WATER QUALITY AND BIOLOGICAL ASSESSMENT OF THE CHEMUNG SUBBASIN

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ABSTRACT

The U.S. Environmental Protection Agency's Rapid Bioassessment Protocol III (RBP III) was used to assess the biological, physical habitat, and chemical water quality conditions of 58 sample sites in the Chemung Subbasin in southcentral New York and northcentral Pennsylvania. Results of this assessment indicate that the majority (47 percent) of the sites surveyed had slightly impaired macroinvertebrate communities. Thirty-one percent of the macroinvertebrate communities sampled were nonimpaired. Both water quality and habitat degradation contributed to impairment. Concentrations of metals were high at many of the sites, and poor or altered habitat contributed to half of the impairments found in this assessment.

INTRODUCTION

Overview

The Susquehanna River drains an area of 27,510 square miles and has one of the largest river basins on the east coast of the United States. The river originates at Otsego Lake in New York State and flows 444 miles to the Chesapeake Bay at Havre de Grace, Maryland. The Susquehanna Basin is comprised of six major subbasins; the Chemung Subbasin constitutes the northwestern headwaters of the Susquehanna River.

The Chemung Subbasin drains approximately 2,596 square miles in southcentral New York and northcentral Pennsylvania (Figure 1). The basin is primarily located in New York, encompassing most of Steuben County, as well as portions of six other New York counties: Chemung, Schuyler, Allegany, Yates, Ontario, and Livingston. Three Pennsylvania counties are partially included in the subbasin: Tioga, Potter, and Bradford. Several streams in the basin cross state boundaries and, therefore, are of special concern. These interstate streams include Chemung, Tioga, and Cowanesque Rivers, and Seeley, South, Troups, and Bentley Creeks. (For more information on interstate waters, refer to the yearly Susquehanna River Basin Commission (SRBC) publication "Water Quality of Interstate Streams in the Susquehanna River Basin.")

South of Athens, Pa., the Chemung River meets the Susquehanna River. The Chemung River is a product of the confluence of two major river systems; the Tioga, which originates in Bradford County, Pa., and the Cohocton, which flows from northwestern New York. The Tioga River lies primarily in Pennsylvania, where its main tributary is the Cowanesque River. The Canisteo River, flowing parallel to the Cohocton River, greatly expands the Tioga drainage in New York. The Tioga and Cohocton Rivers join west of Corning, N.Y.

The Tioga, Cowanesque, Canisteo, Cohocton, and Chemung Rivers and their tributaries comprise five major watersheds of the Chemung Subbasin. (See Figure 1 for delineation of these watersheds.) Sample sites are reviewed by watershed in the "Bioassessment of Streams and Rivers" section.

Topography and ecoregion

The Chemung River drains the dissected plateaus of southcentral New York and north-central Pennsylvania. The Chemung Subbasin lies primarily in the Northern Appalachian Plateau and Uplands (Ecoregion 60), although some Pennsylvania stream reaches flow through the North Central Appalachians (Ecoregion 62). (Refer to Figure 1 and Table 1 for site locations in these ecoregions.) Both areas are composed

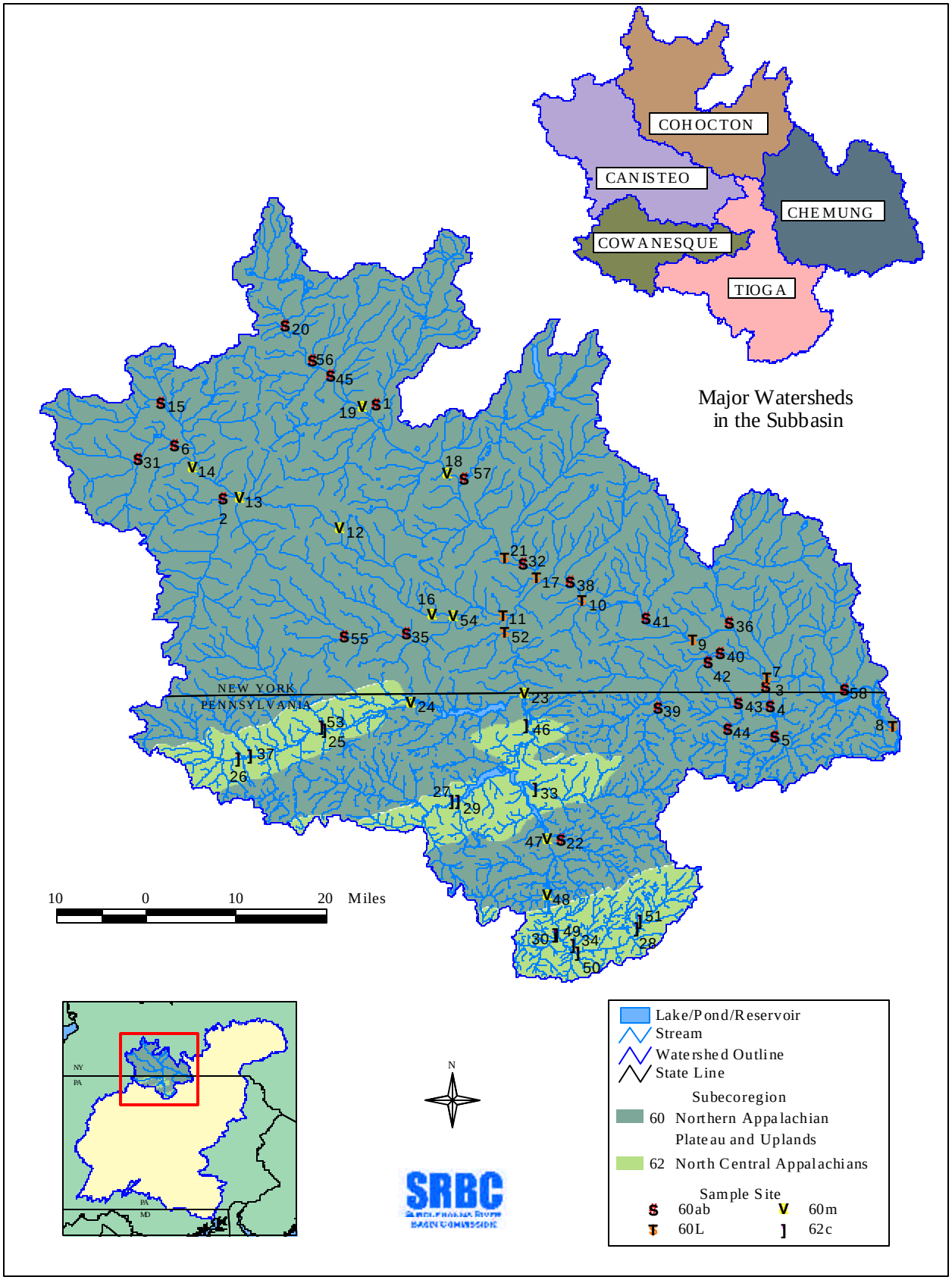


Figure 1. Sample Site Locations in the Chemung Subbasin

Table 1. Sample Site Locations in the Chemung Subbasin

Site Number	Station	Stream	Location	Latitude	Longitude
1	5MIL 1.1	Five Mile Creek	at Kanona	42° 23' 17"	77° 21' 31"
2	BENN 1.0	Bennetts Creek	near Canisteo	42° 15' 49"	77° 36' 13"
3	BNTY 0.7	Bentley Creek	at Wellsburg	42° 0' 43"	76° 43' 53"
4	BNTY 2.5	Bentley Creek	at Mobile Acres Trailer Park	41° 59' 9"	76° 43' 22"
5	BNTY 5.7	Bentley Creek	at Bentley Creek	41° 56' 37"	76° 42' 54"
6	CANA 1.7	Canacadea Creek	near Hornell	42° 20' 1"	77° 40' 55"
7	CHEM 18.5	Chemung River	at Wellsburg	42° 1' 15"	76° 43' 42"
8	CHEM 2.5	Chemung River	at Athens	41° 57' 26"	76° 31' 33"
9	CHEM 28.3	Chemung River	at West Elmira	42° 4' 22"	76° 50' 55"
10	CHEM 40.1	Chemung River	at South Corning	42° 7' 33"	77° 1' 31"
11	CNST 1.0	Canisteo River	near Erwins	42° 6' 21"	77° 9' 12"
12	CNST 21.3	Canisteo River	at West Cameron	42° 13' 18"	77° 24' 58"
13	CNST 31.3	Canisteo River	near Canisteo	42° 15' 50"	77° 34' 42"
14	CNST 36.5	Canisteo River	at Hornell	42° 18' 14"	77° 39' 11"
15	CNST 44.1	Canisteo River	above Arkport	42° 23' 28"	77° 42' 15"
16	CNST 7.7	Canisteo River	at Addison	42° 6' 23"	77° 16' 0"
17	COHO 0.5	Cohocton River	near Painted Post	42° 9' 21"	77°° 5' 58"
18	COHO 14.6	Cohocton River	near Savona	42° 17' 41"	77° 14' 34"
19	COHO 25.0	Cohocton River	near Kanona	42° 23' 8"	77° 22' 48"
20	COHO 37.5	Cohocton River	near Cohocton	42° 29' 41"	77° 30' 14"
21	COHO 4.0	Cohocton River	at Coopers Plains	42° 10' 52'	77° 9' 10"
22	CORY 1.5	Corey Creek	at Mansfield	41° 48' 21"	77° 3' 39"
23	COWN 0.1	Cowanesque River	at Lawrenceville	42° 0' 50"	77° 7' 3"
24	COWN 13.0	Cowanesque River	at Elkland	41° 59' 19"	77° 18' 4"
25	COWN 21.3	Cowanesque River	at Knoxville	41° 57' 6"	77° 26' 29"
26	COWN 30.1	Cowanesque River	at Westfield	41° 54' 52"	77° 34' 48"
27	CRKD 0.1	Crooked Creek	at Crooked Creek	41° 51' 22"	77° 14' 5"
28	FELL 0.1	Fellows Creek	at Chases Mills	41° 41' 8"	76° 56' 15"
29	HILL 0.2	Hills Creek	at Crooked Creek	41° 51' 23"	77° 13' 32"
30	JOHN 0.1	Johnson Creek	at Blossburg	41° 40' 39"	77° 4' 9"
31	KARR 0.1	Karr Valley Creek	at mouth above Almond	42° 18' 59"	77° 44' 28"
32	MEAD 0.1	Meads Creek	near Coopers Plains	42° 10' 31"	77° 7' 17"
33	MILL 0.1	Mill Creek	at Painted Run	41° 52' 24"	77° 6' 7"
34	MORR 0.8	Morris Run	near Blossburg	41° 39' 47"	77° 2' 23"
35	NBTC 0.1	North Branch Tuscarora Creek	at Tuscarora	42° 4' 56"	77° 18' 34"
36	NEWT 0.6	Newtown Creek	at Elmira	42° 5' 46"	76° 47' 19"
37	NFCO 0.1	North Fork Cowanesque River	at Westfield	41° 55' 5"	77° 33' 37"
38	POST 0.4	Post Creek	at Corning	42° 9' 7"	77° 2' 42"
39	SEEL 11.3	Seeley Creek	near Mosherville	41° 58' 57"	76° 54' 17"
40	SEEL 2.8	Seeley Creek	at Southport	42° 3' 22"	76° 48' 9"
41	SING 0.4	Sing Sing Creek	at Route 352 bridge	42° 6' 10"	76° 55' 20"
42	SOUT 1.9	South Creek	at mouth - Elmira	42° 2' 37"	76° 49' 21"
43	SOUT 7.2	South Creek	at Fassett	41° 59' 20"	76° 46' 27"
44	SOUT 11.0	South Creek	at Gillett	41° 57' 17"	76° 47' 32"
45	TENM 0.2	Tenmile Creek	at Avoca	42° 25' 41"	77° 25' 54"
46	TIOG 16.3	Tioga River	at Tioga Junction	41° 57' 28"	77° 6' 57"
47	TIOG 29.8	Tioga River	near Mansfield	41° 48' 18"	77° 4' 55"
48	TIOG 35.4	Tioga River	near Covington	41° 43' 51"	77° 4' 58"
49	TIOG 39.6	Tioga River	at Blossburg	41° 40' 41"	77° 4' 3"
50	TIOG 42.3	Tioga River	near Blossburg	41° 39' 14"	77° 1' 55"
51	TIOG 49.2	Tioga River	near Chases Mills	41° 41' 44"	76° 55' 55"
52	TIOG 6.2	Tioga River	at Presho	42° 4' 58"	77° 8' 57"
53	TRUP 0.4	Troups Creek	at Knoxville	41° 57' 27"	77° 26' 40"
54	TUSC 0.4	Tuscarora Creek	at Addison	42° 6' 14"	77° 13' 59"
55	TUSC 12.5	Tuscarora Creek	at Woodhull	42° 4' 46"	77° 24' 30"
56	TWVE 0.5	Twelvemile Creek	at Wallace	42° 26' 50"	77° 27' 40"
57	WMUD 1.1	Mud Creek	at Savona	42° 17' 21"	77° 13' 1"
58	WYNK 0.5	Wynkoop Creek	at Route 17C bridge	42° 0' 25"	76° 36' 17"

primarily of horizontally bedded sedimentary rock, chiefly Devonian-aged sandstones, shales, and siltstones (Woods and others, 1996).

Typically, the landscape is marked by steeply sloping river valleys filled with layers of stratified sand, gravel, silt, and clay up to 100 feet thick. In areas with steep topography, many of the small headwater tributaries have extremely high gradients. Streams often flood quickly during storm and melting events. However, fluctuations in flow can be so great that even substantial tributaries are dewatered during periods of low precipitation (NYSDEC, 1994).

Ecoregion 60 is the Northern Appalachian Plateau and Uplands region. The plateau area elevation ranges from 1,300 to 2,000 feet and is formed by horizontally bedded Devonian-aged sedimentary rock. Wisconsin glaciation has partially covered hills, valleys, and lower mountains with Olean till. Soils are mostly till-derived mesic Inceptisols. The natural vegetation of the region is mainly Appalachian oak forest, with some areas of northern hardwoods. Ecoregion 60 areas tend to be lower, less rugged, more fertile, and less forested than Ecoregion 62 (Woods and others, 1996).

The Glaciated Low Plateau (Subecoregion 60a) consists of low rolling hills (1,300-1,800 feet), low stream gradients, and wide valleys smoothed by glaciers. Subecoregion 60a is comprised of a "mosaic" of agricultural lands, Appalachian oak forest, and lakes (Woods and others, 1996).

The Northeastern Uplands (Subecoregion 60b) is very similar to Subecoregion 60a. The distinction between subecoregions is based upon lake/bog density, slope angle, channel gradient, stream density, elevation (1,400-2,000 feet), and ratio of woodland to farmland. Northern hardwood forest is the dominant natural vegetation (Woods and others, 1996).

The North Central Appalachians (Ecoregion 62) is an extensive plateau separated from Ecoregion 60 by its more resistant strata. This difference causes the variation in elevation, climate, and forest density between Ecoregions 60 and 62. The plateau was only partly glaciated and is covered by extensive forests. Subecoregion 62c, the Glaciated High Plateau, is deeply dissected, and its plateau remnants, rounded hills, low mountains, and narrow valleys are heavily forested. Hardwoods dominate the landscape, but Appalachian oak forest and scattered lake, swamp, marsh, and bog vegetation also are present. The Inceptisol soils that cover Subecoregion 62c are derived from acidic glacial drift (Woods and others, 1996).

Land and water use

The 1991-92 Rotating Intensive Basin Studies (RIBS) Biennial Report of the New York State Department of Environmental Conservation (NYSDEC) describes the Chemung Subbasin as a "lightly populated agricultural region with a few moderately-sized urban centers." Elmira/Horseheads, Corning/Painted Post, Hornell, and Bath are the largest urban areas in the subbasin. Nearly 60 percent of the New York population of the Chemung Subbasin lives in or near these towns. Commerce and industry are concentrated around these population centers. The Pennsylvania portion of the subbasin is more rural, with Sayre and the boroughs of Mansfield, Blossburg, Elkland, and Westfield representing the population centers of the subbasin. Urban areas in both New York and Pennsylvania represent a combined total of less than 5 percent of land in the subbasin. Agriculture, particularly dairy farming, remains the primary land use, although farming is declining as residential areas expand into rural lands. Land use is outlined in Table 2 and portrayed in Figure 2.

Water withdrawals within the subbasin are primarily for agricultural, municipal and domestic use, and wastewater treatment. Ground water is the main water source for most basin residents. Only a few municipalities such as Elmira, Hornell, and Arkport supply their residents with water from reservoirs or streams. According to the RIBS report (NYSDEC, 1994), major permitted discharges in New York include 8 major municipal facilities and 14 major or significant minor industrial facilities. At least 5 industrial

Table 2. Land Use in the Chemung Subbasin

Level I	Level II	Chemung Basin (square miles)		Percentage of Level II in the Chemung Subbasin
		Level I	Level II	
1 Urban or built-up land		77.50		
	11 Residential		44.300	1.71
	12 Commercial and services		13.700	0.53
	13 Industrial		2.720	0.10
	14 Transportation, communication, utilities		10.400	0.40
	16 Mixed urban or built-up land		2.717	0.10
	17 Other urban or built-up land		3.662	0.14
2 Agricultural land		1,018.36		
	21 Cropland and pasture		1,014.338	39.07
	22 Orchards, groves, vineyards, nurseries, and ornamental horticultural		3.426	0.13
	24 Other agricultural land		0.591	0.02
3 Rangeland		24.93		
	32 Shrub and brush rangeland		24.573	0.95
	33 Mixed rangeland		0.354	0.01
4 Forest land		1,454.17		
	41 Deciduous forest land		507.760	19.56
	42 Evergreen forest land		67.575	2.60
	43 Mixed forest land		878.833	33.85
5 Water		6.97		
	51 Streams and canals		0.473	0.02
	52 Lakes		4.017	0.15
	53 Reservoirs		2.481	0.10
6 Wetland		1.77		
	61 Forested wetland		0.354	0.01
	62 Nonforested wetland		1.417	0.05
7 Barren land		11.93		
	75 Strip mines, quarries, gravel pits		4.017	0.15
	76 Transitional areas		7.915	0.30
Undefined	Undefined	0.35	0.354	0.01

Source: 1998c—calculated using ESRI's spatial analyst extension.

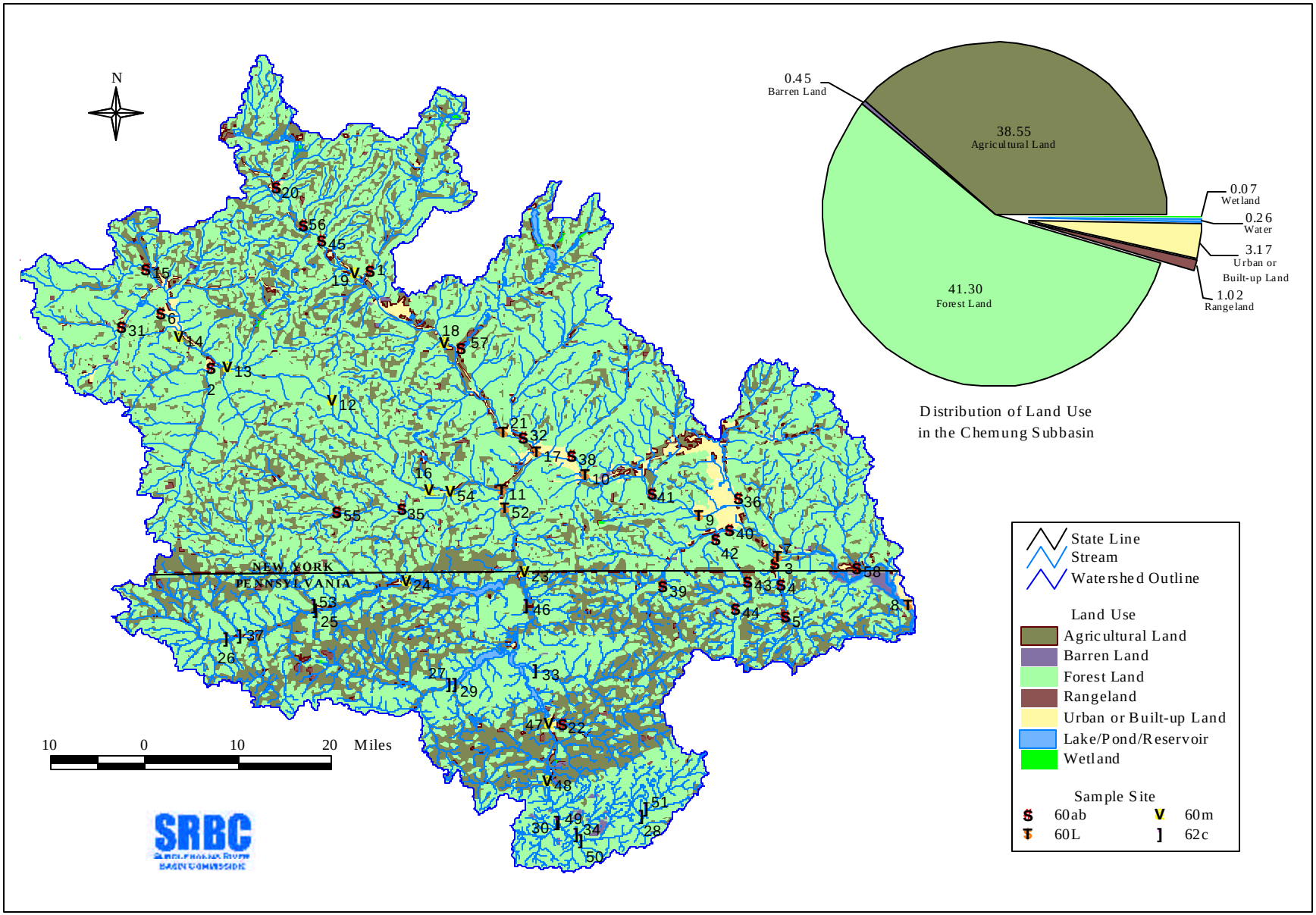


Figure 2. Land Use in the Chemung Subbasin *(Sample sites are listed in Table 1.)*

discharges and 10 borough or township sewage treatment plants are permitted in Pennsylvania. There is no significant use of Chemung Subbasin streams for navigation or power generation.

Management and water quality issues

As mentioned previously, the steep relief of many areas causes flooding, a serious concern for residents of the subbasin. Impermeable surfaces from development add to the problem by increasing runoff. In an attempt to lessen the flooding hazard, streams are regularly dredged and/or contained in levees.

Instability is a serious problem in many glacial streams within the subbasin. Rounded, unconsolidated till, which lines channels and forms many streambanks, tends to shift easily. One of the most common methods of discouraging erosion is covering the streambanks with rock or rubble riprap. Riprap was present at many of the sites surveyed. Dredging also is used to reopen channels choked with cobble, as well as provide stone for commercial use.

Nutrient enrichment from agricultural runoff or failing septic systems is the most widespread water quality problem, according to a NYSDEC Priority Water Problems List released in 1991. NYSDEC (1994) also names siltation and high sediment loads resulting from streambank erosion and resource extraction as primary water quality problems.

Objectives

In this study, SRBC staff used RBP III habitat and biological data in conjunction with the analysis of 38 chemical water quality parameters in an extensive bioassessment of the streams and rivers in the Chemung Subbasin. The water quality component of RBP III was expanded to better identify sources of biological impairment.

The primary objectives of this report are to: (1) provide information to the SRBC for its 305(b) reports; (2) furnish an overview of the existence, severity, and possible source(s) of impairments to stream biological communities; and (3) use standardized methods to build a database that can be used as baseline data for trend monitoring.

METHODS

Field and Laboratory Methods

Field data were collected during a period of little or no precipitation when streamflows were maintained primarily by baseflow. Fifty-eight sites were sampled in the Chemung Subbasin during September and October of 1997. Twenty-six sites were located in the Tioga, Cowanesque, Canisteo, Cohocton, and Chemung Rivers, and 32 sites were distributed among 26 tributaries to these rivers (Table 1). Many of these sites were sampled during SRBC's previous assessment of the subbasin (McMorran, 1985). Physical habitat and chemical water quality conditions were documented at each sample site, and benthic macroinvertebrate and chemical water quality samples were collected for analysis in the laboratory.

Chemical water quality

Water samples were collected at each of the sites to measure nutrient and metal concentrations. Field water quality measurements included water temperature, dissolved oxygen, conductivity, pH, alkalinity, and acidity. (See Table 3 for a complete list of measured parameters.) Dissolved oxygen was measured using a YSI Model 55 dissolved oxygen meter. The dissolved oxygen meter was calibrated at the beginning of each day when samples were collected. Conductivity was measured using a VWR Scientific Model 2052 conductivity meter. A Cole Parmer meter was used to measure pH. Alkalinity was measured by titrating a known volume of sample water to pH 4.5 with 0.02N sulfuric acid (H_2SO_4). Acidity was measured by titrating a known volume of sample water to pH 8.3 with 0.02N sodium hydroxide (NaOH). Approximately 1 liter of water from each site was collected for laboratory analysis.

Table 3. Chemical Water Quality Parameters

Parameter	Symbol	Units	Parameter	Symbol	Units
Field-Measured Parameters					
Water Temperature	Temp	°C	Conductivity	Cond	µ ohms/cm
pH	pH	S.U.	Alkalinity	Alk	mg/l
Dissolved Oxygen	DO	mg/l	Acidity	Acid	mg/l
Laboratory Analysis					
Specific Conductance	Lab cond	µ ohms/cm	Total Calcium	Ca	mg/l
pH	Lab pH	mg/l	Magnesium	Mg	mg/l
Alkalinity (as $CaCO_3$)	Lab Alk	mg/l	Sodium	Na	mg/l
Dissolved Residues	DRes	mg/l	Potassium	K	mg/l
Total Suspended Solids	TSS	mg/l	Chloride	Cl	mg/l
Dissolved Nitrogen	DN	mg/l	Total Sulfate	SO_4	mg/l
Total Nitrogen	TN	mg/l	Fluoride	Fl	mg/l
Dissolved Ammonia	DNH_3	mg/l	Copper	Cu	mg/l
Total Ammonia	TNH_3	mg/l	Dissolved Iron	DFe	mg/l
Dissolved Nitrite	DNO_2	mg/l	Total Iron	TFe	mg/l
Total Nitrite	TNO_2	mg/l	Lead	Pb	mg/l
Dissolved Nitrate	DNO_3	mg/l	Dissolved Manganese	DMn	mg/l
Total Nitrate	TNO_3	mg/l	Total Manganese	TMn	mg/l
Dissolved Phosphorus	DP	mg/l	Nickel	Ni	mg/l
Total Orthophosphorus	TOP	mg/l	Zinc	Zn	mg/l
Total Phosphorus	TP	mg/l	Dissolved Aluminum	DAl	mg/l
Total Organic Carbon	TOC	mg/l	Total Aluminum	TAl	mg/l
Total Hardness ($CaCO_3$)	Hard	mg/l			

Laboratory samples consisted of two 250 ml bottles of water for nutrient analysis and two 250 ml bottles for metal analysis. For both analyses, one bottle of water was filtered with a cellulose nitrate filter with 0.45 micrometer pore size. The samples for metal analyses were acidified to pH 2.0 or less with nitric acid. All samples were chilled on ice and shipped within 24 hours to the Pennsylvania Department of Environmental Protection (Pa. DEP), Bureau of Laboratories in Harrisburg, Pa.

Physical habitat and biological conditions

Physical habitat conditions at each sample site were assessed using a slightly modified version of the habitat assessment procedure outlined by Plafkin and others (1989). Eleven habitat parameters were field-evaluated at each site and used to calculate a site-specific habitat assessment score. Habitat parameters were identified as primary, secondary, or tertiary parameters, based on their contribution to habitat quality. Primary parameters, stream habitat features that have the greatest direct influence on the structure of aquatic communities, were evaluated on a scale of 0 to 20 and included the characterization of stream bottom substrate and instream cover, embeddedness, and velocity/depth diversity. Secondary parameters included stream channel morphology characteristics and were scored on a scale of 0 to15. Tertiary parameters characterized riparian and bank conditions and were scored on a scale of 0 to 10. The criteria used to evaluate habitat parameters are summarized in Table 4.

Benthic macroinvertebrate samples were collected and analyzed using field and laboratory methods described by Plafkin and others (1989). Sampling was performed using a 1-meter-square kick net with size No. 30 mesh to collect organisms dislodged from riffle areas by physical agitation of the streambed. Two areas of the streambed, each approximately 1 meter square, were sampled at each site: one area of high velocity, and one area of lower velocity. The two samples were composited and preserved in a solution of isopropyl alcohol and glycerin for laboratory analysis. In the laboratory, composite samples were sorted into 100-organism subsamples using a gridded pan and a random numbers table. The organisms contained in the subsamples were identified to genus (with the exception of Chironomidae, Simuliidae, Lumbriculidae, Hydracarina, and Planorbidae) and enumerated. Each taxon was assigned an organic pollution tolerance value and a functional feeding category, as outlined in Appendix A. Raw invertebrate data for each site are listed in Appendix B.

Data Analysis Methods

Reference category designation

Biota are influenced by regional differences such as physiography, geology, climate, vegetation, and land use. To account for effects on biota due to zonal variations, large areas can be classified into smaller ecological regions (ecoregions) based on the work of Omernik (1987) and others. It is anticipated that each ecoregion will have a distinct biological community. Within broad ecoregions, further levels of division delineate regional differences on a progressively smaller scale, and therefore, define biological conditions more precisely. Currently, four levels are recognized; the finest is Level IV, which defines subecoregions. For an outline of the characteristics of Chemung Subbasin ecoregions and subecoregions, see the "Topography and Ecoregion" section (page 1).

Regional characteristics are not the only factors that affect the biota at a site. Site-specific characteristics such as drainage area or type of riparian vegetation also help determine the composition of a community (Plafkin and others, 1989). Reference categories have been developed to consider both regional and site-specific influences.

For this assessment, sample sites were grouped into reference categories based on: (1) ecoregion designation; (2) drainage area size; and (3) subecoregion designation. Sites in Subecoregion 62c (Glaciated Allegheny High Plateau) with drainage areas of less than 100 and 100 to 500 square miles were combined into a single reference category due to the limited number of sites with greater than 100-square-mile drainage areas.

Table 4. Criteria Used to Evaluate Physical Habitat Parameters

Habitat Parameter	Excellent	Good	Fair	Poor
1. Bottom Substrate	Greater than 50% cobble, gravel, submerged logs, undercut banks, or other stable habitat. **(16-20)**	30-50% cobble, gravel, or other stable habitat. Adequate habitat. **(11-15)**	10-30% cobble, gravel, or other stable habitat. Habitat availability is less than desirable. **(6-10)**	Less than 10% cobble, gravel, or other stable habitat. Lack of habitat is obvious. **(0-5)**
2. Embeddedness (a)	Larger substrate particles (e.g., gravel, cobble, boulders) are between 0 and 25% surrounded by fine sediment. **(16-20)**	Larger substrate particles (e.g., gravel, cobble, boulders) are between 25 and 50% surrounded by fine sediment. **(11-15)**	Larger substrate particles (e.g., gravel, cobble, boulders) are between 50 and 75% surrounded by fine sediment. **(6-10)**	Larger substrate particles (e.g., gravel, cobble, boulders) are over 75% surrounded by fine sediment. **(0-5)**
3. Velocity/Depth Diversity	Four habitat categories consisting of slow (<1.0 ft/s), deep (>1.5 ft); slow, shallow (<1.5 ft); fast (> 1.0 ft/s), deep; fast, shallow habitats are all present. **(16-20)**	Only 3 of the 4 habitat categories are present. **(11-15)**	Only 2 of the 4 habitat categories are present. **(6-10)**	Dominated by 1 velocity/depth category (usually pools). **(0-5)**
4. Pool/Riffle Ratio (or Run/Bend)	Distance between riffles divided by mean wetted width equals 5-7. Stream contains a variety of habitats including deep riffles and pools. **(12-15)**	Distance between riffles divided by mean wetted width equals 7-15. Adequate depth in pools and riffles. **(8-11)**	Distance between riffles divided by mean wetted width equals 15-25. Stream contains occasional riffles. **(4-7)**	Distance between riffles divided by mean wetted width >25. Stream is essentially straight with all flat water or shallow riffle. Poor habitat. **(0-3)**
5. Pool Quality (b)	Pool habitat contains both deep (>1.5 ft) and shallow areas (<1.5 ft) with complex cover and/or depth greater than 5 ft. **(12-15)**	Pool habitat contains both deep (>1.5 ft) and shallow (<1.5 ft) areas with some cover present. **(8-11)**	Pool habitat consists primarily of shallow (<1.5 ft) areas with little cover. **(4-7)**	Pool habitat rare with maximum depth <0.5 ft, or pool habitat completely absent. **(0-3)**

Table 4. Criteria Used to Evaluate Physical Habitat Parameters—Continued

Habitat Parameter	Excellent	Good	Fair	Poor
6. Riffle/Run Quality (c)	Riffle/run depth generally >8 inch and consisting of stable substrate materials and a variety of current velocities. **(12-15)**	Riffle/run depth generally 4-8 inch and with a variety of current velocities. **(8-11)**	Riffle/run depth generally 1-4 inches; primarily a single current velocity. **(4-7)**	Riffle/run depth <1 inch, or riffle/run substrates concreted. **(0-3)**
7. Channel Alteration (d)	Little or no enlargement of islands or point bars, and/or no channelization. **(12-15)**	Some new increase in bar formation, mostly from coarse gravel; and/or some channelization present. **(8-11)**	Moderate deposition of new gravel, coarse sand on old and new bars; pools partially filled with silt; and/or embankments on both banks. **(4-7)**	Heavy deposits of fine material, increased bar development; most pools filled with silt, and/or extensive channelization. **(0-3)**
8. Upper and Lower Streambank Erosion (e)	Stable. No evidence of erosion or of bank failure. Side slopes generally <30%. Little potential for future problems. **(9-10)**	Moderately stable. Infrequent, small areas of erosion mostly healed over. Side slopes up to 40% on one bank. Slight potential in extreme floods. **(6-8)**	Moderately unstable. Moderate frequency and size of erosional areas. Side slopes up to 60% in some areas. High erosion potential during extreme high flow. **(3-5)**	Unstable. Many eroded areas. Side slopes >60% common. "Raw" areas frequent along straight sections and bends. **(0-2)**
9 Upper and Lower Streambank Stability (e)	Over 80% of the streambank surface is covered by vegetation or boulders and cobble. **(9-10)**	50-79% of the streambank surface is covered by vegetation, gravel, or larger material. **(6-8)**	25-49% of the streambank surface is covered by vegetation, gravel, or larger material. **(3-5)**	Less than 25% of the streambank surface is covered by vegetation, gravel, or larger material. **(0-2)**
10. Streamside Vegetative Cover *(Both Banks)*	Dominant vegetation that provides stream-shading, escape cover, and/or refuge for fish within the bankfull stream channel is shrub. **(9-10)**	Dominant vegetation that provides stream shading, escape cover, and/or refuge for fish within the bankfull stream channel is trees. **(6-8)**	Dominant vegetation that provides stream-shading, escape cover, and/or refuge for fish within the bankfull stream channel is forbs and grasses. **(3-5)**	Over 50% of the streambank has no vegetation and dominant material is soil, rock, bridge materials, culverts, or mine tailings. **(0-2)**

Table 4. Criteria Used to Evaluate Physical Habitat Parameters—Continued

Habitat Parameter	Excellent	Good	Fair	Poor
11. Forested Riparian Buffer Zone Width (f) ***(Least Forested Bank)***	Riparian area consists of all three zones of vegetation, Zones 1-3. (See zone descriptions (f).) **(9-10)**	Riparian area consists of Zones 1 and 2. **(6-8)**	Riparian area is limited primarily to Zone 1. Zone 2 may be forested but is subject to disturbance (e.g., grazing, intensive forestry practices, roads). **(3-5)**	Riparian area lacks Zone 1 with or without Zones 2 and/or 3. **(0-2)**

(a) Embeddedness — The degree to which the substrate materials that serve as habitat for benthic macroinvertebrates and for fish spawning and egg incubation (predominantly cobble and/or gravel) are surrounded by fine sediment. Embeddedness is evaluated with respect to the suitability of these substrate materials as habitat for macroinvertebrates and fish by providing shelter from the current and predators, and by providing egg deposition and incubation sites.

(b) Pool Quality — Rated based on the variety and spatial complexity of slow- or still-water habitat within the sample segment. It should be noted that even in high-gradient segments, functionally important slow-water habitat may exist in the form of plunge-pools and/or larger eddies. Within a category, higher scores are assigned to segments that have undercut banks, woody debris, or other types of cover for fish.

(c) Riffle/Run Quality — Rated based on the depth, complexity, and functional importance of riffle/run habitat in the segment, with highest scores assigned to segments dominated by deeper riffle/run areas, stable substrates, and a variety of current velocities.

(d) Channel Alteration — A measure of large-scale changes in the shape of the stream channel. Channel alteration includes: concrete channels, artificial embankments, obvious straightening of the natural channel, riprap, or other structures, as well as recent sediment bar development. Sediment bars typically form on the inside of bends, below channel constrictions, and where stream gradient decreases. Bars tend to increase in depth and length with continued watershed disturbance. Ratings for this parameter are based on the presence of artificial structures as well as the existence, extent, and coarseness of sediment bars, which indicate the degree of flow fluctuations and substrate stability.

(e) Upper and Lower Streambank Erosion and Stability — These parameters include the concurrent assessment of both the upper and lower banks. The upper bank is the land area from the break in the general slope of the surrounding land to the top of the bankfull channel. The lower bank is the intermittently submerged portion of the stream cross section from the top of the bankfull channel to the existing waterline.

(f) Forested Riparian Buffer Zone Width
- Zone 1: a 15-ft-wide buffer of essentially undisturbed forest located immediately adjacent to the stream.
- Zone 2: a 100-ft-wide buffer of forest, located adjacent to Zone 1, which may be subject to non-intensive forest management practices.
- Zone 3: a 20-ft- wide buffer of vegetation, located adjacent to Zone 2, that provides sediment filtering and promotes the formation of sheet flow of runoff into Zone 2. Zone 3 may be composed of trees, shrubs, and/or dense grasses and forbs, which are subject to haying and grazing, as long as vegetation is maintained in vigorous condition.

Source: Modified from Plafkin and others, 1989.

In several previous SRBC publications, reference category designation has been based, in part, on the Level IV subecoregions outlined by Woods and others (1996). However, ecoregion work in New York has been limited to Level III. Therefore, the boundary between Subecoregions 60a and 60b within New York State is uncertain. Sites with drainage areas of less than 100 square miles in Subecoregions 60a (Glaciated Low Plateau) and 60b (Northeastern Uplands) were combined into a single reference category, due to the relative similarity between these two subecoregions, absence of a subecoregion division in New York, and lack of a suitable reference site for 60b. Reference category delineation criteria are summarized in Table 5. The reference category designation of sites is shown in Figure 1 and in each watershed map.

For each reference category, a reference site was selected for comparison with other sites. The reference site represented the combination of "least disturbed or best attainable" habitat, biological, and water quality conditions in the reference category.

Drainage areas and stream miles were approximated using ArcView Geographic Information System (GIS) software. As names of sampling sites were based on approximate stream mileage (from the mouth), sites surveyed during the last assessment (McMorran, 1985) now may have a slightly different station designation. Drainage areas and differences in the location or name of the sites, as compared to the 1985 sampling effort, are listed in Appendix C.

Chemical water quality

To efficiently describe the water quality characteristics of the sample sites within a given reference category, chemical water quality parameters were consolidated into subsets that account for much of the variation in the data. Principal components analysis (PCA) aided in this process to condense the water quality data into a manageable format and to reveal patterns in the water quality characteristics of the sample sites.

PCA results are presented as graphs (ordinations), in which the axes represent subsets of the parameters included in the analysis. Parameters that had low axis weightings, and thus accounted for only a small part of the overall variability in the data, were removed from the data set. This process was repeated until the original data set of 38 water quality parameters was condensed to a relatively small number of parameters that produced meaningful ordinations.

Next, the condensed data set was used in a hierarchical, agglomerative cluster analysis to produce a dendrogram, a tree-like graph that shows the relative similarity of sample sites. Separate principal components and cluster analyses were performed for each reference category using software developed by Kovach (1993) and Minitab (1996). Principal components and cluster analyses were described by Gauch (1982). Application of these statistical methods is limited in this assessment due to a high degree of correlation among water quality parameters and the limited number of water quality samples taken.

The results of the PCA and cluster analyses were used to group sites within reference categories into water quality categories. These categories offer a general comparison of sites' relative water quality. Cluster analysis dendrograms and water quality groupings are shown in the "Results" section (page 19). Raw water quality data are listed in Appendix D.

Loads, in pounds per day (lb/day), were calculated as [flow in cfs (cubic feet per second)] * [chemical concentration in milligrams per liter (mg/l)] * 5.39. Flow at most sites was calculated utilizing a drainage area ratio. This was done by rating the drainage area at the site to an established United States Geologic Survey (USGS) gage station. Where possible, flow was measured using a Scientific Instruments Model 1205 mini current meter using USGS standard methods. Yields, in pounds per acre per day (lb/acre/day), were calculated as [loading rate (lb/day)] \ [acres].

Table 5. Summary of Reference Category Delineation Criteria

Ecoregion Designation (1)	**Ecoregion 60 Northern Appalachian Plateau**			**Ecoregion 62 North Central Appalachians**
Drainage Area Size (2)	**<100 sq. mi.**	**100 – 500 sq. mi.**	**>500 sq. mi.**	**<100 – 500 sq. mi.**
Subecoregion Designation (1)	**60a and 60b Glaciated Low Plateau and Northeastern Upland**	**N/A**	**N/A**	**62c Glaciated Allegheny High Plateau**
Reference Category	**60ab**	**60m**	**60L**	**62c**
Sample Sites	BENN 1.0 BNTY 0.7 BNTY 2.5 BNTY 5.7 CANA 1.7 CNST 44.1 COHO 37.5 CORY 1.5 5MIL 1.1 KARR 0.1 MEAD 0.1 NBTC 0.1 NEWT 0.6 POST 0.4 SEEL 2.8 SEEL 11.3 SING 0.4 SOUT 1.9 SOUT 7.2 SOUT 11.0 TENM 0.2 TUSC 12.5 TWVE 0.5 WMUD 1.1 WYNK 0.5	CNST 7.7 CNST 21.3 CNST 31.3 CNST 36.5 COHO 14.6 COHO 25.0 COWN 0.1 COWN 13.0 TIOG 29.8 TIOG 35.4 TUSC 0.4	CHEM 2.5 CHEM 18.5 CHEM 28.3 CHEM 40.1 CNST 1.0 COHO 0.5 COHO 4.0 TIOG 6.2	COWN 21.3 COWN 30.1 CRKD 0.1 FELL 0.1 HILL 0.2 JOHN 0.1 MILL 0.1 MORR 0.8 NFCO 0.1 TIOG 16.3 TIOG 39.6 TIOG 42.3 TIOG 49.2 TRUP 0.4
Reference Site	CNST 44.1	CNST 7.7	CHEM 28.3	TIOG 49.2

(1) A.J. Woods and others (1996)
(2) Estimated using ArcView

It should be noted that water quality at the sites is generally discussed according to relative quality, and not by compliance with state water quality standards. This approach was taken primarily as this assessment was neither intended nor designed for effective monitoring of individual chemical water parameters. The purpose of expanding the chemical water quality component of RBP III was to aid in identifying sources of biological impairment. Chemical parameter concentrations that met state standards may have been high for the sites assessed. These locally elevated concentrations could indicate a parameter that did exceed standards on occasion and/or influenced the macroinvertebrate community. Therefore, the description of a parameter as 'high' or 'low' does not necessarily indicate a violation of state water quality standards.

Total and dissolved concentrations of nutrients and some metals were measured in water quality samples. In the following discussion, the name of the parameter (i.e., iron, nitrate, etc.) refers to both total and dissolved concentrations measured.

Physical habitat and biological conditions

Analysis of habitat and biological data followed the modified procedure of Plafkin and others (1989) developed by C.A. McGarrell (1997). Habitat assessment scores of sample sites were compared to those of reference sites to classify each sample site into a habitat condition category (Table 6). The biological integrity of each sample site was assessed using a modified version of RBP III, as described by Plafkin and others (1989). This modification included the substitution of several of the indices ("metrics") used to evaluate the overall integrity of the site's benthic macroinvertebrate community. These substitutions included: (1) Shannon Diversity (log base 2) for the Percent Contribution of Dominant Taxa Metric; (2) Percent Taxonomic Similarity for the EPT/Chironomidae Abundances and Community Loss Metrics; and (3) Percent Trophic Similarity for the Scrapers/Filtering Collectors and Shredders/Total Metrics. The metrics used in this survey are summarized in Table 7.

The 100-organism subsample data were used to generate scores for each of the six metrics. Each metric score was then converted to a biological condition score, based on the percent similarity of the metric score, relative to the metric score of the appropriate reference site. The sum of the biological condition scores constituted the total biological score for the sample site, and total biological scores were used to assign each site to a biological condition category (Table 8).

Table 6. Summary of Criteria Used to Classify the Habitat Conditions of Sample Sites

DETERMINATION OF HABITAT ASSESSMENT SCORES				
	Habitat Parameter Scoring Criteria			
Parameter	Excellent	Good	Fair	Poor
Bottom Substrate	20-16	15-11	10-6	5-0
Embeddedness	20-16	15-11	10-6	5-0
Velocity/Depth Diversity	20-16	15-11	10-6	5-0
Pool-Riffle (Run-Bend) Ratio	15-12	11-8	7-4	3-0
Pool Quality	15-12	11-8	7-4	3-0
Riffle/Run Quality	15-12	11-8	7-4	3-0
Channel Alteration	15-12	11-8	7-4	3-0
Upper and Lower Streambank Erosion	10-9	8-6	5-3	2-0
Upper and Lower Streambank Stability	10-9	8-6	5-3	2-0
Streamside Vegetative Cover	10-9	8-6	5-3	2-0
Forested Riparian Buffer Zone Width	10-9	8-6	5-3	2-0

↓
↓

Habitat Assessment Score = Sum of Habitat Parameter Scores

↓
↓

HABITAT ASSESSMENT	
Percent Comparability of Study and Reference Site Habitat Assessment Scores	Habitat Condition Category
>90	Excellent (comparable to reference)
89-75	Supporting
74-60	Partially supporting
<60	Nonsupporting

Table 7. Summary of Metrics Used to Evaluate Overall Biological Integrity of Stream and River Benthic Macroinvertebrate Communities

Metric	Description
1. Taxonomic Richness (1)	The total number of taxa present in the 100-organism subsample.
2. Shannon Diversity Index (2)	A measure of biological community complexity based on the number of equally or nearly equally abundant taxa in the community.
3. Modified Hilsenhoff Biotic Index (1)	A measure of the overall pollution tolerance of a benthic macroinvertebrate community.
4. EPT Index (1)	The total number of Ephemeroptera (mayfly), Plecoptera (stonefly), and Trichoptera (caddisfly) taxa present in the 100-organism subsample.
5. Percent Taxonomic Similarity (2)	A measure of the similarity between the taxonomic composition of the sample site and its appropriate reference community.
6. Percent Trophic Similarity (2)	A measure of the similarity between the functional feeding group composition of a sample site and its appropriate reference community.

Sources: (1) Plafkin and others (1989); and
(2) calculated using software developed by Kovach (1993).

