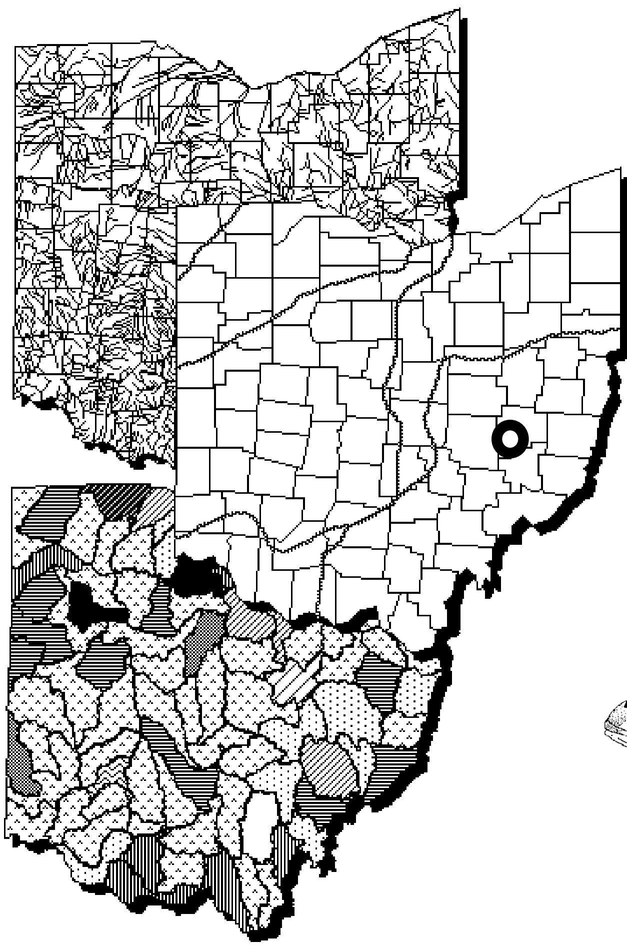
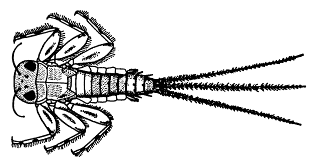
State of Ohio
Environmental Protection Agency

Monitoring and Assessment Section
Division of Surface Water

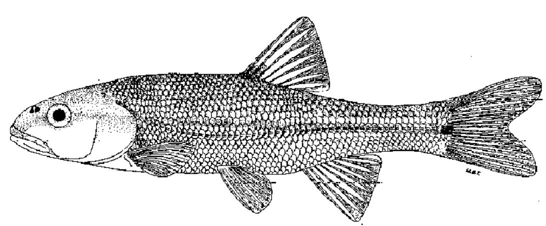
Biological, Sediment and Water Quality Study of Chapman Run and Associated Wetlands

Shieldalloy Metallurgical Corporation
Guernsey County, Ohio





Mayfly (*Stenacron sp.*)



Creek Chub *(Semotilus atromaculatus)*

August 30, 1995

P.O. Box 1049, 1800 WaterMark Dr., Columbus, Ohio 43216-1049

Biological, Sediment and Water Quality Study of Chapman Run and Associated Wetlands

Shieldalloy Metallurgical Corporation

Guernsey County, Ohio

August 30, 1995

OEPA Technical Report MAS/1995-8-10

prepared for

State of Ohio Environmental Protection Agency
Division of Emergency and Remedial Response

prepared by

State of Ohio Environmental Protection Agency
Division of Surface Water
Monitoring & Assessment Section
1685 Westbelt Drive
Columbus, Ohio 43228

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NOTICE TO USERS

Ohio EPA incorporated biological criteria into the Ohio Water Quality Standards (WQS; Ohio Administrative Code 3745-1) regulations in February 1990 (effective May 1990). These criteria consist of numeric values for the Index of Biotic Integrity (IBI) and Modified Index of Well-Being (MIwb), both of which are based on fish assemblage data, and the Invertebrate Community Index (ICI), which is based on macroinvertebrate assemblage data. Criteria for each index are specified for each of Ohio's five ecoregions (as described by Omernik 1987), and are further organized by organism group, index, site type, and aquatic life use designation. These criteria, along with the existing chemical and whole effluent toxicity evaluation methods and criteria, figure prominently in the monitoring and assessment of Ohio's surface water resources.

The following Ohio EPA documents support the use of biological criteria by outlining the rationale for using biological information, the methods by which the biocriteria were derived and calculated, the field methods by which sampling must be conducted, and the process for evaluating results:

Ohio Environmental Protection Agency. 1987a. Biological criteria for the protection of aquatic life: Volume I. The role of biological data in water quality assessment. Division of Water Quality Monitoring & Assessment, Surface Water Section, Columbus, Ohio.

Ohio Environmental Protection Agency. 1987b. Biological criteria for the protection of aquatic life: Volume II. Users manual for biological field assessment of Ohio surface waters. Division of Water Quality Monitoring & Assessment, Surface Water Section, Columbus, Ohio.

Ohio Environmental Protection Agency. 1989b. Addendum to Biological criteria for the protection of aquatic life: Volume II. Users manual for biological field assessment of Ohio surface waters. Division of Water Quality Planning & Assessment, Ecological Assessment Section, Columbus, Ohio.

Ohio Environmental Protection Agency. 1989c. Biological criteria for the protection of aquatic life: Volume III. Standardized biological field sampling and laboratory methods for assessing fish and macroinvertebrate communities. Division of Water Quality Planning & Assessment, Ecological Assessment Section, Columbus, Ohio.

Ohio Environmental Protection Agency. 1990. The use of biological criteria in the Ohio EPA surface water monitoring and assessment program. Division of Water Quality Planning & Assessment, Ecological Assessment Section, Columbus, Ohio.

Rankin, E.T. 1989. The qualitative habitat evaluation index (QHEI): rationale,methods, and application. Division of Water Quality Planning & Assessment, Ecological Assessment Section, Columbus, Ohio.

These documents and this report can be obtained by writing to or calling:

Ohio EPA, Division of Surface Water
Monitoring and Assessment Section
1685 Westbelt Drive
Columbus, Ohio 43228-3809
(614) 728-3377

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The following persons are acknowledged for their significant contributions to this report.

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Physical Habitat - David Altfater
Macroinvertebrate Assemblages - Bernie Counts
Fish Assemblages - David Altfater
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This evaluation and report would not have been possible without the assistance of numerous full and part time staff in the field and offices. The chemistry analyses (laboratory) were conducted by the Ohio EPA, Division of Environmental Services and Ross Analytical Services. Jim Grow and Larry Pennington collected the surface water samples. The following college interns provided support during field sampling activities: Bret Henninger, Mike Pettegrew, and Brenda Hart.

Biological, Sediment and Water Quality Study of Chapman Run and Associated Wetlands

Guernsey County (Ohio)

State of Ohio Environmental Protection Agency
Division of Surface Water
1800 WaterMark Drive
Columbus, Ohio 43216-3669

INTRODUCTION

The Chapman Run study area included the lower six miles of Chapman Run. Included in the study was the collection and evaluation of fish community, macroinvertebrate community, surface water, sediment, and fish tissue data. In addition, sediment samples were collected at numerous wetland sampling locations and small drainageways adjacent to the East and West Slag Piles, which are situated on Shieldalloy Metallurgical Corporation (SMC) property. Specific sampling locations are detailed in Table 2 and Figures 1 and 2. The SMC facility is presently in operation to manufacture ferrovanadium alloys. The Vanadium Corporation of America began operations at the SMC site in 1953. From the original company through various other owners, the facility was used to manufacture ferrocolumbium alloys, ferrovanadium alloys and vanadium compounds. During at least part of the time, radioactive materials (uranium and thorium) were used to produce the ferrocolumbium alloys. Radioactive slags were generated, and this slag material has been stored at the facility from 1953 until the present. Nonradioactive slags and baghouse dust were generated and deposited in the East and West Slag Piles from 1973 until the present (PRC 1993). Two small drainageways (East Slag Ditch and West Slag Ditch) convey surface water runoff from the SMC property and adjacent wetlands into Chapman Run in the vicinity of river mile (RM) 0.8 - RM 1.4.

The principal objectives of this study were to:

1) monitor and assess chemical, physical and biological integrity of the lower Chapman Run,

2) determine the extent of hazardous chemical constituents and other constituents in Chapman Run and the adjacent wetland in the vicinity of Shieldalloy,

3) establish the present aquatic life use status in Chapman Run,

4) evaluate potential impacts associated with nonpoint source runoff (*i.e.* mine drainage) and influences from a sewage lift station located on the Shieldalloy property, and

5) identify the relative significance of Shieldalloy site contaminants on any demonstrated impairments in Chapman Run.

Standardized methods were used throughout the study area to collect quantitative and qualitative biological, chemical, and physical data. Other relevant information indicative of potential environmental impacts within the Chapman Run study area (*e.g.,* spills, overflows, bypasses, unauthorized releases of pollutants, and Ohio Department of Natural Resources fish kill reports) were also reviewed and summarized.

The findings of this report may factor into regulatory actions taken by the Ohio EPA [*e.g.,* NPDES permits, Director's Orders, the Ohio Water Quality Standards (OAC 3745-1)], and may be incorporated into State Water Quality Management Plans, NPDES permits, the Ohio Nonpoint Source Assessment, and the biennial Water Resource Inventory (305[b] report).

SUMMARY/ CONCLUSIONS

Between August and December, 1994 Ohio EPA Division of Surface Water staff conducted biological, surface water, and sediment sampling of Chapman Run upstream, adjacent to, and downstream from the Shieldalloy Metallurgical Corp. In addition, sediment samples were collected in wetland areas adjacent to the East and West Slag Piles located on Shieldalloy property. The results of these sampling events are summarized below:

- Biological community performance indicated NON-attainment of the Warmwater Habitat (WWH) aquatic life use designation at all sampling locations in Chapman Run. The extensive non-attainment appeared to be associated with reduced instream habitat and bottom sedimentation, raw sewage overflows from a malfunctioning lift station, potential influences from an unsewered community, and contaminant contributions from Shieldalloy.

- Biological and water quality sampling results from Chapman Run during 1994 indicated that biological degradation and chemical impairment have occurred in Chapman Run associated with contributions of contaminant material from the Shieldalloy property. In particular, elevated vanadium concentrations in excess of acute and chronic water quality criteria were documented in Chapman Run surface water adjacent to the Shieldalloy property. The fish communities in Chapman Run upstream from Shieldalloy influences (upstream from the East and West Slag Ditches) were in the fair range; sampling locations adjacent to and downstream from Shieldalloy were represented by poor fish communities. Although physical habitat conditions in Chapman Run in the lower two miles were of marginal quality, these conditions alone have not caused the severe disruption of the fish communities observed at and downstream from the Shieldalloy property. Macroinvertebrate communities in Chapman Run were indicative of fair conditions at all sites except RM 0.9. The habitat at RM 0.9 was similar to conditions in Chapman Run upstream from Shieldalloy except for the extensive sediment and silt bed load; however, the macroinvertebrate community was much more severely degraded indicating a toxic effect originating between RM 1.1 and RM 0.9. Pollution tolerant macroinvertebrates were represented by 31% of the taxa collected at RM 0.9; all other Chapman Run sites were represented by between 6% and 17% tolerant taxa. The biological response signatures indicated an overall response to toxic stresses.

- A grab sample of an overflow was collected on December 1, 1994 from the Cambridge sewer system lift station located on Shieldalloy property and discharging into the West Slag Ditch near the confluence with Chapman Run. The chemical results revealed elevated levels of BOD_5 (139 mg/l), ammonia-N (3.94 mg/l) and total phosphorus (2.01 mg/l). Human hygiene products and foamy material were observed in the flow channel leading from the lift station to the West Slag Ditch. Based on Ohio EPA records, raw sewage overflows from this lift station have occurred in the past.

- Radiological constituents in sediments were compared with the average background values from upstream sites on Chapman Run, East Slag Ditch, and the reference wetland area. Four sediment sample results exceeded five times background levels (gross alpha - 1, thorium 230 - 2, and uranium 235 - 1). One thorium-230 value in the East Slag Ditch was substantially higher than the Nuclear Regulatory Commission (NRC) thorium soil contaminant guideline. A majority of the radiological tests conducted on sediment samples were measured below or near background levels.

- Sediment sampling results indicated several metal parameters at highly elevated concentrations and/or exceeding the *Severe Effect Level* guideline. Material, at concentrations above this guideline, are considered highly contaminated and will likely have a significant effect on benthic biological resources (Persaud 1993). Ecotoxicological benchmark guidelines are not available for evaluating vanadium levels in sediment. However, sediment vanadium levels were highly elevated in the East Slag Ditch, West Slag Ditch and wetland sampling locations adjacent to the Shieldalloy slag piles. The highest vanadium value measured in sediment during the Ohio EPA study occurred in West Slag Ditch, with the sample comprised of 2.2% vanadium (22,000 mg/kg). Eight (8) of 38 stream and wetland sediment samples collected on or adjacent to the Shieldalloy property exceeded the *Severe Effect Level* guideline for chromium. The highest chromium levels were primarily from sediment sites located near the West Slag Pile (ditch and wetland areas). Arsenic, cadmium, iron, manganese and nickel samples had between one and eight values exceeding the *Severe Effect Level*. Aside from iron and cadmium, the majority of these elevated levels occurred in the East Slag Ditch, West Slag Ditch, and wetland sites adjacent to the West Slag Pile.

- Natural habitat conditions occurred in Chapman Run at all sampling locations except RM 0.1, where the stream had been relocated due to the construction of the I-70 and I-77 interchange. The Qualitative Habitat Evaluation Index (QHEI) score at RM 0.1 was 16.5, reflective of very poor stream habitat. Physical habitat conditions were generally comparable between stations sampled at RMs 1.6, 1.1 and 0.9 (adjacent to and immediately upstream from Shieldalloy); bottom substrates were predominated by muck, with heavy deposits of silt and extensive embeddedness of the stream substrates. These sites were reflective of poor to fair stream habitat, with QHEI scores ranging from 34.0 to 49.5. Well defined pool and riffle areas occurred at RM 5.2, an area with a much higher gradient compared to the downstream sampling locations (RMs 1.6 - 0.1). The QHEI score was 67.0, reflective of good instream habitat. Bottom substrates were predominated by gravel and sand.

- Vanadium was elevated in fish tissue samples collected in Chapman Run adjacent to Shieldalloy property and downstream from the East Slag Ditch and West Slag Ditch. Concentrations of vanadium ranged from 1.1 mg/kg to 5.7 mg/kg. Vanadium was not present in fish tissue samples collected upstream from Shieldalloy.

RECOMMENDATIONS

Status of Aquatic Life Uses

Chapman Run was originally designated for aquatic life uses in the 1978 Ohio WQS. The techniques used then did not include standardized approaches to the collection of instream biological data or numerical biological criteria. Therefore, this study represents a first use of this type of biological data to evaluate and establish the aquatic life use designation. Ohio EPA is under obligation by a 1981 public notice to review and evaluate all aquatic life use designations outside of the WWH use prior to basing any permitting actions on the existing, unverified use designations.

- The existing Warmwater Habitat aquatic life use that applies to Chapman Run should be retained. The biological communities are partially impaired at a majority of locations due to poor to fair physical habitat conditions resulting from moderate to heavy sedimentation and a lack of well developed riffles. The lower 1.6 miles of Chapman Run flows through a low gradient wetland area and a portion has been relocated. Beaver dams occur in this area, creating impounded-like conditions.

Status of Non-Aquatic Life Uses

- Currently, Chapman Run is designated for Primary Contact Recreational (PCR), and Agricultural and Industrial Water Supplies. Based upon the findings of this investigation for Chapman Run, these use designations should be retained.

Other Recommendations

- Sediment and surface water bioassays of Chapman Run and the wetland should be conducted to determine the relative significance of vanadium contaminants to the documented impairment of the fish communities of Chapman Run.

- The overflow of raw sewage into Chapman Run from a City of Cambridge lift station located on Shieldalloy property needs to be eliminated. One sample of the overflow water collected in December, 1994 revealed highly elevated levels of BOD, ammonia-N, and phosphorus.

Table 1. Aquatic life use attainment status for Chapman Run based on sampling conducted from August to September, 1994. Attainment status is based on biocriteria for the Western Allegheny Plateau ecoregion of Ohio (OAC Chapter 3745-1-07, Table 7-17).

RIVER MILE Fish/ Invert.	**IBI**	**ICI**[a]	**QHEI**	**Attainment Status**	**Comment**
Chapman Run	*Western Allegheny Plateau Ecoregion - WWH Use Designation*				
5.2/ 5.8	38*	18*	67.0	**NON**	Reference
1.6/ 1.6	28*	Fair*	49.5	**NON**	Dst. strip mines
1.1/ 1.1	19*	Fair*	47.5	**NON**	Dst. E. Slag Ditch
0.9/ 0.9	21*	Poor*	34.0	**NON**	Dst. W. Slag Ditch
0.1/ 0.4	19*	14*	16.5	**NON**	Near mouth, new channel

Ecoregion Biocriteria: Western Allegheny Plateau (WAP)

INDEX	**WWH**	**EWH**	**MWH**[b]
IBI - Headwaters	44	50	24
ICI	36	46	22

* Significant departure from ecoregion biocriterion (>4 IBI or ICI units); poor and very poor results are underlined.

a Narrative evaluation used in lieu of ICI when quantitative artificial substrate results are not available (exceptional, good, marginally good, fair, poor, very poor).

b Modified Warmwater Habitat for channel modified and mine drainage affected areas.

