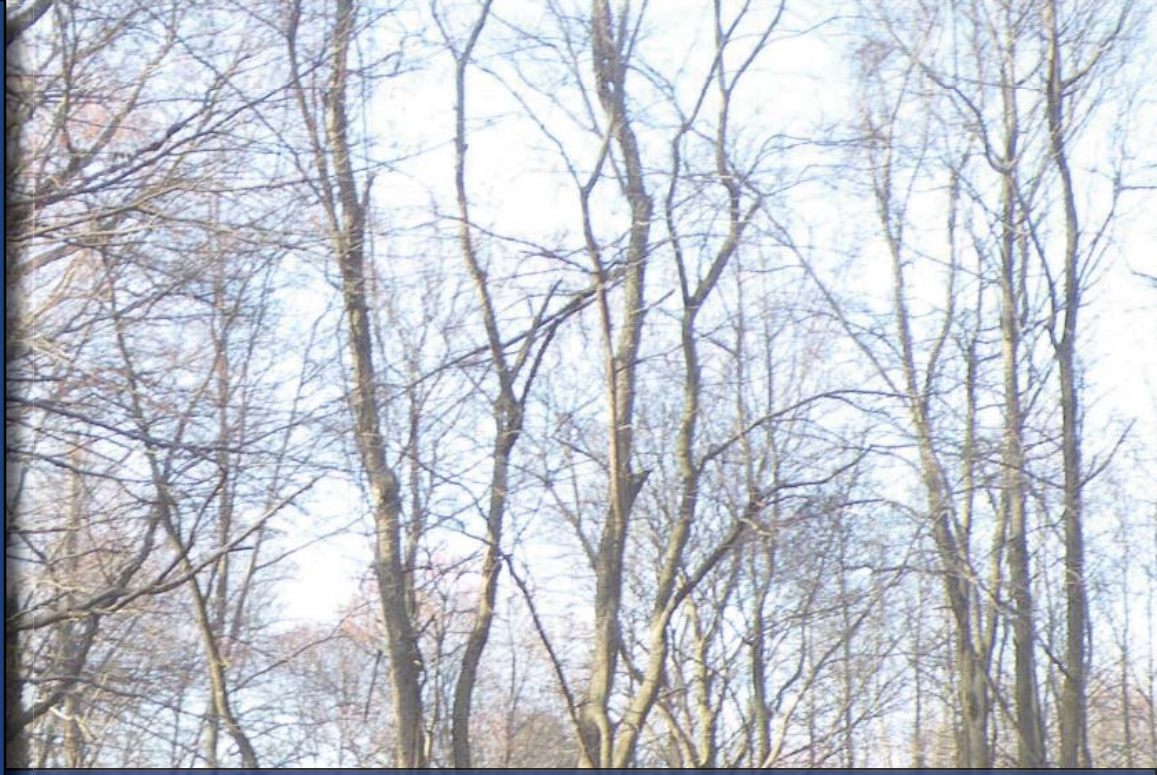

Aquatic Biological Assessment of the Watersheds of Anne Arundel County, Maryland: 2010

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: 2010 Round Two - Year Two

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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. Assessment was continued in 2010 with sampling in five primary sampling units; Ferry Branch, Herring Run, Middle Patuxent, Sawmill Creek, and Stony Run. The indicators used to assess the aquatic life in streams include the Maryland DNR Benthic Index of Biological Integrity (BIBI), the USEPA Rapid Bioassessment Protocol (RBP) physical habitat assessment, the MBSS Physical Habitat Index (PHI), and five water quality measures (temperature, dissolved oxygen, specific conductance, pH, and turbidity), as well as a detailed geomorphic assessment and classification 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, three had 'Poor' biological conditions (Ferry Branch, Sawmill Creek, and Stony Run), while the remaining two (Herring Bay, Middle Patuxent) had 'Fair' biological conditions. Using the PHI, all but one sampling unit had 'Partially Degraded' physical habitat conditions; Sawmill Creek had 'Degraded' physical habitat conditions. Stony Run was the only sampling unit with physical habitat conditions rated 'Supporting' by the RBP method, with the remaining four sampling units rated as 'Partially Supporting.' The majority of reaches (52 percent) were classified as either G or F type streams. Water quality measurements were generally within acceptable COMAR limits, with a few pH readings below the lower limit. Elevated conductivity values were routinely observed in the most developed sampling units (Sawmill Creek and Stony Run). Comparisons of 2010 BIBI data to Round One data resulted in a statistically significant difference for only one sampling unit, Sawmill Creek, which saw the average BIBI score increase. Comparisons of physical habitat data showed a statistically significant increase in the average RBP score for Stony Run and significant decreases for Middle Patuxent and Ferry Branch. A statistically significant decrease in the average PHI score for Ferry Branch 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 also 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 is intensifying point and nonpoint sources of pollutants and multiple other sources of stressors 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 and Ecosystem Services Group of the Department of Public Works). The sampling program involves monitoring the biological health and physical condition of the County's water resources to assess the status and trends at the stream level, the watershed level and ultimately at the County level.

The County initiated the program, in part, to establish a baseline ecological stream condition for all of the County's watersheds and to track changes in condition over time. The program is designed on a five-year rotating basis such that each of the County's 24 watersheds or primary sampling units (PSU) will be sampled once every five years. In general, four to five PSUs are sampled each year with 10 sites sampled in each PSU. Table 1 illustrates the progress made to date within the countywide biological monitoring program. The first sampling rotation, Round 1, was completed in five years (2004-2008). Sampling efforts in 2010 mark the second 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

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, 2010). Documentation of data quality and method performance characteristics, including measurement and data quality objectives (MQOs and DQOs), are presented in Hill and Pieper (2010).

2.1.2 Site Selection

The county was initially 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 2010, ten randomly selected sites were chosen from each of the following PSUs (with PSU code); Ferry Branch (21), Herring Bay (15), Middle Patuxent (18), Sawmill Creek (4), and Stony Run (2). 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 (i.e. permission denied by landowner, no defined channel present, or channel is too deep or unsafe to sample). A total of twelve alternate sites were sampled during this sampling period (Table 2).

Figure 1 - 2010 Sampling Units

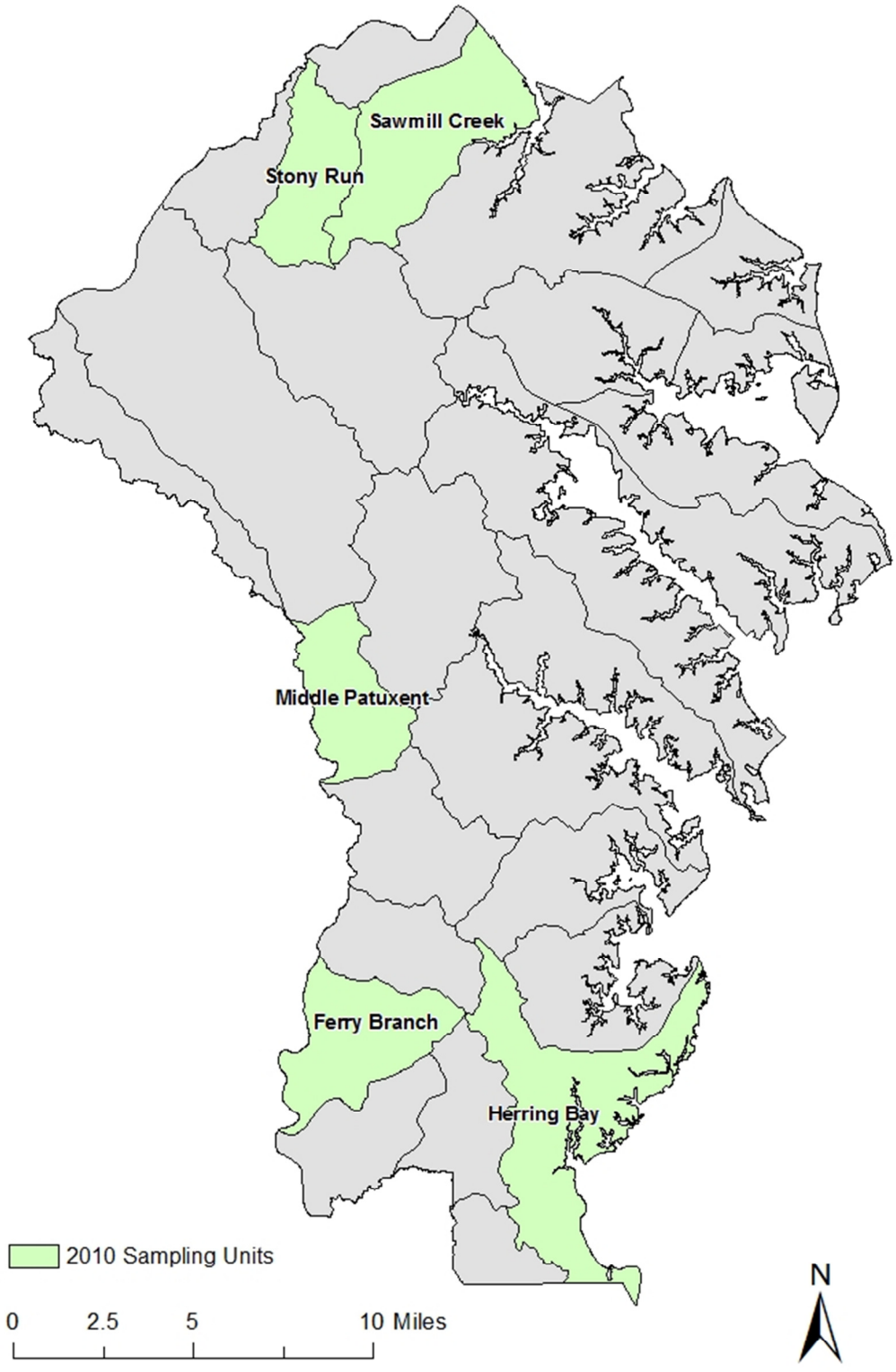


Table 2 - Field Sampling - Alternate Sites Chosen

Original Site	Alternate Site	Reason
R2-02-03	R2-02-15A	Permission denied
R2-02-04	R2-02-16A	No defined channel present
R2-02-05	R2-02-18A	On BWI runway, no access
R2-02-07	R2-02-20A	Ponded wetland due to beaver dam
R2-04-07	R2-04-12A	No channel; piped underground
R2-04-09	R2-04-16A	Permission denied
R2-15-04	R2-15-12A	Permission denied
R2-15-06	R2-15-13A	Permission denied
R2-18-01	R2-18-11A	Permission denied
R2-21-02	R2-21-13A	Permission denied
R2-21-08	R2-21-14A	Permission denied
R2-21-09	R2-21-15A	Permission denied

2.2 Field and Laboratory Procedures

2.2.1 Benthic Macroinvertebrate Sampling and Processing

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

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 using a gridded petri dish until the final count is between 100 and 120 organisms.

Any samples containing greater than 120 organisms after taxonomic identification and enumeration, a post-processing subsampling procedure was conducted using an Excel spreadsheet application (Tetra Tech, 2006). This post-processing application is designed to randomly subsample all identified organisms within a given sample to a desired target number. Each taxon is subsampled based on its original proportion to the entire sample. In this case, the desired sample size selected was 110 individuals. This

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

allows for a final sample size of approximately 110 individuals (±20 percent) but keeps the total number of individuals below the 120 maximum.

Taxa were primarily identified to the genus level for most organisms. Groups including Oligochaeta and Nematomorpha were identified to the family level while Nematoda was left at phylum. Individuals of early instars or those that may be damaged 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 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 Coastal Plain 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) and relationships for urban stream developed specifically for Anne Arundel County (AADPW, 2002). 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 dimensions were derived from the appropriate 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).

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

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 6 – MBSS PHI Scoring

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

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). EPA's RBP document (Barbour et al. 1999) was used as a secondary source 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. However, Morgan et al. (2007) suggest that conductivity values greater than 247 µS/cm may be harmful to aquatic life. Therefore, as proposed in Hill and Pieper (2011), stations where conductivity values exceed this threshold are considered potentially impaired. 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 Nephelometer 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 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 2 percent would be classified as a G4c stream.

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.
- Typically, stream classification using the Rosgen methodology is best performed on riffle or step cross sections. Many of the 75-meter reaches assessed in this study did not contain riffles.
- 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 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 9.2 and 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 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

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 2010. Comparisons primarily focus on the averaged 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
Ferry Branch	2.91 ± 0.47 Poor	68.6 ± 10.1 Partially Degraded	115.3 ± 9.0 Partially Supporting
Herring Bay	3.17 ± 1.00 Fair	66.3 ± 7.3 Partially Degraded	113.8 ± 11.0 Partially Supporting
Middle Patuxent	3.32 ± 0.58 Fair	75.0 ± 10.4 Partially Degraded	123.0 ± 16.3 Partially Supporting
Sawmill Creek	2.37 ± 0.52 Poor	65.8 ± 16.3 Degraded	122.9 ± 35.3 Partially Supporting
Stony Run	2.69 ± 0.98 Poor	68.7 ± 15.1 Partially Degraded	125.5 ± 22.8 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' (44 percent) and 'Poor' (42 percent) with a small proportion of sites rated as either 'Very Poor' (eight percent) or 'Good' (six percent; Figure 2). Three sampling units, Ferry Branch, Sawmill Creek, and Stony Run, had mean BIBI values that resulted in 'Poor' biological condition ratings (Table 12). The remaining two sampling units, Herring Bay and Middle Patuxent, received biological condition ratings 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 'Partially Degraded' (PHI) and four of the five received ratings of 'Partially Supporting' (RBP; Table 12). Stony Run was the only sampling unit that received an RBP rating of 'Supporting,' although, it should be mentioned that the mean score of 125.5 was rounded up to 126, which is the lowest possible score in this category.

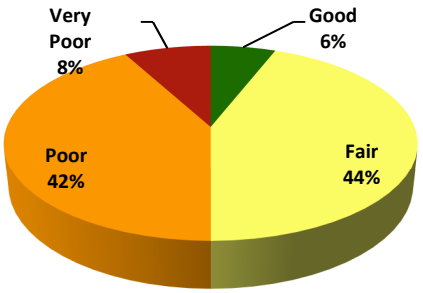


Figure 2 - Proportional distribution of BIBI assessment results for 2010 (n=50)

Over half of the total sites sampled resulted in a RBP rating of 'Partially Supporting'(54 percent) and nearly one-third of the samples (32 percent) resulted in a 'Supporting' rating (Figure 3). Only a small proportion of sites were rated as either 'Comparable to Reference'(six percent) or 'Non Supporting'(eight percent). Similar to the results of the RBP method, over half of the sites received a PHI rating of 'Partially Degraded' (52 percent) and one-third of the samples (30 percent) received a 'Degraded' rating, while the remaining 20 percent of sites were rated as either 'Minimally Degraded' or 'Severely Degraded' (Figure 3).

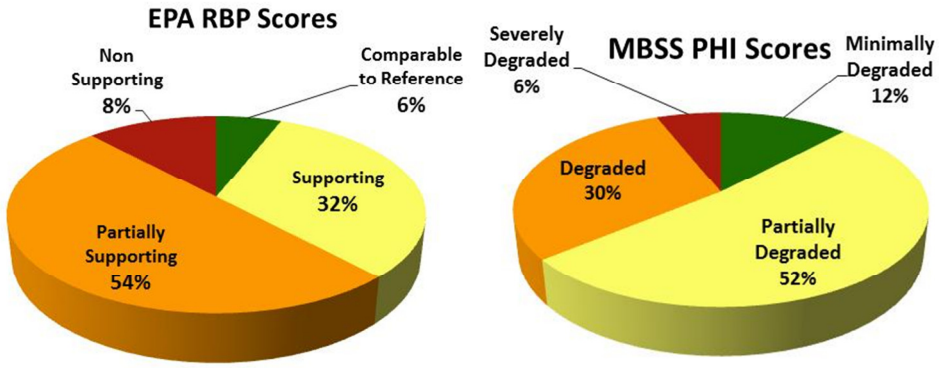


Figure 3 - Summary of 2010 Habitat Scores (n=50)

3.1.2 Water Quality Assessment Summary

Generally, water quality measurements were within COMAR standards for all parameters, with only a few exceptions. Two sites in the Ferry Branch sampling unit and two sites in the Middle Patuxent sampling unit had recorded pH values that fell below state standards of 6.5 standard units. The pH values ranged from 6.10 - 6.35 for the four sites that did not meet COMAR standards for water quality. There were no exceedances for dissolved oxygen, temperature, or turbidity.

3.1.3 Geomorphic Assessment Summary

The stream types throughout the sampling units were highly variable, with the largest portion of the sites (30 percent) being F channels (Figure 4). Ferry Branch had the highest proportion of F channels, followed by the Herring Bay and Stony Run sampling units. Twenty-two percent of the sites were classified as G channels, the majority of which were located in the Middle Patuxent sampling unit.

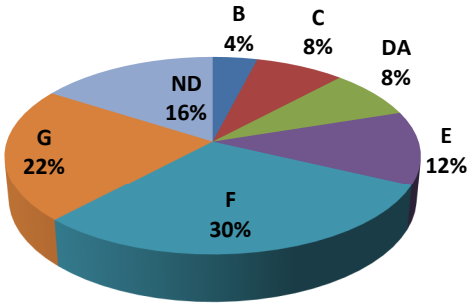


Figure 4 - Distribution of Rosgen stream types within the 2010 sampling units (n=50)

The E and C type channels comprised 12 percent and 8 percent, respectively, and were most commonly found in Stony Run and Herring Bay. While comprising only eight percent, DA channels were predominantly concentrated in Sawmill Creek, with one additional DA channel located in Ferry Branch. The least common stream type, B channels, comprised only four percent of streams assessed and were found only in the Ferry Branch and Middle Patuxent sampling units. Additionally, 16 percent of sites were classified as 'Not Determined' because they were either thought to be transitional reaches and the predominant type was not clear from the data collected, or they exhibited considerable anthropogenic modification (i.e., channel alteration, hardened banks, road crossings), which impacted the natural channel forming process.

Fifty-two percent of the sites sampled in 2010 had channel substrates composed primarily of sand. Sand dominated channels occurred most frequently in the Ferry Branch and Middle Patuxent sampling units, with eight sites each. However, sand bed streams comprised forty percent or less of streams in the remaining sampling units. Gravel dominated streams comprised 28 percent of the total sites, with the highest proportion occurring in Stony Run (six sites), followed by Sawmill Creek (four sites). Ferry Branch and Herring Bay had only one site each that was dominated by gravel substrate. The remaining twenty percent of sites had silt/clay channel substrates, the majority of which occurred in Herring Bay (six sites) and Sawmill Creek (two sites).

Stream slopes were generally low in the assessment reaches. The average slope of all reaches assessed was 0.68 percent. Average slopes for the sampling units ranged from 0.37 percent in Herring Bay to 1.2 percent in Middle Patuxent. However, it should be noted that the average slope in the Middle Patuxent sampling unit is skewed by a single, multiple headcutting stream with a 6.9 percent slope, and without this reach the average channel slope would be 0.52 percent.

3.1.4 Land Use Analysis and Impervious Surface Summary

Nearly one-half of the sites sampled in 2010 had developed land as the dominant land use (48 percent), 38 percent were dominated by forested land, 10 percent were dominated by agricultural use, and the remaining two percent of sites were dominated by open space. At the sampling unit scale, Sawmill Creek had the highest percentage of developed land at 60 percent of the total acreage, which was followed by Stony Run at 51.7 percent (Table 13). With over 50 percent of the drainage area comprised of developed land, both Sawmill Creek and Stony Run can be considered urbanized subwatersheds. In contrast, Ferry Branch was the least developed, with only 23 percent of the sampling unit attributed to developed land. Developed land was also low (<30 percent) in Middle Patuxent (25.3 percent) and Herring Bay (28.3 percent) sampling units, which collectively with Ferry Branch can be considered rural subwatersheds. Herring Bay had the highest proportion of forested land at 54 percent, while Sawmill Creek had the lowest proportion (21.8 percent). The highest proportion of agricultural land use (21 percent) occurred in Middle Patuxent, followed closely by Herring Bay at 19 percent. On the other hand, agriculture comprised less than 0.1 percent of the land use in Sawmill Creek. Figure 5 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 Sawmill Creek (35.5 percent) while Ferry Branch had the lowest percentage impervious surface (6.2 percent). Figure 6 shows impervious surface for the entire County based on the County's 2007 Impervious GIS layer.

Figure 5 - Summarized Land Use in Anne Arundel County (2007)

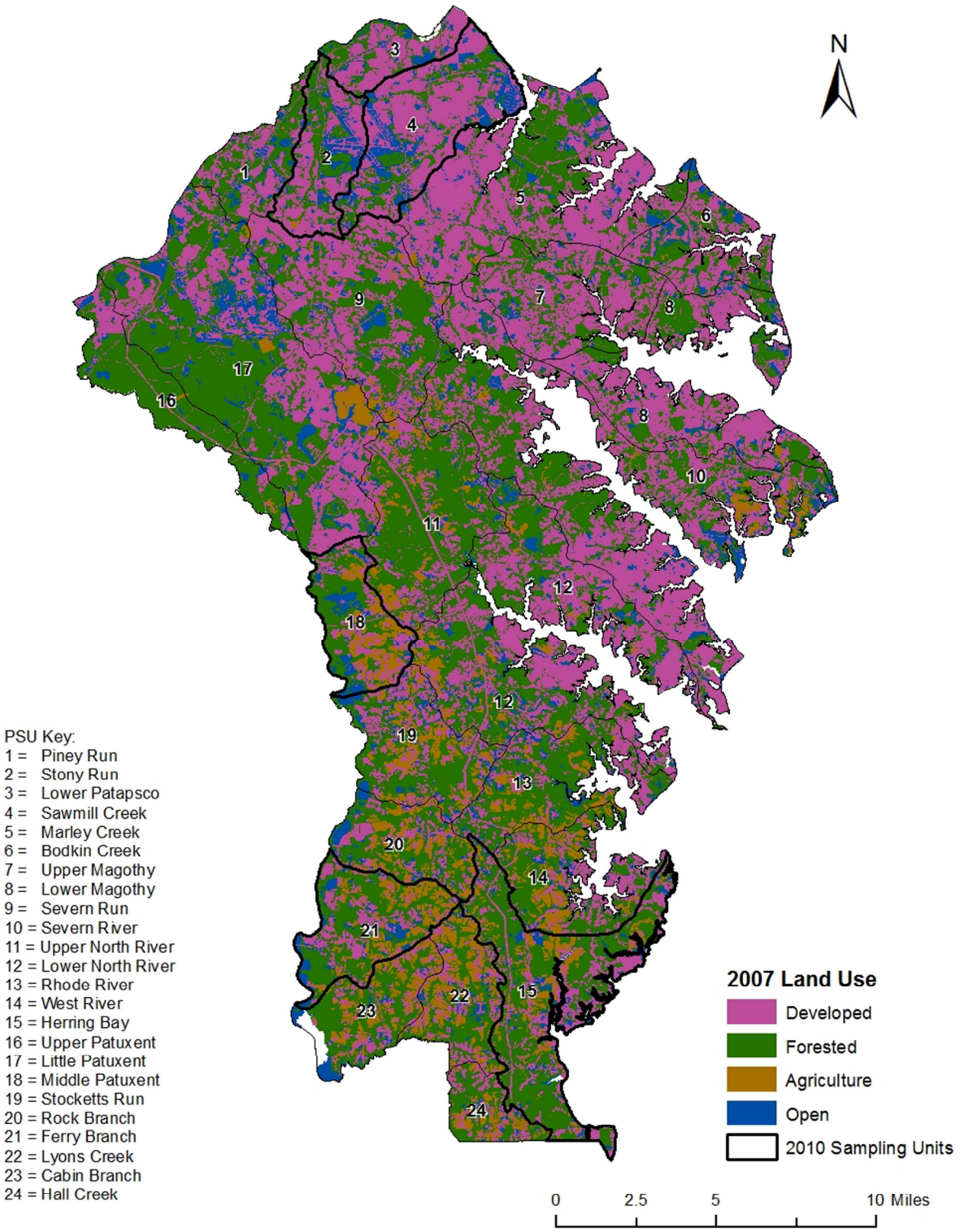


Figure 6 - Impervious Surface in Anne Arundel County (2007)

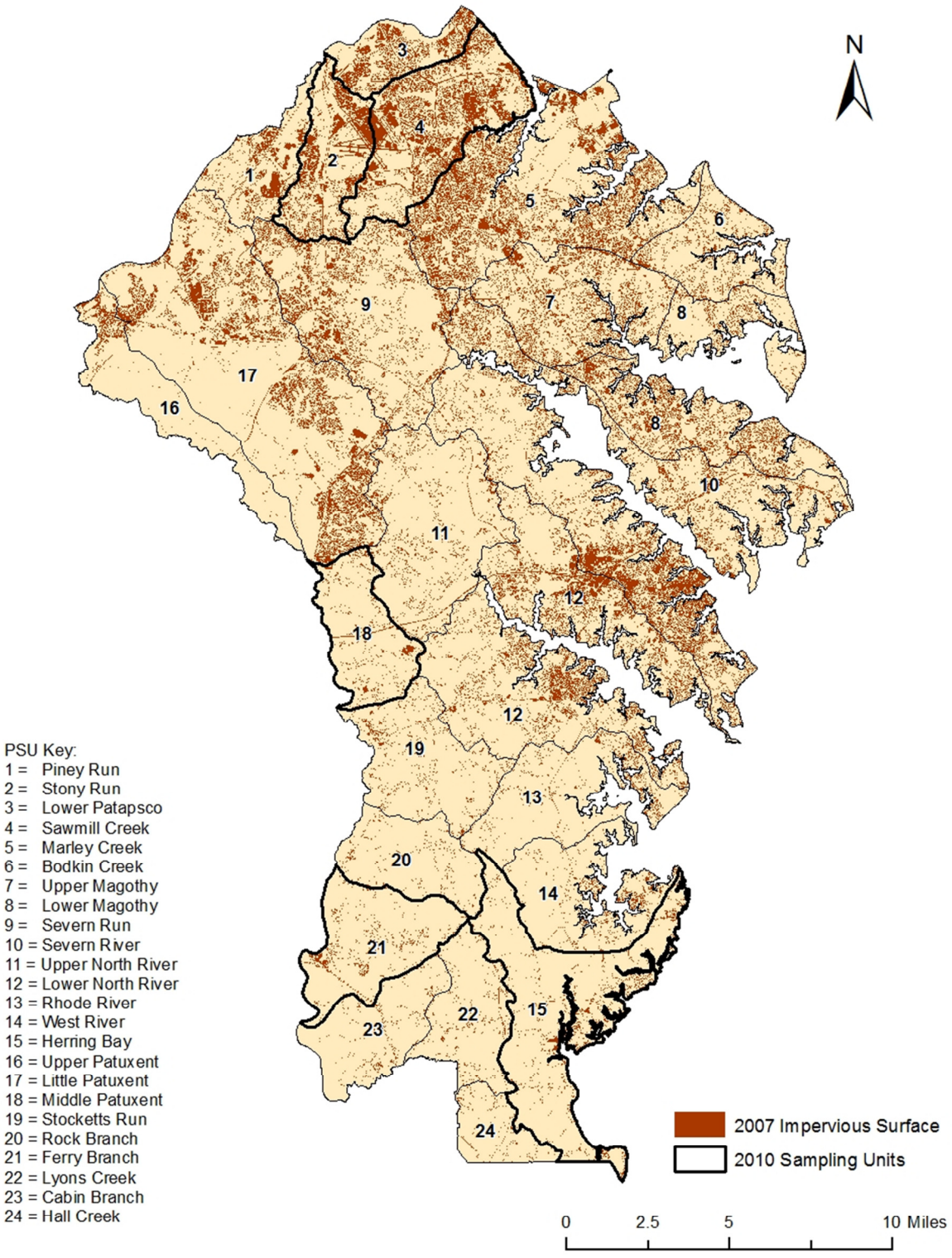


Table 13 - Summary of land use and impervious surface across sampling units

Sampling Unit	Total Acreage	% Impervious	Land Use			
			% Developed	% Forested	% Agriculture	% Open
Ferry Branch	8,038	5.3	23.0	47.2	19.1	10.7
Herring Bay	14,595	6.2	28.3	53.8	10.3	7.6
Middle Patuxent	6,332	7.0	25.3	41.7	20.9	12.0
Sawmill Creek	11,044	35.4	60.0	21.8	<0.1	18.2
Stony Run	6,203	30.6	51.7	33.2	0.5	14.6

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 Ferry Branch

The Ferry Branch sampling unit, located in the southwestern portion of the County, has a total drainage area of 8,038 acres (Figure 1). The ten sampling sites, eight on 1st order streams and two on 2nd order streams, have drainage areas ranging from 53 acres to 2,043 acres (Figure 9). The dominant land use for the Ferry Branch sampling unit is forested land (47 percent) followed by developed (23 percent) and agricultural land use (19 percent). Agricultural land use is the dominant land use for 40 percent of the sites sampled, while the remaining sites either have forested or developed land use dominating drainage areas (30 percent each). Impervious surfaces comprise 5.3 percent of the overall Ferry Branch sampling unit, with individual sites ranging from 3.3 to 9.6 percent impervious surface. This sampling unit has the highest percentage of sites with agricultural land as the dominant land use and the smallest percentage of total impervious surface.

4.1.1 Physical Habitat

The majority of sites in Ferry Branch were rated 'Partially Supporting' (90 percent) with only one site rated as 'Supporting' by the RBP index. The PHI rated 60 percent of the sites as 'Partially Degraded', 30 percent as 'Degraded', and 10 percent as 'Severely Degraded' (Figure 7). The average RBP score was 115.3 ± 9.0 resulting in a 'Partially Supporting' habitat condition for the sampling unit. RBP scores for individual sites ranged from 103 ('Partially Supporting') to 130 ('Supporting'). The average PHI rating was 'Partially Degraded' and a score of 68.6 ± 10.1, with individual site scores ranging from 45.1 ('Severely Degraded') to 79.2 ('Partially Degraded'). There were several reaches that exhibited poor bank stability, vegetative protection, and overall instream physical habitat; however, the majority of sites benefited from wide riparian vegetative zone widths with little impact from human activities.

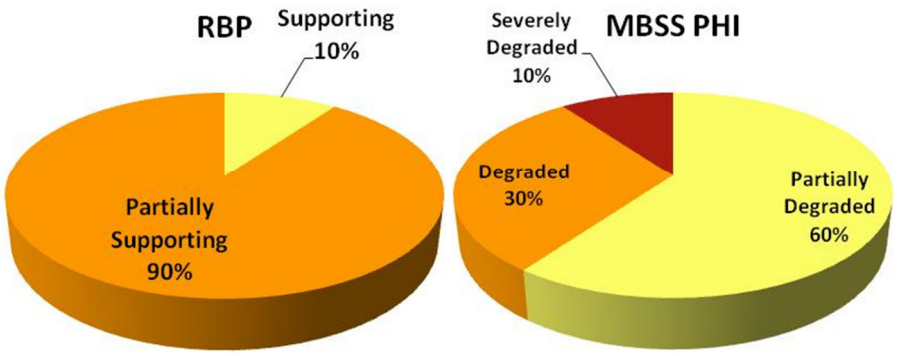


Figure 7 - Ferry Branch Habitat Scores

4.1.2 Benthic Macroinvertebrates

Of the ten sites sampled in Ferry Branch, 70 percent of sites received a BIBI rating of 'Fair' while the remaining sites (30 percent) received 'Poor' biological condition ratings (Figure 8). The average BIBI score for the Ferry Branch sampling unit is 2.91 ± 0.47, with an average biological condition of 'Poor (Table 12). Individual BIBI scores ranged from 2.14 ('Poor') to 3.57 ('Fair'). Site-specific data and assessment results can be found in Appendix D.

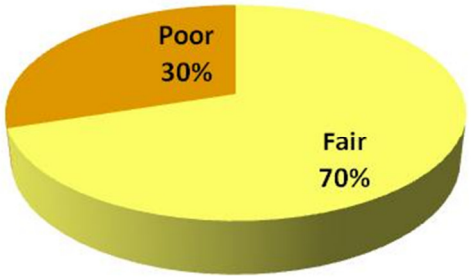


Figure 8 - Ferry Branch BIBI Scores

Sites R2-21-14A and R2-21-15A (Figure 9) received the lowest BIBI scores, both with a score of 2.14 and a biological rating of 'Poor.' Site R2-21-14A, located in the eastern part of the sampling unit near Greenock Road, had the lowest number of total taxa (11), three EPT taxa, and no Ephemeroptera taxa present. Only ten 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 79 percent of the sample, amphipods (*Gammarus*, tolerance value [TV]=6.7) dominated the macroinvertebrate assemblage. Site R2-21-15A, also located in the eastern portion of the sampling unit near the headwaters, had a higher total number of taxa (21) but only one EPT taxa and no Ephemeroptera taxa present. This site had the smallest percentage of intolerant taxa at only 2.7 percent. Twelve genera of the Chironomidae family (midges) were identified and dominated this sample at 87 percent. In particular, Orthocladiinae (TV=7.6) and *Polypedilum* (TV=6.3) accounted for 36 percent and 21 percent of the sample, respectively. Site R2-21-05, located in the western part of the sampling unit near Ed Prout Road, had the highest BIBI score in Ferry Branch (3.57), due to a high number of total taxa (27), four EPT taxa, and one Ephemeroptera taxon. Over one-third of the macroinvertebrates identified in this sample were considered to be intolerant to urban stressors (38 percent), and 21 percent of the sample consisted of the sensitive stonefly *Amphinemura* (TV=3).

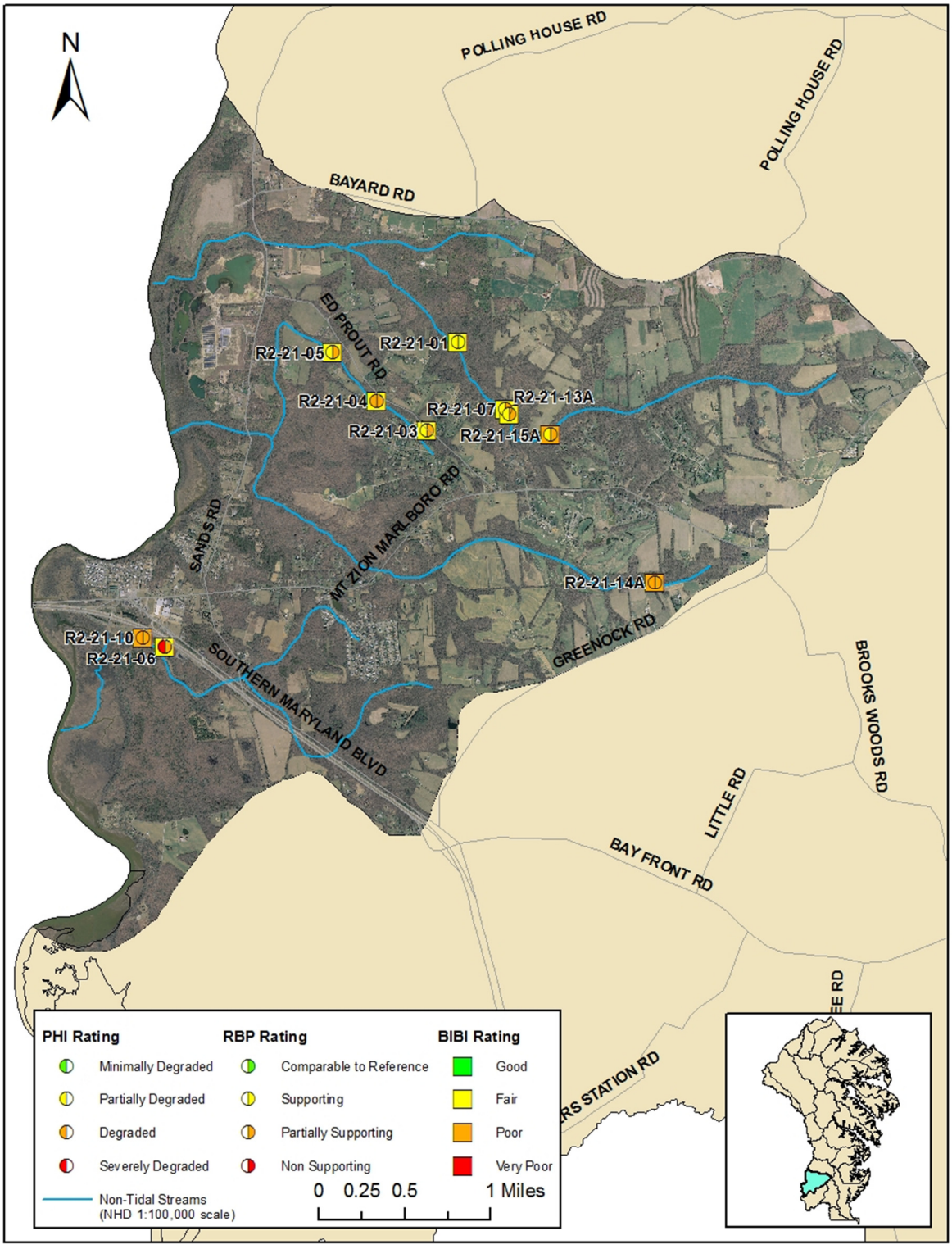
4.1.3 Water Quality

Average water quality values for the Ferry Branch sites are provided in Water temperature ranged from 10.1 to 15.1 °C; dissolved oxygen ranged from 8.5 to 12.4 mg/L; pH ranged from 6.1 to 7.2; conductivity ranged from 153.9 to 253.8 µS/cm; and, turbidity ranged from 2.4 to 18.6 NTU.

Table 14. Of the ten sites sampled, only two sites did not meet COMAR standards for water quality. Sites R2-21-03 and R2-21-14A both measured outside the acceptable COMAR range for pH (6.5 – 8.5),

with values of 6.35 and 6.10, respectively. Site R2-21-03 also had specific conductivity concentrations (253.8 µS/cm) that slightly exceeded the impairment threshold. All other water quality parameters were within acceptable ranges.

Figure 9 - Ferry Branch Sampling Sites



Water temperature ranged from 10.1 to 15.1 °C; dissolved oxygen ranged from 8.5 to 12.4 mg/L; pH ranged from 6.1 to 7.2; conductivity ranged from 153.9 to 253.8 µS/cm; and, turbidity ranged from 2.4 to 18.6 NTU.

Table 14 - Average water quality values - Ferry Branch (n = 10)

Value ± Standard Deviation				
Temperature (°C)	DO (mg/L)	pH (Units)	Conductance (µS/cm)	Turbidity (NTU)
12.32 ± 1.62	10.79 ± 1.12	6.95 ± 0.48	181.6 ± 29.1	7.39 ± 4.73

4.1.4 Geomorphic Assessment

Site-specific geomorphic assessment results can be found in Appendix A. The majority of the sites assessed (60 percent) were F type streams (Figure 10). The remaining sites were G (20 percent), B (10 percent) or DA type (10 percent) channels. With the exception of the anastamosed DA stream, all other streams were noticeably incised, most of which showed signs of heavy bank erosion and sedimentation. Furthermore, both G channels showed evidence of active downcutting, demonstrating further geomorphic instability.

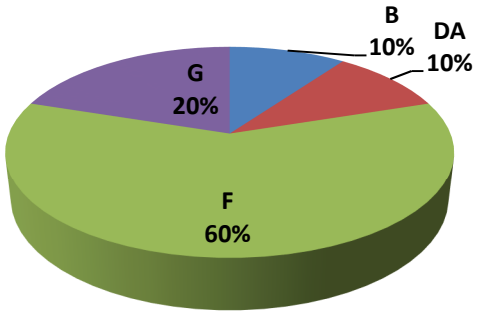


Figure 10 - Rosgen stream types observed in Ferry Branch (n = 10)

Streams in this sampling unit were predominantly sand bottom channels (80 percent), although a small percentage was dominated by clay (10 percent) and gravel (10 percent). The median D_{50} was 0.18 mm (fine sand material). Individual slopes ranged from 0.14 percent to 1.0 percent, with an average slope of 0.44 percent.

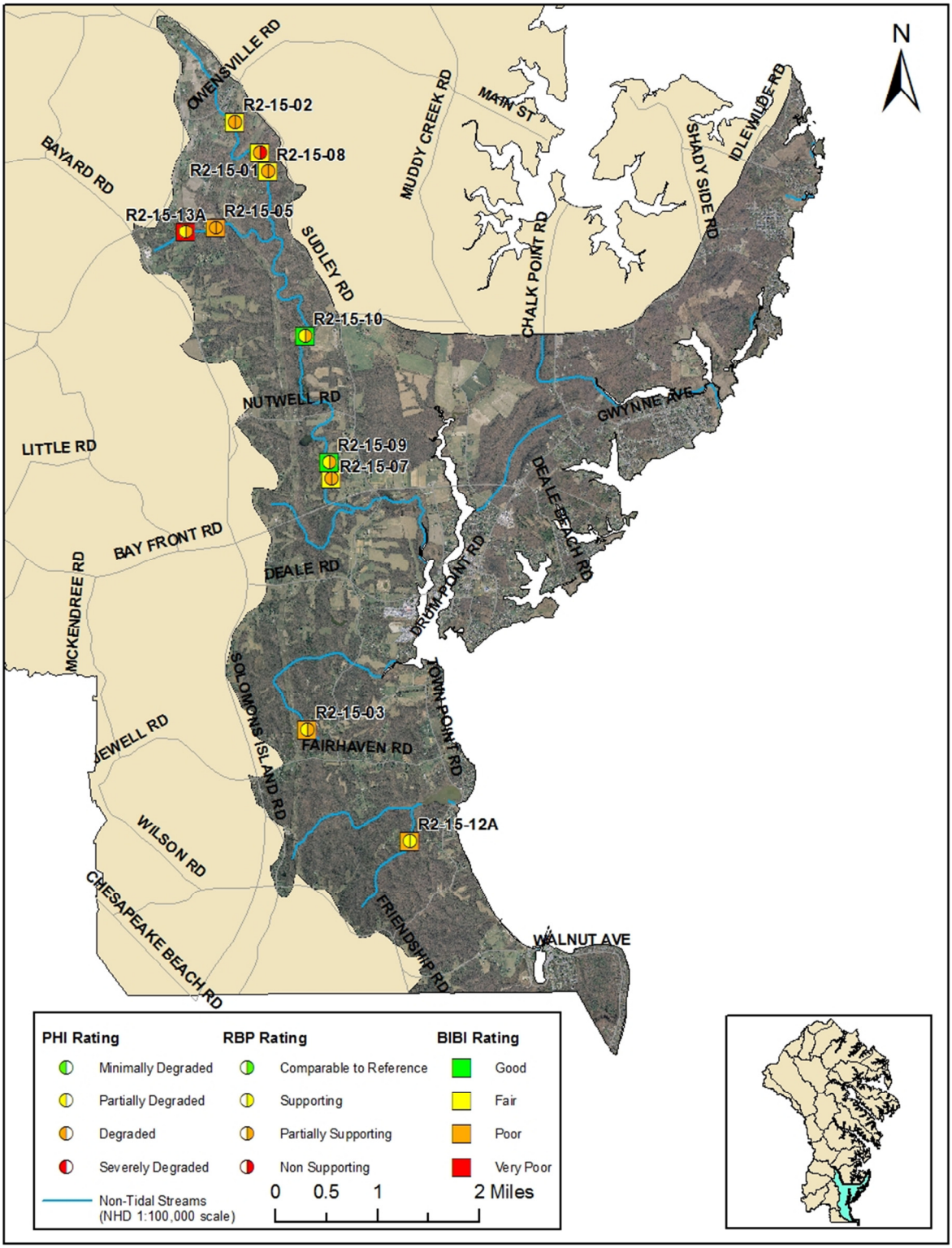
4.2 Herring Bay

The Herring Bay sampling unit is located in the southeastern extent of the County and borders the Chesapeake Bay (Figure 1). Seven sampling sites were located on 1st order streams and three were located on 2nd order streams, with drainage areas ranging from 66 acres to 2,986 acres (Figure 11). The sampling unit has a drainage area of 14,595 acres, 6.2 percent (902 acres) of which is impervious surface. Imperviousness at individual sites ranged from 1.6 to 9.3 percent. Forested land is the dominant land use (54 percent) in the Herring Bay sampling unit, followed by developed and agricultural land use at 28 percent and 10 percent, respectively. The majority of the sampling sites have a dominant land use of forested (90 percent), with the remaining 10 percent dominated by developed land use. Overall, this sampling unit had the highest percentage of sites dominated by forested land use of sites sampled in 2010.

4.2.1 Physical Habitat

Similar to Ferry Branch, the majority of the Herring Bay sampling sites were rated 'Partially Supporting' (80 percent) with only one site (10 percent) rated as 'Supporting' and one site (10 percent) rated as 'Non Supporting' by the EPA RBP method. Fifty percent of the sites received MBSS PHI ratings of 'Partially Degraded' and 50 percent received ratings of 'Degraded' (Figure 12). Four of five 'Degraded' sites (R2-15-01, R2-15-02, R2-15-05, and R2-15-08) are located in the headwaters of Tracys Creek in the

Figure 11 - Herring Bay Sampling Sites



northwestern extent of the sampling unit (Figure 11). Overall, the Herring Bay sampling unit received the lowest averages for RBP scores. The average RBP score was 113.8 ± 11.0, with a narrative rating of 'Partially Supporting.' Individual site scores ranged from 98 ('Non Supporting') to 127 ('Supporting').

The narrative PHI rating for the sampling unit was 'Partially Degraded' due to an average score of 66.3 ± 7.3. Individual site scores ranged from 56.8 ('Degraded') to 76.8 ('Partially Degraded'). While sites within this sampling unit generally received high scores for the riparian vegetative zone, overall low scores for bank stability, vegetative protection, and overall instream physical habitat contributed to the undesirable physical habitat ratings.

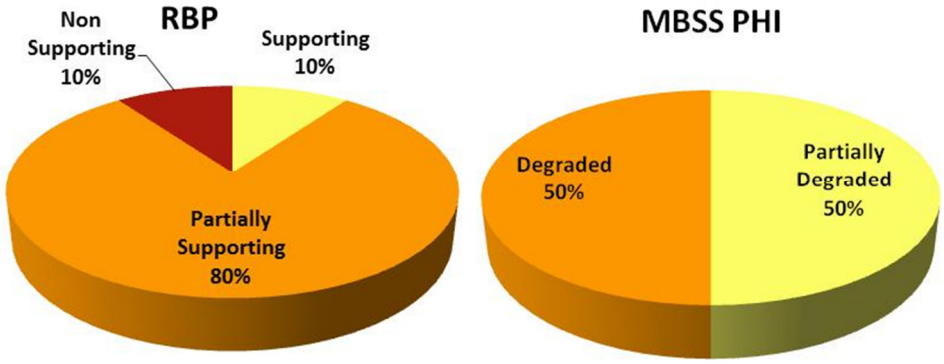


Figure 12 - Herring Bay Habitat Scores (n=10)

4.2.2 Benthic Macroinvertebrates

The average BIBI rating for the Herring Bay sampling unit is 'Fair' with an average score of 3.17 ± 1.0 (Table 12). Forty percent of the individual sites received a biological condition rating of 'Fair', 30 percent received a 'Poor' rating, 20 percent received a 'Good' rating, and the remaining 10 percent received a rating of 'Very Poor' (Figure 13). Site-specific data and assessment results can be found in Appendix D.

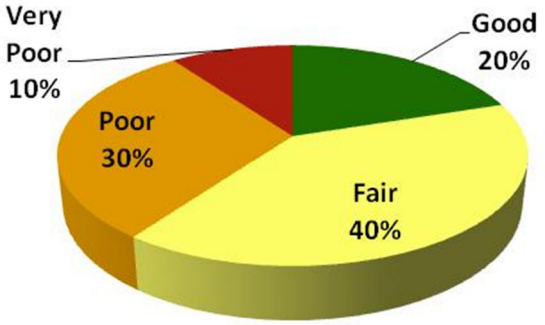


Figure 13 - Herring Bay BIBI Scores (n=10)

Site R2-15-13A, located in the headwaters of an unnamed tributary to Tracys Creek, received the lowest BIBI score of 1.57 and a corresponding narrative rating of 'Very Poor'. This subsample had only ten total taxa, two of which were EPT, and no Ephemeroptera present. Over half of the sample consisted of amphipods (*Gammarus*, TV=6.7) with very few climbers (0.9 percent) and no scraper taxa present.

Located on a second order reach of Tracys Creek, site R2-15-09 received the highest BIBI score of 4.71 ('Good'), which was the highest BIBI score for all sampling units. Seven EPT taxa were identified from a total of 24 taxa, three of which were sensitive Ephemeroptera taxa. This site also had the highest percentage of taxa intolerant to urban stressors (51 percent), which accounted for just over one-half of the total sample.

4.2.3 Water Quality

Average water quality values for the Herring Bay sites are provided in Table 15. All water quality measurements for the Herring Bay sampling sites were within COMAR standards. One site, R2-15-13A, had conductivity values (281.0 µS/cm) that exceeded the impairment threshold. Water temperature ranged from 10.9 to 14.5 °C; dissolved oxygen ranged from 9.5 to 10.9 mg/L; pH ranged from 7.1 to 8.0; conductivity ranged from 137.2 to 281.0 µS/cm; and, turbidity ranged from 14.8 to 33.3 NTU.

Table 15 - Average water quality values - Herring Bay (n = 10)

Value ± Standard Deviation				
Temperature (°C)	DO (mg/L)	pH (Units)	Conductance (µS/cm)	Turbidity (NTU)
12.84 ± 1.57	10.01 ± 0.47	7.31 ± 0.29	179.0 ± 45.4	24.1 ± 6.1

4.2.4 Geomorphic Assessment

Site-specific geomorphic assessment results can be found in Appendix A. Four different Rosgen stream types were observed in the Herring Bay sampling unit (Figure 14). Entrenched streams types (G and F) were dominant, with thirty percent of sites classified as G streams and another 30 percent classified as F streams. The remaining 40 percent of sites were evenly split between less-entrenched, and generally more stable, C and E type streams.

Silt/clay bed channels were predominant (60 percent) in this sampling unit, although sand (30 percent) and gravel (10 percent) dominated streams were also present. The median D_{50} was 0.062 (silt/clay material). Streams in this sampling unit had an average slope of 0.37 percent, with individual slopes ranging from 0.10 percent to 0.98 percent.

