Baseline and Storm Characterization of the Frankstown Branch and Little Juniata Rivers, as well as selected tributaries, August 2015 – August 2017.

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Introduction

The Blair County Conservation District, in cooperation with Blair County's Intergovernmental Stormwater Committee (ISC), received a grant from the National Fish and Wildlife Foundation to develop a plan to improve urban stormwater management. The ISC's goal is to work collectively to achieve individual and group needs in addressing federal and state regulations pertaining to the Municipal Separate Storm Sewer System (MS4) Program.

Work through this grant focused on two (2) areas, the education and implementation of stormwater best management practices through the restoration of eroding stream-banks for sediment reduction, installation of rain gardens to reduce stormwater impacts reaching the stream, and the establishment of riparian buffers for better water quality and wildlife habitat. Together these BMPs will help reduce sediment and nutrient loads to the streams in Blair County and ultimately the Chesapeake Bay. The goal is to assess watershed issues beyond municipal lines and work together to address stormwater pollution.

The second area of focus was to develop a study that would characterize those receiving streams in Blair County as well as any potential impacts from stormwater runoff. This characterization will help develop a baseline from which any future improvements can be compared. The study took place over a two-year period and included the evaluation of nine (9) sites, eight (8) stream sites four on the Little Juniata and/or its tributaries and four on the Frankstown Branch and/or its tributaries, see Table 1 - Stream Sampling Sites and Frequency of Sampling; September 2015 - August 2017. Additionally, one (1) site immediately downstream of a project area was evaluated to show potential future improvement. This study took a wholistic approach to characterize the existing stream conditions by not only looking at the chemical parameters but also at macroinvertebrate life as well as the habitat. See Appendix A – Sample Site Characteristics for more information related to each site including a photograph, site coordinates, watershed size as well as dominate land use numbers. Primary components of the study included extensive laboratory analysis on both base and storm flows; continuous instream monitoring which included, pH, dissolved oxygen, water temperature, specific conductance and turbidity; flow measurements; macroinvertebrate identification; habitat assessment and pebble counts.

Table 1 - Stream Sampling Sites and Frequency of Sampling; September, 2015 - August, 2017

BCCD Identification Number	Stream Name	Tributary to	Drainainge Area (mi^2)	Water Samples Collected	Stream Flow Measurements	Macroinvertebrate Sampling	Latitude[1]	Longitude[1]
SR10	Spring Run	Little Juniata	6.6	10	14	1	40.532795	-78.388649
LJ85	Little Juniata	---	37.5	12	13	1	40.574723	-78.350855
LJ65	Little Juniata	---	75.6	12	13	1	40.627946	-78.304911
LJ50	Little Juniata	---	106.0	12	15	1	40.662119	-78.251038
FB85	Frankstown Branch	---	45.4	7	7	1	40.338024	-78.434419
HC05	Halter Creek	Frankstown Branch	33.1	7	6	1	40.372317	-78.422694
BB10	Beaverdam Branch	Frankstown Branch	72.4	7	6	1	40.422135	-78.392031
FB50	Frankstown Branch	---	215.0	7	6	1	40.440692	-78.355405
BG03	Bells Gap Run	Little Juniata	22.8	2	3	1	40.599913	-78.336583

[1] Horizontal datum is referenced to the North American Datum 1983, in decimal degrees.

Discrete Water Quality Data

Baseline Chemistry Data

This study included both baseline (samples taken during a dry period with at least 48 hours with no precipitation or snowmelt) as well as storm sampling in order to better characterize the existing stream conditions and the possible types of pollution impacting the stream during storm/ run off events. This section will address results collected as baseline samples.

At all sites general information was collected on a Field Sample Log which included date, time, location name, party, weather, whether or not samples were collected, air temperature, recent precipitation; as well as the following field parameters, flow (including width, area, average velocity, gage height, method, meter number, measurement rating as well as an area for remarks regarding flow and cross section), pH, water temperature, dissolved oxygen in concentration as well as percent saturation, specific conductance and turbidity. Additionally water quality samples were collected for laboratory analysis. Table 2 - Water Quality Constituents and their Respective Units below list each of the constituents sampled.

Table 2 - Water Quality Constituents and their Respective Units

CONSTITUENT	UNIT	CONSTITUENT	UNIT
Flow	CFS (Ft^3/Sec)	Iron	mg/L
PH	pH units	Aluminum	mg/L
Temperature	^{0}C	Manganese	mg/L
Dissolved Oxygen	mg/L	Magnesium	mg/L
Specific Conductance	µS/cm	Lead	µg/L
Turbidity	NTU	Cooper	mg/L
Suspended Sediment Concentration (SSC)	mg/L	Arsenic	µg/L
Chloride	mg/L	Cadmium	mg/L
Hardness	mg/L	Chromium	mg/L
Nitrate-Nitrogen	mg/L	Zinc	mg/L
Phosphorus	mg/L	Mercury	mg/L

CONSTITUENT	UNIT	CONSTITUENT	UNIT
Sulfate	mg/L		

Field Parameters

All field measurements were collected with a Manta2 Sub 3 unit which is identical to the ones used to collect continuous instream monitoring data for this study. The Manta 2 Sub3 has probes for pH, temperature, dissolved oxygen, specific conductance, depth/ stage and turbidity. Flow measurements were collected using a YSI Flowtracker acoustic doppler velocimeter. Flow differed greatly between sites depending on watershed size and any recent precipitation events.

The pH, which represents the hydrogen ion concentration, uses a logarithmic scale to identify the acidity or basicity of a solution, with neutral being seven. Depending on the species most fish and macroinvertebrates have a tolerance range of 5.5 to 9.5 pH according to the Pennsylvania Fish and Boat Commission, Pond and Stream Study Guide. Furthermore, the Pennsylvania Department of Environmental Protection's (PA DEP) Pennsylvania Code, Title 25 (Environmental Protection) Chapter 93 (Water Quality Standards) have the range at 6.0 - 9.0 for all designated uses (determined by PA DEP) whether it be for recreational use/ direct contact, potable water supply, or aquatic life use.

Chapter 93 (Water Quality Standards) sets maximum stream water temperatures at below 30.5°C for warm water fish species and below 19°C for cold water species. In general, anything above those temperatures and fish will become stressed and stop eating. Water temperature is also important due to its direct relationship with percent dissolved oxygen which the water can hold when fully saturated, the colder the water the more oxygen it can hold. Dissolved oxygen was measured in both concentration and percent saturation. For almost all fish species the concentration of dissolved oxygen must be greater than 5.0 mg/l with cold water species preferring concentrations greater than 6.0 mg/l. Specific conductance is a measurement of the ability to pass electricity through an aqueous solution adjusted for temperature at 25°C. Specific conductance can vary greatly in a natural stream based on the stream's underlying geology with those in karst topography having higher specific conductance as is reflected in samples from Halter Creek 05 which is influenced by limestone parent material. Finally, turbidity is simply a measurement of the water's clarity. Turbidities less than 10 would be considered "excellent"/ clear for a natural stream, 10.1-40.0 "good", 40.1 -150 "fair" and 150+ "poor" with most baseline data recorded in this study less than 20 NTUs. However, during large storm events numbers in the two-thousand plus range were recorded.

Sampling Methods

All discrete water quality sampling was done using the same protocols. Samples were collected in clean equipment that was rinsed three (3) times in native water. Cleaning collection equipment involved a four-step process, first the equipment was cleaned with lab soap, rinsed three (3) times with tap water, rinsed once with 5% hydrochloric acid and then finally rinsed three (3) times with deionized water.

A DH-81 depth integrating sampler was used to collect a whole sample from the stream. This sampling technique samples the entire width of the stream at several locations as well as the entire water column. Samples from the DH-81 are composited in a churn. Samples are then taken from the churn and placed in the bottles provided by the laboratory for analysis. In this case Geochemical Testing, Somerset Pennsylvania was used for all analyses. The laboratory provided three (3) bottles for each sample, one (1) 500 ml, raw/no preservative; one (1) 500 ml, weighed for Suspended Sediment Concentration; and one (1) 250 ml fixed with nitric acid as well as a chain of custody report. All bottles were bagged and taped together, iced down and immediately placed in a cooler along with a completed chain of custody report. All samples were shipped/ delivered in coolers of ice and were at the lab within 48 hours for analysis.

Analysis included the following standard constituents; Nitrate-Nitrogen, Phosphorus, Sulfates, Chloride, Calcium, Magnesium and hardness. Additionally, storm related constituents were also sampled for; Suspended Sediment Concentrations (SSC), Iron, Aluminum, Manganese, Lead, Cooper, Arsenic, Cadmium, Chromium, Zinc, and Mercury. All tests were done using an approved U.S. Environmental Protection Agency tests or in the absence of an approved tests an ASTM tests was used. All work was done by a certified laboratory.

Background on Chemical Parameters

Although many of the constituents above are not listed in Chapter 93 (Water Quality Standards) a few of them can be found in Chapter 16 - Water Quality Toxics Management Strategy – Statement of Policy (WQTMS). Chapter 93 - Water Quality Standards (WQS) list criteria based on several uses with the three (3) most prominent being recreational/ direct contact use (WC), potable water supply (PWS), and aquatic life use based on the designated use of Warm Water Fishes through Exceptional Value. Chapter 16 (WQTMS) were available list criteria for National Pollution Discharge Elimination System (NPDES) permitting, although several of the criteria are not only based on concentration but also as it relates to a period of time. Chapter 16 (WQTMS) were applicable also included a Human Health Criteria. Finally, it is important to remember that not all metals are dissolved in the stream at all times and that depending on the pH, hardness, presence of other constituents, and bed material all factor in determining whether the metals are dissolved, a precipitate, or attached to the soil as well as their toxicity to biotic organisms which is our primary concern.

Below is a list of all the parameters in which analyses was completed, a not to exceed criteria for a stream sample is listed if applicable as well as possible sources of the constituent (McWayne, 2014).

Nitrate-Nitrogen

-Maximum 10 mg/l (PWS)
-Sources most often include fertilizer or malfunctioning on-lot septic systems

Phosphorus

-No criteria set but research has shown that eutrophication can start at > 1.0mg/l.

-Sources most often include fertilizer, malfunctioning on-lot septic systems, and waste water treatment plants

Sulfates

-Maximum 250 mg/l (PWS)

-Most common sources are from industrial development through metal and coal mining.

Calcium

-No criteria set

-Elevated levels of Calcium are not often found in streams or stormwater, except where used in de-icing materials, but was analyzed as a component of hardness.

Chloride

-Maximum 250 mg/l (PWS)

-Chloride is toxic to freshwater organisms. Sources can include waste water treatment plants and road salts (sodium, calcium, and magnesium chlorides) in regions where de-icing materials are used for winter road maintenance.

Hardness

-No criteria set

-Primary components include magnesium and calcium.

Suspended Sediment Concentrations (SSC)

-No criteria set

-Sources include streambank and bed erosion as well as any earth disturbance adjacent to the stream. SSC better represents solids in the stream than total dissolved solids or total suspended solids which often fail to include larger particle sizes. SSC can also be directly related to turbidity where the others cannot.

Iron

-Maximum 1.5 mg/l (ALS)

-Most common sources are from industrial development through metal and coal mining. However, human consumption for Iron has a secondary maximum containment level of 0.3 mg/l.

Aluminum

-No criteria set, but research has shown depending on pH, aluminum can be toxic at 0.75 mg/l or greater

-Aluminum is the third most abundant element in the earth's crust and is likely to be found in the environment. Additional sources are from industrial development through metal and coal mining. However, human consumption for Aluminum has a secondary maximum containment level of > 2.0 mg/l.

Manganese

-Maximum 1 mg/l (PWS)

-Most common sources are from industrial development through metal and coal mining. However, human consumption for Manganese has a secondary maximum containment level of 0.5 mg/l.

Lead

-Both a continuous 2.50 ug/l and maximum 65 ug/l concentrations have been set for an Aquatic Life Criteria based on a threshold effect human health criterion of 100.

-Most common sources are from industrial development including building construction as well as all other industries.

Cooper

-Both a continuous 9.0 ug/l and maximum 13.0 ug/l concentrations have been set for an Aquatic Life Criteria based on a threshold effect human health criterion of 100. Additionally, human consumption for Cooper has a secondary maximum containment level of 1.0 mg/l.

-Most common sources are from industrial development including building construction as well as electric and electronic products. Median cooper concentration in natural water is between 4-10 ug/l.

Arsenic

-Both a continuous 150 ug/l and maximum 340 ug/l concentrations have been set for an Aquatic Life Criteria as well as 50 ug/l for a Human Health Criteria.

-Most common sources are from industrial development through metal and coal mining as well as glass and electronic production waste.

Cadmium

-Both a continuous 0.25 ug/l and maximum 2.01 ug/l concentrations have been set for an Aquatic Life Criteria based on a threshold effect human health criterion of 100.

-Cadmium is a toxic metal that reaches the soil and streams most often through atmospheric deposition or through direct application of phosphate fertilizers that contain cadmium.

Chromium

-No criteria set for total Chromium

-Chromium is used in all industrial development from mining to lumber to fabricated metals. In most processes Cr (VI) is the most common form and is extremely toxic and mobile in soil. There are maximum concentrations set for Chromium III and VI but not total Chromium.

Zinc

-Both a continuous 118.14 ug/l and maximum 117.18 ug/l concentrations have been set for an Aquatic Life Criteria based on a threshold effect human health criterion of 100. Additionally, human consumption for Zinc has a secondary maximum containment level of 5 mg/l.

-Most common sources include the leaching of Zinc from galvanized metal surfaces and in smaller amounts from motor oil and hydraulic fluid as well as tire dust.

Mercury

-0.05ug/l (Human Health Criteria)

-Most common sources are from industrial development in the electrical equipment, electric utilities, chemical and fabricated metals industries.

Magnesium

-No criteria set

- Elevated levels of Magnesium are not often found in streams or stormwater but was analyzed as a component of hardness.

Analysis

As expected, all sites in general had baseline water quality results well below any maximum criteria mentioned above for metals. However, there was one site Little Juniata 85, that had one (1) exceedance for lead at 3.2 ug/l on 9/24/15. The maximum concentration for lead is 2.5 ug/l under the continuous concentration criteria and 65 ug/l for maximum concentration criteria of a single event. Since 10 subsequent samples at the same site all produced results below detection limit < 1.0 ug/l, except for one sample of 1.1 ug/l on 10/22/15 it is clear that the continuous concentration is well below 2.5 ug/l and at no point did the concentration exceed the maximum concentration criteria of 65 ug/l.

An additional laboratory constituent, nitrate-nitrogen, had the highest level recorded at Halter Creek 05 of 7.29 mg/l on 6/13/17. Although 7.29 mg/l does not exceed the nitrate-nitrogen criteria of 10 mg/l for a potable water supply it was significantly higher than any other reading including others for Halter Creek 05 which were generally at or less than equal to 1 mg/l.

Other minor exceedances were recorded in the field data, with the majority of those related to pH and specific conductance. For example, a pH above 9.00 was recorded at several sites, with the highest being 9.80 at Little Juniata 65 which was one site that often saw whole point swings in pH during the day. It was determined that these swings were directly related to increases in dissolved oxygen from photosynthesis by aquatic plants driving off hydrogen ions. Other exceedances included water temperature with the highest reading of 25.4°C at Little Juniata 50 which was an exceedance of 3.2°C for a TSF in July. Finally, several sites had specific conductance increases of over 100 fold the average recorded levels. The highest of these was 737.40 µS/cm at Beaverdam Branch 10 with the average recorded value around 467 µS/cm, excluding the 737.40 reading. Overall the baseline water chemistry at all the sites was excellent to good and it was promising to see that almost all trace metals were well below detection limits. Summary Data for all nine (9) sites can be found in Appendix B - Summary Statistics for Instantaneous Flow and Selected Water Quality Constituents, tables 1-9.

Storm Chemistry Data

This study included both baseline as well as storm (defined as any precipitation event that would cause significant run-off) sampling in order to better characterize the existing stream conditions and the possible types of pollution impacting the stream during a storm event. This section will address results collected as storm samples.

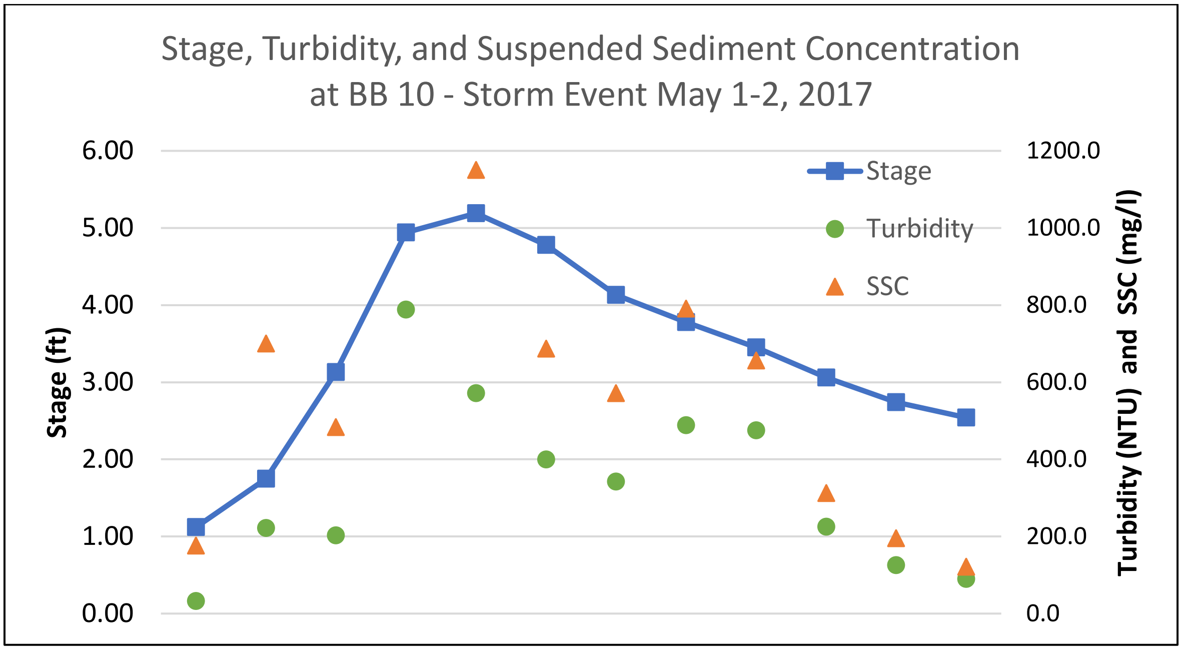
Storm Samples were collected at sites Little Juniata 65 and Beaverdam Branch 10 using a stage activated ISCO automated sampler, model 6712. The sampler contained 24 one (1) liter bottles. The sampler was programed to collect two samples every thirty minutes for the first hour and a half, hoping to catch the initial runoff usually carrying the highest concentration of pollutants known as the "first flush", and then every hour for the last three filling all twenty-four bottles yielding a total of twelve (12) samples. Again the intent was to capture the first flush through at least the peak of the hydrograph. After the sampler had completed its program the samples were collected and handled in the exact same manner as the baseline samples and shipped to the laboratory for analysis. However in this case, because more than 1L of water was needed for laboratory analysis, two (2) samples, were combined in the churn to fill the sample bottles. The same analysis was run on all storm samples as was on baseline samples. Field parameters, pH, water temperature, dissolved oxygen, specific conductance, depth/ stage and turbidity were provided through the continuous instream monitors, in this case a Manta2 Sub3.

Analysis

As expected, the storm sampling yielded results with significant increases in almost all parameters especially in metals concentrations. It is important to note that these numbers are only concentrations and have not been adjusted for loading, so although in some cases the concentrations may decrease from the observed base flow averages that in no way means that there was a total decrease in pollution. Further analysis will be done to determine loading for each of the storm events.

