Monroe County Planning Commission

2017
Water Quality Study

ABSTRACT

The Monroe County Planning Commission along with the Monroe County Conservation District studied 38 stream sites throughout Monroe County in the spring of 2017. The sites were studied based on four parameters, field surface water measurements, laboratory chemistry analysis, macro-invertebrate identification, and habitat assessment.

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Materials & Methods

1. Field Chemistry Sampling *(Appendix A)*

The following parameters were measured and stored using HANNA Instruments-Multiparameter HI 9829 with a Multiparameter Probe 7609829 field meter and recorded on standard data forms:

-pH
-Temperature
-D.O. Concentration
-D.O. %
-Conductivity

2. Lab Chemistry Sampling *(Appendix A)*

The following table shows water chemistry parameters that were tested by Microbac. Laboratories in the analysis of the stream samples.

Test	Units	Method	PQL
Total Organic Carbon (TOC)	mg/L	SM5310 C-2000	0.500
Aluminum, Total	mg/L	E200.7	0.200
Calcium, Total	mg/L	E200.7	0.500
Iron, Total	mg/L	E200.7	0.100
Magnesium, Total	mg/L	E200.7	0.500
Harness	mg/L	SM2340-B-1997	5.00
Chloride	mg/L	EPA 300.0, Rv 2.1	0.250
pH	pH Units	SM4500 H+ B-2000	0.100
Nitrogen, Total as N (Calc)	mg/L	Calculation	0.500
Ammonia as N	mg/L	EPA 350.1, Rv 2	0.0500
Total Kjeldahl Nitrogen (TKN)	mg/L	EPA 351.2, Rv 2	0.500
Nitrate-Nitrate as N	mg/L	EPA 353.2, Rv 2.0	0.0200
Alkalinity to pH 4.5	mg $CaCO_3$/L	SM2320 B-1997	20.0
Total Dissolved Solids (TDS)	mg/L	SM2540 C-1997	20.0
Phosphorus - Total as P	mg/L	SM4500 P E-1999	0.0500
Biochemical Oxygen Demand	mg/L	SM5210 B-2001	3.00

Materials & Methods

3. Macroinvertibrate Sampling *(Appendix B)*

At each site, macroinvertebrates were collected using 12" D-frame nets that were held on the stream bottom. The collector thoroughly disturbed the stream bottom to dislodge any macroinvertebrates from the substrate. This process was repeated 6 times for Riffle/Run streams and 10 times for Multihabitat streams.

Riffle/Run 6 Samples (At least one of each)

-Fast & Shallow
-Fast & Deep
-Slow & Shallow
-Slow & Deep

Multihabitat 10 Samples (Based on abundance)

-Cobble/Gravel
-Snag
-CPOM (Course Particulate Organic Matter)
-Submerged Aquatic Vegetation
-Sand/Fine Sediment

4. Habitat Analysis *(Appendix C)*

The following tables show Habitat Assessment parameters for Riffle/Run and Low Gradient Streams. Each parameter is rated on a score from 1 to 20. 20 being the highest and 1 being the lowest

Riffle Run Streams

1	Instream Fish Cover
2	Epifaunal Substrate
3	Embeddedness
4	Velocity/Depth Regimes
5	Channel Alteration
6	Sediment Deposition
7	Frequency of Riffles
8	Channel Flow Statues
9	Condition of Banks
10	Bank Vegetative Protection
11	Grazing or Other Disruptive Pressures
12	Riparian Vegetative Zone Width

Multihabitat/Low Gradient Streams

1	Epifaunal Substrate/ Available Cover
2	Pool Substrate Characterization
3	Pool Variability
4	Sediment Deposition
5	Channel Flow Status
6	Channel Alteration
7	Bank Stability (score each bank)
8	Vegetative Protection (score each bank)
9	Riparian Vegetative Zone Width (score each bank)

Appendix A:

SURFACE WATER PARAMETERS

The chemical characterization of waterways is important for the general description of water quality conditions. The following parameters were measured in the field, water samples were also analyzed by Microbac Laboratories.

Field Measurements

pH

The pH of a solution refers to its hydrogen ion concentration. Measurement of pH is one of the most important and frequently used tests in water chemistry. The pH value of most natural waters falls within the range of 4 to 9. The pH scale ranges from 0 (acid) to 14 (base). The majority of waters are slightly basic because of the presence of carbonates and bicarbonates (generally, salts within the geology). Most fish can tolerate pH values from 5.0 to 9.0, however optimum fishing habitats fall within the range 6.5 to 8.2.

Temperature

Temperature is essential in determining if acceptable standards exist for a particular stream classification. Elevated temperatures from heated water discharges may have a significant ecological effect. Temperature also affects dissolved oxygen levels.

Dissolved Oxygen

D.O. is a measure of oxygen that is dissolved in water. Different levels of D.O. are necessary to support various types of aquatic life. These levels in natural and waste waters are dependent on the physical, chemical, and biochemical activities prevailing in the water body. The minimum D.O. levels are as follows: HQ-CWF 7.0mg / L CWF 5.0. mg/L TSF (February 15th – July 31st) 6.0 mg/L; Remainder of year 5.0

Specific Conductance

Conductivity is a numerical expression of the ability of water to carry an electrical current. It is an indication of the dissolved inorganic solids in the water. The higher the specific conductance, the more impurities are in the water. Freshly distilled w0ater has a conductivity of 0.5 to 2.0 microsiemens/cm. The conductivity of the drinking water in the U.S. generally ranges from 50 to 500 microseimens/cm (µS). It is an indirect measure of the presence of dissolved solids such as chloride, nitrate, sulfate, phosphate, sodium, magnesium, calcium, and iron.

Laboratory Analysis

Total Organic Carbon

TOC is a measurement of the amount of carbon containing compounds in a sample that can be quantified. This measurement is significant because the amount identified in a stream can be an indicator of the organic character of a stream. The larger the carbon or organic content, the more oxygen is consumed, thus a high content equates to an increase in of microorganisms that could contribute to the depletion of oxygen levels. Samples are preserved in the field by the addition of 1 ml of Sulfuric Acid (H2SO4). There is no numeric standard for TOC.

Aluminum

Aluminum is found naturally in the environment and is found in water in a dissolved form. Its concentration is influenced by multiple factors including pH, surface water flow over soil and bedrock, and groundwater flow through soil horizons and underlying geologic material. The Aluminum concentrations of water in healthy streams and rivers usually range from 0.001 to 0.05 mg/L.

Calcium

Calcium occurs most commonly in sedimentary rocks in the minerals calcite, dolomite and gypsum. Calcium is an important determinant of water harness, and it also functions as a pH stabilizer, because of its buffering qualities. Rivers generally contain 1-2 mg/L calcium, in limestone areas; rivers may contain calcium concentrations as high as 100 mg/L. There is no numeric standard for calcium.

Iron

Surface and groundwater naturally contain iron along with metals. Rainwater infiltrates soil horizons and iron bearing rocks and dissolves the iron into the water solution. There are two kinds of iron that occur in water. The first kind is called ferrous which is soluble in the water, this results in clear colorless water. The other state is called ferric, which results in a reddish-brown color because the iron is not completely dissolved in the water. Iron can also be combined with naturally-occurring acids (tannins) which will stain the water a tea color.

Magnesium

This element is essential to chlorophyll and red blood cells. Magnesium commonly occurs in the minerals of magnesite ($MgCO_3$) and dolomite. It contributes to water hardness and is used in alloys, fertilizers, pharmaceuticals, and foods.

Laboratory Analysis (continued)

TOTAL HARDNESS

Hardness is defined as the total amount of calcium and magnesium salts that are present in the water. Hard water aids buffering capacity. Water can be defined by its total hardness as follows:

Soft Water	0 - 60 mg/L
Moderately Hard Water	60 - 120 mg/L
Hard Water	120 - 180 mg/L
Very Hard Water	180 mg/L and up

CHLORIDES

Chlorides are salts that contain chlorine and metal. Common Chlorides are sodium chloride, calcium chloride and magnesium Chloride. Most productive fish habitats have a chloride concentration of less than 170 mg/L. The recommended maximum chloride levels are 250 mg/L for water supply.

NITROGEN

Nitrate plus nitrite as nitrogen. The maximum recommended level for water supply is 10 mg/L as Nitrogen.

AMMONIA (NH3)

Ammonia is naturally present in surface and ground water and in wastewater. Pure ammonia is strong smelling and colorless. In nature, ammonia is formed by the action of bacteria on proteins and urea. Ammonia concentrations of 0.06 mg/L can cause gill damage in fish; 0.1 mg/L may indicate domestic or agricultural wastes and 0.2 mg/L and above is lethal to trout.

NITRITE (NO2)

Nitrite is the intermediate stage between nitrate and ammonia. It is relatively short-lived because it is quickly converted to nitrates by bacteria. Nitrite concentrations in drinking water seldom exceed 0.1 mg/L. There is no numeric standard for nitrite.

NITRATE (NO3)

Nitrate is found only in small amounts in domestic wastewater and is a major ingredient in farm fertilizer. During precipitation events, varying amounts of this chemical wash into nearby waterways. Nitrates stimulate the growth of phytoplankton and algae. When these photosynthetic organisms die, bacteria consume the dead organic material. This process also requires oxygen which depletes dissolved oxygen levels in the water and the fish may not be able to respire. Because Nitrate can be the limiting nutrient for plant growth in many ecosystems, the discharge from a septic tank into the aquatic environment can trigger prolific plant growth including algal blooms. There is no numeric standard for nitrate.

Laboratory Analysis (continued)

Total Kjeldahl Nitrogen

T.K.N. is the sum of organic nitrogen and ammonia nitrogen. Samples are preserved in the field by the addition of 1 ml of Sulfuric Acid (H_2SO_4). There is no numeric standard for TKN.

Total Alkalinity

Alkalinity measures the water's ability to buffer acid or acid neutralizing capacity. It indicates the water's ability to protect fish and other aquatic life against sudden changes in pH. The best fishing waters are those with alkalinity of 100 - 120 mg/L. The minimum level of total alkalinity for aquatic life buffering capacity is 20 mg/L, except where natural conditions are less. Stream alkalinity can be influenced by geologic material, soil horizons, salts, plant activities and certain industrial wastewater discharges. Water flowing through Carbonate rich limestone generally has high alkalinity – hence good buffering capacity. Conversely, areas rich in granites and some conglomerates and sandstones may have low alkalinity and therefore poor buffering capacity.

T.D.S.

Total dissolved solids (T.D.S.), also termed total filterable residue, refers to the portion of residue that passes through a filter of a particular size. The DEP, as well as the EPA, have established secondary maximum contaminant levels of 500 mg/L of TDS for the Commonwealth's drinking water and waterways. The maximum recommended value for T.D.S. is 750 mg/L.

Total Phosphorus

Total Phosphorus is a measure of all the forms of phosphorus (dissolved or particulate) that are found in a sample. It occurs in natural waters and wastewaters almost solely in the form of phosphates. Phosphates enter waterways from animal wastes, phosphate rich rocks, fertilizers, and from the detritus of aquatic organisms. Phosphorus is essential to the growth of organisms and can be the limiting nutrient to plant growth. If high concentrations are present in streams the algae can grow more rapidly. This increase in algae is eventually consumed by bacteria which require oxygen. This process reduces dissolved oxygen in the water which can impact fish populations. Phosphate levels below 0.03 mg/L are generally considered to be unpolluted. The recommended maximum level is 0.01 mg/L for rivers and streams.

Biological Oxygen Demand

BOD is a measure of the dissolved oxygen required for the complete breakdown of organic matter, by aerobic bacteria over a five-day period. It is a key criterion used where organic loading must be restricted to maintain desired levels of dissolved oxygen in water. Sources of BOD, in addition to direct loading from STPs, include decaying algae, macrophytes and other biota. In streams that are polluted with sewage or high levels of other nutrients, the oxygen use or demand by microorganisms will be high, leaving little oxygen for other aquatic organisms. Most pristine rivers will have a 5-day carbonaceous BOD below 1 mg/L.

Appendix B:

Benthic Macroinvertebrates

What is a Macroinvertebrate?

A macroinvertebrate is an organism that is large enough to see with the naked eye (macro) and lacks a vertebrate (invertebrate). The organisms that are collected for this study are called benthic macroinvertebrates. Benthic refers to the bottom layer of an aquatic ecosystem including underneath stream sediment. These organisms include mayflies, caddisflies, stoneflies, snails, clams, crayfish, freshwater shrimp, beetle larvae, midges, leeches, dragonflies, and more.

Why collect Macroinvertebrates?

- They are relatively easy to collect.
- They play a key role in the ecosystem's food web.
- They are used as bio indicators for environmental stress and can show varying responses to water chemistry and physical habitat.
- Due to their relative immobility (unlike fish) they cannot move upstream or downstream to avoid poor water conditions.
- They are extremely diverse. Different macroinvertebrates will live in different water bodies due to water conditions, available food, and absence or abundance of sediment, nutrients, and detritus (dead organic matter).

Source of Photos: http://kentschools.net thebeachschool.eq.edu.au www.fly-fishing-discounters.com

Macroinvertebrate Analysis

The protocols used in the development for the riffle/run Index of Biotic Integrity (IBI) were conducted from small first through third order riffle/run type streams, which totaled a drainage area of less than 50 square miles. The second protocol type is the multi-habitat assessment for low-gradient streams, which involved sampling a variety of habitat types. The difference between the two assessment protocols involved sampling different micro-habitats for macroinvertebrate collections and different habitat evaluation categories. These bio assessments were employed to cumulatively evaluate the ecological conditions of streams that are present within Monroe County.

Metric Calculations

The following are the riffle/run metrics used for the benthic macroinvertebrate analysis. Metrics are the various counts, indexes, and ratios computed from the results of the subsamples.

Different metrics convey different types of information about the macroinvertebrate community. For example, taxa richness is an index of diversity and the Hilsenhoff Biotic Index measures an organism's pollution tolerance. By using a set of metrics that measures multiple aspects of the macroinvertebrate community, a complete picture of a community can be attained. This enables the reader to understand the importance of measuring the relative stability of the aquatic community.

