The Geochemistry of Oatka Creek, New York State

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Executive Summary

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This investigation on Oatka Creek was initiated by the growing concern of local residents about the condition of their watershed. The purposes of this study were to characterize the geochemistry of Oatka Creek, determine any regional geologic effects on the water chemistry, and observe any anthropogenic effects on Oatka Creek and its watershed. Water and sediment samples from Oatka Creek were collected and analyzed over a three-year period (1998-2000). The creek water was measured for major ions and trace elements to determine baseline levels and identify any significant deviations from the baseline. Sediment extraction experiments were performed to clarify the role of cation exchange and adsorption/desorption reactions in controlling the trace metal concentrations in the surface waters.

The headwaters of Oatka Creek are in Wyoming County, south of Rock Glen. The creek flows north into Genesee County until LeRoy where the creek suddenly begins flowing easterly. Oatka Creek then flows through Livingston County and into Monroe County where it joins the Genesee River at Scottsville. Oatka Creek experiences flow separation during the summer and part of the fall. During the dry season (summer and fall) the creek is a losing stream; it loses water to the ground for a period of time. The water then reappears as seeps and springs between Buttermilk Falls and the Perry Road Bridge. During these dry periods, the creek can be divided into the upper and lower watersheds. The upper watershed is from Rock Glen to the bend in Oatka creek (north of LeRoy) and the lower watershed is from the bend to Scottsville. Oatka Creek has significant groundwater input throughout the lower watershed. During the wetter periods, Oatka Creek flows continuously over its creekbed.

The geology of the Oatka Creek watershed plays an intricate role in the water chemistry of the creek. The major geologic units are limestone ($CaCO_3$), dolostone ($(Ca, Mg)CO_3$), gypsum ($CaSO_4$), evaporites (NaCl, KCl), sandstones (SiO_2), and shales ((Na,K)AlOSi). The majority of the major ions (e.g. Na, K, Mg, Ca, Cl, SO_4, HCO_3) and trace metals measured in ground and surface waters are found naturally in the environment from the weathering of bedrock. During the dry season, the lower watershed (Perry Road Bridge to Scottsville) is sulfate dominated and has a noticeable influx of groundwater. The upper watershed (Rock Glen to LeRoy) is dominated mainly by precipitation with little groundwater influence. Groundwater discharge into the creek and seasonal changes in the water volume of the creek affects the dissolved ion and metal concentrations in the surface water of Oatka Creek. In the wet season (winter and spring), there is no longer a dramatic difference in ion concentrations between Rock Glen and Scottsville since the groundwater signature is diluted by the extra precipitation and runoff.

A combination of natural sources (such as precipitation and weathering of bedrock and sediments) and anthropogenic inputs (such as sewage effluent or air pollution) will contribute to the dissolved trace metal concentrations in the water. Over the three years that this study has taken place, there has been no continuous deviations observed in the dissolved trace metals of the samples. There is very little trace metal input from precipitation. Trace metals readily adsorb onto sediment surfaces so, through desorption/adsorption reactions, the creekbed sediments could be a possible source of trace metals in the creek water. As shown by the data, the sediments of Oakta Creek are a sink for trace metals from anthropogenic and natural sources. However, as the water chemistry demonstrates, the trace metals on the sediments are not being remobilized and reintroduced into the water.

Any future research projects can use this study as a guide as well as a good comparison tool since the data establish the baselines for the major ions and trace metals of Oatka Creek. These data sets also provide a good starting point for examining the effects of trace metals on the food chain. Even though the Oatka Creek is relatively pristine, local communities and governments in the Oatka Creek watershed need to make educated decisions on the future development of towns, recreational facilities, and land-use laws to ensure the continuing high quality of the Oatka Creek Watershed.

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INTRODUCTION

Oatka Creek is the third longest tributary (~98 km) in the Genesee River watershed (Figure 1a). The Oatka Creek's watershed has a surface area of 557 km^2 that covers four counties (Wyoming, Genesee, Livingston, and Monroe). This investigation on Oatka Creek was initiated by the growing concern of local residents about the condition of their watershed. We have been studying, with the assistance of several classes at the University of Rochester, the geochemistry of Oatka Creek. The purposes of this study are to characterize the geochemistry of Oatka Creek, determine any regional geologic effects on the water chemistry, and observe any anthropogenic (man-made) effects on Oatka Creek and its watershed. In 1998, 1999, and 2000, aqueous and sediment samples from Oatka Creek were collected and analyzed. Major ions and trace elements in the surface waters were measured to determine the surface water chemistry of the creek. Sediment extraction experiments were performed to clarify the role of cation exchange and adsorption/desorption reactions in controlling the trace metal concentrations in the surface waters. These aqueous and sediment data sets will help local communities and governments in the Oatka Creek watershed make educated decisions on the future development of towns, recreational facilities, and land-use laws. In addition, they will provide an excellent base for examining the effects of trace metals on the food chain of Oatka Creek. When combined with the research on the Genesee River watershed (Hetling et al., 1978; Litten, 1996; Reddy, 1979), the data will help explain the trace metals sources in Lake Ontario.

Figure 1a: The watershed of Oatka Creek in New York State.

Figure 1b: The locations for the water and precipitation samples for November 1998 and February 1999 trips are shown. The corresponding site numbers for the other sampling trips are listed in Appendix II.

Hydrogeology

The headwaters of Oatka Creek are in Wyoming County, south of Rock Glen (Figure 1). The creek flows north into Genesee County. North of LeRoy and west of Buttermilk Falls, the creek suddenly begins flowing easterly. Oatka Creek then flows through Livingston County and into Monroe County where the creek joins the Genesee River at Scottsville. Oatka Creek experiences flow separation during the summer and part of the fall. During these dry periods, the creek can be divided into the upper and lower watersheds. The upper watershed is from Rock Glen to bend in Oatka creek (north of LeRoy) and the lower watershed is from the bend (north of LeRoy) to Scottsville. Oatka Creek has significant groundwater input throughout the lower watershed. During the dry season (summer and fall) the creek is a losing stream; it loses water to the ground for a period of time. North of LeRoy, the creek becomes a losing stream where the surface water flows into the ground. The loss begins approximately one mile upstream of Buttermilk Falls. The water reappears in seeps and springs between Buttermilk Falls and the Perry Road Bridge.

The geology underlying the Oatka Creek watershed may play an intricate role in the water chemistry of the creek. The major geologic units are limestone, dolostone, gypsum, evaporites, sandstones, and shales (Figure 2a&b). The majority of the major ions and trace metals found in ground and surface waters are naturally found in the environment through the weathering of bedrock:

Limestone	$CaCO_3 \Rightarrow Ca^{2+} + CO_3^{2-}$,
Dolostone	$(Ca,Mg)CO_3 \Rightarrow (Ca^{2+},Mg^{2+}) + CO_3^{2-}$,
Gypsum	$CaSO_4 \Rightarrow Ca^{2+} + SO_4^{2-}$,
Evaporites	$NaCl \Rightarrow Na^+ + Cl^-$
	$KCl \Rightarrow K^+ + Cl^-$,
Shales	$(Na,K)AlOSi \Rightarrow (Na^+, K^+) + Clays$
Sandstones	$SiO_2 \Rightarrow SiO_2$

From Rock Glen to Pavilion, Oatka Creek flows across the subcrops of the Sonyea Group (shale, sandstone), Genesee Group (shales, limestone), and the Tully Limestone. Oatka Creek flows on the Hamilton Group (shales, thin limestones) from Pavilion Center to just north of LeRoy, where the Onondaga Limestone subcrop begins. As the Oatka begins its eastern flow, it passes over the Akron dolomite, the Bertie Group (dolomitic shales), and the Salina Group. The Salina Group, containing both the Syracuse and Camillus Formations, is a sequence consisting primarily of limestones, dolostones, evaporites such as halite and gypsum, and shales. Groundwater discharge into the creek and seasonal changes in the water volume of the creek may affect the dissolved ion and metal concentrations in the surface water of Oatka Creek.

Figure 2a: The geology of the Oatka Creek watershed.

Figure 2b: The legend of the Oatka Creek watershed geology.

SAMPLING AND METHODOLOGY

Selection of Sampling Sites

There were many sampling trips throughout 1998, 1999, and 2000 (Figure 1b). We sampled in September 1998, November 1998 and February 1999 in an effort to differentiate between groundwater and precipitation dominated flows. On Oatka Creek and its tributaries (Spring Creek, Mud Creek, Pearl Creek, Crystal Brook, and an unnamed creek on Parmalee Road), a total of 34 sites were sampled for surface water from Rock Glen to Scottsville. From Pavilion to Scottsville and the intervening tributaries, surface water, creekbed sediment, and bedrock samples were collected in September 1999 (9 sites) and October 2000 (12 sites). The water samples near a tributary were taken in a triangular pattern surrounding the tributary's confluence with Oatka Creek—one sample from Oatka Creek just before the tributary, one from the tributary itself, and one just after the tributary joins Oatka Creek. This was done to assess the tributary's effect on the aqueous chemistry of Oatka Creek.

Sampling Procedures

The preparation and handling of samples were done according to clean lab procedures for water and sediment sample collection in an effort to minimize metal contamination. The cleaning procedure for the water samples bottles (fluorinated HDPE bottles) was a three-step process. First they were filled with 2N EM Omni Trace nitric acid (HNO_3) and heated for two days at 100°F. Then the bottles were rinsed and filled with 18MΩ water, heated for a day and then rinsed again with 18MΩ water. Afterwards, the bottles were dried in a clean lab and placed into ziploc bags for field use.

Field parameters, pH, temperature, conductivity, and latitude and longitude (GPS) were recorded at each site. During sampling, we wore gloves and used non-metal equipment whenever possible. Water samples were collected with a plastic bucket and pumped through a filter by a peristaltic pump into three bottles at each site. For the trace metal and cation samples, the filtered water was acidified to ~pH 2 with ultrapure nitric acid to preserve the trace metals in solution. The other bottles were designated for anion and alkalinity analyses. At each site, there was an individual set of acid-cleaned peristaltic tubing for the pump. For the 1998 and 1999 sampling trip, we utilized individual 0.45 μm Gellman filters at each site. In 2000, we used 0.2 μm non-reusable filters and a reusable filter unit that was rinsed with no less than 500 mL of 18MΩ water after each use.

Creek sediment samples were collected in both 1999 and 2000. A plastic, slotted scoop was used to collect the samples, which were then placed into ziploc bags. In 1999, we collected creekbed sediments or rock at 9 sites, and one surface sediment sample was taken. In 2000, we collected creekbed sediment at all twelve sites along with one surface sample.

In 1999, we also collected precipitation. The precipitation collectors were built at the Rare Gas Facility at the University of Rochester and installed at selected locations in February 1999. The five sites selected were in Warsaw, LeRoy, Harmon Field, Garbutt, and the west part of the Oatka Creek Park. After a precipitation event, the samples were collected and analyzed.

Analytical Methods

Major cations [sodium (Na), potassium (K), magnesium (Mg), and calcium (Ca)] and anions [chloride (Cl), nitrate (NO_3), and sulfate (SO_4)] in the groundwater samples were measured on a Dionex ion chromatograph (IC) according to our established procedures at the University of Rochester (Fehn et al., 2000). We used CS12A and AS4A Ion Pac columns to analyze the cations and anions, respectively. Cation and anion aqueous standards were used to calibrate the IC after every two water samples that were analyzed. The analytical errors for these

IC analyses were usually less than 5% for the cations and anions. Alkalinity of the water samples was measured using titration method 2320 (Greenberg et al., 1992). For the creekbed and surface sediments, the exchangeable and adsorbed trace metals were extracted using an ammonium oxalate acid reagent (McKeague, 1978). Ten mL of 0.2 M oxalate solution was added to 0.25 g of sediment and agitated horizontally for four hours in the dark.

To prepare the groundwater and sediment extracts for trace metal analysis on the ICP-MS, the samples were further diluted with 18 MΩ water and acidified with ultrapure nitric acid. The analyses were done on the VG ICP-MS Plasma Quad II+ at the University of Rochester according to US EPA Method 200.8 (Long and Martin, 1991). To correct for drift, gallium, indium, and bismuth were added as internal standards. A five-point calibration curve was created using 0.1 ppb, 1 ppb, 10 ppb, 30 ppb, and 75 ppb standards. The errors in the trace metal concentration analyses were less than 5% for the samples measured on the VG ICP-MS Plasma Quad II+. Specific trace metals measured were chromium (Cr), manganese (Mn), cobalt (Co), nickel (Ni), copper (Cu), zinc (Zn), arsenic (As), strontium (Sr), molybdenum (Mo), silver (Ag), cadmium (Cd), barium (Ba), lead (Pb), and uranium (U).

RESULTS AND DISCUSSION

All the raw data are presented in the attached Appendices (Appendix III-V). The data sets are in either mmol/L (millimoles/liter), μmol/L (micromoles/liter) or μmol/kg (micromoles/kilogram) and also have been converted to ppm (mg/L; mg/kg; parts per million) or ppb (μg/L; parts per billion). Appendix I explains the units, the methods of conversion from one unit to another, the chemical symbols, and common terminology.

Major Ions

During the "dry" months of the summer and fall, the surface water of Oatka Creek flows into the karstic system of the Onondaga Limestone. The water loss begins approximately one mile upstream of Buttermilk Falls, and the water re-emerges as seeps and springs between Buttermilk Falls and the Perry Road Bridge. Oatka Creek begins flowing again near the Perry Road Bridge where we have observed significant groundwater discharge (e.g. springs, seeps). When precipitation is plentiful (winter and spring), there is no flow division in the creek and it flows continuously along its creekbed. Even though groundwater discharge is not directly observed, it still does occur.

In the summer and fall, the divided creek has two distinct chemical signatures that indicate two different chemical watersheds. Oatka Creek in the lower watershed (Perry Road Bridge to Scottsville) is sulfate dominated while the upper watershed (Rock Glen to LeRoy) is not (Figure 3a). Near Buttermilk Falls, a significant increase in calcium, sulfate, and bicarbonate is observed in the surface water. These increases in certain ions (Ca, SO_4, and HCO_3) come from the groundwater discharging into the surface water. The groundwater is actively weathering the subsurface geology (gypsum and limestone) and discharging into the creek through seeps and

Figure 3a: Ions versus Distance
September 1998

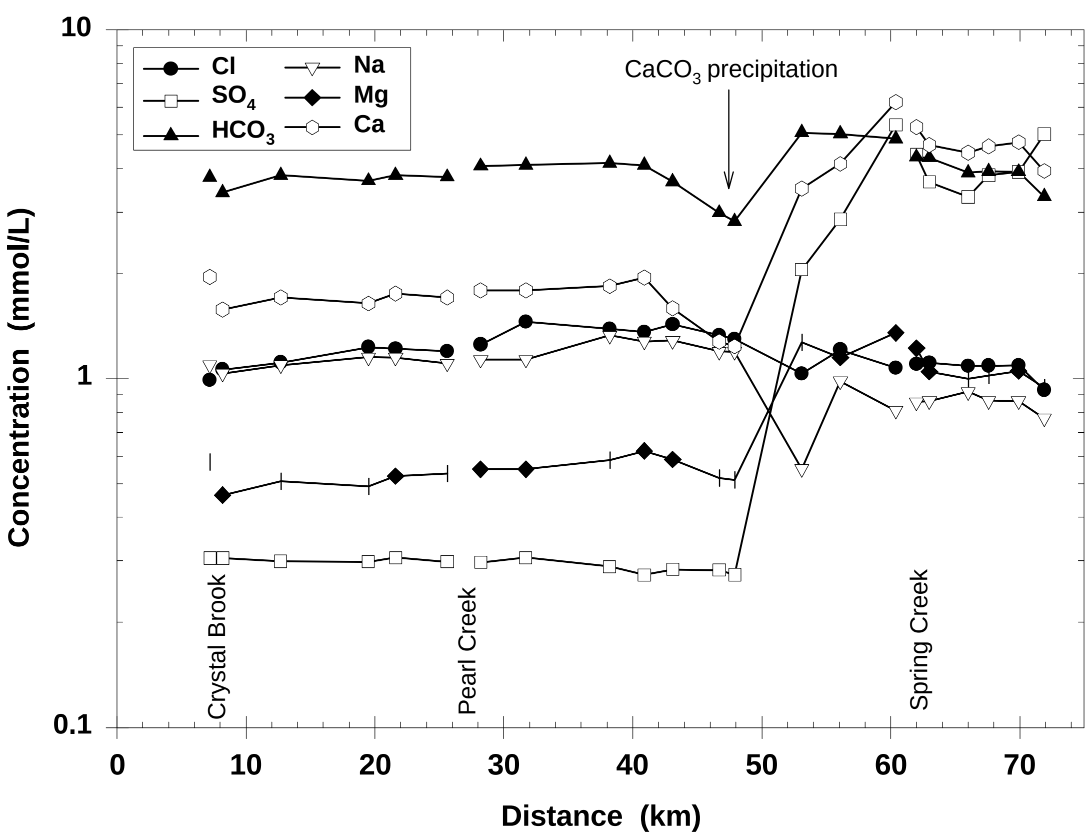
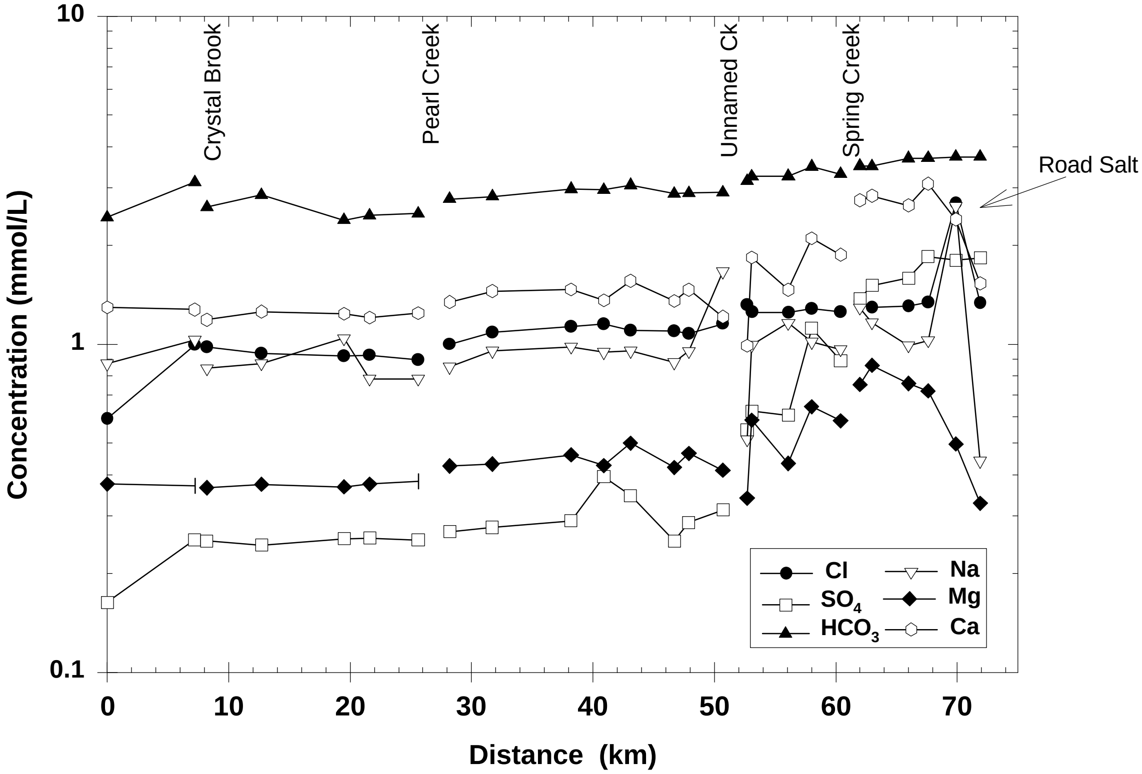