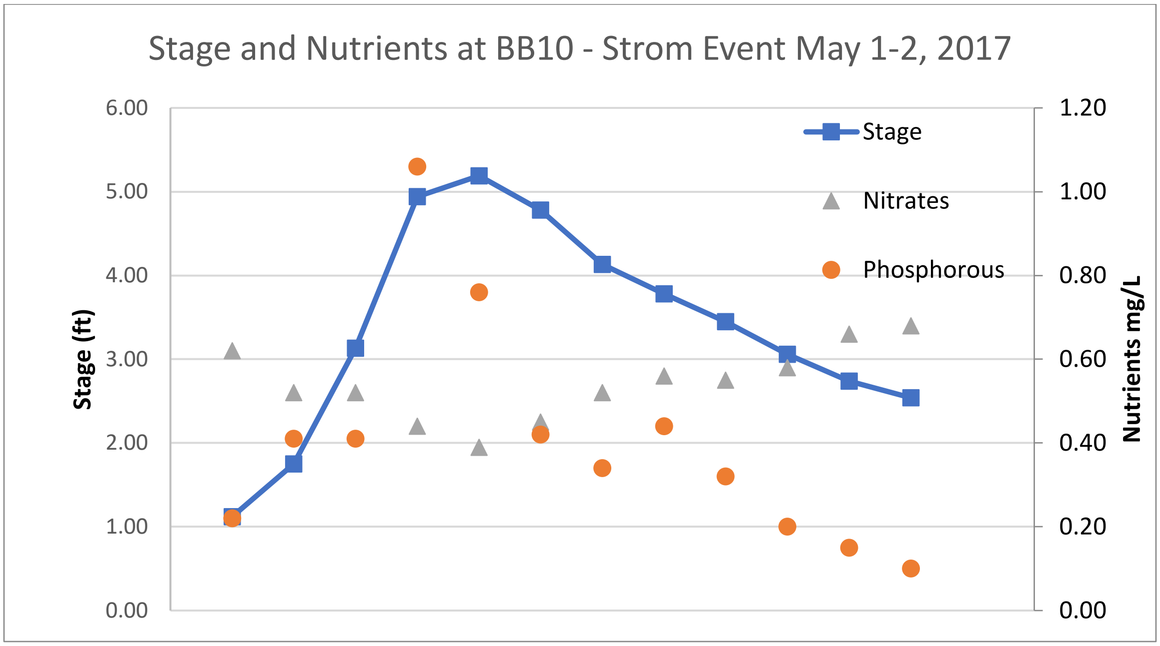
Beaverdam Branch 10 was one of two sites for which six (6) storm events were recorded. Regarding field parameters there were no significant changes in pH or dissolved oxygen. Water temperature however dropped 2°C during one storm in May 2017. Specific conductance had an inverse relationship to stage, whereas the stage/ flow increases, specific conductance decreases. This is most likely due to dilution of total pollutants by the large quantity of water. Finally, as expected turbidity increased significantly from base flow conditions. During one event on May 1-2, 2017 the turbidity went from 32.4 to 788.1, see Figure 1 - Stage, Turbidity and Suspended Sediment Concentration at BB10 – Storm Event May 1-2, 2017 below. According to the U.S. Geological Survey there is direct relationship between turbidity and suspended sediment concentrations (Jastram, 2009). As data analysis continues this relationship will be further investigated. See figures below of data recorded during a storm event on May 1-2, 2017 at Beaverdam Branch 10.

Figure 1 - Stage, Turbidity and Suspended Sediment Concentration at BB10 – Storm Event May 1-2, 2017



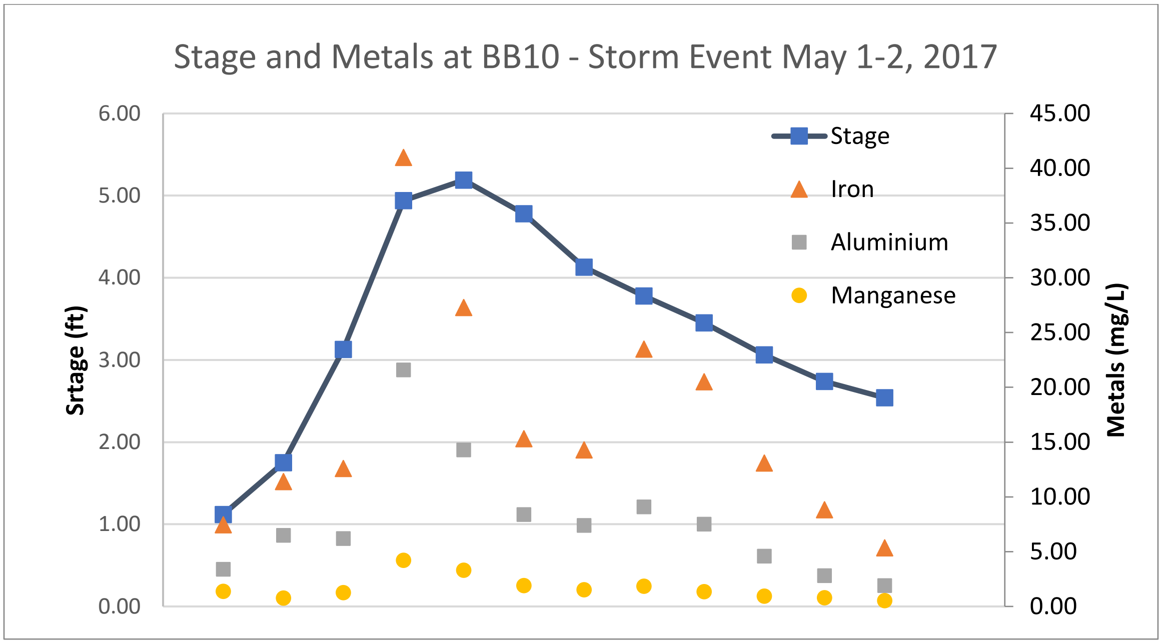
Regarding nutrients, the data recorded at Beaverdam Branch 10 is almost identical to that found at Little Juniata 65. Here as stage/ flow increased nitrate concentrations initially decreased due to dilution and then slow increased as stage decreased returning close to the initial reading. Phosphorous on the other hand increased throughout most events and then decreased as flows decreased. Phosphorus bonds strongly with sediment which may explain why it increased significantly as turbidity increased and why it was not diluted by the increased flow. See Figure 2 – Stage and Nutrients at BB10 – Storm Event May 1-2, 2017.

Figure 2 – Stage and Nutrients at BB10 – Storm Event May 1-2, 2017.



Finally, see Figure 3 – Stage and Metals at BB10 – Storm Event May 1-2, 2017 for data related to iron, aluminum and manganese plotted along with stage. Again, the data recorded at Beaverdam Branch 10 is almost identical to that found at Little Juniata 65. Here as stage/ flow increased all metals increased with iron having the greatest increase, from around 7.4 to 40 mg/land and manganese the least from 1.4 to 4.2 mg/l throughout the event. In this case although there is some historic coal mining within tributary watersheds, initial assessments would suggest this watershed is primarily impacted by urban runoff.

Figure 3 – Stage and Metals at BB10 – Storm Event May 1-2, 2017



Finally, let's look at little Juniata 65 for which six (6) storm events were recorded. Regarding field parameters there were no significant changes in pH or water temperature throughout the storm event. During two (2) of the events there were decreases in the dissolved oxygen concentration of about 1.5 mg/l as well as in the percent dissolved oxygen of about 10% over the recorded period. Specific conductance had an inverse relationship to stage, whereas the stage/ flow increases and specific conductance decreased. Again, this is most likely due to dilution of total pollutants by the large quantity of water. Finally, as expected turbidity increased significantly from base flow conditions. During one event the turbidity went from 13.73 to 306.50.

As can be seen from Table 3 - Little Juniata 65 – Storm Event (May 1, 2017) in most cases both the nutrient and metals concentrations increased during a storm event when compared to the base flow average. Specifically, the chart below represents the storm with the greatest pollutant impact recorded at Little Juniata 65. Those numbers in red highlight exceedances as described previously in the baseline chemistry data section. Further investigation needs to be made as to the source of elevated iron, aluminum, manganese and zinc. Possibilities may include impacts from historic coal mining in upstream tributaries or possible impacts from industrial railroad development in the headwaters of the Little Juniata river.

Table 3 - Little Junita 65 – Storm Event (May 1, 2017)

	Minimum	**Maximum**	**Base Flow Average**
Nitrate-Nitrogen	0.35	0.58	0.64
Phosphorus	0.43	1.64	0.10
Sulfate	10.00	18.00	26.92
Chloride	16.00	30.00	35.25
Hardness	81.40	165.00	108.56
Calcium	22.30	40.90	30.93
Magnesium	6.30	15.30	7.61
SSC (solids)	300.00	1,590.00	9.00
Iron	6.17	30.20	0.14
Aluminum	3.00	16.00	0.20
Manganese	0.620	2.560	0.030
Lead	0.030	0.129	< 0.001
Cooper	0.020	0.080	< 0.010
Arsenic	0.0028	0.0116	< 0.0010
Cadmium	< 0.002	< 0.002	< 0.002
Chromium	< 0.010	0.030	< 0.010
Zinc	0.080	0.350	< 0.010
Mercury	< 0.0002	0.0004	< 0.0002

Continuous Instream Monitoring

A significant component of this study was the use of continuous instream monitoring (CIM). CIM is accomplished by using an unattended sonde which contains a logger component as well as selective probes. According to PA DEP's Continuous Instream Monitoring Protocol when the time interval between repeated measurements is adequately small, the resulting water quality record can be considered continuous. Standard time interval is 15 minutes using an unattended probe with logging capability.

In the case of this study, Manta2 Sub 2s and Sub 3s were used. Manta products are made by Eureka Water Probes, Texas. Manta2 Sub2s include the following probes; pH, dissolved oxygen, specific conductance, water temperature, and stage/ depth (non-vented). Similar to the Sub 2s the Sub 3s have the same probes listed above but add turbidity and the stage/ depth is vented. Vented probes measure depth, through pressure, more accurately because the vented cable adjusts for barometric pressure. Vented probes are more accurate when the streams are shallower.

The sondes were set to take a reading every 15 minutes and can record and store data for at least 30 days with the limiting factor being battery power. The Sub 3 sondes were limited beyond 30 days, depending on temperature, since the turbidity probe has a wiper which consumes more power. As protocol when possible the sondes were maintained every six to seven weeks. At each maintenance interval the probes were checked, previous months data was downloaded using Eureka's Amphibian, a handheld field computer, cleaned, and when necessary calibrated. At each maintenance visit a second sonde was taken out into the field to compare against the field unit in order to create data that could later be used to make any necessary corrections.

All probes were installed in the stream using PVC pipe, concrete forming stakes used as anchor's and stainless-steel cable to secure the device on-shore in the case of anchor failure. This system did work as intended but there were several incidents when the PVC housing was destroyed, the anchor's failed, vented cables snapped all during storm events. However, the two most significant problems were human error and battery failure.

Over the course of this study tens of thousands of data points were created. In order to manage all of the data a software program named Aquarius was purchased. Aquarius, developed by Aquatic Informatics, was designed specifically for the management of CIM data. Highlights to the software include the ability to correct the data, for both fouling and calibration corrections; analyze the data for trends and fluctuations; create charts and tables; and develop significant correlations among measured parameters. See Appendix C – Example Report Generated from Aquarius one of the many reports generated from the Aquarius software. Some initial correlations identified so far, that were discussed earlier, are the relationship between aquatic plant photosynthesis increasing pH during the day and the relationship between temperature and dissolved oxygen as can be seen in Figure 4 – Temperature and Dissolved Oxygen – Spring Run 10 July 2016 and Figure 5 – Temperature and pH – Spring Run 10 July 2016 respectively. Also, below see Figure 6 – Example Screen Shot of Sonde Data collected from the sondes.

Figure 4 – Temperature and Dissolved Oxygen – Spring Run 10 July 2016

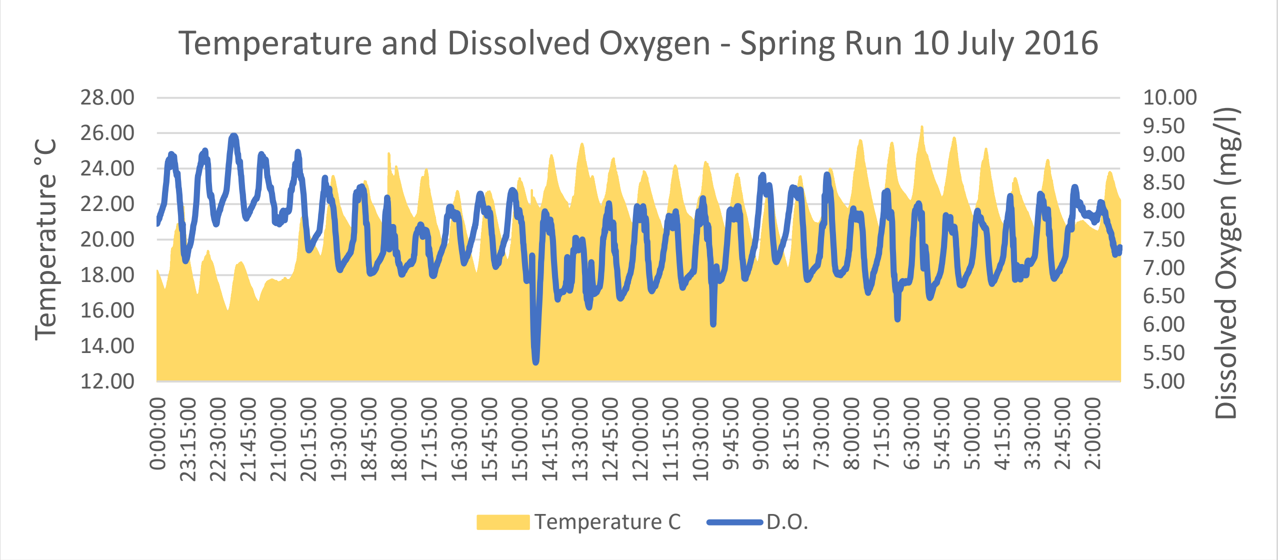


Figure 5 – Temperature and pH – Spring Run 10 July 2016

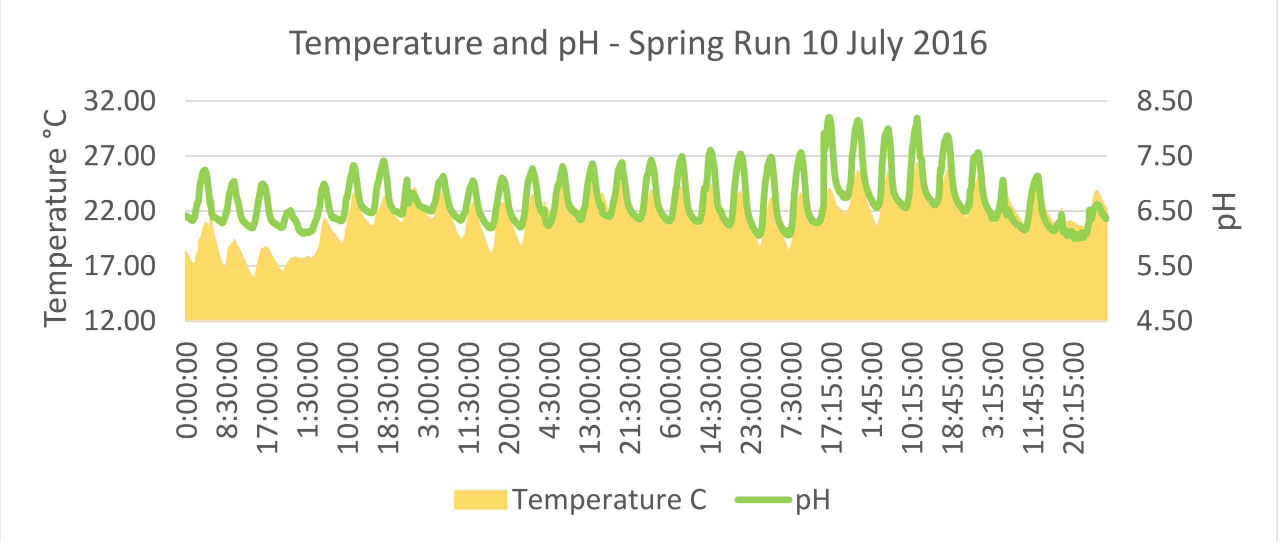
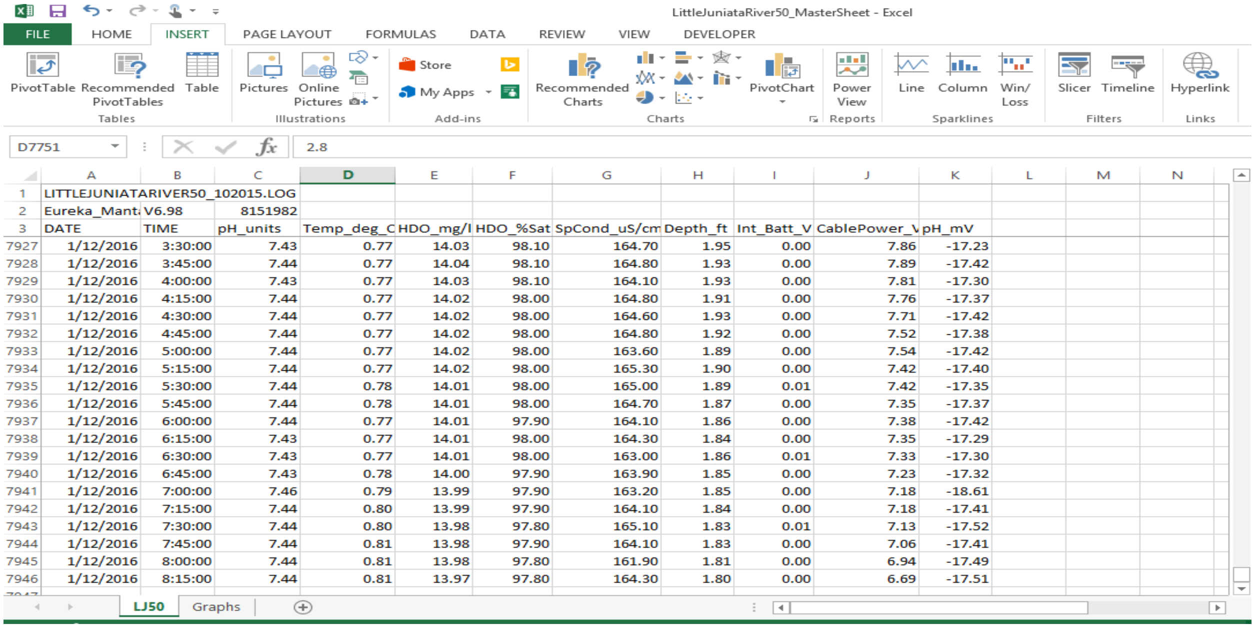


Figure 6 – Example screen shot of sonde data



	A	B	C	D	E	F	G	H	I	J	K
1	LITTLEJUNIATARIVER50_102015.LOG										
2	Eureka_Mant	V6.98	8151982								
3	DATE	TIME	pH_units	Temp_deg_C	HDO_mg/l	HDO_%Sat	SpCond_uS/cm	Depth_ft	Int_Batt_V	CablePower_V	pH_mV
7927	1/12/2016	3:30:00	7.43	0.77	14.03	98.10	164.70	1.95	0.00	7.86	-17.23
7928	1/12/2016	3:45:00	7.44	0.77	14.04	98.10	164.80	1.93	0.00	7.89	-17.42
7929	1/12/2016	4:00:00	7.43	0.77	14.03	98.10	164.10	1.93	0.00	7.81	-17.30
7930	1/12/2016	4:15:00	7.44	0.77	14.02	98.00	164.80	1.91	0.00	7.76	-17.37
7931	1/12/2016	4:30:00	7.44	0.77	14.02	98.00	164.60	1.93	0.00	7.71	-17.42
7932	1/12/2016	4:45:00	7.44	0.77	14.02	98.00	164.80	1.92	0.00	7.52	-17.38
7933	1/12/2016	5:00:00	7.44	0.77	14.02	98.00	163.60	1.89	0.00	7.54	-17.42
7934	1/12/2016	5:15:00	7.44	0.77	14.02	98.00	165.30	1.90	0.00	7.42	-17.40
7935	1/12/2016	5:30:00	7.44	0.78	14.01	98.00	165.00	1.89	0.01	7.42	-17.35
7936	1/12/2016	5:45:00	7.44	0.78	14.01	98.00	164.70	1.87	0.00	7.35	-17.37
7937	1/12/2016	6:00:00	7.44	0.77	14.01	97.90	164.10	1.86	0.00	7.38	-17.42
7938	1/12/2016	6:15:00	7.43	0.77	14.01	98.00	164.30	1.84	0.00	7.35	-17.29
7939	1/12/2016	6:30:00	7.43	0.77	14.01	98.00	163.00	1.86	0.01	7.33	-17.30
7940	1/12/2016	6:45:00	7.43	0.78	14.00	97.90	163.90	1.85	0.00	7.23	-17.32
7941	1/12/2016	7:00:00	7.46	0.79	13.99	97.90	163.20	1.85	0.00	7.18	-18.61
7942	1/12/2016	7:15:00	7.44	0.80	13.99	97.90	164.10	1.84	0.00	7.18	-17.41
7943	1/12/2016	7:30:00	7.44	0.80	13.98	97.80	165.10	1.83	0.01	7.13	-17.52
7944	1/12/2016	7:45:00	7.44	0.81	13.98	97.90	164.10	1.83	0.00	7.06	-17.41
7945	1/12/2016	8:00:00	7.44	0.81	13.98	97.80	161.90	1.81	0.00	6.94	-17.49
7946	1/12/2016	8:15:00	7.44	0.81	13.97	97.80	164.30	1.80	0.00	6.69	-17.51

Habitat Assessment

A habitat assessment assesses twelve (12) physical characteristics, within and outside of the stream channel, to accurately identify those key criteria necessary for a benthic macroinvertebrate community to thrive. The results from this evaluation will identify the existing habitat and can help identify those limiting factors if any. The habitat assessment used is a modified version of *the Environmental Protection Agency's (EPA) Rapid Bioassessment Protocols (RBP) Barbour, MT. et al. 1999.*

The habitat assessment process involves rating 12 parameters as "optimal", "suboptimal", "marginal", or "poor", by assigning a numeric value (ranging from 20 - 1), based on the criteria included on the Water Quality Network Habitat Assessment Riffle/Run Prevalence form [Pennsylvania Department of Environmental Protection (PA DEP), 3800-FM-WSFR0402].

Those parameters are Instream (Fish) Cover, Epifaunal Substrate, Embeddedness, Velocity/ Depth Regimes, Channel Alteration, Sediment Deposition, Frequency of Riffles, Chanel Flow Status, Condition of Banks, Bank Vegetative Protection, Grazing or other Disruptive Pressure and Riparian Vegetative Zone Width.