The following is a list of metric calculations utilized during the 2017 study:

Freestone Riffle/Run (6 D Frame):

Modified Beck's Index (**version 3**)
MBI metric is projected to decline in assessment score when anthropogenic stress to a stream ecosystem increases, therefore representing the loss of pollution-sensitive taxa. It should be noted that this index metric for this project, while similar in name and concept, differs slightly from the Beck's Index used in DEP's multihabitat protocol for assessing biological condition of low gradient pool-glide type streams.

EPT Taxa Richness
EPT Taxa Richness metric is a count of the number of taxa belonging to the orders Ephemeroptera, Plecoptera, and Trichoptera (EPT) in a sub-sample that represents community structure. These orders are commonly referred to as mayflies, stoneflies, and caddisflies, respectively. This metric is expected to decrease in value with increasing anthropogenic stress to a stream ecosystem, reflecting the loss of taxa from these largely pollution-sensitive orders.

Total Taxa Richness
Total Taxa Richness is a community structure metric, which is a count of taxa in the sub sample. Generally, this metric is expected to decrease with increasing anthropogenic stress to the ecosystem, reflecting loss of taxa and increasing dominance of a few pollution tolerant taxa.

Shannon Diversity Index
SDI is a taxonomic composition metric that measures taxonomic richness and evenness of individuals across taxa of a sub-sample. This metric is expected to decrease in values with increasing anthropogenic stress to a stream ecosystem.

Hilsenhoff Biotic Index
HBI is a taxonomic composition metric and is calculated as an average pollution tolerance value weighted by the number of individuals of each taxa in the sub-sample. The Hilsenhoff Biotic Index generally increases with increasing ecosystem stress.

Percent Sensitive Individuals
Percent Sensitive Individuals is a taxonomic composition metric which is the percentage of individuals with pollution tolerance values of three or less in a sub-sample and is expected to decrease in value with increasing anthropogenic stress to a stream ecosystem.

Index Calculation-Riffle/Run:

Through the combination of these various metrics noted previously, standardization is needed. Table 1 depicts the standardization table with the associated standardized and adjusted metric scores with the total producing the IBI score. This index is a way to integrate data that is collected from the above equations. The sum of these specific metric equations constructs an IBI, which then can be related to reflect the ecology and impacts to the aquatic community being studied. There are six metrics involved, the Hilsenhoff Biotic Index (HBI) is the only one predicted to increase in value if the community is stressed. The other five IBI metrics are predicted to decrease in value if the community is exposed to increased stress. The index calculation and standardization is as follows.

Table 1. Metric Standardization Equations and Index calculations for sub-sampled sites.

Metric	**Standardized Equation**	**Observed Metric Value**	**Standardized Metric Score**	**Adjusted Standardized Metric Score** Maximum = 1.000
Modified Beck's Index	Observed value / 33			
EPT Taxa Richness	Observed value / 19			
Total Taxa Richness	Observed value / 38			
Shannon Diversity Index	Observed value / 2.86			
Hilsenhoff Biotic Index	(10 - Observed value) / (10 – 1.89)			
Percent Intolerant Individuals	Observed value / 84.5			
Average of adjusted standardized core metric scores * 100 = **IBI Score**				

Aquatic Life Use Attainment Benchmarks

Table 2 depicts the Aquatic Life Use (ALU) IBI scoring benchmarks utilized by DEP for assessment purposes. DEP implements a multi-tiered benchmark decision process for small wadeable freestone riffle/run streams in Pennsylvania that incorporates sampling season as a factor for determining ALU attainment and impairment; this process is outlined in the diagram below (PADEP 2009). Title 25, Chapter 93 of the Pennsylvania Code provides further information on these uses.

Table 2. Aquatic Life Use (ALU) IBI scoring benchmarks for Instream Comprehensive Evaluation (ICE) assessment purposes.

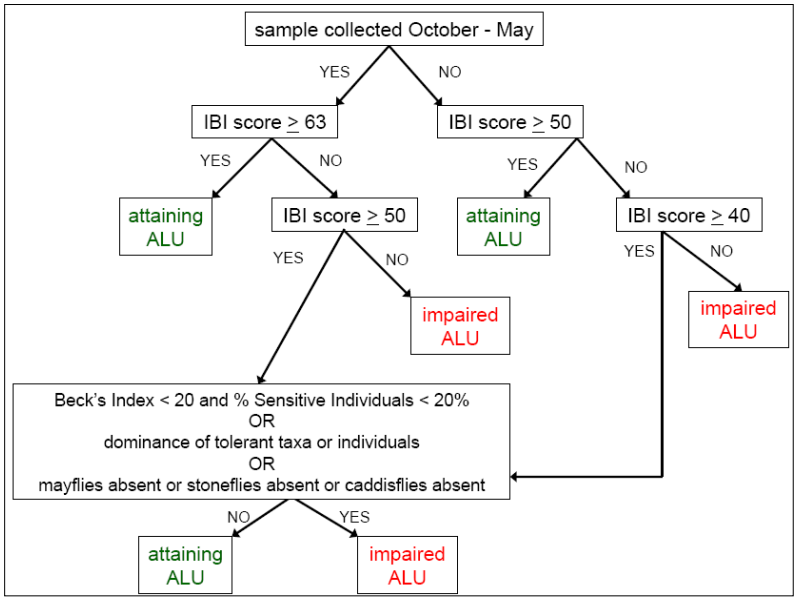

Table 2 depicts the adjusted and standardized Aquatic Life Use (ALU) IBI scoring benchmarks for ICE assessment purposes. For samples collected from smaller streams between October and May, an IBI score > 63 results in ALU attainment and an IBI score < 50 results in ALU impairment; an IBI score between 50 and 63 requires further evaluation to determine ALU impairment – three guidelines may be used:

(1) If the Beck's Index score is < 20 and the % Sensitive Individuals in the sub-sample is < 20%, the ALU should be impaired without compelling reason otherwise;

(**2**) If the sample is dominated by tolerant taxa or individuals, the ALU should be impaired without compelling reason otherwise; or

(**3**) If mayflies, stoneflies or caddisflies are absent from the sub-sample the ALU should be impaired. For samples collected between June and September from smaller streams, an IBI score > 50 results in ALU attainment and an IBI score < 40 results in ALU impairment; an IBI score between 40 and 50 requires further evaluation to determine ALU impairment, guided by the same three guidelines outlined above for October to May samples scoring between 50-63.

Multi-habitat - Low Gradient (10 D Frame):

EPT Taxa Richness - Refer to riffle/run definition.
Total Taxa Richness - Refer to riffle/run definition.

Modified Beck's Index (version 4) - This is a pollution weighted taxa richness measure that is based on the Hilsenhoff Biotic Index Score. It is a modified Beck's Index giving organisms with a Hilsenhoff score of 0 or 1 two points and Hilsenhoff scores of 2, 3, or 4 are given 1 point. This metric differs slightly from the Beck's Index used in DEP's riffle/run protocol for assessing the biological condition of freestone type streams.

Shannon Diversity Index - Refer to riffle/run definition.
#Caddisfly Taxa - Total number of Caddisflies (Trichoptera) in the sub-sample
#Mayfly Taxa - Total number of Mayflies (Ephemeroptera) in the sub-sample

Index Calculation-multihabitat:

Through the combination of the various metrics noted above, normalization is needed. This index is a way to integrate data that is collected from the above equations. Table 3 depicts the standardization table with the associated normalized and adjusted metric scores with the total generating an IBI score. The sum of these specific metric equations builds an IBI, which then can be related to reflect the ecology & impacts to the aquatic community being studied. Of the six metrics utilized, all are predicted to decrease in value if the community is stressed. The normalized scores above 100 are adjusted to a score of 100. The index calculation and normalization is as follows:

Table 3. Normalization of Metric and Total Biological Score Calculation.

Metric	Standardized Equation	Observed Value	Normalized Metric Score	Adjusted Metric Score Maximum = 100
EPT	(Observed value / 17) x 100			
Taxa Richness	(Observed value / 31) x 100			
Beck4	(Observed value / 22) x 100			
Shannon Diversity	(Observed value / 2.43) x 100			
% Caddisfly Taxa	(Observed value / 11) x 100			
% Mayfly Taxa	(Observed value / 6) x 100			
Total Biological Score				

Aquatic Life Use Attainment Benchmarks

The following depicts the aquatic life use (ALU) IBI scoring benchmarks utilized by DEP for assessment purposes. This multimetric approach simplifies management decisions, being presented as a single index score (PADEP 2007). If the total benchmark score of 55 is not reached, then the stream reach is not attaining the threshold for aquatic life. Title 25, Chapter 93 of the Pennsylvania Code provides further information on these uses.

The following summaries are presented in the sequence they were sampled. They depict the macroinvertebrate community per site, specifically genus level taxonomy, water pollution tolerances values (0 intolerant to 10 tolerant), trophic codes and the statistics that comprise the total standardized biological score. The trophic code is a general classification system, which is based on what type of feeding mechanism the macroinvertebrate utilized or how the food is acquired. These categories are presented to facilitate the descriptions on the following pages:

SC - **Scrapers**: graze or scrape materials from mineral and organic substrates

SH - Shredders: chew on plant and some animal material, breaking it down into smaller particles feeding directly on living vascular hydrophytes, or gouge decomposing wood submerged in streams

CG - Collector/Gatherers: feed primarily on fine pieces of decomposing particulate organic matter (< 1 mm diameter) deposited in streams;

FC - Filterer/Collector: remove particulate matter from suspension

PR - Predators: Organisms that feed on animal tissue by either engulfing or piercing and sucking body contents of prey (Merritt & Cummins 1984).

Monroe County executed two progressive stream evaluation surveys, the riffle-run and the multihabitat protocols, which are conducted within a 100 meter stream reach. These biological screening protocols were modified from the United States Environmental Protection Agency (EPA) Rapid Bioassessment Protocols (RBPs), for assessing stream macroinvertebrate communities (PADEP 2009). These biological screening protocols are specifically designed per stream type, to provide intensive field surveys and water quality assessment approaches. The riffle-run Index of Biological Integrity (IBI) applies to benthic macroinvertebrate samples collected using a handheld 500-micron mesh D-frame net, which employed the semi-quantitative (PADEP-RBP) method, applied for each Instream Comprehensive Evaluation (ICE). Staff conducted six swipes from shallow, fast and slow riffle areas within a 100-meter stream reach. Each swipe disturbed approximately one square meter, immediately upstream of the net for approximately one minute, to an approximate depth of 10 cm, as substrate permits (PADEP 2009). The second sampling protocol is the multihabitat approach for low gradient streams, which required 10 jabs utilizing a 500-micron mesh D-frame net distributed between

five possible habitat types: Cobble/Gravel Substrate; Snag; Coarse Particulate Organic Matter (CPOM); Submerged Aquatic Vegetation (SAV); Sand/Fine Sediment) (PADEP 2007).

For the riffle-run dominated streams, each sample is composited into one container preserved with 95% ethanol in the field and transported to the contracted entomologist for enumeration and identification and placed into a pan marked with 28 four square inch grids. Debris from four grids is randomly selected and extracted using a four-square inch circular "cookie cutter," then placed into another identical empty pan. From this second pan, organisms are randomly selected from the grids until a 200-organism sub-sample (+/- 40 organisms) is obtained. Organisms in the sub-sample are identified according to taxonomic groupings and enumerated. Midges are identified to the family level of Chironomidae. Roundworms and proboscis worms are identified to the phylum level, flatworms and segmented worms, aquatic earthworms, and tubificids are identified to class. Water mites are identified as Hydracarina, and all other macroinvertebrates are identified to genus level (PADEP 2009).Adam
For low gradient dominated streams, each sample is composited into one container preserved with 95% ethanol in the field and transported to the contracted entomologist for enumeration and identification and placed into a pan marked with 28 2" x 2" grids. Debris from four grids is randomly selected and extracted until a 200-organism sub-sample (+/- 20 %) is obtained. Organisms in the sub-sample are identified according to taxonomic groupings. Midges are identified to the family level of Chironomidae. Roundworms and proboscis worms are identified to the phylum level; flatworms are identified to Phylum Turbellaria; segmented worms, aquatic earthworms and tubificids are identified to Class Oligochaeta. Water mites are identified as Hydracarina, weevils to family, sand flies to family Ceratopogonidae, Decapoda, Gastropoda, and Pelecypoda to family, and all other macroinvertebrates are identified to genus level (PADEP 2007). The specifics of the macroinvertebrate analyses are discussed in Appendix B of this report.

Precision Quantification

To quantify precision methods, two of the biological samples were replicated and collected by the same investigator to minimize variability, and complies with the PADEP's quality assurance manual to verify identification work performed on macroinvertebrates. The Field data sheets are available for review at the MCPC office.

Quality Assurance

Accuracy was determined through the use of routine laboratory protocols that required random spiking of samples as per *consistency with the Quality Assurance Manual for* PADEP. Data quality requirements were maintained in the field throughout the collections. Calibration of field equipment was performed daily.
During the field sampling, water samples were collected at mid-depth and mid-channel. These water samples were stored in coolers with ice packs in order for stabilization and then transported to Microbac Laboratories, which is EPA certified for analysis. The specifics of the chemical parameters are discussed in Appendix A of this report.

