Water-Quality Data Collected at Lake Anne, Reston, Virginia, 1997-1999

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ABSTRACT

Samples from the Lake Anne watershed were collected and analyzed to assess the water quality from December 1997 through January 1999. Lake Anne is a stream impoundment in suburban Northern Virginia and its outflow is a sub-tributary of the Potomac River. Samples of wet deposition (precipitation), lake water, and streamwater that drain into and from Lake Anne were collected and analyzed. Trace-element clean sampling and analysis protocols were followed throughout the project. This report is a compilation of the precipitation, lake-water, and streamwater data collected in the Lake Anne watershed and the associated quality assurance/quality control data. Concentrations of the trace elements arsenic, barium, cadmium, chromium, copper, lead, manganese, nickel, strontium, vanadium, and zinc, and of the major inorganic ions, aluminum, bicarbonate, calcium, chloride, hydrogen ion, iron, magnesium, potassium, nitrate, sodium, and sulfate are reported.

INTRODUCTION

Lake Anne is a stream impoundment in the planned community of Reston in Fairfax County, Virginia. The lake is located between State Route 7 (Leesburg Pike) and State Route 267 (which parallels the Dulles Airport Access Road), approximately 26 kilometers (km) west of Washington, D.C., and approximately 13 km east of Washington Dulles International Airport (figure 1). Lake Anne is a real-estate lake (built for the purpose of attracting residents to buy waterfront property) and was created by damming an unnamed tributary of Difficult Run. It is situated roughly west (upstream) to east (downstream) and is retained by a 13.7-meter (m) high, 152-m long earthen dam, which is crossed by Wiehle Avenue (Netherton, 1989). The climate of Fairfax County is characterized by warm, humid summers, and mild winters with an annual average air temperature of 10° C (Pavich and others, 1989). Long-term (1964-1996) average annual precipitation measured at Washington Dulles International Airport is 104.8 centimeters (cm) (National Oceanic and Atmospheric Administration, 2000).

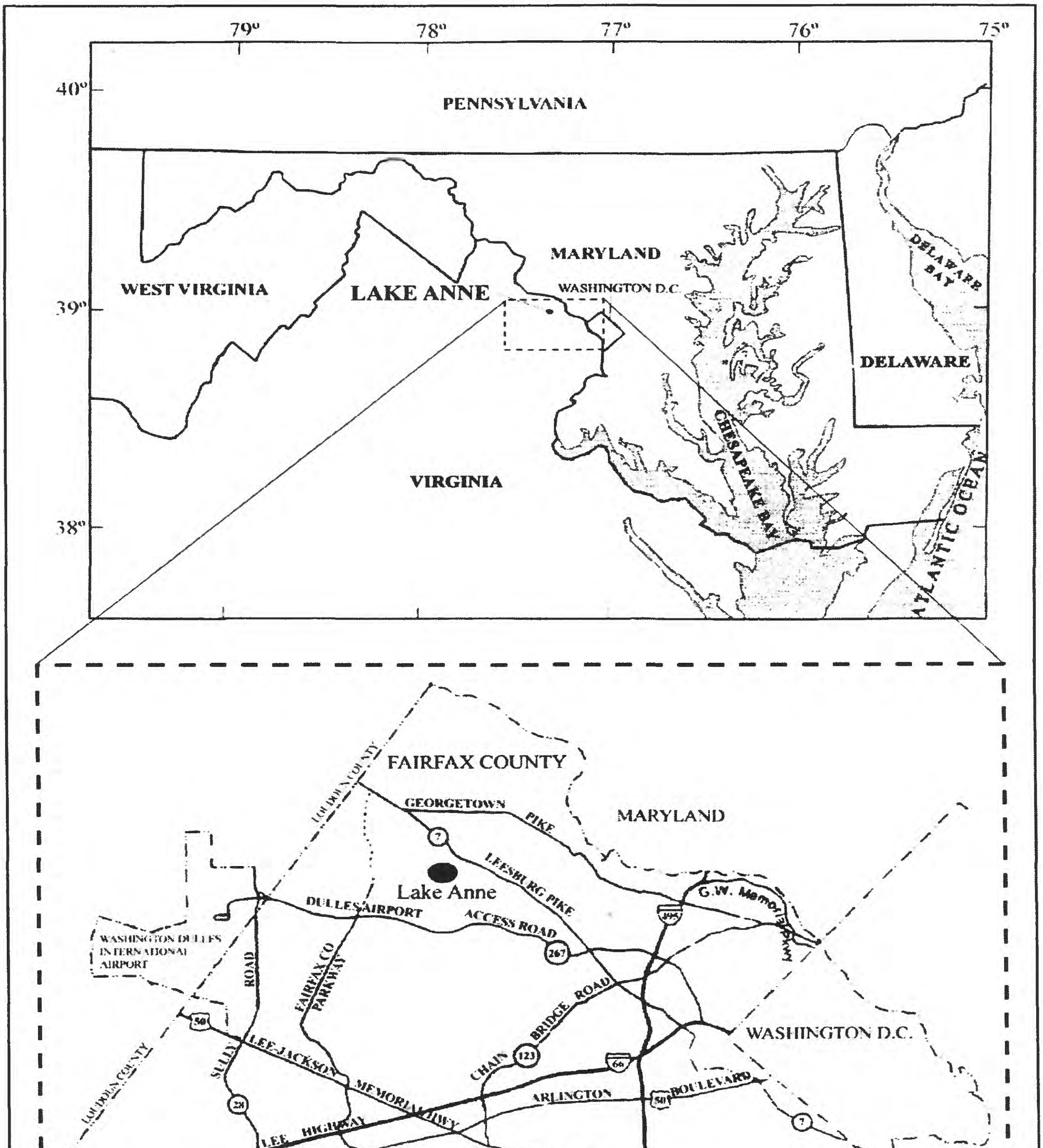

Figure 1. The location of Lake Anne

This report presents the sampling and analytical techniques and the data collected on the quantity and chemical quality of the water samples collected from the Lake Anne watershed from December 1997 through January 1999. The imports (precipitation and stream inflow) to and exports (stream outflow) from the watershed, as well as lake water were collected and analyzed for major and trace cations and major anions. This study provides initial data on the watershed as a base line for future studies of this or other urban and suburban watersheds.

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FIELD DATA COLLECTION METHODS

Precipitation

A precipitation collection station was installed on August 1, 1997 on the judge's tower overlooking the tennis courts on top of the Reston Lake Anne Air Conditioning Corporation (RELAC) building at the intersection of North Shore Drive and Washington Plaza near the RELAC stream-gaging station (figure 2). The amount and timing of rainfall were recorded from October 1, 1997 through February 19, 1999 with a tipping-bucket rain gage connected to a

Campbell Scientific, Inc. CR10X data-logger. The amount of precipitation collected during 1998 was 91.9 cm.

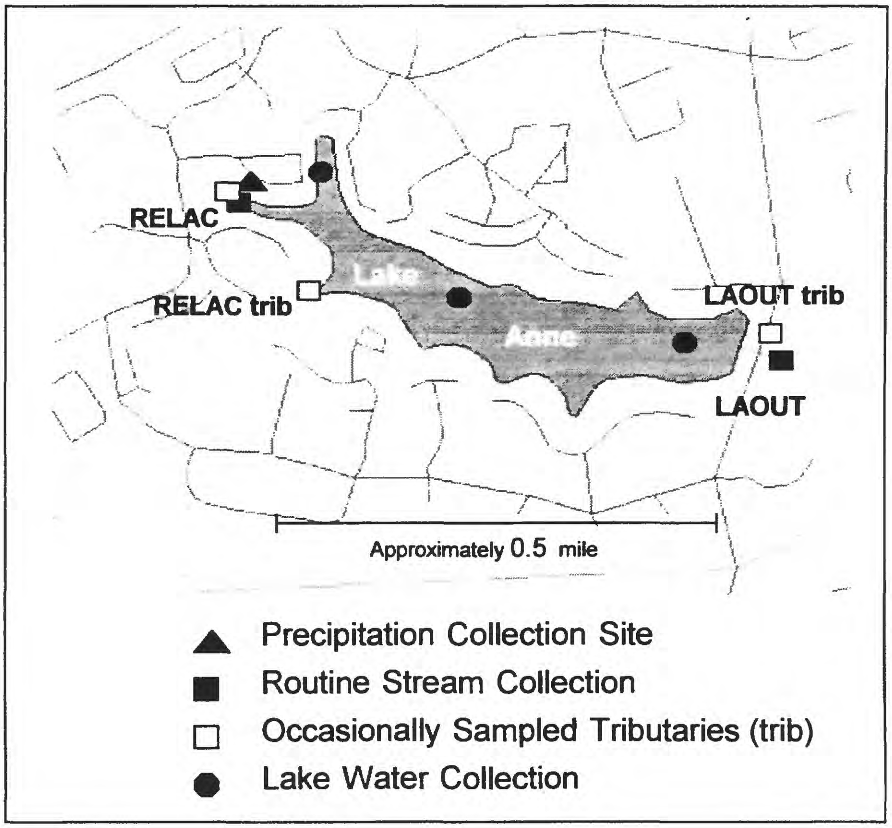

Figure 2. Location of the sampling sites at Lake Anne.

Precipitation samples were collected in the wet side of an Aerochem Metrics (ACM) Model 301 automatic wet-dry precipitation collector, beginning in December 1997 and ending in January 1999. The site was serviced every other Tuesday resulting in a two-week integrated sample. The dates and times of the individual precipitation samples as well as the field parameters measured are listed in Table 1.

The collector was modified for trace-element precipitation collection by encasing the lid in plastic and covering the support arms with Teflon® tape. Three pre-cleaned, two-liter (L) Teflon® coated wide-mouth plastic bottles were placed in a polyethylene bucket in the collector to capture samples of wet-only precipitation to be analyzed for trace-element concentrations. All precipitation collection occurred with vinyl-gloved hands and care was taken to limit the exposure of the sample bottles to ambient air and other potentially contaminating substances. The samples were kept on ice until return to the laboratory (within one hour) and were processed immediately.

All sample collection and storage vessels were cleaned using a validated method (Scudlark and others, 1992). This procedure involved washing the bottles with laboratory soap, rinsing with Acetone, and then soaking for three successive days in the following acids: 6N nitric acid (HNO_3), 10% hydrochloric acid (HCl), and 0.5% HCl. Between each step, the vessels were rinsed three times with laboratory prepared 18-mega ohm laboratory deionized (DI) water. The sample containers were dried in a class 1,000 laminar-flow clean bench and doubly bagged in polyethylene bags for storage.

Three 200-milliliter (mL) wide-mouth polyethylene bottles were placed in between the two-L bottles for trace elements to collect precipitation for determination of major inorganic anion concentrations. The sample collection bottles for major inorganic anions were initially cleaned with laboratory soap and rinsed three times with DI water. The bottles were soaked in DI water for two weeks prior to deployment in the sampler.

Streams and Lake Water

Samples of stream water were routinely collected at two sites, the major inflow to the lake, RELAC, and the outflow from the lake, LAOUT, downstream of the dam (figure 2). The sampling dates, times, and field parameters are listed in Tables 2 and 3.

The watershed area for RELAC is 70.3 hectares (ha), and the watershed area for LAOUT is 267 ha. The lake area is 10.9 ha, and the lake watershed area is 235 ha. The lake covers slightly less than 5% of the watershed. Standard USGS stream-gaging stations were installed at the RELAC site on August 29, 1997 and at the LAOUT site on August 27, 1997. The stream-gaging stations were dismantled on February 19, 1999. The procedures used for measuring and calculating discharge of the streams and for computing stream flow records are detailed in Rantz (1982a; 1982b).

Although standard methods were used to make discharge measurements of the streams, several factors could have introduced error into the measurements, including the small size of the streams, the short time of operation of the gaging stations, and other physical factors of the measuring sites. The measuring section was not ideal at RELAC, and the downstream control was not ideal at LAOUT. Despite these difficulties, the daily mean discharges for the two sites were well correlated with discharge at two nearby stream-gaging stations that are operated by Virginia Department of Environmental Quality with continuous records and well-established rating curves. These two stations are Difficult Run near Great Falls, a downstream site with a continuous record from 1934 to present (USGS station number 01646000), and Accotink Creek near Annandale, a nearby site with a continuous record from 1947 to present (USGS station number 01654000). Standard methods such as application of shifts to the rating curves of RELAC and LAOUT, and analysis of data from the nearby stations, brought the estimated error in the streamflow records for Lake Anne to near 10%.

Streamwater samples were collected as grab samples from the point of maximum flow 5- to 10-meters (m) upstream of each of the gaging stations. These samples for analysis of trace elements and major anions were collected monthly or bi-monthly from December 1997 through January 1999. Samples were collected in Teflon® coated wide-mouth plastic bottles, cleaned by the same procedure as described for the precipitation collection bottles. Upon return to the laboratory, these samples were filtered through 0.1-µm (micrometer) pore-size Gelman® capsule filters using positive pressure created by a peristaltic pump. The 0.1-µm pore size was used as a compromise between eliminating as much colloidal material as possible and the practicality of filtration through a small pore size. In addition to the "dissolved" samples, a second set of samples was collected for a "total" analysis. This total analysis is a measure of trace-element concentrations of the dissolved ions plus the particulate phase. Particulate material as defined in this study includes suspended sediment, inorganic colloidal material, and naturally occurring organic matter that would be retained on a 0.1-µm filter.