The 12 habitat assessment parameters used in the PADEP-RBP evaluations for Riffle/Run prevalent (and Glide/Pool prevalent) streams are described below. All sites for this study were evaluated using the Riffle/ Run Prevalence form.

The first four parameters evaluate stream conditions in the immediate vicinity of the benthic macroinvertebrate sampling point:

Instream Fish Cover

Evaluates the percent makeup of the substrate (boulders, cobble, other rock material) and submerged objects (logs, undercut banks) that provide refuge for fish.

Epifaunal Substrate

Evaluates riffle quality, i.e., areal extent relative to stream width and dominant substrate materials that are present. (In the absence of well-defined riffles, this parameter evaluates whatever substrate is available for aquatic invertebrate colonization.)

Embeddedness

Estimates the percent (vertical depth) of the substrate interstitial spaces filled with fine sediments.

Velocity/Depth Regime

Evaluates the presence/absence of four velocity/depth regimes - fast-deep, fast-shallow, slow-deep and slow-shallow.
(Generally, shallow is < 0.5m and slow is < 0.3m/sec.)

The next four parameters evaluate a larger area surrounding the sampled riffle. As a rule of thumb, this expanded area is the stream length defined by how far upstream and downstream the investigator can see from the sample point.

Channel Alteration

Primarily evaluates the extent of channelization or dredging but can include any other forms of channel disruptions that would be detrimental to the habitat.

Sediment Deposition

Estimates the extent of sediment effects in the formation of islands, point bars, and pool deposition.

Riffle Frequency (pool/riffle or run/bend ratio)

Estimates the frequency of riffle occurrence based on stream width.

Channel Flow Status

Estimates the areal extent of exposed substrates due to water level or flow conditions.

The next four parameters evaluate an even greater area. This area is usually defined as the length of stream that was electroshocked for fish (or an approximate 100-meter stream reach when no fish were sampled). It can also take into consideration upstream land-use activities in the watershed. This study did not include fish assemblages so a 100 meter section was evaluated.

Condition of Banks

Evaluates the extent of bank failure or signs of erosion.

Bank Vegetative Protection

Estimates the extent of stream bank that is covered by plant growth providing stability through well-developed root systems.

Grazing or Other Disruptive Pressures

Evaluates disruptions to surrounding land vegetation due to common human activities, such as crop harvesting, lawn care, excavations, fill, construction projects, and other intrusive activities.

Riparian Vegetative Zone Width

Estimates the width of protective buffer strips or riparian zones. This is a rating of the buffer strip with the least width.

After all parameters in the matrix are evaluated and scored, the scores are summed to obtain a total score. The “optimal” category scores range from 240-192; “suboptimal” from 180-132; “marginal” from 120-72; and “poor” is 60 or less. The gaps between these categories are left to the discretion of the investigator’s best professional judgment. Of the nine (9) sites evaluated, each of the eight (8) stream sites and one (1) of the project sites five (5) sites received the highest rating of “optimal” and four (4) sites were scored as “suboptimal”. Of the four (4) “suboptimal” sites two (2) were scored just over 180 but still best met the “suboptimal” classification.

The five (5) “optimal” sites were Little Juniata 85, Little Juniata 65, Little Juniata 50, Bells Gap 03, and Halter Creek 05 with a tie for the highest score, at 217, going to Little Juniata 50 and Halter Creek 05. The four (4) remaining sites scored as “suboptimal” were Spring Run 10, Beaverdam Branch 10, Frankstown Branch 85 and Frankstown Branch 50.

According to the Department of Environmental Protection, Instream Comprehensive Evaluation Surveys manual, the habitat parameters of “instream cover”, “epifaunal substrate”, “embeddedness”, “sediment deposition”, and “condition of banks” are more critical because they evaluate the instream habitat components that have the most effect on the benthic macroinvertebrate community. Just those parameters can be found in Table 4 - Critical Habitat Parameters. Similar to the total scores, with the majority of the sites earning an “optimal” designation, only two (2) sites were rated as suboptimal when focusing on only the critical habitat parameters.

Table 4 - Critical Habitat Parameters

Site	**Instream Fish Cover**	**Epifaunal Substrate**	**Embeddedness**	**Sediment Deposition**	**Condition of Banks**	**Total Points**
Frankstown Branch 85	14	19	20	17	14	Optimal
Halter Creek 05	16	19	18	17	19	Optimal
Beaverdam Branch 10	16	14	18	13	14	Suboptimal
Frankstown Branch 50	8	16	19	17	15	Optimal
Spring Run 10	17	19	19	20	15	Optimal
Little Juniata 85	14	17	16	14	12	Suboptimal
Little Juniata 65	15	14	15	18	20	Optimal
Little Juniata 50	14	19	20	18	19	Optimal
Bells Gap 03	18	19	18	16	18	Optimal

Despite the overall high scores there were a few individual criteria that alone would have ranked “fair” or even “poor”. For example, the Spring Run 10 site scored a seven for Velocity/ Depth Regimes and five for Riparian Vegetative Zone Width. Although there were not many individual parameter scores below 10 there were a few. For a complete list of all the scores see Appendix D Habitat Assessment Scores by Parameter.

Finally, looking at the average scores for the two watersheds separately the Little Juniata River and Frankstown Branch watersheds, the Little Juniata scored a 199 and the Frankstown Branch a 189. Therefore one could reasonably say that the habitat within the Little Juniata watershed is slightly better than the Frankstown Branch, receiving a score of “optimal” and “suboptimal” respectively.

Pebble Count

Pebble Counts are used to quantify the bed-particle distribution of a stream reach, following methods originally adapted from Wolman (1954). Bed-particle distributions are intended to characterize the bed substrate at the time of monitoring and to serve as a baseline against which future changes can be compared. The particle distribution of a streambed is indicative of the sediment load being supplied to the system and the ability of the stream to transport the load. The coarser the sediment, the more energy required to transport the sediment load.

Pebble Counts were conducted following the procedure developed by Bevenger and King (1995). This procedure uses a zig zag pattern over a stream reach, including two (2) pools and two (2) riffles if present or if not the sample is conducted over a minimum of 200 meters. The sample is collected over the active channel from bank toe to bank toe with a minimum of 200 of particles sampled per reach.

The Pebble Counts collected were then plotted as cumulative percentages in an Excel Spreadsheet using a modified Pebble Count Analyzer from the Commonwealth of Kentucky, Department for Environmental Protection-Division of Water. Bed-particle distributions were extracted from a cumulative frequency curve and reported as a percentage of particles with a medium axis less than or equal to the reported value. D15, D35, D50, D84 and D95 have been provided in the Table below.

Table 5 - Pebble Count – Bed Particle Size Distribution (millimeters)

Site Location	D15	D35	D50	D84	D95	Characterization based on Median Particle Size (D50)
Spring Run 10	24.161	42.422	61.625	131.380	1008.640	Very Coarse Gravel
Little Juniata 85	0.782	10.760	22.067	75.286	116.255	Coarse Gravel
Little Juniata 65	23.000	60.647	85.273	189.500	482.000	Small Cobble
Little Juniata 50	10.225	49.598	76.458	158.759	228.043	Small Cobble
Frankstown Branch 85	17.011	42.930	61.467	129.473	177.617	Very Coarse Gravel
Halter Creek 05	3.271	18.823	41.967	113.353	173.013	Very Coarse Gravel
Beaverdam Branch 10	31.357	45.396	57.271	97.308	135.429	Very Coarse Gravel
Frankstown Branch 50	3.800	20.550	29.300	72.089	118.50	Coarse Gravel
Bells Gap 03	18.864	54.500	81.333	176.038	437.000	Small Cobble

(D15, 15th percentile bed particle size, D35, 35th percentile bed particle size, D50, 50th percentile bed particle size, D84, 84th percentile bed particle size, D95, 95th percentile bed particle size)

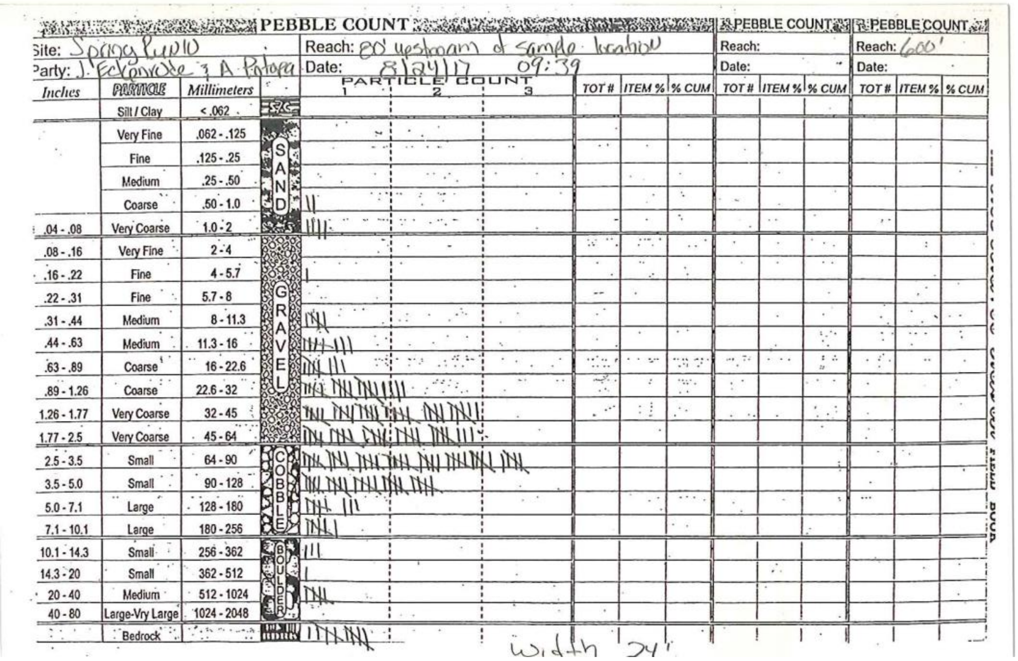
The information from the pebble count collected can then be compared to a stable reference reach to determine whether or not a site is impacted by stormwater. In general reference reaches are those streams that have less than 15% of total particles finer than 8mm, and stable study reaches are those streams with less than 30% of particles finer than 8mm. If total fine particles are greater than 35% (estimated) the study reach is very likely unstable and may be impaired. However, since the basis of this study was to characterize existing conditions, reference reaches were not identified. In this study, although several sites exceeded the 15% threshold for a reference reach, none were classified as impaired or > 35%. Additionally, MacDonald et al (1991) summarized the literature regarding biological impacts by reporting that particles up to 6.4 mm are of the most concern to the fishery resource since they should have the most biological significance and are most likely to smother macroinvertebrate and fish spawning habitat. Since our data was collected by Wentworth size classes, we used, 8mm as the cutoff point because this is the size class closest to 6.4mm see table below.

Table 6 - Percentage of Particle Size < 8 mm

Site Location	**Percentage of Particle Size < 8 mm**	**Site Location**	**Percentage of Particle Size < 8 mm**
Spring Run 10	3.45	Frankstown Branch 85	10.40
Little Juniata 85	28.37	Halter Creek 05	23.65
Little Juniata 65	9.00	Beaverdam Branch 10	3.00
Little Juniata 50	12.81	Frankstown Branch 50	21.43
Bells Gap 03	6.67		

For each of the eight (8) stream sites and one (1) of the project sites a pebble count was conducted. An example of the tally sheet as well as a particle size distribution graph and particle size by category frequency graph is included below. The particle size distribution and particle size by category frequency graphs for all sites can be found in Appendix E.

Figure 7 - Example, Pebble Count Tally Sheet – Spring Run 10



PEBBLE COUNT

Site: Spring Run 10
Reach: 80' upstream of sample location
Party: J. Eckenrode & A. Potopa
Date: 8/24/17 09:39

Inches	PARTICLE	Millimeters		PARTICLE COUNT 1 2 3	TOT #	ITEM %	% CUM
	Silt / Clay	< .062	S/C				
	Very Fine	.062 - .125	SAND				
	Fine	.125 - .25					
	Medium	.25 - .50					
	Coarse	.50 - 1.0					
.04 - .08	Very Coarse	1.0 - 2					
.08 - .16	Very Fine	2 - 4	GRAVEL				
.16 - .22	Fine	4 - 5.7					
.22 - .31	Fine	5.7 - 8					
.31 - .44	Medium	8 - 11.3					
.44 - .63	Medium	11.3 - 16					
.63 - .89	Coarse	16 - 22.6					
.89 - 1.26	Coarse	22.6 - 32					
1.26 - 1.77	Very Coarse	32 - 45					
1.77 - 2.5	Very Coarse	45 - 64					
2.5 - 3.5	Small	64 - 90	COBBLE				
3.5 - 5.0	Small	90 - 128					
5.0 - 7.1	Large	128 - 180					
7.1 - 10.1	Large	180 - 256					
10.1 - 14.3	Small	256 - 362	BOULDER				
14.3 - 20	Small	362 - 512					
20 - 40	Medium	512 - 1024					
40 - 80	Large-Vry Large	1024 - 2048					
	Bedrock		BDRK				

width 24'

PEBBLE COUNT
Reach:
Date:

TOT #	ITEM %	% CUM

PEBBLE COUNT
Reach: 600'
Date:

TOT #	ITEM %	% CUM

Figure 8 - Example, Particle Size Distribution Graph – Spring Run 10

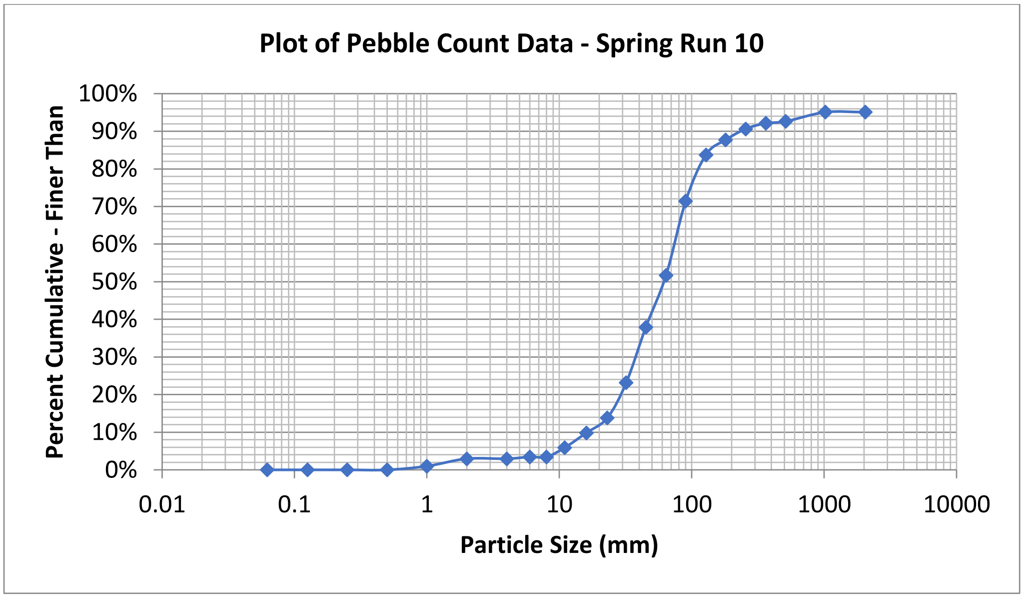
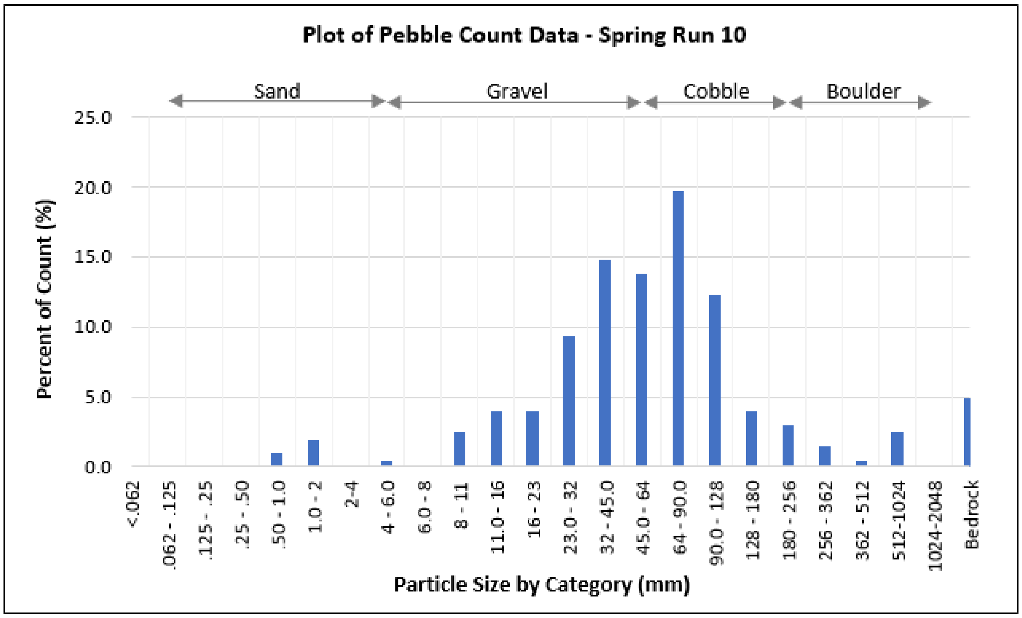


Figure 9 - Example, Particle Size by Category Frequency Graph – Spring Run 10



Benthic Macroinvertebrates

Benthic Macroinvertebrates are an excellent indicator of water quality and whereas chemical sampling can only characterize the water quality at any given moment, macroinvertebrate sampling can indicate water quality over a longer period of time. Macroinvertebrate assemblages were collected in November and December 2016 and February 2017 at nine (9) sites, including the eight (8) stream sites and one (1) project site using the semi-quantitative Pennsylvania Department of Environmental Protection-Rapid Bioassessment Protocol.

For this method, benthic macroinvertebrate samples are collected throughout a 100-meter stream reach by disturbing an approximately one square meter area immediately upstream of the net for one minute to an approximate depth of 10 cm, or as substrate allows. The net used is a standard D-frame net with a 500-micron mesh bag. Kicks include all habitat types including shallow, fast and slow riffle areas. Sample collection consists of 6 D-frame sample efforts from each station, composited and returned to the lab for further processing and identification (Pa DEP, Laboratory Methods…).

Samples collected following the above methods are placed in labeled containers, preserved with denatured alcohol/ ethanol and sent to the laboratory for identification. Since these samples were mailed, the ethanol was drained off, water added and the sampled shipped to Cole Ecological in Greenfield, Massachusetts. In the laboratory, the organisms are sorted from debris and are identified using standard taxonomic references following PA DEP methods. The data is then analyzed using standard metrics. See Analysis below for a complete summary of the findings.

Analysis

The macroinvertebrate assemblages were collected at nine (9) sites, including eight (8) stream sites and one (1) project site. They ranged from impaired to attaining when assessed using the Aquatic Life Use (ALU) Attainment benchmark. Those designations are determined by calculating their Index of Biotic Integrity (IBI) which uses several metrics that when scored and standardized measure the extent to which anthropogenic activities compromise a stream’s ability to support healthy aquatic communities (Davis and Simon 1995). IBI scores range from 0-100 with an IBI Score of greater than or equal to 50 meeting attainment and less than 50 designated as impaired. The scores are further adjusted for watershed size. Watersheds of 25 mile^2 or less are designated as small and watersheds 50 mile^2 or larger are designated as a large watershed. Watersheds in between the 25-50 mile^2 size are further reviewed and evaluated by the biologist to determine which IBI Score should be used. Additionally, sites scoring greater than or equal to 50, must also be screened by four additional questions before they can be designated attaining. See Table 7 below for the IBI Scores and Watershed Size by Site Location. Those numbers highlighted in the table reflect the watershed and subsequent IBI used for ALU determination.

Table 7- IBI Score and Watershed Size by Site Location

Site Location	Small Watershed IBI Score	Large Watershed IBI Score	Watershed Size (miles^2)
Spring Run 10	32.4	34.5	7
Little Juniata 85	29.2	32.3	38
Little Juniata 65	37.0	41.2	76
Little Juniata 50	44.6	49.7	106
Frankstown Branch 85	35.3	38.3	46
Halter Creek 05	34.8	38.6	33
Beaverdam Branch 10	35.5	38.4	73
Frankstown Branch 50	34.3	37.4	215
Bells Gap 03	73.8	87.3	23

The highest scoring site was Bells Gap 03 with an IBI of 73.8, also meeting the four screening questions, it was the only site meeting the attainment criteria. This site had a diverse macroinvertebrate community composed of several pollution sensitive individuals (49.0 %) and lower numbers of pollution tolerant individuals, which indicates that Bells Gap Run is supportive of high-quality aquatic life.

The other small watershed sampled was Spring Run 10 with an IBI score of 32.4, which is significantly less than 50 and is therefore designated as impaired. Regarding the large watersheds, Little Juniata 65, Little Juniata 50, Beaverdam Branch 10, and Frankstown Branch 50 all sites were designated as impaired with IBI Scores of 41.2, 49.7, 38.4 and 37.4 respectively. However, the Little Juniata 50 site with an IBI of 49.7 was very close to that 50-point threshold. Further analysis was done through the four screening questions. It passed three of the four screening questions by answering “no” to all except for the Beck’s Index score along with Percent Sensitive Individuals. The standardized Beck’s Index equaled 13.64, well below 33.3 and the standardize percent sensitive individuals equaled 20.24 which again is less the 25.0. Although included in the IBI calculations, this screening question helps assure sustainable richness and abundance of sensitive organisms (Davis and Simon 1995).

