Muddy Creek

Margaret Keahon Drive Road Culvert

Rockland County, NY

Application of Stream Biological Impairment Criteria

Sample Date: September 2019
Report Date: June 2020

Prepared for
ROCKLAND COUNTY SOIL WATER CONSERVATION DISTRICT

Prepared by

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Background

This study was performed to provide baseline biological data and assess impact to macroinvertebrate communities at the Margaret Keahon Drive crossing culvert on Muddy Creek. Biological impairment criteria developed by the New York State Department of Environmental Conservation Stream Biomonitoring Unit (NYS DEC SBU) (Bode et al. 1990), used to assess potential impact of point and non-point source discharges on resident benthic macroinvertebrates, were applied to communities from an upstream reference location and above, and below the culvert.

Road crossing culverts, depending on their construction, can fragment the benthic macroinvertebrate and other aquatic communities by physically altering the stream channel and natural flow patterns. The physical alteration that culverts may have upon the stream is seen in geomorphic changes within, upstream, and downstream of the structure. These alterations include the retention of fine sediments during high discharge events with increased accumulation of fine sediments downstream or upstream of the culvert, and the creation of pools just below the culvert. Culvert replacement has become a focus of restoration activity in the United States.

In September 2019, replicate benthic macroinvertebrate samples were collected by Rockland County Soil and Water Conservation District. The data was collected and analyzed in anticipation of a future road crossing culvert upgrade and will be used to document any improvements in resident benthic community structure. Sample collection, sample processing, metric calculation, and stream biological impairment criteria analysis followed NYS DEC SBU procedures (Bode et al. 2002, Bode et al. 1990). Stations for assessment were selected by Rockland County Soil Water Conservation District. Watershed Assessment Associates conducted the lab and metric analysis and produced this written report.

Methods

Upstream/Reference Site Selection

The Margaret Keahon Drive culvert is located on Muddy Creek. An upstream reference location was selected. The reference site was approximately 50 meters above the Margaret Keahon Drive culvert. Three additional stations were sampled (Inlet, Outlet, Downstream A, and Downstream B) (See Figure 1).

The Inlet station was located approximately 15 meters above the culvert. The Outlet, Downstream A, and Downstream B stations were located approximately 5, 40, and 120 meters downstream from the culvert respectively. (See Figure 1).

Reference and investigative stations must meet habitat comparability criteria. The median substrate particle size between the stations cannot deviate by more than 3 phi units; substrate embeddedness cannot differ by more than 50%; current velocity should be within 30-150 cm/s and velocity cannot differ by more than 50% between the stations; and canopy cover cannot differ by more than 50% between the stations. In addition, both stations must be sampled using the same collection method (Bode et al. 1990). The habitat comparability criteria were satisfied between the Reference, Inlet, Outlet, and Downstream A & B stations (See Table 2 and 4).

Field Collection

Replicate macroinvertebrate samples were collected from the five stations on Muddy Creek (Figure 1), following methods outlined by NYS SBU (Bode et al. 2002). For some stations an additional fourth replicate was also collected in case of replicate similarity concerns. Ambient water quality parameters were collected (dissolved oxygen, temperature, specific conductance, salinity, and pH) and qualitative habitat assessments were performed concurrently with macroinvertebrate collections (Bode et al. 2002).

Sorting and Organism Identification

Sample sorting and identification followed NYS DEC laboratory methods (Bode et al. 2002). The subsamples were rinsed with tap water in a U.S. number 40 standard sieve to remove fine particles and the remaining material was placed in a 12 x18 pan and evenly distributed with water. A small amount of the sample was randomly removed with a spatula and placed in a Petri dish with water. These portions were then examined under a dissecting microscope to separate organisms from debris (Bode et al. 2002). Macroinvertebrates were then placed in vials containing 70% alcohol. This sorting procedure was repeated for each subsample until 100 organisms were removed. Organisms were identified to lowest taxonomic resolution as outlined in the NYS DEC SBU Quality Assurance Work Plan (QAWP) (Bode et al. 2002), unless specimens were immature or damaged, and enumerated using a dissecting microscope. Oligochaetes and chironomids were slide-mounted in CMCP-10 mounting medium and viewed using a compound microscope.

Replicate Similarity

There must be at least 50% similarity between replicates in order to accurately assess any type of biological impairment (Bode et al. 1990). Bray-Curtis cluster analyses were performed on all taxa abundances (square root transformed) to reveal similarities between replicate samples for all stations. A dendrogram was generated using the Bray-Curtis cluster analysis to visually determine replicate similarity.

Macroinvertebrate Metrics and Impairment Criteria Analysis

The following metrics were calculated for each replicate and then averaged for numerical comparison among stations: Taxa richness, biotic index, species dominance, EPT richness, and percent model affinity.

Violation of one or more of the criteria (Table 1), based on averaged metric results, between downstream stations and the reference station indicates provisional impairment (Bode et al. 1990). If metric results suggest provisional impairment, then a Student's T-test is performed to determine if the results are statistically significant (α=0.05). If the test results are statistically significant then biological impairment is indicated (Bode et al. 2002). Biological impairment criteria is used in this study to assess the influence that physical habitat due to culvert design may have on benthic macroinvertebrate community structure.

Results

Replicate Similarity

Similarity analysis results between replicate samples met the required ≥50% similarly for replicates per station (Figures 2a and 3a) and therefore the first 3 replicates (a, b, c) were used in the analysis.

Macroinvertebrate Parameters and Impairment Criteria Analysis

The following parameters were calculated for each replicate, and then averaged for comparison: Species richness, biotic index, species dominance, EPT richness, and percent model affinity (Table 3).

Mean metric results for the Inlet, Outlet, and Downstream A & B stations, when compared to the Reference station, indicated that

there is no provisional biological impairment based on the EPT richness, biotic index, taxa richness and percent model affinity.

Ambient Water Quality Parameters

Temperature, dissolved oxygen, dissolved oxygen saturation, and pH results were mostly comparable among all stations when compared to same day sampling dates. Specific conductance was slightly variable between the Reference and Inlet station sampled on the same day (September 16, 2019). Of note are the elevated DO mg/l and Dissolved Oxygen Saturation results at the Downstream A station compared to the upstream Outlet station collected on the same day (September 23, 2019) which may be due to an operator or mechanical error rather than an actual elevated reading. See Table 5.

Discussion

For the most part all of the stations community structure consisted, in part, of a group of riffle riverine benthic macroinvertebrates that included Cheumatopsyche *sp*. Stenelmis *sp*. Hydropsyche *betteni*, and Gammarus *sp*. These taxa dominated the community and their dominate presence usually indicates poor water quality conditions. (Appendix and Table 4).

