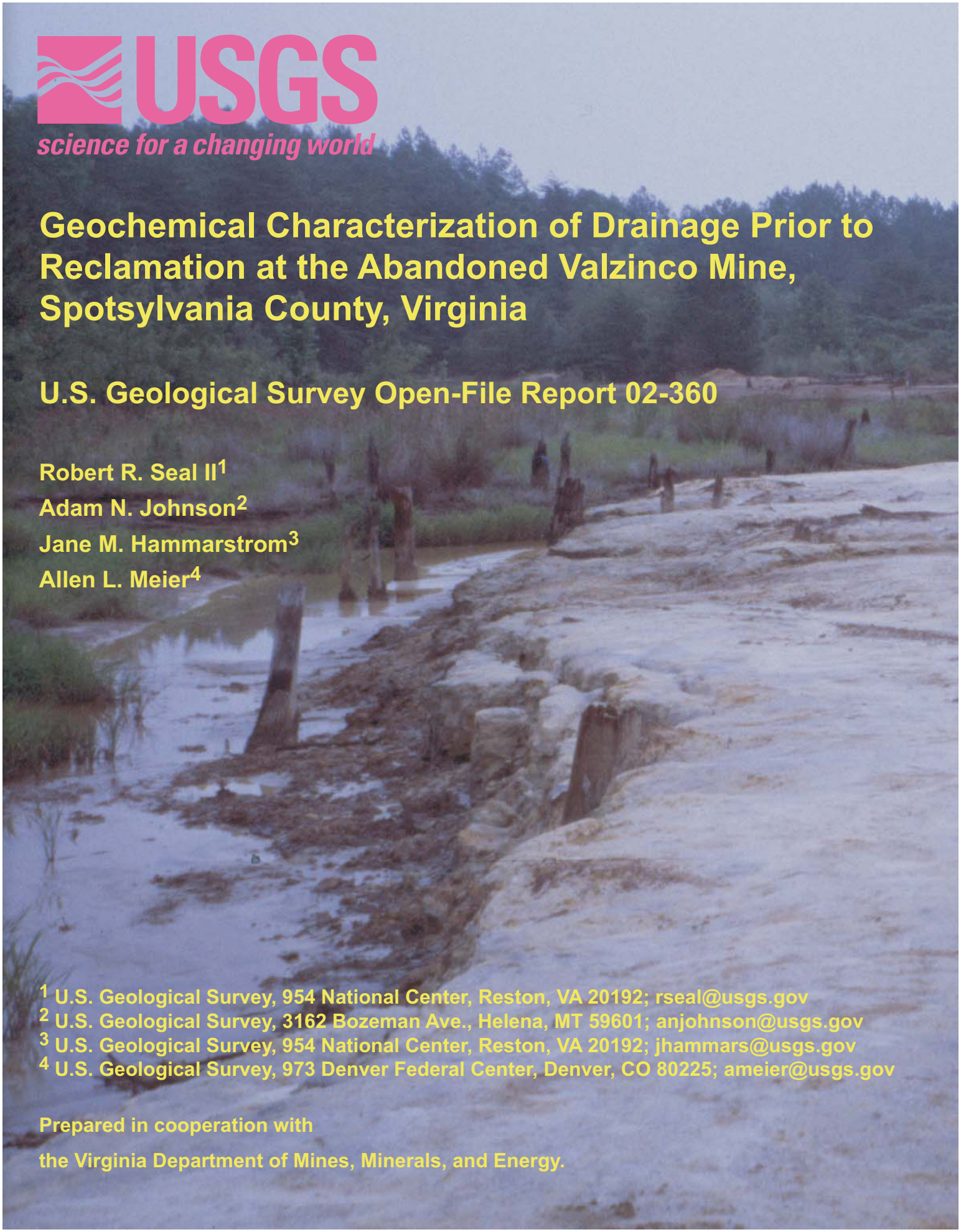

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Geochemical Characterization of Drainage Prior to Reclamation at the Abandoned Valzinco Mine, Spotsylvania County, Virginia

U.S. Geological Survey Open-File Report 02-360

Robert R. Seal II[1]
Adam N. Johnson[2]
Jane M. Hammarstrom[3]
Allen L. Meier[4]

[1] U.S. Geological Survey, 954 National Center, Reston, VA 20192; rseal@usgs.gov
[2] U.S. Geological Survey, 3162 Bozeman Ave., Helena, MT 59601; anjohnson@usgs.gov
[3] U.S. Geological Survey, 954 National Center, Reston, VA 20192; jhammars@usgs.gov
[4] U.S. Geological Survey, 973 Denver Federal Center, Denver, CO 80225; ameier@usgs.gov

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This report is preliminary and has not been reviewed for conformity with the U.S. Geological Survey editorial standards and stratigraphic nomenclature. Any use of trade product or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

INTRODUCTION

The U.S. Geological Survey has undertaken a three part study of water chemistry at the abandoned Valzinco mine, in the Knight's Branch watershed in Spotsylvania County, Virginia, in cooperation with the Virginia Department of Mines, Minerals, and Energy. The first part is a detailed water-quality sampling study. The purpose of this sampling is to delineate the complexity and variety of geochemical environments at the site. The second part is pre-reclamation water-quality sampling at one point upstream of the mine site and at two points downstream of the mine site conducted on a quarterly basis. The purpose of this sampling is to provide a pre-reclamation assessment of seasonal variations of acid and metal concentrations in Knight's Branch to serve as a baseline from which to judge the success of the reclamation project. The third part is post-reclamation water-quality study to be initiated in Summer 2002.

SITE DESCRIPTION

The Valzinco abandoned mine (38° 10.68' N; 77° 47.90' W), also known as the Halladay or Holloday mine (Luttrell, 1966) is located at the headwaters of Knight's Branch in Spotsylvania County, Virginia, approximately 2.2 km south-southwest of Porters, Virginia on the Belmont 7.5' quadrangle. Knight's Branch flows into Northeast Creek, which flows into the North Anna River below Lake Anna Dam. The Anna River empties into the Chesapeake Bay. The site consisted of both underground mine workings and mine tailings deposited within and adjacent to the stream channel. No effluent from the mine workings was identified. The tailings cover approximately 40,000 square meters. The pre-reclamation location of the road and bridge represented a dam structure that apparently contained the spent tailings. Tailings deposits downstream from the road represent material that was eroded and transported as part of the sediment load of Knight's Branch. Significant transported deposits were located immediately below the road and approximately 200 m downstream (Fig. 1). The deposits located 200 m downstream remain today. The Virginia Department of Mines, Minerals, and Energy began reclamation of the site in April 2001 and completed the project in April 2002.

The Mitchell mine is located approximately 1.5 km downstream of Valzinco, also within the Knight's Branch watershed. The Mitchell mine is an abandoned gold mine, and consists of approximately twelve pits and shafts, some water filled, and covered dumps (Sweet, 1980). A significant accumulation of tailings material is present on the banks of Knight's Branch at the Mitchell mine. At present, it is uncertain whether the waste material was transported fluvially downstream from Valzinco, or if it was generated locally.

GEOLOGICAL SETTING AND ECONOMIC GEOLOGY

The Valzinco deposit is hosted by metamorphosed volcanic rocks of the Chopawamsic Formation in the Virginia gold-pyrite belt (Pavlides and others, 1982). The belt compromises metamorphosed volcanic and clastic sedimentary rocks that were originally deposited approximately 460 million years ago (Horton and others, 1998). The host rocks in the mine area have been metamorphosed to upper greenschist to lower amphibolite grade to form quartz-sericite schists (Pavlides and others, 1982). The deposits occur as two subparallel massive sulfide lenses that strike approximately N40E and dip at an angle of 60 to 70° SE,

crossing the foliation in the country rock. The Holloday "vein", and the Discovery "vein" were found during exploration drilling in the 1940s. The Holloday orebody, the larger of the two, was mined to a depth of approximately 115 m, along a strike length of approximately 180 m, and vein thickness varied from 0.6 to 3.0 m, with an average thickness of 1.2 m; the Discovery orebody was mined to a depth of approximately 75 m to within 15 m of the surface, with a strike length of 95 m (Poole, 1974).

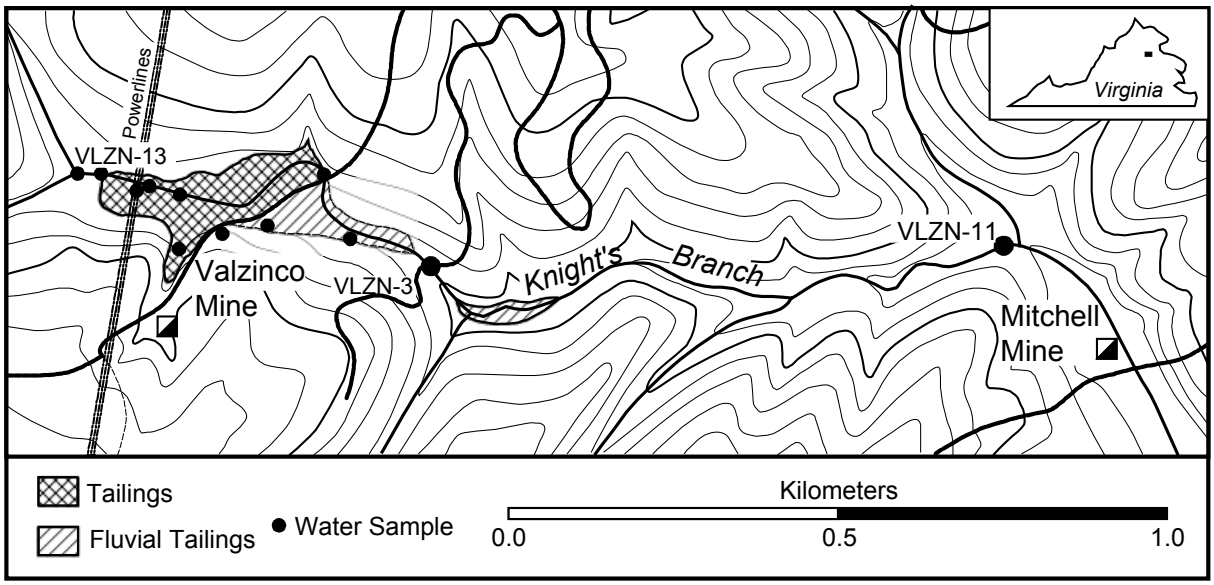

Figure 1. Map of the upper reaches of the Knight's Branch watershed showing the distribution of water-quality sample sites and tailings. VLZN-3, VLZN-11, and VLZN-13 are the quarterly sampling sites. Contour interval is 20 feet. Roads are indicated by heavy lines.

The ore consists of massive accumulations of pyrite (FeS_2), sphalerite (ZnS), galena (PbS), and minor chalcopyrite ($CuFeS_2$) and pyrrhotite ($Fe_{1-x}S$). Gangue mineralogy includes quartz, chlorite, and magnetite. In the immediate vicinity of the orebodies, the wallrocks have been silicified, pyritized, and chloritized (Poole, 1974). The geologic and geochemical features of the deposit conform to the "Kuroko-type" classification of seafloor massive sulfide deposits, which is characterized by massive accumulations of pyrite, with subordinate amounts of chalcopyrite, sphalerite, and galena; host rocks are typified by a felsic-dominated suite of bimodal volcanic rocks, with associated siliciclastic sedimentary rocks (Seal and others, 2000).

MINING HISTORY

Valzinco is a lead-zinc deposit that contains minor amounts of copper. The mine was opened in 1914 by the Virginia Lead and Zinc Company. Initially, the ores were hauled to a mill at the Allah-Cooper mine approximately 29 km to the southwest. Between 1914 and 1918, the mine produced about 5,000 short tons (4,500 metric tonnes) of ore averaging 5 percent lead and 12.5 percent zinc (Grosh, 1949). The mine changed hands in the 1920s and although some development work occurred, no production records exist. In 1942, Panaminus, Inc. reopened the mine with on-site processing facilities consisting of a modern mill with the capacity of handling 100 tons of ore per day and a flotation plant and at the same time, they

dewatered the 360-foot level of the mine (Poole, 1974). The mine was worked from a 75 m vertical main shaft, to a depth of 105 m below the shaft. Initially, the mining method was shrinkage stoping but problems with bad ground necessitated a change to stulled stoping (Grosh, 1949). Underground workings included five mine levels and more than 1,500 m of workings (Grosh, 1949). The ore processed in the flotation plant averaged 7.5 percent zinc, 3.5 percent lead, and 1 percent copper and the products included a lead-zinc concentrate and a zinc concentrate. The U.S. Bureau of Mines drilled the deposit in 1943 to outline the orebody and increase reserves (Grosh, 1949). Fine-grained tailings from the 1940s mining operations were deposited in and along Knight's Branch resulting in an impacted area of about 40,000 square meters. The mill foundation and a concrete silo remain on the site. Poole (1974) reported that dump material was removed and used for road metal for logging roads in the area and for fill.

WATER QUALITY

Sample Sites

The sample sites for the first part of the study were selected to characterize the diversity and complexity of geochemical environments in and around the Valzinco site (Figs. 1 and 2). Sample sites are described in Appendix 1. At various times, water samples were collected from the main channel of Knight's Branch and include, from upstream to downstream: VLZN-13, VLZN-6, VLZN-1, VLZN-4, VLZN-3, and VLZN-11. VLZN-3, VLZN-11, and VLZN-13 are also the three sites selected for quarterly sampling. Samples were also collected from seeps emanating from beneath the tailings (VLZN-8, VLZN-9), downstream from seeps, prior to entering Knight's Branch (VLZN-2, VLZN-7, VLZN-12), and from a small highly concentrated puddle on the tailings (VLZN-10). Reconnaissance sampling of the site was conducted in May 1998. Pre-reclamation quarterly sampling was initiated in July 1999, and continued until April 2001, just prior to the start of reclamation. Water sampling protocols are summarized in Appendix 2 and are modified from the procedures outlined by Ficklin and Mosier (1999).

Results

Geochemical data are summarized in Appendices 3 and 4. Appendix 3 summarizes quality-control and quality-assurance data, and Appendix 4 summarizes the water-quality data from the study. In general, the regional surface waters, upgradient from the mine site (VLZN-6, and VLZN-13), are dilute (< 23 mg/L TDS), slightly acidic (pH = 4.4 to 6.0), and dominated by Na and Cl. Alkalinity is less than 15 mg/L $CaCO_3$ equivalent, and the hardness is less than 10 mg/L $CaCO_3$ equivalent. Thus, the watershed has limited natural acid-neutralizing capacity and the low hardness enhances the toxicity of metals such as Zn, Pb, Cu, and Cd.

At various locations around the impacted site, total dissolved solids (TDS) range from 20 to 17,000 mg/L and pH ranges from 1.1 to 6.4. The dissolved chemistry is dominated by Fe and SO_4 as the dominant cationic and anionic constituents, respectively (Fig. 3). In general, all waters are near saturation with respect to dissolved oxygen. Dissolved metals show a negative correlation with respect to pH (Figs. 3 and 4). In impacted waters, the concentrations of dissolved constituents span a wide range in SO_4 (28 to 53,600 mg/L), Fe (3.6 to 11,000 mg/L), Al (0.0015 to 800 mg/L), Zn (0.65 to 2,300 mg/L), Pb (0.5 to 2,800

μg/L), Cu (0.001 to 59.0 mg/L), and Cd (<0.02 to 3,000 μg/L). Invariably, the highest concentrations are associated with sample VLZN-10-2 (Figs. 3 and 4), which represents an anomalous geochemical setting. This sample probably represents undiluted leachate from the waste pile. As such, it may be the best candidate for end-member acid-mine drainage at the site.

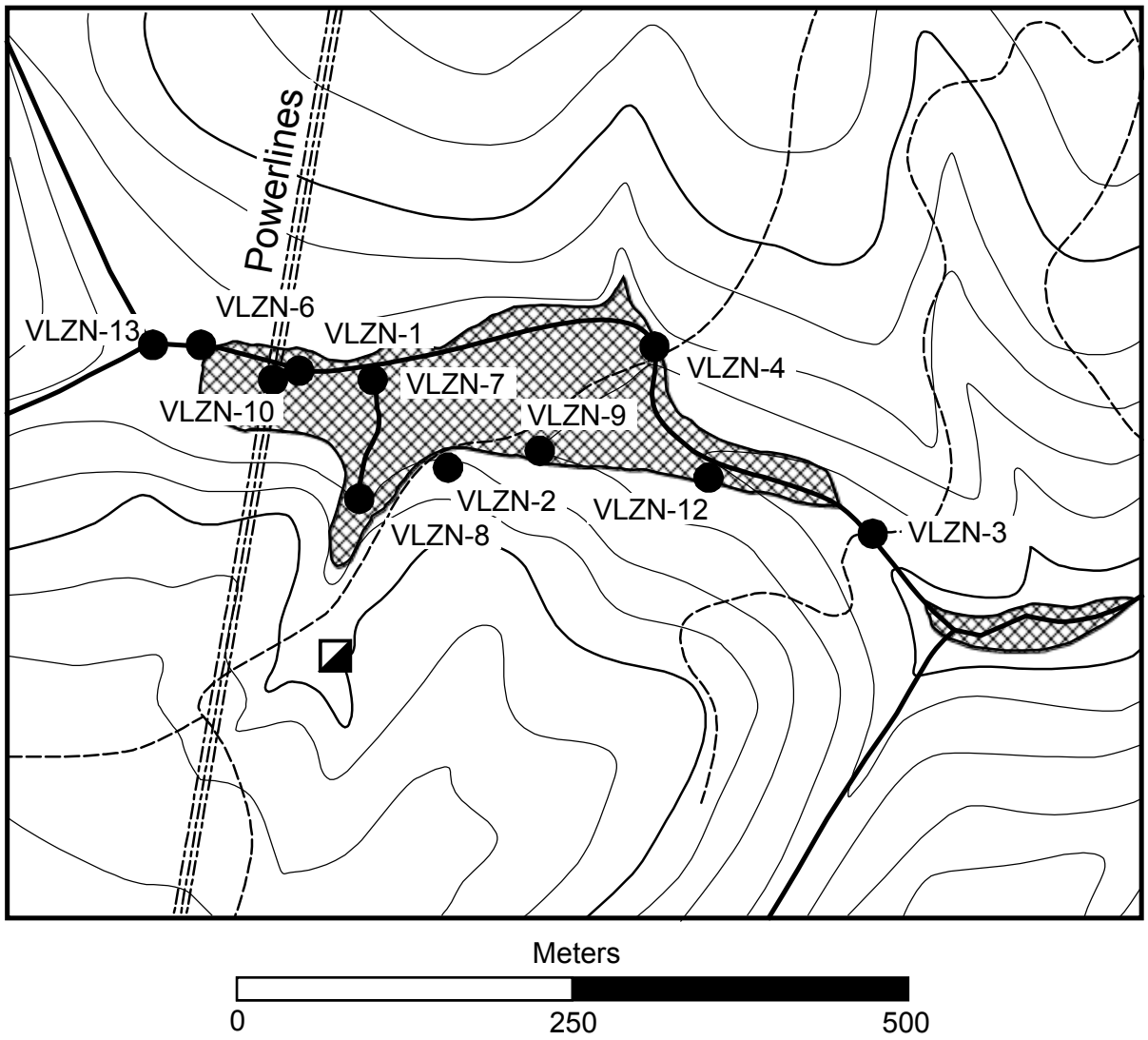

Figure 2. Map showing details of abandoned Valzinco mine site including sample sites. Sites VLZN-3 and VLZN-13 are quarterly sampling sites. Cross-hatched pattern indicates the extent of tailings. Streams are indicated by heavy solid lines. Contour interval is 20 feet. Roads are indicated by dashed lines. The road running roughly from sample site VLZN-2 to VLZN-4 marks the location of the tailings dam. All tailings to the east of this structure have been transported fluvially downstream.