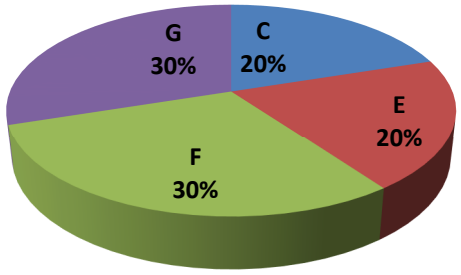


Figure 14 - Rosgen stream types observed in Herring Bay (n=10)

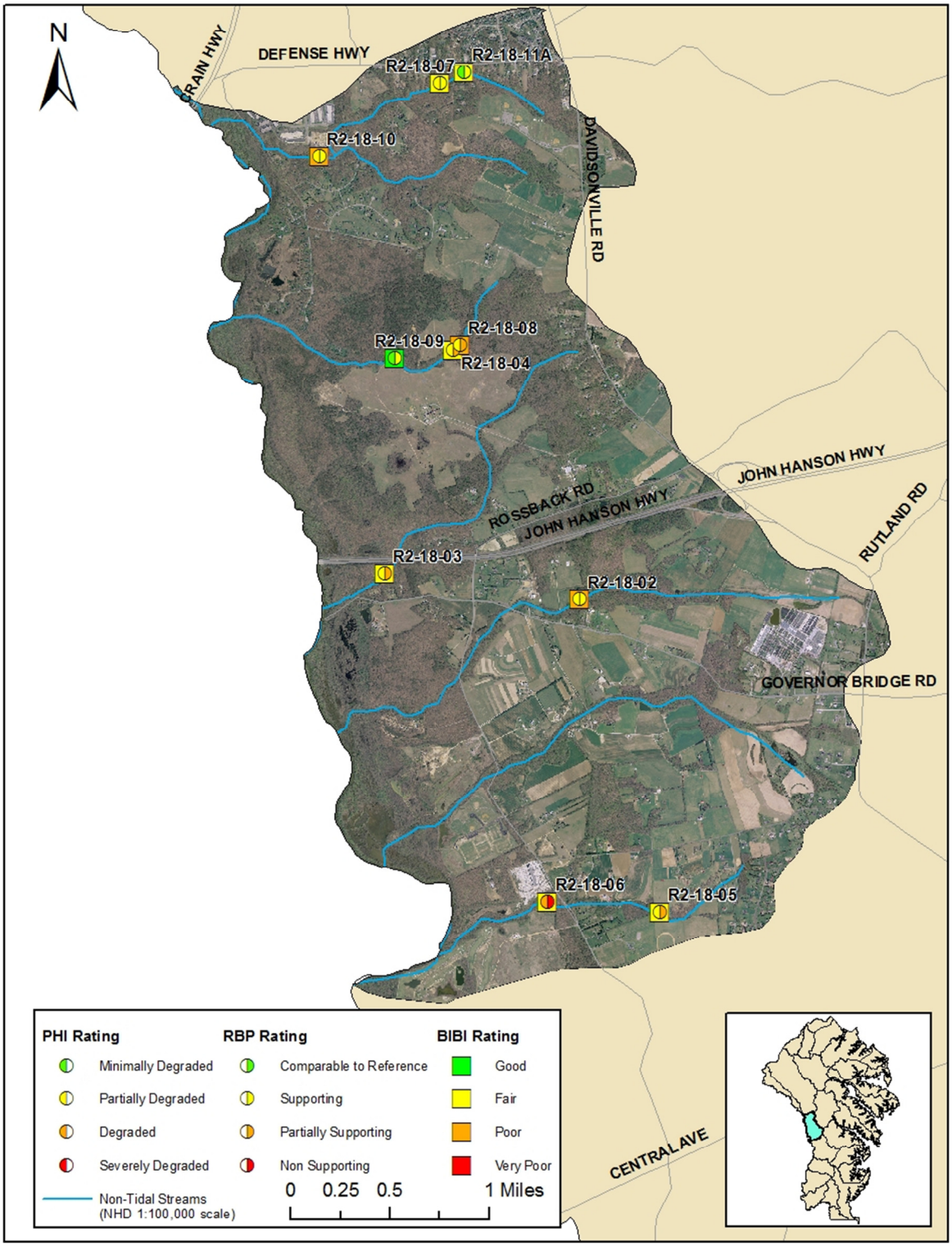
4.3 Middle Patuxent

The Middle Patuxent sampling unit is located in the west central part of the County between Crofton and Davidsonville (Figure 1) and has a drainage area of 6,332 acres. The sampling unit is comprised primarily of 1st order steams, with drainage areas ranging from 199 acres to 906 acres, which drain directly to the Patuxent River. As a result, nine individual sampling sites were located on 1st order streams and one on a 2nd order stream (Figure 15). Land use in the Middle Patuxent sampling unit is comprised of primarily forested land (42 percent) followed by developed land (25 percent) and agriculture (21 percent). Half of the sites have forest as a dominant land use, 40 percent of sites are dominated by developed land, and ten percent are dominated by agriculture. Impervious surfaces comprise 446 acres (seven percent) of the Middle Patuxent sampling unit. Individual sites ranged from 1.3 to 17.2 percent imperviousness.

4.3.1 Physical Habitat

With an average PHI score of 75.0 ± 10.4 and a narrative rating of 'Partially Degraded', the Middle Patuxent sampling unit scored higher than all other sampling units in 2010 (Table 12). PHI scores for

Figure 15 - Middle Patuxent Sampling Sites



individual sites ranged from 51.8 ('Degraded') to 89.5 ('Minimally Degraded'). Site-specific scores for the EPA RBP method ranged from 94.0 ('Non Supporting') to 146.0 ('Supporting'), resulting in an average score of 123.0 ± 16.3 and narrative rating of 'Partially Supporting' for the sampling unit. Although channel alteration was evident in several of the reaches, overall the sites received optimal scores for riparian zone width, suboptimal scores for vegetative protection, and marginal scores for bank stability, instream habitat, and epifaunal substrate. One-half of the sites sampled in the Middle Patuxent sampling unit received RBP ratings of 'Supporting', 40 percent of the sites received 'Partially Supporting' ratings, and the remaining 10 percent received a rating of 'Non Supporting' (Figure 16). Assessments using the PHI method resulted in the majority of sites receiving a 'Partially Degraded' rating (70 percent), while the remaining sites received 'Minimally Degraded' and 'Degraded' ratings (20 percent and 10 percent, respectively).

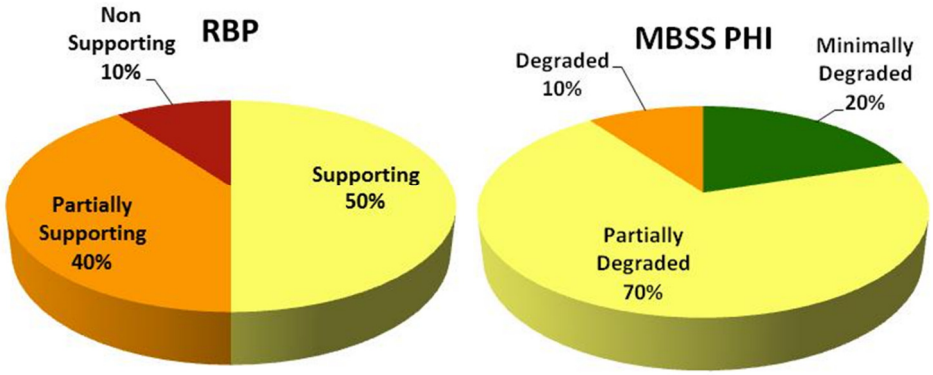


Figure 16 - Middle Patuxent Habitat Scores (n=10)

4.3.2 Benthic Macroinvertebrates

The average BIBI rating for the Middle Patuxent sampling unit is 'Fair' with an average BIBI score of 3.32 ± 0.58 (Table 12),and individual sites ranging from a low of 2.71 ('Poor') to 4.43 ('Good'). The majority of sites received a BIBI rating of 'Fair' (60 percent), while the remaining sites received 'Poor' (30 percent) or 'Good' ratings (10 percent; Figure 17). Site-specific data and assessment results can be found in Appendix D.

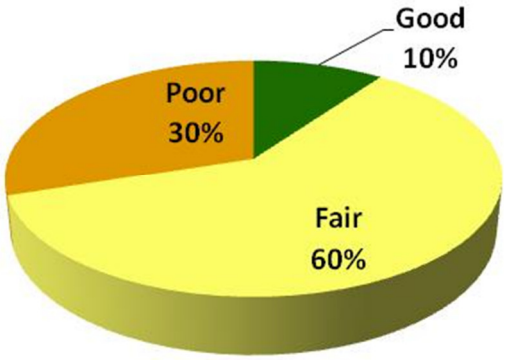


Figure 17 - Middle Patuxent BIBI Scores

Three sites (R2-18-02, R2-18-08, and R2-18-10) all received the lowest BIBI score of 2.71 and a corresponding narrative rating of 'Poor.' All three sites had low percentages of both intolerant and Ephemeroptera taxa as well as low counts of scrapers. In contrast, site R2-18-09 received the highest BIBI score (4.43) and a 'Good' biological condition rating due to a high number of total taxa (34), the presence of 10 EPT taxa including two Ephemeroptera, and a high percentage of intolerant taxa (40 percent).

4.3.3 Water Quality

Average water quality values for the Middle Patuxent sites are provided in Table 16. In general, water quality values were within the acceptable ranges specified by COMAR, with the exception of two pH

measurements. Sites R2-18-05 and R2-18-08 measured pH values of 6.31 and 6.34, respectively, both outside the COMAR range for pH (6.5 – 8.5). Site R2-18-05 also had conductivity values (291.2 µS/cm) that exceeded the impairment threshold, as did site R2-18-02 (268.4 µS/cm). Water temperature ranged from 11.5 to 21.4 °C; dissolved oxygen ranged from 8.4 to 11.1 mg/L; pH ranged from 6.3 to 7.5; conductivity ranged from 54.6 to 291.2 µS/cm; and, turbidity ranged from 3.6 to 9.2 NTU.

Table 16 - Average water quality values - Middle Patuxent (n = 10)

Value ± Standard Deviation				
Temperature (°C)	DO (mg/L)	pH (Units)	Conductance (µS/cm)	Turbidity (NTU)
15.50 ± 2.83	9.83 ± 0.89	6.98 ± 0.46	179.5 ± 92.5	6.09 ± 2.05

4.3.4 Geomorphic Assessment

Site-specific geomorphic assessment results can be found in Appendix A. The majority of sites assessed in the Middle Patuxent sampling unit were classified as G and F type channels, one site was classified as a B type channel, and one site was not determined (Figure 18). Streams classified as G and F channels were notably incised, many with slumping and undercut banks. Site R2-18-10 was not determined due the presence of artificially stabilized stream banks.

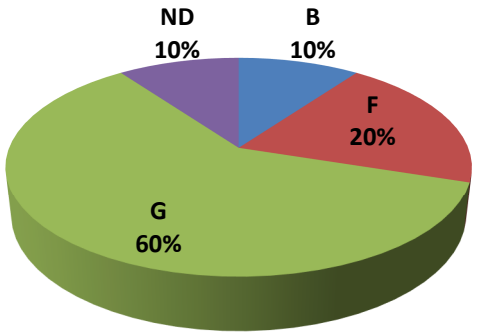


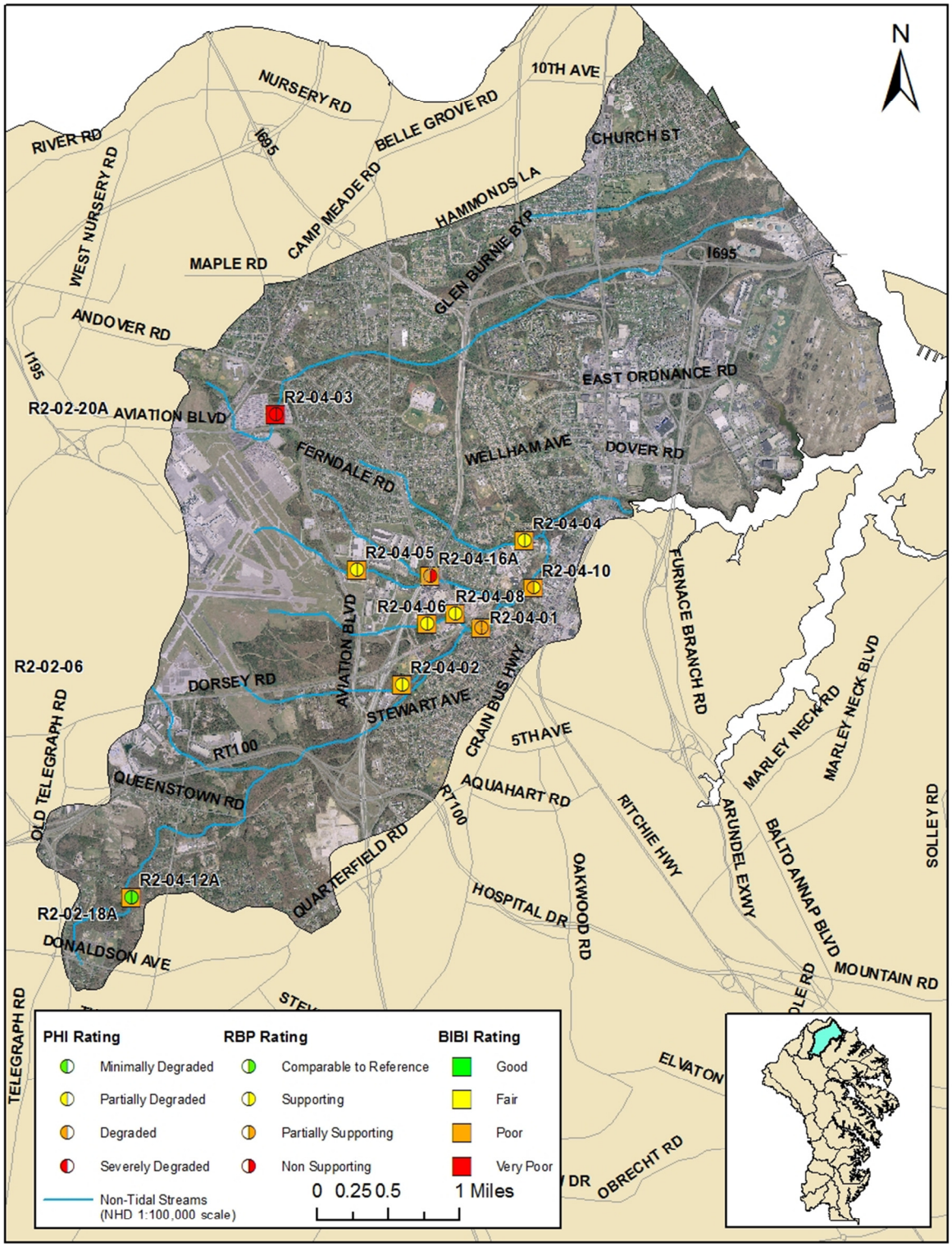
Figure 18 - Rosgen stream types observed in Middle Patuxent (n=10)

Streams in this sampling unit had predominantly sand bottoms (80 percent), while gravel materials dominated the remaining systems. The median D_{50} for the sampling unit was 0.22 mm (fine sand material). With the exception of one site, slopes were fairly gradual ranging from 0.35 percent to 0.67 percent. Site R2-18-06, located just downstream of Patuxent River Road on the southernmost unnamed tributary, was an anomaly with extreme incision and two severe headcuts exceeding five feet in height, resulting in a reach wide slope of 6.9%.

4.4 Sawmill Creek

The Sawmill Creek sampling unit is located in the northern portion of the County in the vicinity of Ferndale and Glen Burnie (Figure 1), and has a total drainage area of 11,044 acres. This sampling unit contains a large portion of Baltimore-Washington Thurgood Marshall International (BWI) Airport, and drains east primarily to Furnace Creek and Curtis Bay before emptying into the Patapsco River (Figure 19). The ten sampling sites (eight 1st order, one 2nd order and one 3rd order) have drainage areas ranging from 157 acres to 4,194 acres. With over one-third of the Sawmill Creek sampling unit (35.4 percent) comprised of impervious surfaces, this was the most developed sampling unit assessed in 2010. Site-specific drainage areas ranged from 11.4 to 53.0 percent impervious. Developed land comprised 60 percent of the total land use followed by forested (22 percent) and open land (18 percent). The majority of sites (60 percent) in the Sawmill Creek sampling unit have developed land as the dominant land use, with two sites (R2-04-02 and R2-04-12A) dominated by forested land use and two sites (R2-04-06 and R2-04-08) dominated by open space.

Figure 19 - Sawmill Creek Sampling Sites



4.4.1 Physical Habitat

Physical habitat conditions were fairly variable for this sampling unit. Based on the RBP scores, over half of the Sawmill Creek sites received a rating of 'Supporting' (60 percent), although the remaining sites received ratings of 'Non Supporting' (20 percent), 'Partially Supporting' (10 percent) and 'Comparable to Reference' (10 percent). PHI scores rated 50 percent of sites as 'Partially Degraded,' 30 percent as 'Degraded,' and the remaining 20 percent split equally between 'Minimally Degraded' and 'Severely Degraded' (Figure 20). The average RBP score for the sampling unit was 122.9 ± 35.3 and the narrative rating was 'Partially Supporting.' Individual RBP scores ranged from a minimum of 60 ('Non Supporting') to a maximum of 157 ('Comparable to Reference'). Overall, the Sawmill Creek sampling unit received the lowest average for PHI scores. The average PHI rating was 'Degraded' with a score of 65.8 ± 16.3, while individual PHI scores ranged from 36.2 ('Severely Degraded') to 94.9 ('Minimally Degraded'). Only one site in Sawmill Creek (R2-04-12A) received 'Comparable to Reference' and 'Minimally Degraded' ratings, and also the highest RBP and PHI scores of all sites sampled in 2010. This site was located in a well-forested catchment in the headwaters of Sawmill Creek, just downstream of Severn-Danza Park. Channel alteration was visible in several reaches sampled and the majority of sites received marginal scores for epifaunal substrate and instream habitat. However, suboptimal scores for bank stability, vegetative protection, and riparian zone width all contributed to the overall 'Supporting' and 'Partially Degraded' ratings.

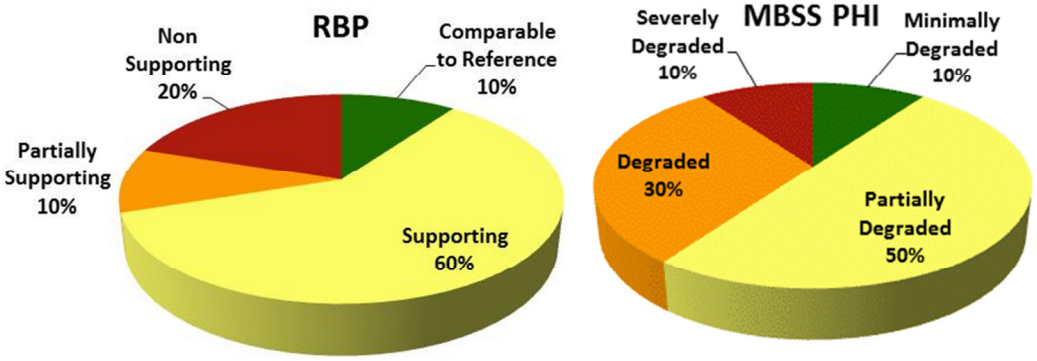


Figure 20 - Sawmill Creek Habitat Scores (n=10)

4.4.2 Benthic Macroinvertebrates

Ninety percent of sites sampled within the Sawmill Creek sampling unit received 'Poor' BIBI ratings, while the remaining 10 percent received ratings of 'Very Poor' (**Error! Reference source not found.**). The average BIBI score for the sampling unit was 2.37 ± 0.52 resulting in a 'Poor' biological condition rating (Table 12). Site-data and assessment results can be found in Appendix D.

Individual BIBI scores ranged from 1.00 ('Very Poor') to 2.70 ('Poor'). Site R2-04-03, located in the headwaters of Cabin Branch Creek within a BWI satellite parking lot (Figure 19), received the lowest BIBI score attainable (1.00) and scored poorly in every metric analyzed. Only seven taxa were present in this sample with worms of the Enchytraeidae family (TV=9.1) accounting for 54 percent

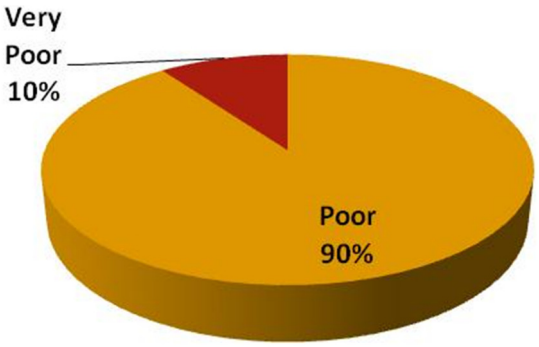


Figure 21 - Sawmill Creek BIBI Scores (n=10)

of the sample and midges of the *Orthocladius* genus (TV=9.2) accounting for 38 percent of the sample. Four sites received the highest score of 2.70 (R2-04-01, R2-04-04, R2-04-08, and R2-04-10), all of which are located the Sawmill Creek mainstem or one of its tributaries. All but site R2-04-01 had more than 22 total taxa in the sample, resulting in the maximum attainable score (5) for this metric; however, a total of five EPT taxa were present at site R2-04-01, which received the maximum attainable score for this metric. In addition, all but site R2-04-04 received the maximum score for scraper taxa, although R2-04-04 received the maximum score for the percent intolerant metric.

4.4.3 Water Quality

Average water quality values for the Sawmill Creek sites are provided in Table 17. All water quality measurements for the Sawmill Creek sampling sites were within COMAR standards. Water temperature ranged from 9.0 to 12.9 °C; dissolved oxygen ranged from 8.0 to 10.6 mg/L; pH ranged from 6.7 to 8.0; conductivity ranged from 183.1 to 1,126.1 µS/cm; and turbidity ranged from 1.9 to 12.7 NTU. It should be noted that nine of the ten sites (all but R2-04-12A) had conductivity levels that exceeded the impairment threshold of 247 µS/cm. These nine sites are located downstream of the Baltimore-Washington International Thurgood Marshall Airport (BWI) in highly developed drainage areas. Conductivity values are related to the type and concentration of inorganic ions in solution. Examples of these inorganic constituents include chloride, carbonate, nitrate, sulfate, and phosphate anions as well as sodium, calcium, magnesium, iron, and aluminum cations. 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 when road conditions often result in the use of de-icing materials. It should be remembered that the biological monitoring sample period occurs between March 1 and May 1 and includes the potential for roadway de-icing.

Table 17 - Average water quality values - Sawmill Creek (n = 10)

Value ± Standard Deviation				
Temperature (°C)	DO (mg/L)	pH (Units)	Conductance (µS/cm)	Turbidity (NTU)
10.77 ± 1.09	9.46 ± 0.82	7.45 ± 0.41	558.8 ± 251.3	5.92 ± 3.71

4.4.4 Geomorphic Assessment

Site-specific geomorphic assessment results can be found in Appendix A. One-half of the sites assessed in the Sawmill Creek sampling unit were classified as either DA or E type channels (30 and 20 percent, respectively); Figure 22. One site was classified as an F type channel. Due to the high percentage of channelized reaches sampled within the Sawmill Creek subwatershed, forty percent of the sites could not be classified using the Rosgen classification system. 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. For instance, site R2-04-05 was an

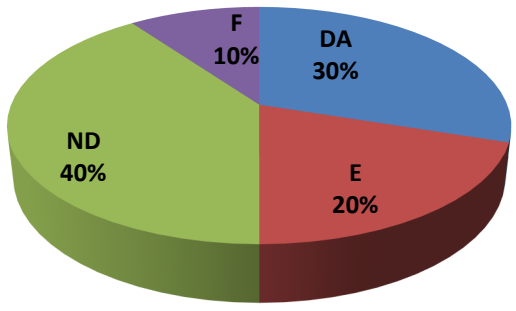


Figure 22 - Rosgen stream types observed in Sawmill Creek (n=10)

engineered channel that appears to have previously been a highly entrenched G type channel, but has recently had its pattern and profile altered and banks re-graded and stabilized to increase floodplain connectivity, resulting in some characteristics and dimensions typical of more stable B type streams.

The majority of streams in this sampling unit were either sand (40 percent) or gravel (40 percent) dominated systems, with a small proportion (20 percent) of silt/clay bottom streams. The median D_{50} for the sampling unit was 0.35 mm (medium sand material). Slopes were moderately gradual, with most sites falling in the range from 0.09 percent to 0.86 percent, although two sites were greater than one percent. Site R2-04-16A, located partially within a box culvert beneath Interstate 97, had a slope of 1.5 percent due to an approximate one foot drop between the culvert apron and the channel bed. Site R2-04-08 was located on a fairly steep transitional reach (3.5 percent) downstream of a low gradient wetland; however, the slope was likely exaggerated slightly because only a short profile could be surveyed (88 feet) due to dense vegetation at the downstream end of the reach.

4.5 Stony Run

The Stony Run sampling unit is located in the northern part of the County near the town of Severn (Figure 1). Like Sawmill Creek, this sampling unit also contains a large portion of BWI Airport but drains north to the Patapsco River. With a drainage area of 6,203 acres, 31 percent of the Stony Run sampling unit is comprised of impervious surface (1,895 acres). Approximately half of the sampling unit is developed land (51 percent) while the remaining land use is forested (34 percent) and open land (15 percent). Seven sampling sites were located on 1st order streams and three on 2nd order streams (Figure 24), with drainage areas ranging from 112 acres to 6,112 acres. The dominant land use to all sampling sites is developed land, mainly residential land cover, which accounts for 53 percent of the developed land in this sampling unit.

4.5.1 Physical Habitat

Of all the sampling units assessed in 2010, Stony Run had the highest proportion of sites rated as either 'Comparable to Reference' (20 percent) by the RBP index or 'Minimally Degraded' (30 percent) by the PHI (Figure 23). These results were primarily due to suboptimal scores for instream habitat, epifaunal substrate, bank stability and vegetative protection, as well as optimal scores for riparian vegetative zone width. The remaining sites received RBP ratings of 'Supporting' (30 percent), 'Partially Supporting' (30 percent), and 'Non Supporting' (20 percent), and PHI ratings of 'Partially Degraded' (30 percent), 'Degraded' (30 percent), and 'Severely Degraded' (10 percent). In contrast to the high proportion of sites rated as 'Minimally Degraded', this sampling unit also had the highest percentage of sites rated

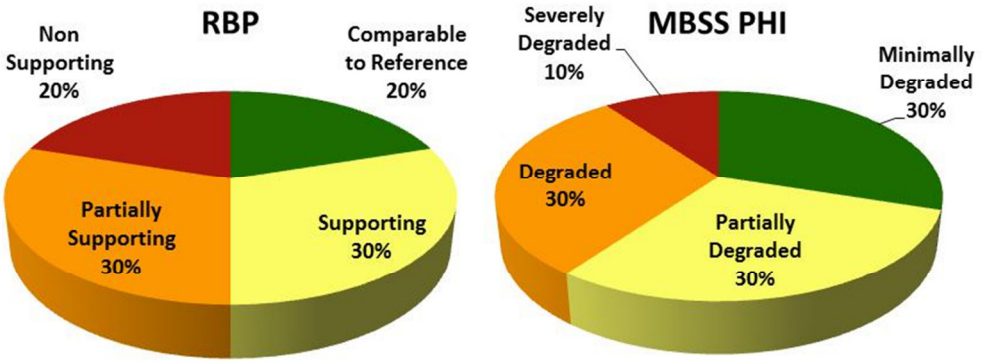
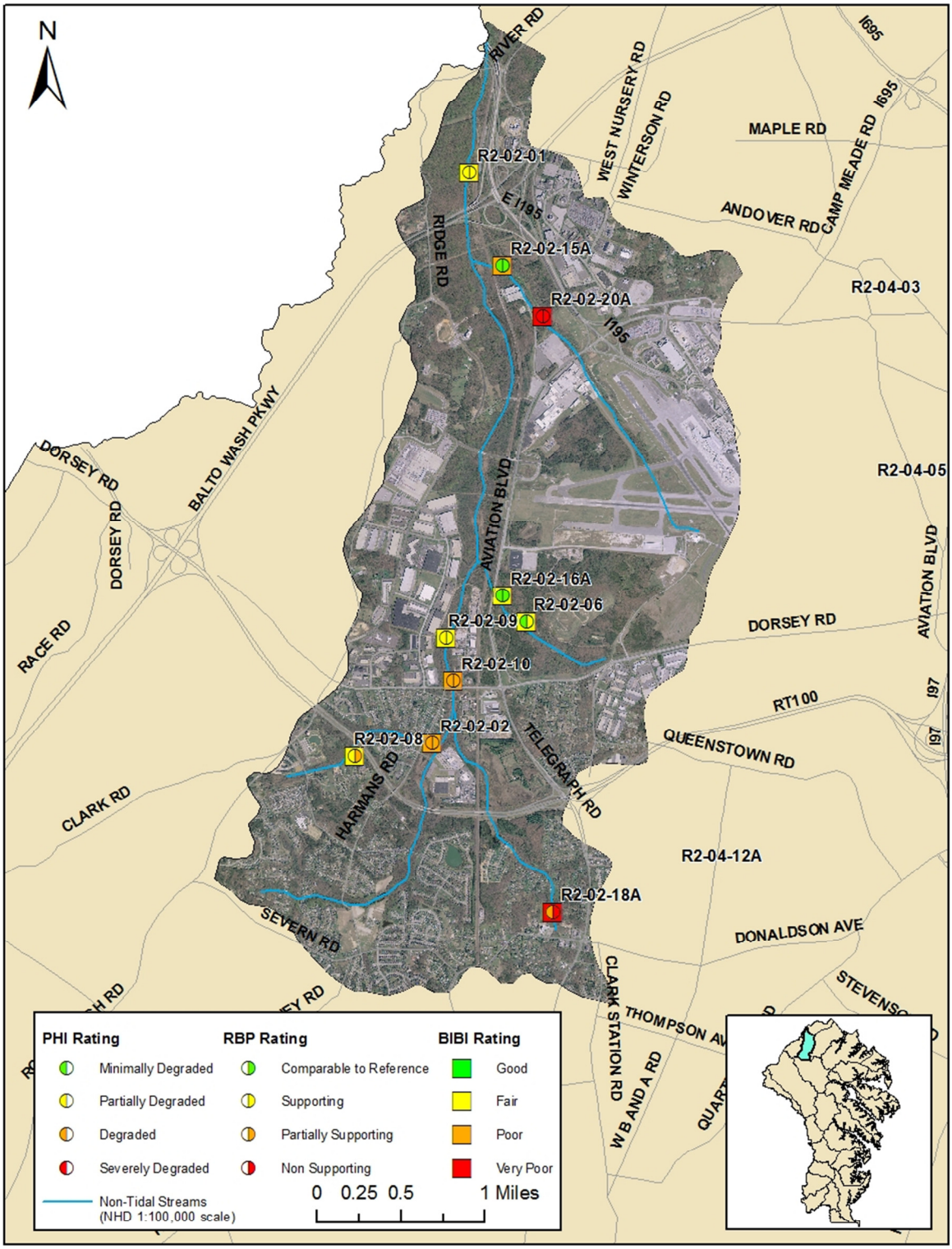


Figure 23 - Stony Run Habitat Scores (n=10)

Figure 24 - Stony Run Sampling Sites



'Severely Degraded.' With an average RBP score of 125.5 ± 22.8 and a narrative rating of 'Supporting', this sampling unit received the highest average RBP score. Individual RBP scores ranged from 88.0 ('Non Supporting') to 153.0 ('Comparable to Reference'). Site scores for the PHI method ranged from 39.5 ('Severely Degraded') to 86.6 ('Minimally Degraded') with an average PHI score of 68.7 ± 15.1 and corresponding rating of 'Partially Degraded.'

4.5.2 Benthic Macroinvertebrates

The average BIBI rating for the Stony Run sampling unit is 'Poor' with an average score of 2.69 ± 0.98 (Table 12). One-half of the sites received a BIBI rating of 'Fair' while the other half were split between 'Poor' (30 percent) and 'Very Poor' ratings (Figure 25). Site-specific data and assessment results can be found in Appendix D.

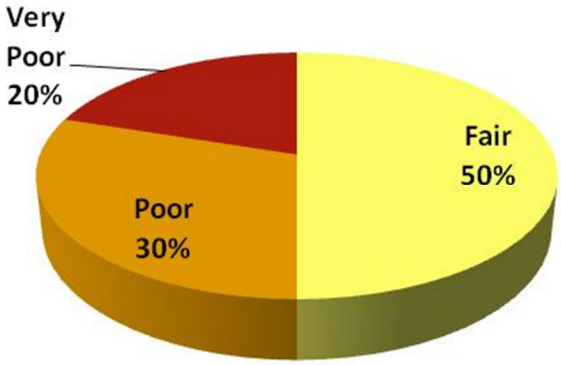


Figure 25 - Stony Run BIBI Scores (n=10)

Individual BIBI scores ranged from 1.00 ('Very Poor') to 3.60 ('Fair'). Located on opposite ends of the Stony Run sampling unit, sites R2-02-18A and R2-02-20A both received the lowest possible score of 1.00. Not surprisingly, these two sites received some of the lowest physical habitat scores in the sampling unit. Ephemeroptera, intolerant organisms, scrapers, and climbers were entirely absent from both sites. Site R2-02-18A was dominated by worms (Enchytraeidae, TV=9.1; Lumbricina, TV=10; Tubificidae, TV=8.4), which accounted for 46 percent of the sample, and midges including *Chaetocladius*, a tolerant midge (TV=7) that accounted for 39 percent of the sample. Site R2-02-20A, which drains a large portion of BWI airport, had only 26 total organisms in the entire sample. The highest score (3.60) was obtained by three sites R2-02-06, R2-02-08, and R2-02-16A, all of which are located on small unnamed tributaries to Stony Run. All three sites had very high taxa counts (28 - 31) and six to eight EPT taxa present. The number of scraper taxa, percentage of intolerant organisms, and percentage of climbers were also high for all three sites.

4.5.3 Water Quality

Average water quality values for the Stony Run sites are provided in Table 18. All water quality measurements for the Stony Run sampling sites were within COMAR standards. Water temperature ranged from 9.1 to 17.5 °C; dissolved oxygen ranged from 9.5 to 12.8 mg/L; pH ranged from 6.8 to 7.6; conductivity ranged from 229.1 to 771.6 µS/cm; and turbidity ranged from 5.4 to 14.2 NTU. However, it should be noted that eight sites (all but R2-02-16A and R2-02-08) had conductivity levels that exceeded the impairment threshold of 247 µS/cm. Four of the eight sites with elevated conductivity are located immediately downstream BWI Airport. 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 18 - Average water quality values - Stony Run (n = 10)

Value ± Standard Deviation				
Temperature (°C)	DO (mg/L)	pH (Units)	Conductance (µS/cm)	Turbidity (NTU)
11.83 ± 2.79	10.77 ± 0.90	7.11 ± 0.22	434.2 ± 184.3	8.67 ± 2.72

4.5.4 Geomorphic Assessment

Site-specific geomorphic assessment results can be found in Appendix A. The majority of sites surveyed in the Stony Run sampling unit were classified as F type channels (30 percent), followed by E and C type channels, each comprising 20 percent (Figure 26). The remaining 30 percent of sites were not determined (ND), primarily due to effects of channelization. Site R2-02-10 could not be classified because it is immediately downstream of a box culvert and check dam, which has affected the stream's ability to naturally adjust its channel dimensions. Site R2-02-18A was modified due to channel armoring. Site R2-02-06 appears to be a transitional reach that exhibits characteristics of both G and C type streams, and as result was not classified.

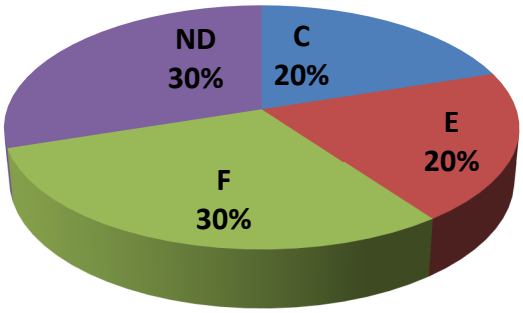


Figure 26 - Rosgen stream types observed in Stony Run (n=10)

Streams in this sampling unit were predominantly gravel bottom channels (60 percent), with a smaller percentage of sand (30 percent) and clay (10 percent) bottom streams. The median D_{50} was 7.1 mm (fine gravel material). Individual slopes ranged from 0.05 percent to 1.3 percent, with an average slope of 0.56 percent.

5 Comparison of Round 1 and Round 2 Results

This section presents a brief comparison of the biological and physical habitat assessment results from Round 1 and Round 2 for each of the five primary sampling units assessed in 2010. Refer to Figure 27 for box plots comparing average BIBI, PHI, and RBP results from Round 1 and Round 2 in the Ferry Branch, Herring Bay, Middle Patuxent, Sawmill Creek, and Stony Run sampling units.

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

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

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

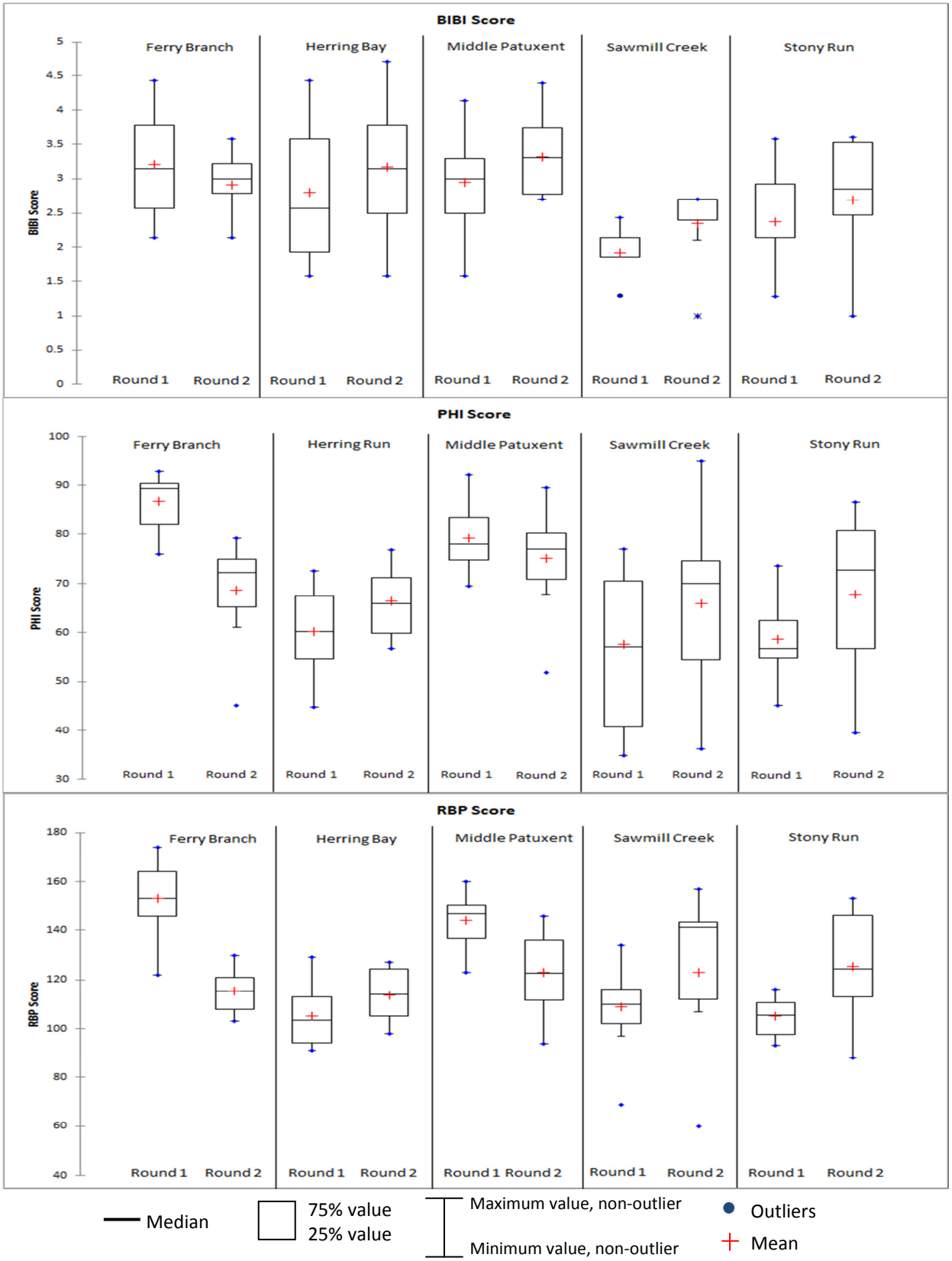


Figure 27 - Box plots comparing mean BIBI, MPHI, and RBP scores between Round 1 and Round 2

5.1 Biological Conditions

A comparison of mean BIBI scores between Rounds One and Two showed a significant change in only one sampling unit, Sawmill Creek (Table 19). The 2008 BIBI score of 1.92 ± 0.13 and rating of 'Very Poor' increased significantly in 2010 to a BIBI score of 2.35 ± 0.16 an a biological rating of 'Poor'. BIBI ratings in Herring Bay and Middle Patuxent sampling units also increased one category from 'Poor' to 'Fair', but the change in BIBI scores was not considered to be significant. Ferry Branch, on the other hand, saw a reduction in biological condition ratings from 'Fair' in 2004 to 'Poor' in 2010, although the mean BIBI scores were not significantly different.

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			
Stony Run	2.69	0.31	2.37	0.22	0.43	-1.07	No
Sawmill Creek	2.35	0.16	1.92	0.13	-0.02	-0.84	Yes (Increase)
Herring Bay	3.17	0.32	2.80	0.34	0.54	-1.28	No
Middle Patuxent	3.32	0.19	2.94	0.22	0.19	-0.95	No
Ferry Branch	2.91	0.15	3.20	0.26	0.87	-0.29	No

5.2 Physical Habitat Conditions

Comparisons of physical habitat conditions between Rounds One and Two for the PHI and RBP indices are shown in Table 20 and Table 21, respectively. Ferry Branch was the only sampling unit where physical habitat conditions changed significantly according to both the PHI and RBP indices. Round 1 PHI data collected in 2004 rated Ferry Branch as 'Minimally Degraded'; however, the 2010 PHI data rated the mean habitat condition as 'Partially Degraded.' Similarly, RBP data from 2004 resulted in a rating of 'Comparable to Reference', while the mean habitat condition decreased to 'Partially Supporting' in 2010. Two sampling units (Stony Run and Herring Bay) improved from 'Degraded' to 'Partially Degraded' conditions based on mean PHI scores, although the difference was not statistically significant. In addition to Ferry Branch, significant differences in mean RBP scores were observed in Stony Run and Middle Patuxent sampling units. The mean RBP score for Stony Run increased from a 105.1 ± 2.66 and a rating of 'Partially Supporting' in 2007 to 125.5 ± 7.20 and a rating of 'Supporting' in 2010. Conversely, Middle Patuxent saw the mean RBP score drop from 144.2 ± 3.50 and a rating of 'Supporting' in 2004 to 123 ± 5.16 and a rating of 'Partially Supporting' in 2010.

Table 20 - 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			
Stony Run	67.78	5.09	58.66	2.50	2.00	-20.23	No
Sawmill Creek	65.87	5.13	60.15	5.33	8.78	-20.21	No
Herring Bay	66.34	2.30	60.17	2.97	1.20	-13.54	No
Middle Patuxent	75.03	3.28	79.24	2.14	11.89	-3.45	No
Ferry Branch	68.63	3.19	86.72	1.77	25.24	10.94	Yes (Decrease)

Table 21 - 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			
Stony Run	125.5	7.20	105.1	2.66	-5.35	-35.45	Yes (Increase)
Sawmill Creek	122.9	11.15	108.9	5.76	10.60	-38.60	No
Herring Bay	113.8	3.49	105.2	4.08	1.92	-19.12	No
Middle Patuxent	123.0	5.16	144.2	3.50	33.42	8.98	Yes (Decrease)
Ferry Branch	115.3	2.84	153.0	4.78	48.59	26.81	Yes (Decrease)

6 Conclusions and Recommendations

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

6.1 Biological and Physical Habitat Conditions

Results of the 2010 assessment indicate impaired biological conditions in all five sampling units, although different levels of impairment were observed. Herring Bay and Middle Patuxent were the least impaired sampling units, while Sawmill Creek was the most impaired. This is a slight shift from the Round 1 results, which showed Ferry Branch as the least impaired sampling unit among the five reported here. The observed differences between Round 1 and Round 2 results were variable for each sampling unit. With the exception of Ferry Branch, average BIBI scores in these sampling units increased between Round 1 and Round 2. However, Sawmill Creek was the only sampling unit where the increase in the average BIBI was statistically significant. This increase in BIBI scores can be partially substantiated by an observed increase in both average RBP and PHI scores, although the increases were not statistically significant. Despite increasing from a 'Very Poor' to a 'Poor' rating, the biological conditions in Sawmill Creek remain in a highly impaired state.

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 'Partially Supporting' physical habitat conditions (86 percent); however, only one-third 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 'Partially Degraded' or 'Degraded' rating (80 percent). However, PHI assessment results showed half of these sites also had biological conditions which matched available habitat (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		R2-02-16A	**R2-02-15A** **R2-04-12A**	
Supporting	R2-18-09	R2-02-01 R2-02-06 R2-02-09 R2-18-07 R2-18-11A R2-21-01	R2-04-02 R2-04-04 R2-04-05 R2-04-06 R2-04-08 R2-04-10 R2-15-12A R2-18-02 R2-18-10	
Partially Supporting	**R2-15-09** **R2-15-10**	R2-02-08 R2-15-02 R2-15-07 R2-15-08 R2-18-03 R2-18-04 R2-18-05 R2-21-03 R2-21-04 R2-21-05 R2-21-06 R2-21-07 R2-21-13A	R2-02-02 R2-02-10 R2-04-01 R2-15-03 R2-15-05 R2-18-08 R2-21-10 R2-21-14A R2-21-15A	R2-15-13A
Non-Supporting		**R2-15-01** **R2-18-06**	R2-04-16A	R2-02-18A R2-02-20A R2-04-03

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 the highly developed sampling units with a high percentage of impervious surfaces, such as Stony Run and Sawmill Creek, water quality stressors are likely responsible for impaired biological conditions. Elevated conductivity values (i.e., >247 µS/cm) were observed exclusively in these two sampling units, with the many of the highest concentrations observed downstream of the BWI airport runways and parking areas (Figure 28). 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, Draft).

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	R2-18-09	R2-02-06 R2-02-16A R2-18-11A	**R2-02-15A** **R2-04-12A**	
Partially Degraded	R2-15-09 R2-15-10	R2-02-01 R2-02-08 R2-02-09 R2-18-03 R2-18-04 R2-18-05 R2-18-07 R2-21-01 R2-21-03 R2-21-05 R2-21-07 R2-21-13A	R2-04-02 R2-04-04 R2-04-05 R2-04-06 R2-04-08 R2-15-03 R2-15-12A R2-18-02 R2-18-08 R2-18-10 R2-21-15A	**R2-15-13A**
Degraded		R2-15-01 R2-15-02 R2-15-07 R2-15-08 R2-18-06 R2-21-04	R2-02-10 R2-04-01 R2-04-10 R2-04-16A R2-15-05 R2-21-10 R2-21-14A	R2-02-18A
Severely Degraded		**R2-21-06**	R2-02-02	R2-02-20A R2-04-03

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.

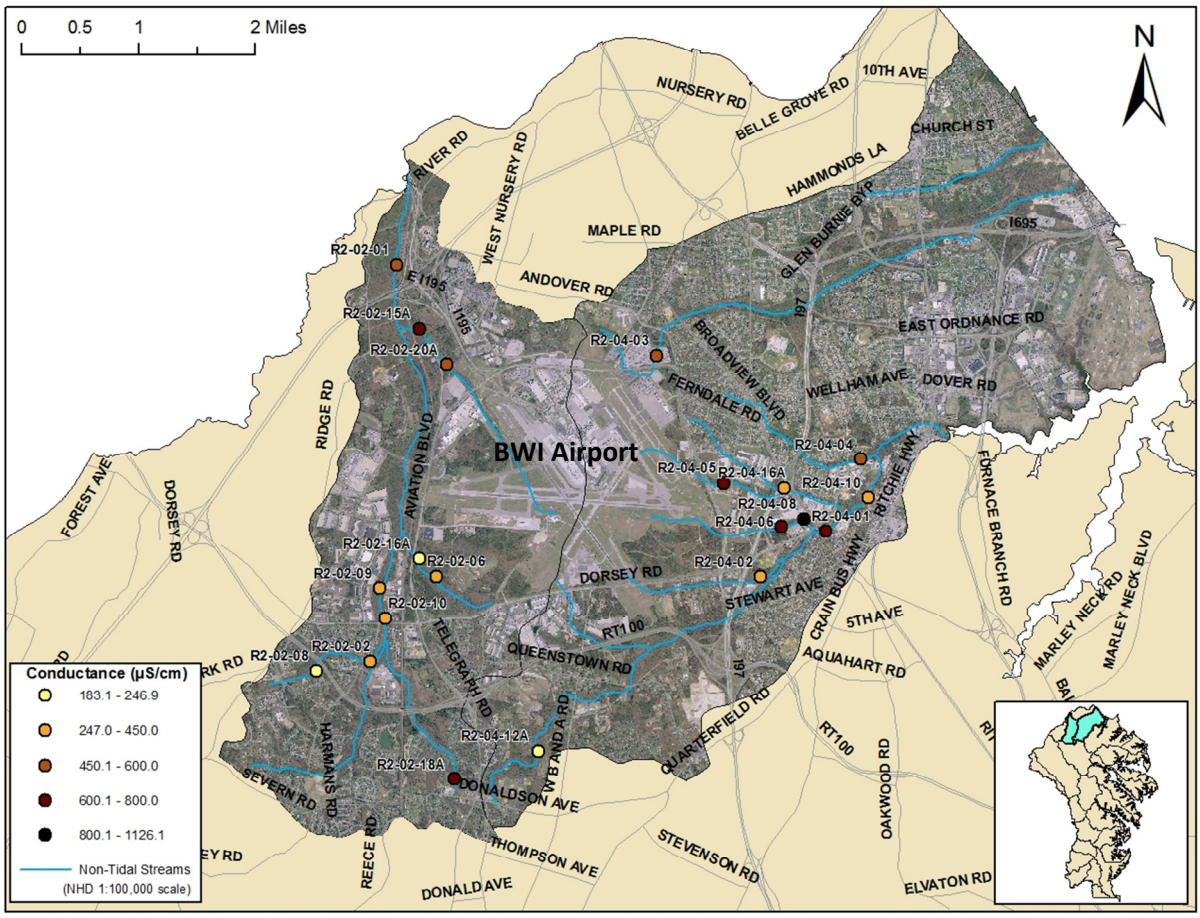


Figure 28 - Conductivity values from Sawmill Creek and Stony Run sampling units.

Identifying additional stressors in the rural sampling units, such as Herring Bay, Ferry Branch, and Middle Patuxent, is much more challenging given the available data. Sites in these watersheds more often had better biological conditions than the physical habitat conditions predicted, which may suggest some degree of nutrient enrichment in these sampling units, especially considering the higher proportion of agricultural land use (>10 percent). MBSS nutrient data from 2000-2004 indicated high baseflow phosphorus levels (i.e., >0.07 mg/L) at 28 percent of sites sample, most of which were concentrated in the southern and central portions of the County (Kazyak et al., 2005); however, more recent data would be necessary to confirm whether nutrients are having an effect on the biota and to what extent.

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 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 both the Maryland Coastal Plain (MCP) regional relationships of bankfull channel geometry (McCandless, 2003) and the relationship for urban streams developed specifically for Anne Arundel County (AADPW, 2002) in order to determine how channel dimensions observed in the field compare to those predicted for rural/suburban and urban 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. It should be noted, however, that there were only two B type streams in the data set, which is an insufficient sample size for trend analysis. Consequently, comparisons of B type streams to reference curves have been omitted from this discussion.