The Reference community structure was similar to all the stations located downstream (Inlet, Outlet, Downstream A and B). The Bray Curtis similarity (Figures 2 a and b) provides a visual of the community similarity and grouping between these stations. The community at the Reference station appears to be already degraded in water quality based on the community structure. Biological impairment is not indicated at the Inlet, Outlet, and Downstream A & B stations based on EPT richness, biotic index, taxa richness, and percent model affinity metrics (Table 3).

In summary, the application of stream biological impairment criteria analysis indicates that the Inlet, Outlet, and Downstream A & B stations on Muddy Brook at the Margaret Keahon Drive culvert are not biologically impaired relative to the upstream Reference station. This stream, in general based on the benthic macroinvertebrate community structure, has significant degraded water quality originating further upstream from the Reference station. The extent that the Margaret Keahon Drive culverts influence of the degraded water quality conditions is questionable and difficult to discern. Further investigation into potential causes of the upstream degraded water quality of the Muddy Brook Margaret Keahon Drive culvert is suggested.

Literature Cited

Bode, R.W., M.A. Novak, L.A. Abele. 1990. Biological impairment criteria for flowing waters in New York State. Stream Biomonitoring Unit, Division of Water, New York State Department of Environmental Conservation, Albany, NY.

Smith, A.J. 2018. Quality assurance work plan for biological stream monitoring in New York State. Stream Biomonitoring Unit, Division of Water, New York State Department of Environmental Conservation, Albany, NY.

Clesceri, L.S., A.E. Greenberg, and A.D. Eaton, editors. 1998. Standard methods for examination of water and wastewater, 20th edition. American Public Health Association, Washington, D.C.

Environmental Protection Agency. 1993. Methods for the Determination of Inorganic Substances in Environmental Samples (EPA/600/R-93/100).

Hilsenhoff, W.L. 1987. An improved biotic index of organic stream pollution. *Great Lakes Entomol*. 20:31-39.

Tables and Figures

Table 1. Descriptions of the metrics calculated for each replicate sample and criteria required to indicate impairment

Metric	Description	**Impairment Criteria (**difference between reference and impacted stations**)**
Taxa Richness	Taxa richness is the total number of unique species or taxa found in the sub-sample. Higher taxa richness values are generally associated with undisturbed sediment conditions	-8
EPT Richness	EPT richness is the total number of taxa represented by Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). These groups are composed largely of mostly clean water taxa and their presence usually indicates good water quality conditions.	-4
Biotic Index	Biotic Index, or the Hilsenhoff Biotic Index (Hilsenhoff 1987), is calculated by multiplying the number of individuals of each species or taxa by its assigned tolerance value to organic material in the substrate, summing these products, and dividing by the total number of individuals. Tolerance values range from intolerant (0) to tolerant (10). High biotic index values are suggestive of organically enriched condition, while low values indicate naturally occurring, ambient conditions.	+1.5
Percent model affinity	Percent model affinity measures the similarity to a model non-impacted community based on the abundance of 7 taxa groups (Bode et al. 2002). Kick sample model community is composed of 40% Ephemeroptera, 5% Plecoptera, 10% Trichoptera, 10% Coleoptera, 20% Chironomidae, 5% Oligochaeta, and 10% Other.	-20
Species dominance	Species dominance is a measure of community balance, or how evenly the most numerous species contribute to the community. High dominance values indicate unbalanced communities strongly dominated by one or more numerous species.	+15

Table 2. Margaret Keahon Drive culvert habitat comparability criteria results.

Station	Reference	Inlet	Outlet	Dwnst A	Dwnst B	Criteria	Meets criteria
Current (cm/sec)	39.84	34.33	30.34	25.13	25.06	<50%	Yes/Yes
Canopy (%)	90	90	90	100	90	<50%	Yes/Yes
Embeddedness (%)	33	17	40	20	21	<50%	Yes/Yes
% Rock	0.05	0.10	0.05	0.15	0.15		
% Rubble	0.30	0.25	0.40	0.30	0.30		
% Gravel	0.35	0.40	0.30	0.30	0.30		
% Sand	0.20	0.15	0.15	0.20	0.15		
% Silt	0.10	0.10	0.10	0.05	0.10		
Median particle size	-2.35	-2.675	-2.95	-3.325	-3.1	≤3 units	Yes/Yes

Table 3. Summary of the average community metric results for Margaret Keahon Drive culvert.

Site	N	EPT Richness	Biotic Index	Taxa Richness	Percent Model Affinity	Species Dominance
Reference	3	3.67	5.47	15.00	41.00	33.00
Inlet	3	4.00	5.63	19.00	51.67	21.67
Outlet	3	4.67	5.50	19.00	49.00	19.00
Dwnst A	3	4.00	5.15	17.00	44.67	23.33
Dwnst B	3	5.00	5.19	16.67	48.67	25.00
Criteria		-4	+1.5	-8	-20	+15
Biological Impact		No	No	No	No	No

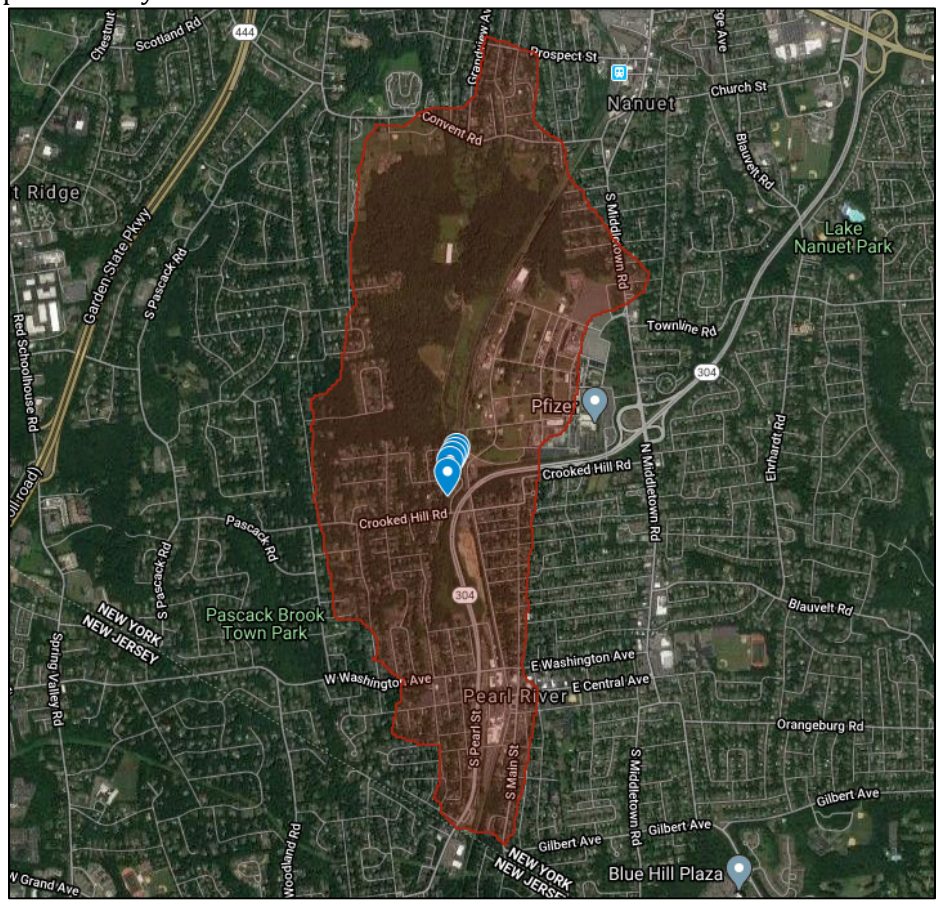
Table 4. Abbreviated benthic macroinvertebrate taxa list.