With the exception of VLZN-2, all waters at the site, including Knight's Branch at the downstream extent of the site (VLZN-3) and 1.3 km downstream (VLZN-11), exceed USEPA guidelines for acute and chronic toxicity in aquatic ecosystems for Fe, Al, Zn, Pb, Cu, and Cd

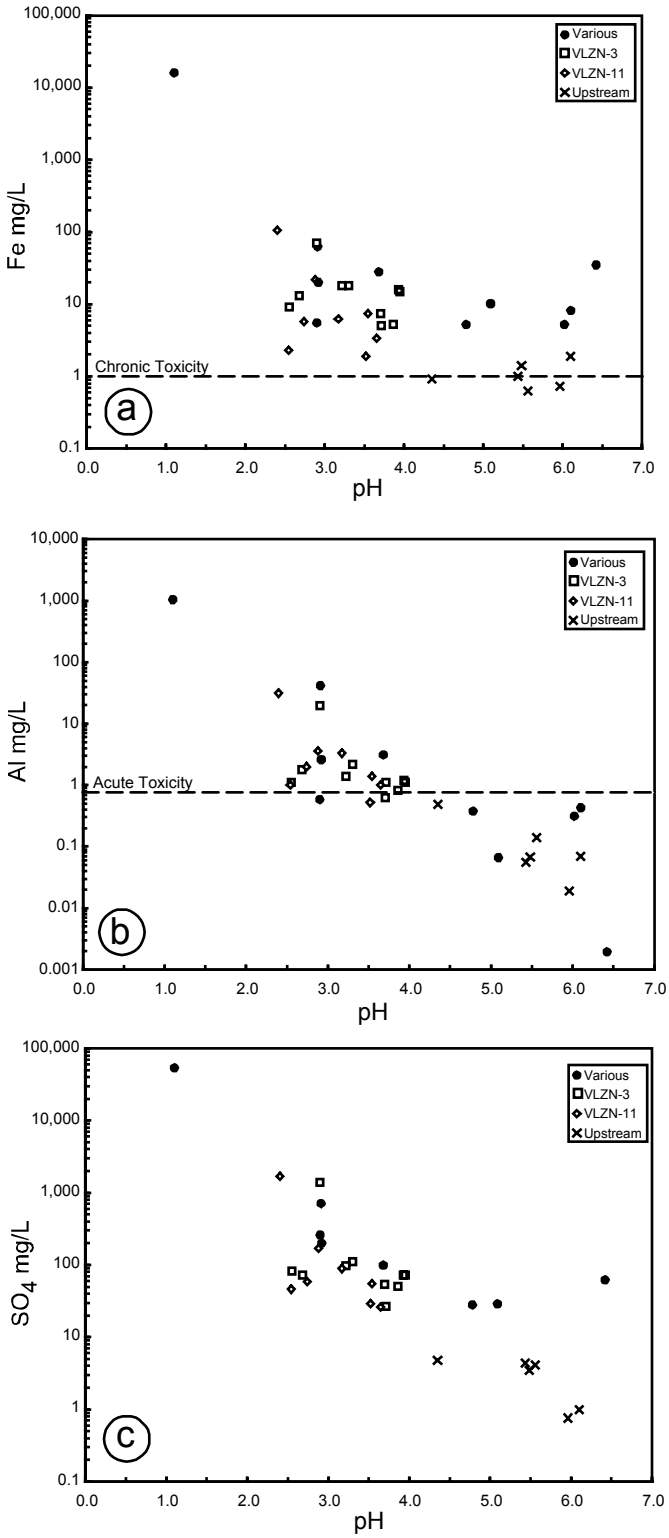

Figure 3. Plots of dissolved concentrations of Fe, Al, and sulfate versus pH. "Various" sites are all of those other than VLZN-3, VLZN-6, VLZN-11, and VLZN-13.

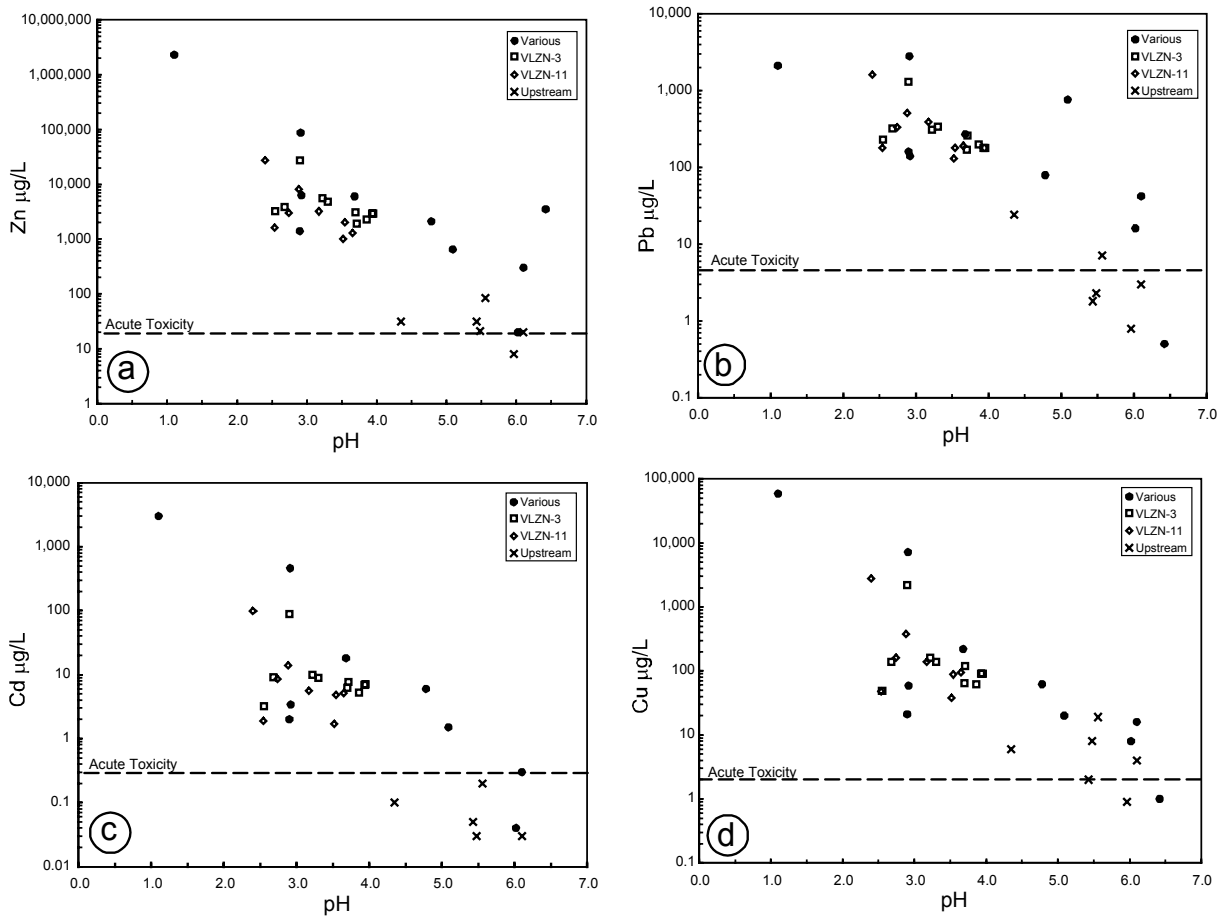

Figure 4. Plots of dissolved concentrations of Zn, Pb, Cd, and Cu versus pH. "Various" sites are all of those other than VLZN-3, VLZN-6, VLZN-11, and VLZN-13.

(Figs. 3 and 4, Table 1; Smith and Huyck, 1999). Toxicity standards were calculated assuming a hardness of 10 mg/L $CaCO_3$ equivalent, which is representative of Knight's Branch upstream of the site. Concentrations of Ag, Ni, Se, and Tl are below acute toxicity levels, as would be expected for this deposit type (Seal and others, 2000). In addition, As and Se are below aquatic ecosystem toxicity guidelines (Table 1).

In Knight's Branch downstream from the site (VLZN-3 and VLZN-11), the seasonal variations in chemistry are more limited than the spatial variations shown around the site (Figs. 5 and 6). Flow in Knight's Branch at VLZN-3 is estimated to have varied from a low of approximately 0.2 L/sec (0.007 cfs) in the summer to a high near 220 L/sec (7.73 cfs) in the spring during the sampling periods. The pH ranged from a low of 2.6 to a high of 3.9. Total dissolved solids varied from 78 to 1,000 mg/L. Variations in dissolved constituents are summarized in Table 1. Comparison of the maximum concentrations of individual constituents between VLZN-3 and VLZN-11 suggests that the fluvial tailings between VLZN-3 and VLZN-11 may be contributing significantly to the metal and acid load of Knight's Branch (Figs. 5 and 6; Table 1). The fluvial tailings between VLZN-3 and VLZN-11 were not addressed in the recently completed reclamation project.

Table 1. Range in concentrations of dissolved constituents in Knight's Branch relative to appropriate acute toxicity guidelines for aquatic ecosystems.

		VLZN-3		VLZN-11	
	Acute Toxicity	Low	High	Low	High
pH		2.6	3.9	2.4	3.6
Specific conductance (mS/cm)		0.089	1.225	0.090	1.540
Acidity (mg/L $CaCO_3$)		58.7	417.2	28.3	497.2
SO_4 (mg/L)		27	1,400	26	1,700
Fe (mg/L)	1.0†	5.0	69.7	1.9	106.0
Ag (µg/L)	0.08*	<0.01	0.04	<0.01	0.02
Al (mg/L)	0.750	0.63	19.5	0.52	31.2
As (µg/L)	360	<0.2	1	<0.2	0.9
Cd (µg/L)	0.3*	3.2	88	1.7	99
Cu (µg/L)	2.0*	49	2,200	38	2,800
Ni (µg/L)	202.0*	2.0	37	2.4	50
Pb (µg/L)	4.4*	170	1,300	130	1,600
Sb (µg/L)	9,000	0.03	0.20	<0.02	0.31
Se (µg/L)	20	<0.2	0.7	<0.2	0.4
Tl (µg/L)	1,400	<0.05	0.3	<0.05	0.09
Zn (mg/L)	0.017*	1.9	27.0	1.0	27.0

*Hardness-based toxicity criteria were calculated assuming a hardness of 10 mg/L $CaCO_3$, which is representative of the Knight's Branch watershed upstream of the mine site (VLZN-13).
†Value is chronic toxicity criterion.

Acid and Metal Loading

Loading from the Valzinco site to Knight's Branch varies as a function of concentration and flow. Total and dissolved concentrations of constituents are presented in Appendix 4. Flow proved difficult to determine accurately in the field in Knight's Branch because of the lack of narrow and distinctly channelized flow of significant velocity to be measured. Because of these challenges, large uncertainties exist in the flows measured in the field. Thus, for the purpose of load calculations, flows were estimated on the basis of gauged flows recorded for the nearby Po River. Flows measured by the Virginia Department of Environmental Quality and the U.S. Geological Survey from the Po River watershed (77.4 square miles) were scaled down for the Knight's Branch watershed at VLZN-3 (0.95 square miles) and at VLZN-11 (1.46 square miles) proportionally to the differences in the areas of the watersheds (Fig. 7a). In addition, the representativeness of the calculated loads for the time periods sampled is variable because the waters were collected as grab samples.

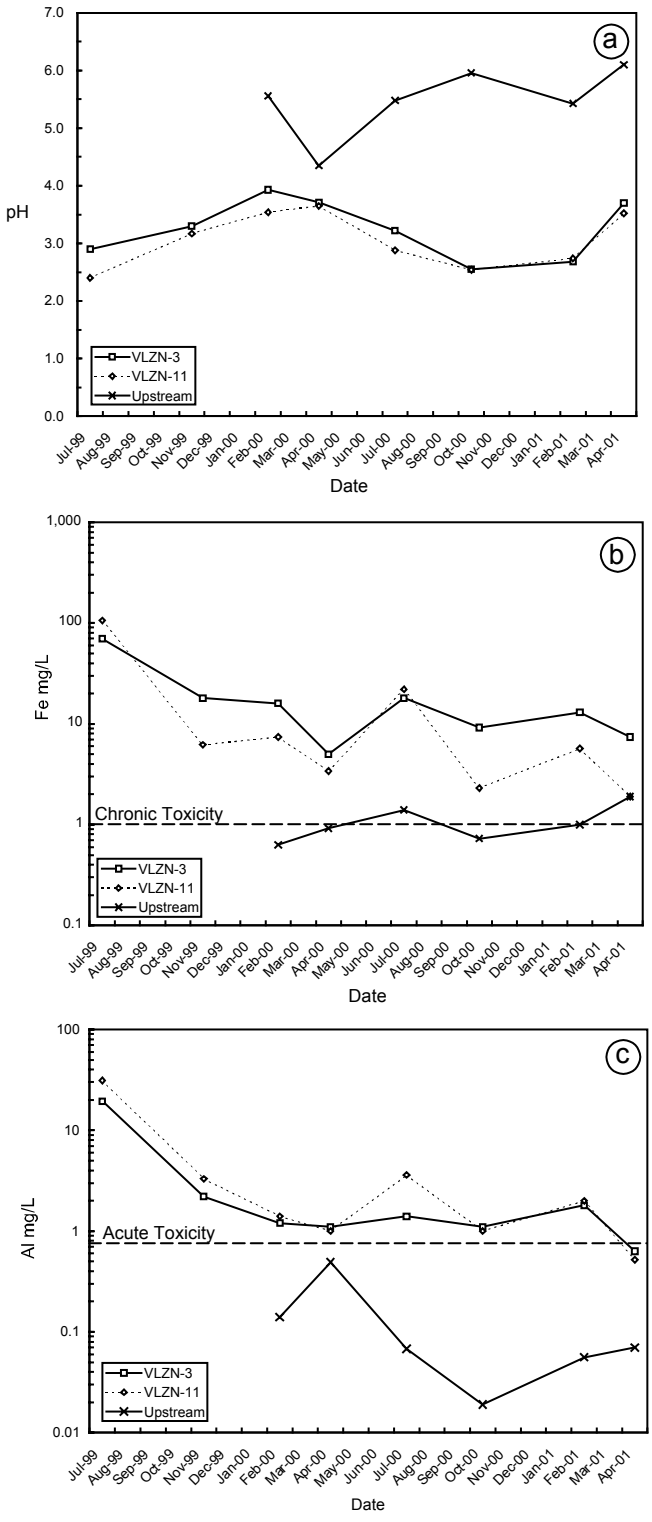

Figure 5. Quarterly variations of pH, and dissolved Fe and Al at sites VLZN-3, VLZN-11, and VLZN-13 (upstream).

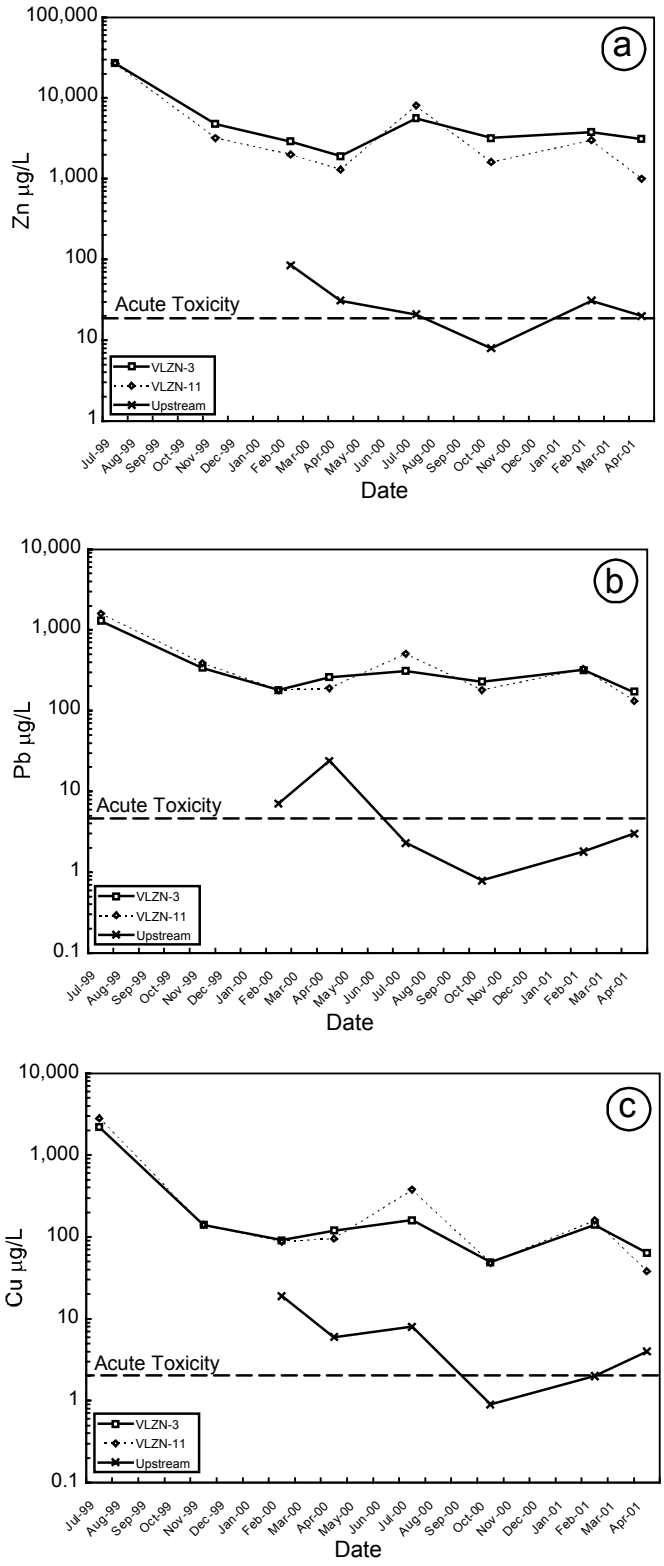

Figure 6. Quarterly variations of dissolved Zn, Pb, and Cu at sites VLZN-3, VLZN-11, and VLZN-13 (upstream).