A comparison of bankfull width values show trendlines for E and C channels closely matching the MCP curve, and high R^2 values of 0.97 and 0.71, respectively, indicate a good fit of the data. Bankfull width trends for F channels indicate a good fit of the data (R^2 = 0.72), and show wider channels compared to the MCP curve, as anticipated. Trendlines from G (R^2 = 0.24) and DA (R^2 = 0.24) channels, on the other hand, contained much more variability, with data points scattered mostly in between the rural and urban curves and some more closely fitting the urban curve. Mean bankfull depth values showed trendlines for F (R^2 = 0.84) type channels closely matching the MCP curve. Mean depth among E (R^2 = 0.78) and C (R^2 = 0.83), and type channels trended below the MCP curve, primarily with sites exceeding two square miles of drainage area. Both DA (R^2 = 0.03), and G (R^2 = 0.33), type channels exhibited a high degree of variability with regard to mean depth, with the majority of DA channels falling well below the MCP curve, G channels scattered between the MCP and urban curves. The trendlines for C (R^2 = 0.91) and F (R^2 = 0.90) type streams indicated a good fit of the data and closely resembled the MCP curve with regard to cross-sectional area dimensions, although F type streams were generally slightly larger. Similar to mean depth, E type channels trended below the MCP curve, primarily with sites exceeding 2 square miles of drainage area, but otherwise the data were a good fit to the trendline (R^2 = 0.95). DA channels also deviated from the MCP curve for sites with larger drainage areas (i.e., greater than one square mile). While the trendline for G streams also followed the MCP closely, the lower R^2 values of 0.27, indicates more variability among this stream type and show some sites more closely fitting the urban curve.

The results of the comparison are not surprising considering that the majority of streams used to derive the MCP curves were Rosgen C type streams, which explains why C type streams 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. Perhaps what is more surprising is that sites located in more urban, or developed, drainage areas did not approximate the urban curve, nor did sites located in more rural drainage areas approximate the MCP rural/suburban curve. This suggests that the type of streams used to derive each curve is more likely to influence the fit than the land use characteristics of the drainage area.

A comparison of E channels from these sampling units and those identified as Western Coastal Plain reference reaches (Starr et al., 2010), show some notable differences in dimensionless ratios (entrenchment and width/depth ratio) and sinuosity (Figure 32). However, a two-tailed Kolmogorov-

Smirnov test comparing the distribution of two samples, indicated that only sinuosity was significantly different ($p < 0.05$) from reference conditions. E channels in these sampling units had significantly less sinuosity (average = 1.17) as compared to reference reach streams (average = 1.39), suggesting these streams may still be evolving to a more, or perhaps less, stable form, although the trajectory for these reaches is unknown at this time.

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, 2011). 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, 2011). 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 begins to fill the channel, decreasing stream depth and increasing floodplain connectivity. This hypothesis is supported by the fact that the mean bankfull depths of C and E type streams in these subwatersheds are generally shallower that those predicted by the MCP regional relationships of bankfull channel geometry (Figure 30). Furthermore, the E type streams in these subwatersheds have significantly less sinuosity than comparable reference reaches, suggesting that they are not yet in a "stable" evolutionary phase. Another possible hypothesis is that the more developed sampling units have a higher proportion of culverts, which act as grade control structures and prevent large-scale downcutting and degradation of the channel bed. 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.

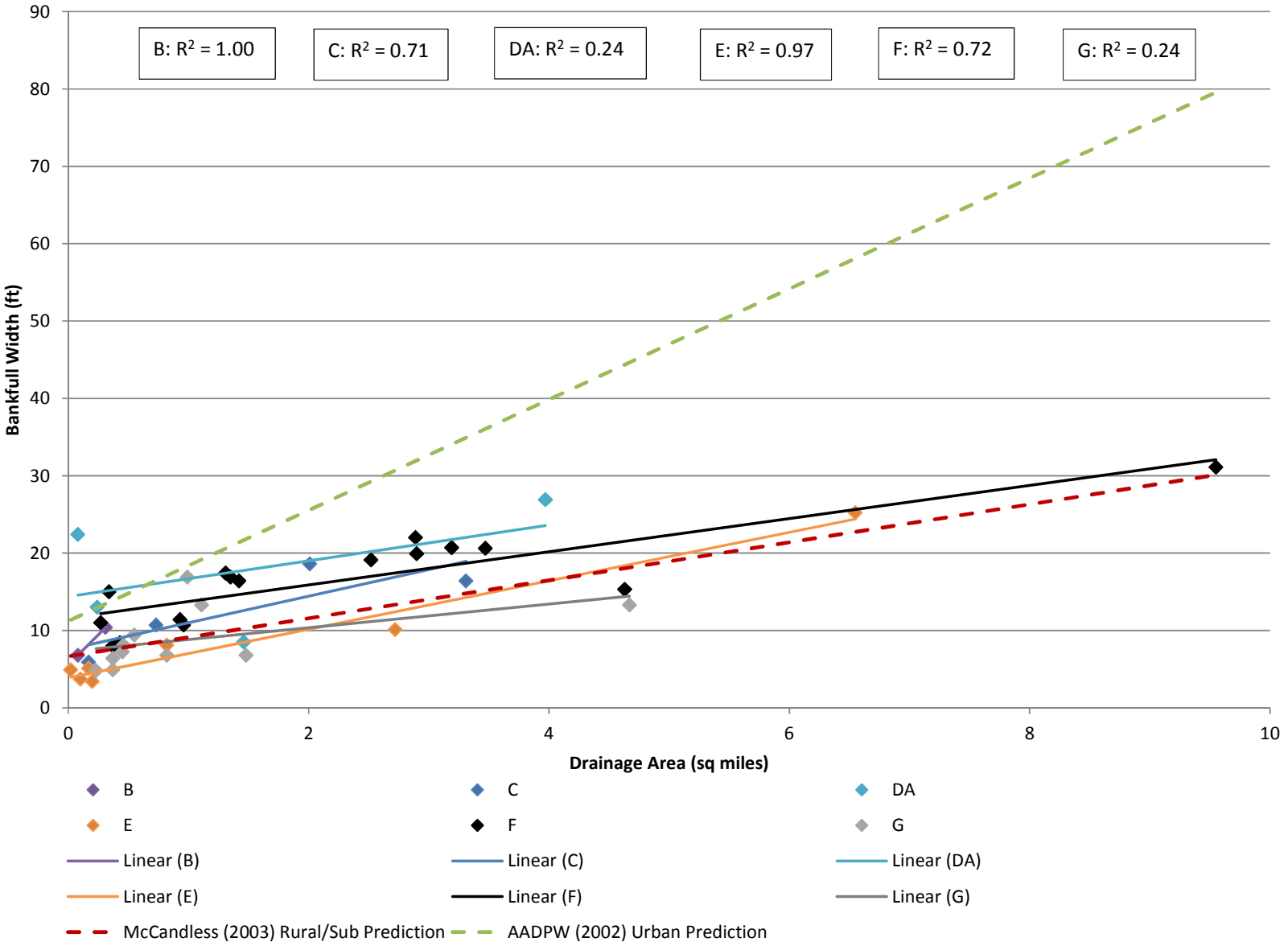


Figure 29 - Comparison of the Bankfull Width - Drainage Area Relationship between Field Data and Regional Relationship Curve Data

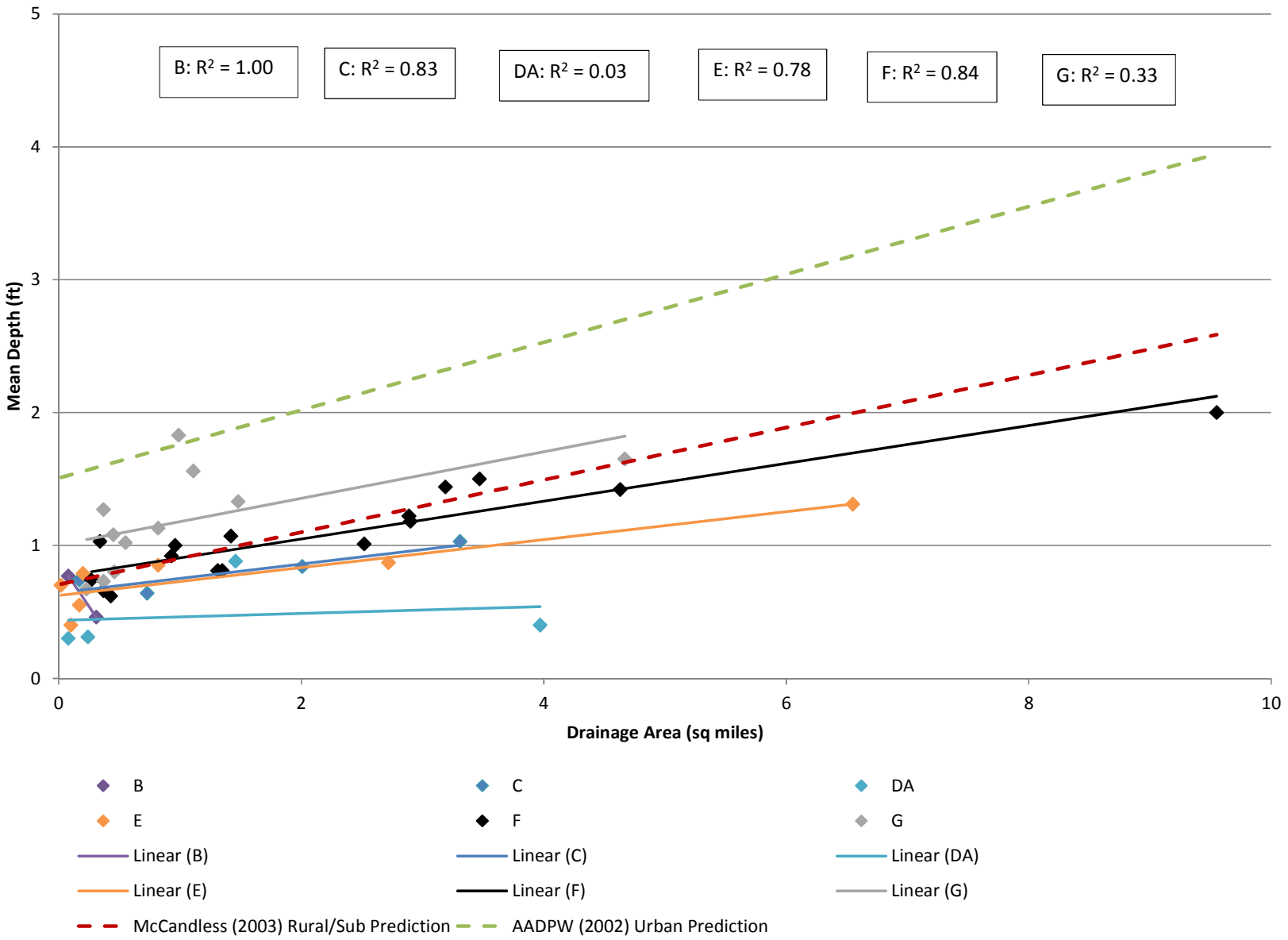


Figure 30 - Comparison of the Mean Bankfull Depth - Drainage Area Relationship between Field Data and Regional Relationship Curve Data

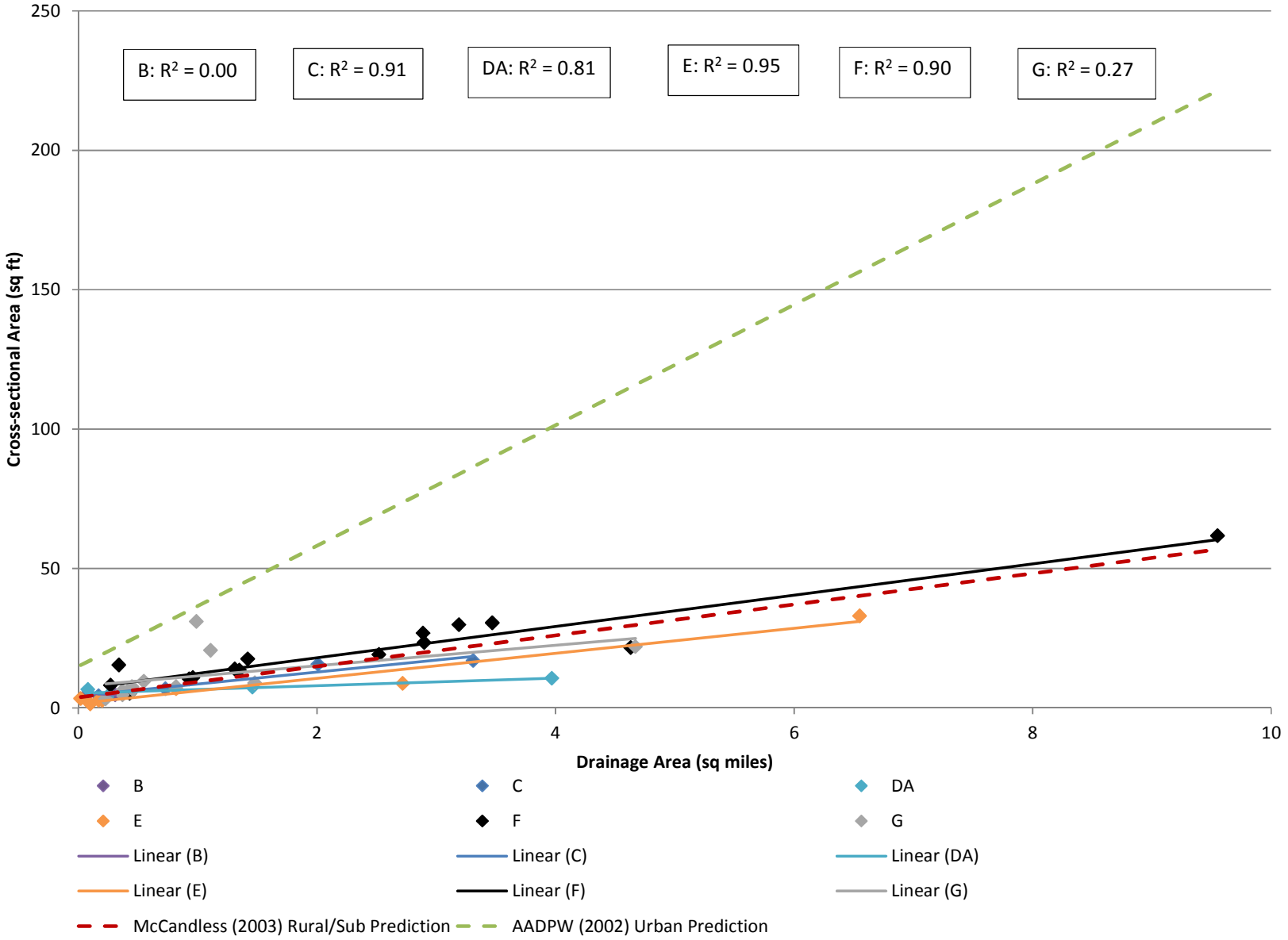


Figure 31 - Comparison of the Bankfull Cross-Sectional Area - Drainage Area Relationship between Field Data and Regional Relationship Curve Data

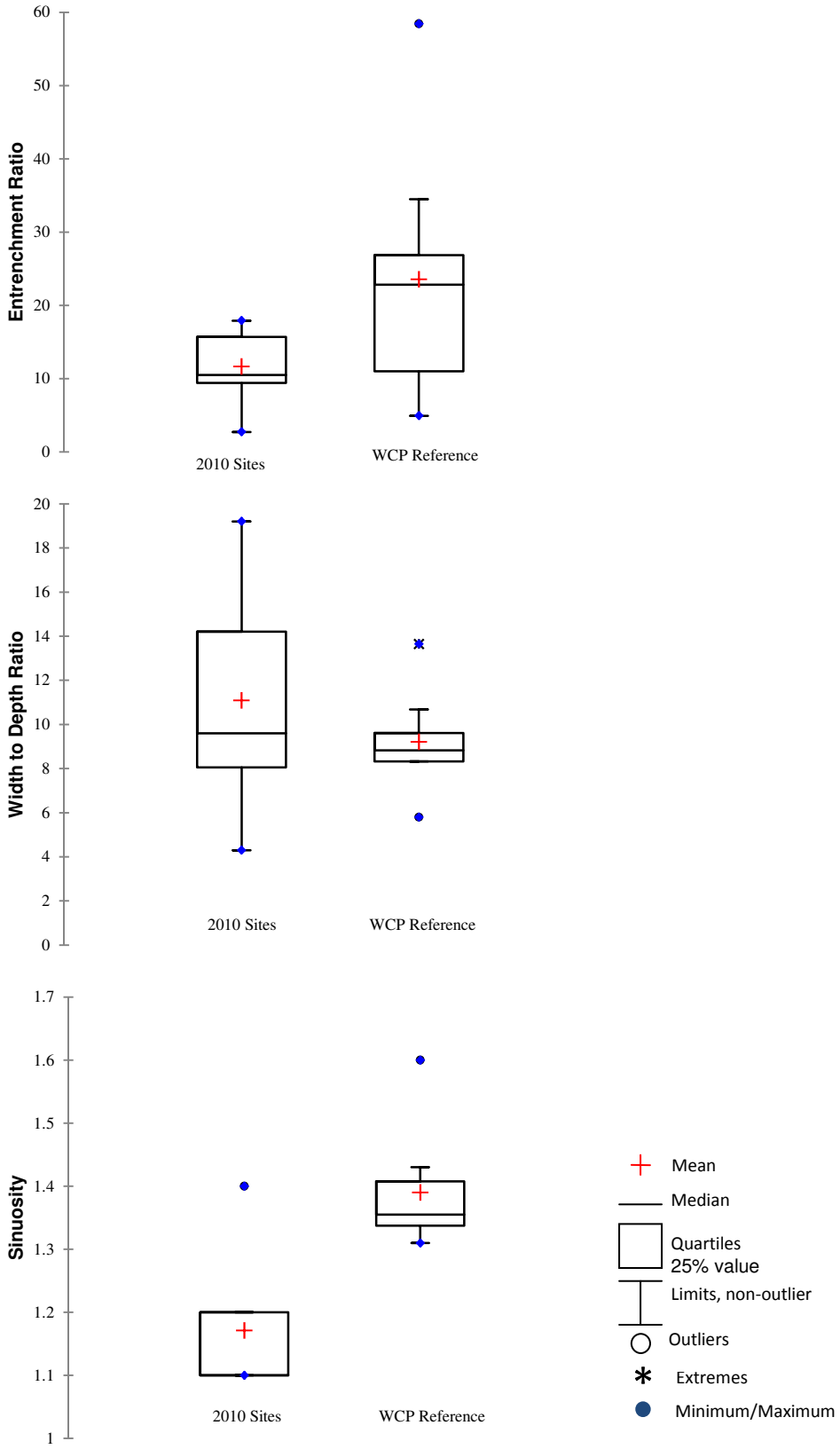


Figure 32 - Box plots comparing E channel dimensions with Western Coastal Plain reference reaches.

6.3 Recommendations

Drawing from the conclusions discussed in the previous section, the following recommendations are presented for future assessment efforts:

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

Two of the sampling units, Sawmill Creek and Stony Run, have extensive amounts of development and impervious surface area, 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 both 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
R2-02-01	9.55	31.1	2	36.2	1.2	15.7	61.8	0.05	1.8	7.3	F4/5	Bimodal distribution of substrate (gravel/sand)
R2-02-02	2.72	10.1	0.87	100	9.9	11.7	8.8	0.77	1.1	0.062	E6	
R2-02-06	0.77	7.5	1.19	22.9	3.1	6.3	8.9	1	1.1	8.3	ND	Channel is incised for majority of reach, but regains some connectivity in downstream end. Stream type not determined due to channel type transitions within the reach.
R2-02-08	0.17	5.9	0.74	12.1	2.1	7.9	4.4	1.3	1.3	11	C4	Adjusted entrenchment ratio +0.1
R2-02-09	3.47	20.6	1.5	26.6	1.3	13.9	30.5	0.32	1.2	0.59	F5/4	Bimodal distribution of substrate (sand/gravel)
R2-02-10	3.25	15.6	1.81	120	7.7	8.7	28.2	0.37	1	6.9	ND	Reach is immediately downstream of box culvert and check dam which appears to have caused some incision at the upstream end of the reach, while the downstream end appears to have some floodplain connectivity. Stream type not determined due to effects from upstream box culvert.
R2-02-15A	2.01	18.6	0.84	200	10.8	22	15.7	0.43	1	9.9	C4/5	Bimodal distribution of substrate (gravel/sand)
R2-02-16A	0.82	8.1	0.85	85	10.5	9.6	6.9	0.087	1.1	0.32	E5	
R2-02-18A	0.2	3.4	0.79	30	8.9	4.3	2.7	0.75	1.1	0.076	ND	Modified channel due to armoring. Stream type not determined due to stream modifications.
R2-02-20A	1.35	16.9	0.81	18.9	1.1	21	13.6	0.49	1.1	7.3	F4	
R2-04-01	4.41	13.8	1.92	22.5	1.6	7.2	26.6	0.12	1.2	14	ND	Reach is mostly channelized with riprap and box culvert. No determination made because the stream is not able to adjust its dimensions due to extensive hardening of the banks.
R2-04-02	3.97	26.9	0.4	75	2.8	68	10.7	0.45	1.1	0.31	DA5	
R2-04-03	0.45	10.3	1.03	21.6	2.1	10.1	10.6	0.27	1	0.082	ND	Reach located in channelized ditch between 2 culverts within airport parking lot facility. All run feature, completely straightened. Stream type not determined due to channelization in ditch.
R2-04-04	0.96	10.7	1	19.6	1.2	10.4	10.9	0.46	1.2	11	F4	Stream clearly incised at upper end but with some minor connectivity in lower reach. Possibly a transitional reach.
R2-04-05	0.92	10.1	1.2	17.1	1.7	8.4	12	0.85	1.4	8.5	ND	Recently restored reach, not formed by fluvial processes. Stream type not determined due to channel type transitions within the reach.
R2-04-06	0.02	4.9	0.7	85	17.4	7	3.4	0.81	1.4	0.062	E6	
R2-04-08	0.08	22.4	0.3	51.3	2.3	74.7	6.7	3.5	1.1	0.39	DA5	Slope is greater than typical DA stream type.
R2-04-10	6.55	25.2	1.31	450	17.9	19.2	33	0.089	1.2	0.062	E6	
R2-04-12A	0.24	13	0.31	73.3	5.6	42.6	4	0.86	1.1	0.074	DA5/6	Bimodal distribution of substrate (sand/clay)
R2-04-16A	0.36	9.4	0.68	10.5	1.1	13.9	6.4	1.5	1.1	13	ND	Upper half of reach in concrete box culvert under I-97. Significant influence of culvert on reach morphology, but reach is clearly incised and overwidened. Stream type not determined due to effects from box culvert in upper half of reach.
R2-15-01	0.82	6.8	1.13	10.5	1.5	6.1	7.7	0.68	1.1	0.062	G6c	Adjusted entrenchment ratio -0.1 to fit G type.
R2-15-02	0.55	9.4	1.02	11.9	1.3	9.2	9.6	0.097	1.1	0.067	G5c	
R2-15-03	0.1	3.7	0.4	9.9	2.7	9.1	1.5	0.92	1.1	0.062	E6	
R2-15-05	0.43	8.4	0.62	11.4	1.4	13.5	5.2	0.26	1	0.062	F6	
R2-15-07	4.67	13.3	1.65	16.4	1.2	8.1	22	0.17	1.2	0.062	G6c	

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
R2-15-08	0.93	11.4	0.92	15.7	1.4	12.4	10.4	0.2	1	0.062	F6	
R2-15-09	4.63	15.3	1.42	18.4	1.2	10.8	21.7	0.27	1.1	4.4	F4/6	Adjusted width depth ratio +2.0. Bimodal distribution of substrate (gravel/clay)
R2-15-10	3.31	16.4	1.03	150	9.1	15.9	17	0.036	1.1	0.07	C5/6c-	Bimodal distribution of substrate (sand/clay)
R2-15-12A	0.73	10.7	0.64	150	14	16.7	6.9	0.12	1.2	0.062	C6	
R2-15-13A	0.17	5.1	0.55	150	29.4	9.2	2.8	0.98	1.2	0.073	E5	
R2-18-02	1.11	13.3	1.56	19.7	1.5	8.5	20.7	0.62	1.2	12	G4c	Adjusted entrenchment ratio -0.2 to fit G type.
R2-18-03	1.42	16.4	1.07	17.8	1.1	15.3	17.6	0.56	1.1	0.12	F5	
R2-18-04	0.37	4.9	1.27	6.9	1.4	3.8	6.2	0.42	1.5	0.11	G5	
R2-18-05	0.31	10.4	0.46	15.2	1.5	22.6	4.7	0.66	1	1.7	B4c	
R2-18-06	0.99	16.9	1.83	24.3	1.4	9.3	31	6.9	1.1	4	G4/5	Bimodal distribution of substrate (gravel/sand)
R2-18-07	0.45	7.2	1.08	10	1.4	6.6	7.7	0.67	2.3	0.12	G5c	
R2-18-08	0.37	6.4	0.73	8.3	1.3	8.8	4.7	0.45	3.2	0.15	G5c	
R2-18-09	0.46	8.1	0.8	10.5	1.3	10.1	6.5	0.44	1.7	1.8	G4/5c	Bimodal distribution of substrate (gravel/sand)
R2-18-10	1.31	17.4	0.81	20.9	1.2	21.4	14	0.35	1.2	0.25	ND	Stream banks artificially stabilized. Stream type not determined due to channel type transitions within the reach.
R2-18-11A	0.37	8	0.66	10.8	1.4	12.1	5.3	0.5	1.8	0.19	F5	
R2-21-01	3.19	20.7	1.44	24.6	1.2	14.3	29.9	0.16	1.4	0.12	F5	
R2-21-03	0.08	6.8	0.77	10.6	1.6	8.9	5.3	0.84	1.4	1.3	B4c/5c	Bimodal distribution of substrate (gravel/sand)
R2-21-04	0.27	11	0.74	12.7	1.2	14.8	8.2	0.58	1.7	2.3	F4/6	Bimodal distribution of substrate (gravel/clay)
R2-21-05	0.34	15	1.03	19.4	1.3	14.5	15.4	0.4	1.5	0.24	F5/4	Bimodal distribution of substrate (sand/gravel)
R2-21-06	1.46	8.5	0.88	156.3	18.3	9.7	7.5	0.42	1.1	0.062	DA5	
R2-21-07	2.9	19.9	1.18	25.3	1.3	16.9	23.4	0.14	1.4	0.12	F5/4	Bimodal distribution of substrate (sand/gravel)
R2-21-10	1.48	6.8	1.33	9.9	1.5	5.1	9	0.27	1	0.088	G6/5c	Bimodal distribution of substrate (clay/sand)
R2-21-13A	2.89	22	1.22	25.3	1.2	18	26.9	0.34	1.1	0.57	F4/5	Bimodal distribution of substrate (gravel/sand)
R2-21-14A	0.23	4.8	0.67	8.4	1.7	7.2	3.2	1	1.2	0.064	G6/5c	Bimodal distribution of substrate (clay/sand)
R2-21-15A	2.52	19.1	1.01	21.4	1.1	19	19.2	0.28	1	0.36	F4/5	Bimodal distribution of substrate (gravel/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, Draft). 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 2010.

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 Draft

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. Only one metric, Percent Climbers, exceeded the MQO for mRPD, but did not exceed the MQOs for RMSE or CV. The high RPD value was due to relatively low percentages of climbers in all samples, which tends to skew RPD values upward when comparing small values as compared to large values. Another metric, Percent Ephemeroptera, exceeded the MQO for RMSE, but passed for mRPD and CV. This was primarily due to a single outlier sample pair (R2-15-10), which had a large proportion of Ephemeroptera relative to the other samples. 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
R2-02-15A	24	0	0.0	0	0.0	2	10.8	2.70	Poor
R2-02-15A-QC	21	0	0.0	0	2.7	0	3.6	1.60	Very Poor
R2-04-12A	23	3	0.0	0	9.1	0	17.3	2.40	Poor
R2-04-12A-QC	19	3	0.0	0	17.0	0	9.0	2.40	Poor
R2-15-10	23	5	31.4	2	38.1	1	3.8	4.43	Good
R2-15-10-QC	22	5	19.7	2	32.5	1	1.7	4.43	Good
R2-18-11A	27	5	0.8	1	20.8	2	5.0	3.90	Fair
R2-18-11A-QC	34	8	2.0	1	15.8	2	5.0	3.90	Fair
R2-21-04	20	3	0.0	0	38.5	3	3.8	3.00	Fair
R2-21-04-QC	20	5	0.0	0	49.5	3	2.9	3.29	Fair
Median RPD	13.3	0.0	0.0	0.0	27.3	0.0	63.1	0.0	-
RMSE	1.7	1.0	1.2	0.0	8.2	0.9	3.6	0.4	-
CV	7.1	27.7	22.6	0.0	36.6	63.3	56.8	13.8	-

Laboratory Sorting and Subsampling

Bias

All sorting was completed following the SOPs described in the QAPP. For these samples, approximately 20 percent (11 samples) underwent quality control procedures for sorting, above the ten percent requirement. Table 4 shows the results of the sorting quality control checks. 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. 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.

Table 4 – Percent Sorting Efficiencies (PSE) Per Sample.

Sample	Organisms Found by Primary Sorter	Organisms Found in QC Check	Total No. of Organisms	Percent Sorting Efficiency
R2-02-18A	149	8	157	94.9%
R2-04-05	102	0	102	100.0%
R2-04-06	372	5	377	98.7%
R2-15-03	169	17	186	90.9%
R2-18-03	98	3	101	97.0%
R2-18-04	107	7	114	93.9%
R2-18-05	128	14	142	90.1%
R2-21-03	117	0	117	100.0%
R2-21-06	446	4	450	99.1%
R2-21-14A	115	5	120	95.8%
R2-21-15A	106	4	110	96.4%

Taxonomic Identification and Enumeration

Five samples (R2-02-09, R2-02-15A, R2-04-12A, R2-18-03, and R2-18-06) 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.

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% (20.00% for R2-02-15A and 18.69% for R2-04-12A). For sample R2-02-15A, there was a minor discrepancy between laboratories concerning two genera of Tanypodinae, *Macropelopia* and *Conchapelopia*. The laboratories verified and agreed that *Macropelopia* is currently considered an invalid name, with the valid name being that of *Conchapelopia*. For sample R2-04-12A, there was a minor discrepancy between laboratories concerning the Trichoptera genus *Ironoquia* (Limnephilidae family). 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 10.00% (R2-02-15A) and 10.19% (R2-04-12A), 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 2010 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.

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

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

Activity	Performance Indicator	Measure	MQO	2010 Results
Field Sampling	Precision	mRPD (BIBI)	<20	0.0
		RMSE (BIBI)	<0.6	0.4
Laboratory Sorting/Subsampling	Bias	PSE	>90	96.1
Taxonomic Identification	Precision	PDE	<5	1.8
		PTD	<15	8.7
Site Assessment	Sensitivity	90% CI (BIBI)	≤0.75	0.73

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

Table 4 - Taxonomic Identification and Enumeration Results: R2-02-09

Order	Family	Subfamily	Tribe	EcoAnalysts Sample ID	R2-02-09 Taxonomist 1	R2-02-09 Taxonomist 2	# of agreements
Diptera	Ceratopogonidae	-	-	Dasyhelea	1	1	1
	Chironomidae	-	-	Chironomidae	1	0	0
	Chironomidae	Chironominae	Chironomini	Chironomini	1	0	0
	Chironomidae	Chironominae	Chironomini	Phaenopsectra	2	3	2
	Chironomidae	Chironominae	Chironomini	Polypedilum	2	2	2
	Chironomidae	Chironominae	Chironomini	Stenochironomus	3	3	3
	Chironomidae	Chironominae	Tanytarsini	Paratanytarsus	2	2	2
	Chironomidae	Chironominae	Tanytarsini	Tanytarsini	1	0	0
	Chironomidae	Chironominae	Tanytarsini	Tanytarsus	3	4	3
	Chironomidae	Orthocladiinae	-	Cricotopus	2	0	0
	Chironomidae	Orthocladiinae	-	Hydrobaenus	2	3	2
	Chironomidae	Orthocladiinae	-	Paratrichocladius	0	1	0
	Chironomidae	Orthocladiinae	-	Orthocladius	12	0	0
	Chironomidae	Orthocladiinae	-	Cricotopus/Orthocladius	0	12	12
Amphipoda	Gammaridae	-	-	Gammarus	24	24	24
	Hyalellidae	-	-	Hyalella	10	9	9
Coleoptera	Elmidae	-	-	Ancyronyx	5	5	5
	Elmidae	-	-	Dubiraphia	2	2	2
	Elmidae	-	-	Macronychus	3	3	3
	Elmidae	-	-	Microcylloepus	1	1	1
	Elmidae	-	-	Oulimnius	2	2	2
	Elmidae	-	-	Stenelmis	18	17	17
	Haliplidae	-	-	Peltodytes	1	1	1
Haplotaxida	not identified	-	-	Lumbricina	1	0	0
	Tubificidae	-	-	Tubificidae	2	0	1
	Tubificidae	-	-	Aulodrilus	0	1	0
Lumbriculada	Lumbriculidae	-	-	Lumbriculidae	0	1	0
Odonata	Calopterygidae	-	-	Calopteryx	2	2	2
	Coenagrionidae	-	-	Argia	1	1	1

Order	Family	Subfamily	Tribe	EcoAnalysts Sample ID	R2-02-09 Taxonomist 1	R2-02-09 Taxonomist 2	# of agreements
	Coenagrionidae	-	-	Enallagma	1	1	1
Plecoptera	Taeniopterygidae	-	-	Taeniopteryx	1	2	1
Trichoptera	Hydropsychidae	-	-	Cheumatopsyche	5	5	5
	Hydropsychidae	-	-	Hydropsyche	1	1	1
	Lepidostomatidae	-	-	Lepidostoma	1	0	0
	Limnephilidae	-	-	Limnephilidae	0	1	0
	Polycentropodidae	-	-	Polycentropus	1	1	1
				Total	114	111	104
				PDE			1.33
				PTD			6.31

Table 5 - Taxonomic Identification and Enumeration Results: R2-02-15A

Order	Family	Subfamily	Tribe	EcoAnalysts Sample ID	R2-02-15A Taxonomist 1	R2-02-15A Taxonomist 2	# of agreements
Diptera	not identified	-	-	Diptera	0	1	0
	Ceratopogonidae	-	-	Ceratopogonidae	1	0	0
	Chironomidae	-	-	Chironomidae	1	0	0
	Chironomidae	Chironominae	Chironomini	Chironomus	1	1	1
	Chironomidae	Chironominae	Chironomini	Dicrotendipes	8	8	8
	Chironomidae	Chironominae	Chironomini	Phaenopsectra	1	1	1
	Chironomidae	Chironominae	Chironomini	Polypedilum	9	9	9
	Chironomidae	Chironominae	Chironomini	Stenochironomus	4	4	4
	Chironomidae	Chironominae	Tanytarsini	Paratanytarsus	1	1	1
	Chironomidae	Orthocladiinae	-	Brillia	1	1	1
	Chironomidae	Orthocladiinae	-	Cricotopus	13	0	0
	Chironomidae	Orthocladiinae	-	Hydrobaenus	1	1	1
	Chironomidae	Orthocladiinae	-	Orthocladius	12	0	0
	Chironomidae	Orthocladiinae	-	Xylotopus	1	1	1

Order	Family	Subfamily	Tribe	EcoAnalysts Sample ID	R2-02-15A Taxonomist 1	R2-02-15A Taxonomist 2	# of agreements
	Chironomidae	-	-	Cricotopus/Orthocladius	0	26	25
	Chironomidae	Tanypodinae	Pentaneurini	Ablabesmyia	2	2	2
	Chironomidae	Tanypodinae	Pentaneurini	Conchapelopia	10	10	10
	Chironomidae	Tanypodinae	Pentaneurini	Thienemannimyia	15	15	15
	Psychodidae	-	-	Psychodidae	1	0	0
Amphipoda	Crangonyctidae	-	-	Crangonyctidae	0	1	0
	Crangonyctidae	-	-	Stygobromus	1	0	1
Basommatophora	Physidae	-	-	Physa	2	2	2
Haplotaxida	not identified	-	-	Lumbricina	6	0	0
	Enchytraeidae	-	-	Enchytraeidae	3	3	3
	Lumbricidae	-	-	Lumbricidae	0	4	0
	Naididae	-	-	Nais	0	1	0
	Tubificidae	-	-	Tubificidae	5	0	4
	Tubificidae	-	-	Bothrioneurum	0	1	0
	Tubificidae	-	-	Limnodrilus	0	2	0
	Tubificidae	-	-	Tubificinae	0	1	0
Lepidoptera	not identified	-	-	Lepidoptera	1	0	0
	Noctuidae	-	-	Noctuidae	0	1	0
Lumbriculada	Lumbriculidae	-	-	Lumbriculidae	1	2	1
not identified	not identified	-	-	Nemata	0	1	0
not identified	not identified	-	-	Nematomorpha	1	0	0
				Total	102	100	90
				PDE			0.99
				PTD			10.00

Table 6 - Taxonomic Identification and Enumeration Results: R2-04-12A

Order	Family	Subfamily	Tribe	EcoAnalysts Sample ID	R2-04-12A Taxonomist 1	R2-04-12A Taxonomist 2	R2-04-12A # of agreements
Diptera	Chironomidae	-	-	Cricotopus/Orthocladius	0	3	3
	Chironomidae	Orthocladiinae	-	Georthocladius	1	1	1
	Chironomidae	Orthocladiinae	-	Gymnometriocnemus	0	1	0
	Chironomidae	Orthocladiinae	-	Heterotrissocladius	1	1	1
	Chironomidae	Chironominae	Tanytarsini	Micropsectra	1	1	1
	Chironomidae	Orthocladiinae	-	Orthocladius	3	0	0
	Chironomidae	Orthocladiinae	-	Rheocricotopus	42	42	42
	Chironomidae	Orthocladiinae	-	Smittia	1	0	0
	Chironomidae	Tanypodinae	-	Tanypodinae	2	2	2
	Chironomidae	Tanypodinae	Pentaneurini	Zavrelimyia	2	2	2
	Simuliidae	Simuliinae	Prosimuliini	Stegopterna	2	2	2
	Tabanidae	-	-	Chrysops	2	2	2
	Tipulidae	-	-	Molophilus	1	1	1
Amphipoda	Crangonyctidae	-	-	Crangonyx	6	0	0
	Crangonyctidae	-	-	Synurella	0	6	0
	Hyalellidae	-	-	Hyalella	1	1	1
Coleoptera	Curculionidae	-	-	Curculionidae	2	0	0
	Dytiscidae	-	-	Agabus	1	1	1
	Dytiscidae	-	-	Hydroporus	1	0	0
	Dytiscidae	Hydroporinae	Hydroporini	Neoporus	0	1	0
Haplotaxida	not identified	-	-	Lumbricina	2	0	0
	Lumbricidae	-	-	Lumbricidae	0	2	0
	Tubificidae	-	-	Tubificidae	5	0	5
	Tubificidae	-	-	Bothrioneurum	0	5	0
Isopoda	Asellidae	-	-	Caecidotea	2	2	2
Lepidoptera	not identified	-	-	Lepidoptera	1	0	0
	Noctuidae	-	-	Noctuidae	0	1	0
Odonata	Libellulidae	-	-	Libellulidae	2	0	0
	-	-	-	Corduliinae/Libelullidae	0	2	2

Order	Family	Subfamily	Tribe	EcoAnalysts Sample ID	R2-04-12A Taxonomist 1	R2-04-12A Taxonomist 2	R2-04-12A # of agreements
Plecoptera	Nemouridae	-	-	Nemouridae	2	2	2
Trichoptera	Limnephilidae	-	-	Limnephilidae	10	10	10
	Limnephilidae	-	-	Ironoquia	15	15	15
	Phryganeidae	-	-	Ptilostomis	1	1	1
Veneroida	Pisidiidae	-	-	Pisidiidae	1	0	0
	Sphaeriidae	-	-	Sphaeriidae	0	1	1
				Total	110	108	97
				PDE			0.92
				PTD			10.19

Table 7 - Taxonomic Identification and Enumeration Results: R2-18-03

Order	Family	Subfamily	Tribe	EcoAnalysts Sample ID	R2-18-03 Taxonomist 1	R2-18-03 Taxonomist 2	R2-18-03 # of agreements
Diptera				Diptera	0	1	0
	Chironomidae	-	-	Chironomidae	1	0	0
	Chironomidae	-	-	Cricotopus/Orthocladius	0	5	4
	Chironomidae	Chironominae	Chironomini	Chironomini	2	0	0
	Chironomidae	Chironominae	Chironomini	Cryptochironomus	1	1	1
	Chironomidae	Chironominae	Chironomini	Paracladopelma	1	1	1
	Chironomidae	Chironominae	Chironomini	Polypedilum	2	6	2
	Chironomidae	Chironominae	Chironomini	Stenochironomus	1	1	1
	Chironomidae	Chironominae	Tanytarsini	Micropsectra	3	3	3
	Chironomidae	Chironominae	Tanytarsini	Tanytarsus	1	0	0
	Chironomidae	Diamesinae	Diamesini	Diamesa	1	1	1
	Chironomidae	Orthocladiinae	-	Hydrobaenus	1	1	1
	Chironomidae	Orthocladiinae	-	Orthocladiinae	3	0	0
	Chironomidae	Orthocladiinae	-	Orthocladius	4	0	0
	Chironomidae	Tanypodinae	Natarsiini	Natarsia	10	9	9

Order	Family	Subfamily	Tribe	EcoAnalysts Sample ID	R2-18-03 Taxonomist 1	R2-18-03 Taxonomist 2	# of agreements
	Chironomidae	Tanypodinae	Pentaneurini	Paramerina	1	1	1
	Chironomidae	Tanypodinae	Pentaneurini	Thienemannimyia	1	1	1
	Simuliidae	-	-	Simuliidae	1	0	0
	Simuliidae	-	-	Simulium	0	1	0
	Tipulidae	-	-	Hexatoma	2	2	2
	Tipulidae	-	-	Tipula	1	1	1
Coleoptera	Ptilodactylidae	-	-	Anchytarsus	14	14	14
	Curculionidae	-	-	Curculionidae	1	1	1
Ephemeroptera	Baetidae	-	-	Baetidae	0	1	0
	Baetidae	-	-	Acerpenna	2	0	0
	Baetidae	-	-	Diphetor	0	2	0
Haplotaxida	Enchytraeidae	-	-	Enchytraeidae	2	1	1
	not identified	-	-	Lumbricina	2	0	0
	Tubificidae	-	-	Tubificidae	9	0	7
	Tubificidae	-	-	Aulodrilus	0	3	0
	Tubificidae	-	-	Limnodrilus	0	3	0
	Tubificidae	-	-	Tubificinae	0	1	0
Isopoda	Asellidae	-	-	Caecidotea	3	3	3
Megaloptera	Corydalidae	-	-	Nigronia	1	1	1
Plecoptera	Chloroperlidae	-	-	Chloroperlidae	1	0	0
	Chloroperlidae	-	-	Haploperla	4	4	4
	Leuctridae	-	-	Leuctra	2	2	2
	Nemouridae	-	-	Amphinemura	16	15	15
	Perlidae	-	-	Eccoptura	1	1	1
Trichoptera	Hydropsychidae	-	-	Diplectrona	1	2	1
	Hydropsychidae	-	-	Hydropsyche	1	0	0
	Polycentropodidae	-	-	Polycentropus	2	2	2
	Limnephilidae	-	-	Pycnopsyche	4	4	4
				Total	103	95	84
				PDE			4.04
				PTD			11.58

Table 8 - Taxonomic Identification and Enumeration Results: R2-18-06

Order	Family	Subfamily	Tribe	EcoAnalysts Sample ID	R2-18-06 Taxonomist 1	R2-18-06 Taxonomist 2	R2-18-06 # of agreements
Diptera	Chironomidae	-	-	Cricotopus/Orthocladius	0	39	36
	Chironomidae	Chironominae	Chironomini	Polypedilum	6	6	6
	Chironomidae	Diamesinae	Diamesini	Diamesa	5	5	5
	Chironomidae	Orthocladiinae	-	Eukiefferiella	1	1	1
	Chironomidae	Orthocladiinae	-	Hydrobaenus	2	2	2
	Chironomidae	Orthocladiinae	-	Orthocladiinae	3	0	0
	Chironomidae	Orthocladiinae	-	Orthocladius	36	0	0
	Simuliidae	-	-	Prosimulium	2	0	0
	Simuliidae	-	-	Simulium	0	1	0
	Simuliidae	Simuliinae	Prosimuliini	Stegopterna	0	1	0
	Tipulidae	-	-	Tipula	1	1	1
Amphipoda	Gammaridae	-	-	Gammarus	36	36	36
Coleoptera	Ptilodactylidae	-	-	Anchytarsus	3	2	2
Ephemeroptera	Ephemerellidae	-	-	Ephemerella	1	1	1
Haplotaxida	not identified	-	-	Lumbricina	2	0	0
	Naididae	-	-	Naididae	1	0	1
	Naididae	-	-	Nais	0	1	0
	Tubificidae	-	-	Tubificidae	5	0	5
	Tubificidae	-	-	Limnodrilus	0	4	0
	Tubificidae	-	-	Tubificinae	0	1	0
Plecoptera	Nemouridae	-	-	Amphinemura	9	8	8
Trichoptera	Hydropsychidae	-	-	Cheumatopsyche	1	0	0
	Hydropsychidae	-	-	Diplectrona	1	2	1
	Hydropsychidae	-	-	Hydropsyche	1	1	1
	Limnephilidae	-	-	Pycnopsyche	2	2	2
				Total	118	114	108
				PDE			1.72
				PTD			5.26

To: Mike Pieper
From: Dan Boward
CC: Ron Klauda, Scott Stranko
Date: December 16, 2010
Subject: KCI Crew Field Audit – March 19, 2010

The following details my field audit of the KCI crew (Colin Hill, Megan Crunkleton, and Susanna Brown) on March 19, 2010. I'll focus on protocols used by both MBSS and KCI crews. Both Colin and Susanna had attended Maryland Biological Stream Survey (MBSS) spring 2010 training. Megan had attended spring training in 2009.

One site (R2-04-04; Sawmill Branch near Glen Burnie) was visited to evaluate the comparability between the KCI Crew's protocols and those of the Maryland Biological Stream Survey.

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 on public 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 unit was used to measure dissolved oxygen, pH, water temperature, and specific conductance at a upstream, mid-segment and downstream location. 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 somewhat comparable. A comparison of the proportions of habitat sampled differed somewhat as follows:

DB riffle: 11 square feet; KCI riffle: 8 square feet
DB leaf pack: 2 square feet; KCI leaf pack: 0 square feet
DB rootwad/woody debris: 7 square feet; KCI rootwad/woody debris: 10 square feet
DB undercut banks: 0 square feet; KCI undercut banks: 2 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 protocols and scored features mostly in line with MBSS protocols. In addition, the extensive geomorphic assessments done by the KCI crew will greatly enhance

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. I recommend that at least the KCI Crew leader attend summer MBSS training to learn, first hand, protocols for summer MBSS habitat assessments.
2. The KCI Crew members are properly disinfecting waders, sampling equipment, etc.
3. Next year, I recommend that the DNR field auditor take a “duplicate” benthic sample to compare results of taxonomic IDs and abundances. This could also provide insights into differences in lab processing and identification protocols.

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: 6 April 2010

On 24 March 2010, I evaluated the field activities of KCI Technologies, Inc., (KCI) personnel as they collected the required geomorphological data as part of Year Two of Round Two of the Countywide Biological Monitoring Program. Work at one site (R2-02-09) was evaluated. This short report describes my findings.

OFFICE WORK. For each site, the drainage area was determined before going to the field and the crew had the information with them in the field. The crew had the information in their possession at the site. However, the crew was a bit unclear on exactly when to use the information in helping them to select the correct bankfull indicator. Additionally, only the equations defining rural conditions (<17% impervious) were used to calculate bankfull channel parameters. It was suggested that the crew should also use urban curves, in addition to the rural curves, to help confirm the bankfull call at developed sites. The survey instrument was a self-leveling laser level type instrument, owned by KCI, which had been inspected and calibrated prior to the commencement of field activities to ensure it was in good working. A minor technique issue was observed in that rod levels were 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, and was not discussed with the crew directly.

One crew member has had some formal fluvial geomorphic training. However, none of the crew has had 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 geomorphic reach was co-located with the bioassessment reach. The bioassessment reach showed moderate disturbance due to development and due to its proximity to a small tributary confluence, making cross section citing difficult. There was not a strong bankfull indicator located within the bioassessment reach, but such an indicator was observed just upstream outside the reach. The crew was reminded that the bankfull indicator should be found throughout the reach. A discussion of the need for a thorough examination of the stream both within and outside of the assessment reach occurred. Suggestions were made to the crew on how to accomplish such a reconnaissance efficiently with no additional work.

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 and the final FPW was measured using a tape measure.

PEBBLE COUNT. A full pebble counts was performed. The transects were properly distributed by feature prevalence in the reach. Particles, when found, were properly measured along the intermediate axis. It was observed that particle selection was distributed along the wetted perimeter of the individual transects and not along the entire bankfull channel width as described in Rosgen's method. This was discussed and will be corrected at future sites. Data were properly recorded on the data sheet.

REACH SLOPE MEASUREMENT. The measurement should have been collected over a longer distance, but was not due to difficult site conditions. However, the crew was aware of this limitation, without discussion, and the compromise should not impact data quality. The survey instrument was set up properly. A feature-to-feature measurement was not made due to the previously mentioned site conditions. To the extent feasible, 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. Better reconnasiance of reach conditions should occur before the cross section is placed and data collection activities begin. The crew was reminded that cross sections can, in limited circumstances, be located outside the bioassessment reach if necessary.
2. A discussion of the application and utility of the regional relationship data and its utility took place. Urban curves were suggested for use in highly urbanized watersheds.
3. The team was cautioned to collect samples across the entire bankfull channel width when grabbing samples for the pebble count.