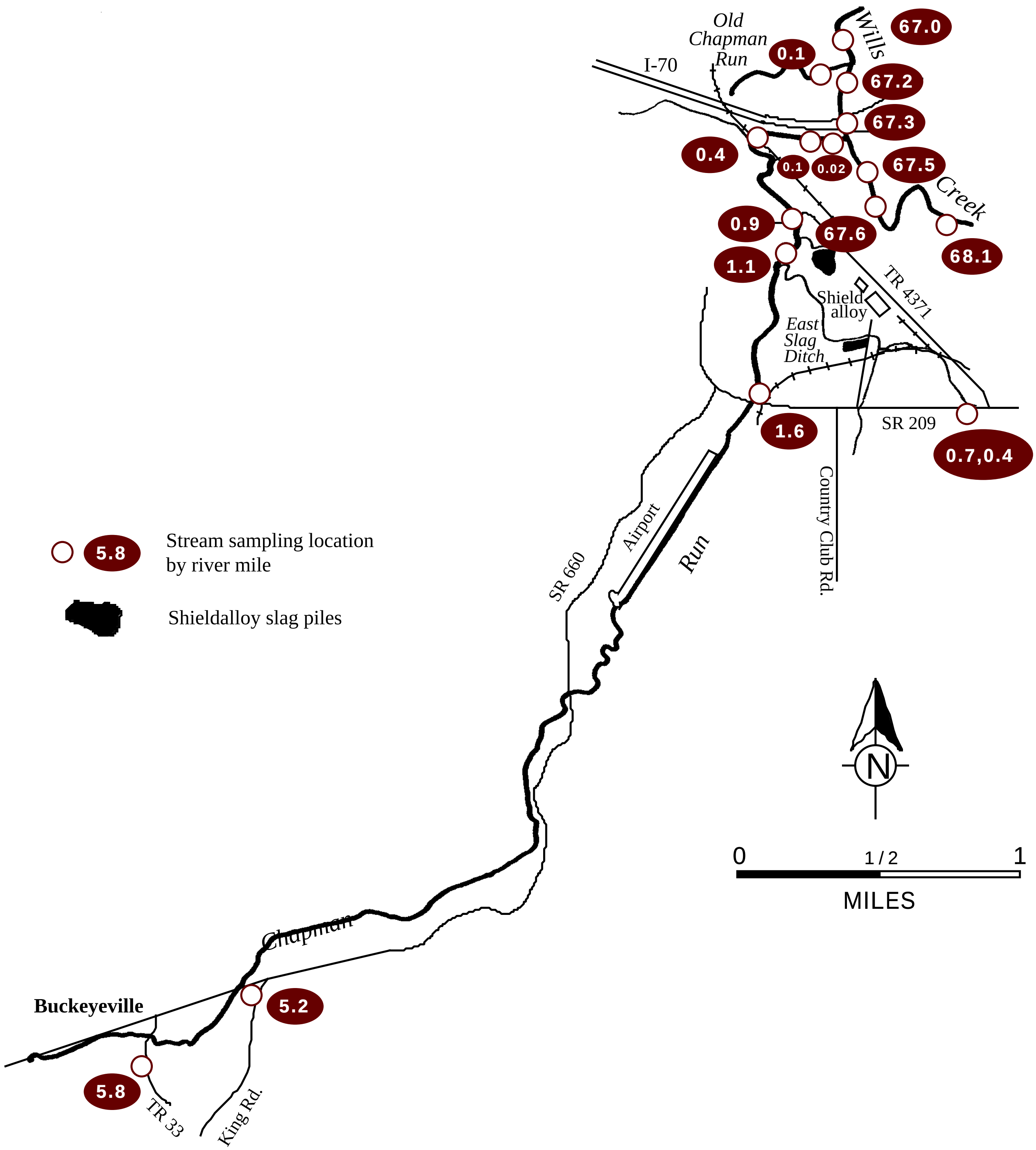

Figure 1. Map of the Chapman Run study area showing principal streams, landmarks and sampling locations.

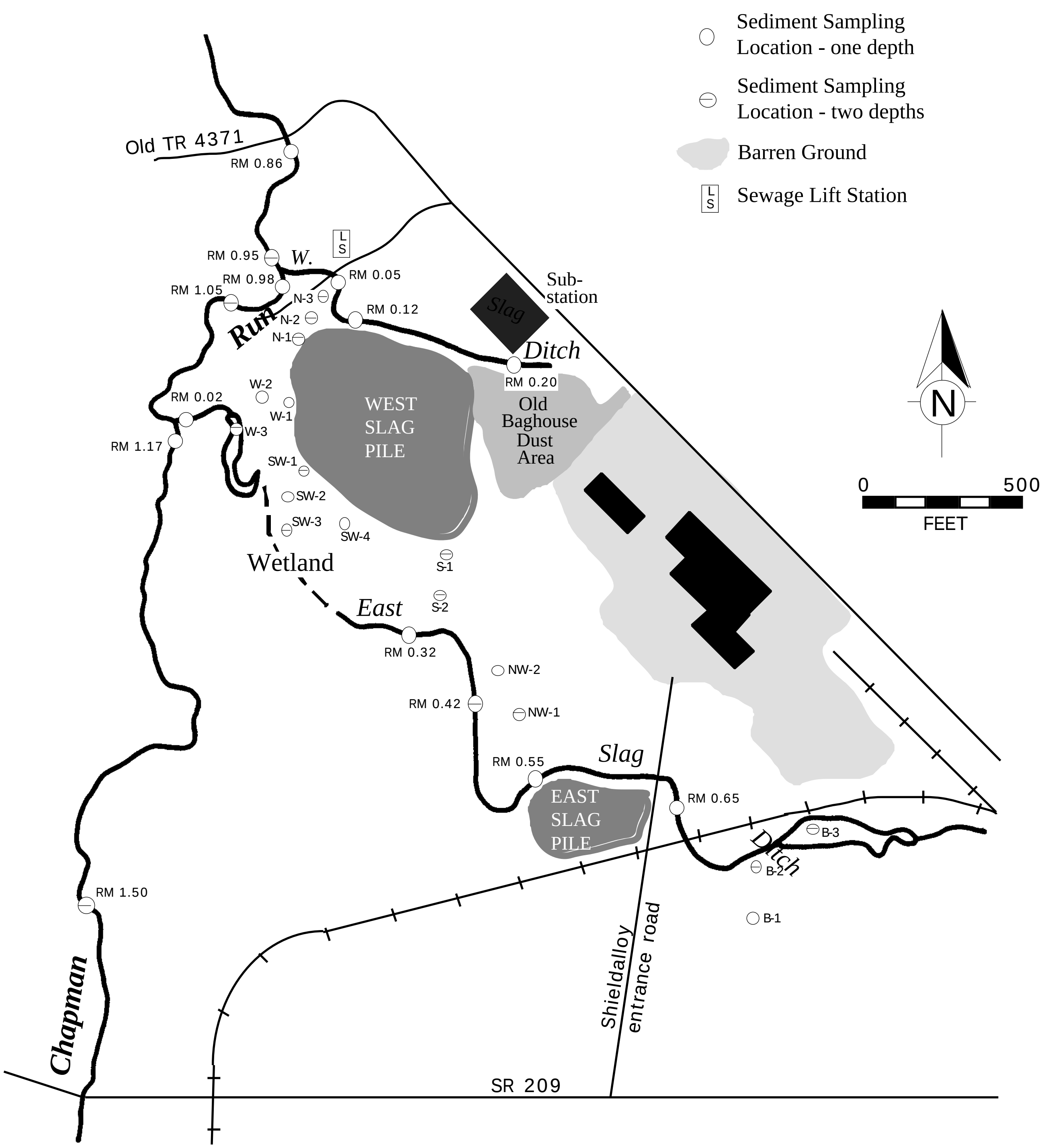

Figure 2. An enlargement of the Shieldalloy Metallurgical Corp. study area showing slag piles, streams and ditches, landmarks and sampling locations.

METHODS

All chemical, physical, and biological field, laboratory, data processing, and data analysis methodologies and procedures adhere to those specified in the Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices (Ohio Environmental Protection Agency 1989a) and Biological Criteria for the Protection of Aquatic Life, Volumes I-III (Ohio Environmental Protection Agency 1987a, 1987b, 1989b, 1989c), and The Qualitative Habitat Evaluation Index (QHEI): Rationale, Methods, and Application (Rankin 1989) for aquatic habitat assessment. All surface water, sediment, fish tissue and biological sampling locations are listed in Table 2.

Determining Use Attainment Status

The attainment status of aquatic life uses (*i.e.*, FULL, PARTIAL, and **NON**) is determined by using the biological criteria codified in the Ohio Water Quality Standards (WQS; Ohio Administrative Code [OAC] 3745-1-07, Table 7-17). The biological community performance measures which are used include the Index of Biotic Integrity (IBI), based on fish community characteristics, and the Invertebrate Community Index (ICI) which is based on macroinvertebrate community characteristics. The IBI and ICI are multimetric indices patterned after an original IBI described by Karr (1981) and Fausch *et al.* (1984). The ICI was developed by Ohio EPA (1987b) and further described by DeShon (1995). Qualitative macroinvertebrate sampling consisted of an inventory of taxa at a sampling station with an attempt to field estimate predominant populations. An assessment of the status of the designated aquatic life use was made at several stations utilizing qualitative sample attributes such as taxa richness and EPT (Ephemeroptera - mayfly, Plecoptera - stonefly, and Trichoptera - caddisfly) richness - an indication of the prevalence of pollution sensitive organisms.

Performance expectations for the principal aquatic life uses in the Ohio WQS (Warmwater Habitat [WWH], Exceptional Warmwater Habitat [EWH], and Modified Warmwater Habitat [MWH]) were developed using the regional reference site approach (Hughes *et al.* 1986; Omernik 1987). This fits the practical definition of biological integrity as the biological performance of the natural habitats within a region (Karr and Dudley 1981). Attainment of the aquatic life use is FULL if all three indices (or those available) meet the applicable biocriteria, PARTIAL if at least one of the indices does not attain and performance at least fair, and **NON**-attainment if all indices fail to attain or any index indicates poor or very poor performance. Partial and non-attainment indicate that the receiving water is impaired and does not meet the designated use criteria specified by the Ohio WQS.

Habitat Assessment

Physical habitat was evaluated using the Qualitative Habitat Evaluation Index (QHEI) developed by the Ohio EPA for streams and rivers in Ohio (Rankin 1989, 1995). Various attributes of the habitat are scored based on the overall importance of each to the maintenance of viable, diverse, and functional aquatic faunas. The type(s) and quality of substrates, amount and quality of instream cover, channel morphology, extent and quality of riparian vegetation, pool, run, and riffle development and quality, and gradient are some of the metrics used to determine the QHEI score which generally ranges from 20 to 100. The QHEI is used to evaluate the characteristics of a stream segment, as opposed to the characteristics of a single sampling site. As such, individual sites may have poorer physical habitat due to a localized disturbance yet still support aquatic communities closely resembling those sampled at adjacent sites with better habitat, provided water quality conditions are similar. QHEI scores from hundreds of segments around the state have indicated that values greater than 60 are *generally* conducive to the existence of warmwater faunas. Scores greater than 75 frequently typify habitat conditions which have the ability to support exceptional warmwater faunas.

Surface Water/ Sediment Assessment

Fine grain sediment samples were collected in the upper 6-8 inches of bottom material at each location (and at various other depths down to 18 inches at selected locations) using decontaminated stainless steel scoops or stainless steel core samplers. Decontamination of sediment sampling equipment followed the procedures outlined in FSOP 10.01, DERR Sampling Guidance, Vol. III, Ohio EPA 1992a). Collected sediment (grab samples) was homogenized in stainless steel pans, transferred into clear glass jars with teflon lined lids, placed on ice (to maintain 4^{o} C) in a cooler, and shipped to an Ohio EPA contract lab. Sediment data is reported on a dry weight basis. Surface water samples were collected directly into appropriate containers, preserved and delivered to the Ohio EPA Environmental Services lab or an Ohio EPA contract lab. Surface water samples were evaluated using comparisons to Ohio Water Quality Criteria, reference conditions and published literature. Sediment evaluations were conducted using guidelines established by the Ontario Ministry of the Environment (Persaud *et al.* 1993), reference conditions and published literature.

Macroinvertebrate Community Assessment

Macroinvertebrates were sampled quantitatively in Chapman Run at two locations using multiple-plate, artificial substrate samplers (modified Hester/Dendy) in conjunction with a qualitative assessment of the available natural substrates. Macroinvertebrate communities at three locations were evaluated qualitatively based on sampling all available natural aquatic habitat types at a sampling site. During the present study, macroinvertebrates collected from the natural substrates were also evaluated using an assessment tool currently in the testing and refinement phase. This method relies on tolerance values derived for each taxon, based upon the abundance data for that taxon from artificial substrate (quantitative) samples collected throughout Ohio. To determine the tolerance value of a given taxon, ICI scores at all locations where the taxon had been collected were weighted by its abundance on the artificial substrates. The mean of the weighted ICI scores for the taxon resulted in a value which represented its relative level of tolerance on the ICI's 0 to 60 scale. For the qualitative collections in the Chapman Run study area, the median tolerance value of all organisms from a site resulted in a score termed the Qualitative Community Tolerance Value (QCTV). The QCTV shows potential as a method to supplement existing assessment methods using the natural substrate collections. QCTV scores for sampling locations in the Chapman Run study area were used in conjunction with other aspects of the community data and were not unilaterally used to interpret quality of the sites or aquatic life use attainment status.

Fish Assessment

Fish were sampled using wading or boat method pulsed DC electrofishing gear. The wading and boat methods were used at a frequency of two samples at each site. The boat method was used only at the mouth of Chapman Run. The specific electrofishing method and fish community statistics for each site is listed in Table 6. Whole body fish were collected in September, 1994 for tissue analysis. Fish tissue sampling procedures are detailed in the Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices (Ohio EPA 1989a). Fish tissue results are reported on a wet weight basis.

Causal Associations

Using the results, conclusions, and recommendations of this report requires an understanding of the methodology used to determine the use attainment status and assigning probable causes and sources of impairment. The identification of impairment in rivers and streams is straightforward - the numerical biological criteria are the principal arbiter of aquatic life use attainment and impairment (partial and non-attainment). The rationale for using the biological criteria in the role of principal arbiter within a weight of evidence framework has been extensively discussed elsewhere (Karr *et al.* 1986; Karr 1991; Ohio EPA 1987a,b; Yoder 1989; Miner and Borton 1991; Yoder 1991; Yoder 1995). Describing the causes and sources associated with observed impairments relies on an interpretation of multiple lines of evidence including water chemistry data, sediment data, habitat data, effluent data, biomonitoring results, land use data, and the biological response signatures (Yoder and Rankin 1995) within the biological data itself. Thus the assignment of principal causes and sources of impairment in this report do not represent a true "cause and effect" analysis, but rather represent the association of impairments (based on response indicators) with stressor and exposure indicators whose links with the biosurvey data are based on previous research or experience with analogous situations and impacts. The reliability of the identification of probable causes and sources is increased where many such prior associations have been identified. The process is similar to making a medical diagnosis in which a doctor relies on multiple lines of evidence concerning patient health. Such diagnoses are based on previous research which experimentally or statistically linked symptoms and test results to specific diseases or pathologies. Thus a doctor relies on previous experience in interpreting symptoms (*i.e.*, multiple lines from test results) to establish a diagnosis, potential causes and/or sources of the malady, a prognosis, and a strategy for alleviating the symptoms of the disease or condition. As in medical science, where the ultimate arbiter of success is the eventual recovery and the well-being of the patient, the ultimate measure of success in water resource management is restoration of lost or damaged ecosystem attributes including aquatic community structure and function. While there have been criticisms of misapplying the metaphor of ecosystem "health" compared to human patient "health" (Suter 1993) here we are referring to the process for identifying biological integrity and causes/sources associated with observed impairment, not whether human health and ecosystem health are analogous concepts.

Table 2. Stream and wetland sampling locations (sediment - S, macroinvertebrate -M, fish - F, fish tissue - T, surface water - C) in the Chapman Run/ Shieldalloy study area, 1994.

Stream/ River Mile	Type of Sampling	Latitude	Longitude	Landmark	County	USGS 7.5 min. Quad. Map
				Stream		
Chapman Run						
5.8	M	39°56’58”	81°36’44”	TR 33, Buckeyeville	Guernsey	Byesville,OH
5.73	S,C	39°56’57”	81°36’42”	TR 33	Guernsey	Byesville,OH
5.2	F,T	39°57’10”	81°36’18”	King Rd.	Guernsey	Byesville,OH
1.62	C	39°58’57”	81°34’16”	State Route 209	Guernsey	Byesville,OH
1.6	F,T,M	39°59’00”	81°34’15”	Dst. SR 209	Guernsey	Byesville,OH
1.50	S	39°59’05”	81°34’16”	Dst. SR 209	Guernsey	Byesville,OH
1.17	S	39°59’17”	81°34’12”	Upst. E. Slag Ditch	Guernsey	Byesville,OH
1.1	F,T,M	39°59’19”	81°34’11”	Dst. E. Slag Ditch	Guernsey	Byesville,OH
1.05	S	39°59’24”	81°34’10”	Dst. E. Slag Ditch	Guernsey	Byesville,OH
0.98	S	39°59’25”	81°34’06”	Upst. W. Slag Ditch	Guernsey	Byesville,OH
0.95	S	39°59’27”	81°34’06”	Dst. W. Slag Ditch	Guernsey	Byesville,OH
0.9	F,T,M	39°59’31”	81°34’06”	Old TR 4371	Guernsey	Byesville,OH
0.86	S,C	39°59’30”	81°34’05”	Old TR 4371	Guernsey	Byesville,OH
0.45	S	39°59’45”	81°34’16”	Upst. Conrail bridge	Guernsey	Byesville,OH
0.4	M	39°59’46”	81°34’15”	Dst. Conrail bridge	Guernsey	Byesville,OH
0.1	F	39°59’46”	81°34’05”	Near the mouth	Guernsey	Byesville,OH
0.02	S	39°59’46”	81°33’52”	At the mouth	Guernsey	Byesville,OH
East Slag Ditch						
0.70, 0.40	S	39°58’54”	81°33’27”	Trib. to E.Slag D., SR209	Guernsey	Byesville,OH
0.65	S	39°59’07”	81°33’46”	Upst. Shieldalloy Road	Guernsey	Byesville,OH
0.55	S	39°59’08”	81°33’55”	Along East Slag Pile	Guernsey	Byesville,OH
0.42	S	39°59’10”	81°34’01”	Dst. East Slag Pile	Guernsey	Byesville,OH
0.32	S	39°59’13”	81°33’59”	Dst. East Slag Pile	Guernsey	Byesville,OH
0.02	S	39°59’22”	81°34’09”	At the mouth	Guernsey	Byesville,OH
West Slag Ditch						
0.20	S	39°59’23”	81°33’55”	Along W. Slag Pile	Guernsey	Byesville,OH
0.12	S	39°59’25”	81°34’01”	Along West Slag Pile	Guernsey	Byesville,OH
0.05	S	39°59’26”	81°34’04”	Upst. gravel road	Guernsey	Byesville,OH
Wills Creek						
68.13	C	39°59’30”	81°33’29”	Twp Rd. 347	Guernsey	Byesville,OH
67.62	S	39°59’30”	81°33’45”	Upst. Chapman Run	Guernsey	Byesville,OH
67.5	T	39°59’35”	81°33’49”	Upst. Chapman Run	Guernsey	Byesville,OH
67.33	C	39°59’50”	81°33’54”	I-70	Guernsey	Byesville,OH
67.2	T	39°59’48”	81°33’54”	Dst. Chapman Run	Guernsey	Byesville,OH
67.00	S	40°00’05”	81°33’53”	Dst. Old Chapman Run	Guernsey	Cambridge,OH
Old Chapman Run						
0.10	S	39°59’58”	81°33’59”	Near the mouth	Guernsey	Byesville,OH

Table 2. Continued.

