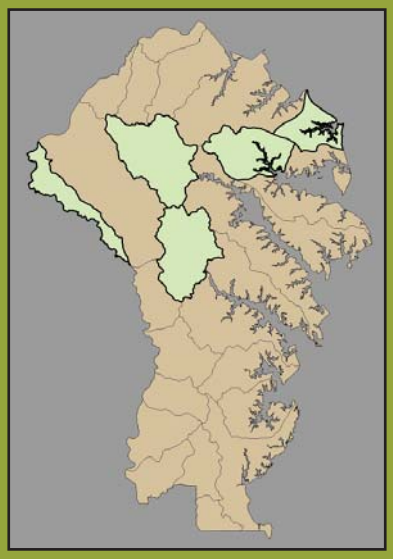

Aquatic Biological Assessment of the Watersheds of Anne Arundel County, Maryland: 2011

Anne Arundel County, Maryland
Department of Public Works
Ecological Assessment Program

ANNE ARUNDEL COUNTY MARYLAND

DPW

Aquatic Biological Assessment of the Watersheds of Anne Arundel County, Maryland: 2011 Round Two - Year Three

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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 and Ecosystem 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 2011 with sampling in five primary sampling units; Bodkin Creek, Severn Run, Upper Magothy, Upper North River, and Upper Patuxent. 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, and five water quality measures (temperature, dissolved oxygen, specific conductance, pH, and turbidity), as well as a detailed geomorphic assessment and classification of Rosgen Level II stream type. Each of these indicators was compared to established thresholds to determine narrative condition ratings. Of the five sampling units assessed, one sampling unit (Severn Run) had a 'Fair' biological condition, while the remaining four (Bodkin Creek, Upper Magothy, Upper North River, and Upper Patuxent) had 'Poor' biological conditions. Severn Run was the only sampling unit with physical habitat conditions rated 'Partially Supporting' by the RBP method, with the remaining four sampling units rated as 'Supporting.' Using the PHI, all but one sampling unit had 'Partially Degraded' physical habitat conditions; Upper Patuxent had 'Minimally Degraded' physical habitat conditions. The majority of reaches (52 percent) were classified E type streams. Generally, water quality measurements were within COMAR standards for dissolved oxygen and turbidity and there were no exceedances for temperature. Over half of the sites sampled (29 sites), spanning all 2011 sampling units, recorded pH values that fell below state standards of 6.5 standard units. However, most sites with pH measurements below 6.5 appear to be on streams draining wetlands, which tend to have naturally low pH levels, and/or in areas with highly acidic soils. Elevated conductivity values were observed at eighteen sites, throughout all sampling units. Comparisons of 2011 BIBI data to Round One data did not result in a statistically significant difference between sampling units. Comparisons of physical habitat data showed a statistically significant increase in the average RBP score for Upper Magothy, Upper North River, and Upper Patuxent. A statistically significant increase in the average PHI score for Upper Magothy and Upper Patuxent was also observed.

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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 sources that affect environmental conditions.

In order to protect these important resources – not only the streams and rivers of the County but ultimately the Chesapeake Bay – basic information about the overall conditions must be collected and analyzed. To better understand 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 individual 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 2011 mark the third 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)		
Round 1				
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
Round 2				
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

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

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 (2011).

2.1.2 Site Selection

The county was separated into 24 primary sampling units (PSUs) in which ten sites are randomly selected for sampling. 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. Final selection and placement of sampling sites was random and stratified by subwatershed and stream order. Four to five PSUs are sampled each year, so that all sampling units are assessed over a five-year period.

For 2011, ten randomly selected sites were chosen from each of the following PSUs (with PSU code); Bodkin Creek (06), Severn Run (09), Upper Magothy (07), Upper North River (11), and Upper Patuxent (16). 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 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 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.

2.1.3 Alternate Sites

In addition to the primary sites, ten secondary (alternate) sites were also chosen at random for each subwatershed 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 eighteen alternate sites were sampled during this sampling period (Table 2).

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.

Figure 1 - 2011 Sampling Units

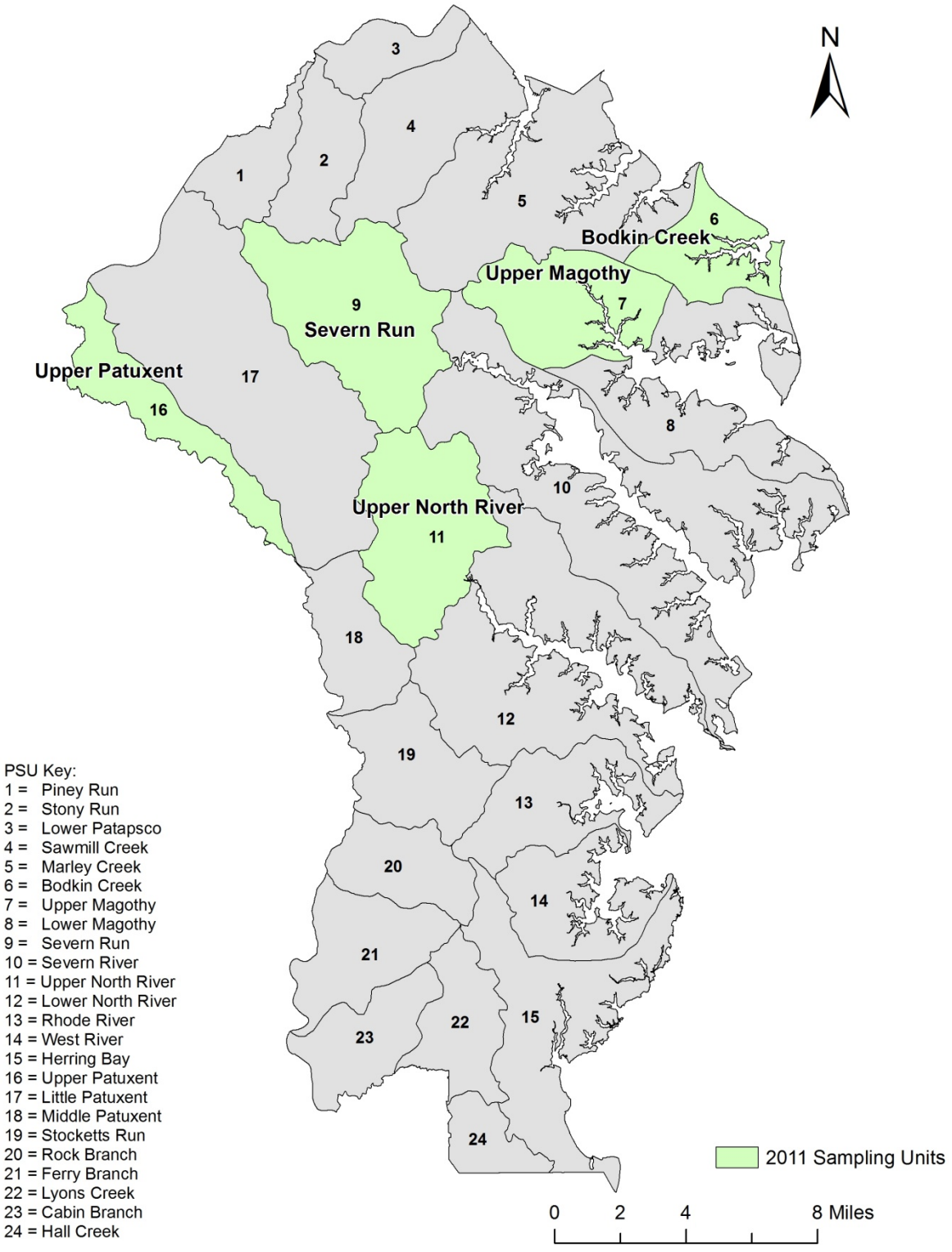


Table 2 - Field Sampling - Alternate Sites Chosen

Original Site	Alternate Site	Reason
R2-06-01	R2-06-19A	Dry, ephemeral channel
R2-06-03	R2-06-11A	Permission denied
R2-06-04	R2-06-13A	Midpoint in stormwater management pond
R2-06-05	R2-06-14A	No channel
R2-06-06	R2-06-16A	Overlaps with R2-06-10
R2-07-02	R2-07-12A	No channel
R2-07-05	R2-07-14A	Overlaps with R2-07-01
R2-07-06	R2-07-16A	Permission denied
R2-07-09	R2-07-17A	Not sampleable
R2-09-06	R2-09-12A	No channel
R2-11-02	R2-11-13A	Open water wetland
R2-11-04	R2-11-11A	No channel
R2-11-07	R2-11-16A	Beaver pond/open wetland
R2-11-08	R2-11-17A	No channel
R2-11-10	R2-11-20A	Open water wetland
R2-16-02	R2-16-11A	Open water wetland
R2-16-07	R2-16-12A	Open water wetland
R2-16-10	R2-16-15A	Patuxent River mainstem, 4th order

All sorting and identification of the subsampled specimens was conducted by Environmental Services and Consulting, LLC[1]. 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 until the final count is between 100 and 120 organisms. A post-processing subsampling procedure (i.e., rarefaction) was conducted on raw taxonomic data for any samples where more than 120 organisms were incidentally identified and enumerated, using an Excel spreadsheet application (Tetra Tech, 2006). This post-processing rarefaction procedure is designed to randomly subsample all identified organisms within a given sample to a desired target number (i.e., 110 individuals). Each taxon is subsampled based on its original proportion to the entire sample, but keeps the total number of individuals below the 120 maximum for metric calculations.

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 are identified to the lowest possible level, which could be phylum or order, but in most cases would be family. Chironomidae can be further subsampled depending on the number of individuals in the sample and the numbers in each subfamily or tribe. Most taxa are 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

[1] Address: 101 Professional Park Drive, STE 303, Blacksburg, VA

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 taken to further document important 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 inspect 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 once at 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). Assessments 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 riffles, 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 extents. 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 in the entire reach. The pebble count technique, modified from Wolman (1954), was conducted in each reach to determine the composition of channel materials and the median particle size (i.e., D_{50}) for each site. 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 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 Scraper Taxa* – Equals the number of scraper 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 Scraper 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 Scraper 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. Currently, there are no standards available for conductivity. 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*. Specific designated uses for Use I streams include water contact sports, fishing, the growth and propagation of fish, and agricultural, and industrial water supply. Table 9 lists water quality standards for Use I streams.

Table 9 - Maryland COMAR Standards

Parameter	Standard
pH (SU)	6.5 to 8.5
Dissolved Oxygen (mg/L)	Minimum of 5 mg/L
Conductivity (µS/cm)	No State standard
Turbidity (NTU)	Maximum of 150 Nephelometric Turbidity Units (NTU's) and maximum monthly average of 50 NTU
Temperature (°C)	Maximum of 32°C (90°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 & 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 two 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. Anastamosed 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 84th 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 2007 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 2007 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 for each bioassessment point.

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 2011. 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
Bodkin Creek	2.40 ± 0.92 Poor	71.1 ± 14.2 Partially Degraded	136.0 ± 29.7 Supporting
Severn Run	3.14 ± 1.05 Fair	70.2 ± 11.9 Partially Degraded	123.9 ± 36.7 Partially Supporting
Upper Magothy	2.91 ± 0.59 Poor	73.0 ± 5.9 Partially Degraded	141.6 ± 14.1 Supporting
Upper North River	2.74 ± 0.88 Poor	70.0 ± 10.1 Partially Degraded	131.6 ± 26.1 Supporting
Upper Patuxent	2.34 ± 0.50 Poor	85.3 ± 6.3 Minimally Degraded	139.9 ± 23.3 Supporting

3.1.1 Biological and Habitat Assessment Summary

Overall, the majority of BIBI scores throughout the sampling units were split between a rating of 'Fair' (36 percent) and 'Poor' (30 percent) with approximately one-fourth of sites rated as 'Very Poor' (26 percent) and a small proportion of sites rated as 'Good' (eight percent; Figure 2). Four sampling units, Bodkin Creek, Upper Magothy, Upper North River, and Upper Patuxent, had mean BIBI values that resulted in 'Poor' biological condition ratings (Table 12). Severn Run was the only sampling unit to receive a biological condition rating of 'Fair'. There were no sampling units rated as either 'Good' or 'Very Poor' for biological condition.

Physical habitat assessment results indicate that four of the five sampling units, as determined by the sampling unit mean, received ratings of 'Supporting' (RBP; Table 12). Approximately half (48 percent) of the total sites sampled resulted in a RBP rating of 'Supporting' and nearly one-third of the samples (28 percent) resulted in a 'Comparable to Reference' rating (Figure 3). Only a small proportion of sites were rated as either 'Partially Supporting' (ten percent) or 'Non Supporting' (14 percent). Similar to the RBP, four of the five sampling units received PHI ratings of 'Partially Degraded' as determined by the sampling unit mean. Half of the total sites sampled resulted in a PHI rating of 'Partially Degraded', approximately one-fourth of the total sites received 'Minimally Degraded' ratings (24 percent), close to one-fourth resulted in 'Degraded' ratings (22 percent), and a very small percentage of sites received 'Severely Degraded' ratings (four percent).

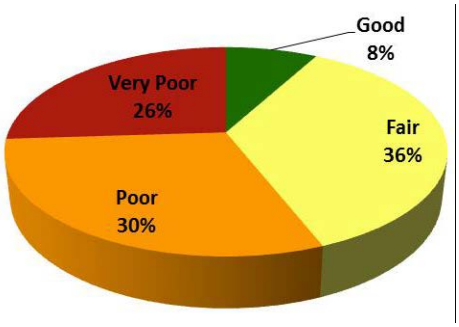


Figure 2 - Proportional distribution of BIBI assessment results for 2011 (n=50)

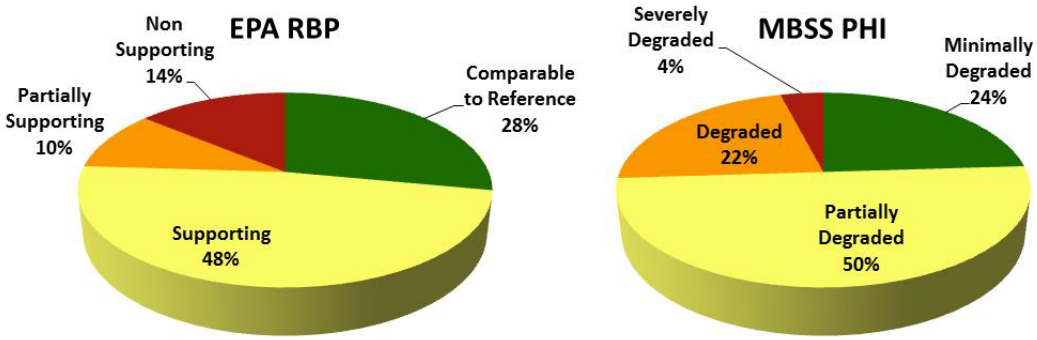
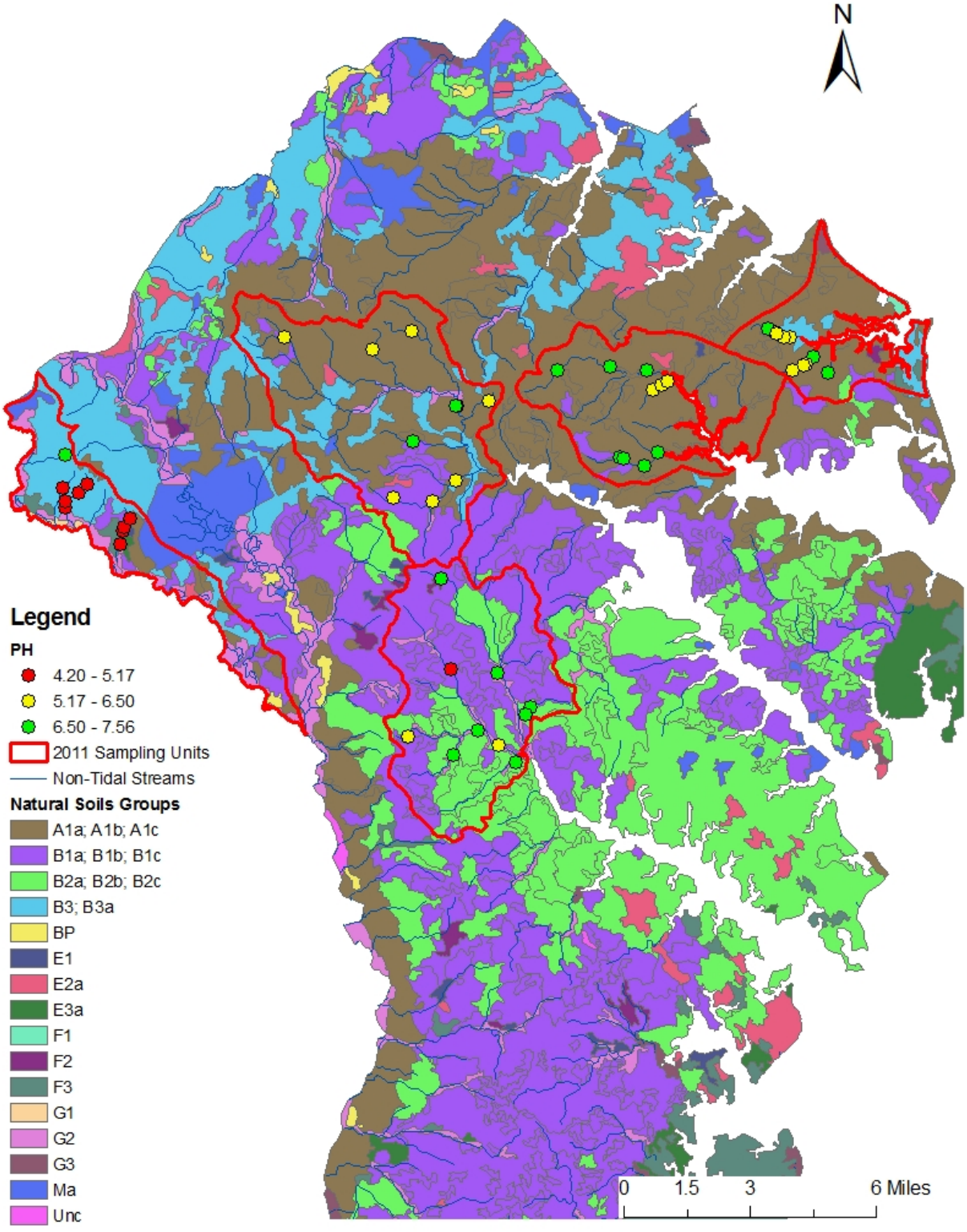


Figure 3 - Summary of 2011 Habitat Scores (n=50)

3.1.2 Water Quality Assessment Summary

Generally, water quality measurements were within COMAR standards for dissolved oxygen and turbidity. Dissolved oxygen was below state standards (<5 mg/L) at two sites, one in the Bodkin Creek sampling unit and one in the Severn Run sampling unit. Turbidity was measured in exceedance of State standards (>150 NTUs) at one site in the Severn Run sampling unit. In addition, low pH values were recorded at over half of the sites sampled (29 sites), spanning all five PSUs sampled in 2011, which were outside the acceptable range of values set forth by COMAR (i.e., 6.5 – 8.5 SU). The pH values ranged from 4.20 – 6.48 for the 29 sites that did not meet COMAR standards for water quality. The majority of sites in Bodkin Creek, Severn Run, and Upper Patuxent measured low pH values (Figure 4). Most sites with pH measurements below 6.5 appear to directly drain wetlands, which have naturally low pH levels. Furthermore, a review of the natural soil groups as defined by Maryland Department of Planning (MDP; 1973) show a predominance of highly acidic soil types (i.e., A1 and B3) in all PSUs except Upper North River (Figure 4). Soil types A1 and B3 are both described as strongly to extremely acidic with a pH range of 4.0 to 5.0 (Appendix E). There were no exceedances for temperature. Eighteen sites showed conductivity levels exceeding 247 µS/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 water quality 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.

Figure 4 - Natural Soil Groups in Anne Arundel County



3.1.3 Geomorphic Assessment Summary

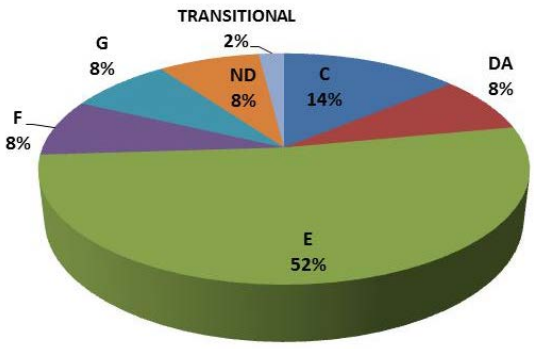


Figure 5 - Distribution of Rosgen stream types within the 2011 sampling units (n=50)

Stream types throughout the sampling units were highly variable, with the largest portion of the sites (52 percent) being E channels (Figure 5). Every sampling unit had E channels accounting for at least half of the sites sampled. Fourteen percent of the sites were classified as C channels, the majority of which were located in the Upper Magothy sampling unit. The F and G type channels each comprised eight percent and were most commonly found in Upper Patuxent. The DA type channels also comprised eight percent and were present in all sampling units with the exception of Upper Patuxent. Additionally, eight percent of sites were lumped into the 'ND' (Not Determined) category due to considerable anthropogenic modification (i.e., channel alteration, hardened banks) or due to natural influences (i.e., wetland ponded by backwater). One site in the Upper Patuxent sampling unit was classified as a transitional reach (C→F) due to a severe headcut in the middle of the reach resulting in a longitudinal transition from a C to an F type channel.

The majority of sites sampled in 2011 (90 percent) had channel substrates composed primarily of sand. Gravel dominated streams comprised six percent of the total sites, with two sites in Upper Patuxent and one site in Upper North River. The remaining four percent of sites had silt/clay channel substrates, which only occurred in the Bodkin Creek sampling unit. Stream slopes were generally low in the assessment reaches. The average slope of all reaches assessed was 0.65 percent. Average slopes for the sampling units ranged from 0.35 percent in Upper North River to 1.0 percent in Upper Patuxent. It should be noted, however, that the average slope in the Upper Patuxent sampling unit was skewed by a single stream with a severe headcut and a 3.3 percent slope, and without this reach the average channel slope would be 0.74 percent.

3.1.4 Land Use Analysis and Impervious Surface Summary

Approximately one-half of the sites sampled in 2011 had developed land as the dominant land use (52 percent) with the remaining 48 percent of sites dominated by forested land. At the sampling unit scale, Upper Magothy had the highest percentage of developed land at 61.1 percent of the total acreage, which was followed by Bodkin Creek at 51.8 percent (Table 13). With over 50 percent of the drainage area comprised of developed land, both Upper Magothy and Bodkin Creek can be considered urbanized subwatersheds. Severn Run is also considered an urban subwatershed with approximately 50 percent developed (49.3 percent). In contrast, Upper Patuxent was the least developed, with only 17.0 percent of the sampling unit attributed to developed land. Developed land was also low (<30 percent) in Upper North River (25.0 percent), which collectively with Upper Patuxent can be considered rural subwatersheds. Upper Patuxent had the highest proportion of forested land at 77.2 percent, while Upper Magothy had the lowest proportion (34.9 percent). The highest proportion of agricultural land use occurred in Upper North River (9.1 percent), followed by Severn Run at 2.7 percent. On the other hand, agriculture comprised less than one percent of the land use in Upper Patuxent, Bodkin Creek, and Upper Magothy. Figure 6 shows land use for the entire County based on the County's 2007 Land Cover GIS layer. The sampling unit with the highest percentage of impervious surface was Upper Magothy (21.9 percent) while Upper Patuxent had the lowest percentage of impervious surface (6.2 percent). Figure 7 shows impervious surface for the entire County based on the County's 2007 Impervious GIS layer.

Figure 6 - Summarized Land Use in Anne Arundel County (2007)

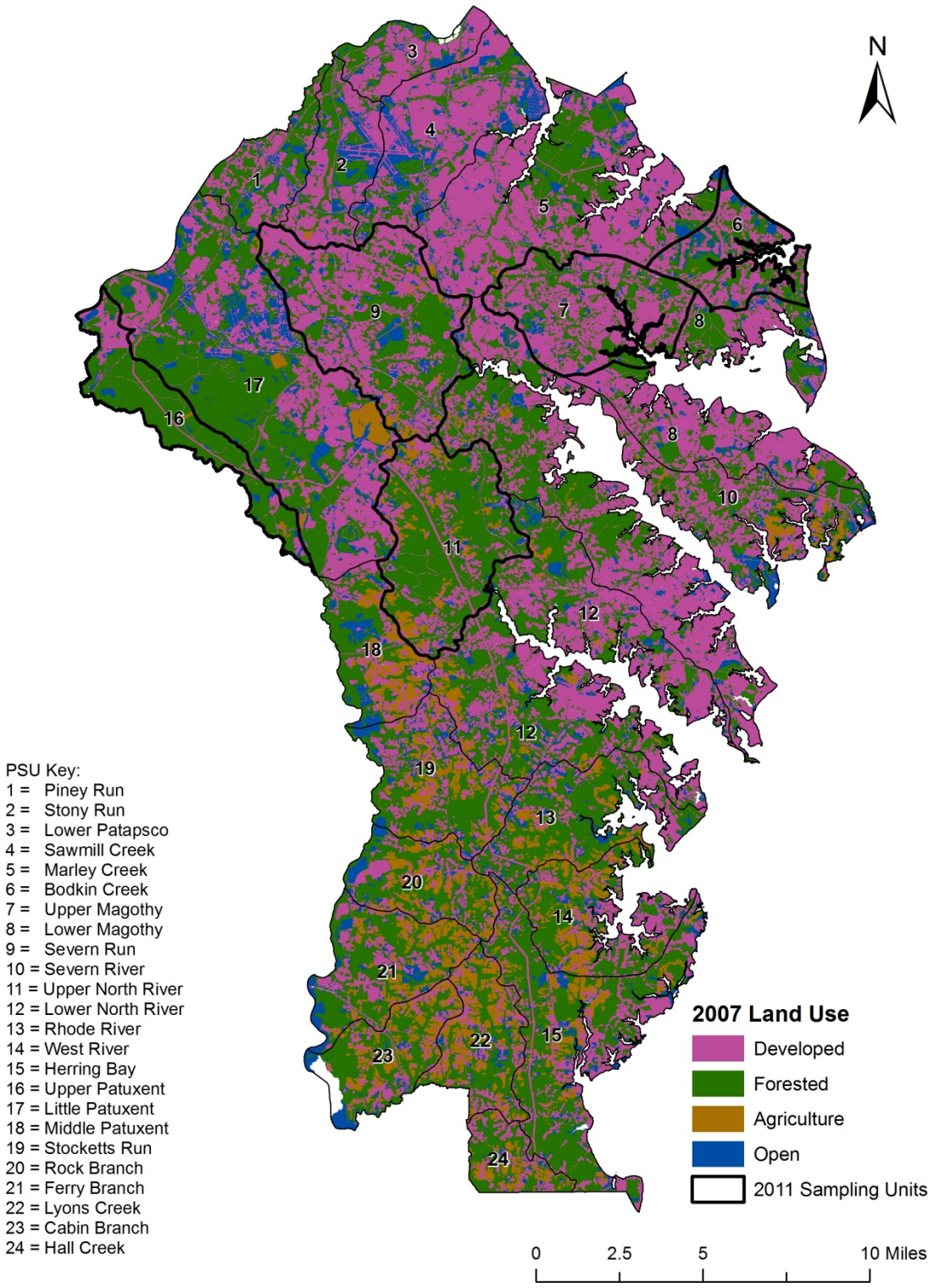


Figure 7 - Impervious Surface in Anne Arundel County (2007)

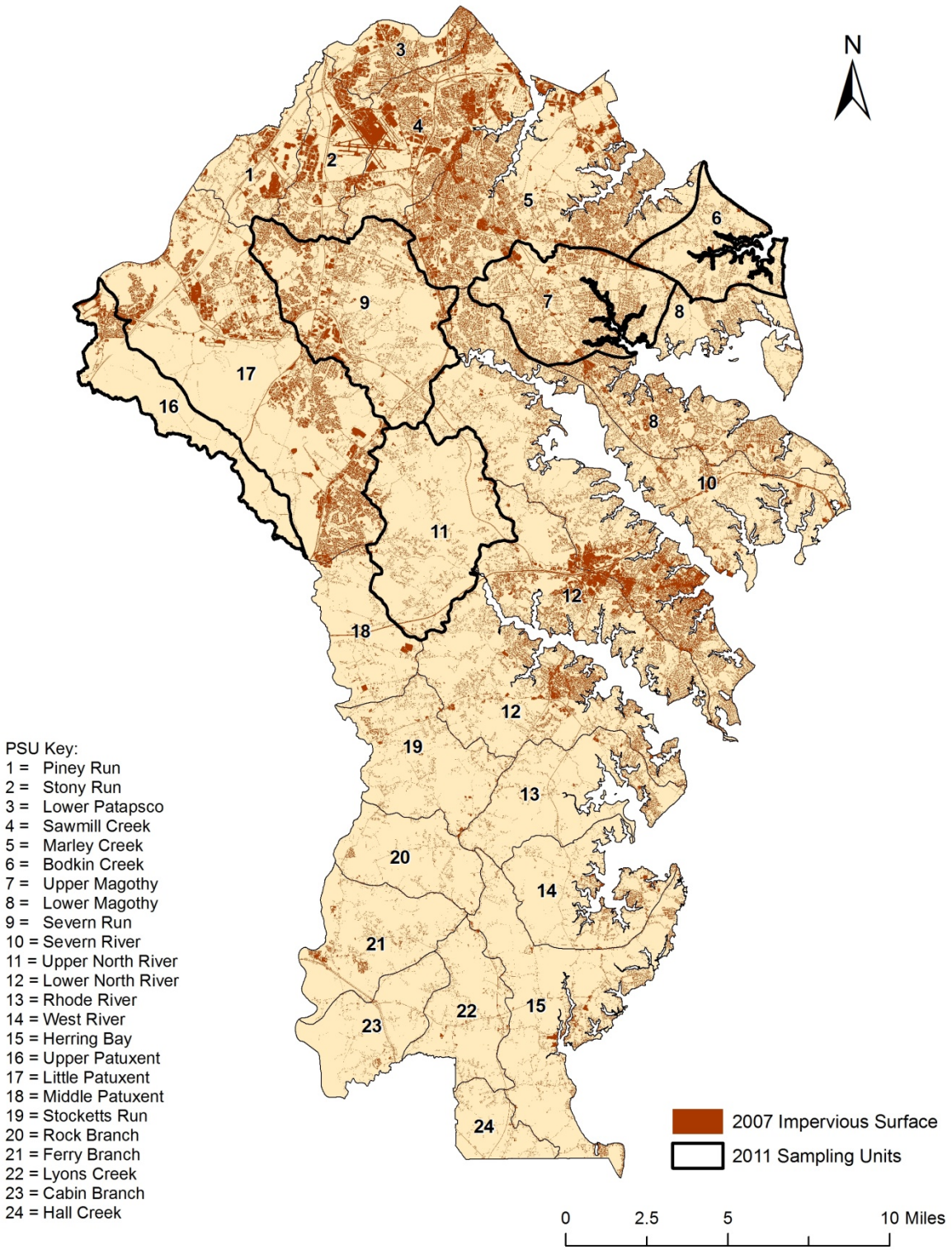


Table 13 - Summary of land use and impervious surface across sampling units

Sampling Unit	Total Acreage	% Impervious	Land Use			
			% Developed	% Forested	% Agriculture	% Open
Bodkin Creek	5,871	13.5	51.8	38.1	0.2	10.0
Severn Run	15,424	18.6	49.3	41.4	2.7	6.6
Upper Magothy	10,030	21.9	61.1	34.9	0.0	4.0
Upper North River	12,795	7.4	25.0	62.3	9.1	3.6
Upper Patuxent	6,905	6.2	17.0	77.2	0.9	5.0

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 Bodkin Creek

The Bodkin Creek sampling unit, located in the northeastern portion of the County, has a total drainage area of 5,871 acres (Figure 1). The ten sampling sites, all on 1st order streams, have drainage areas ranging from 123 to 752 acres (Figure 10). The dominant land use for the Bodkin Creek sampling unit is developed land (52 percent) followed by forested (38 percent) and open (10 percent). Developed land is the dominant land use for 90 percent of the sites sampled, while just 10 percent of sites are dominated by forested land use (R2-06-11A). Impervious surfaces comprise 13.5 percent of the overall Bodkin Creek sampling unit, with individual sites ranging from 11.9 to 17.5 percent impervious surface.

4.1.1 Physical Habitat

Half of the sites sampled in the Bodkin Creek sampling unit received a 'Supporting' narrative RBP rating, one-third received a 'Comparable to Reference' rating, and the remaining 20 percent split equally between 'Partially Supporting' and 'Non Supporting' (Figure 8). The average RBP score was 136.0 ± 29.7 resulting in a 'Supporting' habitat condition for the sampling unit. RBP scores for individual sites ranged from 67 ('Non Supporting'), which was the lowest scoring site in 2011 to 168 ('Comparable to Reference'), which was one of the highest scoring sites in 2011. The PHI rated 40 percent of the sites as 'Degraded,' 30 percent as 'Partially Degraded,' 20 percent as 'Minimally Degraded,' and the remaining 10 percent of sites as 'Severely Degraded.' The average PHI score for the sampling unit was 71.1 ± 14.2 with a rating of 'Partially Degraded.'

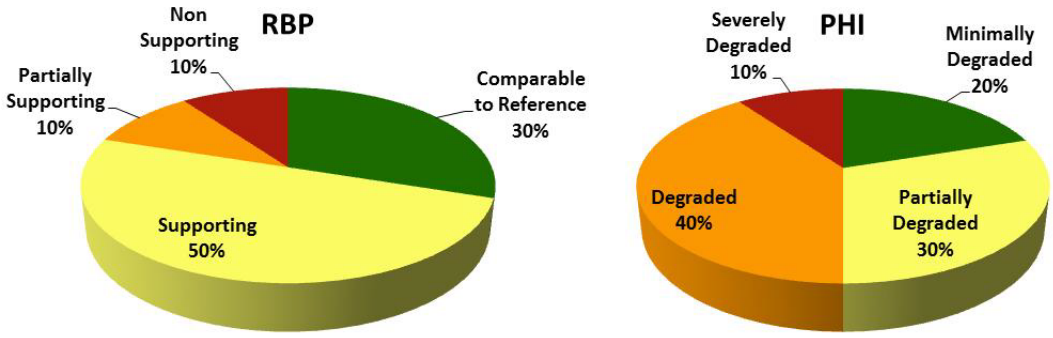


Figure 8 – Bodkin Creek Habitat Scores (n=10)

Individual site scores for PHI ranged from a minimum of 48.9 ('Severely Degraded'), which was the lowest score in 2011, to a maximum of 94.6 ('Minimally Degraded'). With the exception of R2-06-07, the majority of reaches benefited from stable banks with good vegetative protection and wide riparian vegetative zone widths with little impact from recent human activities. Epifaunal substrate, pool substrate/variability, and sediment/deposition scores were variable between reaches.

4.1.2 Benthic Macroinvertebrates

Of the ten sites sampled in Bodkin Creek, half of sites received a BIBI rating of 'Very Poor' while 40 percent of the sites were split equally as 'Fair' or 'Poor' (20 percent each) and the remaining 10 percent of sites (R2-06-02) received a 'Good' biological condition rating (Figure 9). The average BIBI score for the Bodkin Creek sampling unit is 2.40 ± 0.92, with an average biological condition of 'Poor (Table 12). Individual BIBI scores ranged from 1.29 ('Very Poor') to 4.14 ('Good'). Site-specific data and assessment results can be found in Appendix D.

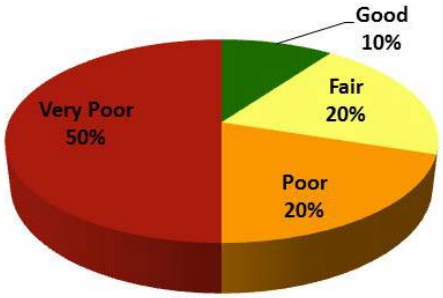


Figure 9 – Bodkin Creek BIBI Scores

Site R2-06-19A, located behind the golf course off of Carnoustie Drive (Figure 10), received the lowest BIBI score, with a score of 1.29 and a biological rating of 'Very Poor.' This site had the lowest number of total taxa (6), no EPT taxa, and no Ephemeroptera taxa present. Less than one percent of the macroinvertebrates identified were considered to be intolerant to urban stressors and just four percent of the sample consisted of climber taxa. At 89 percent of the sample, black flies (*Simulium*, tolerance value [TV]=5.7) dominated the macroinvertebrate assemblage. Four additional sites received a 'Very Poor' biological rating: R2-06-07, R2-06-13A, R2-06-14A, and R2-06-16A. Three of the sites (R2-06-07, R2-06-13A, and R2-06-16A) are located on the same reach, between Braid Hill Drive and Old Nike Missile Site Road and just upstream of site R2-06-19A. With a BIBI score of 4.14, site R2-06-02 was the only site to receive a biological rating of 'Good' in the Bodkin Creek PSU due to a high number of total taxa (23), seven EPT taxa, and two Ephemeroptera taxa. Site R2-06-02 drains Fresh Pond and is located behind Bodkin Park towards the southern end of the PSU. Over half of the macroinvertebrates identified in this sample were considered to be intolerant to urban stressors (55 percent), and 51 percent of the sample consisted of the sensitive isopod *Caecidotea* (TV=2.6).

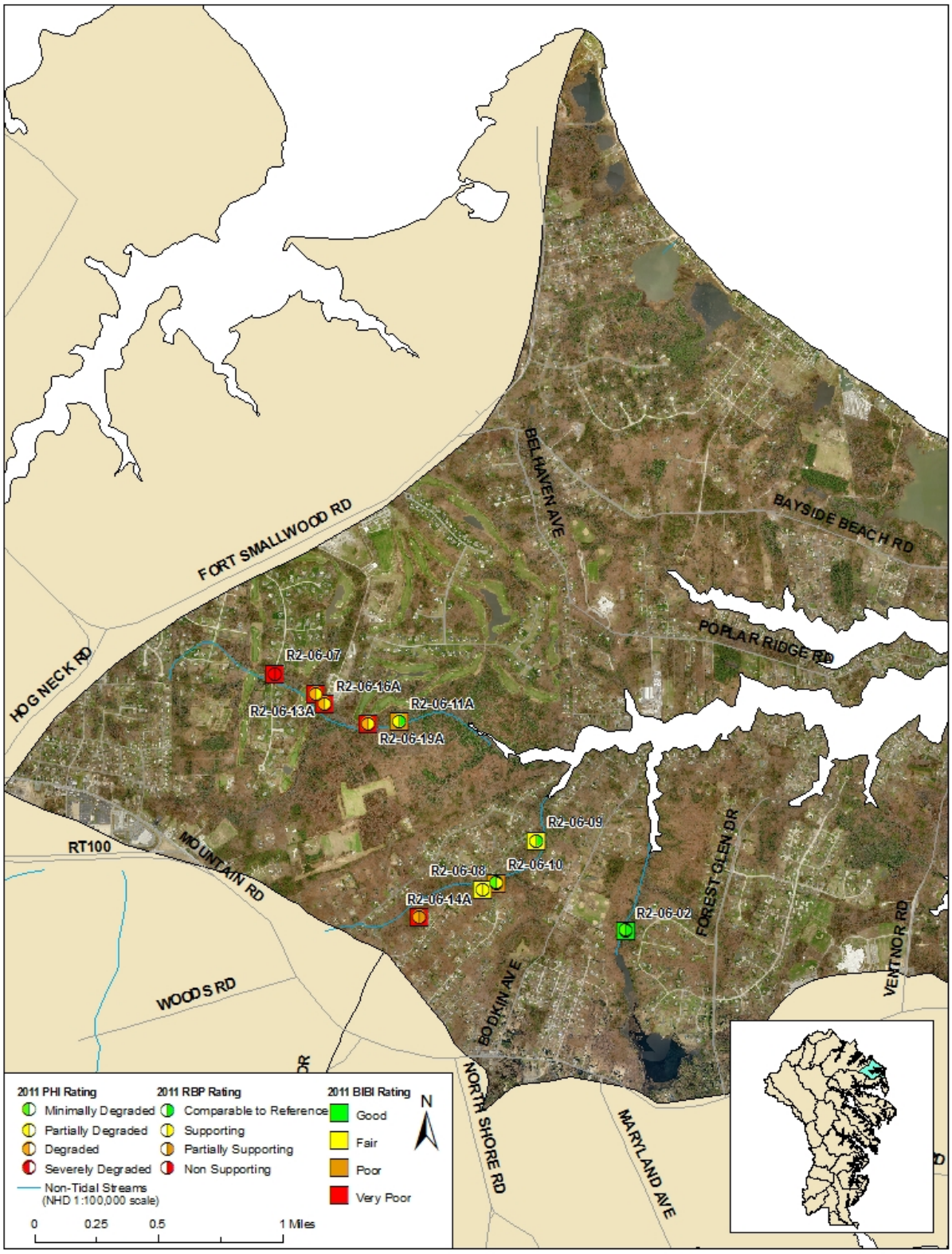
4.1.3 Water Quality

Average water quality values for the Bodkin Creek sites are provided in Table 14. Of the ten sites sampled, seven sites did not meet COMAR standards for water quality. One site, R2-06-14A, measured below COMAR for dissolved oxygen (3.27 mg/L), which is likely due to the virtually stagnant flow observed in the reach. Seven sites (R2-06-08, R2-06-10, R2-06-11A, R2-06-13A, R2-06-14A, R2-06-16A, and R2-06-19A) measured outside the acceptable COMAR range for pH (6.5-8.5), with values ranging from 5.61 to 6.29. All sites with pH measurements below 6.5 appear to be on streams draining wetlands, which have naturally low pH levels, and/or in areas with acidic underlying soils.

Table 14 - Average water quality values – Bodkin Creek (n = 10)

Value ± Standard Deviation				
Temperature (°C)	DO (mg/L)	pH (Units)	Conductance (µS/cm)	Turbidity (NTU)
12.31 ± 2.95	8.85 ± 2.54	6.16 ± 0.40	241.3 ± 88.1	7.21 ± 4.64

Figure 10 – Bodkin Creek Sampling Sites



All measurements for water temperature and turbidity were within COMAR standards. Water temperature ranged from 7.97 to 19.13 °C; dissolved oxygen ranged from 3.27 to 12.72 mg/L; pH ranged from 5.61 to 6.66; specific conductance ranged from 157.8 to 390.2 µS/cm; and, turbidity ranged from 3.57 to 18.80 NTU. However, it should be noted that four sites (R2-06-02, R2-06-07, R2-06-11A, and R2-06-19A) showed conductivity levels exceeding 247 µS/cm, which is the critical threshold between 'Fair' and 'Poor' stream quality determined for Maryland streams (Morgan et al., 2007). Three of the four sites with elevated conductivity drain a golf course and residential development. While the values at these sites are not significantly higher than other elevated sites found throughout the study areas, turf management practices may be investigated further as a potential cause of water quality impairment. 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.

4.1.4 Geomorphic Assessment

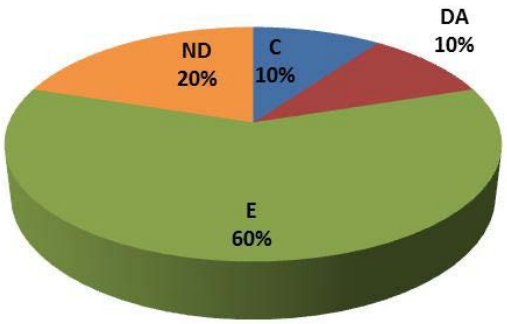


Figure 11 - Rosgen stream types observed in Bodkin Creek (n = 10)

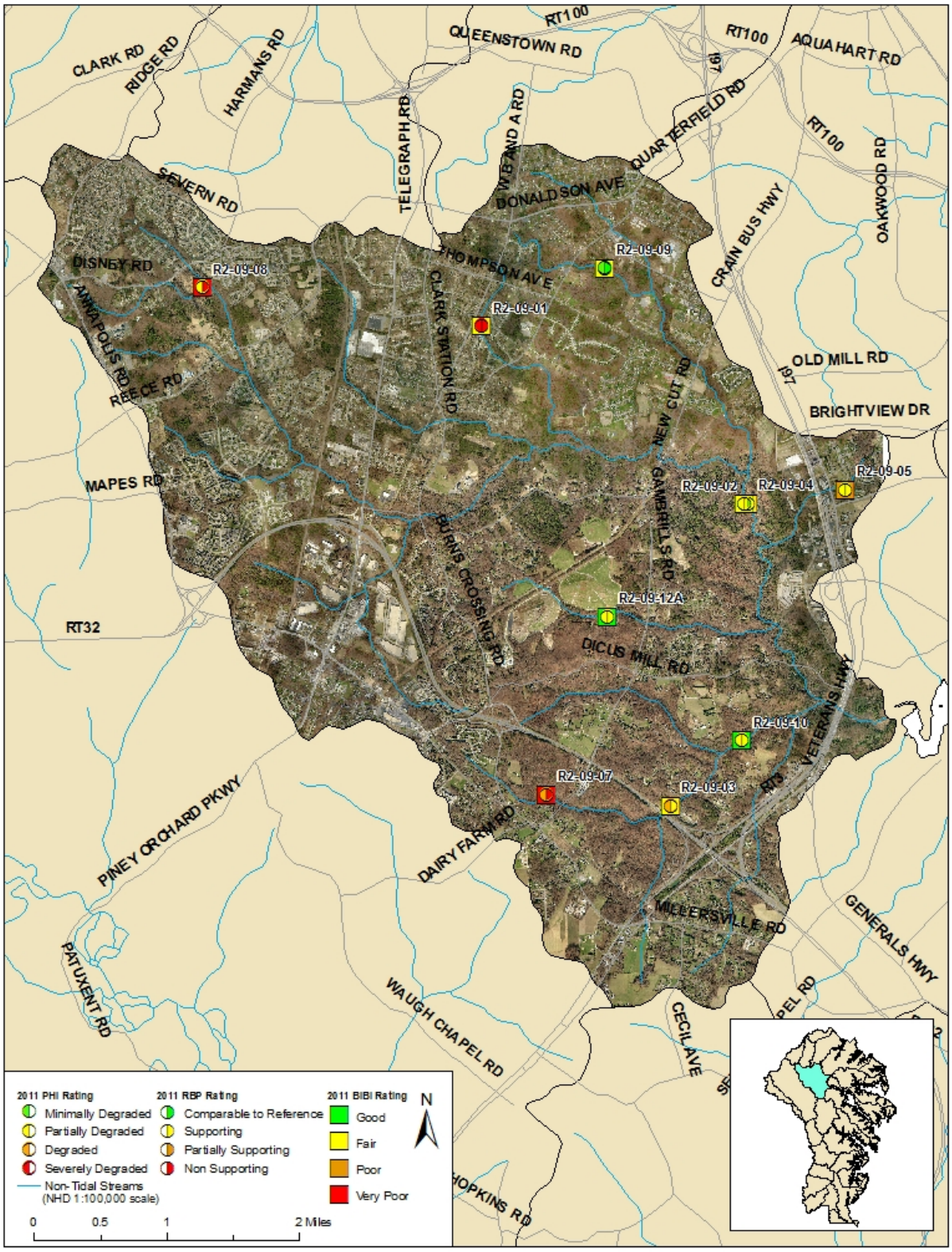
Site-specific geomorphic assessment results can be found in Appendix A. The majority of the sites assessed (60 percent) were E type streams (Figure 11). The remaining sites were 'ND' (20 percent), C (10 percent) or DA type (10 percent) channels. Rosgen stream types were not determined for sites R2-06-07 and R2-06-14A. Site R2-06-07 contained significant anthropogenic modification in the form of a 70-foot long culvert in the middle of the reach, while site R2-06-14A was located within a functional wetland and entirely backwatered.

Streams in this sampling unit were predominantly sand bottom channels (80 percent), although a small percentage of sites were dominated by silt/clay (20 percent). The median D_{50} was 0.28 mm (medium sand material). Individual slopes ranged from 0.02 percent to 0.74 percent, with an average slope of 0.44 percent.

4.2 Severn Run

The Severn Run sampling unit is located in the central part of the County to the east of Fort George G. Meade Military Reservation (Figure 1), and has a drainage area of 15,424 acres. Several major transportation corridors cross through the watershed including highways I-97, Maryland Route 32, and Maryland Route 3. The ten sampling sites (six 1st order, two 2nd order, and two 3rd order) have drainage areas ranging from 90 to 9,795 acres (Figure 12). Land use in the Severn Run sampling unit is comprised of primarily developed land (49 percent) followed by forested land (41 percent). Over half of the sites have developed land as a dominant land use while 40 percent of sites are dominated by forested land. Impervious surfaces comprise 18.6 percent of the Severn Run sampling unit with individual sites ranging from 8 to 23 percent imperviousness.

Figure 12 – Severn Run Sampling Sites



4.2.1 Physical Habitat

Based on the RBP scores, half of the Severn Run sites received a rating of 'Supporting,' 30 percent received a 'Non Supporting' rating, and the remaining 20 percent of sites received a rating of 'Comparable to Reference' (Figure 13). Overall, the Severn Run sampling unit received the lowest average for RBP scores and was the only sampling unit to receive an average rating of 'Partially Supporting.' The average RBP score for the sampling unit was 123.9 ± 36.7 ('Partially Supporting'), while individual RBP scores ranged from a minimum of 69 ('Non Supporting') to a maximum of 158 ('Comparable to Reference'). However, it should be noted, that three sites with very low scores (i.e., <75) skewed the average. Without those three sites, the median score for this PSU would be 140 ('Supporting').

The majority of sites received a PHI rating of 'Partially Degraded' (60 percent), while 20 percent received a 'Degraded' rating, and the remaining 20 percent split equally between 'Minimally Degraded' and 'Severely Degraded'. The average PHI rating was 70.2 ± 11.9 ('Partially Degraded') with individual sites ranging from 50.1 ('Severely Degraded') to 86.2 ('Minimally Degraded'). With the exception of R2-09-01, instream physical habitat scores were generally marginal to suboptimal, benefiting from wide riparian vegetative zone widths with little impact from human activities.

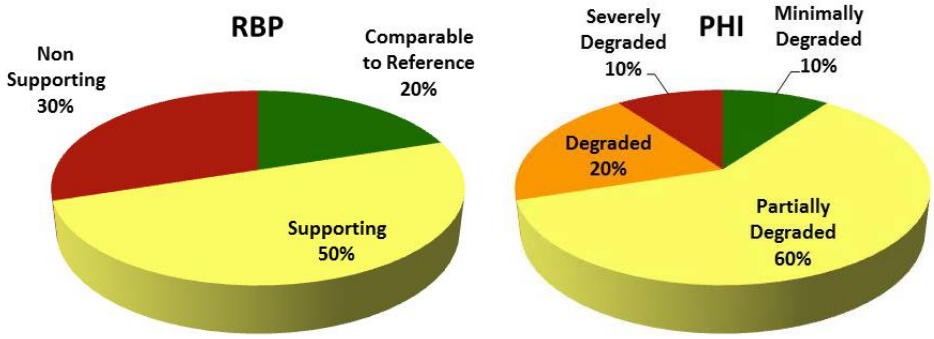


Figure 13 – Severn Run Habitat Scores (n=10)

4.2.2 Benthic Macroinvertebrates

The Severn Run sampling unit was the only sampling unit to receive a BIBI narrative rating of 'Fair' with an average score of 3.14 ± 1.05 (Table 12). Half of the individual sites received a biological condition rating of 'Fair', 20 percent received a 'Good' rating, 20 percent received a 'Very Poor' rating, and the remaining 10 percent received a rating of 'Poor' (Figure 14). Site-specific data and assessment results can be found in Appendix D.

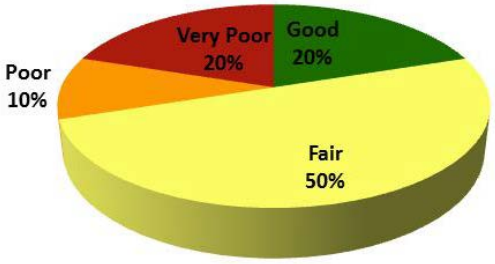


Figure 14 – Severn Run BIBI Scores (n=10)

Site R2-09-07, located in the headwaters of Jabez Branch (Figure 12), automatically received the lowest BIBI score possible (1.00) with a corresponding narrative rating of 'Very Poor' because the sample contained less than 60 organisms (57). This subsample had 17 total taxa, one of which was an EPT taxon, with no Ephemeroptera, scraper, climber or intolerant taxa present. This site had very little flow (i.e., mostly standing water) with heavy sedimentation throughout and an active three-foot headcut,

indicating considerable channel instability. Site R2-09-10, located in the Severn Run Natural Environment Area off of Cecil Avenue, and site R2-09-12A, located downstream of the Millersville Landfill, both received the highest BIBI scores (4.14; 'Good') in the Severn Run sampling unit. For R2-09-10, eight EPT taxa were identified from a total of 32 taxa and 37 percent of the sample consisted of taxa intolerant to urban stressors. Out of 24 total taxa identified, six were EPT taxa for site R2-09-12A, with over a third of the sample (37 percent) consisting of climber taxa.

4.2.3 Water Quality

Average water quality values for the Severn Run sites are provided in Table 15. Seven of ten sites sampled did not meet COMAR standards for water quality. Seven sites (R2-09-01, R2-09-03, R2-09-05, R2-09-07, R2-09-08, R2-09-09, and R2-09-10) measured outside the acceptable COMAR range for pH (6.5-8.5), with values ranging from 5.27-6.08. All sites with pH measurements below 6.5 appear to be on streams draining wetlands, which have naturally low pH levels, as well as acidic underlying soils. One site on Jabez Branch, R2-09-07, measured below COMAR for DO (4.01 mg/L) which is largely attributed to very little flow observed in the stream during the sampling visit. Site R2-09-09 exhibited extremely high levels of turbidity (>1000 NTU) which greatly exceeded the COMAR standard of < 150 NTU. The field crew immediately reported the results to the County for investigation, and it was determined that there was improper sediment and erosion control at a construction site upstream. Therefore, it is unlikely that these results are typical of water quality conditions in this stream. All measurements for water temperature were within COMAR standards. Water temperature ranged from 5.67 to 16.83 °C; dissolved oxygen ranged from 4.01 to 12.22 mg/L; pH ranged from 5.27 to 6.77; specific conductance ranged from 144.5 to 326.4 µS/cm; and, turbidity ranged from 4.27 to 1000 NTU. It should also be noted that four sites (R2-09-02, R2-09-04, R2-09-08, and R2-09-12A) showed conductivity levels exceeding 247 µS/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.