Looking at those three (3) remaining sites caught somewhere in between a small or large watershed, additional evaluations were made to determine the most representative watershed size. Halter Creek 05, a 33 mile^2 watershed best met the characteristics of a small watershed and scored an IBI Score of 34.8. For the Frankstown Branch 85 at 46 mile^2 the watershed best met the characteristics of a large watershed and scored an IBI Score of 38.3 and for the Little Juniata 85 at 38 mile^2 the watershed best met the characteristics of a large watershed and scored an IBI Score of 32.3. However, in this case all three (3) were designated impaired regardless of watershed size.

Halter Creek, a limestone influenced stream whose Chapter 93 Existing Use designation is high-quality cold water fishes had an IBI score of 34.8 and 38.6 respectively for a small and large watershed. Despite the 33 square mile size Halter Creek more closely resembles a small watershed at the monitoring point. Regardless of watershed size any IBI score less than 63.0 on a special protection stream is considered impaired although additional investigation is needed to determine the stream’s baseline IBI score.

Finally, it is important to note that most if not all of the larger watersheds sampled would be considered limestone influenced. For example, site Little Juniata 65 is just downstream of Watt’s Farm which has serval large limestone springs feeding the stream. Similarly, at Little Juniata 85, the flow is almost doubled by the limestone spring feeding Sandy Run immediately upstream. This influence, which can cause less variable flow and thermal patterns, can create a naturally less diverse benthic macroinvertebrate community than a freestone stream. Specifically, these streams can exhibit relatively low stonefly diversity and abundance. Considering these conditions, the IBI benchmark can be reduced slightly with a score greater than or equal to 43 meeting attainment. The only monitoring site that could then be considered attaining based on this consideration is Little Juniata 50 which is discussed in further detail above. However, it does bring other sites like Little Juniata 65 much closer to the attainment threshold. See Appendix F for a complete list of all macroinvertebrates identified.

Conclusion

Together all of the components evaluated through this study have provided a wealth of information clearly meeting our goal to accurately characterize not only the existing conditions of Blair County streams but also provided insight into the impacts on those streams during storm events. The information collected has identified existing conditions which will help the municipalities show future improvement to both the Pennsylvania Department of Environmental Protection and U.S. Environmental Protection Agency. Additionally, it has helped identify possible opportunities for restoration and enhancement and in a few cases documented existing high-quality streams that should be afforded more protection under the State’s water quality standards.

Works Cited

Chalfant, Brian. 2015. An Index of Biotic Integrity for Benthic Macroinvertebrate Communities in Pennsylvania's Wadeable, Freestone, Riffle-Run Streams. Pennsylvania Department of Environmental Protection.

Commonwealth of Pennsylvania. 2003. Standardized Biological Field Collection and Laboratory Methods (Draft). Department of Environmental Protection, Bureau of Water Supply and Wastewater Management.

Davis, W.S. and T.P. Simon. 1995. Introduction to Biological assessment and criteria: tools for water resource planning and decision making, W.S. Davis and T.P. Simon, eds. (pp. 3-6) CRC Press, Boca Raton.

Environmental Protection Agency. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish. (Second Edition). Office of Water. EPA 841-B-99-002. July 1999. (Authors Barbour, MT; J Gerristsen, BD Snyder, Jb Stribling)

Homer, C.G., Dewitz, J.A., Yang, L., Jin, S., Danielson, P., Xian, G., Coulston, J., Herold, N.D., Wickham, J.D., and Megown, K., 2015, Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. *Photogrammetric Engineering and Remote Sensing*, v. 81, no. 5, p. 345-354

Jastram, J.D., Moyer, D.L., and Hyer, K.E., 2009, A comparison of turbidity-based and streamflow-based estimates of suspended-sediment concentrations in three Chesapeake Bay tributaries: U.S. Geological Survey Scientific Investigations Report 2009–5165

MacDonald, L.H.; Smart, A.; Wissmar, R.C. 1991. Monitoring Guidelines to evaluate effects of forestry activities on streams in the Pacific Northwest and Alaska. US EPA Region 10, NPS Section, EPA/910/9-91-001. Seattle, Washington. Pp 166.

McWayne, Erick. December, 2014. Stormwater Pollutant Chemistry and Applications to Monitoring and BMP Effectiveness. National Environmental Management Academy.

Pennsylvania Department of Environmental Protection. 2003. Standardized Biological Field Collection and Laboratory Methods.

Pennsylvania Department of Environmental Protection Bureau of Water Standards and Facility Regulation – Division of Water Quality Standards. December 15, 2007. Pennsylvania Department of Environmental Protection's Title 25 Chapter 93 (Water Quality Standards), Chapter 96 (Water Quality Standards Implementation) and Chapter 16 (Water Quality Toxics Management Strategy-Statement of Policy) of the Commonwealth of Pennsylvania Code, Pennsylvania Code.

Pennsylvania Department of Environmental Protection. February 2013. Continuous Instream Monitoring Protocol.

Pennsylvania Fish and Boat Commission, Pond and Stream Study Guide.

Rosgen, David L. 1994. A Stream Classification System. Catena. Volume 22. Pp 169-199. Elsevier Science, Amsterdam.

Rosgen, David L.   1996.   Applied River Morphology.   Wildlands Hydrology Books, Pagosa Springs, Colorado.

USDA Forest Service.   1995.   A Pebble Count Procedure for Assessing Watershed Cumulative Effects. Rocky Mountain Forest and Range Experiment Station.   RM-RP-319.   (Authors: Gregory S. Bevenger and Rudy M. King)

Wolman, M.G.   1954.   A Method for Sampling Coarse River-bed Material.   Transactions American Geophysical Union.   Volume 35.   Number 6.   Pp 951-956

Tables

Figures

Appendices

Appendix A – Sample Site Characteristics

Spring Run 10

Coordinates	
Latitude	40.532795
Longitude	-78.388649
Chapter 93 (designated/ existing) Use	WWF
Drainage Area ($miles^2$)	6.59
Mean Annual Precipitation (inches)	40
Mean Annual Flow ($feet^3$/ second)	11
Land Use (percent)	
Forest	75
Urban	21
Carbonate (percent)	0
Average percentage of Impervious Area	7.23

Little Juniata 85

Coordinates	
Latitude	40.574723
Longitude	-78.350855
Chapter 93 (designated/ existing) Use	CWF
Drainage Area (miles^2)	37.5
Mean Annual Precipitation (inches)	40
Mean Annual Flow (feet^3/ second)	58
Land Use (percent)	
Forest	68
Urban	20
Carbonate (percent)	9
Average percentage of Impervious Area	8.82

Little Juniata 65

Coordinates	
Latitude	40.627946
Longitude	-78.304911
Chapter 93 (designated/ existing) Use	CWF
Drainage Area (miles^2)	75.6
Mean Annual Precipitation (inches)	40
Mean Annual Flow (feet^3/ second)	122
Land Use (percent)	
Forest	75
Urban	12
Carbonate (percent)	7
Average percentage of Impervious Area	5.28

Little Juniata 50

Coordinates	
Latitude	40.662119
Longitude	-78.251038
Chapter 93 (designated/ existing) Use	TSF
Drainage Area ($miles^2$)	106.0
Mean Annual Precipitation (inches)	40
Mean Annual Flow ($feet^3$/ second)	164
Land Use (percent)	
Forest	78
Urban	10
Carbonate (percent)	7
Average percentage of Impervious Area	4.36

Frankstown Branch 85

Coordinates	
Latitude	40.338024
Longitude	-78.3434419
Chapter 93 (designated/ existing) Use	TSF
Drainage Area (miles^2)	45.4
Mean Annual Precipitation (inches)	40
Mean Annual Flow (feet^3/ second)	63.2
Land Use (percent)	
Forest	66
Urban	3
Carbonate (percent)	11
Average percentage of Impervious Area	2.1

Halter Creek 05

Coordinates	
Latitude	40.372317
Longitude	-78.422694
Chapter 93 (designated/ existing) Use	HQ-CWF
Drainage Area (miles^2)	33.1
Mean Annual Precipitation (inches)	40
Mean Annual Flow (feet^3/ second)	37.6
Land Use (percent)	
Forest	32
Urban	5
Carbonate (percent)	66
Average percentage of Impervious Area	4.23

Beaverdam Branch 10

Coordinates	
Latitude	40.422135
Longitude	-78.392031
Chapter 93 (designated/ existing) Use	TSF
Drainage Area (miles^2)	72.4
Mean Annual Precipitation (inches)	40
Mean Annual Flow (feet^3/ second)	124
Land Use (percent)	
Forest	75
Urban	15
Carbonate (percent)	4
Average percentage of Impervious Area	6

Frankstown Branch 50

Coordinates	
Latitude	40.440692
Longitude	-78.355405
Chapter 93 (designated/ existing) Use	WWF
Drainage Area (miles^2)	215
Mean Annual Precipitation (inches)	40
Mean Annual Flow (feet^3/ second)	322
Land Use (percent)	
Forest	65
Urban	10
Carbonate (percent)	16
Average percentage of Impervious Area	4.98

Bells Gap 03

Coordinates	
Latitude	40.599913
Longitude	-78.3336583
Chapter 93 (designated/ existing) Use	TSF
Drainage Area (miles^2)	22.8
Mean Annual Precipitation (inches)	40
Mean Annual Flow (feet^3/ second)	39.3
Land Use (percent)	
Forest	94
Urban	2
Carbonate (percent)	0
Average percentage of Impervious Area	0.41

Latitude and Longitude (Horizontal datum is referenced to the North American Datum 1983, in decimal degrees), Chapter 93 - designated/ existing use (Commonwealth of Pennsylvania, PA Code – Title 25. Environmental Protection, Department of Environmental Protection Chapter 93 (Designated/ Existing Water Use Protected), Drainage Area (miles^2), Mean Annual Precipitation (inches), Mean Annual Flow (feet^3/ second), Land Use (percent) Forest/ Urban, Carbonate (percent), Average percentage of Impervious Area (National Land Cover Database (2011) impervious dataset).

Table 1 - Summary statistics for instantaneous flow and selected water quality constituents, August 2015 through August 2017.

ft^3/s, cubic feet per second; °C, degrees Celsius; mg/L, milligrams per liter; µS/cm, microseimans per centimeter; NTU, Nephelometric Turbidity Unit; ---, not calculated; <, less than; N, number of measurements; Min, minimum; Max, maximum; P25, 25th percetile; P75, 75th percentile.

Spring Run 10

Statistic	Flow (ft^3/s)	Field pH (standard units)	Temperature (°C)	Oxygen, Dissolved (mg/L)	Specific Conductance (µS/Cm at 25°C)	Turbidity (NTU)	Nitrate (mg/L)	Phosphorus (mg/L)
N	24	33	38	32	34	17	10	10
Min	0.29	7.07	0.02	8.26	0.00	2.80	0.07	0.01
Max	69.05	9.70	24.44	15.31	718.30	16.60	0.43	0.04
Mean	9.65	8.12	13.41	10.78	361.43	5.29	0.24	0.02
P25	0.29	7.15	0.02	8.32	206.20	2.80	0.07	0.01
Median	3.44	8.20	13.56	10.58	350.40	4.00	0.26	0.02
P75	7.88	8.45	19.83	12.43	424.49	5.20	0.32	0.03

Statistic	Sulfate (mg/L)	Chloride (mg/L)	Suspended Sediment (mg/L)	Hardness (mg/L)	Calcium (mg/L)	Mangnesium (mg/L)	Iron (mg/L)	Aluminum (mg/L)
N	14	11	11	11	11	11	11	11
Min	14.00	27.00	< 5.00	53.90	#REF!	4.60	0.04	< 0.1
Max	26.00	75.00	< 5.00	152.00	40.00	12.70	0.21	0.20
Mean	17.93	46.27	6.00	91.62	24.65	7.30	0.08	0.10
P25	14.00	27.00	6.00	53.90	14.00	4.60	0.05	0.10
Median	16.00	45.00	6.00	74.50	20.20	5.80	0.09	0.15
P75	19.50	57.50	6.00	123.50	34.15	9.35	0.14	0.18

Statistic	Manganesse (mg/L)	Lead (mg/L)	Copper (mg/L)	Arsenic (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Zinc (mg/L)	Mercury (mg/L)
N	11	11	11	11	11	11	11	11
Min	< 0.01	< 0.001	< 0.01	< 0.001	< 0.002	< 0.01	< 0.01	< 0.0002
Max	0.01	< 0.001	< 0.01	0.0011	< 0.002	< 0.01	0.030	< 0.0002
Mean	< 0.01	< 0.001	< 0.01	< 0.001	< 0.002	< 0.01	0.017	< 0.0002
P25	< 0.01	---	---	---	---	---	---	---
Median	< 0.01	< 0.001	< 0.01	< 0.001	< 0.002	< 0.01	0.010	< 0.0002
P75	0.01	---	---	---	---	---	---	---

Table 2 - Summary statistics for instantaneous flow and selected water quality constituents, August 2015 through August 2017.

ft^3/s, cubic feet per second; °C, degrees Celsius; mg/L, milligrams per liter; µS/cm, microseimans per centimeter; NTU, Nephelometric Turbidity Unit; ---, not calculated; <, less than; N, number of measurements; Min, minimum; Max, maximum; P25, 25th percetile; P75, 75th percentile.

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Statistic	Flow (ft^3/s)	Field pH (standard units)	Temperature (°C)	Oxygen, Dissolved (mg/L)	Specific Conductance (µS/Cm at 25°C)	Turbidity (NTU)	Nitrate (mg/L)	Phosphorus (mg/L)
N	13	29	30	28	29	26	12	12
Min	7.23	6.93	2.4	8.5	188.2	2.9	0.4	0.0
Max	110.41	8.81	24.5	14.8	567.2	28.3	1.9	0.4
Mean	32.51	7.86	13.5	11.4	399.5	7.6	1.0	0.2
P25	9.57	7.70	7.9	9.4	290.4	5.0	0.7	0.1
Median	19.01	7.78	14.4	11.4	394.2	6.2	1.0	0.2
P75	49.84	8.09	18.2	12.9	504.4	8.5	1.4	0.2

Statistic	Sulfate (mg/L)	Chloride (mg/L)	Suspended Sediment (mg/L)	Hardness (mg/L)	Calcium (mg/L)	Mangnesium (mg/L)	Iron (mg/L)	Aluminum (mg/L)
N	12	12	12	12	12	12	12	12
Min	19.00	26.00	< 5.00	66.80	18.70	4.90	0.10	< 0.1
Max	38.00	77.00	17.00	177.00	50.20	12.60	0.68	0.40
Mean	27.92	47.92	< 5.00	124.15	35.77	8.47	0.20	0.25
P25	22.00	34.75	---	92.33	26.53	6.40	0.13	---
Median	24.00	40.00	< 5.00	117.00	35.20	7.05	0.16	< 0.1
P75	35.50	61.25	---	156.75	44.95	10.80	0.19	---

Statistic	Manganesse (mg/L)	Lead (mg/L)	Copper (mg/L)	Arsenic (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Zinc (mg/L)	Mercury (mg/L)
N	12	12	12	12	12	12	12	12
Min	0.02	< 0.001	< 0.01	< 0.001	< 0.002	< 0.01	< 0.01	<0.0002
Max	0.06	0.0032	< 0.01	0.0011	< 0.002	< 0.01	0.030	<0.0002
Mean	0.03	0.0018	< 0.01	< 0.001	< 0.002	< 0.01	0.017	<0.0002
P25	0.03	---	---	---	---	---	---	---
Median	0.03	< 0.001	< 0.01	< 0.001	< 0.002	< 0.01	0.010	<0.0002
P75	0.04	---	---	---	---	---	---	---

Table 3 - Summary statistics for instantaneous flow and selected water quality constituents, August 2015 through August 2017.

ft^3/s, cubic feet per second; °C, degrees Celsius; mg/L, milligrams per liter; µS/cm, microseimans per centimeter; NTU, Nephelometric Turbidity Unit; ---, not calculated; <, less than; N, number of measurements; Min, minimum; Max, maximum; P25, 25th percetile; P75, 75th percentile.

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Statistic	Flow (ft^3/s)	Field pH (standard units)	Temperature (°C)	Oxygen, Dissolved (mg/L)	Specific Conductance (µS/Cm at 25°C)	Turbidity (NTU)	Nitrate (mg/L)	Phosphorus (mg/L)
N	13	31	33	31	31	30	12	12
Min	49.84	8.09	18.23	9.42	504.40	8.50	1.45	0.02
Max	237.33	9.80	24.81	16.18	501.60	19.44	1.23	0.20
Mean	59.40	8.48	13.42	12.46	317.40	6.34	0.64	0.10
P25	15.05	8.21	5.75	10.44	228.65	4.43	0.42	0.06
Median	29.84	8.49	13.32	12.37	288.00	5.65	0.64	0.10
P75	74.26	8.78	20.51	14.26	430.65	6.91	0.78	0.13

Statistic	Sulfate (mg/L)	Chloride (mg/L)	Suspended Sediment (mg/L)	Hardness (mg/L)	Calcium (mg/L)	Mangnesium (mg/L)	Iron (mg/L)	Aluminum (mg/L)
N	12	12	12	12	12	12	12	12
Min	35.50	61.25	< 5.00	52.20	44.95	10.80	0.19	< 0.1
Max	39.00	58.00	9.00	171.00	48.80	12.10	0.34	0.20
Mean	26.92	35.25	< 5.00	108.56	30.93	7.61	0.14	< 0.1
P25	21.75	24.00	---	75.03	21.30	5.40	0.09	---
Median	23.50	28.00	< 5.00	102.25	30.25	6.50	0.13	< 0.1
P75	35.25	54.00	---	151.75	42.53	10.88	0.16	---

Statistic	Manganesse (mg/L)	Lead (mg/L)	Copper (mg/L)	Arsenic (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Zinc (mg/L)	Mercury (mg/L)
N	12	12	12	12	12	12	12	12
Min	< 0.01	< 0.001	< 0.01	< 0.001	< 0.002	< 0.01	< 0.01	< 0.0002
Max	0.04	0.001	< 0.01	< 0.001	< 0.002	< 0.01	0.01	< 0.0002
Mean	0.02	< 0.001	< 0.01	< 0.001	< 0.002	< 0.01	< 0.01	< 0.0002
P25	---	---	---	---	---	---	---	---
Median	0.02	< 0.001	< 0.01	< 0.001	< 0.002	< 0.01	< 0.01	< 0.0002
P75	---	---	---	---	---	---	---	---

Table 4 - Summary statistics for instantaneous flow and selected water quality constituents, August 2015 through August 2017.

ft^3/s, cubic feet per second; °C, degrees Celsius; mg/L, milligrams per liter; µS/cm, microseimans per centimeter; NTU, Nephelometric Turbidity Unit; ---, not calculated; <, less than; N, number of measurements; Min, minimum; Max, maximum; P25, 25th percetile; P75, 75th percentile.

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Statistic	Flow (ft^3/s)	Field pH (standard units)	Temperature (°C)	Oxygen, Dissolved (mg/L)	Specific Conductance (µS/Cm at 25°C)	Turbidity (NTU)	Nitrate (mg/L)	Phosphorus (mg/L)
N	15	28	30	28	28	24	12	12
Min	16.60	7.42	0.01	9.50	143.70	2.90	0.12	0.02
Max	379.71	9.59	25.43	16.26	462.80	17.80	0.81	0.14
Mean	82.32	8.55	13.82	12.63	283.35	6.19	0.43	0.07
P25	23.43	8.16	7.09	10.90	199.78	4.45	0.30	0.04
Median	47.99	8.59	14.57	12.15	264.20	5.29	0.36	0.08
P75	105.63	8.92	20.00	14.13	331.48	6.74	0.62	0.12

Statistic	Sulfate (mg/L)	Chloride (mg/L)	Suspended Sediment (mg/L)	Hardness (mg/L)	Calcium (mg/L)	Mangnesium (mg/L)	Iron (mg/L)	Aluminum (mg/L)
N	12	12	3	12	12	12	11	2
Min	15.00	11.00	5.00	45.30	12.40	3.50	0.06	0.10
Max	36.00	51.00	10.00	161.00	48.80	11.40	0.27	0.20
Mean	25.17	29.50	7.00	99.70	28.72	6.93	0.13	0.15
P25	19.00	20.25	5.50	64.35	18.13	4.68	0.07	0.13
Median	23.00	24.00	6.00	96.20	28.45	6.05	0.11	0.15
P75	33.25	43.50	8.00	143.50	40.73	9.98	0.16	0.18

Statistic	Manganesse (mg/L)	Lead (mg/L)	Copper (mg/L)	Arsenic (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Zinc (mg/L)	Mercury (mg/L)
N	8	8	8	8	8	8	8	8
Min	0.01	< 0.001	< 0.01	< 0.001	< 0.002	< 0.01	< 0.01	< 0.0002
Max	0.04	< 0.001	< 0.01	< 0.001	< 0.002	< 0.01	< 0.01	< 0.0002
Mean	0.03	< 0.001	< 0.01	< 0.001	< 0.002	< 0.01	< 0.01	< 0.0002
P25	0.02	---	---	---	---	---	---	---
Median	0.03	< 0.001	< 0.01	< 0.001	< 0.002	< 0.01	< 0.01	< 0.0002
P75	0.03	---	---	---	---	---	---	---

Table 6 - Summary statistics for instantaneous flow and selected water quality constituents, October 2016 through August 2017

ft^3/s, cubic feet per second; °C, degrees Celsius; mg/L, milligrams per liter; µS/cm, microseimans per centimeter; NTU, Nephelometric Turbidity Unit; ---, not calculated; <, less than; N, number of measurements; Min, minimum; Max, maximum; P25, 25th percetile; P75, 75th percentile.