Table 8. Summary of Criteria Used to Classify the Biological Conditions of Sample Sites

SAMPLING AND ANALYSIS

↓

TOTAL BIOLOGICAL SCORE DETERMINATION

Metric	Biological Condition Scoring Criteria (percent)			
	6	4	2	0
1. Taxonomic Richness (a)	>80	79 - 60	59 - 40	<40
2. Shannon Diversity Index (a)	>75	74 - 50	49 - 25	<25
3. Modified Hilsenhoff Biotic Index (b)	>85	84 - 70	69 - 50	<50
4. EPT Index (a)	>90	89 - 80	79 - 70	<70
5. Percent Taxonomic Similarity (c)	>45	44 - 33	32 - 20	<20
6. Percent Trophic Similarity (c, d)	>75	74 - 50	49 - 25	<25

↓

Total Biological Score = the sum of Biological Condition Scores assigned to each metric

↓

BIOASSESSMENT

Percent Comparability of Study and Reference Site Total Biological Scores	Biological Condition Category
>81	Nonimpaired
81-53	Slightly impaired
52-20	Moderately impaired
<20	Severely impaired

(a) Score is study site value/reference site value X 100.
(b) Score is reference site value/study site value X 100.
(c) Range of values obtained. A comparison to the reference station is incorporated in this index.
(d) Functional Feeding Group Designations are summarized in Appendix A.

RESULTS

Reference Category 60ab

Reference category 60ab consists of 25 sites located in the Northern Appalachian Glaciated Low Plateau and the Northeastern Uplands (Ecoregion 60), with drainage areas of less than 100 square miles. These sites are distributed throughout the Tioga, Chemung, Cohocton, and Canisteo watersheds.

The reference site for reference category 60ab is CNST 44.1. Biological communities of 8 (32 percent) reference category 60ab sites were nonimpaired. The majority (15 sites, or 60 percent) supported biological communities that are slightly impaired. BNTY 5.7 and WMUD 1.1 possessed moderately and severely impaired biological communities, respectively. Habitat conditions were mixed; at nine of the sites, conditions were excellent (comparable to reference). Habitat conditions were supporting at seven sites, partially supporting at five sites, and nonsupporting at four sites. RBP III physical habitat and biological data are summarized in Tables 9 and 10 and Figure 3.

Eighteen water quality parameters that account for most of the variation in the data were chosen with the aid of PCA. The result of cluster analysis of this subset is presented in Figure 4. Water quality grouping and relative chemical concentrations based on these 18 parameters are shown in Table 11.

Reference Category 60m

Eleven sample sites are located in Ecoregion 60 and have drainage areas ranging from 100 to 500 square miles, and are included in reference category 60m. All 60m sites are located in Subecoregion 60a, and are found in all watersheds except for the Chemung.

CNST 7.7 serves as the reference site for reference category 60m. Of the 11 sites, 4 sites (36 percent) supported nonimpaired biological communities, 2 sites (18 percent) supported slightly impaired communities, and 3 sites (27 percent) had moderately impaired biota. At two sites, TIOG 29.8 and COWN 0.1, biological communities were severely impaired (18 percent). Excellent habitat was found at five 60m sites, supporting habitat was present at three sites, partially supporting habitat existed at one site, and the remaining two sites had nonsupporting conditions. RBP III physical habitat and biological data are summarized in Tables 12 and 13 and Figure 5.

A subset of 19 water quality parameters that account for most of the variation in the data was selected with the aid of PCA. Cluster analysis of the subset is presented in Figure 6. Water quality grouping and relative chemical concentrations based on these 19 parameters are shown in Table 14.

Reference Category 60L

Eight sites within the Northern Appalachian Plateau that have drainage areas greater than 100 square miles are included in reference category 60L. The main stem Chemung River sites and sites near the mouths of the Canisteo, Tioga, and Cohocton Rivers are in reference category 60L.

The reference site for reference category 60L is CHEM 28.3. Half of the reference category 60L sites had nonimpaired biological communities. The remaining sites displayed slight impairment. Habitat was rated as excellent at all sites; however, the ratings were made by comparison to CHEM 28.3, which had less pristine habitat than other reference sites. RBP III physical habitat and biological data are summarized in Tables 15 and 16 and Figure 7.

Eighteen water quality parameters account for most of the variation in the data, according to PCA results. The results of cluster analyses are presented in Figure 8. Water quality grouping and relative chemical concentrations based on these 18 parameters are shown in Table 17.

Reference Category 62c

Reference category 62c consists of 14 sites located in the Glaciated Allegheny High Plateau of the North Central Appalachians (Ecoregion 62). Ecoregion 62 encompasses the southern portion of the subbasin, so reference category 62c sites are restricted to the Tioga and Cowanesque watersheds.

TIOG 49.2 serves as the reference site for reference category 62c. Only two sites (14 percent) received a nonimpaired rating. Biological conditions at six sites were slightly impaired (43 percent), three sites were moderately impaired (21 percent), and three sites had severely impaired communities (21 percent). The severely impaired sites were TIOG 39.6, TIOG 42.3, and MORR 0.8. Excellent habitat conditions were found at nine sites, and supporting habitat conditions were present at five sites. One site had partially supporting habitat. RBP III physical habitat and biological data are summarized in Tables 18 and 19 and Figure 9.

A subset of 17 water quality parameters that account for most of the variation in the data was selected with the aid of PCA. The results of cluster analyses are presented in Figure 10. Water quality grouping and relative chemical concentrations based on these 17 parameters are shown in Table 20.

Table 9. Summary of Reference Category 60ab RBP III Habitat Data

	CNST 44.1	BENN 1.0	BNTY 0.7	BNTY 2.5	BNTY 5.7	CANA 1.7	COHO 37.5	CORY 1.5	5MIL 1.1	KARR 0.1
Primary Parameters										
Bottom Substrate	17	8	15	16	4	15	16	17	17	13
Embeddedness	17	16	17	13	15	14	15	18	14	16
Velocity/Depth Diversity	11	9	15	7	4	10	10	13	10	10
Secondary Parameters										
Pool/Riffle Ratio	11	8	10	9	2	10	7	11	11	11
Pool Quality	8	8	7	6	4	10	8	7	8	7
Riffle/Run Quality	11	9	8	8	3	9	12	10	11	10
Channel Alteration	12	13	3	7	3	13	11	12	12	3
Tertiary Parameters										
Streambank Erosion	7	6	2	2	2	7	6	8	7	9
Streambank Stability	8	5	2	2	5	9	8	9	8	9
Streamside Vegetative Cover	8	3	9	8	4	6	6	9	5	5
Riparian Buffer Zone	5	2	5	5	4	5	5	5	2	4
Total Habitat Score										
Total Habitat Score	115	87	93	83	50	108	104	119	105	97
Habitat % of Reference	100	76	81	72	43	94	90	103	91	84

	MEAD 0.1	NBTC 0.1	NEWT 0.6	POST 0.4	SEEL 2.8	SEEL 11.3	SING 0.4	SOUT 1.9	SOUT 7.2	SOUT 11.0
Primary Parameters										
Bottom Substrate	14	17	7	15	5	11	16	13	7	7
Embeddedness	10	16	11	13	13	16	12	14	17	12
Velocity/Depth Diversity	10	11	7	8	4	6	11	8	7	8
Secondary Parameters										
Pool/Riffle Ratio	7	10	9	8	3	3	12	7	7	7
Pool Quality	7	7	7	6	5	7	10	7	5	7
Riffle/Run Quality	7	11	7	6	6	7	10	6	6	7
Channel Alteration	10	12	8	10	4	3	11	3	12	11
Tertiary Parameters										
Streambank Erosion	7	8	5	6	2	2	2	5	7	7
Streambank Stability	9	8	9	7	2	5	5	9	8	8
Streamside Vegetative Cover	9	5	5	5	2	2	9	9	9	5
Riparian Buffer Zone	5	5	5	2	2	4	5	3	5	5
Total Habitat Score										
Total Habitat Score	95	110	80	86	48	66	103	84	90	84
Habitat % of Reference	83	96	70	75	42	57	90	73	78	73

Table 9. Summary of Reference Category 60ab RBP III Habitat Data—Continued

	TENM 0.2	TUSC 12.5	TWVE 0.5	WMUD 1.1	WYNK 0.5
Primary Parameters					
Bottom Substrate	16	14	17	2	17
Embeddedness	16	16	16	2	16
Velocity/Depth Diversity	10	9	14	3	8
Secondary Parameters					
Pool/Riffle Ratio	11	7	10	2	6
Pool Quality	10	7	11	11	7
Riffle/Run Quality	10	10	11	0	9
Channel Alteration	10	10	10	12	7
Tertiary Parameters					
Streambank Erosion	7	3	6	7	3
Streambank Stability	9	9	9	8	6
Streamside Vegetative Cover	5	5	9	9	3
Riparian Buffer Zone	5	2	5	4	3
Total Habitat Score					
Total Habitat Score	109	92	118	60	85
Habitat % of Reference	95	80	103	52	74

Table 10. Summary of Reference Category 60ab RBP III Biological Data

	CNST 44.1	BENN 1.0	BNTY 0.7	BNTY 2.5	BNTY 5.7	CANA 1.7	COHO 37.5	CORY 1.5	5MIL 1.1	KARR 0.1	MEAD 0.1	NBTC 0.1
Raw Data Summary												
Number of Individuals	113	120	118	121	104	119	114	108	126	107	123	111
% Shredders	2.7	0.8	6.8	3.3	7.7	5.0	7.0	0.0	0.0	0.0	10.6	0.9
% Collector-Gatherers	44.2	52.5	59.3	66.9	75.0	66.4	59.6	17.6	46.8	52.3	21.1	14.4
% Filterer-Collectors	25.7	22.5	17.8	20.7	2.9	4.2	5.3	60.2	33.3	23.4	40.7	56.8
% Scrapers	11.5	15.8	8.5	3.3	1.0	1.7	21.9	17.6	15.9	12.1	23.6	21.6
% Predators	15.9	8.3	6.8	5.8	13.5	22.7	6.1	4.6	4.0	12.1	4.1	6.3
Number of EPT Taxa	15	9	12	13	6	7	11	12	9	12	13	11
Number of EPT Individuals	66	49	51	59	16	34	44	83	81	57	106	88
Metric Scores												
Taxonomic Richness	25	17	16	19	13	15	23	19	16	20	17	18
Diversity Index	3.79	2.63	2.84	2.86	1.68	2.71	3.31	3.12	3.39	3.11	3.34	3.26
Hilsenhoff Biotic Index	4.31	5.33	5.01	4.79	5.79	5.39	4.57	4.26	4.27	4.63	3.24	4.05
EPT Index	15	9	12	13	6	7	11	12	9	12	13	11
% Taxonomic Similarity	100.0	57.5	47.6	49.6	31.3	45.7	41.4	42.5	56.9	50.9	39.0	50.9
% Trophic Similarity	100.0	87.4	80.3	76.7	64.2	68.7	69.8	59.4	85.4	91.3	65.0	58.8
Percent of Reference												
Taxonomic Richness	100.0	68.0	64.0	76.0	52.0	60.0	92.0	76.0	64.0	80.0	68.0	72.0
Diversity Index	100.0	69.4	74.9	75.5	44.3	71.5	87.3	82.3	89.4	82.1	88.1	86.0
Hilsenhoff Biotic Index	100.0	80.9	86.0	89.9	74.5	80.0	94.3	101.2	100.9	93.2	132.9	106.3
EPT Index	100.0	60.0	80.0	86.7	40.0	46.7	73.3	80.0	60.0	80.0	86.7	73.3
% Taxonomic Similarity	100.0	57.5	47.6	49.6	31.3	45.7	41.4	42.5	56.9	50.9	39.0	50.9
% Trophic Similarity	100.0	87.4	80.3	76.7	64.2	68.7	69.8	59.4	85.4	91.3	65.0	58.8
Biological Condition Scores												
Taxonomic Richness	6	4	4	4	2	4	6	4	4	6	4	4
Diversity Index	6	4	4	6	2	4	6	6	6	6	6	6
Hilsenhoff Biotic Index	6	4	6	6	4	4	6	6	6	6	6	6
EPT Index	6	0	4	4	0	0	2	4	0	4	4	2
% Taxonomic Similarity	6	6	6	6	2	6	4	4	6	6	4	6
% Trophic Similarity	6	6	6	6	4	4	4	4	6	6	4	4
Total Biological Score												
Total Biological Score	36	24	30	32	14	22	28	28	28	34	28	28
Biological % of Reference	100	67	83	89	39	61	78	78	78	94	78	78

Table 10. Summary of Reference Category 60ab RBP III Biological Data—Continued

	NEWT 0.6	POST 0.4	SEEL 2.8	SEEL 11.3	SING 0.4	SOUT 1.9	SOUT 7.2	SOUT 11.0	TENM 0.2	TUSC 12.5	TWVE 0.5	WYNK 0.5
Raw Data Summary												
Number of Individuals	113	116	125	113	103	122	129	116	129	113	122	123
% Shredders	4.4	1.7	9.6	0.9	8.7	2.5	2.3	0.0	1.6	0.9	1.6	0.8
% Collector-Gatherers	38.1	75.0	57.6	77.0	38.8	76.2	36.4	67.2	62.8	38.1	45.9	31.7
% Filterer-Collectors	36.3	9.5	7.2	12.4	27.2	12.3	30.2	5.2	7.0	41.6	30.3	38.2
% Scrapers	16.8	10.3	25.6	7.1	20.4	3.3	29.5	25.0	20.2	18.6	18.9	19.5
% Predators	4.4	3.4	0.0	2.7	4.9	5.7	1.6	2.6	8.5	0.9	3.3	9.8
Number of EPT Taxa	7	11	10	11	9	11	13	12	12	11	13	15
Number of EPT Individuals	51	28	59	98	38	37	74	54	75	71	74	86
Metric Scores												
Taxonomic Richness	14	16	14	16	17	20	19	19	22	16	20	22
Diversity Index	2.62	1.92	2.51	2.31	3.13	2.49	3.03	2.65	3.67	2.82	3.56	3.70
Hilsenhoff Biotic Index	5.10	5.93	4.97	2.91	4.79	5.35	4.76	5.31	3.06	4.86	3.61	3.55
EPT Index	7	11	10	11	9	11	13	12	12	11	13	15
% Taxonomic Similarity	39.8	41.9	41.2	27.4	45.4	36.6	41.3	46.3	38.8	46.9	40.9	55.1
% Trophic Similarity	82.3	69.3	65.6	67.3	83.5	68.0	77.5	63.5	72.8	77.0	86.3	79.4
Percent of Reference												
Taxonomic Richness	56.0	64.0	56.0	64.0	68.0	80.0	76.0	76.0	88.0	64.0	80.0	88.0
Diversity Index	69.1	50.7	66.2	60.9	82.6	65.7	79.9	69.9	96.8	74.4	93.9	97.6
Hilsenhoff Biotic Index	84.5	72.7	86.7	148.0	90.0	80.5	90.5	81.2	140.7	88.7	119.2	121.3
EPT Index	46.7	73.3	66.7	73.3	60.0	73.3	86.7	80.0	80.0	73.3	86.7	100.0
% Taxonomic Similarity	39.8	41.9	41.2	27.4	45.4	36.6	41.3	46.3	38.8	46.9	40.9	55.1
% Trophic Similarity	82.3	69.3	65.6	67.3	83.5	68.0	77.5	63.5	72.8	77.0	86.3	79.4
Biological Condition Scores												
Taxonomic Richness	2	4	2	4	4	6	4	4	6	4	6	6
Diversity Index	4	4	4	4	6	4	6	4	6	4	6	6
Hilsenhoff Biotic Index	4	4	6	6	6	4	6	4	6	6	6	6
EPT Index	0	2	0	2	0	2	4	4	4	2	4	6
% Taxonomic Similarity	4	4	4	2	6	4	4	6	4	6	4	6
% Trophic Similarity	6	4	4	4	6	4	6	4	4	6	6	6
Total Biological Score												
Total Biological Score	20	22	20	22	28	24	30	26	30	28	32	36
Biological % of Reference	56	61	56	61	78	67	83	72	83	78	89	100

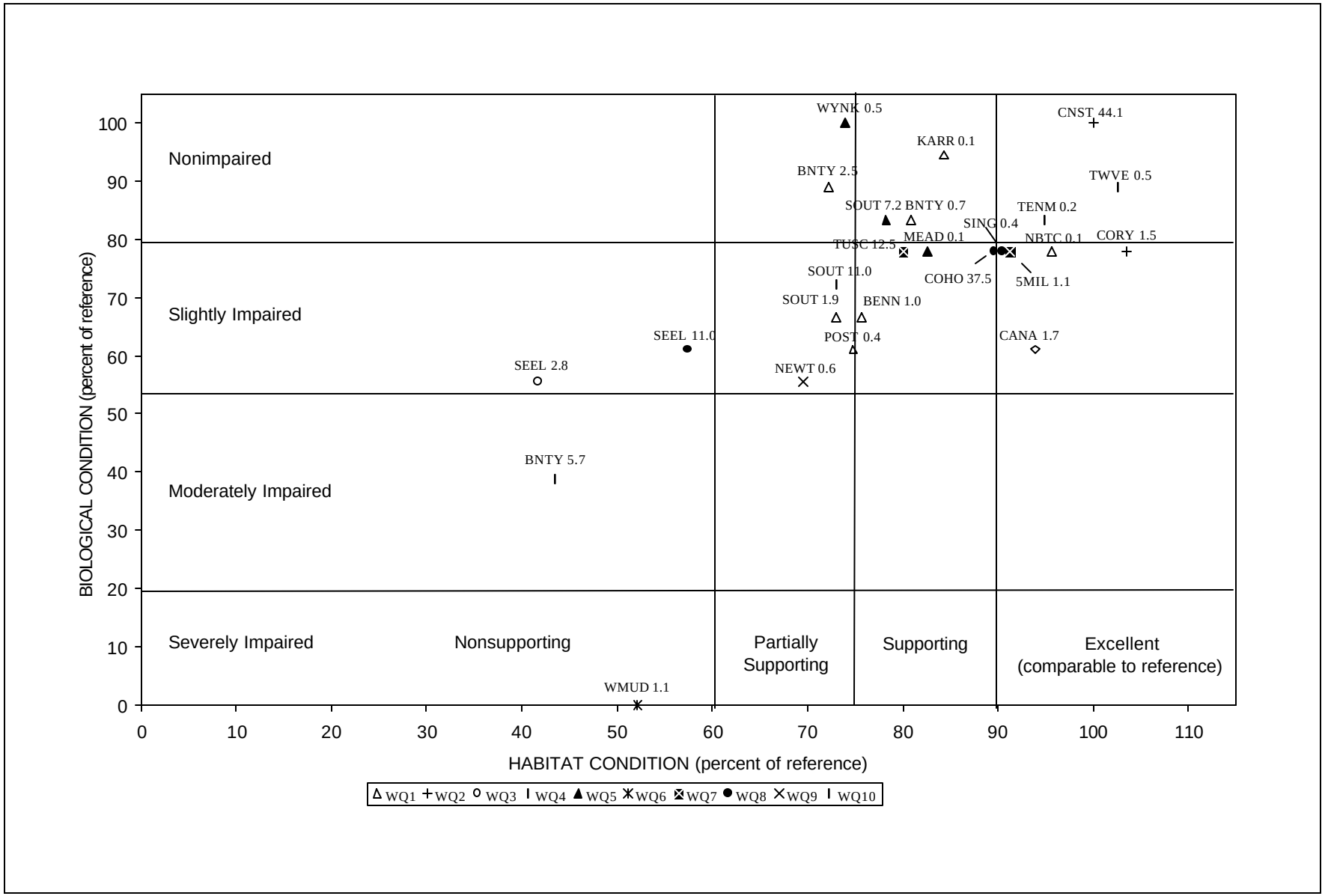
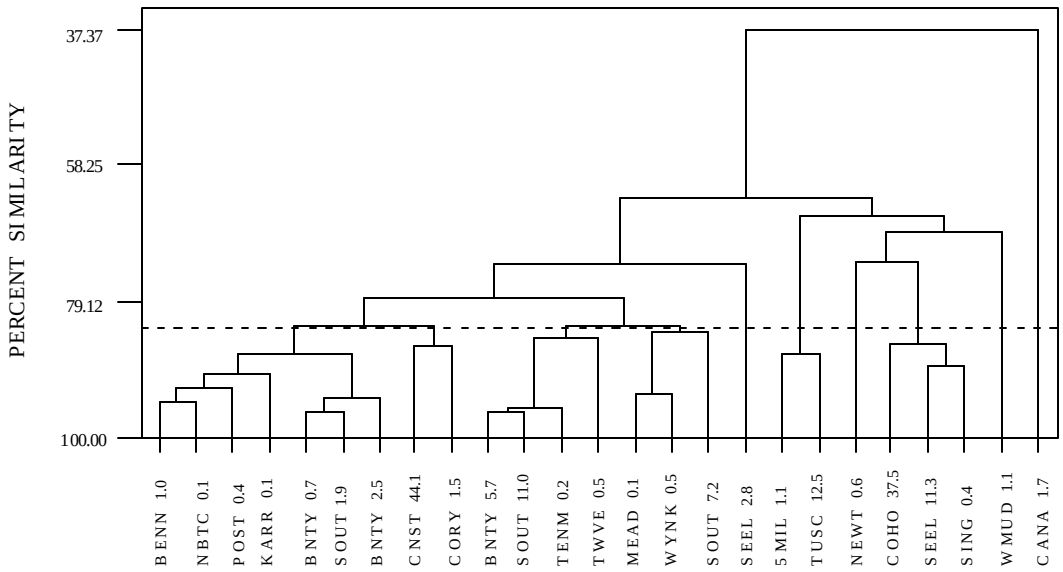


Figure 3. Summary of Reference Category 60ab Habitat and Biological Condition Scores and Water Quality Groupings



Water Quality Variables Used to Generate Dendrogram

General Variables	Nutrients	Organic Matter	Major Ions	Metals
pH	TN	TOC	Ca	TFe
DO	TNH_3		Mg	TMn
Cond	TNO_3		K	TAl
Acid	TOP		Cl	
TSS			SO_4	

Figure 4. Cluster Analysis of Water Quality Parameters That Account for Most of the Variability in Reference Category 60ab Water Quality Data

Table 11. Water Quality Groupings and Relative Chemical Concentrations in Reference Category 60ab

WQ Class	1	2	3	4	5	6	7	8	9	10
	BENN 1.0 NBTC 0.1 POST 0.4 KARR 0.1 BNTY 0.7 SOUT 1.9 BNTY 2.5	CNST 44.1 CORY 1.5	SEEL 2.8	BNTY 5.7 SOUT 11.0 TENM 0.2 TWVE 0.5*	MEAD 0.1 WYNK 0.5 SOUT 7.2	WMUD 1.1	5MIL 1.1 TUSC 12.5	COHO 37.5 SEEL 11.3 SING 0.4	NEWT 0.6	CANA 1.7
pH	M	H	M	M	M	M	H	M	M	M
DO	M	M	M	M	M	L	M	M	M	M
Cond	M	M	M	L	M	M	H	H	VH	M
Acid	M	L	H	H	M	M	VL	M	M	M
TSS	L	VL	VL	VL	M	VL	VL	M	VL	H
TN	VL	VL	M	M	L	M	M	H	H	H
TNH_3	VL	VL	VL	VL	VL	VL	VL	VL	H	H
TNO_3	VL	VL	L	L	VL	L	VL	H	M	M
TOP	L	L	VL	M	M	H	M	M	M	H
TOC	M	M	L	M	M	H	H	M	M	M
Ca	M	M	M	M	L	M	H	H	VH	M
Mg	M	M	M	L	L	M	M	M	H	M
K	M	M	M	M	M	M	H	M	M	H
Cl	M	L	M	M	M	M	H	M	VH	H
SO_4	M	L	VL	L	M	L	M	M	M	M
TFe	L	L	VL	M	H	VH	M	H	M	VH
TMn	VL	M	VL	L	L	M	M	M	M	H
TAl	L	M	VL	L	M	M	M	M	M	H

*TWVE 0.5 has H TN and TNO3

LEGEND			
Condition		Concentration	
	Good	VL	Very Low
		L	Low
		M	Moderate
		H	High
	Poor	VH	Very High

Table 12. Summary of Reference Category 60m RBP III Habitat Data

	CNST 7.7	CNST 21.3	CNST 31.3	CNST 36.5	COHO 14.6	COHO 25.0	COWN 0.1	COWN 13.0	TIOG 29.8	TIOG 35.4	TUSC 0.4
Primary Parameters											
Bottom Substrate	16	16	1	10	17	17	12	10	9	16	16
Embeddedness	17	15	6	10	17	15	13	16	12	17	14
Velocity/Depth Diversity	16	16	7	10	17	16	16	13	8	17	10
Secondary Parameters											
Pool/Riffle Ratio	9	11	3	3	13	11	7	9	6	12	11
Pool Quality	12	11	9	11	11	11	11	13	6	11	7
Riffle/Run Quality	12	12	4	4	12	12	11	9	10	12	11
Channel Alteration	11	8	2	3	13	12	10	9	4	4	3
Tertiary Parameters											
Streambank Erosion	5	5	1	5	8	7	4	7	6	2	9
Streambank Stability	7	6	3	8	9	9	8	9	7	9	9
Streamside Vegetative Cover	5	9	4	4	8	9	5	5	5	8	4
Riparian Buffer Zone	7	4	4	2	8	5	2	2	2	5	2
Total Habitat Score											
Total Habitat Score	117	113	44	70	133	124	99	102	75	113	96
Habitat % of Reference	100	97	38	60	114	106	85	87	64	97	82

Table 13. Summary of Reference Category 60m RBP III Biological Data

	CNST 7.7	CNST 21.3	CNST 31.3	CNST 36.5	COHO 14.6	COHO 25.0	COWN 0.1	COWN 13.0	TIOG 35.4	TUSC 0.4
Raw Data Summary										
Number of Individuals	154	158	110	102	139	125	119	123	6	149
% Shredders	4.5	0.6	2.7	3.9	2.2	0.0	89.1	0.0	0.0	0.0
% Collector-Gatherers	26.6	25.3	89.1	91.2	33.1	52.0	3.4	8.1	0.0	19.5
% Filterer-Collectors	41.6	53.2	2.7	4.9	30.2	30.4	0.8	76.4	0.0	53.0
% Scrapers	22.1	12.7	5.5	0.0	30.2	14.4	0.8	9.8	0.0	22.8
% Predators	5.2	8.2	0.0	0.0	4.3	3.2	5.9	5.7	100.0	4.7
Number of EPT Taxa	13	9	10	5	10	9	2	10	0	9
Number of EPT Individuals	104	120	20	11	72	86	2	118	0	128
Metric Scores										
Taxonomic Richness	20	17	15	7	21	16	8	13	4	17
Diversity Index	3.68	3.45	1.54	0.96	3.64	3.17	0.80	2.77	1.79	3.31
Hilsenhoff Biotic Index	4.20	3.96	6.34	6.72	4.27	3.80	7.77	3.72	3.83	3.76
EPT Index	13	9	10	5	10	9	2	10	0	9
% Taxonomic Similarity	100.0	54.5	29.6	25.0	57.3	40.9	3.7	49.1	3.8	63.4
% Trophic Similarity	100.0	85.4	37.5	35.5	85.4	74.6	14.8	64.6	5.2	87.8
Percent of Reference										
Taxonomic Richness	100.0	85.0	75.0	35.0	105.0	80.0	40.0	65.0	20.0	85.0
Diversity Index	100.0	93.8	41.8	26.1	98.9	86.1	21.7	75.3	48.6	89.9
Hilsenhoff Biotic Index	100.0	106.0	66.3	62.6	98.3	110.6	54.0	112.8	109.6	111.8
EPT Index	100.0	69.2	76.9	38.5	76.9	69.2	15.4	76.9	0.0	69.2
% Taxonomic Similarity	100.00	54.5	29.6	25.0	57.3	40.9	3.7	49.1	3.8	63.4
% Trophic Similarity	100.0	85.4	37.5	35.5	85.4	74.6	14.8	64.6	5.2	87.8
Biological Condition Scores										
Taxonomic Richness	6	6	4	0	6	6	2	4	0	6
Diversity Index	6	6	2	2	6	6	0	6	2	6
Hilsenhoff Biotic Index	6	6	2	2	6	6	2	6	6	6
EPT Index	6	0	2	0	2	0	0	2	0	0
% Taxonomic Similarity	6	6	2	2	6	4	0	6	0	6
% Trophic Similarity	6	6	2	2	6	4	0	4	0	6
Total Biological Score										
Total Biological Score	36	30	14	8	32	26	4	28	8	30
Biological % of Reference	100	83	39	22	89	72	11	78	22	83

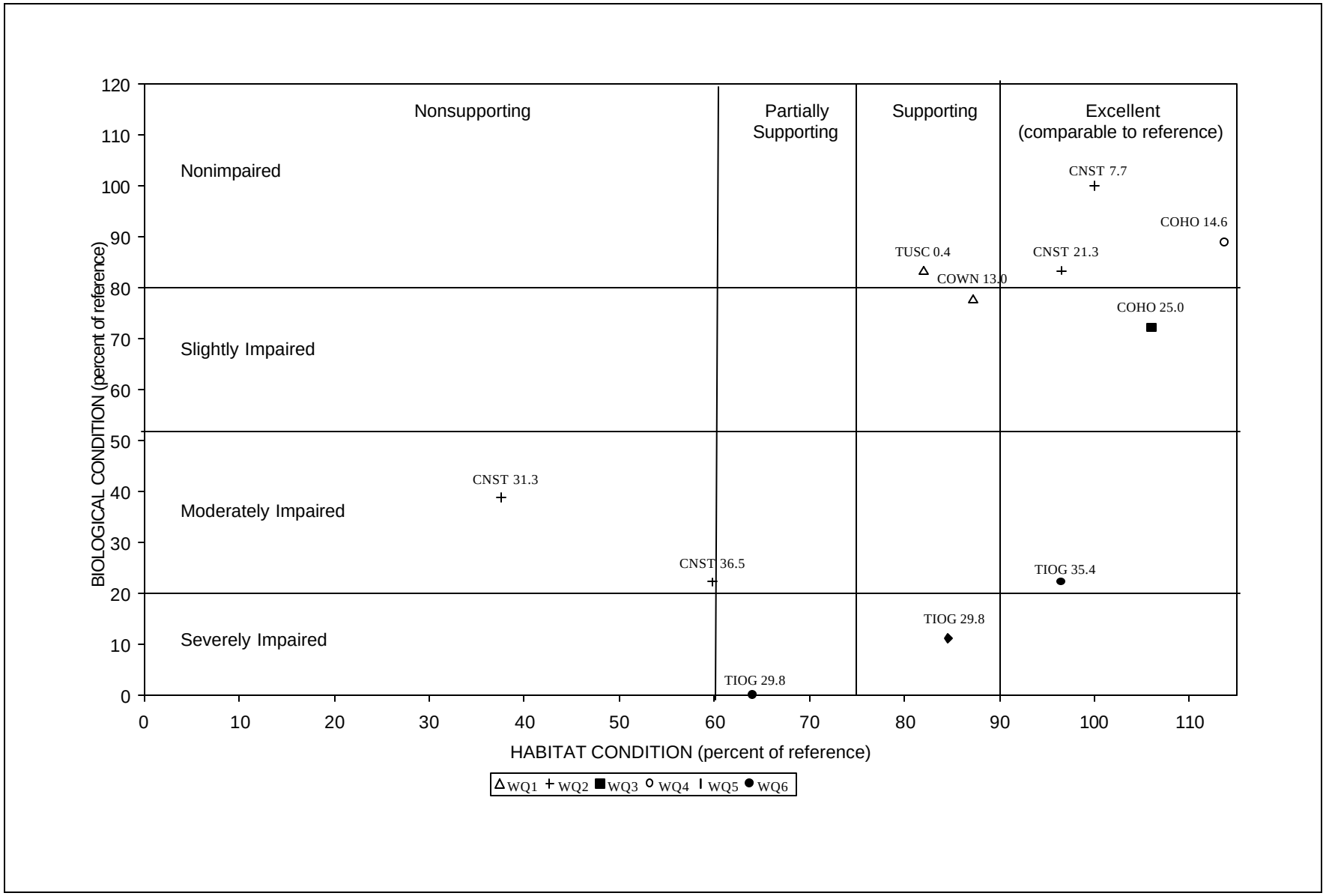
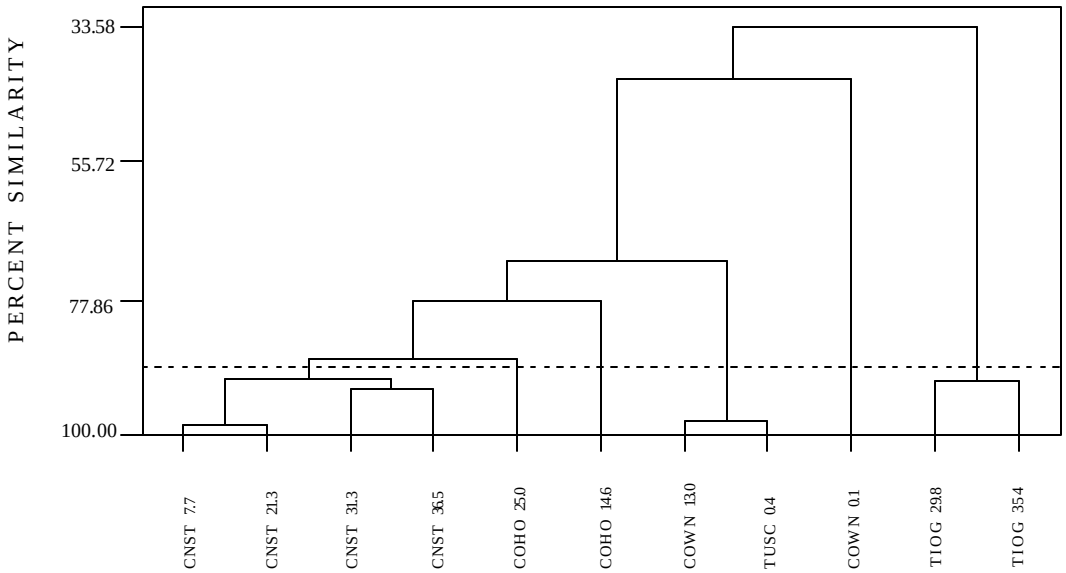


Figure 5. Summary of Reference Category 60m Habitat and Biological Condition Scores and Water Quality Groupings



Water Quality Variables Used to Generate Dendrogram

General Variables	Nutrients	Organic Matter	Major Ions	Metals
pH	TNH_3	TOC	Ca	DFe
Cond	TNO_2		Mg	TFe
Alk	TNO_3		Cl	TMn
Acid	TOP		SO_4	TAl
DRes				
TSS				

Figure 6. Cluster Analysis of Water Quality Parameters That Account for Most of the Variability in Reference Category 60m Water Quality Data

Table 14. Water Quality Groupings and Relative Chemical Concentrations in Reference Category 60m

WQ Class	1	2	3	4	5	6
	COWN 13.0 TUSC 0.4	**CNST 7.7 CNST 21.3 CNST 31.3 CNST 36.5**	**COHO 25.0**	**COHO 14.6**	**COWN 0.1**	**TIOG 29.8 TIOG 35.4**
pH	M	M	M	M	M	L
Cond	M	H	M	VH	M	M
Alk	M	H	H	H	M	VL
Acid	M	VL	M	M	M	VH
DRes	M	M	M	H	L	M
TSS	VL	H	VL	VL	H	M
TNH_3	VL	VL	VL	L	H	M
TNO_2	VL	VL	VL	L	L	VL
TNO_3	VL	M	H	M	L	L
TOP	L	M	M	H	H	M
TOC	L	M	M	M	M	VL
Ca	M	H	H	H	M	M
Mg	L	M	M	M	L	M
Cl	M	M	M	VH	L	L
SO_4	M	M	M	M	L	VH
DFe	VL	VL	VL	VL	L	H
TFe	L	H	M	L	VH	H
TMn	VL	M	L	L	VH	VH
TAl	L	M	L	L	H	VH

*CNST 31.3 has H Acid

LEGEND			
Condition		**Concentration**	
	Good	VL	Very Low
	↑	L	Low
		M	Moderate
		H	High
	Poor	VH	Very High

Table 15. Summary of Reference Category 60L RBP III Habitat Data

	CHEM 28.3	CHEM 2.5	CHEM 18.5	CHEM 40.1	CNST 1.0	COHO 0.5	COHO 4.0	TIOG 6.2
Primary Parameters								
Bottom Substrate	8	15	7	16	12	17	15	14
Embeddedness	11	16	11	14	13	17	16	13
Velocity/Depth Diversity	11	15	10	17	16	17	16	18
Secondary Parameters								
Pool/Riffle Ratio	7	10	3	9	10	12	11	8
Pool Quality	13	13	12	11	11	11	12	13
Riffle/Run Quality	13	12	12	11	10	12	11	12
Channel Alteration	12	8	7	7	11	13	11	9
Tertiary Parameters								
Streambank Erosion	5	5	5	5	8	8	5	6
Streambank Stability	6	8	8	7	8	9	9	8
Streamside Vegetative Cover	5	6	8	5	5	5	8	7
Riparian Buffer Zone	3	5	5	5	5	1	5	5
Total Habitat Score								
Total Habitat Score	94	113	88	107	109	122	119	113
Habitat % of Reference	100	120	94	114	116	130	127	120

Table 16. Summary of Reference Category 60L RBP III Biological Data

	CHEM 28.3	CHEM 2.5	CHEM 18.5	CHEM 40.1	CNST 1.0	COHO 0.5	COHO 4.0	TIOG 6.2
Raw Data Summary								
Number of Individuals	132	129	146	123	115	117	112	122
% Shredders	3.8	0.8	0.7	1.6	3.5	2.6	0.9	0.0
% Collector-Gatherers	18.9	37.2	26.7	19.5	49.6	17.9	20.5	9.0
% Filterer-Collectors	55.3	49.6	65.1	64.2	18.3	59.0	57.1	75.4
% Scrapers	18.9	10.1	4.8	14.6	27.0	17.1	16.1	13.1
% Predators	3.0	2.3	2.7	0.0	1.7	3.4	5.4	2.5
Number of EPT Taxa	12	10	9	8	11	10	8	7
Number of EPT Individuals	99	79	99	95	63	75	54	105
Metric Scores								
Taxonomic Richness	21	19	16	13	16	19	18	14
Diversity Index	3.41	3.00	2.89	3.05	2.67	3.28	3.42	2.34
Hilsenhoff Biotic Index	4.11	5.03	4.97	4.25	4.87	4.65	5.13	2.95
EPT Index	12	10	9	8	11	10	8	7
% Taxonomic Similarity	100.0	56.7	53.2	73.7	54.3	46.6	48.4	48.0
% Trophic Similarity	100.0	81.7	82.5	90.5	61.4	95.9	94.2	79.9
Percent of Reference								
Taxonomic Richness	100.0	90.5	76.2	61.9	76.2	90.5	85.7	66.7
Diversity Index	100.0	88.0	84.8	89.4	78.3	96.2	100.3	68.6
Hilsenhoff Biotic Index	100.0	81.6	82.6	96.6	84.3	88.3	80.1	139.1
EPT Index	100.0	83.3	75.0	66.7	91.7	83.3	66.7	58.3
% Taxonomic Similarity	100.0	56.7	53.2	73.7	54.3	46.6	48.4	48.0
% Trophic Similarity	100.0	81.7	82.5	90.5	61.4	95.9	94.2	79.9
Biological Condition Scores								
Taxonomic Richness	6	6	4	4	4	6	6	4
Diversity Index	6	6	6	6	6	6	6	4
Hilsenhoff Biotic Index	6	4	4	6	4	6	4	6
EPT Index	6	4	2	0	6	4	0	0
% Taxonomic Similarity	6	6	6	6	6	6	6	6
% Trophic Similarity	6	6	6	6	4	6	6	6
Total Biological Score								
Total Biological Score	36	32	28	28	30	34	28	26
Biological % of Reference	100	89	78	78	83	94	78	72

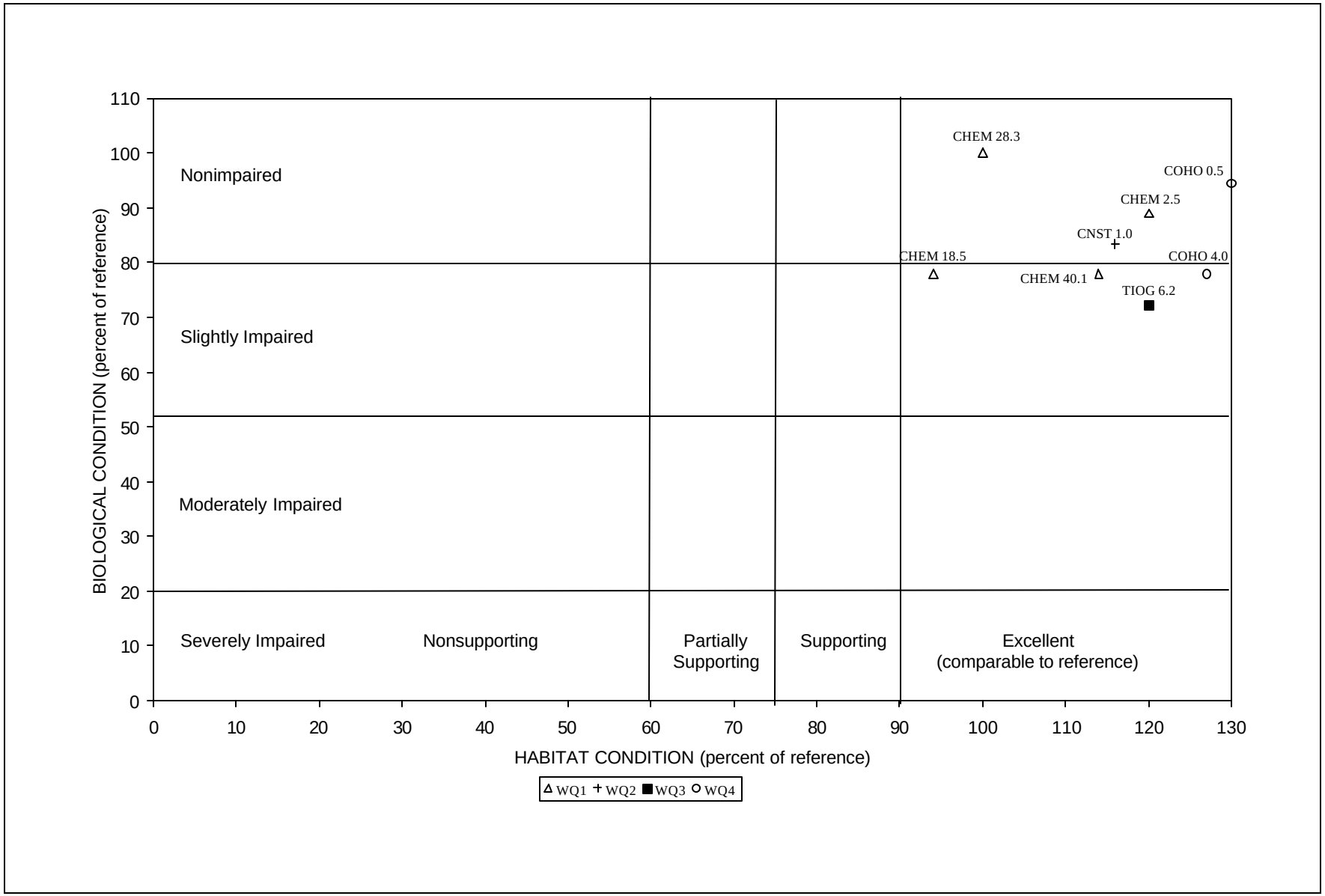


Figure 7. Summary of Reference Category 60L Habitat and Biological Condition Scores and Water Quality Groupings

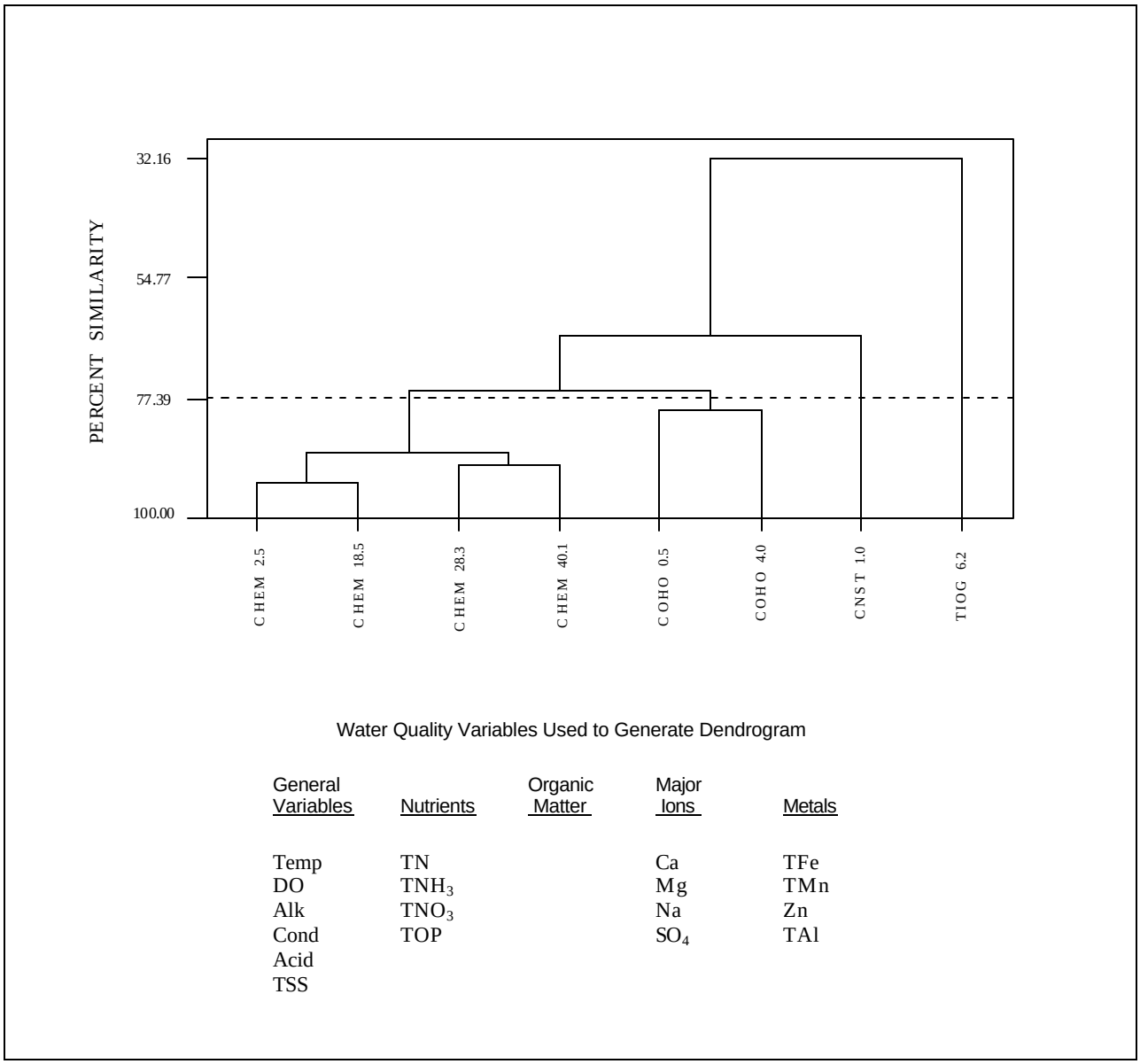


Figure 8. Cluster Analysis of Water Quality Parameters That Account for Most of the Variability in Reference Category 60L Water Quality Data

