BIOLOGICAL AND GEOMORPHOLOGICAL CONDITION IN THE PICTURE SPRING BRANCH SUBWATERSHED, SEVERN RIVER WATERSHED, ANNE ARUNDEL COUNTY, MARYLAND: 2015 - 2016

FINAL REPORT

Prepared for

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February 1, 2017

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1.0 INTRODUCTION

Anne Arundel County is required to perform physical stream monitoring in the Picture Spring Branch Subwatershed in accordance with their National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System Discharge Permit (NPDES permit number MD0068306). The goal of this monitoring effort is to assess the implementation of best management practice (BMP) design criteria from the *2000 Maryland Stormwater Design Manual* approved by Maryland Department of the Environment (MDE). The BMP design criteria were applied to the stormwater management system constructed at the West County Library site, located in Odenton, Maryland, just west of the intersection of State Highways 170 (Telegraph Road) and 175 (Annapolis Road). Specifically, bioretention areas and dry swale structural BMPs, and the nonstructural credit "sheetflow to buffer" were incorporated into the library site development in order to mitigate the effects of stormwater runoff on Picture Spring Branch.

In addition, there are four other BMPs within the watershed that are providing detention for stormwater that are impacting the flows through the study reach. These include a dry detention pond, a retention pond, and two other detention ponds with shallow wetlands. Baseline conditions within the watershed, for both land use and BMP functionality, were developed as part of this long-term study. These conditions are monitored periodically to determine if changes within the watershed affect the conditions found in the stream channel. Stormwater facility locations within the watershed were verified for this 2015 report.

To monitor the effectiveness of these BMPs on stream channel protection, the County has implemented a NPDES Monitoring Program to characterize the biological and geomorphological conditions of the Picture Spring Branch Subwatershed, located within the Severn River Watershed, in the vicinity of the Odenton/West County Library. Physical condition and habitat monitoring for Picture Spring Branch began in 2003 and is conducted on an annual basis. Biological monitoring to measure overall stream health is also performed.

This report summarizes the results of biological, geomorphological, and physical habitat assessments performed in 2016 with comparisons to previous years' conditions, and discusses the current watershed conditions.

2.0 METHODS

2.1 SAMPLING LOCATIONS

The study area is located in the southwestern portion of the Picture Spring Branch Subwatershed, within the Severn River Watershed in Anne Arundel County, Maryland (Figure 2-1). The study area consists of the North Tributary and South Tributary and encompasses approximately 155 acres of drainage. The land use within the Picture Spring Branch study area is dominated by developed land, with over 56% residential, commercial, and industrial uses (Table 2-1). Less than one-third of the subwatershed (31.6%) is open space or wooded land cover, most of which surrounds the stream valley.

Three biological monitoring locations are located within the study area, which were selected by County staff in 2006 (see Figure 2-1). Two sites were placed on the North Tributary and one site was placed downstream of the confluence with the South Tributary and below Piney Orchard Parkway (MD State Highway 170). Sites were marked in the field using silver tree tags labeled with the site name located at the upstream and downstream ends of each 75-meter sampling segment.

Table 2-1. Summary of land use in the Picture Spring Branch Subwatershed, Anne Arundel County

Land Use	Acres	% of Watershed Area
Commercial	15.6	10.0%
Industrial	16.3	10.5%
Open Space	6.0	3.9%
Residential	56.0	36.1%
Transportation	16.8	10.8%
Utility	1.6	1.1%
Forest	43.0	27.7%
Total	**155.3**	

Source: Anne Arundel County Department of Public Works

Five permanent cross sections were previously established for the County's NPDES Program and were measured again in 2016 as part of the annual geomorphological assessment. Three cross sections are located along the North Tributary, one is located on the South Tributary, and another is located downstream of Piney Orchard Parkway (see Figure 2-1). Permanent cross section monuments were placed on each bank and consist of iron bolts set in concrete flush to the ground surface.

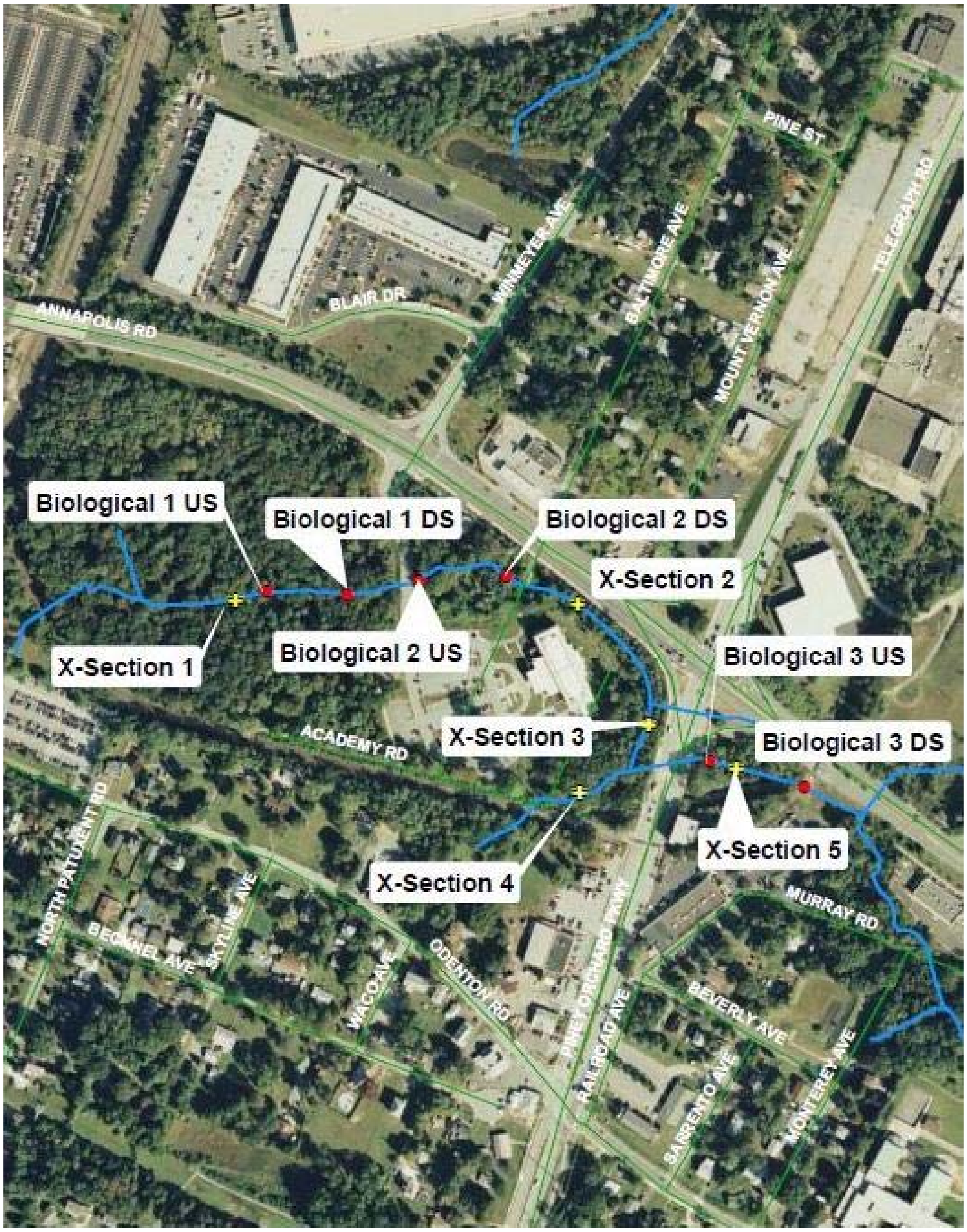

Figure 2-1. Picture Spring Branch study area stream monitoring locations

2.2 FIELD METHODS

All biological assessment data were collected in accordance with the *Anne Arundel County Biological Monitoring and Assessment Program: Quality Assurance Project Plan* (Anne Arundel County 2010), which incorporates many elements of Maryland Department of Natural Resources' Maryland Biological Stream Survey (MBSS). Geomorphic assessment data were collected in accordance with the standard operating procedures (SOPs) approved for the County's NPDES Program. All methods are consistent with previous years' methods (with applicable updates) to ensure data comparability between years. Collection methods are summarized below. Field data were collected in 2016 by Versar, Inc., a consultant to Anne Arundel County.

2.2.1 Stream Habitat

To support the biological monitoring, a visual assessment of physical habitat was completed at each monitoring site to evaluate the reach's ability to support aquatic life. Both the MBSS Physical Habitat Index (PHI; Paul et al. 2003) and the U.S. Environmental Protection Agency (EPA) Rapid Bioassessment Protocol (RBP) habitat assessment for low gradient streams (Barbour et al. 1999) were used to visually assess the physical habitat at each site in conjunction with the spring benthic monitoring. Both habitat assessments consist of a review of biologically significant habitat parameters that assess a stream's ability to support an acceptable level of biological health.

2.2.2 Benthic Macroinvertebrates

Benthic macroinvertebrate samples were collected in March 2016 following the MBSS Spring index period protocols (MD DNR 2010) and consistent with the methods specified in *Anne Arundel County Biological Monitoring and Assessment Program: Quality Assurance Project Plan* (QAPP; Anne Arundel County 2010). This methodology emphasizes the community composition and relative abundance of benthic macroinvertebrates inhabiting the most taxonomically diverse, or productive, instream habitats. In this 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. 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.

2.2.3 Water Quality

To supplement the biological and physical sampling, *in situ* water quality was measured at each site. Field tested 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, midpoint, and downstream end) and results were averaged to minimize variability and better represent water quality conditions throughout the entire sampling reach. All *in situ* parameters were measured with a YSI 6820 multiparameter water quality sonde.

2.2.4 Geomorphic Assessment

Geomorphic assessments included a survey of the longitudinal profile, measurement of permanent cross sections, and representative pebble counts. Data from these measurements were used to determine the stream type of each reach as categorized by the Rosgen Stream Classification (Rosgen 1996), which can be found in Appendix A.

The longitudinal profile was performed throughout the entire study area, totaling 1968 linear feet along the North Tributary and continuing below Telegraph Road (Maryland Route 170 and 356 linear feet along the South Tributary. The goal of the longitudinal profile was to identify indicators and elevations of the bankfull discharge (i.e., bankfull indicators) and to determine the bankfull water surface slope throughout the study reach. Once the bankfull indicators were identified, elevation data on the channel thalweg, water surface, and bankfull indicators were also collected.

The cross section surveys were performed at the five permanent cross section locations (Figure 2-1). Photos were taken of upstream, downstream, left bank, and right bank views at each cross section location. Photographs are included in Appendix B. Cross section surveys consisted of measuring the topographic variability of the associated stream bed, floodplains, and terraces, including:

- Monument elevations
- Changes in topography
- Top of each channel bank
- Elevations of bankfull indicators
- Edge of water during the time of survey
- Thalweg or deepest elevation along active channel
- Depositional and erosional features within the channel

During the cross sectional survey, the following measurements and calculations of the bankfull channel, which are critical for determining the Rosgen stream type of each reach, were also collected:

- Bankfull Width (Wbkf): the width of the channel at the elevation of bankfull discharge or at the stage that defines the bankfull channel.
- Mean Depth (dbkf): the mean depth of the bankfull channel.
- Bankfull Cross Sectional Area (Abkf): the area of the bankfull channel, estimated as the product of bankfull width and mean depth.
- Width Depth Ratio (Wbkf/dbkf): the ratio of the bankfull width to mean depth.
- Maximum Depth (dmbkf): the maximum depth of the bankfull channel, or the difference between the thalweg elevation and the bankfull discharge elevation.

- Width of Floodprone Area (Wfpa): the width of the channel at a stage of twice the maximum depth. If the width of the floodprone area was far outside of the channel, its value was visually estimated or paced off.
- Entrenchment Ratio (ER): the ratio of the width of the floodprone area versus bankfull width.
- Sinuosity (K): ratio of the stream length versus the valley length or the valley slope divided by the channel slope. Sinuosity was visually estimated or the valley length was paced off so that an estimate could be calculated.

To quantify the distribution of channel substrate particle sizes within the study area, a modified Wolman pebble count (Rosgen 1996) was performed at each cross section location. Reach-wide proportional counts were used. Each pebble count consists of stratifying the reach based on the frequency of channel features in that reach (e.g., riffle, run, pool, glide) and measuring 100 particles across ten transects (i.e., 10 particles in each of 10 transects). The transects are allocated across all feature types in the proportion at which they occur within the reach. The intermediate axis of each measured pebble is recorded. The goal of the pebble count is to measure 100 particles across the bankfull width of the channel and calculate the median substrate particle size (i.e., D50) of the reach. This value is used for categorizing the sites into the Rosgen Stream Classification (Rosgen 1996). If a channel was clearly a sand or silt bed channel with no distinct variation in material size, the pebble count was not performed, and the D50 was visually estimated. However, if the channel did have variation in bed material size from feature to feature, a full pebble count was performed.

2.3 DATA ANALYSIS

2.3.1 Aquatic Habitat

At each monitoring site, stream physical habitat was visually assessed utilizing the Maryland Biological Stream Survey (MBSS) Physical Habitat Index (PHI; Paul et al. 2003). The PHI was developed in part based on the EPA's Rapid Bioassessment Protocol (RBP; Barbour et al. 1999), and has been specifically calibrated to each of Maryland's physiographic regions. The habitat metrics for coastal plain streams include epifaunal substrate, percent shading, remoteness (i.e., distance to the nearest road), instream habitat, bank stability, and instream woody debris and rootwads. The metrics selected represent a mixture of physical habitat characteristics including geomorphology, habitat complexity for aquatic biota, riparian condition, and surrounding land use.

To calculate PHI at each site, six parameters were given a numerical score and a categorical rating. The raw scores are then transformed into a scaled score (0-100 scale) as described in Paul et al. (2003), and the six scaled scores are averaged into an aggregate final PHI score. Narrative condition descriptions and scoring ranges for the PHI are displayed in Table 2-2.

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: Epifaunal substrate/available cover, Embeddedness, Velocity/depth regime, Sediment deposition, Channel flow status, Channel alteration, Frequency of riffles/bends, Bank stability, Vegetative protection, and Riparian vegetative zone width (Barbour et al. 1999). In the field, each parameter was 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 individual RBP habitat parameters for each reach were summed to obtain an overall RBP assessment score. Because adequate reference conditions currently do not exist for Anne Arundel County, the percent comparability was calculated based on western coastal plain reference site conditions obtained from work done in Prince George's County streams (Stribling et al. 1999). The percent of reference score, or percent comparability score, was then used to place each site into corresponding narrative rating categories. The ranges are shown in Table 2-3.

Table 2-2. Maryland Biological Stream Survey PHI scoring

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

Table 2-3. EPA Rapid Bioassessment Protocol (RBP) scoring

Percent of Reference Score	**Narrative**
90-100	Comparable to Reference
75.1-89.9	Supporting
60.1-75	Partially Supporting
0-60	Non-Supporting

2.3.2 Benthic Macroinvertebrates

Benthic macroinvertebrate samples were processed and subsampled according to MBSS methods described in the MBSS laboratory methods manual (Boward and Freidman, 2000) and as briefly summarized in the *Anne Arundel County Biological Monitoring and Assessment Program: Quality Assurance Project Plan* (Anne Arundel County 2010). Subsampling is conducted to standardize the sample size and reduce variation caused by field collection methods. In brief, the sample was washed of preservative in a 0.595mm screen and spread evenly across a tray comprised of 100 numbered 5cm x 5cm grids. A random number between one and 100 was selected and the selected gird was picked entirely of macroinvertebrates under a bright light source. This process was repeated until a count of 120 was reached. The 120 organism target was used following MBSS methods to allow for specimens that are missing parts or are early instars, which cannot be properly identified.

The samples were taxonomically identified by Versar taxonomists certified by the Society for Freshwater Science (SFS) (formerly known as the North American Benthological Society, NABS). The taxonomic level for most organisms was genus level when possible, with the exception of Oligochaeta which were identified to the family level. Early instars or damaged specimens were identified to the lowest possible level. Oligochaeta and Chironomidae specimens were permanently slide mounted for identification. Counts and identifications were recorded on a laboratory bench sheet and entered into a master database for analysis. A list of all taxa identified is provided in Appendix C: Master Taxa List.

