assessment consists of a review of ten biologically significant habitat parameters that assess a stream's ability to support an acceptable level of biological health. Each parameter is given a numerical score from 0-20 (20=best, 0=worst), or 0-10 (10=best, 0=worst) for individual bank parameters, and a categorical rating of optimal, suboptimal, marginal or poor. Overall habitat quality typically increases as the total score for each site increases. The RBP parameters assessed for low gradient streams are listed in Table 3.

**Table 3 - RBP Low Gradient Habitat Parameters**

Parameters Assessed	
Epifaunal substrate/available cover	Channel alteration
Pool substrate characterization	Channel sinuosity
Pool variability	Bank stability
Sediment deposition	Vegetative protection
Channel flow status	Riparian vegetation zone width

Source: Barbour et al. 1999

The PHI incorporates the results of a series of habitat parameters selected for Coastal Plain, Piedmont, and Highlands regions. While all parameters are rated during the field assessment, the Coastal Plain parameters are used to develop the PHI score. In developing the PHI, MBSS identified six parameters that have the most discriminatory power for the Coastal Plain streams (Table 4). Each habitat parameter is given an assessment score ranging from 0-20, with the exception of shading (percentage) and woody debris and rootwads (total count).

**Table 4 - PHI Habitat Parameters**

Parameters Assessed	
Remoteness	Instream habitat
Shading	Woody debris and rootwads
Epibenthic substrate	Bank stability

Source: Paul et al. 2003

### 2.2.3 Water Quality Measurement

To assess general water quality conditions, several water chemistry parameters were measured *in situ* at each site. Field measured water chemistry parameters include pH, specific conductivity, dissolved oxygen, temperature, and turbidity. With the exception of turbidity, which was measured at a single point in the upstream end of the site, all measurements were collected from three locations within each sampling reach (upstream end, mid-point, and downstream end) and results were averaged to minimize variability and better represent water quality conditions throughout the entire sampling reach. Most *in situ* parameters (i.e., temperature, pH, conductivity, and dissolved oxygen) were measured with a YSI Professional Plus series multiprobe, while turbidity was measured with a Hach 2100 Turbidimeter. Water quality meters were regularly inspected, maintained, and calibrated to ensure proper usage and accuracy of the readings. Calibration logs were kept by field crew leaders and checked by the project manager regularly.

### 2.2.4 Geomorphic Assessment

Geomorphic assessments, which included a simplified longitudinal profile survey, cross section survey, and modified Wolman pebble count, were conducted within each 75-meter sampling reach. Data were directly entered into the Ohio Department of Natural Resources (ODNR) Reference Reach Spreadsheet Version 4.3L (Mecklenburg, 2006) in the field using a field computer loaded with Microsoft Excel software. Data collected from the assessments were primarily used to determine the morphological stream type of each sampling reach according to the Rosgen Stream Classification (Rosgen, 1994, 1996). Assessment methods followed the standard operating procedures (SOPs) described in the QAPP, and are described briefly below.

Permanent cross sections were established on a representative transitional reach, typically in a riffle feature, and monumented with iron reinforcement bars topped with yellow plastic survey marker caps. The location of each monument was recorded using a Trimble Pathfinder ProXT GPS unit capable of sub-meter accuracy. Cross sections were surveyed using a laser level, calibrated stadia rod, and measuring tape. The surveys captured features of the floodplain, monuments, and all pertinent channel features including:

- Top of bank
- Bankfull elevation
- Edge of water
- Limits of point and instream depositional features

- Thalweg
- Floodprone elevation

Bankfull elevation was determined in the field using appropriate bankfull indicators as described in Rosgen (1996) and with the assistance of the Maryland Coastal Plain (MCP) regional relationships of bankfull channel geometry (McCandless, 2003). Using the drainage areas delineated to each monitoring location, as described in section 2.3.6 *Land Use Analysis and Impervious Surface*, the approximate bankfull cross sectional areas were derived from the MCP curve and field crews verified bankfull elevations while in the field.

Sinuosity was determined based on the length of the survey reach following the thalweg thread (i.e., 75-meters) and the straight-line distance between the upstream and downstream extent of the channel. If the stream was not incised, the floodprone width was measured at the cross section using an elevation of two times the bankfull depth.

Survey points were taken near the upstream, midpoint, and downstream end of the sampling reach to obtain the water surface slope and elevation of the bankfull discharge. Survey points for slope calculations were typically taken at top of riffle features, although this was not always possible due to available instream features. In the absence of riffle features, the best available feature (e.g., run, glide) was used ensuring that the same bed feature was used in the upstream and downstream extents of the reach.

The channel bed materials were characterized throughout each survey reach using a proportional pebble count procedure adapted from Harrelson et al. (1994), which stratifies the reach by the proportion of pool, riffle, run, and glide features within the entire reach. The pebble count technique, modified from Wolman (1954), was conducted at each site to determine the composition of channel materials and the median particle size (i.e.,  $D_{50}$ ) within each survey reach. The pebble count was conducted at 10 transects positioned throughout the entire reach based on the proportion of bed features, and 10 particles (spaced as evenly as possible) were measured across the bankfull channel of each transect, resulting in a total of 100 particles. Particles were chosen without visual bias by reaching forth with an extended finger into the stream bed while looking away and choosing the first particle that comes in contact with the sampler's finger. All particles are then measured to the nearest millimeter across the intermediate axis using a ruler. For channels comprised entirely of fine sediments (e.g., sand, silt, or clay) with no distinct variation in material size, only two transects were performed and the results were extrapolated to the remainder of the reach.

## 2.3 Data Analysis

### 2.3.1 Data Structure

Benthic macroinvertebrate, physical habitat, water chemistry, geomorphic, land cover, land use, and impervious data were entered into an ESRI personal geodatabase. This relational database allows for the input and management of field collected data including physical habitat and water chemistry parameters, as well as taxonomic data, calculated metric and index scores, geomorphic and land use parameters, and other metadata. Furthermore, the data are geospatially linked to each site and drainage area for enhanced mapping and spatial analysis capabilities. Benthic macroinvertebrate index (BIBI) scores and physical habitat index (RBP and PHI) scores were calculated using controlled and verified Microsoft Excel spreadsheets. Final index values and scores for each site were imported into the geodatabase.

### 2.3.2 Physical Habitat

The individual RBP habitat parameters for each reach were summed to obtain an overall RBP assessment score. The total score, with a maximum possible score of 200, was then placed into one of four categories based on their percent comparability to reference conditions (Table 5). Since adequate reference condition scores do not currently exist for Anne Arundel County, the categories used in this report were adapted from Plafkin et al. (1989) and are based on western coastal plain reference conditions obtained from Prince George's County streams (Stribling et al., 1999).

Using the raw habitat values recorded in the field, a scaled PHI score (ranging from 0-100) for each parameter is calculated following the methods described in Paul et al. (2003). Several of the parameters (i.e., epifaunal substrate, instream habitat, and woody debris and rootwads) have been found to be drainage area dependent and are scaled according to the drainage area to each site. A detailed description of the procedure used to delineate site-specific drainage areas is included in section 2.3.6 *Land Use Analysis and Impervious Surface*. Calculated metric scores are then combined and averaged to obtain the overall PHI index score, and a corresponding narrative rating of the physical habitat condition is applied (Table 6).

**Table 5 - EPA RBP Scoring**

Score	Narrative
151 +	Comparable
126-150	Supporting
101-125	Partially Supporting
0-100	Non Supporting

Source: Stribling et al. 1999

**Table 6 - MBSS PHI Scoring**

Score	Narrative
81-100	Minimally Degraded
66-80.9	Partially Degraded
51-65.9	Degraded
0-50.9	Severely Degraded

Source: Paul et al. 2003

### 2.3.3 Biological Index Rating

Benthic macroinvertebrate data were analyzed using methods developed by MBSS as outlined in the *New Biological Indicators to Better Assess the Condition of Maryland Streams* (Southerland et al., 2005). The Benthic Index of Biotic Integrity (BIBI) approach involves statistical analysis using metrics that have a predictable response to water quality and/or habitat impairment. The metrics selected fall into five major groups including taxa richness, composition measures, tolerance to perturbation, trophic classification, and habit measures.

Raw values from each metric are given a score of one (1), three (3) or five (5) based on ranges of values developed for each metric, as shown in Table 7. The scored metrics are combined and averaged into a scaled BIBI score ranging from 1.0 to 5.0, and a corresponding narrative biological condition rating is assigned (Table 8). Three sets of metric calculations have been developed for Maryland streams based on broad physiographic regions, which include the Coastal Plain, Piedmont, and Combined Highlands



regions. Anne Arundel County is located entirely within the Coastal Plain region; therefore, the metrics selected and calibrated specifically for Maryland Coastal Plain streams were used for the BIBI scoring and include:

- 1) *Total Number of Taxa* – Equals the richness of the community in terms of the total number of genera at the genus level or higher. A large variety of genera typically indicate better overall water quality, habitat diversity and/or suitability, and community health.
- 2) *Number of EPT Taxa* – Equals the number of genera that classify as Ephemeroptera (mayflies), Plecoptera (stoneflies), and/or Trichoptera (caddisflies) in the sample. EPT taxa are generally considered pollution sensitive, thus higher levels of EPT taxa would be indicative of higher water quality.
- 3) *Number of Ephemeroptera Taxa* – Equals the total number of Ephemeroptera Taxa in the sample. Ephemeroptera are generally considered pollution sensitive, thus communities dominated by Ephemeroptera usually indicate lower disturbances in water quality.
- 4) *Percent Intolerant Urban* – Percentage of sample considered intolerant to urbanization. Equals the percentage of individuals in the sample with a tolerance value of 0-3. As impairment increases, the percent of intolerant taxa decreases.
- 5) *Percent Ephemeroptera* – Equals the percent of Ephemeroptera individuals in the sample. Ephemeroptera are generally considered pollution sensitive, thus communities dominated by Ephemeroptera usually indicate lower disturbances in water quality.
- 6) *Number Scrapper Taxa* – Equals the number of scrapper taxa in the sample. Individuals in these taxa scrape food from the substrate. As the levels of stressors or pollution rise, there is an expected decrease in the numbers of scrapper taxa.
- 7) *Percent Climbers* – Equals the percentage of the total number of individuals who are adapted to living on stem type surfaces. Higher percentages of climbers typically represent a decrease in stressors and overall better water quality.

Information on functional feeding group, habit, and tolerance values for each organism were derived primarily from Southerland et al. (2005), which is based heavily on information compiled from Merritt and Cummins (1996) and Bressler et al. (2004). Secondary sources, primarily EPA’s RBP document (Barbour et al. 1999), were used only when a particular organism was not included in Southerland et al. (2005).

**Table 7 - MBSS Coastal Plain BIBI Metric Scoring**

Metric	Score		
	5	3	1
Total Number of Taxa	≥22	14-21	<14
Number of EPT Taxa	≥5	2-4	<2
Number of Ephemeroptera Taxa	≥2	1-1	<1
Percent Intolerant Urban	≥28	10-27	<10
Percent Ephemeroptera	≥11.0	0.8-10.9	<0.8
Number of Scrapper Taxa	≥2	1-1	<1
Percent Climbers	≥8.0	0.9-7.9	<0.9

Source: Southerland et al. 2005

**Table 8 - MBSS Biological Condition Rating**

BIBI Score	Narrative Rating	Characteristics
4.0 – 5.0	Good	Comparable to reference streams considered to be minimally impacted.
3.0 – 3.9	Fair	Comparable to reference conditions, but some aspects of biological integrity may not resemble minimally impacted streams.
2.0 – 2.9	Poor	Significant deviation from reference conditions, indicating some degradation.
1.0 – 1.9	Very Poor	Strong deviation from reference conditions, with most aspects of biological integrity not resembling minimally impacted streams indicating severe degradation.

### 2.3.4 Water Quality

The Maryland Department of the Environment (MDE) has established acceptable standards for several of the water chemistry parameters measured in this study for each designated Stream Use Classification. Water quality data were compared to acceptable standards for Use I streams listed in the *Code of Maryland Regulations (COMAR) 26.08.02.03-.03 - Water Quality* (Table 9). Specific designated uses for Use I streams include water contact sports, fishing, the growth and propagation of fish, and agricultural, and industrial water supply. Currently, there are no standards available for conductivity. However, Morgan et al. (2007) identified a critical threshold between 'Fair' and 'Poor' stream quality for Maryland streams at 247  $\mu\text{S}/\text{cm}$ .

**Table 9 - Maryland COMAR Standards for Use I Waters**

Parameter	Standard
pH (SU)	6.5 to 8.5
Dissolved Oxygen (mg/L)	Minimum of 5 mg/L
Conductivity ( $\mu\text{S}/\text{cm}$ )	No State standard
Turbidity (NTU)	Maximum of 150 Nephelometric Turbidity Units (NTU's) and maximum monthly average of 50 NTU
Temperature ( $^{\circ}\text{C}$ )	Maximum of 32 $^{\circ}\text{C}$ (90 $^{\circ}\text{F}$ ) or ambient temperature of the surface water, whichever is greater

Source: Code of Maryland Regulations (COMAR) 26.08.02.03-3 – Water Quality

### 2.3.5 Geomorphic Assessment

Geomorphic assessment data were managed using ODNR's Reference Reach Spreadsheet Version 4.3L (Mecklenburg, 2006). This program was used to compile and plot field data and to analyze geometry, profile, and channel material characteristics of each assessment reach. In addition, the following values and/or ratios were calculated:

- Bankfull height, width, and area
- Mean bankfull depth
- Width/depth ratio
- Entrenchment ratio
- Floodprone width
- Sinuosity
- Water surface slope
- $D_{50}$

Data from the geomorphic assessments were used to determine the stream type of each reach as categorized by the Rosgen Stream Classification (Rosgen, 1996). In this classification method, streams are categorized based on their measured values of entrenchment ratio, width/depth ratio, sinuosity, water surface slope, and channel materials. General descriptions for each major stream type (A, G, F, B, E, C, D and DA) and delineative criteria for broad-level (Level I) classification are provided in Table 10. Rosgen Level II characterization incorporates a numeric code (1 – 6) for dominant bed materials and a slope range modifier (a+, a, b, c, or c-) to provide a more detailed morphological description. For instance, a G type stream with gravel dominated bed and a water surface slope of less than 2 percent would be classified as a G4c stream.

**Table 10 - Rosgen Channel Type Description and Delineative Criteria for Level I Classification.**

Channel Type	General Description	Entr. Ratio	W/D Ratio	Sinuosity	Slope	Landform/Soils/Features
Aa+	Very steep, deeply entrenched, debris transport, torrent streams.	<1.4	<12	1.0-1.1	>10%	Very high relief. Erosional, bedrock or depositional features; debris flow potential. Deeply entrenched streams. Vertical steps with deep scour pools; waterfalls.
A	Steep, entrenched, confined, cascading, step/pool streams. High energy/debris transport associated with depositional soils. Very stable if bedrock or boulder dominated channel.	<1.4	<12	1.0-1.2	4% - 10%	High relief. Erosional or depositional and bedrock forms; Entrenched and confined streams with cascading reaches. Frequently spaced, deep pools in step/pool bed morphology.
B	Moderately entrenched, moderate gradient, riffle dominated channel with infrequently spaced pools. Moderate width/depth ratio. Narrow, gently sloping valleys. Very stable plan and profile. Stable banks.	1.4 - 2.2	>12	>1.2	2%- 3.9%	Moderate relief, colluvial deposition, and/or structural. Moderate entrenchment and W/D ratio. Narrow, gently sloping valleys. Rapids predominate with scour pools.
C	Low gradient, meandering, slightly entrenched, point-bar, riffle/pool, alluvial channels with broad, well-defined floodplains.	>2.2	>12	>1.2	<2%	Broad valleys w/ terraces, in association with floodplains, alluvial soils. Slightly entrenched with well-defined meandering channels. Riffle/pool bed morphology.
D	Braided channel with longitudinal and transverse bars. Very wide channel with eroding banks. Active lateral adjustment, high bedload and bank erosion.	n/a	>40	n/a	<4%	Broad valleys with alluvium, steeper fans. Glacial debris and depositional features. Active lateral adjustment w/abundance of sediment supply. Convergence/divergence bed features, aggradational processes, high bedload and bank erosion.
DA	Anastomosing (multiple channels) narrow and deep with extensive, well-vegetated floodplains and associated wetlands. Very gentle relief with highly variable sinuosities and width/depth ratios. Very stable stream banks.	>2.2	variable	variable	<0.5%	Broad, low-gradient valleys with fine alluvium and/or lacustrine soils. Anastomosed geologic control creating fine deposition w/well-vegetated bars that are laterally stable with broad wetland floodplains. Very low bedload, high wash load sediment.
E	Low gradient, Highly sinuous, riffle/pool stream with low width/depth ratio and little deposition. Very efficient and stable. High meander/width ratio.	>2.2	<12	>1.5	<2%	Broad valley/meadows. Alluvial materials with floodplains. Highly sinuous with stable, well-vegetated banks. Riffle/pool morphology with very low width/depth ratios
F	Entrenched, meandering riffle/pool channel on low gradients with high width/depth ratio and high bank erosion rates.	<1.4	>12	>1.2	<2%	Entrenched in highly weathered material. Gentle gradients, with a high width/depth ratio. Meandering, laterally unstable w/ high bank erosion rates. Riffle/pool morphology.
G	Entrenched 'gully' step/pool and low width/depth ratio on moderate gradients. Narrow valleys. Unstable, with grade control problems and high bank erosion rates.	<1.4	<12	>1.2	2%- 3.9%	Gullies, step/pool morphology w/ moderate slopes and low W/D ratio. Narrow valleys, or deeply incised in alluvial or colluvial materials. Unstable w/ grade control problems and high bank erosion rates.

Source: Rosgen, 1996

Since the primary goal of the geomorphic assessment component is to supplement biological assessments, the survey reach was constrained to within the randomly selected 75-meter sampling reach and a limited suite of geomorphic parameters was collected. Therefore, the data have certain limitations that should be noted:

- Stream classifications, slopes, and channel materials are only representative of the 75-meter reach in which they were evaluated. In some cases, these data are representative of shorter reaches, depending on site conditions. In other cases, a survey reach is located at a transition point between two different stream types and may contain more than one classification. Since only one cross sectional survey is performed per reach, the transitional portion of the reach without the cross sectional data is classified using best professional judgment. This classification is based primarily on the degree of incision and width/depth ratio in comparison to the surveyed cross section.
- Typically, stream classification using the Rosgen methodology is best performed on riffle or step cross sections. Some of the 75-meter survey reaches assessed in this study did not contain riffle or step features.
- Pebble count data were collected for stream classification purposes only and are not appropriate for use in hydraulic calculations of bankfull velocity and discharge. This is particularly the case for the many sand bed channels in the study area, where data on the dune height would be used instead of the 84<sup>th</sup> percentile particle size, or  $D_{84}$ , in hydraulic calculations. Dune height data were not collected for this study.
- No detailed analyses of stream stability were performed for this study. Statements referring to stream stability are based solely on observations and assumptions, which are founded on fundamental geomorphic principles. Conclusive evidence of the stability of the sampling units assessed could only be obtained after detailed watershed and stream stability assessments were performed.

### 2.3.6 Land Use Analysis and Impervious Surface

All geospatial analysis was performed using Countywide GIS coverages in ArcGIS 9.3. Land use analysis was completed with the use of the County's 2011 Land Cover GIS layer. Original land cover categories were combined into four primary land use classes to better summarize the conditions in the sampling units (Table 11). The County's 2011 impervious layer was used to assess imperviousness to each site. Site specific land use and impervious surface analysis was completed using drainage areas delineated to each sampling point. The drainage area to each point was delineated using a countywide 3-meter raster grid digital elevation model (DEM) from the United States Department of Agriculture (USDA) Forest Service dataset. The DEM was used to produce a stream flow accumulation and flow direction grid using the Arc Hydro extension toolset. Bioassessment sampling points were snapped to the closest point on the new stream grid generated from the DEM; then, batch sub-watersheds were generated using these three files. Subwatersheds were then summed where necessary to generate the appropriate drainage area to each bioassessment site.

One site in Lyons Creek and one site in Cabin Branch receive drainage from northern Calvert County. Calvert County drainage includes 578 acres (8.7 percent of the total drainage area) for site R2-22-21A and 914 acres (9.6 percent of the total drainage area) for site R2-23-12A. Calvert County land cover and impervious surface data were not included in the analysis for these sites. Based on an aerial imagery analysis, land use is generally the same within the Calvert County drainage for both sites (forested land

with some residential use). While a 92 acre golf course was identified within the drainage area of R2-23-12A, it accounts for less than one percent of this sites’ total drainage area and, as such, was considered likely to have a minimal impact on biological conditions observed here.

**Table 11 - Combined Land Use Classes**

Land Use Class	Land Cover Type
Developed	Airport, Commercial, Industrial, Transportation, Utility, Residential (1/8-ac., ¼-ac., ½-ac., 1-ac., and 2-ac.)
Forested	Forested wetland, Residential woods, Woods
Agriculture	Pasture/hay, Row crops
Open Space	Open space, Open wetland, Water

### 3 Results and Discussion

This section first discusses the overall results across all sampling units, and is then followed by a more detailed discussion on results specific to each sampling unit. Appendix B includes a thorough discussion on the data quality of the biological results. A listing of all taxa identified and their characteristics (i.e., functional feeding group, habit, tolerance value) is included as Appendix C.

#### 3.1 Comparisons among Sampling Units

Biological, physical, and water quality conditions, as well as geomorphic assessment results, are discussed for all of the sampling units assessed in 2013. Comparisons primarily focus on mean results for each sampling unit, which due to the random nature of the site selection process, are considered representative of the typical condition of streams contained within, even for stream reaches where no data were directly collected. Table 12 summarizes overall biological and habitat conditions for each sampling unit.

**Table 12 - Summary of BIBI and habitat scores across sampling units (n = 10 for each sampling unit)**

Sampling Unit	Average BIBI Score ±SD / Condition Narrative	Average PHI Habitat Score ±SD / Condition Narrative	Average RBP Habitat Score ±SD / Condition Narrative
Cabin Branch	3.34 ± 0.81 Fair	72.4 ± 10.1 Partially Degraded	118.6 ± 20.3 Partially Supporting
Lower Magothy	2.17 ± 0.59 Poor	67.3 ± 10.6 Partially Degraded	117.0 ± 28.8 Partially Supporting
Lyons Creek	3.00 ± 0.98 Fair	71.9 ± 6.1 Partially Degraded	126.7 ± 21.5 Supporting
Severn River	2.77 ± 0.63 Poor	75.2 ± 10.1 Partially Degraded	137.5 ± 19.8 Supporting
Stocketts Run	2.60 ± 0.91 Poor	68.0 ± 5.6 Partially Degraded	118.6 ± 19.4 Partially Supporting

##### 3.1.1 Biological and Habitat Assessment Summary

Overall, the majority of sampling site BIBI scores throughout the sampling units were split between a rating of ‘Poor’ (40 percent) and Fair (36 percent) with a small proportion of sites rated as ‘Very Poor’ (18 percent) and only three sites rated as ‘Good’ (six percent; Figure 2). All sampling units had mean

BIBI values that resulted in 'Poor' or 'Fair' biological condition ratings (Table 12). There were no sampling units rated as 'Good' or 'Very Poor' for biological condition.

Physical habitat assessment results indicate that three of the five sampling units, as determined by the sampling unit mean, received ratings of 'Partially Supporting' (RBP; Table 12). Approximately half (44 percent) of the total sites sampled resulted in a RBP rating of 'Supporting' and approximately one-fourth of the samples (28 percent) resulted in a 'Partially Supporting' rating (Figure 3). Only a small proportion of sites were rated as either 'Non Supporting' (16 percent) or 'Comparable to Reference' (12 percent). All five sampling units received PHI ratings of 'Partially Degraded' as determined by the sampling unit mean. Over half of the total sites sampled resulted in a PHI rating of 'Partially Degraded' (58 percent), approximately one-third of the total sites received 'Degraded' ratings (30 percent), ten percent resulted in 'Minimally Degraded' ratings, and a very small percentage of sites received 'Severely Degraded' ratings (two percent).

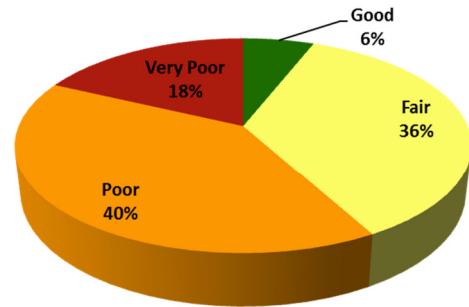


Figure 2 - Summary of Biological Conditions for Sites Assessed in 2013 (n=50)

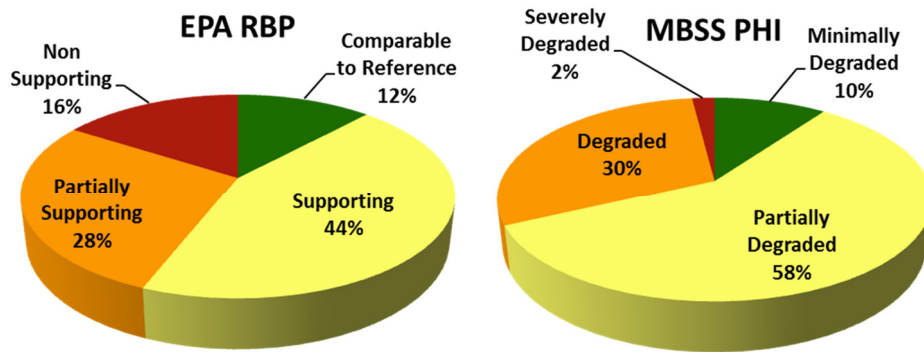


Figure 3 - Summary of Physical Habitat Conditions for Sites Assessed in 2013 (n=50)

### 3.1.2 Water Quality Assessment Summary

Water quality measurements were within COMAR standards for temperature, dissolved oxygen, and turbidity at all sites. Low pH values, which were outside the acceptable range of values set forth by COMAR (i.e., 6.5 – 8.5 SU), were recorded at 12 sites and spanning four of the five PSUs sampled in 2013. The pH values ranged from 5.57 – 6.48 for the 12 sites that did not meet COMAR standards for water quality. Approximately one-third of sites sampled in 2013 (17 sites) showed conductivity levels exceeding 247  $\mu\text{S}/\text{cm}$ , which is the critical threshold between 'Fair' and 'Poor' stream quality determined for Maryland streams (Morgan et al., 2007). While there are currently no COMAR standards for conductivity, elevated levels are commonly associated with increased impervious surface upstream in the watershed and often attributed to runoff from roadways, particularly during winter roadway de-icing periods.

### 3.1.3 Geomorphic Assessment Summary

Stream types throughout the sampling units were highly variable, with the largest portion of the sites being entrenched F or G channels (32 and 16 percent, respectively; Figure 4). Eighteen percent of the sites were classified as E channels, the majority of which were located in the Severn River and Lower Magothy sampling units. Comprising 12 percent, anastomosed DA type channels were found in Lower Magothy, Lyons Creek, and Severn River. Fourteen percent of sites were placed into the 'ND' (Not Determined) category due to considerable anthropogenic modification (i.e., channel alteration, hardened banks) or due to natural influences which inhibit channel classification (i.e., beaver dams). A major assumption of the Rosgen characterization system is that the stream channel has the ability to adjust its dimensions naturally. Thus, reaches that have been heavily channelized or unnaturally modified violate this assumption and the channel dimensions may not be representative of natural conditions. The remaining eight percent of sites were classified as 'Transitional' in which case the Rosgen characterization changed within the boundaries of the sampling reach. The majority of sites classified as Transitional were influenced by the effects of a headcut within the sampling reach.

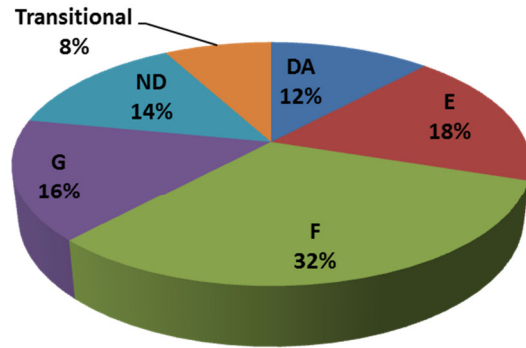


Figure 4 - Distribution of Rosgen Stream Types for Sites Assessed in 2013 (n=50)

Over two-thirds of sites sampled in 2013 (66 percent) had channel substrates composed primarily of sand. Silt/clay dominated streams comprised just over one-fourth (26 percent) of the total sites. The remaining six percent of sites had predominantly gravel channel substrates. One site in the Lower Magothy sampling unit was a channelized trapezoid channel with concrete substrate. Stream slopes in the assessment reaches were generally low (i.e., below one percent). The average slope of all reaches assessed was 0.60 percent. Average slopes for the sampling units ranged from 0.50 percent in Lyons Creek to 0.83 percent in Severn River.

### 3.1.4 Land Use Analysis and Impervious Surface Summary

A summary of land use and impervious surface across each sampling unit assessed in 2013 is presented in Table 13.

Table 13 - Summary of land use and impervious surface across sampling units

Sampling Unit	Total Acreage	% Impervious	Land Use			
			% Developed	% Forested	% Agriculture	% Open
Cabin Branch	6,443	2.9	18.3	44.8	21.8	15.1
Lower Magothy	12,697	19.1	64.4	28.7	0.6	6.3
Lyons Creek	6,154	4.4	24.3	37.6	31.3	6.8
Severn River	28,920	18.9	57.4	32.1	2.7	7.9
Stocketts Run	8,714	4.9	28.9	43.9	17.5	9.7

One-half of the sites sampled in 2013 had developed land as the dominant land use (50.0 percent), while the remaining sites were dominated by forested land (36.0 percent) and agriculture (14.0 percent). At the sampling unit scale, Lower Magothy had the highest percentage of developed land at 64.4 percent of the total acreage, which was followed by Severn River at 57.4 percent (Table 13). With over 50 percent of the drainage area comprised of developed land, Lower Magothy and Severn River can be

considered urbanized subwatersheds. In contrast, Cabin Branch was the least developed, with 18.3 percent of the sampling unit attributed to developed land. Developed land was also low in Lyons Creek (24.3 percent) and Stocketts Run (28.9 percent), which collectively with Cabin Branch can be considered rural subwatersheds. Cabin Branch and Stocketts Run had the highest proportion of forested land at 44.8 and 43.9 percent, respectively, while Lower Magothy had the lowest proportion (28.7 percent). The highest proportion of agricultural land use occurred in Lyons Creek (31.3 percent), followed by Cabin Branch at 21.8 percent. In contrast, agricultural land use was not as predominant in Lower Magothy (0.6 percent) and Severn River (2.7 percent). Figure 5 shows land use for the entire County based on the County's 2011 Land Cover GIS layer. The sampling units with the highest percentage of impervious surface were Lower Magothy (19.1 percent) and Severn River (18.9 percent) while Cabin Branch had the lowest percentage of impervious surface (2.9 percent). Figure 6 shows impervious surface for the entire County based on the County's 2011 Impervious GIS layer.



Figure 5 - Summarized Land Use in Anne Arundel County (2011)

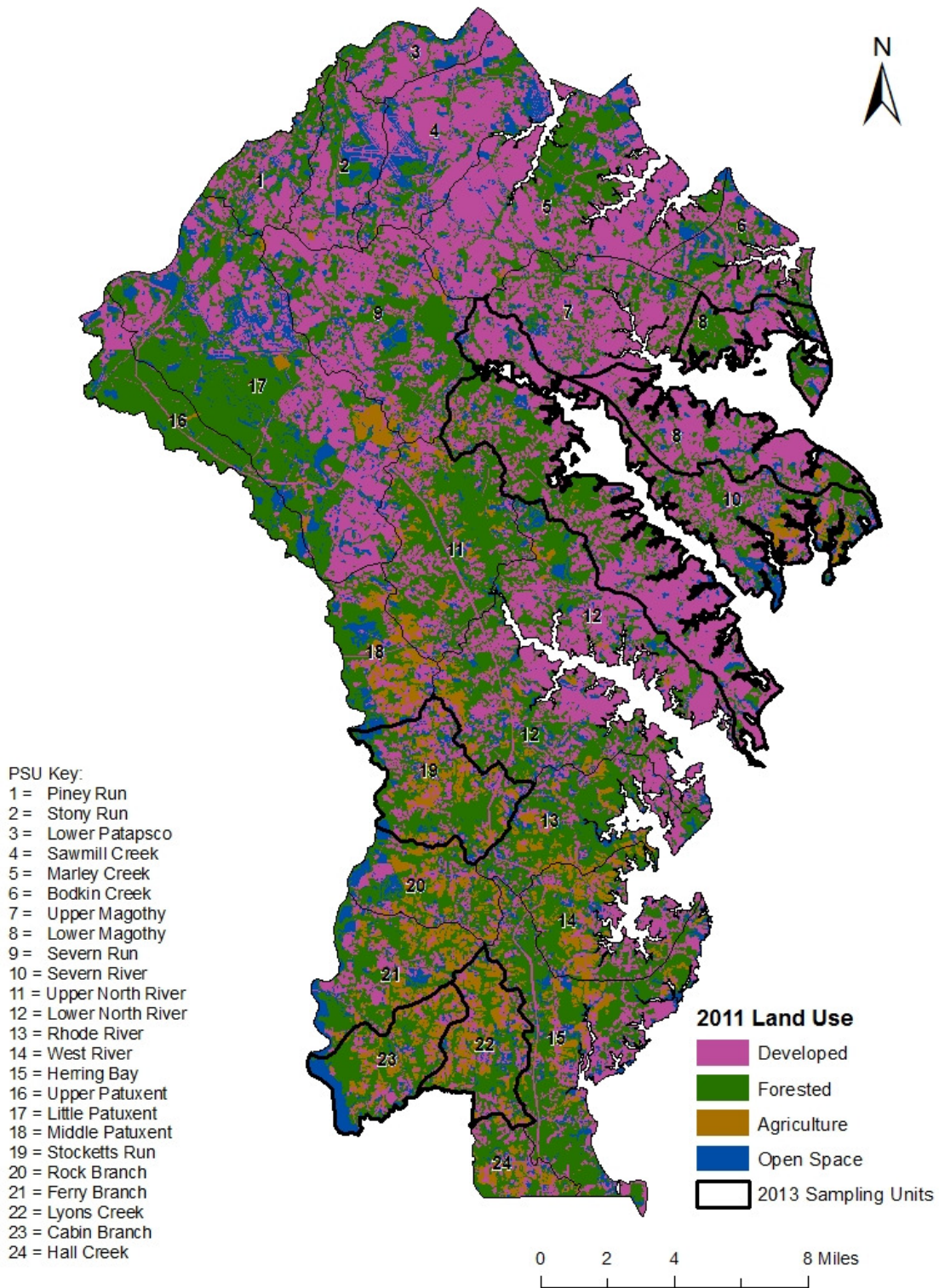
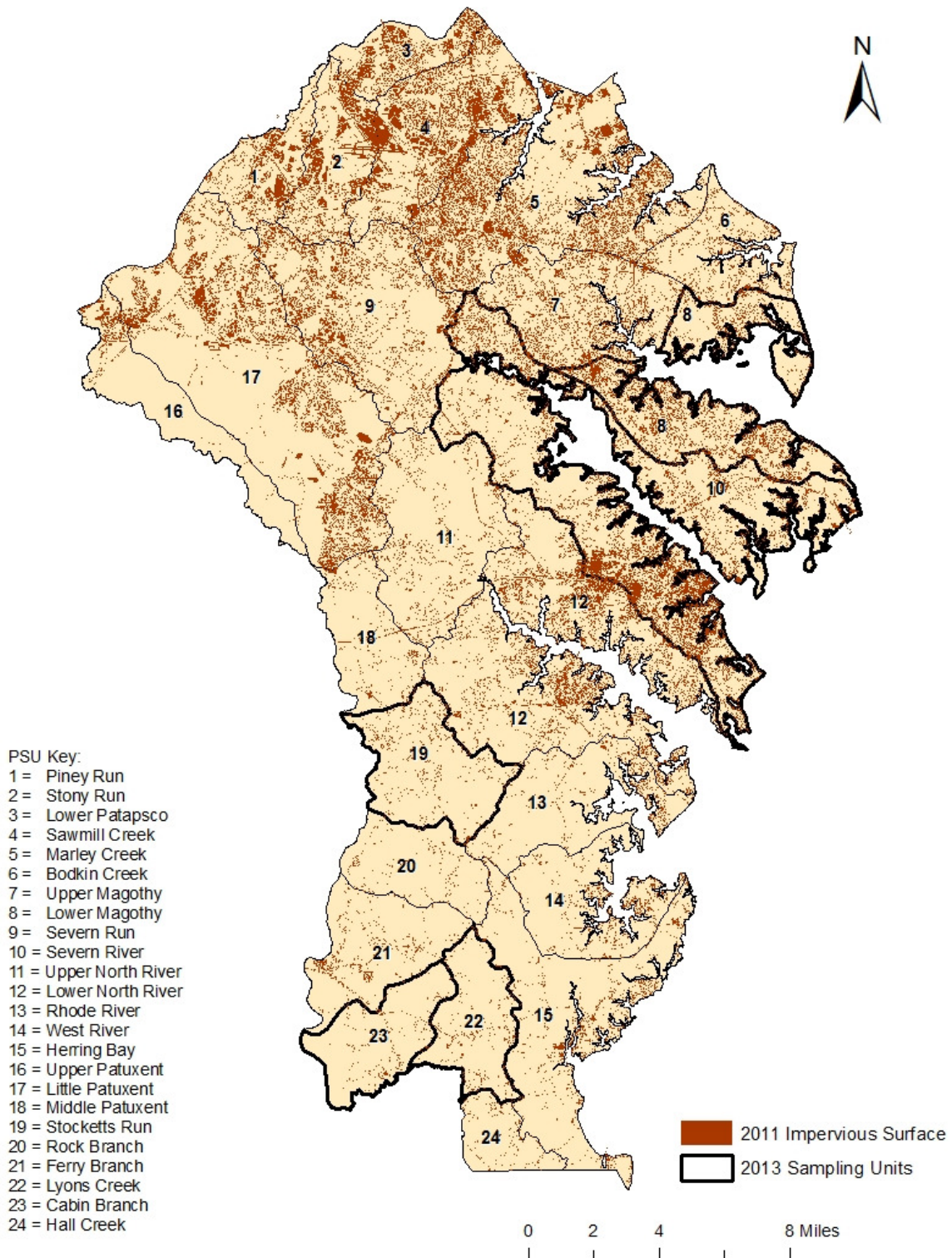


Figure 6 - Impervious Surface in Anne Arundel County (2011)



## 4 Individual Sampling Unit Discussions

The following section summarizes the conditions within each of the five sampling units assessed. Site-specific data and assessment results can be found in Appendix D.

### 4.1 Cabin Branch

The Cabin Branch sampling unit, located in the southern tip of the County (Figure 1), has a total drainage area of 6,443 acres and drains directly into the Patuxent River. The ten sampling sites (eight 1<sup>st</sup> order, one 2<sup>nd</sup> order, and one 3<sup>rd</sup> order) shown in Figure 8, have drainage areas ranging from 47 to 9,573 acres, with one site in the Cabin Branch sampling unit (R2-23-12A) including drainage that extends into Calvert County. The dominant land use for the Cabin Branch sampling unit is forested land (45 percent), followed by agriculture (22 percent) and developed land (18 percent). Forested land is the dominant land use for 80 percent of the sites sampled, while the remaining 20 percent of sites are agricultural (Figure 7). Impervious surfaces comprise only 2.9 percent of the overall Cabin Branch sampling unit, with individual sites ranging from 0.5 percent, which is the lowest percentage for all sites sampled in 2013, to 3.8 percent impervious surface.

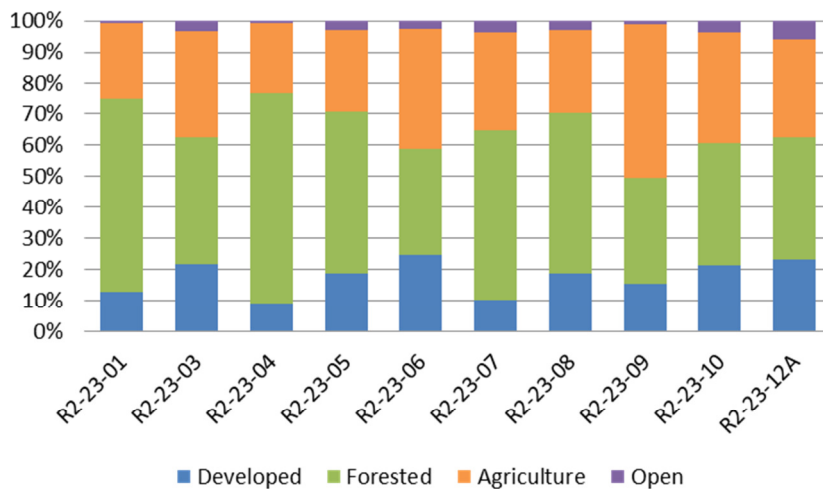
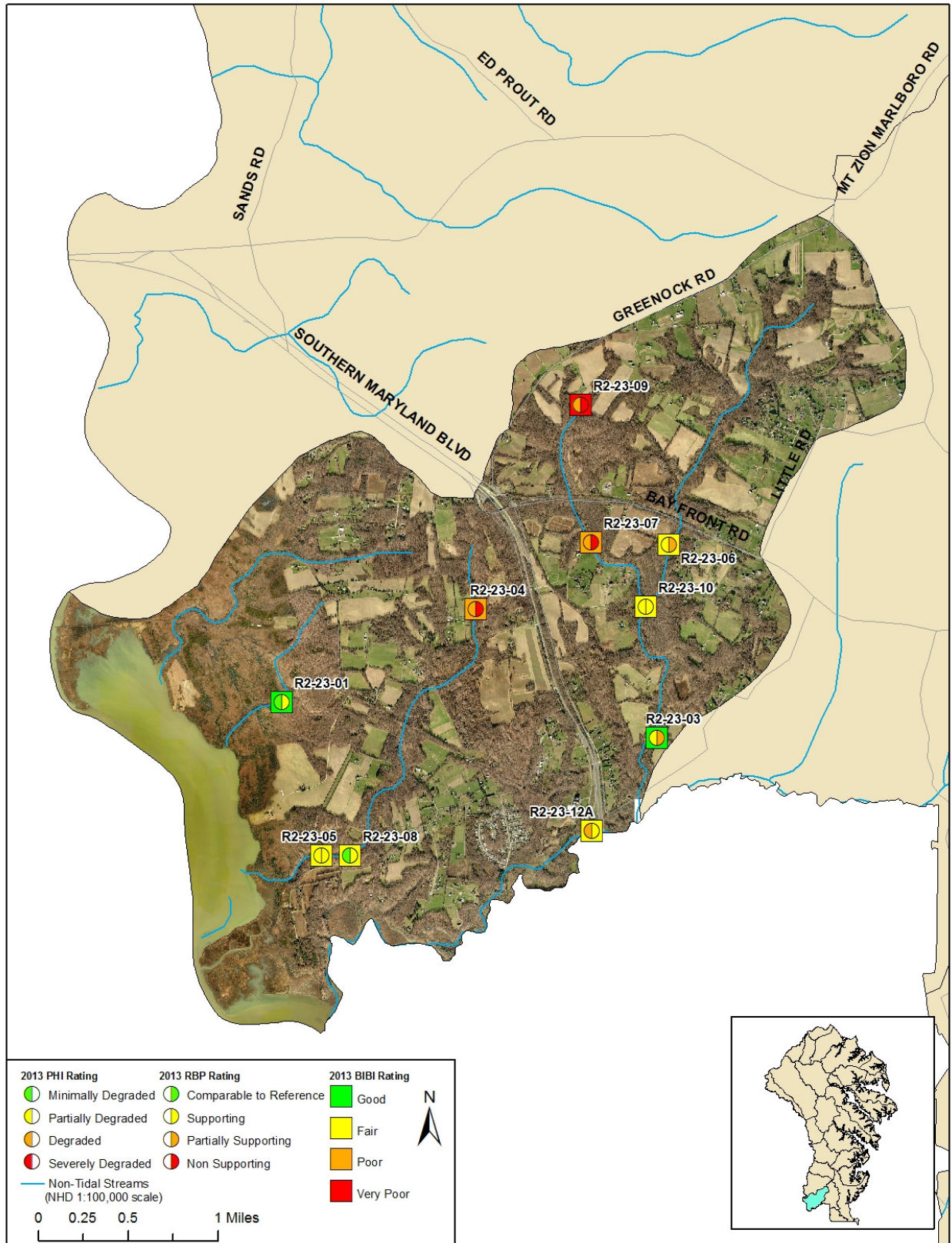


Figure 7 - Cabin Branch Land Use

Figure 8 – Cabin Branch Sampling Sites



### 4.1.1 Physical Habitat

Half of the sites sampled in the Cabin Branch sampling unit (50 percent) received a ‘Supporting’ narrative RBP rating, while 30 percent of the sites received a ‘Non Supporting’ rating, and the remaining 20 percent of sites received a ‘Partially Supporting’ rating (Figure 9). The average RBP score was  $118.6 \pm 20.3$  resulting in a ‘Partially Supporting’ habitat condition for the sampling unit. Overall RBP scores for individual sites ranged from 85 (‘Non Supporting’) to 141 (‘Supporting’). The PHI rated 40 percent of the sites as ‘Partially Degraded,’ 40 percent as ‘Degraded,’ and the remaining 20 percent as ‘Minimally Degraded.’ The average PHI score for the sampling unit was  $72.4 \pm 10.1$  with a habitat condition rating of ‘Partially Degraded.’ Individual site scores for PHI ranged from a minimum of 56.4 (‘Degraded’) to a maximum of 92.7 (‘Minimally Degraded’), which was one of the highest scoring sites in 2013. With the exception of R2-23-04, R2-23-07, and R2-23-09, sites received marginal to sub-optimal scores for instream habitat and epifaunal substrate. Instream woody debris, bank stability, and remoteness were variable between reaches. Riparian vegetation was suboptimal to optimal for all sites.

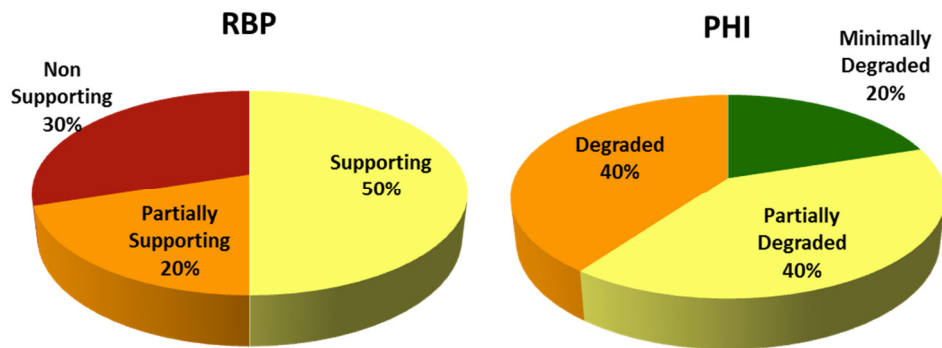


Figure 9 – Cabin Branch Physical Habitat Conditions (n=10)

### 4.1.2 Benthic Macroinvertebrates

Of the ten sites sampled in Cabin Branch, half of sites received a BIBI rating of ‘Fair’ while 20 percent of the sites were ‘Poor,’ an additional 20 percent were ‘Good,’ and the remaining 10 percent of sites received a ‘Very Poor’ biological condition rating (Figure 10). The average BIBI score for the Cabin Branch sampling unit is  $3.34 \pm 0.81$ , with an average biological condition of ‘Fair’ (Table 12). Individual BIBI scores ranged from 1.86 (‘Very Poor’) to 4.43 (‘Good’). Site-specific data and assessment results can be found in Appendix D.

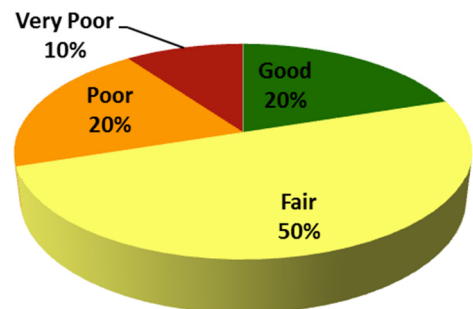


Figure 10 – Cabin Branch Biological Conditions (n=10)

Site R2-23-09, located approximately 0.25 miles east of Greenock Road (Figure 8), received the lowest BIBI score of 1.86 and was the only site in this sampling unit to receive a biological rating of ‘Very Poor.’ This stream reach is deeply incised with heavily eroded banks, minimal woody debris, and overall poor epifaunal substrate. This site had the lowest number of total taxa (13), which lacked Ephemeroptera taxa and only had one EPT taxa and one scraper taxa. Less than one percent of the macroinvertebrates identified consisted of climber taxa; however, over one-third of the sample was considered to be intolerant to urban stressors largely due to the presence of one pollution intolerant isopod (*Caecidotea*,

tolerance value [TV] = 2.6). Not surprisingly, this site had the smallest drainage area (47 acres) in the Cabin Branch PSU, which may be influencing habitat availability for benthic macroinvertebrates. Site R2-23-01, located on Pindell Branch adjacent to Jug Bay Wetland Sanctuary, received the highest BIBI score of all sites sampled in 2013 with a score of 4.43 and a ‘Good’ biological rating. This site had a high number of total taxa (29) including seven EPT taxa, two Ephemeroptera taxa, and three scraper taxa. Over half of the sample consisted of two stonefly taxa in the order Plecoptera that are intolerant to urban stressors (*Sweltsa*, TV = 1.9 and *Amphinemura*, TV = 3.0)

### 4.1.3 Water Quality

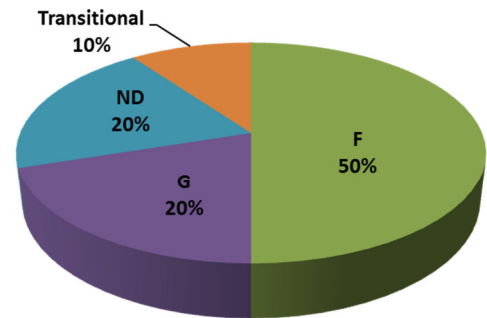
Average water quality values for the Cabin Branch sites are provided in Table 14. All of the sites sampled met COMAR standards for water quality. Water temperature ranged from 12.20 to 20.20 °C; dissolved oxygen ranged from 8.36 to 11.95 mg/L; pH ranged from 6.52 to 7.01; specific conductance ranged from 94.9 to 198.6 µS/cm; and, turbidity ranged from 4.99 to 10.10 NTU.

**Table 14 - Average water quality values – Cabin Branch (n = 10)**

Value ± Standard Deviation				
Temperature (°C)	DO (mg/L)	pH (Units)	Specific Conductance (µS/cm)	Turbidity (NTU)
14.41 ± 2.55	10.78 ± 1.09	6.81 ± 0.19	143.5 ± 34.2	7.14 ± 1.50

### 4.1.4 Geomorphic Assessment

Site-specific geomorphic assessment results can be found in Appendix A. The majority of the sites assessed (70 percent) were entrenched F or G type streams (50 and 20 percent, respectively; Figure 11). The remaining sites were ‘ND’ (20 percent), or Transitional (10 percent) channels. Rosgen stream types were not determined (ND) for sites R2-23-05 and R2-23-12A. Site R2-23-05, located on Deep Creek, was heavily influenced by a beaver dam located downstream, while site R2-23-12A was located on Lyons Creek between two bridge crossings and was entirely backwatered. Site R2-23-04, located on Deep Creek, was classified as a Transitional reach from an E stream type upstream to a G stream type downstream of a headcut.



**Figure 11 - Rosgen Stream Types Observed in Cabin Branch (n = 10)**

All streams in this sampling unit were sand bottom channels (100 percent). The median D<sub>50</sub> was 0.30 mm (medium sand material). Individual slopes ranged from 0.004 percent to 1.40 percent, with an average slope of 0.56 percent. All but two sites (R2-23-04 and R2-23-09) had slopes that were less than one percent.

## 4.2 Lower Magothy

With a drainage area of 12,697 acres, the Lower Magothy sampling unit is located on the eastern edge of the County (Figure 1) and drains directly into the Magothy River which drains into the Chesapeake Bay. The ten sampling sites, all 1<sup>st</sup> order streams, have drainage areas ranging from 106 to 708 acres (Figure 13). With 19 percent of the Lower Magothy sampling unit comprised of impervious surface, this was the most developed sampling unit assessed in 2013. Site-specific drainage areas ranged from 18.0 to 47.9 percent impervious, which is the highest percentage for all sites sampled in 2013. Developed land comprised 64 percent of the total land use in the Lower Magothy sampling unit, including numerous business parks and residential developments (Figure 12). In addition, Route 2 (Ritchie Highway) and Anne Arundel Community College campus are both located in the western portion of this sampling unit. Forested land comprised only 29 percent of the land cover, the lowest proportion of all sampling units assessed in 2013.

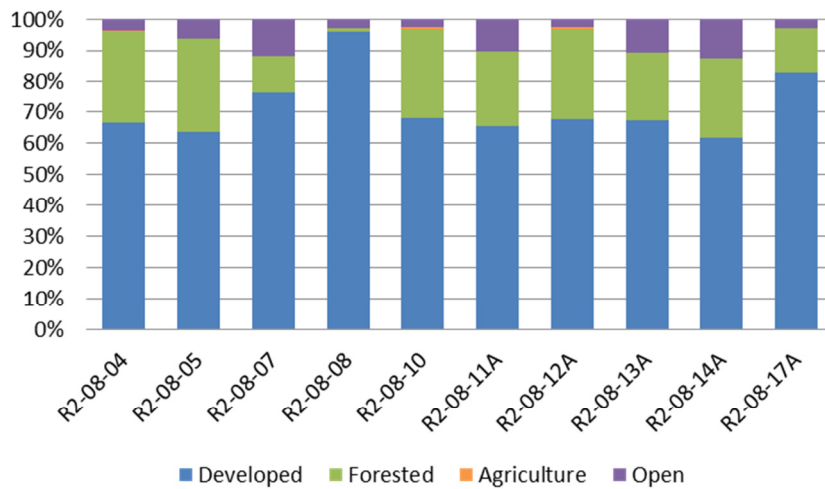
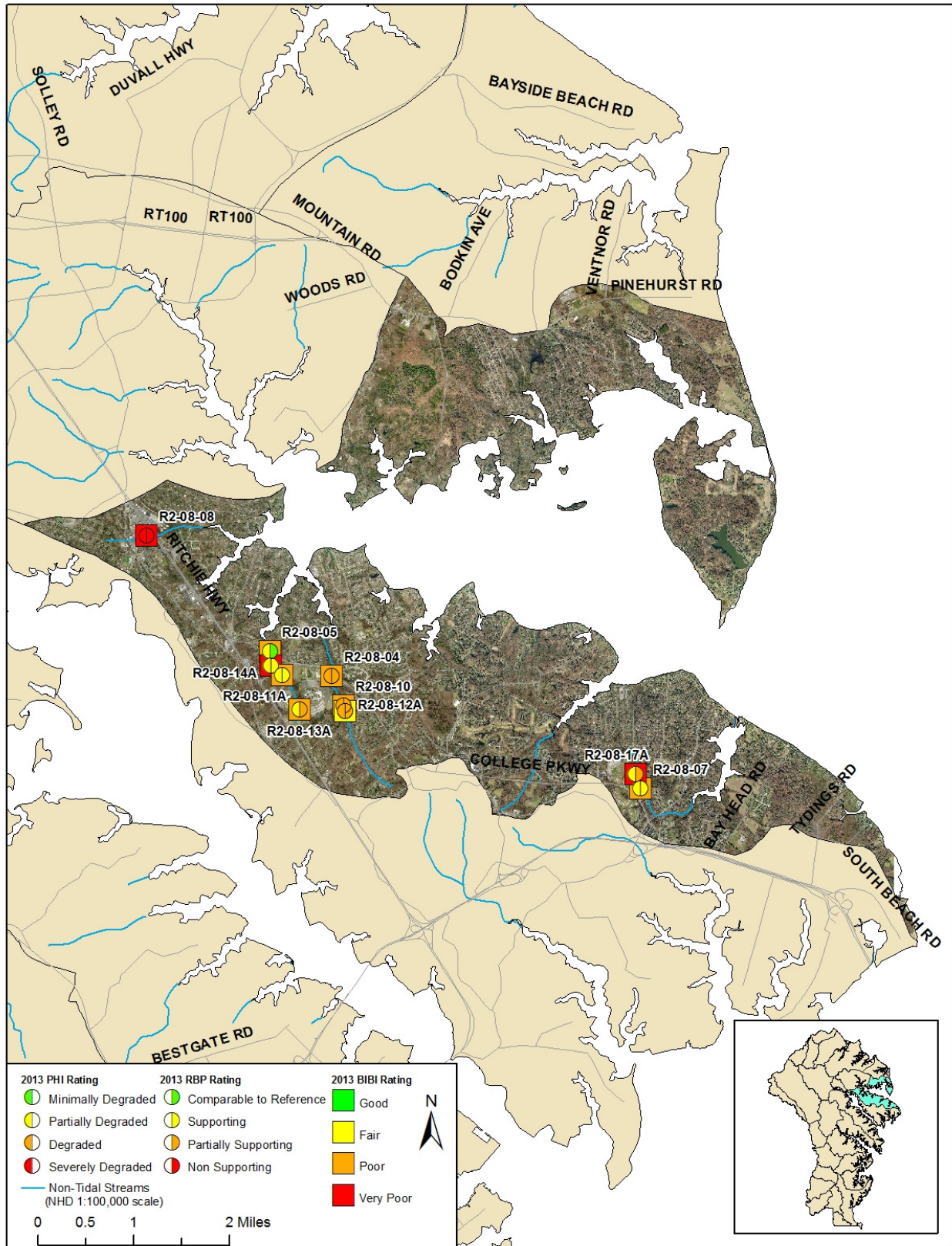


Figure 12 - Lower Magothy Land Use

### 4.2.1 Physical Habitat

Based on the RBP scores, one-half of the Lower Magothy sites received a rating of ‘Partially Supporting,’ 30 percent received a ‘Supporting’ rating, and the remaining 20 percent of sites were equally split between a rating of ‘Non Supporting’ and ‘Comparable to Reference’ (Figure 14). Overall, the Lower Magothy sampling unit received the lowest average RBP score ( $117.0 \pm 28.8$ ). Individual RBP scores ranged from a minimum of 51 at site R2-08-08 (‘Non Supporting’), which was a concrete trapezoid channel and the lowest scoring site in 2013, to a maximum of 162 at site R2-08-05 (‘Comparable to Reference’), which was the highest scoring site in 2013. However, it should be noted, that the single site with a score of 51 for site R2-08-08 skewed the average, and the average value for this PSU would be 124 (‘Partially Supporting’) if this site was not included.

Figure 13 – Lower Magothy Sampling Sites





Sixty percent of sites assessed received a PHI rating of ‘Partially Degraded,’ while 30 percent received a ‘Degraded’ rating, and the remaining 10 percent received a rating of ‘Severely Degraded.’ The average PHI rating was  $67.3 \pm 10.6$  (‘Partially Degraded’) with individual sites ranging from 44.7 at site R2-08-08 (‘Severely Degraded’), which was a concrete trapezoid channel and the lowest scoring site in 2013, to 77.9 at site R2-08-07 (‘Partially Degraded’). All of the sites received poor to marginal epifaunal substrate scores in addition to having poor to marginal riffle/run quality. Vegetative bank protection, pool variability, and remoteness were variable between the reaches assessed. With the exception of sites R2-08-04 and R2-08-10, bank stability was suboptimal to optimal at all sites. Refuse was observed in abundant or moderate amounts at all sites assessed.

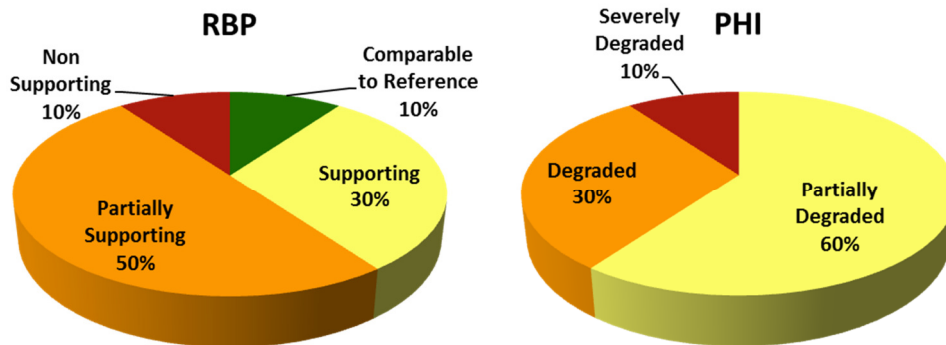


Figure 14 – Lower Magothy Physical Habitat Conditions (n=10)

#### 4.2.2 Benthic Macroinvertebrates

The Lower Magothy sampling unit received a BIBI narrative rating of ‘Poor’ with an average score of  $2.17 \pm 0.59$  (Table 12). Over half of the individual sites received a biological condition rating of ‘Poor’ (60 percent), 30 percent received a ‘Very Poor’ rating, and the remaining 10 percent of sites received a ‘Fair’ rating (Figure 15). Individual BIBI scores ranged from 1.00 (‘Very Poor’) to 3.00 (‘Fair’). Site-specific data and assessment results can be found in Appendix D.

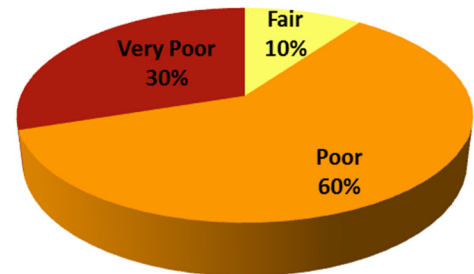


Figure 15 – Lower Magothy Biological Conditions (n=10)

Site R2-08-08, located in a concrete ditched channel that travels through a culvert under West McKinsey Road in Severna Park (Figure 13), received the lowest BIBI score of all sites sampled in 2013 with a score of 1.00 and a narrative rating of ‘Very Poor.’ This site automatically received the lowest BIBI score allowable since there were less than 60 individuals present in the entire sample. This site had poor taxa diversity (nine taxa) with no EPT, Ephemeroptera, scraper, or climber taxa, and consisted of less than three percent of intolerant taxa. Out of the 36 individuals in the sample, 80 percent consisted of worms and was dominated by individuals of the Tubificidae family (TV = 8.5). Additionally, this site is a highly urbanized channel with multiple storm drain outfalls with severely lacking epifaunal substrate. Two additional sites received a ‘Very Poor’ biological rating: R2-08-14A and R2-08-17A. Located on an unnamed tributary that runs behind the houses along Kings College Drive, site R2-08-12A received the highest BIBI score (3.00; ‘Fair’) in the Lower Magothy sampling unit. For R2-08-12A, three EPT taxa and one scraper taxa were identified from a total of 25 taxa, with 13 percent of the sample consisting of climber taxa. Although the lower half of the site was mostly backwatered, a large amount of woody debris provided good habitat for benthic macroinvertebrates.

### 4.2.3 Water Quality

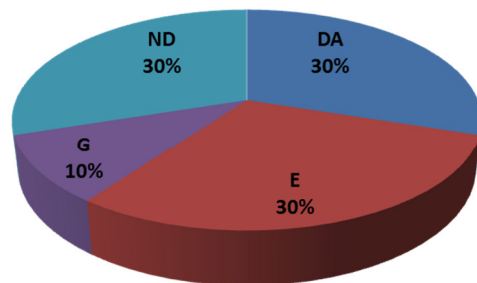
Average water quality values for the Lower Magothy sites are provided in Table 15. One of ten sites sampled did not meet COMAR standards for water quality. Site R2-08-07 measured outside the acceptable COMAR range for pH (6.5-8.5), with a value of 6.34. This site drains a wetland, which have naturally low pH levels. All measurements for water temperature, dissolved oxygen, and turbidity were within COMAR standards. Water temperature ranged from 4.27 to 10.23 °C; dissolved oxygen ranged from 6.13 to 12.89 mg/L; pH ranged from 6.34 to 8.00; specific conductance ranged from 125.8 to 475.7 μS/cm; and, turbidity ranged from 3.10 to 10.02 NTU. It should also be noted that six sites (R2-08-04, R2-08-05, R2-08-08, R2-08-11A, R2-08-13A, and R2-08-14A) showed elevated conductivity levels exceeding 247 μS/cm, which is commonly associated with increased impervious surface upstream in the watershed.

