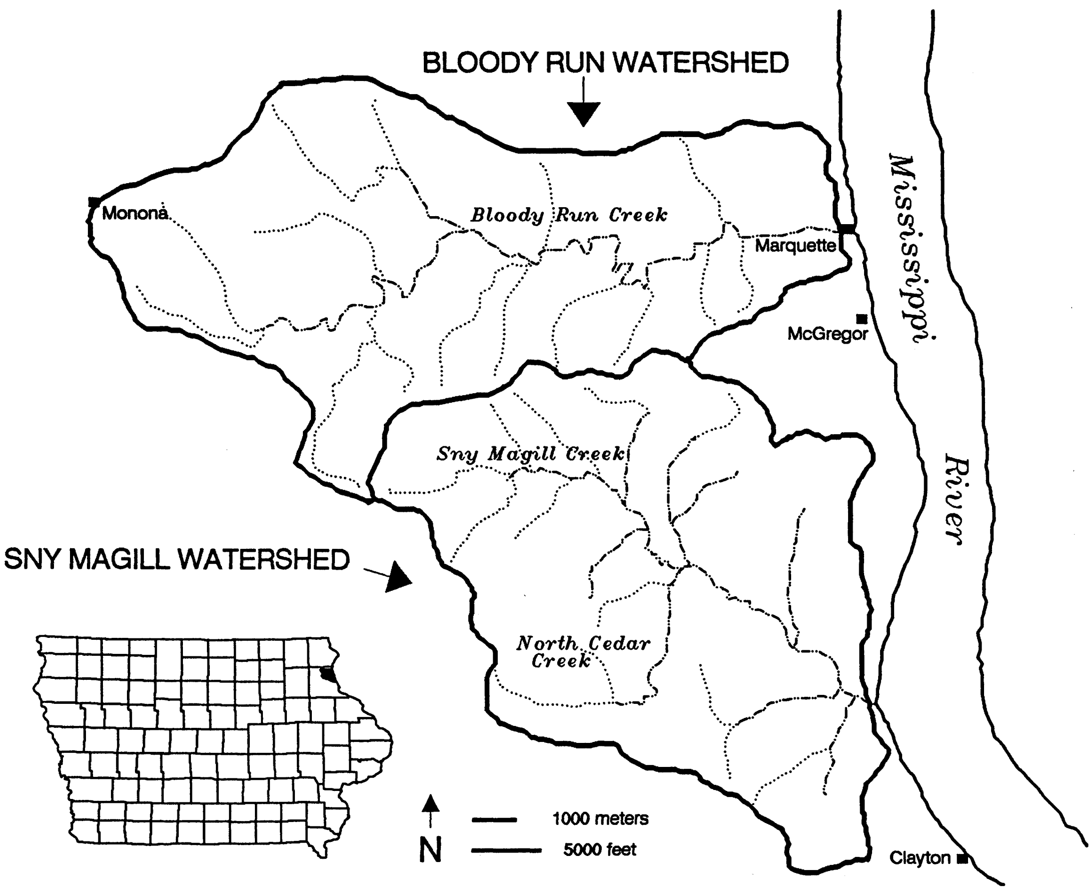
SNY MAGILL NONPOINT SOURCE POLLUTION MONITORING PROJECT, CLAYTON COUNTY, IOWA: WATER YEARS 1992 and 1993

Geological Survey Bureau
Technical Information Series 31



Iowa Department of Natural Resources
Larry J. Wilson, Director
December 1994

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SNY MAGILL NONPOINT SOURCE POLLUTION MONITORING PROJECT, CLAYTON COUNTY, IOWA: WATER YEARS 1992 AND 1993

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ABSTRACT

Since 1992, a consortium of state and federal agencies has been monitoring the water quality of Sny Magill and Bloody Run creeks as part of the Sny Magill Watershed Nonpoint Source Pollution Monitoring Project. The objective of this project is to monitor and assess improvements in water quality resulting from the implementation of special water-quality projects designed to improve farm management practices in the Sny Magill watershed. Two years of water-quality data have been collected. Unusually wet conditions during Water Year 1993 made it difficult to assess whether any improvements in water quality that did occur are attributable to improvements in farm management practices.

Precipitation during Water Year 1992 was 124% of normal and 169% of normal for Water Year 1993. The above normal rainfall for Water Year 1993 directly impacted water quality measurements made on both Sny Magill and Bloody Run creeks. Annual mean discharge for Sny Magill increased from 17.1 ft^3/s in 1992 to 36.6 ft^3/s in 1993; Bloody Run discharge increased from 26.3 ft^3/s to 42.1 ft^3/s. Total suspended sediment discharge for Sny Magill increased from 1,940 tons in 1992 to 13,086 tons in 1993, and increased from 2,720 tons to 22,174 tons on Bloody Run. The average nitrate and triazine pesticide concentrations also increased in response to the increased precipitation and water flux.

The number of benthic macroinvertebrate taxa increased from 60 taxa in Water Year 1992 to 73 taxa in Water Year 1993. Based on the benthic macroinvertebrate data, the water quality in Sny Magill and Bloody Run watersheds was rated "good" to "very good" for both years. Sites located on the tributaries to Sny Magill tended to have better water quality than the main stem sites on Sny Magill. Benthic data from 1993 suggests the water quality may have improved from 1992, however, this improvement is speculative because of the short period of record and the unusual climatic conditions of 1993.

As part of the annual fish assessment, a total of 1,570 fish were sampled in Water Year 1992 and 1,338 in Water Year 1993. The fluctuations in the annual fish populations are a normal response to variation in precipitation, runoff, water clarity, and water stage during the period of sampling. The fish sampled in both Sny Magill and Bloody Run creeks are fish typically found in coldwater streams. For both years, the fish population was dominated by a single species, the fantail darter.

The habitat assessment for Water Year 1993 also recorded the effects of above normal rainfall. Data collected in 1993 show that stream flow during the habitat assessment was two to three times higher in 1993 than Water Year 1992. Also in 1993, stream width and depth were greater at most locations, and noticeable silt deposition and scouring had occurred along many of the stream reaches.

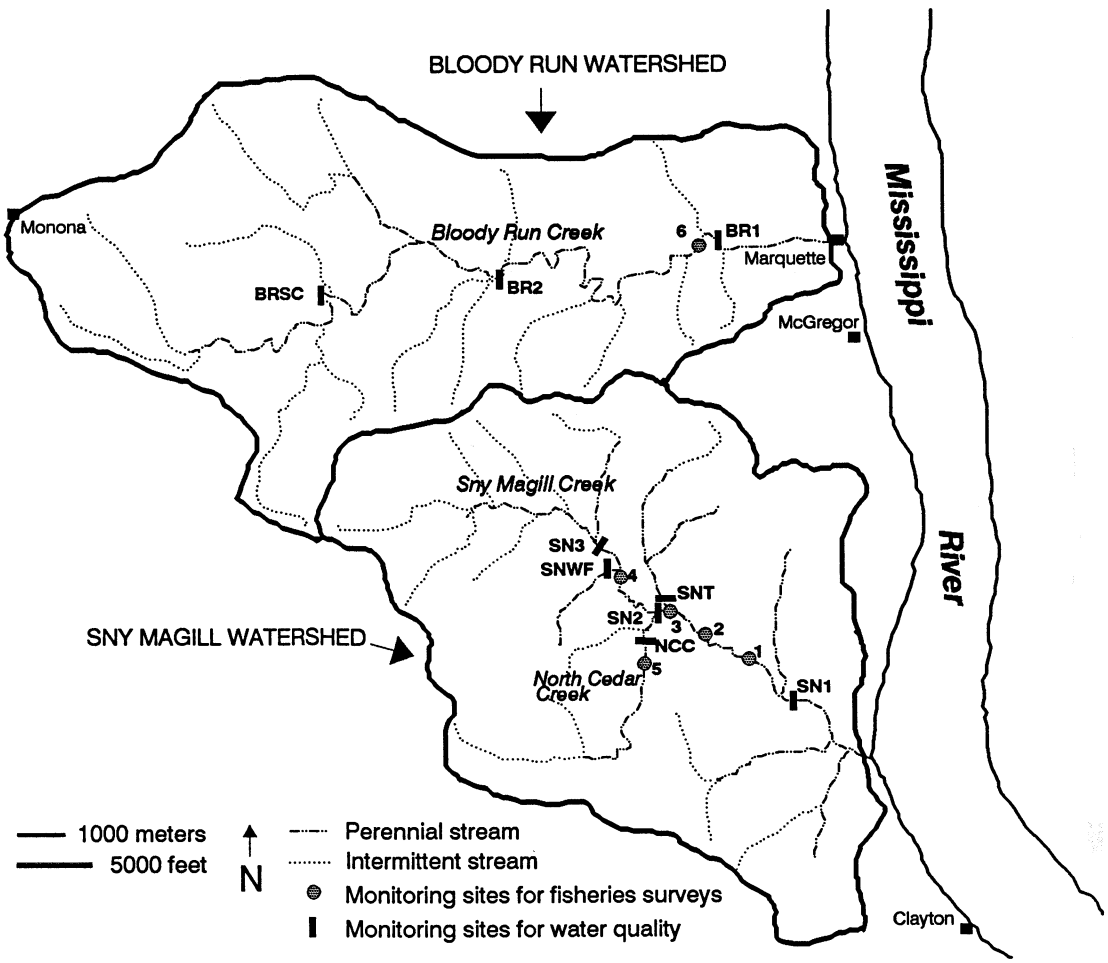


Figure 1. Location of the Sny Magill and Bloody Run watersheds and the monitoring sites for the fisheries surveys and for water quality.

INTRODUCTION

The Sny Magill Watershed Nonpoint Source Pollution Monitoring Project is an interagency effort designed to monitor and assess improvements in water quality resulting from the implementation of two water-quality special projects in the watershed: the Sny Magill Hydrologic Unit Area Project and the North Cedar Creek Water-Quality Special Project. North Cedar Creek is a tributary to Sny Magill Creek. The Sny Magill Watershed Project is supported, in part, by a Nonpoint Source Program (Section 319, Clean Water Act) grant from the U.S. Environmental Protection Agency, Region VII.

Both Sny Magill and North Cedar creeks are Class "B" coldwater streams managed for "put and take" trout fishing. The Sny Magill watershed is affected by water pollutants related to agricultural landuse and management, primarily excess sediment, animal waste, nutrients, and pesticides. A paired watershed approach is being used, with the Bloody Run watershed (adjacent watershed to the north) serving as the control (Figure 1). The watersheds are well suited to a paired approach; the Sny Magill watershed drains 35.6 mi^2 (92.2 hectares) and the Bloody Run watershed drains 37.6 mi^2 (97.4 hectares). The groundwater hydrogeology and known surface water characteristics are similar; both receive groundwater baseflow from the Ordovician Galena aquifer. The watersheds share surface water and groundwater divides and their proximity to one another minimizes rainfall variation.

There are five monitoring components to the project: (1) U.S. Geological Survey (USGS) stream gages near the watershed outlets on both Sny Magill (site SN1) and Bloody Run (site BR1) creeks to measure daily discharge and suspended sediment, (2) an annual habitat assessment along stretches of both stream corridors, (3) biomonitoring of benthic macroinvertebrates on a bi-monthly basis (April - October), (4) an annual fisheries survey, and (5) weekly to monthly monitoring of nine sites on Sny Magill and Bloody Run for chemical and physical water-quality variables. Below is a summary of the water-quality results from water years 1992 and 1993, and a summary of the landuse changes through 1993. (A water year is a 12-month period, from October 1 through September 30, designated by the calendar year in which it ends.)

IMPLEMENTATION PROGRAMS

Sny Magill watershed is the site of two U.S. Department of Agriculture land treatment implementation programs: the Sny Magill Hydrologic Unit Area Project and the North Cedar Creek Water-Quality Special Project. The purpose of the two projects is to provide technical assistance, cost sharing, and educational programs to assist agricultural producers to implement voluntary changes in farm management practices that will result in improved water quality in Sny Magill and North Cedar creeks.

Sny Magill Creek Hydrologic Unit Area

The Sny Magill Creek Cold Water Stream Water Quality Improvement Project is a Hydrologic Unit Area that has been in place since 1991. It includes all of the Sny Magill watershed except for the North Cedar Creek subwatershed. Its purpose is to provide technical and cost-sharing assistance, and educational programs to assist agricultural producers in the watershed to implement voluntary changes in farm management practices that result in improved water quality in Sny Magill Creek. The Soil Conservation Service, Iowa State University Cooperative Extension Service, and the Agricultural Stabilization and Conservation Service are cooperating agencies in this project.

Table 1 summarizes the types and acreage/numbers of practices/activities in the Sny Magill watershed for 1991, 1992, and 1993. Practices include methods to control erosion (i.e., conservation tillage, terraces, strip cropping); nutrient management practices for nitrogen, phosphorus, and pesticides; sediment control (i.e., grade stabilization structures, and water and sediment control basins); and farmstead and wellhead protection. Table 1 also summarizes the applications through 1993.

Table 1. Application of practices/activities as part of the Sny Magill Hydrologic Unit Area for 1991, 1992, and 1993.

Practice Number/Activity	Number Installed	Number of Producers Installing One or More Practices
1991		
Erosion Control		
328/Rotation	310 acres	7
329/Conservation Tillage	34 acres	2
330/Contouring	3 acres	1
344/Residue Management	152 acres	2
585/Stripcropping	48 acres	2
600/Terrace	8000 feet/60 acres	5
612/Tree Planting	5 acres	1
620/Outlet	4476 feet/acre	5
650/Windbreak Renovation	1 acre	1
Timber Management Plans	64 acres	2
1992		
Management Practices		
590/Nutrient Management - Nitrogen	2169 acres	9
590/Nutrient Management - Phosphorus	2169 acres	9
595/Pesticide Management	2169 acres	9
Erosion Control		
327/Conservation Cover	38 acres	1
328/Rotation	514 acres	8
329/Conservation Tillage	451 acres	8
330/Contouring	214 acres	3
344/Residue Management	130 acres	2
386/Field Border	4200 feet/3 acres	1
510/Pasture & Hayland Management	382 acres	5
585/Buffer Strips	95 acres	3
585/Stripcropping	10 acres	1
600/Terrace	64,070 feet/381 acres	20
620/Outlet	30,827 feet/acre	20
Timber Management Plans	327 acres	4
Sediment Control		
410/Grade Stabilization Structure	83	7
638/Water & Sediment Control Basin	17	3
Farmstead & Wellhead Protection		
990/Well Testing	10 wells tested	10
More Effective Use/Application of Nitrogen For Ground-Surface Water	46 pounds - acre weighted average on 78 acres	

1993

Management Practices	
556/Plan Grazing	114 acres
590/Nutrient Management - Nitrogen	1259 acres
590/Nutrient Management - Phosphorus	1259 acres
595/Pesticide Management	1259 acres
Erosion Control	
327/Conservation Cover	201 acres
328/Rotation	1169 acres
329/Conservation Tillage	155 acres
330/Contouring	15 acres
344/Residue Management	11 acres
386/Field Border	5200 feet
585/Buffer Strips	224 acres
600/Terrace	42,720 feet
606/Subsurface Drain	355 feet
620/Outlet	26,038 feet
Timber Management Plans	114 acres
Sediment Control	
638/Water & Sediment Control Basin	4
Farmstead & Wellhead Protection	
990/Well Testing	159 wells tested
More Effective Use/Application of Nitrogen	
For Ground-Surface Water	17.2 pounds - acre weighted average on 2035 acres
Summary:	
327 Conservation Cover	239 acres
328 Rotation	1993 acres
329 Conservation Tillage	640 acres
330 Contouring	232 acres
344 Residue Management	293 acres
386 Field Border	9400 feet
410 Grade Stabilization Structure	83
510 Pasture and Hayland Management	382 acres
556 Plan Grazing	114 acres
585 Buffer Strips	319 acres
585 Strip Cropping	58 acres
600 Terrace	114,790 feet
606 Subsurface Drain	355 feet
612 Tree Planting	5 acres
620 Outlet	61,341 feet
638 Water and Sediment Control Basin	21 acres
650 Windbreak Renovation	1 acre
Timber Management Plans	441 acres

Sources: Sny Magill Creek cold water stream water quality improvement reports (1991,1992,1993).

Table 2. Application of practices/activities as part of the North Cedar Creek Water-Quality Special Project through 1993.

	Practice Number/Activity	Number Installed	Number of Producers Installing One or More Practices
Prior to 1991			
	313/Agricultural Waste Structure	2	2
	410/Grade Stabilization Structure	4	4
	600/Terrace	61,100 feet	3
	600/Old Terrace Repair	200 feet	1
	620/Outlet	32,091 feet	3
1991			
	410/Grade Stabilization Structure	1	1
	600/Terrace	11,895 feet	5
	620/Outlet	6613 feet	4
1992			
	600/Terrace	8235 feet	3
	620/Outlet	4604 feet	3
1993			
	600/Terrace	20,755 feet	6
	620/Outlet	14,086 feet	6
Summary			
	313 Agricultural Waste Structure	2	-
	410 Grade Stabilization Structure	5	-
	600 Terrace	101,985 feet	-
	600 Old Terrace Repair	200 feet	-
	620 Outlet	57,394 feet	-

Sources: Newbern 1991, 1992, 1993, and 1994.

North Cedar Creek Water-Quality Special Project

The North Cedar Creek Water-Quality Special Project began in 1988. It includes the watershed drained by North Cedar Creek, a tributary to Sny Magill Creek. Its purpose is to reduce soil erosion to North Cedar Creek, maintain and improve water quality of North Cedar Creek, and improve the aesthetics of the planning area.

The Clayton County Soil Conservation District, Iowa Department of Natural Resources-Fish and Wildlife Division, U.S. Department of Agriculture Soil Conservation Service, and the Upper Explorerland Resource Conservation and Development Area are cooperating agencies in this project. Table 2 summarizes the types and acreage/numbers of practices/activities in the North Cedar Creek watershed for years prior to 1991, and for years 1991, 1992, and 1993. The table also includes a summary of all practices/activities through 1993. The total allocation for practices/activities in North Cedar Creek was $201,090 (Newbern, 1994). Practices include agricultural waste structures, grade stabilization structures, terraces, and tiles to manage/control sediment and nutrient problems.

FARMING PRACTICES: A BASELINE SURVEY

In the winter of 1992, Iowa State University Cooperative Extension Service (ISU-CES) sent a survey to all active farm operators within the Sny Magill watershed who farm more than 50 acres (20 hectares). The operators were asked to share ideas and information on their farming operation for project planning purposes. Thirty-four operators (74%) responded to the survey. Below is a recap of the survey results as they were printed in an Iowa State University Cooperative Extension publication (ISU-CES, 1992).

Fertilizer Practices

The survey contained several questions on fertilizer rates and practices. Farm operators were asked about the typical rates of nitrogen applied to various corn rotations in 1991. Corn following a good alfalfa stand received an average of 76 pounds of nitrogen per acre. Among respondents with this rotation, most did not report varying rates by field. On corn following a good alfalfa stand, 27 percent of the producers used no additional nitrogen. Second-year corn after alfalfa received an average rate of 120 pounds/acre. Again, most producers did not vary rates by field for their rotation. Finally, corn after corn in a crop rotation received an average of 130 pounds per acre.

The farm operators were asked what information or source was used to determine their nitrogen rates. The primary answer was yield goals, which were used by 20 respondents. Seventeen respondents relied on soil test recommendations, 11 used past experiences and experiments, and nine followed fertilizer dealer recommendations.

When asked how often they soil test, 12 indicated every three years. Five test every year, six test every four or more years, and eight have never soil tested. Approximately one-half of the respondents have changed their nitrogen management in the past three years. The primary change was reduced application rates. The major reasons for this reduction included economics, groundwater/environmental concerns, and accessibility to education and information. Twenty-two are aware of the late spring nitrate soil test. Of those, two used it in 1991. Thirty-one of the 34 respondents indicated they have not tested manure for nutrient availability, but 19 adjusted their fertilizer rates to reflect the contribution from manure. Manure is distributed to an average of 70 acres (28 hectares). The number of acres receiving manure ranged from 5 to 250 acres (2 to 101 hectares). Thirty-one of the farmers rotate their manure to different fields. Past studies in the Big Spring basin (Libra et al., 1992) and Clayton County indicate that producers here have decreased fertilizer nitrogen rates over the past five years.

Groundwater Quality and Farm Profitability

While 30 farmers felt that groundwater contamination is an important environmental problem in their county, only 17 believed that groundwater contamination is an important environmental problem on their farm. Twenty-one felt most farmers in their area could reduce the amount of nitrogen applied without significantly reducing productivity. Twenty noted that in addition to environmental benefits, they need proven profitability before adopting a new technology or practice.

Farm and Operator Characteristics

Survey respondents ranged in age from less than 30 years to more than 61 years. Eighteen respondents were high school graduates. Twenty-five did not hold an off-farm job in 1991. Of the eight who did hold an off-farm job, three indicated they considered farming their primary occupation. The average total acres farmed was 377 (153 hectares). Of the 13,000 acres (526 hectares) inventoried in the survey, 76 percent is owner operated and 24 percent is rented. Sixty-eight percent of the producers rent additional land. The average number of acres of rented land is 140 (57 hectares). Average total corn acres is 152 (62 hectares). The primary rotation is a corn-oat-hay rotation, with an average of 91 acres (37 hectares) in continuous corn. All those surveyed have some livestock. Sixty-two percent have some type of hog enterprise, 56 percent have a beef-cow herd, and 29 percent have dairy cows.

GEOGRAPHIC INFORMATION SYSTEM (GIS) DEVELOPMENT

A GIS at the Department of Natural Resources-Geological Survey Bureau is being utilized to track landuse, farm management practices, and geologic and water-quality information for the Sny Magill project for both Sny Magill and Bloody Run watersheds. Currently, information is included on surficial and bedrock geology, 1991 landuse, and water sampling locations and associated subwatersheds.

Aerial photography was taken September 20, 1991, for both Sny Magill and Bloody Run. The 1991 landuse data for both watersheds was compiled from 1:24,000 scale color infrared aerial photographs. Eleven landuse classes were distinguished by color and pattern differences on the photographs. Landuse classes were originally delineated by hand on the color infrared photographs and then transferred to 7.5' topographic base maps.

Changes in land management practices are occurring in the Sny Magill watershed as a result of the Sny Magill Hydrologic Unit Area and North Cedar Creek Water-Quality Special projects. These changes are tracked by the Soil Conservation Service (SCS) with the tracking package CAMPS (Computer Assisted Management and Planning System). The CAMPS information is downloaded to the GIS and linked by tract number to other available data in the GIS. The land management practice changes can then be summarized by activities occurring above a certain water sampling location. Landuse data is summarized in Table 3 by water-quality sampling locations. Landuse for each site represents the cumulative total for the watershed above each sampling location (i.e., SN2 = SN2 + SNT + NCC + SN3 + SNWF; Figure 1).

Both the surficial and bedrock geology are available in the GIS. The surficial geology information was interpreted from the Soil Survey of Clayton County and transferred onto 7.5' USGS topographic maps. The topographic maps were then digitized. Description of the map units is in Bettis and others (1994). The bedrock geology was field mapped by personnel from the IDNR-Geological Survey Bureau on 7.5' USGS topographic maps and then digitized.

Additional information entered in the GIS includes watershed boundaries and drainage areas associated with each sampling location, 50 and 100 feet (15 and 30 meters) contours along the streams in Sny Magill and Bloody Run to allow summary of landuse within these areas, owner identification and land tract number (T number) from the SCS records, surface-water quality sampling locations, sinkhole locations from the Clayton County Soil Survey, major highways and roads, and location of private wells sampled in the October 1992 well inventory from both watersheds (Seigley and Hallberg, 1994). The private well information includes well depth, nitrate, total coliform bacteria, and fecal coliform bacteria data.

WATER QUALITY OF PRIVATE WATER SUPPLIES IN SNY MAGILL AND BLOODY RUN WATERSHEDS

Private wells in the Sny Magill and Bloody Run watersheds in Clayton County were sampled in October 1992 to determine baseline well-water and groundwater quality for these two watersheds. A total of 151 wells and two springs were sampled for total coliform bacteria, fecal coliform bacteria, and nitrate-nitrogen. Eighteen selected wells were also sampled for common herbicides. The University Hygienic Laboratory in Iowa City analyzed the samples. A well questionnaire was completed for each well to determine well characteristics (depth, casing depth, age), well placement (topographic position, distance from septic system, feedlot, fuel tanks, chemical storage and handling), previous water-quality problems, use of water treatment systems, and presence of sinkholes or abandoned wells near the active well. A more detailed summary can be found in Seigley and Hallberg (1994).

Well depths ranged from 34 to 570 feet (10 to 174 m). Average well depth was 221 feet (67 m). The greatest percentage of wells (29%) ranged between 100 and 199 feet (30 and 61 m) deep. Table 4 summarizes the well-water quality for the two watersheds. Forty percent of the samples contained more than 10 mg/L NO_3-N. These samples showed no significant trend relative to depth. The overall mean NO_3-N concentration

Table 3. Landuse from 1991 for Sny Magill and Bloody Run watersheds. Each site represents the cumulative landuse for the watershed above it (i.e., SN1=SN1+SN2+SN3+NCC+SNWF+SNT).

	Landuse Classes					
	Row Crop (for cropland)	Cover crop, pasture	Forest, forested pasture	Farmstead	Other	Total
Sny Magill (lowermost) - acres	5,842	5,400	11,034	263	28	22,567
Sny Magill (lowermost)- % total	25.9	23.9	48.9	1.2	0.1	100
SN1 - acres	4,871	4,538	8,022	207	28	17,666
SN1- % total	27.6	25.7	45.4	1.2	0.2	100
SN2 - acres	4,011	3,809	6,314	171	28	14,334
SN2 - % total	28.0	26.6	44.1	1.2	0.2	100
SN3 - acres	1,552	2,374	2,017	89	26	6,058
SN3 - % total	25.6	39.2	33.3	1.5	0.4	100
NCC - acres	1,093	387	1,764	25	0	3,269
NCC - % total	33.4	11.8	54.0	0.8	0.0	100
SNWF - acres	431	364	1,124	15	0	1,934
SNWF - % total	22.3	18.8	58.1	0.8	0.0	100
SNT - acres	795	426	752	34	2	2,009
SNT - % total	39.6	21.2	37.5	1.7	0.1	100
Bloody Run (lowermost) - acres	9,344	6,909	7,171	415	376	24,215
Bloody Run (lowermost) - % total	38.6	28.5	29.6	1.7	1.6	100
BR1 - acres	9,061	6,436	5,553	403	167	21,621
BR1 - % total	41.9	29.8	25.7	1.9	0.8	100
BR2 - acres	7,842	4,814	2,000	337	167	15,160
BR2 - % total	51.7	31.8	13.2	2.2	1.1	100
BRSC - acres	3,948	2,050	416	192	167	6,773
BRSC - % total	58.3	30.3	6.2	2.8	2.5	100

declined with increasing well depth range, but the trend was not significant. Forty-two percent of the samples tested positive for total coliform bacteria. The samples testing positive for total coliform bacteria showed no significant trend relative to well depth range. Ten percent of the samples tested positive for fecal coliform bacteria. Of the samples testing positive for fecal coliform bacteria, 55% also had NO_3-N concentrations greater than 10 mg/L. The fecal coliform bacteria results showed no significant trends related to well depth. These results are similar to other findings for this area of Iowa. In other parts of the state, water-quality data from private wells show a pronounced relationship between NO_3-N concentrations and well depth. In parts of northeast Iowa, the substantial local relief and a shallow regional aquifer, allows greater depth of groundwater circulation and hence little depth relation - surficial contaminants penetrate to the depth of the carbonate aquifer (Kross et al., 1990; Hallberg et al., 1983, 1984).

For each private well sampled, an attempt was made to determine total well depth and casing depth. Wells were assigned aquifers based on the structure contour map of the Galena aquifer created for the Big Spring basin (Hallberg et al., 1983) and available well logs from the area. The majority (50%) were Galena aquifer wells and had a mean NO_3-N concentration of 13.5 mg/L (Table 5). Over 50% of the Galena wells had NO_3-N concen-

Table 4. Well-water quality of private wells in Sny Magill and Bloody Run watersheds by well depth categories

Well depth range (feet)	# of wells	% of all wells	% of known well depth	Mean nitrate-N (mg/L)	Percent > 10 mg/L nitrate-N	Range in nitrate-N concentration (mg/L)	Percent positive total coliform bacteria	Percent positive fecal coliform bacteria
0 - 99	18	12%	16%	8.8	28%	<0.2 - 26.4	39%	0%
100 - 199	44	29%	40%	11.9	34%	<0.2 - 47.8	43%	11%
200 - 299	23	15%	21%	9.4	35%	<0.2 - 38.4	43%	4%
> 300	26	17%	23%	8.6	23%	<0.2 - 41.6	15%	0%
unknown	40	26%	—	11.3	30%	0.7 - 32.9	23%	3%
Sny Magill	60	40%	—	8.3	22%	<0.2 - 36.2	35%	12%
Bloody Run	91	60%	—	12.4	52%	<0.2 - 47.8	46%	6%
All wells	151	—	—	10.8	40%	<0.2 - 47.8	42%	10%

trations > 10 mg/L, 57% were positive for total coliform bacteria, and 12% were positive for fecal coliform bacteria.

Water from 18 wells was analyzed for seven common herbicides. Thirteen of the eighteen wells (72%) were Galena wells. Seven samples (39%) had detections of atrazine at concentrations ranging from 0.10 to 0.61 μg/L with a mean detection value of 0.34 μg/L. All of the detections were below the health advisory limit of 3.00 μg/L. Deethylatrazine, a metabolite or breakdown product of atrazine, was detected in one sample at a concentration of 0.23 μg/L. Of the seven wells with detections of atrazine or deethylatrazine, five (71%) tested positive for total coliform bacteria, none tested positive for fecal coliform bacteria, and three (43%) had NO_3-N concentrations greater than 10 mg/L.

A well questionnaire was completed for each well to determine possible point source problems. No one reported storing or mixing chemicals <100 feet (30 m) from the well. No one reported any incident of backsiphoning of chemicals into the well. Eighty-seven percent of the wells were >100 feet (30 m) from a feedlot and 97% were >50 feet (15 m) from a septic system. Thirty people reported sinkholes nearby. The average nitrate concentration was greater for wells with sinkholes nearby, but few of these wells reported NO_3-N concentrations >10 mg/L. Thirty-three people reported using cisterns. Wells with active cisterns had a greater percentage of samples with total coliform bacteria. Wells that were positive for fecal coliform bacteria showed no correlation to distance of well from septic system, feedlot, or abandoned wells.

DRAINAGE BASIN MORPHOLOGY

Drainage-basin characteristics, quantified using a GIS procedure (Majure and Eash, 1991; Eash, 1993), were used to compare the morphology of the Bloody Run and Sny Magill watersheds. These characteristics were calculated by the USGS. Morphologic characteristics that significantly influence the magnitude and frequency of surface-water runoff for streams in Iowa include contributing drainage area, relative relief, and drainage frequency (an indication of the spacing of streams in the drainage network). A detailed description of the GIS procedures used to calculate the drainage basin characteristics can be found in Eash (1993) and Kalkhoff and Eash (1994). Table 6 lists selected basin characteristics that were quantified for Bloody Run and Sny Magill watersheds, and the basin characteristics quantified for the subbasins in

Table 5. Well-water quality of private wells in Sny Magill and Bloody Run watersheds by aquifer type.

Aquifer	Count	% of All Wells	Mean nitrate-N (mg/L)	% > 10 mg/L nitrate-N	Range in nitrate-N (mg/L)	% Positive for Total Coliform Bacteria	% Positive for Fecal Coliform Bacteria
Galena	76	50.3	13.5	53.9	<0.2 - 47.8	56.6	11.8
Combination Galena	20	13.2	9.0	25.0	<0.2 - 37.3	35.0	5.0
Unknown	30	19.9	9.7	26.7	2.4 - 30.9	23.3	3.3
Alluvium	3	2.0	0.8	0.0	0.7 - 1.1	33.3	0.0
Other Bedrock	22	14.6	5.8	22.7	<0.2 - 34.4	22.7	9.1

Bloody Run and Sny Magill. Many of the basin characteristics listed in Table 6 are defined by Strahler (1964). The total drainage area, basin length, and basin relief are greater for Bloody Run than Sny Magill. The main channel slope is greater for all of the Sny Magill sites than the Bloody Run sites.

PRECIPITATION

Rainfall was measured at sites BR1 and SN1 using standard tipping-bucket rain gages attached to the USGS stream gages. Rainfall was recorded by the data-collection platform and transmitted to a satellite and then to a down link station in Denver, Colorado. The data is then decoded and sent to the USGS office in Iowa City. Data collection began on March 12, 1992, at site BR1 and on April 5, 1992, at site SN1.

Water Year 1992

Since data collection of rainfall at sites BR1 and SN1 did not begin until March 12, 1992 and April 5, 1992, respectively, a complete year of rainfall data was unavailable. To provide a complete year of rainfall data for Water Year 1992, rainfall data from a climatic station located nearby in Prairie du Chien, Wisconsin, was used (Table 7 and Figure 2). Rainfall at this site was 38.03 inches (966.0 mm) for Water Year 1992 (Harry Hillaker, personal communication). The long-term average rainfall for the Prairie du Chien site, based on data collected from 1961-1990, is 30.60 inches (777.2 mm) (Wisconsin State Climatology Office, personal communication). Rainfall for Water Year 1992 was 7.43 inches (188.7 mm) above normal, or 124% of normal. The maximum recorded daily rainfall from the climatic station was 1.65 inches (41.9 mm) on November 1, 1991. The maximum monthly rainfall, 6.97 inches (177.0 mm), occurred during September 1992. The September total was 300% of the monthly normal.

The maximum recorded daily rainfall at site BR1 was 1.92 inches (48.8 mm) on July 13, 1992 (Table 8). This rain contributed to the maximum monthly rainfall (6.97 inches, or 177.0 mm, during July) recorded at site BR1 for Water Year 1992. The maximum recorded daily rainfall at site SN1 was 2.26 inches (57.4 mm) on September 14, 1992 (Table 8). The maximum recorded monthly precipitation at site SN1 was 5.57 inches (141.5 mm) during September 1992.

Table 6. Selected morphological characteristics for subbasins in the Bloody Run and Sny Magill watersheds.

Characteristic	Sites				
	SN1	SN2	SN3	SNWF	NCC
Total drainage area: square miles (square kilometers)	27.60 (71.48)	22.50 (58.27)	7.20 (18.65)	3.10 (8.03)	6.00 (15.54)
Contributing drainage area: square miles (square kilometers)	27.60 (71.48)	22.50 (58.27)	7.20 (18.65)	3.10 (8.03)	6.00 (15.54)
Basin length: mi (km)	7.80 (12.55)	5.50 (8.85)	4.00 (6.44)	3.30 (5.31)	4.70 (7.56)
Basin perimeter: mile (kilometer)	25.00 (40.23)	21.90 (35.24)	11.40 (18.35)	8.10 (13.04)	11.10 (17,86)
Basin relief: feet (meter)	496.00 (151.18)	463.00 (141.12)	390.00 (118.87)	396.00 (120.70)	413.00 (125.88)
Relative relief: ft/mi (m/km)	20.00 (3.79)	21.20 (4.02)	34.00 (6.44)	49.00 (9.28)	37.10 (7.03)
Main channel length: mile (kilometer)	9.40 (15.13)	6.50 (10.46)	4.50 (7.24)	3.40 (5.47)	5.30 (8.53)
Total stream length: mile (kilometer)	43.00 (69.20)	35.90 (57.77)	12.70 (20.44)	5.10 (8.21)	8.00 (12.87)
Main channel slope: ft/mi (m/km)	50.00 (9.47)	72.50 (13.73)	88.40 (16.74)	121.00 (22.92)	83.40 (15.80)
Main channel sinuosity ratio	1.20	1.20	1.10	1.00	1.10
Stream density: mi/mile squared (km/km squared)	1.60 (0.97)	1.60 (0.99)	1.80 (1.10)	1.60 (1.02)	1.30 (0.83)
Number of first order streams	17.00	15.00	6.00	2.00	3.00
Drainage frequency: first order streams/mile squared (first order streams/kilometer squared)	0.62 (0.24)	0.67 (0.26)	0.83 (0.32)	0.64 (0.25)	0.50 (0.19)

Characteristic	SNT	BR1	BR2	BRSC
Total drainage area: square miles (square kilometers)	3.20 (8.29)	34.30 (88.83)	24.50 (63.45)	10.50 (27.19)
Contributing drainage area: square miles (square kilometers)	3.20 (8.29)	33.00 (85.47)	23.20 (60.09)	9.30 (24.09)
Basin length: mi (km)	3.40 (5.47)	12.00 (19.31)	8.30 (13.36)	4.80 (7.72)
Basin perimeter: mile (kilometer)	7.40 (11.91)	29.00 (46.67)	22.20 (35.73)	16.50 (26.55)
Basin relief: feet (meter)	376.00 (114.60)	570.00 (173.74)	423.00 (128.93)	300.00 (91.44)
Relative relief: ft/mi (m/km)	51.10 (9.68)	20.00 (3.79)	19.00 (3.60)	18.10 (3.43)
Main channel length: mile (kilometer)	3.60 (5.79)	15.50 (24.94)	9.10 (14.64)	5.90 (9.49)
Total stream length: mile (kilometer)	6.20 (9.98)	61.50 (98.97)	41.20 (66.30)	13.70 (22.05)
Main channel slope: ft/mi (m/km)	100.00 (18.94)	28.00 (5.30)	35.60 (6.74)	37.50 (7.10)
Main channel sinuosity ratio	1.10	1.30	1.10	1.20
Stream density: mi/mile squared (km/km squared)	1.90 (1.20)	1.90 (1.16)	1.80 (1.10)	1.50 (1.47)
Number of first order streams	3.00	25.00	16.00	4.00
Drainage frequency: first order streams/mile squared (first order streams/kilometer squared)	0.93 (0.36)	0.76 (0.29)	0.69 (0.27)	0.43 (0.17)

Table 7. Daily precipitation (in inches) for the Prairie du Chien, Wisconsin climatic station; Water Year 1992.

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
					Prairie du Chien							
1	0.00	1.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.07	0.15
3	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.51
4	0.39	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.09	0.00
5	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.20
7	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.53	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.61	0.80
9	0.00	0.00	0.00	0.00	0.00	0.58	0.46	0.00	0.00	0.00	0.00	0.72
10	0.00	0.05	0.00	0.00	0.00	0.22	0.00	0.00	0.00	0.27	0.00	0.00
11	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.60	0.00
12	0.00	0.05	0.29	0.00	0.00	0.00	0.00	0.36	0.00	0.42	0.18	0.00
13	0.00	0.00	0.43	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.27	0.00
14	0.05	0.00	0.01	0.00	0.00	0.40	0.00	0.00	0.00	1.33	0.00	1.58
15	0.00	0.21	0.00	0.26	0.14	0.00	0.60	0.00	0.00	0.00	0.00	0.68
16	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.00	0.02	0.23	0.00	0.00
17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.88	0.00	0.00	0.42
18	0.00	1.05	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.05	0.05	0.29
19	0.00	0.00	0.00	0.00	0.17	0.00	0.57	0.00	0.00	0.11	0.00	0.00
20	0.00	0.00	0.22	0.00	0.00	0.00	1.00	0.00	0.21	0.23	0.00	0.00
21	0.00	0.00	0.40	0.00	0.00	0.00	0.90	0.00	0.00	0.00	0.00	0.00
22	0.00	0.00	0.00	0.00	0.00	0.40	0.08	0.10	0.00	0.05	0.00	0.00
23	0.00	0.95	0.00	0.28	0.00	0.00	0.00	0.32	0.00	0.62	0.00	0.00
24	0.00	0.81	0.00	0.00	0.16	0.00	0.07	0.00	0.18	0.00	0.00	0.00
25	0.96	0.00	0.00	0.53	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00
26	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.60	0.20
27	0.01	0.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.42
28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
29	0.85	0.14	0.00	0.00	0.00	0.53	0.00	0.00	0.00	0.00	0.00	0.00
30	0.09	0.34	0.00	0.00		0.14	0.00	0.00	0.06	0.00	0.00	0.00
31	0.00		0.00	0.00		0.00		0.00		0.38	0.00	
Total	3.33	5.92	1.60	1.07	0.61	2.27	4.83	1.78	1.35	5.83	2.47	6.97
									Water year total = 38.03 inches			

Water Year 1993

During the extensive flooding in Iowa in the spring and summer months of 1993 it was not possible to provide routine maintenance for the rain gages. As a result, some rainfall data is missing for Water Year 1993 from sites BR1 and SN1. To provide a complete year of rainfall data for Water Year 1993, rainfall data from the Prairie du Chien climatic station was again used (Table 9 and Figure 2). Rainfall at the Prairie du Chien site for Water Year 1993 was 51.85 inches (1317.0 mm), 21.25 inches (539.8 mm) above normal or 169% of normal. The maximum daily rainfall was 3.22 inches (81.8 mm) on June 8, 1993. The maximum recorded monthly precipitation was 9.98 inches (253.5 mm) during June 1993. The June total was 287% of the monthly normal.

Rainfall data for sites BR1 and SN1 is in Table 10. Of the two gage sites, site BR1 had the more complete rainfall data. The maximum recorded daily rainfall at site BR1 was 2.83 inches (71.9 mm) on June 7, 1992.

BENTHIC BIOMONITORING RESULTS

Benthic biomonitoring of the Sny Magill and Bloody Run creeks for water years 1992 and 1993 was completed in April, June, August, and October of each year by personnel from the University Hygienic Laboratory. Results were published in Schueller and others (1993, 1994).

Benthic macroinvertebrate samples were collected using a Modified Hess bottom sampler.