Streamwater samples were collected during three storms and one extended high-flow period and were processed as described above. Four to six samples per storm were collected, spaced out over the duration of the storm in an attempt at sampling as close to peak stream flow as possible for each storm. Grab samples of another smaller tributary to the lake, as well as an additional outflow site, also were collected during storms. These two small streams had minimal flow except during storm events. One other sample was collected at the RELAC site, on the wooden spillway where the stream enters the lake. The locations of the occasionally sampled streams are shown in Figure 2. Data for these other tributaries are listed in Table 4.

Lake-water samples were collected to determine whether there were seasonal differences in lake-water chemistry and to determine the degree of mixing of the lake. Lake-water samples were collected in cleaned plastic bottles as surface grab samples from a rowboat. Three surface samples were collected from the lake, one at the head of the lake, one approximately at the mid-point of the lake, and the third at the lower end of the lake near the lake outlet. A set of lake-water samples (three surface samples) was collected five times during the study. Twice during the study, an additional sample of lake water was collected at depth using a peristaltic pump and pre-cleaned Tygon® tubing. The tubing was weighted with a plastic- and tape-wrapped lead weight and lowered over the side of the boat to a depth of approximately five meters. The lake sampling dates and times as well as the field parameters are listed in Table 5.

LABORATORY ANALYTICAL METHODS
Sample Analysis--Trace Elements

Precipitation

Samples were collected from the field site and returned to the laboratory within minutes of collection. The individual sample collection vessels were weighed and the empty weight of the bottle was subtracted to determine the volume of precipitation collected. The sample was acidified to 0.5% volume/volume (v/v) with Fisher Optima® double-distilled HNO_3 (to a pH less than 2) to increase the stability of the cations in solution. The acidified sample was allowed to sit in a class-1,000 clean bench for one week to desorb any elements from the walls of the collection container (Scudlark and others, 1992). After one week, the samples were homogenized and transferred to an appropriate-sized cleaned low-density polyethylene (LDPE) storage bottle. The bottle was rinsed three times with the sample, filled, and capped tightly. The sample bottle was stored in a sealed polyethylene bag to minimize contamination from ambient dust collection on the bottle.

This sample preparation method is considered a "total" method for analysis of minor and trace elements in precipitation (Church and Scudlark, 1992). The sample preparation and storage method for this project was designed to be comparable to other atmospheric deposition studies in the Mid-Atlantic region, which include the longest continuous record of trace metals in precipitation (Church and Scudlark, 1992; Scudlark and others, 1993; Scudlark and others, 1994; Church and others, 1998; Kim and others, 1999). This sample treatment is termed "unfiltered acidified" (UFA) and is the usual sample preparation method for all of the precipitation samples in this study. A summary of the types of sample treatments and preservations are listed in Table 6.

Because the volume of sample necessary for analysis was minimal (<15 mL) it was possible to have a sample analysis for nearly every two-week interval for which there was a precipitation event. Only one sampling interval (10/20/98 – 11/03/98) had an insufficient volume for analysis other than pH. This is important because small-volume events could contain much higher concentrations of elements due to an initial "wash-out" of the atmosphere. The high concentrations of very small events are included in this study thereby minimizing potential errors. If these very small events were not analyzed due to insufficient volumes, it is possible that loading calculations of elements would be underestimated.

For six separate events the precipitation volume was sufficient to attempt a phase differentiation within the precipitation samples. For this determination, approximately one-third of the sample was filtered through a 0.1-µm pore-size Gelman® capsule filter and acidified to 0.5% volume/volume (v/v) with Fisher Optima® double-distilled HNO_3 for the dissolved or filtered acidified (FA) fraction. This method is identical to the preparation and storage for dissolved analytes in the streamwater and lake-water samples. A second aliquot was unfiltered and acidified (UFA), as described previously. The remainder of the sample was processed using a method for total elements that is described later in the next section of this report. The comparisons of the phase differentiation for these samples are listed in Table 7.

Dissolved (FA), UFA, and total concentrations of trace elements in precipitation were analyzed using a Perkin Elmer Élan 6000 inductively coupled plasma-mass spectrometry (ICP-MS). The instrument parameters were set according to those required by the *EPA Method 200.8 for the Analysis of Drinking Waters* (Perkin Elmer Corporation, 1995). The results of the UFA analysis for the precipitation are listed in Table 8.

Streams and Lake Water

The stream water and lake water samples were returned to the laboratory within minutes of collection and processed immediately. An aliquot of water was removed for pH determination and allowed to equilibrate to room temperature prior to measurement. The pH was measured with a Beckman Φ32 pH meter and a Corning High Performance Glass Combination electrode. The electrode was calibrated prior to sample measurement using buffers of pH 4.00 and 7.00.

Approximately 800 mL of the sample were filtered through a 0.1-μm pore-size Gelman® capsule filter. The sample bottle and filter were rinsed with the first 20 to 50 mL of filtrate. After rinsing, 500 mL of sample were collected into the storage bottle and acidified to 0.5% v/v with Fisher Optima® double-distilled HNO_3 for dissolved-element analysis. The remaining 900 mL were transferred to a storage bottle and acidified to 1% v/v with Fisher Optima® double-distilled HNO_3 for a total analysis.

Because of the very low amount of suspended sediment in the streams and lake during non-storm conditions and because of the potential for error due to contamination or loss of sample from filter leakage, a non-traditional method for total element determination was used. The digestion of an unfiltered "whole-water" stream or lake-water sample provided the total (dissolved plus particulate) element concentration.

After collection and acidification of the total sample, the sample bottle was left uncapped on a Teflon® lined hot-plate (40° C) in a class 1,000 laminar-flow clean bench. The sample was allowed to evaporate gently to an approximate volume of 20 mL. The sample was then transferred to a Teflon® digestion vessel and was completely digested using a combination of concentrated Fisher Optima® double-distilled HNO_3 and hydrofluoric (HF) acids in a laboratory microwave oven (MDS 2100, CEM Corporation). The samples were brought to 10% of the original volume with deionized water. To reduce the concentration of salts and acids prior to

ICP-MS analysis for some samples, an aliquot was diluted (1:5) with deionized water yielding an acid concentration in the sample of approximately 4% HNO_3 and 0.2% HF.

Dissolved and total concentrations of barium (Ba), cadmium (Cd), manganese (Mn), nickel (Ni), lead (Pb), strontium (Sr), and zinc (Zn) as well as dissolved concentrations of chromium (Cr) and vanadium (V) were also analyzed by ICP-MS. To overcome potential analytical interferences in the total element sample-matrix, concentrations of arsenic (As) and copper (Cu) in these samples were analyzed using a Perkin Elmer 5100 GFAAS (Graphite Furnace Atomic Absorption Spectroscopy). Results of the total concentrations of the stream and lake samples are listed in Tables 9 through 16.

Sample Analysis-- Major Cations and Anions

Analyses of the dissolved and total concentrations of major cations: sodium (Na^+), potassium (K^+), calcium (Ca^{2+}), magnesium (Mg^{2+}), aluminum (Al^{3+}), iron (Fe^{2+}), and silica (SiO_2), in the precipitation, stream, and lake samples were determined by inductively coupled plasma –optical emissions spectroscopy (ICP-OES) using a Perkin Elmer, P-2. The results of the cation analysis for precipitation are listed in Table 17. Streamwater and lake-water samples are listed in Tables 18 through 25. These analyses were conducted on the same FA samples that were collected for the determination of dissolved trace elements.

To facilitate the ion balance calculation, the dissolved major cations were converted to microequivalents per liter (μeq/L) and are reported as such. In order to calculate the sum of the μeq/L of cations, aluminum was assumed to have a 3+ oxidation state. The assumed oxidation states were based upon the most abundant species of each ion that was present in the sample at the particular pH of the sample. The pH of all the samples analyzed indicated that the Al^{3+} form of aluminum and the Fe^{2+} form of iron were the most abundant species (iron oxidation to Fe^{3+} is very slow, kinetically, at low pH).

The samples collected for the analysis of major anions for all sites in this study were returned to the laboratory along with the trace-element samples within minutes of collection. An aliqùot was removed for pH determination as described previously. The remainder of the sample was filtered through a 0.1-µm pore-size Gelman® capsule filter into an appropriately cleaned polyethylene bottle. The samples were stored in a refrigerator (about 10 C°) until analytical determination.

Total dissolved concentrations of anions nitrate (NO_3^-), sulfate (SO_4^{2-}), bicarbonate (HCO_3^-), and fluoride (F^-) were determined using a Dionex 2110i ion chromatograph. It was necessary to estimate the chloride (Cl^-) concentrations for the stream and lake samples. This estimation was accomplished by using the difference between the cation and anion concentrations in the ion balance. The concentrations in µeq/L of dissolved anions are listed in Tables 18 through 25. Samples for which the concentration of the constituents was below the analytical detection limit are shown as "less than" (<) the detection limit. Samples for which the constituent was not analyzed are designated as n.a. in the tables.

Alkalinity determinations were performed using Radiometer's Titra Lab 90 System (consisting of a TIM900 Titration Manager, and ABU93 Triburette and a SAC80 Sample Changer). This automated incremental titration system uses equivalence points and a second derivative calculation. Total alkalinity is a measure of the capacity of water to neutralize a specific quantity of acid. In this titration all bicarbonate (HCO_3^-) is measured as well as the small amount of carbonate (CO_3^{2-}) that may be present. Acid-neutralizing capacity (ANC) can be operationally defined as the equivalent sum of all the base that can be titrated with a strong acid to an equivalence point. It measures the net deficiency of protons. In a carbonate system of natural water with a pH range of the samples in this study, it can be assumed that the terms alkalinity, bicarbonate concentration, and positive ANC are equivalent.

Quality Assurance

To ensure the analytical quality of the data generated during this project, it was imperative that all field collection, sample preparation and analysis strictly followed a Quality Assurance Program (QAP). This QAP consists of several important components: (i) the ACM collector efficiency was tracked to make sure that the precipitation collected was representative of the deposition to the watershed; (ii) trace-element clean procedures were followed during all field collection, sample manipulation, and analysis; (iii) routine analysis of field, laboratory, and analytical blanks was conducted, and (iv) routine analysis of standard reference materials (SRM), replicate samples, and sample spikes was conducted.

Field Collection

Collector efficiency was measured to determine the relationship between the amount of precipitation collected for chemical analysis and the amount collected in the tipping-bucket gage. It is possible that the ACM collector could under-collect precipitation due to delays between the beginning of rainfall and the collector lid opening. A significant under-collection could occur during very light or sporadic events, during high wind, and during freezing conditions. Figure 3 shows the correlation between the actual volume of precipitation collected in the sample containers and the predicted volume using the following equation:

$$\text{cm}_{\text{precipitation}} \bullet \text{surface area}_{\text{collector bottles}} (191\ \text{cm}^2) = \text{cm}^3_{\text{predicted}}.$$

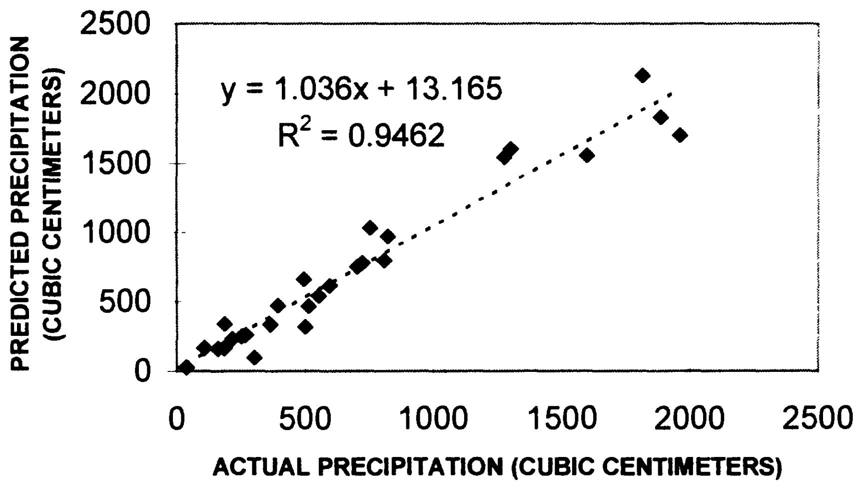

Figure 3. The efficiency of the automated precipitation collector.

Instrument Parameters

Quality assurance and quality control of the laboratory analyses were continuously carried out through a series of approved methods (Pirkey and Glodt, 1998; Rice and others, 1996). The quality assurance directly related to instrument analysis included the following: daily calibration, verification of the calibration and running blanks and SRMs periodically during the analytical run. For each analyte a four- or five-point standard concentration (including blank) curve with an r^2 value of 0.999 or better was constructed. At the beginning and end of each analytical session, the standard calibration was verified by running additional standard solutions and SRMs. During the analysis, known standard solutions and SRMs were run periodically (every fifth to tenth sample) to verify the accuracy of the analysis and to monitor instrument drift.