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Statistic	Flow (ft^3/s)	Field pH (standard units)	Temperature (°C)	Oxygen, Dissolved (mg/L)	Specific Conductance (µS/Cm at 25°C)	Turbidity (NTU)	Nitrate (mg/L)	Phosphorus (mg/L)
N	7	8	8	8	8	6	7	7
Min	19.85	8.02	2.90	9.72	184.10	3.20	0.89	0.02
Max	93.37	9.42	22.24	16.06	414.50	8.00	1.37	0.32
Mean	45.17	8.82	9.68	13.37	284.95	5.27	1.18	0.10
P25	23.15	8.56	4.07	11.95	208.10	3.93	1.09	0.03
Median	28.45	8.91	6.81	13.86	277.60	5.00	1.19	0.07
P75	64.11	9.17	12.09	15.16	354.80	6.38	1.34	0.13

Statistic	Sulfate (mg/L)	Chloride (mg/L)	Suspended Sediment (mg/L)	Hardness (mg/L)	Calcium (mg/L)	Mangnesium (mg/L)	Iron (mg/L)	Aluminum (mg/L)
N	7	7	7	7	7	7	7	7
Min	14.00	13.00	< 5.00	67.80	19.00	4.80	< 0.05	< 0.1
Max	36.00	28.00	9.00	165.00	47.00	11.70	0.20	0.10
Mean	23.14	18.86	< 5.00	117.10	33.30	8.27	0.05	< 0.1
P25	15.50	15.00	---	71.95	20.05	5.40	---	---
Median	24.00	17.00	< 5.00	128.00	37.80	8.20	0.06	< 0.1
P75	28.50	22.00	---	157.50	44.60	11.20	---	---

Statistic	Manganesse (mg/L)	Lead (mg/L)	Copper (mg/L)	Arsenic (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Zinc (mg/L)	Mercury (mg/L)
N	7	7	7	7	7	7	7	7
Min	< 0.01	< 0.001	< 0.01	< 0.001	< 0.002	< 0.01	< 0.01	< 0.0002
Max	0.02	< 0.001	< 0.01	0.0011	< 0.002	< 0.01	0.030	< 0.0002
Mean	< 0.01	< 0.001	< 0.01	< 0.001	< 0.002	< 0.01	0.017	< 0.0002
P25	---	---	---	---	---	---	---	---
Median	< 0.01	< 0.001	< 0.01	< 0.001	< 0.002	< 0.01	0.010	< 0.0002
P75	---	---	---	---	---	---	---	---

Table 7 - Summary statistics for instantaneous flow and selected water quality constituents, October 2016 through August 2017

ft^3/s, cubic feet per second; °C, degrees Celsius; mg/L, milligrams per liter; µS/cm, microseimans per centimeter; NTU, Nephelometric Turbidity Unit; ---, not calculated; <, less than; N, number of measurements; Min, minimum; Max, maximum; P25, 25th percetile; P75, 75th percentile.

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Statistic	Flow (ft^3/s)	Field pH (standard units)	Temperature (°C)	Oxygen, Dissolved (mg/L)	Specific Conductance (µS/Cm at 25°C)	Turbidity (NTU)	Nitrate (mg/L)	Phosphorus (mg/L)
N	6	12	12	12	12	10	7	7
Min	17.37	8.30	3.77	9.35	347.10	3.54	3.90	0.02
Max	31.10	9.09	20.51	16.58	831.10	6.90	7.29	0.05
Mean	23.67	8.67	9.00	13.01	649.24	5.11	5.26	0.03
P25	19.58	8.53	5.07	11.41	569.25	4.31	4.01	0.02
Median	23.27	8.69	7.34	13.37	677.60	4.95	5.20	0.03
P75	27.31	8.81	10.35	14.37	773.58	6.05	6.22	0.05

Statistic	Sulfate (mg/L)	Chloride (mg/L)	Suspended Sediment (mg/L)	Hardness (mg/L)	Calcium (mg/L)	Mangnesium (mg/L)	Iron (mg/L)	Aluminum (mg/L)
N	7	7	7	7	7	7	7	7
Min	30.00	28.00	< 5.00	205.00	54.70	16.60	< 0.05	< 0.1
Max	110.00	58.00	9.00	391.00	97.40	35.90	0.16	0.10
Mean	54.57	44.00	< 5.00	250.50	74.93	26.09	0.09	< 0.1
P25	41.50	40.00	---	250.50	65.90	20.80	---	---
Median	45.00	43.00	< 5.00	319.00	78.40	28.20	0.06	< 0.1
P75	57.00	49.50	---	323.00	81.10	30.15	---	---

Statistic	Manganesse (mg/L)	Lead (mg/L)	Copper (mg/L)	Arsenic (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Zinc (mg/L)	Mercury (mg/L)
N	7	11	11	11	11	11	11	11
Min	< 0.01	< 0.001	< 0.01	< 0.001	< 0.002	< 0.01	< 0.01	< 0.0002
Max	0.01	< 0.001	< 0.01	0.0011	< 0.002	< 0.01	< 0.01	< 0.0002
Mean	< 0.01	< 0.001	< 0.01	< 0.001	< 0.002	< 0.01	< 0.01	< 0.0002
P25	---	---	---	---	---	---	---	---
Median	< 0.01	< 0.001	< 0.01	< 0.001	< 0.002	< 0.01	0.010	< 0.0002
P75	---	---	---	---	---	---	---	---

Table 8 - Summary statistics for instantaneous flow and selected water quality constituents, October 2016 through August 2017

ft^3/s, cubic feet per second; °C, degrees Celsius; mg/L, milligrams per liter; µS/cm, microseimans per centimeter; NTU, Nephelometric Turbidity Unit; ---, not calculated; <, less than; N, number of measurements; Min, minimum; Max, maximum; P25, 25th percetile; P75, 75th percentile.

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Statistic	Flow (ft^3/s)	Field pH (standard units)	Temperature (°C)	Oxygen, Dissolved (mg/L)	Specific Conductance (µS/Cm at 25°C)	Turbidity (NTU)	Nitrate (mg/L)	Phosphorus (mg/L)
N	6	11	11	11	11	9	7	7
Min	37.70	7.51	1.73	8.42	345.60	2.40	0.66	0.02
Max	177.82	8.13	21.56	14.75	737.40	7.60	1.21	0.26
Mean	85.74	7.75	8.05	12.34	491.75	5.70	0.82	0.10
P25	49.02	7.57	3.99	11.85	376.10	5.08	0.73	0.03
Median	58.93	7.78	6.22	12.60	429.40	5.70	0.80	0.07
P75	116.24	7.86	8.28	13.29	585.60	6.40	0.82	0.16

Statistic	Sulfate (mg/L)	Chloride (mg/L)	Suspended Sediment (mg/L)	Hardness (mg/L)	Calcium (mg/L)	Mangnesium (mg/L)	Iron (mg/L)	Aluminum (mg/L)
N	7	7	7	7	7	7	7	7
Min	48.00	33.00	< 5.00	109.00	27.40	9.80	0.13	0.20
Max	116.00	50.00	8.00	238.00	59.30	21.90	1.03	0.60
Mean	85.43	41.57	6.00	168.14	42.06	15.31	0.49	0.34
P25	60.50	37.50	---	115.50	28.65	10.65	0.17	0.20
Median	103.00	41.00	< 5.00	182.00	45.30	16.80	0.41	0.30
P75	105.00	46.00	---	208.50	52.55	18.70	0.77	0.45

Statistic	Manganesse (mg/L)	Lead (mg/L)	Copper (mg/L)	Arsenic (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Zinc (mg/L)	Mercury (mg/L)
N	7	11	11	11	11	11	7	11
Min	0.53	< 0.001	< 0.01	< 0.001	< 0.002	< 0.01	< 0.01	< 0.0002
Max	0.76	<0.001	< 0.01	0.0011	< 0.002	< 0.01	0.030	< 0.0002
Mean	0.66	<0.001	< 0.01	< 0.001	< 0.002	< 0.01	0.017	< 0.0002
P25	0.60	---	---	---	---	---	---	---
Median	0.65	< 0.001	< 0.01	< 0.001	< 0.002	< 0.01	0.020	< 0.0002
P75	0.74	---	---	---	---	---	---	---

Table 9 - Summary statistics for instantaneous flow and selected water quality constituentss, October 2016 through August 2017

ft^3/s, cubic feet per second; °C, degrees Celsius; mg/L, milligrams per liter; µS/cm, microseimans per centimeter; NTU, Nephelometric Turbidity Unit; ---, not calculated; <, less than; N, number of measurements; Min, minimum; Max, maximum; P25, 25th percetile; P75, 75th percentile.

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Statistic	Flow (ft^3/s)	Field pH (standard units)	Temperature (°C)	Oxygen, Dissolved (mg/L)	Specific Conductance (µS/Cm at 25°C)	Turbidity (NTU)	Nitrate (mg/L)	Phosphorus (mg/L)
N	6	11	11	11	11	9	7	7
Min	106.35	7.77	2.06	6.55	292.30	4.90	1.31	0.04
Max	386.22	9.30	22.94	18.41	820.40	10.90	1.96	0.40
Mean	207.89	8.16	8.88	12.29	517.45	6.60	1.60	0.18
P25	118.70	7.88	4.93	11.14	368.95	5.20	1.44	0.05
Median	170.15	7.97	6.28	12.61	529.10	6.20	1.51	0.18
P75	277.21	8.17	9.12	13.36	636.25	6.90	1.79	0.27

Statistic	Sulfate (mg/L)	Chloride (mg/L)	Suspended Sediment (mg/L)	Hardness (mg/L)	Calcium (mg/L)	Mangnesium (mg/L)	Iron (mg/L)	Aluminum (mg/L)
N	7	7	7	7	7	7	7	7
Min	34.00	33.00	< 5.00	106.00	28.20	8.70	0.08	< 0.1
Max	107.00	86.00	9.00	236.00	64.50	18.10	0.43	0.20
Mean	70.14	50.29	< 5.00	178.00	48.17	14.03	0.25	0.18
P25	43.50	35.00	---	120.00	32.65	9.40	0.18	---
Median	72.00	41.00	< 5.00	214.00	57.00	17.20	0.22	0.20
P75	95.50	61.00	---	225.00	61.10	17.70	0.35	---

Statistic	Manganesse (mg/L)	Lead (mg/L)	Copper (mg/L)	Arsenic (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Zinc (mg/L)	Mercury (mg/L)
N	7	7	7	7	7	7	7	7
Min	0.11	< 0.001	< 0.01	< 0.001	< 0.002	< 0.01	< 0.01	< 0.0002
Max	0.29	< 0.001	< 0.01	0.0018	< 0.002	< 0.01	0.020	< 0.0002
Mean	0.20	< 0.001	< 0.01	< 0.001	< 0.002	< 0.01	0.010	< 0.0002
P25	0.17	---	---	---	---	---	---	---
Median	0.20	< 0.001	< 0.01	< 0.001	< 0.002	< 0.01	0.010	< 0.0002
P75	0.23	---	---	---	---	---	---	---

Table 5 - Summary statistics for instantaneous flow and selected water quality constituents, January 2017 through August 2017.

ft^3/s, cubic feet per second; °C, degrees Celsius; mg/L, milligrams per liter; µS/cm, microseimans per centimeter; NTU, Nephelometric Turbidity Unit; ---, not calculated; <, less than; N, number of measurements; Min, minimum; Max, maximum; P25, 25th percetile; P75, 75th percentile.

Bells Gap Run 03

Statistic	Flow (ft^3/s)	Field pH (standard units)	Temperature (°C)	Oxygen, Dissolved (mg/L)	Specific Conductance (µS/Cm at 25°C)	Turbidity (NTU)	Nitrate (mg/L)	Phosphorus (mg/L)
N	3	3	3	3	3	1	2	2
Min	3.71	7.42	4.50	8.52	68.50	5.20	0.08	< 0.01
Max	66.72	7.60	22.09	13.19	77.60	5.20	0.21	< 0.01
Mean	32.43	7.49	15.61	10.12	72.83	5.20	0.15	< 0.01
P25	15.29	7.44	12.37	8.59	70.45	5.20	0.11	---
Median	26.87	7.50	20.23	99.10	72.40	---	---	---
P75	46.79	7.53	21.16	10.93	75.00	5.20	0.18	---

Statistic	Sulfate (mg/L)	Chloride (mg/L)	Suspended Sediment (mg/L)	Hardness (mg/L)	Calcium (mg/L)	Mangnesium (mg/L)	Iron (mg/L)	Aluminum (mg/L)
N	2	2	2	2	2	2	2	2
Min	13.00	3.00	< 5.00	21.20	5.30	1.90	< 0.5	< 0.1
Max	15.00	5.00	< 5.00	27.10	7.20	2.20	0.13	< 0.1
Mean	14.00	4.00	< 5.00	24.15	6.25	2.05	---	< 0.1
P25	13.50	3.50	---	22.68	5.78	1.98	---	---
Median	---	---	---	---	---	---	---	---
P75	14.50	4.50	---	25.63	6.73	2.13	---	---

Statistic	Manganesse (mg/L)	Lead (mg/L)	Copper (mg/L)	Arsenic (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Zinc (mg/L)	Mercury (mg/L)
N	2	2	2	2	2	2	2	2
Min	0.02	< 0.001	< 0.01	< 0.001	< 0.002	< 0.01	< 0.01	< 0.0002
Max	0.03	< 0.001	< 0.01	0.0011	< 0.002	< 0.01	< 0.01	< 0.0002
Mean	0.25	< 0.001	< 0.01	< 0.001	< 0.002	< 0.01	< 0.01	< 0.0002
P25	0.02	---	---	---	---	---	---	---
Median	---	---	---	---	---	---	---	---
P75	0.03	---	---	---	---	---	---	---

