HERCULES RADFORD ARMY AMMUNITION PLANT

BENTHIC STUDY

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TABLE OF CONTENTS

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 1994, 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. In fact in comparing the data from the last seven 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 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 had large amounts of vegetation covering both right and left banks showing some evidence of recent, natural flooding. 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 M. Yates, E. Carico, D. Maddy and J. Newton all of CVLC, on September 27, 1995 through September 29, 1995. Samples were collected between 0840 and 1550 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.

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. Of all the sites sampled, this one demonstrated the most environmental impact. This is the first time that this site has exhibited any impairment when compared to historical data. As listed in Table III, Station 1 had the least number of organisms found. The site itself is used as a public boat launch and appeared very polluted as in the previous two years surveys. The river bed at this site was extremely silty with little vegetation found. On the right bank there was a brown floating detergent-like foam. Also, a large minnow and water strider population is observed. Both banks were muddy and rocks are covered with silt indicating an area of possible erosion or flooding. 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 appeared normal with no signs of impact or impairment. The river bed is composed of large boulders, bedrock and sand, with a healthy population of elodea and other aquatic macrophytes. A large population of snails and bivalves were present. A few minnows were spotted, as were water striders. Some floating foam was noted, however, it was not collecting on shore. Samples from this site were taken near the rapids, and left bank samples were taken from mid-stream. 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. From the right bank to about twenty yards out, the stream-bed is observed to be quite muddy and silty. This is slightly different from the findings in previous years. This silt and mud could be attributed to the stormwater outfall. Overall the condition of this outfall was good. There was very little vegetation and some foam was spotted floating but not collecting on shore. The left bank samples were taken midstream at the island due to extreme current flow on the other side of the centrally located island. 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. Three types of vegetation were found near the shore. Also near shore the stream-bed was muddy with a large population of minnows. Bivalve and bivalve shells are abundant as are snails. A few dead trees and limbs have washed on shore, most likely from a previous years flooding. No signs of environmental impact or impairment were noted. Left bank samples were taken from mid-stream. There was no evidence of Sphaerotilus growth. Also as a part of normal wildlife distribution, bluegills and geese were noted at this site.

Station 5 is located at the Power Plant effluent discharge point. The river bank and shore were muddy with various sized rocks and boulders. The river-bed consisted of bedrock with a thin layer of silt. Three types of vegetation were noted at this site, this is an improvement from previous years findings. Again, snails and bivalves were abundant. Of all of the potentially impacted sites sampled, this site had the least number of organisms, however, most of the organisms found were Ephemeroptera, suggesting no adverse impact. 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 pebbles with very little exposed bedrock, and is shallow to the center island. 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. Stream conditions appear normal; water striders, bivalves, minnows and snails were present.

Station Descriptions (continued)

There was evidence of Sphaerotilus growth. Sphaerotilus has not been found in the last five years studies. It was noted that the Sphaerotilus was found where the combined effluent outfall contacts the shoreline. At this site, left bank samples were taken midstream. (last years sampling transected the entire stream width.)

Station 7 is located downstream of the Blacksburg-Virginia Polytechnic Institute sewage treatment plant. Both the right and left banks were densely overgrown with brush and saplings. The river bed was largely composed of small rocks, with mud and silt near shore. Two species of vegetation are present with snails, bivalves, bluegill and minnows observed. Small birds are noted dipping into water to capture food. There was evidence of Sphaerotilus growth where the outfall contacted shore. (This finding is consistent with the 1994 study). Floating foam is also being released with the outfall discharge. There was no impact in organism numbers as a result of the Sphaerotilus or the foam at the time of sampling (See Table IV). There was a noticeable difference in the conductivity between the outfall and the benthic site. The outfall exhibited a Conductivity of 618 umhos versus 123 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. Three types of vegetation were noted, with algae covering the rocks near shore. Floating foam was also present. Crayfish, snails and bivalves are abundant. Water beetles were present near shore. The river bed had very little exposed bedrock.

