HERCULES RADFORD ARMY AMMUNITION PLANT

BENTHIC STUDY

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EXECUTIVE SUMMARY

According to the discharge permit issued to the Hercules Radford Army Ammunition Plant (RAAP) by the Department of Environmental Quality, an annual benthic study must be performed to determine if any environmental impact has occurred within the New River as a result of the RAAP's activities. By comparing this year's findings with those from 1988 through 1995, potential long term impact can be determined.

In general, our findings this year indicate that no impairment to the New River is occurring as a result of the RAAP. There has been a significant change in the stream bed of the New River in comparison with previous years. This change is being attributed to the harsh winter and excessive flooding which occurred in the winter of 1996. In comparing the data from the last eight years, the condition of the New River seems to be unchanged.

INTRODUCTION

The Hercules Radford Army Ammunition Plant is located near Radford, Virginia; all of its outfalls discharging into the New River. The plant manufactures many types of explosives, ammunitions and rocket fuel. During the sampling event, there was no obvious activity which seemed to have any impact on the New River.

Due to the various river conditions at each station, some of the left bank samples were actually taken at midstream (this is further detailed in the Station Description section). The river bed of the New River generally is a mixture of sand and cobble with sheets of bedrock, as well as plentiful growths of elodea and other macrophytes. Several deep holes and large boulders periodically complicated sampling. The section of the New River which was sampled showed signs of flooding and erosion. Periodic changes in the water level of the New River due to the opening of Claytor Lake dam were possible, however, water level changes were not noted during our sampling period.

METHODS AND PROCEDURES

Central Virginia Laboratories and Consultants (CVLC) was contracted to perform a qualitative benthic survey during the delegated time frame and in accordance with requirements discussed in the Hercules RAAP NPDES Permit. The methods used in this study were approved by the Department of Environmental Quality before any analysis was performed. This study consisted mainly of benthic macroinvertebrate identification and general observations of each site in terms of bank erosion or other possible signs of impact.

Samples were collected by E. Carico, D. Maddy, T. Garnier and A. Sisson all of CVLC, on August 26, 1996 through August 28, 1996. Samples were collected between 0800 and 1600 on each of these days. Eleven stations were studied, ten on the New River and one on Stroubles Creek, each with six subsites. The subsites have been broken down to reflect left and right bank samples. Each subsite has been sampled and analyzed in a separate manner, however, after analysis, data for each station was compiled in order to generate taxa richness and total number of organisms found as requested by the client.

At each station, water was tested for average depth, temperature, specific conductance, pH and Dissolved Oxygen.

As requested, the presence or absence of Sphaerotilus at each site has been noted. Sphaerotilus, or "Sewage Fungus" is a bacteria which uses organic carbon as a growth substrate can become over abundant in polluted waters.

All comparisons and conclusions drawn from this study have been performed only against historical data which has been generated from the same sites.

Benthic sampling was performed using the Canton modification of the Hess Stream Bottom Sampler. The sampler is a stainless steel cylinder 33 cm in diameter and 51 cm high. Organisms were obtained by scrubbing and dislodging any and all organisms from rocks and debris contained within the sampler. Next, the substrate within the sampler was disturbed to 15 cm below packed surface or until bedrock was reached, allowing benthic organisms to be collected. All samples, once collected, were preserved in a 70% ethanol solution for transport to the laboratory. At the laboratory, all organisms were classified to the lowest practical taxonomic level. Stations 1 and 2, and the upstream site at Station 10 represent reference controls since they are areas outside of RAAP's discharge zone. All other stations are located adjacent to or below RAAP and municipal point discharges.

Station descriptions

As mentioned earlier, samples were taken from both left and right banks of the New River. The right bank samples were taken to assess areas of direct impact from the RAAP discharges, the left bank samples serve as a comparison for the section of the river. The river is wide enough that the left bank is not directly affected by the RAAP discharges. In some cases, the river current was too swift to safely cross to obtain left bank samples, so in the instances pointed out below, left bank samples were taken from mid-stream.

Station 1 is located just downstream from the State Route 114 bridge, crossing the New River. This site serves as one of the reference sites to which other sites downstream can be compared. This site has improved since last years sampling. The number of organisms was still lower than any other site but in terms of taxa richness it was very much the same as other sites tested. The site itself is used as a public boat launch and appeared very polluted as in the previous three years surveys. The river bed at this site was extremely muddy and silty with little vegetation found. There was a brown floating detergent-like foam present. Also, crayfish and large fish population was noted. Both banks were muddy with exposed clay. Both banks showed evidence of flooding with exposed tree roots, and large pieces of "driftwood" present. Due to stream conditions, right bank samples were taken directly off the right bank and left bank samples were taken directly off the left bank (this is the only site where there is access to both sides of the river). There was no evidence of any Sphaerotilus growth.

Station descriptions (continued)

Station 2 is also upstream from RAAP activities and is used as a reference site to which downstream sites can be compared. At this station the river was more turbid than previous years. This is probably attributed to the excessive rain and run off which occurred within the past year. Samples from this site were taken near the rapids, and left bank samples were taken from mid-stream. There were fallen trees and vegetation hanging in trees which suggests flooding had occurred. Three species of vegetation were observed. A large population of snails and bivalves were present. A few minnows were present, as were water striders. Heron and small Copperhead snake were also present. There was no evidence of Sphaerotilus growth.

Station 3 is located below the Oleum plant discharge and also has a stormwater outfall which discharges nearby. The stream-bed was observed to be muddy and silty in the 1995 study and is no longer the case this year. The water was noted to be more turbid than usual, possibly caused by storm drain run off, or by the flooding which occurred within the previous year. There was floating foam present as it was last year. The left bank samples were taken midstream at the island due to extreme current flow on the other side of the centrally located island. Fish snails and bivalves were abundant. There was no evidence of Sphaerotilus growth.

Station descriptions (continued)

Station 4 is located directly upstream from the RAAP bridge which crosses the New River. Near shore the stream-bed was muddy and silty. Mid-stream the stream-bed consisted mainly of exposed bedrock. Bivalves and their shells are abundant as are snails. Dead trees and limbs are readily found, indicating flooding has occurred. There were signs of litter in the middle of the river at this site along with floating foam found throughout. Left bank samples were taken from mid-stream. There was no evidence of Sphaerotilus growth.

Station 5 is located at the Power Plant effluent discharge point. Conditions of the river bank and stream-bed are similar to last year. The river bank and shore were muddy with various sized rocks and boulders. The river-bed consisted mostly of bedrock and various sized rocks. The water at this site was also more turbid than usual as discussed earlier. Two types of vegetation were noted at this site. Again, snails and bivalves were abundant. The Power plant Outfall was observed directly and no environmental impact was observed. The left bank samples were taken mid-stream. There was no evidence of Sphaerotilus growth.