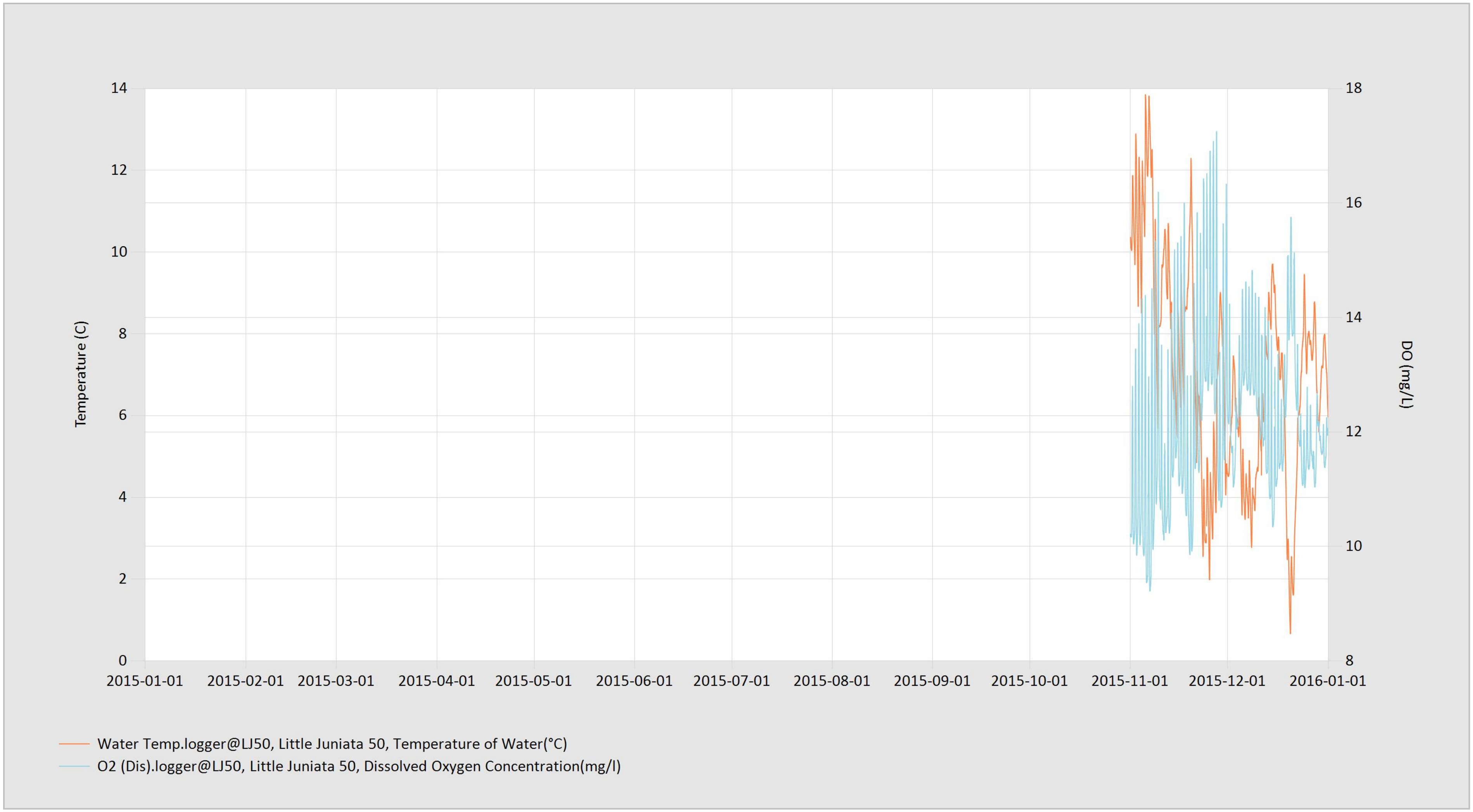
Data Plot Report

LJ65_Temperature_Vs_DO

Nov 22, 2017 | 1 of 3

2015

Period Selected: 2015-11-01 00:00:00 - 2017-06-25 00:00:00

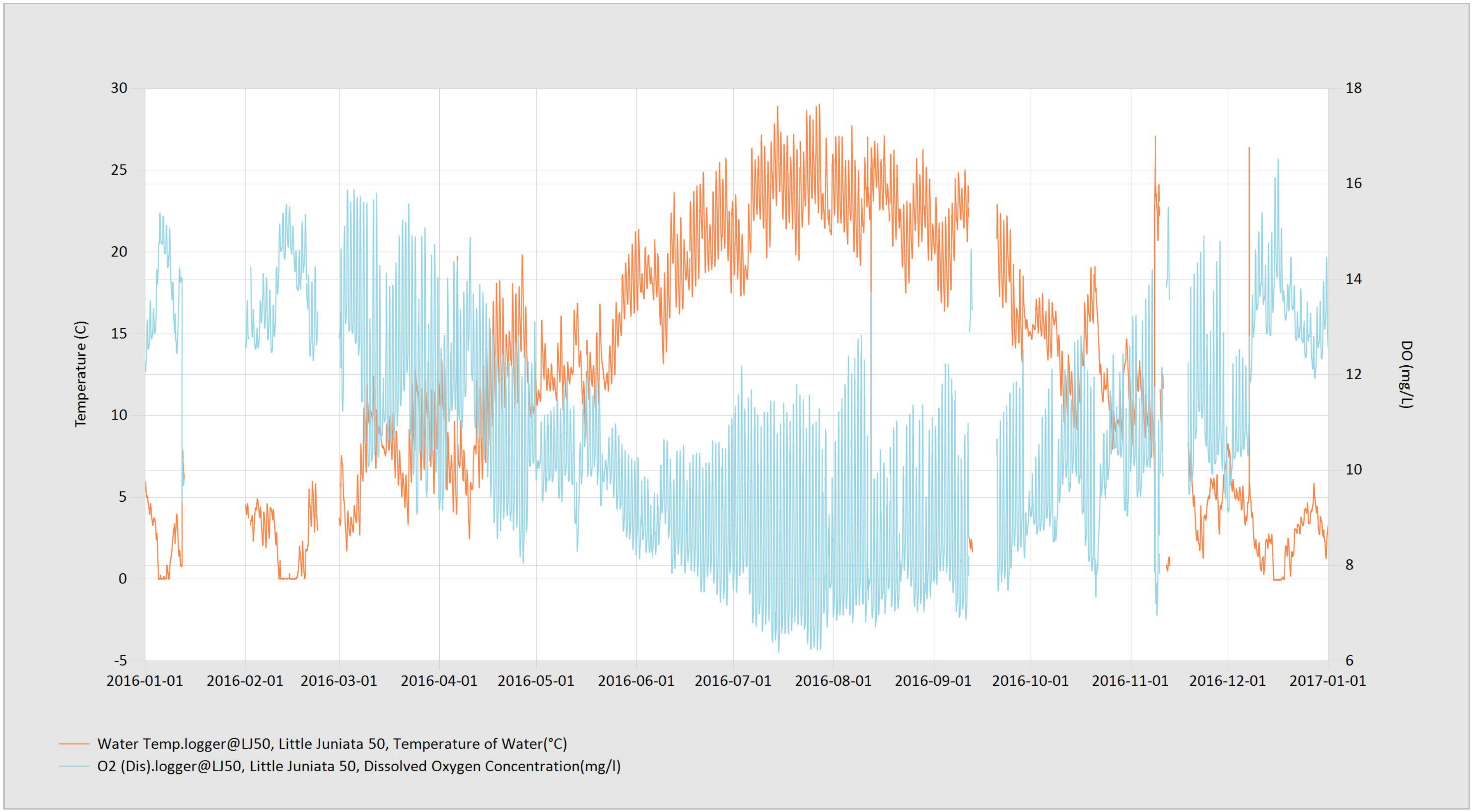


Data Plot Report

LJ65_Temperature_Vs_DO

2016

Period Selected: 2015-11-01 00:00:00 - 2017-06-25 00:00:00

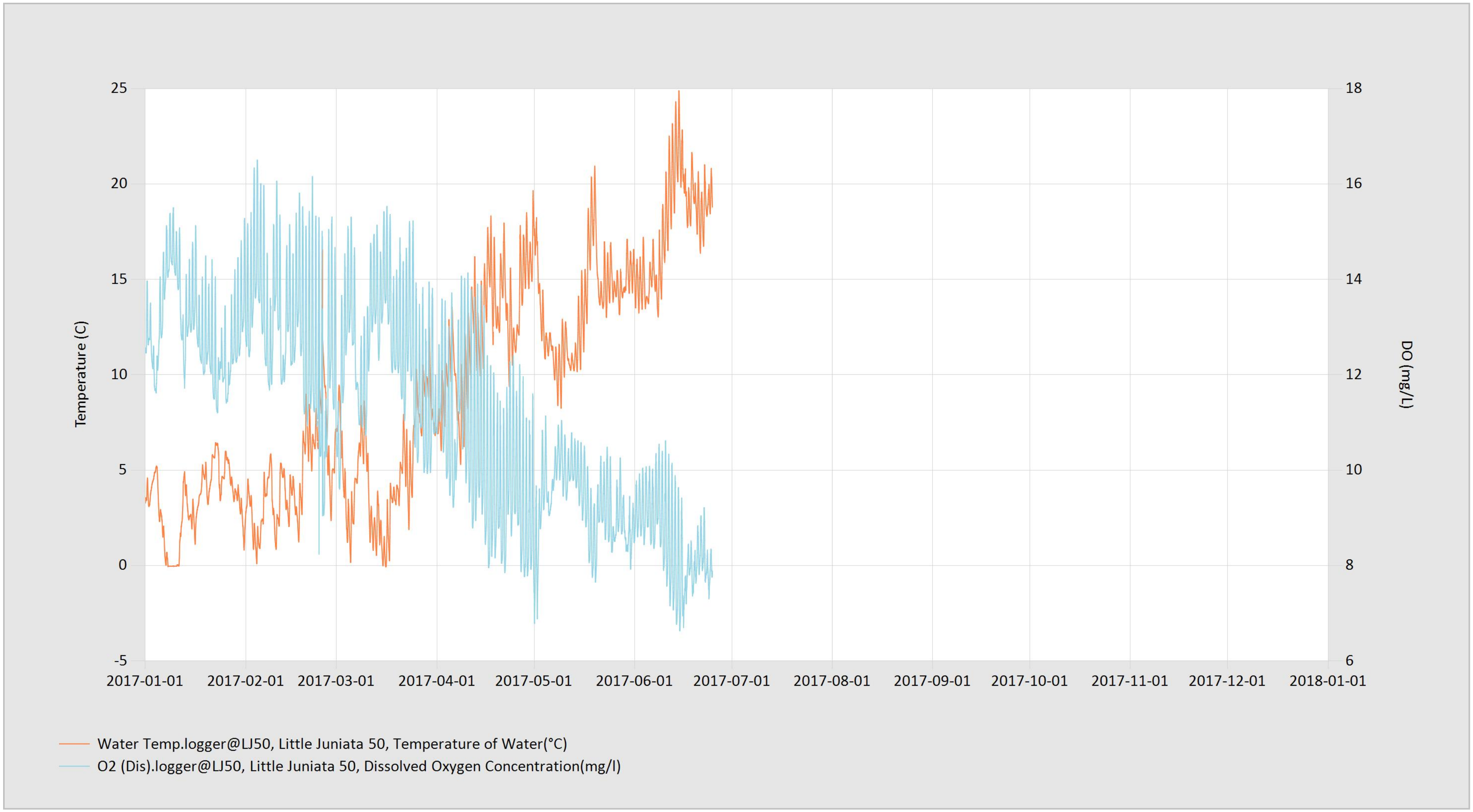


Data Plot Report

LJ65_Temperature_Vs_DO

2017

Period Selected: 2015-11-01 00:00:00 - 2017-06-25 00:00:00



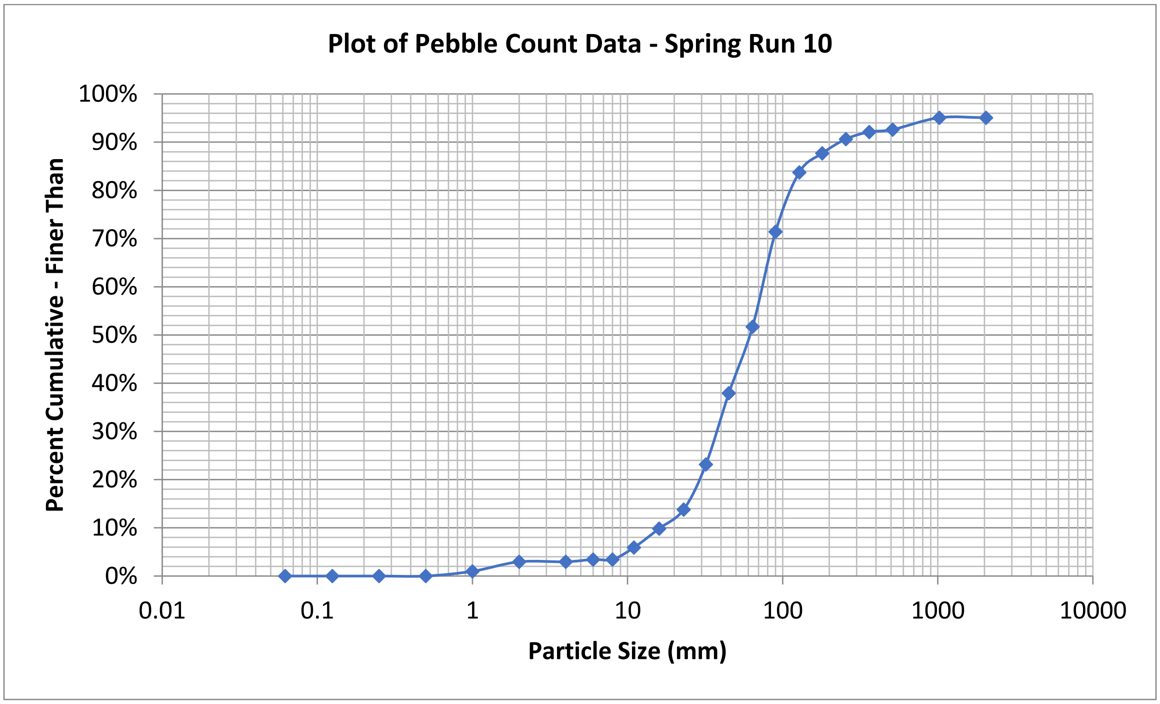
Appendix D - Habitat Assessment Scores by Parameter

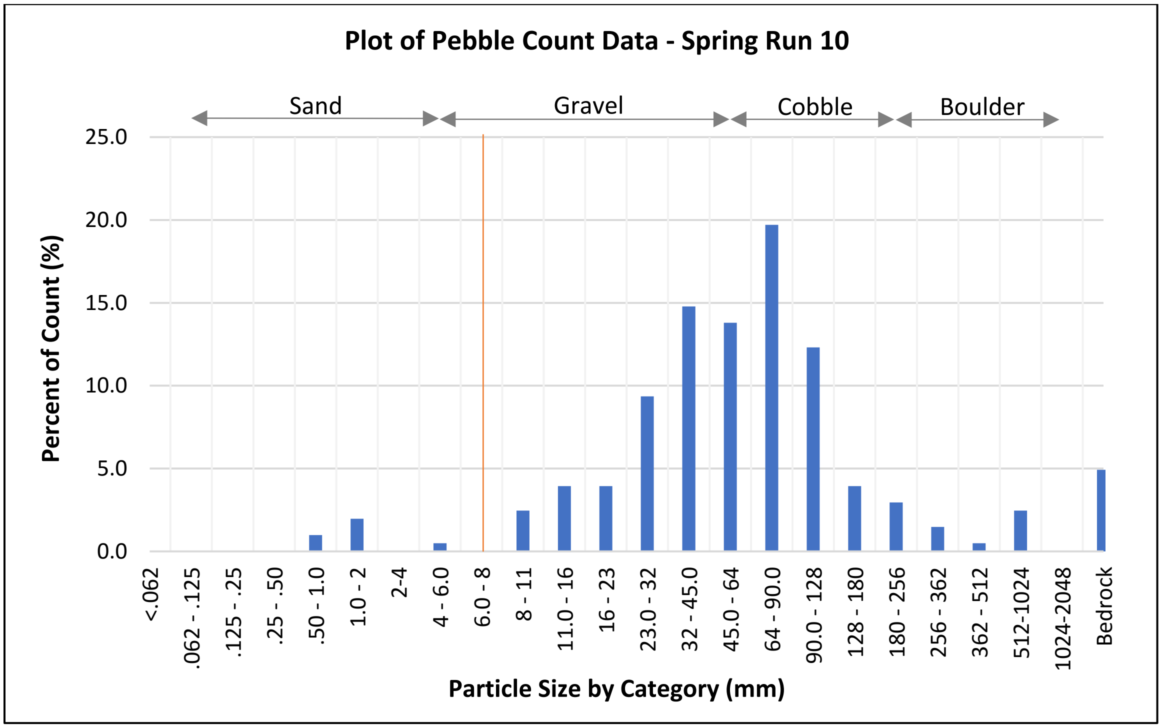
Form Completed: 9/15/2017
Completed by: James Eckenrode

Site	Date	Time	Instream Fish Cover	Epifanual Substrate	Embeddedness	Velocity/ Depth Regimes	Channel Alterations	Sediment Deposition	Frequency of Riffles	Channel Flow Status	Condition of Banks	Bank Vegetative Protection	Disruptive Pressure	Riparian Vegetative Zone Width	Total Points	Condition
Frankstown Branch 85	08/17/17	12:25	14	19	20	18	13	17	18	17	14	16	11	6	183	Suboptimal
Halter Creek 05	08/17/17	10:46	16	19	18	19	18	17	19	20	19	20	18	14	217	Optimal
Beaverdam Branch 10	08/11/17	14:10	16	14	18	16	15	13	9	18	14	13	13	13	172	Suboptimal
Frankstown Branch 50	08/11/17	14:45	8	16	19	14	17	17	10	18	15	14	19	17	184	Suboptimal
Spring Run 10	08/08/17	15:03	17	19	19	7	14	20	19	10	15	14	12	5	171	Suboptimal
Little Juniata 85	08/17/17	13:09	14	17	16	17	17	14	16	19	12	17	19	17	195	Optimal
Little Juniata 65	08/17/17	14:00	15	14	15	15	19	18	16	19	20	19	20	14	204	Optimal
Little Juniata 50	08/17/17	14:38	14	19	20	14	20	18	19	14	19	20	20	20	217	Optimal
Bells Gap 03	08/17/17	13:35	18	19	18	15	19	16	19	14	18	18	17	15	206	Optimal
Frankstown Branch Watershed - Average			13.5	17.0	18.8	16.8	15.8	16.0	14.0	18.3	15.5	15.8	15.3	12.5	189.0	Suboptimal
Little Juniata River Watershed - Average			15.6	17.6	17.6	13.6	17.8	17.2	17.8	15.2	16.8	17.6	17.6	14.2	198.6	Optimal

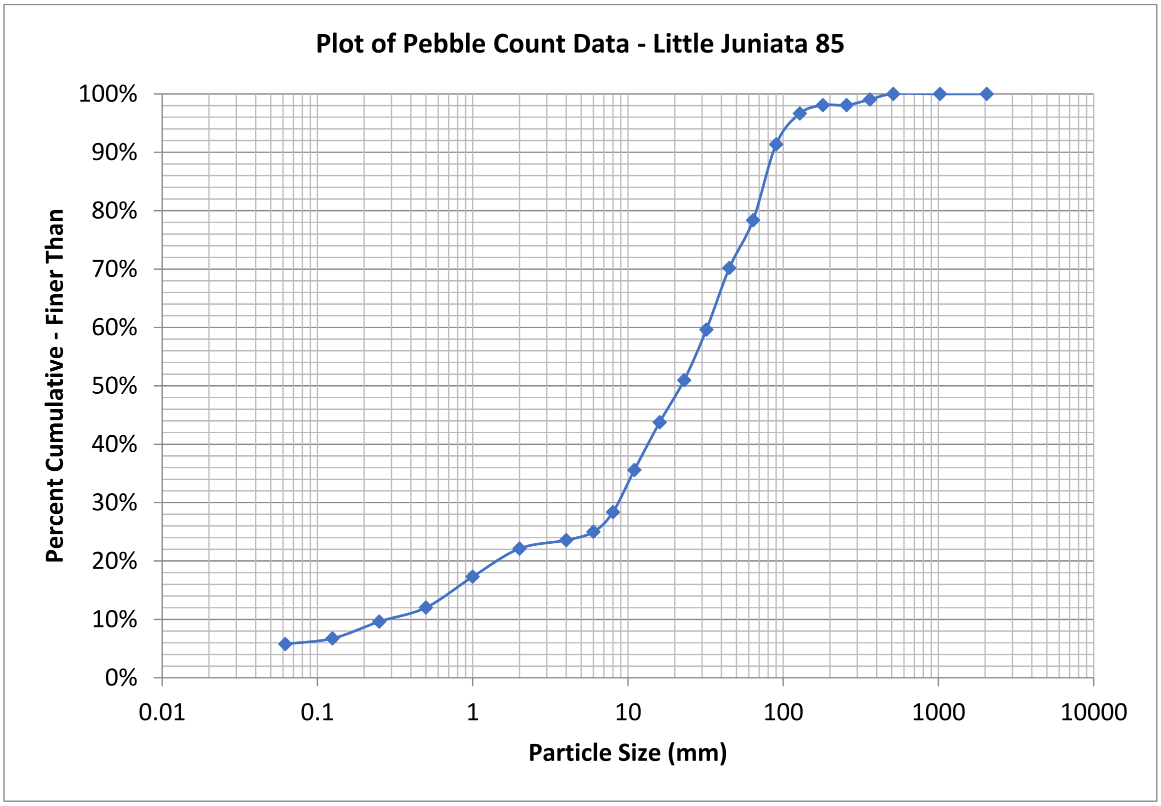
Appendix E

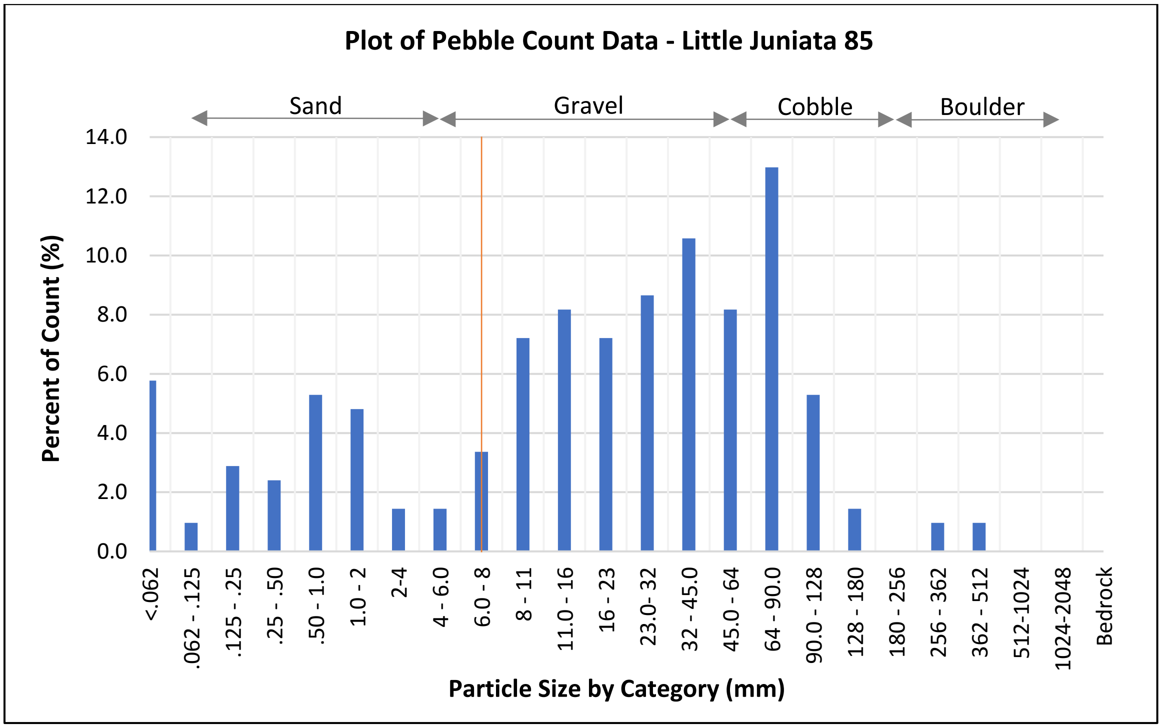
Particle Size Distribution Graphs and Particle Size by Category Frequency Graphs for Spring Run 10



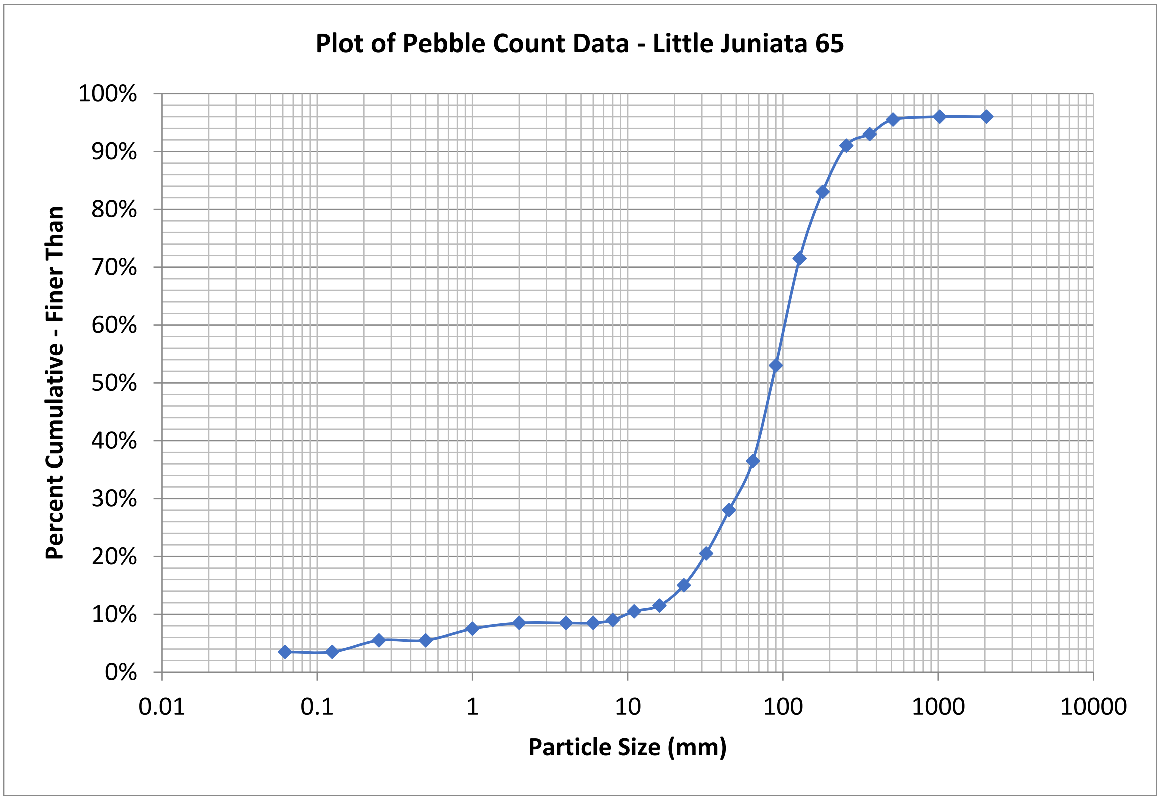


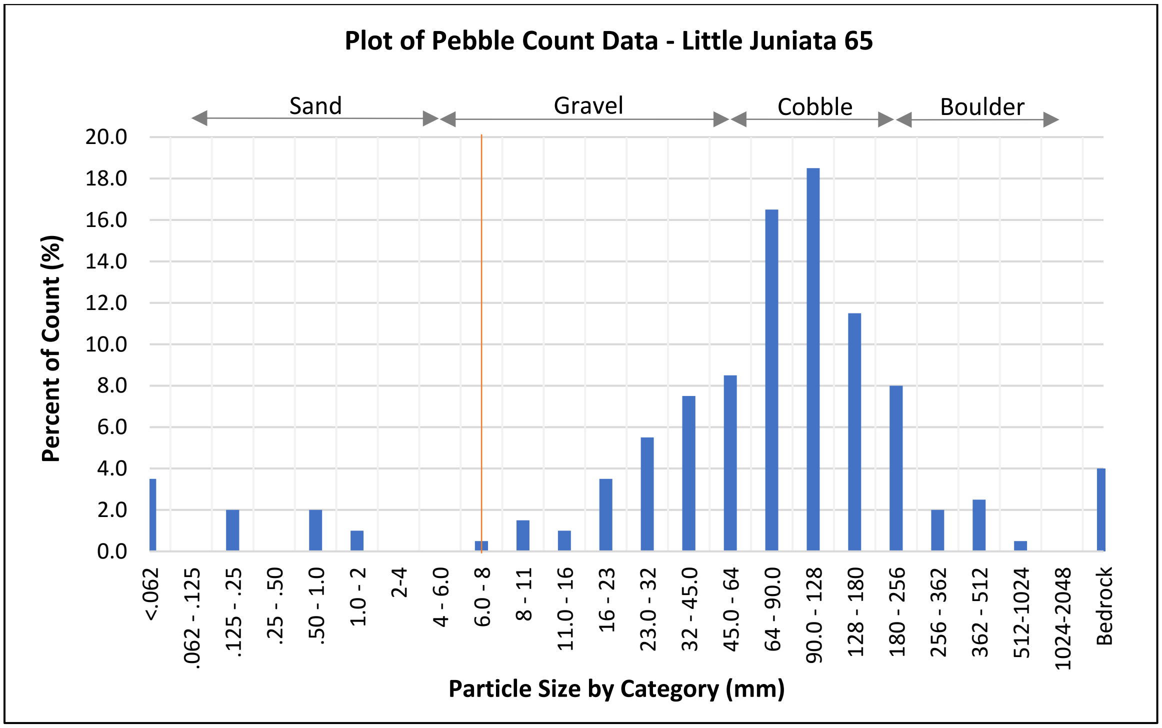
Particle Size Distribution Graphs and Particle Size by Category Frequency Graphs for Little Juniata 85



