Ecological Impact Assessment, Faro Mine, Yukon

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EXECUTIVE SUMMARY

The Faro Mine complex (Faro complex), near Faro, Yukon, includes the Faro Mine and Mill (Faro site) and Vangorda/Grum Mines (Vangorda site), which are located approximately 12 km apart. The complex was formerly owned by the Anvil Range Mining Corporation and produced lead and zinc concentrates to be extracted for lead, zinc, silver and gold. The Faro site was mined between 1969 and 1992, while the Grum and Vangorda sites were active between 1986 and 1998. All operations were terminated in April 1998, due to poor economic circumstances and projections, and the site went into receivership. Since then, management of the mine property has been under the direction of Deloitte and Touche Inc., acting as the court appointed Interim Receiver (the “Interim Receiver”).

An ecological impact assessment was conducted to compile, assess, and integrate the results of the various aquatic receiving environment monitoring activities at the Faro Mine complex over time. This will provide important information for the long-term monitoring program design and serve as a key supporting document for other initiatives related to development of a closure plan for the Faro Mine complex. The study included evaluations of water and sediment quality data, benthic invertebrate communities, fish communities, and fish tissue residues for the Rose/Anvil and Vangorda Creek systems downstream of the mine sites.

Water Quality Data

All water quality data were downloaded from the water quality database developed and managed for the Faro Mine complex by Gartner Lee Limited. At the time the data were downloaded, sample results were available for the period up to June 2006. Water quality data for 25 stations were analyzed in detail, included stations located on permanent surface water courses located upstream (reference/background) and downstream (exposed) of mine-related disturbances or inputs (e.g., roads, rock piles, pits, etc.). All stations for which other types of data were known to exist (e.g., sediment chemistry or benthic community composition) were included. Analytical data for most of the selected stations dated back to the mid-1980’s, except for Station X14 (immediately downstream of the Rose Creek Diversion), where data was available since 1975. In total, analytical results for more than 2,000 samples were examined as part of the water quality assessment.

Sulphate, hardness, conductivity, manganese, magnesium, calcium, strontium, sodium, and uranium were the parameters most often elevated in Rose and Vangorda Creeks relative to upstream reference stations. Therefore, these parameters are most appropriate for evaluating the current influence on surface water quality downstream of the Faro Mine complex (i.e., "mine indicators"). Strong statistical correlations were evident among almost all the mine-indicator parameters. Mine-related influence on water quality was evident at the most downstream monitoring stations in both the Rose/Anvil (R5) and Vangorda (V8) watersheds, based on elevated mean concentrations and higher percentage of samples exceeding background concentrations for mine indicator parameters. This does not necessarily indicate that effects on biota may be expected; no Canadian Water Quality Guidelines (CWQGs) exist for any of the mine-indicators, based on the lower aquatic toxicity of these substances relative to most of those having a CWQG.

Reference station data were sparse or associated with inadequate method detection limits (MDLs) for many substances, including many for which a CWQG exists (e.g., As, Cd, Cr, Hg, Se, Ag, Tl). The percentage of mine-exposed samples containing iron, aluminum, copper, zinc, and lead was slightly greater than for reference stations (background), although most samples were less than CWQG in both areas. Low aqueous concentrations of ammonia, arsenic, chromium, mercury, molybdenum, nickel, selenium, and thallium at mine-exposed stations suggest that these substances do not likely pose a risk to aquatic biota downstream of the Faro Mine complex at the present time. MDLs for cadmium and silver were too high to allow for definitive conclusions with respect to these substances.

Sediment Quality

Sediment quality sampling has been conducted in the Rose-Anvil and Vangorda Creek systems since as early as 1973 and 1991, respectively. Some study-to-study variability has occurred in terms of precise sampling station locations, laboratory equipment/techniques as well as the metal parameters reported. However, in general, the sediment chemistry results were reasonably comparable among studies. Typically fine-grained sediment samples were collected in triplicate from streambed deposits using a trowel or shovel, then placed into glass jars, refrigerated and shipped to a preferred laboratory for analysis of total metals.

The data indicated that sediment metal concentrations were significantly elevated in Rose Creek relative to background benchmarks (e.g., arsenic, cobalt, copper, iron, lead, manganese, mercury, nickel zinc) with elevations of some metals such as manganese, lead, and zinc levels extending further downstream into Anvil Creek (i.e., Stations A4 and A3). Arsenic, lead and zinc were observed at concentrations above Canadian Sediment Quality Guideline (CSQG) Probable Effect Levels (PEL), suggesting some potential to adversely affect aquatic life. These three metals and manganese can be considered the strongest indicators of influence from the Faro site on sediment chemistry (i.e., "mine indicators"). There was no evidence of substantial tailings remnants in the channels of Rose or Anvil Creeks associated with a winter (over-ice) tailings spill which occurred in 1975, although deposits are still evident in the floodplain. Sediment metal concentrations in North Fork Rose Creek were also significantly higher at mine-influenced station R8 relative to the upstream reference station R7, although sediment metal levels at R8 were within reference benchmarks levels suggesting only a minor mine-effect. Although temporal comparison of the Rose-Anvil historical sediment chemistry data may have been confounded by differences in laboratory equipment/techniques from study to study, the data suggested that sediment metal concentrations in the Rose-Anvil system have decreased slightly over the period from 1973 to 2006.

In the Vangorda Creek system, sediment metal concentrations were significantly elevated at Station V27 the nearest downstream station to the Grum and Vangorda mines. Statistical evaluation of the historical data identified that the key indicators of mine influence on sediment chemistry were arsenic, lead and zinc, which were the only metals observed at concentrations above CSQG PEL. Sediment chemistry differed between West Fork/lower Vangorda Creek versus upper Vangorda Creek, possibly reflecting natural variability in the various drainages or other upstream mine influences (roads, waste rock drainage). High natural variability in sediment chemistry was also observed among reference areas in the Rose-Anvil system. In lower Vangorda Creek (V8), sediment metal concentrations were intermediate between the West Fork and upper Vangorda Creek watercourses. Sediment lead and zinc concentrations, likely originating from upper Vangorda Creek, were elevated relative to reference, whereas calcium and strontium, likely originating from the West Fork, were also elevated. Of these, only sediment lead concentrations exceeded the PEL at V8. Temporal comparison of Vangorda sediment data suggested substantially lower metal concentrations at the near-field (V27) location in 2005, whereas metal concentrations at the West Fork and lower Vangorda showed slower temporal decreases.

Benthic Invertebrate Communities

Benthic invertebrate sampling was initiated at some stations in 1973 within the Rose/Anvil Creek system and in 1975 within the Vangorda Creek system. From 1991 on, benthic invertebrate population monitoring has been conducted at standardized station locations every second year as per the requirements of the water licenses (alternating between Rose and Vangorda Creeks). Artificial substrates were used for the majority of studies, providing some consistency across much of the data set, although sample/data analysis varied in terms of factors such as numbers of replicate samples and levels of taxonomic identifications. Furthermore, much of the data were not available in electronic format, so detailed statistical analyses were undertaken for this report only for studies conducted since 2000. The results of previous surveys (1973-1999) were also reviewed and discussed, with comparisons of mean benthic invertebrate abundance and number of taxa where methodologies were sufficiently similar to make such comparisons valid

Consistent with previous studies, detailed analysis of data from even years between 2000 and 2006 confirmed that benthic invertebrate communities downstream of the Faro mine (e.g., R2-R4) showed some differences from reference communities (e.g., R6, R7 and minimally impacted R1). However, such differences were not always consistent with those typically associated with effluent impacts (e.g., higher percentage of sensitive EPT taxa downstream than at reference areas). Overall, it appears that temporal variability has played as large a role as relative station location in structuring benthic communities in Rose Creek, at least in recent years.

Detailed analysis of data from 2001, 2003 and 2005 surveys revealed significant differences in benthic community composition between the reference station V1 and the exposure station V27, which are located immediately upstream and downstream of the Grum/Vangorda site, respectively. However, the nature of such differences may be attributable to habitat differences rather than mine-related effects, based on a higher proportion of EPT, which are often considered sensitive to pollution, at near-field exposure station V27 than at reference station V1. Highest numbers of taxa were found at stations V5 (West Fork Vangorda) and V8 (lower Vangorda) compared to V1 and V27 (upper Vangorda), and some differences in community composition were also evident between these two groups of stations, although none that appeared to be associated with mine-related influences. These and previous surveys have shown that mean benthic invertebrate abundance and taxon richness varies considerably among both stations and years.

Overall, mine-related influences on benthic invertebrate communities, if any, appeared to be minor.

Fish

Fish surveys have been conducted in the Rose-Anvil and Vangorda Creek systems since as early as the mid-1970s. These surveys have focused on fish habitat and/or community characterization, fish production and/or quantification of fish tissue metal concentrations. Despite a relatively high number of studies (approximately 10) conducted in each system over the period from 1974 to 2005, very few consistencies were maintained among studies in terms of station location, sampling frequency, tissues sampled (fish species and tissue type) and/or study objectives. This report focussed on fish community and fish tissue chemistry data collected most consistently over this time period.

The data suggested that fish community diversity and density at areas downstream of mine operations in the Rose-Anvil and Vangorda Creek systems were generally greater than, or comparable to, respective reference area values, and that the mine sites have not adversely affected fish populations. Temporal analysis of the historical fish catch data suggested that, with the presence of Chinook salmon, Rose Creek species diversity may have increased since the late 1970s, whereas no obvious changes in fish diversity or density were observed at lower Vangorda Creek.

Tissue metal concentrations suggested that mining activities have had only very minor influence on the quality of fish tissue in the Rose-Anvil and Vangorda Creek systems, with no clear temporal trends suggested by the available data. Concentrations of cadmium, copper, manganese and zinc were well below human and wildlife consumption benchmarks since the late 1970s in both the Rose-Anvil and Vangorda Creek systems. Although arsenic, lead and mercury tissue metal levels have occasionally exceeded respective consumption benchmark levels (most notably in 1992 and 1997), similar concentrations observed in reference samples and widely variable survey-to-survey tissue concentrations suggested that tissue metal levels may be higher naturally and/or that differing analytical laboratory techniques among studies may have contributed to the apparently high values.

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1.0 INTRODUCTION

1.1 Background

The Faro Mine complex (Faro complex), near Faro, Yukon, includes two mines: the Faro Mine and Mill (Faro site) and Vangorda/Grum Mines (Vangorda site), which are located approximately 12 km apart (Figure 1.1). The complex was formerly owned by the Anvil Range Mining Corporation and produced lead and zinc concentrates to be extracted for lead, zinc, silver and gold. The Faro site was mined between 1969 and 1992[1], while the Grum and Vangorda sites were active between 1986 and 1998. All operations were terminated in April 1998, due to poor economic circumstances and projections, and the site went into receivership. Since then, management of the mine property has been under the direction of Deloitte and Touche Inc., acting as the court appointed Interim Receiver (the "Interim Receiver").

The Faro Mine Closure Office (FMCO) was instated to act on behalf of the federal and Yukon governments, Selkirk First Nation and Ross River Dena Council to work towards the preparation of a comprehensive closure plan for the abandoned Faro Mine complex. Before the closure plan can be implemented, it will be subject to regulatory assessment and approval processes. The plan requires regulatory approval in the form of a water license issued under the *Waters Act* by the Yukon Water Board and will need to be acceptable to relevant government agencies, the First Nations and the public. The assessment process will be carried out through the Yukon Environmental and Socio-Economic Assessment Board under the *Yukon Environmental and Socio-Economic Assessment Act* (YESAA).

Technical studies conducted at the site, which are nearing completion, have indicated that acidification and leaching processes have the potential to result in dramatic increases in metal loadings to surface waters downstream of the Faro mine sites over the next several to many decades (SRK 2004, 2005). Consequently, the closure process is proceeding to the regulatory and development assessment phases with considerable focus on identifying the mitigation measures required to protect the aquatic ecosystem downstream of the mines. Related to this, the FMCO has elected to carry out a detailed and objective study to identify the requirements of a comprehensive, consolidated, and rational site-wide environmental monitoring program. Such a program will need to meet the needs of the development assessment and regulatory processes in the short-term and provide adequate information to guide closure planning activities and evaluate performance in the long-term.

[1] Milling continued at Faro until shutdown of the entire operation in 1998.

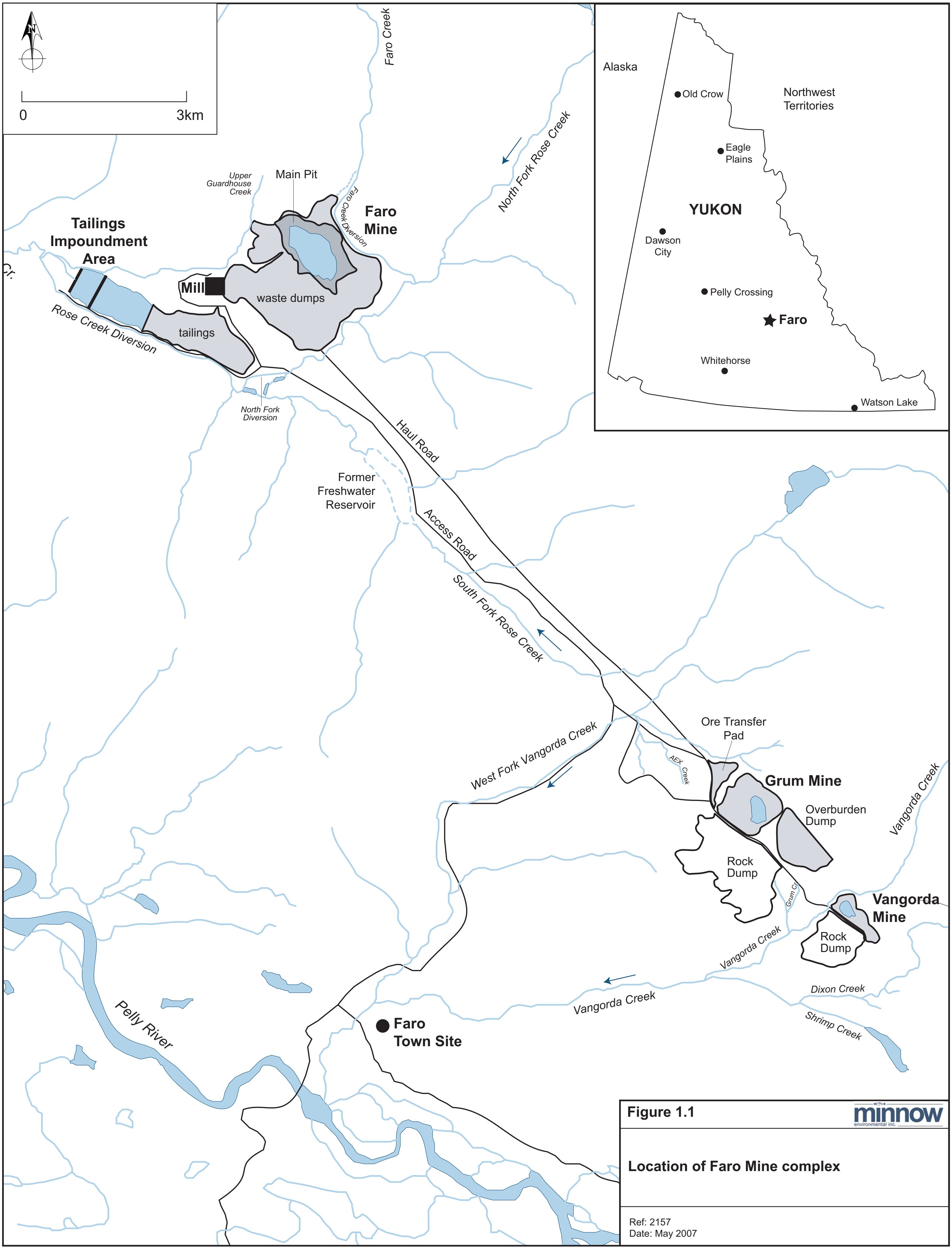


Figure 1.1

Location of Faro Mine complex

Development of a long-term environmental monitoring strategy for the closed Faro Mine complex will depend to a large extent on the results of environmental monitoring conducted during and since the termination of mine operations. Such monitoring data can be used to identify the spatial extent of historical and current mine influence in the aquatic environments receiving effluents and groundwater affected by historical mining activities. Although water and biological monitoring activities continue to be carried out at the site, and the monitoring data have been summarized and discussed in various consultant reports, many studies have lacked rigorous quantitative evaluation of spatial and temporal patterns of mine influence. Therefore, it was identified that, prior to developing rationales for the locations of long-term monitoring stations and identifying appropriate monitoring parameters and sampling frequencies, it would be necessary to complete an ecological impact assessment study based on the data collected in previous studies at the Faro Mine complex.

1.2 Study Objectives

The ecological impact assessment was conducted to compile, assess, and integrate the results of the various aquatic receiving environment monitoring activities at the Faro Mine complex over time. This will provide important information for the long-term monitoring program design. The report will also serve as a key supporting document for other Faro initiatives, such as preparation of the Closure Plan and the development of site-specific water quality objectives.

1.3 Report Organization

Section 2.0 describes the type and sources of historical data evaluated in this study, as well as the approaches used for data analysis. The assessments of water and sediment quality data are presented in Sections 3.0 and 4.0, respectively. Benthic and fish community data are presented in Sections 5.0 and 6.0, respectively. The results and conclusions of the ecological impact assessment are summarized in Section 7.0, with recommendations for future monitoring presented in Section 8.0. References cited throughout the report are listed in Section 9.0.

2.0 METHODS

All water quality data were downloaded from the water quality database developed and managed for the Faro Mine complex by Gartner Lee Limited. At the time the data were downloaded, sample results were available for the period up to June 2006. Other types of information and data were taken from study reports that have been prepared by consultants and government scientists (Table 2.1).

2.1 Water Quality Analysis

Water quality data were available for more than 100 surface water monitoring locations in the vicinity of the Faro Mine complex. Many stations were monitored infrequently, for short durations, and/or have not been monitored in recent years. To comprehensively characterize surface water quality in the Rose/Anvil and Vangorda Creek systems, while maintaining a manageable dataset for analyses, a subset of 19 mine-exposed or potentially-disturbed stations and six reference stations was used for detailed analysis (Table 2.2 and Figure 2.1). These included stations located on permanent surface water courses located upstream (reference/background) and downstream (exposed) of mine-related disturbances or inputs (e.g., roads, rock piles, pits, etc.). All stations for which other types of data were known to exist (e.g., sediment chemistry or benthic community composition) were included. Analytical data for most of the selected stations dated back to the mid-1980's, except for Station X14 (immediately downstream of the Rose Creek Diversion), where data was available since 1975. In total, analytical results for more than 2,000 samples were examined as part of the water quality assessment.

Along with general water chemistry parameters (e.g., alkalinity, pH, conductivity, sulphate, etc.), both total and dissolved concentrations of a variety of metals have been measured in water samples, although the suite of analyses applied to samples has varied within and among stations over time. In total, analytical results were available for 96 parameters. A variety of approaches were taken, as described below, to identify the parameters most strongly associated with mine influence on water quality and to analyze the magnitude, variability, and spatial extent of mine-related influence.

GLL (2005b) reported that copper concentrations at reference stations were relatively stable (and low) until the mid-1990s after which they increased by approximately one order of magnitude. GLL (2005b) also reported that, in the spring of 2004 and for the remainder of the year, copper concentrations dropped again (typically to <0.001 mg/L at reference staitons), corresponding to a change in analytical laboratory. An investigation ensued, involving interlaboratory sample comparisons (Gomm 2005). It was confirmed that the

Table 2.1: Historical reports reviewed for Faro Mine ecological impact assessment

Author	Report Year	Title
Access Consulting Group, Laberge Environmental Services, and White Mountain Environmental Consulting	2005	Pelly River Aquatic Effects Assessment – 2004.
Access Consulting Group, Laberge Environmental Services, and White Mountain Environmental Consulting	2006	Pelly River Aquatic Effects Assessment – 2005.
Baker, S.A.	1979	Environmental Quality of Rose Creek as Affected by Cyprus Anvil Mining Corporation Ltd. (Survey Data from 1974, 1975 and 1976). Department of Environment, Environmental Protection Service. Regional Program Report No. 79-25
Burns, B.	1989	Biological Monitoring at Blind, Vangorda and Anvil Creeks, 1988
Burns, B.	1989	Biological Monitoring at Curragh Resources Inc., 1988.
Burns, B.	1991, 1994, 1997, 1999, 2001, 2002, 2004, 2006?	Biological Monitoring Program at Rose and Anvil Creeks, Y.T., 1990, 1994, 1996, 1998, 2000, 2002, 2004, 2006
Burns, B.	1991, 1993, 1996, 1998, 2000, 2001, 2003, 2005	Biological Monitoring Program at Vangorda Creek, Y.T. 1991, 1993, 1995, 1997, 1999, 2001, 2003, 2005
Davidge, D.	1996	A Report on the Suspended Sediment and Heavy Metals Loading in Vangorda Creek Downstream of the Vangorda Mine Stie Near Faro, Yukon During Spring Freshet 1991, 1992 and 1993. Environment Canada, Environmental Protection Service. Regional Program Report No. 95-09
Gartner Lee Limited	2002	Anvil Range Mine Complex 2002 Baseline Environmental Information
Gartner Lee Limited	2003	2004-2008 Water Licence Renewal - Environmental Assessment Report. Volume II: Description of the Existing Environment
Gartner Lee Limited	2005	Anvil Range Site Derivation of Preliminary Water Quality Objectives – Draft Report
Gartner Lee Limited	2005	Anvil Range Mine Complex 2004 Annual Environmental Report
Gartner Lee Limited	2006	Anvil Range Mine Complex 2005 Annual Environmental Report
Gartner Lee Limited	2006	Technical Summary – Derivation of Preliminary Site Specific Water Quality Objectives for Zinc for the Anvil Range Mine Site.
Godin, B., and T. Osler	1985	Environmental Quality of Rose Creek as Affected by Discharges from the Cyprus Anvil Mine, Yukon Territory (1983). Environment Canada, Environmental Protection Service. Regional Program Report No. 85-12
Harder, P.A., and Associates Ltd.	1987	Baseline Fisheries and Habitat Investigations in Vangorda Creek
Harder, P.A., and Associates Ltd.	1988	Rose Creek Fisheries Study Interim Report No. 2
Harder, P.A., and Associates Ltd.	1989a	Assessment of Over-Winter Habitat Capabilities in Vangorda Creek and Impacts Related to Mine Development
Harder, P.A., and Associates Ltd.	1989b	Impact Assessment of Fish Resources in Vangorda Creek
Harder, P.A., and Associates Ltd.	1990	Impact Assessment of Fish Resources in Vangorda Creek. Addendum: Further Discussion and Recommendations
Harder, P.A., and Associates Ltd.	1991a	Fish Habitat Development and Enhancement Opportunities in Rose Creek (Compensation Related to Causeway Construction on the North Fork of Rose Creek)
Harder, P.A., and Associates Ltd.	1991b	Overview Assessment of Fish Resources in Anvil and Rose Creeks
Harder, P.A., and Associates Ltd.	1991c	Overview Assessment of Fish Resources in the Blind Creek Drainage
Harder, P.A., and Associates Ltd.	1992a	Benthos Analysis Lab Report
Harder, P.A., and Associates Ltd.	1992b	Vangorda Creek Aquatic Studies - 1990 Data Report
Harder, P.A., and Associates Ltd.	1993a	Assessment of Water Quality and Benthic Invertebratres in Rose Creek - 1992 Study
Harder, P.A., and Associates Ltd.	1993b	Environmental Assessment of Rose and Anvil Creeks - 1992 Study
Harder, P.A., and Associates Ltd.	1996	Juvenile Fish Sampling in Vangorda Creek Data Report - August 1996
Hoos, R.A.W., and W.N. Holman	1973	A Preliminary Assessment of the Effects of Anvil Mine on the Environmental Quality of Rose Creek, Yukon
Leverton and Associates Northern Consulting Ltd.	1986	Preliminary Investigation of the Fisheries Resources of the North Fork of Rose Creek
Leverton and Associates Northern Consulting Ltd.	1986?	Biological Monitoring Program - Curragh Minesite
Montreal Engineering Company Limited	1976	1975 Biophysical and Socio-Economic Program
Montreal Engineering Company Limited	1978	Environmental Baseline Investigation: Results of 1977 Program
Perrin, C.J.	1993	Effects of a Gradient of Zinc Additions on a Stream Community in Central Yukon. Limnotek Research and Development Inc.
Robertson Geoconsultants Inc.	1996	Anvil Range Mining Complex – Integrated Comprehensive Abandonment Plan. Volume 1 of 3: Background
Senes Consultants Limited	2006	Anvil Range Mine Tier 2 Ecological and Human Health Risk Assessment of Remediation Scenarios.
Weagle, K.	1980	Benthic Community Monitoring Program at Cyprus Anvil Mine, Faro, Yukon, 1980
Weagle, K.	1981a	An Examination of the Impact of the Discharges from Cyprus Anvil Mine on the Aquatic Environmental Quality of Rose Creek, Yukon Territory (1977 and 1978). Department of Environment, Environmental Protection Service. Manuscript Report 81-25
Weagle, K.	1981b	Benthic Community Monitoring Program at Cyprus Anvile Mine, Faro, Yukon, 1981.
Weagle, K.	1981c	The Impact of the Scheme 2 Abandonment Plan on the Grayling Population of Rose Creek
Weagle, K.	1981d	The Surveillance and Transportation of Fish During the Completion of the Diversion Canal at Cyprus Anvil Mine, Faro, Y.T.
Weagle, K.	1982	Benthic Community Monitoring Program at Cyprus Anvile Mine, Faro, Yukon, 1982
Weagle, K.	1983	Benthic Community Monitoring Program at Cyprus Anvile Mine, Faro, Yukon, 1983
White Mountain Environmental Consulting	2004	Aquatic Life Sampling and Testing Program for the Anvil Range Mine Site, Rose and Vangorda Creek Watersheds, Faro, Yukon.
White Mountain Environmental Consulting	2005	Aquatic Life Sampling and Testing Program for the Anvil Range Mine Site, Rose and Vangorda Creek Watersheds, Faro, Yukon.

Table 2.2: Summary of monitoring stations and samples used in the assessment of water quality

Location ID	Station ID	Ref / Exp	Station Description	Total Visits	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Faro Mine	FDL	Potentially disturbed	FDL, lower Faro Creek Diversion	5																														2	2	1
Faro Mine	R8	Potentially disturbed	R8, N Fork of Rose Creek 900 m below Faro Ck Div.	97																		3			12	17	12	3	4	3	3	4	5	12	12	7
Faro Mine	R9	Potentially disturbed	R9, N Fork of Rose Creek downstream of R8	99																		4	2	2	13	15	12	3	3	2	3	4	5	11	13	7
Faro Mine	R10	Potentially disturbed	R10, North Fork of Rose Creek u/s of rock drain	91																		2	2	2	8	14	12	3	3	3	3	4	4	11	13	7
Faro Mine	NF1	Potentially disturbed	NF1, North Fork Rose Creek Site 1 u/s of Haul Road	22															2	2	3						3	1	2	1	1	1	1	2	2	1
Faro Mine	NF2	Potentially disturbed	NF2, North Fork Rose Creek Site 2 d/s of Haul Road	26															2	3	2				1	2	3	2	2	1	1	1	1	2	2	1
Faro Mine	X2	Potentially disturbed	X2, N Fork of Rose Creek u/s of mine access road	285													17	12	14	12	18	10	18	16	22	16	12	13	14	14	13	19	15	11	12	7
Faro Mine	R1	Potentially disturbed	R1, Rose Creek downstream of Pumphouse Pond	17																						7		3		2				2	2	1
Faro Mine	W8	Potentially disturbed	W8, Upper Guardhouse Creek d/s of NW Dump	24															2	2	4				2	2	1	1	1	1	1	1	1	2	2	1
Faro Mine	X14	Exposed	X14, Rose Cr downstream of Rose Creek diversion channel	437	17		31	26						10	6		17	16	16	17	25	19	13	10	14	19	19	22	15	14	12	13	22	17	32	15
Faro Mine	R2	Exposed	R2, Rose Creek downstream of X14	17																						7		3		2				2	2	1
Faro Mine	R3	Exposed	R3, Rose Creek between X14 and R4	16																						6		3		2				2	2	1
Faro Mine	R4	Exposed	R4, Rose Creek upstream of Anvil Creek	30																4	6	4			1	5		3	1	1				2	2	1
Faro Mine	R5	Exposed	R5, Anvil Creek downstream of Rose Creek confluence	32																4	6	4			2	7		3		2				2	2	
Faro Mine	R11	Exposed	R11, Mouth of Anvil Creek at Pelly River	5																														2	2	1
Vangorda Mine	V27	Exposed	V27, Vangorda Creek, just upstr. of Shrimp	55																	5	3		2	5	4	10	3	5	3	3	4	2	3	2	1
Vangorda Mine	V4	Potentially disturbed	V4, Shrimp Creek, upstr. of Vangorda Creek	48														1	1		4			1	3	3	10	3	4	3	2	4	3	3	2	1
Vangorda Mine	V5	Exposed	V5, west fork Vangorda Creek	177														1	1	1	7	11	2	1	11	4	14	12	10	14	15	26	19	12	11	5
Vangorda Mine	V8	Exposed	V8, lower Vangorda Creek	234														1	3	2	21	27	2	7	12	9	15	12	11	14	15	28	21	14	12	8
Vangorda Mine	V1	Reference	V1, Vangorda Creek, upstream of mine & Blind Cr. Rd	87														1	1	1	9	8	2	2	10	6	7	6	5	3	3	8	6	3	4	2
Faro Mine	FDU	Reference	FDU, Faro Creek upstream of diversion culvert	16															2						1	2	1	1	2			1	1	2	2	1
Faro Mine	FC	Reference	FC, Faro Creek upstream of diversion	24														15	2	2	2				1	2										
Faro Mine	R7	Reference	R7, N Fork of Rose Creek above Faro Ck Diversion	118															2	8	8	4			7	18	13	6	4	5	3	3	3	14	13	7
Faro Mine	W10	Reference	W10, Upper Guardhouse Ck u/s of NW Dump	16																1					1	2	1	1	1	1	1	1	1	2	2	1
Faro Mine	R6	Reference	R6, Anvil Creek upstream of Rose Creek confluence	29																3	6	4			1	5		3		2				2	2	1

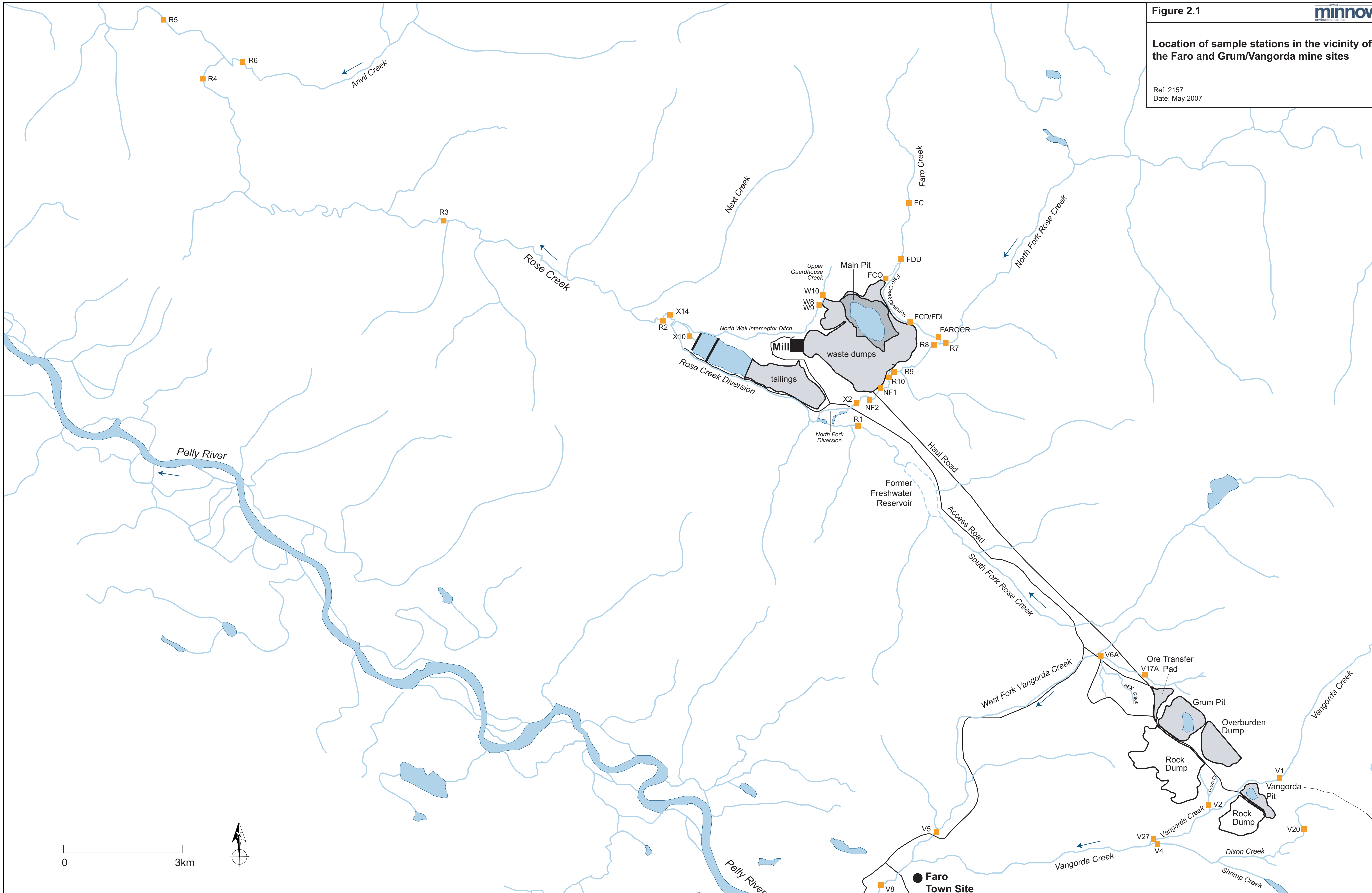


Figure 2.1

Location of sample stations in the vicinity of the Faro and Grum/Vangorda mine sites

Ref: 2157
Date: May 2007

laboratory responsible for sample analyses in recent years up to the spring of 2004 reported unusually high concentrations of copper and some other metals (e.g., iron) compared to two other laboratories. All subsequent samples were sent to a different laboratory. This means that data collected prior to the lab switch are considered suspect, which influenced the approaches used in evaluating water quality for this project. The details are discussed, as applicable, in the following sections, but in general, water quality was evaluated using both the full data set (1975-June 2006) and a reduced data set (May 2004 to June 2006).

2.1.1 Total Versus Dissolved Concentrations

To eliminate potentially redundant analyses in the assessment of water quality, relationships between total and dissolved concentrations of metals were examined. Analysis involved simple correlations between total and dissolved concentrations for selected parameters that have been (Robertson 1996, GLL 2002, 2003), or are predicted to become (Senes 2006), elevated in downstream surface waters. Since data could not be normalized, non-parametric Spearman Rank correlations were used to identify statistically-significant relationships (SPSS 2003). This test of correlation does not require normally distributed data, nor does it necessarily imply a linear increasing or decreasing trend. In addition to the statistical assessment, matched analytical results were graphed relative to a 1:1 line, such that data falling on the line would indicate that the total amount of the parameter measured was in dissolved form (Figure 2.2). Data falling above the line would indicate that dissolved concentrations represent a portion of the total concentration. Data falling below the line would represent cases in which the dissolved concentration exceeded the total concentration, a situation indicating suspect data which was thus used as a rough indication of overall data quality.

In all cases that were examined, total and dissolved concentrations were very well correlated (Table 2.3), indicating that dissolved concentrations vary in accordance with changes in total concentrations. However, for most parameters examined, there were a substantial number of samples for which the dissolved concentrations exceeded the total concentration reported for the same sample (Appendix Figure A.1a-j - points below the 1:1 line). This suggested some problems with data quality. The issue cannot be conclusively attributed to a specific cause, although the problems associated with the analyses of copper and other metals prior to May 2004, described above, suggest potential issues with overall laboratory data quality. It is also not unusual for such problems to be associated with contamination of samples during filtration in the field or because the samples were not truly “split” samples (i.e., one sample that is homogenized and split into two containers versus two samples collected consecutively). Dissolved sample values can also be problematic when samples are not

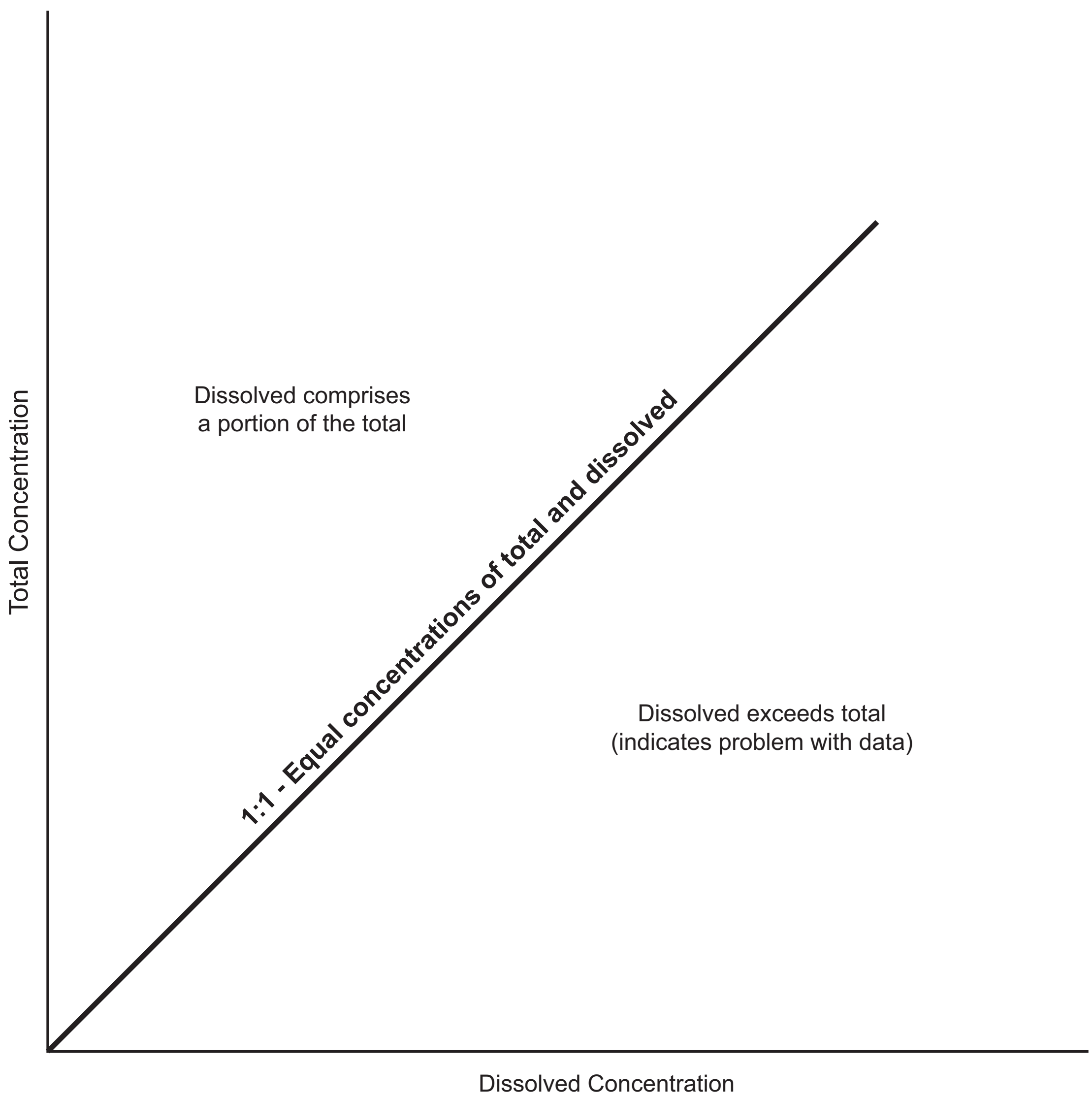


Figure 2.2: Comparison of dissolved versus total metal concentrations in water quality analysis for Faro mine complex

Table 2.3: Relationships between total and dissolved concentrations of select metals (data from 1975 - 2006)

Parameter	Statistic	Result of Correlation Analysis
Zinc	Correlation Coefficient	0.697
	Sig. (2-tailed)	0.000001
	N	735
Lead	Correlation Coefficient	0.895
	Sig. (2-tailed)	0.000001
	N	713
Nickel	Correlation Coefficient	0.793
	Sig. (2-tailed)	0.000001
	N	699
Manganese	Correlation Coefficient	0.799
	Sig. (2-tailed)	0.000001
	N	699
Iron	Correlation Coefficient	0.518
	Sig. (2-tailed)	0.000001
	N	714
Copper	Correlation Coefficient	0.818
	Sig. (2-tailed)	0.000001
	N	716

N = sample size

filtered until they are received at the laboratory, since they cannot be preserved until that time (although this still should not cause a filtered value to exceed the value in an unfiltered sample). Based on a greater number of available results for total concentrations, highly significant correlations between total and dissolved concentrations, and potential issues associated with dissolved data quality, it was determined that the water quality analyses would focus on total metal concentrations.

2.1.2 Summary Statistics

Summary statistics were calculated for each parameter and monitoring station, including the total number of samples, number and percentage of samples below the limit of analytical quantitation (hereafter usually referred to as method detection limit or MDL), minimum concentration, maximum detectable concentration and maximum detection limit. Station means and standard deviation were also calculated for each water quality parameter having at least 20% of all samples (reference and mine-exposed) greater than the MDL. Concentrations that were below the MDL were assumed to equal the detection limit in the calculation of the mean and standard deviation. Summary statistics were computed for both the full data set and for samples collected after May 2004.

2.1.3 Characterization of Background Conditions

Comparison of Reference Areas

Water quality data for six reference monitoring locations (i.e., V1, R6, R7, W10, FDU and FC; Figure 2.1) were examined and utilized in the calculation of background benchmarks. Although additional stations have been varyingly considered reference in previous studies at the Faro site (e.g., R1, V4, V20; GLL 2005; Senes 2006), only those known to be physically situated upstream of mine influences (mining, milling, roads, etc.) were included in this evaluation. Prior to benchmark calculation, potential differences among reference areas were first assessed to determine whether or not reference data from the Vangorda and Rose/Anvil watersheds could be combined. The same parameters considered in the evaluation of total versus dissolved concentrations (Section 2.1.1) were used in this assessment. The full data set was used to maximize the overall sample size; any bias associated with laboratory data quality prior to May 2004 would apply equally to data from all stations, so comparisons among stations would still be valid.

All reference data were first assessed for normality and homogeneity of variance, and log10-transformed as necessary to satisfy statistical assumptions. A one-way analysis of variance (ANOVA) was used to test for differences among areas/stations for the various water quality parameters. Tukey's HSD post-hoc test (equal variances) or Tamhane's T2 post-hoc test (unequal variances) were used to test for specific differences among stations when a significant difference was found in the ANOVA. ANOVA tends to be powerful even when the statistical assumptions are violated, but a non-parametric Kruskal-Wallis test was conducted on untransformed data as further confirmation of statistical findings. Results were considered significant at $p<0.05$.

Comparison of water quality data among reference stations indicated significant differences in conductivity, sulphate, hardness, iron and manganese concentrations (Table 2.4). No differences were found for copper, nickel and lead, and only a marginally significant difference for zinc (in the overall ANOVA, but not post-hoc tests; Appendix Tables A.1 to A.9). Post-hoc comparisons were just as likely to identify differences among reference stations within as between the Rose/Anvil and Vangorda Creek watersheds (Appendix Tables A.1 to A.9). As consistent watershed-specific differences were not found, data from all reference areas were combined for the calculation of background water quality benchmarks for each parameter. Separate benchmarks were computed for the full (1975-2006) versus reduced (2004-2006) data sets.

Development of Background Water Quality Benchmarks

To evaluate the nature and spatial extent of mine influence on water quality, concentrations measured in surface waters downstream of the mine were compared to natural, background concentrations. There is currently no established consensus as to the appropriate measure to use as a benchmark for background water quality, although the most common approaches provide some measure of the upper range of concentrations that occur for a given parameter (e.g., 90th-99th percentile, 95% confidence limit; Roe et al. 2006). Several options were reviewed in detail for selected parameters that are presently, or are predicted to become, elevated in downstream surface waters.

Prior to calculating background benchmarks, all data were examined for potential errors as part of a preliminary data assessment. Errors were identified as extreme outliers relative to other analytical data collected at the same station and were removed from the data sets in the preliminary assessment. Following this, the data were further examined to identify values that exceeded ± 3 standard deviations of the mean. These values were also eliminated from background benchmark calculations.

Potential background benchmarks were examined for selected parameters using a variety of methods, including percentiles (90th, 95th and 99th) and the 95% confidence limit. The 95% confidence limit, describing the distribution of data among samples, was calculated by multiplying the standard deviation by the appropriate t-statistic for the achieved degrees of

Table 2.4: Results of statistical comparisons of reference stations (data from 1975 - 2006)

Parameter	ANOVA	Kruskal-Wallis Test
Conductivity	<0.0001	<0.0001
Copper	0.223	0.364
Hardness	<0.0001	<0.0001
Iron	0.0001	<0.0001
Lead	0.334	0.466
Manganese	<0.0001	<0.0001
Nickel	0.686	0.626
Sulphate	<0.0001	<0.0001
Zinc	0.034	0.051

(shaded) significant at $p < 0.05$

freedom (based on the number of samples). This product was then added to the mean to estimate the upper limit of the reference data distribution. In this case, a result would be expected to exceed this value by chance alone only 5% of the time. Again, concentrations that were below the detection limit were conservatively assumed to be equal to the detection limit in all calculations.

In general, the 95th percentile values corresponded closely to 95% confidence limits (Table 2.5) and, taking into account the variability among reference stations themselves, appeared to be an adequate measure of the upper distribution of concentrations for each parameter (Appendix Table A.65). Percentiles were also considered to be less biased by elevated MDLs and unusually high measured values than means.

The full data set (1975-2006) for the selected parameters was used for this exploratory analysis involving selection of the method for benchmark derivation. However, for the assessment of water quality downstream of the Faro Mine complex (Section 2.1.4), background benchmarks were calculated for both the full data set and the data collected since May 2004 (reduced data set) to allow for separate comparisons of downstream water quality corresponding to the two time periods.

2.1.4 Assessment of Water Quality

As discussed above, background benchmarks were established for all water quality parameters for which >20% of samples had concentrations above the method detection limit. In the case of pH and alkalinity, water quality concerns at acid generating mines are generally associated with a decrease below typical background levels, rather than an increase. Thus in these cases, the 5th percentile was used as a minimum background benchmark (Table 2.6).

Canadian Water Quality Guidelines for the Protection of Aquatic Life (CWQGs; CCME 1999) have also been established for many of the parameters examined. Measured concentrations for each parameter were therefore compared to both background benchmarks and CWQGs (Table 2.6). For parameters having a hardness-based CWQG, mean station hardness was used to develop a site-adapted water quality guideline (CCME 2003) for each station, which was the value used in evaluating the percent of samples exceeding CWQG at that station. Parameters were considered to be indicators of mine-related activities when more than 25% of samples from mine-exposed stations exceeded the background benchmark and/or CWQG (whichever value was greater). The results for these mine indicator parameters were then examined in more detail, in terms of spatial distribution and temporal trends.

Table 2.5: Comparison of background benchmarks computed from pooled reference station data (1975 - 2006)

Parameter	Percentile			Confidence Limits
	90th	95th	99th	95%
Conductivity	238	261	293	261
Copper	0.021	0.026	0.038	0.024
Hardness	134	146	158	151
Iron	0.502	0.840	1.623	0.798
Lead	0.024	0.050	0.060	0.040
Manganese	0.024	0.048	0.082	0.044
Nickel	0.020	0.020	0.021	0.017
Sulphate	17.0	20.0	24.8	19.7
Zinc	0.043	0.060	0.109	0.061

Table 2.6: Background water quality benchmarks and Canadian water quality guidelines used in water quality assessment

Parameter	Units	Background Benchmark (data from 1975 - 2006)	Background Benchmark (data from 2004 - 2006)	CWQG
Alkalinity	mg/L	10 [1]	16.8 [1]	-
Aluminum	mg/L	0.32	0.128	0.1 [2]
Ammonia	mg/L	0.12	0.03	10.3 [3]
Arsenic	mg/L	NC	NC	0.005
Barium	mg/L	0.161	0.0866	-
Boron	mg/L	0.219	no data	-
Cadmium	mg/L	NC	NC	0.000006 - 0.000089 [4]
Calcium	mg/L	43.7	43.8	-
Chromium	mg/L	0.015	NC	0.0089 [5]
Conductivity	µS/cm	261	292	-
Copper	mg/L	0.026	0.002	0.002 - 0.004 [6]
Hardness	mg/L	146	153	-
Iron	mg/L	0.84	0.385	0.3
Lanthanum	mg/L	0.0066	no data	-
Lead	mg/L	0.05	NC	0.001 - 0.007 [7]
Lithium	mg/L	0.012	0.008	-
Magnesium	mg/L	9.5	11.2	-
Manganese	mg/L	0.048	0.045	-
Mercury	mg/L	NC	NC	0.0001
Molybdenum	mg/L	0.01	0.000875	0.073
Nickel	mg/L	0.02	NC	0.025 - 0.150 [8]
pH	pH units	7 [1]	7.1 [1]	6.5 - 9
Phosphorus	mg/L	1	no data	-
Potassium	mg/L	2	1.52	-
Selenium	mg/L	NC	NC	0.001
Silicon	mg/L	13	15.4	-
Silver	mg/L	NC	NC	0.0001
Sodium	mg/L	3.8	3.4	-
Strontium	mg/L	0.19	0.176	-
Sulphate	mg/L	20	20	-
Sulphur	mg/L	7	no data	-
Thallium	mg/L	NC	NC	0.0008
Titanium	mg/L	0.018	0.00365	-
Total Suspended Solids	mg/L	10	3.65	-
Uranium	mg/L	0.0024	0.00236	-
Vanadium	mg/L	0.01	no data	-
Zinc	mg/L	0.06	0.08	0.03

NC - not calculable due to an insufficient number of detectable concentrations

[1] Benchmark represents 5th percentile

[2] 0.1 mg/L at pH ≥ 6.5; [Ca^{2+}] ≥ 4 mg/L; DOC ≥ 2 mg/L

[3] CWQG conservatively assumed at pH = 7.0 and water temperature of 10°C

[4] CWQG for cadmium = $10^{\{0.86[\log(\text{hardness})] - 3.2\}}$, mean station hardness at each station used to compute CWQG

[5] based on trivalent chromium (Cr(III))

[6] 0.002 at [$CaCO_3$] = 0-120 mg/L, 0.003 at [$CaCO_3$] = 120-180 mg/L, 0.004 at [$CaCO_3$] > 180 mg/L, mean station hardness at each station used to compute CWQG

[7] 0.001 at [$CaCO_3$] = 0-60 mg/L, 0.002 at [$CaCO^3$] = 60-120 mg/L, 0.004 at [$CaCO_3$] = 120-180 mg/L, 0.007 at [$CaCO_3$] > 180 mg/L, mean station hardness at each station used to compute CWQG

[8] 0.025 at [$CaCO_3$] = 0-60 mg/L, 0.065 at [$CaCO^3$] = 60-120 mg/L, 0.110 at [$CaCO_3$] = 120-180 mg/L, 0.150 at [$CaCO_3$] > 180 mg/L, mean station hardness at each station used to compute CWQG

Interpretation was confounded for parameters having variable method detection limits, particularly if these exceeded the CWQG. This primarily pertained to parameters having fewer than 20% detectable results at reference stations, in which case a background benchmark also could not be established. Less-than-MDL values that exceeded the CWQG were not included among the total number of samples reported as exceeding the CWQG. The implications of such data limitations on interpretation of water quality are discussed, as applicable, along with the results of the water quality analysis (Section 3.0).

2.2 Sediment Quality

Sediment quality sampling has been conducted in the Rose-Anvil and Vangorda Creek systems since as early as 1973 (Hoos and Holman 1973) and 1991 (Davidge 1996), respectively. Some study-to-study variability has occurred in terms of precise sampling station locations, laboratory equipment/techniques as well as the metal parameters reported. However, in general, the sediment chemistry results were reasonably comparable among studies. In this report, all available historical sediment quality data were reviewed, with all complete data sets (i.e., full metal chemistry suites) compiled to allow a comprehensive statistical examination of the data. The methods provided below detail the historical sampling techniques and the data analysis utilized in this report.

2.2.1 Sample Collection and Laboratory Analysis

Sediment collection field procedures were generally consistent historically. Using a trowel or shovel, fine-grained sediment deposits were collected as triplicate samples from the stream bed at each sampling location (except in 1973, when there was no replication). Sediment samples were always retrieved from below the waterline. Sediment samples were collected into glass jars, refrigerated and shipped to a preferred laboratory for analysis of total metals. Analyses were usually performed on the fraction of each sediment sample which passed through a #100-mesh sieve (particles <0.15mm), except for sediment samples collected by Hoos and Holman (1973) which appear to have been analyzed as bulk samples.

2.2.2 Data Analysis

Historical sediment metal chemistry data were compiled into separate data sets for the Rose/Anvil and Vangorda systems. Mean sediment metal values were calculated for each metal and sampling station, following which general spatial comparisons were undertaken within each creek system. Sediment quality data collected at respective mine-exposed areas were then evaluated relative to 1) reference concentrations, as represented through Principal Components Analysis axes, and/or derived reference benchmarks; and 2) to applicable Canadian Sediment Quality Guidelines.

Principal component analysis (PCA) was used to interpret general trends and patterns of variability in sediment quality data within respective Rose-Anvil (1996 to 2006 data) and Vangorda (1995 to 2005 data) system sediment quality data. PCA was conducted only with data sets that contained robust parameter suites (i.e., greater than 20 metal parameters reported). In some cases, historical sediment quality data results were presented only for those parameters considered at the time to be important and/or for those which Canadian Sediment Quality Guidelines had been established (i.e., arsenic, cadmium, copper, iron, lead, mercury, nickel and/or zinc). These data were excluded from PCA (e.g., 1973 and 1983 Rose/Anvil data and 1993 Vangorda data). Data were also screened to ensure that greater than 90% of the available data for each specific metal parameter were a) analyzed and/or reported, and b) greater than laboratory method detection limits (MDL). If data sets for any specific parameter did not meet these criteria, that parameter was excluded from the PCA data matrix. Principal component axes were then generated from the correlation matrix of the original sediment quality variables using SPSS (SPSS Inc. 2003). Scores for each station were subsequently used as summary variables to test for differences among mine-exposed and references areas using Analysis of Variance (ANOVA) and post-hoc Tukey's testing. All data were transformed as necessary to satisfy assumptions of normality and homogeneity of variance. In instances where normality or variance could not be achieved, post-hoc tests were completed using Tamhane's comparisons. All statistical tests were conducted using SPSS Version 10 software (SPSS Inc. 2003).

Sediment quality benchmarks for each respective mine were established using a similar process to that described to develop background (reference) benchmarks for water quality (see Section 2.1.3). These benchmarks were used to evaluate the nature and spatial extent of any mine-related influence on sediment quality. The sediment benchmark was based on 95th percentile values calculated for each respective metal parameter from all available reference data. For Rose-Anvil, reference areas included the upper Anvil Creek (R6), North Fork Rose Creek (R7) and a number of Rose Creek tributaries (stations 4394, 4396 and 4399 of YTG [1999] unpublished data). At Vangorda, the sole reference station was represented by upper Vangorda Creek station V1 (Figure 2.3). Similar to derived benchmarks for water quality, sediment quality data were visually assessed and screened for outliers (i.e., those exceeding ± 3 standard deviations of the mean) prior to calculation of benchmark values. As well, concentrations that were below MDL were conservatively assumed to be equal to the detection limit for all calculations.

The Canadian Sediment Quality Guidelines for the Protection of Aquatic Life (CSQG) are numerical criteria that are designed to be protective of sediment-dwelling organisms based

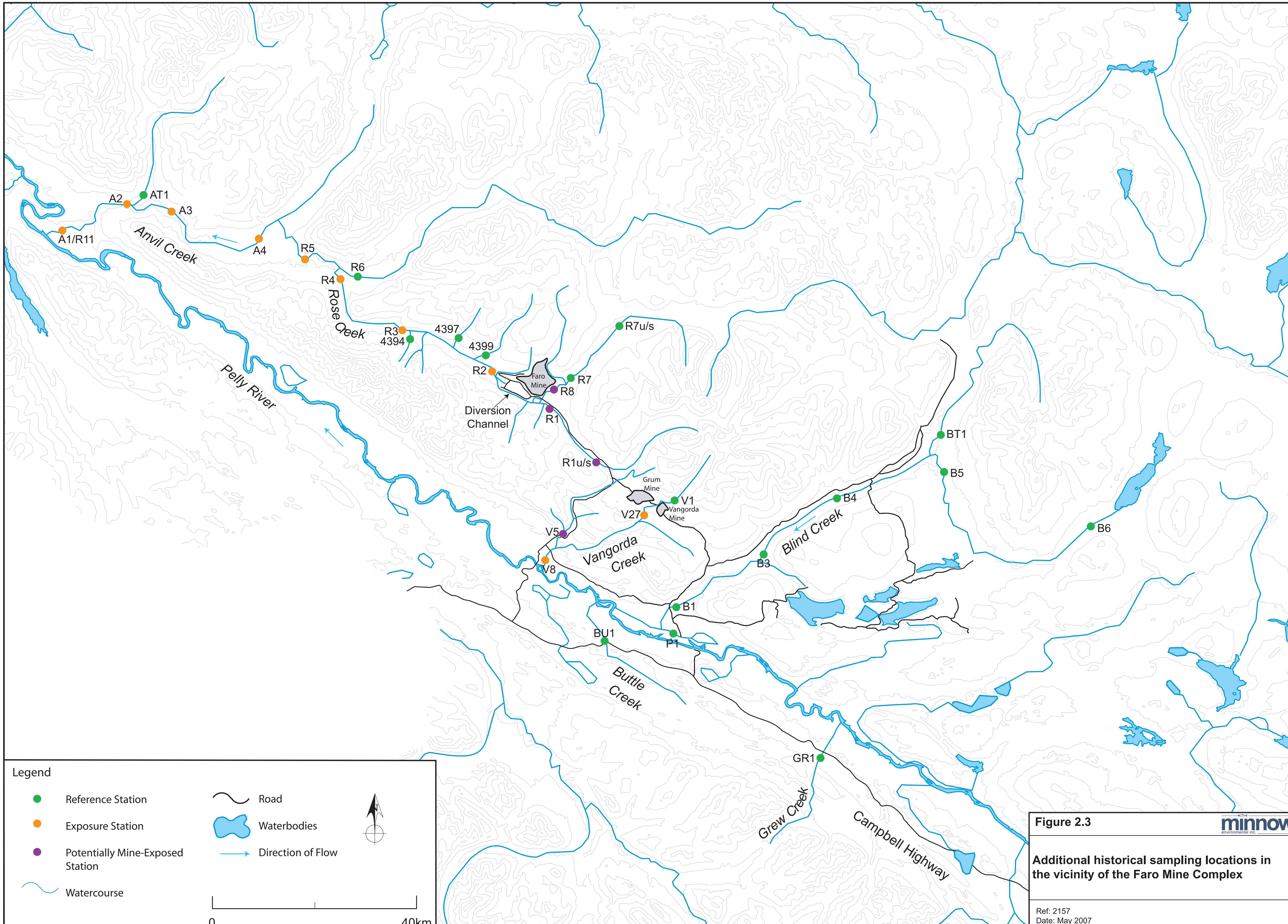


Figure 2.3

Additional historical sampling locations in the vicinity of the Faro Mine Complex

on long-term exposure (CCME 2005). Mean sediment metal concentrations were evaluated relative to applicable CSQG probable effect levels (PEL), which represent the metal concentrations which are expected to impair survival of the majority of benthic organisms (CCME 2005). Currently, CSQG are available for arsenic, cadmium, copper, lead and zinc (CCME 2005).

Finally, temporal comparisons of mean sediment concentration of potential ‘mine-indicators’, as identified through PCA and/or data screening against reference benchmarks, were conducted to evaluate any trends since mine closure.

2.3 Benthic Community Assessment

Benthic invertebrate sampling was initiated at some stations in 1973 within the Rose/Anvil Creek system and in 1975 within the Vangorda Creek system. From 1991 on, benthic invertebrate population monitoring has been conducted at standardized station locations every second year as per the requirements of the water licenses (alternating between Rose and Vangorda Creeks). Artificial substrates were used for the majority of studies, providing some consistency across much of the data set, although sample/data analysis varied in terms of factors such as numbers of replicate samples and levels of taxonomic identifications. Furthermore, much of the data were not available in electronic format, so detailed statistical analyses were undertaken for this report only for studies conducted since 2000. The results of previous surveys (1973-1999) were also reviewed and discussed, with comparisons of mean benthic invertebrate abundance and number of taxa where methodologies were sufficiently similar to make such comparisons valid (Section 5.0). The following sections describe the sampling and analytical methods associated with the detailed analysis of 2000-2006 surveys.

2.3.1 Field Methods

Artificial substrates were rock baskets constructed of galvanized wire with a one centimetre mesh. They were cylindrical in shape, measuring 26 cm long with a diameter of 17 cm. Each substrate sampler was filled with washed indigenous gravels (2-15 cm diameter) collected from the stream bed or the bank at each station.

Three rock filled samplers were typically submerged in riffle areas of the stream at each station in mid to late July and left to colonize for approximately five weeks. The artificial substrates were retrieved by placing a screened bucket with a 300 micron mesh, downstream and under the basket. On shore the basket was opened in the bucket. Individual rocks were then carefully washed in the screened bucket to remove and collect all invertebrates from that sample. The detritus and benthic invertebrates remaining in the bucket were placed in a one litre nalgene bottle and preserved with 10% formalin. These samples were sent to Dr. Charles Low, an entomologist in Victoria, B.C., for enumeration and identification.

2.3.2 Laboratory Analysis

All samples were washed through two screens with mesh sizes 1 millimetre and 180 microns. All of the organisms retained by the coarse screen were counted and identified, whereas the organisms on the 180 micron screen were subsampled as necessary. A Folsom plankton splitter was used for the subsampling. Subsample counts were extrapolated to full samples. Benthic invertebrates were generally identified to the genus level, although some species identifications were possible.

2.3.3 Data Analysis

Detailed data analysis included samples collected from Rose Creek stations in 2000, 2002, 2004, and 2006, and Vangorda Creek stations sampled in 2001, 2003, and 2005. For each sample, some commonly used EEM benthic community metrics were computed, including number of taxa per sample (identified to lowest practicable level), abundance per sample, and percent representation of the most common groups: EPT (Ephemeroptera, Plecoptera, Trichoptera), and chironomid midges.

Community structure was also assessed using a multivariate technique known as correspondence analysis (CA; Thioulouse et al. 1997)). CA was used to calculate axes, which summarized the variation in benthic community data. When depicted in two-dimensional plots, taxa that tend to co-occur will have similar CA axis scores and will plot together, while those that rarely co-occur plot farther apart. Similarly, stations sharing many taxa plot closest to one another, while those with little in common plot farther apart. The greatest variation among either taxa or stations is explained by the first axis, with other axes accounting for progressively less variation. Therefore, this type of multivariate analysis describes not only which stations have distinct benthic communities but also how these benthic communities differ among stations (*i.e.*, which particular taxa differ). CA is influenced by rare species, so those taxa occurring at 10% or fewer stations were eliminated from the analysis. Taxa constituting less than 5% of the total organism abundance were also removed. After screening and data reduction, abundances were log (x+1) transformed. Scores for both stations and taxa were calculated using the ADE-4 package (Thiolouse et al. 1997) and were saved as new summary variables to evaluate the associations of organisms and stations. CA was initially performed on the complete dataset which included all stations and years from both Rose and Vangorda Creeks. Subsequently, this dataset was divided, and CA was carried out separately for one dataset of all years of Rose Creek data, and another of all years of Vangorda Creek data.

Benthic community metrics, including CA scores, were analysed by ANOVA and post-hoc, pair-wise comparisons to determine the significance of location differences and of year-to-year differences using commercial statistics software (SPSS 2002). Depending on whether variances of the various metrics were judged to be homogenous or not, either Bonferroni or Tamhane's post-hoc test was employed. Significant differences were based on an experiment-wise error rate of 10% ($p=0.10$). CA scores were plotted in bivariate scatter graphs to examine spatial variation. The existence of possible temporal trends in the values of these metrics were examined using Pearson's correlations and associated significance tests.

The field study design did not lend itself to a rigorous statistical comparison of the magnitude of the differences between creeks over time, because the two creeks were never sampled in the same year.

2.4 Fish Community and Tissue Metal Concentrations

Fish surveys have been conducted in the Rose-Anvil and Vangorda Creek systems since as early as the mid-1970s. These surveys have focussed on fish habitat and/or community characterization, fish production and/or quantification of fish tissue metal concentrations (Baker 1979; GLL 2003). Despite a relatively high number of studies (approximately 10) conducted in each system over the period from 1974 to 2005, very few consistencies were maintained among studies in terms of station location, sampling frequency, tissues sampled (fish species and tissue type) and/or study objectives. This report focussed on fish community and fish tissue chemistry data collected most consistently over this time period. The methods provided below detail the historical sampling techniques and the data analysis utilized in this report to assess this historical data.

2.4.1 Historical Sampling Areas

Fish sampling station (or reach) locations often differed from study-to-study. To simplify the current analysis, historical data were allocated to either one of eleven Rose-Anvil Creek stations or one of three Vangorda Creek stations based on the proximity of the historical stations to the most recently-established station locations (Figure 2.3). The mine-exposed stations included R1 to R5 and A1 to A4 in the Rose-Anvil system, and V8 in the Vangorda system (Figure 2.3). Reference stations included R6 (Anvil Creek) and R7 (North Fork Rose Creek) in the Rose-Anvil system, and V1 (upper Vangorda) and Blind Creek (Stations B1 and

B3 to B6) for the Vangorda system (Figure 2.3), which have not been influenced by current or past mine-related activities.

2.4.2 Historical Sampling Methods

Historical fish community sampling involved a variety of collection techniques, including backpack electrofishing, minnow trapping, angling, gill netting and/or seine netting. Backpack electrofishing was generally used most consistently as the primary fish collection method. Electrofishing methods are least likely to select for fish size and/or species, providing results that may more accurately reflect the composition of the entire fish community relative to other fishing methods. For these reasons, the current fish community analysis focussed only on backpack electrofishing results.

At each sampling location, electrofishing was conducted by three man crew (electrofisher operator and two netters). Surveys conducted prior to 2002 generally sampled closed stations (i.e., stopnet barriers installed at upstream and downstream station boundaries) using a dual pass removal technique which enabled calculation of quantitative fish density estimates. Surveys conducted in and subsequent to 2002 sampled over an approximately 100 m long stream reach using a single pass removal technique that allowed semi-quantitative estimates of relative fish abundance to be calculated. For each method, captured fish were placed in buckets of water and retained until the pass was completed. At the conclusion of the pass, captured fish were identified, enumerated and were then either released or retained for tissue sampling and/or collection of fork length data. For historical studies employing closed station (i.e., quantitative) sampling, the dimensions of the enclosed station (length and mean wet channel width) were measured and recorded for later determination of the total area sampled. For more recent studies conducted based on semi-quantitative assessment, total shocking effort (i.e., electrofishing seconds) was recorded at the conclusion of each pass.

During some studies, fish habitat characterization data was collected to support the fish community survey findings. Supporting measures collected included mean wet and bankfull width, mean depth, mean water velocity (using floating object method), water temperature and a description of stream morphology, substrate characteristics, riparian vegetation species and relative percent fish cover.

Arctic grayling (*Thymallus arcticus*) and slimy sculpin (*Cottus cognatus*) were most often targeted for tissue metals analysis during historical studies, although Chinook salmon (*Oncorhyncus tshawytsha*), round whitefish (*Prosopium cylindraceum*), longnose sucker (*Catostomus catostomus*) and burbot (*Lota lota*) have also been sampled occasionally. To maintain as much consistency as possible, only the Arctic grayling and slimy sculpin tissue metal results were included in the current analysis. Generally, most studies had attempted to collect up to five adult Arctic grayling (fork length > 200 mm) and five slimy sculpin (fork length > 80 mm) from each sampled station. However, success rates in reaching this target were variable. In certain cases, fish size objectives were not met necessitating the analysis of composite tissue samples.

Fork length and fresh weight measurements were generally collected from all sacrificed fish. Tissue samples collected from Arctic grayling and slimy sculpin may have included muscle tissue, liver tissue and/or whole-body samples during historical studies. However, because the most consistently collected tissue for Arctic grayling was muscle (skinless, boneless muscle sampled from the caudal peduncle) and liver, whereas for slimy sculpin whole-body samples were most often collected, this report focussed on these tissues for each respective fish species. Fish tissue samples were analyzed for total metals using Inductively-Coupled Plasma (ICP) emission spectrometry techniques, with total mercury analysis also conducted during some studies. Tissue metal results were most often expressed in μg/g wet weight units.

2.4.3 Data Analysis

Fish community characteristics were summarized according to species presence-absence, estimated species density and/or relative abundance depending on data source. Although historical fish surveys were occasionally conducted in spring (i.e., May-June) or autumn (i.e., October), summer (i.e., August) surveys were conducted most consistently survey-to-survey and therefore served as the basis for comparisons of fish community structure during the current analysis. Quantitative estimates of fish density were based on fish catch regression models incorporating total stream area sampled for each species (i.e., number of fish captured per 100 square meters of stream surface area). Semi-quantitative estimates of relative fish abundance were compared through analysis of electrofishing catch-per-unit-effort (CPUE). Standardized CPUE values were calculated representing the total catch of each fish species per minute of electrofishing effort. Comparisons of fish communities among mine-exposed and reference stations were conducted based on presence-absence, density and/or relative abundance data to assess for any adverse mine-related effects both spatially (i.e., with distance from the mine) and temporally.

Analysis of fish tissue metal concentrations was based on reported values for arsenic, cadmium, copper, lead, manganese, zinc and/or mercury. These metals were selected for the current analysis simply because they represented the only constituents for which reasonable data sets were available from the historical studies and/or historical laboratory reports. Fish tissue metal concentrations were assessed spatially and temporally to determine if mine-related activities have had any influence on fish tissue quality. To put tissue metal concentrations in perspective, metals in edible muscle, liver and/or whole body tissue were screened against relevant human and/or wildlife consumption benchmarks (Table 2.7). Benchmarks for human consumption were derived utilizing published tolerable daily intake (TDI) values for each metal (Health Canada 1995 and IRIS 2000), established mean daily fish consumption quantities for local peoples (i.e., Yukon First Nations; Receuver *et al*. 1998; SENES 2006) and representative body mass values for human toddlers, children and adults (16.5 kg, 32.9 kg and 70.7 kg, respectively; Richardson 1997). These benchmarks represent the tissue concentrations considered protective of long-term human health while taking age into consideration. Tissue metal benchmarks for piscivorous wildlife represented the food metal concentration that results in a dose equivalent to the NOAEL (No Observed Adverse Effect Level; Sample *et al*. 1996). The benchmark values utilized were representative of the most sensitive piscivorous wildlife species, which was either river otter (*Lutra canadensis*) or belted kingfisher (*Ceryle alcyon*; Table 2.7).

Table 2.7: Fish tissue metal concentration consumption benchmarks (mg/kg) for humans and piscivorous (Fish-eating) wildlife

Parameter	Tolerable Daily Intake (mg/kg.day)[a]	Human Consumer[b]			Piscivorous Wildlife Consumer[c]
		Toddler	Child	Adult	
Arsenic	0.0003 [d]	0.20	0.56	1.0	0.28
Barium	0.016 [e]	10	30	52	
Beryllium	0.002 [d]	1	4	7	
Boron	0.0175 [d]	11	33	57	
Cadmium	0.0008 [d]	0.5	1.5	2.6	3.90
Chromium	0.001 [d]	0.7	1.9	3.3	
Copper	0.03 [d]	20	56	98	61.8
Lead	0.0036 [d]	2.4	6.8	11.8	4.9
Manganese	0.1402 [d]	92	264	459	358
Mercury	0.0001 [d]	0.07	0.19	0.33	0.45
Molybdenum	0.005 [d]	3.3	9.4	16.4	
Nickel	0.0013 [e]	0.9	2.4	4.3	
Selenium	0.005 [d]	3.3	9.4	16.4	
Silver	0.005 [d]	3.3	9.4	16.4	
Strontium	0.6 [d]	393	1,128	1,964	
Uranium	0.0006 [e]	0.4	1.1	2.0	
Zinc	0.3 [d]	196	564	982	650

[a] Where values were reported by both IRIS (2006) and Health Canada (2004), the lowest value was used for benchmark

[b] Benchmarks for human consumers based on mean consumption rate of 16.5 g, 17.5 g and 21.6 g of fish muscle tissue per day for toddler (10.8 kg), child (32.9 kg) and adult (70.7 kg), respectively (SENES 2006).

[c] Most conservative food metal concentration resulting in a dose equivalent to the NOAEL (Sample et al. 1996)

[d] IRIS (2006).

[e] Health Canada (2004)

3.0 WATER QUALITY

3.1 Characterization of Background

Surface waters in mineralized areas often have metal concentrations that exceed Canadian Water Quality Guidelines for the Protection of Aquatic Life (CWQGs; CCME 1999), so the 95th percentile of the pooled data for reference stations was also used (in addition to CWQG) as a benchmark for evaluating concentrations observed at stations located downstream of the mine (Section 2.1.3). This also provided a basis for evaluating parameters lacking a CWQG. Using the full water quality monitoring data set (1975-2004), the background benchmark concentrations exceeded the applicable CWQG for many parameters, especially copper, iron, lead, and zinc (Table 3.1). For such parameters, it was relevant to identify downstream stations having concentrations exceeding the background benchmark, rather than the CWQG, to indicate areas of mine-related influence on water quality. Fewer such instances were observed when more recent data were considered (Table 3.2), likely a reflection of lower reported values for some metals after a change in analytical laboratories in May 2004 (Section 2.1).

Concentrations of calcium, magnesium, sulphate, hardness (which generally reflects calcium and magnesium concentrations), and conductivity (which also reflects the concentrations of dominant ions such as Ca, Mg, and sulphate) were higher at reference station R6 relative to other reference stations, suggesting different geochemistry in the upper Anvil Creek watershed than in the watersheds upstream of the other reference stations (Appendix Figure A.3 and Table A.65). Upper Faro Creek (FDU, FC) showed the opposite pattern, with very low concentrations of alkalinity, calcium, magnesium, and hardness, and higher ammonia, than other reference stations, again suggesting different upstream geochemistry (Appendix Figure A.3 and Table A.65). Nevertheless, it was considered valid to combine the data for the various reference stations for computation of the background benchmarks because the downstream stations to which such values were subsequently compared were comprised of flows from the various upstream tributaries (i.e., thus reflecting the combined water quality of those input reference streams).

In the case of substances having a high proportion of reference stations samples below the MDL, computed background benchmarks were biased high relative to actual reference station concentrations, because such values were taken at the MDL for the benchmark calculation. This would affect the use of such benchmarks in other applications (e.g, for potential future use as site-specific water quality objectives), but did not compromise the

Table 3.1: Parameters in reference and mine-exposed areas exceeding background concentrations and/or Canadian water quality guidelines (data from 1975 - 2006)

Parameter	Units	Background Benchmark	# Ref Samples > Benchmark	% Ref Samples > Benchmark	# Exp Samples > Benchmark	% Exp Samples > Benchmark	CWQG	# Ref Samples > CWQG	% Ref Samples > CWQG	# Exp Samples > CWQG	% Exp Samples > CWQG
Sulphate	mg/L	20	15	7	794	60	-				
Hardness	mg/L	146	8	7	448	59	-				
Conductivity	μS/cm	261	6	5	245	51	-				
Manganese	mg/L	0.048	15	8	629	50	-				
Magnesium	mg/L	9.5	11	6	549	50	-				
Calcium	mg/L	43.7	12	7	518	47	-				
Strontium	mg/L	0.19	10	5	468	43	-				
Sodium	mg/L	3.8	15	8	501	43	-				
Uranium	mg/L	0.0024	1	2	74	27	-				
Ammonia	mg/L	0.12	14	8	244	21	0.7 [3]	0	0	41	4
Zinc	mg/L	0.06	16	7	291	20	0.03	43	18	645	43
Lanthanum	mg/L	0.0066	10	9	119	18	-				
TSS	mg/L	10	11	5	223	16	-				
Potassium	mg/L	2	4	3	137	15	-				
Barium	mg/L	0.161	9	5	160	15	-				
Aluminum	mg/L	0.32	10	5	157	14	0.1 [2]	48	26	432	40
Titanium	mg/L	0.018	11	6	139	13	-				
Iron	mg/L	0.84	13	6	142	12	0.3	46	21	449	37
Copper	mg/L	0.026	16	7	152	11	0.002 - 0.004 [6]	101	42	711	50
Chromium	mg/L	0.015	11	6	97	9	0.0089 [5]	16	9	143	13
Vanadium	mg/L	0.01	6	3	87	8	-				
Phosphorus	mg/L	1	11	6	65	6	-				
Boron	mg/L	0.219	11	7	53	6	-				
pH	pH units	7 [1]	7	4	42	5	6.5 - 9	0	0	3	0
Silicon	mg/L	13	10	6	44	4	-				
Lead	mg/L	0.05	2	1	57	4	0.001 - 0.007 [7]	60	28	300	21
Molybdenum	mg/L	0.01	6	3	43	4	0.073	0	0	0	0
Nickel	mg/L	0.02	3	2	36	3	0.025 - 0.150 [8]	1	1	1	0
Lithium	mg/L	0.012	1	2	5	2	-				
Alkalinity	mg/L	10 [1]	7	5	9	2	-				
Arsenic	mg/L	NC					0.005	14	7	112	10
Cadmium	mg/L	NC					0.000006 - 0.000089 [4]	22	12	131	12
Mercury	mg/L	NC					0.0001	2	2	7	2
Selenium	mg/L	NC					0.001	4	3	39	4
Silver	mg/L	NC					0.0001	9	5	86	8
Thallium	mg/L	NC					0.0008	1	2	3	1

mine indicator parameter

NC - not calculated due to an insufficient number of detectable concentrations and/or inadequate MDLs

[1] Benchmark represents 5th percentile

[2] 0.1 mg/L at pH ≥ 6.5; [Ca^{2+}] ≥ 4 mg/L; DOC ≥ 2 mg/L

[3] CWQG for un-ionized ammonia expressed as total ammonia based on conservative assumptions of pH = 8.0 and water temperature of 15°C

[4] CWQG for cadmium = $10^{\{0.86[\log(\text{hardness})] - 3.2\}}$, mean station hardness at each station used to compute CWQG

[5] based on trivalent chromium (Cr III)

[6] 0.002 at [$CaCO_3$] = 0-120 mg/L, 0.003 at [$CaCO_3$] = 120-180 mg/L, 0.004 at [$CaCO_3$] > 180 mg/L, mean station hardness at each station used to compute CWQG

[7] 0.001 at [$CaCO_3$] = 0-60 mg/L, 0.002 at [$CaCO^3$] = 60-120 mg/L, 0.004 at [$CaCO_3$] = 120-180 mg/L, 0.007 at [$CaCO_3$] > 180 mg/L, mean station hardness at each station used to compute CWQG

[8] 0.025 at [$CaCO_3$] = 0-60 mg/L, 0.065 at [$CaCO^3$] = 60-120 mg/L, 0.110 at [$CaCO_3$] = 120-180 mg/L, 0.150 at [$CaCO_3$] > 180 mg/L, mean station hardness at each station used to compute CWQG

Table 3.2: Parameters in reference and mine-exposed areas exceeding background concentrations and/or Canadian water quality guidelines (data from May 2004 - June 2006)

Parameter	Units	Background Benchmark	# Ref Samples > Benchmark	% Ref Samples > Benchmark	# Exp Samples > Benchmark	% Exp Samples > Benchmark	CWQG	# Ref Samples > CWQG	% Ref Samples > CWQG	# Exp Samples > CWQG	% Exp Samples > CWQG
Sulphate	mg/L	20	4	9	148	57	-				
Calcium	mg/L	43.8	4	8	123	46	-				
Manganese	mg/L	0.045	5	11	121	45	-				
Sodium	mg/L	3.4	4	8	119	44	-				
Hardness	mg/L	153	4	8	111	41	-				
Magnesium	mg/L	11.2	4	8	108	40	-				
Strontium	mg/L	0.176	3	6	105	39	-				
Conductivity	μS/cm	292	3	6	95	35	-				
Uranium	mg/L	0.00236	3	6	70	26	-				
Iron	mg/L	0.385	4	8	66	25	0.3	5	10	80	30
Ammonia	mg/L	0.03	3	7	59	22	0.7 [3]	0	0	0	0
TSS	mg/L	3.65	4	8	47	17	-				
Aluminum	mg/L	0.128	5	11	37	14	0.1 [2]	5	11	46	17
Copper	mg/L	0.002	3	6	35	13	0.002 - 0.004 [6]	3	6	25	9
Titanium	mg/L	0.00365	4	8	33	12	-				
Lithium	mg/L	0.008	1	2	33	12	-				
Potassium	mg/L	1.52	3	6	24	9	-				
Zinc	mg/L	0.08	5	11	13	5	0.03	7	15	71	26
Barium	mg/L	0.0866	3	6	12	4	-				
Silicon	mg/L	15.4	3	6	9	3	-				
pH	pH units	7.1 [1]	2	4	4	2	6.5 - 9	0	0	0	0
Alkalinity	mg/L	16.8 [1]	1	9	1	1	-				
Molybdenum	mg/L	0.000875	6	13	0	0	0.073	0	0	0	0
Chromium	mg/L	NC	-	-	-	-	0.0089 [5]	0	0	1	0.4
Lead	mg/L	NC	-	-	-	-	0.001 - 0.007 [7]	0	0	22	8
Nickel	mg/L	NC	-	-	-	-	0.025 - 0.150 [8]	0	0	0	0
Arsenic	mg/L	NC	-	-	-	-	0.005	0	0	1	0.4
Cadmium	mg/L	NC	-	-	-	-	0.000006 - 0.000089 [4]	1	2	6	2
Mercury	mg/L	NC	-	-	-	-	0.0001	0	0	0	0
Selenium	mg/L	NC	-	-	-	-	0.001	3	6	19	7
Silver	mg/L	NC	-	-	-	-	0.0001	2	4	10	4
Thallium	mg/L	NC	-	-	-	-	0.0008	0	0	0	0

mine indicator parameter

NC - not calculated due to an insufficient number of detectable concentrations

[1] Benchmark represents 5th percentile

[2] 0.1 mg/L at pH ≥ 6.5; $[Ca^{2+}]$ ≥ 4 mg/L; DOC ≥ 2 mg/L

[3] CWQG for un-ionized ammonia expressed as total ammonia based on conservative assumptions of pH = 8.0 and water temperature of 15°C

[4] CWQG for cadmium = $10^{\{0.86[\log(hardness)] - 3.2\}}$, mean station hardness at each station used to compute CWQG

[5] based on trivalent chromium (CR III)

[6] 0.002 at $[CaCO_3]$ = 0-120 mg/L, 0.003 at $[CaCO_3]$ = 120-180 mg/L, 0.004 at $[CaCO_3]$ > 180 mg/L, mean station hardness at each station used to compute CWQG

[7] 0.001 at $[CaCO_3]$ = 0-60 mg/L, 0.002 at $[CaCO^3]$ = 60-120 mg/L, 0.004 at $[CaCO_3]$ = 120-180 mg/L, 0.007 at $[CaCO_3]$ > 180 mg/L, mean station hardness at each station used to compute CWQG

[8] 0.025 at $[CaCO_3]$ = 0-60 mg/L, 0.065 at $[CaCO^3]$ = 60-120 mg/L, 0.110 at $[CaCO_3]$ = 120-180 mg/L, 0.150 at $[CaCO_3]$ > 180 mg/L, mean station hardness at each station used to compute CWQG

current water quality assessment which compared the relative number of samples in reference versus mine-exposed areas that exceeded the background benchmark.

Concentrations of antimony, arsenic, beryllium, bismuth, boron, cadmium, chromium, cobalt, cyanide, gold, lanthanum, mercury, phosphorus, selenium, silver, thallium, thorium, tin, tungsten and vanadium were less than the MDL in at least 50% of samples at *each station*, with rare exceptions for La, P, and Th (slightly more detectable concentrations at one station each; Appendix Tables A.19 to A.64). For most such substances, >80% of *all samples combined* (reference and exposed stations) were less than the method detection limit (Table 3.3). As a result, no background benchmark was computed for these substances. More importantly, the method detection limits were greater than the applicable CWQG for some substances (e.g., cadmium, silver; Tables 3.1 and 3.2), particularly in earlier years of sampling (e.g., arsenic, lead, selenium; Table 3.1), so water quality at reference and mine-exposed stations could not be fully characterized for such parameters.

3.2 Water Quality at Mine-Exposed Stations (Mine Indicators)

Sulphate, hardness, conductivity, manganese, magnesium, calcium, strontium, sodium, and uranium exceeded the background benchmark in more than 25% of samples from mine-exposed stations based on both the full (1975-2006) and reduced (2004-2006) data sets (Tables 3.1 and 3.2, respectively). These nine parameters can be considered the ones most appropriate for evaluating the current influence on surface water quality downstream of the Faro Mine complex (i.e., “mine indicators”). Not surprisingly, strong statistical correlations were evident among almost all the mine-indicator parameters, with some non-significant relationships observed only for uranium (Table 3.4), which tended to be elevated only at some of the Vangorda stations (V4, V5, V8; Appendix Figure A.3). Other parameters were elevated above background concentrations at mine-exposed stations in a percentage of samples that was low and often similar to the percentage of reference samples exceeding the background benchmarks (Tables 3.1 and 3.2).

3.3 Magnitude and Spatial Extent of Mine Influence

Mine influence on water quality during the period 1975-2006 was evident at the most downstream monitoring stations in both the Rose/Anvil (R5) and Vangorda (V8) watersheds, based on elevated mean concentrations and higher percentage of samples exceeding background concentrations for mine indicator parameters (Table 3.5, Appendix Table A.65 and Figure A.3). Similar patterns were evident in the 2004 to 2006 data for most parameters (Appendix Tables A.66-A.97); differences that were evident from comparison of data for the two time periods were noted below, as appropriate. Elevations in the concentrations of mine

Table 3.3: Data limitations associated with water quality evaluation at Faro Mine

		Full Data Set (1975-mid 2006)				May 2004-June 2006			
Parameters Considered	No CWQG Aquatic Life	Low reference n (<40 samples)	Parameters with >50% samples <MDL at reference stations	% reference station samples reported <MDL and MDL exceeds CWQG	>50% samples <MDL in downstream stations	Low reference n (<40 samples)	Parameters with >50% samples <MDL at reference stations	% reference station samples reported <MDL and MDL exceeds CWQG	>50% samples <MDL in downstream stations
Alkalinity	√					√ (11)			
Aluminum				16				0	
Ammonia			√ (56)	0			√ (63)	0	50
Antimony	√		√ (93)		√ (89)		√ (100)		
Arsenic			√ (88)	47	√ (84)		√ (86)	0	84
Barium	√								
Beryllium	√		√ (89)		√ (85)				
Bismuth	√		√ (95)		√ (95)				
Boron	√		√ (63)		63		√ (98)		99
Cadmium			√ (88)	100	88		√ (98)	100	98
Calcium	√								
Chromium			√ (81)	5	71		√ (96)	0	92
Cobalt	√		√ (90)		83		√ (100)		87
Conductivity	√								
Copper				16			√ (75)	0	60
Cyanide		√ (9)		67	59	√ (0)			
Gold	√	√ (7)	√ (100)		100	√ (0)			
Hardness	√								
Iron				0				0	
Lanthanum	√		√ (83)		64	√ (0)			100
Lead			√ (68)	64	68		√ (88)	0	71
Lithium	√								
Magnesium	√								
Manganese	√								
Mercury			√ (98)	45	98		√ (100)	10	
Molybdenum			√ (68)	0	58		√ (54)	0	
Nickel			√ (77)	0	59		√ (84)	0	
pH								0	
Phosphorus	√		√ (74)		71		√ (96)		93
Potassium	√								
Selenium			√ (97)	62	94		√ (92)	0	
Silicon	√								
Silver			√ (95)	96	92		√ (96)	94	
Sodium	√								
Strontium	√								
Sulphate	√								
Total Suspended Solids	narrative		√ (51)				√ (77)		50
Thallium			√ (98)		99		√ (100)		
Thorium	√		√ (98)		95	√ (0)			
Tin	√		√ (87)		86		√ (92)		
Titanium	√		√ (64)		50		√ (63)		51
Tungsten	√		√ (100)		98	√ (0)			
Uranium	√								
Vanadium	√		√ (88)		80		√ (98)		94
Zinc				0			√ (55)	0	

Table 3.4: Relationships between mine-indicator water quality parameters

		Calcium	Conductivity	Hardness	Magnesium	Manganese	Sodium	Ammonia	Sulphate	Strontium	Uranium
Calcium	Correlation Coefficient	1	0.950	0.977	0.940	0.356	0.756	0.257	0.854	0.951	0.835
	Sig. (2-tailed)	.	0.000001	0.000001	0.000001	0.000001	0.000001	0.000001	0.000001	0.000001	0.000001
	N	1101	407	717	1101	1090	1083	817	1073	1083	273
Conductivity	Correlation Coefficient	0.950	1	0.932	0.928	0.258	0.784	0.223	0.886	0.926	0.809
	Sig. (2-tailed)	0.000001	.	0.000001	0.000001	0.000001	0.000001	3.91236E-06	0.000001	0.000001	0.000001
	N	407	476	413	407	407	407	421	466	407	272
Hardness	Correlation Coefficient	0.977	0.932	1	0.950	0.201	0.689	0.243	0.847	0.952	0.848
	Sig. (2-tailed)	0.000001	0.000001	.	0.000001	0.000001	0.000001	0.000001	0.000001	0.000001	0.000001
	N	717	413	766	717	717	717	598	755	717	273
Magnesium	Correlation Coefficient	0.940	0.928	0.950	1	0.253	0.652	0.169	0.851	0.921	0.845
	Sig. (2-tailed)	0.000001	0.000001	0.000001	.	0.000001	0.000001	1.14755E-06	0.000001	0.000001	0.000001
	N	1101	407	717	1101	1090	1083	817	1073	1083	273
Manganese	Correlation Coefficient	0.356	0.258	0.201	0.253	1	0.525	0.533	0.483	0.287	0.010
	Sig. (2-tailed)	0.000001	0.000001	0.000001	0.000001	.	0.000001	0.000001	0.000001	0.000001	0.876
	N	1090	407	717	1090	1255	1175	961	1156	1083	273
Sodium	Correlation Coefficient	0.756	0.784	0.689	0.652	0.525	1	0.405	0.722	0.726	0.656
	Sig. (2-tailed)	0.000001	0.000001	0.000001	0.000001	0.000001	.	0.000001	0.000001	0.000001	0.000001
	N	1083	407	717	1083	1175	1175	893	1148	1083	273
Ammonia	Correlation Coefficient	0.257	0.223	0.243	0.169	0.533	0.405	1	0.336	0.263	-0.027
	Sig. (2-tailed)	0.000001	3.91236E-06	0.000001	1.14755E-06	0.000001	0.000001	.	0.000001	0.000001	0.658
	N	817	421	598	817	961	893	1161	999	813	270
Sulphate	Correlation Coefficient	0.854	0.886	0.847	0.851	0.483	0.722	0.336	1	0.800	0.654
	Sig. (2-tailed)	0.000001	0.000001	0.000001	0.000001	0.000001	0.000001	0.000001	.	0.000001	0.000001
	N	1073	466	755	1073	1156	1148	999	1316	1056	263
Strontium	Correlation Coefficient	0.951	0.926	0.952	0.921	0.287	0.726	0.263	0.800	1	0.870
	Sig. (2-tailed)	0.000001	0.000001	0.000001	0.000001	0.000001	0.000001	0.000001	0.000001	.	0.000001
	N	1083	407	717	1083	1083	1083	813	1056	1083	273
Uranium	Correlation Coefficient	0.835	0.809	0.848	0.845	0.010	0.656	-0.027	0.654	0.870	1
	Sig. (2-tailed)	0.000001	0.000001	0.000001	0.000001	0.876	0.000001	0.658	0.000001	0.000001	.
	N	273	272	273	273	273	273	270	263	273	273

significance at $p < 0.05 / 45 = 0.0011$

Table 3.5: Percent samples exceeding background benchmarks for mine indicator parameters in water samples from exposure and reference areas (data from 1975 - 2006)

Stations			Calcium	Conductivity	Hardness	Magnesium	Manganese	Sodium	Strontium	Sulphate	Uranium	Zinc
Exposed or Potentially Disturbed	Rose/Anvil	FDL	0	0	0	0	20	0	0	0	0	40
		R8	9	12	4	0	9	11	9	0	8	4
		R9	19	21	28	7	12	10	13	5	15	6
		R10	14	22	16	5	10	13	11	7	15	3
		NF1	0	0	0	0	23	0	8	0	0	25
		NF2	13	7	13	6	13	6	19	4	0	9
		X2	24	34	24	23	57	21	26	31	14	16
		R1	18	29	9	9	36	18	18	18	20	9
		W8	0	0	0	0	0	0	0	0	0	33
		X14	71	76	68	71	100	86	57	97	20	41
		R2	64	71	64	64	100	91	55	100	40	9
		R3	64	71	64	64	100	82	55	91	40	9
		R4	63	86	62	63	88	88	56	100	20	20
		R5	33	33	33	47	33	20	7	68	25	8
		R11	40	60	100	100	20	40	20	100	20	0
	Vangorda	V27	10	28	17	26	10	13	26	83	0	30
		V4	94	95	93	97	13	34	94	82	100	10
		V5	84	84	92	99	24	56	77	99	68	8
		V8	75	74	72	95	38	50	72	94	74	12
Reference	Rose/Anvil	FDU	0	0	0	0	0	0	0	7	0	27
		FC	0	0	0	0	0	0	0	0	-	0
		R7	7	9	5	0	14	9	8	4	0	5
		W10	0	0	0	0	0	0	0	0	0	21
		R6	25	43	38	56	0	13	6	36	20	8
	Vangorda	V1	4	0	2	4	6	9	4	3	0	3

> 25% of samples exceeded background benchmark

indicator parameters do not necessarily indicate that effects on biota may be expected; no CWQGs exist for the mine indicator parameters, due to lower toxicity relative to most of the substances having a CWQG. Nevertheless, it is recommended that routine sampling be extended farther downstream to delineate the spatial extent of mine influence on water quality associated with the mine-indicator parameters.

Both historical and recent data show that background zinc[2] concentrations near the Faro Mine complex sometimes exceeded the CWQG (Tables 3.1, 3.2, and 3.5). Approximately 20% of historical samples from mine-influenced stations contained zinc concentrations exceeding the background benchmark computed for the same time period (Table 3.1), but more recent data indicated that zinc concentrations at stations downstream of the mine were usually within the range of background concentrations (Table 3.2).

As noted previously, reference station data were sparse or associated with inadequate MDLs for many of the other substances for which a CWQG exists (Table 3.3). It is recommended that the laboratory responsible for the analyses be advised that a full suite of parameters be included in future analyses, with lower MDLs.

Sulphate, hardness, conductivity, magnesium, and calcium tended to be elevated at stations downstream of both the Faro site (Rose/Anvil creeks) and the Vangorda site (Vangorda Creek; Table 3.5, Appendix Figure A.3). TSS was generally also historically elevated at both Rose (X14, R7) and Vangorda stations (Figure A.3, Table A.56); however, more recent data indicated that TSS concentrations have continued to be elevated at West Vangorda Creek station V5 (mean 38-39 mg/L), while concentrations at V8, X14 and R7 have been lower in recent years (12, 5, and 3 mg/L compared to historical means of 25, 18, and 12 mg/L for the three stations, respectively; Appendix Tables A.56, A.93). Iron concentrations, have also tended to be highest at West Vangorda station V5 (1.4 mg/L; Appendix Table A.37, A.77). Vangorda stations were also characterized by higher concentrations of aluminum (Tables A.20, A.67), magnesium (Tables A.41, A.80) and uranium (Tables A.62 and A.96) than at Rose Creek stations (Appendix Figure A.3). Rose Creek stations were characterized by higher manganese and sodium levels than were Vangorda stations (Appendix Figure A.3).

Other interesting patterns were evident from review of the full (1975-2006) and reduced (2004-2006) data sets. Samples from V4, V5 and V8 more frequently contained elevated concentrations of calcium, conductivity, hardness, and uranium compared to V27, suggesting sources other than those upstream of V27 (Table 3.5 and detailed data tables in Appendix

[2] Zinc would not be considered a good “mine indicator” parameter based on recent monitoring data, but it was included in Table 3.5 based on historical interest. Unlike the other mine-indicator parameters listed in Table 3.5, a CWQG exists for zinc.

B). Also, aluminum (V5 and V8) and iron (V5) concentrations were higher in West Fork Vangorda Creek, again suggesting stronger influences upstream of these stations compared to the main stem of Vangorda Creek (V1 and V27; Appendix Figure A.3).

Of the stations located on the North Fork of Rose Creek (R7-R10, NF1, NF2, and X2), a difference in water quality was most apparent between stations NF2 and X2, with elevations in all mine-indicator parameters at X2 (Table 3.5). This indicated a source (likely groundwater; SRK 2006) between these two stations. Slight elevations in some parameters were also evident at R1 (Table 3.5), likely because of tributaries upstream of R1 which cross the haul road and the mine access road before flowing into the South Fork of Rose Creek.

Despite some data limitations, particularly for reference stations, it was possible to make comparisons to CWQGs for some substances using data collected since May 2004. The percentage of mine-exposed samples containing iron, aluminum, copper, lead and zinc was slightly greater than for reference stations (background), although most samples were less than CWQG in both areas (Table 3.2). Analyses of arsenic, cadmium, chromium, mercury, molybdenum, nickel, selenium, silver, and thallium suggested that these substances pose a low risk to aquatic biota near the Faro Mine complex (Table 3.2), although MDLs for cadmium and silver were too high to make definitive conclusions.

It is recommended that background benchmarks be computed for all substances having CWQG once an adequate reference database has been developed with consistently low MDLs. The same suite of parameters and low MDLs should also be consistently targeted for exposure areas until sufficient data have been collected to determine if such substances pose a potential risk to aquatic biota in areas downstream of the Faro mines.

3.4 Temporal Trends

Inconsistencies in the timing of sample collection among stations, as well as variability in analytical MDLs precluded detailed statistical analysis of temporal trends. However, data for the mine-indicator parameters, plus ammonia, copper, iron, lead, nickel and zinc, were plotted for key reference and downstream stations to identify any obvious upward or downward trends in concentration over time (Appendix Figure A.4). Generally, few trends were observed with the possible exception of declines in ammonia, copper, lead, and sodium (X14 only) although lead reductions were at least partially attributable to reduced MDLs over time (Figure A.4). Although the data were limited, temporal increases in calcium, magnesium, hardness, and strontium may be occurring based on samples collected at Rose Creek stations R3-R5 (Appendix Figure A.4), although no trend was obvious at stations closer to the Faro mine discharge (X14/R2).

3.5 Summary and Recommendations

Sulphate, hardness, conductivity, manganese, magnesium, calcium, strontium, sodium, and uranium were the parameters most often elevated in Rose and Vangorda Creeks relative to upstream reference stations. Therefore, these parameters are most appropriate for evaluating the current influence on surface water quality downstream of the Faro Mine complex (i.e., "mine indicators"). Strong statistical correlations were evident among almost all the mine-indicator parameters. Mine-related influence on water quality was evident at the most downstream monitoring stations in both the Rose/Anvil (R5) and Vangorda (V8) watersheds, based on elevated mean concentrations and higher percentage of samples exceeding background concentrations for mine indicator parameters. This does not necessarily indicate that effects on biota may be expected; no CWQGs exist for any of the mine-indicators, based on the lower toxicity of these substances relative to most of those having a CWQG.

Reference station data were sparse or associated with inadequate MDLs for many substances, including many for which a CWQG exists (e.g., As, Cd, Cr, Hg, Se, Ag, Tl). The percentage of mine-exposed samples containing iron, aluminum, copper, zinc, and lead was slightly greater than for reference stations (background), although most samples were less than CWQG in both areas. Low concentrations of arsenic, chromium, mercury, molybdenum, nickel, selenium, and thallium suggest that these substances do not likely pose a risk to aquatic biota downstream of the Faro Mine complex at the present time. MDLs for cadmium and silver were too high to allow for definitive conclusions with respect to these substances.

Recommendations for future monitoring include:

- The locations of routine monitoring stations should be re-evaluated in terms of the information contained in this report. For example, it would be appropriate to extend routine sampling farther downstream to delineate and track the spatial extent of mine influence on water quality associated with mine-indicator parameters;
- The frequency of monitoring at each station should be rationalized to ensure the collection of adequate but not excessive information to track long-term changes;
- Monitoring at additional reference stations should be considered;
- The laboratory responsible for water quality analyses should be advised that a full suite of parameters be included in future analyses, with sufficiently low MDLs to permit valid comparison to CWQGs;

- The same suite of parameters and low MDLs applied to reference stations should also be consistently targeted for exposure areas; and
- Background benchmarks should be developed for all substances having CWQG once an adequate reference database has been developed with consistently low MDLs.

4.0 SEDIMENT QUALITY

4.1 Rose-Anvil System Sediment Chemistry

4.1.1 Spatial Comparisons

Spatial evaluation of mean sediment metal concentrations for the Rose-Anvil combined data set (i.e., 1996 to 2006 data) generally indicated highest metal concentrations at the near-field tailings-effluent exposure area of Rose Creek (i.e., Stations R2 and R3), with decreasing levels observed with progression downstream through lower Rose Creek and Anvil Creek (Table 4.1).

Statistical analysis of the sediment chemistry data was based on Principal Component Analysis (PCA), which reduced the sediment metal data into two principal components (PC-1 and PC-2) that cumulatively explained 83.5% of the variation in sediment chemistry data. PC-1 (66.5% of variation) represented high concentrations of several metals, with iron, cobalt, nickel and copper contributing most to PC-1 weightings (Figure 4.1; Appendix Table B.4). These metals were slightly elevated (i.e., less than a factor of three) relative to reference benchmarks (Table 4.1; Appendix Table B.3), with statistical comparisons indicating significantly higher PC-1 metal concentrations only at the near-field stations immediately downstream of the tailings-effluent discharge (i.e., Stations R2 and/or R3) relative to reference, lower Anvil Creek, and potentially mine-influenced stations located upstream (Appendix Table B.5; Figure 4.1).

Sediment PC-2 (17.0% of variation) represented high positive weightings of manganese, lead, arsenic, zinc and mercury (Figure 4.1; Appendix Table B.4). It is noteworthy that PC-2 metals were generally elevated by higher factors (i.e., greater than three) than PC-1 metals (Table 4.1; Appendix Table B.3), suggesting that metals representative of PC-2 may be stronger mine-related indicators. Compared to reference and/or lower Anvil Creek (Stations A1 and A2), PC-2 metals were significantly elevated at lower Rose Creek (R2, R3 and R4), below the Rose-Anvil confluence (R5) and in South Fork Rose Creek (R1; Appendix Table B-5; Figure 4.1). Manganese exceeded background concentrations by the greatest magnitude, with mean concentrations at R2 approximately 8 times the 95th percentile of reference (Table 4.1). Of the PC-2 metals, only manganese was elevated above the 95th percentile background concentration as far downstream as the Anvil Creek mouth (Table 4.1). Interestingly, lower Anvil Creek stations A3 and A4 were not significantly different from any mine-exposed or reference stations based on PCA scores (Appendix Table B.5), suggesting that this reach may represent the downstream extent of sediment metal transport from the mine.

Table 4.1: Summary of Rose-Anvil Creek system sediment chemistry data[a] (1973 to 2006) and comparison relative to established reference benchmarks

Metal	Benchmark		Reference Stations			Mine-Influenced Stations							
	95th Percentile[b]	CSQG PEL[c]	North Fork Rose Creek R7	Rose Creek Tributaries	Anvil Creek R6	South Fork Rose Creek R1	North Fork Rose Creek R8	Rose Creek R2	Rose Creek R3	Rose Creek R4	Anvil Creek R5	Anvil Creek A3 and A4	Anvil Creek A1 and A2
Aluminum	30,405		11,856	27,133	13,594	9,927	20,600	19,031	16,436	12,593	13,708	14,400	13,013
Arsenic	14.9	17.0	11.4	8.9	11.8	10.3	12.7	28.7	24.7	16.3	16.5	12.6	12.2
Barium	3,595		165	1,271	194	145	209	917	1,233	402	282	480	456
Berylium	1.85		0.96	1.11	0.97	0.99	1.00	0.97	0.92	0.99	0.90	0.67	0.60
Cadmium	2.0	3.5	0.5	1.7	0.9	0.6	1.1	1.6	1.2	1.0	1.0	1.1	0.9
Calcium	12,740		4,230	11,667	6,123	3,747	6,490	10,006	6,923	5,691	5,993	7,123	8,337
Chromium	78.6		22.6	66.1	35.3	24.7	44.7	58.9	43.0	39.5	39.1	48.5	44.9
Cobalt	20.8		9.0	19.7	12.4	10.4	17.3	30.1	24.6	18.4	14.3	15.8	11.7
Copper	71.5	197	16.9	52.4	28.0	15.1	47.0	88.6	65.5	47.9	48.1	37.7	29.8
Iron	36,085		18,743	32,200	22,688	18,143	23,300	38,323	30,969	23,500	25,144	28,450	25,600
Lead	92.6	91.3	15.2	56.3	13.0	74.0	17.3	332.5	210.4	157.3	98.0	102.3	44.4
Magnesium	13,000		4,217	11,059	6,198	4,291	7,767	8,895	6,579	5,954	6,166	7,375	7,337
Manganese	1,219		793	647	1,049	1,366	773	9,501	7,252	5,350	1,961	2,875	1,448
Mercury	0.128	0.486	0.026	0.100	0.021	0.051	0.033	0.276	0.172	0.113	0.109	0.095	0.048
Nickel	86.2		21.9	60.6	36.0	23.9	48.7	125.5	72.7	45.6	39.8	51.5	45.1
Phosphorus	3,248		1,770	916	1,844	1,253	1,107	1,302	1,723	1,628	1,828	1,001	899
Potassium	5,386		1,389	4,188	1,079	849	1,343	2,577	2,374	1,048	1,089	1,900	2,300
Selenium	2.1		0.6	1.3	0.6	0.4	0.7	0.8	0.8	0.6	0.7	0.2	0.2
Silver	1.0		0.2	0.7	0.2	0.9	0.3	0.9	0.9	0.4	0.8	0.1	0.1
Sodium	1,160		130	772	211	219	215	365	366	278	229	355	300
Strontium	92.7		29.1	77.5	33.5	40.3	36.3	63.6	53.0	41.0	35.8	46.9	46.9
Titanium	1,451		384	1,324	375	249	502	643	645	353	458	466	476
Vanadium	100		28	76	48	21	64	48	43	31	45	48	46
Zinc	199	315	80	183	99	175	142	808	649	470	243	322	186

[a] All metal concentrations expressed in mg/kg

[b] Reference benchmark represents 95th percentile of reference data

[c] Canadian Sediment Quality Guideline for the Protection of Aquatic Life (CSQG) Probable Effect Level (PEL; CCME 2005)

Indicates value that exceeds 95th percentile reference benchmark

Indicates value that exceeds both the 95th percentile reference benchmark and CSQG PEL

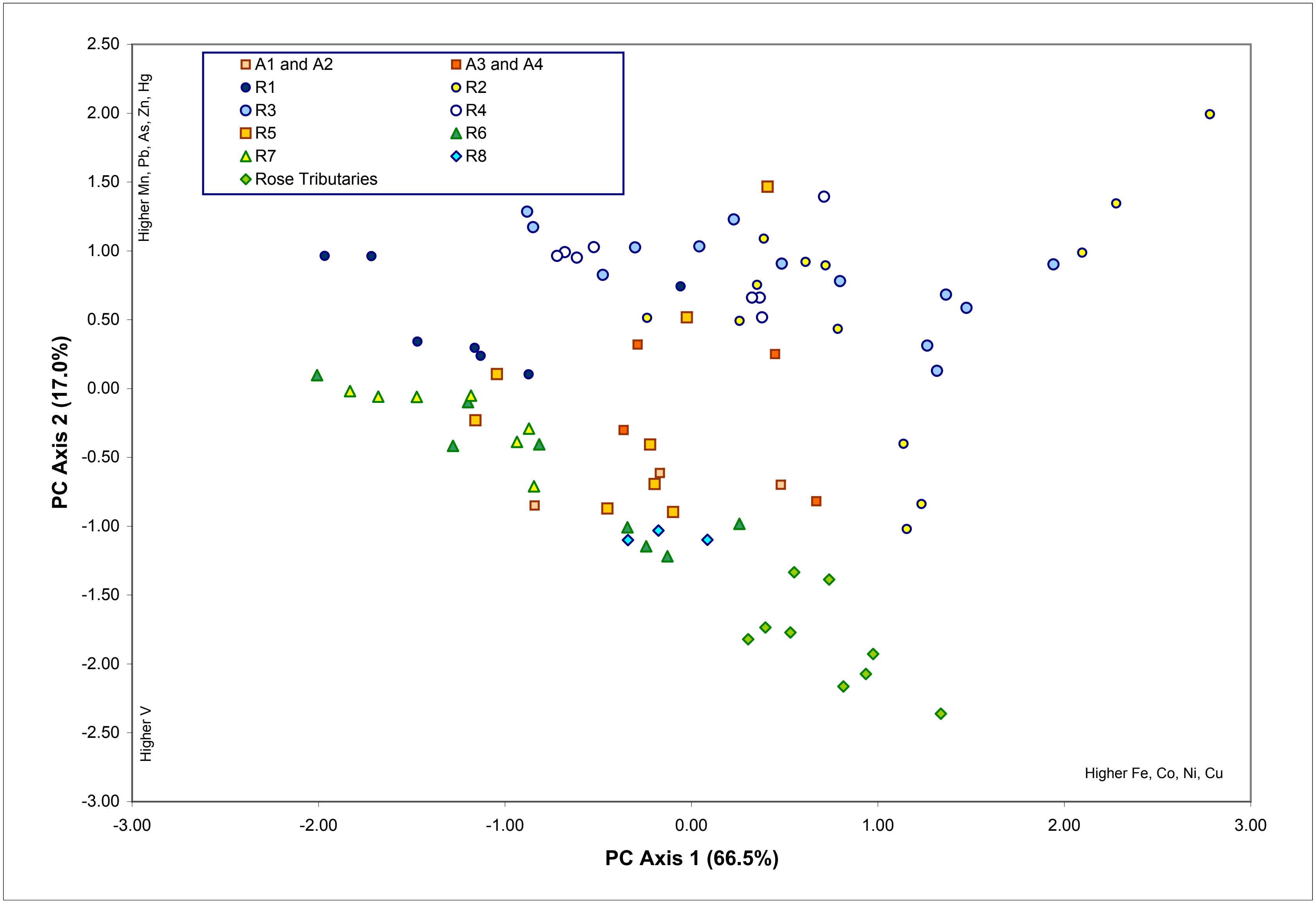


Figure 4.1: Scatter plot of principal component analysis (PCA) results for Rose-Anvil sediment chemistry (1996 to 2006 data)

At North Fork Rose Creek, sediment metal concentrations (as represented by both PC-1 and PC-2 axes) were significantly higher at potentially-mine-influenced station R8 relative to the upstream reference station R7 (Appendix Tables B.4 and B.5; Figure 4.1), suggesting mine-related influence. However, because sediment metal levels at R8 did not exceed reference benchmarks (Table 4.1), the suggested impacts were considered minor. Finally, with respect to comparisons among reference areas, concentrations of sediment metals (as represented by both PC-1 and PC-2 axes) were significantly higher at the Rose Creek tributaries (Stations 4394, 4397 and 4399; Figure 2.3) relative to both Anvil Creek (R6) and North Branch Rose Creek (R7), suggesting high natural variability in local sediment metal characteristics.

Relative to the CSQG, arsenic, lead and zinc often exceeded respective PEL at Rose Creek stations located downstream of the tailings-effluent discharge (i.e., stations R2, R3 and R4) and at lower Anvil Creek stations R5, A3 and A4 (Table 4.1). Arsenic, lead and zinc concentrations were generally less than a factor of three times greater than respective PEL at all stations (Table 4.1).

On March 19th, 1975, a tailings spill occurred as a result of a breach in the tailings impoundment wall. Due to seasonal ice and snow cover, much of the tailings were spilled into the Rose Creek floodplain. Evidence of the spill was observed in and beside Rose Creek as far downstream as the Anvil Creek confluence during a fly-over on March 20th (Weagle 1975). Some environmental studies conducted since that time have concluded that adverse effects to Rose-Anvil sediment quality, benthic invertebrate and fish communities may have been at least partially attributable to the spill (e.g., Godin and Osler 1985; ACG et al. 2006). During the current analysis, sediment metal chemistry data were not indicative of any substantial tailings remnants in the flooded portions of lower Rose or Anvil Creeks[3]. Although mean concentrations of several metals were elevated at lower Anvil Creek stations A3 and A4 relative to upstream (R5) and downstream (A1 and A2) stations, the observed levels were substantially lower than those found immediately downstream of the tailings effluent discharge in Rose Creek (i.e., Station R2; Table 4.1). These data suggested that tailings material may have largely been flushed out of the Rose-Anvil channel[4], which is consistent with what may be expected given the system's high seasonal flows, the small grain size of mine tailings and the passage of three decades.

[3] Soil samples collected from the adjacent floodplain in 2005 showed patches containing elevated metal levels, confirmed to be largely of mine origin through lead isotope analysis (ACG et al. 2006). This information suggests that tailings deposits are still evident in some parts of the floodplain outside of the wetted channel. Seasonal flushing of such areas does not appear to be adversely affecting creek water quality.