Figure 3b: Ions versus Distance
February 1999

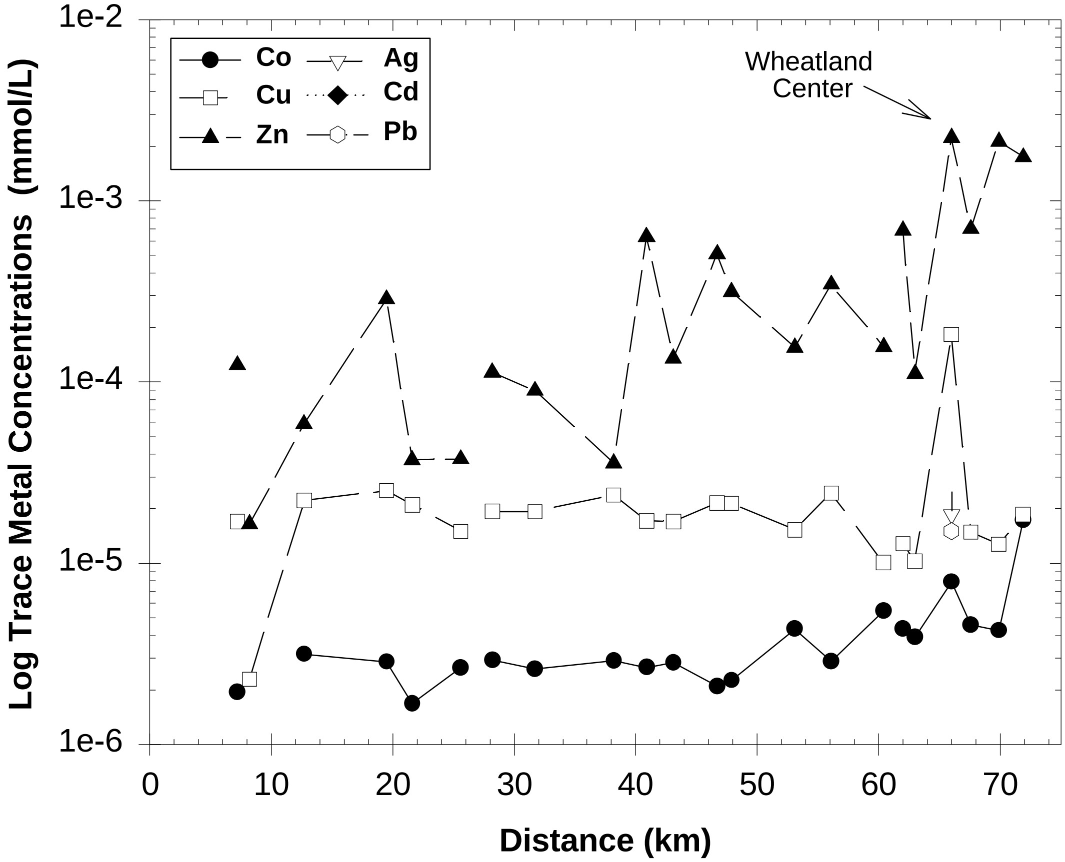


springs. During the summer and fall, the groundwater influence on the surface water chemistry is very noticeable. However, during the winter months (e.g. February 1999), there is no longer a dramatic difference in ion concentrations between Rock Glen and Scottsville (Figure 3b). Oatka Creek is flowing constantly, and the large volume of precipitation and runoff is diluting the groundwater signature. However, weathering of the bedrock is not the only source of major ions in Oatka Creek. Manure and fertilizers could pollute the water with excess nutrients such as nitrates and potassium. Road salt can cause an increase in sodium and chloride in the water as seen as in Figure 3b.

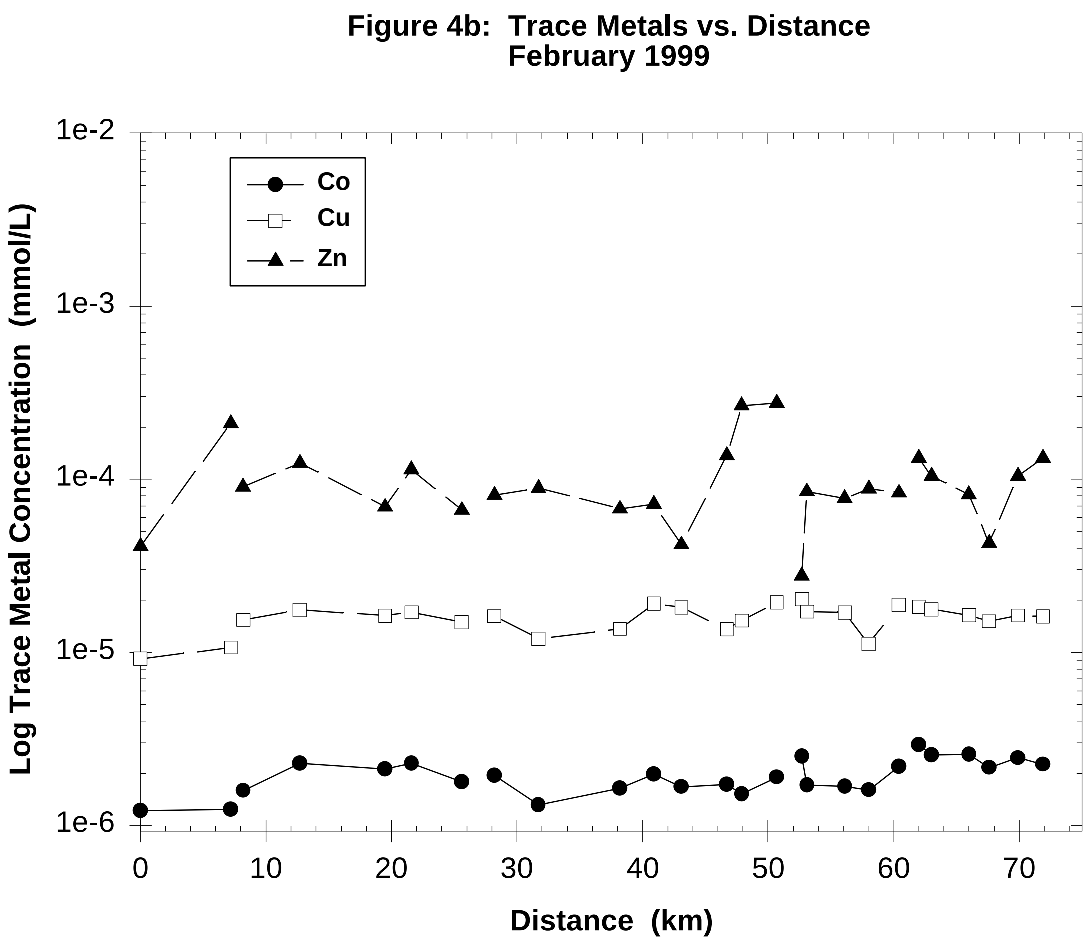
Trace Metals

Certain trace metals in the water naturally occur from the weathering of bedrock and unconsolidated sediments. The background or baseline values need to be established for trace metals in the Oatka Creek watershed so that statistically significant deviations may be noticed.

Figure 4a: Trace Metals vs. Distance September 1998



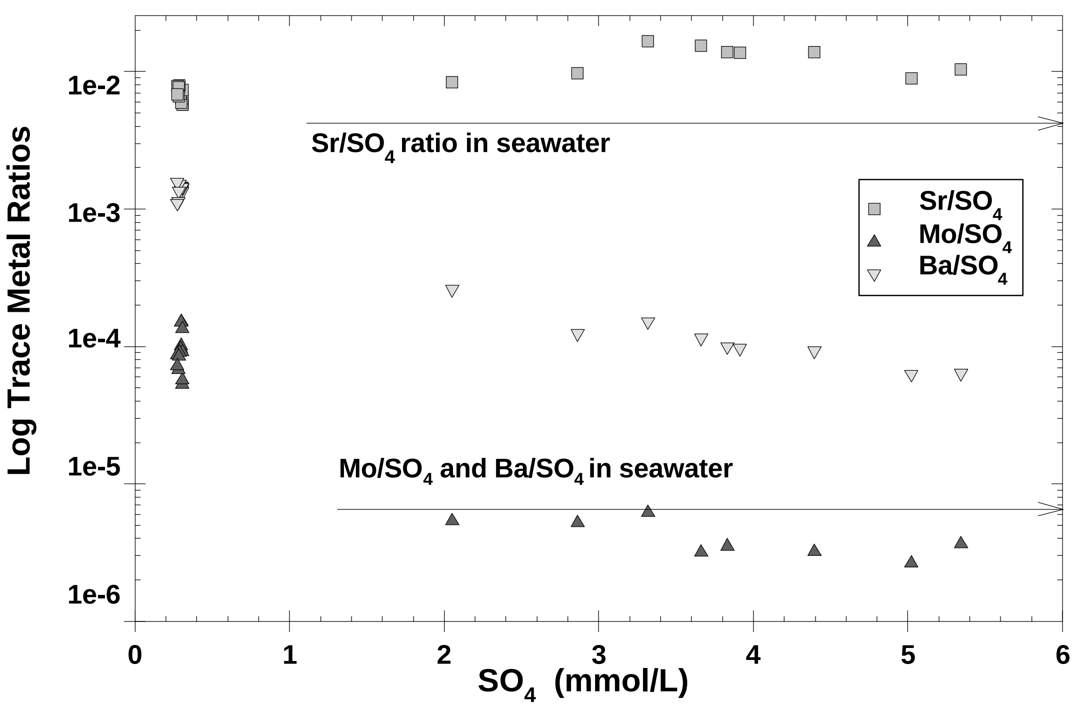
In September 1998, at 0.40 km north of Warsaw on Rt. 19 and at Wheatland Center Road Bridge, there are substantial departures from the baseline (Figure 4a). At Warsaw, the geology changes, which may explain the trace metal increases. However, there is also stagnant water in the creek that may have accumulated metals from vehicle emissions. At Wheatland Center Road Bridge, there is a two-magnitude increase in such metals as Co, Cu, Ag, Cd, and Pb that could be attributed to anthropogenic input. However, in February 1999, Oatka Creek flows continuously



and there are no significant changes in the concentrations of the trace metals (Figure 4b). In subsequent sampling trips, no deviations have been observed at the Wheatland Center sampling site. Other sources of trace metals are brass heat exchangers (Cu and Zn), MMT fuel additive (Mn), rust (Fe and Mn), and arsenate pesticides (As).

In Figure 5, several metals (Sr, Mo, and Ba) have been normalized to SO_4 (sulfate) to see if their ratios are similar to seawater ratios. If the ratios are comparable to the seawater ratios or there is a consistent trend throughout the watershed, then these trace metals in Oatka creek are most likely natural. The trace metals would have precipitated out with the gypsum, limestone, and shales and are now being weathered into the ground and surface waters. Sulfate is used as

Figure 5: Trace Metal Ratios Normalized to SO_4 versus SO_4 September 1998

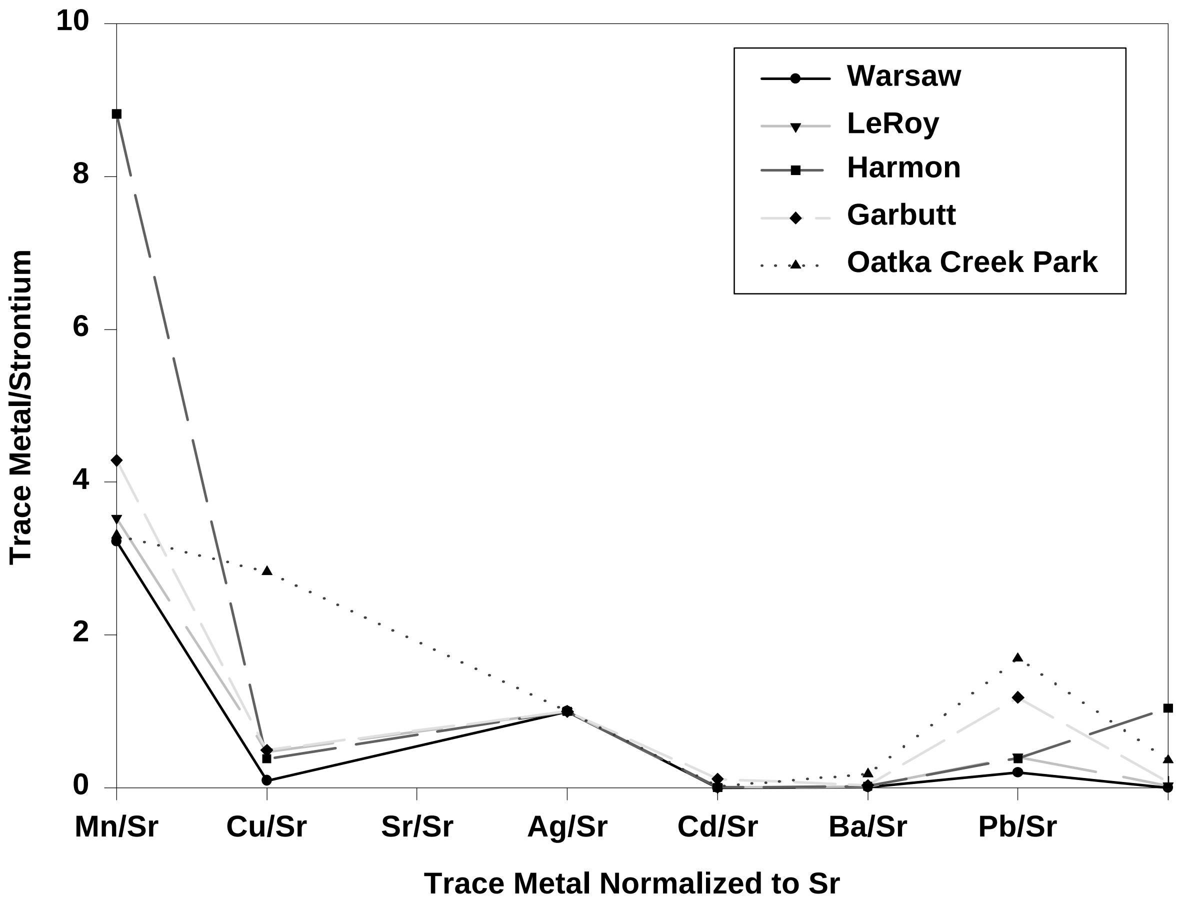


the denominator since it is an important part of the surface water chemistry. As there were two major ion trends seen in the Oatka creek watershed during the summer and fall, there are also two groupings of trace metal ratios observed (Figure 5). In the upper watershed, the weathering of shales adds Mo and Ba to the watershed. The lower watershed data imply that the strontium is coming from the weathering of gypsum ($CaSO_4$) and limestone ($CaCO_3$).

Precipitation

There was one group of precipitation samples collected in February 1999. The five samples collected have different trace metal concentrations, which is typically the result of evaporation. In Figure 6, the samples are normalized to Sr levels to discriminate between evaporation and anthropogenic input. Strontium (Sr) was used since it is a naturally occurring and abundant trace metal in our samples. If only evaporation has occurred, then the line slopes

Figure 6: Precipitation Samples Normalized to Sr



for all the samples should be similar. There are two noticeable deviations. There is a large Cu/Sr at the Oatka Creek Park site and smaller but noticeable Pb/Sr elevated point at the Harmon Field site. The Pb and Cu in the precipitation, although at low concentrations, are most likely from anthropogenic sources such as smokestack and vehicle emissions.