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 covering 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, water striders, bivalves and snails were observed. Three types of vegetation were found including Elodea. Near shore there is a dense population of filamentous algae, this is normal. Overall conditions at this site are very good. 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 silty and had a lot of leaf litter. There was a large population of minnows and sucker fish at both "up" and "down" sites. Crayfish and water striders were also 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 station is fairly new and had not been sampled before 1991. The river bed had a large amount of plant growth, mostly Elodea and filamentous algae near shore. The samples for this site were collected upstream from the riffle zone. Several small fish, bivalves, snails and water beetles were spotted 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 1995 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 New River had basic pH readings and Dissolved Oxygen readings were suitable for aquatic life, ranging from 7.4 to 9.5 mg/l (site ten had a D.O. of 10.4mg/l but this is an upstream site located on Stroubles Creek and does not reflect the actual D.O. readings on the New River.)(see Table I). Temperatures were also constant throughout the river. Stroubles Creek exhibited chemical parameters expected of a mountain stream. The temperatures at Stroubles Creek were much lower than that of the New River (13.0°C as opposed to 19.0 to 21.0°C of the New River). The Dissolved Oxygen readings for all eleven sites were favorable, all exceeding 7.0 mg/l. Overall chemical conditions at all of the sites were very good.

Biological Data

The number of organisms collected at each station ranged from 77 found at Station 1 to 491 organisms found at Station 7. Station 1 has continued to show a decrease in numbers of taxa 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, also the 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 s last year. Overall, the number of taxa found at the stations directly affected by RAAP were about the same with what was found in 1994. 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 five years of data, the stream bed is continuing to thrive after the stress 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, 1992, 1993 and 1994 surveys, the river was dominated by Mayflies and clams. This appears to be true for the 1995 survey as well. The fact that the Mayflies (Ephemeroptera) are present, shows that the river is in good condition despite the Sphaerotilus and foam which were noted to be present. Mayflies are a pollutant sensitive insect 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 1995 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 indicates that water conditions continue to remain favorable for all types aquatic life (both tolerant and intolerant species).

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 be the same as the findings in the 1994 report. The 1995 study suggests that river conditions are favorable for aquatic life despite the increase of Sphaerotilus found at sites 6 and 7. 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

Organism density per Site and Station Station # 1

Insecta	Right Bank				Left Bank			
Ephemeroptera	1	2	3	Total	1	2	3	Total
Heptageniidae Stenonema						2		2
Arthoplea								
Siphlonuridae Isonychia					1	4		5
Baetidae Beatis								
Pseudocloeon	1		1	2			1	1
Ephemeridae Ephemera								
Odonata								
(Zygoptera) Coenagrionidae Argia								
(Anisoptera) Gomphidae Gomphus						1		1
Trichoptera								
Hydroptilidae spp.								
Hydropsychidae Hydropsyche								
Brachycentridae Brachycentrus						1		1
Helicopsychidae Helicopsyche								
Megaloptera								
Sialidae Sialis					1	1		2
Corydalidae Corydalus								
Diptera	1	1	1	3				
Chironimidae	15	5		20	4			4
Simulidae								
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			1	1			1	1
Psephenidae Psephenus							6	6
Non-Insecta								
Annelida								
(Oligochaeta) Tubificidae	12	1	1	14	3	2	1	6
Naididae								
(Hirudinea) Hirudinidae								
Amphipoda								
Gammaridae Gammarus	1			1				
Turbellaria								
(Tricladida) Planariidae Dugesia								
Decapoda								
Astacidae Cambarus								
Pelecypoda								
Corbiculidae Corbicula					7			7
Gastropoda								

Organism density per Site and Station Station # 2

Insecta	Right Bank				Left Bank			
Ephemeroptera	1	2	3	Total	1	2	3	Total
Heptageniidae Stenonema	4	12		16	4	4	6	14
Arthoplea								
Siphlonuridae Isonychia	1	3	1	5	1	4	2	7
Baetidae Beatis					18	1	3	22
Pseudocloeon	1		1	2		1		1
Ephemeridae Ephemera								
Odonata								
(Zygoptera) Coenagrionidae Argia	2			2		1		1
(Anisoptera) Gomphidae Gomphus								
Trichoptera	2	5	1	8	1		3	4
Hydroptilidae spp.								
Hydropsychidae Hydropsyche	2	2	3	7				
Brachycentridae Brachycentrus								
Helicopsychidae Helicopsyche								
Megaloptera								
Sialidae Sialis								
Corydalidae Corydalus	3			3		2		2
Diptera								
Chironimidae	1			1	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								
Elmidae Stenelmis			1	1		2		2
Psephenidae Psephenus								
Non-Insecta								
Annelida								
(Oligochaeta) Tubificidae	2	3		5	1	2		3
Naididae								
(Hirudinea) Hirudinidae								
Amphipoda								
Gammaridae Gammarus	6	2	2	10		6	10	16
Turbellaria								
(Tricladida) Planariidae Dugesia								
Decapoda								
Astacidae Cambarus								
Pelecypoda								
Corbiculidae Corbicula	2			2	2		1	3
Gastropoda	11	2	6	19	20	9	11	40