Station 6 is located below the combined effluent discharge. The river bed consisted of rocks of various sizes and exposed bedrock. A slick algae covered the rocks near shore. On the left bank side of the island the water is much deeper. The island has plentiful vegetation, showing that the middle of the stream has suitable living conditions for vast vegetation. The island and shore showed evidence of flooding. Stream conditions appear normal; water striders, bivalves, minnows and snails were present. A snapping turtle and deer were also present.

Station Descriptions (continued)

There was no evidence of Sphaerotilus growth this year. Sphaerotilus was spotted at this site in 1995 which was the first time it had been present in five years. At this site, left bank samples were taken midstream.

Station 7 is located downstream of the Blacksburg-Virginia Polytechnic Institute sewage treatment plant. Floating foam and a distinct "treated" odor were present at the outfall. The river bed was largely composed of small rocks, sand and exposed bedrock. Two species of vegetation are present with snails, bivalves, bluegill ducks and Heron observed. Erosion was noted on the right bank with muddy conditions and tree roots exposed. There was no evidence of Sphaerotilus growth this year as was found in 1994 and 1995. Slick algae covered the rocks where the effluent met the river. There was a noticeable difference in the conductivity between the outfall and the benthic site. The outfall exhibited a Conductivity of 523 umhos versus 110 umhos found at the benthic site. This difference in conductivity did not appear to pose any hazard to the benthic community. At this site, sampling transected three-fourths of the stream width.

Station 8 is located downstream from the Stroubles Creek-New River confluence. This site is also across from the waste-fuel burning area. The stream itself was very shallow and swift with two islands in the center. The stream bed was composed of various sized rocks, silt and some exposed bedrock. Two types of vegetation were noted, with algae and moss covering the rocks near shore. Floating foam was also present. Water beetles were present near shore with several fish and leeches spotted.

Station descriptions (continued)

There was no evidence of Sphaerotilus growth, consistent with observations since 1989. This station was transected three quarters of the was across when sampled.

Station 9 is located near the lower magazine area. The river bed consisted of small rocks and sand with some exposed bedrock. There was evidence of flooding at the site with fallen trees and aquatic vegetation on tree limbs. Several small springs line the right bank of this site and empty directly into the river. The water current at this site was very steady and swift. Minnows, bivalves and snails were observed along with a river otter were observed. Three types of vegetation were found. A lot of broken glass and litter were noted at this site, as the right bank does have a picnic area. Left bank samples were taken from the island to midstream. There was no evidence of Sphaerotilus growth.

Station 10 is divided into two sections, the upstream and the downstream of the TNT plant on Stroubles Creek. This station was very narrow and was very easy to transect completely. The stream bed was composed mainly of rocks and boulders with exposed bedrock which is different from last year when this site was very silty. Crayfish and minnows and larger fish were present. At site "10 down" some floating foam was noted to be present. The overall condition of this site was good. There was no evidence of Sphaerotilus growth.

Station descriptions (continued)

Station 11 is the farthest away from the RAAP and is downstream from all of the above stations. This site serves as a reference site. This station is fairly new and had not been sampled before 1991. The river bed had a large amount of plant growth. The bank was quite muddy with the stream-bed consisting of various sized rocks and some exposed bedrock. The samples for this site were collected upstream from the riffle zone. Several small fish, bivalves, snails and water beetles were observed at this station. There was no evidence of Sphaerotilus growth at this station.

Chemical and Physical Measurements

Measurements performed in the field included pH, Dissolved Oxygen, temperature and conductivity. The pH and temperature readings were taken using an Orion 250A meter, the Dissolved Oxygen readings were performed using a YSI field meter and the conductivity readings were taken using an Orion meter. All meters were calibrated before measurement at each site.

Biological Sampling

As requested by the contract proposal, biological samples were collected using the Canton Modification of the Hess Stream Bottom Sampler. This sampling method has only been used for the last three sampling events. All sampling events performed before 1991 were performed using a "D" frame kick net. It is important to note, however, when comparing data from 1991 through 1996 to all other historical data, due to different techniques, discrepancies in organism numbers could be noted. For example when sampling with a Hess Bottom sampler a defined area is all that is sampled, when sampling with a "D" frame kick net an undetermined area is sampled due to the size of the individuals foot, stride or the angle of the foot when kicking. As mentioned earlier, this may not affect the total number of taxa found, however it can affect the actual numbers of each of those taxa found.

Biological Sampling (continued)

At each station, six samples were taken, three representing the right bank transection and three representing the left bank transection. Each of the subsites were kept separate and were preserved in 70% ethanol for transport to the laboratory. Once at the laboratory, the organisms were sorted by station and subsite into order classifications. From the order classifications, the organisms were further sorted into the lowest practical taxonomic classification (Family, Genus and species). Using the findings of the laboratory enumeration, data was compiled to determine taxa richness.

RESULTS

Chemical Data

On the days of sample collection, all of the analyses were normal in comparison with historical data. As in the past, the test sites had basic pH readings ranging from 6.98 to 8.80 S.U. and Dissolved Oxygen readings were suitable for aquatic life, ranging from 7.7 to 10.4 mg/l. Temperatures were also constant throughout the river ranging from 19.0 degrees to 23.0 degrees Celsius. Overall chemical conditions at all of the sites were very good.

Biological Data

The number of organisms collected at each station ranged from 72 found at Station 1 to 405 organisms found at Station 11. Station 1 has continued to show a decrease in numbers of organisms compared with all previous samplings dating back to 1988. This could be attributed to the fact that station is now used as a boat launching area and is used by the public frequently. State Route 114 bridge has been widened and the increased surface area of the bridge could potentially cause more run-off and, therefore, more pollution to that site. These findings are the same as previous years.

The number of taxa found at the stations directly affected by RAAP were about the same with what was found in 1995. This would suggest that there has been no new impact to the New River at least within the previous calendar year and in comparing with the last six years of data, the stream bed is continuing to thrive after the stress of recent flooding and severe impairment caused by the Sphaerotilus growth which occurred in the late 1980's.

In comparison with the historical data, the taxa richness is the same this year. Station 1 is a reference site and its impairment appears not to be related to the activities of Hercules RAAP. Overall, taxa diversity showed no signs of impairment as a result of Hercules RAAP discharges.