2017 MONROE COUNTY MACROINVERTEBRATE DATA

TAXON	Pollution Tolerance	NUMBER COLLECTED AT SAMPLING STATION												
ORDER *GENERA/SPECIES*		01	02	03	04	05	06	07	08	09	10	11	12	13
AMPHIPODA (shrimp)														
Gammarus spp.	4	1	1						4				2	7
BIVALVIA (clams)														
Pisidium spp.	8													5
COLEOPTERA (beetles)														
Stenelmis spp.	5		5	6	3	18	3	8	14		14	4	2	2
Promoresia spp.	2		3						2					
Dubiraphia spp.	6	2	1										1	
Optioservus spp.	4	2		2		1		2						1
Ectopria spp.	5													
Psephenus herricki	4	2		20	14	14	20	2	4		24	27	1	
Hydrochus spp.	5												1	
Lutrochus spp.	6												1	
DIPTERA (true flies)														
Chironomidae	6	18	5	13	24	16	20	23	133		7	24	5	26
Blepharicera spp.	0				2							1		
Tipula spp.	4													
Hexatoma spp.	2						1			2		1		
Atherix spp.	2					1								
Antocha spp.	3				2		4	1				1		
Simulium spp.	6	1	2		1				3					2
Dicranota spp.	3								1		1			
Empididae spp.	6				2		4	3				1		
Chrysops spp.	7	1												
Prosimulium spp.	2				2					33				
Aedes spp.	8					1								
Dolichopodidae spp.	4			4										
EPHEMEROPTERA (mayflies)														
Epeorus spp.	0		5		3	6	5	1	6	27	12	9		1
Mccaffertium spp.	3	13	17	18	2	3	5	7		1	18	1	6	
Stenacron spp.	4	1	1					1						
Ephemerella spp.	1	59	42	19	27	8	24	28	2	19	59	13	138	73
Eurylophella spp.	4		1	10	1				1				1	
Drunella spp.	1	9	12	19	2	107	44	55	1	1	10	7	1	
Seratella spp.	2			1		1	1	4	1		2		1	
Paraleptophlebia spp.	1				1					2	17	1		
Cinygmula spp.	1									2				
Rithrogena spp.	3									6				
Heptageniidae	3		4				1				3			
Isonychia spp.	3	1	34	8	3	3	1		1		5			
Baetidae	6													
Baetis spp.	6			2	1	1			1	1		3	2	1
Plauditus spp.	6		1											
Acentrella spp.	4		1	8	13	15	22	32	17	1	4	22		
GASTROPODA (snails)														
Physinae	8													3
Bithynia spp.	7												1	7
Planorbidae	6				1									2
HIRUDINEA (leeches)	8													
Myzobdella spp.											1			
ISOPODA (sowbugs)														
Caecidotea spp.	6	1												
MEGALOPTERA (hellgramites)														
Sialis spp.	6	2	1											
Corydalus spp.	4													
Nigronia spp.	2	1	3		4	1	3				1	2		

TAXON (continued)	Pollution Tolerance	NUMBER COLLECTED AT SAMPLING STATION (continued)												
ORDER *GENERA/SPECIES*		01	02	03	04	05	06	07	08	09	10	11	12	13
ODONATA (dragon flies)														
Ophiogomphus spp.	1					1					1			
Lanthus spp.	5		3			1	1	1			1	1	1	
Gomphidae	4	1	1	1	2		1							
Argia spp.	6													
OLIGOCHAETA (worms)	10		2	1		1	3				1	3		
PLECOPTERA (stoneflies)														
Leuctra spp.	0		1	2	3							3		
Taeniopteryx spp.	2													
Amphinemura spp.	3		3	6								69	27	10
Alloperla spp.	0									16				
Pteronarcys spp.	0				1			2		17				
Acroneuria spp.	0		2	5	4	4	6	4			5	4		
Paragnetina spp.	1			1	4	2	2	3			5	2		
Agnetina spp.	1	1			16	1				5				
Perlesta spp.	4													1
Suwallia/Sweltsa spp.	0			1	4	1	3					5		
Tallaperla spp.	0									30			2	
Diploperla spp.	2				1									
Diura spp.	2									2				
Cultus spp.	2										2			
Isoperla spp.	2				3					4			2	
TURBELLARIA (flatworms)														
Macrostemum spp.	8													
TRICHOPTERA (caddisflies)														
Chimarra spp.	4			6		1	1	1	2				1	
Wormaldia spp.	0		1											
Dolophilodes spp.	0				14	2	6	2				3		
Neophylax spp.	3				5									
Hydropsyche spp.	5	5			1								3	5
Ceratopsyche spp.	5	6	7	3	10	14	15	7	4	3	9		2	
Cheumatopsyche spp.	6	7	19	16	5	16	13	9	6	4	23	2	5	5
Diplectrona spp.	0			1						4		9		
Rhyacophila spp.	1		4	2	1			2	1	8				
Lepidostoma spp.	1	1			4		1		3		2			1
Psilotreta spp.	0				2									
Micrasema spp.	2		4											
Polycentropus spp.	6		1		3		1							
Nectopsyche spp.	3													
Brachycentrus spp.	1				1									
Oecetis spp.	8								1					
Pycnopsyche spp.	4													2
TOTAL		135	187	175	192	240	211	198	208	188	227	218	206	154
METRICS														
Total Taxa Richness		21	30	25	38	26	27	22	21	21	24	25	22	18
Shannon Diversity Index		2.06	2.65	2.80	3.09	2.16	2.66	2.33	1.57	2.49	2.56	2.41	1.41	1.91
EPT Taxa Richness		7	14	14	21	12	13	12	9	16	12	11	9	5
Hilsenhoff Biotic Index		2.89	2.93	3.34	2.73	2.83	3.05	2.84	5.23	1.01	2.71	3.09	1.93	3.32
Percent Intolerant Individuals		63%	72%	47%	58%	59%	51%	57%	9%	95%	63%	60%	86%	54%
Modified Beck's Index		9	19	21	38	25	22	21	13	31	21	31	9	12
Index of Biotic Integrity (New)		**59.7**	**80.0**	**73.5**	**93.0**	**87.1**	**89.6**	**84.6**	**53.2**	**86.1**	**88.6**	**76.0**	**64.4**	**68.7**

2017 MONROE COUNTY MACROINVERTEBRATE DATA

TAXON	Pollution Tolerance	NUMBER COLLECTED AT SAMPLING STATION												
ORDER		14	15	16	17	18	19	20	21	22	23	24	25	26
GENERA/SPECIES														
AMPHIPODA (shrimp)														
Gammarus spp.	4		8						1			1	5	
Lutrochus spp.	6							1						
Microcylloepus spp.	2													
Stenelmis spp.	5								2					
Dubiraphia spp.	6		2						1			1		
Promoresia spp.	2	1		5	1		1	1		10	2		2	8
Stenelmis spp.	5	28	24										3	
Ectopria spp.	5						1							
Optioservus spp.	4	7		1	12		9					3	7	2
Agabus spp.	5													
Micronychus spp.	2													
Psephenus herricki	4	9	7					25	7	1		11	12	
Cambarus spp.	6				1									
DIPTERA (true flies)														
Chironomidae	6	1		19	2		28	24	19	24	65	17	40	5
Bezzia spp.	6													
Hemerodromia spp.	6	1												1
Tipula spp.	4		1								1			1
Hexatoma spp.	2				2		1			2	2			9
Atherix spp.	2													
Antocha spp.	3		1									1	3	3
Empedidae spp.	6	4									2	1		
Dicranota spp.	3										1	1		
Prosimulium spp.	0				2									2
Simulium spp.	6	1		7			4	2	4		10	6	3	
EPHEMEROPTERA (mayflies)														
Epeorus spp.	0			18	56		1	4	1	1	2	1		41
Mccaffertium spp.	3		1	6	1			14	3	3	16	17	2	3
Stenacron spp.	4			1										
Ephemerella spp.	1	82	146	36	41		38	51	54	48	24	30	17	47
Eurylophella spp.	4			4			1		4	1	6			1
Drunella spp.	1	1	4	21				7	17	4	10	9	15	1
Attenuatella spp.	2								1			1		
Heterocloen spp.	2													
Habrophlebiodes spp.	6						1			1				
Paraleptophlebia spp.	1			3	19		2	39		5	1			11
Isonychia spp.	3	2		6				4	6		5	5	1	
Ameletus spp.	0													
Caenis spp.	7													
Baetis spp.	6				6		2	11	2	14	5	1		12
Acerpenna spp.	6									2				1
Acentrella spp.	4							4	2		7	17	9	
Plauditus spp.	6								3					
Diphetor spp.	6				1					7				21
Cinygmula spp.	1				8									
Heptageneidae spp.	3		2											
Ameletus spp.	0													4
MEGALOPTERA (hellgramites)														
Sialis spp.	6			1					1					
Nigronia spp.	2	1	2	8				3	10		5			1
Corydalus spp.	4	1										1		

TAXON (continued)	Pollution Tolerance													
ORDER		14	15	16	17	18	19	20	21	22	23	24	25	26
GENERA/SPECIES														
ODONATA (dragon/damsel flies)	4													
Gomphidae	5			5				1			1			
Lanthus spp.	4									3				
Ophiogomphus spp.	1	1												
OLIGOCHAETA (worms)	10											7		
PLECOPTERA (stoneflies)														
Paraleuctra spp.	0													
Leuctra spp.	0				1					1				
Amphinemura spp.	3						126	7	8					
Pteronarcys spp.	0			3			2	3		3				2
Alloperla spp.	0									3				
Acroneuria spp.	0	5		5			2	9	7	2	6	4	2	1
Paragnetina spp.	1			3							2		1	2
Agnetina spp.	2			1						2				7
Suwallia/Sweltsa spp.	0				1						1			8
Perlesta spp.	4								1					
Tallaperla spp.	0			1	13					1				1
Diploperla spp.	2													
Cultus spp.	2													
Isoperla spp.	2			3	1		1	4		3				3
Isogenoides spp.	0										3			
Diura spp.	2													1
Clioperla spp.	2			2										6
TRICHOPTERA (caddisflies)														
Chimarra spp.	4			1					2					1
Wormaldia spp.	0						1							
Parapsyche spp.	0				5									
Dolophilodes spp.	0			2				1			11			
Hydropsyche spp.	5	1						1	3					
Cheumatopsyche spp.	6	27	4	7			2	3	27	1		16	63	
Ceratopsyche spp.	5	9	2	1	2		1	4	3	4	3	1	11	3
Diplectrona spp.	0			8	12		2	17		2				
Rhyacophila spp.	1			10	4		6	1		9	2		2	7
Glossosoma spp.	0	1												
Psychomyia spp.	2												1	
Protoptila spp.	1	2												
Lepidostoma spp.	1		1							1	2	3		3
Leucotrichia spp.	6													
Micrasema spp.	2			1					1	4			2	
Neophylax spp.	3	6									1	1		2
Brachycentrus spp.	1									1				
Agapetus spp.	0								2		1			
Nectopsyche spp.	3													
Mystacides spp.	4													
Polycentropus spp.	6			1					2		1			
Pycnopsyche spp.	4	3	2	2										
Psilotreta spp.	0									2				1
TOTAL		194	207	192	191		232	241	194	165	198	156	201	222
METRICS														
Total Taxa Richness		23	15	32	21		21	25	29	30	29	25	21	34
Shannon Diversity Index		2.08	1.22	2.92	2.25		1.63	2.59	2.63	2.65	2.56	2.65	2.33	2.87
EPT Taxa Richness		9	6	22	12		11	14	15	19	17	12	11	21
Hilsenhoff Biotic Index		3.02	1.96	2.21	1.05		3.03	2.41	3.12	2.75	3.55	3.67	4.40	2.12
Percent Intolerant Individuals		53%	76%	74%	87%		79%	68%	57%	65%	49%	46%	26%	74%
Modified Beck's Index		17	7	35	32		24	26	17	41	33	14	17	41
		63.9	**59.5**	**95.5**	**81.6**		**70.2**	**80.5**	**76.0**	**91.6**	**81.9**	**78.6**	**69.2**	**97.0**

2017 MONROE COUNTY MACROINVERTEBRATE DATA

TAXON	Pollution Tolerance	NUMBER COLLECTED AT SAMPLING STATION											
ORDER *GENERA/SPECIES*		27	28	29	30	31	32	33	34	35	36	37	38
AMPHIPODA (shrimp)													
Gammarus spp.	4							2	10				
COLEOPTERA (beetles)													
Stenelmis spp.	5		7	1				11				25	
Promoresia spp.	2						24	1		3	3	1	
Stenelmis spp.	5				2		1		72		13		5
Optioservus spp.	4	2		2			7			2			
Ectopria spp.	5						1						
Psephenus herricki	4	8	8		5	20		1	4			2	
DIPTERA (true flies)													
Chironomidae	6	1		2	26	32	14	21		14	30	2	17
Blepharicera spp.	0	2		1									
Hemerodromia spp.	6			14				1					
Empididae	6					3	1						
Tipula spp.	4	1		1		3							
Hexatoma spp.	2	5		9	3	1	1			5			
Antocha spp.	3		2	1	4		1			11			
Prosimulium spp.	2	4				1	1						
Simulium spp.	6						2						
Certopogonidae spp.	6												1
Dicranota spp.	3	6					1						
Chrysops spp.	7						1	1					
Leptotarsus spp.	4								1			1	
EPHEMEROPTERA (mayflies)													
Epeorus spp.	0	47	1	49	11	2	2	5		35	1	1	
Mccaffertium spp.	3		1	3	9		5	4	20		11	7	17
Stenacron spp.	4					6						1	
Cinygmula spp.	1	10			5					3			
Ephemerella spp.	1	56	14	42	30	12	78	39	5	44	9	9	6
Eurylophella spp.	4	4						3	3			11	2
Caenis spp.	7												
Serratella spp.	2						1	5			1		
Drunella spp.	1	3	96	2	17	75		4	8	1	8	46	
Heterocloeon spp.	2											1	
Paraleptophlebia spp.	1				6		5			1	2		1
Leptophlebia spp.	4												
Habrophlebiodes spp.	6												
Isonychia spp.	3		6			2			3		20	6	
Ameletus spp.	0						2						
Baetis spp.	6	2	3	4	34	1	6	3		10			
Diphetor spp.	6												
Acerpenna spp.	6										10		
Acentrella spp.	4		3		6	1		1					
Cynigmula spp.	1												
GASTROPODA (snails)													
Physidae spp	8									1			
ISOPODA (sowbugs)													
Caecidotea spp.	6						1	2	2				
MEGALOPTERA (hellgramites)													
Sialis spp.	6												
Nigronia spp.	2		1								7		1
Corydalus spp.	4								3			2	