Loads calculated for Zn, Fe, and Pb, as representative constituents, for VLZN-3 at the downstream end of the abandoned mine site show limited seasonal correlation with concentration (Figs. 7 and 8). For Zn, and Fe, loads peak in Spring 2000 as dissolved concentrations reach relative minimums (Figs. 7b, 8a), which suggest that dilution due to increased flows caused concentrations to drop, even though loads increased. In contrast, Pb concentrations show a slight relative increase and the Pb load peaks in Spring 2000 (Fig. 8b). The slight increase in dissolved Pb concentration is accompanied by a drop in dissolved sulfate concentration, which suggests that the precipitation of $PbSO_4$ (anglesite) may be exerting a control on Pb solubility. In general, loads decrease on a mass basis in the order (Table 2):

$$SO_4 > \text{acidity} > Fe > Zn > Al > Pb > Cu > Cd.$$

Periodic changes in this order occurred on a sample-date by sample-date basis.

SUMMARY

Prior to reclamation, the weathering of waste material derived from the abandoned Valzinco mine, which exploited a Kuroko-type massive sulfide deposit primarily for its Zn and Pb content, significantly impacted the water quality of the Knight's Branch watershed. Waste materials included original deposits of tailings material and tailings that have been eroded, transported fluvially downstream and redeposited in quiescent settings. Impacts included low pH (2.6 to 3.9), high total dissolved solids (60 to 1,000 mg/L), and elevated dissolved metal concentrations. Specifically, Fe, Al, Zn, Pb, Cu, and Cd exceed acute water-quality guidelines for aquatic ecosystem health. Comparison of water-quality parameters between site VLZN-3 at the downstream limit of the reclamation project and site VLZN-11 approximately 1.3 km downstream of the site VLZN-3 suggests that fluvial tailings between the two sites contribute significantly to impaired downstream water quality.

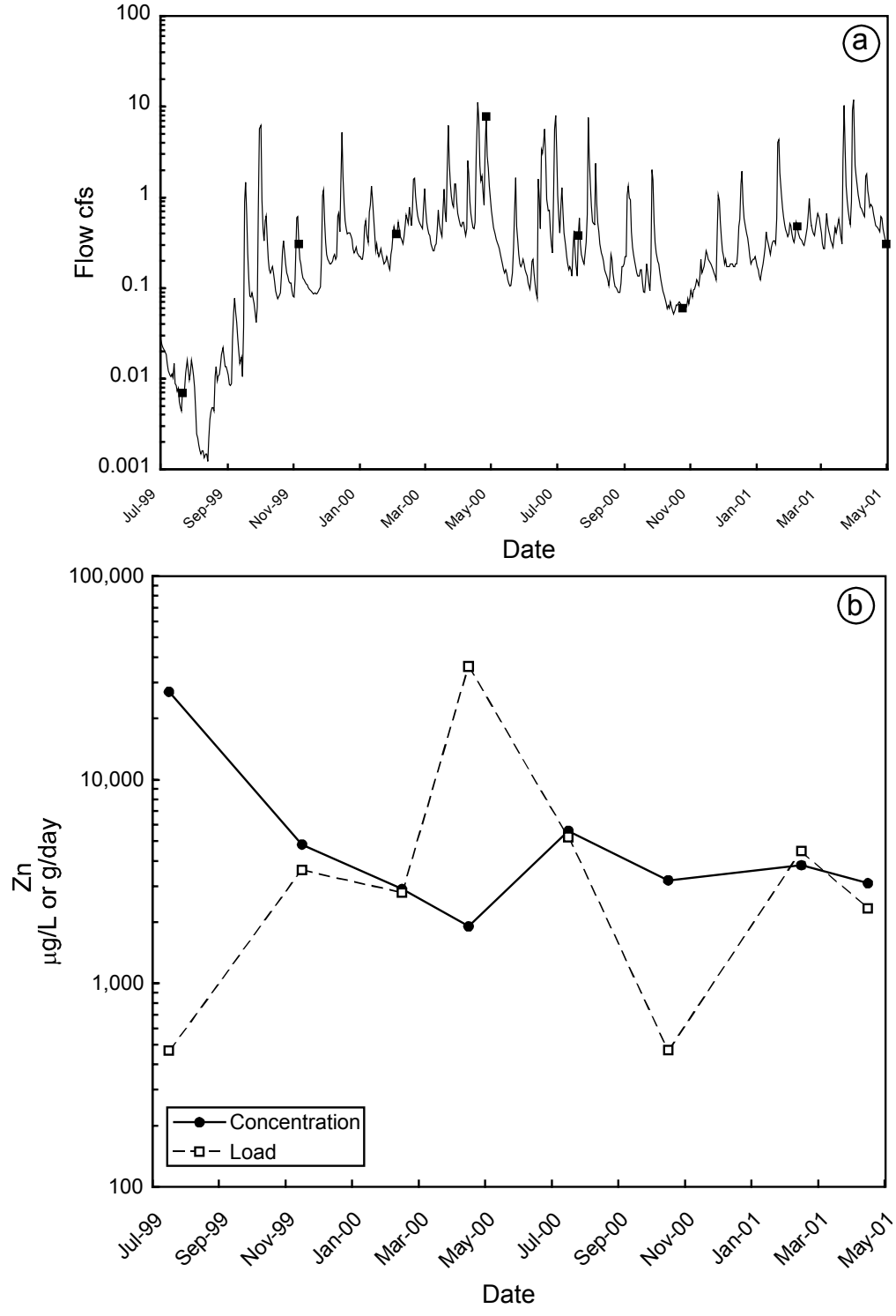

Figure 7. Seasonal variations of flow and dissolved Zn concentrations and loads. a. Estimated flow at site VLZN-3 based on gauged flow from the nearby Po River normalized to the catchment area of VLZN-3. Solid squares indicate sampling dates. b. Quarterly variations of dissolved zinc concentrations and loads.

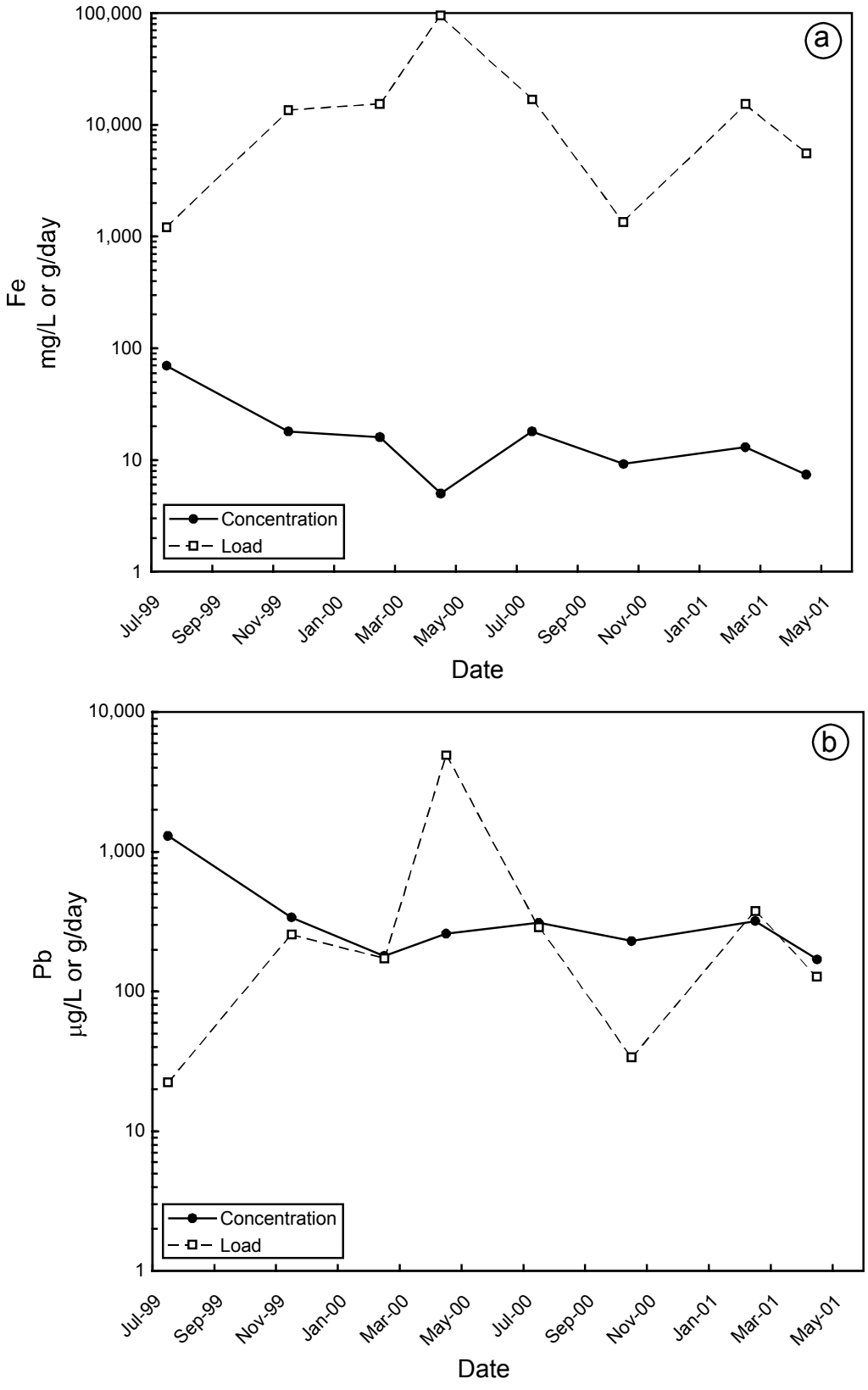

Figure 8. Quarterly variations of dissolved iron and lead concentrations and loads.

Table 2. Estimate of dissolved acid and metal daily loads in surface waters at site VLZN-3

	Daily Load (grams)
Acidity ($CaCO_3$ equivalent)	
7/21/1999	7,210
11/5/1999	80,580
2/3/2000	61,380
4/26/2000	572,190
7/20/2000	85,100
10/24/2000	13,030
2/7/2001	84,600
4/30/2001	
Sulfate (SO_4)	
7/21/1999	24,190
11/5/1999	82,680
2/3/2000	70,010
4/26/2000	510,880
7/20/2000	91,450
10/24/2000	12,040
2/7/2001	85,780
4/30/2001	40,590
Iron (Fe)	
7/21/1999	1,200
11/5/1999	13,530
2/3/2000	15,340
4/26/2000	94,610
7/20/2000	16,800
10/24/2000	1,350
2/7/2001	15,280
4/30/2001	5,560
Aluminum (Al)	
7/21/1999	336
11/5/1999	1,654
2/3/2000	1,151
4/26/2000	20,814
7/20/2000	1,306
10/24/2000	162
2/7/2001	2,115
4/30/2001	474
Zinc (Zn)	
7/21/1999	467
11/5/1999	3,608
2/3/2000	2,781
4/26/2000	35,951
7/20/2000	5,226
10/24/2000	470
2/7/2001	4,465
4/30/2001	2,330

Table 2 (continued). Estimate of dissolved acid and metal daily loads in surface waters at site VLZN-3

	Daily Load (grams)
Lead (Pb)	
7/21/1999	23
11/5/1999	256
2/3/2000	173
4/26/2000	4,920
7/20/2000	289
10/24/2000	34
2/7/2001	376
4/30/2001	128
Copper (Cu)	
7/21/1999	38
11/5/1999	105
2/3/2000	87
4/26/2000	2,271
7/20/2000	149
10/24/2000	7
2/7/2001	164
4/30/2001	48
Cadmium (Cd)	
7/21/1999	2
11/5/1999	7
2/3/2000	7
4/26/2000	146
7/20/2000	9
10/24/2000	1
2/7/2001	11
4/30/2001	5

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APPENDIX 1: DESCRIPTIONS OF SAMPLE SITES

VLZN-1: 38° 10.678’ N, 77° 47.902' W; Knight’s Branch beneath the powerlines.

VLZN-2: Ponded, oxidized seep water on south side of Knight’s Branch and road across dam; contains abundant Fe floc.

VLZN-3: 38° 10.640’ N, 77° 47.569’ W; Knight’s Branch at downstream extent of reclamation project; quarterly monitoring site.

VLZN-4: 38° 10.683’ N, 77° 47.908’ W; Knight’s Branch just upstream of the bridge.

VLZN-6: 38° 10.666’ N, 77° 47.908’ W; Knight’s Branch upstream from tailings.

VLZN-7: 38° 10.655’ N, 77° 47.850’ W; small tributary emptying into Knight’s Branch from the south.

VLZN-8: 38° 10.630’ N, 77° 47.818’ W; small flow emerging from beneath the flotation pond dam, south of Knight’s Branch.

VLZN-9: Flow from seeps emerging from the road dam.

VLZN-10: Small, highly concentrated puddle (< 3 L total volume) in gulley under powerlines.

VLZN-11: 38° 10.587’ N, 77° 46.969’ W; Knight’s Branch approximately 1 km downstream from VLZN-3; quarterly monitoring site.

VLZN-12: Channelized flow from seeps emerging from the road dam, prior to entering the main channel of Knight’s Branch.

VLZN-13: 38° 10. 753’ N, 77° 46.970’W; Knight’s Branch upstream from the mine site, just below the confluence of two small tributaries; quarterly monitoring site.

APPENDIX 2: FIELD AND ANALYTICAL METHODS

Water samples were collected in one-liter high-density polyethylene bottles that were doubly-rinsed with sample water prior to collection. Samples were divided into four splits for chemical analysis: two for cation analysis, one for anion analysis, and one for alkalinity determination. The cations splits included filtered (dissolved: FA) and unfiltered (total acid soluble: RA) aliquots. Samples were filtered through 0.45 μm nitrocellulose filters. Cation splits were stored at ambient temperature in acid-washed (10 % HCl) high-density polyethylene bottles and preserved with 1 drop of ultra-pure nitric acid per each 10 ml of sample. Anion and alkalinity splits were stored in high-density polyethylene bottles that were not acid-washed and were refrigerated until the time that they were analyzed.

On-site measurements at the time of collection included air temperature, water temperature, pH, specific conductance, dissolved oxygen, dissolved ferrous iron, dissolved total iron, dissolved sulfate, dissolved nitrate, and water flow. Methods were similar to those outlined by Ficklin and Mosier (1999). The pH was measured using an Orion 230A pH meter with a 91-07 probe, calibrated with pH = 4.00 and 7.00 buffer solutions. Specific conductance was measured with an Orion 135 specific conductance meter. Dissolved oxygen concentrations were determined with Chemetrix high-range ampoules. Dissolved total iron, and ferrous iron concentrations were determined in the field using a Hach DR2000 spectrophotometer. Alkalinity samples were analyzed by Gran titration with 0.18 N H_2SO_4.

Laboratory analytical methods are summarized by Crock and others (1999). Cations were analyzed at U.S. Geological Survey (Central Mineral Resources Team) laboratories in Denver, CO by inductively-coupled plasma mass spectrometry (ICP-MS) and inductively-coupled plasma atomic emission spectroscopy (ICP-AES). Anions were analyzed at U.S. Geological Survey (Water Resources Division) laboratories in Ocala, FL by ion chromatography (IC: chloride, and sulfate).