Biological Data (continued)

In the 1991 through 1995 surveys, the river was dominated by Mayflies and clams. This appears to be true for the 1996 survey as well except for the fact that the Caddisflies (Trichoptera) have also become more dominant. The fact that the Mayflies (Ephemeroptera) and Caddisflies (Trichoptera) are present, shows that the river is conducive to aquatic life. Mayflies and Caddisflies are two of the most pollutant sensitive insects and can therefore be very indicative of the quality of the water conditions in a river system. The fact that they have been thriving for the last several years shows that river conditions are favorable for aquatic life. In 1990 there was a noticeable drop in the number of clams found; in 1991 they were again dominant and the 1992 report does not have any reference to them. As mentioned earlier, they were another dominant species found during the 1993 through 1996 surveys; however, they are a very pollution tolerant species and their presence may or may not give any indication as to the water quality. CVLC feels that the presence of the mayflies, caddisflies and other naturally occurring biological life indicates that river conditions continue to remain favorable.

CONCLUSIONS

This study was performed to determine if any impact has occurred to the New River as a result of activities performed by Hercules Radford Army Ammunition Plant. In comparison with historical data, river conditions seem to have changed as a result of severe snow runoff and flooding which occurred in the winter of 1995-1996. These changes have caused more bedrock to be exposed within the stream-bed, which can leave less area for benthic organisms to thrive. Overall organism numbers and taxa richness do not show that the increase of exposed bedrock has caused that to happen this year. The changes which have occurred to the stream-bed this year appear to have occurred as the result of natural ecological cycles, not because of any activities occurring at RAAP. There was no Sphaerotilus found at any of the locations this year which would potentially effect benthic organisms. There appears to be no current negative impacts on benthic macroinvertebrates of the New River as a result of the activities of Hercules RAAP.

TABLE I

WATER CHEMISTRY FOR RAAP BENTHIC STUDY

September 1996 Study, CVLC

Station #	Water Depth (cm)	Temp. °C	Specific conductance (umhos)	pH (S.U.)	Dissolved Oxygen (mg/l)
1	0 - 48	21.0	79	6.98	7.7
2	0 - 53	21.0	93	7.25	8.3
3	0 - 42	21.0	88	7.32	10.0
4	0 - 50	23.0	87	7.28	8.4
5	0 - 42	23.0	87	7.30	8.2
6	0 - 47	22.0	97	7.14	7.7
7	0 - 35	22.0	110	7.20	8.3
8	0 - 78	22.0	110	7.01	8.1
9	0 - 40	22.0	104	7.49	9.8
10 Up	0 - 17	19.0	348	8.18	9.2
10 Down	0 - 24	19.0	380	8.80	10.4
11	0 - 37	22.0	97	7.33	9.3

TABLE II

TOTAL TAXA, RIGHT BANK VS. LEFT BANK

September 1996 Study, CVLC

Station #	1	2	3	4	5	6	7	8	9	10	11
Right Bank (Up)	8	9	10	10	9	6	10	11	6	12	15
Left Bank (Down)	10	10	10	7	6	11	11	6	7	14	9

TABLE III

Organism density per Site and Station

Station # 1

Insecta	Right Bank				Left Bank			
Ephemeroptera	1	2	3	Total	1	2	3	Total
Heptageniidae Stenonema	1			1	2	1	2	5
Arthoplea								
Siphlonuridae Isonychia		1	2	3	7		5	12
Baetidae Beatis			2	2			1	1
Pseudocloeon								
Ephemeridae Ephemera								
Odonata								
(Zygoptera) Coenagrionidae Argia								
(Anisoptera) Gomphidae Gomphus								
Trichoptera								
Hydroptilidae spp.								
Hydropsychidae Hydropsyche					1			1
Brachycentridae Brachycentrus	1			1				
Helicopsychidae Helicopsyche		3						
Megaloptera								
Sialidae Sialis								
Corydalidae Corydalus							1	1
Diptera					5			5
Chironimidae								
Simulidae	2			2				
Plecoptera								
Perlidae Perlinella								
Neuroptera Sisrydae								

Organism density per Site and Station

Station # 1

Insecta, Continued	Right Bank				Left Bank			
	1	2	3	Total	1	2	3	Total
Diptera								
Tipulidae								
Coleoptera								
Elmidae Stenelmis								
Psephenidae Psephenus								
Non-Insecta								
Annelida								
(Oligochaeta) Tubificidae	5	2		7	5		2	7
Naididae								
(Hirudinea) Hirudinidae (Leeches)								
Amphipoda								
Gammaridae Gammarus			1	1	1		1	2
Turbellaria								
(Tricladida) Planariidae Dugesia								
Decapoda (Crayfish, Shrimp)								
Astacidae Cambarus								
Pelecypoda (Clams)								
Corbiculidae Corbicula (Clams)	7			7	8	1	2	11
Gastropoda (Snails)						1	2	3

Table III

Organism density per Site and Station

Station # 2

Insecta	Right Bank				Left Bank			
Ephemeroptera	1	2	3	Total	1	2	3	Total
Heptageniidae Stenonema					8		1	9
Arthoplea								
Siphlonuridae Isonychia	8	3	4	15	14	8	11	33
Baetidae Beatis	14	41	3	58	11	8	20	40
Pseudocloeon								
Ephemeridae Ephemera								
Odonata								
(Zygoptera) Coenagrionidae Argia								
(Anisoptera) Gomphidae Gomphus	2			2		1		1
Trichoptera								
Hydroptilidae spp.								
Hydropsychidae Hydropsyche	69	10	4	83	2	9	15	26
Brachycentridae Brachycentrus					2			2
Helicopsychidae Helicopsyche								
Megaloptera								
Sialidae Sialis								
Corydalidae Corydalus	3	1		4				
Diptera								
Chironimidae							1	1
Simulidae								
Plecoptera								
Perlidae Perlinella								
Neuroptera Sisrydae								

Organism density per Site and Station

Station # 2

Insecta, Continued	Right Bank				Left Bank			
	1	2	3	Total	1	2	3	Total
Diptera								
Tipulidae								
Coleoptera	3			3			7	7
Elmidae Stenelmis								
Psephenidae Psephenus								
Non-Insecta								
Annelida								
(Oligochaeta) Tubificidae								
Naididae		1		1				
(Hirudinea) Hirudinidae								
Amphipoda								
Gammaridae Gammarus								
Turbellaria								
(Tricladida) Planariidae Dugesia								
Decapoda								
Astacidae Cambarus								
Pelecypoda	5	10	21	36	2	9	14	25
Corbiculidae Corbicula								
Gastropoda	4	16		20	1	14	6	21