4.1.2 Temporal Comparisons

Evaluation of sediment metal concentrations at Rose-Anvil Creek monitoring stations over the period from 1973 to 2006 indicated a clear step change between data collected before and after 2004 at most stations, with particularly high metal concentrations observed for some metals in 1983 and/or 1999 (e.g., copper, lead and/or mercury; Figure 4.2). The observed trends may have been at least partly attributable to different analytical laboratories conducting the analyses from study to study. Although this observation was supported by unusually high sediment copper and lead concentrations at reference station R6 in 1983 and 1999, less dramatic variation was observed for zinc (Figure 4.2) suggesting that any differences in laboratory analysis techniques may have been metal-specific. Removal of the 1983 and 1999 data from the temporal plots suggested decreasing concentrations of certain metals (e.g., arsenic, lead and mercury), whereas others remained relatively unchanged (e.g., copper, manganese and zinc) over the period from 1973 to 2006 (Appendix Figure B.1).

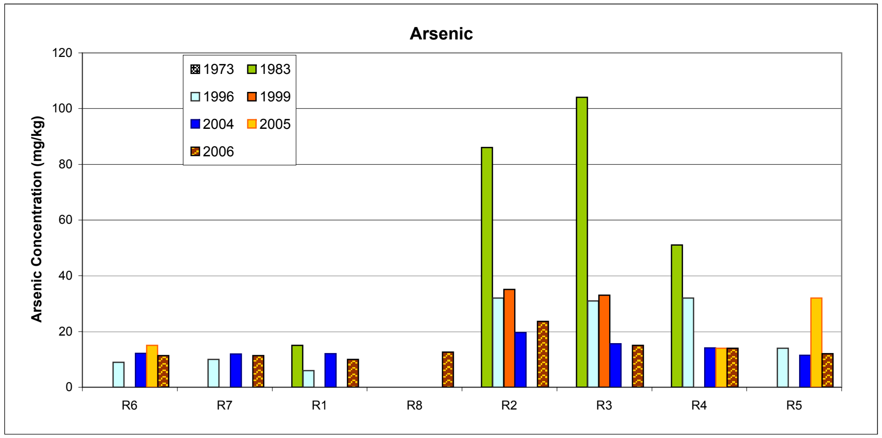
4.2 Vangorda Creek Sediment Chemistry

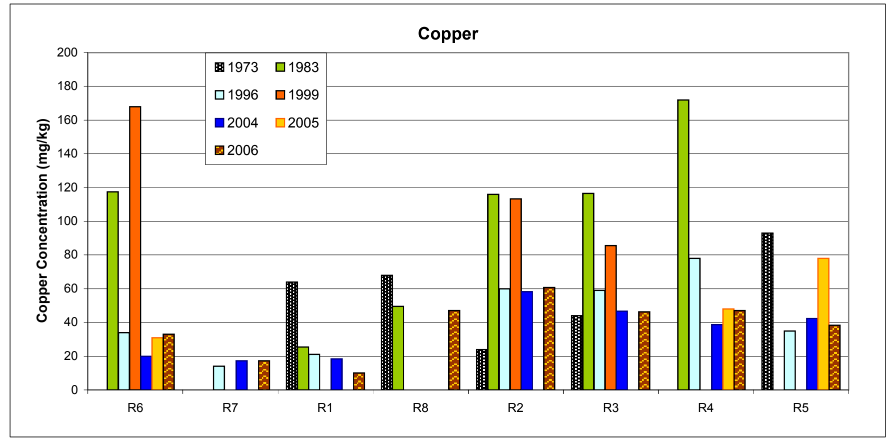
4.2.1 Spatial Comparisons

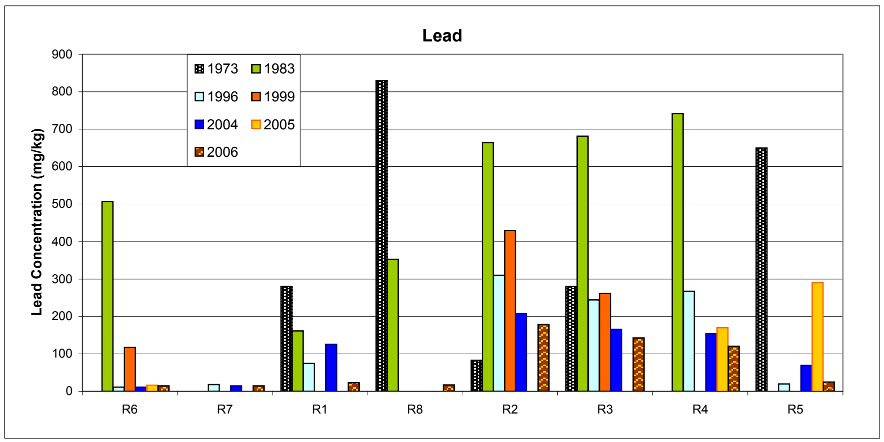
Sediment metal data for the Vangorda Creek system (based on combined 1995 to 2005 data set) indicated highest metal concentrations immediately downstream of the mine effluent discharge (V27) and substantially lower concentrations at the West Fork (V5) and lower (V8) Vangorda Creek areas (Table 4.2). As may be expected, sediment metal concentrations in lower Vangorda Creek were generally intermediate between concentrations observed in the West Fork and upper Vangorda Creek reaches (Table 4.2).

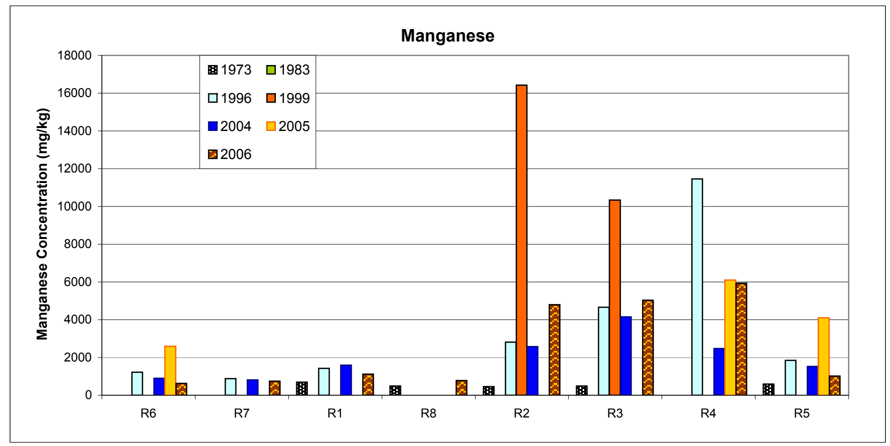
PCA reduced the sediment metal data into four principal components (PC-1 to PC-4) that cumulatively explained 86.7% of the variation in sediment chemistry data (Appendix Table B.9). PC-1 (39.2% of variation) separated Vangorda Creek stations based on high positive weightings of several metals, but most notably copper, iron, arsenic and zinc (Figure 4.3; Appendix Table B.9). Sediment PC-1 values were significantly higher at the near-field upper Vangorda Creek station (V27) compared to all remaining areas, including the upstream reference, West Fork and lower Vangorda Creek areas (Appendix Table B.10, Figure 4.3). Copper, arsenic and zinc concentrations at V27 were elevated by factors from as great as 2.6 to 5.8 times relative to reference (Table 4.2; Appendix Table B.8) suggesting that these metals may be indicative of mine influence.

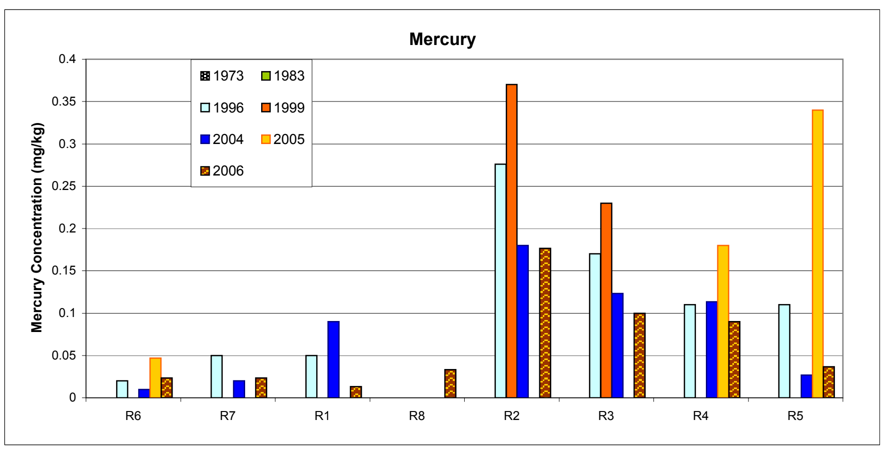
PC-2 (22.1% of variation) mainly reflected high positive weightings of calcium, magnesium, strontium and nickel (Appendix Table B.9). Sediment PC-2 scores were significantly different











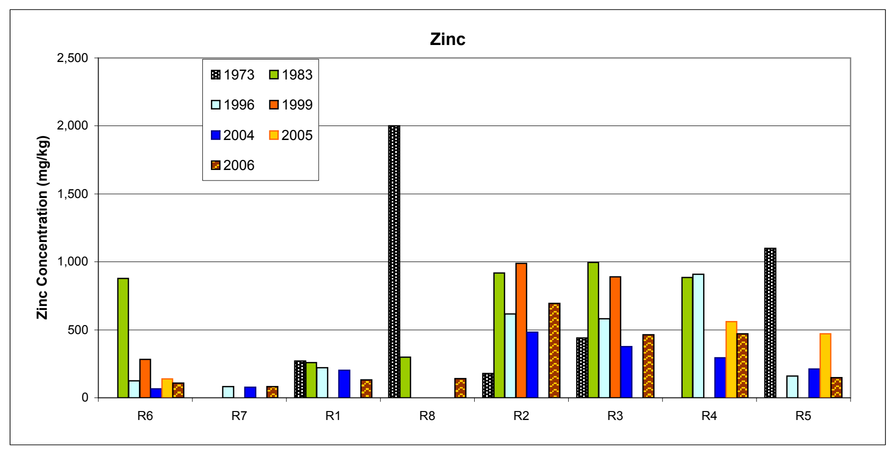


Figure 4.2: Temporal comparison of average mine-indicator sediment metal concentrations at Rose-Anvil Creek monitoring stations, 1973 to 2006
(Source data: Hoos and Holman 1973; Godin and Osler 1985; Burns 1997, 2004, 2006; YTG [unpub.] 1999; ACG et al. 2006)

Table 4.2: Summary of Vangorda Creek system sediment chemistry data[a] (1995 to 2005) and comparison relative to established reference benchmarks

Metal	Benchmark		Reference Station	Mine-Influenced Stations		
	95th Percentile[b]	CSQG PEL[c]	V1	Near-Field V27	West Fork V5	Lower Vangorda V8
Aluminum	17,551		13,892	11,147	7,886	8,995
Arsenic	34.9	17.0	21.1	92.7	17.6	21.8
Barium	298		180	200	214	235
Cadmium	1.1	3.5	0.7	1.6	0.6	0.8
Calcium	5,818		4,211	7,443	16,714	10,005
Chromium	60.5		34.2	43.9	44.0	40.6
Cobalt	20.4		12.7	23.3	11.0	12.0
Copper	55.0	197	31.2	81.4	28.8	35.3
Iron	40,700		27,098	32,516	18,331	20,423
Lead	76.0	91.3	37	1,543	33	113
Magnesium	7,303		5,287	8,325	10,171	8,411
Manganese	1,580		786	611	436	463
Molybdenum	5		2	3	2	2
Nickel	49		31	47	54	46
Phosphorus	1,206		889	1,018	1,142	1,012
Potassium	2,038		1,339	673	630	698
Silver	0.4		0.2	2.0	0.2	0.6
Sodium	415		260	198	245	227
Strontium	47		34.0	41.7	66.0	47.2
Titanium	734		496	348	319	321
Vanadium	36.4		26.8	26.2	26.4	26.2
Zinc	191	315	122	700	99	241

[a] All metal concentrations expressed in mg/kg

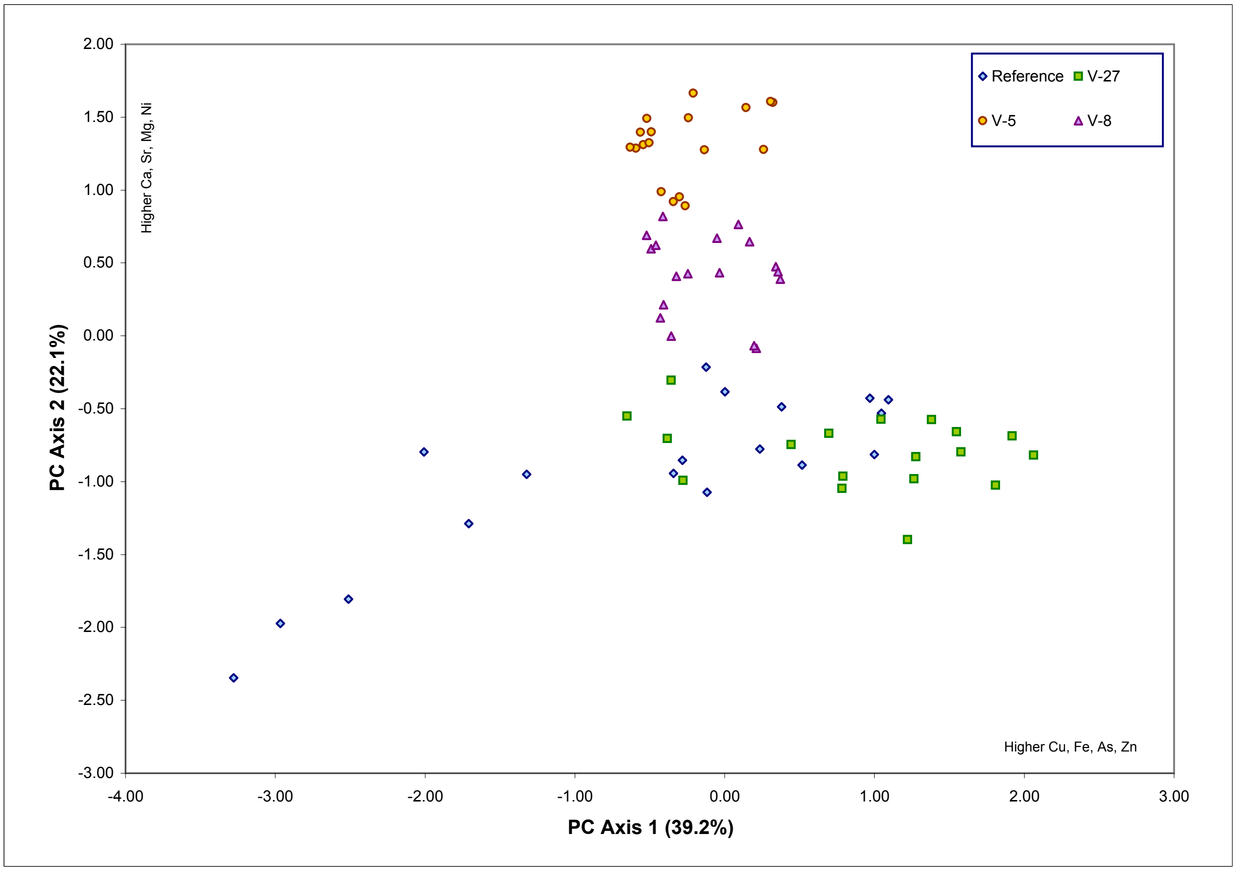
[b] Reference benchmark represents 95th percentile of reference data

[c] Canadian Sediment Quality Guideline for the Protection of Aquatic Life (CSQG) Probable Effect Level (PEL; CCME 2005)

Indicates value that exceeds 95th percentile reference benchmark

Indicates value that exceeds both the 95th percentile reference benchmark and CSQG PEL

Indicates value that exceeds CSQG PEL but not the 95th percentile reference benchmark



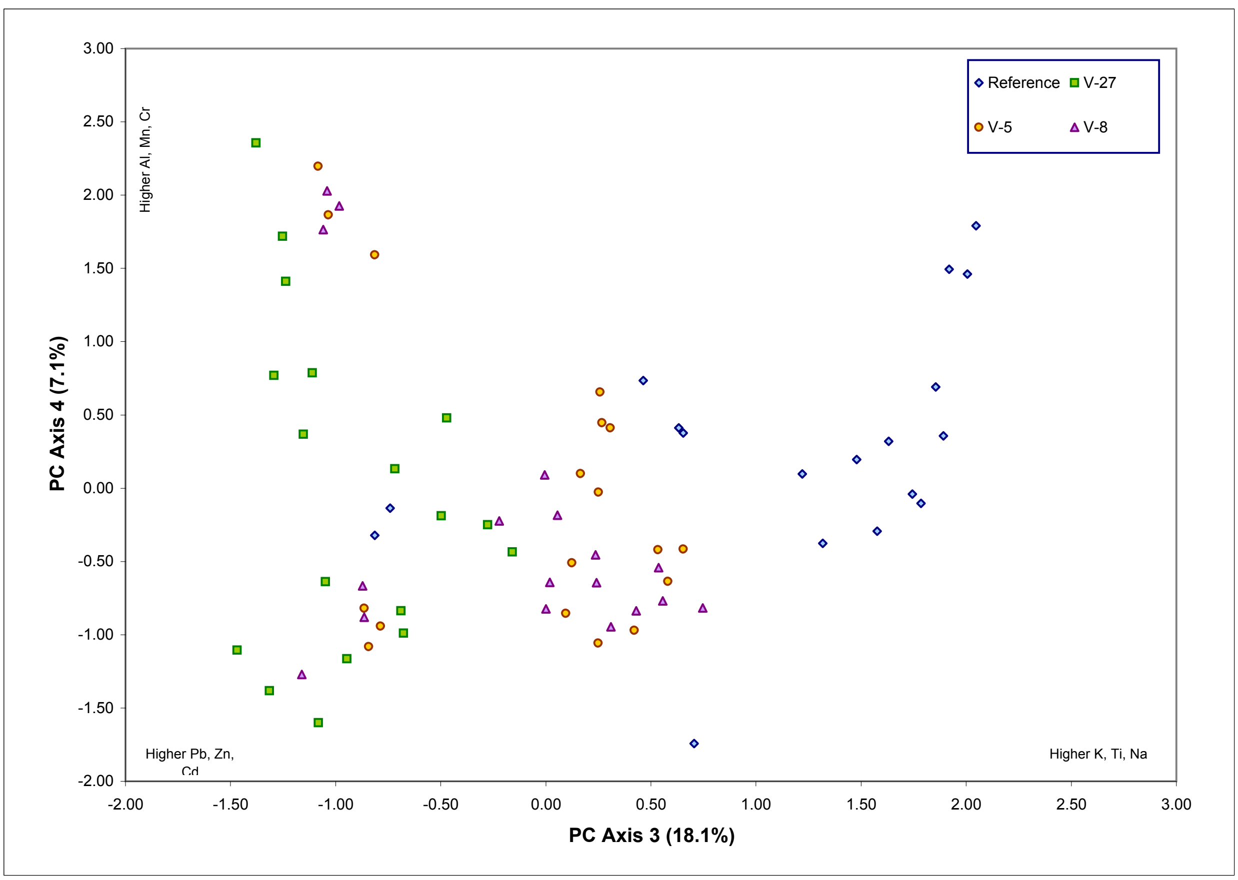


Figure 4.3: Scatter plot of principal component analysis (PCA) results for Vangorda sediment chemistry (1995 to 2005 data)

among all areas except the upper Vangorda Creek near-field (V27) and reference areas (V1; Appendix Table B.10; Figure 4.3). PC-2 values were highest at the West Fork (Station V5), with calcium, strontium and nickel notably elevated above reference benchmarks (Table 4.2; Appendix Table B.8). The patterns observed among areas based on analysis of PC-2 scores suggested localized variability between West Fork and upper Vangorda Creek chemistry based mainly on hardness-related differences (as indicated by greater calcium and magnesium; Appendix Table B.10). Similar patterns were observed in the water quality assessment (Section 3.3).

High positive weightings of potassium, titanium and sodium and moderate negative weightings of lead, zinc and cadmium characterized PC-3 (18.1% of variation; Figure 4.3; Appendix Table B.9). Sediment PC-3 values were significantly different among all areas except that the West Fork and lower Vangorda Creek areas were similar to each other (Appendix Table B.10; Figure 4.3). Statistical analysis of PC-3 values suggested significant differences between the upper Vangorda Creek near-field and reference areas based on high lead, cadmium and zinc levels at the former area (V27), and high potassium, titanium and sodium (and low lead, cadmium and zinc) levels at the latter (V1). Sediment lead and zinc concentrations were elevated considerably (i.e., by a factor of approximately 16 and 6, respectively) at the upper Vangorda Creek near-field area, and to a much lesser extent at lower Vangorda Creek, relative to respective reference benchmarks (Table 4.2; Appendix Table B.8). Sediment cadmium concentrations at the near-field area also exceeded the respective reference benchmark. No other heavily weighted PC-3 metals exceeded reference benchmarks (Table 4.2). Similar to PC-2 statistical comparisons, the differences identified between upper Vangorda Creek and both the West Fork and lower Vangorda Creek stations based on PC-3 values suggested again that conditions in the latter, and the West Fork in particular, were fundamentally different from upper Vangorda Creek.

Because PC-4 (7.1% of variation) values did not vary significantly among areas (Appendix Table B.10), no further interpretation was completed.

Relative to the CSQG, arsenic concentrations exceeded the PEL at all Vangorda Creek system stations, suggesting naturally high background levels (Table 4.2). However, substantially higher sediment arsenic concentrations at the upper Vangorda Creek near-field station compared to reference levels suggested additional mine-related input (Table 4.2). Lead and zinc concentrations also exceeded respective PEL at the near-field location; however, only lead remained elevated above PEL further downstream at lower Vangorda Creek.

4.2.2 Temporal Comparisons

Based on the spatial evaluation of sediment metal chemistry, the best indicators of Grum/ Vangorda mine activity included arsenic, lead and zinc concentrations (see Section 4.2.1). Examination of temporal trends (1995 to 2005) for these parameters suggested markedly lower metal concentrations in 2005 at the near-field exposure area in upper Vangorda Creek (Station V27) relative to all previous studies (Figure 4.4). Prior to 2005, arsenic, copper, iron and lead concentrations at this location appeared temporally stable whereas sediment cadmium and zinc concentrations appeared to be increasing (Figure 4.4). At the West Fork and lower Vangorda Creek stations (V5 and V8, respectively), temporal comparisons suggested slowly decreasing concentrations of sediment metals over the 1995 to 2005 period with the exception of cadmium, which generally showed little change (Figure 4.4). Most recently, sediment cadmium levels at both V5 and V8 have been in the upper portion of respective historical ranges (Figure 4.4). Overall, sediment metal concentrations measured at mine-influenced areas of the Vangorda Creek system suggested that, since 1995, most metals levels have been slowly decreasing.

4.3 Summary and Recommendations

Sediment sample analyses have been conducted in the Rose-Anvil and Vangorda Creek systems since the early 1970s and 1990s, respectively, to determine to what extent, if any, that each site has impacted sediment quality.

Evaluation of the historical data indicated that sediment metal concentrations were significantly elevated in Rose Creek relative to background benchmarks (e.g., arsenic, cobalt, copper, iron, lead, manganese, mercury, nickel zinc) with elevations of some metals such as manganese, lead, and zinc levels extending further downstream into Anvil Creek (i.e., Stations A4 and A3). Arsenic, lead and zinc were observed at concentrations above CSQG PEL, suggesting some potential to adversely affect aquatic life. These three metals, as well as manganese, can be considered the strongest indicators of influence from the Faro site on sediment chemistry (e.g., “mine indicators”). The data were not indicative of any substantial remnants of tailings in the Rose-Anvil system from a reported tailings spill into Rose Creek in 1975. It is suspected that any material has likely been flushed out of the Rose-Anvil channel with the passage of over 30 years’ time, although deposits remain in the floodplain. Sediment metal concentrations at North Fork Rose Creek were also significantly higher at mine-influenced station R8 relative to the upstream reference station R7, although sediment metal levels at R8 were within reference benchmarks levels suggesting only a minor mine-effect. Although temporal comparison of the Rose-Anvil historical sediment chemistry data may have been confounded by differences in laboratory

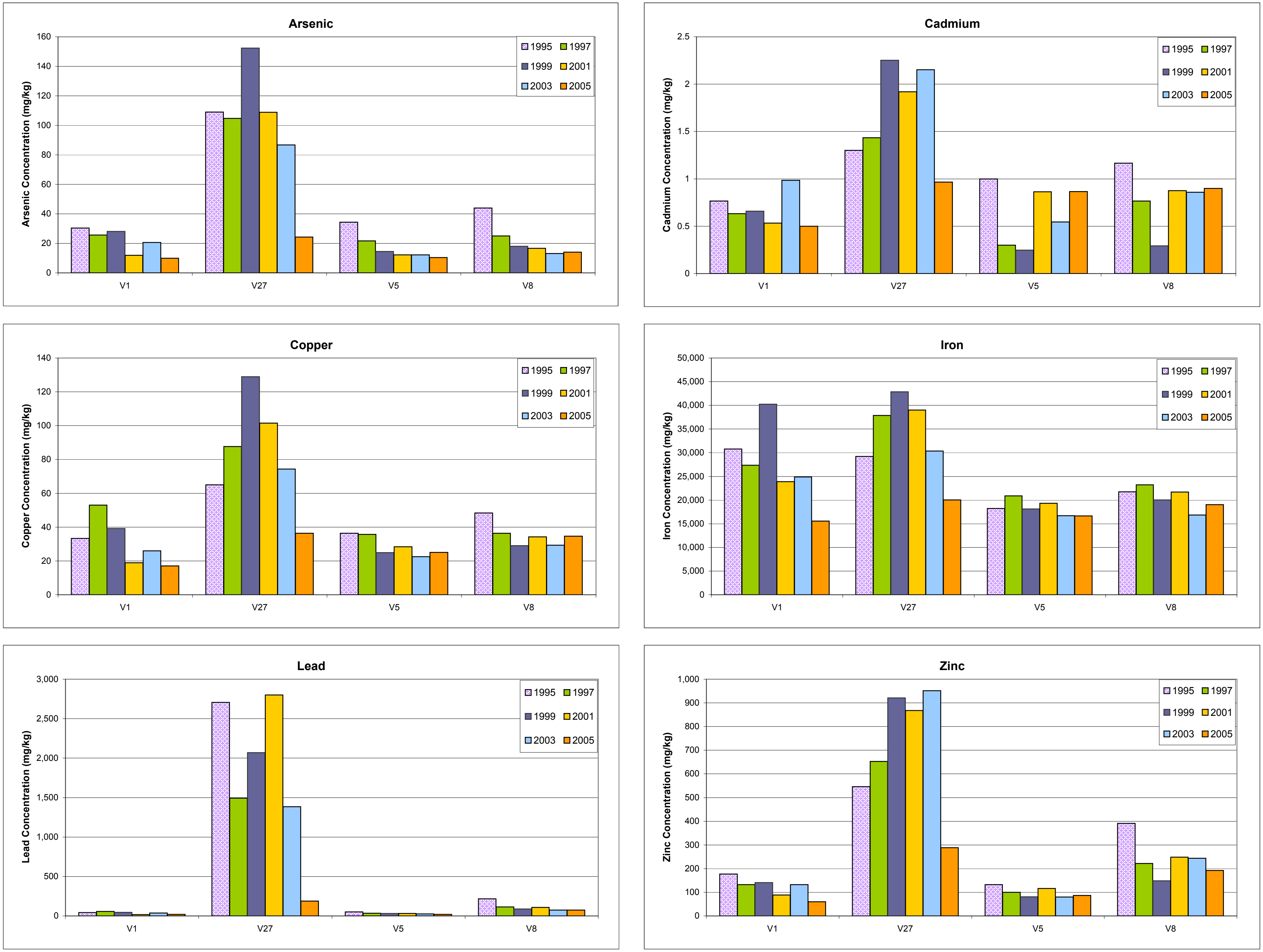


Figure 4.4: Temporal comparison of average mine-indicator sediment metal concentrations at Vangorda Creek monitoring stations, 1995 to 2005

(Source data: Burns 1996, 1998, 2000, 2002a, 2003, 2005) equipment/techniques from study to study, the data suggested that sediment metal concentrations in the Rose-Anvil system have decreased slightly over the period from 1973 to 2006.

In the Vangorda Creek system, sediment metal concentrations were significantly elevated at Station V27 the nearest downstream station to the Grum and Vangorda mines. Statistical evaluation of the historical data identified that the key indicators of mine influence on sediment chemistry were arsenic, lead, and zinc, which were the only metals observed at concentrations above CSQG PEL. Sediment chemistry differed between West Fork/lower Vangorda Creek versus upper Vangorda Creek, possibly reflecting natural variability in the various drainages or other upstream mine influences (roads, waste rock drainage). High natural variability in sediment chemistry was also observed among reference areas in the Rose-Anvil system. In lower Vangorda Creek (V8), sediment metal concentrations were intermediate between the West Fork and upper Vangorda Creek watercourses. Sediment lead and zinc concentrations, likely originating from upper Vangorda Creek, were elevated relative to reference, whereas calcium and strontium, likely originating from the West Fork, were also elevated. Of these, only sediment lead concentrations exceeded the PEL at V8. Temporal comparison of Vangorda sediment data suggested substantially lower metal concentrations at the near-field (V27) location in 2005, whereas metal concentrations at the West Fork and lower Vangorda showed slower temporal decreases.

The benefit of future sediment analyses should be weighed against the amount of environmental insight gained and the associated costs. The aquatic environments near the Faro mine complex are generally high gradient with substantial seasonal scour, and are consequently dominated by larger substrates (gravel to boulder). This type of habitat provides limited opportunity for deposition of chemical precipitates or contaminants associated with fine sediments. If continued, any future sediment analyses should include evaluation of particle size and total organic carbon content to assist in data interpretation.

5.0 BENTHIC COMMUNITY ASSESSMENT

Benthic invertebrate sampling was initiated at some stations in 1973 within the Rose/Anvil Creek system and in 1975 within the Vangorda Creek system. From 1991 on, benthic invertebrate population monitoring has been conducted at standardized station locations every second year as per the requirements of the water licenses (alternating between Rose and Vangorda Creeks). Artificial substrates were used for the majority of studies, providing some consistency across much of the data set, although sample/data analysis varied in terms of factors such as numbers of replicate samples and levels of taxonomic identifications (Table 5.1). Detailed statistical analyses were undertaken for this report based on benthic community surveys conducted since 2000. The results of previous surveys (1973-1999) were also reviewed and discussed, with comparisons of mean benthic invertebrate abundance and number of taxa where methodologies were sufficiently similar to make such comparisons valid.

5.1 Combined Assessment of Rose and Vangorda Creeks

5.1.1 Differences Among Areas and Stations

Sampling conducted in recent years (2000-2006) indicated Vangorda Creek has had fewer taxa (lower diversity), and lower abundance of benthic organisms than has Rose Creek (Figure 5.1a,b, Appendix Tables C.3 and C.4). The community structure of the two creeks also varied significantly, as Rose Creek had significantly greater percent chironomids and lower percent EPT[4] than Vangorda Creek (Figure 5.1c,d).

Correspondence Analysis (CA) of the combined creek data explained 43.1% of the original variation in the first four CA axes (Appendix Tables C.5 and C.6). The two creeks were clearly and significantly separated on CA Axis-1 and Axis-3 scores (Figure 5.2a Appendix Table C.4). Taxa such as larvae of the black fly *Cnephia*, the no-see-um midge *Brillia*, the mayflies of the genus *Heptagenia*, and chironomids (*Thienemannimyia* sp.), which were relatively more abundant at Vangorda stations, dominated the scores of the first axis (Appendix Table C.6). Rose Creek stations scored higher than Vangorda stations on CA Axis 3 based, in part, on greater relative abundance of the stonefly *Podmosta* and the mayfly *Drunella flavilinia*.

Owing to the substantial differences between the community structures of the two creeks, there was little evidence of differences between reference and mine-exposed areas in the

[4] The group comprised of mayflies (Ephemeroptera), stoneflies (Plecoptera) and caddisflies (Trichoptera).

Table 5.1: Summary of methods used in benthic invertebrate community assessments

Reference	Year Sampled	Stations	Sampler	Replicates/ station	Replicate Samples/Data Composited?	Incubation or collection dates	mesh size	Metrics for replicate samples presented in report?	Taxonomy
Hoos and Holman 1973	1973	R1-R3, R5, R11	1 square foot circular sampler	3	n	Sept 17-21, 1973	not specified	n	genus
Baker 1979	1974-1976	R1-R4, R6, R11 and Pelly River	chrome-plated baskets with rocks	3	n	1974, 1975, and 1976 (dates not given)	100 microns (surber)	abundance only	genus
Montreal Engineering 1976	1975	West Fork Vangorda, South Fork Rose (u/s R1), Blind Creek	Surber and plankton tow	3 (surber)	y	August 1975	not specified	n	Partially to family
Weagle 1981a	1977	R1-R4, R6, R11 and Pelly River	chrome-plated baskets with rocks	3	y	August 18 to Oct 5, 1977	100 microns (surber)	n	genus
Weagle 1981a	1978	R1-R4, R6, R11 and Pelly River	Surber	3	y	August 18 to Oct 5, 1977	100 microns (surber)	n	genus
Weagle 1980	1980	R1-R5, V1, V27, VGMAIN, Blind Creek, Swim Creek	cylindrical BBQ baskets, 17cm dia, 24cm long. Filled with rocks to up to 5 cm	2	y	Aug 14-15 to Sept 17-18, 1980	100 microns (surber)	n	genus/species
Weagle 1981b	1981	R1-R6, V1, V27, Blind Creek, Swim Creek	chrome-plated cylindrical BBQ baskets, 17cm dia, 24cm long. Filled with rocks to up to 5 cm	2	y	Aug 27/28 to Sept 30/Oct 2, 1981	100 um (surber)	n	genus/species
Weagle 1982	1982	R1-R5	chrome-plated cylindrical BBQ baskets, 17cm dia, 24cm long. Filled with rocks to up to 5 cm	2	y	September 7-October 8, 1982	100 um (surber)	n	genus/species
Godin and Osler 1985	1983	R1-R6, R11, and Pelly River	Baskets with rocks 1-8 cm diameter	3	y	July 26 to Sept 15, 1983	0.76mm	n	genus
Weagle 1983	1983	R1-R5	BBQ baskets, 40 x 40 x 15 cm. Filled with rocks to up to 2.5 cm	2	y	Aug 19/20 to Oct 13/14, 1983	100 um (drift net)	n	genus/species
Leverton and Associates 1987	1986	R2-R5 (see comment re: R1)	Galvanized wire mesh cylinder 26cm long, 17cm dia. Filled with gravel (2-15cm dia)	3	n	July 14 to August 27, 1986	not specified	n	genus/species
Burns 1989	1988	R1-R5	Galvanized wire mesh cylinder 26cm long, 17cm dia. Filled with gravel (2-15cm dia)	3	y	Aug 5 to Sept 21-22, 1988	retrieved into bucket, no net mentioned	n	genus/species
Burns 1989	1988	R6, V8 and Blind Creek	Galvanized wire mesh cylinder 26cm long, 17cm dia. Filled with gravel (2-15cm dia)	3	y	Aug 5 to Sept 21-22, 1988	retrieved into bucket, no net mentioned	n	genus/species
Burns 1991	1990	R1-R7	Galvanized wire mesh cylinder 26cm long, 17cm dia. Filled with gravel (2-15cm dia)	3	n	Aug 22/24 to	retrieved into bucket, no net mentioned	n	genus
Harder and Associates 1991c	1990	V8 and Blind Creek	baskets with clean substrata; no details provided	3	n	July 29 to Sept. 5, 1990	not specified	y	family/genus
Harder and Associates 1992	1990	V1, V5, V27, V8, Blind and Buttle Creeks	Galvanized wire mesh cylinder 26cm long, 17cm dia. Filled with gravel (2-15cm dia)	3	n	installed July 18-19, 1990, for five weeks	not specified	y	not specified
Harder and Associates 1993a,b	1992	R1-R7	Galvanized wire mesh cylinder 26cm long, 17cm dia. Filled with gravel (2-15cm dia)	3	n	July 8/10 to Aug 16/17, 1992	300 micron, animals > 0.25mm enumerated	y	family/genus
Burns 1994	1994	R1-R7	Galvanized wire mesh cylinder 26cm long, 17cm dia. Filled with gravel (2-15cm dia)	3	n	Installed late July and retrieved after about five weeks		abundance only	genus/species
Burns 1993 1996, 1998, 2000, 2001, 2002b, 2003, 2005	1993, 1995, 1997, 1999, 2001, 2003, 2005	V1, V5, V27, V8	Galvanized wire mesh cylinder 26cm long, 17cm dia. Filled with gravel (2-15cm dia)	3	n	Installed late July and retrieved after about five weeks		n	genus/species
Burns 1997, 1999, 2001, 2002b, 2004, 2006	1996, 1998, 2000, 2002, 2004, 2006	R1-R7	Galvanized wire mesh cylinder 26cm long, 17cm dia. Filled with gravel (2-15cm dia)	3	n	Installed late July and retrieved after about five weeks		y	genus/species

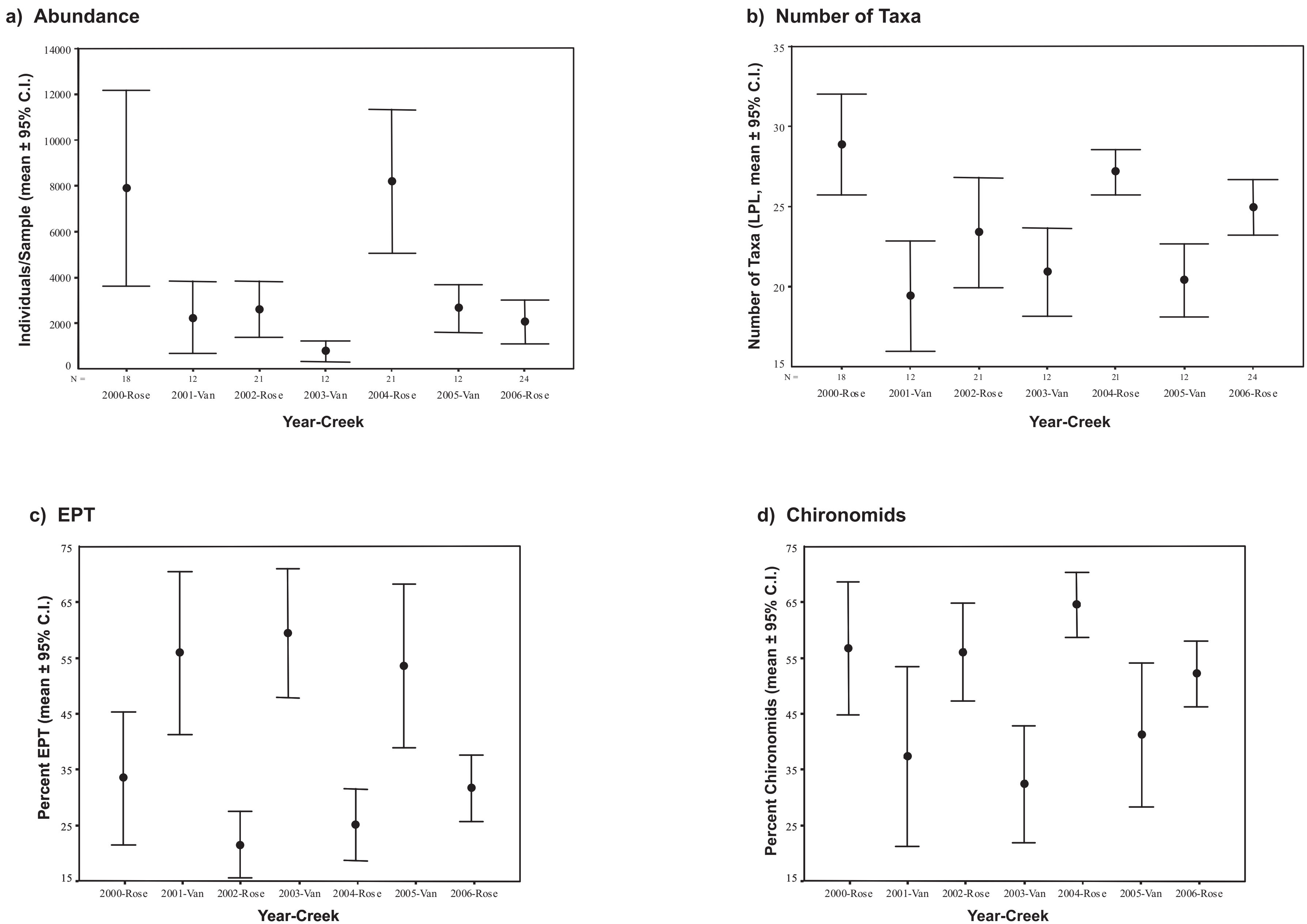


Figure 5.1: Comparison of benthic metrics for Rose and Vangorda Creeks, 2000 - 2006

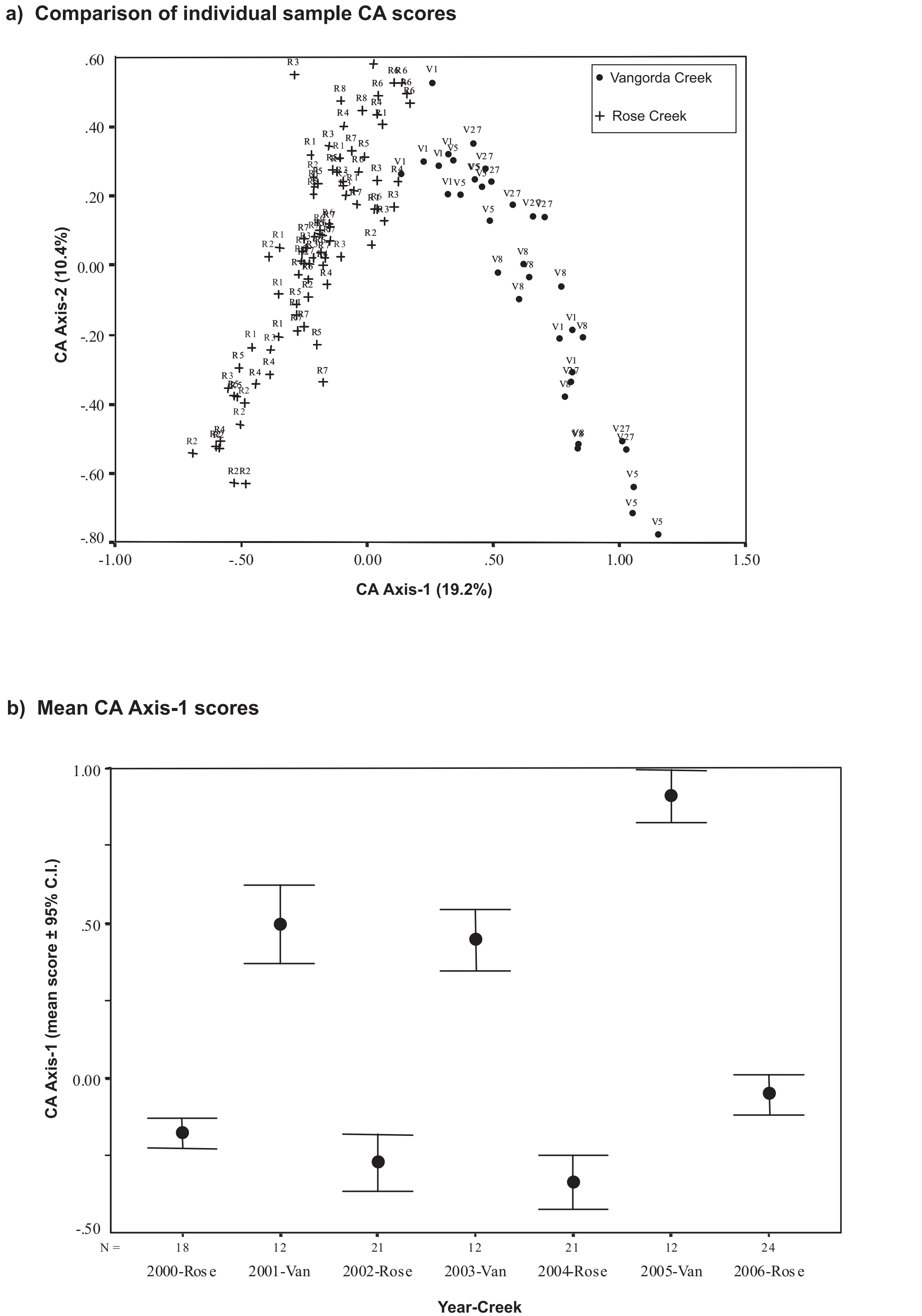


Figure 5.2: Combined correspondence analysis of data for stations located in Rose/Anvil and Vangorda Creek watersheds: a) Comparison of individual sample CA scores and b) Mean CA Axis-1 scores

combined assessment. Also, since the two creeks were never sampled in the same year, an unequivocal test of reference/exposure differences across the two creeks could not be conducted. Accordingly, the data for the two watersheds were divided for further analyses.

5.1.2 Differences Among Years

A statistical test of the differences among years could not be carried out independently of the difference between creeks, since they were sampled in alternate years and never in the same year. Inspection of means and confidence intervals of benthic metrics for each creek and year suggested that substantial differences existed between creeks and among years (Figures 5.1 and 5.2).

5.2 Rose Creek

In CA involving only Rose Creek stations, the first three axes summarized 33.5% of the variation in the original data (Appendix Tables C.10 and C.11). The first CA axis, explaining 15.2% of the variation, contrasted stations with low relative abundance of *Podmosta* stoneflies and high relative abundance of *Mallochohelea* no-see-um midges, *Heptagenia* mayflies, and *Micropsectra* chironomids, from stations with opposite proportional abundances of these taxa. Rose CA-1 tended to separate exposure area R2, downstream of the tailings area, from the exposure area R8, located further upstream and east of the Faro pit (Figures 5.3 and 5.4a). Rose CA Axis-2 contrasted stations with and without high relative abundance of *Ameletus*, *Heptagenia*, and *Seratella* mayflies, *Brachycentrus* caddisflies, and *Mallochohelea* (Figure 5.4b, Appendix Table C.11). Rose CA Axis-3 explained only 8.7% of the variance, and mostly contrasted stations with and without high proportional abundance of *Mallochohelea* and *Heptagenia* (Figure 5.4c, Appendix Table C.11).

5.2.1 Comparisons Among All Rose Creek Stations

All benthic metrics varied significantly among stations and among years, and the station*year interaction term in 2-way ANOVA was also highly significant (Appendix Table C.8a). The significant interaction term indicated that changes in benthic metric values measured over time did not show a similar pattern among stations. This and the year-to-year variation within stations made it difficult to judge differences between individual stations. Considering station effects alone (i.e., ignoring year effect), Tamhane's post-hoc pair-wise tests of the metrics of individual stations showed few differences between the reference stations (Appendix Table C.9). Mean number of taxa was significantly lower at reference R7 (23.0) than at pseudo-

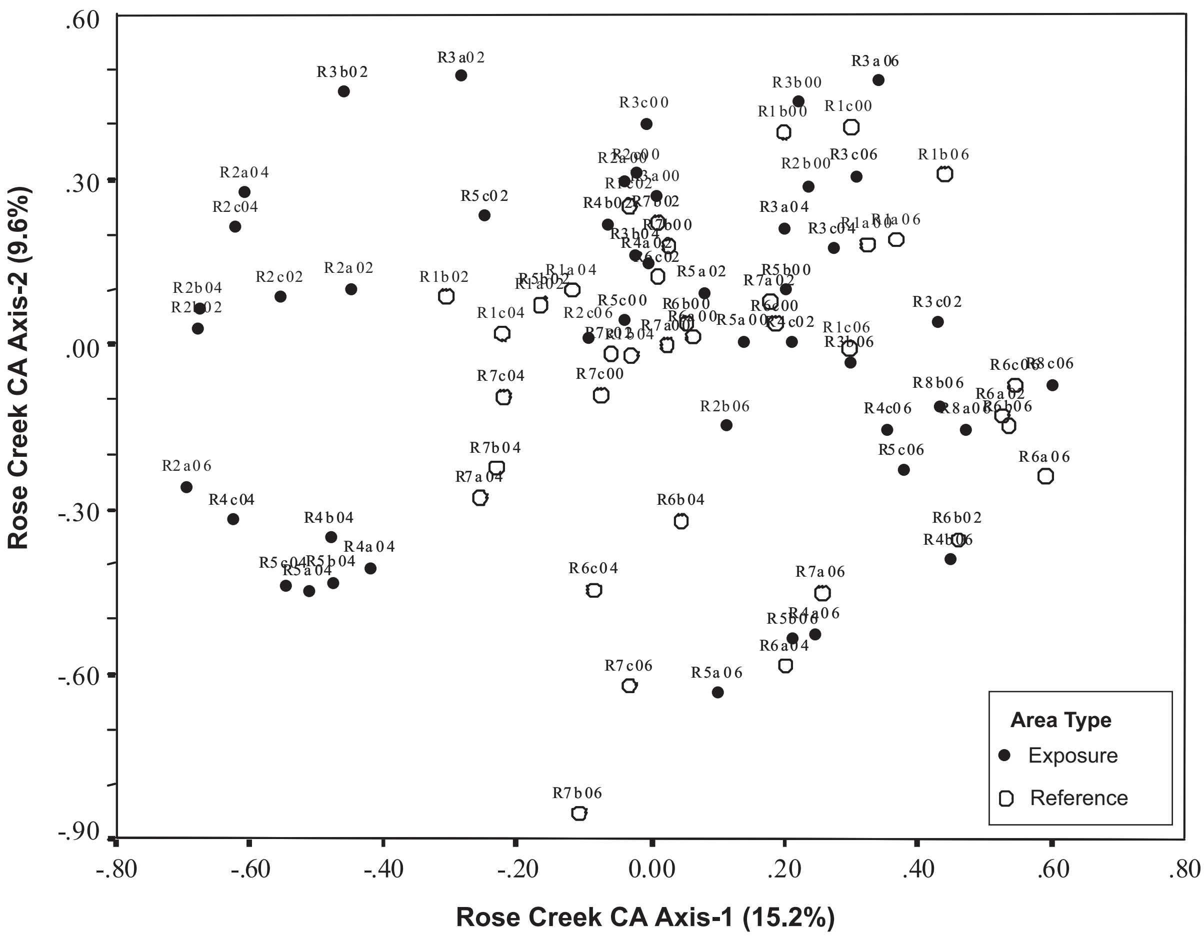
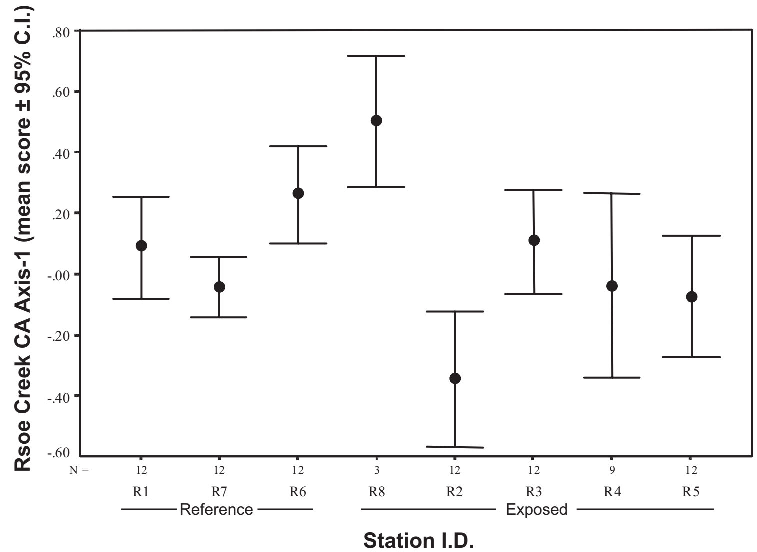
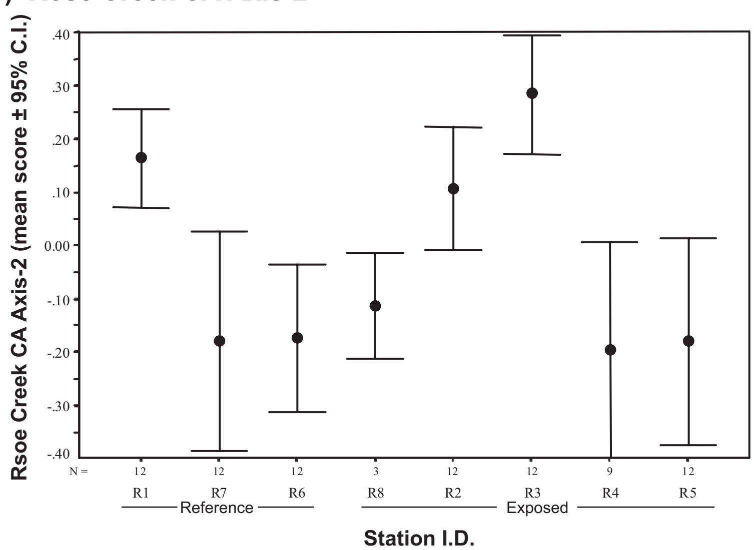


Figure 5.3: Correspondence analysis of Rose Creek data showing individual sample scores on each axis.

a) Rose Creek CA Axis-1



b) Rose Creek CA Axis-2



b) Rose Creek CA Axis-3

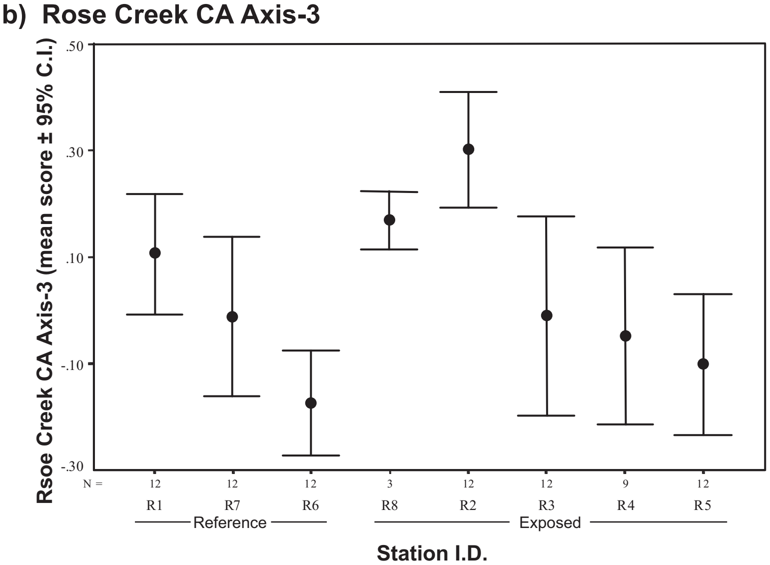


Figure 5.4: CA scores for Rose Creek stations combining data for even years 2000 - 2006: a) CA Axis-1, b) CA Axis-2, and c) CA Axis-3.

reference[5] R1 (29.6; Appendix Tables C.7 and C.9). No significant differences were observed between reference stations for abundance, or percent of either EPT or chironomids in these pair-wise tests. Subtle but statistically significant differences in community structure were indicated between pairs of Rose/Anvil Creek reference stations using CA (Appendix Table C.9). The reference stations R1, R6, and R7 represent different tributaries to the Rose/Anvil Creek system, and could be expected to show some differences in their benthic communities, which change in response to stream size and order (River Continuum Concept of Vannote et al. 1980), as well as physical habitat differences (e.g., water velocity, depth, water quality).

Considering both reference and mine-exposed stations, no differences were found between individual stations for mean abundance (range 1,495 to 7,258) or mean percent EPT (range 17.8% to 39.9%; Appendix Table C.9) despite the significant main effects found by ANOVA for these metrics (Appendix Table C.8). It is probable that this is owing to the lower power of the Tamhane's pair-wise tests and the added constraint of maintaining an experiment-wise error rate of 10% (i.e., $p = 0.10$) across the many pairwise comparisons.

Mean number of taxa was lowest at exposure station R3 (21.4) and reference R7 (23.0), both of which differed significantly from R1 (29.6 taxa; Appendix Tables C.7 and C.9). There were no other differences in number of taxa among Rose Creek stations. Percent chironomids was relatively high at all three reference stations (54.7%-72.7%); and lowest at exposure station R3 (37.4%). Percent EPT was highest at R3 (39.9%), but not significantly different from other stations.

In ANOVA and post-hoc comparisons of Rose Creek CA scores, near-field exposure station R2 had significantly lower CA-Axis 1 scores (15.2% of variance) compared to reference station R1 and R6 as well as minimally exposed station R8, which was sampled only in 2006 (Figures 5.4, Appendix Tables C.7 and C.9). However, CA-Axis 1 scores for R2 did not differ from reference station R7. Numerous other differences were observed among stations, with no consistent reference/exposure or upstream/downstream pattern for CA Axes 1, 2, or 3. Rose Creek CA Axis-4, though explaining little (7%) of the variance, significantly

[5] R1 has sometimes historically been considered a reference station, since upstream mine-related impacts have been limited to drainage associated with mine road crossings over upstream tributaries. The assessment presented in Section 3.0 indicated water quality was only slightly affected; therefore, R1 was categorized as a reference rather than exposure station for the purpose of the benthic community assessment. However, this designation was qualified throughout this section (e.g., "pseudo-reference" or "potential reference") as a reminder of its low-level exposure to mine-related substances. Also, R1 is located downstream of the former freshwater reservoir which likely affected flow patterns and the benthic community at R1. The reservoir dam was breached in 2004 after which the creek reverted to its former meandering configuration.

distinguished reference R1 from all other stations, based on greater relative abundance of the chironomid *Thienemanniella*, the stonefly *Podmosta*, and the no-see-um midge *Brillia* (Appendix Tables C.9 and C.11).

The Rose Creek data also were analysed after grouping the individual stations into Reference or Exposure categories, by 2-way ANOVA with Year as the second factor. This approach ignored the substantial variation among individual reference stations and individual exposure stations, but allowed an overall test of mine effluent exposure directly by ANOVA rather than by less powerful post-hoc pair-wise tests (Appendix Table C.8b). Although the complicating significant effects of Year and the Area*Year interaction were clearly still present for many metrics, no signficant differences were found between reference and exposure areas for either abundance or number of taxa. Percent EPT was greater in the exposure area than in the reference area, and percent chironomids was lower in the exposure area than in the reference area (Appendix Tables C.75b and C.8b), a pattern opposite to the one often associated with pollution-related impact. The combined Rose/Anvil Creek reference areas had significantly greater mean CA-1 score than the exposure area, and mean CA-2 score was significantly lower for the reference areas. Rose Creek CA-3 mean scores did not differ between the areas, but CA-4 scores were significantly lower in the exposure area than in the reference area.

5.2.2 Comparisons Among Years

Significant effects of sample year and its interaction with station (or area) were found for many benthic metrics, as discussed above. It is therefore clear that temporal differences, or even trends through time, may be as important a source of variation as those found between stations or areas. Possible mine related effects must be judged against the background of naturally occurring temporal and longitudinal change.

Using Correspondence Analysis (CA) scores in correlation analysis with sample year showed significant temporal trends in community structure. At exposure stations, a temporal trend could occur as a result of changing effluent concentrations, or from factors affecting reference stations in a similar way, or both.

Appendix Table C.17 identified temporal trends in CA scores for Rose CA-2 and Rose CA-3, but not for Rose CA-1 (which explained the greatest variation), or for Rose CA-4. The second CA axis decreased in value with sampling year, and Rose CA-3 increased through time, but reference and the exposure stations had very similar trends through time, suggesting that year-to-year variation was manifest in both areas, and is not related to changes in mine operation. Rose CA-4 displayed no temporal trend.

5.2.3 Summary

Benthic communities in Rose Creek were strongly affected by temporal change so that year-to-year variation, and its interaction with station or area effects, confounded the analysis of mine-related effects.

ANOVA comparisons of the reference and exposure groups of stations indicated differences at stations downstream of the Faro mine, which could be interpreted as mine-related effects. However, the community metrics affected (i.e., percent EPT, percent chironomids, CA-1, CA-2, CA-4) did not show the type of changes that are often indicative of community stress. Percent EPT, which is often more sensitive to effluent impact, was significantly greater in the exposure area, whereas percent chironomids was significantly greater in the reference area (Appendix Table C.7). Reference station R1, with low potential exposure to mine-related activities, had significantly greater number of taxa than exposure station R3, but R2 — closer to the tailings effluent discharge — was not significantly affected in this commonly used measure of community diversity. Exposure stations R4 and R5 immediately upstream and downstream, respectively, from the confluence of Anvil Creek and Rose Creek, showed no significant differences from reference station R6, on Anvil Creek (Appendix Table C.9). This suggested any mine-related effects are minimal at this distance, some 16 km downstream from the effluent source.

The relative importance of station, and year-to-year differences in Rose Creek was investigated by a variance component analysis. Various types of variance component models may be fit to the data, but all involve some compromises. The minimum norm quadratic unbiased estimator (MINQUE) model, used to examine Rose Creek data, does not assume normality of the data. This model is not ideal, but despite some shortcomings (negative variance proportions for some low-variance metrics), it gives some idea of the relative importance of the factors (Station, Year, and Station*Year interaction) in fitting the data. In Rose Creek, the interaction of station and year was the greatest source of variation for abundance, number of taxa, and percent EPT. Year alone was the most important source of variation for CA-1 and CA-3, whereas station was the main source of variation for percent chironomids and CA-2 (Appendix Table C.18). This suggests that temporal change has generally been playing as large a role in structuring benthic communities as relative station location, at least in recent years. Isolating the effect of temporal variation would be more practically accomplished by examining sufficient station data from a single year in a stand-alone analysis.

5.3 Vangorda Creek

The first three axes of the CA for Vangorda stations summarized 48.5% of the variation in the original data (Appendix Table C.15). The first axis (21.1% of variance) was predominantly a contrast of stations with high relative abundance of the mayfly *Ameletus* and the caddisfly *Dicosmoecus* against those stations with high relative abundance of the chironomid *Thienemanniella*, the black fly *Cnephia*, and the dance fly *Chelifera* (Appendix Table C.16). Vangorda CA-2 (17.7% of variance) contrasted station communities with high relative abundance of *Chelifera* and the cranefly *Dicranota* against those with *Rhithrogena* mayflies and the chironomid *Cardiocladius*. The third CA axis (9.7% of variance) is a *Chelifera/Micropsectra* continuum, and CA Axis-4 (9.4% of variance) was a measure of the relative abundance of *Ameletus* mayflies and Enchytraeidae worms.

5.3.1 Comparisons Among Stations

Significant differences were found among stations for all benthic metrics with the exception of Vangorda CA-4 (Appendix Table C.13). Interpretation of station (or area) differences was, as in the case of the Rose/Anvil watershed, confounded by significant differences among sample years for most metrics, and significant station*year interaction terms. Number of taxa showed neither a significant year main effect or station*year interaction term (Appendix Table C.13).

Mean abundance was significantly greater at West Vangorda Creek station V5 (3,746 organisms) than at Vangorda Creek stations V1 (800) or V27 (1,254; Appendix Tables C.12 and C.14). Number of taxa, which is often decreased in effluent-stressed areas, was also lower at reference station V1 (16.2) and exposure station V27 (18.8) than at V5 (22.4) or V8 (23.5), although only the comparisons between V1 and the West Fork / lower Vangorda Creek stations (V5 and V8) were statistically significant (Appendix Table C.14). That mean abundance and number of taxa at near-field station V27 were similar to those at reference station V1 suggested mine-related effects have had little or no effect.

Percent EPT (pollution intolerant Ephemeroptera, Plecoptera, Trichoptera) was significantly greater at nearfield exposure station V27 than at any other station (Appendix Tables C.12 and C.14). Percent chironomids varied in the opposite fashion, with lowest mean values at V27. No significant differences were observed between mean CA-1 scores for any pair-wise comparison, but most stations could be distinguished significantly on CA Axis-2, other than V5 and V8 (Figures 5.5 and 5.6; Appendix Table C14). V1 had the highest mean CA-2 scores (greatest relative abundance of *Rhithrogena* and *Cardiocladius* and lowest relative abundance of *Chelifera* and *Dicranota*); V27 had intermediate values for this axis, and both

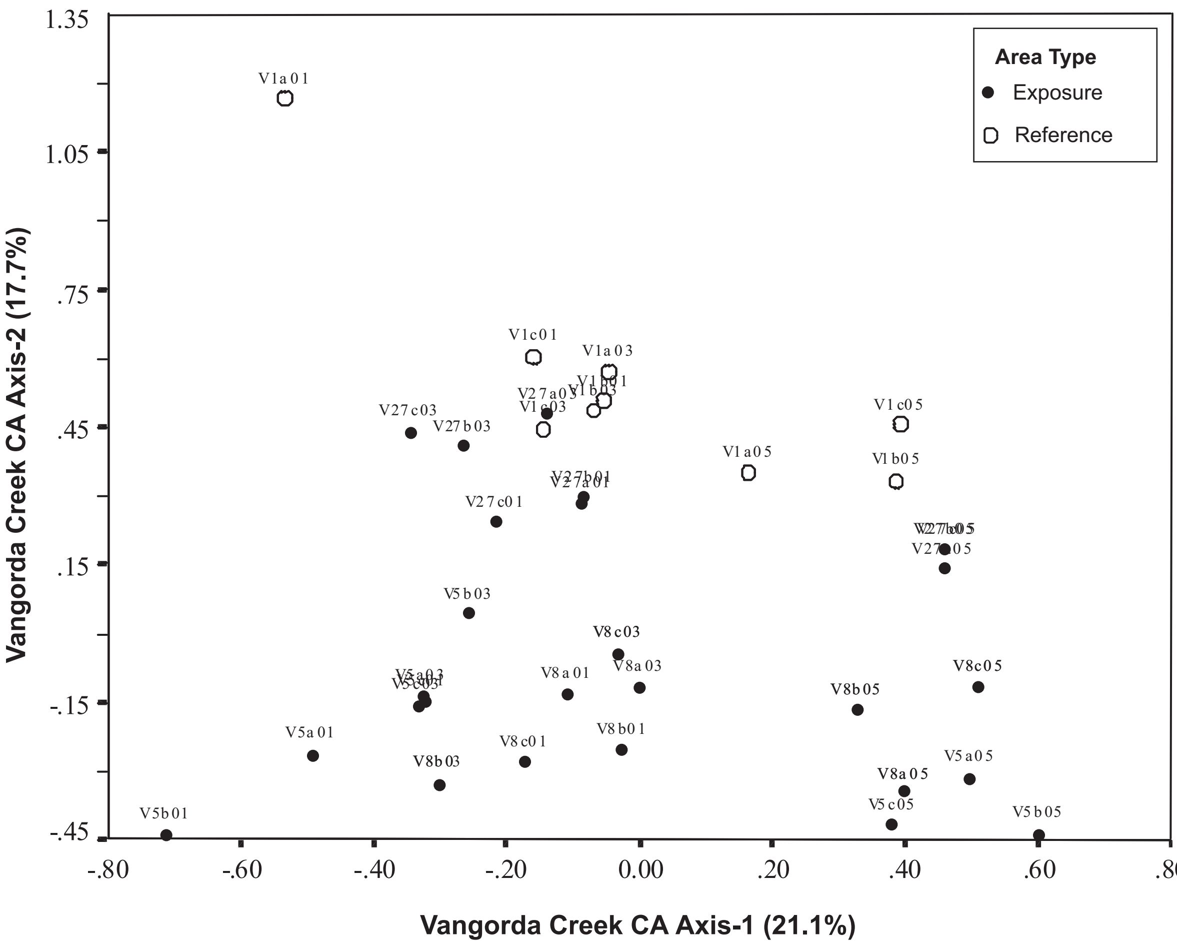


Figure 5.5: Correspondence analysis of Vangorda Creek data showing individual sample scores on each axis.

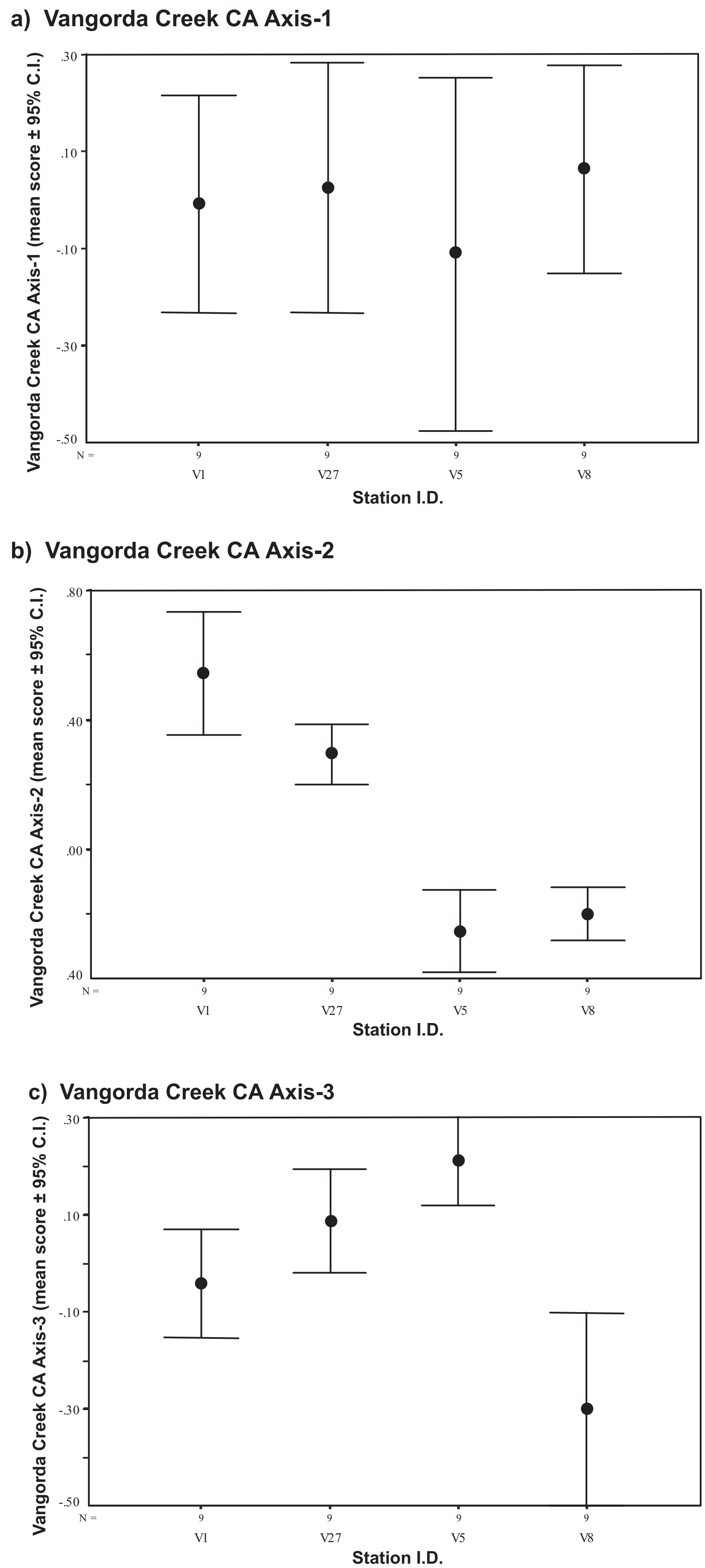


Figure 5.6: CA scores for Vangorda Creek stations combining data for odd years 2001 - 2005: a) CA Axis-1, b) CA Axis-2, and c) CA Axis-3.

V5 and V8 had low CA-2 scores. Vangorda CA-3 (*Chelifera* versus *Micropsectra* abundance) generally separated station V8 from other stations, though the difference was not significant between V8 and reference station V1. No station differences were found in pair-wise comparisons of mean CA-4 scores.

5.3.2 Comparisons Among Years

Community composition differed significantly among sampling years (Appendix Table C.13). Using Vangorda CA scores as descriptors of community structure, a very strong positive linear correlation was observed between year of sampling and CA-1 score (Appendix Table C.17), but additional years' of data would be required to determine if this is indicative of a temporal trend. No time-related correlations were observed with the other CA axes.

5.3.3 Summary

Significant differences in benthic community metrics were found between the reference station V1 and the exposure station V27, which are located immediately upstream and downstream of the Grum/Vangorda site, respectively. Percent EPT was greater and percent chironomids was lower at station V27 than V1, but this community shift is more commonly descriptive of habitat difference or improvement than of a deleterious effect. A similar pattern of greater percent EPT and lower percent chironomids was also observed at stations in Rose Creek downstream of the Faro site. The reference station V1 was also distinguished from all other Vangorda stations by CA-2 scores, which provided further evidence of a community shift in the other areas; however, this shift was not necessarily indicative of mine impact. West Fork / lower Vangorda Creek stations V5 and V8 were similar to each other with respect to most benthic community metrics, but differed from V1 and/or V27 in many respects. Year of sampling had a strong effect on the value of most metrics and the station differences often showed dependence on year of sampling.

Variance component analysis of Vangorda Creek benthic metrics showed that station differences were sometimes more important sources of variation than were year-to-year variations, but that year effects on the variance of metrics such as percent EPT, percent chironomids, and CA Axis-1 score were more important than the effect of station (Appendix Table C.17).

5.4 Comparison to Historical Data

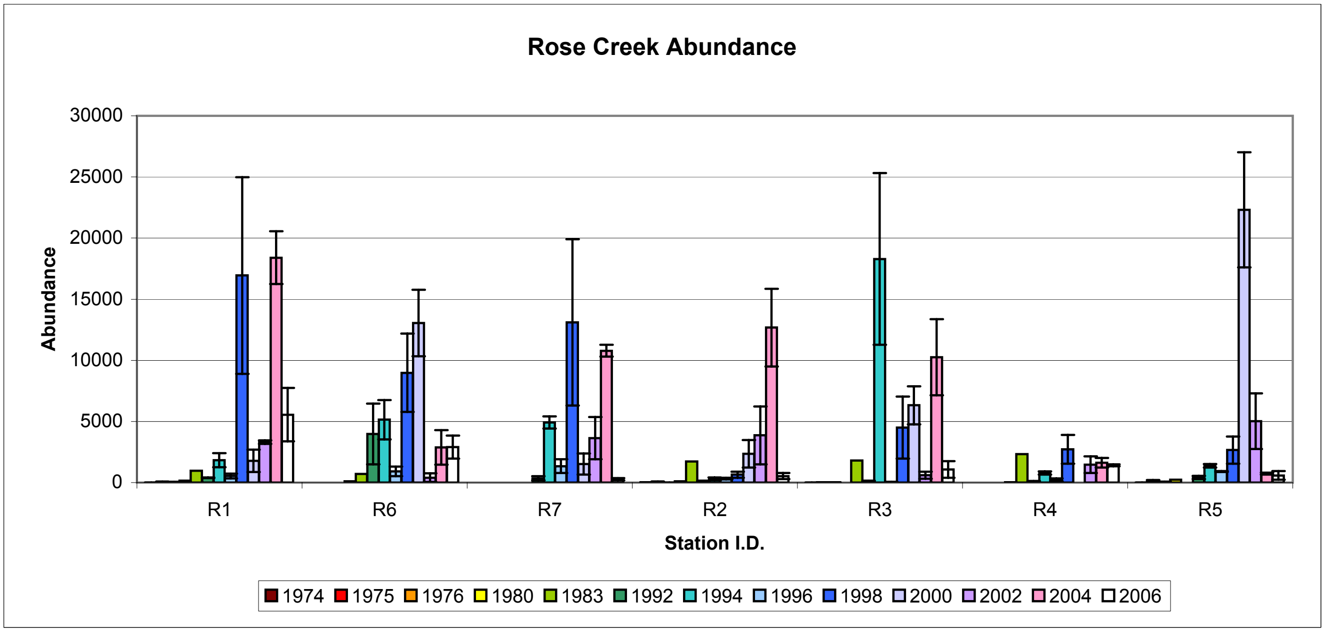
5.4.1 Rose Creek

Numerous benthic invertebrate surveys have been conducted in the Rose/Anvil watershed during the past three decades, although differences in methods for sampling and data analysis (Table 5.1) precluded direct comparisons of data in many cases. Studies conducted in the 1970s and early 1980s reported impacts on benthic communities (e.g., reduced abundance and/or diversity) for distances of approximately 10-16 km in Rose Creek downstream of the Faro site (e.g., R2 to R3 or R4; Hoos and Holman 1973, Baker 1979, Weagle 1981). Improvements were reported in surveys conducted in 1982 and 1983 (Weagle 1983). Godin and Osler (1985) suggested that improvements observed in 1983 relative to the previous year may have been attributable to shutdown of the Faro Mine in 1982.[6] Results of subsequent surveys were somewhat variable. Benthic invertebrate communities were considered stressed (reduced diversity) at R3 and R4, but not R2, in a survey conducted in 1988 (Burns 1989). However, the study was considered potentially confounded by unusually high water flows experienced that year, which may have contributed to reduced overall benthic invertebrate abundance. Overall abundance increased again in 1990 (Burns 1990), but benthic invertebrate diversity was again lower at R3 and R4 (not R2; Burns 1990). In 1992, reductions in benthic invertebrate abundance and number of taxa were observed at Stations R2-R4, with recovery to near-background conditions at R5 (Harder and Associates 1993a,b). However, after the levels of taxonomic identifications were standardized among the 1988, 1990, and 1992 studies, reduced abundance and taxonomic richness were apparent downstream of the Faro site in 1988 (R3) and 1992 (R2-R4) but not in 1990 (Harder and Associates 1993a). Since then, mean invertebrate abundance has been highly variable, both within and among stations within both reference and mine-exposed reaches of the Rose/Anvil system (Figure 5.7). Possible declining trends in taxon richness at stations downstream of the Faro site since 1994, were also evident at reference stations R6 and R7 (Figure 5.7). In an examination of Rose Creek data over the period 1988 to 2004, Burns (2004) concluded that the Faro mine had little or no influence on Rose Creek benthic communities. This is consistent with the detailed analysis of the 2000 to 2006 data presented in Section 5.2.3, which concluded that any mine-related influence in Rose Creek was minor and did not extend past the confluence with Anvil Creek, and that year-to-year variability often exceeded station-to-station variability.

5.4.2 Vangorda Creek

The Grum and Vangorda pits operated between 1986 and 1998. Historical benthic community data for Vangorda Creek date back to 1976, although differences in methods for sampling and data analysis precluded direct comparisons of data in some cases (Table 5.1). As observed for the Rose/Anvil watershed, mean benthic invertebrate abundance and taxon

[6] Mining was reactivated at the Faro site in early 1986 and continued until mine shutdown in 1992. Milling continued until 1998, when all mining (Grum/Vangorda) and milling (Faro) ceased.



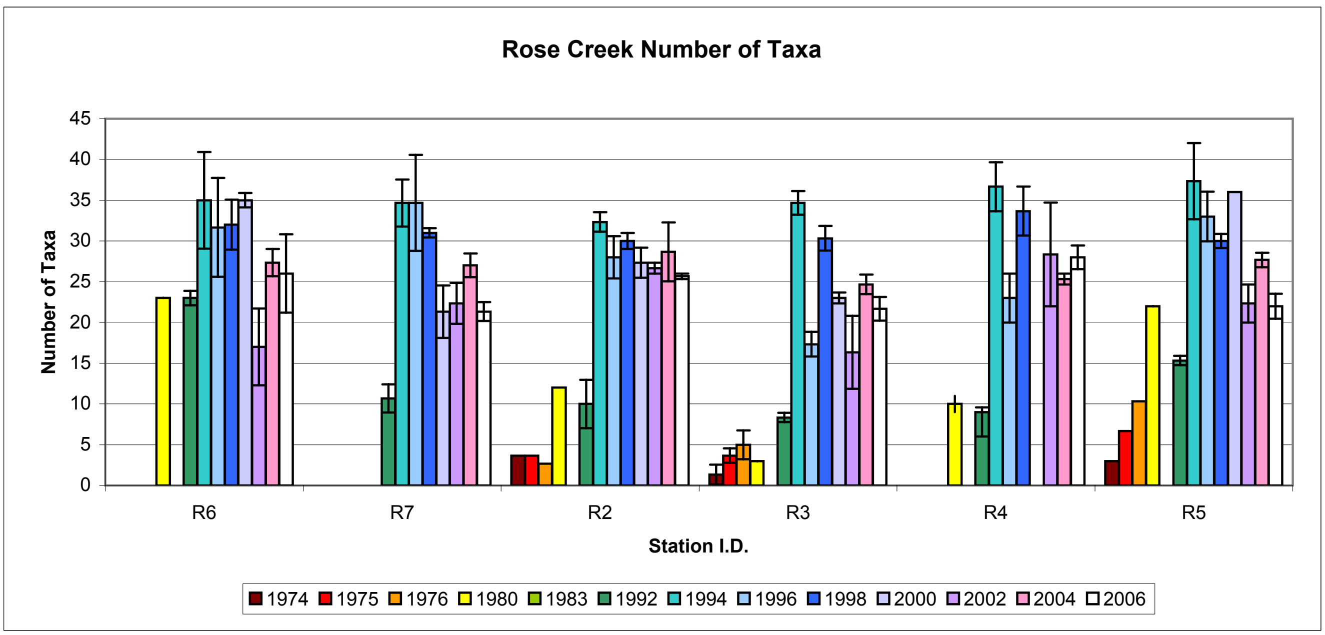


Figure 5.7: Benthic abundance and number of taxa (mean ± SE) in the Rose Creek watershed reported in studies conducted from 1974 to 2006

richness varied considerably among both stations and years (Figure 5.8). Mine related effects were not generally indicated, which is consistent with the detailed evaluation of 2001-2005 data in this report, and the conclusions of Burns (2005) for data from 1991-2005. Overall, only subtle community differences were evident among stations with little or no evidence of mine-related impact and large, natural year-to-year variability.

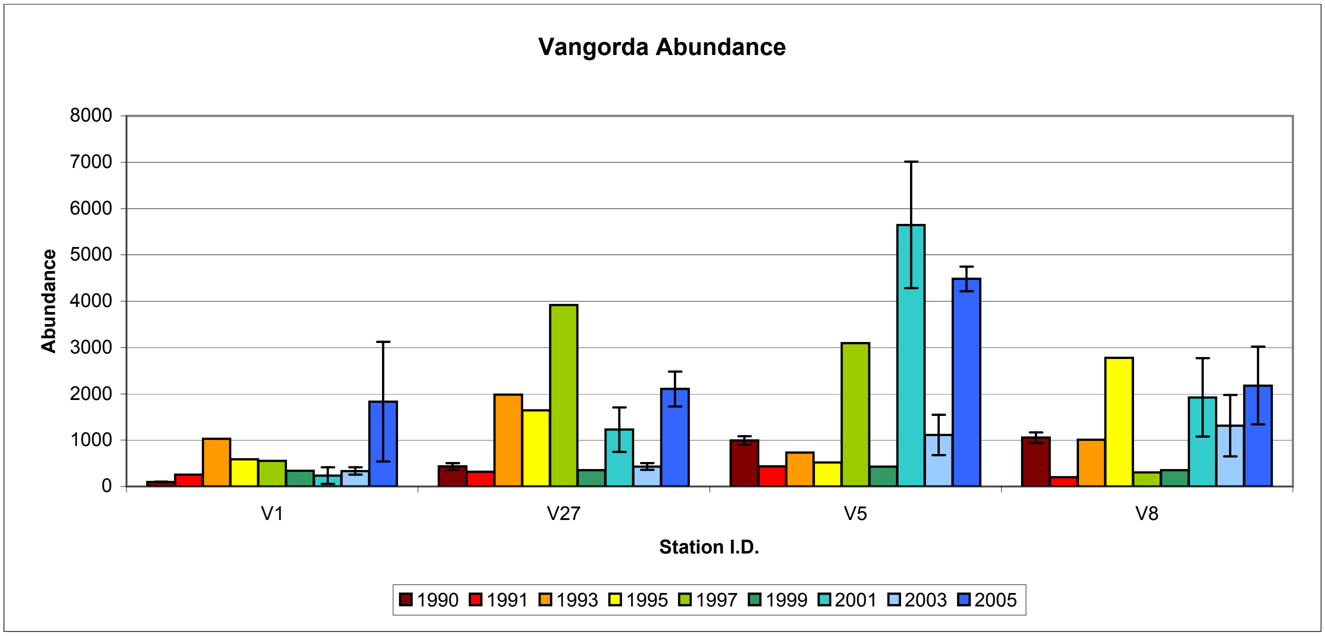
5.5 Summary and Recommendations

Numerous benthic invertebrate surveys have been conducted in the Rose/Anvil watershed during the past three decades, with many concluding that the Faro mine has impacted benthic invertebrate communities as far downstream as the Anvil Creek confluence. Detailed analysis of data from even years between 2000 and 2006 again confirmed that benthic invertebrate communities downstream of the Faro mine (e.g., R2-R4) showed some differences from reference communities (e.g., R6, R7 and minimally impacted R1). However, such differences were not always consistent with those typically associated with effluent impacts (e.g., higher percentage of sensitive EPT taxa downstream than at reference areas). Overall, it appears that temporal variability has played as large a role as relative station location in structuring benthic communities in Rose Creek, at least in recent years.

Detailed analysis of data from 2001, 2003 and 2005 surveys revealed significant differences in benthic community composition between the reference station V1 and the exposure station V27, which are located immediately upstream and downstream of the Grum/Vangorda site, respectively. However, the nature of such differences may be attributable to habitat differences rather than mine-related effects, based on a higher proportion of EPT, which are often considered sensitive to pollution, at near-field exposure station V27 than at reference station V1. Highest numbers of taxa were found at stations V5 and V8 compared to V1 and V27, and some differences in community composition were also evident between these two groups of stations, although none that appeared to be associated with mine-related influences. These and previous surveys have shown that mean benthic invertebrate abundance and taxon richness varied considerably among both stations and years.

Overall, mine-related influences on benthic invertebrate communities, if any, appeared to be minor.

It is recommended that future studies sample less often but with higher intensity (i.e., more stations per sampling area). This would result in a more statistically robust study design that would allow a better test of potential mine-related effects within each single field season. Such studies could be repeated at less frequent intervals (e.g., 3-5 years), because this and previous analyses have not shown evidence of a temporal trend of mine-related degradation.



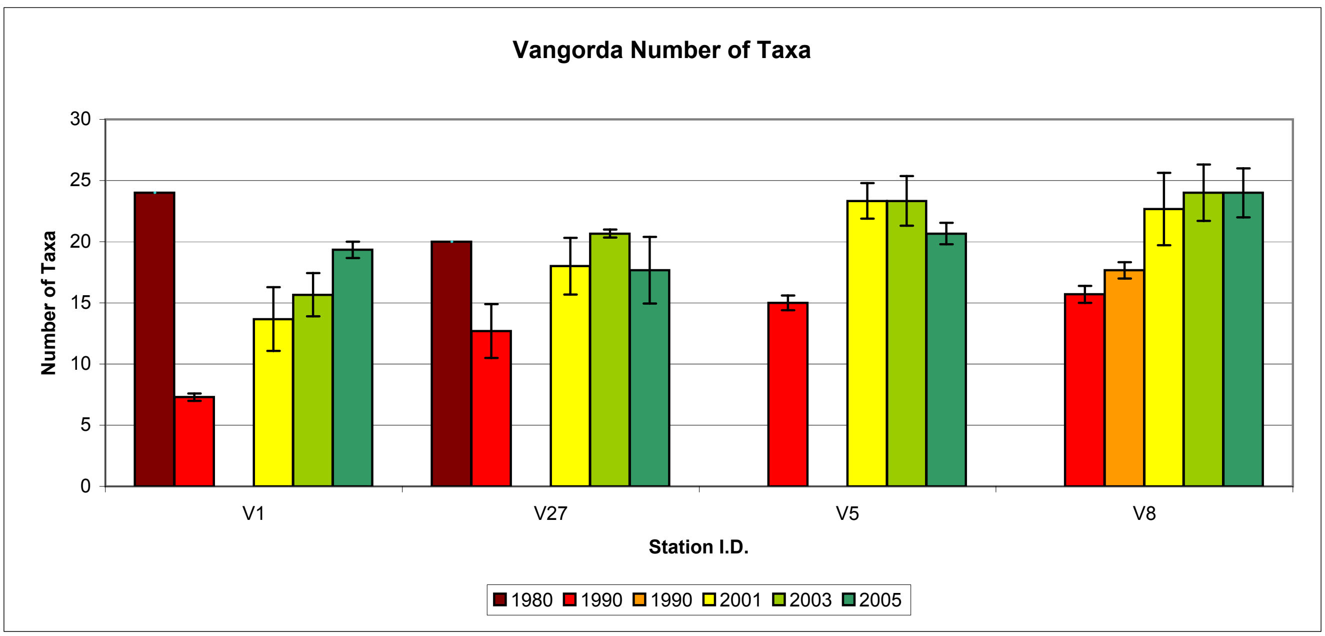


Figure 5.8: Benthic abundance and number of taxa (mean ± SE) in the Vangorda watershed reported in studies conducted from 1980 to 2005

Overall costs would likely be comparable or less relative to the current regime of bi-annual sampling of each watershed in alternate years.

It is also recommended that sampling in the Rose Creek watershed be focused on the stations located closer to the Faro site (upstream of Anvil) unless future studies indicate a trend of increasing spatial extent of mine related degradation. Downstream stations should be compared to stations near the current reference station R7 (and possibly R1 and/or others), with specific sampling locations adjusted to ensure physical habitat is as comparable as possible among stations. Consideration should also be given to the potential addition of more reference areas.

It is suggested that more reference areas be sampled above the Vangorda site and/or in other creeks in the area which possess similar habitat characteristics. This would better characterize benthic communities in unimpacted reference areas and thus allow for more rigorous testing of potential mine-related effects on downstream benthic invertebrate communities. The two branches of Vangorda Creek show some differences that may be natural or may indicate mine-related influences upstream of V5. Therefore, it would be useful to find a suitable a reference community on upper West Fork Vangorda Creek or a suitable alternative reference location.

Lastly, it is recommended that consideration be given to collecting samples (grabs) of resident benthic communities in future surveys. While artificial substrates provide standardization of substrate type and size, communities sampled this way may be skewed to species with greater tendency to drift or be more mobile and thus may not adequately reflect the composition of resident communities. A resident community will also reflect longer-term (year-round) exposure to localized conditions than artificial substrates. The potential for implementing a natural substrate survey will depend on whether adequate standardization of habitats (including substrate type, temperature, depth, flow velocity, and stream order) can be achieved among reference and mine-exposed areas.

6.0 FISH COMMUNITY AND FISH TISSUE METALS

6.1 Fish Community Characteristics

6.1.1 Rose-Anvil System

The fish community of the Rose-Anvil system has been comprised of a total of six species (Table 6.1). Spatially, fish community species diversity has been highest immediately downstream of the tailings discharge (Station R2) in lower Rose Creek, in the North and South Fork of Rose Creek (Station R7 and R1, respectively) as well as in lower Anvil Creek (Stations A4 to A1; Table 6.1). Historically, fish communities in the middle to lower reaches of Rose Creek (Stations R2, R3 and R4) showed the lowest average fish densities (Table 6.1). These observations, coupled with spatial trends of increasing fish densities with distance from the mine in lower Anvil Creek (Table 6.1), suggested a potential adverse mine-related effect. However, Harder (1993, 1991b) suggested that the absence of off-channel habitat, particularly in lower Rose Creek and Anvil Creek just upstream of the Rose-Anvil confluence (i.e., Station R6), was the most likely reason for low fish densities at these locations. This observation was supported by data from more recent surveys (i.e., 2002, 2004 and 2005). For instance, average fish CPUE values (2002 to 2005) at areas below the mine tailings discharge (Station R2) were comparable to those of some lower Anvil Creek stations and greater than those observed upstream (Stations R1 and R7; Table 6.1) despite highest aqueous and sediment metal concentrations observed at R2 (see sections 3.0 and 4.0). In contrast, relatively low CPUE values were observed further downstream in Rose Creek (Stations R3 and R4) despite substantially lower metal concentrations. Nevertheless, average CPUE at these stations was comparable to those observed in Anvil Creek upstream of the Rose-Anvil confluence (Station R6; Table 6.1), all of which shared similar, poor quality fish habitat (Harder 1991b; Table 6.2). Therefore, this suggested that low fish diversity and density in lower Rose Creek was likely related to habitat quality as opposed to mine-activity.

Slimy sculpin were generally the most commonly encountered species in the Rose-Anvil system both spatially (found at every station except R3) and in terms of relative abundance (i.e., highest densities relative to other fish; Table 6.1). Although Arctic grayling have been observed at low densities throughout Anvil Creek and in lower Rose Creek (i.e., stations R3 and R4), moderate densities were generally encountered at areas immediately below (Station R2) and above the mine (Station R1) in Rose Creek (Table 6.1). The upper Rose Creek system, including the North and South Forks, appears to provide excellent spawning, rearing and over-wintering habitat for slimy sculpin (Table 6.2). The North and South Forks of Rose Creek each provides excellent rearing habitat and moderate spawning habitat for

Table 6.1: Summary of fish community species and densities[a] at the Rose-Anvil Creek system monitoring stations during summer (August), 1989 to 2005

Area	Watercourse	Station	Year	Fish Species: Arctic Grayling	Chinook Salmon	Round Whitefish	Slimy Sculpin	Burbot	Longnose Sucker	Total Density or CPUE[a]
Reference	North Fork Rose Creek	R7	1989	1.2	-	-	22.8	-	-	**24.0**
			1992	-	-	-	-	-	-	**0.0**
			2002	-	-	-	1.49	-	-	**1.49**
		R7 (u/s)	1989	1.0	-	-	17.8	-	-	**18.8**
	Anvil Creek	R6	1989	1.0	-	-	39.1	-	-	**40.1**
			1990	-	-	-	31.0	-	-	**31.0**
			1992	-	-	-	2.6	-	-	**2.6**
			2004	0.07	-	-	1.78	-	-	**1.85**
			2005	-	-	-	2.59	-	-	**2.59**
	North Fork Anvil Creek	AT1	1989	-	42.8	-	1.0	-	-	**43.8**
			1990	2.3	2.3	-	4.6	-	-	**9.2**
Mine Exposed	North Fork Rose Creek	R8	1989	14.0	-	-	13.5	-	-	**27.5**
	Rose Creek	R1 u/s	1989	10.5	-	-	10.2	-	-	**20.6**
		R1	1988	-	-	-	13.7	2.9	-	**16.6**
			1989	35.3	-	-	46.6	2.1	-	**84.0**
			2002	-	-	-	0.15	-	-	**0.15**
			2004	1.29	0.22	0.07	2.08	0.14	-	**3.80**
			2005	0.92	-	-	2.90	0.14	-	**3.96**
		Diversion Channel	1981	0.18	-	-	-	-	-	**0.18**
			1989	8.2	-	-	9.2	-	-	**17.4**
			1992	0.8	-	0.4	0.4	0.2	-	**1.7**
		R2	1989	9.4	-	-	2.9	-	-	**12.3**
			1990	12.9	-	0.1	-	-	-	**13.0**
			1992	-	-	-	0.3	-	-	**0.3**
			2002	-	-	-	0.15	-	-	**0.15**
			2004	0.16	-	-	10.04	0.16	-	**10.36**
			2005	1.15	0.14	-	5.63	0.48	-	**7.40**
		R3	1989	-	-	-	-	-	-	**0.0**
			1990	-	-	-	-	-	-	**0.0**
		R4	1990	-	-	-	-	-	-	**0.0**
			2004	0.07	-	-	1.71	-	-	**1.78**
			2005	0.35	-	-	2.93	-	-	**3.28**
	Anvil Creek	R5	1989	-	-	-	9.6	-	-	**9.6**
			1990	-	-	-	24.4	-	-	**24.4**
		A4	1989	-	28.1	-	3.7	-	-	**31.8**
			1990	-	1.1	-	11.0	-	-	**12.1**
			2004	-	0.25	-	4.29	-	-	**4.54**
			2005	0.29	0.10	-	4.39	-	-	**4.78**
		A3	1990	-	29.7	-	9.8	-	-	**39.5**
			2004	0.63	-	-	7.70	-	-	**8.33**
			2005	0.25	-	-	4.59	-	-	**4.84**
		A2	2004	-	9.08	-	11.49	-	-	**20.57**
			2005	0.52	1.78	0.07	5.62	-	-	**7.99**
		A1	1989	-	4.9	2.0	36.0	2.0	-	**44.9**
			1990	-	32.7	14.5	25.4	1.8	3.6	**78.0**
			1992	0.2	6.7	-	1.2	-	-	**8.1**
			2004	-	1.04	-	7.20	-	-	**8.24**
			2005	-	2.73	-	5.62	-	-	**8.35**

[a] - Densities represented either as quantitative density estimates (number of fish per 100 m^2 of stream surface area based on closed station, dual pass electrofishing sampling) or as semi-quantitative relative abundance (number of fish captured per minute of electrofishing effort (CPUE) based on open station, single electrofishing pass).

Values in red text represent quantitative density estimates. Values in blue text represent semi-quantitative CPUE data.

Source data: Weagle (1981d), Harder and Bustard (1988), P.A Harder & Associates (1991, 1993), GLL (2003), WMEC (2004, 2005) and Selkirk First Nation (2006)

Table 6.2: Summary of Arctic grayling, Chinook salmon and slimy sculpin habitat requirements and habitat availability within the Rose-Anvil Creek system and lower Vangorda Creek

Species	Habitat Requirements			Habitat Availability Rating					
	Spawning (S)	Rearing (R)	Overwintering (OW)	Upper Anvil Creek (R6 Reference)	North Fork Rose Creek (R7 Reference)	South Fork Rose Creek (Station R1)	Lower Rose Creek (Station R2, R3, R4)	Lower Anvil Creek (Stations R5, A1 to A4)	Lower Vangorda Creek (Station V8)
Arctic grayling (*Thymallus arcticus*)	Small gravel- or rock-bottomed stream-runs at 0.3 m to 0.8 m depth, often near inlet/outlet of ponds and lakes; males territorial	Fry occupy shallow, quiter waters of stream edges and side channels; older fry and/or juveniles may migrate from hatching grounds to deeper pools and ponds with suitable cover, therefore both rocky-bottomed streams and silt-covered ponds important habitats	Deepwater habitats including lakes & ponds mainly [adults], but also deep pools with ample instream cover (e.g., vegetative debris, undercut banks, large cobble and boulder substrate) in streams and/or rivers [adults and juveniles]; adults relatively tolerant of low oxygen (i.e., winter hypoxia) conditions	Poor S, R & OW (lack of side channels and deep water)	Moderate S, OW habitat; Excellent R	Moderate S, Excellent R, Poor OW	Moderate S, OW Poor R	Moderate S, R, OW	Poor S, OW Moderate R
Chinook salmon (*Oncorhynchus tshawytscha*)	Larger tributaries with relatively large substrate (25 to 305 mm diameter) and deep water (0.3 m to 9.5 m deep) near riffles (water velocity from 0.25 m/s to 2.25 m/s); large redds constructed	Young fry are found primarily along the sides of pools and near the cover of over-hanging banks. Older fry increase their distance from cover and tend to occupy greater water depths and velocities which are sheltered from current.	In small streams, deeper pools with ample instream cover (e.g., vegetative debris, undercut banks, large cobble and boulder substrate) required; fry often migrate out of smaller tributaries in the fall	Poor S, R & OW (? based on low numbers observed)	NA (no access)	Poor S, R & OW (? based on low densities observed)	Poor S, R & OW (? based on low numbers observed)	Poor S Moderate R, OW	Poor S Excellent R Moderate OW
Slimy Sculpin (*Cottus cognatus*)	Rock-bottomed run-habitat of streams, or rocky areas of lakes	Gravel and rock-bottomed areas of streams and lakes; juveniles may occupy areas with smaller substrate and water velocities (e.g., stream edge and side channels) relative to adults	Same as rearing habitat, but often in proportionately deeper waters; species exhibits limited seasonal migration	Unknown S, OW Poor R	Moderate S, R, OW	Excellent S, R, OW	Moderate S,R & OW at R2; Poor S, R and OW at R3 and R4	Moderate S, R, OW	Moderate S, R, OW

Arctic grayling (Weagle 1981d, Harder and Bustard 1988, Harder 1993b, GLL 2003; Table 6.2). Although the North fork provides moderate over-wintering habitat for Arctic grayling (Harder and Bustard 1988), little of this habitat is available in the South Fork following removal of the reservoir (Table 6.2). Chinook salmon were observed in greatest densities in the lower Anvil Creek and until 2004, had not been observed in Rose Creek (Table 6.1). Recently, the presence of Chinook salmon young-of-the-year (YOY; 0+) and of fertilized Chinook salmon embryos in Arctic grayling stomach contents collected at areas upstream of the mine suggested that the South Fork of upper Rose Creek was accessible to and provided suitable spawning habitat for adult spawning Chinook salmon (WMEC 2005). Although Rose Creek only appears to provide juvenile Chinook salmon rearing habitat, lower Anvil Creek appears to provide spawning, rearing and overwintering (based on observations of 1+ size class) habitat for this species (WMEC 2005; Table 6.2). Various habitat requirements for each life history stage for slimy sculpin, Arctic grayling and Chinook salmon, and the availability of these habitats in the Rose-Anvil system, are provided in Table 6.2. Other fish species, including round whitefish, lake chub (*Couesius plumbeus*) and burbot were observed only occasionally and at low densities in the Rose-Anvil system from study-to-study (Table 6.1).

Overall, relatively high fish species diversity and density at areas immediately below the tailings discharge (Station R2) in Rose Creek relative to reference areas and to areas in lower Anvil Creek during the most recent (2004 and 2005) biological studies suggested that mine-related activities were not adversely affecting Rose-Anvil system fish populations.

6.1.2 Vangorda Creek

The same six fish species have been observed in lower Vangorda Creek as in the Rose-Anvil Creek system (Table 6.3). However, no fish have ever been reported in the upper portion of Vangorda Creek upstream of the Town of Faro access road (Figure 2.3; Table 6.3) despite reasonable fishing effort (e.g., Harder 1987). The absence of fish in the West Fork and upper Vangorda Creek is believed to be due to the presence of impassable barriers created by a combination of road construction (i.e., culvert installation) and a steep natural cataract at this location (Harder 1987, GLL 2003). Fish densities in lower Vangorda Creek have generally been high compared to Blind Creek, Buttle Creek and Grew Creek reference systems, as well as to the Rose-Anvil Creek system (Tables 6.1 and 6.3).

The fish community of lower Vangorda Creek has generally been characterized by high numbers of Chinook salmon YOY (Table 6.3). However, this Chinook salmon population varies seasonally, with large numbers of Chinook salmon YOY entering lower Vangorda Creek from the Pelly River in June to early August. The majority of these YOY remain in

Table 6.3: Summary of fish community species and densities[a] at Vangorda and Blind Creek system monitoring stations during summer (August), 1975 to 2005

Area	Watercourse	Station	Year	Fish Species: Arctic Grayling	Chinook Salmon	Round Whitefish	Slimy Sculpin	Burbot	Longnose Sucker	Total Density or CPUE[a]
Reference	Blind Creek	B1	1989	0.7	31.5	0.9	16.3	0.7	-	**49.9**
			1990	-	48.0	0.6	19.8	0.6	-	**69.0**
		B3	1989	-	2.7	-	12.0	-	-	**14.7**
			1990	-	55.3	-	28.1	-	-	**83.4**
		B4	1989	-	13.2	-	9.2	-	-	**22.4**
			1990	-	53.1	-	31.6	-	-	**84.7**
		B5	1989	2.0	4.0	-	8.9	-	-	**14.9**
			1990	15.3	21.3	0.8	35.9	-	-	**73.3**
		B6	1989	20.1	-	-	48.7	1.3	-	**70.1**
			1990	15.0	-	-	35.1	0.9	-	**51.0**
	Blind Creek Tributary	BT1	1989	1.0	1.9	-	9.7	-	-	**12.6**
			1990	-	29.5	-	7.4	-	-	**36.9**
	Buttle Creek	BU1	1989	-	-	-	61.4	-	-	**61.4**
	Grew Creek	GR1	1989	-	18.8	-	10.9	-	-	**29.7**
	Pelly River (Sidechannel)	P2	1987	15.3	1.9	-	P[b]	P[b]	P[b]	**39.5[b]**
	Vangorda Creek	V1	1975	-	-	-	-	-	-	**0.0**
			1987	-	-	-	-	-	-	**0.0**
Mine Exposed	Vangorda Creek	V5	1987	-	-	-	-	-	-	**0.0**
		V4/27	1987	-	-	-	-	-	-	**0.0**
		V8	1987	1.5	7.4	-	P[b]	P[b]	P[b]	**12.5[b]**
			1988	-	-	0.5	2.0	-	-	**2.5**
			1989	0.5	171.6	2.7	26.0	-	-	**200.8**
			1990	2.3	80.0	0.6	42.2	0.8	0.2	**126.0**
			2002	-	7.85	-	3.49	-	-	**11.34**
			2004	1.01	9.96	0.06	0.42	-	-	**11.45**
			2005	0.33	11.17	-	0.23	-	-	**11.73**
	Pelly River (Sidechannel)	P1	1987	-	2.5	-	P[b]	P[b]	P[b]	**9.3[b]**

[a] - Densities represented either as quantitative density estimates (number of fish per 100 m^2 of stream surface area based on closed station, dual pass electrofishing sampling) or as semi-quantitative relative abundance (number of fish captured per minute of electrofishing effort (CPUE) based on open station, single electrofishing pass).
Values in red text represent quantitative density estimates. Values in blue text represent semi-quantitative CPUE data.
Source data: P.A Harder & Associates (1987, 1988, 1989, 1992), GLL (2003) and WMEC (2004, 2005)

[b] - Presence (P) of slimy sculpin, burbot and suckers noted but densities not reported separately; total number of fish per 100 m^2 includes these species

lower Vangorda Creek until approximately late October, migrating downstream thereafter. Although a portion of the YOY remain through the winter, these fish also exit the Vangorda system following spring ice break-up (Harder 1992b). No adult spawning activity has been observed in lower Vangorda Creek, suggesting that the system provides only rearing and overwintering habitat for Chinook salmon populations (Harder 1987, 1989b, 1992b; GLL 2003; Table 6.2). Arctic grayling and slimy sculpin have been commonly collected at low densities in lower Vangorda Creek (Table 6.3). In general, lower Vangorda Creek appears to provide Arctic grayling with marginal spawning and overwintering habitat, but with suitable rearing habitat (Harder 1987, 1989b; Table 6.2). Lower Vangorda Creek did not appear to provide other fish species, including round whitefish, burbot and longnose sucker, with substantial habitat opportunities based on low observed catches of these species historically (Table 6.3). Similar to the Rose-Anvil system, relatively high fish species diversity and density in lower Vangorda Creek compared to reference areas suggested negligible mine-related influence on local fish populations.

6.1.3 Temporal Trends

Comparison of fish community trends over time for both the Rose-Anvil and Vangorda Creek systems was generally confounded by high methodological and environmental variability. Variability in fishing station location, data reporting (e.g., fish density versus CPUE data), study objectives (e.g., fish tissue collection versus fish community characterization and/or fish movement studies), and study teams were apparent from study-to-study. Environmental variables, such as flow and turbidity levels, also varied among seasons and studies, potentially affecting fish populations and/or fish collection success (Harder 1992b; WMEC 2005). Nevertheless, the data suggested that fish community diversity may have increased at near-field mine-exposed and upstream areas of the Rose-Anvil system (i.e., Stations R2 and R1, respectively) from 1988 to 2005 (Table 6.1). Most notably, the presence of fertilized Chinook salmon eggs in the stomach of an Arctic grayling captured in upper (South Fork) Rose Creek in 2005 suggested salmon may have spawned in this area (WMEC 2005). Also, Arctic grayling and slimy sculpin appeared to have increased in abundance in lower Rose Creek (WMEC 2005). No changes in fish community structure were apparent at lower Vangorda Creek over the period from 1987 to 2005 (Table 6.3)

6.2 Fish Tissue Metal Concentrations

Fish tissues have been analyzed historically to assess whether fish tissue quality has been influenced by each mine site. This assessment also provides an interpretation of the significance of observed concentrations to the health of human and/or wildlife consumers of targeted fish species.

6.2.1 Tissue Chemistry

Arctic grayling muscle and liver tissue concentrations of arsenic, copper, lead, mercury and zinc did not show any consistent increase at mine-exposed areas relative to reference areas at either the Rose-Anvil or Vangorda Creek systems over the period 1975 to 2005 (Tables 6.4 and 6.5). In 2002, cadmium concentrations in Arctic grayling muscle and liver were slightly elevated relative to reference at lower Vangorda Creek (Station V8) and to upstream of the tailings discharge at Rose Creek, respectively (Tables 6.4 and 6.5). However, the differences were very small (i.e., less than 1 mg/kg) in both instances. Also, at lower Vangorda Creek a similar increase in liver cadmium levels was not observed, suggesting inconsistent results between tissues (i.e., higher metal concentration in muscle would be expected to correlate with higher liver metal concentration). At Rose Creek in 2005, Arctic grayling muscle manganese concentrations appeared to decrease with distance downstream of the tailings discharge, suggesting a mine-related influence (Table 6.4). These results were not observed during previous Rose-Anvil surveys or in liver tissue, and no similar trends were observed at Vangorda Creek. Therefore, the significance of this trend could not be qualified.

In slimy sculpin, concentrations of arsenic, copper, manganese and mercury did not show any consistent elevation in whole-body samples collected at mine-exposed areas relative to reference areas at either the Rose-Anvil or Vangorda Creek systems over the period 1975 to 2005 (Table 6.6). However, cadmium and zinc whole-body concentrations may have been slightly elevated at Vangorda Creek compared to reference levels (Table 6.6). No spatial trends in tissue cadmium or zinc levels were observed with Rose Creek slimy sculpin (Table 6.6). Whole-body lead concentrations appeared to be elevated at mine-exposed areas of both the Rose-Anvil and Vangorda Creek systems relative to reference, although the incremental difference was very small in both instances (Table 6.6). No clear temporal changes in slimy sculpin whole-body cadmium, lead or zinc concentrations were observed at either location (Table 6.6).

Overall, examination of metal tissue concentration spatial trends suggested that mining activities have had only very minor influences on the quality of fish tissue in the Rose-Anvil and Vangorda Creek systems. Furthermore, no clear temporal trends were suggested by the available data.