Table 15 - Average water quality values – Severn Run (n = 10)

Value ± Standard Deviation				
Temperature (°C)	DO (mg/L)	pH (Units)	Conductance (µS/cm)	Turbidity (NTU)*
9.39 ± 3.42	10.03 ± 2.34	6.09 ± 0.53	224.7 ± 68.3	15.03 ± 11.31

*Turbidity outlier at R2-09-09 not included in average (n=9)

4.2.4 Geomorphic Assessment

Site-specific geomorphic assessment results can be found in Appendix A. Stream type E was observed in half of the sites in the Severn Run sampling unit (Figure 15). Twenty percent of sites were entrenched G type streams. Less-entrenched, and generally more stable, C type streams and the anastamosed DA type streams each accounted for ten percent of the sites. The stream type of one site, R2-09-08, could not be determined due to substantial ditching and straightening of the channel.

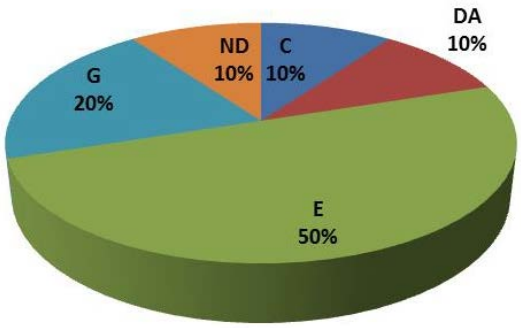


Figure 15 - Rosgen stream types observed in Severn Run (n=10)

All sampling sites in Severn Run were sand dominated channels. The median D_{50} was 0.28 (medium sand material). Streams in this sampling unit had an average slope of 0.80 percent, with individual slopes ranging from 0.13 percent to 2.0 percent. Slopes were moderately gradual, with most sites falling in the range from 0.13 percent to 0.91 percent, although two sites were greater than one percent. Site R2-09-05, a multithread channel located in a wetland system to the east of Interstate 97, had a slope of 1.6 percent. Site R2-09-07, located on an incised channel with heavy bank erosion and virtually no flow present, had a slope of two percent due to an active three foot headcut in the upstream extent of the reach.

4.3 Upper Magothy

The Upper Magothy sampling unit is located in the central portion of the County in the vicinity of Pasadena (Figure 1), and has a total drainage area of 10,030 acres. Nine sampling sites were located on 1st order streams and one site on a 2nd order stream, with site drainage areas ranging from 202 to 2,996 acres (Figure 17). With nearly 22 percent of the Upper Magothy sampling unit comprised of impervious surface, this was the most developed sampling unit assessed in 2011. Several major transportation corridors bisect the watershed including Ritchie Highway (MD Route 2) and Maryland Route 100. Site-specific drainage areas ranged from 12.6 to 32.1 percent impervious. Developed land comprised 61 percent of the total land use followed by forested land (35 percent). All sites in the Upper Magothy sampling unit have developed land as the dominant land use.

4.3.1 Physical Habitat

The majority of sites in Upper Magothy were rated 'Supporting' (70 percent) with two sites (20 percent) rated as 'Comparable to Reference' and only one site (10 percent) rated as 'Partially Supporting' by the EPA RBP method (Figure 16). With an average RBP score of 141.6 ± 14.1 and a narrative rating of 'Supporting,' this sampling unit received the highest average RBP score. Individual site scores ranged from 114 ('Partially Supporting') to 167 ('Comparable to Reference'). Similar to the RBP scores, the majority of sites were rated 'Partially Degraded' (80 percent) with the remaining 20 percent split equally between 'Minimally Degraded' and 'Degraded.' The average PHI rating was 'Partially Degraded' with a score of 73.0 ± 5.9, with individual site scores ranging from 65.9 ('Degraded') to 84.8 ('Minimally Degraded'). The majority of reaches received suboptimal scores for instream physical habitat as well as high scores for bank stability, vegetative protection, and riparian zone width.

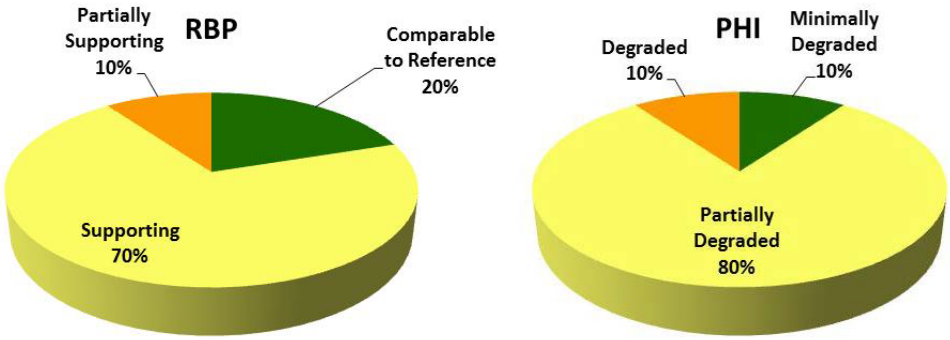
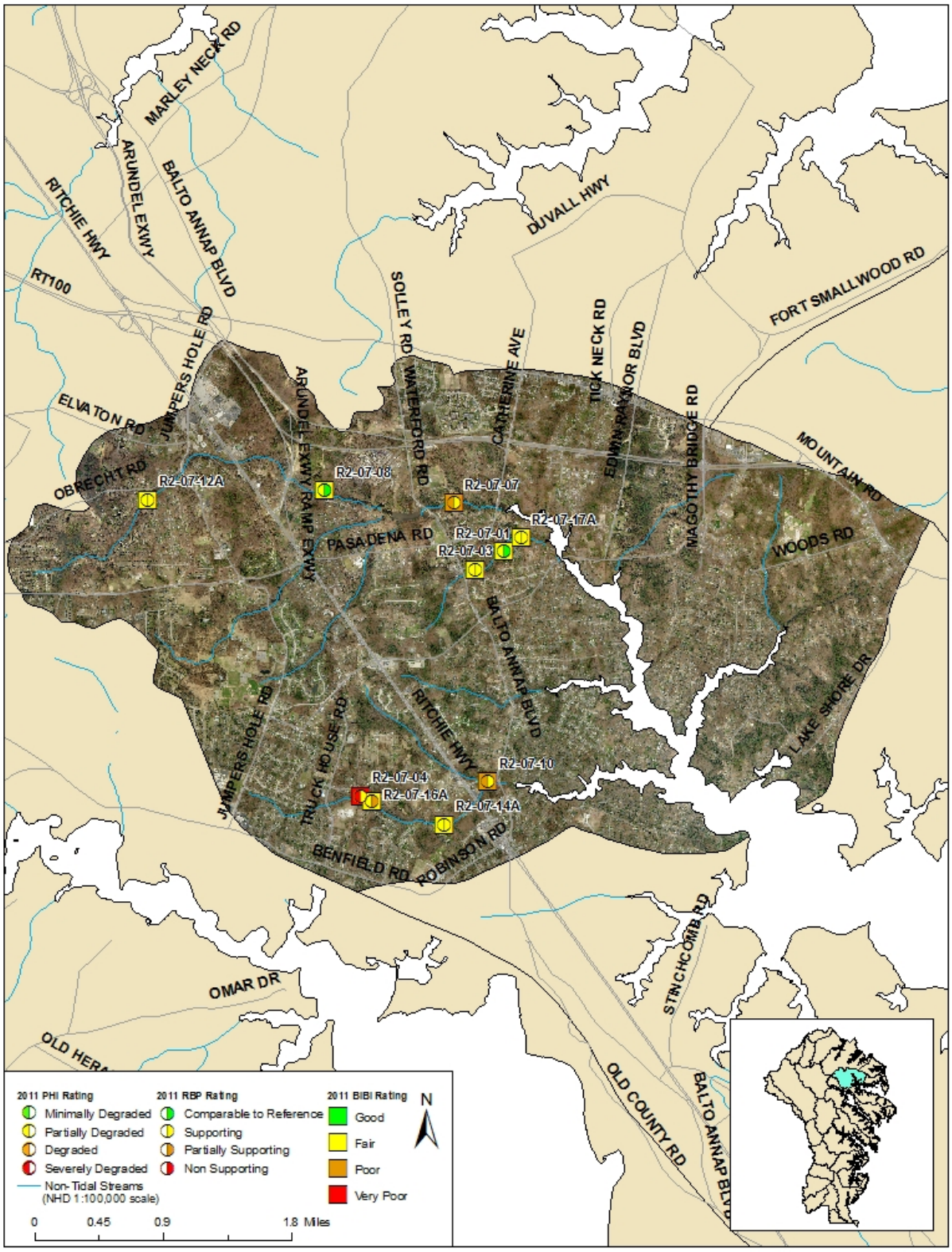


Figure 16 – Upper Magothy Habitat Scores (n=10)

Figure 17 – Upper Magothy Sampling Sites



4.3.2 Benthic Macroinvertebrates

The average BIBI rating for the Upper Magothy sampling unit is 'Poor' with an average BIBI score of 2.91 ± 0.59 (Table 12),and individual sites ranging from a low of 1.86 ('Very Poor') to 3.86 ('Fair'). The majority of sites received a BIBI rating of 'Fair' (70 percent), while the remaining sites received 'Poor' (20 percent) or 'Very Poor' ratings (10 percent; Figure 18). Site-specific data and assessment results can be found in Appendix D.

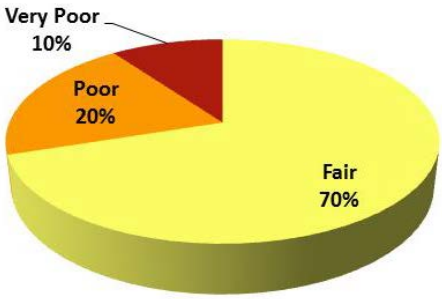


Figure 18 – Upper Magothy BIBI Scores

Site R2-07-04 received the lowest score of 1.86 and was the only site to receive a 'Very Poor' narrative rating in the Upper Magothy sampling unit (Figure 17). Located behind Oak Hills Elementary School, this site completely lacked EPT and Ephemeroptera taxa and only two percent of the sample contained taxa intolerant to urban stressors. This sample was dominated by worms of the Lumbriculidae and Tubificidae families (TV=6.6 and TV=8.4, respectively). In contrast, site R2-07-12A received the highest BIBI score (3.86) and 'Fair' biological condition rating due to a high number of total taxa (30), the presence of five EPT taxa including one Ephemeroptera, and a high percentage of climber taxa (20 percent).

4.3.3 Water Quality

Average water quality values for the Upper Magothy sites are provided in Table 16. Of the ten sites sampled, three sites did not meet COMAR standards for water quality. Sites R2-07-01, R2-07-03, and R2-07-17A measured outside the acceptable COMAR range for pH (6.5-8.5), with values ranging from 5.59 to 6.25. All sites with pH measurements below 6.5 appear to be on streams draining wetlands, which have naturally low pH levels, and/or in areas with acidic underlying soils. All other water quality parameters were within acceptable ranges. Water temperature ranged from 5.80 to 13.33 °C; dissolved oxygen ranged from 6.27 to 11.84 mg/L; pH ranged from 5.59 to 6.89; specific conductance ranged from 136.7 to 330.9 µS/cm; and, turbidity ranged from 4.88 to 40.90 NTU. However, it should be noted that five sites (R2-07-04, R2-07-07, R2-07-08, R2-07-10, and R2-07-17A) showed conductivity levels exceeding 247 µS/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.

Table 16 - Average water quality values – Upper Magothy (n = 10)

Value ± Standard Deviation				
Temperature (°C)	DO (mg/L)	pH (Units)	Conductance (µS/cm)	Turbidity (NTU)
9.05 ± 1.72	9.74 ± 1.35	6.45 ± 0.43	248.6 ± 69.0	12.95 ± 11.27

4.3.4 Geomorphic Assessment

The majority of sites assessed in the Upper Magothy sampling unit were classified as E and C type channels, 50 and 40 percent, respectively. One site was classified as a DA type channel (Figure 19). Site-specific geomorphic assessment results can be found in Appendix A.

All streams sampled in this PSU had predominantly sand bed materials. The median D_{50} for the sampling unit was 0.29 mm (medium sand material). With the exception of one site, slopes were fairly gradual ranging from 0.11 percent to 1.3 percent. Site R2-07-01, located on an unnamed tributary just upstream of the Magothy River, was an anomaly with a rootwad/debris jam providing grade control in the middle of the reach, resulting in a reach wide slope of 2.4 percent.

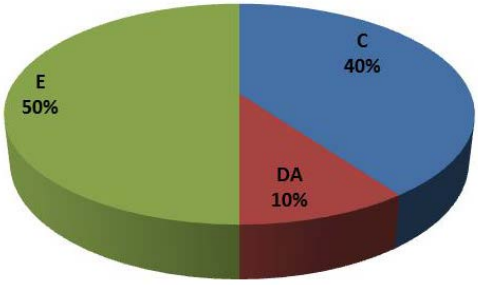


Figure 19 - Rosgen stream types observed in Upper Magothy (n = 10)

4.4 Upper North River

The Upper North River sampling unit is located in the central part of the County between Crofton and Crownsville (Figure 1) and has a drainage area of 12,795 acres. The ten sampling sites (seven 1st order, two 2nd order, and one 3rd order) have drainage areas ranging from 156 to 5,666 acres (Figure 21). Land use in the Upper North River sampling unit is primarily comprised of forested land (62 percent) followed by developed land (25 percent) and agriculture (9 percent). Nine sampling sites have forest as a dominant land use, with just one site located on Bacon Ridge Branch (R2-11-16A) dominated by developed land. Impervious surfaces comprise of 7.4 percent of the Upper North sampling unit with individual sites ranging from 5.1 to 13.6 percent imperviousness. However, two major transportation corridors, Interstate I-97 and John Hanson Highway (MD Routes 50/301), cross through the watershed.

4.4.1 Physical Habitat

Physical habitat conditions were fairly variable for this sampling unit. Based on the RBP scores, close to half of the Upper North River sites received a rating of 'Supporting' (40 percent) and the remaining sites received ratings of 'Comparable to Reference' (30 percent), 'Non Supporting' (20 percent) and 'Partially Supporting' (10 percent); (Figure 20). The average RBP score for the sampling unit was 131.6 ± 26.1 and the narrative rating was 'Supporting.' Individual RBP scores ranged from a minimum of 92 ('Non Supporting') to a maximum of 168 ('Comparable to Reference'), which is one of the highest scoring sites in 2011. PHI scores rated 50 percent of sites as 'Partially Degraded,' 40 percent as 'Degraded,' and the remaining 10 percent as 'Minimally Degraded'. Overall, the Upper North River sampling unit received the lowest average for PHI scores. The average PHI rating was 'Partially Degraded' with a score of 70.0 ± 10.1, while individual PHI scores ranged from 76.5 ('Partially Degraded') to 85.3 ('Minimally Degraded'). While the majority of sites received high scores for bank stability and riparian zone width, half of the sites received poor to marginal scores for instream physical habitat.

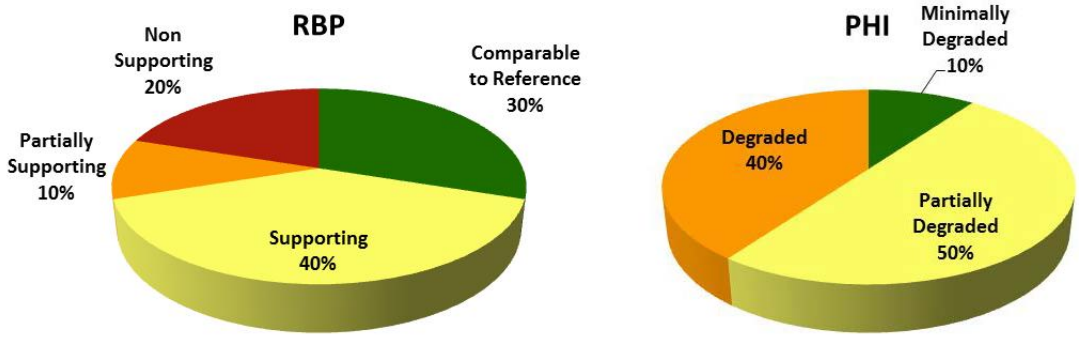
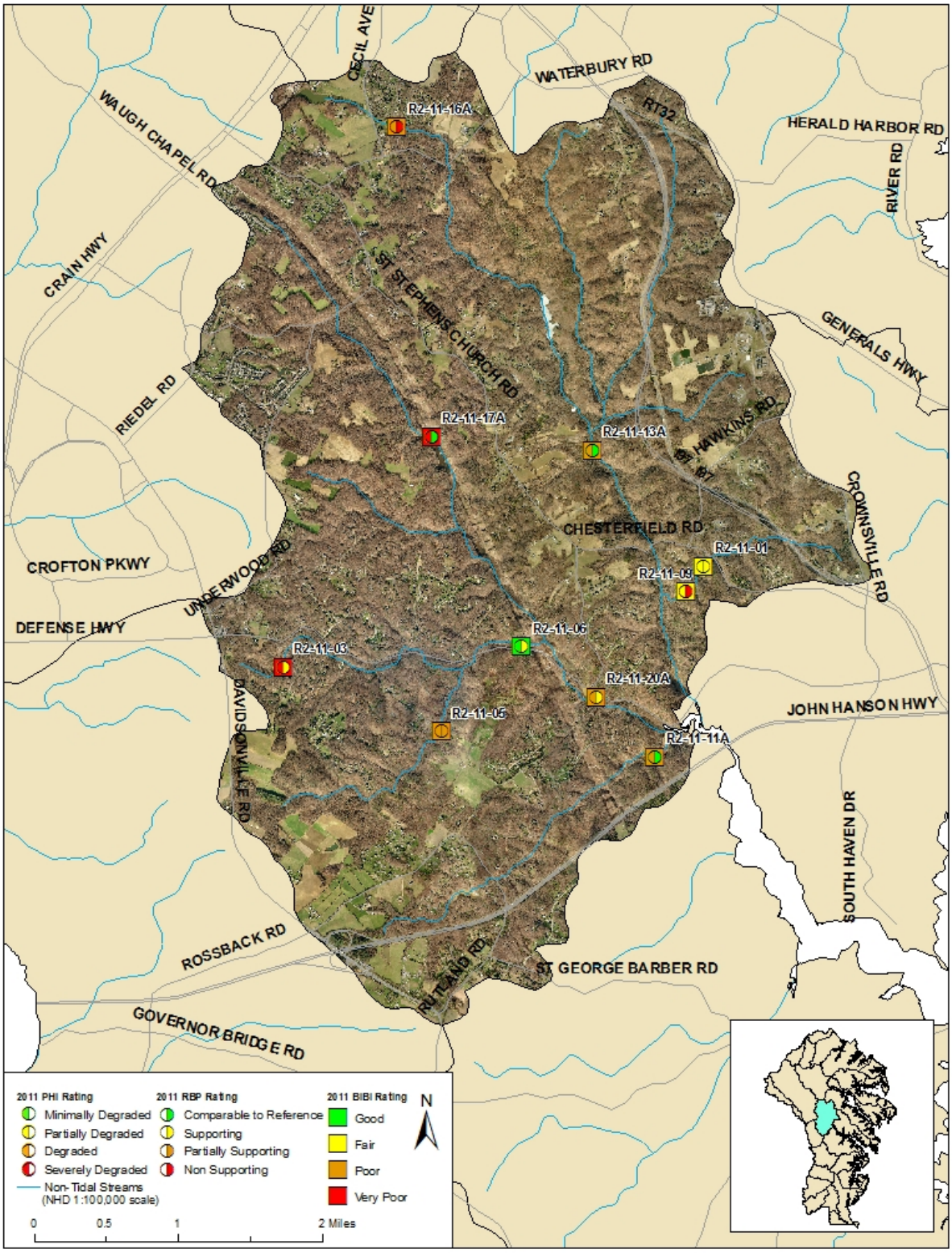


Figure 20 – Upper North River Habitat Scores (n=10)

Figure 21 – Upper North River Sampling Sites



4.4.2 Benthic Macroinvertebrates

Half of sites sampled within the Upper North River sampling unit received 'Poor' BIBI ratings, 40 percent were split equally between 'Fair' and 'Very Poor' ratings while the remaining 10 percent of sites received a 'Good' rating (Figure 22). The average BIBI score for the sampling unit was 2.74 ± 0.88 resulting in a 'Poor' biological condition rating (Table 12). Site-data and assessment results can be found in Appendix D.

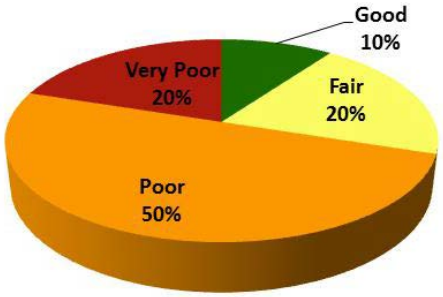


Figure 22 – Upper North River BIBI Scores (n=10)

Site R2-11-17A, located in the headwaters of North River within a wetland complex and adjacent to a powerline right-of-way corridor (Figure 21), received the lowest BIBI score of 1.57 with a 'Very Poor' rating. Fourteen taxa were present in this sample, which was predominantly comprised of midges including *Psectrocladius* (TV=6.6) and *Zalustschia* (TV=6.6) that accounted for 37 and 29 percent of the sample, respectively. This sample consisted of few climbers and no EPT, Ephemeroptera, or scraper taxa. Located on Bell Branch and adjacent to Defense Highway (Route 450), site R2-11-06 received the highest BIBI score of all sites sampled in 2011 (4.43), resulting in a 'Good' biological condition rating. Of the 29 taxa identified in this sample, seven were EPT including two Ephemeroptera taxa. This site also scored high for scraper taxa (total of 4) and percent climbers (24 percent).

4.4.3 Water Quality

Average water quality values for the Upper North sites are provided in Table 17. Three sites did not meet COMAR standards for water quality. Sites R2-11-03, R2-11-17A, and R2-11-20A measured outside the acceptable COMAR range for pH (6.5-8.5), with values ranging from 4.31 to 6.48. All sites with pH measurements below 6.5 appear to be on streams draining wetlands, which have naturally low pH levels, and/or in areas with acidic underlying soils. All other water quality parameters were within acceptable ranges. Water temperature ranged from 3.10 to 9.60 °C; dissolved oxygen ranged from 8.82 to 13.07 mg/L; pH ranged from 4.31 to 7.56; specific conductance ranged from 123.3 to 347.4 µS/cm; and, turbidity ranged from 1.00 to 11.60 NTU. However, it should be noted that four sites (R2-11-01, R2-11-03, R2-11-11A, and R2-11-16A) showed conductivity levels exceeding 247 µS/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.

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

Value ± Standard Deviation				
Temperature (°C)	DO (mg/L)	pH (Units)	Conductance (µS/cm)	Turbidity (NTU)
6.12 ± 2.25	11.58 ± 1.25	6.48 ± 0.85	233.6 ± 63.0	5.09 ± 3.46

4.4.4 Geomorphic Assessment

Site-specific geomorphic assessment results can be found in Appendix A. Seventy percent of the sites assessed in the Upper North River sampling unit were classified as either E or F type channels (50 and 20 percent, respectively; Figure 23). Twenty percent of sites were equally split between C and DA type channels. The remaining site, R2-11-20A, was not determined due to the impacts of bank stabilization and highway slope grading on the channel dimensions. A major assumption of the Rosgen characterization is that the stream channel has the ability to adjust its dimensions naturally. Thus, reaches that have been heavily channelized violate this assumption and the channel dimensions may not be representative of natural conditions.

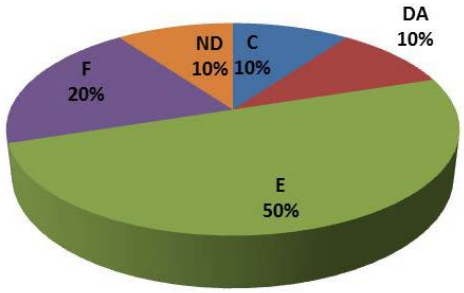


Figure 23 - Rosgen stream types observed in Upper North River (n=10)

The majority of streams in this sampling unit were either sand (90 percent) or gravel (10 percent) dominated systems. The median D_{50} for the sampling unit was 0.22 mm (fine sand material). Slopes were moderately gradual, with an average slope of 0.35 percent, and individual reaches falling in the range from 0.005 percent to 0.82 percent.

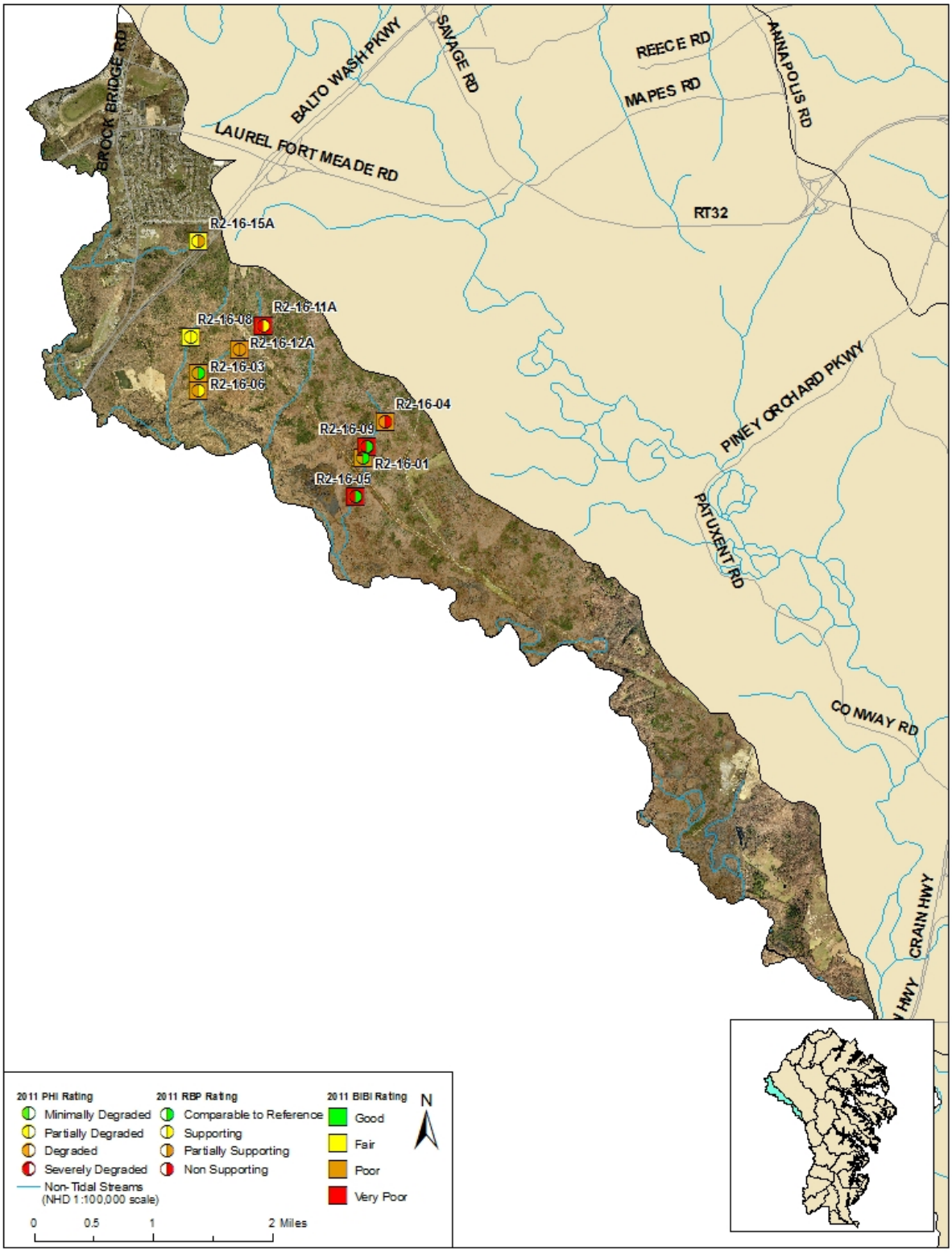
4.5 Upper Patuxent

The Upper Patuxent sampling unit is located along the northwestern border of the County and drains directly to the Patuxent River (Figure 1). As a result, all ten sampling sites are on 1st order streams (Figure 24). With a drainage area of 6,905 acres, only 6.2 percent of the Upper Patuxent sampling unit is comprised of impervious surfaces. Over three-fourths of the sampling unit is comprised of forested lands (77 percent), the majority of which occurs within the Patuxent Wildlife Refuge, and only 17 percent of the sampling unit is comprised of developed land. All but one site (R2-16-15A) were located within the North Tract of the Patuxent Wildlife Refuge and have forest as the dominant land use. The Upper Patuxent was the least developed sampling unit assessed in 2011, with sites ranging from 0.4 to 15.9 percent imperviousness. Only one major transportation corridor, Baltimore-Washington Parkway (MD Route 295), crosses the watershed.

4.5.1 Physical Habitat

Of all the sampling units assessed in 2011, Upper Patuxent had the highest proportion of sites rated as 'Comparable to Reference' (40 percent) by the RBP index or 'Minimally Degraded' (70 percent) by the PHI (Figure 25). The remaining sites received RBP ratings of 'Supporting' (30 percent), 'Partially Supporting' (20 percent), and 'Non Supporting' (10 percent), and PHI ratings of 'Partially Degraded' (30 percent). The average RPB score for this sampling unit was 139.9 ± 23.3 and a narrative rating of 'Supporting.' Individual RBP scores ranged from 96 ('Non Supporting') to 167 ('Comparable to Reference'). With an average PHI score of 85.3 ± 6.3 and a narrative rating of 'Minimally Degraded', this sampling unit received the highest average PHI score. Individual PHI scores ranged from a minimum of 76.5 ('Partially Degraded') to a maximum of 95.4 ('Minimally Degraded'). These results were primarily due to suboptimal scores for epifaunal substrate, pool substrate/characterization, sediment/deposition, bank stability and vegetative protection, as well as optimal scores for riparian vegetative zone width.

Figure 24 – Upper Patuxent Sampling Sites



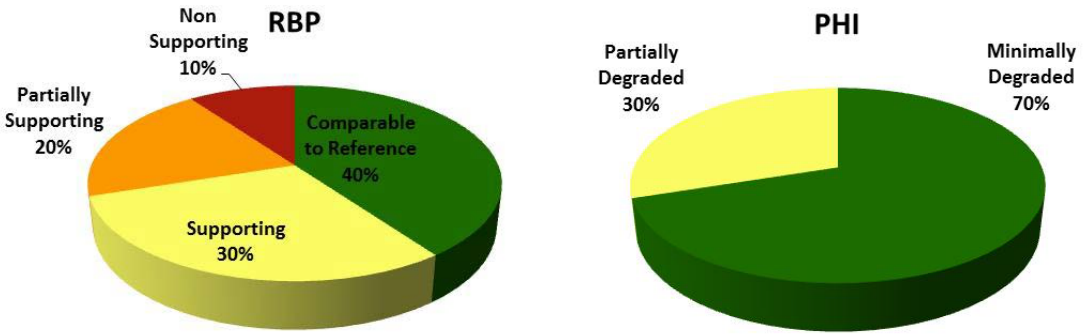


Figure 25 – Upper Patuxent Habitat Scores (n=10)

4.5.2 Benthic Macroinvertebrates

The average BIBI rating for the Upper Patuxent sampling unit is 'Poor' with an average score of 2.34 ± 0.50 (Table 12). One-half of the sites received a BIBI rating of 'Poor' while the other half were split between 'Very Poor' (30 percent) and 'Fair' ratings (Figure 26). Site-specific data and assessment results can be found in Appendix D.

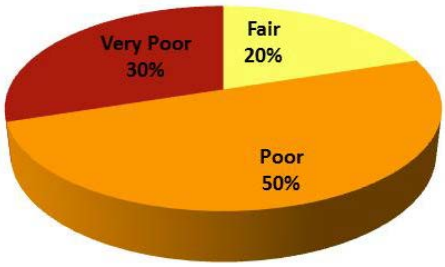


Figure 26 – Upper Patuxent BIBI Scores (n=10)

Located on Thomas Branch, approximately one mile upstream of the confluence with the Patuxent River, site R2-16-05 received the lowest BIBI score with a score of 1.57 and a biological rating of 'Very Poor' (Figure 24). Multiple beaver dams are impacting this reach with over half of the site backwatered by dams. This site was dominated by black flies (*Simulium*; TV=5.7), which accounted for 44 percent of the sample, and midges including *Psectrocladius*, a tolerant midge (TV=6.6) that accounted for 29 percent of the sample. Scrapers, EPT, and Ephemeroptera taxa were entirely absent from this site. Sites R2-16-08 and R2-16-15A, located on opposite sides of the Baltimore-Washington Parkway, both received the highest BIBI scores of 3.00 with a 'Fair' biological rating. Out of 26 taxa identified for site R2-16-08, over half (61 percent) of the sample consisted of taxa intolerant to urban stressors including six EPT taxa. Similarly, a high percentage (67 percent) of intolerant taxa were present in the sample for site R2-16-15A including three EPT and three scraper taxa.

4.5.3 Water Quality

Average water quality values for the Upper Patuxent sites are provided in Table 18. All but one site (R2-16-15A) measured outside the acceptable COMAR range for pH (6.5-8.5), with values ranging from 4.20 to 5.17. All sites with pH measurements below 6.5 appear to be on streams draining wetlands, which have naturally low pH levels, and/or in areas with acidic underlying soils. All other water quality parameters were within acceptable ranges. Water temperature ranged from 11.10 to 16.70 °C; dissolved oxygen ranged from 5.58 to 10.76 mg/L; pH ranged from 4.20 to 7.32; specific conductance ranged from 46.6 to 560.7 µS/cm; and, turbidity ranged from 1.16 to 16.20 NTU. However, it should be noted that one site, R2-16-15A, which drains 1/4-acre residential and commercial property in addition to a section of the Baltimore Washington Parkway, was an outlier for specific conductance measurements (560.7 µS/cm) and skewed the overall average (specific conductance average without site R2-16-15A would equal 55.7 µS/cm). This site showed conductivity levels exceeding 247 µS/cm, which is the critical

threshold between 'Fair' and 'Poor' stream quality determined for Maryland streams (Morgan et al., 2007).

Table 18 - Average water quality values – Upper Patuxent (n = 10)

Value ± Standard Deviation				
Temperature (°C)	DO (mg/L)	pH (Units)	Conductance (µS/cm)	Turbidity (NTU)
13.58 ± 1.71	8.22 ± 1.80	4.89 ± 0.91	106.2 ± 159.8	4.24 ± 4.41

4.5.4 Geomorphic Assessment

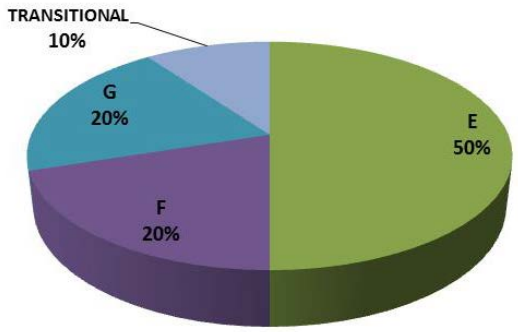


Figure 27 - Rosgen stream types observed in Upper Patuxent (n=10)

Site-specific geomorphic assessment results can be found in Appendix A. Half of the sites surveyed in the Upper Patuxent sampling unit were classified as E type channels, 20 percent as F type and 20 percent as G type channels (Figure 27). Site R2-02-06 was classified as 'Transitional' because it is a transitional reach that exhibits characteristics of both C and F type streams. At the upstream portion of the reach, the channel is narrow with minimal flow but with floodplain access and overflow channels, typical of a C type channel; however, due to active headcutting and severe erosion, the downstream end was notably incised and exhibited characteristics of an F type channel.

Streams in this sampling unit were predominantly sand bottom channels (80 percent), with a smaller percentage of gravel bottom streams (20 percent). The median D_{50} was 0.15 mm (fine sand material). With the exception of one site, slopes were fairly gradual ranging from 0.1 percent to 1.5 percent. Site R2-16-04, the transitional reach, was an anomaly with extreme incision and a severe headcut, resulting in a reach-wide slope of 3.3%.

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 2011. Refer to Figure 28 for box plots comparing average BIBI and RBP results from Round 1 and Round 2 in the Bodkin Creek, Severn Run, Upper Magothy, Upper North River, and Upper Patuxent 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 sampling unit 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 95% confidence interval for the difference in mean values $Q_1 - Q_2$ is estimated using the following formula:

$$(Q_1 - Q_2) \pm 1.96[SE_1^2 + SE_2^2]^{1/2}$$

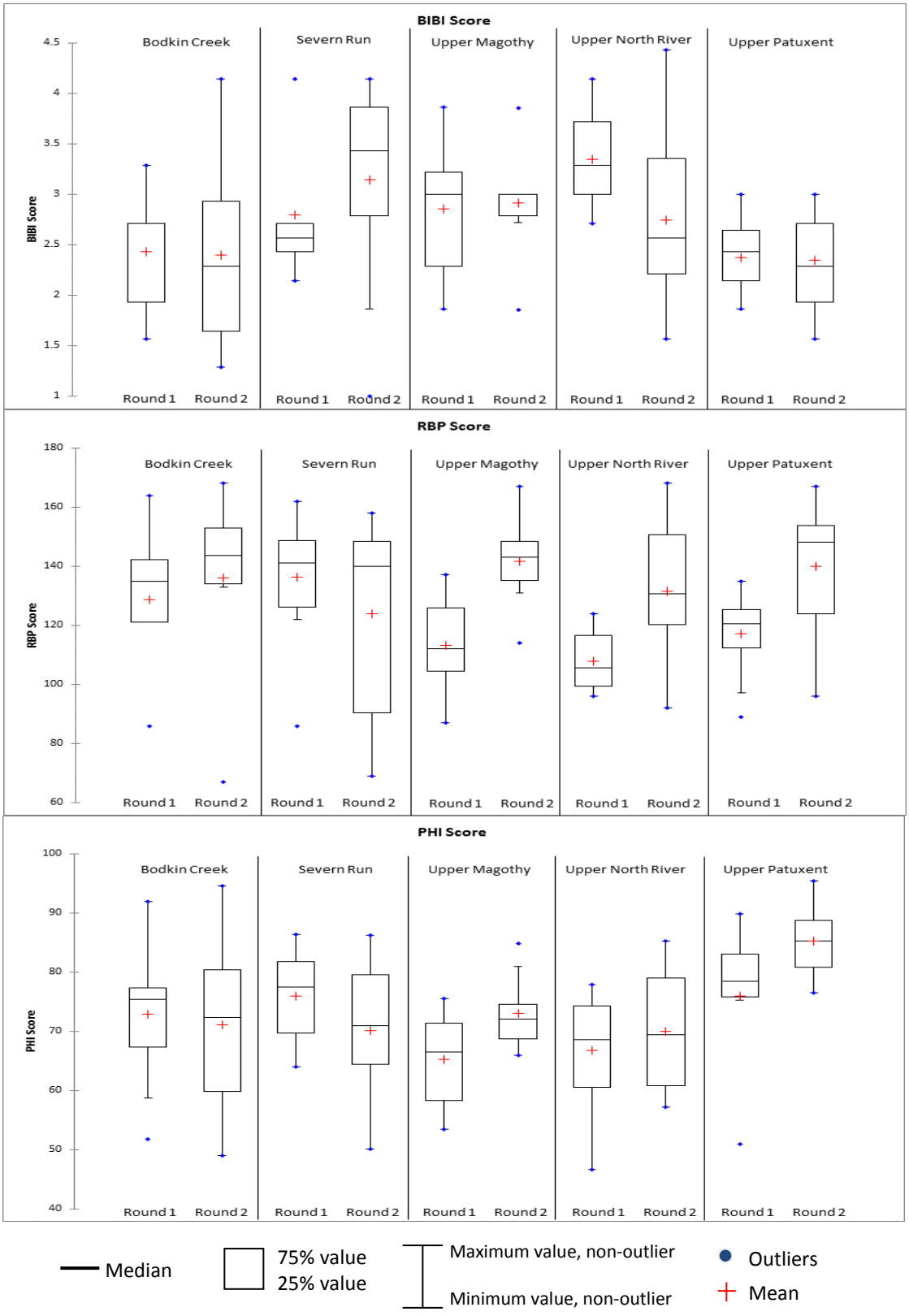


Figure 28 - Box plots comparing mean BIBI, RBP, and PHI scores between Round 1 and Round 2

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 5% nominal level) by examining whether the 95% 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.

5.1 Biological Conditions

A comparison of mean BIBI scores between Rounds One and Two showed no significant changes between sampling rounds (Table 19). BIBI ratings in 2004 for the Severn Run sampling unit increased one category from 'Poor' to 'Fair', but the change in BIBI scores was not considered to be significant. Upper North River, on the other hand, saw a reduction in biological condition ratings from 'Fair' in 2005 to 'Poor' in 2011, although the mean BIBI scores were not significantly different. While BIBI scores may have increased or decreased slightly, BIBI ratings did not change for the remaining three sampling units.

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			
Bodkin Creek	2.40	0.29	2.43	0.19	0.71	-0.65	No
Severn Run	3.14	0.33	2.80	0.23	0.45	-1.14	No
Upper Magothy	2.91	0.19	2.86	0.21	0.49	-0.60	No
Upper North River	2.74	0.28	3.34	0.15	1.22	-0.01	No
Upper Patuxent	2.34	0.16	2.37	0.12	0.42	-0.36	No

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 scores significantly increased according to both the PHI and RBP indices for Upper Magothy and Upper Patuxent sampling units. Round One PHI data collected in 2006 rated Upper Magothy as 'Degraded'; however, the 2011 PHI data rated the mean habitat condition as 'Partially Degraded.' Similarly, RBP data from 2006 resulted in a rating of 'Partially Supporting', while the mean habitat condition increased to 'Supporting' in 2011. In addition, Upper Patuxent received a Round One RBP habitat rating of 'Partially Supporting' in 2007 that significantly increased to a rating of 'Supporting' in 2011. Using the PHI, Upper Patuxent increased from a 2007 habitat rating of 'Partially Degraded' to a rating of 'Minimally Degraded' in 2011. RBP habitat scores significantly increased in Upper North from a Round One rating of 'Partially Supporting' in 2005 to a rating of 'Supporting' in 2011. One sampling unit, Severn Run, decreased from a RBP rating of 'Supporting' to 'Partially Supporting' conditions, although the difference in scores was not statistically significant. RBP habitat scores were not significantly different in Bodkin Creek between 2006 and 2011. PHI habitat scores were not significantly different in Bodkin Creek or Severn Run between 2004 and 2011, or Upper North River from 2005 to 2011.

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			
Bodkin Creek	136.0	9.39	128.8	8.22	17.27	-31.67	No
Severn Run	123.9	11.62	136.3	6.94	38.93	-14.13	No
Upper Magothy	141.6	4.46	113.3	5.32	-14.70	-41.90	Yes (Increase)
Upper North River	131.6	8.27	107.8	3.21	-6.42	-41.18	Yes (Increase)
Upper Patuxent	139.9	7.38	117.0	4.70	-5.76	-40.04	Yes (Increase)

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			
Bodkin Creek	71.12	4.48	72.82	4.03	13.50	-10.11	No
Severn Run	70.15	3.75	75.96	2.56	14.71	-3.09	No
Upper Magothy	73.04	1.87	65.22	2.54	-1.64	-14.00	Yes (Increase)
Upper North River	70.01	3.19	66.75	3.16	5.55	-12.08	No
Upper Patuxent	85.27	1.98	75.88	4.10	-0.46	-18.30	Yes (Increase)

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 result 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 2011 assessment indicate impaired biological conditions in all five sampling units, although different levels of impairment were observed. Severn Run and Upper Magothy were the least impaired sampling units, while Upper Patuxent was the most biologically impaired. This is a slight shift from the Round 1 results, which showed Upper North River as the least impaired sampling unit among the five reported here (Hill and Pieper, 2011b). The observed differences between Round 1 and Round 2 results were variable for each sampling unit. While not significant, average BIBI scores increased slightly between Round 1 and Round 2 in Severn Run and Upper Magothy sampling units. However, despite the significant increase in mean RBP scores for both Upper North River and Upper Patuxent, BIBI scores decreased, although not significantly. Mean RBP scores also decreased between Round 1 and Round 2 for Severn Run, which was previously mentioned as the least biologically impaired sampling unit in 2011.

Despite having the highest percentage of developed land at 61.1 percent of the total acreage, Upper Magothy had the second highest average BIBI score in 2011. The BIBI results for Upper Magothy are very similar to Round One conditions where the average BIBI score equaled 2.86 in 2006 (compared to an average of 2.91 for 2011), which translates to a 'Poor' biological condition for the PSU. Even though this is the second most highly developed PSU in the County at 61.1%, behind Lower Magothy, overall imperviousness is just over 20%. Based on the Round 1 Report (Hill and Pieper, 2001b), this PSU ranks 10th in overall imperviousness and is considerably lower than some of the other heavily developed PSUs (e.g. Sawmill = 35%, Stony Run = 31%, Lower Patapsco = 32%) even though they have lower percentages of developed land. This is due to the fact that the majority of the developed landuse in Upper Magothy is residential ¼-acre, ½-acre, and 1-acre lots with minimum commercial/industrial landuse. This highlights the importance of focusing more on percent imperviousness as a driver for biological and physical habitat conditions, as opposed to percent developed land use.

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 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 'Comparable to Reference' physical habitat conditions (79 percent); however, only 20 percent of these sites 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 'Minimally Degraded' or 'Partially Degraded' rating (74 percent) with 28 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	R2-06-02	R2-06-09 R2-07-01 R2-07-08 R2-09-02 R2-09-09	**R2-06-11A** **R2-11-11A** **R2-11-13A** **R2-16-01** **R2-16-03**	**R2-11-17A** **R2-16-05** **R2-16-09**
Supporting	R2-09-10 R2-09-12A R2-11-06	R2-06-08 R2-07-03 R2-07-12A R2-07-14A R2-07-17A R2-09-03 R2-09-04 R2-11-01 R2-16-08	R2-06-10 R2-07-07 R2-07-10 R2-09-05 R2-11-20A R2-16-06	**R2-06-13A** **R2-06-16A** **R2-06-19A** **R2-07-04** **R2-11-03** **R2-16-11A**
Partially Supporting		R2-07-16A R2-16-15A	R2-11-05 R2-16-12A	R2-06-14A
Non-Supporting		**R2-09-01** **R2-11-09**	R2-11-16A R2-16-04	R2-06-07 R2-09-07 R2-09-08

Green cells: stations where the biological community was less impaired than the habitat scores would predict.
Yellow cells: stations where biological community matched available habitat.
Pink 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 Bodkin Creek, Upper Magothy and Severn Run, water quality stressors related to storm water runoff are likely responsible for impaired biological conditions. Elevated conductivity values (i.e., >247 µS/cm) were observed at sites in all sampling units, with a slight trend (R^2=0.34) of increased conductivity with increased impervious surfaces. This relationship between conductivity and imperviousness is consistent with patterns observed throughout the County (Hill and Pieper, 2011b). These findings suggest that de-icing chemicals and/or road salts 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).

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

MBSS PHI Habitat Rating	BIBI Rating			
	Good	Fair	Poor	Very Poor
Minimally Degraded	R2-06-02	R2-07-01 R2-09-09 R2-11-01 R2-16-08	**R2-06-10** **R2-16-01** **R2-16-03** **R2-16-06**	**R2-16-05** **R2-16-09** **R2-16-11A**
Partially Degraded	R2-09-10 R2-09-12A	R2-06-08 R2-06-09 R2-07-03 R2-07-08 R2-07-12A R2-07-16A R2-07-17A R2-09-02 R2-09-04 R2-16-15A	R2-06-11A R2-07-07 R2-07-10 R2-09-05 R2-11-05 R2-11-11A R2-11-13A R2-16-04 R2-16-12A	**R2-07-04** **R2-09-08** **R2-11-03** **R2-11-17A**
Degraded	**R2-11-06**	R2-07-14A R2-09-03 R2-11-09	R2-11-16A R2-11-20A	R2-06-13A R2-06-14A R2-06-16A R2-06-19A R2-09-07
Severely Degraded		**R2-09-01**		R2-06-07

Green cells: stations where the biological community was less impaired than the habitat scores would predict.
Yellow cells: stations where biological community matched available habitat.
Pink 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.

Identifying additional stressors in the rural sampling units, such as Upper North River and Upper Patuxent, is much more challenging given the available data. According to the RBP, approximately half of the sites in both Upper North River and Upper Patuxent sampling units had worse biological conditions than the physical habitat conditions predicted (five and six sites, respectively). However, three sites in Upper North River 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 this sampling unit (nine percent) when compared to the other sampling units.

In addition, biological impairments observed at some sites in Bodkin Creek, Upper North, and Upper Patuxent may be due to naturally occurring acidic conditions (i.e., acidic soils, wetland complexes), especially where physical habitat conditions should be supporting a diverse biota. All sites located in the Patuxent Wildlife Research Refuge (Upper Patuxent PSU) exhibited pH values below COMAR standards (i.e., < 6.5), with half of the sites located on sections of channel classified as Freshwater Forested/Shrub wetlands according to the National Wetland Inventory (NWI; USFWS, 2011). Additionally, seven of ten sites sampled in the Upper North PSU are classified as Freshwater Forested/Shrub wetlands. Acidic conditions may also be due to underlying highly acidic soil types as shown in Figure 4. In Bodkin Creek, seven of ten sites had pH values below COMAR standards. While only three of these sites are located in channels classified as Freshwater Forested/Shrub wetlands, there is a predominance of highly acidic soils throughout the sampling unit. The majority of sites located within wetland conditions in Bodkin Creek, Upper North, and Upper Patuxent had worse biological conditions than predicted by the physical habitat conditions. This is not unexpected given that previous studies have shown stream acidity can

significantly affect stream biota, especially Plecoptera and Ephemeroptera, which are very sensitive to acidic conditions (Lemly, 1982; King et al., 2005).

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.

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) 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 29, 30, and 31, respectively.

A comparison of bankfull width values show the trendline for E channels as the closest matching the MCP curve (Figure 29); however, with a R^2 value of 0.78, the data show a fair amount of spread from the best fit line, especially among sites with less than three miles of drainage area. The trendline for G channels indicated the closest fit with a R^2 value of 0.92 (n = 4). Trendlines from C (R^2 = 0.80) and F (R^2 = 0.80), channels, on the other hand, contained more variability, with data points scattered mostly above the rural/suburban curve. A very poor fit was observed for DA channels (R^2 = 0.28), primarily due to anastomosing channels and surrounding wetland depressions increasing the bankfull width dimensions. The figure demonstrates the expected bankfull width relationships between the channel types. For the same drainage area, C channels tended to be wider than F type, and E and G channels were the most narrow.

Mean bankfull depth values showed the trendline for E type channels (R^2 = 0.77) closely matching the MCP curve, with the exception of a few outliers (Figure 30). Both DA (R^2 = 0.56), and G (R^2 = 0.36), type channels exhibited a high degree of variability with regard to mean depth. All DA channels fell well below the MCP curve, while G channels were scattered on either side of the curve. The data for F type streams shows a good fit to the trendline (R^2 = 0.97), although it was much steeper than the MCP curve. 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, C, and DA.

Comparisons of bankfull cross-sectional area values show the trendlines for both E type (R^2 = 0.98) and C type (R^2 = 0.92) channels closely matching the MCP curve (Figure 31). G type streams also followed the MCP closely, but the lower R^2 value of 0.80 indicates more variability among the data points. The trendline for F streams was a good fit to the data (R^2 = 0.93), although it deviated slightly from the MCP curve as the drainage areas increased. DA channels not only deviated considerably from the MCP curve, but also showed a poor fit to the trendline (R^2 = 0.02).

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 routinely showed the best fit to the MCP predictions of channel dimensions. Conversely, this also helps to explain why F, G, and DA channels often fit poorly, since the curve was created exclusively from C and E type channels. Although it should also be noted, that there were far fewer F, G, and DA streams in the data set and they were typically confined to drainage areas of two square miles or less.

Channel instability and 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. 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 be 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.