Table III

Organism density per Site and Station

Station # 3

Insecta	Right Bank				Left Bank			
Ephemeroptera	1	2	3	Total	1	2	3	Total
Heptageniidae Stenonema								
Arthoplea								
Siphlonuridae Isonychia		1	2	3	2	1	2	5
Baetidae Beatis	1		1	1	10			10
Pseudocloeon								
Ephemeridae Ephemera								
Odonata								
(Zygoptera) Coenagrionidae Argia								
(Anisoptera) Gomphidae Gomphus							3	3
Trichoptera								
Hydroptilidae spp.								
Hydropsychidae Hydropsyche	4	3	1	8	3		4	7
Brachycentridae Brachycentrus	2		1	3	3		2	5
Helicopsychidae Helicopsyche								
Megaloptera								
Sialidae Sialis								
Corydalidae Corydalus	1	2		3	1			1
Diptera								
Chironimidae								
Simulidae								
Plecoptera								
Perlidae Perlinella								
Neuroptera Sisrydae								

Organism density per Site and Station

Station # 3

Insecta, Continued	Right Bank				Left Bank			
	1	2	3	Total	1	2	3	Total
Diptera								
Tipulidae			1	1				
Coleoptera	2	2	1	5	12		7	19
Elmidae Stenelmis								
Psephenidae Psephenus								
Non-Insecta								
Annelida								
(Oligochaeta) Tubificidae								
Naididae		1		1				
(Hirudinea) Hirudinidae (Leeches)								
Amphipoda								
Gammaridae Gammarus						1		1
Turbellaria								
(Tricladida) Planariidae Dugesia								
Decapoda								
Astacidae Cambarus								
Pelecypoda								
Corbiculidae Corbicula (Clams)	17	11		28	5	2	4	11
Gastropoda (Snails)	25	20	9	54	28	9	28	65

Table III

Organism density per Site and Station

Station # 4

Insecta	Right Bank				Left Bank			
Ephemeroptera	1	2	3	Total	1	2	3	Total
Heptageniidae Stenonema	10			10		7	1	8
Arthoplea								
Siphlonuridae Isonychia	4		2	6		4	6	10
Baetidae Beatis	10	16	9	35		17	15	32
Pseudocloeon								
Ephemeridae Ephemera								
Odonata								
(Zygoptera) Coenagrionidae Argia								
(Anisoptera) Gomphidae Gomphus		1		1				
Trichoptera								
Hydroptilidae spp.								
Hydropsychidae Hydropsyche	1	3	1	5	1	1		2
Brachycentridae Brachycentrus								
Helicopsychidae Helicopsyche	1			1			3	3
Megaloptera								
Sialidae Sialis								
Corydalidae Corydalus	1	1		2				
Diptera								
Chironimidae								
Simulidae								
Plecoptera								
Perlidae Perlinella								
Neuroptera Sisrydae								

Organism density per Site and Station

Station # 4

Insecta, Continued	Right Bank				Left Bank			
	1	2	3	Total	1	2	3	Total
Diptera								
Tipulidae								
Coleoptera			1	1				
Elmidae Stenelmis								
Psephenidae Psephenus								
Non-Insecta								
Annelida								
(Oligochaeta) Tubificidae								
Naididae								
(Hirudinea) Hirudinidae								
Amphipoda								
Gammaridae Gammarus								
Turbellaria								
(Tricladida) Planariidae Dugesia								
Decapoda								
Astacidae Cambarus								
Pelecypoda	1			1	22		1	23
Corbiculidae Corbicula								
Gastropoda	1	60	15	76	10	26	35	71

Table III

Organism density per Site and Station

Station # 5

Insecta	Right Bank				Left Bank			
Ephemeroptera	1	2	3	Total	1	2	3	Total
Heptageniidae Stenonema	3		2	5	2	1	4	7
SPP	1			1				
Siphlonuridae Isonychia					1	3		4
Baetidae Beatis	2			2				
Pseudocloeon								
Ephemeridae Ephemera			4	4				
Odonata								
(Zygoptera) Coenagrionidae Argia								
(Anisoptera) Gomphidae Gomphus								
Trichoptera								
Hydroptilidae spp.								
Hydropsychidae Hydropsyche			2	2		1		1
Brachycentridae Brachycentrus		3	1	4	2		1	3
Helicopsychidae Helicopsyche								
Megaloptera								
Sialidae Sialis								
Corydalidae Corydalus								
Diptera								
Chironimidae								
Simulidae								
Plecoptera								
Perlidae Perlinella								
Neuroptera Sisrydae								

Organism density per Site and Station

Station #5

Insecta, Continued	Right Bank				Left Bank			
	1	2	3	Total	1	2	3	Total
Diptera								
Tipulidae								
Coleoptera								
Elmidae Stenelmis								
Psephenidae Psephenus	1			1				
Non-Insecta								
Annelida								
(Oligochaeta) Tubificidae								
Naididae								
(Hirudinea) Hirudinidae								
Amphipoda								
Gammaridae Gammarus								
Turbellaria								
(Tricladida) Planariidae Dugesia								
Decapoda								
Astacidae Cambarus								
Pelecypoda	23	9		32		2		2
Corbiculidae Corbicula								
Gastropoda		4	8	12	3	3	6	12

Table III

Organism density per Site and Station

Station # 6

Insecta	Right Bank				Left Bank			
Ephemeroptera	1	2	3	Total	1	2	3	Total
Heptageniidae Stenonema		1		1	2			2
Arthoplea								
Siphlonuridae Isonychia					2		1	3
Baetidae Beatis					1			1
Pseudocloeon								
Ephemeridae Ephemera								
Odonata								
(Zygoptera) Coenagrionidae Argia							1	1
(Anisoptera) Gomphidae Gomphus								
Trichoptera								
Hydroptilidae spp.								
Hydropsychidae Hydropsyche	2			2	1	1		2
Brachycentridae Brachycentrus		1		1	1			1
Helicopsychidae Helicopsyche								
Megaloptera								
Sialidae Sialis								
Corydalidae Corydalus							1	1
Diptera								
Chironimidae						1		1
Simulidae								
Plecoptera								
Perlidae Perlinella								
Neuroptera Sisrydae								

Organism density per Site and Station

Station # 6

Insecta, Continued	Right Bank				Left Bank			
	1	2	3	Total	1	2	3	Total
Diptera								
Tipulidae								
Coleoptera								
Elmidae Stenelmis								
Psephenidae Psephenus						1		1
Non-Insecta								
Annelida								
(Oligochaeta) Tubificidae		2		2				
Naididae								
(Hirudinea) Hirudinidae								
Amphipoda								
Gammaridae Gammarus								
Turbellaria								
(Tricladida) Planariidae Dugesia								
Decapoda								
Astacidae Cambarus								
Pelecypoda								
Corbiculidae Corbicula	7	1	9	17		16	4	20
Gastropoda	9	2	10	21	1	2	2	5