Detection limits were calculated for analysis performed on the ICP-MS and the IC. The detection limit is the lowest concentration that can be detected with a 95% confidence and is determined by a statistical calculation of the signal and electronic noise of the instrument. The detection limits for the trace-element (table 26), major-anion (table 27), and major-cation (table 28) analyses are listed. When the concentration of any ion of interest in the sample had a higher concentration than those that formed the standard curve, a quantitative dilution of the sample was made and it was reanalyzed.

Blanks

To determine the type and amount of potential contamination, several types of blanks were routinely conducted during each stage of sample-collection and analysis. Field blanks for precipitation samples were created with sample containers that had been deployed in the ACM collector during a period of no precipitation. Only once during the year was there a completely dry two-week sampling period which would produce a completely representative precipitation blank. Other (two sets) precipitation field blanks were conducted during shorter dry periods. All precipitation field blanks were processed similarly.

The sample-collection vessels were returned to the laboratory and 500 mL of DI water were added to each vessel. The blanks were acidified to 0.5% v/v with Fisher Optima® double-distilled HNO_3 and allowed to desorb for 1 week and processed as a sample. Laboratory blanks for precipitation used sample-collection vessels that had not been deployed and were processed in the same manner.

Field blanks were used to evaluate the potential contamination in both the field sampling and subsequent processing, as well as during the analytical steps. Blanks for the stream and lake sampling were composed of two-liter wide-mouth Teflon® coated bottles initially filled with DI water, taken into the field during sample collection and opened for approximately one minute. This procedure attempted to approximate exposure of the field blanks to the same ambient air conditions as the samples. The blanks were returned to the laboratory and processed exactly as the samples. The results of the precipitation- and field-blank analyses for trace elements are shown in Table 29.

Analytical blanks were used to assess the contamination associated with the laboratory processing and the instrument analysis of the samples. These blanks contained DI water and 0.5% v/v Fisher Optima® double-distilled HNO_3 and were conducted for precipitation, stream, and lake waters. These blanks were used to assess and correct the potential contamination associated with the acid and laboratory water.

Sample Replicates

When a large volume (>1,000 mL) of precipitation occurred, field triplicate samples were collected to give an indication of possible field-collection contamination as well as to evaluate sample homogeneity. These triplicate samples were collected and treated in the same manner as usual samples except that they were not homogenized before transfer and were stored and analyzed separately.

Standard Reference Materials

The fourth component of the QAP was the routine analysis of SRMs. Care was taken to choose SRMs that were similar in both concentration and analytical matrix to the expected range of the samples. The following reference materials were used: **SLRS 3** and **SLRS 4**; National Research Council of Canada, Ottawa, Ontario, Canada. **1634**; National Institute of Standards and Testing, Gaithersburg, Maryland, USA. **WW-11**; Environmental Resource Associates, Arvada, Colorado, USA. **T-155** and **T-145**; USGS, National Water Quality Laboratory, Denver, Colorado, USA. **CRM-ES** and **CRM-soil**; High Purity Standards, Charleston, SC, USA. The results of the SRM analyses are listed in Tables 30 through 32.

Sample Spikes

One specific concern was the accuracy of the As analysis due to a potential molecular interference. To verify that the correction equation (Perkin Elmer Corporation, 1995) could accurately compensate for the interference, a 200-ppm Cl^- standard was routinely analyzed and monitored. An additional test of sample spikes was used to ensure the accuracy of the As analyses. Ten samples were randomly chosen and spiked with 0.2 µg/L As prior to the analysis by ICP-MS. The results of the spiked samples and the calculated recovery are listed in Table 33.

Data Validation

Data validation for laboratory data was done by double-checking the values obtained from the instruments against the reported values in the laboratory computer data files. Once the laboratory computer data files were validated, the data were imported into project computer data files. The project data files were validated by comparison to both the instrument files and the laboratory computer data files. As a final check, ion balances were calculated in the project data files and were compared to those calculated in the laboratory data files.

SUMMARY

To assess water quality in the Lake Anne watershed in Reston, Virginia, precipitation, streamwater, and lake-water samples were collected from December 1997 through January 1999. The samples were collected, processed and analyzed using ultra-clean protocols. Strict quality control was maintained throughout and is documented here. The concentrations of aluminum, arsenic, barium, cadmium, calcium, chloride, chromium, copper, hydrogen ion, iron, magnesium, manganese, nickel, nitrate, silicate, sodium, sulfate, strontium, vanadium, and zinc have been reported along with the associated field parameters, precipitation volume, and stream discharge.

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Table 1. The sampling parameters for Lake Anne precipitation
The list includes the beginning and end date for the precipitation collected –usually a two-week integrated sample, except for 2/03/98 to 2/05/98, which was an individual storm event. Also listed is the amount of precipitation (in centimeters) recorded with the tipping-bucket rain gage as well as the pH of the precipitation at the time of sample retrieval; pH has been converted to microequivalents of hydrogen ion per liter (μeq/L).

Date Start	Date End	Precip cm	pH units	H+ μeq/L
12/23/97	01/06/98	2.06	4.28	52.5
01/06/98	01/20/98	3.68	4.33	46.8
01/20/98	02/03/98	9.50	4.25	56.2
02/03/98	02/05/98	6.81	4.63	23.4
02/05/98	02/17/98	0.83	4.29	51.3
02/17/98	03/03/98	10.25	4.47	33.9
03/03/98	03/17/98	2.69	4.50	31.6
03/17/98	03/31/98	9.86	4.24	57.5
03/31/98	04/14/98	4.24	4.06	87.1
04/14/98	04/28/98	3.12	4.28	52.5
04/28/98	05/12/98	7.67	4.28	52.5
05/12/98	06/02/98	0.58	insufficient volume for pH	
06/02/98	06/16/98	8.36	4.73	18.6
06/16/98	06/30/98	4.04	3.69	204.2
06/30/98	07/14/98	1.12	3.98	104.7
07/14/98	07/28/98	1.40	3.12	758.6
07/28/98	08/11/98	2.62	3.96	109.6
08/11/98	08/24/98	no precipitation -field blank collected		
08/24/98	09/08/98	1.32	3.89	128.8
09/08/98	09/22/98	4.32	3.78	166.0
09/22/98	10/06/98	0.20	3.34	457.1
10/06/98	10/20/98	2.59	3.74	182.0
10/20/98	11/03/98	0.15	3.30	501.2
11/03/98	11/16/98	0.97	3.99	102.3
11/16/98	11/30/98	1.32	3.82	151.4
11/30/98	12/14/98	2.90	4.24	57.5
12/14/98	12/30/98	0.97	3.91	123.0
12/30/98	01/09/99	3.94	4.26	55.0

Table 2. The sampling parameters at Lake Anne inlet stream RELAC
The list includes the date and time sampled, instantaneous discharge (Q) in cubic feet per second (cfs) and liters per second (L/s), the temperature (degrees C) and pH of the water at the time collected. "n.a." indicates a parameter not determined at that time.

Date sampled	Time	Inst. Q, cfs	Inst. Q, L/s	Temperature, °C	pH units
12/09/97	1100	0.990	28.03	n.a.	n.a.
01/06/98	1100	0.207	5.862	n.a.	6.58
02/03/98	1030	0.275	7.787	n.a.	6.38
02/04/98	1045	6.62	187.5	n.a.	6.24
02/04/98	1420	8.29	234.7	n.a.	7.90
02/04/98	1815	8.48	240.1	n.a.	7.16
02/05/98	1410	1.76	49.84	n.a.	6.55
02/06/98	1110	0.760	21.52	n.a.	6.55
03/17/98	1045	0.500	14.16	n.a.	6.74
04/02/98	1540	0.321	9.090	12.5	6.73
04/30/98	1235	0.433	12.26	14.5	6.89
05/05/98	1110	0.663	18.77	n.a.	7.05
05/12/98	1055	1.67	47.26	n.a.	7.11
05/18/98	1525	0.433	12.26	n.a.	6.78
06/16/98	1145	0.235	6.654	18.0	6.61
06/30/98	1130	0.181	5.125	19.5	6.69
07/23/98	1145	0.137	3.879	n.a.	6.97
07/26/98	0835	0.433	12.26	n.a.	7.05
07/28/98	1110	0.137	3.879	21.0	6.80
08/24/98	1020	0.119	3.370	21.5	6.98
09/22/98	1250	0.137	3.879	21.0	6.44
10/08/98	0953	8.29	234.7	17.5	6.36
10/08/98	1433	1.76	49.84	17.8	6.43
10/08/98	1715	0.663	18.77	18.2	6.49
11/16/98	1245	0.207	5.862	9.5	6.68
11/30/98	1135	0.181	5.125	9.5	6.66
12/14/98	1245	0.137	3.879	7.5	6.30
01/08/99	1943	0.137	3.879	2.0	6.39
01/09/99	1040	1.19	33.70	0.5	6.47
01/09/99	1145	2.91	82.40	0.5	6.42
01/09/99	1430	1.84	52.16	1.0	6.32
01/10/99	1120	0.207	5.862	n.a.	6.89

Table 3. The sampling parameters at Lake Anne outlet stream LAOUT
The list includes the date and time sampled, instantaneous discharge (Q) in cubic feet per second (cfs) and liters per second (L/s), the temperature (degrees C) and pH of the water at the time collected "n.a." indicates a parameter not determined at that time.

Date sampled	Time	Inst. Q, cfs	Inst. Q, L/s	Temper-ature, °C	pH, units
12/09/97	1030	0.353	9.996	n.a.	n.a.
01/06/98	1030	0.404	11.44	n.a.	6.74
02/03/98	1015	0.696	19.71	n.a.	6.39
02/04/98	1107	24.7	700.0	n.a.	6.46
02/04/98	1435	42.7	1210	n.a.	8.02
02/04/98	1800	65.9	1867	n.a.	7.18
02/05/98	1425	15.2	431.3	n.a.	6.68
02/06/98	1125	3.40	96.19	n.a.	6.77
03/17/98	1015	0.797	22.57	n.a.	6.79
04/02/98	1530	1.43	40.49	15.0	6.89
04/30/98	1250	0.601	17.02	18.0	6.69
05/05/98	1050	0.961	27.21	n.a.	7.18
05/12/98	1125	2.35	66.66	n.a.	7.16
05/18/98	1540	0.647	18.32	n.a.	7.18
06/16/98	1115	2.57	72.72	23.0	6.74
06/30/98	1405	0.328	9.288	25.0	6.62
07/23/98	1200	0.163	4.616	n.a.	7.24
07/26/98	0815	0.904	25.60	n.a.	6.96
07/28/98	1030	0.142	4.021	21.0	6.68
08/24/98	0945	0.121	3.426	21.0	6.97
09/22/98	1220	0.100	2.832	22.0	6.48
10/08/98	0942	3.15	89.11	n.a.	6.31
10/08/98	1458	2.46	69.66	19.0	6.40
10/08/98	1725	0.255	7.221	18.2	6.48
11/16/98	1213	0.100	2.832	11.0	6.75
11/30/98	1330	0.163	4.616	11.5	6.65
12/14/98	1320	0.121	3.426	8.5	6.37
01/08/99	1957	0.961	27.21	2.5	6.37
01/09/99	0923	1.51	42.82	2.0	6.24
01/09/99	1125	3.15	89.11	2.0	6.31
01/09/99	1404	3.66	103.5	2.5	6.60
01/10/99	1107	1.08	30.50	n.a.	7.37

Table 4. The sampling parameters for the occasionally sampled tributaries at Lake Anne
The list includes the date sampled, the temperature (degrees C), and pH of the water at the time collected. "n.a." indicates a parameter not determined at that time.

Date sampled	Location of sample	Time	Temperature, °C	pH, units
02/03/98	LAOUT, tributary	1017	n.a.	6.49
02/03/98	RELAC, tributary	1033	n.a.	6.37
02/03/98	RELAC, wooden spillway	1035	n.a.	6.51
07/28/98	RELAC tributary	1500	24	7.38
10/08/98	LAOUT tributary	0944	n.a.	6.35
10/08/98	RELAC tributary	0955	n.a.	6.76
01/09/99	LAOUT tributary	1128	0.5	6.28
01/09/99	RELAC tributary	1144	0.5	6.47
01/09/99	LAOUT tributary	1405	n.a.	6.49
01/09/99	LAOUT, tributary	1406	n.a.	6.64
01/09/99	RELAC tributary	1435	n.a.	6.58

Table 5. The sampling parameters for Lake Anne
The list includes the date sampled, the temperature (degrees C), and pH of the water at the time collected. "n.a." indicates a parameter not determined at that time. Samples colleted on 11/30/98, "Lower-a" and "Lower-b", are field replicates.