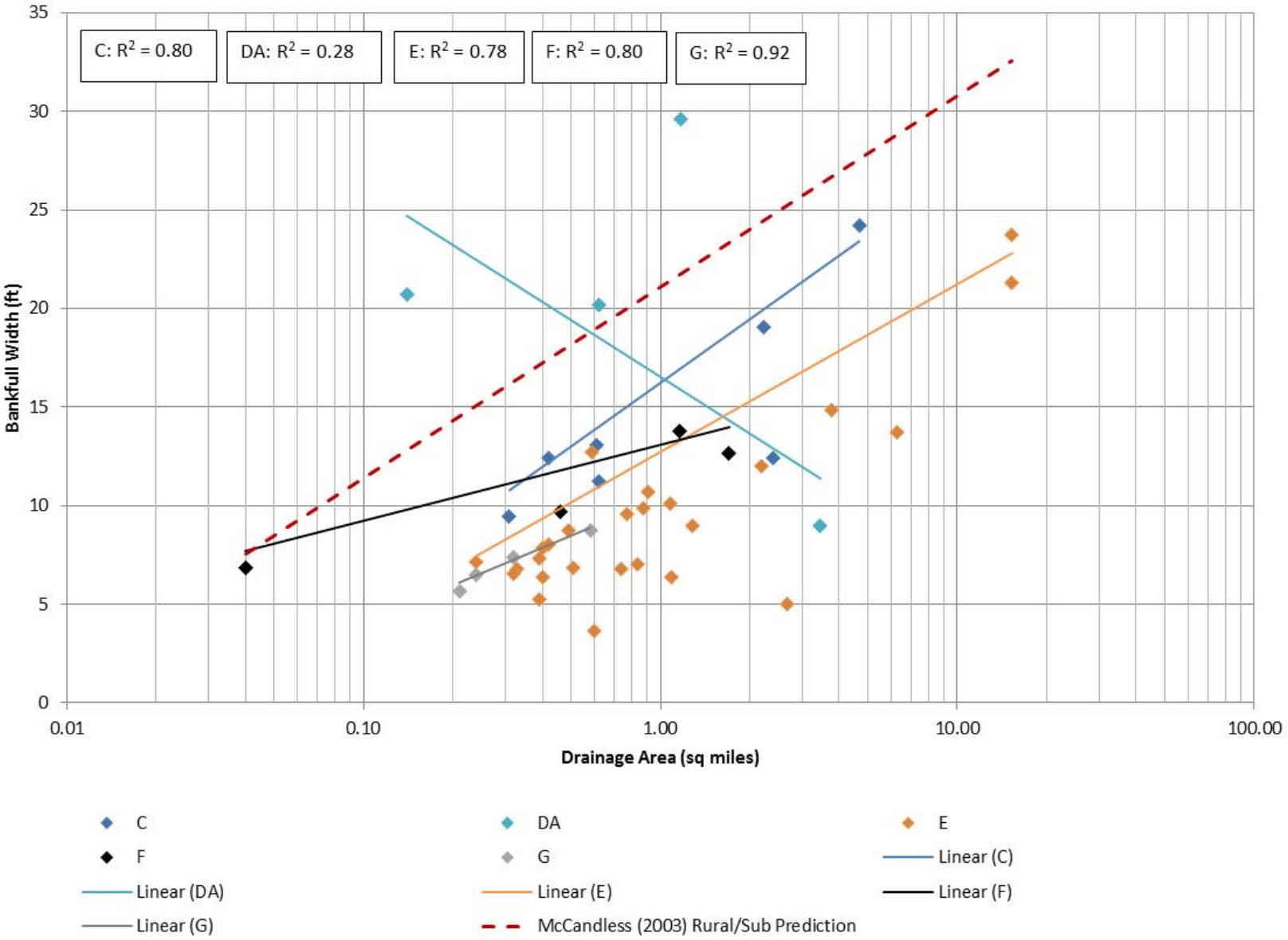


Figure 29 - Comparison of the Bankfull Width - Drainage Area Relationship between Field Data and Regional Relationship Curve Data

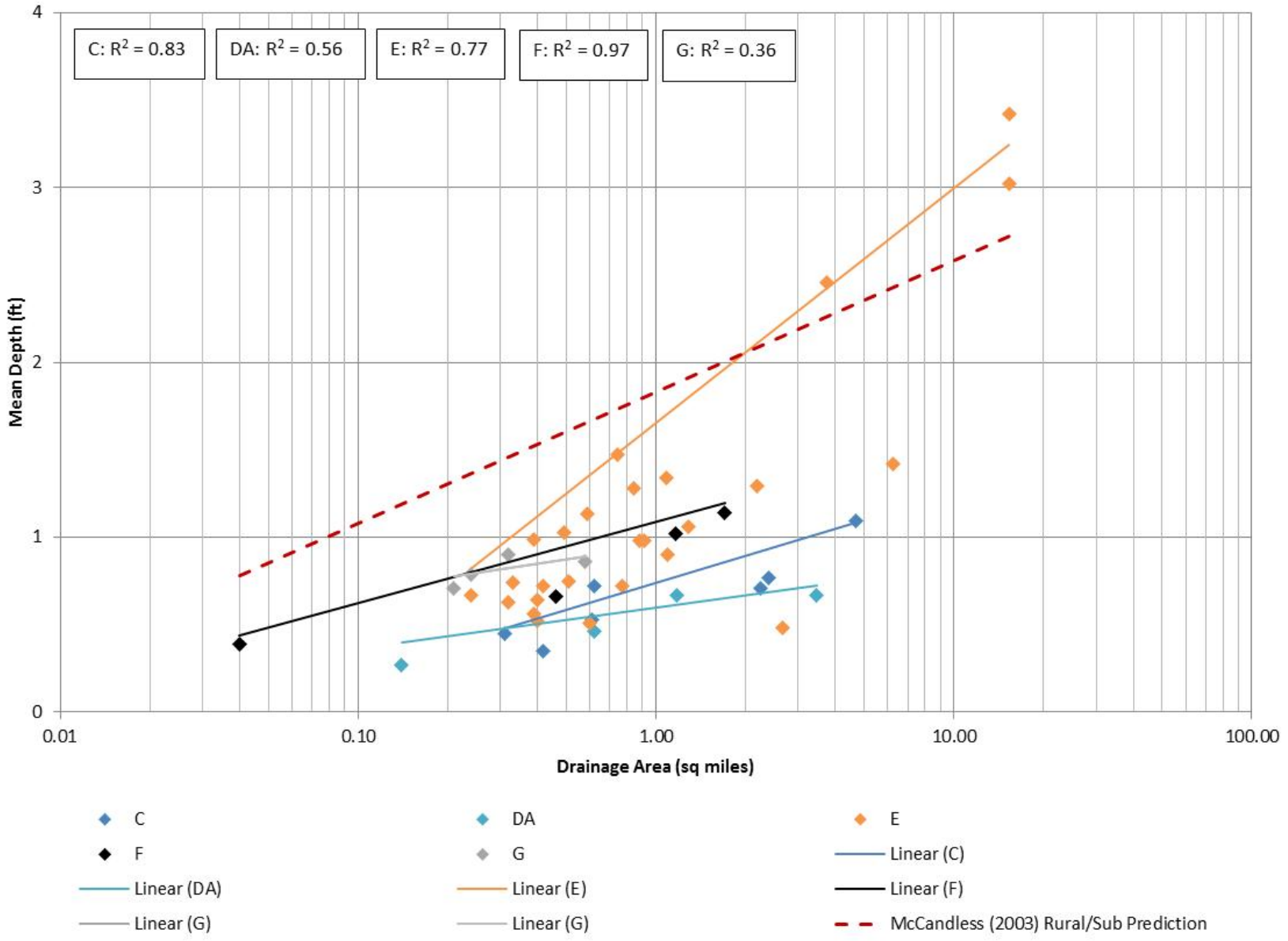


Figure 30 - Comparison of the Mean Bankfull Depth - Drainage Area Relationship between Field Data and Regional Relationship Curve Data

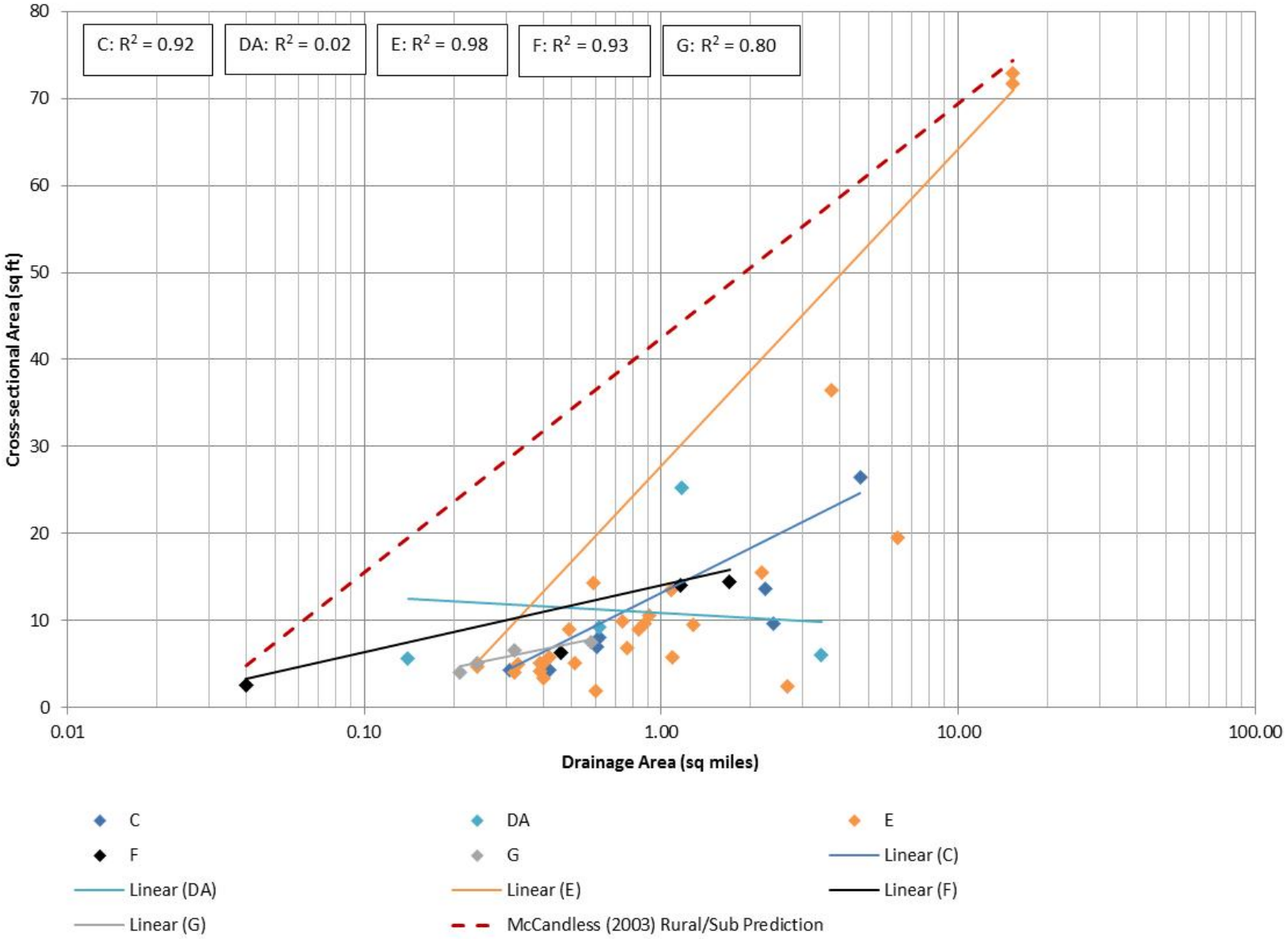


Figure 31 - Comparison of the Bankfull Cross-Sectional Area - Drainage Area Relationship between Field Data and Regional Relationship Curve Data

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, geomorphic variables such as bankfull channel dimensions, dimensionless ratios, and water surface slope were not significantly correlated with BIBI scores (Hill and Pieper, 2011). 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 at stable or unstable. Perhaps a more rapid geomorphic assessment approach would provide sufficient data regarding the geomorphological processes influencing the distribution and abundance of benthic macroinvertebrates in each assessment reach. Alternatively, 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.

Stormwater Management

Three of the sampling units—Bodkin Creek, Upper Magothy, and Severn Run—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 runoff.

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Appendix A: Geomorphic Assessment Results

Site	Drainage Area (mi^2)	Bankfull Width (ft)	Mean Bankfull Depth (ft)	Floodprone Width (ft)	Entrench-ment Ratio	Width to Depth Ratio	Cross Sectional Area (ft^2)	Slope (%)	Sinuosity	D50 (mm)	Rosgen Stream Type	Comments
R2-06-02	0.39	5.24	0.99	105.00	20.05	5.31	5.16	0.42	1.25	0.23	E5	
R2-06-07	0.29	16.30	0.17	48.00	2.94	96.30	2.76	0.47	1.00	0.06	ND	Ephemeral channel with water present only as standing pools in and above culvert. Culvert occupies 70ft of reach and clearly impacts stream dimensions and form; therefore, Rosgen type not determined.
R2-06-08	0.40	6.38	0.52	65.00	10.19	12.19	3.34	0.50	1.23	0.30	E5	Adjusted WD below 12 to fit E type.
R2-06-09	0.91	10.69	0.98	88.00	8.23	10.87	10.52	0.18	1.21	0.25	E5	
R2-06-10	0.40	7.87	0.64	95.00	12.08	12.23	5.06	0.45	1.33	0.35	E5	Adjusted WD below 12 to fit E type.
R2-06-11A	1.17	29.60	0.67	106.00	3.60	39.70	22.00	0.73	1.26	0.50	DA5	
R2-06-13A	0.60	3.67	0.51	94.00	25.64	7.19	1.87	0.44	1.33	0.15	E5/6	Bimodal distribution of substrate (sand/clay)
R2-06-14A	0.19	---	---	---	---	---	---	0.02	1.03	0.06	ND	Survey reach located in functional wetland ponded by backwater and with virtually no visible flow. Stream type indeterminant. Xsec performed at only location reminiscint of stream channel. Otherwise reach is openly ponded.
R2-06-16A	0.61	13.07	0.53	62.00	4.75	24.46	6.98	0.36	1.19	0.14	C5	
R2-06-19A	1.09	6.39	0.90	145.00	22.68	7.13	5.73	0.74	1.20	0.40	E5	
R2-07-01	0.39	7.31	0.56	50.00	6.84	12.98	4.11	2.40	1.20	0.28	E5b	Adjusted WD -1.0 to fit E type.
R2-07-03	0.31	9.46	0.45	40.00	4.23	20.88	4.28	0.66	1.24	0.15	C5	
R2-07-04	0.77	9.58	0.72	100.00	10.43	13.35	6.88	0.81	1.16	0.38	E5/4	Adjusted WD below 12 to fit E type. Bimodal distribution of substrate (sand/clay
R2-07-07	4.68	24.23	1.09	91.00	3.76	22.14	26.51	0.54	1.17	1.30	C5/4	Bimodal distribution of substrate (sand/gravel)
R2-07-08	2.24	19.04	0.71	130.00	6.83	26.65	13.60	0.11	1.09	0.35	C5	
R2-07-10	0.62	20.20	0.46	220.00	10.89	44.29	9.21	0.35	1.20	0.27	DA5	
R2-07-12A	0.84	7.00	1.28	85.00	12.14	5.45	8.99	0.18	1.15	0.30	E5	
R2-07-14A	1.28	9.00	1.06	55.00	6.11	8.52	9.51	0.18	1.25	0.13	E5	
R2-07-16A	0.88	9.86	0.98	85.00	8.62	10.04	9.68	0.19	1.29	0.41	E5	
R2-07-17A	0.42	12.40	0.35	32.00	2.58	35.83	4.29	1.30	1.12	0.25	C5	
R2-09-01	0.24	6.49	0.79	6.83	1.05	8.22	5.11	0.91	1.05	0.26	G5c	
R2-09-02	15.30	21.32	3.42	240.00	11.26	6.23	72.93	0.23	1.35	0.41	E5	
R2-09-03	2.39	12.43	0.77	280.00	22.52	16.14	9.58	0.86	1.08	0.29	C5	
R2-09-04	15.30	23.74	3.02	225.00	9.48	7.86	71.65	0.13	1.19	0.34	E5	
R2-09-05	0.14	20.71	0.27	73.00	3.52	76.66	5.60	1.60	1.27	0.17	DA5	
R2-09-07	0.58	8.75	0.86	9.08	1.04	10.14	7.56	2.00	1.14	0.16	G5	
R2-09-08	0.49	6.09	0.60	18.23	3.00	10.19	3.64	0.59	1.00	0.27	ND	Channelized irrigation/drainage ditch on old orchard property. No Rosgen determination due to substantial ditching and straightening of channel. Original stream channel appears to have flow divided between two ditched channels, likely for irrigation.
R2-09-09	0.42	8.02	0.72	95.00	11.85	11.19	5.75	0.71	1.03	0.12	E5	
R2-09-10	3.76	14.83	2.46	90.00	6.07	6.03	36.43	0.38	1.09	0.38	E5/4	Bimodal distribution of substrate (sand/gravel)
R2-09-12A	0.74	6.77	1.47	45.00	6.65	4.60	9.97	0.62	1.26	0.48	E5/4	Bimodal distribution of substrate (sand/gravel)
R2-11-01	1.08	10.08	1.34	240.00	23.80	7.51	13.54	0.34	1.12	0.22	E5	
R2-11-03	0.24	7.13	0.67	15.66	2.20	10.69	4.76	0.82	1.45	0.21	E5	
R2-11-05	1.70	12.67	1.14	14.74	1.16	11.10	14.46	0.54	1.25	0.32	F5	Adjusted WD +1.0 to fit F type.
R2-11-06	3.46	8.96	0.67	320.00	35.70	13.29	6.04	0.16	1.04	0.13	DA5	
R2-11-09	1.16	13.77	1.02	17.54	1.27	13.55	13.99	0.20	1.07	0.16	F5	
R2-11-11A	2.19	12.01	1.29	220.00	18.32	9.34	15.45	0.67	1.33	0.28	E5	
R2-11-13A	6.28	13.73	1.42	290.00	21.12	9.67	19.51	0.17	1.14	0.16	E5/6	Bimodal distribution of substrate (sand/clay)
R2-11-16A	0.62	11.20	0.72	55.00	4.91	15.48	8.11	0.33	1.03	0.24	C5/6	Bimodal distribution of substrate (sand/clay)
R2-11-17A	2.67	5.00	0.48	260.00	52.00	10.40	2.41	0.27	1.07	0.22	E5	

Site	Drainage Area (mi^2)	Bankfull Width (ft)	Mean Bankfull Depth (ft)	Floodprone Width (ft)	Entrench-ment Ratio	Width to Depth Ratio	Cross Sectional Area (ft^2)	Slope (%)	Sinuosity	D50 (mm)	Rosgen Stream Type	Comments
R2-11-20A	8.85	23.25	2.49	240.00	10.32	9.33	57.94	0.00	1.09	4.10	ND	Channel straightened for 50m below culvert. Rosgen class not determined due to influence of large culvert and bank stabilization, as well as highway grading on the channel dimensions.
R2-16-01	0.33	6.76	0.74	211.00	31.20	9.19	4.98	0.23	1.14	0.08	E5/6	Bimodal distribution of substrate (sand/clay)
R2-16-03	0.49	8.74	1.03	145.00	16.58	8.53	8.97	0.77	1.56	1.10	E5/4	Bimodal distribution of substrate (sand/gravel)
R2-16-04	0.08	5.66	0.36	50.00	8.83	15.91	2.02	3.30	1.09	0.11	C5b→F5b	Stream likely intermittent with severe headcut and scour pool in middle portion of reach. Appears to be a type E/C longitudinally transitioning to an F channel as a result of active headcutting and severe erosion and incision. Single large, deep (~1 m) scour pool below headcut. Upstream portion of reach with minimal flow but with floodplain access and overflow channels.
R2-16-05	0.59	12.73	1.13	88.00	6.91	11.31	14.34	0.92	1.04	0.10	E5	
R2-16-06	0.51	6.82	0.75	130.00	19.05	9.11	5.11	0.10	1.27	0.32	E5	
R2-16-08	0.46	9.67	0.66	11.48	1.19	14.68	6.37	0.69	1.47	2.60	F4/5	Bimodal distribution of substrate (gravel/sand)
R2-16-09	0.32	6.56	0.63	132.00	20.13	10.48	4.10	0.61	1.17	0.15	E5	
R2-16-11A	0.21	5.64	0.71	6.55	1.16	7.90	4.02	0.99	1.32	3.20	G4/5c	Bimodal distribution of substrate (gravel/sand)
R2-16-12A	0.32	7.35	0.90	8.67	1.18	8.17	6.61	0.86	1.15	0.14	G5/4c	Bimodal distribution of substrate (sand/gravel)
R2-16-15A	0.04	6.84	0.39	7.79	1.14	17.67	2.64	1.50	1.21	0.09	F6/5	Bimodal distribution of substrate (clay/sand)

Appendix B: Quality Control Summary

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 (2010). This analysis included performance characteristics of precision, accuracy, bias, sensitivity, and completeness, with comparisons to 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. 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. To ensure consistency with MBSS protocols, a representative from DNR conducted a field audit. The results of the field audit are included as an addendum to this Appendix.

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 2011.

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 and index scores

Attribute	MQO[1]		
	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

[1]Values derived from Hill and Pieper, 2010

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. Two metrics, Number of Scraper Taxa and Percent Climbers, exceeded the MQO for mRPD. The high RPD value was due to relatively few scraper taxa and low percentages of climbers in all samples, which tends to skew RPD values upward when comparing small values as compared to large values. In addition to exceeding the MQO for mRPD, the Percent Climbers metric also exceeded the MQO for CV; which is also due to the comparison of very small percentages. Another metric, Total Taxa, exceeded the MQO for RMSE, but passed for mRPD and CV. This was primarily due to a single outlier sample pair (R2-06-11), which had a difference of 9 taxa between the sample pair mainly because the field replicate contained less Chironomidae taxa. All other values were within acceptable ranges.

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
R2-06-11A	28	3	0.00	0	23.10	1	7.70	2.71	Poor
R2-06-11A QC	19	4	0.00	0	40.10	0	0.00	2.14	Poor
R2-07-08	26	5	0.00	0	8.00	5	2.70	3.00	Fair
R2-07-08 QC	31	5	0.00	0	3.40	5	10.10	3.29	Fair
R2-09-09	20	2	0.00	0	30.10	3	1.90	3.00	Fair
R2-09-09 QC	24	3	0.00	0	10.30	1	3.70	2.71	Poor
R2-11-06	29	7	2.80	2	10.20	4	24.10	4.43	Good
R2-11-06 QC	35	6	1.80	1	11.80	4	21.80	4.14	Good
R2-16-03	17	3	0.00	0	72.50	1	0.90	2.71	Poor
R2-16-03 QC	14	5	0.00	0	77.20	0	3.30	2.71	Poor
Median RPD	18.8	28.6	0.0	0.0	53.8	**100.0**	**114.3**	9.2	-
RMSE	**4.5**	1.1	0.0	0.0	13.2	0.6	6.5	0.4	-
CV	18.7	25.8	0.0	0.0	46.0	25.9	**84.9**	11.6	-

Laboratory Sorting and Subsampling

Bias

All sorting was completed following the SOPs described in the QAPP. For these samples, approximately 36 percent (20 samples) underwent quality control procedures for sorting, above the ten percent requirement. Average percent sorting efficiency was 90% (n=20). 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 5 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 (R2-06-08, R2-07-03, R2-09-08, R2-11-05, and R2-16-08) were randomly selected for QC identification and enumeration by an independent lab. Original identification was completed by Environmental Services and Consulting, LLC[1] (ESC). Re-identification of the randomly selected sites was done by Aquatic Resources Center[2]. 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.

[1] Address: 101 Professional Park Drive, STE 303, Blacksburg, VA
[2] Address: 545 Cathy Jo Circle, Nashville, TN

Precision

Measures of precision were calculated for the identification consistency between the two randomly selected samples. 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 five samples are found in Tables 4-8.

The PDE was below the MQO value of 5% for all verification samples. Following re-identification by the secondary laboratory, the initial PTD of two samples slightly exceeded the acceptable MQO value of 15% (15.6% for R2-06-08 and 15.9% for R2-09-08). For sample R2-06-08, there was a minor discrepancy between laboratories concerning chironomid larvae counts. The second laboratory originally missed the third row of chironomid larvae on the second slide and upon review, verified and agreed with the original laboratory's identifications. For sample R2-09-08, there were minor discrepancies between laboratories concerning Haplotaxida identifications. These discrepancies were largely due to the original laboratory identifying specimens before the slide mounting media was completely dry—initially obscuring features. Upon closer inspection by both the secondary and primary laboratories, there were enough agreements to reduce the PTD for both samples to an acceptable value of 13.24% (R2-06-08) and 3.54% (R2-09-8), respectively.

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. Results indicate that all MQOs were met during the 2011 sampling period, and subsequently, all data are of acceptable quality as specified by the QAPP. Results of field audits by both DNR and the County (attached) indicate general adherence to the sampling and assessment protocols, and any recommended corrective actions were implemented immediately to ensure the quality of data collected in the field.

Table 3. Summary comparison of QC results and measurement quality objectives[1].

Activity	Performance Indicator	Measure	MQO	2011 Results
Field Sampling	Precision	mRPD (BIBI)	<20	9.2
		RMSE (BIBI)	<0.6	0.4
Laboratory Sorting/Subsampling	Bias	PSE	>90	90
Taxonomic Identification	Precision	PDE	<5	1.0
		PTD	<15	8.5
Site Assessment	Sensitivity	90% CI (BIBI)	≤0.75	0.59

[1] MQOs are derived from Hill and Pieper, 2010

Table 4 - Taxonomic Identification and Enumeration Results: R2-06-08

Order	Family	Subfamily	Tribe	Sample ID	R2-06-08 Taxonomist 1	R2-06-08 Taxonomist 2	R2-06-08 # of agreements
Diptera	Ceratopogonidae	-	-	Probezzia	1	0	0
	Ceratopogonidae	-	-	Serromyia	1	0	0
	Ceratopogonidae	Ceratopogoninae	Sphaeromiini	Mallochohelea	0	1	0
	Chironomidae	Chironominae	Chironomini	Chironomini	1	1	1
	Chironomidae	Chironominae	Chironomini	Cryptochironomus	1	1	1
	Chironomidae	Chironominae	Chironomini	Paralauterborniella	2	2	2
	Chironomidae	Chironominae	Chironomini	Phaenopsectra	1	0	0
	Chironomidae	Chironominae	Chironomini	Polypedilum	16	16	16
	Chironomidae	Chironominae	Chironomini	Stictochironomus	1	1	1
	Chironomidae	Chironominae	Chironomini	Tribelos	0	1	0
	Chironomidae	Chironominae	Tanytarsini	Micropsectra	2	1	1
	Chironomidae	Chironominae	Tanytarsini	Paratanytarsus	0	1	0
	Chironomidae	Chironominae	Tanytarsini	Rheotanytarsus	3	3	3
	Chironomidae	Chironominae	Tanytarsini	Tanytarsus	1	1	1
	Chironomidae	Orthocladiinae	-	Parametriocnemus	26	26	26
	Chironomidae	Orthocladiinae	-	Rheocricotopus	10	10	10
	Chironomidae	Prodiamesinae	-	Prodiamesa	1	1	1
	Chironomidae	Tanypodinae	-	Tanypodinae	1	1	1
	Chironomidae	Tanypodinae	Macropelopiini	Apsectrotanypus	2	2	2
	Chironomidae	Tanypodinae	Pentaneurini	Ablabesmyia	1	1	1
	Chironomidae	Tanypodinae	Pentaneurini	Conchapelopia	1	0	0
	Chironomidae	Tanypodinae	Pentaneurini	Thienemannimyia	2	0	0
	Chironomidae	Tanypodinae	Pentaneurini	Thienemannimyia group	13	16	13
	Chironomidae	Tanypodinae	Pentaneurini	Zavrelimyia	9	9	9
	Chironomidae	Tanypodinae	Tanypodini	Clinotanypus	1	1	1
	Simuliidae	-	-	Simulium	5	6	5
	Tipulidae	-	-	Tipula	2	2	2
Amphipoda	not identified	-	-	Amphipoda	11	0	0
	Crangonyctidae	-	-	Crangonyctidae	2	12	2

Order	Family	Subfamily	Tribe	Sample ID	R2-06-08 Taxonomist 1	R2-06-08 Taxonomist 2	R2-06-08 # of agreements
	Crangonyctidae	-	-	Synurella	1	1	1
Haplotaxida	not identified	-	-	Lumbricina	1	0	0
	Tubificidae	-	-	Tubificidae	4	0	0
	Tubificidae	-	-	Spirosperma	0	4	4
Isopoda	Asellidae	-	-	Caecidotea	1	1	1
Lumbriculada	Lumbriculidae	-	-	Lumbriculidae	0	1	0
Odonata	Aeshnidae	-	-	Boyeria	1	1	1
	Corduliidae/Libellulidae	-	-	Corduliidae/Libellulidae	0	1	1
	Libellulidae	-	-	Libellulidae	1	0	0
Trichoptera	Hydropsychidae	-	-	Diplectrona	1	1	1
	Limnephilidae	-	-	Limnephilidae	1	1	1
	Polycentropodidae	-	-	Polycentropus	2	2	2
	Psychomyiidae	-	-	Lype	3	3	3
	Sericostomatidae	-	-	Agarodes	2	2	2
Veneroida	Pisidiidae	-	-	Pisidiidae	2	0	2
	Sphaeriidae	-	-	Sphaeriidae	0	2	0
				Total	137	136	118
				PDE			0.37
				PTD			13.24

Table 5 - Taxonomic Identification and Enumeration Results: R2-07-03

Order	Family	Subfamily	Tribe	Sample ID	R2-07-03 Taxonomist 1	R2-07-03 Taxonomist 2	R2-07-03 # of agreements
Diptera	not identified	-	-	Brachycera	1	0	0
	Chironomidae	Chironominae	Chironomini	Phaenopsectra	9	9	9
	Chironomidae	Orthocladiinae	-	Orthocladiinae	3	0	0
	Chironomidae	Orthocladiinae	-	Gymnometriocnemus	0	1	0
	Chironomidae	Orthocladiinae	-	Limnophyes	2	4	2

Order	Family	Subfamily	Tribe	Sample ID	R2-07-03 Taxonomist 1	R2-07-03 Taxonomist 2	R2-07-03 # of agreements
	Chironomidae	Orthocladiinae	-	Paraphaenocladius	5	6	5
	Chironomidae	Orthocladiinae	-	Smittia	1	0	0
	Chironomidae	Prodiamesinae	-	Prodiamesa	3	3	3
	Chironomidae	Tanypodinae	Natarsiini	Natarsia	0	1	0
	Chironomidae	Tanypodinae	Pentaneurini	Thienemannimyia group	14	13	13
	Chironomidae	Tanypodinae	Pentaneurini	Zavrelimyia	12	12	12
	Ephydridae	-	-	Ephydridae	0	1	0
	Ptychopteridae	Bittacomorphinae	-	Bittacomorpha	1	0	0
	Ptychopteridae	Ptychopterinae	-	Ptychoptera	0	1	0
	Tipulidae	-	-	Limonia	1	1	1
	Tipulidae	-	-	Pseudolimnophila	1	1	1
Amphipoda	Crangonyctidae	-	-	Synurella	8	10	8
	Gammaridae	-	-	Gammarus	1	0	0
Coleoptera	Dytiscidae	Hydroporinae	-	Hydroporinae	1	1	1
Haplotaxida	Enchytraeidae	-	-	Enchytraeidae	6	7	6
	Lumbricidae	-	-	Lumbricidae	0	1	0
	not identified	-	-	Lumbricina	1	0	0
Isopoda	Asellidae	-	-	Caecidotea	15	13	13
Lumbriculada	Lumbriculidae	-	-	Lumbriculidae	1	0	0
Odonata	Calopterygidae	-	-	Calopteryx	1	1	1
Trichoptera	not identified	-	-	Trichoptera	1	0	0
	Hydropsychidae	-	-	Diplectrona	1	1	1
	Polycentropodidae	-	-	Polycentropus	2	2	2
	Psychomyiidae	-	-	Lype	2	2	2
Basommatophora	Physidae	-	-	Physa	3	3	3
Veneroida	Pisidiidae	-	-	Pisidiidae	1	0	0
	Pisidiidae	-	-	Pisidium	0	3	0
	Sphaeriidae	-	-	Musculium	2	0	0
				Total	99	97	83
				PDE			1.02
				PTD			14.43

Table 6 - Taxonomic Identification and Enumeration Results: R2-09-08

Order	Family	Subfamily	Tribe	Sample ID	R2-09-08 Taxonomist 1	R2-09-08 Taxonomist 2	R2-09-08 # of agreements
Diptera	Ceratopogonidae	-	-	Culicoides	1	0	0
	Chironomidae	Orthocladiinae	-	Hydrobaenus	1	1	1
	Tipulidae	-	-	Tipula	1	0	1
Amphipoda	Crangonyctidae	-	-	Stygobromus	4	2	2
Basommatophora	Lymnaeidae	-	-	Fossaria	6	6	6
Coleoptera	Carabidae	-	-	Carabidae	1	1	1
	Curculionidae	-	-	Curculionidae	1	1	1
Haplotaxida	Enchytraeidae	-	-	Enchytraeidae	71	74	71
	Haplotaxidae	-	-	Haplotaxis	4	4	4
	Lumbricidae	-	-	Lumbricidae	7	7	7
	Naididae	-	-	Pristina	0	1	0
	Tubificidae	-	-	Tubificidae	16	9	15
	Tubificidae	-	-	Aulodrilus	0	1	0
	Tubificidae	-	-	Quistadrilus	0	1	0
	Tubificidae	-	-	Spirosperma	0	4	0
Lumbriculada	Lumbriculidae	-	-	Lumbriculidae	5	0	0
Trichoptera	not identified	-	-	Trichoptera	1	0	0
	Limnephilidae	-	-	Limnephilidae	0	1	0
				Total	119	113	109
				PDE			2.59
				PTD			3.54

Table 7 - Taxonomic Identification and Enumeration Results: R2-11-05

Order	Family	Subfamily	Tribe	Sample ID	R2-11-05 Taxonomist 1	R2-11-05 Taxonomist 2	R2-11-05 # of agreements
Diptera	Ceratopogonidae	-	-	Bezzia/Palpomyia	1	1	1

Order	Family	Subfamily	Tribe	Sample ID	R2-11-05 Taxonomist 1	Taxonomist 2	# of agreements
	Chironomidae	Chironominae	Chironomini	Chironomini	1	0	0
	Chironomidae	Chironominae	Chironomini	Paralauterborniella	1	1	1
	Chironomidae	Chironominae	Chironomini	Phaenopsectra	0	1	0
	Chironomidae	Chironominae	Chironomini	Polypedilum	8	9	8
	Chironomidae	Chironominae	Tanytarsini	Rheotanytarsus	17	17	17
	Chironomidae	Orthocladiinae	-	Brillia	4	4	4
	Chironomidae	Orthocladiinae	-	Corynoneura	1	1	1
	Chironomidae	Orthocladiinae	-	Heterotrissocladius	1	1	1
	Chironomidae	Orthocladiinae	-	Limnophyes	1	1	1
	Chironomidae	Orthocladiinae	-	Orthocladius	2	2	2
	Chironomidae	Orthocladiinae	-	Parametriocnemus	38	37	37
	Chironomidae	Orthocladiinae	-	Rheocricotopus	1	1	1
	Chironomidae	Orthocladiinae	-	Thienemanniella	1	1	1
	Chironomidae	Tanypodinae	Coelotanypodini	Alotanypus	1	0	0
	Chironomidae	Tanypodinae	Macropelopiini	Brundiniella	0	1	0
	Chironomidae	Tanypodinae	Pentaneurini	Thienemannimyia group	8	8	8
	Empididae	-	-	Hemerodromia	2	2	2
	Tipulidae	-	-	Tipula	1	1	1
Coleoptera	Ptilodactylidae	-	-	Anchytarsus	7	7	7
Megaloptera	Corydalidae	-	-	Nigronia	3	3	3
Nemata	not identified	-	-	Nemata	1	1	1
Plecoptera	not identified	-	-	Plecoptera	3	0	0
	Leuctridae	-	-	Leuctridae	0	4	0
	Leuctridae	-	-	Leuctra	2	0	2
	Nemouridae	-	-	Amphinemura	2	2	2
Trichoptera	Hydropsychidae	-	-	Diplectrona	1	1	1
	Polycentropodidae	-	-	Polycentropus	2	2	2
				Total	110	109	104
				PDE			0.46
				PTD			4.59

Table 8 - Taxonomic Identification and Enumeration Results: R2-16-08

Order	Family	Subfamily	Tribe	Sample ID	R2-16-08 Taxonomist 1	R2-16-08 Taxonomist 2	R2-16-08 # of agreements
Diptera	Ceratopogonidae	-	-	Ceratopogonidae	1	1	1
	Ceratopogonidae	-	-	Bezzia/Palpomyia	6	5	5
	Ceratopogonidae	Ceratopogoninae	Ceratopogonini	Ceratopogon	0	1	0
	Chironomidae	-	-	Chironomidae	1	0	0
	Chironomidae	Chironominae	Chironomini	Tribelos	1	1	1
	Chironomidae	Chironominae	Tanytarsini	Rheotanytarsus	1	0	0
	Chironomidae	Chironominae	Tanytarsini	Stempellinella	2	2	2
	Chironomidae	Chironominae	Tanytarsini	Tanytarsus	1	2	1
	Chironomidae	Orthocladiinae	-	Parametriocnemus	5	6	5
	Chironomidae	Orthocladiinae	-	Rheocricotopus	3	3	3
	Chironomidae	Tanypodinae	-	Tanypodinae	1	1	1
	Chironomidae	Tanypodinae	Pentaneurini	Ablabesmyia	0	1	0
	Chironomidae	Tanypodinae	Pentaneurini	Thienemannimyia group	1	1	1
	Chironomidae	Tanypodinae	Pentaneurini	Zavrelimyia	1	0	0
	Simuliidae	-	-	Simuliidae	6	6	6
	Simuliidae	-	-	Prosimulium	2	2	2
	Simuliidae	-	-	Simulium	7	7	7
	Simuliidae	Simuliinae	Prosimuliini	Stegopterna	8	8	8
	Tabanidae	-	-	Chrysops	1	1	1
Coleoptera	Dytiscidae	Hydroporinae	-	Hydroporinae	0	1	0
	Dytiscidae	Hydroporinae	Hydroporini	Neoporus	1	0	1
Haplotaxida	Enchytraeidae	-	-	Enchytraeidae	1	2	1
	Haplotaxidae	-	-	Haplotaxis	0	1	0
	Naididae	-	-	Pristina	0	1	0
	not identified	-	-	Lumbricina	2	0	0
	Tubificidae	-	-	Tubificidae	2	0	0
Isopoda	Asellidae	-	-	Caecidotea	1	1	1
Lumbriculada	Lumbriculidae	-	-	Lumbriculidae	7	7	7
Nemata	not identified	-	-	Nemata	0	1	0

Order	Family	Subfamily	Tribe	Sample ID	R2-16-08 Taxonomist 1	R2-16-08 Taxonomist 2	R2-16-08 # of agreements
Plecoptera	Leuctridae	-	-	Leuctra	11	11	11
	Nemouridae	-	-	Amphinemura	60	59	59
Trichoptera	Hydropsychidae	-	-	Diplectrona	1	1	1
	Limnephilidae	-	-	Hydatophylax	0	1	0
	Limnephilidae	-	-	Ironoquia	1	1	1
	Limnephilidae	-	-	Pycnopsyche	1	0	0
	Rhyacophilidae	-	-	Rhyacophila	1	1	1
Veneroida	Sphaeriidae	-	-	Sphaeriidae	0	1	0
	Sphaeriidae	-	-	Musculium	1	0	0
				Total	137	136	127
				PDE			0.37
				PTD			6.62

To: Mike Pieper
From: Dan Boward
CC: Ron Klauda, Scott Stranko
Date: June 21, 2011
Subject: KCI Crew Field Audit – March 27, 2011

The following details my field audit of the KCI crew (Colin Hill, Megan Crunkleton, and Sushanna Brown) on March 27, 2011. I'll focus on protocols used by both MBSS and KCI crews. All three crew members had attended Maryland Biological Stream Survey (MBSS) spring 2011 training. Colin and Sushanna had attended MBSS summer 2010 training.

One site (R2-11-05; Bell Branch near Crofton) was visited to evaluate the comparability between the KCI Crew's protocols and those of the Maryland Biological Stream Survey. Note that the KCI crew uses a mix of MBSS spring and summer protocols and does not incorporate all MBSS protocols into their sampling program.

Permission, Site Location and Site Marking: As is done with the MBSS, permission to sample the site was obtained in advance of our arrival. Unlike MBSS, however, Anne Arundel County protocols call for directly contacting only landowners that clearly own the property adjacent to the sample site. This was a randomly-selected site that required access via private property.

Site location was determined using a hand-held GPS unit (Trible Pro XT) with coordinates previously uploaded, thereby reducing errors due to manual input of data. All site markings were determined in accordance with MBSS protocols. Note that, because Anne Arundel County sites will not be revisited during summer for electrofishing surveys and habitat assessments (as is done using MBSS protocols), only the 0m, midpoint and 75m locations are marked with flagging. Good care was taken to minimally disturb stream habitat while measuring and marking the site.

I evaluated most of the MBSS parameters relating to site location and description similarly to the KCI Crew.

Water Physicochemical Parameters: A YSI Professional Plus unit was used to measure dissolved oxygen, pH, water temperature, and specific conductance at upstream, mid-segment and downstream locations. The average of each reading was reported. This differs slightly from the MBSS protocol where a single measurement is taken for each parameter near mid-segment. The unit had been calibrated the previous evening and is calibrated daily for each field day. All probes and membranes were clean and in good working condition. KCI crew members followed MBSS protocols for the deployment of the unit and allowed ample time for the unit to stabilize.

Benthic Sampling: Benthic sampling equipment, including the D-net and sieve bucket, were in good condition and no holes or tears were observed. The KCI crew effectively sampled 20 ft^2 of the best available

habitat and the proportions of habitats chosen by myself and the KCI crew were quite comparable. A comparison of the proportions of habitat sampled follows:

DB riffle: 0 square feet; KCI riffle: 0 square feet
DB leaf pack: 8 square feet; KCI leaf pack: 9 square feet
DB rootwad/woody debris: 12 square feet; KCI rootwad/woody debris: 11 square feet
DB undercut banks: 0 square feet; KCI undercut banks: 0 square feet

These differences should not result in appreciable differences in sampled benthic taxa or abundances by taxon. Differing slightly from the MBSS protocol, the KCI crew used a bucket to decant off gravel prior to preserving the sample. Montgomery County DEP crews use this approach to reduce sample volume. The volume of sample material was appropriate for the mix of habitat types in the stream.

Habitat Assessment: KCI protocols combine aspects of both spring and summer MBSS habitat protocols. Some summer MBSS habitat parameters are evaluated in the spring (by the KCI crew) and some are not. For example, the KCI crew conducted a woody debris and rootwad count – done in the summer by MBSS crews. The KCI crew also evaluates stream character, bar formation and bank erosion in the spring while MBSS crews do so in the summer. Despite seasonal differences in habitat quality and quantity, the KCI crew followed MBSS protocols. In addition, the extensive geomorphic assessments done by the KCI crew will greatly enhance the interpretation of stressors and associated biological condition.

Summary

The KCI crew adequately followed the field protocols specified by MBSS. The differences that were noted were relatively minor, and in all likelihood would not dramatically affect the overall evaluation of the site.

Other Comments:

1. The KCI Crew members are properly disinfecting waders, sampling equipment, etc.
2. I collected a “duplicate” benthic sample in an adjacent and downstream site once the KCI crew had finished sampling benthos. Once sample processing and identifications are done by both DNR and the KIC contractor, taxonomic comparisons can be conducted and differences (if any) can be compared. Note that my benthic sample ID is 0994-01-2011 (Stream Waders sample naming convention).
3. Once field data are available from Anne Arundel County, more detailed comparisons of actual field measures can be done on a parameter-by-parameter basis.

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: 15 March 2011

On 15 March 2011, I evaluated the field activities of KCI Technologies, Inc., (KCI) personnel as they collected the required geomorphological data as part of Year Three of Round Two of the Countywide Biological Monitoring Program. Work at one site (R2-09-03) was evaluated. This short report describes my findings.

OFFICE WORK. The drainage area was determined before going to the field and the crew had the information with them in the field, but did not need to use it as the bankfull indicator was concurrent with top of bank. The survey instrument was a self-leveling laser level type instrument, owned by KCI, which was only purchased a few months ago and so had not been calibrated recently. However, the field supervisor stated that their survey equipment is maintained on a routine basis that does not necessarily correspond with the beginnings of this work. 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 discussed with the crew.

The field supervisor had Level I training. The two crew members did not have formal Rosgen assessment method training, although the crew 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 and was correctly placed at the downstream end of the reach. The bioassessment reach showed moderate disturbance due to beaver activity and to its proximity to the large culvert that carries the creek under MD 32. The bankfull indicator was the top of bank, making the call quite easy.

CROSS SECTION MEASUREMENT. The zero point was set on the left bank / down stream. 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. Data were properly recorded on the appropriate data sheets. Floodprone width calculations were made in the field using survey data collected by the Trimble unit operated by the field supervisor.

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. It was observed that particle selection was not evenly distributed across the bankfull channel on several transects. This was discussed with the crew. 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, with the following minor deficiencies that either require correction or were corrected in the field:

1. It was suggested that a rod level be used during survey work.
2. The team was cautioned to space samples evenly along the transect during the pebble counts.

Other than the minor issues mentioned above, the work is being performed properly according to published SOPs and should result in the collection of satisfactory data.

Appendix C: Master Taxa List

Order	Family	Genus	Final ID	Functional Feeding Group	Habit[1]	Tolerance Value[2]	% of total number of organisms	% of sites
Diptera	Simuliidae	Simulium	Simulium	Filterer	cn	5.7	8.22	68.00
Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	Collector	sp	4.6	7.48	84.00
Diptera	Chironomidae	Polypedilum	Polypedilum	Shredder	cb	6.3	5.38	66.00
Diptera	Simuliidae	Stegopterna	Stegopterna	Filterer	cn	2.4	5.16	40.00
Isopoda	Asellidae	Caecidotea	Caecidotea	Collector	sp	2.6	4.06	54.00
Diptera	Chironomidae	Rheocricotopus	Rheocricotopus	Collector	sp	6.2	3.86	38.00
Haplotaxida	Tubificidae	not identified	Tubificidae	Collector	cn	8.4	3.71	58.00
Diptera	Chironomidae	Rheotanytarsus	Rheotanytarsus	Filterer	cn	7.2	3.06	50.00
Trichoptera	Hydropsychidae	Cheumatopsyche	Cheumatopsyche	Filterer	cn	6.5	3.04	30.00
Diptera	Chironomidae	not identified	Thienemannimyia group	Predator	sp	8.2	2.73	70.00
Haplotaxida	Enchytraeidae	not identified	Enchytraeidae	Collector	bu	9.1	2.69	38.00
Diptera	Chironomidae	Psectrocladius	Psectrocladius	Shredder	sp	6.6	2.62	14.00
Plecoptera	Leuctridae	Leuctra	Leuctra	Shredder	cn	0.4	2.52	20.00
Lumbriculada	Lumbriculidae	not identified	Lumbriculidae	Collector	bu	6.6	1.73	36.00
Plecoptera	Nemouridae	Amphinemura	Amphinemura	Shredder	sp	3.0	1.67	18.00
Diptera	Chironomidae	Orthocladius	Orthocladius	Collector	sp	9.2	1.67	46.00
Diptera	Simuliidae	not identified	Simuliidae	Filterer	cn	3.2	1.48	30.00
Diptera	Chironomidae	Tanytarsus	Tanytarsus	Filterer	cb	4.9	1.35	48.00
Diptera	Chironomidae	not identified	Orthocladiinae	Collector	bu	7.6	1.22	64.00
Amphipoda	Crangonyctidae	Synurella	Synurella	Collector	sp	6.5	1.22	24.00
Coleoptera	Elmidae	Stenelmis	Stenelmis	Scraper	cn	7.1	1.13	38.00
Trichoptera	Hydropsychidae	Diplectrona	Diplectrona	Filterer	cn	2.7	1.04	30.00
Diptera	Chironomidae	Hydrobaenus	Hydrobaenus	Scraper	sp	7.2	1.00	22.00
Trichoptera	Polycentropodidae	Polycentropus	Polycentropus	Filterer	cn	1.1	0.97	22.00
Diptera	Chironomidae	Zavrelimyia	Zavrelimyia	Predator	sp	5.3	0.95	34.00
Coleoptera	Ptilodactylidae	Anchytarsus	Anchytarsus	Shredder	cn	3.1	0.91	20.00
Neotaenioglossa	Hydrobiidae	Amnicola	Amnicola	Scraper	cb	8.0	0.87	2.00
Diptera	Chironomidae	Dicrotendipes	Dicrotendipes	Collector	bu	9.0	0.87	10.00
Diptera	Chironomidae	Phaenopsectra	Phaenopsectra	Collector	cn	8.7	0.82	34.00
Diptera	Chironomidae	Tvetenia	Tvetenia	Collector	sp	5.1	0.82	22.00
Diptera	Chironomidae	Corynoneura	Corynoneura	Collector	sp	4.1	0.80	34.00
Veneroida	Pisidiidae	not identified	Pisidiidae	Filterer	bu	6.5	0.80	30.00
Diptera	Chironomidae	not identified	Chironomini	Collector	bu	5.9	0.76	42.00
Trichoptera	Psychomyiidae	Lype	Lype	Scraper	cn	4.7	0.72	24.00
Amphipoda	Crangonyctidae	Crangonyx	Crangonyx	Collector	sp	6.7	0.69	18.00
Haplotaxida	not identified	not identified	Lumbricina	Collector	bu	10.0	0.69	34.00
Coleoptera	Elmidae	Macronychus	Macronychus	Scraper	cn	6.8	0.59	20.00
Diptera	Chironomidae	Zalutschia	Zalutschia	Shredder	na	6.6	0.59	4.00
Basommatophora	Physidae	Physa	Physa	Scraper	cb	7.0	0.58	18.00
Veneroida	Pisidiidae	Pisidium	Pisidium	Filterer	bu	5.7	0.54	16.00
Diptera	Tipulidae	Tipula	Tipula	Shredder	bu	6.7	0.54	36.00
Diptera	Chironomidae	Paratanytarsus	Paratanytarsus	Collector	sp	7.7	0.52	12.00
Coleoptera	Elmidae	Ancyronyx	Ancyronyx	Scraper	cn	7.8	0.50	22.00
Veneroida	Sphaeriidae	Musculium	Musculium	Filterer	na	5.5	0.50	12.00
Haplotaxida	Naididae	not identified	Naididae	Collector	bu	8.5	0.50	24.00
Plecoptera	Nemouridae	not identified	Nemouridae	Shredder	sp	2.9	0.48	6.00
Diptera	Chironomidae	Micropsectra	Micropsectra	Collector	cb	2.1	0.43	28.00
Amphipoda	not identified	not identified	Amphipoda	Collector	sp	6.0	0.41	16.00
Trichoptera	Limnephilidae	Ironoquia	Ironoquia	Shredder	sp	4.9	0.41	20.00
Diptera	Chironomidae	Paratendipes	Paratendipes	Collector	bu	6.6	0.41	18.00
Diptera	Chironomidae	Thienemanniella	Thienemanniella	Collector	sp	5.1	0.41	28.00
Diptera	Ceratopogonidae	Bezzia/Palpomyia	Bezzia/Palpomyia	Predator	sp	3.6	0.39	28.00
Diptera	Chironomidae	Chironomus	Chironomus	Collector	bu	4.6	0.37	6.00
Coleoptera	Dytiscidae	Neoporus	Neoporus	Predator	sw	5.4	0.37	20.00
Coleoptera	Dryopidae	Helichus	Helichus	Scraper	cn	6.4	0.35	18.00
Diptera	Chironomidae	Cricotopus	Cricotopus	Shredder	cn	9.6	0.33	18.00
Diptera	Chironomidae	Limnophyes	Limnophyes	Collector	sp	8.6	0.33	16.00
Trichoptera	not identified	not identified	Trichoptera	na	na	4.6	0.33	16.00
Diptera	Chironomidae	Brillia	Brillia	Shredder	bu	7.4	0.32	20.00
Odonata	Calopterygidae	Calopteryx	Calopteryx	Predator	cb	8.3	0.32	22.00
Amphipoda	Crangonyctidae	not identified	Crangonyctidae	Collector	sp	6.5	0.26	12.00
Odonata	Libellulidae	not identified	Libellulidae	Predator	na	9.0	0.26	16.00
Diptera	Chironomidae	Paraphaenocladius	Paraphaenocladius	Collector	sp	4.0	0.26	14.00
Amphipoda	Crangonyctidae	Stygobromus	Stygobromus	Collector	sp	6.5	0.26	12.00
Odonata	Aeshnidae	Boyeria	Boyeria	Predator	cb	6.3	0.24	16.00
Amphipoda	Gammaridae	Gammarus	Gammarus	Shredder	sp	6.7	0.24	10.00
Plecoptera	Chloroperlidae	Haploperla	Haploperla	Predator	cn	1.6	0.24	4.00
Trichoptera	Hydropsychidae	Ceratopsyche	Ceratopsyche	Filterer	cn	5.7	0.22	10.00
Megaloptera	Corydalidae	Nigronia	Nigronia	Predator	cn	1.4	0.22	16.00
Plecoptera	not identified	not identified	Plecoptera	Predator	na	2.4	0.22	12.00
Diptera	Simuliidae	Prosimulium	Prosimulium	Filterer	cn	2.4	0.22	10.00
Diptera	Chironomidae	Pseudorthocladius	Pseudorthocladius	Collector	sp	6.0	0.22	14.00
Diptera	Ceratopogonidae	Culicoides	Culicoides	Predator	bu	5.9	0.20	14.00
Coleoptera	Dytiscidae	not identified	Dytiscidae	Predator	sw	5.4	0.20	2.00
Diptera	Chironomidae	Natarsia	Natarsia	Predator	sp	6.6	0.20	14.00
Ephemeroptera	Heptageniidae	Maccaffertium	Maccaffertium	Scraper	cn	2.6	0.19	6.00