Taxon/Station	Reference	Inlet	Outlet	Downstream A	Downstream B
Stenelmis sp.	81	54	55	56	87
Cheumatopsyche sp.	80	39	40	35	48
Hydropsyche betteni	52	34	56	63	11
Gammarus sp.	24	42	38	73	74

Table 5. Ambient water quality parameters

Station	Date	Temp (deg C)	Spec Cond (µS/cm)	pH	DO (mg/L)	DO % Sat	Salinity
Reference	9/16/2019	18.39	1158	7.35	6.34	67.7	0.58
Inlet	9/16/2019	19.08	1046	7.35	8.97	97	0.52
Outlet	9/23/2019	19.66	1245	7.43	7.61	83.3	0.62
Dwnst A	9/23/2019	20.73	1228	7.5	13	143.6	0.61
Dwnst B	9/24/2019	18.3	1287	7.45	7.09	75.6	0.65

Figure 1. Maps of Muddy Brook watershed and station locations.



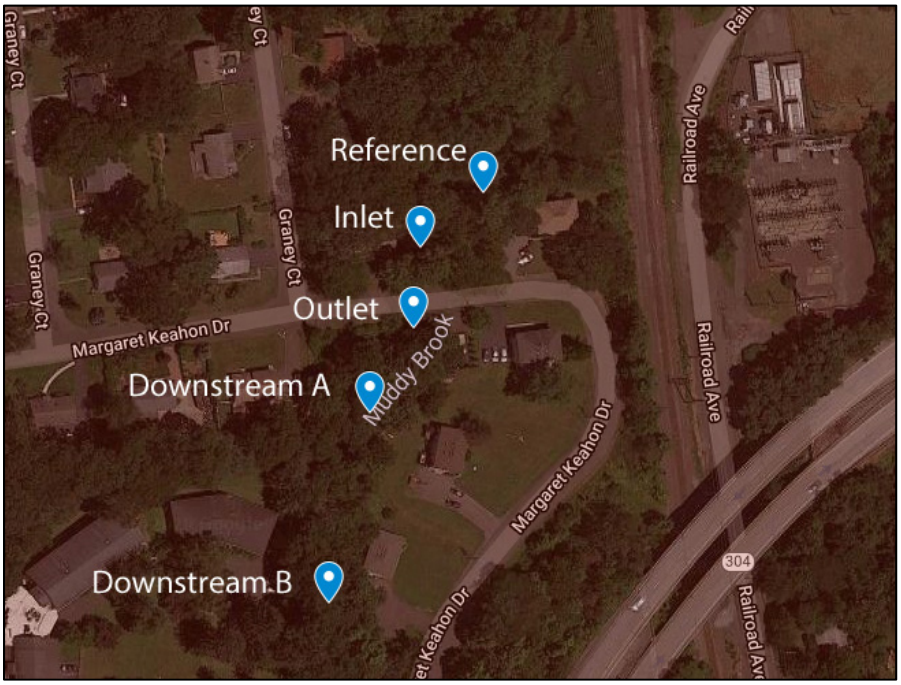
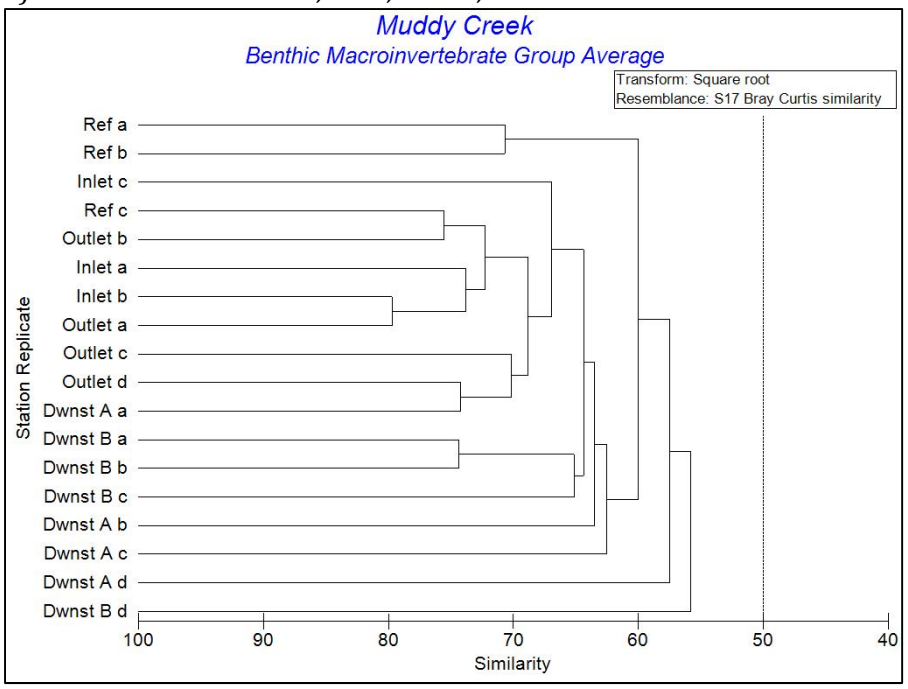
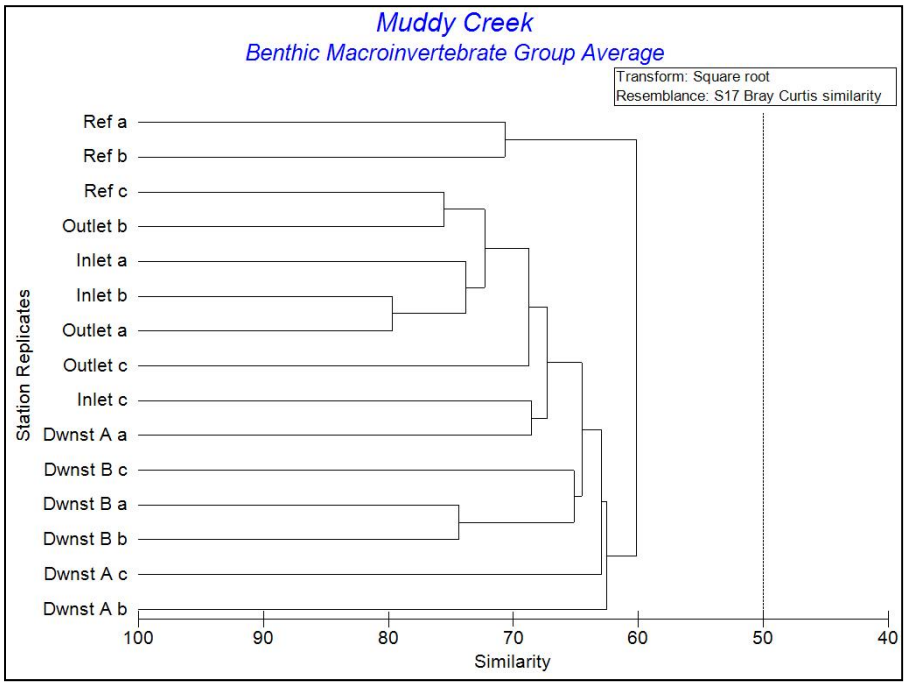