Sediments

Many trace metals in water often act as non-conservative tracers. They tend to flocculate and adsorb onto the sediments within the creek bed thus removing them from the water. Therefore, creek sediments are an important sink for trace metals in a watershed. In 1999 and 2000, surface and creekbed sediments were collected at a total of nineteen sites. Several sites in 1999 were resampled again in 2000. OC-1-sed-99 (Rt. 20, Pavilion), OC-12-surface-sed-99 (Wheatland Center), OK-4-sed-00 (Cole Road), OK-7-sed-00 (On Oatka Trail near Mumford), OK-10-surface-sed-00 (Wheatland Center), and OK-12-sed-00 (Scottsville sewage disposal plant) have significantly higher levels of many elements such as Cr, Co, Ni, Cu, As, Ag, Cd, Pb, and U. Surface sediments collected at the Wheatland Center site show elevated levels of copper and zinc; however, the creekbed sediments do not show the same increase. At the sample site downtream of the sewage disposal plant in Scottsville, there was an enormous increase in Cu and Zn in the creekbed sediments. At both sites, the increases in Cu and Zn are most likely from anthropogenic sources. The other samples, OC-1-sed-99 (Rt. 20, Pavilion), OK-4-sed-00 (Cole Road), and OK-7-sed-00 (On Oatka Trail near Mumford), have elevated trace metal concentrations across the board. This can be attributed either to an unknown anthropogenic source or a large component of silt and fine-grained particles in our sediment sample. Fine-grained particles have a greater surface area to volume ratio meaning that the sediment surface has more exchange sites onto which trace metals can absorb. However, the dissolved trace metal chemistry demonstrates that the trace metals being absorbed onto the sediment surfaces are not being remobilized (e.g. dissolved into the creek water).

CONCLUSIONS

The weathering products of the bedrock geology strongly influence the chemistry of the water. During the dry season, the lower watershed (Perry Road Bridge to Scottsville) is sulfate dominated and has a noticeable input of groundwater. The upper watershed (Rock Glen to LeRoy) is dominated mainly by precipitation with little groundwater influence. In the wet season (winter and spring), there is no longer a dramatic difference in ion concentrations between Rock Glen and Scottsville since the groundwater signature is diluted by the extra precipitation and runoff.

A combination of natural sources (such as precipitation and weathering of bedrock and sediments) and anthropogenic inputs (such as sewage effluent or air pollution) will contribute to the dissolved trace metal concentrations in the water. Over the years, there have been no significant and continuous deviations observed in the dissolved trace metals of the samples. There is very little major ion or trace metal input from precipitation.

Sediments are often a sink for trace metals since trace metals tend to readily adsorb onto sediment surfaces. The sediment's grain size influences its ability to adsorb trace metals. Trace metal adsorption and desorption reactions on sediment surfaces will affect the trace metal concentrations in the surface and groundwater. As shown by the data, the sediments of Oakta Creek are a sink for trace metals from anthropogenic and natural sources. However, as the water chemistry demonstrates, the trace metals on the sediments are not being remobilized and reintroduced into the water.

Relevance of Present and Future Research

These data sets will help the local communities and governments make educated decisions on the future development of towns, recreational facilities, and land-use laws as well as possible remediation of Oatka Creek. A long-term monitoring program could be established on Oatka Creek at precise locations determined using our data. When combined with research on the Genesee River watershed, data from this project would provide important input to the ongoing research on estimating sources of trace metals found in Lake Ontario. This project will also provide a good base for examining the effects of trace metals on the food chain. Trace metals affect the wildlife in Oatka Creek in two ways: bioaccumulation of metals within the food chain and incorporation of trace metals in the early stages of development.

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REFERENCES

Fehn U., Synder G., and Egeberg P. K. (2000) Dating of pore waters with ^{129}I; relevance for the origin of marine gas hydrates. *Science* **289**, 2332-2335.

Greenberg A. E., Clesceri L. S., and Eaton A. D. (1992) *Standard methods for the examination of water and wastewater*. American Public Health Association.

Hetling L., Carlson G., Bloomfield J., Boulton P., and Rafferty M. (1978) Genesee River pilot watershed study. International Joint Commission.

Litten S. (1996) Trackdown of chemical contaminants to Lake Ontario from New York State tributaries, pp. 88. New York State Department of Environmental Conservation.

Long S. E. and Martin T. D. (1991) Method 200.8: Determination of trace elements in waters and wastes by inductively coupled plasma-mass spectrometry. In *Methods for the determination of metals in environmental samples* (ed. U.S. EPA), pp. 83-122. US EPA.

McKeague J. A. (1978) *Manual on soil sampling and methods of analysis*. Canadian Society of Soil Science.

Reddy M. (1979) Variations in bottom sediment nutrient and metal concentrations in the Genesee River watershed, New York. *Environmental International* **2**, 9-12.

Appendix I: Units, Conversions, Chemical Symbols, and Common Terminology

Units

ppm	parts per million (or mg/L)
mg/L	milligrams per liter (or ppm)
mol	moles
mmol/L or mM	millimoles per liter
μmol/L or μM	micromoles per liter
g/mol or mg/mmol	grams per mole or milligrams per millimole (molecular weight)
meq/L	milliequivalent per liter

Conversions

1. ppm to mmol/L — divide by molecular weight

   (mg/L)÷(mg/mmol) = mmol/L

   Example: (40.1 ppm Ca)÷(40.10 mg/mmol Ca) = 1 mmol/L Ca

2. mmol/L to ppm — multiply by molecular weight

   (mmol/L)*(mg/mmol) = mg/L

   Example: (1 mmol/L Ca)*(40.10 mg/mmol Ca) = 40.10 ppm Ca

3. mmol/L to meq/L — multiply by molecular charge

   (mg/L)*(charge) = meq/L

   Example: (1 mmol/L Ca)*(+2) = +2 meq/L Ca

4. meq/L to mmol/L — divide by molecular charge

   (meq/L)÷(charge) = mmol/L

   Example (+2 meq/L Ca)÷(+2 Ca) = 1 mmol/L Ca

Appendix I: Units, Conversions, and Chemical Symbols *continued*

Major Cations | *Major Anions*

Chemical Symbol	Name	Molecular Weight (g/mol)	Chemical Symbol	Name	Molecular Weight (g/mol)
Na	sodium	22.99	Cl	chloride	35.45
K	potassium	39.10	NO_3	nitrate	62.01
Mg	magnesium	24.31	SO_4	sulfate	96.07
Ca	calcium	40.10	HCO_3	bicarbonate	61.02

Trace Metals

Chemical Symbol	Name	Molecular Weight (g/mol)	Chemical Symbol	Name	Molecular Weight (g/mol)
Cr	chromium	52.00	Sr	strontium	87.62
Mn	manganese	54.94	Mo	molybdenum	95.94
Co	cobalt	58.93	Ag	silver	107.87
Ni	nickel	58.69	Cd	cadmium	112.41
Cu	copper	63.55	Ba	barium	137.33
Zn	zinc	65.39	Pb	lead	207.20
As	arsenic	74.92	U	uranium	238.04

Common Terminology

Anthropogenic	man-made
NA	not applicable
NM	not measured
BDL	below detection limits
DO	dissolved oxygen content
ORP	oxidation reduction potential or redox

Appendix II: Sample Names, Locations, and Field Parameters

Table A1-1: September 1998 Sample Names and Locations

Date	Sample	Figure 1 Names	Location	GPS	Sediment Samples
Sep-98	OK-1	OK-2	Washington St.	42/44/23 N 78/07/93 W	N
Sep-98	OK-2	OK-3	Brooklyn Ave. (Crystal Brook)	42/44/22 N 78/06/05 W	N
Sep-98	OK-3	OK-4	West Court St.	42/44/57 N 78/08/18 W	N
Sep-98	OK-4	OK-5	Highway 19 -1/4 mi. outside Warsaw	42/46/51 N 78/07/48 W	N
Sep-98	OK-5	OK-6	School Rd. in Wyoming	42/49/13 N 78/05/18 W	N
Sep-98	OK-6	OK-7	Sherman Ave.	42/49/68 N 78/04/37 W	N
Sep-98	OK-7	OK-8	Rt. 19 Bridge	42/50/94 N 78/03/65 W	N
Sep-98	OK-8	OK-9	Pearl Creek	42/50/91 N 78/02/59 W	N
Sep-98	OK-9	OK-10	Crossman Rd.	42/51/80 N 78/02/86 W	N
Sep-98	OK-10	OK-11	Rt. 63 and River Rd., Pavilion	42/52/81 N 78/01/76 W	N
Sep-98	OK-11	OK-12	Corner of Hartwell, Junction Rd. Bridge	42/55/75 N 78/02/32 W	N
Sep-98	OK-12	OK-13	Corvell Rd.	42/56/65 N 78/02/41 W	N
Sep-98	OK-13	OK-14	Cole Rd.	42/57/42 N 78/01/46 W	N
Sep-98	OK-14	OK-15	Spillway shore, LeRoy	42/58/58 N 77/59/30 W	N
Sep-98	OK-15	OK-16	Church Street, LeRoy	42/59/11 N 77/59/39 W	N
Sep-98	OK-16	OK-20	Perry Rd., McPherson's Orchard	43/00/81 N 77/57/32 W	N
Sep-98	OK-17	OK-22	Access Fishing Point	43/00/86 N 77/56/66 W	N
Sep-98	OK-18	OK-24	On Oatka Trail near Mumford	43/00/12 N 77/55/32 W	N
Sep-98	OK-19	OK-25	Upper Spring Creek	42/58/49 N 77/51/55 W	N
Sep-98	OK-20	OK-26	Bridge at Lower Spring Creek	42/59/38 N 77/51/29 W	N
Sep-98	OK-21	OK-27	State Fishing Site, bridge	42/59/71 N 77/51/80 W	N
Sep-98	OK-22	OK-28	Twin Bridges Rd. with State Rd.	42/59/91 N 77/51/18 W	N
Sep-98	OK-23	OK-29	Wheatland Center	43/00/39 N 77/49/25 W	N
Sep-98	OK-24	OK-30	Creek Gaging Station, Garbutt	43/00/58 N 77/47/48 W	N
Sep-98	OK-25	OK-31	Garbutt: Bowman Rd. Bridge	43/00/58 N 77/45/96 W	N
Sep-98	OK-26	OK-32	Scottsville River Rd. Bridge	43/01/21 N 77/94/44 W	N
Sep-98	OK-27	OK-33	Up Genesee River	43/00/33 N 77/43/88 W	N
Sep-98	OK-28	OK-34	Down Genesee River	43/01/77 N 77/43/42 W	N

Appendix II: Sample Names, Locations, and Field Parameters *continued*

Table A1-2: November 1998 Sample Names and Locations

Date	Sample	Figure 1 Names	Location	GPS	Sediment Samples
Nov-98	OK-1	OK-1	Rock Glen	42/41/08 N 78/07/12 W	N
Nov-98	OK-2	OK-2	Washington St.	42/44/23 N 78/07/93 W	N
Nov-98	OK-3	OK-3	Brooklyn Ave. (Crystal Brook)	42/44/22 N 78/06/05 W	N
Nov-98	OK-4	OK-4	West Court St.	42/44/57 N 78/08/18 W	N
Nov-98	OK-5	OK-5	Highway 19 -1/4 mi. outside Warsaw	42/46/51 N 78/07/48 W	N
Nov-98	OK-6	OK-6	School Rd. in Wyoming	42/49/13 N 78/05/18 W	N
Nov-98	OK-7	OK-7	Sherman Ave.	42/49/68 N 78/04/37 W	N
Nov-98	OK-8	OK-8	Rt. 19 Bridge	42/50/94 N 78/03/65 W	N
Nov-98	OK-9	OK-9	Pearl Creek	42/50/91 N 78/02/59 W	N
Nov-98	OK-10	OK-10	Crossman Rd.	42/51/80 N 78/02/86 W	N
Nov-98	OK-11	OK-11	Rt. 63 and River Rd., Pavilion	42/52/81 N 78/01/76 W	N
Nov-98	OK-12	OK-12	Corner of Hartwell, Junction Rd. Bridge	42/55/75 N 78/02/32 W	N
Nov-98	OK-13	OK-13	Corvell Rd.	42/56/65 N 78/02/41 W	N
Nov-98	OK-14	OK-14	Cole Rd.	42/57/42 N 78/01/46 W	N
Nov-98	OK-15	OK-15	Spillway shore, LeRoy	42/58/58 N 77/59/30 W	N
Nov-98	OK-16	OK-16	Church Street, LeRoy	42/59/11 N 77/59/39 W	N
Nov-98	OK-17	OK-17	Buttermilk Falls	43/00/25 N 77/58/58 W	N
Nov-98	OK-18	OK-18	Unnamed Creek (Parmalee Road)	43/00/92 N 77/58/31 W	N
Nov-98	OK-19	OK-19	Oatka Trail--1st look at Oatka Creek	43/00/99 N 77/87/81 W	N
Nov-98	OK-20	OK-20	Perry Rd., McPherson's Orchard	43/00/81 N 77/57/32 W	N
Nov-98	OK-21	OK-21	Mud Creek	NM	N
Nov-98	OK-22	OK-22	Access Fishing Point	43/00/86 N 77/56/66 W	N
Nov-98	OK-23	OK-23	Some Random Sample	NM	N
Nov-98	OK-24	OK-24	On Oatka Trail near Mumford	43/00/12 N 77/55/32 W	N
Nov-98	OK-25	OK-25	Upper Spring Creek	42/58/49 N 77/51/55 W	N
Nov-98	OK-26	OK-26	Bridge at Lower Spring Creek	42/59/38 N 77/51/29 W	N
Nov-98	OK-27	OK-27	State Fishing Site	42/59/71 N 77/51/80 W	N
Nov-98	OK-28	OK-28	Twin Bridges Rd. with State Rd.	42/59/91 N 77/51/18 W	N
Nov-98	OK-29	OK-29	Wheatland Center	43/00/39 N 77/49/25 W	N
Nov-98	OK-30	OK-30	Creek Gaging Station, Garbutt	43/00/58 N 77/47/48 W	N
Nov-98	OK-31	OK-31	Garbutt: Bowman Rd. Bridge	43/00/58 N 77/45/96 W	N
Nov-98	OK-32	OK-32	Scottsville River Rd. Bridge	43/01/21 N 77/94/44 W	N
Nov-98	OK-33	OK-33	Up Genesee River	43/00/33 N 77/43/88 W	N
Nov-98	OK-34	OK-34	Down Genesee River	43/01/77 N 77/43/42 W	N

Appendix II: Sample Names, Locations, and Field Parameters *continued*

Table A1-3: February 1999 Sample Names and Locations

Date	Sample	Figure 1 Names	Location	GPS	Sediment Samples
Feb-99	OK-1	OK-1	Rock Glen	42/41/08 N 78/07/12 W	N
Feb-99	OK-2	OK-2	Washington St.	42/44/23 N 78/07/93 W	N
Feb-99	OK-3	OK-3	Brooklyn Ave. (Crystal Brook)	42/44/22 N 78/06/05 W	N
Feb-99	OK-4	OK-4	West Court St.	42/44/57 N 78/08/18 W	N
Feb-99	OK-5	OK-5	Highway 19 -1/4 mi. outside Warsaw	42/46/51 N 78/07/48 W	N
Feb-99	OK-6	OK-6	School Rd. in Wyoming	42/49/13 N 78/05/18 W	N
Feb-99	OK-7	OK-7	Sherman Ave.	42/49/68 N 78/04/37 W	N
Feb-99	OK-8	OK-8	Rt. 19 Bridge	42/50/94 N 78/03/65 W	N
Feb-99	OK-9	OK-9	Pearl Creek	42/50/91 N 78/02/59 W	N
Feb-99	OK-10	OK-10	Crossman Rd.	42/51/80 N 78/02/86 W	N
Feb-99	OK-11	OK-11	Rt. 63 and River Rd., Pavilion	42/52/81 N 78/01/76 W	N
Feb-99	OK-12	OK-12	Corner of Hartwell, Junction Rd. Bridge	42/55/75 N 78/02/32 W	N
Feb-99	OK-13	OK-13	Corvell Rd.	42/56/65 N 78/02/41 W	N
Feb-99	OK-14	OK-14	Cole Rd.	42/57/42 N 78/01/46 W	N
Feb-99	OK-15	OK-15	Spillway shore, LeRoy	42/58/58 N 77/59/30 W	N
Feb-99	OK-16	OK-16	Church Street, LeRoy	42/59/11 N 77/59/39 W	N
Feb-99	OK-17	OK-17	Buttermilk Falls	43/00/25 N 77/58/58 W	N
Feb-99	OK-18	OK-18	Unnamed Creek (Parmalee Road)	43/00/92 N 77/58/31 W	N
Feb-99	OK-19	OK-19	Oatka Trail--1st look at Oatka Creek	43/00/99 N 77/87/81 W	N
Feb-99	OK-20	OK-20	Perry Rd., McPherson's Orchard	43/00/81 N 77/57/32 W	N
Feb-99	OK-21	OK-21	Mud Creek	NM	N
Feb-99	OK-22	OK-22	Access Fishing Point	43/00/86 N 77/56/66 W	N
Feb-99	OK-23	OK-23	Some Random Sample	NM	N
Feb-99	OK-24	OK-24	On Oatka Trail near Mumford	43/00/12 N 77/55/32 W	N
Feb-99	OK-25	OK-25	Upper Spring Creek	42/58/49 N 77/51/55 W	N
Feb-99	OK-26	OK-26	Bridge at Lower Spring Creek	42/59/38 N 77/51/29 W	N
Feb-99	OK-27	OK-27	State Fishing Site	42/59/71 N 77/51/80 W	N
Feb-99	OK-28	OK-28	Twin Bridges Rd. with State Rd.	42/59/91 N 77/51/18 W	N
Feb-99	OK-29	OK-29	Wheatland Center	43/00/39 N 77/49/25 W	N
Feb-99	OK-30	OK-30	Creek Gaging Station, Garbutt	43/00/58 N 77/47/48 W	N
Feb-99	OK-31	OK-31	Garbutt: Bowman Rd. Bridge	43/00/58 N 77/45/96 W	N
Feb-99	OK-32	OK-32	Scottsville River Rd. Bridge	43/01/21 N 77/94/44 W	N
Feb-99	OK-33	OK-33	Up Genesee River	43/00/33 N 77/43/88 W	N
Feb-99	OK-34	OK-34	Down Genesee River	43/01/77 N 77/43/42 W	N
Feb-99	Precip-1	P-1	Village of Warsaw	42/45/35 N 78/07/78 W	N
Feb-99	Precip-2	P-2	Village of LeRoy	42/58/41 N 77/59/88 W	N
Feb-99	Precip-3	P-3	Harmon Field	43/00/45 N 77/54/04 W	N
Feb-99	Precip-4	P-4	Garbutt Fishing Access	43/00/69 N 77/47/60 W	N
Feb-99	Precip-5	P-5	Oatka Creek Park	43/00/27 N 77/48/95 W	N