TAXON (continued)	Pollution Tolerance												
ORDER *GENERA/SPECIES*		27	28	29	30	31	32	33	34	35	36	37	38
ODONATA (dragon/damsel flies)													
Boyeria spp.	2												1
Ophiogomphus spp.	1	1				1					2	4	
Argiogomphus spp.	4												2
Dromogomphus spp	4												1
Gomphus spp.	5						4						
Lanthus spp.	5						7						
Argia spp.	6								2				
Macromia spp.	2											1	
Somatochlora spp.	1											1	
Calopteryx spp.	6											1	
OLIGOCHAETA (worms)	10			1	1			9					
PLECOPTERA (stoneflies)													
Leuctra spp.	0	1	1			2	9						
Amphinemura spp.	3	9				2	2	1					
Pteronarcys spp.	0	1								12			
Acroneuria spp.	0	7	3		2		3	1			7	13	3
Paragnetina spp.	1		2		1	1							
Agnetina spp.	1			9	6	1					14	1	
Suwallia/Sweltsa spp.	0	24		3			2						
Paranemoura spp.	2												
Tallaperla spp.	0						4			2			
Diploperla spp.	2				1								
Diura spp.	2									1			
Isoperla spp.	2			5	1		10			4			
TURBELLARIA (flatworms)													
TRICHOPTERA (caddisflies)													
Chimarra spp.	4		1		1			2	22		11		4
Mystacides spp.	4												1
Dolophilodes spp.	0		1	1	11	1		1		3			
Hydropsyche spp.	5					1			10				1
Cheumatopsyche spp.	6		11			14	1	3	45	8	22	26	3
Ceratopsyche spp.	5		35	26	10	34	2	2		32	10	5	
Diplectrona spp.	0	7		3			5			3			1
Rhyacophila spp.	1	4		3	1		4	2		6		2	2
Nyctiophylax spp.	7												1
Neureclipsis spp.	7											1	
Lepidostoma spp.	1		2	2	13	2			2				
Neophylax spp.	3									1			
Polycentropus spp.	6									1			
Pycnopsyche spp.	4							1		1		7	
Leptoceridae	4							1					
Macrostemum spp.	3											2	
Oecetus spp.	8												1
TOTAL		205	198	184	206	218	208	127	212	204	181	179	71
METRICS													
Total Taxa Richness		22	19	22	24	23	32	26	16	24	18	26	20
Shannon Diversity Index		2.34	1.85	2.27	2.69	2.15	2.52	2.51	2.07	2.50	2.61	2.51	2.41
EPT Taxa Richness		12	12	11	16	12	14	14	7	18	10	13	10
Hilsenhoff Biotic Index		1.05	2.45	2.30	2.94	3.22	2.12	3.61	4.47	2.43	3.21	3.02	3.87
Percent Intolerant Individuals		88%	66%	72%	59%	47%	77%	50%	18%	70%	36%	53%	45%
Modified Beck's Index		33	21	27	28	23	32	17	6	29	19	21	14
		83.1	**82.5**	**75.9**	**80.2**	**82.1**	**88.5**	**83.8**	**43.8**	**90.6**	**68.2**	**88.0**	**67.8**

Appendix C:

Habitat Assessment

Both the quality and quantity of available habitat affects the macroinvertebrate community. A healthy biological community not only requires good water quality, but also a supporting habitat. There are two types of rating systems for 2017. One is for a Riffle/Run prevalent stream, like most of the streams in Monroe County, which incorporates three categories for a total of 12 parameters. The second is the Multihabitat Low-Gradient stream for the low gradient streams that utilize 9 parameters. The following is an explanation of the habitat parameters:

Habitat Parameter Descriptions *Riffle/Run Streams*

1. **Instream Cover:**
   This is a measure of quantity and variety of natural structures in the stream that will provide a habitat for fish. (fallen trees, branches, logs, undercut banks, and large rocks)

2. **Substrate for Benthic Macroinvertebrates:**
   This measures the amount of hard substrate available for insects and snail habitat. Many insect larvae attach themselves to submerged substrate. Areas with rocky bottoms are critical for maintaining a healthy variety of insects.

3. **Embeddedness:**
   This refers to the degree to which rocks are covered or sunken into the silt, sand or mud. As substrates become embedded in the stream bottom, the amount of adequate surface space for insects to attach themselves decreases and the quantity and quality of the macroinvertebrate community is predicted to decrease.

4. **Velocity/Depth Regime:**
   There are four basic velocity/depth combinations:
   Shallow/Fast, Shallow/Slow, Deep/Fast, and Deep/Slow

5. **Channel Alteration:**
   This parameter is a measure of changes to the shape of the stream channel. When streams have been altered in any way (i.e., straightened, deepened, diverted, concrete channelized, artificial embankments or stabilization, dams or bridges), it can affect the macroinvertebrate community.

6. **Sediment Deposition:**
This parameter measures the sediment, which has accumulated on the stream bottom as a result of deposition. Deposition occurs as a result of large-scale movement of sediment caused by watershed erosion. This deposition may cause the formation of islands or point bars in the stream, which decreases the available habitat for macroinvertebrates.

7. **Frequency of Riffles:**
This parameter assumes that a stream with riffles or bends provides more diverse habitat than any straight or uniform depth stream. The ratio is calculated by dividing the average distance between riffles or bends by the average depth. The smaller ratio is an indicator of good habitat.

8. **Channel Flow Status:**
This is a measure of the degree to which the channel is filled with water. When the water reaches the base of both banks and a minimal amount of channel substrate is exposed, optimal conditions exist.

9. **Condition of Banks:**
This parameter addresses stream bank erosion (or potential for erosion). Steep banks are generally more susceptible to erosion and failure. Signs of erosion include crumbling banks, unvegetated banks, and exposed tree roots and soil.

10. **Bank Vegetative Protection:**
This measures the amount of stream bank covered by vegetation. Plant root systems on stream banks facilitate soil stability which reduces erosion. This parameter also provides information such as stream shading and nutrient uptake. Banks that support natural plant growth are indicative for supporting a healthier habitat for macroinvertebrates and fish.

11. **Grazing Disruptive Pressure:**
This parameter measures the impact to the riparian zone due to livestock grazing or human activities such as urbanization, golf courses, and residential developments.

12. **Riparian Zone Width:**
This is a measure of the width of the natural vegetation from the edge of the stream bank. This zone serves as a buffer to pollutants entering the stream from surface runoff.

Habitat Parameter Descriptions Multihabitat Low-Gradient Streams

1. **Epifaunal Substrate for Macroinvertebrate:**
   The substrate in muddy bottom streams consists mostly of submerged logs, snags and aquatic vegetation.

2. **Pool Substrate Characterization:**
   This is an evaluation of the type and condition of bottom substrates found in pools. Firm sediment types such as gravel and sand as well as rooted aquatic plants support a wider variety of organisms. A pool substrate dominated by mud or bedrock will not support a diverse community.

3. **Pool Variability:**
   This parameter rates the overall mixture of pool types found in the streams. The four basic types of pools are: Large-shallow, Small-deep, Small-shallow, Large-deep. General guidelines are as follows: greater than one half the cross-section to separate large from small and one meter separating shallow and deep.

4. **Sediment Deposition:**
   This parameter measures the sediment, which has accumulated on the bottom as a result of deposition.

5. **Channel Flow Status:**
   This is a determination of the percent of the channel that is filled with water. The flow status changes as the channel enlarges or as flow is decreased as a result of dams or obstructions, diversions for irrigation, or drought. When water does not cover as much of the streambed the available habitat is decreased.

6. **Channel Alteration:**
   This parameter is a measure of changes to the shape of the stream channel. Streams that run through agricultural or urban areas may have been altered many times. When streams have been changed in any way (i.e., straightened, deepened, diverted, concrete channelized, artificial embankments or stabilization, dams or bridges) it can affect the macroinvertebrate community. Streams that have been altered have fewer natural habitats for fish, macroinvertebrates and plants.

7. **Bank Stability:**
   This parameter addresses stream bank erosion (or potential for erosion). Steep banks are generally more susceptible to erosion and failure. Signs of erosion include crumbling and unvegetated banks and exposed tree roots and soil.

8. **Vegetative Protection:**
   This measures the amount of stream bank, which is covered by vegetation. Plant root systems on stream banks facilitate soil stability, which reduces the stream bank erosion. Banks that support full natural plant growth are indicative for supporting a healthier habitat for macroinvertebrates and fish.

9. **Riparian Vegetative Zone Width:**
   Refer to riffle/run definition.

Site Map

Site Chart

AQUACR14

Location	Upstream of Lower Smith Gap Rd. near Quinton Drive		
Site #	2017-1	Date	4/27/2017
Stream Name	Aquashicola Creek	Time	8:36:47 AM
Township	Eldred	Latitude	40.82939
Habitat Asmt.	178	Longitude	-75.44627

Field Measurements	
Temp C	12.49
pH	7.27
Press inHg	29.3
DO Percent	72.4
DO mg/L	7.55
Cond (uS/cm)	159

Macroinvertebrate Metrics	
Total Taxa	21
Shannon Diversity Index	2.06
EPT Taxa Richness	7
Hilsenhoff Biotic Index	2.89
Intolerant individuals (%)	0.6296
Modified Becks Index	9
Index of Biotic Integrity	**59.7**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	1.51
Aluminum mg/L	<0.100
Calcium mg/L	18.6
Iron mg/L	<0.0500
Magnesium mg/L	4.41
Hardness CaCO3	64.7
Chloride mg/L	9.65
pH	6.28
Nitrogen as N mg/L	
Ammonia as N mg/L	<0.500
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.443
Alkalinity to pH 4.5 mg CaCO3/L	56.0
Total Dissolved Solids mg/L	49
Phosphorus as P mg/L	<0.200
Biochemical Oxygen Demand mg/L	<3.00

BRIGCR02

Location	Upstream of Angler Rd.		
Site #	2017-2	Date	5/8/2017
Stream Name	Brights Creek	Time	11:44:14 AM
Township	Price	Latitude	41.18353
Habitat Asmt.	172	Longitude	-75.16011

Field Measurements	
Temp C	11.39
pH	6.46
Press inHg	28.71
DO Percent	106.8
DO mg/L	11.19
Cond (uS/cm)	81

Macroinvertebrate Metrics	
Total Taxa	30
Shannon Diversity Index	2.65
EPT Taxa Richness	14
Hilsenhoff Biotic Index	2.93
Intolerant individuals (%)	0.722
Modified Becks Index	19
Index of Biotic Integrity	**80**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	4.83
Aluminum mg/L	<0.100
Calcium mg/L	2.1
Iron mg/L	<0.0500
Magnesium mg/L	0.802
Hardness CaCO3	8.55
Chloride mg/L	4.08
pH	6.71
Nitrogen as N mg/L	
Ammonia as N mg/L	<0.500
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	
Alkalinity to pH 4.5 mg CaCO3/L	<20.0
Total Dissolved Solids mg/L	32
Phosphorus as P mg/L	<0.200
Biochemical Oxygen Demand mg/L	<3.00

BUCKCR01

Location	Downstream of Chestnut Ridge Road		
Site #	2017-3	Date	4/27/2017
Stream Name	Buckwah Creek	Time	8:10:26 AM
Township	Eldred	Latitude	40.84714
Habitat Asmt.	157	Longitude	-75.45236

Field Measurements	
Temp C	12.84
pH	7.03
Press inHg	29.29
DO Percent	88.9
DO mg/L	9.19
Cond (uS/cm)	125

Macroinvertebrate Metrics	
Total Taxa	25
Shannon Diversity Index	2.8
EPT Taxa Richness	14
Hilsenhoff Biotic Index	3.34
Intolerant individuals (%)	0.4743
Modified Becks Index	21
Index of Biotic Integrity	**73.5**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	
Aluminum mg/L	
Calcium mg/L	
Iron mg/L	
Magnesium mg/L	
Hardness CaCO3	
Chloride mg/L	
pH	
Nitrogen as N mg/L	
Ammonia as N mg/L	
Total Kjeldahl N mg/L	
Nitrate as N mg/L	
Alkalinity to pH 4.5 mg CaCO3/L	
Total Dissolved Solids mg/L	
Phosphorus as P mg/L	
Biochemical Oxygen Demand mg/L	

BRODCR27

Location	Pasold Farms Nature Preserve		
Site #	2017-4	Date	5/2/2017
Stream Name	Brodhead Creek	Time	7:55:02 AM
Township	Barrett	Latitude	41.18107
Habitat Asmt.	179	Longitude	-75.25104

Field Measurements	
Temp C	12.68
pH	6.82
Press inHg	28.51
DO Percent	79.6
DO mg/L	8.04
Cond (uS/cm)	84

Macroinvertebrate Metrics	
Total Taxa	38
Shannon Diversity Index	3.09
EPT Taxa Richness	21
Hilsenhoff Biotic Index	2.73
Intolerant individuals (%)	0.578
Modified Becks Index	38
Index of Biotic Integrity	**93**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	2.18
Aluminum mg/L	<0.100
Calcium mg/L	4.2
Iron mg/L	<0.0500
Magnesium mg/L	1.16
Hardness CaCO3	15.3
Chloride mg/L	10.3
pH	6.84
Nitrogen as N mg/L	
Ammonia as N mg/L	<0.500
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.171
Alkalinity to pH 4.5 mg CaCO3/L	<20.0
Total Dissolved Solids mg/L	38
Phosphorus as P mg/L	<0.200
Biochemical Oxygen Demand mg/L	<3.00

BRODCR22

Location	Upstream of Paradise confluence		
Site #	2017-5	Date	5/2/2017
Stream Name	Brodhead Creek	Time	9:25:40 AM
Township	Stroud	Latitude	41.06585
Habitat Asmt.	178	Longitude	-75.22065

Field Measurements	
Temp C	13.43
pH	7.07
Press inHg	28.97
DO Percent	89.5
DO mg/L	9.03
Cond (uS/cm)	116