**Table 15 - Average water quality values – Lower Magothy (n = 10)**

Value ± Standard Deviation				
Temperature (°C)	DO (mg/L)	pH (Units)	Specific Conductance (μS/cm)	Turbidity (NTU)
7.42 ± 2.22	10.69 ± 2.29	6.83 ± 0.45	298.0 ± 104.0	6.51 ± 2.61

### 4.2.4 Geomorphic Assessment

Site-specific geomorphic assessment results are presented in Appendix A. The majority of sites in the Lower Magothy sampling unit (60 percent) were classified as either E channels or anastomosed DA channels (30 percent each; Figure 16). The remaining 40 percent of sites were classified as either 'ND' (30 percent) or more entrenched and generally more unstable G type (10 percent) streams. The stream type could not be determined at three sites, R2-08-08, R2-08-13A, and R2-08-17A. Site R2-08-08, off of McKinsey Road, was a concrete trapezoidal channel with triple pipe culverts below the midpoint, while R2-08-13A, located on the campus of Anne Arundel Community College, was altered by double pipe culverts and bed stabilization in the upper half of the reach. Site R2-08-17A, located at Broadneck Senior High School, runs through a breached pond embankment with the upstream half of the reach located in an old pond basin.



**Figure 16 - Rosgen Stream Types Observed in Lower Magothy (n = 10)**

The majority of sites in Lower Magothy were sand bed channels (60 percent) with 30 percent of sites dominated by silt/clay. Site R2-08-08, the trapezoidal channel, was dominated by concrete substrate. The median D<sub>50</sub> was 0.09 mm (very fine sand). Streams in this sampling unit had an average slope of 0.58 percent, with individual slopes ranging from 0.06 percent to 1.40 percent. All but two sites (R2-08-12A and R2-08-17A) had slopes that were less than one percent. Sites R2-08-12A and R2-08-17A were atypical due to the presence of a headcut at site R2-08-12A and the breached pond embankment at R2-08-17A.

### 4.3 Lyons Creek

The Lyons Creek sampling unit is located in the southern portion of the County along the border with Calvert County (Figure 1), and has a total drainage area of 6,154 acres, which drains to the Patuxent River. Of the 10 sites assessed, six were located on 1<sup>st</sup> order streams and four on 2<sup>nd</sup> order streams. Drainage areas to sampling sites ranged from 89 to 6,645 acres (Figure 18), with one site in the Lyons Creek sampling unit (R2-22-21A) including drainage that extends into Calvert County. Land use in the Lyons Creek sampling unit is comprised primarily of forested land (38 percent) and agriculture (31 percent) followed by developed land (24 percent). One-half of the sites have agriculture as the dominant land use, while 40 percent of sites are dominated by forested land, with the remaining 10 percent of sites dominated by developed land (Figure 17). Impervious surfaces account for just 4.4 percent of the Lyons Creek sampling unit, with individual sites ranging from 3.1 to 7.3 percent imperviousness.

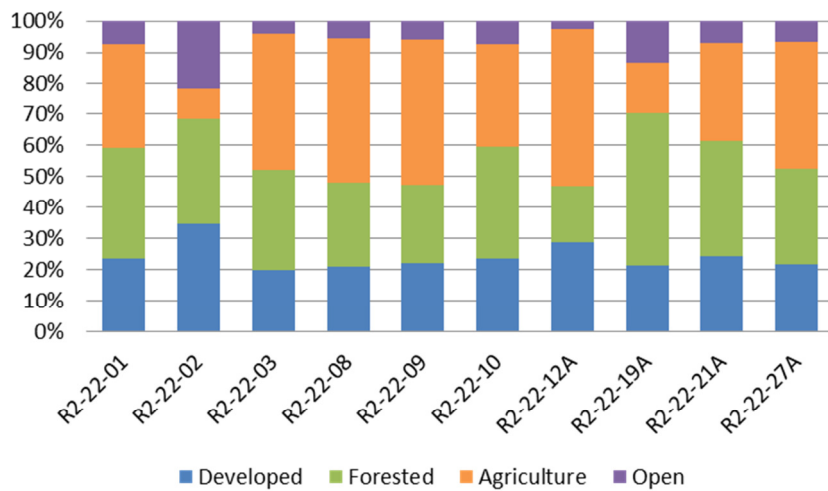


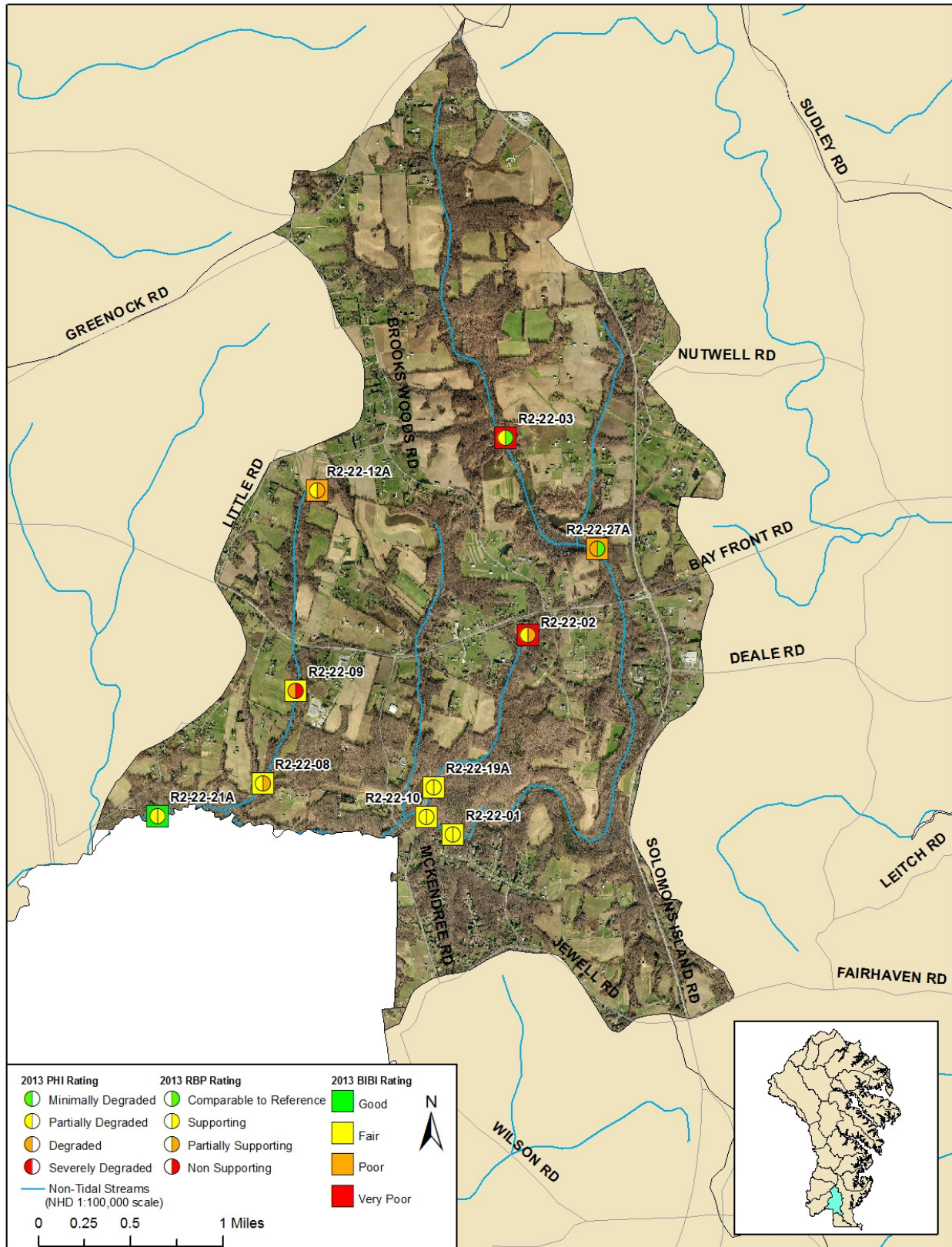
Figure 17 - Lyons Creek Land Use

#### 4.3.1 Physical Habitat

Physical habitat conditions were fairly variable for this sampling unit. The majority of sites in Lyons Creek were rated as either ‘Supporting’ (40 percent) or ‘Partially Supporting’ (30 percent) with two sites (20 percent) rated as ‘Comparable to Reference,’ and one site (10 percent) rated as ‘Non Supporting’ by the RBP habitat index (Figure 19). The average RBP score for the sampling unit was 126.7 ± 21.5 and the corresponding narrative rating was ‘Supporting.’ Individual site scores ranged from 96 (‘Non Supporting’) to 161 (‘Comparable to Reference’), which was one of the highest scoring sites in 2013.

According to the PHI, the majority of sites were rated as ‘Partially Degraded’ (80 percent), while 20 percent received a rating of ‘Degraded.’ The average PHI rating was ‘Partially Degraded’ with a score of 71.9 ± 6.1. Individual site scores ranged from 59.3 (‘Degraded’) to 79.3 (‘Partially Degraded’). All of the reaches sampled received marginal to suboptimal scores for instream physical habitat and epifaunal substrate. Bank stability, instream woody debris, and vegetative bank protection were variable between reaches. However with the exception of site R2-22-12A, all sites received suboptimal to optimal scores for riparian vegetative width.

Figure 18 – Lyons Creek Sampling Sites



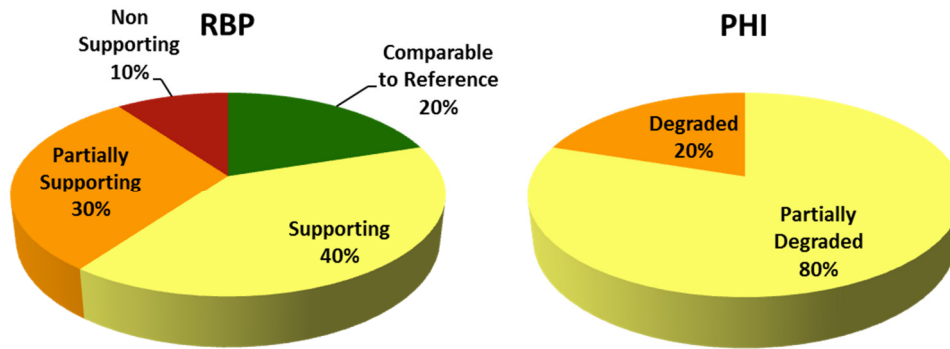


Figure 19 – Lyons Creek Physical Habitat Conditions (n=10)

### 4.3.2 Benthic Macroinvertebrates

The average BIBI rating for the Lyons Creek sampling unit is ‘Fair’ with an average BIBI score of  $3.00 \pm 0.98$  (Table 12), and individual sites ranging from a low of 1.57 (‘Very Poor’) to 4.14 (‘Good’). Half of the sites received a BIBI rating of ‘Fair’ (50 percent), 40 percent of the sites were split equally between ‘Poor’ and ‘Very Poor’ ratings, and the remaining site received a ‘Good’ rating (10 percent; Figure 20). Site-specific data and assessment results can be found in Appendix D.

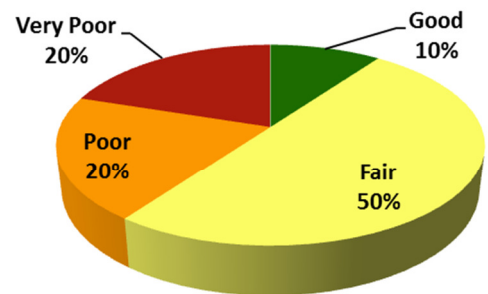


Figure 20 – Lyons Creek Biological Conditions (n=10)

Site R2-22-02, on the headwaters of an unnamed tributary to Lyons Creek, received the lowest score in the Lyons Creek sampling unit of 1.57 with a ‘Very Poor’ narrative rating (Figure 18). Located approximately 550 feet south of Bay Front Road West, this site had moderate taxa diversity (15 taxa) but only had one EPT taxa and completely lacked Ephemeroptera taxa and climber taxa. Only four percent of the sample consisted of taxa intolerant to urban stressors with the sample largely dominated by tolerant midges and amphipods (including *Cricotopus/Orthocladius*, TV = 7.7 and *Crangonyx*, TV = 6.7, respectively). This site also had the smallest drainage area (89 acres) of sites sampled in the Lyons Creek sampling unit. Site R2-22-03 also received a ‘Very Poor’ rating due to low taxa diversity (nine taxa) which completely lacked Ephemeroptera, EPT, and scraper taxa. In contrast, site R2-22-21A, located on Lyons Creek mainstem along the Calvert County border, received the highest BIBI score of 4.14 and was the only site in the Lyons Creek sampling unit with a ‘Good’ biological condition rating. This site had a moderate number of total taxa (19); however, three scraper taxa were present and six were EPT taxa including three Ephemeroptera. Additionally, this site also had the largest drainage area (6,645 acres) in the Lyons Creek PSU with an abundance of woody debris providing the majority of benthic habitat.

### 4.3.3 Water Quality

Average water quality values for the Lyons Creek sites are provided in Table 16. Of the ten sites sampled, two sites did not meet COMAR standards for water quality. Site R2-22-02 and R2-22-12A both

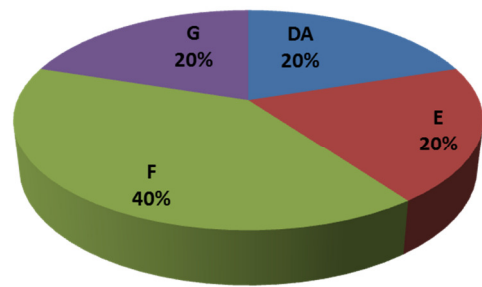
measured outside the acceptable COMAR range for pH (6.5-8.5), with values of 6.18 and 6.33, respectively. All other water quality parameters were within acceptable ranges. Water temperature ranged from 9.90 to 18.30 °C; dissolved oxygen ranged from 7.38 to 11.93 mg/L; pH ranged from 6.18 to 7.23; specific conductance ranged from 123.2 to 220.1 µS/cm; and, turbidity ranged from 4.19 to 15.50 NTU.

**Table 16 - Average water quality values – Lyons Creek (n = 10)**

Value ± Standard Deviation				
Temperature (°C)	DO (mg/L)	pH (Units)	Specific Conductance (µS/cm)	Turbidity (NTU)
14.09 ± 3.54	10.14 ± 1.42	6.81 ± 0.35	159.6 ± 26.5	9.59 ± 3.71

#### 4.3.4 Geomorphic Assessment

The majority of sites (60 percent) assessed in the Lyons Creek sampling unit were classified as entrenched F or G type channels, at 40 and 20 percent, respectively. The remaining 40 percent of sites were split equally between E channels and anastomosed DA type channels (Figure 21). Site-specific geomorphic assessment results can be found in Appendix A.



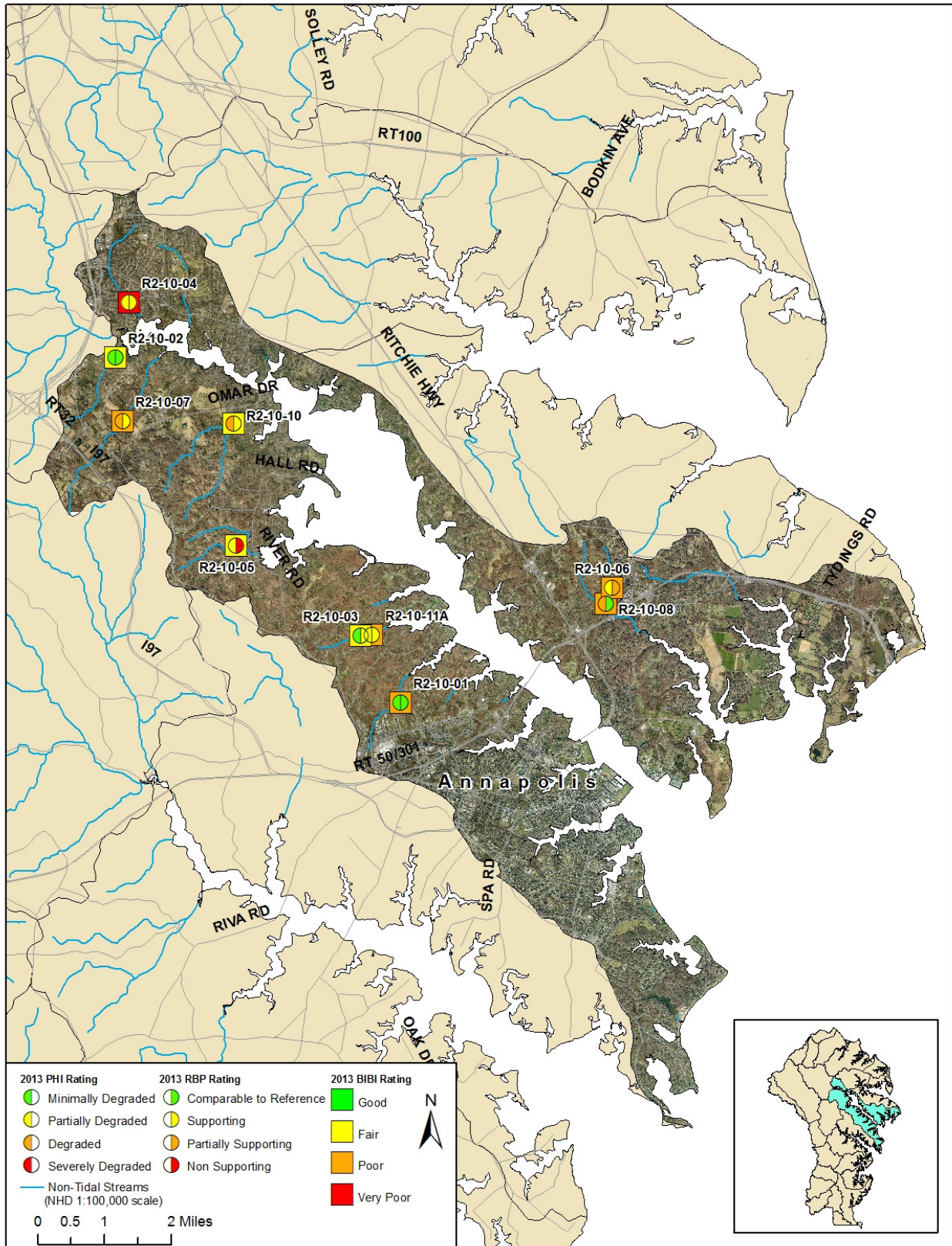
**Figure 21 - Rosgen Stream Types Observed in Lyons Creek (n = 10)**

The majority of streams in this sampling unit had predominantly sand substrate (70 percent) with the remaining sites dominated by silt/clay substrates (30 percent). The median D<sub>50</sub> for the sampling unit was 0.16 mm (fine sand material). With the exception of one site, R2-22-27A, slopes were fairly gradual ranging from 0.1 percent to 1.0 percent.

#### 4.4 Severn River

The Severn River sampling unit, which consists of direct tributaries to the Severn River, is located on the eastern side of the County (Figure 1) and has a drainage area of 28,920 acres. The city of Annapolis is located in the southern portion of the Severn River sampling unit with Route 50/301 traveling through the center of the sampling unit. The ten sampling sites (nine 1<sup>st</sup> order and one 2<sup>nd</sup> order streams) have drainage areas ranging from 215 to 1,364 acres (Figure 22). Land use in the Severn River sampling unit is primarily comprised of developed land (57 percent), followed by forested land (32 percent). Seventy percent of sites sampled in the Severn River sampling unit have predominantly developed land cover with 30 percent of sites predominantly forested (Figure 23). Impervious surfaces comprise 18.9 percent of the overall sampling unit, with individual sites ranging from 6.4 percent to 36.0 percent.

Figure 22 – Severn River Sampling Sites



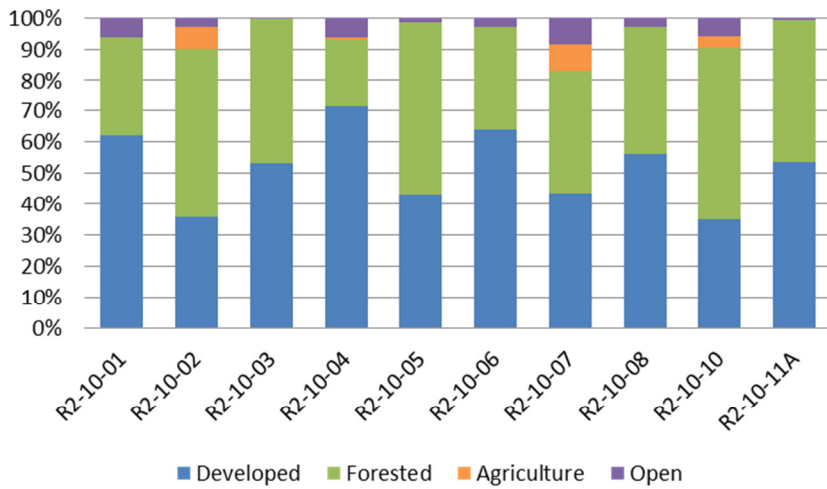


Figure 23 - Severn River Land Use

#### 4.4.1 Physical Habitat

Based on the RBP index, the majority of sites were rated as either ‘Supporting’ (50 percent) or ‘Comparable to Reference’ (30 percent). Only one site received a rating of ‘Non Supporting’ (10 percent), and one site received a ‘Partially Supporting’ rating (10 percent; Figure 24). With an average RBP score of  $137.5 \pm 19.8$  and a narrative rating of ‘Supporting,’ this sampling unit received the highest average RBP score in 2013. Individual RBP scores ranged from a minimum of 96 (‘Non Supporting’) to a maximum of 160 (‘Comparable to Reference’).

The PHI rated 40 percent of sites as ‘Partially Degraded,’ 30 percent as ‘Minimally Degraded,’ and the remaining 30 percent as ‘Degraded’. The average PHI rating was ‘Partially Degraded’ with a score of  $75.2 \pm 10.1$ , which was the highest average PHI score for a sampling unit in 2013. Individual PHI scores ranged from 61.8 (‘Degraded’) to 90.9 (‘Minimally Degraded’), which was one of the highest scoring sites in 2013. The majority of sites received marginal to suboptimal scores for instream habitat, epifaunal substrate, riffle/run quality, and pool variability. All but two sites (R2-10-05 and R2-10-11A) received suboptimal to optimal scores for bank stability. Riparian vegetative zone width was optimal at most sites.

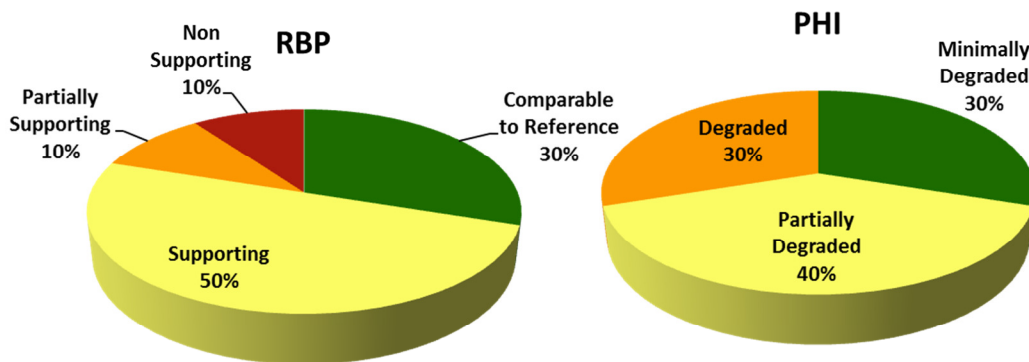


Figure 24 – Severn River Physical Habitat Conditions (n=10)



#### 4.4.2 Benthic Macroinvertebrates

Half of sites sampled within the Severn River sampling unit received 'Poor' BIBI ratings, 40 percent received a 'Fair' rating while the remaining 10 percent of sites received a 'Very Poor' rating (Figure 25). The average BIBI score for the sampling unit was  $2.77 \pm 0.63$  resulting in a 'Poor' biological condition rating (Table 12). Individual BIBI scores ranged from 1.86 ('Very Poor') to 3.57 ('Fair'). Individual site data and assessment results can be found in Appendix D.

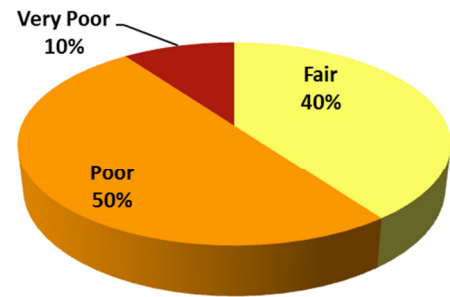


Figure 25 – Severn River Biological Conditions (n=10)

Located 120 feet upstream of West Benfield Road and adjacent to Pixie Drive, site R2-10-04 (Figure 22) received the lowest BIBI score of 1.86 with a 'Very Poor' rating. Sixteen taxa were present in this sample, which was predominantly comprised of midges including *Cricotopus/Orthocladius* (TV = 7.7) that accounted for 52 percent of the sample. Although this sample contained three EPT taxa, Ephemeroptera, scraper taxa, or taxa intolerant to urban stressors were not present. Two sites, R2-10-02 and R2-10-10, received the highest BIBI score of 3.57, resulting in a 'Fair' biological condition rating. Located within the Severn Run Natural Environment Area approximately 0.25 mile upstream of the Severn River, site R2-10-02 is a multi-thread channel through thickly vegetated wetland with an abundance of rootwads providing stable habitat for benthics. Of the 23 taxa identified in this sample, five were EPT taxa with one scraper taxa. This sample also had high percentages of climber taxa (22 percent) and taxa intolerant to urban stressors (47 percent). Site R2-10-10, located just downstream of the confluence of Gumbottom Branch and Plum Creek, had the highest percentage of taxa intolerant to urban stressors and was dominated by pollution intolerant black flies (*Stegopterna* TV = 2.4). Of the 19 taxa identified in this sample, five were EPT including one Ephemeroptera taxa. This site also had the largest drainage area (1,364 acres) in the Severn River sampling unit.

#### 4.4.3 Water Quality

Average water quality values for the Severn River sites are provided in Table 17. Seven sites did not meet COMAR standards for water quality. Sites R2-10-02, R2-10-03, R2-10-05, R2-10-07, R2-10-08, R2-10-10, and R2-10-11A measured outside the acceptable COMAR range for pH (6.5-8.5), with values ranging from 5.57 to 6.38. All other water quality parameters were within acceptable ranges. Water temperature ranged from 2.07 to 9.53 °C; dissolved oxygen ranged from 8.13 to 14.09 mg/L; pH ranged from 5.57 to 6.90; specific conductance ranged from 63.8 to 520.0 μS/cm; and, turbidity ranged from 2.64 to 11.20 NTU. Six sites (R2-10-01, R2-10-03, R2-10-04, R2-10-05, R2-10-10, and R2-10-11A) recorded elevated conductivity levels exceeding 247 μS/cm.

Table 17 - Average water quality values – Severn River (n = 10)

Value ± Standard Deviation				
Temperature (°C)	DO (mg/L)	pH (Units)	Specific Conductance (μS/cm)	Turbidity (NTU)
5.73 ± 2.46	11.53 ± 1.84	6.32 ± 0.41	233.5 ± 129.9	7.26 ± 2.68

#### 4.4.4 Geomorphic Assessment

Site-specific geomorphic assessment results can be found in Appendix A. A variety of stream types were present in the Severn River sampling unit (Figure 26). Forty percent of sites were classified as E type

channels. Twenty percent of the sites assessed were equally split between entrenched G or anastomosed DA type streams (10 percent each) while remaining sites were either transitional (30 percent) or not determined (10 percent). Site R2-10-08, located on Mill Creek, was not determined because the channel is heavily influenced by a beaver dam upstream and open water wetland downstream. Three sites were classified as Transitional channels. Site R2-10-01, located downstream of the Annapolis Mall, was classified as a transitional reach from an E type upstream to a DA type downstream, while R2-10-03 was classified as a Transitional reach from a DA upstream to an E type downstream of a headcut. Site R2-10-06, located on a branch to Mill Creek, was also influenced by a headcut and was classified as a DA channel upstream to a G channel below the headcut.

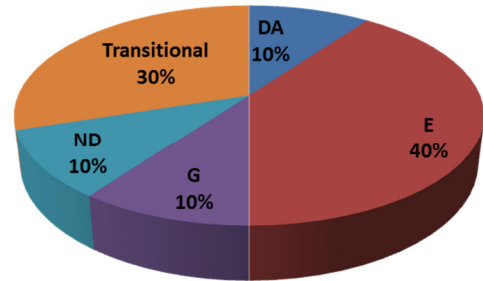


Figure 26 - Rosgen Stream Types Observed in Severn River (n=10)

The majority of streams in this sampling unit had either sand (60 percent) or silt/clay (40 percent) dominated substrates. The median  $D_{50}$  for the sampling unit was 0.12 mm (very fine sand material). With the exception of three sites (R2-10-02, R2-10-03, and R2-10-06), slopes were gradual, with an average slope of 0.83 percent, and individual reaches falling in the range from 0.03 percent to 1.90 percent. Sites R2-10-03 and R2-10-06 were atypical due to a headcut located in each reach, which resulted in a reach wide slope of 1.40 and 1.70 percent, respectively.

#### 4.5 Stocketts Run

The Stocketts Run sampling unit, which drains to the Patuxent River, is located in the south central portion of the County, east of Crain Highway and south of Route 50/301 (Figure 1), and has a drainage area of 8,714 acres. The ten sampling sites (eight 1<sup>st</sup> order and two 2<sup>nd</sup> order streams) have drainage areas ranging from 62 to 3,666 acres (Figure 28). Land use in the Stocketts Run sampling unit is primarily comprised of forested land (44 percent), followed by developed land (29 percent) and agriculture (18 percent). The majority of sites sampled in the Stocketts Run sampling unit have predominantly developed land cover (70 percent) with approximately one-third of sites predominantly forested (Figure 27). Impervious surfaces comprise just 4.9 percent of the overall sampling unit, with individual sites ranging from 3.9 percent to 11.5 percent.

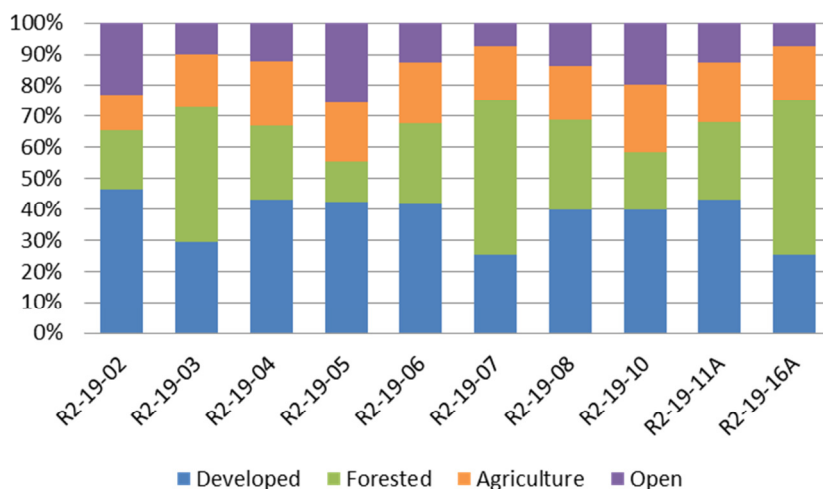
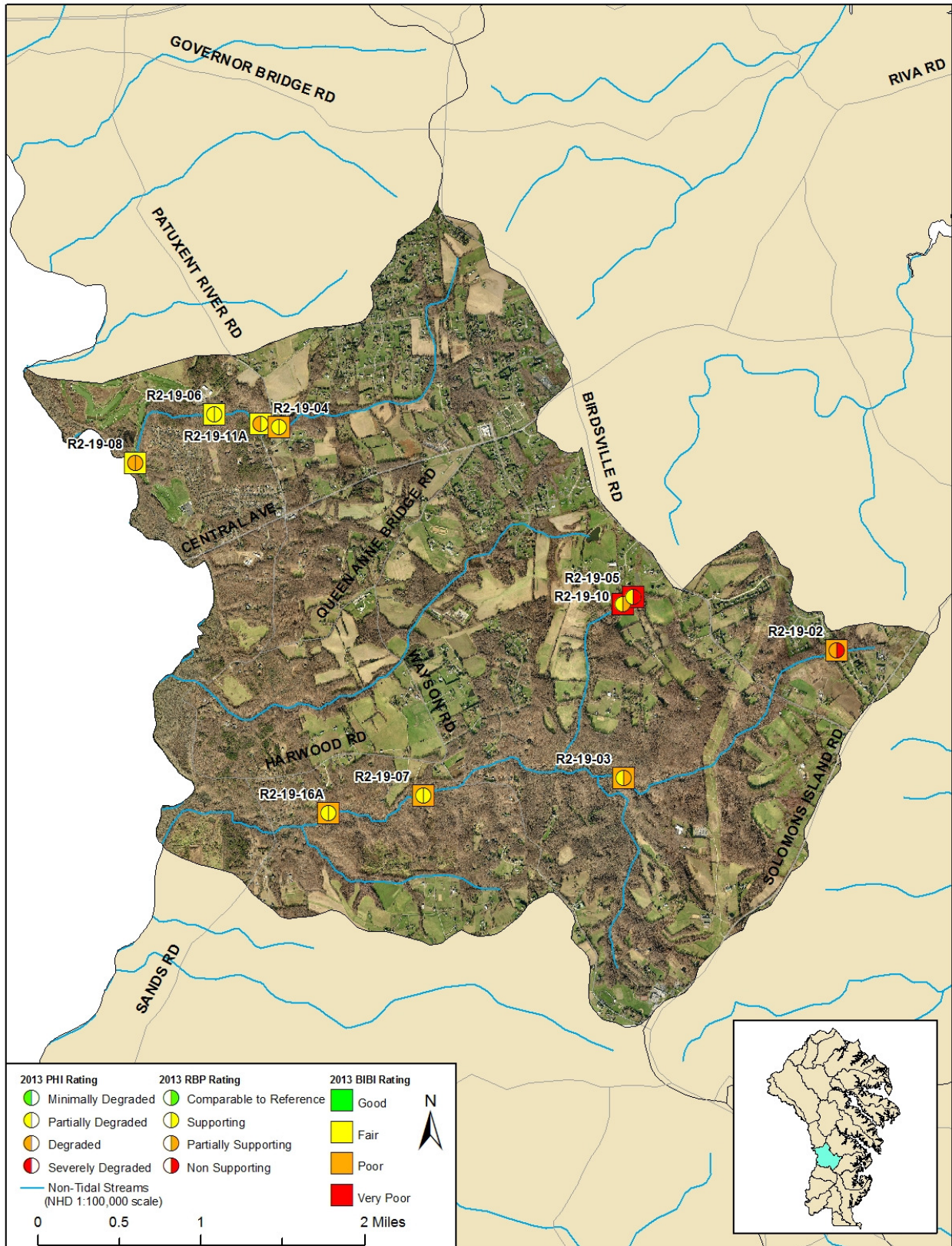


Figure 27 - Stocketts Run Land Use

Figure 28 – Stocketts Run Sampling Sites



### 4.5.1 Physical Habitat

Half of the sites sampled in the Stocketts Run sampling unit (50 percent) received a ‘Supporting’ narrative RBP rating, while 30 percent of the sites received a ‘Partially Supporting’ rating and the remaining 20 percent of sites received a ‘Non Supporting’ rating (Figure 29). The average RBP score for the sampling unit was  $118.6 \pm 19.4$  and the corresponding narrative rating was ‘Partially Supporting.’ Individual RBP scores ranged from a minimum of 78 (‘Non Supporting’) to a maximum of 135 (‘Supporting’).

The PHI rated 70 percent of sites as ‘Partially Degraded’ and 30 percent as ‘Degraded’. The average PHI rating was ‘Partially Degraded’ with a score of  $68.0 \pm 5.6$ . Individual PHI scores ranged from 60.2 (‘Degraded’) to 75.8 (‘Partially Degraded’). The majority of sites received suboptimal scores for instream habitat, epifaunal substrate, sediment deposition, pool variability, and velocity/depth diversity. Bank stability, sinuosity, and remoteness was variable between sites. Riparian vegetative zone width was optimal at most sites.

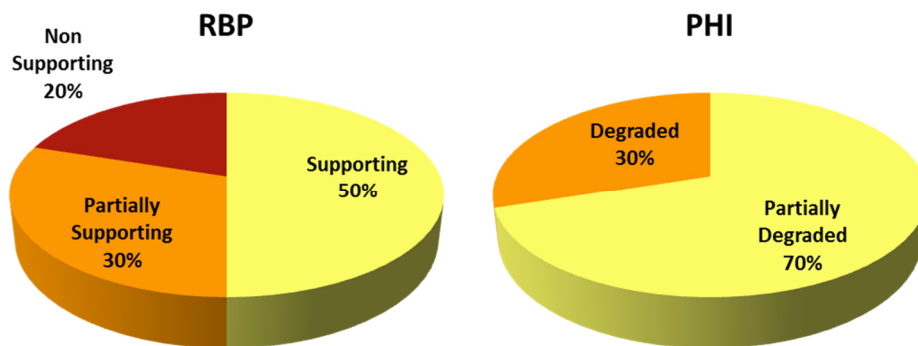


Figure 29 – Stocketts Run Physical Habitat Conditions (n=10)

### 4.5.2 Benthic Macroinvertebrates

Half of sites sampled within the Stocketts Run sampling unit received ‘Poor’ BIBI ratings, 30 percent received a ‘Fair’ rating while the remaining 20 percent of sites received a ‘Very Poor’ rating (Figure 30). The average BIBI score for the sampling unit was  $2.60 \pm 0.91$  resulting in a ‘Poor’ biological condition rating (Table 12). Individual BIBI scores ranged from 1.29 (‘Very Poor’) to 3.86 (‘Fair’). Individual site data and assessment results can be found in Appendix D.

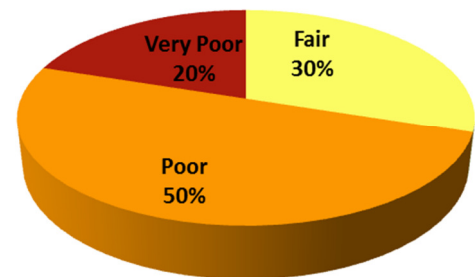


Figure 30 – Stocketts Run Biological Conditions (n=10)

Located at the headwaters of an unnamed tributary to Stocketts Run approximately 0.25 miles west of Birdsville Road, site R2-19-05 (Figure 28) received the lowest BIBI score of 1.29 with a ‘Very Poor’ rating. This site has the smallest drainage area in the sampling unit (62 acres) and is deeply incised with active downcutting, heavily eroded banks, and minimal substrate for benthics. Eleven taxa were present in this sample, which contained one EPT taxa and one scraper taxa but no Ephemeroptera or climber taxa. This site was dominated by midges and worms (including *Diplocladius*, TV = 5.9 and Naididae, TV = 8.9, respectively) with less than two percent of the sample consisting of taxa intolerant to urban stressors.

Site R2-19-10 also received a ‘Very Poor’ biological rating due to a lack of Ephemeroptera, EPT, and climber taxa in addition to very few taxa intolerant to urban stressors. Two sites, R2-19-06 and R2-19-08, received the highest score in Stocketts Run of 3.86 with a biological condition rating of ‘Fair.’ Located on Kings Branch approximately 0.3 miles west of Patuxent River Road, site R2-19-06 had a good mix of riffles and woody debris habitats for benthics. Of the 20 taxa identified in this sample, six were EPT including two Ephemeroptera taxa in addition to four scraper taxa. Site R2-19-08, located in the Renditions Golf Club approximately 250 feet upstream of the Patuxent River confluence, had abundant rootwads which provided stable habitat for benthic macroinvertebrates. Of the 15 taxa identified in this sample, six were EPT including four Ephemeroptera taxa in addition to one scraper taxa.

### 4.5.3 Water Quality

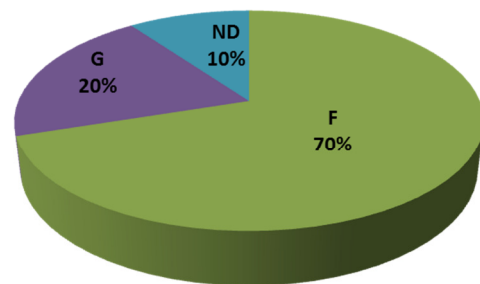
Average water quality values for the Stocketts Run sites are provided in Table 18. Two sites did not meet COMAR standards for water quality. Sites R2-19-02 and R2-19-10 measured outside the acceptable COMAR range for pH (6.5-8.5), with values ranging from 6.29 to 6.48. All other water quality parameters were within acceptable ranges. Water temperature ranged from 5.87 to 14.37 °C; dissolved oxygen ranged from 11.67 to 14.42 mg/L; pH ranged from 6.29 to 8.39; specific conductance ranged from 179.2 to 325.7 µS/cm; and, turbidity ranged from 4.48 to 11.10 NTU. Five sites (R2-19-02, R2-19-05, R2-19-08, R2-19-10, and R2-19-11A) recorded elevated conductivity levels exceeding 247 µS/cm.

**Table 18 - Average water quality values – Stocketts Run (n = 10)**

Value ± Standard Deviation				
Temperature (°C)	DO (mg/L)	pH (Units)	Specific Conductance (µS/cm)	Turbidity (NTU)
11.99 ± 2.75	10.42 ± 1.20	6.73 ± 0.45	220.5 ± 55.4	12.46 ± 5.32

### 4.5.4 Geomorphic Assessment

Site-specific geomorphic assessment results can be found in Appendix A. The majority of sites in the Stocketts Run sampling unit were classified as entrenched F or G type channels (70 and 20 percent, respectively; Figure 31). The stream type of the remaining 10 percent of sites was not determined. Site R2-19-11A, located on Kings Branch, was not determined due to the presence of a large culvert located immediately upstream which is impacting channel morphology.



**Figure 31 - Rosgen Stream Types Observed in Stocketts Run (n=10)**

Dominant substrate type varied throughout the sites in this sampling unit. Forty percent of streams had sand dominated substrates, while the remaining 60 percent of sites were split equally between gravel dominated and silt/clay dominated substrates (30 percent each). The median D<sub>50</sub> for the sampling unit was 1.65 mm (very coarse sand material). With the exception of one site (R2-19-05), slopes were gradual, with an average slope of 0.51 percent, and individual reaches falling in the range from 0.20 percent to 1.70 percent. Site R2-19-05, located on a branch of Stocketts Run, was atypical due to numerous nick points and headcuts located throughout the reach, which resulted in a reach wide slope of 1.70 percent.

## 5 Comparison of Round 1 and Round 2 Results

This section presents a brief comparison of the biological and physical habitat assessment results from Round 1 and Round 2 for each of the five primary sampling units assessed in 2013. Refer to Figure 32 for box plots comparing mean BIBI, RBP, and PHI results from Round 1 and Round 2 in the Cabin Branch, Lower Magothy, Lyons Creek, Severn River, and Stocketts Run sampling units.

To compare statistical differences between mean index values from two time periods (e.g., Round One and Round Two), this report uses the method recommended by Schenker and Gentleman (2001). This is the same method used by the MBSS to evaluate changes in condition over time, and is considered a more robust test than the commonly used method, which examines the overlap between the associated confidence intervals around two means (Roseberry Lincoln et al., 2007). In this method, the 90% confidence interval for the difference in mean values  $Q_1 - Q_2$  is estimated using the following formula:

$$(Q_1 - Q_2) \pm 1.645[SE_1^2 + SE_2^2]^{1/2}$$

where  $Q_1$  and  $Q_2$  are two independent estimates of the mean of a variable (i.e., BIBI, RBP, PHI) and  $SE_1$  and  $SE_2$  are the associated standard errors. The null hypothesis that  $(Q_1 - Q_2)$  is equal to zero was tested (at the 10 percent nominal level) by examining whether the 90 percent confidence interval contains zero. The null hypothesis that the two means are equal was rejected if and only if the interval did not contain zero (Schenker and Gentleman, 2001), resulting in a statistically significant difference between those two values.

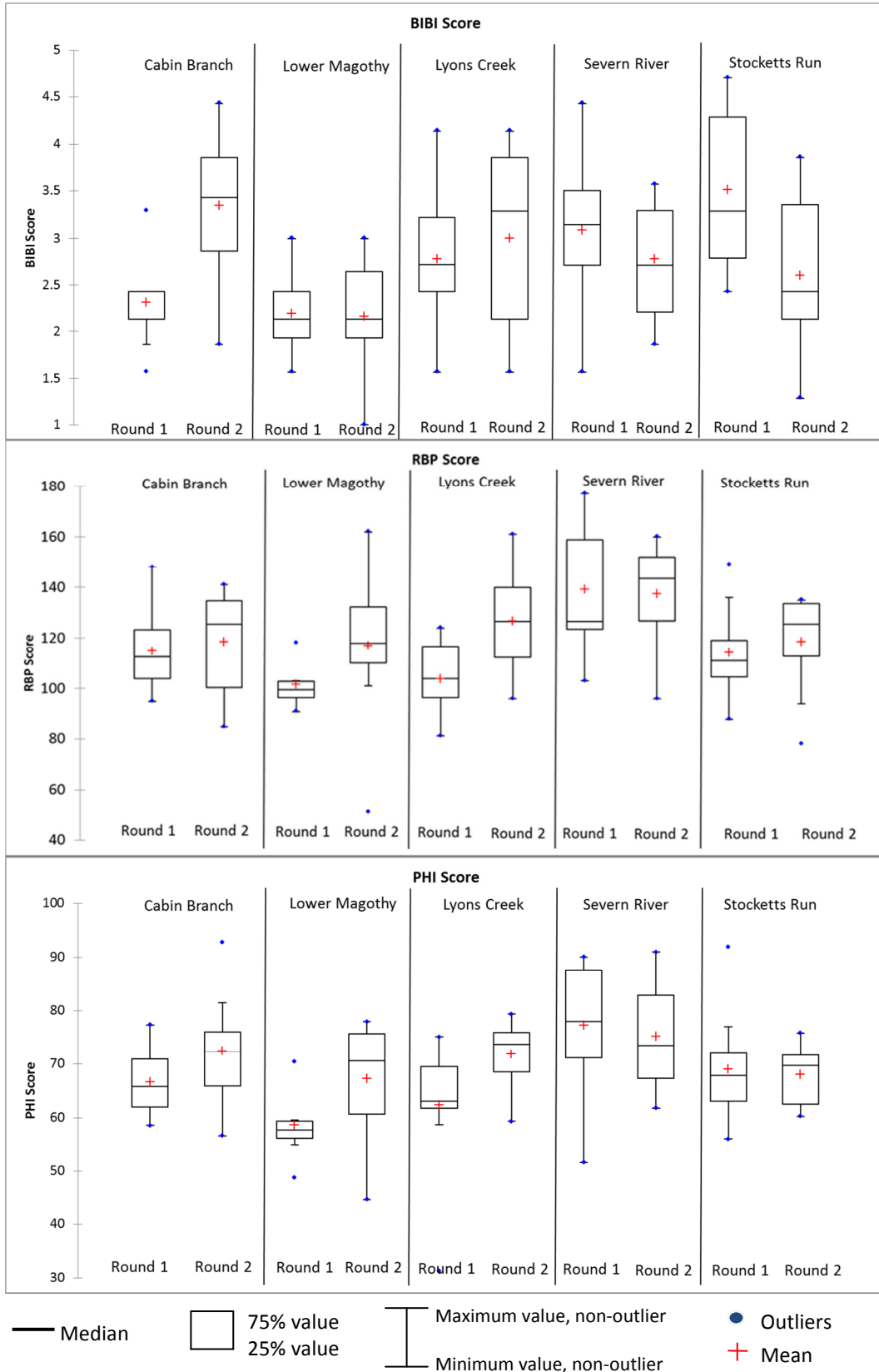


Figure 32 - Box plots comparing mean BIBI, RBP, and PHI scores between Round 1 and Round 2

## 5.1 Biological Conditions

A comparison of mean BIBI scores between Round One and Round Two showed two significant changes between sampling rounds - the Stocketts Run sampling unit significantly decreased from a biological condition rating of 'Fair' in 2005 to 'Poor' in 2013 and the Cabin Branch sampling unit significantly increased from a 'Poor' biological condition rating in 2008 to 'Fair' in 2013 (Table 19). While not statistically significant, the biological condition rating for Severn River decreased from 'Fair' in 2004 to 'Poor' in 2013 and the rating for Lyons Creek increased from 'Poor' in 2007 to 'Fair' in 2013. The biological condition rating remains unchanged in Lower Magothy (2007 – 2013). It is important to note that although a significant difference in BIBI measures was observed in the Cabin Branch and Stocketts Run sampling units between Rounds One and Two, physical habitat conditions were not significantly different between rounds in these sampling units (Section 5.2). This shows that physical habitat conditions may not be a factor that is driving BIBI scores up (Cabin Branch) or down (Stocketts Run) in these sampling units and that other conditions (e.g., water quality, land use) may be influencing benthic macroinvertebrate populations.

**Table 19 - Differences in BIBI measures between Rounds One and Two**

PSU	Round 2		Round 1		Upper 95% CI	Lower 95%CI	Significant Difference? (Direction)
	Mean IBI	SE	Mean IBI	SE			
Cabin Branch	3.34	0.25	2.31	0.16	-0.44	-1.62	Yes (Increase)
Lower Magothy	2.11	0.17	2.20	0.15	0.53	-0.36	No
Lyons Creek	3.00	0.31	2.77	0.25	0.55	-1.01	No
Severn River	2.77	0.20	3.09	0.27	0.98	-0.35	No
Stocketts Run	2.60	0.29	3.51	0.28	1.69	0.13	Yes (Decrease)

## 5.2 Physical Habitat Conditions

Comparisons of physical habitat conditions between Rounds One and Two for the RBP and PHI indices are shown in Table 20 and Table 21, respectively. Physical habitat conditions changed significantly according to both the PHI and RBP indices for the Lyons Creek sampling unit. Round One RBP data collected in 2005 rated Lyons Creek as 'Partially Supporting'; however, the 2013 RBP data rated the mean habitat condition as 'Supporting.' Similarly, PHI data from 2005 resulted in a rating of 'Degraded', while the mean habitat condition increased to 'Partially Degraded' in 2013. In addition, Lower Magothy received a Round One PHI habitat rating of 'Degraded' in 2005 that significantly increased to a rating of 'Partially Degraded' in 2013. RBP habitat conditions did not change for Lower Magothy between 2005 and 2013. PHI and RBP habitat conditions remain unchanged in Cabin Branch (2008 – 2013), Severn River (2004 – 2013), and Stocketts Run (2005 – 2013). It is important to note that although physical habitat conditions significantly changed in Lyons Creek (RBP and PHI) and Lower Magothy (PHI) between Rounds One and Two, BIBI measures did not significantly change in these sampling units. Therefore, an improvement in habitat conditions did not significantly improve the overall benthic macroinvertebrate population in these sampling units.



**Table 20 - Differences in RBP measures between Rounds One and Two**

PSU	Round 2		Round 1		Upper 95% CI	Lower 95%CI	Significant Difference? (Direction)
	Mean RBP	SE	Mean RBP	SE			
Cabin Branch	118.6	6.43	114.9	5.07	12.35	-19.75	No
Lower Magothy	117.0	9.12	101.7	2.71	3.35	-33.95	No
Lyons Creek	126.7	6.80	103.9	4.78	-6.50	-39.10	Yes (Increase)
Severn River	137.5	6.26	139.2	8.05	21.68	-18.28	No
Stocketts Run	118.6	6.12	114.2	5.55	11.80	-20.60	No

**Table 21 - Differences in PHI measures between Rounds One and Two**

PSU	Round 2		Round 1		Upper 95% CI	Lower 95%CI	Significant Difference? (Direction)
	Mean PHI	SE	Mean PHI	SE			
Cabin Branch	72.41	3.20	66.62	2.26	1.88	-13.47	No
Lower Magothy	67.29	3.37	58.68	1.90	-1.04	-16.20	Yes (Increase)
Lyons Creek	71.85	1.92	62.31	3.81	-1.17	-17.91	Yes (Increase)
Severn River	75.16	3.19	77.25	3.84	11.87	-7.70	No
Stocketts Run	68.00	1.78	68.99	3.20	8.16	-6.19	No

## 6 Conclusions and Recommendations

Biological communities respond to a combination of environmental factors, commonly referred to as stressors. Stressors can be organized according to the five major determinants of biological integrity in aquatic ecosystems, which include water chemistry, energy source, habitat structure, flow regime, and biotic interactions (Karr et al., 1986; Angermeier and Karr, 1994; Karr and Chu, 1998). The cumulative effects of human activities within the County's sampling units often results in an alteration of at least one, if not several, of these factors with detrimental consequences for the aquatic biota. Determining which specific stressors are responsible for the observed degradation within a stream or PSU is a challenging task, given that many stressors co-exist and synergistic effects can occur. Furthermore, an added challenge in identifying the stressors affecting stream biota is that the water quality and physical habitat data collected by the County's monitoring program are not comprehensive (i.e., they do not include many possible stressors). For instance, virtually no data are available regarding biotic interactions and energy sources and only limited data regarding flow regime variables, such as land use and impervious cover, are included. Stressor relationships with stream biotic components, and their derived indices (i.e., BIBI), are often difficult to partition from complex temporal-spatial data sets primarily due to the potential array of multiple stressors working at the reach to landscape scale in small streams (Helms et al. 2005; Miltner et al., 2004; Morgan and Cushman, 2005; Volstad et al., 2003; Morgan et al., 2007). Therefore, it should be noted that the current level of analysis cannot identify all stressors for the impaired watersheds, nor will the stressors identified include all of the stressors present.

## 6.1 Biological and Physical Habitat Conditions

Results of the 2013 assessment indicate impaired biological conditions in all five sampling units, although the Cabin Branch and Lyons Creek PSUs did receive a 'Fair' rating. The observed differences between Round 1 and Round 2 results were variable for each sampling unit. Average BIBI scores significantly increased between Round 1 and Round 2 for the Cabin Branch PSU (from the 'Poor' category to 'Fair') while scores significantly decreased for the Stocketts Run PSU (from the 'Fair' category to 'Poor'). While not significant, average BIBI scores increased between Round 1 and Round 2 for the Lyons Creek PSU ('Poor' to 'Fair') and decreased for the Severn Run PSU ('Fair' to 'Poor'). It is also worth pointing out that a statistically significant increase in RBP and PHI scores was observed for the Lyons Run PSU, suggesting that better physical habitat conditions bolstered BIBI scores in 2013. In addition, Lower Magothy saw a statistically significant increase in PHI scores although there was a slight decrease in mean BIBI scores; however, this difference was not statistically significant.

**Overall, both physical habitat assessment methods yielded scores that did not correspond well with predicted BIBI scores. A comparison of narrative biological condition ratings to RBP habitat condition ratings for each site is shown in Table 22. Similarly, Table 23**

Table 23 compares biological condition ratings to PHI habitat ratings. These results are similar to those found by Roberts et al. (2006) and Stribling et al. 2008, and suggest that BIBI scores are not singularly affected by habitat conditions alone and additional stressors are likely present in these systems. Results from the RBP method showed the majority of sites with 'Supporting' or 'Partially Supporting' physical habitat conditions (72 percent); however, half of these sites (50 percent) actually resulted in biological conditions that matched the predicted outcome (Table 22). Similar to the RBP method, results from the PHI method showed the majority of sites with a 'Partially Degraded' or 'Degraded' rating (88 percent) with only 43 percent of sites actually resulting in biological conditions that match the predicted outcome (Table 23).

**Table 22 - Comparison of biological condition ratings to EPA RBP habitat condition ratings.**

EPA RBP Habitat Rating	BIBI Rating			
	Good	Fair	Poor	Very Poor
Comparable to Reference		R2-10-02	R2-08-05 R2-10-01 R2-10-08 R2-22-27A	R2-22-03
Supporting	R2-22-21A R2-23-01	R2-10-03 R2-10-10 R2-19-06 R2-19-11A R2-22-01 R2-22-10 R2-22-19A R2-23-05 R2-23-08 R2-23-10 R2-23-12A	R2-08-07 R2-08-11A R2-10-07 R2-10-11A R2-19-04 R2-19-07 R2-19-16A	R2-08-14A R2-10-04
Partially Supporting	R2-23-03	R2-08-12A R2-19-08 R2-22-08 R2-23-06	R2-08-04 R2-08-10 R2-08-13A R2-10-06	R2-08-17A R2-19-10 R2-22-02

			R2-19-03 R2-22-12A	
<b>Non-Supporting</b>		<b>R2-10-05</b> <b>R2-22-09</b>	R2-19-02 R2-23-04 R2-23-07	R2-08-08 R2-19-05 R2-23-09
Blue cells: stations where the biological community was less impaired than the habitat scores would predict. Gray cells: stations where biological community matched available habitat. Orange cells: stations where the biological community was more impaired than the habitat scores would predict. Bold type stations have biological conditions that differ by at least two qualitative habitat categories.				

**Table 23 - Comparison of biological condition ratings to MBSS PHI habitat condition ratings.**

MBSS PHI Habitat Rating	BIBI Rating			
	Good	Fair	Poor	Very Poor
<b>Minimally Degraded</b>	R2-23-01	R2-10-02 R2-10-03 R2-23-08	<b>R2-10-01</b>	
<b>Partially Degraded</b>	R2-22-21A R2-23-03	R2-10-05 R2-19-06 R2-22-01 R2-22-08 R2-22-10 R2-22-19A R2-23-05 R2-23-06 R2-23-10	R2-08-07 R2-08-05 R2-08-11A R2-08-13A R2-10-06 R2-10-11A R2-19-03 R2-19-04 R2-19-07 R2-19-16A R2-22-12A	<b>R2-08-14A</b> <b>R2-08-17A</b> <b>R2-10-04</b> <b>R2-19-05</b> <b>R2-19-10</b> <b>R2-22-02</b> <b>R2-22-03</b>
<b>Degraded</b>		R2-08-12A R2-10-10 R2-19-08 R2-19-11A R2-22-09 R2-23-12A	R2-08-04 R2-08-10 R2-10-07 R2-10-08 R2-19-02 R2-22-27A R2-23-04 R2-23-07	R2-23-09
<b>Severely Degraded</b>				R2-08-08
Blue cells: stations where the biological community was less impaired than the habitat scores would predict. Gray cells: stations where biological community matched available habitat. Orange cells: stations where the biological community was more impaired than the habitat scores would predict. Bold type stations have biological conditions that differ by at least two qualitative habitat categories.				

Although physical habitat conditions were generally degraded in all five watersheds, degraded habitat alone cannot explain the observed biological conditions in these sampling units. Because habitat conditions did not correspond well to predicted biological conditions at many sites, additional stressors are likely influencing the benthic macroinvertebrate assemblages in these streams.

In developed sampling units with a higher percentage of impervious surfaces, such as Lower Magothy and Severn River, water quality stressors are likely responsible for impaired biological conditions. Elevated conductivity values (i.e., >247 µS/cm) were observed at sites in three of the five sampling units – Lower Magothy, Severn River, and Socketts Run. There was a slight trend (R<sup>2</sup>=0.40) toward increased conductivity with increased impervious surfaces for the sites sampled in 2013. This relationship between

conductivity and imperviousness is consistent with patterns observed throughout Anne Arundel County (Hill and Pieper, 2011b). Cabin Branch and Lyons Creek had the lowest overall imperviousness (2.9 percent and 4.4 percent, respectively) and also did not have any sites with elevated conductivity values. Using data from 2013 sites, conductivity is significantly correlated with BIBI score ( $p < 0.02$ ) with BIBI scores decreasing ( $R^2 = 0.12$ ) as conductivity levels increase. Both the Cabin Branch and Lyons Creek sampling units were the only sampling units that did not measure elevated conductivity values and were also the only sampling units to receive an overall biological condition rating of 'Fair.' The remaining three sampling units all received a biological condition rating of 'Poor,' and half of the sites (five sites) sampled in Stocketts Run and over half of the sites sampled in both Lower Magothy and Severn Run (six sites each) measured elevated conductivity values. These findings suggest that de-icing chemicals, road salts and other inorganic ions such as sulfate, phosphate, and iron may be a predominant water quality stressor responsible for the observed biological impairment in these streams, especially where physical habitat is adequate for supporting healthy benthic macroinvertebrate assemblages. However, additional water quality data would be necessary to determine the constituent (or constituents) responsible for the increased conductivity (e.g., metals, salts, nutrients), and whether there are any known acute or chronic effects to aquatic biota. Nonetheless, data from Round One indicate that BIBI scores are negatively correlated with conductivity values, and conductivity can be a useful predictor of urban runoff in receiving waters (Hill and Pieper, 2011b).

Identifying additional stressors in the rural sampling units, such as Cabin Branch and Lyons Creek, is much more challenging given the available data. According to the PHI, six of the sites in Cabin Branch and five of the sites in Lyons Creek had biological conditions equal to predicted physical habitat conditions. There are similar results using the RBP, in which case biological conditions equaled predicted physical habitat conditions for five sites in the Cabin Branch sampling unit and four sites in the Lyons Creek sampling unit. However, five sites and three sites in the Cabin Branch and Lyons Creek sampling units, respectively, had better biological conditions than the physical habitat conditions which may suggest some degree of nutrient enrichment in this sampling unit, especially considering the higher proportion of agricultural land use in these sampling units (22 percent of Cabin Branch and 31 percent of Lyons Creek) when compared to the other sampling units.

It is also plausible that the biological condition of these sampling units is impaired by stressors related to past land use, commonly referred to as legacy effects, which are the consequences of past disturbances that continue to influence environmental conditions long after the initial appearance of the disturbance (Allan, 2004). Historically, nearly all of Anne Arundel County has experienced deforestation, followed by intensive agriculture, which significantly altered the landscape (Schneider, 1996). These drastic land use changes likely altered the structure and function of the stream ecosystems to a considerable extent, some of which have yet to fully recover. This notion is supported by Harding and others (1998), who found that past land use activity, in particular agriculture, may result in long-term modifications to and reductions in aquatic diversity, regardless of reforestation of riparian zones. What is not clear, however, is how long these legacy effects will persist in these subwatersheds, and consequently, what can be done to improve the biological condition of these streams.

Drainage area may influence biological community composition with larger drainage areas providing an increased potential for full colonization by benthic macroinvertebrate communities (Hill and Pieper, 2011b). Using data from 2013 sites, drainage area is significantly correlated with BIBI score ( $p < 0.02$ ), with a trend ( $R^2 = 0.11$ ) of increased BIBI score with increased drainage area. This relationship is consistent with patterns observed throughout Anne Arundel County (Hill and Pieper, 2011b). The results of the comparison of biological condition ratings using the MBSS PHI shown in Table 23 may also be

skewed because of a drainage area effect. PHI habitat ratings seem to be inflated for sites with smaller drainage areas ('Partially Degraded') and deflated for sites with larger drainage areas ('Degraded' or 'Severely Degraded'). For example, site R2-08-14A received a biological rating of 'Very Poor,' so the habitat rating for this site is expected to be 'Severely Degraded,' not 'Partially Degraded.' All sites that have biological conditions that are worse than the habitat scores would predict by at least two qualitative PHI habitat categories, as indicated by the orange cells with bold type stations in Table 23, have relatively small drainage areas ranging from 62 to 1,497 acres (median = 198 acres; n = 8). Conversely, all sites where the biological community was better than the habitat scores would predict (blue cells; e.g., R2-22-21A) have large drainage areas ranging from 519 to 9,573 acres (median = 1,480 acres; n = 8).

## 6.2 Geomorphologic Conditions

The geomorphic assessment field data were compared to the Maryland Coastal Plain (MCP) regional relationships of bankfull channel geometry (McCandless, 2003), which was derived from E type and C type streams, in order to determine how channel dimensions observed in the field compare to those predicted for rural/suburban subwatersheds. Comparisons of bankfull width, mean bankfull depth, and bankfull cross-sectional area, stratified by Rosgen Level I stream type, are shown in Figures 33, 34, and 35, respectively. Channels where Rosgen classifications could not be determined or were considered transitional, were not included in these analyses (ND = seven sites; Transitional = 4 sites).