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. Tolerance values were obtained from Bressler et al. (2005).

Raw values from each metric are given a score of 1, 3, or 5 based on ranges of values developed for each metric. The results are combined into a scaled BIBI score ranging from 1.0 to 5.0 and a corresponding narrative rating is assigned. Three sets of metric calculations have been developed for Maryland streams based on broad physiographic regions: Coastal Plain, Piedmont and Combined Highlands. The Coastal Plain, and Piedmont regions are divided by the Fall Line. The current study area is located within the Coastal Plain region. Table 2-4 shows the thresholds for the determination of the metric scoring. The metrics calculated for Coastal Plain streams are as follows:

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.

Number of EPT Taxa – Equals the richness of genera within the Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). EPT taxa are generally considered pollution sensitive, thus higher levels of EPT taxa would be indicative of higher water quality.

Number of Ephemeroptera Taxa – Equals the total number of Ephemeroptera Taxa in the sample. Ephemeroptera are generally considered pollution sensitive, thus communities dominated by Ephemeroptera usually indicate lower disturbances in water quality.

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 out of 10. As impairment increases the percent of intolerant taxa decreases.

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.

Number Scraper Taxa – Equals the number of taxa in the sample that have evolved to scrape their food from the substrate in their environment. As the levels of stressors or pollution rise, there is an expected decrease in the numbers of Scraper taxa.

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.

Table 2-4. Biological condition scoring for the coastal plains metrics

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	1.9-1.0	< 1.0
Percent Intolerant Urban	≥ 28	10-27	< 10
Percent Ephemeroptera	≥ 11	0.8-10.9	< 0.8
Number Scraper Taxa	≥ 2	1.9-1.0	< 1.0
Percent Climbers	≥ 8.0	0.9-7.9	< 0.9

All of the metric scores are summed and then averaged to obtain the final BIBI score. Table 2-5 shows the scores and narrative rankings of the MBSS BIBI. The QA/QC information for these calculations is included in Appendix D.

Table 2-5. Maryland Biological Stream Survey BIBI scoring

BIBI Score	**Narrative Ranking**	**Characteristics**
4.0-5.0	Good	Comparable to reference conditions, stream considered to be minimally impacted, biological metrics fall within upper 50th percentile of reference site conditions.
3.0-3.9	Fair	Comparable to reference conditions, but some aspects of biological integrity may not resemble the qualities of minimally impacted streams.
2.0-2.9	Poor	Significant deviation from reference conditions, indicating some degradation. On average, biological metrics fall below the 10th percentile of reference site values.
1.0-1.9	Very Poor	Strong deviation from reference conditions, with most aspects of biological integrity not resembling the qualities of minimally impacted streams, indicating severe degradation. On average, most or all metrics fall below the 10th percentile of reference site values.

2.3.3 Water Quality

Data were compared to the standards for Use I streams listed in the *Code of Maryland Regulations (COMAR) 26.08.02.03-3 Water Quality* and shown in Table 2-6.

Table 2-6. Maryland COMAR water quality standards for Use I streams

Parameter	Standard
pH	6.5 to 8.5
Dissolved Oxygen (mg/L)	Minimum of 5 mg/L
Conductivity (µS/cm)	No existing standard
Turbidity (NTU)	Maximum of 150 NTU and maximum monthly average of 50 NTU
Total Dissolved Solids (mg/L)	No existing standard
Temperature (C)	Maximum of 32 °C (90 °F) or ambient temperature, whichever is greater

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

2.3.4 Geomorphic Assessment

Geomorphic field data were compared to regional relationships of bankfull channel geometry developed by the USFWS for streams in the Maryland Coastal Plain (McCandless 2003) and by Anne Arundel County Department of Public Works (AADPW 2002) for urban streams within the County. Estimates of the bankfull channel parameters, the longitudinal profile survey, the cross section survey, and the pebble count data were entered into *The Reference Reach Spreadsheet* (Mecklenburg 2004) and analyzed for each assessment site. These data were used to identify each stream reach as one of the stream types categorized by the Rosgen Stream Classification (Rosgen 1996). In the Rosgen Classification methodology, streams are categorized based on their measured field values of entrenchment ratio, width/depth ratio, sinuosity, water surface slope, and channel materials according to the table in Appendix A: Rosgen Stream Classification. As illustrated in Appendix A, the Rosgen Stream Classification categorizes streams into broad stream types, which are identified by the letters Aa, A, B, C, D, DA, E, F, and G. Table 2-7 includes general descriptions of each Rosgen stream type. A summary of the stream types identified for the streams in this study is included in Appendix B: Geomorphic Assessment Results.

Table 2-7. Rosgen Stream Classification types

Channel Type	General Description
Aa+	Very steep, deeply entrenched, debris transport, torrent streams.
A	Steep, entrenched, confined, cascading, step/pool streams. High energy/debris transport associated with depositional soils. Very stable if bedrock or boulder dominated channel.
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.
C	Low gradient, meandering, slightly entrenched, point-bar, riffle/pool, alluvial channels with broad, well-defined floodplains.
D	Braided channel with longitudinal and transverse bars. Very wide channel with eroding banks. Active lateral adjustment, 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 streambanks.
E	Low gradient, Highly sinuous, riffle/pool stream with low width/depth ratio and little deposition. Very efficient and stable. High meander/width ratio.
F	Entrenched, meandering riffle/pool channel on low gradients with high width/depth ratio and high bank erosion rates.
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.

Source: Rosgen (1996).

2.4 LAND USE AND STORMWATER MANAGEMENT ASSESSMENT

A previous report (Versar 2013) provided information on land use, based on field reconnaissance conducted during 2013. As seen in an aerial photograph and stormwater best management practice (BMP) facilities map (Figure 2-2), the watershed is a mix of commercial and residential, with a large block of forest adjacent to the stream channels and smaller fragments of forest interspersed with the other land uses. Anecdotal information indicates there has been no significant change in land use in this watershed since the 2013 land use evaluation.

2.4.1 Picture Spring Branch Watershed BMP Inspections

The Picture Spring Branch watershed contains 17 BMPs, as shown in Figure 2-2 and Table 2-8. Inspections were conducted on November 16, 2015 and January 13, 2016 (hereafter termed the "2015/2016 inspections"). Inspections at BMPs under the County's jurisdiction are carried out regularly and the records are maintained at the County offices. Each BMP was inspected during dry weather conditions (defined as a minimum 48 hours of dry weather since the last rain event). A brief overview of actions recommended to address maintenance/performance issues at specific BMPs are in the following section. Further details, including the detailed inspection findings for each of the BMPs, inspection forms, and photographs, are included in Appendix G.

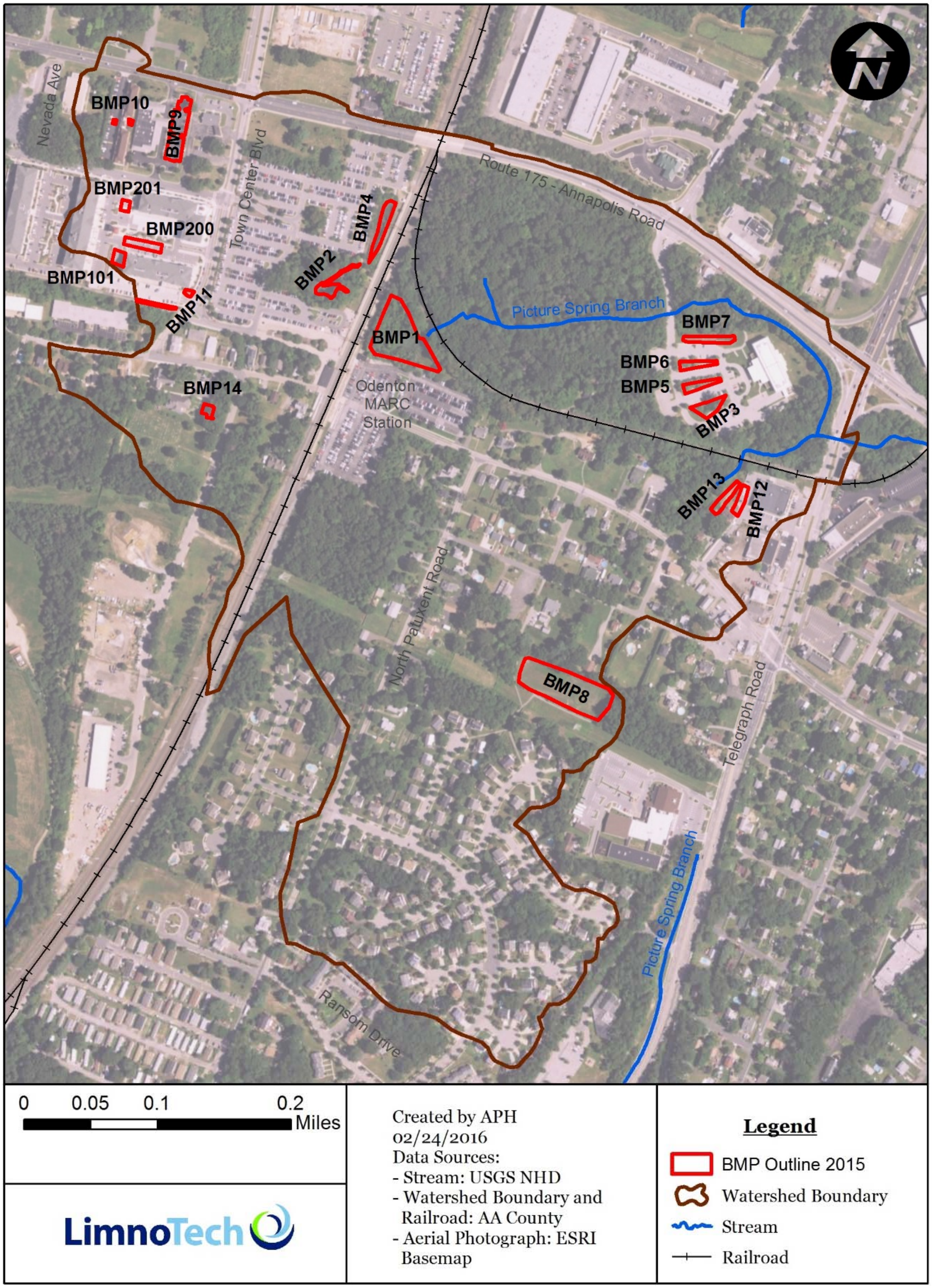

Figure 2-2. Picture Spring Branch BMPs

Table 2-8. Picture Spring Branch BMP Overview

Picture Spring Branch BMP	AA County Urban BMP Database ID[(a)]	Current BMP Type in Data-base[(b)]	Recom-mended Updated BMP Type	Drainage Area (acres)[(c)]	Location	Address	Presumed Owner	County Follow-up Completed
1	AA004443	IBAS	IBAS	2.1	Odenton MARC Station Parking Lot	Odenton MARC Station	MTA	---
2	Not found in 2015 database	N/A	WP	-	Odenton MARC Station Parking Lot	Odenton MARC Station	MTA	---
3	AA012420	FBIO	FBIO	3	West County Library Parking Lot	1325 Annapolis Road	County	Feature moved to correct location
4	Not found in 2015 database	N/A	WP	-	Odenton MARC Station Parking Lot	Odenton MARC Station	MTA	---
5	AA012419	FBIO	FBIO	3	West County Library Parking Lot	1325 Annapolis Road	County	Feature moved to correct location
6	AA012418	FBIO	FBIO	3	West County Library Parking Lot	1325 Annapolis Road	County	Feature moved to correct location
7	AA012421	ODSW	ODSW	3	West County Library Parking Lot	1325 Annapolis Road	County	Feature moved to correct location
8	AA002445	PWED	XDED	36.86	Peach Tree East Neighborhood	Peach Leaf Court	County	---
9	AA004558	XDPD	XDED	2	Donaldson Funeral Home Parking Lot	1411 Annapolis Road	County	---
10	AA000692	ITRN	ITRN and FBIO	-	Odenton Commerce Center Parking Lot (aka Goodman Office Building)	1413A Annapolis Road	County	---
11	AA009980	ITRN	FBIO (2 BMPs)	0.67	The Village at Odenton Parking Lot	Town Center Boulevard	County	Features moved to the correct location, will be separated and the correct BMP type assigned next year
12	AA012190	XDPD	XDED	1.9	Walgreens Parking Lot	8374 Piney Orchard Parkway	County	---

Table2-8. (Continued)

Picture Spring Branch BMP	AA County Urban BMP Database ID[(a)]	Current BMP Type in Data-base[(b)]	Recom-mended Updated BMP Type	Drainage Area (acres)[(c)]	Location	Address	Presumed Owner	County Follow-up Completed
13	AA012189	FSND	FSND	1.9	Walgreens Parking Lot	8374 Piney Orchard Parkway	County	---
14	AA004926	ITRN	ITRN	2.97	Epiphany Episcopal Church Playground	1419 Odenton Road	Private	---
101	AA009978	ITRN	ITRN	0.51	The Village at Odenton Station	360 Morgan Road	Unknown	Feature moved to the correct location
200	AA009979	ITRN	ITRN	0.70	The Village at Odenton Station	360 Morgan Road	Unknown	Feature moved to the correct location
201	AA009976 AA009977	ITRN	ITRN	3	The Village at Odenton Station	360 Morgan Road	Unknown	Feature moved to the correct location

(a) Numbering system carried over from the 2013 BMP inspection report.

(b) The 2015 Anne Arundel County Urban BMP database was used to identify the BMP type data for the 2015/2016 inspections (See List of Acronyms in Appendix A). Thus BMP type data may be different from the 2013 BMP type data for the same BMP. In addition, LimnoTech has recommended that some of these BMP types be changed based on what was observed in the field.

(c) The 2015 Anne Arundel County Urban BMP database was used to update drainage areas for the 2015/2016 inspections. Some drainage areas are missing in the Urban BMP database.

All of the stormwater BMPs identified during the last inspection in 2013 were inspected again during the 2015/2016 inspection effort. No new BMPs have been installed since the 2013 inspection (Versar 2013) and so no new BMPs were inspected; however, the most recent inspections did provide more precise data on the BMPs at the Village at Odenton Station compared to the 2013 inspections. In addition, some BMPs that were inspected are not included in the County's BMP inventory database or have since been more precisely located outside of the Picture Spring Branch watershed. Inspected BMPs that are not in the County's database are a legacy of previous BMP inspections, and were inspected during this effort because they were inspected in 2013.

2.4.2 Summary of Recommended Priority Actions

This section summarizes the results of the inspection of each BMP for its physical condition. In addition, this report notes if there were any issues with the way that BMPs are characterized in the database. For 'Physical Issues,' the BMPs are grouped into three categories: those for which immediate attention is recommended; those that show early signs of stress but do not require corrective action at this point; and those that are in good condition. For 'Database Issues' the BMPs are grouped into two categories - those that have classification issues; and those that are missing from the database, are not located correctly, or require some other changes to be made. Note that some of the BMPs identified for immediate action are owned by Maryland Transportation Authority (MTA); in these cases, we recommend that the County coordinate with MTA to address maintenance issues.

2.4.2.1 Physical Issues

Immediate action recommended:

- The stormwater ponds located along the parking lot and tracks of the Odenton MARC train station (BMPs 1, 2, and 4) have a significant amount of invasive vegetation that should be cleared as soon as possible to prevent failure. BMPs 1 and 2 also have trash and debris build up which should be cleared. Note that these BMPs are owned by MTA and the County may want to coordinate with MTA regarding these BMPs.

Showing early signs of stress, but no immediate action recommended:

- BMP 7, located north of the West County Library, is beginning to show evidence of erosion at the inflow points and trash buildup.

In good condition:

- BMPs 3, 5, 6, 8, 9, 10, 11, 12, 13, are all in good condition.
- BMPs 14, 101, 200, and 201 appear to be in good condition, but it should be noted that the condition of these Infiltration Trenches could not be fully assessed because of the limited access to the underground facilities. Flow-in points appear to be clear.