Figure 2. a.) Bray-Curtis dendrogram of macroinvertebrate community structure similarity (at genus/species level) for all the Margaret Keahon Drive Culvert stations among replicated samples at the Reference, Inlet, Outlet, and Downstream A & B stations. b.) Bray-Curtis dendrogram of macroinvertebrate community structure similarity (at genus/species level) for the three replicate samples (a, b, c) taken at the Reference, Inlet, Outlet, and Downstream A & B stations.





Appendix A: Field and Benthic Data Summary Sheets

Stream Field Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Waterbody: **Muddy Creek** Latitude: **41.07021**
River Basin: **Hudson** Station: **US Reference** Longitude: **-74.02581**
County/State: **Rockland/NY** Coll Date: **9/16/2019** Field Crew: **NL**
Site description: **MC_Natural US Reference**

Physical Characteristics	
Depth (meters):	**0.064**
Width (meters):	**4.42**
Current (cm/sec):	**39.84**
Canopy (%):	**90**
Substrate	
Rock (%):	**5**
Rubble (%):	**30**
Gravel (%):	**35**
Sand (%):	**20**
Silt (%):	**10**
Embeddedness (%):	**33**

Chemical Measurements	
DO (mg/L):	**6.34**
DO sat. (%):	**67.7**
Temperature (C):	**18.39**
Spec. Conduct. (umhos):	**1158**
Baro pressure:	
pH:	**7.35**
Salinity (PSS):	**0.58**

Biological Attributes	
Aquatic vegetation	
Macrophytes:	**Yes**
Diatoms:	**Yes**
Algae-suspended:	**A**
Algae-filamentous:	**P**
Occurance of macroinvertebrates	
Ephemeroptera:	
Plecoptera:	
Trichoptera:	**x**
Coleoptera:	
Megaloptera:	
Odonata:	**x**
Chironomidae:	**x**
Simuliidae:	**x**
Decapoda:	**x**
Gammaridae:	
Mollusca:	
Oligochaeta:	**x**
Other macro's:	
Field Faunal Condition:	

Flow

Flow

Notes/observations::

At Gate of Pfizer Property line- was not granted persmission to access iste. The kick samples had an bundance of worms in sample; odor in stream; 3 samples only as per Alene Onion, NYS DEC recommendation and closeness to Inlet sample.

Lab Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Waterbody: **Muddy Creek**
Station: **MC_NaturalUSReference A**
Collection Date: **9/16/2019** WAA ID: **680.5-001**

Order	Family	Final Determination	Total #
AMPHIPODA	Gammaridae	Gammarus sp.	5
COLEOPTERA	Elmidae	Stenelmis sp.	16
DECAPODA	Cambaridae	Undetermined Cambaridae	1
DIPTERA	Chironomidae	Chaetocladius sp.	5
		Parametriocnemus sp.	3
		Polypedilum flavum	2
		Tvetenia bavarica gr.	1
LUMBRICULIDA	Lumbriculidae	Undetermined Lumbriculidae	1
TRICHOPTERA	Hydropsychidae	Cheumatopsyche sp.	34
		Hydropsyche betteni	23
	Philopotamidae	Chimarra obscura	1
		Chimarra socia	6
TUBIFICIDA	Naididae	Undetermined Naididae	1
	Tubificidae	Undet. Tubificidae w/o cap. setae	1

0 = taxon identified in large/rare scan

Lab Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Waterbody: **Muddy Creek**
Station: **MC_NaturalUSReference B**
Collection Date: **9/16/2019** WAA ID: **680.5-002**

Order	Family	Final Determination	Total #
AMPHIPODA	Gammaridae	Gammarus sp.	5
COLEOPTERA	Elmidae	Stenelmis sp.	33
DECAPODA	Cambaridae	Orconectes sp.	1
DIPTERA	Chironomidae	Polypedilum flavum	1
		Microtendipes pedellus gr.	3
		Parametriocnemus sp.	2
		Rheotanytarsus exiguus gr.	1
		Cricotopus bicinctus	1
		Tvetenia bavarica gr.	1
	Empididae	Hemerodromia sp.	1
TRICHOPTERA	Hydropsychidae	Hydropsyche betteni	17
		Cheumatopsyche sp.	30
	Philopotamidae	Chimarra socia	1
TUBIFICIDA	Tubificidae	Undet. Tubificidae w/o cap. setae	3

0 = taxon identified in large/rare scan

Lab Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Waterbody: **Muddy Creek**
Station: **MC_NaturalUSReference C**
Collection Date: **9/16/2019** WAA ID: **680.5-003**