A comparison of bankfull width values show the trendline for G channels ( $R^2 = 0.76$ ) as the closest matching the MCP curve (Figure 33). Trendlines from DA ( $R^2 = 0.08$ ) and F ( $R^2 = 0.89$ ) channels contained more variability, with data points scattered mostly above the MCP curve. This suggests that DA and F type channels assessed in 2013 are generally wider than the streams used to derive the MCP regional relationships. On the other hand, the trendline for E type ( $R^2 = 0.76$ ) channels was below the MCP curve, indicating narrower channels than predicted by the regional curve. These results are somewhat expected given that F type channels tend to have greater width/depth ratios as compared to E and G type channels. Mean bankfull depth values showed the trendline for G type channels ( $R^2 = 0.85$ ) closely matching the MCP curve, with the exception of a few outliers above the curve (Figure 34). DA type channels exhibited the highest degree of variability ( $R^2 = 0.29$ ), with points scattered well below the curve, showing depths that were shallower than predicted by the MCP. All F channels fell below the MCP curve, suggesting much shallower channels than the MCP would predict. As with bankfull width, the channel types follow the expected mean bankfull depth relationship. For the same drainage area, E channels were the deepest followed by G, F, and DA.

Comparisons of bankfull cross-sectional area values show the trendlines for DA type ( $R^2 = 0.55$ ), E type ( $R^2 = 0.70$ ), F type ( $R^2 = 0.97$ ), and G type ( $R^2 = 0.91$ ) channels closely matching the MCP curve (Figure 35).

The results of the comparison are not surprising considering that the streams used to derive the MCP curves were E type and C type streams, which explains why these stream types typically show a good fit to the MCP predictions of channel dimensions, primarily cross-sectional area. Conversely, this also helps to explain why F, G, and DA channels often deviate from the predictions, since the curve was created exclusively from C and E type channels.

Channel instability, sediment deposition, and bank erosion are likely significant stressors impacting the benthic macroinvertebrate communities in these sampling units; however, the extent of these impacts is

not well understood. Typically, reaches classified as unstable G and F type streams would be expected to have more impaired biological communities than reaches classified as more stable stream types, such as E, C, and B channels. However, geomorphic and biological results from this sampling period, as well as those from Round One do not support this notion. For sites classified as F type and G type channels in 2013 (n=24), close to one-half of sites (41.7 percent) received a 'Fair' biological rating, while one-third of sites (33.3 percent) received a 'Poor' rating, and the remaining 25 percent of sites were split evenly between 'Good' and 'Very Poor' biological ratings. An analysis of the Round One data set found that geomorphic variables did not correlate well with biological variables (Hill and Pieper, 2011b). Furthermore, land use characteristics, while significantly correlated with variables such as entrenchment ratio and flood-prone width, showed relationships that were the opposite of what would have been expected (i.e., positively correlated with percent developed land and negatively correlated with percent agriculture), suggesting a more complex interaction between land use and geomorphic characteristics (Hill and Pieper, 2011b). The pace and age of development may be influencing channel evolution and the types of stream channels found in these sampling units, as suggested by Stribling et al. (2008). However, it is also possible that some of the "stable" E and C type streams are experiencing an aggradation phase of channel evolution whereby an increased sediment supply from bank erosion begins to fill the channel, decreasing stream depth and increasing floodplain connectivity. However, these hypotheses were not tested as part of this study, and further data would be necessary to determine the dominant geomorphological processes in each of these sampling units.

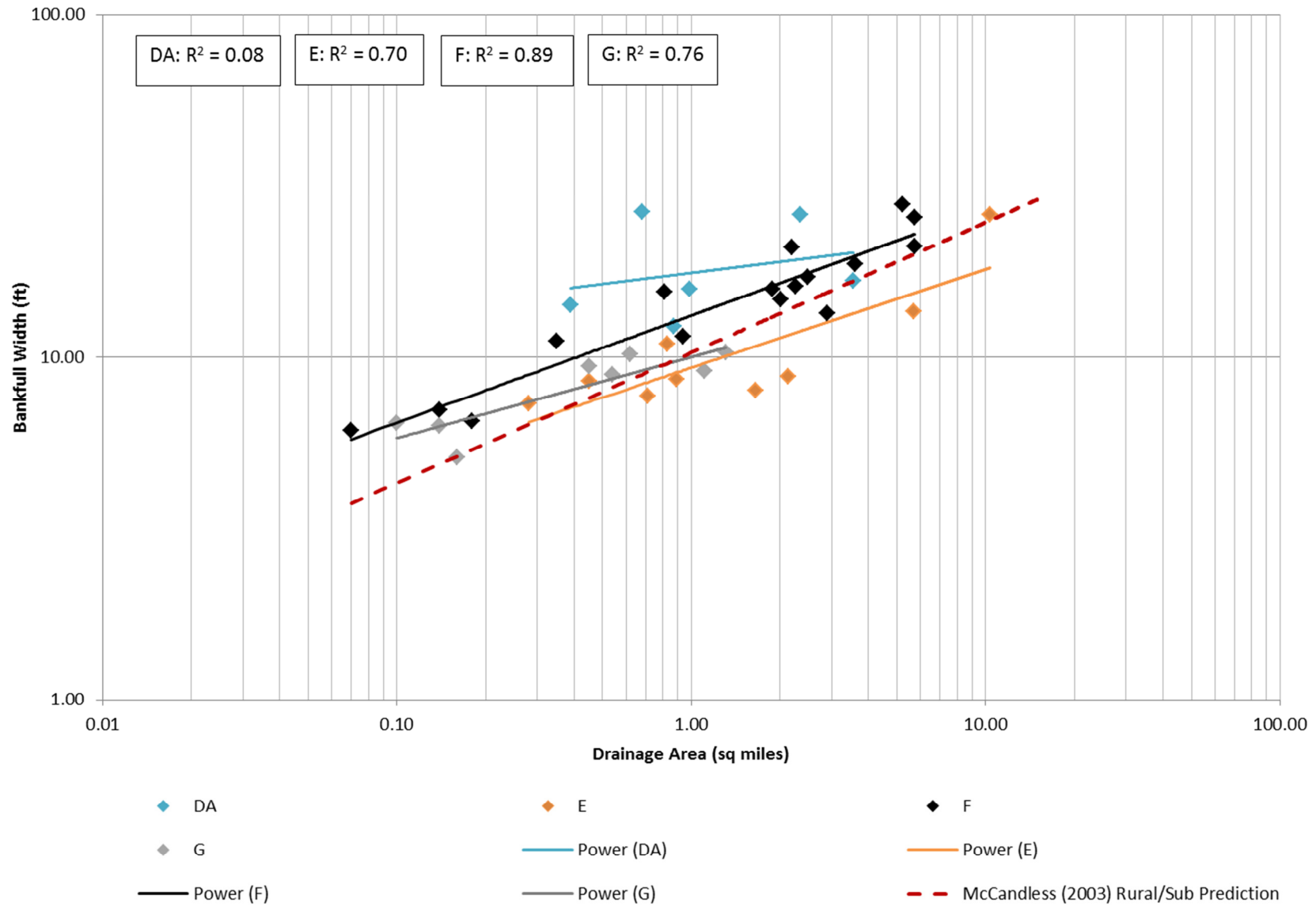


Figure 33 - Comparison of the Bankfull Width - Drainage Area Relationship between Field Data and Regional Relationship Curve Data

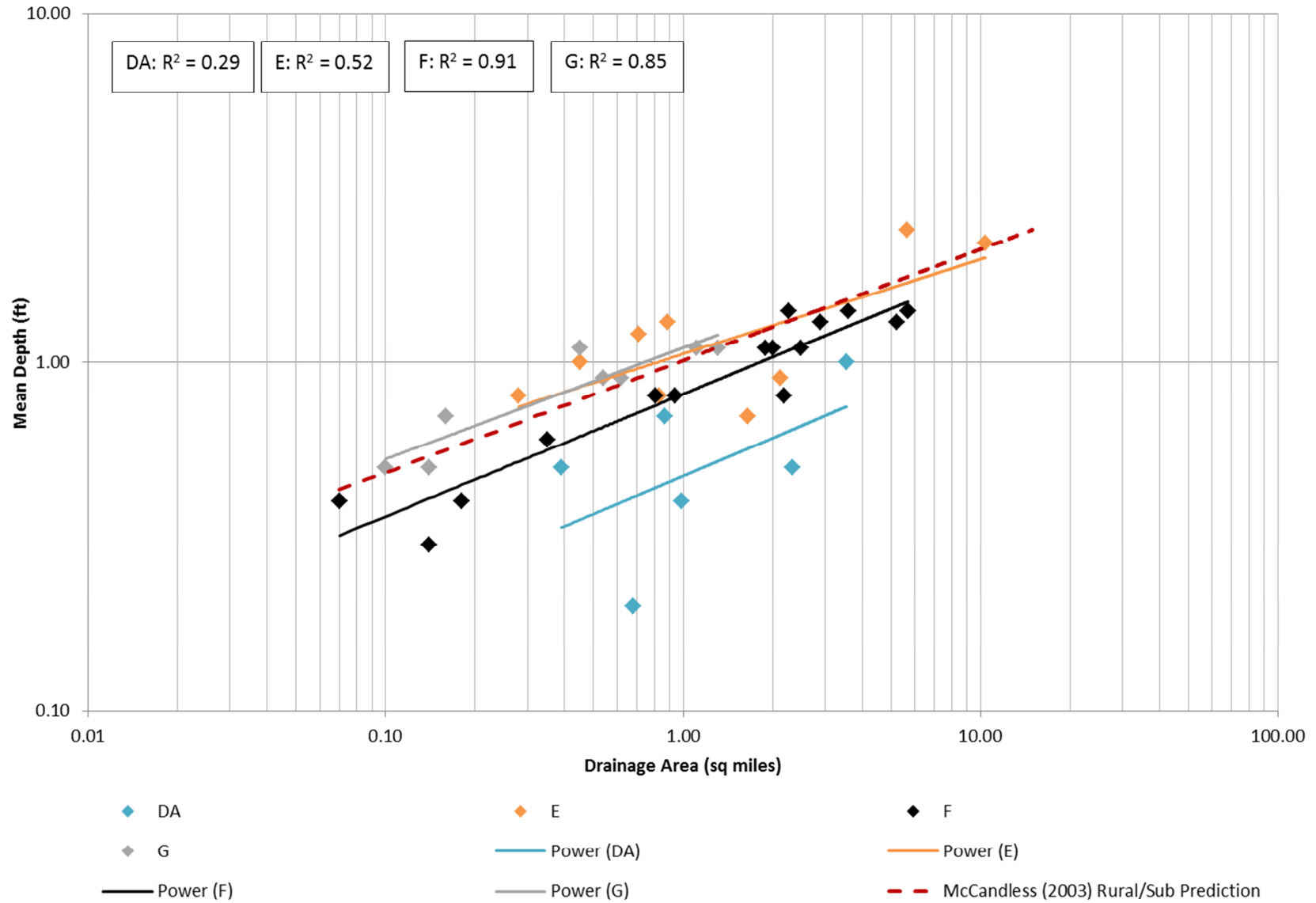


Figure 34 - Comparison of the Mean Bankfull Depth - Drainage Area Relationship between Field Data and Regional Relationship Curve Data



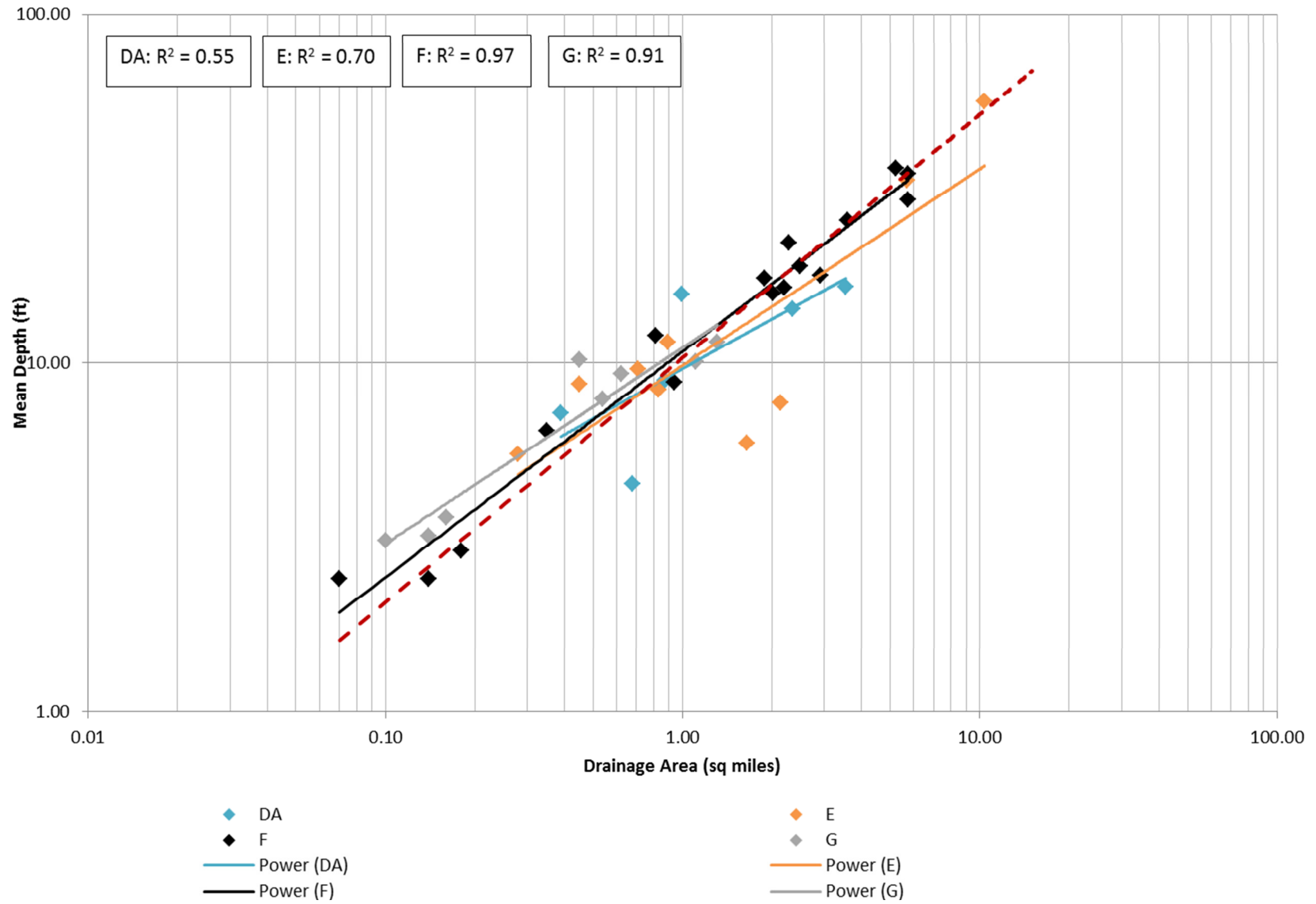


Figure 35 - Comparison of the Bankfull Cross-Sectional Area - Drainage Area Relationship between Field Data and Regional Relationship Curve Data

### 6.3 Recommendations

Based upon the conclusions discussed in the previous section, the following recommendations are made for these sampling units:

#### Stream Channel Evolution and Trajectory

Based on the analysis of Round One data, it was shown that many geomorphic variables such as bankfull channel dimensions, dimensionless ratios, and water surface slope were not significantly correlated with BIBI scores (Hill and Pieper, 2011b). Sinuosity and  $D_{50}$  were the only geomorphic variables correlated with the overall BIBI score (0.05 level). As a result, it is recommended that subsequent assessment efforts should focus more on the dominant geomorphologic processes or channel evolution stage, since these processes are more likely influencing the benthic macroinvertebrate communities than basic channel dimensions and stream type as classified by the Rosgen approach. In a study relating stream geomorphic state to ecological integrity, Sullivan et al. (2004) recommend that stream channels be evaluated in terms of dynamic stability and adjustment rather than simply categorized as stable or unstable. Sites assessed in Rounds One and Two, or at least a subset of sites, should be re-visited and cross sections re-surveyed after a specified period of time (e.g., 5 years, 10 years) so that changes in channel dimensions can be quantified and determinations made regarding the dominant process occurring in each stream. This would help to validate stability assumptions, providing the County with a better understanding of how land use changes impact streams over time, which may ultimately allow for fine tuning zoning and development regulations toward maximum protection of stream channel stability.

#### Water Quality Sampling

Because identifying stressors is critical to the development of management actions that can restore or protect the desired condition of streams, it is recommended that the County consider the addition of water quality grab sampling during subsequent sampling efforts to better understand and document chemical stressors affecting the biota. Water quality sampling should evaluate additional parameters such as nutrients, chloride, and metals, which may potentially be of concern. While this would add considerable costs to the monitoring program, the added benefit would greatly enhance the County's ability to identify predominant water quality stressors and sources. Additionally the program would be positioned well to monitor changes in water chemistry as it relates to tracking progress towards meeting total maximum daily load (TMDL) requirements, both for specific impaired water bodies and for the Chesapeake Bay-wide TMDL.

#### Stressor Identification Studies

While it is assumed that water quality stressors are impacting biota in some of these streams, a more focused stressor identification technique such as the U.S. Environmental Protection Agency's Stressor Identification (SI) process (USEPA, 2000), is necessary to correctly associate biological impacts with their most probable causes. This typically involves the collection of additional data (e.g., water quality grab sampling, storm sampling), which can be both costly and time consuming on a large scale. Therefore, in an effort to optimize the use of limited resources it is recommended that the County prioritize which streams and/or subwatersheds require a more detailed analysis of stressors and sources, whether the goal is for protection, preservation, or enhancement.

## Best Management Practices

### *Stormwater Management*

Two of the sampling units, Lower Magothy and Severn River, have been developed extensively and could benefit from retrofitting existing development and/or increasing stormwater best management practices (BMPs) to treat larger volumes of stormwater runoff. It is recommended that the County consider improving existing BMPs and/or installing new BMPs, wherever practical and feasible, in these subwatersheds, given that they appear to be widely impacted by urban stormwater runoff.

### *Agricultural Lands*

While Cabin Branch and Lyons Creek sampling units contained less developed land, overall BIBI scores still show signs of impairment. These subwatersheds may be impacted by current agricultural land use and may benefit from increasing BMPs to treat agricultural runoff. It is recommended that the County consider working with current landowners to improve existing agricultural BMPs and/or initiate new BMPs, wherever practical and feasible, in the Cabin Branch and Lyons Creek subwatersheds.

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## Appendix A: Geomorphic Assessment Results

Site	Drainage Area (mi <sup>2</sup> )	Bankfull Width (ft)	Mean Bankfull Depth (ft)	Floodprone Width (ft)	Entrenchment Ratio	Width to Depth Ratio	Cross Sectional Area (ft <sup>2</sup> )	Slope (%)	Sinuosity	D50 (mm)	Rosgen Stream Type	Comments
R2-08-04	1.11	9.1	1.1	12.2	1.3	8.1	10.1	0.41	1.7	0.06	G6c	
R2-08-05	0.99	15.8	0.4	143.0	3.3	117.6	15.8	0.70	1.2	0.06	DA6	
R2-08-07	0.28	7.3	0.8	62.0	8.5	9.6	5.5	0.65	1.1	0.07	E5/6	Bimodal distribution of substrate (sand/clay)
R2-08-08	0.28	7.1	0.6	10.4	1.5	11.5	4.4	0.55	1.4	N/A	ND	Concrete trapezoidal channel with triple pipe culvert below midpoint
R2-08-10	0.89	8.6	1.3	152.0	17.7	6.4	11.5	0.17	1.1	0.15	E5	
R2-08-11A	0.39	14.2	0.5	65.0	4.6	27.7	7.2	0.14	1.3	0.14	DA5	
R2-08-12A	0.87	12.3	0.7	75.0	6.1	16.9	8.9	1.30	1.1	0.09	DA5	Slope skewed by presence of headcut in reach
R2-08-13A	0.26	6.4	1.2	13.0	2.0	5.4	7.7	0.41	1.1	0.25	ND	Reach altered by double pipe culverts and bed stabilization in upper half of reach
R2-08-14A	0.45	8.5	1.0	130.0	15.3	8.3	8.7	0.06	1.5	0.19	E5	
R2-08-17A	0.17	7.1	0.4	55.0	7.7	19.1	2.6	1.40	1.1	0.06	ND	Reach runs through breached pond embankment. US half of reach in old pond basin.
R2-10-01	0.58	12.3	1.7	152.0	12.4	7.3	20.6	0.64	1.3	0.20	Transitional	Transitional reach from E upstream to DA downstream
R2-10-02	0.68	26.5	0.2	160.0	6.0	155.8	4.5	1.90	1.2	0.09	DA5	
R2-10-03	0.34	4.4	1.0	140.0	31.7	4.6	4.3	1.40	1.3	0.06	Transitional	Transitional reach from DA upstream to E below headcut
R2-10-04	0.83	10.9	0.8	32.0	2.9	14.1	8.4	0.35	1.1	0.34	E5	Adjusted WD Ratio -2.0 to fit E type
R2-10-05	0.45	9.4	1.1	11.3	1.2	8.6	10.2	0.48	1.3	0.23	G5c	
R2-10-06	0.52	15.2	0.7	220.0	14.5	21.4	10.8	1.70	1.2	0.06	Transitional	Transitional reach from DA upstream to G below headcut.
R2-10-07	1.65	8.0	0.7	86.0	10.8	10.9	5.9	0.75	1.1	1.00	E5	
R2-10-08	1.2	11.3	1.4	145.0	12.8	8.2	15.6	0.03	1.1	0.06	ND	Channel is heavily influenced by beaver dam upstream and open water wetland downstream.
R2-10-10	2.13	8.8	0.9	195.0	22.3	10.0	7.7	0.52	1.1	0.06	E6	
R2-10-11A	0.71	7.7	1.2	195.0	25.2	6.2	9.6	0.56	1.1	0.15	E5	
R2-19-02	0.18	6.5	0.4	8.1	1.2	14.9	2.9	0.20	1.0	0.06	F6	
R2-19-03	2.27	16.1	1.4	21.2	1.3	11.7	22.1	0.22	1.4	0.30	F5	Adjusted WD Ratio +0.5 to fit F type
R2-19-04	1.89	15.8	1.1	24.7	1.6	14.2	17.5	0.45	1.1	18.00	F4/5	Adjusted ER -0.2 to fit F type. Bimodal distribution of substrate (sand/gravel)
R2-19-05	0.1	6.4	0.5	8.7	1.4	13.3	3.1	1.70	1.1	0.06	G6c	Adjusted WD Ratio -1.3 to fit G type
R2-19-06	2.19	20.9	0.8	22.2	1.1	26.5	16.5	0.62	1.3	16.00	F4/5	Bimodal distribution of substrate (sand/gravel)
R2-19-07	5.23	27.9	1.3	35.1	1.3	21.5	36.1	0.28	1.3	1.60	F4/5	Bimodal distribution of substrate (sand/gravel)
R2-19-08	2.49	17.1	1.1	20.2	1.2	15.5	19.0	0.46	1.1	12.00	F4/5	Bimodal distribution of substrate (sand/gravel)
R2-19-10	0.14	6.3	0.5	8.0	1.3	12.3	3.2	0.63	1.1	0.06	G6c	Adjusted WD Ratio -0.3 to fit G type
R2-19-11A	2.03	21.2	1.0	36.6	1.7	22.2	20.3	0.35	1.1	1.70	ND	Reach is immediately DS of large culvert which is impacting channel morphology.
R2-19-16A	5.73	25.5	1.4	37.6	1.5	18.6	34.9	0.23	1.7	1.70	F4/5	Adjusted ER -0.1 to fit F type. Bimodal distribution of substrate (sand/gravel)

Site	Drainage Area (mi <sup>2</sup> )	Bankfull Width (ft)	Mean Bankfull Depth (ft)	Floodprone Width (ft)	Entrenchment Ratio	Width to Depth Ratio	Cross Sectional Area (ft <sup>2</sup> )	Slope (%)	Sinuosity	D50 (mm)	Rosgen Stream Type	Comments
R2-22-01	5.68	13.6	2.4	207.0	15.2	5.6	33.4	0.29	1.1	0.12	E5	
R2-22-02	0.14	7.0	0.3	8.0	1.2	20.4	2.4	0.63	1.1	0.24	F4/5	Bimodal distribution of substrate (sand/gravel)
R2-22-03	2.34	26.1	0.5	550.0	21.1	47.6	14.3	0.10	1.1	0.06	DA6	
R2-22-08	0.94	11.5	0.8	14.2	1.2	15.1	8.8	0.61	1.2	0.90	F4/5	Bimodal distribution of substrate (sand/gravel)
R2-22-09	0.81	15.5	0.8	19.3	1.2	19.9	12.0	0.45	1.1	0.16	F5/6	Bimodal distribution of substrate (sand/clay)
R2-22-10	5.73	21.0	1.4	26.8	1.3	15.1	29.3	0.10	1.1	0.06	F6	
R2-22-12A	0.16	5.1	0.7	8.3	1.6	7.3	3.6	0.76	1.0	0.21	G4/5c	Adjusted ER -0.2 to fit G type. Bimodal distribution of substrate (sand/gravel)
R2-22-19A	0.54	8.9	0.9	9.8	1.1	10.0	7.9	0.89	1.4	0.45	G4/5c	Bimodal distribution of substrate (sand/gravel)
R2-22-21A	10.38	26.0	2.2	175.0	6.7	12.0	56.2	0.14	1.1	0.15	E5	
R2-22-27A	3.54	16.7	1.0	245.0	14.7	16.8	16.6	1.00	1.2	0.06	DA6	
R2-23-01	0.35	11.1	0.6	15.2	1.4	19.1	6.4	0.64	1.3	0.40	F4/5	Bimodal distribution of substrate (sand/gravel)
R2-23-03	3.59	18.7	1.4	21.0	1.1	13.6	25.6	0.38	1.2	0.44	F4/5	Bimodal distribution of substrate (sand/gravel)
R2-23-04	0.16	4.0	0.5	5.5	1.4	7.6	2.1	1.40	1.1	0.08	Transitional	Transitional reach from E upstream to G below headcut
R2-23-05	1.35	13.0	1.3	17.2	1.3	10.2	16.7	0.00	1.0	0.25	ND	Channel is heavily influenced by beaver dam downstream.
R2-23-06	2.01	14.7	1.1	19.6	1.3	13.6	15.9	0.33	1.5	0.26	F5	
R2-23-07	0.62	10.2	0.9	13.1	1.3	11.2	9.3	0.59	1.1	0.43	G6c	Substrate predominantly hardpan clay
R2-23-08	1.31	10.3	1.1	11.6	1.1	9.2	11.5	0.55	1.1	0.33	G4/5c	Bimodal distribution of substrate (sand/gravel)
R2-23-09	0.07	6.1	0.4	7.7	1.2	16.0	2.4	1.20	1.1	0.12	F4/5	Bimodal distribution of substrate (sand/gravel)
R2-23-10	2.9	13.4	1.3	18.7	1.4	10.1	17.9	0.54	1.2	0.52	F4/5	Adjusted WD Ratio +2.0 to fit F type. Bimodal distribution of substrate (sand/gravel)
R2-23-12A	14.96	33.5	2.5	195.0	5.8	13.2	84.7	0.02	1.0	0.13	ND	Reach entirely backwatered and located between two bridge crossings.



## Appendix B: Quality Control Summary

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## Appendix B: Quality Assurance/Quality Control Procedures and Results

A quality assurance and quality control analysis was completed for the assessment work conducted in the Countywide Aquatic Biological Assessment following the methods described by Hill and Pieper (2011). This analysis included performance characteristics of precision, accuracy, bias, sensitivity, and completeness, with comparisons to Measurement Quality Objectives MQOs. Performance measures include:

- Precision (consistency) of field sampling and overall site assessments using intra-team site duplication
  - median relative percent difference (mRPD)
  - root mean square error (RMSE)
  - coefficient of variability (CV)
- Sensitivity of overall site assessments
  - 90% confidence interval (CI)
- Bias of sample sorting and subsampling
  - percent sorting efficiency (PSE)
- Precision of taxonomic identification and enumeration
  - percent taxonomic disagreement (PTD)
  - percent difference in enumeration (PDE)

Data that do not meet performance or acceptable criteria are re-evaluated to correct any problems or investigated further to determine the reason behind the results.

### Field Sampling

All field crew leaders were recently trained in MBSS Spring Sampling protocols prior to the start of field sampling. In addition, benthic macroinvertebrate sampling was conducted only by crew members certified in MBSS benthic macroinvertebrate sampling (Megan Crunkleton and Susanna Brellis certified in 2012; Colin Hill certified in 2013). Certification results are included as an addendum to this Appendix. Prior to the establishment of the certification process in 2012, to ensure consistency with MBSS protocols, a representative from DNR conducted a field audit.

All subjective scoring of physical habitat parameters was completed with the input of all team members at the sampling site to reduce individual sampler bias.

Field water quality measurements were collected *in situ* at all monitoring sites according to methods in the County QAPP. All *in situ* parameters were measured with an YSI Professional Plus series multiprobe except turbidity which was measured with a Hach 2100 Turbidimeter. Water quality equipment was regularly inspected, maintained, and calibrated to ensure proper usage and accuracy of the readings. Calibration logs were kept by field crew leaders and checked by the project manager regularly.

Sample buckets contained both internal and external labels. All chain-of-custody procedures were followed for transfer of the samples between the field and the identification lab.

Replicate (duplicate) samples were taken at ten percent of the overall sites (five sites), one within each sampling unit. QC samples were collected just upstream of the original sampling location to determine the consistency and repeatability of the sampling procedures and the intra-team adherence to those protocols. The QC site was field-selected rather than randomly selected to ensure that the QC sites maintained similar habitat conditions to the original site, and no additional stressors or unusual conditions were present that may affect the biota.

Duplicate samples included collection and analysis of the benthic macroinvertebrate community, completion of the RBP and the PHI habitat assessments, and measurement of *in situ* water chemistry. Photographs were also taken at duplicate sites. Duplicate samples were collected at one site for each of the five primary sampling units (PSUs) sampled in 2013.

### Precision

Performance characteristics calculated for the consistency of field sampling and overall site assessments using intra-team site duplication were:

- Relative Percent Difference (RPD)
- Root Mean Square Error (RMSE)
- Coefficient of Variability (CV)

Acceptable measurement quality objectives are listed in Table 1. DNR’s MBSS protocols were used for the collection and analysis of macroinvertebrate data.

**Table 1 – Measurement quality objectives for metric values and index scores**

Attribute	MQO <sup>1</sup>		
	Median RPD	RMSE	CV
Total Number of Taxa	20	4.3	20
Number of EPT Taxa	30	1.7	50
Number of Ephemeroptera Taxa	30	2.8	100
Percent Intolerant Urban	80	15.9	80
Percent Ephemeroptera	30	0.5	100
Number of Scraper Taxa	30	0.9	100
Percent Climber	30	6.9	70
B-IBI	20	0.6	22

<sup>1</sup>Values derived from Hill and Pieper, 2011

Results of performance characteristics using individual metric values are presented in Table 2. Results are shown for sites where a duplicate sample (i.e., sample pair) was collected and analyzed.

Both metric values and index scores were compared to MQOs to determine exceedances. Three metrics, Number of Taxa, Number of Scraper Taxa, and Percent Climbers, exceeded the MQO for mRPD. The high RPD value for Number of Taxa was largely due to the differences in taxa count for three sites – R2-08-05, R2-10-07, and R2-23-08. The high RPD value for Scraper Taxa was due to relatively few scraper taxa present in the samples which tend to skew RPD values upward when comparing small values as compared to large values. The high mRPD for Percent Climbers was likely due to the variability within this metric between sites sampled in which values range from 0.0 percent to 17.8 percent for the sites analyzed for QC.

In addition to exceeding the MQO for mRPD, the Number of Scraper Taxa metric also exceeded the MQO for RMSE; which is also due to the comparison of small values between sites. One additional metric, Percent Ephemeroptera, and the BIBI index score exceeded the MQO for RMSE, but passed for mRPD. The exceedance for Percent Ephemeroptera was primarily due to the amount of variation between samples in which the percentages of Ephemeroptera taxa

range from 0.0 percent to 53.0 percent for sites analyzed for QC. Because of the variation between samples, the BIBI index rating ranges from Very Poor (1.57) to Good (4.14), which also caused an exceedance for RMSE.

Three metrics, Number of EPT taxa, Number of Ephemeroptera Taxa, and Percent Ephemeroptera, in addition to the BIBI index score, exceeded the MQO for CV. EPT Taxa exceeded the MQO for CV due to the comparison of small values; for example, three sites had a difference of just one EPT taxa while only one site had a difference of two EPT taxa. The exceedance for Ephemeroptera Taxa was primarily due to the amount of variation between samples – R2-23-08 (and QC) had one Ephemeroptera taxa present, R2-19-06 (and QC) had two taxa present, and R2-22-21A (and QC) had three taxa present while all other samples did not contain Ephemeroptera. Percent Ephemeroptera exceeded the MQO for CV due to the range of percentages between sites, as discussed above. The BIBI index score exceeded the MQO for CV because of the differences between site scores.

All other values were within acceptable ranges.

These results show the innate variability that is possible within a sampling reach. Although all samples were collected by a certified benthic macroinvertebrate sampler, variation within a reach (primary site vs. field replicate) is probable due to slight variations in habitat availability (e.g., instream woody debris, quality of leaf packs and riffles) and sample processing and subsampling within the laboratory.

**Table 2 – Individual Metric Values and Related Measures of Precision. Bold values exceed MQOs.**

Site	Total Taxa	EPT Taxa	% Ephem	Ephem Taxa	% Intol Urban	Scraper Taxa	% Climbers	BIBI	Rating
R2-08-05	21	1	0.0	0	0.0	3	17.8	2.43	Poor
R2-08-05 QC	28	2	0.0	0	5.3	4	7.4	2.71	Poor
R2-10-07	21	1	0.0	0	10.8	1	4.5	2.14	Poor
R2-10-07 QC	14	1	0.0	0	10.4	0	1.0	1.86	Very Poor
R2-19-06	21	6	9.4	2	26.0	4	3.1	3.86	Fair
R2-19-06 QC	19	5	16.8	2	28.7	2	4.0	4.43	Good
R2-22-21A	19	6	35.0	3	10.0	3	5.0	4.14	Good
R2-22-21A QC	17	4	53.0	3	6.0	2	2.0	3.57	Fair
R2-23-08	19	4	23.0	1	30.0	3	7.0	3.86	Fair
R2-23-08 QC	28	3	17.0	1	22.0	2	13.0	4.14	Good
Median RPD	<b>28.6</b>	28.6	30.0	0.0	30.8	<b>40.0</b>	<b>82.5</b>	10.9	-
RMSE	0.3	4.7	<b>28.5</b>	2.6	1.2	<b>1.4</b>	4.6	<b>1.7</b>	-
CV	1.6	<b>172.5</b>	<b>178.2</b>	<b>260.8</b>	10.1	62.9	63.6	<b>54.8</b>	-

### *Laboratory Sorting and Subsampling*

#### **Bias**

All sorting was completed following the SOPs described in the QAPP. For these samples, ten percent (five samples) underwent quality control procedures for sorting, meeting the ten percent requirement. Average percent sorting efficiency was 97.2% (n=5). All samples sorted by

laboratory personnel in training (i.e., not consistently achieving >90% sorting efficiency) were checked, while ten percent of samples sorted by experienced laboratory personnel were also checked. When a failed sample was recorded, additional samples, sorted before and/or after the randomly selected failing sample by the same technician, were selected in descending/ascending order to be QC'd until a passing sample was found in either direction. Additionally, trained sorters found to have failed sort QC, were placed back on tray checks until they could produce five consecutive passing squares. This procedure ensures that all sorted samples either initially exceed the MQO of >90% for PSE, or will exceed the MQO following QC checks by experienced sorters.

### ***Taxonomic Identification and Enumeration***

Five samples (R2-08-07, R2-10-11A, R2-19-04, R2-19-07, and R2-22-09) were randomly selected for QC identification and enumeration by an independent lab. Original identification was completed by Environmental Services and Consulting, LLC<sup>1</sup> (ESC). Re-identification of the randomly selected sites was done by Aquatic Resources Center<sup>2</sup>. Each sample was identified to the genus level where possible. Individuals that were not able to be identified to genus level were identified to the lowest possible level, usually family, but in some cases order. For Chironomidae, individuals not identifiable to genus may have been identified to subfamily or tribe level.

### **Precision**

Measures of precision were calculated for the identification consistency for the samples selected at random. These include percent difference in enumeration (PDE) and percent taxonomic disagreement (PTD).

The PDE compares the final specimen counts between the two taxonomy labs, whereas PTD compares the number of agreements in final specimen identifications between the two taxonomic labs. To meet required MQOs set by the QAPP, the PDE for each sample must be equal to or less than 5%, and the PTD must be equal to or less than 15%. Results for the taxonomic comparison and resulting values for PDE and PTD for all four samples are found in Tables 4-8. Dashes shown in the '# of agreements' column signify hierarchical disagreements, which counts as an agreement for PTD calculations. For example, if the primary laboratory identified a specimen as Naididae and the secondary laboratory identified the same specimen as *Dero* (genus of the family Naididae) this would be considered a hierarchical disagreement.

Following re-identification by the secondary laboratory, the initial PDE exceeded the MQO value of 5% for one verification sample (6.9% for R2-10-11A) and the initial PTD of three samples exceeded the acceptable MQO value of 15% (22.7% for R2-08-07, 17.6% for R2-10-11A, and 49.1% for R2-22-09).

For sample R2-08-07, there was a major discrepancy between laboratories concerning Crangonyctidae (Amphipoda) identifications. The original laboratory originally identified 14 *Crangonyx* while the secondary laboratory identified 15 *Synurella*. Upon review, the original laboratory verified and agreed with the secondary laboratory's identifications. An additional 24 samples containing *Crangonyx* specimens were immediately re-identified by the original

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<sup>1</sup> Address: 516 Roanoke St, Christiansburg, VA 24073

<sup>2</sup> Address: 545 Cathy Jo Circle, Nashville, TN

laboratory to assure the identification of *Crangonyx* v. *Synurella* and all subsequent re-identifications were corrected in the dataset.

For sample R2-10-11A, there were discrepancies between laboratories concerning *Caecidotea* (Isopoda) identifications. These discrepancies were due to a large number of small (< 1mm) early instar isopods in the sample which may have come from the brood pouches of several large gravid females. The secondary laboratory counted an additional 15 isopods in the sample when compared to the original laboratory. After discussing the discrepancy, both laboratories agreed not to count the early instar organisms and the secondary lab matched the totals of the original lab.

For sample R2-22-09, there was a major discrepancy between laboratories concerning Amphipoda identifications. The original laboratory identified 44 *Crangonyx* (Crangonyctidae family) while the secondary laboratory identified 42 *Gammarus* (Gammaridae family). Upon review, both laboratories agreed that the specimens appear to be early instars and characters may not be sufficiently developed for identifications. It was decided that the identification should be backed up in hierarchy to Amphipoda.

Upon closer inspection by both the secondary and primary laboratories, there were enough agreements to reduce the PTD for all three samples to an acceptable value of 8.3% (R2-08-07), 4.3% (R2-10-11A), and 12.9% (R2-22-09) and to reduce the PDE for sample R2-10-11A (0.5%).

### Summary

A summary of QC results for this sampling period, as compared to established MQOs, for each activity in the biological sampling process is displayed below in Table 3.

Two QC results, Field Sampling RMSE and Site Assessment 90% CI, both exceeded MQO limits. Both results measure the precision and sensitivity of field sampling efforts. Each field crew member is currently certified as a benthic macroinvertebrate sampler and has therefore proven within reach repeatability with a high level of precision between samples. Benthic Macroinvertebrate Sampling Certifications issued by DNR (attached) indicate adherence to the sampling and assessment protocols. However, field replicates were not collected within reach; rather, they were collected from an adjacent reach immediately upstream. Collecting field replicate samples from an adjacent reach presents the possibility of capturing the variance in bug populations between reaches as opposed to within reach sampling.

As mentioned in Hill and Pieper, 2011, there are generally two forms of error: systematic and random. Systematic error is error associated with a particular method, which can, to a certain extent, be controlled by using an appropriate quality assurance program. Random error, however, is the error that results from the sample itself of the population from which it is derived and can only partly be controlled through a careful sampling design. What we are seeing when comparing the field replicate and primary samples is a combination of both systematic and random error. As certified samplers, the field crew is taking steps to minimize systematic error by following the exact same procedures at every site. Therefore, the MQO exceedances for Field Sampling and Site Assessment are not likely due to systematic error, and are more likely random error due to the spatial heterogeneity between adjacent reaches. This issue can be addressed in the future by taking a field replicate macroinvertebrate sample within the primary sampling reach and not an adjacent reach upstream.

All remaining MQOs were met during the 2013 sampling period, and subsequently, the data are of acceptable quality as specified by the QAPP.

**Table 3. Summary comparison of QC results and measurement quality objectives<sup>1</sup>.**

Activity	Performance Indicator	Measure	MQO	2013 Results
Field Sampling	Precision	mRPD (BIBI)	<20	10.9
		RMSE (BIBI)	<0.6	1.7
Laboratory Sorting/Subsampling	Bias	PSE	>90	97.2
Taxonomic Identification	Precision	PDE	<5	1.2
		PTD	<15	6.8
Site Assessment	Sensitivity	90% CI (BIBI)	≤0.96	2.73

<sup>1</sup> MQOs are derived from Hill and Pieper, 2011

**Table 4 - Taxonomic Identification and Enumeration Results: R2-08-07**

Order	Family	Tribe	Sample ID	R2-08-07		
				Taxonomist 1	Taxonomist 2	# of agreements
Diptera	Ceratopogonidae	-	Bezzia/Palpomylia	0	1	0
	Ceratopogonidae	-	Mallochohelea	1	0	0
	Chironomidae	-	Cricotopus/Orthocladius	1	1	1
	Chironomidae	-	Paracricotopus	0	1	0
	Chironomidae	Chironomini	Paratendipes	1	0	0
	Chironomidae	-	Rheocricotopus	1	1	1
	Tipulidae	-	Erioptera	0	1	0
	Tipulidae	-	Ormosia	1	0	0
Amphipoda	Crangonyctidae	-	Synurella	14	15	14
	Gammaridae	-	Gammarus	14	14	14
Haplotaxida	Enchytraeidae	-	Enchytraeidae	0	3	0
	Lumbricidae	-	Lumbricidae	6	0	0
	Naididae	-	Naididae	1	0	1
	Naididae	-	Dero	0	1	-
	Naididae	-	Nais	0	1	0
Hoplonemertea	Tetrastemmatidae	-	Prostoma	1	1	1
Isopoda	Asellidae	-	Caecidotea	2	2	2
Lumbriculida	Lumbriculidae	-	Lumbriculidae	11	9	9
Odonata	Coenagrionidae	-	Ischnura	1	1	1
Trichoptera	Hydropsychidae	-	Cheumatopsyche	4	4	4
	Limnephilidae	-	Ironoquia	1	1	1
Tubificida	Tubificidae	-	Tubificidae	4	0	4
	Tubificidae	-	Tubificinae	0	3	-
	Tubificidae	-	Limnodrilus	0	1	-
	Tubificidae	-	Spirosperma	25	22	22
Veneroida	Pisidiidae	-	Pisidium	14	11	14
	Pisidiidae	-	Sphaeriidae	0	3	-
<b>Total</b>				103	97	89
<b>PDE</b>						3.00
<b>PTD</b>						8.25



**Table 5 - Taxonomic Identification and Enumeration Results: R2-10-11A**

Order	Family	Tribe	Sample ID	R2-10-11A		
				Taxonomist 1	Taxonomist 2	# of agreements
Diptera	Chironomidae	Pentaneurini	Conchapelopia	3	0	3
	Chironomidae		Diplocladius	2	2	2
	Chironomidae		Odontomesa	2	2	2
	Chironomidae		Orthocladius	2	2	2
	Chironomidae		Parametriocnemus	20	20	20
	Chironomidae	Tanytarsini	Rheotanytarsus	7	7	7
	Chironomidae		Thienemannimyia group	0	3	-
	Chironomidae	Pentaneurini	Zavrelimyia	1	1	1
Amphipoda	Crangonyctidae		Crangonyx	1	0	0
	Crangonyctidae		Synurella	0	1	0
	Gammaridae		Gammarus	1	1	1
Haplotaxida	Enchytraeidae	-	Enchytraeidae	1	0	0
Isopoda	Asellidae	-	Caecidotea	29	29	29
Nemata	-	-	Nemata	0	1	0
Odonata	Aeshnidae	-	Boyeria	1	1	1
Trichoptera	Calamoceratidae	-	Heteroplectron	4	4	4
	Hydropsychidae	-	Diplectrona	1	1	1
	Limnephilidae	Stenophylacini	Pycnopsyche	2	2	2
	Phryganeidae	-	Ptilostomis	1	1	1
	Polycentropodidae	-	Polycentropus	14	12	12
Tubificida	Tubificidae	-	Tubificidae	1	0	1
	Tubificidae	-	Aulodrilus	0	1	-
	Tubificidae	-	Tubificinae	0	1	0
Veneroida	Pisidiidae	-	Pisidium	1	0	0
	Pisidiidae	-	Sphaeriidae	0	1	0
<b>Total</b>				94	93	89
<b>PDE</b>						0.53
<b>PTD</b>						4.30

**Table 6 - Taxonomic Identification and Enumeration Results: R2-19-04**

Order	Family	Tribe	Sample ID	R2-19-04		
				Taxonomist 1	Taxonomist 2	# of agreements
Diptera	Ceratopogonidae	-	Bezzia/Palpomyia	0	1	0
	Ceratopogonidae	-	Probezzia	1	0	0
	Chironomidae	Terrestrial	Chironomidae	1	0	0
	Chironomidae	Culicini	Cricotopus/Orthocladius	22	21	21
	Chironomidae	Chironomini	Dicrotendipes	0	1	0
	Chironomidae	-	Diplocladius	10	10	10
	Chironomidae	-	Hydrobaenus	34	32	32
	Chironomidae	-	Limnophyes	1	0	0
	Chironomidae	Diamesini	Orthoclaadiinae	1	0	0
	Chironomidae	Chironomini	Phaenopsectra	1	1	1
	Chironomidae	-	Pseudorthocladius/Parachaetocladius	0	1	0
	Chironomidae	-	Rheocricotopus	3	3	3
	Simuliidae	Prosimuliini	Stegopterna	2	2	2
Amphipoda	Hyaellidae	-	Hyaella	4	4	4
Coleoptera	Dytiscidae	-	Dytiscidae	0	1	0
	Dytiscidae	-	Neoporus	1	0	0
	Elmidae	-	Stenelmis	2	2	2
Haplotaaxida	Naididae	-	Naididae	1	0	1
	Naididae	-	Nais	0	1	-
Isopoda	Asellidae	-	Caecidotea	5	5	5
Odonata	Coenagrionidae	-	Ischnura	0	1	0
Plecoptera	Nemouridae	-	Amphinemura	1	1	1
Trichoptera	Limnephilidae	-	Limnephilidae	1	2	3
	Limnephilidae	-	Ironoquia	2	1	-
	Polycentropodidae	-	Polycentropus	1	1	1
	Uenoidae	-	Neophylax	1	1	1
<b>Total</b>				95	92	87
<b>PDE</b>						1.60
<b>PTD</b>						5.43

**Table 7 - Taxonomic Identification and Enumeration Results: R2-19-07**

Order	Family	Tribe	Sample ID	R2-19-07		
				Taxonomist 1	Taxonomist 2	# of agreements
Diptera	Chironomidae	-	Chaetocladius	0	1	0
	Chironomidae	Culicini	Cricotopus/Orthocladius	2	2	2
	Chironomidae	-	Diplocladius	2	1	1
	Chironomidae	-	Hydrobaenus	75	76	75
	Chironomidae	Diamesini	Orthoclaadiinae	2	2	2
	Chironomidae	-	Orthocladius	1	0	0
Amphipoda	Gammaridae	-	Gammarus	2	2	2
Ephemeroptera	Baetidae	-	Acerpenna	1	1	1
Isopoda	Asellidae	-	Caecidotea	1	1	1
Plecoptera	Nemouridae	-	Amphinemura	1	1	1
	Nemouridae	-	Shipsa	0	1	0
	Perlodidae	-	Isoperla	4	4	4
	Taeniopterygidae	-	Oemopteryx	1	0	0
Trichoptera	Hydropsychidae	-	Cheumatopsyche	2	2	2
Tubificida	Tubificidae	-	Tubificidae	2	0	1
	Tubificidae	-	Tubificinae	0	1	-
<b>Total</b>				96	95	92
<b>PDE</b>						0.52
<b>PTD</b>						3.16

**Table 8 - Taxonomic Identification and Enumeration Results: R2-22-09**

Order	Family	Tribe	Sample ID	R2-22-09		
				Taxonomist 1	Taxonomist 2	# of agreements
Diptera	Chironomidae	-	Chaetocladius	0	1	0
	Chironomidae	Chironomini	Chironomini	1	0	0
	Chironomidae	Pentaneurini	Conchapelopia	1	0	0
	Chironomidae	Culicini	Cricotopus/Orthocladius	27	27	27
	Chironomidae	-	Diplocladius	1	1	1
	Chironomidae	-	Eukiefferiella	4	6	4
	Chironomidae	-	Hydrobaenus	3	1	1
	Chironomidae	Diamesini	Orthoclaadiinae	1	7	1
	Chironomidae	-	Orthocladius	2	0	0
	Chironomidae	-	Parametricnemus	1	1	1
	Chironomidae	Chironomini	Paratendipes	1	1	1
	Chironomidae	Chironomini	Polypedilum	1	1	1
	Chironomidae	-	Tanypodinae	0	1	0
	Chironomidae	Tanytarsini	Tanytarsus	2	2	2
	Chironomidae	Chironomini	Tvetenia	5	2	2
	Empididae	Hemerodromiini	Hemerodromia	1	1	1
	Simuliidae	Simuliini	Simulium	3	3	3
Amphipoda	not identified	-	Amphipoda	44	42	42
Basommatophora	Physidae	-	Physa	1	1	1
Coleoptera	Elmidae	-	Ancyronyx	1	1	1
	Elmidae	-	Macronychus	1	1	1
Ephemeroptera	Baetidae	-	Acentrella	2	0	0
	Baetidae	-	Baetidae	0	2	0
	Heptageniidae	-	Maccaffertium	1	1	1
Haplotaxida	Naididae	-	Naididae	5	0	5
	Naididae	-	Dero	0	1	-
	Naididae	-	Nais	0	3	-
	Naididae	-	Slavina	0	1	-
Hemiptera	Corixidae	-	Corixidae	0	1	0

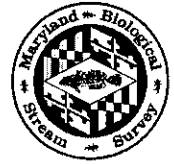
Order	Family	Tribe	Sample ID	R2-22-09		
				Taxonomist 1	Taxonomist 2	# of agreements
	Corixidae	-	Trichocorixa	1	0	0
Isopoda	Asellidae	-	Caecidotea	1	1	1
Nemata	not identified	-	Nemata	2	0	0
Nematomorpha	not identified	-	Nematomorpha	0	2	0
Plecoptera	Taeniopterygidae	-	Taeniopteryx	1	1	1
Trichoptera	Hydropsychidae	-	Diplectrona	1	1	1
	Limnephilidae	-	Ironoquia	1	1	1
Tubificida	Tubificidae	-	Tubificidae	1	0	1
	Tubificidae	-	Aulodrilus	0	1	-
<b>Total</b>				117	116	101
<b>PDE</b>						0.43
<b>PTD</b>						12.93

***References***

Hill, C.R., and M. J. Pieper. 2011. Documentation of Method Performance Characteristics for the Anne Arundel County Biological Monitoring Program. Revised, June 2011. Prepared by KCI Technologies, Sparks, MD for Anne Arundel County, Department of Public Works, Watershed, Ecosystem, and Restoration Services. Annapolis, MD.



Maryland Biological Stream Survey  
 TRAINING AND CERTIFICATION CHECK LIST



BENTHIC MACROINVERTEBRATE SAMPLING

Applicant Name: Megan Crunkleton

Name of DNR staff Person(s) Completing Form: Dan Boward

Element Evaluated	Pass	Fail	Comments	DNR Initials
<b>Attended indoor (Power Point) benthic macroinvertebrate sampling portion of training</b> Training site: Baltimore County Agriculture Center Training date: February 22, 2012	✓			DB
<b>Attended field portion of benthic macroinvertebrate sampling training</b> Training site: Baltimore County Agriculture Center Training date: February 22, 2012	✓			DB
<b>Completed written benthic macroinvertebrate sampling test</b> Training site: Baltimore County Agriculture Center Training date: February 22, 2012 Score = 100% (90% reqd.)	✓			DB
<b>Completed field audit</b>  DNR auditor: Dan Boward Audit site: Church Creek UT Audit date: March 5, 2012	✓			DB
<b>DNR duplicate sample lab analysis</b> DNR lab manager: Ellen Friedman Lab work completed: March 6, 2012	✓		Applicant BIBI: 1.6 Auditor BIBI: 1.6	DB

**Certification Results**

The Applicant HAS HAS NOT (circle one) successfully met all requirements for MBSS Benthic Macroinvertebrate Sampling Certification

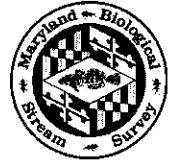
Dan Boward  
 Signature of DNR Staff Person

April 19, 2012  
 Date

Applicant DOES DOES NOT want his/her name listed on DNR's Certification Registry website



**Maryland Biological Stream Survey  
TRAINING AND CERTIFICATION CHECK LIST**



**BENTHIC MACROINVERTEBRATE SAMPLING**

**Applicant Name: Susanna Breillis**

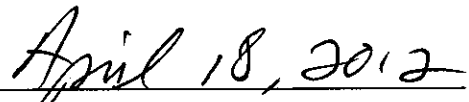
**Name of DNR staff Person(s) Completing Form: Dan Boward**

Element Evaluated	Pass	Fail	Comments	DNR Initials
<b>Attended indoor (Power Point) benthic macroinvertebrate sampling portion of training</b> Training site: Baltimore County Agriculture Center Training date: February 22, 2012	✓			DB
<b>Attended field portion of benthic macroinvertebrate sampling training</b> Training site: Baltimore County Agriculture Center Training date: February 22, 2012	✓			DB
<b>Completed written benthic macroinvertebrate sampling test</b> Training site: Baltimore County Agriculture Center Training date: February 22, 2012 Score = 95% (90% reqd.)	✓			DB
<b>Completed field audit</b>  DNR auditor: Dan Boward Audit site: Church Creek Audit date: March 5, 2012	✓			DB
<b>DNR duplicate sample lab analysis</b> DNR lab manager: Ellen Friedman Lab work completed: March 6, 2012	✓		Applicant BIBI: 2.4 Auditor BIBI: 2.1	DB

**Certification Results**

The Applicant **HAS** ~~HAS NOT~~ (circle one) successfully met all requirements for MBSS Benthic Macroinvertebrate Sampling Certification

  
 \_\_\_\_\_  
 Signature of DNR Staff Person

  
 \_\_\_\_\_  
 Date

Applicant DOES DOES NOT want his/her name listed on DNR's Certification Registry website





**Maryland Biological Stream Survey  
2013 TRAINING AND CERTIFICATION CHECK LIST**



**BENTHIC MACROINVERTEBRATE SAMPLING**

Applicant Name **Colin Hill**

Name of DNR staff Person(s) Completing Form **Dan Boward**

Element Evaluated	Pass	Fail	Comments	DNR Initials
<b>Attended indoor (Power Point) benthic macroinvertebrate sampling portion of training</b> Training site Oregon Ridge Training date February 25, 2013	✓			DB
<b>Attended field portion of benthic macroinvertebrate sampling training</b> Training site Oregon Ridge Training date February 25, 2013	✓			DB
<b>Completed written benthic macroinvertebrate sampling test</b> Test site Oregon Ridge Test date February 25, 2013 Score = 100% (90% reqd.)	✓			DB
<b>Completed field audit</b>  DNR auditor Dan Boward Audit site UT to Severn River Audit date March 29, 2013	✓			DB
<b>DNR duplicate sample lab analysis</b>  DNR Lab Manager Ellen Friedman Lab work completed April 17, 2013	✓		Applicant IBI: 3.6 Auditor IBI: 3.6	DB

**Certification Results**

The Applicant HAS HAS NOT (circle one) successfully met all requirements for MBSS Benthic Macroinvertebrate Sampling Certification

Daniel Boward  
Signature of DNR Staff Person

May 16, 2013  
Date

Applicant DOES DOES NOT want his/her name listed on DNR's Certification Registry website



**Quality Control Field Audit of KCI Technologies, Inc., Performance in the Geomorphological Assessment Work as part of the Countywide Biological Monitoring Program**

**Prepared by: Christopher Victoria, DPW, WERS**

**Date: 8 April 2013**

On 8 April 2013, I evaluated the field activities of KCI Technologies, Inc., (KCI) personnel as they collected the required geomorphological data as part of Year Four of Round Two of the Countywide Biological Monitoring Program. Work at one site (R2-19-16A) was evaluated. This short report describes my findings.

**OFFICE WORK.** A drainage area determination was made before going to the field. The crew had the information with them in the field and used it to assist in their determination of the bankfull indicator. The survey instrument was a self-leveling laser level type instrument, owned by KCI, which had been calibrated recently and was described as fairly new by the crew. A minor technique issue was observed in that a rod level was not used to ensure the survey rod was held plumb and square to the instrument during measurements, but was not thought to significantly compromise the data. The matter was not discussed with the crew.

The field supervisor had Level II training while one crew member had Level I training. The third crew members did not have formal Rosgen assessment method training, but was experienced in performing a variety of habitat assessment methodologies and had performed survey work on streams in the performance of other projects.

**REACH RECONNAISSANCE.** At the site, the cross section was co-located with the bioassessment reach. The cross section was not placed in the approximate midpoint of the reach, but the selected site was judged to be appropriately located. The reach was moderately disturbed, making site placement and determination of the bankfull indicator difficult. The BF indicator was checked against the appropriate regional relationship (McCandless Curves) and found to be consistent with predicted values.

**CROSS SECTION MEASUREMENT.** The zero point was set on the left bank / downstream. The survey instrument was properly set up. Monuments were properly installed and marked. A GPS was taken and the location was properly characterized within the limits of the digital datasheet format. Adequate photos were taken at the cross section. All necessary measurements were made on the cross section, although the natural disturbance within the reach (i.e.—numerous debris jams) made bankfull determination a challenge. Data were properly recorded on the appropriate data sheets. Floodprone width calculations were properly made in the field. This reach was shown as being collocated with a Round 1 site. An attempt was made to find and remeasure this

section, but that was not possible as the old cross section was not discovered until after the new one was installed.

**PEBBLE COUNT.** A full pebble count was performed. The transects were properly distributed by feature prevalence in the reach, which was determined by the field supervisor using best professional judgment. Particles, when found, were properly measured along the intermediate axis. Particle selection was properly distributed along all transects. Data were properly recorded on the data sheet.

**REACH SLOPE MEASUREMENT.** The measurement was collected over the entire reach. The survey instrument was set up properly. A feature-to-feature measurement was made. All required features (i.e.—bankfull, water surface, thalweg, etc.) were surveyed.

**OVERALL COMMENTS.** The geomorphic data collection activities are being properly executed according to published SOPs and should result in the collection of satisfactory data.