Organism density per Site and Station Station # 3

Insecta	Right Bank				Left Bank			
Ephemeroptera	1	2	3	Total	1	2	3	Total
Heptageniidae Stenonema	3			3	1			1
Arthoplea								
Siphlonuridae Isonychia	14	6	12	32	7	15	11	33
Baetidae Beatis		1	2	3	2	3	3	8
Pseudocloeon								
Ephemeridae Ephemera					1		3	4
Odonata								
(Zygoptera) Coenagrionidae Argia					1			1
(Anisoptera) Gomphidae Gomphus							1	1
Trichoptera	2	2		4	2	4	3	9
Hydroptilidae spp.								
Hydropsychidae Hydropsyche								
Brachycentridae Brachycentrus								
Helicopsychidae Helicopsyche								
Megaloptera								
Sialidae Sialis								
Corydalidae Corydalus								
Diptera			1	1				
Chironimidae		8	9	17	3	13	4	20
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								
Coleoptera								
Elmidae Stenelmis							4	4
Psephenidae Psephenus								
Non-Insecta								
Annelida								
(Oligochaeta) Tubificidae	5		2	7	3	7	19	29
Naididae								
(Hirudinea) Hirudinidae								
Amphipoda								
Gammaridae Gammarus			1	1	26			26
Turbellaria								
(Tricladida) Planariidae Dugesia								
Decapoda								
Astacidae Cambarus					1			1
Pelecypoda								
Corbiculidae Corbicula	1			1		4		4
Gastropoda							1	1

Organism density per Site and Station Station # 4

Insecta	Right Bank				Left Bank			
Ephemeroptera	1	2	3	Total	1	2	3	Total
Heptageniidae Stenonema	3	1	3	7	2	1	3	6
Arthoplea								
Siphlonuridae Isonychia	1	1	1	3	3	41	2	46
Baetidae Beatis						1		1
Pseudocloeon					1	2		3
Ephemeridae Ephemera								
Odonata								
(Zygoptera) Coenagrionidae Argia		1		1		1		1
(Anisoptera) Gomphidae Gomphus								
Trichoptera						4	1	5
Hydroptilidae spp.								
Hydropsychidae Hydropsyche								
Brachycentridae Brachycentrus								
Helicopsychidae Helicopsyche								
Megaloptera								
Sialidae Sialis								
Corydalidae Corydalus								
Diptera								
Chironimidae					1			1
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								
Elmidae Stenelmis					1	16		17
Psephenidae Psephenus								
Non-Insecta								
Annelida								
(Oligochaeta) Tubificidae						1		1
Naididae								
(Hirudinea) Hirudinidae								
Amphipoda								
Gammaridae Gammarus						19		19
Turbellaria								
(Tricladida) Planariidae Dugesia					1	1		2
Decapoda								
Astacidae Cambarus								
Pelecypoda								
Corbiculidae Corbicula		2	1	3	2			2
Gastropoda		12	3	15	1		14	15

Organism density per Site and Station Station # 5

Insecta	Right Bank				Left Bank			
Ephemeroptera	1	2	3	Total	1	2	3	Total
Heptageniidae Stenonema	2		1	3				
Arthoplea								
Siphlonuridae Isonychia	2	1	8	11	1	5	2	8
Baetidae Beatis								
Pseudocloeon	1			1		2		2
Ephemeridae Ephemera	1		5	6				
Odonata								
(Zygoptera) Coenagrionidae Argia								
(Anisoptera) Gomphidae Gomphus						1		1
Trichoptera			2	2			1	1
Hydroptilidae spp.								
Hydropsychidae Hydropsyche	1			1				
Brachycentridae Brachycentrus								
Helicopsychidae Helicopsyche								
Megaloptera								
Sialidae Sialis	1		2	3	1			1
Corydalidae Corydalus								
Diptera								
Chironimidae			2	2				
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	6			6	3	4		7
Psephenidae Psephenus								
Non-Insecta								
Annelida								
(Oligochaeta) Tubificidae	1		4	5				
Naididae								
(Hirudinea) Hirudinidae								
Amphipoda								
Gammaridae Gammarus			2	2	1	1		2
Turbellaria								
(Tricladida) Planariidae Dugesia		1		1				
Decapoda								
Astacidae Cambarus								
Pelecypoda								
Corbiculidae Corbicula		4		4	1			1
Gastropoda		1	1	2	2	8	2	12