Table 17. Water Quality Groupings and Relative Chemical Concentrations in Reference Category 60L

WQ Class	1	2	3	4
	CHEM 2.5 CHEM 18.5 CHEM 28.3 CHEM 40.1	CNST 1.0	TIOG 6.2	COHO 0.5 COHO 4.0
Temp	M	H	H	M
DO	M	L	M	H
Cond	M	M	L	M
Alk	M	M	L	H
Acid	M	L	M	VL
TSS	M	M	VL	M
TN	H	L	M	M
TNH_3	L	VL	M	VL
TNO_3	M	L	L	M
TOP	H	M	M	M
Ca	M	H	L	H
Mg	M	M	L	H
Na	M	M	L	H
SO_4	M	M	M	H
TFe	M	M	H	L
TMn	L	L	VH	VL
Zn	VL	L	L	L
TAl	M	M	M	VL

LEGEND			
Condition		Concentration	
	Good	VL	Very Low
		L	Low
		M	Moderate
		H	High
	Poor	VH	Very High

Table 18. Summary of Reference Category 62c RBP III Habitat Data

	TIOG 49.2	COWN 21.3	COWN 30.1	CRKD 0.1	FELL 0.1	HILL 0.2	JOHN 0.1	MILL 0.1	MORR 0.8	NFCO 0.1
Primary Parameters										
Bottom Substrate	16	14	15	16	15	18	11	3	16	17
Embeddedness	17	14	17	15	17	17	16	17	17	17
Velocity/Depth Diversity	13	10	10	17	14	13	8	17	9	9
Secondary Parameters										
Pool/Riffle Ratio	11	6	10	7	11	10	9	8	10	7
Pool Quality	7	6	7	13	6	10	6	8	7	7
Riffle/Run Quality	9	6	7	9	9	10	8	11	7	7
Channel Alteration	12	2	6	11	9	7	3	13	6	12
Tertiary Parameters										
Streambank Erosion	6	4	3	8	5	2	5	7	2	6
Streambank Stability	9	8	5	7	7	5	6	8	2	9
Streamside Vegetative Cover	5	5	5	5	4	5	6	9	6	5
Riparian Buffer Zone	2	4	5	5	9	5	4	5	5	2
Total Habitat Score										
Total Habitat Score	107	79	90	113	106	102	82	106	87	98
Habitat % of Reference	100	74	84	106	99	95	77	99	81	92

	TIOG 16.3	TIOG 39.6	TIOG 42.3	TRUP 0.4
Primary Parameters				
Bottom Substrate	15	8	15	6
Embeddedness	16	15	17	15
Velocity/Depth Diversity	14	14	18	13
Secondary Parameters				
Pool/Riffle Ratio	7	11	14	10
Pool Quality	8	7	13	7
Riffle/Run Quality	11	13	13	8
Channel Alteration	11	4	7	3
Tertiary Parameters				
Streambank Erosion	5	2	2	5
Streambank Stability	8	2	4	9
Streamside Vegetative Cover	5	2	2	7
Riparian Buffer Zone	5	4	9	4
Total Habitat Score				
Total Habitat Score	105	82	114	87
Habitat % of Reference	98	77	107	81

Table 19. Summary of Reference Category 62c RBP III Biological Data

	TIOG 49.2	COWN 21.3	COWN 30.1	CRKD 0.1	FELL 0.1	HILL 0.2	JOHN 0.1	MILL 0.1	MORR 0.8	NFCO 0.1	TIOG 16.3	TRUP 0.4
Raw Data Summary												
Number of Individuals	119	131	120	139	32	136	54	126	109	139	139	111
% Shredders	1.7	0.0	0.0	0.0	15.6	0.0	7.4	0.0	0.0	0.0	0.0	0.0
% Collector-Gatherers	33.6	9.2	11.7	41.7	6.3	46.3	29.6	7.1	99.1	12.9	11.5	9.9
% Filterer-Collectors	49.6	77.9	44.2	25.9	62.5	31.6	5.6	89.7	0.0	29.5	81.3	31.5
% Scrapers	6.7	12.2	36.7	25.2	3.1	12.5	3.7	3.2	0.0	47.5	5.8	51.4
% Predators	8.4	0.8	7.5	7.2	12.5	8.8	53.7	0.0	0.9	10.1	1.4	7.2
Number of EPT Taxa	15	10	11	12	8	12	10	4	0	13	12	10
Number of EPT Individuals	79	122	104	69	25	76	17	19	0	88	124	97
Metric Scores												
Taxonomic Richness	21	13	20	21	12	20	16	7	2	21	16	16
Diversity Index	2.94	2.95	3.18	3.54	2.85	3.41	2.91	1.08	0.08	3.61	2.85	2.74
Hilsenhoff Biotic Index	2.88	4.09	3.92	4.85	1.88	4.58	5.11	5.79	6.98	4.06	4.12	3.51
EPT Index	15	10	11	12	8	12	10	4	0	13	12	10
% Taxonomic Similarity	100.0	22.4	20.1	39.5	9.3	54.9	12.7	9.8	28.1	27.1	21.7	24.4
% Trophic Similarity	100.0	66.2	70.1	73.4	69.0	80.7	49.0	59.9	34.5	57.6	68.3	55.4
Percent of Reference												
Taxonomic Richness	100.0	61.9	95.2	100.0	57.1	95.2	76.2	33.3	9.5	100.0	76.2	76.2
Diversity Index	100.0	100.3	108.2	120.4	96.9	116.0	99.0	36.7	2.7	122.8	96.9	93.2
Hilsenhoff Biotic Index	100.0	70.4	73.6	59.4	153.7	62.9	56.4	49.8	41.3	70.9	69.9	82.0
EPT Index	100.0	66.7	73.3	80.0	53.3	80.0	66.7	26.7	0.0	86.7	80.0	66.7
% Taxonomic Similarity	100.0	22.4	20.1	39.5	9.3	54.9	12.7	9.8	28.1	27.1	21.7	24.4
% Trophic Similarity	100.0	66.2	70.1	73.4	69.0	80.7	49.0	59.9	34.5	57.5	68.3	55.4
Biological Condition Scores												
Taxonomic Richness	6	4	6	6	2	6	4	0	0	6	4	4
Diversity Index	6	6	6	6	6	6	6	2	0	6	6	6
Hilsenhoff Biotic Index	6	4	4	2	6	2	2	0	0	4	2	4
EPT Index	6	0	2	4	0	4	0	0	0	4	4	0
% Taxonomic Similarity	6	2	2	4	0	6	0	0	2	2	2	2
% Trophic Similarity	6	4	4	4	4	6	2	4	2	4	4	4
Total Biological Score												
Total Biological Score	36	20	24	26	18	30	14	6	4	26	22	20
Biological % of Reference	100	56	67	72	50	83	39	17	11	72	61	56

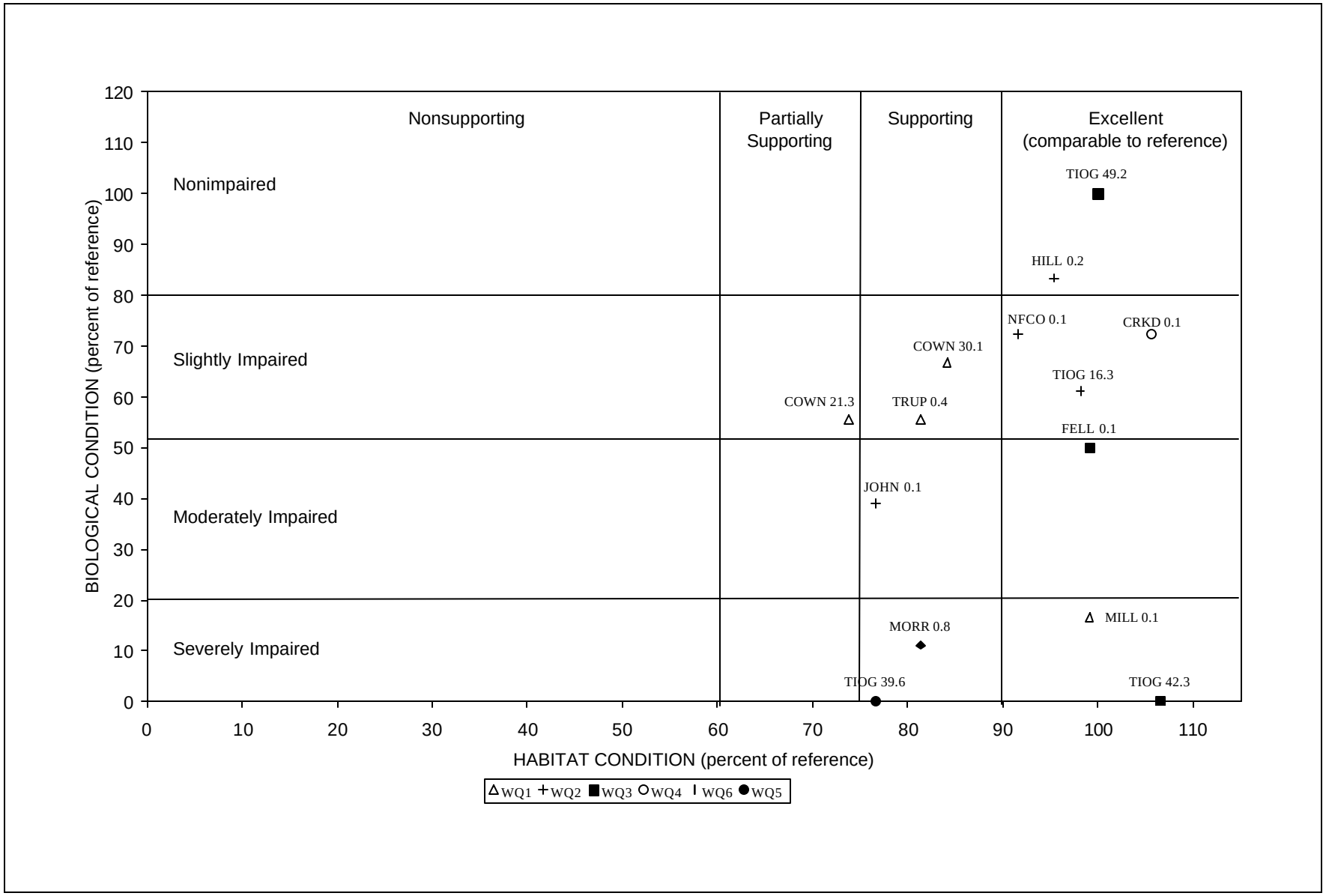
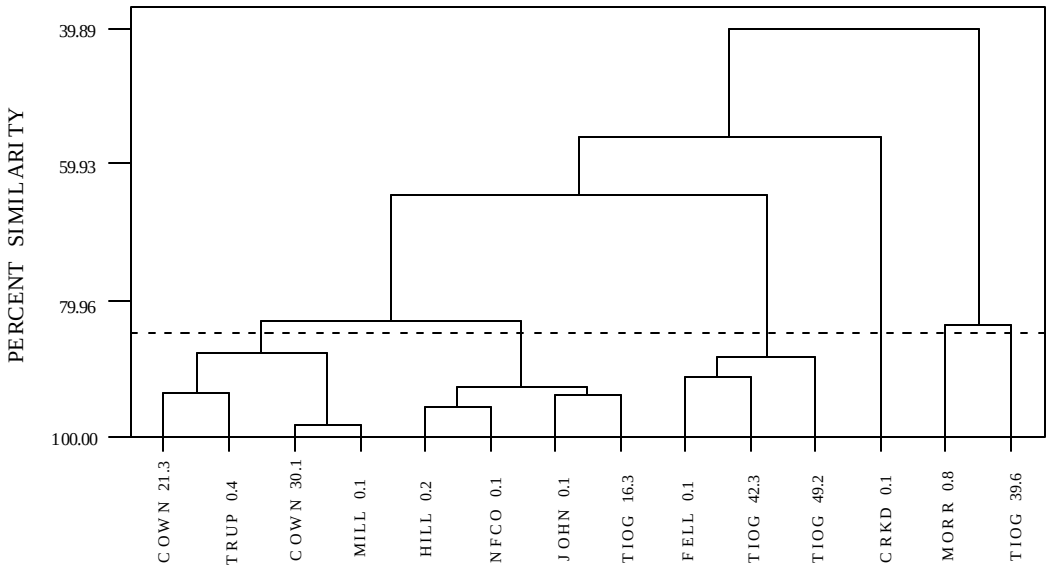


Figure 9. Summary of Reference Category 62c Habitat and Biological Condition Scores and Water Quality Groupings



Water Quality Variables Used to Generate Dendrogram

General Variables	Nutrients	Organic Matter	Major Ions	Metals
Temp	DN		Ca	DFe
pH	TNO_2		Na	TFe
Cond	DP		Cl	TMn
Alk	TOP			Zn
DRes				TAl

Figure 10. Cluster Analysis of Water Quality Parameters That Account for Most of the Variability in Reference Category 62c Water Quality Data

Table 20. Water Quality Groupings and Relative Chemical Concentrations in Reference Category 62c

WQ Class	1	2	3	4	5	6
	COWN 21.3 TRUP 0.4 COWN 30.1 MILL 0.1	**HILL 0.2 NFCO 0.1 JOHN 0.1 TIOG 16.3**	**FELL 0.1 TIOG 42.3* TIOG 49.2**	**CRKD 0.1**	**TIOG 39.6**	**MORR 0.8**
Temp	M	M	M	H	M	M
pH	M	M	L	M	L	VL
Cond	M	M	VL	M	L	VH
Alk	M	L	VL	M	VL	VL
DRes	M	M	L	M	L	VH
DN	L	L	L	M	M	H
TNO_2	VL	VL	VL	L	VL	VL
DP	VL	M	M	M	M	M
TOP	VL	M	M	H	M	M
Ca	M	M	VL	M	VL	H
Na	M	M	VL	H	VL	M
Cl	M	L	VL	M	VL	L
DFe	VL	L	M	L	M	VH
TFe	L	M	L	VH	M	VH
TMn	VL	M	M	M	VH	VH
Zn	VL	M	H	VL	VH	VH
TAl	L	M	M	M	H	VH

*TIOG 42.3 has M Cond and DRes, VH DFe, TFe, TAl and TMn

LEGEND			
Condition		**Concentration**	
	Good	VL	Very Low
	↑	L	Low
		M	Moderate
		H	High
	Poor	VH	Very High

BIOASSESSMENT OF STREAMS AND RIVERS

Tioga River Watershed Sites

Figure 11 depicts site locations within the Tioga River Watershed. Land use is shown in Figure 12.

Abandoned mine drainage (AMD) impacts much of the Tioga River. The headwaters of the Tioga River (TIOG 49.2) and Hills Creek (HILL 0.2) were the only sites sampled in the Tioga watershed that had nonimpaired biological conditions. Five of the seven severely impaired sites assessed in the Chemung Subbasin were located in the Tioga watershed; four of these impairments are a result of AMD.

Good quality conditions existed in the headwaters of the Tioga River (sampled at TIOG 49.2), but AMD enters the Tioga River from tributaries flowing past large active and reclaimed strip mines east of Blossburg. Mine drainage caused severe pollution upstream of Blossburg at TIOG 42.3 to TIOG 29.8 at the Tioga Reservoir. In this segment, there was very high acidity; sulfate, copper, lead, manganese, nickel, zinc, and aluminum concentrations were extremely high. Slight abatement occurred at TIOG 35.4, where flow from good-quality tributaries slightly lessened pollution. This was the only site in this segment where macroinvertebrates were found.

Downstream of the reservoir, water quality improved, and a slightly impaired macroinvertebrate community was found at TIOG 16.3. Slight impairment persisted to TIOG 6.2, although some water quality parameters were degraded by water contributed by the Cowanesque River. Loading rates for the Tioga River are listed in Table 21, and yields are shown in Figures 13 and 14.

Sample sites located in the Tioga River Watershed are listed below with their reference category designations.

60ab	60m	60L	62c
CORY 1.5	TIOG 29.8 TIOG 35.4	TIOG 6.2	CRKD 0.1 FELL 0.1 HILL 0.2 JOHN 0.1 MILL 0.1 MORR 0.8 TIOG 16.3 TIOG 39.6 TIOG 42.3 TIOG 49.2

Tioga River Headwaters

TIOG 49.2

Biological condition category: nonimpaired.

TIOG 49.2 functions as the reference site for reference category 62c. The sample had the highest number of EPT taxa in reference category 62c and an excellent Hilsenhoff Biotic Index for a site with high taxonomic richness. A significant proportion (approximately one third) of the sample was composed of *Dolophilodes* (Trichoptera: Philopotamidae), which have an organic pollution tolerance value of zero. Individuals representing pollution-intolerant genera rarely found at other sites in the survey, including *Boyeria* (Odonata: Aeshnidae), *Alloperla* (Plecoptera: Chloroperlidae), *Paracapnia* (Plecoptera: Capniidae), *Psilotreta* (Trichoptera: Odontoceridae), and *Hydatophylax* (Trichoptera: Limnophilidae), also were in the sample.

Habitat condition category: excellent.

Most primary and secondary parameters were good to excellent. Habitat at the site was one of the least altered, and streambanks were very stable, despite their steep angle. The riparian zone directly adjacent to the stream was restricted, but

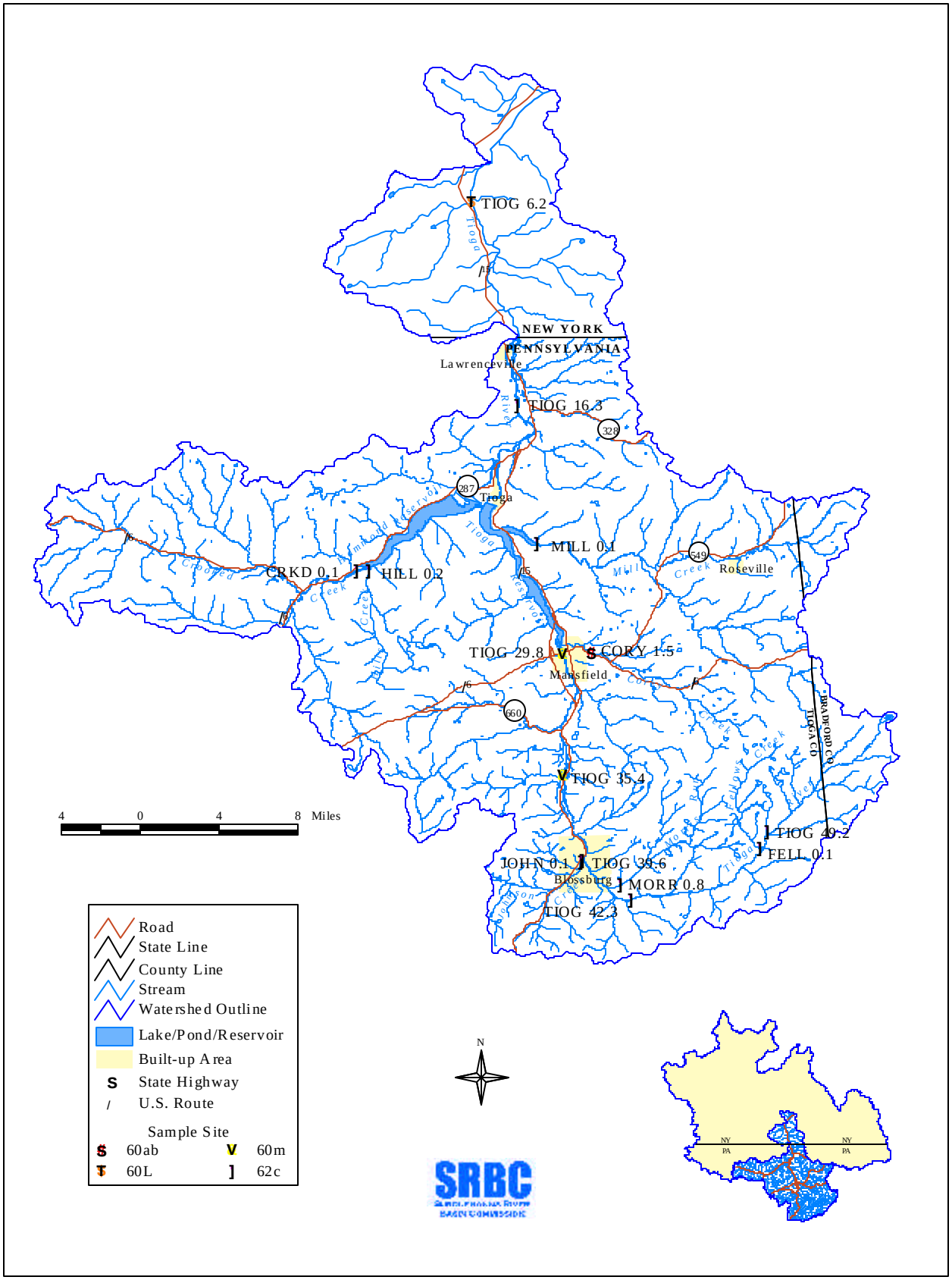


Figure 11. Sample Sites in the Tioga Watershed

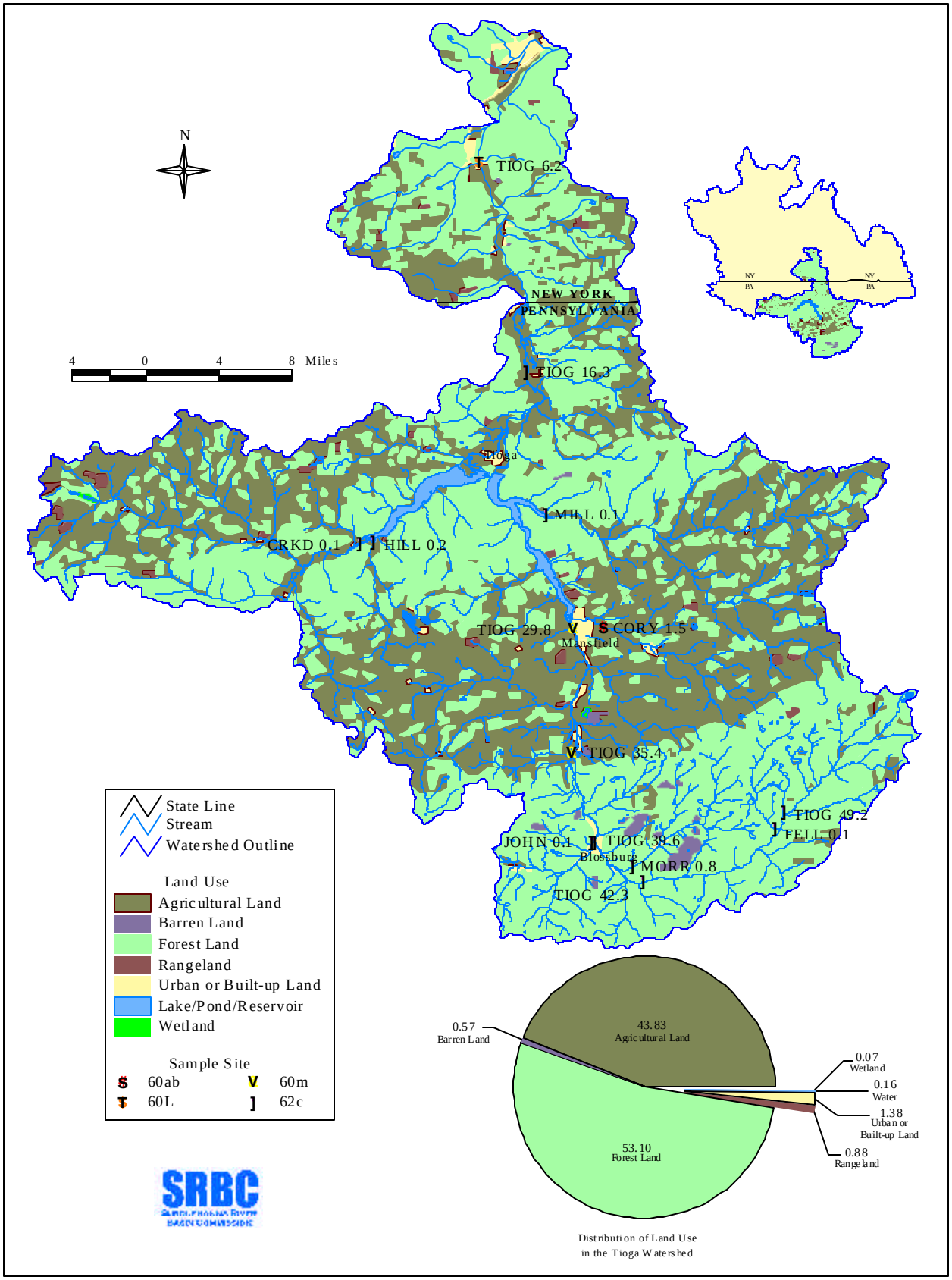
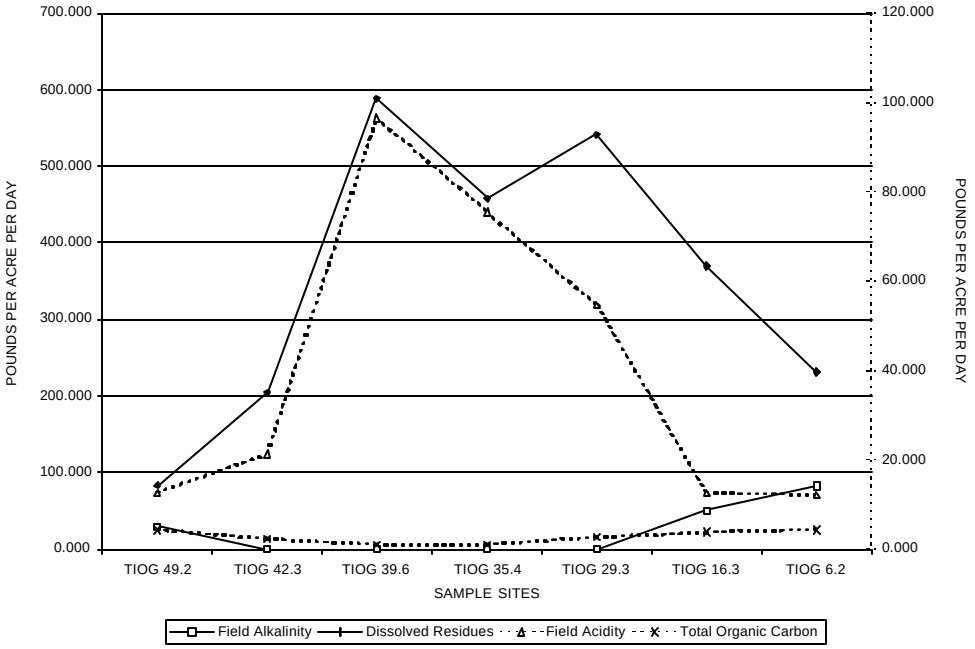


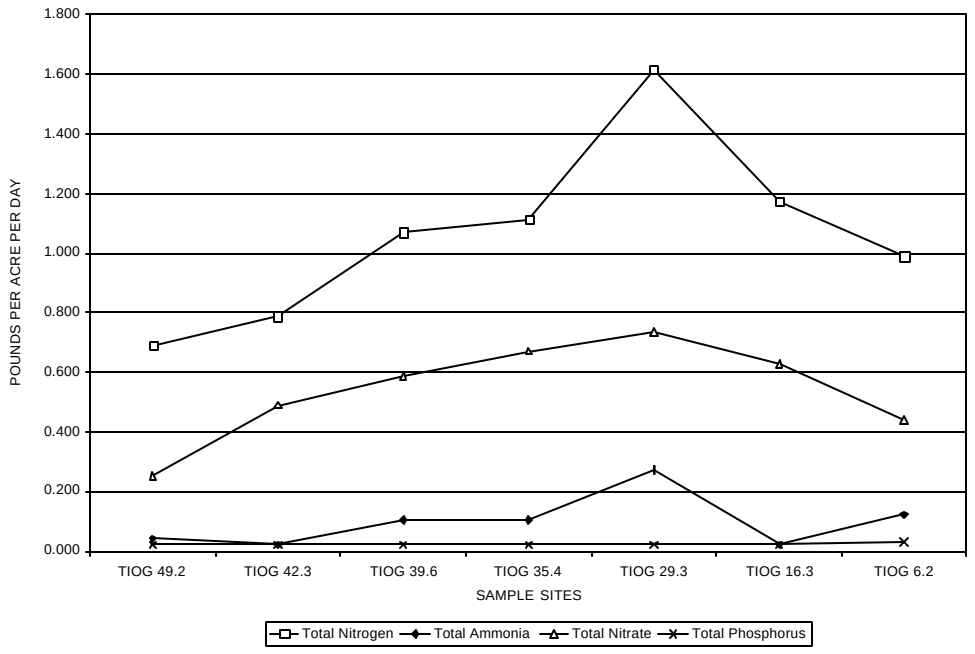
Figure 12. Land Use in the Tioga Watershed

Table 21. Loading Rates for Selected Chemical Parameters From the Main Stem Tioga River

	TIOG 6.2	TIOG 16.3	TIOG 29.8	TIOG 35.4	TIOG 39.6	TIOG 42.3	TIOG 49.2
	pounds per day						
Alk	65,797.07	22,012.77	0.00	0.00	0.00	0.00	469.29
Acid	9,747.71	5,503.19	8,403.81	7,858.11	8,013.42	1,022.05	201.12
DRes	185,206.57	161,426.98	83,391.63	47,585.20	48,777.34	9,811.70	1,340.82
TSS	1,218.46	917.20	2,585.79	218.28	348.41	102.21	33.52
TN	792.00	513.63	248.88	115.69	88.84	37.82	11.06
TNH_3	97.48	9.17	42.02	10.91	8.71	1.02	0.67
TNO_3	353.35	275.16	113.13	69.85	48.78	23.51	4.02
TOP	24.37	11.01	4.53	1.75	2.44	1.12	0.47
TOC	3,533.55	1,650.96	420.19	109.14	87.10	112.43	70.39
Ca	27,780.99	23,755.45	8,597.74	4,300.13	3,449.26	691.93	182.69
Cl	13,403.11	8,254.79	3,232.23	1,091.40	696.82	102.21	33.52
SO_4	34,117.00	54,665.05	52,685.41	34,051.79	31,008.45	4,905.85	241.35
Fl	121.85	91.72	87.27	21.83	17.42	10.22	3.35
Cu	2.44	1.83	4.78	2.44	2.19	0.63	0.07
Fe	534.91	158.68	86.95	77.71	367.57	15.94	2.38
Pb	0.61	0.46	1.26	0.41	0.35	0.05	0.02
Mn	673.81	200.87	985.83	571.90	506.94	148.20	0.67
Ni	2.44	4.77	30.58	16.72	14.72	4.41	0.07
Zn	6.82	8.71	80.48	47.37	40.76	12.06	0.24
Al	155.96	65.58	1,146.80	731.02	686.37	70.21	0.75

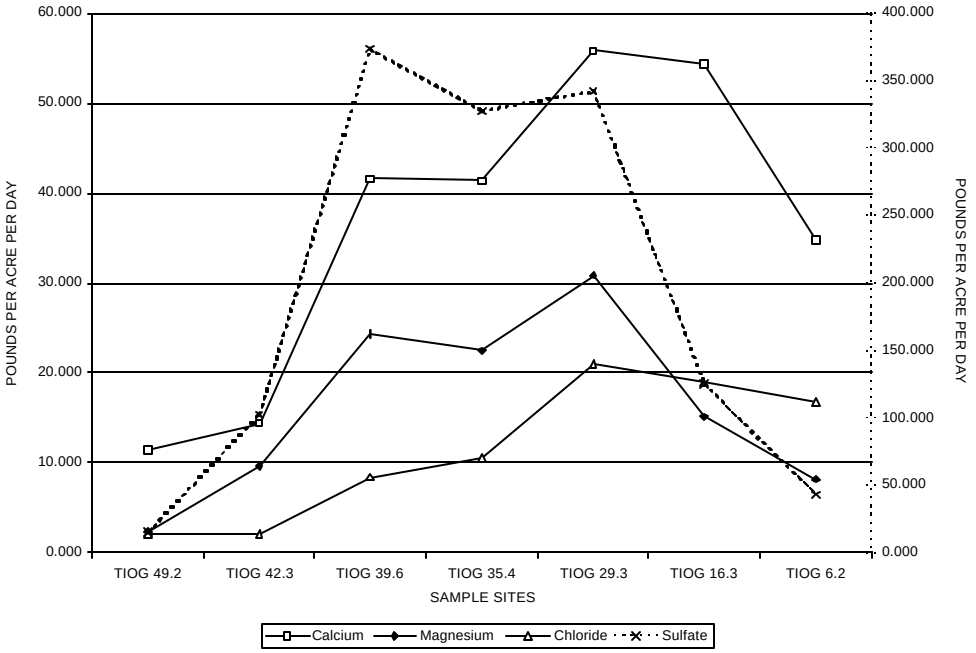


(a)

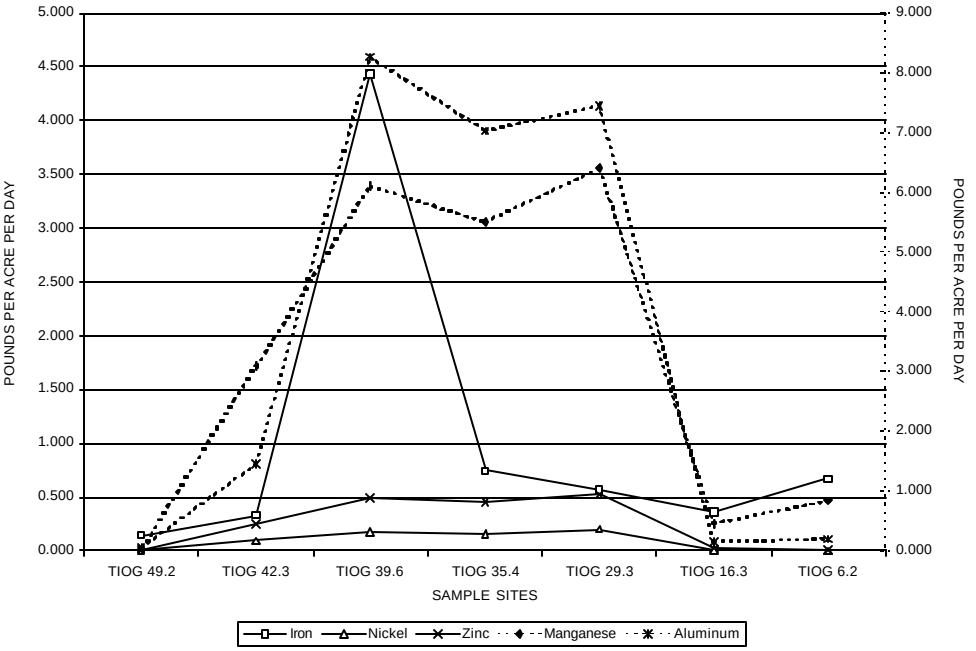


(b)

Figure 13. Yields of General Water Quality Parameters (a) and Nutrients (b) for the Main Stem Tioga River Sample Sites



(a)



(b)

Figure 14. Yields of Ions (a) and Metals (b) for the Main Stem Tioga River Sample Sites

the surrounding area was predominantly forested. Development in the immediate area was limited to seasonally-used cabins.

Water quality was excellent. Samples from TIOG 49.2 had low nutrients and very low concentrations of ions. The pH was 7.05; however, even at this headwaters site, alkalinity was low (14 mg/l), indicating that the stream had little natural buffering capacity. Concentrations of metals were very low in comparison with those measured downstream. This was the only Tioga River site sampled where sulfate, manganese, zinc, and aluminum were not elevated.

Fellows Creek

FELL 0.1

Biological condition category: moderately impaired.

The biological community near the mouth of Fellows Creek displayed low taxonomic richness, and taxonomic similarity to the reference site was very low (about 9 percent). Only 32 individuals were in the FELL 0.1 sample, which was composed almost entirely of genera rarely encountered in this survey. *Drunella* (Ephemeroptera: Ephemerellidae), *Erpetogomphus* (Odonata: Gomphidae), and *Diplectrona* (Trichoptera: Hydropsychidae) are not present in any other subsample. The Hilsenhoff Biotic Index was the lowest in the survey, mainly as a result of the number (14) of organic pollution-intolerant *Diplectrona*. Although the EPT Index was low, the percentage of EPT taxa was comparable to the reference site.

Habitat condition category: excellent.

Most habitat parameters were good. A large riparian zone surrounded the site. The area was mostly undeveloped; it was surrounded by deciduous forest with some seasonally-used cabins.

Water quality appeared very similar to that described in the 1985 assessment. No alkalinity was detected, pH was 4.5, and conductivity, dissolved residues, and ions were very low. Nutrient concentrations were low. Acidity was average for sites in this assessment. Manganese, aluminum, and zinc concentrations were elevated.

The impairment exhibited at the mouth of Fellows Creek was apparently due to its unusual water chemistry. However, the source was not clear. The low pH and elevated metals may have resulted from the influence of surrounding patches of wetland and acidic soils. This inference is supported by the specialized biological community found at FELL 0.1, which is rarely seen in AMD-impacted water. Water chemistry also was atypical of mine drainage. Sulfate, iron, ions, dissolved residues, and conductivity were all low. McMorran (1985) also concluded that these conditions were naturally occurring, due to low levels of solutes and an undeveloped drainage area. However, topographic maps show disturbed land that may be a small mine near the mid-reaches of the stream. Acid deposition (from acid rain) is another possible source.

TIOG 42.3

Biological condition category: severely impaired.

No macroinvertebrates were collected from this site. Neither were any observed during the 1985 assessment (McMorran, 1985).

Habitat condition category: excellent.

Instream habitat was exceptional. The site had excellent velocity/depth diversity, embeddedness, pool/riffle ratio, pool quality, and riffle/run ratio. Unlike many other sites, habitat was diverse and provided bedrock and boulders in addition to a cobble substrate. However, streambanks had little vegetative cover, and erosion was apparent downstream.

Water quality was significantly affected by acidic drainage from strip mines at TIOG 42.3. The pH was 4.5. No alkalinity was detectable from field measurements. While ions remained low, dissolved residues and conductivity had values that were about twice as great as those

observed upstream at TIOG 49.2. Metals and sulfate concentrations were many times those found at TIOG 49.2. This site had very good instream conditions, but the AMD-impacted water chemistry was too harsh to support life.

Morris Run

MORR 0.8

Biological condition category: severely impaired.

Metric scores were extremely poor. The entire sample consisted of 1 *Agabus* (Coleoptera: Dytiscidae) and 108 midges (Diptera: Chironomidae).

Habitat condition category: supporting.

General streambank conditions were poor due to instability and erosion. Most other habitat parameters were good to fair. The boulder substrate at MORR 0.8 was unusual for sites in this survey.

Morris Run has been cited as the greatest source of AMD to the Tioga River (U.S. Army Corps of Engineers, 1977). Water chemistry at MORR 0.8 was the worst surveyed in this assessment. Not only did the water quality sample have the lowest pH in the survey (2.3), but also the highest measured conductivity, dissolved residues, ammonia, hardness, magnesium, and calcium. Levels of metals and sulfate were extremely high, and fluoride was more than twice the normal concentration. In addition, the highest nitrogen and potassium concentrations in the watershed were found at MORR 0.8.

TIOG 39.6

Biological condition category: severely impaired.

Biological sampling yielded no macro-invertebrates from this site.

Habitat condition category: supporting.

The site was channelized and suffered from very poor streambank conditions. Yellow boy, a yellow-orange precipitate indicative of high iron concentrations, was visible. The only excellent habitat parameter was a good riffle/run ratio.

AMD pollution of the main stem Tioga River appeared to be most severe at this site and downstream at TIOG 29.8. The highest acidity and the lowest pH (3.15) of the Tioga River sites were found at TIOG 39.6, and the low pH and high acidity persisted to TIOG 29.8. From site TIOG 39.6 to site TIOG 29.8, sulfate, copper, lead, manganese, nickel, zinc, and aluminum concentrations were extremely high. Iron, sulfate, and aluminum were highest at TIOG 39.6.

Johnson Creek

JOHN 0.1

Biological condition category: moderately impaired.

Biological metrics at the mouth of Johnson Creek were substandard. Only 54 individuals were present in the sample. The most prevalent genus in the sample was *Hemerodromia* (Diptera: Empididae), resulting in an unusual trophic structure dominated by predators.

Habitat condition category: supporting.

Rechannelization near the mouth of Johnson Creek was in progress at the time of sampling. Stream morphology in this segment was braided. Substrate was primarily gravel, with some areas of exposed bedrock in the channel. The only excellent habitat parameter at this site was embeddedness, which was rated good to excellent at most sites assessed.

Concentrations of sulfate, iron, lead, nickel, and aluminum were elevated. Manganese and zinc also were high, although their concentrations in Johnson Creek were lower than the excessive amounts found in the middle reaches of the Tioga River and Morris Run. Alkalinity was low.

McMorran (1985) reported that the poor quality of Johnson Creek was due to mining. Clearly, mining impacts were important, as coal dust was visible on the streambed. However, stream alteration that disturbs the habitat also may have contributed to impairment.

TIOG 35.4

Biological condition category: moderately impaired.

With the exclusion of the good Hilsenhoff Biotic Index, metrics were poor. The macroinvertebrate sample was composed of only six individuals from four taxa. Of these, three taxa and five individuals were of the Order Megaloptera. Therefore, the sample had very low taxonomic and trophic similarity to the reference site.

Habitat condition category: excellent.

Primary parameters were excellent. Some channel alteration and erosion problems existed upstream, although the streambanks were stable and well covered at the sampling site and downstream.

The pH remained very low (3.35). Water quality was similar to TIOG 39.6, except that iron concentration significantly dropped and concentrations of all other metals were slightly lower. It appeared that concentrations of metals were reduced as the metals precipitated out and good quality water from nearby tributaries entered the river.

TIOG 29.8

Biological condition category: severely impaired.

No macroinvertebrates were collected.

Habitat condition category: partially supporting.

Habitat at the site was significantly altered by flood and erosion control measures. The reach was channelized, and extensive riprap covered much of the banks. No riparian buffer existed, although some shrubs grew on the banks. Instream habitat, particularly substrate, pool quality, and velocity/depth diversity, also was poor.

After minor improvement at TIOG 35.4, water quality was further degraded. Water chemistry samples from the Tioga River showed that copper, lead, manganese, nickel, and zinc concentrations peaked near TIOG 29.8. Nitrogen and ammonia also were highest at TIOG 29.8. The pH was 4.0.

TIOG 29.8 is near the town of Mansfield, Pa., upstream of the Tioga Reservoir. Slight nutrient enrichment probably originates as runoff from croplands and pastures adjacent to the Tioga River.

Corey Creek

CORY 1.5

Biological condition category: slightly impaired.

Metrics were generally good, and few midges were present. However, the subsample was noticeably dominated by intermediate-tolerant caddisflies (Trichoptera), and only one stonefly (Plecoptera) was observed.

Habitat condition category: excellent.

Most instream habitat parameters were good to excellent, including excellent scores for embeddedness and the cobble substrate. The streambanks were stable and well covered by vegetation at the site, although areas of substantial erosion were evident in some segments of Corey Creek.

At CORY 1.5, water quality was good. Metals were low, and concentrations of nutrients were very low at the site. The pH was 9.3, the highest in the assessment. Dissolved oxygen (DO) was high for the warm water measured in the afternoon.

Despite good habitat and water quality, a slightly impaired macroinvertebrate community was present. McMorran (1985) sampled downstream of an impoundment in Mansfield, and found good conditions.

Mill Creek

MILL 0.1

Biological condition category: severely impaired.

Over 80 percent of the individuals in the sample were black flies (Diptera: Simuliidae), which resulted in a high Hilsenhoff Biotic Index and low taxonomic similarity to the reference site. Only six other taxa were present; therefore, both diversity and the EPT Index were poor.

Habitat condition category: excellent.

MILL 0.1 was unique in both the Tioga watershed and reference category 62c for its almost exclusively bedrock substrate, which provided poor habitat for macroinvertebrates. Other habitat parameters were good to excellent, including stable and well vegetated streambanks.

Water quality samples showed very low nutrient and low metal concentrations that are indicative of good quality streams. The pH was 8.3, and the sample was one of the most alkaline in the Tioga watershed. Overall, Mill Creek contributed good quality water to buffer and dilute the AMD-impacted water of the Tioga River.

Although the site had excellent habitat and water quality, the level of biological impairment seemed high. This may have been due to the fact that the assessment was based on a *subsample* of the collected invertebrates. Other taxa that were not included in the subsample for MILL 0.1, such as stoneflies, were observable in the total sample, but their presence was masked by the abundant black flies. Lack of suitable substrate for colonization also may have affected the biological conditions at the site.

Hills Creek

HILL 0.2

Biological condition category: nonimpaired.

HILL 0.2 had good biological metrics for reference category 62c. The macroinvertebrate community at the site was taxa-rich, diverse, and had a high degree of trophic similarity to the reference site.

Habitat condition category: excellent.

Channel conditions were generally good, including excellent substrate and embeddedness, but the streambanks were significantly eroded. The site was located in a primarily forested and residential area.

Water quality was good. Nutrient and metal concentrations were low, and alkalinity was high for the Tioga watershed. Hills Creek flows from Hills Creek Lake.

Crooked Creek

CRKD 0.1

Biological condition category: slightly impaired.

CRKD 0.1 was taxa-rich and had good diversity, but the majority of individual macroinvertebrates in the subsample were pollution-tolerant. Less than 24 percent had an organic pollution-tolerance value of 2 or less.

Habitat condition category: excellent.

Pool quality and velocity/depth diversity were excellent at the time of sampling. Most other habitat parameters were good.

CRKD 0.1 yielded the most alkaline sample in the watershed. The alkalinity helped buffer the AMD-impacted water of the Tioga River. Otherwise, chemical water quality was poor. Nitrite, total phosphorus, aluminum, and manganese concentrations were elevated.

Chloride and nitrogen concentrations were high for the Tioga watershed. Total iron was high, and total suspended solids (TSS) were very high.

Land use data show impoundments and agriculture to be the primary influences on water quality in the Crooked Creek Watershed. Downstream of the site, Crooked Creek is impounded near its confluence with the Tioga River to form Hammond Reservoir. Another impoundment is present near the headwaters, creating a small reservoir. Forested wetland surrounds this reservoir, but there is little contiguous forest adjacent to Crooked Creek and its tributaries. Agricultural activities dominate the watershed, and it appears that runoff causes nutrient enrichment.

TIOG 16.3

Biological condition category: slightly impaired.

Taxonomic similarity to the reference site was low. The sample was heavily dominated by 3 genera: *Isonychia* (Ephemeroptera: Isonychiidae), *Cheumatopsyche* (Trichoptera: Hydropsychidae), and *Chimarra* (Trichoptera: Philopotamidae). The Hilsenhoff Biotic Index (4.12) reflected the dominance of intermediate-tolerance *Cheumatopsyche* and *Chimarra.*

Habitat condition category: excellent.

Habitat parameters were good to fair. The cobble substrate was good, embeddedness was low, and a well-vegetated riparian buffer separated the stream channel from fields.

Site TIOG 16.3 was downstream of the Tioga-Hammond Reservoirs. Water quality significantly differed from the highly polluted stretches upstream of the impoundments. Water chemistry testing showed that all parameters improved from TIOG 29.8. Alkalinity was low (24 mg/l). Acidity decreased to moderate levels, and nutrient concentrations were lower. Metals and sulfate concentrations, although lower than at upstream sites, were still relatively high.