6.2.2 Risk to Consumers

Despite the fact that the Faro and Vangorda mines have potentially affected fish tissue quality only to a slight degree, it is of general interest to utilize the available data to interpret

Table 6.4: Summary of Arctic grayling muscle tissue metal concentrations (mg/kg ww), Rose-Anvil and Vangorda Creek systems, 1975 to 2005

Metal	Year	Rose-Anvil System								Vangorda System	
		Reference	Exposure							Reference	Exposure
		R6	R1	R2	R4	A4	A3	A2	A1	B1	V8
Arsenic	1997		0.300	0.515						0.581	0.540
	2002		0.028	0.045						0.038	0.038
	2004						< 0.1	< 0.1			
	2005	< 0.3	< 0.3		< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Cadmium	1992		< 0.1								
	1997		0.013	0.013						0.038	0.093
	2002		< 0.005	0.010						0.011	0.351
	2004						0.019	0.006			
	2005	< 0.05	0.060		0.090	0.062	0.068	0.062	0.075	0.090	0.120
Copper	1975								0.40	0.76	0.75
	1976										0.96
	1977										0.86
	1992		2.45								
	1997		0.32	1.38						0.39	0.83
	2002		0.62	0.73						0.30	1.15
	2004	0.77	0.68	0.74	0.96		0.84	0.65		0.50	0.53
	2005	0.71	0.76		0.80	0.58	0.45	0.57	0.52	0.59	0.67
Lead	1975								0.2	1.0	1.1
	1976										0.9
	1977										< 1.0
	1992		< 2								
	1997		0.479	0.684						0.917	0.940
	2002		0.076	0.075						< 0.02	0.045
	2004	< 0.05	< 0.05	<0.05	< 0.05		0.09	< 0.05		< 0.05	< 0.05
	2005	< 0.5	< 0.5		< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Manganese	1975									0.60	1.5
	1976										2.9
	1977										< 0.50
	1997		4.98	7.97						3.48	3.60
	2004	< 2.0	< 2.0	< 2.0	< 2.0		2.7	< 2.0		< 2.0	< 2.0
	2005	2.76	8.30		10.4	7.85	4.99	4.46	3.75	1.88	2.76
Mercury	1975									0.13	0.08
	1976	0.11	0.07						0.10		0.01
	1977										< 0.062
	1992		0.066								
	1997		0.058	0.052						0.030	0.020
	2002		0.053	0.023						0.022	0.040
	2004	0.042	0.042	0.030	0.041		0.070	0.059		0.046	0.051
Zinc	1975								4.0	9.2	11.8
	1976										14.6
	1977										8.5
	1992		23.7								
	1997		17.9	18.3						17.1	27.3
	2002		11.0	14.6						11.1	24.3
	2004	8.29	9.37	7.74	9.44		8.30	7.48		6.49	8.09
	2005	17.7	13.1		12.6	14.8	10.5	12.8	18.5	10.6	17.7

Value exceeds respective either human or wildlife consumption benchmark (Arsenic - 0.20 mg/kg, 0.56 mg/kg, 0.28 mg/kg for human toddler, human child and wildlife, respectively; Mercury - 0.07 mg/kg for human toddler; see Table 2.7)

Table 6.5: Summary of Arctic grayling liver tissue metal concentrations (mg/kg ww), Rose-Anvil and Vangorda Creek systems, 1975 to 2005

Metal	Year	Rose-Anvil System								Vangorda System	
		Reference	Exposure							Reference	Exposure
		R6	R1	R2	R4	A4	A3	A2	A1	B1	V8
Arsenic	1997		1.17	0.72						2.97	6.74
	2002		0.04	0.05						0.04	0.03
Cadmium	1997		0.244	0.689						1.220	1.296
	2002		0.149	1.25						1.35	0.8
Copper	1975								1.8	3.9	
	1992		8.3								
	1997		2.82	2.76						3.53	3.01
	2002		2.14	5.32						2.81	1.85
Lead	1975								0.20	2.0	
	1992		2.35								
	1997		0.740	0.639						3.81	7.28
	2002		0.138	0.18						< 0.02	< 0.02
Manganese	1975									3.2	
	1997		9.21	5.75						4.97	4.41
Mercury	1975									0.54	
	1976	0.26	0.20						0.11		
	1997		0.161	0.072						0.077	0.056
	2002		0.090	0.054						0.051	0.047
Zinc	1975								20.0	22.2	
	1992		89.8								
	1997		31.1	26.6						29.7	45.9
	2002		22.8	28.8						25.0	19.9

Value exceeds respective wildlife consumption benchmark (0.28 mg/kg for Arsenic; 4.9 mg/kg for lead; 0.45 mg/kg for mercury; see Table 2.7)

Table 6.6: Summary of slimy sculpin whole body tissue metal concentrations (mg/kg ww), Rose-Anvil and Vangorda Creek systems, 1975 to 2005

Metal	Year	Rose-Anvil System								Vangorda System	
		Reference	Exposure							Reference	Exposure
		R6	R1	R2	R4	A4	A3	A2	A1	B1	V8
Arsenic	1997		1.33	3.83						3.27	7.69
	2002		0.23							0.14	0.11
	2004					0.14	0.16	0.22	0.12		
	2005	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Cadmium	1997		0.077	0.227						0.133	0.349
	2002		0.030							0.117	0.453
	2004					0.045	0.086	0.073	0.199		
	2005	0.076	0.050	< 0.05	< 0.05	0.066	0.064	0.096	0.260	0.085	0.180
Copper	1975									0.63	0.73
	1976										1.90
	1977										2.93
	1989										1.26
	1992	3.8							3.7	3.1	4.9
	1997		1.14	0.96						0.24	0.32
	2002		1.18							1.00	0.73
	2004	0.93	0.57	1.2	0.88	0.92	1.1	1.4	1.2	0.87	0.79
	2005	0.98	1.12	1.25	0.96	0.89	0.79	0.99	1.19	1.12	0.95
Lead	1975									1.1	1.9
	1976										2.8
	1977										< 1.0
	1989										0.4
	1992	2.0							< 2	< 2	23.0
	1997		3.70	3.04						2.79	3.77
	2002		0.62							0.04	0.27
	2004	0.13	0.41	0.24	0.22	0.16	0.21	0.19	0.35	0.08	0.16
	2005	< 0.50	0.57	1.02	0.56	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50
Manganese	1975									9.8	5.1
	1976										7.0
	1977										5.5
	1989										4.7
	1997		13.7	30.0						12.7	13.6
	2004	30.8	28.1	31.7	66.5	36.6	18.5	35.2	11.0	9.17	6.7
	2005	26.4	25.0	38.8	47.7	42.7	16.3	17.4	35.2	8.67	7.37
Mercury	1975									0.40	0.190
	1976										0.017
	1977										< 0.050
	1989										0.019
	1997		0.020	0.013						0.027	0.031
	2002		0.032							0.035	0.046
	2004	0.032	0.023	0.029	0.022	0.020	0.021	0.018	0.032	0.036	0.043
Zinc	1975									19.6	26.8
	1976										39.3
	1977										32.0
	1989										27.4
	1992	127							138		184.0
	1997		28.4	44.5						23.2	52.4
	2002		37.4							23.3	71.4
	2004	41.0	53.1	39.3	57.6	47.5	38.3	45.7	48.6	31.3	55.1
	2005	39.1	30.1	51.8	49.9	49.0	33.4	40.1	43.4	26.1	45.7

Value exceeds respective wildlife consumption benchmark (0.28 mg/kg for Arsenic; 4.9 mg/kg for lead; see Table 2.7) the quality of fish muscle tissue relative to established benchmarks for the protection of human and wildlife consumers (Table 2.7). As fish liver tissue is not recommended for human consumption and slimy sculpin are generally not consumed by humans, assessment of the significance of tissue metal concentrations for human consumers was conducted using only Arctic grayling muscle tissue data. Similar limitations were not applicable for wildlife consumers.

Metal concentrations in Arctic grayling muscle collected from the Rose-Anvil and Vangorda systems have been well below the most conservative human consumption benchmarks since 1975 with the exception of arsenic and mercury. Muscle arsenic concentrations exceeded the benchmarks for consumption by human toddlers (Stations R1, R2 and V8) and children (Blind Creek) only in 1997 (Table 6.4). Arsenic appears to be naturally elevated in both systems (see Sections 3.0 and 4.0) suggesting that high tissue concentrations were not mine related. Muscle mercury levels have occasionally exceeded or were at the benchmark for consumption by toddlers (i.e., 0.07 mg/kg) at upstream areas of Rose Creek (Station R1), at upper and lower Anvil Creek (Stations R6, A3 and A1) and at lower Vangorda Creek (Station V8; Table 6.4). Highest muscle mercury concentrations were observed prior to 1977, although mean tissue mercury concentrations in fish collected from the lower Anvil were at benchmark levels more recently (i.e., 2004; Table 6.4). Because levels of mercury were generally higher in muscle of reference fish or in fish collected at areas well below the tailings discharge (i.e., lower Anvil Creek stations), any observed elevations above benchmarks were not likely mine-related.

Tissue metal concentrations were generally well below conservative consumption benchmarks established for wildlife at the Rose-Anvil and Vangorda systems since 1975. However, exceptions were observed in 1992 and 1997 (Tables 6.4 to 6.6). In particular, arsenic concentrations were well above the wildlife consumption benchmark of 0.28 ug/kg in all tissue types only during 1997. Lead concentrations in whole tissues of slimy sculpin, as well as other fish species (including Chinook salmon, arctic grayling and whitefish) collected at lower Vangorda Creek, exceeded the benchmark level only in 1992 (Table 6.6; Harder 1993). Lead concentrations in Arctic grayling liver tissue were also very high at Vangorda Creek in 1997. It is noteworthy that highest tissue metal concentrations were observed consistently (i.e., across all stations) in 1992 and 1997 and were also an order of magnitude higher than observed in other studies (Table 6.6), suggesting the higher metal concentrations reported may have resulted from differences in laboratory analysis and/or sampling techniques as opposed to mine-related affects.

Overall, assessment of the significance of concentrations of metals in fish muscle indicated that Arctic grayling captured in the Rose-Anvil and Vangorda Creek systems had naturally elevated concentrations of arsenic (1997 only) and mercury (prior to 1977) relative to benchmarks for consumption by human toddlers and children (arsenic only). Benchmarks for fish tissue metal concentrations considered safe for consumption by wildlife were exceeded in 1992 and 1997 only for arsenic and/or lead. However, widely varying tissue metal concentrations from survey-to-survey suggested that these elevated values may represent differences in analytical laboratory results and/or sample processing techniques. Since 1997, tissue metal concentrations have not exceeded respective wildlife consumption benchmarks.

6.3 Summary and Recommendations

In summary, fish surveys have been conducted in the Rose-Anvil and Vangorda Creek systems since the early 1970s to examine whether any mine-related effects to fish communities and fish tissue metal concentrations were apparent. Evaluation of the historical data in the current report indicated that fish community diversity and density at areas downstream of mine operations in the Rose-Anvil and fish accessible areas of Vangorda Creek systems were generally greater than, or comparable to, respective reference area values, suggesting that mine-related activities were not adversely affecting fish populations. Temporal analysis of the historical fish catch data suggested that, with the presence of Chinook salmon, Rose Creek species diversity may have increased since the late 1970s, whereas no obvious changes in fish diversity or density were observed at lower Vangorda Creek.

Analysis of tissue metal concentrations suggested that mining activities have had only very minor influences on the quality of fish tissue in the Rose-Anvil and Vangorda Creek systems, with no clear temporal trends suggested by the available data. Concentrations of cadmium, copper, manganese and zinc were well below human and wildlife consumption benchmarks since the late 1970s in both the Rose-Anvil and Vangorda Creek systems. Although arsenic, lead and mercury tissue metal levels have occasionally exceeded respective conservative consumption benchmark levels (most notably in 1992 and 1997), similar concentrations observed in reference samples and widely variable survey-to-survey tissue concentrations suggested that tissue metal levels may be naturally elevated and/or that differing analytical laboratory techniques among studies may have contributed to the apparently high values.

Based on review of the available historical fish survey information collected from the Rose-Anvil and Vangorda Creek systems and the current evaluation of these data, suggested recommendations for future studies include the following:

- Future fish surveys should employ more intensive, statistical approaches to assess whether mine activity is adversely affecting fish health (i.e., growth, reproduction, survival or condition) according to current Environmental Effects Monitoring (EEM) protocols (Environment Canada 2002). Slimy sculpin were the most ubiquitous and abundant fish species observed in both the Rose-Anvil and Vangorda Creek systems, and should therefore be the focus for fish health investigations. It is suggested that initially, a non-lethal study conducted at upstream, near-field and reference locations in Rose Creek (i.e., Stations R1, R2 and R7, respectively) for Faro Mine, and at lower Vangorda Creek and a suitable reference (e.g., Blind, Buttle or Grew Creeks) for Grum/Vangorda, be employed during the ice-free low-flow season (e.g., August). Depending on study results, subsequent studies may wish to increase the study area spatial extent (e.g., lower Anvil Creek) and/or employ a lethal design using slimy sculpin shortly after ice-out to better quantify any reproductive effects (Environment Canada 2002).

- Fish community surveys should continue to be conducted using quantitative electrofishing approaches to allow temporal tracking of fish diversity and density at monitoring stations. Although a quantitative, closed station approach is preferred (i.e., installation of stop net barriers and three pass removal technique), in some cases effective use of this approach may not be feasible (e.g., high flows and/or turbid conditions). At a minimum, fish surveys should record all species captured and the amount of electrofishing effort applied in order to facilitate CPUE calculations.

- Fish tissue monitoring should be discontinued unless observed aqueous or sediment metal concentrations increase over time. In general, most tissue metal concentrations did not appear to correlate well with mine-activity (i.e., no differences between tissue metal levels at reference and mine-exposed areas) and metal concentrations were generally well below consumption benchmarks. Moreover, any adverse affects to fish populations as a result of metal contamination will be assessed through use of the intensive fish health survey described above.

7.0 SUMMARY AND CONCLUSIONS

7.1 Water Quality

Data were analyzed for 19 water quality stations located on permanent surface water courses upstream (reference/background) and downstream (exposed) of mine-related disturbances or inputs (e.g., roads, rock piles, pits, tailings area, etc.). All stations for which other types of data were known to exist (e.g., sediment chemistry or benthic community composition) were included. Analytical data for most of the selected stations dated back to the mid-1980's, except for Station X14 (immediately downstream of the Rose Creek Diversion), for which data was available since 1975. In total, analytical results for more than 2,000 samples were examined as part of the water quality assessment.

Sulphate, hardness, conductivity, manganese, magnesium, calcium, strontium, sodium, and uranium were the parameters most often elevated in Rose and Vangorda Creeks relative to upstream reference stations. Therefore, these parameters are most appropriate for evaluating the current influence on surface water quality downstream of the Faro Mine complex (i.e., "mine indicators"). Strong statistical correlations were evident among almost all the mine-indicator parameters. Mine-related influence on water quality was evident at the most downstream monitoring stations in both the Rose/Anvil (R5) and Vangorda (V8) watersheds, based on elevated mean concentrations and higher percentage of samples exceeding background concentrations for mine indicator parameters. This does not necessarily indicate that effects on biota may be expected; no Canadian Water Quality Guidelines (CWQGs) exist for any of the mine-indicators, based on the lower aquatic toxicity of these substances relative to most of those having a CWQG.

Reference station data were sparse or associated with inadequate MDLs for many substances, including many for which a CWQG exists (e.g., As, Cd, Cr, Hg, Se, Ag, Tl). The percentage of mine-exposed samples containing iron, aluminum, copper, zinc, and lead was slightly greater than for reference stations (background), although most samples were less than CWQG in both areas. Low aqueous concentrations of arsenic, chromium, mercury, molybdenum, nickel, selenium, and thallium suggest that these substances do not likely pose a risk to aquatic biota downstream of the Faro Mine complex at the present time. MDLs for cadmium and silver were too high to allow for definitive conclusions with respect to these substances.

7.2 Sediment Quality

Sediment sample analyses have been conducted in the Rose-Anvil and Vangorda Creek systems since the early 1970s and 1990s, respectively, to determine to what extent, if any, that each site has impacted sediment quality.

Evaluation of the historical data indicated that sediment metal concentrations were significantly elevated in Rose Creek relative to background benchmarks (e.g., arsenic, cobalt, copper, iron, lead, manganese, mercury, nickel zinc) with elevations of some metals such as manganese, lead, and zinc levels extending further downstream into Anvil Creek (i.e., Stations A4 and A3). Arsenic, lead and zinc were observed at concentrations above CSQG PEL, suggesting some potential to adversely affect aquatic life. These three metals and manganese can be considered the strongest indicators of influence from the Faro site on sediment chemistry (i.e., “mine indicators”). The data were not indicative of any substantial remnants of tailings in the Rose-Anvil system from a reported tailings spill into Rose Creek in 1975. It is suspected that any material has likely been flushed out of the Rose-Anvil channel with the passage of over 30 years’ time, although deposits remain in the floodplain. Sediment metal concentrations at North Fork Rose Creek were also significantly higher at mine-influenced station R8 relative to the upstream reference station R7, although sediment metal levels at R8 were within reference benchmarks levels suggesting only a minor mine-effect. Although temporal comparison of the Rose-Anvil historical sediment chemistry data may have been confounded by differences in laboratory equipment/techniques from study to study, the data suggested that sediment metal concentrations in the Rose-Anvil system have decreased slightly over the period from 1973 to 2006.

In the Vangorda Creek system, sediment metal concentrations were significantly elevated at Station V27 the nearest downstream station to the Grum and Vangorda mines. Statistical evaluation of the historical data identified that the key indicators of mine influence on sediment chemistry were arsenic, lead, and zinc, which were the only metals observed at concentrations above CSQG PEL. Sediment chemistry differed between West Fork/lower Vangorda Creek versus upper Vangorda Creek, possibly reflecting natural variability in the various drainages or other upstream mine influences (roads, waste rock drainage). High natural variability in sediment chemistry was also observed among reference areas in the Rose-Anvil system. In lower Vangorda Creek (V8), sediment metal concentrations were intermediate between the West Fork and upper Vangorda Creek watercourses. Sediment lead and zinc concentrations, likely originating from upper Vangorda Creek, were elevated relative to reference, whereas calcium and strontium, likely originating from the West Fork, were also elevated. Of these, only sediment lead concentrations exceeded the PEL at V8.

Temporal comparison of Vangorda sediment data suggested substantially lower metal concentrations at the near-field (V27) location in 2005, whereas metal concentrations at the West Fork and lower Vangorda showed slower temporal decreases.

7.3 Benthic Invertebrate Communities

Numerous benthic invertebrate surveys have been conducted in the Rose/Anvil watershed during the past three decades, with many concluding that the Faro mine has impacted benthic invertebrate communities as far downstream as the Anvil Creek confluence. Detailed analysis of data from even years between 2000 and 2006 again confirmed that benthic invertebrate communities downstream of the Faro mine (e.g., R2-R4) showed some differences from reference communities (e.g., R6, R7 and minimally impacted R1). However, such differences were not always consistent with those typically associated with effluent impacts (e.g., higher percentage of sensitive EPT taxa downstream than at reference areas). Overall, it appears that temporal variability has played as large a role as relative station location in structuring benthic communities in Rose Creek, at least in recent years.

Detailed analysis of data from 2001, 2003 and 2005 surveys revealed significant differences in benthic community composition between the reference station V1 and the exposure station V27, which are located immediately upstream and downstream of the Grum/Vangorda site, respectively. However, the nature of such differences may be attributable to habitat differences rather than mine-related effects, based on a higher proportion of EPT, which are often considered sensitive to pollution, at near-field exposure station V27 than at reference station V1. Highest numbers of taxa were found at stations V5 and V8 compared to V1 and V27, and some differences in community composition were also evident between these two groups of stations, although none that appeared to be associated with mine-related influences. These and previous surveys have shown that mean benthic invertebrate abundance and taxon richness varies considerably among both stations and years.

Overall, mine-related influences on benthic invertebrate communities, if any, appeared to be minor.

7.4 Fish Surveys

Fish surveys have been conducted in the Rose-Anvil and Vangorda Creek systems since the early 1970s to examine whether any mine-related effects to fish communities and fish tissue metals concentrations were apparent. The data suggested that fish community diversity and density at areas downstream of mine operations in the Rose-Anvil and Vangorda Creek systems were generally greater than, or comparable to, respective reference area values, and that the mine sites have not adversely affected fish populations. Temporal analysis of the historical fish catch data suggested that, with the presence of Chinook salmon, Rose Creek species diversity may have increased since the late 1970s, whereas no obvious changes in fish diversity or density were observed at lower Vangorda Creek.

Tissue metal concentrations suggested that mining activities have had only very minor influences on the quality of fish tissue in the Rose-Anvil and Vangorda Creek systems, with no clear temporal trends suggested by the available data. Concentrations of cadmium, copper, manganese and zinc were well below human and wildlife consumption benchmarks since the late 1970s in both the Rose-Anvil and Vangorda Creek systems. Although arsenic, lead and mercury tissue metal levels have occasionally exceeded respective consumption benchmark levels (most notably in 1992 and 1997), similar concentrations observed in reference samples and widely variable survey-to-survey tissue concentrations suggested that tissue metal levels may be higher naturally and/or that differing analytical laboratory techniques among studies may have contributed to the apparently high values.

8.0 RECOMMENDATIONS

Recommendations for future monitoring include the following:

- The locations of routine monitoring stations should be re-evaluated in terms of the information contained in this report. For example, it would be appropriate to extend routine sampling farther downstream to delineate and track the spatial extent of mine influence on water quality associated with mine-indicator parameters;
- The frequency monitoring at each station should be rationalized to ensure the collection of adequate but not excessive information to track long-term changes;
- Monitoring at additional reference stations should be considered;
- The laboratory responsible for water quality analyses should be advised that a full suite of parameters be included in future analyses, with sufficiently low MDLs to permit valid comparison to CWQGs;
- The same suite of parameters and low MDLs applied to reference stations should also be consistently targeted for exposure areas; and
- Background benchmarks should be developed for all substances having CWQG once an adequate reference database has been developed with consistently low MDLs.
- Consideration should be given to potentially discontinuing sediment chemical monitoring. If continued, any future sediment analyses should include evaluation of particle size and total organic carbon content to assist in data interpretation.
- Sample benthic invertebrate communities less often but with higher intensity (i.e., more stations per sampling area) to result in a more statistically robust study design;
- In combination with the above, consider conducting benthic invertebrate surveys at less frequent intervals (e.g., 3-5 years), based on lack of evidence of on going mine-related degradation;
- Consideration should be given to future sampling of resident benthic invertebrates, rather than using of artificial substrates.
- Future fish surveys should employ more intensive, statistical approaches to assess whether mine activity is adversely affecting fish health (i.e., growth, reproduction, survival or condition; as per national Environmental Effects Monitoring Programs for operating mines);

- Fish community surveys should also continue to be conducted using quantitative electrofishing approaches to allow temporal tracking of fish diversity and density at monitoring stations.

- Fish tissue monitoring should be discontinued unless observed aqueous or sediment metal concentrations increase over time.

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APPENDIX A

WATER QUALITY DATA

Table A.1: ANOVA Results for Conductivity
(note: data log-transformed prior to analysis)

Descriptives				
Station ID	N	Mean	Std. Deviation	Std. Error
R7	34	2.192	0.193	0.033
V1	45	1.866	0.194	0.029
R6	7	2.440	0.082	0.031
W10	7	1.954	0.124	0.047
FDU	9	1.595	0.331	0.110
FC	8	1.475	0.131	0.046

ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	6.928	5	1.386	35.832	<0.0001
Within Groups	4.021	104	0.039		
Total	10.949	109			

Multiple Comparisons (Tamhane's T2)				
(I) Area	(J) Area	Mean Difference (I-J)	Std. Error	Sig.
R7	V1	0.327	0.044	0.000
	R6	-0.248	0.045	0.000
	W10	0.238	0.057	0.017
	FDU	0.597	0.115	0.007
	FC	0.717	0.057	0.000
V1	R7	-0.327	0.044	0.000
	R6	-0.574	0.042	0.000
	W10	-0.089	0.055	0.887
	FDU	0.270	0.114	0.468
	FC	0.391	0.055	0.000
R6	R7	0.248	0.045	0.000
	V1	0.574	0.042	0.000
	W10	0.486	0.056	0.000
	FDU	0.845	0.114	0.001
	FC	0.965	0.056	0.000
W10	R7	-0.238	0.057	0.017
	V1	0.089	0.055	0.887
	R6	-0.486	0.056	0.000
	FDU	0.359	0.120	0.171
	FC	0.480	0.066	0.000
FDU	R7	-0.597	0.115	0.007
	V1	-0.270	0.114	0.468
	R6	-0.845	0.114	0.001
	W10	-0.359	0.120	0.171
	FC	0.120	0.120	0.998
FC	R7	-0.717	0.057	0.000
	V1	-0.391	0.055	0.000
	R6	-0.965	0.056	0.000
	W10	-0.480	0.066	0.000
	FDU	-0.120	0.120	0.998

The mean difference is significant at the 0.05 level

Kruskal-Wallis Test	
Chi-Square	67.4
df	5
Asymp. Sig.	<0.0001

Table A.2: ANOVA Results for Copper
(note: data log-transformed prior to analysis)

Descriptives				
Station ID	N	Mean	Std. Deviation	Std. Error
R7	107	-2.493	0.500	0.048
V1	65	-2.325	0.543	0.067
R6	24	-2.487	0.462	0.094
W10	14	-2.381	0.664	0.177
FDU	15	-2.397	0.659	0.170
FC	14	-2.651	0.310	0.083

ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.909	5	0.382	1.404	0.223
Within Groups	63.325	233	0.272		
Total	65.234	238			

Kruskal-Wallis Test	
Chi-Square	5.445
df	5
Asymp. Sig.	0.364

Table A.3: ANOVA Results for Hardness

Descriptives				
Station ID	N	Mean	Std. Deviation	Std. Error
R7	41	88.24	37.27	5.82
V1	55	39.44	42.76	5.77
R6	13	148.54	39.25	10.89
W10	5	41.92	14.33	6.41
FDU	7	10.84	3.25	1.23

ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	171830	4	42958	28.70	<0.0001
Within Groups	173646	116	1497		
Total	345476	120			

Multiple Comparisons (Tukey HSD)				
(I) Area	(J) Area	Mean Difference (I-J)	Std. Error	Sig.
R7	V1	48.80	7.98	0.000
	R6	-60.29	12.32	0.000
	W10	46.32	18.33	0.092
	FDU	77.40	15.82	0.000
V1	R7	-48.80	7.98	0.000
	R6	-109.09	11.93	0.000
	W10	-2.48	18.07	1.000
	FDU	28.60	15.53	0.355
R6	R7	60.29	12.32	0.000
	V1	109.09	11.93	0.000
	W10	106.62	20.36	0.000
	FDU	137.69	18.14	0.000
W10	R7	-46.32	18.33	0.092
	V1	2.48	18.07	1.000
	R6	-106.62	20.36	0.000
	FDU	31.08	22.65	0.647
FDU	R7	-77.40	15.82	0.000
	V1	-28.60	15.53	0.355
	R6	-137.69	18.14	0.000
	W10	-31.08	22.65	0.647

The mean difference is significant at the .05 level.

Kruskal-Wallis Test	
Chi-Square	74.9
df	4
Asymp. Sig.	<0.0001

Table A.4: ANOVA Results for Iron
(note: data log-transformed prior to analysis)

Descriptives				
Station ID	N	Mean	Std. Deviation	Std. Error
R7	99	-0.736	0.427	0.043
V1	63	-1.025	0.625	0.079
R6	18	-0.804	0.282	0.067
W10	14	-1.173	0.484	0.129
FDU	15	-1.052	0.454	0.117
FC	9	-1.264	0.290	0.097

ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	6.399	5	1.280	5.418	0.0001
Within Groups	50.078	212	0.236		
Total	56.477	217			

Multiple Comparisons (Tamhane's T2)				
(I) Area	(J) Area	Mean Difference (I-J)	Std. Error	Sig.
R7	V1	0.289	0.090	0.026
	R6	0.068	0.079	1.000
	W10	0.438	0.136	0.078
	FDU	0.317	0.125	0.269
	FC	0.528	0.106	0.005
V1	R7	-0.289	0.090	0.026
	R6	-0.221	0.103	0.422
	W10	0.149	0.151	0.998
	FDU	0.028	0.141	1.000
	FC	0.239	0.125	0.656
R6	R7	-0.068	0.079	1.000
	V1	0.221	0.103	0.422
	W10	0.370	0.145	0.255
	FDU	0.249	0.135	0.704
	FC	0.460	0.117	0.019
W10	R7	-0.438	0.136	0.078
	V1	-0.149	0.151	0.998
	R6	-0.370	0.145	0.255
	FDU	-0.121	0.174	1.000
	FC	0.091	0.161	1.000
FDU	R7	-0.317	0.125	0.269
	V1	-0.028	0.141	1.000
	R6	-0.249	0.135	0.704
	W10	0.121	0.174	1.000
	FC	0.212	0.152	0.947
FC	R7	-0.528	0.106	0.005
	V1	-0.239	0.125	0.656
	R6	-0.460	0.117	0.019
	W10	-0.091	0.161	1.000
	FDU	-0.212	0.152	0.947

The mean difference is significant at the .05 level.

Kruskal-Wallis Test	
Chi-Square	28.533
df	5
Asymp. Sig.	0.00003

Table A.5: ANOVA Results for Lead
(note: data log-transformed prior to analysis)

Descriptives				
Station ID	N	Mean	Std. Deviation	Std. Error
R7	94	-2.255	0.583	0.060
V1	65	-2.086	0.555	0.069
R6	24	-2.315	0.594	0.121
W10	13	-2.248	0.653	0.181
FDU	13	-2.233	0.738	0.205
FC	8	-1.950	0.488	0.172

ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.985	5	0.397	1.152	0.334
Within Groups	72.718	211	0.345		
Total	74.703	216			

Kruskal-Wallis Test	
Chi-Square	4.603
df	5
Asymp. Sig.	0.466

Table A.6: ANOVA Results for Manganese
(note: data log-transformed prior to analysis)

Descriptives				
Station ID	N	Mean	Std. Deviation	Std. Error
R7	86	-1.762	0.343	0.037
V1	52	-2.321	0.533	0.074
R6	16	-1.895	0.116	0.029
W10	13	-2.220	0.497	0.138
FDU	13	-2.201	0.446	0.124
FC	8	-2.540	0.221	0.078

ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	13.764	5	2.753	16.498	<0.0001
Within Groups	30.369	182	0.167		
Total	44.133	187			

Multiple Comparisons (Tamhane's T2)				
(I) Area	(J) Area	Mean Difference (I-J)	Std. Error	Sig.
R7	V1	0.558	0.083	0.000
	R6	0.133	0.047	0.090
	W10	0.457	0.143	0.093
	FDU	0.438	0.129	0.062
	FC	0.777	0.086	0.000
V1	R7	-0.558	0.083	0.000
	R6	-0.426	0.079	0.000
	W10	-0.101	0.156	1.000
	FDU	-0.120	0.144	1.000
	FC	0.219	0.108	0.561
R6	R7	-0.133	0.047	0.090
	V1	0.426	0.079	0.000
	W10	0.325	0.141	0.443
	FDU	0.306	0.127	0.378
	FC	0.645	0.083	0.000
W10	R7	-0.457	0.143	0.093
	V1	0.101	0.156	1.000
	R6	-0.325	0.141	0.443
	FDU	-0.019	0.185	1.000
	FC	0.320	0.158	0.596
FDU	R7	-0.438	0.129	0.062
	V1	0.120	0.144	1.000
	R6	-0.306	0.127	0.378
	W10	0.019	0.185	1.000
	FC	0.339	0.146	0.385
FC	R7	-0.777	0.086	0.000
	V1	-0.219	0.108	0.561
	R6	-0.645	0.083	0.000
	W10	-0.320	0.158	0.596
	FDU	-0.339	0.146	0.385

The mean difference is significant at the .05 level.

Kruskal-Wallis Test	
Chi-Square	64.6
df	5
Asymp. Sig.	<0.0001

Table A.7: ANOVA Results for Nickel

(note: data log-transformed prior to analysis)

Descriptives				
Station ID	N	Mean	Std. Deviation	Std. Error
R7	86	-2.533	0.389	0.042
V1	53	-2.437	0.546	0.075
R6	16	-2.453	0.432	0.108
W10	13	-2.412	0.557	0.154
FDU	13	-2.396	0.571	0.158

ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	0.501	4	0.125	0.568	0.686
Within Groups	38.861	176	0.221		
Total	39.362	180			

Kruskal-Wallis Test	
Chi-Square	2.605
df	4
Asymp. Sig.	0.626

Table A.8: ANOVA Results for Sulphate
(note: data log-transformed prior to analysis)

Descriptives				
Station ID	N	Mean	Std. Deviation	Std. Error
R7	102	0.886	0.247	0.024
V1	63	0.920	0.263	0.033
R6	22	1.285	0.259	0.055
W10	14	0.558	0.254	0.068
FDU	15	0.424	0.408	0.105
FC	14	0.224	0.210	0.056

ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	13.99	5	2.798	40.15	<0.0001
Within Groups	15.61	224	0.070		
Total	29.60	229			

Multiple Comparisons (Tukey HSD)				
(I) Area	(J) Area	Mean Difference (I-J)	Std. Error	Sig.
R7	V1	-0.034	0.042	0.968
	R6	-0.399	0.062	0.000
	W10	0.328	0.075	0.000
	FDU	0.462	0.073	0.000
	FC	0.662	0.075	0.000
V1	R7	0.034	0.042	0.968
	R6	-0.366	0.065	0.000
	W10	0.361	0.078	0.000
	FDU	0.496	0.076	0.000
	FC	0.695	0.078	0.000
R6	R7	0.399	0.062	0.000
	V1	0.366	0.065	0.000
	W10	0.727	0.090	0.000
	FDU	0.861	0.088	0.000
	FC	1.061	0.090	0.000
W10	R7	-0.328	0.075	0.000
	V1	-0.361	0.078	0.000
	R6	-0.727	0.090	0.000
	FDU	0.134	0.098	0.747
	FC	0.334	0.100	0.012
FDU	R7	-0.462	0.073	0.000
	V1	-0.496	0.076	0.000
	R6	-0.861	0.088	0.000
	W10	-0.134	0.098	0.747
	FC	0.200	0.098	0.325
FC	R7	-0.662	0.075	0.000
	V1	-0.695	0.078	0.000
	R6	-1.061	0.090	0.000
	W10	-0.334	0.100	0.012
	FDU	-0.200	0.098	0.325

The mean difference is significant at the .05 level.

Kruskal-Wallis Test	
Chi-Square	99.8
df	5
Asymp. Sig.	<0.0001

Table A.9: ANOVA Results for Zinc
(note: data log-transformed prior to analysis)

Descriptives				
Station ID	N	Mean	Std. Deviation	Std. Error
R7	106	-1.949	0.471	0.046
V1	65	-1.991	0.511	0.063
R6	24	-2.088	0.513	0.105
W10	14	-1.754	0.485	0.130
FDU	15	-1.664	0.570	0.147
FC	16	-2.142	0.324	0.081

ANOVA					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2.903	5	0.581	2.460	0.034
Within Groups	55.228	234	0.236		
Total	58.131	239			

Multiple Comparisons (Tukey HSD)				
(I) Area	(J) Area	Mean Difference (I-J)	Std. Error	Sig.
R7	V1	0.041	0.077	0.994
	R6	0.138	0.110	0.806
	W10	-0.195	0.138	0.718
	FDU	-0.285	0.134	0.277
	FC	0.193	0.130	0.675
V1	R7	-0.041	0.077	0.994
	R6	0.097	0.116	0.960
	W10	-0.237	0.143	0.563
	FDU	-0.326	0.139	0.180
	FC	0.152	0.136	0.873
R6	R7	-0.138	0.110	0.806
	V1	-0.097	0.116	0.960
	W10	-0.334	0.163	0.321
	FDU	-0.423	0.160	0.090
	FC	0.055	0.157	0.999
W10	R7	0.195	0.138	0.718
	V1	0.237	0.143	0.563
	R6	0.334	0.163	0.321
	FDU	-0.090	0.181	0.996
	FC	0.389	0.178	0.248
FDU	R7	0.285	0.134	0.277
	V1	0.326	0.139	0.180
	R6	0.423	0.160	0.090
	W10	0.090	0.181	0.996
	FC	0.478	0.175	0.072
FC	R7	-0.193	0.130	0.675
	V1	-0.152	0.136	0.873
	R6	-0.055	0.157	0.999
	W10	-0.389	0.178	0.248
	FDU	-0.478	0.175	0.072

The mean difference is significant at the .05 level.

Kruskal-Wallis Test	
Chi-Square	11.0
df	5
Asymp. Sig.	0.051

Table A.10: Comparison of Benchmarks for Conductivity Measured in Water Samples from Reference Areas

		Units	FC	W10	FDU	R6	R7	Rose/Anvil	V1	All Reference
n		**-**	8	7	9	7	34	65	45	110
Mean		µS/cm	31	93	54	280	170	140	80	116
SD		µS/cm	10	25	58	56	65	91	32	79
Min		µS/cm	19	61	19	222	53	19	22	19
Max		µS/cm	54	134	194	382	289	382	164	382
Watershed Specific Benchmarks	95% CI	µS/cm	322	322	322	322	322	322	146	261
	#>95% CI	-	0	0	0	1	0	1	1	6
	%>95% CI	%	0	0	0	14	0	2	2	5
	90th %ile	µS/cm	261	261	261	261	261	261	118	238
	#>90th %ile	-	0	0	0	3	3	6	5	12
	%>90th %ile	%	0	0	0	43	9	9	11	11
	95th %ile	µS/cm	287	287	287	287	287	287	123	261
	#>95th %ile	-	0	0	0	3	1	4	3	6
	%>95th %ile	%	0	0	0	43	3	6	7	5
	99th %ile	µS/cm	340	340	340	340	340	340	146	293
	#>99th %ile	-	0	0	0	1	0	1	1	2
	%>99th %ile	%	0	0	0	14	0	2	2	2
All Reference Areas Combined	95th %ile	µS/cm	261	261	261	261	261	261	261	-
	#>95th %ile	-	0	0	0	3	3	6	0	-
	%>95th %ile	%	0	0	0	43	9	9	0	-

Table A.11: Comparison of Benchmarks for Copper Measured in Water Samples from Reference Areas

		Units	FC	W10	FDU	R6	R7	Rose/Anvil	V1	All Reference
n		**-**	14	14	15	24	107	174	65	239
<MDL		-	8	4	7	8	38	65	24	89
>MDL		-	6	10	8	16	69	109	41	150
%<MDL		%	57	29	47	33	36	37	37	37
Mean		mg/L	0.003	0.016	0.011	0.006	0.007	0.007	0.010	0.008
SD		mg/L	0.003	0.037	0.017	0.009	0.009	0.014	0.016	0.015
Min		mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0006	0.0006
Max Detectable		mg/L	0.003	0.143	0.064	0.036	0.045	0.143	0.103	0.143
Max MDL		mg/L	<0.010	<0.010	<0.010	<0.006	<0.020	<0.020	<0.006	<0.020
Watershed Specific Benchmarks	95% CI	mg/L	0.023	0.023	0.023	0.023	0.023	0.023	0.031	0.024
	#>95% CI	-	0	2	2	2	8	14	4	20
	%>95% CI	%	0	14	13	8	7	8	6	8
	90th %ile	mg/L	0.020	0.020	0.020	0.020	0.020	0.020	0.024	0.021
	#>90th %ile	-	0	2	3	2	11	18	8	26
	%>90th %ile	%	0	14	20	8	10	10	12	11
	95th %ile	mg/L	0.025	0.025	0.025	0.025	0.025	0.025	0.027	0.026
	#>95th %ile	-	0	1	2	2	6	11	4	16
	%>95th %ile	%	0	7	13	8	6	6	6	7
	99th %ile	mg/L	0.037	0.037	0.037	0.037	0.037	0.037	0.048	0.038
	#>99th %ile	-	0	1	1	0	2	4	2	6
	%>99th %ile	%	0	7	7	0	2	2	3	3
All Reference Areas Combined	95th %ile	mg/L	0.026	0.026	0.026	0.026	0.026	0.026	0.026	-
	#>95th %ile	-	0	1	1	2	6	10	6	-
	%>95th %ile	%	0	7	7	8	6	6	9	-

Table A.12: Comparison of Benchmarks for Hardness Measured in Water Samples from Reference Areas

		Units	FC	W10	FDU	R6	R7	Rose/Anvil	V1	All Reference
n		**-**	1	5	7	13	41	67	56	123
Mean		mg/L	7.3	42	11	149	88	87	39	65
SD		mg/L	-	14	3.3	39	37	52	43	54
Min		mg/L	7.3	27	7	99	21	7.3	0	0
Max		mg/L	7.3	60	16	261	153	261	325	325
Watershed Specific Benchmarks	95% CI	mg/L	181	181	181	181	181	181	69	151
	#>95% CI	-	0	0	0	1	0	1	1	7
	%>95% CI	%	0	0	0	8	0	1	2	6
	90th %ile	mg/L	145	145	145	145	145	145	57	134
	#>90th %ile	-	0	0	0	6	2	8	7	14
	%>90th %ile	%	0	0	0	46	5	12	13	11
	95th %ile	mg/L	155	155	155	155	155	155	59	146
	#>95th %ile	-	0	0	0	5	0	5	3	8
	%>95th %ile	%	0	0	0	38	0	7	5	7
	99th %ile	mg/L	162	162	162	162	162	162	65	158
	#>99th %ile	-	0	0	0	2	0	2	2	3
	%>99th %ile	%	0	0	0	15	0	3	4	2
All Reference Areas Combined	95th %ile	mg/L	146	146	146	146	146	146	146	-
	#>95th %ile	-	0	0	0	5	2	7	1	-
	%>95th %ile	%	0	0	0	38	5	10	2	-

Table A.13: Comparison of Benchmarks for Iron Measured in Water Samples from Reference Areas

		Units	FC	W10	FDU	R6	R7	Rose/Anvil	V1	All Reference
n		**-**	9	14	15	18	99	155	63	218
<MDL		-	1	6	2	1	4	14	8	22
>MDL		-	8	8	13	17	95	141	55	196
%<MDL		%	11	43	13	6	4	9	13	10
Mean		mg/L	0.06	0.13	0.13	0.19	0.32	0.253	0.30	0.267
SD		mg/L	0.03	0.22	0.11	0.14	0.41	0.352	0.76	0.503
Min		mg/L	0.018	<0.010	0.007	<0.050	0.016	0.007	<0.006	<0.006
Max Detectable		mg/L	0.10	0.86	0.35	0.62	2.12	2.12	4.44	4.44
Max MDL		mg/L	<0.03	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Watershed Specific Benchmarks	95% CI	mg/L	0.639	0.639	0.639	0.639	0.639	0.639	0.588	0.798
	#>95% CI	-	0	1	0	0	14	15	6	17
	%>95% CI	%	0	7	0	0	14	10	10	8
	90th %ile	mg/L	0.441	0.441	0.441	0.441	0.441	0.441	0.480	0.502
	#>90th %ile	-	0	1	0	1	18	20	8	25
	%>90th %ile	%	0	7	0	6	18	13	13	11
	95th %ile	mg/L	0.801	0.801	0.801	0.801	0.801	0.801	0.610	0.840
	#>95th %ile	-	0	1	0	0	12	13	5	13
	%>95th %ile	%	0	7	0	0	12	8	8	6
	99th %ile	mg/L	0.980	0.980	0.980	0.980	0.980	0.980	0.822	1.623
	#>99th %ile	-	0	0	0	0	7	7	3	6
	%>99th %ile	%	0	0	0	0	7	5	5	3
All Reference Areas Combined	95th %ile	mg/L	0.840	0.840	0.840	0.840	0.840	0.840	0.840	-
	#>95th %ile	-	0	1	0	0	10	11	2	-
	%>95th %ile	%	0	7	0	0	10	7	3	-

Table A.14: Comparison of Benchmarks for Lead Measured in Water Samples from Reference Areas

		Units	FC	W10	FDU	R6	R7	Rose/Anvil	V1	All Reference
n		-	8	13	13	24	94	152	65	217
<MDL		-	0	12	0	15	77	104	43	147
>MDL		-	8	1	13	9	17	48	22	70
%<MDL		%	0	92	0	63	82	68	66	68
Mean		mg/L	0.020	0.014	0.018	0.012	0.011	0.012	0.016	0.013
SD		mg/L	0.021	0.017	0.026	0.017	0.010	0.015	0.019	0.016
Min		mg/L	0.005	<0.001	0.001	<0.001	<0.001	<0.001	<0.0002	<0.0002
Max Detectable		mg/L	0.05	0.003	0.09	0.03	0.05	0.09	0.11	0.11
Max MDL		mg/L	-	<0.05	-	<0.06	<0.03	<0.06	<0.06	<0.06
Watershed Specific Benchmarks	95% CI	mg/L	0.035	0.035	0.035	0.035	0.035	0.035	0.044	0.040
	#>95% CI	-	2	0	2	0	2	6	1	6
	%>95% CI	%	25	0	15	0	2	4	2	3
	90th %ile	mg/L	0.020	0.020	0.020	0.020	0.020	0.020	0.027	0.024
	#>90th %ile	-	3	0	3	1	3	10	2	12
	%>90th %ile	%	38	0	23	4	3	7	3	6
	95th %ile	mg/L	0.031	0.031	0.031	0.031	0.031	0.031	0.050	0.050
	#>95th %ile	-	3	0	2	0	2	7	1	2
	%>95th %ile	%	38	0	15	0	2	5	2	1
	99th %ile	mg/L	0.050	0.050	0.050	0.050	0.050	0.050	0.060	0.060
	#>99th %ile	-	0	0	1	0	0	1	1	2
	%>99th %ile	%	0	0	8	0	0	1	2	1
All Reference Areas Combined	95th %ile	mg/L	0.050	0.050	0.050	0.050	0.050	0.050	0.050	-
	#>95th %ile	-	0	0	1	0	0	1	1	-
	%>95th %ile	%	0	0	8	0	0	1	2	-

Table A.15: Comparison of Benchmarks for Manganese Measured in Water Samples from Reference Areas

		Units	FC	W10	FDU	R6	R7	Rose/Anvil	V1	All Reference
n		**-**	8	13	13	16	86	136	53	189
<MDL		-	2	8	4	2	15	31	22	53
>MDL		-	6	5	9	14	71	105	31	136
%<MDL		%	25	62	31	13	17	23	42	28
Mean		mg/L	0.003	0.010	0.010	0.013	0.027	0.021	0.012	0.018
SD		mg/L	0.002	0.009	0.009	0.004	0.038	0.031	0.027	0.030
Min		mg/L	0.002	<0.001	0.001	0.009	0.005	<0.001	0.0009	0.0009
Max Detectable		mg/L	0.006	0.031	0.03	0.02	0.21	0.21	0.174	0.21
Max MDL		mg/L	<0.005	<0.005	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Watershed Specific Benchmarks	95% CI	mg/L	0.046	0.046	0.046	0.046	0.046	0.046	0.038	0.044
	#>95% CI	-	0	0	0	0	12	12	3	15
	%>95% CI	%	0	0	0	0	14	9	6	8
	90th %ile	mg/L	0.028	0.028	0.028	0.028	0.028	0.028	0.010	0.024
	#>90th %ile	-	0	1	1	0	15	17	6	23
	%>90th %ile	%	0	8	8	0	17	13	12	12
	95th %ile	mg/L	0.051	0.051	0.051	0.051	0.051	0.051	0.022	0.048
	#>95th %ile	-	0	0	0	0	11	11	4	15
	%>95th %ile	%	0	0	0	0	13	8	8	8
	99th %ile	mg/L	0.084	0.084	0.084	0.084	0.084	0.084	0.075	0.082
	#>99th %ile	-	0	0	0	0	6	6	2	7
	%>99th %ile	%	0	0	0	0	7	4	4	4
All Reference Areas Combined	95th %ile	mg/L	0.048	0.048	0.048	0.048	0.048	0.048	0.048	-
	#>95th %ile	-	0	0	0	0	12	12	3	-
	%>95th %ile	%	0	0	0	0	14	9	6	-

Table A.16: Comparison of Benchmarks for Nickel Measured in Water Samples from Reference Areas

		Units	FC	W10	FDU	R6	R7	Rose/Anvil	V1	All Reference
n		-	2	13	13	16	86	130	53	183
<MDL		-	2	12	8	9	68	99	41	140
>MDL		-	0	1	5	7	18	31	12	43
%<MDL		%	100	92	62	56	79	76	77	77
Mean		mg/L	<0.020	0.008	0.008	0.006	0.004	0.005	0.007	0.006
SD		mg/L	0	0.010	0.008	0.006	0.003	0.006	0.007	0.006
Min		mg/L	<0.020	<0.001	<0.001	<0.001	<0.0002	<0.0002	<0.0002	<0.0002
Max Detectable		mg/L	-	0.035	0.023	0.009	0.014	0.035	0.023	0.035
Max MDL		mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Watershed Specific Benchmarks	95% CI	mg/L	0.015	0.015	0.015	0.015	0.015	0.015	0.022	0.017
	#>95% CI	-	0	1	1	0	0	2	1	3
	%>95% CI	%	0	8	8	0	0	2	2	2
	90th %ile	mg/L	0.011	0.011	0.011	0.011	0.011	0.011	0.020	0.020
	#>90th %ile	-	0	1	2	0	2	5	1	3
	%>90th %ile	%	0	8	15	0	2	4	2	2
	95th %ile	mg/L	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020
	#>95th %ile	-	0	1	1	0	0	2	1	3
	%>95th %ile	%	0	8	8	0	0	2	2	2
	99th %ile	mg/L	0.020	0.020	0.020	0.020	0.020	0.020	0.021	0.021
	#>99th %ile	-	0	1	1	0	0	2	1	3
	%>99th %ile	%	0	8	8	0	0	2	2	2
All Reference Areas Combined	95th %ile	mg/L	0.020	0.020	0.020	0.020	0.020	0.020	0.020	-
	#>95th %ile	-	0	1	1	0	0	2	1	-
	%>95th %ile	%	0	8	8	0	0	2	2	-

Table A.17: Comparison of Benchmarks for Sulphate Measured in Water Samples from Reference Areas

		Units	FC	W10	FDU	R6	R7	Rose/Anvil	V1	All Reference
n		-	14	14	15	22	102	167	63	230
#<MDL		-	1	0	0	0	0	1	1	2
#>MDL		-	13	14	15	22	102	166	62	228
%<MDL		%	7	0	0	0	0	1	2	1
Mean		mg/L	1.9	4.4	5.7	24	9.1	9.7	9.6	9.7
SD		mg/L	0.93	4.0	13	21	6.3	11.3	4.5	9.9
Min		mg/L	<1	1	1	6	1.7	<1	<1	<1
Max Detectable		mg/L	4	18	51	91	52	91	26	91
Watershed Specific Benchmarks	95% CI	mg/L	20.1	20.1	20.1	20.1	20.1	20.1	16.3	19.7
	#>95% CI	-	0	0	1	8	4	13	3	20
	%>95% CI	%	0	0	7	36	4	8	5	9
	90th %ile	mg/L	18.8	18.8	18.8	18.8	18.8	18.8	13.0	17.0
	#>90th %ile	-	0	0	1	13	7	21	5	25
	%>90th %ile	%	0	0	7	59	7	13	8	11
	95th %ile	mg/L	20.4	20.4	20.4	20.4	20.4	20.4	13.0	20.0
	#>95th %ile	-	0	0	1	7	4	12	5	15
	%>95th %ile	%	0	0	7	32	4	7	8	7
	99th %ile	mg/L	24.4	24.4	24.4	24.4	24.4	24.4	16.4	24.8
	#>99th %ile	-	0	0	1	2	3	6	3	7
	%>99th %ile	%	0	0	7	9	3	4	5	3
All Reference Areas Combined	95th %ile	mg/L	20.0	20.0	20.0	20.0	20.0	20.0	20.0	-
	#>95th %ile	-	0	0	1	8	4	13	2	-
	%>95th %ile	%	0	0	7	36	4	8	3	-

Table A.18: Comparison of Benchmarks for Zinc Measured in Water Samples from Reference Areas

		Units	FC	W10	FDU	R6	R7	Rose/Anvil	V1	All Reference
n		**-**	16	14	15	24	106	175	65	240
<MDL		-	3	5	3	8	38	57	16	73
>MDL		-	13	9	12	16	68	118	49	167
%<MDL		%	19	36	20	33	36	33	25	30
Mean		mg/L	0.009	0.030	0.052	0.018	0.023	0.024	0.020	0.023
SD		mg/L	0.007	0.028	0.077	0.027	0.050	0.047	0.032	0.044
Min		mg/L	<0.002	<0.005	<0.005	0.001	<0.001	<0.001	<0.001	<0.001
Max Detectable		mg/L	0.023	0.091	0.23	0.118	0.443	0.443	0.24	0.443
Max MDL		mg/L	<0.005	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Watershed Specific Benchmarks	95% CI	mg/L	0.065	0.065	0.065	0.065	0.065	0.065	0.049	0.061
	#>95% CI	-	0	2	4	1	5	12	6	14
	%>95% CI	%	0	14	27	4	5	7	9	6
	90th %ile	mg/L	0.043	0.043	0.043	0.043	0.043	0.043	0.043	0.043
	#>90th %ile	-	0	4	4	3	10	21	7	28
	%>90th %ile	%	0	29	27	13	9	12	11	12
	95th %ile	mg/L	0.063	0.063	0.063	0.063	0.063	0.063	0.050	0.060
	#>95th %ile	-	0	2	4	2	5	13	3	16
	%>95th %ile	%	0	14	27	8	5	7	5	7
	99th %ile	mg/L	0.125	0.125	0.125	0.125	0.125	0.125	0.060	0.109
	#>99th %ile	-	0	0	2	0	4	6	2	8
	%>99th %ile	%	0	0	13	0	4	3	3	3
All Reference Areas Combined	95th %ile	mg/L	0.060	0.060	0.060	0.060	0.060	0.060	0.060	-
	#>95th %ile	-	0	3	4	2	5	14	2	-
	%>95th %ile	%	0	21	27	8	5	8	3	-

Table A.19: Summary Statistics for Alkalinity Measured in Water Samples (1975 - 2006)

Exposed or Potentially Disturbed											
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# < Benchmark**	**% < Benchmark**
FDL	0	0	0	-	-	-	-	-	-	0	-
R8	29	0	29	0	77	58	8	251	-	1	3
R9	35	0	35	0	82	56	10	277	-	0	0
R10	34	0	34	0	83	57	10	277	-	0	0
NF1	7	0	7	0	64	16	45	90	-	0	0
NF2	10	0	10	0	72	26	39	132	-	0	0
X2	74	0	74	0	97	89	24	765	-	0	0
R1	11	0	11	0	92	42	4	177	-	1	9
W8	10	0	10	0	52	12	31	64	-	0	0
X14	109	0	109	0	114	41	36	247	-	0	0
R2	11	0	11	0	114	27	82	165	-	0	0
R3	11	0	11	0	112	24	84	153	-	0	0
R4	19	0	19	0	105	22	59	144	-	0	0
R5	19	0	19	0	122	17	86	147	-	0	0
R11	5	0	5	0	122	14	101	137	-	0	0
V27	28	2	26	7	66	51	<5	247	<5	3	11
V4	15	0	15	0	249	107	46	437	-	0	0
V5	55	2	53	4	189	87	<5	487	<5	2	4
V8	94	2	92	2	143	66	<5	286	<5	2	2
Totals	**576**	**6**	**570**	**1**							
Reference											
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# < Benchmark**	**% < Benchmark**
V1	38	2	36	5	32	17	<2	77	<5	3	8
FDU	5	0	5	0	12	4	7	17	-	2	40
FC	16	1	15	6	13	4	<1	20	<1	2	13
R7	49	0	49	0	78	38	11	166	-	0	0
W10	4	0	4	0	42	18	27	68	-	0	0
R6	19	0	19	0	128	16	89	151	-	0	0
Totals	**131**	**3**	**128**	**2**							

Background Benchmark = 10 mg/L

Table A.20: Summary Statistics for Total Aluminum Measured in Water Samples (1975 - 2006)

Exposed or Potentially Disturbed													
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**	**# > CWQG**	**% > CWQG**
FDL	5	0	5	0	0.083	0.037	0.043	0.13	-	0	0	2	40
R8	81	15	66	19	0.107	0.123	<0.005	0.65	<0.06	8	10	22	27
R9	80	16	64	20	0.112	0.141	<0.005	0.76	<0.06	7	9	22	28
R10	80	14	66	18	0.105	0.118	<0.005	0.47	<0.06	7	9	23	29
NF1	13	3	10	23	0.101	0.092	0.011	0.34	<0.05	1	8	4	31
NF2	16	6	10	38	0.131	0.134	0.012	0.513	<0.2	1	6	4	25
X2	171	35	136	20	0.125	0.143	<0.005	1	<0.06	10	6	63	37
R1	11	1	10	9	0.041	0.034	0.007	0.12	<0.05	0	0	1	9
W8	14	4	10	29	0.096	0.075	0.014	0.22	<0.2	0	0	3	21
X14	211	39	172	18	0.151	0.291	<0.005	3.53	<0.06	26	12	80	38
R2	11	1	10	9	0.047	0.037	0.015	0.14	<0.05	0	0	1	9
R3	11	2	9	18	0.042	0.041	<0.005	0.14	<0.05	0	0	1	9
R4	16	3	13	19	0.104	0.093	<0.005	0.28	<0.05	0	0	6	38
R5	15	1	14	7	0.075	0.058	0.01	0.18	<0.05	0	0	5	33
R11	5	0	5	0	0.034	0.020	0.007	0.061	-	0	0	0	0
V27	31	2	29	6	0.162	0.220	0.016	1.04	<0.05	2	6	14	45
V4	32	3	29	9	0.263	0.300	0.013	1.23	<0.05	8	25	19	59
V5	131	6	125	5	1.014	3.107	0.014	29.5	<0.06	52	40	88	67
V8	149	14	135	9	0.584	2.276	<0.005	21.6	<0.05	35	23	74	50
Totals	**1083**	**165**	**918**	**15**									
Reference													
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**	**# > CWQG**	**% > CWQG**
V1	53	9	44	17	0.381	2.052	0.006	15	<0.06	4	8	14	26
FDU	13	3	10	23	0.137	0.109	0.028	0.4	<0.2	1	8	4	31
FC	2	2	0	100	<0.2	0	<0.2	-	<0.2	0	0	0	0
R7	86	18	68	21	0.113	0.205	<0.005	1.7	<0.06	5	6	21	24
W10	13	4	9	31	0.104	0.089	0.012	0.31	<0.2	0	0	3	23
R6	16	1	15	6	0.085	0.066	0.014	0.24	<0.05	0	0	6	38
Totals	**183**	**37**	**146**	**20**									

Background Benchmark = 0.32 mg/L
CWQG = 0.1 mg/L

Table A.21: Summary Statistics for Total Ammonia Measured in Water Samples (1975 - 2006)

Exposed or Potentially Disturbed														
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**	**CWQG**	**# > CWQG**	**% > CWQG**
FDL	5	5	0	100	<0.01	0	<0.01	-	<0.01	0	0	0.7	0	0
R8	59	42	17	71	0.037	0.028	<0.005	0.16	<0.05	1	2	0.7	0	0
R9	59	43	16	73	0.032	0.022	0.003	0.09	<0.05	0	0	0.7	0	0
R10	61	48	13	79	0.032	0.023	<0.005	0.1	<0.05	0	0	0.7	0	0
NF1	7	5	2	71	0.023	0.019	<0.01	0.02	<0.05	0	0	0.7	0	0
NF2	8	8	0	100	<0.025	0.021	<0.01	-	<0.05	0	0	0.7	0	0
X2	246	130	116	53	0.079	0.167	<0.002	2.09	<0.05	34	14	0.7	3	1
R1	11	8	3	73	0.048	0.029	<0.01	0.1	<0.05	0	0	0.7	0	0
W8	7	6	1	86	0.021	0.020	<0.01	0.05	<0.05	0	0	0.7	0	0
X14	313	57	256	18	0.310	0.434	<0.01	4.71	<1	178	57	0.7	34	11
R2	11	4	7	36	0.102	0.072	0.02	0.26	<0.05	4	36	0.7	0	0
R3	11	5	6	45	0.058	0.032	<0.01	0.11	<0.05	0	0	0.7	0	0
R4	25	10	15	40	0.199	0.264	<0.005	1	<0.05	9	36	0.7	2	8
R5	24	12	12	50	0.097	0.118	<0.005	0.53	<0.05	5	21	0.7	0	0
R11	5	3	2	60	0.014	0.005	<0.01	0.02	<0.01	0	0	0.7	0	0
V27	39	21	18	54	0.064	0.072	<0.005	0.32	<0.05	6	15	0.7	1	3
V4	33	22	11	67	0.070	0.131	<0.005	0.73	<0.05	2	6	0.7	1	3
V5	92	60	32	65	0.038	0.031	<0.002	0.17	<0.05	2	2	0.7	0	0
V8	147	79	68	54	0.045	0.044	<0.002	0.366	<0.05	4	3	0.7	0	0
Totals	**1163**	**568**	**595**	**49**										
Reference														
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**	**CWQG**	**# > CWQG**	**% > CWQG**
V1	53	31	22	58	0.051	0.055	<0.002	0.29	<0.05	3	6	0.7		
FDU	6	4	2	67	0.017	0.016	<0.01	0.01	<0.05	0	0	0.7		
FC	6	0	6	0	0.213	0.140	0.01	0.35	-	4	67	0.7		
R7	87	49	38	56	0.057	0.079	<0.005	0.60	<0.05	5	6	0.7		
W10	6	6	0	100	<0.023	0.021	<0.01	-	<0.05	0	0	0.7		
R6	24	12	12	50	0.054	0.059	0.003	0.25	<0.05	2	8	0.7		
Totals	**182**	**102**	**80**	**56**										

Background Benchmark = 0.12 mg/L

Table A.22: Summary Statistics for Total Antimony Measured in Water Samples (1975 - 2006)

Exposed or Potentially Disturbed							
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Min**	**Max Detectable**	**Max MDL**
FDL	5	5	0	100	< 0.001	-	< 0.001
R8	81	75	6	93	< 0.001	0.06	< 0.05
R9	80	72	8	90	< 0.001	0.05	< 0.03
R10	80	76	4	95	< 0.001	0.042	< 0.05
NF1	13	12	1	92	< 0.001	0.05	< 0.03
NF2	16	16	0	100	< 0.001	-	< 0.2
X2	171	153	18	89	< 0.001	0.05	< 0.2
R1	11	10	1	91	< 0.001	0.02	< 0.03
W8	14	14	0	100	< 0.001	-	< 0.2
X14	211	187	24	89	< 0.001	0.1	< 0.2
R2	11	10	1	91	< 0.001	0.019	< 0.03
R3	11	10	1	91	< 0.001	0.007	< 0.03
R4	16	15	1	94	< 0.001	0.009	< 0.06
R5	15	14	1	93	< 0.001	0.007	< 0.06
R11	5	5	0	100	< 0.001	-	< 0.001
V27	31	26	5	84	< 0.001	0.06	< 0.03
V4	31	27	4	87	< 0.001	0.03	< 0.05
V5	131	109	22	83	< 0.001	0.07	< 0.2
V8	149	130	19	87	< 0.001	0.06	< 0.2
Totals	**1082**	**966**	**116**	**89**			
Reference							
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Min**	**Max Detectable**	**Max MDL**
V1	52	46	6	88	< 0.0002	0.06	< 0.06
FDU	13	13	0	100	< 0.001	-	< 0.2
FC	2	2	0	100	< 0.2	-	< 0.2
R7	86	81	5	94	< 0.001	0.04	< 0.05
W10	13	13	0	100	< 0.001	-	< 0.2
R6	16	15	1	94	< 0.001	0.003	< 0.03
Totals	**182**	**170**	**12**	**93**			

Table A.23: Summary Statistics for Total Arsenic Measured in Water Samples (1975 - 2006)

Exposed or Potentially Disturbed

Station Name	n	<MDL	>MDL	%<MDL	Min	Max Detectable	Max MDL	# > CWQG	% > CWQG
FDL	5	5	0	100	<0.001	-	<0.001	0	0
R8	81	74	7	91	<0.001	0.002	<0.04	0	0
R9	83	74	9	89	<0.001	0.03	<0.04	4	5
R10	84	73	11	87	<0.001	0.07	<0.04	5	6
NF1	13	10	3	77	<0.001	0.01	<0.02	1	8
NF2	16	15	1	94	<0.001	0.012	<0.2	1	6
X2	171	156	15	91	<0.001	0.03	<0.2	11	6
R1	11	11	0	100	<0.001	-	<0.02	0	0
W8	14	14	0	100	<0.001	-	<0.2	0	0
X14	211	189	22	90	<0.001	0.07	<0.2	14	7
R2	11	8	3	73	<0.001	0.001	<0.02	0	0
R3	11	10	1	91	<0.001	0.001	<0.02	0	0
R4	16	15	1	94	<0.001	0.001	<0.06	0	0
R5	14	14	0	100	<0.001	-	<0.06	0	0
R11	5	3	2	60	<0.001	0.001	<0.001	0	0
V27	43	32	11	74	<0.001	0.05	<0.04	9	21
V4	40	27	13	68	<0.0005	0.08	<0.05	11	28
V5	141	105	36	74	<0.001	0.23	<0.2	21	15
V8	172	128	44	74	<0.001	0.14	<0.2	35	20
Totals	**1142**	**963**	**179**	**84**					

Reference

Station Name	n	<MDL	>MDL	%<MDL	Min	Max Detectable	Max MDL	# > CWQG	% > CWQG
V1	63	49	14	78	0.0002	0.05	<0.06	10	16
FDU	13	12	1	92	<0.001	0.02	<0.2	1	8
FC	2	2	0	100	<0.2	-	<0.2	0	0
R7	86	80	6	93	<0.001	0.068	<0.04	1	1
W10	13	11	2	85	<0.001	0.011	<0.2	2	15
R6	16	15	1	94	<0.001	0.003	<0.06	0	0
Totals	**193**	**169**	**24**	**88**					

CWQG = 0.005 mg/L

Table A.24: Summary Statistics for Total Barium Measured in Water Samples (1975 - 2006)

Exposed or Potentially Disturbed											
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**
FDL	5	0	5	0	0.017	0.003	0.011	0.02	-	0	0
R8	81	0	81	0	0.076	0.046	0.004	0.23	-	5	6
R9	80	0	80	0	0.074	0.044	0.004	0.26	-	3	4
R10	80	0	80	0	0.075	0.045	0.005	0.253	-	5	6
NF1	13	0	13	0	0.077	0.054	0.026	0.184	-	1	8
NF2	16	0	16	0	0.073	0.049	0.025	0.192	-	1	6
X2	171	1	170	1	0.095	0.062	<0.002	0.326	<0.002	30	18
R1	11	0	11	0	0.067	0.031	0.046	0.149	-	0	0
W8	14	0	14	0	0.064	0.047	0.012	0.182	-	1	7
X14	211	0	211	0	0.085	0.051	0.013	0.26	-	26	12
R2	11	0	11	0	0.063	0.026	0.0403	0.13	-	0	0
R3	11	0	11	0	0.062	0.028	0.0369	0.139	-	0	0
R4	16	0	16	0	0.082	0.028	0.048	0.159	-	0	0
R5	15	0	15	0	0.078	0.025	0.047	0.155	-	0	0
R11	5	0	5	0	0.076	0.015	0.064	0.10	-	0	0
V27	31	0	31	0	0.086	0.053	0.018	0.213	-	3	10
V4	32	0	32	0	0.115	0.054	0.04	0.244	-	7	22
V5	131	0	131	0	0.138	0.084	0.042	0.678	-	41	31
V8	149	0	149	0	0.119	0.071	0.022	0.424	-	37	25
Totals	**1083**	**1**	**1082**	**0**							
Reference											
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**
V1	53	0	53	0	0.092	0.215	0.013	1.58	-	3	6
FDU	13	0	13	0	0.040	0.049	0.006	0.169	-	1	8
FC	2	0	2	0	0.011	0	0.01	0.011	-	0	0
R7	86	0	86	0	0.075	0.044	0.006	0.25	-	4	5
W10	13	0	13	0	0.049	0.067	0.009	0.238	-	1	8
R6	16	0	16	0	0.079	0.025	0.056	0.161	-	0	0
Totals	**183**	**0**	**183**	**0**							

Background Benchmark = 0.161 mg/L

Table A.25: Summary Statistics for Total Beryllium Measured in Water Samples (1975 - 2006)

Exposed or Potentially Disturbed							
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Min**	**Max Detectable**	**Max MDL**
FDL	5	5	0	100	< 0.001	-	< 0.001
R8	81	76	5	94	< 0.0002	0.003	< 0.003
R9	80	75	5	94	< 0.0002	0.003	< 0.003
R10	80	70	10	88	< 0.0002	0.003	< 0.003
NF1	13	11	2	85	< 0.0002	0.001	< 0.001
NF2	16	14	2	88	< 0.0002	0.001	< 0.005
X2	171	148	23	87	< 0.0002	0.005	< 0.005
R1	11	9	2	82	< 0.0002	0.0002	< 0.001
W8	14	13	1	93	< 0.0002	0.0004	< 0.005
X14	211	178	33	84	< 0.0002	0.3	< 0.005
R2	11	6	5	55	< 0.001	0.001	< 0.001
R3	11	8	3	73	< 0.001	0.0003	< 0.001
R4	16	14	2	88	< 0.001	0.0003	< 0.001
R5	15	13	2	87	< 0.0002	0.0003	< 0.001
R11	5	5	0	100	< 0.001	-	< 0.001
V27	31	27	4	87	< 0.0001	0.002	< 0.001
V4	32	22	10	69	< 0.0002	0.004	< 0.001
V5	131	104	27	79	< 0.0002	0.004	< 0.005
V8	149	124	25	83	< 0.0002	0.003	< 0.005
Totals	**1083**	**922**	**161**	**85**			
Reference							
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Min**	**Max Detectable**	**Max MDL**
V1	53	48	5	91	< 0.0001	0.003	< 0.002
FDU	13	9	4	69	< 0.0002	0.02	< 0.005
FC	2	2	0	100	< 0.005	-	< 0.005
R7	86	76	10	88	< 0.0002	0.005	< 0.003
W10	13	13	0	100	< 0.0002	-	< 0.005
R6	16	14	2	88	< 0.0002	0.0003	< 0.001
Totals	**183**	**162**	**21**	**89**			

Table A.26: Summary Statistics for Total Bismuth Measured in Water Samples (1975 - 2006)

Exposed or Potentially Disturbed							
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Min**	**Max Detectable**	**Max MDL**
FDL	5	5	0	100	< 0.001	-	< 0.001
R8	80	77	3	96	< 0.001	0.05	< 0.05
R9	79	76	3	96	< 0.001	0.05	< 0.05
R10	79	75	4	95	< 0.001	0.05	< 0.05
NF1	13	13	0	100	< 0.001	-	< 0.05
NF2	16	15	1	94	< 0.001	0.01	< 0.1
X2	141	128	13	91	< 0.001	0.05	< 0.1
R1	11	11	0	100	< 0.001	-	< 0.04
W8	14	14	0	100	< 0.001	-	< 0.1
X14	175	165	10	94	< 0.001	0.09	< 0.1
R2	11	11	0	100	< 0.001	-	< 0.04
R3	11	11	0	100	< 0.001	-	< 0.04
R4	14	14	0	100	< 0.001	-	< 0.05
R5	13	13	0	100	< 0.001	-	< 0.05
R11	5	5	0	100	< 0.001	-	< 0.001
V27	31	30	1	97	< 0.001	0.03	< 0.05
V4	30	28	2	93	< 0.001	0.08	< 0.05
V5	116	110	6	95	< 0.001	0.06	< 0.1
V8	129	123	6	95	< 0.001	0.06	< 0.1
Totals	**973**	**924**	**49**	**95**			
Reference							
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Min**	**Max Detectable**	**Max MDL**
V1	38	31	7	82	< 0.0002	0.03	< 0.05
FDU	13	13	0	100	< 0.001	-	< 0.1
FC	2	2	0	100	< 0.1	-	< 0.1
R7	85	84	1	99	< 0.001	0.02	< 0.05
W10	13	13	0	100	< 0.001	-	< 0.1
R6	14	13	1	93	< 0.001	0.04	< 0.05
Totals	**165**	**156**	**9**	**95**			

Table A.27: Summary Statistics for Total Boron Measured in Water Samples (1975 - 2006)

Exposed or Potentially Disturbed											
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**
FDL	5	5	0	100	<0.05	0	<0.05	-	<0.05	0	0
R8	60	37	23	62	0.118	0.257	<0.01	1.99	<0.05	5	8
R9	59	38	21	64	0.106	0.241	<0.01	1.88	<0.05	3	5
R10	59	38	21	64	0.105	0.220	<0.01	1.7	<0.05	4	7
NF1	13	10	3	77	0.062	0.039	<0.05	0.19	<0.05	0	0
NF2	16	11	5	69	0.088	0.079	<0.05	0.29	<0.1	2	13
X2	135	73	62	54	0.104	0.124	<0.01	0.69	<0.1	19	14
R1	9	6	3	67	0.044	0.015	0.01	0.06	<0.05	0	0
W8	14	10	4	71	0.073	0.052	<0.05	0.24	<0.1	1	7
X14	173	123	50	71	0.075	0.080	<0.001	0.73	<0.1	9	5
R2	9	7	2	78	0.049	0.022	<0.002	0.09	<0.05	0	0
R3	9	7	2	78	0.045	0.017	<0.002	0.059	<0.05	0	0
R4	11	8	3	73	0.054	0.042	<0.01	0.17	<0.05	0	0
R5	10	7	3	70	0.041	0.017	<0.01	0.055	<0.05	0	0
R11	5	5	0	100	<0.05	0	<0.05	-	<0.05	0	0
V27	28	18	10	64	0.065	0.039	<0.01	0.22	<0.05	1	4
V4	29	17	12	59	0.062	0.035	<0.001	0.17	<0.05	0	0
V5	123	69	54	56	0.103	0.322	<0.001	3.6	<0.1	5	4
V8	135	78	57	58	0.093	0.271	<0.001	3.16	<0.1	4	3
Totals	**902**	**567**	**335**	**63**							
Reference											
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**
V1	44	21	23	48	0.117	0.215	<0.001	1.2	<0.05	5	11
FDU	13	8	5	62	0.081	0.048	<0.05	0.22	<0.10	1	8
FC	2	2	0	100	<0.1	0	<0.1	-	<0.1	0	0
R7	64	44	20	69	0.107	0.279	<0.002	2.26	<0.050	4	6
W10	13	10	3	77	0.082	0.080	<0.05	0.34	<0.1	1	8
R6	11	8	3	73	0.038	0.017	<0.01	0.048	<0.05	0	0
Totals	**147**	**93**	**54**	**63**							

Background Benchmark = 0.219 mg/L

Table A.28: Summary Statistics for Total Cadmium Measured in Water Samples (1975 - 2006)

Exposed or Potentially Disturbed										
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Min**	**Max Detectable**	**Max MDL**	**CWQG**	**# > CWQG**	**% > CWQG**
FDL	5	5	0	100	<0.0002	-	<0.0002	0.000006	0	0
R8	81	75	6	93	<0.0002	0.004	<0.01	0.000031	6	7
R9	80	76	4	95	<0.0002	0.004	<0.01	0.000034	4	5
R10	80	75	5	94	<0.0002	0.0053	<0.01	0.000034	5	6
NF1	13	12	1	92	<0.0002	0.003	<0.002	0.000025	1	8
NF2	16	15	1	94	<0.0002	0.0014	<0.01	0.000027	1	6
X2	171	151	20	88	<0.0002	0.009	<0.01	0.000034	20	12
R1	11	11	0	100	<0.0001	-	<0.002	0.000033	0	0
W8	14	12	2	86	<0.0002	0.003	<0.01	0.000017	2	14
X14	211	186	25	88	<0.0002	0.007	<0.006	0.000067	25	12
R2	11	10	1	91	<0.0001	0.0005	<0.002	0.000061	1	9
R3	11	10	1	91	<0.0001	0.0012	<0.002	0.000056	1	9
R4	16	13	3	81	<0.0001	0.001	<0.006	0.000055	3	19
R5	15	13	2	87	<0.0001	0.002	<0.006	0.000046	2	13
R11	5	5	0	100	<0.0002	-	<0.0002	0.000056	0	0
V27	31	25	6	81	<0.0002	0.008	<0.002	0.000032	6	19
V4	32	26	6	81	<0.0001	0.008	<0.005	0.000083	6	19
V5	131	104	27	79	<0.0001	0.015	<0.01	0.000089	27	21
V8	149	128	21	86	<0.0001	0.094	<0.01	0.000073	21	14
Totals	**1083**	**952**	**131**	**88**						
Reference										
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Min**	**Max Detectable**	**Max MDL**	**CWQG**	**# > CWQG**	**% > CWQG**
V1	53	46	7	87	<0.00004	0.01	<0.006	0.000015	7	13
FDU	13	12	1	92	<0.0002	0.001	<0.01	0.000005	1	8
FC	2	2	0	100	<0.01	-	<0.01	0.000003	0	0
R7	86	77	9	90	<0.0001	0.025	<0.01	0.000030	9	10
W10	13	10	3	77	<0.0002	0.003	<0.01	0.000016	3	23
R6	16	14	2	88	<0.0001	0.002	<0.006	0.000047	2	13
Totals	**183**	**161**	**22**	**88**						

CWQG for cadmium = $10^{\{0.86[\log(\text{hardness})] - 3.2\}}$

Table A.29: Summary Statistics for Total Calcium Measured in Water Samples (1975 - 2006)

Exposed or Potentially Disturbed											
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**
FDL	5	0	5	0	3.8	0.9	2.3	4.49	-	0	0
R8	81	0	81	0	27.5	12.3	4.1	49.3	-	7	9
R9	84	0	84	0	29.3	12.3	8.1	52.6	-	16	19
R10	84	0	84	0	29.4	12.4	8.0	51.9	-	12	14
NF1	13	0	13	0	19.1	5.4	8.6	26.2	-	0	0
NF2	16	0	16	0	25.5	18.6	9.3	88.1	-	2	13
X2	181	0	181	0	33.6	16.3	8.8	164	-	44	24
R1	11	0	11	0	30.3	13.6	17.9	64.1	-	2	18
W8	14	0	14	0	14.3	4.0	8.4	21.3	-	0	0
X14	211	0	211	0	69.9	39.0	12.6	236	-	149	71
R2	11	0	11	0	60.6	27.1	22.7	107	-	7	64
R3	11	0	11	0	55.6	22.7	23.1	99	-	7	64
R4	16	0	16	0	55.6	19.3	31.2	97	-	10	63
R5	15	0	15	0	41.5	12.3	31.2	81.5	-	5	33
R11	5	0	5	0	53.7	18.6	42.7	85.9	-	2	40
V27	31	0	31	0	25.1	14.4	5.9	57.4	-	3	10
V4	32	0	32	0	69.5	19.7	17.8	112.1	-	30	94
V5	131	0	131	0	75.2	34.7	24.8	244.2	-	110	84
V8	149	0	149	0	63.8	25.1	14.5	131.8	-	112	75
Totals	**1101**	**0**	**1101**	**0**							
Reference											
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**
V1	53	0	53	0	15.6	21.5	2.9	137	-	2	4
FDU	13	0	13	0	3.3	0.7	2.14	4.26	-	0	0
FC	2	0	2	0	3.1	1	2.18	4.04	-	0	0
R7	86	0	86	0	26.9	10.8	7.8	50.2	-	6	7
W10	13	0	13	0	12.6	3.5	7.4	20	-	0	0
R6	16	0	16	0	41.8	11.3	32	77.8	-	4	25
Totals	**183**	**0**	**183**	**0**							

Background Benchmark = 43.7 mg/L

Table A.30: Summary Statistics for Total Chromium Measured in Water Samples (1975 - 2006)

Exposed or Potentially Disturbed													
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**	**# > CWQG**	**% > CWQG**
FDL	5	5	0	100	<0.001	0	<0.001	-	<0.001	0	0	0	0
R8	81	69	12	85	0.004	0.004	<0.001	0.028	<0.01	3	4	6	7
R9	80	69	11	86	0.005	0.008	<0.001	0.061	<0.01	4	5	7	9
R10	80	60	20	75	0.006	0.009	<0.001	0.059	<0.01	6	8	10	13
NF1	13	8	5	62	0.019	0.048	<0.001	0.176	<0.005	2	15	3	23
NF2	16	10	6	63	0.020	0.037	<0.001	0.148	<0.015	5	31	5	31
X2	171	128	43	75	0.010	0.031	<0.001	0.299	<0.01	13	8	16	9
R1	11	10	1	91	0.003	0.006	<0.0002	0.019	<0.005	1	9	1	9
W8	14	10	4	71	0.013	0.024	<0.001	0.093	<0.01	2	14	3	21
X14	211	154	57	73	0.007	0.024	<0.001	0.301	<0.01	10	5	17	8
R2	11	10	1	91	0.004	0.009	<0.0002	0.031	<0.005	1	9	1	9
R3	11	10	1	91	0.007	0.017	<0.0002	0.058	<0.005	1	9	1	9
R4	16	14	2	88	0.018	0.051	<0.0002	0.207	<0.006	2	13	2	13
R5	15	13	2	87	0.004	0.005	<0.0002	0.022	<0.006	1	7	1	7
R11	5	5	0	100	<0.001	0	<0.001	-	<0.001	0	0	0	0
V27	31	18	13	58	0.017	0.042	<0.0002	0.227	<0.005	5	16	9	29
V4	32	21	11	66	0.032	0.123	<0.001	0.694	<0.005	6	19	6	19
V5	131	69	62	53	0.017	0.061	<0.0002	0.6	<0.01	17	13	30	23
V8	149	86	63	58	0.011	0.022	<0.0002	0.157	<0.01	18	12	25	17
Totals	**1083**	**769**	**314**	**71**									
Reference													
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**	**# > CWQG**	**% > CWQG**
V1	53	40	13	75	0.006	0.016	<0.0002	0.121	<0.006	2	4	3	6
FDU	13	8	5	62	0.010	0.013	<0.001	0.039	<0.015	3	23	3	23
FC	2	2	0	100	<0.013	0	<0.010	-	<0.015	0	0	0	0
R7	86	76	10	88	0.004	0.005	<0.0002	0.025	<0.010	4	5	8	9
W10	13	10	3	77	0.008	0.013	<0.001	0.048	<0.015	1	8	1	8
R6	16	13	3	81	0.006	0.010	<0.0002	0.044	<0.006	1	6	1	6
Totals	**183**	**149**	**34**	**81**									

Background Benchmark = 0.015 mg/L
CWQG = 0.0089 mg/L (based on Cr(III))

Table A.31: Summary Statistics for Total Cobalt Measured in Water Samples (1975 - 2006)

Exposed or Potentially Disturbed							
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Min**	**Max Detectable**	**Max MDL**
FDL	5	5	0	100	<0.001	-	<0.001
R8	81	75	6	93	<0.001	0.045	<0.02
R9	84	80	4	95	<0.001	0.011	<0.02
R10	84	79	5	94	<0.001	0.023	<0.02
NF1	13	9	4	69	<0.001	0.025	<0.005
NF2	16	13	3	81	<0.001	0.021	<0.015
X2	181	159	22	88	<0.001	0.118	<0.02
R1	11	10	1	91	<0.0002	0.0011	<0.005
W8	14	11	3	79	<0.001	0.007	<0.015
X14	211	148	63	70	<0.001	0.073	<0.01
R2	11	6	5	55	<0.0002	0.003	<0.005
R3	11	7	4	64	0.0005	0.0036	<0.005
R4	16	16	0	100	<0.0002	-	<0.006
R5	14	13	1	93	<0.0002	0.0012	<0.006
R11	5	5	0	100	<0.001	-	<0.001
V27	31	23	8	74	<0.0002	0.034	<0.005
V4	32	23	9	72	<0.0002	0.057	<0.005
V5	131	107	24	82	<0.0002	0.051	<0.02
V8	149	121	28	81	<0.0002	0.241	<0.02
Totals	**1100**	**910**	**190**	**83**			
Reference							
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Min**	**Max Detectable**	**Max MDL**
V1	53	46	7	87	<0.0002	0.01	<0.006
FDU	13	11	2	85	<0.001	0.012	<0.015
FC	2	2	0	100	<0.01	-	<0.015
R7	86	78	8	91	<0.0002	0.032	<0.02
W10	13	12	1	92	<0.001	0.003	<0.015
R6	16	15	1	94	<0.0002	0.0021	<0.006
Totals	**183**	**164**	**19**	**90**			

Table A.32: Summary Statistics for Conductivity Measured in Water Samples (1975 - 2006)

Exposed or Potentially Disturbed							
Station Name	**n**	**Mean**	**SD**	**Min**	**Max**	**# > Benchmark**	**% > Benchmark**
FDL	5	35	10	22	50	0	0
R8	26	172	69	51	288	3	12
R9	28	189	73	56	309	6	21
R10	27	191	75	56	311	6	22
NF1	11	128	35	68	188	0	0
NF2	14	133	55	80	289	1	7
X2	62	210	83	61	349	21	34
R1	7	205	61	133	285	2	29
W8	14	101	22	68	130	0	0
X14	58	415	258	90	1330	44	76
R2	7	433	190	206	667	5	71
R3	7	399	145	217	553	5	71
R4	7	400	117	251	565	6	86
R5	6	277	57	223	383	2	33
R11	5	305	62	245	383	3	60
V27	25	199	85	46	363	7	28
V4	21	497	160	200	800	20	95
V5	61	474	207	96	1050	51	84
V8	85	415	187	120	784	63	74
Totals	**476**						
Reference							
Station Name	**n**	**Mean**	**SD**	**Min**	**Max**	**# > Benchmark**	**% > Benchmark**
V1	45	80	32	22	164	0	0
FDU	9	54	58	19	194	0	0
FC	8	31	10	19	54	0	0
R7	34	170	65	53	289	3	9
W10	7	93	25	61	134	0	0
R6	7	280	56	222	382	3	43
Totals	**110**						

Background Benchmark = 261 µS/cm

Table A.33: Summary Statistics for Total Copper Measured in Water Samples (1975 - 2006)

Exposed or Potentially Disturbed														
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**	**CWQG**	**# > CWQG**	**% > CWQG**
FDL	5	2	3	40	0.002	0.001	<0.001	0.003	<0.001	0	0	0.002	1	20
R8	84	39	45	46	0.007	0.009	<0.001	0.04	<0.02	5	6	0.002	38	45
R9	87	50	37	57	0.006	0.009	<0.001	0.04	<0.02	5	6	0.002	34	39
R10	86	42	44	49	0.009	0.023	<0.001	0.199	<0.02	7	8	0.002	37	43
NF1	20	4	16	20	0.007	0.009	<0.001	0.031	<0.001	2	10	0.002	8	40
NF2	23	7	16	30	0.008	0.010	<0.001	0.034	<0.01	2	9	0.002	8	35
X2	262	110	152	42	0.011	0.020	<0.001	0.253	<0.02	29	11	0.002	97	37
R1	11	4	7	36	0.008	0.011	<0.001	0.037	<0.001	1	9	0.002	5	45
W8	21	5	16	24	0.015	0.044	<0.001	0.203	<0.01	1	5	0.002	10	48
X14	315	86	229	27	0.033	0.134	<0.001	1.28	<1	44	14	0.004	178	57
R2	11	4	7	36	0.008	0.012	<0.001	0.04	<0.001	1	9	0.004	5	45
R3	11	4	7	36	0.008	0.012	<0.001	0.042	<0.001	1	9	0.004	5	45
R4	25	7	18	28	0.007	0.012	<0.001	0.048	<0.006	2	8	0.004	7	28
R5	24	7	17	29	0.006	0.008	<0.001	0.036	<0.006	1	4	0.003	6	25
R11	5	4	1	80	0.001	0.000	<0.001	0.001	<0.001	0	0	0.004	0	0
V27	46	15	31	33	0.009	0.012	<0.001	0.063	<0.002	3	7	0.002	25	54
V4	40	9	31	23	0.012	0.012	<0.001	0.063	<0.005	4	10	0.004	23	58
V5	149	20	129	13	0.027	0.159	<0.001	1.945	<0.02	19	13	0.004	97	65
V8	196	38	158	19	0.015	0.024	<0.001	0.235	<0.02	25	13	0.004	127	65
Totals	**1421**	**457**	**964**	**32**										
Reference														
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**	**CWQG**	**# > CWQG**	**% > CWQG**
V1	65	24	41	37	0.010	0.016	0.0006	0.103	<0.006	6	9	0.002	35	54
FDU	15	7	8	47	0.011	0.017	<0.001	0.064	<0.01	1	7	0.002	5	33
FC	14	8	6	57	0.003	0.003	0.001	0.003	<0.01	0	0	0.002	1	7
R7	107	38	69	36	0.007	0.009	<0.001	0.045	<0.02	6	6	0.002	44	41
W10	14	4	10	29	0.016	0.037	<0.001	0.143	<0.01	1	7	0.002	5	36
R6	24	8	16	33	0.006	0.009	<0.001	0.036	<0.006	2	8	0.003	11	46
Totals	**239**	**89**	**150**	**37**										

Background Benchmark = 0.026 mg/L
CWQG = 0.002 - 0.004 mg/L

Table A.34: Summary Statistics for Total Cyanide Measured in Water Samples (1975 - 2006)

Exposed or Potentially Disturbed							
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Min**	**Max Detectable**	**Max MDL**
FDL	0	-	-	-	-	-	-
R8	0	-	-	-	-	-	-
R9	1	0	1	0	0.076	0.076	-
R10	2	0	2	0	0.001	0.078	-
NF1	0	-	-	-	-	-	-
NF2	16	15	1	94	< 0.0002	0.0014	< 0.01
X2	148	118	30	80	< 0.001	0.048	< 0.03
R1	0	-	-	-	-	-	-
W8	0	-	-	-	-	-	-
X14	246	106	140	43	< 0.001	0.35	< 0.03
R2	6	5	1	83	< 0.001	0.002	< 0.01
R3	6	5	1	83	< 0.01	0.001	< 0.01
R4	17	6	11	35	< 0.001	-	< 0.03
R5	11	4	7	36	< 0.001	0.037	< 0.03
R11	0	-	-	-	-	-	-
V27	0	-	-	-	-	-	-
V4	0	-	-	-	-	-	-
V5	0	-	-	-	-	-	-
V8	24	21	3	88	< 0.005	190	< 0.1
Totals	**477**	**280**	**197**	**59**			
Reference							
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Min**	**Max Detectable**	**Max MDL**
V1	0	-	-	-	-	-	-
FDU	0	-	-	-	-	-	-
FC	0	-	-	-	-	-	-
R7	1	0	1	0	0.001	0.001	-
W10	0	-	-	-	-	-	-
R6	8	3	5	38	< 0.001	0.011	< 0.03
Totals	**9**	**3**	**6**	**33**			

Table A.35: Summary Statistics for Total Gold Measured in Water Samples (1975 - 2006)

Exposed or Potentially Disturbed							
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Min**	**Max Detectable**	**Max MDL**
FDL	0	-	-	-	-	-	-
R8	6	6	0	100	-	-	-
R9	6	6	0	100	-	-	-
R10	6	6	0	100	< 0.01	-	< 0.01
NF1	0	-	-	-	-	-	-
NF2	0	-	-	-	-	-	-
X2	7	7	0	100	< 0.01	-	< 0.01
R1	0	-	-	-	-	-	-
W8	0	-	-	-	-	-	-
X14	5	5	0	100	< 0.01	-	< 0.01
R2	0	-	-	-	-	-	-
R3	0	-	-	-	-	-	-
R4	1	1	0	100	< 0.01	-	< 0.01
R5	1	1	0	100	< 0.01	-	< 0.01
R11	0	-	-	-	-	-	-
V27	0	-	-	-	-	-	-
V4	0	-	-	-	-	-	-
V5	0	-	-	-	-	-	-
V8	0	-	-	-	-	-	-
Totals	**32**	**32**	**0**	**100**	-	-	-
Reference							
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Min**	**Max Detectable**	**Max MDL**
V1	0	-	-	-	-	-	-
FDU	0	-	-	-	-	-	-
FC	0	-	-	-	-	-	-
R7	6	6	0	100	< 0.01	-	< 0.01
W10	0	-	-	-	-	-	-
R6	1	1	0	100	< 0.01	-	< 0.01
Totals	**7**	**7**	**0**	**100**	-	-	-

Table A.36: Summary Statistics for Hardness Measured in Water Samples (1975 - 2006)

Exposed or Potentially Disturbed							
Station Name	**n**	**Mean**	**SD**	**Min**	**Max**	**# > Benchmark**	**% > Benchmark**
FDL	5	13	2.9	8	16	0	0
R8	28	94	39	27	149	1	4
R9	29	102	41	29	157	8	28
R10	31	103	43	29	174	5	16
NF1	5	72	17	44	87	0	0
NF2	8	80	35	40	156	1	13
X2	66	104	49	21	211	16	24
R1	11	98	43	51	203	1	9
W8	6	46	10	32	61	0	0
X14	173	227	127	44	793	118	68
R2	11	205	94	78	361	7	64
R3	11	186	78	78	334	7	64
R4	13	180	55	118	262	8	62
R5	12	147	44	101	272	4	33
R11	5	183	61	147	290	5	100
V27	35	95	48	18	217	6	17
V4	29	293	101	34	477	27	93
V5	131	317	162	86	1161	121	92
V8	156	251	117	37	577	113	72
Totals	**765**						
Reference							
Station Name	**n**	**Mean**	**SD**	**Min**	**Max**	**# > Benchmark**	**% > Benchmark**
V1	56	39	43	0	325	1	2
FDU	7	11	3.3	7	16	0	0
FC	1	7.3	-	7.3	7.3	0	0
R7	41	88	37	21	153	2	5
W10	5	42	14	27	60	0	0
R6	13	149	39	99	261	5	38
Totals	**123**						

Background Benchmark = 146 mg/L

Table A.37: Summary Statistics for Total Iron Measured in Water Samples (1975 - 2006)

Exposed or Potentially Disturbed													
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**	**# > CWQG**	**% > CWQG**
FDL	5	4	1	80	0.06	0.02	<0.05	0.09	<0.05	0	0	0	0
R8	81	6	75	7	0.27	0.28	<0.01	1.67	<0.05	4	5	18	22
R9	84	4	80	5	0.25	0.32	0.01	1.89	<0.05	4	5	15	18
R10	84	4	80	5	0.25	0.25	0.022	1.26	<0.05	4	5	16	19
NF1	20	0	20	0	0.32	0.24	0.06	0.92	-	1	5	7	35
NF2	23	1	22	4	0.23	0.22	<0.01	1.03	<0.01	1	4	5	22
X2	196	3	193	2	0.47	0.65	<0.01	5	<0.05	27	14	73	37
R1	11	0	11	0	0.53	0.37	0.18	1.24	-	3	27	7	64
W8	21	5	16	24	0.12	0.19	<0.01	0.88	<0.05	1	5	1	5
X14	224	0	224	0	0.50	0.46	0.11	4.62	-	22	10	148	66
R2	11	0	11	0	0.37	0.11	0.24	0.54	-	0	0	7	64
R3	11	1	10	9	0.20	0.10	<0.05	0.35	<0.05	0	0	2	18
R4	19	1	18	5	0.26	0.26	0.02	1.05	<0.05	1	5	5	26
R5	18	1	17	6	0.15	0.08	0.02	0.30	<0.05	0	0	0	0
R11	5	1	4	20	0.09	0.04	<0.05	0.15	<0.05	0	0	0	0
V27	41	4	37	10	0.30	0.54	0.005	2.84	<0.05	3	7	7	17
V4	39	1	38	3	0.38	0.48	0.025	2.56	<0.05	4	10	17	44
V5	141	1	140	1	1.42	4.08	0.005	37.6	<0.01	41	29	64	45
V8	170	10	160	6	0.85	3.02	<0.01	31.1	<0.05	26	15	57	34
Totals	**1204**	**47**	**1157**	**4**									
Reference													
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**	**# > CWQG**	**% > CWQG**
V1	63	8	55	13	0.30	0.76	<0.006	4.44	<0.05	2	3	15	24
FDU	15	2	13	13	0.13	0.11	0.007	0.35	<0.05	0	0	2	13
FC	9	1	8	11	0.06	0.03	0.018	0.10	<0.03	0	0	0	0
R7	99	4	95	4	0.32	0.41	0.016	2.12	<0.05	10	10	25	25
W10	14	6	8	43	0.13	0.22	<0.01	0.86	<0.05	1	7	1	7
R6	18	1	17	6	0.19	0.14	<0.05	0.62	<0.05	0	0	3	17
Totals	**218**	**22**	**196**	**10**									

Background Benchmark = 0.84 mg/L
CWQG = 0.3 mg/L

Table A.38: Summary Statistics for Total Lanthanum Measured in Water Samples (1975 - 2006)

Exposed or Potentially Disturbed											
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**
FDL	0	-	-	-	-	-	-	-	-	0	-
R8	53	45	8	85	0.005	0.004	<0.001	0.024	<0.005	5	9
R9	51	40	11	78	0.006	0.005	<0.001	0.039	<0.005	5	10
R10	51	41	10	80	0.005	0.003	<0.001	0.020	<0.005	5	10
NF1	8	5	3	63	0.023	0.054	<0.001	0.156	<0.005	2	25
NF2	9	6	3	67	0.014	0.027	<0.001	0.085	<0.005	2	22
X2	104	68	36	65	0.007	0.008	<0.001	0.077	<0.005	18	17
R1	6	4	2	67	0.004	0.002	<0.0002	0.005	<0.005	0	0
W8	7	5	2	71	0.004	0.002	<0.001	0.005	<0.005	0	0
X14	110	71	39	65	0.007	0.010	<0.001	0.090	<0.005	18	16
R2	6	4	2	67	0.005	0.004	<0.0002	0.012	<0.005	1	17
R3	6	4	2	67	0.008	0.007	<0.0002	0.020	<0.005	2	33
R4	9	6	3	67	0.005	0.001	0.0029	0.008	<0.005	1	11
R5	9	7	2	78	0.005	0.003	<0.0002	0.009	<0.005	2	22
R11	0	-	-	-	-	-	-	-	-	0	-
V27	26	20	6	77	0.004	0.002	<0.0002	0.008	<0.005	1	4
V4	25	13	12	52	0.007	0.006	<0.001	0.032	<0.005	6	24
V5	91	40	51	44	0.009	0.014	<0.0002	0.122	<0.005	28	31
V8	98	49	49	50	0.008	0.011	<0.0002	0.093	<0.005	23	23
Totals	**669**	**428**	**241**	**64**							
Reference											
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**
V1	31	26	5	84	0.004	0.006	<0.0002	0.033	<0.005	1	3
FDU	6	4	2	67	0.013	0.015	<0.001	0.036	<0.005	2	33
FC	0	-	-	-	-	-	-	-	-	0	-
R7	56	48	8	86	0.005	0.003	<0.0002	0.022	<0.005	5	9
W10	7	6	1	86	0.004	0.002	<0.001	0.002	<0.005	0	0
R6	9	7	2	78	0.006	0.003	<0.0002	0.010	<0.005	2	22
Totals	**109**	**91**	**18**	**83**							

Background Benchmark = 0.0066 mg/L

Table A.39: Summary Statistics for Total Lead Measured in Water Samples (1975 - 2006)

Exposed or Potentially Disturbed														
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**	**CWQG**	**# > CWQG**	**% > CWQG**
FDL	5	0	5	0	0.006	0.002	0.003	0.009	-	0	0	0.001	5	100
R8	83	69	14	83	0.012	0.011	<0.001	0.03	<0.06	0	0	0.002	11	13
R9	86	69	17	80	0.014	0.013	<0.001	0.07	<0.06	1	1	0.002	11	13
R10	85	75	10	88	0.013	0.011	<0.001	0.05	<0.06	0	0	0.002	10	12
NF1	13	9	4	69	0.007	0.007	<0.001	0.004	<0.02	0	0	0.002	1	8
NF2	16	11	5	69	0.014	0.016	<0.001	0.014	<0.05	0	0	0.002	2	13
X2	237	171	66	72	0.017	0.018	<0.001	0.17	<0.06	2	1	0.002	57	24
R1	11	10	1	91	0.005	0.006	<0.001	0.005	<0.02	0	0	0.002	1	9
W8	14	10	4	71	0.014	0.017	<0.001	0.01	<0.05	0	0	0.001	3	21
X14	374	235	139	63	0.053	0.083	<0.001	0.5	<1	35	9	0.007	109	29
R2	11	0	11	0	0.004	0.006	0.001	0.02	-	0	0	0.007	2	18
R3	11	0	11	0	0.005	0.008	0.001	0.02	-	0	0	0.007	2	18
R4	25	11	14	44	0.012	0.016	<0.001	0.06	<0.02	2	8	0.007	0	0
R5	24	15	9	63	0.011	0.016	<0.001	0.013	<0.06	0	0	0.004	1	4
R11	5	5	0	100	<0.001	0	<0.001	-	<0.001	0	0	0.007	0	0
V27	46	30	16	65	0.013	0.010	<0.001	0.037	<0.03	0	0	0.002	12	26
V4	40	31	9	78	0.014	0.012	<0.001	0.056	<0.05	1	3	0.007	2	5
V5	149	100	49	67	0.015	0.019	<0.001	0.142	<0.06	3	2	0.007	26	17
V8	195	115	80	59	0.025	0.051	<0.001	0.46	<0.06	13	7	0.007	45	23
Totals	**1430**	**966**	**464**	**68**										
Reference														
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**	**CWQG**	**# > CWQG**	**% > CWQG**
V1	65	43	22	66	0.016	0.019	<0.0002	0.11	<0.06	1	2	0.002	21	32
FDU	13	0	13	0	0.018	0.026	0.001	0.09	-	1	8	0.001	8	62
FC	8	0	8	0	0.020	0.021	0.005	0.05	-	0	0	0.001	8	100
R7	94	77	17	82	0.011	0.010	<0.001	0.05	<0.03	0	0	0.002	15	16
W10	13	12	1	92	0.014	0.017	<0.001	0.003	<0.05	0	0	0.001	1	8
R6	24	15	9	63	0.012	0.017	<0.001	0.03	<0.06	0	0	0.004	7	29
Totals	**217**	**147**	**70**	**68**										

Background Benchmark = 0.05 mg/L
CWQG = 0.001 - 0.007 mg/L

Table A.40: Summary Statistics for Total Lithium Measured in Water Samples (1975 - 2006)

Exposed or Potentially Disturbed											
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**
FDL	5	0	5	0	0.002	0.0004	0.002	0.003	-	0	0
R8	25	0	25	0	0.005	0.003	0.001	0.01	-	0	0
R9	26	0	26	0	0.005	0.003	0.001	0.009	-	0	0
R10	26	0	26	0	0.005	0.003	0.001	0.01	-	0	0
NF1	5	0	5	0	0.003	0.001	0.002	0.005	-	0	0
NF2	7	2	5	29	0.006	0.005	0.002	0.005	<0.015	0	0
X2	32	3	29	9	0.006	0.003	0.001	0.011	<0.01	0	0
R1	5	1	4	20	0.003	0.002	<0.001	0.005	<0.001	0	0
W8	7	2	5	29	0.005	0.005	0.001	0.003	<0.015	0	0
X14	62	3	59	5	0.007	0.004	0.001	0.019	<0.01	4	6
R2	5	0	5	0	0.007	0.002	0.004	0.01	-	0	0
R3	5	0	5	0	0.006	0.001	0.004	0.008	-	0	0
R4	5	0	5	0	0.005	0.0009	0.004	0.006	-	0	0
R5	4	0	4	0	0.003	0.001	0.002	0.004	-	0	0
R11	5	0	5	0	0.004	0.0008	0.003	0.005	-	0	0
V27	5	1	4	20	0.002	0.0009	<0.001	0.003	<0.001	0	0
V4	5	0	5	0	0.004	0.001	0.002	0.005	-	0	0
V5	25	3	22	12	0.006	0.003	0.003	0.017	<0.01	1	4
V8	30	3	27	10	0.006	0.002	0.002	0.01	<0.01	0	0
Totals	**289**	**18**	**271**	**6**							

Reference											
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**
V1	7	4	3	57	0.001	0.0004	0.0009	0.002	<0.001	0	0
FDU	7	2	5	29	0.005	0.005	0.002	0.002	<0.015	0	0
FC	2	2	0	100	<0.013	0.004	<0.010	-	<0.015	0	0
R7	28	0	28	0	0.005	0.003	0.001	0.009	-	0	0
W10	6	3	3	50	0.005	0.006	<0.001	0.002	<0.015	1	17
R6	5	0	5	0	0.002	0.001	0.001	0.004	-	0	0
Totals	**55**	**11**	**44**	**20**							

Background Benchmark = 0.012 mg/L

Table A.41: Summary Statistics for Total Magnesium Measured in Water Samples (1975 - 2006)

Exposed or Potentially Disturbed											
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**
FDL	5	0	5	0	0.83	0.22	0.48	1.1	-	0	0
R8	81	0	81	0	5.5	2.3	1.0	9.5	-	0	0
R9	84	0	84	0	6.0	2.5	1.6	10	-	6	7
R10	84	0	84	0	6.0	2.4	1.6	11	-	4	5
NF1	13	0	13	0	4.2	1.3	1.9	5.8	-	0	0
NF2	16	0	16	0	4.5	1.9	2	9.9	-	1	6
X2	181	0	181	0	7.1	3.3	1.7	28	-	41	23
R1	11	0	11	0	5.9	1.9	3.6	10	-	1	9
W8	14	0	14	0	2.0	0.65	0.90	3.1	-	0	0
X14	211	0	211	0	14	7.5	3.1	50	-	149	71
R2	11	0	11	0	13	6.0	5.2	23	-	7	64
R3	11	0	11	0	12	5.0	5.0	21	-	7	64
R4	16	0	16	0	11	3.8	6.5	19	-	10	63
R5	15	0	15	0	10	2.3	7.5	17	-	7	47
R11	5	0	5	0	12	3.6	9.7	18	-	5	100
V27	31	0	31	0	6.9	4.5	1.5	21	-	8	26
V4	32	0	32	0	27	8.0	5.9	43	-	31	97
V5	131	0	131	0	32	19	9.5	134	-	130	99
V8	149	0	149	0	26	12	6.1	71	-	142	95
Totals	**1101**	**0**	**1101**	**0**							
Reference											
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**
V1	53	0	53	0	3.1	7.3	0.5	50	-	2	4
FDU	13	0	13	0	0.79	0.32	0.4	1.5	-	0	0
FC	2	0	2	0	0.64	0.26	0.46	0.83	-	0	0
R7	86	0	86	0	5.4	2.1	1.2	9.4	-	0	0
W10	13	0	13	0	1.7	0.43	1.2	2.5	-	0	0
R6	16	0	16	0	10	2.0	7.2	16	-	9	56
Totals	**183**	**0**	**183**	**0**							

Background Benchmark = 9.5 mg/L

Table A.42: Summary Statistics for Total Manganese Measured in Water Samples (1975 - 2006)

Exposed or Potentially Disturbed											
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**
FDL	5	0	5	0	0.018	0.021	0.002	0.052	-	1	20
R8	81	12	69	15	0.024	0.022	0.008	0.16	<0.01	7	9
R9	83	10	73	12	0.026	0.023	<0.01	0.136	<0.01	10	12
R10	84	10	74	12	0.026	0.026	<0.01	0.18	<0.01	8	10
NF1	13	1	12	8	0.039	0.028	<0.01	0.12	<0.01	3	23
NF2	16	3	13	19	0.024	0.017	0.005	0.06	<0.01	2	13
X2	209	3	206	1	0.06	0.04	<0.01	0.21	<0.01	120	57
R1	11	0	11	0	0.078	0.115	0.01	0.38	-	4	36
W8	14	6	8	43	0.010	0.009	<0.001	0.03	<0.01	0	0
X14	338	1	337	0	1.28	1.68	0.11	19.1	<1	337	100
R2	11	0	11	0	0.995	0.626	0.1002	2.12	-	11	100
R3	11	0	11	0	0.509	0.311	0.076	1.11	-	11	100
R4	16	0	16	0	0.224	0.147	0.017	0.48	-	14	88
R5	15	1	14	7	0.043	0.039	<0.01	0.166	<0.01	5	33
R11	5	0	5	0	0.023	0.021	0.006	0.059	-	1	20
V27	31	14	17	45	0.018	0.023	<0.002	0.10	<0.01	3	10
V4	32	2	30	6	0.036	0.046	<0.002	0.28	<0.01	4	13
V5	131	21	110	16	0.048	0.078	<0.002	0.647	<0.01	31	24
V8	149	3	146	2	0.076	0.128	<0.002	0.98	<0.01	57	38
Totals	**1255**	**87**	**1168**	**7**							
Reference											
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**
V1	53	22	31	42	0.012	0.027	0.0009	0.174	<0.01	3	6
FDU	13	4	9	31	0.010	0.009	0.001	0.03	<0.01	0	0
FC	8	2	6	25	0.003	0.002	0.002	0.006	<0.005	0	0
R7	86	15	71	17	0.027	0.038	0.005	0.21	<0.01	12	14
W10	13	8	5	62	0.010	0.009	<0.001	0.031	<0.005	0	0
R6	16	2	14	13	0.013	0.004	0.009	0.02	<0.01	0	0
Totals	**189**	**53**	**136**	**28**							

Background Benchmark = 0.048 mg/L

Table A.43: Summary Statistics for Total Mercury Measured in Water Samples (1975 - 2006)

Exposed or Potentially Disturbed									
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Min**	**Max Detectable**	**Max MDL**	**#>CWQG**	**%>CWQG**
FDL	5	5	0	100	< 0.00002	-	< 0.02	0	0
R8	48	48	0	100	< 0.00002	-	< 0.1	0	0
R9	50	49	1	98	< 0.00002	1.7	< 0.03	1	2
R10	50	48	2	96	< 0.00002	1.8	< 0.03	2	4
NF1	5	5	0	100	< 0.00002	-	< 0.02	0	0
NF2	6	6	0	100	< 0.00002	-	< 0.1	0	0
X2	55	54	1	98	< 0.00002	0.3	< 0.1	1	2
R1	9	9	0	100	< 0.00002	-	< 0.1	0	0
W8	5	5	0	100	< 0.00002	-	< 0.02	0	0
X14	87	85	2	98	< 0.00002	4.2	< 0.1	1	1
R2	9	9	0	100	< 0.00002	-	< 0.1	0	0
R3	9	9	0	100	< 0.00002	-	< 0.1	0	0
R4	12	11	1	92	< 0.00002	-	< 0.1	0	0
R5	11	11	0	100	< 0.00002	-	< 0.1	0	0
R11	5	5	0	100	< 0.00002	-	< 0.00002	0	0
V27	9	9	0	100	< 0.00002	-	< 0.1	0	0
V4	0	-	-	-	-	-	-	0	0
V5	32	31	1	97	< 0.00002	2.4	< 0.02	1	3
V8	42	41	1	98	< 0.00002	2.9	< 0.02	1	2
Totals	**449**	**440**	**9**	**98**					

Reference									
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Min**	**Max Detectable**	**Max MDL**	**#>CWQG**	**%>CWQG**
V1	14	13	1	93	< 0.00002	0.3	< 0.02	1	7
FDU	5	5	0	100	< 0.00002	-	< 0.02	0	0
FC	0	-	-	-	-	-	-	0	0
R7	54	53	1	98	< 0.00002	0.4	< 0.1	1	2
W10	4	4	0	100	< 0.00002	-	< 0.02	0	0
R6	12	12	0	100	< 0.00002	-	< 0.1	0	0
Totals	**89**	**87**	**2**	**98**					

CWQG = 0.0001 mg/L

Table A.44: Summary Statistics for Total Molybdenum Measured in Water Samples (1975 - 2006)

Exposed or Potentially Disturbed													
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**	**# > CWQG**	**% > CWQG**
FDL	5	5	0	100	<0.0005	0	<0.0005	-	<0.0005	0	0	0	0
R8	81	56	25	69	0.002	0.003	<0.0005	0.009	<0.02	0	0	0	0
R9	80	49	31	61	0.002	0.003	<0.0005	0.009	<0.02	0	0	0	0
R10	80	51	29	64	0.002	0.003	<0.0005	0.017	<0.02	2	3	0	0
NF1	13	8	5	62	0.003	0.002	<0.0005	0.008	<0.002	0	0	0	0
NF2	16	14	2	88	0.005	0.010	<0.0005	0.006	<0.03	0	0	0	0
X2	171	110	61	64	0.005	0.006	<0.0005	0.041	<0.02	14	8	0	0
R1	11	6	5	55	0.003	0.003	<0.0005	0.009	<0.002	0	0	0	0
W8	14	13	1	93	0.005	0.010	<0.0005	0.003	<0.03	0	0	0	0
X14	211	118	93	56	0.004	0.004	<0.0005	0.021	<0.01	11	5	0	0
R2	11	4	7	36	0.002	0.002	<0.0005	0.0067	<0.002	0	0	0	0
R3	11	4	7	36	0.002	0.002	<0.0005	0.0073	<0.002	0	0	0	0
R4	16	8	8	50	0.003	0.003	0.0006	0.0047	<0.01	0	0	0	0
R5	15	7	8	47	0.003	0.003	0.0009	0.0051	<0.01	0	0	0	0
R11	5	0	5	0	0.001	0.000	0.0009	0.0013	-	0	0	0	0
V27	31	20	11	65	0.002	0.003	<0.0001	0.013	<0.002	1	3	0	0
V4	32	15	17	47	0.004	0.004	<0.0001	0.015	<0.01	4	13	0	0
V5	131	56	75	43	0.004	0.004	<0.0001	0.02	<0.02	8	6	0	0
V8	149	79	70	53	0.003	0.004	<0.0001	0.02	<0.02	3	2	0	0
Totals	**1083**	**623**	**460**	**58**									
Reference													
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**	**# > CWQG**	**% > CWQG**
V1	53	38	15	72	0.005	0.007	<0.0001	0.033	<0.01	3	6	0	0
FDU	13	12	1	92	0.006	0.011	<0.0005	0.011	<0.03	1	8	0	0
FC	2	2	0	100	<0.03	0	<0.03	-	<0.03	0	0	0	0
R7	86	55	31	64	0.002	0.003	<0.0005	0.015	<0.020	2	2	0	0
W10	13	12	1	92	0.006	0.011	<0.0005	0.006	<0.030	0	0	0	0
R6	16	6	10	38	0.003	0.003	0.001	0.0069	<0.01	0	0	0	0
Totals	**183**	**125**	**58**	**68**									

Background Benchmark = 0.010 mg/L
CWQG = 0.073 mg/L

Table A.45: Summary Statistics for Total Nickel Measured in Water Samples (1975 - 2006)

Exposed or Potentially Disturbed														
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**	**CWQG**	**# > CWQG**	**% > CWQG**
FDL	5	5	0	100	<0.001	0	<0.001	-	<0.001	0	0	0.025	0	0
R8	81	61	20	75	0.004	0.003	<0.001	0.013	<0.02	0	0	0.065	0	0
R9	84	68	16	81	0.005	0.004	<0.001	0.023	<0.02	1	1	0.065	0	0
R10	84	62	22	74	0.006	0.007	<0.001	0.041	<0.02	3	4	0.065	0	0
NF1	13	9	4	69	0.005	0.005	<0.001	0.018	<0.005	0	0	0.065	0	0
NF2	16	12	4	75	0.007	0.008	<0.001	0.026	<0.02	1	6	0.065	0	0
X2	181	127	54	70	0.007	0.009	<0.001	0.05	<0.05	3	2	0.065	0	0
R1	11	6	5	55	0.006	0.009	0.0009	0.031	<0.005	1	9	0.065	0	0
W8	14	10	4	71	0.009	0.013	<0.001	0.048	<0.02	1	7	0.025	1	7
X14	211	90	121	43	0.009	0.011	<0.001	0.103	<0.05	10	5	0.150	0	0
R2	11	3	8	27	0.004	0.003	<0.0002	0.013	<0.005	0	0	0.150	0	0
R3	11	4	7	36	0.003	0.002	<0.0002	0.006	<0.005	0	0	0.150	0	0
R4	16	8	8	50	0.011	0.019	0.001	0.077	<0.02	1	6	0.150	0	0
R5	15	10	5	67	0.006	0.006	0.0007	0.009	<0.02	0	0	0.110	0	0
R11	5	4	1	80	0.001	0	<0.001	0.001	<0.001	0	0	0.150	0	0
V27	31	21	10	68	0.005	0.005	0.0009	0.024	<0.005	1	3	0.065	0	0
V4	32	18	14	56	0.007	0.006	<0.001	0.024	<0.02	2	6	0.150	0	0
V5	131	61	70	47	0.009	0.010	<0.0002	0.07	<0.05	7	5	0.150	0	0
V8	149	68	81	46	0.008	0.010	<0.0002	0.05	<0.05	5	3	0.150	0	0
Totals	**1101**	**647**	**454**	**59**										
Reference														
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**	**CWQG**	**# > CWQG**	**% > CWQG**
V1	53	41	12	77	0.007	0.007	<0.0002	0.023	<0.02	1	2	0.065	0	0
FDU	13	8	5	62	0.008	0.008	<0.001	0.023	<0.02	1	8	0.025	0	0
FC	2	2	0	100	<0.02	0	<0.02	-	<0.02	0	0	0.025	0	0
R7	86	68	18	79	0.004	0.003	<0.0002	0.014	<0.02	0	0	0.065	0	0
W10	13	12	1	92	0.008	0.010	<0.001	0.035	<0.02	1	8	0.025	1	8
R6	16	9	7	56	0.006	0.006	<0.001	0.009	<0.02	0	0	0.110	0	0
Totals	**183**	**140**	**43**	**77**										

Background Benchmark = 0.02 mg/L
CWQG = 0.025 - 0.150 mg/L

Table A.46: Summary Statistics for pH Measured in Water Samples (1975 - 2006)