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	2		3
Arthoplea								
Siphlonuridae Isonychia					2	1		3
Baetidae Beatis								
Pseudocloeon			1	1				
Ephemeridae Ephemera			2	2				
Odonata								
(Zygoptera) Coenagrionidae Argia		1		1				
(Anisoptera) Gomphidae Gomphus			1	1				
Trichoptera					1			1
Hydroptilidae spp.								
Hydropsychidae Hydropsyche	1			1	3			3
Brachycentridae Brachycentrus								
Helicopsychidae Helicopsyche								
Megaloptera								
Sialidae Sialis			1	1		1		1
Corydalidae Corydalus								
Diptera								
Chironimidae	3		1	4				
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	3	1	6	10	2	2		4
Psephenidae Psephenus	1			1				
Non-Insecta								
Annelida								
(Oligochaeta) Tubificidae			3	3	3	2	1	6
Naididae		1	1	2				
(Hirudinea) Hirudinidae								
Amphipoda								
Gammaridae Gammarus		1	2	3	4	2		6
Turbellaria								
(Tricladida) Planariidae Dugesia								
Decapoda								
Astacidae Cambarus								
Pelecypoda								
Corbiculidae Corbicula		9	3	12		2		2
Gastropoda		9	7	16		12	16	28

Organism density per Site and Station Station #____7____

Insecta	Right Bank				Left Bank			
Ephemeroptera	1	2	3	Total	1	2	3	Total
Heptageniidae Stenonema		3	4	7	1	2	1	4
Arthoplea								
Siphlonuridae Isonychia								
Baetidae Beatis	1		3	4	4	4		8
Pseudocloeon					1	6	1	8
Ephemeridae Ephemera								
Odonata								
(Zygoptera) Coenagrionidae Argia			1	1			1	1
(Anisoptera) Gomphidae Gomphus		1		1				
Trichoptera						1		1
Hydroptilidae spp.								
Hydropsychidae Hydropsyche	2	3	1	6	78		1	79
Brachycentridae Brachycentrus								
Helicopsychidae Helicopsyche								
Megaloptera								
Sialidae Sialis								
Corydalidae Corydalus	1			1				
Diptera								
Chironimidae						1		1
Simulidae								
Plecoptera						1		1
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								
Elmidae Stenelmis	6	2	3	11	31	6		37
Psephenidae Psephenus								
Non-Insecta								
Annelida								
(Oligochaeta) Tubificidae	1			1			1	1
Naididae								
(Hirudinea) Hirudinidae								
Amphipoda								
Gammaridae Gammarus		4		4		7	1	8
Turbellaria								
(Tricladida) Planariidae Dugesia								
Decapoda								
Astacidae Cambarus								
Pelecypoda								
Corbiculidae Corbicula	28	4	4	36	17	15	4	36
Gastropoda	24	18	94	136	58	25	15	98

Organism density per Site and Station Station # 8

Insecta	Right Bank				Left Bank			
Ephemeroptera	1	2	3	Total	1	2	3	Total
Heptageniidae Stenonema								
Arthoplea								
Siphlonuridae Isonychia								
Baetidae Beatis		1		1		1		1
Pseudocloeon								
Ephemeridae Ephemera								
Odonata								
(Zygoptera) Coenagrionidae Argia	1			1				
(Anisoptera) Gomphidae Gomphus						1		1
Trichoptera								
Hydroptilidae spp.								
Hydropsychidae Hydropsyche	1	6	1	8	4	38	19	61
Brachycentridae Brachycentrus								
Helicopsychidae Helicopsyche								
Megaloptera								
Sialidae Sialis								
Corydalidae Corydalus		1		1				
Diptera								
Chironimidae								
Simulidae								
Plecoptera								
Perlidae Perlinella					1			1
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								
Elmidae Stenelmis		2	1	3	16	1	4	21
Psephenidae Psephenus								
Non-Insecta								
Annelida								
(Oligochaeta) Tubificidae								
Naididae	2			2				
(Hirudinea) Hirudinidae								
Amphipoda								
Gammaridae Gammarus	1			1	4	1	4	9
Turbellaria								
(Tricladida) Planariidae Dugesia								
Decapoda								
Astacidae Cambarus								
Pelecypoda								
Corbiculidae Corbicula	5	8	36	49	38	25	16	79
Gastropoda			12	12	20	2	11	33