TIOG 6.2

Biological condition category: slightly impaired.

Metrics indicated low taxa richness, diversity, and EPT Index. However, the lowest Hilsenhoff Biotic Index of reference category 60L also was found at TIOG 6.2 due to the large number of *Isonychia* in the subsample.

Habitat condition category: excellent.

Velocity/depth diversity, riffle/run ratio, and pool quality were rated as excellent. Most other parameters were good. Cropland and residential areas were adjacent to the river at this site.

Water quality did not continue to improve downstream of TIOG 16.3. TIOG 6.2 had the second highest concentrations of ammonia and total iron of the Tioga River sites. Although sulfate and nickel concentrations dropped from TIOG 16.3, manganese and total aluminum concentrations were substantially higher.

NYSDEC maintains an intensive RIBS site close to TIOG 6.2. According to 1991-92 studies, (NYSDEC, 1994) high levels of cobalt, manganese, and nickel were found in hellgrammite (Megaloptera: Corydalidae) tissues. NYSDEC listed iron and manganese as parameters of concern in the water column.

Water from Cowanesque River, with its high ammonia, metals, and alkalinity, noticeably impacted water chemistry. Other potential sources of impact may have resulted from local land use. Cropland, pasture, and several small communities line the river, and topographic maps show gravel pits close to TIOG 6.2.

Cowanesque River Watershed Sites

Site locations in the Cowanesque watershed are shown in Figure 15. Figure 16 depicts land use.

Water quality problems have long been documented in the segment between Westfield (COWN 30.1) and Elkland (COWN 13.0) in

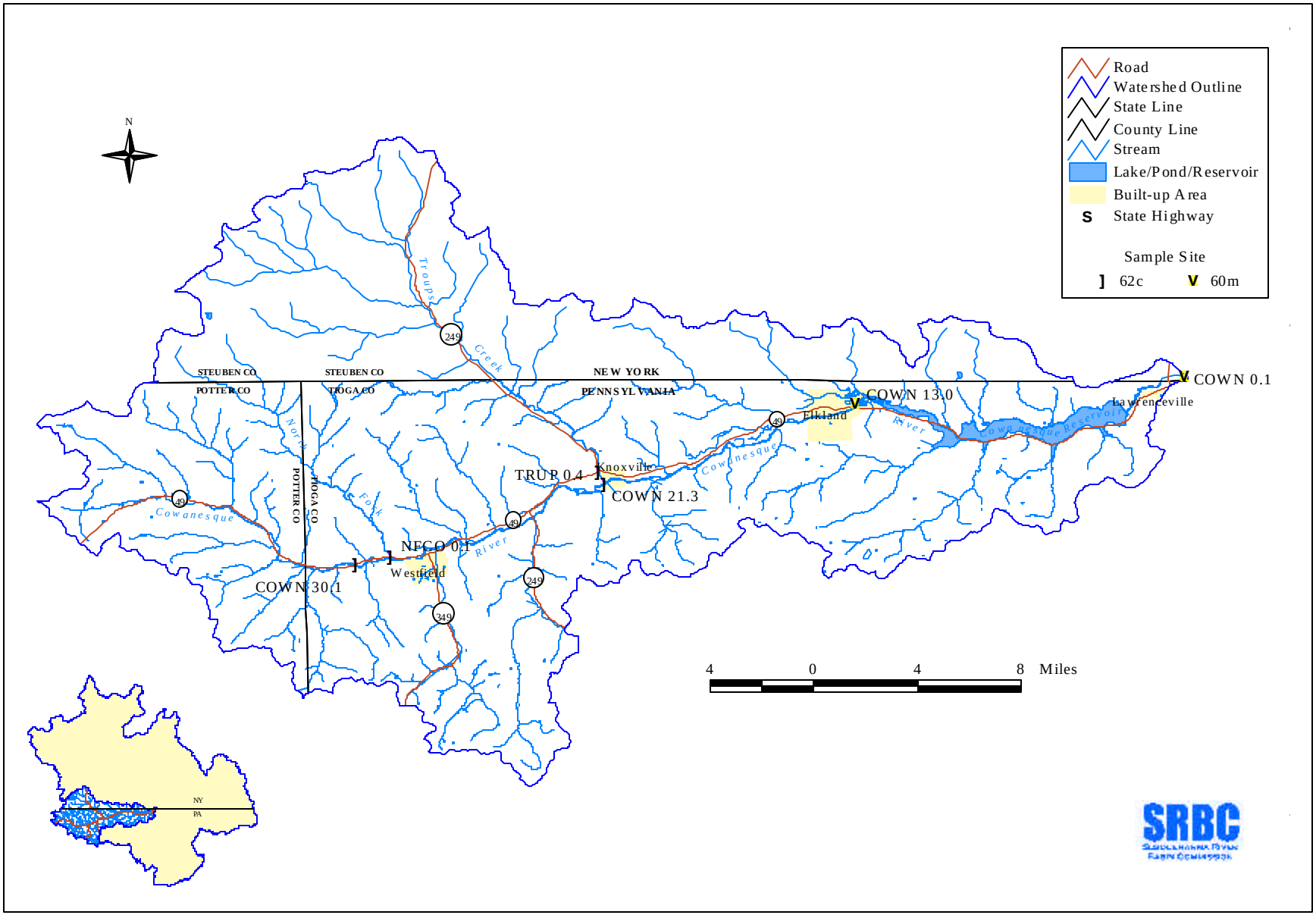


Figure 15. Sample Sites in the Cowanesque Watershed

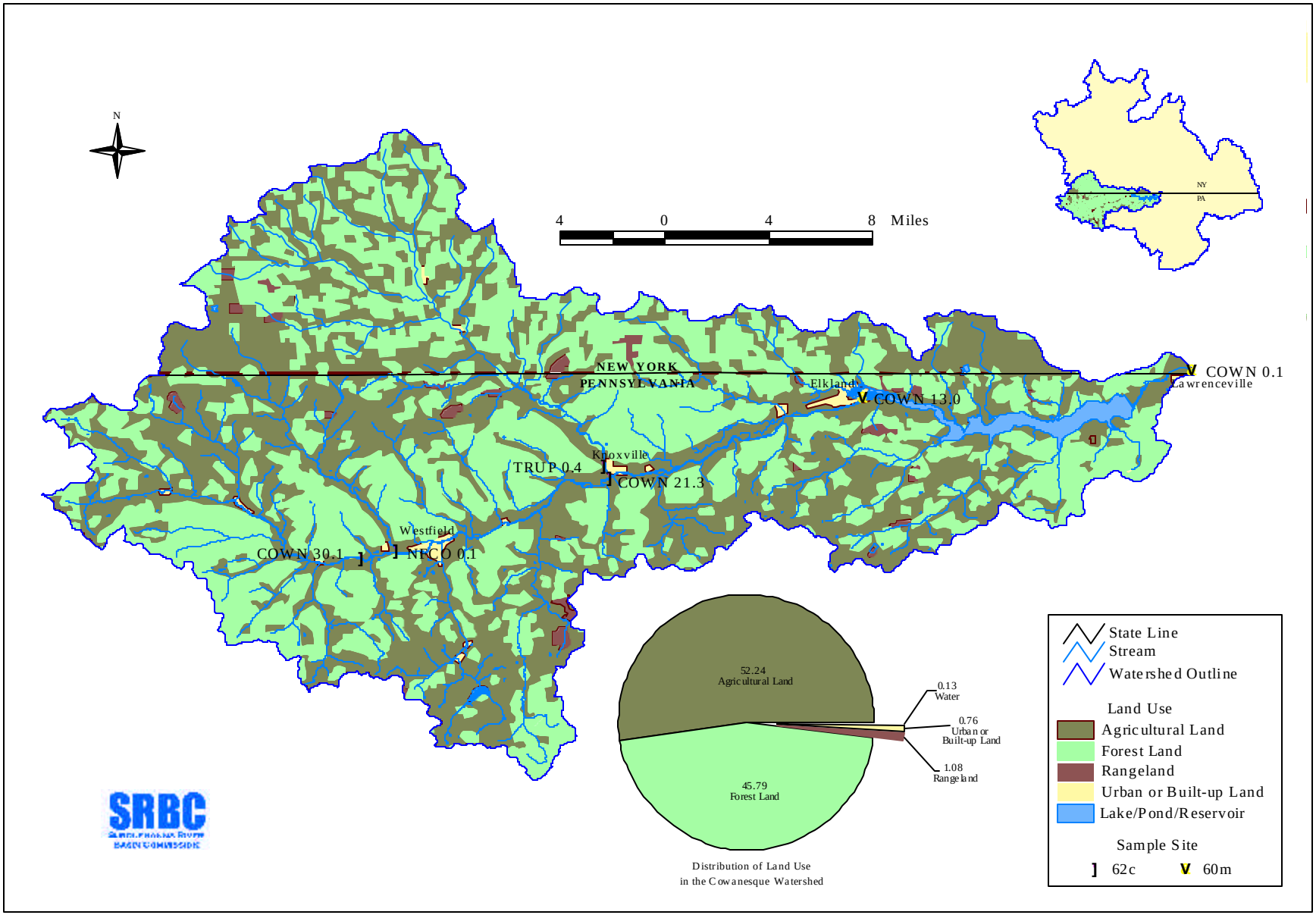


Figure 16. Land Use in the Cowanesque Watershed

Pennsylvania. LaBuy (1967) cited severe degradation from sewage treatment facilities and a tannery. A 1983 study for Pennsylvania Department of Environmental Resources'[1] (Pa. DER's) Priority Water Body Survey found improvement in this section, although nutrient enrichment from overload of the sewage treatment plants (STPs) and nonpoint sources still caused mild degradation (Bieber, 1984).

The most common source of nonpoint pollutants in the watershed is agricultural runoff. Land use data show that the Cowanesque watershed has less than 1 percent urban development.

All of the sites sampled in the Cowanesque watershed had impaired biological communities and supporting or partially supporting habitat. Water quality was good at COWN 30.1, but poor habitat appeared to cause slight impairment. At COWN 21.3, concentrations of most water quality parameters increased. Water quality improved toward COWN 13.0, but at the mouth, water quality was heavily impacted by Cowanesque Reservoir. At COWN 0.1, biological impairment was severe. Loading rates in the Cowanesque River are listed in Table 22, and yields are shown in Figures 17 and 18.

Sample sites located in the Cowanesque River Watershed are listed below with their reference category designations.

60L	62c
COWN 0.1 COWN 13.0	COWN 21.3 COWN 30.1 NFCO 0.1 TRUP 0.4

[1] In 1995, the Pennsylvania Department of Environmental Resources was divided into the Pennsylvania Department of Environmental Protection and the Pennsylvania Department of Conservation and Natural Resources.

Cowanesque River Headwaters

COWN 30.1

Biological condition category: slightly impaired.

Stenonema (Ephemeroptera: Heptageniidae), *Ceratopsyche* (Trichoptera: Hydropsychidae), and *Cheumatopsyche* dominated the sample. Taxonomic richness and diversity were comparable to the reference site, but taxonomic similarity was low. The EPT Index also was low.

Habitat condition category: supporting.

Most habitat parameters were fair. Pools and riffles lacked quality, and little habitat heterogeneity (overhanging branches, woody debris, etc.) was present. While streambanks were erosion-prone, extensive riprap at the bridge did improve stability.

Water quality results indicated a high pH and low dissolved residues, nutrients, ions, and metals. The good water quality and little development in the watershed indicated that slight impairment probably resulted from degraded habitat conditions.

North Fork Cowanesque

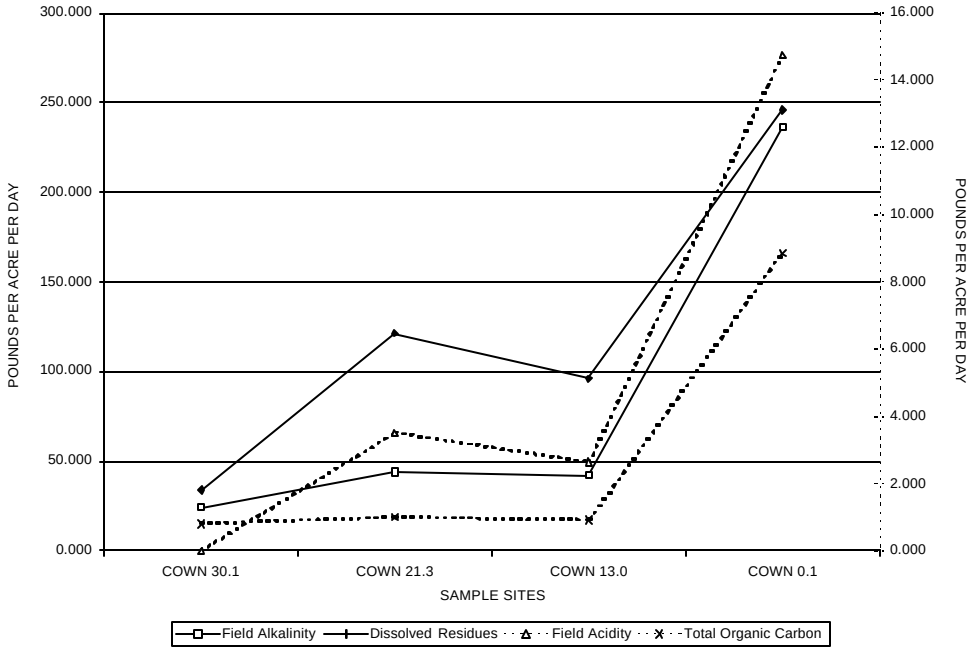
NFCO 0.1

Biological condition category: slightly impaired.

Metrics for this site were generally good; however, like most reference category 62c sites in this assessment, taxonomic similarity was low, and the Hilsenhoff Biotic Index was high. There was a high degree of diversity at this site, as compared to the other sites in reference category 62c.

Table 22. Loading Rates for Selected Chemical Parameters From the Main Stem Cowanesque River

	COWN 0.1	COWN 13.0	COWN 21.3	COWN 30.1
	pounds per day			
Alk	70,889.28	10,396.77	8,936.93	1,291.66
Acid	4,430.58	649.80	714.95	0.00
DRes	73,843.00	23,609.34	24,665.93	1,808.32
TSS	42,828.94	108.30	89.37	215.28
TN	627.67	25.99	46.47	4.31
TNH_3	184.61	1.08	0.89	0.22
TNO_3	140.30	2.17	22.34	0.43
TOP	33.97	0.43	0.54	0.11
TOC	2,658.35	227.43	205.55	43.06
Ca	15,433.19	3,638.87	3,610.52	421.94
Cl	9,599.59	4,765.19	5,719.63	258.33
SO_4	13,291.74	2,924.09	3,127.93	221.73
Fl	73.84	10.83	8.94	2.15
Cu	1.48	0.22	0.18	0.04
Fe	930.42	4.33	10.63	0.67
Pb	1.03	0.05	0.04	0.02
Mn	1,181.49	0.54	1.52	0.11
Ni	1.48	0.22	0.18	0.04
Zn	5.69	0.27	0.22	0.18
Al	224.48	1.68	2.88	0.53



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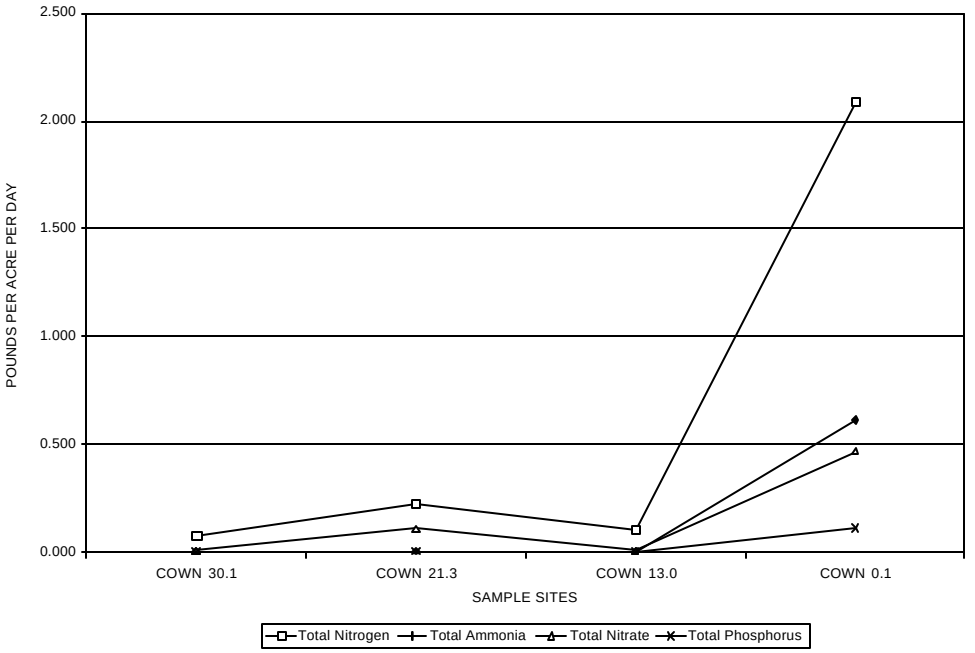
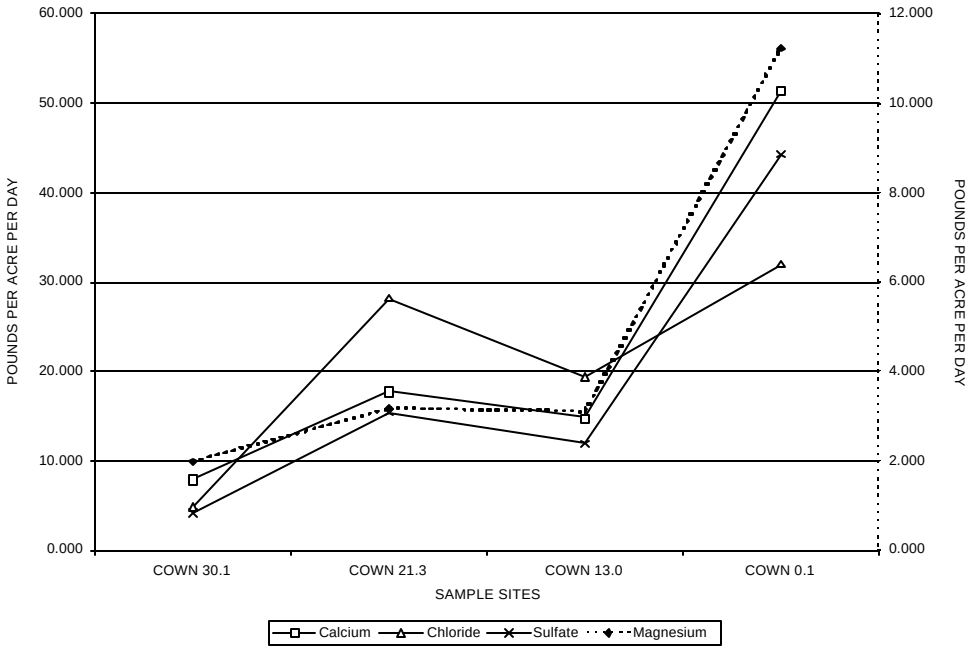


(b)

Figure 17. Yields of General Water Quality Parameters (a) and Nutrients (b) for the Main Stem Cowanesque River Sample Sites



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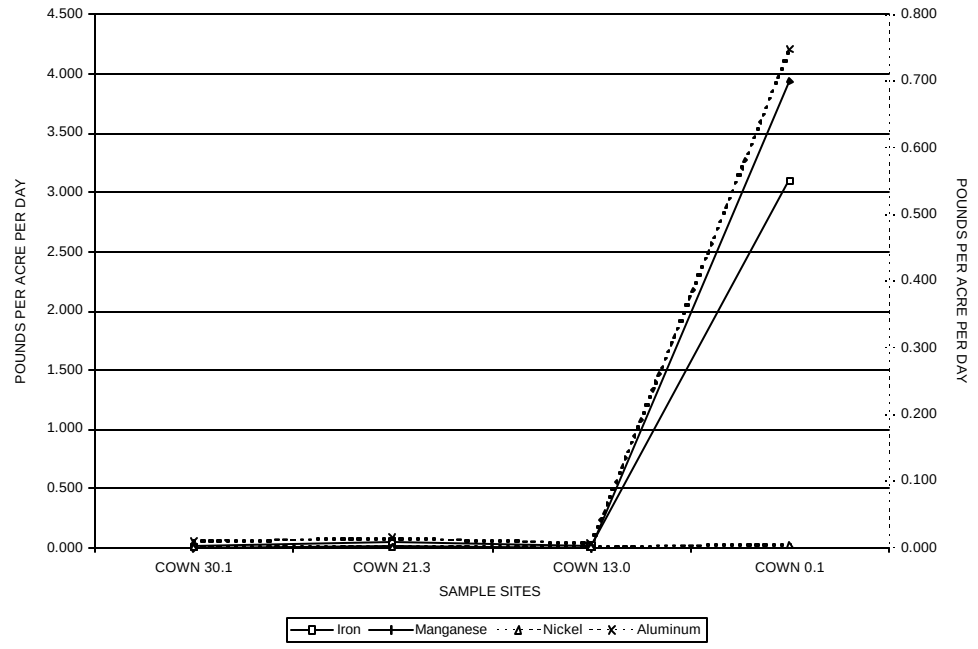


(b)

Figure 18. Yields of Ions (a) and Metals (b) for the Main Stem Cowanesque River Sample Sites

Habitat condition category: excellent.

Substrate and embeddedness received excellent ratings; all other instream habitat was fair. Streambanks were stable and minimally altered.

High total aluminum concentrations were found at NFCO 0.1. The site also had higher total orthophosphorus (TOP), total iron, and manganese concentrations than all Cowanesque watershed sites other than COWN 0.1. TOP appeared to originate from agricultural runoff. Agriculture was the most extensive land use surrounding North Fork Cowanesque River, and cropland was visible at the site. However, land use data show limited residential and commercial activities upstream of the site, which suggests that high metal concentrations may occur naturally.

Troups Creek

TRUP 0.4

Biological condition category: slightly impaired.

Metrics revealed a good Hilsenhoff Biotic Index, but a low EPT Index. Almost half the individuals in the sample were *Stenonema*, resulting in low taxonomic similarity to the reference site.

Habitat condition category: supporting.

Instream habitat was fair. The habitat score was reduced by bedrock substrate and substantial channelization. However, streambanks were stable, which increased the habitat score for this site.

Most chemical parameters measured were average for a Cowanesque watershed site. TRUP 0.4 showed low nutrient and metal concentrations.

Habitat degradation appeared to present a threat to biological conditions at TRUP 0.4. SRBC's Interstate Stream Water Quality Network (ISWQN) monitoring also found evidence of degraded water quality several miles upstream (ISWQN site TRUP 4.5). Elevated concentrations of nutrients, iron, and aluminum were reported there in 1996 and 1997, possibly due to a salvage yard upstream of the site (Rowles and Sitlinger, 1998).

COWN 21.3

Biological condition category: slightly impaired.

Metrics for COWN 21.3 included a low EPT Index and reduced taxonomic similarity to the reference site. The dominant family was net-spinning caddisflies (Hydropsychidae).

Habitat condition category: partially supporting.

The gravel channel was extensively altered, and heavy riprap surrounded the bridge. Little instream habitat for macroinvertebrates or fish was present.

Both channel alteration and water chemistry appeared to negatively impact the biota. Concentrations of sodium, potassium, and chloride were high. Sulfate and calcium concentrations were higher than other Cowanesque River sites. Accordingly, conductivity also was the highest of the sites. Nitrate concentration also increased at COWN 21.3. These parameters suggest that runoff from the surrounding cropland, sewage from Westfield, and/or on-site sewage disposal systems may have affected water quality.

COWN 13.0

Biological condition category: slightly impaired.

Metrics were fair for reference category 60m sites in this assessment. Taxonomic richness was somewhat low, and taxa with intermediate pollution tolerance levels, Hydropsychidae and *Chimarra*, dominated the sample.

Habitat condition category: supporting.

Large levees, a storm drain, and mowing resulted in a lowered habitat evaluation score at the site. Embeddedness and pool quality were the only excellent instream parameters. The stream bottom was thickly covered with algae. Streambank conditions were moderately stable, and riprap augmented stability downstream.

Concentrations of most parameters, including nitrate and iron, returned to the low levels found in the sites upstream of COWN 21.3. Sulfate, sodium, potassium, and chloride concentrations remained high, with only a slight reduction from COWN 21.3. Both habitat and water quality improved somewhat from COWN 21.3, and, accordingly, biological conditions were better.

COWN 0.1

Biological condition category: severely impaired.

Metrics at the mouth of the Cowanesque River were extremely poor. One hundred five of the 119 individuals identified were *Caecidotea* (Isopoda: Asellidae). The macroinvertebrate sample from COWN 0.1 yielded the highest Hilsenhoff Biotic Index (7.77) and one of the lowest diversity scores in the survey.

Habitat condition category: supporting.

Most habitat parameters were good to fair; the only habitat parameter rated as excellent was velocity/depth diversity. COWN 0.1 was the least altered of the Cowanesque River sites and had the most habitat heterogeneity.

In comparison with other Cowanesque River sites, COWN 0.1 had higher total organic carbon (TOC), lower pH, lower DO, and higher nutrient concentrations. A number of chemical parameters were present in high concentrations: TSS, ammonia, TOP, total iron, manganese, and total aluminum. Iron and ammonia concentrations were the highest in reference category 60m sites included in this assessment.

Water quality at the mouth of the Cowanesque River was clearly impacted by discharge from Cowanesque Reservoir. The dam is currently discharging water from the bottom of the reservoir. SRBC's interstate monitoring efforts have identified moderate to severe impairment downstream of the reservoir every year since 1992 (Rowles and Sitlinger, 1998).

Canisteo River Watershed Sites

Figure 19 portrays Canisteo watershed site locations. Land use is shown in Figure 20.

Water quality at most Canisteo watershed sites was usually alkaline, with elevated iron and total aluminum concentrations. Most Canisteo River sites had nonimpaired biological communities and excellent habitat conditions, and two sites (CNST 44.1 and CNST 7.7) served as reference sites for reference categories 60ab and 60m, respectively.

Although most sites were nonimpaired, biological conditions were moderately impaired at CNST 36.5 and CNST 31.3 in the Arkport-Hornell-Canisteo area. Habitat at these sites was nonsupporting, and water chemistry was poor. Nutrients, ions, and metals sharply increased at CNST 36.5. Yields of dissolved residues, nitrogen, chloride, and total iron showed the most dramatic increase from site CNST 44.1. Most parameters continued to increase towards CNST 31.3, where acidity also was high. In addition to habitat and water quality degradation from urban areas at these sites, very poor quality water from Canacadea Creek was an important source of degradation.

At CNST 21.3 at West Cameron, water quality showed significant improvement, and continued to improve downstream. Loading rates in the main stem Canisteo River are listed in Table 23, and yields are shown in Figures 21 and 22.

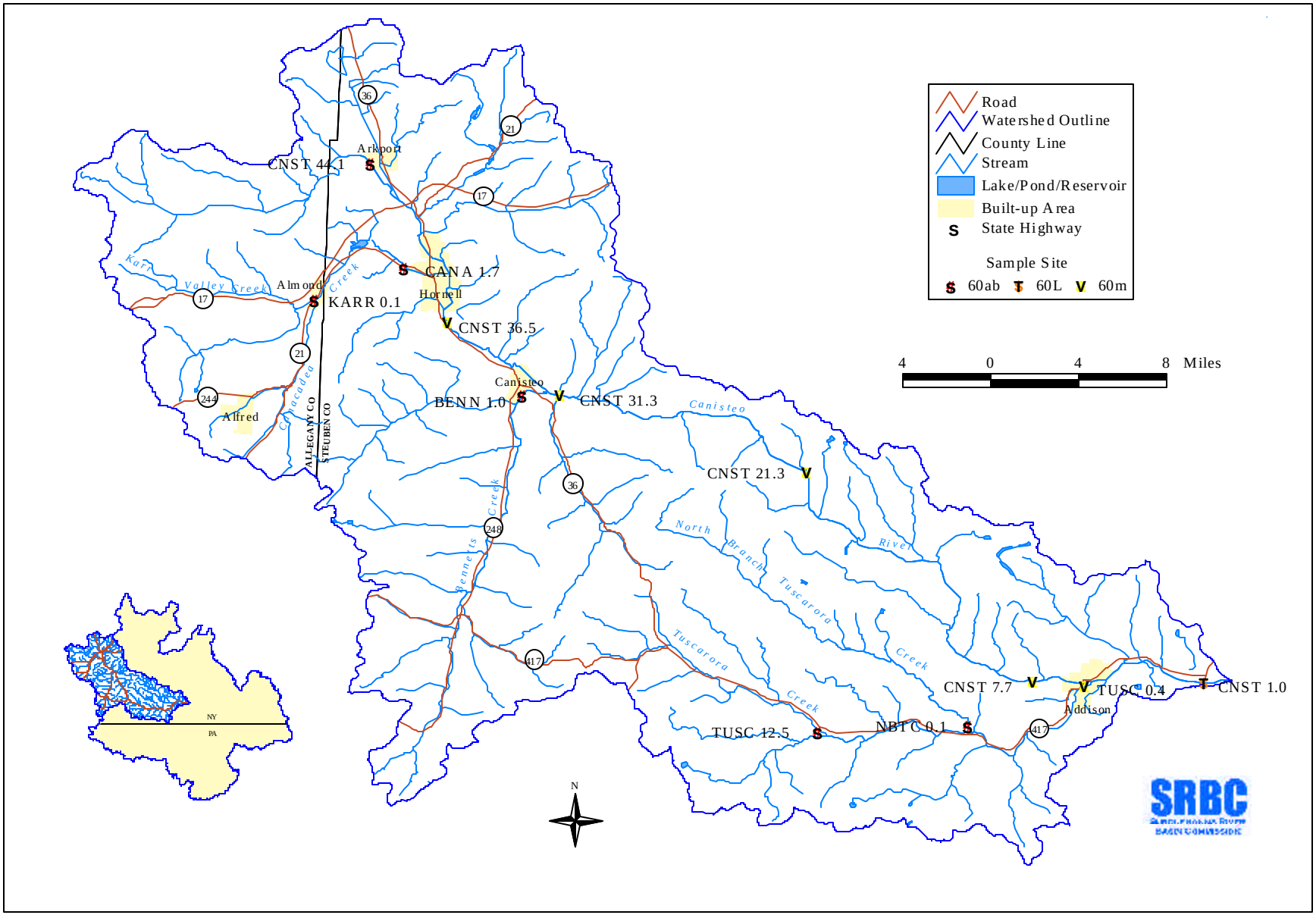


Figure 19. Sample Sites in the Canisteo Watershed

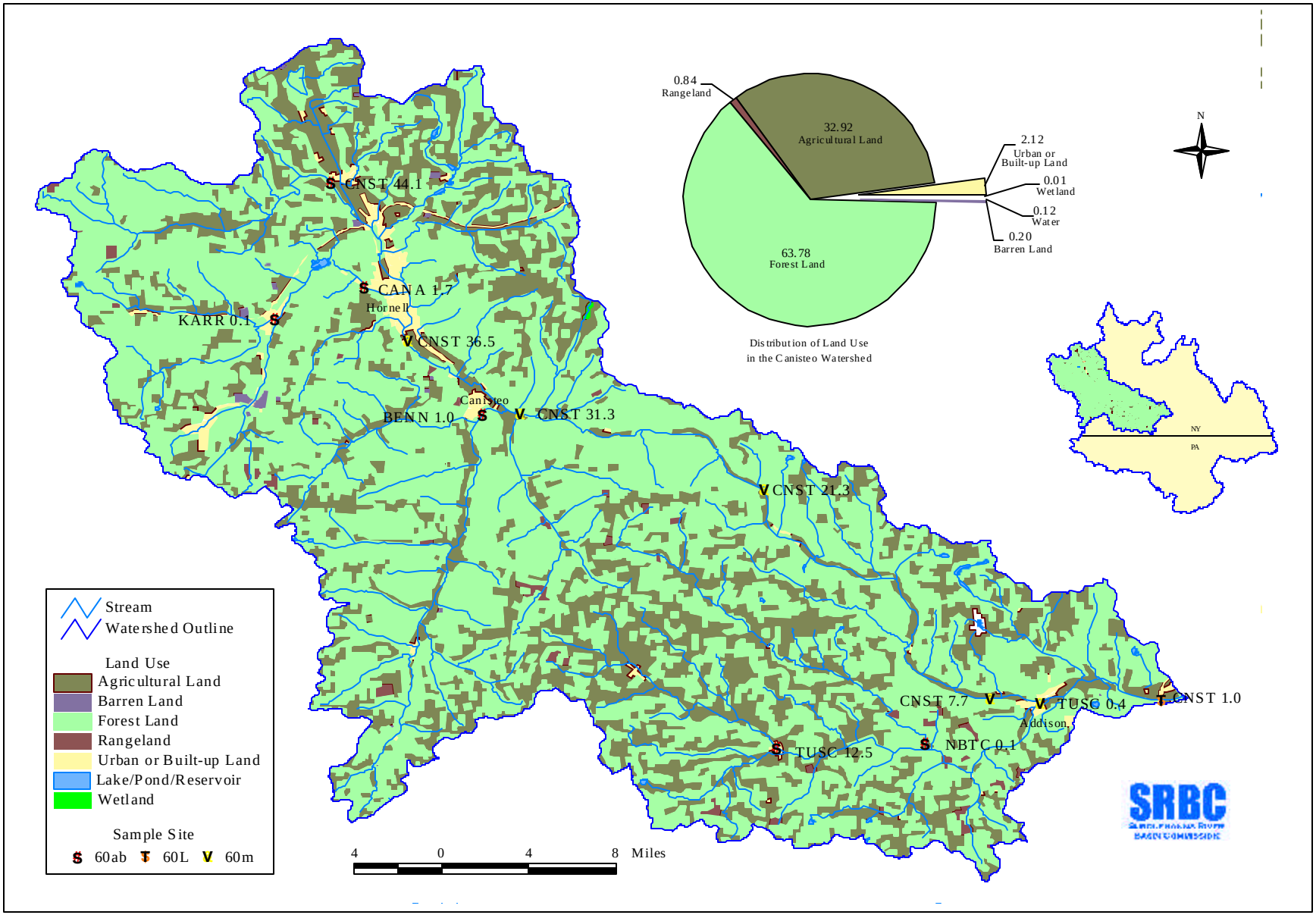
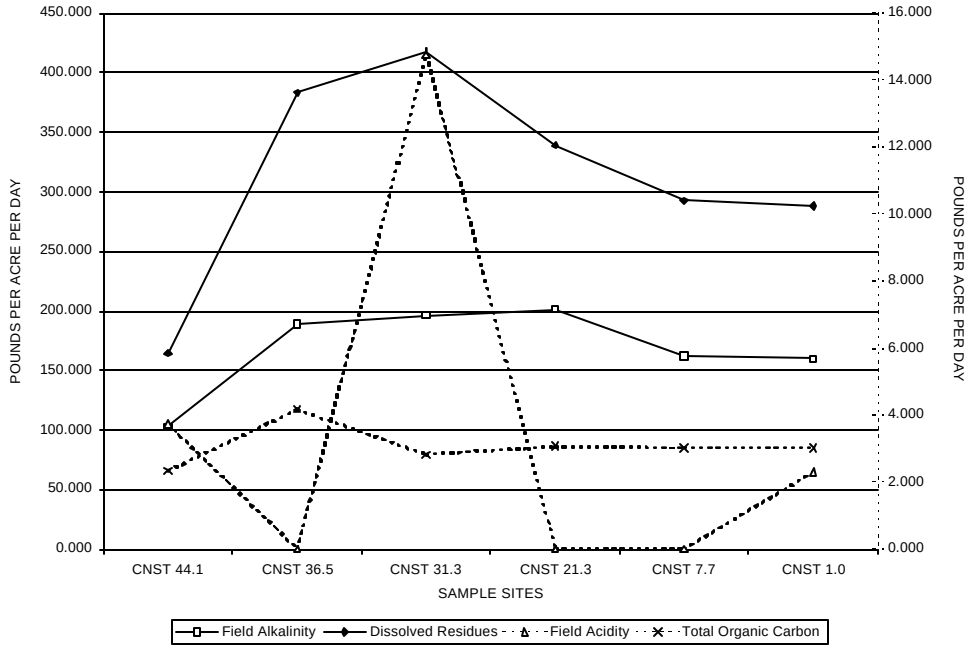


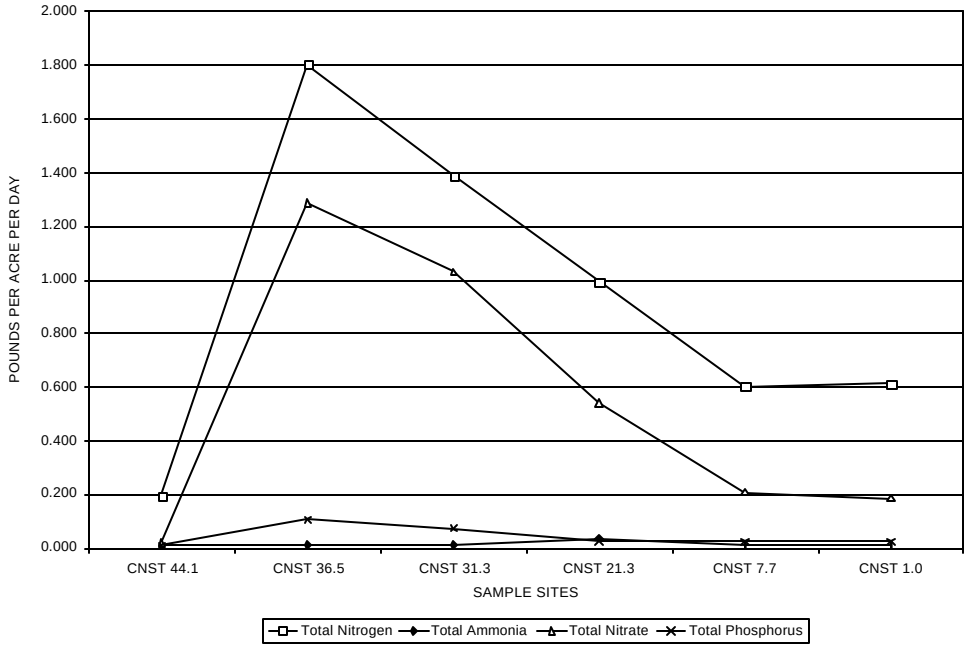
Figure 20. Land Use in the Canisteo Watershed

Table 23. Loading Rates for Selected Chemical Parameters From the Main Stem Canisteo River

	CNST 1.0	CNST 7.7	CNST 21.3	CNST 31.3	CNST 36.5	CNST 44.1
	pounds per day					
Alk	89,955.14	64,465.76	67,673.29	62,878.78	32,340.82	3,083.08
Acid	1,303.70	0.00	0.00	4,715.91	0.00	112.11
DRes	161,658.52	116,038.38	113,889.20	133,617.42	65,521.66	4,932.93
TSS	9,125.88	8,288.46	6,602.27	3,929.92	2,100.05	28.03
TN	345.48	239.44	334.24	444.08	308.71	5.89
TNH_3	6.52	4.60	12.38	3.93	2.10	0.28
TNO_3	104.30	82.88	181.56	330.11	220.51	0.56
TOP	7.17	5.99	6.60	23.58	18.06	0.28
TOC	1,694.81	1,197.22	1,031.61	903.88	714.02	70.07
Ca	32,136.15	24,082.57	23,231.75	24,051.14	11,970.30	992.19
Cl	24,770.26	17,958.32	16,918.32	16,505.68	9,660.24	168.17
SO_4	15,644.37	11,972.21	11,141.33	11,789.77	5,040.13	476.48
Fl	65.18	46.05	41.26	39.30	21.00	2.80
Cu	1.30	0.92	0.83	0.79	0.42	0.06
Fe	174.70	113.28	160.11	276.27	145.32	2.66
Pb	0.33	0.23	0.21	0.20	0.11	0.01
Mn	15.64	14.27	19.81	31.83	22.26	2.30
Ni	1.30	0.92	0.83	0.79	0.42	0.06
Zn	3.65	1.15	1.03	2.36	1.45	0.07
Al	61.14	40.57	55.71	52.27	60.27	1.30

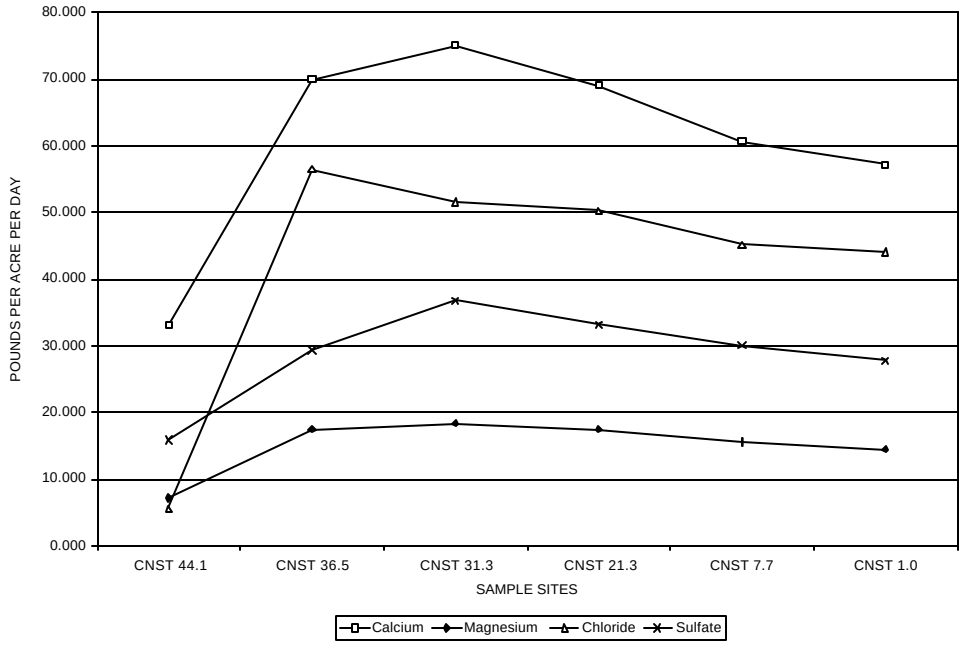


(a)



(b)

Figure 21. Yields of General Water Quality Parameters (a) and Nutrients (b) for the Main Stem Canisteo River Sample Sites



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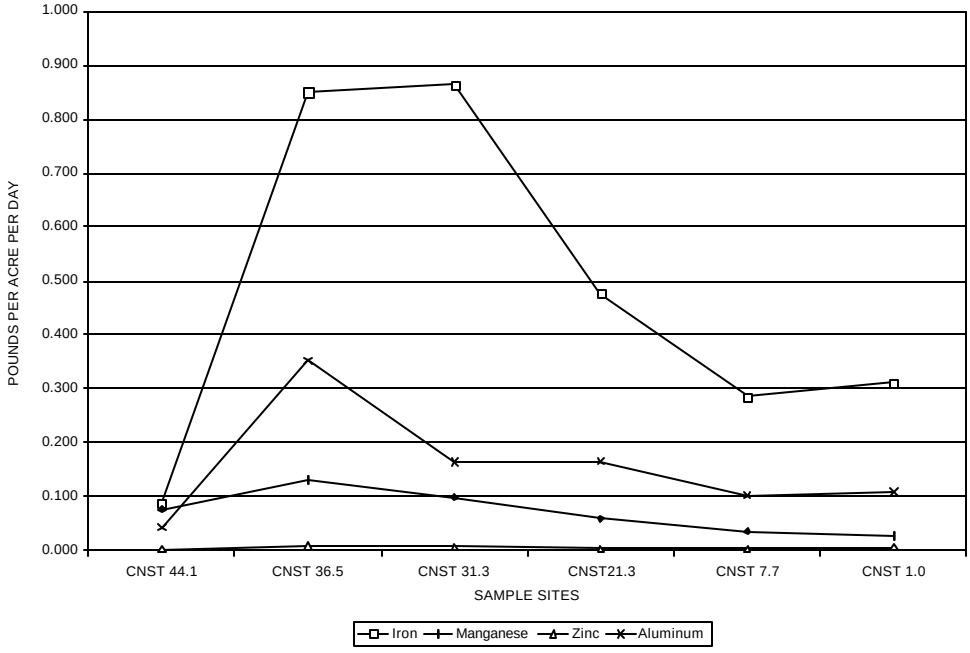


(b)

Figure 22. Yields of Ions (a) and Metals (b) for the Main Stem Canisteo River Sample Sites

Sample sites located in the Canisteo River Watershed are listed below with their reference category designations.

60ab	60m	60L
BENN 1.0	CNST 7.7	CNST 1.0
CANA 1.7	CNST 21.3	
CNST 44.1	CNST 31.3	
KARR 0.1	CNST 36.5	
NBTC 0.1	TUSC 0.4	
TUSC 12.5		

Canisteo River Headwaters

CNST 44.1

Biological condition category: nonimpaired.

CNST 44.1 was the reference site for reference category 60ab. Biological conditions were excellent at CNST 44.1. Both taxa richness and diversity were high. Almost half the genera in the subsample had a Hilsenhoff value of 2 or less, including six Ephemeroptera genera (mayflies): one Odonate (dragonfly); one Megalopteran; three Plecopterans (stoneflies); and one Trichopteran (caddisflies).

Habitat condition category: excellent.

The site received a high total habitat score. Substrate, embeddedness, and channel alteration received excellent scores. Thick brush surrounded the site, and erosion was minimal.

Concentrations of TSS, ions, and nutrients were low. Sodium and chloride were very low. CNST 44.1 had the lowest total iron and aluminum concentrations of the sites sampled on the main stem Canisteo River.

Karr Valley Creek

KARR 0.1

Biological condition category: nonimpaired.

The EPT Index and taxonomic richness for reference category 60ab were good. Trophic similarity to the reference site was over 90 percent.

Habitat condition category: supporting.

Most instream habitat parameters were rated as good to fair at KARR 0.1. In addition to the cobble substrate, a mixture of boulders, bedrock, and gravel provided habitat for macroinvertebrates. Although stability and erosion scores were high at the site, the stability was provided by riprap on both streambanks, and erosion problems occurred downstream. Vegetation at the site was reduced by mowing, and no trees were present.

Karr Valley Creek appeared to contribute good quality water to Canacadea Creek. Water quality testing showed a high pH, low nutrients, and low metals.

Canacadea Creek

CANA 1.7

Biological condition category: slightly impaired.

The impairment of the biological community was substantial. All metrics were marginal to poor; the EPT Index was particularly low. Trophic structure was affected by a large number of *Atherix* (Diptera: Athericidae), which is a predator. There were few pollution-intolerant organisms other than *Atherix* in the subsample.

Habitat condition category: excellent.

A large parking lot was adjacent to the site, and, on that side of the stream, the riparian buffer was thin. Velocity/depth diversity also was lacking. Otherwise, habitat at the site was good.

There was little channel alteration, and streambanks were stable.

In contrast to the excellent habitat found at CANA 1.7, water quality was very poor. Both nutrients and metals were found in high concentrations. Ammonia, total nitrite, total phosphorus, and TOP were high for sites assessed. Total aluminum and manganese concentrations were high, and total iron was very high. Sedimentation was evident. Elevated TSS, TOC, and ions also were present at this site.