Order	Family	Final Determination	Total #
AMPHIPODA	Gammaridae	Gammarus sp.	14
COLEOPTERA	Elmidae	Stenelmis sp.	32
DECAPODA	Cambaridae	Undetermined Cambaridae	1
DIPTERA	Chironomidae	Chaetocladius sp.	1
		Micropsectra/Tanytarsus Complex	1
		Thienemannimyia gr. spp.	1
		Polypedilum flavum	2
		Parametriocnemus sp.	5
		Microtendipes pedellus gr.	1
	Tipulidae	Tipula sp.	1
LUMBRICULIDA	Lumbriculidae	Undetermined Lumbriculidae	1
ODONATA	Aeschnidae	Boyeria sp.	1
TRICHOPTERA	Hydropsychidae	Cheumatopsyche sp.	16
		Hydropsyche betteni	12
	Philopotamidae	Chimarra aterrima?	4
		Chimarra socia	5
TUBIFICIDA	Tubificidae	Undet. Tubificidae w/o cap. setae	2

0 = taxon identified in large/rare scan

Stream Field Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Waterbody: **Muddy Creek**
River Basin: **Hudson**
County/State: **Rockland/NY**
Site description: **MC_Inlet**

Station: **MC_Inlet**
Coll Date: **9/16/2019**

Latitude: **41.07001**
Longitude: **-74.02592**
Field Crew: **NL**

Physical Characteristics	
Depth (meters):	**0.036**
Width (meters):	**5**
Current (cm/sec):	**34.33**
Canopy (%):	**90**
Substrate	
Rock (%):	**10**
Rubble (%):	**25**
Gravel (%):	**40**
Sand (%):	**15**
Silt (%):	**10**
Embeddedness (%):	**17**

Chemical Measurements	
DO (mg/L):	**8.97**
DO sat. (%):	**97**
Temperature (C):	**19.08**
Spec. Conduct. (umhos):	**1046**
Baro pressure:	
pH:	**7.35**
Salinity (PSS):	**0.52**

Biological Attributes	
Aquatic vegetation	
Macrophytes:	**Yes**
Diatoms:	**Yes**
Algae-suspended:	**A**
Algae-filamentous:	**P**
Occurance of macroinvertebrates	
Ephemeroptera:	
Plecoptera:	
Trichoptera:	**x**
Coleoptera:	
Megaloptera:	
Odonata:	**x**
Chironomidae:	**x**
Simuliidae:	
Decapoda:	
Gammaridae:	
Mollusca:	
Oligochaeta:	**x**
Other macro's:	**Nematode**
Field Faunal Condition:	

Flow

Flow

Notes/observations::

Not wide enough for a 4th samples

Lab Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Waterbody: **Muddy Creek**
Station: **MC_Inlet A**
Collection Date: **9/16/2019** WAA ID: **680.5-004**

Order	Family	Final Determination	Total #
AMPHIPODA	Gammaridae	Gammarus sp.	12
COLEOPTERA	Elmidae	Stenelmis sp.	25
DIPTERA	Chironomidae	Cricotopus/Orthocladius Complex	1
		Tvetenia bavarica gr.	1
		Parametriocnemus sp.	3
		Thienemannimyia gr. spp.	3
		Polypedilum flavum	4
		Microtendipes pedellus gr.	6
	Empididae	Hemerodromia sp.	1
ISOPODA	Asellidae	Caecidotea sp.	2
LUMBRICULIDA	Lumbriculidae	Undetermined Lumbriculidae	2
TRICHOPTERA	Hydropsychidae	Cheumatopsyche sp.	18
		Hydropsyche betteni	16
	Philopotamidae	Chimarra aterrima?	5
TUBIFICIDA	Tubificidae	Undet. Tubificidae w/o cap. setae	1

0 = taxon identified in large/rare scan

Lab Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Waterbody: **Muddy Creek**
Station: **MC_Inlet B**
Collection Date: **9/16/2019** WAA ID: **680.5-005**

Order	Family	Final Determination	Total #
AMPHIPODA	Gammaridae	Gammarus sp.	11
COLEOPTERA	Elmidae	Stenelmis sp.	21
DIPTERA	Chironomidae	Chaetocladius sp.	1
		Chironomus sp.	1
		Polypedilum flavum	1
		Tvetenia bavarica gr.	1
		Parametriocnemus sp.	2
		Microtendipes pedellus gr.	5
		Thienemannimyia gr. spp.	2
	Empididae	Hemerodromia sp.	1
	Simuliidae	Simulium sp.	1
EPHEMEROPTERA	Heptageniidae	Stenacron interpunctatum	3
ISOPODA	Asellidae	Caecidotea sp.	6
LUMBRICULIDA	Lumbriculidae	Undetermined Lumbriculidae	5
TRICHOPTERA	Hydropsychidae	Cheumatopsyche sp.	10
		Hydropsyche betteni	12
	Philopotamidae	Chimarra aterrima?	3
		Chimarra socia	6
TRICLADIDA		Undetermined Turbellaria	1
TUBIFICIDA	Tubificidae	Undet. Tubificidae w/o cap. setae	7

0 = taxon identified in large/rare scan

Lab Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Waterbody: **Muddy Creek**
Station: **MC_Inlet C**
Collection Date: **9/16/2019** WAA ID: **680.5-006**

Order	Family	Final Determination	Total #
		Undetermined Nematoda	2
AMPHIPODA	Gammaridae	Gammarus sp.	19
BASOMMATOPHORA	Ancylidae	Ferrissia sp.	1
COLEOPTERA	Elmidae	Stenelmis sp.	8
DIPTERA	Chironomidae	Cryptochironomus sp.	2
		Parametriocnemus sp.	11
		Thienemannimyia gr. spp.	3
		Microtendipes pedellus gr.	2
		Tvetenia bavarica gr.	1
		Polypedilum flavum	1
		Paratanytarsus sp.	1
		Micropsectra sp.	1
	Empididae	Hemerodromia sp.	1
	Simuliidae	Simulium sp.	1
LUMBRICULIDA	Lumbriculidae	Undetermined Lumbriculidae	3
ODONATA	Calopterygidae	Calopteryx sp.	1
TRICHOPTERA	Hydropsychidae	Hydropsyche betteni	6
		Cheumatopsyche sp.	11
	Philopotamidae	Chimarra socia	12
		Chimarra aterrima?	6
TRICLADIDA		Undetermined Turbellaria	1
TUBIFICIDA	Tubificidae	Undet. Tubificidae w/o cap. setae	6

0 = taxon identified in large/rare scan

Stream Field Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Waterbody: **Muddy Creek**
River Basin: **Hudson**
County/State: **Rockland/NY**
Site description: **MC_Outlet**

Station: **MC_Outlet**
Coll Date: **9/23/2019**

Latitude: **41.06981**
Longitude: **-74.02608**
Field Crew: **NL**

Physical Characteristics	
Depth (meters):	**0.054**
Width (meters):	**4.51**
Current (cm/sec):	**30.34**
Canopy (%):	**90**
Substrate	
Rock (%):	**5**
Rubble (%):	**40**
Gravel (%):	**30**
Sand (%):	**15**
Silt (%):	**10**
Embeddedness (%):	**40**