APPENDIX 3: QUALITY-CONTROL AND QUALITY-ASSURANCE DATA

Sample No.	Sample Type	Date	pH	Spec.Cond. µS/cm	IC Cl mg/L	IC SO_4 mg/L	ICPMS Ag µg/L	ICPMS Al µg/L	ICPMS As µg/L
FB040798 FA	Field Blank	4/7/1998					< 0.01	< 0.01	< 0.2
FB040798 RA	Field Blank	4/7/1998					< 0.01	< 0.01	< 0.2
FB070698 RA	Field Blank	7/6/1998					0.06	< 0.01	< 0.2
FB070698 RA	Field Blank	7/6/1998					< 0.01	< 0.01	< 0.2
FB070698 FA	Field Blank	7/6/1998					0.03	< 0.01	< 0.2
FB082598 RA	Field Blank	8/25/1998					0.02	< 0.01	< 0.2
FB082598 FA	Field Blank	8/25/1998					0.01	< 0.01	< 0.2
FB052898 FA	Field Blank	5/28/1998					< 0.01	< 0.01	< 0.2
FB052898 RA	Field Blank	5/28/1998					< 0.01	< 0.01	< 0.2
FB060599FA	Field Blank	6/5/1999					0.3	<0.6	0.3
FB060599 RA	Field Blank	6/5/1999					0.1	<0.6	<0.2
FB042600 FA	Field Blank	4/26/2000					0.04	1	0.2
FB042600 RA	Field Blank	4/26/2000					0.02	<0.5	0.2
FB042600D FA	Field Blank	4/26/2000					0.01	<0.5	0.2
FB042600D RA	Field Blank	4/26/2000					<0.01	<0.5	0.3
FB72000 FA	Field Blank	7/20/2000					<0.01	<0.6	1.5
FB72000 RA	Field Blank	7/20/2000					<0.01	<0.6	0.9
FB102400 FA	Field Blank	10/24/2000					0.02	0.2	<0.2
FB102400 RA	Field Blank	10/24/2000					0.02	<0.2	<0.2
FB42401 RA	Field Blank	4/24/2001					<0.05	<0.1	<0.2
FB 42401 FA	Field Blank	4/24/2001					<0.05	<0.1	<0.2
FB 5201 RA	Field Blank	5/2/2001					<0.05	<0.1	<0.2
FB 5201 FA	Field Blank	5/2/2001					<0.05	<0.1	<0.2
VLZN-3-4 FA	Duplicate	2/3/2000	3.93	139.0	5.6	73	<0.01	830	<0.2
VLZN-3-4 RA	Duplicate	2/3/2000	3.93	139.0			<0.01	830	<0.2
VLZN-3-4D FA	Duplicate	2/3/2000	3.95	138.7	5.7	72	<0.01	860	<0.2
VLZN-3-4D RA	Duplicate	2/3/2000	3.95	138.7			<0.01	860	<0.2

APPENDIX 3 (cont.): QUALITY-CONTROL AND QUALITY-ASSURANCE DATA

Sample No.	ICPMS Au µg/L	ICPMS Ba µg/L	ICPMS Be µg/L	ICPMS Bi µg/L	ICPMS Ca mg/L	ICPMS Cd µg/L	ICPMS Ce µg/L	ICPMS Co µg/L	ICPMS Cr µg/L
FB040798 FA	< 0.01	0.2	< 0.05	< 0.01	< 0.05	< 0.02	< 0.01	< 0.02	< 1
FB040798 RA	< 0.01	< 0.02	< 0.05	< 0.01	< 0.05	< 0.02	< 0.01	< 0.02	< 1
FB070698 RA	< 0.01	< 0.02	< 0.05	< 0.01	< 0.05	< 0.02	< 0.01	< 0.02	< 1
FB070698 RA	< 0.01	< 0.02	< 0.05	< 0.01	< 0.05	< 0.02	< 0.01	< 0.02	< 1
FB070698 FA	< 0.01	< 0.02	< 0.05	< 0.01	< 0.05	< 0.02	< 0.01	< 0.02	< 1
FB082598 RA	< 0.01	< 0.02	< 0.05	< 0.01	< 0.05	< 0.02	< 0.01	< 0.02	< 1
FB082598 FA	< 0.01	2	< 0.05	< 0.01	< 0.05	< 0.02	< 0.01	< 0.02	< 1
FB052898 FA	< 0.01	< 0.02	< 0.05	< 0.01	< 0.05	< 0.02	< 0.01	< 0.02	< 1
FB052898 RA	< 0.01	< 0.02	< 0.05	< 0.01	< 0.05	< 0.02	< 0.01	< 0.02	< 1
FB060599FA		0.6	<0.05		<0.05	<0.02	< 0.01	0.02	<1
FB060599 RA		0.5	<0.05		<0.05	<0.02	< 0.01	0.02	<1
FB042600 FA	< 0.01	0.3	<0.05	< 0.01	<0.05	<0.02	< 0.01	<0.02	<1
FB042600 RA	< 0.01	<0.02	<0.05	< 0.01	<0.05	<0.02	< 0.01	<0.02	<1
FB042600D FA	< 0.01	0.4	<0.05	< 0.01	<0.05	<0.02	< 0.01	<0.02	<1
FB042600D RA	< 0.01	<0.02	<0.05	< 0.01	<0.05	<0.02	< 0.01	<0.02	<1
FB72000 FA	< 0.01	0.8	<0.05	< 0.01	<0.05	<0.02	< 0.01	<0.02	<1
FB72000 RA	< 0.01	<0.02	<0.05	< 0.01	<0.05	<0.02	< 0.01	<0.02	<1
FB102400 FA	< 0.01	0.6	<0.05	< 0.01	<0.05	<0.02	< 0.01	<0.02	<1
FB102400 RA	< 0.01	0.02	<0.05	< 0.01	<0.05	<0.02	< 0.01	<0.02	<1
FB42401 RA	< 0.01	<0.02	<0.05	< 0.01	<0.05	<0.02	< 0.01	<0.02	<1
FB 42401 FA	< 0.01	<0.02	<0.05	< 0.01	<0.05	<0.02	< 0.01	<0.02	<1
FB 5201 RA	< 0.01	<0.02	<0.05	< 0.01	<0.05	0.03	< 0.01	<0.02	<1
FB 5201 FA	< 0.01	<0.02	<0.05	< 0.01	<0.05	<0.02	< 0.01	<0.02	<1
VLZN-3-4 FA	< 0.01	30	0.1	< 0.01	1.5	6.9	9.1	19	<1
VLZN-3-4 RA	< 0.01	32	0.2	< 0.01	1.5	6.9	9.2	20	<1
VLZN-3-4D FA	< 0.01	30	0.09	< 0.01	1.6	7	9.2	20	<1
VLZN-3-4D RA	< 0.01	30	0.2	< 0.01	1.5	6.9	9.4	20	<1

APPENDIX 3 (cont.): QUALITY-CONTROL AND QUALITY-ASSURANCE DATA

Sample No.	ICPMS Cs µg/L	ICPMS Cu µg/L	ICPMS Dy µg/L	ICPMS Er µg/L	ICPMS Eu µg/L	ICPMS Fe µg/L	ICPMS Ga µg/L	ICPMS Gd µg/L	ICPMS Ge µg/L
FB040798 FA	< 0.01	< 0.5	< 0.005	< 0.005	< 0.005	< 10	< 0.02	< 0.005	< 0.02
FB040798 RA	< 0.01	< 0.5	< 0.005	< 0.005	< 0.005	< 10	< 0.02	< 0.005	< 0.02
FB070698 RA	< 0.01	< 0.5	< 0.005	< 0.005	< 0.005	< 10	< 0.02	< 0.005	< 0.02
FB070698 RA	< 0.01	< 0.5	< 0.005	< 0.005	< 0.005	< 10	< 0.02	< 0.005	< 0.02
FB070698 FA	< 0.01	< 0.5	< 0.005	< 0.005	< 0.005	< 10	< 0.02	< 0.005	< 0.02
FB082598 RA	< 0.01	< 0.5	< 0.005	< 0.005	< 0.005	< 10	< 0.02	< 0.005	< 0.02
FB082598 FA	< 0.01	< 0.5	< 0.005	< 0.005	< 0.005	< 10	< 0.02	< 0.005	< 0.02
FB052898 FA	< 0.01	< 0.5	< 0.005	< 0.005	< 0.005	< 10	< 0.02	< 0.005	< 0.02
FB052898 RA	< 0.01	< 0.5	< 0.005	< 0.005	< 0.005	< 10	< 0.02	< 0.005	< 0.02
FB060599FA		<0.5	< 0.005	< 0.005	< 0.005	<30		< 0.005	
FB060599 RA		<0.5	< 0.005	< 0.005	< 0.005	<30		< 0.005	
FB042600 FA	< 0.01	<0.5	< 0.005	< 0.005	< 0.005	<6	< 0.02	< 0.005	< 0.03
FB042600 RA	< 0.01	<0.5	< 0.005	< 0.005	< 0.005	<6	< 0.02	< 0.005	< 0.03
FB042600D FA	< 0.01	<0.5	< 0.005	< 0.005	< 0.005	<6	< 0.02	< 0.005	< 0.03
FB042600D RA	< 0.01	<0.5	< 0.005	< 0.005	< 0.005	<6	< 0.02	0.006	< 0.03
FB72000 FA	< 0.01	<0.5	< 0.005	< 0.005	< 0.005	2	< 0.02	< 0.005	< 0.02
FB72000 RA	< 0.01	<0.5	< 0.005	< 0.005	< 0.005	2	< 0.02	< 0.005	< 0.02
FB102400 FA	< 0.01	<0.5	< 0.005	< 0.005	< 0.005	<2	< 0.02	< 0.005	< 0.02
FB102400 RA	< 0.01	<0.5	< 0.005	< 0.005	< 0.005	<2	< 0.02	< 0.005	< 0.02
FB42401 RA	< 0.01	<0.5	< 0.005	< 0.005	< 0.005	5.8	< 0.02	< 0.005	< 0.02
FB 42401 FA	< 0.01	<0.5	< 0.005	< 0.005	< 0.005	5.4	< 0.02	< 0.005	< 0.02
FB 5201 RA	< 0.01	0.5	< 0.005	< 0.005	< 0.005	5.9	< 0.02	< 0.005	< 0.02
FB 5201 FA	< 0.01	<0.5	< 0.005	< 0.005	< 0.005	3.7	< 0.02	< 0.005	< 0.02
VLZN-3-4 FA	< 0.01	91	0.42	0.18	0.16	11000	< 0.02	0.74	< 0.02
VLZN-3-4 RA	< 0.01	90	0.46	0.2	0.16	11000	< 0.02	0.74	< 0.02
VLZN-3-4D FA	< 0.01	90	0.41	0.2	0.16	11000	< 0.02	0.77	< 0.02
VLZN-3-4D RA	< 0.01	89	0.44	0.18	0.17	11000	< 0.02	0.77	< 0.02

APPENDIX 3 (cont.): QUALITY-CONTROL AND QUALITY-ASSURANCE DATA

Sample No.	ICPMS Ho µg/L	ICPMS In µg/L	ICPMS K µg/L	ICPMS La µg/L	ICPMS Mg mg/L	ICPMS Mn µg/L	ICPMS Mo µg/L	ICPMS Na mg/L	ICPMS Nd µg/L
FB040798 FA	< 0.005	< 0.01	< 0.3	< 0.01	< 0.01	< 0.01	0.2	< 0.01	< 0.01
FB040798 RA	< 0.005	< 0.01	< 0.3	< 0.01	< 0.01	< 0.01	0.2	< 0.01	< 0.01
FB070698 RA	< 0.005	< 0.01	2.1	< 0.01	< 0.01	< 0.01	0.4	< 0.01	< 0.01
FB070698 RA	< 0.005	< 0.01	0.3	< 0.01	< 0.01	< 0.01	< 0.02	< 0.01	< 0.01
FB070698 FA	< 0.005	< 0.01	2.6	< 0.01	< 0.01	< 0.01	0.3	< 0.01	< 0.01
FB082598 RA	< 0.005	< 0.01	3.1	< 0.01	< 0.01	< 0.01	0.2	< 0.01	< 0.01
FB082598 FA	< 0.005	< 0.01	3.5	< 0.01	< 0.01	< 0.01	0.2	< 0.01	< 0.01
FB052898 FA	< 0.005	< 0.01	< 0.3	< 0.01	< 0.01	< 0.01	< 0.02	< 0.01	< 0.01
FB052898 RA	< 0.005	< 0.01	< 0.3	< 0.01	< 0.01	< 0.01	< 0.02	< 0.01	< 0.01
FB060599FA	< 0.005	< 0.01	<2	< 0.01	<0.01	<0.03	0.9	0.01	< 0.01
FB060599 RA	< 0.005	< 0.01	7.5	< 0.01	<0.01	<0.03	0.28	0.01	< 0.01
FB042600 FA	< 0.005	< 0.01	<20	< 0.01	<0.01	0.56	0.2	<0.01	< 0.01
FB042600 RA	< 0.005	< 0.01	<20	< 0.01	<0.01	0.36	0.1	<0.01	< 0.01
FB042600D FA	< 0.005	< 0.01	<20	< 0.01	<0.01	0.24	0.1	<0.01	< 0.01
FB042600D RA	< 0.005	< 0.01	<20	< 0.01	<0.01	0.27	0.07	<0.01	< 0.01
FB72000 FA	< 0.005	< 0.01	<2	< 0.01	<0.01	<0.01	0.03	<0.01	< 0.01
FB72000 RA	< 0.005	< 0.01	<2	< 0.01	<0.01	<0.01	0.03	<0.01	< 0.01
FB102400 FA	< 0.005	< 0.01	<7	< 0.01	<0.01	<0.02	0.08	0.01	< 0.01
FB102400 RA	< 0.005	< 0.01	<7	< 0.01	<0.01	<0.02	0.05	<0.01	< 0.01
FB42401 RA	< 0.005	< 0.01	4	< 0.01	<0.01	0.02	0.4	0.01	< 0.01
FB 42401 FA	< 0.005	< 0.01	6	< 0.01	<0.01	<0.01	0.2	<0.01	< 0.01
FB 5201 RA	< 0.005	< 0.01	7	< 0.01	<0.01	0.03	0.05	<0.01	< 0.01
FB 5201 FA	< 0.005	< 0.01	6	< 0.01	<0.01	0.01	0.03	<0.01	< 0.01
VLZN-3-4 FA	0.069	0.01	1400	4.5	2.2	410	0.02	2.8	4.6
VLZN-3-4 RA	0.078	0.01	1400	4.6	2.2	420	< 0.02	2.8	4.7
VLZN-3-4D FA	0.075	0.01	1500	4.5	2.3	420	0.03	2.9	4.4
VLZN-3-4D RA	0.079	0.01	1500	4.6	2.3	420	0.03	2.8	4.6

APPENDIX 3 (cont.): QUALITY-CONTROL AND QUALITY-ASSURANCE DATA

Sample No.	ICPMS Ni µg/L	ICPMS P µg/L	ICPMS Pb µg/L	ICPMS Pr µg/L	ICPMS Rb µg/L	ICPMS Re µg/L	ICPMS Sb µg/L	ICPMS Se µg/L	ICPMS SiO_2 mg/L
FB040798 FA	< 0.1		0.07	< 0.01	< 0.01	< 0.02	0.06	< 0.2	< 0.5
FB040798 RA	< 0.1		< 0.05	< 0.01	< 0.01	< 0.02	0.02	< 0.2	< 0.5
FB070698 RA	< 0.1		< 0.05	< 0.01	< 0.01	< 0.02	0.05	< 0.2	< 0.5
FB070698 RA	< 0.1		< 0.05	< 0.01	< 0.01	< 0.02	< 0.02	< 0.2	< 0.5
FB070698 FA	< 0.1		< 0.05	< 0.01	< 0.01	< 0.02	0.1	< 0.2	< 0.5
FB082598 RA	< 0.1		< 0.05	< 0.01	< 0.01	< 0.02	< 0.02	< 0.2	< 0.5
FB082598 FA	< 0.1		< 0.05	< 0.01	< 0.01	< 0.02	0.04	< 0.2	< 0.5
FB052898 FA	< 0.1		< 0.05	< 0.01	< 0.01	< 0.02	< 0.02	< 0.2	< 0.5
FB052898 RA	< 0.1		< 0.05	< 0.01	< 0.01	< 0.02	< 0.02	< 0.2	< 0.5
FB060599FA	0.1	< 1	<0.05	< 0.01	< 0.01		0.21	< 0.2	< 0.5
FB060599 RA	0.1	< 1	<0.05	< 0.01	0.01		0.05	< 0.2	< 0.5
FB042600 FA	<0.1	< 4	0.2	< 0.01	0.01	< 0.02	0.2	0.3	< 0.5
FB042600 RA	<0.1	< 4	0.1	< 0.01	< 0.01	< 0.02	0.085	< 0.2	< 0.5
FB042600D FA	<0.1	< 4	0.1	< 0.01	0.01	< 0.02	0.15	< 0.2	< 0.5
FB042600D RA	<0.1	< 4	0.1	< 0.01	< 0.01	< 0.02	0.04	< 0.2	< 0.5
FB72000 FA	<0.1	< 3	<0.05	< 0.01	< 0.01	< 0.02	0.04	< 0.2	< 0.5
FB72000 RA	<0.1	< 3	<0.05	< 0.01	< 0.01	< 0.02	<0.02	< 0.2	< 0.5
FB102400 FA	<0.1	< 2	<0.05	< 0.01	< 0.01	< 0.02	0.05	< 0.2	< 0.5
FB102400 RA	<0.1	< 2	<0.05	< 0.01	< 0.01	< 0.02	<0.02	< 0.2	< 0.5
FB42401 RA	<0.1	2	<0.05	< 0.01	< 0.01	< 0.02	0.02	< 0.2	< 0.5
FB 42401 FA	<0.1	3	<0.05	< 0.01	< 0.01	< 0.02	<0.02	< 0.2	< 0.5
FB 5201 RA	<0.1	1	<0.05	< 0.01	< 0.01	< 0.02	<0.02	< 0.2	< 0.5
FB 5201 FA	<0.1	1	<0.05	< 0.01	< 0.01	< 0.02	<0.02	< 0.2	< 0.5
VLZN-3-4 FA	4.9	< 1	180	1.3	4.5	< 0.02	0.06	< 0.2	9.8
VLZN-3-4 RA	4.8	< 1	190	1.3	4.4	< 0.02	<0.02	< 0.2	9.8
VLZN-3-4D FA	5	< 1	180	1.3	4.4	< 0.02	0.1	< 0.2	10
VLZN-3-4D RA	4.9	< 1	190	1.3	4.4	< 0.02	0.02	< 0.2	9.9