2.4.2.2 Database Issues

BMP classification issues:

- BMP classifications have changed from 2013 to 2015 /2016 for BMPs 8, 9, 11, and 12 based on updated data from the 2015 BMP database. However, field observations of these BMPs do not support the classification changes for these BMPs (see write-ups for individual BMPs for specific information on individual discrepancies). It is recommended that these BMPs undergo further investigation to reconcile information in the BMP database with field observations.
- BMP classifications have changed from 2013 to 2015/2016 for BMPs 1, 3, 5, 6, 7, 10, 13, and 14 based on updated data from the 2015 BMP database. These updates appear to be appropriate based on field observation of these BMPs and are noted here for completeness.

Recommended changes to individual BMPs in the BMP database:

- Based on the 2015/2016 inspections, LimnoTech recommends splitting BMP 10 into two records (the infiltration trench and the rain garden) (see discussion of this BMP below for more information.)
- Based on the 2015/2016 inspections, LimnoTech recommends splitting BMP 11 into two records (see discussion of this BMP below for more information).
- BMPs 2 and 4 are not currently included in the Urban BMP database. LimnoTech recommends adding these BMPs to the database.

3.0 RESULTS

3.1 AQUATIC HABITAT

Physical habitat quality within the Picture Spring Branch study area was primarily rated as "Partially Degraded" by the Maryland PHI. The most upstream reach, PSB-01, received the highest score (79.0). Remoteness was rated very low at all sites due to proximity to roads and parking lots surrounding the stream reach, however, banks exhibited only minor erosion and woody debris and rootwads were present in sufficient amounts for colonization of benthic macroinvertebrates. At site PSB-01 there was substantial riparian buffer and well-vegetated banks throughout this reach providing adequate shading. Site PSB-02, located between the Winmeyer Avenue and Baltimore Avenue culverts, received a score of 67.8. The site downstream of Maryland Route 170 (PSB-03) also received a PHI score of 60.5. Lower PHI scores at Sites PSB-02 and PSB-03 were primarily driven by lower remoteness scores and shading scores than PSB-01. Table 3-1 shows the PHI scores for the sampling sites within the Picture Spring Branch study area. Data for individual parameters are listed in Appendix F.

Physical habitat quality was also evaluated with the RBP and rated "Partially Supporting" for two sites and "Supporting" for one site (Table 3-1). Index scores varied somewhat and ranged from a low of 69 at PSB-02 to a high of 80 at PSB-01. All sites scored low for velocity/depth regime and sediment deposition metrics. PSB-02 scored especially low in sediment deposition.

Table 3-1. PHI and RBP physical habitat assessment results - 2016

Site	PHI Score	PHI Narrative Rating	RBP Score	RBP Narrative Rating
PSB-01	79.0	Partially Degraded	80	Supporting
PSB-02	67.8	Partially Degraded	69	Partially Supporting
PSB-03	68.0	Partially Degraded	72	Partially Supporting

3.2 BENTHIC MACROINVERTEBRATES

The biological condition rated "Fair " at all sites. Table 3-2 contains the BIBI scores and corresponding narrative condition ratings for each sampling location. Detailed data on each site can be found in Appendix F: Biological Assessment Results.

Each 2016 monitoring location in Picture Spring Branch exhibited benthic biotic improvement from the previous two years of monitoring. The most upstream site within the North Tributary (PSB-01) had a BIBI score of 3.29. This site is buffered by a young deciduous forest. The macroinvertebrate community was represented by 22 taxa, seven of which were sensitive EPT taxa. The sample was dominated by individuals of the family Pisidium, a small to minute fresh-water bivalve mollusk. Overall, 26.1% of the individuals present in the subsample were intolerant to urban stressors. However, the low occurrence of Ephemeroptera taxa in the subsample may indicate that stressors such as sedimentation could be affecting the biological community. Climbers made up 3.4% of the sample.

Table 3-2. Benthic macroinvertebrate assessment results - 2016

Site	BIBI Score	Narrative Rating
PSB-01	3.29	Fair
PSB-02	3.00	Fair
PSB-03	3.29	Fair

Site PSB-02, also located on the North Tributary, received a BIBI score of 3.00. Of the 18 taxa present in the subsample, 13.8% were intolerant to urban stressors, and five taxa were the sensitive EPT taxa. The dominant taxa at this site was the chironomid Parametriocnemus, followed by Pisidium. This site lacked Ephemeroptera taxa but had two Scraper taxa. The 2016 PSB-02 benthic subsample had a decrease in the percentage of climbers from 2015, with values of 4.1% and 16.2%, respectively.

Downstream of State Highway 170, site PSB-03 received a BIBI score of 3.29. Overall, this site had a total of 24 taxa identified, including five sensitive EPT taxa, and 41.0% Climbers, with 5 Scraper taxa. Three percent of the individuals present were intolerant to urban stressors, however, Ephemeroptera taxa were absent from the subsample. The benthic community was dominated by the taxa Physa, a sensitive climber taxa adapted to living on stem/leaf type surfaces.

3.3 WATER QUALITY

With the exception of pH at PSB-01, all water quality measurements met Maryland's water quality standards for Use I streams (Table 3-3). Conductivity values were relatively high compared to most coastal plain streams, but are within the range of those found in other urban, or highly impervious, drainage areas in Maryland (DNR, 2001, 2003, 2005; KCI, 2009; Hill and Crunkleton, 2009). Stream conductivity is affected by inorganic dissolved solids such as chloride, nitrate, sulfate, and phosphate anions or sodium, magnesium, calcium, iron, and aluminum cations, many of which are generally found at elevated concentrations in urban streams (Paul and Meyer 2001). Increased stream ion concentrations (measured as conductivity) in urban systems typically result from runoff over impervious surfaces, passage through pipes, and exposure to other infrastructure (Cushman 2006).

Table 3-3. Water Quality Measurement Results - 2016					
	pH	**Temperature**	**Dissolved Oxygen**	**Conductivity**	**Turbidity**
Site	**unit**	**°C**	**mg/L**	**µS/cm**	**NTU**
PSB-01	6.15	15.74	7.80	1565	15.0
PSB-02	6.60	11.93	8.27	1367	13.5
PSB-03	6.85	9.65	11.25	1135	12.6

3.4 GEOMORPHIC ASSESSMENT

The geomorphic assessment field data were compared to both the Maryland Coastal Plain (MCP) regional relationships of bankfull channel geometry (McCandless 2003) and relationships for gaged urban Coastal Plain streams developed specifically for Anne Arundel County (AADPW 2002) to determine how bankfull characteristics observed in the field compared to those predicted by the MCP and urban relationships. Comparisons of bankfull width, bankfull cross-sectional area, and mean bankfull depth are shown in Figures 3-1, 3-2, and 3-3, respectively. Bankfull width values tended to loosely fit the predictions of the urban curve, with some points wider than predicted due to the engineered channel design. All bankfull cross-section area field data values fell between the MCP curve and urban curve predictions. Field data for mean bankfull depth mainly fell between the MCP curve and urban curve predictions, with one site falling just below the MCP curve. Overall, it appears that some of the field data were not consistent with the MCP relationships; however, it should be noted that the regional curves were developed using streams with drainage areas ranging from 0.3 to 89.7 square miles, with the majority of the data collected in watersheds greater than one square-mile with low (zero to three percent) imperviousness. Thus, it is possible that stream channels with smaller drainage areas, such as those studied in this assessment (ranging from 0.07 to 0.23 square miles), exhibit greater variability in channel dimensions when compared to the MCP relationships. Additionally, the Rosgen method is best used on streams that are free to adjust their lateral boundaries under the current discharge regime experienced by the system (Rosgen 1996), conditions which do not necessarily exist in the study area. For example, cross sections 2, 3, and 5 are underlain by concrete trapezoidal channels, possibly making the accurate determination of the bankfull indicators in the field at these locations problematic. Regardless, given the high imperviousness of the study drainage area and the modified nature of the channel, it is not surprising that the field data deviated in many cases from the MCP curve and were more closely matched to urban curve predictions for bankfull width.

Based on the Rosgen Classification scheme, two sites were classified as C channels, two sites as F channels, and one site was classified as an E channel (Table 3-4). Water surface slopes along the study area ranged from 0.0018 ft/ft to 0.015 ft/ft. D50’s ranged from 0.19 mm to 0.40 mm, meaning all five sites had channel substrates dominated by sand. Detailed summaries of the geomorphic data and stream types are included in Appendix B: Geomorphic Assessment Results.

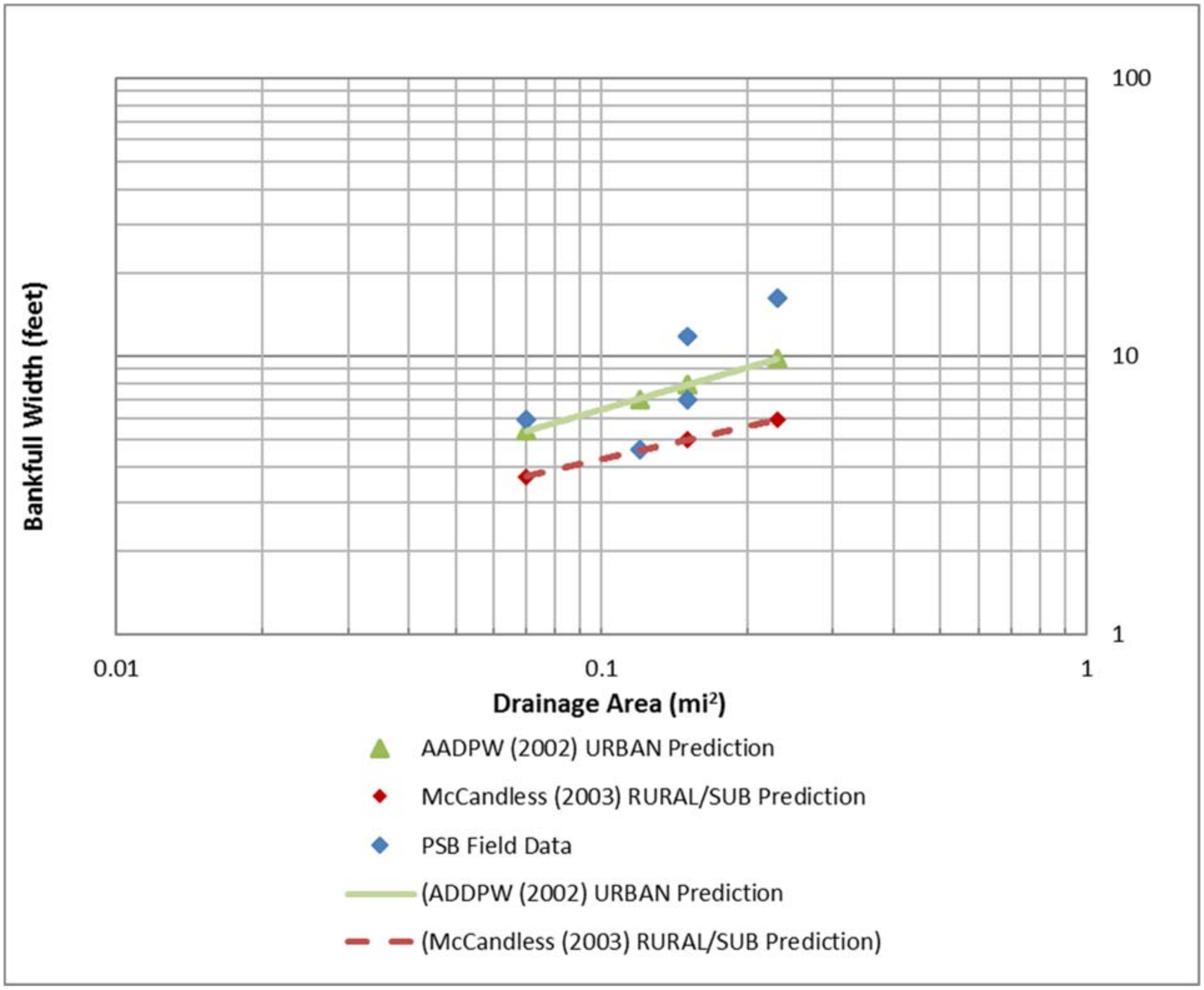

Figure 3-1. Comparison of the bankfull width drainage area relationship between Picture Spring Branch (PSB) 2016 field data and regional relationship curve data

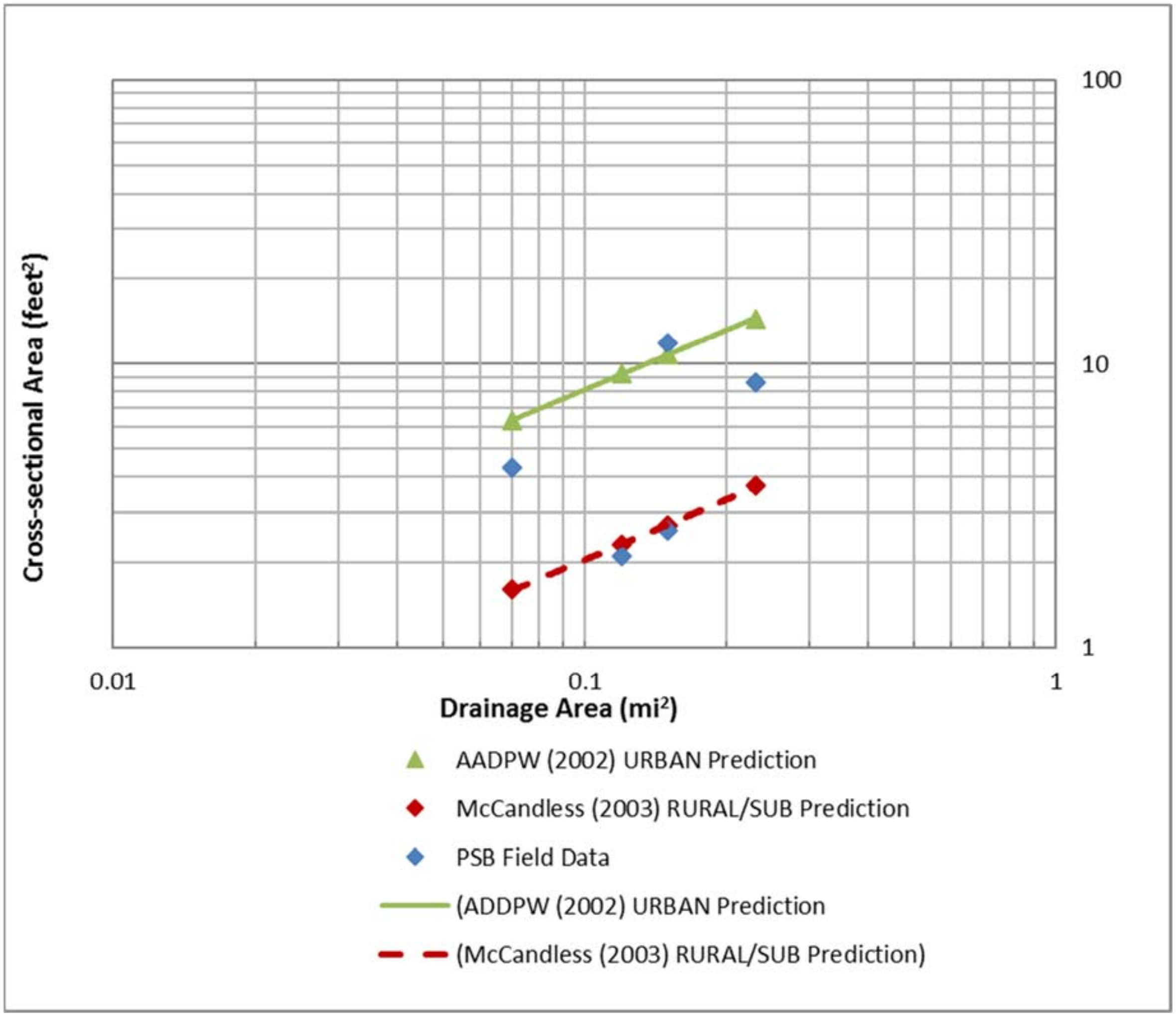

Figure 3-2. Comparison of the bankfull cross-sectional area drainage area relationship between Picture Spring Branch (PSB) 2016 field data and regional relationship curve data