## Appendix C: Master Taxa List

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Order	Family	Genus	Final ID	Functional Feeding Group	Habit <sup>1</sup>	Tolerance Value <sup>2</sup>	% of total number of organisms	% of sites
Diptera	Chironomidae	Hydrobaenus	Hydrobaenus	Scraper	sp	7.2	9.50	82.0
Diptera	Chironomidae	Cricotopus/Orthocladius	Cricotopus/Orthocladius	Shredder	0	7.7	9.26	76.0
Tubificida	Tubificidae	not identified	Tubificidae	Collector	cn	8.4	8.76	90.0
Isopoda	Asellidae	Caecidotea	Caecidotea	Collector	sp	2.6	6.41	64.0
Haplotaxida	Naididae	not identified	Naididae	Collector	bu	8.5	5.40	72.0
Diptera	Chironomidae	Diplocladius	Diplocladius	Collector	sp	5.9	4.58	70.0
Veneroida	Pisidiidae	Pisidium	Pisidium	Filterer	bu	5.7	3.33	54.0
Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	Collector	sp	4.6	2.95	74.0
Diptera	Simuliidae	Simulium	Simulium	Filterer	cn	5.7	2.67	26.0
Ephemeroptera	Baetidae	Acentrella	Acentrella	Collector	sw, cn	4.9	2.53	14.0
Diptera	Chironomidae	Thienemannimyia group	Thienemannimyia group	Predator	sp	8.2	2.39	48.0
Plecoptera	Nemouridae	Amphinemura	Amphinemura	Shredder	sp, cn	3.0	2.01	38.0
Diptera	Simuliidae	Stegopterna	Stegopterna	Filterer	cn	2.4	1.63	24.0
Amphipoda	not identified	not identified	Amphipoda	0	sp	6.0	1.49	16.0
Amphipoda	Crangonyctidae	Crangonyx	Crangonyx	Collector	sp	6.7	1.49	16.0
Haplotaxida	Lumbricidae	not identified	Lumbricidae	Collector	0	10.0	1.45	30.0
Isopoda	Asellidae	not identified	Asellidae	0	0	3.3	1.41	12.0
Trichoptera	Polycentropodidae	Polycentropus	Polycentropus	Filterer	cn	1.1	1.39	22.0
Diptera	Chironomidae	Polypedilum	Polypedilum	Shredder	cb, cn	6.3	1.20	42.0
Amphipoda	Gammaridae	Gammarus	Gammarus	Shredder	sp	6.7	1.16	30.0
Amphipoda	Crangonyctidae	Synurella	Synurella	0	0	0.4	1.16	24.0
Ephemeroptera	Baetidae	Acerpenna	Acerpenna	Collector	sw, cn	2.6	1.14	20.0
Diptera	Chironomidae	Rheotanytarsus	Rheotanytarsus	Filterer	cn	7.2	1.12	28.0
Diptera	Chironomidae	Rheocricotopus	Rheocricotopus	Collector	sp	6.2	1.06	48.0
Diptera	Chironomidae	Zavrelimyia	Zavrelimyia	Predator	sp	5.3	0.98	34.0
Diptera	Chironomidae	Tanytarsus	Tanytarsus	Filterer	cb, cn	4.9	0.92	34.0
not identified	not identified	not identified	Nematomorpha	0	bu	na	0.74	30.0
Trichoptera	Limnephilidae	Ironoquia	Ironoquia	Shredder	sp	4.9	0.72	32.0
Lumbriculida	Lumbriculidae	not identified	Lumbriculidae	Collector	bu	6.6	0.70	26.0
Diptera	Chironomidae	Orthocladius	Orthocladius	Collector	sp, bu	9.2	0.66	40.0
Diptera	Chironomidae	not identified	Orthoclaudiinae	Collector	0	7.6	0.62	42.0
Plecoptera	Chloroperlidae	Sweltsa	Sweltsa	Predator	cn	1.9	0.60	2.0
Diptera	Tipulidae	Tipula	Tipula	Shredder	bu	6.7	0.60	30.0
Diptera	Chironomidae	Ablabesmyia	Ablabesmyia	Predator	sp	8.1	0.54	20.0
Diptera	Chironomidae	Conchapelopia	Conchapelopia	Predator	sp	6.1	0.54	44.0
Diptera	Chironomidae	not identified	Tanytarsini	Collector	0	3.5	0.54	10.0
Haplotaxida	Enchytraeidae	not identified	Enchytraeidae	Collector	bu	9.1	0.52	34.0
Plecoptera	Perlodidae	Isoperla	Isoperla	Predator	cn, sp	2.4	0.52	18.0
Diptera	Chironomidae	Phaenopsectra	Phaenopsectra	Collector	cn	8.7	0.50	18.0
Coleoptera	Dytiscidae	Neoporus	Neoporus	Predator	0	na	0.46	22.0
Trichoptera	Limnephilidae	not identified	Limnephilidae	Shredder	cb, sp, cn	3.4	0.44	14.0
Hoplonemertea	Tetrastemmatidae	Prostoma	Prostoma	Predator	0	7.3	0.44	28.0
Trichoptera	Hydropsychidae	Cheumatopsyche	Cheumatopsyche	Filterer	cn	6.5	0.40	16.0
Diptera	Chironomidae	Eukiefferiella	Eukiefferiella	Collector	sp	6.1	0.40	20.0
Plecoptera	not identified	not identified	Plecoptera	0	0	2.4	0.40	6.0
Diptera	Ceratopogonidae	Culicoides	Culicoides	Predator	bu	5.9	0.36	12.0
Diptera	Chironomidae	Paratendipes	Paratendipes	Collector	bu	6.6	0.34	16.0
Basommatophora	Physidae	Physa	Physa	Scraper	cb	7.0	0.34	16.0
Diptera	Chironomidae	not identified	Chironomidae	0	0	6.6	0.32	28.0
Diptera	Chironomidae	Corynoneura	Corynoneura	Collector	sp	4.1	0.32	16.0
Diptera	Chironomidae	Tvetenia	Tvetenia	Collector	sp	5.1	0.32	16.0
Diptera	Chironomidae	Dicrotendipes	Dicrotendipes	Collector	bu	9.0	0.28	12.0
Basommatophora	Planorbidae	Menetus	Menetus	Scraper	cb	7.6	0.28	16.0
Diptera	Chironomidae	Micropsectra	Micropsectra	Collector	cb, sp	2.1	0.28	12.0
Diptera	Chironomidae	Paraphaenocladus	Paraphaenocladus	Collector	sp	4.0	0.26	10.0
Trichoptera	Hydropsychidae	Diplectrona	Diplectrona	Filterer	cn	2.7	0.24	10.0
Trichoptera	Uenoidae	Neophylax	Neophylax	Scraper	cn	2.7	0.24	14.0
Coleoptera	Dytiscidae	Agabus	Agabus	Predator	sw, dv	5.4	0.22	6.0
Tricladida	Dugesidae	not identified	Dugesidae	0	0	na	0.22	6.0
Amphipoda	Hyalellidae	Hyalella	Hyalella	Shredder	sp	4.2	0.22	6.0
Plecoptera	Leuctridae	Leuctra	Leuctra	Shredder	cn	0.4	0.22	6.0
Trichoptera	Psychomyiidae	Lype	Lype	Scraper	cn	4.7	0.22	10.0
Haplotaxida	not identified	not identified	Pseudorthocladius	0	0	na	0.22	14.0
Diptera	Simuliidae	not identified	Simuliidae	Filterer	cn	3.2	0.22	8.0
Odonata	Calopterygidae	Calopteryx	Calopteryx	Predator	cb	8.3	0.20	12.0
Coleoptera	Scirtidae	Cyphon	Cyphon	Scraper	cb	7.0	0.20	8.0
Diptera	Chironomidae	Heterotrissocladius	Heterotrissocladius	Collector	sp, bu	2.0	0.20	6.0
Basommatophora	Lymnaeidae	Stagnicola	Stagnicola	Scraper	cb	7.8	0.20	6.0
Ephemeroptera	Baetidae	Centroptilum	Centroptilum	Collector	sw, cn	2.3	0.18	8.0
Diptera	Ceratopogonidae	Probezzia	Probezzia	Predator	bu	3.0	0.18	10.0

Order	Family	Genus	Final ID	Functional Feeding Group	Habit <sup>1</sup>	Tolerance Value <sup>2</sup>	% of total number of organisms	% of sites
Diptera	Chironomidae	Stenochironomus	Stenochironomus	Shredder	bu	7.9	0.18	12.0
Haploutaxida	not identified	not identified	Argia	0	0	na	0.16	4.0
Diptera	Chironomidae	Chironomini	Chironomini	0	0	5.9	0.16	10.0
Diptera	Simuliidae	Prosimulium	Prosimulium	Filterer	cn	2.4	0.16	8.0
Diptera	Chironomidae	Tribelos	Tribelos	Collector	bu	7.0	0.16	4.0
Coleoptera	Elmidae	Ancyronyx	Ancyronyx	Scraper	cn, sp	7.8	0.14	12.0
Coleoptera	Dryopidae	Helichus	Helichus	Scraper	cn	6.4	0.14	8.0
Plecoptera	Taeniopterygidae	Oemopteryx	Oemopteryx	Shredder	sp, cn	1.8	0.14	10.0
Coleoptera	Elmidae	Stenelmis	Stenelmis	Scraper	cn	7.1	0.14	10.0
Diptera	Ceratopogonidae	not identified	Bezzia/Palpomya	0	0	na	0.12	6.0
Amphipoda	Crangonyctidae	not identified	Crangonyctidae	Collector	sp	6.5	0.12	4.0
Diptera	Chironomidae	Diamesa	Diamesa	Collector	sp	8.5	0.12	4.0
Diptera	Chironomidae	Microtendipes	Microtendipes	Filterer	cn	4.9	0.12	8.0
Diptera	Chironomidae	Odontomesa	Odontomesa	Collector	sp	6.6	0.12	10.0
Diptera	Ceratopogonidae	Sphaeromias	Sphaeromias	Predator	bu	3.6	0.12	8.0
Diptera	Chironomidae	Apsectrotanypus	Apsectrotanypus	Predator	bu, sp	6.6	0.10	4.0
Odonata	Aeshnidae	Boyeria	Boyeria	Predator	cb, sp	6.3	0.10	8.0
Diptera	Tipulidae	Ormosia	Ormosia	Collector	bu	6.3	0.10	8.0
Diptera	Tipulidae	Pseudolimnophila	Pseudolimnophila	Predator	bu	2.8	0.10	10.0
Trichoptera	Limnephilidae	Pycnopsyche	Pycnopsyche	Shredder	sp, cb, cn	3.1	0.10	8.0
Coleoptera	Ptilodactylidae	Anchytarsus	Anchytarsus	Shredder	cn	3.1	0.08	6.0
Diptera	Chironomidae	not identified	Chironominae	Collector	0	6.6	0.08	8.0
Diptera	Tabanidae	Chrysops	Chrysops	Predator	sp, bu	2.9	0.08	8.0
Trichoptera	Calamoceratidae	Heteroplectron	Heteroplectron	Shredder	sp	3.0	0.08	2.0
Odonata	Coenagrionidae	Ischnura	Ischnura	Predator	cb	9.0	0.08	6.0
Ephemeroptera	Heptageniidae	Maccaffertium	Maccaffertium	Scraper	cn	3.0	0.08	6.0
Diptera	Chironomidae	Paratanytarsus	Paratanytarsus	Collector	sp	7.7	0.08	4.0
Coleoptera	Halipidae	Pelodytes	Pelodytes	Shredder	cb, cn	8.9	0.08	4.0
Plecoptera	Perlidae	Perlesta	Perlesta	Predator	cn	1.6	0.08	4.0
Diptera	Chironomidae	Potthastia	Potthastia	Collector	sp	0.0	0.08	4.0
Megaloptera	Sialidae	Sialis	Sialis	Predator	bu, cb, cn	1.9	0.08	4.0
Diptera	Chironomidae	Thienemanniella	Thienemanniella	Collector	sp	5.1	0.08	6.0
Diptera	Chironomidae	Xylotopus	Xylotopus	Shredder	bu	6.6	0.08	4.0
Ephemeroptera	Baetidae	Callibaetis	Callibaetis	Collector	sw, cn	2.3	0.06	2.0
Diptera	Ceratopogonidae	not identified	Ceratopogonidae	Predator	sp, bu	3.6	0.06	6.0
Diptera	Chironomidae	Chironomus	Chironomus	Collector	bu	4.6	0.06	6.0
Diptera	Chironomidae	Clinotanypus	Clinotanypus	Predator	bu	6.6	0.06	2.0
Diptera	Chironomidae	Cricotopus	Cricotopus	Shredder	cn, bu	9.6	0.06	2.0
Coleoptera	Dytiscidae	not identified	Dytiscidae	Predator	sw, dv	5.4	0.06	2.0
not identified	not identified	not identified	Gastropoda	0	0	na	0.06	4.0
Diptera	Empididae	Hemerodromia	Hemerodromia	Predator	sp, bu	7.9	0.06	6.0
Coleoptera	Elmidae	Macronychus	Macronychus	Scraper	cn	6.8	0.06	4.0
Diptera	Chironomidae	Natarsia	Natarsia	Predator	sp	6.6	0.06	4.0
Trichoptera	Phryganeidae	Ptilostomis	Ptilostomis	Shredder	cb	4.3	0.06	6.0
Diptera	Chironomidae	not identified	Tanypodinae	Predator	0	7.5	0.06	6.0
Trichoptera	Glossosomatidae	Agapetus	Agapetus	Scraper	cn	2.0	0.04	2.0
Diptera	Chironomidae	Chaetocladius	Chaetocladius	Collector	sp	7.0	0.04	2.0
Ephemeroptera	Baetidae	Cloeon	Cloeon	Collector	sw, cn	9.0	0.04	2.0
Odonata	Corduliidae	not identified	Corduliidae	Predator	sp, cb	2.0	0.04	2.0
Odonata	Gomphidae	Dromogomphus	Dromogomphus	Predator	bu	2.2	0.04	4.0
Coleoptera	Elmidae	Dubiraphia	Dubiraphia	Scraper	cn, cb	5.7	0.04	4.0
Diptera	Empididae	not identified	Empididae	Predator	sp, bu	7.5	0.04	4.0
Ephemeroptera	Ephemerellidae	Eurylophella	Eurylophella	Scraper	cn, sp	4.5	0.04	2.0
Diptera	Chironomidae	Georthocladius	Georthocladius	0	sp	na	0.04	2.0
Diptera	Tipulidae	Hexatoma	Hexatoma	Predator	bu, sp	1.5	0.04	2.0
Ephemeroptera	Leptophlebiidae	not identified	Leptophlebiidae	Collector	sw, cn	1.7	0.04	2.0
Coleoptera	Elmidae	Optioservus	Optioservus	Scraper	cn	5.4	0.04	4.0
Diptera	Chironomidae	Prodiamesa	Prodiamesa	Collector	bu, sp	6.6	0.04	4.0
Plecoptera	Taeniopterygidae	Taeniopteryx	Taeniopteryx	Shredder	sp, cn	4.8	0.04	4.0
Diptera	Chironomidae	Tanypus	Tanypus	Predator	0	6.6	0.04	2.0
Diptera	Tipulidae	not identified	Tipulidae	Predator	bu, sp	4.8	0.04	4.0
Plecoptera	Capniidae	Allocapnia	Allocapnia	Shredder	cn	4.2	0.02	2.0
Ephemeroptera	Baetidae	not identified	Baetidae	Collector	sw, cn	2.3	0.02	2.0
Odonata	Aeshnidae	Basiaeschna	Basiaeschna	Predator	cb, sp, cn	6.2	0.02	2.0
Coleoptera	Hydrophilidae	Berosus	Berosus	Collector	sw, dv, cb	4.1	0.02	2.0
not identified	not identified	not identified	Bivalvia	0	0	na	0.02	2.0
Diptera	Chironomidae	Brillia	Brillia	Shredder	bu, sp	7.4	0.02	2.0
Diptera	Ceratopogonidae	Ceratopogon	Ceratopogon	Predator	sp, bu	2.7	0.02	2.0
Plecoptera	Perlodidae	Clioperla	Clioperla	Predator	cn	1.7	0.02	2.0
Lepidoptera	Crambidae	not identified	Crambidae	Shredder	cb	na	0.02	2.0

Order	Family	Genus	Final ID	Functional Feeding Group	Habit <sup>1</sup>	Tolerance Value <sup>2</sup>	% of total number of organisms	% of sites
Diptera	Ceratopogonidae	Dasyhelea	Dasyhelea	Collector	sp	3.6	0.02	2.0
Diptera	Tipulidae	Dicranota	Dicranota	Predator	sp, bu	1.1	0.02	2.0
Coleoptera	Gyrinidae	Dineutus	Dineutus	Predator	sw, dv	4.0	0.02	2.0
Diptera	Chironomidae	Djalmabatista	Djalmabatista	0	0	na	0.02	2.0
Odonata	Coenagrionidae	Enallagma	Enallagma	Predator	cb	9.0	0.02	2.0
Ephemeroptera	Ephemerellidae	Ephemerella	Ephemerella	Collector	cn, sw	2.3	0.02	2.0
Diptera	Ephydriidae	not identified	Ephydriidae	Collector	bu, sp	na	0.02	2.0
Odonata	Libellulidae	Erythemis	Erythemis	Predator	sp	7.0	0.02	2.0
Arhynchobdellida	Hirudinidae	not identified	Gymnometriocnemus	0	0	na	0.02	2.0
not identified	Hirudinea	not identified	Hirudinea	Predator	sp	na	0.02	2.0
Arhynchobdellida	Hirudinidae	not identified	Hirudinidae	0	0	na	0.02	2.0
Trichoptera	Hydropsychidae	Hydropsyche	Hydropsyche	Filterer	cn	7.5	0.02	2.0
Coleoptera	Dytiscidae	Laccophilus	Laccophilus	Predator	sw, dv	5.4	0.02	2.0
Trichoptera	Lepidostomatidae	Lepidostoma	Lepidostoma	Shredder	cb, sp, cn	0.0	0.02	2.0
Ephemeroptera	Leptophlebiidae	Leptophlebia	Leptophlebia	Collector	sw, cn, sp	1.8	0.02	2.0
Hemiptera	not identified	not identified	Limnophyes	0	0	na	0.02	2.0
Diptera	Tipulidae	Limonia	Limonia	Shredder	bu, sp	4.8	0.02	2.0
Lumbricina	not identified	not identified	Lumbricina	Collector	bu	na	0.02	2.0
Diptera	Ceratopogonidae	Mallochohelea	Mallochohelea	Predator	bu	3.6	0.02	2.0
Pharyngobdellida	Erpobdellidae	Mooreobdella	Mooreobdella	Predator	sp	8.0	0.02	2.0
Diptera	Chironomidae	Nanocladius	Nanocladius	Collector	sp	7.6	0.02	2.0
Hemiptera	not identified	not identified	Nigronia	0	0	na	0.02	2.0
Diptera	Psychodinae	Pericoma/Telmatoscopus	Oecetis	0	0	na	0.02	2.0
Diptera	Chironomidae	Parakiefferiella	Parakiefferiella	Collector	sp	2.1	0.02	2.0
Diptera	Psychodinae	Pericoma/Telmatoscopus	Pericoma/Telmatoscopus	0	0	na	0.02	2.0
Plecoptera	Perlidae	not identified	Perlidae	Predator	cn	2.2	0.02	2.0
Diptera	Chironomidae	Phaenopsectra/Tribelos	Phaenopsectra/Tribelos	Collector	0	na	0.02	2.0
Trichoptera	Dipseudopsidae	Phyloctenopus	Phyloctenopus	Collector	bu	5.0	0.02	2.0
Basommatophora	Lymnaeidae	Pseudosuccinea	Pseudosuccinea	Collector	cb	6.3	0.02	2.0
Diptera	Chironomidae	Saetheria	Saetheria	Collector	bu	6.6	0.02	2.0
Coleoptera	Staphylinidae	not identified	Staphylinidae	Predator	cn	na	0.02	2.0
Amphipoda	Crangonyctidae	Stygobromus	Stygobromus	Collector	0	4.0	0.02	2.0
Diptera	Syrphidae	not identified	Syrphidae	Collector	0	na	0.02	2.0
Hemiptera	Corixidae	Trichocorixa	Trichocorixa	Predator	sw, cb	5.6	0.02	2.0
Trichoptera	not identified	not identified	Trichoptera	0	0	4.6	0.02	2.0
Mesogastropoda	Viviparidae	Viviparus	Viviparus	Scraper	cb	1.0	0.02	2.0

<sup>1</sup> Primary habit or form of locomotion includes bu - burrower, cn - clinger, cb - climber, sk - skater, sp - sprawler, sw - swimmer; <sup>2</sup> Tolerance values based on Hilsenhoff, modified for Maryland; 0 or na indicates information for the particular taxa was not available.

## Appendix D: Individual Site Summaries

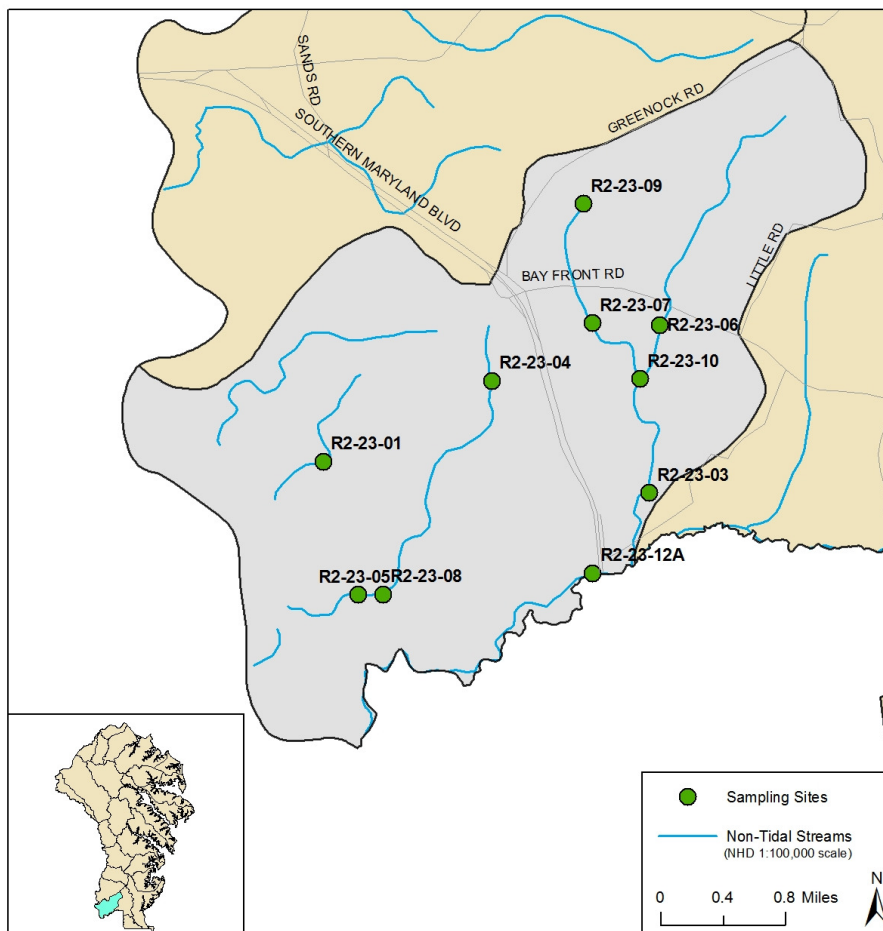
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# Cabin Branch Sampling Unit

## Site Condition Summary

Site	Drainage Area (acres)	Drainage Area (mi <sup>2</sup> )	Percent Impervious	Percent Developed	Percent Forested	Percent Agriculture	Percent Open	BIBI Narrative Rating	PHI Narrative Rating	RBP Narrative Rating	Rosgen Stream Type - L1
R2-23-01	224.8	0.35	2.2	12.7	62.0	24.7	0.6	Good	Minimally Degraded	Supporting	F
R2-23-03	2295.0	3.59	2.8	21.5	41.1	34.0	3.5	Good	Partially Degraded	Partially Supporting	F
R2-23-04	100.1	0.16	0.9	9.1	67.9	22.5	0.5	Poor	Degraded	Non Supporting	Transitional
R2-23-05	863.4	1.35	3.8	18.8	52.0	26.1	3.1	Fair	Partially Degraded	Supporting	ND
R2-23-06	1284.8	2.01	3.1	24.4	34.3	38.8	2.5	Fair	Partially Degraded	Partially Supporting	F
R2-23-07	399.8	0.62	2.1	10.3	54.4	31.8	3.6	Poor	Degraded	Non Supporting	G
R2-23-08	840.4	1.31	3.8	18.7	51.6	26.7	3.0	Fair	Minimally Degraded	Supporting	G
R2-23-09	46.9	0.07	0.5	15.3	34.2	49.5	1.0	Very Poor	Degraded	Non Supporting	F
R2-23-10	1853.3	2.90	2.8	21.4	39.3	35.7	3.6	Fair	Partially Degraded	Supporting	F
R2-23-12A	9572.6	14.96	3.6	23.2	39.1	31.8	5.9	Fair	Degraded	Supporting	ND



## R2-23-01

## Cabin Branch Sampling Unit

### Upstream View:



Latitude: 38.775154325

### Downstream View:



Longitude: -76.690349382

### Land Use/Land Cover Analysis:

**Total Drainage Area (acres) 224.75**

<u>Cover</u>	<u>Acres</u>	<u>% Area</u>
<b>Developed Land</b>	<b>28.58</b>	<b>12.72</b>
Airport	0	0
Commercial	0	0
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	1.27	0.56
Residential 1-Acre	1.29	0.57
Residential 2-Acre	19.79	8.8
Transportation	6.24	2.78
Utility	0	0
<b>Forest Land</b>	<b>139.28</b>	<b>61.97</b>
Forested Wetland	0	0
Residential Woods	0	0
Woods	139.28	61.97
<b>Open Land</b>	<b>1.44</b>	<b>0.64</b>
Open Space	1.44	0.64
Open Wetland	0	0
Water	0	0
<b>Agricultural Land</b>	<b>55.45</b>	<b>24.67</b>
Pasture/Hay	7.27	3.24
Row Crops	48.18	21.44

<u>Impervious Surface</u>	<u>Acres</u>	<u>% Area</u>
Impervious Land	4.9	2.18

### Summary Results:

- Biological condition – “Good”
- Habitat scores “Supporting” and “Minimally Degraded”
- Pollution intolerant Plecoptera (Sweltsa and Amphinemura) dominated the sample.
- Water quality values within COMAR standards.
- Overwidened channel with numerous point bars and areas of undercut banks. Good benthic habitat but lacking deep pool habitat for fish. Moderately stable banks with good vegetative protection and riparian width. Refuse present in minor amounts.
- Bimodal distribution of substrate (sand/gravel).

### Recommendations:

- Maintain the protection of the riparian areas.

# R2-23-01

# Cabin Branch Sampling Unit

## Biological Assessment

### Raw Metric Values

Total Taxa	29
EPT Taxa	7
Ephemeroptera Taxa	2
%Intolerant Urban	53.5
%Ephemeroptera	9.9
Scraper Taxa	3
% Climbers	6.9

### Calculated Metric Scores

Total Taxa	5
EPT Taxa	5
Ephemeroptera Taxa	5
%Intolerant Urban	5
%Ephemeroptera	3
Scraper Taxa	5
% Climbers	3

<b>BIBI Score</b>	<b>4.43</b>
<b>BIBI Narrative Rating</b>	<b>Good</b>

Taxa	Count
Ablabesmyia	1
Acerpenna	8
Amphinemura	9
Crangonyctidae	1
Cricotopus/Orthocladius	7
Diplectrona	1
Diplocladius	4
Dromogomphus	1
Eurylophella	2
Helichus	1
Hexatoma	2
Hydrobaenus	2
Ironoquia	3
Lumbricidae	1
Naididae	1
Neoporus	1
Oecetis	1
Parametricnemus	3
Polypedilum	2
Probezzia	1
Prostoma	2
Pseudolimnophila	1
Rheocricotopus	4
Simulium	1
Stegopterna	1
Sweltsa	30
Tanytarsus	4
Thienemannimyia group	1
Tubificidae	5
<b>TOTAL:</b>	<b>101</b>

## Physical Habitat Assessment

### EPA Rapid Bioassessment Protocol

	Score	Score	
Bank Stability- Left Bank	7	Pool Variability	10
Bank Stability- Right Bank	7	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	12	Sediment Deposition	11
Channel Sinuosity	13	Vegetative Protection - Left Bank	8
Epifaunal Substrate/Available Cover	13	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	12		

<b>RBP Habitat Score</b>	<b>141</b>
<b>RBP Narrative Rating</b>	<b>Supporting</b>

### MBSS Physical Habitat Index

	Value	Score	Value	Score	
Remoteness	19	100	Instream Wood Debris	10	89.99
Shading	96	100	Instream Habitat	11	86.3
Epifaunal Substrate	13	96.46	Bank Stability	14	83.67

<b>PHI Score</b>	<b>92.74</b>
<b>PHI Narrative Rating</b>	<b>Minimally Degraded</b>

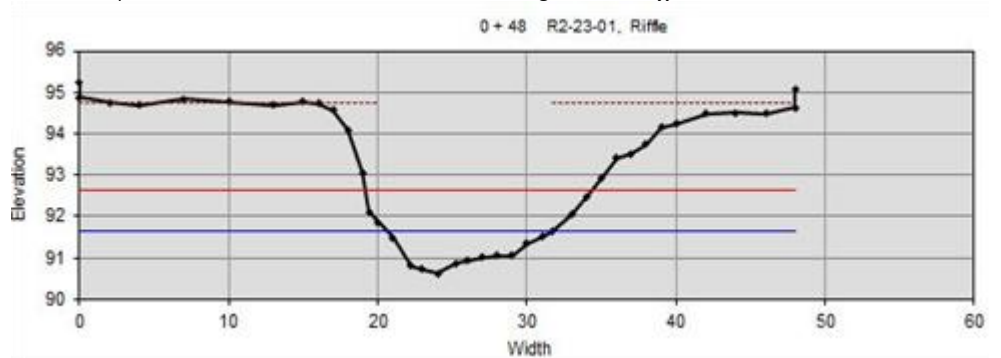
## Water Chemistry

Dissolved Oxygen (mg/L)	11.34	pH (SU)	6.52
Turbidity (NTU)	4.99	Specific Conductivity (µS/cm)	94.9
Temperature (°C)	12.5		

## Geomorphic Assessment

### Rosgen Level II Classification Data

Drainage Area (mi <sup>2</sup> )	0.35	Cross Sectional Area (ft <sup>2</sup> )	6.4
Bankfull Width (ft)	11.1	Water Surface Slope (%)	0.64
Mean Bankfull Depth (ft)	0.58	Sinuosity	1.3
Floodprone Width (ft)	15.2	D50 (mm)	0.4
Entrenchment Ratio	1.4	Adjustments?	None
Width to Depth Ratio	19.1	<b>Rosgen Stream Type</b>	<b>F4/5</b>



## R2-23-03

## Cabin Branch Sampling Unit

### Upstream View:



Latitude: 38.772134445

### Downstream View:



Longitude: -76.651655742

### Land Use/Land Cover Analysis:

**Total Drainage Area (acres) 2295.01**

<u>Cover</u>	<u>Acres</u>	<u>% Area</u>
<b>Developed Land</b>	<b>492.23</b>	<b>21.45</b>
Airport	0	0
Commercial	6.44	0.28
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	26.08	1.14
Residential 1-Acre	54.43	2.37
Residential 2-Acre	372.18	16.22
Transportation	33.1	1.44
Utility	0	0
<b>Forest Land</b>	<b>943.43</b>	<b>41.11</b>
Forested Wetland	0	0
Residential Woods	0	0
Woods	943.43	41.11
<b>Open Land</b>	<b>79.9</b>	<b>3.48</b>
Open Space	74.48	3.25
Open Wetland	0	0
Water	5.42	0.24
<b>Agricultural Land</b>	<b>779.45</b>	<b>33.96</b>
Pasture/Hay	232.52	10.13
Row Crops	546.93	23.83
<b>Impervious Surface</b>	<b>Acres</b>	<b>% Area</b>
Impervious Land	64.14	2.79

### Summary Results:

- Biological condition – “Good”
- Habitat scores “Partially Supporting” and “Partially Degraded”
- Various midges of the Chironomidae family, including Hydrobaenus and Parametricnemus, dominated the sample.
- Water quality values within COMAR standards.
- Deeply incised channel with heavy bank erosion and numerous point bars. An abundance of woody debris and rootwads providing stable habitat. Poor vegetative protection along the left bank but good riparian width.
- Bimodal distribution of substrate (sand/gravel).

### Recommendations:

- Maintain the protection of the riparian areas.
- Determine causes of instability observed in this reach and evaluate potential for stabilization.

# R2-23-03

# Cabin Branch Sampling Unit

## Biological Assessment

### Raw Metric Values

Total Taxa	24
EPT Taxa	4
Ephemeroptera Taxa	2
%Intolerant Urban	14.1
%Ephemeroptera	6.5
Scraper Taxa	2
% Climbers	10.9

### Calculated Metric Scores

Total Taxa	5
EPT Taxa	3
Ephemeroptera Taxa	5
%Intolerant Urban	3
%Ephemeroptera	3
Scraper Taxa	5
% Climbers	5

<b>BIBI Score</b>	<b>4.14</b>
<b>BIBI Narrative Rating</b>	<b>Good</b>

Taxa	Count
Ablabesmyia	1
Acentrella	1
Acerpenna	5
Amphinemura	4
Caecidotea	2
Chironomidae	1
Chironomini	2
Conchapelopia	2
Crangonyx	4
Cricotopus/Orthocladius	4
Hemerodromia	1
Hydrobaenus	19
Ischnura	1
Isoperla	1
Lumbriculidae	1
Menetus	1
Naididae	4
Orthoclaadiinae	1
Parametricnemus	5
Polypedilum	4
Probezzia	1
Rheocricotopus	2
Simulium	10
Tanytarsini	2
Tanytarsus	4
Thienemannimyia group	3
Tipula	1
Tubificidae	3
Tvetenia	2
<b>TOTAL:</b>	<b>92</b>

## Physical Habitat Assessment

### EPA Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	2	Pool Variability	11
Bank Stability- Right Bank	6	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	9
Channel Flow Status	13	Sediment Deposition	9
Channel Sinuosity	10	Vegetative Protection - Left Bank	3
Epifaunal Substrate/Available Cover	13	Vegetative Protection - Right Bank	7
Pool Substrate Characterization	12		

<b>RBP Habitat Score</b>	<b>125</b>
<b>RBP Narrative Rating</b>	<b>Partially Supporting</b>

### MBSS Physical Habitat Index

	Value	Score	Value	Score	
Remoteness	14	75.39	Instream Wood Debris	14	75.52
Shading	90	91.34	Instream Habitat	12	68.07
Epifaunal Substrate	13	81.32	Bank Stability	8	63.25

<b>PHI Score</b>	<b>75.82</b>
<b>PHI Narrative Rating</b>	<b>Partially Degraded</b>

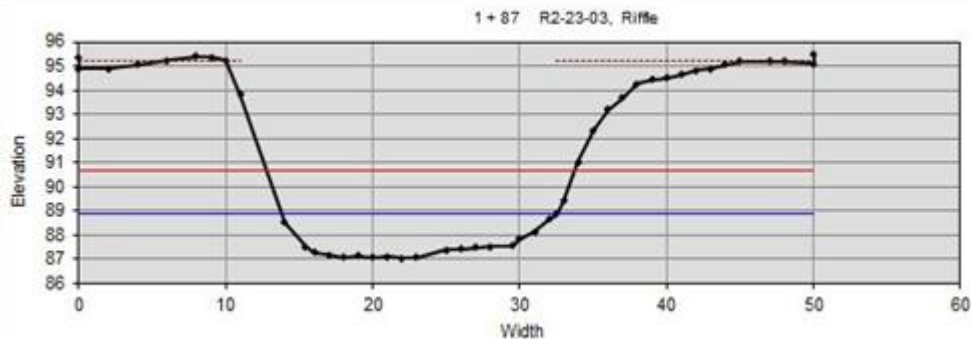
## Water Chemistry

Dissolved Oxygen (mg/L)	11.43	pH (SU)	6.86
Turbidity (NTU)	6.87	Specific Conductivity (µS/cm)	126.37
Temperature (°C)	12.2		

## Geomorphic Assessment

### Rosgen Level II Classification Data

Drainage Area (mi <sup>2</sup> )	3.59	Cross Sectional Area (ft <sup>2</sup> )	25.6
Bankfull Width (ft)	18.7	Water Surface Slope (%)	0.38
Mean Bankfull Depth (ft)	1.37	Sinuosity	1.2
Floodprone Width (ft)	21	D50 (mm)	0.44
Entrenchment Ratio	1.1	Adjustments?	None
Width to Depth Ratio	13.6	<b>Rosgen Stream Type</b>	<b>F4/5</b>



## R2-23-04

## Cabin Branch Sampling Unit

### Upstream View:



Latitude: 38.782614834

### Downstream View:



Longitude: -76.670294578

### Land Use/Land Cover Analysis:

**Total Drainage Area (acres) 100.12**

<u>Cover</u>	<u>Acres</u>	<u>% Area</u>
<b>Developed Land</b>	<b>9.09</b>	<b>9.08</b>
Airport	0	0
Commercial	0	0
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	7.9	7.9
Residential 2-Acre	0.74	0.74
Transportation	0.45	0.45
Utility	0	0
<b>Forest Land</b>	<b>67.97</b>	<b>67.89</b>
Forested Wetland	0	0
Residential Woods	0	0
Woods	67.97	67.89
<b>Open Land</b>	<b>0.53</b>	<b>0.53</b>
Open Space	0.53	0.53
Open Wetland	0	0
Water	0	0
<b>Agricultural Land</b>	<b>22.53</b>	<b>22.5</b>
Pasture/Hay	18.65	18.63
Row Crops	3.87	3.87
<b>Impervious Surface</b>	<b>Acres</b>	<b>% Area</b>
Impervious Land	0.87	0.87

### Summary Results:

- Biological condition – “Poor”
- Habitat scores “Non Supporting” and “Degraded”
- Isopods (Caecidotea and Asellidae) and midges, including Cricotopus/Orthocladus, dominated the sample.
- Water quality values within COMAR standards.
- Heavy sedimentation resulting from bank and bed erosion. Poor benthic substrate, pool/glide/eddy quality, and velocity depth diversity. Poor vegetative protection but good riparian width.
- Transitional reach from E upstream to G below headcut.

### Recommendations:

- Maintain the protection of the riparian areas.
- Determine causes of instability observed in this reach and evaluate potential for stabilization.

**Biological Assessment**

**Raw Metric Values**

Total Taxa	21
EPT Taxa	4
Ephemeroptera Taxa	0
%Intolerant Urban	39.4
%Ephemeroptera	0
Scraper Taxa	1
% Climbers	1

**Calculated Metric Scores**

Total Taxa	3
EPT Taxa	3
Ephemeroptera Taxa	1
%Intolerant Urban	5
%Ephemeroptera	1
Scraper Taxa	3
% Climbers	3

<b>BIBI Score</b>	<b>2.71</b>
<b>BIBI Narrative Rating</b>	<b>Poor</b>

**Taxa Count**

Amphinemura	10
Amphipoda	8
Asellidae	5
Berosus	1
Bezzia/Palpomysia	1
Caecidotea	24
Chrysops	1
Cricotopus/Orthocladius	10
Diplocladius	5
Gammarus	6
Hydrobaenus	3
Isonychia	1
Isoperla	1
Lumbriculidae	3
Oemopteryx	1
Ormosia	1
Orthocladinae	2
Parametriocnemus	1
Pseudorthocladius	1
Rheocricotopus	2
Stegopterna	1
Synurella	1
Tubificidae	10
<b>TOTAL:</b>	<b>99</b>

**Physical Habitat Assessment**

**EPA Rapid Bioassessment Protocol**

	Score		Score
Bank Stability- Left Bank	2	Pool Variability	7
Bank Stability- Right Bank	2	Riparian Vegetative Zone Width- Left Bank	9
Channel Alteration	19	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	12	Sediment Deposition	5
Channel Sinuosity	9	Vegetative Protection - Left Bank	4
Epifaunal Substrate/Available Cover	5	Vegetative Protection - Right Bank	4
Pool Substrate Characterization	7		

<b>RBP Habitat Score</b>	<b>95</b>
<b>RBP Narrative Rating</b>	<b>Non Supporting</b>

**MBSS Physical Habitat Index**

	Value	Score		Value	Score
Remoteness	10	53.85	Instream Wood Debris	4	81.4
Shading	95	99.94	Instream Habitat	4	55.74
Epifaunal Substrate	5	55.25	Bank Stability	4	44.72

<b>PHI Score</b>	<b>65.15</b>
<b>PHI Narrative Rating</b>	<b>Degraded</b>

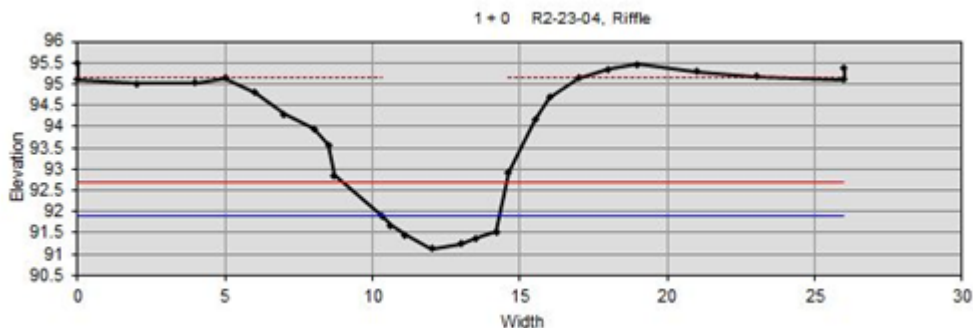
**Water Chemistry**

Dissolved Oxygen (mg/L)	9.81	pH (SU)	6.59
Turbidity (NTU)	7.78	Specific Conductivity (µS/cm)	146.37
Temperature (°C)	20.2		

**Geomorphic Assessment**

**Rosen Level II Classification Data**

Drainage Area (mi <sup>2</sup> )	0.16	Cross Sectional Area (ft <sup>2</sup> )	2.1
Bankfull Width (ft)	4	Water Surface Slope (%)	1.4
Mean Bankfull Depth (ft)	0.53	Sinuosity	1.1
Floodprone Width (ft)	5.5	D50 (mm)	0.076
Entrenchment Ratio	1.4	Adjustments?	None
Width to Depth Ratio	7.6	<b>Rosen Stream Type</b>	<b>Transitional</b>



Upstream View:



Latitude: 38.76274069

Downstream View:



Longitude: -76.68624755

**Land Use/Land Cover Analysis:**

<b>Total Drainage Area (acres)</b>		<b>863.4</b>
<b>Cover</b>	<b>Acres</b>	<b>% Area</b>
<b>Developed Land</b>	<b>162.26</b>	<b>18.79</b>
Airport	0	0
Commercial	0.59	0.07
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	2.99	0.35
Residential 1-Acre	23.04	2.67
Residential 2-Acre	95.4	11.05
Transportation	40.24	4.66
Utility	0	0
<b>Forest Land</b>	<b>449.13</b>	<b>52.02</b>
Forested Wetland	0	0
Residential Woods	0	0
Woods	449.13	52.02
<b>Open Land</b>	<b>26.77</b>	<b>3.1</b>
Open Space	26.77	3.1
Open Wetland	0	0
Water	0	0
<b>Agricultural Land</b>	<b>225.24</b>	<b>26.09</b>
Pasture/Hay	87.39	10.12
Row Crops	137.85	15.97
<b>Impervious Surface</b>	<b>Acres</b>	<b>% Area</b>
Impervious Land	32.92	3.81

**Summary Results:**

- Biological condition – “Fair”
- Habitat scores “Supporting” and “Partially Degraded”
- Various midges of the Chironomidae family, including Polypedilum and Ablabesmyia, dominated the sample.
- Water quality values within COMAR standards.
- Mostly pools with attached algae. No fast flowing water. Good bank stability, vegetative protection, and riparian width. Woody debris and rootwads provide the majority of benthic habitat. Refuse present in minor amounts.
- Channel is heavily influenced by beaver dam downstream. Stream type indeterminate.

**Recommendations:**

- Maintain the protection of the riparian areas.



# R2-23-05

# Cabin Branch Sampling Unit

## Biological Assessment

### Raw Metric Values

Total Taxa	28
EPT Taxa	2
Ephemeroptera Taxa	2
%Intolerant Urban	8.5
%Ephemeroptera	7.3
Scraper Taxa	2
% Climbers	19.5

### Calculated Metric Scores

Total Taxa	5
EPT Taxa	3
Ephemeroptera Taxa	5
%Intolerant Urban	1
%Ephemeroptera	3
Scraper Taxa	5
% Climbers	5

<b>BIBI Score</b>	<b>3.86</b>
<b>BIBI Narrative Rating</b>	<b>Fair</b>

### Taxa Count

Taxa	Count
Ablabesmyia	7
Baetidae	1
Callibaetis	3
Ceratopogonidae	1
Chironomidae	1
Chironominae	1
Conchapelopia	2
Corynoneura	1
Cricotopus/Orthocladius	6
Dicrotendipes	2
Diplocladius	3
Empididae	1
Hydrobaenus	2
Leptophlebiidae	2
Lumbricidae	6
Lumbriculidae	1
Micropsectra	1
Microtendipes	1
Naididae	1
Nematomorpha	2
Neoporus	1
Parametrioctonus	1
Paratendipes	2
Physa	1
Pisidium	2
Polypedilum	8
Rheocricotopus	2
Sphaeromias	1
Stenochironomus	1
Tanytarsini	2
Tanytarsus	6
Tubificidae	8
Zavrelimyia	2

<b>TOTAL:</b>	<b>82</b>
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## Physical Habitat Assessment

### EPA Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	8	Pool Variability	13
Bank Stability- Right Bank	8	Riparian Vegetative Zone Width- Left Bank	9
Channel Alteration	16	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	20	Sediment Deposition	9
Channel Sinuosity	7	Vegetative Protection - Left Bank	8
Epifaunal Substrate/Available Cover	9	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	10		

<b>RBP Habitat Score</b>	<b>135</b>
<b>RBP Narrative Rating</b>	<b>Supporting</b>

### MBSS Physical Habitat Index

	Value	Score	Value	Score	
Remoteness	11	59.24	Instream Wood Debris	12	80.67
Shading	90	91.34	Instream Habitat	9	61.43
Epifaunal Substrate	9	64.45	Bank Stability	16	89.45

<b>PHI Score</b>	<b>74.43</b>
<b>PHI Narrative Rating</b>	<b>Partially Degraded</b>

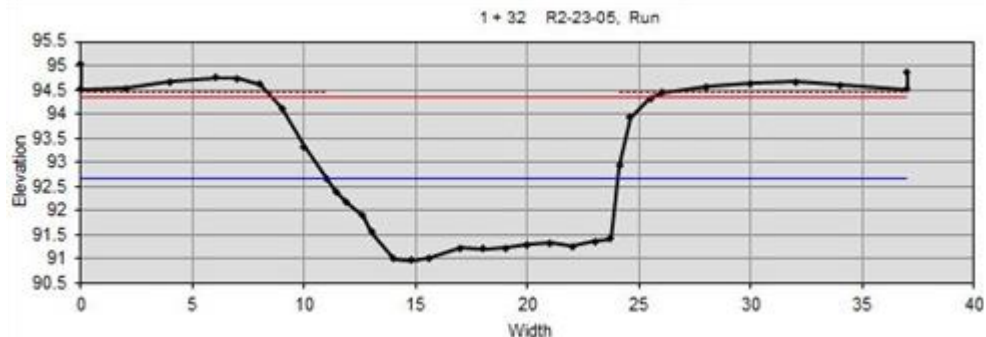
## Water Chemistry

Dissolved Oxygen (mg/L)	9.87	pH (SU)	6.61
Turbidity (NTU)	7.21	Specific Conductivity (µS/cm)	198.63
Temperature (°C)	12.7		

## Geomorphic Assessment

### Rosen Level II Classification Data

Drainage Area (mi <sup>2</sup> )	1.35	Cross Sectional Area (ft <sup>2</sup> )	16.7
Bankfull Width (ft)	13	Water Surface Slope (%)	0.004
Mean Bankfull Depth (ft)	1.28	Sinuosity	1
Floodprone Width (ft)	17.2	D50 (mm)	0.25
Entrenchment Ratio	1.3	Adjustments?	None
Width to Depth Ratio	10.2	<b>Rosen Stream Type</b>	<b>ND</b>



## R2-23-06

## Cabin Branch Sampling Unit

### Upstream View:



Latitude: 38.78771891

### Downstream View:



Longitude: -76.650361275

### Land Use/Land Cover Analysis:

**Total Drainage Area (acres) 1284.75**

<u>Cover</u>	<u>Acres</u>	<u>% Area</u>
<b>Developed Land</b>	<b>314.04</b>	<b>24.44</b>
Airport	0	0
Commercial	5.34	0.42
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	6.37	0.5
Residential 1-Acre	36.3	2.83
Residential 2-Acre	246.07	19.15
Transportation	19.96	1.55
Utility	0	0
<b>Forest Land</b>	<b>440.47</b>	<b>34.28</b>
Forested Wetland	0	0
Residential Woods	0	0
Woods	440.47	34.28
<b>Open Land</b>	<b>31.54</b>	<b>2.46</b>
Open Space	26.12	2.03
Open Wetland	0	0
Water	5.42	0.42
<b>Agricultural Land</b>	<b>498.69</b>	<b>38.82</b>
Pasture/Hay	179.72	13.99
Row Crops	318.98	24.83
<b>Impervious Surface</b>	<b>Acres</b>	<b>% Area</b>
Impervious Land	39.25	3.06

### Summary Results:

- Biological condition – “Fair”
- Habitat scores “Partially Supporting” and “Partially Degraded”
- Isopods (Caecidotea) and worms (Naididae) dominated the sample.
- Water quality values within COMAR standards.
- Incised, overwidened channel with heavy bank erosion and large bar formation. An abundance of woody debris provides most of stable habitat. Poor vegetative protection with good riparian width. Refuse present in minor amounts.

### Recommendations:

- Maintain the protection of the riparian areas.
- Determine causes of instability observed in this reach and evaluate potential for stabilization.

# R2-23-06

# Cabin Branch Sampling Unit

## Biological Assessment

### Raw Metric Values

Total Taxa	25
EPT Taxa	4
Ephemeroptera Taxa	0
%Intolerant Urban	30.7
%Ephemeroptera	0
Scraper Taxa	4
% Climbers	5.9

### Calculated Metric Scores

Total Taxa	5
EPT Taxa	3
Ephemeroptera Taxa	1
%Intolerant Urban	5
%Ephemeroptera	1
Scraper Taxa	5
% Climbers	3

**BIBI Score** 3.29

**BIBI Narrative Rating** Fair

### Taxa Count

Amphinemura	3
Caecidotea	25
Calopteryx	1
Chrysops	1
Conchapelopia	1
Corynoneura	1
Crangonyx	5
Cricotopus/Orthocladius	8
Dipterona	1
Diplocladius	1
Helichus	1
Hydrobaenus	6
Isonychia	3
Lumbriculidae	4
Menetus	1
Naididae	17
Neophylax	1
Parametriocnemus	2
Paratendipes	1
Polypedilum	3
Pseudorthocladius	1
Rheocricotopus	1
Simulium	10
Tanytarsus	1
Thienemannimyia group	1
Tubificidae	1
<b>TOTAL:</b>	<b>101</b>

## Physical Habitat Assessment

### EPA Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	3	Pool Variability	10
Bank Stability- Right Bank	1	Riparian Vegetative Zone Width- Left Bank	8
Channel Alteration	19	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	12	Sediment Deposition	10
Channel Sinuosity	15	Vegetative Protection - Left Bank	3
Epifaunal Substrate/Available Cover	12	Vegetative Protection - Right Bank	3
Pool Substrate Characterization	11		

**RBP Habitat Score** 117

**RBP Narrative Rating** Partially Supporting

### MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	10	53.85	Instream Wood Debris	15	85.05
Shading	85	84.56	Instream Habitat	12	74.01
Epifaunal Substrate	12	79.29	Bank Stability	4	44.72

**PHI Score** 70.25

**PHI Narrative Rating** Partially Degraded

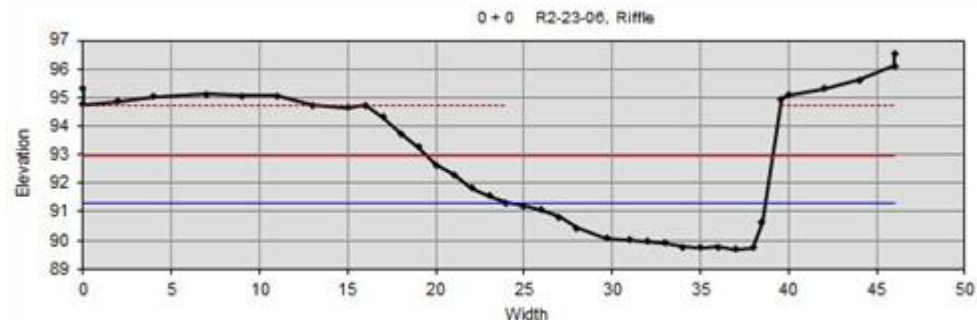
## Water Chemistry

Dissolved Oxygen (mg/L)	11.95	pH (SU)	6.98
Turbidity (NTU)	6.96	Specific Conductivity (µS/cm)	132.67
Temperature (°C)	13.93		

## Geomorphic Assessment

### Rosen Level II Classification Data

Drainage Area (mi <sup>2</sup> )	2.01	Cross Sectional Area (ft <sup>2</sup> )	15.9
Bankfull Width (ft)	14.7	Water Surface Slope (%)	0.33
Mean Bankfull Depth (ft)	1.08	Sinuosity	1.5
Floodprone Width (ft)	19.6	D50 (mm)	0.25
Entrenchment Ratio	1.3	Adjustments?	None
Width to Depth Ratio	13.6	<b>Rosen Stream Type</b>	<b>F5</b>



Upstream View:



Latitude: 38.787939028

Downstream View:



Longitude: -76.65837491

**Land Use/Land Cover Analysis:**

<b>Total Drainage Area (acres)</b>			<b>399.85</b>
<b>Cover</b>	<b>Acres</b>	<b>% Area</b>	
<b>Developed Land</b>	<b>41.04</b>	<b>10.26</b>	
Airport	0	0	
Commercial	1.1	0.28	
Industrial	0	0	
Residential 1/8-acre	0	0	
Residential 1/4-acre	0	0	
Residential 1/2-acre	2.6	0.65	
Residential 1-Acre	14.52	3.63	
Residential 2-Acre	12.97	3.24	
Transportation	9.85	2.46	
Utility	0	0	
<b>Forest Land</b>	<b>217.42</b>	<b>54.38</b>	
Forested Wetland	0	0	
Residential Woods	0	0	
Woods	217.42	54.38	
<b>Open Land</b>	<b>14.33</b>	<b>3.58</b>	
Open Space	14.33	3.58	
Open Wetland	0	0	
Water	0	0	
<b>Agricultural Land</b>	<b>127.06</b>	<b>31.78</b>	
Pasture/Hay	28.37	7.09	
Row Crops	98.69	24.68	
<b>Impervious Surface</b>	<b>Acres</b>	<b>% Area</b>	
Impervious Land	8.29	2.07	

**Summary Results:**

- Biological condition – “Poor”
- Habitat scores “Non Supporting” and “Degraded”
- Cricotopus/Orthocladius (midge) dominated the sample.
- Water quality values within COMAR standards.
- Deeply incised channel downcut to hardpan clay. Little available substrate due to clay bottom and lack of woody debris, but some patches of gravel present. Very poor sinuosity, bank stability, and vegetative protection. Refuse present in minor amounts.
- Substrate predominantly hardpan clay.

**Recommendations:**

- Buffer enhancement.
- Determine causes of instability observed in this reach and evaluate potential for stabilization.

**Biological Assessment**

**Raw Metric Values**

Total Taxa	16
EPT Taxa	2
Ephemeroptera Taxa	0
%Intolerant Urban	12.1
%Ephemeroptera	0
Scraper Taxa	2
% Climbers	0

**Calculated Metric Scores**

Total Taxa	3
EPT Taxa	3
Ephemeroptera Taxa	1
%Intolerant Urban	3
%Ephemeroptera	1
Scraper Taxa	5
% Climbers	1

<b>BIBI Score</b>	<b>2.43</b>
<b>BIBI Narrative Rating</b>	<b>Poor</b>

**Taxa Count**

Amphinemura	11
Ceratopogonidae	1
Chironomidae	1
Cricotopus/Orthocladius	54
Diamesa	5
Diplocladius	1
Eukiefferiella	2
Gammarus	1
Hydrobaenus	9
Naididae	1
Neophylax	1
Orthoclaadiinae	1
Parametriocnemus	1
Rheocricotopus	4
Simulium	3
Tipula	1
Tubificidae	1
Zavrelimyia	1
<b>TOTAL:</b>	<b>99</b>

**Physical Habitat Assessment**

**EPA Rapid Bioassessment Protocol**

	Score		Score
Bank Stability- Left Bank	1	Pool Variability	7
Bank Stability- Right Bank	1	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	16	Riparian Vegetative Zone Width- Right Bank	5
Channel Flow Status	16	Sediment Deposition	17
Channel Sinuosity	4	Vegetative Protection - Left Bank	3
Epifaunal Substrate/Available Cover	6	Vegetative Protection - Right Bank	3
Pool Substrate Characterization	4		

<b>RBP Habitat Score</b>	<b>93</b>
<b>RBP Narrative Rating</b>	<b>Non Supporting</b>

**MBSS Physical Habitat Index**

	Value	Score		Value	Score
Remoteness	9	48.47	Instream Wood Debris	0	53.89
Shading	95	99.94	Instream Habitat	6	52.67
Epifaunal Substrate	6	52.04	Bank Stability	2	31.62

<b>PHI Score</b>	<b>56.44</b>
<b>PHI Narrative Rating</b>	<b>Degraded</b>

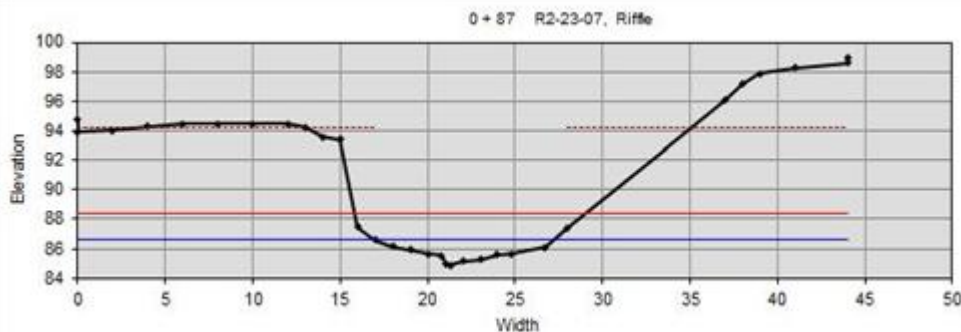
**Water Chemistry**

Dissolved Oxygen (mg/L)	11.19	pH (SU)	7.01
Turbidity (NTU)	5.77	Specific Conductivity (µS/cm)	134.3
Temperature (°C)	17.53		

**Geomorphic Assessment**

**Rosgen Level II Classification Data**

Drainage Area (mi <sup>2</sup> )	0.62	Cross Sectional Area (ft <sup>2</sup> )	9.3
Bankfull Width (ft)	10.2	Water Surface Slope (%)	0.59
Mean Bankfull Depth (ft)	0.91	Sinuosity	1.1
Floodprone Width (ft)	13.1	D50 (mm)	0.43
Entrenchment Ratio	1.3	Adjustments?	None
Width to Depth Ratio	11.2	<b>Rosgen Stream Type</b>	<b>G6c</b>



Upstream View:



Latitude: 38.762750639

Downstream View:



Longitude: -76.683316683

**Land Use/Land Cover Analysis:**

**Total Drainage Area (acres) 840.44**

<u>Cover</u>	<u>Acres</u>	<u>% Area</u>
<b>Developed Land</b>	<b>157.17</b>	<b>18.7</b>
Airport	0	0
Commercial	0.59	0.07
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	2.99	0.36
Residential 1-Acre	21.96	2.61
Residential 2-Acre	93.18	11.09
Transportation	38.46	4.58
Utility	0	0
<b>Forest Land</b>	<b>433.68</b>	<b>51.6</b>
Forested Wetland	0	0
Residential Woods	0	0
Woods	433.68	51.6
<b>Open Land</b>	<b>25.22</b>	<b>3</b>
Open Space	25.22	3
Open Wetland	0	0
Water	0	0
<b>Agricultural Land</b>	<b>224.37</b>	<b>26.7</b>
Pasture/Hay	87.39	10.4
Row Crops	136.98	16.3
<b>Impervious Surface</b>	<b>Acres</b>	<b>% Area</b>
Impervious Land	31.85	3.79

**Summary Results:**

- Biological condition – “Fair”
- Habitat scores “Supporting” and “Minimally Degraded”
- Acerpenna (Ephemeroptera) and various midges of the Chironomidae family dominated the sample.
- Water quality values within COMAR standards.
- Deeply incised channel, but with good velocity depth diversity and stable substrate types. Moderately stable banks with good riparian width.
- Bimodal distribution of substrate (sand/gravel).

**Recommendations:**

- Maintain the protection of the riparian areas.

**Biological Assessment**

**Raw Metric Values**

Total Taxa	19
EPT Taxa	4
Ephemeroptera Taxa	1
%Intolerant Urban	30.4
%Ephemeroptera	22.8
Scraper Taxa	3
% Climbers	6.5

**Calculated Metric Scores**

Total Taxa	3
EPT Taxa	3
Ephemeroptera Taxa	3
%Intolerant Urban	5
%Ephemeroptera	5
Scraper Taxa	5
% Climbers	3

<b>BIBI Score</b>	<b>3.86</b>
<b>BIBI Narrative Rating</b>	<b>Fair</b>

**Taxa Count**

Acerpenna	21
Amphinemura	1
Cheumatopsyche	2
Chironominae	1
Conchapelopia	1
Cricotopus/Orthocladius	9
Culicoides	1
Diplocladius	2
Hydrobaenus	16
Menetus	1
Naididae	3
Neophylax	3
Orthocladius	1
Parametrioconemus	6
Paratanytarsus	1
Polypedilum	1
Rheocricotopus	2
Stegopterna	3
Tanytarsus	4
Thienemannimyia group	5
Tipula	1
Tubificidae	7
<b>TOTAL:</b>	<b>92</b>

**Physical Habitat Assessment**

**EPA Rapid Bioassessment Protocol**

	Score		Score
Bank Stability- Left Bank	6	Pool Variability	13
Bank Stability- Right Bank	6	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	16	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	14	Sediment Deposition	11
Channel Sinuosity	10	Vegetative Protection - Left Bank	7
Epifaunal Substrate/Available Cover	13	Vegetative Protection - Right Bank	7
Pool Substrate Characterization	12		

<b>RBP Habitat Score</b>	<b>135</b>
<b>RBP Narrative Rating</b>	<b>Supporting</b>

**MBSS Physical Habitat Index**

	Value	Score		Value	Score
Remoteness	13	70.01	Instream Wood Debris	9	72.1
Shading	90	91.34	Instream Habitat	13	83.9
Epifaunal Substrate	14	93.68	Bank Stability	12	77.46

<b>PHI Score</b>	<b>81.41</b>
<b>PHI Narrative Rating</b>	<b>Minimally Degraded</b>

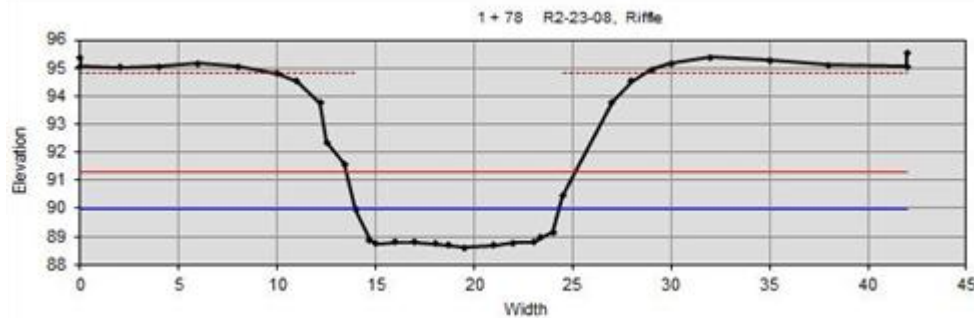
**Water Chemistry**

Dissolved Oxygen (mg/L)	11.41	pH (SU)	6.89
Turbidity (NTU)	6.22	Specific Conductivity (µS/cm)	197.47
Temperature (°C)	13.7		

**Geomorphic Assessment**

**Rosgen Level II Classification Data**

Drainage Area (mi <sup>2</sup> )	1.31	Cross Sectional Area (ft <sup>2</sup> )	11.5
Bankfull Width (ft)	10.3	Water Surface Slope (%)	0.55
Mean Bankfull Depth (ft)	1.12	Sinuosity	1.1
Floodprone Width (ft)	11.6	D50 (mm)	0.33
Entrenchment Ratio	1.1	Adjustments?	None
Width to Depth Ratio	9.2	<b>Rosgen Stream Type</b>	<b>G4/5c</b>



Upstream View:



Latitude: 38.799061324

Downstream View:



Longitude: -76.659390275

**Land Use/Land Cover Analysis:**

**Total Drainage Area (acres) 46.95**

<u>Cover</u>	<u>Acres</u>	<u>% Area</u>
<b>Developed Land 7.16 15.26</b>		
Airport	0	0
Commercial	0	0
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	4.11	8.76
Residential 2-Acre	3.05	6.5
Transportation	0	0
Utility	0	0
<b>Forest Land 16.06 34.22</b>		
Forested Wetland	0	0
Residential Woods	0	0
Woods	16.06	34.22
<b>Open Land 0.47 1.01</b>		
Open Space	0.47	1.01
Open Wetland	0	0
Water	0	0
<b>Agricultural Land 23.25 49.51</b>		
Pasture/Hay	0	0
Row Crops	23.25	49.51
<b>Impervious Surface</b>	<b>Acres</b>	<b>% Area</b>
Impervious Land	0.23	0.49

**Summary Results:**

- Biological condition – “Very Poor”
- Habitat scores “Non Supporting” and “Degraded”
- Caecidotea (isopod), Crangonyx (amphipod), and Naididae (worm) dominated the sample.
- Water quality values within COMAR standards.
- Deeply incised channel with heavily eroded banks and poor vegetative protection. Pools lacking due to heavy sedimentation. Poor epifaunal substrate and instream habitat. Minimal woody debris.
- Bimodal distribution of substrate (sand/gravel).

**Recommendations:**

- Maintain the protection of the riparian areas.
- Determine causes of instability observed in this reach and evaluate potential for stabilization.