APPENDIX 3 (cont.): QUALITY-CONTROL AND QUALITY-ASSURANCE DATA

Sample No.	ICPMS Sm µg/L	ICPMS Sr µg/L	ICPMS Tb µg/L	ICPMS Th µg/L	ICPMS Tl µg/L	ICPMS Tm µg/L	ICPMS U µg/L	ICPMS V µg/L	ICPMS W µg/L
FB040798 FA	< 0.01	< 0.02	< 0.005	< 0.005	< 0.05	< 0.005	< 0.005	< 0.1	< 0.02
FB040798 RA	< 0.01	< 0.02	< 0.005	< 0.005	< 0.05	< 0.005	< 0.005	< 0.1	< 0.02
FB070698 RA	< 0.01	< 0.02	< 0.005	< 0.005	< 0.05	< 0.005	< 0.005	< 0.1	< 0.02
FB070698 RA	< 0.01	< 0.02	< 0.005	< 0.005	< 0.05	< 0.005	< 0.005	< 0.1	< 0.02
FB070698 FA	< 0.01	< 0.02	< 0.005	< 0.005	< 0.05	< 0.005	< 0.005	< 0.1	< 0.02
FB082598 RA	< 0.01	< 0.02	< 0.005	< 0.005	< 0.05	< 0.005	< 0.005	< 0.1	< 0.02
FB082598 FA	< 0.01	< 0.02	< 0.005	< 0.005	< 0.05	< 0.005	< 0.005	< 0.1	< 0.02
FB052898 FA	< 0.01	< 0.02	< 0.005	< 0.005	< 0.05	< 0.005	< 0.005	< 0.1	< 0.02
FB052898 RA	< 0.01	< 0.02	< 0.005	< 0.005	< 0.05	< 0.005	< 0.005	< 0.1	< 0.02
FB060599FA	< 0.01	0.07	< 0.005		0.1	< 0.005	< 0.005	<0.1	0.1
FB060599 RA	< 0.01	0.03	< 0.005		<0.05	< 0.005	< 0.005	<0.1	0.08
FB042600 FA	< 0.01	0.02	< 0.005	< 0.01	<0.05	< 0.005	0.01	<0.1	0.02
FB042600 RA	< 0.01	< 0.02	< 0.005	< 0.01	<0.05	< 0.005	0.01	<0.1	< 0.02
FB042600D FA	< 0.01	< 0.02	< 0.005	< 0.01	<0.05	< 0.005	0.01	<0.1	< 0.02
FB042600D RA	< 0.01	< 0.02	< 0.005	< 0.01	<0.05	< 0.005	0.008	<0.1	< 0.02
FB72000 FA	< 0.01	< 0.02	< 0.005	< 0.005	<0.05	< 0.005	< 0.005	<0.1	< 0.02
FB72000 RA	< 0.01	< 0.02	< 0.005	< 0.005	<0.05	< 0.005	< 0.005	<0.1	< 0.02
FB102400 FA	< 0.01	0.04	< 0.005	< 0.01	<0.05	< 0.005	< 0.005	<0.1	0.04
FB102400 RA	< 0.01	< 0.02	< 0.005	< 0.01	<0.05	< 0.005	< 0.005	<0.1	0.03
FB42401 RA	< 0.01	< 0.02	< 0.005	< 0.02	0.06	< 0.005	0.08	<0.2	< 0.02
FB 42401 FA	< 0.01	< 0.02	< 0.005	< 0.02	<0.05	< 0.005	0.04	<0.2	< 0.02
FB 5201 RA	< 0.01	< 0.02	< 0.005	< 0.02	<0.05	< 0.005	0.01	<0.2	< 0.02
FB 5201 FA	< 0.01	< 0.02	< 0.005	< 0.02	<0.05	< 0.005	0.008	<0.2	< 0.02
VLZN-3-4 FA	0.95	9.5	0.095	0.04	<0.05	0.03	0.15	<0.1	< 0.02
VLZN-3-4 RA	0.93	9.3	0.095	0.07	<0.05	0.03	0.16	0.2	< 0.02
VLZN-3-4D FA	0.92	9.4	0.094	0.04	<0.05	0.03	0.15	<0.1	0.03
VLZN-3-4D RA	0.95	9.4	0.093	0.07	<0.05	0.03	0.16	0.1	< 0.02

APPENDIX 3 (cont.): QUALITY-CONTROL AND QUALITY-ASSURANCE DATA

Sample No.	ICPMS Y µg/L	ICPMS Yb µg/L	ICPMS Zn µg/L	ICPAES Ag µg/L	ICPAES Al mg/L	ICPAES As µg/L	ICPAES Ba µg/L	ICPAES Be µg/L	ICPAES Ca mg/L
FB040798 FA	< 0.01	< 0.01	1						
FB040798 RA	< 0.01	< 0.01	< 0.5						
FB070698 RA	< 0.01	< 0.01	< 0.5						
FB070698 RA	< 0.01	< 0.01	< 0.5						
FB070698 FA	< 0.01	< 0.01	< 0.5						
FB082598 RA	< 0.01	< 0.01	< 0.5						
FB082598 FA	< 0.01	< 0.01	0.7						
FB052898 FA	< 0.01	< 0.01	< 0.5						
FB052898 RA	< 0.01	< 0.01	< 0.5						
FB060599FA		< 0.01	2						
FB060599 RA		< 0.01	1						
FB042600 FA	< 0.01	< 0.01	1	<10	<0.01	<100	<1	<10	<0.1
FB042600 RA	< 0.01	< 0.01	<0.5	<10	<0.01	<100	<1	<10	<0.1
FB042600D FA	< 0.01	< 0.01	1	<10	<0.01	<100	<1	<10	<0.1
FB042600D RA	< 0.01	< 0.01	<0.5	<10	<0.01	<100	<1	<10	<0.1
FB72000 FA	< 0.01	< 0.01	2	<10	<0.01	<100	<1	<10	<0.1
FB72000 RA	< 0.01	< 0.01	<0.5	<10	<0.01	<100	<1	<10	<0.1
FB102400 FA	< 0.01	< 0.01	1	<10	<0.01	<50	<1	<10	<0.1
FB102400 RA	< 0.01	< 0.01	<0.5	<10	<0.01	<50	<1	<10	<0.1
FB42401 RA	< 0.01	< 0.01	<0.5	<1	<0.01	<100	<1	<10	<0.1
FB 42401 FA	< 0.01	< 0.01	<0.5	<1	<0.01	<100	<1	<10	<0.1
FB 5201 RA	< 0.01	< 0.01	<0.5	<1	<0.01	<100	<1	<10	<0.1
FB 5201 FA	< 0.01	< 0.01	<0.5	<1	<0.01	<100	<1	<10	<0.1
VLZN-3-4 FA	1.9	0.2	2900	<10	1.2	<100	29	<10	1.9
VLZN-3-4 RA	1.9	0.2	2900	<10	1.2	<100	28	<10	1.9
VLZN-3-4D FA	1.8	0.2	2900	<10	1.1	<100	27	<10	1.8
VLZN-3-4D RA	1.9	0.2	2900	<10	1.2	<100	27	<10	1.8

APPENDIX 3 (cont.): QUALITY-CONTROL AND QUALITY-ASSURANCE DATA

Sample No.	ICPAES Cd µg/L	ICPAES Co µg/L	ICPAES Cr µg/L	ICPAES Cu µg/L	ICPAES Fe mg/L	ICPAES K mg/L	ICPAES Mg mg/L	ICPAES Mn µg/L	ICPAES Mo µg/L
FB040798 FA									
FB040798 RA									
FB070698 RA									
FB070698 RA									
FB070698 FA									
FB082598 RA									
FB082598 FA									
FB052898 FA									
FB052898 RA									
FB060599FA									
FB060599 RA									
FB042600 FA	<10	<10	<10	<10	<0.05	<0.1	<0.1	<10	<20
FB042600 RA	<10	<10	<10	<10	<0.05	<0.1	<0.1	<10	<20
FB042600D FA	<10	<10	<10	<10	<0.05	<0.1	<0.1	<10	<20
FB042600D RA	<10	<10	<10	<10	<0.05	<0.1	<0.1	<10	<20
FB72000 FA	<10	<10	<10	<10	<0.05	<0.1	<0.1	<10	<20
FB72000 RA	<10	<10	<10	<10	<0.05	<0.1	<0.1	<10	<20
FB102400 FA	<5	<10	<10	<10	<0.02	<0.1	<0.1	<10	<20
FB102400 RA	<5	<10	<10	<10	<0.02	<0.1	<0.1	<10	<20
FB42401 RA	<5	<10	<10	<10	<0.02	<0.1	<0.1	<10	<20
FB 42401 FA	<5	<10	<10	<10	<0.02	<0.1	<0.1	<10	<20
FB 5201 RA	<5	<10	<10	<10	<0.02	<0.1	<0.1	<10	<20
FB 5201 FA	<5	<10	<10	<10	<0.02	<0.1	<0.1	<10	<20
VLZN-3-4 FA	<10	26	<10	110	16	1.8	2.8	500	<20
VLZN-3-4 RA	<10	27	<10	110	17	1.8	2.8	500	<20
VLZN-3-4D FA	<10	23	<10	100	15	1.7	2.6	460	<20
VLZN-3-4D RA	<10	26	<10	100	16	1.6	2.6	470	<20

APPENDIX 3 (cont.): QUALITY-CONTROL AND QUALITY-ASSURANCE DATA

Sample No.	ICPAES Na mg/L	ICPAES Ni µg/L	ICPAES P mg/L	ICPAES Pb µg/L	ICPAES Sb µg/L	ICPAES Si mg/L	ICPAES Sr µg/L	ICPAES Ti µg/L	ICPAES Zn µg/L
FB040798 FA									
FB040798 RA									
FB070698 RA									
FB070698 RA									
FB070698 FA									
FB082598 RA									
FB082598 FA									
FB052898 FA									
FB052898 RA									
FB060599FA									
FB060599 RA									
FB042600 FA	<0.1	<10	<100	<100	<100	<0.1	<1	<50	<10
FB042600 RA	<0.1	<10	<100	<100	<100	<0.1	<1	<50	<10
FB042600D FA	<0.1	<10	<100	<100	<100	<0.1	<1	<50	<10
FB042600D RA	<0.1	<10	<100	<100	<100	<0.1	<1	<50	<10
FB72000 FA	<0.1	<10	<100	<100	<100	<0.1	<1	<50	<10
FB72000 RA	<0.1	<10	<100	<100	<100	<0.1	<1	<50	<10
FB102400 FA	<0.1	<10	<100	<50	<50	<0.1	<1	<50	<10
FB102400 RA	<0.1	<10	<100	<50	<50	<0.1	<1	<50	<10
FB42401 RA	<0.1	<10	<0.1	<50	<50	<0.1	<1	<50	<10
FB 42401 FA	<0.1	<10	<0.1	<50	<50	<0.1	<1	<50	<10
FB 5201 RA	<0.1	<10	<0.1	<50	<50	<0.1	<1	<50	<10
FB 5201 FA	<0.1	<10	<0.1	<50	<50	<0.1	<1	<50	<10
VLZN-3-4 FA	3.6	<10	<100	220	<100	5.5	9.5	<50	3400
VLZN-3-4 RA	3.7	<10	<100	220	<100	5.7	9	<50	3400
VLZN-3-4D FA	3.4	<10	<100	210	<100	5.2	8.6	<50	3200
VLZN-3-4D RA	3.4	<10	<100	200	<100	5.3	8.7	<50	3300

APPENDIX 4: WATER QUALITY DATA

Field No.	Latitude	Longitude	Date	T air °C	T water °C	Flow L/s	pH	spec conduct µS/cm	DO mg/L
VLZN-1-1 RA	38°10.678'N	77°47.902'W	5/22/1998	21.0	20.3		6.1	30.7	11
VLZN-2-1 FA	38°10.655'N	77°47.826'W	5/22/1998	20.7	14.8		6.4	209.7	2
VLZN-2-1 RA	38°10.655'N	77°47.826'W	5/22/1998	20.7	14.8		6.4	209.7	2
VLZN-3-1 FA	38°10.640'N	77°47.569'W	5/22/1998	18.5	17.2	12.5	3.9	124.8	7
VLZN-3-1 RA	38°10.640'N	77°47.569'W	5/22/1998	18.5	17.2	12.5	3.9	124.8	7
VLZN3-2 FA	38°10.640'N	77°47.569'W	7/21/1999	29.7	26.0	0.2	2.9	1225.0	9
VLZN3-2 RA	38°10.640'N	77°47.569'W	7/21/1999	29.7	26.0	0.2	2.9	1225.0	9
VLZN-3-3 FA	38°10.640'N	77°47.569'W	11/5/1999	7.8	5.5	8.7	3.3	247.0	8
VLZN-3-3 RA	38°10.640'N	77°47.569'W	11/4/1999	7.8	5.5	8.7	3.3	247.0	8
VLZN-3-4 FA	38°10.640'N	77°47.569'W	2/3/2000	6.5	1.0	11.1	3.9	139.0	9
VLZN-3-4 RA	38°10.640'N	77°47.569'W	2/3/2000	6.5	1.0	11.1	3.9	139.0	9
VLZN-3-4D FA	38°10.640'N	77°47.569'W	2/3/2000	6.5	0.9	11.1	3.9	138.7	9
VLZN-3-4D RA	38°10.640'N	77°47.569'W	2/3/2000	6.5	0.9	11.1	3.9	138.7	
VLZN-3-5 FA	38°10.640'N	77°47.569'W	4/26/2000	15.4	13.7	219.0	3.7	88.5	10
VLZN-3-5 RA	38°10.640'N	77°47.569'W	4/26/2000	15.4	13.7	219.0	3.7	88.5	10
VLZN-3-6 FA	38°10.640'N	77°47.569'W	7/20/2000	22.6	23.5	10.8	3.2	363.0	9
VLZN-3-6 RA	38°10.640'N	77°47.569'W	7/20/2000	22.6	23.5	10.8	3.2	363.0	9
VLZN-3-7 FA	38°10.640'N	77°47.569'W	10/24/2000	12.5	10.5	1.7	2.6	371.0	8
VLZN-3-7 RA	38°10.640'N	77°47.569'W	10/24/2000	12.5	10.5	1.7	2.6	371.0	8
VLZN-3-8 FA	38°10.640'N	77°47.569'W	2/7/2001	12.7	6.0	13.6	2.7	249.0	11
VLZN-3-8 RA	38°10.640'N	77°47.569'W	2/7/2001	12.7	6.0	13.6	2.7	249.0	11
VLZN-3-9 FA	38°10.640'N	77°47.569'W	4/30/2001	24.9	19.7	8.7	3.7	188.1	6
VLZN-3-9 RA	38°10.640'N	77°47.569'W	4/30/2001	24.9	19.7	8.7	3.7	188.1	6
VLZN-4-1 FA	38°10.683'N	77°47.675'W	5/22/1998	22.5	23.1		4.8	73.1	6.5
VLZN-4-1 RA	38°10.683'N	77°47.675'W	5/22/1998	22.5	23.1		4.8	73.1	6.5
VLZN-4-8 FA	38°10.683'N	77°47.675'W	2/7/2001	14.8	12.5		3.7	273.0	6
VLZN-4-8 RA	38°10.683'N	77°47.675'W	2/7/2001	14.8	12.5		3.7	273.0	6
VLZN-6-1 RA	38°10.666'N	77°47.908'W	5/22/1998	21.4	18.4		6.0	29.7	7
VLZN-7-1 FA	38°10.655'N	77°47.850'W	5/22/1998	22.3	29.7		5.1	76.9	7
VLZN-7-1 RA	38°10.655'N	77°47.850'W	5/22/1998	22.3	29.7		5.1	76.9	7
VLZN-8-1 FA	38°10.630'N	77°47.818'W	5/22/1998	24.0	19.1		2.9	1375.0	9
VLZN-8-1 RA	38°10.630'N	77°47.818'W	5/22/1998	24.0	19.1		2.9	1375.0	9
VLZN-9-2 FA	38°10.659'N	77°47.763'W	7/21/1999	29.7	30.5		2.9	837.0	7
VLZN-9-2 RA	38°10.659'N	77°47.763'W	7/21/1999	29.7	30.5		2.9	837.0	7
VLZN-10-2 FA	38°10.650'N	77°47.904'W	7/21/1999	31.3	31.1		1.1	25800.0	-
VLZN-10-2 RA	38°10.650'N	77°47.904'W	7/21/1999	31.3	31.1		1.1	25800.0	-

APPENDIX 4 (cont.): WATER QUALITY DATA

Field No.	Fe^{2+}/Fe_{Total}	Acidity $CaCO_3$ mg/L	Alkalinity $CaCO_3$ mg/L	IC Cl mg/L	IC SO_4 mg/L	ICPMS Ag µg/L	ICPAES Al mg/L	ICPMS As µg/L
VLZN-1-1 RA	0.161				nd	0.02	0.43	0.5
VLZN-2-1 FA	0.445			1.8	62	< 0.01	0.00	1
VLZN-2-1 RA	0.445					< 0.01	0.05	0.8
VLZN-3-1 FA	0.567			1.8	51	< 0.01	0.83	< 0.2
VLZN-3-1 RA	0.498					< 0.01	0.95	< 0.2
VLZN3-2 FA	0.542	417.2		3	1400	0.04	19.47	1
VLZN3-2 RA	0.542					0.1	19.47	2
VLZN-3-3 FA	0.861	107.2		2.5	110	<0.01	2.20	<0.2
VLZN-3-3 RA	0.861					<0.01	2.20	0.2
VLZN-3-4 FA	0.866	64		5.6	73	<0.01	1.20	<0.2
VLZN-3-4 RA	0.866					<0.01	1.20	<0.2
VLZN-3-4D FA	0.851	58.7		5.7	72	<0.01	1.10	<0.2
VLZN-3-4D RA	0.851					<0.01	1.20	<0.2
VLZN-3-5 FA	0.521	30.24		2.9	27	0.03	1.10	0.8
VLZN-3-5 RA	0.521					<0.01	0.89	0.7
VLZN-3-6 FA	0.923	91.2		2.3	98	<0.01	1.40	0.7
VLZN-3-6 RA	0.923					0.02	1.40	0.8
VLZN-3-7 FA	0.517	88.72		1.9	82	<0.01	1.10	<0.2
VLZN-3-7 RA	0.517					<0.01	1.10	<0.2
VLZN-3-8 FA	0.840	72		5	73	<0.05	1.80	<0.2
VLZN-3-8 RA	0.840					<0.05	1.80	<0.2
VLZN-3-9 FA				2.9	54	<0.05	0.63	<0.2
VLZN-3-9 RA						<0.05	0.70	0.3
VLZN-4-1 FA	0.478			2.2	28	< 0.01	0.38	< 0.2
VLZN-4-1 RA	0.351					< 0.01	0.66	< 0.2
VLZN-4-8 FA	0.983	104		5.5	99	<0.05	3.10	<0.2
VLZN-4-8 RA	0.983					<0.05	3.10	0.3
VLZN-6-1 RA						0.04	0.31	0.5
VLZN-7-1 FA	1.371			2	29	< 0.01	0.07	< 0.2
VLZN-7-1 RA	0.640					0.07	1.08	0.2
VLZN-8-1 FA	0.029			1.4	710	0.03	41.54	0.3
VLZN-8-1 RA	0.029					0.1	41.54	0.4
VLZN-9-2 FA	0.580	78.5		2.4	260	0.06	0.58	<0.2
VLZN-9-2 RA	0.580					0.1	0.73	<0.2
VLZN-10-2 FA	0.650	27064.3		41	53604	<1	1038.40	<20
VLZN-10-2 RA	0.650					<1	1090.32	280