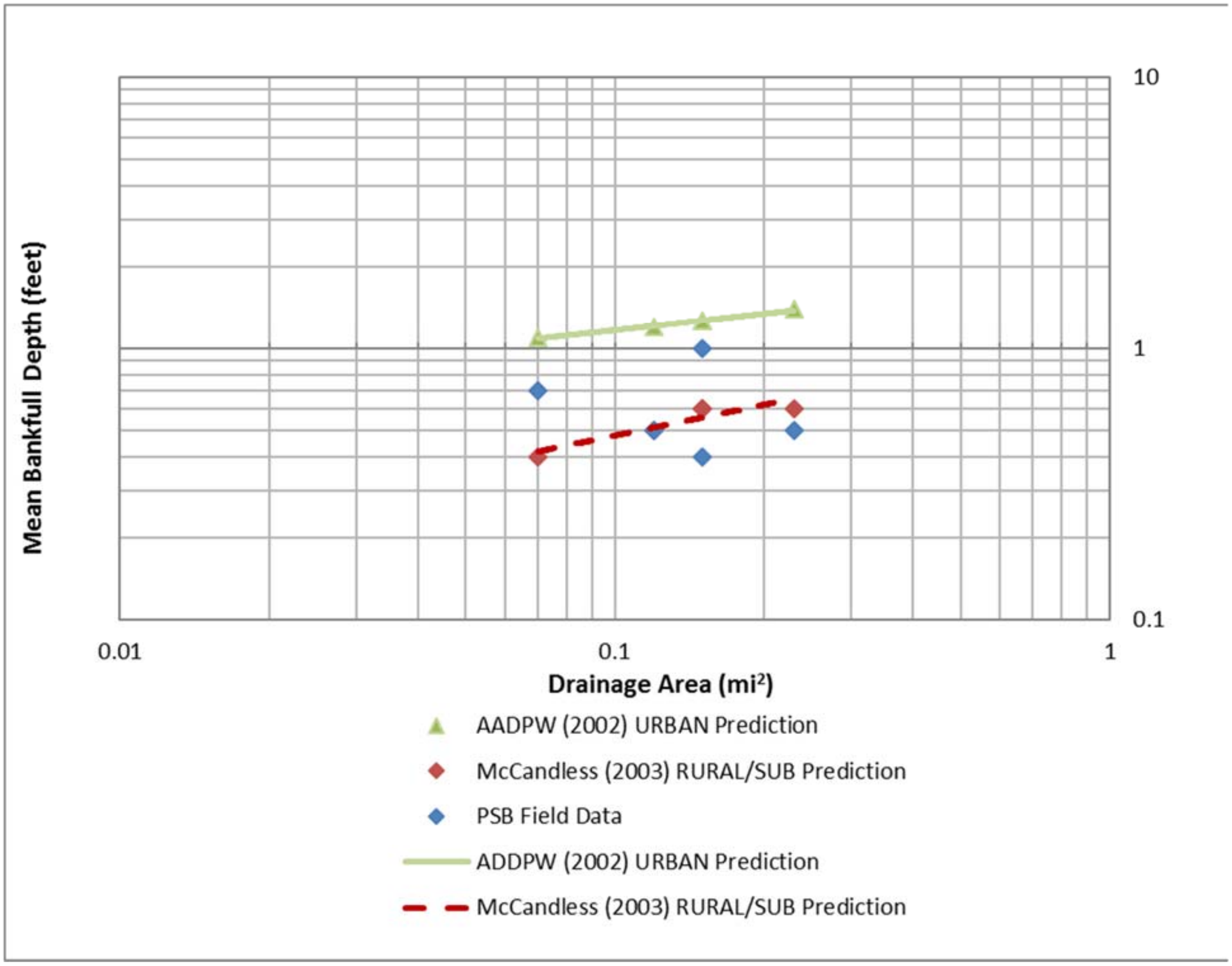

Figure 3-3. Comparison of the mean bankfull depth drainage area relationship between Picture Spring Branch (PSB) 2016 field data and regional relationship curve data

Table 3-4. Rosgen Classification Results - 2016

Cross Section	Classification	D50 (mm)	Water Surface Slope (ft/ft)
XS-1	C5	0.19	0.011
XS-2	F5	0.20	0.0018
XS-3	F5	0.26	0.0048
XS-4	E5	0.28	0.015
XS-5	C5	0.40	0.003

The channel located in the well-forested, upper portion of the North Tributary at cross section 1 exhibited characteristics typical of both C and E type channels, as well as some characteristics that fit neither. For example, E channels are typically very sinuous; however, this reach had very little sinuosity. Likewise, C channels often have numerous point bars, which were not common along this reach. As a result, best professional judgment was applied and the final decision was to assign a C5 classification in order to be consistent with the prior classifications, since there is little evidence to indicate that the channel has evolved from a C to E type channel. F channels were identified at cross sections 2 and 3, which had been altered in the past with concrete trapezoidal channels. The channel along this segment of the North Tributary and downstream of Maryland State Highway 170 was overwidened as a result of the channelization. However, it continues to adjust by filling with sediment and woody debris, thus establishing a more “natural” stream channel within the man-made, engineered channel. Increase in width/ depth ratio and decrease in entrenchment ratio reflect the changes occurring at cross section 5 as a result of continued sediment deposition. Consequently, the Rosgen classification at this cross section has changed from an F5 in 2014, to a C5 in 2015 and has remained a C5 in 2016.

An E channel was identified at cross section 4 on the South Tributary, which appeared to have been channelized in the past and is piped underground for a significant distance upstream, further modifying its hydrology. However, the South Tributary is not overwidened and is significantly steeper than the North Tributary. Indicators were observed that show some limited floodplain connectivity along the upstream portion of the tributary where the cross section is located. However, just downstream of the cross section location, the channel became noticeably entrenched and showed signs of active downcutting. While it is possible that this reach may exhibit both B and E characteristics along different portions of the reach, it was assigned an E5 classification primarily based on the entrenchment and width/depth ratios measured at the cross section location. Evidence of recent downcutting (e.g., nick points) suggests that the reach is unstable and is likely shifting from an E channel to a B channel. Significant changes in the shape of this cross section were observed during the 2013 survey, as the channel had noticeably deepened and widened since the 2012 survey (Appendix B). Over the next year, as seen in the 2014 survey, aggradation occurred affecting the bed level by raising it approximately 0.5 feet. From 2014 to 2015, the channel has shifted slightly, but has remained stable in terms of aggradation or deepening. Noticeable aggradation once again occurred in 2016 by an approximate 0.5-foot rise in bed elevation. Analysis of the longitudinal profile overlay from 2007 through 2016 shows considerable downcutting between stations 1+00 and 2+20 (Appendix B). However, during 2014 the pool near station 2+00 has mostly filled in. This trend has continued in 2015, with the pool working its way up the reach to station 1+80. In 2016, the pool has remained at station 1+80 but has deepened by almost a foot. The headcut and large scour pool between stations 2+68 and 2+90 just downstream from this eroded section have not worsened. However, in 2016 this scour pool has shifted downstream by a few feet. It is recommended that this area continue to be monitored, since further erosion could eventually lead to undermining of the concrete-lined channel just downstream.

An overlay of North Tributary longitudinal profiles shows little change occurring to this reach from 2007 through 2016 (Appendix B). Numerous man-made structures (i.e., culverts, concrete-lined channel) throughout this reach appear to be providing adequate grade control, preventing substantial channel degradation.

4.0 SUMMARY AND CONCLUSIONS

4.1 BIOLOGICAL ASSESSMENT SUMMARY

Water quality measurements showed all parameters within COMAR standards. Conductivity levels at all of the sampling sites continue to be elevated, which is likely due to the high percent of impervious surfaces within the drainage area and the resulting stormwater runoff. In urban systems, high conductivity may be an indicator of road salt usage (Morgan et al. 2012, Southerland et al. 2007, Kaushal et al. 2005); however, chloride concentrations are often necessary to confirm whether road salts are a primary source. Given the presence in the watershed of the large MARC train station Park & Ride lots, which likely receive large quantities of de-icing salts, and two adjacent detention/shallow wetland ponds, which may accumulate the salts and slowly release them through the groundwater, it is plausible that road salt application is responsible, at least in part, for the observed elevated conductivity.

Physical habitat was rated “Partially Degraded” at all sites throughout the study area, which is a slight improvement over the scores from 2015 (Table 4-1). The “Partially Degraded” ratings are a result of an increase in instream woody debris, and consequently, an increase in epifaunal substrate scores. PSB-01 is located along the wooded upper reach of the North Tributary, which had a substantial riparian buffer, adequate shading, minor bank erosion, and sufficient instream woody debris and rootwads. These factors increase the potential of the stream to support a diverse macroinvertebrate community. Sites PSB-02 and PSB-03 had substantial improvement in their physical habitat. While these two sites still had marginal riparian buffers and scored very low for remoteness, they too exhibited an increase in instream woody debris. The resulting improvement in epifaunal substrate and instream habitat moved these two sites into the “Partially Degraded” category, despite their proximity to routes 170 and 175.

During the past five years of monitoring, PHI scores have fluctuated slightly from year to year (Figure 4-1). Fluctuations in annual physical habitat scores may be attributed to two primary factors: 1) changes in habitat suitable for colonization (i.e., changes in substrate/embeddedness and changes in the quantity of woody debris) affects direct scoring of this parameter, and also indirectly influences scoring for epifaunal substrate and instream habitat; and 2) variability in qualitative visual assessment scoring between field crews.

In 2013, the updated MBSS PHI methods (Paul et al. 2003) were used to calculate PHI instead of the original MBSS methods (Hall et al. 2002) which had been used in the Picture Spring Branch watershed reports from prior years. Scores for 2006-2012 shown in Table 4-1 and Figure 4-1 were calculated using the original method, while the scores for 2013-2015 were calculated using the updated method.

In 2016, the benthic macroinvertebrate community at all three sites within the Picture Spring Branch study area were rated as “Fair”. These BIBI scores are higher than in 2014 and 2015, and rank in the “Fair” category for the first time since 2012. Overall, taxa diversity was increased in 2016 at all three sites as compared to 2015. Individuals intolerant to urban stressors at sites showed improvement as well, and ranged from 3.4% (PSB-03) to 26.1% (PSB-01) of the total specimens. The numbers of sensitive EPT taxa increased at all three sites as well. At PSB-02 and PSB-03 there were 5 EPT taxa each, and at PSB-01 there were 7 taxa. However, only one Ephemeroptera taxa was found (at PSB-01) during this sampling period.

Table 4-1. PHI scores from 2006 to 2016

Site		PSB-01	PSB-02	PSB-03
2006	PHI Score	66.0	60.1	50.9
	Rating	Degraded	Degraded	Severely Degraded
2007	PHI Score	79.6	69.5	69.5
	Rating	Partially Degraded	Partially Degraded	Partially Degraded
2008	PHI Score	84.5	73.0	73.3
	Rating	Minimally Degraded	Partially Degraded	Partially Degraded
2009	PHI Score	76.4	65.9	58.6
	Rating	Partially Degraded	Degraded	Degraded
2010	PHI Score	84.3	72.4	73.8
	Rating	Minimally Degraded	Partially Degraded	Partially Degraded
2011	PHI Score	83.3	73.4	71.9
	Rating	Minimally Degraded	Partially Degraded	Partially Degraded
2012	PHI Score	83.9	74.8	73.2
	Rating	Minimally Degraded	Partially Degraded	Partially Degraded
2013	PHI Score	77.2	62.6	57.2
	Rating	Partially Degraded	Degraded	Degraded
2014	PHI Score	77.7	64.7	65.7
	Rating	Partially Degraded	Degraded	Degraded
2015	PHI Score	72.1	64.4	60.5
	Rating	Partially Degraded	Degraded	Degraded
2016	PHI Score	79.0	67.8	68.0
	Rating	Partially Degraded	Partially Degraded	Partially Degraded

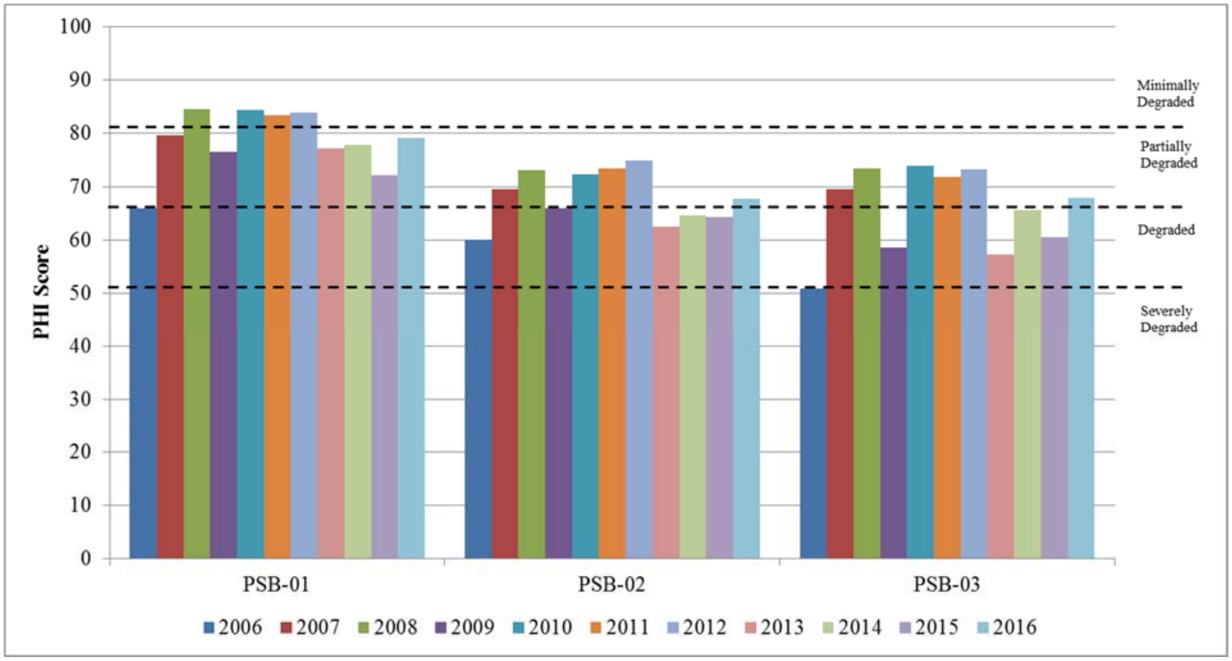

Figure 4-1. Comparison of PHI Habitat Scores from 2006 through 2016

BIBI scores increased at PSB-01, PSB-02, and PSB-03 (Table 4-2). The narrative rating stayed the same at PSB-03, while improving from "Poor" to "Fair" at both PSB-01 and PSB-02. Figure 4-2 provides a visual comparison of BIBI scores over time and shows scores fluctuating from year to year.