Date sampled	Location of sample	Temperature, C	pH, units
04/02/98	Upper	n.a.	6.93
04/02/98	Middle	n.a.	6.93
04/02/98	Lower	n.a.	6.95
06/02/98	Upper	27.0	7.10
06/02/98	Middle	27.5	7.11
06/02/98	Lower	27.5	7.09
06/02/98	Depth	25.5	7.01
07/28/98	Upper	30.0	7.49
07/28/98	Middle	29.8	7.51
07/28/98	Lower	29.0	7.42
09/22/98	Upper	26.0	7.41
09/22/98	Middle	26.0	7.40
09/22/98	Lower	27.0	7.44
09/22/98	Depth	27.0	7.39
11/30/98	Upper	10.0	6.68
11/30/98	Middle	9.7	6.71
11/30/98	Lower-a	10.0	6.79
11/30/98	Lower-b	10.0	6.77

Table 6. Methods of sample preparation for trace element (TE) and major ions (MI)
UFA is unfiltered acidified and FA is filtered acidified.

Type of Sample	Treatment and Preservation
TE- Precipitation (UFA)	Acidify an unfiltered sample to 0.5% HNO_3, leach 1 week, transfer to storage bottle
TE- Precipitation dissolved (FA)	Filter through 0.1µm filter into storage bottle, acidify to 0.5% HNO_3
TE- Precipitation (total)	Acidify to 1% HNO_3, transfer to storage bottle, digest with conc. $HNO_3$and HF
MI- Precipitation	Filter through 0.1µm filter into storage bottle, refrigerate
TE- Stream/Lake	Filter through 0.1µm filter into storage bottle, acidify to 0.5% HNO_3
TE- Stream/Lake whole-water	Filter through 0.1µm filter into storage bottle, refrigerate
MI- Stream/Lake	Filter through 0.1µm filter into storage bottle, refrigerate

Table 7. Comparison of the phase differentiation of trace elements in the Lake Anne precipitation The type of sample is listed: FA – filtered and acidified, UFA –unfiltered and acidified (usual method of precipitation sample treatment as described in the text) and Total –which is a digested method of sample treatment designed to breakdown all particulate matter in the precipitation. The concentrations are listed in micrograms per liter (μg/L).

Sample Date	type	As μg/L	Ba μg/L	Cd μg/L	Cr μg/L	Cu μg/L	Mn μg/L	Ni μg/L	V μg/L	Pb μg/L	Zn μg/L	Fe μg/L
6/16/98	**FA**	0.1	0.4	0.03	0.2	0.8	2.2	0.2	0.1	0.16	4	8
	UFA	0.1	0.9	0.03	0.2	0.3	2.1	0.1	0.2	0.38	3	40
	Total	1.1	7.0	1.0	4.3	6.3	23	2.0	6	0.96	38	620
9/22/98	**FA**	0.2	0.6	0.43	0.1	1.3	6.5	0.5	0.4	0.21	8	10
	UFA	0.2	1.5	0.45	0.3	1.3	6.6	0.6	0.6	0.96	7	70
	Total	1.3	20	1.6	13	15.0	56	7.7	20	8.6	47	300
10/20/98	**FA**	0.1	0.3	0.16	0.1	0.5	0.7	0.2	0.2	0.13	3	9
	UFA	0.1	0.5	0.15	0.2	0.7	0.6	0.2	0.2	0.29	3	20
	Total	0.4	2.1	0.3	5.5	4.0	3.3	2.3	3.8	1.2	11	150
11/16/98	**FA**	0.2	3.5	0.1	0.3	1.7	6.6	0.8	0.3	0.29	6	7
	UFA	0.2	1.1	0.1	0.4	2.3	6.5	0.5	0.5	0.77	7	50
	Total	0.9	5.0	0.3	5.1	4.4	12.2	4.2	5.1	2.9	20	300
12/14/98	**FA**	0.5	0.3	0.22	0.1	1.5	1.0	0.2	0.1	0.26	3	7
	UFA	0.1	0.8	0.02	0.3	2.1	0.9	0.3	0.2	0.53	2	30
	Total	0.6	9.0	2.2	6.6	7.8	15.6	5.6	5.6	3.0	25	130
1/10/99	**FA**	0.1	0.1	0.85	0.2	0.3	0.6	2.4	0.3	0.10	3	10
	UFA	0.1	0.5	0.84	0.2	0.2	0.9	0.2	0.5	0.43	8	30
	Total	0.9	10	0.48	11	5.2	33	4.3	15	4.8	29	400

Table 8. The results of the analysis of trace elements in the Lake Anne precipitation
The sampling date indicated is the end date of the sample collection time. Data are presented in micrograms per liter (µg/L). A "less than" (<) indicates that the analyte concentration is lower than the limit of detection for that element; "n.a." indicates that the sample was not analyzed for that particular element.

Date Sampled	As µg/L	Ba µg/L	Cd µg/L	Cr µg/L	Cu µg/L	Mn µg/L	Ni µg/L	Pb µg/L	Sr µg/L	V µg/L	Zn µg/L
01/06/98	0.1	1.5	0.11	<1	1.1	1.7	0.2	0.76	0.6	0.5	9
01/20/98	0.1	0.9	0.01	<1	0.3	0.5	0.1	0.39	0.2	0.3	6
02/03/98	0.1	0.3	0.07	<1	0.2	0.4	0.1	0.30	0.1	0.3	3
02/05/98	<0.1	0.4	0.02	<1	0.3	0.5	0.4	0.32	0.2	0.4	3
02/17/98	0.1	1.7	0.03	<1	1.0	2.4	0.4	0.61	0.8	0.8	6
03/03/98	0.1	0.5	0.02	<1	0.3	0.9	0.2	0.35	0.3	0.4	2
03/17/98	0.1	1.1	0.02	<1	0.5	2.1	0.2	0.45	0.5	0.4	7
03/31/98	0.1	0.6	0.01	<1	0.3	0.7	0.1	0.26	0.2	0.3	3
04/14/98	0.1	1.0	0.02	<1	0.5	3.5	0.2	0.43	0.6	0.6	4
04/28/98	0.2	1.1	0.04	<1	0.6	5.9	0.2	0.55	1.1	0.7	4
05/12/98	0.1	0.8	0.03	<1	0.5	2.5	0.2	0.56	0.4	0.4	4
06/02/98	0.2	2.3	0.08	<1	1.6	8.8	0.6	1.1	1.8	0.8	11
06/16/98	0.1	1.0	0.02	<1	0.8	2.1	0.1	0.38	0.4	0.2	3
06/30/98	0.2	1.0	0.06	<1	1.2	2.6	0.5	0.48	0.6	0.6	5
07/14/98	0.3	1.9	0.10	<1	1.6	3.6	0.5	1.0	0.9	0.9	11
07/28/98	0.3	1.5	0.08	<1	1.6	6.6	0.9	0.54	1.2	3.4	11
08/11/98	0.3	1.2	0.08	<1	2.6	3.6	0.7	0.74	0.7	1.0	9
08/24/98	no precipitation – field blank collected										
09/08/98	0.2	1.5	0.05	<1	0.9	4.9	0.6	0.66	1.2	1.1	15
09/22/98	0.2	1.4	0.45	<1	1.3	6.6	0.6	0.96	0.6	0.6	7
10/06/98	1.0	7.5	0.19	<1	5.4	20	1.5	3.1	3.7	3.5	3
10/20/98	<0.1	0.5	0.15	<1	0.7	0.6	0.2	0.3	0.5	0.2	3
11/03/98	insufficient volume for analysis										
11/16/98	0.1	3.8	0.10	<1	2.3	6.5	0.5	0.77	0.5	0.5	7
11/30/98	0.3	0.9	0.08	1	3.4	4.0	0.6	1.0	0.8	0.7	6
12/14/98	<0.1	3.1	0.02	<1	2.1	0.9	0.3	0.53	0.2	0.2	2
12/30/98	0.3	0.3	0.06	1	1.8	7.0	0.7	1.0	1.3	0.9	9
01/09/99	0.1	1.0	0.04	<1	0.3	0.8	0.2	0.43	na	0.4	3

Table 9. The results of the analysis of dissolved trace elements in the stream RELAC
The sampling date and time are shown. Data are presented in micrograms per liter (µg/L), a "less than" (<) indicates that the analyte concentration is lower than the limit of detection for that element.

Date	Time	As µg/L	Ba µg/L	Cd µg/L	Cr µg/L	Cu µg/L	Mn µg/L	Ni µg/L	Pb µg/L	Sr µg/L	V µg/L	Zn µg/L
01/06/98	1100	0.1	0.2	0.03	1	0.6	0.26	1.8	0.01	65	0.2	9
02/03/98	1030	0.1	0.1	0.01	1	0.9	16	2.0	0.02	54	0.1	7
02/04/98	1045	0.8	0.1	0.02	1	4.1	5.3	1.2	0.10	28	0.1	9
02/04/98	1420	1.2	0.2	0.02	1	4.1	3	1.2	5.1	19	0.2	9
02/04/98	1815	1.5	0.2	0.02	1	4.0	3.6	1.2	0.10	17	0.2	8
02/05/98	1410	0.8	0.2	0.03	8	4.5	8.7	1.9	0.10	31	0.2	11
02/06/98	1110	0.3	0.1	0.02	<1	2.7	12	2.3	0.07	46	0.1	11
03/17/98	1045	0.1	0.4	0.03	<1	0.8	69	1.7	0.03	49	0.4	8
04/02/98	1540	0.2	0.7	0.02	<1	2.3	75	1.7	0.04	47	0.7	5
04/30/98	1235	0.1	0.6	0.01	<1	1.1	40	1.5	0.01	54	0.6	5
05/05/98	1110	0.3	0.6	0.02	<1	2.0	66	1.9	0.03	50	0.6	7
05/12/98	1055	0.5	0.4	0.04	1	8.6	42	2.2	0.20	35	0.4	8
05/18/98	1525	0.1	0.6	0.03	<1	1.2	98	1.9	0.06	56	0.6	6
06/16/98	1145	0.3	0.6	0.02	1	4.0	110	2.2	0.27	46	0.6	6
06/30/98	1130	0.3	<0.1	0.07	<1	1.5	160	1.6	0.12	56	<0.1	6
07/23/98	1145	0.3	0.1	0.06	<1	1.6	160	2.1	0.13	64	0.1	7
07/26/98	0835	0.3	<0.1	0.1	<1	6.1	170	2.0	0.15	60	<0.1	10
07/28/98	1110	0.3	<0.1	0.02	<1	0.9	90	0.8	<0.05	58	<0.1	2
08/24/98	1020	0.3	<0.1	0.5	<1	0.8	78	1.1	0.05	59	0.3	5
09/22/98	1250	0.3	0.3	0.09	<1	3.6	250	1.8	0.20	60	0.7	6
10/08/98	0953	0.6	0.7	0.4	<1	12.4	120	1.4	0.52	22	0.5	10
10/08/98	1433	0.8	0.5	0.1	<1	13	20	1.6	0.50	24	0.5	9
10/08/98	1715	0.4	0.5	0.1	<1	9.5	65	1.4	0.30	22	0.1	9
11/16/98	1245	0.2	0.1	0.03	<1	1.3	230	1.1	0.08	56	<0.1	5
11/30/98	1135	0.2	0.3	0.04	<1	1.4	80	0.9	0.05	57	0.3	4
12/14/98	1245	0.1	<0.1	0.06	<1	2.9	44	0.9	0.17	44	<0.1	5
01/08/99	1943	0.1	<0.1	0.06	<1	0.8	110	2.3	0.06	88	<0.1	8
01/09/99	1040	0.3	<0.1	0.9	<1	1.4	540	9.5	0.15	400	<0.1	70
01/09/99	1145	0.3	<0.1	1.2	<1	7.2	330	6.4	0.38	350	<0.1	90
01/09/99	1430	<0.1	<0.1	1.2	<1	3.5	400	9.2	0.20	420	<0.1	90
01/10/99	1120	<0.1	0.3	0.5	<1	2.0	140	6.1	0.08	220	0.3	50

Table 10. The results of the analysis of total trace elements in the stream RELAC
The sampling date and times are shown. Data are presented in micrograms per liter (µg/L); "n.a." indicates that the sample was not analyzed for that particular element.