Order	Family	Genus	Final ID	Functional Feeding Group	Habit[1]	Tolerance Value[2]	% of total number of organisms	% of sites
Coleoptera	Elmidae	Microcylloepus	Microcylloepus	Collector	cn	4.8	0.19	6.00
Diptera	Chironomidae	Stempellinella	Stempellinella	Collector	cb	4.2	0.19	14.00
Ephemeroptera	Baetidae	Acerpenna	Acerpenna	Collector	sw	2.6	0.17	6.00
Basommatophora	Lymnaeidae	Fossaria	Fossaria	Scraper	cb	6.9	0.17	8.00
Amphipoda	Hyalellidae	Hyalella	Hyalella	Shredder	sp	4.2	0.17	8.00
Trichoptera	Limnephilidae	not identified	Limnephilidae	Shredder	cb	3.4	0.17	12.00
Diptera	Chironomidae	Prodiamesa	Prodiamesa	Collector	bu	6.6	0.17	8.00
Hoplonemertea	Tetrastemmatidae	Prostoma	Prostoma	Predator	na	7.3	0.17	12.00
Diptera	Chironomidae	Chaetocladius	Chaetocladius	Collector	sp	7.0	0.15	12.00
Diptera	Chironomidae	Diplocladius	Diplocladius	Collector	sp	5.9	0.15	10.00
Diptera	Tipulidae	Eriopterini	Eriopterini	na	na	4.8	0.15	8.00
Trichoptera	Calamoceratidae	Heteroplectron	Heteroplectron	Shredder	sp	3.0	0.15	8.00
Diptera	Tipulidae	Molophilus	Molophilus	Shredder	bu	4.8	0.15	6.00
Plecoptera	Nemouridae	Podmosta	Podmosta	Shredder	sp	2.9	0.15	8.00
Diptera	Chironomidae	Xylotopus	Xylotopus	Shredder	bu	6.6	0.15	10.00
Diptera	not identified	-	Brachycera	na	na	6.0	0.13	6.00
Coleoptera	Elmidae	Dubiraphia	Dubiraphia	Scraper	cn	5.7	0.13	12.00
Diptera	Empididae	Hemerodromia	Hemerodromia	Predator	sp	7.9	0.13	6.00
Diptera	Chironomidae	Heterotrissocladius	Heterotrissocladius	Collector	sp	2.0	0.13	12.00
Lepidoptera	not identified	not identified	Lepidoptera	Shredder	na	6.7	0.13	14.00
Trichoptera	Leptoceridae	Oecetis	Oecetis	Predator	cn	4.7	0.13	8.00
Diptera	Chironomidae	Stenochironomus	Stenochironomus	Shredder	bu	7.9	0.13	12.00
Coleoptera	Dytiscidae	Agabus	Agabus	Predator	sw	5.4	0.11	2.00
Diptera	Chironomidae	not identified	Chironomidae	Collector	na	6.6	0.11	12.00
Ephemeroptera	Baetidae	not identified	Baetidae	Collector	sw	2.3	0.09	6.00
Diptera	Chironomidae	Conchapelopia	Conchapelopia	Predator	sp	6.1	0.09	10.00
Diptera	Chironomidae	Eukiefferiella	Eukiefferiella	Collector	sp	6.1	0.09	6.00
Trichoptera	Leptoceridae	not identified	Leptoceridae	Collector	sp	4.1	0.09	10.00
Coleoptera	Elmidae	Oulimnius	Oulimnius	Scraper	cn	2.7	0.09	10.00
Trichoptera	Limnephilidae	Pycnopsyche	Pycnopsyche	Shredder	sp	3.1	0.09	10.00
Diptera	Chironomidae	Apsectrotanypus	Apsectrotanypus	Predator	bu	6.6	0.07	6.00
Odonata	Cordulegastridae	Cordulegaster	Cordulegaster	Predator	bu	2.4	0.07	4.00
Diptera	Chironomidae	Cryptochironomus	Cryptochironomus	Predator	sp	7.6	0.07	6.00
Trichoptera	Hydropsychidae	Hydropsyche	Hydropsyche	Filterer	cn	7.5	0.07	6.00
Trichoptera	Lepidostomatidae	Lepidostoma	Lepidostoma	Shredder	cb	0.0	0.07	8.00
Basommatophora	Planorbidae	Menetus	Menetus	Scraper	cb	7.6	0.07	6.00
Trichoptera	Phryganeidae	Ptilostomis	Ptilostomis	Shredder	cb	4.3	0.07	6.00
Diptera	Chironomidae	not identified	Tanytarsini	Filterer	na	3.5	0.07	8.00
Diptera	Chironomidae	Ablabesmyia	Ablabesmyia	Predator	sp	8.1	0.06	6.00
Diptera	Culicidae	Aedes	Aedes	Filterer	sw	8.0	0.06	4.00
Diptera	Ceratopogonidae	not identified	Ceratopogonidae	Predator	sp	3.6	0.06	6.00
Trichoptera	Philopotamidae	Chimarra	Chimarra	Filterer	cn	4.4	0.06	4.00
Diptera	Tabanidae	Chrysops	Chrysops	Predator	sp	2.9	0.06	6.00
Coleoptera	Dytiscidae	not identified	Hydroporini	Predator	sw	5.4	0.06	6.00
Diptera	Chironomidae	Paracladopelma	Paracladopelma	Collector	sp	6.6	0.06	6.00
Trichoptera	Rhyacophilidae	Rhyacophila	Rhyacophila	Predator	cn	2.1	0.06	6.00
Diptera	Chironomidae	Smittia	Smittia	Collector	lentic	6.6	0.06	6.00
Diptera	Chironomidae	not identified	Tanypodinae	Predator	sp	7.5	0.06	8.00
Diptera	Chironomidae	Tribelos	Tribelos	Collector	bu	7.0	0.06	6.00
Trichoptera	Sericostomatidae	Agarodes	Agarodes	Shredder	sp	3.0	0.04	2.00
Diptera	Chironomidae	Alotanypus	Alotanypus	na	na	6.6	0.04	4.00
Isopoda	Asellidae	not identified	Asellidae	Collector	na	3.3	0.04	4.00
Trichoptera	Brachycentridae	Brachycentrus	Brachycentrus	Filterer	cn	2.3	0.04	2.00
Diptera	Ceratopogonidae	Ceratopogon	Ceratopogon	Predator	sp	2.7	0.04	4.00
Diptera	Chironomidae	Clinotanypus	Clinotanypus	Predator	bu	6.6	0.04	4.00
Diptera	Culicidae	not identified	Culicidae	Collector	sw	6.0	0.04	2.00
Diptera	Ceratopogonidae	Dasyhelea	Dasyhelea	Collector	sp	3.6	0.04	4.00
Ephemeroptera	Ephemerellidae	Eurylophella	Eurylophella	Scraper	cn	4.5	0.04	2.00
Diptera	Chironomidae	Georthocladius	Georthocladius	Collector	sp	7.6	0.04	4.00
Ephemeroptera	Leptophlebiidae	not identified	Leptophlebiidae	Collector	sw	1.7	0.04	4.00
Diptera	Tipulidae	Limonia	Limonia	Shredder	bu	4.8	0.04	4.00
Trichoptera	Leptoceridae	Nectopsyche	Nectopsyche	Shredder	cb	4.1	0.04	4.00
not identified	not identified	not identified	Nemata	Parasite	na	na	0.04	4.00
Diptera	Chironomidae	Odontomesa	Odontomesa	Collector	sp	6.6	0.04	4.00
Diptera	Chironomidae	Paralauterborniella	Paralauterborniella	Collector	cn	6.6	0.04	4.00
Plecoptera	Nemouridae	Paranemoura	Paranemoura	na	na	2.9	0.04	2.00
Trichoptera	Polycentropodidae	not identified	Polycentropodidae	Filterer	cn	0.2	0.04	4.00
Diptera	Tipulidae	Pseudolimnophila	Pseudolimnophila	Predator	bu	2.8	0.04	4.00
Diptera	Chironomidae	Saetheria	Saetheria	Collector	bu	6.6	0.04	2.00
Megaloptera	Sialidae	Sialis	Sialis	Predator	bu	1.9	0.04	2.00
Trichoptera	Leptoceridae	Triaenodes	Triaenodes	Shredder	sw	5.0	0.04	4.00
Trichoptera	Philopotamidae	Wormaldia	Wormaldia	Filterer	cn	1.8	0.04	4.00
Odonata	Coenagrionidae	Argia	Argia	Predator	cn	9.3	0.02	2.00
Ephemeroptera	Baetidae	Baetis	Baetis	Collector	sw	3.9	0.02	2.00
Diptera	Ptychopteridae	Bittacomorpha	Bittacomorpha	Collector	bu	4.0	0.02	2.00
not identified	not identified	not identified	Bivalvia	Filterer	na	5.5	0.02	2.00

Order	Family	Genus	Final ID	Functional Feeding Group	Habit[1]	Tolerance Value[2]	% of total number of organisms	% of sites
Ephemeroptera	Caenidae	Caenis	Caenis	Collector	sp	2.1	0.02	2.00
Megaloptera	Corydalidae	Chauliodes	Chauliodes	Predator	cn	1.4	0.02	2.00
Diptera	Chironomidae	not identified	Chironominae	Collector	na	6.6	0.02	2.00
Coleoptera	Chrysomelidae	not identified	Chrysomelidae	Shredder	cn	na	0.02	2.00
Diptera	Chironomidae	Cladotanytarsus	Cladotanytarsus	Filterer	-	6.6	0.02	2.00
Coleoptera	not identified	not identified	Coleoptera	na	na	4.1	0.02	2.00
Diptera	Corethrellidae	Corethrella	Corethrella	Predator	sp	6.0	0.02	2.00
Megaloptera	Corydalidae	not identified	Corydalidae	Predator	na	1.4	0.02	2.00
Diptera	Chironomidae	Cryptotendipes	Cryptotendipes	Collector	sp	6.6	0.02	2.00
Coleoptera	Curculionidae	not identified	Curculionidae	Shredder	cn	4.1	0.02	2.00
Plecoptera	Perlidae	Eccoptura	Eccoptura	Predator	cn	0.6	0.02	2.00
Coleoptera	Scirtidae	Elodes	Elodes	Collector	cb	4.0	0.02	2.00
Odonata	Coenagrionidae	Enallagma	Enallagma	Predator	cb	9.0	0.02	2.00
Trichoptera	Sericostomatidae	Fattigia	Fattigia	Shredder	na	4.6	0.02	2.00
not identified	not identified	not identified	Gastropoda	Scraper	cb	na	0.02	2.00
Basommatophora	Planorbidae	Gyraulus	Gyraulus	Scraper	cb	7.6	0.02	2.00
Coleoptera	Dytiscidae	not identified	Hydroporinae	Predator	sw	5.4	0.02	2.00
Trichoptera	Hydropsychidae	not identified	Hydropsychidae	Filterer	cn	5.7	0.02	2.00
Odonata	Coenagrionidae	Ischnura	Ischnura	Predator	cb	9.0	0.02	2.00
Diptera	Chironomidae	Larsia	Larsia	Predator	sp	8.5	0.02	2.00
Diptera	Chironomidae	Lopescladius	Lopescladius	Collector	sp	6.6	0.02	2.00
Basommatophora	Lymnaeidae	not identified	Lymnaeidae	Scraper	cb	6.9	0.02	2.00
Diptera	Chironomidae	Microtendipes	Microtendipes	Filterer	cn	4.9	0.02	2.00
Diptera	Stratiomyidae	Nemotelus	Nemotelus	Collector	sp	6.0	0.02	2.00
Odonata	not identified	-	Odonata	Predator	-	6.6	0.02	2.00
not identified	not identified	not identified	Oligochaeta	Collector	bu	10.0	0.02	2.00
Diptera	Chironomidae	Parachaetocladius	Parachaetocladius	Collector	sp	3.3	0.02	2.00
Diptera	Chironomidae	Parakiefferiella	Parakiefferiella	Collector	sp	2.1	0.02	2.00
Coleoptera	Haliplidae	Peltodytes	Peltodytes	Shredder	cb	8.9	0.02	2.00
Diptera	Psychodidae	Pericoma	Pericoma	Collector	na	4.0	0.02	2.00
Diptera	Ceratopogonidae	Probezzia	Probezzia	Predator	bu	3.0	0.02	2.00
Diptera	Chironomidae	Pseudosmittia	Pseudosmittia	Collector	sp	6.6	0.02	2.00
Basommatophora	Lymnaeidae	Pseudosuccinea	Pseudosuccinea	Collector	cb	6.3	0.02	2.00
Diptera	Chironomidae	Psilometriocnemus	Psilometriocnemus	Collector	sp	6.6	0.02	2.00
Lepidoptera	Pyralidae	not identified	Pyralidae	Shredder	cb	6.7	0.02	2.00
Coleoptera	Scirtidae	Scirtes	Scirtes	Collector	cb	4.0	0.02	2.00
Diptera	Ceratopogonidae	Serromyia	Serromyia	Predator	sp	3.6	0.02	2.00
Odonata	Corduliidae	Somatochlora	Somatochlora	Predator	sp	1.0	0.02	2.00
Trombidiformes	Sperchonidae	Sperchon	Sperchon	Predator	na	na	0.02	2.00
Coleoptera	Staphylinidae	not identified	Staphylinidae	Predator	cn	4.1	0.02	2.00
Diptera	Chironomidae	Stictochironomus	Stictochironomus	Omnivore	bu	9.2	0.02	2.00
Diptera	Tabanidae	not identified	Tabanidae	Predator	sp	2.8	0.02	2.00
Plecoptera	Taeniopterygidae	Taeniopteryx	Taeniopteryx	Shredder	sp	4.8	0.02	2.00
Diptera	Tipulidae	not identified	Tipulidae	Predator	bu	4.8	0.02	2.00
not identified	not identified	not identified	Turbellaria	Predator	sp	4.0	0.02	2.00

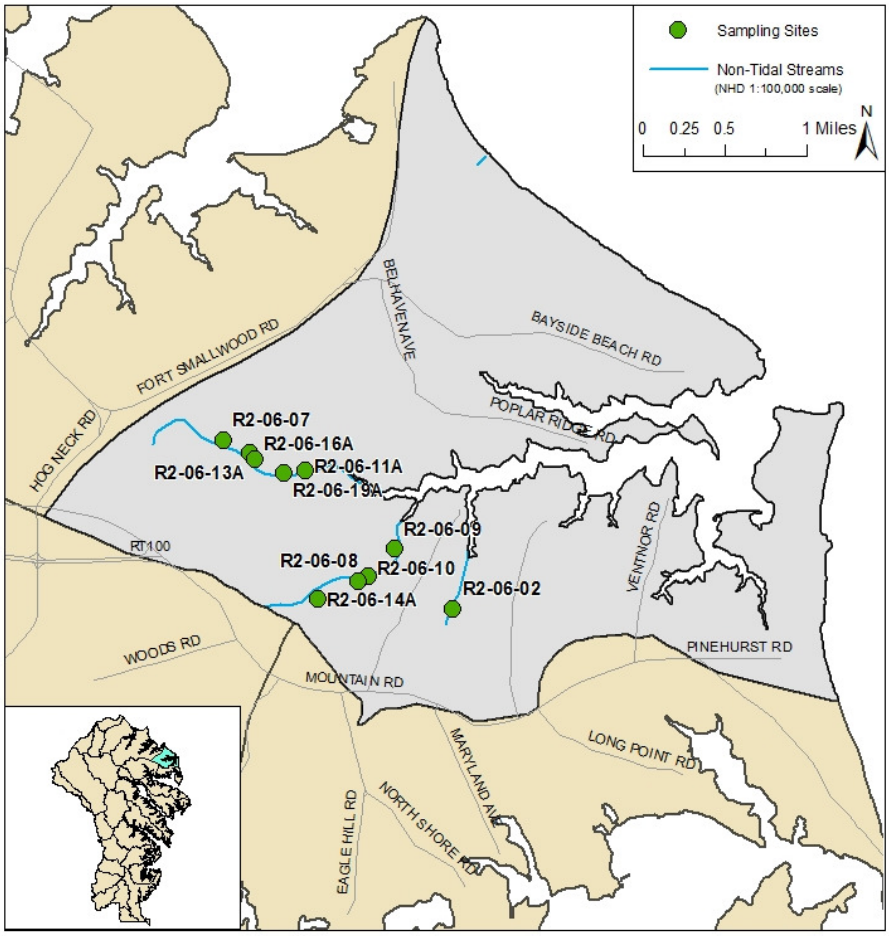
[1] Primary habit or form of locomotion includes bu - burrower, cn - clinger, cb - climber, sk - skater, sp - sprawler, sw - swimmer; [2] Tolerance values based on Hilsenhoff, modified for Maryland; na indicates information for the particular taxa was not available.

Appendix D: Individual Site Summaries

Bodkin Creek Sampling Unit

Site Condition Summary

Site	Drainage Area (acres)	Drainage Area (mi^2)	Percent Impervious	Percent Developed	Percent Forested	Percent Agriculture	Percent Open	BIBI Narrative Rating	PHI Narrative Rating	RBP Narrative Rating	Rosgen Stream Type - L1
R2-06-02	250.3	0.39	13.7	55.4	30.3	0.0	14.3	Good	Minimally Degraded	Comparable to Reference	E
R2-06-07	186.5	0.29	15.3	63.5	25.6	0.0	10.9	Very Poor	Severely Degraded	Non Supporting	ND
R2-06-08	254.6	0.40	13.4	58.9	39.0	2.1	0.0	Fair	Partially Degraded	Supporting	E
R2-06-09	583.9	0.91	17.5	64.5	32.5	0.9	2.1	Fair	Partially Degraded	Comparable to Reference	E
R2-06-10	258.6	0.40	13.3	58.7	39.2	2.1	0.0	Poor	Minimally Degraded	Supporting	E
R2-06-11A	752.0	1.17	11.9	40.5	41.0	0.6	17.9	Poor	Partially Degraded	Comparable to Reference	DA
R2-06-13A	382.1	0.60	14.6	50.3	26.7	0.0	23.1	Very Poor	Degraded	Supporting	E
R2-06-14A	123.1	0.19	14.3	64.5	35.5	0.0	0.0	Very Poor	Degraded	Partially Supporting	ND
R2-06-16A	391.2	0.61	14.7	49.5	27.0	0.0	23.5	Very Poor	Degraded	Supporting	C
R2-06-19A	699.5	1.09	12.8	43.5	38.0	0.2	18.2	Very Poor	Degraded	Supporting	E



R2-06-02 Bodkin Creek Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.1143324878 **Longitude:** -76.4753292197

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		250.3
Cover	**Acres**	**% Area**
Developed Land	**138.6**	**55.4**
Airport	0	0
Commercial	5.5	2.2
Industrial	0	0
Residential 1/8-acre	28	11.2
Residential 1/4-acre	0	0
Residential 1/2-acre	15.6	6.2
Residential 1-Acre	72.1	28.8
Residential 2-Acre	7.8	3.1
Transportation	9.6	3.8
Utility	0	0
Forest Land	**75.8**	**30.3**
Forested Wetland	0	0
Residential Woods	0	0
Woods	75.8	30.3
Open Land	**35.9**	**14.3**
Open Space	3.8	1.5
Open Wetland	14.3	5.7
Water	17.8	7.1
Agricultural Land	**0**	**0**
Pasture/Hay	0	0
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	34.4	13.7

Summary Results:

- Biological condition – *"Good"*
- Habitat scores *"Comparable to Reference"* and *"Minimally Degraded"*
- Sample dominated by isopods (Caecidotea). Scored high in most metric categories.
- Water quality values within COMAR standards but conductivity elevated.
- All habitat variables received sub-optimal to optimal scores. Good riparian width and vegetative protection.

Recommendations:

- Maintain the protection of the riparian areas.
- Investigate potential water quality impacts from residential land uses.

R2-06-02 Bodkin Creek Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	23
EPT Taxa	7
Ephemeroptera Taxa	2
%Intolerant Urban	54.8
%Ephemeroptera	1.7
Scraper Taxa	0
% Climbers	13.9

Calculated Metric Scores

Total Taxa	5
EPT Taxa	5
Ephemeroptera Taxa	5
Intolerant Urban %	5
Ephemeroptera %	3
Scraper Taxa	1
% Climbers	5
BIBI Score	**4.14**
BIBI Narrative Rating	**Good**

Taxa	Count
Baetis	1
Caecidotea	59
Caenis	1
Chaetocladius	2
Cheumatopsyche	4
Chironomini	4
Conchapelopia	1
Dicrotendipes	1
Hydroporini	1
Lepidostoma	1
Leptoceridae	1
Lumbricina	2
Musculium	3
Naididae	1
Pisidium	2
Polycentropodidae	1
Polypedilum	12
Ptilostomis	2
Rheotanytarsus	2
Simuliidae	1
Simulium	5
Stegopterna	1
Stenochironomus	1
Tanytarsus	1
Thienemannimyia_group	4
Triaenodes	1
TOTAL:	**115**

Physical Habitat Assessment

RBP Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	9	Pool Variability	11
Bank Stability- Right Bank	9	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	20	Sediment Deposition	16
Channel Sinuosity	14	Vegetative Protection - Left Bank	10
Epifaunal Substrate/Available Cover	15	Vegetative Protection - Right Bank	10
Pool Substrate Characterization	14		
RBP Habitat Score			**168**
RBP Narrative Rating			**Comparable to Reference**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	15	80.78	Instream Wood Debris	11	91.73
Shading	95	99.94	Instream Habitat	15	100
Epifaunal Substrate	15	100	Bank Stability	18	94.87
PHI Score					**94.55**
PHI Narrative Rating					**Minimally Degraded**

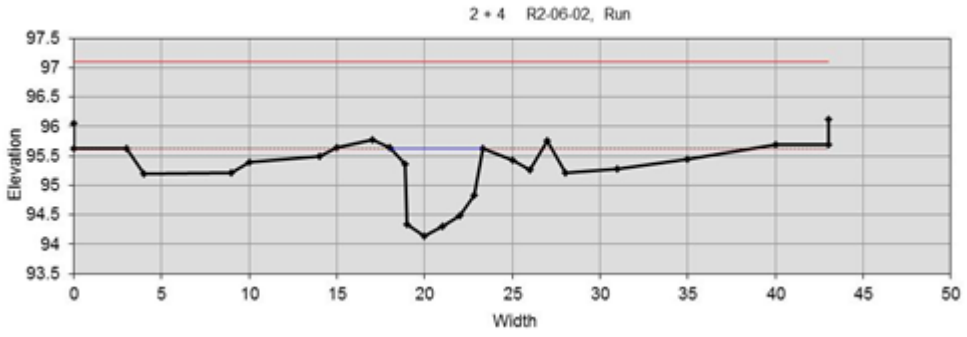
Water Chemistry

Dissolved Oxygen (mg/L)	9.02	pH (SU)	6.64
Turbidity (NTU)	5.57	Specific Conductivity (µS/cm)	351.9
Temperature (°C)	10.43		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.39	Cross Sectional Area (ft^2)	5.16
Bankfull Width (ft)	5.24	Water Surface Slope (%)	0.42
Mean Bankfull Depth (ft)	0.99	Sinuosity	1.25
Floodprone Width (ft)	105	D50 (mm)	0.23
Entrenchment Ratio	20.05	Adjustments?	None
Width to Depth Ratio	5.31	**Rosgen Stream Type**	**E5**



R2-06-07 Bodkin Creek Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.1294721796 **Longitude:** -76.501502838

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**186.5**
Cover	**Acres**	**% Area**
Developed Land	**118.5**	**63.5**
Airport	0	0
Commercial	1.6	0.9
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	50.6	27.1
Residential 2-Acre	63	33.8
Transportation	3.2	1.7
Utility	0	0
Forest Land	**47.7**	**25.6**
Forested Wetland	0	0
Residential Woods	0	0
Woods	47.7	25.6
Open Land	**20.3**	**10.9**
Open Space	20.3	10.9
Open Wetland	0	0
Water	0	0
Agricultural Land	**0**	**0**
Pasture/Hay	0	0
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	28.5	15.3

Summary Results:

- Biological condition – *"Very Poor"*
- Habitat scores *"Non Supporting"* and *"Severely Degraded"*
- Worms (Enchytraeidae and Tubificidae) dominated the sample.
- Water quality values within COMAR standards but conductivity elevated.
- Ephemeral channel with poor habitat diversity and no woody debris/rootwads. Refuse present in moderate amounts.
- Stream type not determined due to effects from culvert within reach.

Recommendations:

- Buffer enhancement.
- Consider trash cleanup for this reach.
- Investigate potential water quality impacts from residential land uses.

R2-06-07 Bodkin Creek Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	14
EPT Taxa	1
Ephemeroptera Taxa	0
%Intolerant Urban	2.5
%Ephemeroptera	0
Scraper Taxa	1
% Climbers	3.8

Calculated Metric Scores

Total Taxa	3
EPT Taxa	1
Ephemeroptera Taxa	1
Intolerant Urban %	1
Ephemeroptera %	1
Scraper Taxa	3
% Climbers	3
BIBI Score	**1.86**
BIBI Narrative Rating	**Very Poor**

Taxa	Count
Aedes	1
Boyeria	1
Chauliodes	1
Coleoptera	1
Corydalidae	1
Culicidae	2
Enchytraeidae	34
Lepidoptera	1
Limnephilidae	1
Lumbricina	6
Lumbriculidae	1
Lymnaeidae	1
Oligochaeta	1
Pisidiidae	1
Pisidium	8
Prostoma	1
Staphylinidae	1
Tipula	3
Tubificidae	14
TOTAL:	**80**

Physical Habitat Assessment

RBP Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	8	Pool Variability	3
Bank Stability- Right Bank	8	Riparian Vegetative Zone Width- Left Bank	4
Channel Alteration	7	Riparian Vegetative Zone Width- Right Bank	6
Channel Flow Status	1	Sediment Deposition	9
Channel Sinuosity	3	Vegetative Protection - Left Bank	5
Epifaunal Substrate/Available Cover	3	Vegetative Protection - Right Bank	5
Pool Substrate Characterization	5		
RBP Habitat Score			**67**
RBP Narrative Rating			**Non Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	0	0	Instream Wood Debris	0	62.52
Shading	65	63.55	Instream Habitat	1	32.73
Epifaunal Substrate	4	45.39	Bank Stability	16	89.45
PHI Score					**48.94**
PHI Narrative Rating					**Severely Degraded**

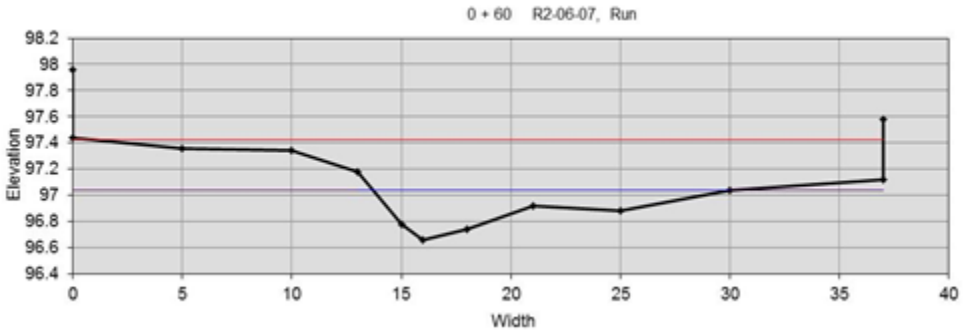
Water Chemistry

Dissolved Oxygen (mg/L)	6.47	pH (SU)	6.66
Turbidity (NTU)	3.57	Specific Conductivity (µS/cm)	390.2
Temperature (°C)	14.8		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.29	Cross Sectional Area (ft^2)	2.76
Bankfull Width (ft)	16.3	Water Surface Slope (%)	0.47
Mean Bankfull Depth (ft)	0.17	Sinuosity	1
Floodprone Width (ft)	48	D50 (mm)	0.062
Entrenchment Ratio	2.94	Adjustments?	None
Width to Depth Ratio	96.3	**Rosgen Stream Type**	**ND**



R2-06-08 Bodkin Creek Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.1168388472 **Longitude:** -76.4860702715

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**254.6**
Cover	**Acres**	**% Area**
Developed Land	**149.8**	**58.9**
Airport	5.4	2.1
Commercial	1	0.4
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	38.2	15
Residential 1-Acre	65.6	25.8
Residential 2-Acre	33.3	13.1
Transportation	6.3	2.5
Utility	0	0
Forest Land	**99.3**	**39**
Forested Wetland	0	0
Residential Woods	0	0
Woods	99.3	39
Open Land	**0**	**0**
Open Space	0	0
Open Wetland	0	0
Water	0	0
Agricultural Land	**5.4**	**2.1**
Pasture/Hay	5.4	2.1
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	34.2	13.4

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Supporting"* and *"Partially Degraded"*
- Sample dominated by midges (Parametriocnemus, Thienemannimyia group, and Polypedilum). Scored high for number of taxa, EPT, and percent climbers.
- Measured below COMAR standards for pH.
- Sub-optimal instream habitat and epibenthic substrate. Good sinuosity and stable, well-vegetated banks.

Recommendations:

- Maintain the protection of the riparian areas.
- Investigate potential water quality impacts from residential land uses.

R2-06-08 Bodkin Creek Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	30
EPT Taxa	5
Ephemeroptera Taxa	0
%Intolerant Urban	6.9
%Ephemeroptera	0
Scraper Taxa	1
% Climbers	15.7

Calculated Metric Scores

Total Taxa	5
EPT Taxa	5
Ephemeroptera Taxa	1
Intolerant Urban %	1
Ephemeroptera %	1
Scraper Taxa	3
% Climbers	5
BIBI Score	**3**
BIBI Narrative Rating	**Fair**

Taxa	Count
Ablabesmyia	1
Agarodes	2
Amphipoda	8
Apsectrotanypus	2
Boyeria	1
Caecidotea	1
Chironomini	1
Conchapelopia	1
Crangonyctidae	2
Cryptochironomus	1
Diplectrona	1
Libellulidae	1
Limnephilidae	1
Lumbricina	1
Lype	3
Micropsectra	2
Paralauterborniella	1
Parametriocnemus	18
Phaenopsectra	1
Polycentropus	1
Polypedilum	11
Prodiamesa	1
Rheocricotopus	9
Rheotanytarsus	2
Serromyia	1
Simulium	5
Stictochironomus	1
Synurella	1
Tanytarsus	1
Thienemannimyia_group	11
Tipula	2
Tubificidae	3
TOTAL:	**98**

Physical Habitat Assessment

RBP Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	8	Pool Variability	10
Bank Stability- Right Bank	8	Riparian Vegetative Zone Width- Left Bank	9
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	17	Sediment Deposition	13
Channel Sinuosity	13	Vegetative Protection - Left Bank	9
Epifaunal Substrate/Available Cover	12	Vegetative Protection - Right Bank	9
Pool Substrate Characterization	11		
RBP Habitat Score			**149**
RBP Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	7	37.7	Instream Wood Debris	10	88.58
Shading	90	91.34	Instream Habitat	11	85.03
Epifaunal Substrate	12	89.84	Bank Stability	16	89.45
PHI Score					**80.32**
PHI Narrative Rating					**Partially Degraded**

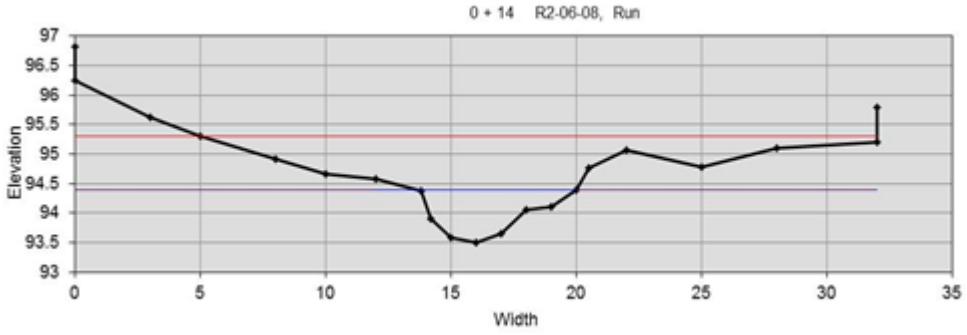
Water Chemistry

Dissolved Oxygen (mg/L)	8.94	pH (SU)	6.29
Turbidity (NTU)	4.51	Specific Conductivity (µS/cm)	169.2
Temperature (°C)	11.9		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.4	Cross Sectional Area (ft^2)	3.34
Bankfull Width (ft)	6.38	Water Surface Slope (%)	0.5
Mean Bankfull Depth (ft)	0.52	Sinuosity	1.23
Floodprone Width (ft)	65	D50 (mm)	0.3
Entrenchment Ratio	10.19	Adjustments?	Yes, WD -1.0
Width to Depth Ratio	12.19	**Rosgen Stream Type**	**E5**



R2-06-09 Bodkin Creek Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.1196607639 **Longitude:** -76.4820002683

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		583.9
Cover	**Acres**	**% Area**
Developed Land	**376.6**	**64.5**
Airport	5.4	0.9
Commercial	8.8	1.5
Industrial	0	0
Residential 1/8-acre	3.9	0.7
Residential 1/4-acre	0	0
Residential 1/2-acre	60.6	10.4
Residential 1-Acre	223.9	38.3
Residential 2-Acre	57.3	9.8
Transportation	16.8	2.9
Utility	0	0
Forest Land	**189.6**	**32.5**
Forested Wetland	0	0
Residential Woods	0	0
Woods	189.6	32.5
Open Land	**12.3**	**2.1**
Open Space	12.3	2.1
Open Wetland	0	0
Water	0	0
Agricultural Land	**5.4**	**0.9**
Pasture/Hay	5.4	0.9
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	102.1	17.5

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Comparable to Reference"* and *"Partially Degraded"*
- Sample dominated by midges (Parametriocnemus, Thienemannimyia group, and Polypedilum) and black flies (Simulium). Scored high for number of taxa, EPT, and percent climbers.
- Water quality values within COMAR standards.
- Sub-optimal instream habitat and epibenthic substrate. Stable, well-vegetated banks and good 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.
- Investigate potential water quality impacts from residential land uses.

R2-06-09 Bodkin Creek Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	25
EPT Taxa	8
Ephemeroptera Taxa	0
%Intolerant Urban	8.6
%Ephemeroptera	0
Scraper Taxa	2
% Climbers	14.7

Calculated Metric Scores

Total Taxa	5
EPT Taxa	5
Ephemeroptera Taxa	1
Intolerant Urban %	1
Ephemeroptera %	1
Scraper Taxa	5
% Climbers	5
BIBI Score	**3.29**
BIBI Narrative Rating	**Fair**

Taxa	Count
Ablabesmyia	1
Anchytarsus	1
Calopteryx	3
Cheumatopsyche	1
Chironomini	1
Diplectrona	2
Fattigia	1
Hyalella	1
Lepidostoma	1
Lype	7
Micropsectra	1
Natarsia	1
Nectopsyche	1
Oecetis	1
Parametriocnemus	24
Polycentropus	4
Polypedilum	10
Rheotanytarsus	2
Simulium	33
Stegopterna	2
Tanytarsus	1
Thienemannimyia_group	10
Tipula	1
Tubificidae	5
TOTAL:	**115**

Physical Habitat Assessment

RBP Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	10	Pool Variability	7
Bank Stability- Right Bank	10	Riparian Vegetative Zone Width- Left Bank	8
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	20	Sediment Deposition	18
Channel Sinuosity	12	Vegetative Protection - Left Bank	9
Epifaunal Substrate/Available Cover	13	Vegetative Protection - Right Bank	9
Pool Substrate Characterization	8		
RBP Habitat Score			**154**
RBP Narrative Rating			**Comparable to Reference**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	10	53.85	Instream Wood Debris	6	67.35
Shading	90	91.34	Instream Habitat	10	70.98
Epifaunal Substrate	13	90.24	Bank Stability	20	100
PHI Score					**78.96**
PHI Narrative Rating					**Partially Degraded**

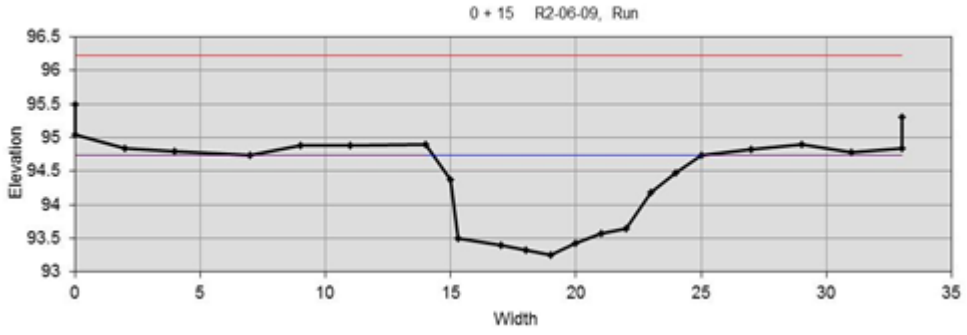
Water Chemistry

Dissolved Oxygen (mg/L)	8.75	pH (SU)	6.54
Turbidity (NTU)	5.24	Specific Conductivity (µS/cm)	199.9
Temperature (°C)	11.3		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.91	Cross Sectional Area (ft^2)	10.52
Bankfull Width (ft)	10.69	Water Surface Slope (%)	0.18
Mean Bankfull Depth (ft)	0.98	Sinuosity	1.21
Floodprone Width (ft)	88	D50 (mm)	0.25
Entrenchment Ratio	8.23	Adjustments?	None
Width to Depth Ratio	10.87	**Rosgen Stream Type**	**E5**



R2-06-10 Bodkin Creek Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.1172007588 **Longitude:** -76.4850051405

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**258.6**
Cover	**Acres**	**% Area**
Developed Land	**151.7**	**58.7**
Airport	5.4	2.1
Commercial	1	0.4
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	38.8	15
Residential 1-Acre	66.8	25.8
Residential 2-Acre	33.3	12.9
Transportation	6.3	2.5
Utility	0	0
Forest Land	**101.4**	**39.2**
Forested Wetland	0	0
Residential Woods	0	0
Woods	101.4	39.2
Open Land	**0**	**0**
Open Space	0	0
Open Wetland	0	0
Water	0	0
Agricultural Land	**5.4**	**2.1**
Pasture/Hay	5.4	2.1
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	34.4	13.3

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Supporting"* and *"Minimally Degraded"*
- Midges, including Parametriocnemus and Polypedilum, dominated the sample. Scored high for number of taxa and percent climbers.
- Measured below COMAR standards for pH.
- Sub-optimal instream habitat and epibenthic substrate. Good sinuosity and stable, well-vegetated banks.

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.
- Investigate potential water quality impacts from residential land uses.

R2-06-10 Bodkin Creek Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	26
EPT Taxa	3
Ephemeroptera Taxa	0
%Intolerant Urban	3.4
%Ephemeroptera	0
Scraper Taxa	1
% Climbers	15.3

Calculated Metric Scores

Total Taxa	5
EPT Taxa	3
Ephemeroptera Taxa	1
Intolerant Urban %	1
Ephemeroptera %	1
Scraper Taxa	3
% Climbers	5
BIBI Score	**2.71**
BIBI Narrative Rating	**Poor**

Taxa	Count
Amphipoda	1
Caecidotea	1
Calopteryx	2
Ceratopogon	1
Chironomini	1
Cryptochironomus	2
Culicoides	1
Enchytraeidae	1
Hydrobaenus	1
Ironoquia	1
Lepidostoma	1
Leptoceridae	1
Lumbriculidae	1
Micropsectra	1
Natarsia	2
Orthocladiinae	1
Paracladopelma	1
Parametriocnemus	53
Paratanytarsus	1
Phaenopsectra	1
Polypedilum	14
Prodiamesa	1
Pseudorthocladius	1
Rheocricotopus	4
Rheotanytarsus	3
Simulium	7
Thienemannimyia_group	8
Tubificidae	5
TOTAL:	**118**

Physical Habitat Assessment

RBP Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	9	Pool Variability	9
Bank Stability- Right Bank	9	Riparian Vegetative Zone Width- Left Bank	9
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	16	Sediment Deposition	11
Channel Sinuosity	12	Vegetative Protection - Left Bank	9
Epifaunal Substrate/Available Cover	12	Vegetative Protection - Right Bank	9
Pool Substrate Characterization	10		
RBP Habitat Score			**145**
RBP Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	8	43.08	Instream Wood Debris	6	76.57
Shading	95	99.94	Instream Habitat	12	90.42
Epifaunal Substrate	12	89.74	Bank Stability	18	94.87
PHI Score					**82.44**
PHI Narrative Rating					**Minimally Degraded**

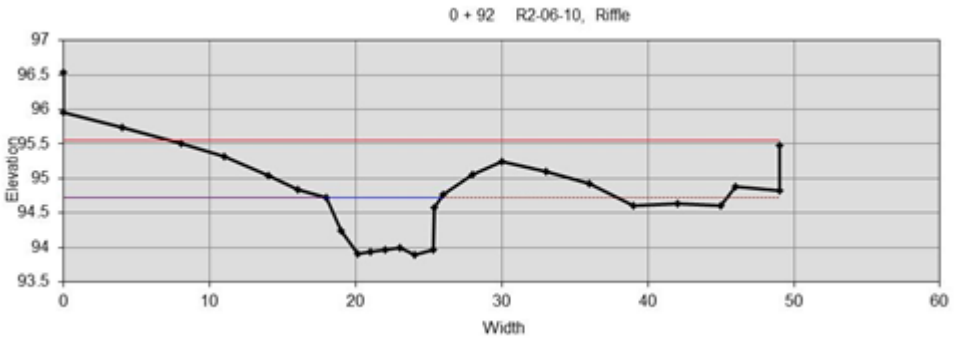
Water Chemistry

Dissolved Oxygen (mg/L)	8.68	pH (SU)	6.23
Turbidity (NTU)	6.09	Specific Conductivity (µS/cm)	203.4
Temperature (°C)	11.53		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.4	Cross Sectional Area (ft^2)	5.06
Bankfull Width (ft)	7.87	Water Surface Slope (%)	0.45
Mean Bankfull Depth (ft)	0.64	Sinuosity	1.33
Floodprone Width (ft)	95	D50 (mm)	0.35
Entrenchment Ratio	12.08	Adjustments?	Yes, WD -1.0
Width to Depth Ratio	12.23	**Rosgen Stream Type**	**E5**



R2-06-11A Bodkin Creek Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.1266454758 **Longitude:** -76.4921792627

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**752**
Cover	**Acres**	**% Area**
Developed Land	**304.4**	**40.5**
Airport	3	0.4
Commercial	35.7	4.8
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	137.6	18.3
Residential 2-Acre	121.8	16.2
Transportation	6.3	0.8
Utility	0	0
Forest Land	**308.4**	**41**
Forested Wetland	0	0
Residential Woods	0	0
Woods	308.4	41
Open Land	**134.8**	**17.9**
Open Space	131.1	17.4
Open Wetland	0	0
Water	3.7	0.5
Agricultural Land	**4.3**	**0.6**
Pasture/Hay	4.3	0.6
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	89.5	11.9

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Comparable to Reference"* and *"Partially Degraded"*
- Midges, including Parametriocnemus and Rheocricotopus, dominated the sample. Scored high for number of taxa.
- Measured below COMAR standards for pH and conductivity elevated.
- Sub-optimal instream habitat and epibenthic substrate. Abundant rootwads and woody debris also provide stable habitat. Good 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.
- Investigate potential water quality impacts from residential land uses.

R2-06-11A Bodkin Creek Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	28
EPT Taxa	3
Ephemeroptera Taxa	0
%Intolerant Urban	23.1
%Ephemeroptera	0
Scraper Taxa	1
% Climbers	7.7

Calculated Metric Scores

Total Taxa	5
EPT Taxa	3
Ephemeroptera Taxa	1
Intolerant Urban %	3
Ephemeroptera %	1
Scraper Taxa	3
% Climbers	3
BIBI Score	**2.71**
BIBI Narrative Rating	**Poor**

Taxa	Count
Ablabesmyia	1
Amphipoda	6
Anchytarsus	1
Bezzia_Palpomyia	1
Caecidotea	4
Chironominae	1
Chironomini	2
Corynoneura	1
Heterotrissocladius	1
Hydrobaenus	1
Micropsectra	1
Naididae	1
Natarsia	1
Nectopsyche	1
Nigronia	1
Orthocladiinae	1
Parametriocnemus	16
Paratendipes	1
Pisidiidae	9
Pisidium	5
Plecoptera	1
Polycentropus	6
Rheocricotopus	13
Rheotanytarsus	2
Sialis	2
Simuliidae	4
Simulium	3
Stegopterna	10
Synurella	2
Tabanidae	1
Tanytarsus	7
Thienemannimyia_group	4
Tubificidae	2
TOTAL:	**113**

Physical Habitat Assessment

RBP Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	8	Pool Variability	13
Bank Stability- Right Bank	8	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	20	Sediment Deposition	15
Channel Sinuosity	14	Vegetative Protection - Left Bank	8
Epifaunal Substrate/Available Cover	13	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	13		
RBP Habitat Score			**160**
RBP Narrative Rating			**Comparable to Reference**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	13	70.01	Instream Wood Debris	6	64.49
Shading	80	78.67	Instream Habitat	14	90.59
Epifaunal Substrate	13	88.59	Bank Stability	16	89.45
PHI Score					**80.3**
PHI Narrative Rating					**Partially Degraded**

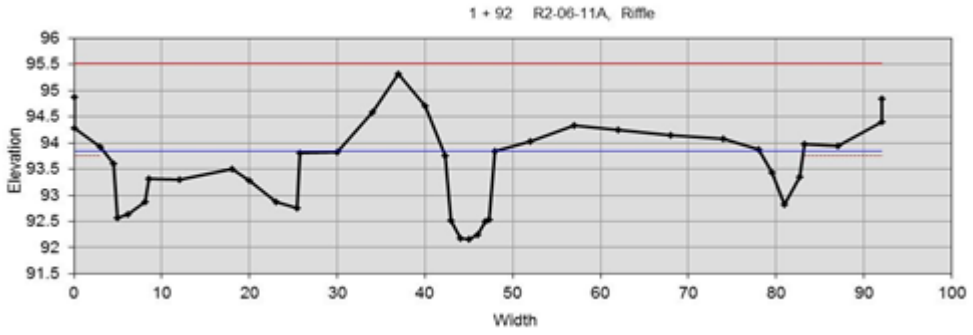
Water Chemistry

Dissolved Oxygen (mg/L)	9.84	pH (SU)	5.64
Turbidity (NTU)	4.29	Specific Conductivity (µS/cm)	263.7
Temperature (°C)	7.97		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	1.17	Cross Sectional Area (ft^2)	22
Bankfull Width (ft)	29.6	Water Surface Slope (%)	0.73
Mean Bankfull Depth (ft)	0.67	Sinuosity	1.26
Floodprone Width (ft)	106	D50 (mm)	0.5
Entrenchment Ratio	3.6	Adjustments?	None
Width to Depth Ratio	39.7	**Rosgen Stream Type**	**DA5**



R2-06-13A Bodkin Creek Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.1283117181 **Longitude:** -76.4984942735

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		382.1
Cover	**Acres**	**% Area**
Developed Land	**192.1**	**50.3**
Airport	0	0
Commercial	23.8	6.2
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	100	26.2
Residential 2-Acre	63	16.5
Transportation	5.2	1.4
Utility	0	0
Forest Land	**101.9**	**26.7**
Forested Wetland	0	0
Residential Woods	0	0
Woods	101.9	26.7
Open Land	**88.1**	**23.1**
Open Space	85.2	22.3
Open Wetland	0	0
Water	2.9	0.8
Agricultural Land	**0**	**0**
Pasture/Hay	0	0
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	55.9	14.6

Summary Results:

- Biological condition – *"Very Poor"*
- Habitat scores *"Supporting"* and *"Degraded"*
- Rheocricotopus (tolerant midge) dominated the sample.
- Measured below COMAR standards for pH.
- Marginal instream habitat and epibenthic substrate with little woody debris. Stable banks and good riparian width.
- Bimodal distribution of substrate (sand/clay).

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.
- Investigate potential water quality impacts from residential land uses.

R2-06-13A Bodkin Creek Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	16
EPT Taxa	1
Ephemeroptera Taxa	0
%Intolerant Urban	0
%Ephemeroptera	0
Scraper Taxa	1
% Climbers	1.9

Calculated Metric Scores

Total Taxa	3
EPT Taxa	1
Ephemeroptera Taxa	1
Intolerant Urban %	1
Ephemeroptera %	1
Scraper Taxa	3
% Climbers	3
BIBI Score	**1.86**
BIBI Narrative Rating	**Very Poor**

Taxa	Count
Cladotanytarsus	1
Crangonyctidae	2
Diplocladius	2
Hydrobaenus	2
Ironoquia	1
Ischnura	1
Libellulidae	1
Limnephilidae	1
Lumbriculidae	1
Naididae	8
Natarsia	1
Neoporus	2
Orthocladiinae	2
Pisidiidae	3
Rheocricotopus	69
Synurella	2
Thienemannimyia_group	1
Tubificidae	5
TOTAL:	**105**

Physical Habitat Assessment

RBP Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	9	Pool Variability	9
Bank Stability- Right Bank	9	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	16	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	19	Sediment Deposition	14
Channel Sinuosity	13	Vegetative Protection - Left Bank	7
Epifaunal Substrate/Available Cover	8	Vegetative Protection - Right Bank	7
Pool Substrate Characterization	11		
RBP Habitat Score			**142**
RBP Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	11	59.24	Instream Wood Debris	2	60.32
Shading	25	26.57	Instream Habitat	8	64.23
Epifaunal Substrate	8	63.95	Bank Stability	18	94.87
PHI Score					**61.53**
PHI Narrative Rating					**Degraded**

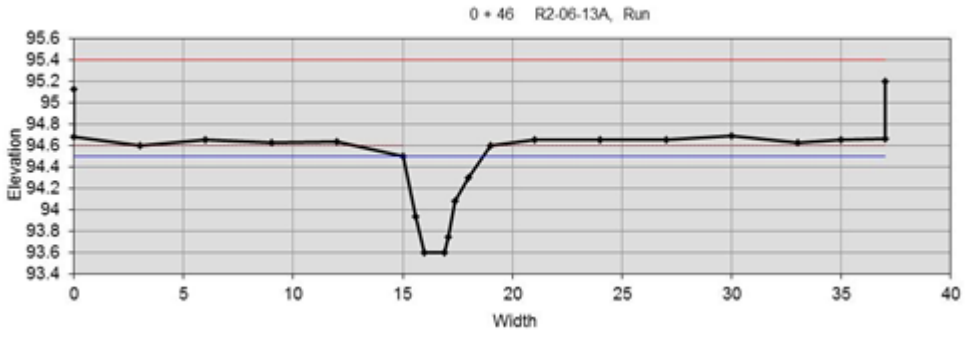
Water Chemistry

Dissolved Oxygen (mg/L)	10.93	pH (SU)	5.61
Turbidity (NTU)	5.32	Specific Conductivity (µS/cm)	158.7
Temperature (°C)	11.47		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.6	Cross Sectional Area (ft^2)	1.87
Bankfull Width (ft)	3.67	Water Surface Slope (%)	0.44
Mean Bankfull Depth (ft)	0.51	Sinuosity	1.33
Floodprone Width (ft)	94	D50 (mm)	0.15
Entrenchment Ratio	25.64	Adjustments?	None
Width to Depth Ratio	7.19	**Rosgen Stream Type**	**E5/6**



R2-06-14A Bodkin Creek Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.1152178816 **Longitude:** -76.4907785777

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**123.1**
Cover	**Acres**	**% Area**
Developed Land	**79.4**	**64.5**
Airport	2.2	1.8
Commercial	0	0
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	2.8	2.3
Residential 1-Acre	48.2	39.2
Residential 2-Acre	23.4	19
Transportation	2.7	2.2
Utility	0	0
Forest Land	**43.7**	**35.5**
Forested Wetland	0	0
Residential Woods	0	0
Woods	43.7	35.5
Open Land	**0**	**0**
Open Space	0	0
Open Wetland	0	0
Water	0	0
Agricultural Land	**0**	**0**
Pasture/Hay	0	0
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	17.7	14.3

Summary Results:

- Biological condition – *"Very Poor"*
- Habitat scores *"Partially Supporting"* and *"Degraded"*
- Beetles (Agabus and Neoporus), midges (Chironomus), and worms (Tubificidae) dominated the sample.
- Measured below COMAR standards for both pH and dissolved oxygen.
- Poor habitat diversity with minimal woody debris. Good bank stability but because a golf course is along the left bank of the reach, riparian width is marginal.
- Located in functional wetland ponded by backwater and with virtually no visible flow. Stream type indeterminate.

Recommendations:

- Buffer enhancement.
- Because habitat is partially supporting and biological condition is very poor, look for problems with water quality and correct, if possible.
- Investigate potential water quality impacts from residential land uses.

R2-06-14A Bodkin Creek Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	19
EPT Taxa	0
Ephemeroptera Taxa	0
%Intolerant Urban	1.8
%Ephemeroptera	0
Scraper Taxa	0
% Climbers	2.6

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
Agabus	6
Bezzia_Palpomyia	1
Boyeria	1
Chaetocladius	1
Chironomini	11
Chironomus	17
Chrysops	2
Cricotopus	1
Culicoides	3
Dytiscidae	11
Libellulidae	1
Naididae	1
Natarsia	2
Neoporus	10
Orthocladiinae	1
Phaenopsectra	1
Pisidiidae	7
Pisidium	9
Polypedilum	1
Rheocricotopus	5
Tanytarsus	1
Tubificidae	18
TOTAL:	**111**

Physical Habitat Assessment

RBP Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	9	Pool Variability	5
Bank Stability- Right Bank	9	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	13	Riparian Vegetative Zone Width- Right Bank	5
Channel Flow Status	14	Sediment Deposition	8
Channel Sinuosity	5	Vegetative Protection - Left Bank	9
Epifaunal Substrate/Available Cover	3	Vegetative Protection - Right Bank	6
Pool Substrate Characterization	9		
RBP Habitat Score			**105**
RBP Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	5	26.93	Instream Wood Debris	1	70.18
Shading	75	73.32	Instream Habitat	3	48.08
Epifaunal Substrate	3	42.29	Bank Stability	18	94.87
PHI Score					**59.28**
PHI Narrative Rating					**Degraded**

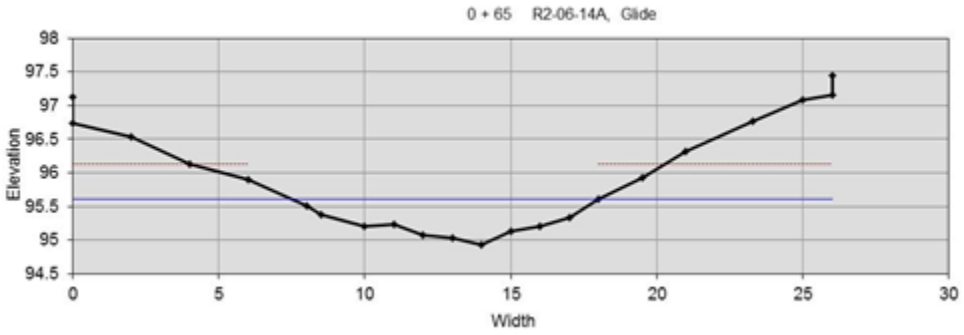
Water Chemistry

Dissolved Oxygen (mg/L)	3.27	pH (SU)	5.77
Turbidity (NTU)	18.8	Specific Conductivity (µS/cm)	157.8
Temperature (°C)	11.63		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.19	Cross Sectional Area (ft^2)	---
Bankfull Width (ft)	---	Water Surface Slope (%)	0.02
Mean Bankfull Depth (ft)	---	Sinuosity	1.03
Floodprone Width (ft)	---	D50 (mm)	0.062
Entrenchment Ratio	---	Adjustments?	None
Width to Depth Ratio	---	**Rosgen Stream Type**	**ND**



R2-06-16A Bodkin Creek Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.1276966526 **Longitude:** -76.4978092954

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**391.2**
Cover	**Acres**	**% Area**
Developed Land	**193.6**	**49.5**
Airport	0	0
Commercial	25.3	6.5
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	100	25.6
Residential 2-Acre	63	16.1
Transportation	5.2	1.3
Utility	0	0
Forest Land	**105.6**	**27**
Forested Wetland	0	0
Residential Woods	0	0
Woods	105.6	27
Open Land	**92.1**	**23.5**
Open Space	89.2	22.8
Open Wetland	0	0
Water	2.9	0.7
Agricultural Land	**0**	**0**
Pasture/Hay	0	0
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	57.3	14.7

Summary Results:

- Biological condition – *"Very Poor"*
- Habitat scores *"Supporting"* and *"Degraded"*
- Rheocricotopus (midge) and Simulium (black fly) dominated the sample.
- Measured below COMAR standards for pH.
- Marginal habitat diversity. Stable, well-vegetated banks with good riparian width. Refuse abundant and unsightly.