Table 4-2. BIBI scores from 2006 to 2016

Site		PSB-01	PSB-02	PSB-03
2006	BIBI Score	3.00	2.71	2.43
	Rating	Fair	Poor	Poor
2007	BIBI Score	3.29	3.00	3.57
	Rating	Fair	Fair	Fair
2008	BIBI Score	3.86	3.00	2.71
	Rating	Fair	Fair	Poor
2009	BIBI Score	2.43	2.71	1.86
	Rating	Poor	Poor	Very Poor
2010	BIBI Score	2.71	3.00	2.43
	Rating	Poor	Fair	Poor
2011	BIBI Score	3.29	3.29	2.71
	Rating	Fair	Fair	Poor
2012	BIBI Score	3.29	3.00	3.00
	Rating	Fair	Fair	Fair
2013	BIBI Score	2.71	3.29	3.00
	Rating	Poor	Fair	Fair
2014	BIBI Score	2.43	2.71	2.43
	Rating	Poor	Poor	Poor
2015	BIBI Score	2.43	2.71	3.00
	Rating	Poor	Poor	Fair
2016	BIBI Score	3.29	3.0	3.29
	Rating	Fair	Fair	Fair

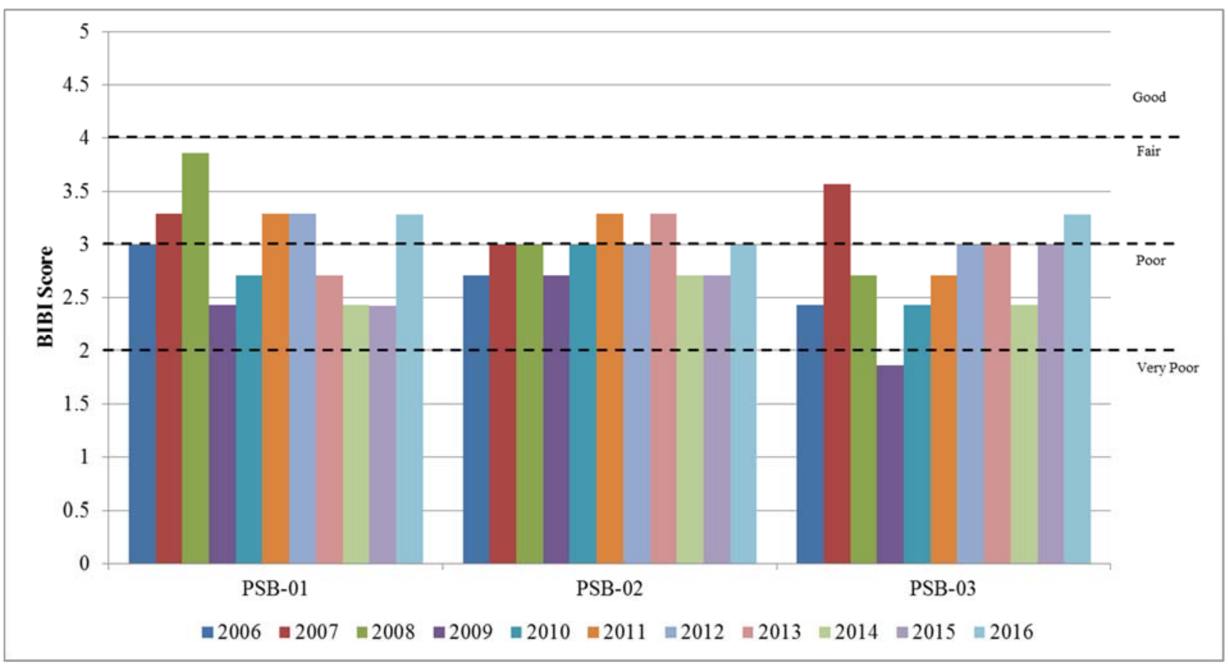

Figure 4-2. Comparison of BIBI Scores from 2006 through 2016

4.2 GEOMORPHIC ASSESSMENT SURVEY

The majority of the streams within the Picture Spring Branch study area have been altered by past channelization and the installation of concrete-lined channels, resulting from modifications made to accommodate runoff from Maryland State Highways 170 and 175, running both parallel and adjacent to the stream channel. Consequently, stream reaches in the vicinity of cross sections XS-2, XS-3, and XS-5, on the North Tributary and mainstem were overwidened resulting in F channels at these locations. A notable amount of sediment has deposited in these concrete channels in the past, and it appears as though these channels have become naturalized, especially below Route 170 where a more natural stream pattern is emerging, resulting in a C channel forming within the larger channel at XS-5. These cross sections also appeared quite stable during recent years, having shown very little change from previous surveys, with the exception of XS-5 which experienced notable aggradation across its total width between 2011 and 2012. Between 2012 and 2013 the right side stream bed at XS-5 eroded slightly while the left side had no change. From 2014 to 2016, surveys continued to show minor erosion at the bottom of the left bank. Past channelization also appears to have occurred on the South Tributary in the vicinity of cross section XS-4. The slope of the South Tributary is much greater than that of the North Tributary, and the channel is showing signs of active downcutting. Historically, the reach of stream in the Picture Spring Branch study area which appeared to be least disturbed was in the vicinity of XS-1. This previously stable section of stream is in a forested upper portion of the North Tributary and is classified as a C5 channel. Although still a C5 channel, the channel is now deepening.

To compare changes in cross sectional area over time, cross sectional area from 2011 through 2016 was calculated using the top of bank elevation from the baseline survey in order to standardize comparisons and reduce variability among more subjective bankfull elevation reference points, or even changes that can occur to top of bank elevations from year to year. It is important to note that calculations prior to 2011 did not use the baseline reference elevation, instead they used the corresponding years top of bank elevation for calculating cross sectional area, and consequently these values are not directly comparable to the cross sectional areas reported in 2011 through 2016. Comparison of baseline cross sectional area is however comparable to 2011 through 2016 since all calculations are made using the same top of bank elevation. Channel dimensions appear moderately constant for two out of the five cross sections,compared to baseline conditions (Table 4-3). The stream channel at XS-2 and XS-3 has remained relatively stable, with cross sectional area decreasing only 0.9% and 10.8% respectively since 2003. In contrast, significant increases in cross sectional areas have occurred at XS-1 and XS-4. Due to channel deepening in the past year, cross-sectional area at XS-1 has increased 53.1% from baseline conditions. XS-4, although relatively stable in the past six years, has had cross sectional area increase 26.3% from baseline conditions. XS-5 has continued to aggrade, resulting in a 4.6% decrease in cross sectional area from 2011, and 6.5% overall from baseline conditions in 2003. This continued deposition of fine sediments at XS-5 has defined the channel, resulting in a C5 stream classification. Unsurprisingly, XS-1 and XS-4 are located in portions of stream where there has been no engineering or armoring of the stream channel, while the other three cross sections have been channelized.

Table 4-3. Summary of cross sectional area (square feet) at the five cross-sections and changes over time

Cross Section[a]	XS-1	XS-2	XS-3	XS-4	XS-5
July 2003	ND	146.0	84.5	7.6	35.5
Jan 2005	6.4	164.4	83.2	5.5	35.2
March 2006	7.6	143.9	81.0	7.6	34.0
March 2007	6.8	142.6	81.1	7.6	32.9
May 2008	6.3	141.5	81.5	7.4	34.9
July 2009	6.8	142.8	80.8	8.4	33.4
May 2010	6.0	145.2	80.5	9.7	34.5
July 2011[b]	9.7	143.0	81.9	9.3	34.8
April 2012[b]	8.0	143.1	81.8	9.2	28.4
July 2013[b]	8.6	142.8	80.4	10.5	30.9
June 2014 [b]	8.8	141.9	77.4	10.0	32.6
June 2015 [b]	10.2	143.0	80.9	10.3	31.6
March 2016 [b]	9.8	144.7	75.4	9.6	33.2
% Change 2003-2016	53.1[c]	-0.9	-10.8	26.3	-6.5
% Change 2011-2016	1.0	1.3	-7.9	3.2	-4.6

[a] All values listed here are for top of bank area
[b] Values obtained using reference elevations (top of bank) from baseline measurements
[c] % change from 2005
ND = No Data

4.3 GENERAL CONCLUSIONS

Based upon the data collected over the course of this study, it appears that the development of the West County Library site has not accelerated the degradation of this system. While physical habitat and biological conditions have fluctuated slightly from year to year, the overall conditions have changed minimally when compared to baseline data. It is likely that the best management practices installed within the watershed have reduced the impact of some stressors affecting the stream (i.e., hydrologic alteration) such that the system has begun to stabilize from past alteration and land use modifications (i.e., extensive channelization).

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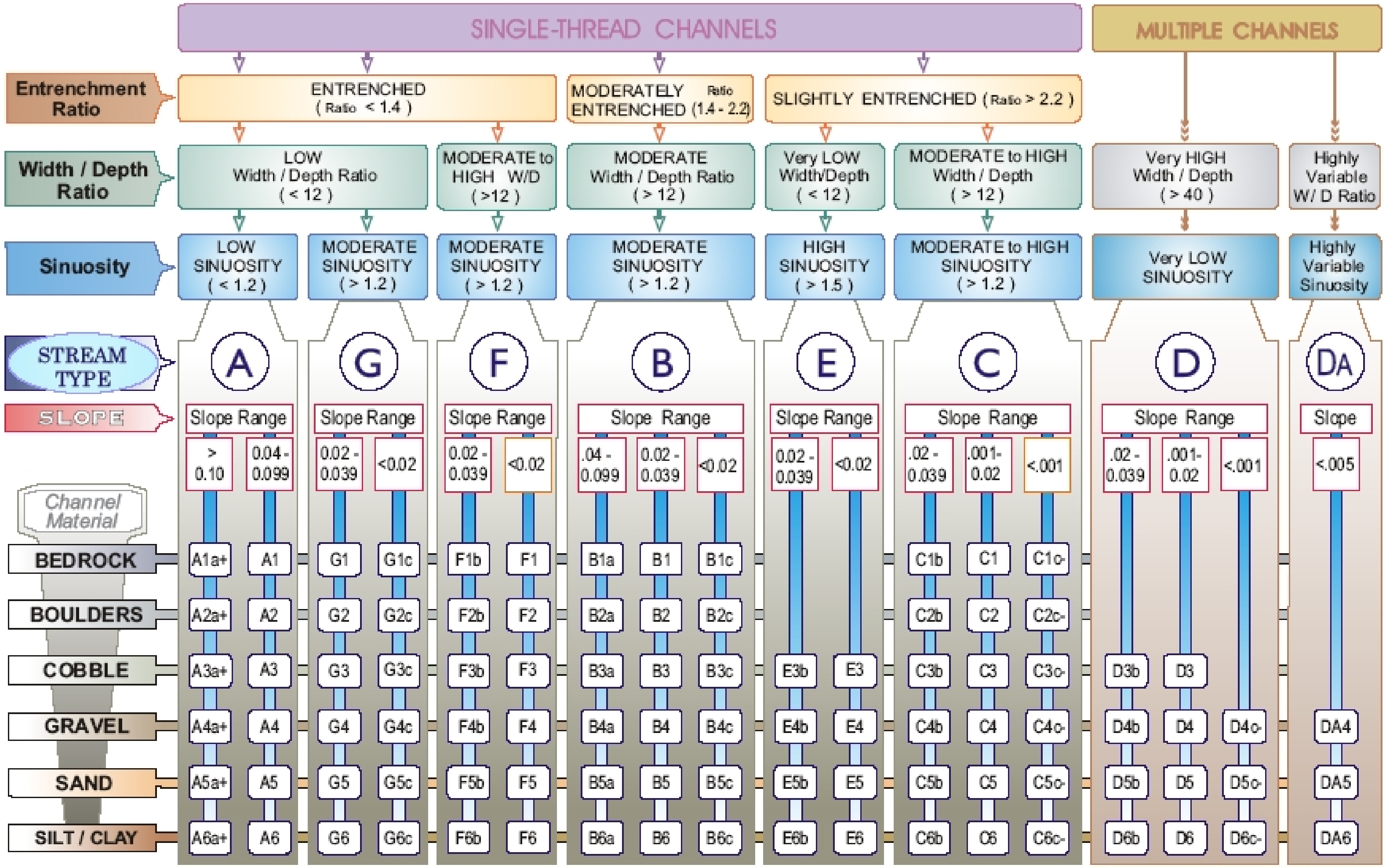
APPENDIX A

ROSGEN STREAM CLASSIFICATION

The Key to the Rosgen Classification of Natural Rivers



KEY to the ROSGEN CLASSIFICATION of NATURAL RIVERS. As a function of the *"continuum of physical variables"* within stream reaches, values of ***Entrenchment*** and ***Sinuosity*** ratios can vary by +/- 0.2 units; while values for ***Width / Depth*** ratios can vary by +/- 2.0 units.

Source: Rosgen, D.L. 1996. *Applied River Morphology*. Wildland Hydrology, Pagosa Springs, CO.