Date	Time	As µg/L	Ba µg/L	Cd µg/L	Cu µg/L	Mn µg/L	Ni µg/L	Pb µg/L	Sr µg/L	Zn µg/L
01/06/98	1100	0.15	29	0.03	1.5	78	3.4	0.2	72	13
02/03/98	1030	0.42	n.a.	n.a.	2.8	n.a.	n.a.	n.a.	n.a.	n.a.
02/04/98	1045	0.82	n.a.	n.a.	7.9	n.a.	n.a.	n.a.	n.a.	n.a.
02/04/98	1420	1.3	n.a.	n.a.	6.0	n.a.	n.a.	n.a.	n.a.	n.a.
02/04/98	1815	2.8	46	0.16	14.0	110	6.0	3.7	56	36
02/05/98	1410	1.5	23	0.04	4.5	57	4.8	0.4	48	16
02/06/98	1110	4.4	n.a.	n.a.	2.9	n.a.	n.a.	n.a.	n.a.	n.a.
03/17/98	1045	0.08	n.a.	n.a.	2.8	n.a.	n.a.	n.a.	n.a.	n.a.
04/02/98	1540	0.24	23	0.02	3.8	79	3.2	0.5	n.a.	9
04/30/98	1235	0.15	18	0.02	4.0	50	5.0	0.6	n.a.	10
05/05/98	1110	0.30	n.a.	n.a.	3.8	n.a.	n.a.	n.a.	n.a.	n.a.
05/12/98	1055	0.79	n.a.	n.a.	13	n.a.	n.a.	n.a.	n.a.	n.a.
05/18/98	1525	0.33	24	0.05	2.4	140	8.3	0.8	65	12
06/16/98	1145	0.74	97	0.1	22	590	13.0	7.3	170	40
06/30/98	1130	0.41	21	0.07	2.4	190	2.6	0.5	65	7
07/23/98	1145	0.62	32	0.08	2.8	390	4.8	1.2	68	12
07/26/98	0835	1.1	85	0.1	21	650	8.0	0.4	230	36
07/28/98	1110	0.40	22	0.02	1.7	170	2.3	0.4	68	7
08/24/98	1020	0.41	24	0.6	1.8	170	2.8	0.6	65	20
09/22/98	1250	0.64	79	0.2	16	900	8.8	2.4	190	26
10/08/98	0953	1.3	55	0.4	24	150	6.0	4.6	28	28
10/08/98	1433	1.5	28	0.1	18	64	4.8	2.3	32	20
10/08/98	1715	0.57	25	0.1	16	50	3.6	2.5	34	16
11/16/98	1245	0.41	21	0.03	1.7	270	2.6	0.3	59	7
11/30/98	1135	0.20	20	0.04	1.4	97	2.3	0.2	60	6
12/14/98	1245	0.22	20	0.06	4.2	50	2.5	0.5	54	8
01/08/99	1943	1.6	33	0.06	0.80	120	4.8	0.5	90	12
01/09/99	1040	0.36	180	0.9	4.8	560	11.0	0.8	410	88
01/09/99	1145	0.47	130	1.2	7.2	350	7.2	1.4	420	98
01/09/99	1430	0.25	150	1.2	7.7	450	10	0.5	450	130
01/10/99	1120	0.05	50	0.5	2.0	190	7.8	0.1	250	72

Table 11. The results of the analysis of dissolved trace elements in the stream LAOUT
The sampling date and time are shown. Data are presented in micrograms per liter (µg/L). A "less than" (<) indicates that the analyte concentration is lower than the limit of detection for that element.

Date	Time	As µg/L	Ba µg/L	Cd µg/L	Cr µg/L	Cu µg/L	Mn µg/L	Ni µg/L	Pb µg/L	Sr µg/L	V µg/L	Zn µg/L
01/06/98	1030	0.5	7	0.01	1	1.5	0.56	0.5	0.02	38	0.2	2
02/03/98	1015	0.4	12	0.01	<1	1.9	170	0.9	0.03	37	0.8	4
02/04/98	1107	0.6	10	<0.01	<1	2.1	2.1	0.7	0.02	32	0.1	3
02/04/98	1435	0.7	11	<0.01	<1	2.2	4.9	0.8	0.03	32	0.3	3
02/04/98	1800	0.8	11	<0.01	1	2.2	1.5	0.8	0.02	32	<0.1	2
02/05/98	1425	0.9	11	<0.01	1	2.4	1.5	0.8	0.02	30	0.1	3
02/06/98	1125	0.7	11	0.01	1	2.4	6.1	0.9	0.03	32	0.1	3
03/17/98	1015	0.6	18	0.07	<1	2.4	250	1.8	0.03	34	0.4	20
04/02/98	1530	0.6	11	0.03	<1	2.3	170	1.0	0.02	29	0.4	3
04/30/98	1250	0.5	12	0.01	<1	2.4	370	0.9	0.03	36	0.6	2
05/05/98	1050	0.5	12	0.01	<1	2.0	220	0.9	0.01	37	0.5	2
05/12/98	1125	0.6	10	0.01	<1	2.6	180	1.1	0.04	33	0.4	2
05/18/98	1540	0.6	11	0.01	<1	2.3	320	1.0	0.02	38	0.4	2
06/16/98	1115	0.8	6	0.01	<1	2.4	97	0.6	0.03	35	0.3	<1
06/30/98	1405	0.5	14	0.07	<1	1.6	800	1.2	0.07	50	<0.1	5
07/23/98	1200	0.3	18	0.09	<1	1.0	1200	1.7	0.05	58	<0.1	6
07/26/98	0815	0.3	24	0.12	<1	0.6	350	3.2	0.33	72	0.5	20
07/28/98	1030	0.3	21	0.07	<1	0.7	1300	1.6	<0.05	66	<0.1	6
08/24/98	0945	0.3	18	0.78	<1	0.5	1800	1.8	0.12	62	<0.1	3
09/22/98	1220	0.2	17	0.08	<1	1.0	2000	2.4	0.14	59	<0.1	7
10/08/98	0942	0.3	7	0.45	<1	4.6	180	1.2	0.45	23	0.8	8
10/08/98	1458	0.2	6	0.11	<1	6.4	140	1.2	0.33	23	0.8	9
10/08/98	1725	0.2	8	0.09	<1	3.7	200	0.9	0.13	34	0.4	9
11/16/98	1213	0.2	14	0.03	<1	0.6	2600	1.8	<0.05	56	<0.1	3
11/30/98	1330	0.2	17	0.08	<1	1.1	3000	2.0	<0.05	58	0.2	4
12/14/98	1320	0.2	16	0.10	<1	0.6	2300	1.5	0.24	48	0.3	5
01/08/99	1957	0.5	13	0.02	<1	1.6	300	0.9	<0.05	42	<0.1	4
01/09/99	0923	0.2	220	0.79	<1	2.2	470	4.9	0.06	320	<0.1	40
01/09/99	1125	<0.1	110	0.54	<1	2.1	360	3.7	0.11	190	0.2	40
01/09/99	1404	0.5	26	0.11	<1	2.0	170	1.3	0.09	62	0.2	10
01/10/99	1107	0.5	16	0.50	<1	1.5	240	1.1	0.06	46	<0.1	7

Table 12. The results of the analysis of total trace elements in the stream LAOUT
The sampling date and times are shown. Data are presented in micrograms per liter (µg/L); "n.a." indicates that the sample was not analyzed for that particular element.

Date	Time	As µg/L	Ba µg/L	Cd µg/L	Cu µg/L	Mn µg/L	Ni µg/L	Pb µg/L	Sr µg/L	Zn µg/L
01/06/98	1030	0.59	16	0.01	3.2	670	1.9	0.3	40	6
02/03/98	1015	0.76	24	0.04	4.4	600	3.6	0.8	56	12
02/04/98	1107	0.97	66	0.08	5.6	240	6.0	4.1	60	20
02/04/98	1435	0.80	n.a.	n.a.	9.6	n.a.	n.a.	n.a.	n.a.	n.a.
02/04/98	1800	0.90	16	0.04	7.3	100	3.2	0.9	38	8
02/05/98	1425	0.92	18	0.04	3.5	150	3.2	0.7	36	8
02/06/98	1125	0.80	n.a.	n.a.	4.4	n.a.	n.a.	n.a.	n.a.	n.a.
03/17/98	1015	0.56	19	0.07	2.9	330	1.8	0.3	37	25
04/02/98	1530	0.61	14	0.03	3.0	230	1.6	0.3	32	5
04/30/98	1250	0.48	n.a.	n.a.	2.7	n.a.	n.a.	n.a.	n.a.	n.a.
05/05/98	1050	0.54	n.a.	n.a.	2.2	n.a.	n.a.	n.a.	n.a.	n.a.
05/12/98	1125	1.1	n.a.	n.a.	2.6	n.a.	n.a.	n.a.	n.a.	n.a.
05/18/98	1540	0.65	n.a.	n.a.	3.0	n.a.	n.a.	n.a.	n.a.	n.a.
06/16/98	1115	0.80	11	0.02	4.2	230	1.4	0.5	38	3
06/30/98	1405	1.2	15	0.07	2.0	940	1.9	0.3	49	4
07/23/98	1200	0.79	24	0.12	1.6	1300	4.0	0.5	60	8
07/26/98	0815	0.32	56	0.12	8.4	440	7.0	3.9	60	30
07/28/98	1030	0.79	21	0.08	0.7	1500	2.7	0.1	64	5
08/24/98	0945	0.30	28	0.96	1.0	2000	2.7	0.6	63	7
09/22/98	1220	0.28	33	0.11	1.8	4200	5.9	0.3	110	13
10/08/98	0942	0.59	46	0.42	7.2	380	6.0	4.0	32	24
10/08/98	1458	0.96	140	0.12	16	540	10	11.0	48	44
10/08/98	1725	0.30	36	0.16	6.8	1600	6.4	1.7	80	24
11/16/98	1213	0.37	18	0.03	1.3	3200	4.0	0.3	64	6
11/30/98	1330	0.24	17	0.09	1.1	4100	4.4	0.1	68	4
12/14/98	1320	0.31	17	0.09	0.7	2600	2.5	0.1	52	5
01/08/99	1957	0.67	27	0.08	4.4	700	4.8	0.6	76	12
01/09/99	0923	0.36	270	0.80	2.2	890	150	2.8	320	46
01/09/99	1125	1.1	940	0.62	58	440	4.4	0.4	720	48
01/09/99	1404	0.58	36	0.12	4.0	220	4.4	1.2	64	16
01/10/99	1107	0.87	17	0.54	2.0	290	3.2	0.4	50	8

Table 13. The results of the analysis of dissolved trace elements in the occasionally sampled tributaries

The sampling date and location are shown. Data are presented in micrograms per liter (μg/L). A "less than" (<) indicates that the analyte concentration is lower than the limit of detection for that element. The locations listed indicate the tributary sampled (refer to figure 2 for exact locations).

Date sampled	Location	As μg/L	Ba μg/L	Cd μg/L	Cr μg/L	Cu μg/L	Mn μg/L	Ni μg/L	Pb μg/L	Sr μg/L	V μg/L	Zn μg/L
02/03/98	LAOUT Tributary	0.6	11	0.02	0.5	2.4	180	0.9	0.03	35	0.1	4
02/03/98	RELAC Tributary	0.06	21	0.02	0.6	0.82	15	2.4	0.02	54	0.1	9
02/03/98	RELAC Wooden Spillway	0.13	21	0.02	0.7	0.96	18	2.0	0.03	53	0.1	8
07/28/98	RELAC Tributary	0.7	27	0.07	<1	4.4	60	1.6	0.08	160	0.9	4
10/08/98	LAOUT Tributary	0.3	6	0.12	<1	3.8	970	1.1	0.29	22	0.9	9
10/08/98	RELAC Tributary	1.5	12	0.38	<1	2.4	140	1.5	0.96	19	0.8	10
01/09/99	LAOUT Tributary	<0.1	190	1.2	<1	2.8	390	6.3	0.13	32	<0.1	80
01/09/99	RELAC Tributary	0.7	160	0.93	<1	2.8	540	9.5	0.15	48	<0.1	70
01/09/99	LAOUT Tributary	<0.1	98	0.45	<1	2.7	210	3.5	0.18	170	<0.1	40
01/09/99	LAOUT Tributary	0.6	13	0.03	<1	1.8	130	0.8	<0.05	47	0.2	7
01/09/99	RELAC Tributary	1.5	28	0.20	1	3.9	90	1.3	0.12	46	0.5	20

Table 14. The results of the analysis of total trace elements in the occasionally sampled tributaries

The sampling date and times are shown. Data are presented in micrograms per liter (μg/L). The locations listed indicate the tributary sampled (refer to figure 2 for exact locations).

Date sampled	Location	Time	As μg/L	Ba μg/L	Cd μg/L	Cu μg/L	Mn μg/L	Ni μg/L	Pb μg/L	Sr μg/L	Zn μg/L
02/03/98	LAOUT Tributary	1017	0.97	45	0.04	8.8	680	4.0	0.2	140	16
02/03/98	RELAC Tributary	1033	0.27	39	0.04	2.1	560	5.6	0.9	92	16
02/03/98	RELAC Wooden Spillway	1035	0.31	42	0.08	1.9	110	6.0	0.3	100	16
07/28/98	RELAC Tributary	1500	1.1	27	0.07	7.0	60	1.6	0.1	160	4
10/08/98	LAOUT Tributary	0944	1.1	52	0.12	7.2	980	5.6	4.0	32	24
10/08/98	RELAC Tributary	0955	31	760	0.46	71	870	42	41	64	84
01/09/99	LAOUT Tributary	1128	0.20	190	1.2	23	390	6.3	0.2	320	80
01/09/99	RELAC Tributary	1144	1.8	160	0.98	14	600	40	9.3	56	70
01/09/99	LAOUT Tributary	1405	0.40	98	0.45	16	210	3.5	0.2	170	40
01/09/99	LAOUT Tributary	1406	0.83	16	0.04	2.8	280	4.4	0.6	46	8
01/09/99	RELAC Tributary	1435	1.8	44	0.20	6.4	94	5.6	3.0	46	36

Table 15. The results of the analysis of dissolved trace elements in Lake Anne
The sampling dates and location of samples are shown. Data are presented in micrograms per liter (µg/L). A "less than" (<) indicates that the analyte concentration is lower than the limit of detection for that element. The locations listed indicate the area of the lake sampled (refer to figure 2 for exact locations). The samples collected on 11/30/98, "Lower-a" and "Lower-b", are field replicates.