Recommendations:

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

R2-06-16A Bodkin Creek Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	15
EPT Taxa	1
Ephemeroptera Taxa	0
%Intolerant Urban	0.9
%Ephemeroptera	0
Scraper Taxa	0
% Climbers	0.9

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
Aedes	2
Chaetocladius	2
Chironomini	2
Chironomus	2
Culicoides	2
Dasyhelea	1
Ironoquia	1
Neoporus	2
Orthocladiinae	5
Phaenopsectra	1
Pisidiidae	1
Polypedilum	1
Rheocricotopus	61
Simulium	23
Stegopterna	1
Tubificidae	1
TOTAL:	**108**

Physical Habitat Assessment

RBP Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	9	Pool Variability	8
Bank Stability- Right Bank	9	Riparian Vegetative Zone Width- Left Bank	9
Channel Alteration	16	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	15	Sediment Deposition	10
Channel Sinuosity	12	Vegetative Protection - Left Bank	9
Epifaunal Substrate/Available Cover	8	Vegetative Protection - Right Bank	9
Pool Substrate Characterization	9		
RBP Habitat Score			**133**
RBP Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	6	32.31	Instream Wood Debris	2	60.05
Shading	85	84.56	Instream Habitat	7	58.44
Epifaunal Substrate	8	63.8	Bank Stability	18	94.87
PHI Score					**65.67**
PHI Narrative Rating					**Degraded**

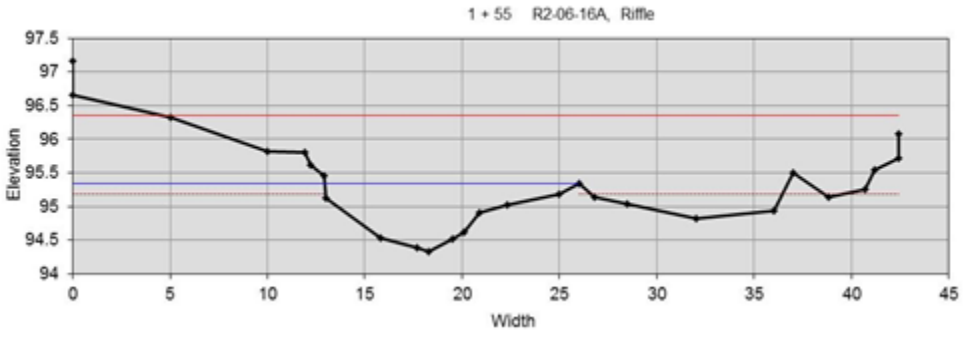
Water Chemistry

Dissolved Oxygen (mg/L)	12.72	pH (SU)	6.24
Turbidity (NTU)	11.6	Specific Conductivity (µS/cm)	181.3
Temperature (°C)	19.13		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.61	Cross Sectional Area (ft^2)	6.98
Bankfull Width (ft)	13.07	Water Surface Slope (%)	0.36
Mean Bankfull Depth (ft)	0.53	Sinuosity	1.19
Floodprone Width (ft)	62	D50 (mm)	0.14
Entrenchment Ratio	4.75	Adjustments?	None
Width to Depth Ratio	24.46	**Rosgen Stream Type**	**C5**



R2-06-19A Bodkin Creek Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.1264945901 **Longitude:** -76.4945496968

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**699.5**
Cover	**Acres**	**% Area**
Developed Land	**304.4**	**43.5**
Airport	3	0.4
Commercial	35.7	5.1
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	137.6	19.7
Residential 2-Acre	121.8	17.4
Transportation	6.3	0.9
Utility	0	0
Forest Land	**265.9**	**38**
Forested Wetland	0	0
Residential Woods	0	0
Woods	265.9	38
Open Land	**127.5**	**18.2**
Open Space	123.8	17.7
Open Wetland	0	0
Water	3.7	0.5
Agricultural Land	**1.7**	**0.2**
Pasture/Hay	1.7	0.2
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	89.2	12.8

Summary Results:

- Biological condition – *"Very Poor"*
- Habitat scores *"Supporting"* and *"Degraded"*
- Rheocricotopus (midge) and Simulium (black fly) dominated the sample.
- Measured below COMAR standards for pH and conductivity elevated.
- Marginal habitat diversity. Because a golf course is along the right bank of the reach, riparian width is marginal. Refuse present in minor amounts.

Recommendations:

- Buffer enhancement.
- Because habitat is supporting and biological condition is very poor, look for problems with water quality and correct, if possible.

R2-06-19A Bodkin Creek Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	6
EPT Taxa	0
Ephemeroptera Taxa	0
%Intolerant Urban	0.9
%Ephemeroptera	0
Scraper Taxa	1
% Climbers	0.9

Calculated Metric Scores

Total Taxa	1
EPT Taxa	1
Ephemeroptera Taxa	1
Intolerant Urban %	1
Ephemeroptera %	1
Scraper Taxa	3
% Climbers	1
BIBI Score	**1.29**
BIBI Narrative Rating	**Very Poor**

Taxa	Count
Gastropoda	1
Parametriocnemus	1
Phaenopsectra	1
Rheocricotopus	20
Simuliidae	1
Simulium	89
Stegopterna	1
TOTAL:	**114**

Physical Habitat Assessment

RBP Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	7	Pool Variability	11
Bank Stability- Right Bank	8	Riparian Vegetative Zone Width- Left Bank	6
Channel Alteration	19	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	19	Sediment Deposition	13
Channel Sinuosity	13	Vegetative Protection - Left Bank	7
Epifaunal Substrate/Available Cover	8	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	8		
RBP Habitat Score			**137**
RBP Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	7	37.7	Instream Wood Debris	2	53.47
Shading	60	58.94	Instream Habitat	8	58.04
Epifaunal Substrate	8	60.01	Bank Stability	15	86.61
PHI Score					**59.13**
PHI Narrative Rating					**Degraded**

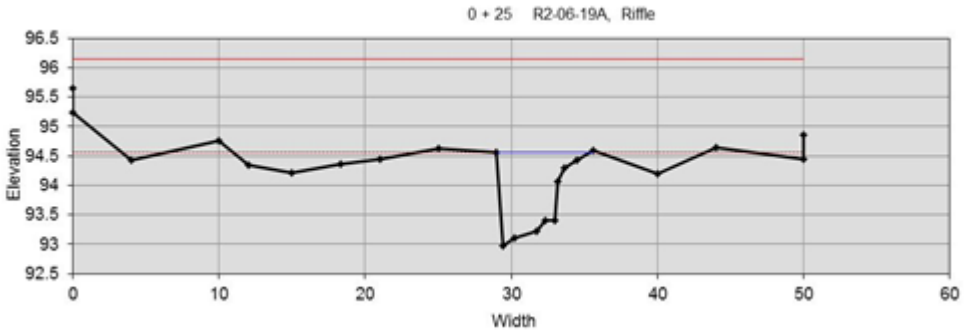
Water Chemistry

Dissolved Oxygen (mg/L)	9.89	pH (SU)	5.97
Turbidity (NTU)	7.11	Specific Conductivity (µS/cm)	336.9
Temperature (°C)	12.93		

Geomorphic Assessment

Rosgen Level II Classification Data

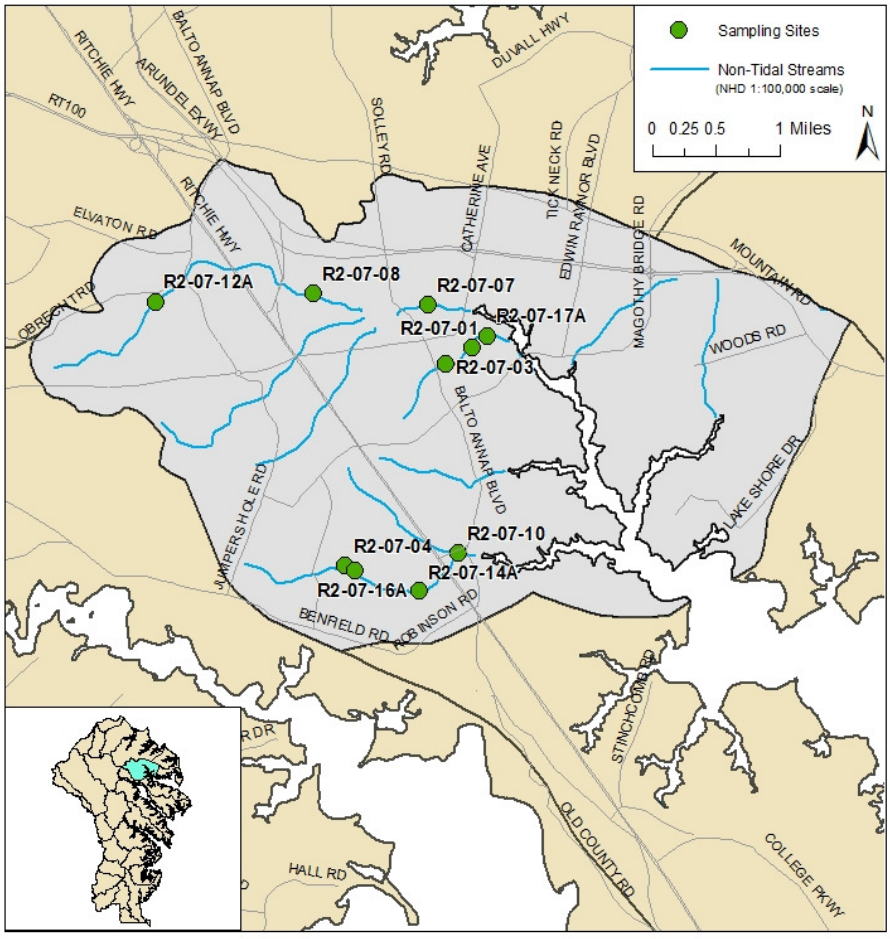
Drainage Area (mi^2)	1.09	Cross Sectional Area (ft^2)	5.73
Bankfull Width (ft)	6.39	Water Surface Slope (%)	0.74
Mean Bankfull Depth (ft)	0.9	Sinuosity	1.2
Floodprone Width (ft)	145	D50 (mm)	0.4
Entrenchment Ratio	22.68	Adjustments?	None
Width to Depth Ratio	7.13	**Rosgen Stream Type**	**E5**



Upper Magothy Sampling Unit

Site Condition Summary

Site	Drainage Area (acres)	Drainage Area (mi^2)	Percent Impervious	Percent Developed	Percent Forested	Percent Agriculture	Percent Open	BIBI Narrative Rating	PHI Narrative Rating	RBP Narrative Rating	Rosgen Stream Type - L1
R2-07-01	247.64	0.39	12.8	57.0	37.5	0.0	5.5	Fair	Minimally Degraded	Comparable to Reference	E
R2-07-03	201.53	0.31	12.6	57.0	36.5	0.0	6.5	Fair	Partially Degraded	Supporting	C
R2-07-04	495.35	0.77	32.1	77.4	17.8	0.0	4.9	Very Poor	Partially Degraded	Supporting	E
R2-07-07	2995.5	4.68	19.8	55.5	37.5	0.5	6.4	Poor	Partially Degraded	Supporting	C
R2-07-08	1436.35	2.24	21.2	58.4	37.3	1.1	3.1	Fair	Partially Degraded	Comparable to Reference	C
R2-07-10	395.43	0.62	19.7	62.9	35.8	0.0	1.3	Poor	Partially Degraded	Supporting	DA
R2-07-12A	538.71	0.84	19.7	66.4	27.6	0.0	6.0	Fair	Partially Degraded	Supporting	E
R2-07-14A	819.35	1.28	26.7	71.4	24.2	0.0	4.4	Fair	Degraded	Supporting	E
R2-07-16A	564.5	0.88	29.9	74.7	20.6	0.0	4.8	Fair	Partially Degraded	Partially Supporting	E
R2-07-17A	269.59	0.42	13.3	58.6	36.4	0.0	5.0	Fair	Partially Degraded	Supporting	C



R2-07-01 Upper Magothy Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.1103415191 **Longitude:** -76.5488940394

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**247.6**
Cover	**Acres**	**% Area**
Developed Land	**141**	**57**
Airport	0	0
Commercial	5.9	2.4
Industrial	0.1	0
Residential 1/8-acre	0.7	0.3
Residential 1/4-acre	0	0
Residential 1/2-acre	30.7	12.4
Residential 1-Acre	69.7	28.1
Residential 2-Acre	29.7	12
Transportation	4.4	1.8
Utility	0	0
Forest Land	**93**	**37.5**
Forested Wetland	0	0
Residential Woods	0	0
Woods	93	37.5
Open Land	**13.6**	**5.5**
Open Space	13.6	5.5
Open Wetland	0	0
Water	0	0
Agricultural Land	**0**	**0**
Pasture/Hay	0	0
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	31.8	12.8

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Comparable to Reference"* and *"Minimally Degraded"*
- Sample dominated by midges, caddisflies, and black flies. Scored high for number of taxa, EPT, scraper taxa, and percent climbers.
- Measured below COMAR standards for pH.
- Sub-optimal instream habitat and epibenthic substrate. Rootwads and woody debris also provide stable habitat. Good riparian width and vegetative protection.

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.
- Investigate potential water quality impacts from residential land uses.

R2-07-01 Upper Magothy Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	36
EPT Taxa	5
Ephemeroptera Taxa	0
%Intolerant Urban	17.2
%Ephemeroptera	0
Scraper Taxa	4
% Climbers	12.1

Calculated Metric Scores

Total Taxa	5
EPT Taxa	5
Ephemeroptera Taxa	1
Intolerant Urban %	3
Ephemeroptera %	1
Scraper Taxa	5
% Climbers	5
BIBI Score	**3.57**
BIBI Narrative Rating	**Fair**

Taxa	Count
Amphinemura	1
Anchytarsus	2
Boyeria	2
Brillia	1
Caecidotea	2
Calopteryx	2
Chironomidae	1
Chironomini	2
Chrysomelidae	1
Cordulegaster	1
Corynoneura	1
Diplectrona	12
Elodes	1
Enchytraeidae	1
Helichus	2
Heteroplectron	2
Lype	4
Naididae	2
Nigronia	2
Orthocladiinae	2
Orthocladius	2
Parametriocnemus	1
Paraphaenocladius	1
Phaenopsectra	4
Physa	4
Pisidiidae	1
Polypedilum	5
Prodiamesa	4
Pseudorthocladius	1
Pycnopsyche	1
Simulium	20
Stenelmis	1
Stenochironomus	1
Synurella	4
Thienemannimyia_group	11
Tipulidae	1
Trichoptera	2
Tubificidae	2
Tvetenia	1
TOTAL:	**111**

Physical Habitat Assessment

RBP Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	9	Pool Variability	11
Bank Stability- Right Bank	9	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	16	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	20	Sediment Deposition	13
Channel Sinuosity	13	Vegetative Protection - Left Bank	9
Epifaunal Substrate/Available Cover	11	Vegetative Protection - Right Bank	9
Pool Substrate Characterization	11		
RBP Habitat Score			**151**
RBP Narrative Rating			**Comparable to Reference**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	10	53.85	Instream Wood Debris	10	88.89
Shading	85	84.56	Instream Habitat	12	90.86
Epifaunal Substrate	13	95.83	Bank Stability	18	94.87
PHI Score					**84.81**
PHI Narrative Rating					**Minimally Degraded**

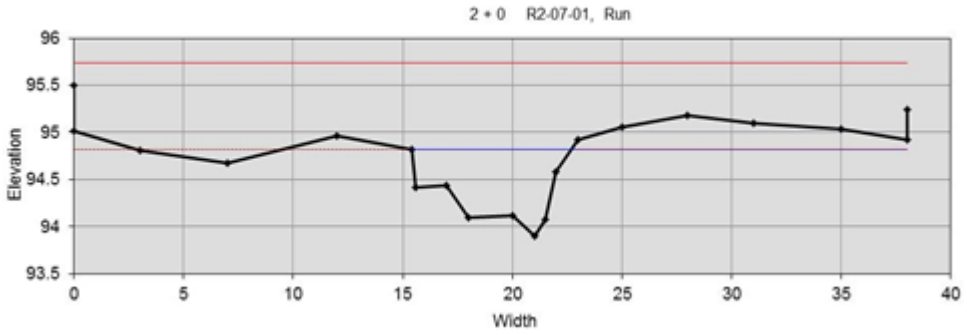
Water Chemistry

Dissolved Oxygen (mg/L)	11.84	pH (SU)	5.59
Turbidity (NTU)	9.03	Specific Conductivity (µS/cm)	136.7
Temperature (°C)	40.9		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.39	Cross Sectional Area (ft^2)	4.11
Bankfull Width (ft)	7.31	Water Surface Slope (%)	2.4
Mean Bankfull Depth (ft)	0.56	Sinuosity	1.2
Floodprone Width (ft)	50	D50 (mm)	0.28
Entrenchment Ratio	6.84	Adjustments?	Yes, WD -1.0
Width to Depth Ratio	12.98	**Rosgen Stream Type**	**E5b**



R2-07-03 Upper Magothy Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.1085183918 **Longitude:** -76.5526256802

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**201.5**
Cover	**Acres**	**% Area**
Developed Land	**114.7**	**57**
Airport	0	0
Commercial	5.3	2.6
Industrial	0.1	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	8.3	4.1
Residential 1-Acre	69.7	34.6
Residential 2-Acre	27.4	13.6
Transportation	4.1	2
Utility	0	0
Forest Land	**73.7**	**36.5**
Forested Wetland	0	0
Residential Woods	0	0
Woods	73.7	36.5
Open Land	**13.1**	**6.5**
Open Space	13.1	6.5
Open Wetland	0	0
Water	0	0
Agricultural Land	**0**	**0**
Pasture/Hay	0	0
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	25.3	12.6

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Supporting"* and *"Partially Degraded"*
- Sample dominated by isopods (intolerant Caecidotea) and midges (Thienemannimyia group and Zavrelimyia). Scored high for number of taxa and scraper taxa.
- Measured below COMAR standards for pH.
- Marginal habitat diversity and moderately stable banks. Poor riparian width along the right bank.

Recommendations:

- Buffer enhancement.
- Investigate potential water quality impacts from residential land uses.

R2-07-03 Upper Magothy Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	25
EPT Taxa	3
Ephemeroptera Taxa	0
%Intolerant Urban	19.2
%Ephemeroptera	0
Scraper Taxa	2
% Climbers	4

Calculated Metric Scores

Total Taxa	5
EPT Taxa	3
Ephemeroptera Taxa	1
Intolerant Urban %	3
Ephemeroptera %	1
Scraper Taxa	5
% Climbers	3
BIBI Score	**3**
BIBI Narrative Rating	**Fair**

Taxa	Count
Bittacomorpha	1
Brachycera	1
Caecidotea	15
Calopteryx	1
Diplectrona	1
Enchytraeidae	6
Gammarus	1
Hydroporinae	1
Limnophyes	2
Limonia	1
Lumbricina	1
Lumbriculidae	1
Lype	2
Musculium	2
Orthocladiinae	3
Paraphaenocladius	5
Phaenopsectra	9
Physa	3
Pisidiidae	1
Polycentropus	2
Prodiamesa	3
Pseudolimnophila	1
Smittia	1
Synurella	8
Thienemannimyia_group	14
Trichoptera	1
TOTAL:	**87**

Physical Habitat Assessment

RBP Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	7	Pool Variability	11
Bank Stability- Right Bank	8	Riparian Vegetative Zone Width- Left Bank	5
Channel Alteration	16	Riparian Vegetative Zone Width- Right Bank	9
Channel Flow Status	20	Sediment Deposition	14
Channel Sinuosity	12	Vegetative Protection - Left Bank	6
Epifaunal Substrate/Available Cover	9	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	10		
RBP Habitat Score			**135**
RBP Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	7	37.7	Instream Wood Debris	5	76.43
Shading	65	63.55	Instream Habitat	7	65.23
Epifaunal Substrate	10	79.74	Bank Stability	15	86.61
PHI Score					**68.21**
PHI Narrative Rating					**Partially Degraded**

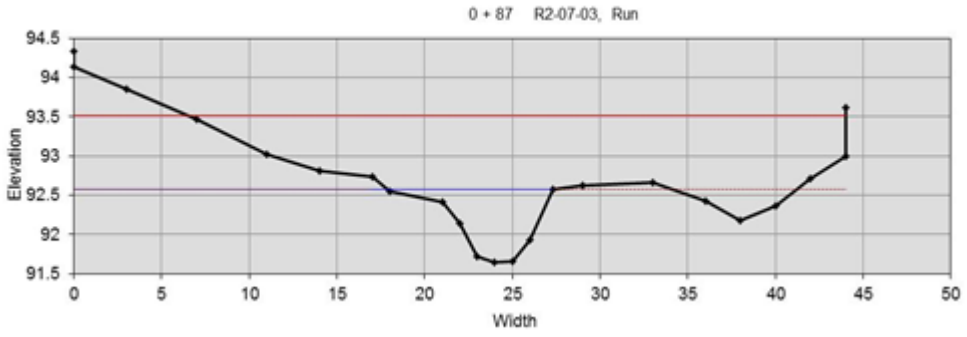
Water Chemistry

Dissolved Oxygen (mg/L)	9.66	pH (SU)	5.71
Turbidity (NTU)	9.26	Specific Conductivity (µS/cm)	153
Temperature (°C)	22.2		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.31	Cross Sectional Area (ft^2)	4.28
Bankfull Width (ft)	9.46	Water Surface Slope (%)	0.66
Mean Bankfull Depth (ft)	0.45	Sinuosity	1.24
Floodprone Width (ft)	40	D50 (mm)	0.15
Entrenchment Ratio	4.23	Adjustments?	None
Width to Depth Ratio	20.88	**Rosgen Stream Type**	**C5**



R2-07-04 Upper Magothy Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.0855739147 **Longitude:** -76.5675690813

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		495.4
Cover	**Acres**	**% Area**
Developed Land	**382.8**	**77.4**
Airport	0	0
Commercial	36.7	7.4
Industrial	0.6	0.1
Residential 1/8-acre	17	3.4
Residential 1/4-acre	232.4	46.9
Residential 1/2-acre	54.8	11.1
Residential 1-Acre	22.3	4.5
Residential 2-Acre	3.3	0.7
Transportation	16.3	3.3
Utility	0	0
Forest Land	**88**	**17.8**
Forested Wetland	0	0
Residential Woods	24	4.8
Woods	64	12.9
Open Land	**24**	**4.9**
Open Space	24	4.9
Open Wetland	0	0
Water	0	0
Agricultural Land	**0**	**0**
Pasture/Hay	0	0
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	159.1	32.1

Summary Results:

- Biological condition – *"Very Poor"*
- Habitat scores *"Supporting"* and *"Partially Degraded"*
- Worms (Lumbriculidae and Tubificidae) dominated the sample.
- Water quality values within COMAR standards but conductivity elevated.
- Marginal to sub-optimal habitat diversity with moderately unstable banks. Refuse present in moderate amounts. Good riparian width and vegetative protection.
- 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.
- Consider trash cleanup for this reach.
- Because habitat is supporting and biological condition is very poor, look for problems with water quality and correct, if possible.

R2-07-04 Upper Magothy Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	20
EPT Taxa	0
Ephemeroptera Taxa	0
%Intolerant Urban	1.8
%Ephemeroptera	0
Scraper Taxa	1
% Climbers	2.8

Calculated Metric Scores

Total Taxa	3
EPT Taxa	1
Ephemeroptera Taxa	1
Intolerant Urban %	1
Ephemeroptera %	1
Scraper Taxa	3
% Climbers	3
BIBI Score	**1.86**
BIBI Narrative Rating	**Very Poor**

Taxa	Count
Caecidotea	1
Calopteryx	1
Chironomini	1
Dicrotendipes	18
Enchytraeidae	6
Georthocladius	1
Limonia	1
Lumbricina	1
Lumbriculidae	35
Musculium	1
Naididae	1
Natarsia	3
Neoporus	1
Paraphaenocladius	1
Physa	1
Pisidiidae	1
Pisidium	1
Polypedilum	1
Pseudorthocladius	1
Somatochlora	1
Stenochironomus	2
Tubificidae	29
TOTAL:	**109**

Physical Habitat Assessment

RBP Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	5	Pool Variability	10
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	16	Sediment Deposition	12
Channel Sinuosity	11	Vegetative Protection - Left Bank	7
Epifaunal Substrate/Available Cover	10	Vegetative Protection - Right Bank	7
Pool Substrate Characterization	13		
RBP Habitat Score			**131**
RBP Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	10	53.85	Instream Wood Debris	7	72.17
Shading	75	73.32	Instream Habitat	9	67.12
Epifaunal Substrate	11	79.69	Bank Stability	10	70.71
PHI Score					**69.48**
PHI Narrative Rating					**Partially Degraded**

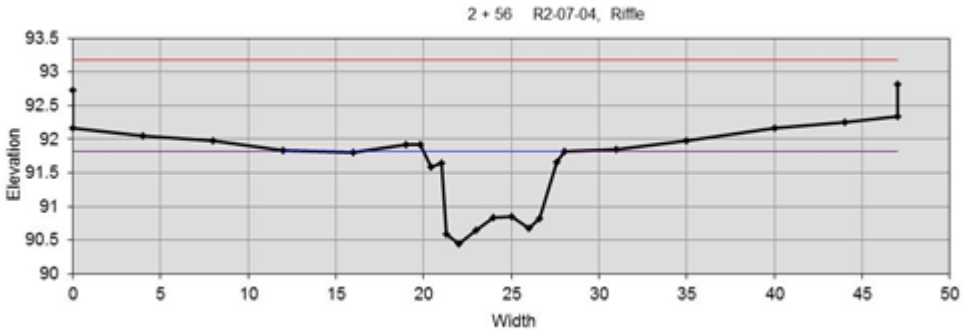
Water Chemistry

Dissolved Oxygen (mg/L)	6.27	pH (SU)	6.53
Turbidity (NTU)	9.27	Specific Conductivity (µS/cm)	306.2
Temperature (°C)	5.58		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.77	Cross Sectional Area (ft^2)	6.88
Bankfull Width (ft)	9.58	Water Surface Slope (%)	0.81
Mean Bankfull Depth (ft)	0.72	Sinuosity	1.16
Floodprone Width (ft)	100	D50 (mm)	0.38
Entrenchment Ratio	10.43	Adjustments?	Yes, WD -1.5
Width to Depth Ratio	13.35	**Rosgen Stream Type**	**E5/4**



R2-07-07 Upper Magothy Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.1152967925 **Longitude:** -76.5553077334

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**2995.5**
Cover	**Acres**	**% Area**
Developed Land	**1656.1**	**55.5**
Airport	0	0
Commercial	215.9	7.2
Industrial	6.7	0.2
Residential 1/8-acre	83.7	2.8
Residential 1/4-acre	90.2	3
Residential 1/2-acre	467.3	15.6
Residential 1-Acre	362.6	12.1
Residential 2-Acre	270.7	9
Transportation	165.7	5.5
Utility	0	0
Forest Land	**1124.3**	**37.5**
Forested Wetland	0.6	0
Residential Woods	0	0
Woods	1123.7	37.5
Open Land	**192.4**	**6.4**
Open Space	168.8	5.6
Open Wetland	4.4	0.1
Water	19.2	0.6
Agricultural Land	**16**	**0.5**
Pasture/Hay	0	0
Row Crops	16	0.5
Impervious Surface	**Acres**	**% Area**
Impervious Land	594.1	19.8

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Supporting"* and *"Partially Degraded"*
- Caddisflies (Cheumatopsyche and Ceratopsyche), amphipods (Crangonyx), and midges dominated the sample. Scored high for number of taxa and scraper taxa.
- Water quality values within COMAR standards but conductivity elevated.
- Abundant rootwads and woody debris providing stable habitat. Moderately stable, well-vegetated banks with 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.
- Because habitat is supporting and biological condition is poor, look for problems with water quality and correct, if possible.

R2-07-07 Upper Magothy Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	26
EPT Taxa	3
Ephemeroptera Taxa	0
%Intolerant Urban	5.6
%Ephemeroptera	0
Scraper Taxa	3
% Climbers	7.4

Calculated Metric Scores

Total Taxa	5
EPT Taxa	3
Ephemeroptera Taxa	1
Intolerant Urban %	1
Ephemeroptera %	1
Scraper Taxa	5
% Climbers	3
BIBI Score	**2.71**
BIBI Narrative Rating	**Poor**

Taxa	Count
Argia	1
Caecidotea	5
Calopteryx	1
Ceratopsyche	5
Cheumatopsyche	18
Crangonyx	12
Cricotopus	2
Hyalella	1
Lepidoptera	1
Lumbricina	1
Macronychus	3
Microcylloepus	9
Oecetis	3
Orthocladiinae	2
Orthocladius	2
Oulimnius	1
Parametriocnemus	4
Pisidiidae	1
Polypedilum	6
Rheotanytarsus	8
Simulium	3
Stenelmis	7
Synurella	1
Tanytarsini	1
Tanytarsus	1
Thienemanniella	5
Thienemannimyia_group	3
Tubificidae	1
TOTAL:	**108**

Physical Habitat Assessment

RBP Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	5	Pool Variability	11
Bank Stability- Right Bank	7	Riparian Vegetative Zone Width- Left Bank	9
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	19	Sediment Deposition	9
Channel Sinuosity	10	Vegetative Protection - Left Bank	7
Epifaunal Substrate/Available Cover	13	Vegetative Protection - Right Bank	7
Pool Substrate Characterization	13		
RBP Habitat Score			**140**
RBP Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	11	59.24	Instream Wood Debris	15	75.46
Shading	65	63.55	Instream Habitat	14	76.44
Epifaunal Substrate	13	79.59	Bank Stability	12	77.46
PHI Score					**71.96**
PHI Narrative Rating					**Partially Degraded**

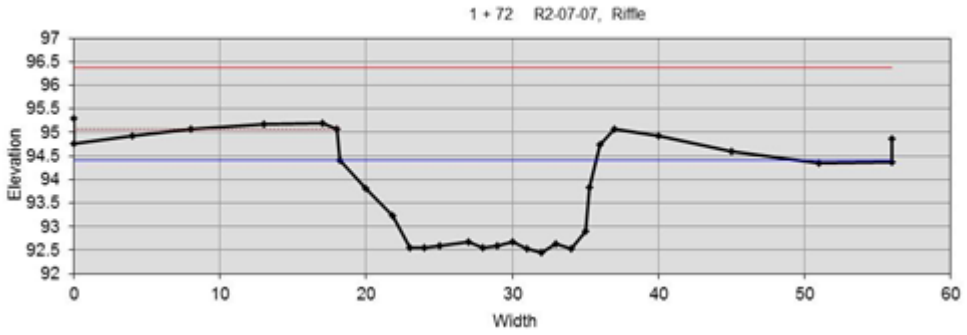
Water Chemistry

Dissolved Oxygen (mg/L)	9.43	pH (SU)	6.83
Turbidity (NTU)	8.97	Specific Conductivity (µS/cm)	323.7
Temperature (°C)	6.86		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	4.68	Cross Sectional Area (ft^2)	26.51
Bankfull Width (ft)	24.23	Water Surface Slope (%)	0.54
Mean Bankfull Depth (ft)	1.09	Sinuosity	1.17
Floodprone Width (ft)	91	D50 (mm)	1.3
Entrenchment Ratio	3.76	Adjustments?	None
Width to Depth Ratio	22.14	**Rosgen Stream Type**	**C5/4**



R2-07-08 Upper Magothy Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.1165842683 **Longitude:** -76.5720496068

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**1436.4**
Cover	**Acres**	**% Area**
Developed Land	**832.6**	**58.4**
Airport	0	0
Commercial	116.2	8.1
Industrial	6.5	0.5
Residential 1/8-acre	0	0
Residential 1/4-acre	78.1	5.4
Residential 1/2-acre	200.1	13.9
Residential 1-Acre	148.4	10.3
Residential 2-Acre	211.3	14.7
Transportation	78.5	5.5
Utility	0	0
Forest Land	**536.1**	**37.3**
Forested Wetland	0	0
Residential Woods	0	0
Woods	536.1	37.3
Open Land	**45.2**	**3.1**
Open Space	41.6	2.9
Open Wetland	0	0
Water	3.5	0.2
Agricultural Land	**16**	**1.1**
Pasture/Hay	0	0
Row Crops	16	1.1
Impervious Surface	**Acres**	**% Area**
Impervious Land	303.9	21.2

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Comparable to Reference"* and *"Partially Degraded"*
- Rheotanytarsus (midge) and Macronychus (beetle) dominated the sample. Scored high for number of taxa, EPT, and scraper taxa.
- Water quality values within COMAR standards but conductivity elevated.
- Sub-optimal instream habitat and epibenthic substrate. Rootwads and woody debris provide adequate stable habitat. Stable, well-vegetated banks and good 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.
- Investigate potential water quality impacts from residential land uses.

R2-07-08 Upper Magothy Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	26
EPT Taxa	5
Ephemeroptera Taxa	0
%Intolerant Urban	8
%Ephemeroptera	0
Scraper Taxa	5
% Climbers	2.7

Calculated Metric Scores

Total Taxa	5
EPT Taxa	5
Ephemeroptera Taxa	1
Intolerant Urban %	1
Ephemeroptera %	1
Scraper Taxa	5
% Climbers	3
BIBI Score	**3**
BIBI Narrative Rating	**Fair**

Taxa	Count
Amphipoda	2
Ancyronyx	5
Brachycentrus	2
Caecidotea	1
Chimarra	2
Chironomini	1
Corynoneura	2
Diplectrona	6
Dubiraphia	1
Enchytraeidae	1
Hyalella	6
Leptoceridae	1
Lype	4
Macronychus	16
Orthocladiinae	1
Orthocladius	1
Parametriocnemus	7
Paraphaenocladius	1
Phaenopsectra	2
Polypedilum	1
Rheotanytarsus	22
Simulium	6
Stenelmis	10
Synurella	4
Tanytarsini	1
Tanytarsus	2
Thienemannimyia_group	1
Tubificidae	1
Tvetenia	1
Xylotopus	1
TOTAL:	**112**

Physical Habitat Assessment

RBP Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	9	Pool Variability	15
Bank Stability- Right Bank	9	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	8
Channel Flow Status	20	Sediment Deposition	16
Channel Sinuosity	13	Vegetative Protection - Left Bank	10
Epifaunal Substrate/Available Cover	13	Vegetative Protection - Right Bank	10
Pool Substrate Characterization	14		
RBP Habitat Score			**167**
RBP Narrative Rating			**Comparable to Reference**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	13	70.01	Instream Wood Debris	9	66.03
Shading	45	45.47	Instream Habitat	13	78.42
Epifaunal Substrate	12	78.56	Bank Stability	18	94.87
PHI Score					**72.23**
PHI Narrative Rating					**Partially Degraded**

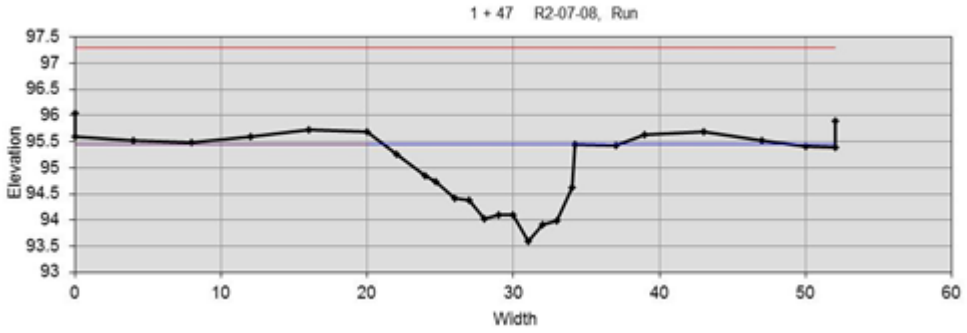
Water Chemistry

Dissolved Oxygen (mg/L)	10.66	pH (SU)	6.72
Turbidity (NTU)	12.83	Specific Conductivity (µS/cm)	324.5
Temperature (°C)	4.88		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	2.24	Cross Sectional Area (ft^2)	13.6
Bankfull Width (ft)	19.04	Water Surface Slope (%)	0.11
Mean Bankfull Depth (ft)	0.71	Sinuosity	1.09
Floodprone Width (ft)	130	D50 (mm)	0.35
Entrenchment Ratio	6.83	Adjustments?	None
Width to Depth Ratio	26.65	**Rosgen Stream Type**	**C5**



R2-07-10 Upper Magothy Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.087021285 **Longitude:** -76.5510484724

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**395.4**
Cover	**Acres**	**% Area**
Developed Land	**247.8**	**62.9**
Airport	0	0
Commercial	15.4	3.9
Industrial	0.9	0.2
Residential 1/8-acre	0	0
Residential 1/4-acre	27.3	6.9
Residential 1/2-acre	51.6	13
Residential 1-Acre	121.2	30.7
Residential 2-Acre	10.1	2.6
Transportation	22.1	5.6
Utility	0	0
Forest Land	**141.6**	**35.8**
Forested Wetland	0	0
Residential Woods	0	0
Woods	141.6	35.8
Open Land	**5.2**	**1.3**
Open Space	5.2	1.3
Open Wetland	0	0
Water	0	0
Agricultural Land	**0**	**0**
Pasture/Hay	0	0
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	77.8	19.7

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Supporting"* and *"Partially Degraded"*
- Sample dominated by snails (Amnicola). Scored high for percent climbers.
- Water quality values within COMAR standards but conductivity elevated.
- Sub-optimal epibenthic substrate and small hummock rootwads and wood provide stable habitat for benthos. Stable, well-vegetated banks. Refuse present in moderate amounts.

Recommendations:

- Buffer enhancement.
- Consider trash cleanup for this reach.
- Because habitat is supporting and biological condition is poor, look for problems with water quality and correct, if possible.
- Investigate potential water quality impacts from residential land uses.

R2-07-10 Upper Magothy Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	18
EPT Taxa	1
Ephemeroptera Taxa	0
%Intolerant Urban	8.7
%Ephemeroptera	0
Scraper Taxa	1
% Climbers	49.5

Calculated Metric Scores

Total Taxa	3
EPT Taxa	1
Ephemeroptera Taxa	1
Intolerant Urban %	1
Ephemeroptera %	1
Scraper Taxa	3
% Climbers	5
BIBI Score	**2.14**
BIBI Narrative Rating	**Poor**

Taxa	Count
Amnicola	47
Caecidotea	9
Chimarra	1
Clinotanypus	1
Crangonyx	10
Gammarus	1
Odontomesa	1
Parametriocnemus	10
Paratanytarsus	1
Pericoma	1
Pisidiidae	8
Polypedilum	2
Rheotanytarsus	5
Simulium	1
Stenochironomus	1
Tanytarsus	2
Thienemanniella	1
Tipula	1
TOTAL:	**103**

Physical Habitat Assessment

RBP Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	9	Pool Variability	12
Bank Stability- Right Bank	9	Riparian Vegetative Zone Width- Left Bank	5
Channel Alteration	14	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	20	Sediment Deposition	13
Channel Sinuosity	13	Vegetative Protection - Left Bank	9
Epifaunal Substrate/Available Cover	12	Vegetative Protection - Right Bank	9
Pool Substrate Characterization	14		
RBP Habitat Score			**149**
RBP Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	4	21.54	Instream Wood Debris	3	62.89
Shading	60	58.94	Instream Habitat	12	86.07
Epifaunal Substrate	12	86.97	Bank Stability	18	94.87
PHI Score					**68.55**
PHI Narrative Rating					**Partially Degraded**

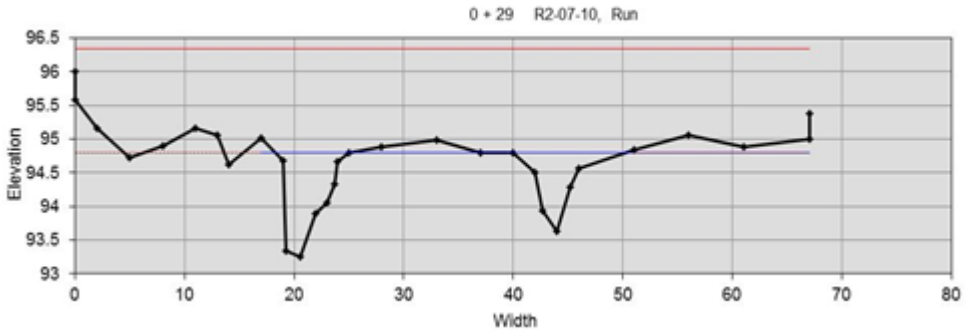
Water Chemistry

Dissolved Oxygen (mg/L)	9.95	pH (SU)	6.89
Turbidity (NTU)	10.6	Specific Conductivity (µS/cm)	330.9
Temperature (°C)	16.7		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.62	Cross Sectional Area (ft^2)	9.21
Bankfull Width (ft)	20.2	Water Surface Slope (%)	0.35
Mean Bankfull Depth (ft)	0.46	Sinuosity	1.2
Floodprone Width (ft)	220	D50 (mm)	0.27
Entrenchment Ratio	10.89	Adjustments?	None
Width to Depth Ratio	44.29	**Rosgen Stream Type**	**DA5**



R2-07-12A Upper Magothy Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.1157342923 **Longitude:** -76.5950913341

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		538.7
Cover	**Acres**	**% Area**
Developed Land	**357.6**	**66.4**
Airport	0	0
Commercial	6.5	1.2
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	72.7	13.5
Residential 1/2-acre	143.6	26.7
Residential 1-Acre	84.1	15.6
Residential 2-Acre	28.3	5.3
Transportation	22.4	4.2
Utility	0	0
Forest Land	**148.9**	**27.6**
Forested Wetland	0	0
Residential Woods	0	0
Woods	148.9	27.6
Open Land	**32.2**	**6**
Open Space	30.4	5.6
Open Wetland	0	0
Water	1.8	0.3
Agricultural Land	**0**	**0**
Pasture/Hay	0	0
Row Crops	0	0

Impervious Surface	**Acres**	**% Area**
Impervious Land	106	19.7

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Supporting"* and *"Partially Degraded"*
- Midges, including Parametriocnemus and Tanytarsus, dominated the sample. Scored high for number of taxa, EPT, scraper taxa, and percent climbers.
- Water quality values within COMAR standards.
- Sub-optimal epibenthic substrate and instream habitat. Wood/rootwads and undercut banks also provide stable habitat. Refuse present in moderate amounts.

Recommendations:

- Maintain the protection of the riparian areas.
- Consider trash cleanup for this reach.
- Investigate potential water quality impacts from residential land uses.

R2-07-12A Upper Magothy Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	30
EPT Taxa	5
Ephemeroptera Taxa	1
%Intolerant Urban	8.7
%Ephemeroptera	1
Scraper Taxa	4
% Climbers	20.4

Calculated Metric Scores

Total Taxa	5
EPT Taxa	5
Ephemeroptera Taxa	3
Intolerant Urban %	1
Ephemeroptera %	3
Scraper Taxa	5
% Climbers	5
BIBI Score	**3.86**
BIBI Narrative Rating	**Fair**

Taxa	Count
Ancyronyx	3
Baetidae	1
Bezzia_Palpomyia	1
Boyeria	3
Cheumatopsyche	4
Conchapelopia	1
Crangonyx	2
Diplectrona	5
Ironoquia	2
Lepidoptera	1
Lopescladius	1
Lype	3
Macronychus	2
Menetus	1
Musculium	1
Nigronia	1
Orthocladiinae	1
Orthocladius	1
Parametriocnemus	30
Paraphaenocladius	1
Polypedilum	6
Pseudolimnophila	1
Rheotanytarsus	5
Simulium	1
Stegopterna	1
Tanytarsus	11
Thienemanniella	2
Thienemannimyia_group	5
Tipula	1
Tvetenia	4
Xylotopus	1
TOTAL:	**103**

Physical Habitat Assessment

RBP Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	8	Pool Variability	10
Bank Stability- Right Bank	7	Riparian Vegetative Zone Width- Left Bank	9
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	20	Sediment Deposition	13
Channel Sinuosity	12	Vegetative Protection - Left Bank	8
Epifaunal Substrate/Available Cover	12	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	10		
RBP Habitat Score			**147**
RBP Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	11	59.24	Instream Wood Debris	12	86.01
Shading	90	91.34	Instream Habitat	11	77.36
Epifaunal Substrate	12	84.95	Bank Stability	15	86.61
PHI Score					**80.92**
PHI Narrative Rating					**Partially Degraded**

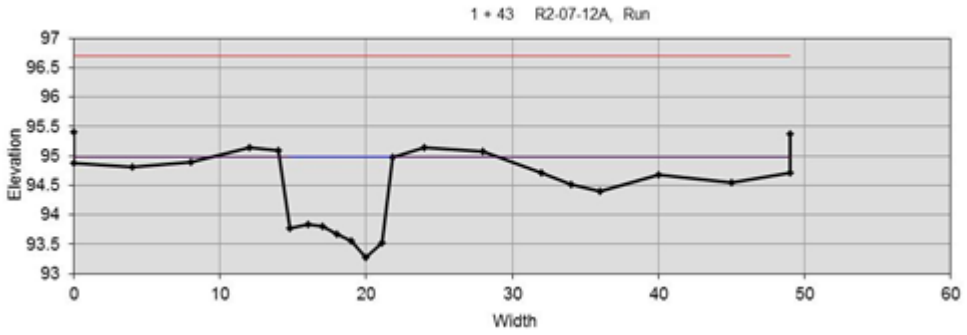
Water Chemistry

Dissolved Oxygen (mg/L)	9.91	pH (SU)	6.65
Turbidity (NTU)	8	Specific Conductivity (µS/cm)	230.5
Temperature (°C)	6.58		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.84	Cross Sectional Area (ft^2)	8.99
Bankfull Width (ft)	7	Water Surface Slope (%)	0.18
Mean Bankfull Depth (ft)	1.28	Sinuosity	1.15
Floodprone Width (ft)	85	D50 (mm)	0.3
Entrenchment Ratio	12.14	Adjustments?	None
Width to Depth Ratio	5.45	**Rosgen Stream Type**	**E5**



R2-07-14A Upper Magothy Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.0826626855 **Longitude:** -76.5567285528

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		819.4
Cover	**Acres**	**% Area**
Developed Land	**583.2**	**71.4**
Airport	0	0
Commercial	52	6.3
Industrial	1.6	0.2
Residential 1/8-acre	23.6	2.9
Residential 1/4-acre	333.6	40.7
Residential 1/2-acre	56.7	6.9
Residential 1-Acre	71.4	8.7
Residential 2-Acre	20.9	2.6
Transportation	24.9	3
Utility	0	0
Forest Land	**198.2**	**24.2**
Forested Wetland	0	0
Residential Woods	24	2.9
Woods	174.2	21.3
Open Land	**36.4**	**4.4**
Open Space	36.4	4.4
Open Wetland	0	0
Water	0	0
Agricultural Land	**0**	**0**
Pasture/Hay	0	0
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	219	26.7

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Supporting"* and *"Degraded"*
- Isopods (tolerant Caecidotea), midges (Rheotanytarsus), and bivalves (Musculium) dominated the sample. Scored high for number of taxa, scraper taxa, and percent climbers.
- Water quality values within COMAR standards.
- Marginal habitat diversity with refuse present in moderate amounts. Stable, well-vegetated banks and good riparian width.

Recommendations:

- Maintain the protection of the riparian areas.
- Investigate potential water quality impacts from residential land uses.

R2-07-14A Upper Magothy Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	28
EPT Taxa	1
Ephemeroptera Taxa	0
%Intolerant Urban	21.7
%Ephemeroptera	0
Scraper Taxa	5
% Climbers	11.3

Calculated Metric Scores

Total Taxa	5
EPT Taxa	1
Ephemeroptera Taxa	1
Intolerant Urban %	3
Ephemeroptera %	1
Scraper Taxa	5
% Climbers	5
BIBI Score	**3**
BIBI Narrative Rating	**Fair**

Taxa	Count
Amphipoda	3
Ancyronyx	6
Caecidotea	23
Calopteryx	1
Cheumatopsyche	4
Clinotanypus	1
Corynoneura	1
Crangonyx	1
Enchytraeidae	2
Gyraulus	1
Lumbriculidae	2
Macronychus	2
Musculium	19
Naididae	1
Neoporus	1
Orthocladius	1
Parametriocnemus	1
Paratanytarsus	1
Paratendipes	2
Physa	3
Polypedilum	2
Prostoma	3
Rheotanytarsus	13
Stenelmis	1
Tanytarsini	1
Tanytarsus	5
Thienemannimyia_group	2
Tipula	1
Tribelos	1
Tubificidae	1
TOTAL:	**106**

Physical Habitat Assessment

RBP Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	9	Pool Variability	12
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	20	Sediment Deposition	12
Channel Sinuosity	10	Vegetative Protection - Left Bank	9
Epifaunal Substrate/Available Cover	9	Vegetative Protection - Right Bank	9
Pool Substrate Characterization	12		
RBP Habitat Score			**146**
RBP Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	6	32.31	Instream Wood Debris	9	72.39
Shading	65	63.55	Instream Habitat	10	67.52
Epifaunal Substrate	9	64.79	Bank Stability	18	94.87
PHI Score					**65.9**
PHI Narrative Rating					**Degraded**

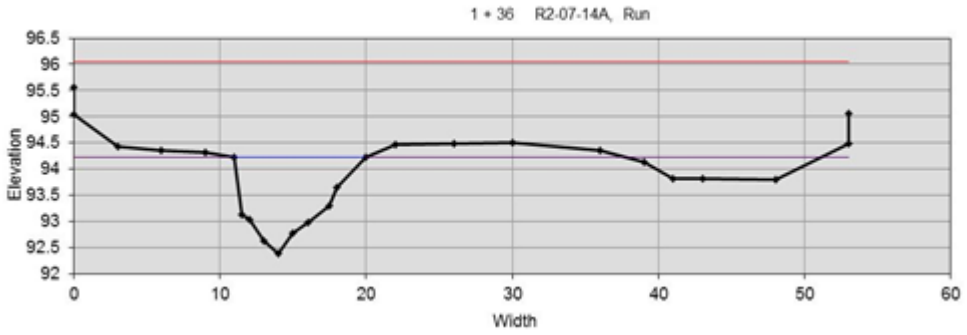
Water Chemistry

Dissolved Oxygen (mg/L)	9.53	pH (SU)	6.68
Turbidity (NTU)	8.13	Specific Conductivity (µS/cm)	189.4
Temperature (°C)	7.65		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	1.28	Cross Sectional Area (ft^2)	9.51
Bankfull Width (ft)	9	Water Surface Slope (%)	0.18
Mean Bankfull Depth (ft)	1.06	Sinuosity	1.25
Floodprone Width (ft)	55	D50 (mm)	0.13
Entrenchment Ratio	6.11	Adjustments?	None
Width to Depth Ratio	8.52	**Rosgen Stream Type**	**E5**



R2-07-16A Upper Magothy Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.0850282144 **Longitude:** -76.5661465693

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**564.5**
Cover	**Acres**	**% Area**
Developed Land	**421.1**	**74.7**
Airport	0	0
Commercial	39.2	6.9
Industrial	0.6	0.1
Residential 1/8-acre	22.1	3.9
Residential 1/4-acre	232.4	41.2
Residential 1/2-acre	54.8	9.7
Residential 1-Acre	40.2	7.1
Residential 2-Acre	15.4	2.7
Transportation	16.9	3
Utility	0	0
Forest Land	**116**	**20.6**
Forested Wetland	0	0
Residential Woods	24	4.2
Woods	92.1	16.3
Open Land	**26.8**	**4.8**
Open Space	26.8	4.8
Open Wetland	0	0
Water	0	0
Agricultural Land	**0**	**0**
Pasture/Hay	0	0
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	168.9	29.9

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Midges, including Parametriocnemus, dominated the sample. Scored high for number of taxa, scraper taxa, and percent climbers.
- Water quality values within COMAR standards.
- Marginal instream habitat and epibenthic substrate with abundant woody debris. Heavily eroded banks with little vegetative protection. Good riparian width.

Recommendations:

- Buffer enhancement.
- Determine causes of instability observed in this reach and evaluate potential for stabilization.
- Investigate potential water quality impacts from residential land uses.