APPENDIX 4 (cont.): WATER QUALITY DATA

Field No.	ICPMS Au µg/L	ICPMS Ba µg/L	ICPMS Be µg/L	ICPMS Bi µg/L	ICPAES Ca mg/L	ICPMS Cd µg/L	ICPMS Ce µg/L
VLZN-1-1 RA	< 0.01	22	< 0.05	0.04	1.6	0.3	3.9
VLZN-2-1 FA	< 0.01	27	< 0.05	< 0.01	6.9	< 0.02	0.08
VLZN-2-1 RA	< 0.01	27	< 0.05	< 0.01	6.8	< 0.02	0.3
VLZN-3-1 FA	< 0.01	23	0.2	< 0.01	1.9	5.2	7.5
VLZN-3-1 RA	< 0.01	24	0.09	< 0.01	1.9	5.4	8.3
VLZN3-2 FA		46	1.1		5.8	88	71
VLZN3-2 RA		46	1		5.8	89	72
VLZN-3-3 FA	< 0.01	34	0.2	< 0.02	2.2	8.9	12
VLZN-3-3 RA	< 0.01	34	0.3	< 0.02	2.2	8.7	12
VLZN-3-4 FA	< 0.01	30	0.1	< 0.01	1.9	6.9	9.1
VLZN-3-4 RA	< 0.01	32	0.2	< 0.01	1.9	6.9	9.2
VLZN-3-4D FA	< 0.01	30	0.09	< 0.01	1.8	7	9.2
VLZN-3-4D RA	< 0.01	30	0.2	< 0.01	1.8	6.9	9.4
VLZN-3-5 FA	< 0.01	47	0.2	0.05	1.6	7.7	7.3
VLZN-3-5 RA	< 0.01	46	0.1	< 0.01	1.6	7.6	6.5
VLZN-3-6 FA	< 0.01	30	0.2	< 0.01	2.2	10	13
VLZN-3-6 RA	< 0.01	30	0.2	< 0.01	2.0	10	13
VLZN-3-7 FA	< 0.01	27	0.08	< 0.01	2.3	3.2	8.5
VLZN-3-7 RA	< 0.01	27	0.08	< 0.01	2.4	3.1	8.5
VLZN-3-8 FA	< 0.01	27	0.1	< 0.01	2.1	9.1	10
VLZN-3-8 RA	< 0.01	27	0.21	< 0.01	2.1	9.3	11
VLZN-3-9 FA	< 0.01	33	0.1	< 0.01	2.2	6.2	8.3
VLZN-3-9 RA	< 0.01	32	0.1	< 0.01	2.1	6.2	8.5
VLZN-4-1 FA	< 0.01	22	0.07	< 0.01	1.7	6	6.5
VLZN-4-1 RA	< 0.01	22	0.07	< 0.01	1.7	6	8.3
VLZN-4-8 FA	< 0.01	23	0.1	< 0.01	2.0	18	15
VLZN-4-8 RA	< 0.01	24	0.2	0.03	2.0	19	16
VLZN-6-1 RA	< 0.01	23	0.1	0.01	1.7	0.04	3.5
VLZN-7-1 FA	< 0.01	16	< 0.05	< 0.01	0.7	1.5	0.51
VLZN-7-1 RA	0.01	19	0.06	0.7	0.8	3.5	1.7
VLZN-8-1 FA	< 0.01	30	2.6	< 0.01	14.6	460	170
VLZN-8-1 RA	< 0.01	29	3	0.08	13.3	450	170
VLZN-9-2 FA		32	<0.05		13.3	2	2.2
VLZN-9-2 RA		34	0.06		13.3	2.4	2.5
VLZN-10-2 FA	< 1	<2	40	2	100.7	3000	870
VLZN-10-2 RA	< 1	<2	50	< 1	112.8	3100	910

APPENDIX 4 (cont.): WATER QUALITY DATA

Field No.	ICPMS Co µg/L	ICPMS Cr µg/L	ICPMS Cs µg/L	ICPMS Cu µg/L	ICPMS Dy µg/L	ICPAES Fe mg/L	ICPMS Er µg/L
VLZN-1-1 RA	5.2	1	< 0.01	16	0.14	8.13	0.079
VLZN-2-1 FA	17	< 1	< 0.01	1	< 0.005	34.85	< 0.005
VLZN-2-1 RA	17	< 1	< 0.01	6	< 0.005	34.85	0.01
VLZN-3-1 FA	12	< 1	< 0.01	62	0.3	5.23	0.13
VLZN-3-1 RA	12	< 1	< 0.01	66	0.34	5.95	0.15
VLZN3-2 FA	140	5		2200	2.9	69.70	1.3
VLZN3-2 RA	140	5		2200	3	69.70	1.3
VLZN-3-3 FA	33	<1	< 0.01	140	0.5	18.00	0.22
VLZN-3-3 RA	32	<1	< 0.01	140	0.5	19.00	0.21
VLZN-3-4 FA	19	<1	< 0.01	91	0.42	16.00	0.18
VLZN-3-4 RA	20	<1	< 0.01	90	0.46	17.00	0.2
VLZN-3-4D FA	20	<1	< 0.01	90	0.41	15.00	0.2
VLZN-3-4D RA	20	<1	< 0.01	89	0.44	16.00	0.18
VLZN-3-5 FA	7.2	1	< 0.01	120	0.33	5.00	0.14
VLZN-3-5 RA	7.2	1	< 0.01	120	0.32	4.20	0.13
VLZN-3-6 FA	36	<1	0.03	160	0.45	18.00	0.2
VLZN-3-6 RA	36	<1	0.03	160	0.46	18.00	0.19
VLZN-3-7 FA	20	<1	0.01	49	0.36	9.20	0.18
VLZN-3-7 RA	20	<1	< 0.01	50	0.37	11.00	0.16
VLZN-3-8 FA	26	<1	< 0.01	140	0.48	13.00	0.21
VLZN-3-8 RA	26	<1	< 0.01	140	0.5	13.00	0.22
VLZN-3-9 FA	18	<1	0.01	64	0.34	7.40	0.16
VLZN-3-9 RA	19	<1	0.01	67	0.36	8.20	0.16
VLZN-4-1 FA	9.2	< 1	< 0.01	62	0.24	5.23	0.12
VLZN-4-1 RA	9.1	< 1	< 0.01	70	0.31	7.11	0.17
VLZN-4-8 FA	40	<1	< 0.01	220	0.75	28.00	0.34
VLZN-4-8 RA	41	<1	< 0.01	220	0.78	30.00	0.34
VLZN-6-1 RA	4	1	< 0.01	8	0.15	5.23	0.058
VLZN-7-1 FA	5.6	< 1	0.06	20	0.03	10.16	0.02
VLZN-7-1 RA	7.6	< 1	0.1	120	0.11	21.78	0.053
VLZN-8-1 FA	130	2	0.04	7200	3.2	62.44	1.4
VLZN-8-1 RA	130	2	0.04	7100	3.3	62.44	1.3
VLZN-9-2 FA	9	<1		21	0.064	5.52	0.03
VLZN-9-2 RA	10	<1		34	0.09	10.60	0.04
VLZN-10-2 FA	14000	400	1	59000	93	15972.00	38
VLZN-10-2 RA	15000	400	1	62000	110	17424.00	42

APPENDIX 4 (cont.): WATER QUALITY DATA

Field No.	ICPMS Eu µg/L	ICPMS Ga µg/L	ICPMS Gd µg/L	ICPMS Ge µg/L	ICPMS Ho µg/L	ICPMS In µg/L	ICPAES K mg/L
VLZN-1-1 RA	0.04	0.09	0.21	< 0.02	0.03	< 0.01	1.1
VLZN-2-1 FA	< 0.005	< 0.02	0.005	< 0.02	< 0.005	< 0.01	4.4
VLZN-2-1 RA	< 0.005	< 0.02	0.007	< 0.02	< 0.005	< 0.01	4.3
VLZN-3-1 FA	0.094	0.08	0.56	< 0.02	0.05	< 0.01	1.9
VLZN-3-1 RA	0.1	0.09	0.6	< 0.02	0.053	< 0.01	1.9
VLZN3-2 FA	1.2		5.2		0.54	0.7	3.6
VLZN3-2 RA	1.2		5.2		0.56	0.72	3.6
VLZN-3-3 FA	0.19	< 0.02	0.78	< 0.02	0.091	0.02	2.4
VLZN-3-3 RA	0.18	< 0.02	0.78	< 0.02	0.083	0.02	2.5
VLZN-3-4 FA	0.16	< 0.02	0.74	< 0.02	0.069	0.01	1.8
VLZN-3-4 RA	0.16	< 0.02	0.74	< 0.02	0.078	0.01	1.8
VLZN-3-4D FA	0.16	< 0.02	0.77	< 0.02	0.075	0.01	1.7
VLZN-3-4D RA	0.17	< 0.02	0.77	< 0.02	0.079	0.01	1.6
VLZN-3-5 FA	0.11	0.09	0.44	< 0.03	0.074	0.03	1.4
VLZN-3-5 RA	0.09	< 0.02	0.42	< 0.03	0.057	< 0.01	1.3
VLZN-3-6 FA	0.16	0.02	0.78	0.03	0.066	0.02	2.6
VLZN-3-6 RA	0.15	< 0.02	0.8	< 0.02	0.068	0.02	2.6
VLZN-3-7 FA	0.14	< 0.02	0.7	< 0.02	0.062	0.01	3.0
VLZN-3-7 RA	0.14	0.03	0.67	< 0.02	0.062	< 0.01	3.1
VLZN-3-8 FA	0.17	< 0.02	0.88	< 0.02	0.09	0.02	2.1
VLZN-3-8 RA	0.17	< 0.02	0.89	< 0.02	0.088	0.02	2.2
VLZN-3-9 FA	0.14	< 0.02	0.67	< 0.02	0.058	< 0.01	2.1
VLZN-3-9 RA	0.13	< 0.02	0.67	< 0.02	0.065	< 0.01	2.1
VLZN-4-1 FA	0.091	0.07	0.48	< 0.02	0.04	< 0.01	1.6
VLZN-4-1 RA	0.12	0.1	0.65	< 0.02	0.056	< 0.01	1.6
VLZN-4-8 FA	0.3	< 0.02	1.4	< 0.02	0.13	0.02	2.3
VLZN-4-8 RA	0.3	< 0.02	1.5	< 0.02	0.14	0.03	2.3
VLZN-6-1 RA	0.03	0.05	0.17	< 0.02	0.02	< 0.01	1.0
VLZN-7-1 FA	< 0.005	< 0.02	0.05	< 0.02	< 0.005	< 0.01	2.8
VLZN-7-1 RA	0.02	0.4	0.19	0.04	0.01	0.1	3.3
VLZN-8-1 FA	1.4	1.4	6.4	0.08	0.55	0.3	3.6
VLZN-8-1 RA	1.4	1.4	6.2	0.1	0.53	0.31	3.6
VLZN-9-2 FA	0.02		0.13		0.02	< 0.01	12.8
VLZN-9-2 RA	0.03		0.14		0.02	< 0.01	12.8
VLZN-10-2 FA	33	< 2	140	< 3	15	47	<0.5
VLZN-10-2 RA	36	98	140	< 3	16	51	<0.5

APPENDIX 4 (cont.): WATER QUALITY DATA

Field No.	ICPMS La µg/L	ICPAES Mg mg/L	ICPMS Mn µg/L	ICPMS Mo µg/L	ICPAES Na mg/L	ICPMS Nd µg/L	ICPMS Ni µg/L
VLZN-1-1 RA	1.2	1.4	370	0.5	2.8	1.4	0.2
VLZN-2-1 FA	0.02	5.7	3600	0.07	1.8	0.02	< 0.1
VLZN-2-1 RA	0.09	5.6	3600	< 0.02	1.8	0.05	< 0.1
VLZN-3-1 FA	3.7	2.5	530	0.08	2.4	3.4	2
VLZN-3-1 RA	4	2.5	540	0.05	2.4	3.9	2.1
VLZN3-2 FA	29	11.5	2100	0.04	2.1	36	37
VLZN3-2 RA	30	11.5	2200	0.07	2.1	36	37
VLZN-3-3 FA	5.5	3.4	770	0.03	2.4	5.6	7.8
VLZN-3-3 RA	5.4	3.5	750	0.04	2.5	5.6	7.8
VLZN-3-4 FA	4.5	2.8	410	0.02	3.6	4.6	4.9
VLZN-3-4 RA	4.6	2.8	420	< 0.02	3.7	4.7	4.8
VLZN-3-4D FA	4.5	2.6	420	0.03	3.4	4.4	5
VLZN-3-4D RA	4.6	2.6	420	0.03	3.4	4.6	4.9
VLZN-3-5 FA	2.8	1.4	220	0.1	2.3	3.2	3.9
VLZN-3-5 RA	2.4	1.3	220	0.09	2.2	2.9	2.6
VLZN-3-6 FA	6	3.5	960	0.1	2.5	6.1	8.4
VLZN-3-6 RA	6	3.4	990	0.06	2.3	6.2	9
VLZN-3-7 FA	4.4	3.7	1000	0.1	2.5	4.5	5.3
VLZN-3-7 RA	4.5	3.7	1000	0.05	2.4	4.5	5.3
VLZN-3-8 FA	5.5	3.0	560	0.04	3.6	5.6	6.2
VLZN-3-8 RA	5.6	3.1	560	0.06	3.6	5.6	6.2
VLZN-3-9 FA	4.5	2.7	820	< 0.02	2.8	4.3	4.7
VLZN-3-9 RA	4.6	2.6	830	< 0.02	2.8	4.5	4.8
VLZN-4-1 FA	3.4	2.1	460	< 0.02	2.5	3.3	1.5
VLZN-4-1 RA	4	2.1	460	< 0.02	2.5	4.3	1.5
VLZN-4-8 FA	9	4.0	620	0.04	4.0	9.6	10
VLZN-4-8 RA	9.2	4.0	620	0.05	4.0	9.7	10
VLZN-6-1 RA	1	1.3	420	0.4	3.2	1.1	< 0.1
VLZN-7-1 FA	0.5	1.4	260	< 0.02	2.0	0.32	2.5
VLZN-7-1 RA	1.1	2.4	480	< 0.02	2.0	0.93	4.9
VLZN-8-1 FA	30	12.6	1900	< 0.02	1.4	42	48
VLZN-8-1 RA	30	13.8	1900	< 0.02	1.4	41	48
VLZN-9-2 FA	0.82	8.5	6200	0.2	1.9	0.75	3.5
VLZN-9-2 RA	0.95	8.4	6000	0.3	2.0	0.91	5
VLZN-10-2 FA	340	1032.3	220000	5	4.5	650	3900
VLZN-10-2 RA	360	1066.7	230000	6	<1	700	4300

APPENDIX 4 (cont.): WATER QUALITY DATA

Field No.	ICPMS P µg/L	ICPMS Pb µg/L	ICPMS Pr µg/L	ICPMS Rb µg/L	ICPMS Re µg/L	ICPMS Sb µg/L	ICPMS Se µg/L
VLZN-1-1 RA		42	0.32	3	< 0.02	0.1	< 0.2
VLZN-2-1 FA		0.5	< 0.01	12	< 0.02	0.78	< 0.2
VLZN-2-1 RA		33	0.01	11	< 0.02	1.2	< 0.2
VLZN-3-1 FA		200	0.93	7.2	< 0.02	0.08	< 0.2
VLZN-3-1 RA		230	1	7.2	< 0.02	< 0.02	< 0.2
VLZN3-2 FA	< 6	1300	7.7	20		0.1	0.7
VLZN3-2 RA	< 6	1400	8	20		0.1	0.9
VLZN-3-3 FA	< 1	340	1.5	9	< 0.02	0.13	0.2
VLZN-3-3 RA	< 1	330	1.5	8.8	< 0.02	<0.03	< 0.2
VLZN-3-4 FA	< 1	180	1.3	4.5	< 0.02	0.06	< 0.2
VLZN-3-4 RA	< 1	190	1.3	4.4	< 0.02	<0.02	< 0.2
VLZN-3-4D FA	< 1	180	1.3	4.4	< 0.02	0.1	< 0.2
VLZN-3-4D RA	< 1	190	1.3	4.4	< 0.02	0.02	< 0.2
VLZN-3-5 FA	10	260	0.83	4.3	< 0.02	0.16	0.3
VLZN-3-5 RA	6	200	0.74	3.9	< 0.02	0.69	0.3
VLZN-3-6 FA	< 3	310	1.4	13	< 0.02	0.06	0.3
VLZN-3-6 RA	< 3	320	1.4	13	< 0.02	0.04	0.4
VLZN-3-7 FA	< 2	230	1.2	14	< 0.02	0.03	< 0.2
VLZN-3-7 RA	< 2	240	1.2	14	< 0.02	0.02	< 0.2
VLZN-3-8 FA	< 1	320	1.5	7.3	< 0.02	0.05	< 0.2
VLZN-3-8 RA	< 1	320	1.6	7.6	< 0.02	0.02	< 0.2
VLZN-3-9 FA	5	170	1.1	9.4	< 0.02	0.2	< 0.2
VLZN-3-9 RA	8	170	1.2	9.5	< 0.02	0.04	< 0.2
VLZN-4-1 FA		79	0.89	6.3	< 0.02	0.1	< 0.2
VLZN-4-1 RA		120	1.1	6.2	< 0.02	< 0.02	< 0.2
VLZN-4-8 FA	< 1	270	2.6	8.4	< 0.02	0.06	< 0.2
VLZN-4-8 RA	1	310	2.6	8.4	< 0.02	0.06	< 0.2
VLZN-6-1 RA		16	0.27	2	< 0.02	0.09	< 0.2
VLZN-7-1 FA		760	0.09	18	< 0.02	0.1	< 0.2
VLZN-7-1 RA		1800	0.27	23	< 0.02	1	< 0.2
VLZN-8-1 FA		2800	10	24	< 0.02	0.09	1
VLZN-8-1 RA		2900	9.9	23	< 0.02	0.1	1
VLZN-9-2 FA	< 6	160	0.2	29		0.06	< 0.2
VLZN-9-2 RA	< 6	170	0.21	31		0.07	< 0.2
VLZN-10-2 FA	2500	2100	150	4	< 2	10	< 40
VLZN-10-2 RA	2400	1500	160	30	< 2	10	70