Other than the above-described corrections, 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
Amphipoda	Gammaridae	Gammarus	Gammarus	Shredder	sp	6.7	12.0	58
Isopoda	Asellidae	Caecidotea	Caecidotea	Collector	sp	2.6	8.3	56
Diptera	Chironomidae	Orthocladius	Orthocladius	Collector	sp	9.2	6.6	96
Haplotaxida	Tubificidae	not identified	Tubificidae	Collector	cn	8.4	4.8	82
Plecoptera	Nemouridae	Amphinemura	Amphinemura	Shredder	sp	3.0	4.6	46
Diptera	Chironomidae	Polypedilum	Polypedilum	Shredder	cb	6.3	3.6	60
Amphipoda	Crangonyctidae	Crangonyx	Crangonyx	Collector	sp	6.7	3.3	38
Diptera	Chironomidae	Rheocricotopus	Rheocricotopus	Collector	sp	6.2	3.0	44
Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	Collector	sp	4.6	2.6	74
Diptera	Chironomidae	Cricotopus	Cricotopus	Shredder	cn	9.6	2.5	56
Trichoptera	Limnephilidae	Ironoquia	Ironoquia	Shredder	sp	4.9	2.4	60
Haplotaxida	Enchytraeidae	not identified	Enchytraeidae	Collector	bu	9.1	2.1	40
Diptera	Chironomidae	Thienemannimyia	Thienemannimyia	Predator	sp	6.7	2.1	58
Basommatophora	Physidae	Physa	Physa	Scraper	cb	7.0	2.0	24
Coleoptera	Ptilodactylidae	Anchytarsus	Anchytarsus	Shredder	cn	3.1	1.8	24
Lumbriculada	Lumbriculidae	not identified	Lumbriculidae	Collector	bu	6.6	1.6	28
Trichoptera	Hydropsychidae	Diplectrona	Diplectrona	Filterer	cn	2.7	1.2	28
Diptera	Chironomidae	not identified	Orthocladiinae	Collector	bu	7.6	1.2	56
Haplotaxida	not identified	not identified	Lumbricina	Collector	bu	10.0	1.2	44
Ephemeroptera	Baetidae	Baetis	Baetis	Collector	sw	3.9	1.2	10
Diptera	Chironomidae	Hydrobaenus	Hydrobaenus	Scraper	sp	7.2	1.1	48
Coleoptera	Elmidae	Stenelmis	Stenelmis	Scraper	cn	7.1	1.1	28
Amphipoda	not identified	not identified	Amphipoda	Collector	sp	6.0	0.9	30
Diptera	Tipulidae	Tipula	Tipula	Shredder	bu	6.7	0.9	42
Odonata	Calopterygidae	Calopteryx	Calopteryx	Predator	cb	8.3	0.9	40
Veneroida	Pisidiidae	Pisidium	Pisidium	Filterer	bu	5.7	0.9	34
Diptera	Chironomidae	Chaetocladius	Chaetocladius	Collector	sp	7.0	0.8	4
Trichoptera	Polycentropodidae	Polycentropus	Polycentropus	Filterer	cn	1.1	0.8	22
Trichoptera	Hydropsychidae	Cheumatopsyche	Cheumatopsyche	Filterer	cn	6.5	0.7	22
Diptera	Simuliidae	Simulium	Simulium	Filterer	cn	5.7	0.7	24
Diptera	Chironomidae	Micropsectra	Micropsectra	Collector	cb	2.1	0.7	36
Diptera	Chironomidae	Natarsia	Natarsia	Predator	sp	6.6	0.6	20
Veneroida	Pisidiidae	not identified	Pisidiidae	Filterer	bu	6.5	0.6	10
Plecoptera	Chloroperlidae	Haploperla	Haploperla	Predator	cn	1.6	0.6	10
Coleoptera	Elmidae	Oulimnius	Oulimnius	Scraper	cn	2.7	0.6	14
Diptera	Chironomidae	Paratanytarsus	Paratanytarsus	Collector	sp	7.7	0.6	20
Diptera	Chironomidae	Rheotanytarsus	Rheotanytarsus	Filterer	cn	7.2	0.6	32
Haplotaxida	Naididae	not identified	Naididae	Collector	bu	8.5	0.5	22
Trichoptera	Limnephilidae	Pycnopsyche	Pycnopsyche	Shredder	sp	3.1	0.5	24
Diptera	Chironomidae	Diplocladius	Diplocladius	Collector	sp	5.9	0.5	28
Diptera	Chironomidae	Tvetenia	Tvetenia	Collector	sp	5.1	0.5	26
Diptera	Chironomidae	not identified	Chironomini	Collector	bu	5.9	0.5	38
Diptera	Chironomidae	Tanytarsus	Tanytarsus	Filterer	cb	4.9	0.5	28
Diptera	Chironomidae	Zavrelimyia	Zavrelimyia	Predator	sp	5.3	0.5	26
Diptera	Tipulidae	Pseudolimnophila	Pseudolimnophila	Predator	bu	2.8	0.5	26
Trichoptera	Limnephilidae	not identified	Limnephilidae	Shredder	cb	3.4	0.5	12
Coleoptera	Elmidae	Ancyronyx	Ancyronyx	Scraper	cn	7.8	0.4	24
Amphipoda	Hyalellidae	Hyalella	Hyalella	Shredder	sp	4.2	0.4	10
Diptera	Ceratopogonidae	not identified	Ceratopogonidae	Predator	sp	3.6	0.4	26
Coleoptera	Elmidae	Macronychus	Macronychus	Scraper	cn	6.8	0.4	18
Diptera	Chironomidae	not identified	Chironomidae	Collector	na	6.6	0.4	32
Ephemeroptera	Heptageniidae	Maccaffertium	Maccaffertium	Scraper	cn	2.6	0.3	6
Diptera	Simuliidae	Stegopterna	Stegopterna	Filterer	cn	2.4	0.3	6
Diptera	Chironomidae	Conchapelopia	Conchapelopia	Predator	sp	6.1	0.3	24
Diptera	Chironomidae	Dicrotendipes	Dicrotendipes	Collector	bu	9.0	0.3	10
Coleoptera	Elmidae	Dubiraphia	Dubiraphia	Scraper	cn	5.7	0.3	22
Trichoptera	Hydropsychidae	Hydropsyche	Hydropsyche	Filterer	cn	7.5	0.3	14
Basommatophora	Planorbidae	Menetus	Menetus	Scraper	cb	7.6	0.3	4
Megaloptera	Corydalidae	Nigronia	Nigronia	Predator	cn	1.4	0.2	18
Diptera	Chironomidae	Stenochironomus	Stenochironomus	Shredder	bu	7.9	0.2	12
Diptera	Chironomidae	not identified	Tanypodinae	Predator	sp	7.5	0.2	14
Coleoptera	Dryopidae	Helichus	Helichus	Scraper	cn	6.4	0.2	14
Trichoptera	Psychomyiidae	Lype	Lype	Scraper	cn	4.7	0.2	16
Diptera	Chironomidae	Phaenopsectra	Phaenopsectra	Collector	cn	8.7	0.2	18
Hoplonemertea	Tetrastemmatidae	Prostoma	Prostoma	Predator	na	7.3	0.2	18
Plecoptera	Perlodidae	Isoperla	Isoperla	Predator	cn	2.4	0.2	4
Diptera	Chironomidae	Ablabesmyia	Ablabesmyia	Predator	sp	8.1	0.2	10
Diptera	Chironomidae	Brillia	Brillia	Shredder	bu	7.4	0.2	16
Diptera	Chironomidae	Eukiefferiella	Eukiefferiella	Collector	sp	6.1	0.2	16
Diptera	Chironomidae	Heterotrissocladius	Heterotrissocladius	Collector	sp	2.0	0.2	12
Diptera	Chironomidae	Macropelopia	Macropelopia	Predator	sp	6.6	0.2	4
Trichoptera	Hydropsychidae	Ceratopsyche	Ceratopsyche	Filterer	cn	5.7	0.2	6
Coleoptera	Curculionidae	not identified	Curculionidae	Shredder	cn	4.1	0.2	12
Coleoptera	Dytiscidae	not identified	Hydroporini	Predator	sw	5.4	0.2	14
Diptera	Chironomidae	Nanocladius	Nanocladius	Collector	sp	7.6	0.2	6
Diptera	Chironomidae	Parachaetocladius	Parachaetocladius	Collector	sp	3.3	0.2	6
Odonata	Coenagrionidae	Argia	Argia	Predator	cn	9.3	0.1	12
Odonata	Corduliidae	not identified	Corduliidae	Predator	sp	2.0	0.1	10
Diptera	Chironomidae	Diamesa	Diamesa	Collector	sp	8.5	0.1	8
Odonata	Libellulidae	not identified	Libellulidae	Predator	na	9.0	0.1	10

Order	Family	Genus	Final ID	Functional Feeding Group	Habit[1]	Tolerance Value[2]	% of total number of organisms	% of sites
Diptera	Chironomidae	Microtendipes	Microtendipes	Filterer	cn	4.9	0.1	6
Trichoptera	Uenoidae	Neophylax	Neophylax	Scraper	cn	2.7	0.1	10
Ephemeroptera	Baetidae	not identified	Baetidae	Collector	sw	2.3	0.1	4
Diptera	Chironomidae	not identified	Chironominae	Collector	na	6.6	0.1	10
Coleoptera	Dytiscidae	not identified	Colymbetini	Predator	sw	5.4	0.1	4
Trichoptera	Lepidostomatidae	Lepidostoma	Lepidostoma	Shredder	cb	0.0	0.1	6
Coleoptera	Elmidae	Microcylloepus	Microcylloepus	Collector	cn	4.8	0.1	6
Diptera	Chironomidae	Pseudorthocladius	Pseudorthocladius	Collector	sp	6.0	0.1	8
Veneroida	Pisidiidae	Sphaerium	Sphaerium	Filterer	bu	5.5	0.1	8
Ephemeroptera	Baetidae	Acerpenna	Acerpenna	Collector	sw	2.6	0.1	6
Diptera	Chironomidae	Chironomus	Chironomus	Collector	bu	4.6	0.1	12
Veneroida	Sphaeriidae	Musculium	Musculium	Filterer	na	5.5	0.1	4
Plecoptera	Perlidae	Perlesta	Perlesta	Predator	cn	1.6	0.1	6
Diptera	Simuliidae	not identified	Simuliidae	Filterer	cn	3.2	0.1	10
Coleoptera	Dytiscidae	Agabus	Agabus	Predator	sw	5.4	0.1	8
Diptera	Tipulidae	Dicranota	Dicranota	Predator	sp	1.1	0.1	8
Diptera	Dixidae	Dixella	Dixella	Predator	sw	5.8	0.1	8
Diptera	Tipulidae	Hexatoma	Hexatoma	Predator	bu	1.5	0.1	8
Diptera	Chironomidae	Odontomesa	Odontomesa	Collector	sp	6.6	0.1	4
Diptera	Simuliidae	Prosimulium	Prosimulium	Filterer	cn	2.4	0.1	6
Amphipoda	Crangonyctidae	Stygobromus	Stygobromus	Collector	sp	6.5	0.1	10
not identified	not identified	not identified	Turbellaria	Predator	sp	4.0	0.1	10
Ephemeroptera	Baetidae	Acentrella	Acentrella	Collector	sw	4.9	0.1	2
Decapoda	Cambaridae	not identified	Cambaridae	Shredder	sp	2.8	0.1	6
Diptera	Tabanidae	Chrysops	Chrysops	Predator	sp	2.9	0.1	4
Collembola	not identified	not identified	Collembola	Collector	sp	6.0	0.1	8
Odonata	Cordulegastridae	Cordulegaster	Cordulegaster	Predator	bu	2.4	0.1	8
Plecoptera	Perlidae	Eccoptura	Eccoptura	Predator	cn	0.6	0.1	6
Basommatophora	Lymnaeidae	Fossaria	Fossaria	Scraper	cb	6.9	0.1	8
Basommatophora	Planorbidae	Gyraulus	Gyraulus	Scraper	cb	7.6	0.1	2
Coleoptera	Hydrophilidae	Hydrobius	Hydrobius	Collector	cb	4.1	0.1	6
Coleoptera	Dytiscidae	Hydroporus	Hydroporus	Predator	sw	4.6	0.1	8
Trichoptera	Hydropsychidae	not identified	Hydropsychidae	Filterer	cn	5.7	0.1	8
not identified	not identified	not identified	Nemata	Parasite	na	na	0.1	4
Coleoptera	Elmidae	Optioservus	Optioservus	Scraper	cn	5.4	0.1	6
Diptera	Chironomidae	Paraphaenocladius	Paraphaenocladius	Collector	sp	4.0	0.1	6
Diptera	Chironomidae	Paratendipes	Paratendipes	Collector	bu	6.6	0.1	6
Trichoptera	Odontoceridae	Psilotreta	Psilotreta	Scraper	sp	0.9	0.1	4
Diptera	Chironomidae	Corynoneura	Corynoneura	Collector	sp	4.1	0.1	6
Amphipoda	Crangonyctidae	not identified	Crangonyctidae	Collector	sp	6.5	0.1	2
Diptera	Chironomidae	Cryptochironomus	Cryptochironomus	Predator	sp	7.6	0.1	6
Diptera	Empididae	Hemerodromia	Hemerodromia	Predator	sp	7.9	0.1	4
Trichoptera	Calamoceratidae	Heteroplectron	Heteroplectron	Shredder	sp	3.0	0.1	4
Hemiptera	Veliidae	Microvelia	Microvelia	Predator	skater	6.0	0.1	6
Plecoptera	Nemouridae	not identified	Nemouridae	Shredder	sp	2.9	0.1	4
Diptera	Chironomidae	Prodiamesa	Prodiamesa	Collector	bu	6.6	0.1	6
Trichoptera	not identified	not identified	Trichoptera	na	na	4.6	0.1	6
Diptera	Culicidae	Anopheles	Anopheles	Filterer	sw	6.0	0.0	4
Odonata	Aeshnidae	Boyeria	Boyeria	Predator	cb	6.3	0.0	4
Diptera	Empididae	Chelifera	Chelifera	Predator	sp	7.1	0.0	4
Coleoptera	Dytiscidae	Colymbetes	Colymbetes	Predator	sw	5.4	0.0	2
Diptera	Ceratopogonidae	Culicoides	Culicoides	Predator	bu	5.9	0.0	4
Diptera	Ceratopogonidae	Dasyhelea	Dasyhelea	Collector	sp	3.6	0.0	4
Coleoptera	Dytiscidae	not identified	Dytiscidae	Predator	sw	5.4	0.0	4
Diptera	Empididae	not identified	Empididae	Predator	sp	7.5	0.0	4
Odonata	Coenagrionidae	Enallagma	Enallagma	Predator	cb	9.0	0.0	4
Arhynchobdellida	Erpobdellidae	Erpobdella	Erpobdella	Predator	sp	10.0	0.0	2
Lepidoptera	not identified	not identified	Lepidoptera	Shredder	na	6.7	0.0	4
Ephemeroptera	Leptophlebiidae	not identified	Leptophlebiidae	Collector	sw	1.7	0.0	4
Plecoptera	Leuctridae	Leuctra	Leuctra	Shredder	cn	0.4	0.0	2
Diptera	Tipulidae	Limonia	Limonia	Shredder	bu	4.8	0.0	2
Diptera	Tipulidae	Molophilus	Molophilus	Shredder	bu	4.8	0.0	4
Diptera	Stratiomyidae	Odontomyia	Odontomyia	Collector	sp	6.0	0.0	2
Diptera	Tipulidae	Ormosia	Ormosia	Collector	bu	6.3	0.0	4
Diptera	Chironomidae	Paracladopelma	Paracladopelma	Collector	sp	6.6	0.0	4
Diptera	Chironomidae	Parakiefferiella	Parakiefferiella	Collector	sp	2.1	0.0	4
Coleoptera	Haliplidae	Peltodytes	Peltodytes	Shredder	cb	8.9	0.0	4
Plecoptera	not identified	not identified	Plecoptera	Predator	na	2.4	0.0	4
Coleoptera	Scirtidae	Scirtes	Scirtes	Collector	cb	4.0	0.0	4
Megaloptera	Sialidae	Sialis	Sialis	Predator	bu	1.9	0.0	4
Plecoptera	Taeniopterygidae	Taeniopteryx	Taeniopteryx	Shredder	sp	4.8	0.0	4
Diptera	Chironomidae	not identified	Tanytarsini	Filterer	na	3.5	0.0	4
Trichoptera	Leptoceridae	Triaenodes	Triaenodes	Shredder	sw	5.0	0.0	2
Diptera	Chironomidae	Xylotopus	Xylotopus	Shredder	bu	6.6	0.0	4
Diptera	Culicidae	Aedes	Aedes	Filterer	sw	8.0	0.0	2
Odonata	Aeshnidae	not identified	Aeshnidae	Predator	cb	6.2	0.0	2
Diptera	Tipulidae	Antocha	Antocha	Collector	cn	8.0	0.0	2
not identified	not identified	not identified	Bivalvia	Filterer	na	5.5	0.0	2
Ephemeroptera	Caenidae	Caenis	Caenis	Collector	sp	2.1	0.0	2
Decapoda	Cambaridae	not identified	Cambarinae	Shredder	sp	2.8	0.0	2

Order	Family	Genus	Final ID	Functional Feeding Group	Habit[1]	Tolerance Value[2]	% of total number of organisms	% of sites
Plecoptera	Chloroperlidae	not identified	Chloroperlidae	Predator	cn	1.6	0.0	2
Odonata	Coenagrionidae	not identified	Coenagrionidae	Predator	cb	9.0	0.0	2
Coleoptera	Dytiscidae	Copelatus	Copelatus	Predator	sw	5.4	0.0	2
Coleoptera	Elmidae	not identified	Elmidae	Collector	cn	4.8	0.0	2
Ephemeroptera	Ephemerellidae	Ephemerella	Ephemerella	Collector	cn	2.3	0.0	2
not identified	not identified	not identified	Gastropoda	Scraper	cb	na	0.0	2
Diptera	Chironomidae	Georthocladius	Georthocladius	Collector	sp	7.6	0.0	2
Diptera	Chironomidae	Harnischia	Harnischia	Collector	cb	5.9	0.0	2
Odonata	Corduliidae	Helocordulia	Helocordulia	Predator	sp	2.0	0.0	2
Ephemeroptera	Heptageniidae	not identified	Heptageniidae	Scraper	cn	2.6	0.0	2
Odonata	Calopterygidae	Hetaerina	Hetaerina	Predator	cb	na	0.0	2
Coleoptera	Dytiscidae	Hydrovatus	Hydrovatus	Predator	sw	5.4	0.0	2
Diptera	Chironomidae	Larsia	Larsia	Predator	sp	8.5	0.0	2
Plecoptera	Leuctridae	not identified	Leuctridae	Shredder	sp	0.8	0.0	2
Diptera	Tipulidae	Liogma	Liogma	na	na	4.8	0.0	2
Isopoda	Asellidae	Lirceus	Lirceus	Collector	sp	3.3	0.0	2
Basommatophora	Lymnaeidae	not identified	Lymnaeidae	Scraper	cb	6.9	0.0	2
not identified	not identified	not identified	Nematomorpha	Parasite	bu	na	0.0	2
Plecoptera	Nemouridae	Nemoura	Nemoura	Shredder	sp	2.9	0.0	2
Trichoptera	Leptoceridae	Oecetis	Oecetis	Predator	cn	4.7	0.0	2
Diptera	Chironomidae	Orthocladius/Cricotopus	Orthocladius/Cricotopus	Shredder	sp	7.7	0.0	2
Diptera	Chironomidae	Paramerina	Paramerina	Predator	sp	6.6	0.0	2
Diptera	Tipulidae	Pediciini	Pedicia	Predator	bu	4.8	0.0	2
Plecoptera	Perlidae	not identified	Perlidae	Predator	cn	2.2	0.0	2
Plecoptera	Perlodidae	not identified	Perlodidae	Predator	cn	2.2	0.0	2
Basommatophora	Planorbidae	not identified	Planorbidae	Scraper	cb	7.6	0.0	2
Trichoptera	Limnephilidae	Platycentropus	Platycentropus	Shredder	cb	3.4	0.0	2
Diptera	Chironomidae	Procladius	Procladius	Predator	sp	1.2	0.0	2
Ephemeroptera	Baetidae	Procloeon	Procloeon	Collector	na	2.3	0.0	2
Basommatophora	Lymnaeidae	Pseudosuccinea	Pseudosuccinea	Collector	cb	6.3	0.0	2
Diptera	Psychodidae	not identified	Psychodidae	Collector	bu	4.0	0.0	2
Trichoptera	Psychomyiidae	not identified	Psychomyiidae	Collector	cn	4.9	0.0	2
Trichoptera	Phryganeidae	Ptilostomis	Ptilostomis	Shredder	cb	4.3	0.0	2
Diptera	Sciomyzidae	Renocera	Renocera	Predator	bu	6.0	0.0	2
Diptera	Chironomidae	Saetheria	Saetheria	Collector	bu	6.6	0.0	2
Diptera	Ceratopogonidae	Serromyia	Serromyia	Predator	sp	3.6	0.0	2
Diptera	Chironomidae	Smittia	Smittia	Collector	lentic	6.6	0.0	2
Odonata	Corduliidae	Somatochlora	Somatochlora	Predator	sp	1.0	0.0	2
Coleoptera	Staphylinidae	not identified	Staphylinidae	Predator	cn	4.1	0.0	2
Diptera	Chironomidae	Stilocladius	Stilocladius	Collector	sp	6.6	0.0	2
Diptera	Tipulidae	not identified	Tipulidae	Predator	bu	4.8	0.0	2
Coleoptera	Hydrophilidae	Tropisternus	Tropisternus	Collector	cb	4.1	0.0	2
Haplotaxida	not identified	not identified	Tubificina	na	na	na	0.0	2
Trichoptera	Philopotamidae	Wormaldia	Wormaldia	Filterer	cn	1.8	0.0	2

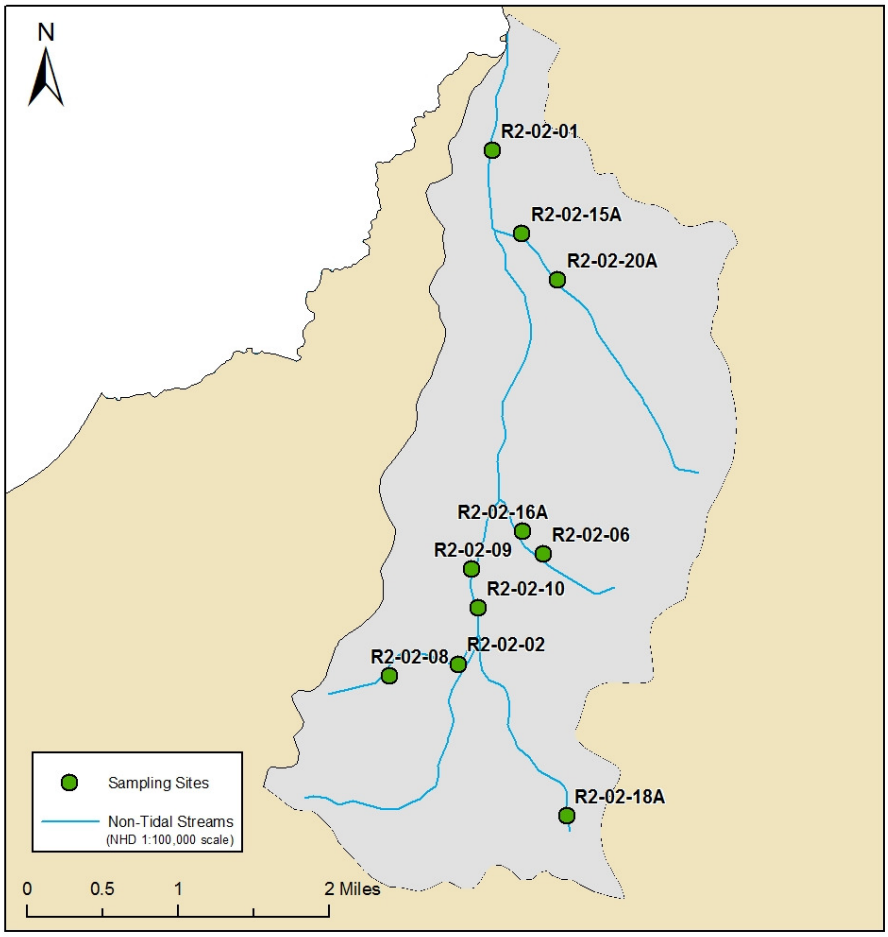
[1] Primary habit or form of locomotion includes bu - burrower, cn - clinger, cb - climber, sk - skater, sp - sprawler, sw - swimmer; [2] Tolerance values based on Hilsenhoff, modified for Maryland; na indicates information for the particular taxa was not available.

Appendix D: Individual Site Summaries

Stony 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
R2-02-01	6112.2	9.55	32.0	53.2	31.4	0.6	14.9	Fair	Partially Degraded	Supporting	F
R2-02-02	1737.9	2.72	25.3	68.1	25.3	1.9	4.8	Poor	Severely Degraded	Partially Supporting	E
R2-02-06	494.9	0.77	25.1	43.8	35.8	0.0	20.4	Fair	Minimally Degraded	Supporting	ND
R2-02-08	111.6	0.17	30.3	74.8	20.6	0.0	4.6	Fair	Partially Degraded	Partially Supporting	C
R2-02-09	2219	3.47	27.3	66.2	25.0	1.5	7.3	Fair	Partially Degraded	Supporting	F
R2-02-10	2081.2	3.25	25.6	65.7	25.0	1.6	7.7	Poor	Degraded	Partially Supporting	ND
R2-02-15A	1284.6	2.01	52.9	62.9	18.1	0.0	19.0	Poor	Minimally Degraded	Comparable to Reference	C
R2-02-16A	525.6	0.82	23.7	41.2	39.5	0.0	19.3	Fair	Minimally Degraded	Comparable to Reference	E
R2-02-18A	126.8	0.20	29.2	78.3	17.5	0.0	4.1	Very Poor	Degraded	Non Supporting	ND
R2-02-20A	865.7	1.35	54.1	61.1	14.4	0.0	24.5	Very Poor	Severely Degraded	Non Supporting	F



R2-02-01 Stony Run Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.20293973 **Longitude:** -76.6980399

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		6112.2
Cover	**Acres**	**% Area**
Developed Land	**3253.2**	**53.2**
Airport	593.8	9.7
Commercial	385.6	6.3
Industrial	564.7	9.2
Residential 1/8-acre	344.2	5.6
Residential 1/4-acre	464.4	7.6
Residential 1/2-acre	233.7	3.8
Residential 1-Acre	111.3	1.8
Residential 2-Acre	168.3	2.8
Transportation	387.2	6.3
Utility	0	0
Forest Land	**1916.9**	**31.4**
Forested Wetland	2	0
Residential Woods	0	0
Woods	1914.9	31.3
Open Land	**908.4**	**14.9**
Open Space	892.6	14.6
Open Wetland	5.9	0.1
Water	9.9	0.2
Agricultural Land	**33.7**	**0.6**
Pasture/Hay	0	0
Row Crops	33.7	0.6
Impervious Surface	**Acres**	**% Area**
Impervious Land	1955.48	32

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Supporting"* and *"Partially Degraded"*
- Sample dominated by amphipods (Gammarus and Hyalella) and midges (Orthocladius, Nanocladius, Polypedilum)
- Water quality values within COMAR standards but conductivity elevated.
- Woody debris and instream habitat scored high.

Recommendations:

- Maintain the protection of the riparian areas.

R2-02-01 Stony Run Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	30
EPT Taxa	2
Ephemeroptera Taxa	0
Intolerant Urban %	5.5
Ephemeroptera %	0
Scraper Taxa	6
% Climbers	16.4

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
Ablabesmyia	3
Ancyronyx	3
Argia	2
Calopteryx	4
Chironomidae	1
Cricotopus	8
Dubiraphia	2
Enallagma	1
Enchytraeidae	2
Gammarus	16
Heterotrissocladius	2
Hyalella	8
Hydrobaenus	5
Lype	1
Micropsectra	2
Nanocladius	7
Orthocladiinae	1
Orthocladius	13
Parametriocnemus	1
Paratanytarsus	3
Phaenopsectra	1
Physa	1
Polycentropus	1
Polypedilum	7
Rheocricotopus	1
Sialis	1
Stenelmis	3
Tanytarsus	3
Thienemannimyia	4
Tubificidae	1
Turbellaria	1
Zavrelimyia	1
TOTAL:	**110**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	7	Pool Variability	13
Bank Stability- Right Bank	7	Riparian Vegetative Zone Width- Left Bank	7
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	16	Sediment Deposition	11
Channel Sinuosity	18	Vegetative Protection - Left Bank	8
Epifaunal Substrate/Available Cover	14	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	10		
EPA Habitat Score			**149**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	9	48.47	Instream Wood Debris	17	73.3
Shading	80	78.67	Instream Habitat	15	74.69
Epifaunal Substrate	14	80.75	Bank Stability	14	83.67
PHI Score					**73.26**
PHI Narrative Rating					**Partially Degraded**

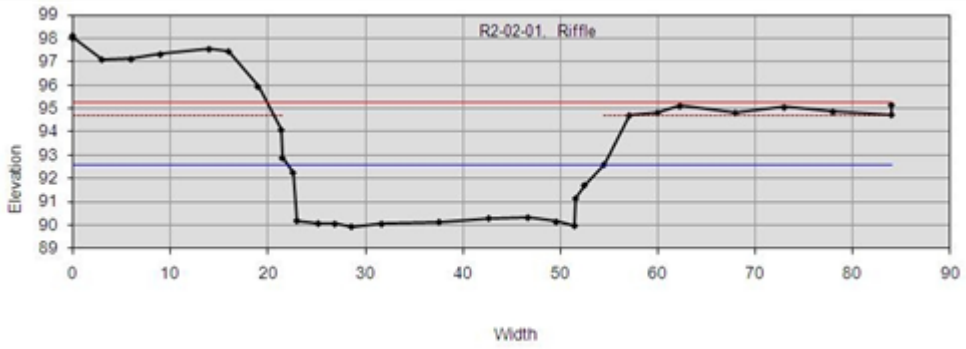
Water Chemistry

Dissolved Oxygen (mg/L)	10.9	pH (SU)	7
Turbidity (NTU)	7.07	Specific Conductivity (µS/cm)	513.9
Temperature (°C)	9.6		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	9.55	Cross Sectional Area (ft^2)	61.8
Bankfull Width (ft)	31.1	Water Surface Slope (%)	0.05
Mean Bankfull Depth (ft)	2	Sinuosity	1.8
Floodprone Width (ft)	36.2	D50 (mm)	7.3
Entrenchment Ratio	1.2	Adjustments?	
Width to Depth Ratio	15.7	**Rosgen Stream Type**	**F4/5**



R2-02-02 Stony Run Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.15368714 **Longitude:** -76.70244564

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**265.1**
Cover	**Acres**	**% Area**
Developed Land	**183.1**	**69.1**
Airport	0	0
Commercial	10.2	3.9
Industrial	0.6	0.2
Residential 1/8-acre	100.8	38
Residential 1/4-acre	0	0
Residential 1/2-acre	25.7	9.7
Residential 1-Acre	36.7	13.8
Residential 2-Acre	0	0
Transportation	9.1	3.4
Utility	0	0
Forest Land	**68.2**	**25.7**
Forested Wetland	0	0
Residential Woods	0	0
Woods	68.2	25.7
Open Land	**13.9**	**5.2**
Open Space	13.9	5.2
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	71.5	27

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Partially Supporting"* and *"Degraded"*
- Sample dominated by worms of the Tubificidae family and clams of the Pisidiidae family.
- Water quality values within COMAR standards.
- Bank stability scored high while instream habitat, epibenthic substrate, and woody debris scored very low. Refuse abundant.

Recommendations:

- Protect riparian area.
- Investigate potential water quality impacts from residential land uses.
- Consider trash cleanup for this reach.

R2-02-02 Stony Run Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	16
EPT Taxa	1
Ephemeroptera Taxa	0
Intolerant Urban %	0
Ephemeroptera %	0
Scraper Taxa	4
% Climbers	14.9

Calculated Metric Scores

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

Taxa	Count
Cheumatopsyche	6
Fossaria	1
Gammarus	4
Lumbriculidae	4
Menetus	4
Musculium	4
Parametriocnemus	3
Physa	12
Pisidiidae	13
Pisidium	10
Sphaerium	3
Stenelmis	1
Thienemannimyia	2
Tubificidae	44
Turbellaria	1
Xylotopus	1
Zavrelimyia	1
TOTAL:	**114**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	9	Pool Variability	5
Bank Stability- Right Bank	9	Riparian Vegetative Zone Width- Left Bank	9
Channel Alteration	14	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	18	Sediment Deposition	10
Channel Sinuosity	11	Vegetative Protection - Left Bank	8
Epifaunal Substrate/Available Cover	5	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	5		
EPA Habitat Score			**121**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	3	16.16	Instream Wood Debris	4	49.08
Shading	60	58.94	Instream Habitat	4	26.53
Epifaunal Substrate	6	42.47	Bank Stability	18	94.87
PHI Score					**56.8**
PHI Narrative Rating					**Degraded**

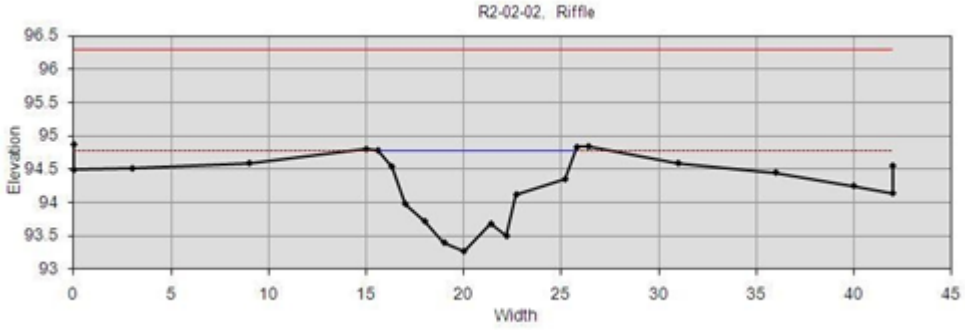
Water Chemistry

Dissolved Oxygen (mg/L)	10.72	pH (SU)	7.24
Turbidity (NTU)	10.8	Specific Conductivity (µS/cm)	319.6
Temperature (°C)	11.3		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.41	Cross Sectional Area (ft^2)	8.8
Bankfull Width (ft)	10.1	Water Surface Slope (%)	0.77
Mean Bankfull Depth (ft)	0.87	Sinuosity	1.1
Floodprone Width (ft)	100	D50 (mm)	0.062
Entrenchment Ratio	9.9	Adjustments?	
Width to Depth Ratio	11.7	**Rosgen Stream Type**	**E6**



R2-02-06 Stony Run Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.16419865 **Longitude:** -76.69189976

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		494.9
Cover	**Acres**	**% Area**
Developed Land	**216.8**	**43.8**
Airport	0	0
Commercial	18.2	3.7
Industrial	69.5	14.1
Residential 1/8-acre	1	0.2
Residential 1/4-acre	0	0
Residential 1/2-acre	91.7	18.5
Residential 1-Acre	17.4	3.5
Residential 2-Acre	0	0
Transportation	19	3.8
Utility	0	0
Forest Land	**177.3**	**35.8**
Forested Wetland	0	0
Residential Woods	0	0
Woods	177.3	35.8
Open Land	**101**	**20.4**
Open Space	101	20.4
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	124.44	25.1

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Supporting"* and *"Minimally Degraded"*
- Sample dominated by Trichoptera (Ceratopsyche) and beetles (Oulimnius). Scored high for intolerant percent.
- Water quality values within COMAR standards.
- Instream habitat and epibenthic substrate scored high.
- Stream type not determined due to channel type transitions within the reach.

Recommendations:

- Protect riparian area.
- Determine causes of instability observed in this reach and evaluate potential for stabilization.
- Because habitat is minimally degraded and biological condition is fair, look for problems with water quality and correct, if possible.

R2-02-06 Stony Run Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	31
EPT Taxa	8
Ephemeroptera Taxa	0
Intolerant Urban %	45.8
Ephemeroptera %	0
Scraper Taxa	9
% Climbers	3.7

Calculated Metric Scores

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

Taxa	Count
Aeshnidae	1
Anchytarsus	1
Ancyronyx	1
Ceratopsyche	5
Chelifera	1
Cricotopus	7
Diplectrona	19
Gammarus	1
Helichus	4
Hydrobaenus	1
Hydrobius	1
Hydropsyche	2
Limnephilidae	1
Lumbriculidae	2
Lype	2
Micropsectra	1
Nemoura	1
Neophylax	1
Nigronia	2
Optioservus	1
Orthocladius	5
Oulimnius	22
Parametriocnemus	3
Paraphaenocladius	1
Pisidium	1
Plecoptera	1
Pseudolimnophila	2
Psilotreta	1
Rheocricotopus	1
Simulium	1
Stenelmis	13
Thienemannimyia	1
TOTAL:	**107**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	5	Pool Variability	10
Bank Stability- Right Bank	5	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	16	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	16	Sediment Deposition	10
Channel Sinuosity	8	Vegetative Protection - Left Bank	7
Epifaunal Substrate/Available Cover	14	Vegetative Protection - Right Bank	7
Pool Substrate Characterization	10		
EPA Habitat Score			**128**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	15	80.78	Instream Wood Debris	8	75.14
Shading	90	91.34	Instream Habitat	12	83.77
Epifaunal Substrate	14	97.13	Bank Stability	10	70.71
PHI Score					**83.14**
PHI Narrative Rating					**Minimally Degraded**

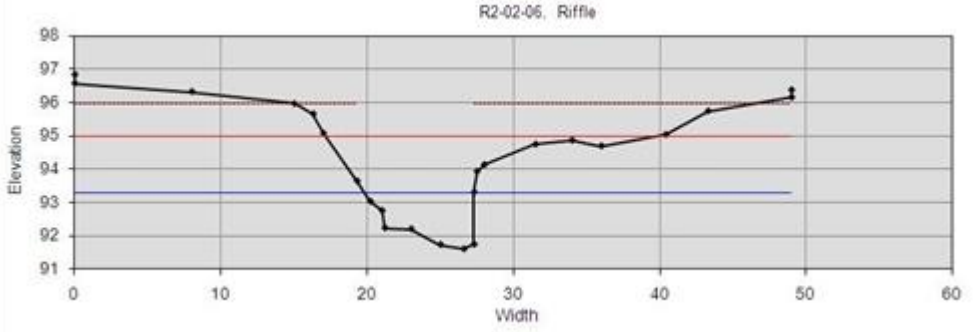
Water Chemistry

Dissolved Oxygen (mg/L)	10.51	pH (SU)	6.77
Turbidity (NTU)	8.09	Specific Conductivity (µS/cm)	267.8
Temperature (°C)	9.7		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.77	Cross Sectional Area (ft^2)	8.9
Bankfull Width (ft)	7.5	Water Surface Slope (%)	1
Mean Bankfull Depth (ft)	1.19	Sinuosity	1.1
Floodprone Width (ft)	22.9	D50 (mm)	8.3
Entrenchment Ratio	3.1	Adjustments?	
Width to Depth Ratio	6.3	**Rosgen Stream Type**	**ND**



R2-02-08 Stony Run Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.152606 **Longitude:** -76.71089746

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		111.6
Cover	**Acres**	**% Area**
Developed Land	**83.5**	**74.8**
Airport	0	0
Commercial	7.5	6.7
Industrial	0.4	0.4
Residential 1/8-acre	21.9	19.6
Residential 1/4-acre	27.1	24.3
Residential 1/2-acre	0	0
Residential 1-Acre	25.7	23
Residential 2-Acre	0	0
Transportation	0.9	0.8
Utility	0	0
Forest Land	**23**	**20.6**
Forested Wetland	0	0
Residential Woods	0	0
Woods	23	20.6
Open Land	**5.1**	**4.6**
Open Space	5.1	4.6
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	33.76	30.3

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Midges and blackflies dominated the sample (Parametriocnemus and Simulium). Sample also had many Trichoptera.
- Water quality values within COMAR standards.
- Most habitat variable scores are marginal. Good riparian vegetation.

Recommendations:

- Maintain the protection of the riparian areas.
- Investigate potential water quality impacts from residential land uses.
- Determine causes of instability observed in this reach and evaluate potential for stabilization.

R2-02-08 Stony Run Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	28
EPT Taxa	7
Ephemeroptera Taxa	0
Intolerant Urban %	15.6
Ephemeroptera %	0
Scraper Taxa	3
% Climbers	8.3

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	2
Anchytarsus	2
Caecidotea	1
Calopteryx	3
Ceratopogonidae	1
Cheumatopsyche	3
Collembola	1
Cordulegaster	1
Cricotopus	3
Diplectrona	11
Helichus	1
Heteroplectron	1
Hydrobaenus	1
Hydrobius	1
Hydroporus	1
Hydropsyche	3
Ironoquia	2
Limnephilidae	3
Micropsectra	1
Natarsia	1
Parametriocnemus	41
Pisidium	1
Pycnopsyche	1
Rheocricotopus	2
Rheotanytarsus	3
Scirtes	1
Simulium	12
Stenelmis	3
Tipula	2
TOTAL:	**109**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	4	Pool Variability	6
Bank Stability- Right Bank	5	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	19	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	10	Sediment Deposition	7
Channel Sinuosity	12	Vegetative Protection - Left Bank	7
Epifaunal Substrate/Available Cover	9	Vegetative Protection - Right Bank	7
Pool Substrate Characterization	7		
EPA Habitat Score			**113**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	6	32.31	Instream Wood Debris	0	68.33
Shading	95	99.94	Instream Habitat	9	82.37
Epifaunal Substrate	10	83.59	Bank Stability	9	67.08
PHI Score					**72.27**
PHI Narrative Rating					**Partially Degraded**

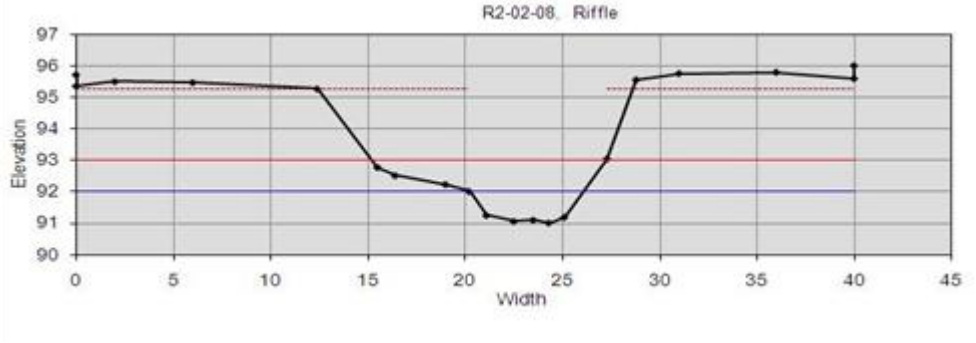
Water Chemistry

Dissolved Oxygen (mg/L)	11.41	pH (SU)	7.04
Turbidity (NTU)	14.2	Specific Conductivity (µS/cm)	234.9
Temperature (°C)	12.4		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.17	Cross Sectional Area (ft^2)	4.4
Bankfull Width (ft)	5.9	Water Surface Slope (%)	1.3
Mean Bankfull Depth (ft)	0.74	Sinuosity	1.3
Floodprone Width (ft)	12.1	D50 (mm)	11
Entrenchment Ratio	2.1	Adjustments?	Yes, ER + 0.1
Width to Depth Ratio	7.9	**Rosgen Stream Type**	**C4**



R2-02-09 Stony Run Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.16276689 **Longitude:** -76.70076527

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**2219**
Cover	**Acres**	**% Area**
Developed Land	**1469.6**	**66.2**
Airport	0	0
Commercial	110.3	5
Industrial	121.2	5.5
Residential 1/8-acre	343.2	15.5
Residential 1/4-acre	464.4	20.9
Residential 1/2-acre	139.5	6.3
Residential 1-Acre	61.9	2.8
Residential 2-Acre	95	4.3
Transportation	134.1	6
Utility	0	0
Forest Land	**553.8**	**25**
Forested Wetland	2	0.1
Residential Woods	0	0
Woods	551.8	24.9
Open Land	**161.9**	**7.3**
Open Space	152.3	6.9
Open Wetland	0	0
Water	9.6	0.4
Agricultural Land	**33.7**	**1.5**
Pasture/Hay	0	0
Row Crops	33.7	1.5
Impervious Surface	**Acres**	**% Area**
Impervious Land	606.77	27.3

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Supporting"* and *"Partially Degraded"*
- Sample dominated by amphipods (Gammarus and Hyalella), midges (Orthocladius) and beetles (Stenelmis).
- Water quality values within COMAR standards but conductivity elevated.
- Woody debris and instream habitat scored high. Good riparian vegetation.

Recommendations:

- Maintain the protection of the riparian areas.
- Seek out opportunities for BMP installation and retrofit to improve water quality to preserve high quality biological community.

R2-02-09 Stony Run Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	28
EPT Taxa	5
Ephemeroptera Taxa	0
Intolerant Urban %	3.5
Ephemeroptera %	0
Scraper Taxa	6
% Climbers	8.8

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
Ancyronyx	5
Argia	1
Calopteryx	2
Cheumatopsyche	5
Chironomidae	1
Chironomini	1
Cricotopus	2
Dasyhelea	1
Dubiraphia	2
Enallagma	1
Gammarus	24
Hyalella	10
Hydrobaenus	2
Hydropsyche	1
Lepidostoma	1
Lumbricina	1
Macronychus	3
Microcylloepus	1
Orthocladius	12
Oulimnius	2
Paratanytarsus	2
Peltodytes	1
Phaenopsectra	2
Polycentropus	1
Polypedilum	2
Stenelmis	18
Stenochironomus	3
Taeniopteryx	1
Tanytarsini	1
Tanytarsus	3
Tubificidae	2
TOTAL:	**114**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	6	Pool Variability	12
Bank Stability- Right Bank	7	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	19	Riparian Vegetative Zone Width- Right Bank	9
Channel Flow Status	15	Sediment Deposition	10
Channel Sinuosity	11	Vegetative Protection - Left Bank	6
Epifaunal Substrate/Available Cover	13	Vegetative Protection - Right Bank	7
Pool Substrate Characterization	13		
EPA Habitat Score			**138**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	8	43.08	Instream Wood Debris	17	84.78
Shading	75	73.32	Instream Habitat	14	79.51
Epifaunal Substrate	13	81.54	Bank Stability	13	80.63
PHI Score					**73.81**
PHI Narrative Rating					**Partially Degraded**

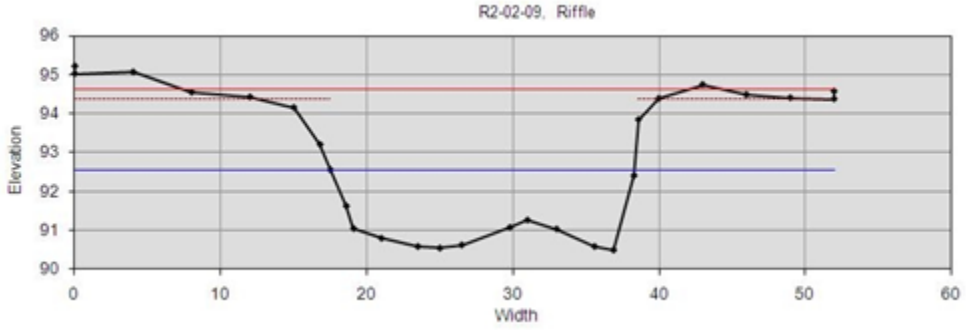
Water Chemistry

Dissolved Oxygen (mg/L)	10.16	pH (SU)	7.09
Turbidity (NTU)	6.45	Specific Conductivity (µS/cm)	431.9
Temperature (°C)	9.1		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	3.47	Cross Sectional Area (ft^2)	30.5
Bankfull Width (ft)	20.6	Water Surface Slope (%)	0.32
Mean Bankfull Depth (ft)	1.5	Sinuosity	1.2
Floodprone Width (ft)	26.6	D50 (mm)	0.59
Entrenchment Ratio	1.3	Adjustments?	
Width to Depth Ratio	13.9	**Rosgen Stream Type**	**F5/4**



R2-02-10 Stony Run Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.1591367 **Longitude:** -76.69999369

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		2081.2
Cover	**Acres**	**% Area**
Developed Land	**1366.4**	**65.7**
Airport	0	0
Commercial	63.9	3.1
Industrial	77.7	3.7
Residential 1/8-acre	343.2	16.5
Residential 1/4-acre	463.3	22.3
Residential 1/2-acre	139.5	6.7
Residential 1-Acre	61.9	3
Residential 2-Acre	92.6	4.4
Transportation	124.3	6
Utility	0	0
Forest Land	**520.1**	**25**
Forested Wetland	2	0.1
Residential Woods	0	0
Woods	518.1	24.9
Open Land	**161**	**7.7**
Open Space	151.4	7.3
Open Wetland	0	0
Water	9.6	0.5
Agricultural Land	**33.7**	**1.6**
Pasture/Hay	0	0
Row Crops	33.7	1.6
Impervious Surface	**Acres**	**% Area**
Impervious Land	532.67	25.6

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Partially Supporting"* and *"Degraded"*
- Sample dominated by amphipods (Gammarus), beetles (Stenelmis), and Trichoptera (Cheumatopsyche).
- Water quality values within COMAR standards but conductivity elevated.
- Instream habitat and epibenthic substrate scored high. Refuse abundant.
- Stream type not determined due to effects from upstream box culvert.

Recommendations:

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

R2-02-10 Stony Run Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	23
EPT Taxa	3
Ephemeroptera Taxa	0
Intolerant Urban %	2.6
Ephemeroptera %	0
Scraper Taxa	7
% Climbers	4.4

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
Ancyronyx	3
Calopteryx	5
Cheumatopsyche	15
Chironominae	1
Cricotopus	2
Dubiraphia	2
Enchytraeidae	2
Gammarus	15
Hyalella	3
Hydrobaenus	1
Hydropsyche	6
Hydropsychidae	1
Libellulidae	1
Macronychus	10
Microcylloepus	6
Naididae	3
Optioservus	2
Orthocladiinae	2
Orthocladius	3
Oulimnius	3
Prostoma	1
Rheotanytarsus	4
Simulium	4
Stenelmis	17
Taeniopteryx	1
Tvetenia	1
TOTAL:	**114**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	4	Pool Variability	12
Bank Stability- Right Bank	3	Riparian Vegetative Zone Width- Left Bank	8
Channel Alteration	14	Riparian Vegetative Zone Width- Right Bank	5
Channel Flow Status	16	Sediment Deposition	13
Channel Sinuosity	8	Vegetative Protection - Left Bank	4
Epifaunal Substrate/Available Cover	12	Vegetative Protection - Right Bank	3
Pool Substrate Characterization	11		
EPA Habitat Score			**113**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	3	16.16	Instream Wood Debris	7	55.92
Shading	55	54.42	Instream Habitat	12	69.07
Epifaunal Substrate	12	76.15	Bank Stability	7	59.16
PHI Score					**55.15**
PHI Narrative Rating					**Degraded**

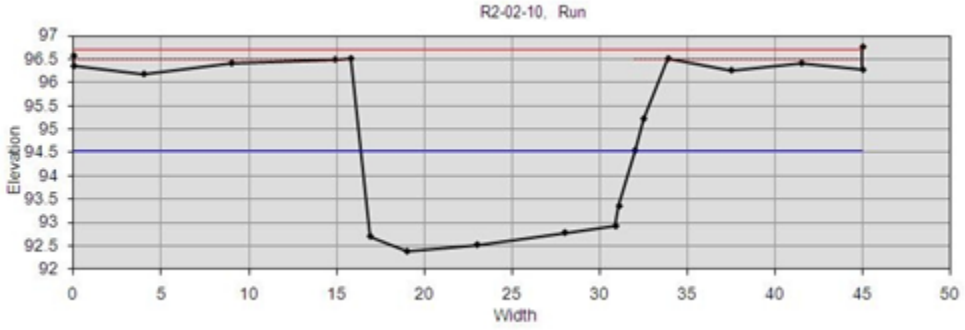
Water Chemistry

Dissolved Oxygen (mg/L)	11.17	pH (SU)	7.11
Turbidity (NTU)	8.89	Specific Conductivity (µS/cm)	403.9
Temperature (°C)	11.3		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	3.25	Cross Sectional Area (ft^2)	28.2
Bankfull Width (ft)	15.6	Water Surface Slope (%)	0.37
Mean Bankfull Depth (ft)	1.81	Sinuosity	1
Floodprone Width (ft)	120	D50 (mm)	6.9
Entrenchment Ratio	7.7	Adjustments?	
Width to Depth Ratio	8.7	**Rosgen Stream Type**	**ND**



R2-02-15A Stony Run Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.19487444 **Longitude:** -76.69442446

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		1284.6
Cover	**Acres**	**% Area**
Developed Land	**808.1**	**62.9**
Airport	420.2	32.7
Commercial	228.7	17.8
Industrial	35.5	2.8
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	27.7	2.2
Residential 2-Acre	13.1	1
Transportation	82.9	6.5
Utility	0	0
Forest Land	**232.6**	**18.1**
Forested Wetland	0	0
Residential Woods	0	0
Woods	232.6	18.1
Open Land	**243.9**	**19**
Open Space	243.9	19
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	678.99	52.9

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Comparable to Reference"* and *"Minimally Degraded"*
- Midges dominated the sample including Thienemannimyia, Cricotopus and Macropelopia.
- Water quality values within COMAR standards but conductivity elevated.
- Instream habitat, epibenthic substrate, and bank stability scored high. Good riparian vegetation.