Chemical Measurements	
DO (mg/L):	**7.61**
DO sat. (%):	**83.3**
Temperature (C):	**19.66**
Spec. Conduct. (umhos):	**1245**
Baro pressure:	
pH:	**7.43**
Salinity (PSS):	**0.62**

Biological Attributes	
Aquatic vegetation	
Macrophytes:	**Yes**
Diatoms:	**Yes**
Algae-suspended:	**A**
Algae-filamentous:	**P**
Occurance of macroinvertebrates	
Ephemeroptera:	
Plecoptera:	
Trichoptera:	**x**
Coleoptera:	
Megaloptera:	**x**
Odonata:	
Chironomidae:	
Simuliidae:	**x**
Decapoda:	**x**
Gammaridae:	
Mollusca:	
Oligochaeta:	**x**
Other macro's:	**Sowbug**
Field Faunal Condition:	

Flow

Flow

Notes/observations::

Small sediment bar in the middle of the stream which split the wetted width, added the two sections together, as it was only in one section.

Lab Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Waterbody: **Muddy Creek**
Station: **MC_Outlet A**
Collection Date: **9/23/2019** WAA ID: **680.5-007**

Order	Family	Final Determination	Total #
AMPHIPODA	Gammaridae	Gammarus sp.	7
ARHYNCHOBDELLIDA	Erpobdellidae	Erpobdella sp.	1
COLEOPTERA	Elmidae	Stenelmis sp.	19
DECAPODA	Cambaridae	Undetermined Cambaridae	1
DIPTERA	Chironomidae	Parametriocnemus sp.	4
		Chaetocladius sp.	1
		Chironomus sp.	1
		Polypedilum flavum	1
		Tvetenia bavarica gr.	1
		Rheotanytarsus exiguus gr.	2
		Thienemannimyia gr. spp.	2
		Microtendipes pedellus gr.	19
	Empididae	Hemerodromia sp.	2
	Simuliidae	Simulium sp.	1
ISOPODA	Asellidae	Caecidotea sp.	1
LUMBRICULIDA	Lumbriculidae	Undetermined Lumbriculidae	1
TRICHOPTERA	Hydropsychidae	Hydropsyche betteni	12
		Cheumatopsyche sp.	3
	Philopotamidae	Chimarra aterrima?	7
		Chimarra socia	9
TUBIFICIDA	Tubificidae	Undet. Tubificidae w/o cap. setae	5

0 = taxon identified in large/rare scan

Lab Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Waterbody: **Muddy Creek**
Station: **MC_Outlet B**
Collection Date: **9/23/2019** WAA ID: **680.5-008**

Order	Family	Final Determination	Total #
AMPHIPODA	Gammaridae	Gammarus sp.	24
COLEOPTERA	Elmidae	Stenelmis sp.	13
DECAPODA	Cambaridae	Undetermined Cambaridae	1
DIPTERA	Chironomidae	Thienemannimyia gr. spp.	1
		Chaetocladius sp.	1
		Polypedilum flavum	1
		Microtendipes pedellus gr.	2
		Rheotanytarsus exiguus gr.	2
		Parametriocnemus sp.	3
		Cryptochironomus sp.	1
	Empididae	Hemerodromia sp.	2
ISOPODA	Asellidae	Caecidotea sp.	4
LUMBRICULIDA	Lumbriculidae	Undetermined Lumbriculidae	1
TRICHOPTERA	Hydropsychidae	Hydropsyche betteni	12
		Ceratopsyche sparna	3
		Cheumatopsyche sp.	16
	Philopotamidae	Chimarra aterrima?	5
		Chimarra socia	8

0 = taxon identified in large/rare scan

Lab Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Waterbody: **Muddy Creek**
Station: **MC_Outlet C**
Collection Date: **9/23/2019** WAA ID: **680.5-009**

Order	Family	Final Determination	Total #
COLEOPTERA	Elmidae	Stenelmis sp.	13
DECAPODA	Cambaridae	Undetermined Cambaridae	1
DIPTERA	Chironomidae	Parametriocnemus sp.	5
		Chaetocladius sp.	5
		Tvetenia bavarica gr.	1
		Rheotanytarsus exiguus gr.	1
		Polypedilum flavum	1
		Microtendipes pedellus gr.	1
	Empididae	Hemerodromia sp.	2
	Simuliidae	Simulium sp.	4
EPHEMEROPTERA	Heptageniidae	Stenacron interpunctatum	1
ISOPODA	Asellidae	Caecidotea sp.	13
LUMBRICULIDA	Lumbriculidae	Undetermined Lumbriculidae	8
TRICHOPTERA	Hydropsychidae	Hydropsyche betteni	13
		Cheumatopsyche sp.	14
	Philopotamidae	Chimarra socia	12
		Chimarra aterrima?	4
TUBIFICIDA	Tubificidae	Undet. Tubificidae w/o cap. setae	1

0 = taxon identified in large/rare scan

Lab Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Waterbody: **Muddy Creek**
Station: **MC_Outlet D**
Collection Date: **9/23/2019** WAA ID: **680.5-010**

Order	Family	Final Determination	Total #
AMPHIPODA	Gammaridae	Gammarus sp.	7
COLEOPTERA	Elmidae	Stenelmis sp.	10
DECAPODA	Cambaridae	Undetermined Cambaridae	1
DIPTERA	Chironomidae	Chironomus sp.	1
		Polypedilum flavum	1
		Microtendipes pedellus gr.	2
		Parametriocnemus sp.	10
	Empididae	Hemerodromia sp.	4
	Simuliidae	Simulium sp.	6
	Tipulidae	Tipula sp.	3
EPHEMEROPTERA	Heptageniidae	Stenacron interpunctatum	1
ISOPODA	Asellidae	Caecidotea sp.	1
LUMBRICULIDA	Lumbriculidae	Undetermined Lumbriculidae	2
TRICHOPTERA	Hydropsychidae	Cheumatopsyche sp.	7
		Hydropsyche betteni	19
	Philopotamidae	Chimarra aterrima?	10
		Chimarra socia	11
TRICLADIDA		Undetermined Turbellaria	1
TUBIFICIDA	Tubificidae	Undet. Tubificidae w/o cap. setae	3

0 = taxon identified in large/rare scan

Stream Field Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Waterbody: **Muddy Creek**
River Basin: **Hudson**
County/State: **Rockland/NY**
Site description: **MC_Dwnst A**