Exposed or Potentially Disturbed									
Station Name	**n**	**Mean**	**SD**	**Min**	**Max**	**# < Benchmark**	**% < Benchmark**	**# >< CWQG**	**% >< CWQG**
FDL	5	7.38	0.36	7.00	7.80	0	0	0	0
R8	64	7.64	0.36	6.86	8.60	4	6	0	0
R9	65	7.48	0.41	6.15	8.40	5	8	1	2
R10	63	7.56	0.37	6.58	8.40	5	8	0	0
NF1	11	7.52	0.49	6.65	8.20	2	18	0	0
NF2	12	7.65	0.52	6.65	8.58	2	17	0	0
X2	141	7.48	0.38	6.61	8.40	16	11	0	0
R1	11	7.88	0.34	7.00	8.24	0	0	0	0
W8	13	7.61	0.34	7.00	8.20	0	0	0	0
X14	177	7.74	0.39	5.94	8.63	7	4	2	1
R2	11	7.81	0.30	7.20	8.17	0	0	0	0
R3	10	8.00	0.27	7.40	8.27	0	0	0	0
R4	12	7.92	0.30	7.52	8.34	0	0	0	0
R5	13	8.12	0.31	7.50	8.48	0	0	0	0
R11	5	7.91	0.46	7.40	8.40	0	0	0	0
V27	19	7.89	0.44	6.66	8.60	1	5	0	0
V4	19	8.09	0.33	7.02	8.42	0	0	0	0
V5	108	8.05	0.34	7.09	8.78	0	0	0	0
V8	124	7.99	0.33	7.00	8.60	0	0	0	0
Totals	**883**								
Reference									
Station Name	**n**	**Mean**	**SD**	**Min**	**Max**	**# < Benchmark**	**% < Benchmark**	**# >< CWQG**	**% >< CWQG**
V1	47	7.65	0.45	6.70	8.60	2	4	0	0
FDU	12	7.44	0.47	6.70	8.20	3	25	0	0
FC	2	7.41	0.57	7.00	7.81	0	0	0	0
R7	71	7.72	0.37	6.86	8.79	2	3	0	0
W10	12	7.84	0.19	7.46	8.00	0	0	0	0
R6	14	7.99	0.36	7.40	8.44	0	0	0	0
Totals	**158**								

Background Benchmark = 7.0
CWQG = 6.5 - 9.0

Table A.47: Summary Statistics for Total Phosphorus Measured in Water Samples (1975 - 2006)

Exposed or Potentially Disturbed											
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**
FDL	5	5	0	100	<0.15	0	<0.15	-	<0.15	0	0
R8	81	63	18	78	0.242	0.432	<0.01	2.49	<1	3	4
R9	80	62	18	78	0.199	0.486	<0.01	4	<1	1	1
R10	80	64	16	80	0.285	0.930	<0.01	8	<1	3	4
NF1	13	10	3	77	0.612	1.357	<0.01	5	<1	1	8
NF2	16	11	5	69	0.597	1.038	0.01	4	<1	3	19
X2	171	127	44	74	0.447	2.070	<0.01	26	<1	7	4
R1	11	7	4	64	0.305	0.459	<0.04	1.66	<0.20	1	9
W8	14	10	4	71	0.415	0.562	<0.01	2	<1	2	14
X14	210	164	46	78	0.277	0.627	<0.01	7	<1	10	5
R2	11	7	4	64	0.310	0.371	<0.04	1.29	<0.2	1	9
R3	11	8	3	73	0.307	0.443	<0.04	1.53	<0.2	1	9
R4	16	10	6	63	0.173	0.176	<0.04	0.62	<0.1	0	0
R5	15	9	6	60	0.271	0.418	<0.04	1.63	<0.2	1	7
R11	5	5	0	100	<0.15	0	<0.15	-	<0.15	0	0
V27	31	16	15	52	0.391	0.597	<0.002	2.05	<1	3	10
V4	32	14	18	44	0.443	0.580	<0.002	2	<1	3	9
V5	131	70	61	53	0.645	1.714	<0.002	13.9	<1	14	11
V8	149	102	47	68	0.421	0.788	<0.002	5.1	<1	11	7
Totals	**1082**	**764**	**318**	**71**							
Reference											
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**
V1	53	41	12	77	0.289	0.693	<0.002	4	<1	3	6
FDU	13	10	3	77	0.144	0.109	<0.01	0.33	<0.30	0	0
FC	2	2	0	100	<0.3	0	<0.3	-	<0.3	0	0
R7	86	60	26	70	0.425	1.409	<0.010	12.4	<1	7	8
W10	13	10	3	77	0.379	0.484	<0.01	1.55	<0.30	1	8
R6	16	12	4	75	0.160	0.155	<0.04	0.6	<0.2	0	0
Totals	**183**	**135**	**48**	**74**							

Background Benchmark = 1.0 mg/L

Table A.48: Summary Statistics for Total Potassium Measured in Water Samples (1975 - 2006)

Exposed or Potentially Disturbed											
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**
FDL	5	0	5	0	0.22	0.08	0.1	0.3	-	0	0
R8	57	13	44	23	1.11	0.68	0.4	4	<1	4	7
R9	56	14	42	25	1.10	0.59	0.4	3	<1	3	5
R10	56	13	43	23	1.30	1.33	0.4	10	<1	4	7
NF1	13	5	8	38	0.96	0.64	0.5	3	<1	1	8
NF2	16	7	9	44	1.13	0.68	0.5	3	<2	1	6
X2	142	50	92	35	1.37	0.76	0.4	5	<2	9	6
R1	9	1	8	11	0.93	0.47	0.43	1.9	<1	0	0
W8	14	6	8	43	1.04	0.55	0.5	2	<2	0	0
X14	181	19	162	10	2.23	1.38	0.6	10	<2	66	36
R2	9	0	9	0	1.84	0.59	0.86	2.6	-	4	44
R3	9	0	9	0	1.67	0.47	0.9	2.3	-	3	33
R4	11	2	9	18	1.63	0.35	1	2	<2	0	0
R5	10	3	7	30	1.38	0.44	<1	2	<2	0	0
R11	5	0	5	0	1.66	0.40	1.2	2.3	-	1	20
V27	27	12	15	44	0.93	0.54	<0.2	3	<1	1	4
V4	26	9	17	35	1.35	0.87	<0.2	4	<1	2	8
V5	124	24	100	19	1.71	1.06	<0.2	9	<2	22	18
V8	138	27	111	20	1.61	0.97	<0.2	7	<2	16	12
Totals	**908**	**205**	**703**	**23**							
Reference											
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**
V1	46	16	30	35	1.09	0.99	0.30	5.51	<2	2	4
FDU	13	4	9	31	0.74	0.67	<0.1	1	<2	0	0
FC	2	2	0	100	<2	0	<2	-	<2	0	0
R7	61	15	46	25	1.04	0.61	0.36	4	<1	2	3
W10	13	6	7	46	1.00	0.61	0.4	2	<2	0	0
R6	11	3	8	27	1.33	0.44	0.88	1.9	<2	0	0
Totals	**146**	**46**	**100**	**32**							

Background Benchmark = 2.0 mg/L

Table A.49: Summary Statistics for Total Selenium Measured in Water Samples (1975 - 2006)

Exposed or Potentially Disturbed									
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Min**	**Max Detectable**	**Max MDL**	**#>CWQG**	**%>CWQG**
FDL	5	5	0	100	< 0.001	-	< 0.001	0	0
R8	58	56	2	97	< 0.0002	0.003	< 0.03	1	2
R9	58	54	4	93	< 0.0002	0.026	< 0.03	3	5
R10	58	56	2	97	< 0.0002	0.002	< 0.03	2	3
NF1	13	13	0	100	< 0.001	-	< 0.03	0	0
NF2	16	16	0	100	< 0.001	-	< 0.2	0	0
X2	145	143	2	99	< 0.0002	0.041	< 0.2	2	1
R1	9	8	1	89	< 0.001	0.001	< 0.005	0	0
W8	14	14	0	100	< 0.001	-	< 0.2	0	0
X14	189	178	11	94	< 0.001	0.071	< 0.2	9	5
R2	9	8	1	89	< 0.001	0.001	< 0.005	0	0
R3	9	8	1	89	< 0.001	0.002	< 0.005	1	11
R4	11	10	1	91	< 0.001	0.002	< 0.06	1	9
R5	10	9	1	90	< 0.001	0.001	< 0.06	0	0
R11	5	4	1	80	< 0.001	0.002	< 0.001	1	20
V27	28	28	0	100	< 0.001	-	< 0.03	0	0
V4	30	29	1	97	< 0.001	0.09	< 0.05	1	3
V5	127	115	12	91	< 0.001	0.07	< 0.2	10	8
V8	142	130	12	92	< 0.001	0.033	< 0.2	8	6
Totals	**936**	**884**	**52**	**94**					
Reference									
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Min**	**Max Detectable**	**Max MDL**	**#>CWQG**	**%>CWQG**
V1	50	48	2	96	< 0.0002	0.023	< 0.06	2	4
FDU	13	13	0	100	< 0.001	-	< 0.2	0	0
FC	2	2	0	100	< 0.2	-	< 0.2	0	0
R7	62	60	2	97	< 0.0002	0.002	< 0.03	1	2
W10	13	13	0	100	< 0.001	-	< 0.2	0	0
R6	11	10	1	91	< 0.001	0.002	< 0.06	1	9
Totals	**151**	**146**	**5**	**97**					

CWQG = 0.001 mg/L

Table A.50: Summary Statistics for Total Silicon Measured in Water Samples (1975 - 2006)

Exposed or Potentially Disturbed											
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**
FDL	5	0	5	0	12.64	5.06	3.7	16.2	-	4	80
R8	77	0	77	0	5.72	3.82	0.84	20.2	-	4	5
R9	76	0	76	0	5.69	3.74	0.87	20.6	-	3	4
R10	76	0	76	0	5.69	3.75	0.95	18.5	-	5	7
NF1	12	0	12	0	5.39	3.39	0.6	10.8	-	0	0
NF2	15	0	15	0	5.36	3.00	0.9	10.6	-	0	0
X2	158	0	158	0	5.42	2.73	0.68	17.7	-	5	3
R1	11	0	11	0	6.79	3.37	3.1	13.7	-	1	9
W8	13	0	13	0	7.62	4.26	2.9	15.9	-	3	23
X14	198	0	198	0	5.48	3.03	0.45	19.9	-	6	3
R2	11	0	11	0	6.54	3.40	2.8	13.6	-	1	9
R3	11	0	11	0	6.44	3.04	2.9	12.2	-	0	0
R4	15	0	15	0	5.09	3.11	1.08	11.9	-	0	0
R5	15	0	15	0	5.21	3.42	0.98	12.4	-	0	0
R11	5	0	5	0	9.00	3.03	5.5	13.8	-	1	20
V27	29	0	29	0	4.25	2.51	1.05	12.3	-	0	0
V4	30	0	30	0	5.20	2.72	1.86	13.3	-	1	3
V5	114	0	114	0	6.74	4.25	1.53	28.8	-	7	6
V8	131	1	130	1	5.55	3.70	<0.2	35.8	<0.2	3	2
Totals	**1002**	**1**	**1001**	**0**							
Reference											
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**
V1	46	0	46	0	4.25	1.95	1.41	10.7	-	0	0
FDU	12	0	12	0	7.32	5.48	0.8	15.8	-	4	33
FC	2	0	2	0	4.78	1.79	3.51	6.04	-	0	0
R7	83	0	83	0	5.65	3.63	0.76	18.5	-	3	4
W10	12	0	12	0	7.87	4.64	3.2	16	-	3	25
R6	16	0	16	0	5.29	3.40	0.89	12.8	-	0	0
Totals	**171**	**0**	**171**	**0**							

Background Benchmark = 13.0 mg/L

Table A.51: Summary Statistics for Total Silver Measured in Water Samples (1975 - 2006)

Exposed or Potentially Disturbed									
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Min**	**Max Detectable**	**Max MDL**	**# > CWQG**	**% > CWQG**
FDL	5	5	0	100	< 0.00025	-	< 0.00025	0	0
R8	81	78	3	96	< 0.0002	0.005	< 0.01	3	4
R9	80	76	4	95	< 0.0002	0.039	< 0.03	4	5
R10	80	76	4	95	< 0.0002	0.0237	< 0.03	4	5
NF1	13	12	1	92	< 0.0002	0.0012	< 0.003	1	8
NF2	16	14	2	88	< 0.00025	0.0005	< 0.015	2	13
X2	171	159	12	93	< 0.0002	0.03	< 0.03	12	7
R1	11	10	1	91	< 0.0001	0.0008	< 0.003	1	9
W8	14	13	1	93	< 0.0002	0.0004	< 0.015	1	7
X14	210	194	16	92	< 0.0002	0.016	<0.03	16	8
R2	11	10	1	91	< 0.0001	0.0004	< 0.003	1	9
R3	11	10	1	91	< 0.00025	0.0006	< 0.003	1	9
R4	16	14	2	88	< 0.00025	0.001	< 0.01	2	13
R5	15	14	1	93	< 0.0001	0.0006	< 0.01	1	7
R11	5	4	1	80	< 0.00025	0.0009	< 0.00025	1	20
V27	31	30	1	97	< 0.0001	0.0003	< 0.003	1	3
V4	31	31	0	100	< 0.0001	-	< 0.01	0	0
V5	130	114	16	88	< 0.0001	0.007	< 0.01	16	12
V8	148	129	19	87	< 0.0001	0.011	< 0.01	19	13
Totals	**1079**	**993**	**86**	**92**					
Reference									
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Min**	**Max Detectable**	**Max MDL**	**# > CWQG**	**% > CWQG**
V1	52	48	4	92	< 0.00005	0.0037	< 0.1	4	8
FDU	13	13	0	100	< 0.0002	-	< 0.015	0	0
FC	2	2	0	100	< 0.01	-	< 0.015	0	0
R7	86	83	3	97	< 0.0001	0.007	< 0.01	3	3
W10	13	13	0	100	< 0.0002	-	< 0.015	0	0
R6	16	14	2	88	< 0.0001	0.0017	< 0.01	2	13
Totals	**182**	**173**	**9**	**95**					

CWQG = 0.0001mg/L

Table A.52: Summary Statistics for Total Sodium Measured in Water Samples (1975 - 2006)

Exposed or Potentially Disturbed											
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**
FDL	5	0	5	0	1.72	0.40	1.03	2.0	-	0	0
R8	81	7	74	9	2.37	1.35	0.8	7.3	<1	9	11
R9	80	10	70	13	2.31	1.38	0.82	8.9	<1	8	10
R10	80	10	70	13	2.40	1.40	0.8	8.3	<1	10	13
NF1	13	2	11	15	1.85	0.68	<1	3	<1	0	0
NF2	16	4	12	25	2.03	0.84	0.8	4	<2	1	6
X2	209	16	193	8	2.71	1.32	0.77	8	<2	44	21
R1	11	1	10	9	3.34	3.00	<1	12	<1	2	18
W8	14	3	11	21	1.69	0.59	0.9	3	<2	0	0
X14	264	3	261	1	18.9	23.2	<1	102	<1	227	86
R2	11	0	11	0	8.11	4.92	2.53	20	-	10	91
R3	11	0	11	0	7.40	5.39	2.58	22	-	9	82
R4	16	0	16	0	7.22	4.29	3	20	-	14	88
R5	15	0	15	0	2.94	2.83	1	12	-	3	20
R11	5	0	5	0	3.87	1.50	2.33	6.3	-	2	40
V27	31	3	28	10	2.49	1.65	0.8	8	<1	4	13
V4	32	1	31	3	3.45	1.91	<1	10	<1	11	34
V5	131	4	127	3	4.55	2.43	1	16	<1	73	56
V8	149	5	144	3	3.96	2.03	<1	12	<1	74	50
Totals	**1174**	**69**	**1105**	**6**							
Reference											
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**
V1	53	3	50	6	2.07	1.46	0.4	8.9	<1	5	9
FDU	13	3	10	23	1.66	0.57	<1	3	<2	0	0
FC	8	1	7	13	1.65	0.28	1.2	2	<2	0	0
R7	86	9	77	10	2.33	1.55	0.77	9	<1	8	9
W10	13	3	10	23	1.64	0.60	1	3	<2	0	0
R6	16	1	15	6	2.52	2.52	1	11	-	2	13
Totals	**189**	**20**	**169**	**11**							

Background Benchmark = 3.8 mg/L

Table A.53: Summary Statistics for Total Strontium Measured in Water Samples (1975 - 2006)

Exposed or Potentially Disturbed											
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**
FDL	5	0	5	0	0.023	0.005	0.014	0.028	-	0	0
R8	81	0	81	0	0.118	0.054	0.025	0.212	-	7	9
R9	80	0	80	0	0.126	0.053	0.039	0.229	-	10	13
R10	80	0	80	0	0.127	0.054	0.038	0.228	-	9	11
NF1	13	0	13	0	0.090	0.044	0.041	0.201	-	1	8
NF2	16	0	16	0	0.110	0.062	0.044	0.232	-	3	19
X2	171	0	171	0	0.145	0.062	0.039	0.346	-	45	26
R1	11	0	11	0	0.148	0.070	0.081	0.32	-	2	18
W8	14	0	14	0	0.052	0.015	0.030	0.079	-	0	0
X14	211	0	211	0	0.236	0.114	0.050	0.749	-	121	57
R2	11	0	11	0	0.220	0.080	0.110	0.37	-	6	55
R3	11	0	11	0	0.202	0.065	0.106	0.33	-	6	55
R4	16	0	16	0	0.193	0.052	0.119	0.291	-	9	56
R5	15	0	15	0	0.131	0.039	0.095	0.26	-	1	7
R11	5	0	5	0	0.172	0.061	0.140	0.28	-	1	20
V27	31	0	31	0	0.117	0.065	0.032	0.25	-	8	26
V4	32	0	32	0	0.293	0.090	0.082	0.48	-	30	94
V5	131	0	131	0	0.301	0.152	0.111	1.08	-	101	77
V8	149	0	149	0	0.276	0.134	0.073	1.23	-	108	72
Totals	**1083**	**0**	**1083**	**0**							
Reference											
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**
V1	53	0	53	0	0.086	0.155	0.004	1.01	-	2	4
FDU	13	0	13	0	0.021	0.006	0.013	0.033	-	0	0
FC	2	0	2	0	0.024	0.006	0.019	0.028	-	0	0
R7	86	0	86	0	0.114	0.050	0.030	0.237	-	7	8
W10	13	0	13	0	0.045	0.011	0.027	0.063	-	0	0
R6	16	0	16	0	0.127	0.037	0.089	0.250	-	1	6
Totals	**183**	**0**	**183**	**0**							

Background Benchmark = 0.19 mg/L

Table A.54: Summary Statistics for Sulphate Measured in Water Samples (1975 - 2006)

Exposed or Potentially Disturbed										
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**# > Benchmark**	**% > Benchmark**
FDL	5	0	5	0	2.5	0.86	1.7	3.9	0	0
R8	79	0	79	0	8.4	3.4	2	17	0	0
R9	85	0	85	0	12	5.8	2.7	39	4	5
R10	84	0	84	0	12	5.9	2.7	38	6	7
NF1	20	0	20	0	8.1	4.4	3	18	0	0
NF2	23	0	23	0	9.4	4.9	3	22	1	4
X2	239	0	239	0	18	26	2	374	73	31
R1	11	0	11	0	16	8.1	6	29.6	2	18
W8	20	0	20	0	6.3	3.4	3	17	0	0
X14	289	0	289	0	165	162	4.4	1890	281	97
R2	11	0	11	0	102	71	21	240	11	100
R3	11	0	11	0	84	51	20	180	10	91
R4	23	0	23	0	112	68	24	276	23	100
R5	22	0	22	0	39	34	9	147	15	68
R11	5	0	5	0	53	19	36.3	81.9	5	100
V27	40	0	40	0	50	41	5	209	33	83
V4	38	0	38	0	50	31	7	139	31	82
V5	140	0	140	0	110	85	15	532	138	99
V8	171	0	171	0	103	79	0	703	161	94
Totals	**1316**	**0**	**1316**	**0**						
Reference										
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**# > Benchmark**	**% > Benchmark**
V1	63	1	62	2	9.6	4.5	<1	26	2	3
FDU	15	0	15	0	5.7	13	1	51	1	7
FC	14	1	13	7	1.9	0.93	<1	4	0	0
R7	102	0	102	0	9.1	6.3	1.7	52	4	4
W10	14	0	14	0	4.4	4.0	1	18	0	0
R6	22	0	22	0	24	21	6	91	8	36
Totals	**230**	**2**	**228**	**1**						

Background Benchmark = 20 mg/L

Table A.55: Summary Statistics for Total Sulphur Measured in Water Samples (1975 - 2006)

Exposed or Potentially Disturbed											
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**
FDL	0	-	-	-	-	-	-	-	-	0	-
R8	51	3	48	6	3.6	2.6	<1	18	<1	3	6
R9	49	1	48	2	4.4	3.0	<1	17	<1	5	10
R10	49	2	47	4	4.3	2.8	<1	15	<1	3	6
NF1	7	1	6	14	3.4	1.7	<1	6	<1	0	0
NF2	8	0	8	0	10	18	1	53	-	1	13
X2	111	0	111	0	6.5	3.4	1	23	-	43	39
R1	5	0	5	0	2.5	1.1	1	4	-	0	0
W8	6	1	5	17	2.4	1.9	<1	6	<1	0	0
X14	112	0	112	0	51	39	5	170	-	108	96
R2	5	0	5	0	13	7.6	7.25	26	-	5	100
R3	5	0	5	0	12	7.5	5	24	-	3	60
R4	8	0	8	0	28	23	5	60	-	7	88
R5	8	0	8	0	6.6	4.5	1	14	-	3	38
R11	0	-	-	-	-	-	-	-	-	0	-
V27	25	1	24	4	14	11	<1	42	<1	18	72
V4	24	1	23	4	15	11	<1	45	<1	16	67
V5	89	1	88	1	41	33	1	177	<1	86	97
V8	99	1	98	1	35	21	<1	113	<1	94	95
Totals	**661**	**12**	**649**	**2**							
Reference											
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**
V1	35	1	34	3	3.5	1.9	<1	9	<1	2	6
FDU	5	2	3	40	4.0	7.2	0.5	17	<1	1	20
FC	0	-	-	-	-	-	-	-	-	0	-
R7	53	2	51	4	3.6	2.6	<1	15	<1	3	6
W10	6	1	5	17	1.9	2.0	<1	6	<1	0	0
R6	8	0	8	0	6.0	5.7	1	18	-	2	25
Totals	**107**	**6**	**101**	**6**							

Background Benchmark = 7.0 mg/L

Table A.56: Summary Statistics for Total Suspended Solids (TSS) Measured in Water Samples (1975 - 2006)

Exposed or Potentially Disturbed											
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**
FDL	5	4	1	80	1.2	0.4	<1	2	<1	0	0
R8	74	47	27	64	6.5	14	<1	92	<10	7	9
R9	75	46	29	61	4.8	5.9	<1	35	<10	6	8
R10	77	47	30	61	4.6	5.1	<1	28	<5	6	8
NF1	11	1	10	9	3.3	2.4	<1	7	<1	0	0
NF2	12	4	8	33	2.0	1.8	<1	7	<1	0	0
X2	240	106	134	44	4.5	7.5	0.8	108	<10	9	4
R1	11	4	7	36	1.9	1.6	<1	2	<5	0	0
W8	10	5	5	50	1.6	1.3	<1	5	<2	0	0
X14	352	93	259	26	18	63	<1	671	<10	68	19
R2	11	5	6	45	2.8	1.5	<1	4	<5	0	0
R3	11	6	5	55	2.1	1.6	<1	3	<5	0	0
R4	25	10	15	40	3.9	2.1	<1	5	<10	0	0
R5	24	10	14	42	4.1	2.0	<1	10	<10	0	0
R11	5	2	3	40	2.0	1.4	<1	4	<1	0	0
V27	45	12	33	27	15	60	<1	405	<5	5	11
V4	39	12	27	31	10	19	<1	98	<5	6	15
V5	149	22	127	15	39	108	<1	974	<10	62	42
V8	197	44	153	22	25	67	<1	590	<10	54	27
Totals	**1373**	**480**	**893**	**35**							
Reference											
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**
V1	65	30	35	46	3.7	3.0	<1	17	<10	1	2
FDU	10	6	4	60	3.3	4.0	<1	13	<5	1	10
FC	3	1	2	33	1.3	0.6	<1	2	<1	0	0
R7	98	53	45	54	12	69	<1	683	<5	9	9
W10	9	5	4	56	1.8	1.4	<1	3	<5	0	0
R6	24	11	13	46	3.7	2.2	<1	5	<10	0	0
Totals	**209**	**106**	**103**	**51**							

Background Benchmark = 10 mg/L

Table A.57: Summary Statistics for Total Thallium Measured in Water Samples (1975 - 2006)

Exposed or Potentially Disturbed									
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Min**	**Max Detectable**	**Max MDL**	**#>CWQG**	**%>CWQG**
FDL	5	5	0	100	< 0.0001	-	< 0.0001	0	0
R8	30	30	0	100	< 0.0001	-	< 0.002	0	0
R9	30	30	0	100	< 0.0001	-	< 0.002	0	0
R10	30	30	0	100	< 0.0001	-	< 0.002	0	0
NF1	6	6	0	100	< 0.0001	-	< 0.002	0	0
NF2	6	6	0	100	< 0.0001	-	< 0.002	0	0
X2	43	42	1	98	< 0.0001	0.002	< 0.2	1	2
R1	5	5	0	100	< 0.0001	-	< 0.0001	0	0
W8	6	6	0	100	< 0.0001	-	< 0.002	0	0
X14	73	70	3	96	< 0.0001	0.003	< 0.2	1	1
R2	5	5	0	100	< 0.0001	-	< 0.0001	0	0
R3	5	5	0	100	< 0.0001	-	< 0.0001	0	0
R4	5	5	0	100	< 0.0001	-	< 0.0001	0	0
R5	4	4	0	100	< 0.0001	-	< 0.0001	0	0
R11	5	5	0	100	< 0.0001	-	< 0.0001	0	0
V27	7	7	0	100	< 0.0001	-	< 0.002	0	0
V4	7	7	0	100	< 0.0001	-	< 0.002	0	0
V5	40	40	0	100	< 0.0001	-	< 0.2	0	0
V8	46	45	1	98	< 0.0001	0.002	< 0.2	1	2
Totals	**358**	**353**	**5**	**99**					
Reference									
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Min**	**Max Detectable**	**Max MDL**	**#>CWQG**	**%>CWQG**
V1	12	12	0	100	< 0.00002	-	< 0.002	0	0
FDU	6	6	0	100	< 0.0001	-	< 0.002	0	0
FC	0	-	-	-	-	-	-	0	0
R7	31	30	1	97	< 0.0001	0.002	< 0.002	1	3
W10	5	5	0	100	< 0.0001	-	< 0.002	0	0
R6	5	5	0	100	< 0.0001	-	< 0.0001	0	0
Totals	**59**	**58**	**1**	**98**					

CWQG = 0.0008 mg/L

Table A.58: Summary Statistics for Total Thorium Measured in Water Samples (1975 - 2006)

Exposed or Potentially Disturbed							
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Min**	**Max Detectable**	**Max MDL**
FDL	5	0	5	0	< 0.0005	-	< 0.0005
R8	25	24	1	96	< 0.0005	0.0017	< 0.0005
R9	26	25	1	96	< 0.0005	0.0015	< 0.0005
R10	26	25	1	96	< 0.0005	0.0011	< 0.0005
NF1	5	5	0	100	< 0.0005	-	< 0.0005
NF2	6	6	0	100	< 0.0005	-	< 0.1
X2	29	28	1	97	< 0.0005	0.0006	< 0.0005
R1	5	5	0	100	< 0.0005	-	< 0.0005
W8	6	6	0	100	< 0.0005	-	< 0.1
X14	59	57	2	97	< 0.0005	0.0016	< 0.0005
R2	5	5	0	100	< 0.0005	-	< 0.0005
R3	5	5	0	100	< 0.0005	-	< 0.0005
R4	5	5	0	100	< 0.0005	-	< 0.0005
R5	4	4	0	100	< 0.0005	-	< 0.0005
R11	5	5	0	100	< 0.0005	-	< 0.0005
V27	5	5	0	100	< 0.0005	-	< 0.0005
V4	5	5	0	100	< 0.0005	-	< 0.0005
V5	22	19	3	86	< 0.0005	0.0016	< 0.0005
V8	27	27	0	100	< 0.0005	-	< 0.0005
Totals	**275**	**261**	**14**	**95**			
Reference							
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Min**	**Max Detectable**	**Max MDL**
V1	7	7	0	100	< 0.0001	-	< 0.0005
FDU	6	6	0	100	< 0.0005	-	< 0.1
FC	1	1	0	100	< 0.1	-	< 0.1
R7	28	27	1	96	< 0.0005	0.002	< 0.0005
W10	5	5	0	100	< 0.0005	-	< 0.1
R6	5	5	0	100	< 0.0005	-	< 0.0005
Totals	**52**	**51**	**1**	**98**			

Table A.59: Summary Statistics for Total Tin Measured in Water Samples (1975 - 2006)

Exposed or Potentially Disturbed							
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Min**	**Max Detectable**	**Max MDL**
FDL	5	4	1	80	< 0.001	0.011	< 0.001
R8	58	52	6	90	< 0.001	0.05	< 0.03
R9	57	51	6	89	< 0.001	0.05	< 0.03
R10	57	48	9	84	< 0.001	0.04	< 0.03
NF1	13	12	1	92	< 0.001	0.005	< 0.01
NF2	16	15	1	94	< 0.001	0.007	< 0.3
X2	144	117	27	81	< 0.001	0.1	< 0.06
R1	9	9	0	100	< 0.001	-	< 0.01
W8	14	14	0	100	< 0.001	-	< 0.3
X14	181	155	26	86	< 0.001	0.06	< 0.06
R2	9	9	0	100	< 0.0004	-	< 0.01
R3	9	9	0	100	< 0.0004	-	< 0.01
R4	11	11	0	100	< 0.0004	-	< 0.06
R5	10	10	0	100	< 0.0004	-	< 0.06
R11	5	5	0	100	< 0.001	-	< 0.001
V27	28	23	5	82	< 0.0004	0.028	< 0.01
V4	29	26	3	90	< 0.0004	0.006	< 0.05
V5	127	106	21	83	< 0.0004	0.09	< 0.06
V8	141	115	26	82	< 0.0004	4.67	< 0.06
Totals	**923**	**791**	**132**	**86**			
Reference							
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Min**	**Max Detectable**	**Max MDL**
V1	49	41	8	84	< 0.0002	0.06	< 0.06
FDU	13	11	2	85	< 0.001	0.02	< 0.3
FC	2	2	0	100	< 0.03	-	< 0.3
R7	62	56	6	90	< 0.0004	0.038	< 0.01
W10	13	11	2	85	< 0.001	-	< 0.3
R6	11	10	1	91	< 0.0004	0.002	< 0.06
Totals	**150**	**131**	**19**	**87**			

Table A.60: Summary Statistics for Total Titanium Measured in Water Samples (1975 - 2006)

Exposed or Potentially Disturbed											
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**
FDL	5	0	5	0	0.002	0.001	0.001	0.003	-	0	0
R8	81	56	25	69	0.005	0.006	<0.001	0.048	<0.005	2	2
R9	80	58	22	73	0.005	0.005	<0.001	0.042	<0.005	1	1
R10	80	61	19	76	0.004	0.004	<0.001	0.028	<0.005	1	1
NF1	13	6	7	46	0.005	0.004	<0.001	0.015	<0.005	0	0
NF2	16	7	9	44	0.006	0.004	<0.001	0.015	<0.01	0	0
X2	171	80	91	47	0.018	0.046	<0.001	0.408	<0.02	28	16
R1	11	6	5	55	0.016	0.023	<0.001	0.058	<0.005	3	27
W8	14	11	3	79	0.004	0.003	<0.001	0.007	<0.01	0	0
X14	211	115	96	55	0.007	0.010	<0.0006	0.096	<0.01	21	10
R2	11	4	7	36	0.009	0.011	<0.001	0.033	<0.005	3	27
R3	11	7	4	64	0.007	0.008	<0.001	0.023	<0.005	1	9
R4	16	8	8	50	0.006	0.005	<0.001	0.017	<0.005	0	0
R5	15	9	6	60	0.006	0.005	<0.001	0.0216	<0.005	1	7
R11	5	1	4	20	0.002	0.001	<0.001	0.002	<0.001	0	0
V27	31	12	19	39	0.006	0.006	<0.001	0.025	<0.005	2	6
V4	32	11	21	34	0.010	0.011	<0.001	0.041	<0.005	8	25
V5	131	27	104	21	0.032	0.092	<0.001	0.867	<0.01	43	33
V8	149	67	82	45	0.016	0.051	<0.001	0.474	<0.01	25	17
Totals	**1083**	**546**	**537**	**50**							
Reference											
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**
V1	53	30	23	57	0.015	0.046	0.0006	0.31	<0.005	8	15
FDU	13	10	3	77	0.004	0.003	<0.001	0.007	<0.01	0	0
FC	2	2	0	100	<0.01	0	<0.01	-	<0.01	0	0
R7	86	58	28	67	0.005	0.007	<0.001	0.061	<0.005	2	2
W10	13	9	4	69	0.004	0.003	<0.001	0.006	<0.010	0	0
R6	16	9	7	56	0.006	0.007	<0.001	0.0283	<0.005	1	6
Totals	**183**	**118**	**65**	**64**							

Background Benchmark = 0.018 mg/L

Table A.61: Summary Statistics for Total Tungsten Measured in Water Samples (1975 - 2006)

Exposed or Potentially Disturbed							
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Min**	**Max Detectable**	**Max MDL**
FDL	0	-	-	-	-	-	-
R8	53	52	1	98	< 0.02	0.05	< 0.03
R9	51	50	1	98	< 0.02	0.04	< 0.03
R10	51	49	2	96	< 0.02	0.29	< 0.03
NF1	8	7	1	88	< 0.03	0.09	< 0.03
NF2	9	9	0	100	< 0.03	-	< 0.03
X2	104	104	0	100	< 0.02	-	< 0.03
R1	6	6	0	100	< 0.001	-	< 0.03
W8	7	7	0	100	< 0.03	-	< 0.03
X14	110	106	4	96	< 0.02	0.05	< 0.03
R2	6	6	0	100	< 0.001	-	< 0.03
R3	6	6	0	100	< 0.001	-	< 0.03
R4	9	9	0	100	< 0.001	-	< 0.03
R5	9	8	1	89	< 0.001	0.098	< 0.03
R11	0	-	-	-	-	-	-
V27	26	26	0	100	< 0.001	-	< 0.03
V4	25	25	0	100	< 0.001	-	< 0.03
V5	91	90	1	99	< 0.001	0.04	< 0.03
V8	99	97	2	98	< 0.001	0.03	< 0.03
Totals	**670**	**657**	**13**	**98**			
Reference							
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Min**	**Max Detectable**	**Max MDL**
V1	31	31	0	100	< 0.001	-	< 0.03
FDU	6	6	0	100	< 0.03	-	< 0.03
FC	0	-	-	-	-	-	-
R7	56	56	0	100	< 0.001	-	< 0.03
W10	7	7	0	100	< 0.03	-	< 0.03
R6	9	9	0	100	< 0.006	-	< 0.03
Totals	**109**	**109**	**0**	**100**			

Table A.62: Summary Statistics for Total Uranium Measured in Water Samples (1975 - 2006)

Exposed or Potentially Disturbed												
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Count**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**
FDL	5	5	0	100	5	<0.0005	0	<0.0005	-	<0.0005	0	0
R8	25	4	21	16	25	0.0013	0.0007	<0.0005	0.0025	<0.0005	2	8
R9	26	4	22	15	26	0.0015	0.0008	<0.0005	0.0027	<0.0005	4	15
R10	26	4	22	15	26	0.0015	0.0008	<0.0005	0.0029	<0.0005	4	15
NF1	5	1	4	20	5	0.0008	0.0003	<0.0005	0.0012	<0.0005	0	0
NF2	5	1	4	20	5	0.0008	0.0003	0.0005	0.0012	-	0	0
X2	29	4	25	14	29	0.0014	0.0008	<0.0005	0.0028	<0.0005	4	14
R1	5	0	5	0	5	0.0019	0.0008	0.0013	0.003	-	1	20
W8	5	5	0	100	5	<0.0005	0	<0.0005	-	<0.0005	0	0
X14	59	2	57	3	59	0.0015	0.0010	<0.0005	0.0043	<0.0005	12	20
R2	5	0	5	0	5	0.0022	0.0009	0.0015	0.0033	-	2	40
R3	5	0	5	0	5	0.0019	0.0007	0.0014	0.0028	-	2	40
R4	5	0	5	0	5	0.0019	0.0007	0.0014	0.003	-	1	20
R5	4	0	4	0	4	0.0020	0.0008	0.0015	0.0032	-	1	25
R11	5	0	5	0	5	0.0020	0.0008	0.0014	0.0032	-	1	20
V27	5	0	5	0	5	0.0013	0.0006	0.0009	0.0022	-	0	0
V4	5	0	5	0	5	0.0056	0.0019	0.0033	0.0083	-	5	100
V5	22	0	22	0	22	0.0032	0.0015	0.0011	0.0056	-	15	68
V8	27	0	27	0	27	0.0045	0.0024	0.0013	0.0082	-	20	74
Totals	**273**	**30**	**243**	**11**								
Reference												
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Count**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**
V1	7	3	4	43	7	0.0007	0.0004	0.0003	0.0014	<0.0005	0	0
FDU	5	5	0	100	5	<0.0005	0	<0.0005	-	<0.0005	0	0
FC	0	-	-	-	0	-	-	-	-	-	0	-
R7	28	4	24	14	28	0.0013	0.0006	<0.0005	0.0024	<0.0005	0	0
W10	4	4	0	100	4	<0.0005	0	<0.0005	-	<0.0005	0	0
R6	5	0	5	0	5	0.0021	0.0006	0.0016	0.0031	-	1	20
Totals	**49**	**16**	**33**	**33**								

Background Benchmark = 0.0024 mg/L

Table A.63: Summary Statistics for Total Vanadium Measured in Water Samples (1975 - 2006)

Exposed or Potentially Disturbed											
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**
FDL	5	5	0	100	<0.001	0	<0.001	-	<0.001	0	0
R8	81	68	13	84	0.005	0.005	<0.001	0.027	<0.03	5	6
R9	80	70	10	88	0.004	0.005	<0.001	0.021	<0.03	4	5
R10	80	70	10	88	0.004	0.005	<0.001	0.021	<0.03	3	4
NF1	13	10	3	77	0.005	0.006	<0.001	0.02	<0.005	2	15
NF2	16	13	3	81	0.011	0.016	<0.001	0.045	<0.03	2	13
X2	171	135	36	79	0.018	0.083	<0.001	0.665	<0.03	17	10
R1	11	10	1	91	0.009	0.021	<0.0002	0.0723	<0.005	1	9
W8	14	12	2	86	0.007	0.010	<0.001	0.015	<0.03	1	7
X14	211	174	37	82	0.005	0.006	<0.001	0.052	<0.03	13	6
R2	11	10	1	91	0.003	0.003	<0.0002	0.0089	<0.005	0	0
R3	11	9	2	82	0.003	0.002	<0.0002	0.0054	<0.005	0	0
R4	16	15	1	94	0.004	0.003	<0.001	0.0014	<0.01	0	0
R5	15	14	1	93	0.004	0.003	<0.0002	0.0013	<0.01	0	0
R11	5	5	0	100	<0.001	0	<0.001	-	<0.001	0	0
V27	31	28	3	90	0.004	0.003	<0.0002	0.012	<0.005	1	3
V4	32	29	3	91	0.004	0.004	<0.0002	0.02	<0.01	1	3
V5	131	83	48	63	0.008	0.011	<0.0002	0.08	<0.03	21	16
V8	149	109	40	73	0.006	0.008	<0.0002	0.044	<0.03	16	11
Totals	**1083**	**869**	**214**	**80**							
Reference											
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**
V1	53	46	7	87	0.005	0.005	<0.0002	0.023	<0.01	2	4
FDU	13	10	3	77	0.009	0.012	<0.001	0.021	<0.03	2	15
FC	2	2	0	100	<0.03	0	<0.03	-	<0.03	0	0
R7	86	77	9	90	0.004	0.006	<0.0002	0.048	<0.03	2	2
W10	13	11	2	85	0.007	0.010	<0.001	0.008	<0.03	0	0
R6	16	15	1	94	0.004	0.003	<0.0002	0.0005	<0.01	0	0
Totals	**183**	**161**	**22**	**88**							

Background Benchmark = 0.010 mg/L

Table A.64: Summary Statistics for Total Zinc Measured in Water Samples (1975 - 2006)

Station Name	n	<MDL	>MDL	%<MDL	Mean	SD	Min	Max Detectable	Max MDL	# > Benchmark	% > Benchmark	# > CWQG	% > CWQG
Exposed or Potentially Disturbed													
FDL	5	0	5	0	0.081	0.083	0.007	0.18	-	2	40	3	60
R8	83	36	47	43	0.017	0.018	0.004	0.1	<0.01	3	4	13	16
R9	87	33	54	38	0.019	0.024	<0.002	0.14	<0.01	5	6	10	11
R10	86	16	70	19	0.020	0.019	0.004	0.11	<0.01	3	3	14	16
NF1	20	0	20	0	0.041	0.033	0.006	0.11	-	5	25	9	45
NF2	23	2	21	9	0.029	0.021	<0.005	0.08	<0.01	2	9	8	35
X2	262	12	250	5	0.044	0.054	<0.002	0.5	<0.01	42	16	117	45
R1	11	2	9	18	0.021	0.019	<0.005	0.07	<0.005	1	9	2	18
W8	21	0	21	0	0.074	0.127	0.009	0.577	-	7	33	11	52
X14	382	10	372	3	0.088	0.141	<0.005	1.48	<1	158	41	285	75
R2	11	0	11	0	0.052	0.048	0.018	0.19	-	1	9	7	64
R3	11	0	11	0	0.041	0.039	0.01	0.15	-	1	9	6	55
R4	25	1	24	4	0.066	0.136	<0.005	0.665	<0.005	5	20	9	36
R5	24	6	18	25	0.033	0.091	0.001	0.453	<0.01	2	8	4	17
R11	5	3	2	60	0.006	0.001	<0.005	0.008	<0.005	0	0	0	0
V27	46	0	46	0	0.065	0.067	0.012	0.44	-	14	30	37	80
V4	40	8	32	20	0.025	0.035	0.001	0.18	<0.01	4	10	7	18
V5	149	31	118	21	0.034	0.112	<0.0004	1.31	<0.01	12	8	34	23
V8	195	8	187	4	0.037	0.042	0.0054	0.364	<0.01	24	12	69	35
Totals	**1486**	**168**	**1318**	**11**									
Reference													
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**	**Max MDL**	**# > Benchmark**	**% > Benchmark**	**# > CWQG**	**% > CWQG**
V1	65	16	49	25	0.020	0.032	<0.001	0.24	<0.01	2	3	12	18
FDU	15	3	12	20	0.052	0.077	<0.005	0.23	<0.01	4	27	6	40
FC	16	3	13	19	0.009	0.007	<0.002	0.023	<0.005	0	0	0	0
R7	106	38	68	36	0.023	0.050	<0.001	0.443	<0.01	5	5	15	14
W10	14	5	9	36	0.030	0.028	<0.005	0.091	<0.01	3	21	6	43
R6	24	8	16	33	0.018	0.027	0.001	0.118	<0.01	2	8	4	17
Totals	**240**	**73**	**167**	**30**									

Background Benchmark = 0.06 mg/L
CWQG = 0.03 mg/L

Table A.65: Percent samples exceeding background benchmarks for mine indicator parameters at exposure and reference stations

Stations		Ammonia				Calcium				Conductivity				Hardness			
		n	Mean	SD	% > Benchmark	n	Mean	SD	% > Benchmark	n	Mean	SD	% > Benchmark	n	Mean	SD	% > Benchmark
Exposed or Potentially Disturbed	FDL	5	<0.01	0	0	5	3.8	0.9	0	5	35	10	0	5	13	2.9	0
	R8	59	0.037	0.028	2	81	27.5	12.3	9	26	172	69	12	28	94	39	4
	R9	59	0.032	0.022	0	84	29.3	12.3	19	28	189	73	21	29	102	41	28
	R10	61	0.032	0.023	0	84	29.4	12.4	14	27	191	75	22	31	103	43	16
	NF1	7	0.023	0.019	0	13	19.1	5.4	0	11	128	35	0	5	72	17	0
	NF2	8	<0.025	0.021	0	16	25.5	18.6	13	14	133	55	7	8	80	35	13
	X2	246	0.079	0.167	14	181	33.6	16.3	24	62	210	83	34	66	104	49	24
	R1	11	0.048	0.029	0	11	30.3	13.6	18	7	205	61	29	11	98	43	9
	W8	7	0.021	0.020	0	14	14.3	4.0	0	14	101	22	0	6	46	10	0
	X14	313	0.310	0.434	57	211	69.9	39.0	71	58	415	258	76	173	227	127	68
	R2	11	0.102	0.072	36	11	60.6	27.1	64	7	433	190	71	11	205	94	64
	R3	11	0.058	0.032	0	11	55.6	22.7	64	7	399	145	71	11	186	78	64
	R4	25	0.199	0.264	36	16	55.6	19.3	63	7	400	117	86	13	180	55	62
	R5	24	0.097	0.118	21	15	41.5	12.3	33	6	277	57	33	12	147	44	33
	R11	5	0.014	0.005	0	5	53.7	18.6	40	5	305	62	60	5	183	61	100
	V27	39	0.064	0.072	15	31	25.1	14.4	10	25	199	85	28	35	95	48	17
	V4	33	0.070	0.131	6	32	69.5	19.7	94	21	497	160	95	29	293	101	93
	V5	92	0.038	0.031	2	131	75.2	34.7	84	61	474	207	84	131	317	162	92
	V8	147	0.045	0.044	3	149	63.8	25.1	75	85	415	187	74	156	251	117	72
Reference	V1	53	0.051	0.055	6	53	15.6	21.5	4	45	80	32	0	56	39	43	2
	FDU	6	0.017	0.016	0	13	3.3	0.7	0	9	54	58	0	7	11	3.3	0
	FC	6	0.213	0.140	67	2	3.1	1	0	8	31	10	0	1	7.3	-	0
	R7	87	0.057	0.079	6	86	26.9	10.8	7	34	170	65	9	41	88	37	5
	W10	6	<0.023	0.021	0	13	12.6	3.5	0	7	93	25	0	5	42	14	0
	R6	24	0.054	0.059	8	16	41.8	11.3	25	7	280	56	43	13	149	39	38

Table A.65: Percent samples exceeding background benchmarks for mine indicator parameters at exposure and reference stations

Stations		Magnesium				Manganese				Sodium				Strontium				
		n	Mean	SD	% > Benchmark	n	Mean	SD	% > Benchmark	n	Mean	SD	% > Benchmark	n	Mean	SD	Min	% > Benchmark
Exposed or Potentially Disturbed	FDL	5	0.83	0.22	0	5	0.018	0.021	20	5	1.72	0.40	0	5	0.023	0.005	0.014	0
	R8	81	5.5	2.3	0	81	0.024	0.022	9	81	2.37	1.35	11	81	0.118	0.054	0.025	9
	R9	84	6.0	2.5	7	83	0.026	0.023	12	80	2.31	1.38	10	80	0.126	0.053	0.039	13
	R10	84	6.0	2.4	5	84	0.026	0.026	10	80	2.40	1.40	13	80	0.127	0.054	0.038	11
	NF1	13	4.2	1.3	0	13	0.039	0.028	23	13	1.85	0.68	0	13	0.090	0.044	0.041	8
	NF2	16	4.5	1.9	6	16	0.024	0.017	13	16	2.03	0.84	6	16	0.110	0.062	0.044	19
	X2	181	7.1	3.3	23	209	0.06	0.04	57	209	2.71	1.32	21	171	0.145	0.062	0.039	26
	R1	11	5.9	1.9	9	11	0.078	0.115	36	11	3.34	3.00	18	11	0.148	0.070	0.081	18
	W8	14	2.0	0.65	0	14	0.010	0.009	0	14	1.69	0.59	0	14	0.052	0.015	0.030	0
	X14	211	14	7.5	71	338	1.28	1.68	100	264	18.9	23.2	86	211	0.236	0.114	0.050	57
	R2	11	13	6.0	64	11	0.995	0.626	100	11	8.11	4.92	91	11	0.220	0.080	0.110	55
	R3	11	12	5.0	64	11	0.509	0.311	100	11	7.40	5.39	82	11	0.202	0.065	0.106	55
	R4	16	11	3.8	63	16	0.224	0.147	88	16	7.22	4.29	88	16	0.193	0.052	0.119	56
	R5	15	10	2.3	47	15	0.043	0.039	33	15	2.94	2.83	20	15	0.131	0.039	0.095	7
	R11	5	12	3.6	100	5	0.023	0.021	20	5	3.87	1.50	40	5	0.172	0.061	0.140	20
	V27	31	6.9	4.5	26	31	0.018	0.023	10	31	2.49	1.65	13	31	0.117	0.065	0.032	26
	V4	32	27	8.0	97	32	0.036	0.046	13	32	3.45	1.91	34	32	0.293	0.090	0.082	94
	V5	131	32	19	99	131	0.048	0.078	24	131	4.55	2.43	56	131	0.301	0.152	0.111	77
	V8	149	26	12	95	149	0.076	0.128	38	149	3.96	2.03	50	149	0.276	0.134	0.073	72
Reference	V1	53	3.1	7.3	4	53	0.012	0.027	6	53	2.07	1.46	9	53	0.086	0.155	0.004	4
	FDU	13	0.79	0.32	0	13	0.010	0.009	0	13	1.66	0.57	0	13	0.021	0.006	0.013	0
	FC	2	0.64	0.26	0	8	0.003	0.002	0	8	1.65	0.28	0	2	0.024	0.006	0.019	0
	R7	86	5.4	2.1	0	86	0.027	0.038	14	86	2.33	1.55	9	86	0.114	0.050	0.030	8
	W10	13	1.7	0.43	0	13	0.010	0.009	0	13	1.64	0.60	0	13	0.045	0.011	0.027	0
	R6	16	10	2.0	56	16	0.013	0.004	0	16	2.52	2.52	13	16	0.127	0.037	0.089	6

Table A.65: Percent samples exceeding background benchmarks for mine indicator parameters at exposure and reference stations

Stations		Sulphate				Uranium				Zinc			
		n	Mean	SD	% > Benchmark	n	Mean	SD	% > Benchmark	n	Mean	SD	% > Benchmark
Exposed or Potentially Disturbed	FDL	5	2.5	0.86	0	5	<0.0005	0	0	5	0.081	0.083	40
	R8	79	8.4	3.4	0	25	0.0013	0.0007	8	83	0.017	0.018	4
	R9	85	12	5.8	5	26	0.0015	0.0008	15	87	0.019	0.024	6
	R10	84	12	5.9	7	26	0.0015	0.0008	15	86	0.020	0.019	3
	NF1	20	8.1	4.4	0	5	0.0008	0.0003	0	20	0.041	0.033	25
	NF2	23	9.4	4.9	4	5	0.0008	0.0003	0	23	0.029	0.021	9
	X2	239	18	26	31	29	0.0014	0.0008	14	262	0.044	0.054	16
	R1	11	16	8.1	18	5	0.0019	0.0008	20	11	0.021	0.019	9
	W8	20	6.3	3.4	0	5	<0.0005	0	0	21	0.074	0.127	33
	X14	289	165	162	97	59	0.0015	0.0010	20	382	0.088	0.141	41
	R2	11	102	71	100	5	0.0022	0.0009	40	11	0.052	0.048	9
	R3	11	84	51	91	5	0.0019	0.0007	40	11	0.041	0.039	9
	R4	23	112	68	100	5	0.0019	0.0007	20	25	0.066	0.136	20
	R5	22	39	34	68	4	0.0020	0.0008	25	24	0.033	0.091	8
	R11	5	53	19	100	5	0.0020	0.0008	20	5	0.006	0.001	0
	V27	40	50	41	83	5	0.0013	0.0006	0	46	0.065	0.067	30
	V4	38	50	31	82	5	0.0056	0.0019	100	40	0.025	0.035	10
	V5	140	110	85	99	22	0.0032	0.0015	68	149	0.034	0.112	8
	V8	171	103	79	94	27	0.0045	0.0024	74	195	0.037	0.042	12
Reference	V1	63	9.6	4.5	3	7	0.0007	0.0004	0	65	0.020	0.032	3
	FDU	15	5.7	13	7	5	<0.0005	0	0	15	0.052	0.077	27
	FC	14	1.9	0.93	0	0	-	-	-	16	0.009	0.007	0
	R7	102	9.1	6.3	4	28	0.0013	0.0006	0	106	0.023	0.050	5
	W10	14	4.4	4.0	0	4	<0.0005	0	0	14	0.030	0.028	21
	R6	22	24	21	36	5	0.0021	0.0006	20	24	0.018	0.027	8

Table A.66: Summary Statistics for Alkalinity Measured in Water Samples (May 2004 - June 2006)

Exposed or Potentially Disturbed								
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**
FDL	0	-	-	-	-	-	-	-
R8	0	-	-	-	-	-	-	-
R9	0	-	-	-	-	-	-	-
R10	0	-	-	-	-	-	-	-
NF1	0	-	-	-	-	-	-	-
NF2	1	0	1	0	45	-	-	-
X2	0	-	-	-	-	-	-	-
R1	5	0	5	0	85	47	4	121
W8	0	-	-	-	-	-	-	-
X14	22	0	22	0	110	42	36	192
R2	5	0	5	0	131	29	100	165
R3	5	0	5	0	129	24	101	153
R4	5	0	5	0	123	17	101	144
R5	4	0	4	0	132	11	117	142
R11	5	0	5	0	122	14	101	137
V27	1	0	1	0	49	-	-	-
V4	1	0	1	0	46	-	-	-
V5	21	0	21	0	183	61	84	271
V8	26	0	26	0	159	55	77	241
Totals	**101**	**0**	**101**	**0**				
Reference								
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**
V1	4	0	4	0	29	14	15	45
FDU	0	-	-	-	-	-	-	-
FC	0	-	-	-	-	-	-	-
R7	2	0	2	0	94	3	92	96
W10	0	-	-	-	-	-	-	-
R6	5	0	5	0	136	9	122	143
Totals	**11**	**0**	**11**	**0**				

Table A.67: Summary Statistics for Total Aluminum Measured in Water Samples (May 2004 - June 2006)

Exposed or Potentially Disturbed								
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**
FDL	5	0	5	0	0.083	0.037	0.043	0.13
R8	25	2	23	8	0.078	0.148	<0.005	0.65
R9	26	2	24	8	0.072	0.121	<0.005	0.5
R10	26	1	25	4	0.063	0.110	<0.005	0.43
NF1	5	0	5	0	0.052	0.037	0.011	0.1
NF2	5	0	5	0	0.058	0.051	0.012	0.135
X2	28	1	27	4	0.048	0.066	<0.005	0.27
R1	5	0	5	0	0.015	0.010	0.007	0.031
W8	5	0	5	0	0.031	0.022	0.014	0.067
X14	58	3	55	5	0.057	0.126	<0.005	0.89
R2	5	0	5	0	0.020	0.005	0.015	0.026
R3	5	1	4	20	0.008	0.003	<0.005	0.012
R4	5	2	3	40	0.012	0.007	<0.005	0.018
R5	4	0	4	0	0.018	0.009	0.01	0.03
R11	5	0	5	0	0.034	0.020	0.007	0.061
V27	5	0	5	0	0.060	0.041	0.023	0.12
V4	5	0	5	0	0.106	0.105	0.014	0.22
V5	21	0	21	0	0.771	1.288	0.021	5.29
V8	26	2	24	8	0.222	0.405	<0.005	1.64
Totals	**269**	**14**	**255**	**5**				
Reference								
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**
V1	7	0	7	0	0.169	0.363	0.006	0.99
FDU	5	0	5	0	0.060	0.029	0.028	0.1
FC	0	-	-	-	-	-	-	-
R7	28	2	26	7	0.065	0.127	<0.005	0.6
W10	4	0	4	0	0.030	0.015	0.012	0.043
R6	5	0	5	0	0.043	0.054	0.014	0.14
Totals	**49**	**2**	**47**	**4**				

Table A.68: Summary Statistics for Total Ammonia Measured in Water Samples (May 2004 - June 2006)

Exposed or Potentially Disturbed								
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**
FDL	5	5	0	100	<0.01	-	<0.01	-
R8	25	14	11	56	0.021	0.024	<0.01	0.11
R9	25	17	8	68	0.017	0.017	<0.01	0.09
R10	25	17	8	68	0.016	0.018	<0.01	0.1
NF1	5	3	2	60	0.012	0.004	<0.01	0.02
NF2	4	4	0	100	<0.01	-	<0.01	-
X2	28	17	11	61	0.015	0.012	<0.01	0.06
R1	5	2	3	40	0.046	0.045	<0.01	0.1
W8	5	5	0	100	<0.01	-	<0.01	-
X14	58	4	54	7	0.106	0.113	<0.01	0.56
R2	5	0	5	0	0.122	0.089	0.02	0.26
R3	5	1	4	20	0.054	0.042	<0.01	0.11
R4	5	1	4	20	0.016	0.009	<0.01	0.03
R5	4	3	1	75	0.010	0.000	<0.01	0.01
R11	5	3	2	60	0.014	0.005	<0.01	0.02
V27	5	4	1	80	0.012	0.004	<0.01	0.02
V4	5	4	1	80	0.010	0.000	<0.01	0.01
V5	21	13	8	62	0.018	0.022	<0.01	0.11
V8	26	17	9	65	0.021	0.026	<0.01	0.13
Totals	**266**	**134**	**132**	**50**				

Reference								
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**
V1	7	6	1	86	0.013	0.008	<0.01	0.03
FDU	5	3	2	60	0.010	0.000	<0.01	0.01
FC	0	-	-	-		-		-
R7	27	13	14	48	0.019	0.017	<0.01	0.07
W10	4	4	0	100	<0.01	0.000	<0.01	-
R6	5	3	2	60	0.010	0.000	<0.01	0.01
Totals	**48**	**29**	**19**	**60**				

Table A.69: Summary Statistics for Total Arsenic Measured in Water Samples (May 2004 - June 2006)

Exposed or Potentially Disturbed						
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Min**	**Max Detectable**
FDL	5	5	0	100	<0.001	-
R8	25	18	7	72	<0.001	0.002
R9	26	22	4	85	<0.001	0.002
R10	26	21	5	81	<0.001	0.002
NF1	5	4	1	80	<0.001	0.001
NF2	5	5	0	100	<0.001	-
X2	28	25	3	89	<0.001	0.001
R1	5	5	0	100	<0.001	-
W8	5	5	0	100	<0.001	-
X14	58	54	4	93	<0.001	0.003
R2	5	3	2	60	<0.001	0.001
R3	5	4	1	80	<0.001	0.001
R4	5	4	1	80	<0.001	0.001
R5	4	4	0	100	<0.001	-
R11	5	3	2	60	<0.001	0.001
V27	5	5	0	100	<0.001	-
V4	5	4	1	80	<0.001	0.001
V5	21	12	9	57	<0.001	0.006
V8	26	23	3	88	<0.001	0.002
Totals	**269**	**226**	**43**	**84**		
Reference						
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Min**	**Max Detectable**
V1	7	4	3	57	<0.001	0.002
FDU	5	5	0	100	<0.001	-
FC	0	-	-	-	-	-
R7	28	24	4	86	<0.001	0.003
W10	4	4	0	100	<0.001	-
R6	5	5	0	100	<0.001	-
Totals	**49**	**42**	**7**	**86**		

Table A.70: Summary Statistics for Total Barium Measured in Water Samples (May 2004 - June 2006)

Exposed or Potentially Disturbed								
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**
FDL	5	0	5	0	0.017	0.003	0.011	0.02
R8	25	0	25	0	0.054	0.016	0.031	0.078
R9	26	0	26	0	0.054	0.016	0.03	0.076
R10	26	0	26	0	0.054	0.017	0.03	0.084
NF1	5	0	5	0	0.038	0.007	0.026	0.046
NF2	5	0	5	0	0.040	0.003	0.035	0.043
X2	28	0	28	0	0.053	0.017	0.027	0.083
R1	5	0	5	0	0.064	0.022	0.046	0.1
W8	5	0	5	0	0.047	0.015	0.02	0.056
X14	58	0	58	0	0.048	0.015	0.013	0.08
R2	5	0	5	0	0.063	0.017	0.048	0.088
R3	5	0	5	0	0.060	0.012	0.051	0.076
R4	5	0	5	0	0.078	0.015	0.064	0.1
R5	4	0	4	0	0.076	0.017	0.064	0.1
R11	5	0	5	0	0.076	0.015	0.064	0.10
V27	5	0	5	0	0.030	0.013	0.018	0.048
V4	5	0	5	0	0.064	0.020	0.04	0.093
V5	21	0	21	0	0.081	0.023	0.059	0.16
V8	26	0	26	0	0.067	0.014	0.042	0.1
Totals	**269**	**0**	**269**	**0**				
Reference								
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**
V1	7	0	7	0	0.039	0.037	0.013	0.12
FDU	5	0	5	0	0.014	0.002	0.011	0.015
FC	0	-	-	-	-	-	-	-
R7	28	0	28	0	0.053	0.014	0.031	0.077
W10	4	0	4	0	0.014	0.004	0.009	0.018
R6	5	0	5	0	0.080	0.012	0.068	0.094
Totals	**49**	**0**	**49**	**0**				

Table A.71: Summary Statistics for Total Cadmium Measured in Water Samples (May 2004 - June 2006)

Exposed or Potentially Disturbed						
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Min**	**Max Detectable**
FDL	5	5	0	100	<0.0002	-
R8	25	25	0	100	<0.0002	-
R9	26	26	0	100	<0.0002	-
R10	26	26	0	100	<0.0002	-
NF1	5	5	0	100	<0.0002	-
NF2	5	5	0	100	<0.0002	-
X2	28	28	0	100	<0.0002	-
R1	5	5	0	100	<0.0002	-
W8	5	5	0	100	<0.0002	-
X14	58	57	1	98	<0.0002	0.0003
R2	5	5	0	100	<0.0002	-
R3	5	5	0	100	<0.0002	-
R4	5	4	1	80	<0.0002	0.0006
R5	4	3	1	75	<0.0002	0.0005
R11	5	5	0	100	<0.0002	-
V27	5	5	0	100	<0.0002	-
V4	5	5	0	100	<0.0002	-
V5	21	18	3	86	<0.0002	0.0004
V8	26	26	0	100	<0.0002	-
Totals	**269**	**263**	**6**	**98**		
Reference						
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Min**	**Max Detectable**
V1	7	7	0	100	<0.00004	-
FDU	5	5	0	100	<0.0002	-
FC	0	-	-	-	-	-
R7	28	27	1	96	<0.0002	0.0002
W10	4	4	0	100	<0.0002	-
R6	5	5	0	100	<0.0002	-
Totals	**49**	**48**	**1**	**98**		

Table A.72: Summary Statistics for Total Calcium Measured in Water Samples (May 2004 - June 2006)

Exposed or Potentially Disturbed								
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**
FDL	5	0	5	0	3.8	0.9	2.3	4.49
R8	25	0	25	0	28.0	11.5	8.0	45.8
R9	26	0	26	0	30.5	12.1	8.7	46.1
R10	26	0	26	0	31.0	12.8	8.8	51.9
NF1	5	0	5	0	21.0	5.0	13.1	26.1
NF2	5	0	5	0	22.1	3.0	18.2	25.2
X2	28	0	28	0	31.4	13.2	9.7	53.4
R1	5	0	5	0	40.4	14.6	30.0	64.1
W8	5	0	5	0	15.4	3.5	10.4	19.7
X14	58	0	58	0	66.9	44.8	12.6	236
R2	5	0	5	0	79.7	26.6	44.1	107
R3	5	0	5	0	71.3	21.7	44.8	99
R4	5	0	5	0	64.1	12.7	48.0	77.4
R5	4	0	4	0	52.6	19.5	39.4	81.5
R11	5	0	5	0	53.7	18.6	42.7	85.9
V27	5	0	5	0	26.0	14.5	14.3	49.7
V4	5	0	5	0	65.9	23.3	40.0	101
V5	21	0	21	0	61.3	21.2	30.8	95.7
V8	26	0	26	0	69.2	26.5	28.8	120
Totals	**269**	**0**	**269**	**0**				
Reference								
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**
V1	7	0	7	0	11.5	5.7	4.31	18.7
FDU	5	0	5	0	3.4	0.8	2.14	4.11
FC	0	-	-	-	-	-	-	-
R7	28	0	28	0	28.5	10.4	8.41	43.9
W10	4	0	4	0	14.9	4.6	8.92	20
R6	5	0	5	0	51.0	15.3	40.3	77.8
Totals	**49**	**0**	**49**	**0**				

Table A.73: Summary Statistics for Total Chromium Measured in Water Samples (May 2004 - June 2006)

Exposed or Potentially Disturbed								
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**
FDL	5	5	0	100	<0.001	0	<0.001	-
R8	25	25	0	100	<0.001	0	<0.001	-
R9	26	26	0	100	<0.001	0	<0.001	-
R10	26	25	1	96	0.001	0.0002	<0.001	0.002
NF1	5	5	0	100	<0.001	0	<0.001	-
NF2	5	4	1	80	0.001	0.0004	<0.001	0.002
X2	28	27	1	96	0.001	0	<0.001	0.001
R1	5	5	0	100	<0.001	0	<0.001	-
W8	5	5	0	100	<0.001	0	<0.001	-
X14	58	56	2	97	0.001	0.0002	<0.001	0.002
R2	5	5	0	100	<0.001	0	<0.001	-
R3	5	5	0	100	<0.001	0	<0.001	-
R4	5	5	0	100	<0.001	0	<0.001	-
R5	4	4	0	100	<0.001	0	<0.001	-
R11	5	5	0	100	<0.001	0	<0.001	-
V27	5	5	0	100	<0.001	0	<0.001	-
V4	5	5	0	100	<0.001	0	<0.001	-
V5	21	11	10	52	0.003	0.003	<0.001	0.012
V8	26	19	7	73	0.001	0.001	<0.001	0.004
Totals	**269**	**247**	**22**	**92**				
Reference								
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**
V1	7	5	2	71	0.001	0.0002	<0.001	0.001
FDU	5	5	0	100	<0.001	0	<0.001	-
FC	0	-	-	-	-	-	-	-
R7	28	28	0	100	<0.001	0	<0.001	-
W10	4	4	0	100	<0.001	0	<0.001	-
R6	5	4	1	80	0.001	0.0009	<0.001	0.003
Totals	**49**	**46**	**3**	**94**				

Table A.74: Summary Statistics for Conductivity Measured in Water Samples (May 2004 - June 2006)

Exposed or Potentially Disturbed					
Station Name	**n**	**Mean**	**SD**	**Min**	**Max**
FDL	5	35	10	22	50
R8	25	169	70	51	288
R9	26	188	75	56	309
R10	26	189	76	56	311
NF1	5	143	34	92	188
NF2	5	142	35	91	190
X2	28	205	82	61	344
R1	5	231	51	176	285
W8	5	100	19	74	126
X14	57	412	259	90	1330
R2	5	498	184	255	667
R3	5	449	138	251	553
R4	5	383	108	251	489
R5	4	289	70	223	383
R11	5	305	62	245	383
V27	5	196	62	129	285
V4	5	389	111	281	548
V5	21	413	185	172	754
V8	26	487	207	172	784
Totals	**268**				

Reference					
Station Name	**n**	**Mean**	**SD**	**Min**	**Max**
V1	6	74	34	35	121
FDU	5	42	32	19	99
FC	0	-	-	-	-
R7	28	176	66	53	289
W10	4	91	18	62	107
R6	5	291	64	222	382
Totals	**48**				

Table A.75: Summary Statistics for Total Copper Measured in Water Samples (May 2004 - June 2006)

Exposed or Potentially Disturbed								
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**
FDL	5	2	3	40	0.002	0.001	<0.001	0.003
R8	25	19	6	76	0.001	0.001	<0.001	0.004
R9	26	20	6	77	0.001	0.001	<0.001	0.003
R10	26	17	9	65	0.001	0.001	<0.001	0.004
NF1	5	4	1	80	0.001	0.000	<0.001	0.002
NF2	5	4	1	80	0.001	0.000	<0.001	0.001
X2	28	19	9	68	0.001	0.001	<0.001	0.003
R1	5	4	1	80	0.001	0.000	<0.001	0.002
W8	5	1	4	20	0.002	0.001	<0.001	0.003
X14	58	33	25	57	0.001	0.001	<0.001	0.006
R2	5	4	1	80	0.001	0.000	<0.001	0.001
R3	5	4	1	80	0.001	0.000	<0.001	0.001
R4	5	4	1	80	0.001	0.000	<0.001	0.002
R5	4	3	1	75	0.001	0.000	<0.001	0.001
R11	5	4	1	80	0.001	0.000	<0.001	0.001
V27	5	1	4	20	0.002	0.001	<0.001	0.002
V4	5	2	3	40	0.002	0.001	<0.001	0.003
V5	21	5	16	24	0.004	0.004	<0.001	0.018
V8	26	11	15	42	0.004	0.009	<0.001	0.045
Totals	**269**	**161**	**108**	**60**				
Reference								
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**
V1	7	5	2	71	0.001	0.000	<0.001	0.002
FDU	5	4	1	80	0.001	0.000	<0.001	0.001
FC	0	-	-	-	-	-		-
R7	28	24	4	86	0.001	0.001	<0.001	0.005
W10	4	0	4	0	0.001	0.001	0.001	0.002
R6	5	3	2	60	0.001	0.001	<0.001	0.003
Totals	**49**	**36**	**13**	**73**				

Table A.76: Summary Statistics for Hardness Measured in Water Samples (May 2004 - June 2006)

Exposed or Potentially Disturbed					
Station Name	**n**	**Mean**	**SD**	**Min**	**Max**
FDL	5	13	3.0	8	16
R8	25	94	38	27	149
R9	26	102	41	29	157
R10	26	105	43	29	174
NF1	5	72	17	44	87
NF2	5	72	19	40	88
X2	28	109	47	33	187
R1	5	132	43	100	203
W8	5	48	11	32	61
X14	58	228	150	44	793
R2	5	273	89	151	361
R3	5	243	72	153	334
R4	5	218	42	164	258
R5	4	183	60	142	272
R11	5	183	61	147	290
V27	5	101	57	55	192
V4	5	270	99	154	415
V5	21	258	94	126	416
V8	26	284	107	116	449
Totals	**269**				
Reference					
Station Name	**n**	**Mean**	**SD**	**Min**	**Max**
V1	7	36	18	13	59
FDU	5	12	3.0	7	16
FC	0	-	-	-	-
R7	28	95	34	28	143
W10	4	46	14	27	60
R6	5	178	47	146	261
Totals	**49**				

Table A.77: Summary Statistics for Total Iron Measured in Water Samples (May 2004 - June 2006)

Exposed or Potentially Disturbed								
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**
FDL	5	4	1	80	0.06	0.02	<0.05	0.09
R8	25	3	22	12	0.29	0.35	<0.05	1.67
R9	26	4	22	15	0.24	0.31	<0.05	1.47
R10	26	4	22	15	0.25	0.29	<0.05	1.26
NF1	5	0	5	0	0.16	0.08	0.06	0.26
NF2	5	0	5	0	0.11	0.05	0.06	0.19
X2	28	2	26	7	0.24	0.17	<0.05	0.66
R1	5	0	5	0	0.46	0.33	0.18	0.99
W8	5	3	2	60	0.06	0.01	<0.05	0.08
X14	58	0	58	0	0.44	0.48	0.12	3.74
R2	5	0	5	0	0.39	0.10	0.24	0.51
R3	5	1	4	20	0.17	0.12	<0.05	0.32
R4	5	1	4	20	0.12	0.06	<0.05	0.2
R5	4	1	3	25	0.11	0.07	<0.05	0.20
R11	5	1	4	20	0.09	0.04	<0.05	0.15
V27	5	3	2	60	0.10	0.07	<0.05	0.19
V4	5	1	4	20	0.22	0.19	<0.05	0.53
V5	21	0	21	0	1.37	2.12	0.11	8.93
V8	26	5	21	19	0.47	0.67	<0.05	2.77
Totals	**269**	**33**	**236**	**12**				
Reference								
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**
V1	7	4	3	57	0.07	0.04	<0.010	0.14
FDU	5	2	3	40	0.07	0.03	<0.05	0.11
FC	0	-	-	-	-	-	-	-
R7	28	4	24	14	0.26	0.34	<0.05	1.71
W10	4	4	0	100	<0.05	0.00	<0.05	-
R6	5	1	4	20	0.13	0.06	<0.05	0.18
Totals	**49**	**15**	**34**	**31**				

Table A.78: Summary Statistics for Total Lead Measured in Water Samples (May 2004 - June 2006)

Exposed or Potentially Disturbed								
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**
FDL	5	0	5	0	0.006	0.002	0.003	0.009
R8	25	21	4	84	0.001	0.001	<0.001	0.007
R9	26	20	6	77	0.001	0.001	<0.001	0.006
R10	26	22	4	85	0.002	0.002	<0.001	0.009
NF1	5	2	3	40	0.002	0.001	<0.001	0.002
NF2	5	2	3	40	0.001	0.001	<0.001	0.002
X2	28	20	8	71	0.002	0.002	<0.001	0.007
R1	5	5	0	100	<0.001	0	<0.001	-
W8	5	2	3	40	0.002	0.003	<0.001	0.007
X14	58	43	15	74	0.002	0.003	<0.001	0.021
R2	5	0	5	0	0.001	0.000	0.001	0.001
R3	5	0	5	0	0.001	0.000	0.001	0.001
R4	5	4	1	80	0.001	0.000	<0.001	0.001
R5	4	4	0	100	<0.001	0	<0.001	-
R11	5	5	0	100	<0.001	0	<0.001	-
V27	5	2	3	40	0.001	0.001	<0.001	0.002
V4	5	4	1	80	0.001	0.000	<0.001	0.001
V5	21	14	7	67	0.003	0.004	<0.001	0.014
V8	26	20	6	77	0.002	0.002	<0.001	0.007
Totals	**269**	**190**	**79**	**71**				
Reference								
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**
V1	7	7	0	100	<0.001	0	<0.0002	-
FDU	5	0	5	0	0.001	0.000	0.001	0.001
FC	0	-	-	-	-	-	-	-
R7	28	27	1	96	0.001	0.000	<0.001	0.001
W10	4	4	0	100	<0.001	0	<0.001	-
R6	5	5	0	100	<0.001	0	<0.001	-
Totals	**49**	**43**	**6**	**88**				

Table A.79: Summary Statistics for Total Lithium Measured in Water Samples (May 2004 - June 2006)

Exposed or Potentially Disturbed								
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**
FDL	5	0	5	0	0.002	0	0.002	0.002
R8	25	0	25	0	0.005	0.003	0.001	0.01
R9	26	0	26	0	0.005	0.003	0.001	0.009
R10	26	0	26	0	0.005	0.003	0.001	0.01
NF1	5	0	5	0	0.003	0.001	0.002	0.005
NF2	4	0	4	0	0.003	0.001	0.002	0.005
X2	28	0	28	0	0.005	0.003	0.001	0.009
R1	5	1	4	20	0.003	0.002	<0.001	0.005
W8	5	0	5	0	0.002	0.001	0.001	0.003
X14	58	0	58	0	0.007	0.004	0.001	0.019
R2	5	0	5	0	0.007	0.002	0.004	0.01
R3	5	0	5	0	0.006	0.001	0.004	0.008
R4	5	0	5	0	0.005	0.0010	0.004	0.006
R5	4	0	4	0	0.003	0.001	0.002	0.004
R11	5	0	5	0	0.004	0.0010	0.003	0.005
V27	5	1	4	20	0.002	0.0010	<0.001	0.003
V4	5	0	5	0	0.004	0.001	0.002	0.005
V5	21	0	21	0	0.005	0.003	0.003	0.017
V8	26	0	26	0	0.005	0.002	0.002	0.01
Totals	**268**	**2**	**266**	**1**				
Reference								
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**
V1	7	4	3	57	0.001	0.0003	<0.001	0.002
FDU	5	0	5	0	0.002	0	0.002	0.002
FC	0	-	-	-	-	-	-	-
R7	28	0	28	0	0.005	0.003	0.001	0.009
W10	4	1	3	25	0.001	0.0005	<0.001	0.002
R6	5	0	5	0	0.002	0.001	0.001	0.004
Totals	**49**	**5**	**44**	**10**				

Table A.80: Summary Statistics for Total Magnesium Measured in Water Samples (May 2004 - June 2006)

Exposed or Potentially Disturbed								
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**
FDL	5	0	5	0	0.83	0.22	0.48	1.1
R8	25	0	25	0	5.8	2.3	1.6	9.04
R9	26	0	26	0	6.5	2.6	1.77	10
R10	26	0	26	0	6.7	2.7	1.82	11
NF1	5	0	5	0	4.9	1.3	2.7	5.8
NF2	5	0	5	0	5.0	0.9	3.6	6.04
X2	28	0	28	0	7.5	3.4	2.03	13
R1	5	0	5	0	7.5	1.7	5.7	10
W8	5	0	5	0	2.2	0.45	1.51	2.8
X14	58	0	58	0	15	9.4	3.1	50
R2	5	0	5	0	18	5.5	10.0	23
R3	5	0	5	0	16	4.4	9.9	21
R4	5	0	5	0	14	2.5	10.6	16
R5	4	0	4	0	13	2.8	10.6	17
R11	5	0	5	0	12	3.6	9.7	18
V27	5	0	5	0	8.8	5.0	4.37	16
V4	5	0	5	0	26	9.9	13.1	40
V5	21	0	21	0	26	10	11.8	43
V8	26	0	26	0	27	11	10.6	42
Totals	**269**	**0**	**269**	**0**				
Reference								
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**
V1	7	0	7	0	1.8	1.0	0.64	2.89
FDU	5	0	5	0	0.81	0.32	0.43	1.31
FC	0	-	-	-	-	-	-	-
R7	28	0	28	0	5.9	2.1	1.62	8.7
W10	4	0	4	0	2.0	0.60	1.2	2.5
R6	5	0	5	0	12	2.1	11	16
Totals	**49**	**0**	**49**	**0**				

Table A.81: Summary Statistics for Total Manganese Measured in Water Samples (May 2004 - June 2006)

Exposed or Potentially Disturbed								
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**
FDL	5	0	5	0	0.018	0.021	0.002	0.052
R8	25	0	25	0	0.029	0.032	0.008	0.16
R9	26	0	26	0	0.026	0.025	0.012	0.13
R10	26	0	26	0	0.033	0.039	0.013	0.18
NF1	5	0	5	0	0.038	0.009	0.029	0.05
NF2	5	0	5	0	0.020	0.008	0.011	0.033
X2	28	0	28	0	0.07	0.05	0.016	0.21
R1	5	0	5	0	0.151	0.143	0.026	0.38
W8	5	1	4	20	0.009	0.012	<0.001	0.03
X14	58	0	58	0	1.37	2.08	0.130	11.2
R2	5	0	5	0	1.370	0.700	0.500	2.12
R3	5	0	5	0	0.530	0.380	0.076	1.11
R4	5	0	5	0	0.210	0.210	0.017	0.47
R5	4	0	4	0	0.036	0.029	0.014	0.077
R11	5	0	5	0	0.023	0.021	0.006	0.059
V27	5	0	5	0	0.011	0.007	0.008	0.02
V4	5	0	5	0	0.028	0.011	0.017	0.041
V5	21	0	21	0	0.055	0.078	0.007	0.34
V8	26	0	26	0	0.060	0.089	0.013	0.38
Totals	**269**	**1**	**268**	**0**				
Reference								
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**
V1	7	3	4	43	0.002	0.002	<0.001	0.005
FDU	5	0	5	0	0.009	0.012	0.001	0.028
FC	0	-	-	-	-	-	-	-
R7	28	0	28	0	0.031	0.044	0.005	0.19
W10	4	3	1	75	0.005	0.007	<0.001	0.015
R6	5	0	5	0	0.014	0.003	0.011	0.018
Totals	**49**	**6**	**43**	**12**				

Table A.82: Summary Statistics for Total Mercury Measured in Water Samples (May 2004 - June 2006)

Exposed or Potentially Disturbed						
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Min**	**Max Detectable**
FDL	5	5	0	100	<0.00002	-
R8	25	25	0	100	<0.00002	-
R9	26	26	0	100	<0.00002	-
R10	26	26	0	100	<0.00002	-
NF1	5	5	0	100	<0.00002	-
NF2	5	5	0	100	<0.00002	-
X2	28	28	0	100	<0.00002	-
R1	5	5	0	100	<0.00002	-
W8	5	5	0	100	<0.00002	-
X14	59	58	1	98	<0.00002	0.00002
R2	5	5	0	100	<0.00002	-
R3	5	5	0	100	<0.00002	-
R4	5	4	1	80	<0.00002	0.00002
R5	4	4	0	100	<0.00002	-
R11	5	5	0	100	<0.00002	-
V27	5	5	0	100	<0.00002	-
V4	0	-	-	-	-	-
V5	21	21	0	100	<0.00002	-
V8	26	26	0	100	<0.00002	-
Totals	**265**	**263**	**2**	**99**		
Reference						
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Min**	**Max Detectable**
V1	7	7	0	100	<0.00002	-
FDU	5	5	0	100	<0.00002	-
FC	0	-	-	-	-	-
R7	28	28	0	100	<0.00002	-
W10	4	4	0	100	<0.00002	-
R6	5	5	0	100	<0.00002	-
Totals	**49**	**49**	**0**	**100**		

Table A.83: Summary Statistics for Total Molybdenum Measured in Water Samples (May 2004 - June 2006)

Exposed or Potentially Disturbed								
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**
FDL	5	5	0	100	<0.0005	-	<0.0005	-
R8	25	12	13	48	0.0006	0.0002	<0.0005	0.009
R9	26	13	13	50	0.0006	0.0001	<0.0005	0.009
R10	26	13	13	50	0.0006	0.0002	<0.0005	0.017
NF1	5	5	0	100	<0.0005	-	<0.0005	-
NF2	5	5	0	100	<0.001	-	<0.0005	-
X2	28	15	13	54	0.0006	0.0001	<0.0005	0.0009
R1	5	4	1	80	0.0005	0.00004	<0.0005	0.0006
W8	5	5	0	100	<0.0005	-	<0.0005	-
X14	58	21	37	36	0.0006	0.0002	<0.0005	0.0014
R2	5	1	4	20	0.0007	0.0002	<0.0005	0.0009
R3	5	1	4	20	0.0006	0.0001	<0.0005	0.0008
R4	5	0	5	0	0.0008	0.0002	0.0006	0.0047
R5	4	0	4	0	0.0012	0.0002	0.0009	0.0051
R11	5	0	5	0	0.0011	0.0002	0.0009	0.0013
V27	5	4	1	80	0.0005	0.00004	<0.0005	0.0006
V4	5	0	5	0	0.0009	0.0003	0.0006	0.0014
V5	21	0	21	0	0.0013	0.0005	0.0006	0.0024
V8	26	4	22	15	0.0008	0.0003	<0.0005	0.0015
Totals	**269**	**108**	**161**	**40**				
Reference								
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**
V1	7	4	3	57	0.0005	0.5761	<0.0001	0.0007
FDU	5	5	0	100	<0.0005	-	<0.0005	-
FC	0	-	-	-	-	-	-	-
R7	28	12	16	43	0.001	0.0001	<0.0005	0.0009
W10	4	4	0	100	<0.0005	-	<0.0005	-
R6	5	0	5	0	0.001	0.0002	0.001	0.0014
Totals	**49**	**25**	**24**	**51**				

Table A.84: Summary Statistics for Total Nickel Measured in Water Samples (May 2004 - June 2006)

Exposed or Potentially Disturbed								
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**
FDL	5	5	0	100	<0.001	-	<0.001	-
R8	25	21	4	84	0.001	0.0002	<0.001	0.002
R9	26	23	3	88	0.001	0.0002	<0.001	0.002
R10	26	22	4	85	0.001	0.0004	<0.001	0.003
NF1	5	5	0	100	<0.001	-	<0.001	-
NF2	5	5	0	100	<0.001	-	<0.001	-
X2	28	16	12	57	0.001	0.0004	<0.001	0.002
R1	5	4	1	80	0.007	0.0130	<0.001	0.031
W8	5	4	1	80	0.001	0.0000	<0.001	0.001
X14	58	3	55	5	0.003	0.0040	<0.001	0.022
R2	5	0	5	0	0.003	0.0010	0.002	0.005
R3	5	1	4	20	0.002	0.0010	<0.001	0.004
R4	5	2	3	40	0.001	0.0004	<0.001	0.002
R5	4	4	0	100	<0.001	-	<0.001	-
R11	5	4	1	80	0.001	0	<0.001	0.001
V27	5	3	2	60	0.001	0	<0.001	0.001
V4	5	2	3	40	0.001	0.0004	<0.001	0.002
V5	21	0	21	0	0.005	0.0050	0.001	0.022
V8	26	2	24	8	0.003	0.0020	<0.001	0.008
Totals	**269**	**126**	**143**	**47**				
Reference								
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**
V1	7	6	1	86	0.001	0.0003	<0.001	0.0003
FDU	5	5	0	100	<0.001	-	<0.001	-
FC	0	-	-	-	-	-	-	-
R7	28	22	6	79	0.001	0.0002	<0.001	0.002
W10	4	4	0	100	<0.001	-	<0.001	-
R6	5	4	1	80	0.001	0.0004	<0.001	0.002
Totals	**49**	**41**	**8**	**84**				

Table A.85: Summary Statistics for pH Measured in Water Samples (May 2004 - June 2006)

Exposed or Potentially Disturbed					
Station Name	**n**	**Mean**	**SD**	**Min**	**Max**
FDL	5	7.38	0.36	7.00	7.80
R8	23	7.69	0.30	7.10	8.20
R9	24	7.64	0.28	7.00	8.10
R10	24	7.69	0.27	7.20	8.10
NF1	4	7.73	0.13	7.60	7.90
NF2	3	7.67	0.21	7.50	7.90
X2	26	7.63	0.22	7.20	8.00
R1	5	7.69	0.43	7.00	8.12
W8	5	7.44	0.27	7.00	7.70
X14	47	7.92	0.23	7.30	8.40
R2	5	7.69	0.32	7.20	8.04
R3	5	7.92	0.37	7.40	8.27
R4	5	7.95	0.32	7.60	8.34
R5	4	8.16	0.45	7.50	8.48
R11	5	7.91	0.46	7.40	8.40
V27	2	8.15	0.07	8.10	8.20
V4	2	8.35	0.07	8.30	8.40
V5	19	8.17	0.26	7.50	8.60
V8	24	8.11	0.27	7.30	8.60
Totals	**237**				
Reference					
Station Name	**n**	**Mean**	**SD**	**Min**	**Max**
V1	5	7.90	0.51	7.00	8.30
FDU	5	7.54	0.35	7.10	7.90
FC	-	-	-	-	-
R7	26	7.78	0.31	7.00	8.20
W10	4	7.78	0.19	7.50	7.90
R6	5	8.03	0.36	7.50	8.43
Totals	**45**				

Table A.86: Summary Statistics for Total Potassium Measured in Water Samples (May 2004-June2006)

Exposed or Potentially Disturbed								
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**
FDL	5	0	5	0	0.22	0.08	0.1	0.3
R8	25	0	25	0	0.87	0.43	0.4	2.1
R9	26	0	26	0	0.90	0.39	0.4	2
R10	26	0	26	0	0.94	0.41	0.4	2
NF1	5	0	5	0	0.60	0.07	0.5	0.7
NF2	5	0	5	0	0.60	0.07	0.5	0.7
X2	28	0	28	0	0.90	0.37	0.4	1.7
R1	5	0	5	0	1.16	0.48	0.8	1.9
W8	5	0	5	0	0.70	0.16	0.5	0.9
X14	58	0	58	0	1.79	0.94	0.6	4.9
R2	5	0	5	0	2.02	0.52	1.3	2.6
R3	5	0	5	0	1.80	0.41	1.3	2.3
R4	5	0	5	0	1.68	0.28	1.4	2
R5	4	0	4	0	1.38	0.44	1.0	2
R11	5	0	5	0	1.66	0.40	1.2	2.3
V27	5	0	5	0	0.68	0.13	0.5	0.8
V4	5	0	5	0	1.02	0.23	0.8	1.4
V5	21	0	21	0	1.21	0.37	0.8	2.3
V8	26	0	26	0	1.16	0.27	0.7	1.6
Totals	**269**	**0**	**269**	**0**				
Reference								
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**
V1	7	0	7	0	0.64	0.38	0.30	1.4
FDU	5	1	4	20	0.22	0.08	<0.1	0.3
FC	0	-	-	-	-	-	-	-
R7	28	0	28	0	0.84	0.40	0.4	2.1
W10	4	0	4	0	0.50	0.08	0.4	0.6
R6	5	0	5	0	1.36	0.34	1	1.9
Totals	**49**	**1**	**48**	**2**				

Table A.87: Summary Statistics for Total Selenium Measured in Water Samples (May 2004 - June 2006)

Exposed or Potentially Disturbed						
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Min**	**Max Detectable**
FDL	5	5	0	100	<0.001	-
R8	25	23	2	92	<0.001	0.003
R9	26	23	3	88	<0.001	0.002
R10	26	24	2	92	<0.001	0.002
NF1	5	5	0	100	<0.001	-
NF2	5	5	0	100	<0.001	-
X2	28	28	0	100	<0.001	-
R1	5	4	1	80	<0.001	0.001
W8	5	5	0	100	<0.001	-
X14	58	54	4	93	<0.001	0.002
R2	5	4	1	80	<0.001	0.001
R3	5	4	1	80	<0.001	0.002
R4	5	4	1	80	<0.001	0.002
R5	4	3	1	75	<0.001	0.001
R11	5	4	1	80	<0.001	0.002
V27	5	5	0	100	<0.001	-
V4	5	5	0	100	<0.001	-
V5	21	14	7	67	<0.001	0.003
V8	26	18	8	69	<0.001	0.002
Totals	**269**	**237**	**32**	**88**		
Reference						
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Min**	**Max Detectable**
V1	7	6	1	86	<0.0002	0.011
FDU	5	5	0	100	<0.001	-
FC	0	-	-	-	-	-
R7	28	26	2	93	<0.001	0.002
W10	4	4	0	100	<0.001	-
R6	5	4	1	80	<0.001	0.002
Totals	**49**	**45**	**4**	**92**		

Table A.88: Summary Statistics for Total Silicon Measured in Water Samples (May 2004 - June 2006)

Exposed or Potentially Disturbed								
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**
FDL	5	0	5	0	12.6	5.1	3.7	16.2
R8	25	0	25	0	9.7	4.1	2.5	20.2
R9	26	0	26	0	9.3	4.0	2.6	20.6
R10	26	0	26	0	9.4	3.9	2.5	18.5
NF1	5	0	5	0	8.6	2.8	3.7	10.8
NF2	4	0	4	0	9.9	0.54	9.3	10.6
X2	28	0	28	0	8.7	3.8	2.3	17.7
R1	5	0	5	0	9.5	3.2	5.4	13.7
W8	5	0	5	0	11.3	4.9	4.8	15.9
X14	58	0	58	0	8.5	3.4	2.2	19.9
R2	5	0	5	0	9.5	2.7	6.2	13.6
R3	5	0	5	0	9.1	2.3	5.8	12.2
R4	5	0	5	0	8.7	2.3	5.5	11.9
R5	4	0	4	0	10.1	1.6	8.6	12.4
R11	5	0	5	0	9.0	3.0	5.5	13.8
V27	5	0	5	0	8.4	3.5	2.8	12.3
V4	5	0	5	0	9.9	3.9	3.2	13.3
V5	21	0	21	0	10.7	3.8	5.6	22.2
V8	26	0	26	0	8.4	2.7	4.1	14.5
Totals	**268**	**0**	**268**	**0**				
Reference								
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**
V1	7	0	7	0	6.9	3.0	2.4	10.7
FDU	5	0	5	0	12.3	4.9	3.7	15.8
FC	0	-	-	-	-	-	-	-
R7	28	0	28	0	9.2	3.7	2.4	18.5
W10	4	0	4	0	12.6	5.3	4.7	16.0
R6	5	0	5	0	9.4	2.7	5.4	12.8
Totals	**49**	**0**	**49**	**0**				

Table A.89: Summary Statistics for Total Silver Measured in Water Samples (May 2004 - June 2006)

Exposed or Potentially Disturbed						
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Min**	**Max Detectable**
FDL	5	5	0	100	<0.00025	-
R8	25	25	0	100	<0.00025	-
R9	26	26	0	100	<0.00025	-
R10	26	25	1	96	<0.00025	0.0029
NF1	5	5	0	100	<0.00025	-
NF2	5	5	0	100	<0.00025	-
X2	28	28	0	100	<0.00025	-
R1	5	4	1	80	<0.00025	0.0008
W8	5	5	0	100	<0.00025	-
X14	59	57	2	97	<0.00025	0.003
R2	5	4	1	80	<0.00025	0.0004
R3	5	4	1	80	<0.00025	0.0006
R4	5	4	1	80	<0.00025	0.0006
R5	4	3	1	75	<0.00025	0.0006
R11	5	4	1	80	<0.00025	0.0009
V27	5	5	0	100	<0.00025	-
V4	5	5	0	100	<0.00025	-
V5	21	20	1	95	<0.00025	0.0004
V8	26	26	0	100	<0.00025	-
Totals	**270**	**260**	**10**	**96**		
Reference						
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Min**	**Max Detectable**
V1	7	7	0	100	<0.00005	-
FDU	5	5	0	100	<0.00025	-
FC	0	-	-	-	-	-
R7	28	27	1	96	<0.00025	0.0004
W10	4	4	0	100	<0.00025	-
R6	5	4	1	80	<0.00025	0.0017
Totals	**49**	**47**	**2**	**96**		

Table A.90: Summary Statistics for Total Sodium Measured in Water Samples (May 2004 - June 2006)

Exposed or Potentially Disturbed								
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**
FDL	5	0	5	0	1.72	0.40	1.03	2.0
R8	25	0	25	0	2.33	0.96	0.80	3.9
R9	26	0	26	0	2.39	0.95	0.82	4.0
R10	26	0	26	0	2.48	1.04	0.80	4.2
NF1	5	0	5	0	1.80	0.38	1.25	2.2
NF2	5	0	5	0	1.76	0.60	0.80	2.3
X2	28	0	28	0	2.55	0.95	0.90	4.31
R1	5	0	5	0	2.95	0.90	1.72	4.15
W8	5	0	5	0	1.80	0.30	1.30	2.02
X14	58	0	58	0	6.8	5.3	1.29	27.7
R2	5	0	5	0	8.07	2.98	4.38	10.6
R3	5	0	5	0	6.67	2.19	4.20	8.7
R4	5	0	5	0	5.31	1.21	3.95	6.73
R5	4	0	4	0	2.93	1.89	1.78	5.75
R11	5	0	5	0	3.87	1.50	2.33	6.3
V27	5	0	5	0	2.03	0.83	1.22	3.31
V4	5	0	5	0	2.67	1.00	1.39	4.03
V5	21	0	21	0	3.43	1.17	1.43	5.37
V8	26	0	26	0	3.53	1.23	1.50	5.31
Totals	**269**	**0**	**269**	**0**				
Reference								
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**
V1	7	0	7	0	1.87	0.58	0.87	2.71
FDU	5	0	5	0	1.64	0.33	1.07	1.92
FC	0	-	-	-	-	-	-	-
R7	28	0	28	0	2.31	0.87	0.77	3.76
W10	4	0	4	0	1.75	0.34	1.26	1.98
R6	5	0	5	0	2.66	1.63	1.41	5.5
Totals	**49**	**0**	**49**	**0**				

Table A.91: Summary Statistics for Total Strontium Measured in Water Samples (May 2004 - June 2006)

Exposed or Potentially Disturbed								
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**
FDL	5	0	5	0	0.023	0.005	0.014	0.028
R8	25	0	25	0	0.114	0.049	0.035	0.19
R9	26	0	26	0	0.126	0.052	0.039	0.2
R10	26	0	26	0	0.128	0.054	0.039	0.22
NF1	5	0	5	0	0.087	0.025	0.051	0.11
NF2	5	0	5	0	0.085	0.022	0.052	0.11
X2	28	0	28	0	0.130	0.057	0.042	0.23
R1	5	0	5	0	0.194	0.082	0.120	0.32
W8	5	0	5	0	0.052	0.012	0.033	0.066
X14	58	0	58	0	0.227	0.125	0.050	0.63
R2	5	0	5	0	0.276	0.077	0.170	0.37
R3	5	0	5	0	0.246	0.063	0.170	0.33
R4	5	0	5	0	0.220	0.028	0.180	0.24
R5	4	0	4	0	0.158	0.069	0.110	0.26
R11	5	0	5	0	0.172	0.061	0.140	0.28
V27	5	0	5	0	0.101	0.061	0.052	0.2
V4	5	0	5	0	0.270	0.111	0.14	0.43
V5	21	0	21	0	0.247	0.085	0.12	0.38
V8	26	0	26	0	0.283	0.110	0.110	0.48
Totals	**269**	**0**	**269**	**0**				
Reference								
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**
V1	7	0	7	0	0.058	0.031	0.022	0.11
FDU	5	0	5	0	0.020	0.005	0.013	0.026
FC	0	-	-	-	-	-	-	-
R7	28	0	28	0	0.114	0.044	0.035	0.19
W10	4	0	4	0	0.048	0.015	0.027	0.063
R6	5	0	5	0	0.150	0.057	0.110	0.250
Totals	**49**	**0**	**49**	**0**				

Table A.92: Summary Statistics for Sulphate Measured in Water Samples (May 2004 - June 2006)

Exposed or Potentially Disturbed								
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**
FDL	5	0	5	0	2.5	0.86	1.7	3.9
R8	24	0	24	0	7.4	2.5	2	11
R9	25	0	25	0	13	5.4	2.7	21
R10	26	0	26	0	13	5.4	2.7	21
NF1	5	0	5	0	10.0	3.2	5.9	14
NF2	5	0	5	0	11.0	4.1	5.5	15
X2	27	0	27	0	21	11	4	40
R1	5	0	5	0	23	6.1	17	30
W8	4	0	4	0	5.2	1.2	4.2	6.9
X14	54	0	54	0	132	116	17	557
R2	5	0	5	0	154	72	58	240
R3	5	0	5	0	119	50	49	180
R4	5	0	5	0	98	39	54	148
R5	4	0	4	0	39	28	21	80
R11	5	0	5	0	53	19	36	82
V27	5	0	5	0	50	26	25	88
V4	5	0	5	0	38	12	23	51
V5	20	0	20	0	84	45	28	174
V8	25	0	25	0	141	77	33	327
Totals	**259**	**0**	**259**	**0**				
Reference								
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**
V1	7	0	7	0	8.8	3.2	3.62	10.9
FDU	5	0	5	0	2.5	1.9	1.13	5.8
FC	0	-	-	-	-	-	-	-
R7	27	0	27	0	7.9	3.1	1.7	16.9
W10	4	0	4	0	3.5	0.5	3	4.2
R6	5	0	5	0	33	27	19.3	80.1
Totals	**48**	**0**	**48**	**0**				

Table A.93: Summary Statistics for Total Suspended Solids (TSS) Measured in Water Samples (May 2004 - June 2006)

Exposed or Potentially Disturbed								
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**
FDL	5	4	1	80	1.2	0.5	<1	2
R8	26	17	9	65	3.6	7	<1	31
R9	26	19	7	73	3.5	6.3	<1	25
R10	26	19	7	73	3.2	5.5	<1	21
NF1	5	0	5	0	2.8	2.5	<1	7
NF2	5	2	3	40	1.8	1.1	<1	3
X2	28	16	12	57	2.3	2.4	<1	9
R1	5	2	3	40	1.2	0.5	<1	2
W8	5	4	1	80	1.0	0.0	<1	1
X14	58	24	34	41	5	13	<1	82
R2	5	1	4	20	2.2	0.8	<1	4
R3	5	4	1	80	1.2	0.5	<1	2
R4	5	3	2	60	1.4	0.9	<1	3
R5	4	2	2	50	2.0	1.2	<1	3
R11	5	2	3	40	2.0	1.4	<1	4
V27	5	2	3	40	2	1	<1	3
V4	5	3	2	60	4	5	<1	13
V5	21	1	20	5	38	58	<1	198
V8	26	12	14	46	12	22	<1	84
Totals	**270**	**137**	**133**	**51**				
Reference								
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**
V1	7	5	2	71	1.3	0.8	<1	3
FDU	5	4	1	80	1.0	0.0	<1	1
FC	0	-	-	-	-	-	-	-
R7	28	21	7	75	3	6	<1	26
W10	4	3	1	75	1.0	0.0	<1	1
R6	5	4	1	80	1.2	0.5	<1	2
Totals	**49**	**37**	**12**	**76**				

Table A.94: Summary Statistics for Total Thallium Measured in Water Samples (May 2004 - June 2006)

Exposed or Potentially Disturbed						
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Min**	**Max Detectable**
FDL	5	5	0	100	<0.0001	-
R8	25	25	0	100	<0.0001	-
R9	26	26	0	100	<0.0001	-
R10	26	26	0	100	<0.0001	-
NF1	5	5	0	100	<0.0001	-
NF2	5	5	0	100	<0.0001	-
X2	28	28	0	100	<0.0001	-
R1	5	5	0	100	<0.0001	-
W8	5	5	0	100	<0.0001	-
X14	58	56	2	97	<0.0001	0.0005
R2	5	5	0	100	<0.0001	-
R3	5	5	0	100	<0.0001	-
R4	5	5	0	100	<0.0001	-
R5	4	4	0	100	<0.0001	-
R11	5	5	0	100	<0.0001	-
V27	5	5	0	100	<0.0001	-
V4	5	5	0	100	<0.0001	-
V5	21	21	0	100	<0.0001	-
V8	26	26	0	100	<0.0001	-
Totals	**269**	**267**	**2**	**99**		
Reference						
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Min**	**Max Detectable**
V1	7	7	0	100	<0.00002	-
FDU	5	5	0	100	<0.0001	-
FC	0	-	-	-	-	-
R7	28	28	0	100	<0.0001	-
W10	4	4	0	100	<0.0001	-
R6	5	5	0	100	<0.0001	-
Totals	**49**	**49**	**0**	**100**		

Table A.95: Summary Statistics for Total Titanium Measured in Water Samples (May 2004 - June 2006)

Exposed or Potentially Disturbed								
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**
FDL	5	0	5	0	0.002	0.001	0.001	0.003
R8	25	12	13	48	0.003	0.005	<0.001	0.023
R9	26	15	11	58	0.003	0.004	<0.001	0.018
R10	26	15	11	58	0.002	0.003	<0.001	0.015
NF1	5	2	3	40	0.002	0.001	<0.001	0.004
NF2	5	1	4	20	0.002	0.002	<0.001	0.005
X2	28	19	9	68	0.002	0.002	<0.001	0.008
R1	5	4	1	80	0.001	0.000	<0.001	0.002
W8	5	4	1	80	0.001	0.000	<0.001	0.002
X14	58	31	27	53	0.002	0.004	<0.001	0.029
R2	5	2	3	40	0.001	0	<0.001	0.001
R3	5	5	0	100	<0.001	-	<0.001	-
R4	5	5	0	100	<0.001	-	<0.001	-
R5	4	4	0	100	<0.001	-	<0.001	-
R11	5	1	4	20	0.002	0.001	<0.001	0.002
V27	5	0	5	0	0.001	0.001	0.001	0.003
V4	5	1	4	20	0.002	0.002	<0.001	0.005
V5	21	2	19	10	0.019	0.029	<0.001	0.12
V8	26	13	13	50	0.006	0.009	<0.001	0.037
Totals	**269**	**136**	**133**	**51**				
Reference								
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**
V1	7	3	4	43	0.001	0.001	<0.001	0.003
FDU	5	4	1	80	0.001	0	<0.001	0.001
FC	0	-	-	-	-	-		-
R7	28	17	11	61	0.002	0.004	<0.001	0.022
W10	4	2	2	50	0.002	0.001	<0.001	0.002
R6	5	4	1	80	0.001	0	<0.001	0.001
Totals	**49**	**30**	**19**	**61**				

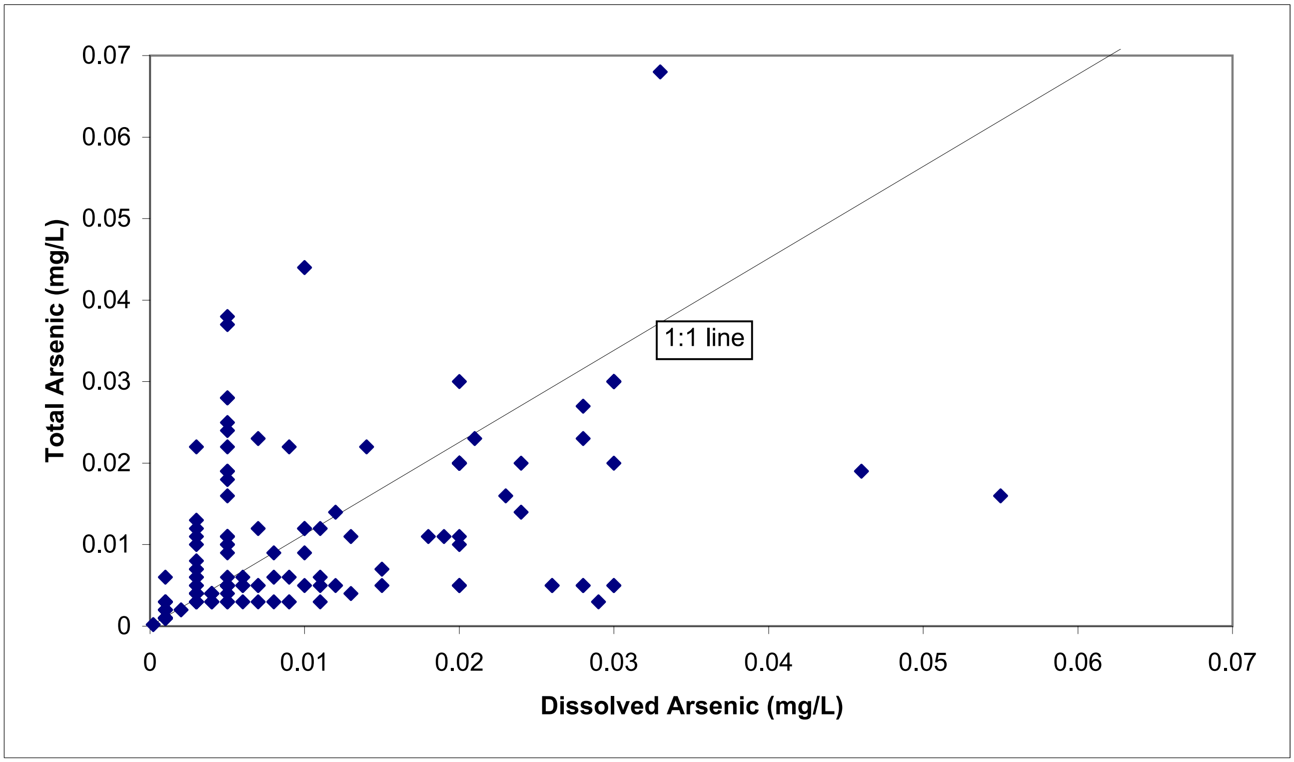
Table A.96: Summary Statistics for Total Uranium Measured in Water Samples (May 2004 - June 2006)

Exposed or Potentially Disturbed								
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**
FDL	5	5	0	100	<0.0005	-	<0.0005	-
R8	25	4	21	16	0.0013	0.0007	<0.0005	0.0025
R9	26	4	22	15	0.0015	0.0008	<0.0005	0.0027
R10	26	4	22	15	0.0015	0.0008	<0.0005	0.0029
NF1	5	1	4	20	0.0008	0.0003	<0.0005	0.0012
NF2	4	0	4	0	0.0009	0.0002	0.0008	0.0012
X2	28	4	24	14	0.0014	0.0008	<0.0005	0.0028
R1	5	0	5	0	0.0019	0.0008	0.0013	0.003
W8	5	5	0	100	<0.0005	-	<0.0005	-
X14	58	2	56	3	0.0015	0.0010	<0.0005	0.0043
R2	5	0	5	0	0.0022	0.0009	0.0015	0.0033
R3	5	0	5	0	0.0019	0.0007	0.0014	0.0028
R4	5	0	5	0	0.0019	0.0007	0.0014	0.003
R5	4	0	4	0	0.0020	0.0008	0.0015	0.0032
R11	5	0	5	0	0.0020	0.0008	0.0014	0.0032
V27	5	0	5	0	0.0013	0.0006	0.0009	0.0022
V4	5	0	5	0	0.0056	0.0019	0.0033	0.0083
V5	21	0	21	0	0.0031	0.0014	0.0011	0.0054
V8	26	0	26	0	0.0044	0.0024	0.0013	0.0082
Totals	**268**	**29**	**239**	**11**				
Reference								
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**
V1	7	3	4	43	0.0007	0.0004	<0.0005	0.0014
FDU	5	5	0	100	<0.0005	-	<0.0005	-
FC	0	-	-	-	-	-	-	-
R7	28	4	24	14	0.0013	0.0006	<0.0005	0.0024
W10	4	4	0	100	<0.0005	-	<0.0005	-
R6	5	0	5	0	0.0021	0.0006	0.0016	0.0031
Totals	**49**	**16**	**33**	**33**				

Table A.97: Summary Statistics for Total Zinc Measured in Water Samples (May 2004 - June 2006)

Exposed or Potentially Disturbed								
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**
FDL	5	0	5	0	0.081	0.083	0.007	0.18
R8	25	16	9	64	0.009	0.009	<0.005	0.043
R9	26	14	12	54	0.008	0.004	<0.005	0.019
R10	26	4	22	15	0.011	0.007	<0.005	0.028
NF1	5	0	5	0	0.040	0.044	0.009	0.11
NF2	5	0	5	0	0.028	0.029	0.007	0.073
X2	28	0	28	0	0.034	0.028	0.007	0.14
R1	5	2	3	40	0.009	0.004	<0.005	0.013
W8	5	0	5	0	0.071	0.102	0.009	0.25
X14	58	0	58	0	0.050	0.046	0.010	0.25
R2	5	0	5	0	0.039	0.018	0.018	0.058
R3	5	0	5	0	0.023	0.013	0.010	0.039
R4	5	1	4	20	0.011	0.008	<0.005	0.025
R5	4	2	2	50	0.006	0.002	<0.005	0.008
R11	5	3	2	60	0.006	0.001	<0.005	0.008
V27	5	0	5	0	0.038	0.029	0.017	0.088
V4	5	1	4	20	0.014	0.018	<0.005	0.046
V5	21	8	13	38	0.014	0.012	<0.005	0.053
V8	26	0	26	0	0.017	0.008	0.007	0.037
Totals	**269**	**51**	**218**	**19**				
Reference								
Station Name	**n**	**<MDL**	**>MDL**	**%<MDL**	**Mean**	**SD**	**Min**	**Max Detectable**
V1	7	3	4	43	0.010	0.013	<0.005	0.038
FDU	5	2	3	40	0.095	0.123	<0.005	0.23
FC	0	-	-	-	-	-	-	-
R7	28	16	12	57	0.019	0.041	<0.005	0.18
W10	4	2	2	50	0.027	0.043	<0.005	0.091
R6	5	3	2	60	0.005	0.001	<0.005	0.006
Totals	**49**	**26**	**23**	**53**				

a) Arsenic



b) Cadmium

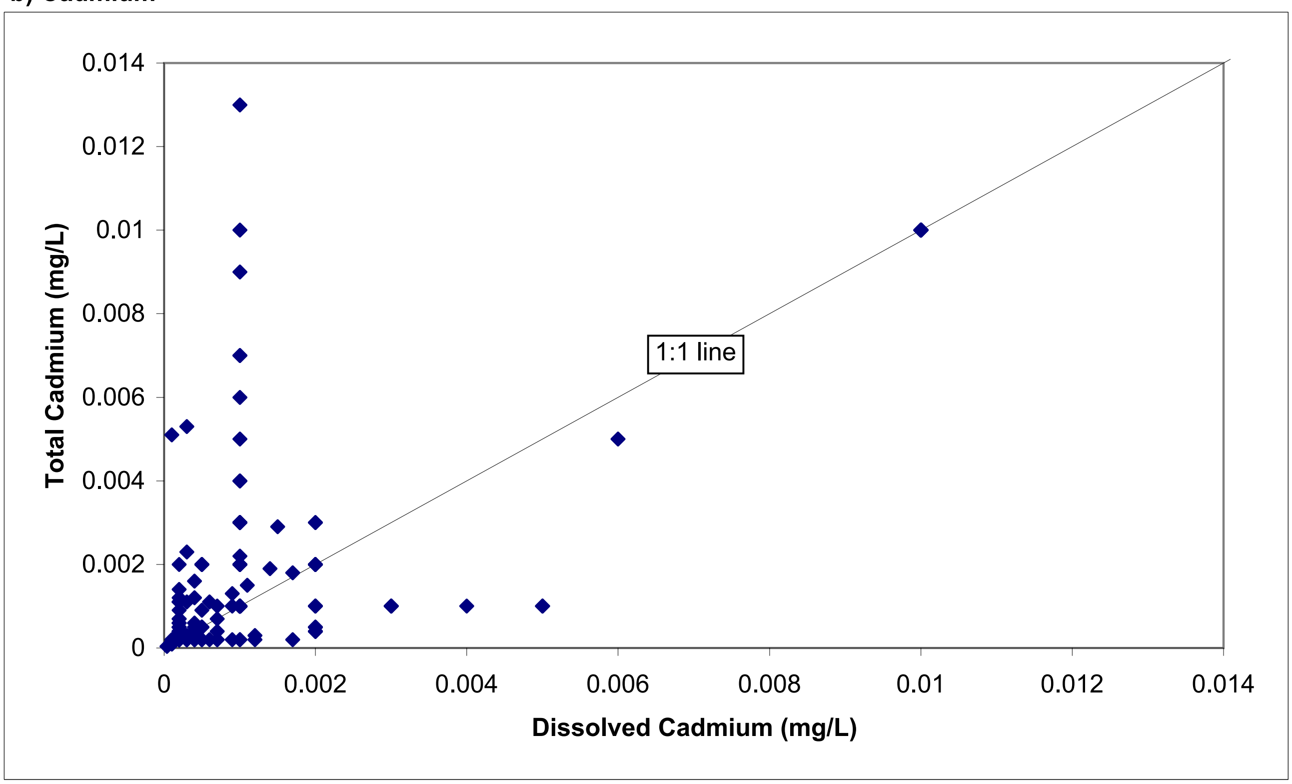
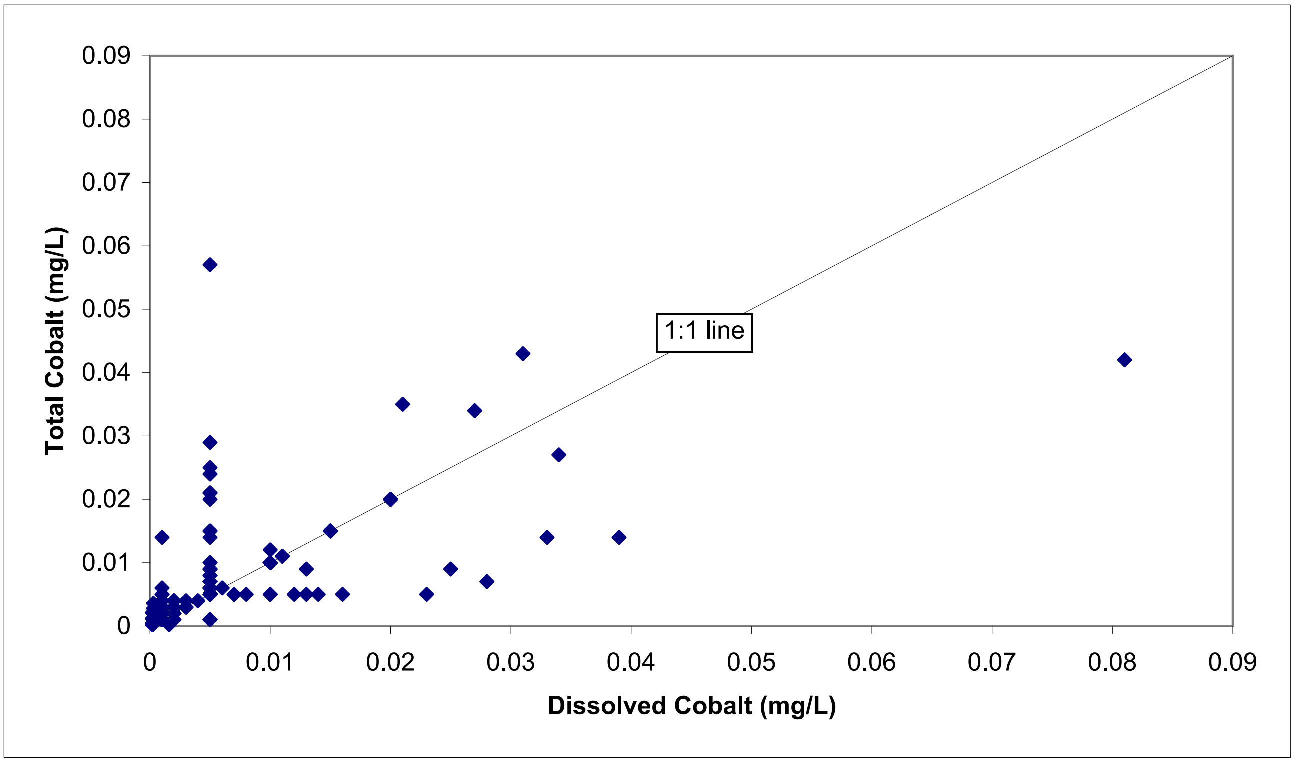