Information from the NYSDEC corroborates these water quality results. NYSDEC maintains an intensive RIBS site very close to CANA 1.7 (NYSDEC, 1994). According to 1991-92 studies, water column testing on 17 separate samples showed iron concentration exceeding the NYSDEC's criteria (>300 microgram per liter (µg/L)) in 76 percent of the samples. Manganese and aluminum both exceeded the criteria (>300 µg/L and >1,000 µg/L, respectively) in 26 percent of the samples.

Almond Reservoir has a direct impact upon the water quality of Canacadea Creek. Primarily constructed as a flood control measure, the lake has a small recreational pool maintained through the summer months. Wetlands surround the reservoir, and may affect nutrient levels. The origin of the high and elevated metal concentrations in Canacadea Creek is unknown. Topographic maps show large tracts of disturbed land, including gravel extraction operations, northeast of Alfred. Urbanization around the Hornell, N.Y., area also may contribute to the water quality degradation.

CNST 36.5

Biological condition category: moderately impaired.

The macroinvertebrate community at CNST 36.5 bordered on a severely impaired designation. All metrics were poor. Taxonomic richness and diversity were particularly poor. Only 7 taxa were found in the subsample, and more than 85 percent of the individual organisms in the subsample were midges.

Habitat condition category: nonsupporting.

CNST 36.5 showed signs of significant alteration. Levees channelized the stream, a storm drain emptied at the site, and riparian vegetation was mowed. Areas of erosion were exposed on the streambanks. No riffles existed at this site, and critical primary parameters (substrate, embeddedness, and velocity/depth diversity) were degraded.

Water chemistry also deteriorated from the excellent water quality found at CNST 44.1. Dissolved residue concentrations were greater than observed upstream. Total iron concentration was high, and some chemical parameters were elevated, including nutrients, ions, total aluminum, and manganese.

Channelization, inputs from Canacadea Creek, and runoff from both urban and agricultural areas appeared to be the main sources of degraded water quality. Gravel extraction north of Hornell, N.Y., also may have contributed to the poor water quality.

Bennetts Creek

BENN 1.0

Biological condition category: slightly impaired.

Biological metrics were marginal. Forty-eight percent of the sample was Chironomidae, and EPT taxa were lacking. However, the biological condition score was raised by a high degree of taxonomic similarity to the reference site.

Habitat condition category: supporting.

The straight bedrock channel was bordered by a cliff on one side and a levee on the other. A low dam was located upstream. Vegetative cover was poor, and the riparian zone was small. Embeddedness and channel alteration were the only habitat parameters rated as excellent.

Low nutrients, ions, metals, and TOC indicated good water quality at the site, and there were few sources of impairment in the relatively

undeveloped watershed. It appeared that a macroinvertebrate community with naturally low productivity may have been constrained by less than optimal habitat.

CNST 31.3

Biological condition category: moderately impaired.

Poor diversity, a high Hilsenhoff Biotic Index, and low similarities to the reference site showed that the macroinvertebrate community was considerably impaired. Chironomidae was the dominant taxon.

Habitat condition category: nonsupporting.

CNST 31.3 had the lowest total habitat score (44) in the assessment. Channel dredging had severely degraded habitat at the site. Streambanks lacked stability and were prone to erosion. Substrate consisted of embedded gravel. The stream was straight, channelized, and lacked both riffles and cobble.

Acidity was high, particularly for Canisteo River sites. Nutrient enrichment, high ions, high total iron, and elevated manganese and total aluminum concentrations present at CNST 36.5 also were present at this site. The combination of extremely poor habitat and poor water quality severely limited the biotic community.

CNST 21.3

Biological condition category: nonimpaired.

Biological metrics at CNST 21.3 were similar to the reference category 60m reference site (CNST 7.7). CNST 21.3 had a lower EPT Index because fewer mayfly genera were present in the subsample. However, a higher Hilsenhoff Biotic Index was found at CNST 21.3.

Habitat condition category: excellent.

The site had a high total habitat score. It was one of the few sites with excellent vegetative cover. Bottom substrate, velocity/depth diversity, and riffle/run ratio also were excellent.

Between CNST 31.3 and CNST 21.3, most of the stream was bordered by forest. Some agricultural patches existed; however, there was little other development, and water quality improved. Concentrations of nutrients and iron were approximately half that measured upstream at CNST 31.3. Manganese was lower, but ions and aluminum remained elevated.

CNST 7.7

Biological condition category: nonimpaired.

Although the Hilsenhoff Biotic Index was higher than ideal for a reference site, CNST 7.7 supported a healthy biological community and served as the reference site for reference category 60m. Good metrics included the highest EPT Index in reference category 60m, high diversity, and 20 taxa.

Habitat condition category: excellent.

CNST 7.7 had the highest total habitat score of Canisteo River main stem sites. Substrate, embeddedness, velocity/depth diversity, pool quality, and riffle/run ratio received excellent scores. The site also was the most remote; the stream reach flowed through forest and agricultural lands. Neither riprap nor a bridge altered the site.

Water chemistry was fair. Nitrogen, total aluminum, total iron, and manganese concentrations were reduced from upstream at CNST 21.3. Most other parameters also were slightly decreased.

The NYSDEC also found 'non-impacted' biological conditions at a nearby intensive RIBS site. The NYSDEC listed iron and pH as parameters of concern in the water column (NYSDEC, 1994).

Tuscarora Creek

TUSC 12.5

Biological condition category: slightly impaired.

Metrics were substandard. The total biological score was raised by high taxonomic and trophic similarities to the reference site.

Habitat condition category: supporting.

Degradation was apparent at TUSC 12.5. Embeddedness was the only excellent instream parameter. Velocity/depth diversity, pool/riffle ratio, and pool quality showed degradation. Vegetation above the streambanks was mowed, and erosion was a problem.

Like most Canisteo watershed sites sampled in this assessment, water quality at TUSC 12.5 was alkaline and had a pH higher than 8.0. Conductivity and concentrations of ions were high. The highest potassium, chloride, and sodium concentrations in the Canisteo watershed were found at this site. Concentrations of nutrients and metals were low.

Habitat affected the stream biota at TUSC 12.5. Water chemistry also may have played a role, although the cause of elevated ions was unclear. One possible source was runoff from a nearby road and bridge. Several villages bordered the creek, including Woodhull, which was adjacent to the site. A mixture of agricultural lands and forest surrounded the villages.

North Branch Tuscarora

NBTC 0.1

Biological condition category: slightly impaired.

NBTC 0.1 was on the border of receiving a slightly impaired/nonimpaired designation. The EPT Index was somewhat low, because there were fewer mayfly genera in the subsample than identified at the reference site. Otherwise, biological conditions were good.

Habitat condition category: excellent.

Habitat was satisfactory; most parameters could be described as good or excellent. Riprap surrounded a washed out bridge, and a large pile of gravel was present near the site. Nevertheless, little instream alteration had been conducted. Streambanks were moderately prone to erosion.

Water quality was good; concentrations of nutrients and ions were low. Forest and cropland were the primary land uses in the area.

TUSC 0.4

Biological condition category: nonimpaired.

TUSC 0.4 had the lowest Hilsenhoff Biotic Index in reference category 60m and high trophic similarity to the reference site, but it also had a low number of EPT taxa. No low tolerance EPT taxa, other than *Stenonema*, *Isonychia*, and *Serratella* (Ephemeroptera: Ephemerellidae) were present in the subsample.

Habitat condition category: supporting.

This site was subject to more channel alteration than the upstream site. Large grass-covered levees surrounded the channel. A storm drain emptied at the site. Vegetative growth was limited, but erosion was minimal, as riprap stabilized problem areas.

Water quality testing revealed no outstanding chemical parameters, only slightly elevated ions. Nutrient and metal concentrations were low. Adjacent land was mostly forested in the segment between the Tuscarora Creek sites.

CNST 1.0

Biological condition category: nonimpaired.

Due to an increase in collector/gatherers and a decrease in filtering collectors, CNST 1.0 was the only site in reference category 60L with less than 80 percent trophic similarity to the reference site. Diversity was rather low, and the EPT Index was high, compared to the reference site.

Habitat condition category: excellent.

The site received a high total habitat score. Almost all parameters fell within the "good" rating, with the exceptions of velocity/depth diversity, which was excellent, and vegetative cover and riparian zone width, which were fair.

Water quality was fair. Nutrient concentrations were the lowest of reference category 60L sites in this assessment, while total iron and aluminum concentrations remained slightly elevated.

Cohocton River Watershed Sites

Figure 23 depicts site locations within the Cohocton watershed. Land use is shown in Figure 24.

In several respects, the Cohocton River is similar to the Canisteo River. Both streams drain areas of roughly 600 square miles and are located exclusively in Ecoregion 60. They are alkaline and carry high sediment loads. Most Canisteo River sites have excellent habitat, and all Cohocton River sites have excellent habitat, including stable streambanks with good vegetative cover.

However, effects of land use differ between the watersheds. Although the percentage of agricultural land is only slightly higher in the Cohocton watershed, it appears to play a greater role because more farmland is concentrated adjacent to the river. More agricultural activity also is centered in the upper- and mid-reaches of the river. Another distinction from the Canisteo watershed is the more plentiful large wetlands and lakes in the Cohocton watershed.

During field sampling, macroinvertebrate communities in the Cohocton River showed slight to nonimpaired conditions. The exceptional habitat found at the Cohocton sites implied that impairment was due to water quality degradation. Metal concentrations were usually low, slight nutrient enrichment was apparent at all Cohocton River sites. Metals are high at COHO 37.5 (near Cohocton, N.Y.) and decreased towards the mouth. Nitrogen concentration, which was high for sites in this assessment, also decreased downstream. Some water quality parameters, including acidity, sodium, chloride, and sulfate, increased between COHO 25.0 (near Kanona, N.Y.) and COHO 14.6 (near Savona, N.Y.), and then decreased toward the mouth. Overall, water quality was better at the mouth than in the headwaters. Loading rates in the Cohocton River are listed in Table 24, and yields are shown in Figures 25 and 26.

Sample sites located in the Cohocton River Watershed are listed below with their reference category designations.

60ab	60m	60L
COHO 37.5	COHO 14.6	COHO 0.5
5MIL 1.1	COHO 25.0	COHO 4.0
MEAD 0.1		
TENM 0.2		
TWVE 0.5		
WMUD 1.1		

Cohocton River Headwaters

COHO 37.5

Biological condition category: slightly impaired.

Next to the reference site (CNST 44.1), COHO 37.5 was the most taxa-rich site in reference category 60ab. Its sample yielded a low EPT Index. Low taxonomic and trophic similarities further depressed the biological condition score.

Habitat condition category: excellent.

Excellent parameters included substrate and riffle/run ratio. Stability was good at the sampling site, but streambanks downstream of the site were prone to erosion. All other parameters were good to fair. Unlike many sites, COHO 37.5 was surrounded by little impervious surface, including minimal riprap.

DO was somewhat lower than normal, possibly due to a large wetland complex between

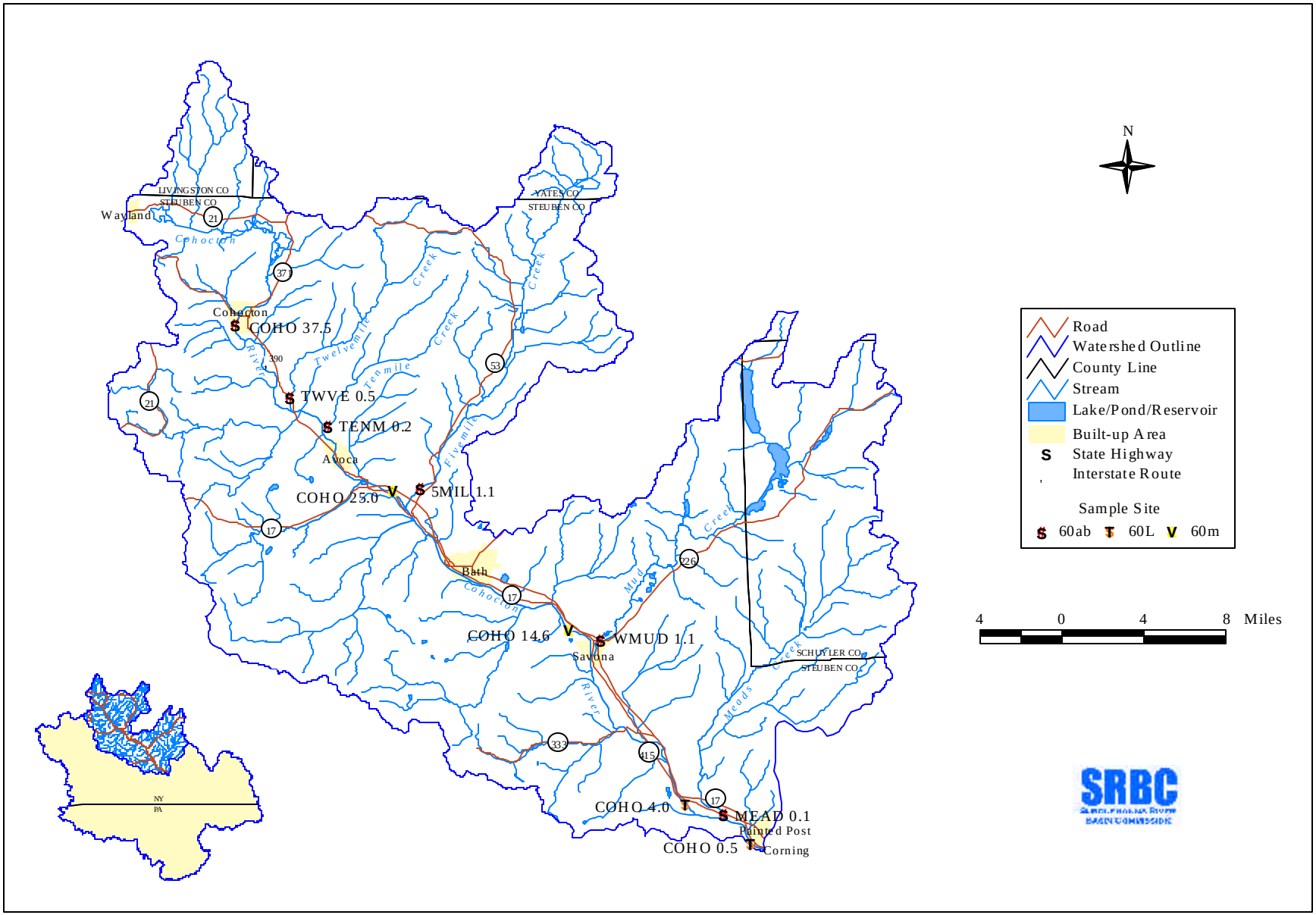


Figure 23. Sample Sites in the Cohocton Watershed

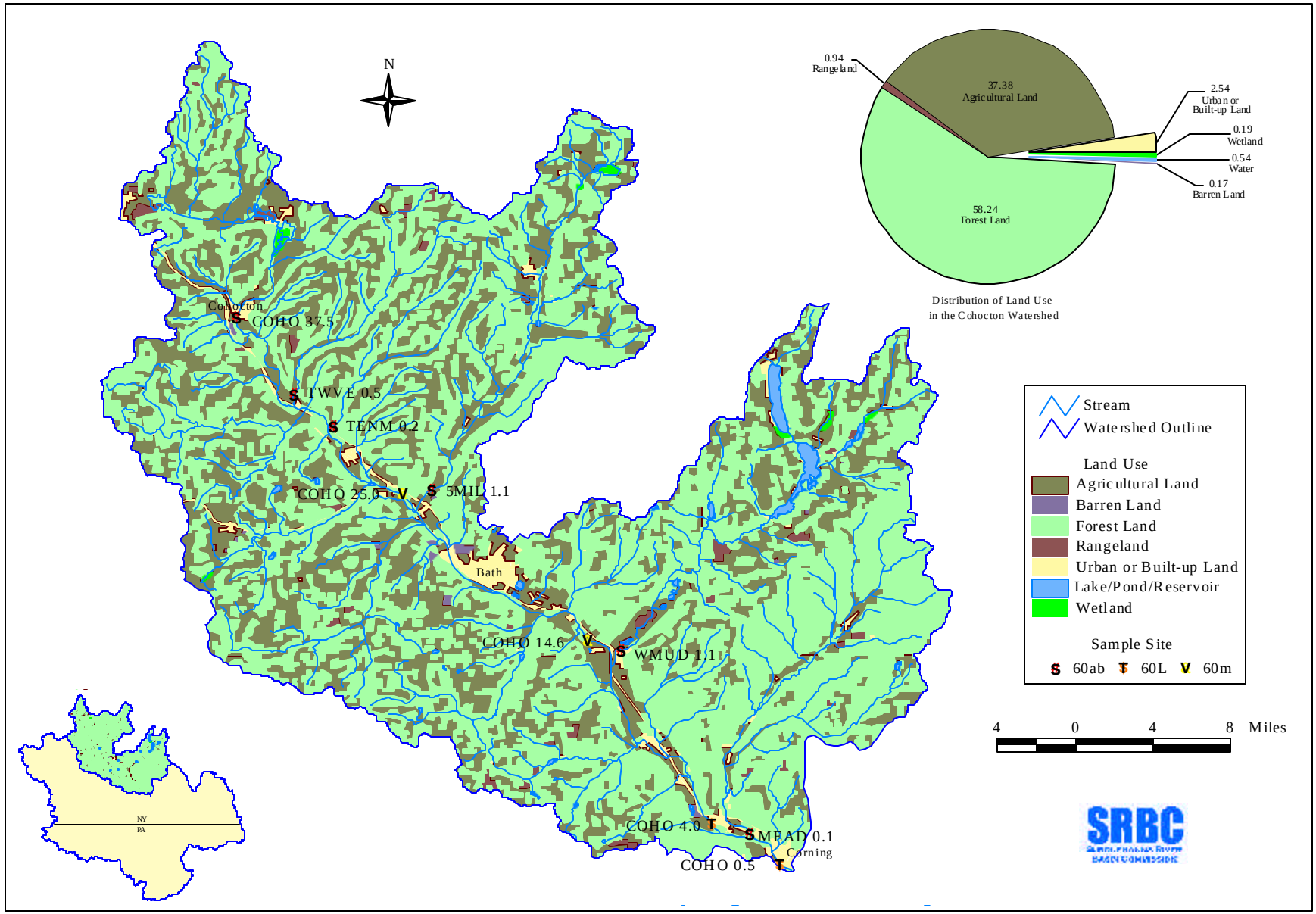
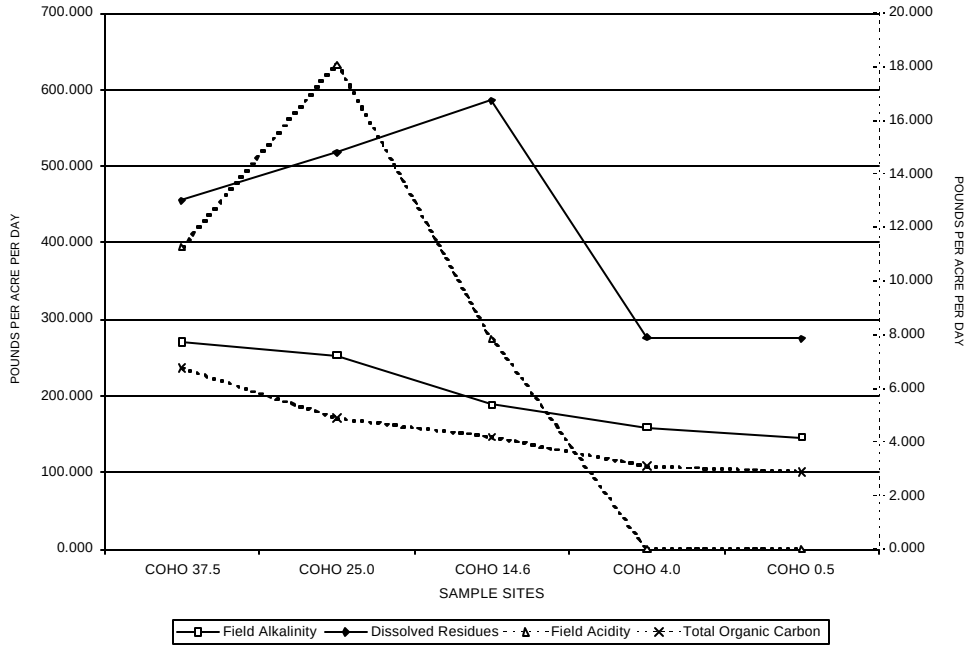


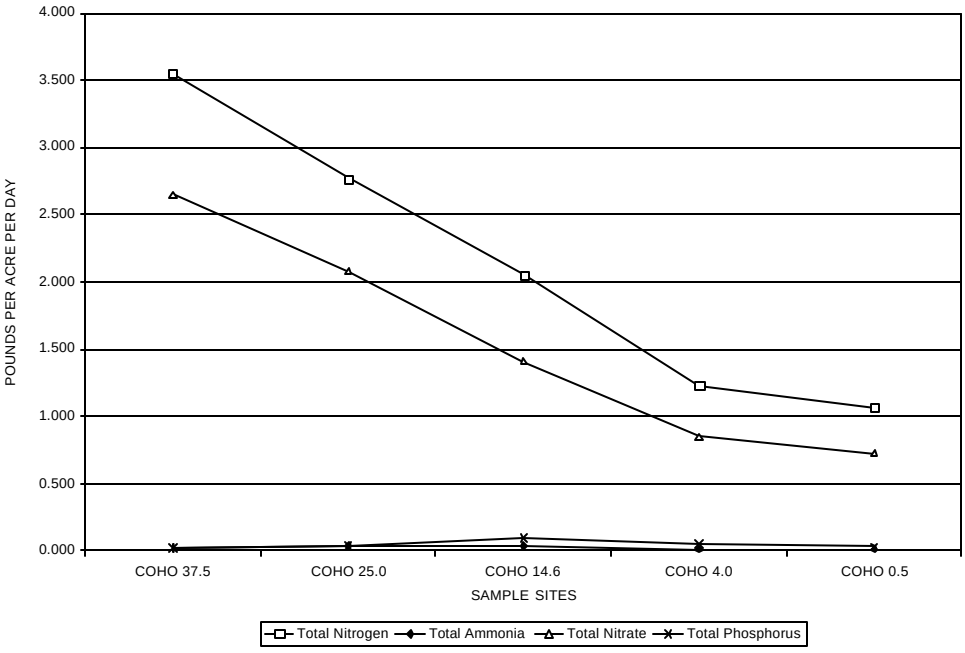
Figure 24. Land Use in the Cohocton Watershed

Table 24. Loading Rates for Selected Chemical Parameters From the Main Stem Cohocton River

	COHO 0.5	COHO 4.0	COHO 14.6	COHO 25.0	COHO 37.5
	pounds per day				
Alk	87,937.28	82,652.78	70,032.75	48,612.13	14,073.01
Acid	0.00	0.00	2,918.03	3,472.29	586.38
DRes	164,727.57	143,837.31	217,879.67	99,307.63	23,650.47
TSS	619.28	5,367.06	486.34	347.23	1,368.21
TN	637.85	638.68	763.55	531.26	184.71
TNH_3	6.19	5.37	14.59	6.94	0.98
TNO_3	433.49	440.10	525.25	399.31	137.80
TOP	16.10	25.23	30.64	3.13	0.98
TOC	1,733.97	1,610.12	1,556.28	937.52	351.83
Ca	30,220.70	30,645.93	28,596.71	18,889.28	5,785.57
Cl	30,344.55	22,541.67	71,491.77	9,722.43	1,563.67
SO_4	14,243.36	31,128.97	15,562.83	6,944.59	2,736.42
Fl	61.93	53.67	48.63	34.72	9.77
Cu	1.24	1.07	0.97	0.69	0.20
Fe	41.49	50.45	47.66	59.72	37.72
Pb	0.31	0.27	0.24	0.17	0.05
Mn	3.10	2.68	8.75	6.94	4.98
Ni	1.24	1.07	0.97	0.69	0.20
Zn	9.97	1.34	1.22	0.87	0.24
Al	15.23	7.57	11.96	14.24	6.57

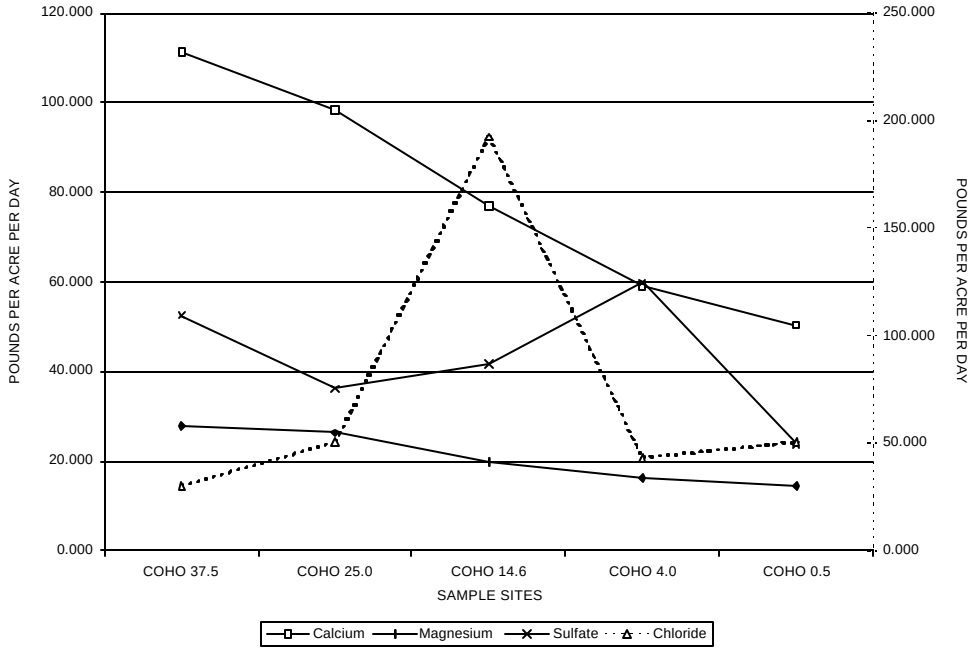


(a)

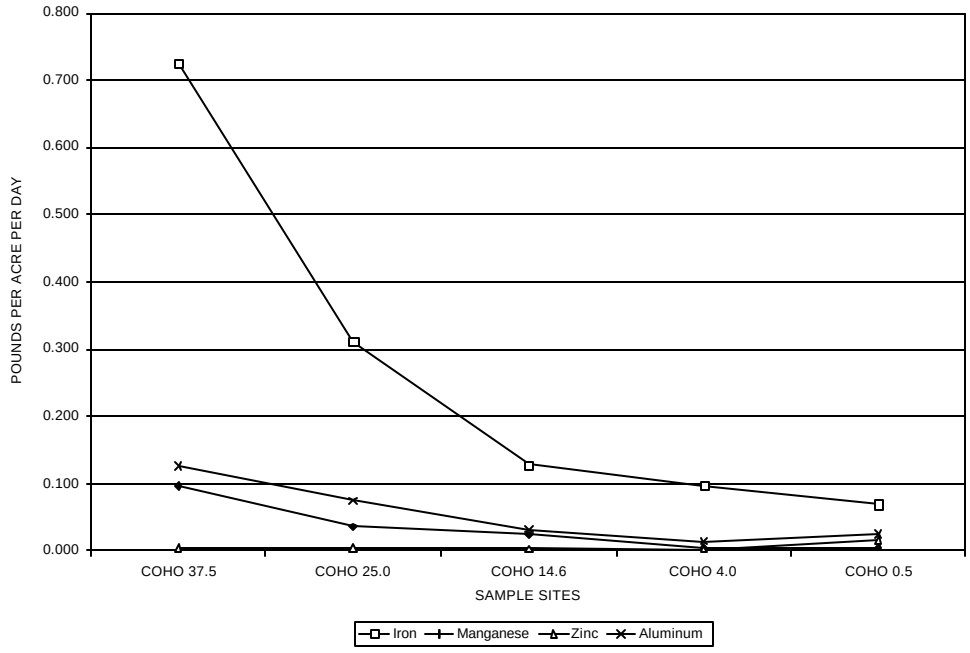


(b)

Figure 25. Yields of General Water Quality Parameters (a) and Nutrients (b) for the Main Stem Cohocton River Sample Sites



(a)



(b)

Figure 26. Yields of Ions (a) and Metals (b) for the Main Stem Cohocton River Sample Sites

North Cohocton and Cohocton. NYSDEC's RIBS also reported low DO at its auxiliary site at the town of Cohocton (1994). Total iron concentration was high, and nitrate concentrations were very high for sites in the assessment. Manganese and total aluminum were elevated for the Cohocton watershed. Like other Cohocton sites, calcium concentration was high.

Despite the lack of channel or streambank alteration at the site, more development surrounded COHO 37.5 than other headwater sites. Commercial/industrial and residential areas of Cohocton, N.Y., were nearby. In the headwaters, agriculture dominated the landscape. Northeast of Cohocton, the stream flowed through a large wetland.

Twelve Mile Creek

TVWE 0.5

Biological condition category: nonimpaired.

Good biological metrics were found at TVWE 0.5, including high diversity and trophic similarity to the reference site. Taxonomic similarity to the reference site (CNST 44.1) was only fair, primarily due to the dominance of Hydropsychidae at TVWE 0.5.

Habitat condition category: excellent.

The habitat was both stable and heterogeneous. TVWE 0.5 was one of the few sites sampled in this assessment where emergent vegetation provided stability and habitat for fish and macroinvertebrates. Only slight channelization was present near a mobile home park and a farm. A lawn abutted a small but dense riparian zone of shrubs and small trees.

Although the headwaters were forested, agricultural land bordered the stream toward the mouth. The site had elevated nitrogen and high total iron concentrations. In comparison with other streams in the Cohocton watershed, TSS and total aluminum concentrations were elevated.

Ten Mile Creek

TENM 0.2

Biological condition category: nonimpaired.

Metrics, particularly the high diversity score and low Hilsenhoff Biotic Index, were very good for reference category 60ab. More than a third of the subsample was composed of pollution-intolerant mayflies such as *Paraleptophlebia* (Ephemeroptera: Leptophlebiidae), *Serratella*, and *Ephemerella* (Ephemeroptera: Ephemerellidae).

Habitat condition category: excellent.

Most habitat parameters were good to excellent, but vegetation in some areas was mowed. Fields were cultivated on either side of a small riparian buffer zone.

Water quality was fair. Concentrations of ions were low, metals were low, and nitrogen was moderate for sites in this assessment.

COHO 25.0

Biological condition category: slightly impaired.

Impairment appeared marginal. The Hilsenhoff Biotic Index was low; 7 of the 16 genera had a Hilsenhoff value of 3 or less, indicating a pollution-intolerant biological community. However, the EPT Index was significantly lower than that of the reference site. The biological condition score also was reduced by low taxonomic and trophic similarities to the reference site. This was primarily due to the dominance of *Ceratopsyche* and *Ephemerella*, which shifted the trophic structure to collector/gatherers and filtering collectors.

Habitat condition category: excellent.

The site was wedged in a small buffer zone between cropland and N.Y. Route 17. Habitat was excellent, and received high scores for stability and vegetative cover. Substrate, velocity/depth diversity, riffle/run ratio, and

channel alteration also were excellent. All other habitat parameters were good.

Concentrations of most water quality parameters, including nitrogen, TOC, manganese, and total aluminum decreased slightly from COHO 37.5. Total iron was significantly decreased. Acidity, sodium, potassium, and chloride increased.

Five Mile Creek

5MIL 1.1

Biological condition category: slightly impaired.

The EPT Index was poor. Only one stonefly (Plecoptera: Perlidae: *Paragnetina*) was identified in the subsample. Taxonomic richness also was slightly reduced.

Habitat condition category: excellent.

Instream habitat was good, but the site was located adjacent to cropland and pasture. Livestock had access to the stream and had heavily grazed the riparian vegetation. Both upstream and downstream areas suffered from erosion, and habitat heterogeneity was poor.

At 5MIL 1.1, Five Mile Creek was the most alkaline tributary sampled in the Cohocton watershed. Dissolved residues and ions (except for sulfate) were higher than other Cohocton tributaries sampled. Concentrations of nutrients were moderate for sites in this assessment, and TOC was high.

Agriculture appeared to be the main source of biological impairment at 5MIL 1.1. Habitat disturbance and siltation from livestock access were obvious. Slight nutrient enrichment also may have occurred.

COHO 14.6

Biological condition category: nonimpaired.

The excellent biological conditions were evidenced by metrics very similar to the 60m reference site (CNST 7.7). The EPT Index was slightly lower at COHO 14.6, as fewer families of intermediate-tolerance Trichoptera were identified in the subsample.

Habitat condition category: excellent.

COHO 14.6 had the highest habitat score in the survey. Seven of the 11 parameters were rated excellent, including pool/riffle ratio and channel alteration. This site was in a relatively undeveloped area, compared to other Cohocton River sites sampled. Cropland and a small wetland surrounded the site. Riprap was absent, and a large riparian zone was present.

Very high sodium and chloride concentrations were found at COHO 14.6. Conductivity also was very high. Dissolved residues and total phosphorus were high. The elevated concentration of nitrogen was comparable to that of COHO 25.0, but nitrite was a larger component of total nitrogen at COHO 14.6. In contrast, metal concentrations were lower.

Mud Creek

WMUD 1.1

Biological condition category: severely impaired.

McMorran (1985) rated Mud Creek as a high quality stream with exceptional biological conditions. However, during this current survey, no invertebrates were collected.

Habitat condition category: nonsupporting.

Habitat conditions were inhospitable to macroinvertebrates, due to a pronounced lack of flow at the time of sampling. Water was only found in a string of pools along the sand/silt/clay channel. Instream habitat was lacking, and there were no riffles. However, streambank conditions appeared good to excellent; streambanks were well covered, stable, and unaltered.

As expected under very low flow conditions, DO was low (5.27 mg/l), although it was slightly above Pennsylvania state standards for aquatic life

(5.0 mg/l). Concentrations of iron and manganese were high, and phosphorus was slightly elevated. However, it was likely that these concentrations were greater than normal because of low flow conditions. Mud Creek drains Lamoka Lake, which appeared to have artificial drainage controls that may have restricted flow during times of low precipitation.

COHO 4.0

Biological condition category: slightly impaired.

Although COHO 4.0 had the highest diversity score in 60L, most organisms were moderate to high pollution-tolerant, non-EPT taxa. The subsample from COHO 4.0 had a high Hilsenhoff Biotic Index and a low EPT Index. Only three taxa had a Hilsenhoff value of 3 or less, indicating a stressed biological community.

Habitat condition category: excellent.

Instream parameters were good to excellent. The riparian buffer was minimal due to an adjacent farm, but livestock did not have access to the stream. Upstream, a metal wall obscured the streambank, presumably as an erosion-control measure.

Although high sulfate levels were present, sodium, chloride, nutrients, and conductivity decreased from concentrations at COHO 14.6. Water quality parameters generally appear to have improved from COHO 14.6, but the biological community showed definite impairment at COHO 4.0. The presence of high sulfate was one indication that water chemistry was still the probable cause of impairment. A stone and gravel quarry was located upstream, although sedimentation was not evident. The NYSDEC RIBS sampled upstream of this site at Curtis, N.Y. Researchers found DDE (a pesticide) in crayfish tissue, although no significant toxicity was noted. Nutrient enrichment was also observed (NYSDEC, 1994).

Meads Creek

MEAD 0.1

Biological condition category: slightly impaired.

Metrics were generally good, especially the Hilsenhoff Biotic Index of 3.13. A number of EPT individuals were in the sample, including several organic pollution intolerant *Attenella* (Ephemeroptera: Ephemerellidae) and *Taeniopteryx* (Plecoptera: Taeniopterigidae). The dominant genera were *Isonychia* and *Stenonema*.

Habitat condition category: supporting.

Most parameters were rated as fair. Habitat was satisfactory, although there was some channelization at a small mobile home park. Streambanks were stable, well covered with vegetation, and had few erosional areas, despite the absence of riprap.

Water quality testing at MEAD 0.1 showed that metal concentrations were lower than at other Cohocton tributaries. Nutrients were very low; total nitrogen concentration was recorded as 0.16 mg/l. As no water quality problems were evident, the slightly impaired biological community may have been due to mild habitat degradation.

COHO 0.5

Biological condition category: nonimpaired.

A healthy biological community was present near the mouth of the Cohocton River. High taxonomic richness, diversity, and a high degree of trophic similarity to the reference site were found at COHO 0.5.

Habitat condition category: excellent.

Instream conditions were excellent, but the stream was heavily channelized. The straight sides of the channel were stabilized with inlaid stone. Large levees bordered the Cohocton River at this site. Grass was the only riparian vegetation.

Water quality testing indicated that levels of metals were low to very low, but zinc was slightly elevated. Nutrient concentrations only slightly decreased from COHO 4.0. Residential, commercial, and industrial areas surrounded the site.

Chemung River Watershed Sites

Sites within the Chemung watershed are shown in Figure 27. Figure 28 shows land use.

The most extensive urban development in the subbasin is found in the Chemung River Watershed. Although it accounts for less than 10 percent of the land use within the watershed, development from Corning/Painted Post and Elmira/Horseheads lies directly adjacent to the Chemung River. Areas not developed for urban/residential use along the river are largely agricultural.

The majority of sites sampled in the Chemung River Watershed were slightly impaired. Many of these sites may have been affected by urban and agricultural runoff or wastewater. Poor or altered habitat also played a role in 80 percent of the impairments. Much of the alteration occurred from flood control measures, particularly in tributaries that had a significant portion of their drainage restricted within a narrow valley. Low flow conditions also affected segments of tributaries. Half of the watershed sites had partially or nonsupporting habitat conditions.

Slight impairment was found at South Corning (CHEM 40.1) and Wellsburg (CHEM 18.5). Nonimpaired conditions occurred at West Elmira (CHEM 28.3) and Athens (CHEM 2.5). Concentrations of ions and nutrients (except for ammonia) increased toward the mouth of the river. Most parameters dropped at CHEM 28.3, then sharply increased toward CHEM 18.5. Ions continued to increase, but nutrients and metals were lower at CHEM 2.5. Chemung River loading rates are listed in Table 25, and yields are shown in Figures 29 and 30.

Sample sites located in the Chemung River Watershed are listed below with their reference category designations.

60ab	60L
BNTY 0.7	CHEM 2.5
BNTY 2.5	CHEM 18.5
BNTY 5.7	CHEM 28.3
NEWT 0.6	CHEM 40.1
POST 0.4	
SEEL 2.8	
SEEL 11.3	
SING 0.4	
SOUT 1.9	
SOUT 7.2	
SOUT 11.0	
WYNK 0.5	

Post Creek

POST 0.4

Biological condition category: slightly impaired.

Metrics indicated a degraded macroinvertebrate community. The sample was characterized by low diversity and a high Hilsenhoff Biotic Index. Over 70 percent of the sample was composed of midges.

Habitat condition category: supporting.

No habitat parameters were optimal; all showed degradation. A sizeable levee bordered the stream channel, and the riparian vegetation was mowed. A large storm drain was present at the site.

Water quality appeared to be good, with low nutrient and metal levels. Chloride concentrations were elevated, but concentrations of other ions were moderate.

Post Creek was sampled near Corning, N.Y. Habitat at the site may have limited the diversity of the biological community. Water chemistry also may have played a role, particularly during storm events.

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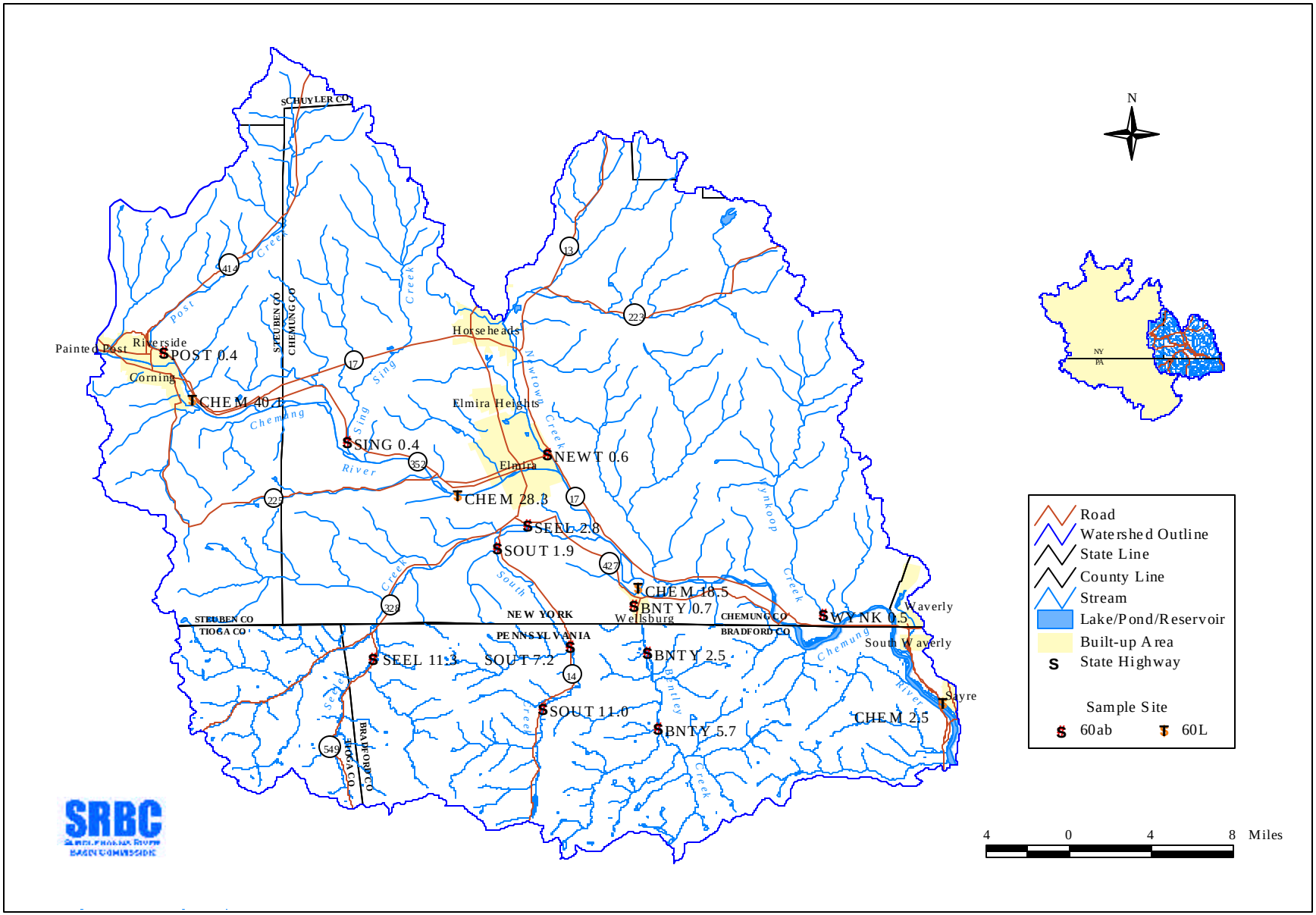


Figure 27 Sample Sites in the Chemung Watershed

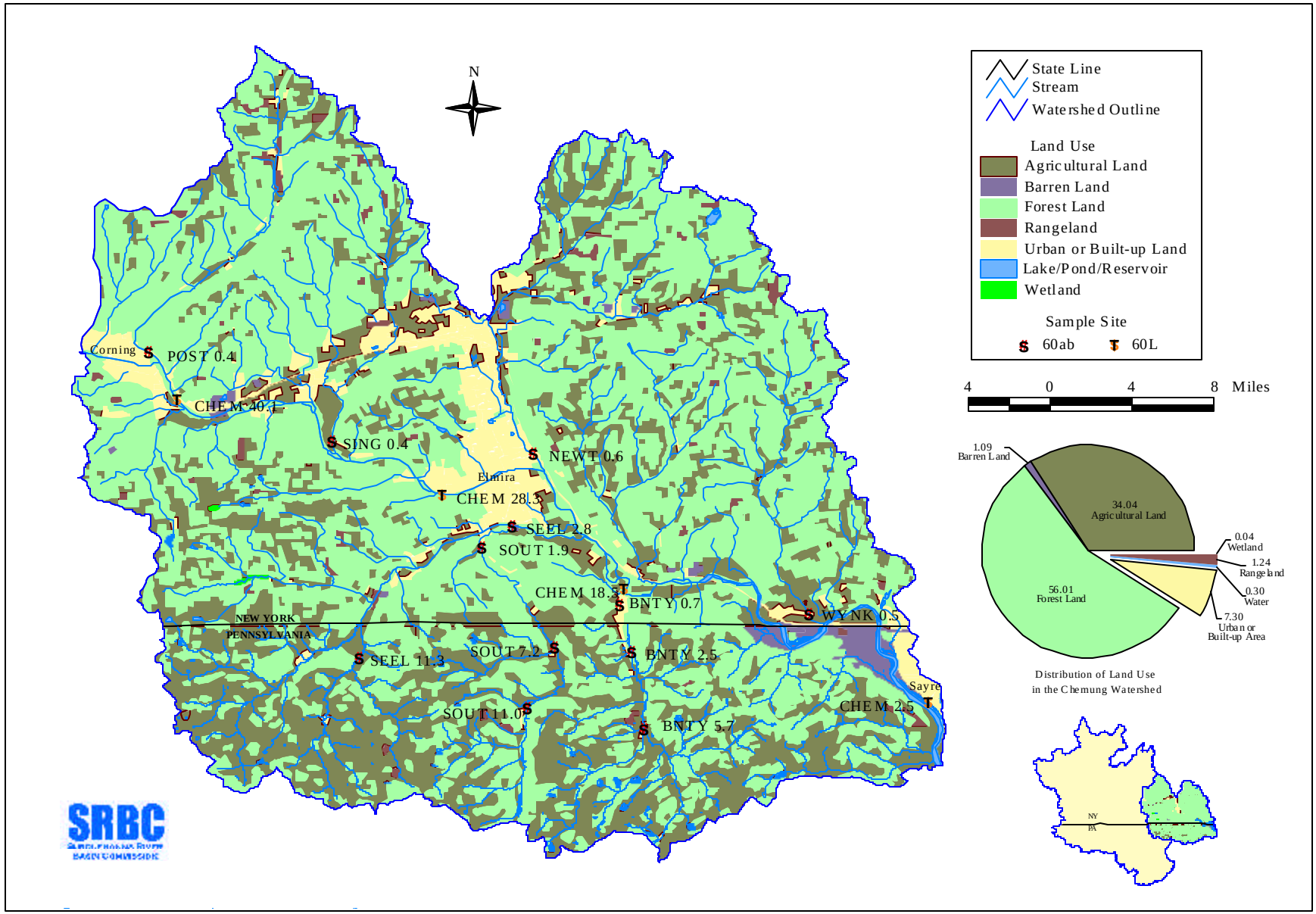
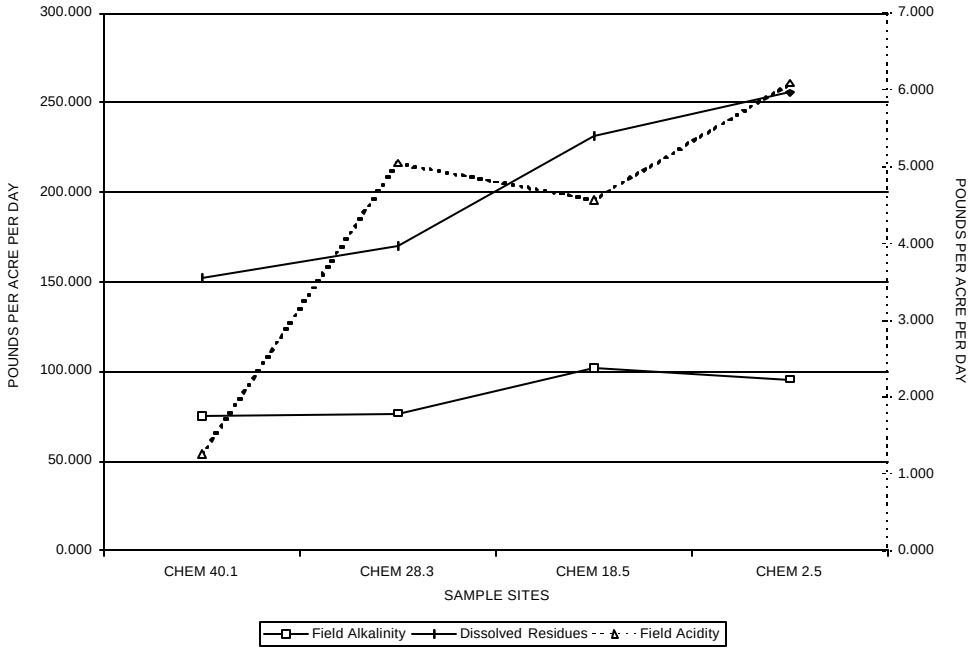