Organism density per Site and Station Station # 9

Insecta	Right Bank				Left Bank			
Ephemeroptera	1	2	3	Total	1	2	3	Total
Heptageniidae Stenonema		1	2	3				
Arthoplea								
Siphlonuridae Isonychia	1		3	4				
Baetidae Beatis	2		1	3		4		4
Pseudocloeon					1			1
Ephemeridae Ephemera								
Odonata								
(Zygoptera) Coenagrionidae Argia								
(Anisoptera) Gomphidae Gomphus					2			2
Trichoptera								
Hydroptilidae spp.			2	2				
Hydropsychidae Hydropsyche		3	1	4	5	2	10	17
Brachycentridae Brachycentrus								
Helicopsychidae Helicopsyche								
Megaloptera								
Sialidae Sialis								
Corydalidae Corydalus						1		1
Diptera								
Chironimidae								
Simulidae								
Plecoptera								
Perlidae Perlinella						1		1
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	1		3	4	1	6	1	8
Psephenidae Psephenus								
Non-Insecta								
Annelida								
(Oligochaeta) Tubificidae								
Naididae								
(Hirudinea) Hirudinidae								
Amphipoda								
Gammaridae Gammarus			2	2		1		1
Turbellaria								
(Tricladida) Planariidae Dugesia								
Decapoda								
Astacidae Cambarus								
Pelecypoda								
Corbiculidae Corbicula	1		36	37	32	63		95
Gastropoda	4	8	7	19	8	3	3	14

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		1		1
Arthoplea								
Siphlonuridae Isonychia								
Baetidae Beatis								
Pseudocloeon		1		1		1		1
Ephemeridae Ephemera								
Odonata								
(Zygoptera) Coenagrionidae Argia								
(Anisoptera) Gomphidae Gomphus								
Trichoptera		1		1	1			1
Hydroptilidae spp.								
Hydropsychidae Hydropsyche								
Brachycentridae Brachycentrus								
Helicopsychidae Helicopsyche								
Megaloptera								
Sialidae Sialis	1			1				
Corydalidae Corydalus								
Diptera								
Chironimidae		10		10		7		7
Simulidae								
Plecoptera								
Perlidae Perlinella								
Neuroptera Sisrydae								

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								
Elmidae Stenelmis	1	25	1	27	2	1	6	9
Psephenidae Psephenus	16	19	6	41	12	18	10	40
Acneus								
Non-Insecta								
Annelida								
(Oligochaeta) Tubificidae							3	3
Naididae								
(Hirudinea) Hirudinidae								
Amphipoda								
Gammaridae Gammarus								
Turbellaria								
(Tricladida) Planariidae Dugesia						1	2	3
Decapoda								
Astacidae Cambarus								
Pelecypoda								
Corbiculidae Corbicula								
Gastropoda						2		2

Organism density per Site and Station Station # 11

Insecta	Right Bank				Left Bank			
Ephemeroptera	1	2	3	Total	1	2	3	Total
Heptageniidae Stenonema		2	5	7	7	5	2	14
Arthoplea								
Siphlonuridae Isonychia								
Baetidae Beatis		1		1		1		1
Pseudocloeon		1	1	2				
Ephemeridae Ephemera			1	1				
Odonata								
(Zygoptera) Coenagrionidae Argia								
(Anisoptera) Gomphidae Gomphus								
Trichoptera								
Hydroptilidae spp.						1		1
Hydropsychidae Hydropsyche	88	16	3	107	1	3	18	22
Brachycentridae Brachycentrus								
Helicopsychidae Helicopsyche								
Megaloptera								
Sialidae Sialis								
Corydalidae Corydalus	2	2	1	5				
Diptera								
Chironimidae	1	1		2			1	1
Simulidae								
Plecoptera								
Perlidae Perlinella	1			1				
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								
Elmidae Stenelmis	12	6	4	22		3	4	7
Psephenidae Psephenus	1			1				
Non-Insecta								
Annelida								
(Oligochaeta) Tubificidae	1			1		2		2
Naididae								
(Hirudinea) Hirudinidae								
Amphipoda								
Gammaridae Gammarus								
Turbellaria								
(Tricladida) Planariidae Dugesia								
Decapoda								
Astacidae Cambarus								
Pelecypoda								
Corbiculidae Corbicula	23			23	2	1		3
Gastropoda	10	1	2	13	1	28	39	68

TABLE II

WATER CHEMISTRY FOR RAAP BENTHIC STUDY

September 1995 Study, CVLC

Station#	Water Depth (inches)	Temp. C	Specific conductance (umhos)	pH (S.U.)	Dissolved Oxygen (mg/l)
1	0-44	19.0	121	7.04	8.0
2	0-50	21.0	121	7.29	7.8
3	0-53	21.0	124	7.95	9.2
4	0-47	20.0	139	7.06	7.4
5	0-48	20.0	139	7.18	7.6
6	0-51	20.0	127	7.24	8.5
7	0-51	20.0	123	7.42	8.6
8	0-48	20.0	123	7.60	8.7
9	0-39	20.0	134	8.14	9.5
10 Up	0-26	13.0	474	7.81	10.4
10 Down	0-20	13.0	413	7.87	9.2
11	0-33	21.0	140	8.10	8.6