Table III

Organism density per Site and Station

Station # 7

Insecta	Right Bank				Left Bank			
Ephemeroptera	1	2	3	Total	1	2	3	Total
Heptageniidae Stenonema	2	3		5				
Arthoplea								
Siphlonuridae Isonychia	2			2	5			5
Baetidae Beatis		3		3	29			29
Pseudocloeon								
Ephemeridae Ephemera								
Odonata								
(Zygoptera) Coenagrionidae Argia								
(Anisoptera) Gomphidae Gomphus								
Trichoptera								
Hydroptilidae spp.								
Hydropsychidae Hydropsyche	6			6	4	1		5
Brachycentridae Brachycentrus	1			1				
Helicopsychidae Helicopsyche								
Megaloptera								
Sialidae Sialis								
Corydalidae Corydalus	2			2	2		1	3
Diptera								
Chironimidae							1	1
Simulidae								
Plecoptera								
Perlidae Perlinella								
Neuroptera Sisrydae								

Organism density per Site and Station

Station # 7

Insecta, Continued	Right Bank				Left Bank			
	1	2	3	Total	1	2	3	Total
Diptera								
Tipulidae								
Coleoptera					1		1	2
Elmidae Stenelmis								
Psephenidae Psephenus								
Non-Insecta								
Annelida								
(Oligochaeta) Tubificidae								
Naididae	1			1			2	2
(Hirudinea) Hirudinidae							1	1
Amphipoda								
Gammaridae Gammarus	2	1	1	4	2		1	3
Turbellaria								
(Tricladida) Planariidae Dugesia								
Decapoda								
Astacidae Cambarus								
Pelecypoda								
Corbiculidae Corbicula	1	17	4	22	4	6	1	11
Gastropoda	12	24	24	60	20	14	2	36

Table III

Organism density per Site and Station

Station # 8

Insecta	Right Bank				Left Bank			
Ephemeroptera	1	2	3	Total	1	2	3	Total
Heptageniidae Stenonema	1	1		2				
Arthoplea								
Siphlonuridae Isonychia	1	3	1	5		3		3
Baetidae Beatis			1	1		11	1	12
Pseudocloeon								
Ephemeridae Ephemera								
Odonata								
(Zygoptera) Coenagrionidae Argia								
(Anisoptera) Gomphidae Gomphus								
Trichoptera								
Hydroptilidae spp.								
Hydropsychidae Hydropsyche						11		11
Brachycentridae Brachycentrus	1	1		2		3	1	4
Helicopsychidae Helicopsyche								
Megaloptera								
Sialidae Sialis								
Corydalidae Corydalus								
Diptera								
Chironimidae								
Simulidae	1	1		2				
Plecoptera								
Perlidae Perlinella								
Neuroptera Sisrydae								

Organism density per Site and Station

Station # 8

Insecta, Continued	Right Bank				Left Bank			
	1	2	3	Total	1	2	3	Total
Diptera								
Tipulidae								
Coleoptera		1	4	5				
Elmidae Stenelmis								
Psephenidae Psephenus	2	6		8				
Non-Insecta								
Annelida								
(Oligochaeta) Tubificidae		1		1				
Naididae			1	1				
(Hirudinea) Hirudinidae								
Amphipoda								
Gammaridae Gammarus								
Turbellaria								
(Tricladida) Planariidae Dugesia								
Decapoda								
Astacidae Cambarus								
Pelecypoda								
Corbiculidae Corbicula		12	11	23	3		1	4
Gastropoda		4	1	5		20	12	32

Table III

Organism density per Site and Station

Station # 9

Insecta	Right Bank				Left Bank			
Ephemeroptera	1	2	3	Total	1	2	3	Total
Heptageniidae Stenonema								
Arthoplea								
Siphlonuridae Isonychia								
Baetidae Beatis	1	5		6	2	2		4
Pseudocloeon								
Ephemeridae Ephemera								
Odonata								
(Zygoptera) Coenagrionidae Argia								
(Anisoptera) Gomphidae Gomphus	2	2		4		1		1
Trichoptera								
Hydroptilidae spp.								
Hydropsychidae Hydropsyche	11	28	1	40			2	2
Brachycentridae Brachycentrus								
Helicopsychidae Helicopsyche								
Megaloptera								
Sialidae Sialis								
Corydalidae Corydalus								
Diptera								
Chironimidae								
Simulidae								
Plecoptera								
Perlidae Perlinella								
Neuroptera Sisrydae								

Organism density per Site and Station

Station # 9

Insecta, Continued	Right Bank				Left Bank			
	1	2	3	Total	1	2	3	Total
Diptera								
Tipulidae								
Coleoptera								
Elmidae Stenelmis								
Psephenidae Psephenus		1		1	1			1
Non-Insecta								
Annelida								
(Oligochaeta) Tubificidae							2	2
Naididae								
(Hirudinea) Hirudinidae								
Amphipoda								
Gammaridae Gammarus								
Turbellaria								
(Tricladida) Planariidae Dugesia								
Decapoda								
Astacidae Cambarus								
Pelecypoda								
Corbiculidae Corbicula		7	16	23	63	13	2	78
Gastropoda	2	7	7	16	9	4		13

Table III

Organism density per Site and Station

Station # 10

Insecta	Right Bank (Up)				Left Bank (Down)			
Ephemeroptera	1	2	3	Total	1	2	3	Total
Heptageniidae Stenonema	1	1		2		3	9	12
Arthoplea	3		2	5		2	1	3
Siphlonuridae Isonychia	1	3	2	6				
Baetidae Beatis	10	35	3	48	16		30	46
Pseudocloeon								
Ephemeridae Ephemera								
Odonata								
(Zygoptera) Coenagrionidae Argia								
(Anisoptera) Gomphidae Gomphus							1	1
Trichoptera						1		1
Hydroptilidae spp.								
Hydropsychidae Hydropsyche		3	1	4	1	2	2	5
Brachycentridae Brachycentrus								
Helicopsychidae Helicopsyche					1		1	2
Megaloptera								
Sialidae Sialis								
Corydalidae Corydalus	1	1		2	1	2	1	4
Diptera								
Chironimidae								
Simulidae			1	1		1	1	2
Plecoptera								
Perlidae Perlinella	3			3				
Neuroptera Sisrydae			1	1				