Wetland Sample No.	Type of Sampling	Latitude	Longitude	Landmark	County	USGS 7.5 min. Quad. Map
			Wetland			
West Slag Pile Wetland - North						
N-1	S	39°59’24”	81°34’03”	2m from W.Slag Pile	Guernsey	Byesville,OH
N-2	S	39°59’25”	81°34’03”	25m from W.Slag Pile	Guernsey	Byesville,OH
N-3	S	39°59’27”	81°34’03”	50m from W.Slag Pile	Guernsey	Byesville,OH
West Slag Pile Wetland - West						
W-1	S	39°59’20”	81°34’04”	3m from W.Slag Pile	Guernsey	Byesville,OH
W-2	S	39°59’22”	81°34’06”	50m from W.Slag Pile	Guernsey	Byesville,OH
W-3	S	39°59’20”	81°34’07”	80m from W.Slag Pile	Guernsey	Byesville,OH
West Slag Pile Wetland - Southwest						
SW-1	S	39°59’18”	81°34’02”	8m from W.Slag Pile	Guernsey	Byesville,OH
SW-2	S	39°59’19”	81°34’04”	50m from W.Slag Pile	Guernsey	Byesville,OH
SW-3	S	39°59’18”	81°34’04”	150m from W.Slag Pile	Guernsey	Byesville,OH
SW-4	S	39°59’17”	81°33’59”	15m from W.Slag Pile	Guernsey	Byesville,OH
West Slag Pile Wetland - South						
S-1	S	39°59’16”	81°33’56”	5m from W.Slag Pile	Guernsey	Byesville,OH
S-2	S	39°59’14”	81°33’57”	70m from W.Slag Pile	Guernsey	Byesville,OH
East Slag Pile Wetland - Northwest						
NW-1	S	39°59’10”	81°33’55”	90m from E.Slag Pile	Guernsey	Byesville,OH
NW-2	S	39°59’12”	81°33’56”	150m from E.Slag Pile	Guernsey	Byesville,OH
Background Wetland						
B-1	S	39°59’01”	81°33’46”	Adj. Golden Rule School	Guernsey	Byesville,OH
B-2	S	39°59’03”	81°33’45”	50m from RR track	Guernsey	Byesville,OH
B-3	S	39°59’05”	81°33’41”	8m from RR track, pond	Guernsey	Byesville,OH

RESULTS AND DISCUSSION

Surface Water Chemical Quality

Surface water grab samples were collected in Chapman Run by Ohio EPA at three locations on six occasions between July 14 and September 22, 1994. Water samples were collected for fecal coliform testing on October 18, 1994. Individual sampling results are presented in Appendix Table 1.

- All vanadium values in Chapman Run upstream from the East and West Slag Ditches were less than the lab detection limit of 10 ug/l (Figure 3). A significant increase in total vanadium was documented in Chapman Run at RM 0.86, a site 0.1 miles downstream from the confluence with West Slag Ditch (RM 0.96) and 0.3 miles downstream from the confluence with East Slag Ditch (RM 1.13). The mean concentration of total vanadium at RM 0.86 was 612 ug/l, with a maximum recorded concentration of 1320 ug/l. An Ohio Water Quality Criterion has recently been developed for vanadium (Skalski 1995) with the maximum outside the mixing zone value equal to 190 ug/l and the 30-day average criterion equal to 87 ug/l. The vanadium levels reported at RM 0.86 in Chapman Run exceeded the 30-day average and maximum vanadium criteria. Several acute toxicity tests conducted on warmwater fish species (goldfish, flagfish and guppy) using either vanadium oxide sulfate or vanadium pentoxide have reported LC50 mortality results ranging from 128 ug/l - 11,200 ug/l (Birge 1978, Holdway and Sprague 1979, Knudtson 1979). Chronic toxicity tests using flagfish reported a reduction in growth over a 4-day period at a vanadium pentoxide mean concentration of 83 ug/l (Holdway and Sprague 1979) and chronic toxicity to fathead minnow was observed at a mean concentration of 170 ug/l (Kimball 1978) . Vanadium was measured in Wills Creek at one location upstream and one location downstream from Chapman Run. Upstream results were all less than lab detection limits; the downstream site had a mean total vanadium concentration of 22 ug/l (maximum = 45 ug/l).

- Total cadmium, total arsenic, hexavalent chromium, total chromium, total copper, total lead, and total nickel were all reported near or below lab detection limits at all Chapman Run sampling locations.

- Nutrient parameters (nitrate-nitrite, N; ammonia-N; total kjheldal nitrogen; 5-day biochemical oxygen demand (BOD_5), and total phosphorus) were generally low at all three Chapman Run sampling locations.

- Sulfate and total dissolved solids (parameters associated with mine drainage) and manganese, total iron, and total aluminum (parameters associated with mine drainage and parent soil conditions) concentrations were plotted for Chapman Run in Figure 3. Manganese, aluminum and iron were generally within or above reference conditions for relatively unimpacted stations in the Western Allegheny Plateau ecoregion. Sulfate and total dissolved solids were below reference conditions in the WAP ecoregion. These results suggest that mine drainage inputs are not substantially influencing the water chemistry of Chapman Run.

- A grab sample of overflow was collected on December 1, 1994 from the sewer system lift station located on Shieldalloy property and discharging into the West Slag Ditch near the confluence with Chapman Run. The chemical results revealed elevated levels of BOD_5 (139 mg/l), ammonia-N (3.94 mg/l) and total phosphorus (2.01 mg/l). Human hygiene products and foamy material were observed in the flow channel leading from the lift station to the West Slag Ditch.

- Chemical spills and wild animal kills are additional indications of impacts due to excessive pollutant loadings. Reviews were conducted for discharges and kills in Chapman Run as reported by the Ohio EPA Division of Emergency and Remedial Response and the Ohio DNR Division of Wildlife. No wildlife kills were reported by ODNR in Chapman Run during the last five years. Three spills were reported in or near Chapman Run and Wills Creek between 1989 and 1994 which were associated with Colgate-Palmolive Co. The material spilled was foam and laundry detergent; however, the amount of material was reported as zero. No spills were reported that were associated with Shieldalloy.

Sediment Quality

Sediment samples were collected by Ohio EPA at nine locations in Chapman Run, six locations in East Slag Ditch, three locations in West Slag Ditch, two locations in Wills Creek, one location in Old Chapman Run, and 17 locations in wetland areas surrounding the slag piles. All sampling locations are indicated by river mile (streams) or site location (wetlands) in Figures 1 and 2. At fifteen of the sediment sampling locations, core samples were collected at two depths. Core depths varied depending on site conditions; generally, sample depths were separated into two ranges of 0-10 inches and 10-18 inches. Samples were analyzed for total analyte list (TAL) metals, total organic carbon, grain size, and select radiological parameters. Specific chemical parameters tested and results are listed in Appendix Table 2. Sediment samples for several metal parameters were evaluated using guidelines established by the Ontario Ministry of the Environment (Persaud *et al.* 1993). The guidelines define two levels of ecotoxic effects and are based on the chronic, long term effects of contaminants on benthic organisms. A *Lowest Effect Level* is a level of sediment contamination that can be tolerated by the majority of benthic organisms, and a *Severe Effect Level* indicates a level at which pronounced disturbance of the sediment-dwelling benthic community can be expected. When any parameters are at or above the Severe Effect Level guideline, the material tested is considered highly contaminated (Persaud *et al.* 1993). The guidelines detailed in Persaud *et al.* (1993) do not include evaluations of vanadium, beryllium and other metal parameters tested during this study.

- At a majority of sites where two sample depths were collected, the upper sample material (0-8 inch depth) was consistently higher in concentrations of vanadium and chromium than sediment material in the lower sample (8-18 inch depth).

- Ecotoxicological benchmark guidelines are not available for evaluating vanadium levels in sediment. Review of the Ohio EPA sediment data revealed highly elevated levels of vanadium in the East Slag Ditch, West Slag Ditch and wetland sampling locations (Table 3), with mean concentrations in each area 26 to 226 times in excess of mean background levels. In addition, mean concentrations of vanadium in Chapman Run adjacent to and downstream from Shieldalloy property were five to six times higher than background stream sediment concentrations. The highest vanadium value measured in sediment during the Ohio EPA study occurred in the West Slag Ditch at RM 0.20, with the sample comprised of 2.2% vanadium (22,000 mg/kg).

- Chromium background samples were all less than 21 mg/kg, a concentration lower than the Lowest Effect Level. One chromium sample in Chapman Run exceeded the Severe Effect Level, and was located immediately downstream from the West Slag Ditch. Overall, 8 of 38 stream and wetland sediment samples collected on or adjacent to the Shieldalloy property exceeded the Severe Effect Level guideline. The highest chromium levels were primarily from sediment sites located near the West Slag Pile (ditch and wetland areas).

- Arsenic, cadmium, iron, manganese and nickel samples had between one and eight values exceeding the Severe Effect Level. Aside from iron and cadmium, the majority of these elevated levels occurred in the East Slag Ditch, West Slag Ditch, and wetland sites adjacent to the West Slag Pile.

- Radiological constituents in sediments were compared with the average reference values from upstream sites on Chapman Run, East Slag Ditch, and the reference wetland area. These reference values were: gross alpha (23 pCi/g), gross beta (33 pCi/g), radium 226 (1.5 pCi/g), radium 228 (1.2 pCi/g), thorium 228 (1.1 pCi/g), thorium 230 (1.3 pCi/g), thorium 232 (1.1 pCi/g), uranium 234 (1.2 pCi/g), uranium 235 (0.07 pCi/g), and uranium 238 (1.2 pCi/g). The reference samples collected from Chapman Run and East Slag Ditch were less than the reference samples collected from the wetland area on the south side of the Shieldalloy property. Below are the constituents and samples which exceeded five times reference levels (a 'rule of thumb' general guidance used by USEPA and Ohio EPA). In addition, the thorium 230 sediment sample from the East Slag Ditch at RM 0.42 (66± 1.9 pCi/g) was substantially higher then the NRC soil contaminant guideline of 5 pCi/g in the upper 5 cm of soil and 15 pCi/g in soil below 5 cm.

gross alpha:	East Slag Ditch RM 0.42 (120±15 pCi/g)
gross beta:	None
radium 226:	None
radium 228:	None
thorium 228:	None
thorium 230:	East Slag Ditch RM 0.42 (66±1.9pCi/g), Wetland SW-1 (8.3 pCi/g)
thorium 232:	None
uranium 234:	None
uranium 235:	Wetland NW-1 (0.74±0.20 pCi/g)
uranium 238:	None

A majority of the radiological tests conducted on sediment samples were measured below or near background levels.

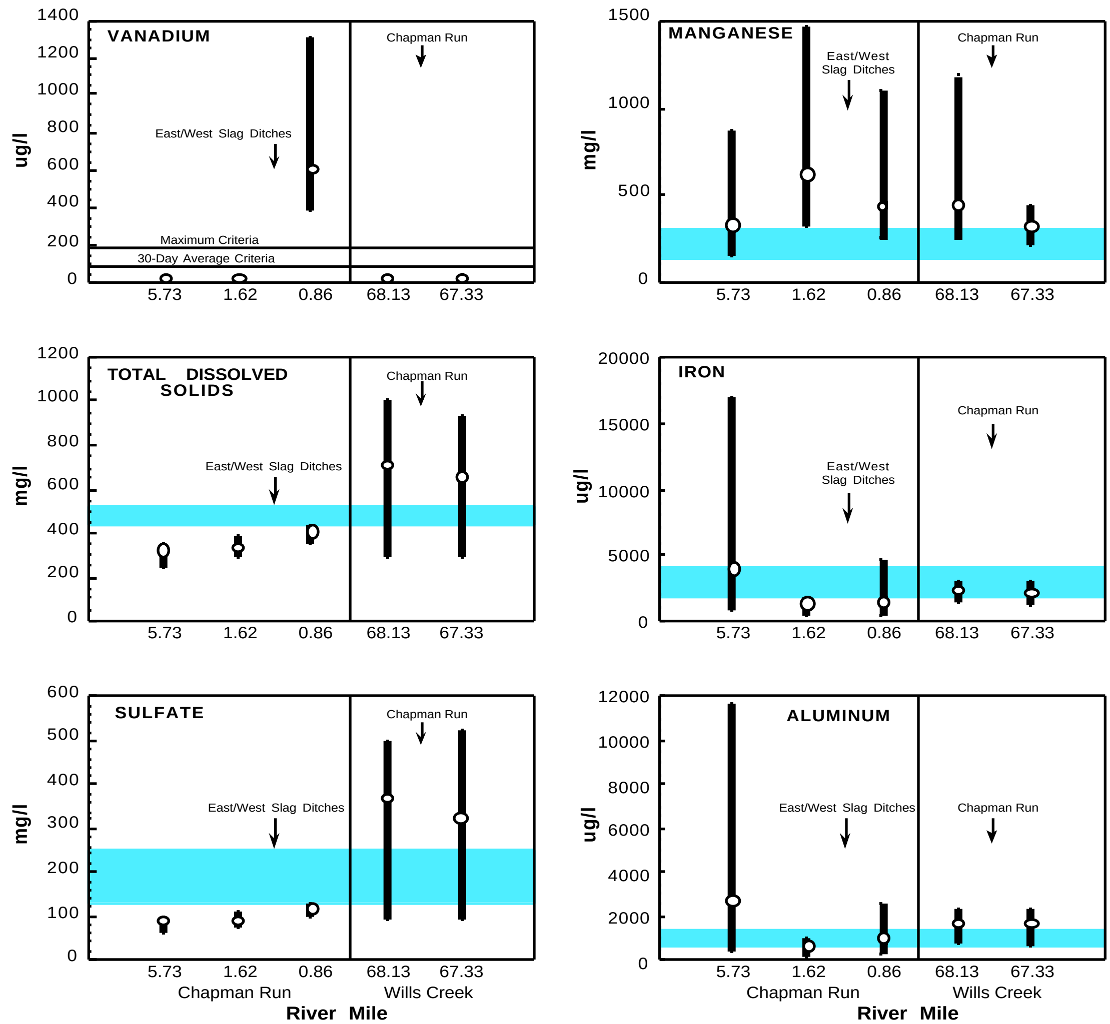

Figure 3. Mean (circle) and range (bar) of values for total vanadium, sulfate, manganese, total aluminum, total iron, and total dissolved solids recorded in Chapman Run and Wills Creek by river mile during 1994 by the Ohio EPA. Shaded areas represent the range between the median and 75th percentile values for relatively unimpacted Western Allegheny Plateau ecoregion reference sites (Ohio EPA 1992b). Shading for aluminum was based on data from the Muskingum River basin as reported in Ohio EPA (1988). Ohio water quality criteria levels for vanadium are indicated by horizontal lines.

Table 3. Mean and range of concentrations of selected chemicals collected in sediment from Chapman Run, East Slag Ditch, West Slag Ditch, Old Chapman Run, and wetland areas by Ohio EPA during 1994. Boldface numbers indicate values exceeding the Severe Effect Level (Persaud *et al.* 1993). Vanadium and beryllium are not included in Persaud *et al.* 1993.

	SEDIMENT (dry weight basis)			
Waterbody Location (# samples)	Vanadium (mg/kg)	Chromium (mg/kg)	Zinc (mg/kg)	Beryllium (mg/kg)
Stream Background 0-18” depth (n=4/5[a])	39.4 (11.4 - 139.0)	7.4 (5.4-12.3)	52.0 (39.0-80.7)	0.59 (0.43-0.80)
Wetland Background 0-15” depth (n=4/5[a])	72.6 (12.3-146)	7.7 (5.2-10.3)	46.3 (29.9-64)	0.51 (0.46-0.57)
Chapman Run - Adjacent Shieldalloy (RM 1.17 - 0.8) 0-18” depth (n=7)	266 (12.3-1300)	20.2 (5.4-76.9)	64.3 (26.9-151)	0.62 (0.44-0.82)
Chapman Run - Lower Section (RM 0.8 - 0.0) 0-10” depth (n=2)	204 (54.0-354)	7.4 (6.5-8.3)	45.8 (39.8-51.8)	0.67 (0.62-0.73)
East Slag Ditch - Adj. Shieldalloy (RM 0.6 - 0.0) 0-12” depth (n=5)	2698 (1760-4030)	64.1 (29.2-**149**)	72.2 (48.4-98.0)	2.30 (1.15-4.0)
West Slag Ditch - Adj. Shieldalloy (RM 0.2 - 0.0) 0-10” depth (n=3)	8907 (1260-22,000)	**209** (95.0-**432**)	294 (188-351)	5.49 (0.82-14.1)
Wills Creek - Downstream Chapman (RM 67.0) 0-8” depth (n=1)	39.6	7.3	40.8	0.43
Old Chapman Run - near mouth (RM 0.1) 0-6” depth (n=1)	38.1	5.7	32.1	0.37
Wetland - Top of Core 0-10” depth (n=13)	2551 (155-8010)	91.7 (16.7-**224**)	78.3 (46.0-107)	2.11 (<0.20-9.88)
Wetland - Bottom of Core 8-18” depth (n=9)	1934 (33.3-8100)	29.5 (9.0-**111**)	52.3 (35.4-74.3)	2.66 (0.43-10.5)

Table 3. Continued.

	SEDIMENT (dry weight basis)		
Waterbody Location (# samples)	Arsenic (mg/kg)	Iron (mg/kg)	Nickel (mg/kg)
Stream Background 0-18" depth (n=4/5[a])	10 (<10-11)	22,450 (10,400-**58,000**)	14.2 (10.2-17.3)
Wetland Background 0-15" depth (n=4/5[a])	11 (<10-15)	19,134 (8840-**40,900**)	11.0 (8.0-13)
Chapman Run - Adjacent Shieldalloy (RM 1.13 - 0.8) 0-18" depth (n=7)	11 (<10-13)	14,893 (10,400-17,900)	36.1 (8.4-**119**)
Chapman Run - Lower Section (RM 0.8 - 0.0) 0-10" depth (n=2)	18 (15-21)	12,575 (8850-16,300)	11.6 (10.4-12.8)
East Slag Ditch - Adj. Shieldalloy (RM 0.6 - 0.0) 0-12" depth (n=3/5[b])	12 (11-14)	32,020 (12,000-**43,500**)	30.0 (11.1-43.0)
West Slag Ditch - Adj. Shieldalloy (RM 0.2 - 0.0) 0-10" depth (n=3)	29 (17-**49**)	17,867 (14,000-22,700)	**416** (156-841)
Wills Creek - Downstream Chapman (RM 67.0) 0-8" depth (n=1)	14	10,500	12.8
Old Chapman Run - near mouth (RM 0.1) 0-6" depth (n=1)	11	8510	10.5
Wetland - Top of Core 0-10" depth (n=13)	**36** (<10-**106**)	15,646 (10,100-24,200)	77.4 (12.1-**466**)
Wetland - Bottom of Core 8-18" depth (n=9)	30 (<10-**106**)	20,057 (13,100-34,100)	15.4 (10.4-23.8)

a One value for beryllium, arsenic and chromium was not used in the mean calculation because the data was reported as a less than value which was substantially higher than the other reported values.

b Two values for arsenic were not used in the mean calculation because the data was reported as a less than value which was substantially higher than the other reported values.

Physical Habitat for Aquatic Life

Physical habitat was evaluated in Chapman Run at the 1994 fish sampling locations. Qualitative Habitat Evaluation Index (QHEI) scores are detailed in Table 4.

- Natural habitat conditions occur in Chapman Run at all sampling locations except RM 0.1, where the stream had been moved due to the construction of the I-70 and I-77 interchange. Substantial modification of the lower 0.5 miles of Chapman Run was the result of a completely new channel constructed along the south side of I-70. Habitat conditions in the lower 0.5 miles consist of bottom substrates predominated by silt and artificial material (riprap), nearly absent instream cover, no riffle development and poorly defined pool areas. There was an almost complete absence of warmwater habitat attributes in the lower 0.5 miles of Chapman Run. The QHEI score at RM 0.1 was 16.5, reflective of poor stream habitat.