R2-07-16A Upper Magothy Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	25
EPT Taxa	3
Ephemeroptera Taxa	0
%Intolerant Urban	0
%Ephemeroptera	0
Scraper Taxa	2
% Climbers	16

Calculated Metric Scores

Total Taxa	5
EPT Taxa	3
Ephemeroptera Taxa	1
Intolerant Urban %	1
Ephemeroptera %	1
Scraper Taxa	5
% Climbers	5
BIBI Score	**3**
BIBI Narrative Rating	**Fair**

Taxa	Count
Brillia	1
Calopteryx	2
Ceratopsyche	2
Cheumatopsyche	4
Chironomini	1
Chironomus	1
Corynoneura	4
Cricotopus	1
Cryptotendipes	1
Dasyhelea	1
Enchytraeidae	1
Gammarus	7
Georthocladius	1
Helichus	1
Limnephilidae	4
Orthocladiinae	3
Orthocladius	6
Paracladopelma	1
Parametriocnemus	36
Paraphaenocladius	4
Phaenopsectra	1
Physa	1
Polypedilum	9
Simulium	1
Stygobromus	1
Tubificidae	1
Xylotopus	4
TOTAL:	**100**

Physical Habitat Assessment

RBP Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	3	Pool Variability	9
Bank Stability- Right Bank	3	Riparian Vegetative Zone Width- Left Bank	9
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	9
Channel Flow Status	17	Sediment Deposition	8
Channel Sinuosity	12	Vegetative Protection - Left Bank	4
Epifaunal Substrate/Available Cover	8	Vegetative Protection - Right Bank	4
Pool Substrate Characterization	8		
RBP Habitat Score			**114**
RBP Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	13	70.01	Instream Wood Debris	14	91.4
Shading	90	91.34	Instream Habitat	10	71.33
Epifaunal Substrate	8	61.41	Bank Stability	6	54.77
PHI Score					**73.38**
PHI Narrative Rating					**Partially Degraded**

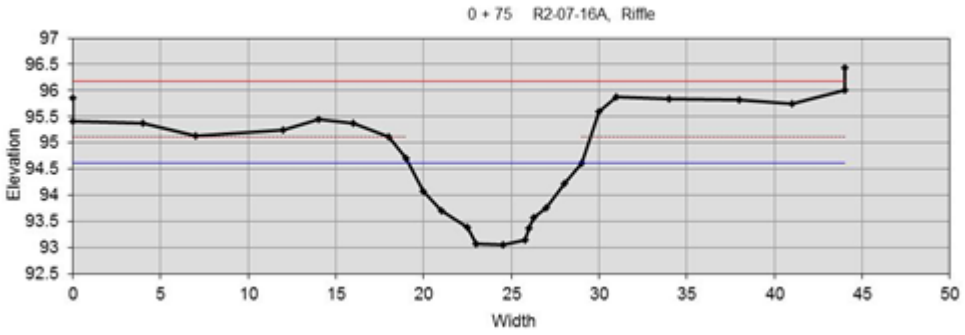
Water Chemistry

Dissolved Oxygen (mg/L)	9.53	pH (SU)	6.61
Turbidity (NTU)	8.63	Specific Conductivity (µS/cm)	227.9
Temperature (°C)	7.25		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.88	Cross Sectional Area (ft^2)	9.68
Bankfull Width (ft)	9.86	Water Surface Slope (%)	0.19
Mean Bankfull Depth (ft)	0.98	Sinuosity	1.29
Floodprone Width (ft)	85	D50 (mm)	0.41
Entrenchment Ratio	8.62	Adjustments?	None
Width to Depth Ratio	10.04	**Rosgen Stream Type**	**E5**



R2-07-17A Upper Magothy Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.1116782747 **Longitude:** -76.5465990656

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**269.6**
Cover	**Acres**	**% Area**
Developed Land	**157.8**	**58.6**
Airport	0	0
Commercial	5.9	2.2
Industrial	0.1	0
Residential 1/8-acre	3.6	1.3
Residential 1/4-acre	0	0
Residential 1/2-acre	44.5	16.5
Residential 1-Acre	69.7	25.8
Residential 2-Acre	29.7	11
Transportation	4.4	1.6
Utility	0	0
Forest Land	**98.1**	**36.4**
Forested Wetland	0	0
Residential Woods	0	0
Woods	98.1	36.4
Open Land	**13.6**	**5**
Open Space	13.6	5
Open Wetland	0	0
Water	0	0
Agricultural Land	**0**	**0**
Pasture/Hay	0	0
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	35.8	13.3

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Supporting"* and *"Partially Degraded"*
- Midges, including Parametriocnemus and Corynoneura, and caddisflies (Diplectrona) dominated the sample. Scored high for number of taxa and EPT.
- Water quality values within COMAR standards but conductivity elevated.
- Woody debris and rootwads providing some stable habitat. Refuse present in moderate amounts. Stable, well-vegetated banks with good riparian width on the left bank; however, poor riparian width on the right bank.

Recommendations:

- Buffer enhancement.
- Consider trash cleanup for this reach.
- Investigate potential water quality impacts from residential land uses.

R2-07-17A Upper Magothy Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	23
EPT Taxa	6
Ephemeroptera Taxa	0
%Intolerant Urban	27.4
%Ephemeroptera	0
Scraper Taxa	1
% Climbers	4.4

Calculated Metric Scores

Total Taxa	5
EPT Taxa	5
Ephemeroptera Taxa	1
Intolerant Urban %	3
Ephemeroptera %	1
Scraper Taxa	3
% Climbers	3
BIBI Score	**3**
BIBI Narrative Rating	**Fair**

Taxa	Count
Anchytarsus	1
Boyeria	1
Caecidotea	8
Calopteryx	1
Corynoneura	16
Cricotopus	3
Diplectrona	16
Enchytraeidae	1
Heteroplectron	4
Lepidoptera	1
Lepidostoma	1
Lumbriculidae	1
Lype	1
Micropsectra	1
Parametriocnemus	26
Phaenopsectra	1
Polycentropodidae	1
Polypedilum	1
Pycnopsyche	1
Simulium	8
Synurella	11
Tanypodinae	1
Thienemannimyia_group	6
Tubificidae	1
TOTAL:	**113**

Physical Habitat Assessment

RBP Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	9	Pool Variability	9
Bank Stability- Right Bank	9	Riparian Vegetative Zone Width- Left Bank	5
Channel Alteration	15	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	17	Sediment Deposition	13
Channel Sinuosity	8	Vegetative Protection - Left Bank	10
Epifaunal Substrate/Available Cover	11	Vegetative Protection - Right Bank	10
Pool Substrate Characterization	10		
RBP Habitat Score			**136**
RBP Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	9	48.47	Instream Wood Debris	4	70.18
Shading	75	73.32	Instream Habitat	10	78.89
Epifaunal Substrate	11	83.65	Bank Stability	18	94.87
PHI Score					**74.9**
PHI Narrative Rating					**Partially Degraded**

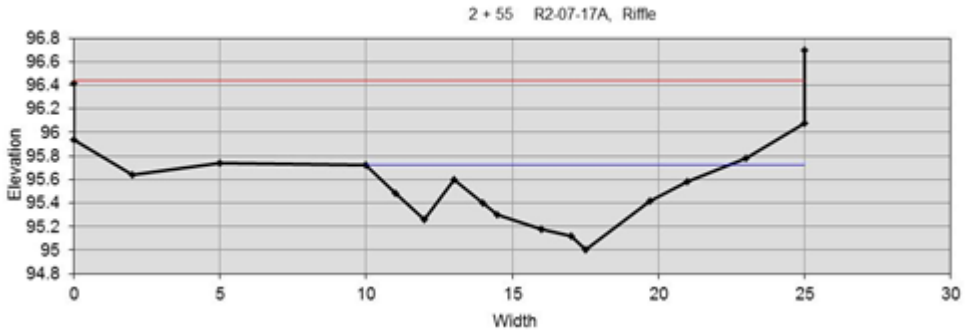
Water Chemistry

Dissolved Oxygen (mg/L)	10.6	pH (SU)	6.25
Turbidity (NTU)	5.8	Specific Conductivity (µS/cm)	263.1
Temperature (°C)	10.9		

Geomorphic Assessment

Rosgen Level II Classification Data

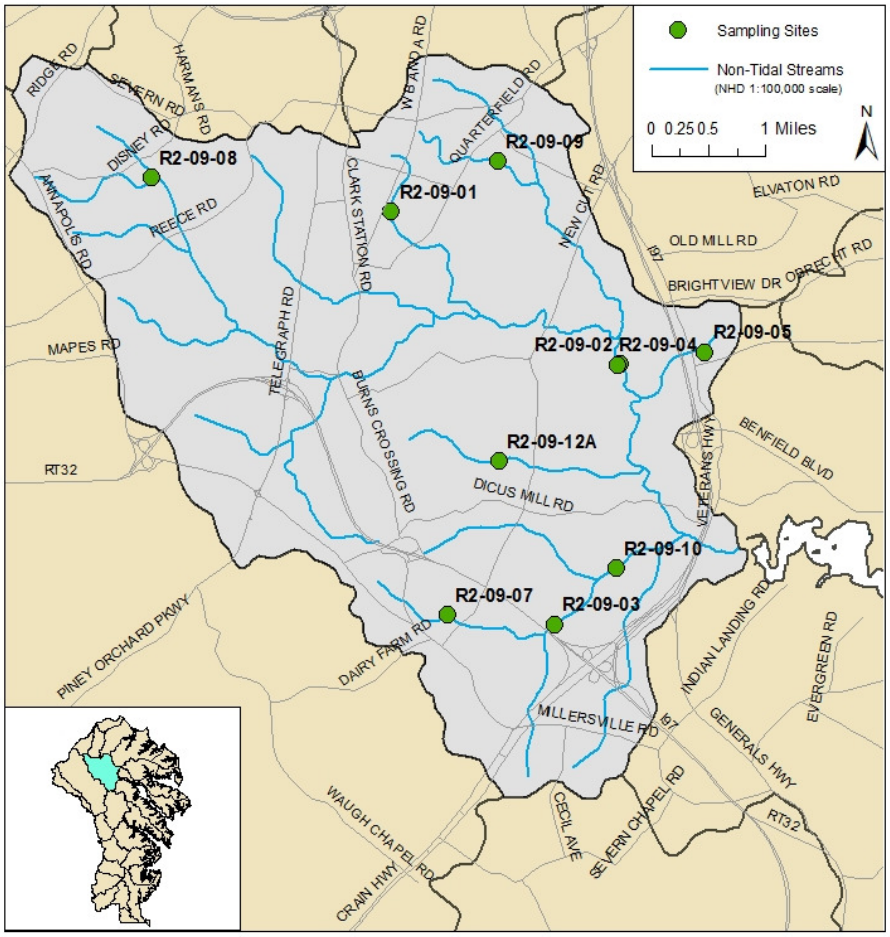
Drainage Area (mi^2)	0.42	Cross Sectional Area (ft^2)	4.29
Bankfull Width (ft)	12.4	Water Surface Slope (%)	1.3
Mean Bankfull Depth (ft)	0.35	Sinuosity	1.12
Floodprone Width (ft)	32	D50 (mm)	0.25
Entrenchment Ratio	2.58	Adjustments?	None
Width to Depth Ratio	35.83	**Rosgen Stream Type**	**C5**



Severn Run Sampling Unit

Site Condition Summary

Site	Drainage Area (acres)	Drainage Area (mi^2)	Percent Impervious	Percent Developed	Percent Forested	Percent Agriculture	Percent Open	BIBI Narrative Rating	PHI Narrative Rating	RBP Narrative Rating	Rosgen Stream Type - L1
R2-09-01	151.0	0.24	12.9	60.7	37.5	0.0	1.7	Fair	Severely Degraded	Non Supporting	G
R2-09-02	9794.0	15.30	22.8	57.7	35.0	1.8	5.5	Fair	Partially Degraded	Comparable to Reference	E
R2-09-03	1532.0	2.39	13.2	38.9	45.3	11.9	3.9	Fair	Degraded	Supporting	C
R2-09-04	9795.2	15.3	22.7	57.7	35.0	1.8	5.5	Fair	Partially Degraded	Supporting	E
R2-09-05	90.4	0.14	13.8	57.5	38.2	0.0	4.3	Poor	Partially Degraded	Supporting	DA
R2-09-07	368.5	0.58	17.4	59.4	33.7	4.1	2.8	Very Poor	Degraded	Non Supporting	G
R2-09-08	311.0	0.49	15.1	36.8	51.4	0.0	11.8	Very Poor	Partially Degraded	Non Supporting	ND
R2-09-09	270.9	0.42	15.1	60.0	37.6	0.0	2.4	Fair	Minimally Degraded	Comparable to Reference	E
R2-09-10	2406.8	3.76	11.6	39.7	47.8	7.6	4.9	Good	Partially Degraded	Supporting	E
R2-09-12A	471.4	0.74	8.0	20.3	45.8	0.0	33.9	Good	Partially Degraded	Supporting	E



R2-09-01 Severn Run Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.1230179736 **Longitude:** -76.6768097419

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**151**
Cover	**Acres**	**% Area**
Developed Land	**91.7**	**60.7**
Airport	0	0
Commercial	0	0
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	17.4	11.5
Residential 1/2-acre	18.9	12.5
Residential 1-Acre	24.8	16.4
Residential 2-Acre	22.4	14.8
Transportation	8.2	5.4
Utility	0	0
Forest Land	**56.7**	**37.5**
Forested Wetland	0	0
Residential Woods	0	0
Woods	56.7	37.5
Open Land	**2.6**	**1.7**
Open Space	2.6	1.7
Open Wetland	0	0
Water	0	0
Agricultural Land	**0**	**0**
Pasture/Hay	0	0
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	19.5	12.9

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Non Supporting"* and *"Severely Degraded"*
- Midges (Polypedilum), caddisflies (Cheumatopsyche), and bivalves (Physa) dominated the sample. Scored high for number of taxa, scraper taxa, and percent climbers.
- Measured below COMAR standards for pH.
- Poor habitat diversity and refuse present in moderate amounts. Incised channel with heavily undercut banks. Minimal vegetative protection and poor riparian width.

Recommendations:

- Buffer enhancement.
- Determine causes of instability observed in this reach and evaluate potential for stabilization.
- Consider trash cleanup for this reach.
- Investigate potential water quality impacts from residential land uses.

R2-09-01 Severn Run Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	22
EPT Taxa	2
Ephemeroptera Taxa	0
%Intolerant Urban	1
%Ephemeroptera	0
Scraper Taxa	5
% Climbers	26.2

Calculated Metric Scores

Total Taxa	5
EPT Taxa	3
Ephemeroptera Taxa	1
Intolerant Urban %	1
Ephemeroptera %	1
Scraper Taxa	5
% Climbers	5
BIBI Score	**3**
BIBI Narrative Rating	**Fair**

Taxa	Count
Brillia	1
Cheumatopsyche	16
Corynoneura	1
Dubiraphia	2
Enchytraeidae	1
Eukiefferiella	3
Heteroplectron	1
Lumbriculidae	5
Macronychus	1
Menetus	2
Molophilus	1
Parametriocnemus	8
Physa	14
Pisidiidae	5
Polypedilum	11
Rheotanytarsus	5
Simulium	1
Stenelmis	9
Tanypodinae	1
Thienemannimyia_group	2
Tipula	2
Trichoptera	1
Tubificidae	9
Tvetenia	1
TOTAL:	**103**

Physical Habitat Assessment

RBP Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	2	Pool Variability	6
Bank Stability- Right Bank	2	Riparian Vegetative Zone Width- Left Bank	2
Channel Alteration	12	Riparian Vegetative Zone Width- Right Bank	2
Channel Flow Status	14	Sediment Deposition	7
Channel Sinuosity	8	Vegetative Protection - Left Bank	3
Epifaunal Substrate/Available Cover	5	Vegetative Protection - Right Bank	3
Pool Substrate Characterization	5		
RBP Habitat Score			**71**
RBP Narrative Rating			**Non Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	3	16.16	Instream Wood Debris	4	76.74
Shading	60	58.94	Instream Habitat	4	51.54
Epifaunal Substrate	5	52.57	Bank Stability	4	44.72
PHI Score					**50.11**
PHI Narrative Rating					**Severely Degraded**

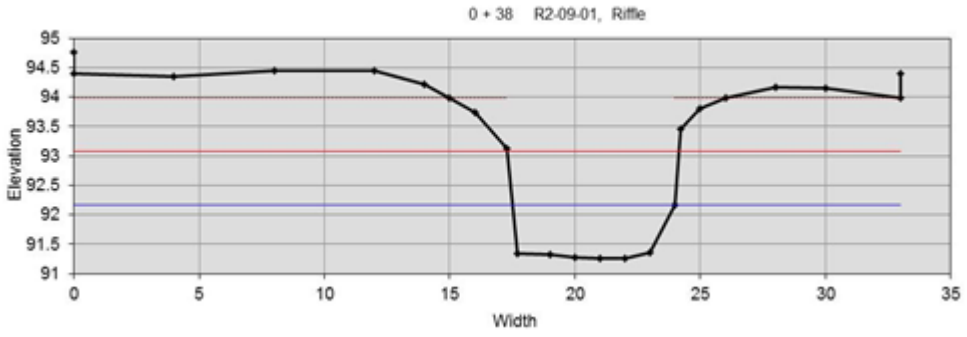
Water Chemistry

Dissolved Oxygen (mg/L)	11.41	pH (SU)	6.05
Turbidity (NTU)	7.72	Specific Conductivity (µS/cm)	206.5
Temperature (°C)	5.95		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.24	Cross Sectional Area (ft^2)	5.11
Bankfull Width (ft)	6.49	Water Surface Slope (%)	0.91
Mean Bankfull Depth (ft)	0.79	Sinuosity	1.05
Floodprone Width (ft)	6.83	D50 (mm)	0.26
Entrenchment Ratio	1.05	Adjustments?	None
Width to Depth Ratio	8.22	**Rosgen Stream Type**	**G5c**



R2-09-02 Severn Run Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.1034152128 **Longitude:** -76.6399789119

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		9794
Cover	**Acres**	**% Area**
Developed Land	**5320**	**57.7**
Airport	0	0
Commercial	447.9	4.6
Industrial	330.2	3.4
Residential 1/8-acre	1769.9	18.1
Residential 1/4-acre	1216	12.4
Residential 1/2-acre	334.6	3.4
Residential 1-Acre	550	5.6
Residential 2-Acre	501.4	5.1
Transportation	446.2	4.6
Utility	54	0.6
Forest Land	**3431.2**	**35**
Forested Wetland	8.9	0.1
Residential Woods	0	0
Woods	3422.3	34.9
Open Land	**541**	**5.5**
Open Space	527.8	5.4
Open Wetland	3.8	0
Water	9.4	0.1
Agricultural Land	**171.6**	**1.8**
Pasture/Hay	21.7	0.2
Row Crops	149.8	1.5
Impervious Surface	**Acres**	**% Area**
Impervious Land	2228.2	22.8

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Comparable to Reference"* and *"Partially Degraded"*
- Cheumatopsyche (caddisfly) dominated the sample. Scored high in most metric categories.
- Water quality values within COMAR standards but conductivity elevated.
- Sub-optimal instream habitat and epibenthic substrate. Abundant woody debris providing additional stable habitat. Banks are moderately stable with good 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 comparable to reference and biological condition is fair, look for problems with water quality and correct, if possible.

R2-09-02 Severn Run Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	26
EPT Taxa	7
Ephemeroptera Taxa	2
%Intolerant Urban	5.3
%Ephemeroptera	3.5
Scraper Taxa	7
% Climbers	7.9

Calculated Metric Scores

Total Taxa	5
EPT Taxa	5
Ephemeroptera Taxa	5
Intolerant Urban %	1
Ephemeroptera %	3
Scraper Taxa	5
% Climbers	3
BIBI Score	**3.86**
BIBI Narrative Rating	**Fair**

Taxa	Count
Ancyronyx	5
Baetidae	2
Calopteryx	2
Ceratopsyche	3
Cheumatopsyche	48
Corynoneura	3
Crangonyx	2
Cricotopus	3
Helichus	3
Hydropsyche	2
Hydropsychidae	1
Lype	2
Maccaffertium	2
Macronychus	4
Microcylloepus	1
Micropsectra	1
Oecetis	2
Orthocladius	5
Oulimnius	1
Parametriocnemus	1
Polypedilum	4
Pseudosuccinea	1
Rheotanytarsus	11
Stenelmis	2
Tanytarsus	1
Thienemannimyia_group	1
Tubificidae	1
TOTAL:	**114**

Physical Habitat Assessment

RBP Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	5	Pool Variability	16
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	14	Vegetative Protection - Left Bank	7
Epifaunal Substrate/Available Cover	15	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	14		
RBP Habitat Score			**158**
RBP Narrative Rating			**Comparable to Reference**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	20	100	Instream Wood Debris	19	73.88
Shading	70	68.32	Instream Habitat	15	69.87
Epifaunal Substrate	15	83.49	Bank Stability	11	74.16
PHI Score					**78.29**
PHI Narrative Rating					**Partially Degraded**

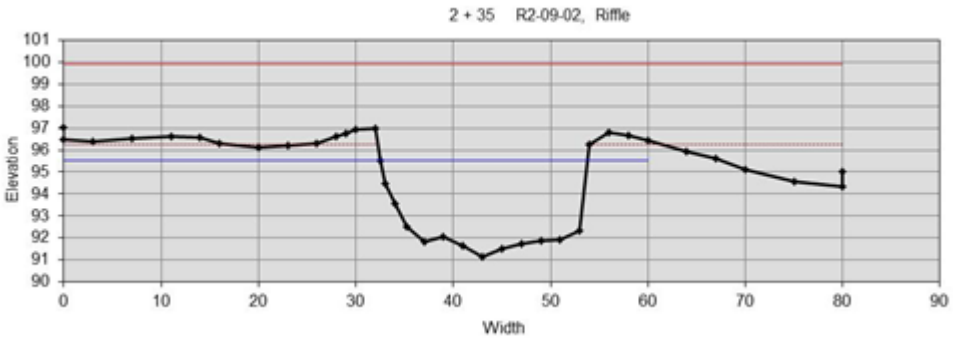
Water Chemistry

Dissolved Oxygen (mg/L)	10.01	pH (SU)	6.76
Turbidity (NTU)	5.22	Specific Conductivity (µS/cm)	300.7
Temperature (°C)	12		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	15.3	Cross Sectional Area (ft^2)	72.93
Bankfull Width (ft)	21.32	Water Surface Slope (%)	0.23
Mean Bankfull Depth (ft)	3.42	Sinuosity	1.35
Floodprone Width (ft)	240	D50 (mm)	0.41
Entrenchment Ratio	11.26	Adjustments?	None
Width to Depth Ratio	6.23	**Rosgen Stream Type**	**E5**



R2-09-03 Severn Run Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.0704027616 **Longitude:** -76.6504826711

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**1532**
Cover	**Acres**	**% Area**
Developed Land	**583.6**	**38.9**
Airport	0	0
Commercial	64.8	4.2
Industrial	13	0.8
Residential 1/8-acre	65.4	4.3
Residential 1/4-acre	158.6	10.4
Residential 1/2-acre	23.2	1.5
Residential 1-Acre	51.5	3.4
Residential 2-Acre	136	8.9
Transportation	82.9	5.4
Utility	1.2	0.1
Forest Land	**693.3**	**45.3**
Forested Wetland	0	0
Residential Woods	0	0
Woods	693.3	45.3
Open Land	**60.1**	**3.9**
Open Space	58.4	3.8
Open Wetland	0	0
Water	1.7	0.1
Agricultural Land	**182**	**11.9**
Pasture/Hay	127.1	8.3
Row Crops	54.9	3.6
Impervious Surface	**Acres**	**% Area**
Impervious Land	201.6	13.2

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Supporting"* and *"Degraded"*
- Sample contained 38 taxa, including Haploperla (tolerant stonefly) and various midges. Scored high in most metric categories.
- Measured below COMAR standards for pH.
- Marginal to sub-optimal habitat diversity with woody debris providing most of the stable habitat. Moderately stable banks with good riparian width.

Recommendations:

- Maintain the protection of the riparian areas.

R2-09-03 Severn Run Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	38
EPT Taxa	9
Ephemeroptera Taxa	1
%Intolerant Urban	21.1
%Ephemeroptera	1.8
Scraper Taxa	4
% Climbers	2.8

Calculated Metric Scores

Total Taxa	5
EPT Taxa	5
Ephemeroptera Taxa	3
Intolerant Urban %	3
Ephemeroptera %	3
Scraper Taxa	5
% Climbers	3
BIBI Score	**3.86**
BIBI Narrative Rating	**Fair**

Taxa	Count
Bezzia_Palpomyia	1
Brillia	2
Caecidotea	1
Cheumatopsyche	1
Chironomini	1
Corynoneura	1
Dicrotendipes	1
Diplectrona	1
Diplocladius	1
Eccoptura	1
Eurylophella	2
Haploperla	10
Hydrobaenus	1
Leuctra	1
Limnophyes	2
Lumbricina	1
Lumbriculidae	2
Lype	6
Microtendipes	1
Naididae	3
Neoporus	1
Orthocladiinae	1
Orthocladius	7
Parametriocnemus	12
Pisidiidae	1
Polycentropus	4
Polypedilum	2
Prosimulium	4
Prostoma	1
Rheotanytarsus	11
Simulium	2
Stegopterna	1
Stenelmis	5
Tanytarsus	1
Thienemanniella	2
Thienemannimyia_group	3
Triaenodes	1
Tubificidae	4
Tvetenia	5
TOTAL:	**108**

Physical Habitat Assessment

RBP Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	7	Pool Variability	13
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	19	Sediment Deposition	11
Channel Sinuosity	12	Vegetative Protection - Left Bank	6
Epifaunal Substrate/Available Cover	11	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	12		
RBP Habitat Score			**146**
RBP Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	10	53.85	Instream Wood Debris	5	53.47
Shading	40	40.96	Instream Habitat	13	77.76
Epifaunal Substrate	10	66.53	Bank Stability	15	86.61
PHI Score					**63.19**
PHI Narrative Rating					**Degraded**

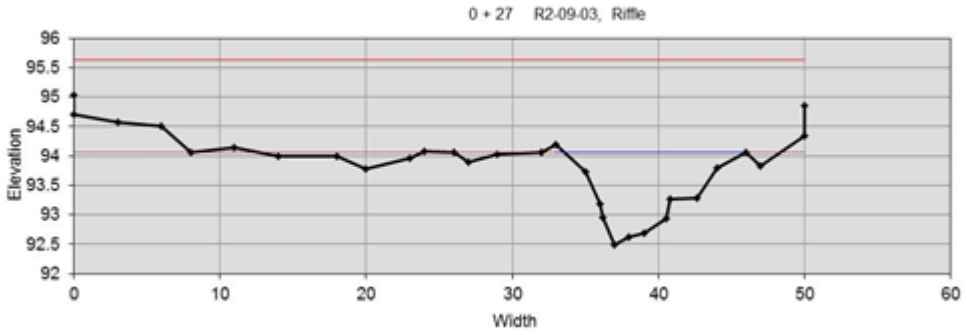
Water Chemistry

Dissolved Oxygen (mg/L)	11.43	pH (SU)	5.95
Turbidity (NTU)	5.2	Specific Conductivity (µS/cm)	221.5
Temperature (°C)	6.52		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	2.39	Cross Sectional Area (ft^2)	9.58
Bankfull Width (ft)	12.43	Water Surface Slope (%)	0.86
Mean Bankfull Depth (ft)	0.77	Sinuosity	1.08
Floodprone Width (ft)	280	D50 (mm)	0.29
Entrenchment Ratio	22.52	Adjustments?	None
Width to Depth Ratio	16.14	**Rosgen Stream Type**	**C5**



R2-09-04 Severn Run Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.103469778 **Longitude:** -76.6394565501

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**9795.2**
Cover	**Acres**	**% Area**
Developed Land	**5320**	**57.7**
Airport	0	0
Commercial	447.9	4.6
Industrial	330.2	3.4
Residential 1/8-acre	1769.9	18.1
Residential 1/4-acre	1216	12.4
Residential 1/2-acre	334.6	3.4
Residential 1-Acre	550	5.6
Residential 2-Acre	501.4	5.1
Transportation	446.2	4.6
Utility	54	0.6
Forest Land	**3432.5**	**35**
Forested Wetland	8.9	0.1
Residential Woods	0	0
Woods	3423.5	35
Open Land	**541**	**5.5**
Open Space	527.8	5.4
Open Wetland	3.8	0
Water	9.4	0.1
Agricultural Land	**171.6**	**1.8**
Pasture/Hay	21.7	0.2
Row Crops	149.8	1.5
Impervious Surface	**Acres**	**% Area**
Impervious Land	2228.2	22.7

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Supporting"* and *"Partially Degraded"*
- Midges (Orthocladius and Rheotanytarsus) and caddisflies (Cheumatopsyche) dominated the sample. Scored high in most metric categories.
- Water quality values within COMAR standards but conductivity elevated.
- Sub-optimal habitat diversity with abundant woody debris. Good mix of velocity and depth. Moderately unstable banks but with good riparian width.

Recommendations:

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

R2-09-04 Severn Run Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	25
EPT Taxa	7
Ephemeroptera Taxa	2
%Intolerant Urban	8.9
%Ephemeroptera	8
Scraper Taxa	6
% Climbers	5.4

Calculated Metric Scores

Total Taxa	5
EPT Taxa	5
Ephemeroptera Taxa	5
Intolerant Urban %	1
Ephemeroptera %	3
Scraper Taxa	5
% Climbers	3
BIBI Score	**3.86**
BIBI Narrative Rating	**Fair**

Taxa	Count
Amphipoda	1
Ancyronyx	4
Baetidae	2
Bezzia_Palpomyia	2
Ceratopsyche	1
Cheumatopsyche	34
Crangonyctidae	1
Crangonyx	7
Cricotopus	4
Hyalella	1
Hydrobaenus	1
Ironoquia	1
Leptoceridae	1
Lumbricina	1
Lype	3
Maccaffertium	7
Macronychus	1
Oecetis	1
Orthocladiinae	1
Orthocladius	14
Oulimnius	1
Paratanytarsus	1
Polypedilum	6
Rheocricotopus	1
Rheotanytarsus	11
Simulium	1
Thienemannimyia_group	1
Tvetenia	1
Xylotopus	1
TOTAL:	**112**

Physical Habitat Assessment

RBP Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	4	Pool Variability	15
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	12
Channel Sinuosity	12	Vegetative Protection - Left Bank	5
Epifaunal Substrate/Available Cover	15	Vegetative Protection - Right Bank	7
Pool Substrate Characterization	13		
RBP Habitat Score			**149**
RBP Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	20	100	Instream Wood Debris	15	62.05
Shading	55	54.42	Instream Habitat	14	64.32
Epifaunal Substrate	15	83.49	Bank Stability	10	70.71
PHI Score					**72.5**
PHI Narrative Rating					**Partially Degraded**

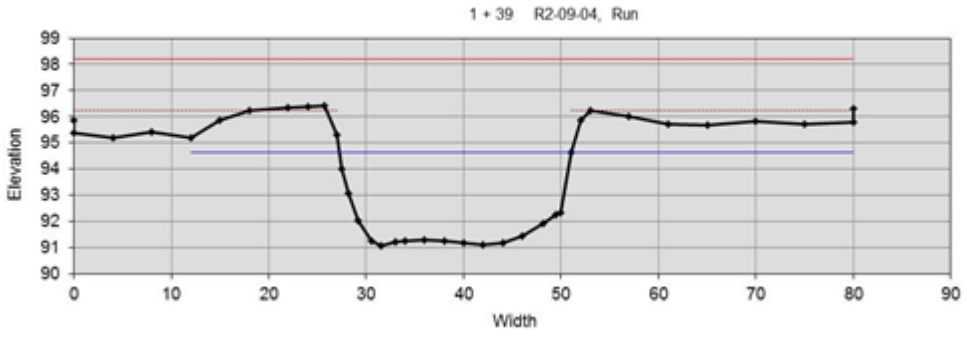
Water Chemistry

Dissolved Oxygen (mg/L)	10.05	pH (SU)	6.77
Turbidity (NTU)	4.27	Specific Conductivity (µS/cm)	300.2
Temperature (°C)	11.6		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	15.3	Cross Sectional Area (ft^2)	71.65
Bankfull Width (ft)	23.74	Water Surface Slope (%)	0.13
Mean Bankfull Depth (ft)	3.02	Sinuosity	1.19
Floodprone Width (ft)	225	D50 (mm)	0.34
Entrenchment Ratio	9.48	Adjustments?	None
Width to Depth Ratio	7.86	**Rosgen Stream Type**	**E5**



R2-09-05 Severn Run Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.1049750884 **Longitude:** -76.6256909978

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**90.4**
Cover	**Acres**	**% Area**
Developed Land	**52**	**57.5**
Airport	0	0
Commercial	0	0
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	37.6	41.6
Residential 1/2-acre	13.6	15
Residential 1-Acre	0.5	0.5
Residential 2-Acre	0	0
Transportation	0.3	0.3
Utility	0	0
Forest Land	**34.6**	**38.2**
Forested Wetland	0	0
Residential Woods	0	0
Woods	34.6	38.2
Open Land	**3.8**	**4.3**
Open Space	2.3	2.6
Open Wetland	0.4	0.4
Water	1.1	1.3
Agricultural Land	**0**	**0**
Pasture/Hay	0	0
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	12.5	13.8

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Supporting"* and *"Partially Degraded"*
- Black flies (Stegopterna and Simulium) and midges (Hydrobaenus) dominated the sample. Scored high for scraper taxa because of the presence of Hydrobaenus and Fossaria (snail).
- Measured below COMAR standards for pH.
- Marginal instream habitat and epibenthic substrate with woody debris and leaf pack providing habitat for benthos. Moderately stable, well-vegetated banks with good 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.
- Investigate potential water quality impacts from residential land uses.

R2-09-05 Severn Run Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	14
EPT Taxa	3
Ephemeroptera Taxa	0
%Intolerant Urban	23.6
%Ephemeroptera	0
Scraper Taxa	2
% Climbers	2.7

Calculated Metric Scores

Total Taxa	3
EPT Taxa	3
Ephemeroptera Taxa	1
Intolerant Urban %	3
Ephemeroptera %	1
Scraper Taxa	5
% Climbers	3
BIBI Score	**2.71**
BIBI Narrative Rating	**Poor**

Taxa	Count
Cheumatopsyche	1
Chironomidae	1
Corynoneura	2
Fossaria	1
Hydrobaenus	34
Limnephilidae	1
Lumbriculidae	1
Orthocladiinae	1
Orthocladius	9
Prostoma	1
Pyralidae	1
Rheocricotopus	6
Simulium	17
Stegopterna	26
Taeniopteryx	1
Thienemanniella	3
Trichoptera	4
TOTAL:	**110**

Physical Habitat Assessment

RBP Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	8	Pool Variability	7
Bank Stability- Right Bank	8	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	20	Sediment Deposition	12
Channel Sinuosity	14	Vegetative Protection - Left Bank	8
Epifaunal Substrate/Available Cover	7	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	8		
RBP Habitat Score			**140**
RBP Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	7	37.7	Instream Wood Debris	5	85.51
Shading	55	54.42	Instream Habitat	7	73.43
Epifaunal Substrate	7	67.53	Bank Stability	16	89.45
PHI Score					**68.01**
PHI Narrative Rating					**Partially Degraded**

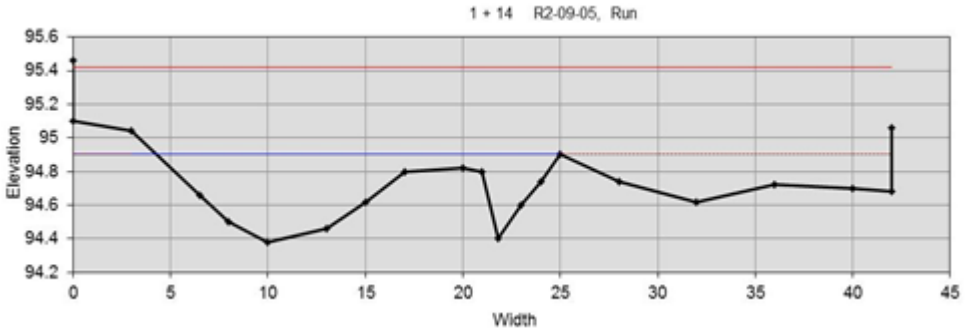
Water Chemistry

Dissolved Oxygen (mg/L)	12	pH (SU)	5.58
Turbidity (NTU)	36.3	Specific Conductivity (µS/cm)	144.5
Temperature (°C)	9.96		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.14	Cross Sectional Area (ft^2)	5.6
Bankfull Width (ft)	20.71	Water Surface Slope (%)	1.6
Mean Bankfull Depth (ft)	0.27	Sinuosity	1.27
Floodprone Width (ft)	73	D50 (mm)	0.17
Entrenchment Ratio	3.52	Adjustments?	None
Width to Depth Ratio	76.66	**Rosgen Stream Type**	**DA5**



R2-09-07 Severn Run Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.071699562 **Longitude:** -76.6679376926

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		368.5
Cover	**Acres**	**% Area**
Developed Land	**218.7**	**59.4**
Airport	0	0
Commercial	14.9	4
Industrial	0	0
Residential 1/8-acre	0.1	0
Residential 1/4-acre	158.6	43
Residential 1/2-acre	4.2	1.1
Residential 1-Acre	3.2	0.9
Residential 2-Acre	19.4	5.3
Transportation	18.2	5
Utility	0	0
Forest Land	**124.1**	**33.7**
Forested Wetland	0	0
Residential Woods	0	0
Woods	124.1	33.7
Open Land	**10.5**	**2.8**
Open Space	10.5	2.8
Open Wetland	0	0
Water	0	0
Agricultural Land	**15.2**	**4.1**
Pasture/Hay	7.9	2.1
Row Crops	7.3	2
Impervious Surface	**Acres**	**% Area**
Impervious Land	64.1	17.4

Summary Results:

- Biological condition – *"Very Poor"*
- Habitat scores *"Non Supporting"* and *"Degraded"*
- Only 57 organisms were present in this sample, which was dominated by midges (Zavrelimyia) and worms (Lumbriculidae and Enchytraeidae). Because this sample contained less than 60 organisms, it automatically received the lowest BIBI score possible.
- Measured below COMAR standards for both pH and dissolved oxygen.
- Very poor habitat diversity with minimal woody debris present. Heavily eroded and undercut banks with poor vegetative protection throughout the reach and heavy sedimentation. Very unstable reach with active headcut.

Recommendations:

- Buffer enhancement.
- Determine causes of instability observed in this reach and evaluate potential for stabilization.
- Investigate potential water quality impacts from residential land uses.

R2-09-07 Severn Run Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	17
EPT Taxa	1
Ephemeroptera Taxa	0
%Intolerant Urban	0
%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
BIBI Score	**1**
BIBI Narrative Rating	**Very Poor**

Taxa	Count
Brachycera	2
Chaetocladius	1
Chironomidae	1
Chironomini	1
Culicoides	1
Enchytraeidae	5
Limnophyes	1
Lumbricina	3
Lumbriculidae	13
Molophilus	6
Naididae	1
Nemotelus	1
Orthocladiinae	2
Phaenopsectra	1
Smittia	1
Stygobromus	1
Thienemannimyia_group	1
Tipula	1
Trichoptera	2
Tubificidae	4
TOTAL:	**49**

Physical Habitat Assessment

RBP 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	16	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	1	Sediment Deposition	1
Channel Sinuosity	13	Vegetative Protection - Left Bank	2
Epifaunal Substrate/Available Cover	3	Vegetative Protection - Right Bank	2
Pool Substrate Characterization	5		
RBP Habitat Score			**69**
RBP Narrative Rating			**Non Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	12	64.62	Instream Wood Debris	3	63.69
Shading	95	99.94	Instream Habitat	1	25.76
Epifaunal Substrate	3	35.14	Bank Stability	2	31.62
PHI Score					**53.46**
PHI Narrative Rating					**Degraded**

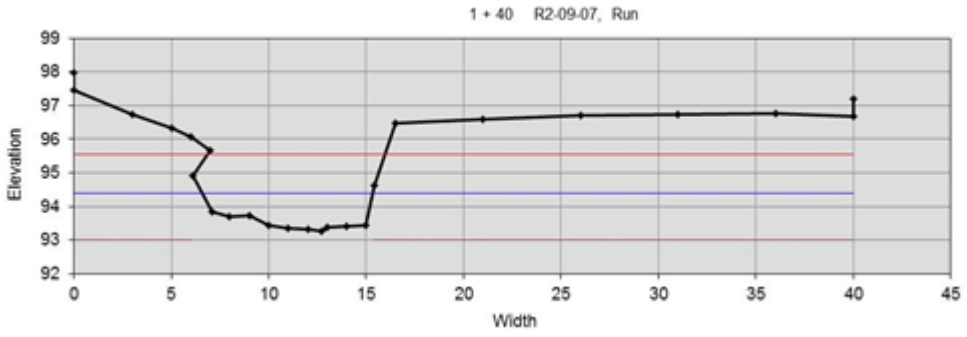
Water Chemistry

Dissolved Oxygen (mg/L)	4.01	pH (SU)	5.66
Turbidity (NTU)	21.4	Specific Conductivity (µS/cm)	175.6
Temperature (°C)	7.61		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.58	Cross Sectional Area (ft^2)	7.56
Bankfull Width (ft)	8.75	Water Surface Slope (%)	2
Mean Bankfull Depth (ft)	0.86	Sinuosity	1.14
Floodprone Width (ft)	9.08	D50 (mm)	0.16
Entrenchment Ratio	1.04	Adjustments?	None
Width to Depth Ratio	10.14	**Rosgen Stream Type**	**G5**



R2-09-08 Severn Run Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.1273823861 **Longitude:** -76.7160231819

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**311**
Cover	**Acres**	**% Area**
Developed Land	**114.3**	**36.8**
Airport	0	0
Commercial	29.3	9.4
Industrial	0.2	0.1
Residential 1/8-acre	18.6	6
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	44.1	14.2
Residential 2-Acre	11	3.5
Transportation	11.4	3.7
Utility	0	0
Forest Land	**159.8**	**51.4**
Forested Wetland	0	0
Residential Woods	0	0
Woods	159.8	51.4
Open Land	**36.6**	**11.8**
Open Space	36.6	11.8
Open Wetland	0	0
Water	0	0
Agricultural Land	**0**	**0**
Pasture/Hay	0	0
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	46.8	15.1

Summary Results:

- Biological condition – *"Very Poor"*
- Habitat scores *"Non Supporting"* and *"Partially Degraded"*
- Worms of the Enchytraeidae family dominated the sample. Scored high for scraper taxa because of the presence of Fossaria (snail).
- Measured below COMAR standards for pH and conductivity elevated.
- Channelized reach, which was a drainage channel for an old orchard. Poor instream habitat and epibenthic substrate. Stable, well-vegetated banks with good riparian width.
- Stream type not determined due to substantial ditching and straightening of channel.

Recommendations:

- Maintain the protection of the riparian areas.

R2-09-08 Severn Run Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	11
EPT Taxa	1
Ephemeroptera Taxa	0
%Intolerant Urban	0
%Ephemeroptera	0
Scraper Taxa	2
% Climbers	5.2

Calculated Metric Scores

Total Taxa	1
EPT Taxa	1
Ephemeroptera Taxa	1
Intolerant Urban %	1
Ephemeroptera %	1
Scraper Taxa	5
% Climbers	3
BIBI Score	**1.86**
BIBI Narrative Rating	**Very Poor**

Taxa	**Count**
Culicoides	1
Curculionidae	1
Enchytraeidae	69
Fossaria	6
Hydrobaenus	1
Lumbricina	7
Lumbriculidae	8
Stygobromus	4
Tipula	1
Trichoptera	1
Tubificidae	16
TOTAL:	**115**

Physical Habitat Assessment

RBP Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	9	Pool Variability	4
Bank Stability- Right Bank	9	Riparian Vegetative Zone Width- Left Bank	8
Channel Alteration	1	Riparian Vegetative Zone Width- Right Bank	8
Channel Flow Status	5	Sediment Deposition	6
Channel Sinuosity	1	Vegetative Protection - Left Bank	7
Epifaunal Substrate/Available Cover	4	Vegetative Protection - Right Bank	7
Pool Substrate Characterization	5		
RBP Habitat Score			**74**
RBP Narrative Rating			**Non Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	15	80.78	Instream Wood Debris	6	74.48
Shading	90	91.34	Instream Habitat	2	33.05
Epifaunal Substrate	4	42.06	Bank Stability	18	94.87
PHI Score					**69.43**
PHI Narrative Rating					**Partially Degraded**

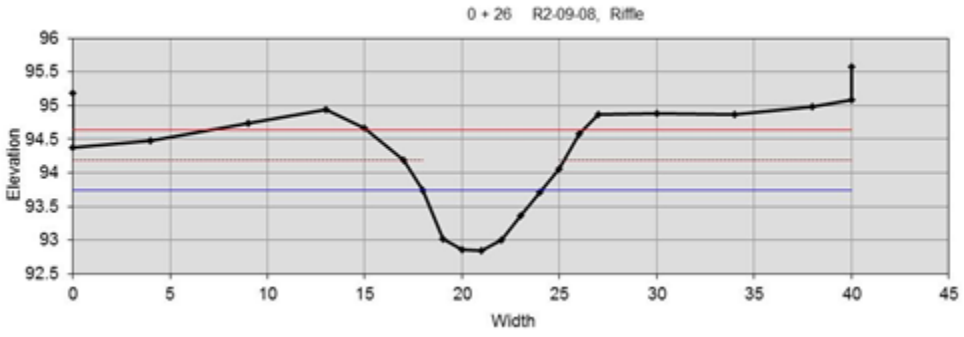
Water Chemistry

Dissolved Oxygen (mg/L)	9.32	pH (SU)	5.27
Turbidity (NTU)	25	Specific Conductivity (µS/cm)	260.9
Temperature (°C)	8.76		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.49	Cross Sectional Area (ft^2)	3.64
Bankfull Width (ft)	6.09	Water Surface Slope (%)	0.59
Mean Bankfull Depth (ft)	0.6	Sinuosity	1
Floodprone Width (ft)	18.23	D50 (mm)	0.27
Entrenchment Ratio	3	Adjustments?	None
Width to Depth Ratio	10.19	**Rosgen Stream Type**	**ND**



R2-09-09 Severn Run Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.1293592841 **Longitude:** -76.6593769965

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**270.9**
Cover	**Acres**	**% Area**
Developed Land	**162.5**	**60**
Airport	0	0
Commercial	3.3	1.2
Industrial	0	0
Residential 1/8-acre	6.5	2.4
Residential 1/4-acre	13	4.8
Residential 1/2-acre	1.6	0.6
Residential 1-Acre	47.4	17.5
Residential 2-Acre	79.9	29.5
Transportation	10.8	4
Utility	0	0
Forest Land	**101.9**	**37.6**
Forested Wetland	0	0
Residential Woods	0	0
Woods	101.9	37.6
Open Land	**6.6**	**2.4**
Open Space	6.6	2.4
Open Wetland	0	0
Water	0	0
Agricultural Land	**0**	**0**
Pasture/Hay	0	0
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	40.9	15.1

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Comparable to Reference"* and *"Minimally Degraded"*
- Amphipods (Synurella) and stoneflies (Nemouridae) dominated the sample. Scored high in most metric categories.
- Measured below COMAR standards for pH. Elevated turbidity levels due to construction upstream.
- Poor visibility of channel bed and features due to excessive turbidity. Sub-optimal habitat diversity. Stable, well-vegetated banks with good 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.
- Investigate potential water quality impacts from residential land uses.

R2-09-09 Severn Run Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	20
EPT Taxa	2
Ephemeroptera Taxa	0
%Intolerant Urban	30.1
%Ephemeroptera	0
Scraper Taxa	3
% Climbers	1.9

Calculated Metric Scores

Total Taxa	3
EPT Taxa	3
Ephemeroptera Taxa	1
Intolerant Urban %	5
Ephemeroptera %	1
Scraper Taxa	5
% Climbers	3
BIBI Score	**3**
BIBI Narrative Rating	**Fair**

Taxa	Count
Asellidae	1
Brachycera	4
Chrysops	1
Helichus	1
Hydrobaenus	8
Libellulidae	4
Menetus	1
Molophilus	1
Nemouridae	20
Orthocladiinae	1
Parametriocnemus	4
Phaenopsectra	1
Pisidiidae	2
Polypedilum	1
Pseudorthocladius	1
Rheocricotopus	3
Simulium	2
Stegopterna	10
Synurella	28
Thienemanniella	1
Tipula	2
Trichoptera	6
TOTAL:	**103**

Physical Habitat Assessment

RBP 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	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	20	Sediment Deposition	12
Channel Sinuosity	8	Vegetative Protection - Left Bank	10
Epifaunal Substrate/Available Cover	11	Vegetative Protection - Right Bank	10
Pool Substrate Characterization	11		
RBP Habitat Score			**152**
RBP Narrative Rating			**Comparable to Reference**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	12	64.62	Instream Wood Debris	7	79
Shading	100	100	Instream Habitat	11	84.39
Epifaunal Substrate	12	89.43	Bank Stability	20	100
PHI Score					**86.24**
PHI Narrative Rating					**Minimally Degraded**

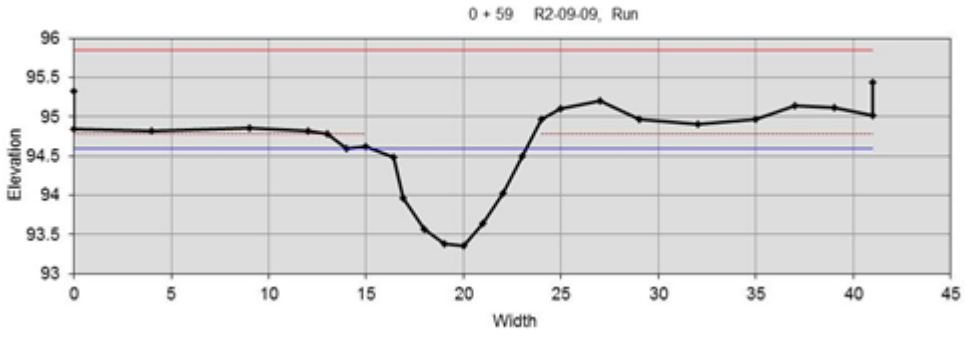
Water Chemistry

Dissolved Oxygen (mg/L)	10.2	pH (SU)	6.08
Turbidity (NTU)	1000	Specific Conductivity (µS/cm)	152.6
Temperature (°C)	8.96		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.42	Cross Sectional Area (ft^2)	5.75
Bankfull Width (ft)	8.02	Water Surface Slope (%)	0.71
Mean Bankfull Depth (ft)	0.72	Sinuosity	1.03
Floodprone Width (ft)	95	D50 (mm)	0.12
Entrenchment Ratio	11.85	Adjustments?	None
Width to Depth Ratio	11.19	**Rosgen Stream Type**	**E5**



R2-09-10 Severn Run Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.0775184364 **Longitude:** -76.6403406622

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**2406.8**
Cover	**Acres**	**% Area**
Developed Land	**935**	**39.7**
Airport	0	0
Commercial	77.5	3.2
Industrial	20.3	0.8
Residential 1/8-acre	65.4	2.7
Residential 1/4-acre	158.6	6.6
Residential 1/2-acre	26.2	1.1
Residential 1-Acre	54.1	2.2
Residential 2-Acre	424.4	17.6
Transportation	119.2	5
Utility	9.5	0.4
Forest Land	**1151.6**	**47.8**
Forested Wetland	0	0
Residential Woods	0	0
Woods	1151.6	47.8
Open Land	**116.9**	**4.9**
Open Space	115.2	4.8
Open Wetland	0	0
Water	1.7	0.1
Agricultural Land	**183**	**7.6**
Pasture/Hay	128.1	5.3
Row Crops	54.9	2.3
Impervious Surface	**Acres**	**% Area**
Impervious Land	279.5	11.6

Summary Results:

- Biological condition – *"Good"*
- Habitat scores *"Supporting"* and *"Partially Degraded"*
- Polycentropus (caddisfly) and beetles (Anchytarsus and Stenelmis) dominated the sample. Scored high in all metric categories.
- Measured below COMAR standards for pH.
- Sub-optimal habitat diversity with an abundance of rootwads/woody debris. Several undercut and raw/unstable banks; however, very 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.

R2-09-10 Severn Run Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	32
EPT Taxa	8
Ephemeroptera Taxa	1
%Intolerant Urban	36.8
%Ephemeroptera	3.8
Scraper Taxa	5
% Climbers	5.7

Calculated Metric Scores

Total Taxa	5
EPT Taxa	5
Ephemeroptera Taxa	3
Intolerant Urban %	5
Ephemeroptera %	3
Scraper Taxa	5
% Climbers	3
BIBI Score	**4.14**
BIBI Narrative Rating	**Good**

Taxa	Count
Acerpenna	4
Anchytarsus	13
Ancyronyx	3
Boyeria	2
Brillia	1
Cheumatopsyche	2
Chironomini	1
Conchapelopia	1
Corynoneura	1
Diplectrona	4
Dubiraphia	1
Enchytraeidae	1
Eukiefferiella	1
Haploperla	3
Helichus	7
Hydropsyche	1
Leptoceridae	1
Lumbricina	1
Lumbriculidae	1
Micropsectra	3
Nigronia	2
Orthocladiinae	3
Oulimnius	2
Parametriocnemus	2
Phaenopsectra	1
Polycentropus	18
Polypedilum	1
Prosimulium	3
Pycnopsyche	1
Rheotanytarsus	3
Stenelmis	12
Thienemannimyia_group	1
Tipula	1
Trichoptera	1
Tvetenia	3
TOTAL:	**106**

Physical Habitat Assessment

RBP Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	3	Pool Variability	15
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	15	Sediment Deposition	11
Channel Sinuosity	12	Vegetative Protection - Left Bank	5
Epifaunal Substrate/Available Cover	14	Vegetative Protection - Right Bank	7
Pool Substrate Characterization	13		
RBP Habitat Score			**140**
RBP Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	15	80.78	Instream Wood Debris	15	77.94
Shading	95	99.94	Instream Habitat	13	73.13
Epifaunal Substrate	14	86.82	Bank Stability	8	63.25
PHI Score					**80.31**
PHI Narrative Rating					**Partially Degraded**

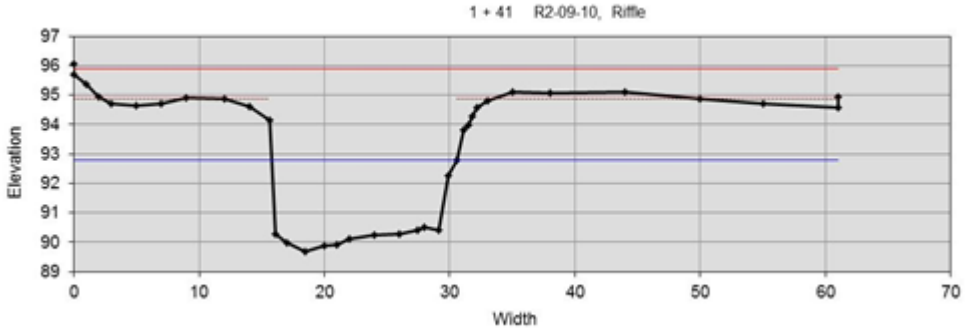
Water Chemistry

Dissolved Oxygen (mg/L)	12.22	pH (SU)	6.06
Turbidity (NTU)	9.24	Specific Conductivity (µS/cm)	158
Temperature (°C)	5.67		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	3.76	Cross Sectional Area (ft^2)	36.43
Bankfull Width (ft)	14.83	Water Surface Slope (%)	0.38
Mean Bankfull Depth (ft)	2.46	Sinuosity	1.09
Floodprone Width (ft)	90	D50 (mm)	0.38
Entrenchment Ratio	6.07	Adjustments?	None
Width to Depth Ratio	6.03	**Rosgen Stream Type**	**E5/4**



R2-09-12A Severn Run Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.0911691368 **Longitude:** -76.6592605845

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**471.4**
Cover	**Acres**	**% Area**
Developed Land	**65**	**20.3**
Airport	0	0
Commercial	0	0
Industrial	30.9	6.6
Residential 1/8-acre	0	0
Residential 1/4-acre	7.5	1.6
Residential 1/2-acre	0	0
Residential 1-Acre	1.2	0.2
Residential 2-Acre	42	8.9
Transportation	5.3	1.1
Utility	9.1	1.9
Forest Land	**215.8**	**45.8**
Forested Wetland	0	0
Residential Woods	0	0
Woods	215.8	45.8
Open Land	**159.6**	**33.9**
Open Space	159.6	33.9
Open Wetland	0	0
Water	0	0
Agricultural Land	**0**	**0**
Pasture/Hay	0	0
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	37.9	8

Summary Results:

- Biological condition – *"Good"*
- Habitat scores *"Supporting"* and *"Partially Degraded"*
- Polypedilum (midge) and Stegopterna (black fly) dominated the sample. Scored high in all metric categories.
- Water quality values within COMAR standards but conductivity elevated.
- Sub-optimal instream habitat and epibenthic substrate. Moderately stable, well-vegetated banks with good riparian width.
- Bimodal distribution of substrate (sand/gravel).