Recommendations:

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

R2-02-15A Stony Run Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	24
EPT Taxa	0
Ephemeroptera Taxa	0
Intolerant Urban %	0
Ephemeroptera %	0
Scraper Taxa	2
% Climbers	10.8

Calculated Metric Scores

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

Taxa	Count
Ablabesmyia	2
Brillia	1
Ceratopogonidae	1
Chironomidae	1
Chironomus	1
Cricotopus	13
Dicrotendipes	8
Enchytraeidae	3
Hydrobaenus	1
Lepidoptera	1
Lumbricina	6
Lumbriculidae	1
Macropelopia	10
Nematomorpha	1
Orthocladius	12
Paratanytarsus	1
Phaenopsectra	1
Physa	2
Polypedilum	9
Psychodidae	1
Stenochironomus	4
Stygobromus	1
Thienemannimyia	15
Tubificidae	5
Xylotopus	1
TOTAL:	**102**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	9	Pool Variability	13
Bank Stability- Right Bank	9	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	19	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	16	Sediment Deposition	11
Channel Sinuosity	12	Vegetative Protection - Left Bank	9
Epifaunal Substrate/Available Cover	14	Vegetative Protection - Right Bank	9
Pool Substrate Characterization	12		
EPA Habitat Score			**153**
EPA Narrative Rating			**Comparable to Reference**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	14	75.39	Instream Wood Debris	11	73.21
Shading	95	99.94	Instream Habitat	14	85.11
Epifaunal Substrate	14	90.91	Bank Stability	18	94.87
PHI Score					**86.57**
PHI Narrative Rating					**Minimally Degraded**

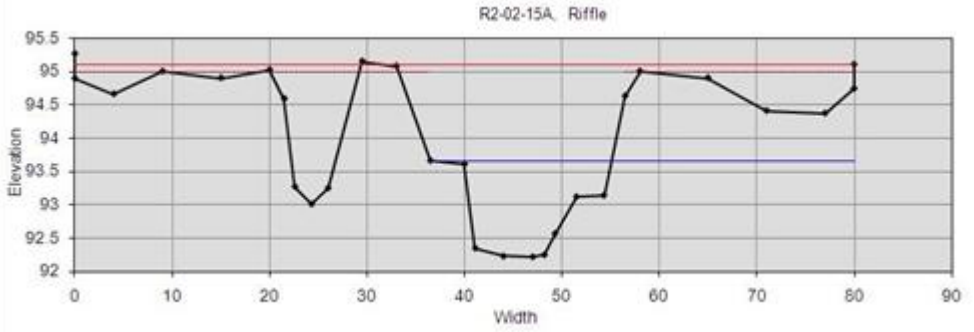
Water Chemistry

Dissolved Oxygen (mg/L)	9.46	pH (SU)	7.2
Turbidity (NTU)	7.01	Specific Conductivity (µS/cm)	771.6
Temperature (°C)	15.3		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	2.01	Cross Sectional Area (ft^2)	15.7
Bankfull Width (ft)	18.6	Water Surface Slope (%)	0.43
Mean Bankfull Depth (ft)	0.84	Sinuosity	1
Floodprone Width (ft)	200	D50 (mm)	9.9
Entrenchment Ratio	10.8	Adjustments?	
Width to Depth Ratio	22	**Rosgen Stream Type**	**C4/5**



R2-02-16A Stony Run Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.16643137 **Longitude:** -76.69452932

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		525.6
Cover	**Acres**	**% Area**
Developed Land	**216.8**	**41.2**
Airport	0	0
Commercial	18.2	3.5
Industrial	69.5	13.2
Residential 1/8-acre	1	0.2
Residential 1/4-acre	0	0
Residential 1/2-acre	91.7	17.4
Residential 1-Acre	17.4	3.3
Residential 2-Acre	0	0
Transportation	19	3.6
Utility	0	0
Forest Land	**207.4**	**39.5**
Forested Wetland	0	0
Residential Woods	0	0
Woods	207.4	39.5
Open Land	**101.5**	**19.3**
Open Space	101.5	19.3
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	124.44	23.7

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Comparable to Reference"* and *"Minimally Degraded"*
- Amphipods (Gammarus) and midges dominated the sample.
- Water quality values within COMAR standards.
- Instream habitat, epibenthic substrate, and bank stability scored high. Good riparian vegetation.

Recommendations:

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

R2-02-16A Stony Run Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	31
EPT Taxa	6
Ephemeroptera Taxa	0
Intolerant Urban %	19.2
Ephemeroptera %	0
Scraper Taxa	5
% Climbers	9.6

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
Anchytarsus	4
Boyeria	1
Brillia	1
Chironomini	1
Coenagrionidae	1
Cordulegaster	1
Crangonyx	3
Diplectrona	3
Gammarus	25
Helichus	1
Hetaerina	1
Heteroplectron	2
Hydrobaenus	1
Ironoquia	1
Limnephilidae	2
Lumbriculidae	2
Micropsectra	4
Natarsia	3
Oecetis	1
Orthocladiinae	1
Oulimnius	1
Parametriocnemus	1
Pisidium	7
Polycentropus	4
Polypedilum	1
Pseudolimnophila	2
Psilotreta	3
Rheocricotopus	1
Stenelmis	1
Stenochironomus	1
Tanypodinae	6
Thienemannimyia	6
Tipula	2
Trichoptera	1
Tubificidae	2
Zavrelimyia	6
TOTAL:	**104**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

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	10
Channel Sinuosity	11	Vegetative Protection - Left Bank	9
Epifaunal Substrate/Available Cover	14	Vegetative Protection - Right Bank	9
Pool Substrate Characterization	9		
EPA Habitat Score			**153**
EPA Narrative Rating			**Comparable to Reference**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	10	53.85	Instream Wood Debris	7	71.5
Shading	95	99.94	Instream Habitat	12	83.16
Epifaunal Substrate	14	96.73	Bank Stability	20	100
PHI Score					**84.2**
PHI Narrative Rating					**Minimally Degraded**

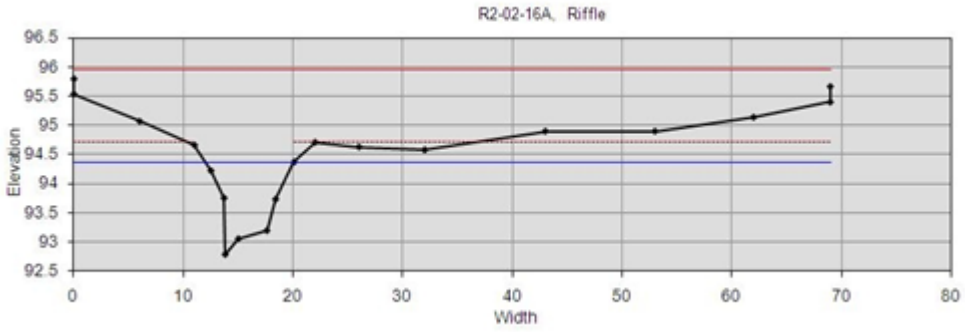
Water Chemistry

Dissolved Oxygen (mg/L)	10.4	pH (SU)	7.2
Turbidity (NTU)	11.5	Specific Conductivity (µS/cm)	229.1
Temperature (°C)	9.1		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.82	Cross Sectional Area (ft^2)	6.9
Bankfull Width (ft)	8.1	Water Surface Slope (%)	0.087
Mean Bankfull Depth (ft)	0.85	Sinuosity	1.1
Floodprone Width (ft)	85	D50 (mm)	0.32
Entrenchment Ratio	10.5	Adjustments?	
Width to Depth Ratio	9.6	**Rosgen Stream Type**	**E5**



R2-02-18A Stony Run Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.13907746 **Longitude:** -76.68909826

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		126.8
Cover	**Acres**	**% Area**
Developed Land	**99.4**	**78.3**
Airport	0	0
Commercial	13.8	10.8
Industrial	0	0
Residential 1/8-acre	22.4	17.7
Residential 1/4-acre	29.6	23.3
Residential 1/2-acre	3.4	2.7
Residential 1-Acre	1.1	0.9
Residential 2-Acre	19.5	15.4
Transportation	9.6	7.5
Utility	0	0
Forest Land	**22.2**	**17.5**
Forested Wetland	0	0
Residential Woods	0	0
Woods	22.2	17.5
Open Land	**5.2**	**4.1**
Open Space	5.2	4.1
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	29.2

Summary Results:

- Biological condition – *"Very Poor"*
- Habitat scores *"Non Supporting"* and *"Degraded"*
- Midges (Chaetocladius) and worms (Enchytraeidae and Tubificidae) dominated the sample.
- Water quality values within COMAR standards but conductivity elevated.
- Very low woody debris score and poor habitat diversity.
- Stream type not determined due to stream modifications.

Recommendations:

- Buffer enhancement.
- Investigate potential water quality impacts from residential land uses.
- Investigate need and feasibility of new BMP installation or retrofits of existing facilities to improve water quality

R2-02-18A Stony Run Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	12
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
Aedes	1
Ceratopogonidae	1
Chaetocladius	40
Chironomidae	1
Collembola	1
Colymbetes	2
Copelatus	1
Cricotopus	1
Dasyhelea	1
Enchytraeidae	15
Ironoquia	5
Lumbricina	8
Natarsia	1
Orthocladiinae	1
Tubificidae	25
TOTAL:	**104**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	8	Pool Variability	5
Bank Stability- Right Bank	8	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	10	Riparian Vegetative Zone Width- Right Bank	2
Channel Flow Status	10	Sediment Deposition	4
Channel Sinuosity	10	Vegetative Protection - Left Bank	6
Epifaunal Substrate/Available Cover	4	Vegetative Protection - Right Bank	6
Pool Substrate Characterization	5		
EPA Habitat Score			**88**
EPA Narrative Rating			**Non Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	6	32.31	Instream Wood Debris	1	69.85
Shading	80	78.67	Instream Habitat	4	53.32
Epifaunal Substrate	4	47.9	Bank Stability	16	89.45
PHI Score					**61.92**
PHI Narrative Rating					**Degraded**

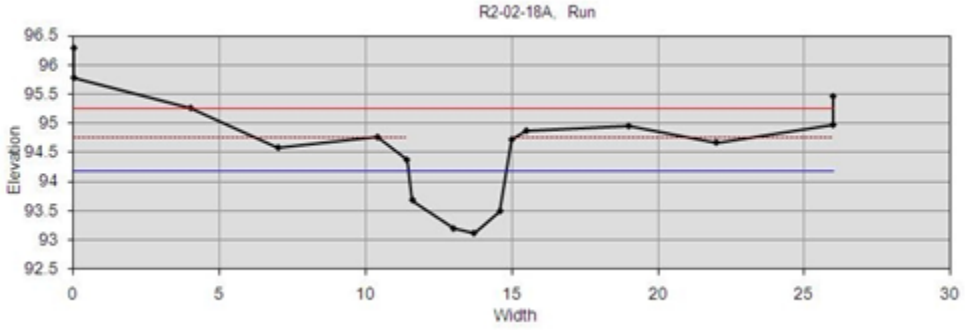
Water Chemistry

Dissolved Oxygen (mg/L)	12.78	pH (SU)	7.58
Turbidity (NTU)	7.36	Specific Conductivity (µS/cm)	676.6
Temperature (°C)	17.5		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.2	Cross Sectional Area (ft^2)	2.7
Bankfull Width (ft)	3.4	Water Surface Slope (%)	0.75
Mean Bankfull Depth (ft)	0.79	Sinuosity	1.1
Floodprone Width (ft)	30	D50 (mm)	0.076
Entrenchment Ratio	8.9	Adjustments?	
Width to Depth Ratio	4.3	**Rosgen Stream Type**	**ND**



R2-02-20A Stony Run Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.19052245 **Longitude:** -76.68997604

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**865.7**
Cover	**Acres**	**% Area**
Developed Land	**529.1**	**61.1**
Airport	420.2	48.5
Commercial	20.1	2.3
Industrial	16.9	2
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	12.8	1.5
Residential 2-Acre	13.1	1.5
Transportation	46	5.3
Utility	0	0
Forest Land	**124.8**	**14.4**
Forested Wetland	0	0
Residential Woods	0	0
Woods	124.8	14.4
Open Land	**211.7**	**24.5**
Open Space	211.7	24.5
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	468.51	54.1

Summary Results:

- Biological condition – *"Very Poor"*
- Habitat scores *"Non Supporting"* and *"Severely Degraded"*
- This sample only contained 26 organisms, the majority of which were midges and worms (Tubificidae).
- Water quality values within COMAR standards but conductivity elevated.
- Very low woody debris score, very little shading, and poor habitat diversity. Good riparian vegetation.

Recommendations:

- Maintain the protection of the riparian areas.
- Determine causes of instability observed in this reach and evaluate potential for stabilization.
- Investigate necessity and feasibility of BMP installation in extensive developed land upstream.

R2-02-20A Stony Run Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	11
EPT Taxa	0
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
Anchytarsus	1
Conchapelopia	1
Dicrotendipes	2
Enchytraeidae	2
Gammarus	1
Natarsia	1
Orthocladius	2
Phaenopsectra	1
Pisidium	1
Tanypodinae	1
Thienemannimyia	4
Tubificidae	9
TOTAL:	**26**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	2	Pool Variability	7
Bank Stability- Right Bank	2	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	15	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	13	Sediment Deposition	6
Channel Sinuosity	12	Vegetative Protection - Left Bank	3
Epifaunal Substrate/Available Cover	8	Vegetative Protection - Right Bank	3
Pool Substrate Characterization	8		
EPA Habitat Score			**99**
EPA Narrative Rating			**Non Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	6	32.31	Instream Wood Debris	2	51.06
Shading	5	0	Instream Habitat	8	55.86
Epifaunal Substrate	7	52.82	Bank Stability	4	44.72
PHI Score					**39.46**
PHI Narrative Rating					**Severely Degraded**

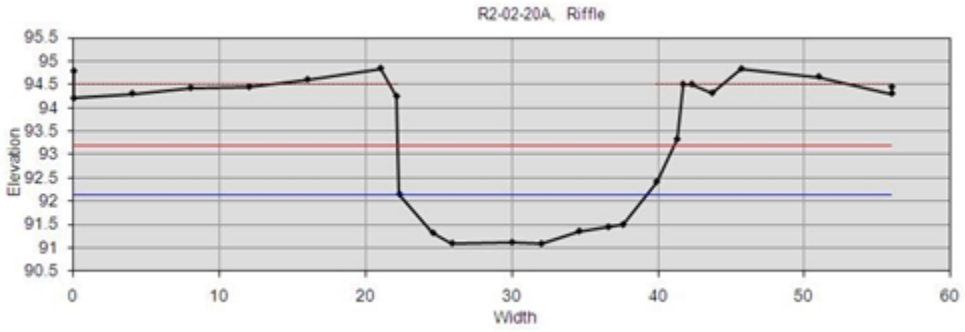
Water Chemistry

Dissolved Oxygen (mg/L)	10.21	pH (SU)	6.92
Turbidity (NTU)	5.36	Specific Conductivity (µS/cm)	492.2
Temperature (°C)	13		

Geomorphic Assessment

Rosgen Level II Classification Data

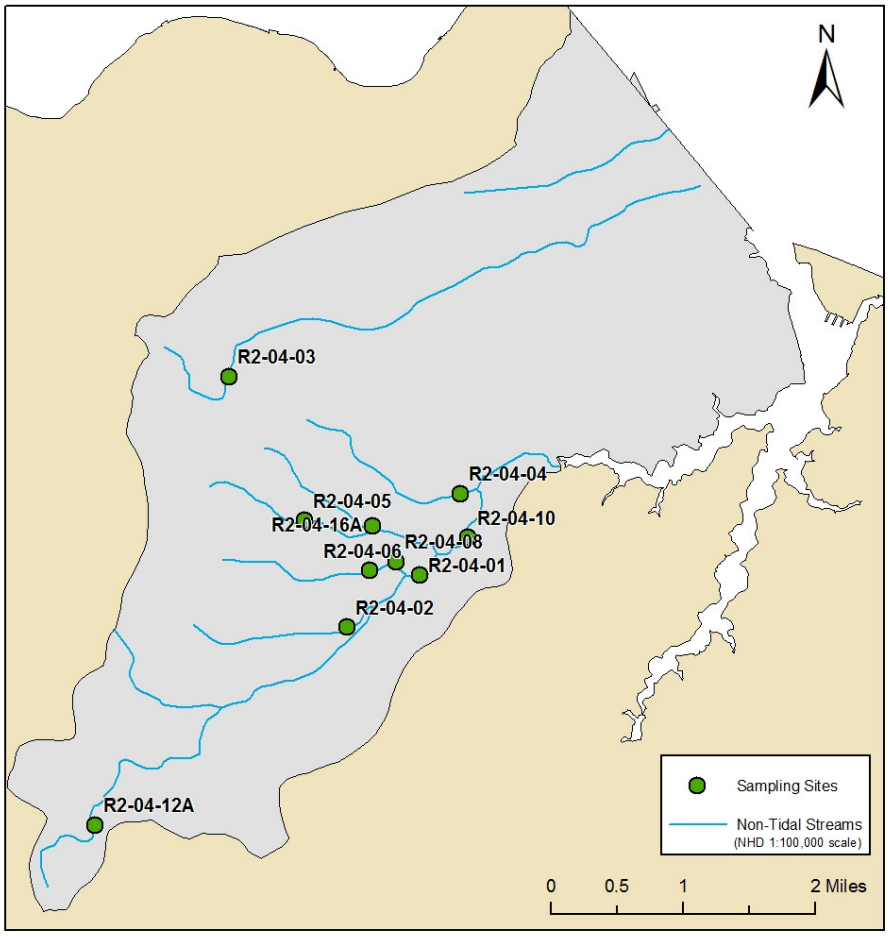
Drainage Area (mi^2)	1.35	Cross Sectional Area (ft^2)	13.6
Bankfull Width (ft)	16.9	Water Surface Slope (%)	0.49
Mean Bankfull Depth (ft)	0.81	Sinuosity	1.1
Floodprone Width (ft)	18.9	D50 (mm)	7.3
Entrenchment Ratio	1.1	Adjustments?	
Width to Depth Ratio	21	**Rosgen Stream Type**	**F4**



Sawmill 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
R2-04-01	2821.9	4.41	22.9	44.7	34.3	0.2	20.8	Poor	Degraded	Partially Supporting	ND
R2-04-02	544.66	0.85	23.3	28.8	35.6	0.0	35.6	Poor	Partially Degraded	Supporting	DA
R2-04-03	285.9	0.45	47.9	54.5	8.0	0.0	37.5	Very Poor	Severely Degraded	Non Supporting	ND
R2-04-04	612.5	0.96	38.3	83.0	9.6	0.0	7.4	Poor	Partially Degraded	Supporting	F
R2-04-05	586.3	0.92	53.0	60.4	6.4	0.0	33.2	Poor	Partially Degraded	Supporting	ND
R2-04-06	238.7	0.37	24.3	26.2	23.2	0.0	50.6	Poor	Partially Degraded	Supporting	E
R2-04-08	277.9	0.43	29.5	32.3	22.6	0.0	45.1	Poor	Partially Degraded	Supporting	DA
R2-04-10	4193.9	6.55	30.5	49.8	27.3	0.1	22.8	Poor	Degraded	Supporting	E
R2-04-12A	156.7	0.24	11.4	32.1	45.9	3.5	18.6	Poor	Minimally Degraded	Comparable to Reference	DA
R2-04-16A	231.1	0.36	47.4	86.1	5.8	0.0	8.2	Poor	Degraded	Non Supporting	ND



R2-04-01 Sawmill Creek Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.16968101 **Longitude:** -76.62992538

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**3099.8**
Cover	**Acres**	**% Area**
Developed Land	**1351.5**	**43.6**
Airport	117.6	3.8
Commercial	109.3	3.5
Industrial	171.5	5.5
Residential 1/8-acre	11	0.4
Residential 1/4-acre	22.1	0.7
Residential 1/2-acre	88.9	2.9
Residential 1-Acre	432.1	13.9
Residential 2-Acre	200.9	6.5
Transportation	179.3	5.8
Utility	18.7	0.6
Forest Land	**1030.6**	**33.2**
Forested Wetland	0	0
Residential Woods	28.6	0.9
Woods	1002	32.3
Open Land	**712.2**	**23**
Open Space	706.8	22.8
Open Wetland	0	0
Water	5.4	0.2
Agricultural Land	**5.5**	**0.2**
Pasture/Hay	0	0
Row Crops	5.5	0.2
Impervious Surface	**Acres**	**% Area**
Impervious Land	727.66	23.5

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Partially Supporting"* and *"Degraded"*
- Sample dominated by amphipods (Gammarus).
- Water quality values within COMAR standards but conductivity elevated.
- Bank stability scored high while remaining habitat variables received marginal scores. Refuse abundant.
- Stream type not determined because the stream is not able to adjust its dimensions due to extensive hardening of the banks.

Recommendations:

- Buffer enhancement.
- Consider trash cleanup for this reach.
- Investigate necessity and feasibility of BMP installation to improve water quality in drainage area.

R2-04-01 Sawmill Creek Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	15
EPT Taxa	6
Ephemeroptera Taxa	0
Intolerant Urban %	1.7
Ephemeroptera %	0
Scraper Taxa	3
% Climbers	3.5

Calculated Metric Scores

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

Taxa	Count
Amphipoda	5
Calopteryx	3
Cheumatopsyche	1
Cricotopus	1
Diplectrona	1
Gammarus	91
Libellulidae	1
Lumbricina	1
Macronychus	1
Neophylax	1
Optioservus	1
Platycentropus	1
Prostoma	1
Pycnopsyche	2
Triaenodes	2
Tubificidae	2
TOTAL:	**115**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	8	Pool Variability	7
Bank Stability- Right Bank	9	Riparian Vegetative Zone Width- Left Bank	4
Channel Alteration	6	Riparian Vegetative Zone Width- Right Bank	1
Channel Flow Status	18	Sediment Deposition	13
Channel Sinuosity	11	Vegetative Protection - Left Bank	4
Epifaunal Substrate/Available Cover	10	Vegetative Protection - Right Bank	7
Pool Substrate Characterization	9		
EPA Habitat Score			**107**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	1	5.39	Instream Wood Debris	10	61.35
Shading	70	68.32	Instream Habitat	9	49.31
Epifaunal Substrate	10	62.55	Bank Stability	17	92.2
PHI Score					**56.08**
PHI Narrative Rating					**Degraded**

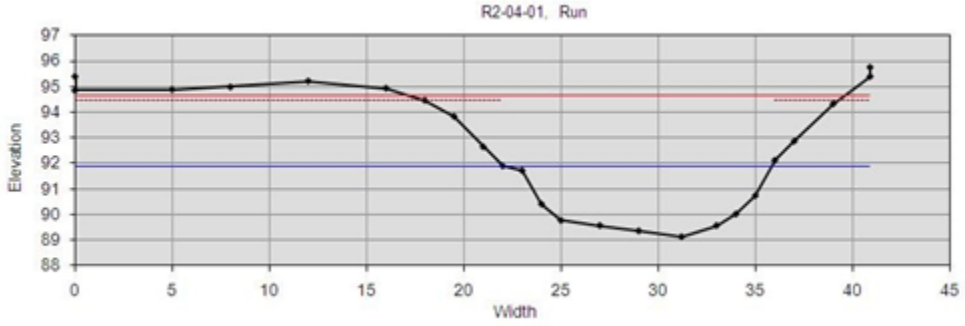
Water Chemistry

Dissolved Oxygen (mg/L)	9.89	pH (SU)	7.41
Turbidity (NTU)	5.08	Specific Conductivity (µS/cm)	717.3
Temperature (°C)	10.9		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	4.84	Cross Sectional Area (ft^2)	26.6
Bankfull Width (ft)	13.8	Water Surface Slope (%)	0.12
Mean Bankfull Depth (ft)	1.92	Sinuosity	1.2
Floodprone Width (ft)	22.5	D50 (mm)	14
Entrenchment Ratio	1.6	Adjustments?	
Width to Depth Ratio	7.2	**Rosgen Stream Type**	**ND**



R2-04-02 Sawmill Creek Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.16403151 **Longitude:** -76.64019069

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**544.7**
Cover	**Acres**	**% Area**
Developed Land	**157**	**28.8**
Airport	92.6	3.6
Commercial	80.2	3.2
Industrial	126.2	5
Residential 1/8-acre	272.4	10.7
Residential 1/4-acre	11	0.4
Residential 1/2-acre	22.1	0.9
Residential 1-Acre	88.9	3.5
Residential 2-Acre	200.9	7.9
Transportation	149.6	5.9
Utility	14.4	0.6
Forest Land	**194.1**	**35.6**
Forested Wetland	0	0
Residential Woods	0	0
Woods	905.2	35.6
Open Land	**193.7**	**35.6**
Open Space	568	22.3
Open Wetland	0	0
Water	5.4	0.2
Agricultural Land	**0**	**0**
Pasture/Hay	0	0
Row Crops	5.5	0.2
Impervious Surface	**Acres**	**% Area**
Impervious Land	530.62	20.9

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Supporting"* and *"Partially Degraded"*
- Sample dominated by amphipods (Gammarus).
- Water quality values within COMAR standards but conductivity elevated.
- Scored high for bank stability but very little woody debris. Good riparian vegetation.

Recommendations:

- Maintain the protection of the riparian areas.
- Because habitat is partially degraded and biological condition is poor, look for problems with water quality and correct, if possible.
- Investigate need and feasibility of adding additional stormwater management in upstream drainage area.

R2-04-02 Sawmill Creek Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	19
EPT Taxa	4
Ephemeroptera Taxa	0
Intolerant Urban %	2.7
Ephemeroptera %	0
Scraper Taxa	2
% Climbers	3.5

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
Amphipoda	3
Calopteryx	2
Chironomidae	2
Curculionidae	1
Elmidae	1
Enchytraeidae	1
Gammarus	76
Ironoquia	1
Lumbricina	1
Lype	1
Nigronia	1
Orthocladius	1
Orthocladius_Cricotopus	1
Parametriocnemus	2
Physa	2
Polycentropus	2
Prodiamesa	2
Pycnopsyche	2
Rheotanytarsus	1
Thienemannimyia	1
Tipula	3
Tubificidae	6
TOTAL:	**113**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	10	Pool Variability	8
Bank Stability- Right Bank	10	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	9
Channel Flow Status	19	Sediment Deposition	16
Channel Sinuosity	7	Vegetative Protection - Left Bank	9
Epifaunal Substrate/Available Cover	13	Vegetative Protection - Right Bank	9
Pool Substrate Characterization	8		
EPA Habitat Score			**148**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	6	32.31	Instream Wood Debris	4	62.22
Shading	60	58.94	Instream Habitat	13	88.34
Epifaunal Substrate	14	96.5	Bank Stability	20	100
PHI Score					**73.05**
PHI Narrative Rating					**Partially Degraded**

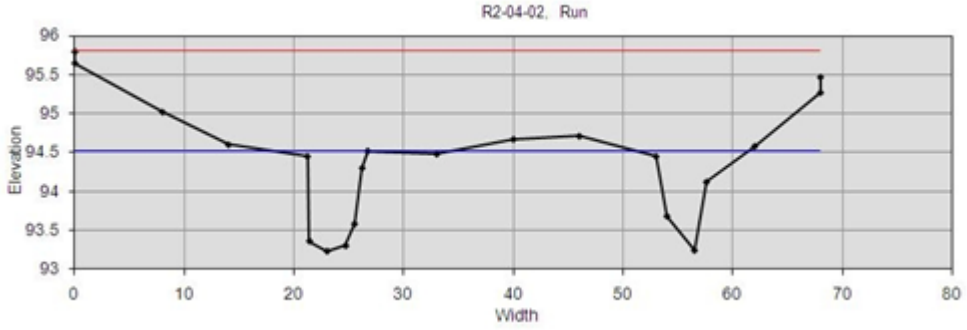
Water Chemistry

Dissolved Oxygen (mg/L)	9.49	pH (SU)	7.96
Turbidity (NTU)	12.7	Specific Conductivity (µS/cm)	436.4
Temperature (°C)	11.5		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.85	Cross Sectional Area (ft^2)	10.7
Bankfull Width (ft)	26.9	Water Surface Slope (%)	0.45
Mean Bankfull Depth (ft)	0.4	Sinuosity	1.1
Floodprone Width (ft)	75	D50 (mm)	0.31
Entrenchment Ratio	2.8	Adjustments?	
Width to Depth Ratio	68	**Rosgen Stream Type**	**DA5**



R2-04-03 Sawmill Creek Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.19145389 **Longitude:** -76.6565764

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**285.9**
Cover	**Acres**	**% Area**
Developed Land	**155.8**	**54.5**
Airport	67.7	23.7
Commercial	16.1	5.6
Industrial	47.6	16.6
Residential 1/8-acre	0	0
Residential 1/4-acre	2.9	1
Residential 1/2-acre	0	0
Residential 1-Acre	4.2	1.5
Residential 2-Acre	0	0
Transportation	17.3	6
Utility	0	0
Forest Land	**22.8**	**8**
Forested Wetland	0	0
Residential Woods	0	0
Woods	22.8	8
Open Land	**107.3**	**37.5**
Open Space	107.3	37.5
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	136.85	47.9

Summary Results:

- Biological condition – *"Very Poor"*
- Habitat scores *"Non Supporting"* and *"Severely Degraded"*
- Worms of the Enchytraeidae family and midges (Orthocladius) dominated the sample.
- Water quality values within COMAR standards but conductivity elevated.
- Very little habitat diversity and no woody debris. Refuse abundant.
- Stream type not determined due to channelization in ditch.

Recommendations:

- Buffer enhancement.
- Consider trash cleanup for this reach.
- Investigate feasibility of restoring this channel to a mor natural state.
- Investigate need and feasibility of enhancing stormwat management in upstream drainage area.

R2-04-03 Sawmill Creek Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	7
EPT Taxa	0
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
Cricotopus	2
Dytiscidae	1
Enchytraeidae	65
Eukiefferiella	2
Lumbricina	3
Orthocladius	45
Simulium	2
TOTAL:	**120**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	9	Pool Variability	4
Bank Stability- Right Bank	9	Riparian Vegetative Zone Width- Left Bank	1
Channel Alteration	5	Riparian Vegetative Zone Width- Right Bank	1
Channel Flow Status	9	Sediment Deposition	6
Channel Sinuosity	1	Vegetative Protection - Left Bank	4
Epifaunal Substrate/Available Cover	2	Vegetative Protection - Right Bank	4
Pool Substrate Characterization	5		
EPA Habitat Score			**60**
EPA Narrative Rating			**Non Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	1	5.39	Instream Wood Debris	0	57.68
Shading	4	0	Instream Habitat	1	28.36
Epifaunal Substrate	2	30.99	Bank Stability	18	94.87
PHI Score					**36.21**
PHI Narrative Rating					**Severely Degraded**

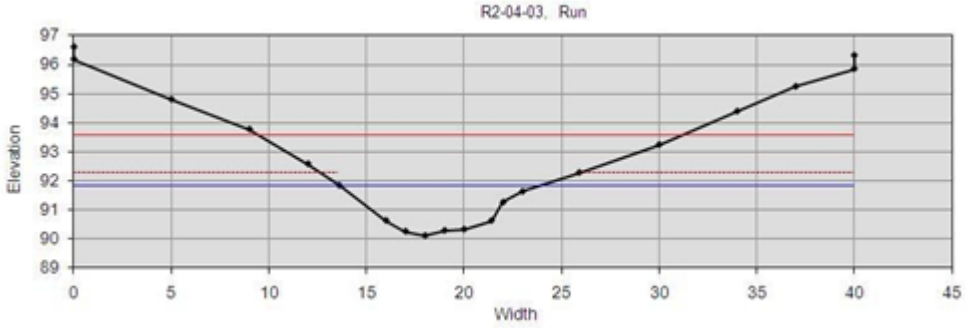
Water Chemistry

Dissolved Oxygen (mg/L)	10.57	pH (SU)	7.7
Turbidity (NTU)	4.37	Specific Conductivity (µS/cm)	475.6
Temperature (°C)	9		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.45	Cross Sectional Area (ft^2)	10.6
Bankfull Width (ft)	10.3	Water Surface Slope (%)	0.27
Mean Bankfull Depth (ft)	1.03	Sinuosity	1
Floodprone Width (ft)	21.6	D50 (mm)	0.082
Entrenchment Ratio	2.1	Adjustments?	
Width to Depth Ratio	10.1	**Rosgen Stream Type**	**ND**



R2-04-04 Sawmill Creek Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.17863008 **Longitude:** -76.62416699

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**612.5**
Cover	**Acres**	**% Area**
Developed Land	**508.1**	**83**
Airport	0	0
Commercial	33.7	5.5
Industrial	7.6	1.2
Residential 1/8-acre	228.3	37.3
Residential 1/4-acre	173.6	28.3
Residential 1/2-acre	0	0
Residential 1-Acre	9.5	1.5
Residential 2-Acre	0	0
Transportation	46.7	7.6
Utility	8.7	1.4
Forest Land	**59**	**9.6**
Forested Wetland	0	0
Residential Woods	0	0
Woods	59	9.6
Open Land	**45.4**	**7.4**
Open Space	44.2	7.2
Open Wetland	0	0
Water	1.2	0.2
Agricultural Land	**0**	**0**
Pasture/Hay	0	0
Row Crops	0	0
Impervious Surface	**Acres**	**% Area**
Impervious Land	234.59	38.3

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Supporting"* and *"Partially Degraded"*
- Sample dominated by the isopod Caecidotea. Scored high for intolerant percent.
- Water quality values within COMAR standards but conductivity elevated.
- Scored high for instream habitat and epibenthic substrate.

Recommendations:

- Protect riparian area.
- Because habitat is partially degraded and biological condition is poor, look for problems with water quality and correct, if possible.

R2-04-04 Sawmill Creek Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	25
EPT Taxa	4
Ephemeroptera Taxa	0
Intolerant Urban %	50
Ephemeroptera %	0
Scraper Taxa	0
% Climbers	7.8

Calculated Metric Scores

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

Taxa	Count
Argia	2
Boyeria	1
Caecidotea	48
Calopteryx	7
Ceratopsyche	2
Cheumatopsyche	1
Conchapelopia	2
Crangonyx	9
Cricotopus	1
Dicrotendipes	1
Enchytraeidae	2
Eukiefferiella	1
Hemerodromia	2
Naididae	1
Paratanytarsus	1
Phaenopsectra	1
Pisidium	1
Prosimulium	2
Psychomyiidae	1
Rheotanytarsus	5
Tanypodinae	1
Tanytarsini	1
Thienemannimyia	1
Tubificidae	3
Tvetenia	3
Wormaldia	1
Zavrelimyia	1
TOTAL:	**102**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	6	Pool Variability	15
Bank Stability- Right Bank	7	Riparian Vegetative Zone Width- Left Bank	9
Channel Alteration	19	Riparian Vegetative Zone Width- Right Bank	7
Channel Flow Status	15	Sediment Deposition	13
Channel Sinuosity	9	Vegetative Protection - Left Bank	7
Epifaunal Substrate/Available Cover	14	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	12		
EPA Habitat Score			**141**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	6	32.31	Instream Wood Debris	5	63.85
Shading	55	54.42	Instream Habitat	14	92.69
Epifaunal Substrate	15	100	Bank Stability	13	80.63
PHI Score					**70.65**
PHI Narrative Rating					**Partially Degraded**

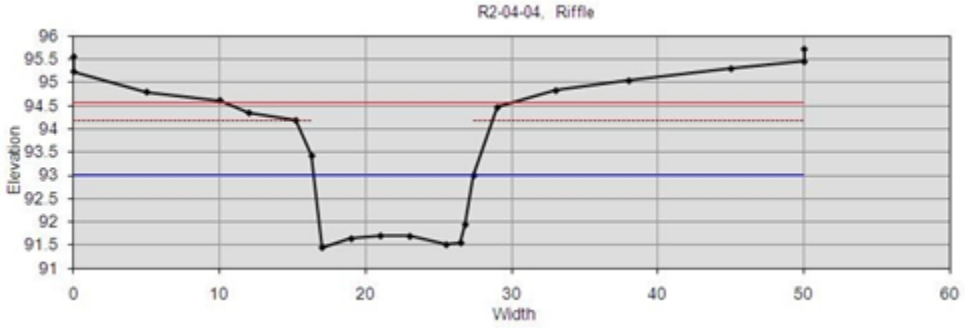
Water Chemistry

Dissolved Oxygen (mg/L)	10.1	pH (SU)	7.81
Turbidity (NTU)	1.94	Specific Conductivity (µS/cm)	456.7
Temperature (°C)	10.3		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.96	Cross Sectional Area (ft^2)	10.9
Bankfull Width (ft)	10.7	Water Surface Slope (%)	0.46
Mean Bankfull Depth (ft)	1	Sinuosity	1.2
Floodprone Width (ft)	19.6	D50 (mm)	11
Entrenchment Ratio	1.2	Adjustments?	
Width to Depth Ratio	10.4	**Rosgen Stream Type**	**F4**



R2-04-05 Sawmill Creek Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.1756877 **Longitude:** -76.6461216

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		586.3
Cover	**Acres**	**% Area**
Developed Land	**354.5**	**60.4**
Airport	310.3	52.9
Commercial	16.4	2.8
Industrial	2.9	0.5
Residential 1/8-acre	5.7	1
Residential 1/4-acre	2.7	0.5
Residential 1/2-acre	0	0
Residential 1-Acre	3.6	0.6
Residential 2-Acre	0	0
Transportation	12.9	2.2
Utility	0	0
Forest Land	**37.5**	**6.4**
Forested Wetland	0	0
Residential Woods	0	0
Woods	37.5	6.4
Open Land	**194.3**	**33.2**
Open Space	192.9	32.9
Open Wetland	0	0
Water	1.4	0.2
Agricultural Land	**0**	**0**
Pasture/Hay	0	0
Row Crops	0	0

Impervious Surface	Acres	% Area
Impervious Land	310.74	53

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Supporting"* and *"Partially Degraded"*
- Snails (Physa) and worms (Tubificidae) dominated the sample.
- Water quality values within COMAR standards but conductivity elevated.
- Good bank stability. Remaining habitat variables scored marginal to sub-optimal. Good riparian vegetation.
- Stream type not determined due to channel type transitions within the reach.

Recommendations:

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

R2-04-05 Sawmill Creek Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	16
EPT Taxa	0
Ephemeroptera Taxa	0
Intolerant Urban %	0
Ephemeroptera %	0
Scraper Taxa	3
% Climbers	48

Calculated Metric Scores

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

Taxa	Count
Argia	1
Cricotopus	1
Dicrotendipes	4
Dubiraphia	1
Enchytraeidae	1
Erpobdella	2
Hydroporus	1
Lumbricina	2
Lumbriculidae	5
Nemata	1
Physa	48
Pisidium	1
Planorbidae	1
Prostoma	1
Thienemannimyia	4
Tubificidae	28
TOTAL:	**102**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	8	Pool Variability	14
Bank Stability- Right Bank	8	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	10	Riparian Vegetative Zone Width- Right Bank	9
Channel Flow Status	18	Sediment Deposition	12
Channel Sinuosity	16	Vegetative Protection - Left Bank	7
Epifaunal Substrate/Available Cover	13	Vegetative Protection - Right Bank	7
Pool Substrate Characterization	10		
EPA Habitat Score			**142**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	7	37.7	Instream Wood Debris	10	79.14
Shading	85	84.56	Instream Habitat	13	87.59
Epifaunal Substrate	10	72.78	Bank Stability	16	89.45
PHI Score					**75.2**
PHI Narrative Rating					**Partially Degraded**

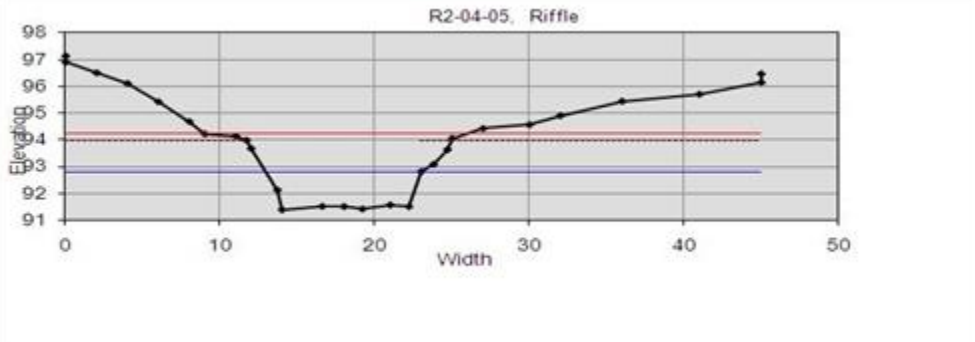
Water Chemistry

Dissolved Oxygen (mg/L)	8.03	pH (SU)	7.22
Turbidity (NTU)	9.35	Specific Conductivity (µS/cm)	610.6
Temperature (°C)	12.9		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.92	Cross Sectional Area (ft^2)	12
Bankfull Width (ft)	10.1	Water Surface Slope (%)	0.85
Mean Bankfull Depth (ft)	1.2	Sinuosity	1.4
Floodprone Width (ft)	17.1	D50 (mm)	8.5
Entrenchment Ratio	1.7	Adjustments?	
Width to Depth Ratio	8.4	**Rosgen Stream Type**	**ND**



R2-04-06 Sawmill Creek Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.17016952 **Longitude:** -76.63690413

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		238.7
Cover	**Acres**	**% Area**
Developed Land	**62.4**	**26.2**
Airport	0	0
Commercial	0	0
Industrial	5	36.4
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	1.9	13.8
Utility	0	0
Forest Land	**55.4**	**23.2**
Forested Wetland	0	0
Residential Woods	0	0
Woods	4.4	31.9
Open Land	**120.9**	**50.6**
Open Space	2.4	17.8
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	7.47	54.9

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Supporting"* and *"Partially Degraded"*
- Sampled dominated by worms (Tubificidae and Lumbriculidae) and clams (Pisidiidae).
- Water quality values within COMAR standards but conductivity elevated.
- Bank stability scored high; however, poor habitat diversity. Refuse abundant.

Recommendations:

- Protect riparian area.
- Because habitat is partially degraded and biological condition is poor, look for problems with water quality and correct, if possible.

R2-04-06 Sawmill Creek Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	14
EPT Taxa	1
Ephemeroptera Taxa	0
Intolerant Urban %	5.6
Ephemeroptera %	0
Scraper Taxa	3
% Climbers	19.4

Calculated Metric Scores

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

Taxa	Count
Agabus	2
Caecidotea	5
Curculionidae	3
Fossaria	1
Ironoquia	2
Lumbriculidae	27
Menetus	10
Micropsectra	1
Orthocladiinae	1
Physa	8
Pisidiidae	16
Pisidium	6
Rheocricotopus	3
Sphaerium	2
Tanytarsus	1
Tubificidae	20
TOTAL:	**108**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	9	Pool Variability	9
Bank Stability- Right Bank	9	Riparian Vegetative Zone Width- Left Bank	8
Channel Alteration	13	Riparian Vegetative Zone Width- Right Bank	9
Channel Flow Status	16	Sediment Deposition	12
Channel Sinuosity	12	Vegetative Protection - Left Bank	7
Epifaunal Substrate/Available Cover	5	Vegetative Protection - Right Bank	7
Pool Substrate Characterization	11		
EPA Habitat Score			**127**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	11	59.24	Instream Wood Debris	11	92.27
Shading	70	68.32	Instream Habitat	5	52.4
Epifaunal Substrate	5	49.59	Bank Stability	18	94.87
PHI Score					**69.45**
PHI Narrative Rating					**Partially Degraded**

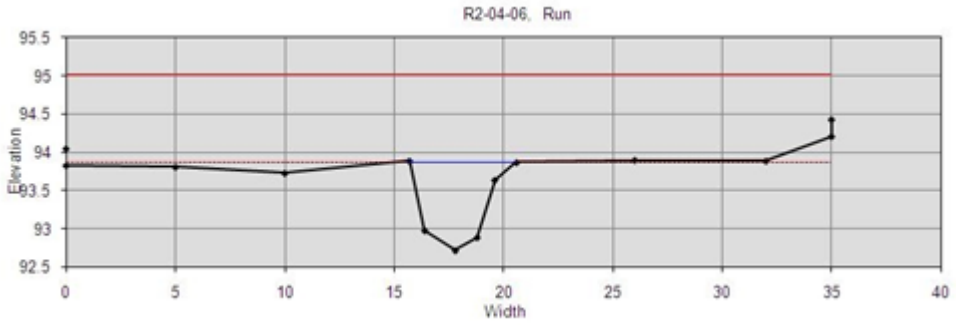
Water Chemistry

Dissolved Oxygen (mg/L)	9.73	pH (SU)	7.32
Turbidity (NTU)	3.14	Specific Conductivity (µS/cm)	695.1
Temperature (°C)	11.6		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.37	Cross Sectional Area (ft^2)	3.4
Bankfull Width (ft)	4.9	Water Surface Slope (%)	0.81
Mean Bankfull Depth (ft)	0.7	Sinuosity	1.4
Floodprone Width (ft)	85	D50 (mm)	0.062
Entrenchment Ratio	17.4	Adjustments?	
Width to Depth Ratio	7	**Rosgen Stream Type**	**E6**



R2-04-08 Sawmill Creek Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.17119672 **Longitude:** -76.63332004

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		277.9
Cover	**Acres**	**% Area**
Developed Land	**89.8**	**32.3**
Airport	0	0
Commercial	3.1	5.9
Industrial	28.3	53.6
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	2.8	5.3
Utility	0	0
Forest Land	**62.9**	**22.6**
Forested Wetland	0	0
Residential Woods	0	0
Woods	11.8	22.3
Open Land	**125.3**	**45.1**
Open Space	6.9	13
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	31.5	59.6

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Supporting"* and *"Partially Degraded"*
- Worms (Tubificidae and Lumbriculidae) and snails (Physa) dominated the sample.
- Water quality values within COMAR standards but conductivity elevated.
- Little woody debris with sub-optimal habitat diversity.

Recommendations:

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

R2-04-08 Sawmill Creek Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	26
EPT Taxa	1
Ephemeroptera Taxa	0
Intolerant Urban %	0
Ephemeroptera %	0
Scraper Taxa	4
% Climbers	34.5

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
Chironomidae	1
Cricotopus	3
Diplocladius	1
Dytiscidae	1
Enchytraeidae	1
Eukiefferiella	1
Fossaria	1
Gyraulus	4
Hydrobaenus	3
Hydroporus	1
Hydrovatus	1
Ironoquia	3
Libellulidae	3
Lumbricina	10
Musculium	2
Odontomyia	2
Orthocladiinae	2
Parametriocnemus	2
Paraphaenocladius	2
Peltodytes	1
Physa	30
Pisidium	4
Polypedilum	1
Rheocricotopus	7
Rheotanytarsus	1
Tanytarsus	1
Thienemannimyia	3
Tubificidae	10
Tvetenia	8
TOTAL:	**110**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	9	Pool Variability	11
Bank Stability- Right Bank	9	Riparian Vegetative Zone Width- Left Bank	4
Channel Alteration	19	Riparian Vegetative Zone Width- Right Bank	9
Channel Flow Status	17	Sediment Deposition	13
Channel Sinuosity	9	Vegetative Protection - Left Bank	9
Epifaunal Substrate/Available Cover	13	Vegetative Protection - Right Bank	9
Pool Substrate Characterization	10		
EPA Habitat Score			**141**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	6	32.31	Instream Wood Debris	1	60.96
Shading	80	78.67	Instream Habitat	12	89.68
Epifaunal Substrate	13	95.07	Bank Stability	18	94.87
PHI Score					**75.26**
PHI Narrative Rating					**Partially Degraded**

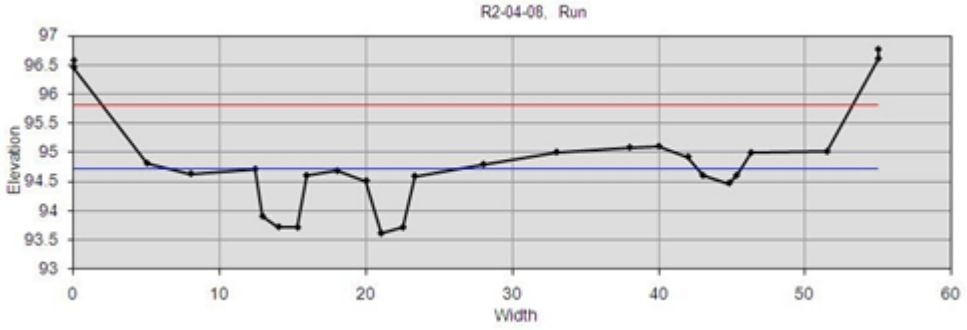
Water Chemistry

Dissolved Oxygen (mg/L)	9.16	pH (SU)	7.97
Turbidity (NTU)	10.7	Specific Conductivity (µS/cm)	1126.1
Temperature (°C)	9.7		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.43	Cross Sectional Area (ft^2)	6.7
Bankfull Width (ft)	22.4	Water Surface Slope (%)	3.5
Mean Bankfull Depth (ft)	0.3	Sinuosity	1.1
Floodprone Width (ft)	51.3	D50 (mm)	0.39
Entrenchment Ratio	2.3	Adjustments?	
Width to Depth Ratio	74.7	**Rosgen Stream Type**	**DA5**



R2-04-10 Sawmill Creek Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.17384104 **Longitude:** -76.62306885

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**4193.9**
Cover	**Acres**	**% Area**
Developed Land	**2087.1**	**49.8**
Airport	427.9	10.2
Commercial	176.8	4.2
Industrial	282.5	6.7
Residential 1/8-acre	525.6	12.5
Residential 1/4-acre	105.2	2.5
Residential 1/2-acre	22.1	0.5
Residential 1-Acre	111.1	2.7
Residential 2-Acre	200.9	4.8
Transportation	213.8	5.1
Utility	21.2	0.5
Forest Land	**1143.1**	**27.3**
Forested Wetland	0	0
Residential Woods	39.1	0.9
Woods	1104	26.3
Open Land	**958.3**	**22.8**
Open Space	951.4	22.7
Open Wetland	0	0
Water	6.9	0.2
Agricultural Land	**5.5**	**0.1**
Pasture/Hay	0	0
Row Crops	5.5	0.1

Impervious Surface	**Acres**	**% Area**
Impervious Land	1278.38	30.5

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Supporting"* and *"Degraded"*
- Sample dominated by amphipods (Gammarus).
- Water quality values within COMAR standards but conductivity elevated.
- Little woody debris with marginal to sub-optimal habitat diversity. Refuse abundant.