Date sampled	Location	As µg/L	Ba µg/L	Cd µg/L	Cr µg/L	Cu µg/L	Mn µg/L	Ni µg/L	Pb µg/L	Sr µg/L	V µg/L	Zn µg/L
04/02/98	Upper	0.7	11	0.04	0.3	3.1	66	1.1	0.03	28	0.4	4
04/02/98	Middle	0.7	14	0.07	0.2	3.9	59	1.7	0.04	27	0.4	10
04/02/98	Lower	0.7	10	0.03	0.3	2.6	48	1.0	0.01	27	0.4	3
06/02/98	Upper	0.8	5	0.01	0.2	2.8	1.2	0.5	0.03	36	0.3	1
06/02/98	Middle	0.8	4	0.01	0.2	2.6	0.7	0.5	0.03	35	0.3	<1
06/02/98	Lower	0.7	4	<0.01	0.2	2.5	0.7	0.4	0.02	35	0.2	<1
06/02/98	Depth	0.8	4	<0.01	0.5	2.4	1.0	0.4	0.02	36	0.2	<1
07/28/98	Upper	1.0	6	<0.01	<1	3.8	3.7	0.4	0.13	42	0.1	2
07/28/98	Middle	1.1	6	0.04	<1	5.0	4.8	0.4	0.13	43	0.1	4
07/28/98	Lower	1.0	6	0.04	<1	2.9	5.7	0.3	0.06	40	0.1	3
09/22/98	Upper	1.4	7	0.03	<1	3.7	5.1	0.5	0.08	44	0.2	2
09/22/98	Middle	1.3	7	0.13	<1	3.8	1.7	0.5	0.10	43	0.2	3
09/22/98	Lower	1.3	7	0.12	<1	3.0	3.5	0.3	<0.05	45	0.2	1
09/22/98	Depth	1.4	9	0.11	<1	2.4	82	0.4	<0.05	43	0.2	2
11/30/98	Upper	0.7	11	0.04	<1	2.5	7	0.3	<0.05	40	0.2	<1
11/30/98	Middle	0.7	10	<0.01	<1	2.2	10	0.2	<0.05	40	0.2	<1
11/30/98	Lower-a	0.8	11	0.03	<1	2.1	6	0.2	0.06	40	0.2	<1
11/30/98	Lower-b	0.7	11	0.06	<1	2.1	8	0.2	0.06	39	0.1	1

Table 16. The results of the analysis of total trace elements in Lake Anne
The sampling date and times are shown. Data are presented in micrograms per liter (µg/L); "n.a." indicates that the sample was not analyzed for that particular element. The locations listed indicate the area of the lake sampled (refer to figure 2 for exact locations). The samples collected on 11/30/98, "Lower-a" and "Lower-b", are field replicates. Upper, Middle and Lower samples were collected at the surface. Samples labeled "Depth" were collected at the Lower site at 2-3 meters of water depth.

Date sampled	Location	As µg/L	Ba µg/L	Cd µg/L	Cu µg/L	Mn µg/L	Ni µg/L	Pb µg/L	Sr µg/L	Zn µg/L
04/02/98	Upper	0.92	25	0.10	3.8	190	2.8	0.7	55	12
04/02/98	Middle	1.0	15	0.12	4.3	120	2.4	0.4	31	11
04/02/98	Lower	1.2	12	0.03	3.9	410	1.4	0.5	38	3
06/02/98	Upper	3.2	29	0.05	12	890	3.9	0.6	110	20
06/02/98	Middle	4.0	32	0.17	14	900	4.5	0.5	140	10
06/02/98	Lower	0.79	n.a.	n.a.	11	n.a.	n.a.	n.a.	n.a.	n.a.
06/02/98	Depth	1.1	13	0.02	3.8	480	1.2	0.2	38	2
07/28/98	Upper	3.1	20	0.05	8.0	440	2.0	0.4	72	3
07/28/98	Middle	1.5	10	0.03	5.0	260	1.2	0.2	58	4
07/28/98	Lower	1.2	8	0.04	3.5	190	1.1	0.1	120	3
09/22/98	Upper	1.8	10	0.14	4.4	160	1.4	0.4	45	7
09/22/98	Middle	2.1	13	0.14	4.0	220	1.5	0.3	43	3
09/22/98	Lower	2.1	7	0.13	4.2	36	1.4	0.3	45	1
09/22/98	Depth	2.7	24	0.10	6.0	370	2.1	1.4	44	8
11/30/98	Upper	0.90	13	0.05	2.7	90	1.2	0.3	40	2
11/30/98	Middle	0.71	n.a.	n.a.	3.1	n.a.	n.a.	n.a.	n.a.	n.a.
11/30/98	Lower-a	0.80	n.a.	n.a.	2.8	n.a.	n.a.	n.a.	n.a.	n.a.
11/30/98	Lower-b	0.90	12	0.06	2.1	65	1.1	1.0	40	2

Table 17. The results of the analysis of dissolved major cations and anions in the Lake Anne precipitation

The sampling date shown is the end date of precipitation collection. Data are presented in microequivalents per liter (µeq/L). A "less than" (<) indicates analyte concentration is lower than the limit of detection for that element. "ISA" indicates that there was insufficient volume for the sample to be analyzed for that particular analyte.

End Date	H^+ µeq/L	Ca^{2+} µeq/L	Mg^{2+} µeq/L	Na^+ µeq/L	K^+ µeq/L	Fe^{2+} µeq/L	Al^{3+} µeq/L	Cl^- µeq/L	NO_3^- µeq/L	SO_4^{2-} µeq/L
01/06/98	52.5	5.0	2.0	7.0	2.6	2.5	11	13.3	34.3	43.9
01/20/98	46.8	5.0	2.0	4.8	2.3	<0.2	5.6	8.7	16.4	36.2
02/03/98	44.7	5.0	2.0	6.1	1.5	0.7	5.6	6.2	16.4	37.4
02/05/98	23.4	5.0	2.0	5.2	1.5	0.7	6.0	3.61	16.7	34.0
02/17/98	51.3	5.0	8.2	28	3.8	1.8	5.6	2.71	37.3	111
03/03/98	33.9	5.0	2.0	2.6	4.9	1.1	<5.5	ISA	ISA	ISA
03/17/98	33.9	5.0	2.0	2.8	1.8	1.4	11	1.37	30.2	39.2
03/31/98	57.5	5.0	2.0	0.22	1.5	0.7	6.0	10.3	48.8	66.0
04/14/98	87.1	5.0	2.0	2.5	7.4	1.4	5.6	7.2	57.2	86.6
04/28/98	87.1	13	8.2	9.1	4.6	1.8	5.6	26.1	95.4	167
05/12/98	50.1	5.0	2.0	19	2.6	1.4	5.5	3.9	31.6	50.4
06/02/98	ISA	22	2.0	5.2	2.6	3.6	22	ISA	ISA	ISA
06/16/98	18.6	5.0	2.0	1.2	2.6	1.1	5.6	4.5	25.5	49.1
06/30/98	204.2	24	5.9	9.6	1.8	1.1	<5.5	1.5	3.1	13.1
07/14/98	104.7	10	0.82	0.22	10	5.3	13	ISA	ISA	ISA
07/28/98	758.6	25	2.8	0.22	14	5.2	12	ISA	ISA	ISA
08/11/98	109.6	10	0.82	0.22	16	5.9	13	17	41.7	155
09/08/98	128.8	13	8.2	24	2.5	2.5	11	ISA	48.2	57.2
09/22/98	166.0	10	0.41	0.22	15	1.3	3.7	6.3	66.3	197
10/06/98	457.1	55	22	24	10	27	72	ISA	ISA	660
10/20/98	182.0	30	2.0	16	3.6	0.2	<5.5	20	32.2	232
11/03/98	501.2	5.0	2.0	3.0	7.7	0.5	<5.5	ISA	ISA	500
11/16/98	102.3	10	0.41	0.44	13	0.9	3.8	14.2	31.3	29.0
11/30/98	151.4	15	1.8	4.4	17	7	16	97.8	120	150
12/14/98	57.5	2.5	2.0	2.2	6.6	0.04	<5.5	3.4	21.2	65.5
12/30/98	123.0	5.0	2.0	3.0	7.2	0.5	<5.5	30.6	62.3	123
01/09/99	55.0	5.0	3.8	35	11	1.1	3.9	52.3	43	114

Table 18. The results of the analysis of dissolved major cations and anions in the stream RELAC The sampling date and time of collection is shown. Data are presented in microequivalents per liter (µeq/L) and mg/L for SiO_2. A "less than" (<) indicates analyte concentration is lower than the limit of detection for that element; "n.a." indicates that the sample was not analyzed for that particular element. The chloride (Cl^-) concentration was determined by difference between the cation and anion balance.

Date sampled	Time	Ca^{2+} µeq/L	Mg^{2+} µeq/L	Na^+ µeq/L	K^+ µeq/L	Al^{3+} µeq/L	Fe^{2+} µeq/L	SiO_2 mg/L	Cl^- µeq/L	NO_3^- µeq/L	SO_4^{2-} µeq/L	HCO_3^- µeq/L	F^- µeq/L
01/06/98	1100	580	390	1900	41	4.4	4.9	12	2400	40.2	61.5	459	1.4
02/03/98	1030	480	350	770	36	7.6	3.4	11	710	47.2	79.9	517	n.a.
02/04/98	1045	220	75	1500	56	7.8	1.1	2.1	1550	17.9	45.3	250	n.a.
02/04/98	1420	180	66	570	46	8.9	1.1	1.9	600	12.7	40.1	223	1.2
02/04/98	1815	220	99	1200	61	6.7	2.2	2.0	1300	10.0	30.9	272	n.a.
02/05/98	1410	320	140	520	49	10	1.8	5.1	660	9.70	36.2	335	n.a.
02/06/98	1110	480	280	780	46	5.6	2.5	9.4	990	39.4	130	444	n.a.
03/17/98	1045	440	300	590	28	3.8	1.9	n.a.	750	44.7	82.9	490	n.a.
04/02/98	1540	460	290	680	38	5.6	2.2	9.8	980	32.8	68.2	402	n.a.
04/30/98	1235	520	350	660	38	<3.0	0.7	12	860	48.1	73.1	592	n.a.
05/05/98	1110	480	320	570	41	<3.0	2.9	11	780	37.2	62.5	62.5	n.a.
05/12/98	1055	320	160	460	49	5.6	8	n.a.	360	33.0	75.6	75.6	2.3
05/18/98	1525	510	330	630	41	18	6.9	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
06/16/98	1145	490	280	530	51	11	25	5.2	820	112	71.5	392	n.a.
06/30/98	1130	520	340	590	36	<3.0	11	13	860	40.0	50.0	560	n.a.
07/23/98	1145	540	360	560	43	11	72	13	830	11.0	38.7	716	1.7
07/26/98	0835	560	350	520	46	<3.0	3.4	13	680	240	290	274	n.a.
07/28/98	1110	540	340	560	36	<3.0	0.4	13	710	29.7	41.7	705	n.a.
08/24/98	1020	560	400	570	33	<3.0	1.8	13	n.a.	n.a.	n.a.	n.a.	n.a.
09/22/98	1250	520	310	460	51	<3.0	7.2	12	690	40.5	93.9	534	1.2
10/08/98	0953	200	74	230	66	<3.0	2.5	2.8	220	43.9	89.2	227	n.a.
10/08/98	1433	260	82	290	54	<3.0	2.2	3.6	260	52.4	120	257	n.a.
10/08/98	1715	270	66	340	54	<3.0	2.2	3.8	n.a.	n.a.	n.a.	n.a.	1.2
11/16/98	1245	560	400	540	49	3.9	4.0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
11/30/98	1135	530	370	550	51	3.1	4.6	n.a.	770	25.4	59.9	653	n.a.
12/14/98	1245	440	290	510	46	<3.0	7.2	10	n.a.	n.a.	n.a.	n.a.	n.a.
01/08/99	1943	660	470	2800	55	5.3	5.3	n.a.	2600	93.8	780	487	n.a.
01/09/99	1040	2300	1200	40000	460	5.3	17	n.a.	32000	2960	8220	395	n.a.
01/09/99	1145	2200	950	52000	530	6.0	9.0	n.a.	55000	n.a.	415	200	n.a.
01/09/99	1430	1740	700	35000	300	7.6	6.0	n.a.	36700	n.a.	345	735	n.a.
01/10/99	1120	1420	810	13000	150	5.7	6.8	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

Table 19. The results of the analysis of total major cations in the stream RELAC The sampling date and times are shown. Data are presented in milligrams per liter (mg/L) or micrograms per liter (µg/L); "n.a." indicates that the sample was not analyzed for that particular element.