TABLE III

TOTAL TAXA, RIGHT BANK VS. LEFT BANK

September 1995 Study, CVLC

Station #	1	2	3	4	5	6	7	8	9	10	11
Right Bank (Up)	6	13	9	5	14	14	11	9	9	7	13
Left Bank(Down)	11	13	14	13	9	10	13	8	10	9	9

Table IV

PERCENT COMPOSITION PER STATION

September 1995 Study, CVLC

Station #	1	2	3	4	5	6	7	8	9	10	11
Total # of Org.	77	197	211	148	84	115	491	284	222	150	305
TAXA	*	*	*	*	*	*	*	*	*	*	*
Ephemeroptera	13	34	40	45	37	8	6	0.7	7	3	9
Odonata	1	2	1	1	1	2	0.6	0.7	1	0	0
Trichoptera	1	10	6	3	5	4	18	24	10	1	43
Megaloptera	3	3	0	0	5	2	0.2	0.3	0.4	0.6	2
Diptera	35	1	18	0.6	2	3	0.2	0	0	11	1
Plecoptera	0	0	0	0	0	0	0.2	0.3	0.4	0	0.3
Neuroptera	0	0	0	0	0	0	0	0	0	0	0
Coleoptera	0.6	7	5.9	4	4.3	5	4.4	17.4	2.6	43	22
Annelida	26	4	17	0.6	6	10	0.4	0.7	0	2	1
Amphipoda	1	13	13	13	5	8	2	4	1.3	0	0
Decapoda	0	0	0.4	0	0	0	0	0	0	0	0
Pelecypoda	9	3	2	3	6	12	15	45	59	0	9
Turbellaria	0	0	0	1	1	0	0	0	0	2	0
Gastropoda	0	59	0.4	20	16	38	48	16	15	1	27

Number of Organisms (% Taxa)

REFERENCES

1993 and 1994 Surveys done for RAAP by Central Virginia laboratories and Consultants.

1991 and 1992 Surveys done for RAAP by Freecol Labs.

1988 through 1990 Surveys done for RAAP by Dr. Ernest F. Benfield

Rapid Bioassessment Protocols for use in Streams and Rivers. EPA/444/4-89-001 May 1989.

Introduction to Aquatic Insects of North America, Second Edition, by R.W. Merrit and K.W. Cummins

An Introduction to the Study of Insects, by Borror, Triplehorn and Johnson.

Freshwater Invertebrates of the United States, by Pennak.

RAW DATA

9/29/95
1030

Site #1

	L. Bank	R. Bank
pH -	6.95	7.04
temp - ~~Hot~~	19°C	19°C
D.O. - ~~7.9~~	7.9 mg/L	8.0 mg/L
Depth range -	0-42"	0-44"
Conductivity -	119 µmhos	121 µmhos

Sphaerotilus - Absent

L. Bank downstream

Observations - Site located underneath large bridge dividing Montgomery & Pulaski County. This seems to be used for recreational purposes. Litter found around bank & old fishing lures. Some floating foam found near shore but not collecting on shore. Large school of minnows, water striders abundant, Bivalve shells abundant. People are docking boats for fishing. River Bed muddy. Towards center of river are Mainly mud & rocks/stones size.

Site #1 (cont)

Very little Bedrock ~~to~~ River seems to be calm. Were only able to go about 30 yds. Out. Very little to no vegetation. Rocks covered w/ sand/silt.

Rn Bank - On this side of the River, an ~~old power/electric building~~ Christopinashay Water Authority Plant sits about 30 yds off shore. Some evidence of flooding as described ~~before~~ in other sites. Water quite calm w/ some floating foam. Foam does not collect on shore. Large minnow population near shore. Water striders also are present. Large pigeon population perched on telephone lines. River bed mainly muddy near shore. Rocks of various sizes are found towards center of river. Very little vegetation. Rocks seem to be covered w/ mud & silt. Could only get about 15 yds out.

Site #2 9/27/95
1245

pH - 7.29 S.U.
temp - 21°C
D.O. - 7.8 mg/L
Depth range - 0-50"
Conductivity - 121 µmhos
Sphaerotilus - Absent

Observations - Site located just upstream from 3rd rapid of Gulf. 2 types of vegetation present. ~~Sno~~ 2 types of algae present. One filamentous & one a slick algae growing on rocks where rapids fast moving water has smoothed the rocks. Vegetation grows thick here. Snails are present clinging to rocks as well as bivalves. ~~No fish sighted~~. Trees show evidence of flooding with dead aquatic vegetation hanging from them. No evidence of recent flooding.