Appendix II: Sample Names, Locations, and Field Parameters *continued*

Table A1-4: September 1999 Sample Names and Locations

Date	Sample	Figure 1 Names	Location	GPS	Sediment Samples
Sep-99	OC-1	OK-11-B	Rt 20, Pavilion	42/52/86 N 78/01/75 W	Y
Sep-99	OC-2	OK-14	Cole Rd	42/57/42 N 78/01/46 W	N
Sep-99	OC-3	OK-15	Spillway shore, LeRoy	42/58/58 N 77/59/30 W	Y
Sep-99	OC-4	OK-18	Unnamed Creek (Parmalee Road)	43/00/92 N 77/58/31 W	N
Sep-99	OC-5	OK-20	Perry Rd., McPherson's Orchard	43/00/81 N 77/57/32 W	N
Sep-99	OC-6	OK-22	Access Fishing Point	43/00/86 N 77/56/66 W	N
Sep-99	OC-7	OK-24	On Oatka Trail near Mumford	43/00/12 N 77/55/32 W	N
Sep-99	OC-8	OK-25	Upper Spring Creek	42/58/49 N 77/51/55 W	Y
Sep-99	OC-9	OK-26	Bridge at Lower Spring Creek	42/59/38 N 77/51/29 W	N
Sep-99	OC-10	OK-27	State Fishing Site	42/59/71 N 77/51/80 W	N
Sep-99	OC-11	OK-28	Twin Bridges Rd. with State Rd.	42/59/91 N 77/51/18 W	Y
Sep-99	OC-12	OK-29	Wheatland Center	43/00/39 N 77/49/25 W	Y
Sep-99	OC-13	OK-30	Creek Gaging Station, Garbutt	43/00/58 N 77/47/48 W	Y
Sep-99	OC-14	OK-31	Garbutt: Bowman Rd. Bridge	43/00/58 N 77/45/96 W	N
Sep-99	OC-15	OK-32	Scottsville River Rd. Bridge	43/01/21 N 77/94/44 W	N

Table A1-5: October 2000 Sample Names and Locations

Date	Sample	Figure 1 Names	Location	GPS	Sediment Samples
Oct-00	OK1	OK-9	Pearl Creek	42/50/91 N 78/02/59 W	Y
Oct-00	OK2	OK-11-B	Rt 20, Pavilion	42/52/86 N 78/01/75 W	Y
Oct-00	OK3	OK-12	Corner of Hartwell, Junction Rd. Bridge	42/55/75 N 78/02/32 W	Y
Oct-00	OK4	OK-14	Cole Road	42/57/42 N 78/01/46 W	Y
Oct-00	OK5	OK-17	Buttermilk Falls	43/00/25 N 77/58/58 W	Y
Oct-00	OK6	OK-20	Perry Rd., McPherson's Orchard	43/00/81 N 77/57/32 W	Y
Oct-00	OK7	OK-24	On Oatka Trail near Mumford	43/00/12 N 77/55/32 W	Y
Oct-00	OK8	OK-26	Bridge at Lower Spring Creek	42/59/38 N 77/51/29 W	Y
Oct-00	OK9	OK-28	Twin Bridges Rd. with State Rd.	42/59/91 N 77/51/18 W	Y
Oct-00	OK10	OK-29	Wheatland Center	43/00/39 N 77/49/25 W	Y
Oct-00	OK11	OK-30	Creek Gaging Station, Garbutt	43/00/58 N 77/47/48 W	Y
Oct-00	OK12	OK-32-B	Sewage Disposal Scottsville	NM	Y

Appendix II: Sample Names, Locations, and Field Parameters *continued*

Table A1-6: September 1998 Field Parameters									
Date	**Sample**	**Temp (C)**	**pH**	**DO[1] (mg/l)**	**DO[1] (%)**	**Conductivity (μS)**	**ORP[1] (mV)**	**River Distance (km)**	**Distance to Oatka Creek (km)**
Sep-98	OK-1	16.49	8.38	10.62	NM	521	NM	0	
Sep-98	OK-2	17	8.6	11.08	NM	451	NM		0.1
Sep-98	OK-3	19	8.54	12.93	NM	512	NM	1	
Sep-98	OK-4	17.15	8.15	7.9	NM	547	NM	5.5	
Sep-98	OK-5	18.57	8.17	9.02	NM	547	NM	12.3	
Sep-98	OK-6	18.21	8.12	8.15	NM	560	NM	14.4	
Sep-98	OK-7	18.68	8.32	10.29	NM	554	NM	18.4	
Sep-98	OK-8	16.85	8.24	8.95	NM	826	NM		1.5
Sep-98	OK-9	18.41	8.19	8.74	NM	580	NM	21	
Sep-98	OK-10	18.36	7.59	7.28	NM	606	NM	24.5	
Sep-98	OK-11	19.02	7.78	9.54	NM	600	NM	31	
Sep-98	OK-12	19.52	8.03	12.13	NM	591	NM	33.7	
Sep-98	OK-13	20.27	8.33	15.43	NM	562	NM	35.9	
Sep-98	OK-14	21.85	8.07	11.63	NM	490	NM	39.5	
Sep-98	OK-15	20.06	8.54	11.88	NM	474	NM	40.7	
Sep-98	OK-16	16.17	7.25	12.51	NM	946	NM	45.9	
Sep-98	OK-17	14.09	7.5	9.99	NM	1062	NM	48.9	
Sep-98	OK-18	16.21	7.78	12.6	NM	1401	NM	53.2	
Sep-98	OK-19	11	7.57	5.9	NM	1123	NM		1.8
Sep-98	OK-20	15.01	8	12.1	NM	1000	NM		0.3
Sep-98	OK-21	16.69	7.96	11.38	NM	1230	NM	54.8	
Sep-98	OK-22	15.47	7.96	11.66	NM	1150	NM	55.8	
Sep-98	OK-23	17.78	8.01	10.92	NM	1075	NM	58.8	
Sep-98	OK-24	18.2	8.05	10.64	NM	1136	NM	60.4	
Sep-98	OK-25	18.36	8.03	10.39	NM	1155	NM	62.7	
Sep-98	OK-26	19.35	8.02	9.72	NM	990	NM	64.7	
Sep-98	OK-27	20.9	8.11	10.2	NM	697	NM		2.7
Sep-98	OK-28	20.5	8.19	10.78	NM	782	NM		0.8

[1]Please see Appendix I for definitions.

Appendix II: Sample Names, Locations, and Field Parameters *continued*

Table A1-7: November 1998 Field Parameters

Date	Sample	Temp (C)	pH*	DO* (mg/l)	DO* (%)	Conductivity (μS)	ORP* (mV)	River Distance (km)	Distance to Oatka Creek (km)
Nov-98	OK-1	5.83	NM	11.01	87.4	497	151	0	
Nov-98	OK-2	6.56	NM	12.39	99.9	500	126	7.2	
Nov-98	OK-3	5.42	NM	13.2	104.8	423	103		0.1
Nov-98	OK-4	6.74	NM	14	115.5	501	107	8.2	
Nov-98	OK-5	6.38	NM	10.03	81.1	540	123	12.7	
Nov-98	OK-6	6.28	NM	10.95	902	545	128	19.5	
Nov-98	OK-7	6.04	NM	10.89	87.5	580	119	21.6	
Nov-98	OK-8	5.87	NM	11.15	88.7	585	116	25.6	
Nov-98	OK-9	6.82	NM	10.14	82.9	834	116		1.5
Nov-98	OK-10	5.72	NM	11.65	92.3	582	108	28.2	
Nov-98	OK-11	5.68	NM	12.73	101.2	587	117	31.7	
Nov-98	OK-12	6.02	NM	12.42	99.2	610	117	38.2	
Nov-98	OK-13	5.57	NM	13.24	105.1	599	98	40.9	
Nov-98	OK-14	5.79	NM	12.72	101.9	596	97	43.1	
Nov-98	OK-15	6.6	NM	NM	NM	634	NM	46.7	
Nov-98	OK-16	6.3	NM	NM	NM	610	NM	47.9	
Nov-98	OK-17	6.1	NM	NM	NM	660	NM	50.7	
Nov-98	OK-18	5.8	NM	NM	NM	1977	NM		0.3
Nov-98	OK-19	8.7	NM	NM	NM	779	NM	52.7	
Nov-98	OK-20	8.3	NM	NM	NM	783	NM	53.1	
Nov-98	OK-21	DRY	DRY	DRY	DRY	DRY	DRY		NA
Nov-98	OK-22	8.5	NM	NM	NM	932	NM	56.1	
Nov-98	OK-23	DRY	DRY	DRY	DRY	DRY	DRY	58	
Nov-98	OK-24	7.8	NM	NM	NM	1259	NM	60.4	
Nov-98	OK-25	9.1	NM	NM	NM	1375	NM		1.8
Nov-98	OK-26	8.6	NM	NM	NM	1193	NM		0.3
Nov-98	OK-27	8.6	NM	NM	NM	1334	NM	62	
Nov-98	OK-28	7.9	NM	NM	NM	1352	NM	63	
Nov-98	OK-29	7.5	NM	NM	NM	1349	NM	66	
Nov-98	OK-30	7.7	NM	NM	NM	1400	NM	67.6	
Nov-98	OK-31	7.2	NM	NM	NM	1405	NM	69.9	
Nov-98	OK-32	7.8	NM	NM	NM	1343	NM	71.9	
Nov-98	OK-33	6.9	NM	NM	NM	559	NM		2.7
Nov-98	OK-34	7.0	NM	NM	NM	604	NM		0.8

*Instruments not working

Appendix II: Sample Names, Locations, and Field Parameters *continued*

Table A1-8: February 1999 Field Parameters

Date	Sample	Temp (C)	pH*	DO* (mg/l)	DO* (%)	Conductivity* (μS)	ORP* (mV)	River Distance (km)	Distance to Oatka Creek (km)
Feb-99	OK-1	1.4	NM	NM	NM	NM	NM	0	
Feb-99	OK-2	1	NM	NM	NM	NM	NM	7.2	
Feb-99	OK-3	0.8	NM	NM	NM	NM	NM		0.1
Feb-99	OK-4	0.4	NM	NM	NM	NM	NM	8.2	
Feb-99	OK-5	0	NM	NM	NM	NM	NM	12.7	
Feb-99	OK-6	1.6	NM	NM	NM	NM	NM	19.5	
Feb-99	OK-7	0.8	NM	NM	NM	NM	NM	21.6	
Feb-99	OK-8	0	NM	NM	NM	NM	NM	25.6	
Feb-99	OK-9	1.5	NM	NM	NM	NM	NM		1.5
Feb-99	OK-10	0.5	NM	NM	NM	NM	NM	28.2	
Feb-99	OK-11	1.8	NM	NM	NM	NM	NM	31.7	
Feb-99	OK-12	2.6	NM	NM	NM	NM	NM	38.2	
Feb-99	OK-13	2.7	NM	NM	NM	NM	NM	40.9	
Feb-99	OK-14	3.3	NM	NM	NM	NM	NM	43.1	
Feb-99	OK-15	0.8	NM	NM	NM	NM	NM	46.7	
Feb-99	OK-16	0.6	NM	NM	NM	NM	NM	47.9	
Feb-99	OK-17	2.2	NM	NM	NM	NM	NM	50.7	
Feb-99	OK-18	1.1	NM	NM	NM	NM	NM		0.3
Feb-99	OK-19	0	NM	NM	NM	NM	NM	52.7	
Feb-99	OK-20	0	NM	NM	NM	NM	NM	53.1	
Feb-99	OK-21	DRY	DRY	DRY	DRY	DRY	DRY		NA
Feb-99	OK-22	0.4	NM	NM	NM	NM	NM	56.1	
Feb-99	OK-23	0.8	NM	NM	NM	NM	NM	58	
Feb-99	OK-24	0.5	NM	NM	NM	NM	NM	60.4	
Feb-99	OK-25	8.2	NM	NM	NM	NM	NM		1.8
Feb-99	OK-26	6.9	NM	NM	NM	NM	NM		0.3
Feb-99	OK-27	0.9	NM	NM	NM	NM	NM	62	
Feb-99	OK-28	2.1	NM	NM	NM	NM	NM	63	
Feb-99	OK-29	2.4	NM	NM	NM	NM	NM	66	
Feb-99	OK-30	2.4	NM	NM	NM	NM	NM	67.6	
Feb-99	OK-31	2.4	NM	NM	NM	NM	NM	69.9	
Feb-99	OK-32	2.1	NM	NM	NM	NM	NM	71.9	
Feb-99	OK-33	0.2	NM	NM	NM	NM	NM		2.7
Feb-99	OK-34	0.9	NM	NM	NM	NM	NM		0.8

*Instruments were not working

Appendix II: Sample Names, Locations, and Field Parameters *continued*

Table A1-9: September 1999 Field Parameters

Date	Sample	Temp (C)	pH	DO (mg/l)	DO (%)	Conductivity (µS)	ORP (mV)	River Distance (km)	Distance to Oatka Creek (km)
Sep-99	OC-1	16.2	8.39	6.0	67	571	64	0	
Sep-99	OC-2	14.5	8.59	8.3	87	593	101	7.9	
Sep-99	OC-3	22	8.53	8.6	101	530	115	11.7	
Sep-99	OC-4	17.4	8.16	5.3	68	1852	124		0.3
Sep-99	OC-5	19	7.96	5.3	94	1038	133	17.7	
Sep-99	OC-6	19.6	7.94	2.9	34	1302	144	20.9	
Sep-99	OC-7	15.7	7.96	5.0	53	1682	145	25.9	
Sep-99	OC-8	14.5	7.67	4.2	43	1350	169		2.3
Sep-99	OC-9	17.4	8.25	8.4	108	1192	165		0.3
Sep-99	OC-10	24.1	8.50	5.8	24	1315	170	27.6	
Sep-99	OC-11	17.8	8.25	4.2	44	1399	176	28.6	
Sep-99	OC-12	17.4	8.35	4.2	61	1342	177	32.7	
Sep-99	OC-13	18.8	8.23	3.8	41	1462	182	35.5	
Sep-99	OC-14	18.9	8.17	3.3	40	1357	183	37.8	
Sep-99	OC-15	18.7	8.24	3.5	51	1315	184	40	

Table A1-10: September 2000 Field Parameters

Date	Sample	Temp (C)	pH	DO (mg/l)	DO (%)	Conductivity (µS)	ORP (mV)	River Distance (km)	Distance to Oatka Creek (km)
Oct-00	OK1	13.4	7.90	NM	55	570	97		1.5
Oct-00	OK2	17.4	8.16	NM	50	546	145	0	
Oct-00	OK3	16.8	8.11	NM	66	373	141	8.5	
Oct-00	OK4	16.3	8.41	NM	91	594	141	14.25	
Oct-00	OK5	19.1	8.86	NM	88	458	146	22.25	
Oct-00	OK6	14.6	8.40	NM	83	504	150	25.75	
Oct-00	OK7	17.8	8.23	NM	78	782	154	34	
Oct-00	OK8	18.2	8.17	NM	93	1070	143		0.3
Oct-00	OK9	17	8.16	NM	84	955	142	36.75	
Oct-00	OK10	16.9	8.31	NM	73	641	149	39.5	
Oct-00	OK11	16.9	8.47	NM	57	450	147	42.25	
Oct-00	OK12	16.5	8.51	NM	69	913	154	46.75	

Appendex III: Major Ion Data of Surface Water and Precipitation

Table A3-1a September 1998 Major Ions. All data are in mmol/L.