Macroinvertebrate Metrics	
Total Taxa	26
Shannon Diversity Index	2.16
EPT Taxa Richness	12
Hilsenhoff Biotic Index	2.83
Intolerant individuals (%)	0.5875
Modified Becks Index	25
Index of Biotic Integrity	**87.1**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	1.77
Aluminum mg/L	<0.100
Calcium mg/L	4
Iron mg/L	<0.0500
Magnesium mg/L	1.06
Hardness CaCO3	14.4
Chloride mg/L	11.1
pH	6.9
Nitrogen as N mg/L	
Ammonia as N mg/L	<0.500
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.0972
Alkalinity to pH 4.5 mg CaCO3/L	<20.0
Total Dissolved Solids mg/L	40
Phosphorus as P mg/L	<0.200
Biochemical Oxygen Demand mg/L	<3.00

BRODCR25 R

Location	Downstream of Paradise confluence (Forevergreen Preserve)		
Site #	2017-6	Date	5/2/2017
Stream Name	Brodhead Creek	Time	9:04:12 AM
Township	Stroud	Latitude	41.06489
Habitat Asmt.	197	Longitude	-75.22034

Field Measurements	
Temp C	13.32
pH	6.87
Press inHg	28.98
DO Percent	85.6
DO mg/L	8.67
Cond (uS/cm)	84

Macroinvertebrate Metrics	
Total Taxa	27
Shannon Diversity Index	2.66
EPT Taxa Richness	13
Hilsenhoff Biotic Index	3.05
Intolerant individuals (%)	0.51
Modified Becks Index	22
Index of Biotic Integrity	**89.6**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	1.72
Aluminum mg/L	<0.100
Calcium mg/L	4.75
Iron mg/L	<0.0500
Magnesium mg/L	1.29
Hardness CaCO3	17.2
Chloride mg/L	11.8
pH	7.02
Nitrogen as N mg/L	
Ammonia as N mg/L	<0.500
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.106
Alkalinity to pH 4.5 mg CaCO3/L	<20.0
Total Dissolved Solids mg/L	22
Phosphorus as P mg/L	<0.200
Biochemical Oxygen Demand mg/L	<3.00

BRODCR25 R

Location	Downstream of Paradise confluence (Forevergreen Preserve)		
Site #	2017-7	Date	5/2/2017
Stream Name	Brodhead Creek	Time	9:04:12 AM
Township	Stroud	Latitude	41.06489
Habitat Asmt.	197	Longitude	-75.22034

Field Measurements	
Temp C	13.32
pH	6.87
Press inHg	28.98
DO Percent	85.6
DO mg/L	8.67
Cond (uS/cm)	84

Macroinvertebrate Metrics	
Total Taxa	22
Shannon Diversity Index	2.33
EPT Taxa Richness	12
Hilsenhoff Biotic Index	2.84
Intolerant individuals (%)	0.57
Modified Becks Index	21
Index of Biotic Integrity	**84.6**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	1.71
Aluminum mg/L	<0.100
Calcium mg/L	4.84
Iron mg/L	<0.0500
Magnesium mg/L	1.29
Hardness CaCO3	17.4
Chloride mg/L	12.4
pH	6.91
Nitrogen as N mg/L	
Ammonia as N mg/L	<0.500
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.116
Alkalinity to pH 4.5 mg CaCO3/L	<20.0
Total Dissolved Solids mg/L	26
Phosphorus as P mg/L	<0.200
Biochemical Oxygen Demand mg/L	<3.00

BRODCR19

Location	Uptream from River Road bridge		
Site #	2017-8	Date	5/2/2017
Stream Name	Brodhead Creek	Time	11:17:12 AM
Township	Smithfield	Latitude	40.99399
Habitat Asmt.	164	Longitude	-75.13839

Field Measurements	
Temp C	14.62
pH	7.88
Press inHg	29.26
DO Percent	87.3
DO mg/L	8.66
Cond (uS/cm)	390

Macroinvertebrate Metrics	
Total Taxa	21
Shannon Diversity Index	1.57
EPT Taxa Richness	9
Hilsenhoff Biotic Index	5.23
Intolerant individuals (%)	0.0865
Modified Becks Index	13
Index of Biotic Integrity	**53.2**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	1.89
Aluminum mg/L	<0.100
Calcium mg/L	13.2
Iron mg/L	<0.0500
Magnesium mg/L	2.37
Hardness CaCO3	42.8
Chloride mg/L	35.2
pH	6.79
Nitrogen as N mg/L	
Ammonia as N mg/L	<0.500
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.352
Alkalinity to pH 4.5 mg CaCO3/L	30.0
Total Dissolved Solids mg/L	87
Phosphorus as P mg/L	<0.200
Biochemical Oxygen Demand mg/L	<3.00

BUHICR07

Location	Just upstream of golfcourse fairway at clubhouse, above falls		
Site #	2017-9	Date	4/24/2017
Stream Name	Buck Hill Creek	Time	8:10:44 AM
Township	Barrett	Latitude	41.19428
Habitat Asmt.	210	Longitude	-75.28143

Field Measurements	
Temp C	7.61
pH	7.83
Press inHg	28.57
DO Percent	118.5
DO mg/L	13.52
Cond (uS/cm)	31

Macroinvertebrate Metrics	
Total Taxa	21
Shannon Diversity Index	2.49
EPT Taxa Richness	16
Hilsenhoff Biotic Index	1.01
Intolerant individuals (%)	0.95
Modified Becks Index	31
Index of Biotic Integrity	**86.1**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	1.77
Aluminum mg/L	<0.100
Calcium mg/L	2.53
Iron mg/L	<0.0500
Magnesium mg/L	0.68
Hardness CaCO3	9.11
Chloride mg/L	4.95
pH	6.19
Nitrogen as N mg/L	
Ammonia as N mg/L	<0.500
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.0669
Alkalinity to pH 4.5 mg CaCO3/L	<20.0
Total Dissolved Solids mg/L	78
Phosphorus as P mg/L	<0.200
Biochemical Oxygen Demand mg/L	10.00

BUSHCR07

Location	Downstream from STP at DWGNRA boundary		
Site #	2017-10	Date	5/8/2017
Stream Name	Bushkill Creek	Time	9:32:52 AM
Township	Middle Smithfield	Latitude	41.08479
Habitat Asmt.	209	Longitude	-75.020822

Field Measurements	
Temp C	10.16
pH	6.73
Press inHg	29.35
DO Percent	88.2
DO mg/L	9.72
Cond (uS/cm)	29

Macroinvertebrate Metrics	
Total Taxa	24
Shannon Diversity Index	2.56
EPT Taxa Richness	12
Hilsenhoff Biotic Index	2.71
Intolerant individuals (%)	0.63
Modified Becks Index	21
Index of Biotic Integrity	**88.6**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	4.35
Aluminum mg/L	<0.100
Calcium mg/L	4.38
Iron mg/L	<0.0500
Magnesium mg/L	1.09
Hardness CaCO3	15.4
Chloride mg/L	8.12
pH	7.11
Nitrogen as N mg/L	
Ammonia as N mg/L	<0.500
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.0615
Alkalinity to pH 4.5 mg CaCO3/L	<20.0
Total Dissolved Solids mg/L	107
Phosphorus as P mg/L	<0.200
Biochemical Oxygen Demand mg/L	<3.00

BUTZRN01

Location	Approximately 50 yards upstream of confluence with Paradise Creek.		
Site #	2017-11	Date	5/2/2017
Stream Name	Butz Run	Time	10:28:39 AM
Township	Paradise	Latitude	41.0764
Habitat Asmt.	203	Longitude	-75.23524

Field Measurements	
Temp C	14.39
pH	7.19
Press inHg	28.74
DO Percent	84.7
DO mg/L	8.3
Cond (uS/cm)	279

Macroinvertebrate Metrics	
Total Taxa	25
Shannon Diversity Index	2.41
EPT Taxa Richness	11
Hilsenhoff Biotic Index	3.09
Intolerant individuals (%)	0.6
Modified Becks Index	31
Index of Biotic Integrity	**76**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	
Aluminum mg/L	
Calcium mg/L	
Iron mg/L	
Magnesium mg/L	
Hardness CaCO3	
Chloride mg/L	
pH	
Nitrogen as N mg/L	
Ammonia as N mg/L	
Total Kjeldahl N mg/L	
Nitrate as N mg/L	
Alkalinity to pH 4.5 mg CaCO3/L	
Total Dissolved Solids mg/L	
Phosphorus as P mg/L	
Biochemical Oxygen Demand mg/L	

CHERCR06 R

Location	Kemmertown Bridge		
Site #	2017-12	Date	5/4/2017
Stream Name	Cherry Creek	Time	8:34:43 AM
Township	Hamilton	Latitude	40.9367
Habitat Asmt.	157	Longitude	-75.25282

Field Measurements	
Temp C	9.52
pH	7.42
Press inHg	29.81
DO Percent	82.3
DO mg/L	9.34
Cond (uS/cm)	312

Macroinvertebrate Metrics	
Total Taxa	22
Shannon Diversity Index	1.41
EPT Taxa Richness	9
Hilsenhoff Biotic Index	1.93
Intolerant individuals (%)	0.86
Modified Becks Index	9
Index of Biotic Integrity	**64.4**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	1.08
Aluminum mg/L	<0.100
Calcium mg/L	25.4
Iron mg/L	0.0942
Magnesium mg/L	5.31
Hardness CaCO3	85.2
Chloride mg/L	6.97
pH	6.91
Nitrogen as N mg/L	
Ammonia as N mg/L	<0.500
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.245
Alkalinity to pH 4.5 mg CaCO3/L	74.0
Total Dissolved Solids mg/L	115
Phosphorus as P mg/L	<0.200
Biochemical Oxygen Demand mg/L	76.00

CHERCR06 R

Location	Kemmertown Bridge		
Site #	2017-13	Date	5/4/2017
Stream Name	Cherry Creek	Time	8:34:43 AM
Township	Hamilton	Latitude	40.9367
Habitat Asmt.	157	Longitude	-75.25282

Field Measurements	
Temp C	9.52
pH	7.42
Press inHg	29.81
DO Percent	82.3
DO mg/L	9.34
Cond (uS/cm)	312

Macroinvertebrate Metrics	
Total Taxa	18
Shannon Diversity Index	1.91
EPT Taxa Richness	5
Hilsenhoff Biotic Index	3.32
Intolerant individuals (%)	0.54
Modified Becks Index	12
Index of Biotic Integrity	**68.7**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	1.2
Aluminum mg/L	<0.100
Calcium mg/L	25.4
Iron mg/L	0.0961
Magnesium mg/L	5.31
Hardness CaCO3	85.3
Chloride mg/L	6.96
pH	6.2
Nitrogen as N mg/L	
Ammonia as N mg/L	<0.500
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.243
Alkalinity to pH 4.5 mg CaCO3/L	70.0
Total Dissolved Solids mg/L	111
Phosphorus as P mg/L	<0.200
Biochemical Oxygen Demand mg/L	<3.00

CHERCR16

Location	Below Cherry Valley Golf Course		
Site #	2017-14	Date	5/4/2017
Stream Name	Cherry Creek	Time	10:31:20 AM
Township	Smithfield	Latitude	40.97322
Habitat Asmt.	150	Longitude	-75.16958

Field Measurements	
Temp C	11.84
pH	7.78
Press inHg	29.88
DO Percent	84.5
DO mg/L	9.11
Cond (uS/cm)	423

Macroinvertebrate Metrics	
Total Taxa	23
Shannon Diversity Index	2.08
EPT Taxa Richness	9
Hilsenhoff Biotic Index	3.02
Intolerant individuals (%)	0.53
Modified Becks Index	17
Index of Biotic Integrity	**63.9**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	1.51
Aluminum mg/L	<0.100
Calcium mg/L	31.2
Iron mg/L	0.137
Magnesium mg/L	6.78
Hardness CaCO3	106
Chloride mg/L	11.3
pH	6.99
Nitrogen as N mg/L	
Ammonia as N mg/L	<0.500
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.253
Alkalinity to pH 4.5 mg CaCO3/L	90.0
Total Dissolved Solids mg/L	136
Phosphorus as P mg/L	<0.200
Biochemical Oxygen Demand mg/L	21.00

CHERCR17

Location	Minisink Park near the mouth		
Site #	2017-15	Date	5/4/2017
Stream Name	Cherry Creek	Time	11:13:49 AM
Township	Smithfield	Latitude	40.98697
Habitat Asmt.	153	Longitude	-75.13752

Field Measurements	
Temp C	12.55
pH	7.85
Press inHg	30
DO Percent	88.9
DO mg/L	9.46
Cond (uS/cm)	485

Macroinvertebrate Metrics	
Total Taxa	15
Shannon Diversity Index	1.22
EPT Taxa Richness	6
Hilsenhoff Biotic Index	1.96
Intolerant individuals (%)	0.76
Modified Becks Index	7
Index of Biotic Integrity	**59.5**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	
Aluminum mg/L	
Calcium mg/L	
Iron mg/L	
Magnesium mg/L	
Hardness CaCO3	
Chloride mg/L	
pH	
Nitrogen as N mg/L	
Ammonia as N mg/L	
Total Kjeldahl N mg/L	
Nitrate as N mg/L	
Alkalinity to pH 4.5 mg CaCO3/L	
Total Dissolved Solids mg/L	
Phosphorus as P mg/L	
Biochemical Oxygen Demand mg/L	

CRANCR02

Location	Upstream from Cranberry Creek Drive (Paradise)		
Site #	2017-16	Date	4/24/2017
Stream Name	Cranberry Creek	Time	8:49:56 AM
Township	Paradise	Latitude	41.12078
Habitat Asmt.	179	Longitude	-75.26208

Field Measurements	
Temp C	8.47
pH	7.52
Press inHg	29.11
DO Percent	122.2
DO mg/L	13.91
Cond (uS/cm)	100

Macroinvertebrate Metrics	
Total Taxa	32
Shannon Diversity Index	2.92
EPT Taxa Richness	22
Hilsenhoff Biotic Index	2.21
Intolerant individuals (%)	0.74
Modified Becks Index	35
Index of Biotic Integrity	**95.5**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	2.42
Aluminum mg/L	<0.100
Calcium mg/L	6.19
Iron mg/L	<0.0500
Magnesium mg/L	1.93
Hardness CaCO3	23.4
Chloride mg/L	17.4
pH	6.21
Nitrogen as N mg/L	
Ammonia as N mg/L	<0.500
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.171
Alkalinity to pH 4.5 mg CaCO3/L	<20.0
Total Dissolved Solids mg/L	109
Phosphorus as P mg/L	<0.200
Biochemical Oxygen Demand mg/L	9.00