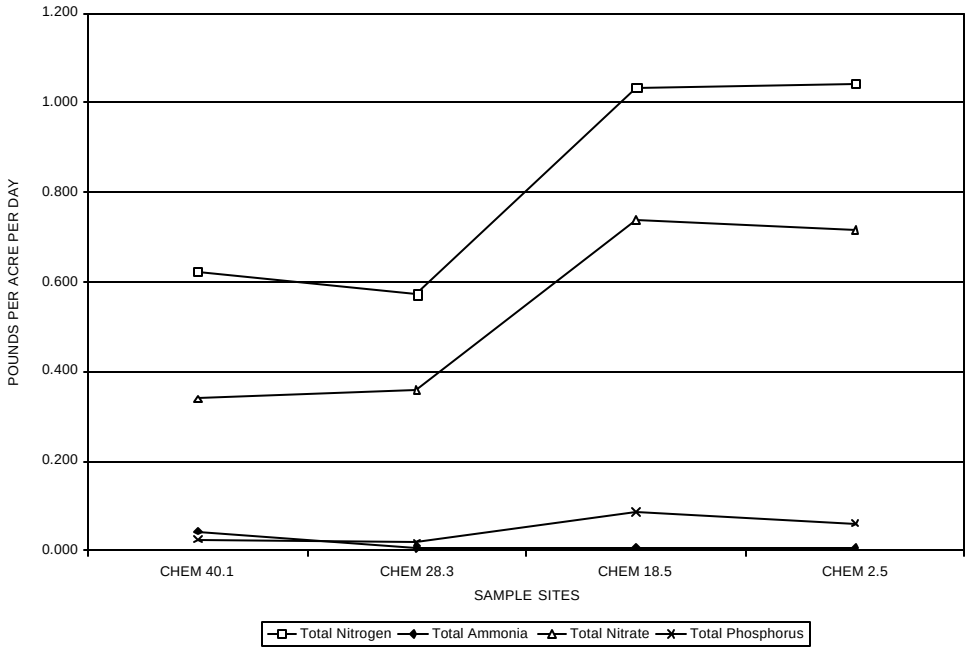
Figure 28. Land Use in the Chemung Watershed

Table 25. Loading Rates for Selected Chemical Parameters From the Main Stem Chemung River

	CHEM 2.5	CHEM 18.5	CHEM 28.3	CHEM 40.1
	pounds per day			
Alk	248,273.94	251,803.97	171,220.34	153,061.89
Acid	15,763.42	11,274.80	11,227.56	2,551.03
DRes	662,063.83	571,256.77	378,930.27	308,674.81
TSS	1,970.43	18,791.34	1,403.45	5,102.06
TN	2,699.49	2,555.62	1,277.14	1,262.76
TNH_3	19.70	18.79	14.03	89.29
TNO_3	1,852.20	1,822.76	799.96	688.78
TOP	159.60	212.34	37.89	51.02
TOC	5,714.24	5,261.58	3,508.61	3,954.10
Ca	108,373.54	88,507.22	58,242.99	51,530.84
Cl	132,018.68	93,956.71	54,734.37	45,918.57
SO_4	55,763.11	39,461.82	28,068.91	34,438.93
Fl	197.04	187.91	140.34	127.55
Cu	3.94	3.76	2.81	2.55
Fe	220.69	279.99	202.10	156.89
Pb	0.99	0.94	0.70	0.64
Mn	37.44	50.74	26.67	30.61
Ni	3.94	3.76	5.61	2.55
Zn	4.93	4.70	3.51	3.19
Al	105.61	140.94	62.17	75.38

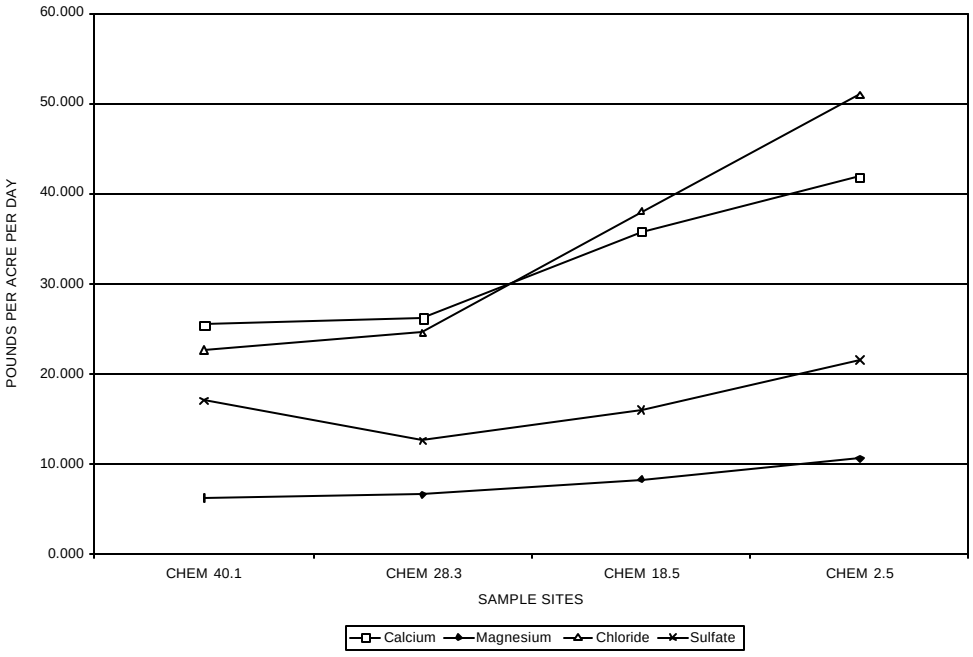


(a)



(b)

Figure 29. Yields of General Water Quality Parameters (a) and Nutrients (b) for the Main Stem Chemung River Sample Sites



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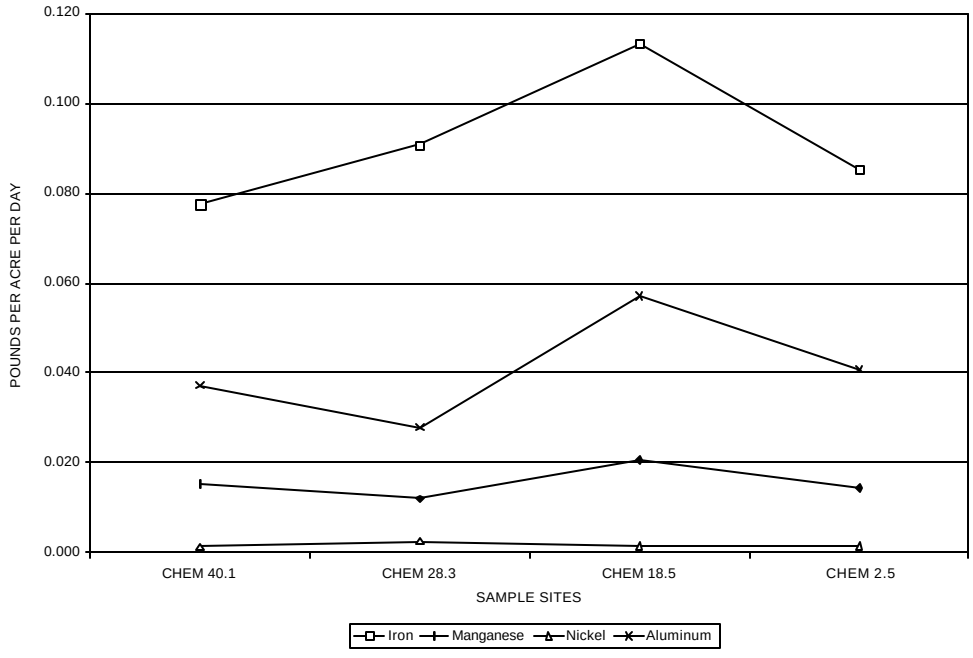

(b)

Figure 30. Yields of Ions (a) and Metals (b) for the Main Stem Chemung River Sample Sites

CHEM 40.1

Biological condition category: slightly impaired.

Taxonomic richness and EPT Index were low. Forty-six percent of the sample consisted of *Ceratopsyche*, *Cheumatopsyche*, and *Chimarra* caddisflies.

Habitat condition category: excellent.

Although few habitat parameters at this site were excellent, none was poor. Instream habitat was good, while most streambank conditions were fair. Habitat was heterogeneous.

Most chemical parameters were average for reference category 60L. Nutrients, chloride, and sulfate were higher than the median concentrations of sites assessed. Ammonia concentrations were higher than at other Chemung River sites.

Sing Sing Creek

SING 0.4

Biological condition category: slightly impaired.

Metrics were generally fair, with the exception of a low EPT Index. Only two mayfly families (Caenidae and Isonychiidae) were present in the subsample.

Habitat condition category: excellent.

Algal growth was abundant, indicating possible nutrient enrichment. Steep streambanks had significant areas of erosion, but most other habitat conditions were good. Substrate and pool/riffle ratio were excellent. Woody debris, undercut banks, overhead cover, and rootwads provided habitat heterogeneity for macroinvertebrates and fish.

Sing Sing Creek is an alkaline stream with high conductivity and moderately high concentrations of ions and dissolved residues. During sampling, total iron concentration was the highest in the watershed. The highest nitrogen and nitrate concentrations of sites assessed were found at SING 0.4.

SING 0.4 was primarily surrounded by agricultural land, and flowed through residential areas between Corning and Elmira/Horseheads. Both agricultural and urban runoff appeared to be important sources of water quality degradation.

CHEM 28.3

CHEM 28.3 served as the reference site for reference category 60L. However, its habitat was of lesser quality than the other reference sites included in this assessment.

Biological condition category: nonimpaired.

Overall, the best metrics for 60L were found at CHEM 28.3, including the highest taxonomic richness and one of the highest diversity scores. A healthy biological community was indicated by the presence of pollution-intolerant organisms such as *Stenonema*, *Taeniopteryx*, *Agnetina* (Plecoptera: Perlidae), and *Macrostemum* (Trichoptera: Hydropsychidae).

Habitat condition category: excellent.

Site CHEM 28.3 was located in a residential area near West Elmira, N.Y. The site had excellent riffle/run and pool quality, and instream alteration was minimal. All other metrics were fair to good. Large levees bordered the stream channel.

Water chemistry showed little significant change from the upstream site at CHEM 40.1. Concentrations of nitrogen, ammonia, sulfate, and total aluminum decreased slightly, while acidity increased.

Newtown Creek

NEWT 0.6

Biological condition category: slightly impaired.

Metric scores indicated definite degradation of the biological community. The dominant families were Hydropsychidae and Chironomidae. Macroinvertebrates with low organic pollution tolerance (Hilsenhoff value of 3 or less) comprised only a small proportion of the sample (less than 12 percent). Additionally, the EPT Index was one of the lowest of the reference category 60ab sites assessed. The biological community at this site bordered on a moderately impaired designation, but its biological score was raised by high trophic similarity to the reference site.

Habitat condition category: partially supporting.

Most habitat parameters, including substrate quality, were below average. The stream was bordered by a large levee. The streambanks were somewhat stable. However, riparian vegetation consisted of grasses, and erosion potential appeared to be great.

Water quality was poor. The highest alkalinity (250 mg/l) and the highest lead concentration (4 µg/l) in the assessment were measured at Newtown Creek. Conductivity, dissolved residues, calcium, sodium, and chloride were very high. Concentrations of ammonia, magnesium, and manganese were high, and nitrogen and total iron concentrations were elevated.

In 1985, Newtown Creek was thought to be severely degraded by sewage from Elmira (McMorran, 1985). It appears that, while the impairment observed in 1997 was not as severe, wastewater and urban runoff continued to influence water chemistry and negatively impact the biological community.

Seeley Creek

SEEL 11.3

Biological condition category: slightly impaired.

There was little taxonomic similarity to the reference site due to an abundance of *Serratella*. Over half the sample was composed of these mayflies, which have an organic pollution tolerance of 2. The result was a low Hilsenhoff Biotic Index and low diversity. SRBC's Interstate Streams Monitoring Program also identified slight biological impairment near this site (Rowles and Sitlinger, 1998).

Habitat condition category: nonsupporting.

SEEL 11.3 was heavily altered. The stream channel was bordered by a wide swath of gravel, and pool/riffle was very poor. Streambanks were prone to erosion, a problem that was compounded by poor vegetative cover.

There was a marked chemistry difference between SEEL 11.3 and SEEL 2.8, the site sampled near the mouth. Elevated nitrate values at SEEL 11.3 were approximately four times the downstream concentrations. High total iron and elevated total aluminum concentrations were nearly ten times greater than downstream. Calcium concentration also was high. The high readings may have resulted from low flow conditions. Both McMorran (1985) and Rowles and Sitlinger (1998) found good quality water in this area.

Poor habitat was a cause of impairment at SEEL 11.3. Fluctuations in streamflow also may have contributed to impairment, especially during periods of low flow.

South Creek

South Creek sites had similar water quality characteristics. Generally, sites had "soft" water and were not highly alkaline. A slight increase in calcium, magnesium, sodium, and chloride could be observed toward the mouth of South Creek, while nutrient concentrations tended to drop

downstream. Refuse was observed at all three sites sampled.

SOUT 11.0

Biological condition category: slightly impaired.

Indices indicated slightly degraded conditions. The Hilsenhoff Biotic Index was high, and diversity was low, with midges comprising almost one half of the subsample. Diversity also was lowered by the prevalence of mayfly taxa.

Habitat condition category: partially supporting.

All habitat parameters were slightly degraded. Most parameters received only a fair rating. Embeddedness was the only instream parameter rated as good.

Water quality was fair. Nitrogen concentrations were moderate for this assessment and slightly higher than measured at downstream sites. Concentrations of metals were low, and ion concentrations were moderate.

Poor habitat appeared to be the primary source of impairment. Periodic episodes of very low flow also may have negatively affected the biological community.

SOUT 7.2

Biological condition category: nonimpaired.

Diversity, Hilsenhoff Biotic Index, and trophic similarity improved from SOUT 11.0. An increase in the number of stonefly and caddisfly genera improved the biological metrics. The site had an interesting trophic structure evenly divided among collector-gatherers, filtering-collectors, and scrapers.

Habitat condition category: supporting.

Most habitat parameters showed degradation, but the habitat received a higher score than SOUT 11.0 because there were a few parameters rated as excellent. Embeddedness was low, streambanks were covered with vegetation, and there was little channel alteration other than riprap at the bridge.

Compared to SOUT 11.0, nitrogen and sulfate were lower at this site. However, most parameters were higher at SOUT 7.2. TOC, iron, and total aluminum were significantly higher, and concentrations of TSS and dissolved residues also increased at SOUT 7.2.

SOUT 1.9

Biological condition category: slightly impaired.

The sample was taxa-rich; otherwise, the metrics were inferior to the other South Creek sites. Over 60 percent of the macroinvertebrates in the subsample were midges, which reduced taxonomic similarity to the reference site. A relatively small number of EPT individuals were identified in the subsample.

Habitat condition category: partially supporting.

The channel was significantly altered, and no primary or secondary parameters were rated as excellent. Substrate and embeddedness were good, but other instream habitat parameters were only fair. Nevertheless, the streambanks were stable and had good vegetative cover.

While habitat quality was worse at SOUT 1.9, water quality was better than at upstream sites. Concentrations of nutrients, metals, and TOC were very low. Despite better water quality than SOUT 7.2, SOUT 1.9 showed impaired biological conditions. This indicates that habitat degradation from significant channel alteration was the main source of impairment. Periodic low flow also may have contributed to impairment.

SEEL 2.8

Biological condition category: slightly impaired.

The sample taken at SEEL 2.8 had reduced diversity, taxonomic richness, and EPT Index scores. Chironomidae was the dominant taxon.

Habitat condition category: nonsupporting.

The site lacked stability. The dredged channel, which consisted of shallow pools, was surrounded by a large area of loose cobble and gravel. Substrate quality was poor and consisted mostly of gravel. Streambank habitat also was very poor; there was a small riparian zone and little vegetative cover.

Except for acidity, most water quality parameter concentrations were not as good as upstream. Aluminum and iron were low. Nitrogen values at SEEL 2.8 were more typical of a reference category 60ab site than the elevated concentrations found upstream.

Heavily altered habitat appeared to be the main source of biological impairment. Flow-related incidents also may have played a role in altering habitat at SEEL 2.8.

CHEM 18.5

Biological condition category: slightly impaired.

Like CHEM 40.1, metrics were fair. Most notable were the reduced EPT Index and high Hilsenhoff Biotic Index. Together, Chironomidae and *Chimarra* comprised over 50 percent of the sample.

Habitat condition category: excellent.

Most parameters were rated only good to fair. Due to less than optimal conditions at the reference site, habitat at CHEM 18.5 was rated as excellent despite several degraded conditions. There was a prominent lack of riffles, and some steep areas were unvegetated due to erosion.

Water quality testing showed that elevated nitrogen concentrations were significantly greater than at CHEM 28.3. Sodium and chloride also were high, and phosphorus concentrations were the highest in this assessment. Total aluminum was slightly elevated, but was present in the highest concentration found at any of the Chemung sites.

NYSDEC sampled a RIBS site downstream of CHEM 18.5 at Chemung, N.Y. Results were similar; a slightly impacted macroinvertebrate community and nutrient enrichment were found. In addition, NYSDEC cited iron, manganese, nickel, and zinc as parameters of concern in sediment samples (NYSDEC, 1994).

Bentley Creek

Bentley Creek had excellent water quality, but there was a lack of good habitat due to stream alteration. Macroinvertebrate samples indicated that the stream would have exceptional macroinvertebrate communities if habitat were improved. Chironomidae was the dominant taxon, but the rest of the sample was mostly EPT taxa with moderate to zero organic pollution tolerance.

BNTY 5.7

Biological condition category: moderately impaired.

At BNTY 5.7, metrics were worse than at other sites on Bentley Creek. Seventy-four percent of the individuals in the sample were Chironomids, which significantly increased the Hilsenhoff Biotic Index. In addition, poor diversity and only six EPT taxa were found at the site. Nevertheless, a few pollution-intolerant organisms were present, including seven *Sweltsa* (Plecoptera: Chloroperlidae).

Habitat condition category: nonsupporting.

Both instream and streambank conditions were extremely poor due to alteration. There was an obvious lack of stable substrate for colonization. Riffles were absent; the channel consisted of multiple small pools. At the time of

sampling, the stream was almost dry. Eroded, steep streambanks had minimal vegetative cover. Human refuse was present at the site during sampling.

Significant channel alteration appeared to cause biological impairment. Water quality was generally good, but compared to other Bentley Creek sites, acidity, iron, and nitrogen were slightly higher.

BNTY 2.5

Biological condition category: nonimpaired.

Metrics showed a significant improvement from BNTY 5.7. All scores were higher, including taxonomic richness and the EPT Index. Six mayfly and four caddisfly genera were present at BNTY 2.5. (In comparison, one mayfly genus and two caddisfly genera were present at BNTY 5.7.)

Habitat condition category: partially supporting.

Channel alteration was less severe at this site, but instability was very high. At BNTY 2.5, the channel was bordered by a wide gravel bar on one side and a steep eroded streambank on the other. Erosion of the steep streambank was accelerated by upstream gravel removal.

Water quality appeared good. Both nutrients and metals concentrations were very low. Ions were low.

BNTY 0.7

Biological condition category: nonimpaired.

Metrics were slightly reduced from BNTY 2.5. Similarity to the reference site increased the rating of this site. The sample included two uncommon stonefly (Plecoptera: Chloroperlidae) individuals with zero pollution-tolerance values.

Habitat condition category: supporting.

Overall habitat at BNTY 0.7 was better than that of upstream sites, but it also was heavily altered and very prone to erosion. Like BNTY 2.5, the stream cut into a very steep bank at this site. Cobble was compacted on the opposite streambank by bulldozers.

Chemical water quality was little changed from the upstream site, except for slightly elevated concentrations of ions. Concentrations of nutrients and metals remained low.

Wynkoop Creek

Biological condition category: nonimpaired.

All metrics were excellent. The site had a very high EPT Index for reference category 60ab and had a lower Hilsenhoff Biotic Index than the reference site.

Habitat condition category: partially supporting.

Most habitat metrics were less than optimal, except for substrate and embeddedness. Erosion was a significant problem, despite the addition of riprap. Vegetative cover was poor.

WYNK 0.5 had the least alkalinity, conductivity, and dissolved residues, and the most TSS in the Chemung watershed. Nutrients and ions were low. Total iron concentration was high, and total aluminum was slightly elevated.

CHEM 2.5

Biological condition category: nonimpaired.

The Hilsenhoff Biotic Index was high, mainly due to a large percentage of Chironomidae and *Cheumatopsyche* in the subsample. Taxonomic richness and diversity scores were good.

Habitat condition category: excellent.

Most habitat parameters were good. Embeddedness, pool quality, and riffle/run ratio were excellent.

Nutrient concentrations were elevated, although phosphorus was slightly lower than at CHEM 18.5. Sodium and chloride were high. Conductivity and dissolved residues were high.

The macroinvertebrate community at this site received a nonimpaired designation. However, NYSDEC's RIBS classified the biological community of a nearby site at Chemung, N.Y., as "slightly impacted" due to high biomass that resulted from nutrient enrichment (NYSDEC, 1994).

Summary of Watersheds

Table 26 lists all sites with their biological and habitat scores and condition category. Possible causes of impairment are listed in Table 27.

AMD influences water chemistry and biotic processes in much of the Tioga River Watershed. From Blossburg, Pa., to the Tioga Reservoir, biological communities of the main stem Tioga River are severely impaired.

During sampling, the biological community at the mouth of the Cowanesque River was severely impacted by Cowanesque Reservoir. Slight impairment was found at all other Cowanesque River Watershed sites; degraded habitat was usually a factor. Nutrient enrichment and wastewater affected water quality in the mid-reaches of the Cowanesque River.

Canisteo River Watershed sites generally had good biological conditions, with the exception of Canacadea Creek and Canisteo River sites near the Arkport-Hornell-Canisteo area. These sites suffered from poor water chemistry and channelization.

Cohocton River Watershed sites usually had excellent habitat, but poor water quality. Agriculture was the predominant influence in the watershed. All Cohocton River sites showed slight nutrient enrichment. Most biological communities at the sites showed non- or slight impairment. The only site with severely impaired biological conditions was Mud Creek, which was impaired by lack of flow.

The Chemung River Watershed is heavily influenced by the urbanized Corning/Painted Post and Elmira/Horseheads areas. Most streams are heavily altered. Bentley Creek was one of the few streams sampled in the watershed that had excellent water quality, but instream alteration negatively affected macroinvertebrate communities. Tributaries are prone to occasional dewatering.

Table 26. Summary of Biological and Physical Habitat Conditions of Sample Sites in the Chemung Subbasin

Sample Site	Biological Score			Habitat Score		
	Total Score	Percent of Reference	Condition Category	Total Score	Percent of Reference	Condition Category
Reference Category 60ab						
CNST 44.1	**36**	**100**	**Nonimpaired**	**115**	**100**	**Excellent**
WYNK 0.5	36	100	Nonimpaired	85	74	Partially supporting
KARR 0.1	34	94	Nonimpaired	97	84	Supporting
TWVE 0.5	32	89	Nonimpaired	118	103	Excellent
BNTY 2.5	32	89	Nonimpaired	83	72	Partially supporting
TENM 0.2	30	83	Nonimpaired	109	95	Excellent
BNTY 0.7	30	83	Nonimpaired	93	81	Supporting
SOUT 7.2	30	83	Nonimpaired	90	78	Supporting
CORY 1.5	28	78	Slightly impaired	119	103	Excellent
NBTC 0.1	28	78	Slightly impaired	110	96	Excellent
5MIL 1.1	28	78	Slightly impaired	105	91	Excellent
COHO 37.5	28	78	Slightly impaired	104	90	Excellent
SING 0.4	28	78	Slightly impaired	103	90	Excellent
MEAD 0.1	28	78	Slightly impaired	95	83	Supporting
TUSC 12.5	28	78	Slightly impaired	92	80	Supporting
SOUT 11.0	26	72	Slightly impaired	84	73	Partially supporting
BENN 1.0	24	67	Slightly impaired	87	76	Supporting
SOUT 1.9	24	67	Slightly impaired	84	73	Partially supporting
CANA 1.7	22	61	Slightly impaired	108	94	Excellent
POST 0.4	22	61	Slightly impaired	86	75	Supporting
SEEL 11.3	22	61	Slightly impaired	66	57	Nonsupporting
NEWT 0.6	20	56	Slightly impaired	80	70	Partially supporting
SEEL 2.8	20	56	Slightly impaired	48	42	Nonsupporting
BNTY 5.7	14	39	Moderately impaired	50	43	Nonsupporting
WMUD 1.1	0	0	Severely impaired	60	52	Nonsupporting
Reference Category 60m						
CNST 7.7	**36**	**100**	**Nonimpaired**	**117**	**100**	**Excellent**
COHO 14.6	32	89	Nonimpaired	133	114	Excellent
CNST 21.3	30	83	Nonimpaired	113	97	Excellent
TUSC 0.4	30	83	Nonimpaired	96	82	Supporting
COWN 13.0	28	78	Slightly impaired	102	87	Supporting
COHO 25.0	26	72	Slightly impaired	124	106	Excellent
CNST 31.3	14	39	Moderately impaired	44	38	Nonsupporting
TIOG 35.4	8	22	Moderately impaired	113	97	Excellent
CNST 36.5	8	22	Moderately impaired	70	60	Nonsupporting
COWN 0.1	4	11	Severely impaired	99	85	Supporting
TIOG 29.8	0	0	Severely impaired	75	64	Partially supporting
Reference Category 60L						
CHEM 28.3	**36**	**100**	**Nonimpaired**	**94**	**100**	**Excellent**
COHO 0.5	34	94	Nonimpaired	122	130	Excellent
CHEM 2.5	32	89	Nonimpaired	113	120	Excellent
CNST 1.0	30	83	Nonimpaired	109	116	Excellent
COHO 4.0	28	78	Slightly impaired	119	127	Excellent
CHEM 40.1	28	78	Slightly impaired	107	114	Excellent
CHEM 18.5	28	78	Slightly impaired	88	94	Excellent
TIOG 6.2	26	72	Slightly impaired	113	120	Excellent

Table 26. Summary of Biological and Physical Habitat Conditions of Sample Sites in the Chemung Subbasin—Continued

Sample Site	Biological Score			Habitat Score		
	Total Score	Percent of Reference	Condition Category	Total Score	Percent of Reference	Condition Category
Reference Category 62c						
TIOG 49.2	**36**	**100**	**Nonimpaired**	**107**	**100**	**Excellent**
HILL 0.2	30	83	Nonimpaired	102	95	Excellent
CRKD 0.1	26	72	Slightly impaired	113	106	Excellent
NFCO 0.1	26	72	Slightly impaired	98	92	Excellent
COWN 30.1	24	67	Slightly impaired	90	84	Supporting
TIOG 16.3	22	61	Slightly impaired	105	98	Excellent
TRUP 0.4	20	56	Slightly impaired	87	81	Supporting
COWN 21.3	20	56	Slightly impaired	79	74	Partially supporting
FELL 0.1	18	50	Moderately impaired	106	99	Excellent
JOHN 0.1	14	39	Moderately impaired	82	77	Supporting
MILL 0.1	6	17	Severely impaired	106	99	Excellent
MORR 0.8	4	11	Severely impaired	87	81	Supporting
TIOG 42.3	0	0	Severely impaired	114	107	Excellent
TIOG 39.6	0	0	Severely impaired	82	77	Supporting

Table 27. Summary of Possible Causes and Sources of Impairment at Chemung Subbasin Sample Sites

Site	Impairment Status	Factors That May Contribute to Impairment			Primary Source(s) of Impairment
		Chemistry	Habitat	Other	
5MIL 1.1	Slightly impaired			X	livestock access
CHEM 18.5	Slightly impaired	X	X		unknown
CHEM 40.1	Slightly impaired	X			multiple sources
COHO 37.5	Slightly impaired	X			multiple sources
COHO 4.0	Slightly impaired	X			unknown
CORY 1.5	Slightly impaired			X	unknown
COWN 13.0	Slightly impaired	X	X		channel alteration, flow from upstream sources
MEAD 0.1	Slightly impaired		X		poor habitat
NBTC 0.1	Slightly impaired			X	unknown/marginal impairment
SING 0.4	Slightly impaired	X			agricultural and/or urban runoff
TUSC 12.5	Slightly impaired	X	X		poor habitat, urban runoff
COHO 25.0	Slightly impaired	X			multiple sources
CRKD 0.1	Slightly impaired	X		X	impoundment
NFCO 0.1	Slightly impaired	X			unknown
SOUT 11.0	Slightly impaired	X	X		poor habitat, low flow episodes
TIOG 6.2	Slightly impaired	X			flow from upstream source (Cowanesque River), multiple sources
BENN 1.0	Slightly impaired		X	X	poor habitat, impoundment
COWN 30.1	Slightly impaired		X		poor habitat
SOUT 1.9	Slightly impaired		X		channel alteration
CANA 1.7	Slightly impaired	X			multiple sources
POST 0.4	Slightly impaired	X	X		poor habitat
SEEL 11.3	Slightly impaired	X	X		channel alteration, periodic low flow conditions
TIOG 16.3	Slightly impaired	X			acid mine drainage
COWN 21.3	Slightly impaired	X	X		channel alteration, runoff or wastewater
NEWT 0.6	Slightly impaired	X	X		wastewater
SEEL 2.8	Slightly impaired	X	X		channel alteration
TRUP 0.4	Slightly impaired		X		poor habitat
FELL 0.1	Moderately impaired	X			naturally occurring conditions
BNTY 5.7	Moderately impaired	X	X		channel alteration
CNST 31.3	Moderately impaired	X	X		channel alteration, multiple
JOHN 0.1	Moderately impaired	X	X		channel alteration, resource extraction
CNST 36.5	Moderately impaired	X	X		channel alteration, multiple
TIOG 35.4	Moderately impaired	X			acid mine drainage
MILL 0.1	Severely impaired			X	bedrock substrate
COWN 0.1	Severely impaired	X	X	X	impoundment
MORR 0.8	Severely impaired	X	X		acid mine drainage
TIOG 29.8	Severely impaired	X	X		acid mine drainage
TIOG 39.6	Severely impaired	X	X		acid mine drainage
TIOG 42.3	Severely impaired	X			acid mine drainage
WMUD 1.1	Severely impaired		X		no flow

CONCLUSIONS AND MANAGEMENT IMPLICATIONS

In spite of some improvements made in water quality during the last two decades, many problems continue to degrade or threaten the health of biological communities within the Chemung Subbasin. During this assessment, some level of biological impairment was present at 69 percent of the sites surveyed.

Approximately 31 percent of the 58 sites assessed in the Chemung Subbasin supported nonimpaired biological communities. Biological conditions were slightly impaired at 47 percent of the sites sampled. Moderate impairment was found at 10 percent of the sites, and severe impairment was evident at 12 percent.

Poor water quality appeared to be the most widespread threat to biological communities. Of the 40 impaired sites, about 30 may have been affected by water chemistry. Water quality was primarily degraded by AMD, wastewater/runoff, and multiple nonpoint sources. High levels of metals have long been documented in Chemung Subbasin streams. During this assessment, total iron concentration exceeded 300 µg/L at 21 sites, and total manganese exceeded 300 µg/L at 16 sites. Nutrient enrichment was not severe, but was evident in many areas, especially when compared to the nutrient-poor condition of relatively pristine stream reaches. Twenty-six of the 58 sites had total nitrogen higher than 0.6 mg/l, although none exceeded drinking water standards for the region.

Mine land reclamation and projects such as treatment wetlands, anoxic limestone drains, diversion wells, and limestone dosing should be investigated as possible means of improving streams degraded by AMD. Best management practices should be implemented to assist in controlling sources of agricultural and urban runoff. Maintenance of riparian buffers and construction of streambank fencing should be used to assist in controlling sediments and nutrients, and would help stabilize streambanks in agricultural areas.

The impaired conditions that have been documented by SRBC below Cowanesque Reservoir warrant more detailed investigation. Potential environmental mitigation measures should be explored in an effort to improve water quality and biological conditions below this reservoir.

Habitat degradation played a pivotal role in impairment documented in this subbasin survey. Most moderately or severely impaired sites had degraded habitat, which was often a result of alteration by human activities. The most severe alteration was instream gravel removal, which drastically altered the stream flow characteristics, channel morphology, and substrate. The operation of heavy machinery in or near the streambed contributed to streambank instability by destroying bank vegetation.

Bentley Creek and several other streams in the Chemung Subbasin have been subjected to significant economic losses resulting from flooding and severe streambank erosion. Over $4 million in damages have been documented in the Bentley Creek Watershed since 1972. These damages do not include those incurred during the January 1996 flood.

Conditions in Bentley Creek have been aggravated by the geology and hydrology of the region, as well as some instream channel modifications. Extensive streambank erosion has been occurring in the watershed since at least 1972.

The Bentley Creek Watershed has been on the USDA, Natural Resources Conservation Service's P.L. 566 project list since 1965. An interagency Flooding and Streambank Erosion Roundtable, chaired by the Pa. DEP, addressed the problem of stream flooding and debris in the northern tier of Pennsylvania. In a December 1995 report, the roundtable recognized the Bentley Creek Watershed as a high priority area for management and restoration. This same task force recognized the need for a model restoration and management plan that could be applied to similar watersheds in the glaciated northern regions of Pennsylvania.

In 1998, the U.S. Fish and Wildlife Service (USFWS) received federal funding to conduct a demonstration project on the Bentley Creek Watershed. David Rosgen, an internationally known expert in stream restoration, was hired as a consultant to assist in developing a restoration plan using techniques of applied fluvial geomorphology. This holistic approach to stream restoration relies on detailed data from the stream to be restored, as well as equivalent data from an appropriate reference stream, and works to restore the stream to naturally stable conditions.

Survey work for the Bentley Creek project was completed in summer 1998, and a restoration plan is presently being developed for the entire watershed. Construction of the first restoration segment is expected to be initiated in 1998, and the remaining areas will be prioritized for future work. The Bentley Creek project holds promise for the future restoration of this watershed, and should serve as a model for addressing erosion and sedimentation problems in other areas of the Chemung Subbasin.

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APPENDIX A

ORGANIC POLLUTION-TOLERANCE VALUES AND FUNCTIONAL FEEDING GROUP DESIGNATIONS OF BENTHIC MACROINVERTEBRATE TAXA

Class: Order	Family	Family/*Genus*	Organic Pollution Tolerance Value	Functional Feeding Group Designation*
Insecta: Coleoptera	**Dytiscidae**	*Agabus*	5	P
	Elmidae	*Dubiraphia*	6	SC
		Optioservus	4	SC
		Ordobrevia	5	SC
		Oulimnius	5	SC
		Stenelmis	5	SC
	Gyrinidae	*Dineutus*	4	P
	Hydrophilidae	*Berosus*	5	CG
	Psephenidae	*Psephenus*	4	SC
		Ectopria	5	SC
Diptera	**Athericidae**	*Atherix*	2	P
	Ceratopogonidae	*Bezzia*	6	P
		Ceratopogoninae	6	P
	Chironomidae	**Chironomidae**	7	CG
	Empididae	*Hemerodromia*	6	P
		Dolichocephala	5	
		Rhamphomyia	6	P
	Simuliidae	**Simuliidae**	6	FC
	Stratiomyiidae	*Odontomyia*	6	CG
	Tabanidae	*Chrysops*	7	P
	Tipulidae	*Antocha*	3	CG
		Dicranota	3	P
		Hexatoma	2	P
		Limnophila	3	P
		Limonia	6	SH
		Tipula	4	SH
Ephemeroptera	**Baetidae**	*Acentrella*	4	CG
		Baetis	6	CG
		Centroptilum	2	CG
		Heterocloeon	2	SC
	Baetiscidae	*Baetisca*	4	CG
	Caenidae	*Brachycercus*	3	CG
		Caenis	7	CG
	Ephemerellidae	*Attenella*	2	CG
		Drunella	1	SC
		Ephemerella	1	CG
		Eurylophella	4	CG
		Serratella	2	CG
	Ephemeridae	*Ephemera*	2	CG
	Heptageniidae	*Epeorus*	0	CG
		Heptagenia	4	SC
		Leucrocuta	1	SC
		Nixe	2	SC
		Stenacron	4	CG
		Stenonema	3	SC
	Isonychiidae	*Isonychia*	2	FC
	Leptophlebiidae	*Leptophlebia*	4	CG
		Paraleptophlebia	1	CG
Ephemeroptera	**Potamanthidae**	*Anthopotamus*	4	CG
	Tricorythidae	*Tricorythodes*	4	CG
Hemiptera	**Veliidae**	*Rhagovelia*	8	P
Lepidoptera	**Pyralidae**	*Petrophila*	5	SC
Megaloptera	**Corydalidae**	*Corydalus*	4	P
		Nigronia	2	P
	Sialidae	*Sialis*	4	P

Class: Order	Family	Family/*Genus*	Organic Pollution Tolerance Value	Functional Feeding Group Designation*
Odonata	**Aeshnidae**	*Boyeria*	2	P
	Coenagrionidae	*Argia*	6	P
	Gomphidae	*Ophiogomphus*	1	P
		Stylogomphus albistylus	4	P
Plecoptera	**Capniidae**	*Paracapnia*	1	SH
	Chloroperlidae	*Alloperla*	0	CG
		Haploperla	0	P
		Sweltsa	0	P
		Utaperla	0	
	Leuctridae	*Leuctra*	0	SH
	Perlidae	*Acroneuria*	0	P
		Agnetina	2	P
		Eccoptura	2	P
		Neoperla	3	P
		Paragnetina	1	P
	Perlodidae	*Isoperla*	2	P
	Pteronarcyidae	*Pteronarcys*	0	SH
	Taeniopterygidae	*Taeniopteryx*	2	SH
Trichoptera	**Hydropsychidae**	*Ceratopsyche*	4	FC
		Cheumatopsyche	5	FC
		Diplectrona	0	FC
		Hydropsyche	4	FC
		Macrostemum	3	FC
		Potamyia flava	5	FC
	Hydroptilidae	*Hydroptila*	6	SC
		Leucotrichia	6	SC
	Leptoceridae	*Mystacides*	4	CG
	Limnophilidae	*Hydatophylax*	2	SH
	Odontoceridae	*Psilotreta*	0	SC
	Philopotamidae	*Chimarra*	4	FC
		Dolophilodes	0	FC
	Polycentropodidae	*Neureclipsis*	7	FC
		Nyctiophylax	5	FC
		Polycentropus	6	FC
	Psychomyiidae	*Psychomyia*	2	CG
	Rhyacophilidae	*Rhyacophila*	1	P
Turbellaria: Tricladida	**Planariidae**	*Dugesia*	7	P
Oligochaeta: Lumbriculida	**Lumbriculidae**	**Lumbriculidae**	8	CG
Crustacea:Amphipoda	**Gammaridae**	*Gammarus*	6	SH
	Talitridae	*Hyalella*	8	SH
Isopoda	**Asellidae**	*Caecidotea*	8	SH
Arachnoidea: Hydracarina	**Hydracarina**	**Hydracarina**	7	P
Gastropoda: Gastropoda	**Physidae**	*Physa*	8	SC
	Planorbidae	**Planorbidae**	6	
Bivalvia: Pelecypoda	**Sphaeriidae**	*Pisidium*	8	FC

* SH Shredder
CG Collector/Gatherer
FC Filtering Collector
SC Scraper
P Predator

Source: US EPA (1990)

APPENDIX B

RAW BENTHIC MACROINVERTEBRATE DATA FROM SAMPLE SITES IN THE CHEMUNG SUBBASIN

Class: Order	Family	Family/*Genus*	Reference Category 60ab			
			BENN 1.0	BNTY 0.7	BNTY 2.5	BNTY 5.7
Insecta: Coleoptera	**Dytiscidae**	*Agabus*				
	Elmidae	*Dubiraphia*				
		Optioservus		2	1	
		Ordobrevia				
		Oulimnius				
		Stenelmis	2			1
	Gyrinidae	*Dineutus*				
	Hydrophilidae	*Berosus*	1			
	Psephenidae	*Psephenus*				
		Ectopria				
Diptera	**Athericidae**	*Atherix*				
	Ceratopogonidae	*Bezzia*	1		3	
		Ceratopogoninae				
	Chironomidae	**Chironomidae**	58	58	52	77
	Empididae	*Hemerodromia*	6	5	1	1
		Dolichocephala				
		Rhamphomyia				
	Simuliidae	**Simuliidae**				
	Stratiomyiidae	*Odontomyia*				
	Tabanidae	*Chrysops*	1			
	Tipulidae	*Antocha*	1		4	
		Dicranota				3
		Hexatoma		2	1	2
		Limnophila				
		Limonia				
		Tipula				3
Ephemeroptera	**Baetidae**	*Acentrella*				
		Baetis			1	
		Centroptilum				
		Heterocloeon				
	Baetiscidae	*Baetisca*				
	Caenidae	*Brachycercus*				
		Caenis	1			
	Ephemerellidae	*Attenella*				
		Drunella				
		Ephemerella		3		
		Eurylophella		3	1	1
		Serratella	1	4	19	
	Ephemeridae	*Ephemera*	1			
	Heptageniidae	*Epeorus*				
		Heptagenia			1	
		Leucrocuta				
		Nixe				
		Stenacron				
		Stenonema	17	8	2	
	Isonychiidae	*Isonychia*	11	6	2	
	Leptophlebiidae	*Leptophlebia*		2		
		Paraleptophlebia			4	
	Potamanthidae	*Anthopotamus*				
	Tricorythidae	*Tricorythodes*				
Hemiptera	**Veliidae**	*Rhagovelia*				
Lepidoptera	**Pyralidae**	*Petrophila*				

Class: Order	Family	Family/*Genus*	Reference Category 60ab			
			BENN 1.0	BNTY 0.7	BNTY 2.5	BNTY 5.7
Megaloptera	**Corydalidae**	*Corydalus*				
		Nigronia				
	Sialidae	*Sialis*				
Odonata	**Aeshnidae**	*Boyeria*				
	Coenagrionidae	*Argia*				
	Gomphidae	*Ophiogomphus*				
		Stylogomphus albistylus				
Plecoptera	**Capniidae**	*Paracapnia*				
	Chloroperlidae	*Alloperla*				
		Haploperla		1		
		Sweltsa				7
		Utaperla		1		
	Leuctridae	*Leuctra*				3
	Perlidae	*Acroneuria*				
		Agnetina				
		Eccoptura				
		Neoperla	1			
		Paragnetina				
	Perlodidae	*Isoperla*			2	
	Pteronarcyidae	*Pteronarcys*				
	Taeniopterygidae	*Taeniopteryx*	1	8	4	2
Trichoptera	**Hydropsychidae**	*Ceratopsyche*	10	9	18	1
		Cheumatopsyche	6			
		Diplectrona				
		Hydropsyche			2	
		Macrostemum				
		Potamyia flava				
	Hydroptilidae	*Hydroptila*				
		Leucotrichia				
	Leptoceridae	*Mystacides*				
	Limnophilidae	*Hydatophylax*				
	Odontoceridae	*Psilotreta*				
	Philopotamidae	*Chimarra*			1	2
		Dolophilodes		2		
	Polycentropodidae	*Neureclipsis*				
		Nyctiophylax				
		Polycentropus		4	2	
	Psychomyiidae	*Psychomyia*				
	Rhyacophilidae	*Rhyacophila*				
Turbellaria: Tricladida	**Planariidae**	*Dugesia*				
Oligochaeta: Lumbriculida	**Lumbriculidae**	**Lumbriculidae**				
Crustacea: Amphipoda	**Gammaridae**	*Gammarus*				
	Talitridae	*Hyalella*				
Isopoda	**Asellidae**	*Caecidotea*				
Arachnoidea: Hydracarina	**Hydracarina**	**Hydracarina**	1			1
Gastropoda: Gastropoda	**Physidae**	*Physa*				
	Planorbidae	**Planorbidae**				
Bivalvia: Pelecypoda	**Sphaeriidae**	*Pisidium*				

Class: Order	Family	Family/*Genus*	Reference Category 60ab			
			CANA 1.7	CNST 44.1	COHO 37.5	CORY 1.5
Insecta: Coleoptera	**Dytiscidae**	*Agabus*				
	Elmidae	*Dubiraphia*		1	1	
		Optioservus			7	3
		Ordobrevia				
		Oulimnius				
		Stenelmis	2	2	9	1
	Gyrinidae	*Dineutus*				
	Hydrophilidae	*Berosus*				
	Psephenidae	*Psephenus*			3	3
		Ectopria			1	
Diptera	**Athericidae**	*Atherix*	21	7		
	Ceratopogonidae	*Bezzia*				
		Ceratopogoninae			1	
	Chironomidae	**Chironomidae**	49	25	40	11
	Empididae	*Hemerodromia*	6	4	2	
		Dolichocephala				
		Rhamphomyia				
	Simuliidae	**Simuliidae**				2
	Stratiomyiidae	*Odontomyia*				
	Tabanidae	*Chrysops*		1		
	Tipulidae	*Antocha*	1	2	2	1
		Dicranota				
		Hexatoma		1		4
		Limnophila				
		Limonia				
		Tipula	2		1	
Ephemeroptera	**Baetidae**	*Acentrella*				1
		Baetis		1		2
		Centroptilum				
		Heterocloeon				
	Baetiscidae	*Baetisca*				
	Caenidae	*Brachycercus*				
		Caenis	11	8		3
	Ephemerellidae	*Attenella*				
		Drunella				
		Ephemerella			2	
		Eurylophella		1		
		Serratella		2	22	
	Ephemeridae	*Ephemera*	1	10	1	
	Heptageniidae	*Epeorus*				
		Heptagenia				
		Leucrocuta				
		Nixe				
		Stenacron	16			
		Stenonema		10	4	12
	Isonychiidae	*Isonychia*		3		2
	Leptophlebiidae	*Leptophlebia*				1
		Paraleptophlebia		1	1	
	Potamanthidae	*Anthopotamus*				
	Tricorythidae	*Tricorythodes*				
Hemiptera	**Veliidae**	*Rhagovelia*				
Lepidoptera	**Pyralidae**	*Petrophila*				