**Biological Assessment**

**Raw Metric Values**

Total Taxa	13
EPT Taxa	1
Ephemeroptera Taxa	0
%Intolerant Urban	37
%Ephemeroptera	0
Scraper Taxa	1
% Climbers	0.9

**Calculated Metric Scores**

Total Taxa	1
EPT Taxa	1
Ephemeroptera Taxa	1
%Intolerant Urban	5
%Ephemeroptera	1
Scraper Taxa	3
% Climbers	1

**BIBI Score** 1.86

**BIBI Narrative Rating** Very Poor

**Taxa** **Count**

Agabus	7
Amphinemura	9
Amphipoda	2
Caecidotea	35
Crangonyx	19
Cricotopus/Orthocladius	7
Diamesa	1
Enchytraeidae	1
Hydrobaenus	9
Naididae	17
Orthocladius	1
Parametricnemus	7
Polypedilum	1
Rheocricotopus	2
Tubificidae	1
<b>TOTAL:</b>	<b>119</b>

**Physical Habitat Assessment**

**EPA Rapid Bioassessment Protocol**

	Score		Score
Bank Stability- Left Bank	1	Pool Variability	4
Bank Stability- Right Bank	1	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	9
Channel Flow Status	8	Sediment Deposition	7
Channel Sinuosity	9	Vegetative Protection - Left Bank	4
Epifaunal Substrate/Available Cover	5	Vegetative Protection - Right Bank	4
Pool Substrate Characterization	3		

**RBP Habitat Score** 85

**RBP Narrative Rating** Non Supporting

**MBSS Physical Habitat Index**

	Value	Score	Value	Score	
Remoteness	11	59.24	Instream Wood Debris	1	81.1
Shading	95	99.94	Instream Habitat	3	57.94
Epifaunal Substrate	6	65.99	Bank Stability	2	31.62

**PHI Score** 65.97

**PHI Narrative Rating** Degraded

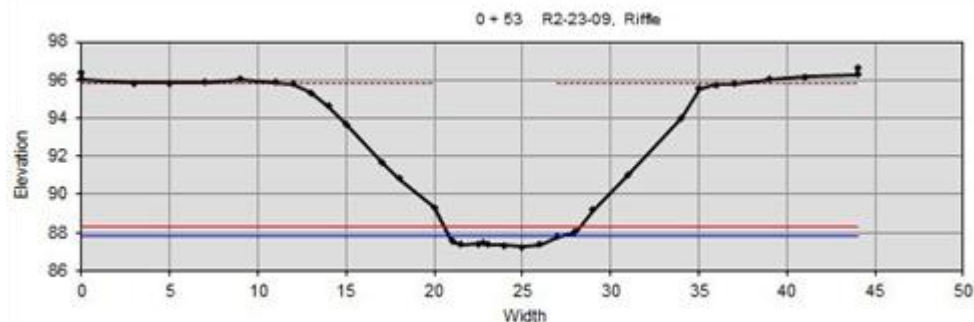
**Water Chemistry**

Dissolved Oxygen (mg/L)	11.25	pH (SU)	6.68
Turbidity (NTU)	10.1	Specific Conductivity (µS/cm)	109.93
Temperature (°C)	12.73		

**Geomorphic Assessment**

**Rosen Level II Classification Data**

Drainage Area (mi <sup>2</sup> )	0.07	Cross Sectional Area (ft <sup>2</sup> )	2.4
Bankfull Width (ft)	6.1	Water Surface Slope (%)	1.2
Mean Bankfull Depth (ft)	0.38	Sinuosity	1.1
Floodprone Width (ft)	7.7	D50 (mm)	0.12
Entrenchment Ratio	1.2	Adjustments?	None
Width to Depth Ratio	16	<b>Rosen Stream Type</b>	<b>F4/5</b>



## R2-23-10

## Cabin Branch Sampling Unit

### Upstream View:



Latitude: 38.782745659

### Downstream View:



Longitude: -76.652692344

### Land Use/Land Cover Analysis:

**Total Drainage Area (acres)** 1853.27

<u>Cover</u>	<u>Acres</u>	<u>% Area</u>
<b>Developed Land</b>	<b>396.46</b>	<b>21.39</b>
Airport	0	0
Commercial	6.44	0.35
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	15.38	0.83
Residential 1-Acre	52.45	2.83
Residential 2-Acre	292.37	15.78
Transportation	29.82	1.61
Utility	0	0
<b>Forest Land</b>	<b>728.37</b>	<b>39.3</b>
Forested Wetland	0	0
Residential Woods	0	0
Woods	728.37	39.3
<b>Open Land</b>	<b>66.42</b>	<b>3.58</b>
Open Space	61	3.29
Open Wetland	0	0
Water	5.42	0.29
<b>Agricultural Land</b>	<b>662.02</b>	<b>35.72</b>
Pasture/Hay	208.08	11.23
Row Crops	453.93	24.49
<b>Impervious Surface</b>	<b>Acres</b>	<b>% Area</b>
Impervious Land	52.49	2.83

### Summary Results:

- Biological condition – “Fair”
- Habitat scores “Supporting” and “Partially Degraded”
- Black flies (Simulium) and midges (Cricotopus/Orthocladius) dominated the sample.
- Water quality values within COMAR standards.
- Deeply incised and overwidened channel with numerous point bars and heavy bank erosion. Abundant woody debris and rootwads with sub-optimal epifaunal substrate and instream habitat.
- Adjusted WD Ratio +2.0 to fit F type. Bimodal distribution of substrate (sand/gravel).

### Recommendations:

- Maintain the protection of the riparian areas.
- Determine causes of instability observed in this reach and evaluate potential for stabilization.

# R2-23-10

# Cabin Branch Sampling Unit

## Biological Assessment

### Raw Metric Values

Total Taxa	26
EPT Taxa	7
Ephemeroptera Taxa	0
%Intolerant Urban	19.2
%Ephemeroptera	0
Scraper Taxa	2
% Climbers	3.3

### Calculated Metric Scores

Total Taxa	5
EPT Taxa	5
Ephemeroptera Taxa	1
%Intolerant Urban	3
%Ephemeroptera	1
Scraper Taxa	5
% Climbers	3

<b>BIBI Score</b>	<b>3.29</b>
<b>BIBI Narrative Rating</b>	<b>Fair</b>

### Taxa Count

Taxa	Count
Agabus	3
Amphinemura	10
Amphipoda	2
Caecidotea	8
Cheumatopsyche	1
Clioperla	1
Cricotopus/Orthocladius	15
Dicrotendipes	1
Enchytraeidae	2
Eukiefferiella	1
Hydrobaenus	8
Ironoquia	2
Isoperla	2
Naididae	2
Neophylax	1
Orthoclaadiinae	3
Parametriocnemus	3
Pisidium	1
Polypedilum	3
Rheocricotopus	1
Rheotanytarsus	1
Simulium	42
Stegopterna	1
Taeniopteryx	1
Tanytarsus	1
Thienemannimyia group	1
Tipula	1
Tubificidae	2

<b>TOTAL:</b>	<b>120</b>
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## Physical Habitat Assessment

### EPA Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	5	Pool Variability	13
Bank Stability- Right Bank	3	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	12	Sediment Deposition	10
Channel Sinuosity	11	Vegetative Protection - Left Bank	3
Epifaunal Substrate/Available Cover	13	Vegetative Protection - Right Bank	4
Pool Substrate Characterization	12		

<b>RBP Habitat Score</b>	<b>126</b>
<b>RBP Narrative Rating</b>	<b>Supporting</b>

### MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	14	75.39	Instream Wood Debris	15	80.9
Shading	80	78.67	Instream Habitat	13	75.81
Epifaunal Substrate	13	82.71	Bank Stability	8	63.25

<b>PHI Score</b>	<b>76.12</b>
<b>PHI Narrative Rating</b>	<b>Partially Degraded</b>

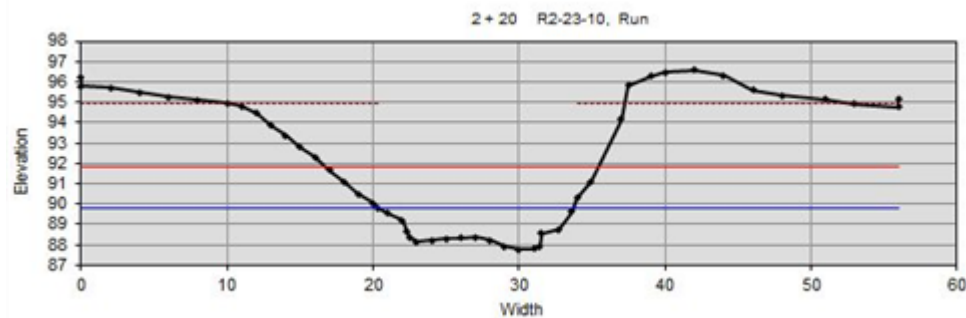
## Water Chemistry

Dissolved Oxygen (mg/L)	11.23	pH (SU)	6.98
Turbidity (NTU)	6.58	Specific Conductivity (µS/cm)	130.7
Temperature (°C)	13.83		

## Geomorphic Assessment

### Rosgen Level II Classification Data

Drainage Area (mi <sup>2</sup> )	2.9	Cross Sectional Area (ft <sup>2</sup> )	17.9
Bankfull Width (ft)	13.4	Water Surface Slope (%)	0.54
Mean Bankfull Depth (ft)	1.33	Sinuosity	1.2
Floodprone Width (ft)	18.7	D50 (mm)	0.49
Entrenchment Ratio	1.4	Adjustments?	Yes, WD +2.0
Width to Depth Ratio	10.1	<b>Rosgen Stream Type</b>	<b>F4/5</b>



## R2-23-12A

## Cabin Branch Sampling Unit

### Upstream View:



Latitude: 38.764643695

### Downstream View:



Longitude: -76.658417359

### Land Use/Land Cover Analysis:

**Total Drainage Area (acres) 9572.59**

\*Calvert County drainage (914.48 ac) not included in land use/land cover analysis.

<u>Cover</u>	<u>Acres</u>	<u>% Area</u>
<b>Developed Land</b>	<b>2011.23</b>	<b>23.23</b>
Airport	0	0
Commercial	100.28	1.16
Industrial	1.94	0.02
Residential 1/8-acre	0	0
Residential 1/4-acre	2.61	0.03
Residential 1/2-acre	78.61	0.91
Residential 1-Acre	335.12	3.87
Residential 2-Acre	1321.66	15.26
Transportation	171.02	1.98
Utility	0	0
<b>Forest Land</b>	<b>3385.74</b>	<b>39.1</b>
Forested Wetland	20.42	0.24
Residential Woods	0	0
Woods	3365.32	38.87
<b>Open Land</b>	<b>507.24</b>	<b>5.86</b>
Open Space	460.06	5.31
Open Wetland	4.13	0.05
Water	43.05	0.5
<b>Agricultural Land</b>	<b>2753.92</b>	<b>31.81</b>
Pasture/Hay	687.87	7.94
Row Crops	2066.04	23.86
<b>Impervious Surface</b>	<b>Acres</b>	<b>% Area</b>
Impervious Land	340.59	3.56

### Summary Results:

- Biological condition – “Fair”
- Habitat scores “Supporting” and “Degraded”
- Various midges of the Chironomidae family, including Cricotopus/Orthocladius, dominated the sample.
- Water quality values within COMAR standards.
- Reach entirely backwatered with very poor sinuosity. Rootwads abundant but fully submerged due to backwatering. Good bank stability, vegetative protection, and riparian width. Poor remoteness due to close proximity to MD 260 and MD 4.
- Reach entirely backwatered and located between two bridge crossings. Stream type indeterminate.

### Recommendations:

- Maintain the protection of the riparian areas.

# R2-23-12A

# Cabin Branch Sampling Unit

## Biological Assessment

### Raw Metric Values

Total Taxa	25
EPT Taxa	1
Ephemeroptera Taxa	1
%Intolerant Urban	12.5
%Ephemeroptera	3.1
Scraper Taxa	3
% Climbers	13.5

### Calculated Metric Scores

Total Taxa	5
EPT Taxa	1
Ephemeroptera Taxa	3
%Intolerant Urban	3
%Ephemeroptera	3
Scraper Taxa	5
% Climbers	5

<b>BIBI Score</b>	<b>3.57</b>
<b>BIBI Narrative Rating</b>	<b>Fair</b>

Taxa	Count
Ablabesmyia	3
Ancyronyx	2
Bezzia/Palpomyia	2
Caecidotea	6
Centroptilum	3
Chironomidae	1
Conchapelopia	2
Cricotopus/Orthocladius	15
Culicoides	1
Dicrotendipes	5
Hyalella	6
Hydrobaenus	3
Ischnura	2
Menetus	1
Microtendipes	1
Naididae	9
Orthocladius	1
Parametriocnemus	2
Peltodytes	2
Polypedilum	2
Probezzia	3
Rheocricotopus	3
Sphaeromias	1
Tanytarsini	4
Tanytarsus	6
Thienemannimyia group	1
Tribelos	1
Tubificidae	5
Zavrelimyia	3
<b>TOTAL:</b>	<b>96</b>

## Physical Habitat Assessment

### EPA Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	9	Pool Variability	13
Bank Stability- Right Bank	9	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	14	Riparian Vegetative Zone Width- Right Bank	9
Channel Flow Status	20	Sediment Deposition	12
Channel Sinuosity	1	Vegetative Protection - Left Bank	8
Epifaunal Substrate/Available Cover	12	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	9		

<b>RBP Habitat Score</b>	<b>134</b>
<b>RBP Narrative Rating</b>	<b>Supporting</b>

### MBSS Physical Habitat Index

	Value	Score	Value	Score	
Remoteness	5	26.93	Instream Wood Debris	15	62.31
Shading	90	91.34	Instream Habitat	13	59
Epifaunal Substrate	11	60.4	Bank Stability	18	94.87

<b>PHI Score</b>	<b>65.81</b>
<b>PHI Narrative Rating</b>	<b>Degraded</b>

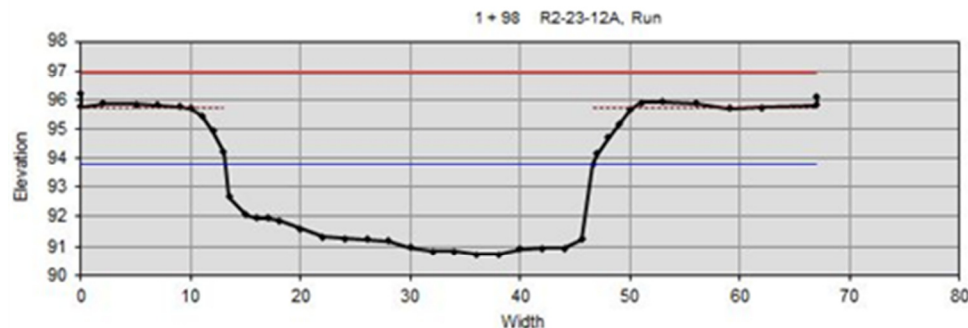
## Water Chemistry

Dissolved Oxygen (mg/L)	8.36	pH (SU)	6.93
Turbidity (NTU)	8.96	Specific Conductivity (µS/cm)	164
Temperature (°C)	14.73		

## Geomorphic Assessment

### Rosgen Level II Classification Data

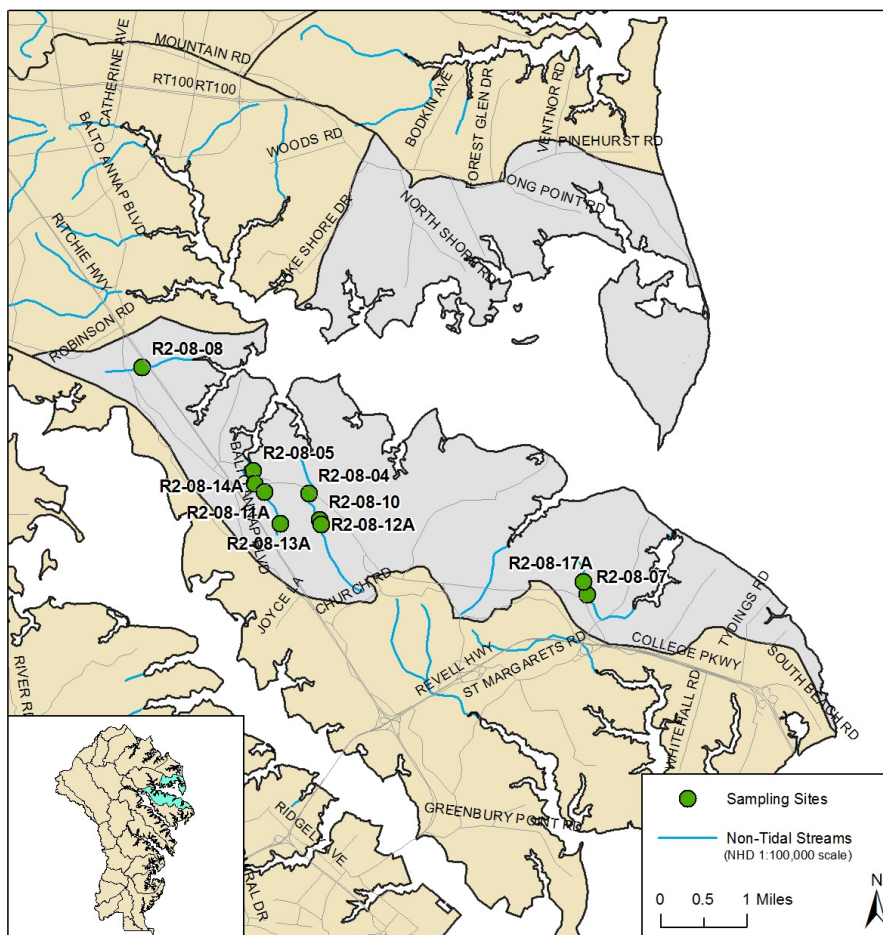
Drainage Area (mi <sup>2</sup> )	14.96	Cross Sectional Area (ft <sup>2</sup> )	84.7
Bankfull Width (ft)	33.5	Water Surface Slope (%)	0.016
Mean Bankfull Depth (ft)	2.53	Sinuosity	1
Floodprone Width (ft)	195	D50 (mm)	0.13
Entrenchment Ratio	5.8	Adjustments?	None
Width to Depth Ratio	13.2	<b>Rosgen Stream Type</b>	<b>ND</b>



# Lower Magothy River Sampling Unit

## Site Condition Summary

Site	Drainage Area (acres)	Drainage Area (mi <sup>2</sup> )	Percent Impervious	Percent Developed	Percent Forested	Percent Agriculture	Percent Open	BIBI Narrative Rating	PHI Narrative Rating	RBP Narrative Rating	Rosgen Stream Type - L1
R2-08-04	708.2	1.11	20.8	66.5	29.4	0.5	3.6	Poor	Degraded	Partially Supporting	G
R2-08-05	635.2	0.99	21.8	63.6	30.0	0.1	6.4	Poor	Partially Degraded	Comparable to Reference	DA
R2-08-07	179.3	0.28	28.9	76.7	11.6	0.0	11.7	Poor	Partially Degraded	Supporting	E
R2-08-08	180.9	0.28	47.9	96.1	1.1	0.0	2.8	Very Poor	Severely Degraded	Non Supporting	ND
R2-08-10	571.3	0.89	18.3	67.9	28.9	0.7	2.5	Poor	Degraded	Partially Supporting	E
R2-08-11A	252.5	0.39	25.8	65.3	24.4	0.0	10.3	Poor	Partially Degraded	Supporting	DA
R2-08-12A	556.7	0.87	18.0	67.5	29.2	0.7	2.6	Fair	Degraded	Partially Supporting	DA
R2-08-13A	165.2	0.26	20.2	67.4	21.8	0.0	10.8	Poor	Partially Degraded	Partially Supporting	ND
R2-08-14A	290.8	0.45	25.0	61.9	25.5	0.0	12.6	Very Poor	Partially Degraded	Supporting	E
R2-08-17A	106.2	0.17	28.0	82.9	14.2	0.0	2.9	Very Poor	Partially Degraded	Partially Supporting	ND



## R2-08-04

## Lower Magothy Sampling Unit

### Upstream View:



Latitude: 39.0526194

### Downstream View:



Longitude: -76.508360868

### Land Use/Land Cover Analysis:

**Total Drainage Area (acres) 708.23**

<u>Cover</u>	<u>Acres</u>	<u>% Area</u>
<b>Developed Land</b>	<b>471.11</b>	<b>66.52</b>
Airport	0	0
Commercial	77.62	10.96
Industrial	1.18	0.17
Residential 1/8-acre	3.33	0.47
Residential 1/4-acre	107.45	15.17
Residential 1/2-acre	77.92	11
Residential 1-Acre	124.16	17.53
Residential 2-Acre	48.11	6.79
Transportation	31.35	4.43
Utility	0	0
<b>Forest Land</b>	<b>207.92</b>	<b>29.36</b>
Forested Wetland	0	0
Residential Woods	0	0
Woods	207.92	29.36
<b>Open Land</b>	<b>25.37</b>	<b>3.58</b>
Open Space	24.97	3.53
Open Wetland	0	0
Water	0.4	0.06
<b>Agricultural Land</b>	<b>3.83</b>	<b>0.54</b>
Pasture/Hay	3.83	0.54
Row Crops	0	0

<u>Impervious Surface</u>	<u>Acres</u>	<u>% Area</u>
Impervious Land	147.48	20.82

### Summary Results:

- Biological condition – “Poor”
- Habitat scores “Partially Supporting” and “Degraded”
- Midges (Thienemannimyia group) dominated the sample.
- Water quality values within COMAR standards but conductivity elevated.
- Incised channel with raw, eroded banks throughout. Bed downcut primarily to clay with rootwads and woody debris providing some stable habitat. Poor remoteness score due to close proximity to College Parkway. Refuse present in moderate amounts.

### Recommendations:

- Maintain the protection of the riparian areas.
- Determine causes of instability observed in this reach and evaluate potential for stabilization.
- Consider trash cleanup for this reach.

**Biological Assessment**

**Raw Metric Values**

Total Taxa	22
EPT Taxa	0
Ephemeroptera Taxa	0
%Intolerant Urban	2.9
%Ephemeroptera	0
Scraper Taxa	4
% Climbers	10.8

**Calculated Metric Scores**

Total Taxa	5
EPT Taxa	1
Ephemeroptera Taxa	1
%Intolerant Urban	1
%Ephemeroptera	1
Scraper Taxa	5
% Climbers	5

<b>BIBI Score</b>	<b>2.71</b>
<b>BIBI Narrative Rating</b>	<b>Poor</b>

Taxa	Count
Ablabesmyia	5
Argia	7
Caecidotea	1
Corynoneura	2
Enchytraeidae	2
Helichus	1
Hydrobaenus	1
Lumbricidae	1
Lumbriculidae	1
Menetus	3
Odontomesa	1
Parametricnemus	6
Paratendipes	3
Phaenopsectra	3
Physa	1
Pisidium	4
Prostoma	2
Rheotanytarsus	5
Synurella	2
Thienemannimyia group	38
Tubificidae	6
Zavrelimyia	8
<b>TOTAL:</b>	<b>103</b>

**Physical Habitat Assessment**

**EPA Rapid Bioassessment Protocol**

	Score	Score	
Bank Stability- Left Bank	3	Pool Variability	10
Bank Stability- Right Bank	2	Riparian Vegetative Zone Width- Left Bank	8
Channel Alteration	13	Riparian Vegetative Zone Width- Right Bank	9
Channel Flow Status	16	Sediment Deposition	14
Channel Sinuosity	14	Vegetative Protection - Left Bank	4
Epifaunal Substrate/Available Cover	8	Vegetative Protection - Right Bank	3
Pool Substrate Characterization	9		

<b>RBP Habitat Score</b>	<b>113</b>
<b>RBP Narrative Rating</b>	<b>Partially Supporting</b>

**MBSS Physical Habitat Index**

	Value	Score	Value	Score	
Remoteness	5	26.93	Instream Wood Debris	18	100
Shading	60	58.94	Instream Habitat	8	57.91
Epifaunal Substrate	7	54.12	Bank Stability	5	50

<b>PHI Score</b>	<b>57.98</b>
<b>PHI Narrative Rating</b>	<b>Degraded</b>

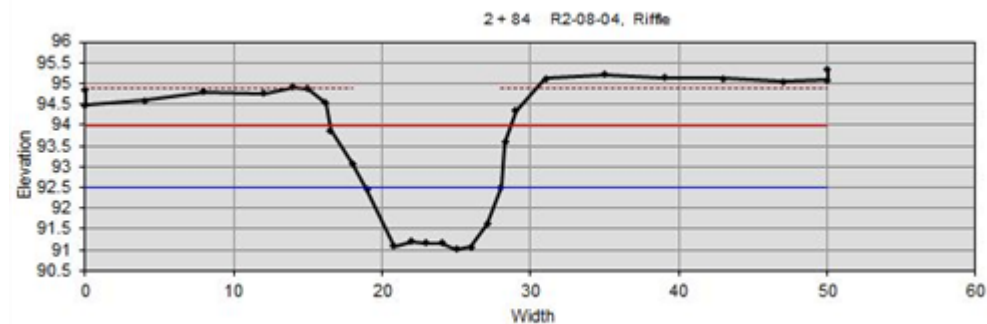
**Water Chemistry**

Dissolved Oxygen (mg/L)	12.89	pH (SU)	6.74
Turbidity (NTU)	6.27	Specific Conductivity (µS/cm)	262.97
Temperature (°C)	7.3		

**Geomorphic Assessment**

**Rosen Level II Classification Data**

Drainage Area (mi <sup>2</sup> )	1.11	Cross Sectional Area (ft <sup>2</sup> )	10.1
Bankfull Width (ft)	9.1	Water Surface Slope (%)	0.41
Mean Bankfull Depth (ft)	1.12	Sinuosity	1.7
Floodprone Width (ft)	12.2	D50 (mm)	0.062
Entrenchment Ratio	1.3	Adjustments?	None
Width to Depth Ratio	8.1	<b>Rosen Stream Type</b>	<b>G6c</b>





## R2-08-05

## Lower Magothy Sampling Unit

### Upstream View:



Latitude: 39.056393665

### Downstream View:



Longitude: -76.520359341

### Land Use/Land Cover Analysis:

**Total Drainage Area (acres) 635.19**

<u>Cover</u>	<u>Acres</u>	<u>% Area</u>
<b>Developed Land</b>	<b>404.24</b>	<b>63.64</b>
Airport	0	0
Commercial	78.55	12.37
Industrial	7.46	1.17
Residential 1/8-acre	28.93	4.55
Residential 1/4-acre	2.2	0.35
Residential 1/2-acre	52.78	8.31
Residential 1-Acre	144.72	22.78
Residential 2-Acre	39.43	6.21
Transportation	50.18	7.9
Utility	0	0
<b>Forest Land</b>	<b>190.21</b>	<b>29.95</b>
Forested Wetland	0	0
Residential Woods	0	0
Woods	190.21	29.95
<b>Open Land</b>	<b>40.44</b>	<b>6.37</b>
Open Space	40.44	6.37
Open Wetland	0	0
Water	0	0
<b>Agricultural Land</b>	<b>0.31</b>	<b>0.05</b>
Pasture/Hay	0	0
Row Crops	0.31	0.05

<u>Impervious Surface</u>	<u>Acres</u>	<u>% Area</u>
Impervious Land	138.24	21.76

### Summary Results:

- Biological condition – “Poor”
- Habitat scores “Comparable to Reference” and “Partially Degraded”
- Tubificidae (worms) dominated the sample.
- Water quality values within COMAR standards but conductivity elevated.
- Multi-thread DA channel through heavily vegetated wetland with abundant rootwads and woody debris. Excellent bank stability and riparian width. Refuse present in moderate amounts.

### Recommendations:

- Maintain the protection of the riparian areas.
- Because habitat is comparable to reference and biological condition is poor, look for problems with water quality and correct, if possible.
- Consider trash cleanup for this reach.

**Biological Assessment**

**Raw Metric Values**

Total Taxa	21
EPT Taxa	1
Ephemeroptera Taxa	0
%Intolerant Urban	0
%Ephemeroptera	0
Scraper Taxa	3
% Climbers	17.8

**Calculated Metric Scores**

Total Taxa	3
EPT Taxa	1
Ephemeroptera Taxa	1
%Intolerant Urban	1
%Ephemeroptera	1
Scraper Taxa	5
% Climbers	5

<b>BIBI Score</b>	<b>2.43</b>
<b>BIBI Narrative Rating</b>	<b>Poor</b>

Taxa	Count
Ablabesmyia	1
Cheumatopsyche	6
Corynoneura	1
Culicoides	2
Enchytraeidae	1
Gastropoda	2
Menetus	5
Naididae	3
Nematomorpha	1
Ormosia	1
Orthocladiinae	1
Parametricnemus	6
Physa	6
Pisidium	11
Prostoma	3
Pseudorthocladius	1
Rheotanytarsus	2
Simulium	1
Stagnicola	5
Stenochironomus	4
Thienemannimyia group	4
Tubificidae	21
Zavrelimyia	2
<b>TOTAL:</b>	<b>90</b>

**Physical Habitat Assessment**

**EPA Rapid Bioassessment Protocol**

	Score		Score
Bank Stability- Left Bank	10	Pool Variability	12
Bank Stability- Right Bank	10	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	9
Channel Flow Status	19	Sediment Deposition	16
Channel Sinuosity	14	Vegetative Protection - Left Bank	10
Epifaunal Substrate/Available Cover	9	Vegetative Protection - Right Bank	10
Pool Substrate Characterization	13		

<b>RBP Habitat Score</b>	<b>162</b>
<b>RBP Narrative Rating</b>	<b>Comparable to Reference</b>

**MBSS Physical Habitat Index**

	Value	Score	Value	Score	
Remoteness	12	64.62	Instream Wood Debris	33	100
Shading	65	63.55	Instream Habitat	8	59.03
Epifaunal Substrate	10	72.26	Bank Stability	20	100

<b>PHI Score</b>	<b>76.58</b>
<b>PHI Narrative Rating</b>	<b>Partially Degraded</b>

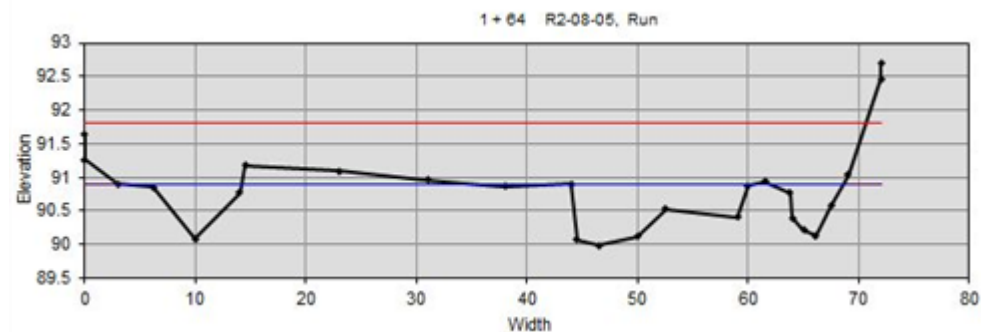
**Water Chemistry**

Dissolved Oxygen (mg/L)	11.94	pH (SU)	7.02
Turbidity (NTU)	10.02	Specific Conductivity (µS/cm)	366.23
Temperature (°C)	5.87		

**Geomorphic Assessment**

**Rosen Level II Classification Data**

Drainage Area (mi <sup>2</sup> )	0.99	Cross Sectional Area (ft <sup>2</sup> )	15.8
Bankfull Width (ft)	43.1	Water Surface Slope (%)	0.7
Mean Bankfull Depth (ft)	0.37	Sinuosity	1.2
Floodprone Width (ft)	143	D50 (mm)	0.062
Entrenchment Ratio	3.3	Adjustments?	None
Width to Depth Ratio	117.6	<b>Rosen Stream Type</b>	<b>DA6</b>



## R2-08-07

## Lower Magothy Sampling Unit

### Upstream View:



Latitude: 39.035251553

### Downstream View:



Longitude: -76.448481474

### Land Use/Land Cover Analysis:

**Total Drainage Area (acres) 179.26**

<u>Cover</u>	<u>Acres</u>	<u>% Area</u>
<b>Developed Land</b>	<b>137.55</b>	<b>76.73</b>
Airport	0	0
Commercial	28.93	16.14
Industrial	0	0
Residential 1/8-acre	11	6.13
Residential 1/4-acre	97.63	54.46
Residential 1/2-acre	0	0
Residential 1-Acre	0	0
Residential 2-Acre	0	0
Transportation	0	0
Utility	0	0
<b>Forest Land</b>	<b>20.71</b>	<b>11.55</b>
Forested Wetland	0	0
Residential Woods	0	0
Woods	20.71	11.55
<b>Open Land</b>	<b>21</b>	<b>11.72</b>
Open Space	20.74	11.57
Open Wetland	0	0
Water	0.26	0.15
<b>Agricultural Land</b>	<b>0</b>	<b>0</b>
Pasture/Hay	0	0
Row Crops	0	0

<u>Impervious Surface</u>	<u>Acres</u>	<u>% Area</u>
Impervious Land	51.8	28.9

### Summary Results:

- Biological condition – “Poor”
- Habitat scores “Supporting” and “Partially Degraded”
- Amphipods (Synurella and Gammarus) and worms (Tubificidae) dominated the sample.
- Measured below COMAR standards for pH.
- Channel flows through wetland system with a large storm drain outfall near the middle of the reach with obvious impacts during storm flows. Woody debris and rootwads provide marginal habitat. Refuse present in moderate amounts.
- Bimodal distribution of substrate (sand/clay).

### Recommendations:

- Maintain the protection of the riparian areas.
- Because habitat is supporting and biological condition is poor, look for problems with water quality and correct, if possible.
- Consider trash cleanup for this reach.

**Biological Assessment**

**Raw Metric Values**

Total Taxa	17
EPT Taxa	2
Ephemeroptera Taxa	0
%Intolerant Urban	15.5
%Ephemeroptera	0
Scraper Taxa	0
% Climbers	1

**Calculated Metric Scores**

Total Taxa	3
EPT Taxa	3
Ephemeroptera Taxa	1
%Intolerant Urban	3
%Ephemeroptera	1
Scraper Taxa	1
% Climbers	3

<b>BIBI Score</b>	<b>2.14</b>
<b>BIBI Narrative Rating</b>	<b>Poor</b>

Taxa	Count
Caecidotea	2
Cheumatopsyche	4
Cricotopus/Orthocladius	1
Gammarus	14
Isonychia	1
Ischnura	1
Lumbricidae	6
Lumbriculidae	11
Mallochochelea	1
Naididae	1
Ormosia	1
Paratendipes	1
Pisidium	14
Prostoma	1
Rheocricotopus	1
Synurella	14
Tubificidae	29
<b>TOTAL:</b>	<b>103</b>

**Physical Habitat Assessment**

**EPA Rapid Bioassessment Protocol**

	Score		Score
Bank Stability- Left Bank	6	Pool Variability	10
Bank Stability- Right Bank	6	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	16	Riparian Vegetative Zone Width- Right Bank	8
Channel Flow Status	16	Sediment Deposition	14
Channel Sinuosity	10	Vegetative Protection - Left Bank	8
Epifaunal Substrate/Available Cover	8	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	10		

<b>RBP Habitat Score</b>	<b>130</b>
<b>RBP Narrative Rating</b>	<b>Supporting</b>

**MBSS Physical Habitat Index**

	Value	Score	Value	Score	
Remoteness	12	64.62	Instream Wood Debris	24	100
Shading	85	84.56	Instream Habitat	8	71.97
Epifaunal Substrate	8	68.88	Bank Stability	12	77.46

<b>PHI Score</b>	<b>77.92</b>
<b>PHI Narrative Rating</b>	<b>Partially Degraded</b>

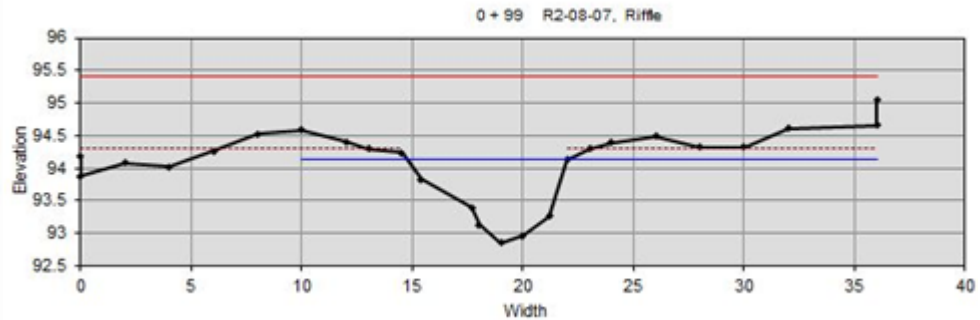
**Water Chemistry**

Dissolved Oxygen (mg/L)	7.2	pH (SU)	6.34
Turbidity (NTU)	6.35	Specific Conductivity (µS/cm)	125.83
Temperature (°C)	4.97		

**Geomorphic Assessment**

**Rosen Level II Classification Data**

Drainage Area (mi <sup>2</sup> )	0.28	Cross Sectional Area (ft <sup>2</sup> )	5.5
Bankfull Width (ft)	7.3	Water Surface Slope (%)	0.65
Mean Bankfull Depth (ft)	0.76	Sinuosity	1.1
Floodprone Width (ft)	62	D50 (mm)	0.071
Entrenchment Ratio	8.5	Adjustments?	None
Width to Depth Ratio	9.6	<b>Rosen Stream Type</b>	<b>E5/6</b>



## R2-08-08

## Lower Magothy Sampling Unit

Upstream View:



Latitude: 39.074010696

Downstream View:



Longitude: -76.544209795

### Land Use/Land Cover Analysis:

**Total Drainage Area (acres) 180.94**

<u>Cover</u>	<u>Acres</u>	<u>% Area</u>
<b>Developed Land</b>	<b>173.95</b>	<b>96.14</b>
Airport	0	0
Commercial	69.92	38.64
Industrial	0	0
Residential 1/8-acre	4.06	2.25
Residential 1/4-acre	91.64	50.65
Residential 1/2-acre	0	0
Residential 1-Acre	0	0
Residential 2-Acre	0	0
Transportation	8.33	4.6
Utility	0	0
<b>Forest Land</b>	<b>2</b>	<b>1.1</b>
Forested Wetland	0	0
Residential Woods	0	0
Woods	2	1.1
<b>Open Land</b>	<b>4.99</b>	<b>2.76</b>
Open Space	4.99	2.76
Open Wetland	0	0
Water	0	0
<b>Agricultural Land</b>	<b>0</b>	<b>0</b>
Pasture/Hay	0	0
Row Crops	0	0

<u>Impervious Surface</u>	<u>Acres</u>	<u>% Area</u>
Impervious Land	86.69	47.91

### Summary Results:

- Biological condition – “*Very Poor*”
- Habitat scores “*Non Supporting*” and “*Severely Degraded*”
- Worms, including Tubificidae and Enchytraeidae, dominated the sample.
- Water quality values within COMAR standards but conductivity elevated.
- Highly urbanized channel with multiple storm drain outfalls. Benthic substrate severely lacking with very poor vegetative protection and riparian width. Refuse abundant and unsightly.
- Concrete trapezoidal channel with triple pipe culvert below midpoint. Stream type indeterminate.

### Recommendations:

- Buffer enhancement.
- Consider trash cleanup for this reach.
- The full length of this site is channelized with concrete making this site a candidate for stream restoration. Opportunity to restore the stream to a natural substrate with vegetated banks. If possible, investigate conditions upstream and downstream of this site to extend restoration length.

**Biological Assessment**

**Raw Metric Values**

Total Taxa	9
EPT Taxa	0
Ephemeroptera Taxa	0
%Intolerant Urban	2.8
%Ephemeroptera	0
Scraper Taxa	0
% Climbers	0

**Calculated Metric Scores**

Total Taxa	1
EPT Taxa	1
Ephemeroptera Taxa	1
%Intolerant Urban	1
%Ephemeroptera	1
Scraper Taxa	1
% Climbers	1

<b>BIBI Score</b>	<b>1.00</b>
<b>BIBI Narrative Rating</b>	<b>Very Poor</b>

Taxa	Count
Caecidotea	1
Chironomus	1
Enchytraeidae	4
Lumbricidae	1
Lumbriculidae	3
Mooreobdella	1
Orthocladius	3
Tipula	1
Tubificidae	21
<b>TOTAL:</b>	<b>36</b>

**Physical Habitat Assessment**

**EPA Rapid Bioassessment Protocol**

	Score		Score
Bank Stability- Left Bank	10	Pool Variability	0
Bank Stability- Right Bank	10	Riparian Vegetative Zone Width- Left Bank	1
Channel Alteration	0	Riparian Vegetative Zone Width- Right Bank	1
Channel Flow Status	7	Sediment Deposition	15
Channel Sinuosity	5	Vegetative Protection - Left Bank	1
Epifaunal Substrate/Available Cover	0	Vegetative Protection - Right Bank	1
Pool Substrate Characterization	0		

<b>RBP Habitat Score</b>	<b>51</b>
<b>RBP Narrative Rating</b>	<b>Non Supporting</b>

**MBSS Physical Habitat Index**

	Value	Score	Value	Score
Remoteness	0	0	Instream Wood Debris	0
Shading	50	49.95	Instream Habitat	0
Epifaunal Substrate	1	28.16	Bank Stability	20

<b>PHI Score</b>	<b>44.74</b>
<b>PHI Narrative Rating</b>	<b>Severely Degraded</b>

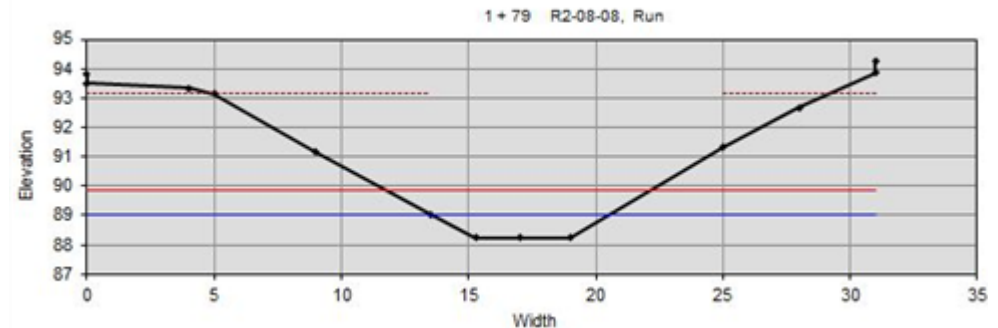
**Water Chemistry**

Dissolved Oxygen (mg/L)	12.7	pH (SU)	8
Turbidity (NTU)	10	Specific Conductivity (µS/cm)	475.67
Temperature (°C)	9.8		

**Geomorphic Assessment**

**Rosen Level II Classification Data**

Drainage Area (mi <sup>2</sup> )	0.28	Cross Sectional Area (ft <sup>2</sup> )	4.4
Bankfull Width (ft)	7.1	Water Surface Slope (%)	0.55
Mean Bankfull Depth (ft)	0.62	Sinuosity	1.4
Floodprone Width (ft)	10.4	D50 (mm)	NA
Entrenchment Ratio	1.5	Adjustments?	None
Width to Depth Ratio	11.5	<b>Rosen Stream Type</b>	<b>ND</b>



## R2-08-10

## Lower Magothy Sampling Unit

### Upstream View:



Latitude: 39.048066373

### Downstream View:



Longitude: -76.506134627

### Land Use/Land Cover Analysis:

**Total Drainage Area (acres) 571.33**

<u>Cover</u>	<u>Acres</u>	<u>% Area</u>
<b>Developed Land</b>	<b>388.17</b>	<b>67.94</b>
Airport	0	0
Commercial	30.41	5.32
Industrial	1.18	0.21
Residential 1/8-acre	0	0
Residential 1/4-acre	97.2	17.01
Residential 1/2-acre	64.39	11.27
Residential 1-Acre	124.16	21.73
Residential 2-Acre	46.92	8.21
Transportation	23.9	4.18
Utility	0	0
<b>Forest Land</b>	<b>164.93</b>	<b>28.87</b>
Forested Wetland	0	0
Residential Woods	0	0
Woods	164.93	28.87
<b>Open Land</b>	<b>14.41</b>	<b>2.52</b>
Open Space	14.41	2.52
Open Wetland	0	0
Water	0	0
<b>Agricultural Land</b>	<b>3.83</b>	<b>0.67</b>
Pasture/Hay	3.83	0.67
Row Crops	0	0

<u>Impervious Surface</u>	<u>Acres</u>	<u>% Area</u>
Impervious Land	104.52	18.29

### Summary Results:

- Biological condition – “Poor”
- Habitat scores “Partially Supporting” and “Degraded”
- Midge (Zavreliomyia) and worms (Tubificidae) dominated the sample.
- Water quality values within COMAR standards.
- Channel downcut with many raw banks. Marginal epifaunal substrate and instream habitat with abundant rootwads and woody debris. Marginal vegetative protection. Refuse present in moderate amounts.

### Recommendations:

- Maintain the protection of the riparian areas.
- Determine causes of instability observed in this reach and evaluate potential for stabilization.
- Consider trash cleanup for this reach.

**Biological Assessment**

**Raw Metric Values**

Total Taxa	22
EPT Taxa	3
Ephemeroptera Taxa	0
%Intolerant Urban	8.4
%Ephemeroptera	0
Scraper Taxa	2
% Climbers	4.8

**Calculated Metric Scores**

Total Taxa	5
EPT Taxa	3
Ephemeroptera Taxa	1
%Intolerant Urban	1
%Ephemeroptera	1
Scraper Taxa	5
% Climbers	3

<b>BIBI Score</b>	<b>2.71</b>
<b>BIBI Narrative Rating</b>	<b>Poor</b>

Taxa	Count
Ablabesmyia	6
Calopteryx	1
Conchapelopia	1
Corynoneura	1
Ironoquia	1
Lumbriculidae	2
Lype	1
Micropsectra	2
Naididae	5
Odontomesa	1
Parametricnemus	4
Paratendipes	2
Phaenopsectra	2
Physa	1
Pisidium	2
Polycentropus	5
Pseudorthocladius	1
Rheotanytarsus	4
Stenochironomus	1
Thienemannimyia group	8
Tipula	1
Tubificidae	19
Zavrelimyia	12
<b>TOTAL:</b>	<b>83</b>

**Physical Habitat Assessment**

**EPA Rapid Bioassessment Protocol**

	Score		Score
Bank Stability- Left Bank	3	Pool Variability	11
Bank Stability- Right Bank	2	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	16	Riparian Vegetative Zone Width- Right Bank	7
Channel Flow Status	16	Sediment Deposition	12
Channel Sinuosity	8	Vegetative Protection - Left Bank	4
Epifaunal Substrate/Available Cover	8	Vegetative Protection - Right Bank	3
Pool Substrate Characterization	9		

<b>RBP Habitat Score</b>	<b>109</b>
<b>RBP Narrative Rating</b>	<b>Partially Supporting</b>

**MBSS Physical Habitat Index**

	Value	Score	Value	Score	
Remoteness	7	37.7	Instream Wood Debris	19	100
Shading	85	84.56	Instream Habitat	8	60.11
Epifaunal Substrate	7	55.52	Bank Stability	5	50

<b>PHI Score</b>	<b>64.65</b>
<b>PHI Narrative Rating</b>	<b>Degraded</b>

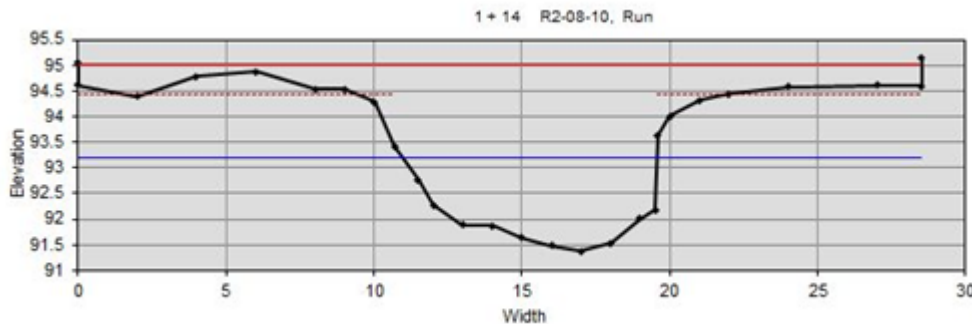
**Water Chemistry**

Dissolved Oxygen (mg/L)	11.95	pH (SU)	6.64
Turbidity (NTU)	3.1	Specific Conductivity (µS/cm)	240.2
Temperature (°C)	8.77		

**Geomorphic Assessment**

**Rosen Level II Classification Data**

Drainage Area (mi <sup>2</sup> )	0.89	Cross Sectional Area (ft <sup>2</sup> )	11.5
Bankfull Width (ft)	8.6	Water Surface Slope (%)	0.17
Mean Bankfull Depth (ft)	1.34	Sinuosity	1.1
Floodprone Width (ft)	152	D50 (mm)	0.15
Entrenchment Ratio	17.7	Adjustments?	None
Width to Depth Ratio	6.4	<b>Rosen Stream Type</b>	<b>E5</b>





## R2-08-11A

## Lower Magothy Sampling Unit

### Upstream View:



Latitude: 39.052819666

### Downstream View:



Longitude: -76.517981359

### Land Use/Land Cover Analysis:

**Total Drainage Area (acres) 252.46**

<u>Cover</u>	<u>Acres</u>	<u>% Area</u>
<b>Developed Land</b>	<b>164.87</b>	<b>65.31</b>
Airport	0	0
Commercial	56.21	22.26
Industrial	7.45	2.95
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	36.27	14.37
Residential 1-Acre	33.3	13.19
Residential 2-Acre	17.48	6.92
Transportation	14.17	5.61
Utility	0	0
<b>Forest Land</b>	<b>61.53</b>	<b>24.37</b>
Forested Wetland	0	0
Residential Woods	0	0
Woods	61.53	24.37
<b>Open Land</b>	<b>26.05</b>	<b>10.32</b>
Open Space	26.05	10.32
Open Wetland	0	0
Water	0	0
<b>Agricultural Land</b>	<b>0</b>	<b>0</b>
Pasture/Hay	0	0
Row Crops	0	0

<u>Impervious Surface</u>	<u>Acres</u>	<u>% Area</u>
Impervious Land	65.07	25.77

### Summary Results:

- Biological condition – “Poor”
- Habitat scores “Supporting” and “Partially Degraded”
- Tubificidae (worms) and Parametrioconemus (midges) dominated the sample.
- Water quality values within COMAR standards but conductivity elevated.
- Multi-thread channel through broad wetland valley. Heavy sedimentation due to inline SWM impoundment just downstream of reach. Excellent bank stability, vegetative protection, and riparian width. Refuse present in moderate amounts.

### Recommendations:

- Maintain the protection of the riparian areas.
- Because habitat is supporting and biological condition is poor, look for problems with water quality and correct, if possible.
- Consider trash cleanup for this reach.

# R2-08-11A

# Lower Magothy Sampling Unit

## Biological Assessment

### Raw Metric Values

Total Taxa	18
EPT Taxa	0
Ephemeroptera Taxa	0
%Intolerant Urban	2.1
%Ephemeroptera	0
Scraper Taxa	1
% Climbers	10.4

### Calculated Metric Scores

Total Taxa	3
EPT Taxa	1
Ephemeroptera Taxa	1
%Intolerant Urban	1
%Ephemeroptera	1
Scraper Taxa	3
% Climbers	5

<b>BIBI Score</b>	<b>2.14</b>
<b>BIBI Narrative Rating</b>	<b>Poor</b>

Taxa	Count
Caecidotea	1
Chironomidae	2
Conchapelopia	1
Crambidae	1
Cricotopus/Orthocladus	1
Diplocladius	2
Enchytraeidae	2
Lumbricina	1
Nematomorpha	4
Neoporus	2
Parametricnemus	13
Phaenopsectra	8
Physa	1
Pisidium	7
Polypedilum	7
Rheocricotopus	2
Sialis	1
Thienemannimyia group	9
Tubificidae	29
Zavrelimyia	2
<b>TOTAL:</b>	<b>96</b>

## Physical Habitat Assessment

### EPA Rapid Bioassessment Protocol

	Score	Score	
Bank Stability- Left Bank	9	Pool Variability	10
Bank Stability- Right Bank	9	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	15	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	16	Sediment Deposition	4
Channel Sinuosity	14	Vegetative Protection - Left Bank	9
Epifaunal Substrate/Available Cover	7	Vegetative Protection - Right Bank	9
Pool Substrate Characterization	13		

<b>RBP Habitat Score</b>	<b>135</b>
<b>RBP Narrative Rating</b>	<b>Supporting</b>

### MBSS Physical Habitat Index

	Value	Score	Value	Score	
Remoteness	8	43.08	Instream Wood Debris	13	97.55
Shading	95	99.94	Instream Habitat	5	51.82
Epifaunal Substrate	7	60.84	Bank Stability	18	94.87

<b>PHI Score</b>	<b>74.68</b>
<b>PHI Narrative Rating</b>	<b>Partially Degraded</b>

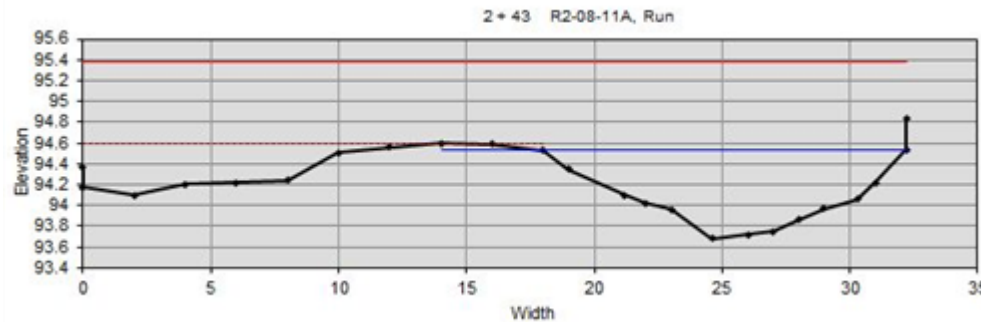
## Water Chemistry

Dissolved Oxygen (mg/L)	11.12	pH (SU)	6.69
Turbidity (NTU)	3.8	Specific Conductivity (µS/cm)	336.77
Temperature (°C)	5.17		

## Geomorphic Assessment

### Rosen Level II Classification Data

Drainage Area (mi <sup>2</sup> )	0.39	Cross Sectional Area (ft <sup>2</sup> )	7.2
Bankfull Width (ft)	14.2	Water Surface Slope (%)	0.14
Mean Bankfull Depth (ft)	0.51	Sinuosity	1.3
Floodprone Width (ft)	65	D50 (mm)	0.14
Entrenchment Ratio	4.6	Adjustments?	None
Width to Depth Ratio	27.7	<b>Rosen Stream Type</b>	<b>DA5</b>



## R2-08-12A

## Lower Magothy Sampling Unit

### Upstream View:



Latitude: 39.047323661

### Downstream View:



Longitude: -76.505794548

### Land Use/Land Cover Analysis:

**Total Drainage Area (acres) 556.66**

<u>Cover</u>	<u>Acres</u>	<u>% Area</u>
<b>Developed Land</b>	<b>375.93</b>	<b>67.53</b>
Airport	0	0
Commercial	29.48	5.3
Industrial	1.18	0.21
Residential 1/8-acre	0	0
Residential 1/4-acre	86.48	15.54
Residential 1/2-acre	64.39	11.57
Residential 1-Acre	124.16	22.31
Residential 2-Acre	46.33	8.32
Transportation	23.9	4.29
Utility	0	0
<b>Forest Land</b>	<b>162.49</b>	<b>29.19</b>
Forested Wetland	0	0
Residential Woods	0	0
Woods	162.49	29.19
<b>Open Land</b>	<b>14.41</b>	<b>2.59</b>
Open Space	14.41	2.59
Open Wetland	0	0
Water	0	0
<b>Agricultural Land</b>	<b>3.83</b>	<b>0.69</b>
Pasture/Hay	3.83	0.69
Row Crops	0	0

<u>Impervious Surface</u>	<u>Acres</u>	<u>% Area</u>
Impervious Land	100.03	17.97

### Summary Results:

- Biological condition – “Fair”
- Habitat scores “Partially Supporting” and “Degraded”
- Various midges of the Chironomidae family, including *Zavrelimyia* and *Polypedilum*, dominated the sample.
- Water quality values within COMAR standards.
- Reach mostly backwatered in lower half due to a large woody debris jam. Poor benthic habitat and a large headcut present in the middle of reach. Moderate bank stability and vegetative protection. Refuse present in moderate amounts.
- Slope skewed by presence of headcut in reach.

### Recommendations:

- Maintain the protection of the riparian areas.
- Consider trash cleanup for this reach.

# R2-08-12A

# Lower Magothy Sampling Unit

## Biological Assessment

### Raw Metric Values

Total Taxa	25
EPT Taxa	3
Ephemeroptera Taxa	0
%Intolerant Urban	4.9
%Ephemeroptera	0
Scraper Taxa	2
% Climbers	13.4

### Calculated Metric Scores

Total Taxa	5
EPT Taxa	3
Ephemeroptera Taxa	1
%Intolerant Urban	1
%Ephemeroptera	1
Scraper Taxa	5
% Climbers	5

<b>BIBI Score</b>	<b>3.00</b>
<b>BIBI Narrative Rating</b>	<b>Fair</b>

### Taxa Count

Ablabesmyia	1
Asellidae	2
Caecidotea	1
Conchapelopia	1
Corynoneura	7
Diplocladius	3
Enchytraeidae	3
Hydrobaenus	1
Limnephilidae	1
Lumbriculidae	1
Lype	2
Naididae	2
Nematomorpha	1
Neoporus	1
Orthocladius	1
Parametricnemus	6
Phaenopsectra	1
Polycentropus	3
Polypedilum	10
Prostoma	1
Pseudorthocladius	1
Rheotanytarsus	2
Thienemannimyia group	2
Tipula	6
Tubificidae	10
Xylotopus	3
Zavrelimyia	9
<b>TOTAL:</b>	<b>82</b>

## Physical Habitat Assessment

### EPA Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	7	Pool Variability	6
Bank Stability- Right Bank	6	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	16	Riparian Vegetative Zone Width- Right Bank	8
Channel Flow Status	16	Sediment Deposition	11
Channel Sinuosity	13	Vegetative Protection - Left Bank	8
Epifaunal Substrate/Available Cover	7	Vegetative Protection - Right Bank	7
Pool Substrate Characterization	6		

<b>RBP Habitat Score</b>	<b>121</b>
<b>RBP Narrative Rating</b>	<b>Partially Supporting</b>

### MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	7	37.7	Instream Wood Debris	10	79.72
Shading	60	58.94	Instream Habitat	6	49.28
Epifaunal Substrate	6	49.88	Bank Stability	13	80.63

<b>PHI Score</b>	<b>59.36</b>
<b>PHI Narrative Rating</b>	<b>Degraded</b>

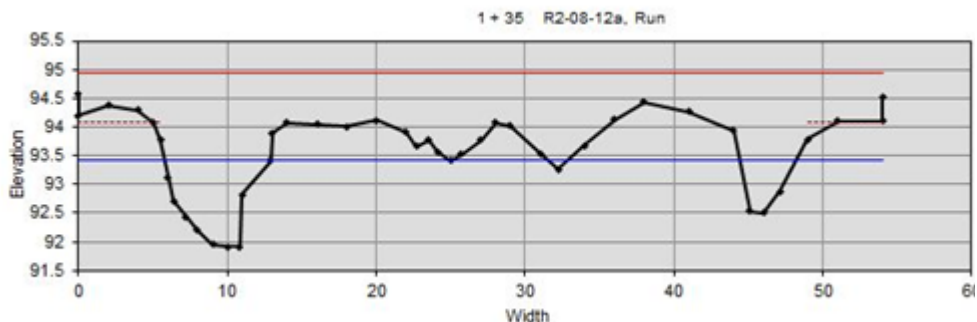
## Water Chemistry

Dissolved Oxygen (mg/L)	11.91	pH (SU)	6.63
Turbidity (NTU)	3.33	Specific Conductivity (µS/cm)	238.17
Temperature (°C)	10.23		

## Geomorphic Assessment

### Rosen Level II Classification Data

Drainage Area (mi <sup>2</sup> )	0.87	Cross Sectional Area (ft <sup>2</sup> )	8.9
Bankfull Width (ft)	12.3	Water Surface Slope (%)	1.3
Mean Bankfull Depth (ft)	0.73	Sinuosity	1.1
Floodprone Width (ft)	75	D50 (mm)	0.093
Entrenchment Ratio	6.1	Adjustments?	None
Width to Depth Ratio	16.9	<b>Rosen Stream Type</b>	<b>DA5</b>



## R2-08-13A

## Lower Magothy Sampling Unit

### Upstream View:



Latitude: 39.047573866

### Downstream View:



Longitude: -76.514573007

### Land Use/Land Cover Analysis:

**Total Drainage Area (acres) 165.16**

<u>Cover</u>	<u>Acres</u>	<u>% Area</u>
<b>Developed Land</b>	<b>111.26</b>	<b>67.36</b>
Airport	0	0
Commercial	8.34	5.05
Industrial	7.45	4.51
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	36.27	21.96
Residential 1-Acre	33.3	20.16
Residential 2-Acre	17.48	10.59
Transportation	8.42	5.1
Utility	0	0
<b>Forest Land</b>	<b>36</b>	<b>21.8</b>
Forested Wetland	0	0
Residential Woods	0	0
Woods	36	21.8
<b>Open Land</b>	<b>17.9</b>	<b>10.84</b>
Open Space	17.9	10.84
Open Wetland	0	0
Water	0	0
<b>Agricultural Land</b>	<b>0</b>	<b>0</b>
Pasture/Hay	0	0
Row Crops	0	0

<u>Impervious Surface</u>	<u>Acres</u>	<u>% Area</u>
Impervious Land	33.32	20.17

### Summary Results:

- Biological condition – “Poor”
- Habitat scores “Partially Supporting” and “Partially Degraded”
- Worms, including Tubificidae and Lubricidae, dominated the sample.
- Water quality values within COMAR standards but conductivity elevated.
- Poor remoteness score due to close proximity to Anne Arundel Community College. Sub-optimal epifaunal habitat, bank stability, and vegetative protection with marginal riparian width. Refuse present in moderate amounts.
- Reach altered by double pipe culverts and bed stabilization in upper half of reach. Stream type indeterminate.

### Recommendations:

- Buffer enhancement.
- Consider trash cleanup for this reach.

# R2-08-13A

# Lower Magothy Sampling Unit

## Biological Assessment

### Raw Metric Values

Total Taxa	24
EPT Taxa	1
Ephemeroptera Taxa	0
%Intolerant Urban	0
%Ephemeroptera	0
Scraper Taxa	1
% Climbers	5.9

### Calculated Metric Scores

Total Taxa	5
EPT Taxa	1
Ephemeroptera Taxa	1
%Intolerant Urban	1
%Ephemeroptera	1
Scraper Taxa	3
% Climbers	3

<b>BIBI Score</b>	<b>2.14</b>
<b>BIBI Narrative Rating</b>	<b>Poor</b>

Taxa	Count
Ceratopogonidae	1
Diplocladius	7
Dugesiiidae	5
Hirudinea	1
Lumbricidae	6
Lumbriculidae	1
Naididae	1
Neoporus	9
Odontomesa	1
Orthoclaadiinae	1
Orthocladius	2
Parametriocnemus	2
Paratendipes	3
Phaenopsectra	5
Physa	5
Pisidium	1
Prodiamesa	1
Prostoma	5
Ptilostomis	1
Rheocricotopus	3
Tipulidae	1
Tubificidae	36
Tvetenia	1
Xylotopus	1
Zavrelimyia	1
<b>TOTAL:</b>	<b>101</b>

## Physical Habitat Assessment

### EPA Rapid Bioassessment Protocol

	Score	Score	
Bank Stability- Left Bank	6	Pool Variability	10
Bank Stability- Right Bank	6	Riparian Vegetative Zone Width- Left Bank	5
Channel Alteration	7	Riparian Vegetative Zone Width- Right Bank	5
Channel Flow Status	14	Sediment Deposition	12
Channel Sinuosity	9	Vegetative Protection - Left Bank	6
Epifaunal Substrate/Available Cover	7	Vegetative Protection - Right Bank	6
Pool Substrate Characterization	8		

<b>RBP Habitat Score</b>	<b>101</b>
<b>RBP Narrative Rating</b>	<b>Partially Supporting</b>

### MBSS Physical Habitat Index

	Value	Score	Value	Score	
Remoteness	1	5.39	Instream Wood Debris	16	100
Shading	95	99.94	Instream Habitat	7	67.26
Epifaunal Substrate	7	63.61	Bank Stability	12	77.46

<b>PHI Score</b>	<b>68.94</b>
<b>PHI Narrative Rating</b>	<b>Partially Degraded</b>

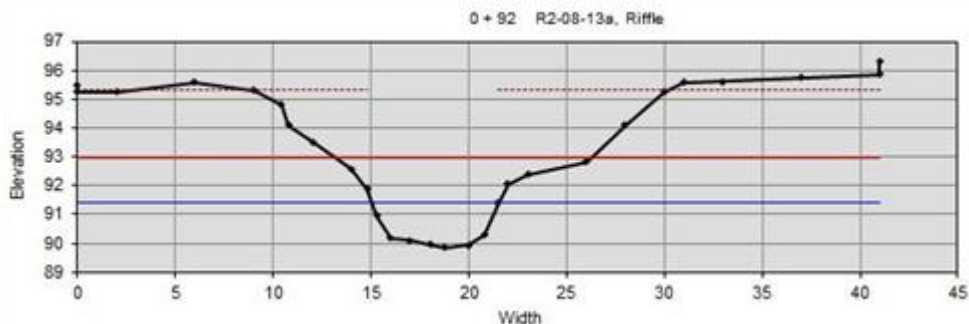
## Water Chemistry

Dissolved Oxygen (mg/L)	10.16	pH (SU)	6.54
Turbidity (NTU)	5.8	Specific Conductivity (µS/cm)	418.7
Temperature (°C)	9.67		

## Geomorphic Assessment

### Rosen Level II Classification Data

Drainage Area (mi <sup>2</sup> )	0.26	Cross Sectional Area (ft <sup>2</sup> )	7.7
Bankfull Width (ft)	6.4	Water Surface Slope (%)	0.41
Mean Bankfull Depth (ft)	1.2	Sinuosity	1.1
Floodprone Width (ft)	13	D50 (mm)	0.25
Entrenchment Ratio	2	Adjustments?	None
Width to Depth Ratio	5.4	<b>Rosen Stream Type</b>	<b>ND</b>



## R2-08-14A

## Lower Magothy Sampling Unit

### Upstream View:



Latitude: 39.054257893

### Downstream View:



Longitude: -76.520126504

### Land Use/Land Cover Analysis:

**Total Drainage Area (acres) 290.77**

<u>Cover</u>	<u>Acres</u>	<u>% Area</u>
<b>Developed Land</b>	<b>180.01</b>	<b>61.91</b>
Airport	0	0
Commercial	58.23	20.03
Industrial	7.45	2.56
Residential 1/8-acre	6.49	2.23
Residential 1/4-acre	0.4	0.14
Residential 1/2-acre	36.27	12.47
Residential 1-Acre	33.3	11.45
Residential 2-Acre	17.48	6.01
Transportation	20.38	7.01
Utility	0	0
<b>Forest Land</b>	<b>74.13</b>	<b>25.49</b>
Forested Wetland	0	0
Residential Woods	0	0
Woods	74.13	25.49
<b>Open Land</b>	<b>36.63</b>	<b>12.6</b>
Open Space	36.63	12.6
Open Wetland	0	0
Water	0	0
<b>Agricultural Land</b>	<b>0</b>	<b>0</b>
Pasture/Hay	0	0
Row Crops	0	0
<b>Impervious Surface</b>	<b>Acres</b>	<b>% Area</b>
Impervious Land	72.56	24.95

### Summary Results:

- Biological condition – “*Very Poor*”
- Habitat scores “*Supporting*” and “*Partially Degraded*”
- Isopods of the Asellidae family, including Caecidotea, dominated the sample.
- Water quality values within COMAR standards but conductivity elevated.
- An abundance of rootwads and woody debris provide marginal habitat for benthics. Sub-optimal sediment deposition, sinuosity, and bank stability. Refuse present in moderate amounts.