Recommendations:

- Maintain the protection of the riparian areas.
- Consider trash cleanup for this reach.
- Given high levels of developed land, investigate opportunities for additional stormwater management i upstream drainage area.

R2-04-10 Sawmill Creek Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	23
EPT Taxa	3
Ephemeroptera Taxa	0
Intolerant Urban %	0.8
Ephemeroptera %	0
Scraper Taxa	2
% Climbers	6.8

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
Ancyronyx	2
Antocha	1
Argia	1
Calopteryx	3
Ceratopogonidae	1
Ceratopsyche	2
Chelifera	1
Cheumatopsyche	1
Chironomidae	1
Cricotopus	12
Eukiefferiella	1
Gammarus	70
Hydropsyche	1
Macronychus	1
Micropsectra	1
Naididae	3
Nanocladius	1
Parachaetocladius	1
Rheotanytarsus	3
Tanytarsus	4
Thienemannimyia	1
Tipula	1
Tubificidae	2
Tvetenia	3
TOTAL:	**118**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	10	Pool Variability	8
Bank Stability- Right Bank	10	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	4
Channel Flow Status	20	Sediment Deposition	13
Channel Sinuosity	12	Vegetative Protection - Left Bank	9
Epifaunal Substrate/Available Cover	10	Vegetative Protection - Right Bank	9
Pool Substrate Characterization	9		
EPA Habitat Score			**144**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	6	32.31	Instream Wood Debris	3	36.15
Shading	35	36.34	Instream Habitat	10	50.8
Epifaunal Substrate	11	65.77	Bank Stability	20	100
PHI Score					**53.56**
PHI Narrative Rating					**Degraded**

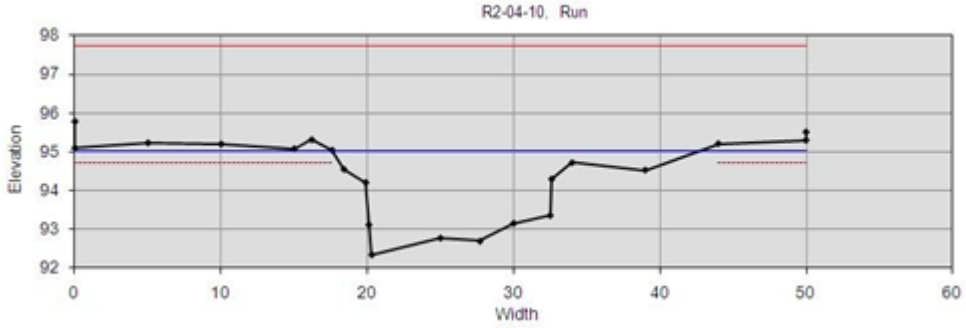
Water Chemistry

Dissolved Oxygen (mg/L)	10.01	pH (SU)	6.71
Turbidity (NTU)	4.72	Specific Conductivity (µS/cm)	447.4
Temperature (°C)	10.7		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	6.55	Cross Sectional Area (ft^2)	33
Bankfull Width (ft)	25.2	Water Surface Slope (%)	0.089
Mean Bankfull Depth (ft)	1.31	Sinuosity	1.2
Floodprone Width (ft)	450	D50 (mm)	0.062
Entrenchment Ratio	17.9	Adjustments?	
Width to Depth Ratio	19.2	**Rosgen Stream Type**	**E6**



R2-04-12A Sawmill Creek Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.14252364 **Longitude:** -76.67573376

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**156.7**
Cover	**Acres**	**% Area**
Developed Land	**50.2**	**32.1**
Airport	0	0
Commercial	17.6	11.2
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	1.4	0.9
Residential 2-Acre	29.8	19
Transportation	1.4	0.9
Utility	0	0
Forest Land	**71.9**	**45.9**
Forested Wetland	0	0
Residential Woods	0	0
Woods	71.9	45.9
Open Land	**29.1**	**18.6**
Open Space	29.1	18.6
Open Wetland	0	0
Water	0	0
Agricultural Land	**5.5**	**3.5**
Pasture/Hay	0	0
Row Crops	5.5	3.5
Impervious Surface	**Acres**	**% Area**
Impervious Land	17.82	11.4

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Comparable to Reference"* and *"Minimally Degraded"*
- Midges (Rheocricotopus) and Trichoptera (Limnephilidae, Ironoquia) dominated the sample.
- Water quality values within COMAR standards.
- Woody debris and habitat diversity scored high. Good riparian vegetation.

Recommendations:

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

R2-04-12A Sawmill Creek Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	23
EPT Taxa	3
Ephemeroptera Taxa	0
Intolerant Urban %	9.1
Ephemeroptera %	0
Scraper Taxa	0
% Climbers	17.3

Calculated Metric Scores

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

Taxa	Count
Agabus	1
Caecidotea	2
Chrysops	2
Crangonyx	6
Curculionidae	2
Georthocladius	1
Heterotrissocladius	1
Hyalella	1
Hydroporus	1
Ironoquia	8
Lepidoptera	1
Libellulidae	2
Limnephilidae	17
Lumbricina	2
Micropsectra	1
Molophilus	1
Nemouridae	2
Orthocladius	3
Pisidiidae	1
Ptilostomis	1
Rheocricotopus	42
Smittia	1
Stegopterna	2
Tanypodinae	2
Tubificidae	5
Zavrelimyia	2
TOTAL:	**110**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	9	Pool Variability	12
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	15	Sediment Deposition	14
Channel Sinuosity	13	Vegetative Protection - Left Bank	10
Epifaunal Substrate/Available Cover	13	Vegetative Protection - Right Bank	10
Pool Substrate Characterization	12		
EPA Habitat Score			**157**
EPA Narrative Rating			**Comparable to Reference**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	15	80.78	Instream Wood Debris	10	94.07
Shading	95	99.94	Instream Habitat	13	100
Epifaunal Substrate	14	100	Bank Stability	18	94.87
PHI Score					**94.94**
PHI Narrative Rating					**Minimally Degraded**

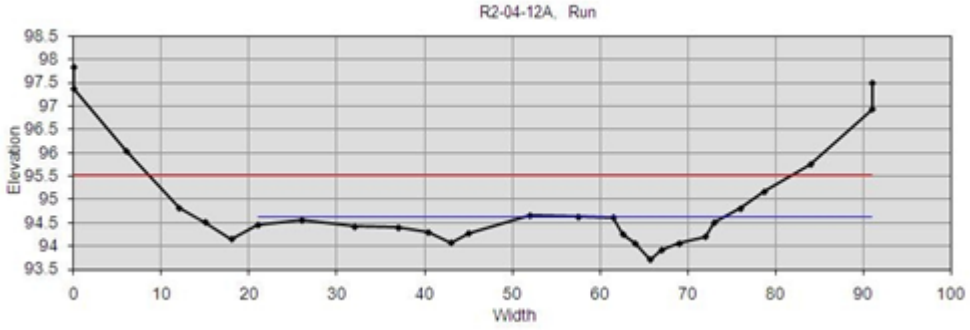
Water Chemistry

Dissolved Oxygen (mg/L)	9.44	pH (SU)	7.26
Turbidity (NTU)	5.01	Specific Conductivity (µS/cm)	183.1
Temperature (°C)	10.1		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.24	Cross Sectional Area (ft^2)	4
Bankfull Width (ft)	13	Water Surface Slope (%)	0.86
Mean Bankfull Depth (ft)	0.31	Sinuosity	1.1
Floodprone Width (ft)	73.3	D50 (mm)	0.074
Entrenchment Ratio	5.6	Adjustments?	
Width to Depth Ratio	42.6	**Rosgen Stream Type**	**DA5/6**



R2-04-16A Sawmill Creek Sampling Unit

Upstream View:

Downstream View:

Latitude: 39.17509665 **Longitude:** -76.63654472

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		231.1
Cover	**Acres**	**% Area**
Developed Land	**199**	**86.1**
Airport	0	0
Commercial	0.4	0.2
Industrial	59.4	25.7
Residential 1/8-acre	77.7	33.6
Residential 1/4-acre	38.7	16.7
Residential 1/2-acre	0	0
Residential 1-Acre	18.6	8.1
Residential 2-Acre	0	0
Transportation	4.2	1.8
Utility	0	0
Forest Land	**13.3**	**5.8**
Forested Wetland	0	0
Residential Woods	0	0
Woods	13.3	5.8
Open Land	**18.8**	**8.2**
Open Space	18.8	8.2
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	109.54	47.4

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Non Supporting"* and *"Degraded"*
- Worms (Lumbricina, Lumbriculidae, Tubificidae), midges (Orthocladius), and amphipods (Gammarus) dominated the sample.
- Water quality values within COMAR standards but conductivity elevated.
- Poor habitat diversity and little woody debris. Refuse abundant.
- Stream type not determined due to effects from box culvert in upper half of reach.

Recommendations:

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

R2-04-16A Sawmill Creek Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	20
EPT Taxa	0
Ephemeroptera Taxa	0
Intolerant Urban %	0.9
Ephemeroptera %	0
Scraper Taxa	4
% Climbers	2.8

Calculated Metric Scores

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

Taxa	Count
Agabus	1
Amphipoda	2
Collembola	1
Cricotopus	1
Dicranota	1
Enchytraeidae	1
Eukiefferiella	2
Fossaria	1
Gammarus	15
Gastropoda	1
Hydrobaenus	3
Lumbricina	11
Lumbriculidae	30
Microvelia	1
Orthocladius	20
Physa	1
Prostoma	2
Staphylinidae	1
Stygobromus	1
Tipula	1
Tubificidae	10
Tubificina	1
TOTAL:	**108**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	4	Pool Variability	6
Bank Stability- Right Bank	4	Riparian Vegetative Zone Width- Left Bank	3
Channel Alteration	4	Riparian Vegetative Zone Width- Right Bank	3
Channel Flow Status	6	Sediment Deposition	7
Channel Sinuosity	6	Vegetative Protection - Left Bank	4
Epifaunal Substrate/Available Cover	4	Vegetative Protection - Right Bank	4
Pool Substrate Characterization	7		
EPA Habitat Score			**62**
EPA Narrative Rating			**Non Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	1	5.39	Instream Wood Debris	2	66.01
Shading	90	91.34	Instream Habitat	4	47.18
Epifaunal Substrate	5	49.8	Bank Stability	8	63.25
PHI Score					**53.83**
PHI Narrative Rating					**Degraded**

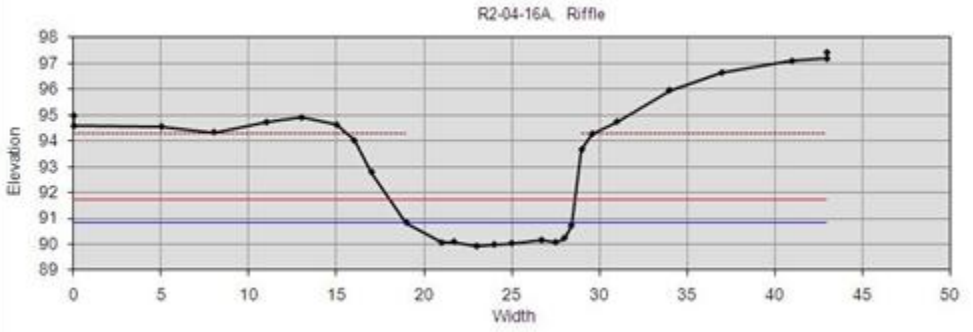
Water Chemistry

Dissolved Oxygen (mg/L)	8.14	pH (SU)	7.12
Turbidity (NTU)	2.16	Specific Conductivity (µS/cm)	439.7
Temperature (°C)	10.9		

Geomorphic Assessment

Rosgen Level II Classification Data

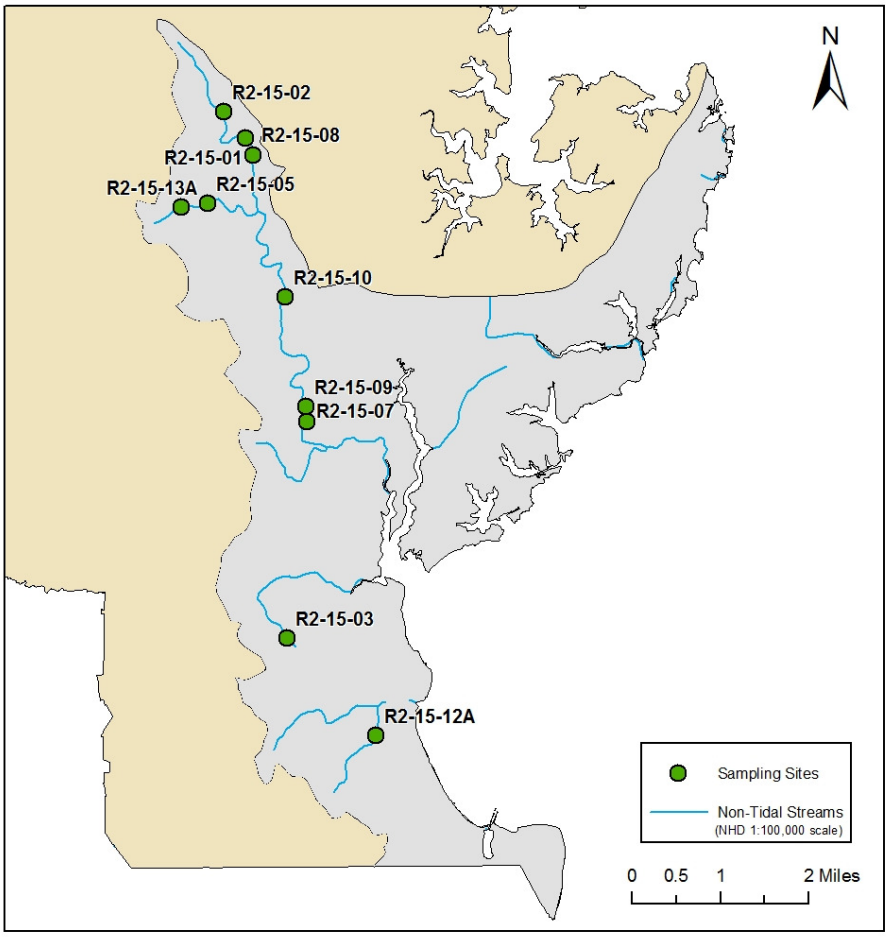
Drainage Area (mi^2)	0.36	Cross Sectional Area (ft^2)	6.4
Bankfull Width (ft)	9.4	Water Surface Slope (%)	1.5
Mean Bankfull Depth (ft)	0.68	Sinuosity	1.1
Floodprone Width (ft)	10.5	D50 (mm)	13
Entrenchment Ratio	1.1	Adjustments?	
Width to Depth Ratio	13.9	**Rosgen Stream Type**	**ND**



Herring Bay 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
R2-15-01	525.8	0.82	6.2	34.2	43.1	12.2	10.5	Fair	Degraded	Non Supporting	G
R2-15-02	353.6	0.55	7.6	37.0	35.3	17.8	9.9	Fair	Degraded	Partially Supporting	G
R2-15-03	66	0.10	3.9	25.5	63.0	9.2	2.4	Poor	Partially Degraded	Partially Supporting	E
R2-15-05	273.8	0.43	5.9	26.5	58.0	11.9	3.6	Poor	Degraded	Partially Supporting	F
R2-15-07	2986	4.67	3.4	23.0	61.2	9.9	5.9	Fair	Degraded	Partially Supporting	G
R2-15-08	596.4	0.93	5.8	33.8	45.0	11.9	9.3	Fair	Degraded	Partially Supporting	F
R2-15-09	2966.2	4.63	3.5	23.1	61.1	10.0	5.9	Good	Partially Degraded	Partially Supporting	F
R2-15-10	2119.4	3.31	3.7	23.7	61.0	10.2	5.0	Good	Partially Degraded	Partially Supporting	C
R2-15-12A	465.4	0.73	1.6	13.5	85.3	0.5	0.8	Poor	Partially Degraded	Supporting	C
R2-15-13A	111.2	0.17	9.3	27.0	59.4	7.3	6.3	Very Poor	Partially Degraded	Partially Supporting	E



R2-15-01 Herring Bay Sampling Unit

Upstream View:

Downstream View:

Latitude: 38.84114268 **Longitude:** -76.59258515

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		525.8
Cover	**Acres**	**% Area**
Developed Land	**179.8**	**34.2**
Airport	0	0
Commercial	1.1	0.2
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	6.1	1.2
Residential 1-Acre	12.9	2.5
Residential 2-Acre	130.5	24.8
Transportation	16.3	3.1
Utility	12.9	2.4
Forest Land	**226.7**	**43.1**
Forested Wetland	0	0
Residential Woods	0	0
Woods	226.7	43.1
Open Land	**55.1**	**10.5**
Open Space	51.5	9.8
Open Wetland	0	0
Water	3.6	0.7
Agricultural Land	**64.2**	**12.2**
Pasture/Hay	18.7	3.6
Row Crops	45.5	8.7
Impervious Surface	**Acres**	**% Area**
Impervious Land	32.38	6.2

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Non Supporting"* and *"Degraded"*
- Sample dominated by midges (Cricotopus, Orthocladius, Parametriocnemus, and Paratanytarsus).
- Water quality values within COMAR standards.
- Very poor habitat diversity and very little woody debris. Good riparian vegetation.

Recommendations:

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

R2-15-01 Herring Bay Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	22
EPT Taxa	5
Ephemeroptera Taxa	2
Intolerant Urban %	7.4
Ephemeroptera %	5.6
Scraper Taxa	2
% Climbers	1.9

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
Agabus	1
Amphinemura	1
Baetis	5
Caecidotea	3
Crangonyx	2
Cricotopus	22
Gammarus	1
Hemerodromia	1
Ironoquia	2
Lymnaeidae	1
Microtendipes	6
Orthocladius	15
Parametriocnemus	15
Paratanytarsus	13
Perlesta	3
Physa	1
Pisidium	1
Procloeon	1
Prostoma	3
Renocera	1
Simulium	9
Turbellaria	1
TOTAL:	**108**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	3	Pool Variability	5
Bank Stability- Right Bank	3	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	16	Sediment Deposition	10
Channel Sinuosity	9	Vegetative Protection - Left Bank	4
Epifaunal Substrate/Available Cover	2	Vegetative Protection - Right Bank	4
Pool Substrate Characterization	2		
EPA Habitat Score			**98**
EPA Narrative Rating			**Non Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	15	80.78	Instream Wood Debris	1	53.74
Shading	90	91.34	Instream Habitat	3	33.22
Epifaunal Substrate	2	27.02	Bank Stability	6	54.77
PHI Score					**56.81**
PHI Narrative Rating					**Degraded**

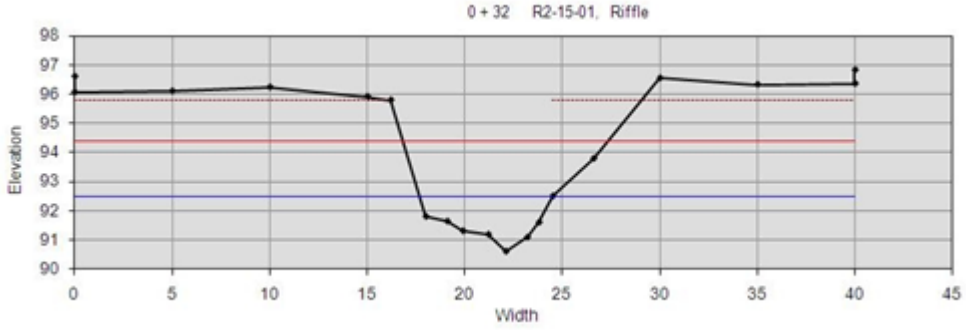
Water Chemistry

Dissolved Oxygen (mg/L)	9.58	pH (SU)	7.13
Turbidity (NTU)	26	Specific Conductivity (µS/cm)	167.1
Temperature (°C)	14.5		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.82	Cross Sectional Area (ft^2)	7.7
Bankfull Width (ft)	6.8	Water Surface Slope (%)	0.68
Mean Bankfull Depth (ft)	1.13	Sinuosity	1.1
Floodprone Width (ft)	10.5	D50 (mm)	0.062
Entrenchment Ratio	1.5	Adjustments?	Yes, ER - 0.1
Width to Depth Ratio	6.1	**Rosgen Stream Type**	**G6c**



R2-15-02 Herring Bay Sampling Unit

Upstream View:

Downstream View:

Latitude: 38.84538873 **Longitude:** -76.59707077

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**353.6**
Cover	**Acres**	**% Area**
Developed Land	**130.8**	**37**
Airport	0	0
Commercial	1.1	0.3
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	6.1	1.7
Residential 1-Acre	7.5	2.1
Residential 2-Acre	100.4	28.4
Transportation	15.7	4.4
Utility	0	0
Forest Land	**124.8**	**35.3**
Forested Wetland	0	0
Residential Woods	0	0
Woods	124.8	35.3
Open Land	**34.9**	**9.9**
Open Space	31.3	8.9
Open Wetland	0	0
Water	3.6	1
Agricultural Land	**63**	**17.8**
Pasture/Hay	17.5	4.9
Row Crops	45.5	12.9
Impervious Surface	**Acres**	**% Area**
Impervious Land	26.99	7.6

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Partially Supporting"* and *"Degraded"*
- Amphipods (Crangonyx) and isopods (Caecidotea) dominated the sample.
- Water quality values within COMAR standards.
- Most habitat variable scores are poor to marginal. Good riparian vegetation.

Recommendations:

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

R2-15-02 Herring Bay Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	27
EPT Taxa	3
Ephemeroptera Taxa	0
Intolerant Urban %	21.1
Ephemeroptera %	0
Scraper Taxa	1
% Climbers	9.2

Calculated Metric Scores

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

Taxa	Count
Amphinemura	3
Caecidotea	16
Ceratopogonidae	1
Conchapelopia	1
Corduliidae	1
Corynoneura	1
Crangonyx	33
Dicrotendipes	1
Diplocladius	3
Hydroporini	1
Ironoquia	3
Lumbricina	1
Lype	1
Naididae	1
Nigronia	1
Ormosia	1
Orthocladius	2
Parametriocnemus	5
Pisidium	8
Polypedilum	10
Procladius	1
Pseudolimnophila	1
Simuliidae	1
Thienemannimyia	2
Tipula	1
Tubificidae	8
Zavrelimyia	1
TOTAL:	**109**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	5	Pool Variability	4
Bank Stability- Right Bank	5	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	9
Channel Flow Status	17	Sediment Deposition	10
Channel Sinuosity	9	Vegetative Protection - Left Bank	4
Epifaunal Substrate/Available Cover	4	Vegetative Protection - Right Bank	4
Pool Substrate Characterization	4		
EPA Habitat Score			**105**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	6	32.31	Instream Wood Debris	6	73.03
Shading	90	91.34	Instream Habitat	4	42.83
Epifaunal Substrate	4	41.22	Bank Stability	10	70.71
PHI Score					**58.57**
PHI Narrative Rating					**Degraded**

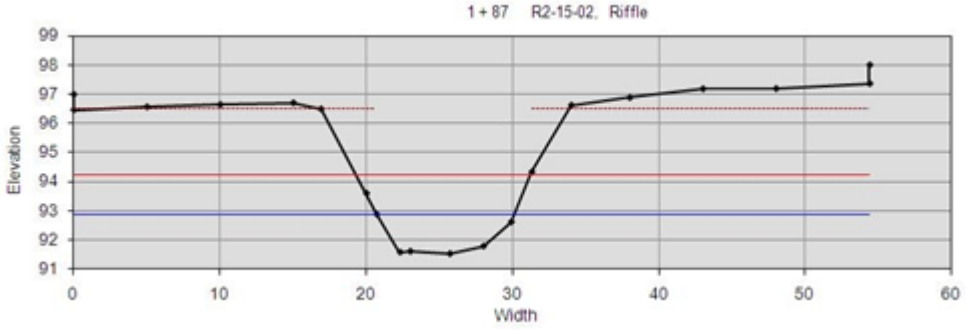
Water Chemistry

Dissolved Oxygen (mg/L)	9.97	pH (SU)	7.09
Turbidity (NTU)	17.1	Specific Conductivity (µS/cm)	190.9
Temperature (°C)	14.4		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.55	Cross Sectional Area (ft^2)	9.6
Bankfull Width (ft)	9.4	Water Surface Slope (%)	0.097
Mean Bankfull Depth (ft)	1.02	Sinuosity	1.1
Floodprone Width (ft)	11.9	D50 (mm)	0.067
Entrenchment Ratio	1.3	Adjustments?	
Width to Depth Ratio	9.2	**Rosgen Stream Type**	**G5c**



R2-15-03 Herring Bay Sampling Unit

Upstream View:

Downstream View:

Latitude: 38.75889382 **Longitude:** -76.58435734

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**66**
Cover	**Acres**	**% Area**
Developed Land	**16.9**	**25.5**
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	11.9	18
Transportation	2.5	3.8
Utility	2.5	3.7
Forest Land	**41.6**	**63**
Forested Wetland	0	0
Residential Woods	0	0
Woods	41.6	63
Open Land	**1.6**	**2.4**
Open Space	1.6	2.4
Open Wetland	0	0
Water	0	0
Agricultural Land	**6**	**9.2**
Pasture/Hay	3.6	5.5
Row Crops	2.4	3.7
Impervious Surface	**Acres**	**% Area**
Impervious Land	2.55	3.9

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Amphipods (Crangonyx) and isopods (Caecidotea) dominated the sample.
- Water quality values within COMAR standards.
- Bank stability scored high. Most remaining habitat variable scores are marginal. Good riparian vegetation.

Recommendations:

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

R2-15-03 Herring Bay Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	21
EPT Taxa	2
Ephemeroptera Taxa	0
Intolerant Urban %	31.6
Ephemeroptera %	0
Scraper Taxa	0
% Climbers	1.7

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	17
Amphipoda	9
Caecidotea	19
Ceratopogonidae	3
Chironomini	1
Conchapelopia	1
Corynoneura	1
Crangonyx	23
Diplocladius	6
Eukiefferiella	1
Hydroporini	2
Ironoquia	1
Odontomesa	4
Orthocladiinae	4
Parametriocnemus	6
Polypedilum	1
Pseudolimnophila	1
Rheocricotopus	4
Serromyia	1
Tanytarsus	1
Thienemannimyia	2
Tipula	1
Tubificidae	2
Tvetenia	1
Zavrelimyia	5
TOTAL:	**117**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	8	Pool Variability	6
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	15	Sediment Deposition	14
Channel Sinuosity	8	Vegetative Protection - Left Bank	6
Epifaunal Substrate/Available Cover	7	Vegetative Protection - Right Bank	6
Pool Substrate Characterization	7		
EPA Habitat Score			**125**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	8	43.08	Instream Wood Debris	4	86.11
Shading	95	99.94	Instream Habitat	6	71.1
Epifaunal Substrate	7	69.58	Bank Stability	16	89.45
PHI Score					**76.54**
PHI Narrative Rating					**Partially Degraded**

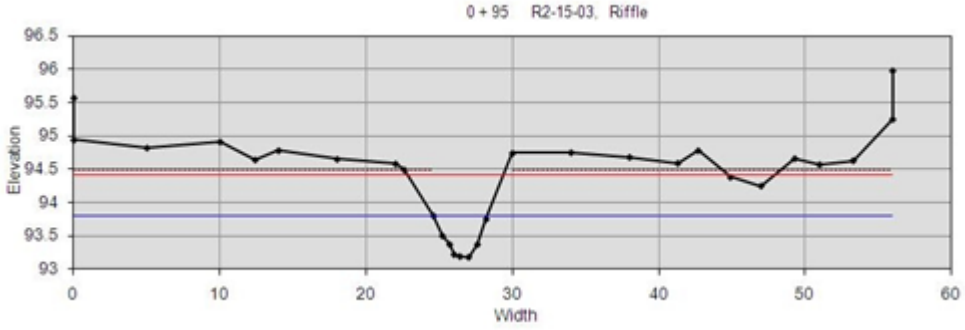
Water Chemistry

Dissolved Oxygen (mg/L)	9.87	pH (SU)	7.47
Turbidity (NTU)	23.5	Specific Conductivity (µS/cm)	226
Temperature (°C)	11.1		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.1	Cross Sectional Area (ft^2)	1.5
Bankfull Width (ft)	3.7	Water Surface Slope (%)	0.92
Mean Bankfull Depth (ft)	0.4	Sinuosity	1.1
Floodprone Width (ft)	9.9	D50 (mm)	0.062
Entrenchment Ratio	2.7	Adjustments?	
Width to Depth Ratio	9.1	**Rosgen Stream Type**	**E6**



R2-15-05 Herring Bay Sampling Unit

Upstream View:

Downstream View:

Latitude: 38.83028322 **Longitude:** -76.60063158

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**273.8**
Cover	**Acres**	**% Area**
Developed Land	**72.5**	**26.5**
Airport	0	0
Commercial	11.5	4.2
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	57.4	21
Transportation	3.6	1.3
Utility	0	0
Forest Land	**158.9**	**58**
Forested Wetland	0	0
Residential Woods	0	0
Woods	158.9	58
Open Land	**9.9**	**3.6**
Open Space	9.9	3.6
Open Wetland	0	0
Water	0	0
Agricultural Land	**32.5**	**11.9**
Pasture/Hay	1.3	0.5
Row Crops	31.2	11.4
Impervious Surface	**Acres**	**% Area**
Impervious Land	16.19	5.9

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Partially Supporting"* and *"Degraded"*
- Sample dominated by amphipods (Crangonyx and Gammarus) and isopods (Caecidotea).
- Water quality values within COMAR standards.
- Sub-optimal bank stability. Remaining habitat variable scores are poor to marginal.

Recommendations:

- Protect riparian area.

R2-15-05 Herring Bay Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	10
EPT Taxa	2
Ephemeroptera Taxa	0
Intolerant Urban %	32.7
Ephemeroptera %	0
Scraper Taxa	0
% Climbers	5.5

Calculated Metric Scores

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

Taxa	Count
Amphinemura	16
Amphipoda	6
Caecidotea	20
Calopteryx	1
Crangonyx	42
Gammarus	15
Ironoquia	2
Parametriocnemus	1
Pisidium	1
Polypedilum	5
Tubificidae	1
TOTAL:	**110**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	7	Pool Variability	4
Bank Stability- Right Bank	7	Riparian Vegetative Zone Width- Left Bank	7
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	14	Sediment Deposition	4
Channel Sinuosity	5	Vegetative Protection - Left Bank	7
Epifaunal Substrate/Available Cover	6	Vegetative Protection - Right Bank	7
Pool Substrate Characterization	3		
EPA Habitat Score			**101**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	7	37.7	Instream Wood Debris	4	70.01
Shading	90	91.34	Instream Habitat	5	50.99
Epifaunal Substrate	6	54.51	Bank Stability	14	83.67
PHI Score					**64.7**
PHI Narrative Rating					**Degraded**

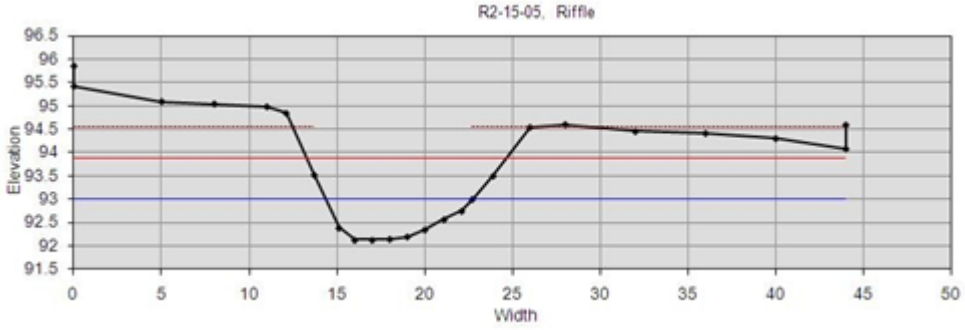
Water Chemistry

Dissolved Oxygen (mg/L)	9.69	pH (SU)	7.12
Turbidity (NTU)	33.3	Specific Conductivity (µS/cm)	189
Temperature (°C)	14.4		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.43	Cross Sectional Area (ft^2)	5.2
Bankfull Width (ft)	8.4	Water Surface Slope (%)	0.26
Mean Bankfull Depth (ft)	0.62	Sinuosity	1
Floodprone Width (ft)	11.4	D50 (mm)	0.062
Entrenchment Ratio	1.4	Adjustments?	
Width to Depth Ratio	13.5	**Rosgen Stream Type**	**F6**



R2-15-07 Herring Bay Sampling Unit

Upstream View:

Downstream View:

Latitude: 38.79445742 **Longitude:** -76.57991653

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**2986**
Cover	**Acres**	**% Area**
Developed Land	**687.9**	**23**
Airport	0	0
Commercial	16.9	0.6
Industrial	8.7	0.3
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	17.2	0.6
Residential 1-Acre	49.3	1.7
Residential 2-Acre	404.8	13.6
Transportation	42	1.4
Utility	149	5
Forest Land	**1826.9**	**61.2**
Forested Wetland	0	0
Residential Woods	0	0
Woods	1826.9	61.2
Open Land	**175.4**	**5.9**
Open Space	167.8	5.6
Open Wetland	3.4	0.1
Water	4.2	0.1
Agricultural Land	**295.7**	**9.9**
Pasture/Hay	71.5	2.4
Row Crops	224.2	7.5
Impervious Surface	**Acres**	**% Area**
Impervious Land	102.9	3.4

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Partially Supporting"* and *"Degraded"*
- Sample dominated by isopods (Caecidotea) and amphipods (Gammarus).
- Water quality values within COMAR standards.
- Poor bank stability and marginal habitat diversity. Scored high for woody debris.

Recommendations:

- Protect riparian area.
- Determine causes of instability observed in this reach and evaluate potential for stabilization.

R2-15-07 Herring Bay Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	14
EPT Taxa	4
Ephemeroptera Taxa	2
Intolerant Urban %	45.9
Ephemeroptera %	10.8
Scraper Taxa	2
% Climbers	0

Calculated Metric Scores

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

Taxa	Count
Acentrella	4
Amphipoda	5
Baetidae	6
Caecidotea	41
Cambarinae	1
Conchapelopia	1
Crangonyx	4
Empididae	1
Gammarus	35
Helocordulia	1
Hyalella	1
Ironoquia	6
Lype	1
Maccaffertium	2
Orthocladius	1
Simulium	1
TOTAL:	**111**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	2	Pool Variability	7
Bank Stability- Right Bank	2	Riparian Vegetative Zone Width- Left Bank	6
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	15	Sediment Deposition	11
Channel Sinuosity	13	Vegetative Protection - Left Bank	3
Epifaunal Substrate/Available Cover	9	Vegetative Protection - Right Bank	3
Pool Substrate Characterization	5		
EPA Habitat Score			**106**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	8	43.08	Instream Wood Debris	14	72.54
Shading	80	78.67	Instream Habitat	10	54.28
Epifaunal Substrate	9	56.37	Bank Stability	4	44.72
PHI Score					**58.28**
PHI Narrative Rating					**Degraded**

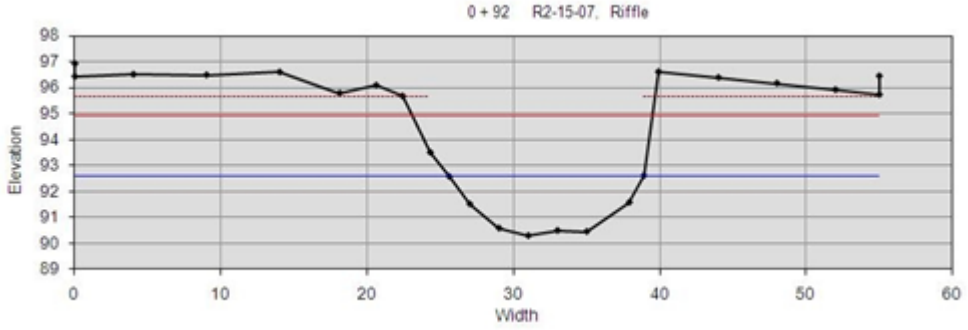
Water Chemistry

Dissolved Oxygen (mg/L)	9.53	pH (SU)	7.22
Turbidity (NTU)	25.4	Specific Conductivity (µS/cm)	137.2
Temperature (°C)	13.3		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	4.67	Cross Sectional Area (ft^2)	22
Bankfull Width (ft)	13.3	Water Surface Slope (%)	0.17
Mean Bankfull Depth (ft)	1.65	Sinuosity	1.2
Floodprone Width (ft)	16.4	D50 (mm)	0.062
Entrenchment Ratio	1.2	Adjustments?	
Width to Depth Ratio	8.1	**Rosgen Stream Type**	**G6c**



R2-15-08 Herring Bay Sampling Unit

Upstream View:

Downstream View:

Latitude: 38.83833029 **Longitude:** -76.59114245

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		596.4
Cover	**Acres**	**% Area**
Developed Land	**201.5**	**33.8**
Airport	0	0
Commercial	1.1	0.2
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	6.1	1
Residential 1-Acre	15.1	2.5
Residential 2-Acre	139.9	23.4
Transportation	17.6	3
Utility	21.7	3.6
Forest Land	**268.5**	**45**
Forested Wetland	0	0
Residential Woods	0	0
Woods	268.5	45
Open Land	**55.2**	**9.3**
Open Space	51.6	8.7
Open Wetland	0	0
Water	3.6	0.6
Agricultural Land	**71.2**	**11.9**
Pasture/Hay	25.7	4.3
Row Crops	45.5	7.6
Impervious Surface	**Acres**	**% Area**
Impervious Land	34.5	5.8

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Partially Supporting"* and *"Degraded"*
- Midges (Orthocladius and Parametriocnemus) dominated the sample.
- Water quality values within COMAR standards.
- Poor scores for woody debris and habitat diversity. Marginal scores for bank stability. Good riparian vegetation.

Recommendations:

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

R2-15-08 Herring Bay Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	28
EPT Taxa	4
Ephemeroptera Taxa	2
Intolerant Urban %	12.2
Ephemeroptera %	2.6
Scraper Taxa	0
% Climbers	2.6

Calculated Metric Scores

Total Taxa	5
EPT Taxa	3
Ephemeroptera Taxa	5
Intolerant Urban %	3
Ephemeroptera %	3
Scraper Taxa	1
% Climbers	3
BIBI Score	**3.29**
BIBI Narrative Rating	**Fair**

Taxa	Count
Amphipoda	3
Baetis	2
Brillia	1
Caecidotea	10
Caenis	1
Chironomini	1
Chironomus	1
Chrysops	2
Colymbetini	6
Conchapelopia	1
Crangonyx	4
Cricotopus	9
Eukiefferiella	1
Gammarus	1
Hydroporini	1
Ironoquia	4
Lumbricina	1
Lumbriculidae	1
Microtendipes	1
Orthocladiinae	3
Orthocladius	25
Parametriocnemus	18
Paratanytarsus	5
Perlesta	1
Prodiamesa	1
Prostoma	1
Pseudosuccinea	1
Simulium	3
Stenochironomus	1
Tanytarsus	2
Tubificidae	3
TOTAL:	**115**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	4	Pool Variability	4
Bank Stability- Right Bank	4	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	18	Sediment Deposition	14
Channel Sinuosity	8	Vegetative Protection - Left Bank	4
Epifaunal Substrate/Available Cover	4	Vegetative Protection - Right Bank	4
Pool Substrate Characterization	6		
EPA Habitat Score			**110**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	15	80.78	Instream Wood Debris	5	64.15
Shading	95	99.94	Instream Habitat	4	37.48
Epifaunal Substrate	4	37.81	Bank Stability	8	63.25
PHI Score					**63.9**
PHI Narrative Rating					**Degraded**

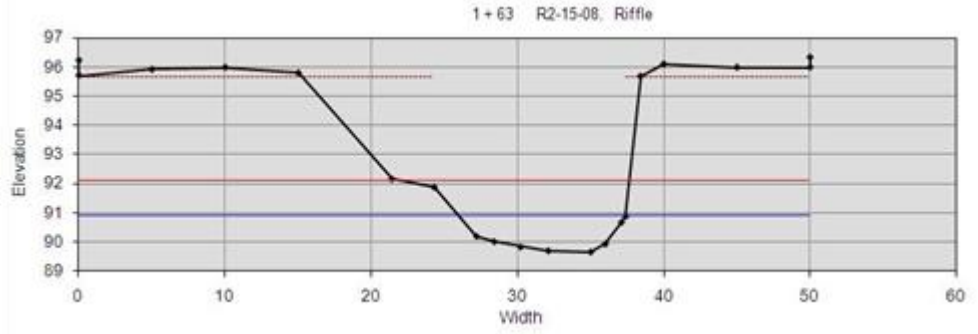
Water Chemistry

Dissolved Oxygen (mg/L)	10.25	pH (SU)	7.08
Turbidity (NTU)	17.2	Specific Conductivity (µS/cm)	158.2
Temperature (°C)	11.2		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.93	Cross Sectional Area (ft^2)	10.4
Bankfull Width (ft)	11.4	Water Surface Slope (%)	0.2
Mean Bankfull Depth (ft)	0.92	Sinuosity	1
Floodprone Width (ft)	15.7	D50 (mm)	0.062
Entrenchment Ratio	1.4	Adjustments?	
Width to Depth Ratio	12.4	**Rosgen Stream Type**	**F6**



R2-15-09 Herring Bay Sampling Unit

Upstream View:

Downstream View:

Latitude: 38.79691806 **Longitude:** -76.58016272

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**2966.2**
Cover	**Acres**	**% Area**
Developed Land	**684**	**23.1**
Airport	0	0
Commercial	16.9	0.6
Industrial	8.7	0.3
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	17.2	0.6
Residential 1-Acre	45.4	1.5
Residential 2-Acre	404.8	13.6
Transportation	42	1.4
Utility	149	5
Forest Land	**1811.5**	**61.1**
Forested Wetland	0	0
Residential Woods	0	0
Woods	1811.5	61.1
Open Land	**175.4**	**5.9**
Open Space	167.8	5.7
Open Wetland	3.4	0.1
Water	4.2	0.1
Agricultural Land	**295.2**	**10**
Pasture/Hay	71	2.4
Row Crops	224.2	7.6
Impervious Surface	**Acres**	**% Area**
Impervious Land	102.69	3.5

Summary Results:

- Biological condition – *"Good"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Isopods (Caecidotea) and the Ephemeroptera genus, Baetis, dominated the sample. Scored high in all metric categories.
- Water quality values within COMAR standards.
- Woody debris scored high with marginal scores for remaining habitat variables.

Recommendations:

- Buffer enhancement.

R2-15-09 Herring Bay Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	24
EPT Taxa	7
Ephemeroptera Taxa	3
Intolerant Urban %	50.5
Ephemeroptera %	39.3
Scraper Taxa	3
% Climbers	0.9

Calculated Metric Scores

Total Taxa	5
EPT Taxa	5
Ephemeroptera Taxa	5
Intolerant Urban %	5
Ephemeroptera %	5
Scraper Taxa	5
% Climbers	3
BIBI Score	**4.71**
BIBI Narrative Rating	**Good**

Taxa	Count
Acerpenna	3
Amphinemura	2
Baetis	32
Caecidotea	38
Cambaridae	1
Cheumatopsyche	1
Chironomini	1
Crangonyx	1
Cricotopus	1
Empididae	1
Gammarus	5
Hexatoma	1
Ironoquia	2
Maccaffertium	7
Orthocladius	1
Parametriocnemus	1
Perlesta	2
Physa	1
Pisidium	1
Rheotanytarsus	1
Simulium	1
Stenelmis	1
Thienemannimyia	1
Tubificidae	1
TOTAL:	**107**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	7	Pool Variability	11
Bank Stability- Right Bank	7	Riparian Vegetative Zone Width- Left Bank	1
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	1
Channel Flow Status	17	Sediment Deposition	13
Channel Sinuosity	7	Vegetative Protection - Left Bank	7
Epifaunal Substrate/Available Cover	12	Vegetative Protection - Right Bank	7
Pool Substrate Characterization	13		
EPA Habitat Score			**123**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	7	37.7	Instream Wood Debris	18	84.45
Shading	75	73.32	Instream Habitat	11	59.9
Epifaunal Substrate	12	73.84	Bank Stability	14	83.67
PHI Score					**68.81**
PHI Narrative Rating					**Partially Degraded**

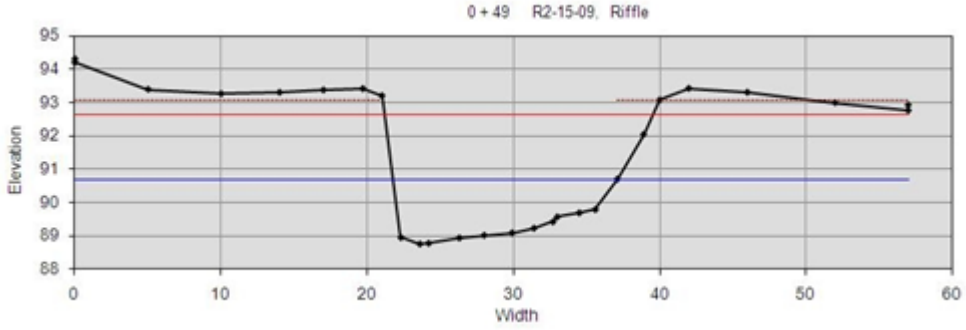
Water Chemistry

Dissolved Oxygen (mg/L)	9.56	pH (SU)	7.17
Turbidity (NTU)	24.4	Specific Conductivity (µS/cm)	137.9
Temperature (°C)	14.5		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	4.63	Cross Sectional Area (ft^2)	21.7
Bankfull Width (ft)	15.3	Water Surface Slope (%)	0.27
Mean Bankfull Depth (ft)	1.42	Sinuosity	1.1
Floodprone Width (ft)	18.4	D50 (mm)	4.4
Entrenchment Ratio	1.2	Adjustments?	Yes, WD + 2.0
Width to Depth Ratio	10.8	**Rosgen Stream Type**	**F4/6**



R2-15-10 Herring Bay Sampling Unit

Upstream View:

Downstream View:

Latitude: 38.81489632 **Longitude:** -76.58439833

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**2119.4**
Cover	**Acres**	**% Area**
Developed Land	**503**	**23.7**
Airport	0	0
Commercial	15.9	0.8
Industrial	6.2	0.3
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	17.2	0.8
Residential 1-Acre	25.6	1.2
Residential 2-Acre	312.4	14.7
Transportation	30.5	1.4
Utility	95.2	4.5
Forest Land	**1292.4**	**61**
Forested Wetland	0	0
Residential Woods	0	0
Woods	1292.4	61
Open Land	**106.9**	**5**
Open Space	103.3	4.9
Open Wetland	0	0
Water	3.6	0.2
Agricultural Land	**216.9**	**10.2**
Pasture/Hay	56.4	2.7
Row Crops	160.5	7.6
Impervious Surface	**Acres**	**% Area**
Impervious Land	77.63	3.7

Summary Results:

- Biological condition – *"Good"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Plecoptera and Ephemeroptera dominated the sample (Amphinemura and Baetis). Scored high in most metric categories.
- Water quality values within COMAR standards.
- Most habitat variables received sub-optimal scores. Good riparian vegetation.

Recommendations:

- Protect riparian area.

R2-15-10 Herring Bay Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	23
EPT Taxa	5
Ephemeroptera Taxa	2
Intolerant Urban %	38.1
Ephemeroptera %	31.4
Scraper Taxa	1
% Climbers	3.8

Calculated Metric Scores

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

Taxa	Count
Amphinemura	21
Amphipoda	6
Anopheles	1
Baetis	23
Caecidotea	6
Calopteryx	1
Cambaridae	2
Chironomini	1
Conchapelopia	1
Crangonyx	8
Gammarus	4
Hydroporini	1
Ironoquia	4
Maccaffertium	10
Nanocladius	1
Orthocladius	3
Parametriocnemus	1
Perlodidae	1
Pisidium	1
Polypedilum	3
Pseudorthocladius	1
Rheotanytarsus	1
Stygobromus	1
Tipula	1
Tubificidae	2
TOTAL:	**105**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	8	Pool Variability	4
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	18	Sediment Deposition	10
Channel Sinuosity	6	Vegetative Protection - Left Bank	7
Epifaunal Substrate/Available Cover	11	Vegetative Protection - Right Bank	7
Pool Substrate Characterization	7		
EPA Habitat Score			**125**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	6	32.31	Instream Wood Debris	12	70.5
Shading	85	84.56	Instream Habitat	10	57.79
Epifaunal Substrate	11	70.22	Bank Stability	15	86.61
PHI Score					**67**
PHI Narrative Rating					**Partially Degraded**

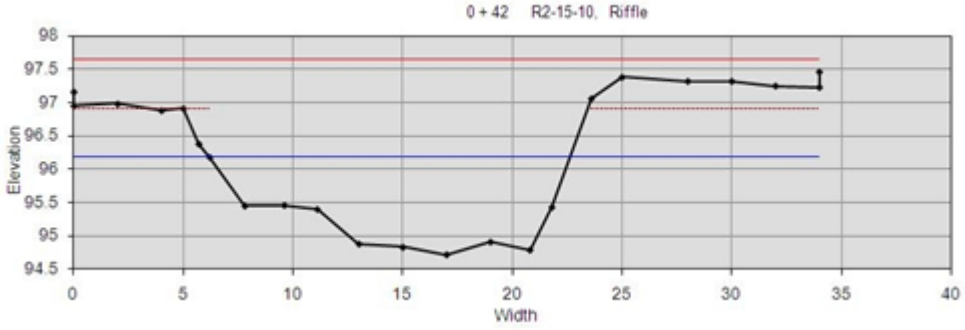
Water Chemistry

Dissolved Oxygen (mg/L)	10.65	pH (SU)	7.62
Turbidity (NTU)	29.9	Specific Conductivity (µS/cm)	141.3
Temperature (°C)	10.9		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	3.31	Cross Sectional Area (ft^2)	17
Bankfull Width (ft)	16.4	Water Surface Slope (%)	0.036
Mean Bankfull Depth (ft)	1.03	Sinuosity	1.1
Floodprone Width (ft)	150	D50 (mm)	0.07
Entrenchment Ratio	9.1	Adjustments?	
Width to Depth Ratio	15.9	**Rosgen Stream Type**	**C5/6c-**



R2-15-12A Herring Bay Sampling Unit

Upstream View:

Downstream View:

Latitude: 38.7429167 **Longitude:** -76.56586563

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**465.4**
Cover	**Acres**	**% Area**
Developed Land	**62.7**	**13.5**
Airport	0	0
Commercial	0	0
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0.8	0.2
Residential 1/2-acre	4.5	1
Residential 1-Acre	0.3	0.1
Residential 2-Acre	51.1	11
Transportation	6	1.3
Utility	0	0
Forest Land	**396.9**	**85.3**
Forested Wetland	0	0
Residential Woods	0	0
Woods	396.9	85.3
Open Land	**3.6**	**0.8**
Open Space	3.6	0.8
Open Wetland	0	0
Water	0	0
Agricultural Land	**2.3**	**0.5**
Pasture/Hay	1.8	0.4
Row Crops	0.5	0.1
Impervious Surface	**Acres**	**% Area**
Impervious Land	7.66	1.6

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Supporting"* and *"Partially Degraded"*
- Sample dominated by isopods (Caecidotea), amphipods (Crangonyx), and Plecoptera (Isoperla and Amphinemura).
- Water quality values within COMAR standards.
- Bank stability scored high. Most remaining habitat variable scores are marginal. Good riparian vegetation.