- Physical habitat conditions were comparable between stations sampled at RMs 1.6, 1.1 and 0.9; however, several notable differences were observed. All three locations had bottom substrates predominated by muck, with heavy deposits of silt and extensive embeddedness of the stream substrates. Instream cover was considered moderate at RMs 1.6 and 1.1 and moderate to sparse at RM 0.9. Riffles were of fair quality at RMs 1.6 and 1.1 and the one riffle at RM 0.9 was poorly developed. The appearance of channelized conditions at RM 0.9, along with a significant bedload downstream from the confluence with the West Slag Ditch (RM 0.95) contributed to the lower QHEI score at RM 0.9 (34.0) in comparison to RMs 1.6 (49.5) and 1.1 (47.5). The extensive sediment bedload observed at RM 0.9 appeared to be in part associated with runoff material from the West Slag Pile. Modified warmwater habitat attributes predominated at all of these sites. Overall, these sites were reflective of fair (RMs 1.6 and 1.1) to poor (RM 0.9) stream habitat.

- Well defined pool and riffle areas occurred at RM 5.2, an area with a much higher gradient than compared to the downstream sampling locations (RMs 1.6 - 0.1). The QHEI score was 67.0, reflective of good stream habitat. Bottom substrates were predominated by gravel and sand, instream cover was considered moderate (logs, woody debris, boulders, undercut banks) and warmwater habitat attributes predominated.

Table 4. Qualitative Habitat Evaluation Index (QHEI) matrix showing modified and warmwater habitat characteristics for Chapman Run, 1994.

Key QHEI Components

River Mile	QHEI	Gradient (ft/mile)	WWH Attributes: No Channelization or Recovered	Boulder/Cobble/Gravel Substrates	Silt Free Substrates	Good/Excellent Development	Moderate/High Sinuousity	Extensive/Moderate Cover	Fast Current/ Eddies	Low/Normal Embeddedness	Max Depth > 40 cm	Low/No Riffle Embeddedness	**Total WWH Attributes**	MWH Attributes, High Influence: Channelized or No Recovery	Silt/Muck Substrates	Low Sinuousity	Sparse/No Cover	Max Depth < 40 cm (WD,HW)	**Total H.I. MWH Attributes**	MWH Attributes, Moderate Influence: Recovering Channel	Heavy/Moderate Silt Cover	Sand Substrates (Boat)	Hardpan Substrate Origin	Fair/Poor Development	Low/No Sinuosity	Only 1-2 Cover Types	Intermittent & Poor Pools	No Fast Current	High/Moderate Embeddedness	Ext./Moderate Riffle Embed.	No Riffle	**Total M.I. MWH Attributes**	**MWH H.I./WWH Ratio**	**MWH M.I./WWH Ratio**
(17-817) – Chapman Creek																																		
Year: 94																																		
5.2	67.0	10.5	■	■		■	■	■			■	■	7						0		▲			▲				▲	▲			4	.13	.63
1.6	49.5	2.0	■					■			■		3		●	●			2		▲		▲	▲	▲			▲	▲	▲		7	.75	2.50
1.1	47.5	2.0	■					■			■		3		●	●			2		▲			▲	▲			▲	▲	▲		6	.75	2.25
.9	34.0	2.0						■			■		2		●	●	●		3	▲	▲			▲	▲			▲	▲	▲	▲	8	1.33	4.00
.1	16.5	.1									■		1	●	●	●	●		4		▲			▲	▲	▲		▲	▲		▲	7	2.50	6.00

Macroinvertebrate Community

Macroinvertebrate communities were sampled in Chapman Run between August 12 and September 28, 1994. Artificial substrate samplers were placed instream at RMs 5.8, 1.6, and 0.4 and qualitative natural substrate samples were taken at RMs 1.1 and 0.9 (Table 2, Figure 1). ICI metrics, scores, and raw data tables by river mile are presented in Appendix Tables 3 and 4.

- The site at Buckeyeville (RM 5.8) was chosen based on the similarity of habitat to that found in the vicinity of the Shieldalloy facility. The habitat characteristics consisted of low gradient with very slow current velocity, no riffle/run development, and very steep, poorly developed margins. The macroinvertebrate community was in the fair range with an ICI score of 18 and an EPT taxa richness in the qualitative sample of 2. However, results from both quantitative and qualitative sampling yielded 7 distinct EPT taxa (5 mayfly and 2 caddisfly) (Table 5, Figure 4). Thirteen percent of the qualitative taxa were considered to be pollution tolerant (Ohio EPA 1987b).

- At the site downstream from State Route 209 (RM 1.6), the channel had been modified with a backhoe and the artificial substrate samplers removed. The results of qualitative sampling indicated a macroinvertebrate community in the fair range including 29 total taxa and an EPT taxa richness of 3. An old beaver dam provided a major portion of the habitat structure at this site with high densities of caddisflies from the *Hydropsyche (H.) depravata* group and the genus *Cheumatopsyche*. Also present was the pollution sensitive caddisfly *Chimarra obscura*. Fourteen percent of the qualitative taxa were considered to be pollution tolerant.

- The site between the Shieldalloy East Slag Ditch and West Slag Ditch (RM 1.1) included an area with a narrow, shallow chute with good current velocity and emergent vegetation providing good habitat structure. The macroinvertebrate community was in the fair range with 24 total and an EPT taxa richness of 5. The narrow chute had 4 mayfly taxa including the mayfly genus and species *Labiobaetis frondalis*, *Baetis intercalaris*, *Stenacron*, *Hexagenia* and the caddisfly genus *Cheumatopsyche*. Seventeen percent of the qualitative taxa were considered to be pollution tolerant.

- The site below the Shieldalloy West Slag Ditch (RM 0.9) was very sediment and silt laden with poor habitat; the only real habitat structure was woody debris. The results of the qualitative sampling indicated a macroinvertebrate community in the poor range with only 13 total taxa and no EPT taxa. Thirty-one percent of the qualitative taxa were considered to be pollution tolerant. The habitat was similar to conditions upstream except for the silt load; however, the macroinvertebrate community was much more severely degraded and indicated a toxic effect originating between RM 1.1 and RM 0.9.

- The site at the mouth of Chapman Run (RM 0.4) was sampled as part of the larger Wills Creek study. The results of the macroinvertebrate sampling indicated a community in the fair range with an ICI score of 14, an overall EPT taxa richness of 3, and a total of 34 taxa present based on both quantitative and qualitative sampling. Six percent of the qualitative taxa were considered to be pollution tolerant. This site had very slow current velocity and poor instream habitat.

Table 5. Summary of macroinvertebrate data collected from artificial substrates (quantitative sampling) and natural substrates (qualitative sampling) in Chapman Run, 1994. Chapman Run has a WWH aquatic life use designation in the Ohio Water Quality Standards.

Quantitative Evaluation

Stream/ River Mile	Relative Density	Total Taxa	Quantitative Taxa	Qualitative Taxa	Qualitative EPT[a]	ICI	Narrative Evaluation
Chapman Run							
5.8	256	41	25	24	2	18*	Fair
0.4	111	34	28	17	2	14*	Fair

Qualitative Evaluation

Stream/ River Mile	No. Qual. Taxa	QCTV[b]	Qual. EPT[a]	Relative Density	Predominant Organisms	Narrative Evaluation[c]
Chapman Run						
1.6	29	37.2	3	Moderately low	Midges, caddisflies	Fair
1.1	24	42.9	5	Low	Midges, mayflies	Fair
0.9	13	30.3	0	Low	Midges	Poor

Ecoregional Biocriteria: Western Allegheny Plateau (WAP)
(from OAC 3745-1-07, Table 7-17)

INDEX	WWH	EWH	MWH[d]
ICI	36	46	22

[a] EPT= total Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) taxa richness.
[b] Qualitative Community Tolerance Value (QCTV) derived as the median of the tolerance values calculated for each qualitative taxon present.
[c] The qualitative narrative evaluation is based on best professional judgement utilizing sample attributes such as taxa richness, EPT richness, and QCTV score and is used when quantitative data is not available to calculate the Invertebrate Community Index (ICI) scores.
[d] Modified Warmwater Habitat for channel modified areas.
* Significant departure from ecoregional biocriterion (>4 ICI units); poor and very poor results are underlined.

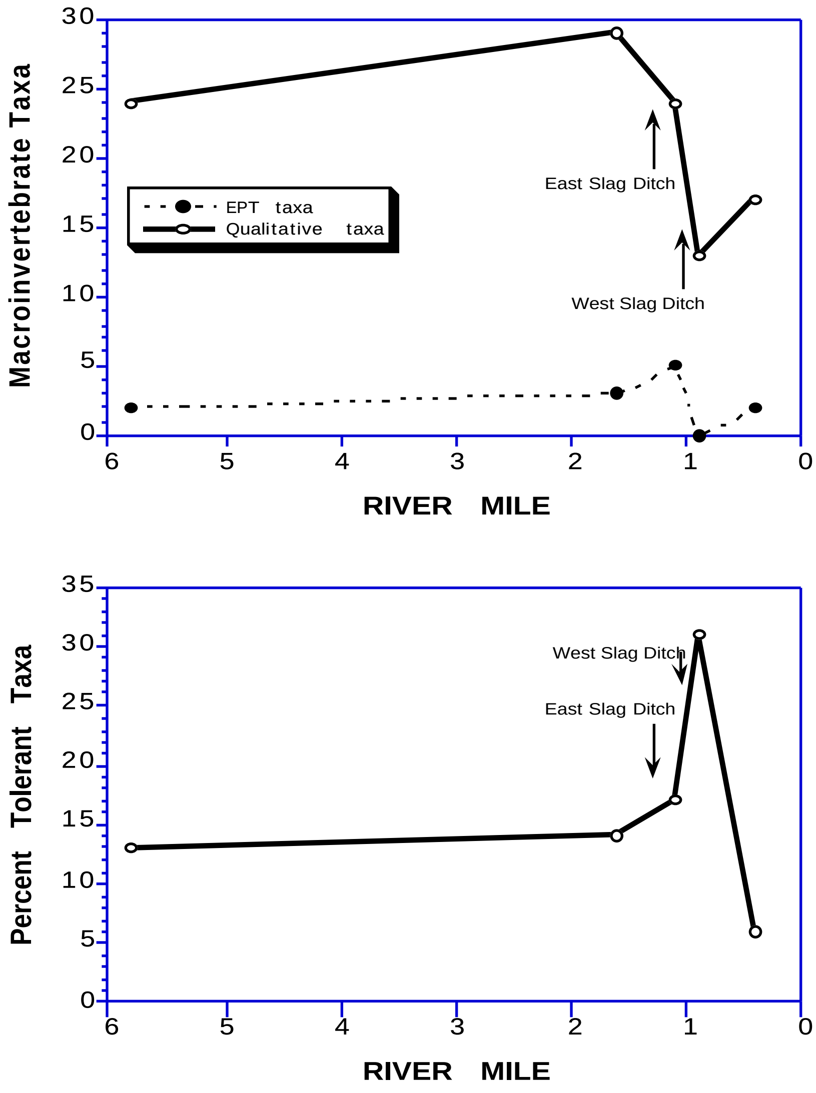

Figure 4. Longitudinal trend of qualitative macroinvertebrate taxa and EPT (Ephemeroptera, Plecoptera, and Trichoptera) taxa (upper) and percent of tolerant taxa in the qualitative sample (lower) in Chapman Run, 1994.

Fish Community

A total of 2,539 fish representing 32 species and two hybrids were collected from Chapman Run between August 10 and October 4, 1994. The sampling effort included a cumulative distanced electrofished of 2.40 km at five locations (Table 6, Figure 1). Relative numbers, species collected, and IBI metric information per location is presented in Appendix Tables 5 and 6.

- Creek chub (29.2%) and bluntnose minnow (26.6%), two pollution tolerant species, predominated the catch numerically. Sixty-four (64) percent of the relative number of fish from the study area were collected from RM 5.2. The lowest number of fish collected occurred at RM 0.1, with less than 2% of the relative number measured in Chapman Run.

- The fish community at the most upstream Chapman Run sampling location (RM 5.2) was evaluated as fair, with a large proportion of pollution tolerant species present. The IBI score of 38 was not achieving the WWH ecoregional biocriterion. Potential causes for the reduced fish community include sedimentation of the stream bottom (moderate level of substrate embeddedness) and water quality influences associated with the unsewered community of Buckeyeville.

- A decline in the fish community was observed at RM 1.6, a site located upstream from the Shieldalloy property. The IBI score was 28 and reflective of marginally fair water resource conditions. The fish community at RM 1.6 was not achieving the WWH ecoregional biocriterion. Reduced instream habitat conditions were noted at RM 1.6, in comparison to upstream locations. These habitat conditions (low gradient, muck bottom, extensive embeddedness) appeared to be a predominant factor in a fish community reflective of fair water quality.

- The fish communities in Chapman Run from RMs 1.1, 0.9 and 0.1 were reflective of poor water quality. IBI scores at these stations varied between 19 and 21, showing significant departure from the WWH ecoregion biocriterion. As was observed at the upstream sampling locations, pollution tolerant species predominated at RMs 1.1, 0.9 and 0.1. The greatest variability in species richness between the two sampling passes occurred at RMs 1.1 and 0.9 (Figure 5). Chemical water quality sampling results from Chapman Run revealed that within the area of RM 0.9, vanadium concentrations exceeded chronic and acute water quality criteria. These elevated vanadium levels appear to be at least a partial contributor to the poor fish communities observed in the lower 1.1 miles of Chapman Run. Other potential influences include raw sewage discharged sporadically from a Cambridge sanitary sewer lift station and reduced instream physical habitat conditions.

Table 6. Fish community indices from Chapman Run, 1994 based on pulsed D.C. electrofishing at sites sampled by Ohio EPA. Sites were sampled using wading methods (RM 5.2 - 0.9) and boat methods (RM 0.3). Relative numbers are per 0.3 km for wading methods and 1.0 km for boat methods. Chapman Run has a WWH aquatic life use designation in the Ohio Water Quality Standards.

Stream/ River Mile	Mean Number of Species	Cumulative Species	Mean Relative Number	QHEI	Mean Index of Biotic Integrity	Narrative Evaluation[a]
Chapman Run						
5.2	14.0	15	1664	67.0	38*	Fair
1.6	15.5	18	347	49.5	28*	Fair
1.1	12.0	15	391	47.5	<u>19</u>*	Poor
0.9	9.5	15	163	34.0	<u>21</u>*	Poor
0.1	9.0	13	46	16.5	<u>19</u>*	Poor

Ecoregion Biocriteria: Western Allegheny Plateau (WAP)

INDEX	WWH	EWH	MWH[b]
IBI - Headwaters	44	50	24

* Significant departure from ecoregion biocriterion (>4 IBI units); poor and very poor results are underlined.

ns Nonsignificant departure from WWH biocriterion (≤4 IBI units).

a Narrative evaluation is based on IBI scores.

b Modified Warmwater Habitat for channel modified and mine drainage affected areas.

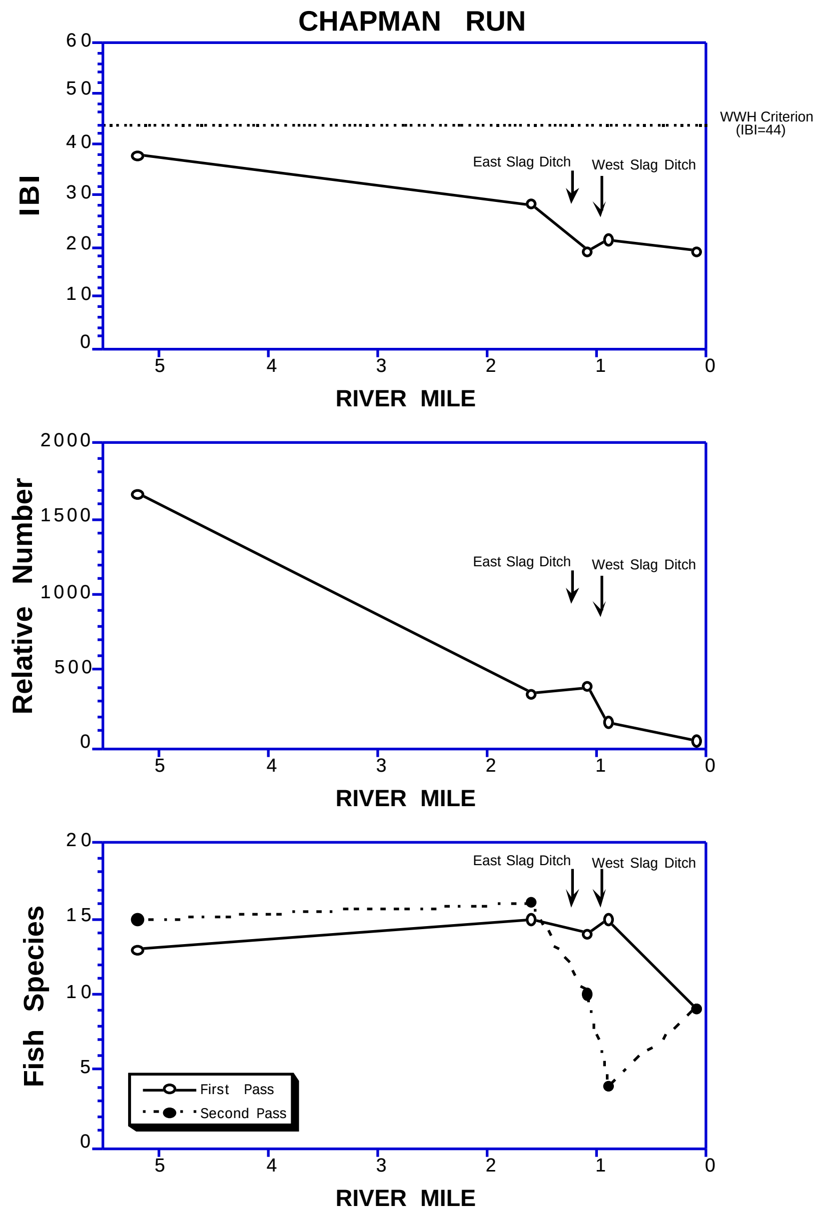

Figure 5. Longitudinal trend of the Index of Biotic Integrity (IBI), number of fish species and relative numbers of fish in Chapman Run, 1994.

Fish Tissue

Fish tissue samples were collected from Chapman Run at four locations and Wills Creek at two locations by the Ohio EPA during 1994 (Tables 7 and 8). Whole body composite samples representing four fish species were collected in Chapman Run and analyzed for vanadium, mercury, chromium, cadmium, lead, and percent lipids. Whole body composite and fillet samples representing two species were collected in Wills Creek immediately upstream and downstream from Chapman Run and analyzed for the above parameters as well as radiologicals. At one location in Chapman Run (RM 0.9), two fish species were composited into one sample because of a lack of adequate sample material.

- Vanadium was detected in fish tissue samples from Chapman Run collected at RMs 1.1 and 0.9, sites located adjacent to Shieldalloy property and receiving surface runoff from the East Slag Ditch and West Slag Ditch. Concentrations of vanadium detected ranged from 1.1 mg/kg to 5.7 mg/kg. Fish tissue samples collected upstream from Shieldalloy had no detectable vanadium (measurements were reported as below the estimated quantitation limit - EQL of 0.2 mg/kg or 0.4 mg/kg). The fish tissue vanadium results for samples from Wills Creek reported no difference between the two sites, with concentrations reported at 0.6 mg/kg for common carp and less than the EQL of 0.2 mg/kg for channel catfish.

- Fish tissue concentrations of mercury, chromium, cadmium and lead were comparable among all sites sampled in Chapman Run. All values were low, with a majority of the measurements below the estimated quantitation limits. Similar results were recorded in Wills Creek. Mercury, the only parameter of those listed above with a Food and Drug Administration (FDA) Consumption Action Level (1 mg/kg), was detected in six of sixteen samples at low levels (i.e. well below the 1 mg/kg level).