### Recommendations:

- Maintain the protection of the riparian areas.
- Because habitat is supporting and biological condition is very poor, look for problems with water quality and correct, if possible.
- Consider trash cleanup for this reach.

# R2-08-14A

# Lower Magothy Sampling Unit

## Biological Assessment

### Raw Metric Values

Total Taxa	18
EPT Taxa	1
Ephemeroptera Taxa	0
%Intolerant Urban	27.3
%Ephemeroptera	0
Scraper Taxa	0
% Climbers	0.9

### Calculated Metric Scores

Total Taxa	3
EPT Taxa	1
Ephemeroptera Taxa	1
%Intolerant Urban	3
%Ephemeroptera	1
Scraper Taxa	1
% Climbers	3

**BIBI Score** 1.86

**BIBI Narrative Rating** Very Poor

### Taxa Count

Ablabesmyia	1
Asellidae	39
Caecidotea	28
Corynoneura	1
Djalmabatista	1
Enchytraeidae	1
Naididae	1
Nematomorpha	1
Neoporus	1
Parametricnemus	2
Pisidium	5
Polycentropus	2
Polypedilum	1
Prostoma	1
Rheotanytarsus	1
Stenochironomus	1
Thienemannimyia group	10
Tubificidae	11
Zavrelimyia	2
<b>TOTAL:</b>	<b>110</b>

## Physical Habitat Assessment

### EPA Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	6	Pool Variability	12
Bank Stability- Right Bank	6	Riparian Vegetative Zone Width- Left Bank	7
Channel Alteration	16	Riparian Vegetative Zone Width- Right Bank	9
Channel Flow Status	16	Sediment Deposition	12
Channel Sinuosity	14	Vegetative Protection - Left Bank	8
Epifaunal Substrate/Available Cover	10	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	9		

**RBP Habitat Score** 133

**RBP Narrative Rating** Supporting

### MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	7	37.7	Instream Wood Debris	18	100
Shading	90	91.34	Instream Habitat	11	83.67
Epifaunal Substrate	8	65.73	Bank Stability	12	77.46

**PHI Score** 75.98

**PHI Narrative Rating** Partially Degraded

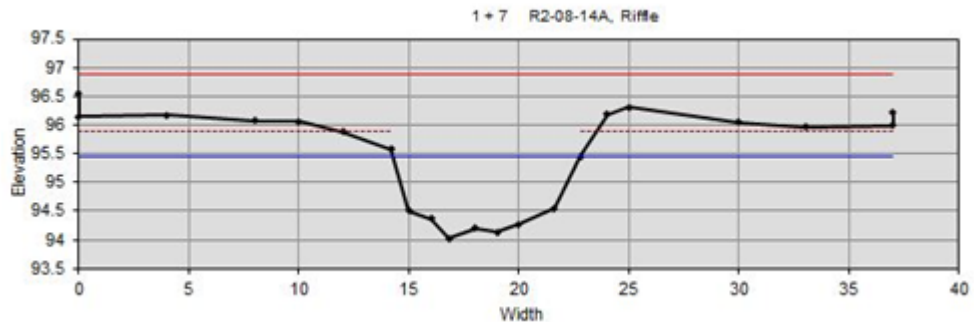
## Water Chemistry

Dissolved Oxygen (mg/L)	10.93	pH (SU)	6.91
Turbidity (NTU)	9.07	Specific Conductivity (µS/cm)	301.83
Temperature (°C)	8.17		

## Geomorphic Assessment

### Rosen Level II Classification Data

Drainage Area (mi <sup>2</sup> )	0.45	Cross Sectional Area (ft <sup>2</sup> )	8.7
Bankfull Width (ft)	8.5	Water Surface Slope (%)	0.056
Mean Bankfull Depth (ft)	1.02	Sinuosity	1.5
Floodprone Width (ft)	130	D50 (mm)	0.19
Entrenchment Ratio	15.3	Adjustments?	None
Width to Depth Ratio	8.3	<b>Rosen Stream Type</b>	<b>E5</b>





## R2-08-17A

## Lower Magothy Sampling Unit

### Upstream View:



Latitude: 39.03749707

### Downstream View:



Longitude: -76.449327571

### Land Use/Land Cover Analysis:

**Total Drainage Area (acres) 106.17**

<u>Cover</u>	<u>Acres</u>	<u>% Area</u>
<b>Developed Land 88.05 82.93</b>		
Airport	0	0
Commercial	9.02	8.5
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	79.03	74.43
Residential 1/2-acre	0	0
Residential 1-Acre	0	0
Residential 2-Acre	0	0
Transportation	0	0
Utility	0	0
<b>Forest Land 15.07 14.2</b>		
Forested Wetland	0	0
Residential Woods	0	0
Woods	15.07	14.2
<b>Open Land 3.05 2.87</b>		
Open Space	3.05	2.87
Open Wetland	0	0
Water	0	0
<b>Agricultural Land 0 0</b>		
Pasture/Hay	0	0
Row Crops	0	0

<u>Impervious Surface</u>	<u>Acres</u>	<u>% Area</u>
Impervious Land	29.71	27.99

### Summary Results:

- Biological condition – “*Very Poor*”
- Habitat scores “*Partially Supporting*” and “*Partially Degraded*”
- Tubificidae (worms) dominated the sample.
- Water quality values within COMAR standards.
- Very little flow in channel with heavy iron flocculent. Abundant rootwads and woody debris provide marginal epifaunal habitat. Good bank stability and vegetative protection. Refuse present in moderate amounts.
- Reach runs through breached pond embankment with upstream half of reach in old pond basin. Stream type indeterminate.

### Recommendations:

- Maintain the protection of the riparian areas.
- Because habitat is partially supporting and biological condition is very poor, look for problems with water quality and correct, if possible.
- Consider trash cleanup for this reach.

# R2-08-17A

# Lower Magothy Sampling Unit

## Biological Assessment

### Raw Metric Values

Total Taxa	9
EPT Taxa	0
Ephemeroptera Taxa	0
%Intolerant Urban	2
%Ephemeroptera	0
Scraper Taxa	1
% Climbers	1

### Calculated Metric Scores

Total Taxa	1
EPT Taxa	1
Ephemeroptera Taxa	1
%Intolerant Urban	1
%Ephemeroptera	1
Scraper Taxa	3
% Climbers	3

<b>BIBI Score</b>	<b>1.57</b>
<b>BIBI Narrative Rating</b>	<b>Very Poor</b>

### Taxa Count

Bezzia/Palpomyia	3
Cyphon	1
Enchytraeidae	1
Lumbricidae	19
Pisidium	19
Prostoma	1
Pseudorthocladus	2
Synurella	2
Tubificidae	52
<b>TOTAL:</b>	<b>100</b>

## Physical Habitat Assessment

### EPA Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	9	Pool Variability	7
Bank Stability- Right Bank	9	Riparian Vegetative Zone Width- Left Bank	7
Channel Alteration	14	Riparian Vegetative Zone Width- Right Bank	6
Channel Flow Status	10	Sediment Deposition	13
Channel Sinuosity	10	Vegetative Protection - Left Bank	9
Epifaunal Substrate/Available Cover	6	Vegetative Protection - Right Bank	9
Pool Substrate Characterization	6		

<b>RBP Habitat Score</b>	<b>115</b>
<b>RBP Narrative Rating</b>	<b>Partially Supporting</b>

### MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	7	37.7	Instream Wood Debris	14	100
Shading	80	78.67	Instream Habitat	5	60.69
Epifaunal Substrate	6	60.68	Bank Stability	18	94.87

<b>PHI Score</b>	<b>72.1</b>
<b>PHI Narrative Rating</b>	<b>Partially Degraded</b>

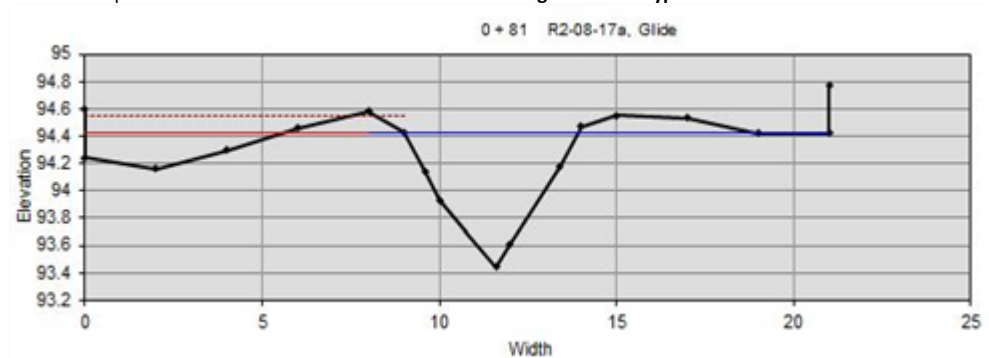
## Water Chemistry

Dissolved Oxygen (mg/L)	6.13	pH (SU)	6.76
Turbidity (NTU)	7.35	Specific Conductivity (µS/cm)	213.37
Temperature (°C)	4.27		

## Geomorphic Assessment

### Rosgen Level II Classification Data

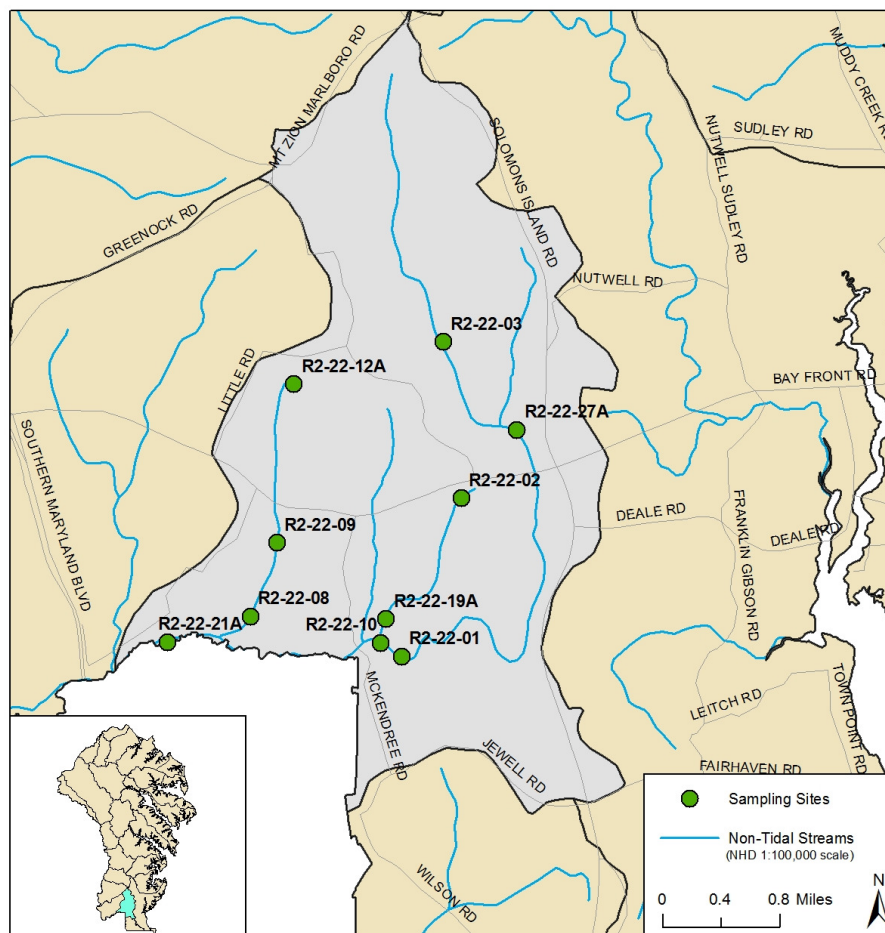
Drainage Area (mi <sup>2</sup> )	0.17	Cross Sectional Area (ft <sup>2</sup> )	2.6
Bankfull Width (ft)	7.1	Water Surface Slope (%)	1.4
Mean Bankfull Depth (ft)	0.4	Sinuosity	1.1
Floodprone Width (ft)	55	D50 (mm)	0.062
Entrenchment Ratio	7.7	Adjustments?	None
Width to Depth Ratio	19.1	<b>Rosgen Stream Type</b>	<b>ND</b>



# Lyons Creek Sampling Unit

## Site Condition Summary

Site	Drainage Area (acres)	Drainage Area (mi <sup>2</sup> )	Percent Impervious	Percent Developed	Percent Forested	Percent Agriculture	Percent Open	BIBI Narrative Rating	PHI Narrative Rating	RBP Narrative Rating	Rosgen Stream Type - L1
R2-22-01	3638.1	5.68	4.1	23.3	35.9	33.3	7.4	Fair	Partially Degraded	Supporting	E
R2-22-02	89.3	0.14	7.3	34.8	33.6	10.2	21.4	Very Poor	Partially Degraded	Partially Supporting	F
R2-22-03	1497.2	2.34	3.1	19.9	32.3	43.6	4.2	Very Poor	Partially Degraded	Comparable to Reference	DA
R2-22-08	599.5	0.94	4.4	21.1	26.8	46.8	5.4	Fair	Partially Degraded	Partially Supporting	F
R2-22-09	518.6	0.81	4.4	21.9	25.4	46.8	5.9	Fair	Degraded	Non Supporting	F
R2-22-10	3667.4	5.73	4.2	23.5	36.0	33.1	7.4	Fair	Partially Degraded	Supporting	F
R2-22-12A	103.4	0.16	3.7	28.6	18.3	50.7	2.4	Poor	Partially Degraded	Partially Supporting	G
R2-22-19A	345.3	0.54	4.2	21.2	49.0	16.5	13.3	Fair	Partially Degraded	Supporting	G
R2-22-21A	6644.8	10.38	4.0	24.3	37.2	31.7	6.9	Good	Partially Degraded	Supporting	E
R2-22-27A	2266.8	3.54	3.5	21.5	31.1	40.9	6.5	Poor	Degraded	Comparable to Reference	DA



Upstream View:



Latitude: 38.766790225

Downstream View:



Longitude: -76.617119002

**Land Use/Land Cover Analysis:**

**Total Drainage Area (acres) 3638.12**

<u>Cover</u>	<u>Acres</u>	<u>% Area</u>
<b>Developed Land 848.71 23.33</b>		
Airport	0	0
Commercial	62.1	1.71
Industrial	1.94	0.05
Residential 1/8-acre	0	0
Residential 1/4-acre	1.22	0.03
Residential 1/2-acre	32.24	0.89
Residential 1-Acre	118.5	3.26
Residential 2-Acre	567.71	15.6
Transportation	65	1.79
Utility	0	0
<b>Forest Land 1306.56 35.91</b>		
Forested Wetland	20.42	0.56
Residential Woods	0	0
Woods	1286.14	35.35
<b>Open Land 269.93 7.42</b>		
Open Space	231.33	6.36
Open Wetland	4.13	0.11
Water	34.47	0.95
<b>Agricultural Land 1212.92 33.34</b>		
Pasture/Hay	202.03	5.55
Row Crops	1010.89	27.79

<u>Impervious Surface</u>	<u>Acres</u>	<u>% Area</u>
Impervious Land	149.73	4.12

**Summary Results:**

- Biological condition – “Fair”
- Habitat scores “Supporting” and “Partially Degraded”
- Acentrella (mayfly) and Naididae (worm) dominated the sample.
- Water quality values within COMAR standards.
- Several areas of raw, eroded banks, other areas well vegetated. An abundance of woody debris provides stable substrate. Good riparian width.

**Recommendations:**

- Maintain the protection of the riparian areas.
- Determine causes of instability observed in this reach and evaluate potential for stabilization.

**Biological Assessment**

**Raw Metric Values**

Total Taxa	15
EPT Taxa	3
Ephemeroptera Taxa	1
%Intolerant Urban	15.3
%Ephemeroptera	41.5
Scraper Taxa	1
% Climbers	0

**Calculated Metric Scores**

Total Taxa	3
EPT Taxa	3
Ephemeroptera Taxa	3
%Intolerant Urban	3
%Ephemeroptera	5
Scraper Taxa	3
% Climbers	1

<b>BIBI Score</b>	<b>3.00</b>
<b>BIBI Narrative Rating</b>	<b>Fair</b>

Taxa	Count
Acentrella	49
Asellidae	1
Caecidotea	12
Crangonyx	2
Cricotopus/Orthocladius	9
Dicranota	1
Isonychia	1
Lumbriculidae	2
Naididae	28
Nematomorpha	2
Perlesta	3
Pisidium	1
Potthastia	2
Simuliidae	1
Stenelmis	1
Tubificidae	3
<b>TOTAL:</b>	<b>118</b>

**Physical Habitat Assessment**

**EPA Rapid Bioassessment Protocol**

	Score		Score
Bank Stability- Left Bank	3	Pool Variability	12
Bank Stability- Right Bank	7	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	19	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	20	Sediment Deposition	12
Channel Sinuosity	11	Vegetative Protection - Left Bank	4
Epifaunal Substrate/Available Cover	13	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	13		

<b>RBP Habitat Score</b>	<b>142</b>
<b>RBP Narrative Rating</b>	<b>Supporting</b>

**MBSS Physical Habitat Index**

	Value	Score	Value	Score	
Remoteness	12	64.62	Instream Wood Debris	20	88.05
Shading	75	73.32	Instream Habitat	13	68.9
Epifaunal Substrate	13	78.32	Bank Stability	10	70.71

<b>PHI Score</b>	<b>73.99</b>
<b>PHI Narrative Rating</b>	<b>Partially Degraded</b>

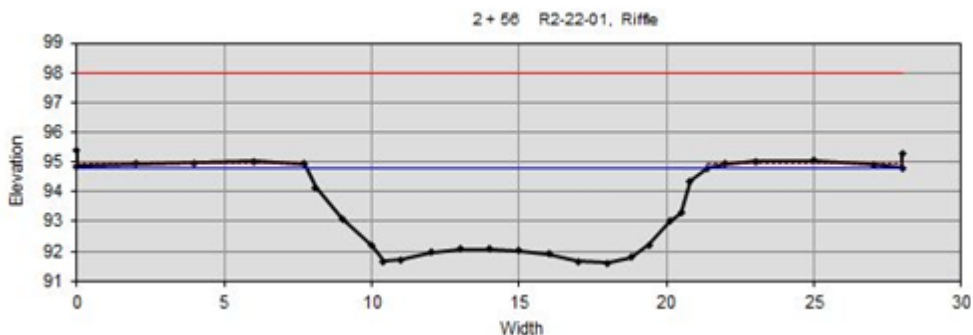
**Water Chemistry**

Dissolved Oxygen (mg/L)	10.56	pH (SU)	7.15
Turbidity (NTU)	11.9	Specific Conductivity (µS/cm)	163.07
Temperature (°C)	17.37		

**Geomorphic Assessment**

**Rosgen Level II Classification Data**

Drainage Area (mi <sup>2</sup> )	5.68	Cross Sectional Area (ft <sup>2</sup> )	33.4
Bankfull Width (ft)	13.6	Water Surface Slope (%)	0.29
Mean Bankfull Depth (ft)	2.45	Sinuosity	1.1
Floodprone Width (ft)	207	D50 (mm)	0.12
Entrenchment Ratio	15.2	Adjustments?	None
Width to Depth Ratio	5.6	<b>Rosgen Stream Type</b>	<b>E5</b>



Upstream View:



Latitude: 38.782469253

Downstream View:



Longitude: -76.609432743

**Land Use/Land Cover Analysis:**

<b>Total Drainage Area (acres)</b>		<b>89.33</b>
<b>Cover</b>	<b>Acres</b>	<b>% Area</b>
<b>Developed Land</b>	<b>31.11</b>	<b>34.82</b>
Airport	0	0
Commercial	1.68	1.88
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	12.42	13.9
Residential 2-Acre	11.03	12.35
Transportation	5.98	6.69
Utility	0	0
<b>Forest Land</b>	<b>29.99</b>	<b>33.58</b>
Forested Wetland	0	0
Residential Woods	0	0
Woods	29.99	33.58
<b>Open Land</b>	<b>19.08</b>	<b>21.36</b>
Open Space	19.08	21.36
Open Wetland	0	0
Water	0	0
<b>Agricultural Land</b>	<b>9.15</b>	<b>10.24</b>
Pasture/Hay	0.07	0.07
Row Crops	9.08	10.17
<b>Impervious Surface</b>	<b>Acres</b>	<b>% Area</b>
Impervious Land	6.56	7.34

**Summary Results:**

- Biological condition – “Very Poor”
- Habitat scores “Partially Supporting” and “Partially Degraded”
- Crangonyx (amphipod) and Cricotopus/Orthocladius (midge) dominated the sample.
- Measured below COMAR standards for pH.
- Deeply incised channel scoured to clay in many locations with numerous point bars. Shallow flows and sedimentation limit habitat. Moderately unstable banks with sub-optimal vegetative protection and good riparian width. Refuse present in minor amounts.
- Bimodal distribution of substrate (sand/gravel).

**Recommendations:**

- Maintain the protection of the riparian areas.
- Determine causes of instability observed in this reach and evaluate potential for stabilization.
- Because habitat is partially supporting and biological condition is very poor, look for problems with water quality and correct, if possible.

**Biological Assessment**

**Raw Metric Values**

Total Taxa	15
EPT Taxa	1
Ephemeroptera Taxa	0
%Intolerant Urban	4
%Ephemeroptera	0
Scraper Taxa	1
% Climbers	0

**Calculated Metric Scores**

Total Taxa	3
EPT Taxa	1
Ephemeroptera Taxa	1
%Intolerant Urban	1
%Ephemeroptera	1
Scraper Taxa	3
% Climbers	1

**BIBI Score** 1.57

**BIBI Narrative Rating** Very Poor

**Taxa Count**

Amphinemura	3
Caecidotea	1
Conchapelopia	2
Crangonyx	32
Cricotopus/Orthocladius	20
Diplocladius	7
Dugesiidae	1
Dytiscidae	3
Enchytraeidae	1
Gammarus	1
Hydrobaenus	4
Laccophilus	1
Naididae	5
Nematomorpha	1
Orthoclaadiinae	1
Orthocladius	2
Rheocricotopus	11
Tubificidae	3
<b>TOTAL:</b>	<b>99</b>

**Physical Habitat Assessment**

**EPA Rapid Bioassessment Protocol**

	Score		Score
Bank Stability- Left Bank	6	Pool Variability	8
Bank Stability- Right Bank	3	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	7
Channel Flow Status	12	Sediment Deposition	9
Channel Sinuosity	10	Vegetative Protection - Left Bank	5
Epifaunal Substrate/Available Cover	8	Vegetative Protection - Right Bank	7
Pool Substrate Characterization	7		

**RBP Habitat Score** 112

**RBP Narrative Rating** Partially Supporting

**MBSS Physical Habitat Index**

	Value	Score		Value	Score
Remoteness	10	53.85	Instream Wood Debris	8	94.52
Shading	90	91.34	Instream Habitat	8	79.1
Epifaunal Substrate	8	73.42	Bank Stability	9	67.08

**PHI Score** 76.55

**PHI Narrative Rating** Partially Degraded

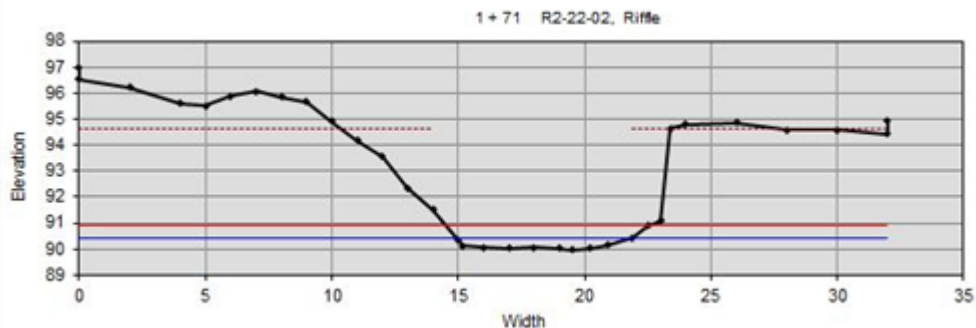
**Water Chemistry**

Dissolved Oxygen (mg/L)	10.22	pH (SU)	6.18
Turbidity (NTU)	7.07	Specific Conductivity (µS/cm)	220.07
Temperature (°C)	10.5		

**Geomorphic Assessment**

**Rosgen Level II Classification Data**

Drainage Area (mi <sup>2</sup> )	0.14	Cross Sectional Area (ft <sup>2</sup> )	2.4
Bankfull Width (ft)	7	Water Surface Slope (%)	0.63
Mean Bankfull Depth (ft)	0.34	Sinuosity	1.1
Floodprone Width (ft)	8	D50 (mm)	0.13
Entrenchment Ratio	1.2	Adjustments?	None
Width to Depth Ratio	20.4	<b>Rosgen Stream Type</b>	<b>F4/5</b>



Upstream View:



Latitude: 38.797988772

Downstream View:



Longitude: -76.611629126

**Land Use/Land Cover Analysis:**

**Total Drainage Area (acres) 1497.21**

<u>Cover</u>	<u>Acres</u>	<u>% Area</u>
<b>Developed Land</b>	<b>297.71</b>	<b>19.88</b>
Airport	0	0
Commercial	15.87	1.06
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	1.42	0.1
Residential 1-Acre	33.12	2.21
Residential 2-Acre	224.7	15.01
Transportation	22.6	1.51
Utility	0	0
<b>Forest Land</b>	<b>483.76</b>	<b>32.31</b>
Forested Wetland	0	0
Residential Woods	0	0
Woods	483.76	32.31
<b>Open Land</b>	<b>63.24</b>	<b>4.22</b>
Open Space	60.85	4.06
Open Wetland	0	0
Water	2.39	0.16
<b>Agricultural Land</b>	<b>652.5</b>	<b>43.58</b>
Pasture/Hay	109.41	7.31
Row Crops	543.09	36.27
<b>Impervious Surface</b>	<b>Acres</b>	<b>% Area</b>
Impervious Land	46.15	3.08

**Summary Results:**

- Biological condition – “*Very Poor*”
- Habitat scores “*Comparable to Reference*” and “*Partially Degraded*”
- Caecidotea (isopod) and Naididae (worm) dominated the sample.
- Water quality values within COMAR standards.
- Multi-thread channel through densely vegetated wetland. Attached algae, submerged vegetation, and floating vegetation abundant. Excellent bank stability and riparian width.

**Recommendations:**

- Maintain the protection of the riparian areas.
- Because habitat is comparable to reference and biological condition is very poor, look for problems with water quality and correct, if possible.



**Biological Assessment**

**Raw Metric Values**

Total Taxa	9
EPT Taxa	0
Ephemeroptera Taxa	0
%Intolerant Urban	46.6
%Ephemeroptera	0
Scraper Taxa	0
% Climbers	3.4

**Calculated Metric Scores**

Total Taxa	1
EPT Taxa	1
Ephemeroptera Taxa	1
%Intolerant Urban	5
%Ephemeroptera	1
Scraper Taxa	1
% Climbers	3

**BIBI Score** 1.86

**BIBI Narrative Rating** Very Poor

**Taxa** **Count**

Caecidotea	38
Lumbriculidae	4
Naididae	16
Neoporus	1
Pisidium	12
Sphaeromias	1
Synurella	3
Tanytarsus	3
Tubificidae	10
<b>TOTAL:</b>	<b>88</b>

**Physical Habitat Assessment**

**EPA Rapid Bioassessment Protocol**

	Score		Score
Bank Stability- Left Bank	10	Pool Variability	10
Bank Stability- Right Bank	10	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	19	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	20	Sediment Deposition	14
Channel Sinuosity	8	Vegetative Protection - Left Bank	10
Epifaunal Substrate/Available Cover	11	Vegetative Protection - Right Bank	10
Pool Substrate Characterization	12		

**RBP Habitat Score** 154

**RBP Narrative Rating** Comparable to Reference

**MBSS Physical Habitat Index**

	Value	Score	Value	Score	
Remoteness	11	59.24	Instream Wood Debris	14	80.35
Shading	90	91.34	Instream Habitat	12	72.44
Epifaunal Substrate	11	72.48	Bank Stability	20	100

**PHI Score** 79.31

**PHI Narrative Rating** Partially Degraded

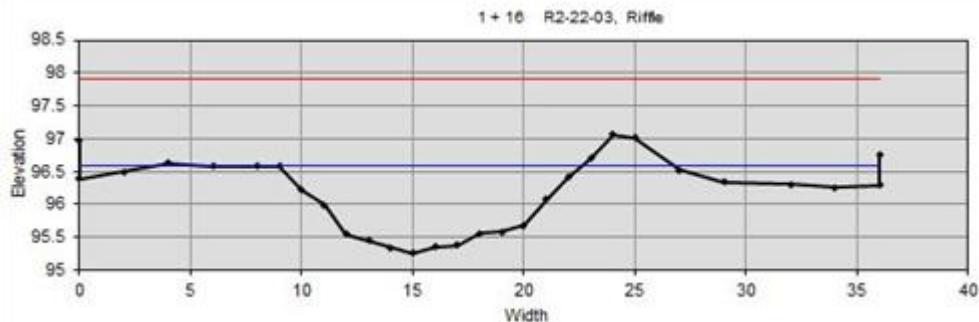
**Water Chemistry**

Dissolved Oxygen (mg/L)	11.46	pH (SU)	6.83
Turbidity (NTU)	7.21	Specific Conductivity (µS/cm)	161.13
Temperature (°C)	17.83		

**Geomorphic Assessment**

**Rosgen Level II Classification Data**

Drainage Area (mi <sup>2</sup> )	2.34	Cross Sectional Area (ft <sup>2</sup> )	14.3
Bankfull Width (ft)	26.1	Water Surface Slope (%)	0.099
Mean Bankfull Depth (ft)	0.55	Sinuosity	1.1
Floodprone Width (ft)	550	D50 (mm)	0.062
Entrenchment Ratio	21.1	Adjustments?	None
Width to Depth Ratio	47.6	<b>Rosgen Stream Type</b>	<b>DA</b>



Upstream View:



Latitude: 38.770825388

Downstream View:



Longitude: -76.636220703

**Land Use/Land Cover Analysis:**

**Total Drainage Area (acres) 599.45**

<u>Cover</u>	<u>Acres</u>	<u>% Area</u>
<b>Developed Land</b>	<b>126.25</b>	<b>21.06</b>
Airport	0	0
Commercial	12.74	2.13
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0.1	0.02
Residential 1-Acre	27.13	4.52
Residential 2-Acre	72.67	12.12
Transportation	13.61	2.27
Utility	0	0
<b>Forest Land</b>	<b>160.73</b>	<b>26.81</b>
Forested Wetland	0	0
Residential Woods	0	0
Woods	160.73	26.81
<b>Open Land</b>	<b>32.11</b>	<b>5.36</b>
Open Space	31.48	5.25
Open Wetland	0	0
Water	0.64	0.11
<b>Agricultural Land</b>	<b>280.36</b>	<b>46.77</b>
Pasture/Hay	133.57	22.28
Row Crops	146.79	24.49

<u>Impervious Surface</u>	<u>Acres</u>	<u>% Area</u>
Impervious Land	26.44	4.41

**Summary Results:**

- Biological condition – “Fair”
- Habitat scores “Partially Supporting” and “Partially Degraded”
- Cricotopus/Orthocladius (midge) dominated the sample.
- Water quality values within COMAR standards.
- Deeply incised channel with extensive bank erosion and moderate bar formation. An abundance of woody debris providing stable substrate. Excellent riparian width. Refuse present in minor amounts.
- Bimodal distribution of substrate (sand/gravel).

**Recommendations:**

- Maintain the protection of the riparian areas.
- Determine causes of instability observed in this reach and evaluate potential for stabilization.

**Biological Assessment**

**Raw Metric Values**

Total Taxa	20
EPT Taxa	5
Ephemeroptera Taxa	3
%Intolerant Urban	8.4
%Ephemeroptera	12.1
Scraper Taxa	2
% Climbers	1.9

**Calculated Metric Scores**

Total Taxa	3
EPT Taxa	5
Ephemeroptera Taxa	5
%Intolerant Urban	1
%Ephemeroptera	5
Scraper Taxa	5
% Climbers	3

<b>BIBI Score</b>	<b>3.86</b>
<b>BIBI Narrative Rating</b>	<b>Fair</b>

Taxa	Count
Acentrella	8
Acerpenna	4
Amphinemura	2
Brillia	1
Chironomini	2
Crangonyx	6
Cricotopus/Orthocladius	54
Empididae	1
Gammarus	1
Hemerodromia	1
Hydrobaenus	4
Isoperla	2
Maccaffertium	1
Naididae	2
Nematomorpha	1
Orthocladius	2
Parametricnemus	3
Polypedilum	2
Saetheria	1
Simulium	2
Tubificidae	2
Tvetenia	5
<b>TOTAL:</b>	<b>107</b>

**Physical Habitat Assessment**

**EPA Rapid Bioassessment Protocol**

	Score	Score	
Bank Stability- Left Bank	2	Pool Variability	11
Bank Stability- Right Bank	2	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	19	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	12	Sediment Deposition	7
Channel Sinuosity	11	Vegetative Protection - Left Bank	4
Epifaunal Substrate/Available Cover	11	Vegetative Protection - Right Bank	4
Pool Substrate Characterization	10		

<b>RBP Habitat Score</b>	<b>113</b>
<b>RBP Narrative Rating</b>	<b>Partially Supporting</b>

**MBSS Physical Habitat Index**

	Value	Score	Value	Score	
Remoteness	16	86.16	Instream Wood Debris	14	90.72
Shading	85	84.56	Instream Habitat	10	70.72
Epifaunal Substrate	11	78.45	Bank Stability	4	44.72

<b>PHI Score</b>	<b>75.89</b>
<b>PHI Narrative Rating</b>	<b>Partially Degraded</b>

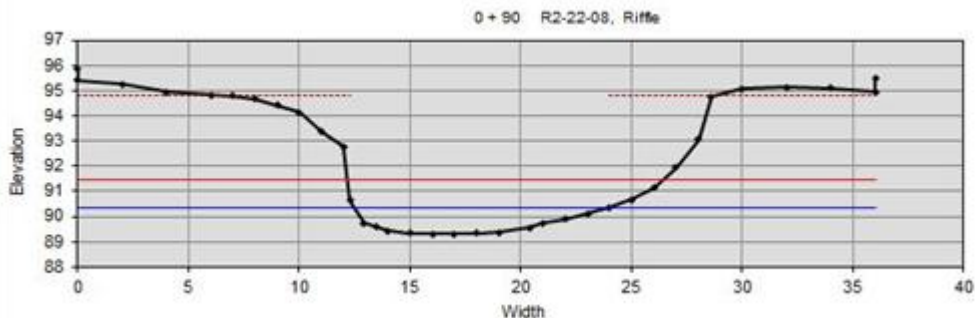
**Water Chemistry**

Dissolved Oxygen (mg/L)	11.93	pH (SU)	7.23
Turbidity (NTU)	5.1	Specific Conductivity (µS/cm)	151.43
Temperature (°C)	10.53		

**Geomorphic Assessment**

**Rosgen Level II Classification Data**

Drainage Area (mi <sup>2</sup> )	0.94	Cross Sectional Area (ft <sup>2</sup> )	8.8
Bankfull Width (ft)	11.5	Water Surface Slope (%)	0.61
Mean Bankfull Depth (ft)	0.76	Sinuosity	1.2
Floodprone Width (ft)	14.2	D50 (mm)	0.92
Entrenchment Ratio	1.2	Adjustments?	None
Width to Depth Ratio	15.1	<b>Rosgen Stream Type</b>	<b>F4/5</b>



Upstream View:



Latitude: 38.778133355

Downstream View:



Longitude: -76.632867352

**Land Use/Land Cover Analysis:**

<b>Total Drainage Area (acres)</b>	<b>518.62</b>	
<b>Cover</b>	<b>Acres</b>	<b>% Area</b>
<b>Developed Land</b>	<b>113.57</b>	<b>21.9</b>
Airport	0	0
Commercial	7.54	1.45
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0.1	0.02
Residential 1-Acre	27.13	5.23
Residential 2-Acre	65.19	12.57
Transportation	13.61	2.63
Utility	0	0
<b>Forest Land</b>	<b>131.8</b>	<b>25.41</b>
Forested Wetland	0	0
Residential Woods	0	0
Woods	131.8	25.41
<b>Open Land</b>	<b>30.59</b>	<b>5.9</b>
Open Space	29.96	5.78
Open Wetland	0	0
Water	0.64	0.12
<b>Agricultural Land</b>	<b>242.65</b>	<b>46.79</b>
Pasture/Hay	95.86	18.48
Row Crops	146.79	28.3
<b>Impervious Surface</b>	<b>Acres</b>	<b>% Area</b>
Impervious Land	23.01	4.44

**Summary Results:**

- Biological condition – “Fair”
- Habitat scores “Non Supporting” and “Degraded”
- Amphipoda (amphipod) and Cricotopus/Orthocladius (midge) dominated the sample.
- Water quality values within COMAR standards.
- Incised, overwidened channel with extensive bank erosion and undercutting. Poor sinuosity with mostly shallow water in run features. Poor vegetative protection but good riparian width. Refuse present in minor amounts.
- Bimodal distribution of substrate (sand/clay).

**Recommendations:**

- Maintain the protection of the riparian areas.
- Determine causes of instability observed in this reach and evaluate potential for stabilization.

**Biological Assessment**

**Raw Metric Values**

Total Taxa	26
EPT Taxa	5
Ephemeroptera Taxa	2
%Intolerant Urban	2.6
%Ephemeroptera	2.6
Scraper Taxa	5
% Climbers	4.3

**Calculated Metric Scores**

Total Taxa	5
EPT Taxa	5
Ephemeroptera Taxa	5
%Intolerant Urban	1
%Ephemeroptera	3
Scraper Taxa	5
% Climbers	3

<b>BIBI Score</b>	<b>3.86</b>
<b>BIBI Narrative Rating</b>	<b>Fair</b>

Taxa	Count
Acentrella	2
Amphipoda	44
Ancyronyx	1
Caecidotea	1
Chironomini	1
Conchapelopia	1
Cricotopus/Orthocladius	27
Diplectrona	1
Diplocladius	1
Eukiefferiella	4
Hemerodromia	1
Hydrobaenus	3
Ironoquia	1
Maccaffertium	1
Macronychus	1
Naididae	5
Nematomorpha	2
Orthoclaadiinae	1
Orthocladius	2
Parametricnemus	1
Paratendipes	1
Physa	1
Polypedilum	1
Simulium	3
Taeniopteryx	1
Tanytarsus	2
Trichocorixa	1
Tubificidae	1
Tvetenia	5
<b>TOTAL:</b>	<b>117</b>

**Physical Habitat Assessment**

**EPA Rapid Bioassessment Protocol**

	Score		Score
Bank Stability- Left Bank	2	Pool Variability	7
Bank Stability- Right Bank	2	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	16	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	10	Sediment Deposition	9
Channel Sinuosity	4	Vegetative Protection - Left Bank	5
Epifaunal Substrate/Available Cover	8	Vegetative Protection - Right Bank	5
Pool Substrate Characterization	8		

<b>RBP Habitat Score</b>	<b>96</b>
<b>RBP Narrative Rating</b>	<b>Non Supporting</b>

**MBSS Physical Habitat Index**

	Value	Score	Value	Score	
Remoteness	10	53.85	Instream Wood Debris	7	71.65
Shading	70	68.32	Instream Habitat	7	55.55
Epifaunal Substrate	8	61.96	Bank Stability	4	44.72

<b>PHI Score</b>	<b>59.34</b>
<b>PHI Narrative Rating</b>	<b>Degraded</b>

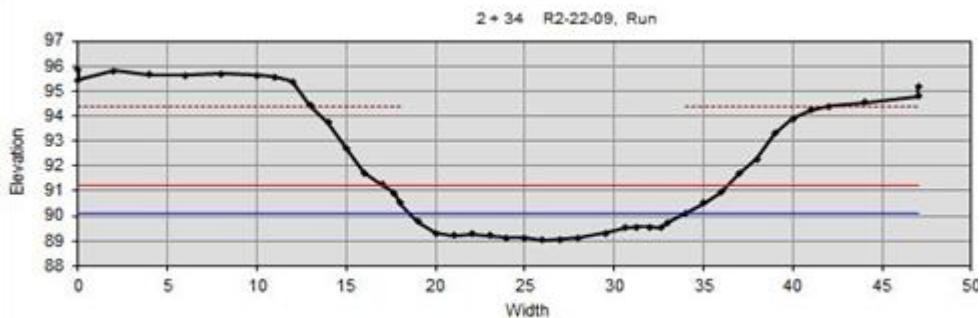
**Water Chemistry**

Dissolved Oxygen (mg/L)	10.02	pH (SU)	7.02
Turbidity (NTU)	8.67	Specific Conductivity (µS/cm)	143
Temperature (°C)	15.93		

**Geomorphic Assessment**

**Rosgen Level II Classification Data**

Drainage Area (mi <sup>2</sup> )	0.81	Cross Sectional Area (ft <sup>2</sup> )	12
Bankfull Width (ft)	15.5	Water Surface Slope (%)	0.45
Mean Bankfull Depth (ft)	0.78	Sinuosity	1.1
Floodprone Width (ft)	19.3	D50 (mm)	0.16
Entrenchment Ratio	1.2	Adjustments?	None
Width to Depth Ratio	19.9	<b>Rosgen Stream Type</b>	<b>F5/6</b>



Upstream View:



Latitude: 38.768165913

Downstream View:



Longitude: -76.619769031

**Land Use/Land Cover Analysis:**

**Total Drainage Area (acres) 3667.4**

<u>Cover</u>	<u>Acres</u>	<u>% Area</u>
<b>Developed Land</b>	<b>862.99</b>	<b>23.53</b>
Airport	0	0
Commercial	62.1	1.69
Industrial	1.94	0.05
Residential 1/8-acre	0	0
Residential 1/4-acre	1.22	0.03
Residential 1/2-acre	32.24	0.88
Residential 1-Acre	132.78	3.62
Residential 2-Acre	567.71	15.48
Transportation	65	1.77
Utility	0	0
<b>Forest Land</b>	<b>1321.56</b>	<b>36.04</b>
Forested Wetland	20.42	0.56
Residential Woods	0	0
Woods	1301.14	35.48
<b>Open Land</b>	<b>269.93</b>	<b>7.36</b>
Open Space	231.33	6.31
Open Wetland	4.13	0.11
Water	34.47	0.94
<b>Agricultural Land</b>	<b>1212.92</b>	<b>33.07</b>
Pasture/Hay	202.03	5.51
Row Crops	1010.89	27.56

<u>Impervious Surface</u>	<u>Acres</u>	<u>% Area</u>
Impervious Land	152.26	4.15

**Summary Results:**

- Biological condition – “Fair”
- Habitat scores “Supporting” and “Partially Degraded”
- Acentrella (mayfly), Simulium (black fly), and Caecidotea (isopod) dominated the sample.
- Water quality values within COMAR standards.
- Reach mostly pool habitat with extensive siltation on bed. Moderately unstable banks with good riparian width. Some submerged vegetation in lower portion or reach.

**Recommendations:**

- Maintain the protection of the riparian areas.
- Determine causes of instability observed in this reach and evaluate potential for stabilization.

# R2-22-10

# Lyons Creek Sampling Unit

## Biological Assessment

### Raw Metric Values

Total Taxa	20
EPT Taxa	2
Ephemeroptera Taxa	2
%Intolerant Urban	19.4
%Ephemeroptera	29.1
Scraper Taxa	3
% Climbers	5.8

### Calculated Metric Scores

Total Taxa	3
EPT Taxa	3
Ephemeroptera Taxa	5
%Intolerant Urban	3
%Ephemeroptera	5
Scraper Taxa	5
% Climbers	3

**BIBI Score** 3.86

**BIBI Narrative Rating** Fair

### Taxa Count

Acentrella	29
Acerpenna	1
Caecidotea	15
Cricotopus/Orthocladius	2
Dicrotendipes	1
Dubiraphia	1
Hydrobaenus	1
Naididae	7
Neoporus	1
Parametricnemus	1
Physa	1
Pisidium	1
Polypedilum	1
Potthastia	2
Prostoma	1
Simulium	17
Synurella	2
Tanytus	2
Tanytarsus	3
Tubificidae	14

**TOTAL:** 103

## Physical Habitat Assessment

### EPA Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	6	Pool Variability	13
Bank Stability- Right Bank	3	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	19	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	15	Sediment Deposition	10
Channel Sinuosity	11	Vegetative Protection - Left Bank	7
Epifaunal Substrate/Available Cover	12	Vegetative Protection - Right Bank	4
Pool Substrate Characterization	14		

**RBP Habitat Score** 134

**RBP Narrative Rating** Supporting

### MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	12	64.62	Instream Wood Debris	14	70.21
Shading	70	68.32	Instream Habitat	12	63.27
Epifaunal Substrate	12	72.46	Bank Stability	9	67.08

**PHI Score** 67.66

**PHI Narrative Rating** Partially Degraded

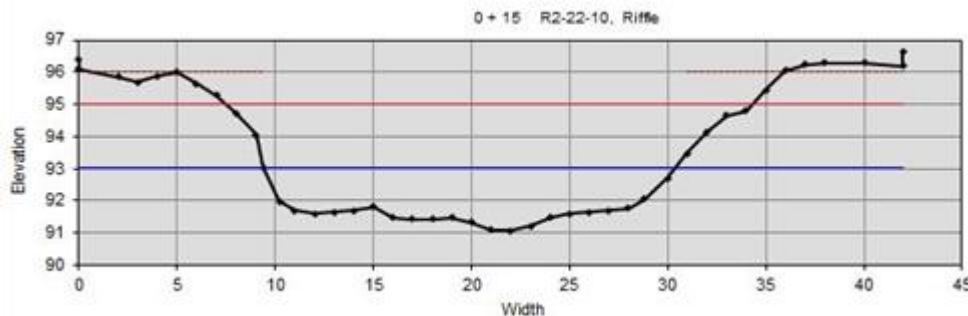
## Water Chemistry

Dissolved Oxygen (mg/L)	7.38	pH (SU)	7.01
Turbidity (NTU)	11.2	Specific Conductivity (µS/cm)	178.93
Temperature (°C)	13.1		

## Geomorphic Assessment

### Rosgen Level II Classification Data

Drainage Area (mi <sup>2</sup> )	5.73	Cross Sectional Area (ft <sup>2</sup> )	29.3
Bankfull Width (ft)	21	Water Surface Slope (%)	0.098
Mean Bankfull Depth (ft)	1.39	Sinuosity	1.1
Floodprone Width (ft)	26.8	D50 (mm)	0.062
Entrenchment Ratio	1.3	Adjustments?	None
Width to Depth Ratio	15.1	<b>Rosgen Stream Type</b>	<b>F6</b>



## R2-22-12A

## Lyons Creek Sampling Unit

### Upstream View:



Latitude: 38.793879002

### Downstream View:



Longitude: -76.630633752

### Land Use/Land Cover Analysis:

**Total Drainage Area (acres) 103.44**

<u>Cover</u>	<u>Acres</u>	<u>% Area</u>
<b>Developed Land 29.58 28.59</b>		
Airport	0	0
Commercial	0.88	0.85
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	2.15	2.08
Residential 2-Acre	23.86	23.07
Transportation	2.68	2.59
Utility	0	0
<b>Forest Land 18.96 18.33</b>		
Forested Wetland	0	0
Residential Woods	0	0
Woods	18.96	18.33
<b>Open Land 2.47 2.39</b>		
Open Space	2.47	2.39
Open Wetland	0	0
Water	0	0
<b>Agricultural Land 52.43 50.69</b>		
Pasture/Hay	2.91	2.81
Row Crops	49.53	47.88
<b>Impervious Surface 3.87 3.74</b>		
Impervious Land	3.87	3.74

### Summary Results:

- Biological condition – “Poor”
- Habitat scores “Partially Supporting” and “Partially Degraded”
- Midges of the Chironomidae family, stoneflies, and amphipods dominated the sample.
- Measured below COMAR standards for pH.
- Reach adjacent to cropland, with little buffer from fields. Predominantly shallow water with few pools and poor sinuosity. Benthic habitat diversity lacking. Moderately stable banks with sub-optimal vegetative protection. Refuse present in minor amounts.
- Adjusted ER -0.2 to fit G type. Bimodal distribution of substrate (sand/gravel).

### Recommendations:

- Buffer enhancement.



# R2-22-12A

# Lyons Creek Sampling Unit

## Biological Assessment

### Raw Metric Values

Total Taxa	14
EPT Taxa	2
Ephemeroptera Taxa	0
%Intolerant Urban	23.8
%Ephemeroptera	0
Scraper Taxa	1
% Climbers	0

### Calculated Metric Scores

Total Taxa	3
EPT Taxa	3
Ephemeroptera Taxa	1
%Intolerant Urban	3
%Ephemeroptera	1
Scraper Taxa	3
% Climbers	1

<b>BIBI Score</b>	<b>2.14</b>
<b>BIBI Narrative Rating</b>	<b>Poor</b>

Taxa	Count
Amphinemura	13
Amphipoda	15
Caecidotea	10
Chironomidae	1
Cricotopus/Orthocladius	11
Diplocladius	5
Gammarus	6
Hydrobaenus	4
Isonychia	2
Naididae	10
Nematomorpha	1
Neoporus	5
Orthocladius	1
Parametricnemus	5
Pisidium	1
Plecoptera	1
Thienemanniella	2
Tubificidae	8
<b>TOTAL:</b>	<b>101</b>

## Physical Habitat Assessment

### EPA Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	6	Pool Variability	7
Bank Stability- Right Bank	6	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	15	Riparian Vegetative Zone Width- Right Bank	2
Channel Flow Status	13	Sediment Deposition	10
Channel Sinuosity	6	Vegetative Protection - Left Bank	6
Epifaunal Substrate/Available Cover	7	Vegetative Protection - Right Bank	6
Pool Substrate Characterization	8		

<b>RBP Habitat Score</b>	<b>102</b>
<b>RBP Narrative Rating</b>	<b>Partially Supporting</b>

### MBSS Physical Habitat Index

	Value	Score	Value	Score	
Remoteness	13	70.01	Instream Wood Debris	4	81.03
Shading	75	73.32	Instream Habitat	7	72.05
Epifaunal Substrate	7	66.66	Bank Stability	12	77.46

<b>PHI Score</b>	<b>73.42</b>
<b>PHI Narrative Rating</b>	<b>Partially Degraded</b>

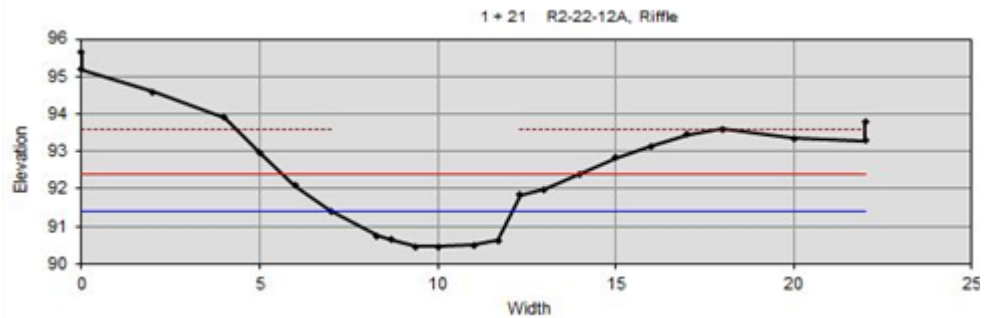
## Water Chemistry

Dissolved Oxygen (mg/L)	9.26	pH (SU)	6.33
Turbidity (NTU)	15.5	Specific Conductivity (µS/cm)	123.2
Temperature (°C)	17.07		

## Geomorphic Assessment

### Rosgen Level II Classification Data

Drainage Area (mi <sup>2</sup> )	0.16	Cross Sectional Area (ft <sup>2</sup> )	3.6
Bankfull Width (ft)	5.1	Water Surface Slope (%)	0.76
Mean Bankfull Depth (ft)	0.7	Sinuosity	1
Floodprone Width (ft)	8.3	D50 (mm)	0.22
Entrenchment Ratio	1.6	Adjustments?	Yes, ER -0.2
Width to Depth Ratio	7.3	<b>Rosgen Stream Type</b>	<b>G4/5</b>



## R2-22-19A

## Lyons Creek Sampling Unit

### Upstream View:



Latitude: 38.770495596

### Downstream View:



Longitude: -76.619034116

### Land Use/Land Cover Analysis:

**Total Drainage Area (acres) 345.28**

<u>Cover</u>	<u>Acres</u>	<u>% Area</u>
<b>Developed Land 73.34 21.24</b>		
Airport	0	0
Commercial	1.68	0.49
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	3.42	0.99
Residential 1-Acre	12.42	3.6
Residential 2-Acre	49.09	14.22
Transportation	6.73	1.95
Utility	0	0
<b>Forest Land 169.02 48.95</b>		
Forested Wetland	0	0
Residential Woods	0	0
Woods	169.02	48.95
<b>Open Land 45.96 13.31</b>		
Open Space	45.96	13.31
Open Wetland	0	0
Water	0	0
<b>Agricultural Land 56.96 16.5</b>		
Pasture/Hay	7.64	2.21
Row Crops	49.33	14.29
<b>Impervious Surface 14.39 4.17</b>		
Impervious Land	14.39	4.17

### Summary Results:

- Biological condition – “Fair”
- Habitat scores “Supporting” and “Partially Degraded”
- Stoneflies (including Amphinemura and Isoperla) and midges (including Diplocladius and Cricotopus/Orthocladius) dominated the sample.
- Water quality values within COMAR standards.
- Deeply incised channel with extensive bank erosion and undercut banks. Woody debris abundant but not optimal for stable habitat. Riffles of marginal habitat quality. Good riparian width.
- Bimodal distribution of substrate (sand/gravel).

### Recommendations:

- Maintain the protection of the riparian areas.
- Determine causes of instability observed in this reach and evaluate potential for stabilization.

# R2-22-19A

# Lyons Creek Sampling Unit

## Biological Assessment

### Raw Metric Values

Total Taxa	26
EPT Taxa	6
Ephemeroptera Taxa	1
%Intolerant Urban	24.5
%Ephemeroptera	1
Scraper Taxa	1
% Climbers	3.9

### Calculated Metric Scores

Total Taxa	5
EPT Taxa	5
Ephemeroptera Taxa	3
%Intolerant Urban	3
%Ephemeroptera	3
Scraper Taxa	3
% Climbers	3

<b>BIBI Score</b>	<b>3.57</b>
<b>BIBI Narrative Rating</b>	<b>Fair</b>

Taxa	Count
Acentrella	1
Amphinemura	6
Caecidotea	1
Conchapelopia	1
Corduliidae	2
Crangonyctidae	5
Cricotopus/Orthocladius	9
Dasyhelea	1
Diplocladius	12
Enchytraeidae	1
Eukiefferiella	2
Gymnometriocnemus	1
Hydrobaenus	3
Ironoquia	3
Isoperla	2
Naididae	15
Nematomorpha	3
Orthoclaadiinae	2
Parametriocnemus	3
Perlesta	1
Pisidium	2
Plecoptera	13
Polypedilum	1
Pycnopsyche	1
Rheocricotopus	6
Simulium	2
Tipula	1
Tipulidae	1
Tubificidae	1
<b>TOTAL:</b>	<b>102</b>

## Physical Habitat Assessment

### EPA Rapid Bioassessment Protocol

	Score	Score	
Bank Stability- Left Bank	3	Pool Variability	10
Bank Stability- Right Bank	5	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	14	Sediment Deposition	8
Channel Sinuosity	14	Vegetative Protection - Left Bank	4
Epifaunal Substrate/Available Cover	10	Vegetative Protection - Right Bank	6
Pool Substrate Characterization	12		

<b>RBP Habitat Score</b>	<b>126</b>
<b>RBP Narrative Rating</b>	<b>Supporting</b>

### MBSS Physical Habitat Index

	Value	Score	Value	Score	
Remoteness	16	86.16	Instream Wood Debris	8	79.21
Shading	75	73.32	Instream Habitat	10	76.36
Epifaunal Substrate	10	76.23	Bank Stability	8	63.25

<b>PHI Score</b>	<b>75.76</b>
<b>PHI Narrative Rating</b>	<b>Partially Degraded</b>

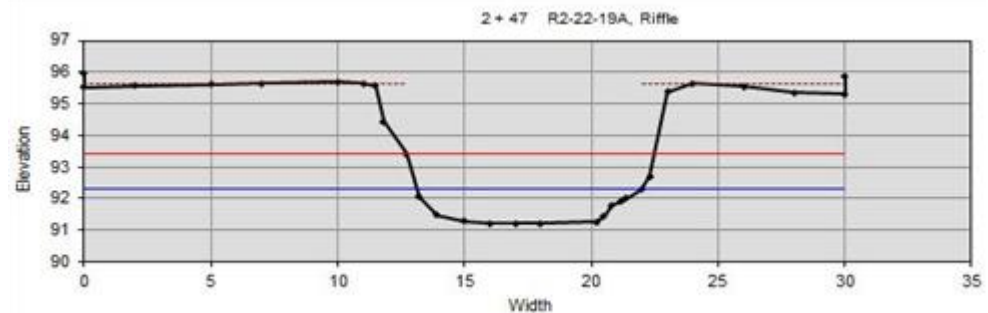
## Water Chemistry

Dissolved Oxygen (mg/L)	9.8	pH (SU)	6.54
Turbidity (NTU)	4.19	Specific Conductivity (µS/cm)	137
Temperature (°C)	10.37		

## Geomorphic Assessment

### Rosgen Level II Classification Data

Drainage Area (mi <sup>2</sup> )	0.54	Cross Sectional Area (ft <sup>2</sup> )	7.9
Bankfull Width (ft)	8.9	Water Surface Slope (%)	0.89
Mean Bankfull Depth (ft)	0.89	Sinuosity	1.4
Floodprone Width (ft)	9.8	D50 (mm)	0.45
Entrenchment Ratio	1.1	Adjustments?	None
Width to Depth Ratio	10	<b>Rosgen Stream Type</b>	<b>G4/5c</b>



## R2-22-21A

## Lyons Creek Sampling Unit

### Upstream View:



Latitude: 38.768301686

### Downstream View:



Longitude: -76.64679357

### Land Use/Land Cover Analysis:

**Total Drainage Area (acres)** **6644.84**

\*Calvert County drainage (578.20 ac) not included in land use/land cover analysis.

<u>Cover</u>	<u>Acres</u>	<u>% Area</u>
<b>Developed Land</b>	<b>1473.64</b>	<b>24.29</b>
Airport	0	0
Commercial	93.84	1.55
Industrial	1.94	0.03
Residential 1/8-acre	0	0
Residential 1/4-acre	2.61	0.04
Residential 1/2-acre	51.31	0.85
Residential 1-Acre	278.67	4.59
Residential 2-Acre	925.21	15.25
Transportation	120.06	1.98
Utility	0	0
<b>Forest Land</b>	<b>2256.73</b>	<b>37.2</b>
Forested Wetland	20.42	0.34
Residential Woods	0	0
Woods	2236.31	36.86
<b>Open Land</b>	<b>415.56</b>	<b>6.85</b>
Open Space	373.81	6.16
Open Wetland	4.13	0.07
Water	37.62	0.62
<b>Agricultural Land</b>	<b>1920.72</b>	<b>31.66</b>
Pasture/Hay	452.96	7.47
Row Crops	1467.76	24.19
<b>Impervious Surface</b>	<b>Acres</b>	<b>% Area</b>
Impervious Land	264.04	3.97

### Summary Results:

- Biological condition – “Good”
- Habitat scores “Supporting” and “Partially Degraded”
- Acentrella (mayfly), Simulium (black fly) and Cricotopus/Orthocladius (midge) dominated the sample.
- Water quality values within COMAR standards.
- An abundance of wood debris provides majority of habitat. Banks heavily eroded and sediment deposition fairly extensive in bed. Good velocity depth diversity. Poor vegetative protection but good riparian width.

### Recommendations:

- Maintain the protection of the riparian areas.
- Determine causes of instability observed in this reach and evaluate potential for stabilization.