Class: Order	Family	Family/*Genus*	Reference Category 60ab			
			CANA 1.7	CNST 44.1	COHO 37.5	CORY 1.5
Megaloptera	**Corydalidae**	*Corydalus*				
		Nigronia		1		
	Sialidae	*Sialis*			1	
Odonata	**Aeshnidae**	*Boyeria*				
	Coenagrionidae	*Argia*				
	Gomphidae	*Ophiogomphus*		3		
		Stylogomphus albistylus				
Plecoptera	**Capniidae**	*Paracapnia*				
	Chloroperlidae	*Alloperla*				
		Haploperla				
		Sweltsa				
		Utaperla				
	Leuctridae	*Leuctra*		2		
	Perlidae	*Acroneuria*				
		Agnetina				
		Eccoptura				1
		Neoperla		1		
		Paragnetina			1	
	Perlodidae	*Isoperla*			2	
	Pteronarcyidae	*Pteronarcys*				
	Taeniopterygidae	*Taeniopteryx*	1	1	5	
Trichoptera	**Hydropsychidae**	*Ceratopsyche*	2	18	4	15
		Cheumatopsyche	2	6	1	1
		Diplectrona				
		Hydropsyche	1			3
		Macrostemum				
		Potamyia flava				
	Hydroptilidae	*Hydroptila*				
		Leucotrichia				
	Leptoceridae	*Mystacides*				
	Limnophilidae	*Hydatophylax*				
	Odontoceridae	*Psilotreta*				
	Philopotamidae	*Chimarra*		1	1	41
		Dolophilodes		1		
	Polycentropodidae	*Neureclipsis*				1
		Nyctiophylax				
		Polycentropus				
	Psychomyiidae	*Psychomyia*				
	Rhyacophilidae	*Rhyacophila*				
Turbellaria: Tricladida	**Planariidae**	*Dugesia*				
Oligochaeta: Lumbriculida	**Lumbriculidae**	**Lumbriculidae**	1			
Crustacea: Amphipoda	**Gammaridae**	*Gammarus*			2	
	Talitridae	*Hyalella*				
Isopoda	**Asellidae**	*Caecidotea*	3			
Arachnoidea: Hydracarina	**Hydracarina**	**Hydracarina**				
Gastropoda: Gastropoda	**Physidae**	*Physa*				
	Planorbidae	**Planorbidae**				
Bivalvia: Pelecypoda	**Sphaeriidae**	*Pisidium*				

Class: Order	Family	Family/*Genus*	Reference Category 60ab			
			5MIL 1.1	KARR 0.1	MEAD 0.1	NBTC 0.1
Insecta: Coleoptera	**Dytiscidae**	*Agabus*		1		
	Elmidae	*Dubiraphia*				
		Optioservus	3	1	3	
		Ordobrevia				
		Oulimnius				
		Stenelmis	4			1
	Gyrinidae	*Dineutus*				
	Hydrophilidae	*Berosus*				
	Psephenidae	*Psephenus*				2
		Ectopria	1			
Diptera	**Athericidae**	*Atherix*	1			3
	Ceratopogonidae	*Bezzia*		1		
		Ceratopogoninae				
	Chironomidae	**Chironomidae**	24	42	9	13
	Empididae	*Hemerodromia*	3			1
		Dolichocephala				
		Rhamphomyia		1		
	Simuliidae	**Simuliidae**				
	Stratiomyiidae	*Odontomyia*				
	Tabanidae	*Chrysops*				
	Tipulidae	*Antocha*	9		2	1
		Dicranota				
		Hexatoma		2	3	2
		Limnophila		1		
		Limonia				
		Tipula				
Ephemeroptera	**Baetidae**	*Acentrella*		6		
		Baetis	1		2	1
		Centroptilum				
		Heterocloeon				
	Baetiscidae	*Baetisca*				
	Caenidae	*Brachycercus*				
		Caenis				1
	Ephemerellidae	*Attenella*			4	
		Drunella				
		Ephemerella	11	6	1	
		Eurylophella				
		Serratella				
	Ephemeridae	*Ephemera*			1	
	Heptageniidae	*Epeorus*				
		Heptagenia				
		Leucrocuta				
		Nixe				
		Stenacron	13			
		Stenonema	12	12	26	21
	Isonychiidae	*Isonychia*		2	28	6
	Leptophlebiidae	*Leptophlebia*			7	
		Paraleptophlebia				
	Potamanthidae	*Anthopotamus*				
	Tricorythidae	*Tricorythodes*		1		
Hemiptera	**Veliidae**	*Rhagovelia*				
Lepidoptera	**Pyralidae**	*Petrophila*				

Class: Order	Family	Family/*Genus*	Reference Category 60ab			
			5MIL 1.1	KARR 0.1	MEAD 0.1	NBTC 0.1
Megaloptera	**Corydalidae**	*Corydalus*				
		Nigronia				
	Sialidae	*Sialis*				
Odonata	**Aeshnidae**	*Boyeria*				
	Coenagrionidae	*Argia*				
	Gomphidae	*Ophiogomphus*		1		
		Stylogomphus albistylus				
Plecoptera	**Capniidae**	*Paracapnia*				
	Chloroperlidae	*Alloperla*		1		
		Haploperla				
		Sweltsa		5		
		Utaperla				
	Leuctridae	*Leuctra*				
	Perlidae	*Acroneuria*				
		Agnetina			2	1
		Eccoptura				
		Neoperla		1		
		Paragnetina	1			
	Perlodidae	*Isoperla*				
	Pteronarcyidae	*Pteronarcys*				
	Taeniopterygidae	*Taeniopteryx*			13	1
Trichoptera	**Hydropsychidae**	*Ceratopsyche*	24	15	11	16
		Cheumatopsyche	10		9	4
		Diplectrona				
		Hydropsyche		5	1	10
		Macrostemum				
		Potamyia flava				
	Hydroptilidae	*Hydroptila*				
		Leucotrichia				
	Leptoceridae	*Mystacides*				
	Limnophilidae	*Hydatophylax*				
	Odontoceridae	*Psilotreta*				
	Philopotamidae	*Chimarra*	8	2	1	26
		Dolophilodes				
	Polycentropodidae	*Neureclipsis*		1		1
		Nyctiophylax				
		Polycentropus				
	Psychomyiidae	*Psychomyia*	1			
	Rhyacophilidae	*Rhyacophila*				
Turbellaria: Tricladida	**Planariidae**	*Dugesia*				
Oligochaeta: Lumbriculida	**Lumbriculidae**	**Lumbriculidae**				
Crustacea: Amphipoda	**Gammaridae**	*Gammarus*				
	Talitridae	*Hyalella*				
Isopoda	**Asellidae**	*Caecidotea*				
Arachnoidea: Hydracarina	**Hydracarina**	**Hydracarina**				
Gastropoda: Gastropoda	**Physidae**	*Physa*				
	Planorbidae	**Planorbidae**				
Bivalvia: Pelecypoda	**Sphaeriidae**	*Pisidium*				

Class: Order	Family	Family/*Genus*	Reference Category 60ab			
			NEWT 0.6	POST 0.4	SEEL 2.8	SEEL 11.3
Insecta: Coleoptera	**Dytiscidae**	*Agabus*				
	Elmidae	*Dubiraphia*	1			
		Optioservus	6	1		
		Ordobrevia				
		Oulimnius				
		Stenelmis	7	1	1	
	Gyrinidae	*Dineutus*				
	Hydrophilidae	*Berosus*				
	Psephenidae	*Psephenus*		2		
		Ectopria				
Diptera	**Athericidae**	*Atherix*	3			
	Ceratopogonidae	*Bezzia*				
		Ceratopogoninae				
	Chironomidae	**Chironomidae**	43	82	60	7
	Empididae	*Hemerodromia*	1			
		Dolichocephala				
		Rhamphomyia				
	Simuliidae	**Simuliidae**				
	Stratiomyiidae	*Odontomyia*				
	Tabanidae	*Chrysops*				
	Tipulidae	*Antocha*				5
		Dicranota				
		Hexatoma				
		Limnophila				
		Limonia			3	1
		Tipula				
Ephemeroptera	**Baetidae**	*Acentrella*				
		Baetis				
		Centroptilum				
		Heterocloeon				
	Baetiscidae	*Baetisca*				
	Caenidae	*Brachycercus*				
		Caenis		1		
	Ephemerellidae	*Attenella*				
		Drunella				
		Ephemerella				
		Eurylophella				2
		Serratella		1	1	70
	Ephemeridae	*Ephemera*		3		
	Heptageniidae	*Epeorus*				
		Heptagenia				
		Leucrocuta			3	
		Nixe				
		Stenacron			5	3
		Stenonema	5	8	28	7
	Isonychiidae	*Isonychia*		4	4	3
	Leptophlebiidae	*Leptophlebia*				
		Paraleptophlebia			1	
	Potamanthidae	*Anthopotamus*				
	Tricorythidae	*Tricorythodes*			5	
Hemiptera	**Veliidae**	*Rhagovelia*				
Lepidoptera	**Pyralidae**	*Petrophila*				

Class: Order	Family	Family/*Genus*	Reference Category 60ab			
			NEWT 0.6	POST 0.4	SEEL 2.8	SEEL 11.3
Megaloptera	**Corydalidae**	*Corydalus*				
		Nigronia				
	Sialidae	*Sialis*				
Odonata	**Aeshnidae**	*Boyeria*				
	Coenagrionidae	*Argia*				
	Gomphidae	*Ophiogomphus*				
		Stylogomphus albistylus				
Plecoptera	**Capniidae**	*Paracapnia*				
	Chloroperlidae	*Alloperla*				
		Haploperla				
		Sweltsa				
		Utaperla				
	Leuctridae	*Leuctra*			5	
	Perlidae	*Acroneuria*		1		
		Agnetina		1		1
		Eccoptura				
		Neoperla				
		Paragnetina				
	Perlodidae	*Isoperla*				1
	Pteronarcyidae	*Pteronarcys*				
	Taeniopterygidae	*Taeniopteryx*	4	2	2	
Trichoptera	**Hydropsychidae**	*Ceratopsyche*	6	3	5	5
		Cheumatopsyche		2		3
		Diplectrona				
		Hydropsyche	33	2		
		Macrostemum				
		Potamyia flava				
	Hydroptilidae	*Hydroptila*				
		Leucotrichia				
	Leptoceridae	*Mystacides*				
	Limnophilidae	*Hydatophylax*				
	Odontoceridae	*Psilotreta*				
	Philopotamidae	*Chimarra*	1			1
		Dolophilodes				
	Polycentropodidae	*Neureclipsis*				2
		Nyctiophylax				
		Polycentropus	1			
	Psychomyiidae	*Psychomyia*				
	Rhyacophilidae	*Rhyacophila*	1			
Turbellaria: Tricladida	**Planariidae**	*Dugesia*				
Oligochaeta: Lumbriculida	**Lumbriculidae**	**Lumbriculidae**				
Crustacea: Amphipoda	**Gammaridae**	*Gammarus*				
	Talitridae	*Hyalella*			2	
Isopoda	**Asellidae**	*Caecidotea*	1			
Arachnoidea: Hydracarina	**Hydracarina**	**Hydracarina**		2		1
Gastropoda: Gastropoda	**Physidae**	*Physa*				1
	Planorbidae	**Planorbidae**				
Bivalvia: Pelecypoda	**Sphaeriidae**	*Pisidium*				

Class: Order	Family	Family/*Genus*	Reference Category 60ab			
			SING 0.4	SOUT 1.9	SOUT 7.2	SOUT 11.0
Insecta: Coleoptera	**Dytiscidae**	*Agabus*				
	Elmidae	*Dubiraphia*				
		Optioservus	16	1	7	1
		Ordobrevia				
		Oulimnius			1	
		Stenelmis	5	1		
	Gyrinidae	*Dineutus*				1
	Hydrophilidae	*Berosus*				
	Psephenidae	*Psephenus*			1	1
		Ectopria				
Diptera	**Athericidae**	*Atherix*		2		
	Ceratopogonidae	*Bezzia*				
		Ceratopogoninae				
	Chironomidae	**Chironomidae**	36	74	44	56
	Empididae	*Hemerodromia*				
		Dolichocephala				
		Rhamphomyia				
	Simuliidae	**Simuliidae**	1	1		
	Stratiomyiidae	*Odontomyia*				
	Tabanidae	*Chrysops*				
	Tipulidae	*Antocha*	3	1	1	1
		Dicranota				
		Hexatoma		3		
		Limnophila				
		Limonia				
		Tipula				
Ephemeroptera	**Baetidae**	*Acentrella*		1	1	
		Baetis		1		2
		Centroptilum				
		Heterocloeon				
	Baetiscidae	*Baetisca*				
	Caenidae	*Brachycercus*				
		Caenis	1			9
	Ephemerellidae	*Attenella*				
		Drunella				
		Ephemerella		7		1
		Eurylophella				
		Serratella				
	Ephemeridae	*Ephemera*				3
	Heptageniidae	*Epeorus*				
		Heptagenia			2	3
		Leucrocuta				
		Nixe				
		Stenacron				
		Stenonema		2	25	23
	Isonychiidae	*Isonychia*	6		4	
	Leptophlebiidae	*Leptophlebia*		5		
		Paraleptophlebia				5
	Potamanthidae	*Anthopotamus*				
	Tricorythidae	*Tricorythodes*				
Hemiptera	**Veliidae**	*Rhagovelia*				
Lepidoptera	**Pyralidae**	*Petrophila*				

Class: Order	Family	Family/*Genus*	Reference Category 60ab			
			SING 0.4	SOUT 1.9	SOUT 7.2	SOUT 11.0
Megaloptera	**Corydalidae**	*Corydalus*			1	
		Nigronia	2			
	Sialidae	*Sialis*	1			1
Odonata	**Aeshnidae**	*Boyeria*				
	Coenagrionidae	*Argia*				
	Gomphidae	*Ophiogomphus*		1		
		Stylogomphus albistylus	1			1
Plecoptera	**Capniidae**	*Paracapnia*				
	Chloroperlidae	*Alloperla*		4	1	1
		Haploperla				
		Sweltsa	1			
		Utaperla				
	Leuctridae	*Leuctra*				
	Perlidae	*Acroneuria*				
		Agnetina				
		Eccoptura				
		Neoperla				
		Paragnetina				
	Perlodidae	*Isoperla*				
	Pteronarcyidae	*Pteronarcys*				
	Taeniopterygidae	*Taeniopteryx*	9	3	3	
Trichoptera	**Hydropsychidae**	*Ceratopsyche*	10	6	3	
		Cheumatopsyche	3		6	3
		Diplectrona				
		Hydropsyche	1		4	1
		Macrostemum				
		Potamyia flava				
	Hydroptilidae	*Hydroptila*				1
		Leucotrichia			2	
	Leptoceridae	*Mystacides*				
	Limnophilidae	*Hydatophylax*				
	Odontoceridae	*Psilotreta*				
	Philopotamidae	*Chimarra*	6	5	21	2
		Dolophilodes		2		
	Polycentropodidae	*Neureclipsis*				
		Nyctiophylax	1			
		Polycentropus		1	1	
	Psychomyiidae	*Psychomyia*				
	Rhyacophilidae	*Rhyacophila*			1	
Turbellaria: Tricladida	**Planariidae**	*Dugesia*				
Oligochaeta: Lumbriculida	**Lumbriculidae**	**Lumbriculidae**				
Crustacea: Amphipoda	**Gammaridae**	*Gammarus*				
	Talitridae	*Hyalella*				
Isopoda	**Asellidae**	*Caecidotea*				
Arachnoidea: Hydracarina	**Hydracarina**	**Hydracarina**		1		
Gastropoda: Gastropoda	**Physidae**	*Physa*				
	Planorbidae	**Planorbidae**				
Bivalvia: Pelecypoda	**Sphaeriidae**	*Pisidium*				

Class: Order	Family	Family/*Genus*	Reference Category 60ab			
			TENM 0.2	TUSC 12.5	TWVE 0.5	WYNK 0.5
Insecta: Coleoptera	**Dytiscidae**	*Agabus*				
	Elmidae	*Dubiraphia*				
		Optioservus	15		17	3
		Ordobrevia				
		Oulimnius				
		Stenelmis	1	1	1	
	Gyrinidae	*Dineutus*				
	Hydrophilidae	*Berosus*				
	Psephenidae	*Psephenus*	2	2	2	4
		Ectopria				
Diptera	**Athericidae**	*Atherix*	2			
	Ceratopogonidae	*Bezzia*	1			
		Ceratopogoninae				
	Chironomidae	**Chironomidae**	17	37	11	21
	Empididae	*Hemerodromia*	1		2	4
		Dolichocephala				
		Rhamphomyia				
	Simuliidae	**Simuliidae**		1		
	Stratiomyiidae	*Odontomyia*				
	Tabanidae	*Chrysops*				
	Tipulidae	*Antocha*	12		14	2
		Dicranota	2			1
		Hexatoma				
		Limnophila				
		Limonia				
		Tipula				
Ephemeroptera	**Baetidae**	*Acentrella*			1	
		Baetis				2
		Centroptilum				
		Heterocloeon				
	Baetiscidae	*Baetisca*				
	Caenidae	*Brachycercus*				
		Caenis	1	3		1
	Ephemerellidae	*Attenella*				
		Drunella				
		Ephemerella	21		13	4
		Eurylophella		1		
		Serratella	10		15	3
	Ephemeridae	*Ephemera*	1	1		
	Heptageniidae	*Epeorus*				
		Heptagenia				
		Leucrocuta				
		Nixe				
		Stenacron				
		Stenonema	8	18	3	15
	Isonychiidae	*Isonychia*		9	1	25
	Leptophlebiidae	*Leptophlebia*				
		Paraleptophlebia	19		2	6
	Potamanthidae	*Anthopotamus*				
	Tricorythidae	*Tricorythodes*				
Hemiptera	**Veliidae**	*Rhagovelia*				
Lepidoptera	**Pyralidae**	*Petrophila*				

Class: Order	Family	Family/*Genus*	Reference Category 60ab			
			TENM 0.2	TUSC 12.5	TWVE 0.5	WYNK 0.5
Megaloptera	**Corydalidae**	*Corydalus*				
		Nigronia	1			
	Sialidae	*Sialis*				
Odonata	**Aeshnidae**	*Boyeria*				
	Coenagrionidae	*Argia*		1		
	Gomphidae	*Ophiogomphus*				2
		Stylogomphus albistylus				
Plecoptera	**Capniidae**	*Paracapnia*				
	Chloroperlidae	*Alloperla*				
		Haploperla	1			
		Sweltsa				4
		Utaperla				
	Leuctridae	*Leuctra*				
	Perlidae	*Acroneuria*				
		Agnetina	2		1	1
		Eccoptura				
		Neoperla				
		Paragnetina			1	
	Perlodidae	*Isoperla*	1			
	Pteronarcyidae	*Pteronarcys*				
	Taeniopterygidae	*Taeniopteryx*	2	1	2	1
Trichoptera	**Hydropsychidae**	*Ceratopsyche*	5	1	19	14
		Cheumatopsyche	4	10	13	1
		Diplectrona				
		Hydropsyche			2	
		Macrostemum				
		Potamyia flava			1	
	Hydroptilidae	*Hydroptila*				
		Leucotrichia				2
	Leptoceridae	*Mystacides*		1		
	Limnophilidae	*Hydatophylax*				
	Odontoceridae	*Psilotreta*				
	Philopotamidae	*Chimarra*		25		5
		Dolophilodes				2
	Polycentropodidae	*Neureclipsis*				
		Nyctiophylax				
		Polycentropus		1		
	Psychomyiidae	*Psychomyia*				
	Rhyacophilidae	*Rhyacophila*				
Turbellaria: Tricladida	**Planariidae**	*Dugesia*				
Oligochaeta: Lumbriculida	**Lumbriculidae**	**Lumbriculidae**				
Crustacea: Amphipoda	**Gammaridae**	*Gammarus*				
	Talitridae	*Hyalella*				
Isopoda	**Asellidae**	*Caecidotea*				
Arachnoidea: Hydracarina	**Hydracarina**	**Hydracarina**				
Gastropoda: Gastropoda	**Physidae**	*Physa*				
	Planorbidae	**Planorbidae**				
Bivalvia: Pelecypoda	**Sphaeriidae**	*Pisidium*			1	

Class: Order	Family	Family/*Genus*	Reference Category 60m		
			CNST 7.7	CNST 21.3	CNST 31.3
Insecta: Coleoptera	**Dytiscidae**	*Agabus*			
	Elmidae	*Dubiraphia*			
		Optioservus		1	
		Ordobrevia			1
		Oulimnius			
		Stenelmis	4	3	
	Gyrinidae	*Dineutus*			
	Hydrophilidae	*Berosus*			1
	Psephenidae	*Psephenus*		2	
		Ectopria			
Diptera	**Athericidae**	*Atherix*	3	4	
	Ceratopogonidae	*Bezzia*			
		Ceratopogoninae			
	Chironomidae	**Chironomidae**	25	17	86
	Empididae	*Hemerodromia*			
		Dolichocephala			
		Rhamphomyia			
	Simuliidae	**Simuliidae**	9		
	Stratiomyiidae	*Odontomyia*			
	Tabanidae	*Chrysops*			
	Tipulidae	*Antocha*	1		
		Dicranota			
		Hexatoma			
		Limnophila			
		Limonia			
		Tipula			
Ephemeroptera	**Baetidae**	*Acentrella*			
		Baetis	4		1
		Centroptilum			
		Heterocloeon			
	Baetiscidae	*Baetisca*			
	Caenidae	*Brachycercus*			
		Caenis	2		2
	Ephemerellidae	*Attenella*			
		Drunella			
		Ephemerella	6		
		Eurylophella			2
		Serratella		22	1
	Ephemeridae	*Ephemera*		1	2
	Heptageniidae	*Epeorus*			1
		Heptagenia			
		Leucrocuta			
		Nixe			
		Stenacron	3		2
		Stenonema	30	12	5
	Isonychiidae	*Isonychia*	16	12	
	Leptophlebiidae	*Leptophlebia*			
		Paraleptophlebia			
	Potamanthidae	*Anthopotamus*			
	Tricorythidae	*Tricorythodes*			
Hemiptera	**Veliidae**	*Rhagovelia*			
Lepidoptera	**Pyralidae**	*Petrophila*		2	

Class: Order	Family	Family/*Genus*	Reference Category 60m		
			CNST 7.7	CNST 21.3	CNST 31.3
Megaloptera	**Corydalidae**	*Corydalus*	5	8	
		Nigronia		1	
	Sialidae	*Sialis*			
Odonata	**Aeshnidae**	*Boyeria*			
	Coenagrionidae	*Argia*			
	Gomphidae	*Ophiogomphus*			
		Stylogomphus albistylus			
Plecoptera	**Capniidae**	*Paracapnia*			
	Chloroperlidae	*Alloperla*			
		Haploperla			
		Sweltsa			
		Utaperla			
	Leuctridae	*Leuctra*			
	Perlidae	*Acroneuria*			
		Agnetina			
		Eccoptura			
		Neoperla			
		Paragnetina			
	Perlodidae	*Isoperla*			
	Pteronarcyidae	*Pteronarcys*			
	Taeniopterygidae	*Taeniopteryx*	7	1	1
Trichoptera	**Hydropsychidae**	*Ceratopsyche*	7	17	3
		Cheumatopsyche	6	32	
		Diplectrona			
		Hydropsyche	2	6	
		Macrostemum			
		Potamyia flava	1		
	Hydroptilidae	*Hydroptila*			
		Leucotrichia			
	Leptoceridae	*Mystacides*			
	Limnophilidae	*Hydatophylax*			
	Odontoceridae	*Psilotreta*			
	Philopotamidae	*Chimarra*	19	17	
		Dolophilodes			
	Polycentropodidae	*Neureclipsis*			
		Nyctiophylax			
		Polycentropus	1		
	Psychomyiidae	*Psychomyia*			
	Rhyacophilidae	*Rhyacophila*			
Turbellaria: Tricladida	**Planariidae**	*Dugesia*			
Oligochaeta: Lumbriculida	**Lumbriculidae**	**Lumbriculidae**			
Crustacea: Amphipoda	**Gammaridae**	*Gammarus*			1
	Talitridae	*Hyalella*			
Isopoda	**Asellidae**	*Caecidotea*			1
Arachnoidea: Hydracarina	**Hydracarina**	**Hydracarina**			
Gastropoda: Gastropoda	**Physidae**	*Physa*			
	Planorbidae	**Planorbidae**			
Bivalvia: Pelecypoda	**Sphaeriidae**	*Pisidium*	3		

Class: Order	Family	Family/*Genus*	Reference Category 60m		
			CNST 36.5	COHO 14.6	COHO 25.0
Insecta: Coleoptera	**Dytiscidae**	*Agabus*			
	Elmidae	*Dubiraphia*			
		Optioservus		16	4
		Ordobrevia			
		Oulimnius			
		Stenelmis		3	7
	Gyrinidae	*Dineutus*			
	Hydrophilidae	*Berosus*			
	Psephenidae	*Psephenus*		1	
		Ectopria			
Diptera	**Athericidae**	*Atherix*		4	1
	Ceratopogonidae	*Bezzia*			
		Ceratopogoninae			
	Chironomidae	**Chironomidae**	87	22	23
	Empididae	*Hemerodromia*		1	1
		Dolichocephala			
		Rhamphomyia			
	Simuliidae	**Simuliidae**		5	
	Stratiomyiidae	*Odontomyia*			
	Tabanidae	*Chrysops*			
	Tipulidae	*Antocha*		2	2
		Dicranota			
		Hexatoma			
		Limnophila			
		Limonia			
		Tipula			
Ephemeroptera	**Baetidae**	*Acentrella*	2		
		Baetis		3	
		Centroptilum			
		Heterocloeon			
	Baetiscidae	*Baetisca*			
	Caenidae	*Brachycercus*			
		Caenis	2		1
	Ephemerellidae	*Attenella*			
		Drunella			
		Ephemerella		15	25
		Eurylophella			
		Serratella		3	9
	Ephemeridae	*Ephemera*	2		5
	Heptageniidae	*Epeorus*			
		Heptagenia			
		Leucrocuta			
		Nixe			
		Stenacron			
		Stenonema		22	7
	Isonychiidae	*Isonychia*	1	3	
	Leptophlebiidae	*Leptophlebia*			
		Paraleptophlebia			
	Potamanthidae	*Anthopotamus*			
	Tricorythidae	*Tricorythodes*			
Hemiptera	**Veliidae**	*Rhagovelia*			
Lepidoptera	**Pyralidae**	*Petrophila*			

Class: Order	Family	Family/*Genus*	Reference Category 60m		
			CNST 36.5	COHO 14.6	COHO 25.0
Megaloptera	**Corydalidae**	*Corydalus*			
		Nigronia			
	Sialidae	*Sialis*		1	
Odonata	**Aeshnidae**	*Boyeria*			
	Coenagrionidae	*Argia*			
	Gomphidae	*Ophiogomphus*			
		Stylogomphus albistylus			
Plecoptera	**Capniidae**	*Paracapnia*			
	Chloroperlidae	*Alloperla*		1	
		Haploperla			
		Sweltsa			
		Utaperla			
	Leuctridae	*Leuctra*			
	Perlidae	*Acroneuria*			
		Agnetina			
		Eccoptura			
		Neoperla			
		Paragnetina			1
	Perlodidae	*Isoperla*			
	Pteronarcyidae	*Pteronarcys*			
	Taeniopterygidae	*Taeniopteryx*		2	
Trichoptera	**Hydropsychidae**	*Ceratopsyche*	4	19	29
		Cheumatopsyche		2	8
		Diplectrona			
		Hydropsyche			
		Macrostemum			
		Potamyia flava			
	Hydroptilidae	*Hydroptila*			
		Leucotrichia			
	Leptoceridae	*Mystacides*			
	Limnophilidae	*Hydatophylax*			
	Odontoceridae	*Psilotreta*			
	Philopotamidae	*Chimarra*		2	1
		Dolophilodes			
	Polycentropodidae	*Neureclipsis*			
		Nyctiophylax			
		Polycentropus			
	Psychomyiidae	*Psychomyia*			
	Rhyacophilidae	*Rhyacophila*			
Turbellaria: Tricladida	**Planariidae**	*Dugesia*			
Oligochaeta: Lumbriculida	**Lumbriculidae**	**Lumbriculidae**			
Crustacea: Amphipoda	**Gammaridae**	*Gammarus*		1	
	Talitridae	*Hyalella*	4		
Isopoda	**Asellidae**	*Caecidotea*			
Arachnoidea: Hydracarina	**Hydracarina**	**Hydracarina**			1
Gastropoda: Gastropoda	**Physidae**	*Physa*			
	Planorbidae	**Planorbidae**			
Bivalvia: Pelecypoda	**Sphaeriidae**	*Pisidium*		11	

Class: Order	Family	Family/*Genus*	Reference Category 60m			
			COWN 0.1	COWN 13.0	TIOG 35.4	TUSC 0.4
Insecta: Coleoptera	**Dytiscidae**	*Agabus*			1	
	Elmidae	*Dubiraphia*				
		Optioservus				
		Ordobrevia				
		Oulimnius				
		Stenelmis				
	Gyrinidae	*Dineutus*		1		
	Hydrophilidae	*Berosus*				3
	Psephenidae	*Psephenus*				
		Ectopria				
Diptera	**Athericidae**	*Atherix*				1
	Ceratopogonidae	*Bezzia*				
		Ceratopogoninae	6			
	Chironomidae	**Chironomidae**	3	2		8
	Empididae	*Hemerodromia*				2
		Dolichocephala				
		Rhamphomyia				
	Simuliidae	**Simuliidae**				1
	Stratiomyiidae	*Odontomyia*				
	Tabanidae	*Chrysops*				
	Tipulidae	*Antocha*				
		Dicranota				
		Hexatoma				
		Limnophila				
		Limonia				
		Tipula				
Ephemeroptera	**Baetidae**	*Acentrella*				
		Baetis		3		1
		Centroptilum				
		Heterocloeon				
	Baetiscidae	*Baetisca*				
	Caenidae	*Brachycercus*				
		Caenis				4
	Ephemerellidae	*Attenella*				
		Drunella				
		Ephemerella				
		Eurylophella				
		Serratella		4		13
	Ephemeridae	*Ephemera*				
	Heptageniidae	*Epeorus*				
		Heptagenia				
		Leucrocuta				
		Nixe				
		Stenacron	1			
		Stenonema		12		32
	Isonychiidae	*Isonychia*		19		19
	Leptophlebiidae	*Leptophlebia*				
		Paraleptophlebia				
	Potamanthidae	*Anthopotamus*				
	Tricorythidae	*Tricorythodes*		1		
Hemiptera	**Veliidae**	*Rhagovelia*				
Lepidoptera	**Pyralidae**	*Petrophila*				

Class: Order	Family	Family/*Genus*	Reference Category 60m			
			COWN 0.1	COWN 13.0	TIOG 35.4	TUSC 0.4
Megaloptera	**Corydalidae**	*Corydalus*		2	3	3
		Nigronia			1	
	Sialidae	*Sialis*	1		1	1
Odonata	**Aeshnidae**	*Boyeria*				
	Coenagrionidae	*Argia*				
	Gomphidae	*Ophiogomphus*				
		Stylogomphus albistylus				
Plecoptera	**Capniidae**	*Paracapnia*				
	Chloroperlidae	*Alloperla*				
		Haploperla				
		Sweltsa				
		Utaperla				
	Leuctridae	*Leuctra*				
	Perlidae	*Acroneuria*				
		Agnetina		4		
		Eccoptura				
		Neoperla				
		Paragnetina				
	Perlodidae	*Isoperla*				
	Pteronarcyidae	*Pteronarcys*				
	Taeniopterygidae	*Taeniopteryx*				
Trichoptera	**Hydropsychidae**	*Ceratopsyche*	1	6		22
		Cheumatopsyche		20		11
		Diplectrona				
		Hydropsyche		2		2
		Macrostemum				
		Potamyia flava				
	Hydroptilidae	*Hydroptila*				
		Leucotrichia				
	Leptoceridae	*Mystacides*				
	Limnophilidae	*Hydatophylax*				
	Odontoceridae	*Psilotreta*				
	Philopotamidae	*Chimarra*		47		24
		Dolophilodes				
	Polycentropodidae	*Neureclipsis*				
		Nyctiophylax				
		Polycentropus				
	Psychomyiidae	*Psychomyia*				
	Rhyacophilidae	*Rhyacophila*				
Turbellaria: Tricladida	**Planariidae**	*Dugesia*				
Oligochaeta: Lumbriculida	**Lumbriculidae**	**Lumbriculidae**				
Crustacea: Amphipoda	**Gammaridae**	*Gammarus*				
	Talitridae	*Hyalella*	1			
Isopoda	**Asellidae**	*Caecidotea*	105			
Arachnoidea: Hydracarina	**Hydracarina**	**Hydracarina**				
Gastropoda: Gastropoda	**Physidae**	*Physa*	1			
	Planorbidae	**Planorbidae**				2
Bivalvia: Pelecypoda	**Sphaeriidae**	*Pisidium*				

Class: Order	Family	Family/*Genus*	Reference Category 60L			
			CHEM 2.5	CHEM 18.5	CHEM 28.3	CHEM 40.1
Insecta: Coleoptera	**Dytiscidae**	*Agabus*				
	Elmidae	*Dubiraphia*				
		Optioservus	1		1	2
		Ordobrevia				
		Oulimnius				
		Stenelmis	2	1	4	1
	Gyrinidae	*Dineutus*				
	Hydrophilidae	*Berosus*				
	Psephenidae	*Psephenus*				
		Ectopria				
Diptera	**Athericidae**	*Atherix*				
	Ceratopogonidae	*Bezzia*				
		Ceratopogoninae				
	Chironomidae	**Chironomidae**	38	34	21	20
	Empididae	*Hemerodromia*	1	3	1	
		Dolichocephala				
		Rhamphomyia				
	Simuliidae	**Simuliidae**	1		1	4
	Stratiomyiidae	*Odontomyia*				
	Tabanidae	*Chrysops*				
	Tipulidae	*Antocha*	2	2	1	1
		Dicranota				
		Hexatoma				
		Limnophila				
		Limonia				
		Tipula			1	
Ephemeroptera	**Baetidae**	*Acentrella*				
		Baetis	1		2	
		Centroptilum				
		Heterocloeon				
	Baetiscidae	*Baetisca*				
	Caenidae	*Brachycercus*				
		Caenis			1	
	Ephemerellidae	*Attenella*				
		Drunella				
		Ephemerella				
		Eurylophella				
		Serratella	6	2		2
	Ephemeridae	*Ephemera*				
	Heptageniidae	*Epeorus*				
		Heptagenia				
		Leucrocuta				
		Nixe				
		Stenacron	1			
		Stenonema	10	5	18	15
	Isonychiidae	*Isonychia*	8	6	31	18
	Leptophlebiidae	*Leptophlebia*				
		Paraleptophlebia				
	Potamanthidae	*Anthopotamus*		1		1
	Tricorythidae	*Tricorythodes*				
Hemiptera	**Veliidae**	*Rhagovelia*				
Lepidoptera	**Pyralidae**	*Petrophila*				

Class: Order	Family	Family/*Genus*	Reference Category 60L			
			CHEM 2.5	CHEM 18.5	CHEM 28.3	CHEM 40.1
Megaloptera	**Corydalidae**	*Corydalus*	1			
		Nigronia				
	Sialidae	*Sialis*				
Odonata	**Aeshnidae**	*Boyeria*				
	Coenagrionidae	*Argia*	1			
	Gomphidae	*Ophiogomphus*				
		Stylogomphus albistylus				
Plecoptera	**Capniidae**	*Paracapnia*				
	Chloroperlidae	*Alloperla*				
		Haploperla				
		Sweltsa				
		Utaperla				
	Leuctridae	*Leuctra*				
	Perlidae	*Acroneuria*				
		Agnetina			3	
		Eccoptura				
		Neoperla				
		Paragnetina				
	Perlodidae	*Isoperla*				
	Pteronarcyidae	*Pteronarcys*				
	Taeniopterygidae	*Taeniopteryx*	1	1	4	2
Trichoptera	**Hydropsychidae**	*Ceratopsyche*	2	6	4	12
		Cheumatopsyche	39	31	15	22
		Diplectrona				
		Hydropsyche	3	5	1	
		Macrostemum			2	
		Potamyia flava				
	Hydroptilidae	*Hydroptila*				
		Leucotrichia				
	Leptoceridae	*Mystacides*				
	Limnophilidae	*Hydatophylax*				
	Odontoceridae	*Psilotreta*				
	Philopotamidae	*Chimarra*	8	42	16	23
		Dolophilodes				
	Polycentropodidae	*Neureclipsis*			2	
		Nyctiophylax				
		Polycentropus				
	Psychomyiidae	*Psychomyia*				
	Rhyacophilidae	*Rhyacophila*				
Turbellaria: Tricladida	**Planariidae**	*Dugesia*				
Oligochaeta: Lumbriculida	**Lumbriculidae**	**Lumbriculidae**				
Crustacea: Amphipoda	**Gammaridae**	*Gammarus*				
	Talitridae	*Hyalella*				
Isopoda	**Asellidae**	*Caecidotea*				
Arachnoidea: Hydracarina	**Hydracarina**	**Hydracarina**		1		
Gastropoda: Gastropoda	**Physidae**	*Physa*		1	2	
	Planorbidae	**Planorbidae**				
Bivalvia: Pelecypoda	**Sphaeriidae**	*Pisidium*	3	5	1	

Class: Order	Family	Family/*Genus*	Reference Category 60L			
			CNST 1.0	COHO 0.5	COHO 4.0	TIOG 6.2
Insecta: Coleoptera	**Dytiscidae**	*Agabus*				
	Elmidae	*Dubiraphia*				
		Optioservus	1	8	8	
		Ordobrevia				
		Oulimnius				
		Stenelmis		3	5	
	Gyrinidae	*Dineutus*				
	Hydrophilidae	*Berosus*				1
	Psephenidae	*Psephenus*		4	2	4
		Ectopria				
Diptera	**Athericidae**	*Atherix*		1		2
	Ceratopogonidae	*Bezzia*	1			
		Ceratopogoninae				
	Chironomidae	**Chironomidae**	47	16	21	5
	Empididae	*Hemerodromia*	1	1	3	
		Dolichocephala				
		Rhamphomyia				
	Simuliidae	**Simuliidae**			14	
	Stratiomyiidae	*Odontomyia*				
	Tabanidae	*Chrysops*				
	Tipulidae	*Antocha*	2	3	1	3
		Dicranota				
		Hexatoma				
		Limnophila				
		Limonia				
		Tipula				
Ephemeroptera	**Baetidae**	*Acentrella*	1		1	
		Baetis		1		1
		Centroptilum				
		Heterocloeon				
	Baetiscidae	*Baetisca*				
	Caenidae	*Brachycercus*				1
		Caenis	1			
	Ephemerellidae	*Attenella*				
		Drunella				
		Ephemerella				
		Eurylophella				
		Serratella	1	1		
	Ephemeridae	*Ephemera*				
	Heptageniidae	*Epeorus*				
		Heptagenia				
		Leucrocuta				
		Nixe				
		Stenacron	2			
		Stenonema	30	5	3	11
	Isonychiidae	*Isonychia*	7	2	2	67
	Leptophlebiidae	*Leptophlebia*				
		Paraleptophlebia				
	Potamanthidae	*Anthopotamus*	3			
	Tricorythidae	*Tricorythodes*				
Hemiptera	**Veliidae**	*Rhagovelia*				
Lepidoptera	**Pyralidae**	*Petrophila*				

Class: Order	Family	Family/*Genus*	Reference Category 60L			
			CNST 1.0	COHO 0.5	COHO 4.0	TIOG 6.2
Megaloptera	**Corydalidae**	*Corydalus*				
		Nigronia				1
	Sialidae	*Sialis*				
Odonata	**Aeshnidae**	*Boyeria*				
	Coenagrionidae	*Argia*		1	2	
	Gomphidae	*Ophiogomphus*				
		Stylogomphus albistylus				
Plecoptera	**Capniidae**	*Paracapnia*				
	Chloroperlidae	*Alloperla*				
		Haploperla				
		Sweltsa				
		Utaperla				
	Leuctridae	*Leuctra*				
	Perlidae	*Acroneuria*				
		Agnetina				
		Eccoptura				
		Neoperla				
		Paragnetina		1		
	Perlodidae	*Isoperla*				
	Pteronarcyidae	*Pteronarcys*				
	Taeniopterygidae	*Taeniopteryx*	4	3		
Trichoptera	**Hydropsychidae**	*Ceratopsyche*	5	33	22	18
		Cheumatopsyche	8	24	17	5
		Diplectrona				
		Hydropsyche		1	4	
		Macrostemum				
		Potamyia flava				
	Hydroptilidae	*Hydroptila*				
		Leucotrichia				
	Leptoceridae	*Mystacides*				
	Limnophilidae	*Hydatophylax*				
	Odontoceridae	*Psilotreta*				
	Philopotamidae	*Chimarra*	1	4	3	2
		Dolophilodes				
	Polycentropodidae	*Neureclipsis*			2	
		Nyctiophylax				
		Polycentropus				
	Psychomyiidae	*Psychomyia*				
	Rhyacophilidae	*Rhyacophila*				
Turbellaria: Tricladida	**Planariidae**	*Dugesia*			1	
Oligochaeta: Lumbriculida	**Lumbriculidae**	**Lumbriculidae**				
Crustacea: Amphipoda	**Gammaridae**	*Gammarus*			1	
	Talitridae	*Hyalella*				
Isopoda	**Asellidae**	*Caecidotea*				
Arachnoidea: Hydracarina	**Hydracarina**	**Hydracarina**				
Gastropoda: Gastropoda	**Physidae**	*Physa*				1
	Planorbidae	**Planorbidae**				
Bivalvia: Pelecypoda	**Sphaeriidae**	*Pisidium*		5		

Class: Order	Family	Family/*Genus*	Reference Category 62c			
			COWN 21.3	COWN 30.1	CRKD 0.1	FELL 0.1
Insecta: Coleoptera	**Dytiscidae**	*Agabus*				
	Elmidae	*Dubiraphia*				
		Optioservus	2	4	2	
		Ordobrevia				
		Oulimnius				
		Stenelmis	1	1	14	
	Gyrinidae	*Dineutus*				
	Hydrophilidae	*Berosus*				
	Psephenidae	*Psephenus*		1	3	
		Ectopria				
Diptera	**Athericidae**	*Atherix*		2	2	
	Ceratopogonidae	*Bezzia*		1		
		Ceratopogoninae				
	Chironomidae	**Chironomidae**	6	2	37	2
	Empididae	*Hemerodromia*		2	2	
		Dolichocephala				
		Rhamphomyia				
	Simuliidae	**Simuliidae**				3
	Stratiomyiidae	*Odontomyia*				
	Tabanidae	*Chrysops*				
	Tipulidae	*Antocha*			8	
		Dicranota			1	1
		Hexatoma				
		Limnophila				
		Limonia				
		Tipula				
Ephemeroptera	**Baetidae**	*Acentrella*		1		
		Baetis	2	5	7	
		Centroptilum				
		Heterocloeon				
	Baetiscidae	*Baetisca*				
	Caenidae	*Brachycercus*				
		Caenis	3		2	
	Ephemerellidae	*Attenella*				
		Drunella				1
		Ephemerella				
		Eurylophella				
		Serratella		2		
	Ephemeridae	*Ephemera*			4	
	Heptageniidae	*Epeorus*				
		Heptagenia				
		Leucrocuta				
		Nixe				
		Stenacron				
		Stenonema	13	38	13	
	Isonychiidae	*Isonychia*	11	2	1	
	Leptophlebiidae	*Leptophlebia*		4		
		Paraleptophlebia				
	Potamanthidae	*Anthopotamus*				
	Tricorythidae	*Tricorythodes*				
Hemiptera	**Veliidae**	*Rhagovelia*				
Lepidoptera	**Pyralidae**	*Petrophila*				

Class: Order	Family	Family/*Genus*	Reference Category 62c			
			COWN 21.3	COWN 30.1	CRKD 0.1	FELL 0.1
Megaloptera	**Corydalidae**	*Corydalus*				
		Nigronia				
	Sialidae	*Sialis*			1	
Odonata	**Aeshnidae**	*Boyeria*				1
	Coenagrionidae	*Argia*				
	Gomphidae	*Ophiogomphus*		1		
		Stylogomphus albistylus		2		
Plecoptera	**Capniidae**	*Paracapnia*				2
	Chloroperlidae	*Alloperla*	1			
		Haploperla				
		Sweltsa				
		Utaperla				
	Leuctridae	*Leuctra*				3
	Perlidae	*Acroneuria*				
		Agnetina	1	1		
		Eccoptura				
		Neoperla			3	
		Paragnetina				
	Perlodidae	*Isoperla*				1
	Pteronarcyidae	*Pteronarcys*				
	Taeniopterygidae	*Taeniopteryx*				
Trichoptera	**Hydropsychidae**	*Ceratopsyche*	39	20	22	
		Cheumatopsyche	21	22	5	
		Diplectrona				14
		Hydropsyche	9	8	7	
		Macrostemum				
		Potamyia flava				1
	Hydroptilidae	*Hydroptila*				
		Leucotrichia			3	
	Leptoceridae	*Mystacides*				
	Limnophilidae	*Hydatophylax*				
	Odontoceridae	*Psilotreta*				
	Philopotamidae	*Chimarra*	22	1	1	
		Dolophilodes				
	Polycentropodidae	*Neureclipsis*				
		Nyctiophylax				
		Polycentropus				2
	Psychomyiidae	*Psychomyia*				
	Rhyacophilidae	*Rhyacophila*			1	1
Turbellaria: Tricladida	**Planariidae**	*Dugesia*				
Oligochaeta: Lumbriculida	**Lumbriculidae**	**Lumbriculidae**				
Crustacea: Amphipoda	**Gammaridae**	*Gammarus*				
	Talitridae	*Hyalella*				
Isopoda	**Asellidae**	*Caecidotea*				
Arachnoidea: Hydracarina	**Hydracarina**	**Hydracarina**				
Gastropoda: Gastropoda	**Physidae**	*Physa*				
	Planorbidae	**Planorbidae**				
Bivalvia: Pelecypoda	**Sphaeriidae**	*Pisidium*				

Class: Order	Family	Family/*Genus*	Reference Category 62c			
			HILL 0.2	JOHN 0.1	MILL 0.1	MORR 0.8
Insecta: Coleoptera	**Dytiscidae**	*Agabus*				1
	Elmidae	*Dubiraphia*				
		Optioservus	3			
		Ordobrevia				
		Oulimnius				
		Stenelmis	4		1	
	Gyrinidae	*Dineutus*				
	Hydrophilidae	*Berosus*				
	Psephenidae	*Psephenus*				
		Ectopria				
Diptera	**Athericidae**	*Atherix*	2	2		
	Ceratopogonidae	*Bezzia*				
		Ceratopogoninae				
	Chironomidae	**Chironomidae**	41	7	2	108
	Empididae	*Hemerodromia*	1	25		
		Dolichocephala	1			
		Rhamphomyia				
	Simuliidae	**Simuliidae**			104	
	Stratiomyiidae	*Odontomyia*		1		
	Tabanidae	*Chrysops*				
	Tipulidae	*Antocha*	3			
		Dicranota				
		Hexatoma	5			
		Limnophila				
		Limonia		1		
		Tipula		1		
Ephemeroptera	**Baetidae**	*Acentrella*	3	2		
		Baetis	14	4	7	
		Centroptilum	1			
		Heterocloeon		1		
	Baetiscidae	*Baetisca*				
	Caenidae	*Brachycercus*				
		Caenis				
	Ephemerellidae	*Attenella*				
		Drunella				
		Ephemerella				
		Eurylophella				
		Serratella		2		
	Ephemeridae	*Ephemera*				
	Heptageniidae	*Epeorus*				
		Heptagenia				
		Leucrocuta				
		Nixe				
		Stenacron				
		Stenonema	10	1	3	
	Isonychiidae	*Isonychia*	2			
	Leptophlebiidae	*Leptophlebia*				
		Paraleptophlebia				
	Potamanthidae	*Anthopotamus*				
	Tricorythidae	*Tricorythodes*				
Hemiptera	**Veliidae**	*Rhagovelia*				
Lepidoptera	**Pyralidae**	*Petrophila*				