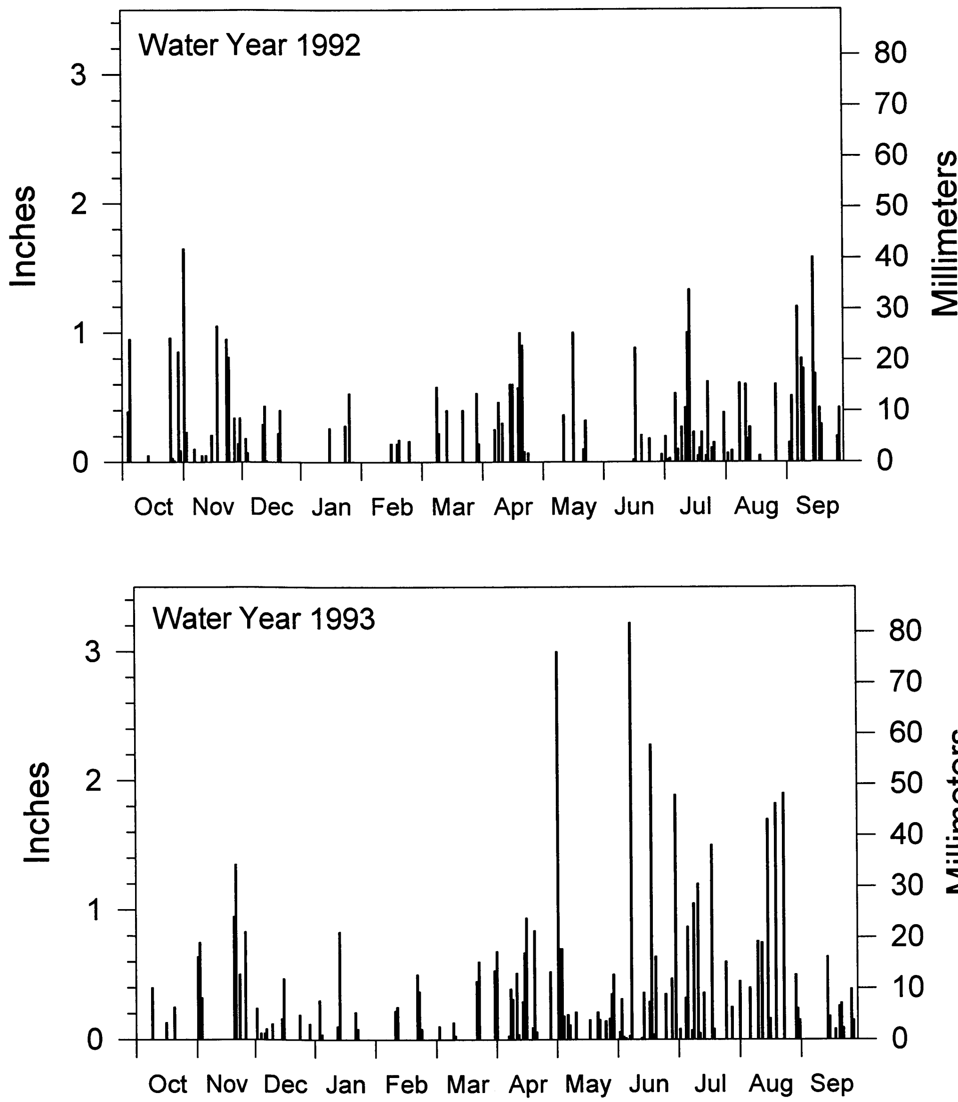


Figure 2. Daily precipitation for the Prairie du Chien, Wisconsin, climatic station; water years 1992 and 1993.

Schueller and others (1992) determined the Modified Hess bottom sampler to be the preferred sampling method over kicknets or Hester-Dendy artificial substrates. A total of 96 samples were collected at eight water quality sites during the sampling season (Figure 1; benthic biomonitoring was not completed at site BRSC). Triplicate samples were collected at each site for each of the four months. Samples were preserved in the field in a 10% formalin solution. Laboratory processing and data analysis were performed as described in the Environmental Protection Agency's Rapid Bioassessment Protocols (RBP) for Use in Streams and Rivers: Benthic Macroinvertebrates and Fish (Plafkin et al., 1989). Below is a summary of the results from Schueller and others (1993, 1994).

Table 8. Daily precipitation (in inches) in the Bloody Run and Sny Magill watersheds; Water Year 1992.

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
						Site BR1						
1							0.00	0.00	0.00	0.00	0.00	0.00
2							0.00	0.00	0.00	0.22	0.11	0.43
3							0.00	0.00	0.00	0.00	0.06	0.01
4							0.00	0.02	0.00	0.08	0.01	0.00
5							0.00	0.00	0.00	0.00	0.00	0.82
6							0.16	0.00	0.00	0.00	0.00	0.24
7							0.01	0.00	0.00	0.51	0.81	0.04
8							0.44	0.00	0.00	0.10	0.00	0.00
9							0.01	0.00	0.00	0.16	0.00	0.80
10							0.12	0.00	0.00	0.27	0.18	0.00
11							0.00	0.10	0.00	0.48	0.00	0.00
12						0.00	0.00	0.01	0.00	0.74	0.31	0.00
13						0.00	0.00	0.00	0.00	1.92	0.00	0.00
14						0.40	0.00	0.00	0.00	0.00	0.00	1.65
15						0.00	0.91	0.05	0.00	0.07	0.01	0.00
16						0.10	0.23	0.55	0.55	0.18	0.00	0.54
17						0.00	0.00	0.52	0.68	0.24	0.08	0.02
18						0.00	0.21	0.00	0.00	0.01	0.00	0.27
19						0.00	0.85	0.00	0.32	0.26	0.01	0.00
20						0.10	1.03	0.00	0.00	0.00	0.00	0.00
21						0.00	0.05	0.16	0.00	0.00	0.00	0.00
22						0.16	0.02	0.34	0.13	0.88	0.00	0.00
23						0.00	0.08	0.00	0.06	0.01	0.00	0.00
24						0.00	0.03	0.00	0.01	0.00	0.00	0.00
25						0.20	0.00	0.00	0.00	0.48	0.07	0.00
26						0.00	0.00	0.00	0.00	0.01	0.01	0.43
27						0.00	0.01	0.00	0.00	0.00	0.00	0.00
28						0.45	0.00	0.00	0.00	0.00	0.00	0.00
29						0.25	0.00	0.00	0.00	0.00	0.00	0.01
30						0.01	0.00	0.00	0.01	0.34	0.00	0.00
31						0.00		0.00		0.01	0.00	
Total							4.16	1.75	1.76	6.97	1.66	5.26
						Site SN1						
1								0.00		0.00	0.00	0.00
2								0.00	0.00	0.27	0.13	0.46
3								0.00	0.00	0.00	0.05	0.01
4								0.04	0.00	0.27	0.01	0.00
5							0.00	0.00	0.00	0.00	0.00	0.64
6							0.10	0.00	0.00	0.00	0.00	0.46
7							0.00	0.00	0.00	1.06	0.73	0.09
8							0.32	0.00	0.00	0.06	0.00	0.00
9							0.00	0.00	0.00	0.07	0.00	0.48
10							0.14	0.00	0.00	0.07	0.44	0.01
11							0.00	0.09	0.00	0.02	0.00	0.00
12							0.00	0.00	0.00	0.83	0.26	0.00
13							0.00	0.00	0.00	1.05	0.00	0.00
14							0.00	0.00	0.03	0.00	0.00	2.26
15							0.69	0.03	0.00	0.08	0.00	0.00
16							0.11	0.03	0.23	0.17	0.00	0.29
17							0.00	0.03	0.35	0.16	0.10	0.01
18							0.19	0.00	0.00	0.01	0.00	0.50
19							1.03	0.00	0.40	0.07	0.00	0.00
20							1.08	0.00	0.00	0.01	0.00	0.03
21							0.04	0.03	0.00	0.00	0.00	0.00
22							0.01	0.00	0.12	0.49	0.01	0.00
23							0.04	0.01	0.12	0.04	0.00	0.00
24							0.03	0.00	0.00	0.00	0.00	0.00
25							0.00	0.00	0.00	0.27	0.72	0.00
26							0.00	0.00	0.00	0.01	0.00	0.31
27							0.00	0.00	0.00	0.00	0.00	0.01
28							0.00	0.00	0.00	0.00	0.00	0.00
29							0.00	0.00	0.00	0.00	0.00	0.01
30							0.00	0.00	0.00	0.53	0.00	0.00
31								0.00		0.01	0.00	
Total							3.78	0.26	1.25	5.55	2.45	5.57

Table 9. Daily precipitation (in inches) for the Prairie du Chien, Wisconsin climatic station; Water Year 1993.

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
				Prairie du Chien								
1	0.00	0.64	0.00	0.00	0.00	0.00	0.68	0.00	0.00	0.00	0.45	0.00
2	0.00	0.75	0.24	0.00	0.00	0.00	0.00	3.00	0.06	0.08	0.00	0.00
3	0.00	0.32	0.00	0.30	0.00	0.10	0.00	0.70	0.31	0.00	0.00	0.00
4	0.00	0.00	0.05	0.04	0.00	0.00	0.00	0.70	0.02	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.01	0.32	0.00	0.00
6	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.87	0.40	0.00
7	0.00	0.00	0.08	0.00	0.00	0.00	0.03	0.19	0.03	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.39	0.11	3.22	0.07	0.00	0.00
9	0.40	0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.00	1.05	0.00	0.00
10	0.00	0.00	0.12	0.00	0.22	0.13	0.00	0.00	0.00	0.00	0.76	0.00
11	0.00	0.00	0.00	0.00	0.25	0.03	0.51	0.21	0.00	1.20	0.00	0.00
12	0.00	0.00	0.00	0.10	0.00	0.00	0.04	0.00	0.00	0.05	0.75	0.00
13	0.00	0.00	0.00	0.83	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
14	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.36	0.36	0.00	0.64
15	0.00	0.00	0.16	0.00	0.00	0.00	0.67	0.00	0.00	0.00	1.70	0.18
16	0.13	0.00	0.47	0.00	0.00	0.00	0.94	0.00	0.00	0.00	0.16	0.00
17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.00	0.00
18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	2.28	1.50	0.00	0.08
19	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.04	0.08	1.82	0.00
20	0.25	0.95	0.00	0.00	0.00	0.00	0.84	0.00	0.64	0.00	0.00	0.26
21	0.00	1.35	0.00	0.21	0.50	0.00	0.06	0.00	0.00	0.00	0.00	0.28
22	0.00	0.00	0.00	0.08	0.37	0.45	0.00	0.21	0.00	0.00	0.00	0.09
23	0.00	0.50	0.00	0.00	0.08	0.60	0.00	0.15	0.00	0.00	1.90	0.00
24	0.00	0.00	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35	0.60	0.00	0.00
26	0.00	0.83	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.39
27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15
28	0.00	0.00	0.00	0.00	0.00	0.00	0.52	0.16	0.47	0.25	0.00	0.00
29	0.00	0.00	0.12	0.00		0.00	0.00	0.35	0.00	0.00	0.50	0.00
30	0.00	0.00	0.00	0.00		0.00	0.00	0.50	1.89	0.00	0.24	0.00
31	0.00		0.00	0.00		0.53				0.00	0.15	
Total	0.78	5.34	1.48	1.56	1.84	1.42	5.37	6.75	9.98	6.43	8.83	2.07

Water year total = 51.85 inches

Water Year 1992

A total of 60 taxa were collected from the Sny Magill and Bloody Run watersheds in 1992. Figure 3 shows the total number of taxa collected per sampling site. Site SNT had the greatest number (35) of taxa collected in 1992. The predominant taxa collected were *Ceratopsyche slossonae* (caddisfly), *Optioservus spp.* (beetle), *Baetis tricaudatus* (mayfly), and Chironomidae (midge) (Figure 4). These four taxa comprised 67% of the total taxa composition for the two watersheds. An evaluation of the similarity of the benthic communities among the sampling sites indicated that all sites were relatively similar.

Metrics were calculated for all eight sites (Table 11). The water quality of the two basins was classified as "good" to "very good" based on the Hilsenhoff Biotic Index (HBI). The HBI values in the Sny Magill watershed ranged from 1.99 (site SN2) to 2.58 (site SN3), with a mean value for all sites in the watershed of 2.21. HBI values in the Bloody Run watershed ranged from 2.06 (site BR2) to 2.42 (site BR1), with a mean value for all sites of 2.24.

Sites SNWF and NCC had the best overall water quality in the watershed. Despite that, when all metrics from the Rapid Bioassessment Protocols were evaluated, the water quality of these two sites indicated slight organic pollution based on the HBI values. Sites SNWF and NCC also had the most balanced benthic communities of the eight sites. Site SN3 had the worst water quality. This was

Table 10. Daily precipitation (in inches) in the Bloody Run and Sny Magill watersheds; Water Year 1993.

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
						Site BR1						
1	0.00	0.96	0.00	0.00	0.00	0.00	0.13	1.74	0.03	0.00	0.00	0.00
2	0.00	0.40	0.00	0.00	0.00	0.15	0.00	2.22	0.51	0.03	0.00	0.04
3	0.00	0.00	0.00	0.09	0.00	0.05	—	0.30	0.00	0.00	0.02	0.00
4	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.20	0.04	0.01	0.28	0.00
5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.05	0.01	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.34	2.83	0.00	0.00	0.00
8	0.35	0.01	0.00	0.00	0.00	0.00	0.34	0.00	0.00	0.58	0.09	0.00
9	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.45	0.52	0.00
10	0.00	0.02	0.12	0.00	0.58	0.16	0.04	0.73	0.00	0.89	0.00	0.00
11	0.00	0.00	0.02	0.00	0.00	0.00	0.48	0.03	0.00	0.62	0.00	0.00
12	0.00	0.02	0.01	0.01	0.03	0.00	0.00	—	—	0.01	0.28	0.00
13	0.00	0.00	0.07	0.00	0.02	0.00	0.03	0.00	—	0.38	0.00	0.56
14	0.00	0.00	0.28	0.00	0.00	0.00	0.50	0.00	—	0.00	0.25	0.13
15	0.11	0.00	0.92	0.00	0.00	0.01	0.93	0.00	0.00	0.00	1.30	0.00
16	0.00	0.00	0.01	0.00	0.00	0.02	0.38	0.00	0.35	0.00	0.23	0.00
17	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.14	1.14	1.27	0.00	0.07
18	0.01	0.00	0.01	0.00	0.00	—	0.09	0.00	0.10	0.09	1.20	0.00
19	0.01	0.80	0.00	0.04	0.00	0.12	0.47	0.03	0.85	0.00	0.01	0.29
20	0.22	1.87	0.00	0.01	0.00	0.00	0.61	0.00	0.00	0.00	0.00	0.21
21	0.00	—	0.00	0.77	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.06
22	0.00	—	0.00	0.12	0.02	0.05	0.00	0.11	0.00	0.00	0.07	0.00
23	0.00	—	0.00	0.07	0.00	0.41	0.00	0.19	0.00	0.00	2.11	0.00
24	0.00	0.00	0.00	0.00	0.00	0.48	0.00	0.01	0.08	0.00	0.00	0.00
25	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.51	0.00	0.47
26	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.09	0.15
27	0.00	0.00	0.00	0.00	0.00	0.00	0.58	0.19	0.00	0.24	0.00	0.02
28	0.00	0.00	0.10	0.01	0.01	0.00	0.00	0.02	0.33	0.01	0.02	0.00
29	0.00	0.00	0.53	0.00	—	0.00	0.00	0.00	1.77	0.00	0.77	0.00
30	0.00	0.00	0.05	0.00	—	0.38	0.00	0.62	0.08	0.00	0.02	0.00
31	0.26	—	0.00	0.00	—	0.91	—	0.00	—	—	0.00	—
Total	0.97	—	2.12	1.14	0.71	—	—	—	—	—	7.55	2.00
						Site SN1						
1	0.00	0.87	0.00	0.00	0.00	0.00	0.04	—	—	—	—	0.00
2	0.00	0.34	0.00	0.00	0.01	0.20	0.00	—	—	—	—	0.01
3	0.00	0.00	0.00	0.05	0.00	0.06	—	—	—	—	—	0.00
4	0.00	0.00	0.00	0.03	0.00	0.00	0.00	—	—	—	—	0.00
5	0.00	0.01	0.00	0.00	0.00	0.00	0.00	—	—	—	—	0.00
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	—	—	—	—	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00	0.23	—	—	—	—	0.00
8	0.34	0.00	0.00	0.00	0.00	0.00	0.40	—	—	—	—	0.01
9	0.00	0.00	0.00	0.00	0.05	0.00	0.00	—	—	—	—	0.00
10	0.00	0.02	0.11	0.00	0.43	0.14	0.02	—	—	—	—	0.00
11	0.00	0.00	0.04	0.00	0.00	0.00	0.36	—	—	—	—	0.02
12	0.00	0.05	0.00	0.01	0.00	0.00	0.00	—	—	—	—	0.00
13	0.00	0.00	0.10	0.00	0.07	0.00	0.07	—	—	—	—	0.51
14	0.00	0.00	0.21	0.02	0.21	0.00	0.55	—	—	—	—	0.24
15	0.17	0.00	0.66	0.00	0.00	0.01	0.91	—	—	—	—	0.00
16	0.01	0.00	0.01	0.00	0.00	0.00	0.06	—	—	—	—	0.00
17	0.01	0.00	0.00	0.00	0.00	—	0.00	—	—	—	—	0.06
18	0.00	0.00	0.00	0.00	0.00	—	0.04	—	—	—	—	0.01
19	0.01	0.61	—	0.00	0.00	—	0.59	—	—	—	—	0.25
20	0.19	—	—	0.00	0.00	0.01	—	—	—	—	—	0.29
21	0.00	0.07	0.00	0.45	0.01	0.04	—	—	—	—	—	0.03
22	0.00	0.28	0.00	0.17	0.00	0.04	—	—	—	—	—	0.01
23	0.00	0.16	0.00	0.00	0.00	0.68	—	—	—	—	—	0.02
24	0.00	0.00	0.00	0.00	0.00	0.40	—	—	—	—	—	0.00
25	0.00	0.07	0.30	0.00	0.00	0.00	—	—	—	—	—	0.46
26	0.00	0.00	0.00	0.00	0.01	0.00	—	—	—	—	—	0.08
27	0.00	0.04	0.00	0.00	0.00	0.00	—	—	—	—	—	0.02
28	0.00	0.00	0.09	0.01	0.09	0.00	—	—	—	—	—	0.00
29	0.00	0.00	0.41	0.00	—	0.00	—	—	—	—	—	0.00
30	0.00	0.00	0.09	0.00	—	0.36	—	—	—	—	—	0.00
31	0.21	—	0.17	0.00	—	0.72	—	—	—	—	0.00	—
Total	0.94	—	—	0.74	0.88	—	—	—	—	—	—	2.02

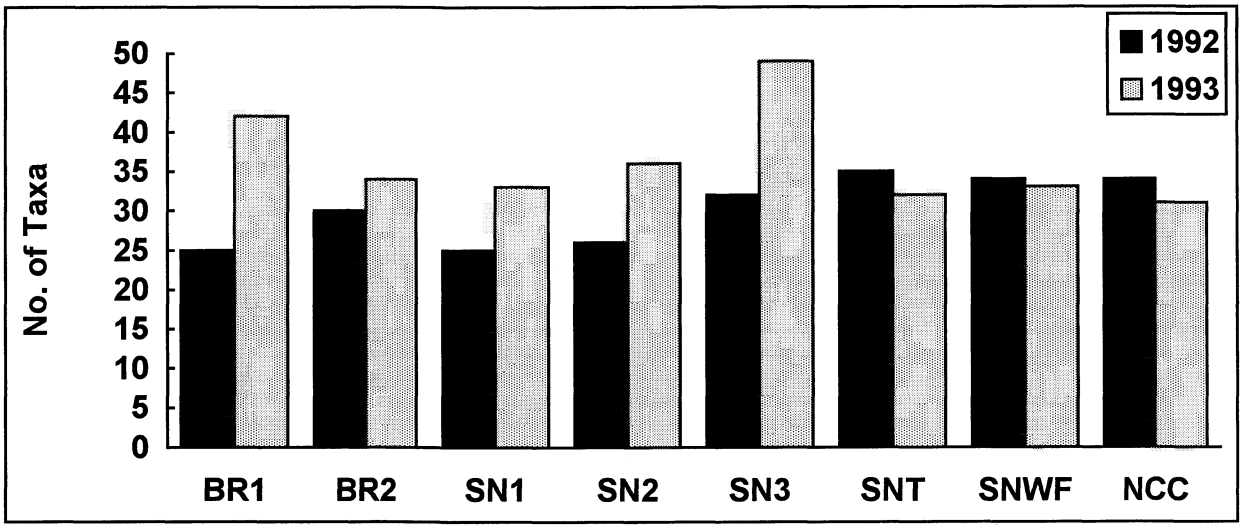


Figure 3. Comparison of the total number of benthic taxa collected per sampling site in the Sny Magill and Bloody Run watersheds during the 1992 and 1993 sampling seasons.

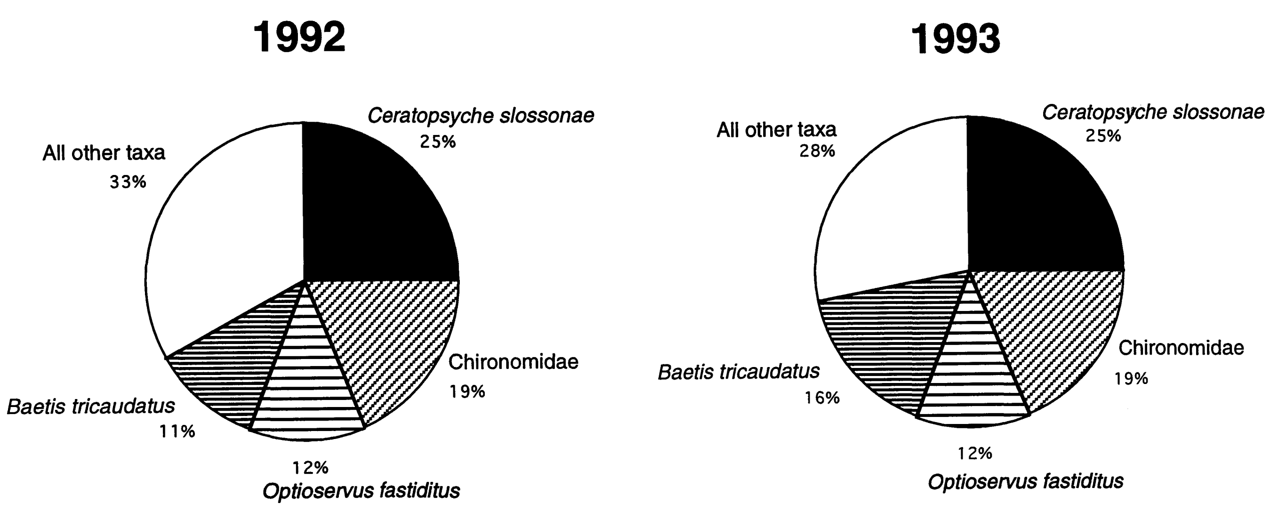


Figure 4. Comparison of predominant benthic taxa relative percent composition from the 1992 and 1993 sampling seasons in the Sny Magill and Bloody Run watersheds.

Table 11. Mean (n=12) metric values and standard deviations (in parentheses) for benthic macroinvertebrate samples collected in the Bloody Run and Sny Magill watersheds during the 1992 sampling season.

METRICS	BR1	BR2	SN1	SN2	SN3	SNT	SNWF	NCC
Taxa Richness	10.42 (1.73)	13.42 (1.73)	10.50 (1.38)	10.42 (2.02)	9.50 (3.34)	13.08 (2.11)	12.25 (2.26)	12.58 (2.81)
HBI	2.06 (0.18)	2.42 (0.14)	2.24 (0.26)	1.99 (0.30)	2.58 (0.29)	2.06 (0.38)	2.20 (0.13)	2.18 (0.21)
EPT Index	6.17 (1.11)	7.50 (1.98)	6.25 (0.62)	6.33 (1.30)	5.25 (2.56)	5.92 (1.00)	7.33 (1.67)	7.25 (2.05)
% Dominant Taxa	39.67 (11.18)	29.42 (7.48)	49.17 (10.33)	48.58 (9.54)	58.58 (20.46)	35.08 (17.97)	32.33 (7.34)	39.42 (12.77)
EPT/Chironomidae	20.41 (32.60)	2.75 (2.14)	25.62 (30.28)	36.10 (33.84)	1.46 (1.66)	19.41 (23.57)	8.39 (17.27)	10.84 (8.58)
Scrapers/Filters & Collectors	0.22 (0.18)	0.23 (0.14)	0.18 (0.09)	0.21 (0.15)	0.08 (0.06)	0.65 (0.46)	0.82 (0.63)	0.90 (1.23)

Overall and individual site metric value rank for sample benthic macroinvertebrates.

	BR1	BR2	SN1	SN2	SN3	SNT	SNWF	NCC
Overall Rank	6.0	2.5	7.0	5.0	8.0	4.0	2.5	1.0
Average Rank	4.3	3.5	5.7	4.0	8.0	3.7	3.5	3.3
Taxa Richness	5.0	1.0	7.0	6.0	8.0	2.0	4.0	3.0
HBI	2.0	7.0	6.0	1.0	8.0	3.0	5.0	4.0
EPT Index	6.0	1.0	5.0	4.0	8.0	7.0	2.0	3.0
% Dominant Taxa	5.0	1.0	7.0	6.0	8.0	3.0	2.0	4.0
EPT/Chironomidae	3.0	7.0	2.0	1.0	8.0	4.0	6.0	5.0
Scrapers/Filters & Collectors	5.0	4.0	7.0	6.0	8.0	3.0	2.0	1.0

likely the result of a major disturbance of the stream reach. A county road crew altered the stream bank and streambed at site SN3 during January 1992 while removing a log jam. The ranking of this site as the worst overall was a significant decline from the pilot study results (Schueller et al., 1992). The streambed was devoid of visible growth or colonization when sampling began in April 1992. The metrics data from this site showed a gradual but steady improvement in the benthic community during the remainder of 1992 after the disturbance.

Water Year 1993

A total of 73 benthic macroinvertebrate taxa were collected from the Sny Magill and Bloody Run watersheds in 1993. Figure 3 shows the total number of taxa collected per sampling site for 1993. Site SN3 had the greatest number of taxa collected in 1993 (49 taxa) compared to site SNT, which showed the greatest number of taxa (35 taxa) in 1992. The predominant taxa collected were the caddisfly *Ceratopsyche slossonae* (25%), the beetle *Optioservus fastiditus* (12%), the mayfly *Baetis tricaudatus* (16%), and Chironomidae (midge; 19%) (Figure 4). These four taxa comprised 72% of the total taxa composition for the two watersheds, compared to 68% in 1992. A complete summary of the data is provided in Schueller and others (1994).

Metrics were calculated for all eight sites (Table 12). An evaluation of the water quality in the Sny Magill and Bloody Run watersheds using the Hilsenhoff Biotic Index (HBI) indicated "good" to "very good" water quality at the sampling sites. The HBI values in the Sny Magill watershed ranged from 1.80 (site SNWF) to 2.33 (site SN3), with a mean value of 1.99 for all sites in the watershed. HBI values in the Bloody Run watershed ranged from 2.01 (site BR1) to 2.31 (site BR2), with a mean value of 2.16 for all sites.

All of the metrics were evaluated to determine the best overall water quality. Site SNWF, a tributary site, was determined to have the best overall water quality. Sites SNWF and NCC had the best overall water quality in 1992. Site by site examinations revealed that the water quality in the main stem of Sny Magill was not as good as the water quality of the tributary sites. HBI values for all of the sites declined from 1992 to 1993. Based on these values it appears the water quality improved, but this improvement is speculative because it is based on only two years of data. Sample collection over a longer period should confirm whether this observation is accurate.

As previously mentioned, in early 1992 the benthic population at site SN3 was affected by a major disturbance of the stream reach. As a result, this site showed the greatest amount of positive change in water quality from 1992 to 1993 at any given site. The total number of taxa inhabiting this site increased from slightly more than 30 in 1992 to 49 in 1993. The mean taxa richness value (n=12) increased approximately four taxa per sampling period from 9.50 in 1992 to 13.58 in 1993. The mean HBI and mean EPT Index (measure of the generally pollution-sensitive insect orders of mayfly, stonefly, and caddisfly; increasing EPT value and decreasing HBI value indicate a higher number of these insect orders and improved water quality) values also attested to a recovery at site SN3. The EPT Index increased from 5.25 to 8.00 and the HBI dropped from 2.58 to 2.33. Since the number of taxa increased and the quality of the taxa was good based on the HBI and EPT numbers, it appears the water quality in this reach of the watershed is sufficient to support the re-establishment of a significant, productive benthic population. If the water quality was largely impaired, it is not likely the benthic community would re-establish itself to the degree that was observed in the 1993 sampling year. Subsequent sampling should provide further insight into the degree of recovery the benthic community can attain and sustain at this site.

FISH ASSESSMENT RESULTS

The Iowa Department of Natural Resources-Fisheries Bureau (DNR-FB) inventoried the forage fish population at five locations in the Sny Magill watershed and one site in the Bloody Run watershed (Figure 1) in September 1992 and August 1993. During the baseline fish inventory in September 1991, four locations on the main branch of Sny Magill Creek were sampled. Since 1992, a site was

Table 12. Mean (n=12) metric values and standard deviations (in parentheses) for benthic macroinvertebrate samples collected in the Bloody Run and Sny Magill watersheds during the 1993 sampling season.

METRICS	BR1	BR2	SN1	SN2	SN3	SNT	SNWF	NCC
Taxa Richness	14.25 (3.11)	12.42 (2.07)	12.42 (2.19)	13.25 (2.86)	13.58 (4.14)	12.50 (1.68)	13.25 (1.96)	12.25 (1.76)
HBI	2.01 (0.27)	2.31 (0.34)	2.09 (0.29)	1.86 (0.28)	2.33 (0.30)	1.97 (0.51)	1.80 (0.21)	1.89 (0.17)
EPT Index	7.25 (1.06)	6.33 (1.44)	6.33 (1.15)	7.00 (1.86)	8.00 (2.41)	5.83 (1.27)	8.58 (1.68)	8.08 (1.38)
% Dominant Taxa	45.50 (17.35)	37.17 (11.85)	48.33 (8.87)	42.17 (11.05)	38.75 (14.78)	41.33 (15.06)	38.58 (9.20)	30.08 (10.08)
EPT/Chironomidae	22.33 (23.67)	4.64 (5.10)	18.71 (17.21)	20.41 (25.79)	7.91 (12.77)	27.46 (26.57)	37.98 (18.36)	20.80 (13.36)
Scrapers/Filters & Collectors	0.08 (0.07)	0.16 (0.13)	0.11 (0.06)	0.37 (0.35)	0.25 (0.18)	0.43 (0.40)	0.43 (0.41)	0.40 (0.26)

Overall and individual site metric value rank for Modified Hess benthic macroinvertebrate samples.

	BR1	BR2	SN1	SN2	SN3	SNT	SNWF	NCC
Overall Rank *	5.0 (6.0)	7.0 (2.5)	8.0 (7.0)	3.5 (5.0)	6.0 (8.0)	3.5 (4.0)	1.0 (2.5)	2.0 (1.0)
Average Rank	4.7	6.0	6.7	4.3	4.8	4.3	1.8	3.5
Taxa Richness	1.0	6.5	6.5	3.5	2.0	5.0	3.5	8.0
HBI	5.0	7.0	6.0	2.0	8.0	4.0	1.0	3.0
EPT Index	4.0	6.5	6.5	5.0	3.0	8.0	1.0	2.0
% Dominant Taxa	7.0	2.0	8.0	6.0	4.0	5.0	3.0	1.0
EPT/Chironomidae	3.0	8.0	6.0	5.0	7.0	2.0	1.0	4.0
Scrapers/Filters & Collectors	8.0	6.0	7.0	4.0	5.0	1.5	1.5	3.0

* 1992 rank in parentheses.

added on North Cedar Creek, and a site was added upstream of the USGS gage (site BR1) on Bloody Run to assess the fish population in Bloody Run Creek. These sites were added to provide comparative data for the Sny Magill sites. The collection date was chosen to minimize stocked trout numbers and associated angler interaction with fish sampling personnel. Sampling gear consisted of two backpack-mounted stream electrofishing units operated at 100 volts DC and 100 pulses per second. Small seines were used to block the upper and lower site boundaries and prohibit inter-site fish movement. All fish captured were identified to species, counted, and immediately released downstream. All sample runs were made through approximately 300 feet (91 m) of mixed pool-riffle habitat. A small subsample of creek chubs was collected from Site 1 on Sny Magill Creek in 1992 and autopsied to provide fish health/condition data. Below is a summary of the fish assessment data collected from water years 1992 and 1993.

Water Year 1992

Fish species collected were common to this type of stream habitat and were indicative of typical, Iowa coldwater streams. Forage fish species collected in order of abundance from Sny Magill and Bloody Run include fantail darter, blacknose dace, slimy sculpin, bluntnose minnow, brook stickleback, johnny darter, longnose dace, creek chub, central stoneroller, redbelly dace, and burbot (Table 13). Fantail darter were the most abundant forage fish, comprising 59% of the samples, followed by blacknose dace (27%). In Sny Magill, fantail darters were the most dominant species (63%) while slimy sculpins were the most common in Bloody Run (52%).

In the Sny Magill watershed, redbelly dace declined in prevalence from second in abundance in the baseline study in Water Year 1991 (Wunder and Stahl, 1994) to ninth in Water Year 1992. The significant reduction of redbelly dace in Sny Magill Creek was unexpected and should be monitored in future surveys. These small fish may be vulnerable to subtle changes in water or habitat quality that can cause considerable fluctuations in population numbers.

Ten creek chubs were autopsied from Site 1 on Sny Magill Creek. Autopsy data revealed no gross irregularities or problems. The chubs deviated from what is considered normal in only two of the ten categories: fat storage and kidney condition. The other eight categories included condition of the eye, gill, pseudobranch, thyroid, spleen, gut, liver, and bile. All the fish were in normal condition and in good health.

Water Year 1993

The species of fish sampled in Water Year 1993 were similar to previous years, with a few exceptions. Table 13 summarizes the relative abundance of forage fish species from the six sites. Rainbow and brown trout were also sampled but not included in Table 13. Rainbow and brown trout made up 7% of the total sampled population at Sites 1 and 3, <1% at Site 2, 2% at Site 4, and brown trout made up <1% of the sampled population at Site 5. Overall, rainbow and brown trout made up less than one percent of the fish sampled.

White suckers appeared for the first time at the Sny Magill sites, and creek chubs, previously sampled, were not found in Water Year 1993. White sucker and central stoneroller were collected for the first time at the Bloody Run site in 1993. The percent of longnose dace and fantail darter increased from 1992 to 1993, and blacknose dace and slimy sculpin decreased. The North Cedar Creek site showed minor changes from 1992 to 1993. The creek chub population in North Cedar Creek declined and bluntnose minnow increased.

A total of 1,570 fish were sampled in 1992 and 1,338 in 1993 (Table 13). The fluctuations in the annual fish populations are a normal response to variations in precipitation, runoff, water clarity, and water stage both within and below these streams. During all three years of data (baseline year of 1991 included), the majority of the fish population was dominated by a single species. Forage fish species collected during 1993, in order of abundance from all sites, include fantail darter (53%), blacknose dace (18%), slimy sculpin (11%), longnose dace (7%), white sucker (6%), central stoneroller (2%),

Table 13. Relative abundance of forage fish species sampled from six sites in Sny Magill and Bloody Run watersheds; September 1992 and August 1993.

	Number (%)							
Species (common name)	Site 1 Sny Magill 1992	Site 1 Sny Magill 1993	Site 2 Sny Magill 1992	Site 2 Sny Magill 1993	Site 3 Sny Magill 1992	Site 3 Sny Magill 1993	Site 4 Sny Magill 1992	Site 4 Sny Magill 1993
Campostoma anomalum (Central stoneroller)	-	7 (5%)	-	14 (4%)	-	-	3 (3%)	3 (2%)
Catastomus commersoni (White sucker)	-	6 (4%)	-	27 (8%)	-	4 (3%)	-	6 (4%)
Cottus cognatus (Slimy sculpin)	-	-	-	-	-	-	-	-
Culaea inconstans (Brook stickleback)	2 (<1%)	-	36 (6%)	-	1 (<1%)	-	3 (3%)	-
Etheostoma flabellare (Fantail darter)	91 (41%)	130 (86%)	401 (66%)	164 (46%)	307 (79%)	112 (94%)	41 (38%)	119 (74%)
Etheostoma nigrum (Johnny darter)	-	-	16 (3%)	8 (2%)	6 (2%)	-	16 (15%)	1 (1%)
Lota lota (Burbot)	-	-	-	-	-	1 (1%)	-	-
Phoxinus erythrogaster (Redbelly dace)	1 (<1%)	-	1 (<1%)	9 (3%)	-	-	-	-
Pimephales notatus (Bluntnose minnow)	6 (3%)	-	35 (6%)	6 (2%)	1 (<1%)		-	-
Rhinicthys atratulus (Blacknose dace)	122 (54%)	7 (5%)	114 (19%)	78 (22%)	62 (16%)	2 (2%)	44 (40%)	29 (18%)
Rhinicthys cataractae (Longnose dace)	-	1 (1%)	-	53 (15%)	11 (3%)	-	2 (2%)	2 (1%)
Semotilus atromaculatus (Creek chub)	2 (<1%)	-	2 (<1%)	-	-	-	-	-
Total	224	151	605	359	388	119	109	160

Species (common name)	Site 5 Sny Magill (North Cedar) 1992	Site 5 Sny Magill (North Cedar) 1993	Site 6 Bloody Run 1992	Site 6 Bloody Run 1993	Sny Magill sites 1,2,3,4 1992	Sny Magill sites 1,2,3,4 1993	Sny Magill/ Bloody Run Sites 1992	Sny Magill/ Bloody Run Sites 1993
Campostoma anomalum (Central stoneroller)	1 (<1%)	-	-	1 (<1%)	3 (<1%)	24 (3%)	4 (<1%)	25 (2%)
Catastomus commersoni (White sucker)	-	-	-	34 (10%)	-	43 (5%)	-	77 (6%)
Cottus cognatus (Slimy sculpin)	-	-	64 (52%)	153 (43%)	-	-	64 (4%)	153 (11%)
Culaea inconstans (Brook stickleback)	-	-	-	-	42 (3%)	-	42 (3%)	-
Etheostoma flabellare (Fantail darter)	60 (50%)	99 (51%)	25 (20%)	91 (25%)	840 (63%)	525 (66%)	925 (59%)	715 (53%)
Etheostoma nigrum (Johnny darter)	-	-	-	-	38 (3%)	9 (1%)	38 (2%)	9 (1%)
Lota lota (Burbot)	1 (<1%)	-	-	-	-	1 (<1%)	1 (<1%)	1 (<1%)
Phoxinus erythrogaster (Redbelly dace)	1 (<1%)	-	-	-	2 (<1%)	9 (1%)	3 (<1%)	9 (1%)
Pimephales notatus (Bluntnose minnow)	1 (<1%)	7 (4%)	-	-	42 (3%)	6 (1%)	43 (3%)	13 (1%)
Rhinicthys atratulus (Blacknose dace)	53 (45%)	84 (44%)	29 (23%)	37 (10%)	342 (26%)	116 (15%)	424 (27%)	237 (18%)
Rhinicthys cataractae (Longnose dace)	-	1 (<1%)	6 (5%)	41 (11%)	13 (1%)	56 (7%)	19 (<1%)	98 (7%)
Semotilus atromaculatus (Creek chub)	3 (3%)	1 (<1%)	-	-	4 (<1%)	-	7 (<1%)	1 (<1%)
Total	120	192	124	357	1326	789	1570	1338

bluntnose minnow (1%), johnny darter (1%), redbelly dace (<1%), burbot (<1%), and creek chub (<1%).

HABITAT ASSESSMENT

Aquatic habitat evaluations were completed August 31-September 2, 1992, at eight water quality locations; six in Sny Magill and two in Bloody Run (Figure 1; habitat evaluation was not completed at site BRSC). The objectives of the assessments were to characterize stream habitat conditions and to test standardized habitat evaluation methods developed for use on coldwater streams in Iowa. Procedures involved measuring and observing instream and streamside habitat variables at a series of ten regularly-spaced, cross-sectional stream transects within a predefined reach. The sampling procedures used are described in Habitat Evaluation Data Collection Procedures (Iowa DNR, 1991), a document prepared by the IDNR-Water Quality Bureau for standardization of coldwater stream data collection procedures in Iowa. Observational methods were patterned after those described by Hamilton and Bergersen (1984), Platts and others (1983), and several other sources (Lyons, 1990; OEPA, 1989; Pajak, 1987; Rankin, 1989; Simonson and Kaminski, 1990). A summary of the 1991 baseline habitat evaluation for Sny Magill and Bloody Run is provided in Wilton (1994).

The potential uses for habitat data include characterization of aquatic habitat at monitoring locations; detection of temporal trends in habitat characteristics; measurement of the effects of Best Management Practices (BMP) implementation; and supporting information for interpretation of biomonitoring data.

Habitat evaluations were completed by personnel from the Iowa Department of Natural Resources-Water Quality Bureau (IDNR) and the University Hygienic Laboratory (UHL) working in teams of two or more observers. Habitat evaluation participants in 1992 were: Mike Birmingham, Jack Kennedy, John Miller, and Mike Schueller of the UHL-Limnology Section, and Matt Culp, Janet Gastineau, and Tom Wilton of the IDNR-Water Quality Bureau. Habitat evaluation participants in 1993 were: Mike Birmingham and Mike Schueller of the UHL-Limnology Section, and Matt Culp, Janet Gastineau, and Tom Wilton of the IDNR-Water Quality Bureau.

Water Year 1992

Aquatic habitat data for water years 1991 through 1993 are summarized in Appendix I, and habitat variables are defined in Table 14. Water Year 1991 represents baseline data. Although measurement of the effects of BMP implementation was one of the potential uses of the habitat data, the ability to measure BMP effects was hampered by the following: (a) temporal and observational-related variability of data; (b) lack of BMP implementation/ stream corridor improvements in close proximity to monitoring sites; and (c) the importance of and lack of control over natural factors (e.g., climate, channel morphological processes) that shape aquatic habitat characteristics.

Baseline habitat data from 1991 was evaluated using the RBP habitat model (Plafkin et al., 1989), and a simple ranking process and habitat similarity index (Wilton, 1994). The purpose of the comparison was to look for patterns in habitat characteristics among sampling sites. These metrics and evaluation indices will be further evaluated after a few more years of data become available for comparison.

Water Year 1993

Appendix I summarizes the habitat data from Water Year 1993. Sampling occurred September 1993. The intent was to sample under low-flow conditions. The above normal rainfall during 1993 caused problems because there was no appropriate low-flow period. As a result, the habitat assessment occurred under stream flow conditions two to three times higher than the Water Year 1992 sampling. Average stream flow for the eight sites when sampled was 5.3 ft^3/s (cfs; 0.15 m^3/s or cms) in 1992 and 15.1 cfs (0.43 cms) in 1993.

The high water conditions during the spring and summer of 1993 were reflected in the habitat measurements. Stream width and depth measurements

Table 14. Definitions of habitat variables appearing in Appendix I.