Site #2 (con't)

Water current strong due
to rapids
This outfall is located adjacent
to ~~the intake~~ a building taking in ~~diversion dam~~, water for filtration use.
Can see fallen trees on other
side of river which is further
evidence of previous flooding.
Since this year has remained
relatively dry, ~~the evidence of~~
flooding has most likely not
occurred within the last year.
Large blocks of cement show
that something manmade,
probably part of the old dam,
~~have not~~ has been destroyed
from construction. Few minnows spotted.
Water Striders spotted. Could
only get about 1/3 accross
river before water was too deep.
Some floating foam but not
in abundance and not collecting
on shore

9/27/95
1500

Site #3

pH: 7.95 S.U.
temp: 21°C
DO: 9.2 mg/L
Depth range - 0-53"
Conductivity - 124 µmhos

Sphaerotilus - Absent

Observations - Site located downstream from small rapids and a small island in the middle of the river. From shore out to about 20 yards out, the bottom is pride muds and silty. Towards the center of the river the bottom substrate is mainly rocks of various sizes & sand w/ little bedrock exposed. Downstream from site there is some type of bridge with pipes running over the river. ~~for~~ of metal. Air compressor sounds - Steam pipes used for heat;

Site #3 Kent

Near shore, small ~~white~~ benthos ~~beetles~~ and small minnows are found. Very little vegetation (one species). Some floating foam but not in abundance or not collecting on island. Some signs of bank erosion but probably not done this year. Could only get about 3/4 way across river

9/27/95

Site # 4

~~1000~~
1030

pH - 7.06 s.u.
temp - 20°C
D.O. - 7.4 mg/L
Depth range - 0 - 47"
Conductivity - 139 µmhos

Spherotilus - Absent

Observations - Muddy bottom towards shore. Large population of minnows also near shore. No evidence of recent flooding. Some dead trees & limbs washed on ~~bank from~~ most likely from floods previous years ago. 3 types of vegetation. Large floc of geese flying over. Clam shells living and dead are abundant as well as snails. Site located upstream from bridge. Sand, pebbles & rock of various sizes & bedrock. is situation towards center of river.

Site #4 Cont

Jackhammer bit found about middle of river. River calm. No environmental impact to report based on visual observations. Bluegill found

09-27-95

Site #5

~~1000~~

0945

pH - 7.18 S.U.
temp - 20°C
D.O. - 7.6 mg/L
Depth range - 0 - 48"
Conductivity - 139 µmhos

Sphaerotilus - Absent

Observations - Site located downstream from bridge. River bank & shore are muddy with some small to medium sized rocks. Could only get about 1/2 way across river before river was too deep to sample. Mainly bedrock, ~~sand~~ & rocks of various sizes towards center of river. Snails and bivalves abundant. Some vegetation. Observed 3 types of vegetation. Abundance of small rocks on river floor towards shore. Appears to be an Allied Outfall about 50-100 yards downstream from site

Site #3 Cont

Could only get 3/4 across river

56

9/28/93

Site # 6 1130

pH - (outfall) - 7.1 - 7.3 (above outfall) - 7.24
temp - (outfall) - 21-24 °C (above outfall) - 20°C
D.O. - (outfall) - 7.9 mg/L (above outfall) - 8.5 mg/L
Depth range - 0 - 5'
Conductivity - (outfall) - 500-1000 (above outfall) - 127

Sphaerotilus - Present on & near shore where outfall contacts shore

Observations - This site is located just below RAAP Effluent A + B. ~~On~~ Near shore seems to be a high level of silt and ~~mud~~. Also, ~~foam~~ floating foam is coming from outfall but not collecting on shore. River Bed composed of various sizes of rock w/ very little exposed bed rock. An island sits about 30 yds from shore. Sampling occurred just downstream from island. Large schools of minnows populated around shallow waters around island. Water here is calm.

Site 6 cont

Water striders also present around island and near shore. Bivalves & snails abundant. Could only get about 3/4 across river. 3 species of vegetation present.