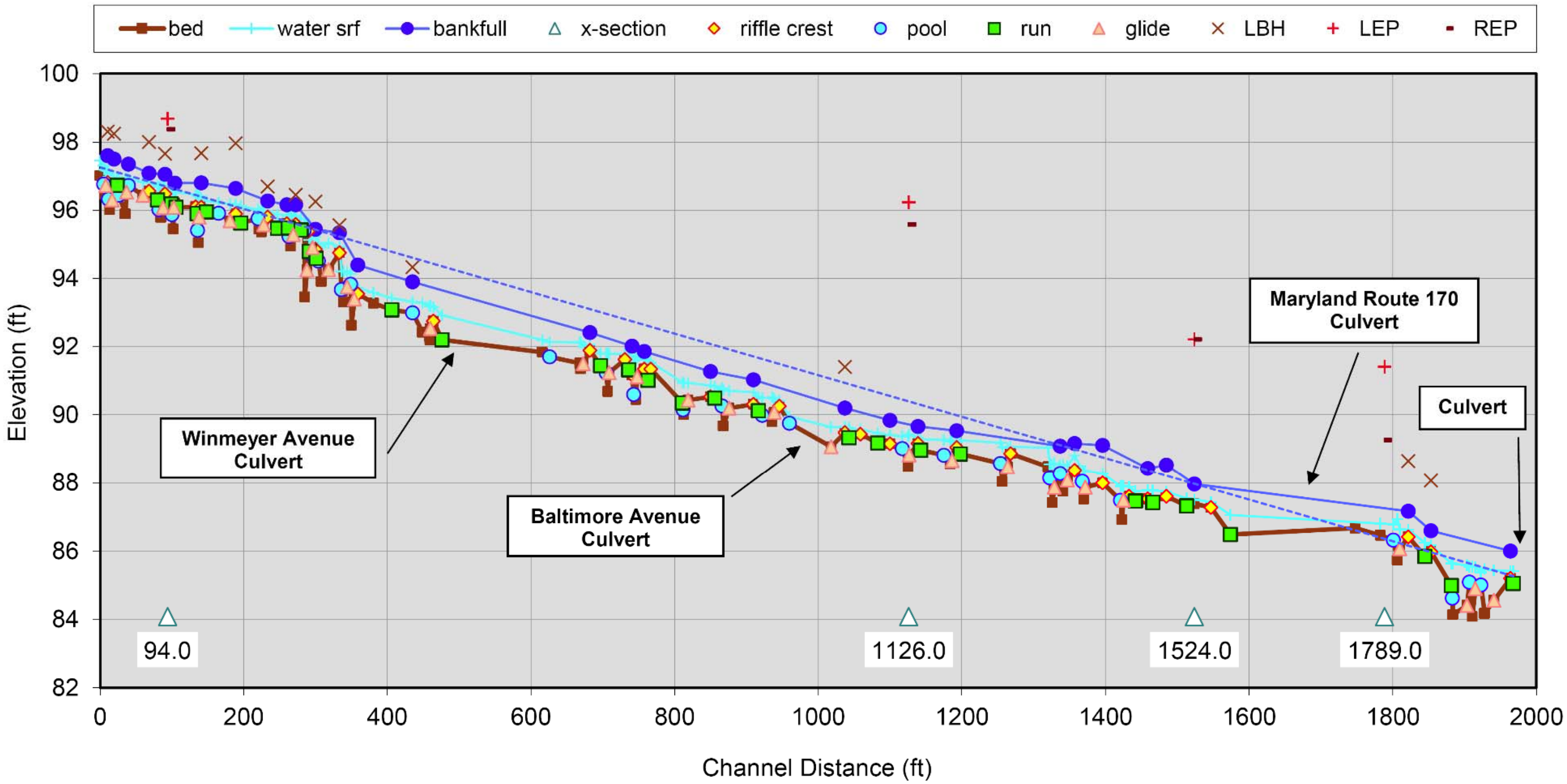
APPENDIX B

GEOMORPHIC ASSESSMENT RESULTS

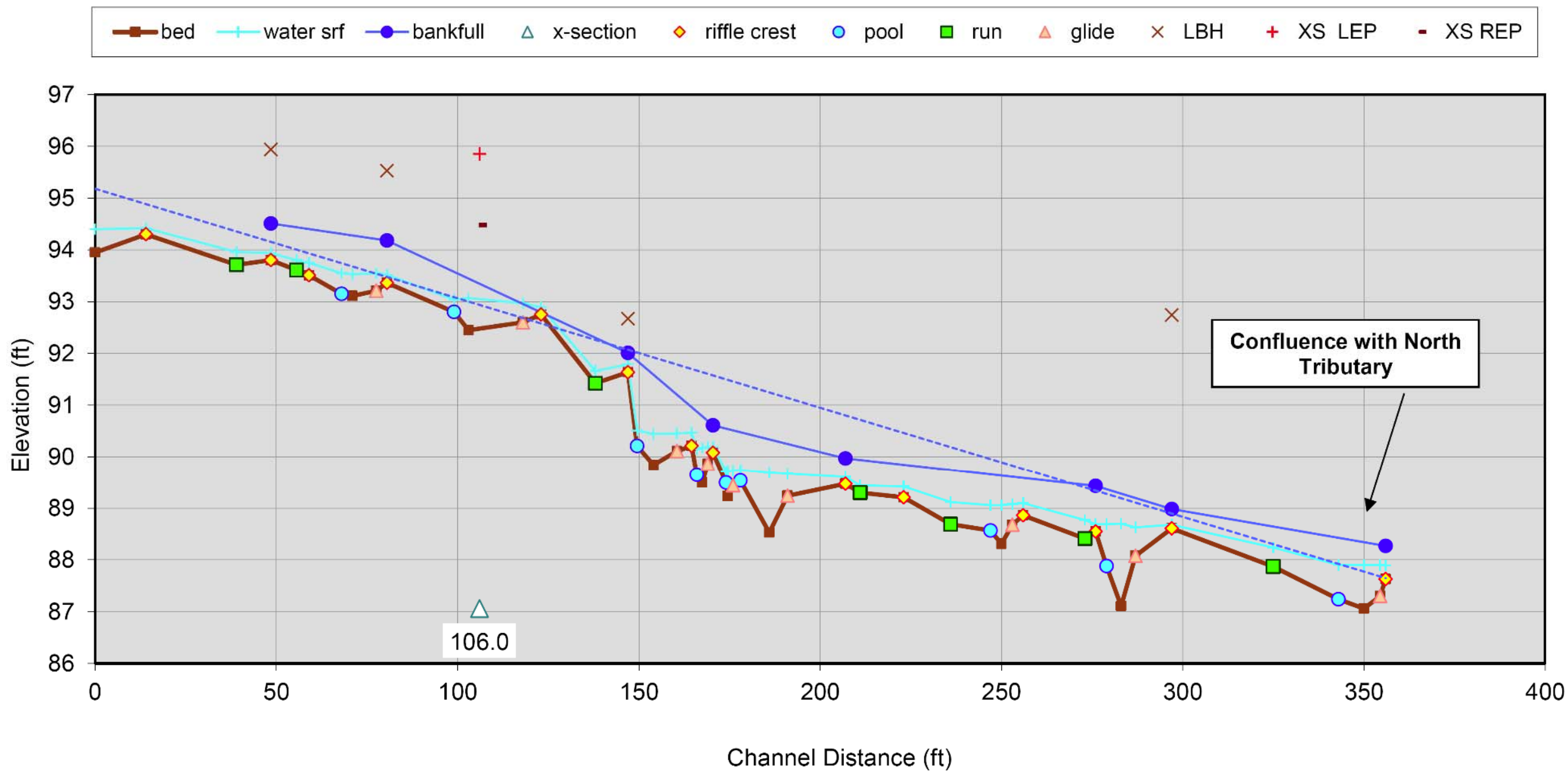
Picture Spring Branch
2016 Geomorphic Assessment Results Summary

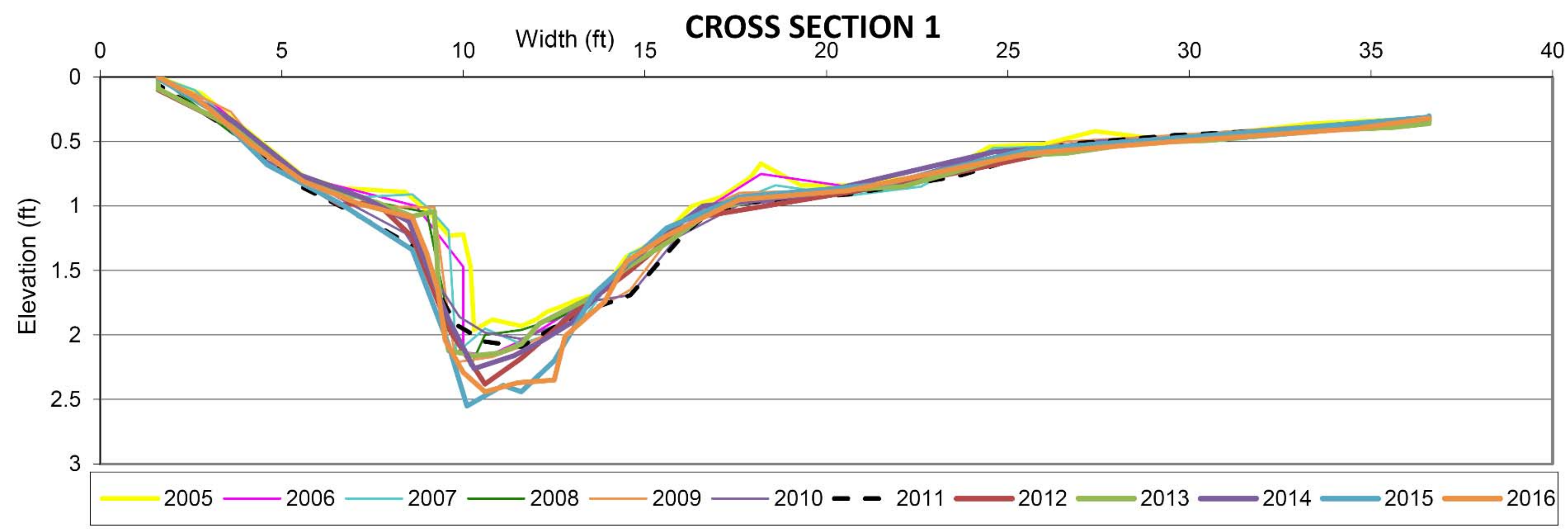
Assessment Parameter	Cross Section				
	XS-1 Run @ Sta. 0+94	XS-2 Run @ Sta. 11+26	XS-3 Run @ Sta. 15+24	XS-4 Run @ Sta. 1+06 on South Tributary	XS-5 Run @ Sta. 17+89
Classification	C5	F5	F5	E5	C5
Bankfull Width (ft)	4.6	11.8	7.0	4.4	8.3
Mean Depth (ft)	0.5	1.0	0.4	0.9	0.6
Bankfull X-Sec Area (sq ft)	2.1	11.9	2.6	3.9	5.2
Width:Depth Ratio	9.8	11.7	18.9	4.9	13.4
Flood-Prone Width (ft)	9.0	16.9	11.9	24.3	20.2
Entrenchment Ratio	2.0	1.4	1.7	5.6	2.4
D50(mm)	0.19	0.20	0.26	0.28	0.40
Water Surface Slope (ft/ft)	0.011	0.0018	0.0048	0.015	0.003
Sinuosity	<1.2	<1.2	<1.2	<1.2	<1.2
Drainage Area (mi^2)	0.12	0.15	0.15	0.07	0.23
Adjustments?	Sin ↑, ER ↑, WD ↑	Sin ↑, WD ↑	Sin ↑, ER ↓	Sin ↑	Sin ↑

Picture Spring Branch
North Tributary Longitudinal Profile



Picture Spring Branch
South Tributary Longitudinal Profile





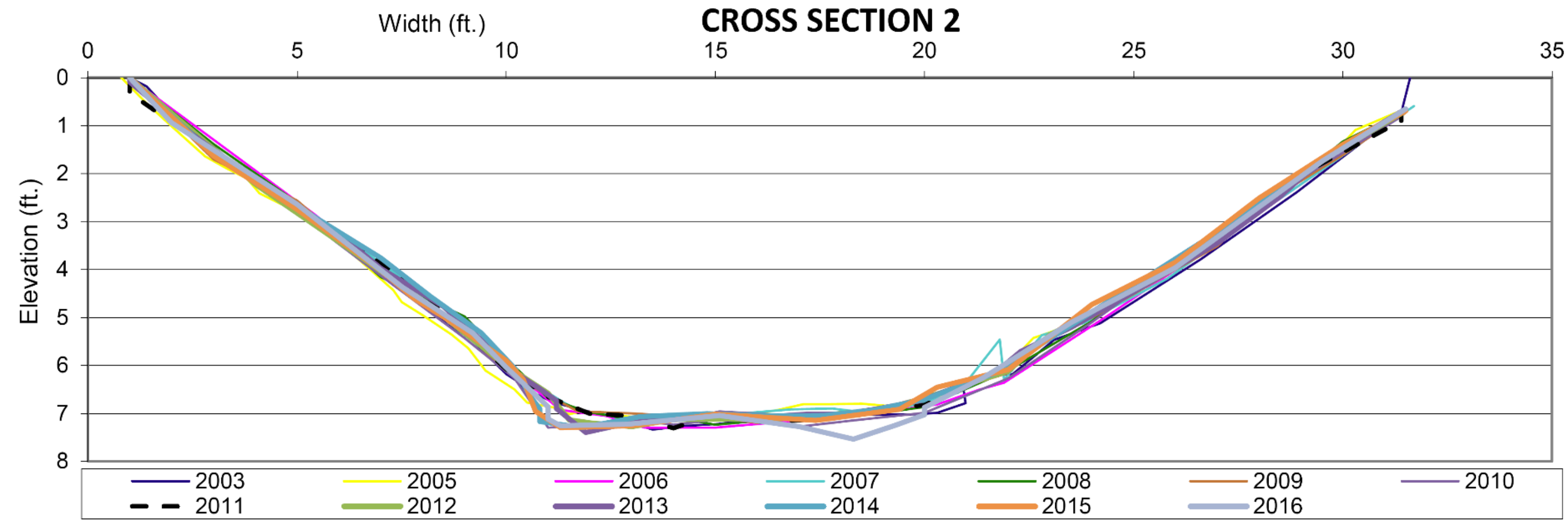
Upstream View

Downstream View

Left Bank View

Right Bank View

2016 Geomorphic Assessment Results	
Bankfull Width (W_{bkf}) (feet)	4.6
Mean Depth (d_{bkf}) (feet)	0.5
Bankfull Cross-sectional Area (A_{bkf}) (feet$_2$)	2.1
Width/Depth Ratio (W_{bkf}/d_{bkf})	9.8
Width of Flood-prone Area (W_{fpa}) (feet)	9.0
Entrenchment Ratio (ER) = W_{fpa}/W_{bkf}	2.0
Channel Materials D_{50} (millimeters)	0.19
Water Surface Slope (S)	0.011
Sinuosity (K) = stream length/valley length	<1.2
Adjustments?	Sin ↑, ER ↑, WD ↑
STREAM TYPE	**C5**



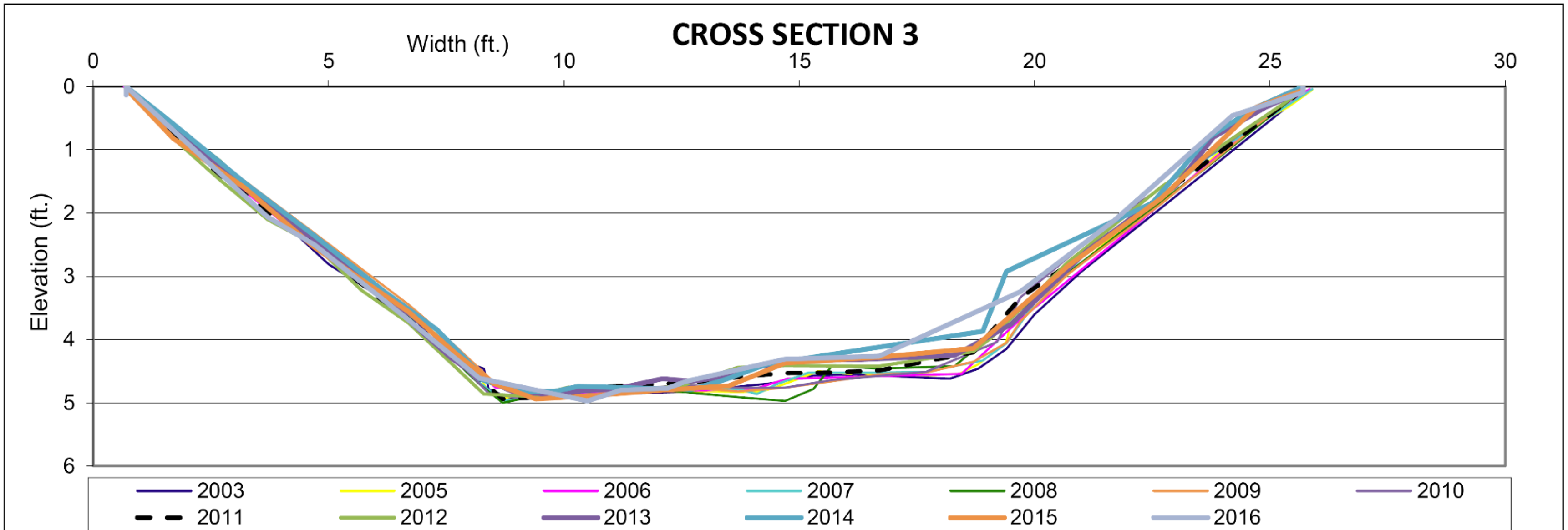
Upstream View

Downstream View

Left Bank View

Right Bank View

2016 Geomorphic Assessment Results	
Bankfull Width (W_{bkf}) (feet)	11.8
Mean Depth (d_{bkf}) (feet)	1.0
Bankfull Cross-sectional Area (A_{bkf}) ($feet_2$)	11.9
Width/Depth Ratio (W_{bkf}/d_{bkf})	11.7
Width of Flood-prone Area (W_{fpa}) (feet)	16.9
Entrenchment Ratio (ER) = W_{fpa}/W_{bkf}	1.4
Channel Materials D_{50} (millimeters)	0.20
Water Surface Slope (S)	0.0018
Sinuosity (K) = stream length/valley length	<1.2
Adjustments?	Sin ↑, WD ↑
STREAM TYPE	**F5**



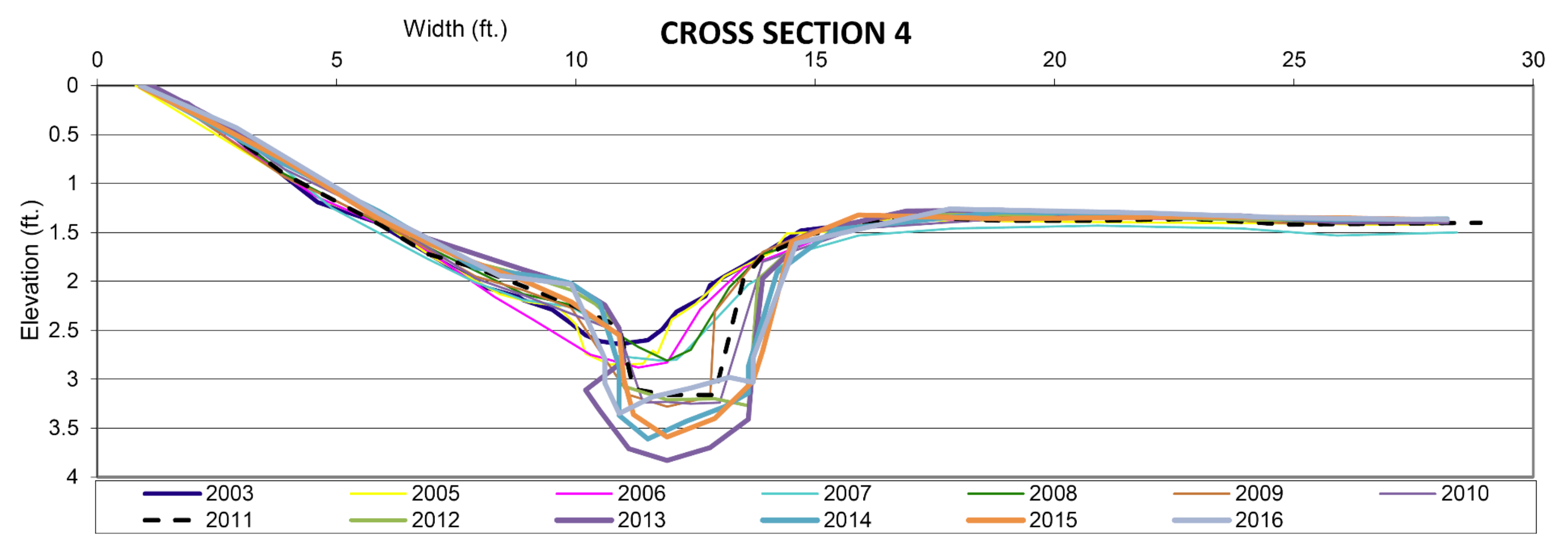
Upstream View

Downstream View

Left Bank View

Right Bank View

2016 Geomorphic Assessment Results	
Bankfull Width (W_{bkf}) (feet)	7.0
Mean Depth (d_{bkf}) (feet)	0.4
Bankfull Cross-sectional Area (A_{bkf}) (feet$_2$)	2.6
Width/Depth Ratio (W_{bkf}/d_{bkf})	18.9
Width of Flood-prone Area (W_{fpa}) (feet)	11.9
Entrenchment Ratio (ER) = W_{fpa}/W_{bkf}	1.7
Channel Materials D_{50} (millimeters)	0.26
Water Surface Slope (S)	0.0048
Sinuosity (K) = stream length/valley length	<1.2
Adjustments?	Sin ↑, ER ↓
STREAM TYPE	**F5**