Site	See Figure 1
STREAM REACH DIMENSIONS:	
Area	Surface area of stream reach evaluated (square feet).
Length	Length of stream reach evaluated (feet).
Flow	Stream flow in cubic feet per second.
Average width	Average stream width from 10 transect measurements (feet).
Maximum depth	Maximum depth in stream reach evaluated (feet).
Average transect maximum depth	Average maximum depth (thalweg depth) measured at 10 transects (feet).
Average depth	Average depth measured at 50 points along 10 transect lines (feet).
INSTREAM HABITAT:	
Dominant habitat type	Predominant type of habitat found in stream reach (i.e., pool, riffle, run).
Riffle repeat frequency (X average width)	Frequency in which riffles repeat in stream reach (expressed as multiple of average stream width in meters).
% reach with instream cover	Percentage of reach area comprised of suitable cover for adult fish.
Dominant cover type	Predominant type of cover found (i.e., pool, undercut bank, woody debris).
% reach with pool habitat	Percentage of reach area comprised of pool habitat.
Dominant pool size class	Predominant pool class in reach (1=large and deep; 2=moderate size and depth; 3=small and shallow).
% reach with silt deposition	Percentage of stream bottom affected by sediment deposition.
% reach with scoured substrate	Percentage of stream bottom affected by scouring.
% reach with vascular aquatic vegetation	Percentage of stream bottom covered by aquatic vegetation.
Dominant vascular aquatic vegetation type	Predominant type of aquatic vegetation.
SUBSTRATE COMPOSITION	
% clay	% of 50 substrate observations from 10 transects comprised of this type of substrate.
% silt	" " "
% sand	" " "
% gravel	" " "
% cobble	" " "
% boulder	" " "
% wood	
% other	" " "
RIFFLE/RUN COARSE SUBSTRATE OBSERVATIONS:	
Periphyton colonization amount	Degree of periphyton colonization (i.e., light, moderate, heavy).
Dominant periphyton form	Predominant form of periphyton found (i.e., filamentous, non filamentous).
Average embeddedness rating	Average rating of percent large substrate (cobble and boulder) surface area that is embedded in fine substrate particles at riffle and run transects (embeddedness rating scale: 1 = >75%; 2 = 75-50%; 3 = 50-25%; 4 = 25-0%).
STREAMSIDE OBSERVATIONS:	
Average stream shading rating	Average rating (20 observations) of percentage stream area shaded. Rating scale for streambank variables: 1 = 0-20%; 2 = 20-40%; 3 = 40-60%; 4 = 60-80%; 5 = 80-100%.
Average streambank tree coverage rating	Average rating (20 observations) of % streambank area covered by tree canopy.
Average streambank shrub coverage rating	Average rating (20 observations) of % streambank area covered by shrub canopy.
Average streambank herbaceous coverage rating	Average rating (20 observations) of % streambank area covered by herbaceous vegetation.
Average streambank instability rating	Average rating (20 observations) of % streambank area that is eroding or unstable.

were greater at most locations, probably reflecting higher flow levels at the time of the habitat assessment. Average stream width for the eight sites was 18.4 feet (5.6 m) in 1992 and 19.7 feet (6.0 m) in 1993. Average stream depth was 0.9 feet (0.27 m) in 1992 and 1.0 feet (0.32 m) in 1993. There was noticeable silt deposition and scouring from the excess rainfall. The 1993 data showed greater variability in comparison to 1992. The data has yet to be statistically evaluated.

STREAM AND SUSPENDED SEDIMENT DISCHARGE

Hydrologic data were collected in the Bloody Run and Sny Magill watersheds in Clayton County, Iowa, during water years 1992 and 1993 by U.S. Geological Survey personnel to provide information on suspended sediment and stream discharge from these watersheds. Below is a summary of the results. A more detailed analysis of Water Year 1992 data can be found in Kalkhoff and Eash (1994). The Water Year 1992 data in this report and Kalkhoff and Eash (1994) differs from Gorman and others (1992) because a large event in March 1993 changed the channel configuration and afforded the reevaluation of the stage-discharge relationship (rating curve) developed during Water Year 1992 for Sny Magill and Bloody Run creeks. The USGS data in this report represents the data recalculated using the new rating curve.

Water Year 1992

Suspended Sediment

Suspended-sediment samples were collected daily by local observers at sites SN1 and BR1 during normal flow, and by an automatic sampler several times during rainstorms (Figure 1). Suspended-sediment concentrations were determined by the U.S. Geological Survey sediment laboratory in Iowa City, using standard filtration and evaporation techniques (Guy, 1969). The wet-sieve method was used to determine the sand and silt-clay fractions (Guy, 1969; Matthes et al., 1992). Stream stage was recorded continuously and stream-discharge measurements were made monthly to develop a stage-discharge relation at the two gage sites. Stage data also were collected at supplemental sites BRSC, BR2, SN3, SNWF, NCC, SNT, and SN2 (Figure 1). Data on drainage-basin morphology and precipitation were quantified to help understand the variability in sediment and stream discharge.

Daily suspended-sediment concentrations and loads for monitoring sites BR1 and SN1 are listed in Tables 15 and 16. The daily suspended-sediment loads are plotted in relation to the daily mean discharge in Figure 5. The greatest daily mean suspended sediment concentration at site BR1 was 1,110 mg/L on November 1, 1991. The maximum daily stream discharge also occurred on November 1. The variability in sediment concentrations is shown in Figure 6. At site BR1, the greatest monthly median sediment concentration was 25 mg/L in March 1992 and the smallest monthly median concentration was 12 mg/L in January 1992. The silt-clay sized fraction of the suspended sediment ranged from 14% on December 5, 1991, and April 10, 1992, when the instantaneous discharge was 26 and 23 cfs (0.74 and 0.65 cms), respectively, to 95% on September 14, 1992, when the instantaneous discharge was 73 cfs (2.07 cms) (Table 17).

The total suspended-sediment discharge at site BR1 for Water Year 1992 was about 2,720 tons. This represents an average loss of 79 tons/mi^2 for the drainage area above the gaging station. The greatest monthly discharge, 1,250 tons or 46% of the annual total, occurred in April 1992 and the smallest suspended-sediment discharge (20 tons) occurred in October 1991. The maximum daily suspended-sediment discharge was 916 tons on April 20, 1992, which accounted for 34% of the annual total. Mean daily suspended-sediment discharge exceeded 0.52 tons about 90% of the year; exceeded 1.1 tons about 50% of the year; and exceeded 3.2 tons about 10% of the year in Water Year 1992 (Figure 7).The largest daily mean suspended-sediment concentration at site SN1 was 2,390 mg/L on April 20, 1992. At site SN1, the largest monthly median sediment concentration was 41 mg/L in May 1992 and the smallest monthly median concentration was 9 mg/L in January 1992

Table 15. Daily mean suspended-sediment concentration and daily suspended-sediment load at site BR1 on Bloody Run Creek; Water Year 1992.

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
				Mean daily suspended-sediment concentration, in milligrams per liter								
1	19.00	1110.00	22.00	11.00	11.00	16.00	13.00	30.00	23.00	27.0	16.00	15.00
2	22.00	185.00	20.00	12.00	8.00	20.00	7.00	29.00	24.00	21.0	17.00	10.00
3	20.00	39.00	20.00	12.00	103.00	17.00	5.00	22.00	24.00	15.0	18.00	21.00
4	17.00	27.00	21.00	12.00	107.00	22.00	5.00	10.00	24.00	14.0	10.00	30.00
5	15.00	17.00	17.00	12.00	42.00	20.00	7.00	16.00	23.00	18.0	13.00	21.00
6	14.00	19.00	17.00	12.00	26.00	25.00	9.00	18.00	20.00	14.0	13.00	27.00
7	16.00	12.00	17.00	13.00	14.00	25.00	8.00	25.00	17.00	17.0	15.00	27.00
8	17.00	18.00	17.00	11.00	10.00	26.00	13.00	24.00	16.00	18.0	16.00	9.00
9	17.00	16.00	17.00	12.00	11.00	40.00	13.00	12.00	14.00	16.0	13.00	18.00
10	15.00	13.00	18.00	4.00	10.00	25.00	12.00	20.00	16.00	14.0	10.00	19.00
11	16.00	18.00	18.00	12.00	10.00	46.00	16.00	27.00	17.00	13.0	17.00	16.00
12	16.00	16.00	122.00	26.00	12.00	51.00	12.00	23.00	19.00	22.0	17.00	9.00
13	13.00	16.00	43.00	14.00	23.00	47.00	13.00	30.00	38.00	34.0	12.00	11.00
14	12.00	17.00	27.00	3.00	15.00	42.00	12.00	17.00	39.00	30.0	12.00	41.00
15	12.00	24.00	13.00	13.00	8.00	40.00	22.00	27.00	34.00	22.0	15.00	30.00
16	11.00	13.00	11.00	9.00	17.00	27.00	19.00	22.00	24.00	19.0	15.00	24.00
17	13.00	20.00	11.00	5.00	12.00	22.00	15.00	33.00	50.00	14.0	11.00	24.00
18	9.00	220.00	13.00	2.00	18.00	31.00	15.00	20.00	39.00	17.0	11.00	16.00
19	11.00	73.00	14.00	3.00	17.00	18.00	24.00	12.00	16.00	19.0	12.00	12.00
20	11.00	36.00	14.00	12.00	43.00	26.00	1060.00	13.00	32.00	22.0	9.00	13.00
21	9.00	21.00	14.00	11.00	70.00	35.00	783.00	13.00	15.00	15.0	8.00	12.00
22	7.00	32.00	14.00	38.00	70.00	21.00	129.00	30.00	15.00	18.0	9.00	10.00
23	11.00	21.00	14.00	200.00	97.00	33.00	76.00	31.00	27.00	18.0	12.00	11.00
24	15.00	22.00	13.00	19.00	79.00	19.00	65.00	31.00	48.00	16.0	12.00	14.00
25	17.00	25.00	13.00	9.00	57.00	24.00	36.00	33.00	21.00	12.0	13.00	13.00
26	22.00	18.00	12.00	9.00	50.00	27.00	20.00	15.00	24.00	15.0	33.00	14.00
27	8.00	18.00	12.00	13.00	55.00	26.00	27.00	13.00	17.00	19.0	22.00	14.00
28	11.00	20.00	12.00	14.00	35.00	11.00	22.00	19.00	15.00	25.0	18.00	12.00
29	20.00	18.00	11.00	19.00	19.00	15.00	27.00	22.00	34.00	18.0	32.00	10.00
30	27.00	55.00	11.00	11.00		12.00	27.00	24.00	26.00	17.0	19.00	11.00
31	8.00		11.00	14.00		15.00		23.00		14.0	12.00	
				Suspended-sediment load, in tons per day								
1	0.72	798.00	2.10	0.62	0.53	1.20	0.81	2.80	1.20	1.70	1.20	0.67
2	0.83	40.00	1.70	0.66	0.37	1.60	0.43	2.70	1.20	1.60	1.20	0.42
3	0.71	4.30	1.60	0.68	37.00	1.30	0.33	2.10	1.20	1.10	1.30	0.89
4	0.68	2.40	1.40	0.69	14.00	1.50	0.33	0.98	1.30	1.00	0.70	1.20
5	0.62	1.30	1.20	0.67	3.50	1.40	0.38	1.50	1.30	1.30	0.86	0.80
6	0.52	1.30	1.10	0.68	1.80	1.70	0.48	1.70	1.30	1.00	0.89	2.20
7	0.64	0.69	1.00	0.70	0.87	1.70	0.43	2.40	1.10	1.40	1.10	1.40
8	0.90	1.10	1.00	0.61	0.61	1.70	0.74	2.30	1.10	1.30	1.20	0.40
9	0.88	0.99	1.10	0.82	0.64	3.70	0.80	1.00	0.97	1.20	0.85	1.30
10	0.74	0.77	1.00	0.23	0.57	2.20	0.73	1.70	1.10	1.00	0.68	1.00
11	0.72	1.00	1.10	0.63	0.52	3.80	0.99	2.30	1.10	1.00	1.10	0.75
12	0.72	0.89	15.00	1.70	0.61	3.90	0.72	2.00	1.10	2.00	1.20	0.42
13	0.61	0.92	4.90	1.20	1.20	3.50	0.75	2.50	2.20	4.20	0.84	0.43
14	0.55	0.94	2.40	0.20	0.81	3.00	0.67	1.40	2.20	3.20	0.80	5.50
15	0.57	1.30	1.10	0.74	0.45	2.80	1.40	2.20	1.80	1.90	0.95	2.20
16	0.50	0.71	0.90	0.46	0.86	1.90	1.50	1.60	1.50	1.60	0.93	1.40
17	0.54	1.20	0.86	0.27	0.72	1.40	1.20	3.20	4.50	1.10	0.65	1.40
18	0.38	34.00	0.93	0.09	1.70	2.00	1.10	1.50	2.90	1.40	0.61	0.87
19	0.47	7.30	0.94	0.17	1.00	1.10	1.90	0.81	1.10	1.60	0.68	0.65
20	0.49	3.10	0.95	0.58	3.70	1.60	916.00	0.88	2.30	1.80	0.50	0.70
21	0.40	1.80	0.89	0.59	7.50	2.40	261.00	0.93	1.00	1.20	0.42	0.59
22	0.30	2.70	0.89	5.60	12.00	1.30	23.00	2.30	1.10	1.60	0.48	0.47
23	0.39	1.80	0.87	48.00	13.00	2.10	11.00	2.30	1.90	1.60	0.59	0.48
24	0.60	1.70	0.85	1.40	8.70	1.10	8.80	2.20	3.40	1.30	0.57	0.63
25	0.88	1.80	0.79	0.55	7.10	1.40	4.50	2.30	1.40	0.95	0.65	0.59
26	1.00	1.30	0.74	0.50	4.20	1.60	2.30	1.10	1.30	1.20	2.10	0.61
27	0.37	1.30	0.68	0.75	5.90	1.50	2.90	0.82	1.00	1.50	1.20	0.66
28	0.43	1.40	0.67	0.74	3.60	0.68	2.30	1.20	0.89	1.90	0.90	0.57
29	1.10	1.20	0.65	1.00	1.60	0.99	2.70	1.30	2.10	1.30	1.50	0.48
30	1.50	7.40	0.65	0.58		0.71	2.60	1.40	1.60	1.30	0.89	0.51
31	0.42		0.67	0.67		0.89		1.20		1.00	0.55	
Total:	20.18	924.61	50.63	72.78	135.06	57.67	1252.79	54.62	48.16	47.25	28.09	30.19
										Water year Total:		***2722.03***
Mean:	0.65	31.00	1.60	2.30	4.70	1.90	42.00	1.80	1.60	1.50	0.91	1.00
Maximum	1.50	798.00	15.00	48.00	37.00	3.90	916.00	3.20	4.50	4.20	2.10	5.50
Minimum:	0.30	0.69	0.65	0.09	0.37	0.68	0.33	0.81	0.89	0.95	0.42	0.40

Table 16. Daily mean suspended-sediment concentration and daily suspended-sediment load at site SN1 on Sny Magill Creek; Water Year 1992.

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
					Mean daily suspended-sediment concentration, in milligrams per Liter							
1	28.00	236.00	21.00	16.00	3.00	31.00	38.00	31.00	32.00	14.00	39.00	18.00
2	26.00	88.00	12.00	11.00	10.00	37.00	28.00	29.00	18.00	35.00	44.00	20.00
3	20.00	35.00	9.00	12.00	115.00	31.00	16.00	29.00	32.00	36.00	31.00	16.00
4	29.00	30.00	22.00	16.00	41.00	35.00	20.00	30.00	40.00	43.00	22.00	15.00
5	47.00	28.00	30.00	15.00	13.00	42.00	11.00	31.00	36.00	32.00	33.00	15.00
6	45.00	27.00	21.00	11.00	12.00	58.00	16.00	46.00	39.00	44.00	21.00	27.00
7	42.00	22.00	14.00	10.00	10.00	67.00	29.00	44.00	42.00	86.00	23.00	29.00
8	28.00	31.00	11.00	10.00	6.00	67.00	22.00	40.00	34.00	45.00	40.00	29.00
9	29.00	24.00	14.00	11.00	4.00	68.00	17.00	40.00	20.00	24.00	24.00	31.00
10	36.00	14.00	14.00	6.00	4.00	61.00	21.00	37.00	19.00	32.00	21.00	13.00
11	35.00	16.00	15.00	6.00	3.00	56.00	19.00	27.00	29.00	77.00	21.00	12.00
12	35.00	27.00	31.00	11.00	2.00	55.00	33.00	28.00	28.00	99.00	23.00	23.00
13	37.00	32.00	24.00	12.00	5.00	65.00	17.00	45.00	16.00	42.00	23.00	28.00
14	23.00	48.00	9.00	3.00	6.00	64.00	17.00	41.00	8.00	39.00	15.00	320.00
15	16.00	26.00	5.00	1.00	4.00	53.00	20.00	30.00	39.00	15.00	18.00	212.00
16	27.00	17.00	11.00	5.00	40.00	44.00	26.00	41.00	32.00	19.00	24.00	26.00
17	46.00	16.00	19.00	3.00	58.00	34.00	17.00	80.00	47.00	20.00	25.00	22.00
18	61.00	115.00	18.00	15.00	67.00	20.00	11.00	46.00	73.00	22.00	19.00	21.00
19	67.00	58.00	18.00	7.00	39.00	29.00	29.00	40.00	55.00	32.00	31.00	8.00
20	34.00	49.00	14.00	1.00	41.00	38.00	2390.00	38.00	86.00	32.00	26.00	10.00
21	21.00	40.00	6.00	5.00	44.00	21.00	325.00	43.00	64.00	25.00	15.00	11.00
22	22.00	34.00	6.00	45.00	41.00	11.00	61.00	54.00	22.00	35.00	19.00	10.00
23	69.00	40.00	9.00	61.00	35.00	22.00	85.00	49.00	13.00	32.00	26.00	15.00
24	84.00	38.00	14.00	16.00	43.00	22.00	63.00	49.00	23.00	31.00	27.00	19.00
25	71.00	39.00	16.00	9.00	51.00	24.00	43.00	77.00	16.00	42.00	14.00	18.00
26	77.00	40.00	13.00	9.00	41.00	18.00	32.00	68.00	18.00	35.00	10.00	21.00
27	80.00	40.00	12.00	3.00	38.00	16.00	37.00	30.00	45.00	23.00	10.00	11.00
28	85.00	40.00	10.00	5.00	37.00	23.00	35.00	53.00	39.00	27.00	17.00	10.00
29	99.00	40.00	10.00	7.00	28.00	15.00	22.00	66.00	35.00	38.00	20.00	12.00
30	85.00	45.00	17.00	5.00		24.00	36.00	80.00	25.00	43.00	16.00	10.00
31	77.00		20.00	9.00		31.00		76.00		47.00	16.00	
					Suspended-sediment load, in tons per day							
1	0.64	58.00	1.40	0.58	0.11	1.70	1.90	2.20	1.20	0.50	1.50	0.42
2	0.66	10.00	0.70	0.42	0.33	2.20	1.30	2.00	0.71	1.40	1.70	0.55
3	0.53	2.80	0.47	0.44	20.00	1.80	0.70	2.00	1.20	1.40	1.10	0.50
4	1.10	1.90	0.96	0.59	2.60	1.90	0.82	2.00	1.40	1.60	0.83	0.50
5	2.00	1.60	1.40	0.55	0.56	2.40	0.45	2.00	1.20	1.10	1.20	0.48
6	1.50	1.30	0.96	0.42	0.47	3.30	0.61	2.80	1.10	1.50	0.75	1.70
7	1.30	0.91	0.62	0.38	0.38	3.90	1.10	2.50	1.30	4.80	1.20	1.20
8	0.80	1.20	0.47	0.43	0.22	3.80	0.88	2.30	1.20	1.90	1.90	1.10
9	0.78	1.00	0.64	0.48	0.15	4.90	0.74	2.20	0.72	0.89	0.93	1.50
10	0.96	0.57	0.61	0.23	0.11	4.30	1.10	1.90	0.68	1.30	0.76	0.55
11	0.94	0.67	0.69	0.21	0.09	3.50	0.97	1.40	1.10	2.90	0.68	0.41
12	1.00	1.10	2.90	0.47	0.08	3.10	1.50	1.50	1.10	5.10	0.83	0.78
13	1.10	1.20	2.10	0.57	0.16	3.50	0.71	2.10	0.58	2.80	0.80	0.90
14	0.64	1.80	0.61	0.11	0.22	3.30	0.70	2.00	0.30	2.60	0.50	52.00
15	0.45	1.00	0.30	0.04	0.15	2.60	0.94	1.40	1.50	0.74	0.59	18.00
16	0.78	0.66	0.62	0.16	1.50	2.10	1.60	1.70	1.30	0.90	0.76	1.60
17	1.30	0.69	1.00	0.09	2.20	1.60	0.94	5.40	2.10	0.86	0.75	1.30
18	1.70	11.00	0.77	0.42	3.60	0.88	0.61	2.20	2.60	0.97	0.58	1.40
19	1.90	4.00	0.77	0.16	1.60	1.30	1.90	1.80	1.80	1.30	0.95	0.44
20	0.93	2.90	0.66	0.04	3.40	1.60	1190.00	1.60	4.00	1.40	0.75	0.50
21	0.58	2.00	0.28	0.15	2.90	0.84	71.00	2.00	2.40	0.99	0.42	0.54
22	0.62	1.50	0.25	2.60	2.60	0.44	7.90	2.50	0.84	1.70	0.53	0.47
23	1.80	1.90	0.38	5.30	2.20	0.86	9.80	2.30	0.54	1.60	0.71	0.63
24	2.40	1.60	0.61	0.53	3.00	0.82	6.70	2.10	0.95	1.50	0.67	0.75
25	2.90	1.40	0.65	0.32	3.20	0.92	4.40	3.30	0.66	1.90	0.39	0.71
26	3.30	1.50	0.53	0.30	2.00	0.66	3.00	3.00	0.68	1.60	0.35	0.85
27	3.30	1.60	0.41	0.11	2.30	0.52	3.20	1.30	1.70	0.93	0.27	0.49
28	3.30	1.50	0.34	0.16	2.20	0.90	2.90	2.20	1.40	1.00	0.46	0.37
29	4.40	1.60	0.36	0.22	1.50	0.72	1.70	2.50	1.20	1.50	0.50	0.46
30	4.00	4.20	0.57	0.17		1.10	2.60	3.30	0.86	1.80	0.39	0.37
31	3.30		0.74	0.29		1.50		2.90		2.10	0.38	
Total:	50.91	123.10	23.77	16.94	59.83	62.96	1322.67	70.40	38.32	52.58	24.13	91.47
											Water year Total:	***1937.08***
Mean:	1.64	4.10	0.77	0.55	2.06	2.03	44.09	2.27	1.27	1.70	0.78	3.05
Maximum	4.40	58.00	2.90	5.30	20.00	4.90	1190.00	5.40	4.00	5.10	1.90	52.00
Minimum:	0.45	0.57	0.25	0.04	0.08	0.44	0.45	1.30	0.30	0.50	0.27	0.37

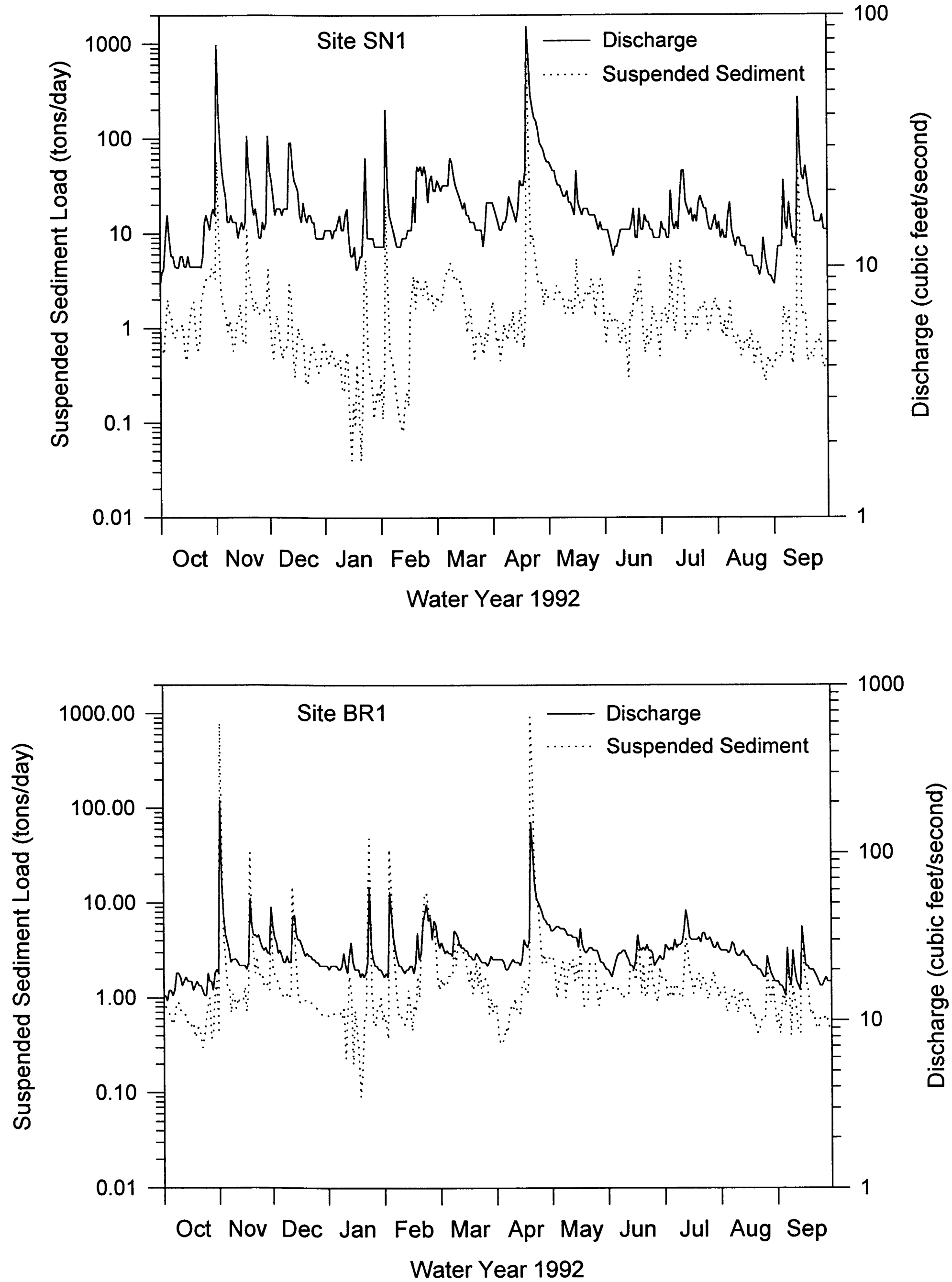


Figure 5. Summary of mean daily suspended-sediment concentrations and stream discharge for Sny Magill and Bloody Run creeks during Water Year 1992.

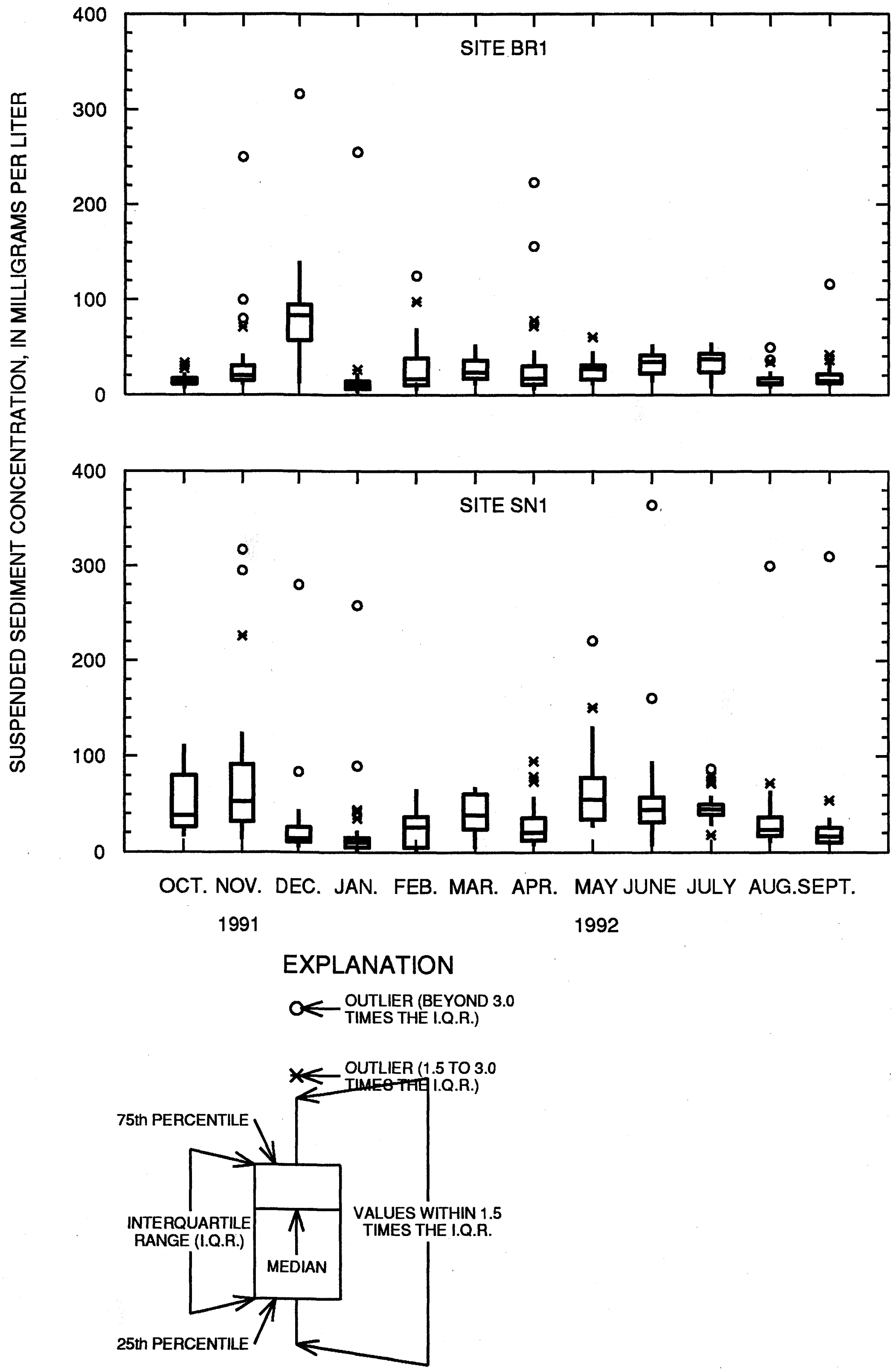


Figure 6. Summary of monthly mean daily suspended-sediment concentrations at the monitoring sites in Sny Magill and Bloody Run creeks for Water Year 1992.

Table 17. Particle size distribution of suspended sediment at sites SN1 and BR1; Water Year 1992.

Date	Time (24-hour)	Instan-taneous discharge (cubic feet/sec)	Sediment Concen-tration (mg/L)	Silt-clay (percent <0.62 mm)	Sand (percent >0.62mm)
		Site BR1			
11/8/91	1530	27	22	55	45
12/5/91	1630	26	39	14	86
1/10/92	1015	21	18	25	75
2/13/92	1630	21	14	31	69
3/4/92	1630	25	13	76	24
4/9/92	1630	21	29	42	58
4/10/92	1230	23	28	14	86
4/24/92	1515	47	46	69	31
4/24/92	1800	49	48	66	34
5/7/92	1900	31	19	61	39
5/8/92	1210	35	39	59	41
6/4/92	1030	23	26	48	52
7/8/92	1045	27	59	53	47
7/8/92	1900	26	47	34	66
8/5/92	1930	23	10	39	61
9/2/92	1715	18	10	69	31
9/14/92	1445	73	104	95	5
		Site SN1			
11/7/91	0930	14	22	58	42
12/6/91	0930	16	30	33	67
1/9/92	1100	16	18	34	66
2/14/92	1000	13	9	54	46
3/5/92	1000	21	13	66	34
6/5/92	1000	14	40	49	51
8/6/92	1200	14	44	67	33
9/3/92	1515	11	48	88	12
9/14/92	1135	103	163	98	2
9/14/92	1735	55	488	99	1

(Figure 6). The silt-clay sized fraction of the suspended sediment ranged from 33% on December 6, 1991, when the instantaneous discharge was 16 cfs (0.45 cms), to 99% on September 14, 1992, when the instantaneous discharge was 55 cfs (1.56 cms).The total suspended-sediment discharge at site SN1 during Water Year 1992 was about 1,940 tons. This represents an average loss of 70 tons/mi^2 for the drainage area above the gaging site. The greatest monthly discharge, 1,320 tons or 68% of the annual total, occurred in April 1992 and the smallest monthly discharge (17 tons) occurred in January 1992. The maximum daily suspended-sediment discharge was 1,190 tons on April 20, 1992, which accounted for 61% of the annual total. Mean daily suspended-sediment discharge exceeded 0.38 tons 90% of the year; exceeded 1.1 tons, 50% of the year; and exceeded 3.3 tons, 10% of the year in Water Year 1992 (Figure 7).

Stream Discharge

Daily mean discharges for Bloody Run at site BR1 are listed in Table 18 and illustrated in Figure

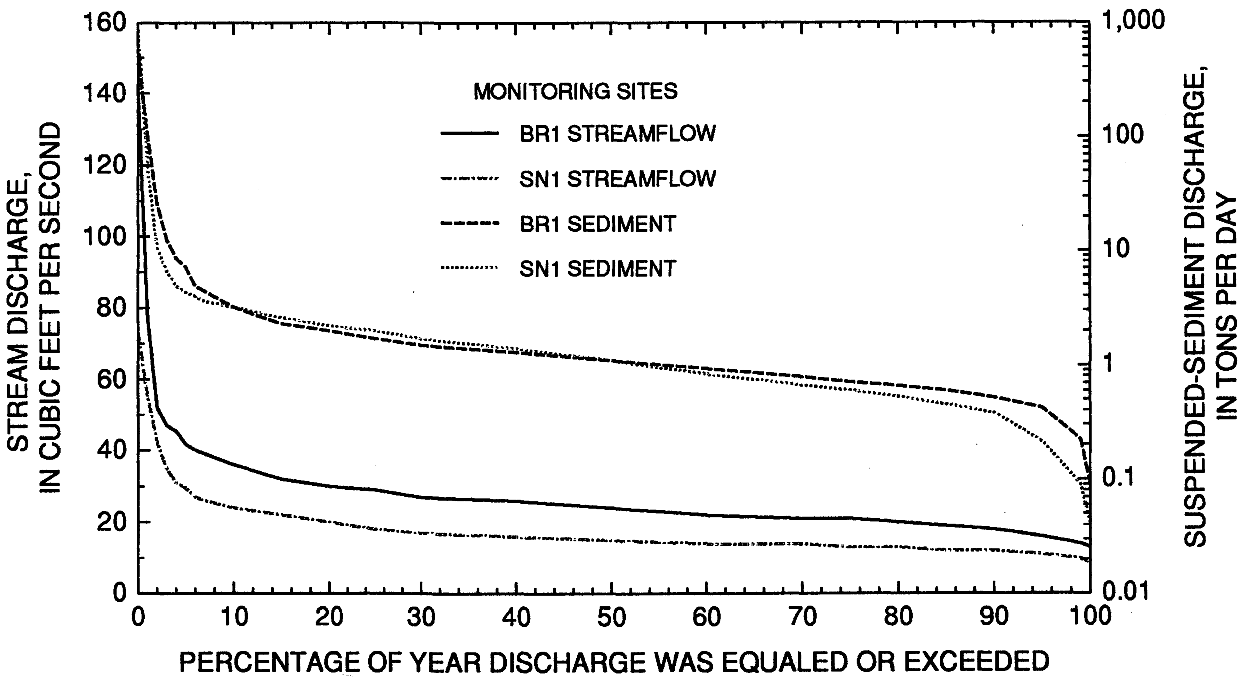


Figure 7. Percentage of year stream and suspended-sediment discharge was equaled or exceeded in Sny Magill and Bloody Run creeks for Water Year 1992.

5. The mean daily discharge at site BR1 for Water Year 1992 was 26.3 cfs (0.74 cms). The maximum daily mean discharge (205 cfs; 5.80 cms) occurred on November 1, 1991 and the minimum daily mean discharge (13 cfs; 0.37 cms) was recorded on October 3, 1991. The maximum recorded instantaneous discharge of 476 cfs (13.47 cms) occurred at 10:00 am on November 1, 1991. Stream discharge duration is shown in Figure 7. Daily mean discharge exceeded 18 cfs (0.51 cms) about 90% of the year and exceeded 36 cfs (1.02 cms) about 10% of the year. Daily mean discharges for Sny Magill Creek at site SN1 are listed in Table 18 and illustrated in Figure 5. The mean discharge at site SN1 for Water Year 1992 was 17.1 cfs (0.48 cms). The maximum daily mean discharge (90 cfs; 2.55 cms) occurred on April 20, 1992, and the minimum mean daily discharge (8.5 cfs; 0.24 cms) occurred on October 1, 1991. The greatest recorded instantaneous discharge during the water year, 390 cfs (11.04 cms), occurred at 6:00 pm on April 20, 1992. Flow duration is shown in Figure 7. Daily mean discharge exceeded 12 cfs (0.34 cms) about 90% of the year and exceeded 24 cfs (0.68 cms about 10% of the year.

Supplemental Sites

Stream discharge was measured periodically at seven supplemental sites in the Bloody Run and Sny Magill watersheds during Water Year 1992 (Table 19). The greatest measured discharge at the supplemental sites in the Bloody Run watershed (11.0 cfs; 0.31 cms) occurred at site BR2 on June 4, 1992. At the supplemental sites in the Sny Magill watershed, the greatest stream discharge (15.8 cfs; 0.45 cms) occurred on March 5, 1992, and again on May 8, 1992.

Summary

The total suspended-sediment discharge for

Table 18. Daily mean discharge at the monitoring sites in the Bloody Run and Sny Magill watersheds; Water Year 1992.

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Site BR1 (Discharge in cubic feet per second)												
1	14.0	205.0	36.0	20.0	19.0	27.0	23.0	34.0	20.0	23.0	26.0	17.0
2	14.0	64.0	31.0	21.0	18.0	29.0	23.0	34.0	19.0	28.0	26.0	16.0
3	13.0	41.0	29.0	21.0	58.0	27.0	23.0	35.0	18.0	27.0	26.0	16.0
4	15.0	32.0	25.0	21.0	43.0	25.0	23.0	36.0	20.0	26.0	26.0	15.0
5	15.0	29.0	26.0	21.0	31.0	26.0	22.0	36.0	22.0	27.0	25.0	14.0
6	14.0	26.0	24.0	20.0	26.0	25.0	20.0	35.0	24.0	26.0	26.0	27.0
7	15.0	22.0	22.0	20.0	23.0	25.0	20.0	35.0	25.0	30.0	29.0	18.0
8	19.0	23.0	22.0	21.0	21.0	24.0	21.0	35.0	25.0	27.0	28.0	16.0
9	19.0	23.0	24.0	25.0	21.0	34.0	22.0	34.0	26.0	28.0	25.0	26.0
10	18.0	23.0	22.0	21.0	20.0	33.0	23.0	32.0	26.0	28.0	24.0	20.0
11	16.0	22.0	22.0	19.0	19.0	31.0	22.0	32.0	24.0	29.0	24.0	17.0
12	17.0	21.0	41.0	24.0	20.0	28.0	22.0	32.0	23.0	34.0	25.0	16.0
13	18.0	21.0	42.0	29.0	20.0	27.0	22.0	31.0	21.0	45.0	26.0	15.0
14	17.0	21.0	33.0	22.0	21.0	27.0	21.0	31.0	21.0	39.0	24.0	36.0
15	17.0	21.0	30.0	20.0	21.0	26.0	23.0	31.0	20.0	31.0	24.0	27.0
16	17.0	20.0	30.0	20.0	19.0	26.0	30.0	27.0	23.0	30.0	23.0	21.0
17	15.0	22.0	28.0	20.0	22.0	24.0	28.0	35.0	32.0	30.0	22.0	21.0
18	16.0	53.0	26.0	18.0	33.0	24.0	27.0	28.0	27.0	30.0	21.0	20.0
19	17.0	37.0	24.0	19.0	23.0	23.0	30.0	26.0	26.0	30.0	21.0	20.0
20	16.0	32.0	25.0	18.0	25.0	23.0	152.0	25.0	27.0	31.0	21.0	20.0
21	16.0	32.0	24.0	19.0	38.0	25.0	105.0	26.0	26.0	29.0	20.0	19.0
22	15.0	31.0	24.0	22.0	43.0	24.0	65.0	27.0	28.0	33.0	20.0	18.0
23	14.0	32.0	23.0	61.0	49.0	23.0	53.0	27.0	26.0	33.0	19.0	17.0
24	14.0	29.0	23.0	27.0	39.0	22.0	50.0	26.0	26.0	30.0	18.0	16.0
25	19.0	27.0	22.0	23.0	41.0	22.0	47.0	26.0	25.0	30.0	18.0	16.0
26	17.0	26.0	22.0	21.0	30.0	22.0	44.0	26.0	21.0	31.0	24.0	17.0
27	17.0	27.0	21.0	21.0	39.0	21.0	40.0	24.0	22.0	29.0	21.0	18.0
28	15.0	25.0	21.0	20.0	37.0	22.0	39.0	22.0	23.0	27.0	19.0	17.0
29	19.0	25.0	21.0	20.0	30.0	24.0	37.0	22.0	24.0	27.0	18.0	17.0
30	20.0	47.0	21.0	19.0	---	23.0	37.0	21.0	23.0	29.0	17.0	17.0
31	19.0	---	21.0	18.0	---	23.0	---	20.0	---	27.0	17.0	---
TOTAL	507	1059	805	691	849	785	1114	911	713	924	703	570
MEAN	16.4	35.3	26.0	22.3	29.3	25.3	37.1	29.4	23.8	29.8	22.7	19.0
MAX	20	205	42	61	58	34	152	36	28	45	29	36
MIN	13	20	21	18	18	21	20	20	18	23	17	14
AC-FT	1010	2100	1600	1370	1690	1560	2210	1810	1420	1830	1340	1130
CFSM	0.48	1.04	0.76	0.65	0.86	0.74	1.09	0.86	0.70	0.87	0.67	0.56
IN.	0.56	1.16	0.88	0.75	0.93	0.86	1.22	1.00	0.78	1.01	0.74	0.62
Site SN1 (Discharge in cubic feet per second)												
1	8.5	76.0	24.0	14.0	12.0	20.0	18.0	26.0	14.0	13.0	14.0	8.5
2	9.4	42.0	22.0	14.0	12.0	22.0	17.0	26.0	14.0	15.0	15.0	10.0
3	9.8	30.0	19.0	14.0	42.0	21.0	16.0	25.0	14.0	14.0	13.0	12.0
4	13.0	24.0	16.0	14.0	21.0	20.0	15.0	24.0	13.0	14.0	14.0	12.0
5	16.0	21.0	17.0	13.0	16.0	21.0	14.0	24.0	12.0	13.0	13.0	12.0
6	13.0	19.0	17.0	14.0	15.0	21.0	14.0	22.0	11.0	13.0	13.0	22.0
7	11.0	15.0	17.0	14.0	14.0	21.0	15.0	21.0	12.0	20.0	16.0	15.0
8	11.0	15.0	16.0	15.0	13.0	21.0	15.0	21.0	12.0	15.0	18.0	14.0
9	10.0	16.0	17.0	16.0	12.0	27.0	16.0	20.0	13.0	14.0	14.0	18.0
10	9.9	15.0	17.0	14.0	12.0	26.0	19.0	19.0	14.0	15.0	13.0	15.0
11	9.9	15.0	17.0	14.0	12.0	23.0	18.0	19.0	14.0	14.0	12.0	13.0
12	11.0	15.0	31.0	16.0	13.0	21.0	17.0	20.0	14.0	19.0	13.0	13.0
13	11.0	13.0	31.0	17.0	13.0	20.0	16.0	18.0	14.0	24.0	13.0	12.0
14	10.0	14.0	25.0	13.0	13.0	19.0	15.0	18.0	14.0	24.0	12.0	47.0
15	10.0	15.0	22.0	11.0	14.0	18.0	17.0	17.0	14.0	18.0	12.0	29.0
16	11.0	14.0	21.0	11.0	14.0	17.0	22.0	16.0	15.0	17.0	12.0	23.0
17	10.0	15.0	20.0	12.0	14.0	18.0	21.0	24.0	17.0	16.0	11.0	22.0
18	10.0	33.0	16.0	9.7	19.0	16.0	21.0	18.0	13.0	17.0	11.0	25.0
19	10.0	25.0	15.0	10.0	15.0	16.0	24.0	17.0	13.0	15.0	11.0	22.0
20	10.0	22.0	18.0	11.0	25.0	15.0	90.0	16.0	17.0	16.0	11.0	19.0
21	10.0	18.0	16.0	11.0	24.0	15.0	69.0	17.0	14.0	15.0	10.0	18.0
22	10.0	16.0	15.0	16.0	25.0	15.0	48.0	17.0	14.0	18.0	10.0	17.0
23	9.9	17.0	16.0	27.0	23.0	14.0	43.0	17.0	16.0	19.0	9.9	15.0
24	11.0	15.0	16.0	13.0	25.0	14.0	39.0	16.0	15.0	18.0	9.2	15.0
25	15.0	13.0	15.0	13.0	23.0	14.0	38.0	16.0	15.0	17.0	10.0	15.0
26	16.0	13.0	15.0	13.0	18.0	14.0	35.0	16.0	14.0	17.0	13.0	15.0
27	15.0	15.0	13.0	13.0	22.0	12.0	31.0	16.0	14.0	15.0	11.0	16.0
28	14.0	14.0	13.0	12.0	23.0	14.0	30.0	15.0	13.0	14.0	9.9	14.0
29	16.0	15.0	13.0	12.0	20.0	18.0	29.0	14.0	13.0	14.0	9.2	14.0
30	17.0	33.0	13.0	12.0	---	18.0	27.0	15.0	13.0	15.0	9.2	14.0
31	16.0	---	13.0	12.0	---	18.0	---	14.0	---	16.0	8.8	---
TOTAL	364.4	623	556	420.7	524	569	809	584	415	504	371.2	516.5
MEAN	11.8	20.8	17.9	13.6	18.1	18.4	27.0	18.8	13.8	16.3	12.0	17.2
MAX	17	76	31	27	42	27	90	26	17	24	18	47
MIN	8.5	13	13	9.7	12	12	14	14	11	13	8.8	9
AC-FT	720	1240	1100	840	1040	1130	1610	1160	820	1000	740	1030
CFSM	0.43	0.75	0.65	0.49	0.66	0.67	0.98	0.68	0.50	0.59	0.44	0.62
IN.	0.49	0.84	0.75	0.57	0.71	0.77	1.09	0.79	0.56	0.70	0.50	0.70

Water Year 1992 was 2,720 tons at site BR1 on Bloody Run Creek and 1,940 tons at site SN1 on Sny Magill Creek. The daily mean suspended-sediment discharge was 1.1 tons at both BR1 and SN1. The maximum daily mean stream discharge (205 cfs; 5.80 cms) at site BR1 on Bloody Run occurred on November 1, 1991. The mean daily discharge at site BR1 for the 1992 water year was 26.3 cfs (0.74 cms). The maximum daily mean stream discharge at site SN1 on Sny Magill Creek was 90 cfs (2.55 cms) which occurred on April 20, 1992. The mean daily discharge at site SN1 for Water Year 1992 was 17.1 cfs (0.48 cms).