JONACR01

Location	PHLT Jonas Mountain Nature Preserve		
Site #	2017-17	Date	4/27/2017
Stream Name	Jonas Creek	Time	10:40:23 AM
Township	Polk	Latitude	40.97618
Habitat Asmt.	223	Longitude	-75.50773

Field Measurements	
Temp C	10.14
pH	6.49
Press inHg	28.42
DO Percent	83.2
DO mg/L	8.88
Cond (uS/cm)	87

Macroinvertebrate Metrics	
Total Taxa	21
Shannon Diversity Index	2.25
EPT Taxa Richness	12
Hilsenhoff Biotic Index	1.05
Intolerant individuals (%)	0.87
Modified Becks Index	32
Index of Biotic Integrity	**81.6**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	
Aluminum mg/L	
Calcium mg/L	
Iron mg/L	
Magnesium mg/L	
Hardness CaCO3	
Chloride mg/L	
pH	
Nitrogen as N mg/L	
Ammonia as N mg/L	
Total Kjeldahl N mg/L	
Nitrate as N mg/L	
Alkalinity to pH 4.5 mg CaCO3/L	
Total Dissolved Solids mg/L	
Phosphorus as P mg/L	
Biochemical Oxygen Demand mg/L	

KEIPRN01

Location	Upstream of culvert pipes on Schochs Rd. in SGL		
Site #	2017-18	Date	4/26/2017
Stream Name	Keiper Run	Time	7:59:09 AM
Township	Tunkhannock	Latitude	41.05041
Habitat Asmt.	185	Longitude	-75.53227

Field Measurements	
Temp C	8.62
pH	6.51
Press inHg	27.58
DO Percent	82.5
DO mg/L	8.86
Cond (uS/cm)	175

Macroinvertebrate Metrics	
Total Taxa	
Shannon Diversity Index	
EPT Taxa Richness	
Hilsenhoff Biotic Index	
Intolerant individuals (%)	
Modified Becks Index	
Index of Biotic Integrity	

Lab Chemistry Analysis	
Total Organic Carbon mg/L	
Aluminum mg/L	
Calcium mg/L	
Iron mg/L	
Magnesium mg/L	
Hardness CaCO3	
Chloride mg/L	
pH	
Nitrogen as N mg/L	
Ammonia as N mg/L	
Total Kjeldahl N mg/L	
Nitrate as N mg/L	
Alkalinity to pH 4.5 mg CaCO3/L	
Total Dissolved Solids mg/L	
Phosphorus as P mg/L	
Biochemical Oxygen Demand mg/L	

MARSCR06

Location	Upstream of Wood Dale Rd in Delaware State Forest		
Site #	2017-19	Date	5/8/2017
Stream Name	Marshalls Creek	Time	10:48:37 AM
Township	Middle Smithfield	Latitude	41.10866
Habitat Asmt.	207	Longitude	-75.15682

Field Measurements	
Temp C	9.67
pH	6.36
Press inHg	28.74
DO Percent	71.6
DO mg/L	7.82
Cond (uS/cm)	73

Macroinvertebrate Metrics	
Total Taxa	21
Shannon Diversity Index	1.63
EPT Taxa Richness	11
Hilsenhoff Biotic Index	3.03
Intolerant individuals (%)	0.79
Modified Becks Index	24
Index of Biotic Integrity	**70.2**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	
Aluminum mg/L	
Calcium mg/L	
Iron mg/L	
Magnesium mg/L	
Hardness CaCO3	
Chloride mg/L	
pH	
Nitrogen as N mg/L	
Ammonia as N mg/L	
Total Kjeldahl N mg/L	
Nitrate as N mg/L	
Alkalinity to pH 4.5 mg CaCO3/L	
Total Dissolved Solids mg/L	
Phosphorus as P mg/L	
Biochemical Oxygen Demand mg/L	

MARSCR11

Location	Approximately 100 yards upstream of Newton Run and White Heron Lake		
Site #	2017-20	Date	5/8/2017
Stream Name	Marshalls Creek	Time	10:16:06 AM
Township	Middle Smithfield	Latitude	41.05435
Habitat Asmt.	206	Longitude	-75.13667

Field Measurements	
Temp C	9.47
pH	6.81
Press inHg	29.16
DO Percent	93.7
DO mg/L	10.43
Cond (uS/cm)	113

Macroinvertebrate Metrics	
Total Taxa	25
Shannon Diversity Index	2.59
EPT Taxa Richness	14
Hilsenhoff Biotic Index	2.41
Intolerant individuals (%)	0.6846
Modified Becks Index	26
Index of Biotic Integrity	**80.5**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	2.55
Aluminum mg/L	<0.100
Calcium mg/L	7.58
Iron mg/L	<0.0500
Magnesium mg/L	1.63
Hardness CaCO3	25.6
Chloride mg/L	12.4
pH	6.81
Nitrogen as N mg/L	
Ammonia as N mg/L	<0.500
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.155
Alkalinity to pH 4.5 mg CaCO3/L	<20.0
Total Dissolved Solids mg/L	58
Phosphorus as P mg/L	<0.200
Biochemical Oxygen Demand mg/L	<3.00

MARSCR18

Location	Upstream from Post Office Road		
Site #	2017-21	Date	5/8/2017
Stream Name	Marshalls Creek	Time	7:55:43 AM
Township	Smithfield	Latitude	40.99872
Habitat Asmt.	175	Longitude	-75.13971

Field Measurements	
Temp C	10.21
pH	7.01
Press inHg	29.42
DO Percent	85.5
DO mg/L	9.43
Cond (uS/cm)	261

Macroinvertebrate Metrics	
Total Taxa	29
Shannon Diversity Index	2.63
EPT Taxa Richness	15
Hilsenhoff Biotic Index	3.12
Intolerant individuals (%)	0.57
Modified Becks Index	17
Index of Biotic Integrity	**76**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	2.59
Aluminum mg/L	<0.100
Calcium mg/L	22.3
Iron mg/L	<0.0500
Magnesium mg/L	2.87
Hardness CaCO3	67.5
Chloride mg/L	27.2
pH	6.85
Nitrogen as N mg/L	
Ammonia as N mg/L	<0.500
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.181
Alkalinity to pH 4.5 mg CaCO3/L	38.0
Total Dissolved Solids mg/L	125
Phosphorus as P mg/L	<0.200
Biochemical Oxygen Demand mg/L	<3.00

MCMICR01

Location	Near headwaters downstream of Rt. 715		
Site #	2017-22	Date	5/9/2017
Stream Name	McMichael Creek	Time	8:30:58 AM
Township	Chestnuthill	Latitude	40.99452
Habitat Asmt.	204	Longitude	-75.39839

Field Measurements	
Temp C	7.64
pH	5.83
Press inHg	28.83
DO Percent	96.4
DO mg/L	11.09
Cond (uS/cm)	18

Macroinvertebrate Metrics	
Total Taxa	30
Shannon Diversity Index	2.65
EPT Taxa Richness	19
Hilsenhoff Biotic Index	2.75
Intolerant individuals (%)	0.65
Modified Becks Index	41
Index of Biotic Integrity	**91.6**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	0.975
Aluminum mg/L	<0.100
Calcium mg/L	2
Iron mg/L	<0.0500
Magnesium mg/L	0.945
Hardness CaCO3	8.89
Chloride mg/L	4.59
pH	5.11
Nitrogen as N mg/L	
Ammonia as N mg/L	<0.500
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.143
Alkalinity to pH 4.5 mg CaCO3/L	<20.0
Total Dissolved Solids mg/L	60
Phosphorus as P mg/L	<0.200
Biochemical Oxygen Demand mg/L	<3.00

MCMICR22

Location	Upstream of McIlhaney Rd.		
Site #	2017-23	Date	5/9/2017
Stream Name	McMichael Creek	Time	9:07:38 AM
Township	Chestnuthill	Latitude	40.93075
Habitat Asmt.	200	Longitude	-75.36402

Field Measurements	
Temp C	8.22
pH	6.62
Press inHg	29.18
DO Percent	91.8
DO mg/L	10.54
Cond (uS/cm)	30

Macroinvertebrate Metrics	
Total Taxa	29
Shannon Diversity Index	2.56
EPT Taxa Richness	17
Hilsenhoff Biotic Index	3.55
Intolerant individuals (%)	0.49
Modified Becks Index	33
Index of Biotic Integrity	**81.9**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	
Aluminum mg/L	
Calcium mg/L	
Iron mg/L	
Magnesium mg/L	
Hardness CaCO3	
Chloride mg/L	
pH	
Nitrogen as N mg/L	
Ammonia as N mg/L	
Total Kjeldahl N mg/L	
Nitrate as N mg/L	
Alkalinity to pH 4.5 mg CaCO3/L	
Total Dissolved Solids mg/L	
Phosphorus as P mg/L	
Biochemical Oxygen Demand mg/L	

MCMICR37

Location	Hickory Valley Park		
Site #	2017-24	Date	5/9/2017
Stream Name	McMichael Creek	Time	11:34:00 AM
Township	Stroud	Latitude	40.96202
Habitat Asmt.	186	Longitude	-75.23635

Field Measurements	
Temp C	11.05
pH	7.32
Press inHg	29.48
DO Percent	114.8
DO mg/L	12.44
Cond (uS/cm)	48

Macroinvertebrate Metrics	
Total Taxa	25
Shannon Diversity Index	2.65
EPT Taxa Richness	12
Hilsenhoff Biotic Index	3.67
Intolerant individuals (%)	0.46
Modified Becks Index	14
Index of Biotic Integrity	**78.6**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	1.53
Aluminum mg/L	<0.100
Calcium mg/L	12.8
Iron mg/L	0.0855
Magnesium mg/L	2.29
Hardness CaCO3	41.3
Chloride mg/L	20.3
pH	7.03
Nitrogen as N mg/L	
Ammonia as N mg/L	<0.500
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.408
Alkalinity to pH 4.5 mg CaCO3/L	30.0
Total Dissolved Solids mg/L	127
Phosphorus as P mg/L	<0.200
Biochemical Oxygen Demand mg/L	<3.00

MCMICR10

Location	Upstream of confluence with Brodhead		
Site #	2017-25	Date	5/9/2017
Stream Name	McMichael Creek	Time	10:33:23 AM
Township	Stroudsburg	Latitude	40.98812
Habitat Asmt.	180	Longitude	-75.18502

Field Measurements	
Temp C	10.43
pH	7.35
Press inHg	29.6
DO Percent	99.9
DO mg/L	11.04
Cond (uS/cm)	130

Macroinvertebrate Metrics	
Total Taxa	21
Shannon Diversity Index	2.33
EPT Taxa Richness	11
Hilsenhoff Biotic Index	4.4
Intolerant individuals (%)	0.26
Modified Becks Index	17
Index of Biotic Integrity	**69.2**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	1.97
Aluminum mg/L	<0.100
Calcium mg/L	14.2
Iron mg/L	0.0775
Magnesium mg/L	2.58
Hardness CaCO3	46.1
Chloride mg/L	36.2
pH	7.04
Nitrogen as N mg/L	
Ammonia as N mg/L	<0.500
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.31
Alkalinity to pH 4.5 mg CaCO3/L	28.0
Total Dissolved Solids mg/L	167
Phosphorus as P mg/L	<0.200
Biochemical Oxygen Demand mg/L	<3.00

MILLCR03

Location	Mill Creek Road Natural Lands Trust property		
Site #	2017-26	Date	4/24/2017
Stream Name	Mill Creek Creek	Time	9:27:37 AM
Township	Barrett	Latitude	41.16326
Habitat Asmt.	213	Longitude	-75.24884

Field Measurements	
Temp C	8.31
pH	7.57
Press inHg	29
DO Percent	128.1
DO mg/L	14.57
Cond (uS/cm)	80

Macroinvertebrate Metrics	
Total Taxa	34
Shannon Diversity Index	2.87
EPT Taxa Richness	21
Hilsenhoff Biotic Index	2.12
Intolerant individuals (%)	0.74
Modified Becks Index	41
Index of Biotic Integrity	**97**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	
Aluminum mg/L	
Calcium mg/L	
Iron mg/L	
Magnesium mg/L	
Hardness CaCO3	
Chloride mg/L	
pH	
Nitrogen as N mg/L	
Ammonia as N mg/L	
Total Kjeldahl N mg/L	
Nitrate as N mg/L	
Alkalinity to pH 4.5 mg CaCO3/L	
Total Dissolved Solids mg/L	
Phosphorus as P mg/L	
Biochemical Oxygen Demand mg/L	

MOUNRN01

Location	Above Cherry Creek Confluence		
Site #	2017-27	Date	5/4/2017
Stream Name	Mountain Run	Time	9:47:50 AM
Township	Stroud	Latitude	40.95436
Habitat Asmt.	183	Longitude	-75.19679

Field Measurements	
Temp C	10.11
pH	7.51
Press inHg	29.59
DO Percent	84.1
DO mg/L	9.35
Cond (uS/cm)	236

Macroinvertebrate Metrics	
Total Taxa	22
Shannon Diversity Index	2.34
EPT Taxa Richness	12
Hilsenhoff Biotic Index	1.05
Intolerant individuals (%)	0.88
Modified Becks Index	33
Index of Biotic Integrity	**83.1**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	2.62
Aluminum mg/L	<0.100
Calcium mg/L	14.6
Iron mg/L	0.0927
Magnesium mg/L	2.14
Hardness CaCO3	45.2
Chloride mg/L	16.4
pH	6.77
Nitrogen as N mg/L	
Ammonia as N mg/L	<0.500
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.101
Alkalinity to pH 4.5 mg CaCO3/L	38.0
Total Dissolved Solids mg/L	87
Phosphorus as P mg/L	<0.200
Biochemical Oxygen Demand mg/L	<3.00