# R2-22-21A

# Lyons Creek Sampling Unit

## Biological Assessment

### Raw Metric Values

Total Taxa	19
EPT Taxa	6
Ephemeroptera Taxa	3
%Intolerant Urban	10
%Ephemeroptera	35.5
Scraper Taxa	3
% Climbers	5.5

### Calculated Metric Scores

Total Taxa	3
EPT Taxa	5
Ephemeroptera Taxa	5
%Intolerant Urban	3
%Ephemeroptera	5
Scraper Taxa	5
% Climbers	3

<b>BIBI Score</b>	<b>4.14</b>
<b>BIBI Narrative Rating</b>	<b>Good</b>

### Taxa Count

Taxa	Count
Acentrella	36
Acerpena	1
Amphinemura	1
Ancyronyx	1
Caecidotea	3
Chironomini	1
Conchapelopia	1
Cricotopus/Orthocladius	19
Diplocladius	2
Hydrobaenus	1
Isoperla	3
Maccaffertium	2
Microtendipes	2
Naididae	2
Orthoclaadiinae	1
Orthocladius	2
Parametriocnemus	3
Perlidae	1
Polypedilum	6
Simulium	19
Stenochironomus	1
Thienemannimyia group	1
Tvetenia	1
<b>TOTAL:</b>	<b>110</b>

## Physical Habitat Assessment

### EPA Rapid Bioassessment Protocol

	Score	Score	
Bank Stability- Left Bank	2	Pool Variability	13
Bank Stability- Right Bank	2	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	15	Sediment Deposition	11
Channel Sinuosity	11	Vegetative Protection - Left Bank	3
Epifaunal Substrate/Available Cover	14	Vegetative Protection - Right Bank	3
Pool Substrate Characterization	13		

<b>RBP Habitat Score</b>	<b>127</b>
<b>RBP Narrative Rating</b>	<b>Supporting</b>

### MBSS Physical Habitat Index

	Value	Score	Value	Score	
Remoteness	14	75.39	Instream Wood Debris	15	66.44
Shading	90	91.34	Instream Habitat	14	68.29
Epifaunal Substrate	14	80.2	Bank Stability	4	44.72

<b>PHI Score</b>	<b>71.07</b>
<b>PHI Narrative Rating</b>	<b>Partially Degraded</b>

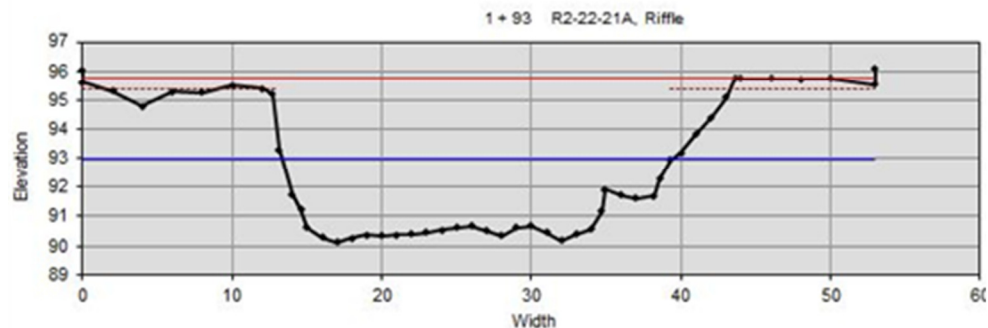
## Water Chemistry

Dissolved Oxygen (mg/L)	11.88	pH (SU)	6.99
Turbidity (NTU)	11.7	Specific Conductivity (µS/cm)	165.73
Temperature (°C)	9.9		

## Geomorphic Assessment

### Rosgen Level II Classification Data

Drainage Area (mi <sup>2</sup> )	10.38	Cross Sectional Area (ft <sup>2</sup> )	56.2
Bankfull Width (ft)	26	Water Surface Slope (%)	0.14
Mean Bankfull Depth (ft)	2.16	Sinuosity	1.1
Floodprone Width (ft)	175	D50 (mm)	0.16
Entrenchment Ratio	6.7	Adjustments?	None
Width to Depth Ratio	12	<b>Rosgen Stream Type</b>	<b>E5</b>



Upstream View:



Latitude: 38.789226488

Downstream View:



Longitude: -76.602393222

**Land Use/Land Cover Analysis:**

**Total Drainage Area (acres) 2266.83**

<u>Cover</u>	<u>Acres</u>	<u>% Area</u>
<b>Developed Land</b>	<b>487.01</b>	<b>21.48</b>
Airport	0	0
Commercial	26.65	1.18
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	1.22	0.05
Residential 1/2-acre	10.21	0.45
Residential 1-Acre	52.59	2.32
Residential 2-Acre	360.12	15.89
Transportation	36.22	1.6
Utility	0	0
<b>Forest Land</b>	<b>704.1</b>	<b>31.06</b>
Forested Wetland	19.63	0.87
Residential Woods	0	0
Woods	684.47	30.19
<b>Open Land</b>	<b>148.24</b>	<b>6.54</b>
Open Space	120.88	5.33
Open Wetland	4.13	0.18
Water	23.23	1.02
<b>Agricultural Land</b>	<b>927.48</b>	<b>40.92</b>
Pasture/Hay	124.56	5.49
Row Crops	802.92	35.42
<b>Impervious Surface</b>	<b>Acres</b>	<b>% Area</b>
Impervious Land	78.63	3.47

**Summary Results:**

- Biological condition – “Poor”
- Habitat scores “Comparable to Reference” and “Degraded”
- Naididae (worm), Simulium (black fly), and Caecidotea (isopod) dominated the sample.
- Water quality values within COMAR standards.
- Multi-thread channel through broad wetland valley. Submerged vegetation present providing stable habitat for benthos. Good bank stability, vegetative protection, and riparian width.

**Recommendations:**

- Maintain the protection of the riparian areas.
- Because habitat is comparable to reference and biological condition is poor, look for problems with water quality and correct, if possible.

# R2-22-27A

# Lyons Creek Sampling Unit

## Biological Assessment

### Raw Metric Values

Total Taxa	14
EPT Taxa	0
Ephemeroptera Taxa	0
%Intolerant Urban	14.7
%Ephemeroptera	0
Scraper Taxa	1
% Climbers	4.2

### Calculated Metric Scores

Total Taxa	3
EPT Taxa	1
Ephemeroptera Taxa	1
%Intolerant Urban	3
%Ephemeroptera	1
Scraper Taxa	3
% Climbers	3

**BIBI Score** 2.14

**BIBI Narrative Rating** Poor

Taxa	Count
Amphipoda	1
Caecidotea	13
Cricotopus/Orthocladius	6
Diplocladius	1
Lumbricidae	1
Menetus	1
Naididae	33
Orthocladius	3
Parametricnemus	1
Peltodytes	2
Pisidium	9
Prosimulium	1
Prostoma	1
Simulium	21
Tanytarsus	1
<b>TOTAL:</b>	<b>95</b>

## Physical Habitat Assessment

### EPA Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	9	Pool Variability	13
Bank Stability- Right Bank	9	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	18	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	20	Sediment Deposition	16
Channel Sinuosity	12	Vegetative Protection - Left Bank	9
Epifaunal Substrate/Available Cover	12	Vegetative Protection - Right Bank	9
Pool Substrate Characterization	14		

**RBP Habitat Score** 161

**RBP Narrative Rating** Comparable to Reference

### MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	13	70.01	Instream Wood Debris	8	57.91
Shading	25	26.57	Instream Habitat	12	68.2
Epifaunal Substrate	12	75.59	Bank Stability	18	94.87

**PHI Score** 65.52

**PHI Narrative Rating** Degraded

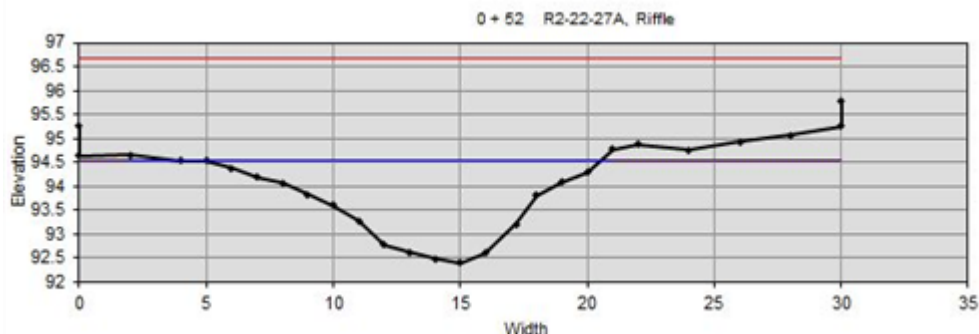
## Water Chemistry

Dissolved Oxygen (mg/L)	8.89	pH (SU)	6.82
Turbidity (NTU)	13.4	Specific Conductivity (µS/cm)	152.83
Temperature (°C)	18.3		

## Geomorphic Assessment

### Rosen Level II Classification Data

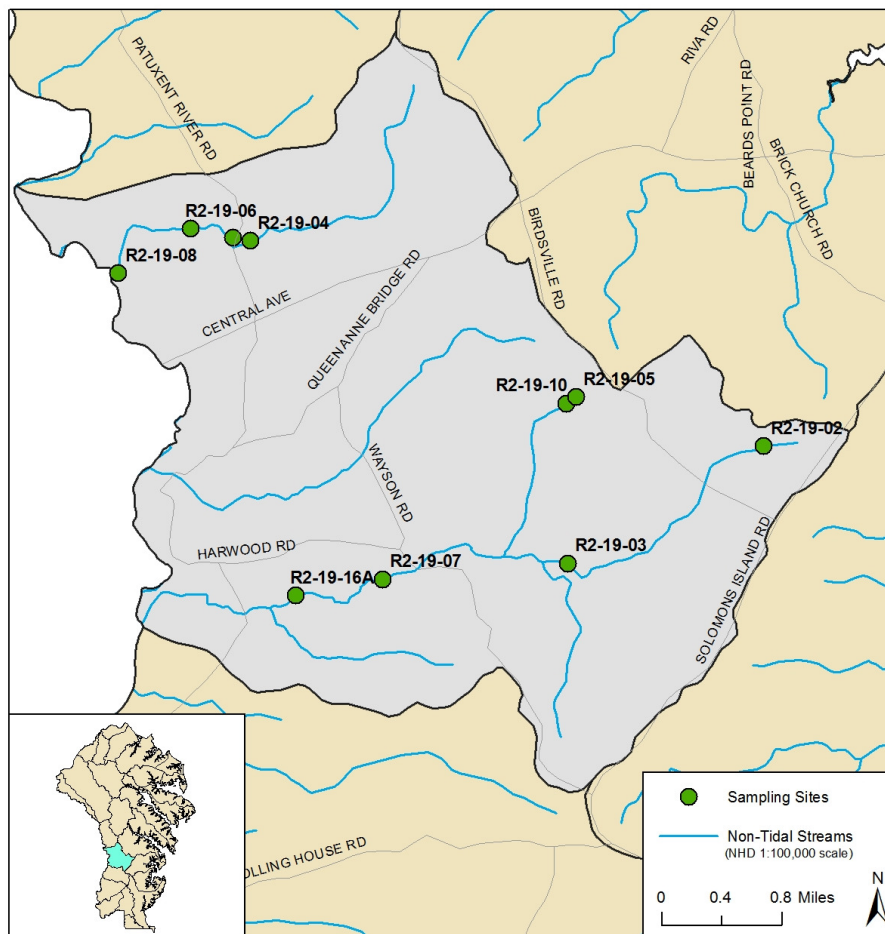
Drainage Area (mi <sup>2</sup> )	3.54	Cross Sectional Area (ft <sup>2</sup> )	16.6
Bankfull Width (ft)	16.7	Water Surface Slope (%)	1
Mean Bankfull Depth (ft)	0.99	Sinuosity	1.2
Floodprone Width (ft)	245	D50 (mm)	0.062
Entrenchment Ratio	14.7	Adjustments?	None
Width to Depth Ratio	16.8	<b>Rosen Stream Type</b>	<b>DA6</b>



# Stocketts Run Sampling Unit

## Site Condition Summary

Site	Drainage Area (acres)	Drainage Area (mi <sup>2</sup> )	Percent Impervious	Percent Developed	Percent Forested	Percent Agriculture	Percent Open	BIBI Narrative Rating	PHI Narrative Rating	RBP Narrative Rating	Rosgen Stream Type - L1
R2-19-02	112.9	0.18	11.5	46.5	19.1	11.6	22.8	Poor	Degraded	Non Supporting	F
R2-19-03	1452.6	2.27	4.5	29.6	43.4	17.2	9.9	Poor	Partially Degraded	Partially Supporting	F
R2-19-04	1210.8	1.89	7.6	43.1	24.0	20.8	12.1	Poor	Partially Degraded	Supporting	F
R2-19-05	61.7	0.10	7.2	42.6	13.0	18.8	25.6	Very Poor	Partially Degraded	Non Supporting	G
R2-19-06	1399.9	2.19	7.4	42.1	25.6	19.7	12.6	Fair	Partially Degraded	Supporting	F
R2-19-07	3349.5	5.23	4.0	25.4	49.9	17.3	7.5	Poor	Partially Degraded	Supporting	F
R2-19-08	1595.7	2.49	7.0	39.8	29.1	17.4	13.7	Fair	Degraded	Partially Supporting	F
R2-19-10	87.3	0.14	6.8	39.7	18.6	21.9	19.8	Very Poor	Partially Degraded	Partially Supporting	G
R2-19-11A	1300.8	2.03	7.6	43.2	24.7	19.7	12.4	Fair	Degraded	Supporting	ND
R2-19-16A	3665.6	5.73	3.9	25.2	50.1	17.3	7.4	Poor	Partially Degraded	Supporting	F





## R2-19-02

## Stocketts Run Sampling Unit

### Upstream View:



Latitude: 38.899253785

### Downstream View:



Longitude: -76.598485482

### Land Use/Land Cover Analysis:

**Total Drainage Area (acres) 112.85**

<u>Cover</u>	<u>Acres</u>	<u>% Area</u>
<b>Developed Land</b>	<b>52.52</b>	<b>46.54</b>
Airport	0	0
Commercial	2.91	2.57
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	3.45	3.06
Residential 2-Acre	41.51	36.78
Transportation	4.65	4.12
Utility	0	0
<b>Forest Land</b>	<b>21.5</b>	<b>19.05</b>
Forested Wetland	0	0
Residential Woods	0	0
Woods	21.5	19.05
<b>Open Land</b>	<b>25.76</b>	<b>22.82</b>
Open Space	25.76	22.82
Open Wetland	0	0
Water	0	0
<b>Agricultural Land</b>	<b>13.08</b>	<b>11.59</b>
Pasture/Hay	6.17	5.47
Row Crops	6.91	6.12
<b>Impervious Surface</b>	<b>Acres</b>	<b>% Area</b>
Impervious Land	12.96	11.49

### Summary Results:

- Biological condition – “Poor”
- Habitat scores “Non Supporting” and “Degraded”
- Close to one-third of the sample consisted of Diplocladius, a midge of the Chironomidae family.
- Measured below COMAR standards for pH and conductivity elevated.
- Straight, incised reach that is backwatered throughout the lower half due to a debris jam. Poor epifaunal substrate, instream habitat, and pool variability. Very poor bank stability and vegetative protection. Refuse present in minor amounts.

### Recommendations:

- Maintain the protection of the riparian areas.
- Determine causes of instability observed in this reach and evaluate potential for stabilization.

# R2-19-02

# Stocketts Run Sampling Unit

## Biological Assessment

### Raw Metric Values

Total Taxa	21
EPT Taxa	3
Ephemeroptera Taxa	0
%Intolerant Urban	9.6
%Ephemeroptera	0
Scraper Taxa	4
% Climbers	7.8

### Calculated Metric Scores

Total Taxa	3
EPT Taxa	3
Ephemeroptera Taxa	1
%Intolerant Urban	1
%Ephemeroptera	1
Scraper Taxa	5
% Climbers	3

**BIBI Score** 2.43

**BIBI Narrative Rating** Poor

### Taxa Count

Allocapnia	1
Caecidotea	6
Cricotopus/Orthocladius	6
Cyphon	2
Diplocladius	38
Enchytraeidae	2
Gammarus	1
Hydrobaenus	9
Ironoquia	10
Limnephilidae	3
Lumbricidae	2
Naididae	1
Neophylax	4
Orthoclaadiinae	2
Paraphaenocladus	4
Pisidium	5
Prosimulium	1
Stagnicola	4
Stygobromus	1
Syrphidae	1
Tanypodinae	1
Tipula	1
Tubificidae	6
Zavrelimyia	4
<b>TOTAL:</b>	<b>115</b>

## Physical Habitat Assessment

### EPA Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	1	Pool Variability	3
Bank Stability- Right Bank	1	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	12	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	15	Sediment Deposition	10
Channel Sinuosity	2	Vegetative Protection - Left Bank	3
Epifaunal Substrate/Available Cover	4	Vegetative Protection - Right Bank	3
Pool Substrate Characterization	4		

**RBP Habitat Score** 78

**RBP Narrative Rating** Non Supporting

### MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	12	64.62	Instream Wood Debris	5	83
Shading	85	84.56	Instream Habitat	3	48.97
Epifaunal Substrate	4	48.66	Bank Stability	2	31.62

**PHI Score** 60.24

**PHI Narrative Rating** Degraded

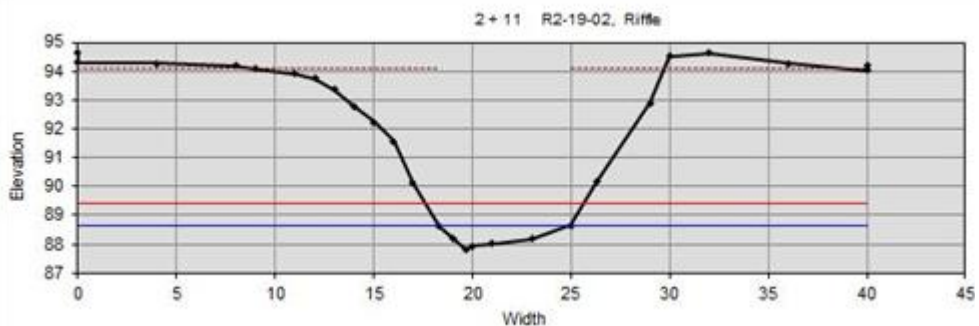
## Water Chemistry

Dissolved Oxygen (mg/L)	12.39	pH (SU)	6.48
Turbidity (NTU)	6.69	Specific Conductivity (µS/cm)	325.73
Temperature (°C)	7.33		

## Geomorphic Assessment

### Rosgen Level II Classification Data

Drainage Area (mi <sup>2</sup> )	0.18	Cross Sectional Area (ft <sup>2</sup> )	2.9
Bankfull Width (ft)	6.5	Water Surface Slope (%)	0.2
Mean Bankfull Depth (ft)	0.44	Sinuosity	1
Floodprone Width (ft)	8.1	D50 (mm)	0.062
Entrenchment Ratio	1.2	Adjustments?	None
Width to Depth Ratio	14.9	<b>Rosgen Stream Type</b>	<b>F6</b>



## R2-19-03

## Stocketts Run Sampling Unit

### Upstream View:



Latitude: 38.887950562

### Downstream View:



Longitude: -76.622772231

### Land Use/Land Cover Analysis:

**Total Drainage Area (acres) 1452.63**

<u>Cover</u>	<u>Acres</u>	<u>% Area</u>
<b>Developed Land</b>	<b>429.78</b>	<b>29.59</b>
Airport	0	0
Commercial	15.27	1.05
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	20.99	1.45
Residential 1-Acre	85.66	5.9
Residential 2-Acre	191.94	13.21
Transportation	34.25	2.36
Utility	81.66	5.62
<b>Forest Land</b>	<b>630.44</b>	<b>43.4</b>
Forested Wetland	0	0
Residential Woods	0	0
Woods	630.44	43.4
<b>Open Land</b>	<b>143.28</b>	<b>9.86</b>
Open Space	140.41	9.67
Open Wetland	0	0
Water	2.87	0.2
<b>Agricultural Land</b>	<b>249.14</b>	<b>17.15</b>
Pasture/Hay	105.82	7.28
Row Crops	143.32	9.87

<u>Impervious Surface</u>	<u>Acres</u>	<u>% Area</u>
Impervious Land	65.57	4.51

### Summary Results:

- Biological condition – “Poor”
- Habitat scores “Partially Supporting” and “Partially Degraded”
- Midges of the Chironomidae family, including Hydrobaenus and Cricotopus/Orthocladius, dominated the sample.
- Water quality values within COMAR standards.
- Attached algae and sedimentation abundant throughout reach reducing available benthic habitat. Marginal bank stability and vegetative protection but excellent riparian width.
- Adjusted WD Ratio +0.5 to fit F type.

### Recommendations:

- Maintain the protection of the riparian areas.
- Determine causes of instability observed in this reach and evaluate potential for stabilization.

# R2-19-03

# Stocketts Run Sampling Unit

## Biological Assessment

### Raw Metric Values

Total Taxa	13
EPT Taxa	2
Ephemeroptera Taxa	0
%Intolerant Urban	8.6
%Ephemeroptera	0
Scraper Taxa	2
% Climbers	1

### Calculated Metric Scores

Total Taxa	1
EPT Taxa	3
Ephemeroptera Taxa	1
%Intolerant Urban	1
%Ephemeroptera	1
Scraper Taxa	5
% Climbers	3

<b>BIBI Score</b>	<b>2.14</b>
<b>BIBI Narrative Rating</b>	<b>Poor</b>

### Taxa Count

Cricotopus/Orthocladius	10
Dicrotendipes	3
Diplocladius	2
Eukiefferiella	5
Hydrobaenus	50
Isoperla	2
Lype	2
Micropsectra	1
Naididae	1
Nematomorpha	12
Orthoclaadiinae	1
Parakiefferiella	1
Prosimulium	5
Simuliidae	9
Zavrelimyia	1
<b>TOTAL:</b>	<b>105</b>

## Physical Habitat Assessment

### EPA Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	2	Pool Variability	12
Bank Stability- Right Bank	4	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	13	Sediment Deposition	9
Channel Sinuosity	14	Vegetative Protection - Left Bank	3
Epifaunal Substrate/Available Cover	11	Vegetative Protection - Right Bank	4
Pool Substrate Characterization	11		

<b>RBP Habitat Score</b>	<b>123</b>
<b>RBP Narrative Rating</b>	<b>Partially Supporting</b>

### MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	16	86.16	Instream Wood Debris	5	54.07
Shading	85	84.56	Instream Habitat	11	67.2
Epifaunal Substrate	11	72.68	Bank Stability	6	54.77

<b>PHI Score</b>	<b>69.91</b>
<b>PHI Narrative Rating</b>	<b>Partially Degraded</b>

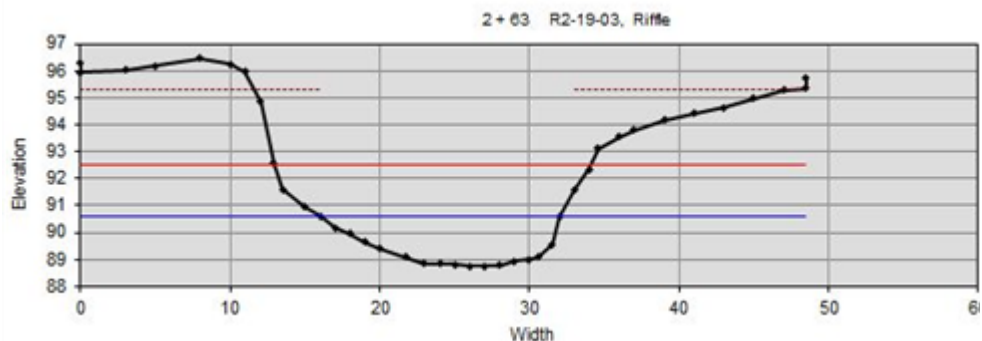
## Water Chemistry

Dissolved Oxygen (mg/L)	14.42	pH (SU)	8.39
Turbidity (NTU)	7.35	Specific Conductivity (µS/cm)	192
Temperature (°C)	14.37		

## Geomorphic Assessment

### Rosgen Level II Classification Data

Drainage Area (mi <sup>2</sup> )	2.27	Cross Sectional Area (ft <sup>2</sup> )	22.1
Bankfull Width (ft)	16.1	Water Surface Slope (%)	0.22
Mean Bankfull Depth (ft)	1.38	Sinuosity	1.4
Floodprone Width (ft)	21.2	D50 (mm)	0.3
Entrenchment Ratio	1.3	Adjustments?	Yes, WD +0.5
Width to Depth Ratio	11.7	<b>Rosgen Stream Type</b>	<b>F5</b>



## R2-19-04

## Stocketts Run Sampling Unit

### Upstream View:



Latitude: 38.919312347

### Downstream View:



Longitude: -76.661859396

### Land Use/Land Cover Analysis:

**Total Drainage Area (acres) 1210.77**

<u>Cover</u>	<u>Acres</u>	<u>% Area</u>
<b>Developed Land</b>	<b>522.05</b>	<b>43.12</b>
Airport	0	0
Commercial	23.41	1.93
Industrial	0.97	0.08
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	1.34	0.11
Residential 1-Acre	43.73	3.61
Residential 2-Acre	424.9	35.09
Transportation	27.7	2.29
Utility	0	0
<b>Forest Land</b>	<b>290.4</b>	<b>23.98</b>
Forested Wetland	0	0
Residential Woods	0	0
Woods	290.4	23.98
<b>Open Land</b>	<b>146.61</b>	<b>12.11</b>
Open Space	142.77	11.79
Open Wetland	0	0
Water	3.84	0.32
<b>Agricultural Land</b>	<b>251.71</b>	<b>20.79</b>
Pasture/Hay	73.65	6.08
Row Crops	178.06	14.71

<u>Impervious Surface</u>	<u>Acres</u>	<u>% Area</u>
Impervious Land	91.94	7.59

### Summary Results:

- Biological condition – “Poor”
- Habitat scores “Supporting” and “Partially Degraded”
- Midges of the Chironomidae family, including Hydrobaenus and Cricotopus/Orthocladius, dominated the sample.
- Water quality values within COMAR standards.
- Incised channel with extensive point bars. Banks eroded but mostly healed over. Rootwads and woody debris provide marginal epifaunal habitat. Sub-optimal bank stability and vegetative protection. Excellent riparian buffer.
- Adjusted ER -0.2 to fit F type. Bimodal distribution of substrate (sand/gravel).

### Recommendations:

- Maintain the protection of the riparian areas.
- Because habitat is supporting and biological condition is poor, look for problems with water quality and correct, if possible.

# R2-19-04

# Stocketts Run Sampling Unit

## Biological Assessment

### Raw Metric Values

Total Taxa	17
EPT Taxa	4
Ephemeroptera Taxa	0
%Intolerant Urban	11.6
%Ephemeroptera	0
Scraper Taxa	3
% Climbers	1.1

### Calculated Metric Scores

Total Taxa	3
EPT Taxa	3
Ephemeroptera Taxa	1
%Intolerant Urban	3
%Ephemeroptera	1
Scraper Taxa	5
% Climbers	3

<b>BIBI Score</b>	<b>2.71</b>
<b>BIBI Narrative Rating</b>	<b>Poor</b>

Taxa	Count
Amphinemura	1
Caecidotea	5
Chironomidae	1
Cricotopus/Orthocladius	22
Diplocladius	10
Hyalella	4
Hydrobaenus	34
Ironoquia	2
Limnephilidae	1
Limnophyes	1
Naididae	1
Neophylax	1
Neoporus	1
Orthoclaadiinae	1
Phaenopsectra	1
Polycentropus	1
Probezzia	1
Rheocricotopus	3
Stegopterna	2
Stenelmis	2
<b>TOTAL:</b>	<b>95</b>

## Physical Habitat Assessment

### EPA Rapid Bioassessment Protocol

	Score	Score	
Bank Stability- Left Bank	6	Pool Variability	11
Bank Stability- Right Bank	6	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	11	Sediment Deposition	12
Channel Sinuosity	13	Vegetative Protection - Left Bank	6
Epifaunal Substrate/Available Cover	12	Vegetative Protection - Right Bank	6
Pool Substrate Characterization	11		

<b>RBP Habitat Score</b>	<b>134</b>
<b>RBP Narrative Rating</b>	<b>Supporting</b>

### MBSS Physical Habitat Index

	Value	Score	Value	Score	
Remoteness	13	70.01	Instream Wood Debris	11	73.88
Shading	85	84.56	Instream Habitat	11	69.07
Epifaunal Substrate	12	79.68	Bank Stability	12	77.46

<b>PHI Score</b>	<b>75.78</b>
<b>PHI Narrative Rating</b>	<b>Partially Degraded</b>

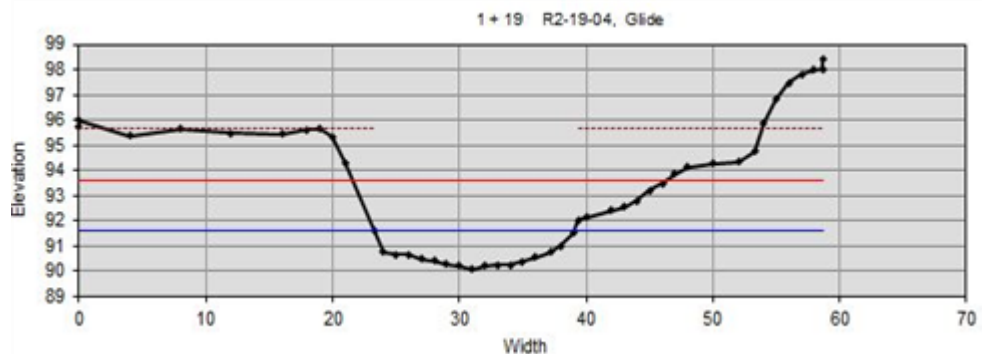
## Water Chemistry

Dissolved Oxygen (mg/L)	12.39	pH (SU)	6.75
Turbidity (NTU)	4.81	Specific Conductivity (µS/cm)	245.83
Temperature (°C)	6.53		

## Geomorphic Assessment

### Rosgen Level II Classification Data

Drainage Area (mi <sup>2</sup> )	1.89	Cross Sectional Area (ft <sup>2</sup> )	23.8
Bankfull Width (ft)	16.4	Water Surface Slope (%)	0.45
Mean Bankfull Depth (ft)	1.45	Sinuosity	1.1
Floodprone Width (ft)	26.2	D50 (mm)	18
Entrenchment Ratio	1.6	Adjustments?	Yes, ER -0.2
Width to Depth Ratio	11.4	<b>Rosgen Stream Type</b>	<b>F4/5</b>



## R2-19-05

## Stocketts Run Sampling Unit

### Upstream View:



Latitude: 38.904076621

### Downstream View:



Longitude: -76.621643876

### Land Use/Land Cover Analysis:

<b>Total Drainage Area (acres)</b>		<b>61.69</b>
<b>Cover</b>	<b>Acres</b>	<b>% Area</b>
<b>Developed Land</b>	<b>26.27</b>	<b>42.58</b>
Airport	0	0
Commercial	0	0
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	2.37	3.84
Residential 2-Acre	22.06	35.76
Transportation	1.84	2.98
Utility	0	0
<b>Forest Land</b>	<b>8</b>	<b>12.96</b>
Forested Wetland	0	0
Residential Woods	0	0
Woods	8	12.96
<b>Open Land</b>	<b>15.81</b>	<b>25.62</b>
Open Space	14.32	23.22
Open Wetland	0	0
Water	1.48	2.4
<b>Agricultural Land</b>	<b>11.62</b>	<b>18.83</b>
Pasture/Hay	5	8.1
Row Crops	6.62	10.73
<b>Impervious Surface</b>	<b>Acres</b>	<b>% Area</b>
Impervious Land	4.47	7.24

### Summary Results:

- Biological condition – “*Very Poor*”
- Habitat scores “*Non Supporting*” and “*Partially Degraded*”
- Midges (Diplocladius) and worms (Naididae) dominated the sample.
- Water quality values within COMAR standards but conductivity elevated.
- Deeply incised channel actively downcutting. Heavily eroded banks and minimal stable substrate for benthos. Poor vegetative protection and pool/glide/eddy quality. Excellent riparian width.
- Adjusted WD Ratio -1.3 to fit G type.

### Recommendations:

- Maintain the protection of the riparian areas.
- Determine causes of instability observed in this reach and evaluate potential for stabilization.

# R2-19-05

# Stocketts Run Sampling Unit

## Biological Assessment

### Raw Metric Values

Total Taxa	11
EPT Taxa	1
Ephemeroptera Taxa	0
%Intolerant Urban	1.8
%Ephemeroptera	0
Scraper Taxa	1
% Climbers	0

### Calculated Metric Scores

Total Taxa	1
EPT Taxa	1
Ephemeroptera Taxa	1
%Intolerant Urban	1
%Ephemeroptera	1
Scraper Taxa	3
% Climbers	1

<b>BIBI Score</b>	<b>1.29</b>
<b>BIBI Narrative Rating</b>	<b>Very Poor</b>

### Taxa Count

Agabus	1
Cricotopus/Orthocladus	2
Diplocladius	47
Enchytraeidae	1
Hydrobaenus	1
Ironoquia	2
Naididae	27
Pisidium	13
Pseudolimnophila	1
Stegopterna	1
Tubificidae	18
<b>TOTAL:</b>	<b>114</b>

## Physical Habitat Assessment

### EPA Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	1	Pool Variability	6
Bank Stability- Right Bank	1	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	15	Riparian Vegetative Zone Width- Right Bank	9
Channel Flow Status	15	Sediment Deposition	9
Channel Sinuosity	10	Vegetative Protection - Left Bank	2
Epifaunal Substrate/Available Cover	6	Vegetative Protection - Right Bank	3
Pool Substrate Characterization	7		

<b>RBP Habitat Score</b>	<b>94</b>
<b>RBP Narrative Rating</b>	<b>Non Supporting</b>

### MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	12	64.62	Instream Wood Debris	7	95.75
Shading	85	84.56	Instream Habitat	5	66.25
Epifaunal Substrate	6	64.21	Bank Stability	2	31.62

<b>PHI Score</b>	<b>67.84</b>
<b>PHI Narrative Rating</b>	<b>Partially Degraded</b>

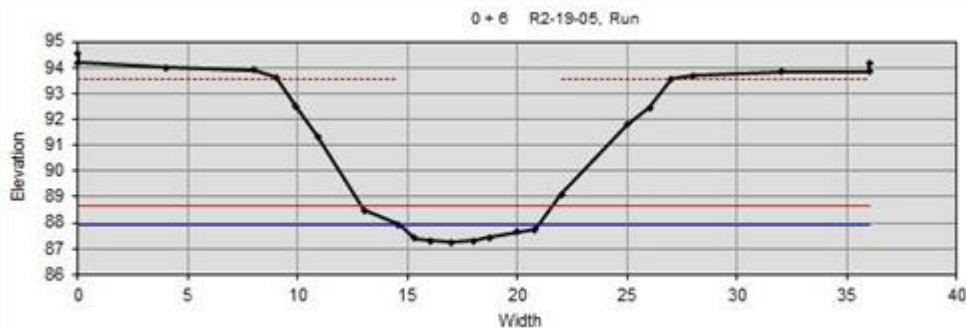
## Water Chemistry

Dissolved Oxygen (mg/L)	12.19	pH (SU)	6.53
Turbidity (NTU)	9.51	Specific Conductivity (µS/cm)	248.1
Temperature (°C)	7.13		

## Geomorphic Assessment

### Rosen Level II Classification Data

Drainage Area (mi <sup>2</sup> )	0.1	Cross Sectional Area (ft <sup>2</sup> )	3.1
Bankfull Width (ft)	6.4	Water Surface Slope (%)	1.7
Mean Bankfull Depth (ft)	0.48	Sinuosity	1.1
Floodprone Width (ft)	8.7	D50 (mm)	0.062
Entrenchment Ratio	1.4	Adjustments?	Yes, WD -1.3
Width to Depth Ratio	13.3	<b>Rosen Stream Type</b>	<b>G6c</b>





## R2-19-06

## Stocketts Run Sampling Unit

### Upstream View:



Latitude: 38.920478898

### Downstream View:



Longitude: -76.669225626

### Land Use/Land Cover Analysis:

**Total Drainage Area (acres) 1399.89**

<u>Cover</u>	<u>Acres</u>	<u>% Area</u>
<b>Developed Land</b>	<b>589.61</b>	<b>42.12</b>
Airport	0	0
Commercial	23.41	1.67
Industrial	0.97	0.07
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	1.34	0.1
Residential 1-Acre	44.03	3.15
Residential 2-Acre	483.83	34.56
Transportation	36.03	2.57
Utility	0	0
<b>Forest Land</b>	<b>358.16</b>	<b>25.59</b>
Forested Wetland	0	0
Residential Woods	0	0
Woods	358.16	25.59
<b>Open Land</b>	<b>176.71</b>	<b>12.62</b>
Open Space	172.29	12.31
Open Wetland	0	0
Water	4.42	0.32
<b>Agricultural Land</b>	<b>275.41</b>	<b>19.67</b>
Pasture/Hay	73.65	5.26
Row Crops	201.75	14.41
<b>Impervious Surface</b>	<b>Acres</b>	<b>% Area</b>
Impervious Land	103.87	7.42

### Summary Results:

- Biological condition – “Fair”
- Habitat scores “Supporting” and “Partially Degraded”
- Midges of the Chironomidae family, including Hydrobaenus and Cricotopus/Orthocladius, dominated the sample.
- Water quality values within COMAR standards.
- Overwidened channel with numerous point bars. Good mix of riffle/rootwad/woody debris habitats. Good velocity depth diversities and riparian width. Marginal bank stability and vegetative protection. Refuse present in minor amounts.
- Bimodal distribution of substrate (sand/gravel).

### Recommendations:

- Maintain the protection of the riparian areas.
- Determine causes of instability observed in this reach and evaluate potential for stabilization.

# R2-19-06

# Stocketts Run Sampling Unit

## Biological Assessment

### Raw Metric Values

Total Taxa	20
EPT Taxa	6
Ephemeroptera Taxa	2
%Intolerant Urban	26
%Ephemeroptera	9.4
Scraper Taxa	4
% Climbers	3.1

### Calculated Metric Scores

Total Taxa	3
EPT Taxa	5
Ephemeroptera Taxa	5
%Intolerant Urban	3
%Ephemeroptera	3
Scraper Taxa	5
% Climbers	3

**BIBI Score** 3.86

**BIBI Narrative Rating** Fair

Taxa	Count
Acerpenna	8
Amphinemura	9
Ancyronyx	1
Boyeria	1
Caecidotea	1
Centroptilum	1
Chironominae	1
Conchapelopia	1
Cricotopus/Orthocladius	10
Dromogomphus	1
Eukiefferiella	1
Gammarus	10
Hydrobaenus	32
Isonychia	2
Limnephilidae	2
Neophylax	1
Oemopteryx	2
Optioservus	1
Orthoclaadiinae	3
Prostoma	1
Rheotanytarsus	1
Simulium	2
Stegopterna	2
Thienemannimyia group	2
<b>TOTAL:</b>	<b>96</b>

## Physical Habitat Assessment

### EPA Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	5	Pool Variability	12
Bank Stability- Right Bank	5	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	10	Sediment Deposition	10
Channel Sinuosity	14	Vegetative Protection - Left Bank	6
Epifaunal Substrate/Available Cover	12	Vegetative Protection - Right Bank	6
Pool Substrate Characterization	12		

**RBP Habitat Score** 132

**RBP Narrative Rating** Supporting

### MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	12	64.62	Instream Wood Debris	5	54.49
Shading	90	91.34	Instream Habitat	12	73.13
Epifaunal Substrate	12	78.73	Bank Stability	10	70.71

**PHI Score** 72.17

**PHI Narrative Rating** Partially Degraded

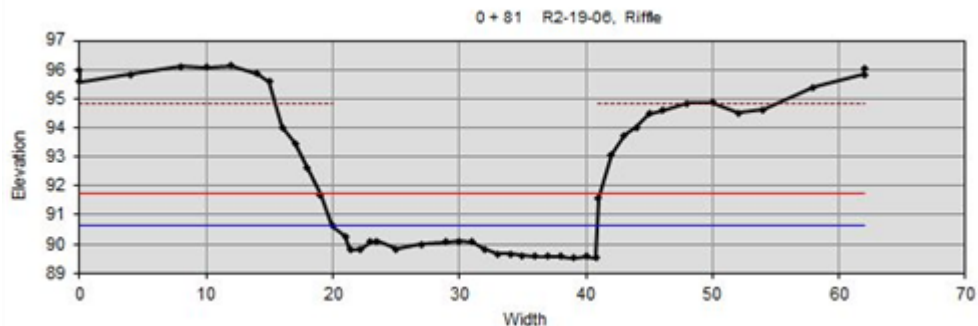
## Water Chemistry

Dissolved Oxygen (mg/L)	12.22	pH (SU)	6.64
Turbidity (NTU)	5.18	Specific Conductivity (µS/cm)	255.9
Temperature (°C)	5.87		

## Geomorphic Assessment

### Rosgen Level II Classification Data

Drainage Area (mi <sup>2</sup> )	2.19	Cross Sectional Area (ft <sup>2</sup> )	16.5
Bankfull Width (ft)	20.9	Water Surface Slope (%)	0.62
Mean Bankfull Depth (ft)	0.79	Sinuosity	1.3
Floodprone Width (ft)	22.2	D50 (mm)	16
Entrenchment Ratio	1.1	Adjustments?	None
Width to Depth Ratio	26.5	<b>Rosgen Stream Type</b>	<b>F4/5</b>



## R2-19-07

## Stocketts Run Sampling Unit

### Upstream View:



Latitude: 38.886489251

### Downstream View:



Longitude: -76.645622603

### Land Use/Land Cover Analysis:

**Total Drainage Area (acres) 3349.45**

<u>Cover</u>	<u>Acres</u>	<u>% Area</u>
<b>Developed Land</b>	<b>850.19</b>	<b>25.38</b>
Airport	0	0
Commercial	41.66	1.24
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	22.61	0.67
Residential 1-Acre	125.38	3.74
Residential 2-Acre	510.84	15.25
Transportation	51.78	1.55
Utility	97.91	2.92
<b>Forest Land</b>	<b>1670.62</b>	<b>49.88</b>
Forested Wetland	0	0
Residential Woods	0	0
Woods	1670.62	49.88
<b>Open Land</b>	<b>249.83</b>	<b>7.46</b>
Open Space	243.96	7.28
Open Wetland	0	0
Water	5.88	0.18
<b>Agricultural Land</b>	<b>578.82</b>	<b>17.28</b>
Pasture/Hay	200.42	5.98
Row Crops	378.4	11.3
<b>Impervious Surface</b>	<b>Acres</b>	<b>% Area</b>
Impervious Land	134.52	4.02

### Summary Results:

- Biological condition – “Poor”
- Habitat scores “Supporting” and “Partially Degraded”
- Hydrobaenus (midge) dominated the sample.
- Water quality values within COMAR standards.
- Severe erosion and bank slumping on right bank throughout the downstream section of the reach. Rootwads, woody debris, and a few riffles provide some stable habitat for benthos. Excellent riparian width. Refuse present in minor amounts.
- Bimodal distribution of substrate (sand/gravel).

### Recommendations:

- Maintain the protection of the riparian areas.
- Determine causes of instability observed in this reach and evaluate potential for stabilization.
- Because habitat is supporting and biological condition is poor, look for problems with water quality and correct, if possible.

**Biological Assessment**

**Raw Metric Values**

Total Taxa	11
EPT Taxa	5
Ephemeroptera Taxa	1
%Intolerant Urban	8.3
%Ephemeroptera	1
Scraper Taxa	1
% Climbers	0

**Calculated Metric Scores**

Total Taxa	1
EPT Taxa	5
Ephemeroptera Taxa	3
%Intolerant Urban	1
%Ephemeroptera	3
Scraper Taxa	3
% Climbers	1

**BIBI Score** 2.43

**BIBI Narrative Rating** Poor

**Taxa Count**

Acerpenna	1
Amphinemura	1
Caecidotea	1
Cheumatopsyche	2
Cricotopus/Orthocladius	2
Diplocladius	2
Gammarus	2
Hydrobaenus	75
Isoperla	4
Oemopteryx	1
Orthocladiinae	2
Orthocladius	1
Tubificidae	2
<b>TOTAL:</b>	<b>96</b>

**Physical Habitat Assessment**

**EPA Rapid Bioassessment Protocol**

	Score		Score
Bank Stability- Left Bank	3	Pool Variability	13
Bank Stability- Right Bank	5	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	18	Riparian Vegetative Zone Width- Right Bank	9
Channel Flow Status	14	Sediment Deposition	13
Channel Sinuosity	15	Vegetative Protection - Left Bank	7
Epifaunal Substrate/Available Cover	13	Vegetative Protection - Right Bank	4
Pool Substrate Characterization	11		

**RBP Habitat Score** 135

**RBP Narrative Rating** Supporting

**MBSS Physical Habitat Index**

	Value	Score		Value	Score
Remoteness	11	59.24	Instream Wood Debris	16	77.16
Shading	70	68.32	Instream Habitat	13	69.75
Epifaunal Substrate	13	78.86	Bank Stability	8	63.25

**PHI Score** 69.43

**PHI Narrative Rating** Partially Degraded

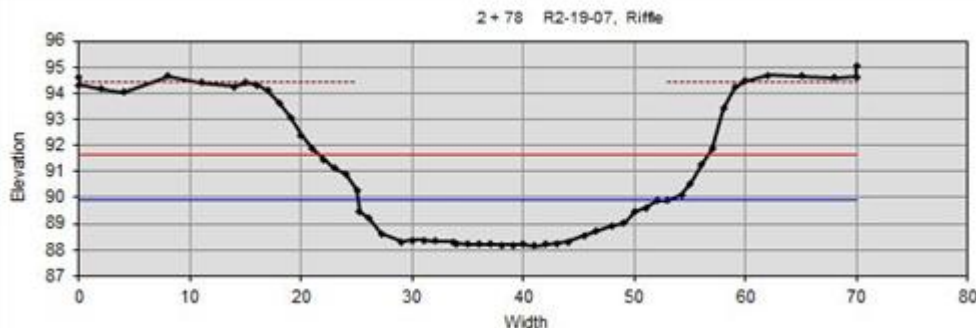
**Water Chemistry**

Dissolved Oxygen (mg/L)	12.81	pH (SU)	7.63
Turbidity (NTU)	5.41	Specific Conductivity (µS/cm)	183.3
Temperature (°C)	12.2		

**Geomorphic Assessment**

**Rosgen Level II Classification Data**

Drainage Area (mi <sup>2</sup> )	5.23	Cross Sectional Area (ft <sup>2</sup> )	36.1
Bankfull Width (ft)	27.9	Water Surface Slope (%)	0.28
Mean Bankfull Depth (ft)	1.3	Sinuosity	1.3
Floodprone Width (ft)	35.1	D50 (mm)	1.3
Entrenchment Ratio	1.3	Adjustments?	None
Width to Depth Ratio	21.5	<b>Rosgen Stream Type</b>	<b>F4/5</b>



Upstream View:



Latitude: 38.916204485

Downstream View:



Longitude: -76.678239675

**Land Use/Land Cover Analysis:**

**Total Drainage Area (acres) 1595.66**

<u>Cover</u>	<u>Acres</u>	<u>% Area</u>
<b>Developed Land 634.59 39.77</b>		
Airport	0	0
Commercial	32.42	2.03
Industrial	0.97	0.06
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	7.37	0.46
Residential 1-Acre	45.69	2.86
Residential 2-Acre	511.2	32.04
Transportation	36.95	2.32
Utility	0	0
<b>Forest Land 465.01 29.14</b>		
Forested Wetland	0	0
Residential Woods	0	0
Woods	465.01	29.14
<b>Open Land 218.03 13.66</b>		
Open Space	213.3	13.37
Open Wetland	0	0
Water	4.73	0.3
<b>Agricultural Land 278.03 17.42</b>		
Pasture/Hay	73.65	4.62
Row Crops	204.37	12.81

<u>Impervious Surface</u>	<u>Acres</u>	<u>% Area</u>
Impervious Land	111.49	6.99

**Summary Results:**

- Biological condition – “Fair”
- Habitat scores “Partially Supporting” and “Degraded”
- Hydrobaenus (midge) dominated the sample.
- Water quality values within COMAR standards but conductivity elevated.
- Poor remoteness score due to close proximity to Renditions Golf Club. Riparian vegetation mostly intact with moderately stable banks. Rootwads abundant and providing stable habitat. Refuse present in minor amounts.
- Bimodal distribution of substrate (sand/gravel).

**Recommendations:**

- Buffer enhancement.

# R2-19-08

# Stocketts Run Sampling Unit

## Biological Assessment

### Raw Metric Values

Total Taxa	15
EPT Taxa	6
Ephemeroptera Taxa	4
%Intolerant Urban	14.4
%Ephemeroptera	12.5
Scraper Taxa	1
% Climbers	1

### Calculated Metric Scores

Total Taxa	3
EPT Taxa	5
Ephemeroptera Taxa	5
%Intolerant Urban	3
%Ephemeroptera	5
Scraper Taxa	3
% Climbers	3

<b>BIBI Score</b>	<b>3.86</b>
<b>BIBI Narrative Rating</b>	<b>Fair</b>

Taxa	Count
Acerpenna	7
Centroptilum	4
Cheumatopsyche	2
Chironomidae	1
Cricotopus/Orthocladius	11
Ephemerella	1
Eukiefferiella	2
Gammarus	5
Hydrobaenus	60
Leptophlebia	1
Micropsectra	1
Naididae	1
Orthoclaadiinae	1
Orthocladius	3
Polycentropus	1
Rheocricotopus	1
Thienemannimyia group	1
Tubificidae	1
<b>TOTAL:</b>	<b>104</b>

## Physical Habitat Assessment

### EPA Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	6	Pool Variability	10
Bank Stability- Right Bank	6	Riparian Vegetative Zone Width- Left Bank	4
Channel Alteration	16	Riparian Vegetative Zone Width- Right Bank	8
Channel Flow Status	12	Sediment Deposition	8
Channel Sinuosity	6	Vegetative Protection - Left Bank	7
Epifaunal Substrate/Available Cover	12	Vegetative Protection - Right Bank	7
Pool Substrate Characterization	10		

<b>RBP Habitat Score</b>	<b>112</b>
<b>RBP Narrative Rating</b>	<b>Partially Supporting</b>

### MBSS Physical Habitat Index

	Value	Score	Value	Score	
Remoteness	5	26.93	Instream Wood Debris	9	64.84
Shading	50	49.95	Instream Habitat	11	66.24
Epifaunal Substrate	12	77.88	Bank Stability	12	77.46

<b>PHI Score</b>	<b>60.55</b>
<b>PHI Narrative Rating</b>	<b>Degraded</b>

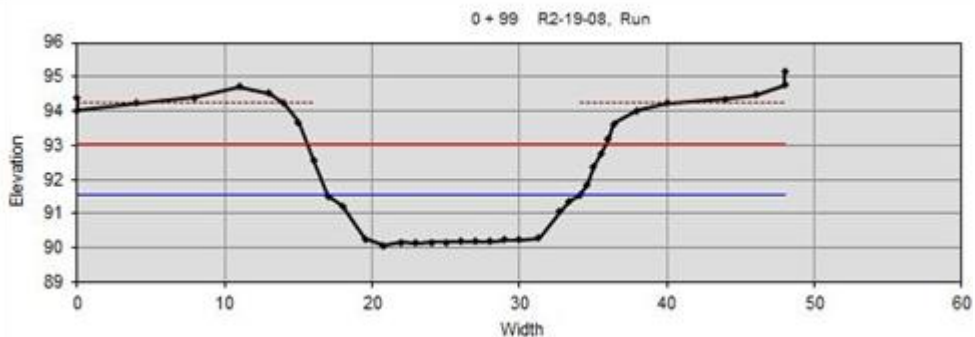
## Water Chemistry

Dissolved Oxygen (mg/L)	13.12	pH (SU)	6.89
Turbidity (NTU)	4.48	Specific Conductivity (µS/cm)	262.8
Temperature (°C)	9.87		

## Geomorphic Assessment

### Rosgen Level II Classification Data

Drainage Area (mi <sup>2</sup> )	2.49	Cross Sectional Area (ft <sup>2</sup> )	19
Bankfull Width (ft)	17.1	Water Surface Slope (%)	0.46
Mean Bankfull Depth (ft)	1.11	Sinuosity	1.1
Floodprone Width (ft)	20.2	D50 (mm)	12
Entrenchment Ratio	1.2	Adjustments?	None
Width to Depth Ratio	15.5	<b>Rosgen Stream Type</b>	<b>F4/5</b>



## R2-19-10

## Stocketts Run Sampling Unit

### Upstream View:



Latitude: 38.903442993

### Downstream View:



Longitude: -76.622809621

### Land Use/Land Cover Analysis:

**Total Drainage Area (acres) 87.32**

<u>Cover</u>	<u>Acres</u>	<u>% Area</u>
<b>Developed Land</b>	<b>34.66</b>	<b>39.69</b>
Airport	0	0
Commercial	0.64	0.73
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	2.37	2.71
Residential 2-Acre	29.81	34.14
Transportation	1.84	2.11
Utility	0	0
<b>Forest Land</b>	<b>16.27</b>	<b>18.63</b>
Forested Wetland	0	0
Residential Woods	0	0
Woods	16.27	18.63
<b>Open Land</b>	<b>17.25</b>	<b>19.75</b>
Open Space	15.77	18.05
Open Wetland	0	0
Water	1.48	1.7
<b>Agricultural Land</b>	<b>19.15</b>	<b>21.93</b>
Pasture/Hay	10.21	11.69
Row Crops	8.94	10.24
<b>Impervious Surface</b>	<b>Acres</b>	<b>% Area</b>
Impervious Land	5.89	6.75

### Summary Results:

- Biological condition – “Very Poor”
- Habitat scores “Partially Supporting” and “Partially Degraded”
- Diplocladius (midge) dominated the sample.
- Measured below COMAR standards for pH and conductivity elevated.
- Deeply incised channel, with shallow depth and lacking velocity depth diversity and stable habitat. Mostly silt/muck substrates. Moderately unstable banks with sub-optimal vegetative protection. Excellent riparian width.
- Adjusted WD Ratio -0.3 to fit G type.

### Recommendations:

- Maintain the protection of the riparian areas.
- Determine causes of instability observed in this reach and evaluate potential for stabilization.
- Because habitat is partially supporting and biological condition is very poor, look for problems with water quality and correct, if possible.

# R2-19-10

# Stocketts Run Sampling Unit

## Biological Assessment

### Raw Metric Values

Total Taxa	15
EPT Taxa	0
Ephemeroptera Taxa	0
%Intolerant Urban	5.9
%Ephemeroptera	0
Scraper Taxa	0
% Climbers	2

### Calculated Metric Scores

Total Taxa	3
EPT Taxa	1
Ephemeroptera Taxa	1
%Intolerant Urban	1
%Ephemeroptera	1
Scraper Taxa	1
% Climbers	3

**BIBI Score** 1.57

**BIBI Narrative Rating** Very Poor

### Taxa Count

Caecidotea	1
Chrysops	1
Crangonyx	5
Cricotopus/Orthocladius	8
Diplocladius	48
Enchytraeidae	1
Gastropoda	1
Micropsectra	1
Naididae	6
Orthoclaadiinae	1
Paraphaenocladus	1
Pisidium	17
Polypedilum	1
Stegopterna	3
Thienemannimyia group	1
Tubificidae	5
<b>TOTAL:</b>	<b>101</b>

## Physical Habitat Assessment

### EPA Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	4	Pool Variability	7
Bank Stability- Right Bank	6	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	16	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	16	Sediment Deposition	10
Channel Sinuosity	9	Vegetative Protection - Left Bank	6
Epifaunal Substrate/Available Cover	6	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	7		

**RBP Habitat Score** 115

**RBP Narrative Rating** Partially Supporting

### MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	13	70.01	Instream Wood Debris	12	100
Shading	50	49.95	Instream Habitat	5	62.69
Epifaunal Substrate	7	67.76	Bank Stability	10	70.71

**PHI Score** 70.19

**PHI Narrative Rating** Partially Degraded

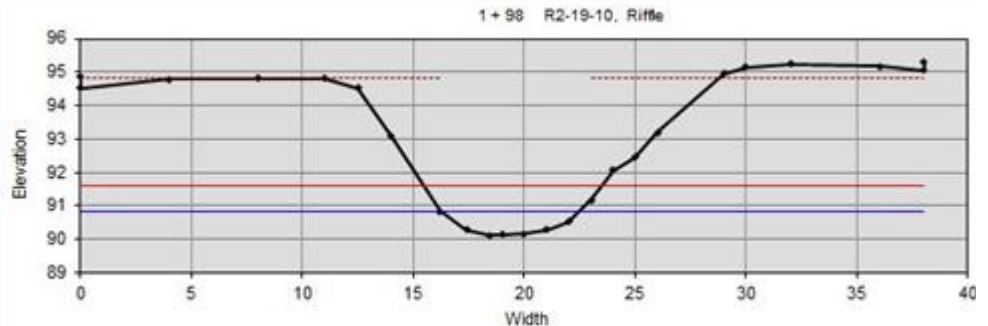
## Water Chemistry

Dissolved Oxygen (mg/L)	12.27	pH (SU)	6.29
Turbidity (NTU)	11.1	Specific Conductivity (µS/cm)	272.37
Temperature (°C)	5.9		

## Geomorphic Assessment

### Rosgen Level II Classification Data

Drainage Area (mi <sup>2</sup> )	0.14	Cross Sectional Area (ft <sup>2</sup> )	3.2
Bankfull Width (ft)	6.3	Water Surface Slope (%)	0.63
Mean Bankfull Depth (ft)	0.51	Sinuosity	1.1
Floodprone Width (ft)	8	D50 (mm)	0.062
Entrenchment Ratio	1.3	Adjustments?	Yes, WD -0.3
Width to Depth Ratio	12.3	<b>Rosgen Stream Type</b>	<b>G6c</b>





## R2-19-11A

## Stocketts Run Sampling Unit

### Upstream View:



Latitude: 38.919622696

### Downstream View:



Longitude: -76.663953382

### Land Use/Land Cover Analysis:

**Total Drainage Area (acres) 1300.76**

<u>Cover</u>	<u>Acres</u>	<u>% Area</u>
<b>Developed Land</b>	<b>562.34</b>	<b>43.23</b>
Airport	0	0
Commercial	23.41	1.8
Industrial	0.97	0.07
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	1.34	0.1
Residential 1-Acre	43.73	3.36
Residential 2-Acre	462.14	35.53
Transportation	30.74	2.36
Utility	0	0
<b>Forest Land</b>	<b>320.93</b>	<b>24.67</b>
Forested Wetland	0	0
Residential Woods	0	0
Woods	320.93	24.67
<b>Open Land</b>	<b>161.34</b>	<b>12.4</b>
Open Space	156.91	12.06
Open Wetland	0	0
Water	4.42	0.34
<b>Agricultural Land</b>	<b>256.15</b>	<b>19.69</b>
Pasture/Hay	73.65	5.66
Row Crops	182.5	14.03
<b>Impervious Surface</b>	<b>Acres</b>	<b>% Area</b>
Impervious Land	98.46	7.57

### Summary Results:

- Biological condition – “Fair”
- Habitat scores “Supporting” and “Degraded”
- Hydrobaenus and Cricotopus/Orthocladius (midges) dominated the sample.
- Water quality values within COMAR standards but conductivity elevated.
- Incised, overwidened channel with heavily eroded banks and extensive deposition bars. Good diversity of depths and flow velocities. Poor remoteness score due to close proximity to Patuxent River Road. Refuse present in minor amounts.
- Reach is immediately downstream of large culvert which is impacting channel morphology. Stream type indeterminate.

### Recommendations:

- Maintain the protection of the riparian areas.
- Determine causes of instability observed in this reach and evaluate potential for stabilization.

# R2-19-11A

# Stocketts Run Sampling Unit

## Biological Assessment

### Raw Metric Values

Total Taxa	22
EPT Taxa	4
Ephemeroptera Taxa	2
%Intolerant Urban	8.9
%Ephemeroptera	2
Scraper Taxa	4
% Climbers	5.9

### Calculated Metric Scores

Total Taxa	5
EPT Taxa	3
Ephemeroptera Taxa	5
%Intolerant Urban	1
%Ephemeroptera	3
Scraper Taxa	5
% Climbers	3

<b>BIBI Score</b>	<b>3.57</b>
<b>BIBI Narrative Rating</b>	<b>Fair</b>

Taxa	Count
Acerpenna	1
Amphinemura	3
Amphipoda	1
Boyeria	2
Centroptilum	1
Chironomidae	1
Conchapelopia	1
Cricotopus/Orthocladius	29
Diplocladius	3
Dubiraphia	1
Enallagma	1
Gammarus	1
Hyaella	1
Hydrobaenus	40
Naididae	3
Nigronia	1
Oemopteryx	1
Optioservus	1
Orthocladius	1
Parametricnemus	1
Prosimulium	1
Stegopterna	1
Stenelmis	1
Tanytarsus	1
Thienemannimyia group	1
Tubificidae	2
<b>TOTAL:</b>	<b>101</b>

## Physical Habitat Assessment

### EPA Rapid Bioassessment Protocol

	Score	Score	
Bank Stability- Left Bank	5	Pool Variability	14
Bank Stability- Right Bank	5	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	15	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	11	Sediment Deposition	12
Channel Sinuosity	9	Vegetative Protection - Left Bank	6
Epifaunal Substrate/Available Cover	12	Vegetative Protection - Right Bank	6
Pool Substrate Characterization	13		

<b>RBP Habitat Score</b>	<b>128</b>
<b>RBP Narrative Rating</b>	<b>Supporting</b>

### MBSS Physical Habitat Index

	Value	Score	Value	Score	
Remoteness	5	26.93	Instream Wood Debris	5	55.32
Shading	65	63.55	Instream Habitat	11	68.33
Epifaunal Substrate	12	79.21	Bank Stability	10	70.71

<b>PHI Score</b>	<b>60.68</b>
<b>PHI Narrative Rating</b>	<b>Degraded</b>

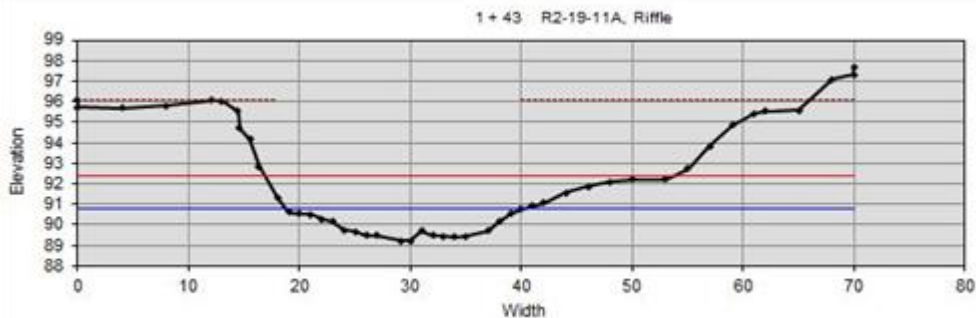
## Water Chemistry

Dissolved Oxygen (mg/L)	12.1	pH (SU)	6.76
Turbidity (NTU)	5.92	Specific Conductivity (µS/cm)	262.07
Temperature (°C)	6.5		

## Geomorphic Assessment

### Rosen Level II Classification Data

Drainage Area (mi <sup>2</sup> )	2.03	Cross Sectional Area (ft <sup>2</sup> )	20.3
Bankfull Width (ft)	21.2	Water Surface Slope (%)	0.35
Mean Bankfull Depth (ft)	0.96	Sinuosity	1.1
Floodprone Width (ft)	36.6	D50 (mm)	1.8
Entrenchment Ratio	1.7	Adjustments?	None
Width to Depth Ratio	22.2	<b>Rosen Stream Type</b>	<b>ND</b>



## R2-19-16A

## Stocketts Run Sampling Unit

### Upstream View:



Latitude: 38.884950656

### Downstream View:



Longitude: -76.656401818

### Land Use/Land Cover Analysis:

<b>Total Drainage Area (acres)</b>			<b>3665.6</b>
<b>Cover</b>	<b>Acres</b>	<b>% Area</b>	
<b>Developed Land</b>	<b>925.36</b>	<b>25.24</b>	
Airport	0	0	
Commercial	41.66	1.14	
Industrial	0	0	
Residential 1/8-acre	0	0	
Residential 1/4-acre	0	0	
Residential 1/2-acre	22.61	0.62	
Residential 1-Acre	131.42	3.59	
Residential 2-Acre	571.21	15.58	
Transportation	60.55	1.65	
Utility	97.91	2.67	
<b>Forest Land</b>	<b>1835.19</b>	<b>50.07</b>	
Forested Wetland	0	0	
Residential Woods	0	0	
Woods	1835.19	50.07	
<b>Open Land</b>	<b>269.93</b>	<b>7.36</b>	
Open Space	264.05	7.2	
Open Wetland	0	0	
Water	5.88	0.16	
<b>Agricultural Land</b>	<b>635.12</b>	<b>17.33</b>	
Pasture/Hay	256.72	7	
Row Crops	378.4	10.32	
<b>Impervious Surface</b>	<b>Acres</b>	<b>% Area</b>	
Impervious Land	143.91	3.93	

### Summary Results:

- Biological condition – “Poor”
- Habitat scores “Supporting” and “Partially Degraded”
- Hydrobaenus (midge) dominated the sample.
- Water quality values within COMAR standards.
- Overwidened channel with large point bars and some areas of heavy bank erosion. An abundance of woody debris provides stable habitat. Good sinuosity and riparian width. Refuse present in minor amounts.
- Adjusted ER -0.1 to fit F type. Bimodal distribution of substrate (sand/gravel).

### Recommendations:

- Maintain the protection of the riparian areas.
- Determine causes of instability observed in this reach and evaluate potential for stabilization.
- Because habitat is supporting and biological condition is poor, look for problems with water quality and correct, if possible.