Water Year 1993

Suspended Sediment

Suspended sediment samples were collected daily by local observers at sites SN1 and BR1 during normal flow and by an automatic sampler several times during rainstorms. The methods for measuring suspended-sediment concentrations were previously mentioned. Stream stage was recorded continuously and stream-discharge measurements were made monthly. Stage data also were collected at supplemental sites BRSC, BR2, SN3, SNWF, NCC, SNT, and SN2.

Daily suspended-sediment concentrations and loads for sites SN1 and BR1 are listed in Tables 20 and 21. The daily suspended-sediment loads are plotted in relation to the daily mean discharge in Figure 8.

The largest mean daily suspended sediment concentration at site BR1 was 2,780 mg/L on March 31, 1993. The maximum daily stream discharge of 550 cfs was also measured on March 31, 1993. The variability in sediment concentrations is shown in Figure 9. At site BR1, the greatest monthly median sediment concentration was 118 mg/L in February 1993 and the smallest monthly median concentration was 14 mg/L in October 1992.

The total suspended-sediment discharge at site BR1 for Water Year 1993 was 22,174 tons. This represents an average loss of 647 tons/mi^2 for the drainage area above site BR1. The greatest monthly discharge, 11,155 tons or 50% of the annual total, occurred in March 1993 and the smallest suspended-sediment discharge (327 tons) occurred in October 1992. The maximum daily suspended-sediment discharge was 4,500 tons on March 31, which accounted for 20% of the annual total. Mean daily suspended-sediment discharge exceeded 1.20 tons 90% of the year, exceeded 3.30 tons 50% of the year, and exceeded 14.50 tons 10% of the year in Water Year 1993 (Figure 10).

The largest mean daily suspended-sediment concentration at site SN1 was 2,010 mg/L on March 28, 1993. At site SN1, the largest monthly median sediment concentration was 78.5 mg/L in June 1993 and the smallest monthly median concentration was 7 mg/L in January 1993.

The total suspended-sediment discharge at site SN1 during Water Year 1993 was 13,086 tons. The greatest monthly discharge, 4,915 tons or 38% of the annual total, occurred in March 1993 and the smallest monthly discharge (12 tons) occurred in October 1992. The maximum daily suspended-sediment discharge was 1,850 tons on August 24, 1993, which accounted for 14% of the annual total. Mean daily suspended-sediment discharge exceeded 0.24 tons 90% of the year, exceeded 2.00 tons 50% of the year, and exceeded 28.00 tons 10% of the year in Water Year 1993 (Figure 10).

Stream Discharge

Daily mean discharges for Bloody Run at site BR1 are listed in Table 22 and illustrated in Figure 8. The mean daily discharge at site BR1 for Water Year 1993 was 42.1 cfs (1.19 cms). The maximum daily mean discharge (550 cfs; 15.57 cms) occurred on March 31, 1993, and the minimum daily mean discharge (15 cfs; 0.42 cms) was recorded on October 23, 1992. The maximum recorded instantaneous discharge of 1540 cfs (43.58 cms) occurred on March 31, 1993. Stream discharge duration is shown in Figure 10. Daily mean discharge exceeded 18 cfs (0.51 cms) 90% of the year and exceeded 25 cfs (0.71 cms) 10% of the year.

Daily mean discharges for Sny Magill Creek at site SN1 are listed in Table 22 and are illustrated in Figure 8. The mean daily discharge at site SN1 for

Table 19. Stage, mean velocity, and discharge measurements at supplemental sites in Bloody Run and Sny Magill watersheds; Water Year 1992.

Site	Date	Stage (Feet below reference mark)	Mean velocity (feet/sec)	Discharge (cubic feet/sec)	Site	Date	Stage (Feet below reference mark)	Mean velocity (feet/sec)	Discharge (cubic feet/sec)
BRSC	10/10/91		0.23	2.95	NCC	10/10/91	9.32	0.09	1.28
	12/5/91	18.60	0.46	6.22		11/7/91	9.91	0.98	2.48
	1/10/92	18.70	0.40	5.14		12/6/91	9.80	1.40	3.36
	2/13/92	18.63	0.44	5.61		1/9/91	9.90	1.30	2.59
	3/4/92	18.67	0.44	5.98		2/14/92	9.95	1.35	2.79
	4/10/92	18.70	0.41	5.72		3/5/92	9.88	1.15	2.28
	5/7/92	18.49	0.41	5.83		4/9/92	9.94	1.34	2.65
	6/4/92	18.55	0.37	5.00		5/8/92	9.73	1.44	3.54
	7/9/92	18.54	0.36	4.72		6/5/92	9.95	1.20	2.58
	8/7/92	18.57	0.40	4.85		7/8/92	9.96	1.15	2.32
BR2	10/10/91	17.58	0.15	3.88		8/6/92	9.88	1.21	1.92
	6/4/92	17.48	0.60	11.00	SNT	10/10/91	12.69	0.20	0.45
	7/9/92	17.70	0.57	9.36		11/7/91	12.69	0.47	0.87
	8/7/92	17.57	0.34	7.72		12/6/91	12.65	0.64	1.08
SN3	10/10/91	18.93	0.48	1.40		1/9/91	12.70	0.92	1.46
	11/7/91	18.80	0.86	2.32		2/14/92	12.72	0.47	0.71
	12/6/91	18.57	0.97	2.70		3/5/92	12.70	0.74	1.28
	1/9/92	18.74	0.88	2.66		4/9/92	12.74	0.74	1.08
	2/14/92		0.96	2.10		5/8/92	12.51	0.91	1.49
	3/5/92	18.77	1.15	3.96		6/5/92	12.73	0.61	0.80
	4/9/92	18.76	0.78	2.81		7/8/92	12.74	0.85	0.82
	5/8/92	18.67	0.67	3.11		8/6/92	12.62	0.50	0.54
	6/5/92	18.73	0.77	2.76	SN2	10/10/91	21.06	0.46	7.65
	7/8/92	18.74	0.85	2.79		11/7/91	21.06	0.94	13.40
	8/6/92	18.77	0.43	2.20		12/6/91	20.94	1.16	12.10
SNWF	10/10/91	10.74	0.22	1.96		1/9/91	21.05	0.94	12.70
	11/7/91	10.79	0.38	2.01		2/14/92	21.20	1.05	10.30
	12/6/91	10.73	0.69	1.98		3/5/92	21.00	1.38	15.80
	1/9/92	10.82	1.12	2.99		4/9/92	21.10	1.17	12.80
	2/14/92	10.90	0.92	2.23		5/8/92	20.79	1.35	15.80
	3/5/92	10.82	0.98	3.86		6/5/92	20.96	0.91	11.50
	4/9/92	10.81	1.04	2.55		7/8/92	20.94	1.02	12.30
	5/8/92	10.62	0.91	2.66		8/6/92	20.98	0.88	9.27
	6/5/92	10.80	0.82	2.31					
	7/8/92	10.77	0.81	2.12					
	8/6/92	10.62	0.96	2.57					

Table 20. Daily mean suspended-sediment concentration and daily suspended-sediment load at site BR1 on Bloody Run Creek; Water Year 1993.

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Mean daily suspended-sediment concentration, in milligrams per liter												
1	11.00	39.00	71.00	45.00	79.00	136.00	2000.00	49.00	26.00	187.00	57.00	24.00
2	20.00	37.00	55.00	41.00	115.00	142.00	33.00	2350.00	34.00	86.00	38.00	21.00
3	40.00	45.00	52.00	33.00	103.00	109.00	30.00	401.00	34.00	62.00	48.00	19.00
4	11.00	43.00	46.00	39.00	118.00	99.00	36.00	81.00	23.00	58.00	41.00	17.00
5	10.00	37.00	57.00	45.00	118.00	55.00	32.00	61.00	21.00	110.00	43.00	28.00
6	6.00	30.00	51.00	45.00	123.00	27.00	39.00	31.00	26.00	110.00	44.00	21.00
7	8.00	42.00	68.00	46.00	136.00	40.00	35.00	30.00	2190.00	49.00	32.00	14.00
8	18.00	58.00	70.00	42.00	132.00	26.00	63.00	25.00	1650.00	93.00	28.00	18.00
9	23.00	64.00	54.00	35.00	111.00	26.00	49.00	26.00	84.00	348.00	30.00	18.00
10	24.00	49.00	88.00	50.00	69.00	25.00	46.00	30.00	62.00	609.00	33.00	16.00
11	6.00	51.00	120.00	42.00	24.00	16.00	83.00	40.00	69.00	598.00	34.00	18.00
12	4.00	44.00	91.00	35.00	71.00	11.00	63.00	42.00	56.00	103.00	27.00	26.00
13	11.00	46.00	333.00	34.00	126.00	10.00	57.00	34.00	64.00	88.00	25.00	19.00
14	14.00	39.00	55.00	23.00	106.00	14.00	30.00	31.00	51.00	58.00	36.00	18.00
15	8.00	45.00	93.00	40.00	123.00	85.00	43.00	21.00	38.00	63.00	90.00	19.00
16	10.00	27.00	54.00	37.00	131.00	140.00	50.00	18.00	57.00	53.00	54.00	19.00
17	8.00	28.00	21.00	51.00	127.00	130.00	59.00	13.00	351.00	499.00	34.00	11.00
18	5.00	49.00	22.00	49.00	118.00	34.00	60.00	21.00	697.00	172.00	83.00	20.00
19	4.00	45.00	20.00	41.00	115.00	20.00	58.00	32.00	102.00	66.00	111.00	13.00
20	3.00	45.00	30.00	25.00	130.00	28.00	45.00	25.00	113.00	58.00	57.00	17.00
21	4.00	31.00	39.00	27.00	125.00	70.00	48.00	25.00	69.00	43.00	52.00	17.00
22	22.00	12.00	42.00	22.00	111.00	78.00	41.00	23.00	52.00	41.00	49.00	17.00
23	57.00	9.00	44.00	30.00	114.00	42.00	33.00	29.00	66.00	44.00	1490.00	19.00
24	67.00	9.00	44.00	21.00	94.00	89.00	35.00	23.00	58.00	44.00	124.00	20.00
25	52.00	11.00	34.00	18.00	124.00	97.00	25.00	21.00	45.00	114.00	57.00	18.00
26	58.00	13.00	50.00	24.00	131.00	121.00	30.00	22.00	32.00	39.00	39.00	18.00
27	61.00	14.00	45.00	23.00	140.00	132.00	24.00	20.00	35.00	39.00	40.00	17.00
28	46.00	45.00	45.00	19.00	104.00	1100.00	24.00	23.00	36.00	35.00	36.00	17.00
29	27.00	52.00	38.00	27.00	-	1860.00	23.00	17.00	1190.00	50.00	54.00	18.00
30	38.00	42.00	64.00	51.00	-	1260.00	37.00	30.00	2200.00	34.00	55.00	17.00
31	44.00	-	34.00	71.00	-	2780.00	-	38.00	-	43.00	36.00	-
Suspended-sediment load, in tons per day												
1	0.53	1.90	4.10	2.50	4.40	7.60	710.00	7.40	2.80	23.00	6.30	2.50
2	1.00	2.20	3.00	2.30	6.70	8.00	5.80	2050.00	3.80	8.90	4.00	2.20
3	2.00	2.50	3.00	1.80	6.00	6.50	5.10	207.00	3.70	6.10	5.00	1.90
4	0.52	2.10	2.60	2.10	7.00	6.90	5.00	26.00	2.40	5.50	4.20	1.70
5	0.48	1.90	3.30	2.40	7.00	4.40	4.20	16.00	2.10	15.00	4.40	2.80
6	0.32	1.50	2.90	2.40	7.40	2.10	4.60	6.70	2.60	14.00	4.70	2.20
7	0.35	1.90	3.70	2.40	8.20	2.80	4.00	6.20	1230.00	4.90	3.20	1.40
8	0.93	2.70	3.70	2.30	7.80	2.40	9.40	4.40	746.00	10.00	2.70	1.80
9	1.20	2.80	3.00	1.80	6.70	2.80	7.10	4.00	13.00	77.00	3.50	1.80
10	1.10	2.10	4.90	2.50	4.10	2.40	6.40	5.10	7.90	165.00	3.30	1.60
11	0.28	2.30	6.50	2.10	1.50	1.30	12.00	6.40	8.30	225.00	3.40	1.80
12	0.20	1.90	5.00	1.70	4.20	0.79	7.20	6.30	6.60	23.00	2.60	2.50
13	0.51	2.10	18.00	1.70	7.40	0.74	6.00	4.90	7.50	15.00	2.30	2.00
14	0.65	1.80	2.90	1.20	5.70	0.94	3.40	4.30	5.80	8.70	3.40	2.00
15	0.35	2.00	5.50	2.10	6.30	5.30	7.10	2.90	3.90	8.20	18.00	2.00
16	0.47	1.20	4.20	1.90	6.70	53.00	9.50	2.40	6.10	6.40	6.20	1.90
17	0.41	1.20	1.50	2.60	6.80	20.00	11.00	1.70	130.00	150.00	3.50	1.10
18	0.22	2.00	1.60	2.20	6.40	3.20	10.00	2.70	171.00	34.00	24.00	1.90
19	0.17	1.80	1.30	2.00	6.20	1.40	10.00	4.20	16.00	10.00	16.00	1.30
20	0.15	3.20	2.00	1.30	7.00	1.70	11.00	3.10	18.00	8.40	6.60	1.70
21	0.20	4.30	2.50	1.30	6.80	4.30	9.40	2.90	9.70	5.90	5.50	1.60
22	0.95	1.00	2.70	1.10	6.00	4.70	6.70	2.70	6.60	5.10	5.20	1.50
23	2.30	0.71	2.80	1.50	6.20	2.40	5.00	3.60	8.20	5.30	1580.00	1.70
24	2.90	0.62	2.60	1.10	5.10	4.90	4.90	2.90	7.30	5.10	21.00	1.80
25	2.30	0.68	1.90	0.87	6.00	16.00	3.10	2.40	5.60	15.00	7.80	1.70
26	2.50	0.84	2.60	1.20	6.70	39.00	2.30	2.40	3.80	4.40	4.90	1.80
27	2.80	0.94	2.30	1.20	7.20	100.00	3.00	2.30	4.10	4.50	4.80	1.60
28	2.00	2.90	2.30	0.97	5.30	1660.00	3.00	2.60	4.40	3.90	4.20	1.50
29	1.20	3.20	2.20	1.20	-	3110.00	2.50	1.90	159.00	5.40	7.00	1.50
30	1.70	2.50	3.80	2.60	-	1580.00	4.00	3.60	1980.00	3.70	6.50	1.50
31	2.00	-	2.10	3.60	-	4500.00	-	4.20	-	4.80	4.00	-
Total:	32.69	58.79	110.50	57.94	172.80	11155.57	892.70	2403.20	4576.20	881.20	1778.20	54.30
										Water year total:		***22,174.09***
Mean:	1.05	1.96	3.56	1.87	6.17	359.86	29.76	77.52	152.54	28.43	57.36	1.81
Maximum:	2.90	4.30	18.00	3.60	8.20	4500.00	710.00	2050.00	1980.00	225.00	1580.00	2.80
Minimum:	0.15	0.62	1.30	0.87	1.50	0.74	2.30	1.70	2.10	3.70	2.30	1.10

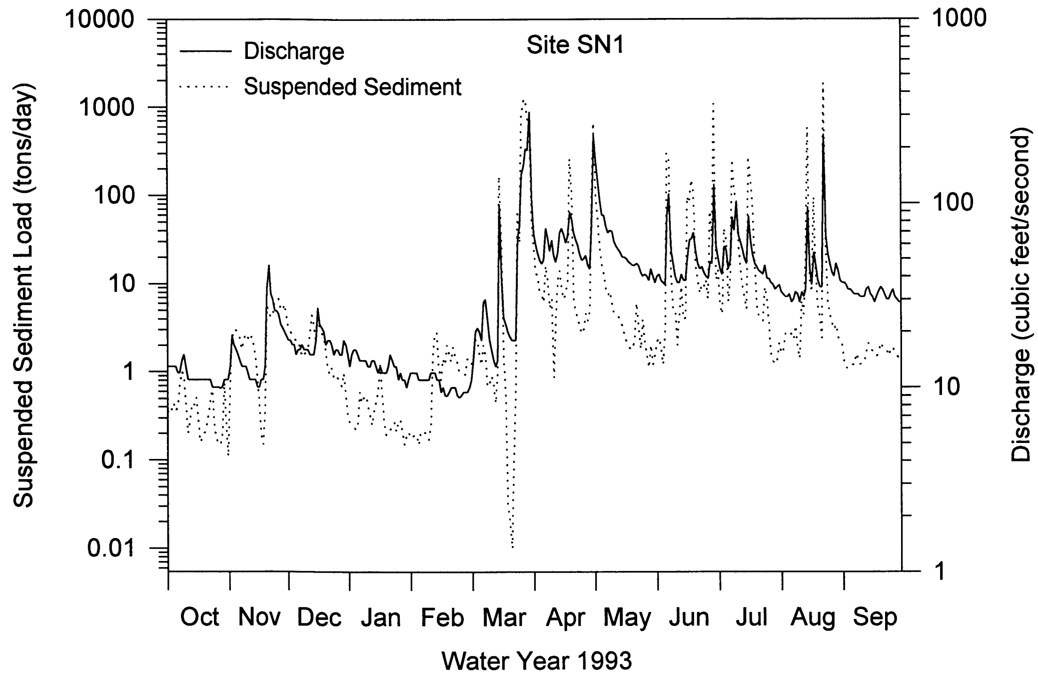
Table 21. Daily mean suspended-sediment concentration and daily suspended-sediment load at site SN1 on Sny Magill Creek; Water Year 1993.

Mean daily suspended-sediment concentration, in milligrams per liter

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	10.00	19.00	62.00	7.00	5.00	46.00	161.00	336.00	16.00	72.00	21.00	20.00
2	9.00	50.00	58.00	6.00	6.00	40.00	153.00	902.00	20.00	101.00	17.00	14.00
3	11.00	57.00	57.00	6.00	6.00	39.00	85.00	216.00	21.00	46.00	21.00	11.00
4	13.00	70.00	56.00	5.00	5.00	43.00	85.00	139.00	19.00	41.00	33.00	12.00
5	11.00	65.00	53.00	6.00	7.00	39.00	61.00	93.00	12.00	206.00	33.00	12.00
6	12.00	63.00	50.00	15.00	8.00	30.00	60.00	68.00	32.00	202.00	34.00	13.00
7	22.00	50.00	44.00	12.00	7.00	26.00	47.00	55.00	806.00	52.00	33.00	14.00
8	26.00	66.00	33.00	14.00	6.00	25.00	78.00	43.00	672.00	78.00	28.00	19.00
9	22.00	77.00	33.00	14.00	6.00	18.00	63.00	40.00	76.00	976.00	35.00	16.00
10	13.00	77.00	37.00	11.00	8.00	11.00	36.00	42.00	42.00	405.00	21.00	14.00
11	6.00	74.00	42.00	9.00	48.00	15.00	37.00	31.00	46.00	320.00	18.00	15.00
12	10.00	84.00	65.00	7.00	86.00	21.00	6.00	27.00	20.00	157.00	70.00	16.00
13	14.00	71.00	107.00	9.00	90.00	19.00	30.00	27.00	42.00	88.00	54.00	19.00
14	14.00	53.00	84.00	13.00	37.00	12.00	75.00	27.00	81.00	61.00	175.00	23.00
15	17.00	32.00	48.00	19.00	32.00	25.00	74.00	26.00	38.00	51.00	1170.00	21.00
16	10.00	17.00	60.00	35.00	50.00	428.00	43.00	24.00	40.00	40.00	91.00	20.00
17	5.00	7.00	51.00	17.00	48.00	275.00	37.00	19.00	396.00	819.00	80.00	19.00
18	6.00	5.00	51.00	8.00	81.00	21.00	48.00	16.00	383.00	888.00	440.00	18.00
19	7.00	10.00	47.00	6.00	62.00	9.00	63.00	15.00	591.00	563.00	107.00	18.00
20	8.00	53.00	36.00	6.00	48.00	1.00	937.00	14.00	505.00	137.00	54.00	22.00
21	11.00	40.00	22.00	5.00	70.00	0.00	457.00	14.00	107.00	46.00	45.00	21.00
22	15.00	47.00	19.00	7.00	55.00	0.00	34.00	18.00	83.00	36.00	25.00	21.00
23	25.00	55.00	24.00	8.00	54.00	2.00	28.00	47.00	65.00	34.00	1420.00	22.00
24	8.00	86.00	22.00	6.00	43.00	15.00	25.00	25.00	81.00	33.00	127.00	19.00
25	7.00	90.00	21.00	9.00	41.00	182.00	23.00	16.00	81.00	71.00	44.00	20.00
26	5.00	102.00	20.00	9.00	37.00	119.00	20.00	36.00	98.00	64.00	36.00	20.00
27	5.00	89.00	18.00	7.00	37.00	1120.00	23.00	19.00	63.00	32.00	31.00	20.00
28	6.00	88.00	17.00	5.00	55.00	2010.00	32.00	14.00	453.00	15.00	28.00	19.00
29	26.00	105.00	20.00	7.00	-	1550.00	31.00	11.00	180.00	13.00	27.00	18.00
30	9.00	85.00	12.00	7.00	-	984.00	42.00	17.00	1790.00	13.00	21.00	18.00
31	4.00	-	8.00	5.00	-	796.00	-	11.00	-	14.00	20.00	-

Suspended-sediment load, in tons per day

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	0.36	0.70	3.10	0.27	0.18	1.30	52.00	98.00	1.60	11.00	2.10	2.00
2	0.33	2.60	2.90	0.26	0.20	1.20	27.00	664.00	2.20	14.00	1.60	1.30
3	0.37	2.60	2.60	0.24	0.19	1.40	14.00	103.00	2.40	5.50	1.80	1.10
4	0.44	3.00	2.50	0.22	0.15	2.30	12.00	52.00	1.90	4.50	2.70	1.10
5	0.36	2.60	2.20	0.26	0.21	2.30	8.10	26.00	1.20	42.00	2.80	1.10
6	0.39	2.40	2.20	0.59	0.21	1.60	7.60	16.00	3.00	32.00	2.90	1.20
7	0.71	1.80	1.90	0.45	0.21	1.20	6.20	13.00	299.00	6.20	2.60	1.20
8	1.00	2.30	1.50	0.52	0.18	2.00	16.00	8.70	278.00	12.00	2.30	1.60
9	0.90	2.70	1.50	0.54	0.17	1.50	11.00	7.40	12.00	252.00	3.30	1.40
10	0.43	2.50	1.70	0.42	0.26	0.68	5.30	8.20	5.20	109.00	1.90	1.20
11	0.20	2.20	1.80	0.32	1.50	0.74	6.70	6.00	5.10	94.00	1.40	1.30
12	0.29	2.50	2.60	0.25	2.70	0.90	0.85	4.50	2.00	29.00	6.40	1.30
13	0.44	2.10	4.40	0.36	2.80	0.74	3.90	4.20	4.30	15.00	4.50	1.70
14	0.42	1.50	3.40	0.46	1.10	0.44	11.00	4.20	9.20	9.30	20.00	2.10
15	0.51	0.89	2.30	0.62	0.81	1.00	14.00	3.80	3.90	6.80	586.00	1.80
16	0.29	0.46	4.50	1.20	1.40	165.00	8.60	3.30	4.10	5.10	11.00	1.70
17	0.16	0.20	3.10	0.55	1.20	35.00	6.70	2.70	96.00	274.00	7.90	1.50
18	0.18	0.15	2.80	0.26	2.00	1.50	7.80	2.20	81.00	152.00	95.00	1.50
19	0.20	0.38	2.50	0.19	1.60	0.54	11.00	1.90	150.00	82.00	13.00	1.60
20	0.24	5.50	1.70	0.21	1.30	0.03	261.00	1.80	105.00	18.00	5.50	2.10
21	0.33	4.90	1.10	0.22	1.90	0.02	111.00	1.80	16.00	5.60	4.20	1.90
22	0.46	4.10	0.94	0.26	1.50	0.01	6.30	2.30	11.00	4.20	2.40	1.80
23	0.69	4.40	1.10	0.27	1.30	0.11	4.70	6.00	7.70	3.90	1850.00	1.80
24	0.23	6.10	0.87	0.21	1.00	0.77	4.00	3.20	9.80	3.70	24.00	1.50
25	0.18	6.30	0.94	0.27	1.00	68.00	3.30	1.80	9.10	9.10	6.30	1.80
26	0.15	6.80	0.85	0.29	0.94	29.00	2.70	3.90	11.00	6.80	4.50	1.90
27	0.15	5.30	0.77	0.21	0.94	789.00	3.10	2.20	6.70	3.40	3.60	1.60
28	0.18	4.90	0.69	0.15	1.40	1150.00	4.60	1.50	66.00	1.50	3.00	1.50
29	0.75	5.80	0.97	0.19	-	1250.00	3.80	1.10	34.00	1.30	3.40	1.40
30	0.24	4.40	0.56	0.21	-	748.00	5.00	2.00	1090.00	1.20	2.50	1.30
31	0.11	-	0.32	0.18	-	659.00	-	1.20	-	1.40	2.10	-
Total:	11.69	92.08	60.31	10.65	28.35	4915.28	639.25	1057.90	2328.40	1215.50	2680.70	46.30
											Water year total:	***13086.41***
Mean:	0.38	3.07	1.95	0.34	1.01	158.56	21.31	34.13	77.61	39.21	86.47	1.54
Maximum	1.00	6.80	4.50	1.20	2.80	1250.00	261.00	664.00	1090.00	274.00	1850.00	2.10
Minimum:	0.11	0.15	0.32	0.15	0.15	0.01	0.85	1.10	1.20	1.20	1.40	1.10



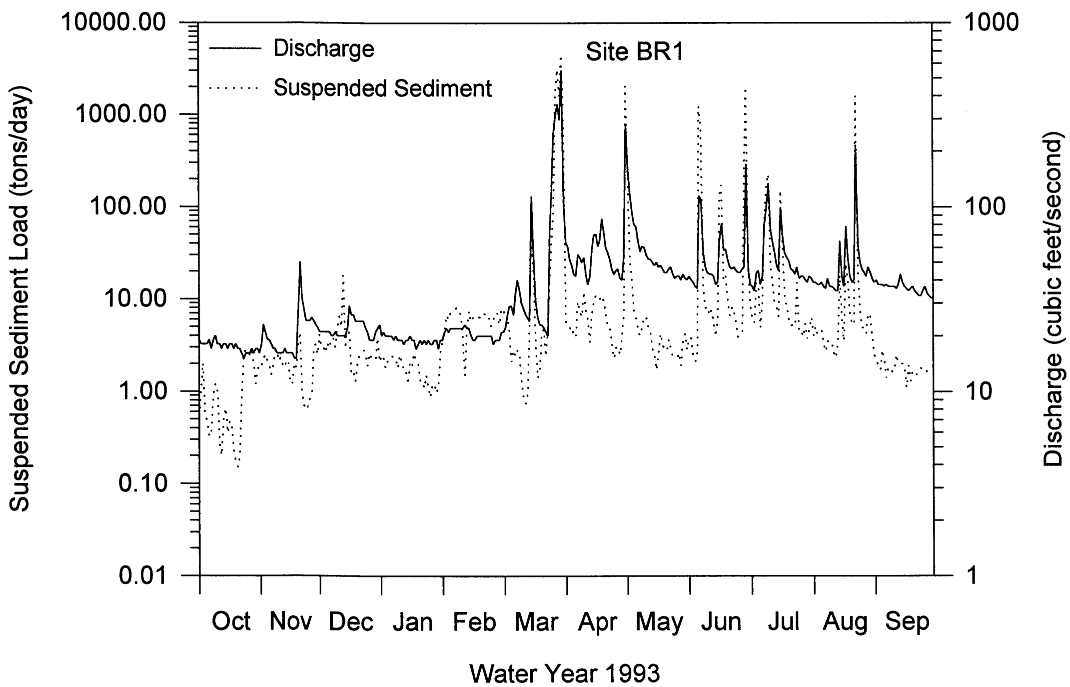


Figure 8. Summary of mean daily suspended-sediment concentrations and stream discharge for Sny Magill and Bloody Run creeks during Water Year 1993.

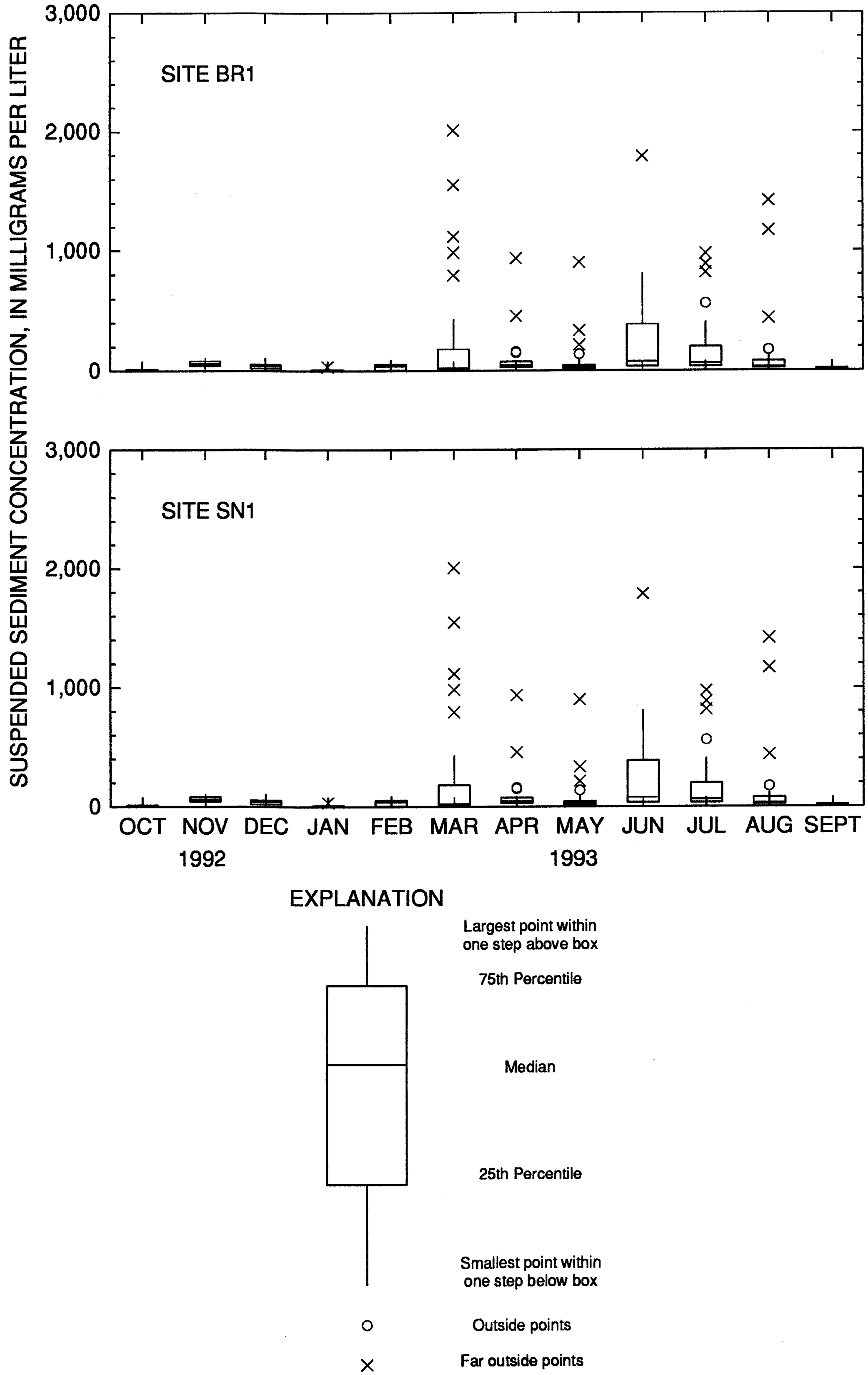


Figure 9. Summary of monthly mean daily suspended-sediment concentrations at the monitoring sites in Sny Magill and Bloody Run creeks for Water Year 1993.

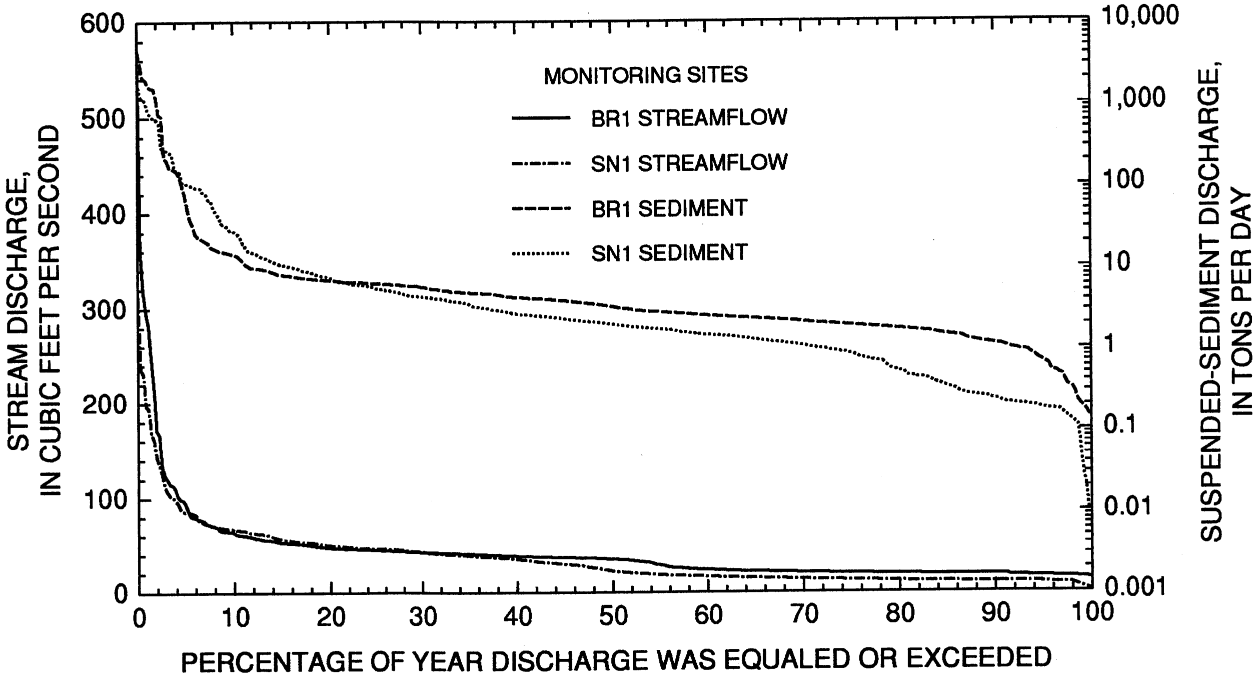


Figure 10. Percentage of year stream and suspended-sediment discharge was equaled or exceeded in Sny Magill and Bloody Run creeks for Water Year 1993.

Water Year 1992 was 36.6 cfs (1.04 cms). The maximum daily mean discharge (313 cfs; 8.86 cms) occurred on March 31, 1993, and the minimum mean daily discharge (8.8 cfs; 0.25 cms) occurred on February 24, 1993. The greatest recorded instantaneous discharge during the water year, 1300 cfs (36.79 cms), occurred on August 23, 1993. Flow duration is shown in Figure 10. Daily mean discharge exceeded 11 cfs (0.31 cms) 90% of the year and exceeded 68 cfs (1.92 cms) 10% of the year.

Supplemental Sites

Stream discharge was measured periodically at seven supplemental sites in the Bloody Run and Sny Magill watersheds during Water Year 1993 (Table 23). The greatest measured discharge at the supplemental sites in the Bloody Run watershed (70.8 cfs; 2.00 cms) occurred at site BR2 on March 30, 1993. At the supplemental sites in the Sny Magill Creek watershed, the greatest stream discharge (62.90 cfs; 1.78 cms) was at site SN2 on August 24, 1993.

Summary

The total suspended-sediment discharge for Water Year 1993 was 22,174 tons at site BR1 and 13,086 tons at site SN1. The daily median suspended-sediment discharge was 3.4 tons at BR1 and 2.1 tons at SN1. The maximum daily mean stream discharge at site BR1 (550 cfs; 15.57 cms) occurred on March 31, 1993. The mean daily discharge at site BR1 was 42.1 cfs (1.19 cms). The maximum daily mean stream discharge at site SN1, 313 cfs (8.86 cms), occurred on March 31, 1993. The mean daily discharge at site SN1 for Water Year 1993 was 36.6 cfs (1.04 cms).

Table 22. Daily mean discharge sites SN1 and BR1; Water Year 1993.