Sample	Na	K	Mg	Ca	Cl	NO_3	SO_4	HCO_3
OK-1	1.09	0.05	0.58	1.96	0.99	0.01	0.31	3.78
OK-2	0.79	0.09	0.54	1.73	0.74	0.02	0.23	3.33
OK-3	1.03	0.06	0.46	1.58	1.06	0.01	0.31	3.42
OK-4	1.09	0.07	0.51	1.71	1.11	0.01	0.30	3.83
OK-5	1.15	0.07	0.49	1.64	1.23	0.02	0.30	3.70
OK-6	1.15	0.08	0.52	1.75	1.22	0.01	0.31	3.83
OK-7	1.10	0.07	0.53	1.71	1.20	0.01	0.30	3.79
OK-8	1.64	0.14	0.80	2.69	1.88	0.08	0.30	5.86
OK-9	1.13	0.07	0.55	1.79	1.25	0.02	0.30	4.07
OK-10	1.72	0.10	0.72	2.28	1.45	0.02	0.31	4.10
OK-11	1.71	0.10	0.77	2.40	1.39	0.01	0.29	4.15
OK-12	1.28	0.08	0.62	1.95	1.36	0.01	0.27	4.09
OK-13	1.29	0.08	0.59	1.59	1.43	0.01	0.28	3.67
OK-14	1.20	0.09	0.52	1.28	1.33	0.00	0.28	2.99
OK-15	1.19	0.09	0.51	1.24	1.30	0.00	0.27	2.83
OK-16	0.55	0.06	1.27	3.51	1.03	0.02	2.05	5.07
OK-17	0.98	0.07	1.15	4.13	1.21	0.02	2.86	5.03
OK-18	0.81	0.05	1.35	6.20	1.07	0.01	5.34	4.88
OK-19	1.04	0.08	0.87	4.69	1.46	0.02	3.40	4.34
OK-20	0.99	0.09	0.85	4.14	1.16	0.01	2.98	4.26
OK-21	0.86	0.06	1.22	5.27	1.10	0.01	4.40	4.32
OK-22	0.86	0.06	1.05	4.68	1.11	0.01	3.66	4.30
OK-23	0.92	0.06	1.00	4.45	1.09	0.01	3.32	3.89
OK-24	0.86	0.06	1.02	4.63	1.09	0.01	3.83	3.93
OK-25	0.86	0.06	1.05	4.76	1.09	0.01	3.91	3.92
OK-26	0.89	0.09	0.92	4.03	0.93	0.01	5.02	3.32
OK-27	2.18	0.14	0.72	1.72	1.89	0.01	0.55	3.70
OK-28	2.16	0.09	0.81	2.26	1.99	0.01	0.97	3.74

Appendex III: Major Ion Data of Surface Water and Precipitation *continued*

Table A3-1b September 1998 Major Ions. All data are in ppm.

Sample	Na	K	Mg	Ca	Cl	NO_3	SO_4	HCO_3
OK-1	25.12	2.12	14.02	78.44	35.12	0.63	29.36	230.53
OK-2	18.20	3.36	13.24	69.38	26.19	1.50	22.19	203.08
OK-3	23.78	2.16	11.26	63.23	37.64	0.62	29.36	208.63
OK-4	25.14	2.70	12.34	68.56	39.44	0.89	28.78	233.77
OK-5	26.48	2.64	11.94	65.90	43.65	0.94	28.69	225.50
OK-6	26.42	3.02	12.76	70.28	43.20	0.92	29.46	233.49
OK-7	25.38	2.88	12.98	68.46	42.47	0.91	28.70	231.08
OK-8	37.66	5.32	19.48	107.98	66.69	5.10	29.03	357.35
OK-9	26.04	2.90	13.36	71.90	44.38	1.18	28.55	248.47
OK-10	39.60	3.98	17.44	91.55	51.57	1.21	29.49	250.05
OK-11	39.20	4.00	18.74	96.41	49.19	0.90	27.74	253.18
OK-12	29.36	3.32	15.08	78.24	48.22	0.69	26.29	249.71
OK-13	29.56	3.22	14.27	63.81	50.64	0.37	27.26	223.93
OK-14	27.49	3.43	12.62	51.22	47.09	0.13	27.15	182.37
OK-15	27.42	3.56	12.44	49.63	45.96	0.11	26.32	172.45
OK-16	12.66	2.50	30.93	140.60	36.58	1.22	197.24	309.64
OK-17	22.60	2.82	27.89	165.63	42.90	1.12	275.00	307.15
OK-18	18.58	1.96	32.89	248.66	38.08	0.50	513.34	297.72
OK-19	23.94	3.09	21.21	188.12	51.82	1.05	326.43	264.72
OK-20	22.70	3.64	20.62	166.21	41.20	0.86	285.86	260.03
OK-21	19.70	2.22	29.69	211.16	38.98	0.68	422.24	263.55
OK-22	19.84	2.34	25.41	187.50	39.34	0.92	351.83	262.20
OK-23	21.06	2.20	24.28	178.32	38.50	0.86	318.93	237.47
OK-24	19.86	2.32	24.77	185.76	38.62	0.82	368.23	239.79
OK-25	19.84	2.32	25.59	190.88	38.76	0.86	375.93	239.08
OK-26	20.44	3.48	22.46	161.47	32.88	0.79	482.59	202.82
OK-27	50.10	5.50	17.54	69.04	66.83	0.76	52.60	225.64
OK-28	49.66	3.42	19.62	90.45	70.43	0.70	93.23	228.00

Appendex III: Major Ion Data of Surface Water and Precipitation *continued*

Table A3-2a: November 1998 Major Ions. All data are in mmol/L.

Sample	Na	K	Mg	Ca	Cl	NO_3	SO_4	HCO_3
OK-1	0.77	0.05	0.51	1.63	0.83	0.02	0.27	3.56
OK-2	0.96	0.02	0.53	1.69	1.02	0.01	0.31	4.32
OK-3	0.80	0.10	0.56	1.66	1.33	0.02	0.38	3.32
OK-4	0.94	0.07	0.50	1.56	0.92	0.02	0.26	3.53
OK-5	1.04	0.08	0.51	1.64	1.06	0.01	0.29	3.61
OK-6	1.05	0.06	0.48	1.54	1.15	0.01	0.29	3.59
OK-7	1.53	0.08	0.55	1.76	1.52	0.01	0.29	3.54
OK-8	1.21	0.07	0.55	1.75	1.31	0.02	0.29	3.76
OK-9	1.28	0.09	0.81	2.55	1.78	0.05	0.33	5.84
OK-10	1.11	0.07	0.58	1.81	1.20	0.02	0.31	3.91
OK-11	1.16	0.07	0.58	1.80	1.25	0.01	0.30	3.90
OK-12	1.13	0.06	0.59	1.82	1.37	0.01	0.32	4.04
OK-13	1.10	0.06	0.58	1.78	1.33	0.01	0.31	4.01
OK-14	1.18	0.06	0.58	1.71	1.43	0.01	0.31	3.94
OK-15	1.33	0.08	0.63	1.83	1.42	0.01	0.29	3.98
OK-16	1.27	0.08	0.61	1.73	1.42	0.01	0.29	3.93
OK-17	0.96	0.06	0.65	1.86	1.54	0.01	0.30	3.88
OK-18	1.75	0.05	2.03	7.27	2.32	0.01	7.11	4.98
OK-19	1.26	0.07	0.74	2.16	1.51	0.02	0.80	3.96
OK-20	1.29	0.09	0.75	2.14	1.49	0.02	0.85	4.04
OK-22	1.11	0.06	0.88	2.87	1.37	0.02	1.48	4.31
OK-24	0.74	0.04	1.04	4.61	1.27	0.01	3.26	4.53
OK-25	0.91	0.05	0.96	5.55	1.34	0.01	4.55	4.34
OK-26	0.73	0.04	1.03	4.46	1.18	0.01	3.20	4.36
OK-27	0.73	0.02	1.07	4.77	1.32	0.01	3.81	4.57
OK-28	0.65	0.02	1.24	5.30	1.28	0.01	4.20	4.74
OK-29	0.66	0.02	1.23	5.53	1.26	0.01	4.53	4.67
OK-30	0.67	0.03	1.29	5.75	1.38	0.01	4.68	4.62
OK-31	0.67	0.03	1.32	5.79	1.32	0.01	4.93	4.68
OK-32	1.13	0.07	1.39	5.86	1.41	0.01	4.62	4.68
OK-33	1.03	0.07	0.59	1.58	1.02	0.01	0.93	2.85
OK-34	0.94	0.06	0.63	1.99	1.02	0.01	1.20	3.03
Snow 1997	0.03	0.00	0.00	0.02	0.07	0.00	0.01	0.26

Appendex III: Major Ion Data of Surface Water and Precipitation *continued*

Table A3-2b: November 1998 Major Ions. All data are in ppm.

Sample	Na	K	Mg	Ca	Cl	NO_3	SO_4	HCO_3
OK-1	17.76	2.03	12.34	65.53	29.28	1.10	25.48	217.15
OK-2	22.01	0.86	12.98	67.64	36.03	0.70	30.13	263.47
OK-3	18.32	4.07	13.72	66.73	47.21	1.07	36.57	202.42
OK-4	21.61	2.63	12.05	62.73	32.57	1.11	25.22	215.58
OK-5	23.86	2.98	12.51	65.67	37.46	0.92	28.31	220.00
OK-6	24.03	2.53	11.76	61.91	40.75	0.78	28.25	219.25
OK-7	35.24	3.31	13.32	70.59	53.83	0.76	27.78	215.82
OK-8	27.83	2.75	13.31	70.00	46.34	0.94	28.02	229.29
OK-9	29.37	3.43	19.63	102.26	63.14	3.20	31.33	356.39
OK-10	25.44	2.89	14.07	72.73	42.68	1.05	29.93	238.48
OK-11	26.60	2.92	13.99	72.05	44.48	0.92	29.01	237.84
OK-12	25.95	2.22	14.31	72.95	48.42	0.88	30.66	246.43
OK-13	25.37	2.54	14.14	71.58	47.06	0.87	29.58	244.99
OK-14	27.18	2.43	14.09	68.63	50.52	0.86	29.86	240.12
OK-15	30.61	3.23	15.41	73.27	50.27	0.55	27.51	242.60
OK-16	29.22	2.96	14.85	69.47	50.39	0.56	28.26	239.81
OK-17	22.18	2.24	15.71	74.57	54.65	0.79	29.00	236.48
OK-18	40.24	1.84	49.32	291.47	82.15	0.40	683.17	303.63
OK-19	28.94	2.85	18.06	86.76	53.54	1.00	76.88	241.82
OK-20	29.74	3.52	18.18	85.76	52.84	1.05	81.47	246.37
OK-22	25.62	2.41	21.50	115.26	48.67	1.03	142.01	262.71
OK-24	17.08	1.57	25.26	184.95	44.97	0.75	313.02	276.55
OK-25	20.98	2.15	23.22	222.45	47.66	0.72	437.49	264.92
OK-26	16.88	1.75	25.16	178.95	41.92	0.72	307.35	266.11
OK-27	16.74	0.96	26.10	191.46	46.80	0.80	366.16	279.03
OK-28	14.94	0.91	30.17	212.49	45.30	0.68	403.28	289.46
OK-29	15.14	0.96	29.92	221.85	44.70	0.72	434.97	284.69
OK-30	15.30	1.00	31.40	230.45	49.02	0.84	449.25	281.89
OK-31	15.46	1.00	32.00	232.00	46.66	0.76	473.37	285.61
OK-32	26.00	2.75	33.72	235.14	49.92	0.88	444.13	285.36
OK-33	23.62	2.61	14.26	63.37	36.04	0.44	89.57	174.06
OK-34	21.72	2.45	15.26	79.90	36.20	0.48	114.85	184.68
Snow 1997	0.65	0.13	0.05	0.62	2.48	0.18	0.56	15.62

Appendex III: Major Ion Data of Surface Water and Precipitation *continued*

Table A3-3a: February 1999 Major Ions. All data are in mmol/L.

Sample	Na	K	Mg	Ca	Cl	NO_3	SO_4	HCO_3
OK-1	0.87	0.06	0.37	1.30	0.59	0.09	0.16	2.44
OK-2	1.03	0.06	0.37	1.28	1.00	0.11	0.25	3.12
OK-3	0.54	0.06	0.37	1.13	0.66	0.20	0.22	2.67
OK-4	0.84	0.05	0.36	1.19	0.98	0.12	0.25	2.62
OK-5	0.87	0.05	0.37	1.26	0.94	0.12	0.24	2.85
OK-6	1.04	0.09	0.37	1.24	0.92	0.12	0.26	2.39
OK-7	0.78	0.05	0.37	1.21	0.93	0.12	0.26	2.47
OK-8	0.79	0.05	0.38	1.24	0.90	0.11	0.25	2.51
OK-9	1.10	0.10	0.72	2.16	1.51	0.20	0.37	4.54
OK-10	0.85	0.12	0.43	1.34	1.00	0.12	0.27	2.77
OK-11	0.96	0.06	0.43	1.45	1.09	0.12	0.28	2.82
OK-12	0.98	0.06	0.46	1.47	1.13	0.12	0.29	2.97
OK-13	0.95	0.05	0.43	1.36	1.15	0.12	0.40	2.96
OK-14	0.96	0.05	0.50	1.56	1.10	0.11	0.35	3.05
OK-15	0.88	0.07	0.42	1.36	1.10	0.10	0.25	2.88
OK-16	0.95	0.06	0.46	1.47	1.08	0.10	0.29	2.89
OK-17	1.67	0.18	0.41	1.21	1.16	0.11	0.31	2.90
OK-18	1.77	0.09	1.48	5.84	2.15	0.03	4.89	4.87
OK-19	0.51	0.03	0.34	0.99	1.32	0.11	0.55	3.15
OK-20	1.00	0.06	0.59	1.84	1.25	0.11	0.63	3.25
OK-22	1.16	0.10	0.43	1.47	1.25	0.11	0.61	3.26
OK-23	1.02	0.06	0.65	2.10	1.29	0.10	1.12	3.48
OK-24	0.96	0.06	0.58	1.87	1.26	0.10	0.89	3.30
OK-25	0.95	0.07	0.75	3.69	1.38	0.13	2.50	4.00
OK-26	1.18	0.09	0.89	4.10	1.34	0.12	2.53	4.14
OK-27	1.29	0.07	0.75	2.75	1.35	0.09	1.38	3.50
OK-28	1.17	0.12	0.86	2.84	1.30	0.11	1.51	3.49
OK-29	0.99	0.09	0.76	2.65	1.31	0.11	1.59	3.69
OK-30	1.03	0.06	0.72	3.09	1.34	0.12	1.85	3.69
OK-31	2.63	0.44	0.50	2.40	2.70	0.10	1.81	3.73
OK-32	0.44	0.03	0.33	1.53	1.34	0.12	1.84	3.73
OK-33	1.27	0.18	0.23	0.74	0.77	0.06	0.34	1.82
OK-34	0.73	0.05	0.42	1.42	0.94	0.08	0.80	2.48
Precip-1	0.07	0.00	0.00	0.05	0.07	0.03	0.03	NA
Precip-2	0.01	0.00	0.00	0.01	0.02	0.02	0.01	NA
Precip-3	0.04	0.01	0.00	0.00	0.03	0.02	0.01	NA
Precip-4	0.02	0.00	0.00	0.01	0.03	0.03	0.01	NA
Precip-5	0.00	0.00	0.00	0.00	0.06	0.02	0.01	NA

Appendex III: Major Ion Data of Surface Water and Precipitation *continued*

Table A3-3b: February 1999 Major Ions. All data are in ppm.

Sample	Na	K	Mg	Ca	Cl	NO_3	SO_4	HCO_3
OK-1	20.06	2.35	9.10	51.97	21.04	5.42	15.68	148.71
OK-2	23.72	2.17	9.00	51.19	35.30	6.67	24.36	190.57
OK-3	12.47	2.16	9.05	45.47	23.43	12.40	21.06	162.98
OK-4	19.43	1.91	8.87	47.64	34.79	7.74	24.16	159.83
OK-5	20.09	2.10	9.09	50.39	33.23	7.16	23.46	174.06
OK-6	23.98	3.43	8.94	49.64	32.60	7.31	24.55	145.85
OK-7	18.04	1.77	9.10	48.36	32.84	7.30	24.65	150.70
OK-8	18.05	1.77	9.29	49.87	31.77	6.64	24.28	152.92
OK-9	25.24	3.93	17.51	86.44	53.50	12.40	35.76	277.19
OK-10	19.62	4.54	10.34	53.89	35.48	7.46	25.76	169.14
OK-11	21.97	2.16	10.49	58.29	38.62	7.58	26.56	172.26
OK-12	22.58	2.18	11.18	58.94	40.15	7.58	27.81	181.49
OK-13	21.77	2.14	10.38	54.61	40.80	7.19	37.95	180.41
OK-14	21.96	2.12	12.14	62.59	39.05	6.55	33.21	186.31
OK-15	20.25	2.55	10.24	54.36	38.92	6.21	24.12	175.66
OK-16	21.91	2.49	11.30	58.83	38.15	6.33	27.48	176.23
OK-17	38.29	7.11	10.03	48.64	40.95	6.60	30.02	177.06
OK-18	40.60	3.67	36.02	234.20	76.30	2.00	469.80	296.88
OK-19	11.77	1.29	8.25	39.72	46.80	6.62	52.69	192.09
OK-20	22.88	2.25	14.28	73.80	44.40	7.00	60.09	198.51
OK-22	26.71	3.87	10.53	58.79	44.24	6.54	58.39	198.73
OK-23	23.38	2.25	15.70	84.38	45.58	6.20	107.55	212.34
OK-24	22.18	2.19	14.20	75.16	44.56	6.20	85.61	201.66
OK-25	21.82	2.61	18.12	148.09	48.94	8.14	240.65	243.85
OK-26	27.22	3.43	21.62	164.36	47.62	7.56	243.45	252.74
OK-27	29.72	2.73	18.32	110.19	47.74	5.88	132.29	213.53
OK-28	26.80	4.87	20.94	113.74	46.00	6.82	145.24	213.13
OK-29	22.80	3.63	18.46	106.33	46.42	6.88	152.96	225.08
OK-30	23.62	2.35	17.50	123.74	47.64	7.22	177.84	225.28
OK-31	60.54	17.16	12.06	96.39	95.62	6.38	173.44	227.59
OK-32	10.14	1.10	7.96	61.55	47.42	7.50	176.30	227.57
OK-33	29.18	7.16	5.56	29.50	27.34	3.76	32.52	111.12
OK-34	16.77	2.08	10.14	56.77	33.32	4.76	76.81	151.16
Precip-1	1.59	0.00	0.01	2.03	2.57	2.10	2.60	NA
Precip-2	0.18	0.08	0.04	0.41	0.64	1.47	0.93	NA
Precip-3	0.88	0.50	0.02	0.19	1.24	1.42	0.92	NA
Precip-4	0.48	0.00	0.06	0.33	1.12	1.60	1.19	NA
Precip-5	0.00	0.00	0.00	0.00	2.00	1.30	1.19	NA

Appendex III: Major Ion Data of Surface Water and Precipitation *continued*

Table A3-4a: September 1999 Major Ions. All data are in mmol/L.