Class: Order	Family	Family/*Genus*	Reference Category 62c			
			HILL 0.2	JOHN 0.1	MILL 0.1	MORR 0.8
Megaloptera	**Corydalidae**	*Corydalus*				
		Nigronia				
	Sialidae	*Sialis*				
Odonata	**Aeshnidae**	*Boyeria*				
	Coenagrionidae	*Argia*				
	Gomphidae	*Ophiogomphus*				
		Stylogomphus albistylus				
Plecoptera	**Capniidae**	*Paracapnia*				
	Chloroperlidae	*Alloperla*	1			
		Haploperla				
		Sweltsa				
		Utaperla				
	Leuctridae	*Leuctra*				
	Perlidae	*Acroneuria*		2		
		Agnetina	3			
		Eccoptura				
		Neoperla	1			
		Paragnetina				
	Perlodidae	*Isoperla*				
	Pteronarcyidae	*Pteronarcys*		1		
	Taeniopterygidae	*Taeniopteryx*		1		
Trichoptera	**Hydropsychidae**	*Ceratopsyche*	15		6	
		Cheumatopsyche	1	2		
		Diplectrona				
		Hydropsyche		1	3	
		Macrostemum				
		Potamyia flava				
	Hydroptilidae	*Hydroptila*				
		Leucotrichia				
	Leptoceridae	*Mystacides*				
	Limnophilidae	*Hydatophylax*				
	Odontoceridae	*Psilotreta*				
	Philopotamidae	*Chimarra*	16			
		Dolophilodes	9			
	Polycentropodidae	*Neureclipsis*				
		Nyctiophylax				
		Polycentropus				
	Psychomyiidae	*Psychomyia*				
	Rhyacophilidae	*Rhyacophila*				
Turbellaria: Tricladida	**Planariidae**	*Dugesia*				
Oligochaeta: Lumbriculida	**Lumbriculidae**	**Lumbriculidae**				
Crustacea: Amphipoda	**Gammaridae**	*Gammarus*				
	Talitridae	*Hyalella*				
Isopoda	**Asellidae**	*Caecidotea*				
Arachnoidea: Hydracarina	**Hydracarina**	**Hydracarina**				
Gastropoda: Gastropoda	**Physidae**	*Physa*				
	Planorbidae	**Planorbidae**				
Bivalvia: Pelecypoda	**Sphaeriidae**	*Pisidium*				

Class: Order	Family	Family/*Genus*	Reference Category 62c			
			NFCO 0.1	TIOG 16.3	TIOG 49.2	TRUP 0.4
Insecta: Coleoptera	**Dytiscidae**	*Agabus*				
	Elmidae	*Dubiraphia*				
		Optioservus	17	1	1	2
		Ordobrevia				
		Oulimnius				
		Stenelmis	16			1
	Gyrinidae	*Dineutus*				
	Hydrophilidae	*Berosus*				
	Psephenidae	*Psephenus*	2			
		Ectopria				
Diptera	**Athericidae**	*Atherix*	4			2
	Ceratopogonidae	*Bezzia*				
		Ceratopogoninae				
	Chironomidae	**Chironomidae**	9	9	32	7
	Empididae	*Hemerodromia*				
		Dolichocephala				
		Rhamphomyia				
	Simuliidae	**Simuliidae**		2	1	
	Stratiomyiidae	*Odontomyia*				
	Tabanidae	*Chrysops*				
	Tipulidae	*Antocha*	1			
		Dicranota				
		Hexatoma	1		4	1
		Limnophila				
		Limonia				
		Tipula				
Ephemeroptera	**Baetidae**	*Acentrella*			1	
		Baetis	2	5		2
		Centroptilum				
		Heterocloeon				
	Baetiscidae	*Baetisca*			1	
	Caenidae	*Brachycercus*				
		Caenis	2			2
	Ephemerellidae	*Attenella*				
		Drunella				
		Ephemerella				
		Eurylophella				
		Serratella	2			
	Ephemeridae	*Ephemera*				
	Heptageniidae	*Epeorus*				
		Heptagenia				1
		Leucrocuta				
		Nixe				1
		Stenacron				
		Stenonema	31	7	6	52
	Isonychiidae	*Isonychia*	2	20	2	13
	Leptophlebiidae	*Leptophlebia*				
		Paraleptophlebia	2	1	1	
	Potamanthidae	*Anthopotamus*				
	Tricorythidae	*Tricorythodes*				
Hemiptera	**Veliidae**	*Rhagovelia*	1			
Lepidoptera	**Pyralidae**	*Petrophila*				

Class: Order	Family	Family/*Genus*	Reference Category 62c			
			NFCO 0.1	TIOG 16.3	TIOG 49.2	TRUP 0.4
Megaloptera	**Corydalidae**	*Corydalus*				
		Nigronia			1	
	Sialidae	*Sialis*				
Odonata	**Aeshnidae**	*Boyeria*			1	
	Coenagrionidae	*Argia*				
	Gomphidae	*Ophiogomphus*				1
		Stylogomphus albistylus				
Plecoptera	**Capniidae**	*Paracapnia*			1	
	Chloroperlidae	*Alloperla*		1	5	
		Haploperla				
		Sweltsa				
		Utaperla				
	Leuctridae	*Leuctra*				
	Perlidae	*Acroneuria*			1	
		Agnetina	4	2	3	
		Eccoptura				
		Neoperla	4			4
		Paragnetina				
	Perlodidae	*Isoperla*				
	Pteronarcyidae	*Pteronarcys*				
	Taeniopterygidae	*Taeniopteryx*				
Trichoptera	**Hydropsychidae**	*Ceratopsyche*	11	2	10	13
		Cheumatopsyche	17	24	1	7
		Diplectrona				
		Hydropsyche		6		2
		Macrostemum				
		Potamyia flava	1			
	Hydroptilidae	*Hydroptila*				
		Leucotrichia				
	Leptoceridae	*Mystacides*				
	Limnophilidae	*Hydatophylax*			1	
	Odontoceridae	*Psilotreta*			1	
	Philopotamidae	*Chimarra*	9	54		
		Dolophilodes		1	43	
	Polycentropodidae	*Neureclipsis*				
		Nyctiophylax				
		Polycentropus	1	1	2	
	Psychomyiidae	*Psychomyia*				
	Rhyacophilidae	*Rhyacophila*				
Turbellaria: Tricladida	**Planariidae**	*Dugesia*				
Oligochaeta: Lumbriculida	**Lumbriculidae**	**Lumbriculidae**				
Crustacea: Amphipoda	**Gammaridae**	*Gammarus*				
	Talitridae	*Hyalella*				
Isopoda	**Asellidae**	*Caecidotea*				
Arachnoidea: Hydracarina	**Hydracarina**	**Hydracarina**				
Gastropoda: Gastropoda	**Physidae**	*Physa*				
	Planorbidae	**Planorbidae**				
Bivalvia: Pelecypoda	**Sphaeriidae**	*Pisidium*		3		

APPENDIX C

COMPARISON OF 1985 AND 1997 SAMPLING SITE STATIONS AND APPROXIMATE DRAINAGE AREA

Stations Sampled in 1997	Stations Sampled in 1985	Approximate Drainage Area of Stations Sampled in 1997 (sq. mi.)
BENN 1.0	BENN 0.1	98
BNTY 0.7	BNTY 0.3	54
BNTY 2.5*		32
BNTY 5.7*		51
CANA 1.7	CANA 1.7	62
CHEM 2.5	CHEM 2.8	2,590
CHEM 18.5	CHEM 18.5	2,470
CHEM 28.3	CHEM 29.8	2,227
CHEM 40.1	CHEM 39.5	2,024
CNST 1.0	CNST 1.0	562
CNST 7.7	CNST 5.9	397
CNST 21.3	CNST 24.7	336
CNST 31.3	CNST 32.8	320
CNST 36.5	CNST 40.8	171
CNST 44.1*		30
COHO 0.5	COHO 1.0	600
COHO 4.0	COHO 2.3	520
COHO 14.6	COHO 14.9	372
COHO 25.0	COHO 26.6	192
COHO 37.5	COHO 36.0	52
CORY 1.5	CORY 0.9	21
COWN 0.1*		300
COWN 13.0*		246
COWN 21.3*		203
COWN 30.1*		53
CRKD 0.1	CRKD 6.5	83
FELL 0.1	FELL 0.3	6
5MIL 1.1	5MIL 0.3	65
HILL 0.2*		16
JOHN 0.1	JOHN 0.1	17
KARR 0.1*		29
MEAD 0.1	MEAD 0.1	67
MILL 0.1	MILL 4.8	73
MORR 0.8	MORR 0.2	5
NBTC 0.1*		32
NEWT 0.6	NEWT 0.2	79
NFCO 0.1*		22
SEEL 2.8	SEEL 1.1	97
SEEL 11.3	SEEL 11.5	23
SING 0.4*		32
SOUT 1.9		43
SOUT 7.2	SOUT 2.8	30
SOUT 11.0*		18
TENM 0.2*		16
TIOG 6.2*		800
TIOG 16.3*		437
TIOG 29.8	TIOG 25.6	154
TIOG 35.4	TIOG 32.1	104
TIOG 39.6	TIOG 37.4	83
TIOG 42.3	TIOG 39.1	48

Stations Sampled in 1997	Stations Sampled in 1985	Approximate Drainage Area of Stations Sampled in 1997 (sq. mi.)
TIOG 49.2	TIOG 55.9	16
TRUP 0.4*		69
TUSC 0.4	TUSC 0.1	122
TUSC 12.5*		46
WMUD 1.1	WMUD 0.1	80
WYNK 0.5		36

*No equivalent station was sampled in 1985.

APPENDIX D

RAW WATER QUALITY DATA FROM SAMPLE SITES IN THE CHEMUNG SUBBASIN

Parameter Symbol	Parameter Name	Units	BENN 1.0	BNTY 0.7	BNTY 2.5	BNTY 5.7	CANA 1.7	CNST 44.1	COHO 37.5
RC	Reference Category		60ab	60ab	60ab	60ab	60ab	60ab	60ab
Date	Date	yymmdd	971013	971029	971029	971029	971008	971008	971014
Time	Time	hhmm	1200	1400	1155	910	845	1100	1310
Temp	Water Temperature	°C	13.0	8.3	9.4	9.3	13.8	13.3	13.7
pH	pH (field)	S.U.	8.00	8.15	7.45	6.90	8.1	8.00	8.05
DO	Dissolved Oxygen	mg/l	8.52	9.25	8.62	6.88	7.24	7.65	6.36
Cond	Conductivity (field)	µ ohms/cm	314	249	217	210	427	258	375
Alk	Alkalinity (field)	mg/l	112	108	84	84	140	110	144
Acid	Acidity (field)	mg/l	6	4	6	10	6	4	6
Lab cond	Specific Conductance	µ ohms/cm	310	250	217	211	420	256	365
Lab pH	pH (lab)	mg/l	8.0	8.3	7.4	7.1	7.3	7.1	7.8
Lab Alk	Alkalinity (as $CaCO_3$)	mg/l	108	92	84	80	138	112	138
DRes	Dissolved Residues	mg/l	190	150	148	122	262	176	242
TSS	Total Suspended Solids	mg/l	6	<2	6	<2	36	<2	14
DN	Dissolved Nitrogen	mg/l	0.19	0.19	0.16	0.51	0.75	0.21	1.81
TN	Total Nitrogen	mg/l	0.20	0.20	0.19	0.51	0.95	0.21	1.89
DNH3	Dissolved Ammonia	mg/l	<0.02	<0.02	<0.02	<0.02	0.06	<0.02	<0.02
TNH3	Total Ammonia	mg/l	<0.02	<0.02	<0.02	<0.02	0.08	<0.02	<0.02
DNO2	Dissolved Nitrite	mg/l	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	0.01
TNO2	Total Nitrite	mg/l	<0.01	<0.01	<0.01	<0.01	0.04	<0.01	0.01
DNO3	Dissolved Nitrate	mg/l	<0.04	0.04	<0.04	0.28	0.4	<0.04	1.41
TNO3	Total Nitrate	mg/l	<0.04	0.04	<0.04	0.28	0.4	<0.04	1.41
DP	Dissolved Phosphorus	mg/l	0.013	0.006	0.006	0.012	0.011	0.01	0.008
TP	Total Phosphorus	mg/l	<0.02	<0.02	<0.02	<0.02	0.094	<0.02	<0.02
TOP	Total Orthophosphorus	mg/l	0.004	0.003	0.004	0.010	0.094	0.010	0.010
TOC	Total Organic Carbon	mg/l	1.6	1.6	1.4	1.8	3.9	2.5	3.6
Hard	Total Hardness ($CaCO_3$)	mg/l	110	85	84	71	134	100	157
Ca	Total Calcium	mg/l	40.0	32.8	28.6	28.7	48.6	35.4	59.2
Mg	Magnesium	mg/l	7.84	6.82	6.39	5.35	12.50	7.69	14.90
Na	Sodium	mg/l	13.00	9.93	7.05	6.86	26.00	5.36	8.27
K	Potassium	mg/l	2.82	1.87	1.90	2.06	3.67	1.81	1.69
Cl	Chloride	mg/l	24	16	10	10	45	6	16
SO4	Total Sulfate	mg/l	23.0	17.0	12.0	10.1	17.0	17.0	28.0
Fl	Fluoride	mg/l	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cu	Copper	µg/l	<4	<4	<4	<4	<4	<4	<4
DFe	Dissolved Iron	µg/l	<10	<20	<20	<20	25	<20	87
TFe	Total Iron	µg/l	43	<20	<20	40	2,110	95	386
Pb	Lead	µg/l	<1	<1	<1	<1	1.5	<1	<1
DMn	Dissolved Manganese	µg/l	<10	<10	<10	<10	79	75	37
TMn	Total Manganese	µg/l	<10	<10	<10	<10	213	82	51
Ni	Nickel	µg/l	<4	<4	<4	<4	<4	<4	<4
Zn	Zinc	µg/l	6.4	<5	<5	<5	8	<5	<5
DAl	Dissolved Aluminum	µg/l	<10	13.2	<10	<10	12.6	<10	<10
TAl	Total Aluminum	µg/l	26.9	13.2	<10	15.5	708	46.3	67.2

Parameter Symbol	Parameter Name	Units	CORY 1.5	5MIL 1.1	KARR 0.1	MEAD 0.1	NBTC 0.1	NEWT 0.6	POST 0.4
RC	Reference Category		60ab	60ab	60ab	60ab	60ab	60ab	60ab
Date	Date	yymmdd	970922	971015	971007	971021	971007	971023	971022
Time	Time	hhmm	1325	1255	1900	1400	1215	915	940
Temp	Water Temperature	°C	18.8	9.5	17.9	8.8	15.2	6.5	5.2
pH	pH (field)	S.U.	9.30	8.35	8.65	7.40	7.90	7.95	7.95
DO	Dissolved Oxygen	mg/l	9.79	9.25	8.13	7.98	7.98	6.47	7.53
Cond	Conductivity (field)	µ ohms/cm	235	376	383	205	271	807	354
Alk	Alkalinity (field)	mg/l	84	136	126	62	112	250	108
Acid	Acidity (field)	mg/l	0	0	0	8	6	8	6
Lab cond	Specific Conductance	µ ohms/cm	233	372	380	205	268	795	350
Lab pH	pH (lab)	mg/l	8.7	8.3	8.1	7.3	7.2	7.9	7.7
Lab Alk	Alkalinity (as $CaCO_3$)	mg/l	80	128	126	60	98	246	108
DRes	Dissolved Residues	mg/l	154	238	240	118	178	548	238
TSS	Total Suspended Solids	mg/l	<2	<2	2	8	2	2	6
DN	Dissolved Nitrogen	mg/l	0.19	0.56	0.25	0.16	0.21	1.17	0.24
TN	Total Nitrogen	mg/l	0.21	0.60	0.28	0.17	0.24	1.24	0.24
DNH3	Dissolved Ammonia	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	0.06	<0.02
TNH3	Total Ammonia	mg/l	<0.02	0.02	<0.02	<0.02	<0.02	0.06	<0.02
DNO2	Dissolved Nitrite	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01
TNO2	Total Nitrite	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01
DNO3	Dissolved Nitrate	mg/l	<0.04	0.07	0.04	<0.04	<0.04	0.84	<0.04
TNO3	Total Nitrate	mg/l	<0.04	0.07	0.04	<0.04	<0.04	0.84	<0.04
DP	Dissolved Phosphorus	mg/l	0.007	0.014	0.010	0.009	0.013	0.006	0.008
TP	Total Phosphorus	mg/l	<0.02	0.03	<0.02	<0.02	<0.02	0.02	<0.02
TOP	Total Orthophosphorus	mg/l	0.008	0.013	0.005	0.009	0.007	0.010	0.009
TOC	Total Organic Carbon	mg/l	2.5	5.2	2.7	1.5	2.5	2.0	2.6
Hard	Total Hardness ($CaCO_3$)	mg/l	62	139	121	59	97	226	104
Ca	Total Calcium	mg/l	27.2	51.0	41.5	21.2	38.3	81.3	36.3
Mg	Magnesium	mg/l	5.33	12.60	8.28	5.49	4.87	21.10	8.14
Na	Sodium	mg/l	9.4	15.6	21.5	10.4	8.9	58.3	20.4
K	Potassium	mg/l	2.47	2.68	2.11	1.37	2.75	2.50	2.06
Cl	Chloride	mg/l	17	29	37	17	16	101	39
SO4	Total Sulfate	mg/l	14.7	18.0	18.0	17.0	15.0	26.0	16.0
Fl	Fluoride	mg/l	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cu	Copper	µg/l	<4	<4	<4	<4	<4	<4	<4
DFe	Dissolved Iron	µg/l	<10	84	<20	22	47	<20	35
TFe	Total Iron	µg/l	26	245	42	60	81	292	156
Pb	Lead	µg/l	<1	<1	<1	<1	<1	4	<1
DMn	Dissolved Manganese	µg/l	31	26	<10	<10	<10	101	19
TMn	Total Manganese	µg/l	46	50	<10	<10	<10	112	20
Ni	Nickel	µg/l	<4	<4	<4	<4	<4	<4	<4
Zn	Zinc	µg/l	7.4	<5	<5	<5	<5	<5	<5
DAl	Dissolved Aluminum	µg/l	<10	<10	<10	<10	13.3	<10	<10
TAl	Total Aluminum	µg/l	42.3	35.8	22.0	16.0	53.6	48.2	16.8

Parameter Symbol	Parameter Name	Units	SEEL 2.8	SEEL 11.3	SING 0.4	SOUT 1.9	SOUT 7.2	SOUT 11.0	TENM 0.2
RC	Reference Category		60ab	60ab	60ab	60ab	60ab	60ab	60ab
Date	Date	yymmdd	971027	971027	971022	971028	971028	971028	971015
Time	Time	hhmm	1350	1125	1435	1445	1140	835	835
Temp	Water Temperature	°C	10.9	8.2	6.9	6.3	4.4	7.2	12.8
pH	pH (field)	S.U.	7.60	7.95	7.95	7.50	7.60	7.05	6.80
DO	Dissolved Oxygen	mg/l	8.28	9.24	7.44	8.78	8.50	7.07	7.61
Cond	Conductivity (field)	µ ohms/cm	329	330	517	252	214	192	188
Alk	Alkalinity (field)	mg/l	108	116	186	70	64	60	52
Acid	Acidity (field)	mg/l	14	8	8	6	4	8	10
Lab cond	Specific Conductance	µ ohms/cm	324	324	511	250	217	193	187
Lab pH	pH (lab)	mg/l	7.7	8.0	7.9	7.3	7.2	6.9	7.1
Lab Alk	Alkalinity (as $CaCO_3$)	mg/l	108	114	180	66	68	60	50
DRes	Dissolved Residues	mg/l	nd	232	320	140	164	128	138
TSS	Total Suspended Solids	mg/l	<2	6	<2	<2	10	<2	<2
DN	Dissolved Nitrogen	mg/l	0.48	1.36	1.89	0.12	0.29	0.63	0.69
TN	Total Nitrogen	mg/l	0.48	1.41	1.93	0.15	0.36	0.63	0.71
DNH3	Dissolved Ammonia	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
TNH3	Total Ammonia	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
DNO2	Dissolved Nitrite	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
TNO2	Total Nitrite	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
DNO3	Dissolved Nitrate	mg/l	0.28	1.14	1.63	<0.04	<0.04	0.37	0.41
TNO3	Total Nitrate	mg/l	0.28	1.17	1.63	<0.04	<0.04	0.37	0.41
DP	Dissolved Phosphorus	mg/l	0.005	0.011	0.006	0.004	0.011	0.008	0.014
TP	Total Phosphorus	mg/l	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	0.02
TOP	Total Orthophosphorus	mg/l	0.004	0.013	0.014	0.002	0.014	0.005	0.010
TOC	Total Organic Carbon	mg/l	1.4	1.4	1.7	1.5	3.6	1.8	2.6
Hard	Total Hardness ($CaCO_3$)	mg/l	126	99	189	83	57	61	58
Ca	Total Calcium	mg/l	43.5	54.6	58.8	27.3	22.6	22.3	22.3
Mg	Magnesium	mg/l	7.81	7.32	16.40	6.46	5.32	4.11	4.92
Na	Sodium	mg/l	14.2	12.5	22.4	13.6	12.8	10.0	9.0
K	Potassium	mg/l	1.84	2.15	1.63	1.74	2.86	2.30	1.81
Cl	Chloride	mg/l	27	21	42	28	19	15	17
SO4	Total Sulfate	mg/l	<10	17.5	22.0	17.0	8.6	11.1	15.0
Fl	Fluoride	mg/l	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cu	Copper	µg/l	<4	<4	<4	<4	<4	<4	<4
DFe	Dissolved Iron	µg/l	<20	<20	43	<20	110	<20	75
TFe	Total Iron	µg/l	<20	339	425	26	360	54	111
Pb	Lead	µg/l	<1	<1	<1	<1	<1	<1	<1
DMn	Dissolved Manganese	µg/l	<10	<10	21	<10	20	24	<10
TMn	Total Manganese	µg/l	<10	15	25	<10	25	26	13
Ni	Nickel	µg/l	<4	<4	<4	<4	<4	<4	<4
Zn	Zinc	µg/l	8	<5	<5	<5	<5	5.2	<5
DAl	Dissolved Aluminum	µg/l	<10	<10	<10	<10	<10	<10	<10
TAl	Total Aluminum	µg/l	<10	96.3	55.3	<10	42.8	13.3	26.1

Parameter Symbol	Parameter Name	Units	TUSC 12.5	TWVE 0.5	WMUD 1.1	WYNK 0.5	CNST 7.7	CNST 21.3	CNST 31.3
RC	Reference Category		60ab	60ab	60ab	60ab	60m	60m	60m
Date	Date	yymmdd	971007	971014	971015	971027	971014	971013	971013
Time	Time	hhmm	935	1545	1630	1615	855	1615	1405
Temp	Water Temperature	°C	15.4	12.8	12.6	9.5	15.5	14.9	13.9
pH	pH (field)	S.U.	8.35	7.50	7.60	7.20	8.40	8.30	7.90
DO	Dissolved Oxygen	mg/l	7.55	7.24	5.27	8.57	8.83	7.97	7.69
Cond	Conductivity (field)	µ ohms/cm	555	204	240	174	429	456	479
Alk	Alkalinity (field)	mg/l	116	60	92	48	140	164	160
Acid	Acidity (field)	mg/l	0	16	8	6	0	0	12
Lab cond	Specific Conductance	µ ohms/cm	550	202	243	172	420	449	470
Lab pH	pH (lab)	mg/l	7.2	7.5	7.3	7.1	8.3	8.1	7.9
Lab Alk	Alkalinity (as $CaCO_3$)	mg/l	118	60	86	48	136	150	156
DRes	Dissolved Residues	mg/l	330	108	172	106	252	276	340
TSS	Total Suspended Solids	mg/l	<2	20	<2	22	18	16	10
DN	Dissolved Nitrogen	mg/l	0.33	1.51	0.47	0.16	0.43	0.71	1.08
TN	Total Nitrogen	mg/l	0.35	1.56	0.56	0.20	0.52	0.81	1.13
DNH3	Dissolved Ammonia	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
TNH3	Total Ammonia	mg/l	<0.02	<0.02	0.02	<0.02	<0.02	0.03	<0.02
DNO2	Dissolved Nitrite	mg/l	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
TNO2	Total Nitrite	mg/l	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
DNO3	Dissolved Nitrate	mg/l	<0.04	1.16	0.08	<0.04	0.18	0.44	0.83
TNO3	Total Nitrate	mg/l	<0.04	1.17	0.08	<0.04	0.18	0.44	0.84
DP	Dissolved Phosphorus	mg/l	0.013	0.013	0.022	0.005	0.009	0.013	0.029
TP	Total Phosphorus	mg/l	<0.02	0.02	0.03	<0.02	0.02	0.02	0.06
TOP	Total Orthophosphorus	mg/l	0.011	0.016	0.025	0.005	0.013	0.016	0.060
TOC	Total Organic Carbon	mg/l	3.9	3.0	4.3	1.6	2.6	2.5	2.3
Hard	Total Hardness ($CaCO_3$)	mg/l	127	65	88	59	149	162	174
Ca	Total Calcium	mg/l	46.8	27.1	31.0	16.9	52.3	56.3	61.2
Mg	Magnesium	mg/l	8.06	6.00	7.76	5.02	13.40	14.20	15.00
Na	Sodium	mg/l	54.00	7.78	9.77	9.43	21.80	21.90	23.20
K	Potassium	mg/l	5.13	2.05	1.77	1.67	3.02	3.16	2.93
Cl	Chloride	mg/l	91	14	16	15	39	41	42
SO4	Total Sulfate	mg/l	22.0	14.0	14.0	18.0	26.0	27.0	30.0
Fl	Fluoride	mg/l	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cu	Copper	µg/l	<4	<4	<4	<4	<4	<4	<4
DFe	Dissolved Iron	µg/l	26	71	146	30	<20	<20	<20
TFe	Total Iron	µg/l	82	353	509	391	246	388	703
Pb	Lead	µg/l	<1	<1	<1	<1	<1	<1	<1
DMn	Dissolved Manganese	µg/l	21	22	102	<10	14	32	61
TMn	Total Manganese	µg/l	21	31	121	22	31	48	81
Ni	Nickel	µg/l	<4	<4	<4	<4	<4	<4	<4
Zn	Zinc	µg/l	<5	<5	<5	6.9	<5	<5	6
DAl	Dissolved Aluminum	µg/l	10.8	<10	<10	<10	<10	<10	<10
TAl	Total Aluminum	µg/l	42.3	84.6	68.7	70.6	88.1	135	133

Parameter Symbol	Parameter Name	Units	CNST 36.5	COHO 14.6	COHO 25.0	COWN 0.1	COWN 13.0	TIOG 29.8	TIOG 35.4
RC	Reference Category		60m	60m	60m	60m	60m	60m	60m
Date	Date	yymmdd	971008	971015	971015	971006	970924	970922	970916
Time	Time	hhmm	1320	1505	1045	1140	1610	1105	1625
Temp	Water Temperature	°C	14.6	10.3	8.6	15.2	12.3	15.3	19.3
pH	pH (field)	S.U.	8.30	8.15	7.75	7.35	8.10	4.00	3.35
DO	Dissolved Oxygen	mg/l	8.39	8.31	7.58	7.45	9.84	9.21	8.38
Cond	Conductivity (field)	µ ohms/cm	472	793	390	203	373	347	322
Alk	Alkalinity (field)	mg/l	154	144	140	96	96	0	0
Acid	Acidity (field)	mg/l	0	6	10	6	6	26	36
Lab cond	Specific Conductance	µ ohms/cm	460	786	387	200	370	345	308
Lab pH	pH (lab)	mg/l	7.6	8.2	8.0	6.6	7.4	4.7	4.1
Lab Alk	Alkalinity (as $CaCO_3$)	mg/l	150	144	136	66	90	2	0
DRes	Dissolved Residues	mg/l	312	448	286	100	218	258	218
TSS	Total Suspended Solids	mg/l	10	<2	<2	58	<2	8	<2
DN	Dissolved Nitrogen	mg/l	1.35	1.49	1.51	0.75	0.21	0.76	0.53
TN	Total Nitrogen	mg/l	1.47	1.57	1.53	0.85	0.24	0.77	0.53
DNH3	Dissolved Ammonia	mg/l	<0.02	0.02	<0.02	0.20	<0.02	0.12	0.05
TNH3	Total Ammonia	mg/l	<0.02	0.03	0.02	0.25	<0.02	0.13	0.05
DNO2	Dissolved Nitrite	mg/l	<0.01	0.04	<0.01	0.02	<0.01	<0.01	<0.01
TNO2	Total Nitrite	mg/l	0.02	0.04	<0.01	0.04	<0.01	<0.01	<0.01
DNO3	Dissolved Nitrate	mg/l	1.05	1.08	1.15	0.19	<0.04	0.34	0.32
TNO3	Total Nitrate	mg/l	1.05	1.08	1.15	0.19	<0.04	0.35	0.32
DP	Dissolved Phosphorus	mg/l	0.042	0.062	0.012	0.014	0.006	0.008	0.012
TP	Total Phosphorus	mg/l	0.086	0.070	0.020	0.046	<0.02	<0.02	<0.02
TOP	Total Orthophosphorus	mg/l	0.086	0.063	0.009	0.046	0.004	0.014	0.008
TOC	Total Organic Carbon	mg/l	3.4	3.2	2.7	3.6	2.1	1.3	<1
Hard	Total Hardness ($CaCO_3$)	mg/l	158	172	159	60	100	132	89
Ca	Total Calcium	mg/l	57.0	58.8	54.4	20.9	33.6	26.6	19.7
Mg	Magnesium	mg/l	14.20	15.20	14.60	4.56	7.05	14.70	10.70
Na	Sodium	mg/l	26.20	91.40	12.70	8.83	25.90	7.38	4.27
K	Potassium	mg/l	3.11	2.36	2.03	2.90	3.49	2.06	1.15
Cl	Chloride	mg/l	46	147	28	13	44	10	5
SO4	Total Sulfate	mg/l	24.0	32.0	20.0	18.0	27.0	163	156
Fl	Fluoride	mg/l	<0.2	<0.2	<0.2	<0.2	<0.2	0.27	<0.2
Cu	Copper	µg/l	<4	<4	<4	<4	<4	14.8	11.2
DFe	Dissolved Iron	µg/l	<20	<20	<20	27	<20	180	356
TFe	Total Iron	µg/l	692	98	172	1,260	40	269	356
Pb	Lead	µg/l	<1	<1	<1	1.4	<1	3.9	1.9
DMn	Dissolved Manganese	µg/l	56	12	14	1,310	<10	3,050	2,620
TMn	Total Manganese	µg/l	106	18	20	1,600	<10	3,050	2,620
Ni	Nickel	µg/l	<4	<4	<4	<4	<4	94.6	76.6
Zn	Zinc	µg/l	6.9	<5	<5	7.7	<5	249	217
DAl	Dissolved Aluminum	µg/l	12	<10	<10	11.5	<10	2,566	3,349
TAl	Total Aluminum	µg/l	287	24.6	41.0	304	15.5	3,548	3,349

Parameter Symbol	Parameter Name	Units	TUSC 0.4	CHEM 2.5	CHEM 18.5	CHEM 28.3	CHEM 40.1	CNST 1.0	COHO 0.5
RC	Reference Category		60m	60L	60L	60L	60L	60L	60L
Date	Date	yymmdd	971007	971023	971023	971022	971022	971014	971021
Time	Time	hhmm	1505	1355	1135	1650	1205	1050	1645
Temp	Water Temperature	°C	17.9	7.3	7.8	8.8	7.3	14.9	8.4
pH	pH (field)	S.U.	8.05	8.05	8.10	8.05	8.15	8.20	8.35
DO	Dissolved Oxygen	mg/l	8.16	6.99	7.14	7.44	7.88	6.50	9.38
Cond	Conductivity (field)	µ ohms/cm	339	520	465	413	394	418	467
Alk	Alkalinity (field)	mg/l	94	126	134	122	120	138	142
Acid	Acidity (field)	mg/l	4	8	6	8	2	2	0
Lab cond	Specific Conductance	µ ohms/cm	335	514	462	410	387	412	456
Lab pH	pH (lab)	mg/l	7.0	8.2	8.1	8.2	8.3	8.0	8.6
Lab Alk	Alkalinity (as $CaCO_3$)	mg/l	92	134	130	120	118	130	144
DRes	Dissolved Residues	mg/l	194	336	304	270	242	248	266
TSS	Total Suspended Solids	mg/l	2	<2	10	<2	4	14	<2
DN	Dissolved Nitrogen	mg/l	0.24	1.28	1.29	0.85	0.91	0.44	1.00
TN	Total Nitrogen	mg/l	0.27	1.37	1.36	0.91	0.99	0.53	1.03
DNH3	Dissolved Ammonia	mg/l	<0.02	<0.02	<0.02	<0.02	0.07	<0.02	<0.02
TNH3	Total Ammonia	mg/l	<0.02	<0.02	<0.02	<0.02	0.07	<0.02	<0.02
DNO2	Dissolved Nitrite	mg/l	<0.01	0.01	0.02	<0.01	0.01	0.01	<0.01
TNO2	Total Nitrite	mg/l	<0.01	0.01	0.02	<0.01	0.01	0.01	<0.01
DNO3	Dissolved Nitrate	mg/l	<0.04	0.94	0.97	0.57	0.54	0.16	0.70
TNO3	Total Nitrate	mg/l	<0.04	0.94	0.97	0.57	0.54	0.16	0.70
DP	Dissolved Phosphorus	mg/l	0.011	0.053	0.072	0.018	0.027	0.010	0.019
TP	Total Phosphorus	mg/l	<0.02	0.081	0.113	0.030	0.040	0.020	0.030
TOP	Total Orthophosphorus	mg/l	0.008	0.081	0.113	0.027	0.040	0.011	0.026
TOC	Total Organic Carbon	mg/l	2.5	2.9	2.8	2.5	3.1	2.6	2.8
Hard	Total Hardness ($CaCO_3$)	mg/l	96	141	142	128	124	141	143
Ca	Total Calcium	mg/l	38.8	55.0	47.1	41.5	40.4	49.3	48.8
Mg	Magnesium	mg/l	5.75	13.90	10.90	10.50	9.82	12.50	14.10
Na	Sodium	mg/l	22.1	42.4	29.7	22.3	21.5	21	28.8
K	Potassium	mg/l	3.09	2.79	2.82	2.43	2.36	3.08	2.10
Cl	Chloride	mg/l	40	67	50	39	36	38	49
SO4	Total Sulfate	mg/l	16.0	28.3	21.0	20.0	27.0	24.0	23.0
Fl	Fluoride	mg/l	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cu	Copper	µg/l	<4	<4	<4	<4	<4	<4	<4
DFe	Dissolved Iron	µg/l	<20	<20	<20	41	<20	<20	<20
TFe	Total Iron	µg/l	76	112	149	144	123	268	67
Pb	Lead	µg/l	<1	<1	<1	<1	<1	<1	<1
DMn	Dissolved Manganese	µg/l	<10	<10	15	<10	15	<10	<10
TMn	Total Manganese	µg/l	<10	19	27	19	24	24	<10
Ni	Nickel	µg/l	<4	<4	<4	4	<4	<4	<4
Zn	Zinc	µg/l	<5	<5	<5	<5	<5	5.6	16.1
DAl	Dissolved Aluminum	µg/l	<10	10.7	<10	<10	<10	<10	<10
TAl	Total Aluminum	µg/l	30.7	53.6	75.0	44.3	59.1	93.8	24.6

Parameter Symbol	Parameter Name	Units	COHO 4.0	TIOG 6.2	COWN 21.3	COWN 30.1	CRKD 0.1	FELL 0.1	HILL 0.2
RC	Reference Category		60L	60L	62c	62c	62c	62c	62c
Date	Date	yymmdd	971021	971006	970924	970923	970917	970915	970917
Time	Time	hhmm	1130	1355	1245	1605	1115	1330	900
Temp	Water Temperature	°C	7.5	17.2	11.4	15.8	18.4	14.8	14.9
pH	pH (field)	S.U.	8.40	7.50	8.05	8.55	7.75	4.50	7.15
DO	Dissolved Oxygen	mg/l	8.88	7.54	9.15	8.91	7.80	9.19	8.19
Cond	Conductivity (field)	µ ohms/cm	453	210	476	182	334	28	212
Alk	Alkalinity (field)	mg/l	154	54	100	60	102	0	84
Acid	Acidity (field)	mg/l	0	8	8	0	10	6	14
Lab cond	Specific Conductance	µ ohms/cm	450	208	456	181	333	27	214
Lab pH	pH (lab)	mg/l	8.5	6.6	7.3	7.4	6.9	5.0	6.7
Lab Alk	Alkalinity (as $CaCO_3$)	mg/l	154	54	96	62	110	2.4	84
DRes	Dissolved Residues	mg/l	268	152	276	84	214	52	164
TSS	Total Suspended Solids	mg/l	10	<2	<2	10	76	<2	<2
DN	Dissolved Nitrogen	mg/l	1.12	0.59	0.45	0.17	0.75	0.17	0.28
TN	Total Nitrogen	mg/l	1.19	0.65	0.52	0.20	0.96	0.21	0.33
DNH3	Dissolved Ammonia	mg/l	<0.02	0.06	<0.02	<0.02	<0.02	<0.02	<0.02
TNH3	Total Ammonia	mg/l	<0.02	0.08	<0.02	<0.02	<0.02	<0.02	<0.02
DNO2	Dissolved Nitrite	mg/l	<0.01	0.01	<0.01	<0.01	0.04	<0.01	<0.01
TNO2	Total Nitrite	mg/l	<0.01	0.01	<0.01	<0.01	0.04	<0.01	<0.01
DNO3	Dissolved Nitrate	mg/l	0.82	0.29	0.24	<0.04	0.37	<0.04	0.05
TNO3	Total Nitrate	mg/l	0.82	0.29	0.25	<0.04	0.37	<0.04	0.06
DP	Dissolved Phosphorus	mg/l	0.032	0.012	0.005	0.006	0.016	0.012	0.014
TP	Total Phosphorus	mg/l	0.047	0.020	<0.02	<0.02	0.040	<0.02	0.020
TOP	Total Orthophosphorus	mg/l	0.047	0.020	0.006	0.005	0.021	0.012	0.012
TOC	Total Organic Carbon	mg/l	3.0	2.9	2.3	2.0	3.1	3.1	2.0
Hard	Total Hardness ($CaCO_3$)	mg/l	146	68	111	48	71	11	56
Ca	Total Calcium	mg/l	57.1	22.8	40.4	19.6	33.4	1.57	31.3
Mg	Magnesium	mg/l	15.8	5.37	7.21	4.87	4.68	0.658	4.08
Na	Sodium	mg/l	26.50	7.79	40.80	7.88	23.10	0.582	5.60
K	Potassium	mg/l	2.35	2.43	3.56	2.24	3.32	0.542	1.36
Cl	Chloride	mg/l	42	11	64	12	24	<1	8
SO4	Total Sulfate	mg/l	58.0	28.0	35.0	10.3	19.9	10.3	11.8
Fl	Fluoride	mg/l	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cu	Copper	µg/l	<4	<4	<4	<4	<4	<4	<4
DFe	Dissolved Iron	µg/l	<20	<20	<20	<20	32	42	21
TFe	Total Iron	µg/l	94	439	119	31	791	54	183
Pb	Lead	µg/l	<1	<1	<1	1.1	<1	<1	<1
DMn	Dissolved Manganese	µg/l	<10	488	12	<10	89	189	39
TMn	Total Manganese	µg/l	<10	553	17	<10	119	197	39
Ni	Nickel	µg/l	<4	<4	<4	<4	<4	8.3	<4
Zn	Zinc	µg/l	<5	5.6	<5	8.3	<5	45.8	<5
DAl	Dissolved Aluminum	µg/l	<10	<10	<10	10.8	14.0	188	22.2
TAl	Total Aluminum	µg/l	14.1	128	32.2	24.6	213	219	31.7

Parameter Symbol	Parameter Name	Units	JOHN 0.1	MILL 0.1	MORR 0.8	NFCO 0.1	TIOG 16.3	TIOG 39.6	TIOG 42.3
RC	Reference Category		62c	62c	62c	62c	62c	62c	62c
Date	Date	yymmdd	970916	970922	970915	970923	970923	970916	970916
Time	Time	hhmm	1140	1650	1640	1245	910	1350	915
Temp	Water Temperature	°C	20.0	15.0	12.7	14.9	16.7	17.0	14.4
pH	pH (field)	S.U.	7.35	8.30	2.30	8.30	7.05	3.15	4.50
DO	Dissolved Oxygen	mg/l	7.74	9.09	9.72	8.93	7.40	8.53	9.01
Cond	Conductivity (field)	µ ohms/cm	222	234	1,322	227	242	363	109
Alk	Alkalinity (field)	mg/l	16	90	0	76	24	0	0
Acid	Acidity (field)	mg/l	4	0	186	0	6	46	10
Lab cond	Specific Conductance	µ ohms/cm	220	233	1,257	226	240	342	113
Lab pH	pH (lab)	mg/l	6.2	7.5	3.4	7.1	6.4	4.0	5.1
Lab Alk	Alkalinity (as $CaCO_3$)	mg/l	15.8	88.0	0	78.0	32.0	0	3.0
DRes	Dissolved Residues	mg/l	174	162	1,174	144	176	280	96
TSS	Total Suspended Solids	mg/l	<2	<2	<2	6	<2	2	<2
DN	Dissolved Nitrogen	mg/l	0.28	0.15	1.12	0.20	0.52	0.48	0.35
TN	Total Nitrogen	mg/l	0.31	0.16	1.12	0.28	0.56	0.51	0.37
DNH3	Dissolved Ammonia	mg/l	<0.02	<0.02	0.59	<0.02	<0.02	0.05	<0.02
TNH3	Total Ammonia	mg/l	0.02	<0.02	0.59	<0.02	<0.02	0.05	<0.02
DNO2	Dissolved Nitrite	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
TNO2	Total Nitrite	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
DNO3	Dissolved Nitrate	mg/l	0.16	<0.04	0.35	<0.04	0.30	0.27	0.23
TNO3	Total Nitrate	mg/l	0.18	<0.04	0.35	<0.04	0.30	0.28	0.23
DP	Dissolved Phosphorus	mg/l	0.010	0.006	0.01	0.008	0.006	0.011	0.011
TP	Total Phosphorus	mg/l	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02
TOP	Total Orthophosphorus	mg/l	0.014	0.005	0.010	0.011	0.012	0.014	0.011
TOC	Total Organic Carbon	mg/l	1.1	1.9	1.1	2.2	1.8	<1	1.1
Hard	Total Hardness ($CaCO_3$)	mg/l	67	75	531	63	79	95	38
Ca	Total Calcium	mg/l	19.40	31.80	81.30	24.10	25.90	19.80	6.77
Mg	Magnesium	mg/l	6.46	4.58	66.60	6.74	7.22	11.60	4.54
Na	Sodium	mg/l	8.53	6.24	7.78	9.03	6.87	3.52	0.92
K	Potassium	mg/l	1.31	2.36	3.79	3.49	2.19	1.19	0.73
Cl	Chloride	mg/l	14	11	5	15	9	4	1
SO4	Total Sulfate	mg/l	58.7	13.0	779	11.8	59.6	178	48.0
Fl	Fluoride	mg/l	<0.2	<0.2	0.48	<0.2	<0.2	<0.2	<0.2
Cu	Copper	µg/l	<4	<4	60.6	<4	<4	12.6	6.2
DFe	Dissolved Iron	µg/l	104	<20	6,000	<20	<20	1,440	71
TFe	Total Iron	µg/l	284	21	6,230	284	173	2,110	156
Pb	Lead	µg/l	2.2	<1	3.7	<1	<1	2	<1
DMn	Dissolved Manganese	µg/l	461	<10	23,700	<10	143	2,890	1450
TMn	Total Manganese	µg/l	461	<10	24,500	28	219	2,910	1450
Ni	Nickel	µg/l	10.0	<4	483	<4	5.2	84.5	43.1
Zn	Zinc	µg/l	41.7	<5	1,360	6.8	9.5	234	118
DAl	Dissolved Aluminum	µg/l	51.7	36.8	16,400	11.7	15.9	3,770	400
TAl	Total Aluminum	µg/l	192	36.8	17,000	202.0	71.5	3,940	687

Parameter Symbol	Parameter Name	Units	TIOG 49.2	TRUP 0.4
RC	Reference Category		62c	62c
Date	Date	yymmdd	970915	970924
Time	Time	hhmm	1030	935
Temp	Water Temperature	°C	13.4	8.90
pH	pH (field)	S.U.	7.05	7.9
DO	Dissolved Oxygen	mg/l	9.34	9.54
Cond	Conductivity (field)	µ ohms/cm	50	313
Alk	Alkalinity (field)	mg/l	14	118
Acid	Acidity (field)	mg/l	6	6
Lab cond	Specific Conductance	µ ohms/cm	54	310
Lab pH	pH (lab)	mg/l	6.2	7.5
Lab Alk	Alkalinity (as $CaCO_3$)	mg/l	16.4	112
DRes	Dissolved Residues	mg/l	40	178
TSS	Total Suspended Solids	mg/l	<2	2
DN	Dissolved Nitrogen	mg/l	0.28	0.20
TN	Total Nitrogen	mg/l	0.33	0.20
DNH3	Dissolved Ammonia	mg/l	<0.02	<0.02
TNH3	Total Ammonia	mg/l	0.02	<0.02
DNO2	Dissolved Nitrite	mg/l	<0.01	<0.01
TNO2	Total Nitrite	mg/l	<0.01	<0.01
DNO3	Dissolved Nitrate	mg/l	0.10	<0.04
TNO3	Total Nitrate	mg/l	0.12	<0.04
DP	Dissolved Phosphorus	mg/l	0.013	0.004
TP	Total Phosphorus	mg/l	<0.02	<0.02
TOP	Total Orthophosphorus	mg/l	0.014	0.006
TOC	Total Organic Carbon	mg/l	2.1	1.9
Hard	Total Hardness ($CaCO_3$)	mg/l	15	110
Ca	Total Calcium	mg/l	5.5	38.9
Mg	Magnesium	mg/l	1.15	8.01
Na	Sodium	mg/l	0.97	11.5
K	Potassium	mg/l	0.97	3.34
Cl	Chloride	mg/l	1	20
SO4	Total Sulfate	mg/l	7.2	18.8
Fl	Fluoride	mg/l	<0.2	<0.2
Cu	Copper	µg/l	<4	<4
DFe	Dissolved Iron	µg/l	46	<20
TFe	Total Iron	µg/l	71	78
Pb	Lead	µg/l	<1	<1
DMn	Dissolved Manganese	µg/l	15	<10
TMn	Total Manganese	µg/l	20	<10
Ni	Nickel	µg/l	<4	<4
Zn	Zinc	µg/l	7.1	<5
DAl	Dissolved Aluminum	µg/l	13.7	<10
TAl	Total Aluminum	µg/l	22.4	46.1