Date	Time	Ca^{2+} mg/L	Mg^{2+} mg/L	Na^{+} mg/L	K^{+} mg/L	Al^{3+} µg/L	Fe^{2+} µg/L
01/06/98	1100	9.6	4.3	38	1.4	150	540
02/03/98	1030	n.a.	n.a.	n.a.	n.a.	210	560
02/04/98	1045	3.9	1.2	29	2.2	3900	2400
02/04/98	1420	n.a.	n.a.	n.a.	n.a.	4700	2700
02/04/98	1815	n.a.	n.a.	n.a.	n.a.	4600	2800
02/05/98	1410	n.a.	n.a.	n.a.	n.a.	370	450
02/06/98	1110	7.7	3.0	14	1.6	1400	1100
03/17/98	1045	7.4	3.6	12	1.4	70	330
04/02/98	1540	7.7	3.2	13	1.5	370	600
04/30/98	1235	n.a.	n.a.	n.a.	n.a.	520	780
05/05/98	1110	n.a.	n.a.	n.a.	n.a.	300	900
05/12/98	1055	6.3	2.0	9.2	1.9	1900	1700
05/18/98	1525	9.0	4.0	13	1.6	4900	1200
06/16/98	1145	n.a.	n.a.	n.a.	n.a.	990	1240
06/30/98	1130	n.a.	n.a.	n.a.	n.a.	120	1300
07/23/98	1145	8.6	3.7	10	1.8	1060	2260
07/26/98	0835	8.0	3.5	8.8	2.5	3750	4820
07/28/98	1110	8.5	3.7	11	1.2	200	1600
08/24/98	1020	9.3	4.2	11	1.3	330	1440
09/22/98	1250	9.1	4.0	11	1.3	820	1300
10/08/98	0953	3.4	1.3	5.3	3.8	6800	3900
10/08/98	1433	3.2	1.3	5.0	3.8	2300	1600
10/08/98	1715	n.a.	n.a.	n.a.	n.a.	2460	1790
11/16/98	1245	9.3	4.2	11	1.9	150	1340
11/30/98	1135	8.8	4.1	11	1.8	140	790
12/14/98	1245	n.a.	n.a.	n.a.	n.a.	260	550
01/08/99	1943	10.7	5.0	53	2.4	180	510
01/09/99	1040	34.2	11.5	900	16.0	620	840
01/09/99	1145	35.7	9.8	1200	22.3	1900	1600
01/09/99	1430	28.4	7.4	780	12.6	1200	800
01/10/99	1120	23.5	8.5	350	5.9	110	220

Table 20. The results of the analysis of dissolved major cations and anions in the stream LAOUT The sampling date and time of collection is shown. Data are presented in microequivalents per liter (μeq/L) and mg/L for SiO_2. A "less than" (<) indicates analyte concentration is lower than the limit of detection for that element; "n.a." indicates that the sample was not analyzed for that particular element. The chloride (Cl^-) concentration was determined by difference between the cation and anion balance.

Date sampled	Time	Ca^{2+} μeq/L	Mg^{2+} μeq/L	Na^+ μeq/L	K^+ μeq/L	Al^{3+} μeq/L	Fe^{2+} μeq/L	SiO_2 mg/L	Cl^- μeq/L	NO_3^- μeq/L	SO_4^{2-} μeq/L	HCO_3^- μeq/L	F^- μeq/L
01/06/98	1030	420	230	1000	64	<3.0	16	5.4	1200	26.3	81.6	425	2.1
02/03/98	1015	400	210	860	67	<3.0	2.7	3.0	1040	27.1	88.4	385	2.2
02/04/98	1107	340	160	850	61	<3.0	1.6	1.3	990	28.3	93.1	305	1.8
02/04/98	1435	340	140	770	59	<3.0	2.2	n.a.	840	28.7	94.5	353	n.a.
02/04/98	1800	340	140	780	64	<3.0	2.2	2.8	870	23.2	87.8	331	1.8
02/05/98	1425	330	120	740	61	<3.0	2.2	2.6	760	28.3	96.1	385	2.1
02/06/98	1125	350	160	790	61	<3.0	2.2	3.0	900	20.8	91.6	340	1.7
03/17/98	1015	360	190	660	44	<3.0	2.7	n.a.	770	20.3	91.9	371	1.4
04/02/98	1530	320	160	490	51	<3.0	2.7	3.0	594	19.1	90.5	348	1.3
04/30/98	1250	330	210	480	54	<3.0	3.2	3.6	610	20.2	87.3	358	1.8
05/05/98	1050	330	200	440	56	<3.0	1.1	3.6	520	19.2	87.9	404	1.9
05/12/98	1125	380	170	500	56	<3.0	<1.0	n.a.	590	16.6	90.5	405	1.9
05/18/98	1540	400	200	550	57	<3.0	<1.0	n.a.	720	14	64.3	413	1.6
06/16/98	1115	390	190	490	61	<3.0	11	3.0	610	56.3	75.6	397	2.3
06/30/98	1405	500	330	630	51	<3.0	27	4.9	810	15.1	56.8	661	2.1
07/23/98	1200	570	450	790	49	<3.0	1.1	7.3	1100	11.0	38.7	716	1.7
07/26/98	0815	550	360	590	100	<3.0	48	6.2	850	245	283	274	1.4
07/28/98	1030	600	510	860	110	<3.0	0.11	7.1	1300	35.2	55.3	661	1.2
08/24/98	0945	630	550	920	36	<3.0	0.38	6.4	2100	8.5	2.02	2.02	n.a.
09/22/98	1220	530	440	660	45	<3.0	16	6.2	840	14.7	67.2	769	1.8
10/08/98	0942	110	60	100	59	<3.0	2.2	1.2	96	27.6	59.5	262	1.4
10/08/98	1458	120	60	110	51	<3.0	1.6	1.4	78	30.2	77.1	235	2.1
10/08/98	1725	270	130	310	49	<3.0	3.8	3.6	720	3.4	34.0	34.0	2.0
11/16/98	1213	610	550	840	39	<3.0	2.7	n.a.	1000	3.3	33.9	972	2.0
11/30/98	1330	560	510	810	44	<3.0	38	6.2	1100	5.2	38.6	836	2.3
12/14/98	1320	480	420	710	44	<3.0	48	5.8	310	9.5	63.7	1330	1.8
01/08/99	1957	410	240	960	67	<3.0	50	n.a.	1100	15.3	120	458	0.8
01/09/99	0923	1600	690	49000	150	4.4	76	n.a.	51000	98.5	360	350	n.a.
01/09/99	1125	1100	440	40000	110	4.8	42	n.a.	41000	48.5	340	276	n.a.
01/09/99	1404	410	230	6100	77	4.2	38	n.a.	6200	114	207	373	n.a.
01/10/99	1107	430	230	1500	77	3.7	4.8	6.6	1300	220	360	360	n.a.

Table 21. The results of the analysis of total major cations in the stream LAOUT
The sampling date and times are shown. Data are presented in milligrams per liter (mg/L) or micrograms per liter (µg/L); "n.a." indicates that the sample was not analyzed for that particular element.

Date	Time	Ca^{2+} mg/L	Mg^{2+} mg/L	Na^{+} mg/L	K^{+} mg/L	Al^{3+} µg/L	Fe^{2+} µg/L
01/06/98	1030	n.a.	n.a.	n.a.	n.a.	170	1000
02/03/98	1015	n.a.	n.a.	n.a.	n.a.	890	1300
02/04/98	1107	n.a.	n.a.	n.a.	n.a.	7400	4300
02/04/98	1435	n.a.	n.a.	n.a.	n.a.	1900	1300
02/04/98	1800	n.a.	n.a.	n.a.	n.a.	2300	1500
02/05/98	1425	n.a.	n.a.	n.a.	n.a.	1500	1100
02/06/98	1125	n.a.	n.a.	n.a.	n.a.	990	950
03/17/98	1015	6.2	2.4	13	1.8	220	660
04/02/98	1530	n.a.	n.a.	n.a.	n.a.	1500	550
04/30/98	1250	n.a.	n.a.	n.a.	n.a.	290	660
05/05/98	1050	n.a.	n.a.	n.a.	n.a.	210	640
05/12/98	1125	n.a.	n.a.	n.a.	n.a.	180	640
05/18/98	1540	n.a.	n.a.	n.a.	n.a.	240	640
06/16/98	1115	6.3	2.2	8.8	2.2	120	580
06/30/98	1405	9.1	4.8	15	1.4	750	1200
07/23/98	1200	9.0	4.6	14	1.7	120	1600
07/26/98	0815	7.4	3.3	9.1	4.2	420	4200
07/28/98	1030	9.4	5.0	16	1.6	1200	1400
08/24/98	0945	10.4	5.7	18	1.5	1800	3000
09/22/98	1220	10.3	5.5	17	1.5	2100	260
10/08/98	0942	2.5	1.1	2.5	3.9	350	3600
10/08/98	1458	2.8	1.6	3.0	6.5	460	9000
10/08/98	1725	n.a.	n.a.	n.a.	n.a.	1400	2000
11/16/98	1213	n.a.	n.a.	n.a.	n.a.	3300	3000
11/30/98	1330	n.a.	n.a.	n.a.	n.a.	2900	1700
12/14/98	1320	n.a.	n.a.	n.a.	n.a.	3100	2100
01/08/99	1957	7.0	2.7	19	2.6	360	470
01/09/99	0923	27.3	7.8	1200	5.0	190	430
01/09/99	1125	18.0	4.8	1000	5.0	40	6200
01/09/99	1404	8.2	2.8	140	3.0	130	910
01/10/99	1107	n.a.	n.a.	n.a.	n.a.	250	390

Table 22. The results of the analysis of dissolved major cations and anions in the occasionally sampled tributaries
The sampling date and location of collection is shown. Data are presented in microequivalents per liter (μeq/L) and mg/L for SiO_2. A "less than" (<) indicates analyte concentration is lower than the limit of detection for that element, "n.a." indicates that the sample was not analyzed for that particular element. The chloride (Cl^-) concentration was determined by difference between the cation and anion balance. The locations listed indicate the tributary sampled (refer to figure 2 for exact locations).

Date Sampled	Location of sample	Time	Ca^{2+} μeq/L	Mg^{2+} μeq/L	Na^+ μeq/L	K^+ μeq/L	Al^{3+} μeq/L	Fe^{2+} μeq/L	SiO_2 mg/L	Cl^- μeq/L	NO_3^- μeq/L	SO_4^{2-} μeq/L	HCO_3^- μeq/L	F^- μeq/L
02/03/98	LAOUT Tributary	1017	400	180	870	60	n.a.	n.a.	2.8	1000	27.1	88.4	385	n.a.
02/03/98	RELAC Tributary	1033	470	350	810	24	n.a.	n.a.	12	1200	24.7	84.3	313	1.7
02/03/98	RELAC spillway	1035	490	210	770	36	n.a.	n.a.	12	n.a.	n.a.	n.a.	n.a.	n.a.
07/28/98	RELAC Tributary	1500	1300	700	420	110	<3.0	2.1	2.5	1800	29.7	41.7	705	n.a.
10/08/98	LAOUT Tributary	0944	80	41	61	66	6.2	3.4	3.6	94	35.8	54.4	202	0.7
10/08/98	RELAC Tributary	0955	160	42	35	56	5.6	1.7	0.7	145	15.5	65.3	73.0	n.a.
01/09/99	LAOUT Tributary	1128	1300	490	44000	170	5.6	2.8	6.4	45000	110	507	112	n.a.
01/09/99	RELAC Tributary	1144	420	120	11000	280	5.9	2.8	n.a.	11000	145	292	147	n.a.
01/09/99	LAOUT Tributary	1405	750	350	3500	130	6.4	3.6	1.1	4200	88.9	299	127	n.a.
01/09/99	LAOUT Tributary	1406	400	200	810	74	4.0	2.7	6.4	748	n.a.	298	446	n.a.
01/09/99	RELAC Tributary	1435	360	120	6400	260	4.6	2.4	13	6900	43	75.5	92.6	n.a.

Table 23. The results of the analysis of total major cations in the occasionally sampled tributaries The sampling date and times are shown. Data are presented in milligrams per liter (mg/L) or micrograms per liter (µg/L); "n.a." indicates that the sample was not analyzed for that particular element. The locations listed indicate the tributary sampled (refer to figure 2 for exact locations).