Sample	Na	K	Mg	Ca	Cl	NO_3	SO_4	HCO_3
OC-1	1.73	0.10	0.58	1.67	1.55	0.02	0.46	3.34
OC-2	1.67	0.23	0.58	1.65	1.67	0.02	0.39	4.06
OC-3	1.54	0.12	0.57	1.31	1.53	0.00	0.37	2.73
OC-4	2.58	0.04	2.15	7.32	3.03	0.00	7.70	2.83
OC-5	1.26	0.10	1.60	3.67	1.20	0.04	2.41	4.74
OC-6	1.15	0.33	1.68	5.59	1.32	0.08	4.35	4.98
OC-7	0.93	0.00	1.90	8.43	1.01	0.02	7.11	4.53
OC-8	1.37	0.00	1.16	5.87	1.61	0.03	4.51	4.28
OC-9	1.30	0.00	1.12	5.04	1.44	0.03	3.62	4.17
OC-10	1.33	0.00	1.29	5.49	1.44	0.03	4.30	4.27
OC-11	1.12	0.00	1.38	6.11	1.24	0.03	6.96	4.31
OC-12	0.75	0.32	0.92	5.77	1.19	0.02	4.31	4.14
OC-13	1.32	0.00	1.44	6.25	1.03	0.03	5.38	4.23
OC-14	1.44	0.00	1.49	6.91	1.44	0.03	5.27	4.37
OC-15	1.37	0.00	1.42	6.35	1.41	0.03	5.38	4.05

Table A3-4b: September 1999 Major Ions. All data are in ppm.

Sample	Na	K	Mg	Ca	Cl	NO_3	SO_4	HCO_3
OC-1	39.82	3.94	14.15	66.82	54.80	1.02	44.24	203.67
OC-2	38.44	9.14	14.06	66.12	59.14	1.06	37.10	247.64
OC-3	35.36	4.81	13.75	52.67	54.25	0.00	35.40	166.46
OC-4	59.20	1.62	52.25	293.53	107.45	0.00	739.85	172.96
OC-5	28.92	3.85	38.90	147.28	42.60	2.18	231.76	289.51
OC-6	26.44	12.92	40.84	224.35	46.96	4.84	418.32	303.80
OC-7	21.36	0.00	46.12	338.21	35.92	1.07	682.90	276.15
OC-8	31.60	0.00	28.32	235.48	56.91	2.00	433.70	260.88
OC-9	29.80	0.00	27.20	201.94	51.11	2.06	348.08	254.54
OC-10	30.56	0.00	31.32	220.11	51.02	2.12	413.00	260.32
OC-11	25.76	0.00	33.44	244.88	44.09	1.72	669.08	262.88
OC-12	17.16	12.60	22.48	231.36	42.21	1.49	414.04	252.56
OC-13	30.28	0.00	34.92	250.48	36.41	1.58	516.96	257.94
OC-14	33.00	0.00	36.24	277.26	51.21	1.85	506.60	266.81
OC-15	31.40	0.00	34.56	254.49	49.98	1.56	516.56	247.33

Appendex III: Major Ion Data of Surface Water and Precipitation *continued*

Table A3-5a: October 2000 Major Ions. All data are in mmol/L.

Sample	Na	K	Mg	Ca	Cl	NO_3	SO_4	HCO_3
OK-1	1.10	0.08	0.49	1.73	1.23	0.13	0.29	3.91
OK-2	1.18	0.08	0.55	1.77	1.33	0.13	0.29	3.82
OK-3	1.12	0.08	0.51	1.63	1.21	0.12	0.28	3.72
OK-4	1.16	0.08	0.53	1.70	1.29	0.11	0.30	3.92
OK-5	1.16	0.08	0.48	1.58	1.26	0.11	0.29	3.35
OK-6	1.12	0.08	0.50	1.64	1.12	0.11	0.40	3.63
OK-7	1.20	0.08	0.76	2.65	1.25	0.10	1.34	4.09
OK-8	1.19	0.08	0.97	4.40	1.32	0.07	3.16	4.26
OK-9	1.20	0.08	0.82	3.33	1.43	0.10	2.11	4.04
OK-10	1.15	0.08	0.79	3.05	1.40	0.08	2.03	4.11
OK-11	1.20	0.08	0.90	3.57	1.46	0.10	2.37	4.07
OK-12	1.24	0.08	0.88	3.68	1.54	0.09	2.38	4.11

Table A3-5b: October 2000 Major Ions. All data are in ppm.

Sample	Na	K	Mg	Ca	Cl	NO_3	SO_4	HCO_3
OK-1	25.28	3.13	11.82	69.23	43.77	8.19	27.41	238.50
OK-2	27.22	3.13	13.26	71.15	47.16	7.92	27.74	232.81
OK-3	25.66	3.13	12.43	65.47	42.74	7.63	27.01	227.10
OK-4	26.67	3.13	12.84	68.28	45.86	7.03	28.76	239.10
OK-5	26.66	3.13	11.58	63.51	44.77	6.72	27.70	204.55
OK-6	25.74	3.13	12.25	65.58	39.67	7.07	38.70	221.41
OK-7	27.52	3.13	18.37	106.09	44.43	6.51	129.16	249.67
OK-8	27.26	3.13	23.46	176.30	46.70	4.35	303.39	259.83
OK-9	27.57	3.13	19.92	133.63	50.87	6.03	203.14	246.51
OK-10	26.54	3.13	19.13	122.49	49.66	4.98	195.06	250.77
OK-11	27.51	3.13	21.77	143.29	51.61	6.11	227.46	248.36
OK-12	28.59	3.13	21.48	147.55	54.43	5.85	228.66	250.76

Appendix IV: Dissolved Trace Metal Data

Table A4-1a September 1998 Dissolved Trace Metals. All data are in μmol/L.

Sample	Mn	Co	Cu	Zn	As	Sr	Mo	Ag	Cd	Ba	Pb	U
OK-1	0.24	bdl	0.02	0.12	0.01	1.76	0.02	bdl	bdl	0.43	bdl	bdl
OK-2	0.01	bdl	0.02	0.12	0.01	1.36	0.01	bdl	bdl	0.30	bdl	bdl
OK-3	0.31	bdl	0.00	0.02	bdl	1.75	0.02	bdl	bdl	0.41	bdl	bdl
OK-4	1.23	bdl	0.02	0.06	0.02	1.91	0.05	bdl	bdl	0.44	bdl	bdl
OK-5	1.49	bdl	0.03	0.53	0.02	1.97	0.04	bdl	bdl	0.42	bdl	bdl
OK-6	1.29	bdl	0.02	0.04	0.02	1.97	0.04	bdl	bdl	0.44	bdl	bdl
OK-7	1.54	bdl	0.02	0.04	0.02	1.78	0.03	bdl	bdl	0.41	bdl	bdl
OK-8	0.32	bdl	0.02	0.09	0.01	2.24	0.01	bdl	bdl	0.46	bdl	bdl
OK-9	0.80	bdl	0.02	0.11	0.02	2.05	0.03	bdl	bdl	0.43	bdl	bdl
OK-10	1.04	bdl	0.02	0.09	0.02	2.26	0.03	bdl	bdl	0.44	bdl	bdl
OK-11	0.70	bdl	0.02	0.04	0.02	2.28	0.03	bdl	bdl	0.44	bdl	bdl
OK-12	0.41	bdl	0.02	0.63	0.02	2.16	0.02	bdl	bdl	0.43	bdl	bdl
OK-13	0.14	bdl	0.02	0.14	0.02	2.17	0.02	bdl	bdl	0.38	bdl	bdl
OK-14	0.09	bdl	0.02	0.51	0.02	1.87	0.02	bdl	bdl	0.32	bdl	bdl
OK-15	0.31	bdl	0.02	0.32	0.02	1.86	0.02	bdl	bdl	0.30	bdl	bdl
OK-16	0.25	bdl	0.02	0.16	0.01	17.23	0.01	bdl	bdl	0.53	bdl	bdl
OK-17	0.23	bdl	0.02	0.35	bdl	27.87	0.01	bdl	bdl	0.36	bdl	0.01
OK-18	0.37	0.01	0.01	0.05	0.01	44.54	0.02	bdl	bdl	0.39	bdl	0.01
OK-19	0.03	bdl	0.02	0.15	bdl	56.53	0.01	bdl	bdl	0.44	bdl	0.01
OK-20	0.02	bdl	0.01	0.20	bdl	57.37	0.01	bdl	bdl	0.46	bdl	bdl
OK-21	0.25	bdl	0.01	0.69	0.01	60.87	0.01	bdl	bdl	0.41	bdl	0.01
OK-22	0.17	bdl	0.01	0.14	bdl	56.80	0.01	bdl	bdl	0.42	bdl	bdl
OK-23	0.28	0.01	0.19	2.41	0.01	55.01	0.02	0.02	0.02	0.50	0.01	bdl
OK-24	0.13	bdl	0.01	0.70	0.01	53.06	0.01	bdl	bdl	0.38	bdl	bdl
OK-25	0.11	bdl	0.01	2.14	0.01	53.88	bdl	bdl	bdl	0.38	bdl	bdl
OK-26	0.24	0.02	0.02	1.74	0.01	44.88	0.01	bdl	bdl	0.32	bdl	bdl
OK-27	1.10	bdl	0.02	1.96	0.02	3.78	0.01	bdl	bdl	0.47	bdl	bdl
OK-28	0.88	bdl	0.02	0.38	0.02	10.19	0.01	bdl	bdl	0.48	bdl	bdl

Appendix IV: Dissolved Trace Metal Data *continued*

Table A4-1b September 1998 Dissolved Trace Metals. All data are in ppb.

Sample	Mn	Co	Cu	Zn	As	Sr	Mo	Ag	Cd	Ba	Pb	U
OK-1	13.27	bdl	1.08	8.12	0.52	154.43	1.55	bdl	bdl	58.92	bdl	bdl
OK-2	0.70	bdl	1.40	7.79	0.63	119.15	1.39	bdl	bdl	40.85	bdl	bdl
OK-3	16.91	bdl	0.15	1.08	bdl	153.77	1.67	bdl	bdl	56.47	bdl	bdl
OK-4	67.66	bdl	1.41	3.84	1.15	167.73	4.33	bdl	bdl	60.50	bdl	bdl
OK-5	81.75	bdl	1.76	34.79	1.49	172.18	4.30	bdl	bdl	58.08	bdl	bdl
OK-6	70.72	bdl	1.24	2.58	1.53	172.26	3.96	bdl	bdl	60.41	bdl	bdl
OK-7	84.44	bdl	0.95	2.46	1.39	155.93	2.89	bdl	bdl	55.97	bdl	bdl
OK-8	17.44	bdl	1.03	5.88	0.57	196.56	0.61	bdl	bdl	63.59	bdl	bdl
OK-9	44.05	bdl	1.23	7.38	1.36	179.85	2.75	bdl	bdl	59.65	bdl	bdl
OK-10	56.87	bdl	1.22	5.87	1.28	197.99	2.68	bdl	bdl	60.84	bdl	bdl
OK-11	38.28	bdl	1.51	2.33	1.30	200.09	2.49	bdl	bdl	60.65	bdl	bdl
OK-12	22.53	bdl	1.09	41.28	1.25	188.90	2.28	bdl	bdl	58.70	bdl	bdl
OK-13	7.55	bdl	1.08	8.83	1.26	190.32	2.30	bdl	bdl	52.57	bdl	bdl
OK-14	5.05	bdl	1.37	33.24	1.19	163.72	1.84	bdl	bdl	44.09	bdl	bdl
OK-15	17.02	bdl	1.36	20.62	1.29	163.22	1.89	bdl	bdl	41.49	bdl	bdl
OK-16	13.88	bdl	0.97	10.17	0.46	1510.11	1.06	bdl	bdl	73.25	bdl	bdl
OK-17	12.89	bdl	1.55	22.58	bdl	2442.02	1.43	bdl	bdl	48.81	bdl	1.25
OK-18	20.48	0.30	0.66	3.03	0.47	3902.42	2.20	bdl	bdl	53.44	bdl	1.53
OK-19	1.51	bdl	0.98	9.72	bdl	4952.89	0.99	bdl	bdl	60.51	bdl	1.30
OK-20	0.90	bdl	0.68	13.31	bdl	5026.37	0.95	bdl	bdl	62.86	bdl	bdl
OK-21	13.93	bdl	0.82	45.01	0.43	5333.57	1.35	bdl	bdl	56.06	bdl	1.23
OK-22	9.38	bdl	0.58	9.12	bdl	4977.09	1.11	bdl	bdl	57.97	bdl	bdl
OK-23	15.60	0.48	11.84	157.67	0.44	4819.72	1.97	2.27	2.19	69.33	3.00	bdl
OK-24	6.97	bdl	0.94	45.74	0.39	4649.07	1.29	bdl	bdl	52.64	bdl	bdl
OK-25	6.26	bdl	0.78	139.65	0.42	4721.40	bdl	bdl	bdl	52.18	bdl	bdl
OK-26	13.13	1.02	1.18	113.90	0.43	3932.75	1.27	bdl	bdl	43.39	bdl	bdl
OK-27	60.20	bdl	1.48	128.20	1.30	331.33	1.21	bdl	bdl	65.02	bdl	bdl
OK-28	48.30	bdl	1.41	24.81	1.18	892.48	1.29	bdl	bdl	65.77	bdl	bdl

Appendix IV: Dissolved Trace Metal Data *continued*

Table A4-2a: November 1998 Dissolved Trace Metals. All data are in μmol/L.

Sample	Mn	Co	Cu	Zn	As	Sr	Mo	Ag	Cd	Ba	Pb	U
OK-1	0.49	bdl	0.01	0.11	0.01	1.54	0.01	bdl	bdl	0.45	bdl	bdl
OK-2	0.25	bdl	0.02	0.16	0.01	1.65	0.01	bdl	bdl	0.41	bdl	bdl
OK-3	0.01	bdl	0.02	0.16	0.01	1.16	0.01	bdl	bdl	0.29	bdl	bdl
OK-4	0.19	bdl	0.02	0.13	0.01	1.61	0.01	bdl	bdl	0.37	bdl	bdl
OK-5	1.12	bdl	0.02	0.09	0.01	1.54	0.02	bdl	bdl	0.44	bdl	bdl
OK-6	0.91	bdl	0.02	0.04	0.01	1.61	0.01	bdl	bdl	0.37	bdl	bdl
OK-7	1.10	bdl	0.02	0.11	0.01	1.60	0.02	bdl	bdl	0.43	bdl	bdl
OK-8	1.51	bdl	0.02	0.09	0.01	1.90	0.02	bdl	bdl	0.42	bdl	bdl
OK-9	0.13	bdl	0.01	0.01	0.01	2.03	0.01	bdl	bdl	0.43	bdl	bdl
OK-10	0.82	bdl	0.01	0.08	0.01	1.89	0.01	bdl	bdl	0.39	bdl	bdl
OK-11	0.56	bdl	0.01	0.03	0.01	1.86	0.01	bdl	bdl	0.38	bdl	bdl
OK-12	0.41	bdl	0.02	0.01	0.01	2.01	0.02	bdl	bdl	0.42	bdl	bdl
OK-13	0.19	bdl	0.02	0.03	0.01	2.15	0.01	bdl	bdl	0.39	bdl	bdl
OK-14	0.12	bdl	0.02	0.04	bdl	2.23	0.01	bdl	bdl	0.38	bdl	bdl
OK-15	0.39	bdl	0.02	0.07	0.01	2.12	0.01	bdl	bdl	0.38	bdl	bdl
OK-16	0.21	bdl	0.02	0.07	0.01	2.10	0.01	bdl	bdl	0.38	bdl	bdl
OK-17	0.03	bdl	0.02	0.07	0.01	2.18	0.01	bdl	bdl	0.37	bdl	bdl
OK-18	0.22	0.01	0.01	0.04	0.01	58.03	0.03	bdl	bdl	0.41	bdl	0.01
OK-19	0.01	bdl	0.02	0.09	0.01	7.25	0.02	bdl	bdl	0.33	bdl	bdl
OK-20	0.04	bdl	0.02	0.05	0.01	7.27	0.01	bdl	bdl	0.34	bdl	bdl
OK-22	0.06	bdl	0.02	0.03	0.01	12.79	0.01	bdl	bdl	0.32	bdl	bdl
OK-24	0.23	0.01	0.01	0.03	0.01	33.02	0.02	bdl	bdl	0.30	bdl	bdl
OK-25	0.00	0.01	0.01	0.12	bdl	60.75	0.01	bdl	bdl	0.46	bdl	0.01
OK-26	0.02	bdl	0.01	0.06	bdl	58.71	0.01	bdl	bdl	0.52	bdl	0.01
OK-27	0.16	0.05	0.01	0.06	bdl	59.17	0.01	bdl	bdl	0.46	bdl	bdl
OK-28	0.66	0.01	0.01	0.08	0.01	59.01	0.02	bdl	bdl	0.46	bdl	0.01
OK-29	0.29	0.06	0.01	0.05	bdl	62.70	0.02	bdl	bdl	0.42	bdl	0.01
OK-30	0.05	0.01	0.01	0.25	bdl	58.76	0.02	bdl	bdl	0.39	bdl	0.01
OK-31	0.05	0.01	0.01	0.08	bdl	60.42	0.02	bdl	bdl	0.39	bdl	0.01
OK-32	0.07	0.01	0.01	0.08	bdl	60.49	0.02	bdl	bdl	0.41	bdl	0.01
OK-33	1.44	bdl	0.02	0.08	0.01	5.99	0.01	bdl	bdl	0.37	bdl	bdl
OK-34	0.92	bdl	0.02	0.11	0.01	10.63	0.01	bdl	bdl	0.34	bdl	bdl

Appendix IV: Dissolved Trace Metal Data *continued*

Table A4-2b: November 1998 Dissolved Trace Metals. All data are in ppb.