Organism density per Site and Station

Station # 10

Insecta, Continued	Right Bank (Up)				Left Bank (Down)			
	1	2	3	Total	1	2	3	Total
Diptera								
Tipulidae								
Coleoptera	8	2	1	11	19	5	22	46
Elmidae Stenelmis								
Psephenidae Psephenus	4	10	2	16	3	1	16	20
Acneus								
Non-Insecta								
Annelida								
(Oligochaeta) Tubificidae	4	2	1	7	4		1	5
Naididae								
(Hirudinea) Hirudinidae								
Amphipoda								
Gammaridae Gammarus								
Turbellaria								
(Tricladida) Planariidae Dugesia								
Decapoda								
Astacidae Cambarus							1	1
Pelecypoda								
Corbiculidae Corbicula					1			1
Gastropoda								

Table III

Organism density per Site and Station

Station # 11

Insecta	Right Bank				Left Bank			
Ephemeroptera	1	2	3	Total	1	2	3	Total
Heptageniidae Stenonema								
Arthoplea		1		1				
Siphlonuridae Isonychia		1		1			1	1
Baetidae Beatis		5		5				
Pseudocloeon								
Ephemeridae Ephemera					1			1
Odonata								
(Zygoptera) Coenagrionidae Argia								
(Anisoptera) Gomphidae Gomphus	1			1				
Trichoptera								
Hydroptilidae spp.		2		2				
Hydropsychidae Hydropsyche		8	1	9	8	9	6	23
Brachycentridae Brachycentrus		1		1				
Helicopsychidae Helicopsyche		10		10		3	3	6
Megaloptera								
Sialidae Sialis								
Corydalidae Corydalus	4	2		6	1			1
Diptera								
Chironimidae								
Simulidae								
Plecoptera							1	1
Perlidae Perlinella								
Neuroptera Sisrydae								

Organism density per Site and Station

Station # 11

Insecta, Continued	Right Bank				Left Bank			
	1	2	3	Total	1	2	3	Total
Diptera								
Tipulidae								
Coleoptera		11	9	20	3	1	2	6
Elmidae Stenelmis								
Psephenidae Psephenus								
Non-Insecta								
Annelida								
(Oligochaeta) Tubificidae		1		1				
Naididae								
(Hirudinea) Hirudinidae	1			1				
Amphipoda								
Gammaridae Gammarus	6			6				
Turbellaria								
(Tricladida) Planariidae Dugesia								
Decapoda								
Astacidae Cambarus								
Pelecypoda								
Corbiculidae Corbicula	1	3	103	107	113	17	30	160
Gastropoda	8		15	23		6	6	12

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TABLE IV

PERCENT COMPOSITION PER STATION

September 1996 Study, CVLC

Station #	1	2	3	4	5	6	7	8	9	10	11
Total # of Org.	72	387	234	287	92	82	204	121	191	255	405
TAXA	*	*	*	*	*	*	*	*	*	*	*
Ephemeroptera	33	40	8	35	25	8.5	21	19	5	48	2.2
Odonata	0	0.7	1.2	0.3	0	1.2	0	0	2.6	0.7	0.2
Trichoptera	3	29	9.8	3.8	11	7.3	5.8	14	22	4.3	12
Megaloptera	1.4	1	1.7	0.6	0	1.2	2	0	0	2.3	1.7
Diptera	9.7	0.3	0.4	0	0	1.2	0.4	1.6	0	1.1	0
Plecoptera	0	0	0	0	0	0	0	0	0	1.1	0.2
Neuroptera	0	0	0	0	0	0	0	0	0	0.4	0
Coleoptera	0	2.6	10	0.3	0.1	1.2	0.9	11	1	36	6.4
Annelida	19	0.3	0.4	0	0	2.4	1.9	1.2	1	4.7	0.4
Amphipoda	4.2	0	0.4	0	0	0	3.4	0	0	0	1.5
Decapoda	0	0	0	0	0	0	0	0	0	0.4	0
Pelecypoda	25	16	17	83	37	45	16	22	53	0.4	66
Gastropoda	4.2	11	51	51	26	32	4.7	31	15	0	8.6

Number of Organisms (% Taxa)