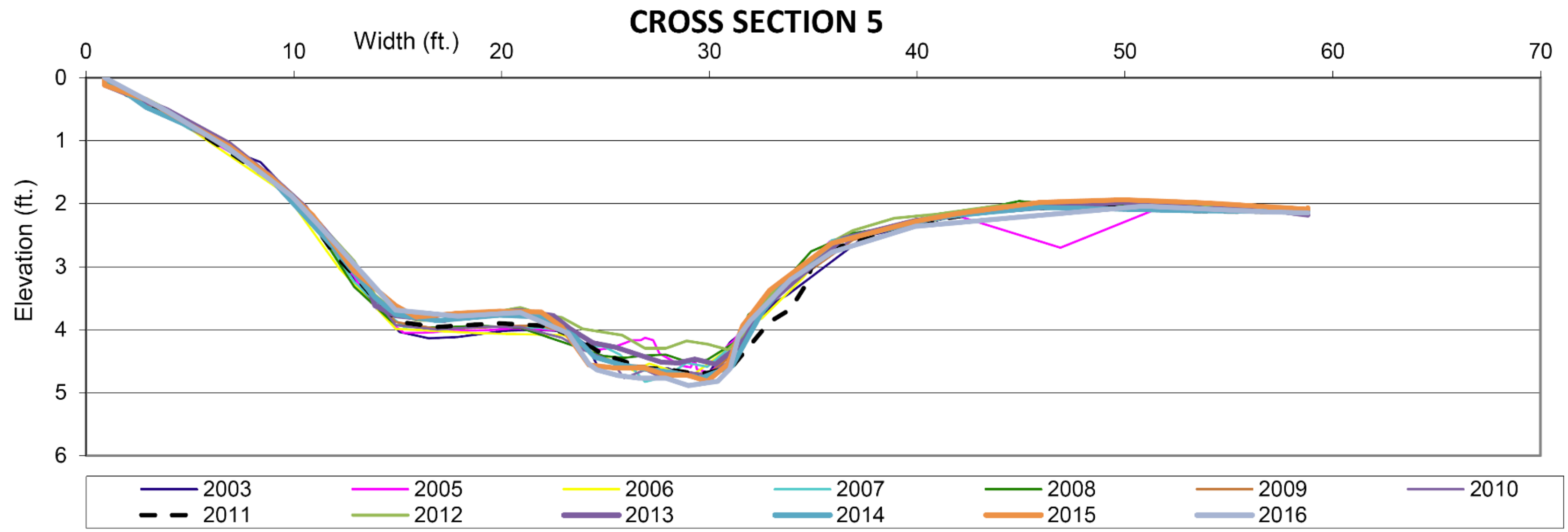
Upstream View

Downstream View

Left Bank View

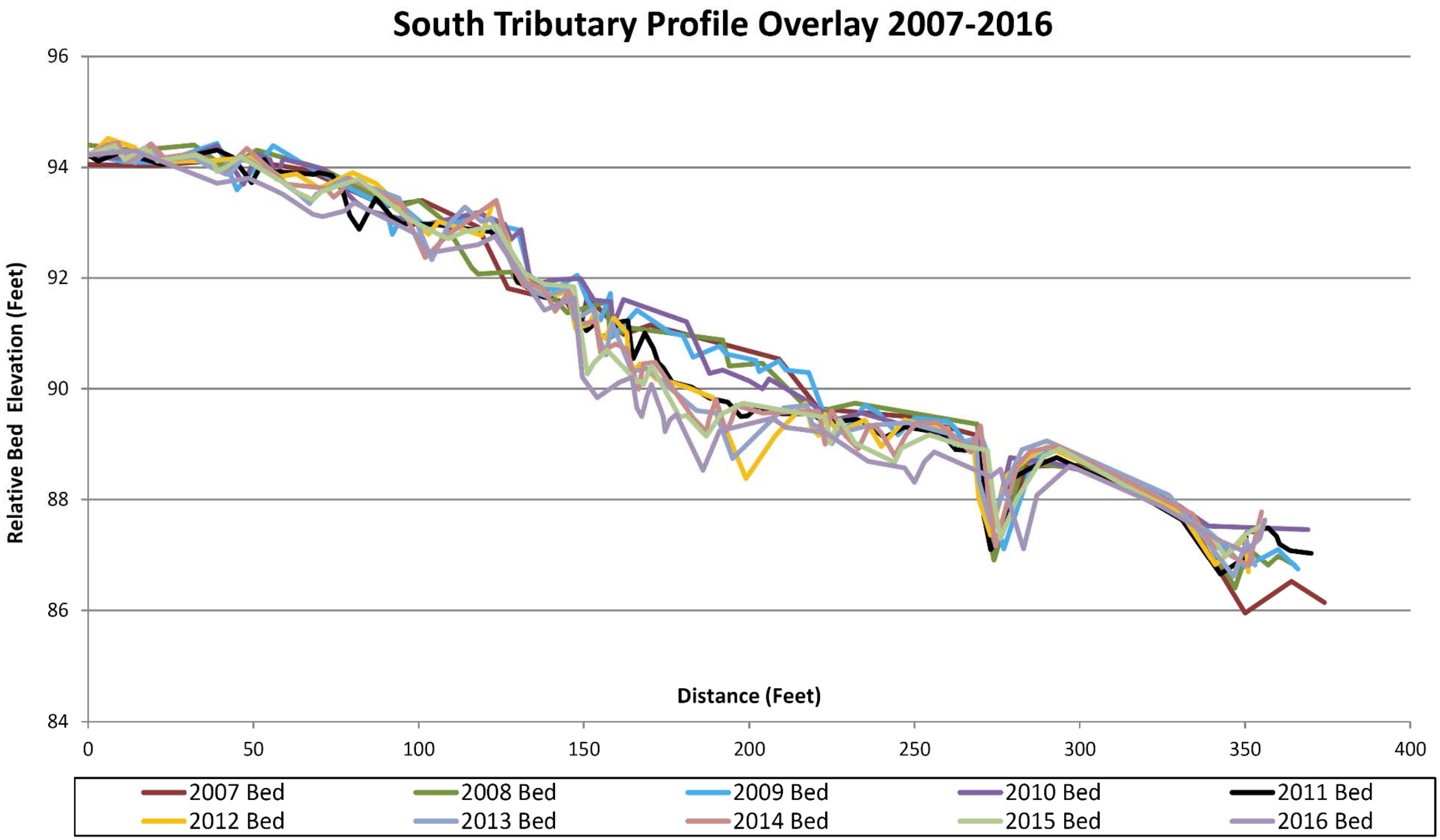
Right Bank View

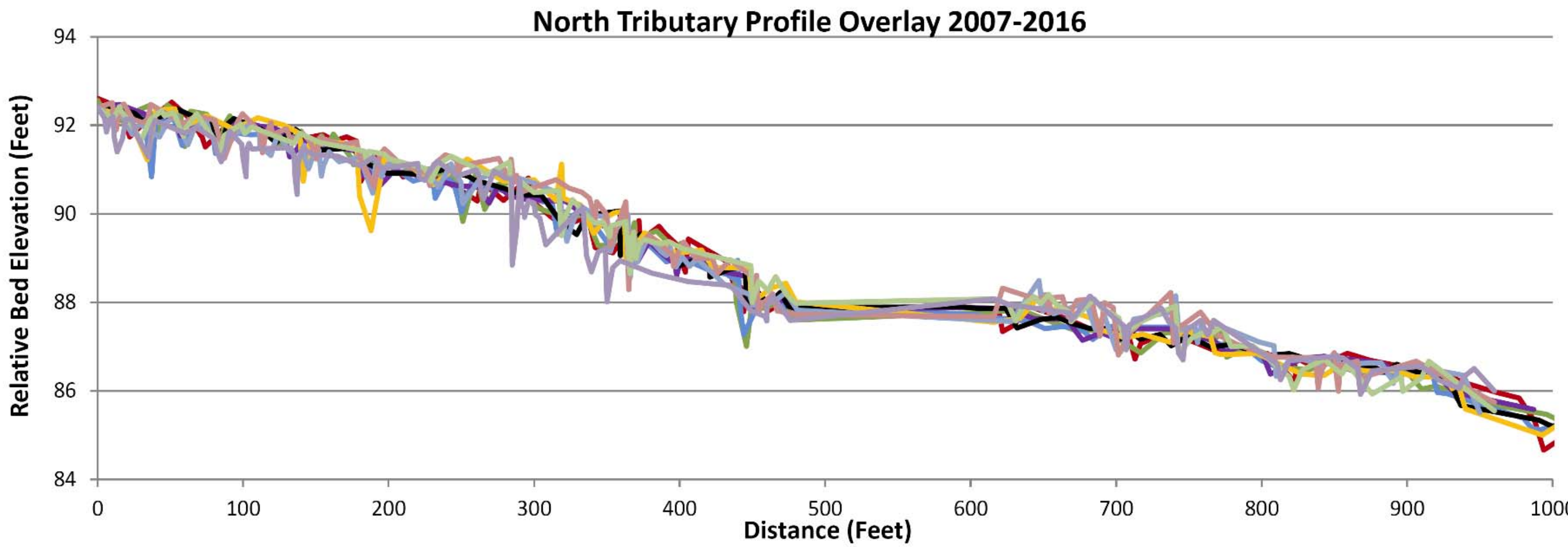
2016 Geomorphic Assessment Results	
Bankfull Width (W_{bkf}) (feet)	4.4
Mean Depth (d_{bkf}) (feet)	0.9
Bankfull Cross-sectional Area (A_{bkf}) (feet^2)	3.9
Width/Depth Ratio (W_{bkf}/d_{bkf})	4.9
Width of Flood-prone Area (W_{fpa}) (feet)	24.3
Entrenchment Ratio (ER) = W_{fpa}/W_{bkf}	5.6
Channel Materials D_{50} (millimeters)	0.28
Water Surface Slope (S)	0.015
Sinuosity (K) = stream length/valley length	<1.2
Adjustments?	Sin ↑
STREAM TYPE	**E5**

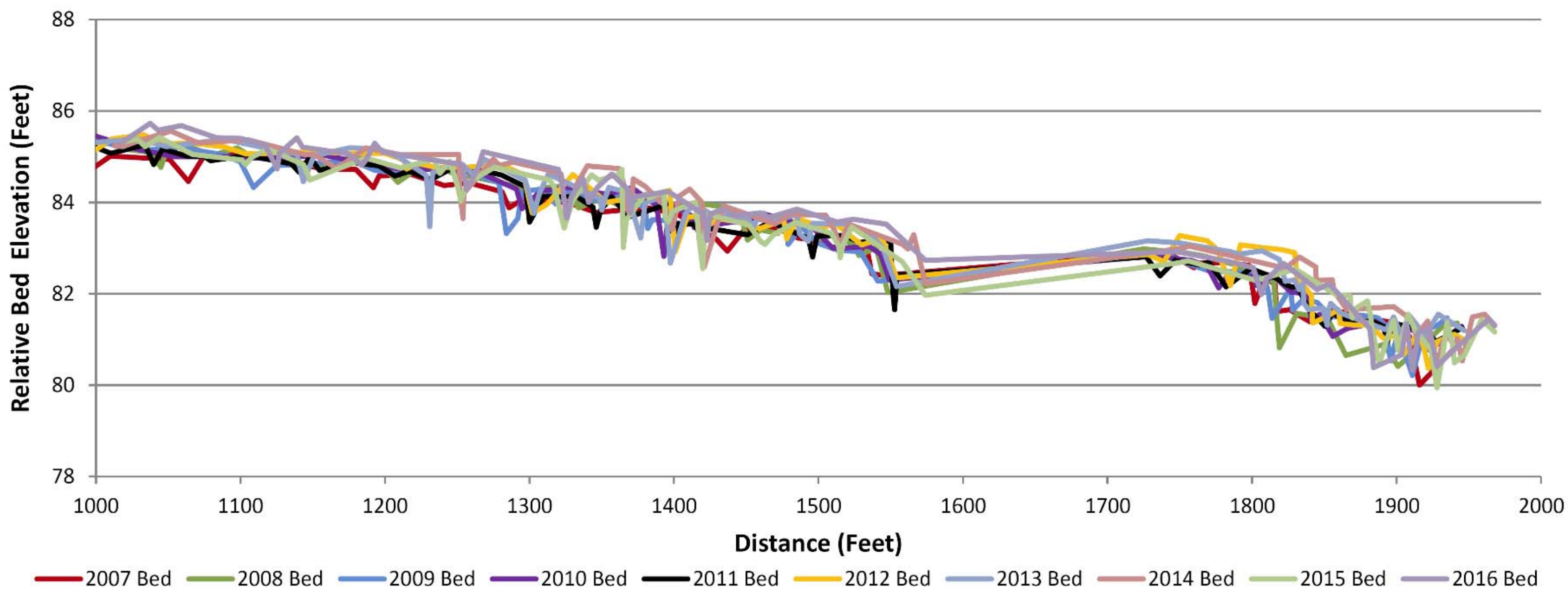


	
Upstream View	Downstream View
	
Left Bank View	Right Bank View

2016 Geomorphic Assessment Results	
Bankfull Width (W_{bkf}) (feet)	8.3
Mean Depth (d_{bkf}) (feet)	0.6
Bankfull Cross-sectional Area (A_{bkf}) (feet$_2$)	5.2
Width/Depth Ratio (W_{bkf}/d_{bkf})	13.4
Width of Flood-prone Area (W_{fpa}) (feet)	20.2
Entrenchment Ratio (ER) = W_{fpa}/W_{bkf}	2.4
Channel Materials D_{50} (millimeters)	0.40
Water Surface Slope (S)	0.003
Sinuosity (K) = stream length/valley length	<1.2
Adjustments?	Sin ↑
STREAM TYPE	**C5**


South Tributary Profile Overlay 2007-2016
Relative Bed Elevation (Feet)
96
94
92
90
88
86
84
Distance (Feet)
0
50
100
150
200
250
300
350
400
2007 Bed
2008 Bed
2009 Bed
2010 Bed
2011 Bed
2012 Bed
2013 Bed
2014 Bed
2015 Bed
2016 Bed


North Tributary Profile Overlay 2007-2016
Relative Bed Elevation (Feet)
Distance (Feet)
94
92
90
88
86
84
0
100
200
300
400
500
600
700
800
900
1000


Relative Bed Elevation (Feet)
Distance (Feet)
88
86
84
82
80
78
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
2007 Bed
2008 Bed
2009 Bed
2010 Bed
2011 Bed
2012 Bed
2013 Bed
2014 Bed
2015 Bed
2016 Bed