Sample	Mn	Co	Cu	Zn	As	Sr	Mo	Ag	Cd	Ba	Pb	U
OK-1	26.96	bdl	0.78	7.32	0.47	135.20	0.82	bdl	bdl	62.40	bdl	bdl
OK-2	13.67	bdl	1.02	10.79	0.40	144.84	1.27	bdl	bdl	56.05	bdl	bdl
OK-3	0.67	bdl	0.97	10.61	0.47	101.55	0.81	bdl	bdl	39.19	bdl	bdl
OK-4	10.24	bdl	1.00	8.33	0.44	140.64	1.16	bdl	bdl	51.48	bdl	bdl
OK-5	61.34	bdl	1.17	5.67	0.77	135.22	1.54	bdl	bdl	61.05	bdl	bdl
OK-6	49.76	bdl	1.16	2.40	0.77	140.98	1.16	bdl	bdl	50.86	bdl	bdl
OK-7	60.30	bdl	1.32	7.31	0.67	140.30	1.57	bdl	bdl	58.44	bdl	bdl
OK-8	83.07	bdl	1.22	5.63	0.83	166.91	1.58	bdl	bdl	57.06	bdl	bdl
OK-9	6.90	bdl	0.73	0.65	0.44	178.11	0.52	bdl	bdl	59.08	bdl	bdl
OK-10	45.13	bdl	0.93	5.34	0.74	165.94	1.32	bdl	bdl	53.93	bdl	bdl
OK-11	30.61	bdl	0.93	2.03	0.75	162.80	1.24	bdl	bdl	52.07	bdl	bdl
OK-12	22.59	bdl	1.21	0.45	0.67	176.36	1.50	bdl	bdl	57.06	bdl	bdl
OK-13	10.48	bdl	1.00	1.70	0.69	188.55	1.34	bdl	bdl	52.92	bdl	bdl
OK-14	6.86	bdl	0.98	2.70	bdl	195.62	1.25	bdl	bdl	52.49	bdl	bdl
OK-15	21.29	bdl	1.13	4.36	0.67	185.68	1.28	bdl	bdl	52.68	bdl	bdl
OK-16	11.47	bdl	1.42	4.70	0.67	183.79	1.28	bdl	bdl	51.93	bdl	bdl
OK-17	1.72	bdl	1.29	4.64	0.59	190.88	1.36	bdl	bdl	51.28	bdl	bdl
OK-18	12.16	0.59	0.52	2.55	0.65	5084.79	2.55	bdl	bdl	55.80	bdl	1.85
OK-19	0.80	bdl	1.39	5.80	0.80	635.63	1.44	bdl	bdl	45.23	bdl	bdl
OK-20	2.32	bdl	1.30	3.53	0.73	636.85	1.38	bdl	bdl	47.33	bdl	bdl
OK-22	3.23	bdl	0.96	1.93	0.64	1120.43	1.43	bdl	bdl	43.37	bdl	bdl
OK-24	12.60	0.33	0.88	1.99	0.46	2893.04	1.73	bdl	bdl	40.85	bdl	bdl
OK-25	0.24	0.33	0.75	7.64	bdl	5323.32	1.15	bdl	bdl	63.05	bdl	1.43
OK-26	1.24	bdl	0.62	4.16	bdl	5144.35	0.89	bdl	bdl	70.79	bdl	1.28
OK-27	8.79	2.95	0.70	3.77	bdl	5184.34	1.06	bdl	bdl	63.13	bdl	bdl
OK-28	36.50	0.37	0.72	5.27	0.42	5170.24	1.61	bdl	bdl	62.51	bdl	1.37
OK-29	15.68	3.47	0.67	3.34	bdl	5493.59	1.48	bdl	bdl	58.20	bdl	1.30
OK-30	2.88	0.37	0.68	16.23	bdl	5148.28	1.45	bdl	bdl	53.33	bdl	1.30
OK-31	2.77	0.35	0.66	5.52	bdl	5293.93	1.49	bdl	bdl	53.93	bdl	1.31
OK-32	3.81	0.33	0.71	5.49	bdl	5300.05	1.57	bdl	bdl	56.62	bdl	1.32
OK-33	78.86	bdl	1.01	5.03	0.79	524.55	0.89	bdl	bdl	51.47	bdl	bdl
OK-34	50.30	bdl	0.99	7.20	0.81	931.59	0.82	bdl	bdl	46.71	bdl	bdl

Appendix IV: Dissolved Trace Metal Data *continued*

Table A4-3a: February 1999 Dissolved Trace Metals. All data are in μmol/L.

Sample	Mn	Co	Cu	Zn	As	Sr	Mo	Ag	Cd	Ba	Pb	U
OK-1	0.37	bdl	0.01	0.04	bdl	0.86	bdl	bdl	bdl	0.26	bdl	bdl
OK-2	0.29	bdl	0.01	0.21	bdl	0.80	0.01	bdl	bdl	0.22	bdl	bdl
OK-3	0.06	bdl	0.01	0.06	bdl	0.58	bdl	bdl	bdl	0.19	bdl	bdl
OK-4	0.44	bdl	0.02	0.09	0.01	1.13	0.01	bdl	bdl	0.31	bdl	bdl
OK-5	1.13	bdl	0.02	0.12	0.01	1.20	0.01	bdl	bdl	0.31	bdl	bdl
OK-6	0.93	bdl	0.02	0.07	0.01	1.04	0.01	bdl	bdl	0.26	bdl	bdl
OK-7	0.96	bdl	0.02	0.11	0.01	1.11	0.01	bdl	bdl	0.28	bdl	bdl
OK-8	0.75	bdl	0.01	0.07	bdl	0.94	0.01	bdl	bdl	0.24	bdl	bdl
OK-9	0.57	bdl	0.01	0.06	bdl	1.24	bdl	bdl	bdl	0.28	bdl	bdl
OK-10	0.68	bdl	0.02	0.08	bdl	1.08	0.01	bdl	bdl	0.28	bdl	bdl
OK-11	0.51	bdl	0.01	0.09	bdl	0.84	bdl	bdl	bdl	0.18	bdl	bdl
OK-12	0.56	bdl	0.01	0.07	bdl	1.11	0.01	bdl	bdl	0.23	bdl	bdl
OK-13	4.85	bdl	0.02	0.07	bdl	1.46	0.01	bdl	bdl	0.32	bdl	bdl
OK-14	0.39	bdl	0.02	0.04	0.01	1.57	0.01	bdl	bdl	0.28	bdl	bdl
OK-15	0.57	bdl	0.01	0.14	bdl	1.06	bdl	bdl	bdl	0.22	bdl	bdl
OK-16	0.31	bdl	0.02	0.27	bdl	1.10	0.01	bdl	bdl	0.22	bdl	bdl
OK-17	0.34	bdl	0.02	0.28	0.01	1.45	0.01	bdl	bdl	0.27	bdl	bdl
OK-18	0.57	0.01	0.02	0.09	0.01	42.33	0.01	bdl	bdl	0.35	bdl	0.01
OK-19	0.25	bdl	0.02	0.03	0.01	3.67	0.01	bdl	bdl	0.30	bdl	bdl
OK-20	0.18	bdl	0.02	0.08	bdl	3.30	0.01	bdl	bdl	0.27	bdl	bdl
OK-22	0.17	bdl	0.02	0.08	bdl	3.59	0.01	bdl	bdl	0.27	bdl	bdl
OK-23	0.12	bdl	0.01	0.09	bdl	5.71	0.01	bdl	bdl	0.17	bdl	bdl
OK-24	0.22	bdl	0.02	0.08	0.01	7.63	0.01	bdl	bdl	0.31	bdl	bdl
OK-25	0.00	bdl	0.00	0.10	bdl	39.77	0.01	bdl	bdl	0.41	bdl	bdl
OK-26	0.02	bdl	0.01	0.08	bdl	45.58	0.01	bdl	bdl	0.43	bdl	0.01
OK-27	0.71	bdl	0.02	0.13	bdl	12.41	0.01	bdl	bdl	0.33	bdl	bdl
OK-28	0.22	bdl	0.02	0.10	0.01	19.56	0.01	bdl	bdl	0.34	bdl	bdl
OK-29	0.19	bdl	0.02	0.08	0.01	21.52	0.01	bdl	bdl	0.34	bdl	bdl
OK-30	0.14	bdl	0.02	0.04	nd	20.38	0.01	bdl	bdl	0.30	bdl	bdl
OK-31	0.15	bdl	0.02	0.10	0.01	22.18	0.01	bdl	bdl	0.33	bdl	bdl
OK-32	0.12	bdl	0.02	0.13	nd	18.58	0.01	bdl	bdl	0.31	bdl	bdl
OK-33	0.71	bdl	0.01	0.03	0.01	2.13	bdl	bdl	bdl	0.27	bdl	bdl
OK-34	0.36	bdl	0.01	0.06	0.01	6.26	0.01	bdl	bdl	0.22	bdl	bdl
Precip-1	0.24	bdl	0.01	0.69	bdl	0.08	bdl	bdl	bdl	0.02	bdl	bdl
Precip-2	0.13	bdl	0.02	0.39	bdl	0.04	bdl	bdl	bdl	0.01	bdl	bdl
Precip-3	0.26	0.01	0.01	0.51	bdl	0.03	bdl	bdl	bdl	0.01	0.03	bdl
Precip-4	0.01	bdl	bdl	0.38	bdl	0.00	bdl	bdl	bdl	0.00	bdl	bdl
Precip-5	0.44	0.01	0.37	5.33	0.01	0.13	bdl	nd	0.02	0.22	0.05	bdl

Appendix IV: Dissolved Trace Metal Data *continued*

Table A4-3b: February 1999 Dissolved Trace Metals. All data in ppb.

Sample	Mn	Co	Cu	Zn	As	Sr	Mo	Ag	Cd	Ba	Pb	U
OK-1	20.26	bdl	0.58	2.67	bdl	75.22	bdl	bdl	bdl	36.23	bdl	bdl
OK-2	15.82	bdl	0.68	13.75	bdl	69.74	0.51	bdl	bdl	30.64	bdl	bdl
OK-3	3.24	bdl	0.56	4.12	bdl	51.16	bdl	bdl	bdl	25.70	bdl	bdl
OK-4	24.29	bdl	0.98	5.90	0.38	98.78	0.73	bdl	bdl	42.92	bdl	bdl
OK-5	62.23	bdl	1.12	8.11	0.41	105.01	0.73	bdl	bdl	42.09	bdl	bdl
OK-6	50.82	bdl	1.04	4.53	0.39	90.71	0.65	bdl	bdl	36.25	bdl	bdl
OK-7	52.65	bdl	1.08	7.46	0.39	97.10	0.68	bdl	bdl	38.20	bdl	bdl
OK-8	41.02	bdl	0.95	4.33	bdl	82.56	0.63	bdl	bdl	32.33	bdl	bdl
OK-9	31.40	bdl	0.88	3.63	bdl	108.70	bdl	bdl	bdl	38.66	bdl	bdl
OK-10	37.43	bdl	1.03	5.29	bdl	94.25	0.66	bdl	bdl	38.05	bdl	bdl
OK-11	28.07	bdl	0.76	5.81	bdl	73.19	bdl	bdl	bdl	25.37	bdl	bdl
OK-12	30.62	bdl	0.87	4.40	bdl	96.87	0.55	bdl	bdl	31.37	bdl	bdl
OK-13	266.21	bdl	1.21	4.68	bdl	128.33	0.75	bdl	bdl	43.86	bdl	bdl
OK-14	21.39	bdl	1.16	2.73	0.41	137.93	0.65	bdl	bdl	37.92	bdl	bdl
OK-15	31.36	bdl	0.86	8.94	bdl	92.78	bdl	bdl	bdl	30.16	bdl	bdl
OK-16	16.87	bdl	0.97	17.40	bdl	96.38	0.52	bdl	bdl	30.08	bdl	bdl
OK-17	18.50	bdl	1.24	18.09	0.42	126.94	0.69	bdl	bdl	37.19	bdl	bdl
OK-18	31.16	0.30	1.01	5.99	0.60	3709.10	1.44	bdl	bdl	48.08	bdl	1.51
OK-19	13.53	bdl	1.29	1.81	0.46	321.21	0.77	bdl	bdl	41.44	bdl	bdl
OK-20	9.94	bdl	1.09	5.54	bdl	289.47	0.66	bdl	bdl	37.14	bdl	bdl
OK-22	9.60	bdl	1.08	5.05	bdl	314.92	0.68	bdl	bdl	36.66	bdl	bdl
OK-23	6.74	bdl	0.71	5.75	bdl	500.38	0.58	bdl	bdl	23.69	bdl	bdl
OK-24	12.24	bdl	1.19	5.45	0.42	668.80	0.90	bdl	bdl	41.97	bdl	bdl
OK-25	0.16	bdl	0.09	6.62	bdl	3485.03	1.35	bdl	bdl	56.44	bdl	bdl
OK-26	1.07	bdl	0.85	5.49	bdl	3993.96	1.26	bdl	bdl	59.19	bdl	1.27
OK-27	38.99	bdl	1.16	8.66	bdl	1087.30	1.01	bdl	bdl	45.30	bdl	bdl
OK-28	12.03	bdl	1.13	6.82	0.40	1713.90	1.04	bdl	bdl	47.31	bdl	bdl
OK-29	10.23	bdl	1.04	5.32	0.38	1885.32	0.98	bdl	bdl	46.16	bdl	bdl
OK-30	7.64	bdl	0.96	2.79	bdl	1785.83	1.10	bdl	bdl	41.82	bdl	bdl
OK-31	8.16	bdl	1.04	6.81	0.45	1943.50	1.19	bdl	bdl	44.72	bdl	bdl
OK-32	6.51	bdl	1.02	8.65	bdl	1628.04	1.02	bdl	bdl	42.99	bdl	bdl
OK-33	39.07	bdl	0.84	1.76	0.56	186.38	bdl	bdl	bdl	37.48	bdl	bdl
OK-34	19.66	bdl	0.71	4.21	0.45	548.24	0.50	bdl	bdl	29.95	bdl	bdl
Precip-1	13.32	bdl	0.45	44.96	bdl	6.60	bdl	bdl	bdl	2.08	bdl	bdl
Precip-2	7.14	bdl	1.10	25.63	bdl	3.23	bdl	bdl	bdl	2.04	bdl	bdl
Precip-3	14.45	0.37	0.72	33.03	bdl	2.61	bdl	bdl	bdl	1.59	6.45	bdl
Precip-4	0.78	bdl	bdl	24.56	bdl	0.29	bdl	bdl	bdl	0.54	bdl	bdl
Precip-5	23.98	0.36	23.73	348.65	0.39	11.58	bdl	bdl	2.64	30.71	9.89	bdl

Appendix IV: Dissolved Trace Metal Data *continued*

Table A4-4a: September 1999 Dissolved Trace Metals. All data are in μmol/L.