Recommendations:

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

R2-15-12A Herring Bay Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	19
EPT Taxa	3
Ephemeroptera Taxa	0
Intolerant Urban %	41.7
Ephemeroptera %	0
Scraper Taxa	1
% Climbers	2.8

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	10
Amphipoda	2
Caecidotea	24
Crangonyx	18
Culicoides	1
Gammarus	2
Hydroporini	1
Ironoquia	13
Isoperla	10
Lumbriculidae	2
Orthocladius	12
Parametriocnemus	1
Physa	2
Polypedilum	1
Rheocricotopus	2
Somatochlora	1
Sphaerium	1
Thienemannimyia	1
Tipula	1
Tubificidae	3
TOTAL:	**108**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	8	Pool Variability	5
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	9
Channel Sinuosity	13	Vegetative Protection - Left Bank	7
Epifaunal Substrate/Available Cover	7	Vegetative Protection - Right Bank	7
Pool Substrate Characterization	7		
EPA Habitat Score			**127**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	16	86.16	Instream Wood Debris	4	64
Shading	85	84.56	Instream Habitat	6	51.11
Epifaunal Substrate	7	56.86	Bank Stability	16	89.45
PHI Score					**72.02**
PHI Narrative Rating					**Partially Degraded**

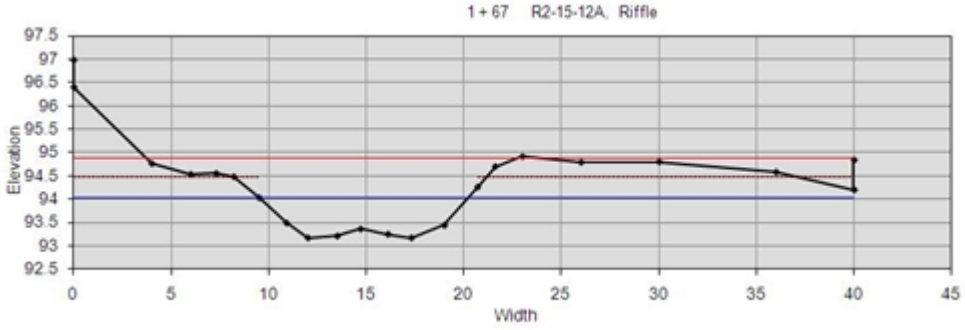
Water Chemistry

Dissolved Oxygen (mg/L)	10.14	pH (SU)	7.22
Turbidity (NTU)	14.8	Specific Conductivity (µS/cm)	161.8
Temperature (°C)	12.6		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.73	Cross Sectional Area (ft^2)	6.9
Bankfull Width (ft)	10.7	Water Surface Slope (%)	0.12
Mean Bankfull Depth (ft)	0.64	Sinuosity	1.2
Floodprone Width (ft)	150	D50 (mm)	0.062
Entrenchment Ratio	14	Adjustments?	
Width to Depth Ratio	16.7	**Rosgen Stream Type**	**C6**



R2-15-13A Herring Bay Sampling Unit

Upstream View:

Downstream View:

Latitude: 38.82984566 **Longitude:** -76.60613532

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**111.2**
Cover	**Acres**	**% Area**
Developed Land	**30.1**	**27**
Airport	0	0
Commercial	9.8	8.8
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	0	0
Residential 2-Acre	17.5	15.8
Transportation	2.8	2.5
Utility	0	0
Forest Land	**66**	**59.4**
Forested Wetland	0	0
Residential Woods	0	0
Woods	66	59.4
Open Land	**7**	**6.3**
Open Space	7	6.3
Open Wetland	0	0
Water	0	0
Agricultural Land	**8.1**	**7.3**
Pasture/Hay	0	0
Row Crops	8.1	7.3
Impervious Surface	**Acres**	**% Area**
Impervious Land	10.37	9.3

Summary Results:

- Biological condition – *"Very Poor"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Sample dominated by amphipods (Crangonyx and Gammarus) and isopods (Caecidotea).
- Water quality values within COMAR standards.
- Bank stability scored high. Most remaining habitat variable scores are marginal. Good riparian vegetation.

Recommendations:

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

R2-15-13A Herring Bay Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	10
EPT Taxa	2
Ephemeroptera Taxa	0
Intolerant Urban %	22.6
Ephemeroptera %	0
Scraper Taxa	0
% Climbers	0.9

Calculated Metric Scores

Total Taxa	1
EPT Taxa	3
Ephemeroptera Taxa	1
Intolerant Urban %	3
Ephemeroptera %	1
Scraper Taxa	1
% Climbers	1
BIBI Score	**1.57**
BIBI Narrative Rating	**Very Poor**

Taxa	Count
Amphinemura	9
Caecidotea	16
Crangonyx	7
Gammarus	74
Hydroporini	1
Ironoquia	3
Micropsectra	1
Orthocladius	1
Parametriocnemus	2
Rheocricotopus	1
TOTAL:	**115**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	8	Pool Variability	3
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	13	Sediment Deposition	9
Channel Sinuosity	13	Vegetative Protection - Left Bank	6
Epifaunal Substrate/Available Cover	7	Vegetative Protection - Right Bank	6
Pool Substrate Characterization	5		
EPA Habitat Score			**118**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	12	64.62	Instream Wood Debris	4	80.21
Shading	95	99.94	Instream Habitat	5	60.22
Epifaunal Substrate	7	66.19	Bank Stability	16	89.45
PHI Score					**76.77**
PHI Narrative Rating					**Partially Degraded**

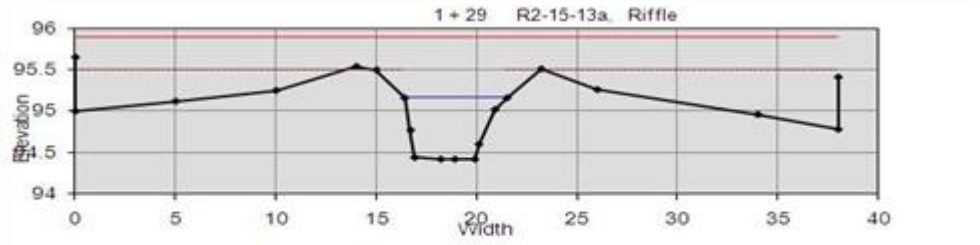
Water Chemistry

Dissolved Oxygen (mg/L)	10.88	pH (SU)	7.97
Turbidity (NTU)	29.6	Specific Conductivity (µS/cm)	281
Temperature (°C)	11.4		

Geomorphic Assessment

Rosgen Level II Classification Data

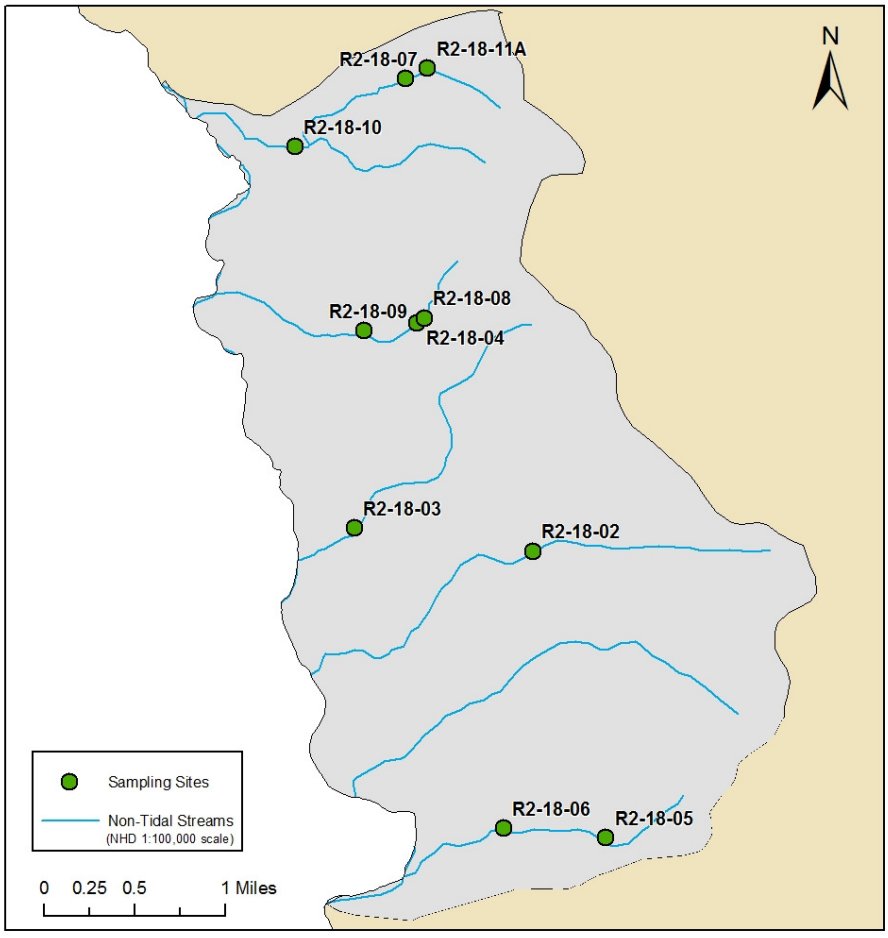
Drainage Area (mi^2)	0.17	Cross Sectional Area (ft^2)	2.8
Bankfull Width (ft)	5.1	Water Surface Slope (%)	0.98
Mean Bankfull Depth (ft)	0.55	Sinuosity	1.2
Floodprone Width (ft)	150	D50 (mm)	0.073
Entrenchment Ratio	29.4	Adjustments?	
Width to Depth Ratio	9.2	**Rosgen Stream Type**	**E5**



Middle 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
R2-18-02	712.5	1.11	12.2	30.6	24.5	39.9	5.0	Poor	Partially Degraded	Supporting	G
R2-18-03	906	1.42	6.6	24.8	39.3	18.8	17.2	Fair	Partially Degraded	Partially Supporting	F
R2-18-04	237.4	0.37	1.4	7.7	45.1	40.3	6.9	Fair	Partially Degraded	Partially Supporting	G
R2-18-05	198.6	0.31	10.2	54.5	13.3	31.4	0.8	Fair	Partially Degraded	Partially Supporting	B
R2-18-06	633.1	0.99	7.2	41.2	21.3	36.4	1.0	Fair	Degraded	Non Supporting	G
R2-18-07	290.2	0.45	17.2	50.8	26.1	7.0	16.1	Fair	Partially Degraded	Supporting	G
R2-18-08	234.3	0.37	1.4	7.8	44.4	40.9	6.9	Poor	Partially Degraded	Partially Supporting	G
R2-18-09	292.5	0.46	1.3	6.2	46.8	32.7	14.2	Good	Minimally Degraded	Supporting	G
R2-18-10	838.4	1.31	10.3	38.0	39.0	14.9	8.1	Poor	Partially Degraded	Supporting	ND
R2-18-11A	234	0.37	16.6	48.7	25.4	8.6	17.2	Fair	Minimally Degraded	Supporting	F



R2-18-02 Middle Patuxent Sampling Unit

Upstream View:

Downstream View:

Latitude: 38.95288063 **Longitude:** -76.66940895

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		712.5
Cover	**Acres**	**% Area**
Developed Land	**217.6**	**30.6**
Airport	0	0
Commercial	58.4	8.2
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0.7	0.1
Residential 1-Acre	23.5	3.3
Residential 2-Acre	108.1	15.2
Transportation	26.9	3.8
Utility	0	0
Forest Land	**174.5**	**24.5**
Forested Wetland	0	0
Residential Woods	0	0
Woods	174.5	24.5
Open Land	**35.9**	**5**
Open Space	30.4	4.3
Open Wetland	0	0
Water	5.5	0.8
Agricultural Land	**284.4**	**39.9**
Pasture/Hay	15.9	2.2
Row Crops	268.5	37.7
Impervious Surface	**Acres**	**% Area**
Impervious Land	86.93	12.2

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Supporting"* and *"Partially Degraded"*
- Sample dominated by midges (Rheocricotopus, Thienemannimyia, and Polypedilum).
- Water quality values within COMAR standards.
- Most habitat variables received sub-optimal scores. Good riparian vegetation.

Recommendations:

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

R2-18-02 Middle Patuxent Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	32
EPT Taxa	3
Ephemeroptera Taxa	0
Intolerant Urban %	6.1
Ephemeroptera %	0
Scraper Taxa	1
% Climbers	11.4

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
Caecidotea	2
Calopteryx	3
Cambaridae	1
Ceratopogonidae	4
Chironomidae	1
Chironominae	1
Chironomini	4
Collembola	1
Conchapelopia	1
Corduliidae	1
Diplocladius	4
Enchytraeidae	3
Haploperla	1
Hydrobaenus	3
Ironoquia	3
Lumbricina	1
Microvelia	1
Natarsia	1
Nigronia	1
Orthocladiinae	6
Orthocladius	1
Parametriocnemus	1
Paraphaenocladius	1
Paratendipes	2
Phaenopsectra	1
Pisidium	1
Polypedilum	10
Pseudolimnophila	1
Pseudorthocladius	3
Pycnopsyche	4
Rheocricotopus	24
Simulium	1
Stenochironomus	3
Tanypodinae	1
Tanytarsus	3
Thienemannimyia	11
Tubificidae	3
TOTAL:	**114**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	7	Pool Variability	13
Bank Stability- Right Bank	4	Riparian Vegetative Zone Width- Left Bank	9
Channel Alteration	15	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	11	Sediment Deposition	12
Channel Sinuosity	12	Vegetative Protection - Left Bank	8
Epifaunal Substrate/Available Cover	11	Vegetative Protection - Right Bank	6
Pool Substrate Characterization	12		
EPA Habitat Score			**130**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	15	80.78	Instream Wood Debris	11	79.89
Shading	90	91.34	Instream Habitat	12	80.04
Epifaunal Substrate	11	77.32	Bank Stability	11	74.16
PHI Score					**80.59**
PHI Narrative Rating					**Partially Degraded**

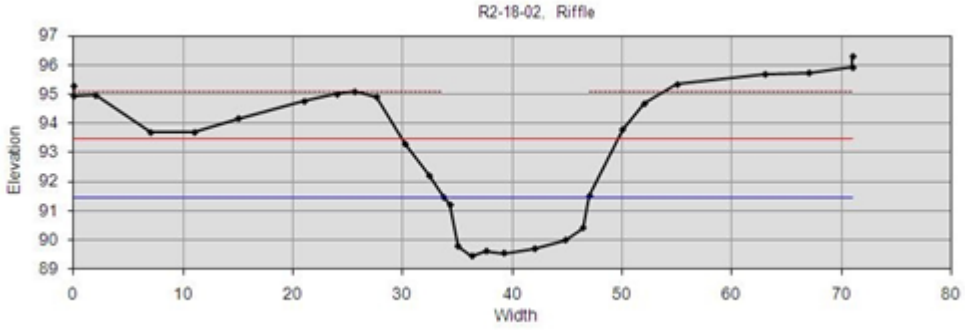
Water Chemistry

Dissolved Oxygen (mg/L)	10.33	pH (SU)	7.43
Turbidity (NTU)	8.9	Specific Conductivity (µS/cm)	268.4
Temperature (°C)	13.5		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	1.11	Cross Sectional Area (ft^2)	20.7
Bankfull Width (ft)	13.3	Water Surface Slope (%)	0.62
Mean Bankfull Depth (ft)	1.56	Sinuosity	1.2
Floodprone Width (ft)	19.7	D50 (mm)	12
Entrenchment Ratio	1.5	Adjustments?	Yes, ER - 0.2
Width to Depth Ratio	8.5	**Rosgen Stream Type**	**G4c**



R2-18-03 Middle Patuxent Sampling Unit

Upstream View:

Downstream View:

Latitude: 38.95478176 **Longitude:** -76.68767381

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**906**
Cover	**Acres**	**% Area**
Developed Land	**224.4**	**24.8**
Airport	0	0
Commercial	13.1	1.5
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	3.1	0.3
Residential 2-Acre	168	18.5
Transportation	40.2	4.4
Utility	0	0
Forest Land	**356**	**39.3**
Forested Wetland	0	0
Residential Woods	0	0
Woods	356	39.3
Open Land	**155.7**	**17.2**
Open Space	155.7	17.2
Open Wetland	0	0
Water	0	0
Agricultural Land	**169.9**	**18.8**
Pasture/Hay	121.4	13.4
Row Crops	48.5	5.4
Impervious Surface	**Acres**	**% Area**
Impervious Land	59.59	6.6

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Plecoptera (Amphinemura), beetles (Anchytarsus), and midges (Natarsia) dominated the sample.
- Water quality values within COMAR standards.
- Most habitat variables received sub-optimal scores. Good riparian vegetation.

Recommendations:

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

R2-18-03 Middle Patuxent Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	32
EPT Taxa	10
Ephemeroptera Taxa	1
Intolerant Urban %	36.9
Ephemeroptera %	1.9
Scraper Taxa	1
% Climbers	5.8

Calculated Metric Scores

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

Taxa	Count
Acerpenna	2
Amphinemura	16
Anchytarsus	14
Caecidotea	3
Chironomidae	1
Chironomini	2
Chloroperlidae	1
Cryptochironomus	1
Curculionidae	1
Diamesa	1
Diplectrona	1
Eccoptura	1
Enchytraeidae	2
Haploperla	4
Hexatoma	2
Hydrobaenus	1
Hydropsyche	1
Leuctra	2
Lumbricina	2
Micropsectra	3
Natarsia	10
Nigronia	1
Orthocladiinae	3
Orthocladius	4
Paracladopelma	1
Paramerina	1
Polycentropus	2
Polypedilum	2
Pycnopsyche	4
Simuliidae	1
Stenochironomus	1
Tanytarsus	1
Thienemannimyia	1
Tipula	1
Tubificidae	9
TOTAL:	**103**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	4	Pool Variability	8
Bank Stability- Right Bank	3	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	15	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	13	Sediment Deposition	7
Channel Sinuosity	11	Vegetative Protection - Left Bank	6
Epifaunal Substrate/Available Cover	10	Vegetative Protection - Right Bank	5
Pool Substrate Characterization	8		
EPA Habitat Score			**110**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	8	43.08	Instream Wood Debris	13	83.08
Shading	90	91.34	Instream Habitat	11	72.04
Epifaunal Substrate	10	69.95	Bank Stability	7	59.16
PHI Score					**69.78**
PHI Narrative Rating					**Partially Degraded**

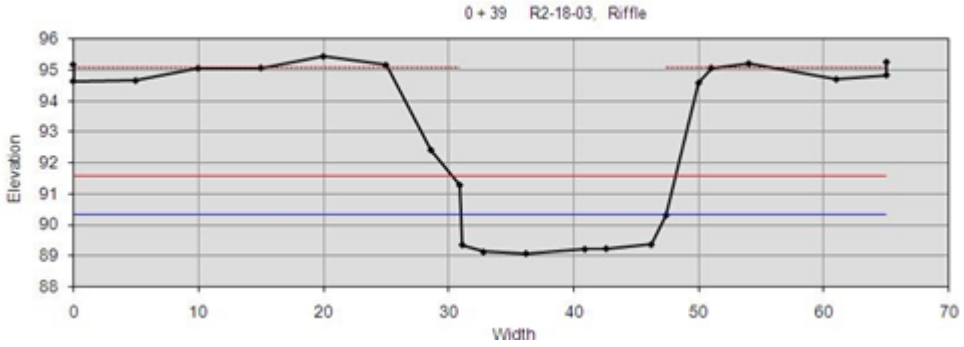
Water Chemistry

Dissolved Oxygen (mg/L)	10.36	pH (SU)	6.8
Turbidity (NTU)	4.97	Specific Conductivity (µS/cm)	113.5
Temperature (°C)	16.6		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	1.42	Cross Sectional Area (ft^2)	17.6
Bankfull Width (ft)	16.4	Water Surface Slope (%)	0.56
Mean Bankfull Depth (ft)	1.07	Sinuosity	1.1
Floodprone Width (ft)	17.8	D50 (mm)	0.12
Entrenchment Ratio	1.1	Adjustments?	
Width to Depth Ratio	15.3	**Rosgen Stream Type**	**F5**



R2-18-04 Middle Patuxent Sampling Unit

Upstream View:

Downstream View:

Latitude: 38.97116174 **Longitude:** -76.68121649

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		237.4
Cover	**Acres**	**% Area**
Developed Land	**18.3**	**7.7**
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	16.9	7.1
Transportation	1.4	0.6
Utility	0	0
Forest Land	**107.1**	**45.1**
Forested Wetland	0	0
Residential Woods	0	0
Woods	107.1	45.1
Open Land	**16.3**	**6.9**
Open Space	16.3	6.9
Open Wetland	0	0
Water	0	0
Agricultural Land	**95.8**	**40.3**
Pasture/Hay	0	0
Row Crops	95.8	40.3
Impervious Surface	**Acres**	**% Area**
Impervious Land	3.27	1.4

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Midges dominated the sample including Thienemannimyia, Rheocricotopus, and Pseudolimnophila.
- Water quality values within COMAR standards.
- Most habitat variables received marginal scores. Good riparian vegetation.

Recommendations:

- Maintain the protection of the riparian areas.

R2-18-04 Middle Patuxent Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	26
EPT Taxa	5
Ephemeroptera Taxa	0
Intolerant Urban %	18.1
Ephemeroptera %	0
Scraper Taxa	1
% Climbers	3.4

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
Amphinemura	5
Anchytarsus	14
Ceratopogonidae	1
Chironomidae	3
Chironomini	1
Cordulegaster	1
Diplectrona	1
Diplocladius	1
Dixella	1
Helichus	1
Heterotrissocladius	2
Ironoquia	4
Larsia	1
Lumbricina	1
Micropsectra	1
Natarsia	6
Orthocladiinae	4
Parakiefferiella	1
Parametriocnemus	7
Polycentropus	1
Polypedilum	3
Pseudolimnophila	9
Pseudorthocladius	2
Pycnopsyche	4
Rheocricotopus	19
Rheotanytarsus	1
Simuliidae	2
Thienemannimyia	15
Tubificidae	4
TOTAL:	**116**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	5	Pool Variability	6
Bank Stability- Right Bank	7	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	16	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	13	Sediment Deposition	6
Channel Sinuosity	16	Vegetative Protection - Left Bank	6
Epifaunal Substrate/Available Cover	8	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	8		
EPA Habitat Score			**119**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	16	86.16	Instream Wood Debris	4	71.62
Shading	95	99.94	Instream Habitat	7	63.55
Epifaunal Substrate	8	67.05	Bank Stability	12	77.46
PHI Score					**77.63**
PHI Narrative Rating					**Partially Degraded**

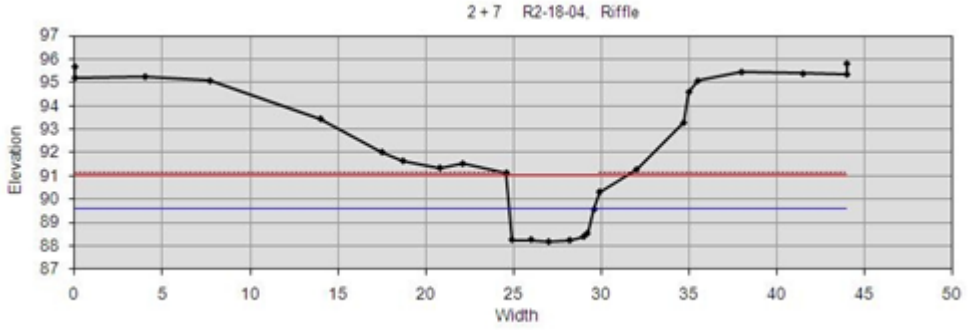
Water Chemistry

Dissolved Oxygen (mg/L)	8.39	pH (SU)	6.75
Turbidity (NTU)	6.33	Specific Conductivity (µS/cm)	65.2
Temperature (°C)	21.4		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.37	Cross Sectional Area (ft^2)	6.2
Bankfull Width (ft)	4.9	Water Surface Slope (%)	0.42
Mean Bankfull Depth (ft)	1.27	Sinuosity	1.5
Floodprone Width (ft)	6.9	D50 (mm)	0.11
Entrenchment Ratio	1.4	Adjustments?	
Width to Depth Ratio	3.8	**Rosgen Stream Type**	**G5**



R2-18-05 Middle Patuxent Sampling Unit

Upstream View:

Downstream View:

Latitude: 38.92991223 **Longitude:** -76.66202406

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		198.6
Cover	**Acres**	**% Area**
Developed Land	**108.3**	**54.5**
Airport	0	0
Commercial	0	0
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	0	0
Residential 1-Acre	2.9	1.4
Residential 2-Acre	101.2	51
Transportation	4.2	2.1
Utility	0	0
Forest Land	**26.4**	**13.3**
Forested Wetland	0	0
Residential Woods	0	0
Woods	26.4	13.3
Open Land	**1.6**	**0.8**
Open Space	1.6	0.8
Open Wetland	0	0
Water	0	0
Agricultural Land	**62.3**	**31.4**
Pasture/Hay	51.2	25.8
Row Crops	11.1	5.6
Impervious Surface	**Acres**	**% Area**
Impervious Land	20.31	10.2

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Amphinemura (Plecoptera) and Stegopterna (midge) dominated the sample. Scored high for intolerant percent.
- Measured below COMAR standards for pH.
- Most habitat variables received marginal scores.

Recommendations:

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

R2-18-05 Middle Patuxent Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	21
EPT Taxa	4
Ephemeroptera Taxa	0
Intolerant Urban %	52.7
Ephemeroptera %	0
Scraper Taxa	2
% Climbers	10

Calculated Metric Scores

Total Taxa	3
EPT Taxa	3
Ephemeroptera Taxa	1
Intolerant Urban %	5
Ephemeroptera %	1
Scraper Taxa	5
% Climbers	5
BIBI Score	**3.29**
BIBI Narrative Rating	**Fair**

Taxa	Count
Amphinemura	30
Caecidotea	4
Chironomini	1
Crangonyx	4
Curculionidae	1
Diplectrona	1
Diplocladius	1
Gammarus	4
Helichus	1
Ironoquia	4
Limonia	2
Lumbriculidae	6
Micropsectra	4
Microvelia	1
Neophylax	2
Parametriocnemus	7
Pisidiidae	1
Pisidium	1
Polypedilum	7
Pseudolimnophila	1
Stegopterna	16
Tipula	7
Tubificidae	4
TOTAL:	**110**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	8	Pool Variability	8
Bank Stability- Right Bank	6	Riparian Vegetative Zone Width- Left Bank	9
Channel Alteration	15	Riparian Vegetative Zone Width- Right Bank	1
Channel Flow Status	13	Sediment Deposition	11
Channel Sinuosity	7	Vegetative Protection - Left Bank	8
Epifaunal Substrate/Available Cover	8	Vegetative Protection - Right Bank	5
Pool Substrate Characterization	10		
EPA Habitat Score			**109**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	15	80.78	Instream Wood Debris	3	70.68
Shading	70	68.32	Instream Habitat	8	70.93
Epifaunal Substrate	8	68.22	Bank Stability	14	83.67
PHI Score					**73.76**
PHI Narrative Rating					**Partially Degraded**

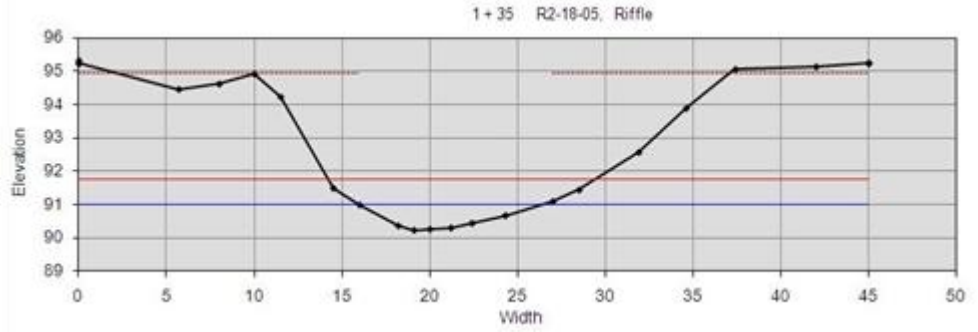
Water Chemistry

Dissolved Oxygen (mg/L)	9.97	pH (SU)	6.31
Turbidity (NTU)	9.22	Specific Conductivity (µS/cm)	291.2
Temperature (°C)	15.2		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.31	Cross Sectional Area (ft^2)	4.7
Bankfull Width (ft)	10.4	Water Surface Slope (%)	0.66
Mean Bankfull Depth (ft)	0.46	Sinuosity	1
Floodprone Width (ft)	15.2	D50 (mm)	1.7
Entrenchment Ratio	1.5	Adjustments?	
Width to Depth Ratio	22.6	**Rosgen Stream Type**	**B4c**



R2-18-06 Middle Patuxent Sampling Unit

Upstream View:

Downstream View:

Latitude: 38.93072558 **Longitude:** -76.67252466

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		633.1
Cover	**Acres**	**% Area**
Developed Land	**261.1**	**41.2**
Airport	0	0
Commercial	3.1	0.5
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	4	0.6
Residential 1-Acre	33.6	5.3
Residential 2-Acre	205.9	32.5
Transportation	14.5	2.3
Utility	0	0
Forest Land	**135.1**	**21.3**
Forested Wetland	0	0
Residential Woods	0	0
Woods	135.1	21.3
Open Land	**6.5**	**1**
Open Space	6.5	1
Open Wetland	0	0
Water	0	0
Agricultural Land	**230.4**	**36.4**
Pasture/Hay	147.7	23.3
Row Crops	82.7	13.1
Impervious Surface	**Acres**	**% Area**
Impervious Land	45.33	7.2

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Non Supporting"* and *"Degraded"*
- Gammarus (amphipod) and Orthocladius (midge) dominated the sample.
- Water quality values within COMAR standards.
- With the exception of shading, all habitat variables scored poorly. Refuse abundant. Good riparian vegetation.

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.

R2-18-06 Middle Patuxent Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	18
EPT Taxa	6
Ephemeroptera Taxa	1
Intolerant Urban %	11
Ephemeroptera %	0.8
Scraper Taxa	1
% Climbers	5.1

Calculated Metric Scores

Total Taxa	3
EPT Taxa	5
Ephemeroptera Taxa	3
Intolerant Urban %	3
Ephemeroptera %	3
Scraper Taxa	3
% Climbers	3
BIBI Score	**3.29**
BIBI Narrative Rating	**Fair**

Taxa	Count
Amphinemura	9
Anchytarsus	3
Cheumatopsyche	1
Diamesa	5
Diplectrona	1
Ephemerella	1
Eukiefferiella	1
Gammarus	36
Hydrobaenus	2
Hydropsyche	1
Lumbricina	2
Naididae	1
Orthocladiinae	3
Orthocladius	36
Polypedilum	6
Prosimulium	2
Pycnopsyche	2
Tipula	1
Tubificidae	5
TOTAL:	**118**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	1	Pool Variability	9
Bank Stability- Right Bank	1	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	13	Riparian Vegetative Zone Width- Right Bank	9
Channel Flow Status	13	Sediment Deposition	12
Channel Sinuosity	12	Vegetative Protection - Left Bank	2
Epifaunal Substrate/Available Cover	4	Vegetative Protection - Right Bank	2
Pool Substrate Characterization	6		
EPA Habitat Score			**94**
EPA Narrative Rating			**Non Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	11	59.24	Instream Wood Debris	2	54.6
Shading	90	91.34	Instream Habitat	4	36.87
Epifaunal Substrate	4	37.43	Bank Stability	2	31.62
PHI Score					**51.85**
PHI Narrative Rating					**Degraded**

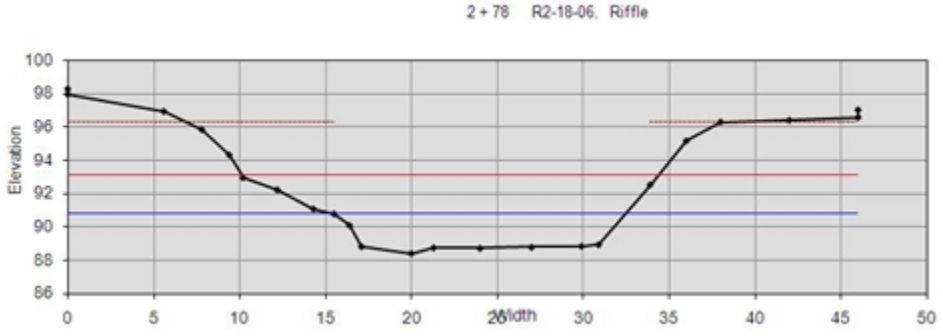
Water Chemistry

Dissolved Oxygen (mg/L)	10.77	pH (SU)	7.45
Turbidity (NTU)	5.38	Specific Conductivity (µS/cm)	246.4
Temperature (°C)	17.5		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.99	Cross Sectional Area (ft^2)	31
Bankfull Width (ft)	16.9	Water Surface Slope (%)	6.9
Mean Bankfull Depth (ft)	1.83	Sinuosity	1.1
Floodprone Width (ft)	24.3	D50 (mm)	4
Entrenchment Ratio	1.4	Adjustments?	
Width to Depth Ratio	9.3	**Rosgen Stream Type**	**G4/5**



R2-18-07 Middle Patuxent Sampling Unit

Upstream View:

Downstream View:

Latitude: 38.99082573 **Longitude:** -76.6823072

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		290.2
Cover	**Acres**	**% Area**
Developed Land	**147.4**	**50.8**
Airport	0	0
Commercial	25.4	8.8
Industrial	0	0
Residential 1/8-acre	10.7	3.7
Residential 1/4-acre	44.6	15.4
Residential 1/2-acre	0	0
Residential 1-Acre	9.7	3.3
Residential 2-Acre	47.1	16.2
Transportation	9.9	3.4
Utility	0	0
Forest Land	**75.8**	**26.1**
Forested Wetland	0	0
Residential Woods	0	0
Woods	75.8	26.1
Open Land	**46.7**	**16.1**
Open Space	46.7	16.1
Open Wetland	0	0
Water	0	0
Agricultural Land	**20.2**	**7**
Pasture/Hay	0	0
Row Crops	20.2	7
Impervious Surface	**Acres**	**% Area**
Impervious Land	49.81	17.2

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Supporting"* and *"Partially Degraded"*
- Worms (Naididae, Enchytraeidae, and unidentified Lumbricina) and midges (Rheocricotopus) dominated the sample
- Water quality values within COMAR standards.
- Most habitat variables received sub-optimal scores. Good riparian vegetation.

Recommendations:

- Maintain the protection of the riparian areas.

R2-18-07 Middle Patuxent Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	34
EPT Taxa	6
Ephemeroptera Taxa	0
Intolerant Urban %	16.8
Ephemeroptera %	0
Scraper Taxa	3
% Climbers	2.8

Calculated Metric Scores

Total Taxa	5
EPT Taxa	5
Ephemeroptera Taxa	1
Intolerant Urban %	3
Ephemeroptera %	1
Scraper Taxa	5
% Climbers	3
BIBI Score	**3.29**
BIBI Narrative Rating	**Fair**

Taxa	Count
Amphinemura	4
Amphipoda	3
Anchytarsus	7
Brillia	2
Caecidotea	3
Calopteryx	2
Ceratopogonidae	1
Corduliidae	1
Crangonyx	4
Diamesa	2
Dicranota	1
Diplectrona	3
Diplocladius	1
Enchytraeidae	7
Haploperla	4
Helichus	1
Hydrobaenus	1
Hydropsychidae	1
Ironoquia	2
Lumbricina	8
Lype	3
Naididae	7
Nemata	3
Orthocladiinae	2
Orthocladius	3
Parametriocnemus	2
Plecoptera	1
Polycentropus	1
Polypedilum	1
Prostoma	1
Pseudorthocladius	1
Rheocricotopus	13
Rheotanytarsus	1
Stilocladius	1
Thienemannimyia	2
Tipula	4
Tubificidae	2
Zavrelimyia	1
TOTAL:	**107**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	4	Pool Variability	9
Bank Stability- Right Bank	8	Riparian Vegetative Zone Width- Left Bank	9
Channel Alteration	19	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	15	Sediment Deposition	8
Channel Sinuosity	20	Vegetative Protection - Left Bank	6
Epifaunal Substrate/Available Cover	12	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	10		
EPA Habitat Score			**138**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	10	53.85	Instream Wood Debris	7	78.22
Shading	90	91.34	Instream Habitat	11	83.69
Epifaunal Substrate	12	88.98	Bank Stability	12	77.46
PHI Score					**78.93**
PHI Narrative Rating					**Partially Degraded**

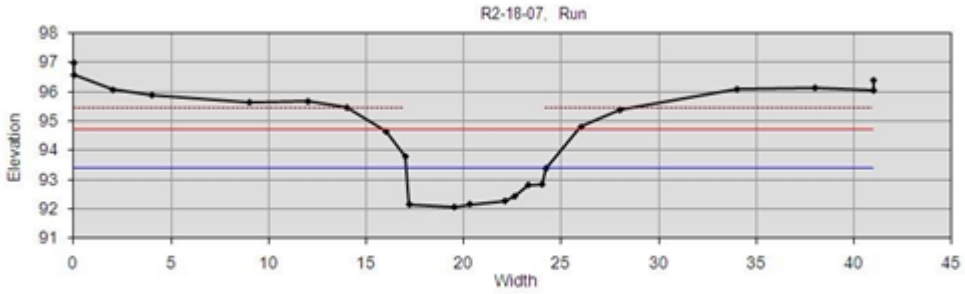
Water Chemistry

Dissolved Oxygen (mg/L)	9.96	pH (SU)	6.66
Turbidity (NTU)	3.63	Specific Conductivity (µS/cm)	233.9
Temperature (°C)	13.6		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.45	Cross Sectional Area (ft^2)	7.7
Bankfull Width (ft)	7.2	Water Surface Slope (%)	0.67
Mean Bankfull Depth (ft)	1.08	Sinuosity	2.3
Floodprone Width (ft)	10	D50 (mm)	0.12
Entrenchment Ratio	1.4	Adjustments?	
Width to Depth Ratio	6.6	**Rosgen Stream Type**	**G5c**



R2-18-08 Middle Patuxent Sampling Unit

Upstream View:

Downstream View:

Latitude: 38.97156645 **Longitude:** -76.68054821

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		234.3
Cover	**Acres**	**% Area**
Developed Land	**18.3**	**7.8**
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	16.9	7.2
Transportation	1.4	0.6
Utility	0	0
Forest Land	**104.1**	**44.4**
Forested Wetland	0	0
Residential Woods	0	0
Woods	104.1	44.4
Open Land	**16.1**	**6.9**
Open Space	16.1	6.9
Open Wetland	0	0
Water	0	0
Agricultural Land	**95.8**	**40.9**
Pasture/Hay	0	0
Row Crops	95.8	40.9
Impervious Surface	**Acres**	**% Area**
Impervious Land	3.27	1.4

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Midges dominated the sample including Orthocladiinae, Thienemannimyia, and Rheocricotopus.
- Measured below COMAR standards for pH.
- Most habitat variables received marginal scores. Good riparian vegetation.

Recommendations:

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

R2-18-08 Middle Patuxent Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	28
EPT Taxa	4
Ephemeroptera Taxa	0
Intolerant Urban %	22.3
Ephemeroptera %	0
Scraper Taxa	0
% Climbers	16.5

Calculated Metric Scores

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

Taxa	Count
Amphinemura	1
Anchytarsus	3
Calopteryx	1
Ceratopogonidae	1
Chironomidae	1
Chironominae	2
Curculionidae	1
Diplocladius	2
Enchytraeidae	1
Heterotrissocladius	2
Ironoquia	1
Limnephilidae	1
Lumbricina	2
Lype	2
Micropsectra	8
Natarsia	8
Nemouridae	1
Nigronia	4
Orthocladiinae	13
Parakiefferiella	1
Parametriocnemus	8
Paratanytarsus	1
Pisidium	1
Polycentropus	1
Polypedilum	6
Prosimulium	1
Pseudolimnophila	3
Pycnopsyche	1
Rheocricotopus	10
Rheotanytarsus	1
Sialis	1
Tanypodinae	1
Tanytarsus	1
Thienemannimyia	11
Tubificidae	1
TOTAL:	**104**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	6	Pool Variability	6
Bank Stability- Right Bank	5	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	18	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	12	Sediment Deposition	7
Channel Sinuosity	19	Vegetative Protection - Left Bank	6
Epifaunal Substrate/Available Cover	7	Vegetative Protection - Right Bank	5
Pool Substrate Characterization	6		
EPA Habitat Score			**117**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	16	86.16	Instream Wood Debris	6	77.69
Shading	95	99.94	Instream Habitat	6	58.14
Epifaunal Substrate	7	61.33	Bank Stability	11	74.16
PHI Score					**76.24**
PHI Narrative Rating					**Partially Degraded**

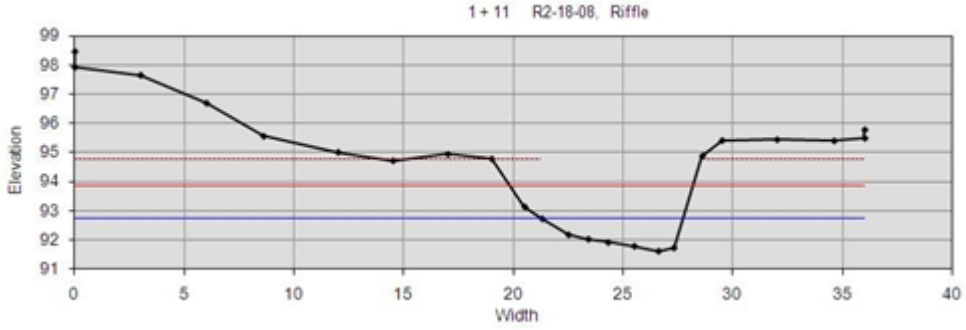
Water Chemistry

Dissolved Oxygen (mg/L)	8.61	pH (SU)	6.34
Turbidity (NTU)	8.37	Specific Conductivity (µS/cm)	71.1
Temperature (°C)	17.5		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.37	Cross Sectional Area (ft^2)	4.7
Bankfull Width (ft)	6.4	Water Surface Slope (%)	0.45
Mean Bankfull Depth (ft)	0.73	Sinuosity	3.2
Floodprone Width (ft)	8.3	D50 (mm)	0.15
Entrenchment Ratio	1.3	Adjustments?	
Width to Depth Ratio	8.8	**Rosgen Stream Type**	**G5c**



R2-18-09 Middle Patuxent Sampling Unit

Upstream View:

Downstream View:

Latitude: 38.97064743 **Longitude:** -76.68665864

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		292.5
Cover	**Acres**	**% Area**
Developed Land	**18.3**	**6.2**
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	16.9	5.8
Transportation	1.4	0.5
Utility	0	0
Forest Land	**136.9**	**46.8**
Forested Wetland	0	0
Residential Woods	0	0
Woods	136.9	46.8
Open Land	**41.6**	**14.2**
Open Space	41.6	14.2
Open Wetland	0	0
Water	0	0
Agricultural Land	**95.8**	**32.7**
Pasture/Hay	0	0
Row Crops	95.8	32.7
Impervious Surface	**Acres**	**% Area**
Impervious Land	3.8	1.3

Summary Results:

- Biological condition – *"Good"*
- Habitat scores *"Supporting"* and *"Minimally Degraded"*
- Beetles (Anchytarsus), Plecoptera (Amphinemura and Haploperla), and Trichoptera (Polycentropus and Diplectrona) dominated the sample. Scored high in most metric categories.
- Water quality values within COMAR standards.
- Woody debris scored very high with sub-optimal scores for habitat diversity. Good riparian vegetation.

Recommendations:

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

R2-18-09 Middle Patuxent Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	34
EPT Taxa	10
Ephemeroptera Taxa	2
Intolerant Urban %	39.8
Ephemeroptera %	1.7
Scraper Taxa	3
% Climbers	5.9

Calculated Metric Scores

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

Taxa	Count
Acerpenna	1
Amphinemura	12
Anchytarsus	25
Calopteryx	1
Ceratopogonidae	1
Cricotopus	1
Diplectrona	6
Dixella	2
Eccoptura	2
Enchytraeidae	1
Haploperla	5
Helichus	3
Heptageniidae	1
Heterotrissocladius	2
Hydropsychidae	1
Lepidostoma	1
Leuctridae	1
Molophilus	1
Nigronia	1
Orthocladiinae	1
Orthocladius	3
Oulimnius	2
Parametriocnemus	4
Polycentropus	12
Polypedilum	4
Pseudolimnophila	1
Pycnopsyche	3
Rheocricotopus	3
Rheotanytarsus	1
Simuliidae	1
Tanytarsus	1
Thienemannimyia	3
Tipula	4
Trichoptera	1
Tubificidae	1
Turbellaria	1
Zavrelimyia	4
TOTAL:	**118**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	5	Pool Variability	14
Bank Stability- Right Bank	3	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	15	Sediment Deposition	13
Channel Sinuosity	18	Vegetative Protection - Left Bank	7
Epifaunal Substrate/Available Cover	14	Vegetative Protection - Right Bank	5
Pool Substrate Characterization	12		
EPA Habitat Score			**146**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	16	86.16	Instream Wood Debris	12	92.93
Shading	95	99.94	Instream Habitat	13	94.7
Epifaunal Substrate	14	100	Bank Stability	8	63.25
PHI Score					**89.5**
PHI Narrative Rating					**Minimally Degraded**

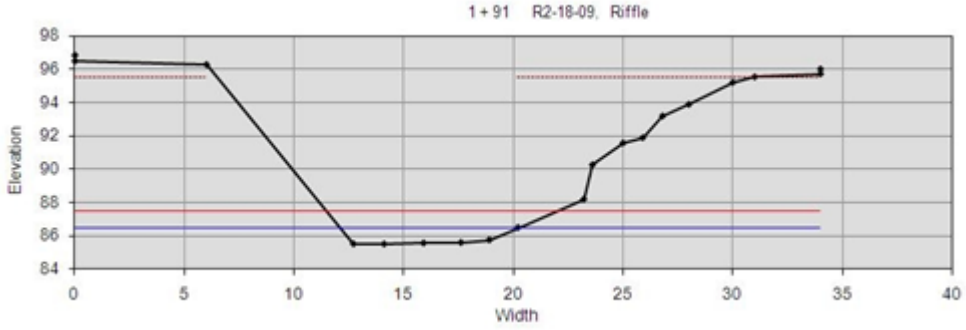
Water Chemistry

Dissolved Oxygen (mg/L)	9.82	pH (SU)	7.37
Turbidity (NTU)	4.54	Specific Conductivity (µS/cm)	54.6
Temperature (°C)	14.2		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.46	Cross Sectional Area (ft^2)	6.5
Bankfull Width (ft)	8.1	Water Surface Slope (%)	0.44
Mean Bankfull Depth (ft)	0.8	Sinuosity	1.7
Floodprone Width (ft)	10.5	D50 (mm)	1.8
Entrenchment Ratio	1.3	Adjustments?	
Width to Depth Ratio	10.1	**Rosgen Stream Type**	**G4/5c**



R2-18-10 Middle Patuxent Sampling Unit

Upstream View:

Downstream View:

Latitude: 38.9853502 **Longitude:** -76.69373167

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		838.4
Cover	**Acres**	**% Area**
Developed Land	**318.9**	**38**
Airport	0	0
Commercial	32.8	3.9
Industrial	7.8	0.9
Residential 1/8-acre	10.7	1.3
Residential 1/4-acre	51.9	6.2
Residential 1/2-acre	0	0
Residential 1-Acre	12.5	1.5
Residential 2-Acre	186.1	22.2
Transportation	17.1	2
Utility	0	0
Forest Land	**326.6**	**39**
Forested Wetland	0	0
Residential Woods	0	0
Woods	326.6	39
Open Land	**67.5**	**8.1**
Open Space	67.5	8.1
Open Wetland	0	0
Water	0	0
Agricultural Land	**125.4**	**14.9**
Pasture/Hay	4.4	0.5
Row Crops	121	14.4
Impervious Surface	**Acres**	**% Area**
Impervious Land	86.61	10.3

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Supporting"* and *"Partially Degraded"*
- Plecoptera (Amphinemura and Haploperla) and worms of the Tubificidae family dominated the sample. Scored high for intolerant percent.
- Water quality values within COMAR standards.
- Bank stability scored high but habitat diversity received marginal scores. Very little woody debris. Good riparian vegetation.
- Stream type not determined due to channel type transitions within the reach.

Recommendations:

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

R2-18-10 Middle Patuxent Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	21
EPT Taxa	6
Ephemeroptera Taxa	0
Intolerant Urban %	49.2
Ephemeroptera %	0
Scraper Taxa	0
% Climbers	7.5

Calculated Metric Scores

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

Taxa	Count
Amphinemura	26
Anchytarsus	5
Brillia	1
Chironomini	1
Diplectrona	5
Eccoptura	1
Enchytraeidae	1
Haploperla	17
Lepidostoma	5
Lumbricina	1
Micropsectra	1
Naididae	1
Natarsia	1
Nigronia	1
Orthocladiinae	8
Parachaetocladius	7
Perlidae	1
Polypedilum	2
Pseudolimnophila	2
Pycnopsyche	4
Rheocricotopus	2
Tipula	11
Tropisternus	1
Tubificidae	15
TOTAL:	**120**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	9	Pool Variability	7
Bank Stability- Right Bank	7	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	11	Riparian Vegetative Zone Width- Right Bank	9
Channel Flow Status	16	Sediment Deposition	10
Channel Sinuosity	14	Vegetative Protection - Left Bank	8
Epifaunal Substrate/Available Cover	9	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	8		
EPA Habitat Score			**126**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	10	53.85	Instream Wood Debris	2	51.42
Shading	90	91.34	Instream Habitat	8	56.18
Epifaunal Substrate	9	64.64	Bank Stability	16	89.45
PHI Score					**67.81**
PHI Narrative Rating					**Partially Degraded**

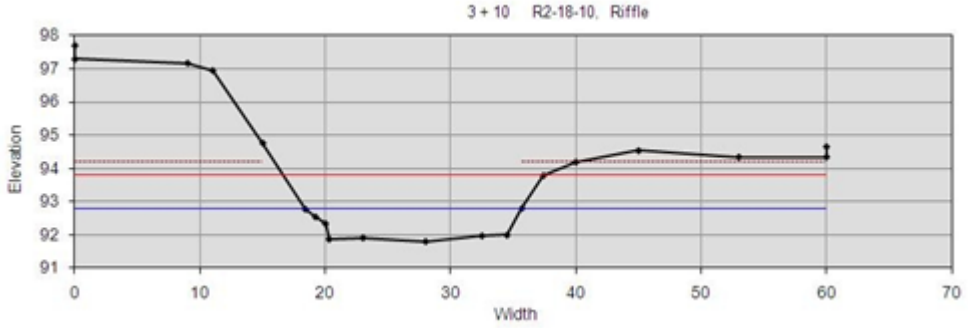
Water Chemistry

Dissolved Oxygen (mg/L)	11.07	pH (SU)	7.14
Turbidity (NTU)	3.99	Specific Conductivity (µS/cm)	218.9
Temperature (°C)	11.5		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	1.31	Cross Sectional Area (ft^2)	14
Bankfull Width (ft)	17.4	Water Surface Slope (%)	0.35
Mean Bankfull Depth (ft)	0.81	Sinuosity	1.2
Floodprone Width (ft)	20.9	D50 (mm)	0.25
Entrenchment Ratio	1.2	Adjustments?	
Width to Depth Ratio	21.4	**Rosgen Stream Type**	**ND**



R2-18-11A Middle Patuxent Sampling Unit

Upstream View:

Downstream View:

Latitude: 38.99157108 **Longitude:** -76.68009332

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		234
Cover	**Acres**	**% Area**
Developed Land	**114**	**48.7**
Airport	0	0
Commercial	19.5	8.3
Industrial	0	0
Residential 1/8-acre	10.7	4.6
Residential 1/4-acre	31.4	13.4
Residential 1/2-acre	0	0
Residential 1-Acre	9.7	4.2
Residential 2-Acre	34.4	14.7
Transportation	8.3	3.5
Utility	0	0
Forest Land	**59.5**	**25.4**
Forested Wetland	0	0
Residential Woods	0	0
Woods	59.5	25.4
Open Land	**40.2**	**17.2**
Open Space	40.2	17.2
Open Wetland	0	0
Water	0	0
Agricultural Land	**20.2**	**8.6**
Pasture/Hay	0	0
Row Crops	20.2	8.6
Impervious Surface	**Acres**	**% Area**
Impervious Land	38.91	16.6

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Supporting"* and *"Minimally Degraded"*
- Midges (Rheocricotopus) and the beetle Anchytarsus dominated the sample.
- Water quality values within COMAR standards.
- Woody debris scored high with sub-optimal scores for remaining habitat variables. Good riparian vegetation.