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Site BR1 (Discharge in cubic feet per second)												
1	19	18	21	20	21	21	102	53	40	45	41	39
2	18	23	21	21	22	21	64	281	42	38	39	40
3	18	21	21	20	21	22	61	166	40	37	39	38
4	18	19	21	20	22	26	52	120	39	35	38	38
5	18	19	21	20	22	29	48	94	37	44	38	38
6	19	18	21	20	22	29	43	80	36	45	39	37
7	17	17	20	19	22	26	42	78	115	38	37	38
8	19	17	20	20	22	34	55	65	110	42	36	37
9	20	16	21	19	22	40	53	57	56	80	41	37
10	18	16	20	19	22	35	50	61	47	98	37	37
11	18	16	20	19	23	30	53	60	44	134	37	37
12	17	16	20	18	22	28	43	55	43	76	36	36
13	18	17	20	19	22	26	38	52	43	65	35	38
14	18	16	20	19	20*	25	42	52	42	56	35	43
15	17	16	22	20	19*	24	58	50	38	48	65	39
16	18	16	29	19	19*	114	70	48	39	45	42	37
17	18	16	26	19	20*	55	71	50	66	99	37	36
18	17	15	26	17*	20*	31	61	47	81	69	78	35
19	18	15	24	18*	20*	25	65	48	58	56	53	36
20	17	26	24	19*	20*	23	86	46	59	53	42	37
21	17	50	24	18	20*	23	73	44	51	51	39	35
22	16	32	24	19	20*	22	60	44	47	46	40	34
23	15	28	24	18	20*	21	56	46	46	45	216	33
24	16	24	22	19	20*	20	52	47	47	43	62	33
25	16	24	21	18*	18*	73	46	43	45	47	50	35
26	16	24	19	18*	19*	124	43	41	44	41	46	37
27	17	25	19	19*	19*	246	45	42	44	42	44	34
28	16	24	19	19*	19*	317	46	42	46	42	42	33
29	17	23	21	17*	---	360	41	40	47	40	47	32
30	17	22	22	19*	---	296	40	43	171	39	44	32
31	16	---	23	19*	---	550	---	41	---	42	41	---
TOTAL	539	629	676.0	588	578	2716	1659	2036	1663	1681	1516	1091
MEAN	17.4	21.0	21.8	19.0	20.6	87.6	55.3	65.7	55.4	54.2	48.9	36.4
MAX	20	50	29	21	23	550	102	281	171	134	216	43
MIN	15	15	19	17	18	20	38	40	36	35	35	32
AC-FT	1070	1250	1340	1170	1150	5390	3290	4040	3300	3330	3010	2160
CFSM	0.51	0.61	0.64	0.56	0.60	2.57	1.62	1.92	1.62	1.59	1.43	1.07
IN.	0.59	0.69	0.74	0.64	0.63	2.96	1.81	2.22	1.81	1.83	1.65	1.19
Site SN1 (Discharge in cubic feet per second)												
1	13	13	18	13	12	10	107	77	37	58	36	37
2	13	19	18	15	12	11	69	231	40	50	33	37
3	13	17	17	16	12	14	60	169	41	44	32	36
4	13	16	17	16	11	20	54	134	38	41	31	34
5	13	15	15	15	11	21	49	103	37	58	31	34
6	12	14	16	14	11	20	47	86	36	56	32	33
7	12	13	16	14	11	18	49	86	86	44	29	32
8	14	13	17	14	11	29	73	74	112	49	30	32
9	15	13	16	14	11	30	65	69	55	84	33	32
10	13	12	16	13	12	23	55	71	47	71	32	31
11	11	11	16	13	12	18	63	70	40	102	29	31
12	11	11	15	14	12	16	52	62	37	67	33	31
13	11	11	15	14	11	14	48	58	37	62	31	34
14	11	11	15	13	11	13	54	56	41	56	34	35
15	11	10	18	12*	9.4*	14	69	54	38	50	95	32
16	11	10	27	13*	10*	98	73	51	38	47	44	31
17	11	11	22	12*	9*	41	67	51	50	85	36	29
18	11	11	21	12*	9*	24	61	50	63	63	54	31
19	11	13	20	12*	9.4*	22	66	48	64	53	46	33
20	11	34	17	13*	10*	20	89	47	69	47	38	35
21	11	46	18	15	10*	19	82	46	54	45	35	34
22	11	32	18	14	10*	18	69	46	47	43	35	32
23	10	30	17	13	9*	18	63	47	44	42	236	30
24	10	26	15	13	8.8*	18	59	46	45	41	66	30
25	10	26	16	11*	9*	65	53	42	42	46	53	32
26	10	25	16	12*	9.4*	75	49	40	40	39	47	34
27	9.9	22	15	11*	9.4*	143	50	41	39	39	42	31
28	10	21	15	11*	9.4*	160	52	40	48	37	40	30
29	11	20	18	10*	---	197	46	38	47	36	47	29
30	11	19	17	11*	---	194	44	44	126	34	43	29
31	11	---	15	12	---	313	---	40	---	35	38	---
TOTAL	355.9	545	532	405	291.8	1696	1837	2117	1538	1624	1441	971
MEAN	11.5	18.2	17.2	13.1	10.4	54.7	61.2	68.3	51.3	52.4	46.5	32.4
MAX	15	46	27	16	12	313	107	231	126	102	236	37
MIN	9.9	10	15	10	8.8	10	44	38	36	34	29	29
AC-FT	706	1080	1060	803	579	3360	3640	4200	3050	3220	2860	1930
CFSM	0.42	0.66	0.62	0.47	0.38	1.98	2.22	2.47	1.86	1.90	1.68	1.17
IN.	0.48	0.73	0.72	0.55	0.39	2.29	2.48	2.85	2.07	2.19	1.94	1.31

*estimated value

Table 23. Stage, mean velocity, and discharge measurements at supplemental sites in Bloody Run and Sny Magill watersheds; Water Year 1993.

Site	Date	Stage (Feet below reference mark)	Mean velocity (feet/sec)	Discharge (cubic feet/sec)
BRSC	03/30/93	18.22	1.370	33.00
	04/30/93	18.63	0.600	8.28
	05/28/93	18.63	0.584	8.58
	06/30/93	18.34	1.070	20.40
	08/24/93	18.34	1.090	16.60
	09/27/93	18.43	0.725	9.13
BR2	03/30/93	16.90	1.640	70.80
	04/30/93	17.46	0.760	22.10
	05/28/93	17.57	0.699	20.00
	06/30/93	17.00	1.320	57.80
	09/27/93	17.42	0.620	18.60
SN3	03/30/93	17.92	1.680	33.20
	04/30/93	18.66	0.920	6.29
	05/28/93	18.64	0.805	6.44
	06/30/93	18.19	1.220	12.80
	08/24/93	18.14	1.290	14.60
	09/28/93	18.18	1.060	7.49
SNWF	03/30/93	10.42	1.610	10.60
	04/30/93	10.87	1.010	3.98
	05/28/93	10.56	1.320	3.47
	06/30/93	10.56	1.200	6.75
	08/24/93	9.50	1.990	8.15
	09/28/93	9.98	0.640	5.56
NCC	03/30/93	8.80	2.160	52.60
	04/30/93	9.79	1.160	7.37
	05/28/93	9.86	1.280	4.54
	06/30/93	9.53	1.760	16.60
	08/24/93	9.50	1.650	15.90
	09/28/93	9.77	1.340	6.05
SNT	03/30/93	11.90	1.820	18.60
	04/30/93	12.60	1.240	3.73
	05/28/93	12.66	1.020	2.20
	06/30/93	12.57	1.480	4.11
	08/24/93	12.20	2.120	8.63
	09/28/93	12.40	1.290	2.64
SN2	03/30/93	19.72	---	---
	04/30/93	20.76	1.410	24.30
	05/28/93	20.75	1.470	23.80
	06/30/93	20.53	2.480	57.20
	08/24/93	20.49	1.960	62.90
	09/28/93	20.81	0.881	24.40

Comparison of Water Years 1992 and 1993

The hydrologic data collected during water years 1992 and 1993 showed the effects of significant increases in precipitation during Water Year 1993. Annual precipitation data from the Prairie du Chien, Wisconsin climatic station increased from 124% of normal in Water Year 1992 to 169% of normal in Water Year 1993. Stream discharge and suspended-sediment loads increased from Water Year 1992 to Water Year 1993 at both Sny Magill and Bloody Run creeks. At site BR1, mean daily discharge increased from 26.3 cfs (0.74 cms) in Water Year 1992 to 42.1 cfs (1.19 cms) in Water Year 1993. At site SN1, mean daily discharge increased from 17.1 cfs (0.48 cms) in Water Year 1992 to 36.6 cfs (1.04 cms) in Water Year 1993. Suspended-sediment discharge showed a similar increase. A total of 2,720 tons were discharged from site BR1 during Water Year 1992 and 22,174 tons in Water Year 1993 (815% of 1992). Site SN1 discharged 1,940 tons in Water Year 1992 and 13,086 tons in Water Year 1993 (675% of 1992).

WATER QUALITY MONITORING RESULTS

Water quality was monitored at six sites in the Sny Magill watershed and three sites in the Bloody Run watershed (Figure 1). Table 24 lists the parameters analyzed, detection limit, method description, and reference. Monitoring was conducted by Iowa Department of Natural Resources - Geological Survey Bureau (IDNR-GSB) and U.S. National Park Service-Effigy Mounds National Monument personnel. Sites BR2, SN2, and SNT were sampled monthly, while all other sites were sampled weekly. Runoff events were not targeted for increased sample collection. Appendices II and III provide a statistical summary of the results for water years 1992 and 1993 based on an annual basis for all sites and quarterly for the sites sampled weekly.

Water Year 1992

Table 25 shows mean values for the parameters monitored for all sites. Field measurements included temperature, conductivity, dissolved oxygen, and turbidity. Mean temperatures varied 8 to 10° C. Mean specific conductance values, a measure of the total dissolved solids content of the water, were in the 500 to 600 µmhos/cm range, typical of ground- and surface waters in northeast Iowa (Hallberg et al., 1984). Higher conductance values consistently occurred in Bloody Run versus Sny Magill, and likely result from the generally higher nitrate and chloride concentrations in Bloody Run. Mean dissolved oxygen (D.O.) concentrations are relatively high, ranging from 8 to 10 mg/L and adequate for aquatic life. Occasionally, anomalously low concentrations, <5 mg/L, were detected in these streams (Appendix II). The cause of these occurrences is unclear, as they do not appear related to any other unusual parameter values or discharge conditions. In addition, they are not consistent with respect to sites, dates, or field personnel. At times, low concentrations occur at up- and downstream sites within the watersheds, but generally this does not occur. As a result of these anomalous values, a second field measurement method for D.O. (i.e., YSI meter and membrane D.O. probe) was initiated in Water Year 1993. Turbidity values were generally low, with annual means varying from 6.5 to 17.5 NTU (Table 26).

Median annual fecal coliform counts varied among the sampling sites, from 20 to 620 organisms/100 ml. The highest annual median occurred at BRSC and may be related to the septic system which serves a campground located less than one-half mile upstream.

Mean annual nitrate-N concentrations ranged from 2.3 to 2.8 mg/L in tributaries to Sny Magill and declined from 3.4 to 1.9 mg/L in a downstream direction on Sny Magill Creek. Note that the combined drainage area of the upstream tributary sites is 19.5 mi^2 (50.51 km^2), while the drainage area at SN2 is 22.5 mi^2 (58.27 km^2). The concentrations of parameters such as nitrate and chloride at SN2 are essentially a "composite" of those from

Table 24. Summary of chemical parameters analyzed and method detection limits for Sny Magill project samples.

Analyte	Lab	Method Detection	Sample Holding Time	Method Description & Reference
Fecal bacteria	UHL-IC	count	8 hours	Standard Method 9222D (APHA, 1985) using media fecal coliform at 44.5 °C.
Nitrate & nitrite-N	UHL-DM	0.10 mg/L	28 days	Automated, copper-cadmium reduction & colorimetric quantitation, EPA Method 353.2 (USEPA, 1983).
Ammonia-N	UHL-DM	0.10 mg/L	28 days	Automated, phenate reaction, & colorimetric quantitation, EPA Method 350.1 & 350.2 (USEPA, 1983).
Organic-N	UHL-DM	0.10 mg/L	28 days	Total Kjeldahl procedure, semi-automated block digester, AAII, colorimetric quantitation, EPA Method 351.2 (USEPA, 1983).
Anions	SGL			Ion chromatography using a Waters Ion Chromatograph (Waters Ion Chromatography Cookbook, 1989).
Bromide		0.06 mg/L	14 days	
Chloride		0.02 mg/L	14 days	
Fluoride		0.04 mg/L	14 days	
Nitrate		0.10 mg/L	14 days	
Nitrite		0.04 mg/L	14 days	
Phosphate		0.15 mg/L	14 days	
Sulfate		0.10 mg/L	14 days	
Total P	UHL-DM	0.10 mg/L	28 days	Colorimetric, automated, block digester, EPA Method 365.4 (USEPA, 1983).
5-Day BOD	UHL-DM	1.00 mg/L	48 hours	Samples incubated in dark for 5 days at 20 °C, Standard Method 507 (APHA, 1985).
IMA triazines	UHL-IC	0.10 ug/L	14 days	Immuno assay using spectrophotometric measurement & analysis; Millipore triazine kit.

UHL-DM: University Hygienic Laboratory, Des Moines
UHL-IC: University Hygienic Laboratory, Iowa City
SGL: Sedimentary Geochemistry Laboratory, Iowa City

Table 25. Mean values for water-quality parameters for water years 1992 and 1993.

Water Year 1992

Parameter	Units	SN1	SN2	SN3	NCC	SNT	SNWF	BR1	BR2	BRSC
n		52	12	52	52	12	52	52	12	52
Drainage Area	sq. mi.	27.6	22.5	7.2	6.0	3.2	3.1	34.3	24.5	10.5
Row Crop	%	27.6%	28.0%	25.6%	33.4%	39.6%	22.3%	41.9%	51.7%	58.3%
Temperature	degrees C	10	8	10	9	8	9	10	8	10
Conductivity	umhos/cm	516	512	544	507	515	545	524	573	582
Dissolved Oxygen	mg/L	9	8	9	9	9	9	10	9	10
Turbidity	NTU	13.3	8.7	8.2	8.7	6.5	10.0	11.1	9.1	17.5
NO2+NO3-N	mg/L	1.9	2.5	3.4	2.3	2.8	2.6	5.0	8.7	8.8
Ammonium-N	mg/L	<0.1	<0.1	0.1	<0.1	<0.1	0.1	0.1	0.2	0.3
Organic-N	mg/L	0.2						0.4		
Fecal Bacteria *(median)*	count/100 ml	110	150	70	20	60	340	85	330	620
Total P	mg/L	0.1						0.2		
BOD	mg/L	1						2		
IMA	ug/L	0.14						0.40		
Nitrate-N	mg/L	2.1	2.5	3.6	2.2	2.2	2.7	4.9	8.9	9.0
Nitrite-N	mg/L	0.08	0.07	0.08	0.08	0.06	0.08	0.08	0.08	0.11
Phosphorus	mg/L	0.03	<0.03	0.04	<0.03	<0.03	<0.03	0.04	0.03	0.06
Sulfate	mg/L	26.5	27.5	26.1	26.5	23.7	34.0	21.0	20.9	26.0
Fluoride	mg/L	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.3	0.3
Chloride	mg/L	6.5	7.0	8.4	7.0	7.0	7.4	9.7	13.8	15.5
Bromide	mg/L	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
Chloride/Nitrate-N		3.4	2.8	2.5	3.0	2.5	2.8	1.9	1.6	1.8

Water Year 1993

Parameter	Units	SN1	SN2	SN3	NCC	SNT	SNWF	BR1	BR2	BRSC
n		52	12	52	52	12	52	52	52	12
Drainage Area	sq. mi.	27.6	22.5	7.2	6.0	3.2	3.1	34.3	24.5	10.5
Row Crop	%	27.6%	28.0%	25.6%	33.4%	39.6%	22.3%	41.9%	51.7%	58.3%
Temperature	degrees C	8	8	9	8	8	9	9	9	8
Conductivity	umhos/cm	512	523	546	515	520	549	539	571	574
Dissolved Oxygen	mg/L	9	9	9	10	8	9	10	9	11
Turbidity	NTU	15.4	9.7	12.3	13.1	8.3	9.8	14.9	15.4	12.7
NO2+NO3-N	mg/L	2.5	3.0	3.8	3.2	2.9	3.3	5.7	8.7	9.4
Ammonium-N	mg/L	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.2
Organic-N	mg/L	0.3						0.6		
Fecal Bacteria *(median)*	count/100 ml	78	65	105	40	70	250	85	460	110
Total P	mg/L	0.2						0.2		
BOD	mg/L	1						1		
IMA	ug/L	0.40						0.67		
Nitrate-N	mg/L	2.6	2.9	3.9	3.3	2.8	3.1	5.9	9.4	9.8
Nitrite-N	mg/L	0.03	0.10	0.03	0.03	0.04	0.03	0.03	0.04	0.05
Phosphorus	mg/L	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.03	<0.03
Sulfate	mg/L	24.6	25.3	23.4	25.1	21.9	31.8	20.1	20.1	24.1
Fluoride	mg/L	0.2	0.2	0.2	0.3	0.3	0.2	0.3	0.3	0.3
Chloride	mg/L	7.0	7.2	8.7	7.7	7.7	7.5	11.0	15.2	16.2
Bromide	mg/L	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
Chloride/Nitrate-N		2.8	2.4	2.3	2.4	2.7	2.3	1.9	1.7	1.7

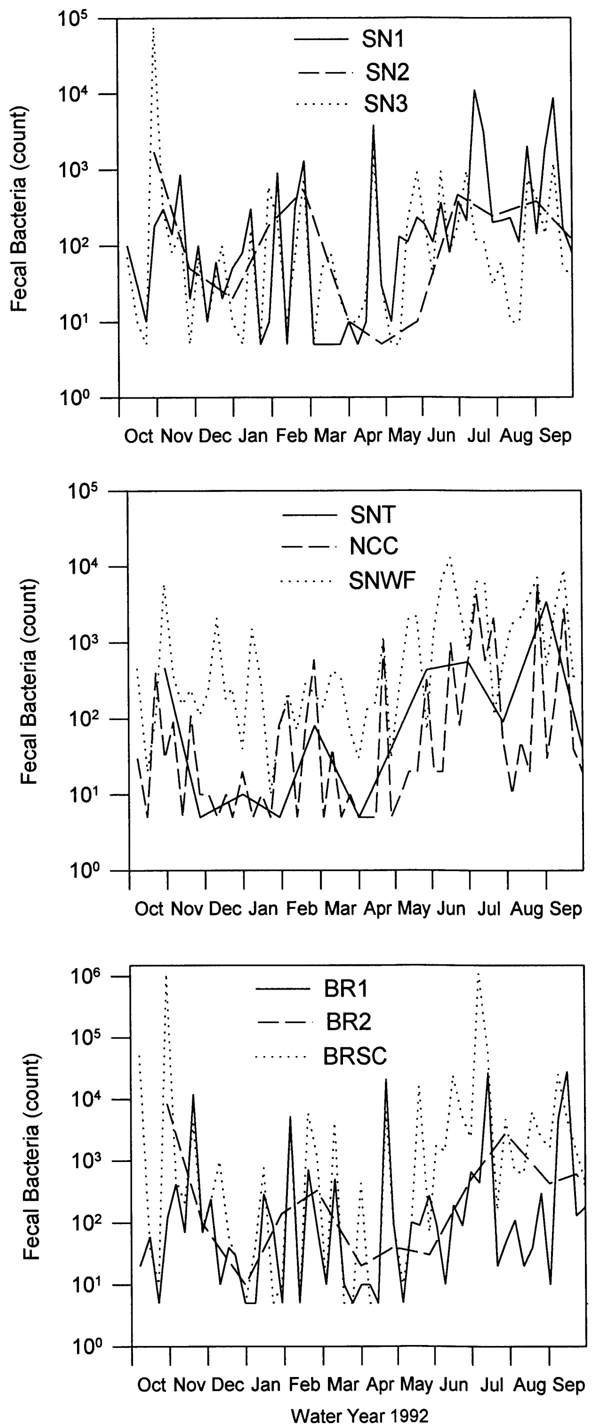


Figure 11. Fecal bacteria counts for all sites during Water Year 1992.

the upstream sites. Annual nitrate-N concentrations declined from 8.8 to 5.4 mg/L in a downstream direction on Bloody Run. Most of this decline (from 8.7 to 5.0 mg/L) occurred between BR2 and BR1. The higher nitrate-N concentrations are related to the greater percentage of row-crop acreage in Bloody Run relative to Sny Magill (see Seigley et al., 1993). Mean annual ammonium-N concentrations were 0.3 mg/L or less at all sites and below the 0.1 mg/L method detection limit at most sites. Biological Oxygen Demand (BOD) was measured at the gaged sites only, and averaged 1 mg/L at both sites. Total phosphorus was measured at the gaged sites and averaged 0.1 mg/L at SN1 and 0.2 at BR1. Mean annual triazine concentrations from immunoassays were 0.14 μg/l at SN1, and 0.40 μg/L at BR1. As with nitrate, higher triazine concentrations at BR1 likely relate to the greater percentage of row-crop agriculture in the Bloody Run watershed relative to Sny Magill.

The concentration of a number of anions other than nitrate were determined during Water Year 1992 (Table 25). The concentrations of most of these were routinely low (Table 25). Mean annual nitrite-N concentrations ranged from 0.06 and 0.11 mg/L; for phosphorus, the range was from <0.03 to 0.06 mg/L with almost one-half of all samples containing less than detectable concentrations. Mean annual fluoride concentrations fell in a narrow range, from 0.2 to 0.3 mg/L, and the annual means for bromide were all below detection limits.

Sulfate and chloride were present in significantly greater concentrations than the ions discussed above. Mean sulfate concentrations were relatively uniform, ranging from 21 to 28 mg/L, at most sites in the Sny Magill basin. An exception was site SNWF, where concentrations were consistently higher, averaging 34 mg/L during the water year. Mean sulfate concentrations were about 21 mg/L at the two downstream sites on Bloody Run and 26 mg/L at the upstream site BRSC. Chloride concentrations were also relatively uniform at Sny Magill sites, varying between 6.5 and 8.4 mg/L. Mean concentrations declined downstream from 15.5 to 9.7 mg/L along Bloody Run. The higher concentrations in Bloody Run relative to Sny Magill are likely related to the greater row-crop acreage in the Bloody Run watershed, where a greater percentage of the land surface likely receives potassium fertilizer inputs in the form of potassium chloride (KCl).

Temporal Trends

Temporal trends for a number of constituents, including fecal coliform bacteria, nitrate-N, chloride, BOD, and triazines, are discussed below. Figure 11 shows the fecal bacteria counts for all sites during Water Year 1992. Fecal coliform counts varied considerably among sites and for each site during the year. Site BRSC showed the greatest range, varying from <10 to >1,000,000. Figure 12 shows nitrate-N concentration at all sites. In general, the concentrations at all sites were rather low, relatively constant, and showed a consistent downstream decline. Somewhat greater concentrations occurred during the November through May period, when discharges were generally greater. Concentrations were typically 3 to 4 mg/L at SN3 and about 2 mg/L at SN1 during this period. Concentrations declined slowly along with discharge during the June through September growing season, to 3 mg/L at SN3 and 1 mg/L at SN1. Nitrate levels at sites SNT, NCC, and SNWF were generally greater than those at SN1, but slightly lower than those at SN3. SNWF showed a less pronounced growing season decline, relative to the other Sny Magill mainstream or tributary sites. Nitrate-N concentrations at the Bloody Run sites (Figure 12) showed the same general temporal trends, but were greater and more variable. During the November through May period, concentrations at BRSC typically ranged from 8 to 12 mg/L and from 5 to 6 mg/L at BR1. During the May through September lower-flow period, concentrations typically remained below 9 mg/L at BRSC, and about 5 mg/L at BR1. Concentrations declined consistently in a downstream direction.

Chloride concentrations at the Sny Magill and Bloody Run sites (Figure 13) showed relationships similar to nitrate, with lower, less variable concentrations occurring at the Sny Magill sites relative to the Bloody Run sites. Chloride concentrations showed a less pronounced growing season decline

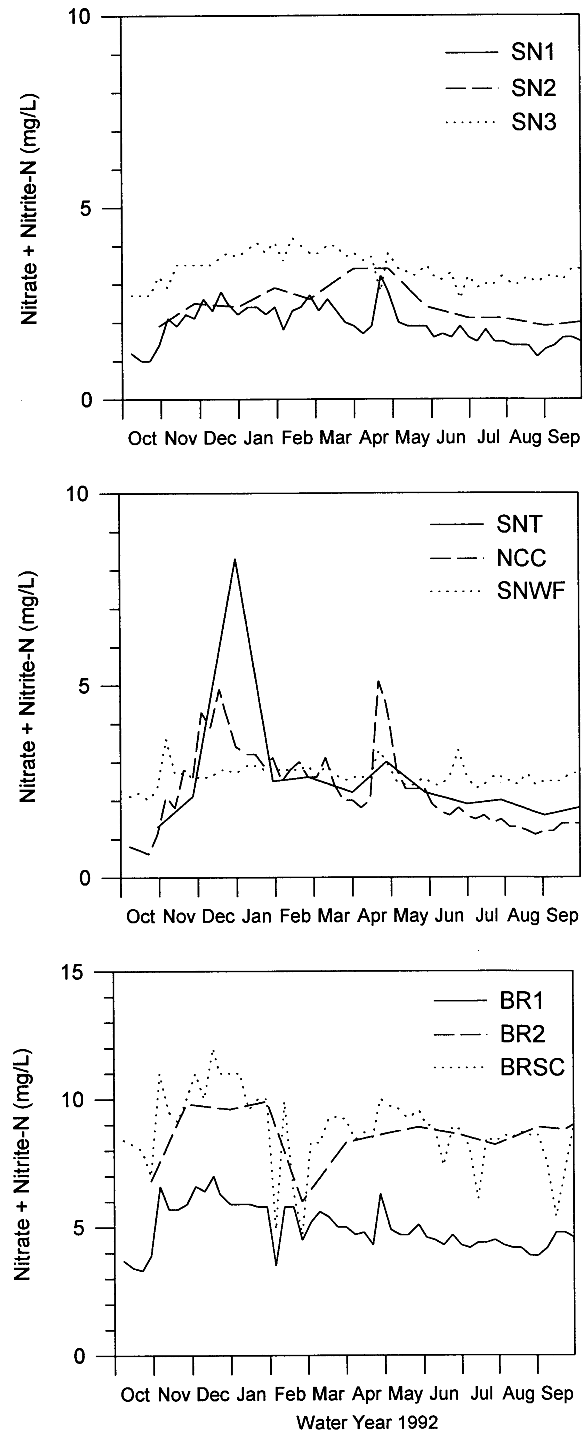


Figure 12. Nitrate-N concentrations for all sites during Water Year 1992.

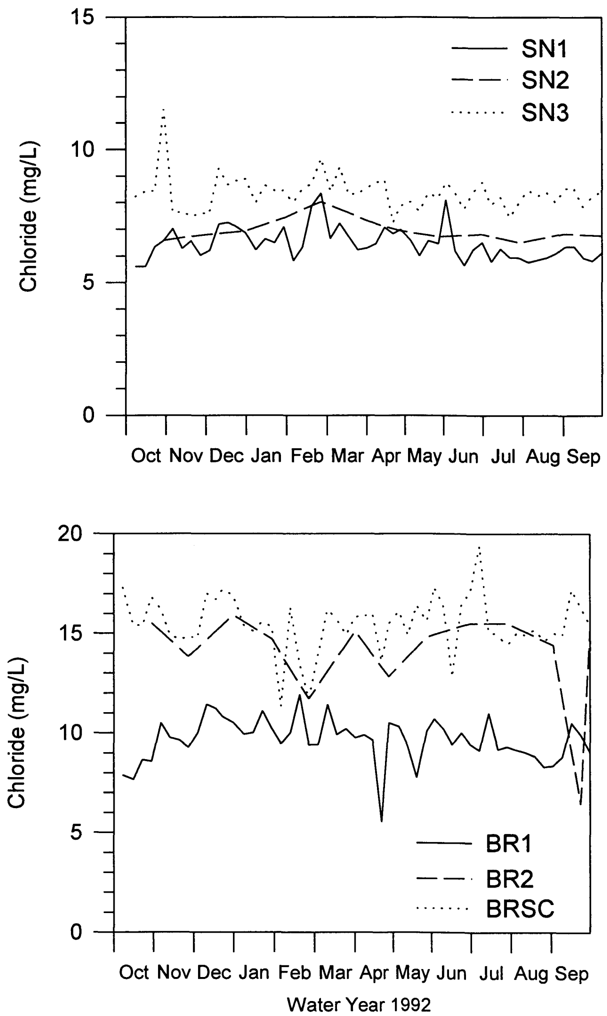


Figure 13. Chloride concentrations for sites SN1, SN2, SN3, BR1, BR2, and BRSC during Water Year 1992.

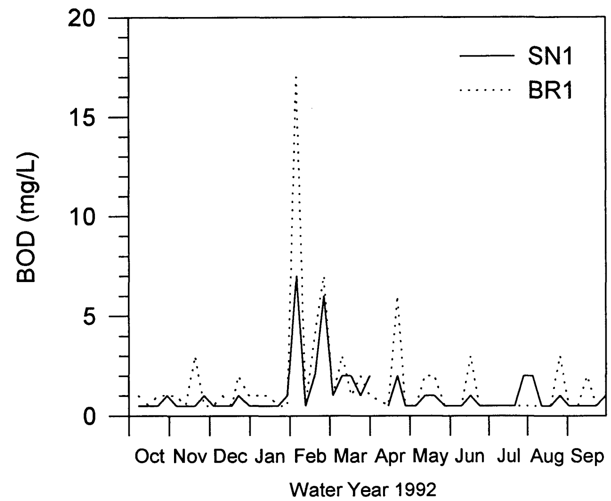


Figure 14. BOD concentrations for sites SN1 and BR1 during Water Year 1992.

than nitrate. Both streams showed a downstream decline in chloride.

Figure 14 shows BOD levels at the gaged sites. Over one-half of the samples from both sites had BOD concentrations below the detection limit. Peak concentrations occurred during runoff periods, likely from increased input of organic matter. Following runoff periods, BOD levels often decline below the detection limit by the following week's sample collection. The highest concentrations were measured at these sites during runoff periods in February.

Figure 15 shows triazine concentrations at the gaged sites. At SN1, 60% of the samples collected contained detectable levels of triazines, as did 98% of the samples from BR1. Concentrations were relatively low during the period prior to pesticide application (late April-May), ranging from below the detection limit (0.10 µg/L) to 0.40 µg/L at SN1 and typically to about 0.30 µg/L at BR1. Peak concentrations occurred during runoff periods in the post-application season, particularly in May and June. Maximum concentrations exceeded 0.50 µg/L at SN1 and approached 2.00 µg/l at BR1.

Discussion

The quality of water in Sny Magill and Bloody Run creeks is directly affected by the proportion of row-crop agriculture that occurs in their respective watersheds. The greater percentage of land in row crop in the Bloody Run watershed, relative to Sny Magill, is reflected by the greater concentrations of ag-related contaminants. For Water Year 1992, annual mean nitrate-N concentrations were 5.0 mg/L at BR1, versus 1.9 mg/L at SN1, and chloride concentrations were 9.7 mg/L and 6.5 mg/L, respectively. Similarly, triazine concentrations aver-

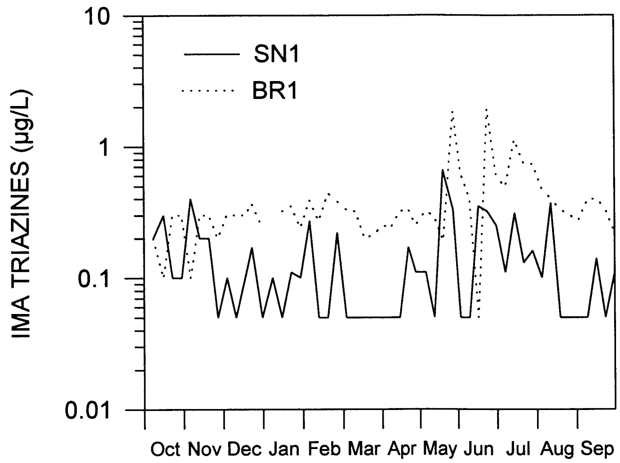


Figure 15. IMA triazine concentrations for sites SN1 and BR1 during Water Year 1992.

aged 0.40 µg/L at BR1, with 98% of the samples collected containing detectable triazines, versus a mean of 0.14 µg/L at SN1, with only 60% of the samples having detectable triazines. Median suspended sediment discharge was roughly equal at these sites, at about 1.1 tons/day. The annual suspended sediment load per unit area was slightly greater for Bloody Run, 79 tons/mi^2, versus 70 tons/mi^2 at Sny Magill.

Water Year 1993

Table 25 shows the mean values for the parameters monitored at all sites during Water Year 1993. Mean water temperatures varied 8 to 9° C. Mean specific conductance values were in the 500 to 600 µmhos/cm range. Somewhat higher values occurred in Bloody Run versus Sny Magill. Mean dissolved oxygen concentrations were relatively high, ranging from 8 to 11 mg/L. Turbidity values were generally low, surprising when considering the abnormally high rainfall conditions. Annual means for turbidity ranged from 8.3 to 15.4 NTU (Table 26).

Fecal coliform counts varied widely among the sampling sites, from below the detection limit of 10 to 160,000 organisms/100 ml. Median values are reported in Table 25 to more accurately reflect the bacteria quality of the water. Extremely high values tend to occur during rain events. Median fecal coliform counts ranged from 40 to 460 organisms/100 ml. The highest median fecal coliform value among the Bloody Run sites was 460 at BR2. Site SNWF had the highest median value (250) on Sny Magill.

Mean annual nitrate-N concentrations ranged from 2.9 to 3.2 mg/L in tributaries to Sny Magill and declined from 3.8 to 2.5 mg/L in a downstream direction at sites on the Sny Magill main stem. Nitrate-N concentrations declined from 9.4 to 5.7 mg/L in a downstream direction at sites on Bloody Run. The mean annual nitrate-N concentrations for all of the sites in Sny Magill and Bloody Run watersheds, except site BR2, increased from 1992 to 1993. The mean annual nitrate-N concentration for site BR2 remained unchanged. Mean annual ammonium-N concentrations varied from 0.2 to 0.3 mg/L within both watersheds. Biological Oxygen Demand (BOD) was measured at the gaged sites only and averaged 1 mg/L at both sites during the water year. Total phosphorus was measured at the gaged sites and averaged 0.2 mg/L at both sites. Mean annual triazine concentrations from immunoassays were 0.40 µg/L at site SN1 and 0.67 µg/L at site BR1. The significantly higher nitrate-N and triazine concentrations at site BR1 are likely the result of the greater proportion of row-crop agriculture in the Bloody Run watershed, relative to Sny Magill.

In addition to nitrate, several other anions were analyzed for during Water Year 1993 (Table 25). The concentrations of most were generally low. Mean annual nitrite-N concentrations for all sites ranged from 0.03-0.10 mg/L; mean phosphorus concentrations were below the detection limit of 0.03 mg/L for all sites except BR2, which averaged 0.03 mg/L. Mean annual fluoride concentrations varied from 0.22 to 0.29 mg/L, and all of the annual means for bromide were below the detection limit of 0.06 mg/L.

Mean annual sulfate concentrations were relatively uniform at most sites in the Sny Magill watershed, ranging from 21 to 25 mg/L. An

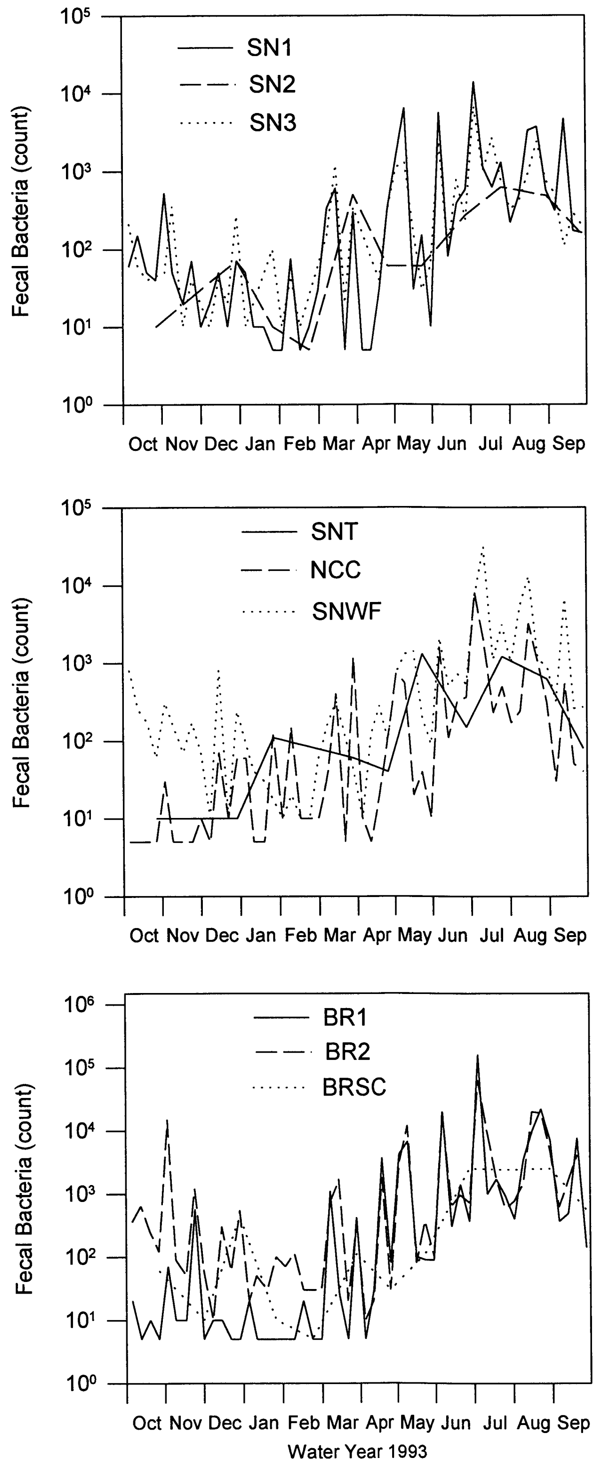


Figure 16. Fecal bacteria counts for all sites during Water Year 1993.

exception was site SNWF, where concentrations were consistently higher, averaging 32 mg/L. This same trend occurred during Water Year 1992. Mean sulfate concentrations were 20 mg/L at the two downstream sites on Bloody Run and 24 mg/L at the upstream site BRSC. Chloride concentrations were relatively uniform at the Sny Magill sites, ranging from 7.0 to 8.7 mg/L. Mean chloride concentrations on Bloody Run were higher, varying from 11.0 to 16.2 mg/L. Mean chloride concentrations declined in a downstream manner along both Bloody Run and Sny Magill. This trend also occurred during Water Year 1992. As with the nitrate concentrations, the higher chloride concentrations in Bloody Run relative to Sny Magill are likely a result of the greater row-crop acreage in the Bloody Run watershed.

Temporal Trends

Figure 16 show the fecal bacteria counts for all sites. Fecal coliform counts varied widely among sites. Site BRSC was changed from weekly sampling following Water Year 1992 to monthly in Water Year 1993, and the sampling at site BR2 was changed from monthly to weekly. The fecal bacteria concentrations for site BRSC declined from Water Year 1992 to Water Year 1993. This may be reflective of the change in sampling frequency (i.e., decreased sampling frequency may have missed the extreme highs detected during 1992). The Bloody Run sites showed an overall decline in fecal concentrations during February and March, followed by generally increasing concentrations during the remainder of the year. The main stem sites on Sny Magill (SN1, SN2, SN3) also showed declining concentrations in February, followed by generally increasing concentrations.

Figure 17 shows nitrate-N concentrations from all sites. Site SN2 was sampled monthly, whereas, sites SN1 and SN3 were sampled weekly. There was a general downstream decline in concentrations from SN3 to SN1. The average annual nitrate-N concentration for SN3 was 3.8 mg/L, 3.0 mg/L for SN2, and 2.5 mg/L for SN1. Concentrations generally increased from October to February and generally declined during March and April in association with periods of increased runoff. Concentrations showed an increasing trend during the remainder of the water year. The average annual concentration for SNT was 2.9 mg/L, 3.2 mg/L for NCC, and 3.3 mg/L for SNWF. The nitrate-N concentrations from the Bloody Run sites (Figure 17) fluctuated to a greater extent than the concentrations from sites in the Sny Magill watershed. All three sites on the main stem of Bloody Run showed pronounced decreases in concentrations near the end of March related to a significant snow-melt event (Figure 8). The Bloody Run sites then showed a trend of increasing nitrate-N concentrations from April through the remainder of the water year. Nitrate-N concentrations declined in a downstream direction within both watersheds.

Chloride concentrations from the Sny Magill and Bloody Run sites (Figure 18) show trends similar to the nitrate-N concentrations. Chloride concentrations tended to be lower at the Sny Magill sites and less variable. Both streams showed a decline in chloride concentration in response to increased runoff during the latter part of March. As with nitrate-N, both streams showed a downstream decline in chloride concentration.

Figure 19 shows BOD levels from sites SN1 and BR1. Over one-half of the samples from both sites had BOD concentrations below the detection limit. Peak BOD concentrations occurred during runoff periods, especially the March snow-melt event.

Figure 20 shows triazine concentrations from sites SN1 and BR1. At site SN1, 45% of the samples contained detectable levels of triazines, as did 100% of the samples from BR1. Triazine concentrations generally remained below the detection limit from November through April at site SN1, and concentrations remained near 0.20 µg/L for site BR1. Peak triazine concentrations occurred during June for both sites. The maximum concentrations sampled were 10.56 µg/L for SN1 and 17.12 µg/L for BR1.

Discussion

The concentrations of agricultural contaminants were generally greater in Bloody Run Creek than in Sny Magill Creek. For Water Year 1993, the

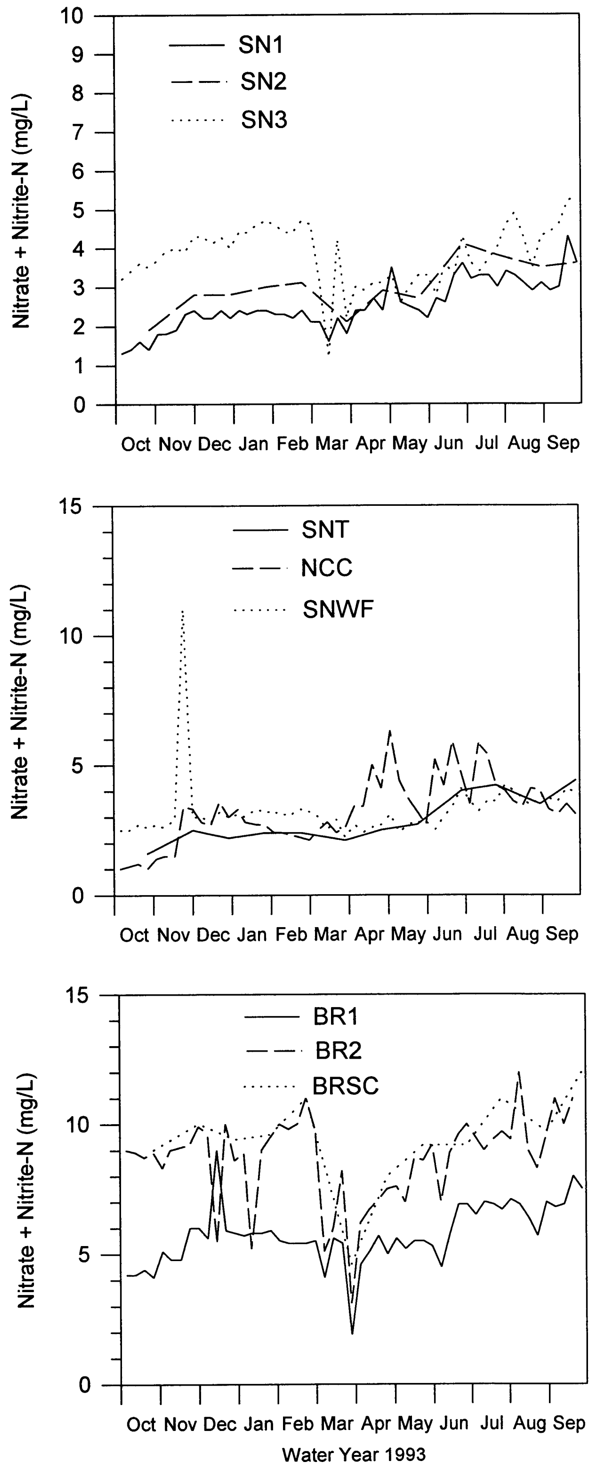


Figure 17. Nitrate-N concentrations for all sites during Water Year 1993.