Sample	Cr	Mn	Co	Ni	Cu	Zn	As	Sr	Mo	Ag	Cd	Ba	Pb	U
OC-1	0.03	0.65	bdl	0.03	0.03	0.07	0.02	1.69	0.04	bdl	bdl	0.48	bdl	nd
OC-2	0.04	0.10	bdl	0.03	0.02	0.05	0.02	1.95	0.02	bdl	bdl	0.53	bdl	nd
OC-3	0.02	0.24	bdl	0.03	0.02	0.03	0.02	1.72	0.03	bdl	bdl	0.44	bdl	nd
OC-4	0.04	0.19	0.01	0.12	0.02	0.10	0.02	57.96	0.04	bdl	bdl	0.49	bdl	0.02
OC-5	0.05	4.09	0.01	0.07	0.01	0.08	0.02	16.69	0.02	bdl	bdl	0.91	bdl	0.01
OC-6	0.05	0.38	0.01	0.08	0.02	0.16	0.01	29.67	0.02	bdl	bdl	0.65	bdl	0.02
OC-7	0.04	0.62	0.01	0.10	0.01	0.06	0.01	63.28	0.02	bdl	bdl	0.42	bdl	0.01
OC-8	0.03	0.13	0.01	0.08	0.02	0.08	0.01	57.69	0.02	bdl	bdl	0.54	bdl	0.01
OC-9	0.04	0.02	0.01	0.07	0.02	0.14	bdl	54.91	0.01	bdl	bdl	0.72	bdl	0.01
OC-10	0.03	0.15	0.01	0.08	0.01	0.07	0.01	57.23	0.01	bdl	bdl	0.66	bdl	0.01
OC-11	0.05	0.32	0.01	0.10	0.01	0.12	0.01	59.92	0.01	bdl	bdl	0.65	bdl	0.01
OC-12	0.04	0.22	0.01	0.08	0.02	0.17	0.01	59.38	0.02	bdl	bdl	0.56	bdl	0.01
OC-13	0.03	0.13	0.01	0.08	0.02	0.08	0.01	57.77	0.02	bdl	bdl	0.55	bdl	0.01
OC-14	0.05	0.13	0.01	0.09	0.02	0.13	0.01	62.47	0.02	bdl	bdl	0.54	bdl	0.01
OC-15	0.03	0.14	0.01	0.08	0.02	0.11	0.01	57.93	0.02	bdl	bdl	0.54	bdl	0.01

Table A4-4b: September 1999 Dissolved Trace Metals. All data are in ppb.

Sample	Cr	Mn	Co	Ni	Cu	Zn	As	Sr	Mo	Ag	Cd	Ba	Pb	U
OC-1	1.50	35.66	bdl	1.63	1.67	4.31	1.56	147.75	3.40	bdl	bdl	66.53	bdl	nd
OC-2	2.20	5.73	bdl	2.02	1.49	3.37	1.51	170.84	1.83	bdl	bdl	72.70	bdl	nd
OC-3	1.16	13.39	bdl	1.66	1.43	2.05	1.19	150.89	2.93	bdl	bdl	60.35	bdl	nd
OC-4	1.98	10.18	0.64	6.96	1.16	6.75	1.18	5078.81	3.49	bdl	bdl	66.61	bdl	4.76
OC-5	2.49	224.80	0.54	4.01	0.59	5.46	1.18	1462.05	2.03	bdl	bdl	124.59	bdl	2.38
OC-6	2.65	20.81	0.46	4.71	1.02	10.29	0.46	2599.82	1.69	bdl	bdl	88.78	bdl	4.76
OC-7	1.95	33.84	0.55	5.89	0.70	3.99	0.56	5544.26	2.24	bdl	bdl	57.72	bdl	2.38
OC-8	1.50	7.19	0.40	4.63	1.00	5.25	0.54	5055.14	1.86	bdl	bdl	74.83	bdl	2.38
OC-9	1.87	0.96	0.37	4.08	1.10	9.16	bdl	4811.16	1.15	bdl	bdl	99.16	bdl	2.38
OC-10	1.73	8.03	0.40	4.66	0.88	4.75	0.38	5014.11	1.21	bdl	bdl	90.24	bdl	2.38
OC-11	2.56	17.58	0.52	5.84	0.87	8.11	0.57	5250.60	1.33	bdl	bdl	89.07	bdl	2.38
OC-12	1.94	12.06	0.44	4.84	1.00	10.91	0.50	5202.68	1.46	bdl	bdl	77.49	bdl	2.38
OC-13	1.50	7.20	0.40	4.64	1.00	5.26	0.54	5062.15	1.87	bdl	bdl	74.93	bdl	2.38
OC-14	2.84	7.35	0.46	5.33	1.13	8.25	0.43	5473.86	1.75	bdl	bdl	73.91	bdl	2.38
OC-15	1.62	7.57	0.42	4.94	1.12	7.08	0.75	5075.54	1.81	bdl	bdl	73.80	bdl	2.38

Appendix IV: Dissolved Trace Metal Data *continued*

Table A4-5a: October 2000 Dissolved Trace Metals. All data are in μmol/L.

Sample	Cr	Mn	Co	Ni	Cu	Zn	As	Sr	Mo	Ag	Cd	Ba	Pb	U
OK-1	0.01	0.55	0.01	0.03	0.04	0.10	0.01	2.88	0.01	bdl	bdl	0.43	bdl	bdl
OK-2	0.01	0.69	0.01	0.04	0.04	0.05	0.01	3.30	0.01	bdl	bdl	0.44	bdl	bdl
OK-3	0.01	0.40	0.01	0.04	0.04	0.11	0.01	3.27	0.02	bdl	bdl	0.44	bdl	bdl
OK-4	0.01	0.25	0.01	0.04	0.04	0.17	0.01	3.49	0.02	bdl	bdl	0.47	bdl	bdl
OK-5	0.01	0.10	0.01	0.04	0.05	0.10	0.01	3.19	0.02	bdl	bdl	0.42	bdl	bdl
OK-6	0.01	0.11	0.01	0.04	0.05	0.21	0.01	6.16	0.02	bdl	bdl	0.46	bdl	bdl
OK-7	0.01	0.24	0.01	0.04	0.04	0.07	0.01	20.28	0.02	bdl	bdl	0.32	bdl	bdl
OK-8	0.01	0.03	0.01	0.06	0.02	0.15	0.01	63.47	0.01	bdl	bdl	0.49	bdl	0.01
OK-9	0.01	0.21	0.01	0.05	0.03	0.12	0.01	35.11	0.02	bdl	bdl	0.39	bdl	bdl
OK-10	0.01	0.20	0.01	0.05	0.03	0.23	0.01	38.03	0.02	bdl	bdl	0.41	bdl	bdl
OK-11	0.01	0.13	0.01	0.05	0.03	0.13	0.01	39.10	0.02	bdl	bdl	0.40	bdl	bdl
OK-12	0.01	0.09	0.01	0.06	0.03	0.08	0.01	40.24	0.02	bdl	bdl	0.42	bdl	bdl

Table A4-5b: October 2000 Dissolved Trace Metals. All data are in ppb.

Sample	Cr	Mn	Co	Ni	Cu	Zn	As	Sr	Mo	Ag	Cd	Ba	Pb	U
OK-1	0.70	30.24	0.45	2.02	2.32	6.23	0.86	252.24	1.37	bdl	bdl	59.66	bdl	bdl
OK-2	0.62	37.71	0.47	2.07	2.41	3.27	0.85	289.55	1.43	bdl	bdl	61.06	bdl	bdl
OK-3	0.65	22.04	0.43	2.08	2.48	7.02	0.87	286.59	1.52	bdl	bdl	61.03	bdl	bdl
OK-4	0.77	13.65	0.63	2.29	2.66	11.11	0.87	306.05	1.62	bdl	bdl	64.13	bdl	bdl
OK-5	0.62	5.59	0.43	2.20	3.41	6.74	0.93	279.88	1.79	bdl	bdl	57.17	bdl	bdl
OK-6	0.65	6.22	0.54	2.43	3.28	13.45	0.83	540.06	1.91	bdl	bdl	63.35	bdl	bdl
OK-7	0.50	13.09	0.39	2.13	2.28	4.52	0.83	1776.86	1.79	bdl	bdl	43.89	bdl	bdl
OK-8	0.68	1.47	0.57	3.48	1.54	9.75	0.44	5561.11	1.31	bdl	bdl	67.01	bdl	2.38
OK-9	0.58	11.68	0.37	2.65	1.94	7.64	0.70	3076.17	1.55	bdl	bdl	53.34	bdl	bdl
OK-10	0.57	11.08	0.34	2.89	1.92	15.28	0.75	3332.32	1.47	bdl	bdl	56.09	bdl	bdl
OK-11	0.53	7.12	0.34	3.12	1.91	8.49	0.73	3426.08	1.64	bdl	bdl	55.11	bdl	bdl
OK-12	0.67	4.73	0.40	3.26	1.98	5.49	0.71	3526.23	1.61	bdl	bdl	57.97	bdl	bdl

Appendix V: Adsorbed Trace Metal Data

Table A5-1a: September 1999 Adsorbed Trace Metals. All data are in μmol/kg.

Creekbed Samples	Cr	Mn	Co	Ni	Cu	Zn	As	Sr	Mo	Ag	Cd	Ba	Pb	U
OC-1-sed	88.76	3154.66	56.66	71.17	107.78	318.18	36.51	19.25	13.89	11.26	11.24	62.76	16.52	6.60
OC-3-sed	35.05	287.29	9.55	24.32	13.76	539.28	5.65	2.18	2.18	bdl	bdl	14.77	2.68	0.47
OC-8-sed	30.08	1114.77	14.67	21.89	11.81	120.00	5.42	9.60	4.55	3.51	3.32	12.02	2.18	1.33
OC-9-sed	27.82	65.53	5.11	10.06	7.99	130.19	6.79	7.48	2.72	1.69	1.99	6.76	1.57	0.81
OC-11-sed	24.82	366.07	5.83	6.90	8.53	81.24	4.97	7.19	1.50	0.89	1.03	6.82	1.04	0.41
OC-12-sed	22.72	1949.68	8.69	13.97	12.99	126.21	3.86	11.31	1.53	0.71	1.06	14.93	1.09	0.36
OC-12-surface-sed	35.82	675.67	12.83	16.92	125.18	306.47	6.80	9.90	1.33	bdl	0.89	13.58	2.26	0.76
OC-13-sed	26.28	220.04	8.07	10.48	8.87	76.72	4.91	10.37	3.31	2.62	2.80	7.56	1.98	1.28

Rock Samples	Cr	Mn	Co	Ni	Cu	Zn	As	Sr	Mo	Ag	Cd	Ba	Pb	U
OC-Parmalee Rd--top	41.98	926.45	43.96	19.44	32.33	72.02	16.01	7.59	4.80	3.59	3.43	39.26	3.35	1.50
OC-PR-bottom	26.39	589.57	26.23	8.52	21.50	55.12	bdl	1.74	bdl	bdl	bdl	43.08	1.03	0.23
OC-Onondaga	33.56	1237.31	5.39	8.70	10.65	82.65	9.93	4.85	3.09	1.66	1.92	24.66	1.22	0.71

Table A5-1b: September 1999 Adsorbed Trace Metals. All data are in mg/kg.

Creekbed Samples	Cr	Mn	Co	Ni	Cu	Zn	As	Sr	Mo	Ag	Cd	Ba	Pb	U
OC-1-sed	4615.7	173317.0	3338.7	4176.8	6849.6	20805.5	2735.2	1686.9	1332.9	1214.1	1263.0	8618.2	3422.9	1570.2
OC-3-sed	1822.6	15783.7	562.6	1427.6	874.5	35263.7	423.0	191.2	208.7	bdl	bdl	2028.3	554.9	112.9
OC-8-sed	1563.9	61245.4	864.5	1284.5	750.5	7846.9	406.1	841.6	436.2	378.4	373.5	1650.8	451.5	316.1
OC-9-sed	1446.6	3600.3	301.0	590.7	507.9	8513.4	508.9	655.5	260.9	182.5	223.8	928.2	325.5	192.5
OC-11-sed	1290.8	20112.0	343.8	405.0	541.8	5312.2	372.0	629.7	144.3	95.7	116.3	936.9	215.6	98.6
OC-12-sed	1181.6	107115.6	512.2	819.7	825.5	8252.7	289.0	991.3	146.9	76.1	119.4	2050.1	225.7	85.6
OC-12-surface-sed	1862.6	37121.1	755.9	992.9	7955.0	20040.1	509.6	867.4	127.2	bdl	100.0	1864.5	469.0	180.5
OC-13-sed	1366.8	12089.1	475.8	615.1	563.5	5016.9	367.6	908.6	317.6	282.1	315.0	1037.8	410.0	303.9

Rock Samples	Cr	Mn	Co	Ni	Cu	Zn	As	Sr	Mo	Ag	Cd	Ba	Pb	U
OC-Parmalee Rd--top	2183.2	50899.3	2590.7	1141.2	2054.3	4709.1	1199.6	665.1	460.8	387.2	385.5	5391.1	694.1	357.9
OC-PR-bottom	1372.3	32390.8	1545.8	499.8	1366.1	3604.5	bdl	152.2	bdl	bdl	bdl	5916.8	212.5	54.1
OC-Onondaga	1744.9	67977.6	317.4	510.5	676.9	5404.7	744.2	425.3	296.4	179.3	216.3	3386.7	251.8	170.0

Appendix V: Adsorbed Trace Metal Data *continued*

Table A5-2a: October 2000 Adsorbed Trace Metals. All data are in μmol/kg.

Sample	Cr	Mn	Co	Ni	Cu	Zn	As	Sr	Mo	Ag	Cd	Ba	Pb	U
OK-1-sed	41.14	2517.99	34.84	49.79	79.33	232.50	23.44	bdl	bdl	bdl	bdl	44.11	6.74	bdl
OK-2-sed	35.14	1830.37	29.04	34.39	52.53	176.87	18.34	bdl	bdl	bdl	bdl	27.04	6.48	bdl
OK-3-sed	55.06	1242.37	26.12	36.77	48.88	232.24	20.97	bdl	bdl	bdl	bdl	35.69	13.05	bdl
OK-4-sed	51.85	10188.15	60.56	73.24	97.09	359.17	45.96	bdl	bdl	bdl	bdl	79.05	6.96	bdl
OK-5-sed	27.52	338.00	25.48	25.43	25.19	51.16	bdl	bdl	bdl	bdl	bdl	13.70	5.13	bdl
OK-6-sed	33.53	535.78	26.27	40.14	61.93	397.02	20.39	12.89	bdl	bdl	bdl	34.41	6.17	bdl
OK-7-sed	96.39	753.47	85.57	118.50	81.01	311.72	66.50	64.05	45.25	38.07	35.54	65.90	21.07	15.37
OK-8-sed	43.09	85.20	23.98	44.50	21.49	428.97	19.92	22.07	13.28	10.32	10.04	20.28	10.92	5.43
OK-9-sed	57.95	1134.62	38.37	51.44	49.68	291.77	27.65	23.30	16.84	14.64	13.98	31.55	9.98	6.88
OK-10-sed	59.72	678.66	33.07	40.27	43.28	159.75	24.92	24.05	16.30	14.32	14.12	17.30	10.02	6.35
OK-10-surface-sed	52.71	1021.54	37.97	51.89	182.87	230.72	24.69	19.82	12.41	11.07	10.53	21.38	8.95	5.69
OK-11-sed	42.12	417.05	24.17	34.30	28.76	145.13	18.24	18.99	11.79	10.09	9.90	15.60	7.21	4.79
OK-12-sed	88.85	886.28	25.62	45.24	55943.28	5899.85	34.22	19.72	13.60	10.94	10.70	15.77	32.86	4.99

Table A5-2b: October 2000 Adsorbed Trace Metals. All data are in mg/kg.

Sample	Cr	Mn	Co	Ni	Cu	Zn	As	Sr	Mo	Ag	Cd	Ba	Pb	U
OK-1-sed	2139.1	138338.3	2053.2	2922.2	5041.4	15202.9	1755.9	bdl	bdl	bdl	bdl	6057.2	1396.9	bdl
OK-2-sed	1827.3	100560.8	1711.1	2018.3	3338.1	11565.5	1374.0	bdl	bdl	bdl	bdl	3712.7	1343.2	bdl
OK-3-sed	2863.2	68255.8	1539.2	2158.3	3106.6	15185.9	1570.8	bdl	bdl	bdl	bdl	4900.6	2704.9	bdl
OK-4-sed	2696.1	559737.0	3569.1	4298.4	6170.3	23486.4	3443.7	bdl	bdl	bdl	bdl	10856.0	1441.1	bdl
OK-5-sed	1430.9	18569.8	1501.4	1492.5	1601.1	3345.3	bdl	bdl	bdl	bdl	bdl	1882.0	1062.6	bdl
OK-6-sed	1743.7	29435.6	1547.9	2355.9	3936.0	25961.4	1528.0	1129.2	bdl	bdl	bdl	4725.7	1278.4	bdl
OK-7-sed	5012.2	41395.9	5042.6	6954.7	5148.3	20383.1	4982.5	5612.2	4341.8	4106.8	3994.7	9050.5	4366.1	3658.4
OK-8-sed	2240.5	4681.0	1412.9	2611.5	1365.9	28050.6	1492.7	1934.0	1274.5	1113.6	1128.8	2785.6	2261.8	1293.2
OK-9-sed	3013.3	62335.9	2261.0	3018.8	3157.4	19078.8	2071.6	2041.1	1616.1	1578.8	1571.3	4332.9	2067.5	1637.5
OK-10-sed	3105.4	37285.3	1948.8	2363.2	2750.2	10445.9	1866.7	2107.7	1564.2	1544.9	1587.2	2376.3	2076.5	1510.5
OK-10-surface-sed	2741.1	56123.2	2237.5	3045.3	11621.4	15087.1	1849.4	1736.7	1190.3	1193.7	1184.2	2935.8	1854.1	1355.1
OK-11-sed	2190.0	22913.0	1424.3	2013.2	1827.6	9490.3	1366.6	1664.1	1130.9	1088.2	1113.1	2142.8	1494.5	1139.8
OK-12-sed	4620.4	48692.0	1509.8	2655.0	3555195.4	385791.2	2563.7	1727.6	1304.9	1180.4	1202.4	2165.3	6808.7	1188.6