APPENDIX 4 (cont.): WATER QUALITY DATA

Field No.	ICPMS SiO_2 mg/L	ICPMS Sm µg/L	ICPMS Sr µg/L	ICPMS Tb µg/L	ICPMS Th µg/L	ICPMS Tl µg/L	ICPMS Tm µg/L
VLZN-1-1 RA	12	0.25	7.3	0.03	0.16	< 0.05	0.007
VLZN-2-1 FA	11	< 0.01	18	< 0.005	< 0.005	< 0.05	< 0.005
VLZN-2-1 RA	10	0.02	18	< 0.005	< 0.005	< 0.05	< 0.005
VLZN-3-1 FA	12	0.63	8	0.059	0.01	< 0.05	0.02
VLZN-3-1 RA	12	0.74	8	0.07	0.04	< 0.05	0.02
VLZN3-2 FA	18	7.3	21	0.61		0.3	0.18
VLZN3-2 RA	18	7.7	21	0.63		0.3	0.2
VLZN-3-3 FA	13	1.2	11	0.094	0.056	<0.1	0.03
VLZN-3-3 RA	12	1.1	11	0.098	0.06	<0.1	0.03
VLZN-3-4 FA	9.8	0.95	9.5	0.095	0.04	<0.05	0.03
VLZN-3-4 RA	9.8	0.93	9.3	0.095	0.07	<0.05	0.03
VLZN-3-4D FA	10	0.92	9.4	0.094	0.04	<0.05	0.03
VLZN-3-4D RA	9.9	0.95	9.4	0.093	0.07	<0.05	0.03
VLZN-3-5 FA	7.9	0.64	10	0.072	0.14	<0.05	0.03
VLZN-3-5 RA	7.8	0.59	10	0.07	0.16	<0.05	0.02
VLZN-3-6 FA	20	1.1	10	0.082	0.04	0.07	0.02
VLZN-3-6 RA	20	1.1	11	0.072	0.06	0.07	0.03
VLZN-3-7 FA	15	0.84	13	0.09	0.02	<0.05	0.02
VLZN-3-7 RA	15	0.84	13	0.083	0.03	<0.05	0.03
VLZN-3-8 FA	13	1.1	10	0.11	0.05	0.05	0.03
VLZN-3-8 RA	13	1.1	11	0.11	0.06	<0.05	0.03
VLZN-3-9 FA	15	0.85	12	0.072	< 0.02	<0.05	0.02
VLZN-3-9 RA	15	0.88	13	0.076	< 0.02	<0.05	0.02
VLZN-4-1 FA	12	0.68	7.9	0.052	0.01	< 0.05	0.01
VLZN-4-1 RA	12	0.83	7.9	0.064	0.06	< 0.05	0.02
VLZN-4-8 FA	13	1.9	9.8	0.17	0.05	0.05	0.05
VLZN-4-8 RA	13	2	10	0.17	0.07	0.06	0.053
VLZN-6-1 RA	12	0.2	8	0.02	0.14	< 0.05	0.01
VLZN-7-1 FA	13	0.07	2.6	< 0.005	< 0.005	0.1	< 0.005
VLZN-7-1 RA	15	0.2	2.8	0.02	0.36	0.3	< 0.005
VLZN-8-1 FA	28	8.6	67	0.76	1.8	0.5	0.2
VLZN-8-1 RA	29	8.7	66	0.78	1.8	0.4	0.2
VLZN-9-2 FA	17	0.1	34	0.01		0.1	< 0.005
VLZN-9-2 RA	18	0.2	35	0.02		0.2	0.006
VLZN-10-2 FA	100	180	20	19	200	<5	5.8
VLZN-10-2 RA	100	170	36	22	210	<5	5.3

APPENDIX 4 (cont.): WATER QUALITY DATA

Field No.	ICPMS U µg/L	ICPMS V µg/L	ICPMS W µg/L	ICPMS Y µg/L	ICPMS Yb µg/L	ICPMS Zn µg/L
VLZN-1-1 RA	0.08	2	< 0.02	0.94	0.08	300
VLZN-2-1 FA	< 0.005	< 0.1	< 0.02	0.02	< 0.01	3500
VLZN-2-1 RA	< 0.005	< 0.1	< 0.02	0.05	0.02	3000
VLZN-3-1 FA	0.1	< 0.1	< 0.02	1.6	0.1	2300
VLZN-3-1 RA	0.1	0.1	< 0.02	1.9	0.2	2300
VLZN3-2 FA	3.9	1.2	< 0.02		1.1	27000
VLZN3-2 RA	4.1	1.4	< 0.02		1.2	27000
VLZN-3-3 FA	0.28	0.1	< 0.02	2.3	0.2	4800
VLZN-3-3 RA	0.28	0.2	< 0.02	2.2	0.2	4700
VLZN-3-4 FA	0.15	<0.1	< 0.02	1.9	0.2	2900
VLZN-3-4 RA	0.16	0.2	< 0.02	1.9	0.2	2900
VLZN-3-4D FA	0.15	<0.1	0.03	1.8	0.2	2900
VLZN-3-4D RA	0.16	0.1	< 0.02	1.9	0.2	2900
VLZN-3-5 FA	0.22	1.1	0.03	1.4	0.1	1900
VLZN-3-5 RA	0.18	0.57	0.04	1.3	0.1	1900
VLZN-3-6 FA	0.29	0.1	< 0.02	3.3	0.2	5600
VLZN-3-6 RA	0.25	0.2	< 0.02	3.3	0.2	5600
VLZN-3-7 FA	0.17	<0.1	< 0.02	1.7	0.1	3200
VLZN-3-7 RA	0.14	<0.1	< 0.02	1.6	0.2	3100
VLZN-3-8 FA	0.27	<0.1	0.02	2.4	0.2	3800
VLZN-3-8 RA	0.27	0.1	0.03	2.4	0.2	3800
VLZN-3-9 FA	0.11	<0.2	< 0.02	1.6	0.2	3100
VLZN-3-9 RA	0.11	0.2	< 0.02	1.7	0.1	3100
VLZN-4-1 FA	0.06	< 0.1	< 0.02	1.5	0.1	2100
VLZN-4-1 RA	0.11	0.4	< 0.02	1.8	0.2	2100
VLZN-4-8 FA	0.43	<0.1	< 0.02	3.7	0.3	6000
VLZN-4-8 RA	0.46	0.3	0.02	3.7	0.31	6000
VLZN-6-1 RA	0.08	2	< 0.02	0.82	0.07	20
VLZN-7-1 FA	0.04	< 0.1	< 0.02	0.2	< 0.01	650
VLZN-7-1 RA	0.28	3	< 0.02	0.5	0.04	1200
VLZN-8-1 FA	10	2	< 0.02	13	1.5	87000
VLZN-8-1 RA	10	2	< 0.02	13	1.6	87000
VLZN-9-2 FA	0.06	<0.1	0.06		0.03	1400
VLZN-9-2 RA	0.08	<0.1	0.08		0.04	1600
VLZN-10-2 FA	370	1100	3	370	41	2300000
VLZN-10-2 RA	380	1100	6	400	37	2400000

APPENDIX 4 (cont.): WATER QUALITY DATA

Field No.	Latitude	Longitude	Date	T air °C	T water °C	Flow L/s	pH	spec conduct µS/cm	DO mg/L
VLZN-11-2 FA	38°10.587'N	77°46.969'W	7/21/1999	31.3	25.4	0.3	2.4	1540.0	10
VLZN-11-2 RA	38°10.587'N	77°46.969'W	7/21/1999	31.3	25.4	0.3	2.4	1540.0	10
VLZN-11-3 FA	38°10.587'N	77°46.969'W	11/5/1999	12.3	7.4	13.4	3.2	250.0	9
VLZN-11-3 RA	38°10.587'N	77°46.969'W	11/5/1999	12.3	7.4	13.4	3.2	250.0	9
VLZN-11-4 FA	38°10.587'N	77°46.969'W	2/3/2000	4.3	0.6	17.1	3.5	120.7	11
VLZN-11-4 RA	38°10.587'N	77°46.969'W	2/3/2000	4.3	0.6	17.1	3.5	120.7	11
VLZN-11-5 FA	38°10.587'N	77°46.969'W	4/26/2000	17.3	11.3	336.5	3.6	89.8	9
VLZN-11-5 RA	38°10.587'N	77°46.969'W	4/26/2000	17.3	11.3	336.5	3.6	89.8	9
VLZN-11-6 FA	38°10.587'N	77°46.969'W	7/20/2000	22.4	19.6	16.6	2.9	605.0	7
VLZN-11-6 RA	38°10.587'N	77°46.969'W	7/20/2000	22.4	19.6	16.6	2.9	605.0	7
VLZN-11-7 FA	38°10.587'N	77°46.969'W	10/24/2000	11.0	9.0	2.6	2.5	224.0	9
VLZN-11-7 RA	38°10.587'N	77°46.969'W	10/24/2000	11.0	9.0	2.6	2.5	224.0	9
VLZN-11-8 FA	38°10.587'N	77°46.969'W	2/7/2001	6.6	3.6	20.8	2.7	228.0	11
VLZN-11-8 RA	38°10.587'N	77°46.969'W	2/7/2001	6.6	3.6	20.8	2.7	228.0	11
VLZN-11-9 FA	38°10.587'N	77°46.969'W	4/30/2001	20.1	13	13.4	3.5	116.9	8
VLZN-11-9 RA	38°10.587'N	77°46.969'W	4/30/2001	20.1	13	13.4	3.5	116.9	8
VLZN-12-3 FA	38°10.652'N	77°46.649'W	11/5/1999	7.9	6.2		2.9	515.0	9
VLZN-12-3 RA	38°10.652'N	77°46.649'W	11/5/1999	7.9	6.2		2.9	515.0	9
VLZN-13-4 FA	38°10.753'N	77°46.970'W	2/3/2000	5.3	1.8		5. 6	35.2	11
VLZN-13-4 RA	38°10.753'N	77°46.970'W	2/3/2000	5.3	1.8		5. 6	35.2	11
VLZN-13-5 FA	38°10.753'N	77°46.970'W	4/26/2000	16.8	11.1		4.4	35.9	9
VLZN-13-5 RA	38°10.753'N	77°46.970'W	4/26/2000	16.8	11.1		4.4	35.9	9
VLZN-13-6 FA	38°10.753'N	77°46.970'W	7/20/2000	26.6	20.8		5.5	49.8	6
VLZN-13-6 RA	38°10.753'N	77°46.970'W	7/20/2000	26.6	20.8		5.5	49.8	6
VLZN-13-7 FA	38°10.753'N	77°46.970'W	10/24/2000	15.1	11.9		6.0	40.1	3
VLZN-13-7 RA	38°10.753'N	77°46.970'W	10/24/2000	15.1	11.9		6.0	40.1	3
VLZN-13-8 FA	38°10.753'N	77°46.970'W	2/7/2001	12.1	7.9		5.4	50.3	8
VLZN-13-8 RA	38°10.753'N	77°46.970'W	2/7/2001	12.1	7.9		5.4	50.3	8
VLZN-13-9 FA	38°10.753'N	77°46.970'W	4/30/2001	26.7	15.8		6.1	42.4	6
VLZN-13-9 RA	38°10.753'N	77°46.970'W	4/30/2001	26.7	15.8		6.1	42.4	6

APPENDIX 4 (cont.): WATER QUALITY DATA

Field No.	Fe^{2+}/Fe_{Total}	Acidity $CaCO_3$ mg/L	Alkalinity $CaCO_3$ mg/L	IC Cl mg/L	IC SO_4 mg/L	ICPMS Ag µg/L	ICPAES Al mg/L	ICPMS As µg/L
VLZN-11-2 FA	0.151	497.2		2.8	1700	<1	31.15	<20
VLZN-11-2 RA	0.151					<1	29.85	<20
VLZN-11-3 FA	0.581	84.32		2.2	89	<0.01	3.30	<0.2
VLZN-11-3 RA	0.581					<0.01	3.30	<0.2
VLZN-11-4 FA	0.857	44.6		3.5	55	<0.01	1.40	<0.2
VLZN-11-4 RA	0.857					<0.01	1.40	<0.2
VLZN-11-5 FA	0.491	28.32		2.4	26	<0.01	1.00	0.6
VLZN-11-5 RA	0.491					<0.01	1.20	0.7
VLZN-11-6 FA	0.605	165.6		2	170	0.02	3.60	0.9
VLZN-11-6 RA	0.605					0.03	3.60	1.1
VLZN-11-7 FA	0.391	56.05		1.6	46	<0.01	1.00	<0.2
VLZN-11-7 RA	0.391					<0.01	1.00	<0.2
VLZN-11-8 FA	0.579	56		3.4	59	<0.05	2.00	<0.2
VLZN-11-8 RA	0.579					<0.05	2.00	<0.2
VLZN-11-9 FA				2.2	29	<0.05	0.52	<0.2
VLZN-11-9 RA						<0.05	0.56	0.2
VLZN-12-3 FA	0.259	186.7		1.3	200	<0.01	2.60	<0.2
VLZN-12-3 RA	0.259					<0.01	2.90	<0.2
VLZN-13-4 FA	0.155		1.6	7	4.1	0.01	0.14	<0.2
VLZN-13-4 RA	0.155					<0.01	0.21	0.2
VLZN-13-5 FA	0.376	14.24		3.4	4.8	0.01	0.49	0.6
VLZN-13-5 RA	0.376					0.01	0.53	0.6
VLZN-13-6 FA	0.103		1.68	3.5	3.5	<0.01	0.07	1.1
VLZN-13-6 RA	0.103					<0.01	0.31	1.3
VLZN-13-7 FA	0.244	11.01	1.56	2.4	0.76	0.01	0.02	0.3
VLZN-13-7 RA	0.244					<0.01	0.29	0.4
VLZN-13-8 FA	0.075	3.6	3.3	6.4	4.4	<0.05	0.06	0.2
VLZN-13-8 RA	0.075			6.4	4.4	<0.05	0.49	0.3
VLZN-13-9 FA			13.18	3.1	1	<0.05	0.07	0.6
VLZN-13-9 RA				3.1	1	<0.05	0.70	0.9

APPENDIX 4 (cont.): WATER QUALITY DATA

Field No.	ICPMS Au µg/L	ICPMS Ba µg/L	ICPMS Be µg/L	ICPMS Bi µg/L	ICPAES Ca mg/L	ICPMS Cd µg/L	ICPMS Ce µg/L
VLZN-11-2 FA		10	<5		<5	99	100
VLZN-11-2 RA		10	<5		<5	98	98
VLZN-11-3 FA	< 0.01	36	0.5	< 0.02	1.7	5.6	19
VLZN-11-3 RA	< 0.01	37	0.6	< 0.02	1.8	5.7	19
VLZN-11-4 FA	< 0.01	30	0.2	< 0.01	1.4	4.8	11
VLZN-11-4 RA	< 0.01	30	0.2	< 0.01	1.4	4.7	11
VLZN-11-5 FA	< 0.01	48	0.3	< 0.01	1.3	5.1	8
VLZN-11-5 RA	< 0.01	50	0.3	< 0.01	1.3	5.3	9.1
VLZN-11-6 FA	< 0.01	38	0.4	< 0.01	2.4	14	22
VLZN-11-6 RA	< 0.01	39	0.4	< 0.01	2.3	14	22
VLZN-11-7 FA	< 0.01	30	0.1	< 0.01	1.4	1.9	8.9
VLZN-11-7 RA	< 0.01	31	0.2	< 0.01	1.4	2.2	9.1
VLZN-11-8 FA	< 0.01	31	0.27	< 0.01	1.5	8.6	14
VLZN-11-8 RA	< 0.01	30	0.21	< 0.01	1.5	8.5	14
VLZN-11-9 FA	< 0.01	38	0.2	< 0.01	1.4	1.7	6.4
VLZN-11-9 RA	< 0.01	38	0.2	< 0.01	1.4	1.8	6.8
VLZN-12-3 FA	< 0.01	26	0.2	< 0.02	4.8	3.4	8.2
VLZN-12-3 RA	< 0.01	26	0.2	< 0.02	4.8	3.8	9
VLZN-13-4 FA	< 0.01	31	0.08	< 0.01	1.9	0.2	0.98
VLZN-13-4 RA	< 0.01	32	0.2	< 0.01	1.8	0.2	1.3
VLZN-13-5 FA	< 0.01	45	0.2	< 0.01	1.3	0.1	3.7
VLZN-13-5 RA	< 0.01	47	0.3	< 0.01	1.4	0.1	4
VLZN-13-6 FA	< 0.01	26	<0.05	< 0.01	2.2	0.03	1.7
VLZN-13-6 RA	< 0.01	32	0.06	< 0.01	2.2	0.04	3.3
VLZN-13-7 FA	< 0.01	15	<0.05	< 0.01	1.9	<0.02	0.58
VLZN-13-7 RA	< 0.01	17	<0.05	< 0.01	1.9	0.03	1.2
VLZN-13-8 FA	< 0.01	26	0.06	< 0.01	2.0	0.05	0.58
VLZN-13-8 RA	< 0.01	28	<0.05	< 0.01	2.0	0.06	0.99
VLZN-13-9 FA	< 0.01	26	0.06	< 0.01	2.0	0.03	1.3
VLZN-13-9 RA	< 0.01	32	0.1	< 0.01	2.2	0.06	3.1