PARACR08

Location	Upstream of Brodhead confluence		
Site #	2017-28	Date	5/2/2017
Stream Name	Paradise Creek	Time	9:39:32 AM
Township	Stroud	Latitude	41.06629
Habitat Asmt.	176	Longitude	-75.22138

Field Measurements	
Temp C	13.64
pH	7.66
Press inHg	29
DO Percent	89.3
DO mg/L	8.97
Cond (uS/cm)	432

Macroinvertebrate Metrics	
Total Taxa	19
Shannon Diversity Index	1.85
EPT Taxa Richness	12
Hilsenhoff Biotic Index	2.45
Intolerant individuals (%)	0.66
Modified Becks Index	21
Index of Biotic Integrity	**82.5**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	1.5
Aluminum mg/L	<0.100
Calcium mg/L	9.64
Iron mg/L	<0.0500
Magnesium mg/L	2.56
Hardness CaCO3	34.6
Chloride mg/L	42
pH	6.74
Nitrogen as N mg/L	
Ammonia as N mg/L	<0.500
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.372
Alkalinity to pH 4.5 mg CaCO3/L	20.0
Total Dissolved Solids mg/L	95
Phosphorus as P mg/L	<0.200
Biochemical Oxygen Demand mg/L	<3.00

POCOCR01

Location	Approximately 250 yards downstream of Wilke Road, east of Wilkie Road.		
Site #	2017-29	Date	5/1/2017
Stream Name	Pocono Creek	Time	8:36:27 AM
Township	Pocono	Latitude	41.0628
Habitat Asmt.	205	Longitude	-75.3581

Field Measurements	
Temp C	10.58
pH	6.88
Press inHg	28.38
DO Percent	79
DO mg/L	8.33
Cond (uS/cm)	118

Macroinvertebrate Metrics	
Total Taxa	22
Shannon Diversity Index	2.27
EPT Taxa Richness	11
Hilsenhoff Biotic Index	2.3
Intolerant individuals (%)	0.72
Modified Becks Index	27
Index of Biotic Integrity	**75.9**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	
Aluminum mg/L	
Calcium mg/L	
Iron mg/L	
Magnesium mg/L	
Hardness CaCO3	
Chloride mg/L	
pH	
Nitrogen as N mg/L	
Ammonia as N mg/L	
Total Kjeldahl N mg/L	
Nitrate as N mg/L	
Alkalinity to pH 4.5 mg CaCO3/L	
Total Dissolved Solids mg/L	
Phosphorus as P mg/L	
Biochemical Oxygen Demand mg/L	

POCOCR09

Location	Upstream of Old Mill Rd. on Pocono Heritage Land Trust property		
Site #	2017-30	Date	5/1/2017
Stream Name	Pocono Creek	Time	9:03:27 AM
Township	Pocono	Latitude	41.03934
Habitat Asmt.	180	Longitude	-75.30962

Field Measurements	
Temp C	11.26
pH	7.12
Press inHg	28.86
DO Percent	80.1
DO mg/L	8.46
Cond (uS/cm)	257

Macroinvertebrate Metrics	
Total Taxa	24
Shannon Diversity Index	2.69
EPT Taxa Richness	16
Hilsenhoff Biotic Index	2.94
Intolerant individuals (%)	0.59
Modified Becks Index	28
Index of Biotic Integrity	**80.2**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	1.6
Aluminum mg/L	<0.100
Calcium mg/L	10.3
Iron mg/L	<0.0500
Magnesium mg/L	2.59
Hardness CaCO3	36.4
Chloride mg/L	47.6
pH	6.67
Nitrogen as N mg/L	
Ammonia as N mg/L	<0.500
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.27
Alkalinity to pH 4.5 mg CaCO3/L	20.0
Total Dissolved Solids mg/L	126
Phosphorus as P mg/L	<0.200
Biochemical Oxygen Demand mg/L	<3.00

POCOCR14

Location	Upstream of confuence with McMichael Creek		
Site #	2017-31	Date	5/1/2017
Stream Name	Pocono Creek	Time	9:53:58 AM
Township	Stroudsburg	Latitude	40.98101
Habitat Asmt.	156	Longitude	-75.19698

Field Measurements	
Temp C	12.84
pH	7.33
Press inHg	29.43
DO Percent	79.6
DO mg/L	8.26
Cond (uS/cm)	272

Macroinvertebrate Metrics	
Total Taxa	23
Shannon Diversity Index	2.15
EPT Taxa Richness	12
Hilsenhoff Biotic Index	3.22
Intolerant individuals (%)	0.47
Modified Becks Index	23
Index of Biotic Integrity	**82.1**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	2.26
Aluminum mg/L	<0.100
Calcium mg/L	16.4
Iron mg/L	<0.0500
Magnesium mg/L	3.35
Hardness CaCO3	54.7
Chloride mg/L	57
pH	6.55
Nitrogen as N mg/L	
Ammonia as N mg/L	<0.500
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.262
Alkalinity to pH 4.5 mg CaCO3/L	40.0
Total Dissolved Solids mg/L	155
Phosphorus as P mg/L	0.681
Biochemical Oxygen Demand mg/L	<3.00

POHOCR01

Location	Southern end of Shiffer Property off Merwinsburg Road (near Burger Hollow Road)		
Site #	2017-32	Date	4/27/2017
Stream Name	Pohopoco Creek	Time	9:48:06 AM
Township	Chestnuthill	Latitude	40.96147
Habitat Asmt.	207	Longitude	-75.46486

Field Measurements	
Temp C	10.84
pH	7.18
Press inHg	28.82
DO Percent	73.2
DO mg/L	7.79
Cond (uS/cm)	121

Macroinvertebrate Metrics	
Total Taxa	32
Shannon Diversity Index	2.52
EPT Taxa Richness	14
Hilsenhoff Biotic Index	2.12
Intolerant individuals (%)	0.77
Modified Becks Index	32
Index of Biotic Integrity	**88.5**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	
Aluminum mg/L	
Calcium mg/L	
Iron mg/L	
Magnesium mg/L	
Hardness CaCO3	
Chloride mg/L	
pH	
Nitrogen as N mg/L	
Ammonia as N mg/L	
Total Kjeldahl N mg/L	
Nitrate as N mg/L	
Alkalinity to pH 4.5 mg CaCO3/L	
Total Dissolved Solids mg/L	
Phosphorus as P mg/L	
Biochemical Oxygen Demand mg/L	

POHOCR29

Location	Near Whitey B. Drive on Polk Township Property		
Site #	2017-33	Date	4/27/2017
Stream Name	Pohopoco Creek	Time	9:11:15 AM
Township	Polk	Latitude	40.89956
Habitat Asmt.	190	Longitude	-75.50643

Field Measurements	
Temp C	12.6
pH	6.99
Press inHg	29.13
DO Percent	75.5
DO mg/L	7.81
Cond (uS/cm)	122

Macroinvertebrate Metrics	
Total Taxa	26
Shannon Diversity Index	2.51
EPT Taxa Richness	14
Hilsenhoff Biotic Index	3.61
Intolerant individuals (%)	0.5
Modified Becks Index	17
Index of Biotic Integrity	**83.8**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	
Aluminum mg/L	
Calcium mg/L	
Iron mg/L	
Magnesium mg/L	
Hardness CaCO3	
Chloride mg/L	
pH	
Nitrogen as N mg/L	
Ammonia as N mg/L	
Total Kjeldahl N mg/L	
Nitrate as N mg/L	
Alkalinity to pH 4.5 mg CaCO3/L	
Total Dissolved Solids mg/L	
Phosphorus as P mg/L	
Biochemical Oxygen Demand mg/L	

PONDCR04

Location	Immediately downstream of Primrose Lane		
Site #	2017-34	Date	5/1/2017
Stream Name	Pond Creek	Time	7:43:36 AM
Township	Middle Smithfield	Latitude	41.05645
Habitat Asmt.	162	Longitude	-75.10336

Field Measurements	
Temp C	12.89
pH	6.39
Press inHg	29.37
DO Percent	71.1
DO mg/L	7.36
Cond (uS/cm)	290

Macroinvertebrate Metrics	
Total Taxa	16
Shannon Diversity Index	2.07
EPT Taxa Richness	7
Hilsenhoff Biotic Index	4.47
Intolerant individuals (%)	0.18
Modified Becks Index	6
Index of Biotic Integrity	**43.8**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	
Aluminum mg/L	
Calcium mg/L	
Iron mg/L	
Magnesium mg/L	
Hardness CaCO3	
Chloride mg/L	
pH	
Nitrogen as N mg/L	
Ammonia as N mg/L	
Total Kjeldahl N mg/L	
Nitrate as N mg/L	
Alkalinity to pH 4.5 mg CaCO3/L	
Total Dissolved Solids mg/L	
Phosphorus as P mg/L	
Biochemical Oxygen Demand mg/L	

SWIFCR10

Location	Immediately Downstream of Route 314 Bridge		
Site #	2017-35	Date	4/24/2017
Stream Name	Swiftwater Creek	Time	10:11:07 AM
Township	Pocono	Latitude	41.1009
Habitat Asmt.	173	Longitude	-75.34643

Field Measurements	
Temp C	8.06
pH	7.84
Press inHg	28.57
DO Percent	125.1
DO mg/L	14.1
Cond (uS/cm)	143

Macroinvertebrate Metrics	
Total Taxa	24
Shannon Diversity Index	2.5
EPT Taxa Richness	18
Hilsenhoff Biotic Index	2.43
Intolerant individuals (%)	0.7
Modified Becks Index	29
Index of Biotic Integrity	**90.6**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	
Aluminum mg/L	
Calcium mg/L	
Iron mg/L	
Magnesium mg/L	
Hardness CaCO3	
Chloride mg/L	
pH	
Nitrogen as N mg/L	
Ammonia as N mg/L	
Total Kjeldahl N mg/L	
Nitrate as N mg/L	
Alkalinity to pH 4.5 mg CaCO3/L	
Total Dissolved Solids mg/L	
Phosphorus as P mg/L	
Biochemical Oxygen Demand mg/L	

TOBYCR01

Location	Upstream of Route 423 bridge in SGL. 127		
Site #	2017-36	Date	4/26/2017
Stream Name	Tobyhanna Creek	Time	10:25:18 AM
Township	Coolbaugh	Latitude	41.16198
Habitat Asmt.	196	Longitude	-75.45486

Field Measurements	
Temp C	10.97
pH	7.38
Press inHg	27.7
DO Percent	90.9
DO mg/L	9.27
Cond (uS/cm)	176

Macroinvertebrate Metrics	
Total Taxa	18
Shannon Diversity Index	2.61
EPT Taxa Richness	10
Hilsenhoff Biotic Index	3.21
Intolerant individuals (%)	0.36
Modified Becks Index	19
Index of Biotic Integrity	**68.2**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	
Aluminum mg/L	
Calcium mg/L	
Iron mg/L	
Magnesium mg/L	
Hardness CaCO3	
Chloride mg/L	
pH	
Nitrogen as N mg/L	
Ammonia as N mg/L	
Total Kjeldahl N mg/L	
Nitrate as N mg/L	
Alkalinity to pH 4.5 mg CaCO3/L	
Total Dissolved Solids mg/L	
Phosphorus as P mg/L	
Biochemical Oxygen Demand mg/L	

TOBYCR14

Location	Upstream of Route 115 bridge in Blakeslee		
Site #	2017-37	Date	4/26/2017
Stream Name	Tobyhanna Creek	Time	9:12:22 AM
Township	Tobyhanna	Latitude	41.08276
Habitat Asmt.	180	Longitude	-75.58399

Field Measurements	
Temp C	12.01
pH	6.89
Press inHg	27.91
DO Percent	93.1
DO mg/L	9.34
Cond (uS/cm)	133

Macroinvertebrate Metrics	
Total Taxa	26
Shannon Diversity Index	2.51
EPT Taxa Richness	13
Hilsenhoff Biotic Index	3.02
Intolerant individuals (%)	0.53
Modified Becks Index	21
Index of Biotic Integrity	**88**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	7.51
Aluminum mg/L	0.107
Calcium mg/L	2.02
Iron mg/L	0.245
Magnesium mg/L	0.758
Hardness CaCO3	8.16
Chloride mg/L	11.8
pH	6.79
Nitrogen as N mg/L	
Ammonia as N mg/L	<0.500
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.156
Alkalinity to pH 4.5 mg CaCO3/L	<20.0
Total Dissolved Solids mg/L	67
Phosphorus as P mg/L	0.905
Biochemical Oxygen Demand mg/L	5.00

TUNKCR03

Location	Immediately upstream of Route 115		
Site #	2017-38	Date	4/26/2017
Stream Name	Tunkhannock Creek	Time	8:37:59 AM
Township	Hunkhannock	Latitude	41.05923
Habitat Asmt.	196	Longitude	-75.55314

Field Measurements	
Temp C	9.9
pH	5.35
Press inHg	27.66
DO Percent	91.8
DO mg/L	9.59
Cond (uS/cm)	49

Macroinvertebrate Metrics	
Total Taxa	20
Shannon Diversity Index	2.41
EPT Taxa Richness	10
Hilsenhoff Biotic Index	3.87
Intolerant individuals (%)	0.45
Modified Becks Index	14
Index of Biotic Integrity	**67.8**

Lab Chemistry Analysis	
Total Organic Carbon mg/L	5.8
Aluminum mg/L	<0.100
Calcium mg/L	4.82
Iron mg/L	0.193
Magnesium mg/L	0.995
Hardness CaCO3	16.1
Chloride mg/L	25.4
pH	5.9
Nitrogen as N mg/L	
Ammonia as N mg/L	<0.500
Total Kjeldahl N mg/L	<1.00
Nitrate as N mg/L	0.131
Alkalinity to pH 4.5 mg CaCO3/L	<20.0
Total Dissolved Solids mg/L	80
Phosphorus as P mg/L	<0.200
Biochemical Oxygen Demand mg/L	6.00

Conclusions and Recommendations

Macroinvertebrates

The potentially impaired sites are indicated below.
IBI Scores did not reach the recommended Aquatic Life Use Attainment Benchmarks

Site 1 (AQUACR14) IBI Score 59.7
Aquashicola– Upstream of Lower Smith Gap Rd. near Quinton Drive
The low IBI score from this site could be influence by the low gradient of the stream channel. This stream did not qualify as a low gradient/multi-habitat stream because of the riffles at the upper end of the reach. The low IBI score could be related to the limited amount of dissolved oxygen in the water caused by a decreased number of riffles along the stream reach. It is recommended that a site on the lower Aquashicola Creek with higher quality riffle-run habitat be added to the 2018 study.