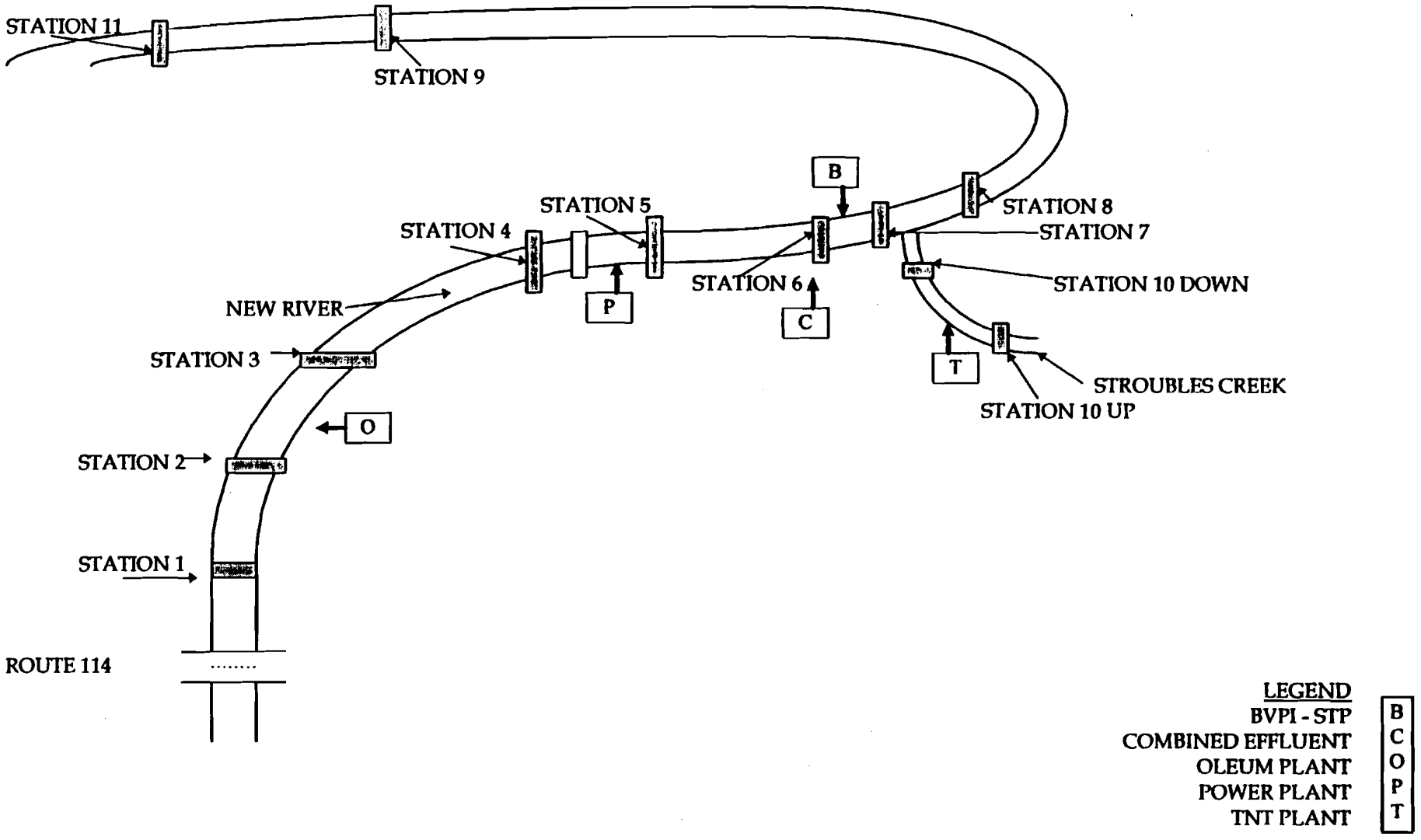

FIGURE 1: Sample stations on the New River and Stroubles Creek near RAAP.

"Rite in the Rain"
ALL-WEATHER WRITING PAPER ®

Name Lou Martin

Address

Phone (540) 639-7514

Project Hercules Benthics Study

Site #1 date - 8/28/16
[L. Bank] [Rt. Bank] time - 0800
pH - 7.02 / 6.96
temp - 21 °C / 21.0 °C
D.O. - 7.7 mg/L / 7.6 mg/L
Depth range - 110 cm/48" (120 cm)
Conductivity - 78 µmhos / 79 µmhos

Substrates - Absent

Observations - Left bank - site is located downstream under large bridge. River bottom here is muddy & silty w/ much litter, campfires, old tires, some erosion on bank and evidence of flooding. Could only get about 15' out - next is deep hole. Some water beetles; some floating foam. Construction is going on under bridge. Many birds are gathered on overhead power lines. 1 species aquatic vegetation - very little observed. River bed shows few rocks and no bedrock but much silt and leaf litter. Minnows were spotted. Some of the shoreline is exposed clay. Tree roots also exposed. Crayfish & larger fish

Site #1 (cont.)

Right bank – site is near Christianity
to Authority plant. Shoreline muddy
w/ some trash, reed-like vegetation
on shore. Some Canada geese
were spotted, also water beetles,
minnows. River muddy
and silty as before. Same evidence
of flooding as on left bank. Some
large rocks and driftwood on
riverbed. Large fish jumping

Site #2 3/26/96
0950

pH - 7.2 S.U.
Temp - 21°C
D.O. - 8.3 mg/L
Depth range - 132cm
Conductivity - 93 µmhos

Sphaerotilus - Absent

Observations - Site upstream from small rapids. ~~Two~~ Three species of vegetation occur here. Current is swift here. Snails and bivalves abundant. Water seems more turbid than previous years. May be caused by excessive rainfall for this time of year. Could only get about 1/3 across river before it became too deep. River bottom consists of rocks of various sizes with little bedrock exposed. This site is located ~~on~~ beside a diversion dam on the right bank. The dam does not

Site # 2 (Cont'l)
appear to be in use.
Fallen trees provide evidence
of flooding. As last year &
previous years, large cement
blocks are collected here.
It seems as if something
man made was destroyed and
left as waste. Slick algae
occurs on rocks where ~~rapids~~
water runs over them. More
evidence of flooding ~~in the branches.~~
Where aquatic vegitation is
clinging to limbs on trees.
Some floating foam but
not collecting on shore.
A brown 2-foot snake
was encountered walking
to the site. Probably a
~~moc~~ Copperhead. Herons
spotted. Crayfish spotted
walking over vegetation.
Whirly beetles and water
striders spotted near shore.
Minnows also spotted

Site # 3 08-26-96 1200

pH - 7.32
temp - 21.0°C
D.O. - 10.0mg/l
Depth range - ~~250cm~~ 45 106cm
Conductivity - 88 µmhs

Sphaerotilus - Absent

Observations - Site is downstream from small rapids and small island in middle of river. Many smaller rocks, Power lines overhead and steam pipes downstream. Some evidence of flooding. Fish jumping. Current fairly swift. Cave in rock wall across the river (left bank). Snails and bivalves abundant. Some floating foam evident but not collecting on shore. No bedrock showing in substrate, one species of vegetation present, Some small birds flying low over river. (Barn swallows) Could only get 1/2 way across river. Small colony of whirly beetles near shore. Steampipes are

60

~~for~~

are used as a head source. Water still move faster than usual. Very little silt or sand here.

Site # 4 08/26/96
1445

pH - 7.28 S.U.
temp - 23°C
D.O. - 8.4 mg/L
Depth range - ~~12~~ 0-125 cm 50 in
Conductivity - 87 µmhos

Sphaeroticus - Absent

Observations - This site is located on the left side of bridge. Water seems to be calm here. Near shore the river bottom is muddy and silty. Towards the middle there are few rocks. The bottom ~~is mos~~ mostly consists of ~~be~~ exposed bedrock. Bivalves and snails are abundant. Some floating foam but not collecting on shore. Very little vegetation. (one specie). Fallen trees and aquatic vegetation on limbs indicate flooding has occurred.

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Site 4 (Cont)

Tree limbs on the stanchions of the bridge also indicate flooding. Water striders spotted. Sucker fish also spotted (probably a hog-nosed sucker. Some litter found towards the middle of river. Got 2/3 the way across the River

Site # 5 8/26/96
1600

pH - 7.30 S.U.
Temp - 23°C
D.O. - 8.2 mg/L
Depth range - 0-105 cm
Conductivity - 87 umhos

Sphaerotilus - Absent

Observations - This site is located downstream from bridge. More evidence of flooding on river-bank - fallen trees & vegetation on limbs. A large population of water striders are just off shore. Very little vegetation - two species. Conditions here are similar to site # 4 - muddy ~~bot~~ banks & silty shore, mainly exposed bedrock and rocks of various sizes. Bivalves and snails abundant. Water is still more turbid than usual. A large caterpillar nest can be seen on the left bank.

Site # 5 (cont)

Could only get about 1/3 across river. About 50 yds downstream there is an outfall discharging into the river. I walked up to observe the outfall and there was no obvious impact. Some floating foam but not collecting on shore.