# R2-19-16A

# Stocketts Run Sampling Unit

## Biological Assessment

### Raw Metric Values

Total Taxa	11
EPT Taxa	3
Ephemeroptera Taxa	0
%Intolerant Urban	12.1
%Ephemeroptera	0
Scraper Taxa	1
% Climbers	1

### Calculated Metric Scores

Total Taxa	1
EPT Taxa	3
Ephemeroptera Taxa	1
%Intolerant Urban	3
%Ephemeroptera	1
Scraper Taxa	3
% Climbers	3

**BIBI Score** 2.14

**BIBI Narrative Rating** Poor

Taxa	Count
Amphinemura	1
Boyeria	1
Chironomidae	1
Cricotopus/Orthocladius	7
Dicrotendipes	2
Diplocladius	1
Hydrobaenus	70
Isoperla	9
Lumbricidae	1
Oemopteryx	2
Tipula	3
Tubificidae	1
<b>TOTAL:</b>	<b>99</b>

## Physical Habitat Assessment

### EPA Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	3	Pool Variability	12
Bank Stability- Right Bank	4	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	11	Sediment Deposition	13
Channel Sinuosity	15	Vegetative Protection - Left Bank	5
Epifaunal Substrate/Available Cover	13	Vegetative Protection - Right Bank	7
Pool Substrate Characterization	12		

**RBP Habitat Score** 135

**RBP Narrative Rating** Supporting

### MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	14	75.39	Instream Wood Debris	17	79.09
Shading	80	78.67	Instream Habitat	13	68.83
Epifaunal Substrate	13	78.27	Bank Stability	7	59.16

**PHI Score** 73.24

**PHI Narrative Rating** Partially Degraded

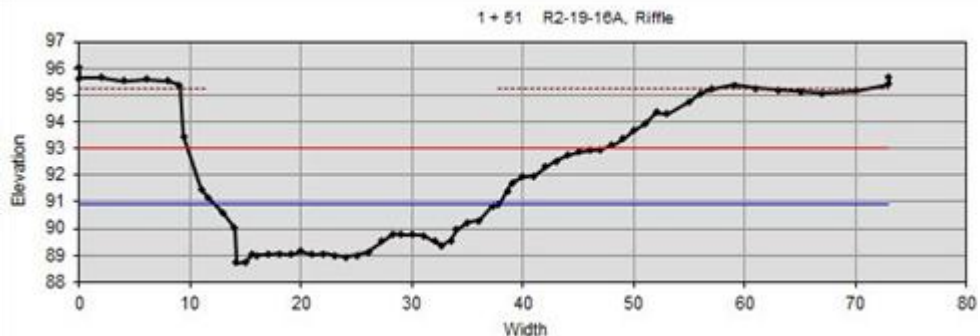
## Water Chemistry

Dissolved Oxygen (mg/L)	11.67	pH (SU)	7
Turbidity (NTU)	4.81	Specific Conductivity (µS/cm)	179.2
Temperature (°C)	10.3		

## Geomorphic Assessment

### Rosen Level II Classification Data

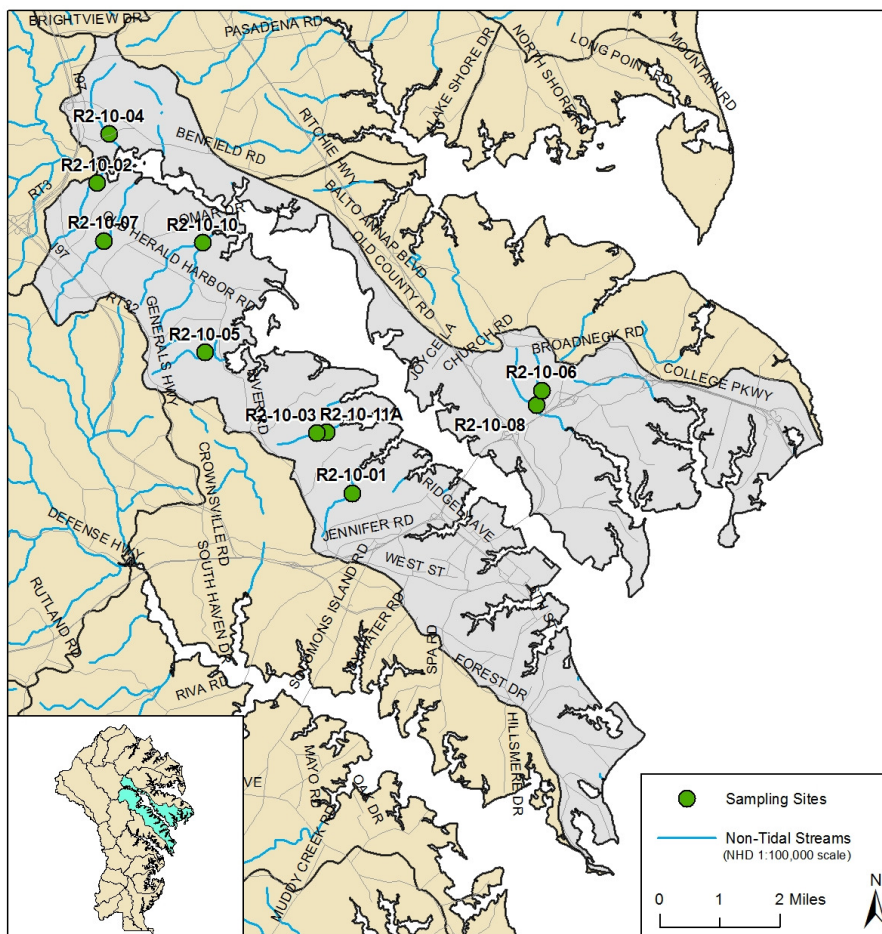
Drainage Area (mi <sup>2</sup> )	5.73	Cross Sectional Area (ft <sup>2</sup> )	34.9
Bankfull Width (ft)	25.5	Water Surface Slope (%)	0.23
Mean Bankfull Depth (ft)	1.37	Sinuosity	1.7
Floodprone Width (ft)	37.6	D50 (mm)	2
Entrenchment Ratio	1.5	Adjustments?	Yes, ER -0.1
Width to Depth Ratio	18.6	<b>Rosen Stream Type</b>	<b>F4/5</b>



# Severn River Sampling Unit

## Site Condition Summary

Site	Drainage Area (acres)	Drainage Area (mi <sup>2</sup> )	Percent Impervious	Percent Developed	Percent Forested	Percent Agriculture	Percent Open	BIBI Narrative Rating	PHI Narrative Rating	RBP Narrative Rating	Rosgen Stream Type - L1
R2-10-01	373.2	0.58	36.0	62.0	31.8	0.0	6.2	Poor	Minimally Degraded	Comparable to Reference	Transitional
R2-10-02	436.3	0.68	8.8	35.7	54.4	7.0	3.0	Fair	Minimally Degraded	Comparable to Reference	DA
R2-10-03	215.0	0.34	10.4	53.4	46.2	0.0	0.4	Fair	Minimally Degraded	Supporting	Transitional
R2-10-04	528.8	0.83	27.3	71.6	21.2	1.0	6.2	Very Poor	Partially Degraded	Supporting	E
R2-10-05	287.0	0.45	11.1	43.2	55.3	0.0	1.5	Fair	Partially Degraded	Non Supporting	G
R2-10-06	330.9	0.52	20.7	64.0	33.0	0.1	3.0	Poor	Partially Degraded	Partially Supporting	Transitional
R2-10-07	1054.5	1.65	9.9	43.7	39.1	8.7	8.5	Poor	Degraded	Supporting	E
R2-10-08	770.1	1.20	15.1	56.1	41.2	0.0	2.8	Poor	Degraded	Comparable to Reference	ND
R2-10-10	1364.2	2.13	6.4	34.9	55.5	3.8	5.9	Fair	Degraded	Supporting	E
R2-10-11A	456.0	0.71	10.7	53.5	45.7	0.0	0.8	Poor	Partially Degraded	Supporting	E



## R2-10-01

## Severn River Sampling Unit

### Upstream View:



Latitude: 39.000017212

### Downstream View:



Longitude: -76.540553731

### Land Use/Land Cover Analysis:

**Total Drainage Area (acres) 373.18**

<u>Cover</u>	<u>Acres</u>	<u>% Area</u>
<b>Developed Land</b>	<b>231.31</b>	<b>61.98</b>
Airport	0	0
Commercial	76.98	20.63
Industrial	62.91	16.86
Residential 1/8-acre	23.49	6.29
Residential 1/4-acre	0	0
Residential 1/2-acre	0.36	0.1
Residential 1-Acre	46.77	12.53
Residential 2-Acre	4.65	1.25
Transportation	14.66	3.93
Utility	1.49	0.4
<b>Forest Land</b>	<b>118.57</b>	<b>31.77</b>
Forested Wetland	0	0
Residential Woods	0	0
Woods	118.57	31.77
<b>Open Land</b>	<b>23.3</b>	<b>6.24</b>
Open Space	23.3	6.24
Open Wetland	0	0
Water	0	0
<b>Agricultural Land</b>	<b>0</b>	<b>0</b>
Pasture/Hay	0	0
Row Crops	0	0

<u>Impervious Surface</u>	<u>Acres</u>	<u>% Area</u>
Impervious Land	134.18	35.95

### Summary Results:

- Biological condition – “Poor”
- Habitat scores “Comparable to Reference” and “Minimally Degraded”
- Tubificidae (worms) and various midges of the Chironomidae family dominated the sample.
- Water quality values within COMAR standards but conductivity elevated.
- Large woody debris jam in the middle of the reach causing backwatering in upper half. Sub-optimal epifaunal substrate and instream habitat with an abundance of rootwads and woody debris. Excellent bank stability and riparian width.
- Transitional reach from E upstream to DA downstream.

### Recommendations:

- Maintain the protection of the riparian areas.
- Because habitat is comparable to reference and biological condition is poor, look for problems with water quality and correct, if possible.

# R2-10-01

# Severn River Sampling Unit

## Biological Assessment

### Raw Metric Values

Total Taxa	24
EPT Taxa	2
Ephemeroptera Taxa	0
%Intolerant Urban	5.7
%Ephemeroptera	0
Scraper Taxa	5
% Climbers	2.9

### Calculated Metric Scores

Total Taxa	5
EPT Taxa	3
Ephemeroptera Taxa	1
%Intolerant Urban	1
%Ephemeroptera	1
Scraper Taxa	5
% Climbers	3

<b>BIBI Score</b>	<b>2.71</b>
<b>BIBI Narrative Rating</b>	<b>Poor</b>

Taxa	Count
Anchyrtarsus	1
Ancyronyx	1
Chironomidae	1
Chironomini	2
Conchapelopia	2
Cricotopus/Orthocladius	1
Culicoides	2
Diplocladius	10
Erythemis	1
Gammarus	2
Lumbricidae	3
Lype	3
Menetus	1
Naididae	9
Nematomorpha	4
Orthoclaadiinae	2
Paratendipes	4
Phaenopsectra	1
Pisidium	3
Polycentropus	5
Prostoma	1
Rheocricotopus	1
Rheotanytarsus	9
Stagnicola	1
Thienemannimyia group	4
Tipula	2
Tubificidae	28
Viviparus	1
<b>TOTAL:</b>	<b>105</b>

## Physical Habitat Assessment

### EPA Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	9	Pool Variability	14
Bank Stability- Right Bank	9	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	19	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	18	Sediment Deposition	12
Channel Sinuosity	12	Vegetative Protection - Left Bank	10
Epifaunal Substrate/Available Cover	11	Vegetative Protection - Right Bank	10
Pool Substrate Characterization	11		

<b>RBP Habitat Score</b>	<b>155</b>
<b>RBP Narrative Rating</b>	<b>Comparable to Reference</b>

### MBSS Physical Habitat Index

	Value	Score	Value	Score	
Remoteness	14	75.39	Instream Wood Debris	21	100
Shading	97	100	Instream Habitat	11	81.11
Epifaunal Substrate	10	75.73	Bank Stability	18	94.87

<b>PHI Score</b>	<b>87.85</b>
<b>PHI Narrative Rating</b>	<b>Minimally Degraded</b>

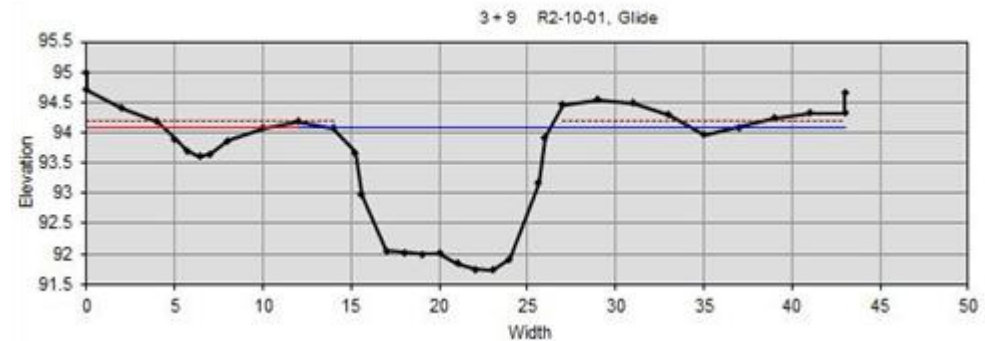
## Water Chemistry

Dissolved Oxygen (mg/L)	11.82	pH (SU)	6.85
Turbidity (NTU)	11.1	Specific Conductivity (µS/cm)	272.47
Temperature (°C)	9.53		

## Geomorphic Assessment

### Rosen Level II Classification Data

Drainage Area (mi <sup>2</sup> )	0.58	Cross Sectional Area (ft <sup>2</sup> )	20.6
Bankfull Width (ft)	12.3	Water Surface Slope (%)	0.64
Mean Bankfull Depth (ft)	1.7	Sinuosity	1.3
Floodprone Width (ft)	152	D50 (mm)	0.2
Entrenchment Ratio	12.4	Adjustments?	None
Width to Depth Ratio	7.3	<b>Rosen Stream Type</b>	<b>Transitional</b>



## R2-10-02

## Severn River Sampling Unit

### Upstream View:



Latitude: 39.075292135

### Downstream View:



Longitude: -76.619359396

### Land Use/Land Cover Analysis:

**Total Drainage Area (acres) 436.34**

<u>Cover</u>	<u>Acres</u>	<u>% Area</u>
<b>Developed Land</b>	<b>155.69</b>	<b>35.68</b>
Airport	0	0
Commercial	15.84	3.63
Industrial	0.72	0.16
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	10.76	2.47
Residential 1-Acre	46.35	10.62
Residential 2-Acre	70.28	16.11
Transportation	8.86	2.03
Utility	2.87	0.66
<b>Forest Land</b>	<b>237.22</b>	<b>54.37</b>
Forested Wetland	0	0
Residential Woods	0	0
Woods	237.22	54.37
<b>Open Land</b>	<b>13.12</b>	<b>3.01</b>
Open Space	13.12	3.01
Open Wetland	0	0
Water	0	0
<b>Agricultural Land</b>	<b>30.31</b>	<b>6.95</b>
Pasture/Hay	11.76	2.7
Row Crops	18.55	4.25
<b><u>Impervious Surface</u></b>	<b><u>Acres</u></b>	<b><u>% Area</u></b>
Impervious Land	38.2	8.75

### Summary Results:

- Biological condition – “Fair”
- Habitat scores “Comparable to Reference” and “Minimally Degraded”
- Various midges of the Chironomidae family, including Tanytarsini and Micropsectra, dominated the sample.
- Measured below COMAR standards for pH.
- Multi-thread channel through thickly vegetated wetland with an abundance of rootwads providing stable habitat. Excellent bank stability, vegetative protection, and riparian width.

### Recommendations:

- Maintain the protection of the riparian areas.
- Because habitat is comparable to reference and biological condition is fair, look for problems with water quality and correct, if possible.



**Biological Assessment**

**Raw Metric Values**

Total Taxa	23
EPT Taxa	5
Ephemeroptera Taxa	0
%Intolerant Urban	46.5
%Ephemeroptera	0
Scraper Taxa	1
% Climbers	21.8

**Calculated Metric Scores**

Total Taxa	5
EPT Taxa	5
Ephemeroptera Taxa	1
%Intolerant Urban	5
%Ephemeroptera	1
Scraper Taxa	3
% Climbers	5

<b>BIBI Score</b>	<b>3.57</b>
<b>BIBI Narrative Rating</b>	<b>Fair</b>

**Taxa Count**

Agapetus	2
Apsictrotanytus	3
Calopteryx	2
Cheumatopsyche	1
Chrysops	1
Conchapelopia	1
Heterotrissocladius	8
Lepidostoma	1
Leuctra	6
Micropsectra	8
Microtendipes	2
Natarsia	2
Parametricnemus	7
Phaenopsectra/Tribelos	1
Pisidium	1
Plecoptera	6
Polycentropus	5
Polypedilum	1
Pseudolimnophila	1
Rheotanytarsus	2
Sialis	3
Stegopterna	1
Synurella	5
Tanytarsini	18
Tanytarsus	7
Thienemannimyia group	6
<b>TOTAL:</b>	<b>101</b>

**Physical Habitat Assessment**

**EPA Rapid Bioassessment Protocol**

	Score		Score
Bank Stability- Left Bank	10	Pool Variability	11
Bank Stability- Right Bank	10	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	16	Sediment Deposition	16
Channel Sinuosity	14	Vegetative Protection - Left Bank	10
Epifaunal Substrate/Available Cover	12	Vegetative Protection - Right Bank	10
Pool Substrate Characterization	11		

<b>RBP Habitat Score</b>	<b>160</b>
<b>RBP Narrative Rating</b>	<b>Comparable to Reference</b>

**MBSS Physical Habitat Index**

	Value	Score		Value	Score
Remoteness	19	100	Instream Wood Debris	9	79.52
Shading	96	100	Instream Habitat	10	73.97
Epifaunal Substrate	13	92.14	Bank Stability	20	100

<b>PHI Score</b>	<b>90.94</b>
<b>PHI Narrative Rating</b>	<b>Minimally Degraded</b>

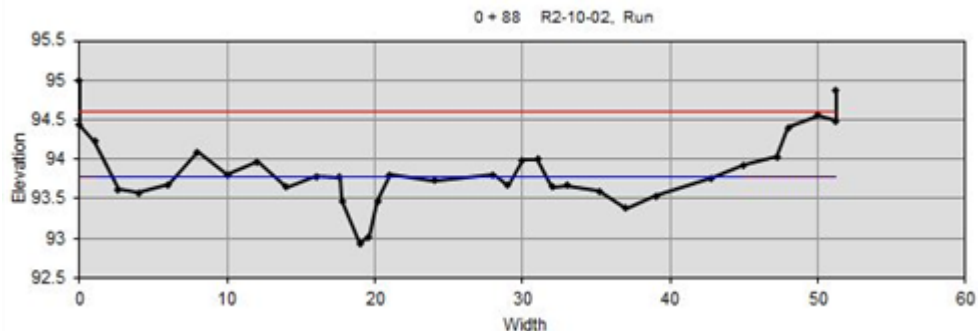
**Water Chemistry**

Dissolved Oxygen (mg/L)	11.72	pH (SU)	5.57
Turbidity (NTU)	2.64	Specific Conductivity (µS/cm)	63.8
Temperature (°C)	6.9		

**Geomorphic Assessment**

**Rosen Level II Classification Data**

Drainage Area (mi <sup>2</sup> )	0.68	Cross Sectional Area (ft <sup>2</sup> )	4.5
Bankfull Width (ft)	26.5	Water Surface Slope (%)	1.9
Mean Bankfull Depth (ft)	0.17	Sinuosity	1.2
Floodprone Width (ft)	160	D50 (mm)	0.094
Entrenchment Ratio	6	Adjustments?	None
Width to Depth Ratio	155.8	<b>Rosen Stream Type</b>	<b>DA5</b>



## R2-10-03

## Severn River Sampling Unit

### Upstream View:



Latitude: 39.01457271

### Downstream View:



Longitude: -76.551512592

### Land Use/Land Cover Analysis:

**Total Drainage Area (acres) 214.99**

<u>Cover</u>	<u>Acres</u>	<u>% Area</u>
<b>Developed Land</b>	<b>114.79</b>	<b>53.39</b>
Airport	0	0
Commercial	0.35	0.16
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	42.55	19.79
Residential 1-Acre	62.2	28.93
Residential 2-Acre	3	1.4
Transportation	4.32	2.01
Utility	2.37	1.1
<b>Forest Land</b>	<b>99.29</b>	<b>46.19</b>
Forested Wetland	0	0
Residential Woods	0	0
Woods	99.29	46.19
<b>Open Land</b>	<b>0.9</b>	<b>0.42</b>
Open Space	0.9	0.42
Open Wetland	0	0
Water	0	0
<b>Agricultural Land</b>	<b>0</b>	<b>0</b>
Pasture/Hay	0	0
Row Crops	0	0

<u>Impervious Surface</u>	<u>Acres</u>	<u>% Area</u>
Impervious Land	22.35	10.39

### Summary Results:

- Biological condition – “Fair”
- Habitat scores “Supporting” and “Minimally Degraded”
- Isopods (Caecidotea) and midges (Rheotanytarsus and Parametricnemus) dominated the sample.
- Measured below COMAR standards for pH and conductivity elevated.
- An abundance of woody debris in channel is providing roughness and stable habitat. Minor bank erosion is present but with good floodplain connectivity. Excellent riparian vegetation. Refuse present in minor amounts.
- Transitional reach from DA upstream to E below headcut.

### Recommendations:

- Maintain the protection of the riparian areas.

**Biological Assessment**

**Raw Metric Values**

Total Taxa	23
EPT Taxa	6
Ephemeroptera Taxa	0
%Intolerant Urban	41.7
%Ephemeroptera	0
Scraper Taxa	1
% Climbers	2.1

**Calculated Metric Scores**

Total Taxa	5
EPT Taxa	5
Ephemeroptera Taxa	1
%Intolerant Urban	5
%Ephemeroptera	1
Scraper Taxa	3
% Climbers	3

<b>BIBI Score</b>	<b>3.29</b>
<b>BIBI Narrative Rating</b>	<b>Fair</b>

Taxa	Count
Anchytarsus	1
Asellidae	14
Caecidotea	17
Calopteryx	1
Cricotopus/Orthocladius	1
Diplectrona	8
Diplocladius	2
Gammarus	2
Heterotrissocladius	1
Isonychia	1
Lumbricidae	4
Lype	3
Odontomesa	1
Orthoclaadiinae	1
Parametricnemus	8
Paraphaenocladus	1
Phylocentropus	1
Pisidium	1
Polycentropus	11
Pycnopsyche	1
Rheotanytarsus	10
Synurella	3
Thienemannimyia group	1
Tipula	1
Tubificidae	1
<b>TOTAL:</b>	<b>96</b>

**Physical Habitat Assessment**

**EPA Rapid Bioassessment Protocol**

	Score		Score
Bank Stability- Left Bank	7	Pool Variability	11
Bank Stability- Right Bank	6	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	20	Sediment Deposition	13
Channel Sinuosity	13	Vegetative Protection - Left Bank	8
Epifaunal Substrate/Available Cover	12	Vegetative Protection - Right Bank	7
Pool Substrate Characterization	12		

<b>RBP Habitat Score</b>	<b>149</b>
<b>RBP Narrative Rating</b>	<b>Supporting</b>

**MBSS Physical Habitat Index**

	Value	Score	Value	Score	
Remoteness	13	70.01	Instream Wood Debris	20	100
Shading	80	78.67	Instream Habitat	11	86.76
Epifaunal Substrate	12	90.94	Bank Stability	13	80.63

<b>PHI Score</b>	<b>84.5</b>
<b>PHI Narrative Rating</b>	<b>Minimally Degraded</b>

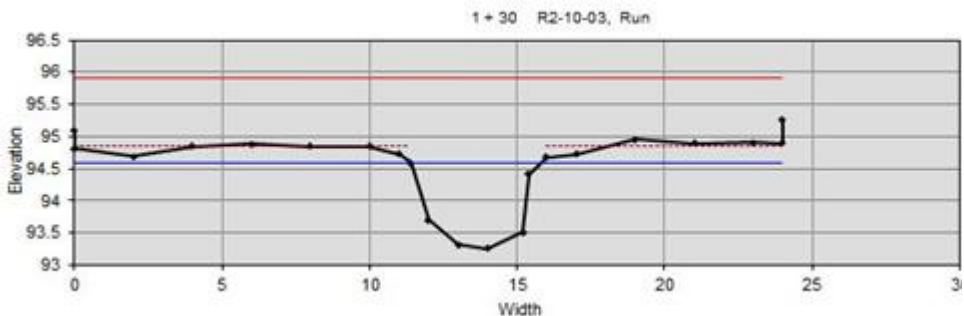
**Water Chemistry**

Dissolved Oxygen (mg/L)	11.3	pH (SU)	6.16
Turbidity (NTU)	6.48	Specific Conductivity (µS/cm)	259.67
Temperature (°C)	8.3		

**Geomorphic Assessment**

**Rosgen Level II Classification Data**

Drainage Area (mi <sup>2</sup> )	0.34	Cross Sectional Area (ft <sup>2</sup> )	4.3
Bankfull Width (ft)	4.4	Water Surface Slope (%)	1.4
Mean Bankfull Depth (ft)	0.96	Sinuosity	1.3
Floodprone Width (ft)	140	D50 (mm)	0.062
Entrenchment Ratio	31.7	Adjustments?	None
Width to Depth Ratio	4.6	<b>Rosgen Stream Type</b>	<b>Transitional</b>



## R2-10-04

## Severn River Sampling Unit

### Upstream View:



Latitude: 39.08715254

### Downstream View:



Longitude: -76.61561181

### Land Use/Land Cover Analysis:

**Total Drainage Area (acres) 528.76**

<u>Cover</u>	<u>Acres</u>	<u>% Area</u>
<b>Developed Land</b>	<b>378.51</b>	<b>71.58</b>
Airport	0	0
Commercial	34.6	6.54
Industrial	28.95	5.47
Residential 1/8-acre	0	0
Residential 1/4-acre	174.43	32.99
Residential 1/2-acre	112.02	21.19
Residential 1-Acre	0	0
Residential 2-Acre	2.56	0.49
Transportation	25.94	4.91
Utility	0	0
<b>Forest Land</b>	<b>112.21</b>	<b>21.22</b>
Forested Wetland	0	0
Residential Woods	0	0
Woods	112.21	21.22
<b>Open Land</b>	<b>32.6</b>	<b>6.17</b>
Open Space	32.19	6.09
Open Wetland	0	0
Water	0.41	0.08
<b>Agricultural Land</b>	<b>5.44</b>	<b>1.03</b>
Pasture/Hay	0	0
Row Crops	5.44	1.03

<u>Impervious Surface</u>	<u>Acres</u>	<u>% Area</u>
Impervious Land	144.25	27.28

### Summary Results:

- Biological condition – “*Very Poor*”
- Habitat scores “*Supporting*” and “*Partially Degraded*”
- Cricotopus/Orthocladius (midge) dominated the sample.
- Water quality values within COMAR standards but conductivity elevated.
- An abundance of rootwads and woody debris provide stable habitat. Banks undercut but mostly stable due to vegetation. Poor remoteness score due to close proximity to West Benfield Road.
- Adjusted WD Ratio -2.0 to fit E type.

### Recommendations:

- Maintain the protection of the riparian areas.
- Because habitat is supporting and biological condition is very poor, look for problems with water quality and correct, if possible.

**Biological Assessment**

**Raw Metric Values**

Total Taxa	16
EPT Taxa	3
Ephemeroptera Taxa	0
%Intolerant Urban	0
%Ephemeroptera	0
Scraper Taxa	0
% Climbers	4.7

**Calculated Metric Scores**

Total Taxa	3
EPT Taxa	3
Ephemeroptera Taxa	1
%Intolerant Urban	1
%Ephemeroptera	1
Scraper Taxa	1
% Climbers	3

**BIBI Score** 1.86

**BIBI Narrative Rating** Very Poor

**Taxa** **Count**

Cheumatopsyche	2
Chironomidae	2
Chironominae	1
Cricotopus	3
Cricotopus/Orthocladius	55
Hydropsyche	1
Limnephilidae	1
Naididae	12
Orthoclaadiinae	2
Orthocladius	2
Parametricnemus	1
Polypedilum	2
Rheocricotopus	1
Rheotanytarsus	8
Tanypodinae	1
Tanytarsini	1
Tanytarsus	2
Thienemanniella	1
Tipula	1
Tubificidae	6
Tvetenia	1

**TOTAL:** 106

**Physical Habitat Assessment**

**EPA Rapid Bioassessment Protocol**

	Score		Score
Bank Stability- Left Bank	7	Pool Variability	11
Bank Stability- Right Bank	7	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	14	Riparian Vegetative Zone Width- Right Bank	9
Channel Flow Status	19	Sediment Deposition	11
Channel Sinuosity	11	Vegetative Protection - Left Bank	8
Epifaunal Substrate/Available Cover	12	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	12		

**RBP Habitat Score** 139

**RBP Narrative Rating** Supporting

**MBSS Physical Habitat Index**

	Value	Score		Value	Score
Remoteness	4	21.54	Instream Wood Debris	16	98.06
Shading	85	84.56	Instream Habitat	11	77.55
Epifaunal Substrate	12	85.08	Bank Stability	14	83.67

**PHI Score** 75.07

**PHI Narrative Rating** Partially Degraded

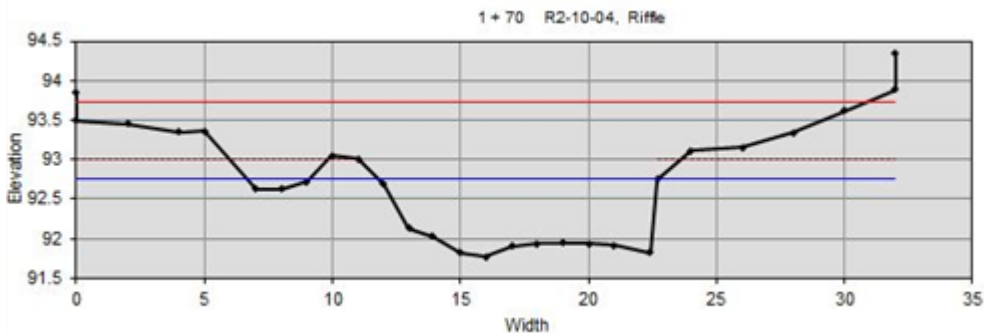
**Water Chemistry**

Dissolved Oxygen (mg/L)	12.15	pH (SU)	6.9
Turbidity (NTU)	5.7	Specific Conductivity (µS/cm)	520
Temperature (°C)	5.7		

**Geomorphic Assessment**

**Rosgen Level II Classification Data**

Drainage Area (mi <sup>2</sup> )	0.83	Cross Sectional Area (ft <sup>2</sup> )	8.4
Bankfull Width (ft)	10.9	Water Surface Slope (%)	0.35
Mean Bankfull Depth (ft)	0.77	Sinuosity	1.1
Floodprone Width (ft)	32	D50 (mm)	0.34
Entrenchment Ratio	2.9	Adjustments?	Yes, WD -2.0
Width to Depth Ratio	14.1	<b>Rosgen Stream Type</b>	<b>E5</b>



## R2-10-05

## Severn River Sampling Unit

### Upstream View:



Latitude: 39.034220252

### Downstream View:



Longitude: -76.586062359

### Land Use/Land Cover Analysis:

**Total Drainage Area (acres) 286.99**

<u>Cover</u>	<u>Acres</u>	<u>% Area</u>
<b>Developed Land</b>	<b>123.97</b>	<b>43.2</b>
Airport	0	0
Commercial	14.31	4.99
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	49.03	17.08
Residential 2-Acre	50.02	17.43
Transportation	8.77	3.05
Utility	1.84	0.64
<b>Forest Land</b>	<b>158.67</b>	<b>55.29</b>
Forested Wetland	0	0
Residential Woods	0	0
Woods	158.67	55.29
<b>Open Land</b>	<b>4.35</b>	<b>1.52</b>
Open Space	4.35	1.52
Open Wetland	0	0
Water	0	0
<b>Agricultural Land</b>	<b>0</b>	<b>0</b>
Pasture/Hay	0	0
Row Crops	0	0

<u>Impervious Surface</u>	<u>Acres</u>	<u>% Area</u>
Impervious Land	31.73	11.06

### Summary Results:

- Biological condition – “Fair”
- Habitat scores “Non Supporting” and “Partially Degraded”
- Approximately one-third of the sample consisted of various midges of the Chironomidae family.
- Measured below COMAR standards for pH and conductivity elevated.
- Incised, overwidened channel with heavily eroded banks and numerous depositional point bars. Very little stable substrate for benthos. Excellent riparian width. Refuse present in minor amounts.

### Recommendations:

- Maintain the protection of the riparian areas.
- Determine causes of instability observed in this reach and evaluate potential for stabilization.

**Biological Assessment**

**Raw Metric Values**

Total Taxa	32
EPT Taxa	2
Ephemeroptera Taxa	0
%Intolerant Urban	18.1
%Ephemeroptera	0
Scraper Taxa	2
% Climbers	22.3

**Calculated Metric Scores**

Total Taxa	5
EPT Taxa	3
Ephemeroptera Taxa	1
%Intolerant Urban	3
%Ephemeroptera	1
Scraper Taxa	5
% Climbers	5

<b>BIBI Score</b>	<b>3.29</b>
<b>BIBI Narrative Rating</b>	<b>Fair</b>

**Taxa Count**

Anchytarsus	2
Caecidotea	3
Calopteryx	1
Ceratopogon	1
Chaetocladus	2
Crangonyx	1
Cricotopus/Orthocladus	1
Cyphon	6
Dineutus	1
Diplocladius	3
Enchytraeidae	1
Ephydriidae	1
Eukiefferiella	3
Georthocladus	2
Helichus	4
Heterotrissocladius	1
Leuctra	2
Limnephilidae	11
Lumbricidae	3
Nematomorpha	1
Ormosia	2
Orthoclaadiinae	1
Orthocladus	2
Parametricnemus	5
Paraphaenocladus	1
Phaenopsectra	3
Pisidium	1
Polypedilum	2
Pseudolimnophila	1
Pseudorthocladus	4
Pycnopsyche	1
Rheotanytarsus	1
Synurella	9
Tipula	8
Tubificidae	3
<b>TOTAL:</b>	<b>94</b>

**Physical Habitat Assessment**

**EPA Rapid Bioassessment Protocol**

	Score		Score
Bank Stability- Left Bank	3	Pool Variability	7
Bank Stability- Right Bank	3	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	16	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	9	Sediment Deposition	4
Channel Sinuosity	12	Vegetative Protection - Left Bank	5
Epifaunal Substrate/Available Cover	6	Vegetative Protection - Right Bank	5
Pool Substrate Characterization	6		

<b>RBP Habitat Score</b>	<b>96</b>
<b>RBP Narrative Rating</b>	<b>Non Supporting</b>

**MBSS Physical Habitat Index**

	Value	Score		Value	Score
Remoteness	20	100	Instream Wood Debris	5	72.43
Shading	95	99.94	Instream Habitat	5	50.51
Epifaunal Substrate	6	54.2	Bank Stability	6	54.77

<b>PHI Score</b>	<b>71.98</b>
<b>PHI Narrative Rating</b>	<b>Partially Degraded</b>

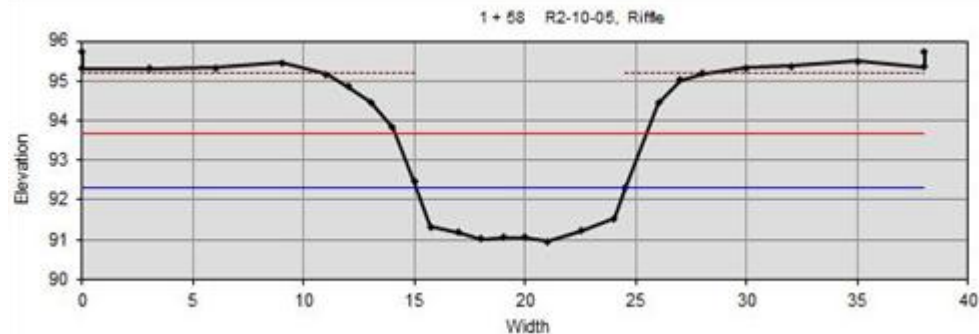
**Water Chemistry**

Dissolved Oxygen (mg/L)	14.09	pH (SU)	6.11
Turbidity (NTU)	5.25	Specific Conductivity (µS/cm)	281.37
Temperature (°C)	2.07		

**Geomorphic Assessment**

**Rosgen Level II Classification Data**

Drainage Area (mi <sup>2</sup> )	0.45	Cross Sectional Area (ft <sup>2</sup> )	10.2
Bankfull Width (ft)	9.4	Water Surface Slope (%)	0.48
Mean Bankfull Depth (ft)	1.09	Sinuosity	1.3
Floodprone Width (ft)	11.3	D50 (mm)	0.23
Entrenchment Ratio	1.2	Adjustments?	None
Width to Depth Ratio	8.6	<b>Rosgen Stream Type</b>	<b>G5c</b>



## R2-10-06

## Severn River Sampling Unit

### Upstream View:



Latitude: 39.02464543

### Downstream View:



Longitude: -76.48167972

### Land Use/Land Cover Analysis:

**Total Drainage Area (acres) 330.9**

<u>Cover</u>	<u>Acres</u>	<u>% Area</u>
<b>Developed Land</b>	<b>211.64</b>	<b>63.96</b>
Airport	0	0
Commercial	4.94	1.49
Industrial	5.06	1.53
Residential 1/8-acre	101.07	30.54
Residential 1/4-acre	31.58	9.54
Residential 1/2-acre	9.11	2.75
Residential 1-Acre	34.41	10.4
Residential 2-Acre	8.41	2.54
Transportation	17.07	5.16
Utility	0	0
<b>Forest Land</b>	<b>109.06</b>	<b>32.96</b>
Forested Wetland	0	0
Residential Woods	0	0
Woods	109.06	32.96
<b>Open Land</b>	<b>9.75</b>	<b>2.95</b>
Open Space	9.27	2.8
Open Wetland	0	0
Water	0.48	0.14
<b>Agricultural Land</b>	<b>0.46</b>	<b>0.14</b>
Pasture/Hay	0	0
Row Crops	0.46	0.14

<u>Impervious Surface</u>	<u>Acres</u>	<u>% Area</u>
Impervious Land	68.5	20.7

### Summary Results:

- Biological condition – “Poor”
- Habitat scores “Partially Supporting” and “Partially Degraded”
- Worms, including Tubificidae and Naididae, dominated the sample.
- Water quality values within COMAR standards.
- Marginal remoteness score due to close proximity to Shot Town Road. Marginal epifaunal substrate, instream habitat, and bank stability with abundant rootwads and woody debris. Refuse abundant and unsightly.
- Transitional reach from DA upstream to G below headcut.

### Recommendations:

- Buffer enhancement.
- Consider trash cleanup for this reach.



**Biological Assessment**

**Raw Metric Values**

Total Taxa	19
EPT Taxa	1
Ephemeroptera Taxa	0
%Intolerant Urban	4.3
%Ephemeroptera	0
Scraper Taxa	2
% Climbers	1.1

**Calculated Metric Scores**

Total Taxa	3
EPT Taxa	1
Ephemeroptera Taxa	1
%Intolerant Urban	1
%Ephemeroptera	1
Scraper Taxa	5
% Climbers	3

<b>BIBI Score</b>	<b>2.14</b>
<b>BIBI Narrative Rating</b>	<b>Poor</b>

**Taxa Count**

Argia	1
Chironomidae	1
Conchapelopia	2
Corynoneura	2
Cricotopus/Orthocladius	2
Enchytraeidae	1
Hirudinidae	1
Macronychus	2
Naididae	16
Pisidium	4
Polycentropus	4
Prostoma	1
Rheotanytarsus	3
Sphaeromias	3
Staphylinidae	1
Stenelmis	3
Thienemannimyia group	2
Tipula	1
Tribelos	7
Tubificidae	34
Tvetenia	1
<b>TOTAL:</b>	<b>92</b>

**Physical Habitat Assessment**

**EPA Rapid Bioassessment Protocol**

	Score		Score
Bank Stability- Left Bank	6	Pool Variability	7
Bank Stability- Right Bank	6	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	15	Riparian Vegetative Zone Width- Right Bank	3
Channel Flow Status	16	Sediment Deposition	12
Channel Sinuosity	12	Vegetative Protection - Left Bank	8
Epifaunal Substrate/Available Cover	8	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	9		

<b>RBP Habitat Score</b>	<b>120</b>
<b>RBP Narrative Rating</b>	<b>Partially Supporting</b>

**MBSS Physical Habitat Index**

	Value	Score		Value	Score
Remoteness	6	32.31	Instream Wood Debris	13	94.49
Shading	95	99.94	Instream Habitat	7	60.15
Epifaunal Substrate	8	64.89	Bank Stability	12	77.46

<b>PHI Score</b>	<b>71.54</b>
<b>PHI Narrative Rating</b>	<b>Partially Degraded</b>

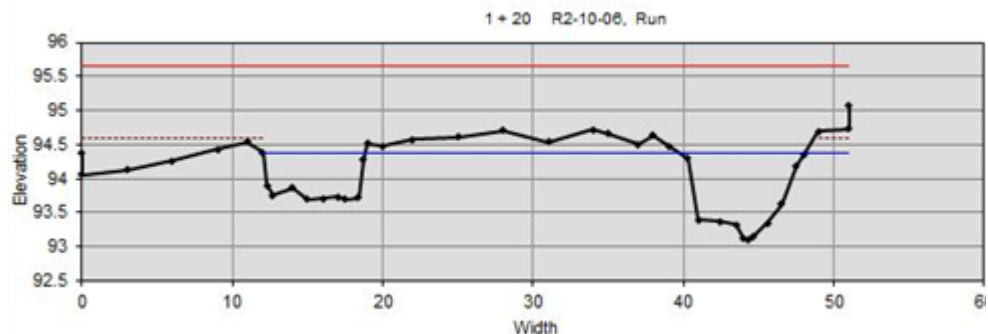
**Water Chemistry**

Dissolved Oxygen (mg/L)	12.43	pH (SU)	6.74
Turbidity (NTU)	7.05	Specific Conductivity (µS/cm)	137.9
Temperature (°C)	6.5		

**Geomorphic Assessment**

**Rosen Level II Classification Data**

Drainage Area (mi <sup>2</sup> )	0.52	Cross Sectional Area (ft <sup>2</sup> )	10.8
Bankfull Width (ft)	15.2	Water Surface Slope (%)	1.7
Mean Bankfull Depth (ft)	0.71	Sinuosity	1.2
Floodprone Width (ft)	220	D50 (mm)	0.062
Entrenchment Ratio	14.5	Adjustments?	None
Width to Depth Ratio	21.4	<b>Rosen Stream Type</b>	<b>Transitional</b>



Upstream View:



Latitude: 39.061300989

Downstream View:



Longitude: -76.617370584

**Land Use/Land Cover Analysis:**

**Total Drainage Area (acres) 1054.54**

<u>Cover</u>	<u>Acres</u>	<u>% Area</u>
<b>Developed Land</b>	<b>460.86</b>	<b>43.7</b>
Airport	0	0
Commercial	24.46	2.32
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0.03	0
Residential 1-Acre	67.47	6.4
Residential 2-Acre	290.65	27.56
Transportation	67.08	6.36
Utility	11.17	1.06
<b>Forest Land</b>	<b>412</b>	<b>39.07</b>
Forested Wetland	0	0
Residential Woods	0	0
Woods	412	39.07
<b>Open Land</b>	<b>89.6</b>	<b>8.5</b>
Open Space	89.6	8.5
Open Wetland	0	0
Water	0	0
<b>Agricultural Land</b>	<b>92.08</b>	<b>8.73</b>
Pasture/Hay	57.74	5.48
Row Crops	34.34	3.26
<b>Impervious Surface</b>	<b>Acres</b>	<b>% Area</b>
Impervious Land	104.28	9.89

**Summary Results:**

- Biological condition – “Poor”
- Habitat scores “Supporting” and “Degraded”
- Midges (Parametricnemus and Thienemannimyia), worms (Lumbricidae), and amphipods (Synurella) dominated the sample.
- Measured below COMAR standards for pH.
- Channel runs through wetland valley with very little flow present and with heavy iron flocculent. Minimal habitat present in reach. Sub-optimal bank stability with good vegetative protection and riparian width.

**Recommendations:**

- Maintain the protection of the riparian areas.
- Because habitat is supporting and biological condition is poor, look for problems with water quality and correct, if possible.

**Biological Assessment**

**Raw Metric Values**

Total Taxa	21
EPT Taxa	1
Ephemeroptera Taxa	0
%Intolerant Urban	20.7
%Ephemeroptera	0
Scraper Taxa	1
% Climbers	4.5

**Calculated Metric Scores**

Total Taxa	3
EPT Taxa	1
Ephemeroptera Taxa	1
%Intolerant Urban	3
%Ephemeroptera	1
Scraper Taxa	3
% Climbers	3

<b>BIBI Score</b>	<b>2.14</b>
<b>BIBI Narrative Rating</b>	<b>Poor</b>

Taxa	Count
Ablabesmyia	1
Bivalvia	1
Caecidotea	8
Chironomidae	1
Chironomus	2
Conchapelopia	1
Culicoides	3
Cyphon	1
Diplocladius	4
Limnephilidae	3
Lumbricidae	16
Naididae	1
Natarsia	1
Parametrioconemus	18
Pericoma/Telmatoscopus	1
Phaenopsectra	1
Pisidium	9
Probezzia	3
Prodiamesa	1
Pseudolimnophila	1
Pseudosuccinea	1
Synurella	11
Tanypodinae	1
Thienemannimyia group	15
Tubificidae	6
<b>TOTAL:</b>	<b>111</b>

**Physical Habitat Assessment**

**EPA Rapid Bioassessment Protocol**

	Score		Score
Bank Stability- Left Bank	7	Pool Variability	8
Bank Stability- Right Bank	8	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	19	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	10	Sediment Deposition	11
Channel Sinuosity	9	Vegetative Protection - Left Bank	8
Epifaunal Substrate/Available Cover	8	Vegetative Protection - Right Bank	9
Pool Substrate Characterization	9		

<b>RBP Habitat Score</b>	<b>126</b>
<b>RBP Narrative Rating</b>	<b>Supporting</b>

**MBSS Physical Habitat Index**

	Value	Score	Value	Score	
Remoteness	14	75.39	Instream Wood Debris	14	84.32
Shading	55	54.42	Instream Habitat	6	42.74
Epifaunal Substrate	7	51.53	Bank Stability	15	86.61

<b>PHI Score</b>	<b>65.83</b>
<b>PHI Narrative Rating</b>	<b>Degraded</b>

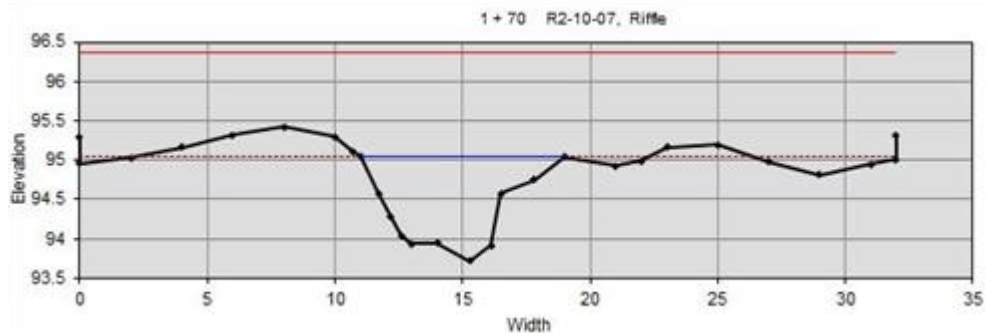
**Water Chemistry**

Dissolved Oxygen (mg/L)	8.73	pH (SU)	6.05
Turbidity (NTU)	9.27	Specific Conductivity (µS/cm)	143.47
Temperature (°C)	4.5		

**Geomorphic Assessment**

**Rosgen Level II Classification Data**

Drainage Area (mi <sup>2</sup> )	1.65	Cross Sectional Area (ft <sup>2</sup> )	5.9
Bankfull Width (ft)	8	Water Surface Slope (%)	0.75
Mean Bankfull Depth (ft)	0.74	Sinuosity	1.1
Floodprone Width (ft)	86	D50 (mm)	1
Entrenchment Ratio	10.8	Adjustments?	None
Width to Depth Ratio	10.9	<b>Rosgen Stream Type</b>	<b>E5</b>



Upstream View:



Latitude: 39.021193127

Downstream View:



Longitude: -76.483432758

**Land Use/Land Cover Analysis:**

**Total Drainage Area (acres) 770.07**

<u>Cover</u>	<u>Acres</u>	<u>% Area</u>
<b>Developed Land</b>	<b>431.64</b>	<b>56.05</b>
Airport	0	0
Commercial	39.14	5.08
Industrial	4.86	0.63
Residential 1/8-acre	0	0
Residential 1/4-acre	19.27	2.5
Residential 1/2-acre	171.49	22.27
Residential 1-Acre	99.57	12.93
Residential 2-Acre	74.48	9.67
Transportation	22.82	2.96
Utility	0	0
<b>Forest Land</b>	<b>317.27</b>	<b>41.2</b>
Forested Wetland	0	0
Residential Woods	0	0
Woods	317.27	41.2
<b>Open Land</b>	<b>21.16</b>	<b>2.75</b>
Open Space	21.13	2.74
Open Wetland	0.03	0
Water	0	0
<b>Agricultural Land</b>	<b>0</b>	<b>0</b>
Pasture/Hay	0	0
Row Crops	0	0

<u>Impervious Surface</u>	<u>Acres</u>	<u>% Area</u>
Impervious Land	116.28	15.1

**Summary Results:**

- Biological condition – “Poor”
- Habitat scores “Comparable to Reference” and “Degraded”
- Caecidotea (isopod), Pisidium (bivalve), and Polycentropus (caddisfly) dominated the sample.
- Measured below COMAR standards for pH.
- Channel runs through a broad wetland and is heavily influenced by a beaver dam located upstream and an open water wetland downstream. Minimal woody debris with good vegetative protection and riparian width.
- Channel is heavily influenced by beaver dam upstream and open water wetland downstream. Stream type indeterminate.

**Recommendations:**

- Maintain the protection of the riparian areas.
- Because habitat is comparable to reference and biological condition is poor, look for problems with water quality and correct, if possible.

**Biological Assessment**

**Raw Metric Values**

Total Taxa	19
EPT Taxa	1
Ephemeroptera Taxa	0
%Intolerant Urban	39
%Ephemeroptera	0
Scraper Taxa	1
% Climbers	4.8

**Calculated Metric Scores**

Total Taxa	3
EPT Taxa	1
Ephemeroptera Taxa	1
%Intolerant Urban	5
%Ephemeroptera	1
Scraper Taxa	3
% Climbers	3

<b>BIBI Score</b>	<b>2.43</b>
<b>BIBI Narrative Rating</b>	<b>Poor</b>

**Taxa Count**

Amphipoda	1
Ancyronyx	1
Apsectrotanypus	2
Asellidae	9
Basiaeschna	1
Caecidotea	18
Calopteryx	4
Clinotanypus	3
Dugesiiidae	5
Gammarus	5
Lumbricidae	2
Lumbriculidae	1
Nanocladus	1
Nematomorpha	1
Paratanytarsus	3
Pisidium	19
Polycentropus	18
Prostoma	1
Synurella	5
Thienemannimyia group	1
Trichoptera	1
Tubificidae	3
<b>TOTAL:</b>	<b>105</b>

**Physical Habitat Assessment**

**EPA Rapid Bioassessment Protocol**

	Score		Score
Bank Stability- Left Bank	10	Pool Variability	12
Bank Stability- Right Bank	10	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	20	Sediment Deposition	10
Channel Sinuosity	11	Vegetative Protection - Left Bank	10
Epifaunal Substrate/Available Cover	8	Vegetative Protection - Right Bank	10
Pool Substrate Characterization	12		

<b>RBP Habitat Score</b>	<b>153</b>
<b>RBP Narrative Rating</b>	<b>Comparable to Reference</b>

**MBSS Physical Habitat Index**

	Value	Score	Value	Score	
Remoteness	14	75.39	Instream Wood Debris	2	52.38
Shading	25	26.57	Instream Habitat	8	57.05
Epifaunal Substrate	8	59.39	Bank Stability	20	100

<b>PHI Score</b>	<b>61.8</b>
<b>PHI Narrative Rating</b>	<b>Degraded</b>

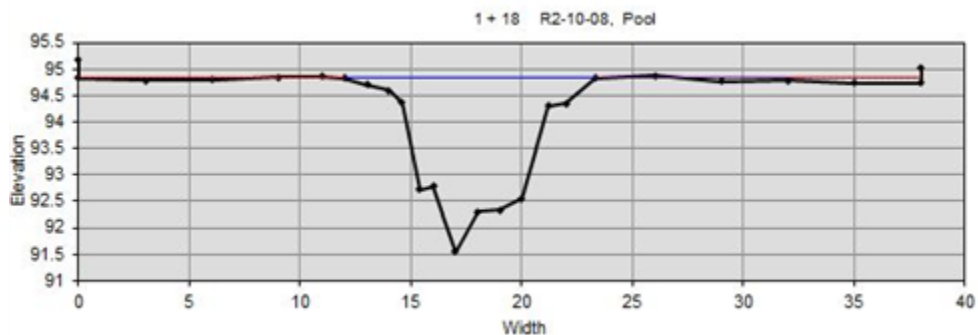
**Water Chemistry**

Dissolved Oxygen (mg/L)	8.13	pH (SU)	6.28
Turbidity (NTU)	11.2	Specific Conductivity (µS/cm)	109.17
Temperature (°C)	4.6		

**Geomorphic Assessment**

**Rosen Level II Classification Data**

Drainage Area (mi <sup>2</sup> )	1.2	Cross Sectional Area (ft <sup>2</sup> )	15.6
Bankfull Width (ft)	11.3	Water Surface Slope (%)	0.027
Mean Bankfull Depth (ft)	1.4	Sinuosity	1.1
Floodprone Width (ft)	145	D50 (mm)	0.062
Entrenchment Ratio	12.8	Adjustments?	None
Width to Depth Ratio	8.2	<b>Rosen Stream Type</b>	<b>ND</b>



## R2-10-10

## Severn River Sampling Unit

### Upstream View:



Latitude: 39.060731418

### Downstream View:



Longitude: -76.586673976

### Land Use/Land Cover Analysis:

**Total Drainage Area (acres) 1364.17**

<u>Cover</u>	<u>Acres</u>	<u>% Area</u>
<b>Developed Land</b>	<b>476.04</b>	<b>34.9</b>
Airport	0	0
Commercial	17.28	1.27
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	30.41	2.23
Residential 1/2-acre	2.33	0.17
Residential 1-Acre	71.95	5.27
Residential 2-Acre	317.47	23.27
Transportation	28.59	2.1
Utility	8	0.59
<b>Forest Land</b>	<b>756.48</b>	<b>55.45</b>
Forested Wetland	20.65	1.51
Residential Woods	0	0
Woods	735.83	53.94
<b>Open Land</b>	<b>80.35</b>	<b>5.89</b>
Open Space	77.09	5.65
Open Wetland	0	0
Water	3.26	0.24
<b>Agricultural Land</b>	<b>51.3</b>	<b>3.76</b>
Pasture/Hay	42.31	3.1
Row Crops	8.99	0.66
<b>Impervious Surface</b>	<b>Acres</b>	<b>% Area</b>
Impervious Land	87.81	6.44

### Summary Results:

- Biological condition – “Fair”
- Habitat scores “Supporting” and “Degraded”
- Black flies (Stegopterna) dominated the sample.
- Measured below COMAR standards for pH and conductivity elevated.
- Stream runs through broad wetland valley. Minimal woody debris present with good bank stability, vegetative protection, and riparian width. Marginal epifaunal substrate and instream habitat.

### Recommendations:

- Maintain the protection of the riparian areas.

# R2-10-10

# Severn River Sampling Unit

## Biological Assessment

### Raw Metric Values

Total Taxa	19
EPT Taxa	5
Ephemeroptera Taxa	1
%Intolerant Urban	69.5
%Ephemeroptera	1.9
Scraper Taxa	1
% Climbers	2.9

### Calculated Metric Scores

Total Taxa	3
EPT Taxa	5
Ephemeroptera Taxa	3
%Intolerant Urban	5
%Ephemeroptera	3
Scraper Taxa	3
% Climbers	3

<b>BIBI Score</b>	<b>3.57</b>
<b>BIBI Narrative Rating</b>	<b>Fair</b>

Taxa	Count
Amphinemura	3
Caecidotea	2
Cloeon	2
Culicoides	9
Hydrobaenus	3
Isonychia	1
Leuctra	3
Limonia	1
Orthocladius	1
Paraphaenocladus	6
Polypedilum	1
Ptilostomis	1
Rheocricotopus	1
Simuliidae	1
Stegopterna	65
Stenochironomus	1
Tanytarsus	1
Thienemanniella	1
Thienemannimyia group	1
Zavrelimyia	1
<b>TOTAL:</b>	<b>105</b>

## Physical Habitat Assessment

### EPA Rapid Bioassessment Protocol

	Score	Score	
Bank Stability- Left Bank	9	Pool Variability	10
Bank Stability- Right Bank	9	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	18	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	20	Sediment Deposition	13
Channel Sinuosity	10	Vegetative Protection - Left Bank	9
Epifaunal Substrate/Available Cover	8	Vegetative Protection - Right Bank	9
Pool Substrate Characterization	13		

<b>RBP Habitat Score</b>	<b>148</b>
<b>RBP Narrative Rating</b>	<b>Supporting</b>

### MBSS Physical Habitat Index

	Value	Score	Value	Score	
Remoteness	9	48.47	Instream Wood Debris	3	48.87
Shading	90	91.34	Instream Habitat	8	51.2
Epifaunal Substrate	7	49.85	Bank Stability	18	94.87

<b>PHI Score</b>	<b>64.1</b>
<b>PHI Narrative Rating</b>	<b>Degraded</b>

## Water Chemistry

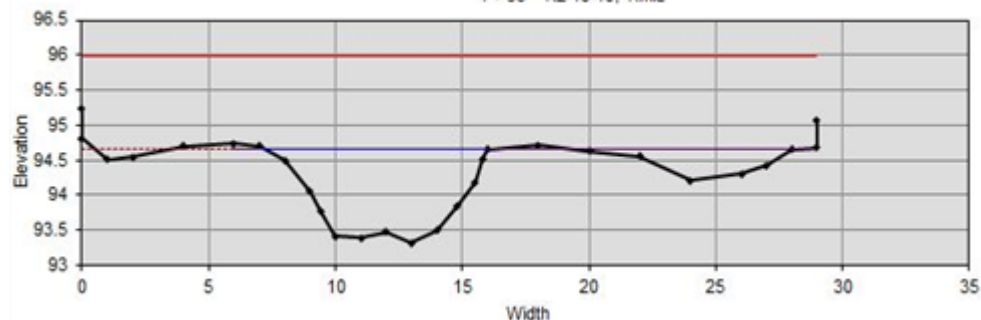
Dissolved Oxygen (mg/L)	13.33	pH (SU)	6.15
Turbidity (NTU)	5.98	Specific Conductivity (µS/cm)	292.13
Temperature (°C)	2.1		

## Geomorphic Assessment

### Rosgen Level II Classification Data

Drainage Area (mi <sup>2</sup> )	2.13	Cross Sectional Area (ft <sup>2</sup> )	7.7
Bankfull Width (ft)	8.8	Water Surface Slope (%)	0.52
Mean Bankfull Depth (ft)	0.88	Sinuosity	1.1
Floodprone Width (ft)	195	D50 (mm)	0.062
Entrenchment Ratio	22.3	Adjustments?	None
Width to Depth Ratio	10	<b>Rosgen Stream Type</b>	<b>E6</b>

1 + 56 R2-10-10, Riffle



## R2-10-11A

## Severn River Sampling Unit

### Upstream View:



Latitude: 39.01472192

### Downstream View:



Longitude: -76.548453258

### Land Use/Land Cover Analysis:

**Total Drainage Area (acres) 455.99**

<u>Cover</u>	<u>Acres</u>	<u>% Area</u>
<b>Developed Land</b>	<b>243.91</b>	<b>53.49</b>
Airport	0	0
Commercial	0.35	0.08
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	83.62	18.34
Residential 1-Acre	124.33	27.27
Residential 2-Acre	19.91	4.37
Transportation	10.4	2.28
Utility	5.3	1.16
<b>Forest Land</b>	<b>208.41</b>	<b>45.71</b>
Forested Wetland	0	0
Residential Woods	0	0
Woods	208.41	45.71
<b>Open Land</b>	<b>3.66</b>	<b>0.8</b>
Open Space	3.66	0.8
Open Wetland	0	0
Water	0	0
<b>Agricultural Land</b>	<b>0</b>	<b>0</b>
Pasture/Hay	0	0
Row Crops	0	0

<u>Impervious Surface</u>	<u>Acres</u>	<u>% Area</u>
Impervious Land	48.85	10.71

### Summary Results:

- Biological condition – “Poor”
- Habitat scores “Supporting” and “Partially Degraded”
- Caecidotea (isopod), Parametricnemus (midge) and Polycentropus (caddisfly) dominated the sample.
- Measured below COMAR standards for pH and conductivity elevated.
- Slightly incised reach with extensive bank erosion. Rootwads and wood provide some stable habitat. Excellent riparian width.

### Recommendations:

- Maintain the protection of the riparian areas.
- Determine causes of instability observed in this reach and evaluate potential for stabilization.
- Because habitat is supporting and biological condition is poor, look for problems with water quality and correct, if possible.



# R2-10-11A

# Severn River Sampling Unit

## Biological Assessment

### Raw Metric Values

Total Taxa	19
EPT Taxa	5
Ephemeroptera Taxa	0
%Intolerant Urban	52.1
%Ephemeroptera	0
Scraper Taxa	0
% Climbers	4.3

### Calculated Metric Scores

Total Taxa	3
EPT Taxa	5
Ephemeroptera Taxa	1
%Intolerant Urban	5
%Ephemeroptera	1
Scraper Taxa	1
% Climbers	3

<b>BIBI Score</b>	<b>2.71</b>
<b>BIBI Narrative Rating</b>	<b>Poor</b>

Taxa	Count
Boyeria	1
Caecidotea	29
Conchapelopia	3
Diplectrona	1
Diplocladius	2
Enchytraeidae	1
Gammarus	1
Heteroplectron	4
Odontomesa	2
Orthocladius	2
Parametricnemus	20
Pisidium	1
Polycentropus	14
Ptilostomis	1
Pycnopsyche	2
Rheotanytarsus	7
Synurella	1
Tubificidae	1
Zavrelimyia	1
<b>TOTAL:</b>	<b>94</b>

## Physical Habitat Assessment

### EPA Rapid Bioassessment Protocol

	Score	Score	
Bank Stability- Left Bank	2	Pool Variability	11
Bank Stability- Right Bank	3	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	19	Sediment Deposition	13
Channel Sinuosity	10	Vegetative Protection - Left Bank	5
Epifaunal Substrate/Available Cover	10	Vegetative Protection - Right Bank	6
Pool Substrate Characterization	10		

<b>RBP Habitat Score</b>	<b>129</b>
<b>RBP Narrative Rating</b>	<b>Supporting</b>

### MBSS Physical Habitat Index

	Value	Score	Value	Score	
Remoteness	13	70.01	Instream Wood Debris	16	99.73
Shading	99	100	Instream Habitat	10	73.51
Epifaunal Substrate	10	74.42	Bank Stability	5	50

<b>PHI Score</b>	<b>77.95</b>
<b>PHI Narrative Rating</b>	<b>Partially Degraded</b>

## Water Chemistry

Dissolved Oxygen (mg/L)	11.63	pH (SU)	6.38
Turbidity (NTU)	7.9	Specific Conductivity (µS/cm)	254.57
Temperature (°C)	7.1		

## Geomorphic Assessment

### Rosgen Level II Classification Data

Drainage Area (mi <sup>2</sup> )	0.71	Cross Sectional Area (ft <sup>2</sup> )	9.6
Bankfull Width (ft)	7.7	Water Surface Slope (%)	0.56
Mean Bankfull Depth (ft)	1.24	Sinuosity	1.1
Floodprone Width (ft)	195	D50 (mm)	0.15
Entrenchment Ratio	25.2	Adjustments?	None
Width to Depth Ratio	6.2	<b>Rosgen Stream Type</b>	<b>E5</b>