9/22/82
1015

Site #7

pH - (outfall) - 6.63 s.u. (site) - 7.02 s.u.
temp - (outfall) - 20°C (site) - 20°C
D.O. - (outfall) - 8.5 mg/l - (site) - 8.6 mg/l
Depth range - 0 - 51"
Conductivity - (outfall) - 618 μmhos (site) - 123 μmhos

Sphaerotilus - Present ~~near shore~~ where outfall conducts shower. Absent beyond outfall.
Observations: This site is located just down stream from VPI WWTP Outfall. ~~floating~~ foam is also being discharged from outfall. Birds described in Site #8 are also present. Could only get approx 3/4 across river. 2 species of ~~vegetation~~ algae present & filamentous algae present. Water striders present. River bed composed of a wide variety of substrate; from sand - small pebbles to larger rocks & ~~bedrock~~ exposed Bedrock. Snails & Bivalves abundant. Blue gill and small minnows spotted near VPI outfall.

Site #7 Cont

Muddy Mud + silt seen
shore.
Note the difference of
pH + conductivity between
outfall - site.

9/28/71

Site # 8 0900

pH - 7.6
temp - 20°C
D.O. - 8.7 mg/l
Depth range - 0 - 48"
Conductivity - 123 μmhos

Sphaerotilus - Absent

Observations: This site is just where a creek meets the river. Here there is an island about 20 yds offshore. River bed is mainly composed of rocks of many sizes. Near shore rocks are covered w/ algae. Vegetation (3) is fairly dense towards the center. High population of birds (small, white belly, blue and brown wings) which are diving to hopefully capture food. Could only get about 3/4 out. Current is quite swift. Slight rapids. Some floating foam is present. Crayfish, snails & bivalves abundant.

Site #3 (cont)

Water beetles are also present near shore. Bucket has been left behind exposed.

9/28/95
Site # 9 1415

pH - 8.14 S.u.
temp - 20°C
DO. - 9.5 mg/L
Depth range 0-39"
Conductivity - 134 umho

Sphaerotilus - Absent

Observations - For this sight, due to the bending of the river, the bank is now considered to be the Left Bank. Fallen trees & aquatic vegetation on tree limbs are evidence of previous flooding. An island is present in the middle of the river. As in previous years we have been advised not to cross the river the island and to consider the bank to the island as the sight. Rocks show there is a dense population of filamentous algae. 3 species of aquatic vegetation are found including Elodea. Vegetation is thick.
Snails more abundant for bivalves

SL-9 /cont.

More bivalve shells are found towards shore. Mainly various sizes of rock + lithe bedrock on river bed. Minnows present in shallow water near shore. Water striders present. The current is rather swift here.

9/24/93

Site ± 10 ~~up~~ down 0840

pH - 7.87 s.u

temp - ~~20~~ 13 °c

DO - 9.2 mg/l

Depth range - 0-30"

Conductivity - 413 umhos

Sphaeriidae - Absent

Observations - This site is just downstream of bridge and just upstream of steampipes. No vegetation growing in the creek. Stream is only about 8 or 9 yards wide. Many fish populate the stream. They appear to be sucker fish. There are also crawdads & Crayfish. River bed is mainly small rocks and some sand. There is very little bedrock. There is a large amount of silt on the bottom of the creek. Large population of water striders.

This site is actually Stoneables Creek

9/29/93
0930

Site = 10 ~~down~~ up

pH - 7.81 S.U.
temp - 13°C
D.O. - 10.4 mg/L
Depth range -2-26"
Conductivity - 474 umho

Sphaerotilus - Absent

Observations - ~~[illegible]~~
Mainly mud @ edge of shore. Leaf litter abundant. Large fish population found. Minnows and suckerfish predominant. Rocky situation in middle of creek. This sight is located outside of RAAP near a baseball/softball field. Rocks seem to be covered with mud, silt or algae. No vegetation. This not part of the New River but a ~~[illegible]~~ creek (Stroubles Creek) which feeds into the New River.

9/23/93
1550

Site - 12

pH - 8.10 S.U.
temp - 21°C
D.O. - 8.6 mg/l
Depth range - 0 - 33"
Conductivity - 140 µmhos

Sphaerotilus - Absent

Observations - Whirly beetles (Gyrinidae) abundant. This site is located about 1/2 mile downstream from Site #9. On the right bank a ~~railroad~~ train has stopped probably to load or unload contents of ~~freight~~ removed cars. Small minnows inhabit the shallow waters on shore. In sampling this ~~sight~~ site, we walked along a small shelf which causes small rapids to occur & The current is rather swift here. This site is probably the widest part of the river ~~compared to~~ the other

Site #12 (Cont)

sites. Some evidence of flooding is present as explained in earlier site observations. Filamentous algae is abundant toward bank. Bivalves and snails abundant, River bed composed mainly of bedrock and rocks of various sizes, 3 species of aquatic vegetation occurs here. Vegetation is moderately abundant. Near shore is quite muddy. *Elodea* present.

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