APPENDIX C

MASTER BENTHIC MACROINVERTEBRATE TAXA LIST

Order	Family	Genus	Taxon	FFG[a]	Habit[b]	Tolerance Value[c]
Amphipoda	Crangonyctidae	Crangonyx	Crangonyx	Collector	sp	6.7
Basommatophora	Lymnaeidae	Fossaria	Fossaria	Scraper	cb	6.9
Basommatophora	Physidae	Physa	Physa	Scraper	cb	7
Coleoptera	Dryopidae	Helichus	Helichus	Scraper	cn	6.4
Coleoptera	Elmidae	Stenelmis	Stenelmis	Scraper	cn	7.1
Coleoptera	Hydrophilidae	Hydrobius	Hydrobius	Collector	cb, cn, sp	4.1
Diptera	Chironomidae		Gymnometriocnemus	Collector	sp	7
Diptera	Chironomidae	Conchapelopia	Conchapelopia	Predator	sp	6.1
Diptera	Chironomidae	Hydrobaenus	Hydrobaenus	Scraper	sp	7.2
Diptera	Chironomidae	Orthocladius	Orthocladius	Collector	sp, bu	9.2
Diptera	Chironomidae	Parachaetocladius	Parachaetocladius	Collector	sp	3.3
Diptera	Chironomidae	Paracladopelma	Paracladopelma	Collector	sp	6.6
Diptera	Chironomidae	Parametriocnemus	Parametriocnemus	Collector	sp	4.6
Diptera	Chironomidae	Polypedilum	Polypedilum	Shredder	cb, cn	6.3
Diptera	Chironomidae	Stictochironomus	Stictochironomus	Collector	bu	9.2
Diptera	Chironomidae	Tanytarsus	Tanytarsus	Filterer	cb, cn	4.9
Diptera	Chironomidae	Thienemannimyia group	Thienemannimyia group	Predator	sp	8.2
Diptera	Chironomidae	Tvetenia	Tvetenia	Collector	sp	5.1
Diptera	Chironomidae	Zavrelimyia	Zavrelimyia	Predator	sp	5.3
Diptera	Dolichopodidae		Dolichopodidae	Predator	sp, bu	7.5
Diptera	Empididae	Hemerodromia	Hemerodromia	Predator	sp, bu	7.9
Diptera	Simuliidae	Simulium	Simulium	Filterer	cn	5.7
Diptera	Tipulidae	Tipula	Tipula	Shredder	bu	6.7
Ephemeroptera	Ameletidae	Ameletus	Ameletus	Collector	sw, cb	2.6
Isopoda	Asellidae	Caecidotea	Caecidotea	Collector	sp	2.6
Lepidoptera			Lepidoptera			6.7
Lumbricida	Lumbricidae		Lumbricidae	Collector		10
Lumbriculida	Lumbriculidae		Lumbriculidae	Collector	bu	6.6
Megaloptera	Corydalidae	Nigronia	Nigronia	Predator	cn, cb	1.4
Odonata	Calopterygidae	Calopteryx	Calopteryx	Predator	cb	8.3
Plecoptera	Leuctridae		Leuctridae	Shredder	sp, cn	0.8
Plecoptera	Nemouridae	Amphinemura	Amphinemura	Shredder	sp, cn	3
Trichoptera	Hydropsychidae		Hydropsychidae	Filterer	cn	5.7
Trichoptera	Hydropsychidae	Cheumatopsyche	Cheumatopsyche	Filterer	cn	6.5
Trichoptera	Hydropsychidae	Diplectrona	Diplectrona	Filterer	cn	2.7
Trichoptera	Limnephilidae	Ironoquia	Ironoquia	Shredder	sp	4.9
Trichoptera	Philopotamidae		Philopotamidae	Filterer	cn	2.6
Trichoptera	Philopotamidae	Chimarra	Chimarra	Filterer	cn	4.4
Trichoptera	Polycentropodidae	Polycentropus	Polycentropus	Filterer	cn	1.1
Tubificida	Tubificidae		Tubificidae	Collector	cn	8.4
Veneroida	Pisidiidae	Pisidium	Pisidium	Filterer	bu	5.7

[a] Functional Feeding Group
[b] Primary habit or form of locomotion, includes bu - burrower, cn - clinger, cb - climber, sk - skater, sp - sprawler, sw - swimmer Some information for the particular taxa was not available
[c] Tolerance Values, based on Hilsenhoff, modified for Maryland

APPENDIX D

QUALITY ASSURANCE/QUALITY CONTROL

This section describes all Quality Assurance/Quality Control (QA/QC) procedures implemented for this project including field sampling, laboratory sorting and subsampling, data entry, metric calculation, final IBI calculation, geomorphic field sampling, and classification of stream types.

Field Sampling
Initial QA/QC procedures for benthic macroinvertebrate field sampling included formal training for field crew leaders in MBSS Sampling Protocols. All field crew members have attended at least one MBSS Spring Index Period Training. At least one crew member extensively trained and certified in MBSS sampling protocols was present for each field sampling day. Also during field sampling, each data sheet was double checked for completeness and sample bottle labels were double checked for accuracy. Geomorphic assessment field crews have more than one year of experience conducting similar assessment using the Rosgen Stream Classification Methodology.

Geomorphic assessment survey equipment is calibrated annually and regularly inspected to ensure proper functioning. Cross section and profile data were digitally plotted and analyzed in Ohio Department of Natural Resources (ODNR) Reference Reach Spreadsheet Version 4.3L for accuracy.

Water quality QA/QC procedures included calibration of the YSI multiprobe meter daily during the sampling season. Dissolved oxygen probe membranes were inspected regularly and replaced when dirty or damaged.

Laboratory Sorting and Subsampling
Sorting QA/QC was conducted on one sample since only seven samples were collected for this survey (the three samples from Picture Spring Branch are analyzed concurrently with three samples taken in Church Creek). This check consisted of entirely resorting the sorted grid cells of one randomly selected sample. This QC met the sorting efficiency criterion of 90%, so no further action was required. As a taxonomic QC, one sample was re-identified completely by another Versar SFS-certified taxonomist following the same identification methods stated above. The Percent Difference in Enumeration (PDE) and the Percent Taxonomic Disagreement (PTD) were calculated, and no further action was required since both the PDE and PTD met MBSS requirements.

Data Entry
All data entered were double checked by someone other than the person who performed the initial data entry. Any errors found during QA/QC were corrected to ensure 100% accuracy of the data.

Metric and IBI Calculations
Ten percent of metric and IBI calculations were checked by hand using a calculator to ensure correct calculation by the Access database. Any discrepancies were addressed at that time.

Identification of Stream Types
All stream types were determined by hand based on the methods of the Rosgen Stream Classification (Rosgen, 1996). Due to the natural variability, or continuum, of streams, adjustments in the values of Width Depth Ratio (+/- 2.0) and Entrenchment Ratio (+/- 0.2) are allowed, which

may result in assigning a different stream type. Therefore, all stream types assigned were checked by a second person and any necessary adjustments were made.

APPENDIX E

BMP CODES

MDE Approved BMP Classifications

ESD BMPs		
Category	Code	Code Description
Alternative Surfaces (A)		
E	AGRE	Green Roof - Extensive
E	AGRI	Green Roof - Intensive
E	APRP	Permeable Pavements
E	ARTF	Reinforced Turf
Nonstructural Techniques (N)		
E	NDRR	Disconnection of Rooftop Runoff
E	NDNR	Disconnection of Non-Rooftop Runoff
E	NSCA	Sheetflow to Conservation Areas
Micro-Scale Practices (M)		
E	MRWH	Rainwater Harvesting
E	MSGW	Submerged Gravel Wetlands
E	MILS	Landscape Infiltration
E	MIBR	Infiltration Berms
E	MIDW	Dry Wells
E	MMBR	Micro-Bioretention
E	MRNG	Rain Gardens
E	MSWG	Grass Swale
E	MSWW	Wet Swale
E	MSWB	Bio-Swale
E	MENF	Enhanced Filters
Structural BMPs		
Ponds (P)		
S	PWED	Extended Detention Structure, Wet
S	PWET	Retention Pond (Wet Pond)
S	PMPS	Mutliple Pond System
S	PPKT	Pocket Pond
S	PMED	Micropool Extended Detention Pond
Wetlands (W)		
S	WSHW	Shallow Marsh
S	WEDW	ED - Wetland
S	WPWS	Wet Pond - Wetland
S	WPKT	Pocket Wetland
Infiltration (I)		
S	IBAS	Infiltration Basin
S	ITRN	Infiltration Trench

MDE Approved BMP Classifications

Structural BMPs		
Filtering Systems (F)		
S	FBIO	Bioretention
S	FSND	Sand Filter
S	FUND	Underground Filter
S	FPER	Perimeter (Sand) Filter
S	FORG	Organic Filter (Peat Filter)
S	FBIO	Bioretention
Open Channels (O)		
S	ODSW	Dry Swale
S	OWSW	Wet Swale
Other Practices (X)		
S	XDPD	Detention Structure (Dry Pond)
S	XDED	Extended Detention Structure, Dry
S	XFLD	Flood Management Area
S	XOGS	Oil Grit Separator
S	XOTH	Other

MDE Approved Alternative BMP Classifications

Alt. BMPs (A)	**Code**	**Code Description**
A	MSS	Mechanical Street Sweeping
A	VSS	Regenerative/Vacuum Street Sweeping
A	IMPP	Impervious Surface Elimination (to pervious)
A	IMPF	Impervious Surface Elimination (to forest)
A	FPU	Planting Trees or Forestation on Pervious Urban
A	CBC	Catch Basin Cleaning
A	SDV	Storm Drain Vacuuming
A	STRE	Stream Restoration
A	OUT	Outfall Stabilization
A	SPSC	Regenerative Step Pool Storm Conveyance
A	SHST	Shoreline Management
A	SEPP	Septic Pumping
A	SEPD	Septic Denitrification
A	SEPC	Septic Connections to WWTP

APPENDIX F

BIOLOGICAL ASSESSMENT RESULTS

Picture Spring Branch Site PSB-01

Sampled: 3/24/2016

Biological Condition

Benthic Macroinvertebrate IBI

Narrative Rating	Fair
BIBI Score	3.29

Metric	Value	Score
Total Taxa	22	5
EPT Taxa	7	5
Number Ephemeroptera	1	3
% Intolerant to Urban	26.05	3
% Ephemeroptera	0.840336	3
Scraper Taxa	0	1
% Climbers	3.36	3

Benthic Macroinvertebrate Taxa List

Taxa	Count
Ameletus	1
Amphinemura	1
Caecidotea	1
Calopteryx	1
Conchapelopia	8
Crangonyx	1
Diplectrona	12
Gymnometriocnemus	5
Hydrobius	1
Hydropsychidae	1
Ironoquia	6
Leuctridae	10
Lumbricidae	4
Lumbriculidae	1
Nigronia	1
Parachaetocladius	5
Parametriocnemus	38
Pisidium	3
Polycentropus	5
Tipula	2
Tubificidae	4
Zavrelimyia	8

Physical Habitat

Maryland Biological Stream Survey PHI

Narrative Rating	Partially Degraded
PHI Score	79.03

Metric	Score
Drainage area (acres)	76.80
Remoteness	42.78
Percent Shading	73.32
Epifaunal Substrate	91.83
Instream Habitat	97.29
Instream Wood Debris	100.00
Bank Stability	68.93

Rapid Bioassessment Protocal

Narrative Rating	Supporting
RBP Score	80

Metric	Score
Epifaunal Substrate / Cover	11
Embeddedness	12
Velocity / Depth Regime	8
Sediment Deposition	8
Channel Flow Status	15
Channel Alteration	20
Frequency of Riffles	16
Bank Stability	7(Left)/8(Right)
Vegetative Protection	6(Left)/6(Right)
Riparian Veg Zone Width	9(Left)/9(Right)

Water Chemistry

Dissolved Oxygen (mg/L)	7.8
pH	6.15
Specific Conductance (µS/cm)	1565
Temperature (°C)	15.74
Turbidity (NTUs)	15

Picture Spring Branch Site PSB-02

Sampled: 3/24/2016

Biological Condition

Benthic Macroinvertebrate IBI

Narrative Rating	Fair
BIBI Score	3.00

Metric	Value	Score
Total Taxa	18	3
EPT Taxa	5	5
Number Ephemeroptera	0	1
% Intolerant to Urban	13.82	3
% Ephemeroptera	0	1
Scraper Taxa	2	5
% Climbers	4.07	3

Benthic Macroinvertebrate Taxa List

Taxa	Count
Caecidotea	1
Cheumatopsyche	1
Chimarra	4
Conchapelopia	6
Diplectrona	10
Dolichopodidae	1
Hemerodromia	1
Lepidoptera	1
Leuctridae	2
Lumbricidae	1
Parametriocnemus	42
Physa	3
Pisidium	30
Polycentropus	4
Polypedilum	2
Simulium	9
Stenelmis	2
Stictochironomus	3

Physical Habitat

Maryland Biological Stream Survey PHI

Narrative Rating	Partially Degraded
PHI Score	67.77

Metric	Score
Drainage area (acres)	96.00
Remoteness	15.79
Percent Shading	63.55
Epifaunal Substrate	72.95
Instream Habitat	78.37
Instream Wood Debris	100.00
Bank Stability	75.96

Rapid Bioassessment Protocal

Narrative Rating	Partially Supporting
RBP Score	69

Metric	Score
Epifaunal Substrate / Cover	7
Embeddedness	7
Velocity / Depth Regime	4
Sediment Deposition	5
Channel Flow Status	17
Channel Alteration	17
Frequency of Riffles	17
Bank Stability	9(Left)/9(Right)
Vegetative Protection	6(Left)/6(Right)
Riparian Veg Zone Width	6(Left)/6(Right)

Water Chemistry

Dissolved Oxygen (mg/L)	8.27
pH	6.6
Specific Conductance (µS/cm)	1367
Temperature (°C)	11.93
Turbidity (NTUs)	13.5

Picture Spring Branch Site PSB-03

Sampled: 3/24/2016

Biological Condition

Benthic Macroinvertebrate IBI

Narrative Rating	Fair
BIBI Score	3.29

Metric	Value	Score
Total Taxa	24	5
EPT Taxa	5	5
Number Ephemeroptera	0	1
% Intolerant to Urban	3.42	1
% Ephemeroptera	0	1
Scraper Taxa	5	5
% Climbers	41.03	5

Benthic Macroinvertebrate Taxa List

Taxa	Count
Calopteryx	10
Cheumatopsyche	7
Chimarra	3
Conchapelopia	9
Crangonyx	1
Diplectrona	1
Fossaria	4
Helichus	1
Hemerodromia	1
Hydrobaenus	4
Hydropsychidae	1
Leuctridae	1
Nigronia	1
Orthocladius	5
Paracladopelma	1
Philopotamidae	1
Physa	31
Pisidium	5
Polypedilum	1
Simulium	3
Stenelmis	2
Stictochironomus	1
Tanytarsus	1
Thienemannimyia group	4
Tvetenia	18

Physical Habitat

Maryland Biological Stream Survey PHI

Narrative Rating	Partially Degraded
PHI Score	67.99

Metric	Score
Drainage area (acres)	147.20
Remoteness	15.79
Percent Shading	49.95
Epifaunal Substrate	75.98
Instream Habitat	96.18
Instream Wood Debris	100.00
Bank Stability	70.02

Rapid Bioassessment Protocal

Narrative Rating	Partially Supporting
RBP Score	72

Metric	Score
Epifaunal Substrate / Cover	11
Embeddedness	12
Velocity / Depth Regime	10
Sediment Deposition	8
Channel Flow Status	13
Channel Alteration	15
Frequency of Riffles	10
Bank Stability	8(Left)/8(Right)
Vegetative Protection	6(Left)/6(Right)
Riparian Veg Zone Width	8(Left)/6(Right)

Water Chemistry

Dissolved Oxygen (mg/L)	11.25
pH	6.85
Specific Conductance (µS/cm)	1135
Temperature (°C)	9.65
Turbidity (NTUs)	12.6

Select physical habitat parameters (raw scores) 2016			
Site	Epifaunal Substrate (0 – 20)	Instream Habitat (0-20)	Embeddedness (0 – 100%)
PSB-01	11	11	90
PSB-02	8	8	100
PSB-03	9	12	90

APPENDIX G

BMP INSPECTIONS

(see accompanying Adobe PDF file for Appendix G)