Recommendations:

- Maintain the protection of the riparian areas.

R2-09-12A Severn Run Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	24
EPT Taxa	6
Ephemeroptera Taxa	1
%Intolerant Urban	19.5
%Ephemeroptera	2.7
Scraper Taxa	3
% Climbers	37.2

Calculated Metric Scores

Total Taxa	5
EPT Taxa	5
Ephemeroptera Taxa	3
Intolerant Urban %	3
Ephemeroptera %	3
Scraper Taxa	5
% Climbers	5
BIBI Score	**4.14**
BIBI Narrative Rating	**Good**

Taxa	Count
Acerpenna	3
Amphinemura	1
Chaetocladius	1
Cheumatopsyche	8
Diplectrona	4
Dubiraphia	1
Heteroplectron	1
Ironoquia	1
Macronychus	3
Micropsectra	1
Naididae	1
Neoporus	1
Orthocladius	5
Parametriocnemus	6
Polypedilum	38
Rheocricotopus	3
Rheotanytarsus	2
Simulium	4
Stegopterna	12
Stenelmis	3
Tanytarsus	3
Thienemanniella	1
Thienemannimyia_group	8
Tvetenia	2
TOTAL:	**113**

Physical Habitat Assessment

RBP Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	8	Pool Variability	12
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	11	Sediment Deposition	9
Channel Sinuosity	13	Vegetative Protection - Left Bank	8
Epifaunal Substrate/Available Cover	13	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	11		
RBP Habitat Score			**140**
RBP Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	11	59.24	Instream Wood Debris	5	66.81
Shading	90	91.34	Instream Habitat	12	84.27
Epifaunal Substrate	13	91.63	Bank Stability	15	86.61
PHI Score					**79.98**
PHI Narrative Rating					**Partially Degraded**

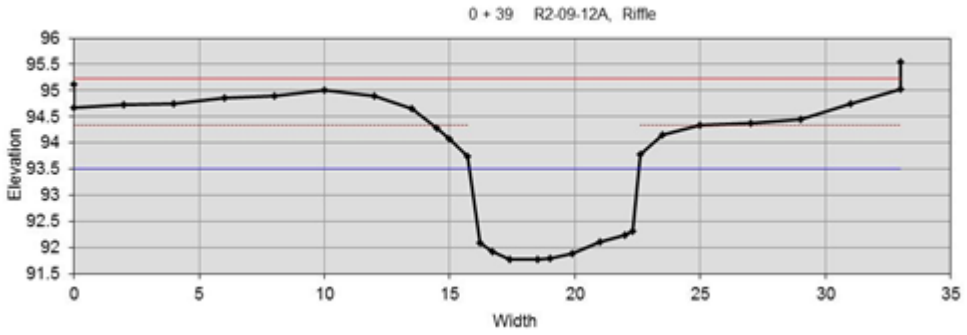
Water Chemistry

Dissolved Oxygen (mg/L)	9.62	pH (SU)	6.77
Turbidity (NTU)	20.9	Specific Conductivity (µS/cm)	326.4
Temperature (°C)	16.83		

Geomorphic Assessment

Rosgen Level II Classification Data

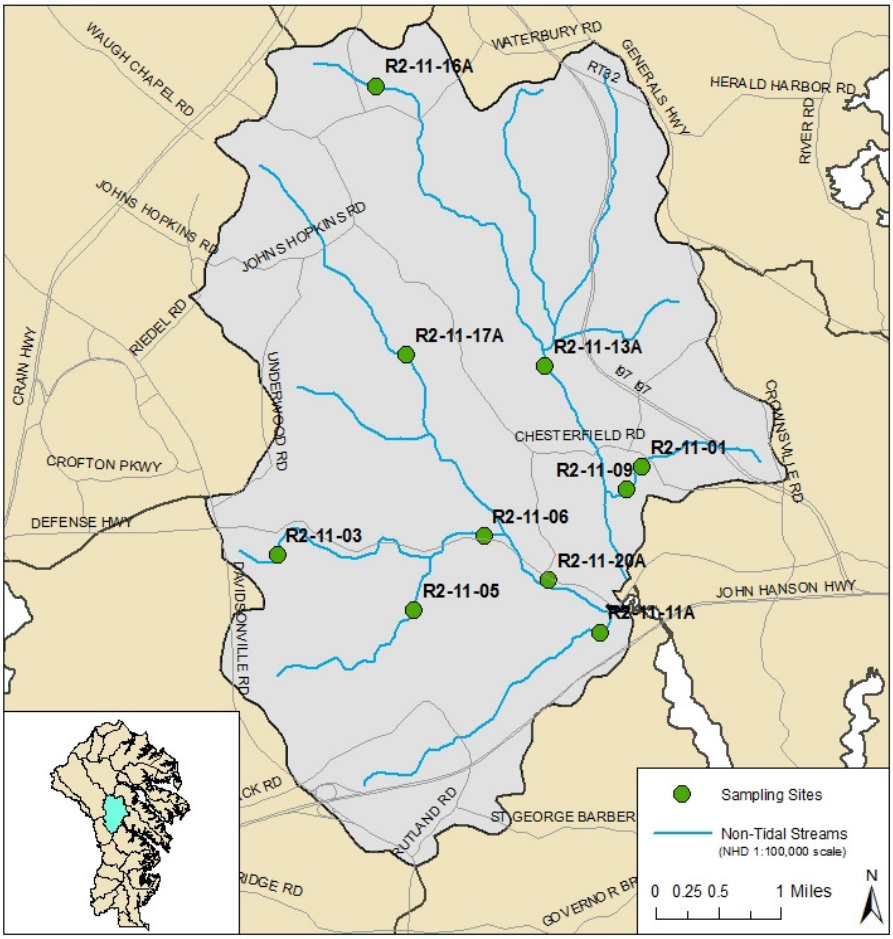
Drainage Area (mi^2)	0.74	Cross Sectional Area (ft^2)	9.97
Bankfull Width (ft)	6.77	Water Surface Slope (%)	0.62
Mean Bankfull Depth (ft)	1.47	Sinuosity	1.26
Floodprone Width (ft)	45	D50 (mm)	0.48
Entrenchment Ratio	6.65	Adjustments?	None
Width to Depth Ratio	4.6	**Rosgen Stream Type**	**E5/4**



Upper North River Sampling Unit

Site Condition Summary

Site	Drainage Area (acres)	Drainage Area (mi^2)	Percent Impervious	Percent Developed	Percent Forested	Percent Agriculture	Percent Open	BIBI Narrative Rating	PHI Narrative Rating	RBP Narrative Rating	Rosgen Stream Type - L1
R2-11-01	688.6	1.08	10.0	30.4	59.4	2.8	7.4	Fair	Minimally Degraded	Supporting	E
R2-11-03	156.4	0.24	13.6	39.2	57.9	0.0	2.9	Very Poor	Partially Degraded	Supporting	E
R2-11-05	1086.9	1.70	5.1	18.2	56.9	23.7	1.2	Poor	Partially Degraded	Partially Supporting	F
R2-11-06	2213.0	3.46	7.4	15.0	71.4	12.3	1.3	Good	Degraded	Supporting	DA
R2-11-09	741.4	1.16	9.4	28.6	61.7	2.6	7.0	Fair	Degraded	Non Supporting	F
R2-11-11A	1404.2	2.19	10.2	35.6	50.3	9.8	4.3	Poor	Partially Degraded	Comparable to Reference	E
R2-11-13A	4017.8	6.28	7.2	25.3	59.9	10.0	4.8	Poor	Partially Degraded	Comparable to Reference	E
R2-11-16A	398.9	0.62	11.2	39.6	19.0	31.1	10.3	Poor	Degraded	Non Supporting	C
R2-11-17A	1707.1	2.67	10.8	37.0	51.0	7.9	4.1	Very Poor	Partially Degraded	Comparable to Reference	E
R2-11-20A	5665.9	8.85	8.0	24.6	64.1	9.0	2.3	Poor	Degraded	Supporting	ND



R2-11-01 Upper North River Sampling Unit

Upstream View:

Downstream View:

Latitude: 38.9994264882 **Longitude:** -76.6077250488

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		688.6
Cover	**Acres**	**% Area**
Developed Land	**209.3**	**30.4**
Airport	0	0
Commercial	17.4	2.5
Industrial	0	0
Residential 1/8-acre	33.8	4.9
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	70.8	10.3
Residential 2-Acre	46.9	6.8
Transportation	40.3	5.9
Utility	0	0
Forest Land	**409.1**	**59.4**
Forested Wetland	0	0
Residential Woods	0	0
Woods	409.1	59.4
Open Land	**50.6**	**7.4**
Open Space	50.6	7.4
Open Wetland	0	0
Water	0	0
Agricultural Land	**19.6**	**2.8**
Pasture/Hay	0.5	0.1
Row Crops	19.1	2.8
Impervious Surface	**Acres**	**% Area**
Impervious Land	68.8	10

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Supporting"* and *"Minimally Degraded"*
- This sample contained 32 taxa including Rheotanytarsus and Parametriocneums (both midges) and Anchytarsus (beetle). Scored high in most metric categories.
- Water quality values within COMAR standards but conductivity elevated.
- Sub-optimal instream habitat and epibenthic substrate with abundant rootwads/woody debris providing stable habitat. Moderately stable banks with good vegetative protection and riparian width.

Recommendations:

- Maintain the protection of the riparian areas.

R2-11-01 Upper North River Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	32
EPT Taxa	6
Ephemeroptera Taxa	1
%Intolerant Urban	17.9
%Ephemeroptera	0.9
Scraper Taxa	0
% Climbers	13.2

Calculated Metric Scores

Total Taxa	5
EPT Taxa	5
Ephemeroptera Taxa	3
Intolerant Urban %	3
Ephemeroptera %	3
Scraper Taxa	1
% Climbers	5
BIBI Score	**3.57**
BIBI Narrative Rating	**Fair**

Taxa	Count
Amphinemura	1
Anchytarsus	17
Bezzia_Palpomyia	1
Brillia	1
Caecidotea	1
Ceratopsyche	1
Conchapelopia	1
Corynoneura	2
Diplocladius	1
Hemerodromia	2
Heterotrissocladius	2
Leptophlebiidae	1
Leuctra	1
Limnephilidae	1
Nigronia	1
Orthocladiinae	1
Orthocladius	1
Parametriocnemus	12
Pisidiidae	1
Plecoptera	2
Polycentropus	9
Polypedilum	4
Probezzia	1
Rheotanytarsus	16
Sperchon	1
Stempellinella	5
Stenochironomus	1
Synurella	4
Tanytarsini	1
Tanytarsus	4
Thienemanniella	2
Thienemannimyia_group	2
Tipula	3
Tubificidae	1
Turbellaria	1
TOTAL:	**106**

Physical Habitat Assessment

RBP Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	6	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	14	Sediment Deposition	9
Channel Sinuosity	13	Vegetative Protection - Left Bank	7
Epifaunal Substrate/Available Cover	14	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	12		
RBP Habitat Score			**140**
RBP Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	12	64.62	Instream Wood Debris	9	74.36
Shading	95	99.94	Instream Habitat	15	97.04
Epifaunal Substrate	14	94.97	Bank Stability	13	80.63
PHI Score					**85.26**
PHI Narrative Rating					**Minimally Degraded**

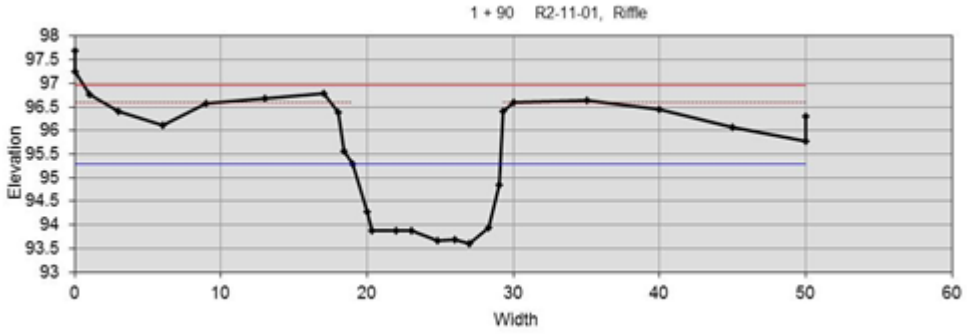
Water Chemistry

Dissolved Oxygen (mg/L)	12.44	pH (SU)	6.92
Turbidity (NTU)	3.14	Specific Conductivity (µS/cm)	257.1
Temperature (°C)	3.8		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	1.08	Cross Sectional Area (ft^2)	13.54
Bankfull Width (ft)	10.08	Water Surface Slope (%)	0.34
Mean Bankfull Depth (ft)	1.34	Sinuosity	1.12
Floodprone Width (ft)	240	D50 (mm)	0.22
Entrenchment Ratio	23.8	Adjustments?	None
Width to Depth Ratio	7.51	**Rosgen Stream Type**	**E5**



R2-11-03 Upper North River Sampling Unit

Upstream View:

Downstream View:

Latitude: 38.9894593629 **Longitude:** -76.6619701798

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**156.4**
Cover	**Acres**	**% Area**
Developed Land	**54.9**	**39.2**
Airport	0	0
Commercial	4.8	3.1
Industrial	6.4	4.1
Residential 1/8-acre	1.9	1.2
Residential 1/4-acre	6.2	4
Residential 1/2-acre	0	0
Residential 1-Acre	3.8	2.4
Residential 2-Acre	29.5	18.8
Transportation	8.7	5.5
Utility	0	0
Forest Land	**90.6**	**57.9**
Forested Wetland	0	0
Residential Woods	5.9	3.8
Woods	84.6	54.1
Open Land	**4.6**	**2.9**
Open Space	4.6	2.9
Open Wetland	0	0
Water	0	0
Agricultural Land	**0**	**0**
Pasture/Hay	0	0
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	21.4	13.6

Summary Results:

- Biological condition – *"Very Poor"*
- Habitat scores *"Supporting"* and *"Partially Degraded"*
- Tubificidae (worm) and Polypedilum (midge) dominated the sample. Scored high for percent climbers because of presence of Polypedilum.
- Measured below COMAR standards for pH and conductivity elevated.
- Marginal instream habitat and epibenthic substrate with rootwads, woody debris, and leaf packs providing most of the habitat for benthos. Moderately stable banks with good vegetative protection and riparian width.

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.

R2-11-03 Upper North River Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	17
EPT Taxa	0
Ephemeroptera Taxa	0
%Intolerant Urban	4.6
%Ephemeroptera	0
Scraper Taxa	0
% Climbers	29.4

Calculated Metric Scores

Total Taxa	3
EPT Taxa	1
Ephemeroptera Taxa	1
Intolerant Urban %	1
Ephemeroptera %	1
Scraper Taxa	1
% Climbers	5
BIBI Score	**1.86**
BIBI Narrative Rating	**Very Poor**

Taxa	Count
Bezzia_Palpomyia	1
Chironomini	4
Cordulegaster	3
Enchytraeidae	2
Eriopterini	1
Heterotrissocladius	1
Limnophyes	8
Micropsectra	1
Orthocladiinae	2
Paracladopelma	1
Paratendipes	1
Phaenopsectra	10
Polypedilum	30
Prostoma	1
Scirtes	1
Thienemannimyia_group	1
Tipula	3
Tubificidae	37
TOTAL:	**108**

Physical Habitat Assessment

RBP Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	8	Pool Variability	7
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	14	Sediment Deposition	10
Channel Sinuosity	16	Vegetative Protection - Left Bank	9
Epifaunal Substrate/Available Cover	7	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	6		
RBP Habitat Score			**131**
RBP Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	16	86.16	Instream Wood Debris	1	67.47
Shading	95	99.94	Instream Habitat	7	67.82
Epifaunal Substrate	8	69.77	Bank Stability	15	86.61
PHI Score					**79.63**
PHI Narrative Rating					**Partially Degraded**

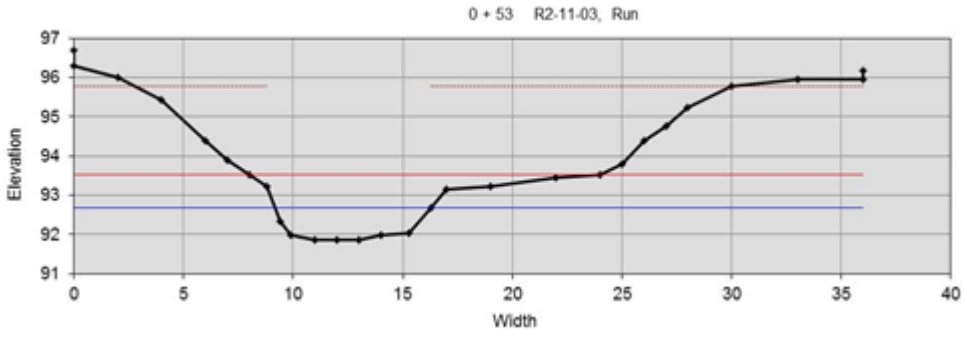
Water Chemistry

Dissolved Oxygen (mg/L)	10.44	pH (SU)	6.11
Turbidity (NTU)	11.6	Specific Conductivity (µS/cm)	277.3
Temperature (°C)	9.6		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.24	Cross Sectional Area (ft^2)	4.76
Bankfull Width (ft)	7.13	Water Surface Slope (%)	0.82
Mean Bankfull Depth (ft)	0.67	Sinuosity	1.45
Floodprone Width (ft)	15.66	D50 (mm)	0.21
Entrenchment Ratio	2.2	Adjustments?	None
Width to Depth Ratio	10.69	**Rosgen Stream Type**	**E5**



R2-11-05 Upper North River Sampling Unit

Upstream View:

Downstream View:

Latitude: 38.9829270901 **Longitude:** -76.641654497

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		1086.9
Cover	**Acres**	**% Area**
Developed Land	**198.2**	**18.2**
Airport	0	0
Commercial	1.7	0.2
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	2.6	0.2
Residential 1-Acre	71	6.5
Residential 2-Acre	101.3	9.3
Transportation	21.6	2
Utility	0	0
Forest Land	**618.4**	**56.9**
Forested Wetland	0	0
Residential Woods	79.1	7.3
Woods	539.3	49.6
Open Land	**12.5**	**1.2**
Open Space	10.9	1
Open Wetland	0	0
Water	1.6	0.1
Agricultural Land	**257.7**	**23.7**
Pasture/Hay	70.9	6.5
Row Crops	186.8	17.2
Impervious Surface	**Acres**	**% Area**
Impervious Land	55.5	5.1

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Parametriocnemus and Rheotanytarsus (midges) dominated the sample. Scored high for number of taxa.
- Water quality values within COMAR standards.
- Deeply incised channel with heavily eroded/undercut banks. Large stable rootwads and woody debris providing most habitat. Poor vegetative protection on banks 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.

R2-11-05 Upper North River Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	23
EPT Taxa	4
Ephemeroptera Taxa	0
%Intolerant Urban	12.7
%Ephemeroptera	0
Scraper Taxa	0
% Climbers	7.3

Calculated Metric Scores

Total Taxa	5
EPT Taxa	3
Ephemeroptera Taxa	1
Intolerant Urban %	3
Ephemeroptera %	1
Scraper Taxa	1
% Climbers	3
BIBI Score	**2.43**
BIBI Narrative Rating	**Poor**

Taxa	Count
Alotanypus	1
Amphinemura	2
Anchytarsus	7
Bezzia_Palpomyia	1
Brillia	4
Chironomini	1
Corynoneura	1
Diplectrona	1
Hemerodromia	2
Heterotrissocladius	1
Leuctra	2
Limnophyes	1
Nemata	1
Nigronia	3
Orthocladius	2
Paralauterborniella	1
Parametriocnemus	38
Plecoptera	3
Polycentropus	2
Polypedilum	8
Rheocricotopus	1
Rheotanytarsus	17
Thienemanniella	1
Thienemannimyia_group	8
Tipula	1
TOTAL:	**110**

Physical Habitat Assessment

RBP Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	2	Pool Variability	15
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	10
Channel Sinuosity	11	Vegetative Protection - Left Bank	2
Epifaunal Substrate/Available Cover	11	Vegetative Protection - Right Bank	3
Pool Substrate Characterization	7		
RBP Habitat Score			**118**
RBP Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	14	75.39	Instream Wood Debris	5	57.36
Shading	95	99.94	Instream Habitat	12	75.72
Epifaunal Substrate	11	74.57	Bank Stability	4	44.72
PHI Score					**71.28**
PHI Narrative Rating					**Partially Degraded**

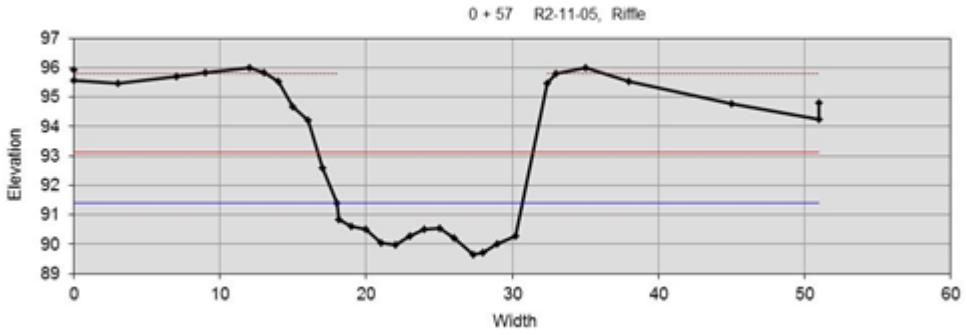
Water Chemistry

Dissolved Oxygen (mg/L)	13.07	pH (SU)	6.53
Turbidity (NTU)	4.76	Specific Conductivity (µS/cm)	169.9
Temperature (°C)	3.43		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	1.7	Cross Sectional Area (ft^2)	14.46
Bankfull Width (ft)	12.67	Water Surface Slope (%)	0.54
Mean Bankfull Depth (ft)	1.14	Sinuosity	1.25
Floodprone Width (ft)	14.74	D50 (mm)	0.32
Entrenchment Ratio	1.16	Adjustments?	Yes, WD +1.0
Width to Depth Ratio	11.1	**Rosgen Stream Type**	**F5**



R2-11-06 Upper North River Sampling Unit

Upstream View:

Downstream View:

Latitude: 38.9914553003 **Longitude:** -76.6312456861

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		2213
Cover	**Acres**	**% Area**
Developed Land	**322.2**	**15**
Airport	0	0
Commercial	9.3	0.4
Industrial	8.9	0.4
Residential 1/8-acre	1.9	0.1
Residential 1/4-acre	6.2	0.3
Residential 1/2-acre	2.6	0.1
Residential 1-Acre	78.5	3.5
Residential 2-Acre	166.5	7.5
Transportation	57.1	2.6
Utility	0	0
Forest Land	**1580.9**	**71.4**
Forested Wetland	0	0
Residential Woods	405.2	18.3
Woods	1175.7	53.1
Open Land	**28.8**	**1.3**
Open Space	27.3	1.2
Open Wetland	0	0
Water	1.6	0.1
Agricultural Land	**272.2**	**12.3**
Pasture/Hay	75.6	3.4
Row Crops	196.6	8.9
Impervious Surface	**Acres**	**% Area**
Impervious Land	164.2	7.4

Summary Results:

- Biological condition – *"Good"*
- Habitat scores *"Supporting"* and *"Degraded"*
- Parametriocnemus and Polypedilum (midges) dominated the sample. Scored high in all metric categories.
- Water quality values within COMAR standards.
- Marginal instream habitat and epibenthic substrate with little woody debris. Stable banks with good vegetative protection and riparian width. Refuse present in moderate amounts.

Recommendations:

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

R2-11-06 Upper North River Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	29
EPT Taxa	7
Ephemeroptera Taxa	2
%Intolerant Urban	10.2
%Ephemeroptera	2.8
Scraper Taxa	4
% Climbers	24.1

Calculated Metric Scores

Total Taxa	5
EPT Taxa	5
Ephemeroptera Taxa	5
Intolerant Urban %	3
Ephemeroptera %	3
Scraper Taxa	5
% Climbers	5
BIBI Score	**4.43**
BIBI Narrative Rating	**Good**

Taxa	Count
Acerpenna	2
Alotanypus	1
Amphinemura	1
Anchytarsus	2
Ancyronyx	1
Asellidae	1
Bezzia_Palpomyia	1
Brillia	4
Cheumatopsyche	1
Diplectrona	1
Diplocladius	1
Gammarus	1
Helichus	2
Lype	2
Maccaffertium	1
Naididae	2
Nemata	1
Nigronia	1
Orthocladiinae	1
Orthocladius	2
Parametriocnemus	35
Paratendipes	1
Plecoptera	1
Polycentropus	4
Polypedilum	25
Prostoma	2
Rheocricotopus	1
Rheotanytarsus	3
Stempellinella	1
Thienemannimyia_group	2
Tubificidae	4
TOTAL:	**108**

Physical Habitat Assessment

RBP Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	9	Pool Variability	9
Bank Stability- Right Bank	9	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	15	Riparian Vegetative Zone Width- Right Bank	7
Channel Flow Status	20	Sediment Deposition	11
Channel Sinuosity	6	Vegetative Protection - Left Bank	9
Epifaunal Substrate/Available Cover	7	Vegetative Protection - Right Bank	9
Pool Substrate Characterization	9		
RBP Habitat Score			**130**
RBP Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	6	32.31	Instream Wood Debris	1	37.47
Shading	95	99.94	Instream Habitat	7	40.7
Epifaunal Substrate	8	52.51	Bank Stability	18	94.87
PHI Score					**59.63**
PHI Narrative Rating					**Degraded**

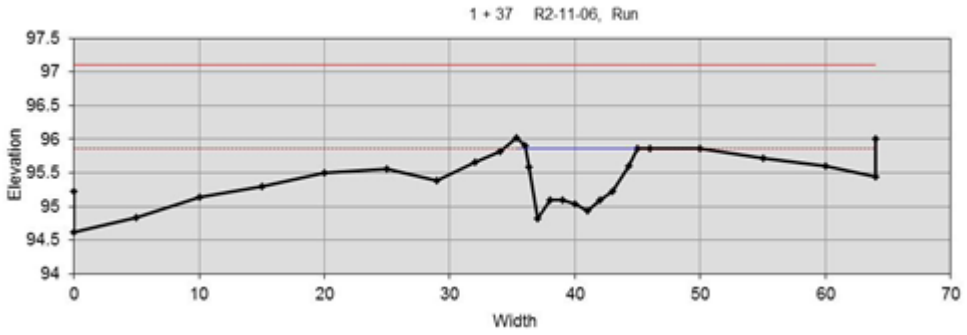
Water Chemistry

Dissolved Oxygen (mg/L)	12.03	pH (SU)	6.65
Turbidity (NTU)	5.16	Specific Conductivity (µS/cm)	211.3
Temperature (°C)	6.87		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	3.46	Cross Sectional Area (ft^2)	6.04
Bankfull Width (ft)	8.96	Water Surface Slope (%)	0.16
Mean Bankfull Depth (ft)	0.67	Sinuosity	1.04
Floodprone Width (ft)	320	D50 (mm)	0.13
Entrenchment Ratio	35.7	Adjustments?	None
Width to Depth Ratio	13.29	**Rosgen Stream Type**	**DA5**



R2-11-09 Upper North River Sampling Unit

Upstream View:

Downstream View:

Latitude: 38.996883023 **Longitude:** -76.6100868551

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**741.4**
Cover	**Acres**	**% Area**
Developed Land	**212.2**	**28.6**
Airport	0	0
Commercial	17.4	2.4
Industrial	0	0
Residential 1/8-acre	33.8	4.6
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	70.8	9.6
Residential 2-Acre	49.5	6.7
Transportation	40.7	5.5
Utility	0	0
Forest Land	**457.5**	**61.7**
Forested Wetland	0	0
Residential Woods	0	0
Woods	457.5	61.7
Open Land	**52.2**	**7**
Open Space	52.2	7
Open Wetland	0	0
Water	0	0
Agricultural Land	**19.6**	**2.6**
Pasture/Hay	0.5	0.1
Row Crops	19.1	2.6
Impervious Surface	**Acres**	**% Area**
Impervious Land	69.4	9.4

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Non Supporting"* and *"Degraded"*
- Parametriocnemus and Polypedilum (midges) dominated the sample. Scored high in most metric categories.
- Water quality values within COMAR standards.
- Marginal habitat diversity. Channel incised and over widened with severely eroded banks and heavy sediment deposition. Good riparian width.

Recommendations:

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

R2-11-09 Upper North River Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	29
EPT Taxa	5
Ephemeroptera Taxa	1
%Intolerant Urban	9
%Ephemeroptera	0.9
Scraper Taxa	1
% Climbers	27.9

Calculated Metric Scores

Total Taxa	5
EPT Taxa	5
Ephemeroptera Taxa	3
Intolerant Urban %	1
Ephemeroptera %	3
Scraper Taxa	3
% Climbers	5
BIBI Score	**3.57**
BIBI Narrative Rating	**Fair**

Taxa	Count
Anchytarsus	4
Apsectrotanypus	1
Boyeria	2
Brillia	1
Caecidotea	1
Chironomidae	1
Chironomini	1
Corynoneura	6
Eriopterini	1
Heterotrissocladius	1
Leptophlebiidae	1
Leuctra	2
Lype	2
Nigronia	1
Orthocladius	3
Parametriocnemus	24
Phaenopsectra	5
Plecoptera	3
Polycentropus	1
Polypedilum	27
Pycnopsyche	1
Rheocricotopus	1
Rheotanytarsus	6
Stempellinella	1
Stygobromus	1
Tanytarsus	1
Thienemanniella	2
Thienemannimyia_group	2
Tipula	2
Tubificidae	2
Xylotopus	1
TOTAL:	**108**

Physical Habitat Assessment

RBP Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	2	Pool Variability	6
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	12	Sediment Deposition	4
Channel Sinuosity	8	Vegetative Protection - Left Bank	3
Epifaunal Substrate/Available Cover	6	Vegetative Protection - Right Bank	3
Pool Substrate Characterization	6		
RBP Habitat Score			**92**
RBP Narrative Rating			**Non Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	16	86.16	Instream Wood Debris	6	64.65
Shading	95	99.94	Instream Habitat	5	40.8
Epifaunal Substrate	6	48.02	Bank Stability	4	44.72
PHI Score					**64.05**
PHI Narrative Rating					**Degraded**

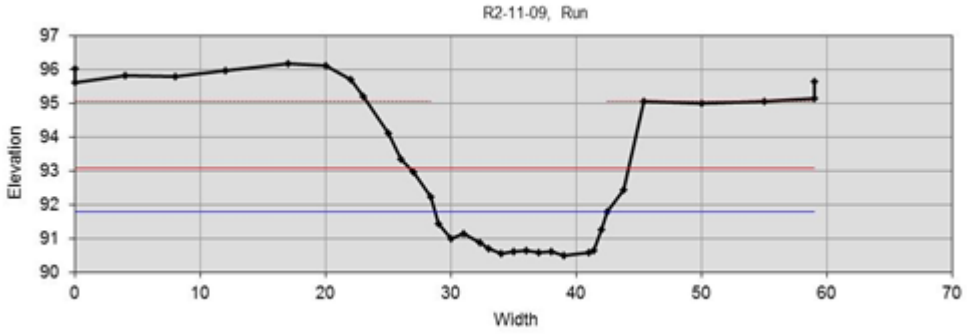
Water Chemistry

Dissolved Oxygen (mg/L)	12.76	pH (SU)	7
Turbidity (NTU)	3.74	Specific Conductivity (µS/cm)	240.2
Temperature (°C)	3.1		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	1.16	Cross Sectional Area (ft^2)	13.99
Bankfull Width (ft)	13.77	Water Surface Slope (%)	0.2
Mean Bankfull Depth (ft)	1.02	Sinuosity	1.07
Floodprone Width (ft)	17.54	D50 (mm)	0.16
Entrenchment Ratio	1.27	Adjustments?	None
Width to Depth Ratio	13.55	**Rosgen Stream Type**	**F5**



R2-11-11A Upper North River Sampling Unit

Upstream View:

Downstream View:

Latitude: 38.980298569 **Longitude:** -76.6141452737

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		1404.2
Cover	**Acres**	**% Area**
Developed Land	**499.7**	**35.6**
Airport	0	0
Commercial	9.6	0.7
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0.1	0
Residential 1-Acre	139.7	10
Residential 2-Acre	230	16.4
Transportation	90.6	6.4
Utility	29.7	2.1
Forest Land	**706.8**	**50.3**
Forested Wetland	0	0
Residential Woods	0	0
Woods	706.8	50.3
Open Land	**59.8**	**4.3**
Open Space	54.8	3.9
Open Wetland	2.9	0.2
Water	2.2	0.2
Agricultural Land	**137.8**	**9.8**
Pasture/Hay	60.2	4.3
Row Crops	77.6	5.5
Impervious Surface	**Acres**	**% Area**
Impervious Land	143.5	10.2

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Comparable to Reference"* and *"Partially Degraded"*
- Simuliidae (black fly), Cheumatopsyche (caddisfly), and midges Polypedilum and Rheotanytarsus dominated the sample. Scored high for scraper taxa and percent climbers.
- Water quality values within COMAR standards but conductivity elevated.
- Sub-optimal instream habitat and epibenthic substrate. Abundant woody debris and rootwads providing most of the stable habitat for benthos. Good 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.

R2-11-11A Upper North River Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	18
EPT Taxa	2
Ephemeroptera Taxa	0
%Intolerant Urban	5.3
%Ephemeroptera	0
Scraper Taxa	2
% Climbers	17.7

Calculated Metric Scores

Total Taxa	3
EPT Taxa	3
Ephemeroptera Taxa	1
Intolerant Urban %	1
Ephemeroptera %	1
Scraper Taxa	5
% Climbers	5
BIBI Score	**2.71**
BIBI Narrative Rating	**Poor**

Taxa	Count
Caecidotea	6
Cheumatopsyche	18
Hemerodromia	3
Hydrobaenus	1
Hydropsyche	1
Orthocladiinae	1
Orthocladius	5
Parametriocnemus	2
Polypedilum	11
Pseudorthocladius	1
Pseudosmittia	1
Rheotanytarsus	13
Simuliidae	24
Simulium	5
Stempellinella	1
Stenelmis	9
Synurella	1
Tanytarsus	8
Thienemanniella	1
Thienemannimyia_group	1
TOTAL:	**113**

Physical Habitat Assessment

RBP 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	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	20	Sediment Deposition	14
Channel Sinuosity	11	Vegetative Protection - Left Bank	8
Epifaunal Substrate/Available Cover	14	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	14		
RBP Habitat Score			**154**
RBP Narrative Rating			**Comparable to Reference**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	15	80.78	Instream Wood Debris	12	75.16
Shading	55	54.42	Instream Habitat	14	84.2
Epifaunal Substrate	14	90.33	Bank Stability	12	77.46
PHI Score					**77.06**
PHI Narrative Rating					**Partially Degraded**

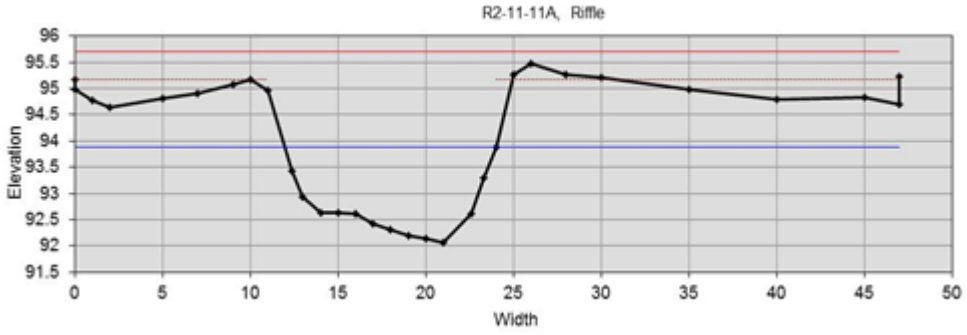
Water Chemistry

Dissolved Oxygen (mg/L)	11.39	pH (SU)	6.61
Turbidity (NTU)	3.59	Specific Conductivity (µS/cm)	278.2
Temperature (°C)	6.97		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	2.19	Cross Sectional Area (ft^2)	15.45
Bankfull Width (ft)	12.01	Water Surface Slope (%)	0.67
Mean Bankfull Depth (ft)	1.29	Sinuosity	1.33
Floodprone Width (ft)	220	D50 (mm)	0.28
Entrenchment Ratio	18.32	Adjustments?	None
Width to Depth Ratio	9.34	**Rosgen Stream Type**	**E5**



R2-11-13A Upper North River Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.01112648 **Longitude:** -76.6220555105

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		4017.8
Cover	**Acres**	**% Area**
Developed Land	**1008.5**	**25.3**
Airport	0	0
Commercial	113.6	2.8
Industrial	8.2	0.2
Residential 1/8-acre	0	0
Residential 1/4-acre	0.8	0
Residential 1/2-acre	164.5	4.1
Residential 1-Acre	109.7	2.7
Residential 2-Acre	518.3	12.9
Transportation	101.7	2.5
Utility	0	0
Forest Land	**2406.8**	**59.9**
Forested Wetland	0	0
Residential Woods	0	0
Woods	2406.8	59.9
Open Land	**192**	**4.8**
Open Space	159.6	4
Open Wetland	12.4	0.3
Water	20	0.5
Agricultural Land	**402.3**	**10**
Pasture/Hay	221.8	5.5
Row Crops	180.5	4.5
Impervious Surface	**Acres**	**% Area**
Impervious Land	288.9	7.2

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Comparable to Reference"* and *"Partially Degraded"*
- Black flies (Simulium) dominated the sample. Scored high for scraper taxa because of the presence of one snail (Physa).
- Water quality values within COMAR standards.
- Abundance of woody debris/rootwads and submerged vegetation provide a good mix of stable habitat. Moderately stable, well-vegetated banks with good riparian width.
- Bimodal distribution of substrate (sand/clay).

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.

R2-11-13A Upper North River Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	14
EPT Taxa	2
Ephemeroptera Taxa	0
%Intolerant Urban	1.8
%Ephemeroptera	0
Scraper Taxa	2
% Climbers	2.7

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
Cricotopus	3
Dubiraphia	2
Enallagma	1
Nemouridae	1
Orthocladiinae	4
Orthocladius	11
Paratanytarsus	3
Peltodytes	1
Physa	1
Pisidium	1
Polycentropus	1
Psectrocladius	2
Rheocricotopus	4
Simuliidae	12
Simulium	63
Stenochironomus	1
TOTAL:	**111**

Physical Habitat Assessment

RBP Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	8	Pool Variability	16
Bank Stability- Right Bank	8	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	20	Sediment Deposition	14
Channel Sinuosity	13	Vegetative Protection - Left Bank	7
Epifaunal Substrate/Available Cover	17	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	17		
RBP Habitat Score			**168**
RBP Narrative Rating			**Comparable to Reference**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	20	100	Instream Wood Debris	17	78.05
Shading	25	26.57	Instream Habitat	17	90.08
Epifaunal Substrate	16	95.1	Bank Stability	16	89.45
PHI Score					**79.88**
PHI Narrative Rating					**Partially Degraded**

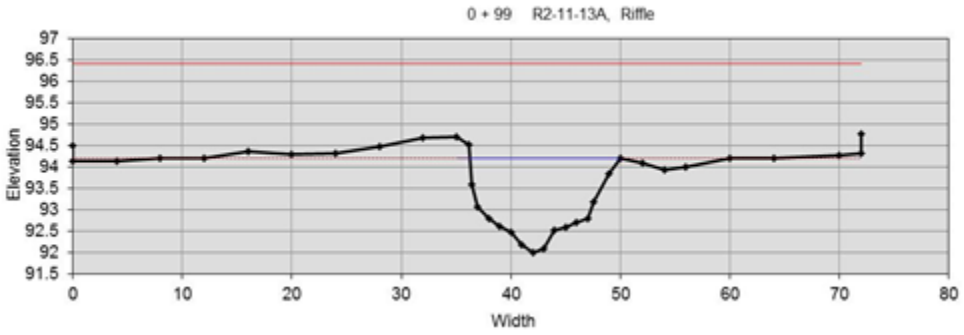
Water Chemistry

Dissolved Oxygen (mg/L)	11.41	pH (SU)	6.65
Turbidity (NTU)	6.28	Specific Conductivity (µS/cm)	236.4
Temperature (°C)	6.47		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	6.28	Cross Sectional Area (ft^2)	19.51
Bankfull Width (ft)	13.73	Water Surface Slope (%)	0.17
Mean Bankfull Depth (ft)	1.42	Sinuosity	1.14
Floodprone Width (ft)	290	D50 (mm)	0.16
Entrenchment Ratio	21.12	Adjustments?	None
Width to Depth Ratio	9.67	**Rosgen Stream Type**	**E5/6**



R2-11-16A Upper North River Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.0437133989 **Longitude:** -76.6470124834

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		398.9
Cover	**Acres**	**% Area**
Developed Land	**149.7**	**39.6**
Airport	0	0
Commercial	14.1	3.5
Industrial	8.2	2.1
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	36.7	9.2
Residential 1-Acre	20.9	5.2
Residential 2-Acre	65.9	16.5
Transportation	12.2	3.1
Utility	0	0
Forest Land	**75.9**	**19**
Forested Wetland	0	0
Residential Woods	0	0
Woods	75.9	19
Open Land	**40.9**	**10.3**
Open Space	33.2	8.3
Open Wetland	0	0
Water	7.7	1.9
Agricultural Land	**124.2**	**31.1**
Pasture/Hay	116	29.1
Row Crops	8.1	2
Impervious Surface	**Acres**	**% Area**
Impervious Land	44.6	11.2

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Non Supporting"* and *"Degraded"*
- Parametriocnemus (midge), Tubificidae (worm), and Simulium (black fly) dominated the sample. Scored high for number of taxa, scraper taxa, and percent climbers; but, received low scores for remaining metrics.
- Water quality values within COMAR standards but conductivity elevated.
- Poor habitat diversity with minimal woody debris. Poor vegetative protection and riparian width along the right bank of the channel.
- Bimodal distribution of substrate (sand/clay).

Recommendations:

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

R2-11-16A Upper North River Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	25
EPT Taxa	0
Ephemeroptera Taxa	0
%Intolerant Urban	3.3
%Ephemeroptera	0
Scraper Taxa	3
% Climbers	14.2

Calculated Metric Scores

Total Taxa	5
EPT Taxa	1
Ephemeroptera Taxa	1
Intolerant Urban %	1
Ephemeroptera %	1
Scraper Taxa	5
% Climbers	5
BIBI Score	**2.71**
BIBI Narrative Rating	**Poor**

Taxa	Count
Caecidotea	1
Chaetocladius	1
Dicrotendipes	1
Enchytraeidae	1
Fossaria	1
Hydrobaenus	4
Lumbricina	2
Micropsectra	3
Naididae	5
Orthocladius	9
Parametriocnemus	25
Phaenopsectra	1
Physa	3
Pisidiidae	1
Polypedilum	5
Psilometriocnemus	1
Rheocricotopus	2
Simulium	17
Smittia	1
Tanytarsus	5
Thienemanniella	1
Thienemannimyia_group	1
Tipula	1
Tubificidae	25
TOTAL:	**117**

Physical Habitat Assessment

RBP Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	6	Pool Variability	6
Bank Stability- Right Bank	5	Riparian Vegetative Zone Width- Left Bank	3
Channel Alteration	15	Riparian Vegetative Zone Width- Right Bank	8
Channel Flow Status	13	Sediment Deposition	8
Channel Sinuosity	7	Vegetative Protection - Left Bank	3
Epifaunal Substrate/Available Cover	6	Vegetative Protection - Right Bank	7
Pool Substrate Characterization	6		
RBP Habitat Score			**93**
RBP Narrative Rating			**Non Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	6	32.31	Instream Wood Debris	2	59.83
Shading	90	91.34	Instream Habitat	4	41.59
Epifaunal Substrate	6	52.05	Bank Stability	11	74.16
PHI Score					**58.55**
PHI Narrative Rating					**Degraded**

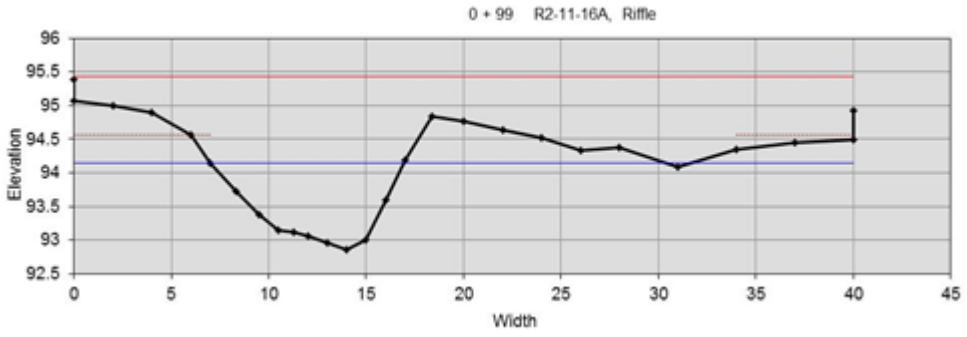
Water Chemistry

Dissolved Oxygen (mg/L)	12.26	pH (SU)	7.56
Turbidity (NTU)	1.44	Specific Conductivity (µS/cm)	347.4
Temperature (°C)	5.73		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.62	Cross Sectional Area (ft^2)	8.11
Bankfull Width (ft)	11.2	Water Surface Slope (%)	0.33
Mean Bankfull Depth (ft)	0.72	Sinuosity	1.03
Floodprone Width (ft)	55	D50 (mm)	0.24
Entrenchment Ratio	4.91	Adjustments?	None
Width to Depth Ratio	15.48	**Rosgen Stream Type**	**C5/6**



R2-11-17A Upper North River Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.012581593 **Longitude:** -76.6426850127

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**1707.1**
Cover	**Acres**	**% Area**
Developed Land	**631.1**	**37**
Airport	0	0
Commercial	24.9	1.5
Industrial	0.6	0
Residential 1/8-acre	85	5
Residential 1/4-acre	139.4	8.2
Residential 1/2-acre	0	0
Residential 1-Acre	97.5	5.7
Residential 2-Acre	125	7.3
Transportation	44.9	2.6
Utility	114.3	6.7
Forest Land	**870.8**	**51**
Forested Wetland	0	0
Residential Woods	0	0
Woods	870.8	51
Open Land	**69.4**	**4.1**
Open Space	66.4	3.9
Open Wetland	0	0
Water	3.1	0.2
Agricultural Land	**135.1**	**7.9**
Pasture/Hay	57.4	3.4
Row Crops	77.7	4.6
Impervious Surface	**Acres**	**% Area**
Impervious Land	185.1	10.8

Summary Results:

- Biological condition – *"Very Poor"*
- Habitat scores *"Comparable to Reference"* and *"Partially Degraded"*
- Midges, Zalutschia and Psectrocladius, dominated the sample.
- Measured below COMAR standards for pH.
- Sub-optimal habitat diversity but little woody debris. Stable, well-vegetated banks and good 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.

R2-11-17A Upper North River Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	14
EPT Taxa	0
Ephemeroptera Taxa	0
%Intolerant Urban	5.4
%Ephemeroptera	0
Scraper Taxa	0
% Climbers	0.9

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**
Anchytarsus	1
Bezzia_Palpomyia	3
Caecidotea	6
Chironomidae	1
Corynoneura	1
Culicoides	1
Limnophyes	1
Lumbricina	4
Lumbriculidae	13
Orthocladiinae	1
Parametriocnemus	1
Paratendipes	2
Polypedilum	1
Psectrocladius	41
Tubificidae	2
Zalutschia	32
TOTAL:	**111**

Physical Habitat Assessment

RBP Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	9	Pool Variability	11
Bank Stability- Right Bank	9	Riparian Vegetative Zone Width- Left Bank	8
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	20	Sediment Deposition	17
Channel Sinuosity	14	Vegetative Protection - Left Bank	9
Epifaunal Substrate/Available Cover	12	Vegetative Protection - Right Bank	9
Pool Substrate Characterization	15		
RBP Habitat Score			**163**
RBP Narrative Rating			**Comparable to Reference**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	20	100	Instream Wood Debris	3	46.33
Shading	20	21.22	Instream Habitat	12	71.1
Epifaunal Substrate	11	71.63	Bank Stability	18	94.87
PHI Score					**67.52**
PHI Narrative Rating					**Partially Degraded**

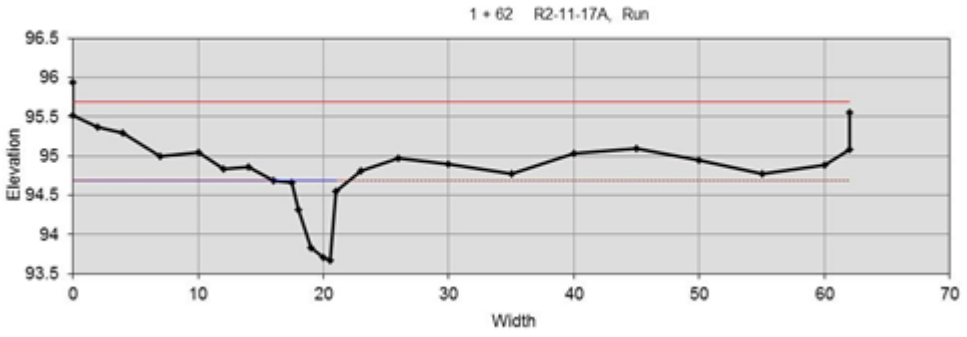
Water Chemistry

Dissolved Oxygen (mg/L)	8.82	pH (SU)	4.31
Turbidity (NTU)	1	Specific Conductivity (µS/cm)	123.3
Temperature (°C)	5.9		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	2.67	Cross Sectional Area (ft^2)	2.41
Bankfull Width (ft)	5	Water Surface Slope (%)	0.27
Mean Bankfull Depth (ft)	0.48	Sinuosity	1.07
Floodprone Width (ft)	260	D50 (mm)	0.22
Entrenchment Ratio	52	Adjustments?	None
Width to Depth Ratio	10.4	**Rosgen Stream Type**	**E5**



R2-11-20A Upper North River Sampling Unit

Upstream View:

Downstream View:

Latitude: 38.9863224981 **Longitude:** -76.6216249846

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**5665.9**
Cover	**Acres**	**% Area**
Developed Land	**1384.7**	**24.6**
Airport	0	0
Commercial	40.2	0.7
Industrial	9.5	0.2
Residential 1/8-acre	89.1	1.6
Residential 1/4-acre	145.6	2.6
Residential 1/2-acre	2.7	0
Residential 1-Acre	319.7	5.6
Residential 2-Acre	426.3	7.5
Transportation	139.3	2.5
Utility	221.8	3.9
Forest Land	**3629.5**	**64.1**
Forested Wetland	0	0
Residential Woods	542.6	9.6
Woods	3087	54.5
Open Land	**129.5**	**2.3**
Open Space	124.9	2.2
Open Wetland	0	0
Water	4.6	0.1
Agricultural Land	**512.6**	**9**
Pasture/Hay	187.9	3.3
Row Crops	324.8	5.7
Impervious Surface	**Acres**	**% Area**
Impervious Land	450.7	8

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Supporting"* and *"Degraded"*
- Dicrotendipes, Paratanytarsus, and Polypedilum (midges) dominated the sample. Scored high for percent climbers because of the presence of Polypedilum.
- Measured below COMAR standards for pH.
- Sub-optimal habitat diversity. Defense High runs adjacent to the right bank with little buffer between the road and stream. Stable banks with large boulder reinforcement along the majority of the right bank.
- Stream type not determined due to influence of large culvert and bank stabilization, as well as highway grading on the channel dimensions.

Recommendations:

- Buffer enhancement.
- Because habitat is supporting and biological condition is poor, look for problems with water quality and correct, if possible.