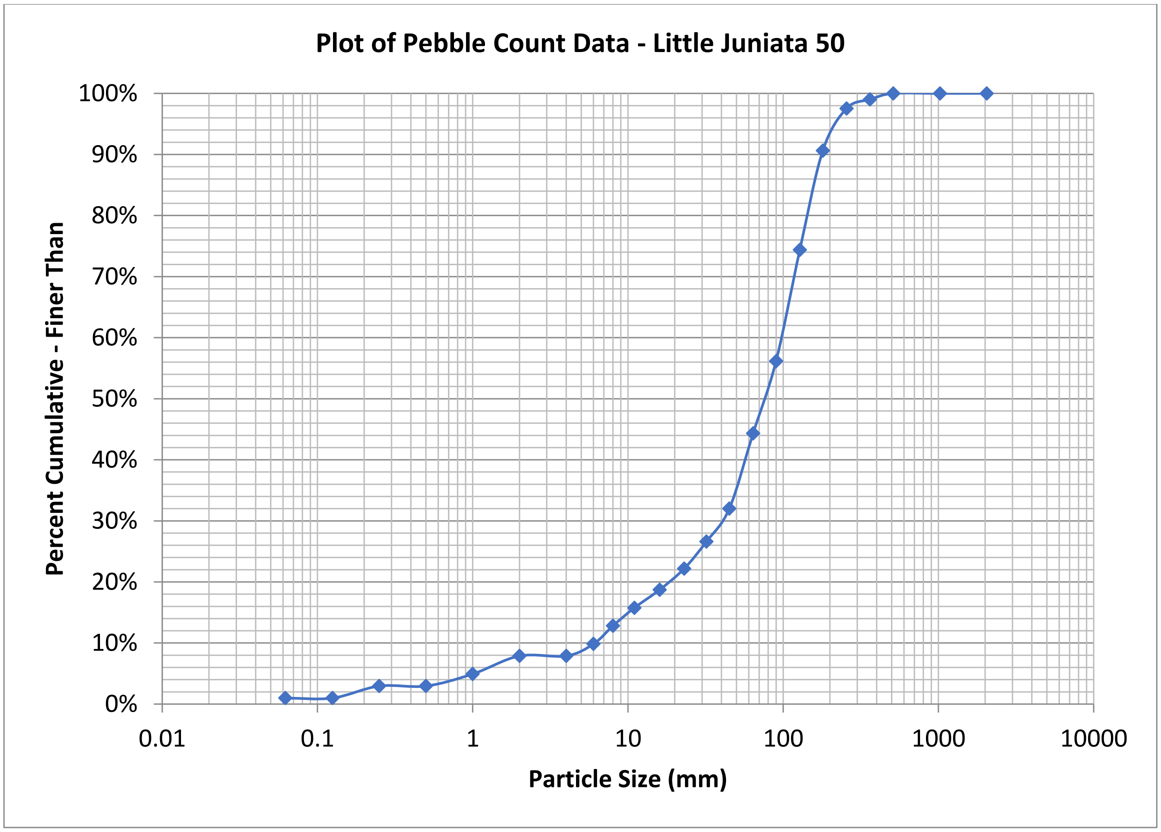


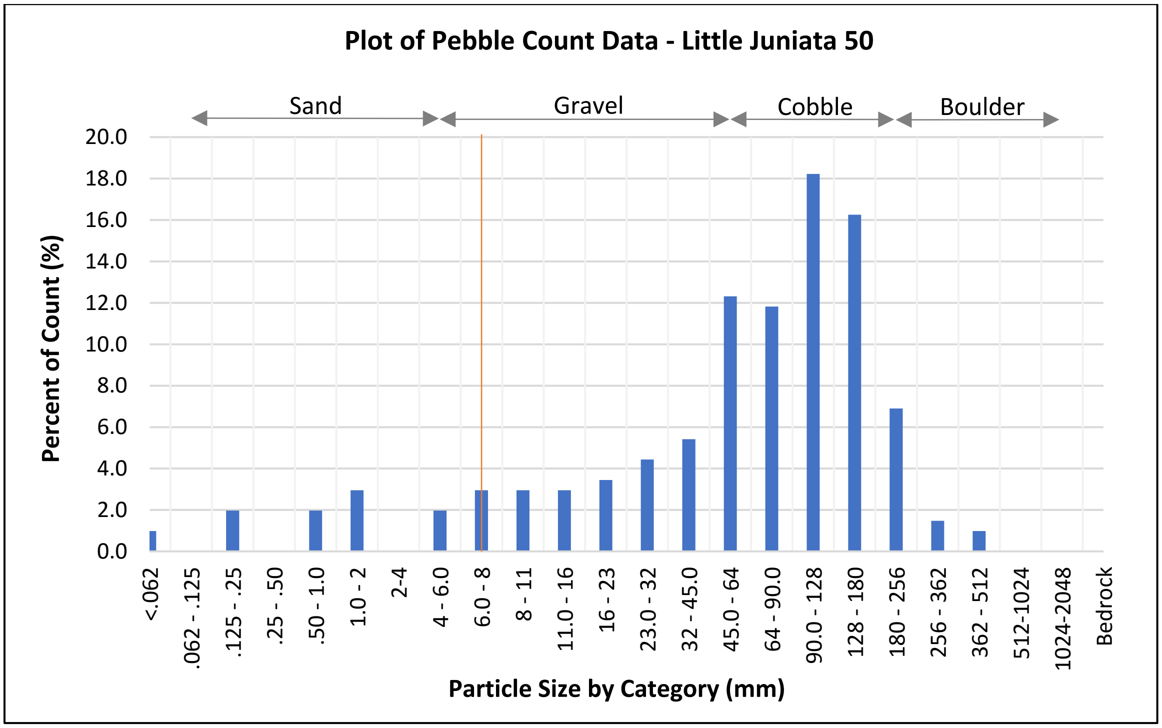
Particle Size Distribution Graphs and Particle Size by Category Frequency Graphs for Little Juniata 65



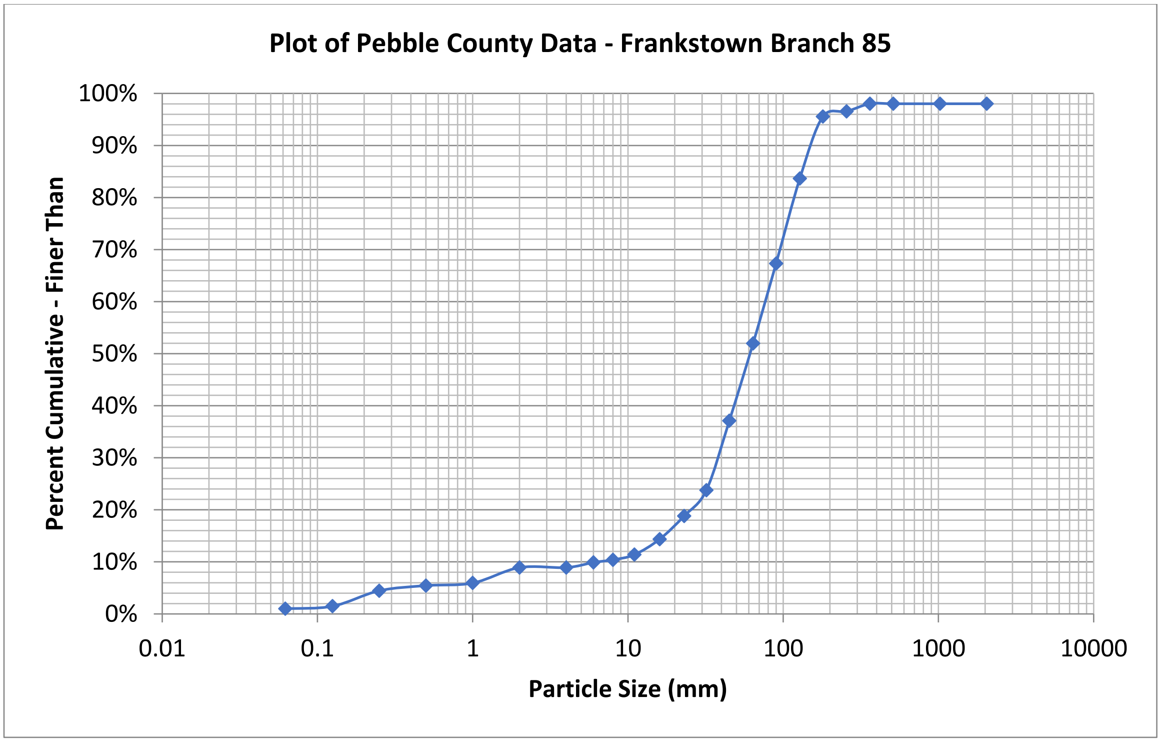


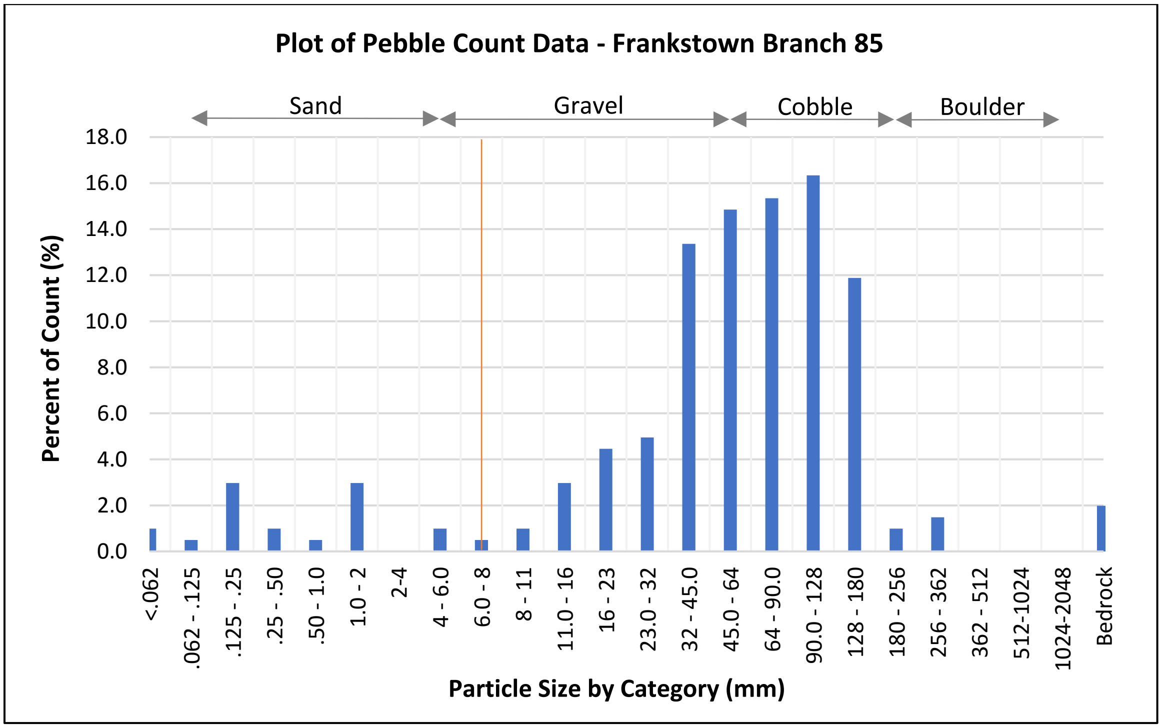
Particle Size Distribution Graphs and Particle Size by Category Frequency Graphs for Little Juniata 50



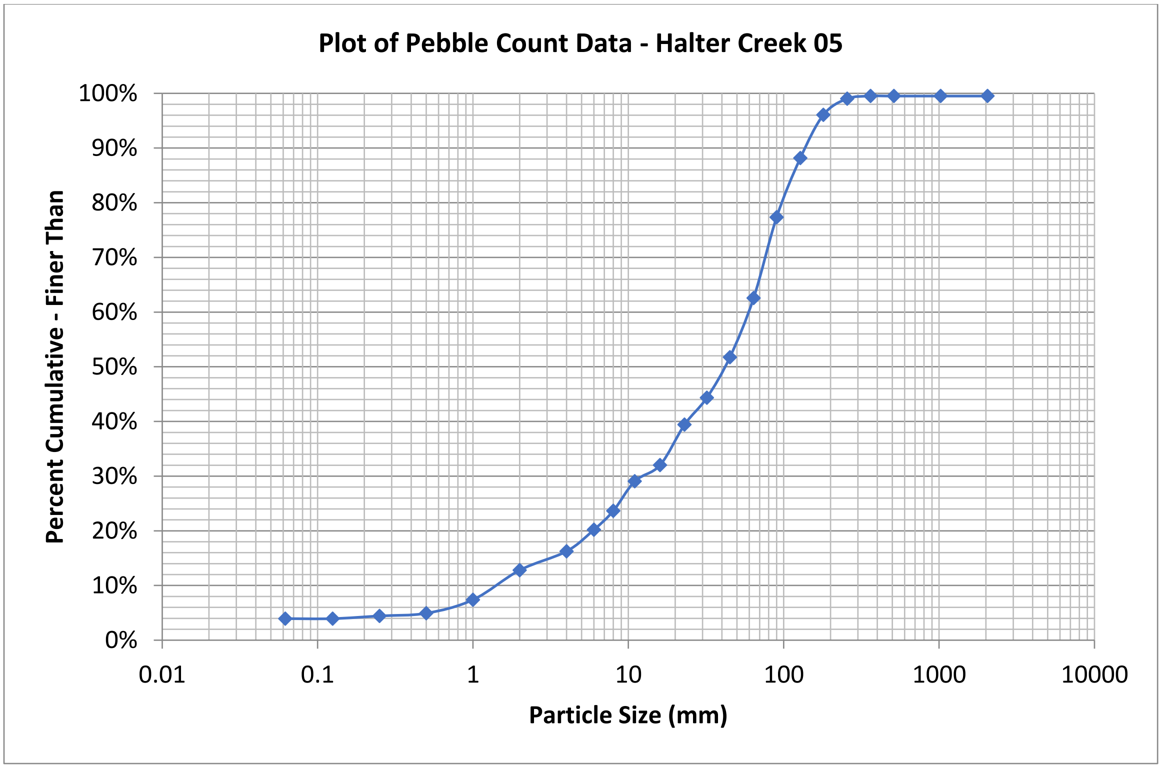


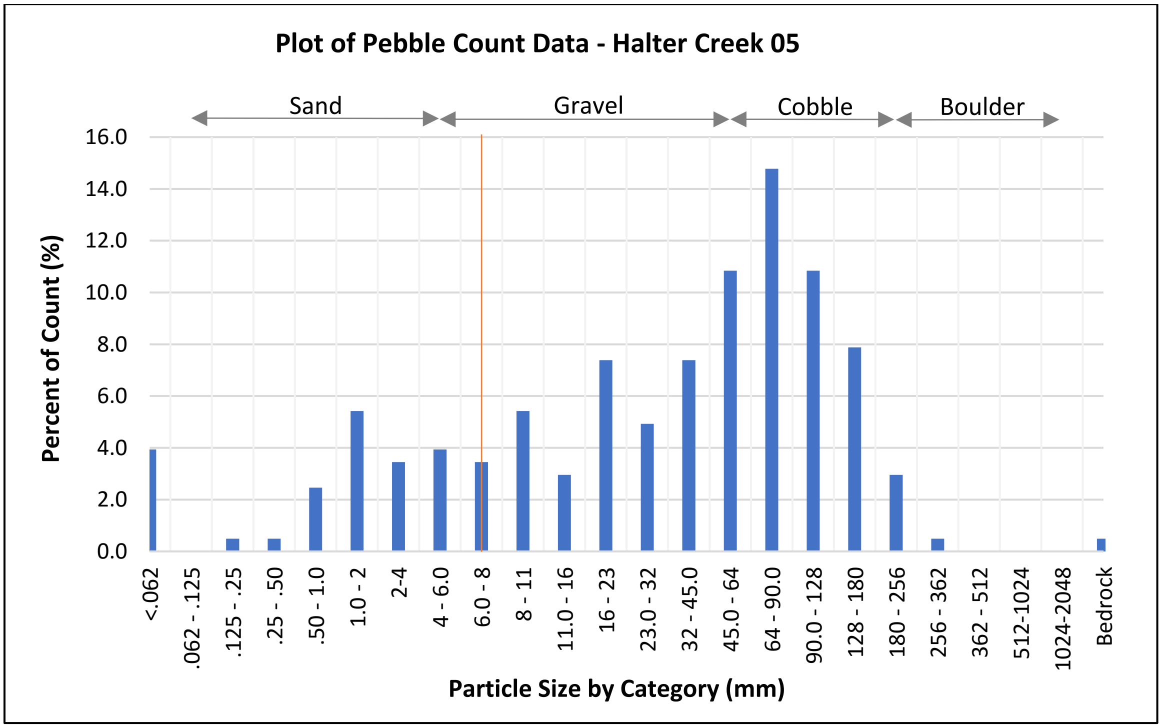
Particle Size Distribution Graphs and Particle Size by Category Frequency Graphs for Frankstown Branch 85



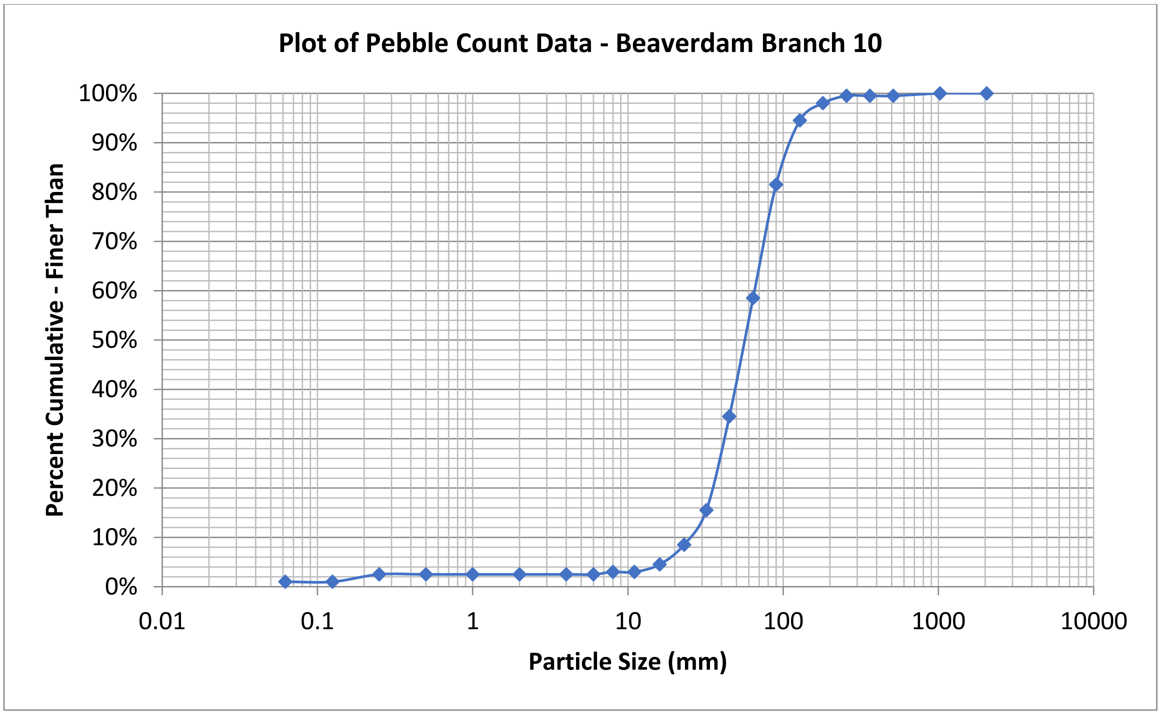


Particle Size Distribution Graphs and Particle Size by Category Frequency Graphs for Halter Creek 05