- All gross alpha, thorium 228, 230, and 232 isotopes, and uranium 234 and 235 isotopes were below laboratory detection limits. Five of six uranium 238 samples were less than lab detection limits; the one detected sample was very low (0.7± 0.7 pCi/g). All samples had detectable levels of gross beta, with values ranging from 19 to 35 pCi/g. The levels of gross beta - in the absence of detectable levels of gross alpha, thorium, and uranium - were probably due to potassium^{40} or other naturally occurring beta emitters. No detectable difference in radiological parameters was observed between fish sampling results upstream and downstream from Chapman Run.

Table 7. Results of metal and lipid tissue analyses from fish collected by the Ohio EPA in Chapman Run and Wills Creek during 1994.

Stream **River Mile** Fish Species	Lipid (%)	Vanadium (mg/kg)	Mercury (mg/kg)	Chromium (mg/kg)	Cadmium (mg/kg)	Lead (mg/kg)
	FISH TISSUE -METALS					
Chapman Run						
RM 5.2 (Adj. King Rd.)						
White sucker - WBC	0.70	<0.2	0.14	0.05	<0.04	<0.10
White sucker - lab duplicate	1.62	<0.2	0.10	0.05	<0.04	<0.10
Creek chub - WBC	1.65	<0.2	<0.08	<0.04	<0.04	<0.10
RM 1.6 (SR 209)						
White sucker - WBC	1.34	<0.2	<0.08	0.10	<0.04	0.12
Creek chub - WBC	0.85	<0.2	<0.08	0.05	<0.04	<0.10
Grass pickerel - WB	1.61	<0.4	<0.08	0.09	<0.07	<0.17
RM 1.1 (Dst. E. Slag Ditch)						
White sucker - WBC	0.98	1.7	<0.08	0.14	<0.04	0.20
Creek chub - WBC	1.05	1.1	<0.08	<0.04	<0.04	<0.10
Grass pickerel - WBC	1.31	4.6	<0.08	0.10	<0.04	<0.10
RM 0.9 (Dst. W. Slag Ditch)						
White sucker/ green sunfish - WBC	2.43	5.7	<0.08	0.14	<0.04	0.26
Wills Creek						
RM 67.5 (Upst. Chapman Run)						
Common carp - WBC	2.5	0.6	<0.08	0.05	0.73	<0.10
Channel catfish - SFFC	0.62	<0.2	0.11	0.05	<0.04	<0.10
Channel catfish - SFF	1.6	<0.2	0.16	<0.04	<0.04	<0.10
RM 67.0 (Dst. Chapman Run)						
Common carp - WBC	4.2	0.6	<0.08	0.06	0.14	0.15
Channel catfish - SFFC	1.4	<0.2	0.10	<0.04	<0.04	<0.10
Channel catfish - SFF	1.0	<0.2	0.10	<0.04	<0.04	<0.10

Table 8. Results of radiological tissue analyses from fish collected by the Ohio EPA in Wills Creek during 1994.

FISH TISSUE - RADIOLOGICALS (pCi/g)

	Gross Alpha	Gross Beta	Thorium 228	Thorium 230	Thorium 232	Uranium 234	Uranium 235	Uranium 238
Wills Creek								
RM 67.5 (Upst. Chapman Run)								
Common carp - WBC	ND	21±6.9	ND	ND	ND	ND	ND	ND
Channel catfish - SFFC	ND	34±7.5	ND	ND	ND	ND	ND	ND
Channel catfish - SFF	ND	22±7.0	ND	ND	ND	ND	ND	0.07±0.07
RM 67.0 (Dst. Chapman Run)								
Common carp - WBC	ND	19±7.0	ND	ND	ND	ND	ND	ND
Channel catfish - SFFC	ND	35±7.8	ND	ND	ND	ND	ND	ND
Channel catfish - SFF	ND	23±7.1	ND	ND	ND	ND	ND	ND

WBC = whole body composite.
SFFC = skin off fillet composite.
SFF = skin off fillet.
ND = not detected

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APPENDIX TABLES

Appendix Table 1. Results of the chemical/ physical surface water sampling conducted by Ohio EPA in the Chapman Run study area during July - October, 1994.

Date	Time	Temp. (°C)	D.O. (mg/l)	pH (field) (S.U.)	pH (lab) (S.U.)	BOD_5 (mg/l)	COD (mg/l)	Field Conduct. (umhos/cm)	Lab Conduct. (umhos/cm)
Chapman Run: RM 5.73 - Twp.33 (Buckeyeville)									
940714	1045	22.2	8.3	7.35	7.70	7.2	247	335	350
940728	1035	22.0	5.7	7.76	7.70	1.6	19	495	518
940810	1010	20.6	7.0	8.20	7.73	1.9	26	500	563
940810	1010 (Dup)	20.6	7.0	8.20	7.68	2.1	19	500	-
940825	1030	22.2	7.3	7.44	7.79	1.2	22	520	539
940907	1045	18.3	9.2	7.75	7.87	1.0	13	450	553
940922	1100	17.7	7.5	7.27	7.78	1.2	18	450	550
Chapman Run: RM 1.62 - State Route 209									
940714	1115	24.8	5.9	7.34	7.47	1.9	30	650	631
940728	1055	22.6	5.9	7.38	7.63	2.7	34	580	618
940810	1105	20.5	6.4	7.55	7.52	1.6	22	500	565
940825	1115	22.9	7.2	7.43	7.67	1.3	21	500	498
940907	1055	19.2	8.2	7.56	7.58	1.0	12	410	-
940922	1110	18.6	6.6	7.35	7.80	1.4	19	410	480
Chapman Run: RM 0.86 - Old TR 4371									
940714	1520	24.7	5.0	7.55	7.59	6.0	51	600	571
940728	1100	19.8	6.5	8.20	7.95	1.0	11	200	654
940810	1045	18.4	7.3	8.03	7.94	1.0	28	600	591
940825	1055	21.3	5.9	7.5	7.91	1.9	22	690	688
940907	1110	17.7	9.5	7.75	8.20	<1.0	13	530	650
940922	1125	16.6	7.8	7.4	8.26	1.2	15	520	652
Wills Creek: RM 68.13 - Twp. 347									
940714	1145	24.9	5.3	7.93	7.85	3.6	44	1300	1330
940728	0930	21.9	4.75	7.84	7.79	1.3	24	1150	1290
940810	0915	19.7	5.8	7.98	7.60	1.4	33	820	905
940825	0925	23.2	6.7	7.60	7.71	2.6	52	405	426
940907	0950	18.0	7.6	7.73	7.61	1.2	16	800	984
940922	0955	17.7	5.9	7.21	7.66	1.2	26	900	1010
Wills Creek: RM 67.33 - I-70									
940714	1300	27	5.7	8.31	7.98	9.3	48	1100	1000
940728	0920	20.2	4.9	8.24	7.78	1.5	25	1180	1300
940810	0900	20.0	5.3	7.51	7.54	1.2	44	800	863
940825	0915	23.0	6.5	7.51	7.65	2.5	39	450	432
940907	0940	18.1	7.2	7.74	7.64	1.1	47	800	945
940922	0945	17.6	5.3	7.19	7.57	1.3	30	800	960

Appendix Table 1. Continued.

Date	Time	Chloride (mg/l)	NO_3-NO_2 (mg/l)	NH_3-N (mg/l)	TKN (mg/l)	T-Phos. (mg/l)	TSS (mg/l)	TDS (mg/l)	Sulfate (mg/l)
Chapman Run: RM 5.73 - Twp.33 (Buckeyeville)									
940714	1045	16	0.47	0.05	0.4	0.14	415	236	61
940728	1035	25	0.15	0.06	0.3	<0.05	26	312	85
940810	1010	25	0.12	0.06	0.4	<0.05	31	360	97
940810	1010 (Dup)	25	0.12	0.06	0.4	<0.05	31	362	102
940825	1030	21	0.80	0.11	0.3	<0.05	19	348	101
940907	1045	18	0.96	0.12	0.3	<0.05	20	339	97
940922	1100	18	0.24	<0.05	0.4	<0.05	18	348	96
Chapman Run: RM 1.62 - State Route 209									
940714	1115	43	<0.10	<0.05	-	0.09	35	386	98
940728	1055	29	<0.10	0.10	0.3	<0.05	27	374	110
940810	1105	31	<0.10	<0.05	0.4	<0.05	25	362	88
940825	1115	25	<0.10	<0.05	0.3	<0.05	13	312	76
940907	1055	21	<0.10	<0.05	0.2	<0.05	12	296	82
940922	1110	25	<0.10	<0.05	0.4	<0.05	<5	308	73
Chapman Run: RM 0.86 - Old TR 4371									
940714	1520	34	0.20	<0.05	0.4	0.07	97	359	98
940728	1100	28	<0.10	0.08	0.3	<0.05	19	414	130
940810	1045	39	<0.10	0.10	0.4	<0.05	33	428	111
940825	1055	43	0.14	0.22	0.5	<0.05	10	440	128
940907	1110	40	<0.10	<0.05	0.3	<0.05	6	410	115
940922	1125	37	<0.10	<0.05	0.5	<0.05	5	410	110
Wills Creek: RM 68.13 - Twp. 347									
940714	1145	17	0.28	<0.05	0.4	0.06	54	1010	500
940728	0930	15	0.42	0.12	0.4	0.11	46	896	483
940810	0915	14	0.28	0.14	0.5	0.09	56	632	310
940825	0925	8	<0.10	<0.05	0.5	0.13	82	292	96
940907	0950	17	0.28	0.07	0.3	0.16	46	694	370
940922	0955	18	0.30	<0.05	0.4	0.12	32	730	450
Wills Creek: RM 67.33 - I-70									
940714	1300	20	<0.10	<0.05	0.4	0.06	90	710	390
940728	0920	14	0.30	0.10	0.4	<0.05	41	937	524
940810	0900	14	0.24	0.10	0.50	0.05	47	609	290
940825	0915	11	<0.10	<0.05	0.4	0.08	63	296	97
940907	0940	16	0.23	<0.05	0.3	0.10	43	664	338
940922	0945	16	0.18	<0.05	0.4	0.05	30	690	299

Appendix Table 1. Continued.

Date	Time	Al-T (ug/l)	As-T (ug/l)	Cd-T (ug/l)	Ca-T (mg/l)	Cr-Hex (ug/l)	Cr-T (ug/l)	Cu-T (ug/l)	Fe-T (ug/l)
Chapman Run: RM 5.73 - Twp.33 (Buckeyeville)									
940714	1045	11,700	3	<0.2	48	-	<30	<10	17,100
940728	1035	1010	<2	<0.2	44	<20	<30	<10	1250
940810	1010	1060	<2	<0.2	59	<20	<30	<10	1600
940810	1010 (Dup)	1010	<2	<0.2	59	-	<30	<10	1570
940825	1030	810	<2	<0.2	62	<60	<30	<10	1250
940907	1045	1070	<2	<0.2	62	<20	<30	<10	1630
940922	1100	404	<2	<0.2	67	<20	<30	<10	923
Chapman Run: RM 1.62 - State Route 209									
940714	1115	796	5	<0.2	47	-	<30	<10	1930
940728	1055	1010	<2	<0.2	51	<20	<30	<10	1540
940810	1105	832	<2	<0.2	52	<20	<30	<10	1660
940825	1115	382	<2	<0.2	51	<60	<30	<10	1040
940907	1055	461	<2	<0.2	51	<20	<30	<10	1210
940922	1110	<200	<2	<0.2	51	<20	<30	<10	554
Chapman Run: RM 0.86 - Old TR 4371									
940714	1520	2650	3	<0.2	49	-	<30	<10	4770
940728	1100	864	<2	<0.2	56	<20	<30	<10	1070
940810	1045	1140	2	<0.2	54	<20	<30	<10	1620
940825	1055	414	3	<0.2	54	<60	<30	<10	780
940907	1110	376	2	<0.2	55	<20	<30	<10	572
940922	1125	296	<2	<0.2	57	<20	<30	<10	558
Wills Creek: RM 68.13 - Twp. 347									
940714	1145	1690	<2	<0.2	109	-	<30	<10	2120
940728	0930	1690	<2	<0.2	98	<20	<30	<10	1880
940810	0915	2150	<2	<0.2	82	<20	<30	<10	2640
940825	0925	2310	<2	<0.2	52	<60	<30	<10	3050
940907	0950	1730	<2	<0.2	88	<20	<30	<10	2480
940922	0955	684	<2	<0.2	100	<20	<30	<10	1350
Wills Creek: RM 67.33 - I-70									
940714	1300	2340	<2	<0.2	85	-	<30	<10	3000
940728	0920	1530	<2	<0.2	100	<20	<30	<10	1570
940810	0900	1970	<2	<0.2	79	<20	<30	<10	2360
940825	0915	1710	<2	<0.2	51	<60	<30	<10	2160
940907	0940	1760	2	<0.2	91	<20	<30	<10	2290
940922	0945	652	<2	<0.2	91	<20	<30	<10	1240

Appendix Table 1. Continued.

Date	Time	Pb-T (ug/l)	Mg-T (mg/l)	Mn-T (ug/l)	Ni-T (ug/l)	Vn-T (ug/l)	Zn-T (ug/l)	Hardness T-$CaCO_3$ (mg/l)	Fecal Coliform (#/100ml)
Chapman Run: RM 5.73 - Twp.33 (Buckeyeville)									
940714	1045	10	13	875	<40	-	109	173	-
940728	1035	<2	18	193	<40	<10	<10	184	-
940810	1010	<2	20	309	<40	<10	<10	230	-
940810	1010 (Dup)	<2	20	310	<40	-	<10	230	-
940825	1030	<2	19	205	<40	<10	<10	233	-
940907	1045	<2	18	163	<40	<10	<10	229	-
940922	1100	<2	21	204	<40	<10	<10	254	-
941018	1230	-	-	-	-	-	-	-	<10
Chapman Run: RM 1.62 - State Route 209									
940714	1115	2	17	1460	<40	-	23	187	-
940728	1055	<2	19	638	<40	<10	30	206	-
940810	1105	<2	19	527	<40	<10	<10	208	-
940825	1115	<2	17	320	<40	<10	<10	197	-
940907	1055	<2	17	464	<40	<10	<10	197	-
940922	1110	<2	17	351	<40	<10	<10	197	-
941018	1235	-	-	-	-	-	-	-	10
Chapman Run: RM 0.86 - Old TR 4371									
940714	1520	4	17	1100	<40	-	18	192	-
940728	1100	<2	22	364	<40	386	<10	230	-
940810	1045	<2	21	350	<40	390	14	221	-
940825	1055	<2	20	323	<40	1320	<10	217	-
940907	1110	<2	20	253	<40	426	<10	220	-
940922	1125	<2	21	256	<40	540	<10	229	-
941018	1240	-	-	-	-	-	-	-	255
Wills Creek: RM 68.13 - Twp. 347									
940714	1145	<2	51	1185	<40	-	<10	482	-
940728	0930	<2	50	269	<40	<10	<10	450	-
940810	0915	10	36	325	<40	<10	27	353	-
940825	0925	<2	11	254	<40	<10	20	175	-
940907	0950	<2	39	321	<40	<10	11	380	-
940922	0955	<2	47	325	<40	<10	<10	443	-
Wills Creek: RM 67.33 - I-70									
940714	1300	<2	37	441	<40	-	18	365	-
940728	0920	<2	52	294	<40	11	<10	464	-
940810	0900	<2	35	319	<40	10	12	341	-
940825	0915	2	17	213	<40	45	<10	197	-
940907	0940	<2	40	355	<40	19	56	392	-
940922	0945	<2	45	333	<40	24	<10	413	-

Appendix Table 2. Inorganic target analyte list (TAL) parameters (metals), select radiologicals, total organic carbon, and grain size analyses of sediment collected from the Chapman Run study area, 1994. Included in the table are results of tests conducted during 1990 (Weston 1990) and 1993 (PRC 1993). Depth of sediment sample is noted in parentheses. **D** = duplicate sediment sample.

	Sampling Location - by River Mile					
	Chapman Run					
Parameter	OEPA **5.73** (0-6”)	Weston **1.55**	OEPA **1.50** (0-6”)	OEPA **1.50** (12-18”)	PRC **1.44**	PRC **1.27**
Metals						
Aluminum (mg/kg)	4300	3920	3760	3870	7760	5350
Antimony (mg/kg)	<10	<5	<10	<10	-	-
Arsenic (mg/kg)	<10	0.1	10	11	9.0	9.8
Barium (mg/kg)	51.7	35.8	38.1	41.3	85.3	84.8
Beryllium (mg/kg)	0.46	<0.5	0.76	0.80	2.0	2.3
Cadmium (mg/kg)	2.57	<0.5	2.93	4.63	-	-
Calcium (mg/kg)	6530	-	1390	3430	2230	3520
Chromium (mg/kg)	6.8	<3.0	6.2	6.3	13.6	16.1
Cobalt (mg/kg)	6.9	-	11.2	17.6	19.8	17.3
Copper (mg/kg)	11.1	7.3	8.6	11.5	15.2	23.8
Iron (mg/kg)	13,600	-	15,100	25,000	31,800	30,900
Lead (mg/kg)	10.1	6.4	8.9	17.5	14.6	15.2
Magnesium (mg/kg)	1750	-	886	1210	2000	1750
Manganese (mg/kg)	425	-	352	866	1310	1100
Mercury (mg/kg)	<0.08	0.07	<0.08	<0.08	0.38	ND
Nickel (mg/kg)	10.2	12.5	13.1	17.3	21.6	24.2
Potassium (mg/kg)	487	-	346	292	365	257
Selenium (mg/kg)	<10	0.14	<10	<10	-	-
Silver (mg/kg)	<5.0	0.96	<5.0	<5.0	3.8	4.5
Sodium (mg/kg)	70	-	58	74	243	365
Thallium (mg/kg)	<80	<5	<80	<80	-	-
Vanadium (mg/kg)	12.4	19.3	11.4	14.6	31.0	36.4
Zinc (mg/kg)	44.5	36.1	45.7	61.1	75.2	77.2
T. Organic Carbon (mg/kg)	8680	-	9610	5390	-	-
Grain size						
% Gravel	10.1	-	2.2	6.9	-	-
% Sand	33.8	-	38.9	37.8	-	-
% Silt	41.7	-	43.7	41.7	-	-
% Clay	14.4	-	15.2	13.6	-	-
Radiologicals						
Radium 226 (pCi/g)	1.1±0.29	-	-	-	-	-
Radium 228 (pCi/g)	1.0±0.41	-	-	-	-	-
Gross Alpha (pCi/g)	18±6.9	0+57.8	-	-	-	-
Gross Beta (pCi/g)	22±7.1	5.9±3.8	-	-	-	-
Thorium-228 (pCi/g)	ND	-	-	-	-	-
Thorium-230 (pCi/g)	1.0±0.23	-	-	-	-	-
Thorium-232 (pCi/g)	ND	-	-	-	-	-
Uranium 234 (pCi/g)	ND	-	-	-	-	-
Uranium 235 (pCi/g)	ND	-	-	-	-	-
Uranium 238 (pCi/g)	ND	-	-	-	-	-

Appendix Table 2. Continued.