Figure A.1: Comparison of dissolved versus total concentrations of select metals in water samples

c) Cobalt



d) Copper

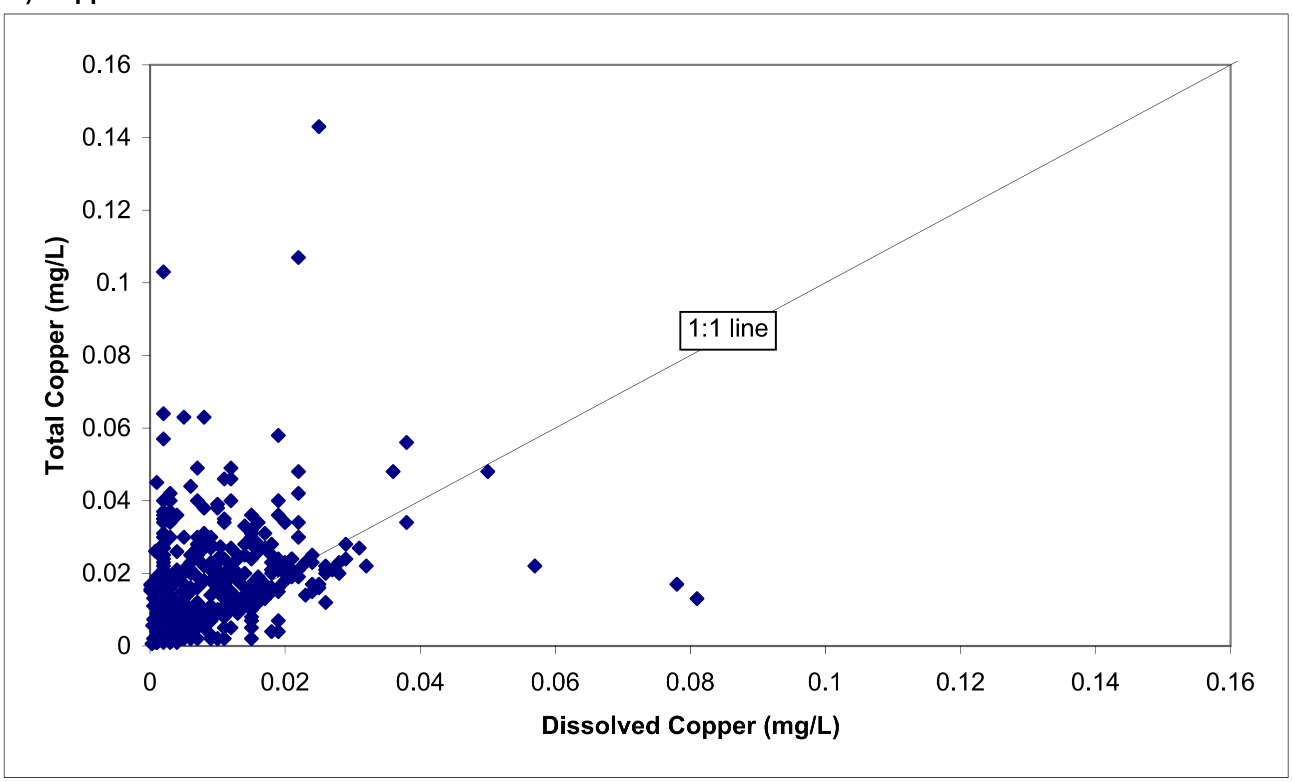
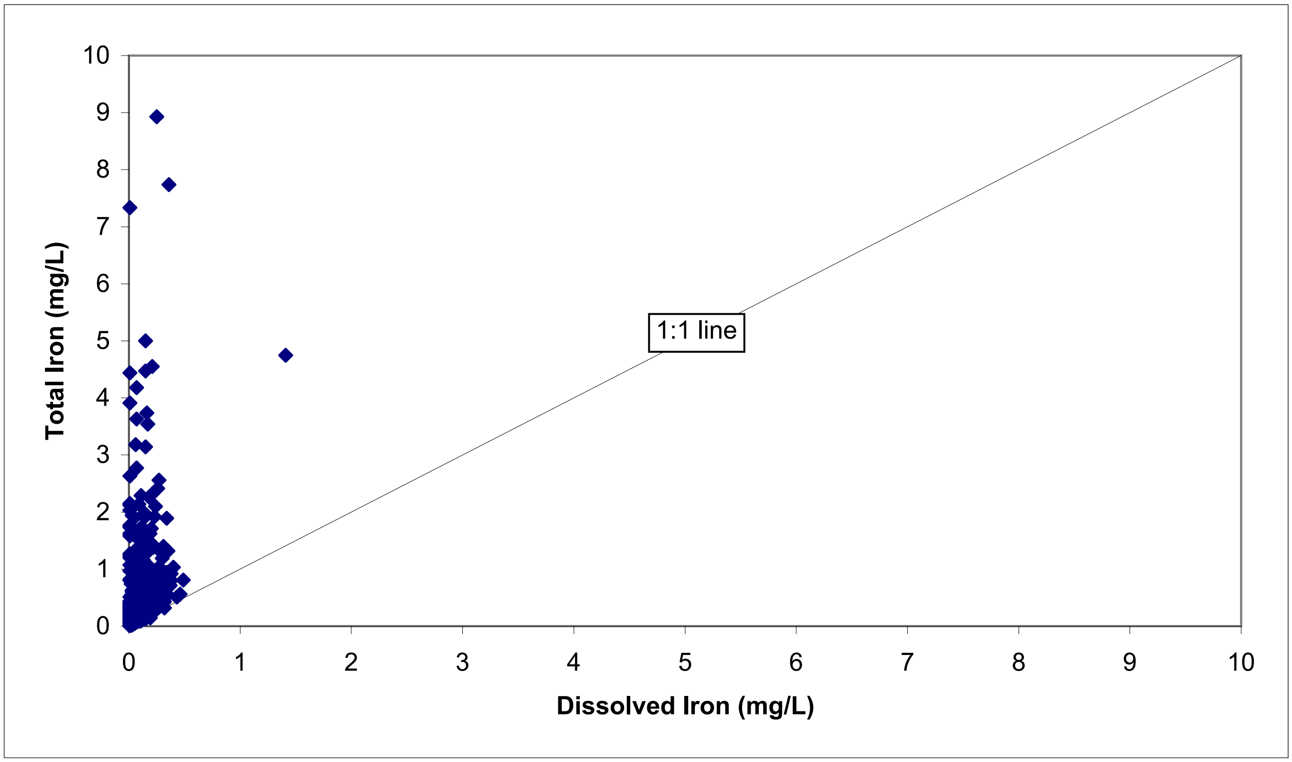


Figure A.1: Comparison of dissolved versus total concentrations of select metals in water samples

e) Iron



f) Lead

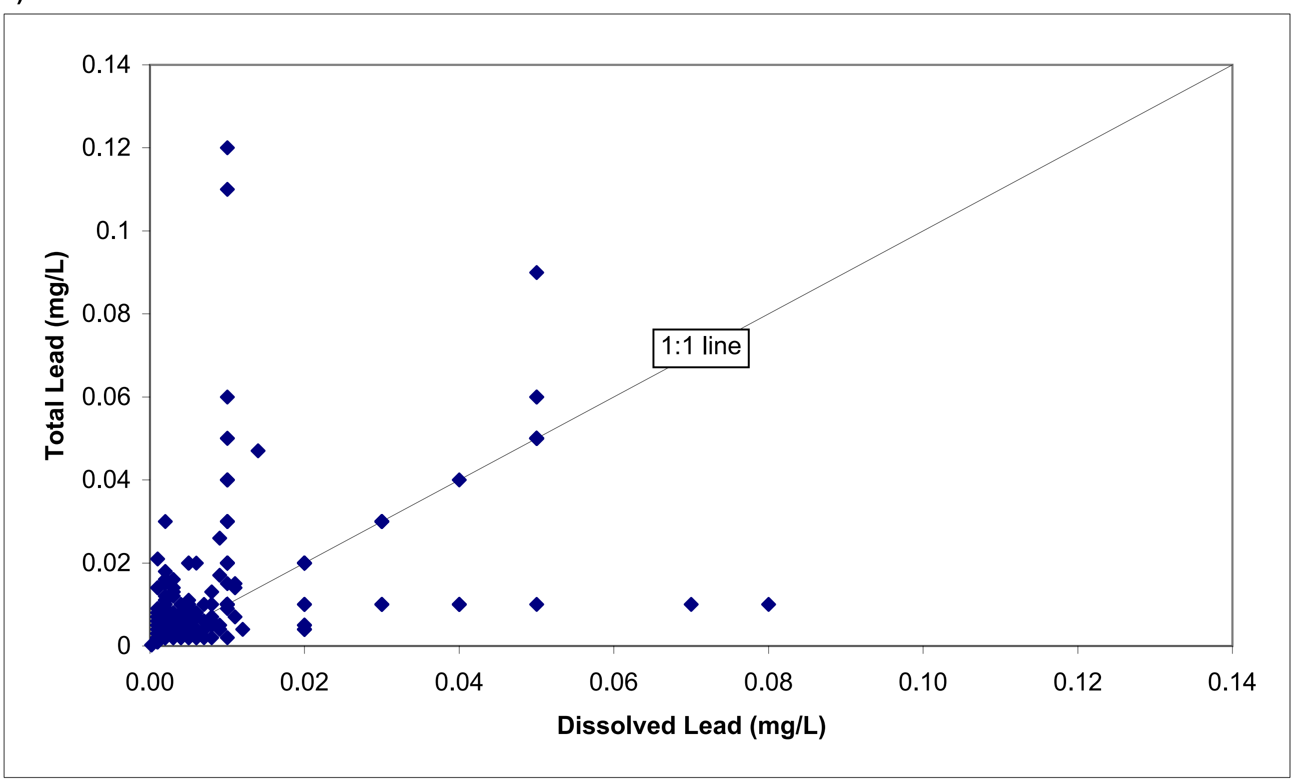
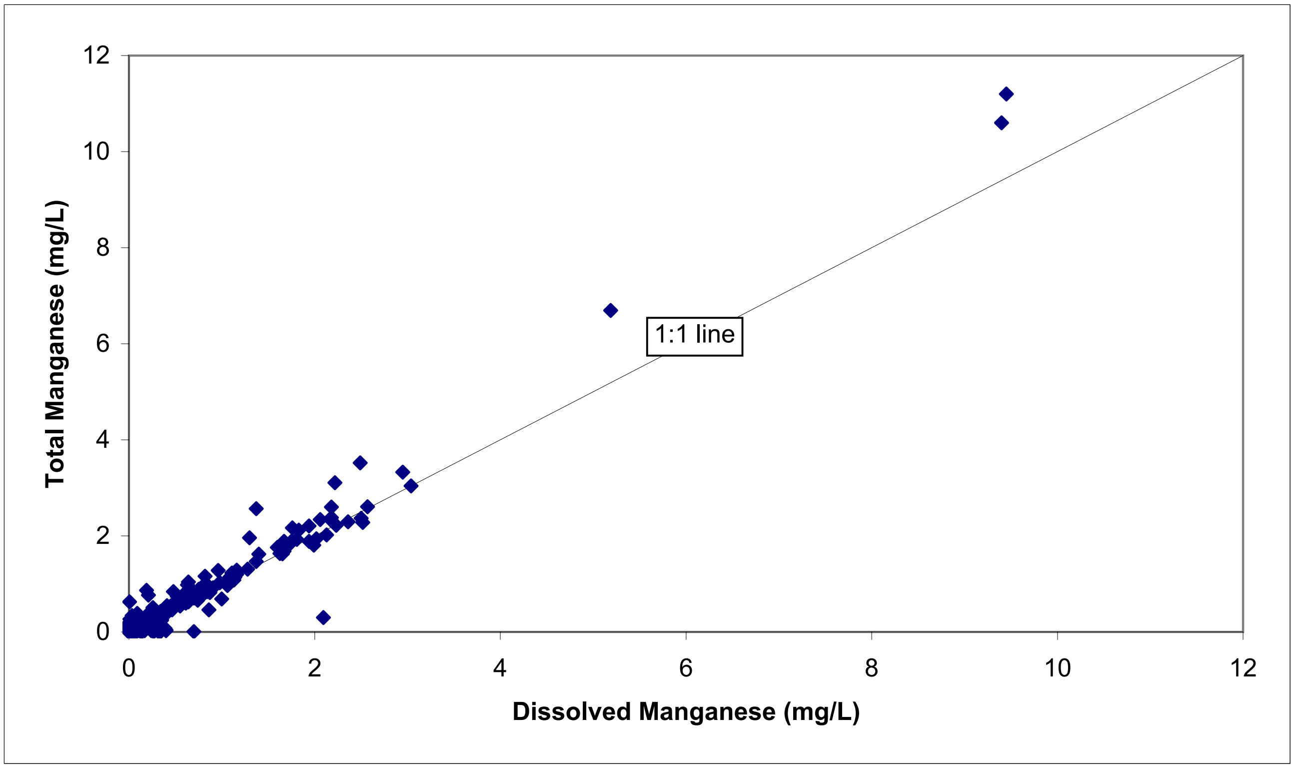


Figure A.1: Comparison of dissolved versus total concentrations of select metals in water samples

g) Manganese



h) Nickel

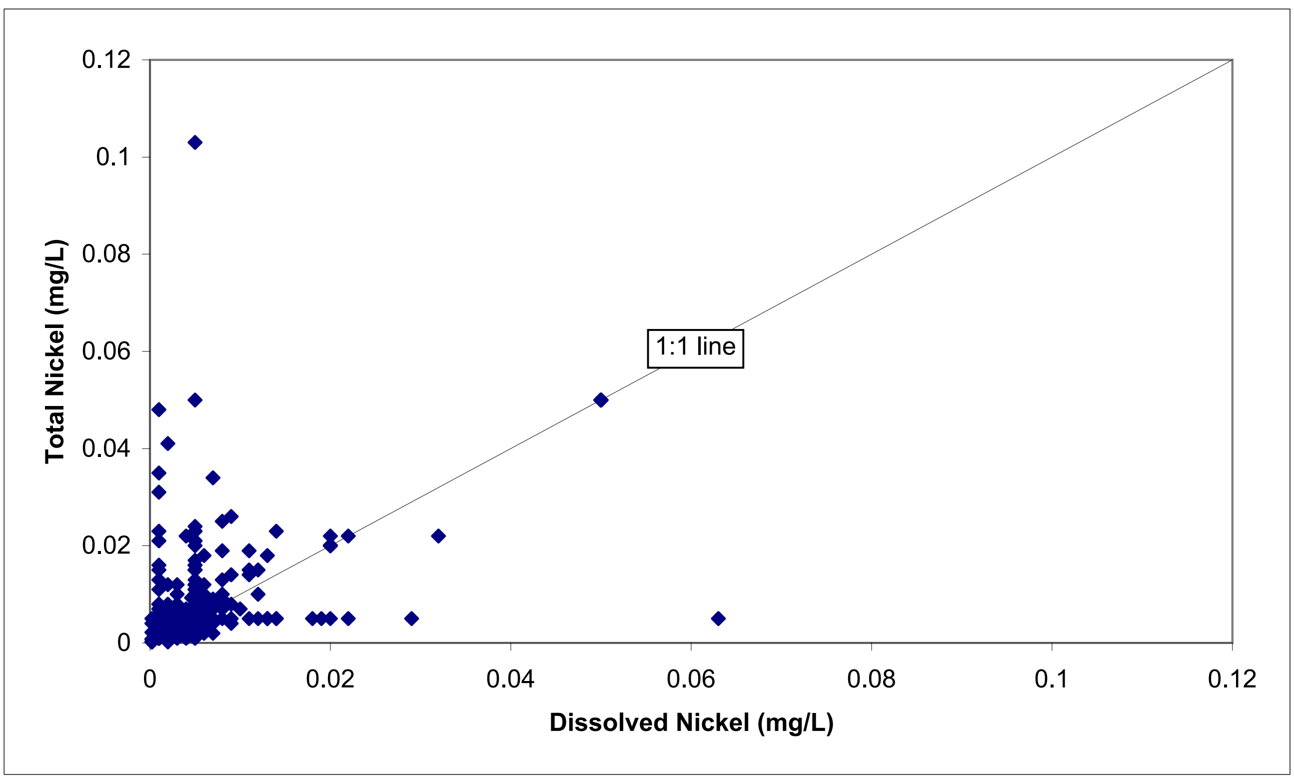


Figure A.1: Comparison of dissolved versus total concentrations of select metals in water samples

I) Zinc

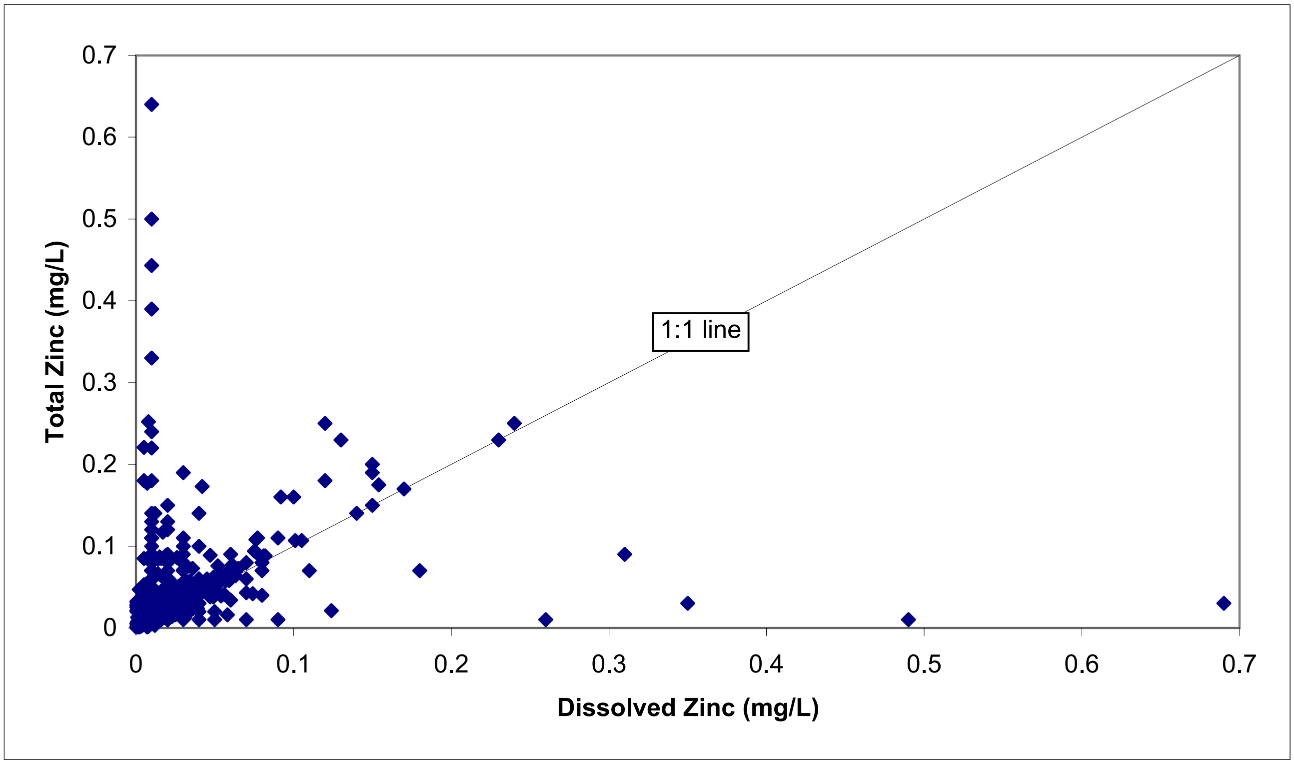


Figure A.1: Comparison of dissolved versus total concentrations of select metals in water samples

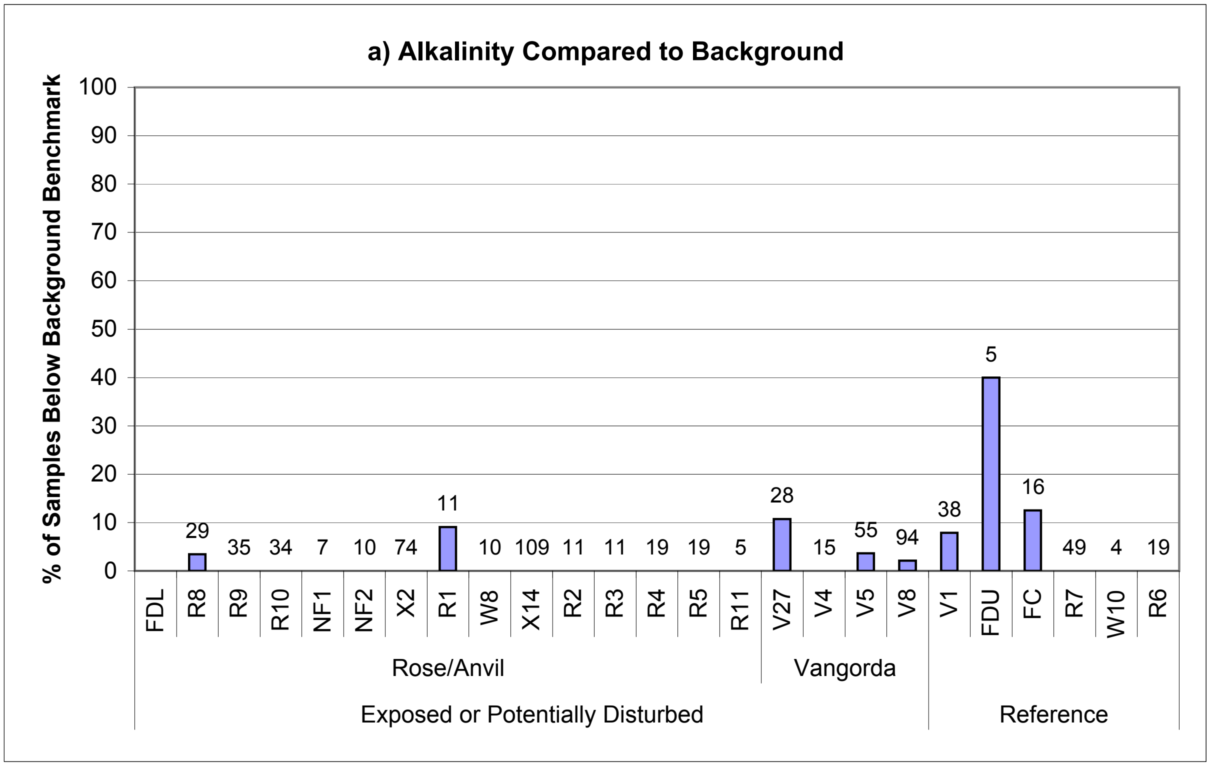
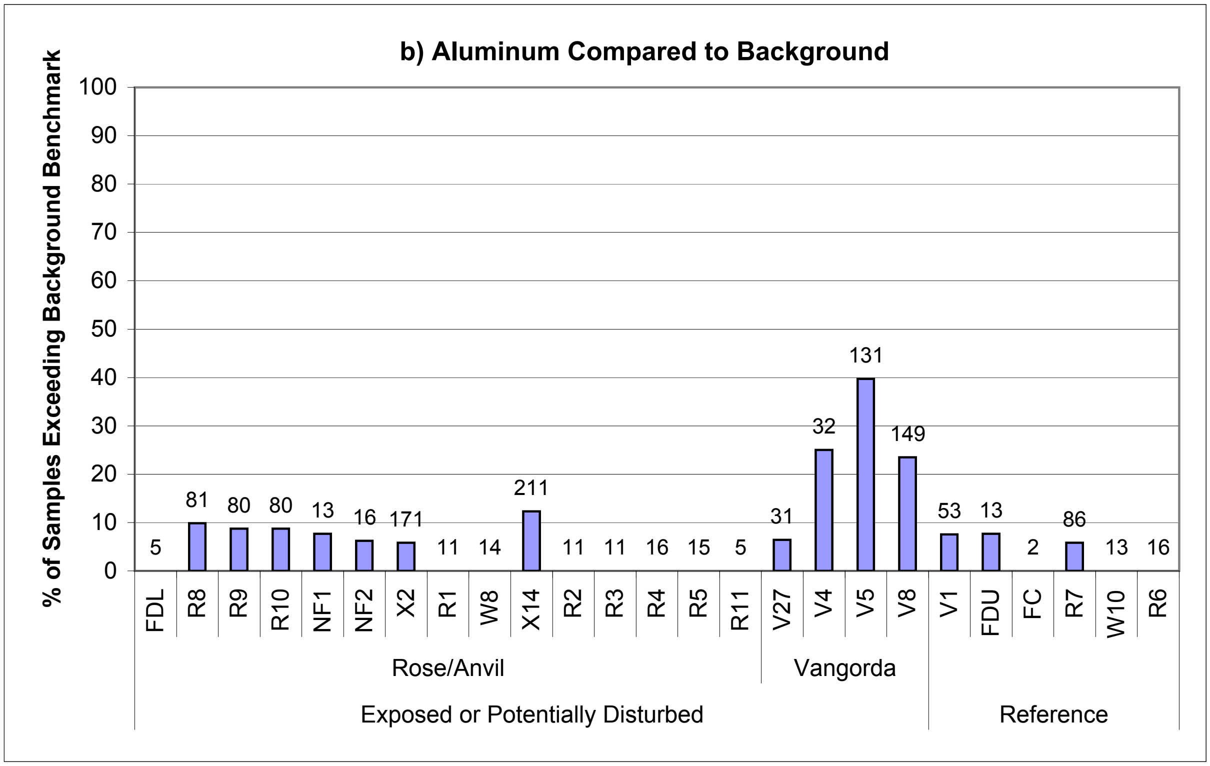


Figure A.2: Percentage and number of samples exceeding background benchmarks for water quality parameters measured at exposed and reference sites Sample size (total n) indicated above each bar (data 1975 - 2006).



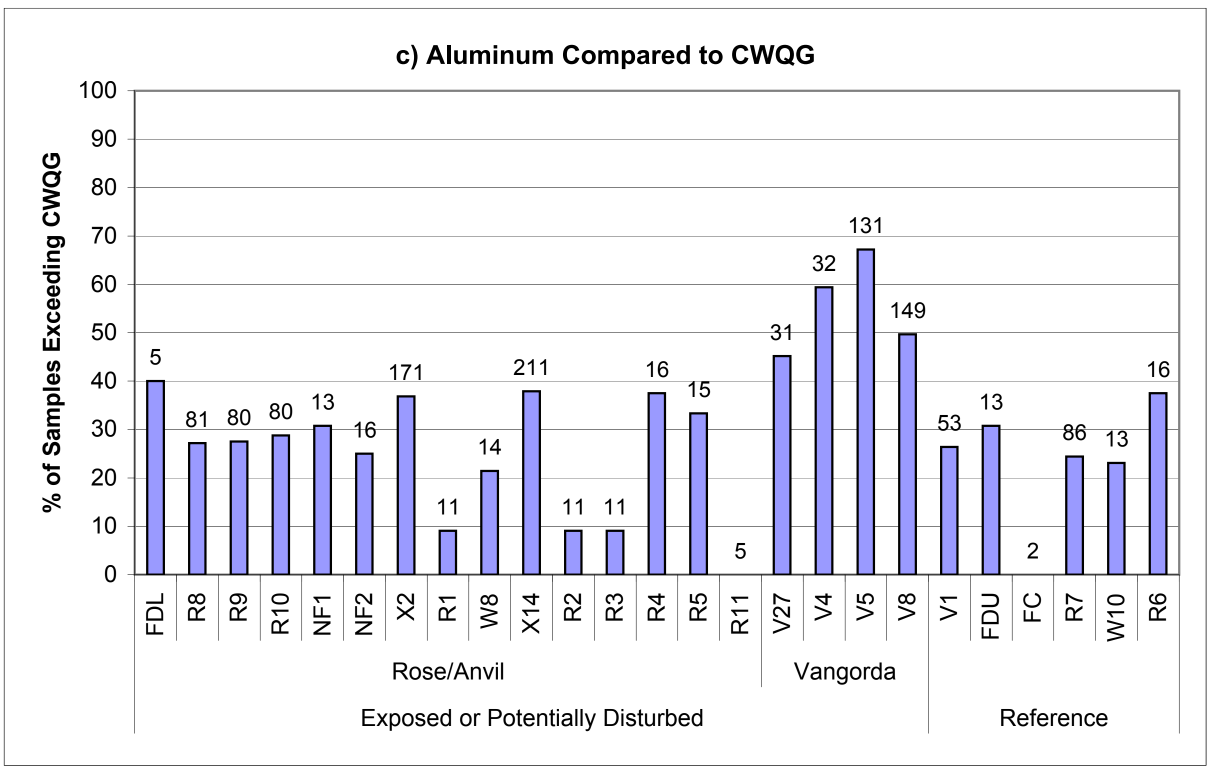


Figure A.2: Percentage and number of samples exceeding background benchmarks and CWQGs for water quality parameters measured at exposed and reference sites. Sample size (total n) indicated above each bar (data 1975 - 2006).

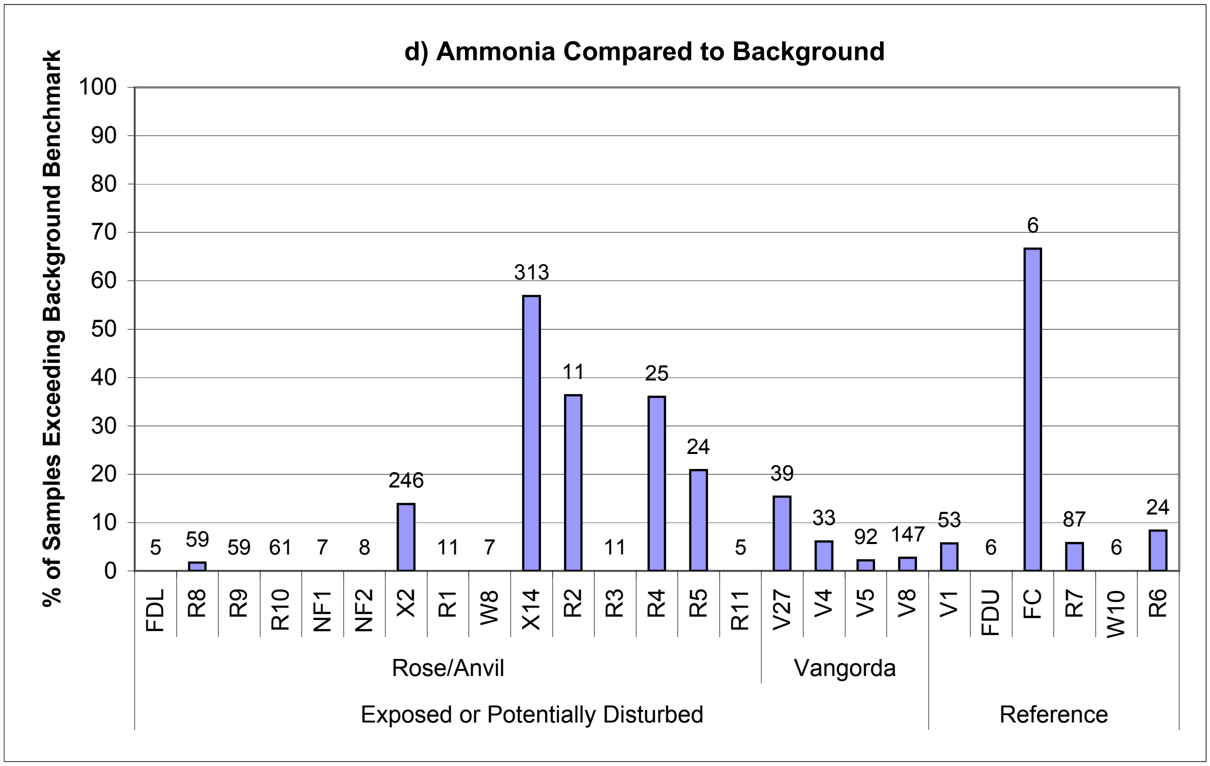


Figure A.2: Percentage and number of samples exceeding background benchmarks for water quality parameters measured at exposed and reference sites Sample size (total n) indicated above each bar (data 1975 - 2006).

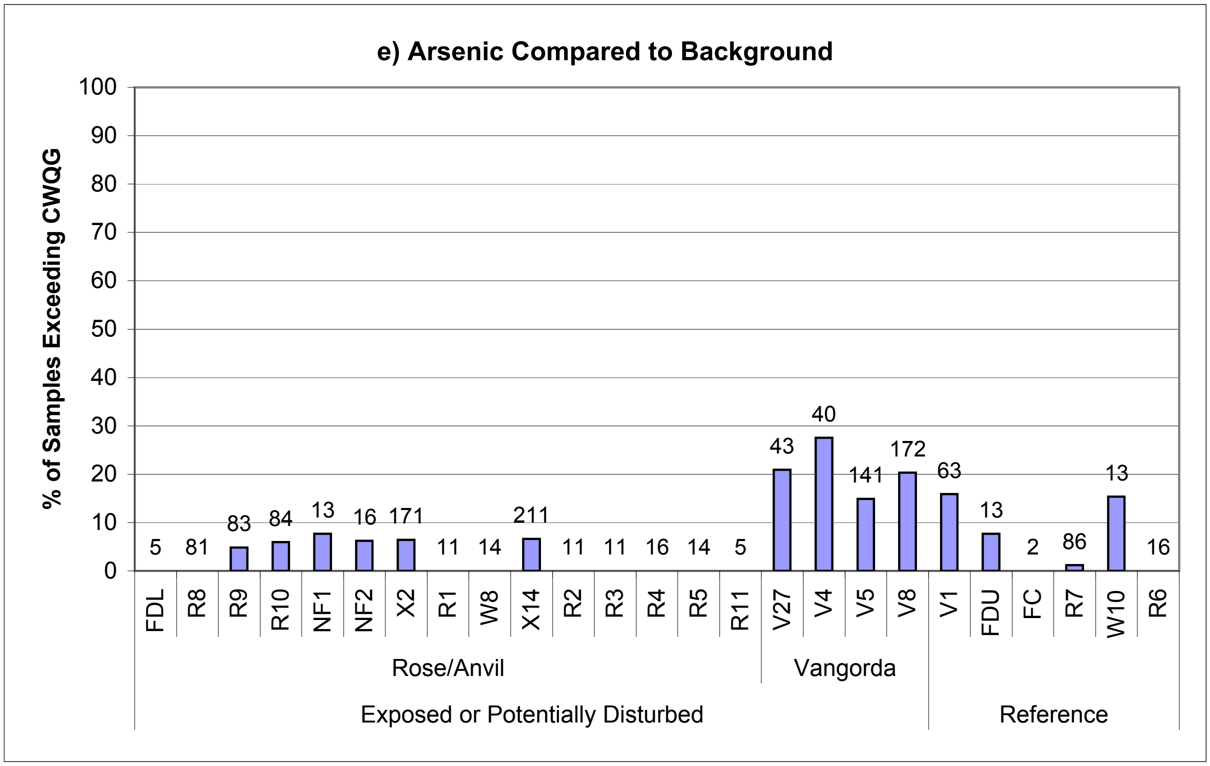


Figure A.2: Percentage and number of samples exceeding CWQGs for water quality parameters measured at exposed and reference sites
Sample size (total n) indicated above each bar (data 1975 - 2006).

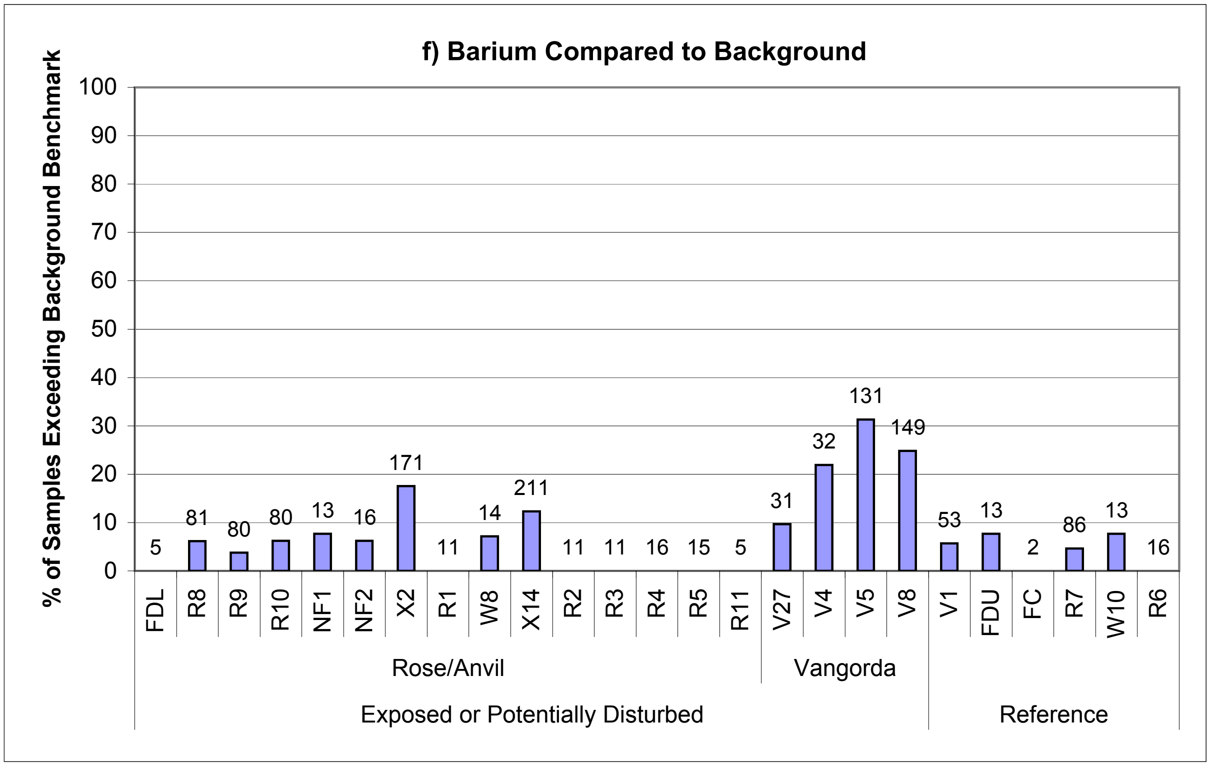


Figure A.2: Percentage and number of samples exceeding background benchmarks for water quality parameters measured at exposed and reference sites Sample size (total n) indicated above each bar (data 1975 - 2006).

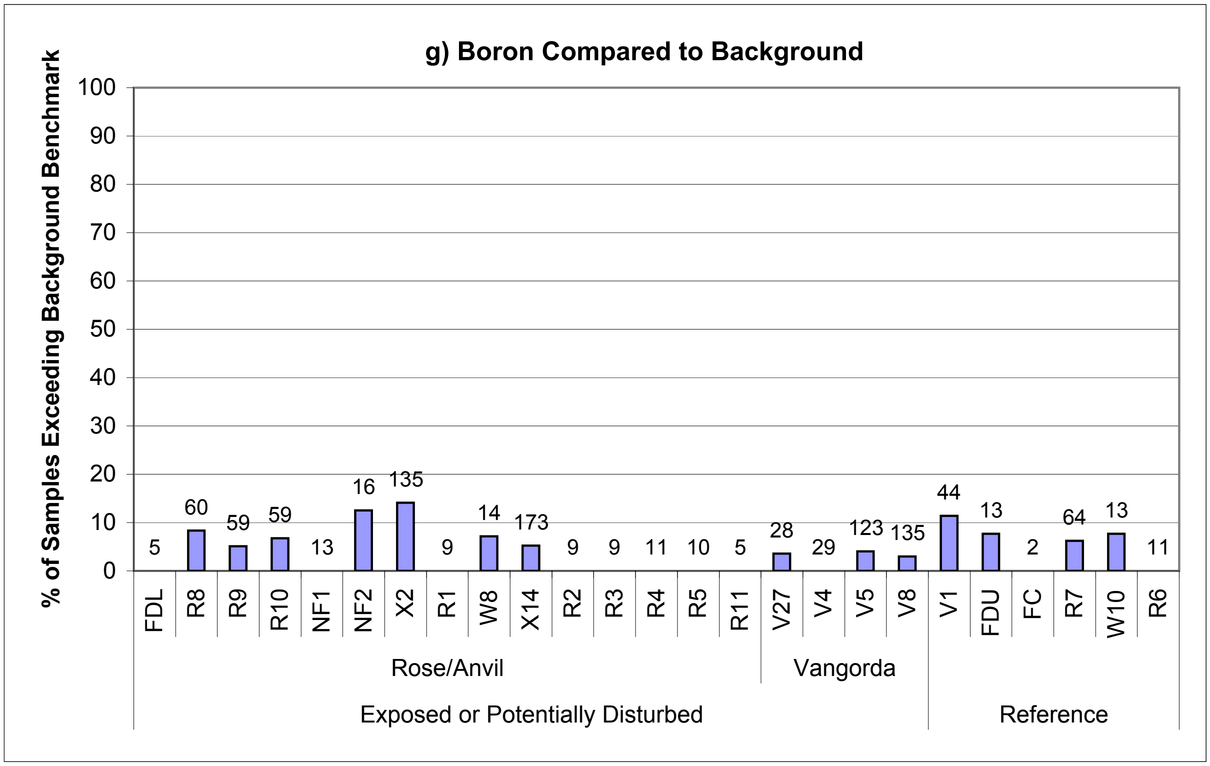


Figure A.2: Percentage and number of samples exceeding background benchmarks for water quality parameters measured at exposed and reference sites Sample size (total n) indicated above each bar (data 1975 - 2006).

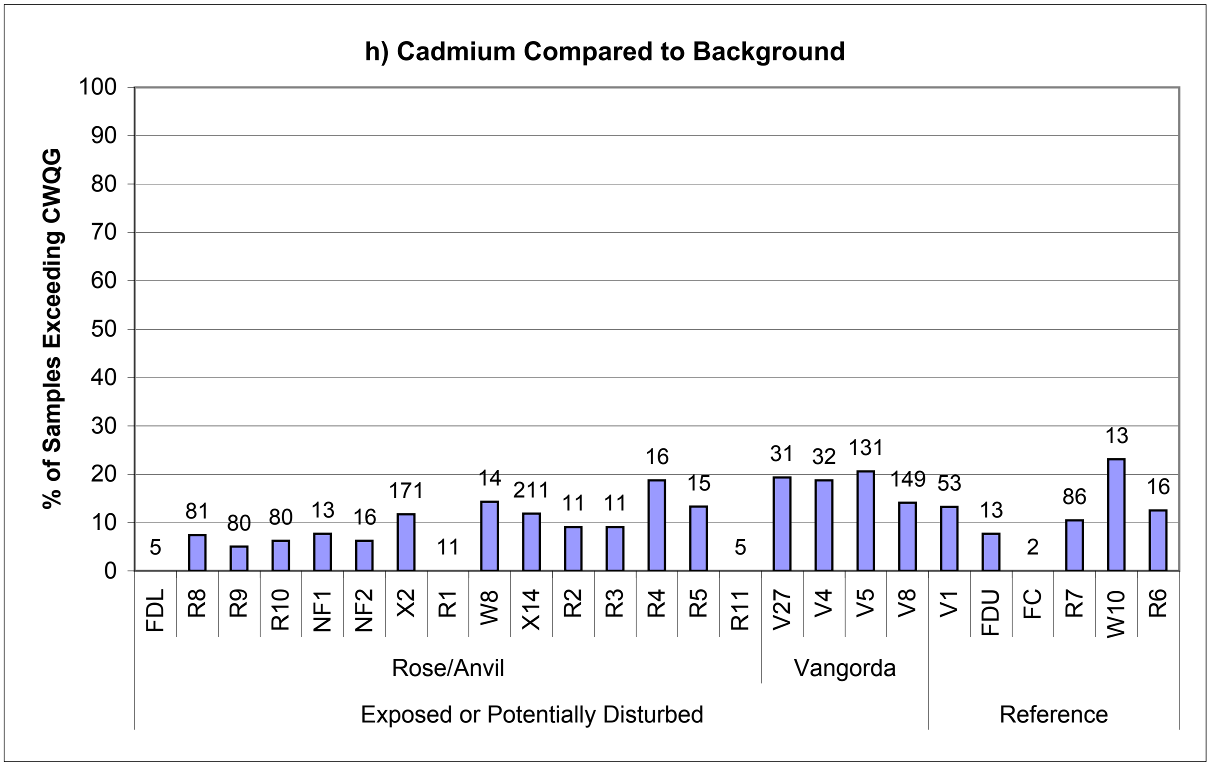


Figure A.2: Percentage and number of samples exceeding CWQGs for water quality parameters measured at exposed and reference sites Sample size (total n) indicated above each bar (data 1975 - 2006).

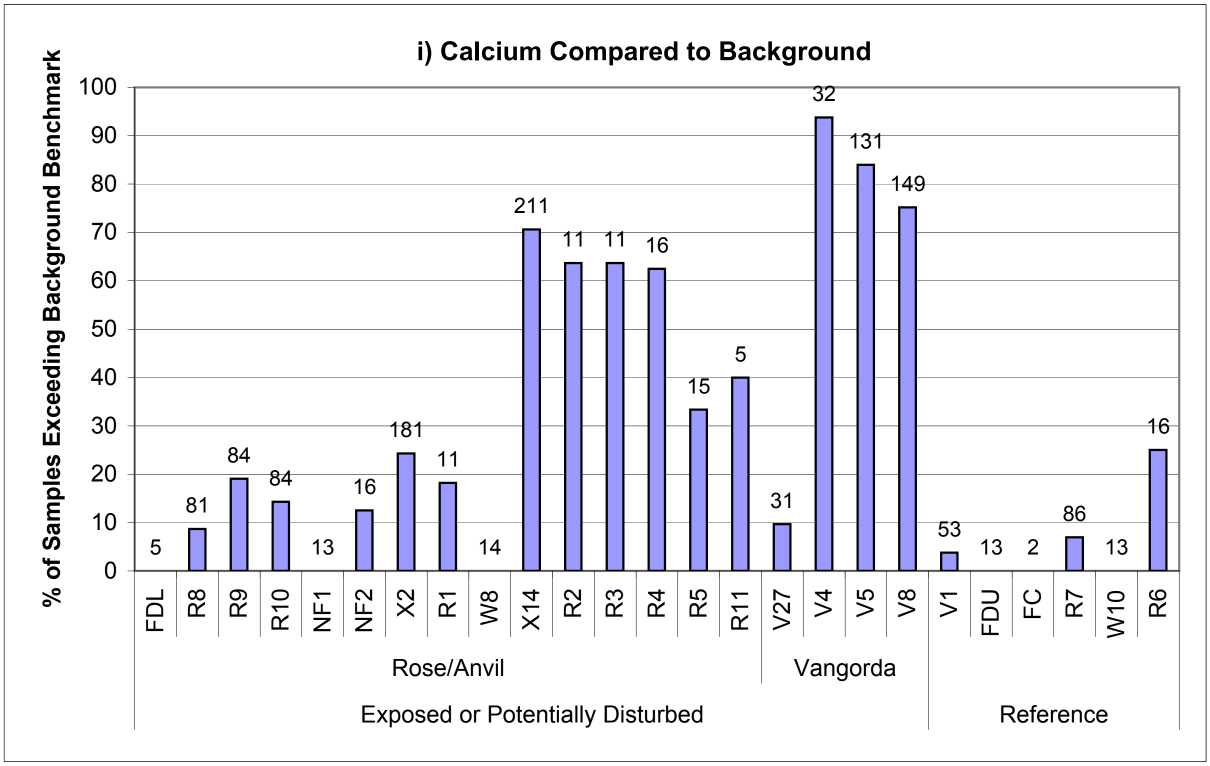
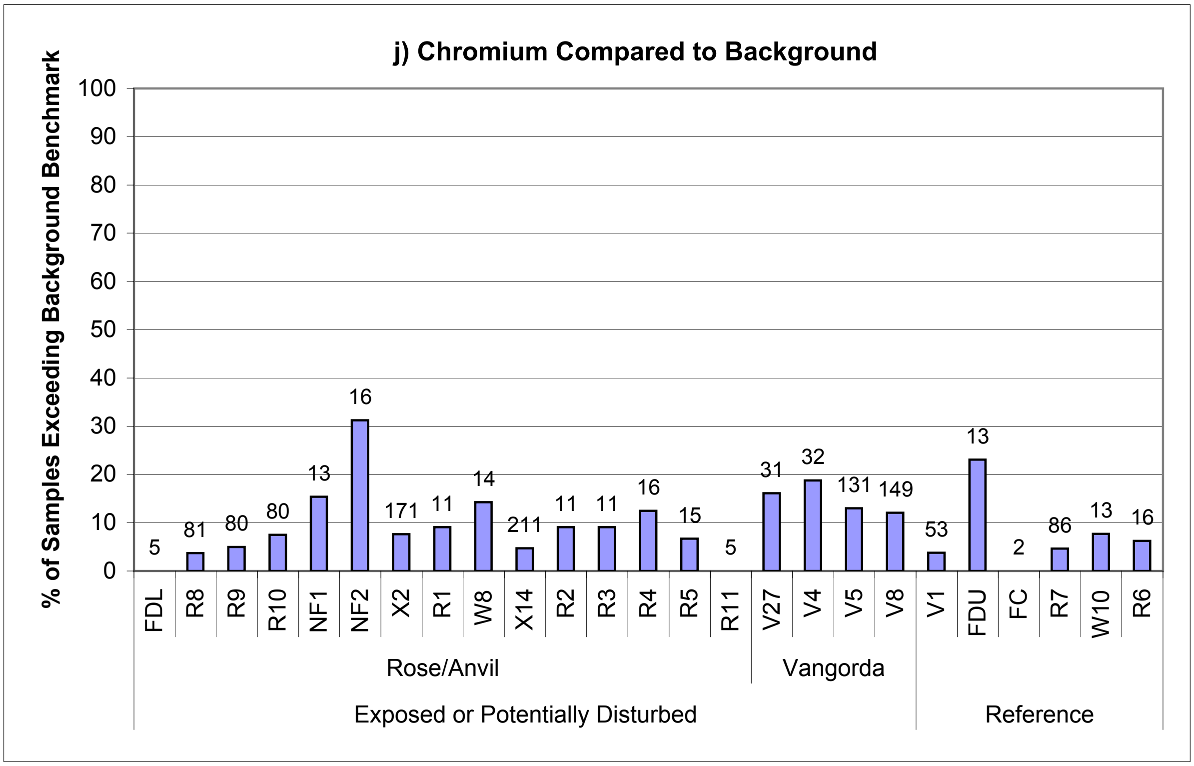


Figure A.2: Percentage and number of samples exceeding background benchmarks for water quality parameters measured at exposed and reference sites Sample size (total n) indicated above each bar (data 1975 - 2006).



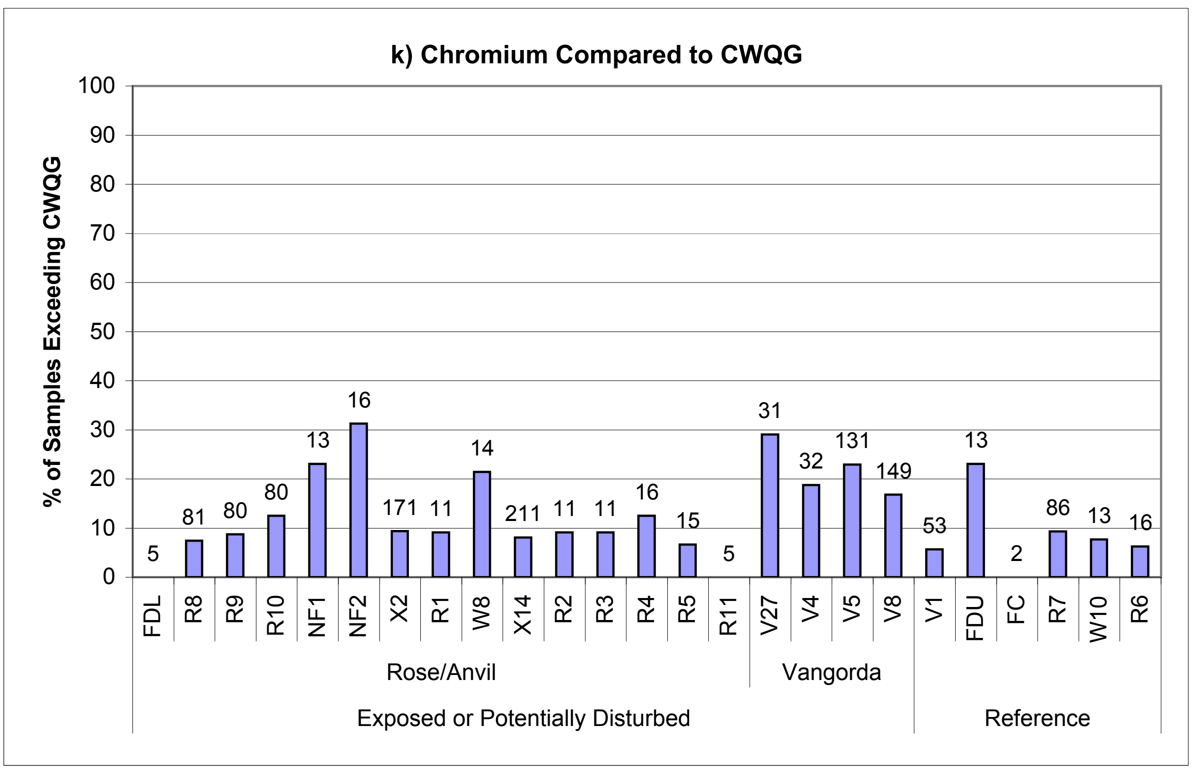


Figure A.2: Percentage and number of samples exceeding background benchmarks and CWQGs for water quality parameters measured at exposed and reference sites. Sample size (total n) indicated above each bar (data 1975 - 2006).

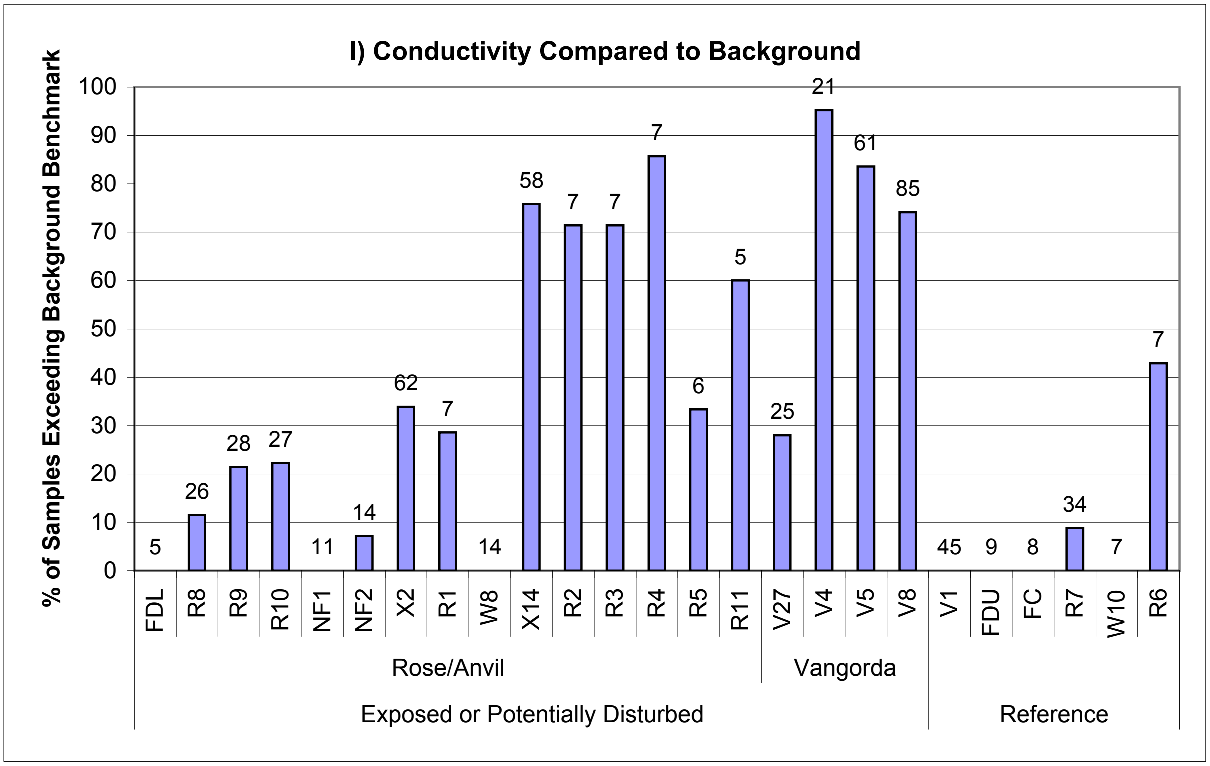
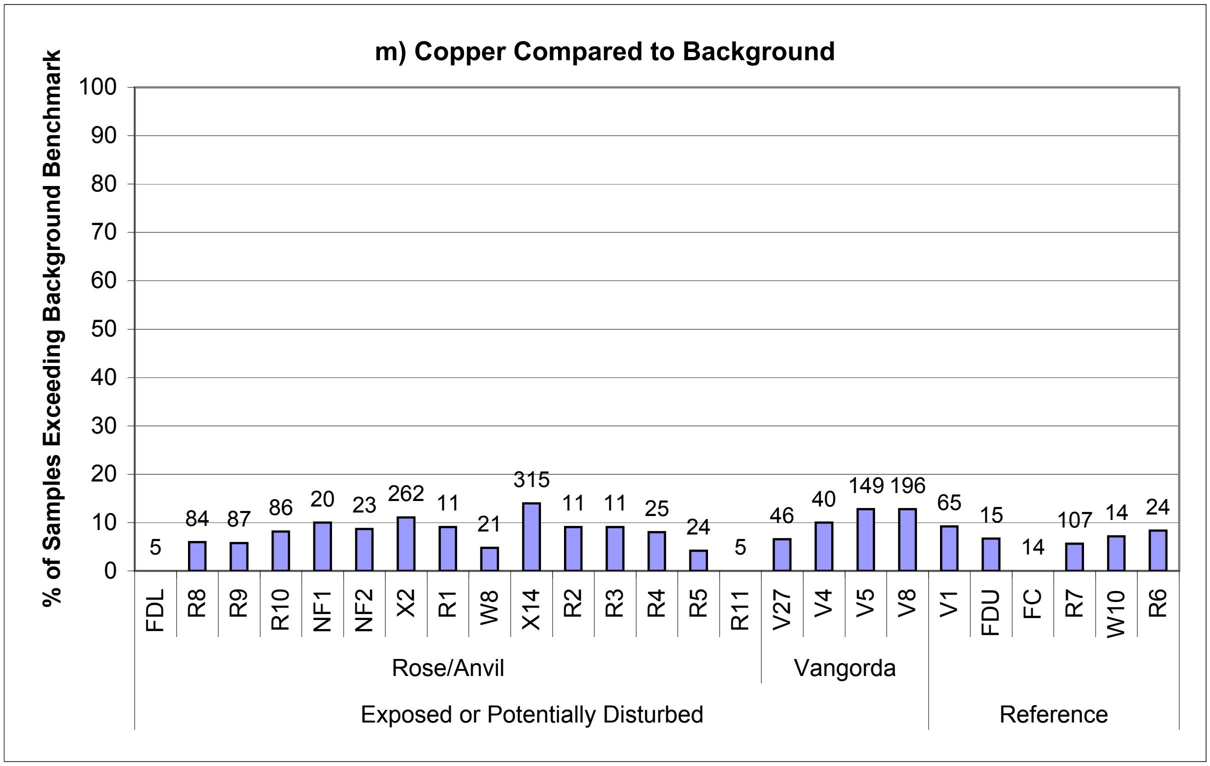


Figure A.2: Percentage and number of samples exceeding background benchmarks for water quality parameters measured at exposed and reference sites Sample size (total n) indicated above each bar (data 1975 - 2006).



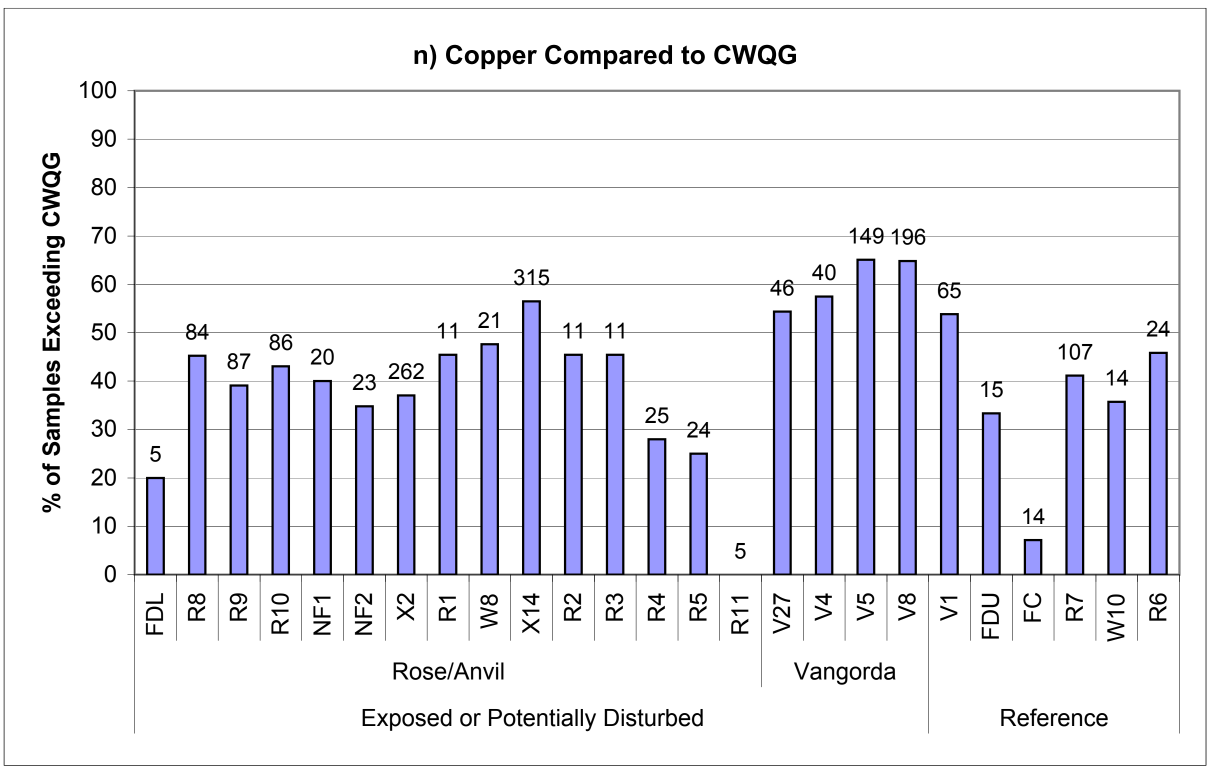


Figure A.2: Percentage and number of samples exceeding background benchmarks and CWQGs for water quality parameters measured at exposed and reference sites Sample size (total n) indicated above each bar (data 1975 - 2006).

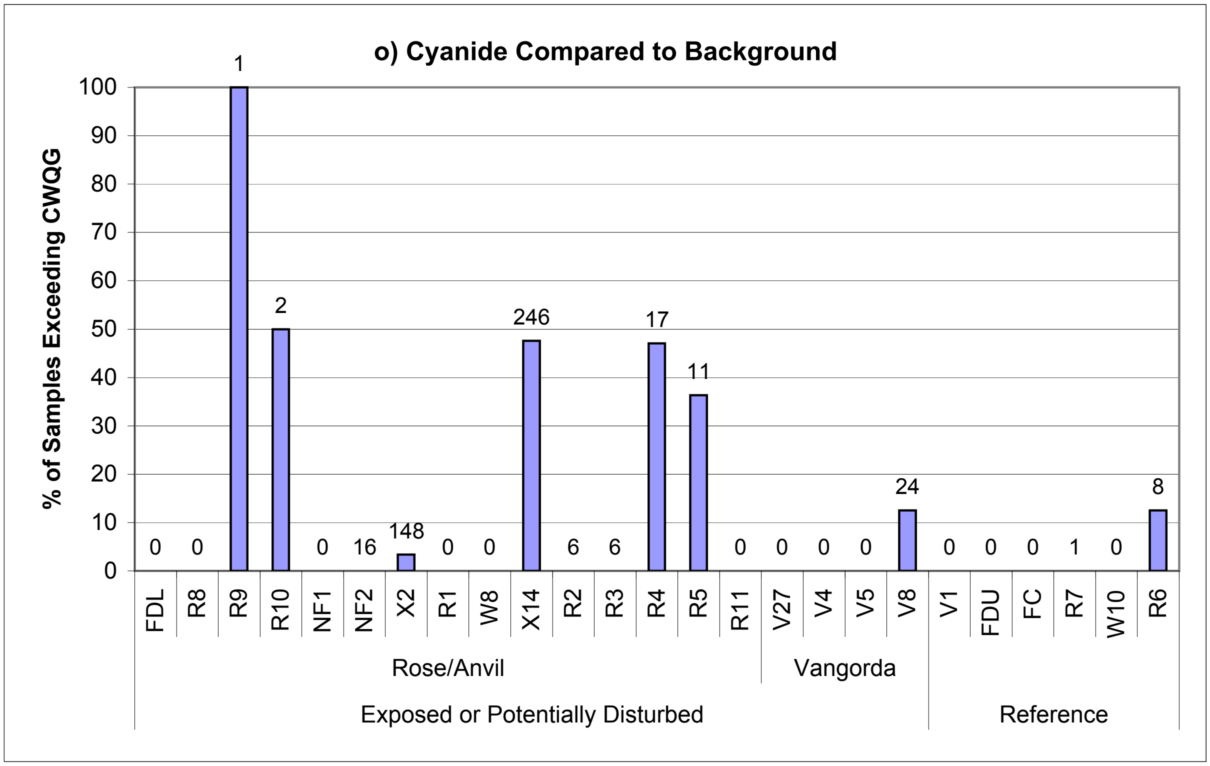


Figure A.2: Percentage and number of samples exceeding CWQGs for water quality parameters measured at exposed and reference sites Sample size (total n) indicated above each bar (data 1975 - 2006).

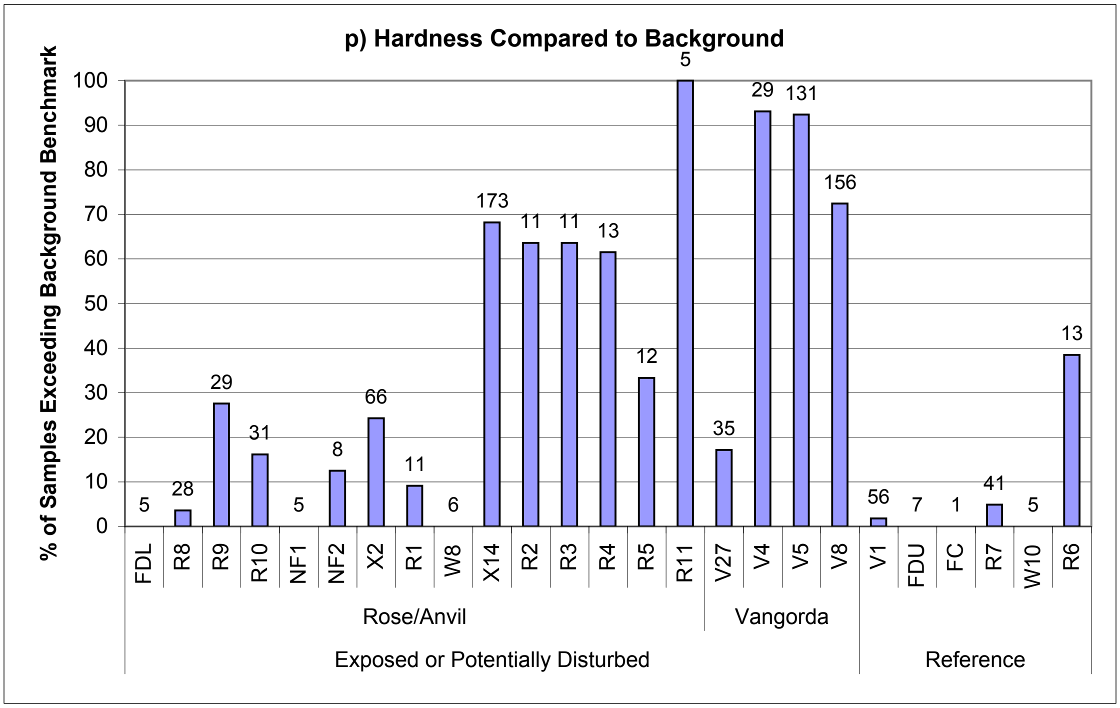
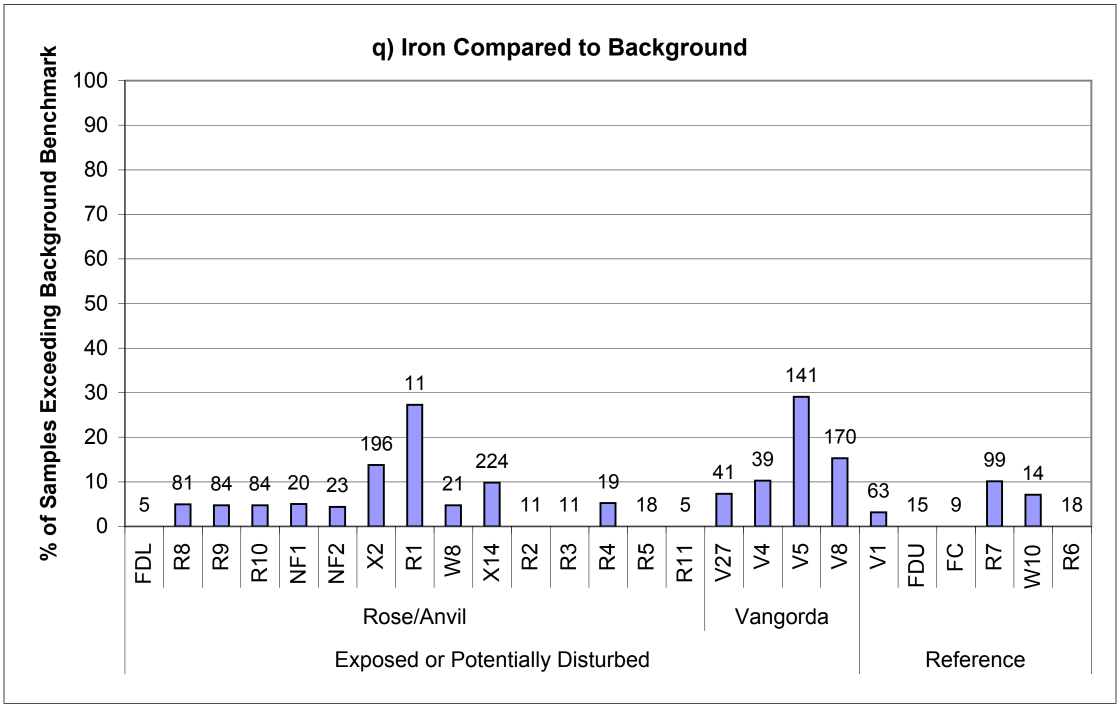


Figure A.2: Percentage and number of samples exceeding background benchmarks for water quality parameters measured at exposed and reference sites Sample size (total n) indicated above each bar (data 1975 - 2006).



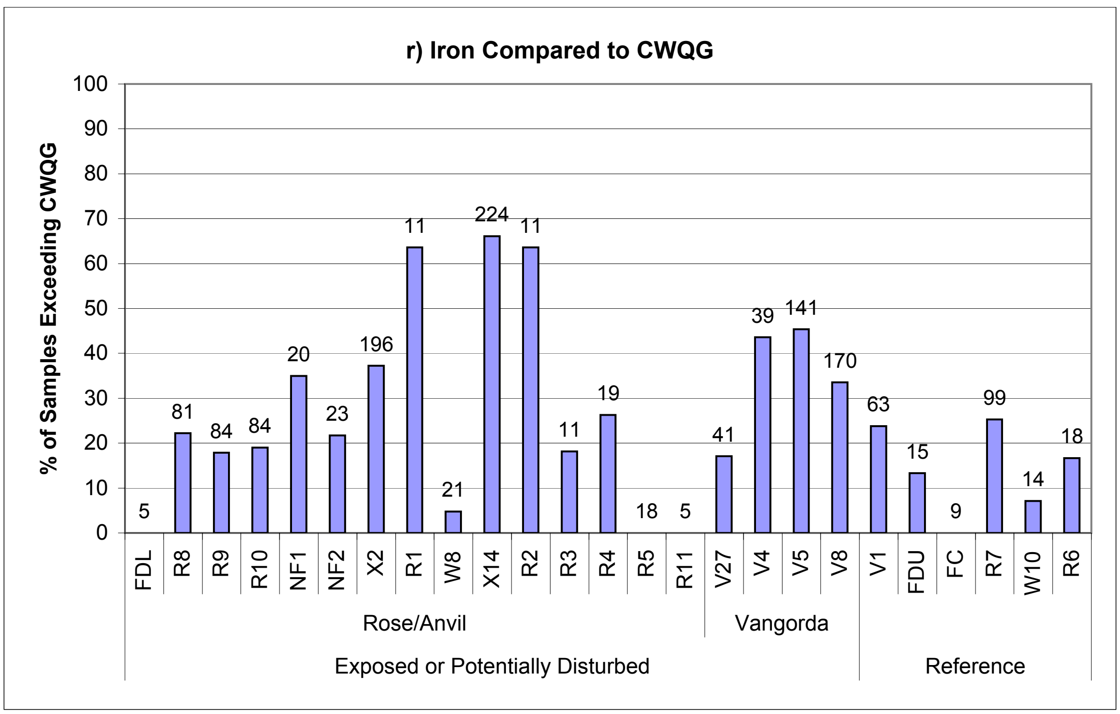


Figure A.2: Percentage and number of samples exceeding background benchmarks and CWQGs for water quality parameters measured at exposed and reference sites. Sample size (total n) indicated above each bar (data 1975 - 2006).

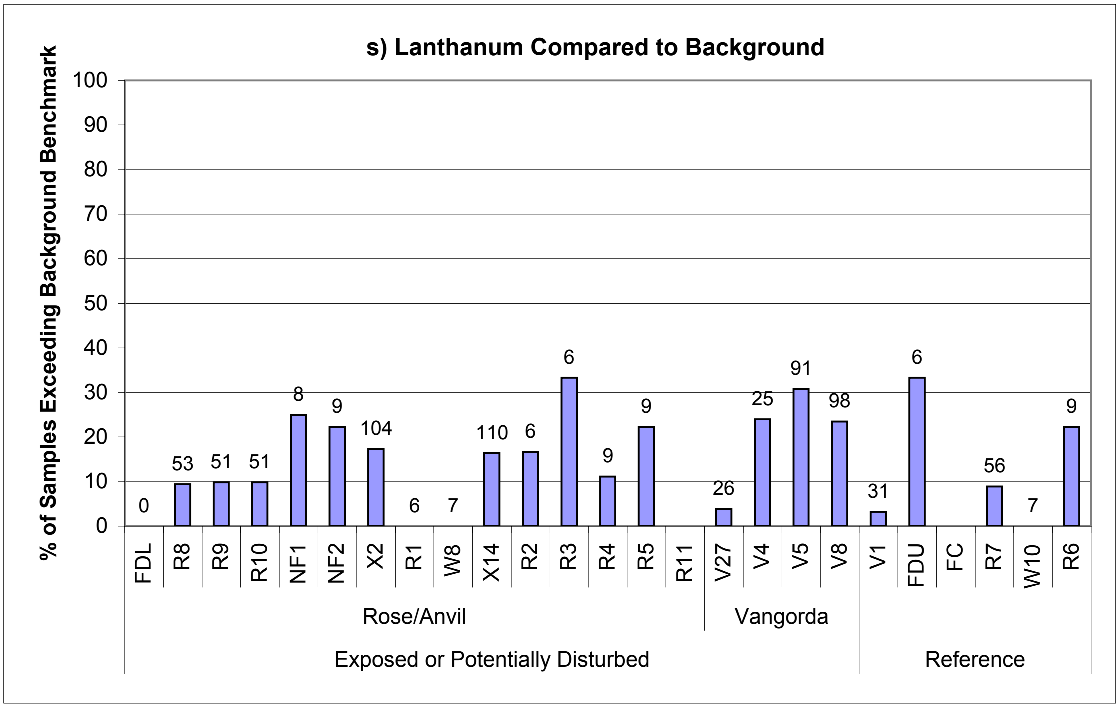
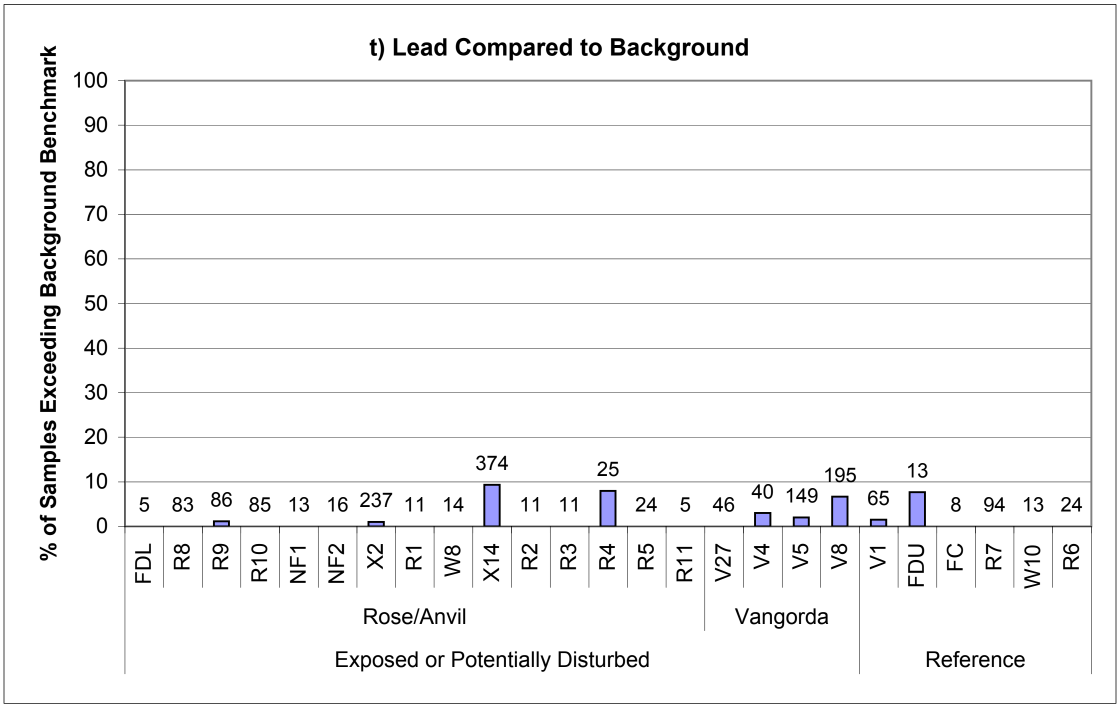


Figure A.2: Percentage and number of samples exceeding background benchmarks for water quality parameters measured at exposed and reference sites Sample size (total n) indicated above each bar (data 1975 - 2006).



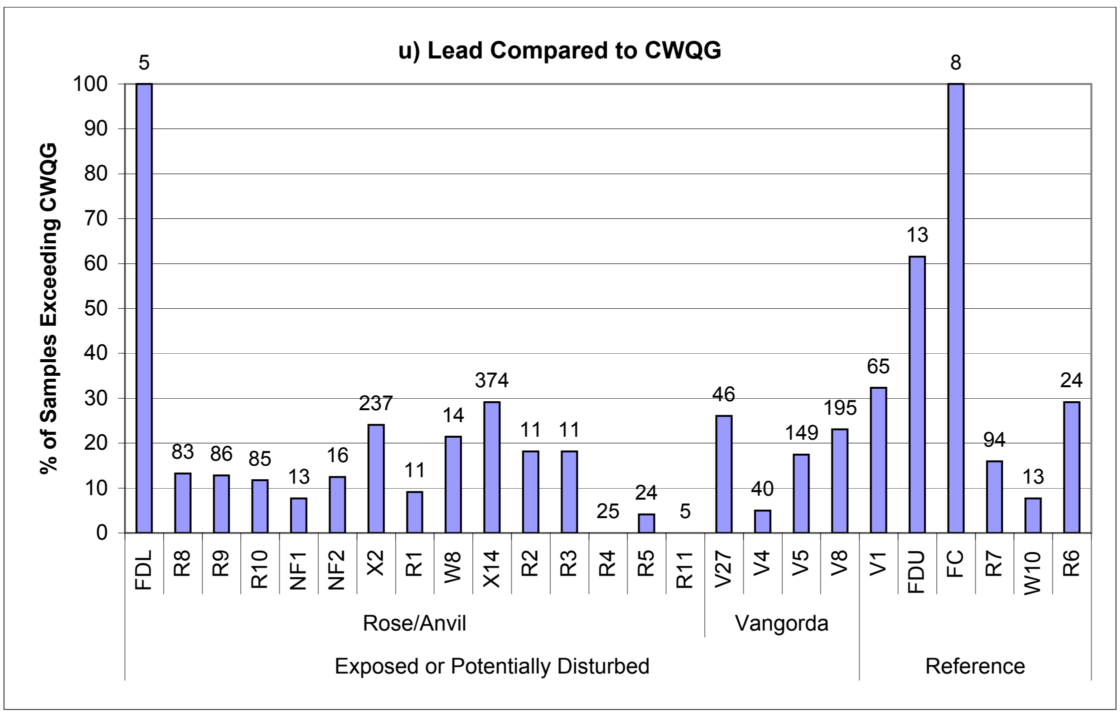


Figure A.2: Percentage and number of samples exceeding background benchmarks and CWQGs for water quality parameters measured at exposed and reference sites. Sample size (total n) indicated above each bar (data 1975 - 2006).

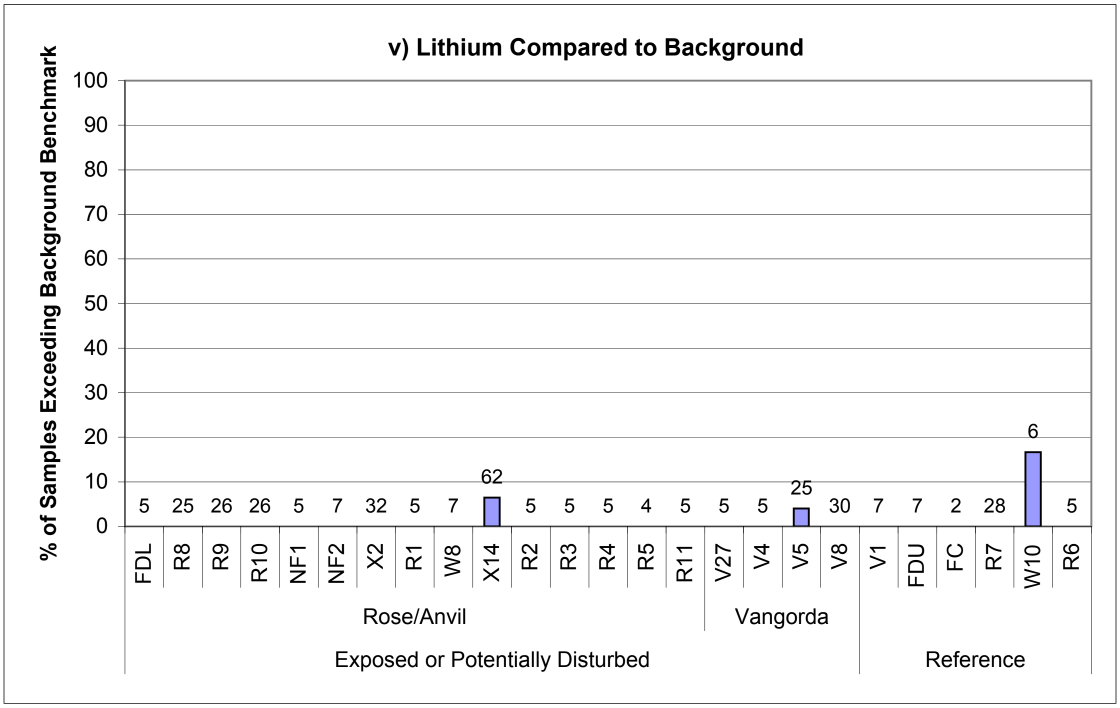


Figure A.2: Percentage and number of samples exceeding background benchmarks for water quality parameters measured at exposed and reference sites Sample size (total n) indicated above each bar (data 1975 - 2006).

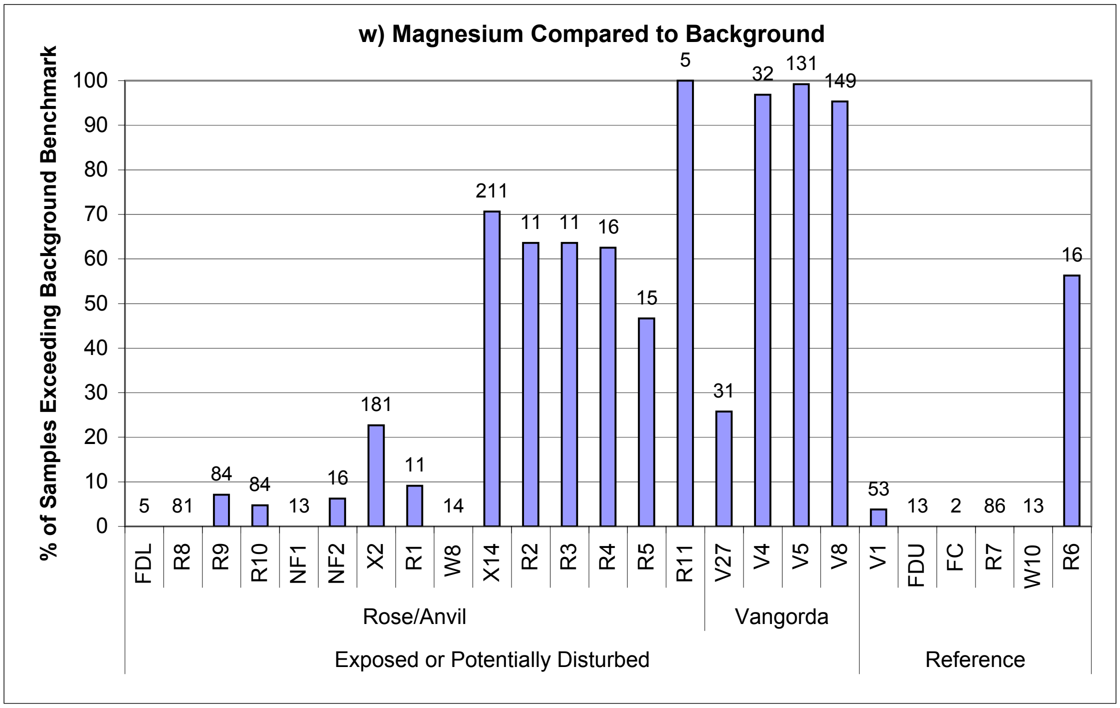


Figure A.2: Percentage and number of samples exceeding background benchmarks for water quality parameters measured at exposed and reference sites Sample size (total n) indicated above each bar (data 1975 - 2006).

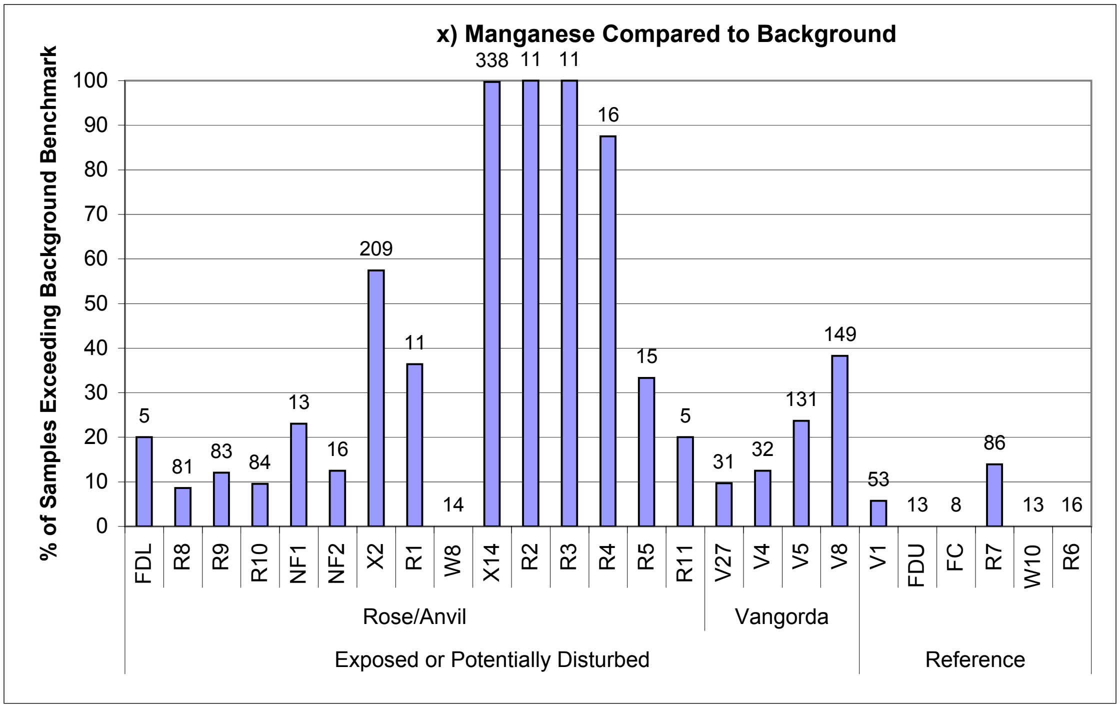


Figure A.2: Percentage and number of samples exceeding background benchmarks for water quality parameters measured at exposed and reference sites Sample size (total n) indicated above each bar (data 1975 - 2006).

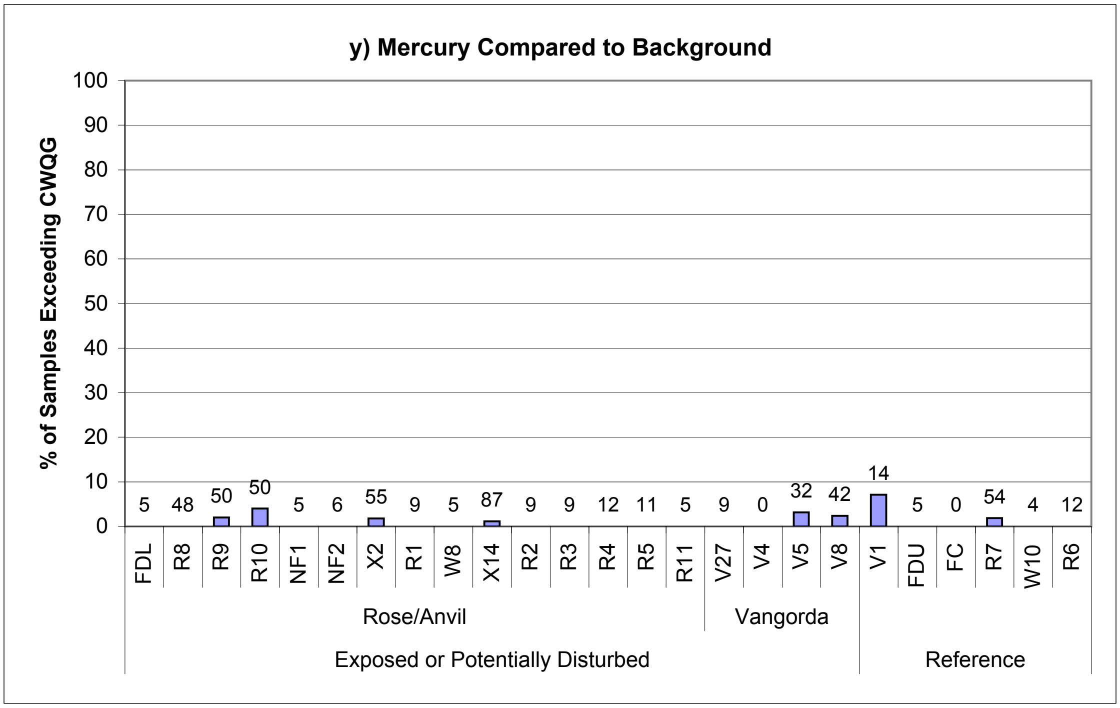
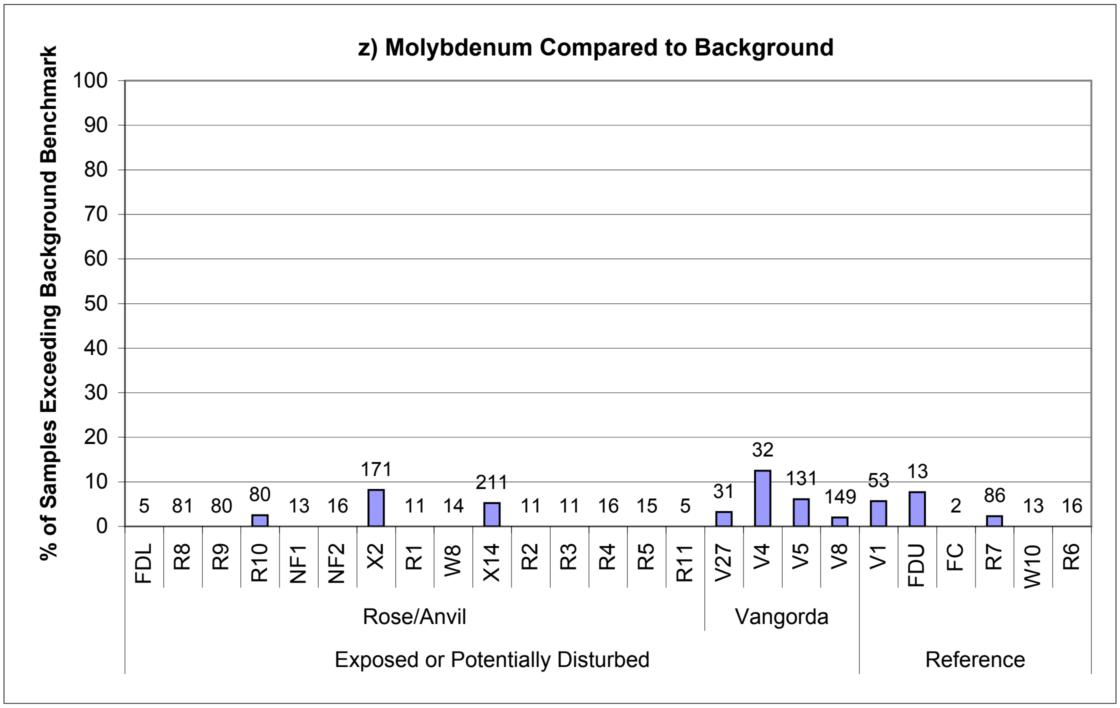


Figure A.2: Percentage and number of samples exceeding CWQGs for water quality parameters measured at exposed and reference sites Sample size (total n) indicated above each bar (data 1975 - 2006).



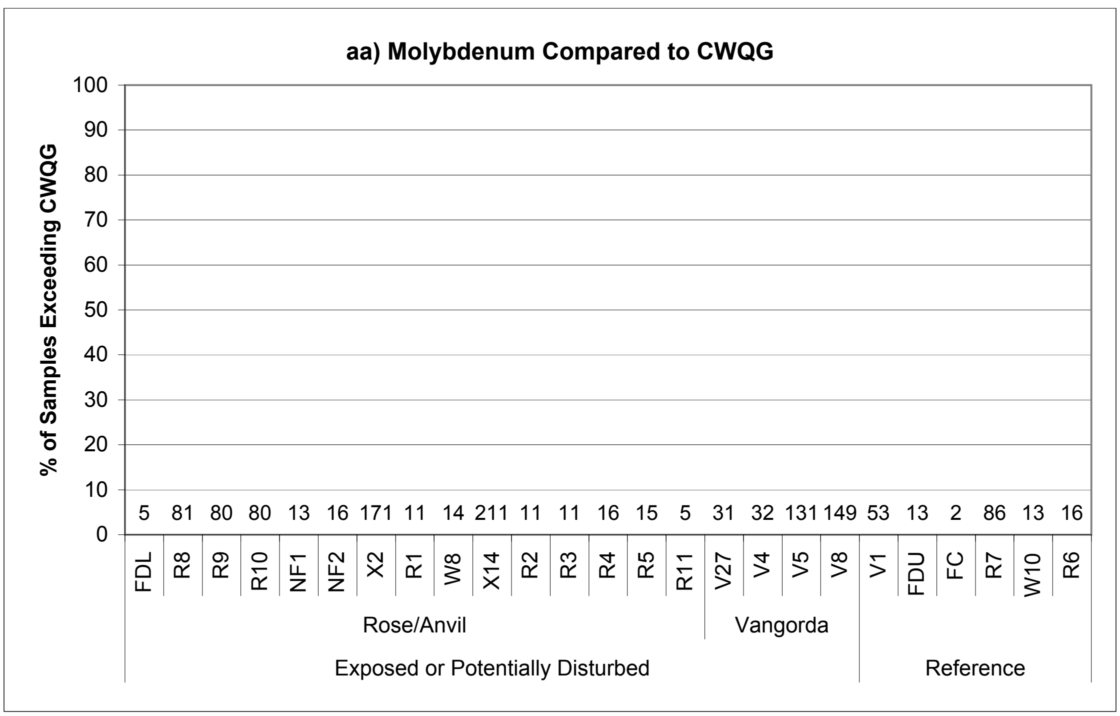
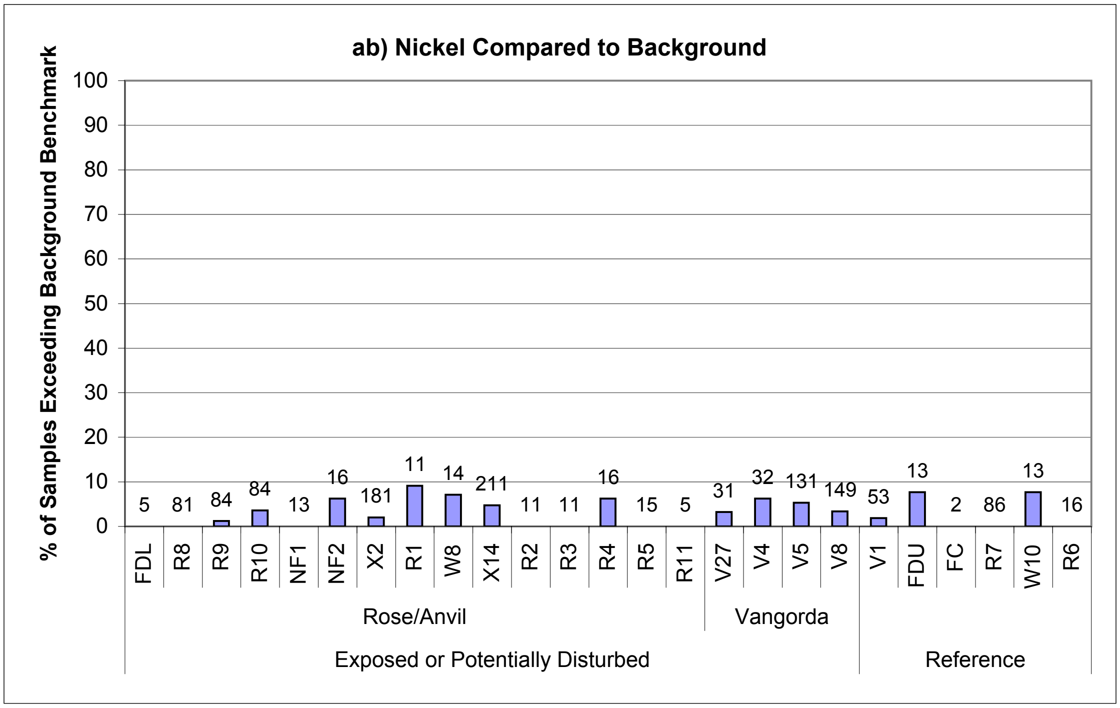


Figure A.2: Percentage and number of samples exceeding background benchmarks and CWQGs for water quality parameters measured at exposed and reference sites. Sample size (total n) indicated above each bar (data 1975 - 2006).



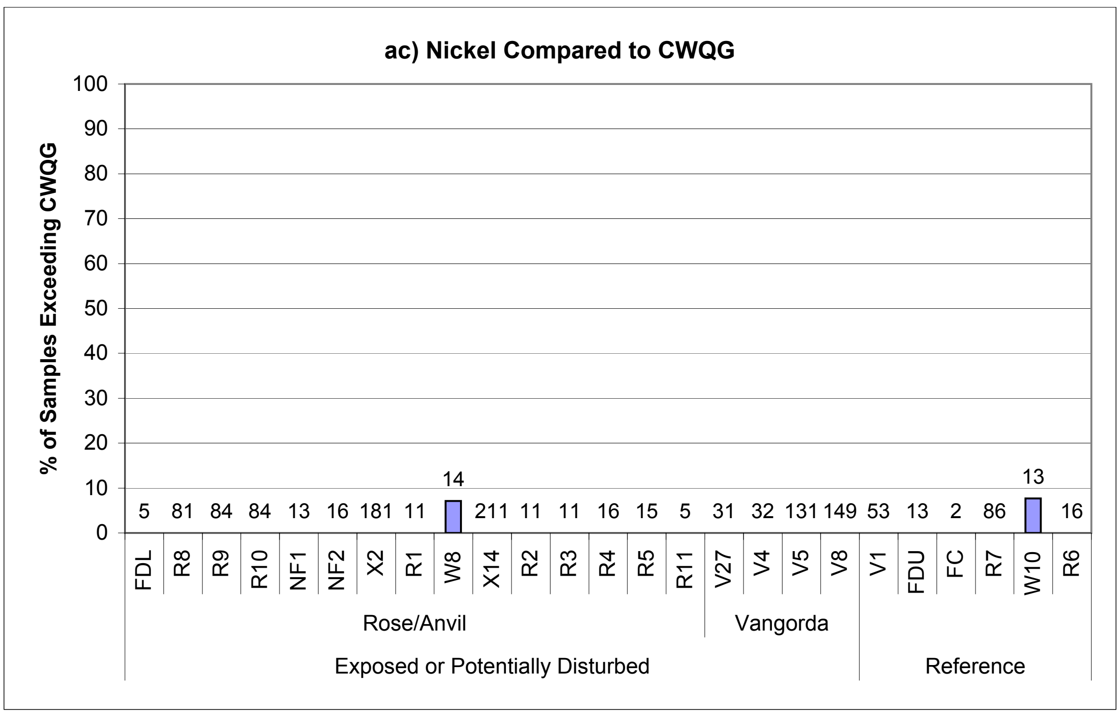
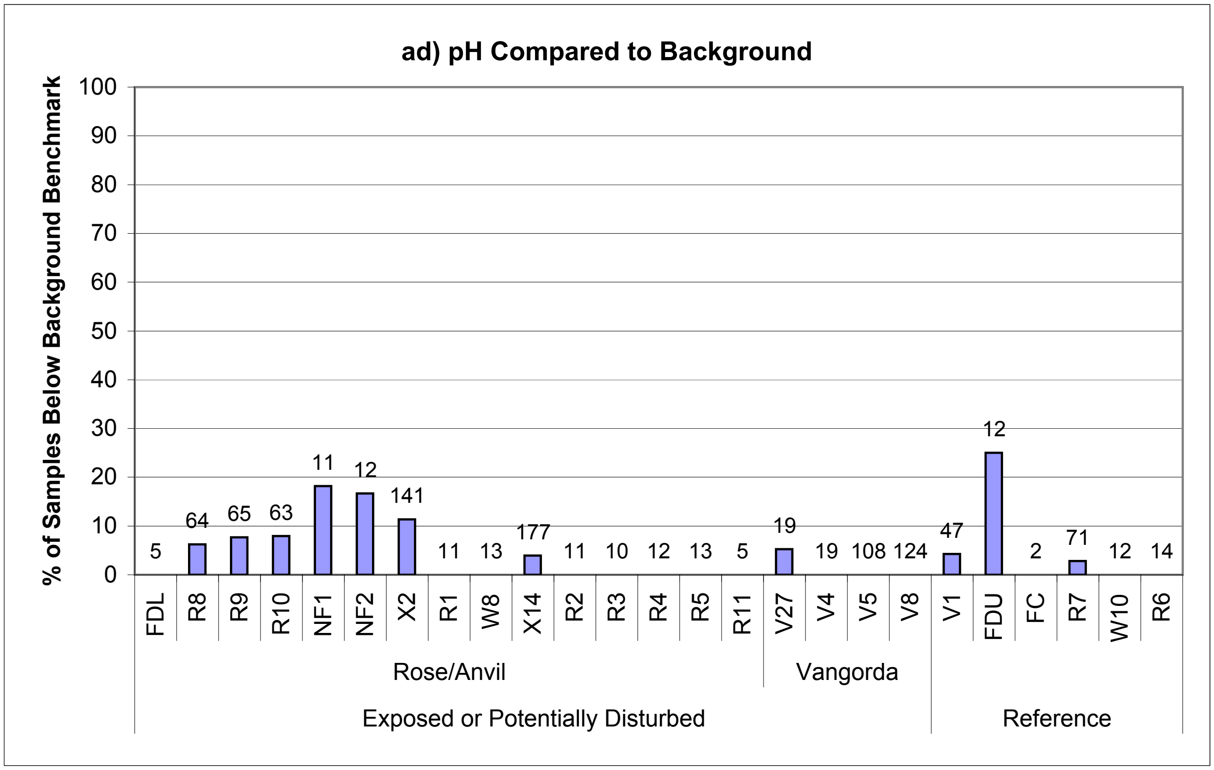


Figure A.2: Percentage and number of samples exceeding background benchmarks and CWQGs for water quality parameters measured at exposed and reference sites. Sample size (total n) indicated above each bar (data 1975 - 2006).



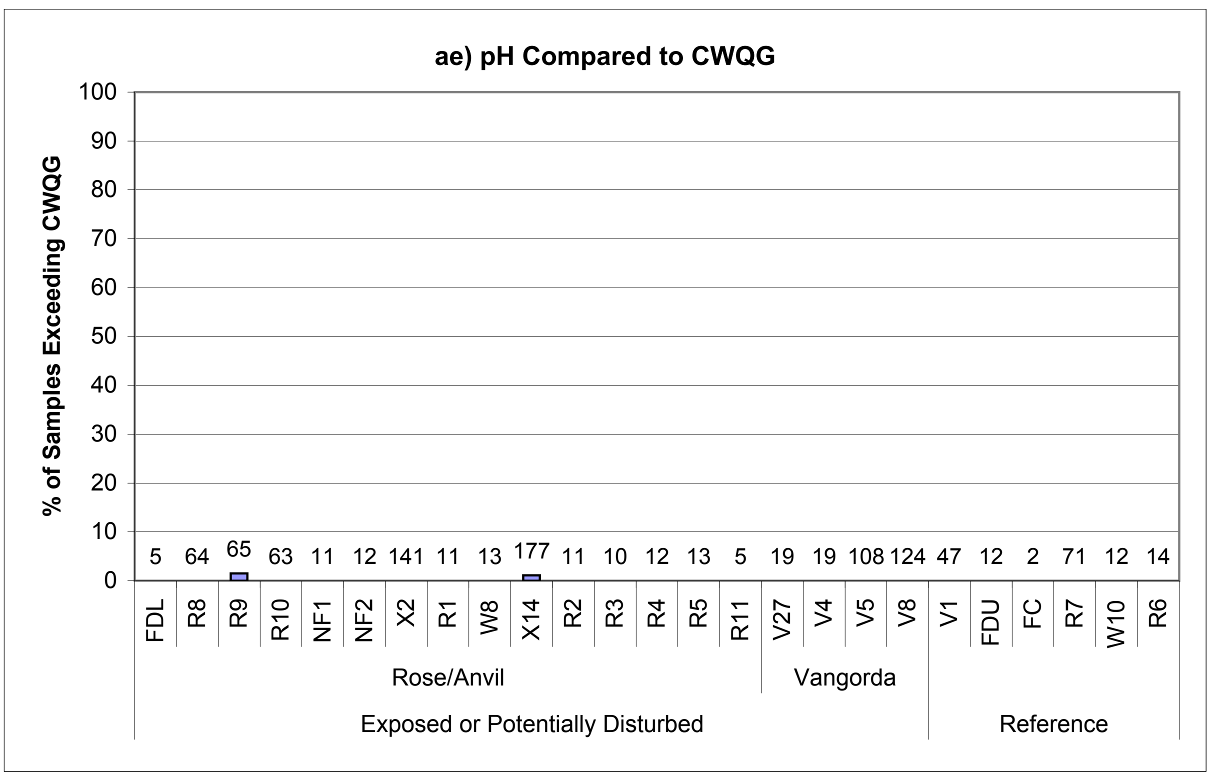
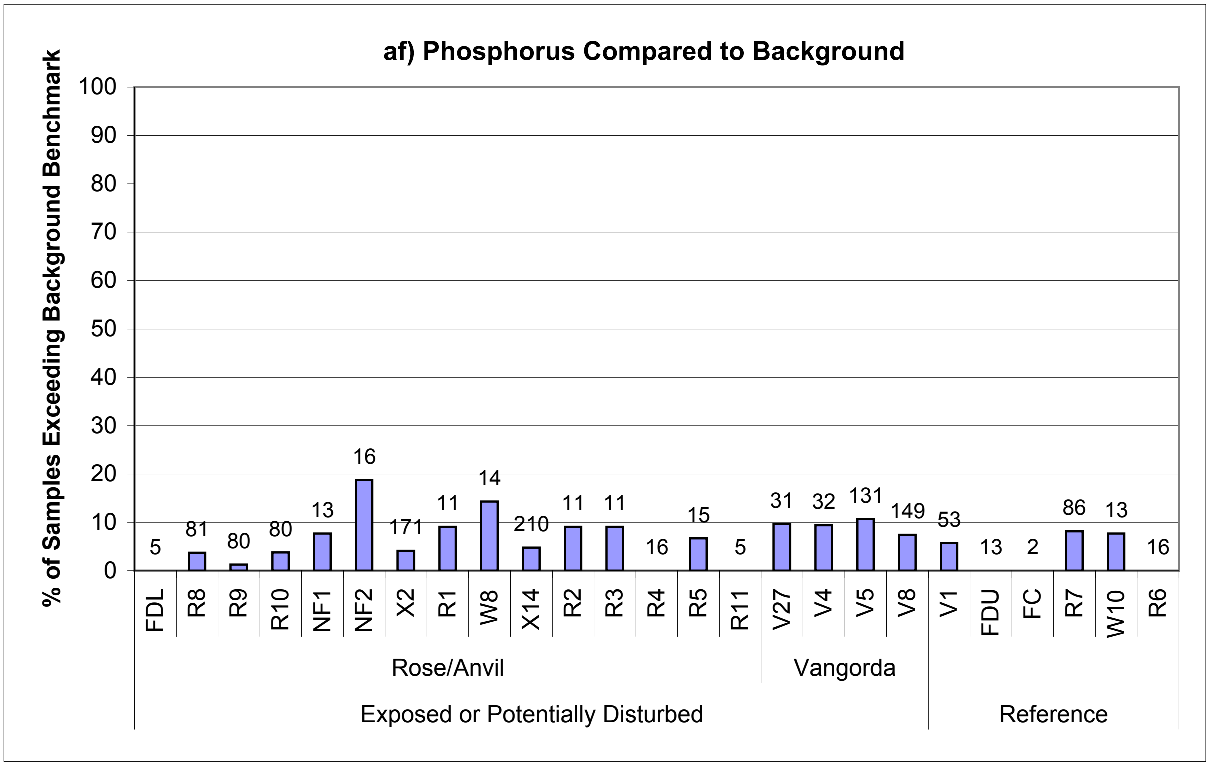


Figure A.2: Percentage and number of samples exceeding background benchmarks and CWQGs for water quality parameters measured at exposed and reference sites. Sample sizes (total n) indicated above each bar (data 1975 - 2006).