Recommendations:

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

R2-18-11A Middle Patuxent Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	27
EPT Taxa	5
Ephemeroptera Taxa	1
Intolerant Urban %	20.8
Ephemeroptera %	0.8
Scraper Taxa	2
% Climbers	5

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
Amphinemura	5
Anchytarsus	20
Brillia	2
Caecidotea	1
Ceratopogonidae	5
Chironomidae	1
Chironomini	2
Crangonyx	6
Diplectrona	6
Diplocladius	3
Dubiraphia	1
Enchytraeidae	1
Hydropsychidae	1
Ironoquia	4
Leptophlebiidae	1
Libellulidae	1
Lirceus	1
Lumbricina	2
Macronychus	1
Micropsectra	2
Orthocladiinae	2
Orthocladius	1
Pisidiidae	1
Polycentropus	9
Polypedilum	4
Prostoma	1
Pseudolimnophila	1
Rheocricotopus	23
Sphaerium	1
Thienemannimyia	3
Tipula	1
Tubificidae	7
TOTAL:	**120**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	5	Pool Variability	10
Bank Stability- Right Bank	6	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	19	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	15	Sediment Deposition	11
Channel Sinuosity	19	Vegetative Protection - Left Bank	6
Epifaunal Substrate/Available Cover	13	Vegetative Protection - Right Bank	7
Pool Substrate Characterization	10		
EPA Habitat Score			**141**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	11	59.24	Instream Wood Debris	10	89.53
Shading	95	99.94	Instream Habitat	11	85.89
Epifaunal Substrate	13	96.2	Bank Stability	11	74.16
PHI Score					**84.16**
PHI Narrative Rating					**Minimally Degraded**

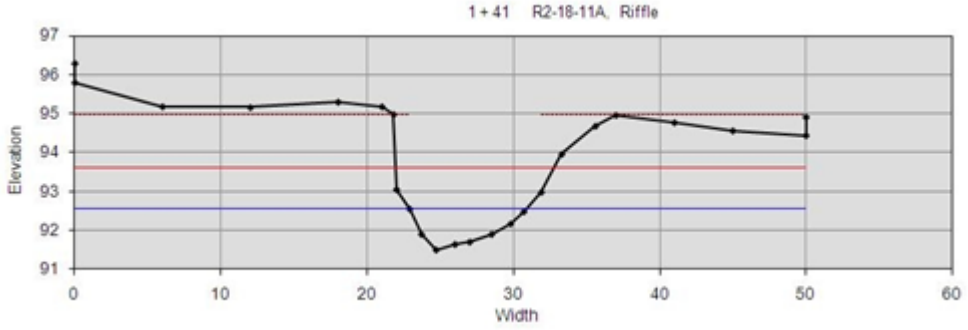
Water Chemistry

Dissolved Oxygen (mg/L)	9.06	pH (SU)	7.5
Turbidity (NTU)	5.56	Specific Conductivity (µS/cm)	232.3
Temperature (°C)	14.1		

Geomorphic Assessment

Rosgen Level II Classification Data

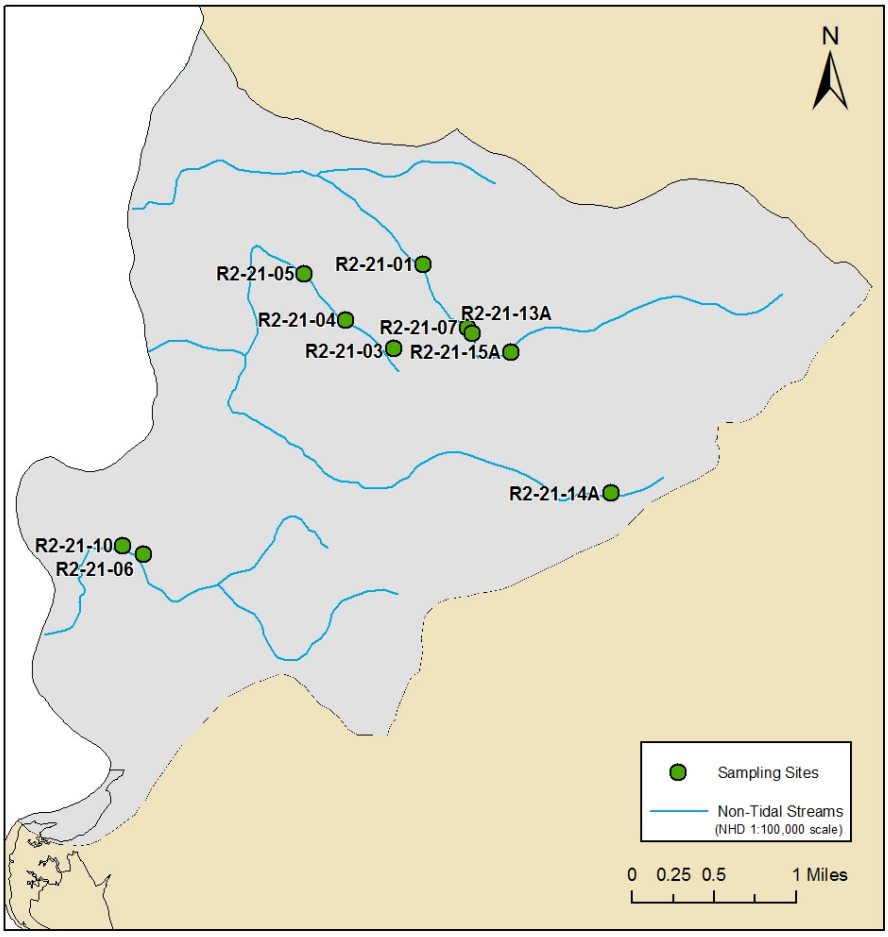
Drainage Area (mi^2)	0.37	Cross Sectional Area (ft^2)	5.3
Bankfull Width (ft)	8	Water Surface Slope (%)	0.5
Mean Bankfull Depth (ft)	0.66	Sinuosity	1.8
Floodprone Width (ft)	10.8	D50 (mm)	0.19
Entrenchment Ratio	1.4	Adjustments?	
Width to Depth Ratio	12.1	**Rosgen Stream Type**	**F5**



Ferry Branch 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
R2-21-01	2042.6	3.19	3.7	18.4	41.3	36.3	4.0	Fair	Partially Degraded	Supporting	F
R2-21-03	53.2	0.08	9.6	55.4	24.5	14.4	5.8	Fair	Partially Degraded	Partially Supporting	B
R2-21-04	172.2	0.27	9.4	56.8	23.6	8.5	11.1	Fair	Degraded	Partially Supporting	F
R2-21-05	217.7	0.34	8.8	55.9	27.2	8.1	8.8	Fair	Partially Degraded	Partially Supporting	F
R2-21-06	934.5	1.46	8.8	27.4	54.9	13.8	3.9	Fair	Severely Degraded	Partially Supporting	DA
R2-21-07	1857.1	2.9	4.0	19.4	38.1	38.3	4.2	Fair	Partially Degraded	Partially Supporting	F
R2-21-10	944.3	1.48	8.8	27.2	55.2	13.7	3.8	Poor	Degraded	Partially Supporting	G
R2-21-13A	1851.5	2.89	4.0	19.4	37.9	38.4	4.3	Fair	Partially Degraded	Partially Supporting	F
R2-21-14A	148.3	0.23	4.9	21.6	37.1	39.3	2.0	Poor	Degraded	Partially Supporting	G
R2-21-15A	1610.9	2.52	3.3	16.6	37.6	43.0	2.9	Poor	Partially Degraded	Partially Supporting	F



R2-21-01 Ferry Branch Sampling Unit

Upstream View:

Downstream View:

Latitude: 38.83321321 **Longitude:** -76.66624422

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		2042.6
Cover	**Acres**	**% Area**
Developed Land	**376.5**	**18.4**
Airport	0	0
Commercial	15.5	0.8
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	6.1	0.3
Residential 1-Acre	44.6	2.2
Residential 2-Acre	282.6	13.8
Transportation	27.7	1.4
Utility	0	0
Forest Land	**843.7**	**41.3**
Forested Wetland	0	0
Residential Woods	0	0
Woods	843.7	41.3
Open Land	**81.3**	**4**
Open Space	80.2	3.9
Open Wetland	0	0
Water	1.1	0.1
Agricultural Land	**741.3**	**36.3**
Pasture/Hay	303.8	14.9
Row Crops	437.5	21.4
Impervious Surface	**Acres**	**% Area**
Impervious Land	75.87	3.7

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Supporting"* and *"Partially Degraded"*
- Sample dominated by midges (Orthocladius and Polypedilum) and isopods (Caecidotea).
- Water quality values within COMAR standards.
- Most habitat variables received sub-optimal scores. Woody debris scored low. Good riparian vegetation.

Recommendations:

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

R2-21-01 Ferry Branch Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	33
EPT Taxa	3
Ephemeroptera Taxa	0
Intolerant Urban %	21.8
Ephemeroptera %	0
Scraper Taxa	4
% Climbers	16.4

Calculated Metric Scores

Total Taxa	5
EPT Taxa	3
Ephemeroptera Taxa	1
Intolerant Urban %	3
Ephemeroptera %	1
Scraper Taxa	5
% Climbers	5
BIBI Score	**3.29**
BIBI Narrative Rating	**Fair**

Taxa	Count
Ablabesmyia	3
Ancyronyx	4
Anopheles	1
Caecidotea	18
Calopteryx	3
Chironominae	2
Chironomini	1
Colymbetini	1
Conchapelopia	5
Cordulegaster	1
Corduliidae	3
Diplocladius	1
Dixella	1
Dubiraphia	1
Gammarus	2
Hydrobaenus	4
Hydroporini	2
Ironoquia	6
Lumbriculidae	1
Lype	1
Micropsectra	2
Orthocladiinae	3
Orthocladius	11
Paracladopelma	1
Parametriocnemus	1
Paratanytarsus	2
Polypedilum	7
Pycnopsyche	1
Rheocricotopus	2
Rheotanytarsus	1
Scirtes	1
Tanypodinae	1
Tanytarsus	5
Thienemannimyia	4
Tipula	1
Tubificidae	2
Zavrelimyia	4
TOTAL:	**110**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	5	Pool Variability	13
Bank Stability- Right Bank	3	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	18	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	15	Sediment Deposition	7
Channel Sinuosity	16	Vegetative Protection - Left Bank	7
Epifaunal Substrate/Available Cover	12	Vegetative Protection - Right Bank	4
Pool Substrate Characterization	10		
EPA Habitat Score			**130**
EPA Narrative Rating			**Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	16	86.16	Instream Wood Debris	9	62.05
Shading	95	99.94	Instream Habitat	12	69.26
Epifaunal Substrate	12	76.27	Bank Stability	9	67.08
PHI Score					**76.79**
PHI Narrative Rating					**Partially Degraded**

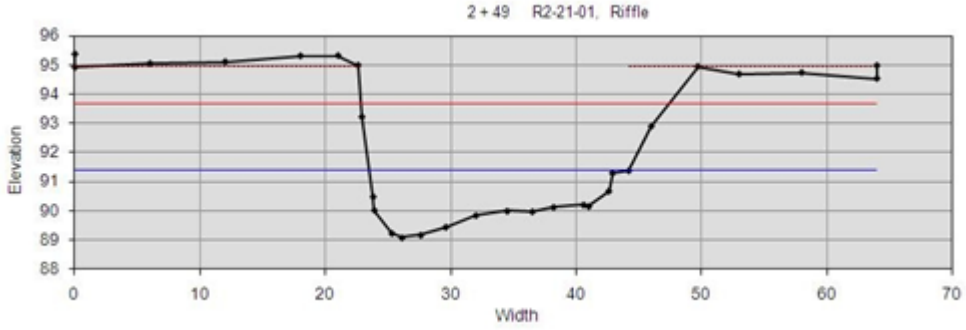
Water Chemistry

Dissolved Oxygen (mg/L)	11.04	pH (SU)	7.09
Turbidity (NTU)	6.41	Specific Conductivity (µS/cm)	165.8
Temperature (°C)	11.8		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	3.19	Cross Sectional Area (ft^2)	29.9
Bankfull Width (ft)	20.7	Water Surface Slope (%)	0.16
Mean Bankfull Depth (ft)	1.44	Sinuosity	1.4
Floodprone Width (ft)	24.6	D50 (mm)	0.12
Entrenchment Ratio	1.2	Adjustments?	
Width to Depth Ratio	14.3	**Rosgen Stream Type**	**F5**



R2-21-03 Ferry Branch Sampling Unit

Upstream View:

Downstream View:

Latitude: 38.82581407 **Longitude:** -76.66955892

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**53.2**
Cover	**Acres**	**% Area**
Developed Land	**29.5**	**55.4**
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	26.8	50.4
Transportation	2.7	5
Utility	0	0
Forest Land	**13**	**24.5**
Forested Wetland	0	0
Residential Woods	0	0
Woods	13	24.5
Open Land	**3.1**	**5.8**
Open Space	3.1	5.8
Open Wetland	0	0
Water	0	0
Agricultural Land	**7.6**	**14.4**
Pasture/Hay	0	0
Row Crops	7.6	14.4
Impervious Surface	**Acres**	**% Area**
Impervious Land	5.12	9.6

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Isopods (Caecidotea) and Trichoptera (Ironoquia and Polycentropus) dominated the sample. Scored high for intolerant percent.
- Measured below COMAR standards for pH.
- Woody debris scored high with marginal scores for habitat diversity.

Recommendations:

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

R2-21-03 Ferry Branch Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	21
EPT Taxa	5
Ephemeroptera Taxa	0
Intolerant Urban %	66.7
Ephemeroptera %	0
Scraper Taxa	3
% Climbers	2.6

Calculated Metric Scores

Total Taxa	3
EPT Taxa	5
Ephemeroptera Taxa	1
Intolerant Urban %	5
Ephemeroptera %	1
Scraper Taxa	5
% Climbers	3
BIBI Score	**3.29**
BIBI Narrative Rating	**Fair**

Taxa	Count
Amphinemura	7
Amphipoda	4
Bivalvia	1
Caecidotea	56
Calopteryx	1
Corduliidae	2
Crangonyx	3
Culicoides	1
Diplectrona	4
Diplocladius	2
Gammarus	2
Hydrobaenus	1
Ironoquia	11
Limnephilidae	1
Neophylax	1
Orthocladiinae	2
Parametriocnemus	2
Physa	1
Polycentropus	7
Pseudolimnophila	1
Rheocricotopus	3
Tubificidae	2
Turbellaria	1
Zavrelimyia	1
TOTAL:	**117**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	6	Pool Variability	6
Bank Stability- Right Bank	7	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	15	Riparian Vegetative Zone Width- Right Bank	4
Channel Flow Status	10	Sediment Deposition	7
Channel Sinuosity	13	Vegetative Protection - Left Bank	7
Epifaunal Substrate/Available Cover	8	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	7		
EPA Habitat Score			**108**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	6	32.31	Instream Wood Debris	5	91.51
Shading	90	91.34	Instream Habitat	7	78.86
Epifaunal Substrate	8	76.8	Bank Stability	13	80.63
PHI Score					**75.24**
PHI Narrative Rating					**Partially Degraded**

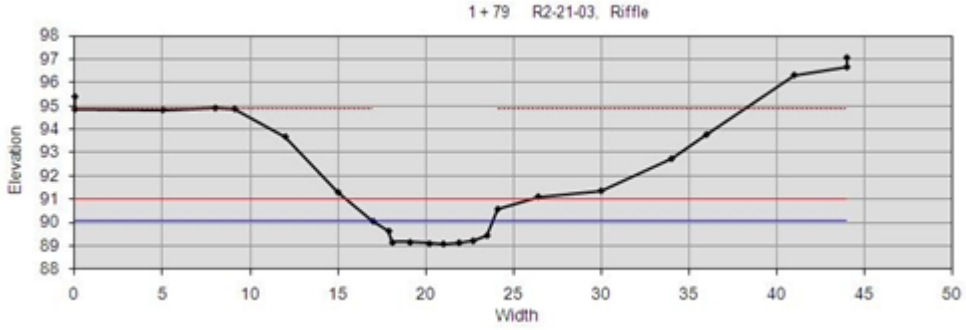
Water Chemistry

Dissolved Oxygen (mg/L)	10.32	pH (SU)	6.35
Turbidity (NTU)	2.42	Specific Conductivity (µS/cm)	253.8
Temperature (°C)	11.3		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.08	Cross Sectional Area (ft^2)	5.3
Bankfull Width (ft)	6.8	Water Surface Slope (%)	0.84
Mean Bankfull Depth (ft)	0.77	Sinuosity	1.4
Floodprone Width (ft)	10.6	D50 (mm)	1.3
Entrenchment Ratio	1.6	Adjustments?	
Width to Depth Ratio	8.9	**Rosgen Stream Type**	**B4c/5c**



R2-21-04 Ferry Branch Sampling Unit

Upstream View:

Downstream View:

Latitude: 38.82827473 **Longitude:** -76.67504265

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		172.2
Cover	**Acres**	**% Area**
Developed Land	**97.8**	**56.8**
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	2.1	1.2
Residential 1-Acre	0	0
Residential 2-Acre	89.6	52
Transportation	6.1	3.5
Utility	0	0
Forest Land	**40.6**	**23.6**
Forested Wetland	0	0
Residential Woods	0	0
Woods	40.6	23.6
Open Land	**19.2**	**11.1**
Open Space	19.2	11.1
Open Wetland	0	0
Water	0	0
Agricultural Land	**14.6**	**8.5**
Pasture/Hay	0	0
Row Crops	14.6	8.5
Impervious Surface	**Acres**	**% Area**
Impervious Land	16.13	9.4

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Partially Supporting"* and *"Degraded"*
- Sample dominated by Amphinemura (Plecoptera), Gammarus (Amphipoda), and Ironoquia (Trichoptera).
- Water quality values within COMAR standards.
- Poor bank stability and marginal habitat diversity. Little woody debris. Good riparian vegetation.

Recommendations:

- Maintain the protection of the riparian areas.
- Investigate potential water quality impacts from residential land uses.
- Determine causes of instability observed in this reach and evaluate potential for stabilization.

R2-21-04 Ferry Branch Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	20
EPT Taxa	3
Ephemeroptera Taxa	0
Intolerant Urban %	38.5
Ephemeroptera %	0
Scraper Taxa	3
% Climbers	3.8

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	28
Caecidotea	7
Calopteryx	1
Chironomini	1
Cryptochironomus	1
Gammarus	17
Hexatoma	1
Hydrobaenus	2
Ironoquia	16
Neophylax	3
Orthocladius	7
Parametriocnemus	2
Pedicia	1
Polypedilum	3
Saetheria	1
Simulium	2
Stegopterna	1
Stenelmis	1
Tipula	1
Tubificidae	5
Tvetenia	3
TOTAL:	**104**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	2	Pool Variability	6
Bank Stability- Right Bank	3	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	18	Riparian Vegetative Zone Width- Right Bank	9
Channel Flow Status	11	Sediment Deposition	6
Channel Sinuosity	15	Vegetative Protection - Left Bank	3
Epifaunal Substrate/Available Cover	8	Vegetative Protection - Right Bank	5
Pool Substrate Characterization	7		
EPA Habitat Score			**103**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	7	37.7	Instream Wood Debris	2	69.34
Shading	95	99.94	Instream Habitat	7	66.84
Epifaunal Substrate	8	69.15	Bank Stability	5	50
PHI Score					**65.49**
PHI Narrative Rating					**Degraded**

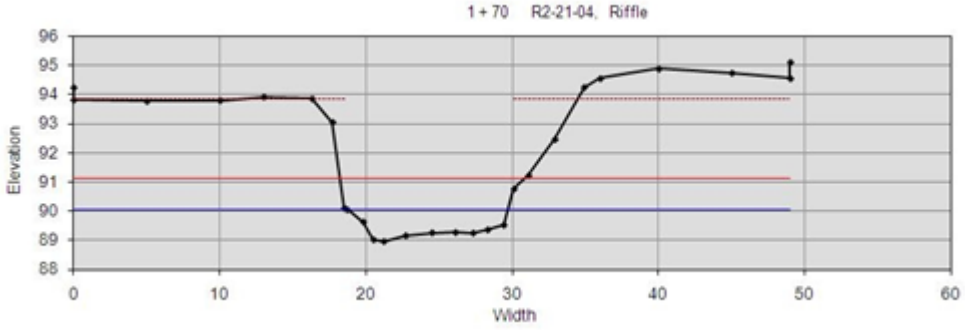
Water Chemistry

Dissolved Oxygen (mg/L)	10.78	pH (SU)	6.67
Turbidity (NTU)	3.55	Specific Conductivity (µS/cm)	185.9
Temperature (°C)	10.9		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.27	Cross Sectional Area (ft^2)	8.2
Bankfull Width (ft)	11	Water Surface Slope (%)	0.58
Mean Bankfull Depth (ft)	0.74	Sinuosity	1.7
Floodprone Width (ft)	12.7	D50 (mm)	2.3
Entrenchment Ratio	1.2	Adjustments?	
Width to Depth Ratio	14.8	**Rosgen Stream Type**	**F4/6**



R2-21-05 Ferry Branch Sampling Unit

Upstream View:

Downstream View:

Latitude: 38.83235609 **Longitude:** -76.67970368

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		217.7
Cover	**Acres**	**% Area**
Developed Land	**121.6**	**55.9**
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	2.1	1
Residential 1-Acre	0	0
Residential 2-Acre	111.5	51.2
Transportation	8	3.7
Utility	0	0
Forest Land	**59.2**	**27.2**
Forested Wetland	0	0
Residential Woods	0	0
Woods	59.2	27.2
Open Land	**19.2**	**8.8**
Open Space	19.2	8.8
Open Wetland	0	0
Water	0	0
Agricultural Land	**17.7**	**8.1**
Pasture/Hay	2.9	1.3
Row Crops	14.8	6.8
Impervious Surface	**Acres**	**% Area**
Impervious Land	19.07	8.8

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Sample dominated by Amphinemura (Plecoptera), Gammarus (Amphipoda), and Caecidotea (Isopoda).
- Water quality values within COMAR standards.
- Most habitat variables received marginal scores. Good riparian vegetation.

Recommendations:

- Maintain the protection of the riparian areas.
- Investigate potential water quality impacts from residential land uses.
- Determine causes of instability observed in this reach and evaluate potential for stabilization.

R2-21-05 Ferry Branch Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	27
EPT Taxa	4
Ephemeroptera Taxa	1
Intolerant Urban %	37.9
Ephemeroptera %	1
Scraper Taxa	1
% Climbers	7.8

Calculated Metric Scores

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

Taxa	Count
Amphinemura	22
Amphipoda	1
Brillia	1
Caecidotea	15
Calopteryx	2
Corynoneura	1
Crangonyctidae	3
Dixella	1
Gammarus	15
Hydrobaenus	1
Hydrobius	2
Ironoquia	8
Isoperla	1
Leptophlebiidae	1
Naididae	1
Natarsia	3
Ormosia	1
Orthocladius	5
Parametriocnemus	1
Paratendipes	1
Phaenopsectra	1
Polypedilum	4
Rheocricotopus	1
Simulium	1
Stygobromus	1
Thienemannimyia	1
Tipula	2
Tipulidae	1
Tubificidae	4
Tvetenia	1
TOTAL:	**103**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	4	Pool Variability	6
Bank Stability- Right Bank	6	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	19	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	10	Sediment Deposition	6
Channel Sinuosity	13	Vegetative Protection - Left Bank	5
Epifaunal Substrate/Available Cover	8	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	6		
EPA Habitat Score			**111**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	10	53.85	Instream Wood Debris	9	87.39
Shading	95	99.94	Instream Habitat	7	64.44
Epifaunal Substrate	8	67.62	Bank Stability	10	70.71
PHI Score					**73.99**
PHI Narrative Rating					**Partially Degraded**

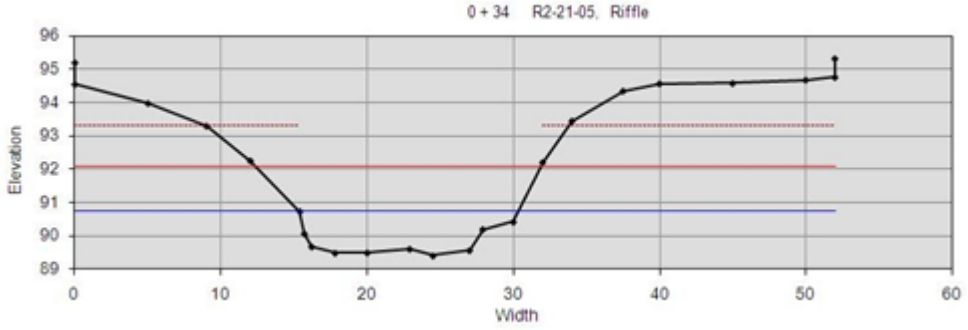
Water Chemistry

Dissolved Oxygen (mg/L)	10.88	pH (SU)	7.38
Turbidity (NTU)	3.15	Specific Conductivity (µS/cm)	191.3
Temperature (°C)	10.7		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.34	Cross Sectional Area (ft^2)	15.4
Bankfull Width (ft)	15	Water Surface Slope (%)	0.4
Mean Bankfull Depth (ft)	1.03	Sinuosity	1.5
Floodprone Width (ft)	19.4	D50 (mm)	0.24
Entrenchment Ratio	1.3	Adjustments?	
Width to Depth Ratio	14.5	**Rosgen Stream Type**	**F5/4**



R2-21-06 Ferry Branch Sampling Unit

Upstream View:

Downstream View:

Latitude: 38.80761327 **Longitude:** -76.69791882

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		**934.5**
Cover	**Acres**	**% Area**
Developed Land	**255.8**	**27.4**
Airport	0	0
Commercial	6.2	0.7
Industrial	0	0
Residential 1/8-acre	93.9	10.1
Residential 1/4-acre	0	0
Residential 1/2-acre	1.9	0.2
Residential 1-Acre	33	3.5
Residential 2-Acre	73.3	7.8
Transportation	47.5	5.1
Utility	0	0
Forest Land	**513.2**	**54.9**
Forested Wetland	0	0
Residential Woods	0	0
Woods	513.2	54.9
Open Land	**36.2**	**3.9**
Open Space	34.4	3.7
Open Wetland	0	0
Water	1.8	0.2
Agricultural Land	**129.2**	**13.8**
Pasture/Hay	5.1	0.5
Row Crops	124.1	13.3
Impervious Surface	**Acres**	**% Area**
Impervious Land	81.86	8.8

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Partially Supporting"* and *"Severely Degraded"*
- Isopods (Caecidotea) and midges (Orthocladius and Cricotopus) dominated the sample. Scored high for intolerant percent.
- Water quality values within COMAR standards.
- Most habitat variables received marginal scores.

Recommendations:

- Protect riparian area.
- Determine causes of instability observed in this reach and evaluate potential for stabilization.

R2-21-06 Ferry Branch Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	21
EPT Taxa	1
Ephemeroptera Taxa	1
Intolerant Urban %	41.7
Ephemeroptera %	0.9
Scraper Taxa	2
% Climbers	0.9

Calculated Metric Scores

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

Taxa	Count
Ablabesmyia	1
Baetidae	1
Brillia	1
Caecidotea	46
Calopteryx	1
Chaetocladius	1
Chironomidae	1
Conchapelopia	1
Cricotopus	18
Dubiraphia	3
Heterotrissocladius	1
Lumbriculidae	1
Macronychus	1
Naididae	4
Odontomesa	1
Orthocladius	25
Parachaetocladius	1
Rheocricotopus	1
Simuliidae	1
Thienemannimyia	1
Tubificidae	2
Tvetenia	2
TOTAL:	**115**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	5	Pool Variability	5
Bank Stability- Right Bank	5	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	5
Channel Flow Status	20	Sediment Deposition	18
Channel Sinuosity	8	Vegetative Protection - Left Bank	7
Epifaunal Substrate/Available Cover	7	Vegetative Protection - Right Bank	7
Pool Substrate Characterization	4		
EPA Habitat Score			**121**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	5	26.93	Instream Wood Debris	9	70.9
Shading	5	0	Instream Habitat	7	49.53
Epifaunal Substrate	7	52.32	Bank Stability	10	70.71
PHI Score					**45.06**
PHI Narrative Rating					**Severely Degraded**

Water Chemistry

Dissolved Oxygen (mg/L)	11.01	pH (SU)	7.45
Turbidity (NTU)	8.47	Specific Conductivity (µS/cm)	186.9
Temperature (°C)	12.7		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	1.46	Cross Sectional Area (ft^2)	7.5
Bankfull Width (ft)	8.5	Water Surface Slope (%)	0.42
Mean Bankfull Depth (ft)	0.88	Sinuosity	1.1
Floodprone Width (ft)	156.3	D50 (mm)	0.062
Entrenchment Ratio	18.3	Adjustments?	
Width to Depth Ratio	9.7	**Rosgen Stream Type**	**DA5**

R2-21-07 Ferry Branch Sampling Unit

Upstream View:

Downstream View:

Latitude: 38.82764104 **Longitude:** -76.66117341

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		1857.1
Cover	**Acres**	**% Area**
Developed Land	**359.7**	**19.4**
Airport	0	0
Commercial	15.5	0.8
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	6.1	0.3
Residential 1-Acre	41.8	2.2
Residential 2-Acre	268.6	14.5
Transportation	27.7	1.5
Utility	0	0
Forest Land	**707.1**	**38.1**
Forested Wetland	0	0
Residential Woods	0	0
Woods	707.1	38.1
Open Land	**78.8**	**4.2**
Open Space	77.7	4.2
Open Wetland	0	0
Water	1.1	0.1
Agricultural Land	**711.7**	**38.3**
Pasture/Hay	284.9	15.3
Row Crops	426.8	23
Impervious Surface	**Acres**	**% Area**
Impervious Land	74.04	4

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Midges dominated the sample including Polypedilum, Hydrobaenus, and Orthocladius.
- Water quality values within COMAR standards.
- Most habitat variables received marginal to sub-optimal scores.

Recommendations:

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

R2-21-07 Ferry Branch Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	25
EPT Taxa	2
Ephemeroptera Taxa	0
Intolerant Urban %	3.8
Ephemeroptera %	0
Scraper Taxa	2
% Climbers	24.5

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
Ancyronyx	2
Argia	1
Caecidotea	3
Cheumatopsyche	5
Chironomidae	1
Chironomini	3
Chironomus	1
Conchapelopia	1
Crangonyx	3
Cryptochironomus	1
Diplocladius	1
Enchytraeidae	1
Harnischia	1
Hydrobaenus	17
Ironoquia	1
Liogma	1
Lumbriculidae	4
Microtendipes	1
Nigronia	1
Orthocladius	15
Parametriocnemus	2
Paratanytarsus	1
Polypedilum	24
Rheotanytarsus	4
Tanytarsus	1
Thienemannimyia	7
Tipula	2
Trichoptera	1
TOTAL:	**106**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	3	Pool Variability	11
Bank Stability- Right Bank	6	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	19	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	14	Sediment Deposition	6
Channel Sinuosity	15	Vegetative Protection - Left Bank	4
Epifaunal Substrate/Available Cover	10	Vegetative Protection - Right Bank	7
Pool Substrate Characterization	9		
EPA Habitat Score			**124**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	16	86.16	Instream Wood Debris	8	60.17
Shading	95	99.94	Instream Habitat	11	64.69
Epifaunal Substrate	10	65.27	Bank Stability	9	67.08
PHI Score					**73.88**
PHI Narrative Rating					**Partially Degraded**

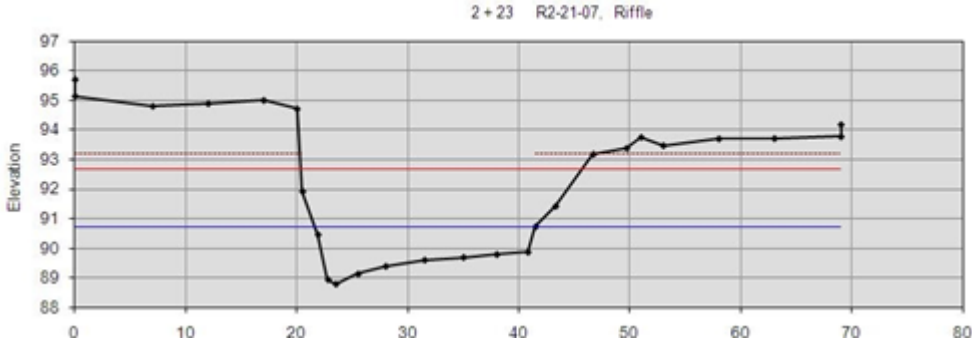
Water Chemistry

Dissolved Oxygen (mg/L)	12.34	pH (SU)	6.98
Turbidity (NTU)	6.37	Specific Conductivity (µS/cm)	159.9
Temperature (°C)	13.1		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	2.9	Cross Sectional Area (ft^2)	23.4
Bankfull Width (ft)	19.9	Water Surface Slope (%)	0.14
Mean Bankfull Depth (ft)	1.18	Sinuosity	1.4
Floodprone Width (ft)	25.3	D50 (mm)	0.12
Entrenchment Ratio	1.3	Adjustments?	
Width to Depth Ratio	16.9	**Rosgen Stream Type**	**F5/4**



R2-21-10 Ferry Branch Sampling Unit

Upstream View:

Downstream View:

Latitude: 38.80837629 **Longitude:** -76.70031657

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		944.3
Cover	**Acres**	**% Area**
Developed Land	**257**	**27.2**
Airport	0	0
Commercial	6.2	0.7
Industrial	0	0
Residential 1/8-acre	93.9	9.9
Residential 1/4-acre	0	0
Residential 1/2-acre	1.9	0.2
Residential 1-Acre	33	3.5
Residential 2-Acre	73.3	7.8
Transportation	48.7	5.2
Utility	0	0
Forest Land	**521.7**	**55.2**
Forested Wetland	0	0
Residential Woods	0	0
Woods	521.7	55.2
Open Land	**36.2**	**3.8**
Open Space	34.4	3.6
Open Wetland	0	0
Water	1.8	0.2
Agricultural Land	**129.2**	**13.7**
Pasture/Hay	5.1	0.5
Row Crops	124.1	13.1
Impervious Surface	**Acres**	**% Area**
Impervious Land	83.02	8.8

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Partially Supporting"* and *"Degraded"*
- Isopods (Caecidotea) and midges (Orthocladius and Cricotopus) dominated the sample. Scored high for intolerant percent.
- Water quality values within COMAR standards.
- Most habitat variables received marginal scores.

Recommendations:

- Protect riparian area.
- Determine causes of instability observed in this reach and evaluate potential for stabilization.

R2-21-10 Ferry Branch Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	13
EPT Taxa	1
Ephemeroptera Taxa	1
Intolerant Urban %	40.4
Ephemeroptera %	0.9
Scraper Taxa	4
% Climbers	0

Calculated Metric Scores

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

Taxa	Count
Ancyronyx	2
Baetis	1
Caecidotea	46
Chironomidae	1
Chironomus	1
Cricotopus	27
Dubiraphia	3
Gammarus	6
Macronychus	4
Orthocladiinae	1
Orthocladius	13
Parametriocnemus	1
Stenelmis	4
Thienemannimyia	1
Tvetenia	3
TOTAL:	**114**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	3	Pool Variability	7
Bank Stability- Right Bank	4	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	6
Channel Flow Status	16	Sediment Deposition	13
Channel Sinuosity	8	Vegetative Protection - Left Bank	4
Epifaunal Substrate/Available Cover	9	Vegetative Protection - Right Bank	4
Pool Substrate Characterization	3		
EPA Habitat Score			**107**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	5	26.93	Instream Wood Debris	7	64.87
Shading	90	91.34	Instream Habitat	9	60.52
Epifaunal Substrate	9	63.87	Bank Stability	7	59.16
PHI Score					**61.11**
PHI Narrative Rating					**Degraded**

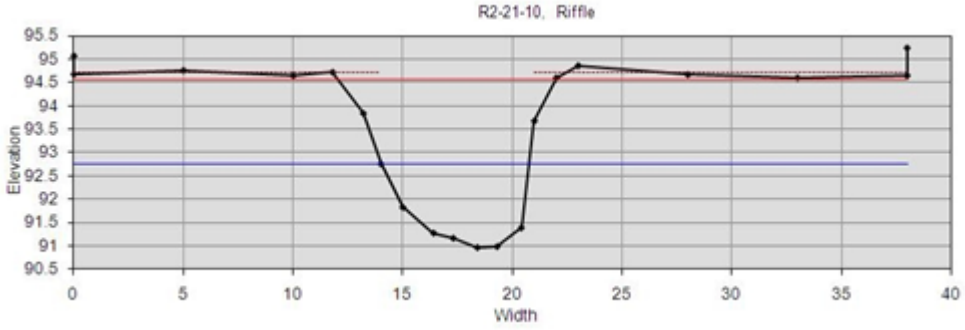
Water Chemistry

Dissolved Oxygen (mg/L)	10.68	pH (SU)	7.54
Turbidity (NTU)	8.72	Specific Conductivity (µS/cm)	189.4
Temperature (°C)	10.1		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	1.48	Cross Sectional Area (ft^2)	9
Bankfull Width (ft)	6.8	Water Surface Slope (%)	0.27
Mean Bankfull Depth (ft)	1.33	Sinuosity	1
Floodprone Width (ft)	9.9	D50 (mm)	0.088
Entrenchment Ratio	1.5	Adjustments?	
Width to Depth Ratio	5.1	**Rosgen Stream Type**	**G6/5c**



R2-21-13A Ferry Branch Sampling Unit

Upstream View:

Downstream View:

Latitude: 38.82708914 **Longitude:** -76.66066039

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		1851.5
Cover	**Acres**	**% Area**
Developed Land	**359.7**	**19.4**
Airport	0	0
Commercial	15.5	0.8
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	6.1	0.3
Residential 1-Acre	41.8	2.3
Residential 2-Acre	268.6	14.5
Transportation	27.7	1.5
Utility	0	0
Forest Land	**701.9**	**37.9**
Forested Wetland	0	0
Residential Woods	0	0
Woods	701.9	37.9
Open Land	**78.8**	**4.3**
Open Space	77.7	4.2
Open Wetland	0	0
Water	1.1	0.1
Agricultural Land	**711.2**	**38.4**
Pasture/Hay	284.9	15.4
Row Crops	426.3	23
Impervious Surface	**Acres**	**% Area**
Impervious Land	74.04	4

Summary Results:

- Biological condition – *"Fair"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Sample dominated by midges including Polypedilum and Orthocladius.
- Water quality values within COMAR standards.
- Woody debris scored high with sub-optimal scores for habitat diversity. Good riparian vegetation.

Recommendations:

- Maintain the protection of the riparian areas.
- Investigate potential water quality impacts from agricultural and residential land uses.
- Determine causes of instability observed in this reach and evaluate potential for stabilization.

R2-21-13A Ferry Branch Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	24
EPT Taxa	3
Ephemeroptera Taxa	0
Intolerant Urban %	4.7
Ephemeroptera %	0
Scraper Taxa	2
% Climbers	44.9

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
Ablabesmyia	1
Amphinemura	2
Ancyronyx	1
Caecidotea	1
Cheumatopsyche	1
Chironomidae	2
Chironomini	1
Chironomus	1
Conchapelopia	2
Diplocladius	1
Gammarus	3
Hydrobaenus	5
Ironoquia	4
Lumbriculidae	2
Micropsectra	2
Naididae	6
Orthocladiinae	1
Orthocladius	12
Paratanytarsus	1
Paratendipes	1
Polypedilum	46
Prostoma	1
Rheotanytarsus	1
Stygobromus	1
Thienemannimyia	4
Tipula	3
Tubificidae	1
TOTAL:	**107**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	2	Pool Variability	11
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	6
Channel Sinuosity	12	Vegetative Protection - Left Bank	4
Epifaunal Substrate/Available Cover	10	Vegetative Protection - Right Bank	8
Pool Substrate Characterization	8		
EPA Habitat Score			**121**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	17	91.55	Instream Wood Debris	17	86.83
Shading	95	99.94	Instream Habitat	11	64.72
Epifaunal Substrate	10	65.29	Bank Stability	9	67.08
PHI Score					**79.23**
PHI Narrative Rating					**Partially Degraded**

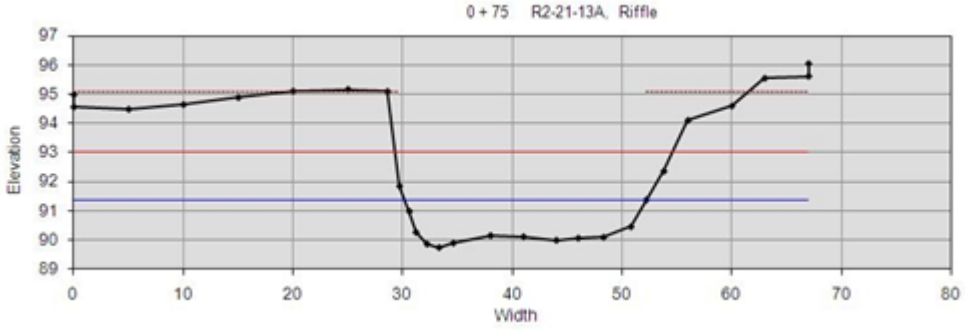
Water Chemistry

Dissolved Oxygen (mg/L)	12.36	pH (SU)	7.19
Turbidity (NTU)	5.58	Specific Conductivity (µS/cm)	173.3
Temperature (°C)	14.2		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	2.89	Cross Sectional Area (ft^2)	26.9
Bankfull Width (ft)	22	Water Surface Slope (%)	0.34
Mean Bankfull Depth (ft)	1.22	Sinuosity	1.1
Floodprone Width (ft)	25.3	D50 (mm)	0.57
Entrenchment Ratio	1.2	Adjustments?	
Width to Depth Ratio	18	**Rosgen Stream Type**	**F4/5**



R2-21-14A Ferry Branch Sampling Unit

Upstream View:

Downstream View:

Latitude: 38.8128703 **Longitude:** -76.64509373

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		148.3
Cover	**Acres**	**% Area**
Developed Land	**32**	**21.6**
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	26.5	17.9
Transportation	5.5	3.7
Utility	0	0
Forest Land	**55.1**	**37.1**
Forested Wetland	0	0
Residential Woods	0	0
Woods	55.1	37.1
Open Land	**3**	**2**
Open Space	3	2
Open Wetland	0	0
Water	0	0
Agricultural Land	**58.2**	**39.3**
Pasture/Hay	14.4	9.7
Row Crops	43.8	29.5

Impervious Surface	**Acres**	**% Area**
Impervious Land	7.28	4.9

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Partially Supporting"* and *"Degraded"*
- Sampled dominated by amphipods (Gammarus).
- Measured below COMAR standards for pH.
- Instream habitat and epibenthic substrate received poor scores. Good riparian vegetation.

Recommendations:

- Maintain the protection of the riparian areas.
- Investigate potential water quality impacts from agricultural and residential land uses.
- Determine causes of instability observed in this reach and evaluate potential for stabilization.

R2-21-14A Ferry Branch Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	11
EPT Taxa	3
Ephemeroptera Taxa	0
Intolerant Urban %	10
Ephemeroptera %	0
Scraper Taxa	1
% Climbers	4.2

Calculated Metric Scores

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

Taxa	Count
Amphinemura	3
Amphipoda	2
Caecidotea	1
Chironominae	1
Crangonyx	1
Dicranota	3
Diplectrona	5
Gammarus	95
Hydrobaenus	1
Polypedilum	5
Pycnopsyche	1
Tubificidae	1
Tvetenia	1
TOTAL:	**120**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	4	Pool Variability	4
Bank Stability- Right Bank	4	Riparian Vegetative Zone Width- Left Bank	9
Channel Alteration	20	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	16	Sediment Deposition	10
Channel Sinuosity	11	Vegetative Protection - Left Bank	5
Epifaunal Substrate/Available Cover	6	Vegetative Protection - Right Bank	5
Pool Substrate Characterization	4		
EPA Habitat Score			**108**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	7	37.7	Instream Wood Debris	3	73.99
Shading	95	99.94	Instream Habitat	5	57.27
Epifaunal Substrate	6	58.5	Bank Stability	8	63.25
PHI Score					**65.11**
PHI Narrative Rating					**Degraded**

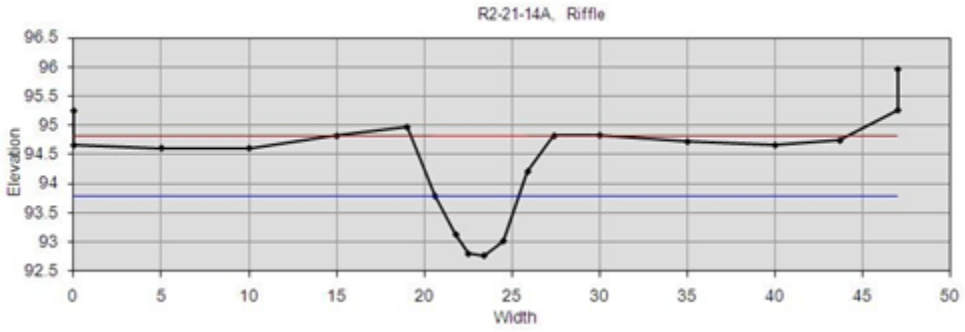
Water Chemistry

Dissolved Oxygen (mg/L)	8.46	pH (SU)	6.1
Turbidity (NTU)	18.6	Specific Conductivity (µS/cm)	153.9
Temperature (°C)	13.3		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	0.23	Cross Sectional Area (ft^2)	3.2
Bankfull Width (ft)	4.8	Water Surface Slope (%)	1
Mean Bankfull Depth (ft)	0.67	Sinuosity	1.2
Floodprone Width (ft)	8.4	D50 (mm)	0.064
Entrenchment Ratio	1.7	Adjustments?	
Width to Depth Ratio	7.2	**Rosgen Stream Type**	**G6/5c**



R2-21-15A Ferry Branch Sampling Unit

Upstream View:

Downstream View:

Latitude: 38.82542298 **Longitude:** -76.65630464

Land Use/Land Cover Analysis:

Total Drainage Area (acres)		1610.9
Cover	**Acres**	**% Area**
Developed Land	**266.9**	**16.6**
Airport	0	0
Commercial	8.3	0.5
Industrial	0	0
Residential 1/8-acre	0	0
Residential 1/4-acre	0	0
Residential 1/2-acre	6.1	0.4
Residential 1-Acre	33	2
Residential 2-Acre	198.5	12.3
Transportation	21	1.3
Utility	0	0
Forest Land	**605.5**	**37.6**
Forested Wetland	0	0
Residential Woods	0	0
Woods	605.5	37.6
Open Land	**46.4**	**2.9**
Open Space	45.3	2.8
Open Wetland	0	0
Water	1.1	0.1
Agricultural Land	**692.2**	**43**
Pasture/Hay	276.8	17.2
Row Crops	415.4	25.8
Impervious Surface	**Acres**	**% Area**
Impervious Land	53.36	3.3

Summary Results:

- Biological condition – *"Poor"*
- Habitat scores *"Partially Supporting"* and *"Partially Degraded"*
- Midges dominated the sample including Polypedilum, Hydrobaenus, and Orthocladius.
- Water quality values within COMAR standards.
- Most habitat variables received marginal scores. Good riparian vegetation.

Recommendations:

- Maintain the protection of the riparian areas.
- Investigate potential water quality impacts from agricultural and residential land uses.
- Determine causes of instability observed in this reach and evaluate potential for stabilization.

R2-21-15A Ferry Branch Sampling Unit

Biological Assessment

Raw Metric Values

Total Taxa	21
EPT Taxa	1
Ephemeroptera Taxa	0
Intolerant Urban %	2.7
Ephemeroptera %	0
Scraper Taxa	1
% Climbers	22.7

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
Calopteryx	1
Ceratopogonidae	1
Chironomini	4
Chironomus	1
Diplocladius	1
Enchytraeidae	1
Gammarus	1
Hexatoma	1
Hydrobaenus	6
Ironoquia	5
Micropsectra	1
Naididae	1
Orthocladiinae	3
Orthocladius	48
Parametriocnemus	1
Phaenopsectra	4
Polypedilum	23
Pseudolimnophila	1
Rheotanytarsus	1
Thienemannimyia	1
Tubificidae	2
Tvetenia	2
TOTAL:	**110**

Physical Habitat Assessment

EPA Rapid Bioassessment Protocol

Bank Stability- Left Bank	4	Pool Variability	11
Bank Stability- Right Bank	5	Riparian Vegetative Zone Width- Left Bank	10
Channel Alteration	19	Riparian Vegetative Zone Width- Right Bank	10
Channel Flow Status	15	Sediment Deposition	7
Channel Sinuosity	10	Vegetative Protection - Left Bank	5
Epifaunal Substrate/Available Cover	10	Vegetative Protection - Right Bank	6
Pool Substrate Characterization	8		
EPA Habitat Score			**120**
EPA Narrative Rating			**Partially Supporting**

MBSS Physical Habitat Index

	Value	Score		Value	Score
Remoteness	14	75.39	Instream Wood Debris	8	61.78
Shading	90	91.34	Instream Habitat	10	60.6
Epifaunal Substrate	10	66.2	Bank Stability	9	67.08
PHI Score					**70.4**
PHI Narrative Rating					**Partially Degraded**

Water Chemistry

Dissolved Oxygen (mg/L)	10.07	pH (SU)	6.81
Turbidity (NTU)	10.61	Specific Conductivity (µS/cm)	156.2
Temperature (°C)	15.1		

Geomorphic Assessment

Rosgen Level II Classification Data

Drainage Area (mi^2)	2.52	Cross Sectional Area (ft^2)	19.2
Bankfull Width (ft)	19.1	Water Surface Slope (%)	0.28
Mean Bankfull Depth (ft)	1.01	Sinuosity	1
Floodprone Width (ft)	21.4	D50 (mm)	0.36
Entrenchment Ratio	1.1	Adjustments?	
Width to Depth Ratio	19	**Rosgen Stream Type**	**F4/5**