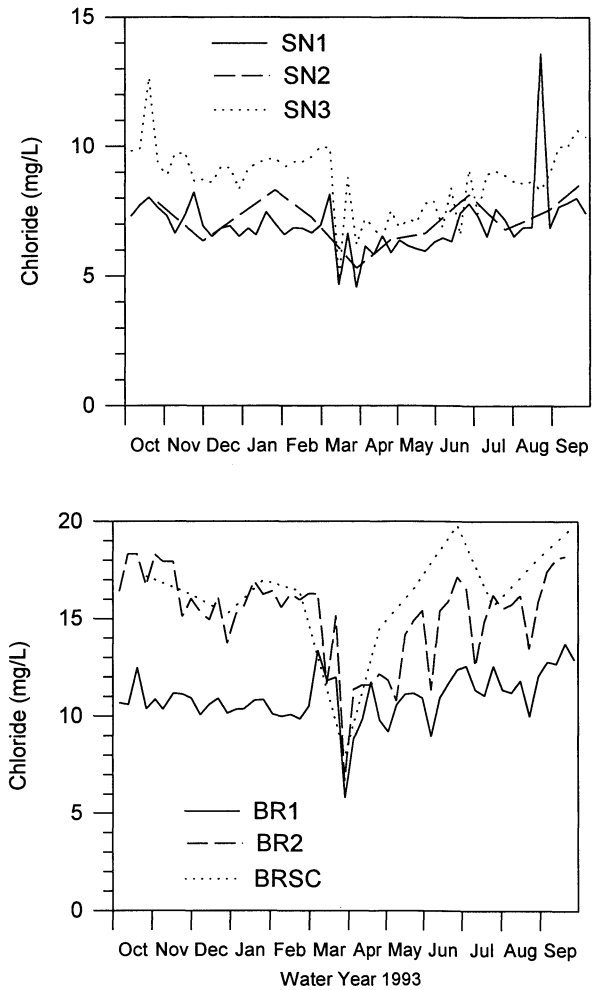


Figure 18. Chloride concentrations for sites SN1, SN2, SN3, BR1, BR2, and BRSC during Water Year 1993.

annual mean nitrate-N concentration was 5.7 mg/L at BR1 and 2.5 mg/L at SN1. The mean annual chloride concentrations were 11.0 mg/L and 7.0 mg/L, respectively. The mean annual triazine concentration was 0.67 µg/L at BR1, with 100% of the samples collected containing detectable triazines. Site SN1 had a mean annual concentration of 0.40 µg/L, with 45% of the samples having detectable triazines. Median suspended sediment loads were 3.30 tons for BR1 and 2.00 tons for SN1. The annual suspended sediment load per unit area was greater for Bloody Run, 647 tons/mi^2, versus 474 tons/mi^2 at Sny Magill.

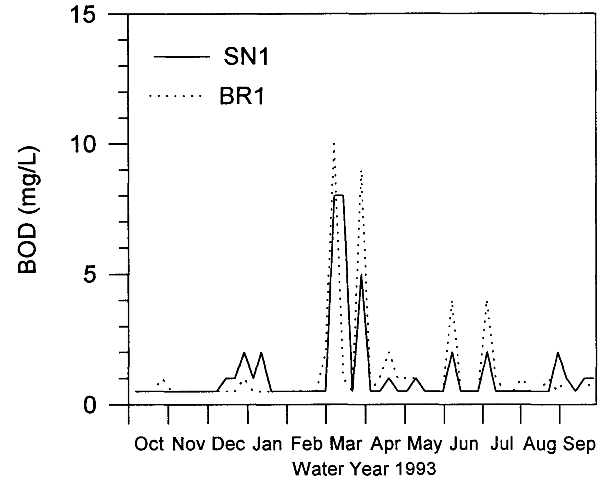


Figure 19. BOD concentrations for sites SN1 and BR1 during Water Year 1993.

Comparison of Water Years 1992 and 1993

The water-quality data from Sny Magill and Bloody Run creeks for water years 1992 and 1993 showed both similarities and differences in trends between the two years (Table 26). Concentrations of ag-related contaminants, such as nitrate, chloride, and triazine concentrations, were consistently higher in Bloody Run Creek than Sny Magill Creek during both water years. This is related to the greater percentage of land in row crop within the Bloody Run watershed, relative to Sny Magill. For Water Year 1992, mean NO_3-N concentrations ranged from 5.4 to 8.8 mg/L for sites on Bloody Run Creek and from 1.9 to 3.4 mg/L for the main stem sites on Sny Magill Creek. For Water Year 1993, mean NO_3-N concentrations ranged from 5.7 to 9.4 mg/L for sites on Bloody Run Creek and 2.5 to 3.8 mg/L for sites on Sny Magill Creek. Nitrate concentrations declined in a downstream manner at both the main stem sites on Sny Magill Creek and the sites on Bloody Run Creek. Fecal coliform counts varied widely among the sampling sites during both water years. BOD and total phosphorus concentrations remained low at both sites during both water years.

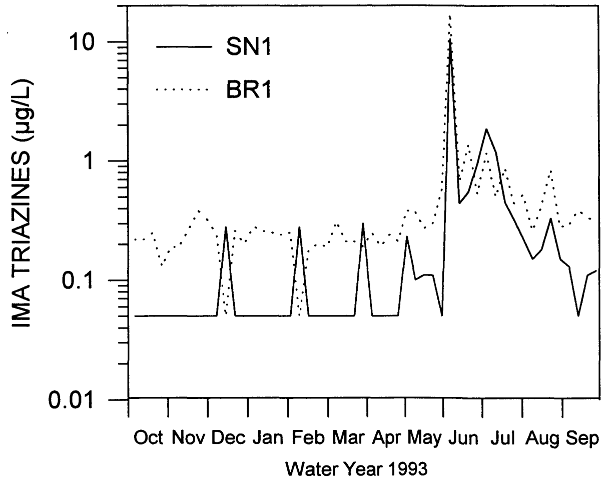


Figure 20. IMA triazine concentrations for sites SN1 and BR1 during Water Year 1993.

The significant increase in precipitation from Water Year 1992 to Water Year 1993 affected the concentrations of several parameters. In addition to increased suspended sediment loads, nitrate-N and triazine concentrations also increased from Water Year 1992 to Water Year 1993.

Comparison with Other Data

Figure 21 shows the long-term mean nitrate-N and atrazine concentrations from three sites associated with the Big Spring Basin Demonstration Project. Big Spring is the groundwater discharge point for the 103 mi^2 (268 km^2) groundwater basin. Site RC02 is on Roberts Creek at Saint Olaf and is the main surface-water discharge point for the associated surface-water basin (drainage area is 70.7 mi^2 or 183 km^2), and site TR01 is on the Turkey River at Garber, Iowa (drainage area is 1,545 mi^2 or 4,002 km^2). The water-quality data from Sny Magill and Bloody Run creeks show trends similar to the Big Spring data for water years 1992 and 1993. The differences in concentrations from Water Year 1982 through Water Year 1993 in Figure 21 are largely related to different hydrologic conditions caused by variations in climate.

SUMMARY

Significant differences in rainfall between water years 1992 and 1993 affected the monitoring components of the Sny Magill Watershed Nonpoint Source Pollution Monitoring Project. Water Year 1993 was much wetter than 1992 and resulted in significant increases in stream discharge and suspended sediment concentration loads of both Sny Magill and Bloody Run creeks, as well as greater nitrate-N and triazine pesticide concentrations. Despite these increases, consistent differences between Sny Magill and Bloody Run were apparent both years. Concentrations of agricultural contaminants and sediment loads were consistently higher in Bloody Run than Sny Magill.

The number of benthic taxa increased from Water Year 1992 to Water Year 1993. The HBI values for all sites varied from 1992 to 1993, and site SN3 showed the greatest amount of positive change. This site was impacted by a major disturbance of the stream reach in January 1992. This disturbance resulted in site SN3 having the worst water quality of all sites monitored during Water Year 1992. During Water Year 1993, the number of taxa increased to 49. The benthic data from water years 1992 and 1993 suggests the water quality may have improved, however, this improvement is speculative because of the short period of record and the unusual climatic conditions of 1993.

The fish assessment data for both years were dominated by a single fish, the fantail darter. The species of fish sampled in Water Year 1993 were similar to those in Water Year 1992. The total number of fish sampled declined from 1992 to 1993. This decline is considered a normal response to variations in precipitation, runoff, water clarity, and water stage. Autopsies of ten creek chubs in 1992 revealed no consistent gross irregularities or problems.

The habitat assessment reflected the above normal rainfall conditions of Water Year 1993. During the 1993 assessment, stream flow was two to three times higher than during Water Year 1992, causing greater stream width and depth measurements at most locations. Noticeable silt deposition and scouring had occurred along many of the stream reaches in Water Year 1993.

Table 26. Summary of water-quality data for Sny Magill and Bloody Run watersheds; water years 1992 and 1993.

	Water Year 1992	Water Year 1993
Precipitation (Prairie du Chien, WI)	38.03 inches (124% of normal)	51.85 inches (169% of normal)
Annual Mean Discharge (cubic feet per second)		
Sny Magill	17.1	36.6
Bloody Run	26.3	42.1
Total Suspended Sediment Discharge (tons)		
Sny Magill	1,940	13,086
Bloody Run	2,720	22,174
Annual Suspended Sediment Load Per Unit Area (tons per square mile)		
Sny Magill	70	474
Bloody Run	79	647
Average Nitrate + Nitrite-N (mg/L)		
Sny Magill	1.9	2.5
Bloody Run	5.0	5.7
Average Triazine Pesticides (ug/L)		
Sny Magill	0.14	0.40
Bloody Run	0.40	0.67

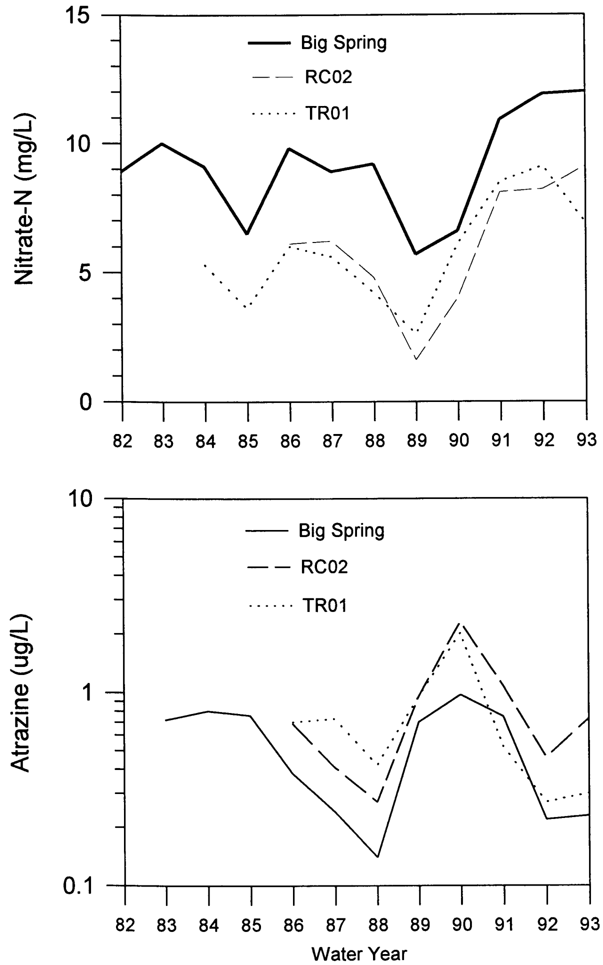


Figure 21. Nitrate-N and atrazine concentrations (mean of analyses) for Big Spring, Roberts Creek, and the Turkey River during water years 1982-1993.

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This report represents the compilation of reports summarizing the first and second years' (Water Year 1992 and Water Year 1993) water-quality monitoring efforts in the Sny Magill and Bloody Run watersheds by various agencies. Steve Kalkhoff, Jim Wellman, and David Eash of the U.S. Geological Survey made significant contributions to the text of this report. Benthic work was conducted by Mike Schueller, Mike Birmingham, and Jack Kennedy of the UHL; fish assessments were completed by Gaige Wunder and Lester Stahl of the IDNR-Fisheries Bureau; the habitat assessment was directed by Tom Wilton of the IDNR-Water Quality Bureau, with the assistance of Mike Birmingham, Jack Kennedy, John Miller, and Mike Schueller of the UHL, and Matt Culp and Janet Gastineau of the IDNR-Water Quality Bureau; stream discharge and suspended sediment data was collected and compiled by Steve Kalkhoff and Jim Wellman of the U.S. Geological Survey (USGS) in Iowa City and by local observors William Gruver and Joseph Kruse; drainage basin morphometrics were calculated by David Eash and Josef Pohl of the USGS; and water quality data was collected by Rodney Rovang, Dave McIlrath, Sharon Greener, and Jennifer McLimans of Effigy Mounds National Monument, Bob Rowden, Deb Quade, Bob Libra, K.D. Rex, Brenda Nations, Karen Mumford, and Lynette Seigley of the IDNR-Geological Survey Bureau (IDNR-GSB), and Matt Culp of the IDNR-Water Quality Bureau. Don Newbern of the Soil Conservation Service-Clayton County (SCS) provided land management change information from North Cedar Creek, and Nick Rolling of Iowa State University-Cooperative Extension Service (ISU-CES) and Dave Brommel and Jeff Tisl of the SCS compiled management practice changes for the Sny Magill watershed. ISU-CES conducted the survey of farming practices in the Sny Magill watershed. Jim Giglierano of the IDNR-GSB developed the Geographic Information System coverages for Sny Magill and Bloody Run watersheds.

George Hallberg of the UHL was instrumental in the development of this project. Several individuals have played key roles in the coordination of inter-agency activities. Those include Dr. Gerald Miller, ISU-CES; Julie Elfving with the U.S. EPA; Jim Gulliford, Division of Soil Conservation, Iowa Department of Agriculture and Land Stewardship; Roger Link of the U.S. Department of Agriculture-SCS; Ubbo Agena of the IDNR-Water Quality Bureau; Nick Melcher of the USGS; and Lynn Hudachek of the UHL.

Pat Lohmann oversaw the design and layout of this report, and aided in the development of several of the graphics. Thanks to Bob Rowden who edited this report and Paul Van Dorpe and Angie Bowman who proof read this report. Mary Clare Jones provided assistance in the management of the water quality database, and Mary Skopec and Angie Bowman developed needed graphics.

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APPENDIX I.

Summary of aquatic habitat evaluations for Bloody Run and Sny Magill watersheds for water years 1991 through 1993.

	SN1			SN2		
	'91	'92	'93	'91	'92	'93
STREAM REACH DIMENSIONS:						
Area: square feet	33226.3	31309.2	32947.5	8986.9	8962.1	11599.3
(square meters)	(3086.8)	(2908.7)	(3060.9)	(834.9)	(832.6)	(1077.6)
Length: feet	951.4	951.4	951.4	482.3	482.3	482.3
(meters)	(290.0)	(290.0)	(290.0)	(147.0)	(147.0)	(147.0)
Flow: cubic feet per second	10.95	9.53	25.42	8.12	9.89	20.83
(cubic meters per second)	(0.31)	(0.27)	(0.72)	(0.23)	(0.28)	(0.59)
Average width: feet	35.1	32.8	34.8	18.7	18.7	23.9
(meters)	(10.7)	(10.0)	(10.6)	(5.7)	(5.7)	(7.3)
Maximum depth: feet	6.20	5.18	6.49	5.93	5.57	4.9+
(meters)	(1.89)	(1.58)	(1.98)	(1.81)	(1.7)	(1.5+)
Average transect maximum depth: feet	3.05	2.72	3.28	1.67	1.34	1.96
(meters)	(0.93)	(0.83)	(1.00)	(0.51)	(0.41)	(0.60)
Average depth: feet	2.13	1.83	2.19	1.01	0.82	1.24
(meters)	(0.65)	(0.56)	(0.67)	(0.31)	(0.25)	(0.38)
INSTREAM HABITAT:						
Dominant habitat type	POOL	POOL	POOL	RUN	POOL	RUN
Riffle repeat frequency (X average width)	14	10	27	6	9	10
% reach with instream cover	70	70	50	30	25	25
Dominant cover type	POOL	POOL	POOL	POOL	POOL	POOL
% reach with pool habitat	60	85	75	30	55	20
Dominant pool size class *	1	1	1	1	1	1
% reach with silt deposition	65	80	65	30	45	50
% reach with scoured substrate	10	5	<5	<5	10	5
% reach with vascular aquatic vegetation	-	10	5	-	15	0
Dominant vascular aquatic vegetation type	-	SUBMERG	SUBMERG	-	SUBMERG	NA
SUBSTRATE COMPOSITION						
% clay	2	2	4	0	0	2
% silt	48	68	52	18	44	42
% sand	8	2	0	10	4	2
% gravel	10	20	29	36	32	48
% cobble	22	6	10	34	20	6
% boulder	10	2	5	0	0	0
% wood	0	0	0	0	0	0
% other	0	0	0	0	0	0
RIFFLE/RUN COARSE SUBSTRATE OBSERVATIONS:						
Periphyton colonization amount	-	HVY	LGHT	-	MOD	MOD
Dominant periphyton form	-	FLMNT	NONFLMNT	-	FLMNT	NONFLMNT
Average embeddedness rating **	-	2.1	3.0	-	2.0	3.4
STREAMSIDE OBSERVATIONS:						
Average stream shading rating	-	1.7	1.5	-	2.4	2.8
Average streambank tree coverage rating	1.9	1.9	1.1	2.1	1.6	1.5
Average streambank shrub coverage rating	1.0	1.0	1.2	1.2	2.0	1.0
Average streambank herbaceous coverage rating	4.3	3.8	4.0	4.2	4.1	3.4
Average streambank instability rating	1.2	1.6	2.9	1.3	2.0	2.0

* Pool class rating: 1=large and deep pools; 2=pools of moderate size and depth; 3=small and shallow pools.
** 1-5 rating scale: 1 = 0-20%; 2 = 20-40%; 3 = 40-60%; 4 = 60-80%; 5 = 80-100%.

	SN3 '91	SN3 '92	SN3 '93	SNWF '91	SNWF '92	SNWF '93
STREAM REACH DIMENSIONS:						
Area: square feet	3647.9	4918.1	4344.4	1871.8	2061.3	2549.9
(square meters)	(338.9)	(456.9)	(403.6)	(173.9)	(191.5)	(236.9)
Length: feet	315.6	311.7	311.7	232.3	236.2	236.2
(meters)	(96.2)	(95.0)	(95.0)	(70.8)	(72.0)	(72.0)
Flow: cubic feet per second	1.76	1.76	5.65	1.76	2.12	5.65
(cubic meters per second)	(0.05)	(0.05)	(0.16)	(0.05)	(0.06)	
Average width: feet	11.8	15.7	13.7	7.8	8.5	10.8
(meters)	(3.6)	(4.8)	(4.2)	(2.4)	(2.6)	(3.3)
Maximum depth: feet	2.16	2.03	2.49	1.44	1.51	2.19
(meters)	(0.66)	(0.62)	(0.76)	(0.44)	(0.46)	(0.67)
Average transect maximum depth: feet	0.95	0.59	1.18	0.78	0.78	0.95
(meters)	(0.29)	(0.18)	(0.36)	(0.24)	(0.24)	(0.29)
Average depth: feet	0.45	0.26	0.59	0.49	0.39	0.52
(meters)	(0.14)	(0.08)	(0.18)	(0.15)	(0.12)	(0.16)
INSTREAM HABITAT:						
Dominant habitat type	RUN	RN/RFFL	RUN	RUN	RUN	RUN
Riffle repeat frequency (X average width)	5	6	10	5	7	11
% reach with instream cover	15	<5	5	5	5	<5
Dominant cover type	POOL	POOL	OVRVEG	UCUTBNK	WDDEBR	UCUTBNK
% reach with pool habitat	30	10	10	5 10	20	
Dominant pool size class *	3	3	3	3	3	3
% reach with silt deposition	10	30	20	25	35	5
% reach with scoured substrate	5	5	<5	5	5	5
% reach with vascular aquatic vegetation	-	15	0	-	0	0
Dominant vascular aquatic vegetation type	-	EMERG	NA	-	NA	NA
SUBSTRATE COMPOSITION						
% clay	1	0	2	6	5	6
% silt	0	21	16	5	16	2
% sand	3	5	1	5	4	4
% gravel	33	42	45	49	50	54
% cobble	54	32	31	31	22	28
% boulder	7	0	3	4	0	0
% wood	0	0	0	0	3	6
% other	1	0	2	0	0	0
RIFFLE/RUN COARSE SUBSTRATE OBSERVATIONS:						
Periphyton colonization amount	-	HVY	MOD	-	MOD	MOD
Dominant periphyton form	-	FLMNT	FLMNT	-	FLMNT	NONFLMNT
Average embeddedness rating **	-	2.5	2.2	-	2.2	1.6
STREAMSIDE OBSERVATIONS:						
Average stream shading rating	-	2.0	2.3	-	4.0	3.6
Average streambank tree coverage rating	2.0	1.6	1.3	2.2	2.0	1.5
Average streambank shrub coverage rating	1.6	1.4	1.6	1.1	1.2	2.0
Average streambank herbaceous coverage rating	2.7	3.4	2.5	3.9	2.9	2.4
Average streambank instability rating	1.9	1.3	2.3	1.8	2.6	

* Pool class rating: 1=large and deep pools; 2=pools of moderate size and depth; 3=small and shallow pools.

** 1-5 rating scale: 1 = 0-20%; 2 = 20-40%; 3 = 40-60%; 4 = 60-80%; 5 = 80-100%.

	NCC			SNT		
	'91	'92	'93	'91	'92	'93
STREAM REACH DIMENSIONS:						
Area: square feet	3281.9	3298.1	3970.8	976.2	975.2	1133.4
(square meters)	(304.9)	(306.4)	(368.9)	(90.7)	(90.6)	(105.3)
Length: feet	324.7	324.7	323.1	149.9	150.9	150.9
(meters)	(99.0)	(99.0)	(98.5)	(45.7)	(46.0)	(46.0)
Flow: cubic feet per second	1.05	2.11	4.94	0.35	0.35	1.41
(cubic meters per second)	(0.03)	(0.06)	(0.14)	(0.01)	(0.01)	(0.04)
Average width: feet	10.1	10.1	12.5	6.5	6.5	7.5
(meters)	(3.1)	(3.1)	(3.8)	(2.0)	(2.0)	(2.3)
Maximum depth: feet	3.41	3.21	3.15	0.78	0.78	0.85
(meters)	(1.04)	(0.98)	(0.96)	(0.24)	(0.24)	(0.26)
Average transect maximum depth: feet	0.78	0.75	1.11	0.45	0.45	0.59
(meters)	(0.24)	(0.23)	(0.34)	(0.14)	(0.14)	(0.18)
Average depth: feet	0.52	0.42	0.65	0.26	0.29	0.39
(meters)	(0.16)	(0.13)	(0.20)	(0.08)	(0.09)	(0.12)
INSTREAM HABITAT:						
Dominant habitat type	RUN	RUN	RUN	RUN	RUN	RUN
Riffle repeat frequency (X average width)	6	8	10	6	12	7
% reach with instream cover	20	10	<5	0	5	<5
Dominant cover type	WDDEBR	OVRVEG	WDDEBR	NA	OVRVEG	BOULD
% reach with pool habitat	15	20	15	<5	20	<5
Dominant pool size class *	2	2	2	3	3	3
% reach with silt deposition	15	35	10	25	15	10
% reach with scoured substrate	5	<5	<5	30	<5	<5
% reach with vascular aquatic vegetation	-	<5	<5	-	5	<5
Dominant vascular aquatic vegetation type	-	SUBMERG	EMERG	-	EMERG	EMERG
SUBSTRATE COMPOSITION						
% clay	8	0	7	3	0	0
% silt	2	12	12	3	10	0
% sand	0	10	2	3	7	17
% gravel	56	46	55	17	43	47
% cobble	34	28	22	57	33	30
% boulder	0	4	1	17	7	6
% wood	0	0	0	0	0	0
% other	0	0	1	0	0	0
RIFFLE/RUN COARSE SUBSTRATE OBSERVATIONS:						
Periphyton colonization amount	-	HVY	MOD	-	MOD	MOD/HVY
Dominant periphyton form	-	FLMNT	FLMNT	-	NONFLMNT	NONFLMNT
Average embeddedness rating **	-	2.7	2.1	-	2.3	1.9
STREAMSIDE OBSERVATIONS:						
Average stream shading rating	-	3.3	2.9	-	4.7	2.6
Average streambank tree coverage rating	1.8	2.3	1.2	2.5	1.2	1.2
Average streambank shrub coverage rating	1.0	1.6	1.3	1.0	1.8	2.2
Average streambank herbaceous coverage rating	3.6	4.1	3.2	4.9	4.2	3.5
Average streambank instability rating	1.2	1.8	2.4	1.0	1.0	1.0

* Pool class rating: 1=large and deep pools; 2=pools of moderate size and depth; 3=small and shallow pools.

** 1-5 rating scale: 1 = 0-20%; 2 = 20-40%; 3 = 40-60%; 4 = 60-80%; 5 = 80-100%.

	BR1			BR2		
	'91	'92	'93	'91	'92	'93
STREAM REACH DIMENSIONS:						
Area: square feet	35821.5	38990.4	40010.8		15535.6	14930.74
(square meters)	(3327.9)	(3622.3)	(3717.1)	N	(1443.3)	(1387.1)
Length: feet	1149.9	1151.5	1151.5		757.8	757.8
(meters)	(350.5)	(351.0)	(351.0)	O	(231.0)	(231.0)
Flow: cubic feet per second	10.94	8.82	37.4		7.06	19.06
(cubic meters per second)	(0.31)	(0.25)	(1.06)	T	(0.2)	(0.54)
Average width: feet	28.8	33.8	34.7		20.6	19.7
(meters)	(8.8)	(10.3)	(10.6)		(6.3)	(6.0)
Maximum depth: feet	6.00	5.90	4.9+		4.9	4.9+
(meters)	(1.83)	(1.80)	(1.5+)		(1.5)	(1.5+)
Average transect maximum depth: feet	3.21	2.98	2.91		2.16	1.80
(meters)	(0.98)	(0.91)	(0.89)		(0.66)	(0.55)
Average depth: feet	1.93	1.74	1.77		1.37	1.08
(meters)	(0.59)	(0.53)	(0.54)		(0.42)	(0.33)
INSTREAM HABITAT:						
Dominant habitat type	POOL	POOL	POOL	E	POOL	POOL
Riffle repeat frequency (X average width)	13	17	17	V	9	10
% reach with instream cover	50	35	10	L	50	15
Dominant cover type	POOL	POOL	WDDEB	U	POOL	POOL
% reach with pool habitat	50	60	55	A	75	50
Dominant pool size class *	1	1	1	T	2	2
% reach with silt deposition	80	40	35	E	65	35
% reach with scoured substrate	<5	<5	<5	D	10	<5
% reach with vascular aquatic vegetation	-	15	5		0	0
Dominant vascular aquatic vegetation type	-	SUBMERG	SUBMERG		NA	NA
SUBSTRATE COMPOSITION						
% clay	4	2	8	N	2	0
% silt	34	30	16	O	30	24
% sand	8	20	24	T	10	8
% gravel	14	24	28		34	40
% cobble	34	20	14		18	24
% boulder	6	2	6		6	4
% wood	0	0	2		0	0
% other	0	2	2		0	0
RIFFLE/RUN COARSE SUBSTRATE OBSERVATIONS:						
Periphyton colonization amount	-	HVY	MOD	E	MOD	MOD
Dominant periphyton form	-	FLMNT	FLMNT	V	FLMNT	FLMNT
Average embeddedness rating **	-	2.1	2.7	A	2.8	3.3
				L		
STREAMSIDE OBSERVATIONS:				U		
Average stream shading rating	-	1.7	2.0	A	2.1	2.0
Average streambank tree coverage rating	1.9	1.7	1.3	T	1.4	1.2
Average streambank shrub coverage rating	1.0	1.2	2.0	E	1.2	1.6
Average streambank herbaceous coverage rating	3.2	3.9	3.4	D	3.6	3.8
Average streambank instability rating	2.1	2.0	2.4		3.6	2.2

* Pool class rating: 1=large and deep pools; 2=pools of moderate size and depth; 3=small and shallow pools.
** 1-5 rating scale: 1 = 0-20%; 2 = 20-40%; 3 = 40-60%; 4 = 60-80%; 5 = 80-100%.

APPENDIX II.

Summary of water quality data on an annual and quarterly basis; Water Year 1992.

Site SN1
ANNUAL

Parameters	Units	Number	Range	Quartile 25th	Quartile 50th	Quartile 75th	std. dev.	Mean
Temperature	degree C	52	1 - 19	5	10	15	5.62	10
Conductivity	umhos/cm	52	385 - 640	479	528	560	61.88	516
Dissolved Oxygen	mg/L	51	3 - 17	7	10	12	3.36	9
Turbidity	NTU	49	2.0 - 54.0	6.8	8.9	14.0	12.10	13.3
NO2+NO3-N	mg/L	52	1.0 - 3.2	1.5	1.9	2.3	0.50	1.9
Ammonium-N	mg/L	52	<0.1 - 0.6	<0.1	<0.1	<0.1	0.10	<0.1
Organic-N	mg/L	52	<0.1 - 1.8	<0.1	0.2	0.2	0.30	0.2
Fecal Bacteria	count 100 ml.	52	<10 - 11000	18	110	300	2000.73	735
Total P	mg/L	51	<0.1 - 0.5	<0.1	<0.1	0.2	0.11	0.1
BOD	mg/L	52	<1 - 7	<1	<1	1	1.23	1
IMA	ug/L	52	<0.10 - 0.66	<0.10	0.10	0.20	0.12	0.14
Nitrate-N	mg/L	52	0.88 - 5.29	1.49	2.03	2.40	3.44	2.06
Nitrite-N	mg/L	52	<0.01 - 0.34	0.03	0.05	0.10	0.31	0.08
Phosphorus	mg/L	52	<0.03 - 0.25	<0.03	<0.03	<0.03	0.25	0.03
Sulfate	mg/L	52	18.71 - 33.48	25.50	26.55	27.46	2.34	26.46
Fluoride	mg/L	52	0.10 - 0.78	0.15	0.21	0.37	0.14	0.26
Chloride	mg/L	52	5.59 - 8.35	6.01	6.33	6.73	0.61	6.46
Bromide	mg/L	52	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site SN1
Oct-Nov-Dec

Parameters	Units	Number	Range	Quartile 25th	Quartile 50th	Quartile 75th	std. dev.	Mean
Temperature	degree C	13	1 - 13	4	6	9	3.73	7
Conductivity	umhos/cm	13	425 - 620	520	560	590	66.12	536
Dissolved Oxygen	mg/L	13	3 - 14	7	9	13	3.73	10
Turbidity	NTU	11	3.6 - 12.0	5.0	6.8	7.8	2.47	6.7
NO2+NO3-N	mg/L	13	1.0 - 2.8	1.4	2.1	2.3	0.61	2.0
Ammonium-N	mg/L	13	<0.1 - 0.1	<0.1	<0.1	<0.1	0.01	<0.1
Organic-N	mg/L	13	<0.1 - 0.4	<0.1	0.2	0.2	0.11	0.2
Fecal Bacteria	count 100 ml.	13	10 - 860	20	60	140	230.53	145
Total P	mg/L	12	<0.1 - 0.3	<0.1	0.1	0.2	0.09	0.1
BOD	mg/L	13	<1 - 1	<1	<1	<1	0.22	<1
IMA	ug/L	13	<0.10 - 0.40	0.10	0.10	0.20	0.11	0.16
Nitrate-N	mg/L	13	0.93 - 2.80	1.34	2.29	2.65	3.27	2.08
Nitrite-N	mg/L	13	0.10 - 0.34	0.12	0.16	0.18	0.32	0.17
Phosphorus	mg/L	13	<0.03 - <0.03	<0.03	<0.03	<0.03	0.00	<0.03
Sulfate	mg/L	13	24.8 - 33.48	27.20	27.41	28.17	1.99	27.84
Fluoride	mg/L	13	0.11 - 0.43	0.15	0.19	0.35	0.12	0.24
Chloride	mg/L	13	5.59 - 7.24	6.19	6.54	7.02	0.57	6.50
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site SN1
Jan-Feb-Mar

	Units	Number	Range	Quartile 25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	1 - 10	3	4	5	2.59	4
Conductivity	umhos/cm	13	420 - 618	470	503	550	61.00	505
Dissolved Oxygen	mg/L	13	3 - 17	9	12	12	3.64	11
Turbidity	NTU	12	2.4 - 54.0	5.2	7.0	29.5	17.90	16.9
NO2+NO3-N	mg/L	13	1.8 - 2.7	2.2	2.3	2.4	0.26	2.3
Ammonium-N	mg/L	13	<0.1 - 0.6	<0.1	<0.1	<0.1	0.17	0.1
Organic-N	mg/L	13	<0.1 - 1.8	<0.1	0.2	0.3	0.53	0.4
Fecal Bacteria	count 100 ml.	13	<10.00 - 1300	<10	10	1300	411.27	227
Total P	mg/L	13	<0.1 - 0.5	<0.1	0.1	0.3	0.17	0.2
BOD	mg/L	13	<1 - 7	<1	1	2	2.10	2
IMA	ug/L	13	<0.10 - 0.27	<0.10	0.10	0.27	0.07	0.10
Nitrate-N	mg/L	13	1.72 - 5.29	2.01	2.17	2.72	4.35	2.57
Nitrite-N	mg/L	13	0.02 - 0.20	0.03	0.05	0.07	0.22	0.06
Phosphorus	mg/L	13	<0.03 - 0.25	<0.03	<0.03	0.08	0.44	0.07
Sulfate	mg/L	13	18.71 - 30.24	24.61	26.34	27.82	3.30	25.76
Fluoride	mg/L	13	0.10 - 0.78	0.13	0.15	0.31	0.20	0.25
Chloride	mg/L	13	5.81 - 8.35	6.28	6.63	7.08	0.71	6.75
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site SN1
Apr-May-June

	Units	Number	Range	Quartile 25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	8 - 18	10	13	16	3.46	13
Conductivity	umhos/cm	13	385 - 584	475	510	540	57.84	504
Dissolved Oxygen	mg/L	13	3 - 14	9	10	12	3.64	10
Turbidity	NTU	13	2.0 - 49.0	8.3	11.0	12.0	11.67	13.4
NO2+NO3-N	mg/L	13	1.6 - 3.2	1.7	1.9	1.9	0.48	2.0
Ammonium-N	mg/L	13	<0.1 - 0.3	<0.1	<0.1	<0.1	0.07	<0.1
Organic-N	mg/L	13	<0.1 - 0.5	<0.1	0.2	0.3	0.17	0.2
Fecal Bacteria	count 100 ml.	13	<10 - 3800	30	110	230	1023.52	419
Total P	mg/L	13	<0.1 - 0.3	<0.1	<0.1	<0.1	0.07	<0.1
BOD	mg/L	12	<1 - 2	<1	<1	1	0.45	<1
IMA	ug/L	13	<0.10 - 0.66	<0.10	0.11	0.32	0.18	0.20
Nitrate-N	mg/L	13	1.13 - 3.00	1.52	1.99	2.28	2.54	1.96
Nitrite-N	mg/L	13	<0.01 - 0.11	0.02	0.04	0.04	0.11	0.04
Phosphorus	mg/L	13	<0.03 - <0.03	<0.03	<0.03	<0.03	0.00	<0.03
Sulfate	mg/L	13	20.52 - 28.92	25.33	26.23	26.56	1.94	25.85
Fluoride	mg/L	13	0.11 - 0.27	0.14	0.18	0.21	0.05	0.18
Chloride	mg/L	13	5.64 - 8.10	6.22	6.49	6.82	0.60	6.57
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site SN1
July-Aug-Sept

	Units	Number	Range	Quartile 25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	10 - 19	15	16	17	2.59	16
Conductivity	umhos/cm	13	390 - 640	510	535	550	63.90	521
Dissolved Oxygen	mg/L	12	5 - 11	7	9	10	2.10	8
Turbidity	NTU	13	8.5 - 45.0	10.0	13.0	15.0	9.64	15.3
NO2+NO3-N	mg/L	13	1.1 - 1.8	1.4	1.5	1.5	0.17	1.5
Ammonium-N	mg/L	13	<0.1 - 0.3	<0.1	<0.1	<0.1	0.07	<0.1
Organic-N	mg/L	13	<0.1 - 0.6	<0.1	0.2	0.2	0.15	0.2
Fecal Bacteria	count 100 ml.	13	80 - 11000	170	210	2000	3578.82	2150
Total P	mg/L	13	<0.1 - 0.2	<0.1	0.1	0.1	0.04	<0.1
BOD	mg/L	13	<1 - 2	<1	<1	1	0.56	<1
IMA	ug/L	13	<0.10 - 0.37	<0.10	0.11	0.14	0.10	0.13
Nitrate-N	mg/L	13	0.88 - 2.68	1.38	1.52	1.74	1.98	1.61
Nitrite-N	mg/L	13	0.02 - 0.08	0.03	0.04	0.04	0.07	0.04
Phosphorus	mg/L	13	<0.03 - 0.04	<0.03	<0.03	<0.03	0.11	<0.03
Sulfate	mg/L	13	24.68 - 28.51	25.20	26.53	27.08	1.25	26.40
Fluoride	mg/L	13	0.14 - 0.48	0.28	0.40	0.46	0.11	0.36
Chloride	mg/L	13	5.76 - 6.34	5.84	5.92	6.11	0.21	6.00
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site BR1
ANNUAL

	Units	Number	Range	Quartile 25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	52	1 - 20	5	10	14	5.16	10
Conductivity	umhos/cm	52	336 - 620	499	540	562	65.56	524
Dissolved Oxygen	mg/L	52	3 - 15	8	10	12	2.78	10
Turbidity	NTU	49	0.5 - 64.0	5.4	7.5	9.5	12.63	11.1
NO2+NO3-N	mg/L	52	3.3 - 7.0	4.3	4.8	5.8	0.90	5.0
Ammonium-N	mg/L	52	<0.1- 2.1	<0.1	<0.1	<0.1	0.31	0.1
Organic-N	mg/L	52	<0.1 - 3.9	<0.1	0.2	0.4	0.66	0.4
Fecal Bacteria	count 100 ml.	52	<10 - 12000	10	85	275	6172.70	1995
Total P	mg/L	51	<0.1 - 1.2	<0.1	0.1	0.2	0.24	0.2
BOD	mg/L	51	<1 - 17	<1	<1	2	2.59	2
IMA	ug/L	51	<0.10 - 1.92	0.25	0.32	0.40	0.35	0.40
Nitrate-N	mg/L	52	2.40 - 7.18	4.18	4.86	5.75	5.09	4.90
Nitrite-N	mg/L	52	0.02 - 0.31	0.04	0.05	0.11	0.29	0.08
Phosphorus	mg/L	52	<0.03 - 0.39	<0.03	<0.03	<0.03	0.37	0.04
Sulfate	mg/L	52	13.35 - 32.18	20.35	20.84	21.66	2.38	21.00
Fluoride	mg/L	52	<0.04 - 0.5	0.13	0.20	0.33	0.14	0.23
Chloride	mg/L	52	5.53 - 11.90	9.14	9.75	10.23	1.10	9.65
Bromide	mg/L	52	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site BR1
Oct-Nov-Dec

	Units	Number	Range	Quartile 25th	Quartile 50th	Quartile 75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	2 - 12	4	7	9	3.52	7
Conductivity	umhos/cm	13	430 - 610	515	560	600	58.33	553
Dissolved Oxygen	mg/L	13	3 - 15	8	10	12	3.35	10
Turbidity	NTU	11	1.9 - 64.0	3.5	5.4	6.2	17.91	10.4
NO2+NO3-N	mg/L	13	3.3 - 7.0	3.9	5.9	6.4	1.34	5.4
Ammonium-N	mg/L	13	<0.1 - 0.2	<0.1	<0.1	<0.1	0.07	<0.1
Organic-N	mg/L	13	<0.1 - 0.9	<1.0	0.2	0.3	0.26	0.3
Fecal Bacteria	count 100 ml.	13	<10 - 12000	20	60	120	3305.10	1006
Total P	mg/L	12	<0.1 - 0.5	<0.1	0.2	0.2	0.13	0.2
BOD	mg/L	13	<1 - 3	<1	1	1	0.72	1
IMA	ug/L	13	0.10 - 0.37	0.20	0.30	0.30	0.08	0.25
Nitrate-N	mg/L	13	3.15 - 7.18	3.67	5.76	6.66	6.89	5.38
Nitrite-N	mg/L	13	0.11 - 0.31	0.13	0.16	0.18	0.27	0.17
Phosphorus	mg/L	13	<0.03 - <0.03	<0.03	<0.03	<0.03	0.00	<0.03
Sulfate	mg/L	13	17.29 - 23.13	20.39	20.60	21.41	1.40	20.69
Fluoride	mg/L	13	0.11 - 0.47	0.13	0.24	0.36	0.13	0.24
Chloride	mg/L	13	7.67 - 11.40	8.64	9.74	10.50	1.22	9.67
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site BR1
Jan-Feb-Mar

	Units	Number	Range	Quartile 25th	Quartile 50th	Quartile 75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	1 - 11	4	5	7	2.68	5
Conductivity	umhos/cm	13	360 - 620	480	540	560	74.75	516
Dissolved Oxygen	mg/L	13	5 - 14	8	10	12	2.67	10
Turbidity	NTU	13	5.3 - 47.0	5.7	9.0	16.0	15.75	16.4
NO2+NO3-N	mg/L	13	3.5 - 5.9	5.0	5.6	5.8	0.70	5.3
Ammonium-N	mg/L	13	<0.1 - 2.1	<0.1	<0.1	0.1	0.59	0.3
Organic-N	mg/L	13	<0.1 - 2.4	0.1	0.3	0.6	0.73	0.6
Fecal Bacteria	count 100 ml.	13	<10 - 5200	<10	10	290	1420.37	532
Total P	mg/L	13	<0.1 - 1.1	0.1	0.2	0.2	0.28	0.2
BOD	mg/L	13	<1 - 17	1	1	3	4.59	3
IMA	ug/L	12	0.20- 0.44	0.25	0.32	0.36	0.08	0.31
Nitrate-N	mg/L	13	3.58 - 6.39	5.06	5.69	6.18	3.60	5.46
Nitrite-N	mg/L	13	0.02 - 0.17	0.03	0.06	0.09	0.19	0.07
Phosphorus	mg/L	13	<0.03 - 0.39	<0.03	0.10	0.11	0.60	0.10
Sulfate	mg/L	13	13.35 - 28.88	20.04	21.39	21.77	2.84	20.35
Fluoride	mg/L	13	<0.04 - 0.50	<0.04	0.09	0.30	0.15	0.15
Chloride	mg/L	13	9.38 - 11.90	9.75	10.00	10.20	0.79	10.20
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site BR1
Apr-May-June