R2-11-20A Upper North River Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	21
EPT Taxa	0
Ephemeroptera Taxa	0
%Intolerant Urban	1.9
%Ephemeroptera	0
Scraper Taxa	1
% Climbers	26.4

Calculated Metric Scores

Total Taxa	3
EPT Taxa	1
Ephemeroptera Taxa	1
Intolerant Urban %	1
Ephemeroptera %	1
Scraper Taxa	3
% Climbers	5
BIBI Score	**2.14**
BIBI Narrative Rating	**Poor**

Taxa	Count
Amphipoda	1
Bezzia_Palpomyia	1
Caecidotea	1
Chironomini	1
Cricotopus	1
Cryptochironomus	1
Dicrotendipes	26
Gammarus	3
Helichus	1
Larsia	1
Odontomesa	1
Orthocladius	3
Parakiefferiella	1
Paratanytarsus	21
Paratendipes	6
Phaenopsectra	3
Pisidium	1
Polypedilum	16
Psectrocladius	1
Rheotanytarsus	2
Saetheria	2
Stempellinella	1
Tanytarsus	11
TOTAL:	**106**

Physical Habitat Assessment

RBP Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	9	Pool Variability	13
Bank Stability- Right Bank	8	Riparian Vegetative Zone Width- Left Bank	4
Channel Alteration	7	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	20	Sediment Deposition	14
Channel Sinuosity	5	Vegetative Protection - Left Bank	5
Epifaunal Substrate/Available Cover	11	Vegetative Protection - Right Bank	7
Pool Substrate Characterization	14		
RBP Habitat Score			**127**
RBP Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	2	10.77	Instream Wood Debris	8	47.54
Shading	60	58.94	Instream Habitat	14	69.92
Epifaunal Substrate	11	63.81	Bank Stability	17	92.2
PHI Score					**57.2**
PHI Narrative Rating					**Degraded**

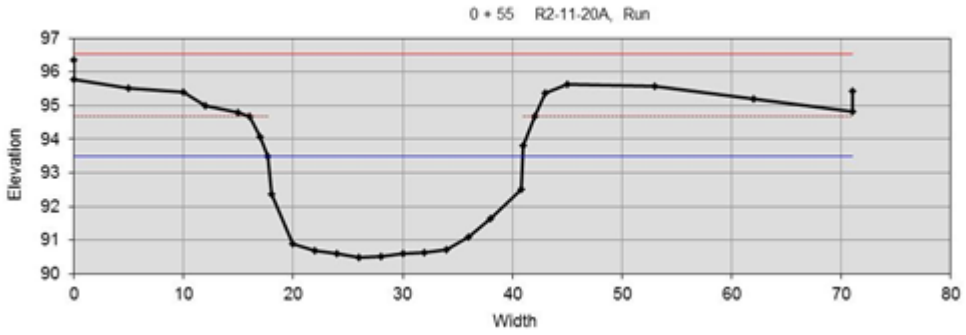
Water Chemistry

Dissolved Oxygen (mg/L)	11.21	pH (SU)	6.48
Turbidity (NTU)	10.2	Specific Conductivity (µS/cm)	194.6
Temperature (°C)	9.3		

Geomorphic Assessment

Rosgen Level II Classification Data

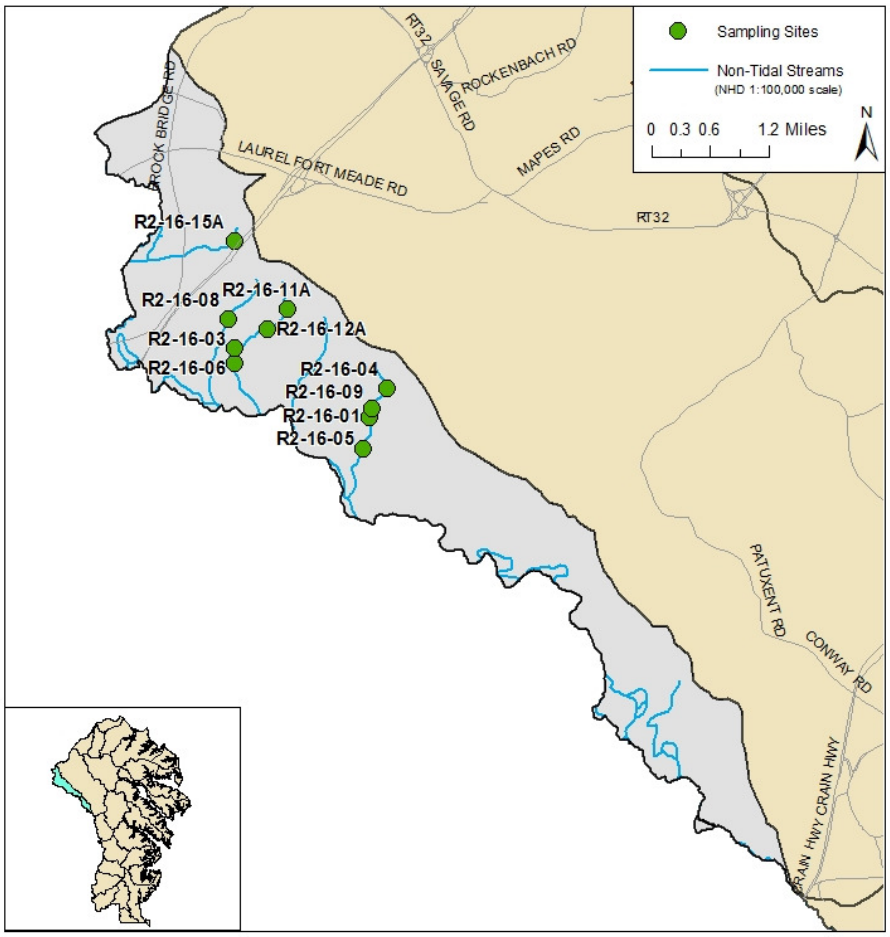
Drainage Area (mi^2)	8.85	Cross Sectional Area (ft^2)	57.94
Bankfull Width (ft)	23.25	Water Surface Slope (%)	0.0047
Mean Bankfull Depth (ft)	2.49	Sinuosity	1.09
Floodprone Width (ft)	240	D50 (mm)	4.1
Entrenchment Ratio	10.32	Adjustments?	None
Width to Depth Ratio	9.33	**Rosgen Stream Type**	**ND**



Upper Patuxent Sampling Unit

Site Condition Summary

Site	Drainage Area (acres)	Drainage Area (mi^2)	Percent Impervious	Percent Developed	Percent Forested	Percent Agriculture	Percent Open	BIBI Narrative Rating	PHI Narrative Rating	RBP Narrative Rating	Rosgen Stream Type - L1
R2-16-01	211.6	0.33	1.3	4.0	95.4	0.0	0.6	Poor	Minimally Degraded	Comparable to Reference	E
R2-16-03	312.7	0.49	1.0	9.6	88.9	0.0	1.5	Poor	Minimally Degraded	Comparable to Reference	E
R2-16-04	51.4	0.08	0.4	1.7	97.0	0.0	1.3	Poor	Partially Degraded	Non Supporting	C→F
R2-16-05	377.6	0.59	1.1	7.4	91.3	0.8	0.5	Very Poor	Minimally Degraded	Comparable to Reference	E
R2-16-06	324.8	0.51	0.9	9.3	89.3	0.0	1.4	Poor	Minimally Degraded	Supporting	E
R2-16-08	295.2	0.46	1.0	8.8	91.0	0.0	0.2	Fair	Minimally Degraded	Supporting	F
R2-16-09	203.8	0.32	1.3	4.2	95.2	0.0	0.6	Very Poor	Minimally Degraded	Comparable to Reference	E
R2-16-11A	132.9	0.21	1.2	3.4	93.1	0.0	3.5	Very Poor	Minimally Degraded	Supporting	G
R2-16-12A	207.4	0.32	1.2	11.1	86.7	0.0	2.2	Poor	Partially Degraded	Partially Supporting	G
R2-16-15A	22.4	0.04	15.9	37.0	63.0	0.0	0.0	Fair	Partially Degraded	Partially Supporting	F



R2-16-01 Upper Patuxent Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.0606967855 **Longitude:** -76.7878588022

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**211.6**
Cover	**Acres**	**% Area**
Developed Land	**8.5**	**4**
Airport	0	0
Commercial	0.4	0.2
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	0	0
Residential 2-Acre	0	0
Transportation	8.1	3.8
Utility	0	0
Forest Land	**201.9**	**95.4**
Forested Wetland	0	0
Residential Woods	0	0
Woods	201.9	95.4
Open Land	**1.2**	**0.6**
Open Space	1.2	0.6
Open Wetland	0	0
Water	0	0
Agricultural Land	**0**	**0**
Pasture/Hay	0	0
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	2.7	1.3

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Comparable to Reference"* and *"Minimally Degraded"*
- Caecidotea (intolerant isopod) and Psectrocladius (midge) dominated the sample. Scored high for intolerant percent.
- Measured below COMAR standards for pH.
- Sub-optimal instream habitat and epibenthic substrate. Very stable banks with excellent vegetative protection and riparian width.
- Bimodal distribution of substrate (sand/clay).

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.

R2-16-01 Upper Patuxent Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	19
EPT Taxa	1
Ephemeroptera Taxa	0
%Intolerant Urban	34.7
%Ephemeroptera	0
Scraper Taxa	0
% Climbers	6.9

Calculated Metric Scores

Total Taxa	3
EPT Taxa	1
Ephemeroptera Taxa	1
Intolerant Urban %	5
Ephemeroptera %	1
Scraper Taxa	1
% Climbers	3
BIBI Score	**2.14**
BIBI Narrative Rating	**Poor**

Taxa	Count
Apsectrotanypus	1
Bezzia_Palpomyia	1
Brillia	1
Caecidotea	32
Corethrella	1
Crangonyctidae	3
Crangonyx	1
Hydroporini	1
Micropsectra	1
Natarsia	1
Orthocladiinae	2
Parametriocnemus	1
Paratendipes	1
Podmosta	2
Polypedilum	1
Psectrocladius	20
Pseudorthocladius	1
Simulium	11
Stygobromus	6
Tanytarsus	5
Thienemannimyia_group	8
TOTAL:	**101**

Physical Habitat Assessment

RBP 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	20	Sediment Deposition	16
Channel Sinuosity	9	Vegetative Protection - Left Bank	10
Epifaunal Substrate/Available Cover	12	Vegetative Protection - Right Bank	10
Pool Substrate Characterization	13		
RBP Habitat Score			**161**
RBP Narrative Rating			**Comparable to Reference**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	19	100	Instream Wood Debris	5	75.88
Shading	90	91.34	Instream Habitat	13	98.02
Epifaunal Substrate	12	91.04	Bank Stability	20	100
PHI Score					**92.71**
PHI Narrative Rating					**Minimally Degraded**

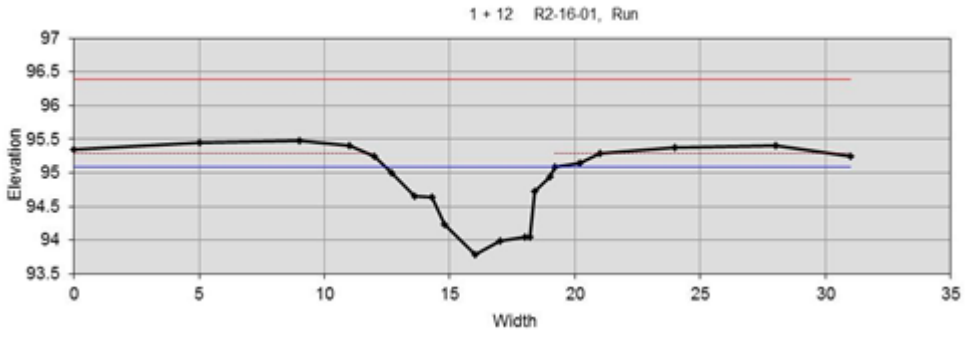
Water Chemistry

Dissolved Oxygen (mg/L)	6.87	pH (SU)	5.17
Turbidity (NTU)	3.39	Specific Conductivity (µS/cm)	55.9
Temperature (°C)	14.2		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.33	Cross Sectional Area (ft^2)	4.98
Bankfull Width (ft)	6.76	Water Surface Slope (%)	0.23
Mean Bankfull Depth (ft)	0.74	Sinuosity	1.14
Floodprone Width (ft)	211	D50 (mm)	0.082
Entrenchment Ratio	31.2	Adjustments?	None
Width to Depth Ratio	9.19	**Rosgen Stream Type**	**E5/6**



R2-16-03 Upper Patuxent Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.0710410637 **Longitude:** -76.8134100555

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		312.7
Cover	**Acres**	**% Area**
Developed Land	**30.1**	**9.6**
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	0	0
Residential 2-Acre	0	0
Transportation	11.7	3.7
Utility	18.4	5.9
Forest Land	**278**	**88.9**
Forested Wetland	0	0
Residential Woods	0	0
Woods	278	88.9
Open Land	**4.6**	**1.5**
Open Space	4.6	1.5
Open Wetland	0	0
Water	0	0
Agricultural Land	**0**	**0**
Pasture/Hay	0	0
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	3	1

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Comparable to Reference"* and *"Minimally Degraded"*
- Leuctra (intolerant stonefly) and Stegopterna (intolerant black fly) dominated the sample. Scored high for intolerant percent.
- Measured below COMAR standards for pH.
- A very sinuous reach with sub-optimal instream habitat and epibenthic substrate. Stable, well-vegetated banks and good riparian width.
- Bimodal distribution of substrate (sand/gravel).

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.

R2-16-03 Upper Patuxent Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	17
EPT Taxa	3
Ephemeroptera Taxa	0
%Intolerant Urban	72.5
%Ephemeroptera	0
Scraper Taxa	1
% Climbers	0.9

Calculated Metric Scores

Total Taxa	3
EPT Taxa	3
Ephemeroptera Taxa	1
Intolerant Urban %	5
Ephemeroptera %	1
Scraper Taxa	3
% Climbers	3
BIBI Score	**2.71**
BIBI Narrative Rating	**Poor**

Taxa	Count
Amphinemura	4
Caecidotea	1
Ceratopogon	1
Helichus	1
Hydroporini	1
Leuctra	43
Libellulidae	4
Lumbricina	1
Lumbriculidae	1
Parametriocnemus	1
Prosimulium	2
Ptilostomis	1
Simuliidae	9
Simulium	7
Stegopterna	28
Thienemannimyia_group	1
Tipula	2
Tvetenia	1
TOTAL:	**109**

Physical Habitat Assessment

RBP Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	7	Pool Variability	13
Bank Stability- Right Bank	8	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	16	Sediment Deposition	13
Channel Sinuosity	17	Vegetative Protection - Left Bank	8
Epifaunal Substrate/Available Cover	13	Vegetative Protection - Right Bank	9
Pool Substrate Characterization	11		
RBP Habitat Score			**155**
RBP Narrative Rating			**Comparable to Reference**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	19	100	Instream Wood Debris	3	65.55
Shading	95	99.94	Instream Habitat	12	88.47
Epifaunal Substrate	13	94.31	Bank Stability	15	86.61
PHI Score					**89.14**
PHI Narrative Rating					**Minimally Degraded**

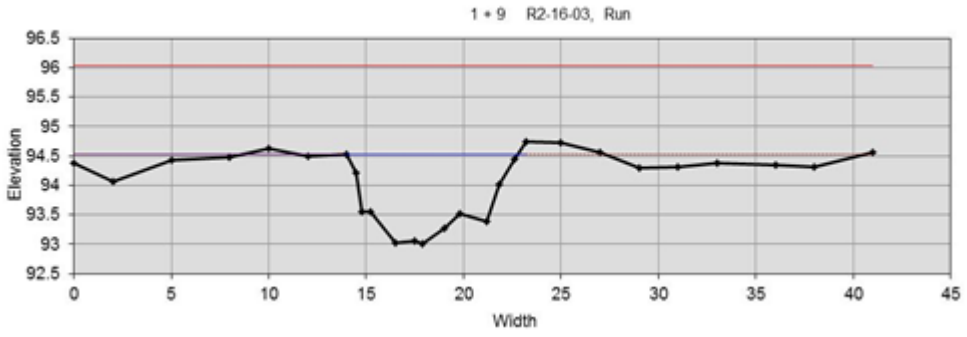
Water Chemistry

Dissolved Oxygen (mg/L)	10.76	pH (SU)	4.83
Turbidity (NTU)	2.8	Specific Conductivity (µS/cm)	46.6
Temperature (°C)	12.83		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.49	Cross Sectional Area (ft^2)	8.97
Bankfull Width (ft)	8.74	Water Surface Slope (%)	0.77
Mean Bankfull Depth (ft)	1.03	Sinuosity	1.56
Floodprone Width (ft)	145	D50 (mm)	1.1
Entrenchment Ratio	16.58	Adjustments?	None
Width to Depth Ratio	8.53	**Rosgen Stream Type**	**E5/4**



R2-16-04 Upper Patuxent Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.0649806729 **Longitude:** -76.7844211999

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**51.4**
Cover	**Acres**	**% Area**
Developed Land	**0.9**	**1.7**
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	0	0
Residential 2-Acre	0	0
Transportation	0.9	1.7
Utility	0	0
Forest Land	**49.8**	**97**
Forested Wetland	0	0
Residential Woods	0	0
Woods	49.8	97
Open Land	**0.7**	**1.3**
Open Space	0.7	1.3
Open Wetland	0	0
Water	0	0
Agricultural Land	**0**	**0**
Pasture/Hay	0	0
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	0.2	0.4

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Non Supporting"* and *"Partially Degraded"*
- Midges dominated the sample including Tvetenia and Orthocladiinae.
- Measured below COMAR standards for pH.
- Poor instream habitat and epibenthic substrate with woody debris and leaf packs providing habitat for benthos. Moderately unstable bank with a severe headcut in the middle portion of the reach. Good riparian width.
- Stream transitioning from C to F due to a severe headcut and scour pool in middle portion of the reach.

Recommendations:

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

R2-16-04 Upper Patuxent Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	20
EPT Taxa	2
Ephemeroptera Taxa	0
%Intolerant Urban	12.2
%Ephemeroptera	0
Scraper Taxa	0
% Climbers	4.3

Calculated Metric Scores

Total Taxa	3
EPT Taxa	3
Ephemeroptera Taxa	1
Intolerant Urban %	3
Ephemeroptera %	1
Scraper Taxa	1
% Climbers	3
BIBI Score	**2.14**
BIBI Narrative Rating	**Poor**

Taxa	Count
Caecidotea	3
Chironomini	3
Crangonyx	1
Culicoides	2
Enchytraeidae	10
Eriopterini	4
Heterotrissocladius	1
Ironoquia	10
Limnophyes	2
Micropsectra	5
Odonata	1
Orthocladiinae	18
Paratendipes	7
Podmosta	2
Pseudorthocladius	6
Simuliidae	1
Stegopterna	3
Stygobromus	1
Thienemannimyia_group	5
Tipula	1
Tubificidae	3
Tvetenia	25
TOTAL:	**114**

Physical Habitat Assessment

RBP Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	4	Pool Variability	6
Bank Stability- Right Bank	4	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	18	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	6	Sediment Deposition	8
Channel Sinuosity	8	Vegetative Protection - Left Bank	6
Epifaunal Substrate/Available Cover	5	Vegetative Protection - Right Bank	6
Pool Substrate Characterization	5		
RBP Habitat Score			**96**
RBP Narrative Rating			**Non Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	15	80.78	Instream Wood Debris	5	91.91
Shading	95	99.94	Instream Habitat	5	68.12
Epifaunal Substrate	5	59.6	Bank Stability	8	63.25
PHI Score					**77.26**
PHI Narrative Rating					**Partially Degraded**

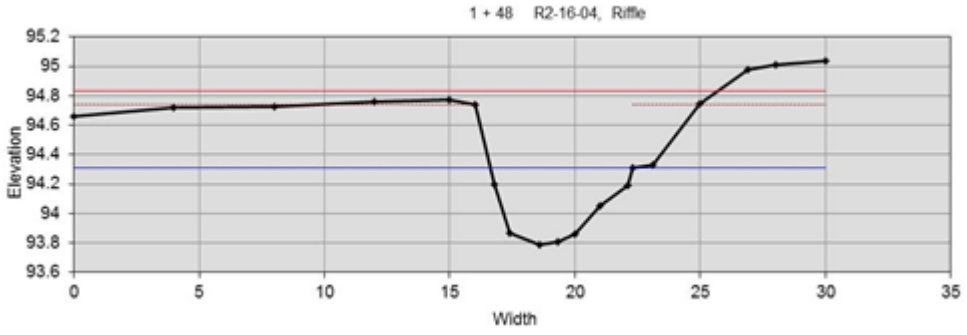
Water Chemistry

Dissolved Oxygen (mg/L)	6.19	pH (SU)	4.27
Turbidity (NTU)	1.52	Specific Conductivity (µS/cm)	54.8
Temperature (°C)	14.53		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.08	Cross Sectional Area (ft^2)	2.02
Bankfull Width (ft)	5.66	Water Surface Slope (%)	3.3
Mean Bankfull Depth (ft)	0.36	Sinuosity	1.09
Floodprone Width (ft)	50	D50 (mm)	0.11
Entrenchment Ratio	8.83	Adjustments?	None
Width to Depth Ratio	15.91	**Rosgen Stream Type**	**C5b→F5b**



R2-16-05 Upper Patuxent Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.0559656298 **Longitude:** -76.7890439542

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		377.6
Cover	**Acres**	**% Area**
Developed Land	**27.8**	**7.4**
Airport	0	0
Commercial	1.5	0.4
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	0	0
Residential 2-Acre	0	0
Transportation	12.4	3.3
Utility	14	3.7
Forest Land	**344.7**	**91.3**
Forested Wetland	0	0
Residential Woods	0	0
Woods	344.7	91.3
Open Land	**2**	**0.5**
Open Space	2	0.5
Open Wetland	0	0
Water	0	0
Agricultural Land	**3.2**	**0.8**
Pasture/Hay	0	0
Row Crops	3.2	0.8
Impervious Surface	**Acres**	**% Area**
Impervious Land	4.2	1.1

Summary Results:

- Biological condition – *"Very Poor"*
- Habitat scores *"Comparable to Reference"* and *"Minimally Degraded"*
- The black fly, Simulium, and midges, Psectrocladius and Polypedilum, dominated the sample. Scored high for percent climbers because of the presence of Polypedilum.
- Measured below COMAR standards for pH.
- Sub-optimal habitat diversity with an abundance of woody debris. Poor velocity/depth diversity due to multiple beaver dams impacting the reach. Stable, well-vegetated banks and good 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.

R2-16-05 Upper Patuxent Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	11
EPT Taxa	0
Ephemeroptera Taxa	0
%Intolerant Urban	2.9
%Ephemeroptera	0
Scraper Taxa	0
% Climbers	16.2

Calculated Metric Scores

Total Taxa	1
EPT Taxa	1
Ephemeroptera Taxa	1
Intolerant Urban %	1
Ephemeroptera %	1
Scraper Taxa	1
% Climbers	5
BIBI Score	**1.57**
BIBI Narrative Rating	**Very Poor**

Taxa	**Count**
Caecidotea	2
Chironomini	1
Crangonyctidae	1
Eriopterini	2
Lepidoptera	1
Orthocladiinae	1
Orthocladius	1
Polypedilum	17
Psectrocladius	30
Simulium	46
Stegopterna	1
Thienemannimyia_group	1
Tribelos	1
TOTAL:	**105**

Physical Habitat Assessment

RBP 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	16	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	17	Sediment Deposition	15
Channel Sinuosity	7	Vegetative Protection - Left Bank	9
Epifaunal Substrate/Available Cover	11	Vegetative Protection - Right Bank	9
Pool Substrate Characterization	14		
RBP Habitat Score			**150**
RBP Narrative Rating			**Comparable to Reference**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	20	100	Instream Wood Debris	10	84.12
Shading	75	73.32	Instream Habitat	12	86.54
Epifaunal Substrate	11	81.46	Bank Stability	20	100
PHI Score					**87.57**
PHI Narrative Rating					**Minimally Degraded**

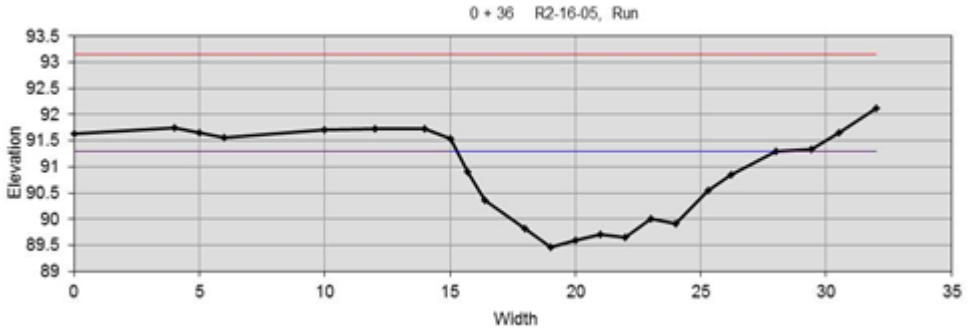
Water Chemistry

Dissolved Oxygen (mg/L)	5.58	pH (SU)	4.29
Turbidity (NTU)	4.21	Specific Conductivity (µS/cm)	53
Temperature (°C)	12.27		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.59	Cross Sectional Area (ft^2)	14.34
Bankfull Width (ft)	12.73	Water Surface Slope (%)	0.92
Mean Bankfull Depth (ft)	1.13	Sinuosity	1.04
Floodprone Width (ft)	88	D50 (mm)	0.097
Entrenchment Ratio	6.91	Adjustments?	None
Width to Depth Ratio	11.31	**Rosgen Stream Type**	**E5**



R2-16-06 Upper Patuxent Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.0688470987 **Longitude:** -76.8133717848

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**324.8**
Cover	**Acres**	**% Area**
Developed Land	**30.1**	**9.3**
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	0	0
Residential 2-Acre	0	0
Transportation	11.7	3.6
Utility	18.4	5.7
Forest Land	**290.1**	**89.3**
Forested Wetland	0	0
Residential Woods	0	0
Woods	290.1	89.3
Open Land	**4.6**	**1.4**
Open Space	4.6	1.4
Open Wetland	0	0
Water	0	0
Agricultural Land	**0**	**0**
Pasture/Hay	0	0
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	3	0.9

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Supporting"* and *"Minimally Degraded"*
- Black flies (Simulium and Stegopterna) dominated the sample. Scored high for intolerant percent.
- Measured below COMAR standards for pH.
- Sub-optimal habitat diversity. Stable, well-vegetated banks and good 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.

R2-16-06 Upper Patuxent Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	19
EPT Taxa	4
Ephemeroptera Taxa	0
%Intolerant Urban	50.5
%Ephemeroptera	0
Scraper Taxa	0
% Climbers	1.8

Calculated Metric Scores

Total Taxa	3
EPT Taxa	3
Ephemeroptera Taxa	1
Intolerant Urban %	5
Ephemeroptera %	1
Scraper Taxa	1
% Climbers	3
BIBI Score	**2.43**
BIBI Narrative Rating	**Poor**

Taxa	Count
Amphinemura	3
Caecidotea	2
Ceratopogonidae	1
Enchytraeidae	1
Ironoquia	1
Lepidoptera	1
Leuctra	11
Libellulidae	1
Lumbriculidae	1
Micropsectra	1
Orthocladiinae	2
Paranemoura	2
Paraphaenocladius	1
Plecoptera	2
Prosimulium	1
Psectrocladius	5
Rheocricotopus	1
Simuliidae	7
Simulium	32
Stegopterna	34
Tanytarsus	1
TOTAL:	**111**

Physical Habitat Assessment

RBP Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	7	Pool Variability	12
Bank Stability- Right Bank	8	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	16	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	17	Sediment Deposition	14
Channel Sinuosity	14	Vegetative Protection - Left Bank	8
Epifaunal Substrate/Available Cover	11	Vegetative Protection - Right Bank	9
Pool Substrate Characterization	13		
RBP Habitat Score			**149**
RBP Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	18	96.93	Instream Wood Debris	4	68.07
Shading	95	99.94	Instream Habitat	11	82.53
Epifaunal Substrate	11	82.44	Bank Stability	15	86.61
PHI Score					**86.09**
PHI Narrative Rating					**Minimally Degraded**

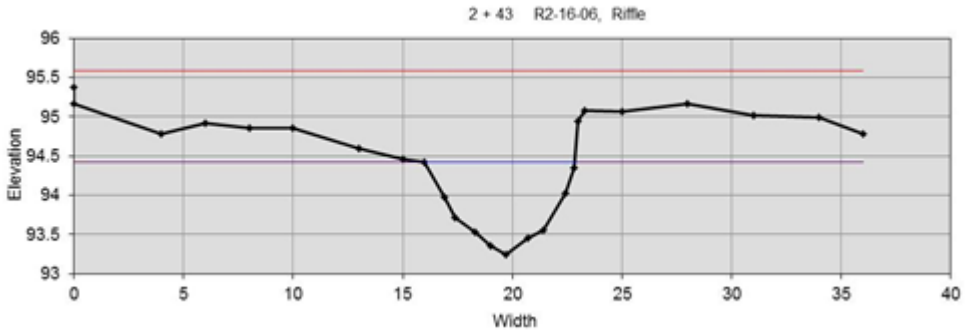
Water Chemistry

Dissolved Oxygen (mg/L)	10.15	pH (SU)	4.81
Turbidity (NTU)	3.76	Specific Conductivity (µS/cm)	47
Temperature (°C)	11.1		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.51	Cross Sectional Area (ft^2)	5.11
Bankfull Width (ft)	6.82	Water Surface Slope (%)	0.1
Mean Bankfull Depth (ft)	0.75	Sinuosity	1.27
Floodprone Width (ft)	130	D50 (mm)	0.32
Entrenchment Ratio	19.05	Adjustments?	None
Width to Depth Ratio	9.11	**Rosgen Stream Type**	**E5**



R2-16-08 Upper Patuxent Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.075369021 **Longitude:** -76.8146504384

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**295.2**
Cover	**Acres**	**% Area**
Developed Land	**26**	**8.8**
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	0	0
Residential 2-Acre	0	0
Transportation	10.2	3.5
Utility	15.8	5.3
Forest Land	**268.6**	**91**
Forested Wetland	0	0
Residential Woods	0	0
Woods	268.6	91
Open Land	**0.7**	**0.2**
Open Space	0.7	0.2
Open Wetland	0	0
Water	0	0
Agricultural Land	**0**	**0**
Pasture/Hay	0	0
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	3.1	1

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Supporting"* and *"Minimally Degraded"*
- Simulium (black fly) and Psectrocladius (midge) dominated the sample. Scored high for percent climbers because of the presence of Polypedilum (midge).
- Measured below COMAR standards for pH.
- Most habitat parameters received sub-optimal scores. Incised reach with areas of active bank erosion; however, banks are well vegetated with good riparian width.
- Bimodal distribution of substrate (gravel/sand).

Recommendations:

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

R2-16-08 Upper Patuxent Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	26
EPT Taxa	6
Ephemeroptera Taxa	0
%Intolerant Urban	61.3
%Ephemeroptera	0
Scraper Taxa	0
% Climbers	0.9

Calculated Metric Scores

Total Taxa	5
EPT Taxa	5
Ephemeroptera Taxa	1
Intolerant Urban %	5
Ephemeroptera %	1
Scraper Taxa	1
% Climbers	3
BIBI Score	**3**
BIBI Narrative Rating	**Fair**

Taxa	Count
Amphinemura	45
Bezzia_Palpomyia	4
Caecidotea	1
Ceratopogonidae	1
Chironomidae	1
Diplectrona	1
Enchytraeidae	1
Ironoquia	1
Leuctra	9
Lumbricina	2
Lumbriculidae	6
Musculium	1
Parametriocnemus	4
Prosimulium	2
Pycnopsyche	1
Rheocricotopus	3
Rheotanytarsus	1
Simuliidae	4
Simulium	5
Stegopterna	7
Stempellinella	1
Thienemannimyia_group	1
Tribelos	1
Tubificidae	2
TOTAL:	**105**

Physical Habitat Assessment

RBP Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	5	Pool Variability	13
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	10
Channel Sinuosity	20	Vegetative Protection - Left Bank	7
Epifaunal Substrate/Available Cover	14	Vegetative Protection - Right Bank	7
Pool Substrate Characterization	12		
RBP Habitat Score			**147**
RBP Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	14	75.39	Instream Wood Debris	3	66.2
Shading	95	99.94	Instream Habitat	13	94.61
Epifaunal Substrate	14	100	Bank Stability	10	70.71
PHI Score					**84.47**
PHI Narrative Rating					**Minimally Degraded**

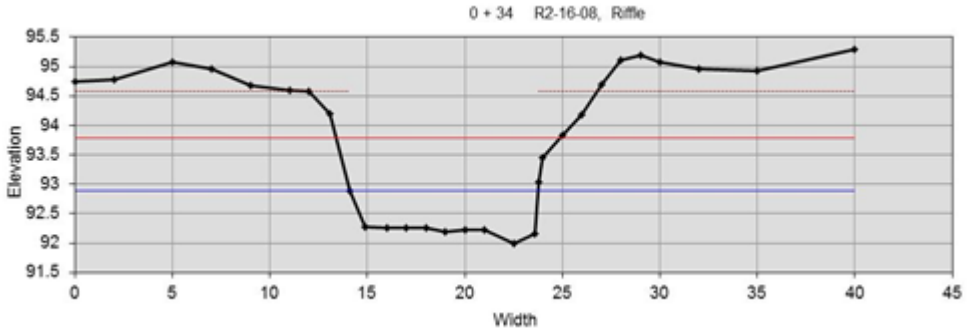
Water Chemistry

Dissolved Oxygen (mg/L)	9.3	pH (SU)	5
Turbidity (NTU)	5.42	Specific Conductivity (µS/cm)	65.1
Temperature (°C)	12.63		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.46	Cross Sectional Area (ft^2)	6.37
Bankfull Width (ft)	9.67	Water Surface Slope (%)	0.69
Mean Bankfull Depth (ft)	0.66	Sinuosity	1.47
Floodprone Width (ft)	11.48	D50 (mm)	2.6
Entrenchment Ratio	1.19	Adjustments?	None
Width to Depth Ratio	14.68	**Rosgen Stream Type**	**F4/5**



R2-16-09 Upper Patuxent Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.0620109226 **Longitude:** -76.7873252399

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		203.8
Cover	**Acres**	**% Area**
Developed Land	**8.5**	**4.2**
Airport	0	0
Commercial	0.4	0.2
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	0	0
Residential 2-Acre	0	0
Transportation	8.1	4
Utility	0	0
Forest Land	**194**	**95.2**
Forested Wetland	0	0
Residential Woods	0	0
Woods	194	95.2
Open Land	**1.2**	**0.6**
Open Space	1.2	0.6
Open Wetland	0	0
Water	0	0
Agricultural Land	**0**	**0**
Pasture/Hay	0	0
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	2.7	1.3

Summary Results:

- Biological condition – *"Very Poor"*
- Habitat scores *"Comparable to Reference"* and *"Minimally Degraded"*
- Psectrocladius (midge) and Caecidotea (intolerant isopod) dominated the sample. Scored high for intolerant percent.
- Measured below COMAR standards for pH.
- Sub-optimal instream habitat and epibenthic substrate with abundant rootwads/woody debris providing stable habitat. Very stable banks with excellent vegetative protection 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.

R2-16-09 Upper Patuxent Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	10
EPT Taxa	1
Ephemeroptera Taxa	0
%Intolerant Urban	31.3
%Ephemeroptera	0
Scraper Taxa	0
% Climbers	1

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	31
Ceratopogonidae	1
Crangonyctidae	5
Crangonyx	1
Eukiefferiella	1
Libellulidae	1
Orthocladiinae	2
Paratendipes	1
Psectrocladius	42
Ptilostomis	1
Simulium	3
Thienemannimyia_group	10
TOTAL:	**99**

Physical Habitat Assessment

RBP 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	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	20	Sediment Deposition	16
Channel Sinuosity	14	Vegetative Protection - Left Bank	10
Epifaunal Substrate/Available Cover	13	Vegetative Protection - Right Bank	10
Pool Substrate Characterization	14		
RBP Habitat Score			**167**
RBP Narrative Rating			**Comparable to Reference**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	19	100	Instream Wood Debris	7	82.23
Shading	95	99.94	Instream Habitat	12	92.86
Epifaunal Substrate	13	97.1	Bank Stability	20	100
PHI Score					**95.35**
PHI Narrative Rating					**Minimally Degraded**

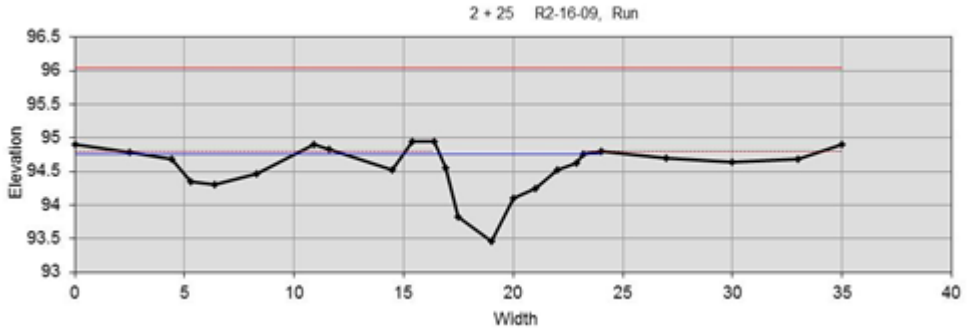
Water Chemistry

Dissolved Oxygen (mg/L)	7.5	pH (SU)	4.2
Turbidity (NTU)	2.42	Specific Conductivity (µS/cm)	57
Temperature (°C)	14.53		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.32	Cross Sectional Area (ft^2)	4.1
Bankfull Width (ft)	6.56	Water Surface Slope (%)	0.61
Mean Bankfull Depth (ft)	0.63	Sinuosity	1.17
Floodprone Width (ft)	132	D50 (mm)	0.15
Entrenchment Ratio	20.13	Adjustments?	None
Width to Depth Ratio	10.48	**Rosgen Stream Type**	**E5**



R2-16-11A Upper Patuxent Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.0767777897 **Longitude:** -76.8034434742

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**132.9**
Cover	**Acres**	**% Area**
Developed Land	**4.5**	**3.4**
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	0	0
Residential 2-Acre	0	0
Transportation	4.5	3.4
Utility	0	0
Forest Land	**123.7**	**93.1**
Forested Wetland	0	0
Residential Woods	0	0
Woods	123.7	93.1
Open Land	**4.6**	**3.5**
Open Space	4.6	3.5
Open Wetland	0	0
Water	0	0
Agricultural Land	**0**	**0**
Pasture/Hay	0	0
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	1.5	1.2

Summary Results:

- Biological condition – *"Very Poor"*
- Habitat scores *"Supporting"* and *"Minimally Degraded"*
- Stegopterna (intolerant black fly) and Leuctra (intolerant isopod) dominated the sample. Scored high for intolerant percent.
- Measured below COMAR standards for pH.
- Marginal to sub-optimal habitat diversity with moderately stable banks. Good vegetative protection and excellent riparian width.
- Bimodal distribution of substrate (gravel/sand).

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.

R2-16-11A Upper Patuxent Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	10
EPT Taxa	4
Ephemeroptera Taxa	0
%Intolerant Urban	90.8
%Ephemeroptera	0
Scraper Taxa	0
% Climbers	0

Calculated Metric Scores

Total Taxa	1
EPT Taxa	3
Ephemeroptera Taxa	1
Intolerant Urban %	5
Ephemeroptera %	1
Scraper Taxa	1
% Climbers	1
BIBI Score	**1.86**
BIBI Narrative Rating	**Very Poor**

Taxa	Count
Bezzia_Palpomyia	2
Caecidotea	1
Enchytraeidae	1
Leuctra	29
Lumbricina	2
Nemouridae	5
Rhyacophila	2
Simuliidae	4
Simulium	2
Stegopterna	71
Wormaldia	1
TOTAL:	**120**

Physical Habitat Assessment

RBP 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	15	Sediment Deposition	12
Channel Sinuosity	14	Vegetative Protection - Left Bank	9
Epifaunal Substrate/Available Cover	11	Vegetative Protection - Right Bank	9
Pool Substrate Characterization	11		
RBP Habitat Score			**145**
RBP Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	15	80.78	Instream Wood Debris	2	72.28
Shading	90	91.34	Instream Habitat	10	86.14
Epifaunal Substrate	11	88.26	Bank Stability	14	83.67
PHI Score					**83.74**
PHI Narrative Rating					**Minimally Degraded**

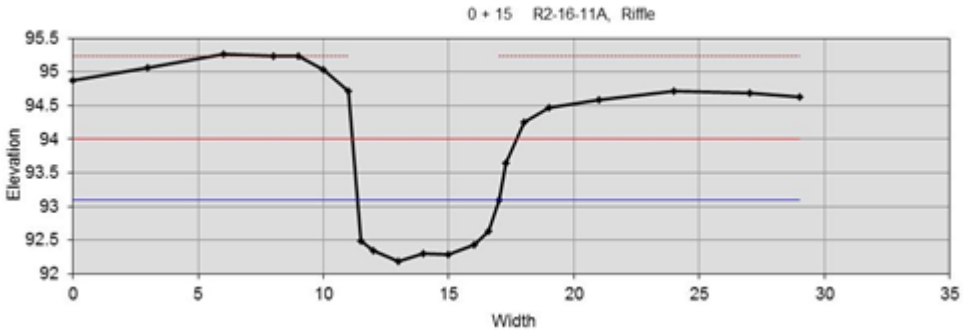
Water Chemistry

Dissolved Oxygen (mg/L)	8.52	pH (SU)	4.43
Turbidity (NTU)	1.16	Specific Conductivity (µS/cm)	70.7
Temperature (°C)	15.1		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.21	Cross Sectional Area (ft^2)	4.02
Bankfull Width (ft)	5.64	Water Surface Slope (%)	0.99
Mean Bankfull Depth (ft)	0.71	Sinuosity	1.32
Floodprone Width (ft)	6.55	D50 (mm)	3.2
Entrenchment Ratio	1.16	Adjustments?	None
Width to Depth Ratio	7.9	**Rosgen Stream Type**	**G4/5c**



R2-16-12A Upper Patuxent Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.0739002174 **Longitude:** -76.8071398371

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**207.4**
Cover	**Acres**	**% Area**
Developed Land	**22.9**	**11.1**
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	0	0
Residential 2-Acre	0	0
Transportation	9	4.3
Utility	14	6.7
Forest Land	**179.8**	**86.7**
Forested Wetland	0	0
Residential Woods	0	0
Woods	179.8	86.7
Open Land	**4.6**	**2.2**
Open Space	4.6	2.2
Open Wetland	0	0
Water	0	0
Agricultural Land	**0**	**0**
Pasture/Hay	0	0
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	2.6	1.2

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Stegopterna and Simulium (black flies) and Leuctra (intolerant stonefly) dominated the sample. Scored high for EPT taxa and intolerant percent.
- Measured below COMAR standards for pH.
- Most habitat parameters received marginal to sub-optimal scores. Over widened channel with moderately unstable banks.
- Bimodal distribution of substrate (sand/gravel).

Recommendations:

- Buffer enhancement.

R2-16-12A Upper Patuxent Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	12
EPT Taxa	5
Ephemeroptera Taxa	0
%Intolerant Urban	69.4
%Ephemeroptera	0
Scraper Taxa	1
% Climbers	1.8

Calculated Metric Scores

Total Taxa	1
EPT Taxa	5
Ephemeroptera Taxa	1
Intolerant Urban %	5
Ephemeroptera %	1
Scraper Taxa	3
% Climbers	3
BIBI Score	**2.71**
BIBI Narrative Rating	**Poor**

Taxa	Count
Calopteryx	1
Diplectrona	1
Leuctra	38
Micropsectra	1
Parachaetocladius	1
Podmosta	2
Rhyacophila	1
Simuliidae	9
Simulium	20
Stegopterna	33
Stenelmis	2
Thienemannimyia_group	1
Wormaldia	1
TOTAL:	**111**

Physical Habitat Assessment

RBP Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	6	Pool Variability	9
Bank Stability- Right Bank	6	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	11	Riparian Vegetative Zone Width- Right Bank	5
Channel Flow Status	14	Sediment Deposition	12
Channel Sinuosity	10	Vegetative Protection - Left Bank	7
Epifaunal Substrate/Available Cover	11	Vegetative Protection - Right Bank	7
Pool Substrate Characterization	9		
RBP Habitat Score			**117**
RBP Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	6	32.31	Instream Wood Debris	7	82.03
Shading	95	99.94	Instream Habitat	10	81.58
Epifaunal Substrate	11	85.36	Bank Stability	12	77.46
PHI Score					**76.45**
PHI Narrative Rating					**Partially Degraded**

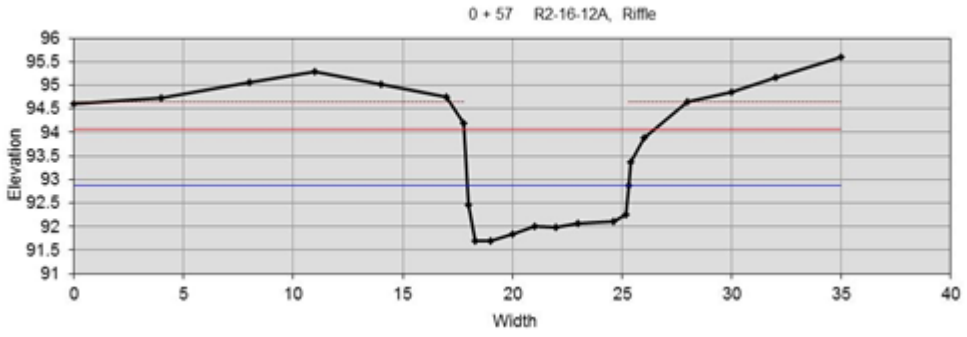
Water Chemistry

Dissolved Oxygen (mg/L)	10.08	pH (SU)	4.61
Turbidity (NTU)	1.56	Specific Conductivity (µS/cm)	51.5
Temperature (°C)	16.7		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.32	Cross Sectional Area (ft^2)	6.61
Bankfull Width (ft)	7.35	Water Surface Slope (%)	0.86
Mean Bankfull Depth (ft)	0.9	Sinuosity	1.15
Floodprone Width (ft)	8.67	D50 (mm)	0.14
Entrenchment Ratio	1.18	Adjustments?	None
Width to Depth Ratio	8.17	**Rosgen Stream Type**	**G5/4c**



R2-16-15A Upper Patuxent Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.0869942043 **Longitude:** -76.8133531514

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		22.4
Cover	**Acres**	**% Area**
Developed Land	**7.8**	**37**
Airport	0	0
Commercial	2	8.9
Industrial	0.5	2.1
Residential 1/8-acre	0.2	0.7
Residential 1/4-acre	4	17.8
Residential 1/2-acre	0	0
Residential 1-Acre	0	0
Residential 2-Acre	0	0
Transportation	1.7	7.5
Utility	0	0
Forest Land	**14.1**	**63**
Forested Wetland	0	0
Residential Woods	0	0
Woods	14.1	63
Open Land	**0**	**0**
Open Space	0	0
Open Wetland	0	0
Water	0	0
Agricultural Land	**0**	**0**
Pasture/Hay	0	0
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	3.6	15.9

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Stegopterna (intolerant black fly) and Amphinemura (intolerant stonefly) dominated the sample. Scored high for intolerant percent and scraper taxa.
- Water quality values within COMAR standards but conductivity elevated.
- Very little flow in channel due to small drainage area. Most habitat parameters received marginal scores. Moderately unstable banks with good vegetative protection and excellent riparian width.
- Bimodal distribution of substrate (clay/sand).

Recommendations:

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

R2-16-15A Upper Patuxent Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	19
EPT Taxa	3
Ephemeroptera Taxa	0
%Intolerant Urban	67.3
%Ephemeroptera	0
Scraper Taxa	3
% Climbers	2.9

Calculated Metric Scores

Total Taxa	3
EPT Taxa	3
Ephemeroptera Taxa	1
Intolerant Urban %	5
Ephemeroptera %	1
Scraper Taxa	5
% Climbers	3
BIBI Score	**3**
BIBI Narrative Rating	**Fair**

Taxa	Count
Amphinemura	32
Bivalvia	1
Diplocladius	3
Fossaria	1
Helichus	1
Ironoquia	3
Lepidoptera	1
Libellulidae	1
Limnophyes	1
Lumbricina	1
Neoporus	2
Physa	1
Pisidium	2
Podmosta	2
Rheocricotopus	1
Simuliidae	4
Stegopterna	36
Tanypodinae	1
Tanytarsus	1
Thienemannimyia_group	6
Tubificidae	1
TOTAL:	**102**

Physical Habitat Assessment

RBP Rapid Bioassessment Protocol

	Score		Score
Bank Stability- Left Bank	5	Pool Variability	6
Bank Stability- Right Bank	5	Riparian Vegetative Zone Width- Left Bank	9
Channel Alteration	15	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	11	Sediment Deposition	9
Channel Sinuosity	12	Vegetative Protection - Left Bank	7
Epifaunal Substrate/Available Cover	9	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	7	37.7	Instream Wood Debris	1	89.47
Shading	95	99.94	Instream Habitat	8	93.26
Epifaunal Substrate	9	88.24	Bank Stability	10	70.71
PHI Score					**79.88**
PHI Narrative Rating					**Partially Degraded**

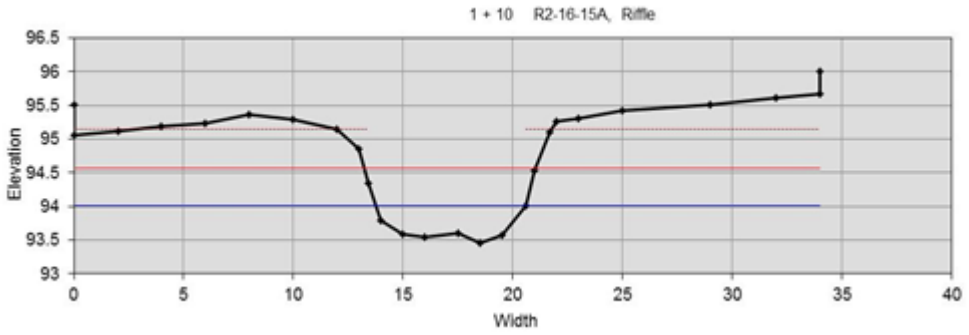
Water Chemistry

Dissolved Oxygen (mg/L)	7.27	pH (SU)	7.32
Turbidity (NTU)	16.2	Specific Conductivity (µS/cm)	560.7
Temperature (°C)	11.9		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.04	Cross Sectional Area (ft^2)	2.64
Bankfull Width (ft)	6.84	Water Surface Slope (%)	1.5
Mean Bankfull Depth (ft)	0.39	Sinuosity	1.21
Floodprone Width (ft)	7.79	D50 (mm)	0.088
Entrenchment Ratio	1.14	Adjustments?	None
Width to Depth Ratio	17.67	**Rosgen Stream Type**	**F6/5**



Appendix E: Natural Soils Groups of Maryland

Estimated physical and chemical properties of Natural Soils Groups of Maryland (Maryland Department of Planning)

SOIL	DEPBED	DEPWAT	DEPSOL	TEXTUR	EROK	HYDGRP	IRRMAX	PERMAX	PERC	AWC	PH
A1,A1a,A1b,A1c	72+	4+	0-60	loamy sand; sand, sandy loam	0.17	A	1.00	>6.0	<45	0.2-0.6	4.0-5.0
A2	72+	1-10	0-60	sand	0.17	A	N/A	>6.0	<45	<0.06	5.0-8.0
B1,B1a,B1b,B1c	72+	3+	0-60	silt loam,loam, fine sandy loam, sandy loam, silty clay loam, clay loam,silty clay, clay	0.32	B	0.4-0.6	0.6-2.0	45-60	0.12-0.24	4.5-6.5
B2,B2a,B2b, B2c	72+	4+	0-60	silt loam, loam, gravelly loam, clay loam,silty clay loam	0.43	C	0.3-0.4	0.2-0.6	>60	0.12-0.24	4.5-7.3
B3	72+	5+	0-60	clay, silty clay, silt loam, loam,loamy sand	0.37	C	0.3	<0.6	>60	0.06-0.24	4.0-5.0
C1,C1a,C1b,C1c	20-40	In bed-rock	0-40	silt loam, loam, shaly silty loam, shaly loam, channery loam, channery silt loam, sandy loam	0.22	C	0.3	0.6-6.0	>60	0.12-0.24	4.-7.3
C2	20-40	3+	0-40	silty clay loam, silty clay, clay	0.37	C	0.3	<0.6	>60	0.12-0.24	5.0-7.5
D1,D1a,D1b, D1c	<20	In bed-rock	0-20	shaly silt loam, shaly loam, silty clay loam, silty clay	0.28	C-D	0.3	0.6-6.0	45-60	0.18-0.24	4.0-7.3
E1, E1a,E1b	72+	1.5-2.5	0-60	sandy loam, sandy clay, loam, loamy	0.28	C	0.4-0.6	0.6-6.0	<60	0.12-0.24	4.0-5.0

				sand, sand							
E2,E2a,E2b	72+	1-3	0-60	silt loam, loam, silty clay loam, fine sandy loam, sandy clay loam	0.43	C	0.3-0.4	<0.6	>60	0.12-0.24	4.0-6.5
E3, E3a, E3b	72+	1.5-2.5	0-60	silt loam, loam, silty clay loam	0.37	C	0.4	0.2-0.6	>60	0.18-0.24	4.5-5.5
F1	72+	0-1	0-60	loamy sand, sand	N/A	D	1.0	>60	<45	<0.06	3.5-5.0
F2	72+	0-1	0-60	sandy loam, fine sandy loam, sandy clay loam, loam, loamy sand	0.28	D	0.4-0.6	0.6-2.0	<60	0.12-0.24	4.0-5.0
F3	72+	0-1	0-60	silty clay loam, silty clay, clay, loam, silt loam	0.43	D	0.3	<0.6	>60	0.18-0.24	4.0-7.8
G1,G1a	72+	3+	0-60	silt loam, loam, fine sandy loam, sandy loam, silty clay loam	N/A	B-C	0.5-0.7	0.2-2.0	45-60	0.12-0.24	4.0-7.3
G2	72+	0-1	0-60	silt loam, silty clay loam, silty clay, fine sandy loam, sandy loam, loam, muck	N/A	D	0.5	0.6-6.0	45-60	0.18-0.24	4.0-7.3
G3	72+	0	0-60	variable	N/A	N/A	N/A	Var.	Var.	Var.	3.5-9.0
H1,H1a,H1b,H1c	Too variable to rate. Determine the specific soil series name from detailed soil map and use the information for the group that the series is in.										
H2,H2a,H2b,H2c	Too variable to rate. Determine the specific soil series name from detailed soil map and use the information for the group that the series is in.										

EXPLANATION

DEPBED = Depth to bedrock (in.) -- distance from the surface of the soil downward to the surface of the rock layers. Soils were observed only to a depth of 6 feet: greater depths are specified at 72+ in.

DEPWAT = Depth to water table (ft) -- distance from the surface of the soil downward to the highest level reached In most years by ground water.

DEPSOL = Soil depth (in.) -- this does not imply that the soils are only 60 in. deep, but rather that the estimates In the table are for the 0-60 in. depth and not below.

TEXTUR = Dominant texture -- relative percentages of sand, silt, and clay in a soil sample. If the soil contains gravel or other particles coarser than sand, then an appropriate modifier Is added.

EROK = Erodibility (K factor) -- a measure of the susceptibility of bare soil to erosion and the same K factor as that used in the Universal Soil Loss Equation (Wischmeier and Smith, 1965).

HYDGRP = Hydrologic Soil Group -- a measure of the runoff potential of soils, when fully saturated. Group A soils have the lowest potential and D soils the highest.

IRRZMAX = maximum irrigation rate (in/hr)-- maximum rate of irrigation water applied by sprinklers.

PERMAX = Permeability (in/hr) -- rate at which soil transmits water while saturated. Permeability rates shown are based on the least permeable section of the soil.

PERC = Percolation (min/in) -- rate at which water can move through a soil with moisture at field capacity.

AWC = Available Water Capacity (in/in) -- the difference between the amount of water in the soil at field capacity and the amount in the soil at the wilting point of most crops.

PH = Reaction (pH) -- the degree of acidity or alkalinity of a Soil group, expressed in pH units.