Station: **MC_Dwnst A**
Coll Date: **9/23/2019**

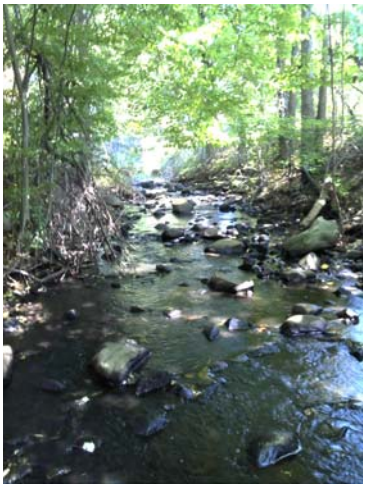
Latitude: **41.06956**
Longitude: **-74.02625**
Field Crew: **BR**

Physical Characteristics	
Depth (meters):	**0.08**
Width (meters):	**14.07**
Current (cm/sec):	**25.13**
Canopy (%):	**100**
Substrate	
Rock (%):	**15**
Rubble (%):	**30**
Gravel (%):	**30**
Sand (%):	**20**
Silt (%):	**5**
Embeddedness (%):	**20**

Chemical Measurements	
DO (mg/L):	**13**
DO sat. (%):	**143.6**
Temperature (C):	**20.73**
Spec. Conduct. (umhos):	**1228**
Baro pressure:	
pH:	**7.5**
Salinity (PSS):	**0.61**

Biological Attributes	
Aquatic vegetation	
Macrophytes:	**Yes**
Diatoms:	**Yes**
Algae-suspended:	**A**
Algae-filamentous:	**P**
Occurance of macroinvertebrates	
Ephemeroptera:	
Plecoptera:	
Trichoptera:	**x**
Coleoptera:	
Megaloptera:	
Odonata:	
Chironomidae:	
Simuliidae:	
Decapoda:	**x**
Gammaridae:	
Mollusca:	
Oligochaeta:	**x**
Other macro's:	
Field Faunal Condition:	

Flow



Flow

Notes/observations::

Lab Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Waterbody: **Muddy Creek**
Station: **MC_Dwnst Aa**
Collection Date: **9/23/2019** WAA ID: **680.5-011**

Order	Family	Final Determination	Total #
AMPHIPODA	Gammaridae	Gammarus sp.	22
COLEOPTERA	Elmidae	Stenelmis sp.	9
DECAPODA	Cambaridae	Undetermined Cambaridae	1
DIPTERA	Chironomidae	Polypedilum flavum	3
		Microtendipes pedellus gr.	6
		Cricotopus bicinctus	1
		Tvetenia bavarica gr.	2
		Parametriocnemus sp.	7
		Polypedilum fallax gr.	1
		Diamesa sp.	1
	Empididae	Hemerodromia sp.	1
	Simuliidae	Simulium sp.	2
EPHEMEROPTERA	Heptageniidae	Stenacron interpunctatum	1
LUMBRICULIDA	Lumbriculidae	Undetermined Lumbriculidae	1
TRICHOPTERA	Hydropsychidae	Cheumatopsyche sp.	7
		Hydropsyche betteni	17
	Philopotamidae	Chimarra aterrima?	4
		Chimarra socia	14

0 = taxon identified in large/rare scan

Lab Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Waterbody: **Muddy Creek**
Station: **MC_Dwnst Ab**
Collection Date: **9/23/2019** WAA ID: **680.5-012**

Order	Family	Final Determination	Total #
AMPHIPODA	Gammaridae	Gammarus sp.	7
COLEOPTERA	Elmidae	Macronychus glabratus	1
		Stenelmis sp.	17
DIPTERA	Chironomidae	Polypedilum flavum	1
		Brillia sp.	1
		Microtendipes pedellus gr.	1
		Micropsectra/Tanytarsus Complex	1
		Parametriocnemus sp.	2
	Simuliidae	Simulium sp.	1
	Tipulidae	Tipula sp.	1
ODONATA	Coenagrionidae	Undetermined Coenagrionidae	1
TRICHOPTERA	Hydropsychidae	Hydropsyche betteni	24
		Cheumatopsyche sp.	9
	Philopotamidae	Chimarra aterrima?	7
		Chimarra socia	25
TUBIFICIDA	Tubificidae	Undet. Tubificidae w/o cap. setae	1

0 = taxon identified in large/rare scan

Lab Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Waterbody: **Muddy Creek**
Station: **MC_Dwnst Ac**
Collection Date: **9/23/2019** WAA ID: **680.5-013**

Order	Family	Final Determination	Total #
AMPHIPODA	Gammaridae	Gammarus sp.	23
COLEOPTERA	Elmidae	Stenelmis sp.	17
		Macronychus glabratus	1
DECAPODA	Cambaridae	Undetermined Cambaridae	1
DIPTERA	Chironomidae	Tvetenia bavarica gr.	3
		Parametriocnemus sp.	9
		Polypedilum illinoense	1
		Polypedilum fallax gr.	1
		Rheotanytarsus exiguus gr.	1
		Polypedilum flavum	1
	Empididae	Hemerodromia sp.	2
	Simuliidae	Simulium sp.	1
ISOPODA	Asellidae	Caecidotea sp.	2
ODONATA	Calopterygidae	Calopteryx sp.	1
TRICHOPTERA	Hydropsychidae	Hydropsyche betteni	8
		Cheumatopsyche sp.	14
	Philopotamidae	Chimarra aterrima?	14

0 = taxon identified in large/rare scan

Lab Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Waterbody: **Muddy Creek**
Station: **MC_Dwnst Ad**
Collection Date: **9/23/2019** WAA ID: **680.5-014**

Order	Family	Final Determination	Total #
AMPHIPODA	Gammaridae	Gammarus sp.	21
COLEOPTERA	Elmidae	Stenelmis sp.	13
DIPTERA	Chironomidae	Polypedilum illinoense	1
		Rheotanytarsus exiguus gr.	2
		Diamesa sp.	2
		Thienemanniella sp.	1
		Stenochironomus sp.	1
		Polypedilum flavum	1
		Chaetocladius sp.	1
EPHEMEROPTERA	Heptageniidae	Stenacron interpunctatum	3
LUMBRICULIDA	Lumbriculidae	Undetermined Lumbriculidae	1
ODONATA	Calopterygidae	Calopteryx sp.	1
TRICHOPTERA	Hydropsychidae	Hydropsyche betteni	14
		Cheumatopsyche sp.	5
	Philopotamidae	Chimarra socia	23
		Chimarra aterrima?	9
TUBIFICIDA	Naididae	Undetermined Naididae	1

0 = taxon identified in large/rare scan

Stream Field Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Waterbody: **Muddy Creek**
River Basin: **Hudson**
County/State: **Rockland/NY**
Site description: **MC_Dwnst B**