	Sampling Location - by River Mile					
	Chapman Run					
Parameter	OEPA **1.17** (0-6”)	PRC **1.10**	OEPA **1.05** (0-6”)	OEPA **1.05** (12-18”)	OEPA **0.98** (0-12”)	PRC **0.95**
Metals						
Aluminum (mg/kg)	3010	12,600	5040	3730	5270	11,900
Antimony (mg/kg)	<10	ND	<10	<10	<10	ND
Arsenic (mg/kg)	<10	14.0	<10	<10	10	10.8
Barium (mg/kg)	31.1	131	50.0	52.5	70.8	197
Beryllium (mg/kg)	0.47	9.6	0.63	0.44	0.57	10.2
Cadmium (mg/kg)	2.01	-	2.95	2.17	3.47	-
Calcium (mg/kg)	990	11,200	935	399	1070	34,600
Chromium (mg/kg)	5.4	96.1	8.0	6.9	8.7	128
Cobalt (mg/kg)	8.8	28.2	10.7	6.3	10.6	67.4
Copper (mg/kg)	8.1	27.0	11.8	7.1	8.0	54.5
Iron (mg/kg)	10,400	33,000	15,100	11,800	17,900	42,200
Lead (mg/kg)	8.5	24.1	10.0	8.7	9.6	125
Magnesium (mg/kg)	772	3720	1140	916	1390	13,200
Manganese (mg/kg)	191	2130	503	109	271	3910
Mercury (mg/kg)	<0.08	-	<0.08	<0.08	<0.08	-
Nickel (mg/kg)	10.7	98.7	14.1	8.4	14.9	150
Potassium (mg/kg)	259	539	416	251	343	1220
Selenium (mg/kg)	<10	-	<10	<10	<10	-
Silver (mg/kg)	<5.0	-	<5.0	<5.0	<5.0	-
Sodium (mg/kg)	65	438	61	57	66	1260
Thallium (mg/kg)	<80	-	<80	<80	<80	-
Vanadium (mg/kg)	19.7	2150	55.6	12.3	36.2	2360
Zinc (mg/kg)	39.0	154	51.8	26.9	47.6	438
T. Organic Carbon (mg/kg)	18,300	-	11,600	4200	5970	-
Grain size						
% Gravel	0.0	-	0.0	0.0	0.0	-
% Sand	36.4	-	14.8	19.8	4.8	-
% Silt	47.3	-	66.5	63.6	72.1	-
% Clay	16.3	-	18.7	16.6	23.1	-
Radiologicals						
Radium 226 (pCi/g)	-	-	1.1±0.28	-	-	-
Radium 228 (pCi/g)	-	-	1.2±0.37	-	-	-
Gross Alpha (pCi/g)	-	-	17±6.7	-	-	-
Gross Beta (pCi/g)	-	-	31±6.9	-	-	-
Thorium-228 (pCi/g)	-	-	ND	-	-	-
Thorium-230 (pCi/g)	-	-	ND	-	-	-
Thorium-232 (pCi/g)	-	-	ND	-	-	-
Uranium 234 (pCi/g)	-	-	1.1±0.22	-	-	-
Uranium 235 (pCi/g)	-	-	ND	-	-	-
Uranium 238 (pCi/g)	-	-	1.0±0.22	-	-	-

Appendix Table 2. Continued.

Parameter	Sampling Location - by River Mile: Chapman Run OEPA 0.95 (0-6")	OEPA 0.95 (7-15")	OEPA 0.86 (0-6")	OEPA 0.86D (0-6")	Weston 0.75	PRC 0.75
Metals						
Aluminum (mg/kg)	5630	5900	6450	6270	10,100	10,400
Antimony (mg/kg)	<10	<10	<10	<10	<5	ND
Arsenic (mg/kg)	13	12	12	13	0.1	11.2
Barium (mg/kg)	86.4	76.2	43.0	41.7	60.5	134
Beryllium (mg/kg)	0.82	0.61	0.81	0.78	1.09	4.8
Cadmium (mg/kg)	4.06	3.44	2.78	2.84	<0.51	-
Calcium (mg/kg)	10,900	4210	2140	2230	-	7210
Chromium (mg/kg)	76.9	15.9	19.2	20.6	3.2	63.1
Cobalt (mg/kg)	18.8	9.4	11.1	10.6	-	19.7
Copper (mg/kg)	19.2	13.4	12.1	12.2	16.9	51.6
Iron (mg/kg)	17,700	17,700	13,800	13,500	-	28,400
Lead (mg/kg)	44.3	12.9	12.6	12.8	11.6	44.1
Magnesium (mg/kg)	5500	2200	1430	1450	-	5240
Manganese (mg/kg)	1390	677	355	392	-	1320
Mercury (mg/kg)	<0.08	<0.08	<0.08	<0.08	0.05	-
Nickel (mg/kg)	119	21.8	29.6	29.7	20.6	88.4
Potassium (mg/kg)	734	501	509	534	-	703
Selenium (mg/kg)	<10	<10	<10	<10	0.2	-
Silver (mg/kg)	<5.0	<5.0	<5.0	<5.0	162	-
Sodium (mg/kg)	194	69	144	135	-	645
Thallium (mg/kg)	<80	<80	<80	<80	<5	-
Vanadium (mg/kg)	1300	134	302	312	161	810
Zinc (mg/kg)	151	54.2	80.6	78.2	90	204
T. Organic Carbon (mg/kg)	11,100	6860	11,800	11,600	-	-
Grain size						
% Gravel	8.2	0.2	0.0	0.0	-	-
% Sand	30.5	9.0	9.6	10.6	-	-
% Silt	46.6	63.3	70.0	67.5	-	-
% Clay	14.7	27.5	20.4	21.9	-	-
Radiologicals						
Radium 226 (pCi/g)	-	-	0.99±0.50	1.0±0.44	-	-
Radium 228 (pCi/g)	-	-	1.8±0.59	ND	-	-
Gross Alpha (pCi/g)	-	-	16±6.0	24±7.2	95.2±73.6	-
Gross Beta (pCi/g)	-	-	23±7.3	29±7.5	28.9±5.0	-
Thorium-228 (pCi/g)	-	-	ND	ND	-	-
Thorium-230 (pCi/g)	-	-	ND	1.4±0.26	-	-
Thorium-232 (pCi/g)	-	-	1.1±0.25	ND	-	-
Uranium 234 (pCi/g)	-	-	1.7±0.29	1.9±0.31	-	-
Uranium 235 (pCi/g)	-	-	ND	ND	-	-
Uranium 238 (pCi/g)	-	-	1.5±0.26	1.6±0.28	-	-

Appendix Table 2. Continued.

	Sampling Location - by River Mile					
	Chapman Run			East Slag Ditch		
Parameter	OEPA **0.45** (0-10")	OEPA **0.02** (0-6")	Weston **0.02**	OEPA **0.7,0.40** (0-6")	Weston **0.7,0.2**	Weston **0.75**
Metals						
Aluminum (mg/kg)	306	4820	7250	4690	2880	5500
Antimony (mg/kg)	<10	<10	<5	<100	<5	<5
Arsenic (mg/kg)	15	21	<0.1	<100	0.2	<0.1
Barium (mg/kg)	32.7	73.5	97.8	45.0	27.1	85.3
Beryllium (mg/kg)	0.73	0.62	0.58	<2.0	<0.5	<0.5
Cadmium (mg/kg)	1.85	3.21	<0.5	11.0	<0.5	<0.5
Calcium (mg/kg)	1300	1240	-	863	-	-
Chromium (mg/kg)	8.3	6.5	5.6	<40.0	<3.0	3.9
Cobalt (mg/kg)	6.7	9.2	-	<10.0	-	-
Copper (mg/kg)	8.5	12.7	12.1	<20.0	3.85	7.1
Iron (mg/kg)	8850	16,300	-	58,000	-	-
Lead (mg/kg)	6.3	9.7	35.9	<50.0	23.4	9.4
Magnesium (mg/kg)	791	1390	-	685	-	-
Manganese (mg/kg)	240	667	-	83.0	-	-
Mercury (mg/kg)	<0.08	<0.08	0.04	<0.08	0.04	0.02
Nickel (mg/kg)	10.4	12.8	20.8	<20.0	13.7	11.9
Potassium (mg/kg)	238	390	-	381	-	-
Selenium (mg/kg)	<10	<10	0.18	<100	0.15	0.21
Silver (mg/kg)	<5.0	<5.0	19.2	<50.0	<1.0	14.1
Sodium (mg/kg)	92	76	-	<500	-	-
Thallium (mg/kg)	<80	<80	<5	<800	<5	<5
Vanadium (mg/kg)	354	54.0	19.9	22.0	21.0	22.9
Zinc (mg/kg)	51.8	39.8	82.5	<50.0	13.7	52
T. Organic Carbon (mg/kg)	33,700	5100	-	14,000	-	-
Grain size						
% Gravel	0.0	0.0	-	1.0	-	-
% Sand	8.2	24.8	-	11.5	-	-
% Silt	70.6	56.9	-	58.5	-	-
% Clay	21.2	18.3	-	29.0	-	-
Radiologicals						
Radium 226 (pCi/g)	1.1±0.47	-	-	1.5±0.41	-	-
Radium 228 (pCi/g)	ND	-	-	0.97±0.58	-	-
Gross Alpha (pCi/g)	20±8.6	-	289±93.0	8.6±5.8	1.7±6.4	86.5±72.6
Gross Beta (pCi/g)	34±7.1	-	30.2±5.0	24±6.6	8.3±3.9	16.6±4.4
Thorium-228 (pCi/g)	ND	-	-	ND		-
Thorium-230 (pCi/g)	1.2±0.22	-	-	ND		-
Thorium-232 (pCi/g)	1.1±0.22	-	-	ND		-
Uranium 234 (pCi/g)	1.0±0.23	-	-	ND		-
Uranium 235 (pCi/g)	ND	-	-	ND		-
Uranium 238 (pCi/g)	1.1±0.22	-	-	ND		-

Appendix Table 2. Continued.

	Sampling Location - by River Mile					
	East Slag Ditch					
Parameter	PRC **0.65**	OEPA **0.65** (0-6”)	PRC **0.59**	OEPA **0.55** (0-6”)	PRC **0.53**	PRC **0.53D**
Metals						
Aluminum (mg/kg)	9610	5450	18,600	4690	25,000	14,900
Antimony (mg/kg)	-	<10	ND	<10	ND	ND
Arsenic (mg/kg)	17.2	<10	9.4	11	ND	9.0
Barium (mg/kg)	148	51.3	127	29.8	141	127
Beryllium (mg/kg)	2.4	0.64	8.1	2.57	25.7	22.3
Cadmium (mg/kg)	-	2.29	-	5.26	-	-
Calcium (mg/kg)	9620	1710	5970	800	5800	6200
Chromium (mg/kg)	20.9	12.3	142	29.2	72.6	68.7
Cobalt (mg/kg)	17.2	10.9	24.7	18.7	77.2	61.5
Copper (mg/kg)	24.3	10.7	31.8	8.2	45.9	39.1
Iron (mg/kg)	28,300	12,600	38,200	33,300	70,300	71,100
Lead (mg/kg)	29.2	11.8	105	14.5	25.3	44.2
Magnesium (mg/kg)	2750	1030	4280	322	2220	1990
Manganese (mg/kg)	2650	668	1980	207	4280	4970
Mercury (mg/kg)	0.78	<0.08	-	<0.08	-	-
Nickel (mg/kg)	26.5	19.7	99.8	26.8	153	106
Potassium (mg/kg)	750	322	784	145	ND	ND
Selenium (mg/kg)	-	<10	-	<10	-	-
Silver (mg/kg)	ND	<5.0	-	<5.0	-	-
Sodium (mg/kg)	434	81	409	67	520	773
Thallium (mg/kg)	-	<80	-	<80	-	-
Vanadium (mg/kg)	75.4	139	1520	4030	5570	5520
Zinc (mg/kg)	123	80.7	305	88.2	460	346
T. Organic Carbon (mg/kg)	-	10,700	-	10,500	-	-
Grain size						
% Gravel	-	0.0	-	0.0	-	-
% Sand	-	1.4	-	50.8	-	-
% Silt	-	75.6	-	37.1	-	-
% Clay	-	23.0	-	12.1	-	-
Radiologicals						
Radium 226 (pCi/g)	-	-	-	0.87 ± 0.60	-	-
Radium 228 (pCi/g)	-	-	-	1.5 ± 0.95	-	-
Gross Alpha (pCi/g)	-	-	-	17 ± 6.9	-	-
Gross Beta (pCi/g)	-	-	-	24 ± 7.4	-	-
Thorium-228 (pCi/g)	-	-	-	1.1 ± 0.24	-	-
Thorium-230 (pCi/g)	-	-	-	2.8 ± 0.38	-	-
Thorium-232 (pCi/g)	-	-	-	1.0 ± 0.23	-	-
Uranium 234 (pCi/g)	-	-	-	3.5 ± 0.41	-	-
Uranium 235 (pCi/g)	-	-	-	ND	-	-
Uranium 238 (pCi/g)	-	-	-	2.9 ± 0.38	-	-

Appendix Table 2. Continued.

	Sampling Location - by River Mile					
	East Slag Ditch					
Parameter	OEPA **0.42** (0-6”)	OEPA **0.42** (8-12”)	OEPA **0.32** (0-6”)	PRC **0.31**	PRC **0.20**	OEPA **0.02** (0-6”)
Metals						
Aluminum (mg/kg)	8880	7080	5600	25,300	9510	4690
Antimony (mg/kg)	<100	<10	<100	21.2	ND	<10
Arsenic (mg/kg)	<100	14	<100	9.7	6.2	12
Barium (mg/kg)	31.0	49.9	133	148	103	38.1
Beryllium (mg/kg)	4.0	1.76	2.0	59.8	3.9	1.15
Cadmium (mg/kg)	7.0	4.75	8.0	-	-	2.43
Calcium (mg/kg)	1050	1050	1880	35,300	6590	1500
Chromium (mg/kg)	149	46.5	50.0	129	73.4	46.2
Cobalt (mg/kg)	<10	5.6	29.0	17.9	13.4	9.0
Copper (mg/kg)	24.0	11.0	26.0	19.0	16.8	9.1
Iron (mg/kg)	38,900	32,400	43,500	22,600	16,400	12,000
Lead (mg/kg)	<50.0	14.2	<50.0	96.1	25.4	12.9
Magnesium (mg/kg)	934	1280	788	23,800	4770	1300
Manganese (mg/kg)	114	140	7430	1160	1490	603
Mercury (mg/kg)	0.80	0.89	0.48	-	-	<0.08
Nickel (mg/kg)	43.0	11.1	37.0	626	39.0	32.1
Potassium (mg/kg)	512	547	370	823	1060	335
Selenium (mg/kg)	<100	<10	<100	-	-	<10
Silver (mg/kg)	<50	<5	<50	-	-	<5
Sodium (mg/kg)	<500	79	<500	687	1470	115
Thallium (mg/kg)	<800	<80	<800	-	-	<80
Vanadium (mg/kg)	3950	1900	1760	16,000	740	1850
Zinc (mg/kg)	55.0	48.4	98.0	134	112	71.4
T. Organic Carbon (mg/kg)	13,400	10,200	8900	-	-	20,700
Grain size						
% Gravel	0.0	0.0	5.3	-	-	0.0
% Sand	22.2	7.6	37.9	-	-	6.8
% Silt	47.6	39.7	45.1	-	-	71.8
% Clay	30.2	52.7	11.7	-	-	21.4
Radiologicals						
Radium 226 (pCi/g)	2.3±0.59	-	-	-	-	1.4±0.57
Radium 228 (pCi/g)	1.9±0.85	-	-	-	-	1.4±0.74
Gross Alpha (pCi/g)	120±15	-	-	-	-	15±7.0
Gross Beta (pCi/g)	51±8.4	-	-	-	-	26±7.7
Thorium-228 (pCi/g)	1.3±0.27	-	-	-	-	1.2±0.25
Thorium-230 (pCi/g)	66±1.9	-	-	-	-	1.4±0.27
Thorium-232 (pCi/g)	1.5±0.29	-	-	-	-	1.1±0.24
Uranium 234 (pCi/g)	2.8±0.37	-	-	-	-	1.5±0.26
Uranium 235 (pCi/g)	ND	-	-	-	-	ND
Uranium 238 (pCi/g)	3.6±0.42	-	-	-	-	1.2±0.23

Appendix Table 2. Continued.

	Sampling Location - by River Mile					
	E. Slag Ditch	West Slag Ditch				
Parameter	Weston **0.02**	OEPA **0.20** (0-6”)	OEPA **0.12** (0-10”)	OEPA **0.05** (0-6”)	PRC **0.05**	Weston **0.02**
Metals						
Aluminum (mg/kg)	9890	6330	7700	6290	7150	5890
Antimony (mg/kg)	<5	<10	<10	<10	ND	<5
Arsenic (mg/kg)	<0.1	49	20	17	6.7	<0.1
Barium (mg/kg)	82.9	77.4	74.7	74.4	81.7	56.9
Beryllium (mg/kg)	<0.5	14.1	1.56	0.82	5.9	<0.5
Cadmium (mg/kg)	<0.5	5.59	5.80	4.84	-	<0.5
Calcium (mg/kg)	-	5200	5940	9970	110,000	-
Chromium (mg/kg)	23.8	432	99.4	95.0	169	59.2
Cobalt (mg/kg)	-	89.9	33.6	20.7	12.2	-
Copper (mg/kg)	10.3	39	20.9	30.4	36.8	14.2
Iron (mg/kg)	-	14,000	22,700	16,900	16,400	-
Lead (mg/kg)	11.9	161	52.3	70.4	53.2	40.3
Magnesium (mg/kg)	-	3050	3370	6710	9860	-
Manganese (mg/kg)	-	585	950	1440	1370	-
Mercury (mg/kg)	0.03	<0.08	<0.08	<0.08	-	0.02
Nickel (mg/kg)	20.7	841	251	156	92.2	127
Potassium (mg/kg)	-	1310	931	1610	1070	-
Selenium (mg/kg)	0.21	<10	<10	<10	-	0.22
Silver (mg/kg)	24.5	<5	<5	<5	-	6.3
Sodium (mg/kg)	-	1120	544	1940	1550	-
Thallium (mg/kg)	<5	118	<80	<80	-	<5
Vanadium (mg/kg)	745	22,000	3460	1260	1460	931
Zinc (mg/kg)	65	351	188	342	398	153
T. Organic Carbon (mg/kg)	-	12,000	6490	8950	-	-
Grain size						
% Gravel	-	15.0	1.1	19.5	-	-
% Sand	-	25.3	9.3	36.2	-	-
% Silt	-	41.8	64.7	36.0	-	-
% Clay	-	17.9	24.9	8.3	-	-
Radiologicals						
Radium 226 (pCi/g)	-	-	-	1.2±0.31	-	-
Radium 228 (pCi/g)	-	-	-	1.6±0.41	-	-
Gross Alpha (pCi/g)	194±84.1	-	-	24±8.1	-	34.5±66.5
Gross Beta (pCi/g)	30.2±5.0	-	-	25±7.7	-	21.3±4.6
Thorium-228 (pCi/g)	-	-	-	1.5±0.25	-	-
Thorium-230 (pCi/g)	-	-	-	1.7±0.28	-	-
Thorium-232 (pCi/g)	-	-	-	ND	-	-
Uranium 234 (pCi/g)	-	-	-	ND	-	-
Uranium 235 (pCi/g)	-	-	-	ND	-	-
Uranium 238 (pCi/g)	-	-	-	ND	-	-

Appendix Table 2. Continued.