APPENDIX 4 (cont.): WATER QUALITY DATA

Field No.	ICPMS Co µg/L	ICPMS Cr µg/L	ICPMS Cs µg/L	ICPMS Cu µg/L	ICPMS Dy µg/L	ICPAES Fe mg/L	ICPMS Er µg/L
VLZN-11-2 FA	230	<100		2800	3	106.00	2
VLZN-11-2 RA	250	<100		3700	3	104.54	1
VLZN-11-3 FA	32	<1	< 0.01	140	0.82	6.20	0.34
VLZN-11-3 RA	32	<1	< 0.01	150	0.81	6.20	0.36
VLZN-11-4 FA	17	<1	< 0.01	88	0.5	7.40	0.23
VLZN-11-4 RA	17	<1	< 0.01	87	0.51	7.80	0.22
VLZN-11-5 FA	8.1	1	< 0.01	95	0.39	3.40	0.17
VLZN-11-5 RA	8.5	1	< 0.01	100	0.44	3.70	0.19
VLZN-11-6 FA	63	1	0.04	380	0.86	22.00	0.36
VLZN-11-6 RA	65	1	0.04	390	0.86	23.00	0.35
VLZN-11-7 FA	12	<1	< 0.01	48	0.4	2.30	0.16
VLZN-11-7 RA	12	<1	< 0.01	52	0.43	2.40	0.18
VLZN-11-8 FA	24	<1	< 0.01	160	0.61	5.70	0.27
VLZN-11-8 RA	24	<1	< 0.01	150	0.61	5.70	0.26
VLZN-11-9 FA	11	<1	< 0.01	38	0.28	1.90	0.14
VLZN-11-9 RA	11	<1	< 0.01	38	0.31	2.80	0.14
VLZN-12-3 FA	39	<1	0.01	59	0.28	20.00	0.13
VLZN-12-3 RA	42	<1	0.01	74	0.33	20.00	0.14
VLZN-13-4 FA	2.2	<1	< 0.01	19	0.054	0.63	0.03
VLZN-13-4 RA	2.2	<1	< 0.01	6	0.057	0.85	0.03
VLZN-13-5 FA	1.6	<1	< 0.01	6	0.2	0.92	0.12
VLZN-13-5 RA	1.7	<1	0.03	7	0.24	1.10	0.11
VLZN-13-6 FA	1.9	<1	< 0.01	8	0.066	1.40	0.04
VLZN-13-6 RA	2.1	<1	0.01	3	0.13	3.80	0.062
VLZN-13-7 FA	0.54	<1	< 0.01	0.9	0.02	0.73	0.01
VLZN-13-7 RA	0.52	<1	< 0.01	1	0.04	2.00	0.02
VLZN-13-8 FA	1.1	<1	< 0.01	2	0.03	1.00	0.02
VLZN-13-8 RA	1	<1	< 0.01	3	0.04	2.10	0.03
VLZN-13-9 FA	2.8	<1	< 0.01	4	0.06	1.90	0.04
VLZN-13-9 RA	3.2	<1	< 0.01	6	0.12	7.40	0.068

APPENDIX 4 (cont.): WATER QUALITY DATA

Field No.	ICPMS Eu µg/L	ICPMS Ga µg/L	ICPMS Gd µg/L	ICPMS Ge µg/L	ICPMS Ho µg/L	ICPMS In µg/L	ICPAES K mg/L
VLZN-11-2 FA	1		6.4		0.7	< 1	1.4
VLZN-11-2 RA	2		5.8		0.9	1	1.4
VLZN-11-3 FA	0.26	< 0.02	0.99	< 0.02	0.15	0.02	2.3
VLZN-11-3 RA	0.27	< 0.02	1	< 0.02	0.14	0.02	2.4
VLZN-11-4 FA	0.16	< 0.02	0.85	< 0.02	0.094	0.01	1.6
VLZN-11-4 RA	0.16	< 0.02	0.82	< 0.02	0.094	0.01	1.6
VLZN-11-5 FA	0.12	0.02	0.51	< 0.03	0.071	< 0.01	1.3
VLZN-11-5 RA	0.13	0.03	0.61	< 0.03	0.088	0.01	1.4
VLZN-11-6 FA	0.27	0.06	1.4	0.04	0.12	0.1	2.4
VLZN-11-6 RA	0.27	0.07	1.4	< 0.02	0.12	0.1	2.4
VLZN-11-7 FA	0.13	< 0.02	0.59	< 0.02	0.069	< 0.01	2.5
VLZN-11-7 RA	0.13	< 0.02	0.62	< 0.02	0.069	< 0.01	2.6
VLZN-11-8 FA	0.2	< 0.02	1	< 0.02	0.11	0.03	1.9
VLZN-11-8 RA	0.21	< 0.02	0.99	< 0.02	0.11	0.03	1.9
VLZN-11-9 FA	0.091	< 0.02	0.48	< 0.02	0.05	< 0.01	1.8
VLZN-11-9 RA	0.095	< 0.02	0.45	< 0.02	0.053	< 0.01	1.8
VLZN-12-3 FA	0.1	0.04	0.41	< 0.02	0.052	0.01	3.5
VLZN-12-3 RA	0.12	0.04	0.45	< 0.02	0.058	0.02	3.5
VLZN-13-4 FA	0.02	< 0.02	0.068	< 0.02	0.01	< 0.01	1.8
VLZN-13-4 RA	0.02	< 0.02	0.08	< 0.02	0.01	< 0.01	1.7
VLZN-13-5 FA	0.065	0.02	0.23	< 0.03	0.04	< 0.01	1.3
VLZN-13-5 RA	0.059	0.04	0.22	< 0.03	0.04	< 0.01	1.3
VLZN-13-6 FA	0.02	< 0.02	0.089	< 0.02	0.01	< 0.01	2.7
VLZN-13-6 RA	0.03	0.05	0.13	< 0.02	0.02	< 0.01	2.7
VLZN-13-7 FA	0.008	< 0.02	0.03	< 0.02	0.005	< 0.01	1.9
VLZN-13-7 RA	0.01	< 0.02	0.059	< 0.02	0.008	< 0.01	2.0
VLZN-13-8 FA	0.006	< 0.02	0.03	< 0.02	0.005	< 0.01	2.2
VLZN-13-8 RA	0.01	0.03	0.053	< 0.02	0.009	< 0.01	2.3
VLZN-13-9 FA	0.02	< 0.02	0.07	< 0.02	0.01	< 0.01	1.4
VLZN-13-9 RA	0.04	0.03	0.15	< 0.02	0.02	< 0.01	1.5

APPENDIX 4 (cont.): WATER QUALITY DATA

Field No.	ICPMS La µg/L	ICPAES Mg mg/L	ICPMS Mn µg/L	ICPMS Mo µg/L	ICPAES Na mg/L	ICPMS Nd µg/L	ICPMS Ni µg/L
VLZN-11-2 FA	40	14.9	2400	< 2	<1	42	50
VLZN-11-2 RA	40	14.9	2400	< 2	1.1	46	60
VLZN-11-3 FA	8.3	2.5	710	< 0.02	2.0	7	6.4
VLZN-11-3 RA	8.4	2.6	720	0.04	2.3	7	7.2
VLZN-11-4 FA	5.4	2.0	390	0.03	2.6	4.5	3.8
VLZN-11-4 RA	5.3	2.1	400	0.03	2.7	4.5	3.8
VLZN-11-5 FA	3.2	1.2	240	0.06	1.9	3.4	2.4
VLZN-11-5 RA	3.7	1.2	250	0.06	1.9	3.5	2.6
VLZN-11-6 FA	10	5.2	1200	< 0.02	2.0	9.9	15
VLZN-11-6 RA	10	5.1	1200	0.02	2.0	9.8	16
VLZN-11-7 FA	4.2	2.0	580	< 0.02	2.0	3.6	3.1
VLZN-11-7 RA	4.2	2.0	570	0.02	2.1	3.9	4
VLZN-11-8 FA	6.7	2.4	480	0.06	2.6	6	5.4
VLZN-11-8 RA	6.6	2.4	470	0.07	2.7	6	5.3
VLZN-11-9 FA	3.2	1.6	490	< 0.02	2.2	2.6	2.4
VLZN-11-9 RA	3.3	1.5	490	< 0.02	2.2	2.7	2.5
VLZN-12-3 FA	2.8	6.5	2000	< 0.02	1.5	2.9	8.2
VLZN-12-3 RA	3.1	6.6	2000	0.02	1.5	3.2	8.8
VLZN-13-4 FA	0.4	1.4	120	0.1	4.7	0.38	0.8
VLZN-13-4 RA	0.4	1.2	130	0.1	4.4	0.46	0.8
VLZN-13-5 FA	1.3	0.9	99	0.1	2.5	1.4	1
VLZN-13-5 RA	1.5	1.0	100	0.09	2.6	1.7	1
VLZN-13-6 FA	0.57	1.2	160	0.1	2.6	0.58	1
VLZN-13-6 RA	1.1	1.2	170	0.06	2.4	1	1
VLZN-13-7 FA	0.2	1.2	92	0.1	3.3	0.2	0.3
VLZN-13-7 RA	0.3	1.2	97	0.07	3.4	0.33	0.4
VLZN-13-8 FA	0.2	1.4	130	0.04	4.6	0.2	0.5
VLZN-13-8 RA	0.3	1.4	120	0.04	4.5	0.33	0.6
VLZN-13-9 FA	0.4	1.3	300	0.07	3.6	0.39	0.8
VLZN-13-9 RA	0.91	1.4	370	0.08	3.6	0.93	1.1

APPENDIX 4 (cont.): WATER QUALITY DATA

Field No.	ICPMS P µg/L	ICPMS Pb µg/L	ICPMS Pr µg/L	ICPMS Rb µg/L	ICPMS Re µg/L	ICPMS Sb µg/L	ICPMS Se µg/L
VLZN-11-2 FA	< 2000	1600	10	20		<2	< 20
VLZN-11-2 RA	< 2000	1600	10	20		<2	< 20
VLZN-11-3 FA	< 1	390	1.9	7.5	< 0.02	<0.03	< 0.2
VLZN-11-3 RA	< 1	390	1.9	7.6	< 0.02	<0.03	< 0.2
VLZN-11-4 FA	< 1	180	1.3	3.9	< 0.02	0.03	< 0.2
VLZN-11-4 RA	< 1	180	1.3	3.8	< 0.02	<0.02	< 0.2
VLZN-11-5 FA	5	190	0.88	3.7	< 0.02	0.31	< 0.2
VLZN-11-5 RA	7	210	0.98	3.9	< 0.02	0.08	0.2
VLZN-11-6 FA	< 3	510	2.3	14	< 0.02	0.04	0.4
VLZN-11-6 RA	< 3	530	2.3	14	< 0.02	0.05	0.4
VLZN-11-7 FA	< 2	180	1	9	< 0.02	<0.02	< 0.2
VLZN-11-7 RA	< 2	190	1.1	9.5	< 0.02	<0.02	< 0.2
VLZN-11-8 FA	< 1	330	1.7	5.7	< 0.02	<0.02	< 0.2
VLZN-11-8 RA	20	330	1.7	5.7	< 0.02	0.03	< 0.2
VLZN-11-9 FA	4	130	0.71	6.4	< 0.02	0.04	< 0.2
VLZN-11-9 RA	6	140	0.75	6.5	< 0.02	0.04	< 0.2
VLZN-12-3 FA	< 1	140	0.75	14	< 0.02	0.04	0.3
VLZN-12-3 RA	< 1	210	0.85	14	< 0.02	<0.03	0.3
VLZN-13-4 FA	3.3	7.1	0.09	2.1	< 0.02	0.2	< 0.2
VLZN-13-4 RA	3.9	10	0.1	2.2	< 0.02	0.05	< 0.2
VLZN-13-5 FA	10	24	0.37	2.9	< 0.02	0.26	0.3
VLZN-13-5 RA	13	28	0.42	3.1	< 0.02	0.076	0.3
VLZN-13-6 FA	26	2.3	0.1	4.8	< 0.02	4.2	< 0.2
VLZN-13-6 RA	65	6.3	0.24	5	< 0.02	0.06	< 0.2
VLZN-13-7 FA	8	0.79	0.04	3.4	< 0.02	0.3	< 0.2
VLZN-13-7 RA	27	2.1	0.09	3.4	< 0.02	0.02	< 0.2
VLZN-13-8 FA	17	1.8	0.05	3.4	< 0.02	0.3	< 0.2
VLZN-13-8 RA	30	4.1	0.08	3.5	< 0.02	0.1	< 0.2
VLZN-13-9 FA	20	3	0.1	3.1	< 0.02	0.62	< 0.2
VLZN-13-9 RA	51	11	0.24	3.4	< 0.02	0.2	< 0.2

APPENDIX 4 (cont.): WATER QUALITY DATA

Field No.	ICPMS SiO_2 mg/L	ICPMS Sm µg/L	ICPMS Sr µg/L	ICPMS Tb µg/L	ICPMS Th µg/L	ICPMS Tl µg/L	ICPMS Tm µg/L
VLZN-11-2 FA	< 50	9	< 8	0.8		<5	< 0.5
VLZN-11-2 RA	< 50	7	< 8	0.8		<5	< 0.5
VLZN-11-3 FA	13	1.4	9	0.15	0.057	<0.1	0.05
VLZN-11-3 RA	13	1.3	9.5	0.15	0.052	<0.1	0.05
VLZN-11-4 FA	11	0.88	7.8	0.11	0.03	<0.05	0.03
VLZN-11-4 RA	10	0.87	7.6	0.1	0.05	<0.05	0.03
VLZN-11-5 FA	8.2	0.66	9	0.069	0.12	<0.05	0.02
VLZN-11-5 RA	8.5	0.8	9.2	0.084	0.13	<0.05	0.03
VLZN-11-6 FA	18	1.6	11	0.15	0.42	0.09	0.04
VLZN-11-6 RA	18	1.6	11	0.15	0.46	0.09	0.05
VLZN-11-7 FA	14	0.69	8.9	0.079	< 0.01	<0.05	0.02
VLZN-11-7 RA	13	0.68	9.2	0.086	< 0.01	<0.05	0.03
VLZN-11-8 FA	13	1.1	8.1	0.13	0.05	<0.05	0.04
VLZN-11-8 RA	13	1.2	8.2	0.12	0.03	<0.05	0.04
VLZN-11-9 FA	15	0.49	8.7	0.059	< 0.02	<0.05	0.02
VLZN-11-9 RA	15	0.5	8.9	0.059	< 0.02	<0.05	0.02
VLZN-12-3 FA	12	0.6	16	0.054	0.07	<0.1	0.02
VLZN-12-3 RA	12	0.64	17	0.059	0.092	<0.1	0.02
VLZN-13-4 FA	13	0.07	9.7	0.009	0.04	<0.05	< 0.005
VLZN-13-4 RA	13	0.08	10	0.01	0.02	<0.05	0.005
VLZN-13-5 FA	5.4	0.32	8.9	0.04	0.16	<0.05	0.02
VLZN-13-5 RA	5.6	0.34	9	0.04	0.097	<0.05	0.02
VLZN-13-6 FA	11	0.08	12	0.01	0.05	<0.05	< 0.005
VLZN-13-6 RA	12	0.2	12	0.02	0.1	<0.05	0.008
VLZN-13-7 FA	15	0.03	11	< 0.005	< 0.01	<0.05	< 0.005
VLZN-13-7 RA	15	0.06	11	0.008	< 0.01	<0.05	< 0.005
VLZN-13-8 FA	15	0.05	12	0.006	< 0.02	<0.05	< 0.005
VLZN-13-8 RA	16	0.07	12	0.009	< 0.02	<0.05	< 0.005
VLZN-13-9 FA	14	0.09	12	0.01	0.05	<0.05	0.005
VLZN-13-9 RA	14	0.2	13	0.02	0.14	<0.05	0.009

APPENDIX 4 (cont.): WATER QUALITY DATA

Field No.	ICPMS U µg/L	ICPMS V µg/L	ICPMS W µg/L	ICPMS Y µg/L	ICPMS Yb µg/L	ICPMS Zn µg/L
VLZN-11-2 FA	4	<20	< 2		2	27000
VLZN-11-2 RA	4	<20	< 2		1	27000
VLZN-11-3 FA	0.32	<0.1	< 0.02	3.7	0.27	3200
VLZN-11-3 RA	0.32	0.1	< 0.02	3.8	0.26	3200
VLZN-11-4 FA	0.15	<0.1	0.04	2.4	0.2	2000
VLZN-11-4 RA	0.15	0.1	0.03	2.4	0.2	2000
VLZN-11-5 FA	0.17	0.54	0.03	1.7	0.2	1300
VLZN-11-5 RA	0.2	0.76	0.04	1.9	0.2	1400
VLZN-11-6 FA	0.69	0.2	< 0.02	6.2	0.28	8100
VLZN-11-6 RA	0.71	0.3	< 0.02	6.4	0.29	8200
VLZN-11-7 FA	0.1	<0.1	< 0.02	1.8	0.1	1600
VLZN-11-7 RA	0.11	<0.1	< 0.02	1.8	0.2	1600
VLZN-11-8 FA	0.28	<0.1	0.03	3.1	0.21	3000
VLZN-11-8 RA	0.28	<0.1	0.03	3	0.21	3000
VLZN-11-9 FA	0.08	<0.2	< 0.02	1.4	0.1	1000
VLZN-11-9 RA	0.08	<0.2	< 0.02	1.5	0.1	990
VLZN-12-3 FA	0.19	<0.1	< 0.02	1.3	0.1	6300
VLZN-12-3 RA	0.23	0.1	< 0.02	1.5	0.1	6600
VLZN-13-4 FA	0.03	0.3	0.05	0.3	0.02	85
VLZN-13-4 RA	0.03	0.47	0.04	0.3	0.02	86
VLZN-13-5 FA	0.09	0.73	< 0.02	0.95	0.1	31
VLZN-13-5 RA	0.1	1	< 0.02	0.97	0.09	30
VLZN-13-6 FA	0.04	0.69	< 0.02	0.55	0.02	21
VLZN-13-6 RA	0.08	2.3	< 0.02	0.92	0.05	20
VLZN-13-7 FA	0.02	0.3	0.04	0.1	< 0.01	8
VLZN-13-7 RA	0.03	1	0.03	0.2	0.02	8
VLZN-13-8 FA	0.02	0.3	< 0.02	0.1	0.01	31
VLZN-13-8 RA	0.03	0.72	< 0.02	0.2	0.02	34
VLZN-13-9 FA	0.04	0.7	< 0.02	0.3	0.03	20
VLZN-13-9 RA	0.07	2.5	< 0.02	0.6	0.06	20