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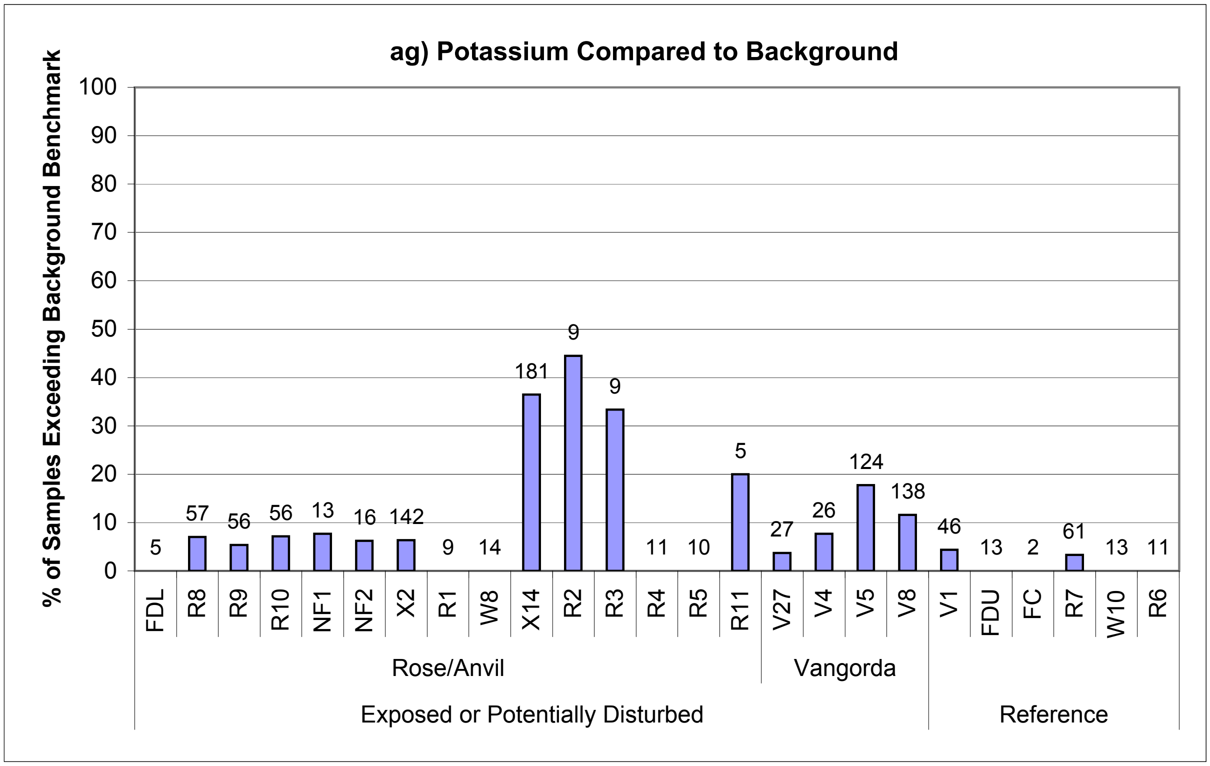

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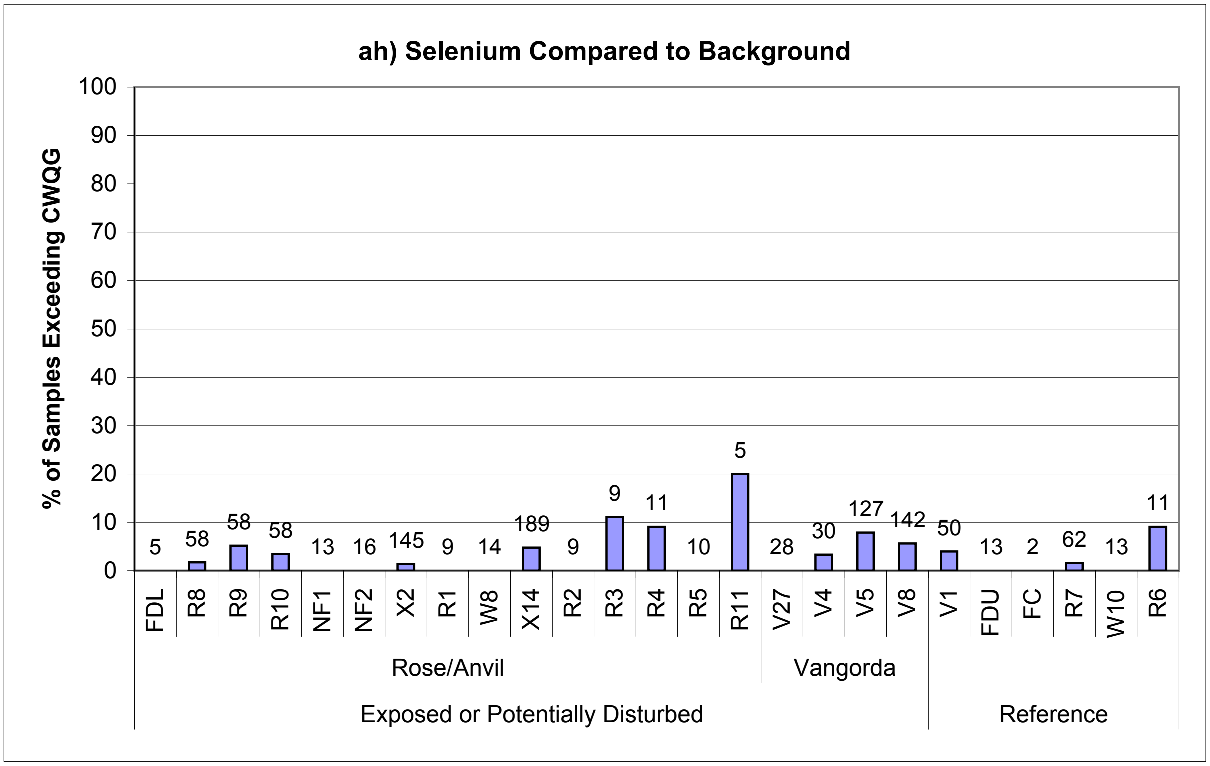


Figure A.2: Percentage and number of samples exceeding CWQGs for water quality parameters measured at exposed and reference sites Sample sizes (total n) indicated above each bar (data 1975 - 2006).

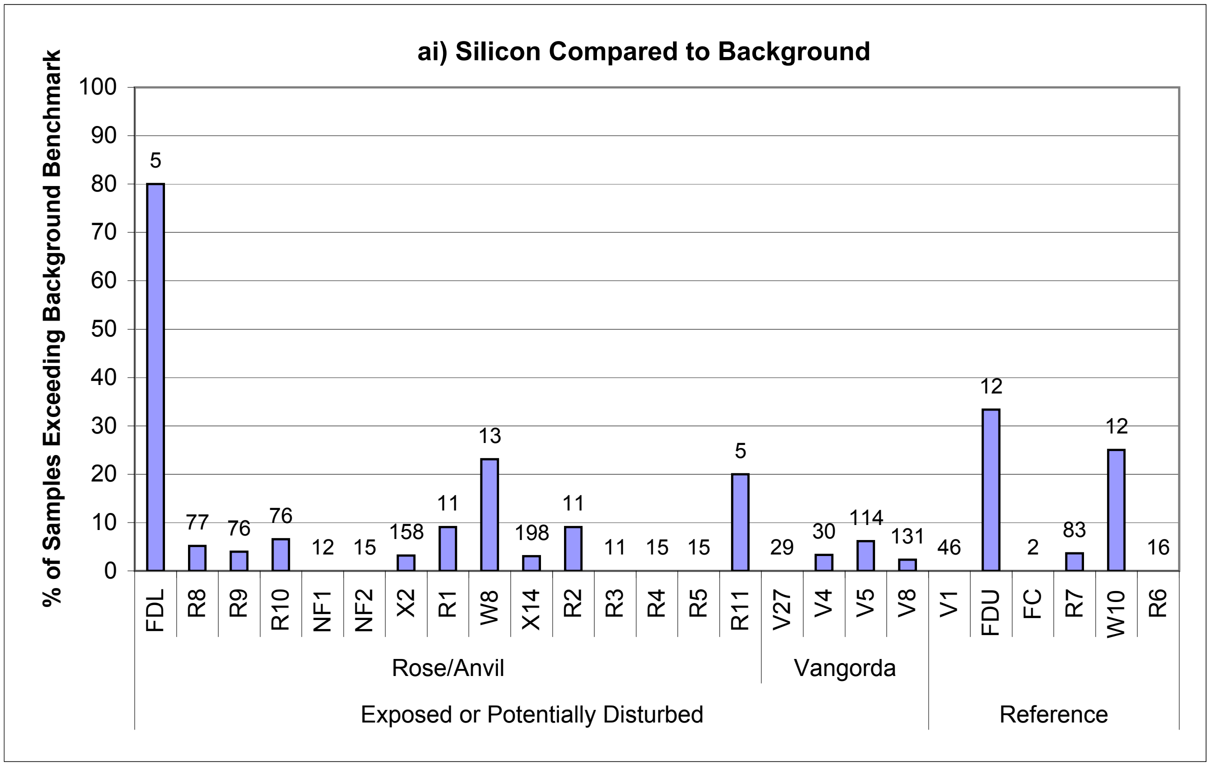


Figure A.2: Percentage and number of samples exceeding background benchmarks for water quality parameters measured at exposed and reference sites Sample sizes (total n) indicated above each bar (data 1975 - 2006).

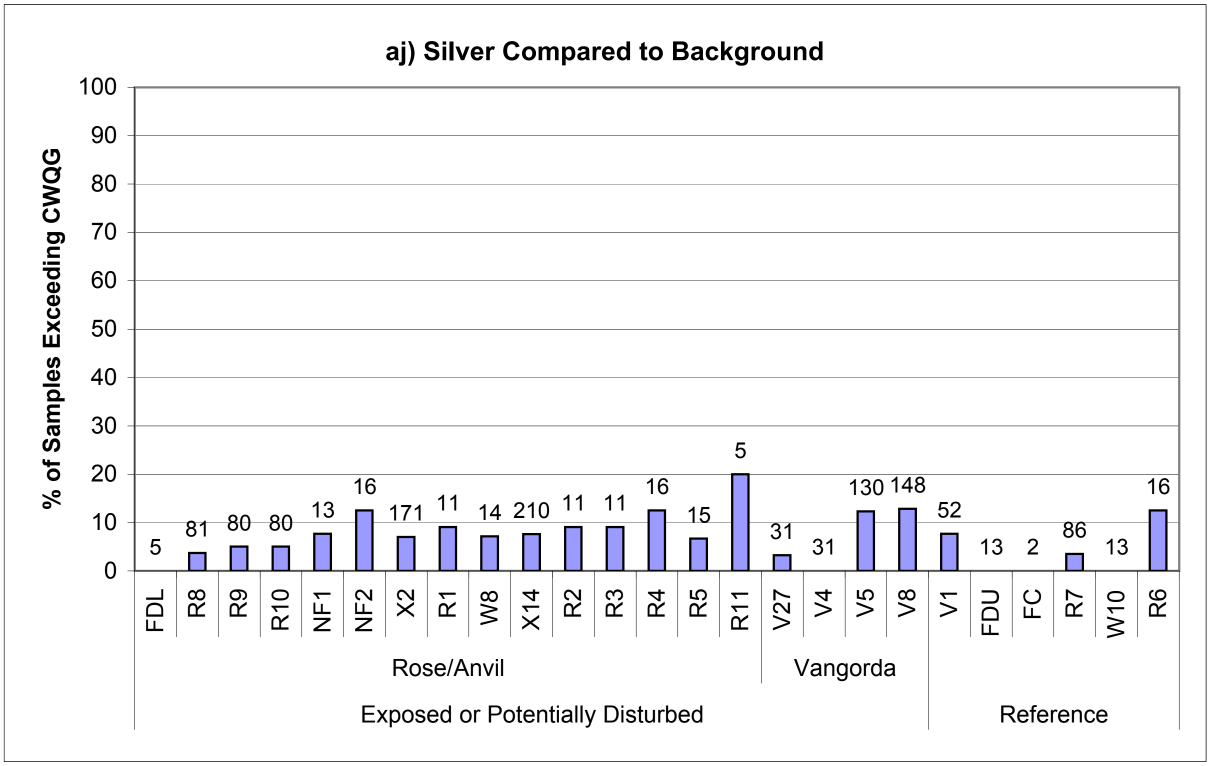


Figure A.2: Percentage and number of samples exceeding CWQGs for water quality parameters measured at exposed and reference sites Sample sizes (total n) indicated above each bar (data 1975 - 2006).

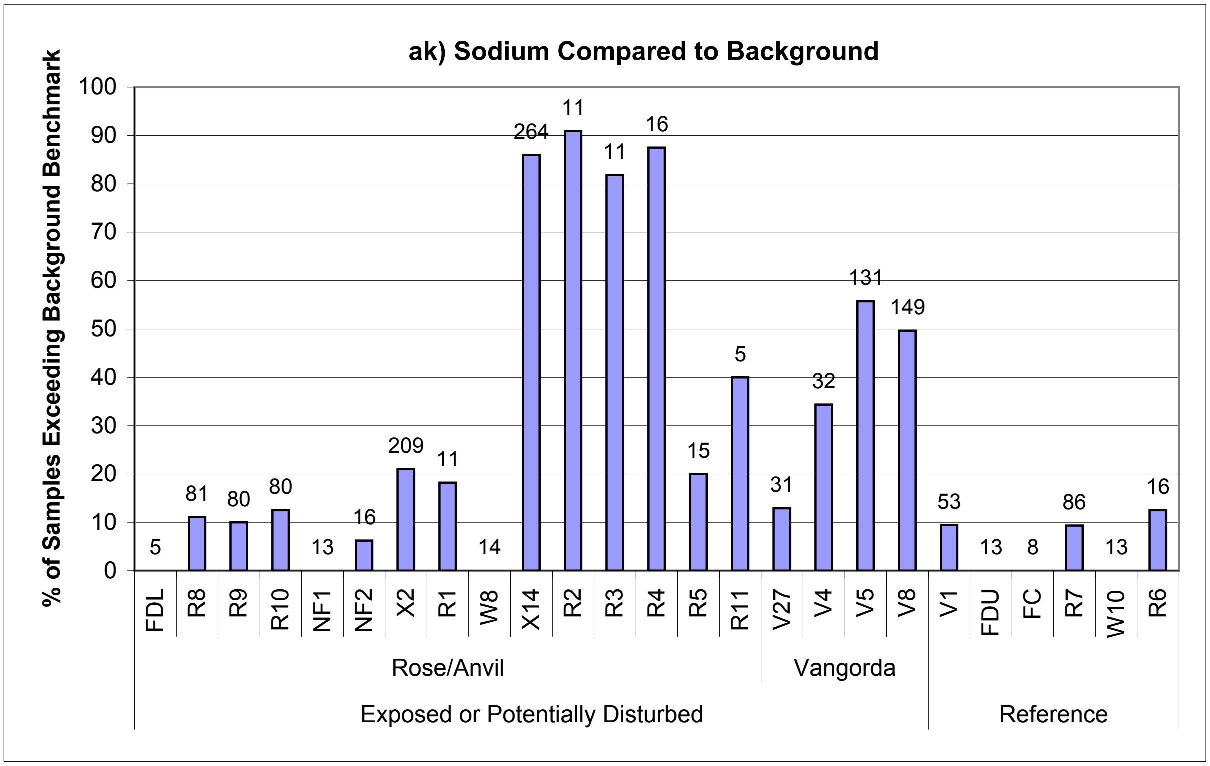
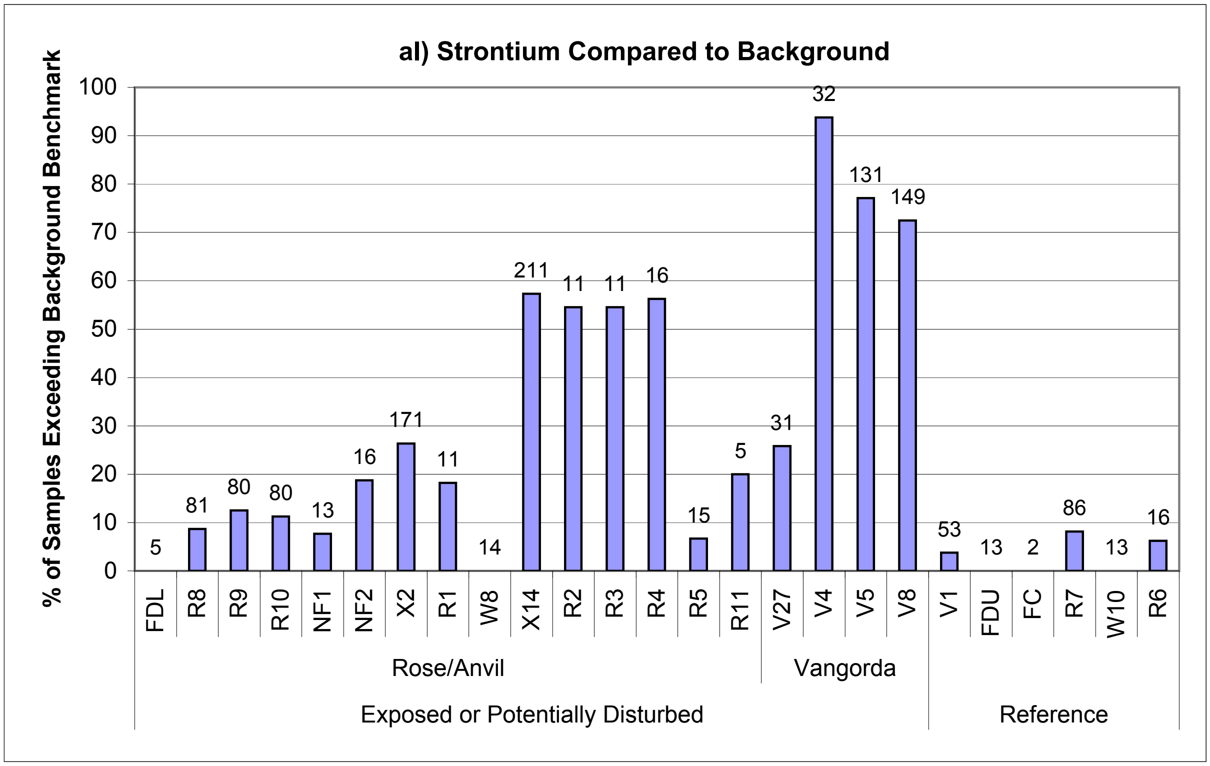


Figure A.2: Percentage and number of samples exceeding reference-based benchmarks for water quality parameters measured at exposed and reference sites Sample sizes (total n) indicated above each bar (data 1975 - 2006).



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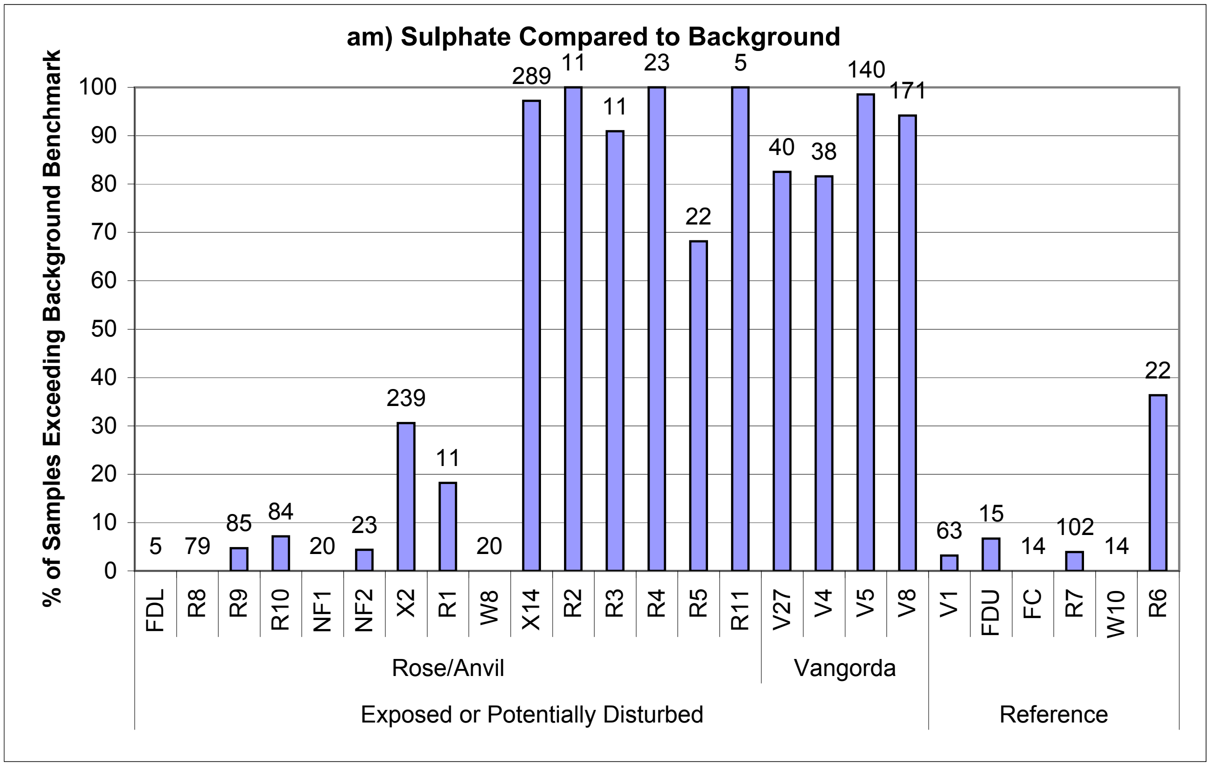

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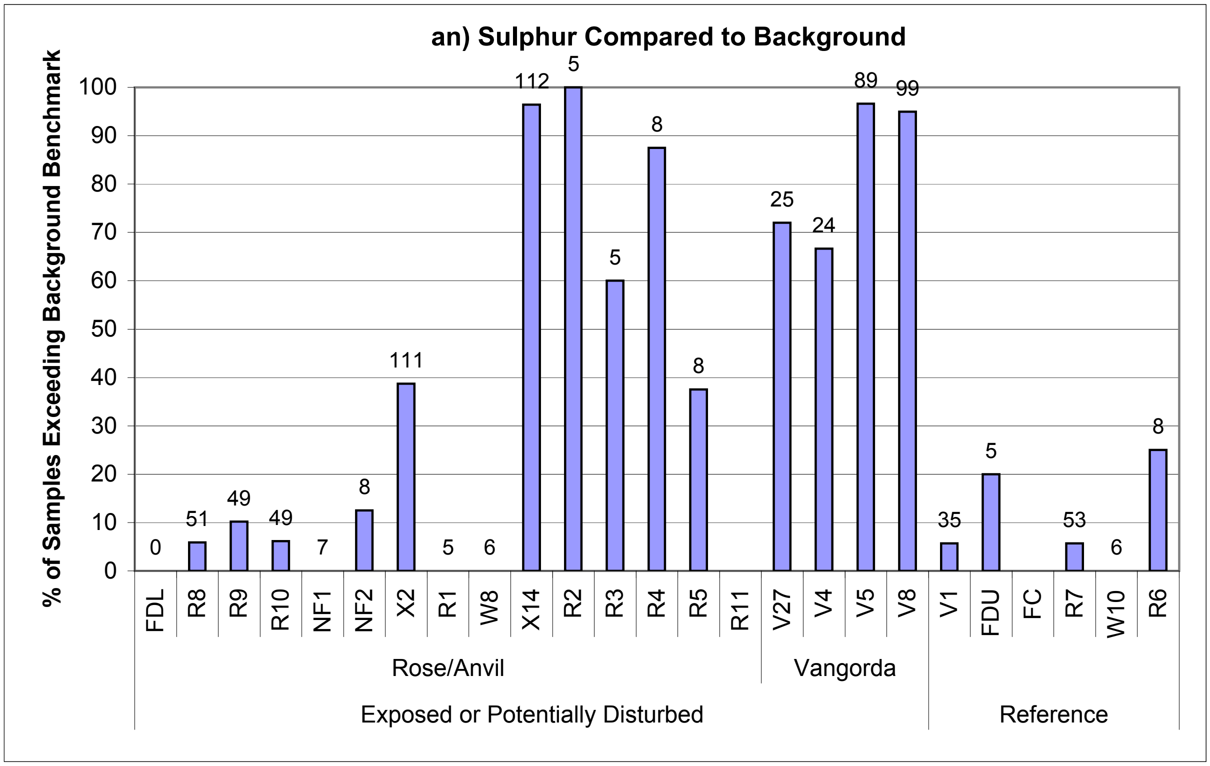

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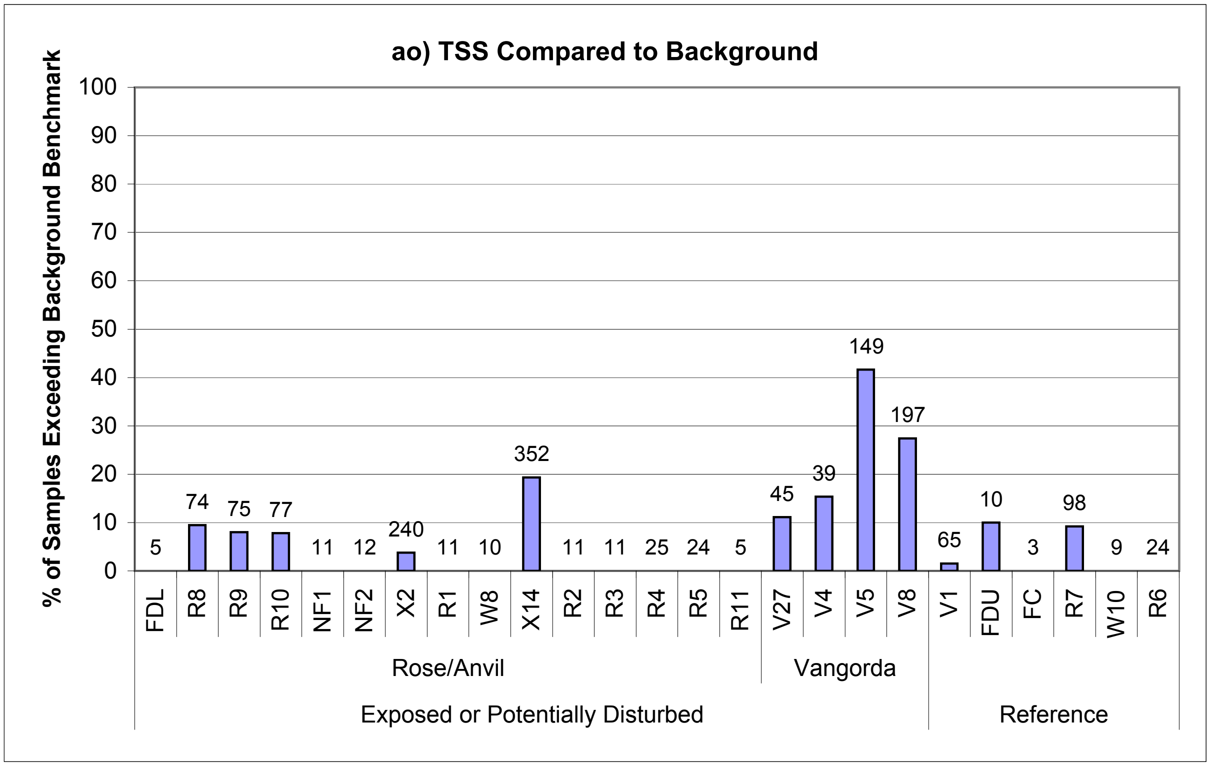

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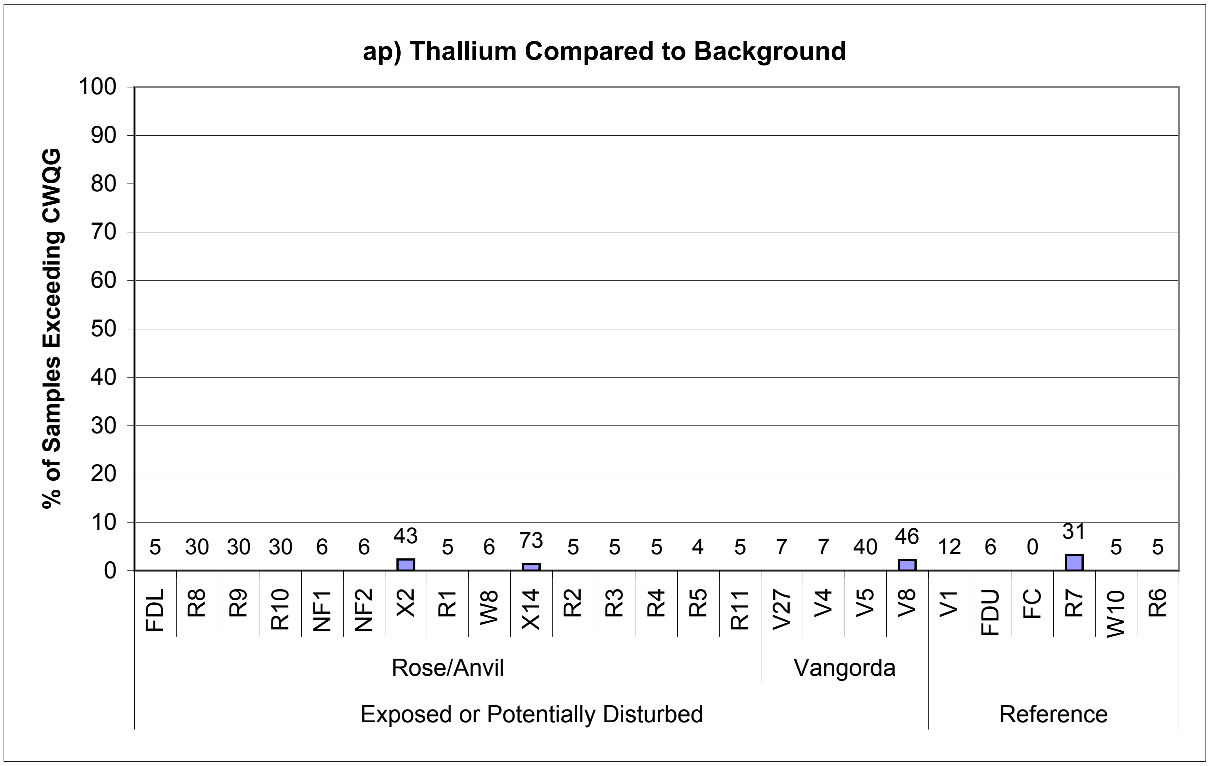
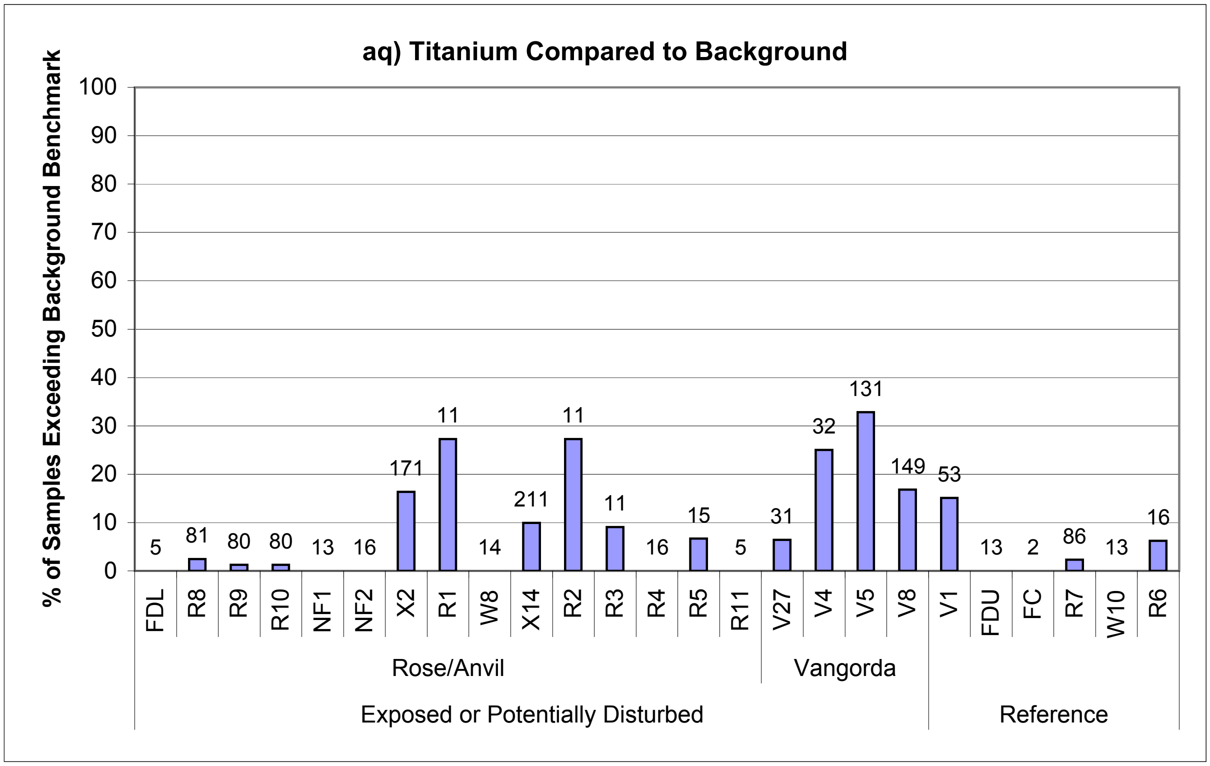


**Figure A.2: Percentage and number of samples exceeding CWQGs for water quality parameters measured at exposed and reference sites
Sample sizes (total n) indicated above each bar (data 1975 - 2006).**



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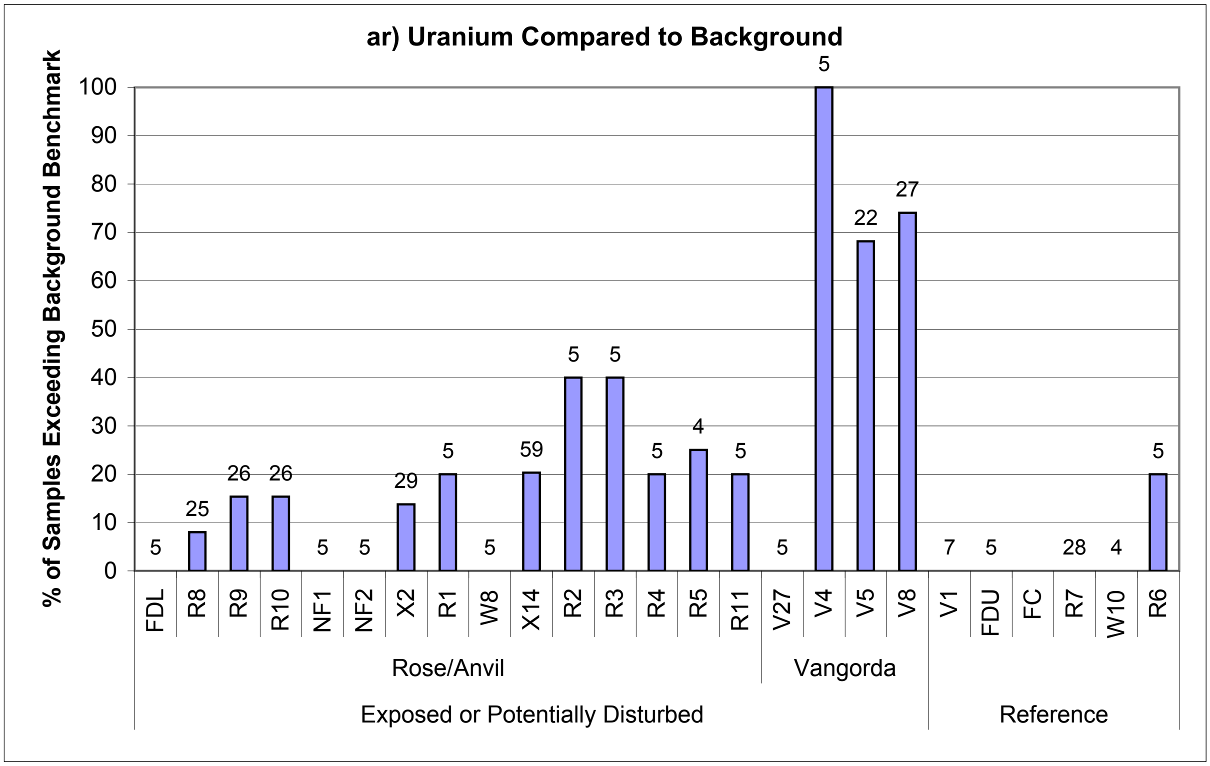

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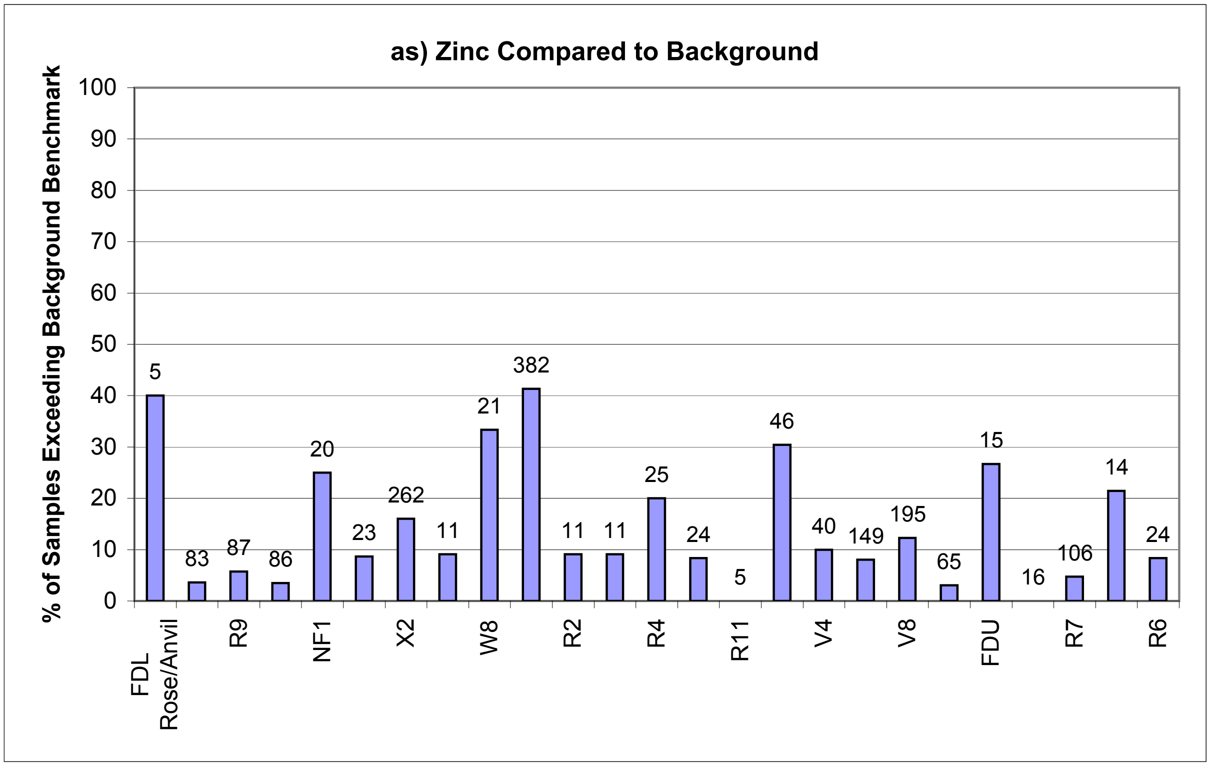


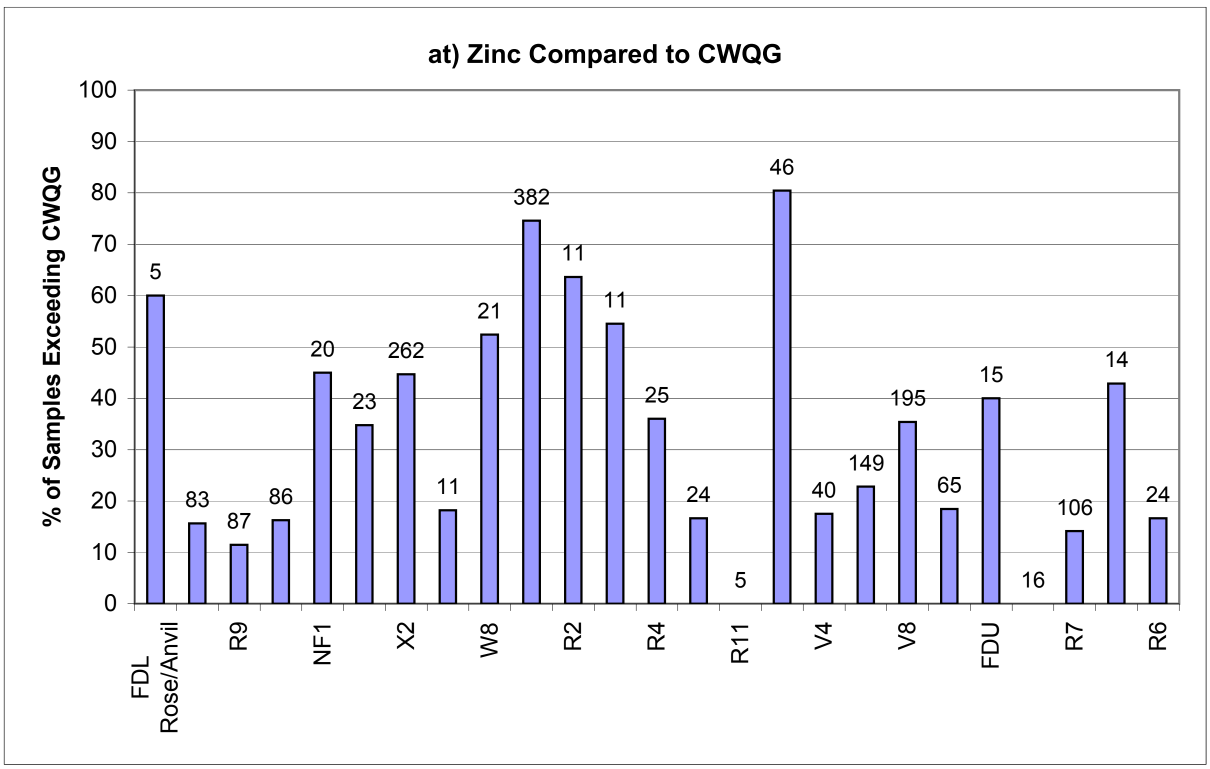
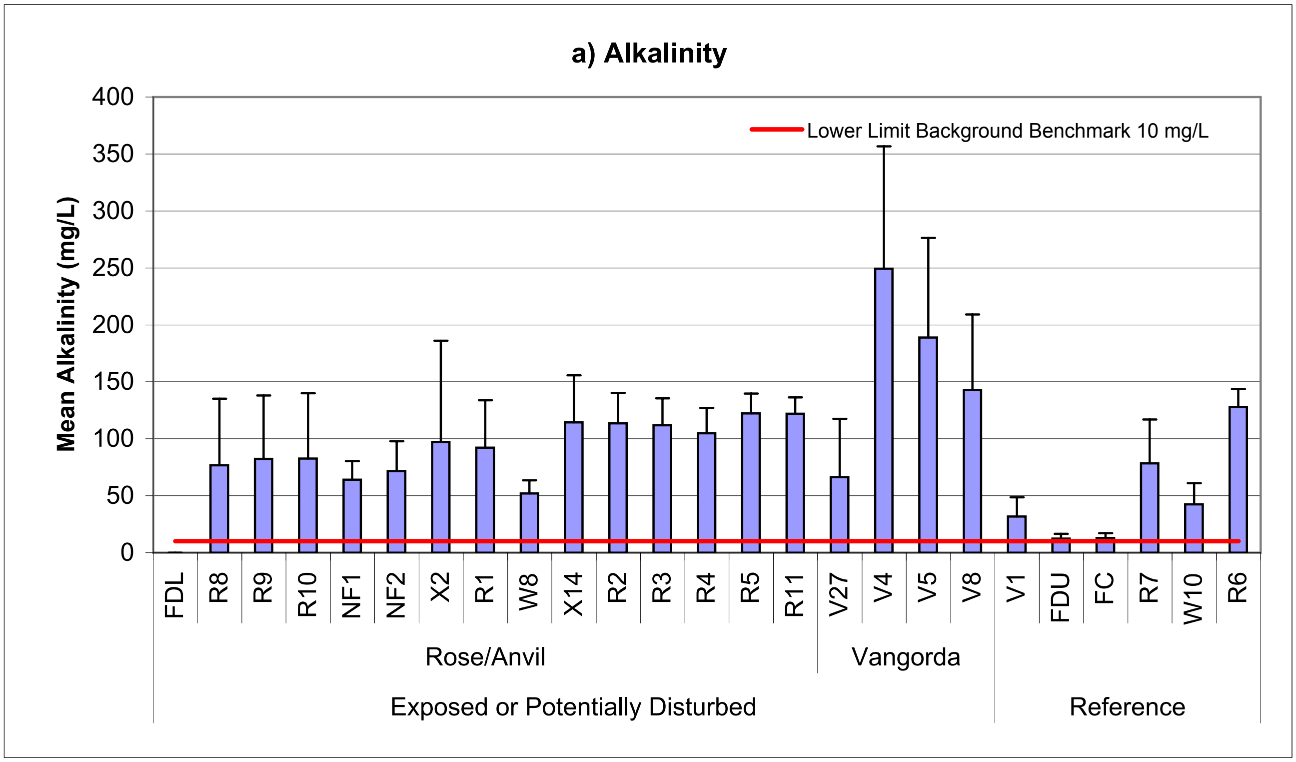


Figure A.2: Percentage and number of samples exceeding background benchmarks and CWQGs for water quality parameters measured at exposed and reference sites. Sample size (total n) indicated above each bar (data 1975 - 2006).



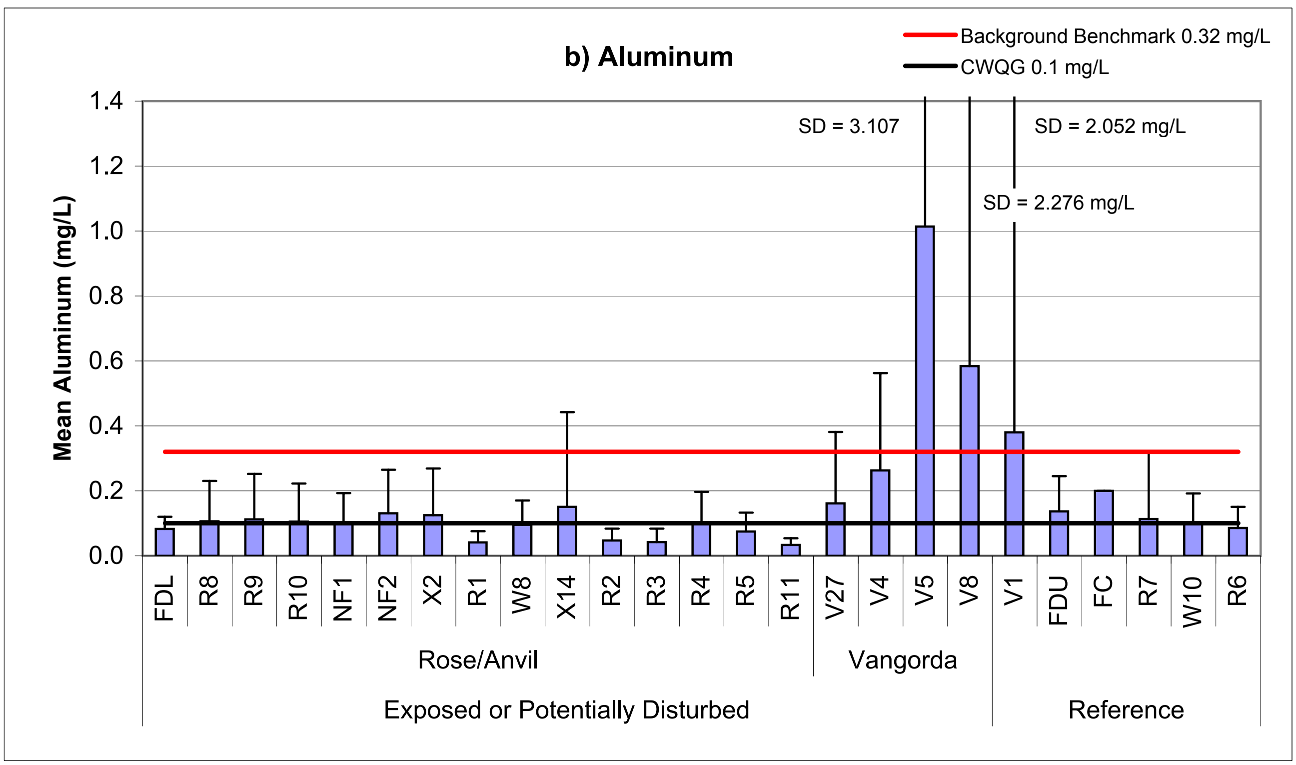
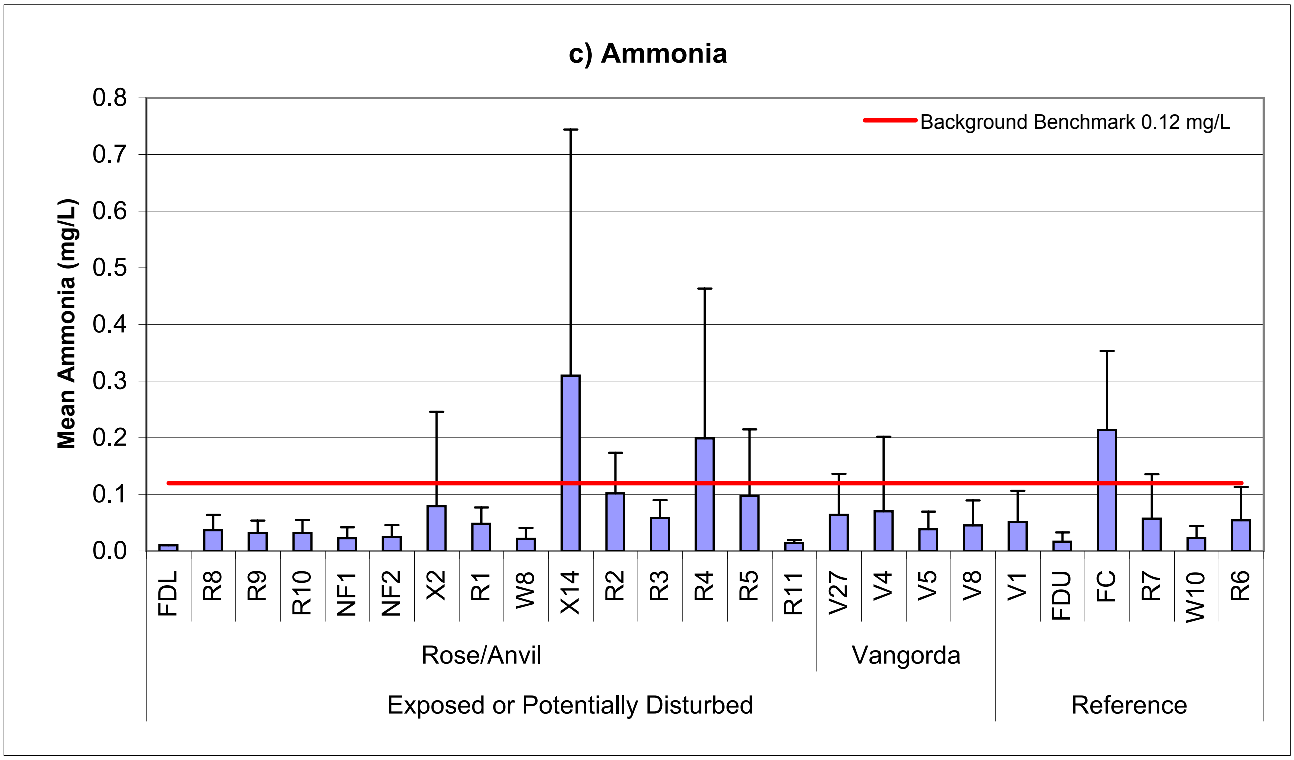
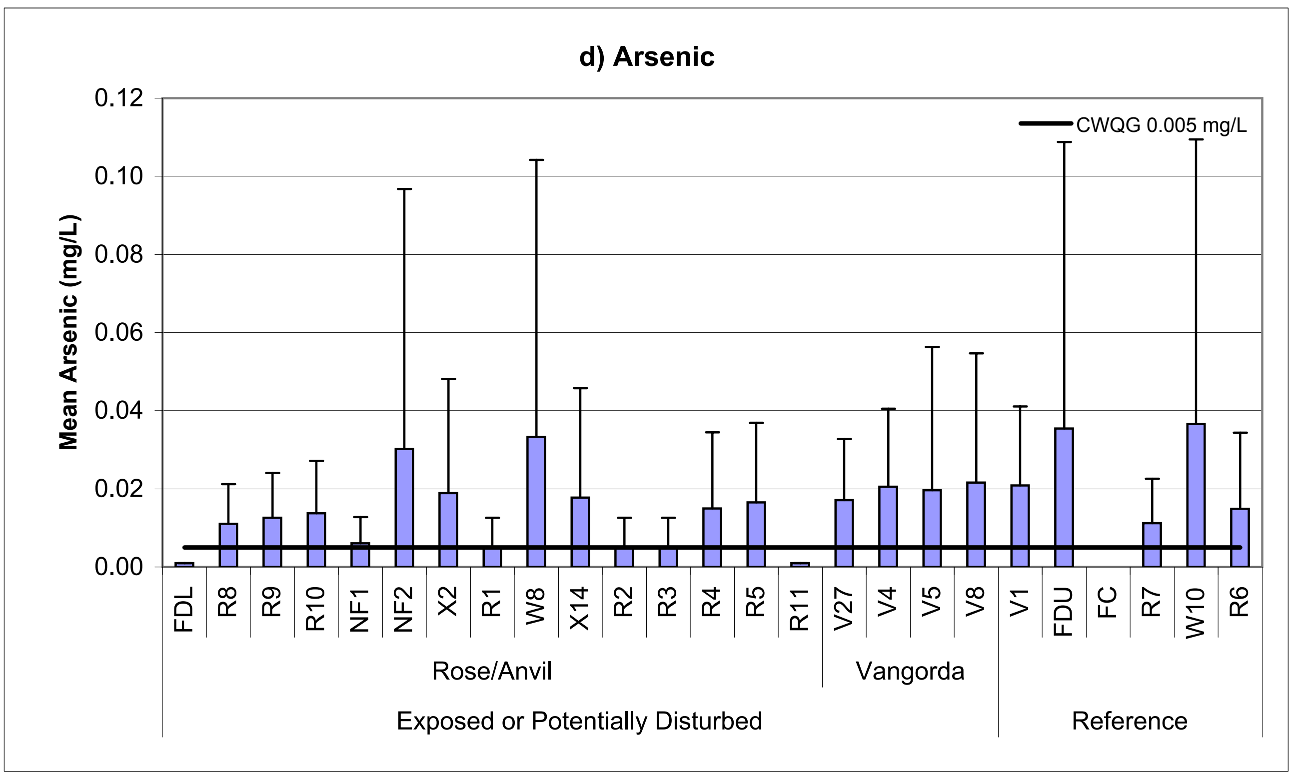


Figure A.3: Mean (and SD) concentrations of water quality parameters at each station relative to background benchmarks and Canadian water quality guidelines (CWQG), where applicable (data 1975 - 2006).





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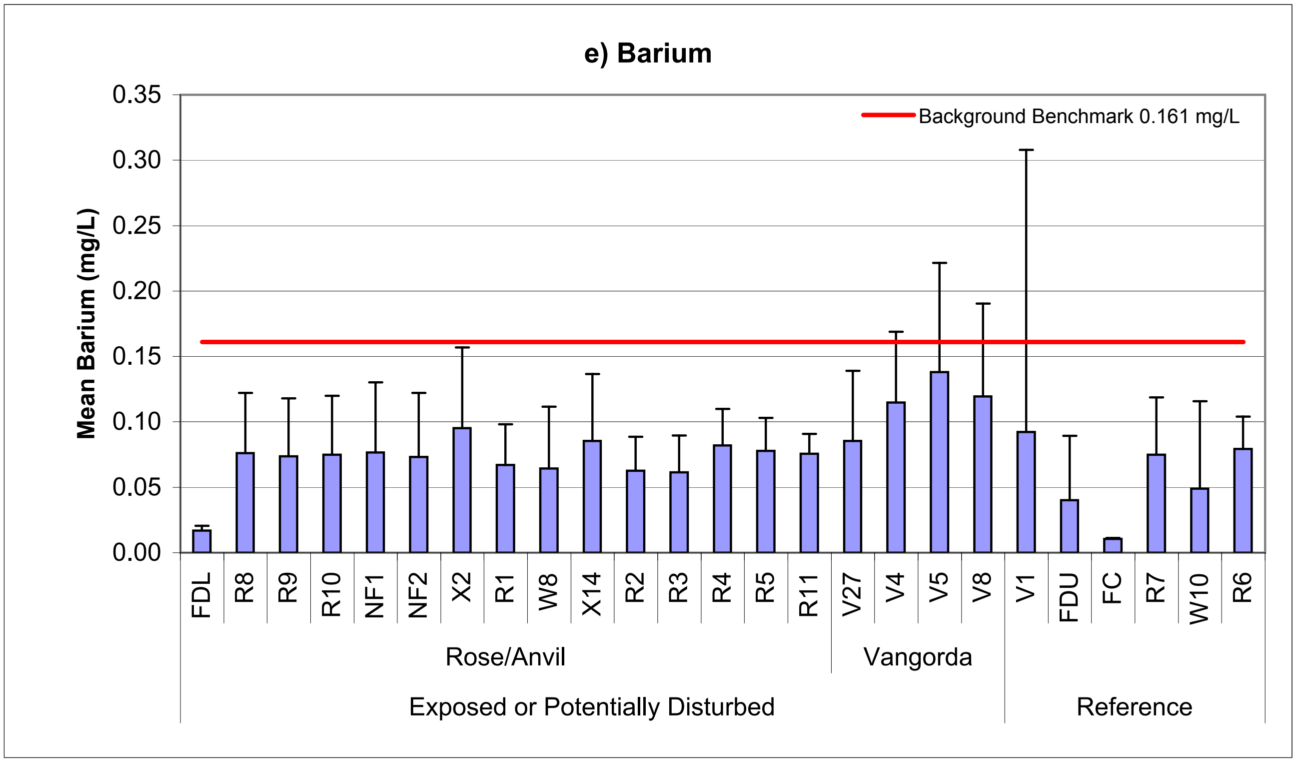

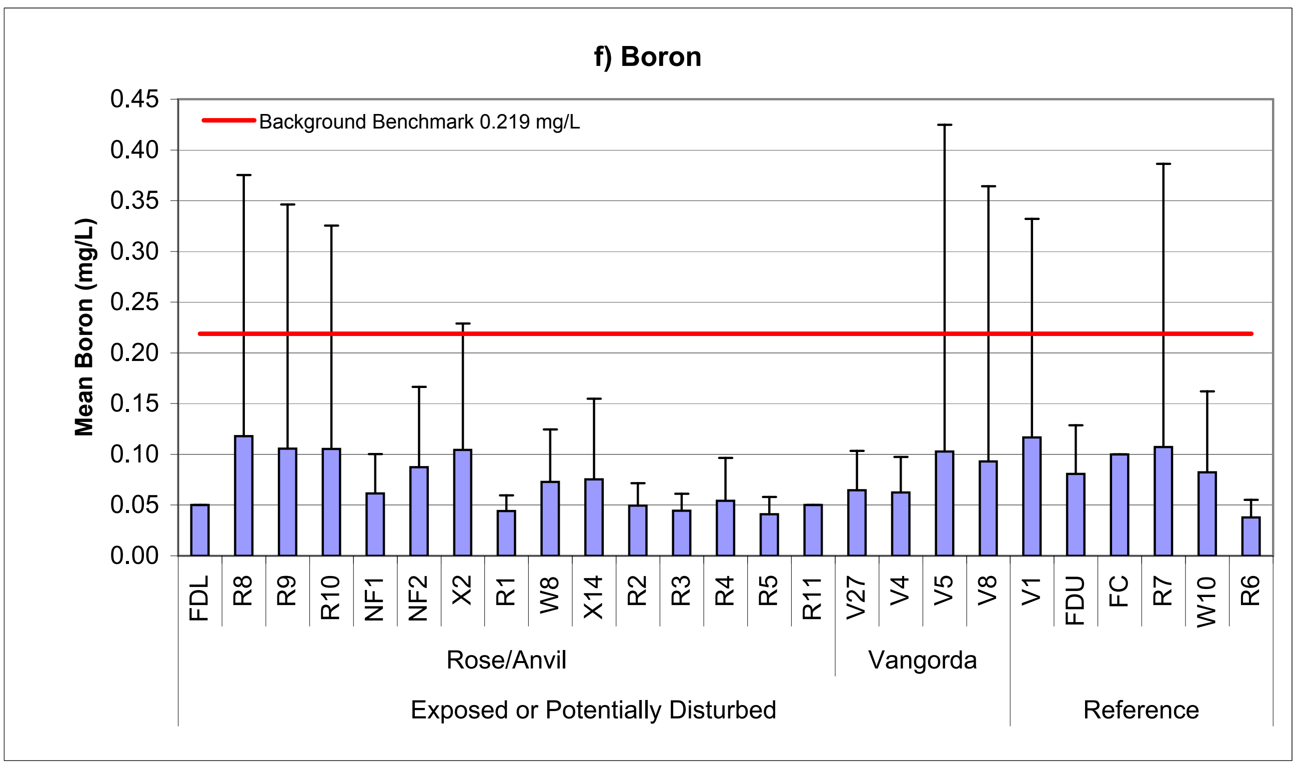

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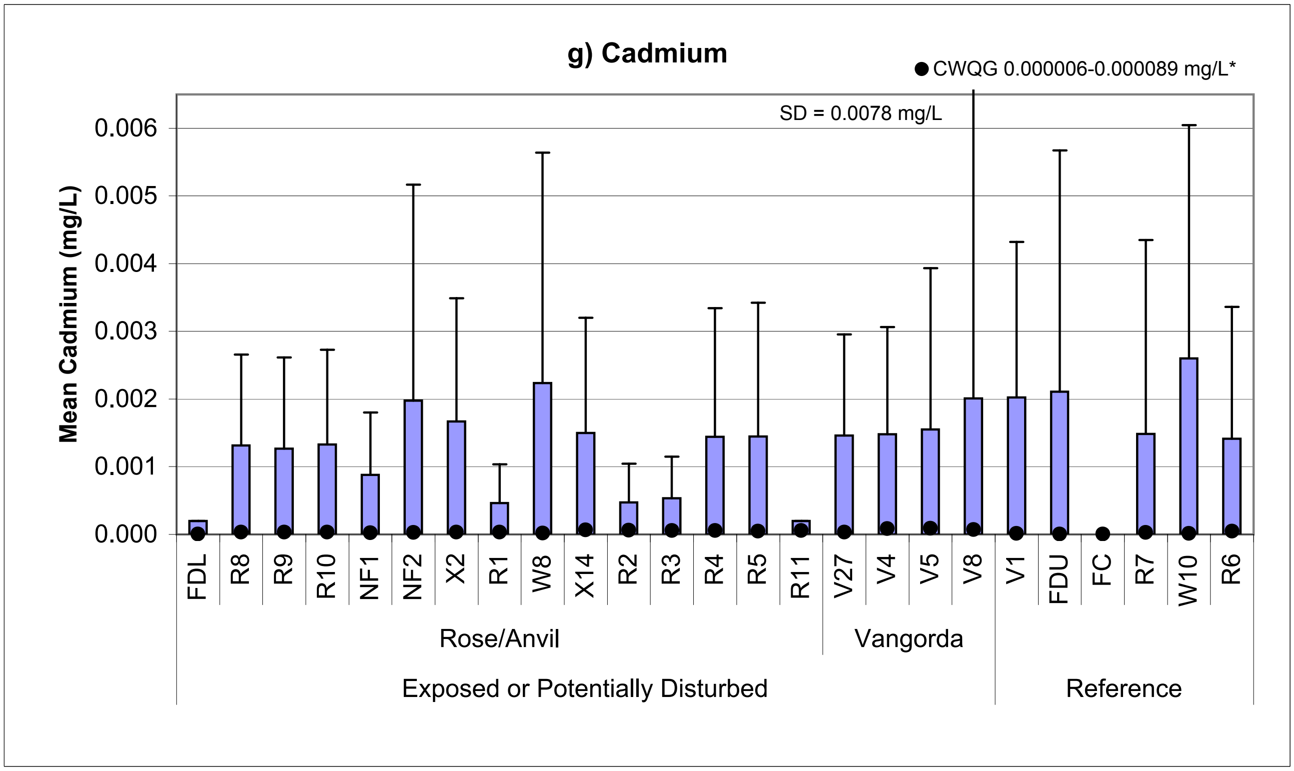

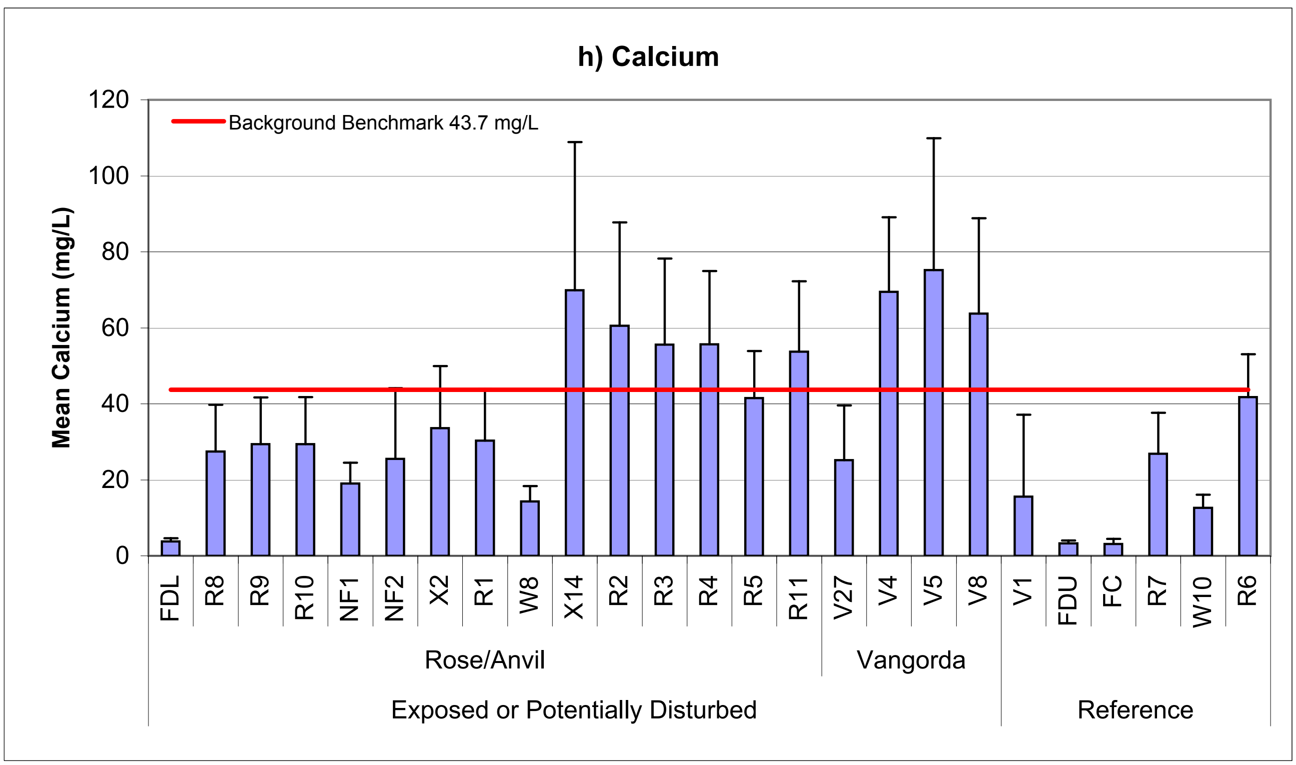

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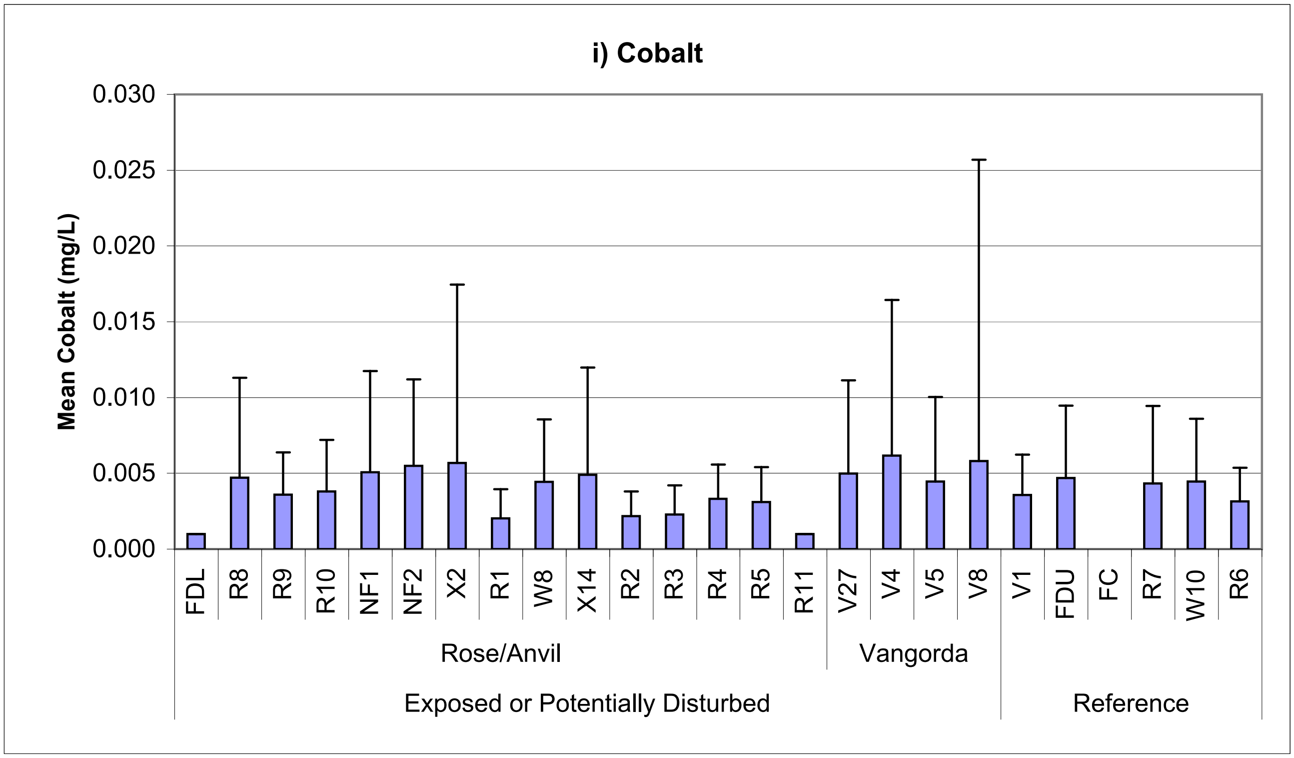

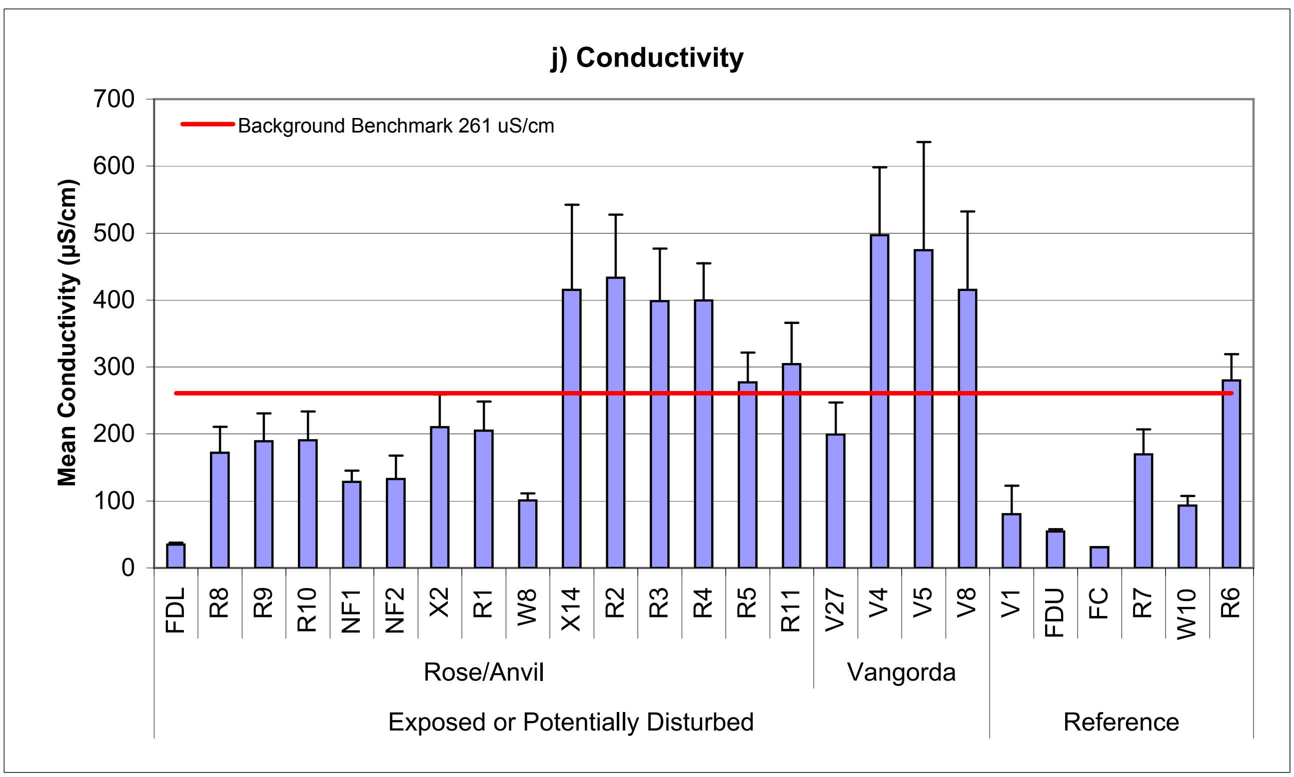

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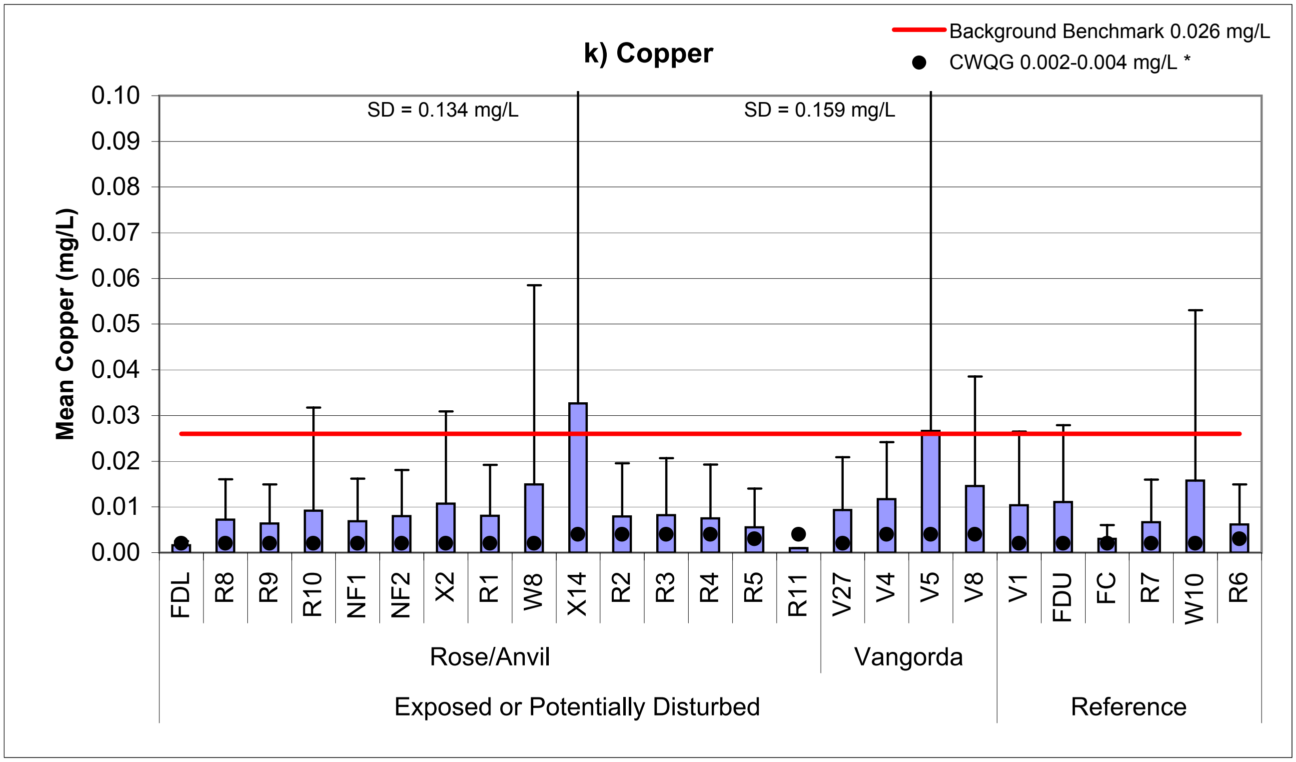

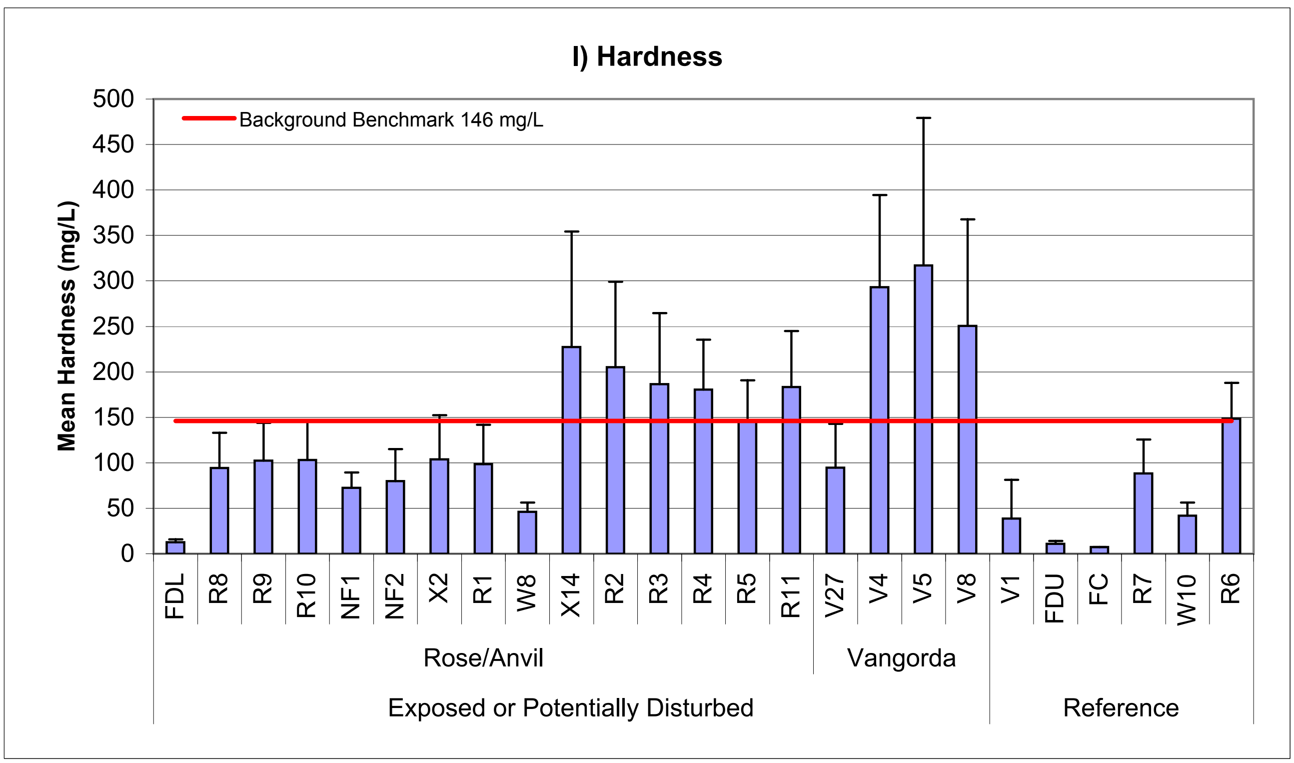

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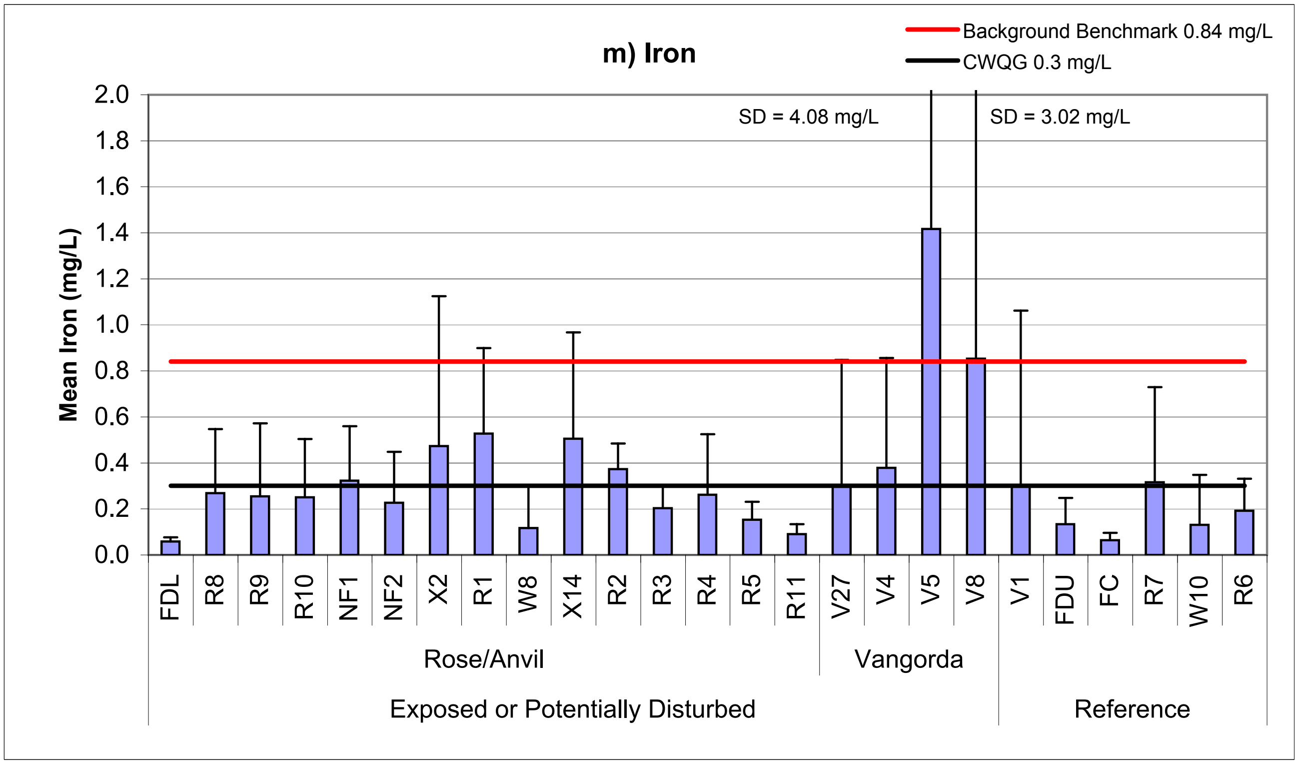

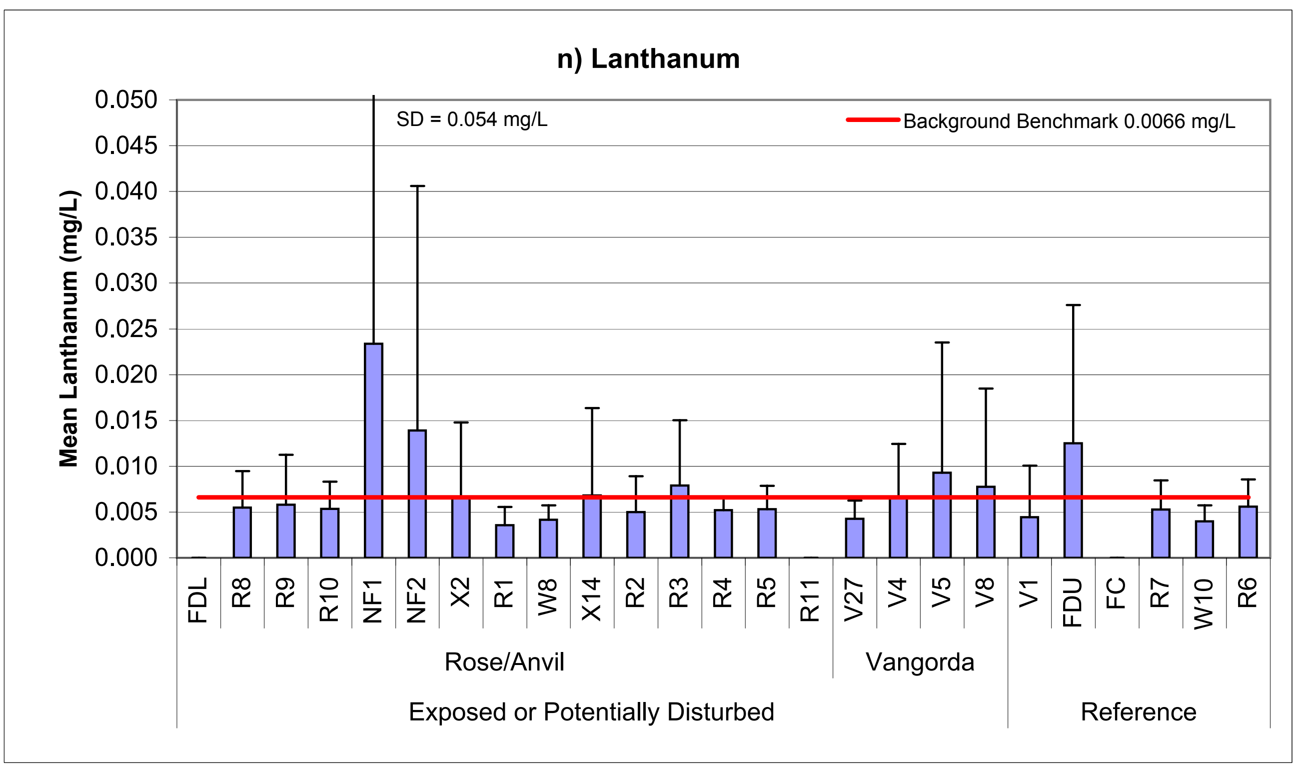

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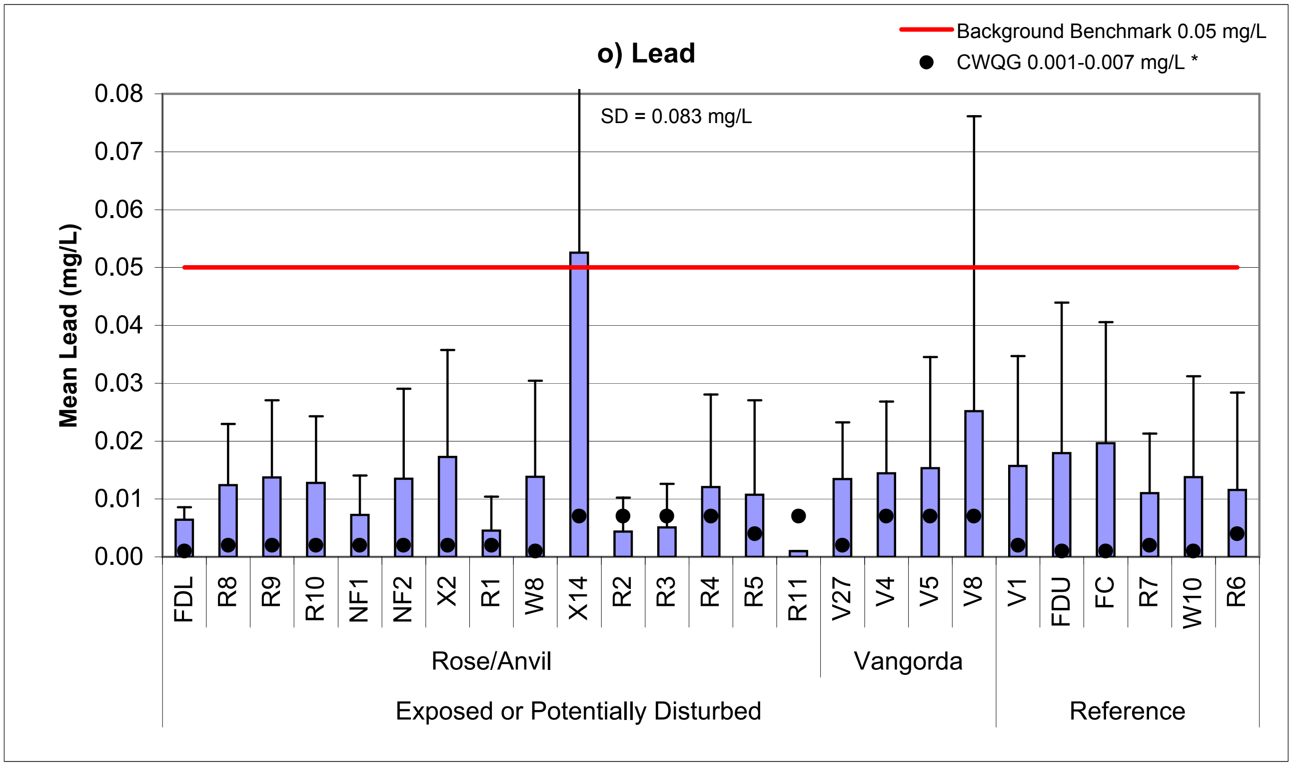

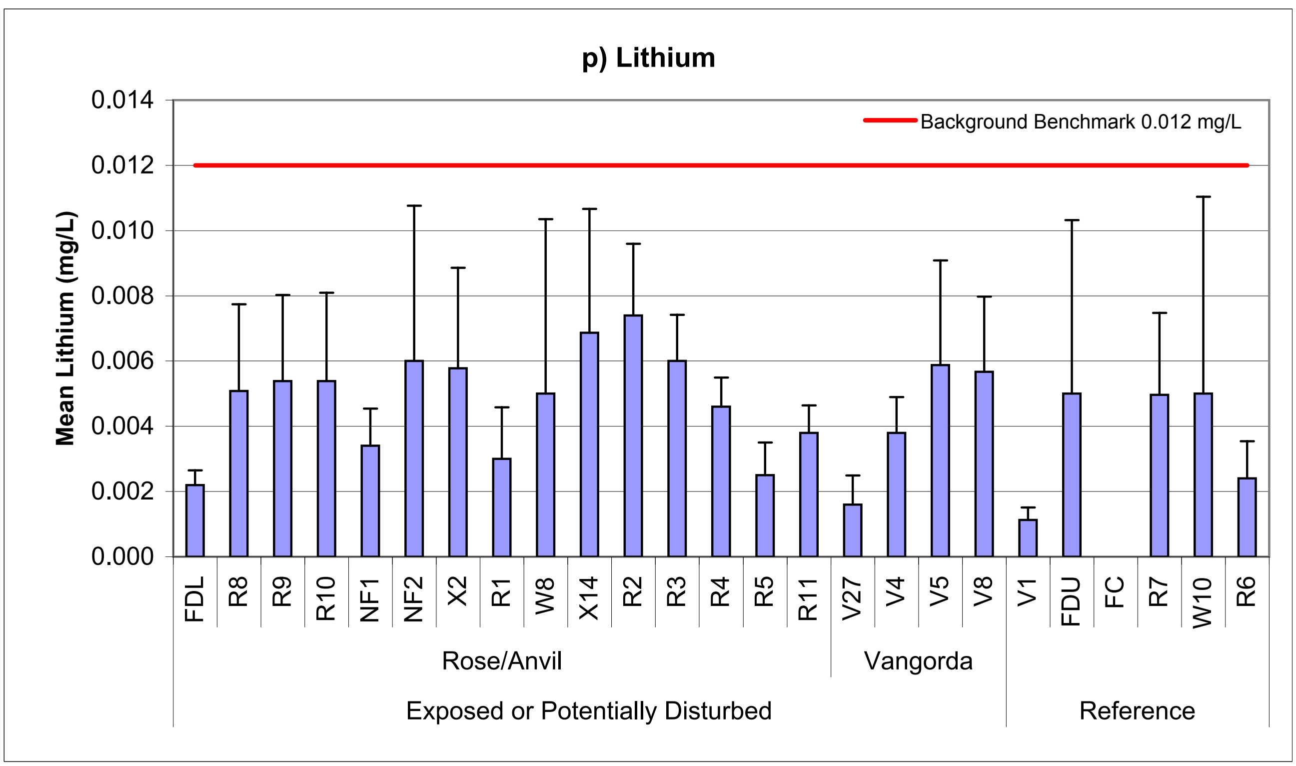

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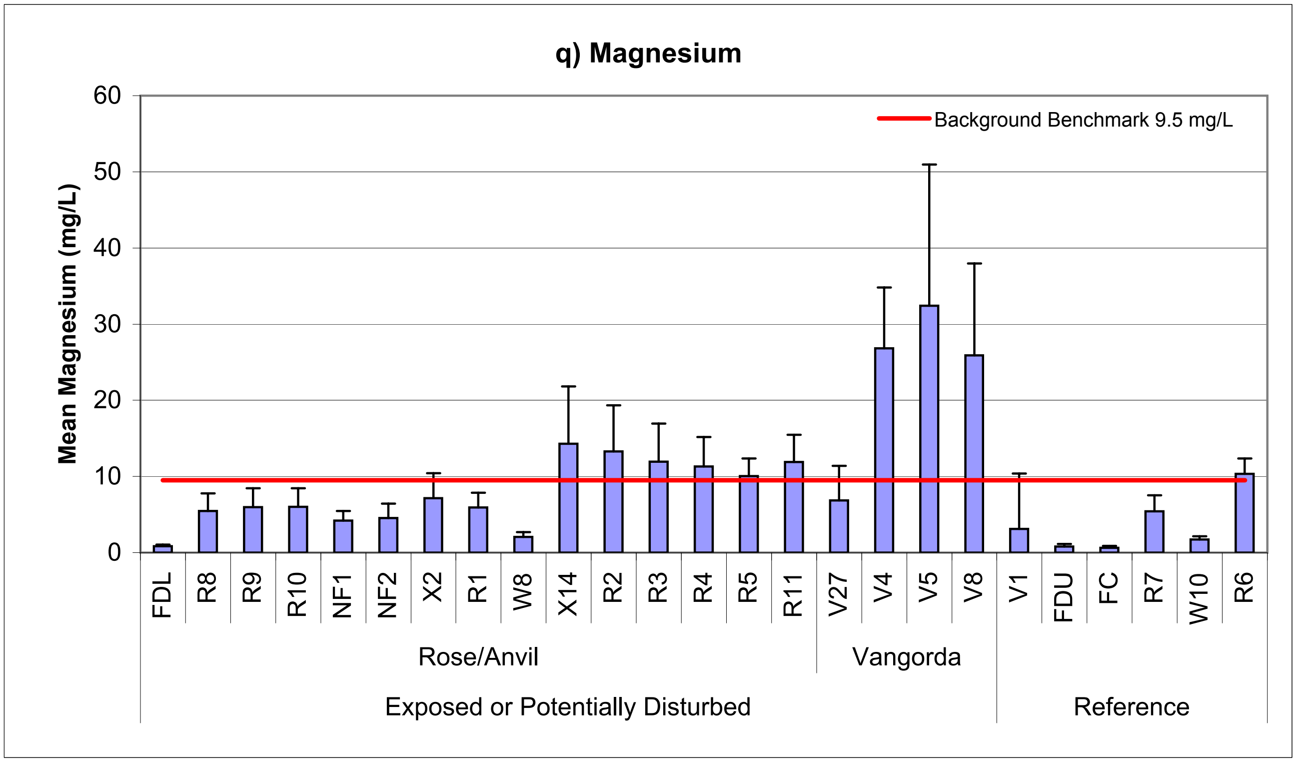

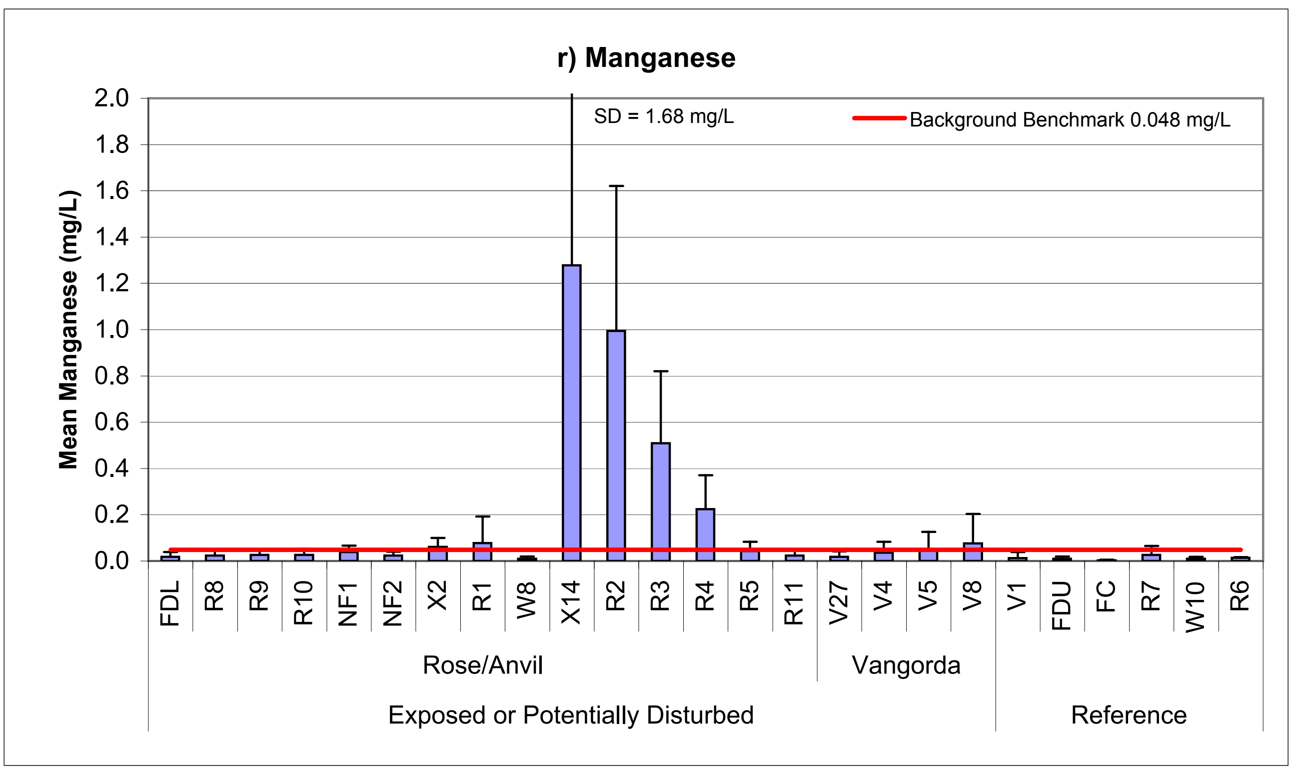

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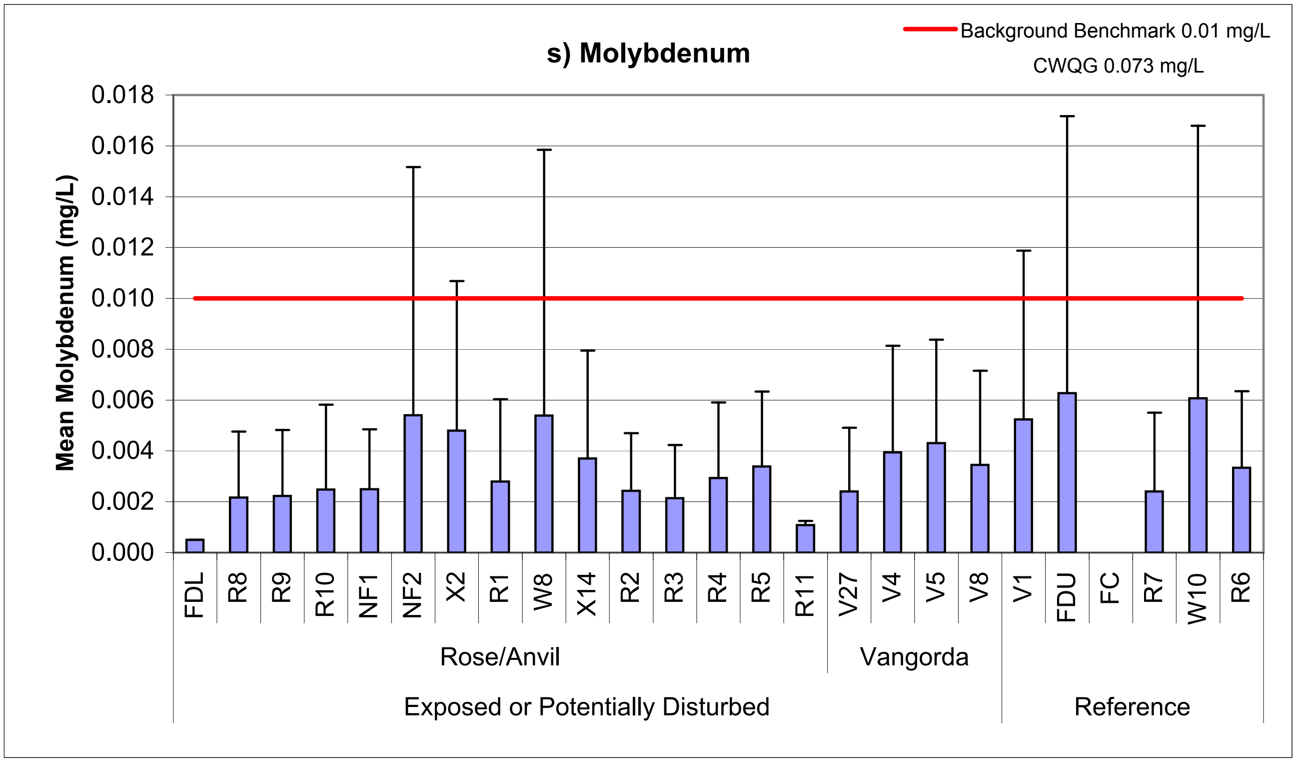

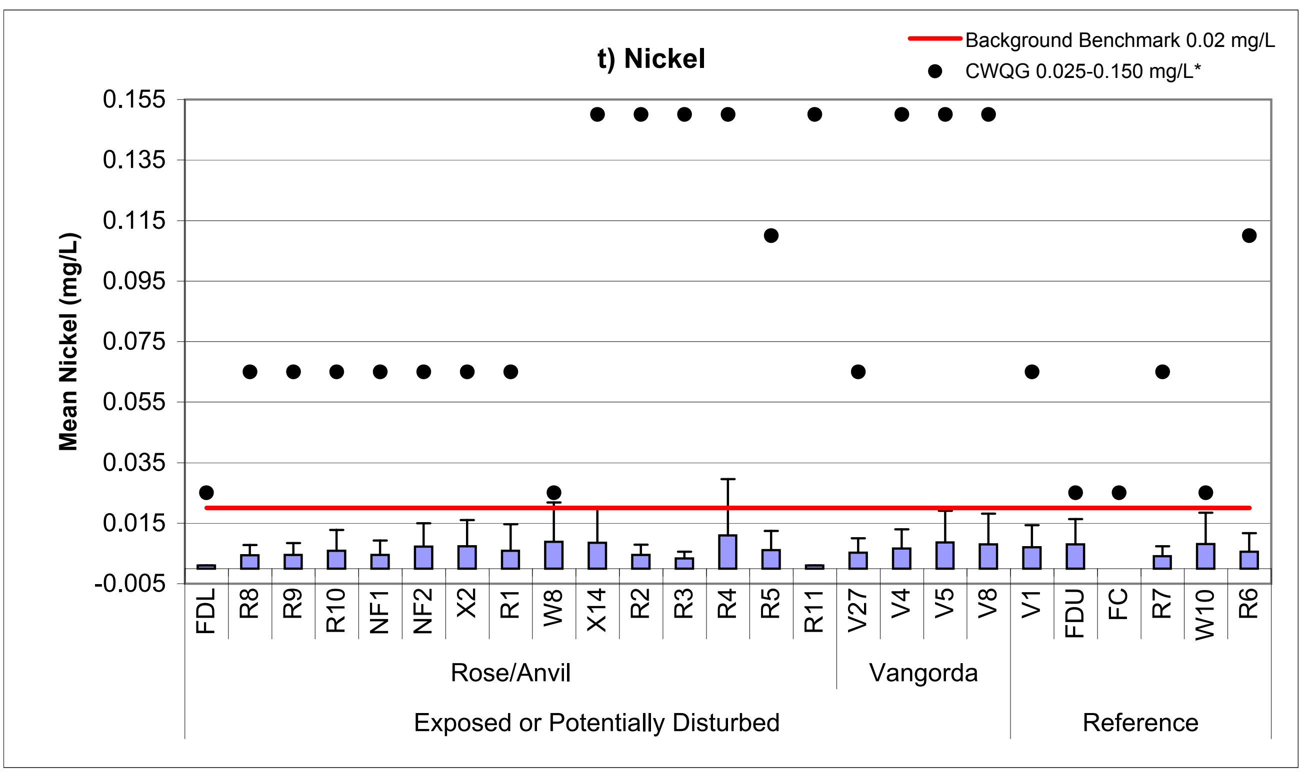

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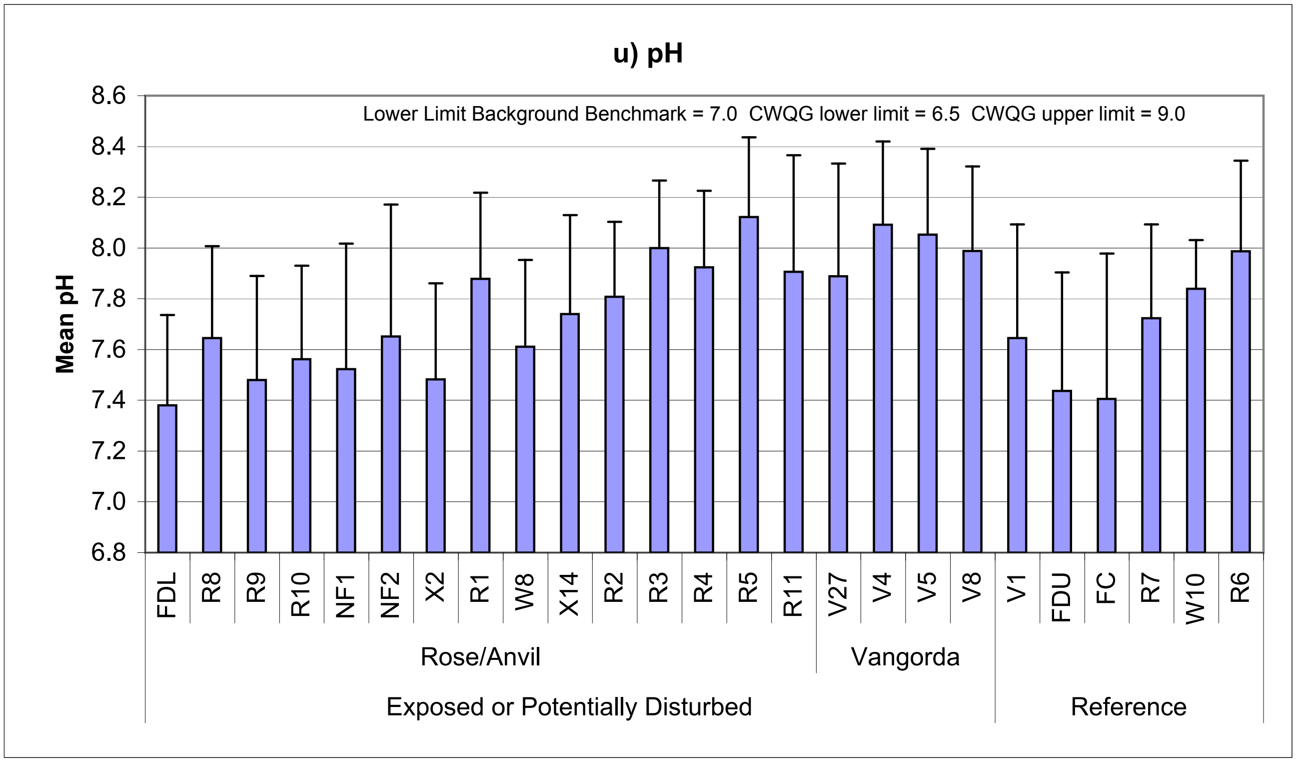

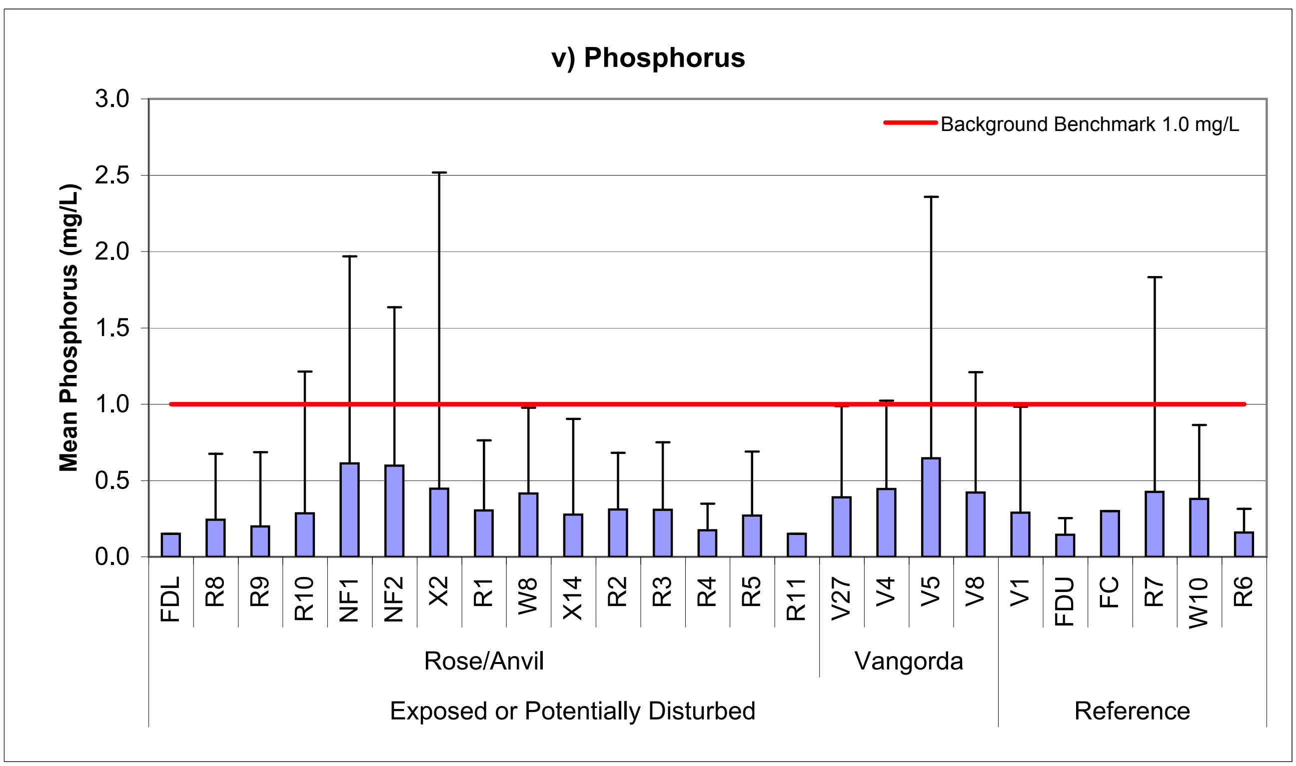

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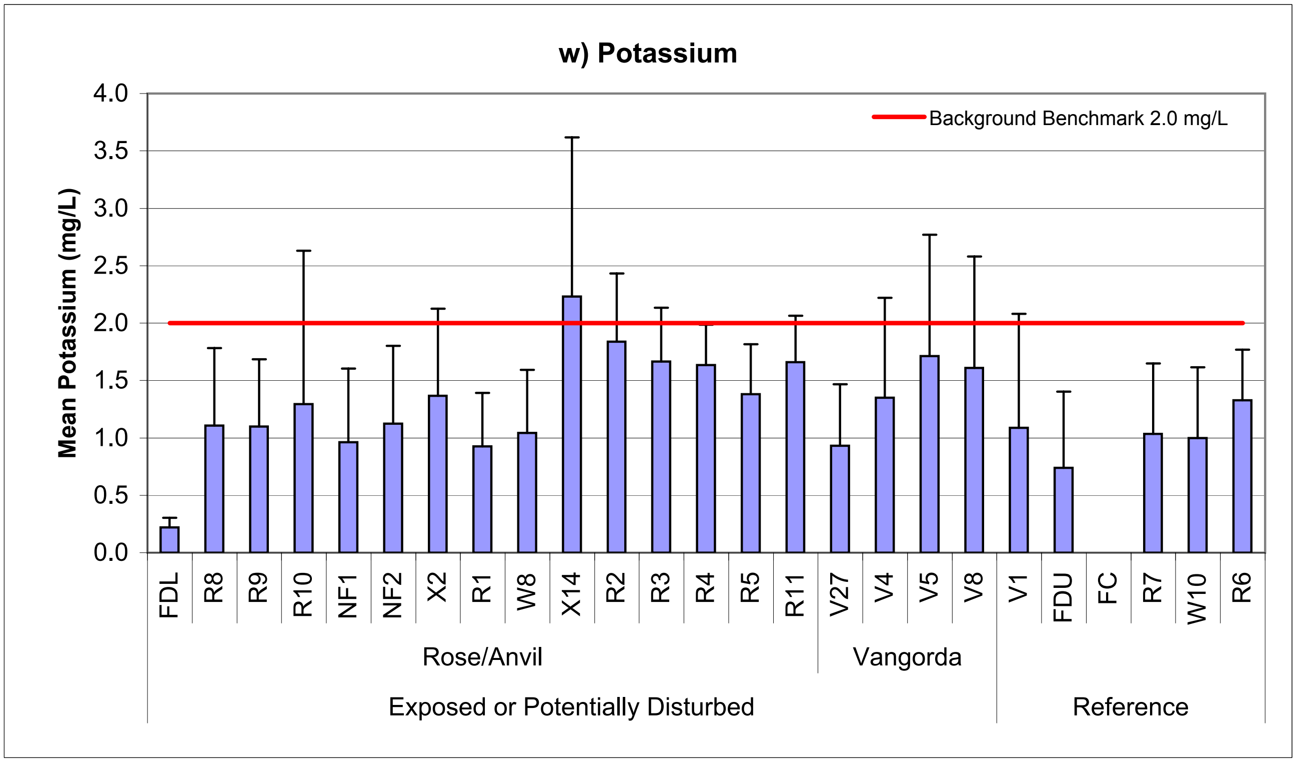

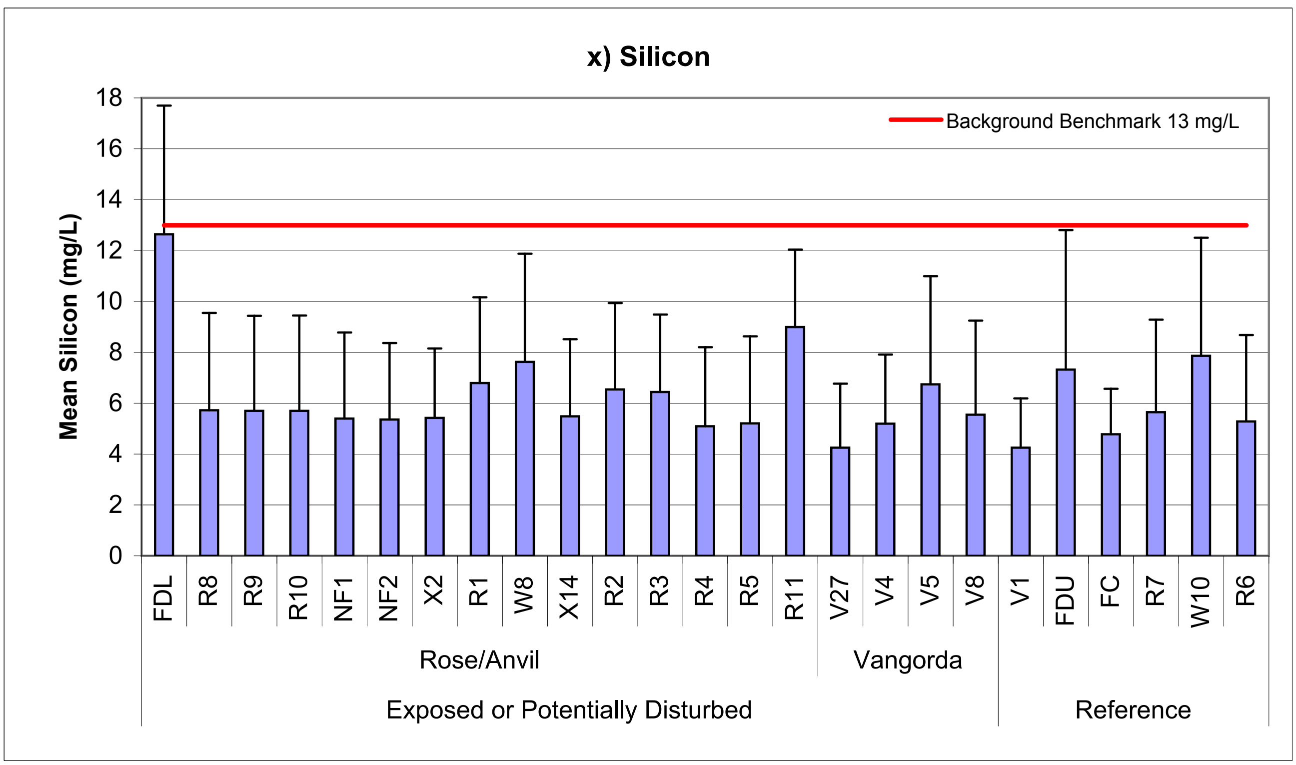

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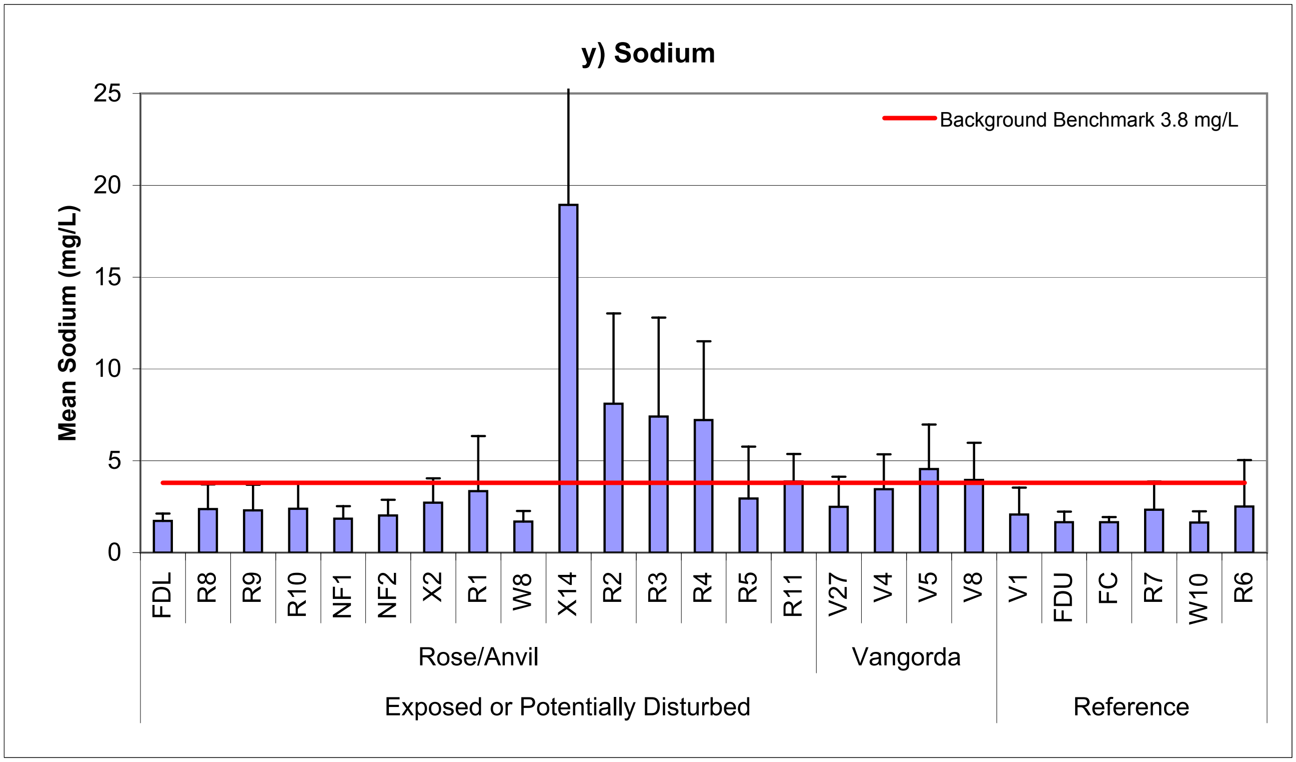


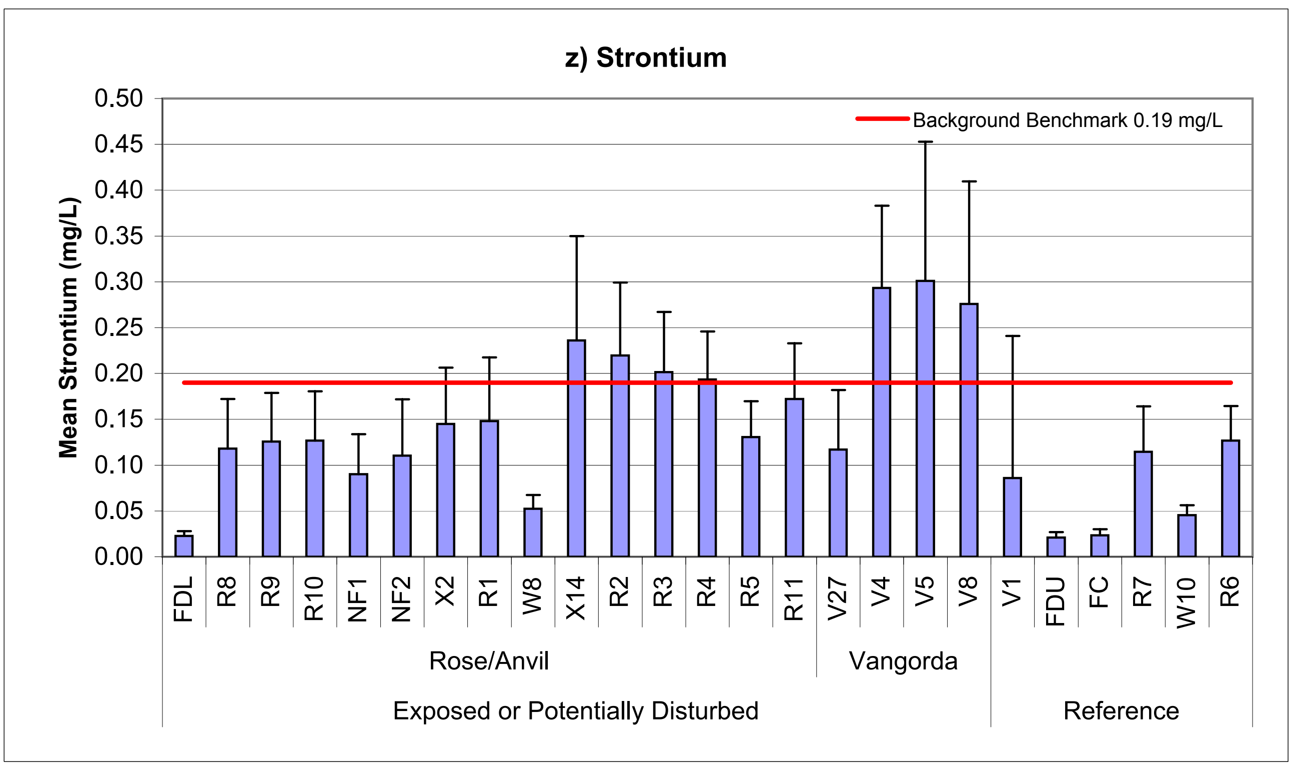
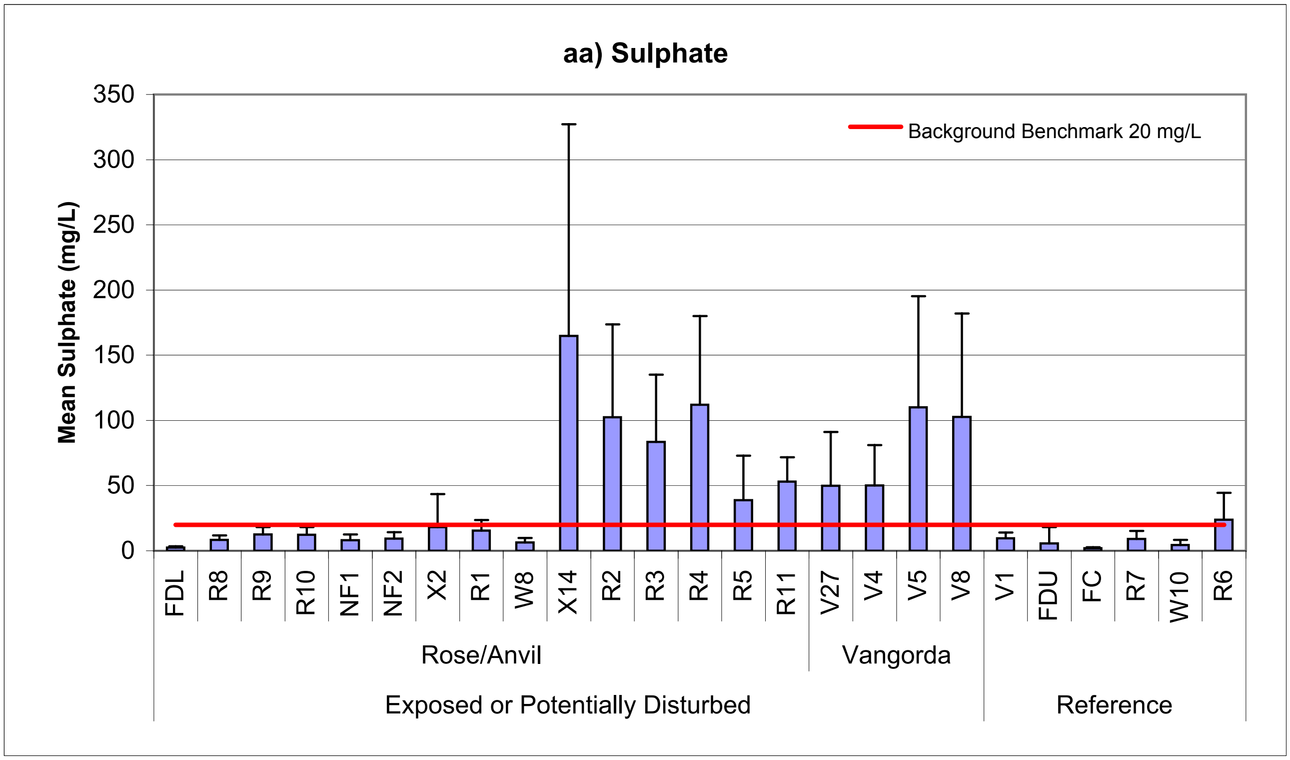


Figure A.3: Mean (and SD) concentrations of water quality parameters at each station relative to background benchmarks and Canadian water quality guidelines (CWQG), where applicable (data 1975 - 2006).