Date sampled	Location	Time	Ca^{2+} mg/L	Mg^{2+} mg/L	Na^{+} mg/L	K^{+} mg/L	Al^{3+} µg/L	Fe^{2+} µg/L
02/03/98	LAOUT Tributary	1017	n.a.	n.a.	n.a.	n.a.	980	1200
02/03/98	RELAC Tributary	1033	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
02/03/98	RELAC Wooden Spillway	1035	2.0	13	5.7	24	140	390
07/28/98	RELAC Tributary	1500	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
10/08/98	LAOUT Tributary	0944	1.6	0.5	1.4	2.6	660	3200
10/08/98	RELAC Tributary	0955	3.1	0.5	0.8	2.2	n.a.	n.a.
01/09/99	LAOUT Tributary	1128	26	5.9	1000	6.8	n.a.	n.a.
01/09/99	RELAC Tributary	1144	7.2	1.5	300	11	24000	11000
01/09/99	LAOUT Tributary	1405	15	4.2	80	5.2	n.a.	n.a.
01/09/99	LAOUT Tributary	1406	6.7	2.5	16	2.9	660	790
01/09/99	RELAC Tributary	1435	7.1	1.5	120	9.7	4800	2500

Table 24. The results of the analysis of dissolved major cations and anions in Lake Anne The sampling date and location of collection is shown. Data are presented in microequivalents per liter (μeq/L). A "less than" (<) indicates analyte concentration is lower than the limit of detection for that element, "n.a." indicates that the sample was not analyzed for that particular element. The chloride (Cl^-) concentration was determined by difference between the cation and anion balance. The locations listed indicate the area of the lake sampled (refer to figure 2 for exact locations). The samples collected on 11/30/98, "Lower-a" and "Lower-b", are field replicates.

Date sampled	Location of sample	Ca^{2+} μeq/L	Mg^{2+} μeq/L	Na^+ μeq/L	K^+ μeq/L	Al^{3+} μeq/L	Fe^{2+} μeq/L	Cl^- μeq/L	NO_3^- μeq/L	SO_4^{2-} μeq/L	HCO_3^- μeq/L	F^- μeq/L
04/02/98	Upper	330	160	500	60	3.8	1.8	690	13.3	75.2	280	n.a.
04/02/98	Middle	320	160	490	54	4.0	1.8	620	12.9	83.3	312	1.31
04/02/98	Lower	310	150	460	54	4.7	2.3	570	13.5	85.4	313	1.13
06/02/98	Upper	430	210	530	61	3.4	2.6	670	11.9	85.3	468	1.8
06/02/98	Middle	400	190	510	61	3.8	2.8	620	16.7	84.7	441	1.76
06/02/98	Lower	390	220	510	72	17.8	12.9	680	13.4	85.4	444	1.84
06/02/98	Depth	400	190	510	59	3.9	1.9	620	9.59	86.0	449	1.79
07/28/98	Upper	440	200	500	66	<3.0	0.5	630	4.39	65.8	473	2.04
07/28/98	Middle	440	200	470	59	<3.0	0.4	620	5.11	67.2	478	2.1
07/28/98	Lower	430	200	480	64	<3.0	0.2	570	4.53	67.1	532	1.91
09/22/98	Upper	440	210	510	66	3.1	1.6	680	4.22	64.7	480	2.41
09/22/98	Middle	460	210	510	69	3.6	1.1	700	2.62	62.5	492	2.27
09/22/98	Lower	440	210	480	61	3.8	1.1	650	1.03	51.4	492	1.72
09/22/98	Depth	440	210	490	74	4.1	0.3	690	n.a.	47.2	485	1.42
11/30/98	Upper	440	210	490	72	24.5	4.3	610	11.4	101	521	2.04
11/30/98	Middle	440	210	480	66	6.7	0.9	580	9.20	101	515	2.06
11/30/98	Lower-a	440	210	490	66	4.4	0.7	580	9.35	101	516	2.17
11/30/98	Lower-b	370	210	420	56	4.2	0.8	430	9.67	100	520	2.38

Table 25. The results of the analysis of total major cations in Lake Anne
The sampling date and times are shown. Data are presented in milligrams per liter (mg/L) or micrograms per liter (µg/L); "n.a." indicates that the sample was not analyzed for that particular element. The locations listed indicate the area of the lake sampled (refer to figure 2 for exact locations). The samples collected on 11/30/98, "Lower-a" and "Lower-b", are field replicates.

Date sampled	**Location**	**Ca^{2+}** mg/L	**Mg^{2+}** mg/L	**Na^{+}** mg/L	**K^{+}** mg/L	**Al^{3+}** µg/L	**Fe^{2+}** µg/L
04/02/98	Upper	5.6	1.9	9.6	2.3	190	350
04/02/98	Middle	5.4	1.9	9.7	2.0	230	470
04/02/98	Lower	5.3	1.8	9.3	2.1	100	450
06/02/98	Upper	6.6	2.3	9.6	2.2	330	1200
06/02/98	Middle	6.7	2.3	9.7	2.2	230	1200
06/02/98	Lower	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
06/02/98	Depth	6.7	2.3	9.8	2.3	170	500
07/28/98	Upper	2.1	6.3	8.2	2.0	180	1100
07/28/98	Middle	6.9	2.3	8.7	2.2	120	610
07/28/98	Lower	6.4	2.2	8.5	2.1	30	250
09/22/98	Upper	8.2	2.7	10	2.7	860	2100
09/22/98	Middle	8.3	2.8	11	2.8	250	800
09/22/98	Lower	8.7	2.9	10	3.2	420	1500
09/22/98	Depth	8.7	2.9	11	3.2	1700	2100
11/30/98	Upper	7.7	2.7	10	2.8	220	50
11/30/98	Middle	7.5	2.6	9.7	2.7	310	70
11/30/98	Lower-a	7.5	2.5	9.6	2.5	350	70
11/30/98	Lower-b	7.4	2.5	9.7	2.4	180	42

Table 26. Detection limits for the trace-element analysis conducted by ICP-MS (Inductively coupled plasma – mass spectroscopy)
Concentrations are listed as micrograms per liter (µg/L).

	µg/L		µg/L
As	0.1	Ni	0.1
Ba	0.2	Pb	0.01
Cd	0.01	Sr	0.1
Cr	1	V	0.2
Cu	0.1	Zn	1
Mn	0.1		

Table 27. Detection limits for the cation analysis conducted by ICP-OES (Inductively coupled plasma – optical emissions spectroscopy)
Concentrations are listed as milligrams per liter (µeq/L).

	mg/L
Ca^{2+}	0.1
Mg^{2+}	0.05
Na^{+}	0.5
K^{+}	0.1
Fe^{2+}	0.01
Al^{3+}	0.05

Table 28. Detection limits for the anion analysis conducted by IC (Ion chromatography)
Concentrations are listed as microequivalents per liter (µeq/L).

	µeq/L
F^{-}	0.6
Cl^{-}	1.2
NO_3^{-}	0.4
SO_4^{2-}	0.8

Table 29. Mean concentration and standard deviation (std. dev.) of the trace elements in the Precipitation and Field Blanks
The "n" indicates the number of blanks analyzed.

Precipitation Blanks			n=6							
	V	Cr	Mn	Ni	Cu	Sr	Cd	Zn	As	Ba	Pb
	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Mean	0.05	0.09	0.01	0.2	0.03	0.01	0.00	0.5	0.01	0.01	0.01
std. dev.	0.08	0.1	0.03	0.3	0.06	0.01	0.01	0.6	0.02	0.02	0.02

Field Blanks				n=7							
	V	Cr	Mn	Ni	Cu	Sr	Cd	Zn	As	Ba	Pb
	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
Mean	0.05	0.05	0.03	0.2	0.20	0.3	0.04	0.4	0.00	0.2	0.05
std. dev.	0.01	0.09	0.04	0.2	0.08	0.3	0.03	0.3	0.00	0.1	0.04

Table 30. The results of the analysis of SRM (Standard Reference Materials) used during ICP-MS accuracy checks
The literature values and standard deviation (where available) and the mean and standard deviation results of the SRM analyses are listed. Data are listed in micrograms per liter (µg/L).

	V µg/L	Cr µg/L	Mn µg/L	Ni µg/L	Cu µg/L	Sr µg/L	Cd µg/L	Zn µg/L	As µg/L	Ba µg/L	Pb µg/L
SLRS-3	**N=7**										
Literature	0.3	0.3	3.9	0.83	1.35	28.1	0.013	1.04	0.72	13.4	0.07
Lit std. dev.	0.02	0.04	0.3	0.08	0.07	nr	0	0.09	0.05	0.6	0.01
mean	0.3	0.3	4.0	0.8	1.5	32.0	0.0	1.0	0.8	13.9	0.1
std. dev.	0.03	0.03	0.10	0.04	0.05	0.63	0.002	0.11	0.04	0.38	0.00
SLRS-4	**N=5**										
Literature	0.32	0.33	3.4	0.67	1.8	26.3	0.012	0.93	0.68	12.2	0.09
Lit std. dev.	0.03	0.02	0.18	0.08	0.08	3.2	0.002	0.1	0.06	0.6	0.007
mean	0.5	0.3	3.6	0.7	1.8	28.4	0.0	1.1	0.7	12.4	0.1
std dev.	0.03	0.02	0.11	0.01	0.04	0.62	0.001	0.11	0.01	0.16	0.005
1634d	**n=10**										
Literature	35.1	18.53	37.66	58.1	20.5	294.8	6.44	72.5	56	506.5	18.2
Lit std. dev.	1.4	0.2	0.83	2.7	3.8	3.4	0.37	0.65	0.73	8.9	0.64
mean	35.5	18.5	37.9	56.6	20.4	294.2	6.3	72.6	55.3	504.6	18.2
std. dev.	1.50	0.36	0.90	1.14	0.22	4.66	0.11	0.70	0.69	4.30	0.12
T-155	**N=4**										
Literature	25.4	8.49	50.9	8.3	38	363	11.4	58.7	32.9	21.8	18.8
Lit std. dev.	1	0.78	2.4	1.5	2.4	14	0.8	4.1	2.8	1.1	1.7
mean	26.1	8.5	51.2	8.2	37.7	361.5	11.4	57.2	33.1	21.7	18.4
std. dev.	1.82	0.53	2.35	0.13	0.78	5.07	0.13	1.02	0.19	0.17	0.17
T-145	**N=4**										
Literature	11.7	15.3	20.9	11	11	203	9.33	10	9.88	37.1	12.7
Lit std. dev.	1.7	1.4	1.5	1.3	1.4	9	0.82	2.4	1.04	1.9	1.2
mean	11.6	15.5	21.8	11.2	11.1	201.0	9.4	9.2	10.1	37.2	12.5
std. dev.	0.80	0.90	0.74	0.15	0.29	3.46	0.25	0.70	0.12	0.35	0.15
WW-11	**N=6**										
Literature*	31.4	11.9	43.2	32.4	23.8	55.1	5.95	11.9	3.24	29.7	64.9
mean	33.8	12.9	43.9	32.6	24.1	56.5	6.0	12.0	3.4	29.5	64.8
std. dev.	0.55	0.88	0.66	0.27	0.14	0.85	0	0.10	0.04	0.38	0.63

* Literature standard deviation not available.

Table 31. The results of the analysis of SRM (Standard Reference Materials) used during ICP-OES accuracy checks
The literature values and the mean and standard deviation results of the SRM analyses are shown. Data are listed in milligrams per liter (mg/L).

	Ca^{2+} mg/L	Mg^{2+} mg/L	Na^{+} mg/L	K^{+} mg/L	Al^{3+} mg/L	Fe^{2+} mg/L
CRM-ES	**n= 6**					
Literature	80	100	200	150	not used	350
Mean	83	99	191	142		346
Std. dev.	1.3	2.5	1.2	3.4		4
CRM-soil	**n=5**					
Literature	350	70	70	200	not used	not used
Mean	368	70	75	165		
Std. dev.	8.3	1.7	2.1	6.2		

Table 32. The results of the analysis of SRM (Standard Reference Materials) used for accuracy checks during the GF-AAS analysis for As and Cu in the total (digested) water samples
The literature values and the mean and standard deviation results of the SRM analyses are shown. Data are listed in micrograms per liter (µg/L).

	T-155	n=5	T-145	n=5
	As µg/L	Cu µg/L	As µg/L	Cu µg/L
Literature	33	38	9.9	11
Mean	31.2	36.7	10	10.8
Std. dev.	1.3	1.1	0.71	0.56

Table 33. List of sample spikes and recovery of arsenic during the ICP-MS analysis The list includes the type of sample and the date of sample collection. Recovery was calculated as the theoretical (sample concentration + 0.2 μg/L) divided by the actual (spiked concentration) multiplied by 100%. Spike recoveries within +/- 10% of the expected value are considered within the analytical reproducibility of the instrument.

ID	Date	Sample Conc μg/L	Spiked Conc μg/L	Recovery %
Blank	06/30/98	0.0	0.2	100
Precip	06/30/98	0.2	0.4	100
Precip	07/14/98	0.3	0.4	125
Precip	09/22/98	0.2	0.5	80
Precip	10/06/98	1.0	1.2	100
Precip	10/20/98	0.1	0.2	150
Precip	11/30/98	0.3	0.4	125
Laout	09/22/98	0.2	0.4	100
Laout	12/14/98	0.2	0.4	100
L-trib	07/28/98	0.7	1.0	90
Relac	07/23/98	0.3	0.5	100