Site #8 (BRODCR19) IBI Score 53.2
Brodhead Creek– Upstream from River Road Bridge
Through the years, this site has seen increased and decreased water quality based on past study data. The non-attaining IBI score from this site is most likely caused by point and nonpoint source pollution from urban runoff upstream from the mouth. It is recommended that this site be monitored annually in future studies because of the large percentage of the county that this stream drains. The IBI scores from sites upstream of the mouth have increased with elevation and surrounding land cover. The highest IBI score on the Brodhead was 93 which is the most upstream study site on the main stem of the Brodhead.

Site 15 (CHERCR17) IBI Score 59.5
Cherry Creek– Minisink Park near the mouth
Similar to Aquashicola Creek, the low IBI score of this site near the mouth of Cherry Creek did not quality as a low gradient/multi-habitat stream. The low gradient of Cherry Creek may influence the score because of the decrease in oxygen dissolving riffles. Cherry Creek is not classified as a limestone creek however it is a limestone influenced creek due to the surrounding bedrock geology. Limestone creeks tend to be lower in biodiversity but can have a larger biomass of macro invertebrates. It is recommended that a site on Cherry Creek be added above Minisink Park in higher quality habitat.

Site 34 (PONDCR04) IBI Score 43.8
Pond Creek– Immediately downstream of Primrose Lane
The low IBI score could be influenced by the proximity to the Pond Creek impoundments which produce warmer water temperatures and lack of oxygen. This site also had the lowest dissolved oxygen measurement in the study which would further support the relative warmer water temperature cause by the impoundments.

Chemistry Analysis

Low Alkalinity throughout Monroe County

Most of the sites showed low alkalinity scores. Low alkalinity is not harmful to a stream, however, low alkalinity decreases the water's ability to buffer acids and protect aquatic life against sudden changes in pH. These values are normal when considering the geology of Monroe County. Most of the streams that were studied in this report flow within areas of silica rich sandstone and quartzite conglomerates, as well as red and grey sandstone and shales. These rocks generally have low carbonate values which would be responsible for low surface and ground water alkalinity values. Cherry Creek, the lower half of Marshalls Creek, and the mouth of Brodhead Creek flow through carbonate rich shales and siltstones which may be the reason for higher alkalinity values when compared to the rest of the county.

Recommendations

After reviewing the data from the 2017 Water Quality Study, the lead and cooperating agencies recommend the following:

- All of the sites listed as impaired should be retested the following year to continue with data trend collection.
- 34 of 38 sites in the county are healthy attaining streams.
- Overall, much of the data that was collected during the study represents many miles of quality streams in Monroe County.
- Continued monitoring and increased trend data are essential tools to stream quality protection.

Bibliography

Clesceri, L.S., A. E. Greenberg, and A. D. Eaton., 1998. Standard Methods for the Examination of Water and Wastewater, 20th Edition. American Public Health Association. Washington DC.

Commonwealth of Pennsylvania., 2000. Title 25, Pennsylvania Code, Section 93. Specific Water Quality Criteria.

Environmental Protection Agency., 2001. Ambient Water Quality Criteria Recommendations. Rivers and Streams in Nutrient Ecoregion VIII. Doc. ID: EPA 822-B-01-015. Office of Water. Washington, DC.

Karr, J. R., and E. W. Chu., 1999. Restoring Life in Running Waters Better Biological Monitoring. Island Press, Washington, DC. 206p.

Merritt, R., and K. Cummins., 1984. An Introduction to the Aquatic Insects of North America. Kendall/Hunt Publishing Company, Dubuque Iowa. 31p.

Monroe County Planning Commission., 2008. Monroe County Water Quality Study 2008, Vol. I & II., Stroudsburg, Pennsylvania. 182pp.

Pennsylvania Department of Environmental Protection., 2009. Draft-Instream Comprehensive Evaluation Surveys. Doc. ID: 391-3200-001. Bureau of Water Standards and Facility Regulation. Harrisburg, Pennsylvania. 56pp.

Pennsylvania Department of Environmental Protection., 2007. Multi-habitat Stream Assessment Protocol. Bureau of Water Standards and Facility Regulation. Harrisburg, Pennsylvania. 44pp.

United States Environmental Protection Agency. (2007). Ecoregions of North America. Retrieved February 9, 2009, Web site: http://www.epa.gov/wed/pages/ecoregions.htm.

Vølstad, J.H, N.E. Roth, M.T. Southerland and G. Mercurio. 2003. Pilot Study for Montgomery County and Maryland DNR Data Integration: Comparison of Benthic Macroinvertebrate Sampling Protocols for Freshwater Streams. Prepared by Versar, Inc., Columbia, Maryland for U.S. Environmental Protection Agency, Office of Environmental Information and Mid-Atlantic Integrated Assessment Program, Region 3, Ft. Meade, MD. 30pp.

2017 Water Quality Study Site List

Site #	Site ID	Stream Name	Location	Municipality	Habitat Assesment	Index of Biotic Integrity	Air Temp. Fahrenheit	Water Temp. Fahrenheit	Water Temp Celcius	Latitude	Longitude
2017-1	AQUACR14	Aquashicola Creek	Upstream of Lower Smith Gap Rd. near Quinton Drive	Eldred Township	178	59.7	56	55.29	12.49	40.82939	-75.44627
2017-2	BRIGCR02	Brights Creek	Upstream of Angler Rd.	Price Township	172	80	54	52.5	11.39	41.18353	-75.16011
2017-4	BUCKCR01	Buckwah Creek	Downstream of Chestnut Ridge Road	Eldred Township	157	73.5	61	55.11	12.84	40.84714	-75.45236
2017-4	BRODCR27	Brodhead Creek	Pasold Farms Nature Preserve	Barrett Township	179	93	55	54.82	12.68	41.18107	-75.25104
2017-5	BRODCR22	Brodhead Creek	Upstream of Paradise confluence	Stroud Township	178	87.1	58	56.17	13.43	41.06585	-75.22065
2017-6	BRODCR25 R	Brodhead Creek	Downstream of Paradise confluence (Forevergreen Preserve)	Stroud Township	197	89.6	60	55.97	13.32	41.06489	-75.22034
2017-7	BRODCR25 R	Brodhead Creek	Downstream of Paradise confluence (Forevergreen Preserve)	Stroud Township	197	84.6	60	55.97	13.32	41.06489	-75.22034
2017-8	BRODCR19	Brodhead Creek	Upstream from River Road bridge	Smithfield Township	164	53.2	60	58.31	14.62	40.99399	-75.13839
2017-9	BUHICR07	Buck Hill Creek	Just upstream of golfcourse fairway at clubhouse, above falls	Barrett Township	210	86.1	49	45.69	7.61	41.19428	-75.28143
2017-10	BUSHCR07	Bushkill Creek	Downstream from STP at DWGNRA boundary	Middle Smithfield Township	209	88.6	49	50.28	10.16	41.08479	-75.020822
2017-11	BUTZRN01	Butz Run	Approximately 50 yards upstream of confluence with Paradise Creek.	Paradise Township	203	76	61	57.9	14.39	41.0764	-75.23524
2017-12	CHERCR06 R	Cherry Creek	Kemmertown Bridge	Hamilton Township	157	64.4	55	49.136	9.52	40.9367	-75.25282
2017-13	CHERCR06 R	Cherry Creek	Kemmertown Bridge	Hamilton Township	157	68.7	55	49.13	9.52	40.9367	-75.25282
2017-14	CHERCR16	Cherry Creek	Below Cherry Valley Golf Course	Smithfield Township	150	63.9	58	53.31	11.84	40.97322	-75.16958
2017-15	CHERCR17	Cherry Creek	Minisink Park near the mouth	Smithfield Township	153	59.5	58	54.59	12.55	40.98697	-75.13752
2017-16	CRANCR02	Cranberry Creek	Upstream from Cranberry Creek Drive (Paradise)	Paradise Township	179	95.5	50	47.24	8.47	41.12078	-75.26208
2017-17	JONACR01	Jonas Creek	PHLT Jonas Mountain Nature Preserve	Polk Township	223	81.6	53	50.25	10.14	40.97618	-75.50773
2017-18	KEIPRN01	Keiper Run	Upstream of culvert pipes on Schochs Rd. in SGL	Tunkhannock Township	185	0.0	49	47.51	8.62	41.05041	-75.53227
2017-19	MARSCR06	Marshalls Creek	Upstream of Wood Dale Rd in Delaware State Forest	Middle Smithfield Township	207	70.2	51	49.4	9.67	41.10866	-75.15682
2017-20	MARSCR11	Marshalls Creek	Approximately 100 yards upstream of Newton Run and White Heron Lake	Middle Smithfield Township	206	80.5	53	49.04	9.47	41.05435	-75.13667
2017-21	MARSCR18	Marshalls Creek	Upstream from Post Office Road	Smithfield Township	175	76	52	50.37	10.21	40.99872	-75.13971
2017-22	MCMICR01	McMichael Creek	Near headwaters downstream of Rt. 715	Chestnuthill Township	204	91.6	55	45.75	7.64	40.99452	-75.39839
2017-23	MCMICR22	McMichael Creek	Upstream of McIlhaney Rd.	Chestnuthill Township	200	81.9	56	46.79	8.22	40.93075	-75.36402
2017-24	MCMICR37	McMichael Creek	Hickory Valley Park	Stroud Township	186	78.6	56	51.89	11.05	40.96202	-75.23635
2017-25	MCMICR10	McMichael Creek	Upstream of confluence with Brodhead	Stroudsburg Borough	180	69.2	60	50.77	10.43	40.98812	-75.18502
2017-26	MILLCR03	Mill Creek Creek	Mill Creek Road Natural Lands Trust property	Barrett Township	213	97	55	46.95	8.31	41.16326	-75.24884
2017-27	MOUNRN01	Mountain Run	Above Cherry Creek Confluence	Stroud Township	183	83.1	54	50.19	10.11	40.95436	-75.19679
2017-28	PARACR08	Paradise Creek	Upstream of Brodhead confluence	Stroud Township	176	82.5	59	56.55	13.64	41.06629	-75.22138
2017-29	POCOCR01	Pocono Creek	Approximately 250 yards downstream of Wilke Road, east of Wilkie Road.	Pocono Township	205	75.9	54	51.04	10.58	41.0628	-75.3581
2017-30	POCOCR09	Pocono Creek	Upstream of Old Mill Rd. on Pocono Heritage Land Trust property	Pocono Township	180	80.2	55	52.26	11.26	41.03934	-75.30962
2017-31	POCOCR14	Pocono Creek	Upstream of confuence with McMichael Creek	Stroudsburg Borough	156	82.1	51	55.11	12.84	40.98101	-75.19698
2017-32	POHOCR01	Pohopoco Creek	Southern end of Shiffer Property off Merwinsburg Road (near Burger Hollow Road)	Chestnuthill Township	207	88.5	58	51.51	10.84	40.96147	-75.46486
2017-33	POHOCR29	Pohopoco Creek	Near Whitey B. Drive on Polk Township Property	Polk Township	190	83.8	62	54.68	12.6	40.89956	-75.50643
2017-34	PONDCR04	Pond Creek	Immediatley downstream of Primrose Lane	Middle Smithfield Township	162	43.8	57	55.2	12.89	41.05645	-75.10336
2017-35	SWIFCR10	Swiftwater Creek	Immediately Downstream of Route 314 Bridge	Pocono Township	173	90.6	54	46.5	8.06	41.1009	-75.34643
2017-36	TOBYCR01	Tobyhanna Creek	Upstream of Route 423 bridge in SGL. 127	Coolbaugh Township	196	68.2	54	51.74	10.97	41.16198	-75.45486
2017-37	TOBYCR14	Tobyhanna Creek	Upstream of Route 115 bridge in Blakeslee	Tobyhanna Township	180	88	60	53.61	12.01	41.08276	-75.58399
2017-38	TUNKCR03	Tunkhannock Creek	Immediatley upstream of Route 115	Tunkhannock Township	196	67.8	52	49.82	9.9	41.05923	-75.55314

2017 WATER QUALITY STUDY

MONROE COUNTY, PENNSYLVANIA

LACKAWANNA

WAYNE

PIKE

LUZERNE

SUSSEX
NJ

WARREN, NJ

CARBON

NORTHAMPTON

LEGEND

- Study Sites
- Streams
- Lakes & Ponds
- County Boundary
- Municipal Boundaries

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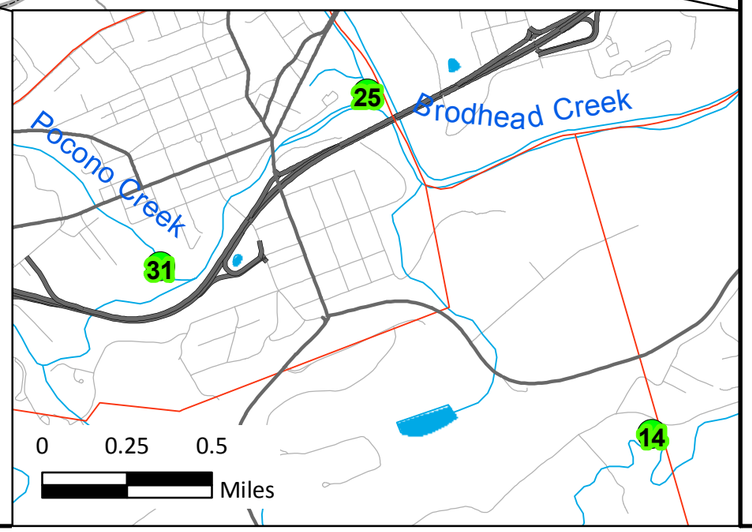

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MONROE 2030

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May 2017

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