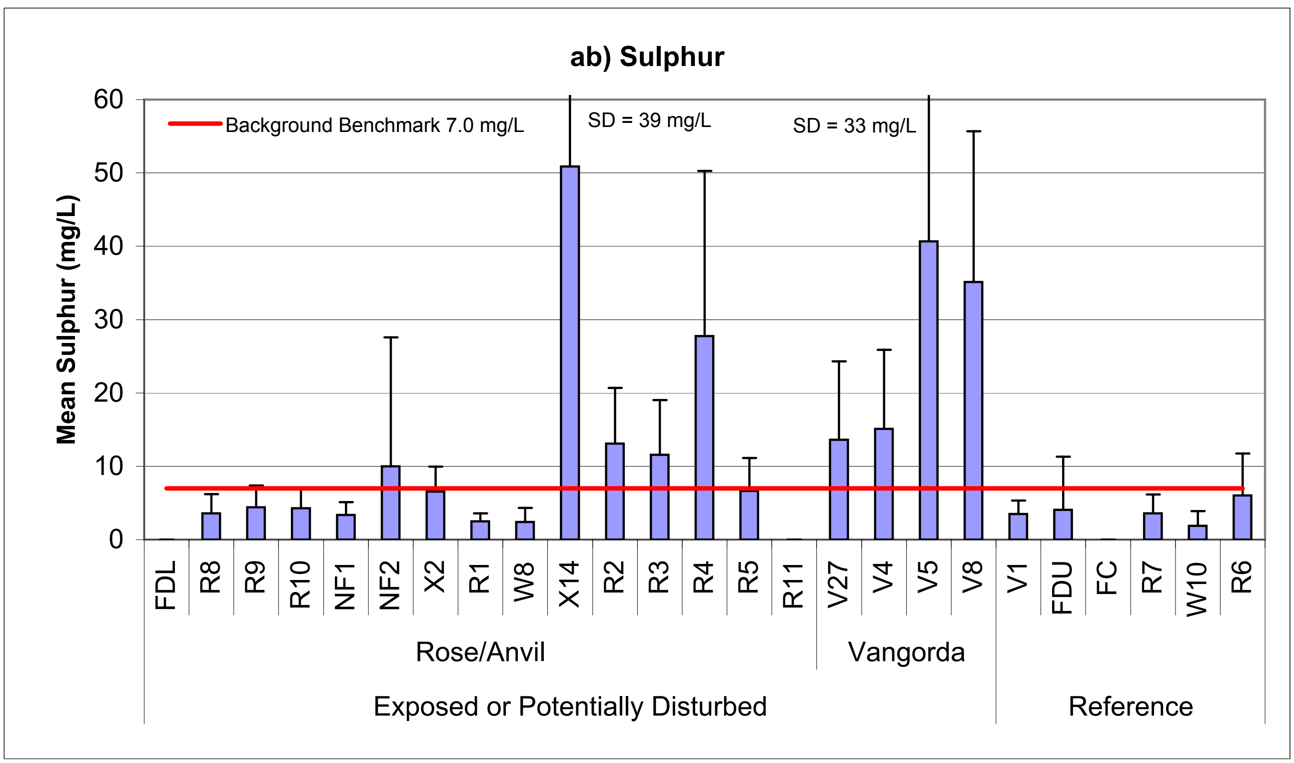
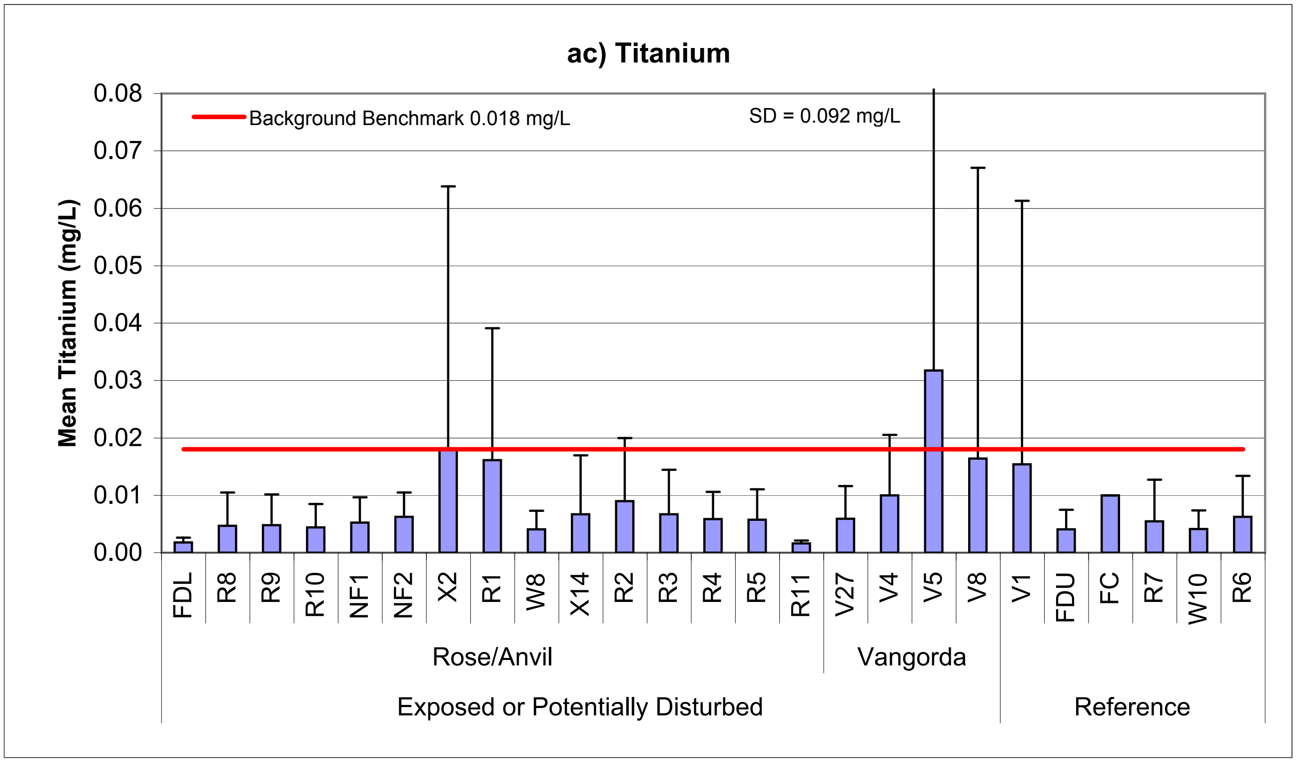


Figure A.3: Mean (and SD) concentrations of water quality parameters at each station relative to background benchmarks and Canadian water quality guidelines (CWQG), where applicable (data 1975 - 2006).



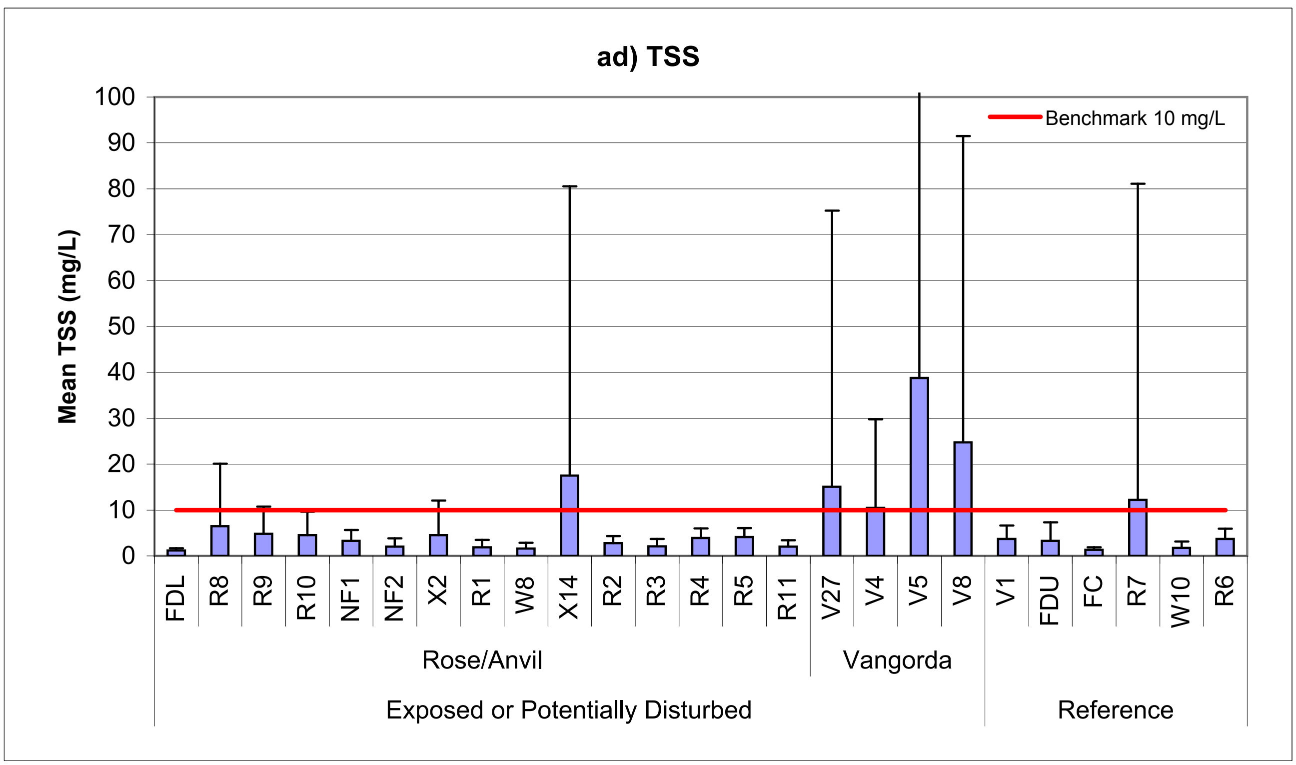
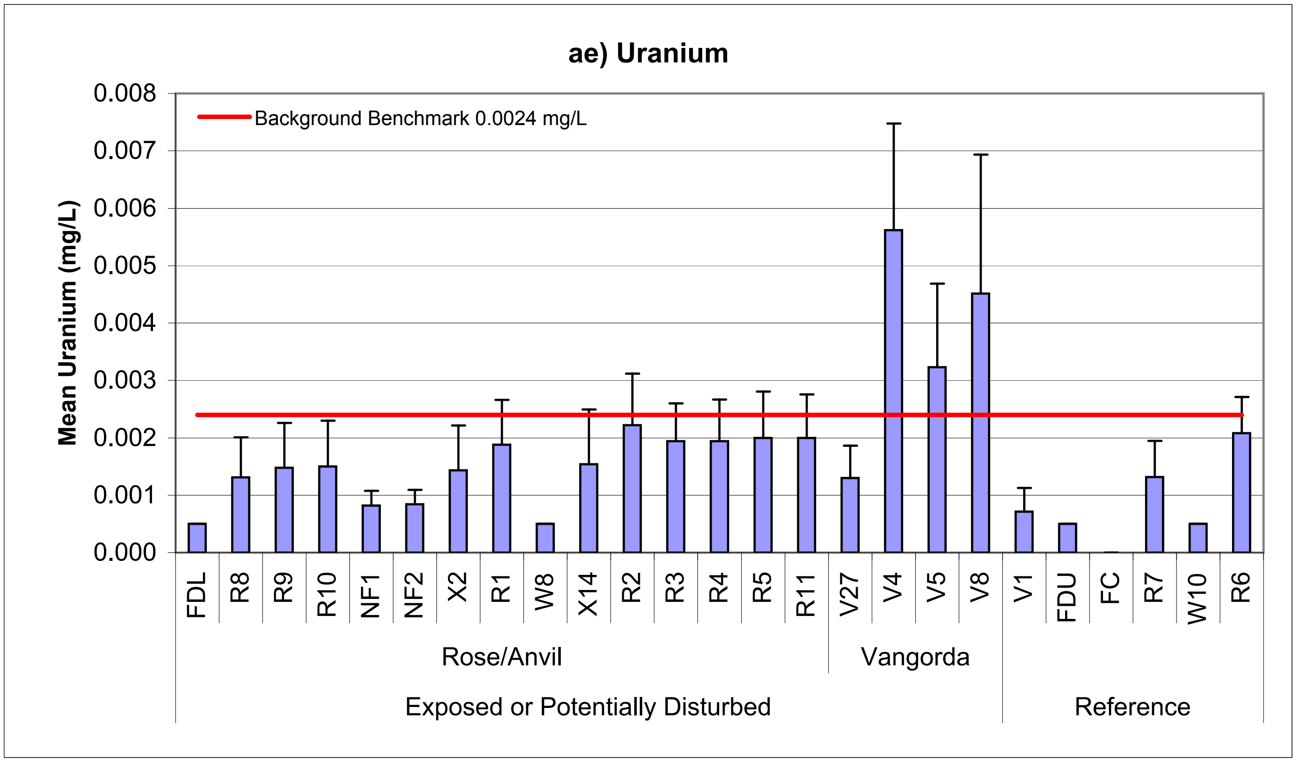


Figure A.3: Mean (and SD) concentrations of water quality parameters at each station relative to background benchmarks and Canadian water quality guidelines (CWQG), where applicable (data 1975 - 2006).



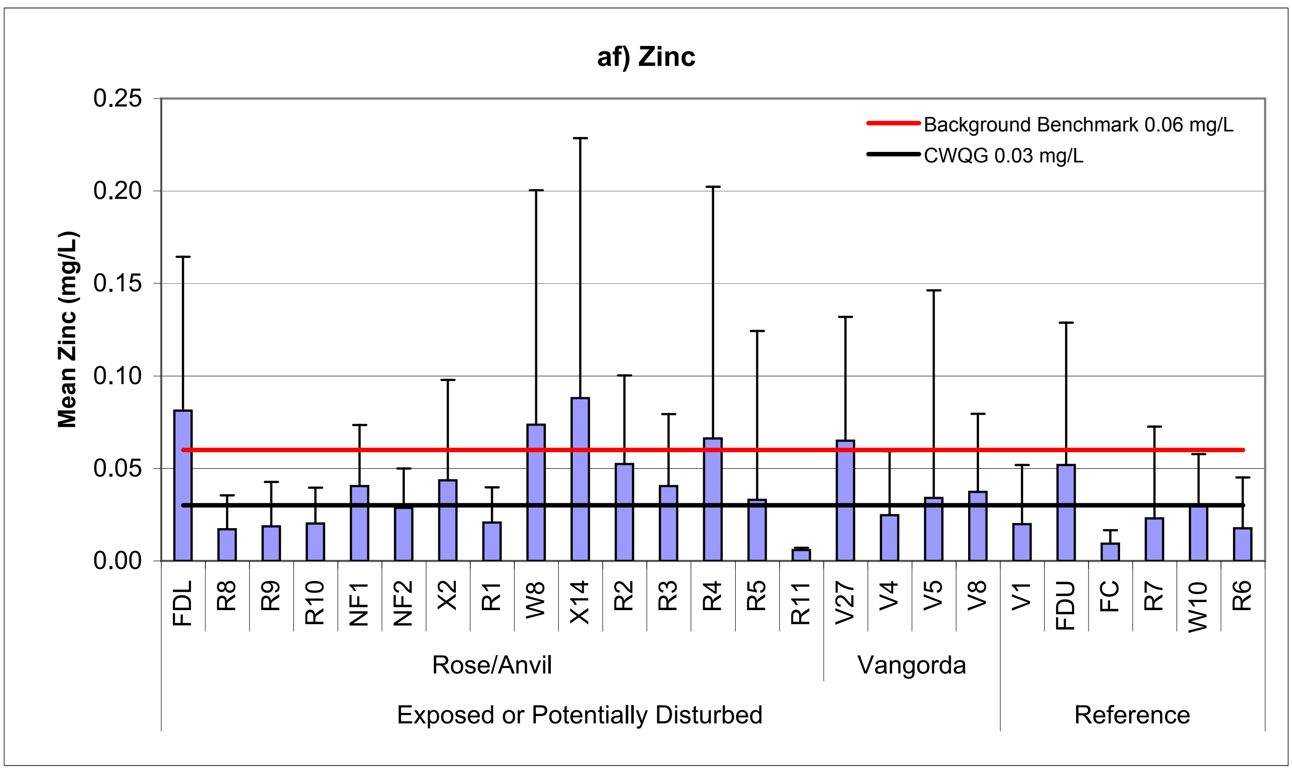


Figure A.3: Mean (and SD) concentrations of water quality parameters at each station relative to background benchmarks and Canadian water quality guidelines (CWQG), where applicable (data 1975 - 2006).

a) Ammonia

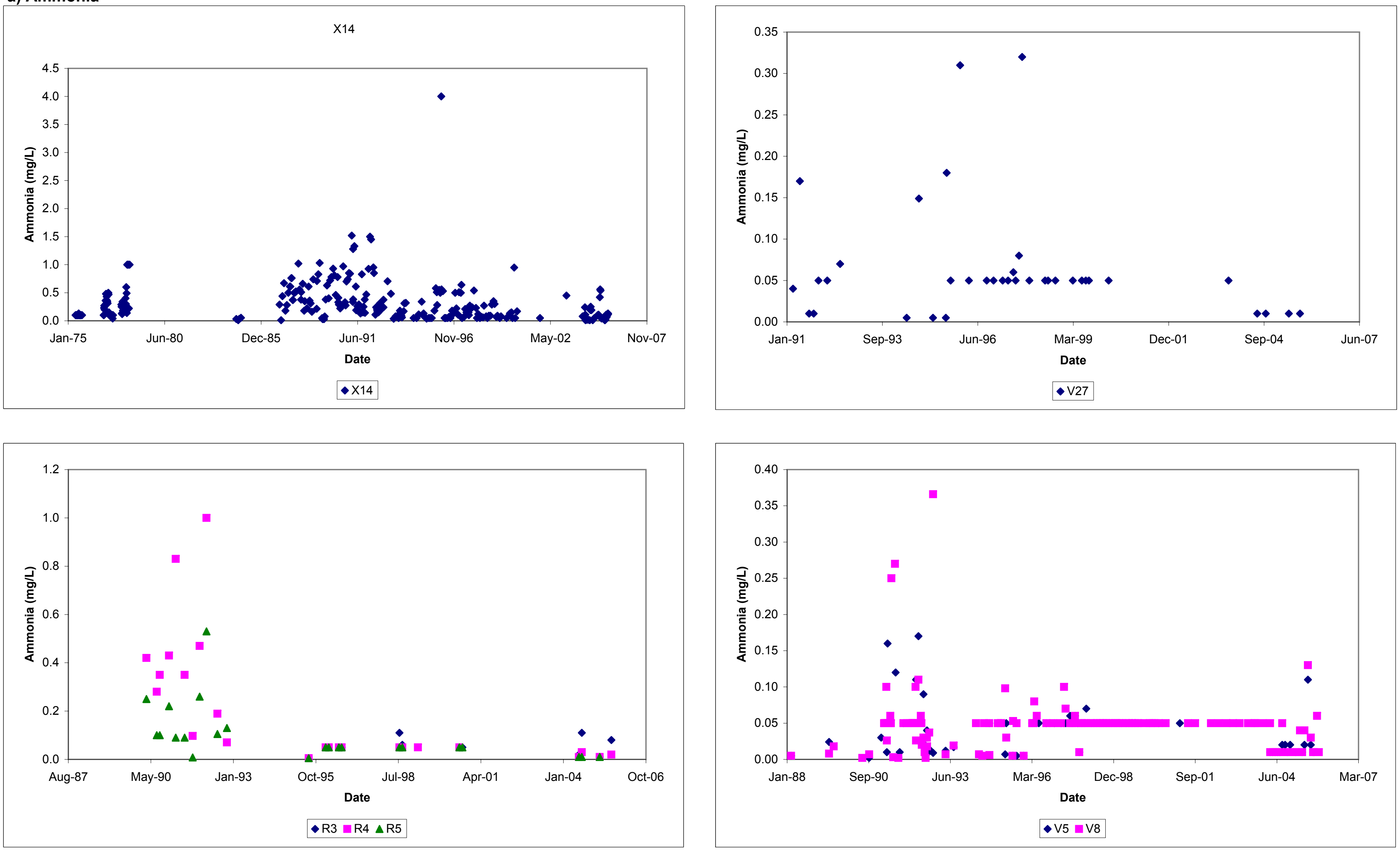


Figure A.4: Ammonia measurements taken downstream of tailings on Rose and Vangorda Creeks in relation to sampling date

b) Calcium

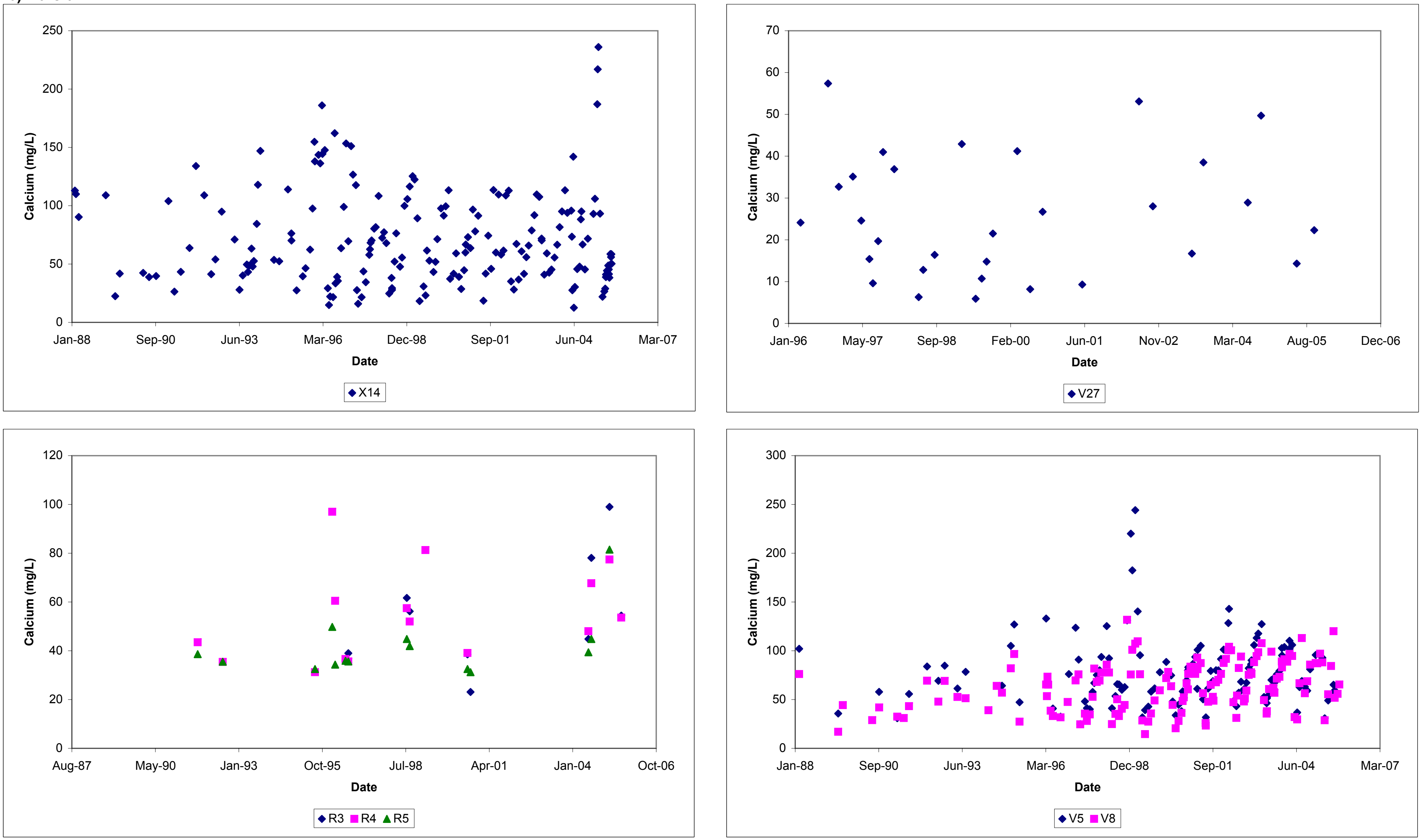


Figure A.4: Calcium measurements taken downstream of tailings on Rose and Vangorda Creeks in relation to sampling date

c) Conductivity

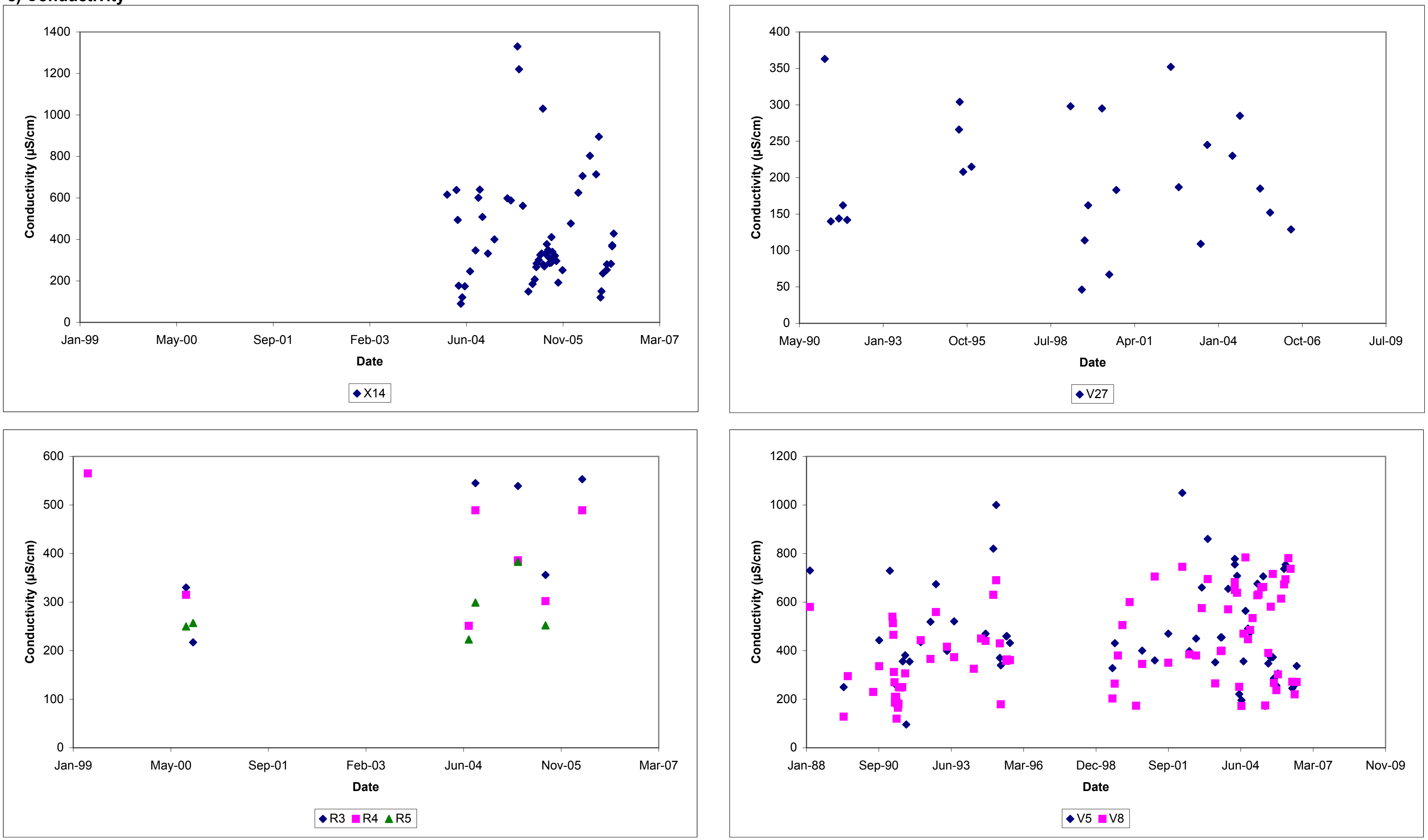


Figure A.4: Conductivity measurements taken downstream of tailings on Rose and Vangorda Creeks in relation to sampling date

d) Copper

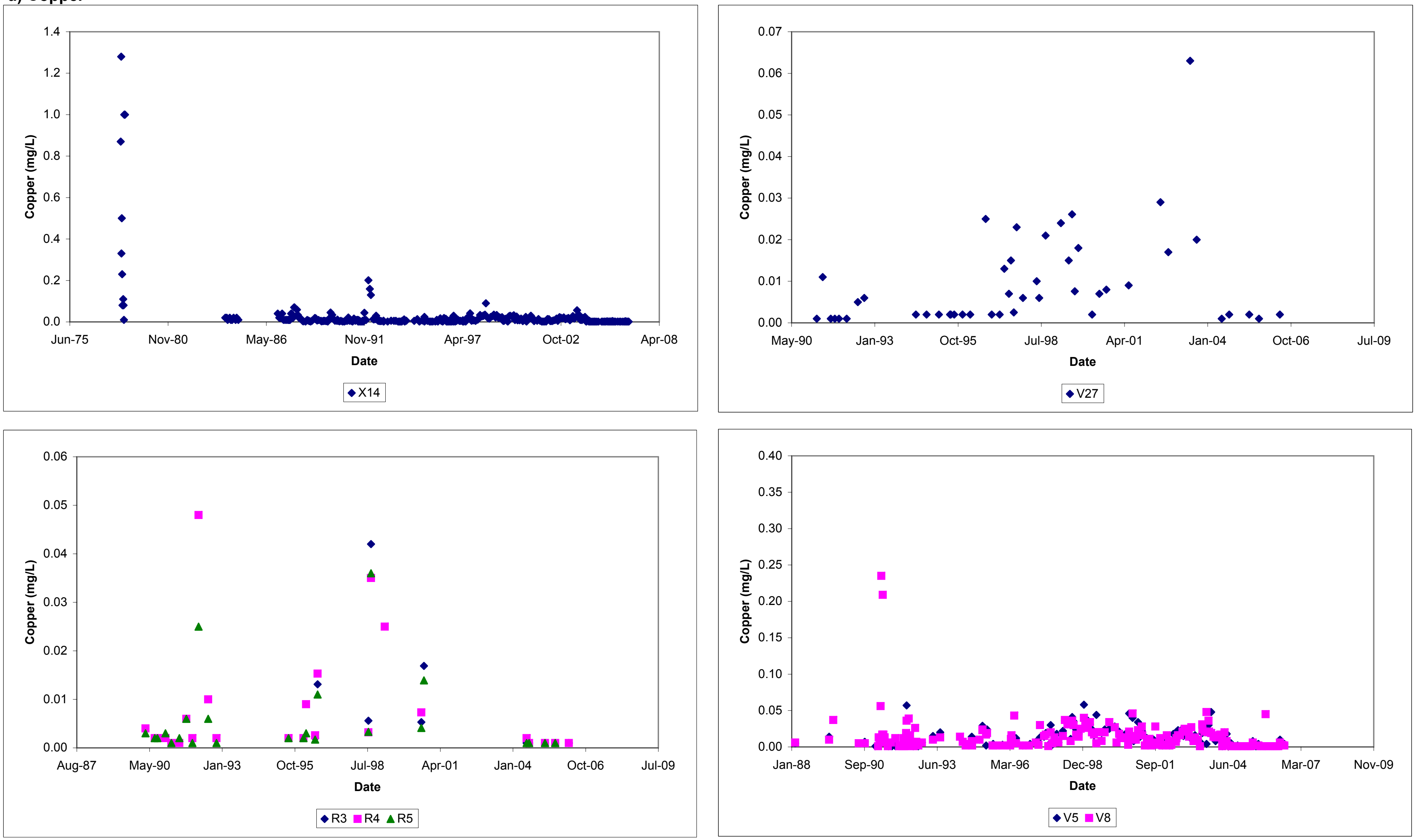


Figure A.4: Copper measurements taken downstream of tailings on Rose and Vangorda Creeks in relation to sampling date

e) Hardness

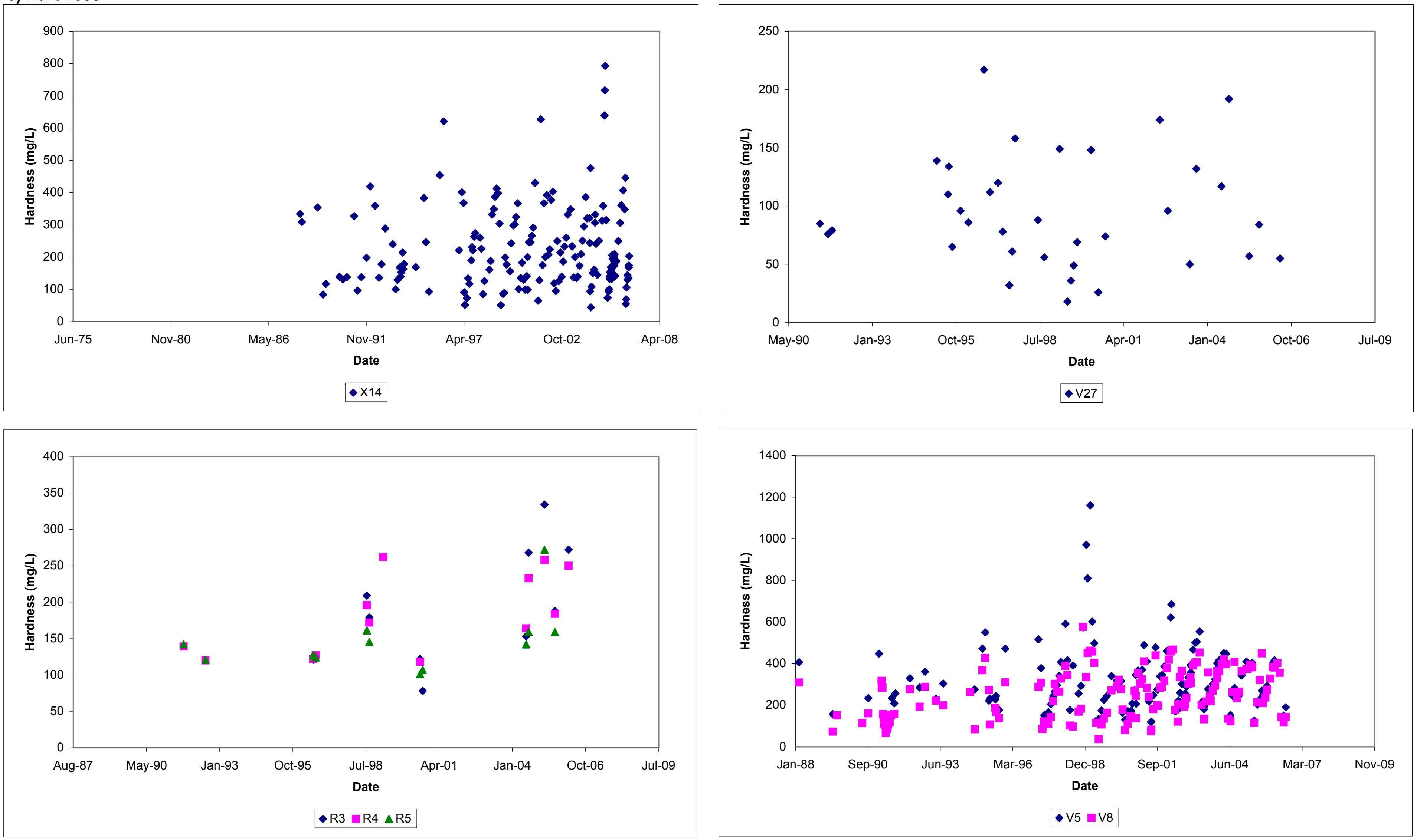


Figure A.4: Hardness measurements taken downstream of tailings on Rose and Vangorda Creeks in relation to sampling date

f) Iron

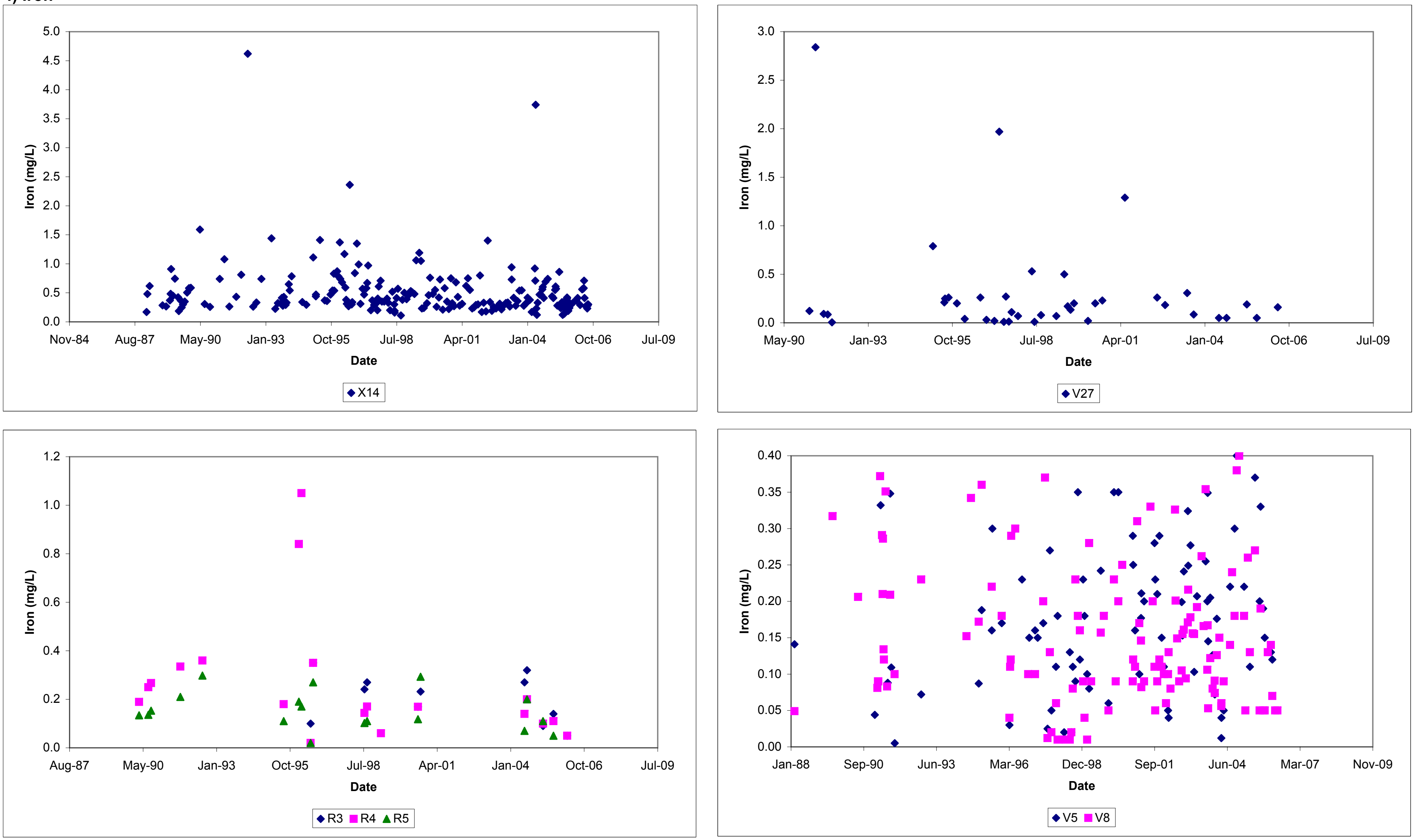
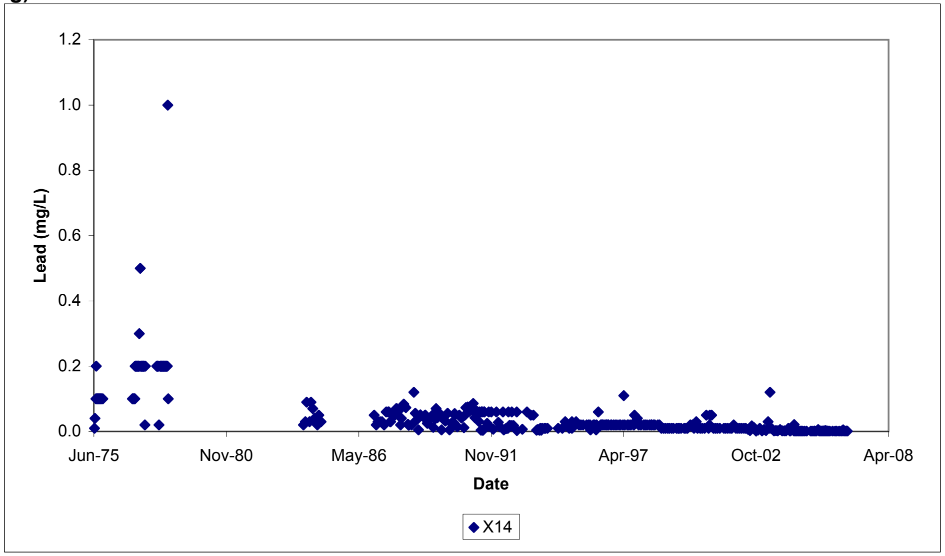
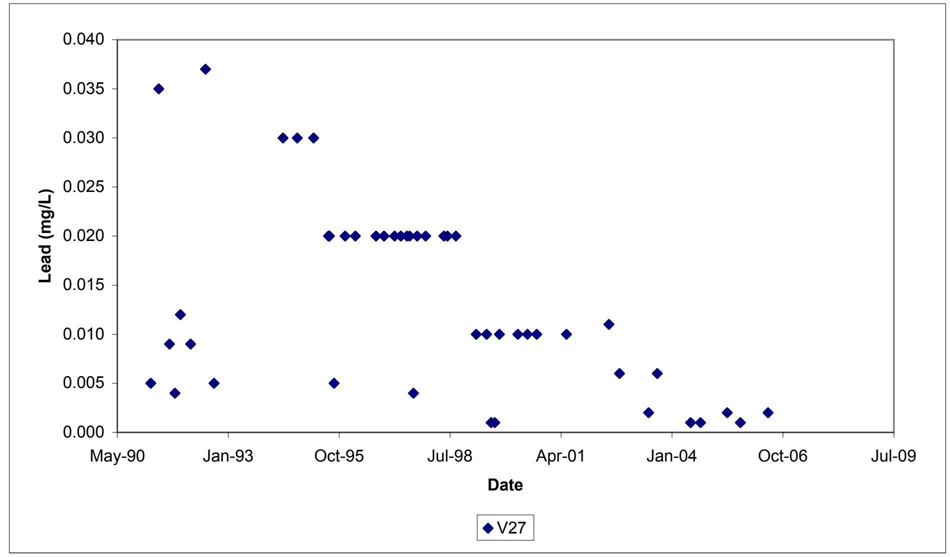
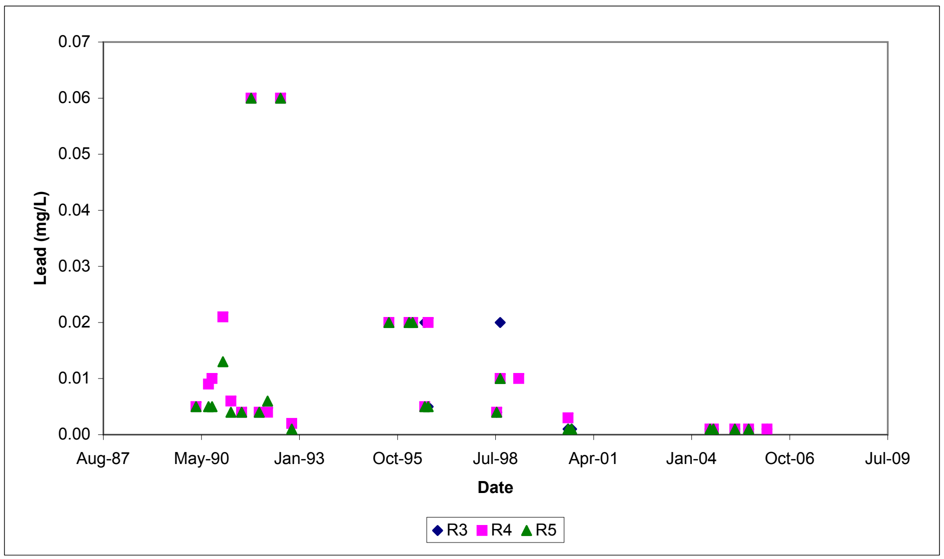


Figure A.4: Iron measurements taken downstream of tailings on Rose and Vangorda Creeks in relation to sampling date

g) Lead







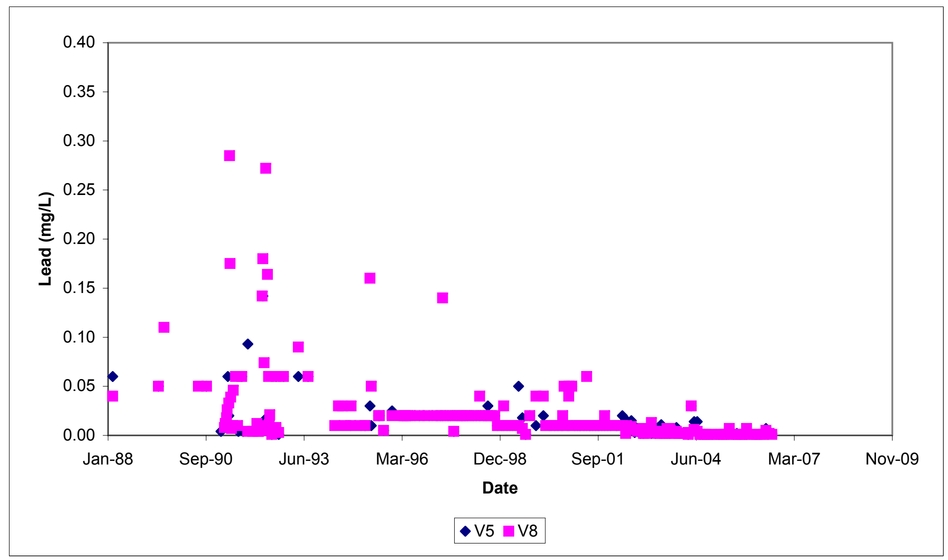
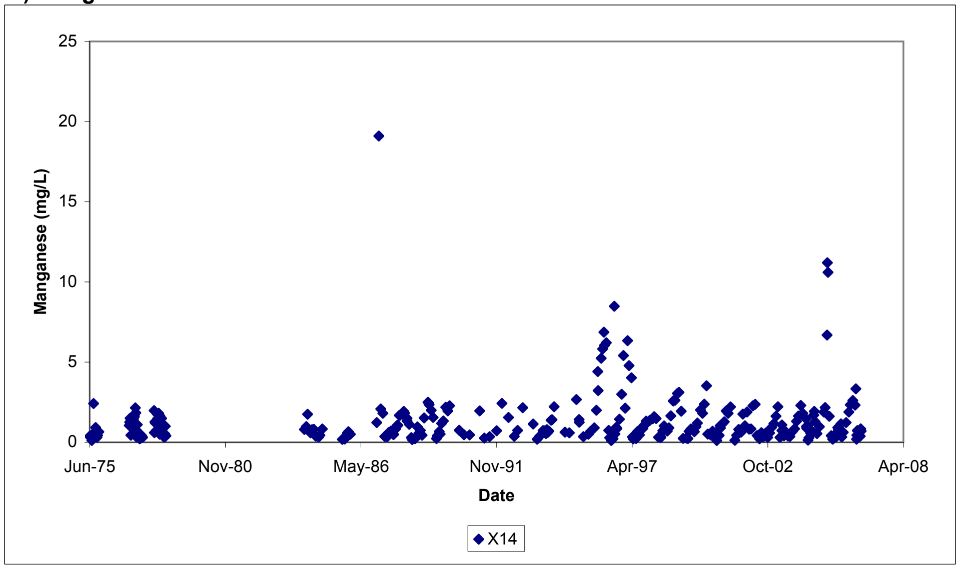
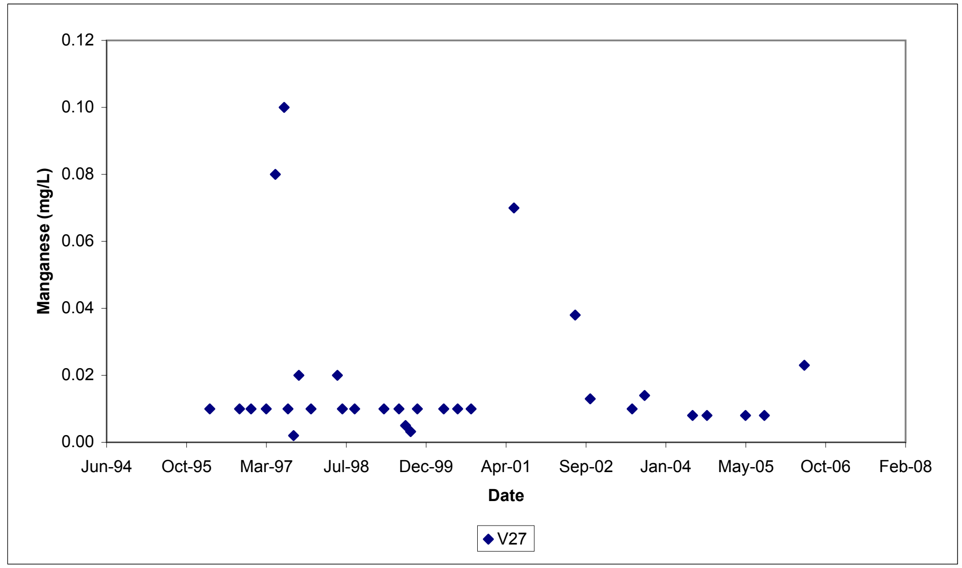
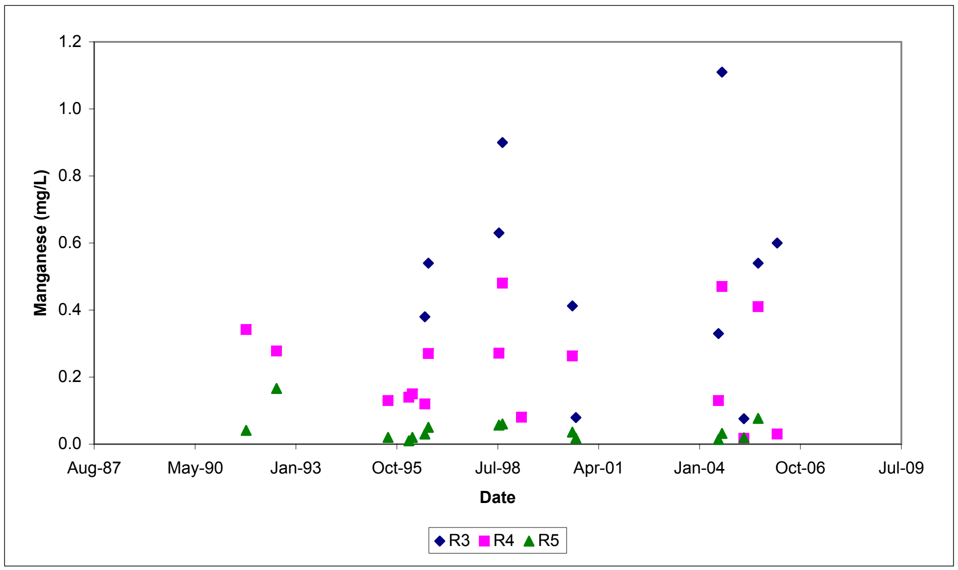


Figure A.4: Lead measurements taken downstream of tailings on Rose and Vangorda Creeks in relation to sampling date

h) Manganese







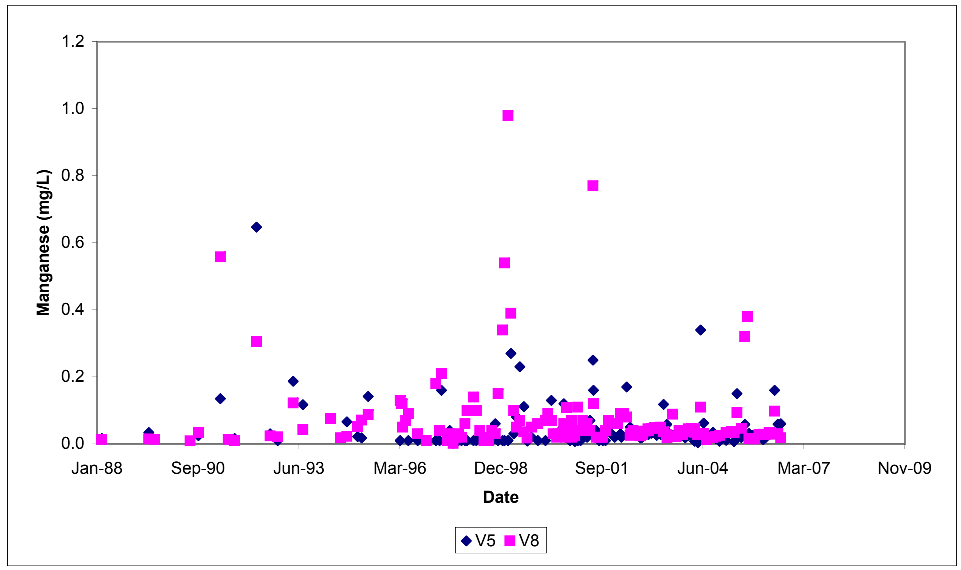


Figure A.4: Manganese measurements taken downstream of tailings on Rose and Vangorda Creeks in relation to sampling date

i) Magnesium

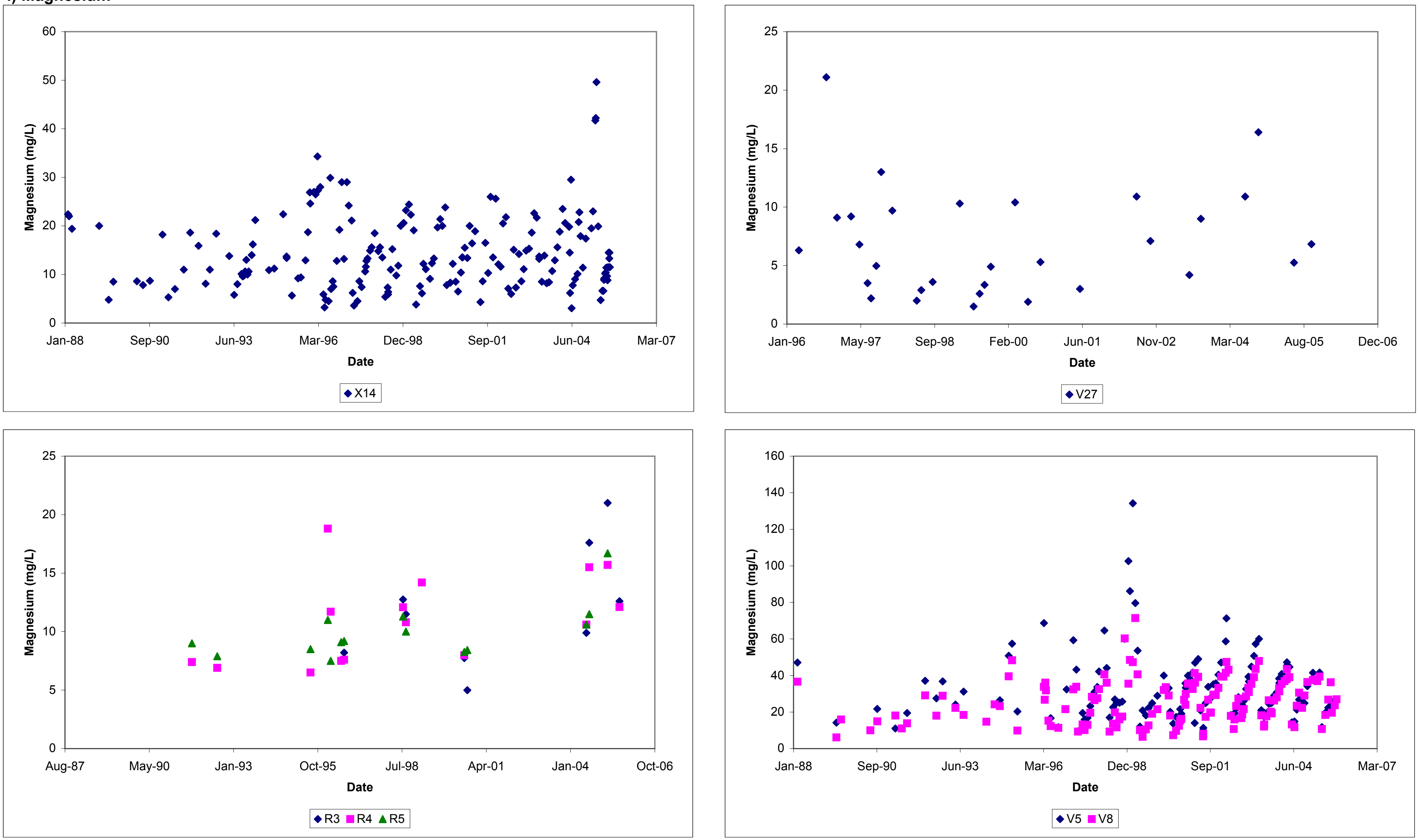


Figure A.4: Magnesium measurements taken downstream of tailings on Rose and Vangorda Creeks in relation to sampling date

j) Nickel

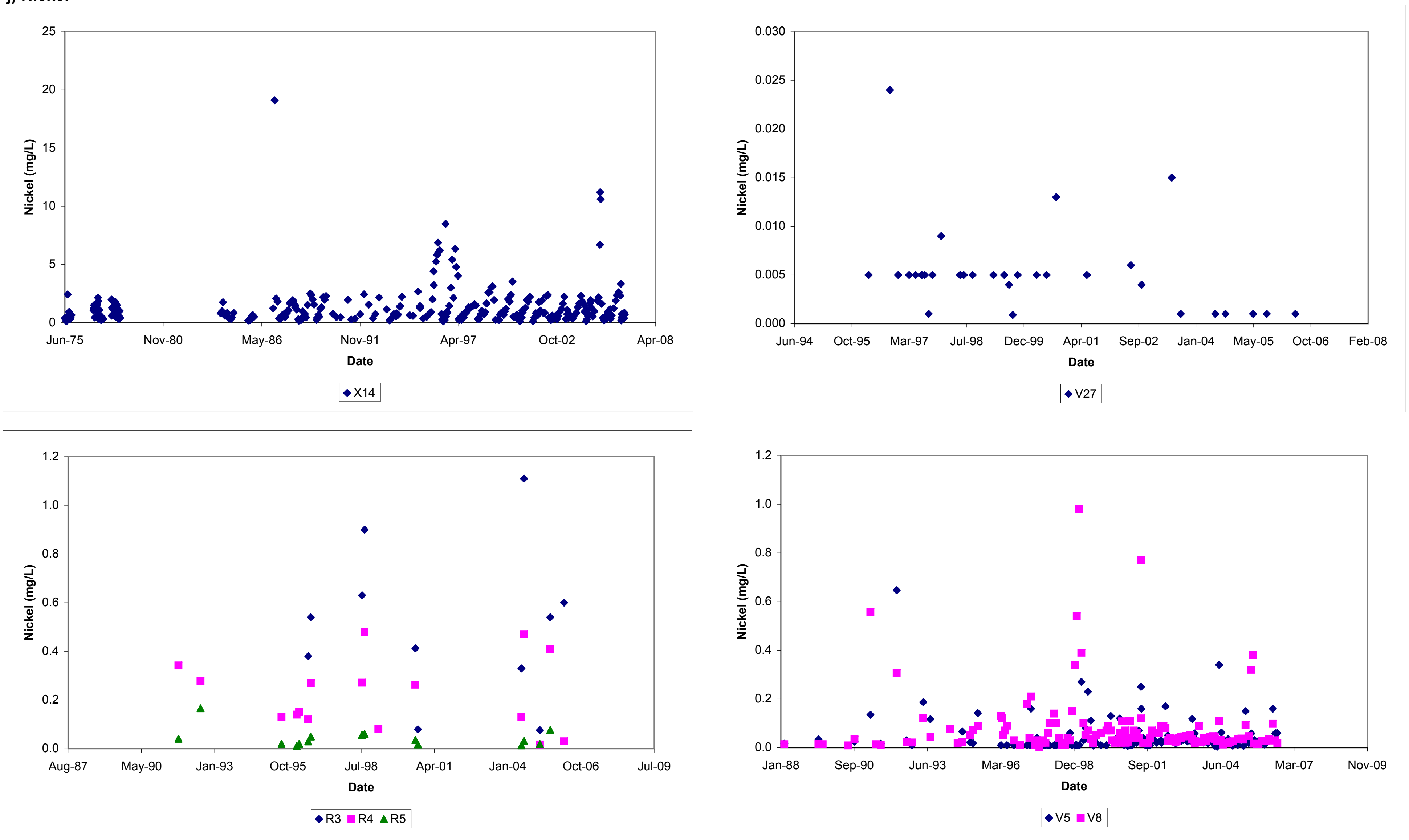


Figure A.4: Nickel measurements taken downstream of tailings on Rose and Vangorda Creeks in relation to sampling date

k) Sodium

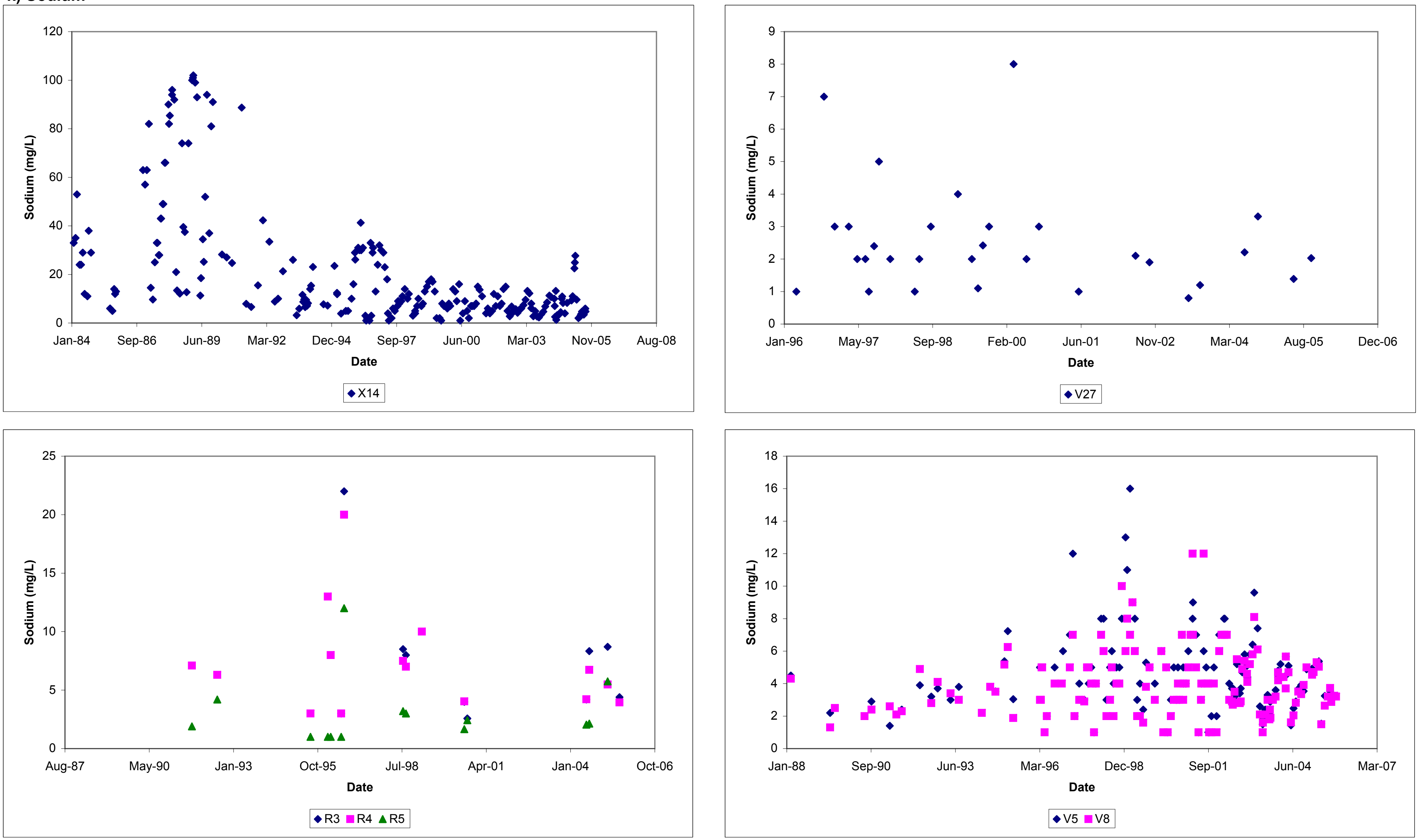
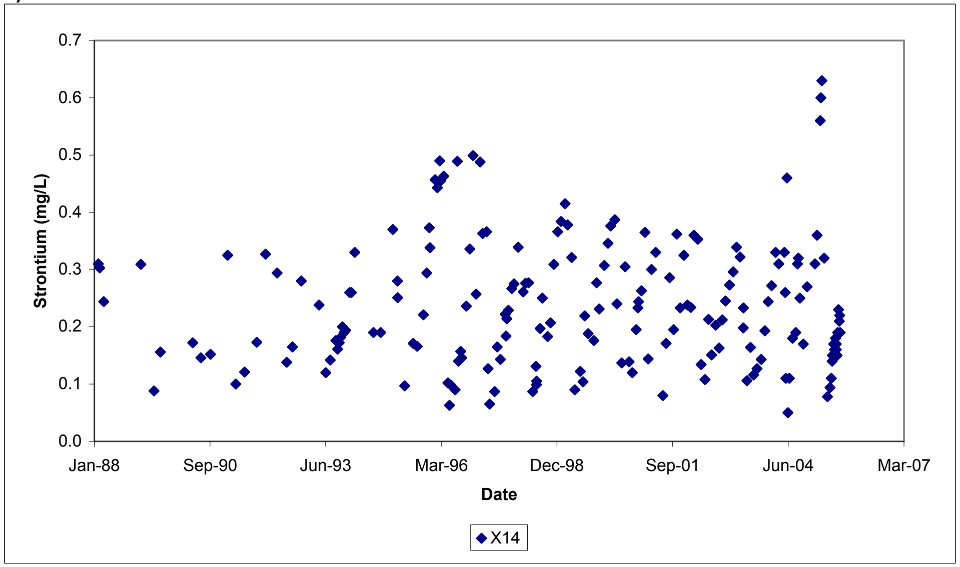
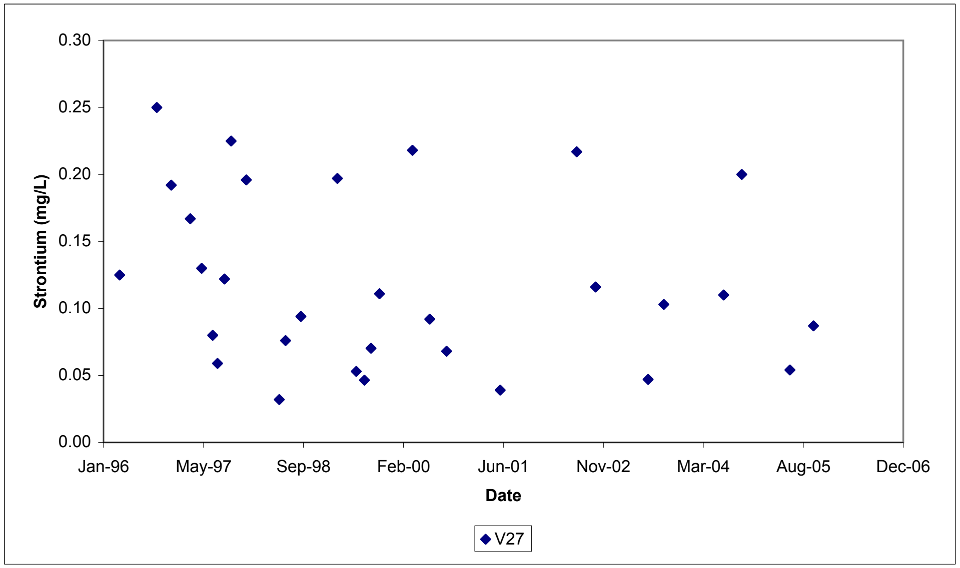
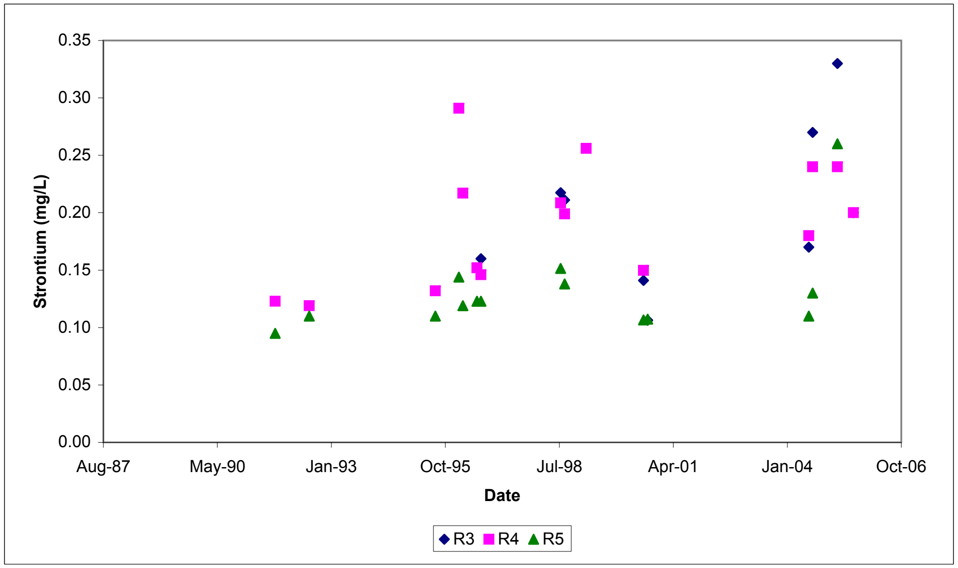


Figure A.4: Sodium measurements taken downstream of tailings on Rose and Vangorda Creeks in relation to sampling date

l) Strontium







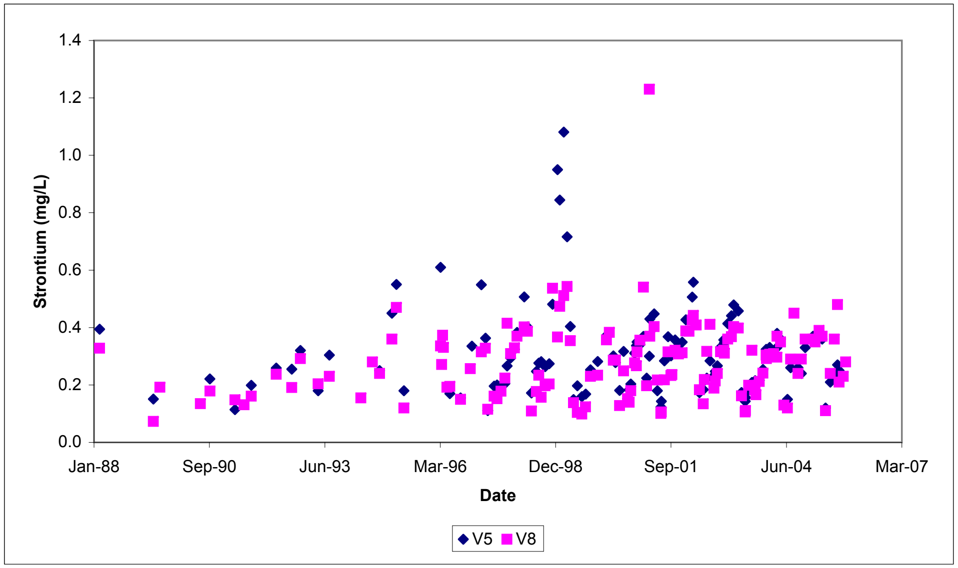
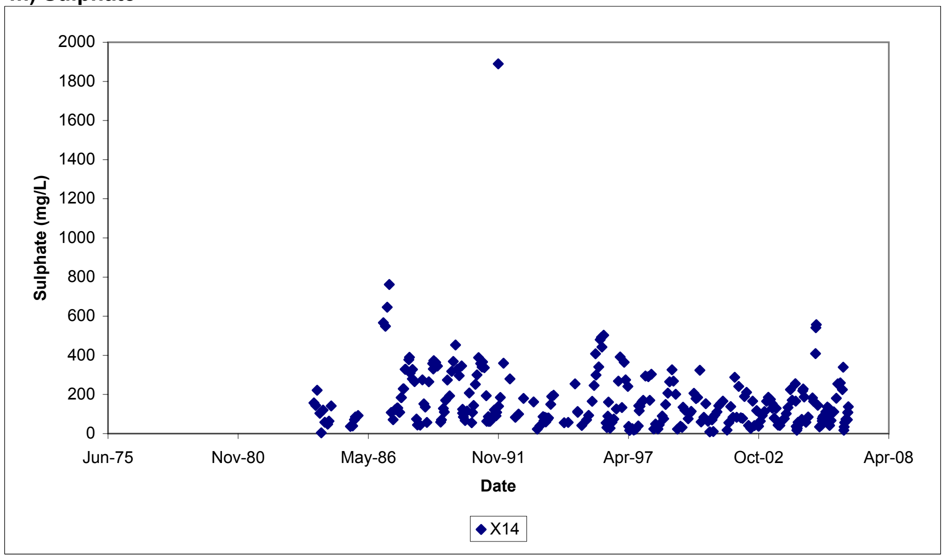
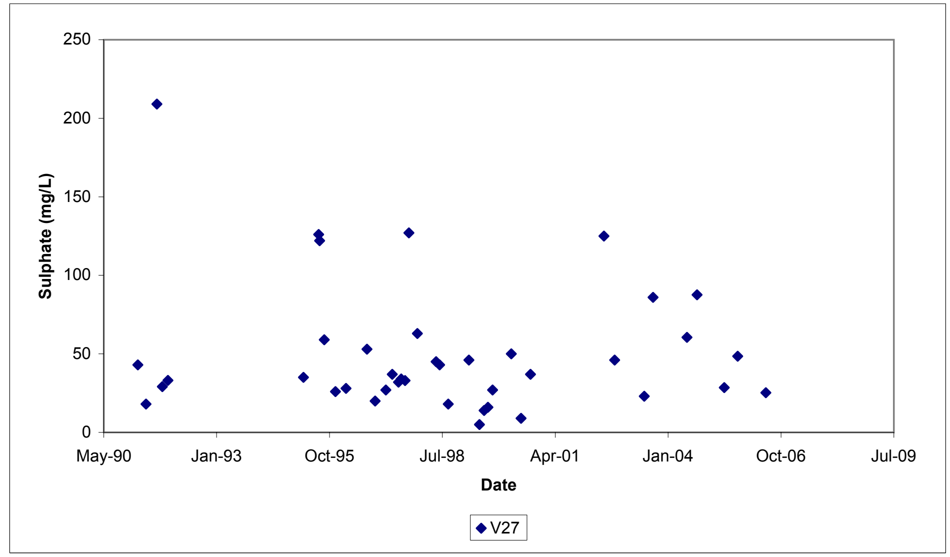
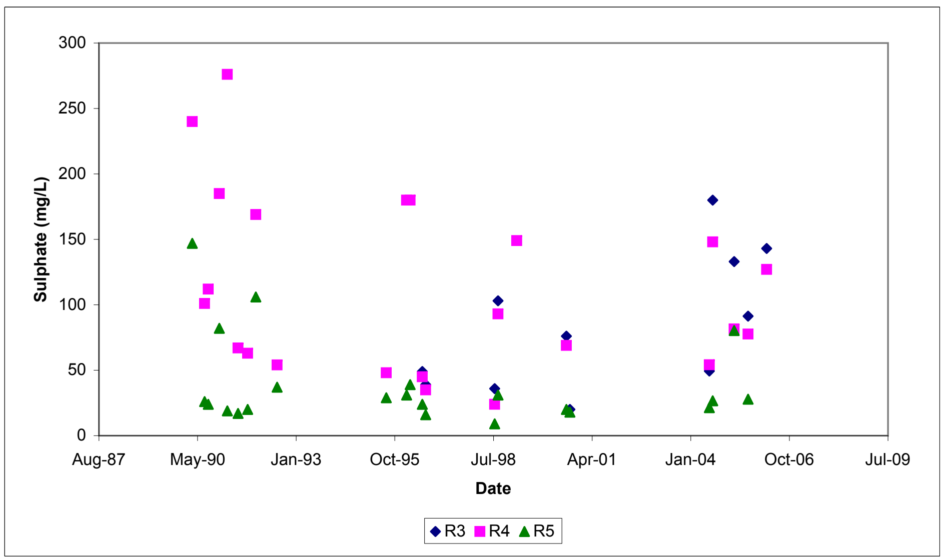


Figure A.4: Strontium measurements taken downstream of tailings on Rose and Vangorda Creeks in relation to sampling date

m) Sulphate







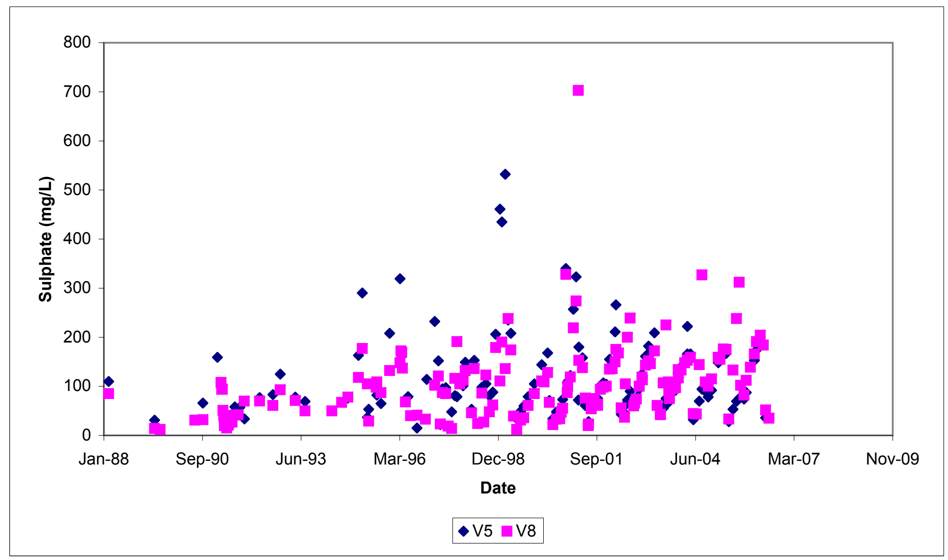


Figure A.4: Sulphate measurements taken downstream of tailings on Rose and Vangorda Creeks in relation to sampling date

n) Uranium

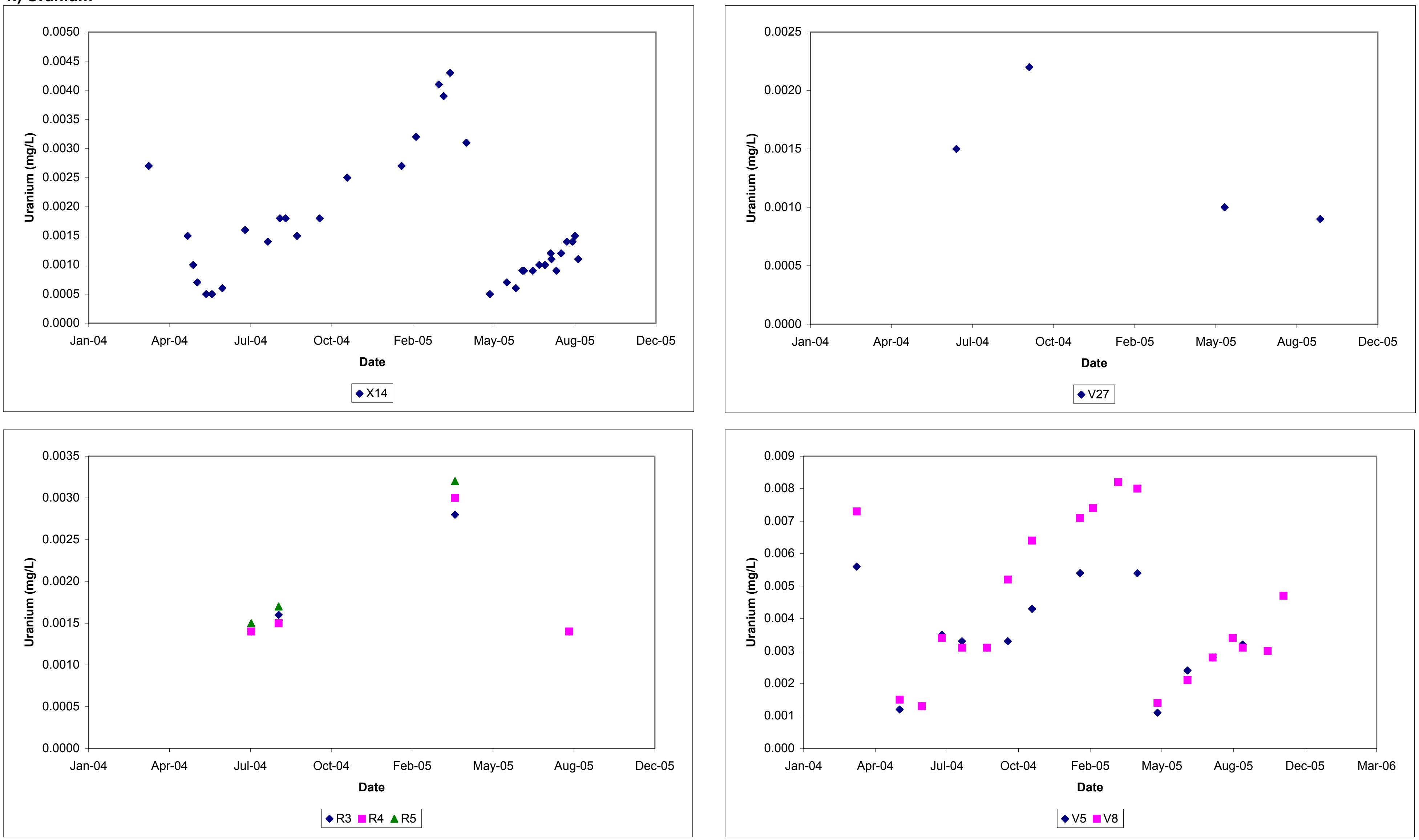


Figure A.4: Uranium measurements taken downstream of tailings on Rose and Vangorda Creeks in relation to sampling date

o) Zinc

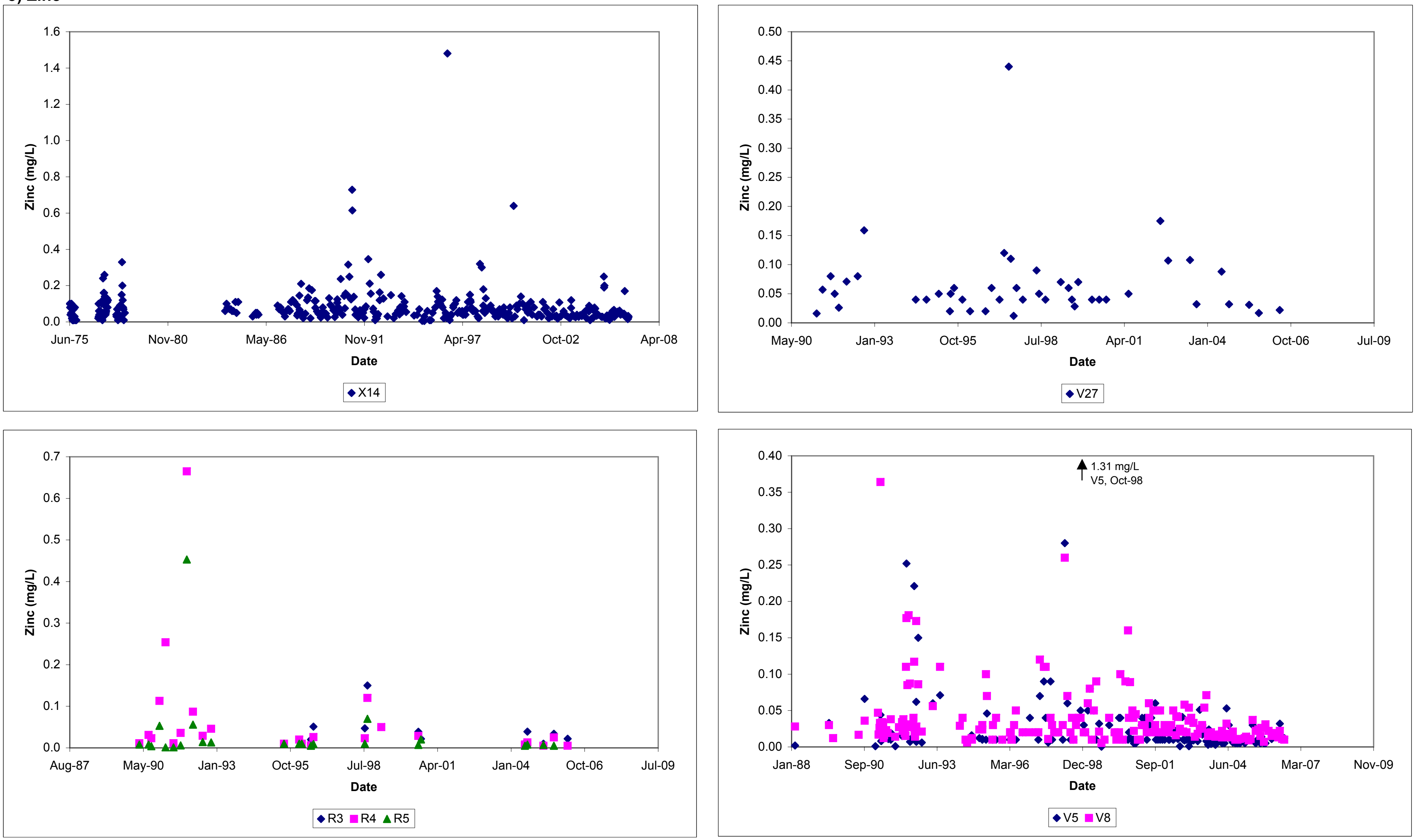


Figure A.4: Zinc measurements taken downstream of tailings on Rose and Vangorda Creeks in relation to sampling date

APPENDIX B

SEDIMENT QUALITY DATA

Table B.1: Rose-Anvil sediment chemistry data (1996 to 2006)

Station	Date	Metal (mg/kg)														
		Aluminum	Antimony	Arsenic	Barium	Berylium	Boron	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese
R-1	1-Jul-96	10900	2	6	195	0.9		0.6	5300	27	9	21	20900	74	4500	1419
R-1	19-Jul-04	13400	0.7	18	252	1	1	1.2	5840	39	17	27	26800	249	5670	2520
R-1	19-Jul-04	10200	0.1	8.9	137	1	1	0.5	3880	32	9	15	16400	69.5	4360	1080
R-1	19-Jul-04	11000	0.1	9.4	136	1	1	0.5	3670	24	10	13	18800	57.3	4810	1170
R-1	24-Jul-06	9880	10	10	103	1	1	0.5	3040	23	10	11	16100	23	4590	1090
R-1	24-Jul-06	7510	10	10	102	1	1	0.5	2340	15	10	11	14600	29	3410	1220
R-1	24-Jul-06	6600	10	10	88	1	1	0.5	2160	13	8	8	13400	16	2700	1060
R-2	1-Jul-96	12100	3	32	399	1		1.6	7900	50	16	60	33800	310	7200	2808
R-2	14-Oct-99	23500	29	68	2970	1	2	3.1	10900	78.1	57.3	209	68600	1130	11200	18800
R-2	14-Oct-99	25400	9	40	1370	1	2	1.9	8710	64.3	50.9	210	57700	757	10400	15400
R-2	14-Oct-99	18600	21	37.1	1790	0.9	2	2.2	15900	69.7	68	128	47300	476	9870	60200
R-2	14-Oct-99	24800	8	23.8	893	0.9	2	1.35	12100	81.2	23.9	70	41600	178	11900	1200
R-2	14-Oct-99	20200	8	22.5	1080	0.9	2	1.7	9870	67.9	24.4	60.4	41600	183	10200	1710
R-2	14-Oct-99	23900	8	19.15	724	0.9	2	0.94	12900	92.3	24.6	57.9	43900	130	14400	1270
R-2	19-Jul-04	12900	1.3	16	238	1	1	0.8	5400	37	14	39	25500	142	7280	1560
R-2	19-Jul-04	15100	1.1	18.6	566	1	1	1.4	7530	38	19	47	29500	216	6830	3310
R-2	20-Jul-04	11700	1.4	24.3	586	1	2	1.7	11000	33	18	89	27500	264	5110	2860
R-2	24-Jul-06	19600	10	29	508	1	1	1.4	8460	49	28	64	29300	214	6960	6700
R-2	24-Jul-06	21200	10	23	476	1	1	1.3	11200	60	28	61	28100	162	7620	5450
R-2	24-Jul-06	18400	10	19	327	1	1	1	8210	45	19	57	23800	160	6660	2240
R-3	1-Jul-96	10500	2	31	263	0.9		1	6500	39	17	59	29500	244	5900	4665
R-3	14-Oct-99	15200	8	27.25	3230	0.5	2	0.935	6830	47.1	25.8	68.3	33800	197	5880	5540
R-3	14-Oct-99	21400	10	49	2870	0.8	2	1.4	8190	52.1	24.8	112	45000	343	8130	3870
R-3	14-Oct-99	25000	8	22.95	2300	0.9	2	1.8	7730	59.3	26.3	71.5	37400	245	7660	5270
R-3	14-Oct-99	22000	9	39	2400	0.9	2	1.485	9130	57.4	30	87.5	41100	234	8310	8970
R-3	14-Oct-99	22900	10	29.1	2290	1	2	2.57	10300	54.8	51.5	96.5	42000	296	8220	29900
R-3	14-Oct-99	22800	8	30.9	920	1	2	1.6	7440	63	31.8	77.1	39500	251	10100	8490
R-3	20-Jul-04	12700	1.3	15.2	390	1	1	1	6660	33	20	48	26200	174	5800	6410
R-3	20-Jul-04	11700	2	13	329	1	1	0.8	4120	27	21	39	23800	171	5850	5120
R-3	20-Jul-04	8070	1.7	18.5	121	1	1	0.5	8240	21	10	53	22400	151	3860	923
R-3	25-Jul-06	10000	10	11	161	1	1	0.6	2700	26	16	44	18100	146	4670	2880
R-3	25-Jul-06	18400	10	20	505	1	1	1.3	7020	48	29	58	23900	166	6210	9240
R-3	25-Jul-06	13000	10	14	244	1	1	0.5	5140	31	16	37	19900	117	4940	3000
R-4	1-Jul-96	12000	2	32	600	1.2		2.1	6800	46	24	78	32400	267	7000	11466
R-4	20-Jul-04	9830	1.5	16.1	210	1	1	0.7	5290	28	12	51	22900	155	5100	2180
R-4	20-Jul-04	9730	1.3	12.6	307	1	1	0.8	4230	33	12	32	19000	166	4830	2810
R-4	20-Jul-04	10100	1.2	13.8	284	1	1	0.6	4950	26	11	33	19500	140	5020	2460
R-4	5-Aug-05	14000	<1	14	560	0.69	<1	1.2	6600	45	20	48	30000	170	7300	6100
R-4	25-Jul-06	9380	10	10	226	1	1	0.7	4020	26	17	39	18300	97	4820	3560
R-4	25-Jul-06	18000	10	16	498	1	1	1.1	6880	64	25	51	23500	135	6770	6670
R-4	25-Jul-06	17700	10	16	533	1	1	1.1	6760	48	26	51	22400	128	6790	7550
R-5	1-Jul-96	13600	3	14	308	0.9		0.8	6500	45	13	35	26500	20	7300	1855
R-5	20-Jul-04	10000	0.8	9.5	242	1	1	0.6	4490	25	9	17	17900	24.7	4980	925
R-5	20-Jul-04	11600	1	16.8	396	1	1	1.5	7630	39	14	88	23600	152	5330	2630
R-5	20-Jul-04	8570	0.8	8	120	1	1	0.6	4230	41	10	22	19300	31.2	4120	1000
R-5	5-Aug-05	11000	1	32	350	0.61		1.4	6000	39	18	78	37000	290	5900	4100
R-5	5-Aug-05	11000	<1	32	350	0.61	<1	1.4	6000	39	18	78	37000	290	5900	4100
R-5	25-Jul-06	17500	10	10	238	1	1	0.8	6170	40	14	32	20400	24	6890	731
R-5	25-Jul-06	19700	10	13	289	1	1	0.9	6470	41	16	38	21700	28	7360	1340
R-5	25-Jul-06	20400	10	13	247	1	1	1.2	6450	43	17	45	22900	22	7710	970
R-6	1-Jul-96	14200	<2	9	238	0.9		1	6900	45	13	34	26500	11	7600	1222
R-6	20-Jul-04	10700	1	14.3	163	1	1	0.8	7270	28	11	21	23100	12.2	5210	1150
R-6	20-Jul-04	9120	1.1	13.4	156	1	1	0.7	3860	21	9	25	19600	12.8	4580	911
R-6	20-Jul-04	6630	0.7	8.9	107	1	1	0.4	2940	15	6	14	13400	7.9	3090	608
R-6	5-Aug-05	17000	<1	15	360	0.86	<1	1.6	9800	48	16	31	36000	16	8300	2600
R-6	25-Jul-06	10100	10	10	114	1	1	0.5	4320	27	11	16	18600	10	5260	632
R-6	25-Jul-06	20300	10	12	211	1	1	1	7130	57	17	41	22500	17	7850	690

Table B.1: Rose-Anvil sediment chemistry data (1996 to 2006)

Station	Date	Metal (mg/kg)														
		Aluminum	Antimony	Arsenic	Barium	Berylium	Boron	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese
R-6	25-Jul-06	20700	**10**	12	204	**1**	1	1	6760	41	16	42	21800	17	7690	580
R-7	1-Jul-96	8600	**<2**	10	173	0.7		0.4	4000	20	4	14	18400	18	3500	887
R-7	20-Jul-04	11500	1.2	14.5	156	**1**	**1**	0.6	4360	28	11	21	22900	12.3	5670	924
R-7	20-Jul-04	11200	0.6	11.9	181	**1**	**1**	0.6	4710	19	9	20	19400	19.1	4050	881
R-7	20-Jul-04	9410	**0.1**	9.3	150	**1**	**1**	0.4	4160	17	7	11	15800	12.7	3140	621
R-7	26-Jul-06	9780	**10**	**10**	92	**1**	**1**	**0.5**	2540	17	8	10	14800	9	3620	506
R-7	26-Jul-06	15700	**10**	14	216	**1**	**1**	0.6	4790	27	12	19	20400	16	4610	1200
R-7	26-Jul-06	16800	**10**	**10**	188	**1**	**1**	0.6	5050	30	12	23	19500	19	4930	529
R-8	26-Jul-06	21900	**10**	13	239	**1**	**1**	1.2	7490	53	19	51	24900	18	8330	1260
R-8	26-Jul-06	19400	**10**	11	188	**1**	**1**	0.9	6030	40	16	41	22000	16	7330	500
R-8	26-Jul-06	20500	**10**	14	200	**1**	**1**	1.1	5950	41	17	49	23000	18	7640	559
T-1(Ref)	14-Oct-99	30600	8	6.87	283	1	2	1	11600	53	19.8	38.4	32100	70	9670	563
T-1(Ref)	14-Oct-99	37200	8	6.36	332	1	**2**	1.05	16500	62.9	20.9	42.9	36100	96	12100	656
T-1(Ref)	14-Oct-99	29300	8	8.41	303	1	2	1.7	12800	54.2	19.8	43.8	32400	120	9750	714
T-2(Ref)	14-Oct-99	25400	8	7.72	176	0.8	2	1.85	9800	58.6	17.4	37.8	28400	42	9040	534
T-2(Ref)	14-Oct-99	24600	8	15.1	240	0.8	2	1.7	12400	61.6	18.7	54	27400	73	8820	525
T-2(Ref)	14-Oct-99	24500	8	8.39	187	0.7	2	1.65	11900	65.3	17.8	42.6	30300	47	9750	675
T-3(Ref)	14-Oct-99	21600	80	8.61	3850	2	**2**	1.99	10000	81	20	64	32200	19	13000	734
T-3(Ref)	14-Oct-99	23400	80	9.61	2150	2	**2**	2.02	9800	61	20	75	33000	18	13000	756
T-3(Ref)	14-Oct-99	27600	8	8.94	3920	0.7	2	2.51	10200	96.9	23.2	72.8	37900	21.5	14400	664
Anvil A1	13-Aug-04	9840	1.3	11	287	0.37	0.7	0.46	7210	29.5	7.48	18	21200	19.4	6130	381
Anvil A2	13-Aug-04	12200	1	13.6	500	0.52	0.6	0.78	6800	55.1	10.7	27.5	25600	52.9	7080	862
Anvil A2	5-Aug-05	17000	<1	12	580	0.92	**<1**	1.4	11000	50	17	44	30000	61	8800	3100
Anvil A3	13-Aug-04	11100	1.4	13	326	0.47	0.8	0.73	6170	42.1	10.8	26.8	24500	62	6360	1020
Anvil A3	5-Aug-05	20000	<1	12	380	1	**<1**	1.8	9800	56	19	58	32000	99	9800	1100
Anvil A4	13-Aug-04	10500	1	11.5	453	0.42	0.5	0.71	5020	50.7	13.5	24	25300	98	5640	3580
Anvil A4	5-Aug-05	16000	<1	14	760	0.78	**<1**	1.1	7500	45	20	42	32000	150	7700	5800
Averages	R-1	9,927	5	10	145	0.99	1.00	0.61	3,747	25	10	15	18,143	74	4,291	1,366
	R-2	19,031	9	29	917	0.97	1.58	1.57	10,006	59	30	89	38,323	332	8,895	9,501
	R-3	16,436	7	25	1,233	0.92	1.50	1.19	6,923	43	25	65	30,969	210	6,579	7,252
	R-4	12,593	5	16	402	0.99	1.00	1.04	5,691	40	18	48	23,500	157	5,954	5,350
	R-5	13,708	5	16	282	0.90	1.00	1.02	5,993	39	14	48	25,144	98	6,166	1,961
	R-6	13,594	5	12	194	0.97	1.00	0.88	6,123	35	12	28	22,688	13	6,198	1,049
	R-7	11,856	5	11	165	0.96	1.00	0.53	4,230	23	9	17	18,743	15	4,217	793
	R-8	20,600	10	13	209	1.00	1.00	1.07	6,490	45	17	47	23,300	17	7,767	773
	A1 and A2	13,013	1	12	456	0.60	0.65	0.88	8,337	45	12	30	25,600	44	7,337	1,448
	A3 and A4	14,400	1	13	480	0.67	0.65	1.09	7,123	48	16	38	28,450	102	7,375	2,875
	Tributaries	27,133	24	9	1,271	1.11	2.00	1.72	11,667	66	20	52	32,200	56	11,059	647