	Units	Number	Range	Quartile 25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	8 - 20	10	14	16	3.71	13
Conductivity	umhos/cm	13	336 - 566	480	525	540	68.95	497
Dissolved Oxygen	mg/L	13	4 - 14	8	10	12	3.06	10
Turbidity	NTU	12	0.5 - 10.0	5.7	7.0	7.9	3.05	6.4
NO2+NO3-N	mg/L	13	4.3 - 6.3	4.5	4.7	4.8	0.52	4.8
Ammonium-N	mg/L	13	<0.1 - <0.1	<0.1	<0.1	<0.1	0.00	<0.1
Organic-N	mg/L	13	<0.1 - 3.9	<0.1	0.2	0.6	1.04	0.5
Fecal Bacteria	count 100 ml.	13	<10 - 21000	10	90	190	5789.58	1740
Total P	mg/L	13	<0.1 - 1.2	<0.1	<0.1	<0.1	0.34	0.2
BOD	mg/L	12	<1 - 6	<1	<1	2	1.68	1
IMA	ug/L	13	<0.10 - 1.92	0.25	0.32	0.60	0.60	0.57
Nitrate-N	mg/L	13	2.40 - 6.21	4.33	4.58	4.94	4.59	4.40
Nitrite-N	mg/L	13	0.02 - 0.08	0.02	0.04	0.05	0.08	0.04
Phosphorus	mg/L	13	<0.03 - <0.03	<0.03	<0.03	<0.03	0.00	<0.03
Sulfate	mg/L	13	20.23 - 32.18	20.90	21.17	21.59	3.24	22.27
Fluoride	mg/L	13	0.12 - 0.26	0.13	0.16	0.19	0.04	0.17
Chloride	mg/L	13	5.53- 10.70	9.40	9.88	10.20	1.39	9.44
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site BR1
July-Aug-Sept

	Units	Number	Range	Quartile 25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	10 - 19	13	14	16	2.69	15
Conductivity	umhos/cm	13	395 - 590	515	540	560	51.67	531
Dissolved Oxygen	mg/L	13	7 - 14	9	9	12	2.15	10
Turbidity	NTU	13	5.0- 35.0	7.5	8.6	9.4	7.86	10.9
NO2+NO3-N	mg/L	13	3.9 - 4.8	4.2	4.3	4.5	0.29	4.3
Ammonium-N	mg/L	13	<0.1 - 0.4	<0.1	<0.1	<0.1	0.10	<0.1
Organic-N	mg/L	13	<0.1 - 0.8	<0.1	<0.1	0.3	0.26	0.2
Fecal Bacteria	count 100 ml.	13	10 - 28000	10	40	130	10203.02	4700
Total P	mg/L	13	<0.1 - 0.4	<0.1	0.1	0.2	0.13	0.2
BOD	mg/L	13	<1 - 3	<1	<1	<1	0.77	<1
IMA	ug/L	13	0.22 - 1.12	0.33	0.40	0.49	0.25	0.48
Nitrate-N	mg/L	13	3.68 - 4.96	3.90	4.56	4.74	2.17	4.36
Nitrite-N	mg/L	13	0.02 - 0.07	0.04	0.04	0.05	0.06	0.04
Phosphorus	mg/L	13	<0.03 - 0.18	<0.03	<0.03	<0.03	0.25	<0.03
Sulfate	mg/L	13	19.26 - 23.41	19.93	20.57	20.83	1.07	20.68
Fluoride	mg/L	13	0.17 - 0.49	0.27	0.40	0.46	0.10	0.36
Chloride	mg/L	13	8.30 - 11.00	8.84	9.13	9.31	0.78	9.27
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site NCC
ANNUAL

Parameters	Units	Number	Range	Quartile 25th	Quartile 50th	Quartile 75th	std. dev.	Mean
Temperature	degree C	51	1 - 18	4	10	15	5.45	9
Conductivity	umhos/cm	49	360 - 640	460	520	545	62.88	507
Dissolved Oxygen	mg/L	51	2 - 15	8	10	12	3.19	9
Turbidity	NTU	50	<0.1 - 49.0	3.5	5.6	9.6	9.06	8.7
NO2+NO3-N	mg/L	51	0.6 - 5.1	1.4	2.0	2.8	1.08	2.3
Ammonium-N	mg/L	51	<0.1 - 0.5	<0.1	<0.1	<0.1	0.09	<0.1
Fecal Bacteria	count 100 ml.	51	<10 - 5700	9	20	125	1069.60	397
Nitrate-N	mg/L	51	0.52 - 4.83	1.29	2.21	2.83	4.64	2.17
Nitrite-N	mg/L	51	<0.01 - 0.26	0.03	0.05	0.13	0.30	0.08
Phosphorus	mg/L	51	<0.03 - 0.17	<0.03	<0.03	<0.03	0.18	<0.03
Sulfate	mg/L	51	18.95 - 30.10	25.67	26.83	27.89	2.15	26.47
Fluoride	mg/L	51	<0.04 - 0.53	0.15	0.27	0.36	0.13	0.26
Chloride	mg/L	51	5.03 - 10.9	6.02	6.88	7.68	1.30	6.97
Bromide	mg/L	51	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site NCC
Oct-Nov-Dec

Parameters	Units	Number	Range	Quartile 25th	Quartile 50th	Quartile 75th	std. dev.	Mean
Temperature	degree C	13	2 - 13	3	6	10	4.20	7
Conductivity	umhos/cm	13	410 - 610	520	540	570	66.10	528
Dissolved Oxygen	mg/L	13	3 - 14	8	11	13	3.50	10
Turbidity	NTU	11	1.4 - 7.1	2.6	5.0	5.6	1.90	4.2
NO2+NO3-N	mg/L	13	0.6 - 4.9	1.1	2.6	3.9	1.50	2.6
Ammonium-N	mg/L	13	<0.1 - 0.2	<0.1	<0.1	<0.1	0.04	<0.1
Fecal Bacteria	count 100 ml.	13	<10 -400	<10	10	30	108.70	56
Nitrate-N	mg/L	13	0.52 - 4.83	1.13	2.64	3.88	6.80	2.60
Nitrite-N	mg/L	13	0.11 - 0.26	0.14	0.16	0.21	0.20	0.17
Phosphorus	mg/L	13	<0.03 - <0.03	<0.03	<0.03	<0.03	0.00	<0.03
Sulfate	mg/L	13	24.35 - 29.15	27.27	27.50	28.25	1.40	27.34
Fluoride	mg/L	13	0.12 - 0.47	0.16	0.26	0.36	0.10	0.27
Chloride	mg/L	13	5.07 - 10.9	5.77	7.35	8.70	1.90	7.47
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site NCC
Jan-Feb-Mar

Parameters	Units	Number	Range	Quartile 25th	Quartile 50th	Quartile 75th	std. dev.	Mean
Temperature	degree C	13	1 - 10	2	3	6	2.66	7
Conductivity	umhos/cm	13	360 - 570	430	483	530	65.56	482
Dissolved Oxygen	mg/L	13	5 - 15	8	11	12	3.18	10

Turbidity	NTU	12	2.4 - 49.0	2.8	7.3	18.5	15.68	14.1
NO2+NO3-N	mg/L	13	2.0 - 3.2	2.5	2.8	3.1	0.42	2.7
Ammonium-N	mg/L	13	<0.1 - 0.4	<0.1	<0.1	<0.1	0.11	0.1
Fecal Bacteria	count 100 ml.	13	<10 - 590	<10	10	80	161.58	78
Nitrate-N	mg/L	13	1.83 - 3.21	2.30	2.62	2.86	1.88	2.57
Nitrite-N	mg/L	13	<0.01 - 0.19	0.03	0.04	0.09	0.23	0.06
Phosphorus	mg/L	13	<0.03 - 0.17	<0.03	<0.03	0.09	0.31	0.06
Sulfate	mg/L	13	18.95 - 30.10	27.20	27.88	28.47	3.22	26.79
Fluoride	mg/L	13	<0.04 - 0.53	0.12	0.15	0.31	0.14	0.21
Chloride	mg/L	13	6.59 - 8.94	7.03	7.33	7.84	0.68	7.42
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site NCC
Apr-May-June

					Quartile			
	Units	Number	Range	25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	8 - 16	8	14	15	3.36	12
Conductivity	umhos/cm	13	395 - 566	470	510	546	52.52	501
Dissolved Oxygen	mg/L	13	3 - 14	7	10	12	3.46	9
Turbidity	NTU	13	0.5 - 9.0	4.0	5.5	6.0	2.23	5.4
NO2+NO3-N	mg/L	13	1.6 - 5.1	1.8	2.0	2.3	1.11	2.4
Ammonium-N	mg/L	13	<0.1 - 0.5	<0.1	<0.1	<0.1	0.12	<0.1
Fecal Bacteria	count 100 ml.	13	<10 - 1000	10	20	320	373.20	234
Nitrate-N	mg/L	13	1.10 - 4.58	1.54	2.24	2.65	4.29	2.20
Nitrite-N	mg/L	13	<0.01 - 0.11	0.02	0.02	0.05	0.16	0.04
Phosphorus	mg/L	13	<0.03 - 0.08	<0.03	<0.03	<0.03	0.10	<0.03
Sulfate	mg/L	13	20.05 - 27.90	25.14	25.86	26.58	1.93	25.52
Fluoride	mg/L	13	0.13 - 0.33	0.15	0.18	0.24	0.07	0.20
Chloride	mg/L	13	6.19 - 8.73	6.85	7.12	7.59	0.79	7.23
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site NCC
July-Aug-Sept

					Quartile			
	Units	Number	Range	25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	9 - 18	14	15	16	2.46	15
Conductivity	umhos/cm	11	410 - 640	490	535	540	64.27	516
Dissolved Oxygen	mg/L	13	2 - 11	8	9	10	2.53	8
Turbidity	NTU	12	2.8 - 20.0	7.5	10.0	13.5	5.10	10.8
NO2+NO3-N	mg/L	13	1.1 - 1.6	1.2	1.4	1.4	0.15	1.4
Ammonium-N	mg/L	13	<0.1 - 0.2	<0.1	<0.1	<0.1	0.04	<0.1
Fecal Bacteria	count 100 ml.	13	10 - 5700	30	50	2100	1919.23	1222
Nitrate-N	mg/L	13	0.90 - 2.06	1.16	1.26	1.34	1.25	1.32
Nitrite-N	mg/L	13	0.03 - 0.12	0.03	0.04	0.04	0.10	0.05
Phosphorus	mg/L	13	<0.03 - <0.03	<0.03	<0.03	<0.03	0.00	<0.03
Sulfate	mg/L	13	23.92 - 28.27	25.76	26.19	26.75	1.20	26.21

Fluoride	mg/L	13	0.18 - 0.49	0.29	0.41	0.47	0.10	0.37
Chloride	mg/L	13	5.03 - 6.40	5.54	5.66	6.05	0.37	5.76
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site SNWF
ANNUAL

				Quartile				
	Units	Number	Range	25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	51	0 - 18	5	10	14	5.36	9
Conductivity	umhos/cm	52	370 - 640	520	560	580	55.78	545
Dissolved Oxygen	mg/L	49	2 - 14	6	10	11	3.25	9
Turbidity	NTU	50	0.5 - 49.0	5.0	7.5	10.8	9.48	10.0
NO2+NO3-N	mg/L	52	2.0 - 3.6	2.5	2.6	2.8	0.28	2.6
Ammonium-N	mg/L	52	<0.1 - 3.3	<0.1	<0.1	<0.1	0.45	0.1
Fecal Bacteria	count 100 ml.	52	10 - 13000	138	340	2025	2722.83	1648
Nitrate-N	mg/L	52	1.85 - 4.08	2.46	2.71	2.93	1.83	2.73
Nitrite-N	mg/L	52	0.01 - 0.34	0.04	0.06	0.09	0.28	0.08
Phosphorus	mg/L	52	<0.03 - 0.17	<0.03	<0.03	<0.03	0.16	<0.03
Sulfate	mg/L	52	24.47 - 39.94	32.64	33.93	35.75	2.96	34.03
Fluoride	mg/L	52	0.09 - 0.57	0.14	0.23	0.35	0.13	0.26
Chloride	mg/L	52	5.79 - 8.75	7.08	7.29	7.73	0.55	7.35
Bromide	mg/L	52	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site SNWF
Oct-Nov-Dec

				Quartile				
	Units	Number	Range	25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	0 - 14	3	6	9	4.29	6
Conductivity	umhos/cm	13	370 - 640	520	560	590	74.40	548
Dissolved Oxygen	mg/L	13	3 - 13	10	11	12	3.31	10
Turbidity	NTU	11	2.4 - 8.5	4.1	5.5	7.5	2.02	5.6
NO2+NO3-N	mg/L	13	2.0 - 3.6	2.3	2.6	2.7	0.41	2.6
Ammonium-N	mg/L	13	<0.1 - 0.2	<0.1	<0.1	<0.1	0.04	<0.1
Fecal Bacteria	count 100 ml.	13	20 - 5900	110	230	380	1629.94	782
Nitrate-N	mg/L	13	1.85 - 3.81	2.52	2.84	2.97	2.29	2.77
Nitrite-N	mg/L	13	0.06 - 0.34	0.12	0.16	0.19	0.34	0.16
Phosphorus	mg/L	13	<0.03 - <0.03	<0.03	<0.03	<0.03	0.00	<0.03
Sulfate	mg/L	13	25.62 - 38.01	33.19	35.26	35.91	3.06	34.20
Fluoride	mg/L	13	0.09 - 0.55	0.13	0.15	0.33	0.11	0.23
Chloride	mg/L	13	6.19 - 8.75	6.62	7.13	7.53	0.72	7.26
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site SNWF
Jan-Feb-Mar

	Units	Number	Range	Quartile 25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	1 - 10	3	3	5	2.53	4
Conductivity	umhos/cm	13	460 - 625	500	550	560	45.62	536
Dissolved Oxygen	mg/L	11	2 - 14	7	9	12	3.70	9
Turbidity	NTU	13	2.3 - 49.0	3.6	5.0	7.5	14.60	11.1
NO2+NO3-N	mg/L	13	2.5 - 2.9	2.7	2.8	2.9	0.13	2.8
Ammonium-N	mg/L	13	<0.1 - <0.1	<0.1	<0.1	<0.1	0.00	<0.1
Fecal Bacteria	count 100 ml.	13	10 - 1500	70	210	300	388.27	290
Nitrate-N	mg/L	13	2.17 - 4.08	2.64	2.95	3.19	2.35	2.92
Nitrite-N	mg/L	13	0.01 - 0.12	0.04	0.06	0.09	0.15	0.06
Phosphorus	mg/L	13	<0.03 - 0.17	<0.03	<0.03	0.06	0.30	0.05
Sulfate	mg/L	13	32.45 - 39.94	32.83	33.77	35.45	2.37	34.76
Fluoride	mg/L	13	0.09 - 0.55	0.13	0.15	0.33	0.11	0.23
Chloride	mg/L	13	7.08 - 7.91	7.23	7.40	7.68	0.28	7.44
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site SNWF
Apr-May-June

	Units	Number	Range	Quartile 25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	12	8 - 17	10	12	16	3.28	13
Conductivity	umhos/cm	13	420 - 610	539	560	570	46.12	546
Dissolved Oxygen	mg/L	13	3 - 13	6	10	11	3.17	9
Turbidity	NTU	13	0.5 - 17.0	7.0	7.5	11.0	4.63	8.9
NO2+NO3-N	mg/L	13	2.4 - 3.3	2.4	2.6	2.6	0.32	2.7
Ammonium-N	mg/L	13	<0.1 - 3.3	<0.1	<0.1	<0.1	0.90	0.3
Fecal Bacteria	count 100 ml.	13	30 - 13000	160	1200	2200	3672.84	2387
Nitrate-N	mg/L	13	2.26 - 3.18	2.40	2.61	2.74	1.18	2.61
Nitrite-N	mg/L	13	0.02 - 0.08	0.04	0.04	0.06	0.07	0.05
Phosphorus	mg/L	13	<0.03 - <0.03	<0.03	<0.03	<0.03	0.00	<0.03
Sulfate	mg/L	13	24.47 - 39.79	32.36	32.84	35.68	3.86	33.59
Fluoride	mg/L	13	0.13 - 0.27	0.14	0.18	0.22	0.04	0.18
Chloride	mg/L	13	5.79 - 8.19	7.16	7.75	7.95	0.71	7.48
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site SNWF
July-Aug-Sept

	Units	Number	Range	Quartile 25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	9 - 18	13	15	15	2.57	14
Conductivity	umhos/cm	13	405 - 640	540	560	590	57.68	552
Dissolved Oxygen	mg/L	12	2 - 12	8	8	10	2.83	8
Turbidity	NTU	13	5.0 - 37.0	8.2	10.0	13.0	9.72	13.6

NO2+NO3-N	mg/L	13	2.3 - 2.7	2.4	2.5	2.6	0.13	2.5
Ammonium-N	mg/L	13	<0.1 - 0.2	<0.1	<0.1	<0.1	0.04	<0.1
Fecal Bacteria	count 100 ml.	13	110 - 9100	470	2100	5900	3061.54	3142
Nitrate-N	mg/L	13	2.26 - 2.82	2.58	2.67	2.75	0.81	2.63
Nitrite-N	mg/L	13	0.02 - 0.08	0.04	0.04	0.05	0.07	0.05
Phosphorus	mg/L	13	<0.03 - <0.03	<0.03	<0.03	<0.03	0.00	<0.03
Sulfate	mg/L	13	26.62 - 36.33	32.45	34.23	35.29	2.53	33.58
Fluoride	mg/L	13	0.20 - 0.57	0.28	0.40	0.46	0.11	0.39
Chloride	mg/L	13	6.37 - 8.12	7.05	7.18	7.35	0.40	7.22
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site SN3
ANNUAL

				Quartile				
	Units	Number	Range	25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	52	1 - 19	5	11	16	5.78	10
Conductivity	umhos/cm	51	405 - 660	508	550	579	59.23	544
Dissolved Oxygen	mg/L	52	2 - 15	5	9	12	3.75	9
Turbidity	NTU	50	0.5 - 77.0	3.6	5.5	8.1	11.12	8.2
NO2+NO3-N	mg/L	52	2.6 - 4.2	3.1	3.4	3.7	0.41	3.4
Ammonium-N	mg/L	52	<0.1 - 1.8	<0.1	<0.1	<0.1	0.25	0.1
Fecal Bacteria	count 100 ml.	52	<10 - 77000	10	70	203	10653.63	1692
Nitrate-N	mg/L	52	2.44 - 7.32	3.17	3.49	3.82	3.82	3.63
Nitrite-N	mg/L	52	<0.01 - 0.34	0.03	0.04	0.10	0.31	0.08
Phosphorus	mg/L	52	<0.03 - 0.64	<0.03	<0.03	<0.03	0.49	0.04
Sulfate	mg/L	52	18.14 - 37.45	23.84	25.55	28.04	3.68	26.06
Fluoride	mg/L	52	<.04 - 0.56	0.14	0.19	0.39	0.14	0.25
Chloride	mg/L	52	7.25 - 11.5	7.98	8.37	8.56	0.66	8.35
Bromide	mg/L	52	<0.06 - 0.17	<0.06	<0.06	<0.06	0.02	<0.06

Site SN3
Oct-Nov-Dec

				Quartile				
	Units	Number	Range	25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	2 - 15	4	6	10	4.12	7
Conductivity	umhos/cm	12	420 - 630	525	580	610	72.67	556
Dissolved Oxygen	mg/L	13	2 - 15	10	12	13	4.16	10
Turbidity	NTU	11	2.0 - 8.2	3.1	4.5	5.9	2.14	4.7
NO2+NO3-N	mg/L	13	2.7 - 3.8	2.9	3.5	3.5	0.41	3.3
Ammonium-N	mg/L	13	<0.1 - <0.1	<0.1	<0.1	<0.1	0.00	<0.1
Fecal Bacteria	count 100 ml.	13	<10 - 77000	10	70	100	21336.24	5989
Nitrate-N	mg/L	13	2.44 - 4.37	3.03	3.57	3.78	3.04	3.41
Nitrite-N	mg/L	13	0.08 - 0.34	0.10	0.16	0.20	0.33	0.17

Phosphorus	mg/L	13	<0.03 - <0.03	<0.03	<0.03	<0.03	0.00	<0.03
Sulfate	mg/L	13	22.59 - 32.81	25.01	27.25	28.11	2.85	27.11
Fluoride	mg/L	13	0.12 - 0.44	0.13	0.16	0.39	0.13	0.24
Chloride	mg/L	13	7.48 - 11.50	7.62	8.40	8.80	1.09	8.47
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site SN3
Jan-Feb-Mar

	Units	Number	Range	Quartile 25th	Quartile 50th	Quartile 75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	1 - 10	2	3	5	2.68	4
Conductivity	umhos/cm	13	425 - 600	505	510	550	48.86	525
Dissolved Oxygen	mg/L	13	3 - 14	5	11	13	4.04	10
Turbidity	NTU	13	1.7 - 77.0	3.4	5.5	14.0	20.43	13.4
NO2+NO3-N	mg/L	13	3.6 - 4.2	3.8	3.9	4.0	0.18	3.9
Ammonium-N	mg/L	13	<0.1 - 0.4	<0.1	<0.1	<0.1	0.13	0.1
Fecal Bacteria	count 100 ml.	13	<10 - 760	10	50	160	242.95	153
Nitrate-N	mg/L	13	3.25 - 5.86	3.66	4.03	4.46	3.64	4.18
Nitrite-N	mg/L	13	0.01 - 0.15	0.03	0.04	0.08	0.18	0.06
Phosphorus	mg/L	13	<0.03 - 0.64	<0.03	<0.03	0.07	0.92	0.10
Sulfate	mg/L	13	19.69 - 29.69	23.69	26.43	28.81	3.34	25.40
Fluoride	mg/L	13	<0.04 - 0.47	0.09	0.12	0.30	0.15	0.19
Chloride	mg/L	13	7.98 - 9.66	8.33	8.44	8.65	0.47	8.56
Bromide	mg/L	13	<0.06 - 0.17	<0.06	<0.06	<0.06	0.04	<0.06

Site SN3
Apr-May-June

	Units	Number	Range	Quartile 25th	Quartile 50th	Quartile 75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	8 - 18	10	13	16	3.55	13
Conductivity	umhos/cm	13	405 - 610	500	560	570	54.71	542
Dissolved Oxygen	mg/L	12	3 - 12	5	8	9	2.99	7
Turbidity	NTU	13	0.5 - 23.0	4.0	5.5	6.0	5.43	6.2
NO2+NO3-N	mg/L	13	2.6 - 3.8	3.2	3.3	3.5	0.34	3.3
Ammonium-N	mg/L	13	<0.1 - 1.8	<0.1	<0.1	<0.1	0.48	0.2
Fecal Bacteria	count 100 ml.	13	<10 - 1600	20	80	210	501.54	326
Nitrate-N	mg/L	13	2.46 - 3.82	3.21	3.41	3.50	1.46	3.32
Nitrite-N	mg/L	13	0.01 - 0.08	0.02	0.03	0.05	0.09	0.04
Phosphorus	mg/L	13	<0.03 - <0.03	<0.03	<0.03	<0.03	0.00	<0.03
Sulfate	mg/L	13	18.99 - 31.17	23.56	25.12	25.53	2.84	24.89
Fluoride	mg/L	13	0.12 - 0.25	0.15	0.17	0.19	0.04	0.17
Chloride	mg/L	13	7.25 - 8.82	7.86	8.34	8.75	0.50	8.22
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site SN3
July-Aug-Sept

Parameters	Units	Number	Range	Quartile 25th	50th	75th	std. dev.	Mean
Temperature	degree C	13	10 - 19	15	16	17	2.60	16
Conductivity	umhos/cm	13	405 - 660	550	550	570	61.07	555
Dissolved Oxygen	mg/L	13	2 - 12	6	8	10	3.06	8
Turbidity	NTU	13	3.5 - 14.0	6.3	7.4	10.0	3.06	7.9
NO2+NO3-N	mg/L	13	2.9 - 3.4	3.0	3.1	3.2	0.16	3.1
Ammonium-N	mg/L	13	<0.1 - <0.1	<0.1	<0.1	<0.1	0.00	<0.1
Fecal Bacteria	count 100 ml.	13	10 - 1200	40	110	440	405.03	300
Nitrate-N	mg/L	13	2.75 - 7.32	3.06	3.31	3.49	5.23	3.60
Nitrite-N	mg/L	13	<0.01 - 0.07	0.03	0.04	0.04	0.08	0.04
Phosphorus	mg/L	13	<0.03 - <0.03	<0.03	<0.03	<0.03	0.00	<0.03
Sulfate	mg/L	13	18.14 - 37.45	25.01	25.55	27.24	5.13	26.85
Fluoride	mg/L	13	0.15 - 0.56	0.29	0.40	0.47	0.11	0.39
Chloride	mg/L	13	7.43 - 8.53	7.97	8.23	8.39	0.32	8.16
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site BR2
ANNUAL

Parameters	Units	Number	Range	Quartile 25th	50th	75th	std. dev.	Mean
Temperature	degree C	13	0 - 17	4	10	13	6.07	8
Conductivity	umhos/cm	13	410 - 660	530	590	605	76.26	573
Dissolved Oxygen	mg/L	13	2 - 15	7	10	10	3.90	9
Turbidity	NTU	12	3.4 - 22.0	6.8	8.8	9.1	4.63	9.1
NO2+NO3-N	mg/L	13	6.0 - 9.9	8.3	8.8	9.0	1.02	8.7
Ammonium-N	mg/L	13	<0.1 - 1.2	<0.1	<0.1	<0.1	0.38	0.2
Fecal Bacteria	count 100 ml.	13	10 - 8400	40	330	490	769.16	451
Nitrate-N	mg/L	13	6.18 - 10.14	8.46	8.83	9.65	4.73	8.86
Nitrite-N	mg/L	13	0.03 - 0.24	0.04	0.07	0.11	0.26	0.08
Phosphorus	mg/L	13	<0.03 - 0.26	<0.03	<0.03	<0.03	0.37	0.03
Sulfate	mg/L	13	15.55 - 22.00	20.73	21.79	22.16	2.30	20.94
Fluoride	mg/L	13	0.11 - 0.80	0.15	0.28	0.40	0.19	0.32
Chloride	mg/L	13	6.44 - 15.90	13.80	14.80	15.50	2.63	13.83
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site BRSC
ANNUAL

Parameters	Units	Number	Range	Quartile 25th	50th	75th	std. dev.	Mean
Temperature	degree C	51	1 - 19	6	11	15	5.00	10
Conductivity	umhos/cm	51	380 - 710	540	595	630	78.98	582
Dissolved Oxygen	mg/L	51	3 - 17	7	10	12	41.34	10
Turbidity	NTU	51	0.5 - >100.0	4.9	7.5	18.0	24.78	17.5

NO2+NO3-N	mg/L	51	4.7 - 12.0	8.3	8.9	9.7	1.51	8.8
Ammonium-N	mg/L	51	<0.1 - 2.4	<0.1	<0.1	<0.1	0.56	0.3
Fecal Bacteria	count 100 ml.	51	<10 - 1100000	40	620	4450	215006.93	47773
Nitrate-N	mg/L	51	4.75 - 11.92	8.28	8.90	10.02	7.08	8.95
Nitrite-N	mg/L	51	0.02 - 0.37	0.05	0.08	0.17	0.35	0.11
Phosphorus	mg/L	51	<0.03 - 0.69	<0.03	<0.03	<0.03	0.71	0.06
Sulfate	mg/L	51	19.78 - 32.48	25.26	26.28	27.16	2.11	26.01
Fluoride	mg/L	51	<0.04 - 0.53	0.14	0.23	0.41	0.15	0.26
Chloride	mg/L	51	11.30 - 19.40	14.90	15.40	16.35	1.40	15.46
Bromide	mg/L	51	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site BRSC
Oct-Nov-Dec

				Quartile				
	Units	Number	Range	25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	2 - 15	5	7	9	3.71	8
Conductivity	umhos/cm	13	485 - 700	540	620	670	78.73	605
Dissolved Oxygen	mg/L	13	4 - 17	7	11	12	4.13	10
Turbidity	NTU	11	2.6 - 45.0	3.7	4.3	6.8	12.28	8.5
NO2+NO3-N	mg/L	13	7.0 - 12.0	8.4	10.0	11.0	1.49	9.7
Ammonium-N	mg/L	13	<0.1 - 1.0	<0.1	<0.1	<0.1	0.26	0.1
Fecal Bacteria	count 100 ml.	13	<10 - 1100000	40	210	1000	304085.51	89012
Nitrate-N	mg/L	13	6.55 - 11.92	8.65	10.20	10.97	7.94	9.61
Nitrite-N	mg/L	13	0.14 - 0.37	0.17	0.21	0.21	0.27	0.22
Phosphorus	mg/L	13	<0.03 - 0.69	<0.03	<0.03	<0.03	0.99	0.07
Sulfate	mg/L	13	23.31 - 28.33	26.69	27.15	27.84	1.41	26.91
Fluoride	mg/L	13	<0.04 - 0.49	0.13	0.23	0.42	0.17	0.27
Chloride	mg/L	13	14.70 - 17.30	14.90	16.20	16.90	1.03	16.01
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site BRSC
Jan-Feb-Mar

				Quartile				
	Units	Number	Range	25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	1 - 11	3	5	8	3.02	5
Conductivity	umhos/cm	13	380 - 680	495	575	620	94.64	551
Dissolved Oxygen	mg/L	12	4 - 14	6	12	13	3.78	10
Turbidity	NTU	13	3.5 - 50.0	4.7	10.0	21.0	13.48	14.6
NO2+NO3-N	mg/L	13	4.7 - 11.0	8.3	9.2	9.9	1.99	8.5
Ammonium-N	mg/L	13	<0.1 - 2.4	<0.1	<0.1	<0.1	0.86	0.6
Fecal Bacteria	count 100 ml.	13	<10 - 5900	<10	40	1200	1999.42	1252
Nitrate-N	mg/L	13	4.75 - 11.24	8.62	9.66	10.48	9.98	8.93
Nitrite-N	mg/L	13	0.02 - 0.19	0.04	0.06	0.11	0.22	0.08
Phosphorus	mg/L	13	<0.03 - 0.56	<0.03	<0.03	0.21	0.91	0.13
Sulfate	mg/L	13	19.78 - 32.48	26.28	26.64	27.50	3.31	26.40
Fluoride	mg/L	13	<0.04 - 0.51	0.08	0.16	0.35	0.16	0.21

Chloride	mg/L	13	11.30 - 16.30	13.90	15.30	15.70	1.62	14.67
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site BRSC
Apr-May-June

					Quartile			
	Units	Number	Range	25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	7 - 17	11	13	16	3.21	13
Conductivity	umhos/cm	13	470 - 710	540	612	630	65.50	589
Dissolved Oxygen	mg/L	13	3 - 15	8	11	12	3.92	10
Turbidity	NTU	13	0.5 - 99.0	5.9	7.5	9.5	27.81	17.3
NO2+NO3-N	mg/L	13	7.4 - 10.0	8.7	8.9	9.6	0.68	9.00
Ammonium-N	mg/L	13	<0.1 - 1.4	<0.1	<0.1	<0.1	0.39	0.2
Fecal Bacteria	count 100 ml.	13	<10 - 24000	70	1400	5400	7396.62	4421
Nitrate-N	mg/L	13	8.09 - 10.27	8.76	8.92	9.15	2.39	9.02
Nitrite-N	mg/L	13	0.02 - 0.10	0.04	0.06	0.08	0.11	0.06
Phosphorus	mg/L	13	<0.03 - <0.03	<0.03	<0.03	<0.03	0.00	<0.03
Sulfate	mg/L	13	21.71 - 27.39	25.18	25.49	26.25	1.60	25.28
Fluoride	mg/L	13	0.12 - 0.29	0.16	0.20	0.23	0.05	0.20
Chloride	mg/L	13	12.80 - 17.30	15.50	15.90	16.40	1.28	15.68
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site BRSC
July-Aug-Sept

					Quartile			
	Units	Number	Range	25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	12	11 - 19	14	15	17	2.35	15
Conductivity	umhos/cm	12	415 - 680	568	595	630	73.00	584
Dissolved Oxygen	mg/L	12	3 - 13	8	10	10	2.52	9
Turbidity	NTU	12	5.8 - >100.0	7.8	15.0	25.3	35.55	21.9
NO2+NO3-N	mg/L	12	5.4 - 9.0	8.0	8.5	8.6	1.12	8
Ammonium-N	mg/L	12	<0.1 - 1.3	<0.1	<0.1	0.2	0.49	0.3
Fecal Bacteria	count 100 ml.	12	160 - 1100000	673	3550	10900	315233.17	100460
Nitrate-N	mg/L	12	5.40 - 9.65	8.08	8.28	8.64	4.56	8.18
Nitrite-N	mg/L	12	0.04 - 0.17	0.05	0.06	0.08	0.17	0.07
Phosphorus	mg/L	12	<0.03 - 0.19	<0.03	<0.03	<0.03	0.30	0.03
Sulfate	mg/L	12	24.27 - 27.35	24.49	25.33	25.81	1.04	25.41
Fluoride	mg/L	12	0.20 - 0.53	0.29	0.41	0.47	0.10	0.38
Chloride	mg/L	12	14.40 - 19.40	14.90	15.05	15.25	1.41	15.50
Bromide	mg/L	12	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site SN2
ANNUAL

Parameters	Units	Number	Range	Quartile 25th	Quartile 50th	Quartile 75th	std. dev.	Mean
Temperature	degree C	12	1 - 15	4	8	13	4.78	8
Conductivity	umhos/cm	12	390 - 600	473	535	553	65.42	512
Dissolved Oxygen	mg/L	12	2 - 15	5	10	12	3.61	8
Turbidity	NTU	11	4.0 - 26.0	6.5	7.0	8.3	6.07	8.7
NO2+NO3-N	mg/L	12	1.9 - 3.4	2.1	2.4	2.7	0.53	2.5
Ammonium-N	mg/L	12	<0.1 - 0.4	<0.1	<0.1	<0.1	0.10	<0.1
Fecal Bacteria	count 100 ml.	12	<10 - 1700	18	150	400	475.83	309
Nitrate-N	mg/L	12	1.94 - 3.58	2.20	2.46	2.61	2.04	2.49
Nitrite-N	mg/L	12	0.02 - 0.22	0.03	0.05	0.08	0.29	0.07
Phosphorus	mg/L	12	<0.03 - 0.15	<0.03	<0.03	<0.03	0.20	<0.03
Sulfate	mg/L	12	22.45 - 29.85	26.95	27.65	28.88	2.04	27.48
Fluoride	mg/L	12	0.12 - 0.64	0.16	0.26	0.37	0.16	0.29
Chloride	mg/L	12	6.48 - 8.03	6.73	6.82	7.02	0.43	6.96
Bromide	mg/L	12	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site SNT
ANNUAL

Parameters	Units	Number	Range	Quartile 25th	Quartile 50th	Quartile 75th	std. dev.	Mean
Temperature	degree C	12	4 - 13	5	9	11	3.50	8
Conductivity	umhos/cm	12	380 - 625	454	510	540	58.26	515
Dissolved Oxygen	mg/L	12	3 - 13	7	10	10	3.35	9
Turbidity	NTU	11	4.0 - 10.0	5.6	6.5	7.3	8.14	6.5
NO2+NO3-N	mg/L	12	1.3 - 8.3	1.9	2.2	2.5	0.91	2.8
Ammonium-N	mg/L	12	<0.1 - <0.1	<0.1	<0.1	<0.1	0.00	<0.1
Fecal Bacteria	count 100 ml.	12	<10 - 3400	9	60	438	1004.80	423
Nitrate-N	mg/L	12	1.47 - 3.26	1.87	2.27	2.54	2.42	2.19
Nitrite-N	mg/L	12	<0.01 - 0.21	0.02	0.04	0.08	0.31	0.06
Phosphorus	mg/L	12	<0.03 - <0.03	<0.03	<0.03	<0.03	0.00	<0.03
Sulfate	mg/L	12	21.34 - 26.26	22.40	23.80	25.36	5.27	23.68
Fluoride	mg/L	12	0.12 - 0.64	0.16	0.26	0.37	0.13	0.30
Chloride	mg/L	12	6.14 - 7.74	6.61	7.08	7.32	0.61	7.03
Bromide	mg/L	12	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

APPENDIX III.

Summary of water quality data on an annual and quarterly basis; Water Year 1993.

Site SN1
ANNUAL

	Units	Number	Range	Quartile 25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	52	0 - 19	4	8	13	5.73	8
Conductivity	umhos/cm	49	260 - 650	465	510	570	82.72	512
Dissolved Oxygen	mg/L	51	3 - 14	8	10	11	2.71	9
Turbidity	NTU	51	0.5 - >100	7.0	9.0	14.5	19.13	15.4
NO2+NO3-N	mg/L	52	1.3 - 4.3	2.2	2.4	3.0	0.64	2.5
Ammonium-N	mg/L	52	<0.1 - 0.9	<0.1	<0.1	0.3	0.22	0.2
Organic-N	mg/L	52	<0.1 - 2.5	<0.1	0.2	0.4	0.47	0.3
Fecal Bacteria	count 100 ml.	52	<10 - 14000	20	78	530	2334.47	929
Total P	mg/L	52	<0.1 - 0.8	<0.1	0.1	0.3	0.17	0.2
BOD	mg/L	52	<1 - 8	<1	<1	1	1.58	1
IMA	ug/L	52	<0.10 - 10.56	<0.10	<0.10	0.22	1.47	0.40
Nitrate-N	mg/L	52	1.59 - 4.94	2.22	2.58	2.92	2.56	2.58
Nitrite-N	mg/L	52	<0.01 - 0.26	0.01	0.02	0.04	0.16	0.03
Phosphorus	mg/L	52	<0.03 - 0.14	<0.03	<0.03	<0.03	0.12	<0.03
Sulfate	mg/L	52	12.03 - 35.42	21.47	23.90	28.56	4.87	24.58
Fluoride	mg/L	52	<0.04 - 0.41	0.11	0.18	0.39	0.13	0.23
Chloride	mg/L	52	4.56 - 13.59	6.52	6.85	7.41	1.20	6.98
Bromide	mg/L	52	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site SN1
Oct-Nov-Dec

	Units	Number	Range	Quartile 25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	1 - 13	4	6	8	3.28	6
Conductivity	umhos/cm	12	455 - 600	485	510	544	42.14	513
Dissolved Oxygen	mg/L	13	3 - 13	8	10	11	2.95	9
Turbidity	NTU	13	5.5 - 48.0	8.5	9.0	13.0	10.99	12.9
NO2+NO3-N	mg/L	13	1.3 - 2.4	1.6	1.9	2.2	0.40	1.9
Ammonium-N	mg/L	13	<0.1 - <0.1	<0.1	<0.1	<0.1	0.00	<0.1
Organic-N	mg/L	13	<0.1 - 0.6	<0.1	<0.1	0.2	0.19	0.2
Fecal Bacteria	count 100 ml.	13	10 - 520	20	50	70	135.37	86
Total P	mg/L	13	<0.1 - 0.5	<0.1	<0.1	0.2	0.16	0.2
BOD	mg/L	13	<1 - 2	<1	<1	<1	0.43	1
IMA	ug/L	13	<0.10 - 0.28	<0.10	<0.10	<0.10	0.06	<0.10
Nitrate-N	mg/L	13	1.70 - 4.94	2.14	2.55	2.91	4.00	2.68
Nitrite-N	mg/L	13	<0.01 - 0.26	0.03	0.04	0.05	0.29	0.05
Phosphorus	mg/L	13	<0.03 - <0.03	<0.03	<0.03	<0.03	0.00	<0.03
Sulfate	mg/L	13	26.53 - 35.42	27.39	29.07	31.12	2.64	29.46
Fluoride	mg/L	13	<0.04 - 0.40	0.33	0.34	0.39	0.10	0.33
Chloride	mg/L	13	6.52 - 8.23	6.84	7.31	7.63	0.56	7.23
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site SN1
Jan-Feb-Mar

				Quartile				
	Units	Number	Range	25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	0 - 4	1	1	2	1.33	1
Conductivity	umhos/cm	13	260 - 570	440	490	510	88.60	461
Dissolved Oxygen	mg/L	12	3 - 14	9	11	12	3.17	10
Turbidity	NTU	13	0.5 - 70.0	5.7	7.0	12.0	20.34	14.7
NO2+NO3-N	mg/L	13	1.6 - 2.4	2.1	2.3	2.4	0.25	2.2
Ammonium-N	mg/L	13	<0.1 - 0.9	<0.1	<0.1	0.20	0.35	0.3
Organic-N	mg/L	13	<0.1 - 2.5	<0.1	<0.1	1.1	0.82	0.6
Fecal Bacteria	count 100 ml.	13	<10 - 600	<10	10	75	184.82	110
Total P	mg/L	13	<0.1 - 0.8	<0.1	0.1	0.2	0.22	0.2
BOD	mg/L	13	<1 - 8	<1	<1	2	2.88	2
IMA	ug/L	13	<0.10 - 0.30	<0.10	<0.10	<0.10	0.09	<0.10
Nitrate-N	mg/L	13	1.59 - 2.96	1.96	2.21	2.47	1.84	2.21
Nitrite-N	mg/L	13	0.01 - 0.04	0.02	0.02	0.03	0.04	0.02
Phosphorus	mg/L	13	<0.03 - 0.14	<0.03	<0.03	<0.03	0.23	0.03
Sulfate	mg/L	13	12.03 - 30.58	27.36	28.13	29.03	6.15	25.73
Fluoride	mg/L	13	0.10 - 0.41	0.14	0.39	0.40	0.14	0.29
Chloride	mg/L	13	4.56 - 8.15	6.59	6.82	6.95	0.98	6.60
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site SN1
Apr-May-June

				Quartile				
	Units	Number	Range	25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	7 - 15	8	11	13	3.15	11
Conductivity	umhos/cm	11	400 - 565	430	445	490	53.25	464
Dissolved Oxygen	mg/L	13	3 - 12	7	10	11	2.80	9
Turbidity	NTU	12	2.6 - >100	8.8	10.5	17.3	30.49	22.6
NO2+NO3-N	mg/L	13	2.2 - 3.6	2.4	2.6	2.7	0.45	2.7
Ammonium-N	mg/L	13	<0.1 - 0.5	<0.1	0.2	0.3	0.15	0.2
Organic-N	mg/L	13	0.1 - 1.0	0.2	0.4	0.5	0.30	0.4
Fecal Bacteria	count 100 ml.	13	<10 - 6400	30	150	580	2191.57	1162
Total P	mg/L	13	<0.1 - 0.4	0.2	0.2	0.4	0.12	0.3
BOD	mg/L	13	<1 - 2	<1	<1	<1	0.43	1
IMA	ug/L	13	<0.10 - 10.56	<0.10	0.11	0.44	2.88	1.02
Nitrate-N	mg/L	13	2.07 - 3.13	2.36	2.46	2.84	1.66	2.60
Nitrite-N	mg/L	13	<0.01 - 0.04	<0.01	0.01	0.03	0.05	0.02
Phosphorus	mg/L	13	<0.03 - <0.03	<0.03	<0.03	<0.03	0.00	<0.03
Sulfate	mg/L	13	19.36 - 24.81	20.38	21.60	22.91	1.65	21.71
Fluoride	mg/L	13	<0.08 - 0.35	0.09	0.11	0.18	0.08	0.15
Chloride	mg/L	13	5.83 - 7.78	6.03	6.28	6.45	0.58	6.39
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site SN1
July-Aug-Sept