	Sampling Location - by River Mile				
	Wills Creek		Old Chapman Run	Unnamed Trib.	
	OEPA	OEPA	OEPA	Weston	Weston
Parameter	**67.62** (0-8")	**67.00** (0-8")	**0.10** (0-6")	**0.02**	**0.02D**
Metals					
Aluminum (mg/kg)	5030	4600	3380	7520	9060
Antimony (mg/kg)	<10	<10	<10	<5	5.1
Arsenic (mg/kg)	19	14	11	0.4	0.1
Barium (mg/kg)	63.4	50.3	45.6	70.5	68.9
Beryllium (mg/kg)	0.52	0.43	0.37	<0.5	<0.5
Cadmium (mg/kg)	2.52	2.25	1.80	<0.5	<0.5
Calcium (mg/kg)	2200	3600	1640	-	-
Chromium (mg/kg)	12.5	7.3	5.7	135	355
Cobalt (mg/kg)	10.9	7.4	6.6	-	-
Copper (mg/kg)	17.3	10.8	9.7	9.9	13
Iron (mg/kg)	12,000	10,500	8510	-	-
Lead (mg/kg)	14.5	8.2	8.4	11.3	9.4
Magnesium (mg/kg)	1420	1950	1110	-	-
Manganese (mg/kg)	387	462	288	-	-
Mercury (mg/kg)	<0.08	<0.08	<0.08	0.01	0.05
Nickel (mg/kg)	23.3	12.8	10.5	75	49.9
Potassium (mg/kg)	503	532	353	-	-
Selenium (mg/kg)	<10	<10	<10	0.61	0.94
Silver (mg/kg)	<5	<5	<5	3.8	<0.1
Sodium (mg/kg)	60	85	87	-	-
Thallium (mg/kg)	<80	<80	<80	<5	<5
Vanadium (mg/kg)	36.5	39.6	38.1	2100	2680
Zinc (mg/kg)	54.1	40.8	32.1	93.5	126
T. Organic Carbon (mg/kg)	25,400	9930	19,600	-	-
Grain size					
% Gravel	0.0	0.0	0.0	-	-
% Sand	11.4	15.4	10.0	-	-
% Silt	62.8	60.0	63.0	-	-
% Clay	25.8	24.6	27.0	-	-
Radiologicals					
Radium 226 (pCi/g)	-	-	1.3±0.43	-	-
Radium 228 (pCi/g)	-	-	ND	-	-
Gross Alpha (pCi/g)	-	-	25±9.2	8.6±63.2	51.8±68.6
Gross Beta (pCi/g)	-	-	36±7.4	11.7±4.2	11.6±4.2
Thorium-228 (pCi/g)	-	-	1.1±0.22	-	
Thorium-230 (pCi/g)	-	-	1.3±0.24	-	
Thorium-232 (pCi/g)	-	-	ND	-	
Uranium 234 (pCi/g)	-	-	0.99±0.20	-	
Uranium 235 (pCi/g)	-	-	ND	-	
Uranium 238 (pCi/g)	-	-	0.98±0.20	-	

Appendix Table 2. Continued.

Parameter	Sampling Location - Wetlands: West Slag Pile Wetland - North OEPA N-1 (0-6")	OEPA N-1 (6-16")	OEPA N-2 (0-10")	OEPA N-2 (10-17")	OEPA N-3 (0-10")	OEPA N-3 (10-16")
Metals						
Aluminum (mg/kg)	7660	9090	7220	11,800	8990	8300
Antimony (mg/kg)	<10	<10	<10	<10	<10	<10
Arsenic (mg/kg)	16	10	13	15	17	10
Barium (mg/kg)	103	113	71.5	97.4	80.8	42.7
Beryllium (mg/kg)	1.55	0.86	1.23	0.79	1.12	0.43
Cadmium (mg/kg)	2.94	2.85	2.64	2.85	2.99	2.65
Calcium (mg/kg)	2700	1350	5160	809	1620	410
Chromium (mg/kg)	61.8	16.3	75.5	17.3	34.9	11.8
Cobalt (mg/kg)	9.7	9.6	8.5	8.8	10.3	7.0
Copper (mg/kg)	13.3	12.0	16.8	10.4	12.6	9.5
Iron (mg/kg)	16,100	17,600	14,700	17,600	17,700	16,712
Lead (mg/kg)	20.5	12.2	35.1	8.5	16.3	9.1
Magnesium (mg/kg)	2690	1880	4460	2000	2130	1546
Manganese (mg/kg)	858	816	500	533	695	213
Mercury (mg/kg)	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
Nickel (mg/kg)	34.7	16.1	152	16.6	25.8	10.4
Potassium (mg/kg)	2910	2390	2660	2370	2210	1099
Selenium (mg/kg)	<10	<10	<10	<10	<10	<10
Silver (mg/kg)	<5	<5	<5	<5	<5	<5
Sodium (mg/kg)	2240	2000	2350	2400	2430	1906
Thallium (mg/kg)	<80	<80	<80	<80	<80	<80
Vanadium (mg/kg)	1670	266	1400	197	730	109
Zinc (mg/kg)	70.5	50.7	107	50.8	65.3	35.4
T. Organic Carbon (mg/kg)	9030	8290	7160	8450	9310	3550
Grain size						
% Gravel	0.0	0.0	0.0	0.0	0.0	0.0
% Sand	1.4	2.0	1.6	0.8	1.8	2.6
% Silt	68.1	62.7	70.5	55.8	65.2	65.7
% Clay	30.5	35.3	27.9	43.4	33.0	31.7
Radiologicals						
Radium 226 (pCi/g)	1.1±0.34	1.3±0.32	0.72±0.38	-	-	-
Radium 228 (pCi/g)	1.3±0.43	1.1±0.35	1.1±0.47	-	-	-
Gross Alpha (pCi/g)	19±8.1	25±8.2	22±7.8	-	-	-
Gross Beta (pCi/g)	37±8.2	56±8.1	44±8.2	-	-	-
Thorium-228 (pCi/g)	ND	1.1±0.26	ND	-	-	-
Thorium-230 (pCi/g)	1.2±0.25	1.4±0.29	1.3±0.27	-	-	-
Thorium-232 (pCi/g)	1.3±0.26	1.4±0.28	1.2±0.26	-	-	-
Uranium 234 (pCi/g)	1.0±0.22	1.1±0.24	ND	-	-	-
Uranium 235 (pCi/g)	ND	ND	ND	-	-	-
Uranium 238 (pCi/g)	1.1±0.23	1.2±0.26	ND	-	-	-

Appendix Table 2. Continued.

Parameter	Sampling Location - Wetlands					
	West Slag Pile Wetland					
	West				Southwest	
	OEPA **W-1** (0-10”)	OEPA **W-2** (0-7”)	OEPA **W-3** (0-7”)	OEPA **W-3** (7-18”)	OEPA **SW-1** (0-9”)	OEPA **SW-1** (9-18”)
Metals						
Aluminum (mg/kg)	8220	8770	8680	8690	10,100	12,500
Antimony (mg/kg)	<10	<10	<10	<10	<10	<10
Arsenic (mg/kg)	37	31	87	89	98	106
Barium (mg/kg)	110	102	59.6	40.5	35.0	19.4
Beryllium (mg/kg)	2.02	1.69	7.48	8.89	9.92	10.5
Cadmium (mg/kg)	3.70	4.58	3.29	5.81	2.50	5.52
Calcium (mg/kg)	3470	2170	44,300	9830	17,700	3160
Chromium (mg/kg)	224	128	215	111	168	63.1
Cobalt (mg/kg)	9.7	10.3	9.6	7.9	10.1	7.8
Copper (mg/kg)	16.4	13.8	14.7	15.9	12.8	12.4
Iron (mg/kg)	17,700	16,600	14,900	34,100	11,200	33,600
Lead (mg/kg)	18.1	14.1	19.8	21.1	19.2	15.6
Magnesium (mg/kg)	3190	2450	8550	2750	6900	563
Manganese (mg/kg)	938	1010	1450	849	1520	272
Mercury (mg/kg)	<0.08	<0.08	<0.08	0.10	0.21	0.09
Nickel (mg/kg)	19.6	21.1	61.8	23.8	63.0	11.2
Potassium (mg/kg)	2460	2050	440	525	331	367
Selenium (mg/kg)	<10	<10	<10	<10	<10	<10
Silver (mg/kg)	<5	<5	<5	<5	<5	<5
Sodium (mg/kg)	1640	1120	309	271	489	621
Thallium (mg/kg)	<80	<80	<80	<80	<80	<80
Vanadium (mg/kg)	1140	854	6130	7250	8060	8100
Zinc (mg/kg)	83.1	67.8	96.7	74.3	98.4	61.9
T. Organic Carbon (mg/kg)	10,200	8240	22,100	20,400	14,700	14,600
Grain size						
% Gravel	0.0	0.0	0.0	0.0	0.0	0.0
% Sand	3.0	3.0	15.0	13.6	56.2	52.0
% Silt	61.4	60.8	67.6	71.5	31.7	33.6
% Clay	35.6	36.2	17.4	14.9	12.1	14.4
Radiologicals						
Radium 226 (pCi/g)	1.6±0.34	0.99±0.30	-	-	ND	ND
Radium 228 (pCi/g)	1.7±0.40	1.5±0.66	-	-	ND	ND
Gross Alpha (pCi/g)	19±8.5	19±9.3	-	-	24±9.5	39±10
Gross Beta (pCi/g)	62±8.3	45±8.4	-	-	35±7.4	54±10
Thorium-228 (pCi/g)	1.1±0.22	1.1±0.22	-	-	ND	1.4±0.26
Thorium-230 (pCi/g)	1.3±0.23	1.2±0.23	-	-	1.9±0.3	12±0.76
Thorium-232 (pCi/g)	1.1±0.22	1.2±0.23	-	-	ND	1.3±0.26
Uranium 234 (pCi/g)	0.94±0.20	1.0±0.21	-	-	2.8±0.33	4.9±0.46
Uranium 235 (pCi/g)	ND	ND	-	-	ND	ND
Uranium 238 (pCi/g)	1.2±0.22	1.1±0.21	-	-	2.6±0.32	5.0±0.47

Appendix Table 2. Continued.

Parameter	OEPA **SW-1D** (0-9")	OEPA **SW-1D** (9-18")	OEPA **SW-2** (0-7")	OEPA **SW-3** (0-8")	OEPA **SW-3** (8-18")	OEPA **SW-4** (0-18")
	Sampling Location - Wetlands					
	West Slag Pile Wetland - Southwest					
Metals						
Aluminum (mg/kg)	10,000	-	10,800	7740	5710	8120
Antimony (mg/kg)	<10	-	<50	<10	<10	<10
Arsenic (mg/kg)	97	-	<50	13	<10	20
Barium (mg/kg)	33.7	-	88.1	60.9	84.1	67.5
Beryllium (mg/kg)	9.84	-	<1.0	0.27	0.55	<0.20
Cadmium (mg/kg)	2.38	-	4.0	2.71	2.46	3.04
Calcium (mg/kg)	16,000	-	1780	1350	666	18,200
Chromium (mg/kg)	180	-	38	45.3	9.0	184
Cobalt (mg/kg)	9.7	-	12.7	10.0	5.7	8.2
Copper (mg/kg)	12.8	-	16	15.7	10.8	19.8
Iron (mg/kg)	10,600	-	24,200	14,700	14,400	12,400
Lead (mg/kg)	19.3	-	<25	15.3	13.6	41.1
Magnesium (mg/kg)	6330	-	2140	1530	1450	8540
Manganese (mg/kg)	1400	-	1200	502	133	984
Mercury (mg/kg)	<0.08	-	<0.08	0.08	<0.08	<0.08
Nickel (mg/kg)	59.8	-	30	26.9	12.7	124
Potassium (mg/kg)	310	-	824	654	631	808
Selenium (mg/kg)	<10	-	<50	<10	<10	<10
Silver (mg/kg)	<5	-	<25	<5	<5	<5
Sodium (mg/kg)	493	-	<250	229	271	877
Thallium (mg/kg)	<80	-	<400	<80	<80	<80
Vanadium (mg/kg)	7960	-	1690	2530	33.3	6350
Zinc (mg/kg)	98.4	-	85	80.4	39.8	125
T. Organic Carbon (mg/kg)	15,600	-	16,800	14,800	12,200	18,300
Grain size						
% Gravel	0.0	-	0.0	0.0	0.0	0.0
% Sand	51.4	-	4.6	2.0	1.6	8.4
% Silt	37.5	-	64.4	56.2	63.6	60.5
% Clay	11.1	-	31.0	41.8	34.8	31.1
Radiologicals						
Radium 226 (pCi/g)	-	0.93±0.55	0.81±0.36	-	-	1.1±0.45
Radium 228 (pCi/g)	-	1.3±0.76	1.5±0.50	-	-	ND
Gross Alpha (pCi/g)	-	31±10	23±8.8	-	-	18±8.8
Gross Beta (pCi/g)	-	39±7.5	34±7.1	-	-	38±7.5
Thorium-228 (pCi/g)	-	1.4±0.25	1.3±0.30	-	-	1.1±0.30
Thorium-230 (pCi/g)	-	4.6±0.45	1.3±0.30	-	-	2.1±0.42
Thorium-232 (pCi/g)	-	1.0±0.22	1.3±0.29	-	-	1.1±0.30
Uranium 234 (pCi/g)	-	4.5±0.46	1.4±0.29	-	-	1.8±0.33
Uranium 235 (pCi/g)	-	ND	ND	-	-	0.11±0.08
Uranium 238 (pCi/g)	-	3.8±0.42	1.5±0.31	-	-	1.7±0.32

Appendix Table 2. Continued.

	Sampling Location - **Wetlands**					
	West Slag Pile Wetland South				East Slag Pile Wetland Northwest	
Parameter	OEPA **S-1** (0-10")	OEPA **S-1** (10-17")	OEPA **S-2** (0-7")	OEPA **S-2** (7-12")	OEPA **NW-1** (0-8")	OEPA **NW-1** (8-14")
Metals						
Aluminum (mg/kg)	8840	10,400	7320	8000	5290	6980
Antimony (mg/kg)	<10	<10	<10	<10	<10	<10
Arsenic (mg/kg)	14	15	11	10	<10	<10
Barium (mg/kg)	132	104	99.7	129	55.3	123
Beryllium (mg/kg)	<0.20	0.60	<0.20	0.73	0.27	0.59
Cadmium (mg/kg)	2.10	3.22	2.23	2.69	2.88	2.26
Calcium (mg/kg)	13,100	1540	62,100	2060	1430	817
Chromium (mg/kg)	99.4	14.1	36.8	11.7	42.4	11.4
Cobalt (mg/kg)	9.1	12.2	5.2	7.5	6.4	5.9
Copper (mg/kg)	17.5	10.9	18.4	9.7	17.3	12.0
Iron (mg/kg)	10,100	18,200	10,400	15,200	16,900	13,100
Lead (mg/kg)	45.1	14.3	17.7	10.2	12.3	10.0
Magnesium (mg/kg)	7190	2130	4030	2160	914	1520
Manganese (mg/kg)	1200	732	843	313	232	148
Mercury (mg/kg)	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08
Nickel (mg/kg)	466	16.9	79.6	17.7	12.1	13.2
Potassium (mg/kg)	713	957	613	471	281	429
Selenium (mg/kg)	<10	<10	<10	<10	<10	<10
Silver (mg/kg)	<5	<5	<5	<5	<5	<5
Sodium (mg/kg)	1190	644	643	465	66	70
Thallium (mg/kg)	<80	<80	<80	<80	<80	<80
Vanadium (mg/kg)	6130	1220	2220	196	503	37
Zinc (mg/kg)	79.8	56.4	88.0	51.6	46.0	49.7
T. Organic Carbon (mg/kg)	13,000	12,300	28,200	15,700	20,900	10,400
Grain size						
% Gravel	0.0	0.0	0.0	0.0	0.4	0.0
% Sand	7.2	4.2	4.0	2.4	16.3	1.4
% Silt	62.7	59.0	59.0	55.3	58.7	61.7
% Clay	30.1	36.8	37.0	42.3	24.6	36.9
Radiologicals						
Radium 226 (pCi/g)	1.2±0.38	1.4±0.31	1.5±0.39	-	1.0±0.49	1.5±0.32
Radium 228 (pCi/g)	1.7±0.46	1.8±0.43	ND	-	1.6±0.61	1.3±0.36
Gross Alpha (pCi/g)	40±11	24±9.4	25±9.5	-	32±10	27±9.8
Gross Beta (pCi/g)	38±7.3	35±7.4	40±7.6	-	40±7.6	43±7.5
Thorium-228 (pCi/g)	1.3±0.30	1.0±0.27	0.81±0.26	-	1.7±0.41	1.0±0.28
Thorium-230 (pCi/g)	1.3±0.30	3.2±0.47	2.5±0.45	-	2.0±0.46	1.3±0.32
Thorium-232 (pCi/g)	1.1±0.29	1.3±0.30	1.0±0.29	-	1.2±0.35	1.0±0.29
Uranium 234 (pCi/g)	1.1±0.26	1.2±0.26	1.2±0.23	-	2.4±0.37	1.4±0.27
Uranium 235 (pCi/g)	ND	ND	ND	-	0.13±0.09	0.74±0.20
Uranium 238 (pCi/g)	1.1±0.26	1.5±0.29	1.0±0.21	-	2.4±0.35	1.9±0.31

Appendix Table 2. Continued.