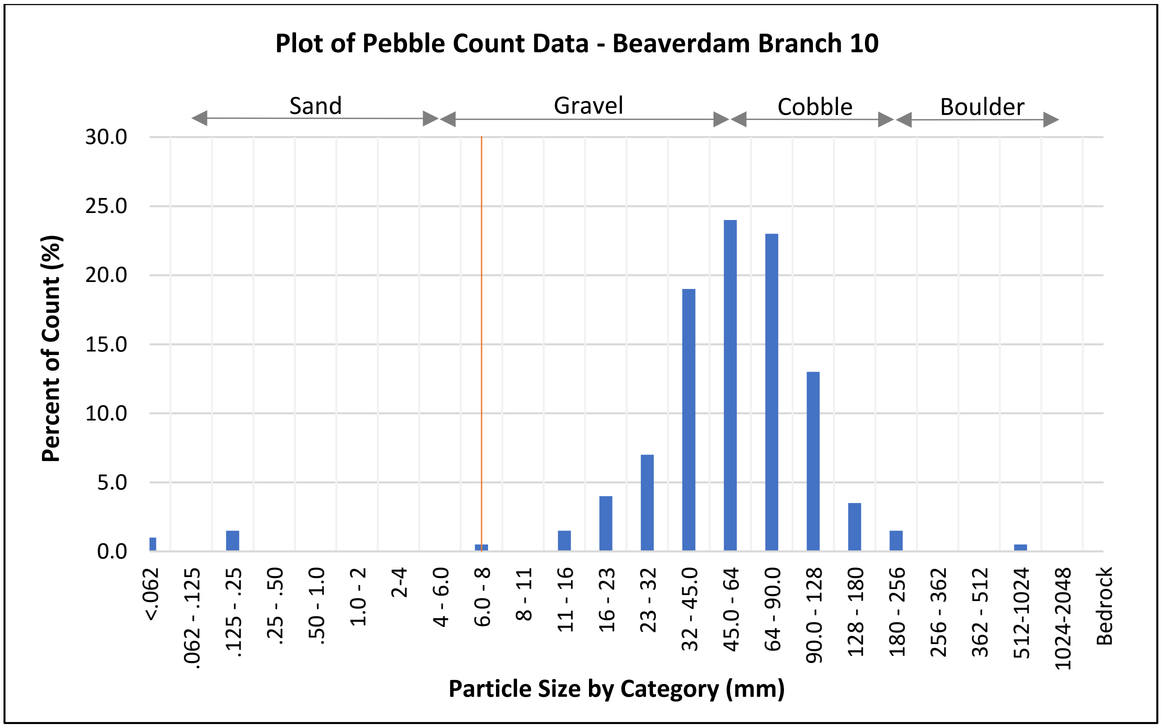




Particle Size Distribution Graphs and Particle Size by Category Frequency Graphs for Beaverdam Branch 10

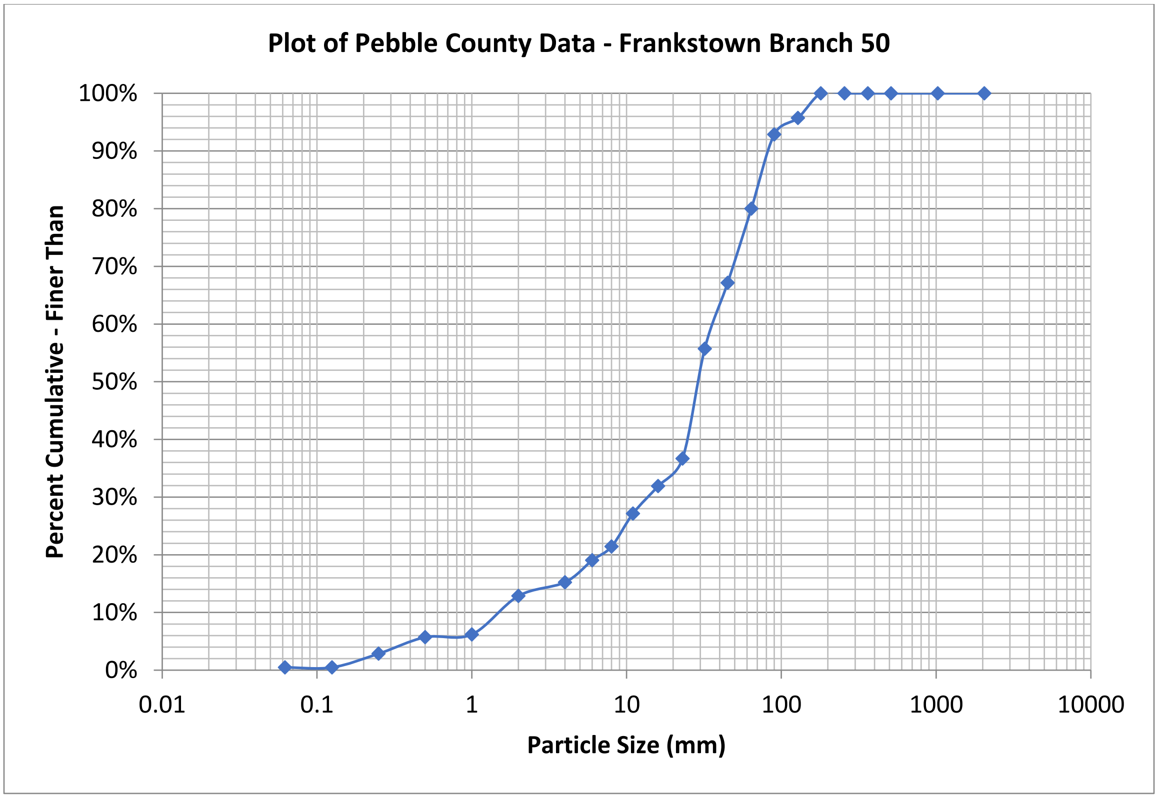


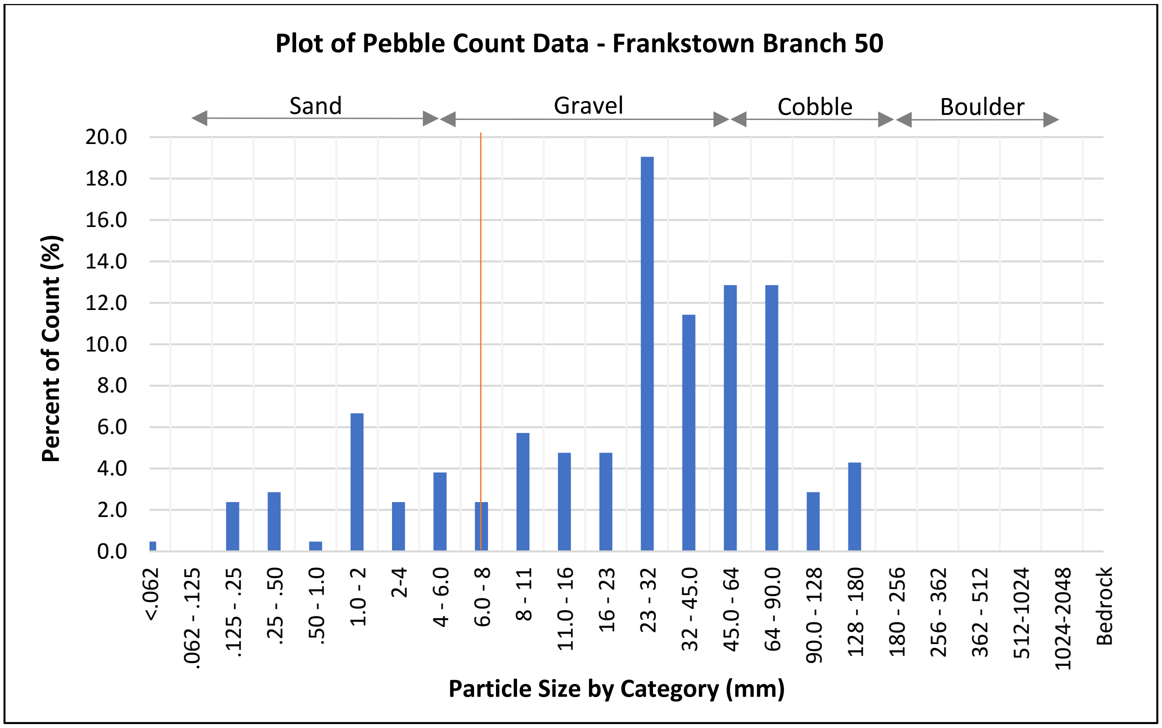
Plot of Pebble Count Data - Beaverdam Branch 10



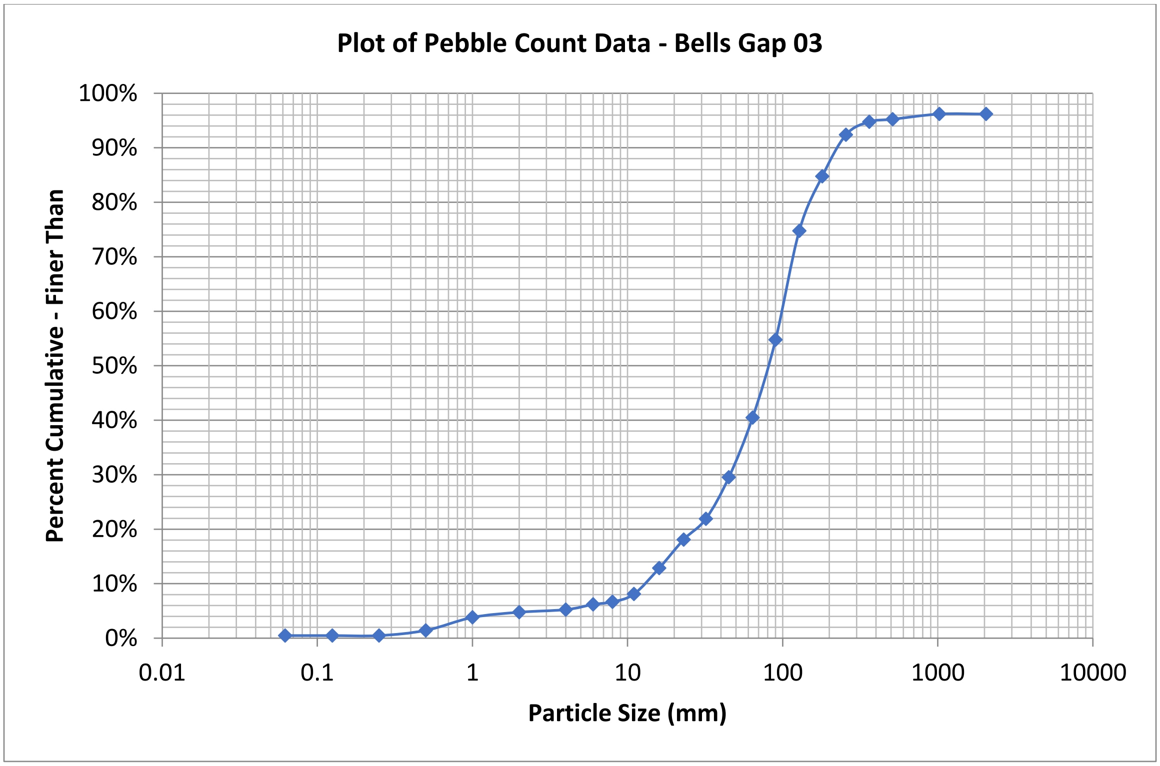
Plot of Pebble Count Data - Beaverdam Branch 10

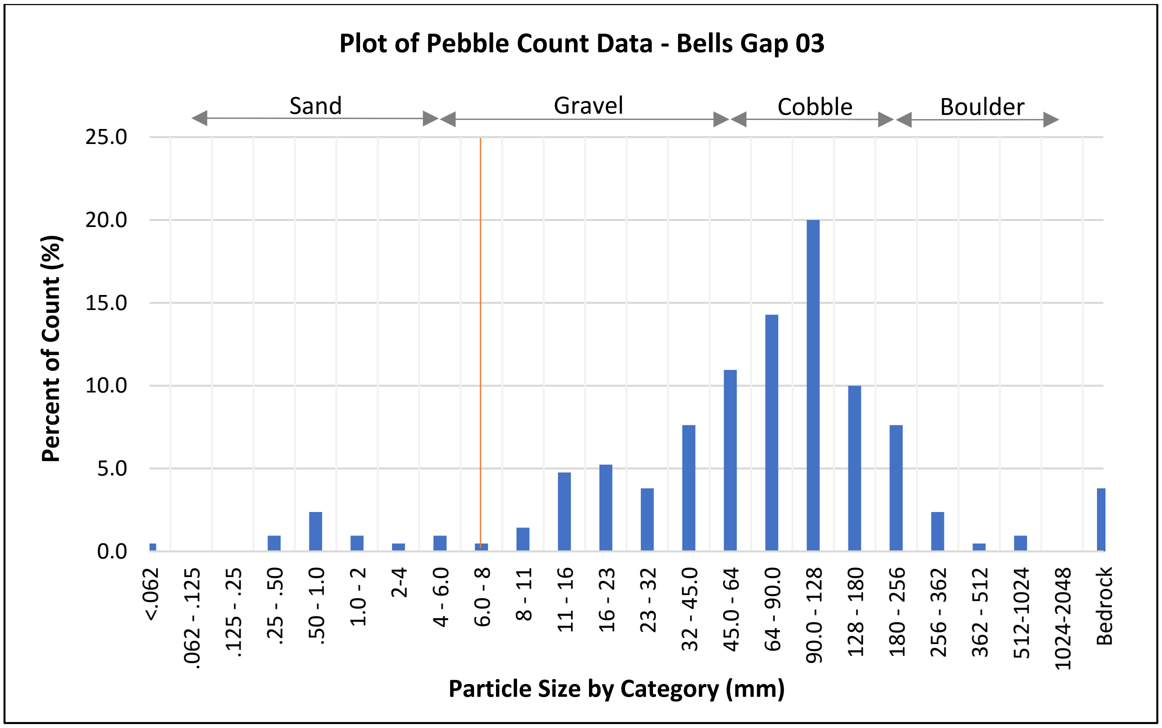
Particle Size Distribution Graphs and Particle Size by Category Frequency Graphs for Frankstown Branch 50





Particle Size Distribution Graphs and Particle Size by Category Frequency Graphs for Bells Gap 03





2016/2017 Blair County Conservation District Macroinvertebrates

					17-108-01	17-108-02	17-108-03	17-108-04
					FB50-1216-01	BB10-1216-02	FB85-1216-03	HC05-1216-04
Phylum	Class	Order	Family	PA Taxon	14-Dec-16	14-Dec-16	14-Dec-16	14-Dec-16
Annelida	**Oligochaeta**			Oligochaeta	5	32	9	45
Arthropoda	**Arachnida**			Hydracarina	6	3	3	9
	Crustacea	Amphipoda	**Crangonyctidae**	Crangonyx	1	5	6	5
			Gammaridae	Gammarus	2	35		
		Isopoda	**Asellidae**	Caecidotea	1	9	27	4
		Ostracoda		Ostracoda		1		1
	Insecta	Coleoptera	**Elmidae**	Microcylloepus	1			
				Optioservus				18
				Oulimnius				
				Stenelmis	26	5	1	2
			Psephenidae	Psephenus	6			4
		Diptera	**Chironomidae**	Chironomidae	115	38	50	61
			Empididae	Chelifera	1			
				Hemerodromia	1	1		
			Psychodidae	Pericoma				
			Simuliidae	Prosimulium				
				Simulium	1			
			Tipulidae	Antocha	1	1	9	10
				Hexatoma				
		Ephemeropte	**Baetidae**	Acentrella				
				Baetidae				
				Baetis				3
			Ephemerellidae	Drunella				
				Ephemerella				24
				Eurylophella				
				Teloganopsis				
			Heptageniidae	Epeorus				
				Leucrocuta				
				Maccaffertium	8		10	

Arthropoda	**Insecta**	Ephemeropte	**Heptageniidae**	Stenacron		4	13	
Arthropoda	**Insecta**		**Isonychiidae**	Isonychia				
Arthropoda	**Insecta**		**Leptophlebiidae**	Paraleptophlebia				
Arthropoda	**Insecta**	Plecoptera	**Capniidae**	Allocapnia		1		
Arthropoda	**Insecta**		**Nemouridae**	Amphinemura				
Arthropoda	**Insecta**			Prostoia				
Arthropoda	**Insecta**		**Perlidae**	Acroneuria				
Arthropoda	**Insecta**		**Taeniopterygidae**	Taeniopterygidae				
Arthropoda	**Insecta**	Trichoptera	**Apataniidae**	Apatania				
Arthropoda	**Insecta**		**Brachycentridae**	Micrasema				
Arthropoda	**Insecta**		**Glossosomatidae**	Glossosoma				
Arthropoda	**Insecta**		**Hydropsychidae**	Cheumatopsyche	3	13	41	1
Arthropoda	**Insecta**			Hydropsyche	2	33	16	15
			Hydroptilidae	Hydroptila	6	1		
				Leucotrichia			7	
			Philopotamidae	Chimarra	12	1	4	2
			Polycentropodidae	Polycentropus				
			Psychomyiidae	Lype		1		
				Psychomyia				
			Rhyacophilidae	Rhyacophila				
Mollusca	**Gastropoda**	Basommatoph	**Ancylidae**	Ferrissia	4		2	
	Pelecypoda	Veneroida	**Corbiculidae**	Corbicula				
			Sphaeriidae	Pisidium				
				Sphaeriidae	1			
Nemata				Nematoda	3	6	1	
Nemertea	**Enopla**		**Tetrastemmatidae**	Prostoma	2	8	1	
Platyhelminth	**Turbellaria**			Turbellaria	4	28	6	8
Grand Total					**212**	**226**	**206**	**212**

2016/2017 Blair County Conservation District Macroinvertebrates

					17-108-05	17-108-06	17-108-07	17-108-08	17-108-09
					LJ85-1116-05	LJ65-1116-06	LJ50-1116-07	SR10-1116-08	BG00-0217-09
Phylum	Class	Order	Family	PA Taxon	22-Nov-16	22-Nov-16	22-Nov-16	22-Nov-16	06-Feb-17
Annelida	**Oligochaeta**			Oligochaeta	15	18	17	48	10
Arthropoda	**Arachnida**			Hydracarina	19	8	12	14	1
	Crustacea	Amphipoda	**Crangonyctidae**	Crangonyx		1		11	
			Gammaridae	Gammarus		2	1	23	
		Isopoda	**Asellidae**	Caecidotea	2	3	2	15	
		Ostracoda		Ostracoda					
	Insecta	Coleoptera	**Elmidae**	Microcylloepus					
				Optioservus	2		20	1	
				Oulimnius				2	
				Stenelmis	4	9	10	1	
			Psephenidae	Psephenus	1	15	6	8	4
		Diptera	**Chironomidae**	Chironomidae	116	101	70	62	83
			Empididae	Chelifera					
				Hemerodromia					2
			Psychodidae	Pericoma				1	
			Simuliidae	Prosimulium					25
				Simulium				1	
			Tipulidae	Antocha	1		1	1	2
				Hexatoma					1
		Ephemeropter	**Baetidae**	Acentrella		1			
				Baetidae	1				
				Baetis				1	
			Ephemerellidae	Drunella					4
				Ephemerella					17
				Eurylophella					2
				Teloganopsis			12		7
			Heptageniidae	Epeorus					1
				Leucrocuta			1		
				Maccaffertium		11	14		4
				Stenacron		7	2		
			Isonychiidae	Isonychia			1		1
			Leptophlebiidae	Paraleptophlebia		1			3
		Plecoptera	**Capniidae**	Allocapnia					11

Arthropoda	**Insecta**	Plecoptera	**Nemouridae**	Amphinemura					1
Arthropoda	**Insecta**			Prostoia					2
Arthropoda	**Insecta**		**Perlidae**	Acroneuria					3
Arthropoda	**Insecta**		**Taeniopterygidae**	Taeniopterygidae					2
Arthropoda	**Insecta**	Trichoptera	**Apataniidae**	Apatania			3		
Arthropoda	**Insecta**		**Brachycentridae**	Micrasema					1
Arthropoda	**Insecta**		**Glossosomatidae**	Glossosoma	2				1
Arthropoda	**Insecta**		**Hydropsychidae**	Cheumatopsyche	5	6	14	1	1
Arthropoda	**Insecta**			Hydropsyche	16	16	27	8	7
			Hydroptilidae	Hydroptila				1	
				Leucotrichia			3	1	
			Philopotamidae	Chimarra	4	2	6	1	5
			Polycentropodidae	Polycentropus				1	2
			Psychomyiidae	Lype					
				Psychomyia		1			
			Rhyacophilidae	Rhyacophila					1
Mollusca	**Gastropoda**	Basommatoph	**Ancylidae**	Ferrissia	1			1	1
	Pelecypoda	Veneroida	**Corbiculidae**	Corbicula		4			
			Sphaeriidae	Pisidium			1	2	2
				Sphaeriidae	1				
Nemata				Nematoda	10	16	3		2
Nemertea	**Enopla**		**Tetrastemmatidae**	Prostoma					
Platyhelminth	**Turbellaria**			Turbellaria	5		11	14	1
Grand Total					**205**	**222**	**237**	**219**	**210**