Site # 6 08/27/96
1225

pH - 7.14
temp - 22°C
D.O. - 7.7 mg/L
Depth range - 0-47" (0-118cm)
Conductivity - ~~88~~ 97 µmhos

Sphaerotilus - Absent

Observations - This site is located just downstream from Alliant Effluent A & B. A slick algae covers the rocks near shore. About 30 yds of the right bank is an island. A large population of minnows surrounds the island in shallow water. Water striders are also present around the island and of the right bank. Water is calm here. The river bottom consists of rocks of various rocks and exposed bedrock. Could only get about 3/4 across river. Bivalves and snails are abundant

07

Site # 6 (cont)

The pH, temp, D.O. & Conductivity were checked at the effluent. There was little to no difference from the readings taken @ the middle of the river. 3 species of vegetation were found. Filamentous algae was also found. Right bank is muddy and silty - None evidence of flooding - ~~veget~~ aquatic vegetation on tree limbs. Island also shows evidence of flooding. Snapping turtle spotted. Deer also spotted

Site # 7 8-27-96 1130

	VPI	Site
pH -	7.7	7.2
Temp -	22°C	22°C
D.O. -	7.8	8.3

Depth range 0-88 cm 0-88 cm

Conductivity - @ outfall: 523 μmhos
in river: 110 μmhos

Sphaerotilus - Absent

Observations - Site is located just downstream from VPI outfall. Some floating foam is being discharged from outfall and there is an odor of treated water. Bluegill, ducks and heron spotted here. There is some erosion on right bank — tree roots exposed. River bed composed of small + large pebbles, sand and exposed bedrock. Two types aquatic vegetation present. Vegetation is thick @ middle of river. Bank is quite muddy. Algae Slick algae covers the rocks where the treated water meets the river water near shore. Snails and bivalves abundant.

No ~~significant~~ difference in pH and conductivity of the effluent water and river water. Burning grounds are on left bank. Could only get 3/4 across river.

Site #8 08/27/96
1045

pH - 7.01 su
temp - 22 °C
D.O. - 8.1 mg/L
Depth range - 195 cm
Conductivity - 110 µmhos

Sphaerotilus - Absent

Observations - The site is just downstream from an island where Straddles creek meets the river. Riverbed composed of small pebbles, large rocks, silt and some bedrock showing. Current quite strong, mid river. Lots of ducks and small birds present. Many bivalves, some snails, some floating foam. Could only get 3/4 of the way across. Most aquatic vegetation found where current is swift, at least 2 species. Algae and moss on rocks and trees near island. Some water beetles present. Many small minnows spotted. Some leeches discovered also.

Clam shells are mostly empty. Saw larger fish & minnows.

Site #9 08/27/96
1530

pH - 7.49
temp - 22°C
D.O. - 9.8
Depth range - 40" (0 - 100cm)
Conductivity - 104 µmhos

Sphaerotilus - Absent

Observations - There is an island in middle of river with large trees. This is considered the right bank. Water is waist deep to the island a current moderately swift. 3 species vegetation present. Many small rocks and sand on river bed. Bedrock shows in places. Many snails and empty bivalve shells, much broken glass and litter — there is a picnic area on right bank. Aquatic vegetation in tree limbs shows evidence of flooding. An otter or muskrat is swimming nearby. Minnows spotted and fish jumping. Vegetation quite thick in places

Site # 10 up 8/28/96
0915

pH - 8.18
Temp - 19.0°C
D.O. - 9.2
Depth range - 17" (0-42.5cm)
Conductivity - 348

Sphaeroidinus - Absent

Observations: very rocky creek (Strouhles) which feeds into New River. Small gravel and larger stones in streambed. Some small rapids. Some bedrock exposed. Minnows and larger fish spotted. Some trash on shore. (flooding evidence) Site is located near baseball field outside of plant. Heavily wooded area. Much leaf litter in stream. No vegetation. Rocks covered w/ algae and moss above water. ~~St~~ Banks are rocky w/ little mud/silt. Site next to a trailer with a sign that says "T-807 Water monitor station

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Site # 10 down 8/28/96
1015

pH - 8.80 su
Temp - 19.0°C
D.O. - 10.4 mg/L
Depth range - 24" (0 - 60 cm)
Conductivity - 380 μmhos

Sphaerotilus -

Observations - Site is just downstream from bridge on Stoubles creek. Riverbed is sandy w/ small rocks. Some steam pipes run overhead. Some floating foam is collecting near shore & around bridge. Water beetles numerous. Some bedrock shows in streambed. Algae on rocks in stream. Where steampipes cross stream a tension cable is laying in the water. No vegetation growing in stream. Crayfish spotted.

8/ /E
1130

pH - 7.33 S.U.
Temp - 22°C
D.O. - 9.3.
Depth range - 0-37" (0-925cm)
Conductivity - 97 µmhos

Sphaerotilus - Absent

Observations - This site is located about ½ mile downstream from site #9. Like site #9, the bank near the gate is the left bank due to shaping of the river. We transect the river along a small shelf causing rapids to occur. None evidence of flooding as described in other sites. Bank is quite muddy. Minnows are abundant around bank. Several larger fish spotted towards center of river (mainly bluegill). Water striders & whorly beetles abundant on right bank.

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Site # 12 (cont.)

Bivalves and snails abundant. 4 species of vegetation and some filamentous algae. Vegetion is thick in some areas. Current was very strong here. ~~This site was~~ The river was widest here when compared to other sites. The river bottom is composed of a fairly equal amount of bedrock, rocks of various sizes and sand. An old washing machine was located just downstream from the left Bank.

REFERENCES

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Limnology, by Charles R. Goldman and Alexander J. Horne.

Radford Army Ammunition Plant
Route 114, P.O. Box 1
Radford, VA 24141
USA

January 28, 2002

US Army Corps of Engineers
ATTN: CENAB-EN-HM
10 South Howard Street
Baltimore, MD 21201

Attention: Mr. John Tesner

Subject: Benthic Surveys, Radford Army Ammunition Plant

Dear Sir:

Enclosed please find copies of our Benthic Studies conducted in the years 1994 thru 1998, in accordance with the requirements of our Virginia Pollution Discharge Elimination System Permit.

If additional information is needed, please contact Mr. J. J. Redder (540) 639-7536.

Very truly yours,

C. A. Jake, Environmental Manager
Alliant Ammunition and Powder Company LLC

Enclosures

Coordination: J. McKenna

bc: Administrative File
J. J. Redder
J. McKenna
Env File – Enclosures located in the Water Cabinet (Env. Library)

02-815-21
LG Martin