Parameter	East Slag Pile Wetland Northwest OEPA **NW-2** (0-8")	Background Wetland OEPA **B-1** (0-8")	OEPA **B-2** (0-8")	OEPA **B-2** (8-15")	OEPA **B-2D** (0-8")	OEPA **B-2D** (8-15")
	Sampling Location - Wetlands					
Metals						
Aluminum (mg/kg)	7840	6170	5980	3660	-	3910
Antimony (mg/kg)	<10	<10	<10	<10	-	<10
Arsenic (mg/kg)	12	<10	15	<10	-	<10
Barium (mg/kg)	134	93.5	74.7	97.1	-	86.2
Beryllium (mg/kg)	0.54	0.54	0.46	0.50	-	0.44
Cadmium (mg/kg)	3.19	2.18	3.72	1.93	-	1.56
Calcium (mg/kg)	1070	1170	897	699	-	700
Chromium (mg/kg)	16.7	8.8	10.3	4.8	-	5.6
Cobalt (mg/kg)	5.7	5.6	5.9	4.6	-	4.8
Copper (mg/kg)	10.2	9.4	15.6	8.7	-	7.4
Iron (mg/kg)	18,200	12,700	21,100	10,300	-	8840
Lead (mg/kg)	10.6	11.6	15.0	8.7	-	6.6
Magnesium (mg/kg)	1480	1410	1130	807	-	927
Manganese (mg/kg)	230	257	195	204	-	199
Mercury (mg/kg)	<0.08	<0.08	<0.08	<0.08	-	<0.08
Nickel (mg/kg)	13.8	12.2	11.8	7.5	-	8.4
Potassium (mg/kg)	575	368	281	163	-	193
Selenium (mg/kg)	<10	<10	<10	<10	-	<10
Silver (mg/kg)	<5	<5	<5	<5	-	<5
Sodium (mg/kg)	70	54	58	59	-	61
Thallium (mg/kg)	<80	<80	<80	<80	-	<80
Vanadium (mg/kg)	155	55.9	146	12.7	-	11.9
Zinc (mg/kg)	50.2	44.6	47.7	29.4	-	30.4
T. Organic Carbon (mg/kg)	18,600	13,200	19,300	10,300	-	7300
Grain size						
% Gravel	0.0	0.0	0.0	0.0	0.0	-
% Sand	4.4	2.6	5.8	2.6	3.4	-
% Silt	68.1	66.8	58.7	71.6	59.3	-
% Clay	27.5	30.6	35.5	25.8	37.3	-
Radiologicals						
Radium 226 (pCi/g)	1.5±0.39	-	1.8±0.44	1.5±0.33	-	-
Radium 228 (pCi/g)	1.1±0.03	-	ND	1.5±0.41	-	-
Gross Alpha (pCi/g)	19±8.3	-	38±11	26±9.4	-	-
Gross Beta (pCi/g)	32±7.0	-	41±7.6	36±7.2	-	-
Thorium-228 (pCi/g)	0.92±0.24	-	1.5±0.33	0.88±0.23	-	-
Thorium-230 (pCi/g)	1.3±0.28	-	1.7±0.35	1.2±0.26	-	-
Thorium-232 (pCi/g)	1.2±0.27	-	1.6±0.34	1.0±0.24	-	-
Uranium 234 (pCi/g)	1.5±0.30	-	1.5±0.25	1.1±0.24	-	-
Uranium 235 (pCi/g)	0.09±0.07	-	0.08±0.06	0.05±0.05	-	-
Uranium 238 (pCi/g)	1.1±0.25	-	1.6±0.26	1.1+0.23	-	-

Appendix Table 2. Continued.

	Sampling Location - Wetlands	
	Background Wetland	
Parameter	OEPA **B-3** (0-6”)	OEPA **B-3** (6-15”)
Metals		
Aluminum (mg/kg)	5310	5040
Antimony (mg/kg)	<100	<10
Arsenic (mg/kg)	<100	<10
Barium (mg/kg)	56	70.6
Beryllium (mg/kg)	<2.0	0.57
Cadmium (mg/kg)	7.1	2.14
Calcium (mg/kg)	797	553
Chromium (mg/kg)	<40	6.7
Cobalt (mg/kg)	<10	6.6
Copper (mg/kg)	21	15.8
Iron (mg/kg)	40,900	11,400
Lead (mg/kg)	<50	13.9
Magnesium (mg/kg)	965	1030
Manganese (mg/kg)	71	83.6
Mercury (mg/kg)	<0.08	<0.08
Nickel (mg/kg)	<20	13.0
Potassium (mg/kg)	349	247
Selenium (mg/kg)	<100	<10
Silver (mg/kg)	<50	<5
Sodium (mg/kg)	<500	72
Thallium (mg/kg)	<800	<80
Vanadium (mg/kg)	136	13.0
Zinc (mg/kg)	64	45.5
T. Organic Carbon (mg/kg)	16,800	17,900
Grain size		
% Gravel	2.1	0.2
% Sand	4.7	1.8
% Silt	52.9	62.6
% Clay	40.3	35.4
Radiologicals		
Radium 226 (pCi/g)	1.8+0.40	-
Radium 228 (pCi/g)	1.8+0.54	-
Gross Alpha (pCi/g)	26+9.5	-
Gross Beta (pCi/g)	40+7.3	-
Thorium-228 (pCi/g)	1.0+0.27	-
Thorium-230 (pCi/g)	1.4+0.31	-
Thorium-232 (pCi/g)	1.0+0.26	-
Uranium 234 (pCi/g)	1.2+0.23	-
Uranium 235 (pCi/g)	ND	-
Uranium 238 (pCi/g)	1.1+0.22	-

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/28/94 River Code: 17-817 River: Chapman Run RM: 5.80 .

Taxa Code	Taxa	Quan/Qual	
01320	*Hydra sp*	432	
03360	*Plumatella sp*	5	
03600	*Oligochaeta*	204	+
04666	*Helobdella triserialis*	31	
06700	*Crangonyx sp*	1	+
08260	*Orconectes (Crokerinus) sanbornii*	0	+
11001	*Baetidae*	1	
13400	*Stenacron sp*	5	
13521	*Stenonema femoratum*	18	
15000	*Paraleptophlebia sp*	2	
17200	*Caenis sp*	37	+
22001	*Coenagrionidae*	3	+
22300	*Argia sp*	0	+
27307	*Epitheca (Epicordulia) princeps*	0	+
27610	*Epitheca (Tetragoneuria) cynosura*	0	+
23618	*Aeshna umbrosa*	0	+
23804	*Basiaeschna janata*	0	+
47600	*Sialis sp*	0	+
52200	*Cheumatopsyche sp*	0	+
53800	*Hydroptila sp*	4	
60900	*Peltodytes sp*	0	+
63300	*Hydroporus sp*	0	+
68130	*Helichus sp*	0	+
77120	*Ablabesmyia mallochi*	0	+
77750	*Hayesomyia senata or Thienemannimyia*	6	+
80370	*Corynoneura lobata*	8	
81250	*Nanocladius (N.) minimus*	12	
82730	*Chironomus (C.) decorus group*	12	
83002	*Dicrotendipes modestus*	96	
83003	*Dicrotendipes fumidus*	48	
83051	*Dicrotendipes simpsoni*	228	
83158	*Endochironomus nigricans*	18	+
84315	*Phaenopsectra flavipes*	12	
84470	*Polypedilum (P.) illinoense*	0	+
83300	*Glyptotendipes (Phytotendipes) sp*	60	
85814	*Tanytarsus glabrescens group*	0	+
96900	*Ferrissia sp*	7	
94400	*Fossaria sp*	0	+
95100	*Physella sp*	18	+
96002	*Helisoma anceps anceps*	11	+
98600	*Sphaerium sp*	0	+

Taxa Code	Taxa	Quan/Qual

No. Quantitative Taxa: 25 Total Taxa: 41

No. Qualitative Taxa: 24 ICI: **18**

Number of Organisms: 1279 Qual EPT: **2**

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/28/94 River Code: 17-817 River: Chapman Run RM: 1.60 .

Taxa Code	Taxa	Quan/Qual	
03600	*Oligochaeta*	0	+
06700	*Crangonyx sp*	0	+
08260	*Orconectes (Crokerinus) sanbornii*	0	+
22001	*Coenagrionidae*	0	+
22300	*Argia sp*	0	+
24900	*Gomphus sp*	0	+
42700	*Belostoma sp*	0	+
47600	*Sialis sp*	0	+
50315	*Chimarra obscura*	0	+
52200	*Cheumatopsyche sp*	0	+
52530	*Hydropsyche (H.) depravata group*	0	+
71900	*Tipula sp*	0	+
74100	*Simulium sp*	0	+
72700	*Anopheles sp*	0	+
77120	*Ablabesmyia mallochi*	0	+
77800	*Helopelopia sp*	0	+
81650	*Parametriocnemus sp*	0	+
83002	*Dicrotendipes modestus*	0	+
83158	*Endochironomus nigricans*	0	+
83300	*Glyptotendipes (Phytotendipes) sp*	0	+
84450	*Polypedilum (P.) convictum*	0	+
84470	*Polypedilum (P.) illinoense*	0	+
84790	*Tribelos fuscicorne*	0	+
84800	*Tribelos jucundum*	0	+
85501	*Paratanytarsus n.sp 1*	0	+
85625	*Rheotanytarsus exiguus group*	0	+
95100	*Physella sp*	0	+
97601	*Corbicula fluminea*	0	+
96900	*Ferrissia sp*	0	+

No. Quantitative Taxa: 0 Total Taxa: 29

No. Qualitative Taxa: 29 ICI:

Number of Organisms: 0 Qual EPT:

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/28/94 River Code: 17-817 River: Chapman Run RM: 1.10 .

Taxa Code	Taxa	Quan/Qual	
03600	*Oligochaeta*	0	+
06700	*Crangonyx sp*	0	+
08260	*Orconectes (Crokerinus) sanbornii*	0	+
11125	*Labiobaetis frondalis*	0	+
11130	*Baetis intercalaris*	0	+
13400	*Stenacron sp*	0	+
18700	*Hexagenia sp*	0	+
21200	*Calopteryx sp*	0	+
22001	*Coenagrionidae*	0	+
42700	*Belostoma sp*	0	+
47600	*Sialis sp*	0	+
52200	*Cheumatopsyche sp*	0	+
63300	*Hydroporus sp*	0	+
63900	*Laccophilus sp*	0	+
74100	*Simulium sp*	0	+
74501	*Ceratopogonidae*	0	+
77355	*Clinotanypus pinguis*	0	+
80640	*Epoicocladius sp*	0	+
82300	*Xylotopus par*	0	+
84470	*Polypedilum (P.) illinoense*	0	+
84790	*Tribelos fuscicorne*	0	+
95100	*Physella sp*	0	+
96900	*Ferrissia sp*	0	+
97601	*Corbicula fluminea*	0	+

No. Quantitative Taxa: 0 Total Taxa: 24

No. Qualitative Taxa: 24 ICI:

Number of Organisms: 0 Qual EPT:

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/28/94 River Code: 17-817 River: Chapman Run RM: 0.90 .

Taxa Code	Taxa	Quan/Qual		Taxa Code	Taxa	Quan/Qual
03600	*Oligochaeta*	0	+			
06700	*Crangonyx sp*	0	+			
08260	*Orconectes (Crokerinus) sanbornii*	0	+			
22001	*Coenagrionidae*	0	+			
22300	*Argia sp*	0	+			
44501	*Corixidae*	0	+			
47600	*Sialis sp*	0	+			
63300	*Hydroporus sp*	0	+			
77355	*Clinotanypus pinguis*	0	+			
84460	*Polypedilum (P.) fallax group*	0	+			
84470	*Polypedilum (P.) illinoense*	0	+			
84790	*Tribelos fuscicorne*	0	+			
95100	*Physella sp*	0	+			

No. Quantitative Taxa: 0 Total Taxa: 13

No. Qualitative Taxa: 13 ICI:

Number of Organisms: 0 Qual EPT:

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/21/94 River Code: 17-817 River: Chapman Run RM: 0.40 .

Taxa Code	Taxa	Quan/Qual	
01320	*Hydra sp*	3	
03600	*Oligochaeta*	112	+
06800	*Gammarus sp*	0	+
08260	*Orconectes (Crokerinus) sanbornii*	0	+
11200	*Callibaetis sp*	0	+
14950	*Leptophlebia sp or Paraleptophebia sp*	2	
17200	*Caenis sp*	17	+
22001	*Coenagrionidae*	3	+
22300	*Argia sp*	1	
45100	*Palmacorixa sp*	0	+
63300	*Hydroporus sp*	3	+
65800	*Berosus sp*	1	
74501	*Ceratopogonidae*	3	
77120	*Ablabesmyia mallochi*	25	
77140	*Ablabesmyia peleensis*	0	+
77355	*Clinotanypus pinguis*	10	+
77750	*Hayesomyia senata or Thienemannimyia*	15	
79020	*Tanypus neopunctipennis*	30	+
78650	*Procladius sp*	20	+
81250	*Nanocladius (N.) minimus*	40	+
82730	*Chironomus (C.) decorus group*	50	+
82820	*Cryptochironomus sp*	0	+
83040	*Dicrotendipes neomodestus*	15	
83051	*Dicrotendipes simpsoni*	15	
83300	*Glyptotendipes (Phytotendipes) sp*	20	
84460	*Polypedilum (P.) fallax group*	10	
84470	*Polypedilum (P.) illinoense*	25	
84790	*Tribelos fuscicorne*	25	+
85500	*Paratanytarsus sp*	15	
85800	*Tanytarsus sp*	50	+
85814	*Tanytarsus glabrescens group*	30	
94400	*Fossaria sp*	1	
95100	*Physella sp*	11	
96002	*Helisoma anceps anceps*	1	

No. Quantitative Taxa: 28 Total Taxa: 34

No. Qualitative Taxa: 17 ICI: **14**

Number of Organisms: 553 Qual EPT: **2**

Appendix Invertebrate Community Index (ICI) metrics and scores for Chapman Run, 1994.

River Mile	Drainage Area (sq mi)	Number of: Total Taxa	Mayfly Taxa	Caddisfly Taxa	Dipteran Taxa	Percent: Mayflies	Caddisflies	Tanytarsini	Other Dipt/NI	Tolerant Taxa	Qual. EPT	Ecoregion	ICI
CHAPMAN RUN — 17-817													
Year: 94													
5.80	6.8	25(4)	5(4)	1(4)	10(2)	4.9(2)	0.3(2)	0.0(0)	94.5(0)	36.7(0)	2(0)	4	**18**
0.40	19.3	28(4)	2(0)	0(0)	17(4)	3.4(2)	0.0(0)	17.2(4)	77.9(0)	40.3(0)	2(0)	4	**14**

Appendix Table 5. Summary of relative numbers of fish and species collected at each location by river mile sampled in Chapman Run, 1994. Relative numbers are per 0.3 km for RMs 5.2, 1.6, 1.1, and 0.9 and per 1.0 km for RM 0.1. Chapman Run stream code is 17-817.

Species	Stream Code: Year: River Mile:	17817 94 .1	17817 94 .9	17817 94 1.1	17817 94 1.6	17817 94 5.2
GIZZARD SHAD		8.0	-	-	0.8	-
GRASS PICKEREL		-	0.8	14.2	3.0	-
QUILLBACK CARPSUCKER		1.0	2.3	-	-	-
GOLDEN REDHORSE		-	-	0.8	-	-
NORTHERN HOG SUCKER		-	-	-	-	2.5
WHITE SUCKER		1.0	1.5	10.0	19.5	45.0
COMMON CARP		12.0	0.8	1.7	0.8	-
GOLDEN SHINER		-	0.8	-	-	-
BLACKNOSE DACE		-	-	6.7	4.5	41.3
CREEK CHUB		-	5.3	82.5	202.5	475.0
SOUTH. REDBELLY DACE		-	-	-	-	10.0
REDFIN SHINER		1.0	-	-	-	-
COMMON SHINER		-	-	-	-	103.8
SPOTFIN SHINER		1.0	6.8	-	2.3	-
SILVERJAW MINNOW		-	-	-	-	11.3
BLUNTNOSE MINNOW		1.0	48.0	179.9	18.0	450.0
CENTRAL STONEROLLER		-	-	5.8	3.0	11.3
YELLOW BULLHEAD		-	-	1.7	9.8	-
BLACK BULLHEAD		-	-	-	0.8	-
TROUT-PERCH		-	2.3	0.8	-	-
WHITE CRAPPIE		1.0	-	-	0.8	-
ROCK BASS		-	3.0	3.3	2.3	-
LARGEMOUTH BASS		-	-	2.5	12.0	3.8
WARMOUTH SF		3.0	-	-	-	-
GREEN SUNFISH		2.0	37.5	37.5	36.8	86.3
BLUEGILL SUNFISH		6.0	11.3	0.8	10.5	1.3
OR'GESPOTTED SUNFISH		1.0	-	-	-	-
PUMPKINSEED SUNFISH		-	0.8	-	-	-
GREEN SF X BLUEGILL		-	3.0	1.7	1.5	-
BLACKSIDE DARTER		-	2.3	-	-	-
LOGPERCH		-	-	-	-	3.8
JOHNNY DARTER		1.0	36.8	40.8	23.3	196.3
FANTAIL DARTER		-	-	-	5.3	222.5
SAUGER X WALLEYE		7.0	-	-	-	-
Total Relative Number		46.0	162.7	390.6	357.0	1663.7
Total Number of Species		13	15	15	18	15
Total Number of Hybrids		1	1	1	1	
Distance Sampled		1.00	.40	.36	.40	.24
Number of Passes		2	2	2	2	2

Appendix Table 6. Index of Biotic Integrity (IBI) metrics and scores by river mile for locations sampled in Chapman Run, 1994

River Mile	Type	Date	Drainage area (sq mi)	Number of: Total species	Sunfish species	Sucker species	Intolerant species	Darter species	Percent of Individuals: Simple Lithophils	Tolerant fishes	Omni-vores	Top carnivores	Insect-ivores	DELT anomalies	Rel.No. minus tolerants /(0.3km)	IBI	Mo
Chapman Run - (17817)																	
Year: 94																	
5.20	E	08/11/94	6	13(5)	1(0)	1(0)	0(1)	3(0)	13(3)	63(1)	25(3)	0.3(0)	41(5)	0.0(5)	730(5)	40	
5.20	E	09/28/94	6	15(5)	2(0)	2(0)	0(1)	3(0)	11(5)	70(1)	36(1)	0.2(0)	33(3)	0.0(5)	403(3)	36	
1.60	E	08/11/94	13	14(3)	4(0)	1(0)	0(1)	2(0)	6(1)	84(1)	11(5)	4.8(0)	21(1)	0.0(5)	90(1)	26	
1.60	E	09/28/94	13	16(5)	3(0)	1(0)	0(1)	2(0)	10(1)	74(1)	12(5)	4.8(0)	40(3)	0.0(5)	41(1) *	30	
1.10	E	08/11/94	15	13(3)	3(0)	1(0)	0(1)	1(0)	3(1)	82(1)	53(1)	5.7(0)	16(1)	0.0(5)	98(1)	20	
1.10	E	09/28/94	15	9(3)	2(0)	2(0)	0(1)	1(0)	7(1)	81(1)	39(1)	3.6(0)	33(3)	0.7(3)	43(1)	18	
0.90	E	08/12/94	16	14(3)	4(0)	2(0)	0(1)	2(0)	2(1)	53(3)	37(1)	2.8(0)	55(5)	0.0(5)	126(1)	26	
0.90	E	09/28/94	16	4(1)	2(0)	1(0)	0(1)	0(0)	3(1)	78(1)	11(1)	0.0(0)	86(1)	0.0(5)	12(1) *	16	

na - Qualitative data, Modified Iwb not applicable.
▲ - IBI is low-end adjusted.
● - One or more species excluded from IBI calculation.

Appendix Table 6. Index of Biotic Integrity (IBI) metrics and scores by river mile for locations sampled in Chapman Run, 1994

River Mile	Type	Date	Drainage area (sq mi)	Number of: Total species	Number of: Sunfish species	Number of: Sucker species	Number of: Intolerant species	Percent of Individuals: Rnd-bodied suckers	Percent of Individuals: Simple Lithophils	Percent of Individuals: Tolerant fishes	Percent of Individuals: Omni-vores	Percent of Individuals: Top carnivores	Percent of Individuals: Insect-ivores	Percent of Individuals: DELT anomalies	Rel.No. minus tolerants /(1.0 km)	IBI	M
Chapman Run - (17-817)																	
Year: 94																	
0.10	A	09/14/94	19	8(1)	4(0)	1(0)	0(1)	0(0)	5(1)	45(3)	50(1)	18(0)	32(1)	0.0(5)	24(1)* *	18	
0.10	A	10/04/94	19	8(1)	4(0)	1(0)	0(1)	0(0)	0(1)	25(5)	50(1)	25(0)	25(1)	0.0(5)	36(1)* *	20	

▲ - IBI is low end adjusted.