	Units	Number	Range	Quartile 25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	10 - 19	14	15	16	2.45	15
Conductivity	umhos/cm	13	510 - 650	588	605	629	38.23	604
Dissolved Oxygen	mg/L	13	6 - 12	8	9	10	1.86	9
Turbidity	NTU	13	5.3 - 34.0	7.0	9.0	15.0	8.12	11.9
NO2+NO3-N	mg/L	13	2.9 - 4.3	3.0	3.2	3.3	0.37	3.3
Ammonium-N	mg/L	13	<0.1 - 0.6	0.2	0.2	0.4	0.18	0.3
Organic-N	mg/L	13	<0.1 - 0.4	<0.1	0.2	0.3	0.13	0.2
Fecal Bacteria	count 100 ml.	13	160 - 14000	310	620	3300	3813.77	2356
Total P	mg/L	13	<0.1 - 0.6	<0.1	0.1	0.2	0.17	0.2
BOD	mg/L	13	<1 - 2	<1	<1	1	0.55	1
IMA	ug/L	13	<0.10 - 1.87	0.13	0.18	0.33	0.53	0.40
Nitrate-N	mg/L	13	2.30 - 3.13	2.72	2.89	2.98	1.01	2.84
Nitrite-N	mg/L	13	<0.01 - 0.05	<0.01	0.01	0.05	0.10	0.02
Phosphorus	mg/L	13	<0.03 - <0.03	<0.03	<0.03	<0.03	0.00	<0.03
Sulfate	mg/L	13	15.91 - 25.18	20.35	22.01	22.65	2.47	21.40
Fluoride	mg/L	13	0.07 - 0.31	0.10	0.13	0.15	0.07	0.15
Chloride	mg/L	13	6.52 - 13.59	6.86	7.31	7.66	1.83	7.70
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site BR1
ANNUAL

	Units	Number	Range	Quartile 25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	52	0 - 20	5	8	13	5.18	9
Conductivity	umhos/cm	50	285 - 660	496	545	590	74.40	539
Dissolved Oxygen	mg/L	51	4 - 17	8	10	11	2.94	10
Turbidity	NTU	51	0.7 - >100	6.1	8.0	11.5	22.91	14.9
NO2+NO3-N	mg/L	52	1.9 - 9.0	5.2	5.7	6.6	1.15	5.7
Ammonium-N	mg/L	52	<0.1 - 1.9	<0.1	<0.1	0.2	0.31	0.2
Organic-N	mg/L	51	<0.1 - 14.0	<0.1	0.3	0.4	1.96	0.6
Fecal Bacteria	count 100 ml.	52	<10 - 160000	<10	85	1025	22379.31	4895
Total P	mg/L	51	<0.1 - 1.0	<0.1	0.2	0.3	0.24	0.2
BOD	mg/L	52	<1 - 10	<1	<1	1	1.84	1
IMA	ug/L	52	<0.10 - 17.12	0.21	0.27	0.38	2.34	0.67
Nitrate-N	mg/L	52	1.93 - 7.47	5.31	5.95	6.48	4.32	5.85
Nitrite-N	mg/L	52	<0.01 - 0.21	0.01	0.03	0.04	0.14	0.03
Phosphorus	mg/L	52	<0.03 - 0.29	<0.03	<0.03	<0.03	0.23	<0.03
Sulfate	mg/L	52	10.63 - 24.75	18.77	20.50	21.57	2.60	20.10
Fluoride	mg/L	52	0.08 - 0.47	0.14	0.28	0.39	0.13	0.26
Chloride	mg/L	52	5.79 - 13.72	10.29	10.90	11.77	1.31	10.95
Bromide	mg/L	52	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site BR1
Oct-Nov-Dec

	Units	Number	Range	Quartile 25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	3 - 13	5	7	8	2.66	7
Conductivity	umhos/cm	13	475 - 590	510	520	550	34.09	526
Dissolved Oxygen	mg/L	13	4 - 17	9	10	12	3.31	10
Turbidity	NTU	13	4.9 - 11.0	6.5	8.0	9.5	1.91	7.9
NO2+NO3-N	mg/L	13	4.1 - 9.0	4.4	5.1	5.9	1.31	5.4
Ammonium-N	mg/L	13	<0.1 - <0.1	<0.1	<0.1	<0.1	0.00	<0.1
Organic-N	mg/L	13	<0.1 - 0.5	<0.1	<0.1	0.2	0.17	0.2
Fecal Bacteria	count 100 ml.	13	<10 - 570	<10	10	10	155.26	57
Total P	mg/L	12	<0.1 - 0.6	<0.1	0.2	0.3	0.20	0.2
BOD	mg/L	13	<1 - 2	<1	<1	<1	0.43	1
IMA	ug/L	13	<0.10 - 0.38	0.19	0.22	0.26	0.08	0.22
Nitrate-N	mg/L	13	4.44 - 7.47	5.28	6.38	6.55	4.46	6.01
Nitrite-N	mg/L	13	<0.01 - 0.21	0.03	0.04	0.05	0.23	0.05
Phosphorus	mg/L	13	<0.03 - <0.03	<0.03	<0.03	<0.03	0.00	<0.03
Sulfate	mg/L	13	20.38 - 24.75	21.70	22.62	23.57	1.44	22.70
Fluoride	mg/L	13	0.28 - 0.42	0.32	0.39	0.41	0.06	0.36
Chloride	mg/L	13	10.06 - 12.47	10.37	10.68	10.91	0.61	10.78
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site BR1
Jan-Feb-Mar

	Units	Number	Range	Quartile 25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	0 - 5	2	3	4	1.55	3
Conductivity	umhos/cm	13	285 - 650	480	515	580	91.86	515
Dissolved Oxygen	mg/L	13	4 - 15	7	11	12	3.55	10
Turbidity	NTU	13	0.7 - >100	5.0	6.2	8.3	34.26	19.3
NO2+NO3-N	mg/L	13	1.9 - 5.9	5.4	5.5	5.7	1.08	5.2
Ammonium-N	mg/L	13	<0.1 - 1.9	<0.1	<0.1	0.2	0.57	0.3
Organic-N	mg/L	12	<0.1 - 14.0	<0.1	<0.1	0.4	3.99	1.4
Fecal Bacteria	count 100 ml.	13	<10 - 1100	<10	<10	20	314.23	125
Total P	mg/L	13	<0.1 - 1	<0.1	<0.1	0.2	0.31	0.2
BOD	mg/L	13	<1 - 10	<1	<1	1	3.34	2
IMA	ug/L	13	<0.10 - 0.31	0.19	0.21	0.25	0.06	0.22
Nitrate-N	mg/L	13	1.93 - 6.34	5.34	5.66	6.04	5.28	5.37
Nitrite-N	mg/L	13	0.01 - 0.06	0.02	0.02	0.03	0.06	0.03
Phosphorus	mg/L	13	<0.03 - 0.29	<0.03	<0.03	<0.03	0.44	0.05
Sulfate	mg/L	13	10.63 - 22.75	20.54	21.14	21.46	3.12	20.22
Fluoride	mg/L	13	0.11 - 0.41	0.14	0.39	0.40	0.14	0.29
Chloride	mg/L	13	5.79 - 13.37	10.07	10.37	10.83	1.72	10.45
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site BR1
Apr-May-June

	Units	Number	Range	Quartile 25th	Quartile 50th	Quartile 75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	6 - 15	8	10	13	3.07	11
Conductivity	umhos/cm	11	439 - 600	455	480	525	54.10	494
Dissolved Oxygen	mg/L	12	4 - 15	8	10	11	3.29	9
Turbidity	NTU	12	1.0 - >100	7.6	9.1	12.8	29.44	18.4
NO2+NO3-N	mg/L	13	4.5 - 6.9	5.1	5.5	5.7	0.73	5.5
Ammonium-N	mg/L	13	<0.1 - 0.6	<0.1	0.2	0.4	0.19	0.2
Organic-N	mg/L	13	<0.1 - 2.0	0.2	0.4	0.7	0.65	0.6
Fecal Bacteria	count 100 ml.	13	<10 - 20005	90	300	3700	5574.75	2852
Total P	mg/L	13	<0.1 - 1.0	0.1	0.2	0.3	0.25	0.3
BOD	mg/L	13	<1 - 4	<1	<1	4	0.99	1
IMA	ug/L	13	0.19 - 17.12	0.25	0.37	0.56	4.64	1.73
Nitrate-N	mg/L	13	4.81 - 6.93	5.15	5.25	5.56	2.53	5.42
Nitrite-N	mg/L	13	<0.01 - 0.20	0.01	0.02	0.03	0.06	0.02
Phosphorus	mg/L	13	<0.03 - <0.03	<0.03	<0.03	<0.03	0.00	<0.03
Sulfate	mg/L	13	15.55 - 21.90	18.35	19.02	19.94	1.84	18.93
Fluoride	mg/L	13	0.08 - 0.33	0.09	0.11	0.18	0.08	0.15
Chloride	mg/L	13	8.84 - 12.38	9.78	10.92	11.17	1.14	10.55
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site BR1
July-Aug-Sept

	Units	Number	Range	Quartile 25th	Quartile 50th	Quartile 75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	10 - 20	14	14	17	2.75	15
Conductivity	umhos/cm	13	540 - 660	580	630	648	39.40	616
Dissolved Oxygen	mg/L	13	7 - 13	9	10	10	1.45	10
Turbidity	NTU	13	3.6 - 42.0	7.0	12.0	17.0	11.38	14.2
NO2+NO3-N	mg/L	13	5.7 - 8.0	6.7	6.9	7.0	0.54	6.9
Ammonium-N	mg/L	13	<0.1 - 0.4	0.2	0.3	0.3	0.10	0.3
Organic-N	mg/L	13	<0.1 -1.4	0.3	0.3	0.4	0.33	0.4
Fecal Bacteria	count 100 ml.	13	140 - 160000	490	1700	7600	43539.49	16548
Total P	mg/L	13	<0.1 - 0.6	0.2	0.2	0.3	0.19	0.3
BOD	mg/L	13	<1 - 4	<1	<1	1	0.95	1
IMA	ug/L	13	0.26 - 1.16	0.32	0.42	0.52	0.28	0.51
Nitrate-N	mg/L	13	5.96 - 7.22	6.38	6.60	6.86	1.69	6.60
Nitrite-N	mg/L	13	<0.01 - 0.08	<0.01	0.01	0.06	0.12	0.03
Phosphorus	mg/L	13	<0.03 - <0.03	<0.03	<0.03	<0.03	0.00	<0.03
Sulfate	mg/L	13	16.01 - 20.91	18.07	19.04	19.31	1.43	18.53
Fluoride	mg/L	13	0.10 - 0.47	0.12	0.21	0.27	0.12	0.22
Chloride	mg/L	13	9.99 - 13.72	11.37	12.05	12.70	0.99	12.01
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site NCC
ANNUAL

Parameters	Units	Number	Range	Quartile 25th	50th	75th	std. dev.	Mean
Temperature	degree C	51	0 - 18	3	8	14	5.79	8
Conductivity	umhos/cm	49	310 - 635	468	520	555	77.90	515
Dissolved Oxygen	mg/L	51	2 - 14	8	10	12	2.54	10
Turbidity	NTU	50	0.5 - 80.0	4.3	7.3	12.0	16.84	13.1
NO2+NO3-N	mg/L	51	1.0 - 6.3	2.5	3.2	3.9	1.24	3.2
Ammonium-N	mg/L	52	<0.1 - 0.6	<0.1	<0.1	0.3	0.15	0.2
Fecal Bacteria	count 100 ml.	52	<10 - 8200	10	40	313	1239.81	433
Nitrate-N	mg/L	52	1.22 - 5.80	2.58	3.08	3.84	5.03	3.25
Nitrite-N	mg/L	52	<0.01 - 0.06	0.01	0.02	0.04	0.08	0.03
Phosphorus	mg/L	52	<0.03 - <0.03	<0.03	<0.03	<0.03	0.00	<0.03
Sulfate	mg/L	52	14.73 - 34.92	21.80	25.03	29.34	4.84	25.07
Fluoride	mg/L	52	0.05 - 0.53	0.13	0.21	0.39	0.13	0.25
Chloride	mg/L	52	5.92 - 9.74	7.06	7.75	8.07	0.87	7.68
Bromide	mg/L	52	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site NCC
Oct-Nov-Dec

Parameters	Units	Number	Range	Quartile 25th	50th	75th	std. dev.	Mean
Temperature	degree C	13	1 - 14	4	6	8	3.54	6
Conductivity	umhos/cm	12	460 - 620	498	515	544	43.09	528
Dissolved Oxygen	mg/L	12	6 - 14	7	10	12	2.77	10
Turbidity	NTU	12	0.8 - 12.0	4.1	5.6	7.3	3.20	6.1
NO2+NO3-N	mg/L	13	1.0 - 3.6	1.2	1.5	3.0	1.02	2.1
Ammonium-N	mg/L	13	<0.1 - <0.1	<0.1	<0.1	<0.1	0.00	<0.1
Fecal Bacteria	count 100 ml.	13	<10 - 70	<10	<10	10	22.50	17
Nitrate-N	mg/L	13	1.22 - 4.38	1.48	2.59	3.52	5.08	2.60
Nitrite-N	mg/L	13	<0.01 - 0.06	0.03	0.04	0.04	0.08	0.03
Phosphorus	mg/L	13	<0.03 - <0.03	<0.03	<0.03	<0.03	0.00	<0.03
Sulfate	mg/L	13	25.82 - 32.96	27.59	29.29	30.93	2.30	29.18
Fluoride	mg/L	13	0.28 - 0.42	0.34	0.40	0.41	0.05	0.37
Chloride	mg/L	13	6.51 - 9.74	7.31	7.75	8.90	1.06	7.97
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site NCC
Jan-Feb-Mar

Parameters	Units	Number	Range	Quartile 25th	50th	75th	std. dev.	Mean
Temperature	degree C	13	0 - 3	1	1	1	0.99	1
Conductivity	umhos/cm	13	310 - 540	445	495	510	74.39	464
Dissolved Oxygen	mg/L	13	2 - 13	9	10	11	2.98	10

Turbidity	NTU	13	0.5 - 80.0	3.5	6.2	9.6	27.38	17.4
NO2+NO3-N	mg/L	13	2.1 - 3.3	2.4	2.5	2.7	0.32	2.6
Ammonium-N	mg/L	13	<0.1 - 0.6	<0.1	<0.1	<0.1	0.16	0.1
Fecal Bacteria	count 100 ml.	13	<10 - 1190	10	10	120	330.40	154
Nitrate-N	mg/L	13	2.09 - 3.52	2.35	2.60	2.78	1.87	2.63
Nitrite-N	mg/L	13	0.01 - 0.06	0.02	0.02	0.03	0.06	0.03
Phosphorus	mg/L	13	<0.03 - <0.03	<0.03	<0.03	<0.03	0.00	<0.03
Sulfate	mg/L	13	14.73 - 30.81	26.49	29.13	29.81	5.53	26.66
Fluoride	mg/L	13	0.12 - 0.43	0.16	0.39	0.40	0.13	0.30
Chloride	mg/L	13	5.92 - 8.82	6.93	7.10	8.01	0.82	7.41
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site NCC
Apr-May-June

	Units	Number	Range	25th	Quartile 50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	6 - 18	8	11	13	3.57	11
Conductivity	umhos/cm	11	380 - 555	413	460	530	63.85	464
Dissolved Oxygen	mg/L	13	3 - 13	10	11	12	2.96	10
Turbidity	NTU	12	1.2 - 50.0	7.5	11.0	23.5	15.31	17.7
NO2+NO3-N	mg/L	12	2.7 - 6.3	3.4	4.2	5.1	1.11	4.3
Ammonium-N	mg/L	13	<0.1 - 0.3	<0.1	<0.1	0.2	0.10	0.1
Fecal Bacteria	count 100 ml.	13	<10 - 1600	20	110	360	455.81	299
Nitrate-N	mg/L	13	2.52 - 5.80	3.67	4.16	4.97	4.41	4.22
Nitrite-N	mg/L	13	<0.01 - 0.06	0.01	0.01	0.02	0.07	0.02
Phosphorus	mg/L	13	<0.03 - <0.03	<0.03	<0.03	<0.03	0.00	<0.03
Sulfate	mg/L	13	17.23 - 25.26	20.61	21.25	22.26	2.09	21.55
Fluoride	mg/L	13	0.09 - 0.30	0.11	0.13	0.21	0.06	0.16
Chloride	mg/L	13	6.90 - 9.51	7.10	7.92	8.32	0.85	7.89
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site NCC
July-Aug-Sept

	Units	Number	Range	25th	Quartile 50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	12	9 - 18	14	15	16	2.26	15
Conductivity	umhos/cm	13	540 - 635	580	608	622	32.50	597
Dissolved Oxygen	mg/L	13	6 - 12	8	9	10	1.41	9
Turbidity	NTU	13	3.2 - 32.0	5.4	7.0	13.0	9.40	10.9
NO2+NO3-N	mg/L	13	3.1 - 5.8	3.4	3.6	4.1	0.83	3.9
Ammonium-N	mg/L	13	0.2 - 0.5	0.2	0.4	0.4	0.10	0.3
Fecal Bacteria	count 100 ml.	13	30 - 8200	170	310	990	2276.02	1262
Nitrate-N	mg/L	13	2.71 - 5.80	2.94	3.20	3.80	4.29	3.55
Nitrite-N	mg/L	13	<0.01 - 0.06	<0.01	0.01	0.05	0.10	0.03
Phosphorus	mg/L	13	<0.03 - <0.03	<0.03	<0.03	<0.03	0.00	<0.03
Sulfate	mg/L	13	17.32 - 34.92	19.77	23.09	23.49	4.44	22.90

Fluoride	mg/L	13	0.12 - 0.43	0.16	0.39	0.40	0.13	0.30
Chloride	mg/L	13	5.92 - 8.82	6.93	7.10	8.01	0.82	7.41
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site SNWF
ANNUAL

				Quartile				
	Units	Number	Range	25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	52	0 - 19	3	10	14	5.57	9
Conductivity	umhos/cm	49	375 - 670	511	560	595	71.64	549
Dissolved Oxygen	mg/L	50	2 - 12	8	10	11	2.82	9
Turbidity	NTU	50	0.6 - 50.0	6.1	8.0	10.0	8.14	9.8
NO2+NO3-N	mg/L	52	2.2 - 11.0	2.7	3.1	3.5	1.20	3.3
Ammonium-N	mg/L	52	<0.1 - 0.6	<0.1	<0.1	0.2	0.17	0.2
Fecal Bacteria	count 100 ml.	51	<10 - 31000	60	250	855	4788.71	1636
Nitrate-N	mg/L	52	2.05 - 4.56	2.83	3.16	3.38	2.19	3.12
Nitrite-N	mg/L	52	<0.01 - 0.25	0.01	0.02	0.04	0.16	0.03
Phosphorus	mg/L	52	<0.03 - 0.07	<0.03	<0.03	<0.03	0.04	<0.03
Sulfate	mg/L	52	21.30 - 43.17	27.19	29.65	36.85	5.67	31.77
Fluoride	mg/L	52	0.08 - 0.44	0.13	0.21	0.39	0.12	0.24
Chloride	mg/L	52	5.17 - 9.10	6.69	7.65	8.20	0.97	7.45
Bromide	mg/L	52	<0.06 - 0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site SNWF
Oct-Nov-Dec

				Quartile				
	Units	Number	Range	25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	2 - 14	4	7	10	3.53	7
Conductivity	umhos/cm	12	495 - 620	523	535	561	35.12	545
Dissolved Oxygen	mg/L	13	3 - 12	8	11	11	2.87	9
Turbidity	NTU	12	4.6 - 10.0	6.0	6.7	8.5	1.88	7.2
NO2+NO3-N	mg/L	13	2.5 - 11.0	2.6	2.8	3.0	2.29	3.4
Ammonium-N	mg/L	13	<0.1 - 0.3	<0.1	<0.1	<0.1	0.07	0.1
Fecal Bacteria	count 100 ml.	13	10 - 800	70	170	250	265.27	240
Nitrate-N	mg/L	13	2.82 - 4.56	2.93	3.25	3.76	2.70	3.41
Nitrite-N	mg/L	13	<0.01 - 0.25	0.03	0.04	0.05	0.28	0.05
Phosphorus	mg/L	13	<0.03 - <0.03	<0.03	<0.03	<0.03	0.00	<0.03
Sulfate	mg/L	13	33.81 - 43.17	35.39	36.82	39.71	3.00	37.51
Fluoride	mg/L	13	0.28 - 0.44	0.33	0.38	0.40	0.05	0.36
Chloride	mg/L	13	7.21 - 8.50	7.51	7.99	8.35	0.46	7.94
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site SNWF
Jan-Feb-Mar

	Units	Number	Range	Quartile 25th	Quartile 50th	Quartile 75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	0 - 3	1	2	2	1.13	2
Conductivity	umhos/cm	13	375 - 610	484	535	580	69.55	523
Dissolved Oxygen	mg/L	11	2 - 12	4	10	10	3.67	7
Turbidity	NTU	13	0.6 - 50.0	6.0	8.3	15.0	14.14	13.1
NO2+NO3-N	mg/L	13	2.2 - 3.3	3.0	3.1	3.2	0.32	3.0
Ammonium-N	mg/L	13	<0.1 - 0.5	<0.1	<0.1	<0.1	0.15	0.1
Fecal Bacteria	count 100 ml.	12	<10 - 320	10	25	45	92.40	60
Nitrate-N	mg/L	13	2.05 - 3.44	2.94	3.19	3.22	1.61	3.05
Nitrite-N	mg/L	13	0.01 - 0.04	0.02	0.03	0.03	0.05	0.03
Phosphorus	mg/L	13	<0.03 - 0.07	<0.03	<0.03	<0.03	0.08	<0.03
Sulfate	mg/L	13	22.82 - 38.70	36.14	36.95	37.61	4.59	35.25
Fluoride	mg/L	13	0.11 - 0.40	0.13	0.39	0.40	0.14	0.29
Chloride	mg/L	13	6.29 - 9.08	7.98	8.20	8.56	0.69	8.13
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site SNWF
Apr-May-June

	Units	Number	Range	Quartile 25th	Quartile 50th	Quartile 75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	7 - 17	9	12	14	3.20	12
Conductivity	umhos/cm	11	400 - 580	440	500	540	63.60	492
Dissolved Oxygen	mg/L	13	3 - 12	8	10	11	2.58	9
Turbidity	NTU	12	1.0 - 20.0	7.4	8.9	13.0	4.76	9.6
NO2+NO3-N	mg/L	13	2.4 - 4.1	2.6	2.7	3.0	0.47	2.9
Ammonium-N	mg/L	13	<0.1 - 0.6	<0.1	0.1	0.2	0.19	0.2
Fecal Bacteria	count 100 ml.	13	10 - 2100	120	500	750	630.88	625
Nitrate-N	mg/L	13	2.27 - 3.13	2.5	2.60	2.76	1.20	2.64
Nitrite-N	mg/L	13	<0.01 - 0.03	<0.01	0.01	0.01	0.05	0.01
Phosphorus	mg/L	13	<0.03 - <0.03	<0.03	<0.03	<0.03	0.00	<0.03
Sulfate	mg/L	13	21.30 - 29.42	25.16	27.04	28.55	2.32	26.75
Fluoride	mg/L	13	0.08 - 0.28	0.11	0.13	0.20	0.07	0.16
Chloride	mg/L	13	5.17 - 8.09	6.11	6.27	6.50	0.79	6.38
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site SNWF
July-Aug-Sept

	Units	Number	Range	Quartile 25th	Quartile 50th	Quartile 75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	10 - 19	13	14	15	2.43	14
Conductivity	umhos/cm	13	560 - 670	610	631	654	33.66	625
Dissolved Oxygen	mg/L	13	3 - 11	8	9	10	2.05	9
Turbidity	NTU	13	3.6 - 20.0	6.0	8.0	10.0	5.28	9.3

NO2+NO3-N	mg/L	13	3.2 - 4.2	3.6	3.7	3.9	0.28	3.7
Ammonium-N	mg/L	13	0.1 - 0.6	0.2	0.2	0.4	0.14	0.3
Fecal Bacteria	count 100 ml.	13	260 - 31000	910	1100	6700	8556.82	5497
Nitrate-N	mg/L	13	3.14 - 3.62	3.23	3.43	3.50	0.77	3.38
Nitrite-N	mg/L	13	<0.01 - 0.05	<0.01	0.01	0.03	0.09	0.02
Phosphorus	mg/L	13	<0.03 - <0.03	<0.03	<0.03	<0.03	0.00	<0.03
Sulfate	mg/L	13	23.17 - 31.87	26.77	27.91	28.95	2.47	27.58
Fluoride	mg/L	13	0.12 - 0.27	0.13	0.14	0.17	0.05	0.17
Chloride	mg/L	13	6.06 - 9.10	6.77	7.34	7.87	0.83	7.35
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site SN3
ANNUAL

	Units	Number	Range	25th	Quartile 50th	75th	std	Mean
Parameters								
Temperature	degree C	52	0 - 20	2	9	15	6.13	9
Conductivity	umhos/cm	49	160 - 690	505	545	610	96.01	546
Dissolved Oxygen	mg/L	50	2 - 13	8	10	12	2.92	9
Turbidity	NTU	50	0.6 - >100	4.6	6.8	10.8	19.32	12.3
NO2+NO3-N	mg/L	52	1.2 - 5.3	3.3	4.0	4.4	0.78	3.8
Ammonium-N	mg/L	52	<0.1 - 1.5	<0.1	<0.1	0.30	0.33	0.2
Fecal Bacteria	count 100 ml.	52	<10 - 6800	20	105	443	1089.19	514
Nitrate-N	mg/L	52	1.19 - 6.56	3.18	3.89	4.56	4.53	3.91
Nitrite-N	mg/L	52	<0.01 - 0.23	0.01	0.02	0.04	0.15	0.03
Phosphorus	mg/L	52	<0.03 - 0.29	<0.03	<0.03	<0.03	0.23	<0.03
Sulfate	mg/L	52	9.55 - 30.65	19.18	23.47	28.03	4.90	23.40
Fluoride	mg/L	52	<0.04 - 0.43	0.11	0.18	0.39	0.13	0.23
Chloride	mg/L	52	4.86 - 12.65	7.84	8.89	9.50	1.34	8.68
Bromide	mg/L	52	<0.06 - <0.06	<0.06	<0.06	<0.06	<0.06	<0.06

Site SN3
Oct-Nov-Dec

	Units	Number	Range	25th	Quartile 50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	2 - 15	4	6	9	3.88	7
Conductivity	umhos/cm	12	485 - 610	520	553	560	37.75	547
Dissolved Oxygen	mg/L	13	3 - 13	5	10	12	3.64	9
Turbidity	NTU	12	4.0 - 15.0	4.4	6.3	9.0	3.34	7.1
NO2+NO3-N	mg/L	13	3.2 - 4.3	3.6	3.9	4.1	0.36	3.9
Ammonium-N	mg/L	13	<0.1 - 0.1	<0.1	<0.1	<0.1	0.01	<0.1
Fecal Bacteria	count 100 ml.	13	<10 - 350	10	40	60	114.12	85
Nitrate-N	mg/L	13	3.60 - 6.56	3.94	4.55	5.18	3.91	4.67
Nitrite-N	mg/L	13	<0.01 - 0.23	0.03	0.04	0.04	0.26	0.05

Phosphorus	mg/L	13	<0.03 - <0.03	<0.03	<0.03	<0.03	0.23	<0.03
Sulfate	mg/L	13	25.10 - 30.65	26.27	27.24	28.98	1.91	27.60
Fluoride	mg/L	13	<0.04 - 0.41	0.33	0.35	0.40	0.10	0.34
Chloride	mg/L	13	8.34 - 12.65	8.72	9.20	9.75	1.09	9.44
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site SN3
Jan-Feb-Mar

				Quartile				
	Units	Number	Range	25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	0 - 3	1	1	2	0.95	1
Conductivity	umhos/cm	13	160 - 620	490	530	580	122.23	497
Dissolved Oxygen	mg/L	12	2 - 13	7	11	12	3.92	9
Turbidity	NTU	13	0.6 - >100	4.5	5.5	14.0	35.61	21.1
NO2+NO3-N	mg/L	13	1.2 - 4.7	4.2	4.4	4.6	1.10	4.0
Ammonium-N	mg/L	13	<0.1 - 1.3	<0.1	<0.1	<0.1	0.48	0.3
Fecal Bacteria	count 100 ml.	13	<10 - 1200	10	20	100	330.12	148
Nitrate-N	mg/L	13	1.19 - 5.52	4.38	4.54	4.65	5.65	4.11
Nitrite-N	mg/L	13	0.01 - 0.04	0.02	0.02	0.03	0.04	0.02
Phosphorus	mg/L	13	<0.03 - 0.29	<0.03	<0.03	<0.03	0.45	0.05
Sulfate	mg/L	13	9.55 - 29.61	25.12	28.50	28.81	6.48	25.18
Fluoride	mg/L	13	0.11 - 0.40	0.12	0.39	0.40	0.14	0.29
Chloride	mg/L	13	4.86 - 10.00	9.14	9.40	9.53	1.52	8.83
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site SN3
Apr-May-June

				Quartile				
	Units	Number	Range	25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	8 - 18	9	13	15	3.47	12
Conductivity	umhos/cm	11	410 - 625	450	480	515	60.80	488
Dissolved Oxygen	mg/L	13	6 - 13	10	11	12	1.83	11
Turbidity	NTU	12	2.0 - 30.0	5.3	7.2	12.8	9.16	10.8
NO2+NO3-N	mg/L	13	2.6 - 4.3	3.0	3.1	3.3	0.42	3.2
Ammonium-N	mg/L	13	<0.1 - 0.6	<0.1	0.2	0.4	0.19	0.2
Fecal Bacteria	count 100 ml.	13	<10 - 2400	40	170	780	717.94	502
Nitrate-N	mg/L	13	2.56 - 3.57	2.79	3.05	3.18	1.29	2.99
Nitrite-N	mg/L	13	<0.01 - 0.10	0.01	0.01	0.02	0.12	0.02
Phosphorus	mg/L	13	<0.03 - <0.03	<0.03	<0.03	<0.03	0.00	<0.03
Sulfate	mg/L	13	16.96 - 27.93	18.34	20.20	21.04	2.84	20.38
Fluoride	mg/L	13	0.07 - 0.27	0.09	0.09	0.17	0.06	0.13
Chloride	mg/L	13	6.44 - 9.10	6.84	7.17	7.78	0.76	7.36
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site SN3
July-Aug-Sept

Parameters	Units	Number	Range	Quartile 25th	Quartile 50th	Quartile 75th	std. dev.	Mean
Temperature	degree C	13	10 - 20	14	15	16	2.95	15
Conductivity	umhos/cm	13	570 - 690	623	650	670	36.58	644
Dissolved Oxygen	mg/L	13	5 - 12	9	9	9	1.55	9
Turbidity	NTU	13	4.0 - 27.0	5.5	8.2	11.0	7.04	9.7
NO2+NO3-N	mg/L	13	3.4 - 5.3	3.7	4.3	4.6	0.63	4.3
Ammonium-N	mg/L	13	<0.1 - 1.5	0.2	0.3	0.3	0.36	0.4
Fecal Bacteria	count 100 ml.	13	110 - 6800	320	730	1000	1831.99	1320
Nitrate-N	mg/L	13	3.09 - 4.92	3.51	3.89	4.13	2.53	3.88
Nitrite-N	mg/L	13	<0.01 - 0.05	<0.01	0.01	0.03	0.09	0.02
Phosphorus	mg/L	13	<0.03 - <0.03	<0.03	<0.03	<0.03	0.00	<0.03
Sulfate	mg/L	13	17.22 - 26.13	18.64	20.48	21.04	2.51	20.43
Fluoride	mg/L	13	0.07 - 0.43	0.10	0.15	0.16	0.09	0.16
Chloride	mg/L	13	7.41 - 10.64	8.63	8.91	9.98	0.91	9.10
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site BR2
ANNUAL

Parameters	Units	Number	Range	Quartile 25th	Quartile 50th	Quartile 75th	std. dev.	Mean
Temperature	degree C	52	0 - 19	4	8	14	5.66	9
Conductivity	umhos/cm	50	330 - 730	520	580	633	78.55	571
Dissolved Oxygen	mg/L	50	3 - 15	7	10	12	3.21	9
Turbidity	NTU	51	0.6 - >100	6.0	9.0	10.5	22.53	15.4
NO2+NO3-N	mg/L	52	3.1 - 12.0	8.3	9.1	9.7	1.70	8.7
Ammonium-N	mg/L	52	<0.1 - 2.9	<0.1	0.1	0.3	0.56	0.3
Fecal Bacteria	count 100 ml.	52	10 - 63000	60	460	1625	9875.34	3653
Nitrate-N	mg/L	52	3.58 - 11.88	8.80	9.85	10.46	7.75	9.35
Nitrite-N	mg/L	52	<0.01 - 0.24	0.02	0.03	0.05	0.16	0.04
Phosphorus	mg/L	52	<0.03 - 0.51	<0.03	<0.03	<0.03	0.39	0.03
Sulfate	mg/L	52	10.75 - 27.36	18.31	20.58	22.06	3.19	20.11
Fluoride	mg/L	52	<0.04 - 0.58	0.12	0.29	0.40	0.14	0.26
Chloride	mg/L	52	6.66 - 18.33	14.66	15.79	16.46	2.38	15.21
Bromide	mg/L	52	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site BR2
OCT-NOV-DEC

Parameters	Units	Number	Range	Quartile 25th	Quartile 50th	Quartile 75th	std. dev.	Mean
Temperature	degree C	13	2 - 13	5	6	8	3.20	6
Conductivity	umhos/cm	13	510 - 600	550	575	580	24.90	566
Dissolved Oxygen	mg/L	13	4 - 13	9	11	12	3.02	10
Turbidity	NTU	13	3.8 - 20.0	7.0	9.0	10.0	3.98	9.1

NO2+NO3-N	mg/L	13	5.4 - 10.0	8.7	9.0	9.2	1.14	8.8
Ammonium-N	mg/L	13	<0.1 - 2.9	<0.1	<0.1	<0.1	0.79	0.3
Fecal Bacteria	count 100 ml.	13	10 - 15000	60	250	550	4088.56	1438
Nitrate-N	mg/L	13	9.40 - 11.88	9.70	10.31	11.11	3.87	10.36
Nitrite-N	mg/L	13	0.01 - 0.24	0.04	0.04	0.06	0.25	0.06
Phosphorus	mg/L	13	<0.03 - <0.03	<0.03	<0.03	<0.03	0.00	<0.03
Sulfate	mg/L	13	19.34 - 27.36	21.65	22.09	24.11	2.21	23.07
Fluoride	mg/L	13	<0.04 - 0.41	0.34	0.38	0.41	0.11	0.34
Chloride	mg/L	13	13.75 - 18.33	15.36	16.40	17.93	1.51	16.55
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site BR2
JAN-FEB-MAR

				Quartile				
	Units	Number	Range	25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	0 - 5	1	1	3	1.63	2
Conductivity	umhos/cm	13	330 - 650	510	540	600	87.31	543
Dissolved Oxygen	mg/L	13	3 - 15	5	11	12	4.34	9
Turbidity	NTU	13	0.6 - >100	5.0	6.2	12.0	31.75	19.0
NO2+NO3-N	mg/L	13	3.1 - 11.0	6.0	9.0	9.8	2.44	8.1
Ammonium-N	mg/L	13	<0.1 - 2.6	<0.1	<0.1	0.2	0.75	0.4
Fecal Bacteria	count 100 ml.	13	20 - 1700	30	50	115	479.36	253
Nitrate-N	mg/L	13	3.58 - 10.96	8.95	9.96	10.27	10.59	8.90
Nitrite-N	mg/L	13	0.01 - 0.09	0.02	0.03	0.03	0.08	0.03
Phosphorus	mg/L	13	<0.03 - 0.51	<0.03	<0.03	<0.03	0.75	0.08
Sulfate	mg/L	13	10.75 - 23.93	21.23	21.50	22.68	3.94	20.28
Fluoride	mg/L	13	0.09 - 0.42	0.12	0.41	0.41	0.15	0.29
Chloride	mg/L	13	6.66 - 16.93	15.26	15.95	16.27	2.81	14.94
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site BR2
APR-MAY-JUNE

				Quartile				
	Units	Number	Range	25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	6 - 16	8	12	14	3.22	11
Conductivity	umhos/cm	11	432 - 650	466	490	558	67.29	514
Dissolved Oxygen	mg/L	11	4 - 13	6	9	12	3.56	9
Turbidity	NTU	12	6.0 - >100	8.4	9.3	13.0	29.05	19.2
NO2+NO3-N	mg/L	13	6.2 - 10.0	7.0	7.6	8.9	1.22	8.0
Ammonium-N	mg/L	13	<0.1 - 1.1	<0.1	0.2	0.3	0.30	0.3
Fecal Bacteria	count 100 ml.	13	10 - 20000	80	650	1800	6033.07	3057
Nitrate-N	mg/L	13	6.08 - 10.47	7.01	7.65	8.83	5.87	8.00
Nitrite-N	mg/L	13	<0.01 - 0.07	0.01	0.02	0.04	0.09	0.03
Phosphorus	mg/L	13	<0.03 - <0.03	<0.03	<0.03	<0.03	0.00	<0.03
Sulfate	mg/L	13	14.86 - 22.12	17.01	18.57	19.73	2.10	18.55
Fluoride	mg/L	13	0.08 - 0.34	0.09	0.10	0.19	0.09	0.15

Chloride	mg/L	13	10.77 - 17.15	11.57	12.15	15.40	2.18	13.35
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site BR2
JULY-AUG-SEPT

	Units	Number	Range	25th	Quartile 50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	13	9 - 19	14	15	17	2.85	15
Conductivity	umhos/cm	13	580 - 730	610	655	675	45.98	652
Dissolved Oxygen	mg/L	13	6 - 12	9	9	10	1.61	9
Turbidity	NTU	13	4.2 - 56.0	6.0	9.0	10.0	15.67	14.6
NO2+NO3-N	mg/L	13	8.3 - 12.0	9.4	9.6	11.0	1.04	9.9
Ammonium-N	mg/L	13	0.1 - 0.8	0.2	0.3	0.3	0.19	0.3
Fecal Bacteria	count 100 ml.	13	550 - 63000	780	1700	9900	17352.52	9864
Nitrate-N	mg/L	13	8.31 - 11.09	9.86	10.36	10.62	3.73	10.12
Nitrite-N	mg/L	13	<0.01 - 0.07	<0.01	0.01	0.06	0.12	0.03
Phosphorus	mg/L	13	<0.03 - <0.03	<0.03	<0.03	<0.03	0.00	<0.03
Sulfate	mg/L	13	15.78 - 21.75	16.86	19.15	19.72	1.89	18.54
Fluoride	mg/L	13	0.09 - 0.58	0.15	0.22	0.36	0.14	0.26
Chloride	mg/L	13	12.56 - 18.20	15.53	16.19	17.24	1.66	15.99
Bromide	mg/L	13	<0.06 -<0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site BRSC
ANNUAL

	Units	Number	Range	25th	Quartile 50th	75th	Std	Mean
Temperature	degree C	13	0 - 18	5	8	11	5.03	8
Conductivity	umhos/cm	13	295 - 730	516	583	655	120.19	574
Dissolved Oxygen	mg/L	12	4 - 19	9	11	13	4.09	11
Turbidity	NTU	13	3.2 - 66.0	7.3	8.3	9.1	16.98	12.7
NO2+NO3-N	mg/L	13	4.6 - 12.0	9.2	9.5	10.3	1.85	9.4
Ammonium-N	mg/L	13	<0.1 - 1.1	<0.1	0.1	0.3	0.31	0.2
Fecal Bacteria	count 100 ml.	13	<10 - 2500	25	110	1028	1063.21	729
Nitrate-N	mg/L	13	4.30 - 11.62	9.34	10.36	10.93	8.99	9.83
Nitrite-N	mg/L	13	<0.01 - 0.27	0.02	0.03	0.04	0.32	0.05
Phosphorus	mg/L	13	<0.03 - <0.03	<0.03	<0.03	<0.03	0.00	<0.03
Sulfate	mg/L	13	13.73 - 27.58	22.82	25.32	27.07	4.12	24.11
Fluoride	mg/L	13	0.09 - 0.47	0.12	0.36	0.41	0.15	0.29
Chloride	mg/L	13	7.98 - 19.81	15.55	16.47	17.39	3.06	16.20
Bromide	mg/L	13	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site SN2
ANNUAL

	Units	Number	Range	25th	Quartile 50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	12	0 - 15	3	9	12	5.39	8
Conductivity	umhos/cm	12	345 - 660	470	513	586	93.34	523

Dissolved Oxygen	mg/L	12	2 - 14	7	10	10	3.29	9
Turbidity	NTU	12	3.8 - 32.0	5.9	8.0	10.3	7.49	9.7
NO2+NO3-N	mg/L	12	1.9 - 4.1	2.8	3.0	3.5	0.65	3.0
Ammonium-N	mg/L	12	<0.1 - 0.8	<0.1	<0.1	0.2	0.25	0.2
Fecal Bacteria	count 100 ml.	12	<10 - 620	25	65	323	222.63	190
Nitrate-N	mg/L	12	2.18 - 3.43	2.56	2.88	3.26	1.89	2.89
Nitrite-N	mg/L	12	<0.01 - 0.73	0.01	0.02	0.04	0.94	0.10
Phosphorus	mg/L	12	<0.03 - 0.10	<0.03	<0.03	<0.03	0.14	<0.03
Sulfate	mg/L	11	15.61 - 42.23	21.51	23.47	27.61	6.98	25.32
Fluoride	mg/L	12	<0.04 - 0.41	0.11	0.20	0.37	0.15	0.22
Chloride	mg/L	12	5.30 - 8.67	6.57	7.29	7.90	0.97	7.21
Bromide	mg/L	12	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

Site SNT

ANNUAL

				Quartile				
	Units	Number	Range	25th	50th	75th	std. dev.	Mean
Parameters								
Temperature	degree C	12	1 - 14	5	8	12	4.62	8
Conductivity	umhos/cm	12	360 - 650	465	493	595	93.91	520
Dissolved Oxygen	mg/L	12	1 - 12	4	9	11	3.92	8
Turbidity	NTU	12	4.5 -14.0	6.0	8.0	9.5	3.04	8.3
NO2+NO3-N	mg/L	12	1.6 - 4.4	2.4	2.5	3.6	0.91	2.9
Ammonium-N	mg/L	12	<0.1 -0.8	<0.1	0.1	0.3	0.25	0.2
Fecal Bacteria	count 100 ml.	12	<10 - 1300	33	70	268	475.48	299
Nitrate-N	mg/L	12	2.01 - 3.82	2.22	2.57	3.34	2.91	2.76
Nitrite-N	mg/L	12	<0.01 - 0.24	0.01	0.02	0.04	0.30	0.04
Phosphorus	mg/L	12	<0.03 - <0.03	<0.03	<0.03	<0.03	0.00	<0.03
Sulfate	mg/L	12	14.45 - 30.84	18.82	21.75	24.30	4.56	21.89
Fluoride	mg/L	12	0.07 - 0.40	0.12	0.27	0.39	0.13	0.25
Chloride	mg/L	12	5.23 - 9.62	7.29	7.75	8.12	1.14	7.71
Bromide	mg/L	12	<0.06 - <0.06	<0.06	<0.06	<0.06	0.00	<0.06

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