Station: **MC_Dwnst B**
Coll Date: **9/24/2019**

Latitude: **41.069**
Longitude: **-74.02641**
Field Crew: **BR**

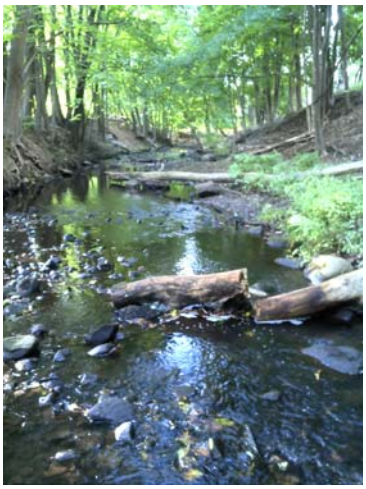
Physical Characteristics	
Depth (meters):	**0.06**
Width (meters):	**17.7**
Current (cm/sec):	**25.06**
Canopy (%):	**90**
Substrate	
Rock (%):	**15**
Rubble (%):	**30**
Gravel (%):	**30**
Sand (%):	**15**
Silt (%):	**10**
Embeddedness (%):	**21**

Chemical Measurements	
DO (mg/L):	**7.09**
DO sat. (%):	**75.6**
Temperature (C):	**18.3**
Spec. Conduct. (umhos):	**1287**
Baro pressure:	
pH:	**7.45**
Salinity (PSS):	**0.65**

Biological Attributes	
Aquatic vegetation	
Macrophytes:	**Yes**
Diatoms:	**Yes**
Algae-suspended:	**A**
Algae-filamentous:	**P**
Occurance of macroinvertebrates	
Ephemeroptera:	**x**
Plecoptera:	
Trichoptera:	**x**
Coleoptera:	
Megaloptera:	
Odonata:	
Chironomidae:	
Simuliidae:	
Decapoda:	**x**
Gammaridae:	**x**
Mollusca:	
Oligochaeta:	**x**
Other macro's:	**Nematode**
Field Faunal Condition:	

Flow

Flow



Notes/observations::

Lab Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Waterbody: **Muddy Creek**
Station: **MC_Dwnst Ba**
Collection Date: **9/24/2019** WAA ID: **680.5-015**

Order	Family	Final Determination	Total #
AMPHIPODA	Gammaridae	Gammarus sp.	25
COLEOPTERA	Elmidae	Stenelmis sp.	20
DECAPODA	Cambaridae	Undetermined Cambaridae	1
DIPTERA	Chironomidae	Micropsectra/Tanytarsus Complex	1
		Parametriocnemus sp.	2
		Tvetenia bavarica gr.	6
	Empididae	Hemerodromia sp.	4
	Simuliidae	Simulium sp.	1
	Tipulidae	Tipula sp.	2
		Limonia sp.	1
EPHEMEROPTERA	Heptageniidae	Stenacron interpunctatum	3
LUMBRICULIDA	Lumbriculidae	Undetermined Lumbriculidae	1
TRICHOPTERA	Hydropsychidae	Hydropsyche betteni	3
		Cheumatopsyche sp.	9
	Philopotamidae	Chimarra aterrima?	4
		Chimarra socia	16
TRICLADIDA		Undetermined Turbellaria	1

0 = taxon identified in large/rare scan

Lab Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Waterbody: **Muddy Creek**
Station: **MC_Dwnst Bb**
Collection Date: **9/24/2019** WAA ID: **680.5-016**

Order	Family	Final Determination	Total #
AMPHIPODA	Gammaridae	Gammarus sp.	19
COLEOPTERA	Elmidae	Stenelmis sp.	20
DIPTERA	Chironomidae	Chaetocladius sp.	1
		Tvetenia bavarica gr.	3
		Parametriocnemus sp.	3
		Paratendipes sp.	1
		Microtendipes pedellus gr.	1
		Micropsectra/Tanytarsus Complex	1
		Cricotopus bicinctus	1
	Empididae	Hemerodromia sp.	3
	Simuliidae	Simulium sp.	1
	Tipulidae	Tipula sp.	2
EPHEMEROPTERA	Heptageniidae	Stenacron sp.	8
ISOPODA	Asellidae	Caecidotea sp.	4
LUMBRICULIDA	Lumbriculidae	Undetermined Lumbriculidae	2
TRICHOPTERA	Hydropsychidae	Hydropsyche betteni	3
		Cheumatopsyche sp.	13
	Philopotamidae	Chimarra aterrima?	4
		Chimarra socia	8
TUBIFICIDA	Tubificidae	Undet. Tubificidae w/o cap. setae	2

0 = taxon identified in large/rare scan

Lab Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Waterbody: **Muddy Creek**
Station: **MC_Dwnst Bc**
Collection Date: **9/24/2019** WAA ID: **680.5-017**

Order	Family	Final Determination	Total #
AMPHIPODA	Gammaridae	Gammarus sp.	30
COLEOPTERA	Elmidae	Stenelmis sp.	25
DIPTERA	Chironomidae	Thienemanniella sp.	1
		Parametriocnemus sp.	5
		Microtendipes pedellus gr.	4
		Tvetenia bavarica gr.	1
		Polypedilum illinoense	1
		Thienemannimyia gr. spp.	2
EPHEMEROPTERA	Heptageniidae	Stenacron interpunctatum	6
TRICHOPTERA	Hydropsychidae	Hydropsyche betteni	4
		Cheumatopsyche sp.	9
	Philopotamidae	Chimarra aterrima?	2
		Chimarra socia	10

0 = taxon identified in large/rare scan

Lab Data Summary

Watershed Assessment Associates
Environmental Services / Biomonitoring / Invertebrate Taxonomy / Professional Training

Waterbody: **Muddy Creek**
Station: **MC_Dwnst Bd**
Collection Date: **9/24/2019** WAA ID: **680.5-018**

Order	Family	Final Determination	Total #
COLEOPTERA	Elmidae	Stenelmis sp.	22
DIPTERA	Chironomidae	Tvetenia bavarica gr.	9
		Parametriocnemus sp.	3
		Paratanytarsus sp.	1
	Tipulidae	Tipula sp.	1
EPHEMEROPTERA	Heptageniidae	Stenacron interpunctatum	1
ISOPODA	Asellidae	Caecidotea sp.	20
LUMBRICULIDA	Lumbriculidae	Undetermined Lumbriculidae	2
TRICHOPTERA	Hydropsychidae	Hydropsyche betteni	1
		Cheumatopsyche sp.	17
	Philopotamidae	Chimarra aterrima?	8
		Chimarra socia	14
TUBIFICIDA	Tubificidae	Undet. Tubificidae w/o cap. setae	1

0 = taxon identified in large/rare scan