(grey) Indicates parameter not used during PCA as a result of > 10% missing and/or below MDL values

Bolding Indicates MDL for respective parameter/study

Table B.1: Rose-Anvil sediment chemistry data (1996 to 2006)

Station	Date	Metal (mg/kg)														
		Mercury	Molybdenum	Nickel	Phosphorus	Potassium	Selenium	Silver	Sodium	Strontium	Thallium	Tin	Titanium	Vanadium	Zinc	Zirconium
R-1	1-Jul-96		1	25	1167			0.1	500	55			500	27	221	
R-1	19-Jul-04	0.18	1.4	35	2770	1260	0.9	0.3	201	43	0.3	5	335	32	336	1
R-1	19-Jul-04	0.05	1.1	24	1910	949	0.4	0.1	218	38	0.2	5	246	20	139	1
R-1	19-Jul-04	0.04	0.7	24	1580	1030	0.5	0.1	205	42	0.2	5	264	21	135	2
R-1	24-Jul-06	0.01	4	23	604	565	0.2	2	138	30		5	131	20	122	2
R-1	24-Jul-06	0.02	4	21	421	743	0.3	2	138	25		5	158	15	157	2
R-1	24-Jul-06	0.01	4	15	317	548	0.2	2	130	49		5	108	12	113	2
R-2	1-Jul-96		1	49	1162			0.6	500	51			500	34	617	
R-2	14-Oct-99	1.2	2	250	1100	3700	0.8	2.4	470	84.9		8	950	65	1680	
R-2	14-Oct-99	0.314	2	201	1000	4710	1.3	1	470	74.2		8	1020	70	1630	
R-2	14-Oct-99	0.32	4	598	1200	2920	0.5	0.4	430	110		8	852	50	1500	
R-2	14-Oct-99	0.134	2	68	1100	4100	0.5	0.2	520	78		8	986	74	522	
R-2	14-Oct-99	0.173	2	76	1200	3040	1.1	0.2	420	66.2		8	851	74	557	
R-2	14-Oct-99	0.106	2	95	1000	3330	0.5	0.2	460	73.2		8	871	66	471	
R-2	19-Jul-04	0.16	1.3	36	2150	1190	0.5	0.3	209	34	0.3	5	286	29	301	2
R-2	19-Jul-04	0.22	1	47	2300	1580	1	0.4	201	42	0.4	5	416	33	539	1
R-2	20-Jul-04	0.16	1.4	48	2080	1320	1.1	0.4	179	50	0.5	14	335	29	607	2
R-2	24-Jul-06	0.19	4	56	907	1610	0.9	2	266	54		5	452	36	736	2
R-2	24-Jul-06	0.14	4	62	792	1880	0.9	2	311	61		5	431	36	843	2
R-2	24-Jul-06	0.2	4	45	929	1540	0.6	2	307	48		5	410	31	502	2
R-3	1-Jul-96		1	42	1183			0.4	500	45			400	29	581	
R-3	14-Oct-99	0.17	2	64	980	2310	0.5	0.6	350	60.7		8	993	53	627	
R-3	14-Oct-99	0.313	2	67	1000	3230	1.4	0.8	550	73.1		8	1070	61	584	
R-3	14-Oct-99	0.234	2	69	1000	5030	0.9	1	630	71.6		8	1050	71	938	
R-3	14-Oct-99	0.267	2	100	1100	3630	1.2	1	550	76.9		8	1150	68	850	
R-3	14-Oct-99	0.265	2	286	1000	4210	1.3	1	550	83		8	1030	65	1640	
R-3	14-Oct-99	0.139	2	94	970	3780	0.5	0.3	490	62.7		8	928	57	701	
R-3	20-Jul-04	0.15	1.4	43	2140	1210	0.8	0.3	186	40	0.4	5	309	29	502	1
R-3	20-Jul-04	0.06	1.9	40	1700	1200	0.5	0.3	170	35	0.4	5	224	26	400	3
R-3	20-Jul-04	0.16	0.8	23	9040	579	0.7	0.5	121	26	0.2	5	275	24	227	1
R-3	25-Jul-06	0.06	4	32	483	825	0.3	2	132	22		5	169	20	326	2
R-3	25-Jul-06	0.14	4	52	898	1480	0.7	2	288	53		5	435	32	727	2
R-3	25-Jul-06	0.1	4	33	907	999	0.4	2	239	40		5	354	26	338	1
R-4	1-Jul-96		2	66	1043			0.9	700	57			500	35	908	
R-4	20-Jul-04	0.14	1.1	31	3860	780	0.5	0.4	150	29	0.2	5	359	30	300	1
R-4	20-Jul-04	0.08	1.7	33	2130	975	0.6	0.3	179	33	0.3	5	239	24	294	1
R-4	20-Jul-04	0.12	1.1	30	2670	811	0.6	0.3	178	32	0.3	5	281	25	287	1
R-4	5-Aug-05	0.18	2.2	52	930	1300	0.5	0.3	340	52	1	1.9	410	38	560	4.7
R-4	25-Jul-06	0.05	4	41	828	787	0.5	0.3	135	27		5	184	26	280	1
R-4	25-Jul-06	0.11	4	56	781	1340	0.8	0.3	278	49		5	434	34	546	1
R-4	25-Jul-06	0.11	4	56	782	1340	0.8	0.3	266	49		5	416	32	584	1
R-5	1-Jul-96		1	41	1413			0.1	400	39			700	53	161	
R-5	20-Jul-04	0.01	1.2	26	3170	799	0.6	0.1	141	27	0.1	5	291	37	83	2
R-5	20-Jul-04	0.06	2.2	42	3090	1030	1.5	0.2	148	36	0.3	40	326	38	242	1
R-5	20-Jul-04	0.01	2.4	31	2860	1160	0.5	0.1	121	20	0.2	5	575	33	311	3
R-5	5-Aug-05	0.34	2.2	44	1200	990	0.5	0.3	270	45	0.84	3.6	380	39	470	4.4
R-5	5-Aug-05	0.34	2.2	44	1200	990	0.5	0.5	270	45	0.84	3.6	380	39	470	4.4
R-5	25-Jul-06	0.03	4	40	1250	1100	0.6	2	220	35		5	449	52	134	2
R-5	25-Jul-06	0.04	4	43	1140	1330	0.8	2	260	38		5	495	52	153	2
R-5	25-Jul-06	0.04	4	47	1130	1310	0.8	2	229	37		5	527	61	160	2
R-6	1-Jul-96		1	40	1349			0.1	400	40			700	54	125	
R-6	20-Jul-04	0.01	1.9	32	3380	897	0.6	0.1	153	33	0.1	5	275	40	82	2
R-6	20-Jul-04	0.01	1.8	27	2790	889	0.6	0.1	123	23	0.1	5	183	40	71	2
R-6	20-Jul-04	0.01	1.3	18	2240	676	0.5	0.1	96	18	0.1	5	135	29	46	2
R-6	5-Aug-05	0.047	1.5	48	1400	1600	0.5	0.3	360	56	<0.5	3.9	530	67	140	6.2
R-6	25-Jul-06	0.01	4	30	1330	663	0.4	0.3	91	24		5	148	35	69	2
R-6	25-Jul-06	0.03	4	48	1160	1450	0.8	0.3	232	37		5	532	61	133	2

Table B.1: Rose-Anvil sediment chemistry data (1996 to 2006)

Station	Date	Metal (mg/kg)														
		Mercury	Molybdenum	Nickel	Phosphorus	Potassium	Selenium	Silver	Sodium	Strontium	Thallium	Tin	Titanium	Vanadium	Zinc	Zirconium
R-6	25-Jul-06	0.03	**4**	45	1100	1380	0.7	**0.3**	233	37		**5**	496	58	126	2
R-7	1-Jul-96		**1**	17	1109		0.6	**0.1**	100	31			500	24	82	
R-7	20-Jul-04	0.01	1.5	33	3270	1120	**0.5**	**0.1**	147	25	0.1	**5**	243	41	82	3
R-7	20-Jul-04	0.03	0.8	20	2590	1280	0.7	0.1	101	30	0.2	**5**	403	27	86	1
R-7	20-Jul-04	0.02	0.6	17	3120	978	0.6	**0.1**	97	25	0.1	**5**	320	25	67	1
R-7	26-Jul-06	0.01	**4**	17	510	962	0.3	**0.3**	130	24		**5**	262	19	54	1
R-7	26-Jul-06	0.03	**4**	23	916	1560	0.8	**0.3**	158	34		**5**	460	30	95	1
R-7	26-Jul-06	0.03	**4**	26	878	1770	0.7	**0.3**	178	35		**5**	500	32	95	1
R-8	26-Jul-06	0.04	**4**	52	1100	1550	0.8	**0.3**	234	40		**5**	545	65	144	2
R-8	26-Jul-06	0.03	**4**	46	1140	1200	0.7	**0.3**	204	34		**5**	455	61	135	2
R-8	26-Jul-06	0.03	**4**	48	1080	1280	0.7	**0.3**	207	35		**5**	505	66	146	2
T-1(Ref)	14-Oct-99	0.095	**2**	65	820	3870	0.5	1	1200	93.1		**8**	1390	59	185	
T-1(Ref)	14-Oct-99	0.093	**2**	44	810	5570	1.1	1	1500	111		**8**	1460	66	196	
T-1(Ref)	14-Oct-99	0.195	**2**	56	900	3530	1.4	0.5	930	90.1		**8**	1200	57	229	
T-2(Ref)	14-Oct-99	0.037	**2**	46	670	3920	0.9	0.6	790	61.6		**8**	1400	56	138	
T-2(Ref)	14-Oct-99	0.106	**2**	46	910	3320	0.5	1	700	68.4		**8**	1460	59	180	
T-2(Ref)	14-Oct-99	0.044	**2**	46	830	3460	0.5	0.2	700	60.6		**8**	1400	56	150	
T-3(Ref)	14-Oct-99	0.086	**20**	60	1000	3970	2	0.8	300	69		**80**	1150	100	174	
T-3(Ref)	14-Oct-99	0.117	**20**	90	1000	4340	2.1	0.2	400	68		**80**	1160	100	198	
T-3(Ref)	14-Oct-99	0.13	2	92	1300	5710	2.3	0.7	430	75.4		**8**	1300	130	199	
Anvil A1	13-Aug-04	0.04	0.77	30.8	765		**0.2**			37.1	<0.2	0.5	452	35.1	89.7	2.22
Anvil A2	13-Aug-04	0.06	1.08	45.5	933		**0.2**	0.16		41.5	<0.2	0.7	516	44.7	167	2.31
Anvil A2	5-Aug-05	0.044	1.3	59	1000	2300	**0.2**		300	62	1.2	0.69	460	58	300	6.9
Anvil A3	13-Aug-04	0.06	1.12	40.4	952		**0.2**	0.11		34.8	<0.2	0.5	453	39.6	184	2.27
Anvil A3	5-Aug-05	0.13	1.8	66	1100	2300	**0.2**		340	59	0.52	0.66	500	66	400	7.8
Anvil A4	13-Aug-04	0.05	1.75	47.6	851		**0.2**	0.18		36.6	0.4	0.5	429	34.7	274	2.1
Anvil A4	5-Aug-05	0.14	2.2	52	1100	1500	**0.2**		370	57	1	1	480	50	430	5
Averages	R-1	0.05	2.31	24	1,253	849	0.42	0.94	219	40	0.2	5.0	249	21	175	1.7
	R-2	0.28	2.36	125	1,302	2,577	0.81	0.93	365	64	0.4	7.3	643	48	808	1.8
	R-3	0.17	2.24	73	1,723	2,374	0.77	0.94	366	53	0.3	6.5	645	43	649	1.7
	R-4	0.11	2.51	46	1,628	1,048	0.61	0.39	278	41	0.5	4.6	353	31	470	1.5
	R-5	0.11	2.58	40	1,828	1,089	0.73	0.81	229	36	0.5	9.0	458	45	243	2.6
	R-6	0.02	2.44	36	1,844	1,079	0.59	0.20	211	34	0.1	4.8	375	48	99	2.6
	R-7	0.03	2.27	22	1,770	1,389	0.60	0.19	130	29	0.1	5.0	384	28	80	1.3
	R-8	0.03	4.00	49	1,107	1,343	0.73	0.30	215	36		5.0	502	64	142	2.0
	A1 and A2	0.05	1.05	45	899	2,300	0.20	0.12	300	47	1.2	0.6	476	46	186	3.8
	A3 and A4	0.10	1.72	52	1,001	1,900	0.20	0.15	355	47	0.6	0.7	466	48	322	4.3
	Tributaries	0.10	6.00	61	916	4,188	1.26	0.67	772	77		24.0	1,324	76	183	

Indicates parameter not used during PCA as a result of > 10% missing and/or below MDL values

Bolding Indicates MDL for respective parameter/study

Table B.2: Rose-Anvil sediment chemistry data, average values by year (1996 to 2006)

Station	Year	Metal (mg/kg)														
		Aluminum	Antimony	Arsenic	Barium	Berylium	Boron	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese
R1	1996	10,900.00	2.00	6.00	195.00	0.90	0.00	0.60	5,300.00	27.00	9.00	21.00	20,900.00	74.00	4,500.00	1,419.00
	1999															
	2004	11,533.33	0.30	12.10	175.00	1.00	1.00	0.73	4,463.33	31.67	12.00	18.33	20,666.67	125.27	4,946.67	1,590.00
	2005															
	2006	7,996.67	10.00	10.00	97.67	1.00	1.00	0.50	2,513.33	17.00	9.33	10.00	14,700.00	22.67	3,566.67	1,123.33
R2	1996	12,100.00	3.00	32.00	399.00	1.00	0.00	1.60	7,900.00	50.00	16.00	60.00	33,800.00	310.00	7,200.00	2,808.00
	1999	22,733.33	13.83	35.09	1,471.17	0.93	2.00	1.87	11,730.00	75.58	41.52	122.55	50,116.67	475.67	11,328.33	16,430.00
	2004	13,233.33	1.27	19.63	463.33	1.00	1.33	1.30	7,976.67	36.00	17.00	58.33	27,500.00	207.33	6,406.67	2,576.67
	2005															
	2006	19,733.33	10.00	23.67	437.00	1.00	1.00	1.23	9,290.00	51.33	25.00	60.67	27,066.67	178.67	7,080.00	4,796.67
R3	1996	10,500.00	2.00	31.00	263.00	0.90	0.00	1.00	6,500.00	39.00	17.00	59.00	29,500.00	244.00	5,900.00	4,665.00
	1999	21,550.00	8.83	33.03	2,335.00	0.85	2.00	1.63	8,270.00	55.62	31.70	85.48	39,800.00	261.00	8,050.00	10,340.00
	2004	10,823.33	1.67	15.57	280.00	1.00	1.00	0.77	6,340.00	27.00	17.00	46.67	24,133.33	165.33	5,170.00	4,151.00
	2005															
	2006	13,800.00	10.00	15.00	303.33	1.00	1.00	0.80	4,953.33	35.00	20.33	46.33	20,633.33	143.00	5,273.33	5,040.00
R4	1996	12,000.00	2.00	32.00	600.00	1.20	0.00	2.10	6,800.00	46.00	24.00	78.00	32,400.00	267.00	7,000.00	11,466.00
	1999															
	2004	9,886.67	1.33	14.17	267.00	1.00	1.00	0.70	4,823.33	29.00	11.67	38.67	20,466.67	153.67	4,983.33	2,483.33
	2005	14,000.00	<1	14.00	560.00	0.69	<1	1.20	6,600.00	45.00	20.00	48.00	30,000.00	170.00	7,300.00	6,100.00
	2006	15,026.67	10.00	14.00	419.00	1.00	1.00	0.97	5,886.67	46.00	22.67	47.00	21,400.00	120.00	6,126.67	5,926.67
R5	1996	13,600.00	3.00	14.00	308.00	0.90	0.00	0.80	6,500.00	45.00	13.00	35.00	26,500.00	20.00	7,300.00	1,855.00
	1999															
	2004	10,056.67	0.87	11.43	252.67	1.00	1.00	0.90	5,450.00	35.00	11.00	42.33	20,266.67	69.30	4,810.00	1,518.33
	2005	11,000.00	1.00	32.00	350.00	0.61	#DIV/0!	1.40	6,000.00	39.00	18.00	78.00	37,000.00	290.00	5,900.00	4,100.00
	2006	19,200.00	10.00	12.00	258.00	1.00	1.00	0.97	6,363.33	41.33	15.67	38.33	21,666.67	24.67	7,320.00	1,013.67
R6	1996	14,200.00	<2	9.00	238.00	0.90	0.00	1.00	6,900.00	45.00	13.00	34.00	26,500.00	11.00	7,600.00	1,222.00
	1999															
	2004	8,816.67	0.93	12.20	142.00	1.00	1.00	0.63	4,690.00	21.33	8.67	20.00	18,700.00	10.97	4,293.33	889.67
	2005	17,000.00	<1	15.00	360.00	0.86	<1	1.60	9,800.00	48.00	16.00	31.00	36,000.00	16.00	8,300.00	2,600.00
	2006	17,033.33	10.00	11.33	176.33	1.00	1.00	0.83	6,070.00	41.67	14.67	33.00	20,966.67	14.67	6,933.33	634.00
R7	1996	8,600.00	<2	10.00	173.00	0.70	0.00	0.40	4,000.00	20.00	4.00	14.00	18,400.00	18.00	3,500.00	887.00
	1999															
	2004	10,703.33	0.63	11.90	162.33	1.00	1.00	0.53	4,410.00	21.33	9.00	17.33	19,366.67	14.70	4,286.67	808.67
	2005															
	2006	14,093.33	10.00	11.33	165.33	1.00	1.00	0.57	4,126.67	24.67	10.67	17.33	18,233.33	14.67	4,386.67	745.00
R8	1996															
	1999															
	2004															
	2005															
	2006	20,600.00	10.00	12.67	209.00	1.00	1.00	1.07	6,490.00	44.67	17.33	47.00	23,300.00	17.33	7,766.67	773.00
A4	1996															
	1999															
	2004	10,500.00	1.00	11.50	453.00	0.42	0.50	0.71	5,020.00	50.70	13.50	24.00	25,300.00	98.00	5,640.00	3,580.00
	2005															
	2006	16,000.00	<1	14.00	760.00	0.78	<1	1.10	7,500.00	45.00	20.00	42.00	32,000.00	150.00	7,700.00	5,800.00
A3	1996															
	1999															
	2004	11,100.00	1.40	13.00	326.00	0.47	0.80	0.73	6,170.00	42.10	10.80	26.80	24,500.00	62.00	6,360.00	1,020.00
	2005															
	2006	20,000.00	<1	12.00	380.00	1.00	<1	1.80	9,800.00	56.00	19.00	58.00	32,000.00	99.00	9,800.00	1,100.00
A2	1996															
	1999															
	2004	12,200.00	1.00	13.60	500.00	0.52	0.60	0.78	6,800.00	55.10	10.70	27.50	25,600.00	52.90	7,080.00	862.00
	2005															
	2006	17,000.00	<1	12.00	580.00	0.92	<1	1.40	11,000.00	50.00	17.00	44.00	30,000.00	61.00	8,800.00	3,100.00

Table B.2: Rose-Anvil sediment chemistry data, average values by year (1996 to 2006)

Station	Year	Metal (mg/kg)													
		Mercury	Molybdenum	Nickel	Phosphorus	Potassium	Selenium	Silver	Sodium	Strontium	Thallium	Tin	Titanium	Vanadium	Zinc
R1	1996	0.05	1.00	25.00	1,167.00	849.17	0.42	0.10	500.00	55.00	0.00	0.00	500.00	27.00	221.00
	1999														
	2004	0.09	1.07	27.67	2,086.67	1,079.67	0.60	0.17	208.00	41.00	0.23	5.00	281.67	24.33	203.33
	2005														
	2006	0.01	4.00	19.67	447.33	618.67	0.23	2.00	135.33	34.67		5.00	132.33	15.67	130.67
R2	1996	0.28	1.00	49.00	1,162.00	2,576.67	0.81	0.60	500.00	51.00	0.00	0.00	500.00	34.00	617.00
	1999	0.37	2.33	214.67	1,100.00	3,633.33	0.78	0.73	461.67	81.08		8.00	921.67	66.50	1,060.00
	2004	0.18	1.23	43.67	2,176.67	1,363.33	0.87	0.37	196.33	42.00	0.40	8.00	345.67	30.33	482.33
	2005														
	2006	0.18	4.00	54.33	876.00	1,676.67	0.80	2.00	294.67	54.33		5.00	431.00	34.33	693.67
R3	1996	0.17	1.00	42.00	1,183.00	2,373.58	0.77	0.40	500.00	45.00	0.00	0.00	400.00	29.00	581.00
	1999	0.23	2.00	113.33	1,008.33	3,698.33	0.97	0.78	520.00	71.33		8.00	1,036.83	62.50	890.00
	2004	0.12	1.37	35.33	4,293.33	996.33	0.67	0.37	159.00	33.67	0.33	5.00	269.33	26.33	376.33
	2005														
	2006	0.10	4.00	39.00	762.67	1,101.33	0.47	2.00	219.67	38.33		5.00	319.33	26.00	463.67
R4	1996	0.11	2.00	66.00	1,043.00	1,047.57	0.61	0.90	700.00	57.00	0.00	0.00	500.00	35.00	908.00
	1999														
	2004	0.11	1.30	31.33	2,886.67	855.33	0.57	0.33	169.00	31.33	0.27	5.00	293.00	26.33	293.67
	2005	0.18	2.20	52.00	930.00	1,300.00	0.50	0.30	340.00	52.00	1.00	1.90	410.00	38.00	560.00
	2006	0.09	4.00	51.00	797.00	1,155.67	0.70	0.30	226.33	41.67		5.00	344.67	30.67	470.00
R5	1996	0.11	1.00	41.00	1,413.00	1,088.63	0.73	0.10	400.00	39.00	0.00	0.00	700.00	53.00	161.00
	1999														
	2004	0.03	1.93	33.00	3,040.00	996.33	0.87	0.13	136.67	27.67	0.20	16.67	397.33	36.00	212.00
	2005	0.34	2.20	44.00	1,200.00	990.00	0.50	0.40	270.00	45.00	0.84	3.60	380.00	39.00	470.00
	2006	0.04	4.00	43.33	1,173.33	1,246.67	0.73	2.00	236.33	36.67		5.00	490.33	55.00	149.00
R6	1996	0.02	1.00	40.00	1,349.00	1,079.29	0.59	0.10	400.00	40.00	0.00	0.00	700.00	54.00	125.00
	1999														
	2004	0.01	1.67	25.67	2,803.33	820.67	0.57	0.10	124.00	24.67	0.10	5.00	197.67	36.33	66.33
	2005	0.05	1.50	48.00	1,400.00	1,600.00	0.50	0.30	360.00	56.00	<0.5	3.90	530.00	67.00	140.00
	2006	0.02	4.00	41.00	1,196.67	1,164.33	0.63	0.30	185.33	32.67		5.00	392.00	51.33	109.33
R7	1996	0.05	1.00	17.00	1,109.00	2,055.83	0.60	0.10	100.00	31.00	0.00	0.00	500.00	24.00	82.00
	1999														
	2004	0.02	0.97	23.33	2,993.33	1,126.00	0.60	0.10	115.00	26.67	0.13	5.00	322.00	31.00	78.33
	2005														
	2006	0.02	4.00	22.00	768.00	1,430.67	0.60	0.30	155.33	31.00		5.00	407.33	27.00	81.33
R8	1996														
	1999														
	2004														
	2005														
	2006	0.03	4.00	48.67	1,106.67	1,343.33	0.73	0.30	215.00	36.33		5.00	501.67	64.00	141.67
A4	1996														
	1999														
	2004	0.05	1.75	47.60	851.00	1,500.00	0.20	0.18	370.00	36.60	0.40	0.50	429.00	34.70	274.00
	2005														
	2006	0.14	2.20	52.00	1,100.00	1,500.00	0.20	0.18	370.00	57.00	1.00	1.00	480.00	50.00	430.00
A3	1996														
	1999														
	2004	0.06	1.12	40.40	952.00	2,300.00	0.20	0.11	340.00	34.80	<0.2	0.50	453.00	39.60	184.00
	2005														
	2006	0.13	1.80	66.00	1,100.00	2,300.00	0.20	0.11	340.00	59.00	0.52	0.66	500.00	66.00	400.00
A2	1996														
	1999														
	2004	0.06	1.08	45.50	933.00	2,300.00	0.20	0.16	300.00	41.50	<0.2	0.70	516.00	44.70	167.00
	2005														
	2006	0.04	1.30	59.00	1,000.00	2,300.00	0.20	0.16	300.00	62.00	1.20	0.69	460.00	58.00	300.00

Indicates parameter not used during PCA as a result of > 10% missing and/or below MDL values

Table B.3: Relative magnitude of difference between mine-exposed and mean reference values at Rose-Anvil Creek system monitoring stations (1973 to 2006 data)

Metal	Mean Reference Value	Mine-Influenced Stations							
		South Fork Rose Creek R1	North Fork Rose Creek R8	Rose Creek R2	Rose Creek R3	Rose Creek R4	Anvil Creek R5	Anvil Creek A3 and A4	Anvil Creek A1 and A2
Aluminum	17,528	0.6	1.2	1.1	0.9	0.7	0.8	0.8	0.7
Arsenic	10.7	1.0	1.2	2.7	2.3	1.5	1.5	1.2	1.1
Barium	543	0.3	0.4	1.7	2.3	0.7	0.5	0.9	0.8
Berylium	1.01	1.0	1.0	1.0	0.9	1.0	0.9	0.7	0.6
Cadmium	1.0	0.6	1.0	1.5	1.1	1.0	1.0	1.0	0.8
Calcium	7,340	0.5	0.9	1.4	0.9	0.8	0.8	1.0	1.1
Chromium	41.3	0.6	1.1	1.4	1.0	1.0	0.9	1.2	1.1
Cobalt	13.7	0.8	1.3	2.2	1.8	1.3	1.0	1.2	0.9
Copper	32.4	0.5	1.5	2.7	2.0	1.5	1.5	1.2	0.9
Iron	24,543	0.7	0.9	1.6	1.3	1.0	1.0	1.2	1.0
Lead	28.1	2.6	0.6	11.8	7.5	5.6	3.5	3.6	1.6
Magnesium	7,158	0.6	1.1	1.2	0.9	0.8	0.9	1.0	1.0
Manganese	829	1.6	0.9	11.5	8.7	6.4	2.4	3.5	1.7
Mercury	0.049	1.0	0.7	5.6	3.5	2.3	2.2	1.9	1.0
Nickel	39.5	0.6	1.2	3.2	1.8	1.2	1.0	1.3	1.1
Phosphorus	1,510	0.8	0.7	0.9	1.1	1.1	1.2	0.7	0.6
Potassium	2,219	0.4	0.6	1.2	1.1	0.5	0.5	0.9	1.0
Selenium	0.8	0.5	0.9	1.0	0.9	0.8	0.9	0.2	0.2
Silver	0.4	2.7	0.9	2.7	2.7	1.1	2.3	0.4	0.4
Sodium	371	0.6	0.6	1.0	1.0	0.7	0.6	1.0	0.8
Strontium	46.7	0.9	0.8	1.4	1.1	0.9	0.8	1.0	1.0
Titanium	694	0.4	0.7	0.9	0.9	0.5	0.7	0.7	0.7
Vanadium	51	0.4	1.3	1.0	0.9	0.6	0.9	0.9	0.9
Zinc	121	1.4	1.2	6.7	5.4	3.9	2.0	2.7	1.5

Indicates mean value that exceeds mean reference value by a factor equal to or greater than three

Table B.4: Weightings of sediment metal variates in PCA of Rose-Anvil Creek system sediment samples (1996 to 2006 data)

Sediment Parameter (mg/kg, log x+1 transformed)	Sediment Metal PCA Axis-1 (66.5 %)	Sediment Metal PCA Axis-2 (17.0 %)
Iron	0.9505	-0.0059
Cobalt	0.9234	0.1519
Nickel	0.9213	0.0459
Copper	0.9086	0.1696
Cadmium	0.8949	-0.0792
Chromium	0.8805	-0.3293
Strontium	0.8631	-0.1849
Barium	0.8575	0.0354
Magnesium	0.8414	-0.4679
Calcium	0.8321	-0.3403
Zinc	0.7942	0.5345
Potassium	0.7855	-0.4069
Aluminum	0.7727	-0.5066
Vanadium	0.7181	-0.5933
Mercury	0.7141	0.4592
Lead	0.6715	0.6189
Arsenic	0.6461	0.5995
Manganese	0.5864	0.7122

Indicates heavily positive-weighted parameter on respective sediment PCA axis

Indicates heavily negative-weighted parameter on respective sediment PCA axis

Table B.5a: Summary of Principal Component Analysis (PCA) statistical comparisons among Rose-Anvil sediment sampling stations (1996 to 2006 data)

Principal Component Axis	Three-group Comparison			Pair-wise Comparisons				
	Significant Difference Among Areas?	p-value	Statistical Test	(I) Area	(J) Area	Significant Difference Between 2 Areas?	p-value	Statistical Test[a]
PCA Axis-1	YES	0.024	ANOVA	South Fork Rose (R1)	Near-Field Rose (R2)	YES	0.000	Tamhane's
					Lower Rose (R3)	YES	0.009	Tamhane's
					Lower Rose (R4)	NO	0.206	Tamhane's
					Lower Anvil (R5)	NO	0.386	Tamhane's
					Upper Anvil (R6)	NO	1.000	Tamhane's
					North Fork Rose (Ref R7)	NO	1.000	Tamhane's
					North Fork Rose (Exp R8)	NO	0.213	Tamhane's
					Rose Tributaries	YES	0.003	Tamhane's
					Lower Anvil (A3 & A4)	NO	0.301	Tamhane's
					Mouth of Anvil (A1 & A2)	NO	0.995	Tamhane's
				Near-Field Rose (R2)	Lower Rose (R3)	NO	1.000	Tamhane's
					Lower Rose (R4)	NO	0.114	Tamhane's
					Lower Anvil (R5)	YES	0.020	Tamhane's
					Upper Anvil (R6)	YES	0.007	Tamhane's
					North Fork Rose (Ref R7)	YES	0.000	Tamhane's
					North Fork Rose (Exp R8)	YES	0.039	Tamhane's
					Rose Tributaries	NO	1.000	Tamhane's
					Lower Anvil (A3 & A4)	NO	0.802	Tamhane's
					Mouth of Anvil (A1 & A2)	NO	0.959	Tamhane's
				Lower Rose (R3)	Lower Rose (R4)	NO	0.996	Tamhane's
					Lower Anvil (R5)	NO	0.797	Tamhane's
					Upper Anvil (R6)	NO	0.215	Tamhane's
					North Fork Rose (Ref R7)	YES	0.001	Tamhane's
					North Fork Rose (Exp R8)	NO	0.923	Tamhane's
					Rose Tributaries	NO	1.000	Tamhane's
					Lower Anvil (A3 & A4)	NO	1.000	Tamhane's
					Mouth of Anvil (A1 & A2)	NO	1.000	Tamhane's
				Lower Rose (R4)	Lower Anvil (R5)	NO	1.000	Tamhane's
					Upper Anvil (R6)	NO	0.992	Tamhane's
					North Fork Rose (Ref R7)	YES	0.036	Tamhane's
					North Fork Rose (Exp R8)	NO	1.000	Tamhane's
					Rose Tributaries	NO	0.250	Tamhane's
					Lower Anvil (A3 & A4)	NO	1.000	Tamhane's
					Mouth of Anvil (A1 & A2)	NO	1.000	Tamhane's
				Lower Anvil (R5)	Upper Anvil (R6)	NO	1.000	Tamhane's
					North Fork Rose (Ref R7)	NO	0.051	Tamhane's
					North Fork Rose (Exp R8)	NO	1.000	Tamhane's
					Rose Tributaries	YES	0.025	Tamhane's
					Lower Anvil (A3 & A4)	NO	1.000	Tamhane's
					Mouth of Anvil (A1 & A2)	NO	1.000	Tamhane's
				Upper Anvil (R6)	North Fork Rose (Ref R7)	NO	0.998	Tamhane's
					North Fork Rose (Exp R8)	NO	0.990	Tamhane's
					Rose Tributaries	YES	0.031	Tamhane's
					Lower Anvil (A3 & A4)	NO	0.946	Tamhane's
					Mouth of Anvil (A1 & A2)	NO	1.000	Tamhane's
				North Fork Rose (Ref R7)	North Fork Rose (Exp R8)	YES	0.038	Tamhane's
					Rose Tributaries	YES	0.000	Tamhane's
					Lower Anvil (A3 & A4)	NO	0.268	Tamhane's
					Mouth of Anvil (A1 & A2)	NO	0.994	Tamhane's
				North Fork Rose (Exp R8)	Rose Tributaries	NO	0.129	Tamhane's
					Lower Anvil (A3 & A4)	NO	1.000	Tamhane's
					Mouth of Anvil (A1 & A2)	NO	1.000	Tamhane's
				Rose Tributaries	Lower Anvil (A3 & A4)	NO	0.995	Tamhane's
					Mouth of Anvil (A1 & A2)	NO	1.000	Tamhane's
				Mouth of Anvil (A1 & A2)	Lower Anvil (A3 & A4)	NO	1.000	Tamhane's

[a] Post-hoc analysis of 1-way ANOVA among all areas protected for multiple comparisons

Table B.5b: Summary of Principal Component Analysis (PCA) statistical comparisons among Rose-Anvil sediment sampling stations (1996 to 2006 data)

Principal Component Axis	Three-group Comparison			Pair-wise Comparisons				
	Significant Difference Among Areas?	p-value	Statistical Test	(I) Area	(J) Area	Significant Difference Between 2 Areas?	p-value	Statistical Test[a]
PCA Axis-2	YES	0.001	ANOVA	South Fork Rose (R1)	Near-Field Rose (R2)	NO	1.000	Tamhane's
					Lower Rose (R3)	NO	0.991	Tamhane's
					Lower Rose (R4)	NO	0.927	Tamhane's
					Lower Anvil (R5)	NO	1.000	Tamhane's
					Upper Anvil (R6)	YES	0.010	Tamhane's
					North Fork Rose (Ref R7)	NO	0.053	Tamhane's
					North Fork Rose (Exp R8)	YES	0.001	Tamhane's
					Rose Tributaries	YES	0.000	Tamhane's
					Lower Anvil (A3 & A4)	NO	0.992	Tamhane's
					Mouth of Anvil (A1 & A2)	YES	0.002	Tamhane's
				Near-Field Rose (R2)	Lower Rose (R3)	NO	1.000	Tamhane's
					Lower Rose (R4)	NO	1.000	Tamhane's
					Lower Anvil (R5)	NO	1.000	Tamhane's
					Upper Anvil (R6)	YES	0.039	Tamhane's
					North Fork Rose (Ref R7)	NO	0.368	Tamhane's
					North Fork Rose (Exp R8)	YES	0.001	Tamhane's
					Rose Tributaries	YES	0.000	Tamhane's
					Lower Anvil (A3 & A4)	NO	0.994	Tamhane's
					Mouth of Anvil (A1 & A2)	YES	0.009	Tamhane's
				Lower Rose (R3)	Lower Rose (R4)	NO	1.000	Tamhane's
					Lower Anvil (R5)	NO	0.867	Tamhane's
					Upper Anvil (R6)	YES	0.001	Tamhane's
					North Fork Rose (Ref R7)	YES	0.000	Tamhane's
					North Fork Rose (Exp R8)	YES	0.000	Tamhane's
					Rose Tributaries	YES	0.000	Tamhane's
					Lower Anvil (A3 & A4)	NO	0.794	Tamhane's
					Mouth of Anvil (A1 & A2)	YES	0.000	Tamhane's
				Lower Rose (R4)	Lower Anvil (R5)	NO	0.773	Tamhane's
					Upper Anvil (R6)	YES	0.001	Tamhane's
					North Fork Rose (Ref R7)	YES	0.000	Tamhane's
					North Fork Rose (Exp R8)	YES	0.000	Tamhane's
					Rose Tributaries	YES	0.000	Tamhane's
					Lower Anvil (A3 & A4)	NO	0.729	Tamhane's
					Mouth of Anvil (A1 & A2)	YES	0.000	Tamhane's
				Lower Anvil (R5)	Upper Anvil (R6)	NO	0.984	Tamhane's
					North Fork Rose (Ref R7)	NO	1.000	Tamhane's
					North Fork Rose (Exp R8)	NO	0.296	Tamhane's
					Rose Tributaries	YES	0.009	Tamhane's
					Lower Anvil (A3 & A4)	NO	1.000	Tamhane's
					Mouth of Anvil (A1 & A2)	NO	0.880	Tamhane's
				Upper Anvil (R6)	North Fork Rose (Ref R7)	NO	0.972	Tamhane's
					North Fork Rose (Exp R8)	NO	0.930	Tamhane's
					Rose Tributaries	YES	0.006	Tamhane's
					Lower Anvil (A3 & A4)	NO	1.000	Tamhane's
					Mouth of Anvil (A1 & A2)	NO	1.000	Tamhane's
				North Fork Rose (Ref R7)	North Fork Rose (Exp R8)	YES	0.004	Tamhane's
					Rose Tributaries	YES	0.000	Tamhane's
					Lower Anvil (A3 & A4)	NO	1.000	Tamhane's
					Mouth of Anvil (A1 & A2)	NO	0.171	Tamhane's
				North Fork Rose (Exp R8)	Rose Tributaries	YES	0.006	Tamhane's
					Lower Anvil (A3 & A4)	NO	0.882	Tamhane's
					Mouth of Anvil (A1 & A2)	NO	0.763	Tamhane's
				Rose Tributaries	Lower Anvil (A3 & A4)	NO	0.187	Tamhane's
					Mouth of Anvil (A1 & A2)	YES	0.000	Tamhane's
				Mouth of Anvil (A1 & A2)	Lower Anvil (A3 & A4)	NO	0.999	Tamhane's

[a] Post-hoc analysis of 1-way ANOVA among all areas protected for multiple comparisons

Table B.6: Vangorda sediment chemistry data (1995 to 2005)

Station	Year	Metal (mg/kg)												
		Aluminum	Arsenic	Barium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Molybdenum
V-1	1995	14,400	34.0	228	0.5	4,500	36.0	15.0	34.0	33,600	37	5,700	892	1
V-1	1995	16,100	26.0	232	0.8	5,300	35.0	11.0	31.0	30,100	34	5,900	354	1
V-1	1995	12,500	31.0	236	1.0	5,200	50.0	10.0	35.0	28,600	59	4,900	1,014	5
V-1	1997	16,600	28.0	292	0.6	4,300	32.0	14.0	71.0	31,500	76	5,800	973	2
V-1	1997	18,400	40.0	332	1.1	5,400	35.0	16.0	55.0	36,000	81	6,200	1,363	1
V-1	1997	7,000	9.0	96	**0.2**	2,000	16.0	7.0	33.0	14,500	18	2,400	563	**1**
V-1	1999	17,270	26.9	289	0.6	5,247	59.5	20.5	41.0	41,670	62	7,268	1,363	4
V-1	1999	17,249	28.7	292	1.0	5,589	52.6	18.9	37.7	39,180	41	6,788	1,583	2
V-1	1999	17,191	28.7	272	0.4	5,075	66.3	20.4	38.9	39,841	31	7,504	1,579	3
V-1	2001	10,829	14.4	89	0.5	2,844	29.9	10.8	17.7	23,793	16	5,243	461	1
V-1	2001	17,401	14.0	162	0.6	6,229	37.0	13.0	26.1	27,301	25	6,175	376	1
V-1	2001	10,616	7.3	70	0.5	2,913	23.4	6.2	12.8	20,494	12	5,634	352	**1**
V-1	2003	14,601	23.4	149	1.1	5,746	26.6	10.9	23.8	24,089	44	4,160	654	1
V-1	2003	15,231	21.8	145	0.8	4,596	31.6	14.0	27.2	27,997	26	4,958	1,017	1
V-1	2003	14,820	16.5	152	1.1	5,592	33.5	11.4	26.9	22,507	42	4,524	607	1
V-1	2005	8,000	**10.0**	49	**0.5**	1,350	13.0	8.0	19.0	13,800	22	3,330	280	**4**
V-1	2005	13,600	**10.0**	96	**0.5**	2,510	25.0	11.0	18.0	17,500	22	4,990	391	**4**
V-1	2005	8,240	**10.0**	56	**0.5**	1,410	13.0	10.0	14.0	15,300	14	3,700	335	**4**
V-27	1995	7,400	48.0	193	0.8	5,100	27.0	27.0	47.0	20,500	270	5,300	364	1
V-27	1995	7,600	82.0	160	0.9	7,600	36.0	36.0	67.0	25,100	1,002	6,500	405	1
V-27	1995	7,150	109.0	144	1.3	7,350	43.0	21.5	65.0	29,200	2,707	6,350	403	1
V-27	1997	11,900	143.0	244	1.4	7,400	54.0	32.0	101.0	45,200	2,036	8,700	756	3
V-27	1997	11,900	102.0	299	1.3	6,600	52.0	26.0	83.0	37,600	1,656	8,500	687	3
V-27	1997	9,700	69.0	256	1.6	5,600	38.0	22.0	79.0	30,800	783	6,500	554	3
V-27	1999	11,435	174.0	398	2.5	5,471	42.1	22.0	158.9	46,632	2,486	8,100	666	7
V-27	1999	9,229	123.8	210	1.3	7,594	43.6	20.7	77.2	35,070	1,761	8,928	576	4
V-27	1999	12,603	159.4	491	2.9	6,278	44.3	22.3	150.7	46,876	1,961	9,071	731	6
V-27	2001	11,257	110.8	108	1.9	7,977	50.5	21.9	93.4	37,091	2,826	9,242	566	3
V-27	2001	11,653	111.0	108	2.0	9,313	54.9	27.0	108.8	41,512	3,943	10,071	688	2
V-27	2001	12,543	104.7	98	1.8	9,830	53.3	22.9	102.4	38,489	1,636	11,042	593	2
V-27	2003	11,988	91.1	201	3.0	5,996	44.1	25.9	81.3	31,049	1,753	8,327	672	2
V-27	2003	11,893	93.0	174	1.3	7,059	39.8	23.2	63.9	29,264	1,082	8,677	534	2
V-27	2003	13,501	75.8	208	2.1	7,788	46.0	23.7	77.9	30,811	1,316	9,719	714	2
V-27	2005	12,500	27.0	121	1.0	9,140	39.0	16.0	40.0	20,200	267	7,910	806	**4**
V-27	2005	13,800	23.0	83	1.0	8,770	40.0	15.0	31.0	20,000	114	8,650	664	**4**
V-27	2005	12,600	23.0	113	0.9	9,100	42.0	15.0	38.0	19,900	183	8,270	620	**4**
V-5	1995	6,200	32.0	178	1.0	14,400	37.0	9.0	37.0	18,400	55	9,000	389	2
V-5	1995	5,900	34.0	182	1.0	14,800	35.0	10.0	34.0	17,900	51	8,800	391	2
V-5	1995	6,200	37.0	182	1.0	14,800	37.0	10.0	38.0	18,400	51	9,200	426	2
V-5	1997	8,800	22.0	344	0.4	20,700	45.0	12.0	38.0	21,100	33	11,300	483	2
V-5	1997	8,400	21.0	354	0.3	19,700	42.0	11.0	34.0	20,200	34	10,600	468	3
V-5	1997	8,900	22.0	343	0.2	20,000	45.0	12.0	35.0	21,400	38	11,100	511	1
V-5	1999	6,550	15.1	248	0.3	18,318	35.1	10.4	26.2	17,922	30	9,014	408	2
V-5	1999	7,014	15.9	275	**0.2**	15,436	34.7	9.7	23.8	17,983	32	8,454	375	2
V-5	1999	7,528	12.5	286	**0.2**	15,697	34.8	9.7	24.6	18,522	29	8,366	371	2
V-5	2001	7,114	10.5	192	0.7	13,580	42.8	7.9	21.7	17,742	24	8,855	348	2
V-5	2001	8,273	12.0	218	0.8	14,959	43.9	9.3	28.3	19,501	34	9,447	468	2
V-5	2001	8,734	14.2	216	1.1	17,016	47.9	10.7	35.0	20,753	39	10,209	591	2

Table B.6: Vangorda sediment chemistry data (1995 to 2005)

Station	Year	Metal (mg/kg)												
		Aluminum	Arsenic	Barium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Molybdenum
V-5	2003	7,531	13.7	148	0.7	13,412	43.9	11.1	26.4	16,742	34	9,273	482	1
V-5	2003	7,109	10.9	132	0.5	14,369	52.0	11.6	19.0	15,794	18	11,370	388	1
V-5	2003	7,634	12.1	134	0.4	15,366	61.7	12.6	22.0	17,595	22	12,783	396	1
V-5	2005	10,200	11.0	165	0.9	20,300	54.0	14.0	27.0	16,300	22	11,500	479	**4**
V-5	2005	9,890	**10.0**	109	0.9	19,500	41.0	13.0	22.0	17,000	20	11,700	456	**4**
V-5	2005	9,970	**10.0**	139	0.8	18,500	59.0	14.0	26.0	16,700	20	12,100	422	**4**
V-8	1995	8,300	42.0	239	1.4	9,400	34.0	13.0	52.0	22,600	178	7,400	555	2
V-8	1995	6,300	43.0	154	0.8	9,500	31.0	12.0	44.0	20,600	299	6,900	403	1
V-8	1995	8,100	47.0	258	1.3	9,300	34.0	13.0	49.0	22,000	177	7,100	558	1
V-8	1997	10,700	26.0	406	0.4	8,200	42.0	13.0	40.0	23,200	116	8,300	451	2
V-8	1997	10,600	28.0	344	0.5	8,500	41.0	14.0	38.0	23,800	119	8,400	508	2
V-8	1997	9,700	21.0	384	1.4	8,300	42.0	12.0	31.0	22,700	107	8,100	419	2
V-8	1999	8,351	15.1	247	**0.2**	10,122	32.3	10.3	27.5	20,001	71	7,412	437	1
V-8	1999	7,892	15.9	255	0.3	12,494	31.4	10.5	28.8	19,344	61	7,813	435	2
V-8	1999	7,576	23.0	247	0.3	8,962	36.6	11.1	30.8	20,692	135	7,540	444	2
V-8	2001	8,617	16.8	247	0.7	10,094	42.8	9.7	34.9	21,230	141	8,592	380	2
V-8	2001	9,100	17.4	287	0.9	9,706	45.5	9.9	33.4	21,847	76	8,849	363	2
V-8	2001	9,186	15.8	246	1.0	10,528	44.3	10.4	34.5	21,981	113	9,151	453	2
V-8	2003	7,329	12.8	139	0.7	11,269	41.7	11.3	28.7	16,152	60	8,988	382	1
V-8	2003	7,816	12.6	206	0.7	10,561	38.9	10.7	26.0	16,461	82	8,439	359	1
V-8	2003	8,438	13.8	171	1.2	11,145	42.8	12.9	33.4	17,912	79	9,219	493	1
V-8	2005	11,500	13.0	119	0.9	10,200	52.0	14.0	35.0	18,900	70	9,650	568	**4**
V-8	2005	11,400	14.0	152	0.9	11,700	53.0	14.0	34.0	19,100	83	10,200	582	**4**
V-8	2005	11,000	15.0	129	0.9	10,100	46.0	15.0	35.0	19,100	71	9,340	549	**4**
Averages	V-1	13,892	21.1	180	0.7	4,211	34.2	12.7	31.2	27,098	37	5,287	786	2
	V-27	11,147	92.7	200	1.6	7,443	43.9	23.3	81.4	32,516	1,543	8,325	611	3
	V-5	7,886	17.6	214	0.6	16,714	44.0	11.0	28.8	18,331	33	10,171	436	2
	V-8	8,995	21.8	235	0.8	10,005	40.6	12.0	35.3	20,423	113	8,411	463	2

Indicates parameter not used during PCA as a result of > 10% missing and/or below MDL values

Bolding Indicates MDL for respective parameter/study

Table B.6: Vangorda sediment chemistry data (1995 to 2005)

Station	Year	Metal (mg/kg)								
		Nickel	Phosphorus	Potassium	Silver	Sodium	Strontium	Titanium	Vandium	Zinc
V-1	1995	39.0	970	1,339	0.20	200	39	800	28	157
V-1	1995	34.0	1,075	1,339	0.40	200	46	700	30	150
V-1	1995	48.0	1,187	1,339	0.30	200	44	700	26	223
V-1	1997	31.0	1,181	1,400	**0.10**	400	39	600	33	153
V-1	1997	36.0	1,314	1,500	0.40	500	48	600	35	191
V-1	1997	13.0	411	700	**0.01**	300	18	300	13	53
V-1	1999	54.4	1,112	1,770	**0.10**	330	44	722	36	153
V-1	1999	46.8	1,150	1,777	**0.10**	332	47	703	37	140
V-1	1999	46.0	1,067	1,722	**0.10**	324	43	701	35	129
V-1	2001	27.2	601	701	**0.10**	192	21	392	23	76
V-1	2001	33.3	1,074	1,620	0.12	353	46	525	32	125
V-1	2001	22.1	430	719	**0.10**	309	22	253	20	64
V-1	2003	23.1	1,153	1,777	0.12	256	41	472	28	145
V-1	2003	26.2	997	1,944	**0.10**	252	35	532	31	114
V-1	2003	21.7	1,094	2,256	0.11	271	42	514	28	137
V-1	2005	14.0	279	559	**< 2**	83	8	94	13	49
V-1	2005	25.0	522	1,110	**< 2**	124	18	209	20	76
V-1	2005	17.0	380	533	**< 2**	55	13	112	14	54
V-27	1995	37.0	988	673	0.10	100	30	300	18	470
V-27	1995	48.0	1,084	673	0.80	100	43	300	20	536
V-27	1995	51.5	1,282	673	1.55	100	42	450	23	547
V-27	1997	57.0	1,530	700	1.90	300	45	600	35	711
V-27	1997	50.0	1,427	800	1.70	300	41	500	31	644
V-27	1997	41.0	1,150	600	1.50	200	34	400	25	602
V-27	1999	56.1	1,412	698	4.71	274	53	308	25	1,102
V-27	1999	50.1	1,050	528	1.80	197	44	382	26	587
V-27	1999	61.9	1,484	787	3.73	302	57	337	28	1,074
V-27	2001	55.9	893	623	2.36	269	42	343	30	886
V-27	2001	61.5	933	601	3.28	250	46	326	30	945
V-27	2001	57.0	926	597	1.65	273	50	351	30	772
V-27	2003	35.5	779	925	2.08	189	36	454	29	973
V-27	2003	30.0	786	879	1.22	208	40	418	27	817
V-27	2003	40.0	762	1,008	1.30	245	45	413	30	1,063
V-27	2005	38.0	496	497	< 2	81	34	148	21	312
V-27	2005	38.0	455	403	< 2	84	34	117	22	261
V-27	2005	40.0	882	442	< 2	89	34	123	22	291
V-5	1995	55.0	1,348	630	0.10	100	60	300	22	129
V-5	1995	54.0	1,320	630	0.10	100	61	300	21	136
V-5	1995	57.0	1,204	630	1.00	100	61	300	21	133
V-5	1997	55.0	1,488	800	**0.10**	300	84	400	30	97
V-5	1997	52.0	1,397	800	**0.10**	300	81	400	29	97
V-5	1997	54.0	1,563	800	**0.10**	300	82	400	31	106
V-5	1999	47.4	1,066	595	**0.10**	254	69	346	24	80
V-5	1999	43.3	1,123	586	**0.10**	244	61	367	24	80
V-5	1999	43.0	1,168	637	**0.10**	252	63	375	25	83
V-5	2001	47.5	1,133	483	**0.10**	353	57	344	26	92
V-5	2001	56.6	1,115	652	0.16	401	63	301	28	121
V-5	2001	67.6	1,106	769	0.11	450	70	289	30	135

Table B.6: Vangorda sediment chemistry data (1995 to 2005)

Station	Year	Metal (mg/kg)								
		Nickel	Phosphorus	Potassium	Silver	Sodium	Strontium	Titanium	Vandium	Zinc
V-5	2003	38.6	953	721	**0.10**	291	63	320	26	98
V-5	2003	44.1	875	667	**0.10**	317	65	433	29	68
V-5	2003	48.6	1,034	606	**0.10**	308	70	453	31	75
V-5	2005	68.0	1,210	501	**< 2**	114	67	135	26	92
V-5	2005	66.0	832	401	**< 2**	114	61	128	26	80
V-5	2005	77.0	614	425	**< 2**	114	52	153	25	87
V-8	1995	55.0	1,040	698	3.90	100	51	300	22	438
V-8	1995	46.0	1,145	698	0.60	100	46	200	19	264
V-8	1995	54.0	1,095	698	1.80	100	53	300	21	471
V-8	1997	45.0	1,343	900	0.30	400	46	400	30	222
V-8	1997	45.0	1,355	800	0.40	300	46	400	31	246
V-8	1997	42.0	1,377	800	0.50	300	45	500	33	196
V-8	1999	40.1	994	693	**0.10**	260	47	381	25	134
V-8	1999	41.9	1,092	648	**0.10**	271	54	366	26	117
V-8	1999	41.1	881	595	0.29	228	44	369	26	194
V-8	2001	46.1	1,082	626	0.14	303	48	356	27	232
V-8	2001	52.0	1,091	709	0.15	314	47	390	30	218
V-8	2001	52.5	1,056	713	0.21	322	50	344	28	294
V-8	2003	37.5	861	698	0.14	263	52	299	24	219
V-8	2003	32.5	886	826	0.15	283	50	386	26	185
V-8	2003	39.7	830	890	0.15	294	55	355	27	325
V-8	2005	53.0	671	541	**< 2**	88	38	140	24	199
V-8	2005	52.0	735	472	**< 2**	82	41	159	27	189
V-8	2005	53.0	678	561	**< 2**	83	36	140	24	189
Averages	V-1	31.0	889	1,339	0.16	260	34	496	27	122
	V-27	47.1	1,018	673	1.98	198	42	348	26	700
	V-5	54.1	1,142	630	0.16	245	66	319	26	99
	V-8	46.0	1,012	698	0.60	227	47	321	26	241

Indicates parameter not used during PCA as a result of > 10% missing and/or below MDL values

Bolding Indicates MDL for respective parameter/study

Table B.7: Vangorda sediment chemistry data, average values by year (1995 to 2005)

Station	Year	Metal (mg/kg)										
		Aluminum	Arsenic	Barium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium
V-1	1995	14,333	30.3	232	0.8	5,000	40.3	12.0	33.3	30,767	43	5,500
	1997	14,000	25.7	240	0.6	3,900	27.7	12.3	53.0	27,333	58	4,800
	1999	17,237	28.1	284	0.7	5,304	59.5	20.0	39.2	40,230	45	7,187
	2001	12,949	11.9	107	0.5	3,995	30.1	10.0	18.9	23,863	18	5,684
	2003	14,884	20.5	149	1.0	5,311	30.6	12.1	26.0	24,864	37	4,547
	2005	9,947	10.0	67	**0.5**	1,757	17.0	9.7	17.0	15,533	19	4,007
V-27	1995	7,150	109.0	144	1.3	7,350	43.0	21.5	65.0	29,200	2,707	6,350
	1997	11,167	104.7	266	1.4	6,533	48.0	26.7	87.7	37,867	1,492	7,900
	1999	11,089	152.4	366	2.3	6,448	43.3	21.6	128.9	42,859	2,069	8,700
	2001	11,817	108.8	105	1.9	9,040	52.9	23.9	101.5	39,031	2,801	10,118
	2003	12,461	86.6	194	2.2	6,948	43.3	24.3	74.4	30,375	1,384	8,908
	2005	12,967	24.3	106	1.0	9,003	40.3	15.3	36.3	20,033	188	8,277
V-5	1995	6,100	34.3	181	1.0	14,667	36.3	9.7	36.3	18,233	52	9,000
	1997	8,700	21.7	347	0.3	20,133	44.0	11.7	35.7	20,900	35	11,000
	1999	7,030	14.5	269	0.2	16,484	34.8	9.9	24.9	18,142	30	8,611
	2001	8,040	**12.2**	209	**0.9**	15,185	44.9	9.3	28.3	19,332	32	9,504
	2003	7,425	**12.2**	138	**0.5**	14,382	52.5	11.8	22.5	16,710	25	11,142
	2005	10,020	**10.3**	138	**0.9**	19,433	51.3	13.7	25.0	16,667	21	11,767
V-8	1995	7,567	44.0	217	1.2	9,400	33.0	12.7	48.3	21,733	218	7,133
	1997	10,333	25.0	378	0.8	8,333	41.7	13.0	36.3	23,233	114	8,267
	1999	7,940	18.0	250	0.3	10,526	33.4	10.7	29.0	20,012	89	7,588
	2001	8,968	16.7	260	0.9	10,109	44.2	10.0	34.3	21,686	110	8,864
	2003	7,861	13.1	172	0.9	10,992	41.1	11.6	29.4	16,842	74	8,882
	2005	11,300	14.0	133	0.9	10,667	50.3	14.3	34.7	19,033	75	9,730

Table B.7 (con't): Vangorda sediment chemistry data, average values by year (1995 to 2005)

Station	Year	Metal (mg/kg)										
		Manganese	Molybdenum	Nickel	Phosphorus	Potassium	Silver	Sodium	Strontium	Titanium	Vandium	Zinc
V-1	1995	753	2	40.3	1,077	1,339	0.30	200	43	733	28	177
	1997	966	1	26.7	969	1,200	0.17	400	35	500	27	132
	1999	1,508	3	49.1	1,110	1,756	0.10	329	44	708	36	141
	2001	396	1	27.6	702	1,013	0.11	285	30	390	25	88
	2003	759	1	23.6	1,082	1,992	0.11	260	39	506	29	132
	2005	335	**4**	18.7	394	734		87	13	138	16	60
V-27	1995	403	1	51.5	1,282	673	1.55	100	42	450	23	547
	1997	666	3	49.3	1,369	700	1.70	267	40	500	30	652
	1999	657	6	56.0	1,315	671	3.41	258	51	342	26	921
	2001	616	3	58.1	917	607	2.43	264	46	340	30	868
	2003	640	2	35.2	776	937	1.53	214	40	428	29	951
	2005	697	**4**	38.7	611	447		85	34	129	22	288
V-5	1995	402	2	55.3	1,291	630	0.40	100	61	300	21	133
	1997	487	2	53.7	1,483	800	0.10	300	82	400	30	100
	1999	384	2	44.6	1,119	606	0.10	250	64	363	25	81
	2001	469	**2**	57.2	**1,118**	635	**0.12**	401	63	311	28	116
	2003	422	**1**	43.8	**954**	665	**0.10**	305	66	402	29	80
	2005	452	**4**	70.3	**885**	442		114	60	139	26	86
V-8	1995	505	1	51.7	1,093	698	2.10	100	50	267	21	391
	1997	459	2	44.0	1,358	833	0.40	333	46	433	31	221
	1999	439	2	41.0	989	646	0.16	253	48	372	26	148
	2001	399	2	50.2	1,076	682	0.17	313	48	363	29	248
	2003	411	1	36.6	859	805	0.14	280	52	347	26	243
	2005	566	4	52.7	695	525		84	38	146	25	192

Table B.8: Relative magnitude of difference between mine-exposed and mean reference values at Vangorda Creek system sampling stations (1993 to 2005 data)

Metal	Mean Reference Value	Mine-Influenced Stations		
		Near-Field V27	West Fork V5	Lower Vangorda V8
Aluminum	13,892	0.8	0.6	0.6
Arsenic	21.1	4.4	0.8	1.0
Barium	180	1.1	1.2	1.3
Cadmium	0.7	2.4	0.9	1.2
Calcium	4,211	1.8	4.0	2.4
Chromium	34.2	1.3	1.3	1.2
Cobalt	12.7	1.8	0.9	0.9
Copper	31.2	2.6	0.9	1.1
Iron	27,098	1.2	0.7	0.8
Lead	36.8	41.9	0.9	3.1
Magnesium	5,287	1.6	1.9	1.6
Manganese	786	0.8	0.6	0.6
Molybdenum	2	1.4	1.0	0.9
Nickel	31	1.5	1.7	1.5
Phosphorus	889	1.1	1.3	1.1
Potassium	1,339	0.5	0.5	0.5
Silver	0.5	4.3	0.4	1.3
Sodium	260	0.8	0.9	0.9
Strontium	34	1.2	1.9	1.4
Titanium	496	0.7	0.6	0.6
Vanadium	26.8	1.0	1.0	1.0
Zinc	122	5.8	0.8	2.0

Indicates mean value that exceeds mean reference value by a factor equal to or greater than three

Table B.9: Weightings of sediment metal variates in PCA of Vangorda Creek system sediment samples (1995 to 2005 data)

Sediment Parameter (mg/kg, log x+1 transformed)	Sediment Metal PCA Axis-1 (39.2 %)	Sediment Metal PCA Axis-2 (22.3 %)	Sediment Metal PCA Axis-3 (18.1 %)	Sediment Metal PCA Axis-4 (7.1 %)
Copper	0.82950	-0.32863	-0.32160	-0.16739
Iron	0.82648	-0.44985	0.18308	0.03475
Arsenic	0.78443	-0.41517	-0.31761	-0.24806
Zinc	0.75916	-0.36672	-0.43842	-0.12068
Cobalt	0.73908	-0.39308	-0.28842	0.14363
Vanadium	0.72911	0.28596	0.48748	0.25800
Chromium	0.72519	0.45694	-0.03768	0.41282
Lead	0.71264	-0.38427	-0.50103	-0.19237
Phosphorus	0.69442	0.43376	0.23543	-0.37161
Barium	0.62931	0.34333	0.34517	-0.37356
Nickel	0.62323	0.59981	-0.32631	0.16041
Cadmium	0.62208	-0.37405	-0.42279	0.07508
Manganese	0.54682	-0.34511	0.39086	0.41617
Calcium	0.27960	0.89585	-0.23513	0.06051
Strontium	0.53082	0.79356	0.05358	-0.07757
Magnesium	0.46189	0.72051	-0.34224	0.27418
Potassium	0.25239	-0.31688	0.82723	-0.02015
Titanium	0.53879	-0.02821	0.69361	-0.32192
Sodium	0.38040	0.19528	0.66298	-0.18878
Aluminum	0.37125	-0.48575	0.46376	0.55661

Indicates heavily positive-weighted parameter on respective sediment PCA axis

Indicates heavily negative-weighted parameter on respective sediment PCA axis

Table B.10: Summary of Principal Component Analysis (PCA) statistical comparisons among Grum/Vangorda sediment sampling stations (1995 to 2005 data)

Principal Component Analysis Axis	Four-group Comparison			Pair-wise Comparisons				
	Significant Difference Among Areas?	p-value	Statistical Test	(I) Area	(J) Area	Significant Difference Between 2 Areas?	p-value	Statistical Test[a]
PCA Axis-1	YES	0.000	ANOVA	Reference (V1)	West Fork (V5)	NO	0.975	Tamhane's
				Reference (V1)	Lower Vangorda (V8)	NO	0.817	Tamhane's
				Reference (V1)	Near-Field (V27)	YES	0.007	Tamhane's
				West Fork (V5)	Lower Vangorda (V8)	NO	0.673	Tamhane's
				West Fork (V5)	Near-Field (V27)	YES	0.000	Tamhane's
				Lower Vangorda (V8)	Near-Field (V27)	YES	0.001	Tamhane's
PCA Axis-2	YES	0.011	ANOVA	Reference (V1)	West Fork (V5)	YES	0.000	Tamhane's
				Reference (V1)	Lower Vangorda (V8)	YES	0.000	Tamhane's
				Reference (V1)	Near-Field (V27)	NO	0.909	Tamhane's
				West Fork (V5)	Lower Vangorda (V8)	YES	0.000	Tamhane's
				West Fork (V5)	Near-Field (V27)	YES	0.000	Tamhane's
				Lower Vangorda (V8)	Near-Field (V27)	YES	0.000	Tamhane's
PCA Axis-3	YES	0.023	ANOVA	Reference (V1)	West Fork (V5)	YES	0.000	Tamhane's
				Reference (V1)	Lower Vangorda (V8)	YES	0.000	Tamhane's
				Reference (V1)	Near-Field (V27)	YES	0.000	Tamhane's
				West Fork (V5)	Lower Vangorda (V8)	NO	0.999	Tamhane's
				West Fork (V5)	Near-Field (V27)	YES	0.000	Tamhane's
				Lower Vangorda (V8)	Near-Field (V27)	YES	0.001	Tamhane's
PCA Axis-4	NO	0.384	ANOVA	Not Applicable				

[a] Post-hoc analysis of 1-way ANOVA among all areas protected for multiple comparisons

APPENDIX C

BENTHIC DATA

Table C.1: Raw benthic community data (organisms per artificial substrate sample)

	R1a00	R1b00	R1c00	R2a00	R2b00	R2c00	R3a00	R3b00	R3c00	R5a00	R5b00	R5c00	R6b00	R6a00	R6c00	R7a00	R7b00	R7c00	V1a01	V1b01	V1c01	V5a01	V5b01	V5c01	V8a01	V8b01	V8c01	V27a01	V27b01	V27c01	R1a02	R1c02	R1b02	R2a02	R2b02	R2c02	R3a02	R3b02	R3c02	R4a02	R4b02	R4c02	R5a02	R5b02	R5c02	R6a02	R6b02	R6c02	R7a02	R7b02
	R	R	R	E	E	E	E	E	E	E	E	E	R	R	R	R	R	R	R	R	R	E	E	E	E	E	E	E	E	E	R	R	R	E	E	E	E	E	E	E	E	E	E	E	E	R	R	R	R	R
Ameletus sp	1																	3			11	41							1																				
Baetis sp	47	350	76	316	203	1,373	5,288	2,608	6,795	2,528	5,154	6,432	1,528	1,218	555	24	32	43	2	25	1	98	212	133	141	11	134	134	170	335	802	469	326	1,722	1	74	86	31		107	242	8	57	626	532	3	2	85	26	140
Drunella coloradensis																			1	1		2	1																												
Drunella doddsi	1									14	6	3	4	32			2	8												10	3	3	295			1		3	7	2	7	8		1	3	8	2	4	
Drunella flavilinea										2	3	2	3					1																																
Drunella grandis	7	7	4							10	37	18	29	6	8																36	15	19											5						
Drunella spinosa		1									1																																								
Ephemerella sp	2	16	3	24	1	36				72	206	8	178	162	5	2	3	56															15	6				1			8	5		2	3	33			12	1	
Seratella tibialis+sp	1	6	3	1		1				1	2		4	2	1	1		1																	1		1								4						
Heptageneia sp																															10			1		11															
Epeorus (Iron) sp	1						2	2	1	32	65	3	2	33	32	4				1	1	1		6				1		1																1	2	1		
Cinygmula sp	1	9		24	7	8	96	8	130	68	195	259	244	68	132	4		89		5	5	77	20	115	1	1		19		16	2			132	3					15	22	3	3	1	32		2		11	33
Rhithrogena sp	2									35	5	71	138	39	3	2		2	22	12	2			1	4		1	8	5	14	3		1							12	18	19		1		3	6	4	8	1
Paraleptophlebia sp																																																		
Amphinemoura sp	1																														1																		
Capnia sp			1			1	36		1	3	328	144	217	196	106	2	2	41	3	3	2	1,241	2,159	1,125	38	13	27	5	1	15	1			3		2	1			7	5	4	1	16	16					
Isoperla sp	10	6	6	92	15	47	49	27	52	2	7	11	5			1								1	1		2				4	1	9	33	4	32	3				4									5
Leuctra sp																						1																												
Kogotus sp														2				1																															
Malenka sp	1																																																
Megarcys sp								1		4	2	5	3	1	3					3				3				1																							
Podmosta sp	1	8	2	4	2						1		1												2																									
Pteronarcella sp																																																		
Skwala curvata	1	1	1	3	5			1	1	2	80	74	9	35	35			1																3								1									
Skwala paralella	4	1	1	17	3	12	1		1	2	1		2													1		4						8		4				4	1		2							
Taenionema sp	10	13	5	4	1	32			1	7	65	1	1	32	32		2			4		21	8	643	121	17	234	34	9	53	5	1	3	2		1				19	25				34		1	1	11	2
Sweltsa sp gp		1						1		6	10	5	19	10	7		1	6	5		3	79	44	22	8	1	17			40						1					1			1						
Zapada sp	26	69	19	120	19	83	146	34	160	810	2,198	1,072	1,228	595	854	41	43	263	12	229	17	530	1,264	1,203	175	36	198	238	58	668	84	44	43	415	8	153	38	23		208	184	22	26	502	364	2	6	45	205	367
Brachycentrus sp		1		5	4	1		2	1	1	4	2	1	1																	2	1		1			11	1		22	4	2								
Dicosmoecus sp				1	1					1	2		3	1	3									17								1				2	8				1									2	
Ecclisomyia sp																						10	17																												
Glossosoma sp	5		5			9												16													1																		
Arctopsyche+Hydrosychidae J	3	11	7	6	9	16				15	83	336	58	46	169	2	4	3		12	3	32	16		4		17	217	82	197	2	1	11	44	5	12				29	39	7	4	17	34	3	2	30	33	7
Hydroptila sp																																																		
Micrasema sp																																					7			1		1								
sum Rhyacophilidae	3	4	5	2	1	10	32	1		1	5	4	2	5	4		2	2			1	95	110	247	22	2	9	176	67	213	14	10	7	10		32	3	1		12	32	1	2		18	1		1	1	1
Bezzia sp		1					1				2	6	3	1																	2		24	86		32		1						17						
Culicoides sp																																								1										
Mallochohelia sp																																																		
Brillia sp	1		3																						1,085	235	1,992	58	7	63																				
Cardiocladius sp	62	130	89	231	39	211	2	2	41	319	781	576	537	561	190	23	12	212	15	30	5			106	11	8	36			11	57	74	64	57	42	98	5	5		89	96	10	37	176	68	3	2	32	67	121
Corynoneura sp																																				5														
Cricotopus sp	25	216	54	158	21	201	156	74	262	1,561	2,040	898	2,183	1,453	1,093	84	27	271		91		287	2,002	738	113	23	298	30	23	227	74	64	213	63	63	210	66	3	8	95	60	8	230	553	522	4	5	34	128	635
Polypedilum (Pentapedilum) sp																																																		
Pagastiella sp																																																		
Parorthocladius sp																																																		
Cyphomella sp																																																1		
Diamesa sp	282	2,041	620	165	42	472	191	199	277	432	1,594	1,591	1,202	458	156	63	105	361		22	1	142	543	841	29	5	34	45	10	42	421	993	491	64	8	15	76	10		84	286	28	28	185	196	2		53	80	184
Eukiefferiella sp	45	273	35	270	16	715	197	296	742	3,892	9,164	9,204	6,612	3,620	4,244	389	259	1,143		109	2	239	702	212	235	5	91	5		69	687	1,119	1,165	685	23	361	95	185	1	401	766	38	34	4,505	4,182	2	4	710	1,393	3,996
Euryhapsis sp		12	22	7	4	94	2			38	2		3	34									3	206		1	21	22				10	12				5							5							36
Heterotrissocladius sp																			2													2					10				3	6		1	20						36
Micropsectra sp			1			12								34				16								6	1	10				7		11	48	2	20														
Rheotanytarsus sp	6	122		231	17	340	62	20	30	2,070	2,979	2,522	1,875	1,550	1,350	49	40	514													280	185	310	1,739	180	933	12	72		58	82	2	5	187				12	163	1,358
Tanytarsus sp																									19	2	30																								
Synorthocladius sp			1	7	1		62									5		28																																
Thienemanniella sp		11	1																															19												20						
Thienemannimyia sp				112	3	31						98				2															2		11	198	6	167									22			5		2
Chelifera						1					1	1	7	2	3																		17			2					4		2						1	1
Clinocera sp																								16	1		3																								
Weidemannia sp																								1				5		1						4														
Limnophora sp (Muscidae)																																																		
Lispe sp (Muscidae)					1	2																																													
Pericoma sp (Psychodidae)	3	21	5	8		16	5	26	36	138	853	268	179	199	231							117	202	190	9		20				5		2	11		9	8	5		25	23			35	138				9	1
Family Scimyzidae L																																																		
Prosimulium L+P		9	1	2	8	12	1	14	1	4	34	10	50	8	35					17	1		48	99	24	1	59	67	20	74	3	4		1			1			10	22	4		1		2	1		32	2
Cnephia sp																								2																1										
Simulium L+P	89	171	83	2	22	67	51	88	111	106	294	161	24	109	61	8	4	12		1		8	16	100	16	1	42	32	16	70	3	18	8			1	16	8	3	39	22	16	4	67	5	6	3	24	16	2
Dicranota sp		1			1		16			1	69	2	99	1	35							118	171	82	1		17				3					4	1						1	2				4		1
Tipula sp														1								2																									1		
Ormosia sp																																																		
Hesperoconopa sp																																																		
Hydracarina (all)	2	18	17	296	88	594	134	48	40	273	725	787	514	335	4	12	28	107		22	6	24	1	32			9	8	2	4	74	164	186	199	17	134	26	12		67	112	10	45	256	112	2	5	29	151	42
Alona sp																																4				4	1											4		
Bosmina longirostris							16		16																							38	32	32				1			2										
Chydorus gibbus																															4																		
Daphnia sp		1																													3																		
Eurycercus (Bullatifrons) sp																																									1								
Calanoida																															1																		
Cyclopoida																2																					1												
Harpacticoida							16					64	32	64																1						64		4				2		1								
Candona sp													96				2									4					4																			
Enchytraeidae	1	16	11	4		16	3		33			65	4	36	65	3		2						16							2	1	2	32		8	2				4	1		1	58		1			
Chaetogaster sp							32		16	64		768	608																		16	28	16	2,497	146	268	376	468		214	344	3	6	401	336					
Naididae																																									4		1								
Tubificidae (all stages)																								1													1		1	1												
Pisicola sp																															1																		
Valvata sincera																																																		
cf Trogochetus sp																																																		
Nematoda	3	64	2	4			64	32	86	384	320	1,219	641	353	131		4	64		2			32	32	4					8	28	50	76		13		19	84	2	98	137	7		114	144			29	10	98
Sphaerium sp																																																		
Hydra sp																															316	158	384		4	8		1		2										
after collapsing, re-attributing																																																		
number of individuals	648	3,611	1,084	2,115	534	4,411	6,660	3,484	8,834	12,899	27,448	26,597	18,411	11,268	9,484	721	573	3,261	65	590	50	3,136	7,834	5,967	2,077	384	3,307	1,084	472	2,125	3,019	3,465	3,442	8,431	527	2,631	859	911	17	1,646	2,549	203	508	7,713	6,846	37	50	1,119	2,352	7,072
number of taxa	31	32	29	28	26	28	26	20	23	34	39	35	40	36	29	20	19	25	9	18	14	21	23	26	27	17	24	18	14	22	40	25	27	29	18	33	27	17	5	32	29	24	22	25	20	14	15	22	21	23
percent EPT	19.8	14.0	12.7	29.3	50.7	36.9	84.8	77.1	80.9	28.0	30.8	31.8	20.0	22.0	20.6	11.5	15.9	16.3	73.8	50.0	70.0	70.1	49.9	58.6	24.9	21.1	19.4	76.8	83.1	73.1	32.4	16.2	12.4	31.7	4.4	12.6	17.6	6.1	17.6	27.5	22.9	36.9	21.5	15.2	15.5	43.2	58.0	16.2	12.8	7.9
percent Chironomidae	65.1	77.7	76.3	55.8	26.8	47.0	10.1	17.0	15.3	64.4	60.3	56.0	67.4	68.4	74.1	85.4	77.1	78.0	26.2	42.9	16.0	21.4	44.1	31.8	72.2	78.4	76.0	12.8	8.7	19.3	51.1	70.6	66.4	33.9	61.3	69.3	29.5	30.2	52.9	44.3	50.8	41.9	67.1	73.2	72.9	29.7	22.0	75.7	77.8	90.1

Table C.1: Raw benthic community data (organisms per artificial substrate sample)

	R7c02	V1a03	V1b03	V1c03	V5a03	V5b03	V5c03	V8a03	V8b03	V8c03	V27a03	V27b03	V27c03	R1a04	R1b04	R1c04	R2a04	R2b04	R2c04	R3a04	R3b04	R3c04	R4a04	R4b04	R4c04
	R	R	R	R	E	E	E	E	E	E	E	E	E	R	R	R	E	E	E	E	E	E	E	E	E
Ameletus sp												7	9								1		3	1	1
Baetis sp	8	19	39	3	56	45	12	74	276	59	91	49	50	3,824	1,420	3,472	1,893	1,230	3,172	2,148	2,051	6,457	514	24	51
Drunella coloradensis																									
Drunella doddsi	2													24	3	16	3	3	3	5	3	3			
Drunella flavilinea														72	4	19									
Drunella grandis															14	10							1	2	4
Drunella spinosa																									
Ephemerella sp	4				4									216	27	163	44	12	25	16	1	1	32	11	20
Seratella tibialis+sp																									
Heptageneia sp																1	2	3							2
Epeorus (Iron) sp		5	3	8	6	2	4	3	5	3	13	1	2							6		36	56	6	16
Cinygmula sp	26	3	7		50	28	18	14	52	24	31	147	58	72	4	69			1		32		15	6	14
Rhithrogena sp	4	4	17	1	4			2	5		5	2	2		1	1		2	4	15	9	36	29	56	6
Paraleptophlebia sp																									
Amphinemoura sp																									
Capnia sp	20		3	1	179	68	37	38	184	39	5	4	2	16	1	1		33		16	1		29	18	10
Isoperla sp	1													80	24	76	13	33	27	17	56	28			3
Leuctra sp																						1			
Kogotus sp																									
Malenka sp																									
Megarcys sp					3	1			1	1	1	2	2												
Podmosta sp																									
Pteronarcella sp																									
Skwala curvata																1		1	4						1
Skwala paralella	1														1					1	7	2			
Taenionema sp			1		26	15	17	64	148	26	1	1	2	256	198	459	34	1	65	3	17	98	8	2	
Sweltsa sp gp			1		17	2	4		1	3	1		1					1	1		1	2		1	
Zapada sp	263	54	169	53	595	199	268	186	457	151	132	123	53	864	332	523	240	242	485	51	342	519	29	10	17
Brachycentrus sp														8		2	33	1	2	23	41	6	1	3	
Dicosmoecus sp							5		42			1		8			6	7	9		1				
Ecclisomyia sp					10																				
Glossosoma sp					1								3												
Arctopsyche+Hydrosychidae J	34	2	1	7	72	28	77	11	9	5	42	24	24	112	40	41	224	38	25	5	9	4			2
Hydroptila sp																									
Micrasema sp																									
sum Rhyacophilidae			8	6	131	34	52	10	17	5	86	65	28		2	5	41	35	12	79	51	55	4	2	2
Bezzia sp																									
Culicoides sp																									
Mallochohelia sp														8	1		69	37	132	2	1	2			5
Brillia sp			2		3		5	92	662	156	2	2													
Cardiocladius sp	69	15	36	10				3			11	2		3,321	3,745	2,498	620	488	1,318	168	524	722	342	88	346
Corynoneura sp																									
Cricotopus sp	121	20	13	7	261	35	26	52	306	25	16	12	18	2,232	1,330	1,440	1,970	1,765	5,352	758	2,457	2,330	739	337	661
Polypedilum (Pentapedilum) sp										2			3												
Pagastiella sp																		101							
Parorthocladius sp																									
Cyphomella sp																									
Diamesa sp	34	42	25	69	60	95	44	9	82	6	36	2	6	7,519	4,964	7,663	1,470	1,521	3,092	2,633	1,312	4,958	42	52	125
Eukiefferiella sp	560	42	132	81	204	54	56	98	182	67	11	16	15	133	385	1,060	84	101	12	215	122	169	8	4	36
Euryhapsis sp					23			2	9					27			82								
Heterotrissocladius sp	9																								
Micropsectra sp								2	2					27		150	163	101	192				51	16	18
Rheotanytarsus sp	207													930	766	899	2,695	1,014	3,488	32			134	40	36
Tanytarsus sp																									
Synorthocladius sp																									
Thienemanniella sp														213	382	304							42		24
Thienemannimyia sp	11															2	771	342	237		84		2	6	54
Chelifera								3	1					72		1		32		1				1	
Clinocera sp																									
Weidemannia sp					1						1	4	1												
Limnophora sp (Muscidae)																	1		2						
Lispe sp (Muscidae)																									
Pericoma sp (Psychodidae)	1		1		34	3	5	2	6	1				24	3	65				1	16	1			
Family Scimyzidae L																						9			
Prosimulium L+P	1	10	16	44	203	38	34	21	82	9	25	10	6							48					
Cnephia sp																									
Simulium L+P	5			1		2	3	4	5		9	4	5	48		1		1	1	551	115	672	4		
Dicranota sp					10	1	4	2	14	1				80	1	66						32			
Tipula sp					1		1																		
Ormosia sp							1																		
Hesperoconopa sp																									
Hydracarina (all)	90	8	11	2	20	8	11	12	52	12	2	3	2	1,012	452	455	868	322	523	83	162	321	29	29	29
Alona sp																									
Bosmina longirostris																									
Chydorus gibbus																									
Daphnia sp																									
Eurycercus (Bullatifrons) sp																									
Calanoida																									
Cyclopoida																									
Harpacticoida																									
Candona sp																								1	
Enchytraeidae	8				9	1	3	2	14	4				8	1		35	1	64						
Chaetogaster sp														8		64	128	288	256		16		152	200	138
Naididae																									
Tubificidae (all stages)									4																
Pisicola sp									1								1	1							
Valvata sincera														8											
cf Trogochetus sp																	1								
Nematoda	14	1	1	1	1	1	3	1	16					64	64	192	128	32	128				21	2	12
Sphaerium sp														8											
Hydra sp																									4
after collapsing, re-attributing																									
number of individuals	1,493	225	485	295	1,984	659	690	707	2,634	599	521	480	292	21,292	14,164	19,719	11,619	7,789	18,632	6,877	7,433	16,464	2,288	917	1,636
number of taxa	23	13	19	15	27	20	23	24	28	20	20	21	21	31	26	31	27	31	28	24	26	24	24	25	27
percent EPT	24.3	38.7	51.3	26.8	58.2	64.0	71.6	56.9	45.4	52.8	78.3	88.8	80.8	26.1	14.6	24.6	21.8	21.1	20.6	34.7	35.3	44.0	31.5	15.5	9.1
percent Chironomidae	67.7	52.9	42.7	56.9	27.8	27.8	19.0	36.5	47.2	42.7	14.6	6.9	14.4	67.6	81.7	71.1	67.6	69.8	73.5	55.3	60.5	49.7	59.5	59.1	79.4

	R5a04	R5b04	R5c04	R6a04	R6b04	R6c04	R7a04	R7b04	R7c04	V1a05	V1b05	V1c05	V5a05	V5b05	V5c05	V8a05	V8b05	V8c05	V27a05	V27b05	V27c05	R1a06	R1b06	R1c06	R2a06
	E	E	E	R	R	R	R	R	R	R	R	R	E	E	E	E	E	E	E	E	E	R	R	R	E
Ameletus sp	1	3	4	1	2		5	4	9	5															
Baetis sp	16	6	4	44	1,257	323	1,110	852	712	77	1,243	69	321	177	80	193	60	396	450	153	116	1,055	211	198	7
Drunella coloradensis																									
Drunella doddsi	1	3		7	35	13	4	4														8	1	23	
Drunella flavilinea																						28	3	5	
Drunella grandis	1	9	4	2	27	14	2										1					3	2	5	
Drunella spinosa																									
Ephemerella sp	13	14	17	32	160	99	17	36	8																
Seratella tibialis+sp																									
Heptageneia sp		1																							3
Epeorus (Iron) sp	3	5	2	2	53	1	44	32		2	14	2	3	3	4	1		1	2		1			1	
Cinygmula sp	15	19	29	73	50	67	101	60	56	24	7	13			18	3	21	3	150	5	68	36	1	2	
Rhithrogena sp	2	2	2	111	59	180	9		16	17	13	21				1		1	1				1		
Paraleptophlebia sp																									1
Amphinemoura sp																									
Capnia sp	8	6	2	49	56	60	5	4		2			16	1	22	187	23	110	16	16	24	34		1	6
Isoperla sp	2	1	1		1		2				1	1		1		1		1	1			22	2	3	
Leuctra sp																									
Kogotus sp																									
Malenka sp																									
Megarcys sp				1	1					2	1	2		1		1			2			2			
Podmosta sp																						146	2	19	
Pteronarcella sp																									
Skwala curvata		1		3	2		4	4	24													5			2
Skwala paralella			2	1	1							1										1		2	
Taenionema sp	1			5	23	17	31	16	24	5	33	6	17	34	6	104	19	84	58			206	113	28	4
Sweltsa sp gp		1					1								1			1	1			1			1
Zapada sp	17	40	39	55	313	147	389	412	488	168	1,210	223	493	267	642	541	74	584	1,497	977	1,010	252	142	117	4
Brachycentrus sp																									
Dicosmoecus sp	4	1	4	2		6	4	4														1		9	3
Ecclisomyia sp													1	1				1	9	8		1			
Glossosoma sp																									
Arctopsyche+Hydrosychidae J	2			6	149	29	77	12	80	14	185	64	441	315	226	20		10	144	122	108	5			1
Hydroptila sp																	1								
Micrasema sp																						1	2		
sum Rhyacophilidae		2	6	1	6	2	4			4	17	13	110	175	301	22	4	16	125	82	106	51	103	13	3
Bezzia sp																									
Culicoides sp		1																							
Mallochohelia sp																						1			1
Brillia sp								37		63	671	69	2,146	2,214	2,529	706	29	389	97	84	96	42			
Cardiocladius sp	36	22	105	24	501	205	2,191	286	547	13	329	44	22		1	8		18	34	52	28	288	88	48	
Corynoneura sp								37		3	26					8		9							
Cricotopus sp	201	372	433	139	1,338	1,110	2,703	4,771	2,364	29	318	42	178	372	454	961	214	999	94	38	137	588	411	184	30
Polypedilum (Pentapedilum) sp																									
Pagastiella sp	9																								
Parorthocladius sp																									
Cyphomella sp																									
Diamesa sp	27	24	5	9	149	72	635	507	508		58	3	45	18	2	2	3	1		16		5,293	3,057	1,098	
Eukiefferiella sp	7	4	13	6	810	77	2,583	1,833	5,059	32	199	20	191	167	178	145	17	94	114	48	55	277	123	82	1
Euryhapsis sp										3						8	1						60		
Heterotrissocladius sp																									
Micropsectra sp	2	4	5				55	37								8									2
Rheotanytarsus sp	9	10	15		137	23	337	184	391													252		131	24
Tanytarsus sp																									
Synorthocladius sp				2										18			1	10							
Thienemanniella sp	7	6	10		27	45	55	157								8	1	18	11			63		20	
Thienemannimyia sp	11	6	15			9	3	9	20															1	17
Chelifera					1	1	1	4	8				16	64	16	8	1	1				1			1
Clinocera sp																									
Weidemannia sp																			10	8	9				
Limnophora sp (Muscidae)																									
Lispe sp (Muscidae)																									
Pericoma sp (Psychodidae)				1		1	1						56	22	49	2		2	1			5	2	1	
Family Scimyzidae L																									
Prosimulium L+P					13	2	43	8	64		8				2	14	1	3	1	1					
Cnephia sp										6	46	6	227	241	294	59	8	89	25	56	33	1			
Simulium L+P					31	1	2	28														510	292	80	1
Dicranota sp								4					2	17	67	17						1			
Tipula sp																									
Ormosia sp																									
Hesperoconopa sp																									
Hydracarina (all)	27	28	43	13	158	74	368	316	168	2	32	9		16	48	49	23	104	11	1	2	379	243	99	26
Alona sp																									
Bosmina longirostris																									
Chydorus gibbus																									
Daphnia sp																									
Eurycercus (Bullatifrons) sp																									
Calanoida																									
Cyclopoida		1																							1
Harpacticoida																									
Candona sp	1	1																				2			2
Enchytraeidae		9	2		1												1	9				17	1		
Chaetogaster sp	193	89	121		64	12	768	240	320																2
Naididae																									
Tubificidae (all stages)													1	1								16		2	
Pisicola sp																									
Valvata sincera																									
cf Trogochetus sp																									
Nematoda	1	7	5	7	21	4	24	4	16	1	1		32	1	64							32			
Sphaerium sp																									
Hydra sp																									
after collapsing, re-attributing																									
number of individuals	617	697	888	596	5,446	2,593	11,577	9,900	10,881	472	4,412	608	4,317	4,127	5,004	3,079	503	2,955	2,856	1,668	1,793	9,627	4,861	2,171	143
number of taxa	27	31	25	25	30	27	32	29	20	20	20	18	19	22	21	26	20	26	23	16	14	37	21	25	23
percent EPT	13.9	16.4	13.1	66.3	40.3	36.9	15.6	14.5	13.0	67.8	61.7	68.3	32.5	23.6	26.0	34.9	40.4	40.9	86.0	81.7	79.9	19.3	12.0	19.6	24.5
percent Chironomidae	50.1	64.1	67.7	30.2	54.4	59.4	73.9	79.4	81.7	30.3	36.3	29.3	59.8	67.6	63.2	60.3	52.9	52.1	12.3	14.3	17.6	70.7	76.9	72.0	51.7

Table C.1: Raw benthic community data (organisms per artificial substrate sample)

	R2b06	R2c06	R3a06	R3b06	R3c06	R4a06	R4b06	R4c06	R5a06	R5b06	R5c06	R6a06	R6b06	R6c06	R7a06	R7b06	R7c06	R8a06	R8b06	R8c06
	E	E	E	E	E	E	E	E	E	E	E	R	R	R	R	R	R	E	E	E
Ameletus sp	2		2			19	4		1							1	4			
Baetis sp	132	85	23	55	468	155	227	336	10	16	156	56	465	307	5		1	422	851	192
Drunella coloradensis																				
Drunella doddsi	9			9		16	20	20	5	5	14	9	59	4				171	359	91
Drunella flavilinea		1	1				20	10				13	1	6	5			12	8	27
Drunella grandis		5				16	20		2	5	19	4	3	4		3		8	24	27
Drunella spinosa																				
Ephemerella sp																				
Seratella tibialis+sp																				
Heptageneia sp		2							2	2						3	2			
Epeorus (Iron) sp					4			1				5	17		4	2	1	4	6	12
Cinygmula sp	32	21	1	6	8	125	143	29	8	16	51	3	32	16	44	1	3	82	135	15
Rhithrogena sp	2			1	2	13	90	52	6	10	30	17	23	23	2	2		23	12	19
Paraleptophlebia sp																				
Amphinemoura sp																				
Capnia sp	11		1	2		126	83	45	11	6	48	18	80	19	17	6	10			
Isoperla sp	20	17	2	1	10	5	5			1						1	2	29	91	18
Leuctra sp																				
Kogotus sp																				
Malenka sp																				
Megarcys sp	1		2		3	1	2					5	4	3				1		2
Podmosta sp											5		2	2						
Pteronarcella sp	1																			
Skwala curvata		2	2		2		1	1			2								3	2
Skwala paralella		3		1		6	9	1	1	4	6	8		1	4		5	34	4	32
Taenionema sp	2	3		1			60	1		4	8	6	27	36				32	64	43
Sweltsa sp gp	4					8	3	1	1				1			1	1		3	
Zapada sp	230	93	16	15	85	60	86	104	9	7	71	109	95	101	22	5	12	235	144	211
Brachycentrus sp			5	1	3		1	4												1
Dicosmoecus sp	2	3				9	15		1		1	1		2	15	4	11	1	2	
Ecclisomyia sp																				
Glossosoma sp							4													
Arctopsyche+Hydrosychidae J	37	13		3	3	12	60	32	1	4	10	21	117	322		1	2	55	264	203
Hydroptila sp													1							
Micrasema sp		1				4	28	12												
sum Rhyacophilidae	7	7	13		4		7	16				2	3	4	1			2	4	6
Bezzia sp																				
Culicoides sp																				
Mallochohelia sp		1	4		9															
Brillia sp	3		6		9		4	1			4									
Cardiocladius sp	65	13	10	5	69	146	136	178	26	5	38	57	151	88	27	3	26	99	25	64
Corynoneura sp																				
Cricotopus sp	252	99	30	25	142	170	139	193	108	57	443	157	304	536	79	37	201	1,519	187	409
Polypedilum (Pentapedilum) sp																				
Pagastiella sp																				
Parorthocladius sp																		1		
Cyphomella sp																				
Diamesa sp	17	11	199	18	996	90	41	156	14	4	48	414	654	1,663	1		17	792	1,636	675
Eukiefferiella sp	15	10	19		143	47	22	59	2	3	184	126	340	604	20	2	47	72	744	753
Euryhapsis sp	1			3		8	4	12	1		4		8	1	4	1	2	68	33	17
Heterotrissocladius sp																				
Micropsectra sp		1						4												
Rheotanytarsus sp	56	27		2		5	29	4	8	2	40		1	1	1	1			99	
Tanytarsus sp																				
Synorthocladius sp						1														
Thienemanniella sp									1								3	17		
Thienemannimyia sp	18	4		2	1	5							1		2	2				
Chelifera		3																		
Clinocera sp																				
Weidemannia sp																		1		
Limnophora sp (Muscidae)																				
Lispe sp (Muscidae)																				
Pericoma sp (Psychodidae)		2	5			4	5				3				1			1		1
Family Scimyzidae L																				
Prosimulium L+P		1	5		17							14	110	181	1			66	5	28
Cnephia sp								4				1		1				1		
Simulium L+P	11	4	215	18	325	39	38	95	1		1	110	320	404	4	2		22	83	122
Dicranota sp	6												8							8
Tipula sp																				
Ormosia sp																				
Hesperoconopa sp																1				
Hydracarina (all)	63	6	3	44	120	176	140	134	55	21	119	63	177	161	44	20	72	274	353	225
Alona sp																				
Bosmina longirostris																				
Chydorus gibbus																				
Daphnia sp																				
Eurycercus (Bullatifrons) sp																				
Calanoida																				
Cyclopoida																				
Harpacticoida																				
Candona sp					8															
Enchytraeidae			2									1					1	1		
Chaetogaster sp																				
Naididae									1											
Tubificidae (all stages)			1																1	
Pisicola sp																				
Valvata sincera																				
cf Trogochetus sp																				
Nematoda		1	1							1	4		1	2	1		1	16		
Sphaerium sp																				
Hydra sp																				
after collapsing, re-attributing																				
number of individuals	1,000	440	568	212	2,431	1,266	1,446	1,506	275	174	1,311	1,218	3,005	4,491	304	100	425	4,060	5,140	3,203
number of taxa	26	28	24	19	22	26	31	27	23	19	24	24	28	26	22	21	21	30	26	26
percent EPT	49.2	58.2	12.0	44.8	24.4	45.3	61.5	44.2	21.1	46.0	32.1	22.7	30.9	18.9	39.1	30.0	12.7	27.4	38.4	28.1
percent Chironomidae	42.8	37.7	46.5	25.9	55.9	37.4	25.9	40.4	58.2	41.4	58.2	61.8	48.6	64.4	44.1	47.0	69.9	63.2	53.0	59.9

Table C.2: Benthic metrics for individual samples, Rose and Vangorda Creek stations, 2000 - 2006.

Station/ Year	Station ID	Sample Year	Year-Creek	Creek Name	Area Type	Area	Number of Individuals	Number of Taxa (LPL, collapsed)	EPT (percent)	Chironomids (percent)	Faro CA Axis-1 (19.2 %)	Faro CA Axis-2 (10.4 %)	Faro CA Axis-3 (6.9 %)	Faro CA Axis-4 (6.7 %)	Faro CA Axis-5 (5.8 %)	Faro CA Axis-6 (5.5 %)	Rose CA Axis-1 (15.2 %)	Rose CA Axis-2 (9.6 %)	Rose CA Axis-3 (8.7 %)	Rose CA Axis-4 (7.0 %)	Vangorda CA Axis-1 (21.1 %)	Vangorda CA Axis-2 (17.7 %)	Vangorda CA Axis-3 (9.7 %)	Vangorda CA Axis-4 (9.4 %)
R1a00	R1	2000	2000-Rose	Rose Creek	Reference	R	648	31	19.8	65.1	-0.112	0.307	0.334	-0.034	-0.065	0.016	0.323	0.182	0.110	0.179	.	.	.	.
R1a02	R1	2002	2002-Rose	Rose Creek	Reference	R	3,019	40	32.4	51.1	-0.354	-0.086	0.049	-0.007	0.211	0.084	-0.165	0.072	0.121	-0.155	.	.	.	.
R1a04	R1	2004	2004-Rose	Rose Creek	Reference	R	21,292	31	26.1	67.6	-0.285	-0.145	0.305	-0.009	-0.006	0.332	-0.119	0.099	0.096	0.359	.	.	.	.
R1a06	R1	2006	2006-Rose	Rose Creek	Reference	R	9,627	37	19.3	70.7	0.026	0.162	0.560	-0.145	-0.090	0.368	0.367	0.190	0.307	0.711	.	.	.	.
R1b00	R1	2000	2000-Rose	Rose Creek	Reference	R	3,611	32	14.0	77.7	-0.209	0.227	0.434	0.260	-0.131	0.272	0.200	0.385	-0.083	0.309	.	.	.	.
R1b02	R1	2002	2002-Rose	Rose Creek	Reference	R	3,442	27	12.4	66.4	-0.458	-0.236	0.123	-0.055	-0.231	0.067	-0.310	0.086	-0.040	0.258	.	.	.	.
R1b04	R1	2004	2004-Rose	Rose Creek	Reference	R	14,164	26	14.6	81.7	-0.277	-0.029	0.242	-0.220	-0.340	0.273	-0.030	-0.022	-0.002	0.526	.	.	.	.
R1b06	R1	2006	2006-Rose	Rose Creek	Reference	R	4,861	21	12.0	76.9	0.056	0.404	0.471	-0.067	0.188	0.024	0.439	0.309	0.371	0.126	.	.	.	.
R1c00	R1	2000	2000-Rose	Rose Creek	Reference	R	1,084	29	12.7	76.3	-0.054	0.216	0.508	0.128	0.099	0.206	0.298	0.395	0.226	0.293	.	.	.	.
R1c02	R1	2002	2002-Rose	Rose Creek	Reference	R	3,465	25	16.2	70.6	-0.349	0.049	0.170	0.141	-0.211	-0.100	-0.033	0.252	-0.132	-0.008	.	.	.	.
R1c04	R1	2004	2004-Rose	Rose Creek	Reference	R	19,719	31	24.6	71.1	-0.356	-0.205	0.150	-0.036	-0.213	0.341	-0.222	0.018	-0.067	0.433	.	.	.	.
R1c06	R1	2006	2006-Rose	Rose Creek	Reference	R	2,171	25	19.6	72.0	-0.227	0.317	0.493	-0.406	-0.059	0.337	0.295	-0.009	0.369	0.534	.	.	.	.
R2a00	R2	2000	2000-Rose	Rose Creek	Exposure	E	2,115	28	29.3	55.8	-0.395	0.023	0.380	0.019	0.250	-0.015	-0.041	0.301	0.254	-0.078	.	.	.	.
R2a02	R2	2002	2002-Rose	Rose Creek	Exposure	E	8,431	29	31.7	33.9	-0.486	-0.399	0.070	-0.014	0.156	-0.065	-0.451	0.101	0.115	-0.214	.	.	.	.
R2a04	R2	2004	2004-Rose	Rose Creek	Exposure	E	11,619	27	21.8	67.6	-0.589	-0.528	0.171	-0.007	0.523	-0.253	-0.609	0.276	0.475	-0.130	.	.	.	.
R2a06	R2	2006	2006-Rose	Rose Creek	Exposure	E	143	23	24.5	51.8	-0.482	-0.630	-0.273	-0.210	0.883	0.076	-0.696	-0.258	0.603	-0.389	.	.	.	.
R2b00	R2	2000	2000-Rose	Rose Creek	Exposure	E	534	26	50.8	26.8	-0.216	0.253	0.396	-0.026	0.250	-0.168	0.233	0.288	0.275	-0.112	.	.	.	.
R2b02	R2	2002	2002-Rose	Rose Creek	Exposure	E	527	18	4.4	61.3	-0.694	-0.544	-0.138	0.039	-0.068	-0.156	-0.681	0.027	-0.070	-0.119	.	.	.	.
R2b04	R2	2004	2004-Rose	Rose Creek	Exposure	E	7,789	31	21.1	69.8	-0.531	-0.628	-0.006	-0.068	0.415	-0.207	-0.678	0.065	0.359	-0.161	.	.	.	.
R2b06	R2	2006	2006-Rose	Rose Creek	Exposure	E	1,000	26	49.2	42.8	0.016	0.056	-0.135	-0.134	0.321	0.003	0.114	-0.150	0.266	-0.120	.	.	.	.
R2c00	R2	2000	2000-Rose	Rose Creek	Exposure	E	4,411	28	36.9	47.0	-0.252	0.003	0.301	0.098	0.302	-0.012	-0.024	0.309	0.230	-0.122	.	.	.	.
R2c02	R2	2002	2002-Rose	Rose Creek	Exposure	E	2,631	33	12.6	69.3	-0.508	-0.459	-0.038	0.011	0.612	0.103	-0.555	0.087	0.379	-0.299	.	.	.	.
R2c04	R2	2004	2004-Rose	Rose Creek	Exposure	E	18,632	28	20.6	73.5	-0.599	-0.524	0.096	0.006	0.352	-0.277	-0.622	0.214	0.340	-0.030	.	.	.	.
R2c06	R2	2006	2006-Rose	Rose Creek	Exposure	E	440	28	58.2	37.7	-0.239	-0.092	0.170	-0.223	0.387	0.020	-0.093	0.016	0.389	-0.165	.	.	.	.
R3a00	R3	2000	2000-Rose	Rose Creek	Exposure	E	6,660	26	84.8	10.1	-0.105	0.022	0.064	0.370	0.018	-0.002	0.007	0.269	-0.163	-0.093	.	.	.	.
R3a02	R3	2002	2002-Rose	Rose Creek	Exposure	E	859	27	17.6	29.5	-0.384	-0.243	0.162	0.495	-0.185	-0.284	-0.283	0.488	-0.289	-0.125	.	.	.	.
R3a04	R3	2004	2004-Rose	Rose Creek	Exposure	E	6,877	24	34.7	55.3	-0.087	0.202	0.184	0.028	0.042	-0.477	0.201	0.213	0.082	-0.174	.	.	.	.
R3a06	R3	2006	2006-Rose	Rose Creek	Exposure	E	568	24	12.0	46.5	0.105	0.169	0.291	0.224	0.303	-0.465	0.339	0.477	0.325	0.072	.	.	.	.
R3b00	R3	2000	2000-Rose	Rose Creek	Exposure	E	3,484	20	77.1	17.0	-0.098	0.240	0.223	0.396	-0.053	-0.274	0.220	0.439	-0.213	-0.160	.	.	.	.
R3b02	R3	2002	2002-Rose	Rose Creek	Exposure	E	911	17	6.2	30.2	-0.551	-0.357	0.004	0.563	-0.446	-0.272	-0.459	0.457	-0.537	-0.076	.	.	.	.
R3b04	R3	2004	2004-Rose	Rose Creek	Exposure	E	7,433	26	35.3	60.5	-0.217	0.022	0.118	-0.071	0.295	-0.386	-0.023	0.164	0.292	-0.257	.	.	.	.
R3b06	R3	2006	2006-Rose	Rose Creek	Exposure	E	212	19	44.8	25.9	-0.152	0.342	0.209	-0.292	0.207	-0.196	0.297	-0.036	0.304	-0.258	.	.	.	.
R3c00	R3	2000	2000-Rose	Rose Creek	Exposure	E	8,834	23	80.9	15.3	-0.247	0.048	0.209	0.369	-0.093	-0.132	-0.010	0.401	-0.205	-0.084	.	.	.	.
R3c02	R3	2002	2002-Rose	Rose Creek	Exposure	E	17	5	17.7	52.9	-0.294	0.550	0.353	-0.075	-0.380	-0.123	0.431	0.041	-0.195	-0.108	.	.	.	.
R3c04	R3	2004	2004-Rose	Rose Creek	Exposure	E	16,464	24	44.0	49.7	0.038	0.245	0.175	0.012	0.124	-0.303	0.272	0.175	0.144	-0.061	.	.	.	.
R3c06	R3	2006	2006-Rose	Rose Creek	Exposure	E	2,431	22	24.4	55.9	0.067	0.127	0.240	-0.037	0.214	-0.641	0.305	0.306	0.335	-0.023	.	.	.	.
R4a02	R4	2002	2002-Rose	Rose Creek	Exposure	E	1,646	32	27.5	44.3	-0.176	-0.003	0.007	0.175	-0.212	-0.260	-0.006	0.148	-0.246	-0.177	.	.	.	.
R4a04	R4	2004	2004-Rose	Rose Creek	Exposure	E	2,288	24	31.5	59.5	-0.389	-0.316	-0.390	-0.186	-0.347	0.069	-0.421	-0.408	-0.199	0.325	.	.	.	.
R4a06	R4	2006	2006-Rose	Rose Creek	Exposure	E	1,266	26	45.3	37.4	-0.096	0.400	-0.364	-0.306	0.307	0.207	0.246	-0.528	0.162	-0.298	.	.	.	.
R4b02	R4	2002	2002-Rose	Rose Creek	Exposure	E	2,549	29	22.9	50.8	-0.160	-0.057	-0.008	0.291	-0.192	-0.216	-0.064	0.219	-0.275	-0.142	.	.	.	.
R4b04	R4	2004	2004-Rose	Rose Creek	Exposure	E	917	25	15.5	59.1	-0.446	-0.346	-0.448	-0.099	-0.131	-0.150	-0.480	-0.352	-0.153	-0.097	.	.	.	.
R4b06	R4	2006	2006-Rose	Rose Creek	Exposure	E	1,446	31	61.5	25.9	0.039	0.432	-0.064	-0.387	0.150	0.213	0.449	-0.391	0.241	-0.036	.	.	.	.
R4c02	R4	2002	2002-Rose	Rose Creek	Exposure	E	203	24	37.0	41.9	-0.122	0.269	-0.073	0.030	-0.234	-0.410	0.210	0.002	-0.241	-0.280	.	.	.	.
R4c04	R4	2004	2004-Rose	Rose Creek	Exposure	E	1,636	27	9.1	79.4	-0.583	-0.510	-0.291	-0.276	-0.012	-0.017	-0.628	-0.319	0.086	0.174	.	.	.	.
R4c06	R4	2006	2006-Rose	Rose Creek	Exposure	E	1,506	27	44.2	40.4	0.121	0.241	0.109	-0.321	0.030	-0.102	0.357	-0.156	0.197	-0.124	.	.	.	.
R5a00	R5	2000	2000-Rose	Rose Creek	Exposure	E	12,899	34	28.0	64.5	-0.215	0.204	-0.030	0.152	-0.200	0.062	0.140	0.003	-0.291	-0.093	.	.	.	.
R5a02	R5	2002	2002-Rose	Rose Creek	Exposure	E	508	22	21.5	67.1	-0.186	0.087	0.196	-0.016	-0.041	0.041	0.078	0.095	0.021	-0.127	.	.	.	.
R5a04	R5	2004	2004-Rose	Rose Creek	Exposure	E	617	27	13.9	50.1	-0.517	-0.383	-0.405	-0.269	-0.161	0.099	-0.514	-0.451	-0.053	0.155	.	.	.	.
R5a06	R5	2006	2006-Rose	Rose Creek	Exposure	E	275	23	21.1	58.2	-0.196	0.235	-0.334	-0.519	0.186	0.244	0.100	-0.634	0.203	-0.196	.	.	.	.
R5b00	R5	2000	2000-Rose	Rose Creek	Exposure	E	27,448	39	30.8	60.3	-0.097	0.228	0.046	0.334	-0.108	0.215	0.204	0.100	-0.311	-0.013	.	.	.	.
R5b02	R5	2002	2002-Rose	Rose Creek	Exposure	E	7,713	25	15.2	73.2	-0.283	-0.114	-0.059	0.241	-0.395	0.100	-0.158	0.083	-0.404	0.160	.	.	.	.
R5b04	R5	2004	2004-Rose	Rose Creek	Exposure	E	697	31	16.4	64.1	-0.510	-0.296	-0.436	-0.173	-0.117	0.233	-0.478	-0.435	-0.095	0.125	.	.	.	.
R5b06	R5	2006	2006-Rose	Rose Creek	Exposure	E	174	19	46.0	41.4	-0.138	0.274	-0.146	-0.575	0.095	0.113	0.212	-0.537	0.182	-0.271	.	.	.	.
R5c00	R5	2000	2000-Rose	Rose Creek	Exposure	E	26,597	35	31.8	56.0	-0.263	0.011	-0.105	0.224	-0.149	-0.065	-0.042	0.043	-0.307	-0.175	.	.	.	.
R5c02	R5	2002	2002-Rose	Rose Creek	Exposure	E	6,846	20	15.5	72.9	-0.199	-0.228	-0.068	0.368	-0.130	-0.058	-0.248	0.232	-0.263	-0.061	.	.	.	.
R5c04	R5	2004	2004-Rose	Rose Creek	Exposure	E	888	25	13.1	67.7	-0.530	-0.380	-0.428	-0.273	-0.098	0.183	-0.549	-0.438	0.007	0.175	.	.	.	.
R5c06	R5	2006	2006-Rose	Rose Creek	Exposure	E	1,311	24	32.1	58.2	-0.014	0.313	0.106	-0.286	-0.073	0.235	0.377	-0.229	0.103	0.109	.	.	.	.
R6a00	R6	2000	2000-Rose	Rose Creek	Reference	R	11,268	36	22.0	68.4	-0.153	0.119	-0.053	0.254	-0.087	0.165	0.064	0.011	-0.272	-0.077	.	.	.	.
R6a02	R6	2002	2002-Rose	Rose Creek	Reference	R	37	14	43.2	29.7	0.104	0.526	-0.040	-0.271	-0.201	-0.554	0.526	-0.130	-0.060	-0.284	.	.	.	.
R6a04	R6	2004	2004-Rose	Rose Creek	Reference	R	596	25	66.3	30.2	-0.034	0.268	-0.443	-0.271	-0.244	0.060	0.201	-0.586	-0.236	-0.128	.	.	.	.
R6a06	R6	2006	2006-Rose	Rose Creek	Reference	R	1,218	24	22.7	61.8	0.134	0.526	0.075	-0.356	-0.095	-0.121	0.590	-0.241	0.055	-0.115	.	.	.	.
R6b00	R6	2000	2000-Rose	Rose Creek	Reference	R	18,411	40	20.0	67.4	-0.188	0.101	-0.076	0.329	-0.164	0.214	0.055	0.038	-0.383	-0.074	.	.	.	.
R6b02	R6	2002	2002-Rose	Rose Creek	Reference	R	50	15	58.0	22.0	0.044	0.488	-0.152	-0.382	-0.265	-0.342	0.461	-0.353	-0.130	-0.259	.	.	.	.

Table C.2: Benthic metrics for individual samples, Rose and Vangorda Creek stations, 2000 - 2006.

Station/ Year	Station ID	Sample Year	Year-Creek	Creek Name	Area Type	Area	Number of Individuals	Number of Taxa (LPL, collapsed)	EPT (percent)	Chironomids (percent)	Faro CA Axis-1 (19.2 %)	Faro CA Axis-2 (10.4 %)	Faro CA Axis-3 (6.9 %)	Faro CA Axis-4 (6.7 %)	Faro CA Axis-5 (5.8 %)	Faro CA Axis-6 (5.5 %)	Rose CA Axis-1 (15.2 %)	Rose CA Axis-2 (9.6 %)	Rose CA Axis-3 (8.7 %)	Rose CA Axis-4 (7.0 %)	Vangorda CA Axis-1 (21.1 %)	Vangorda CA Axis-2 (17.7 %)	Vangorda CA Axis-3 (9.7 %)	Vangorda CA Axis-4 (9.4 %)
R6b04	R6	2004	2004-Rose	Rose Creek	Reference	R	5,446	30	40.3	54.4	-0.180	0.085	-0.216	-0.176	-0.420	0.020	0.046	-0.321	-0.272	0.137	.	.	.	.
R6b06	R6	2006	2006-Rose	Rose Creek	Reference	R	3,005	28	31.0	48.6	0.155	0.493	-0.021	-0.097	-0.033	-0.068	0.535	-0.150	-0.058	-0.094	.	.	.	.
R6c00	R6	2000	2000-Rose	Rose Creek	Reference	R	9,484	29	20.6	74.2	0.040	0.163	-0.133	0.411	-0.137	0.171	0.187	0.036	-0.435	-0.083	.	.	.	.
R6c02	R6	2002	2002-Rose	Rose Creek	Reference	R	1,119	22	16.2	75.7	-0.184	0.035	0.034	0.099	-0.200	-0.197	0.009	0.123	-0.186	-0.054	.	.	.	.
R6c04	R6	2004	2004-Rose	Rose Creek	Reference	R	2,593	27	37.0	59.4	-0.237	-0.041	-0.266	-0.328	-0.320	0.149	-0.085	-0.448	-0.141	0.171	.	.	.	.
R6c06	R6	2006	2006-Rose	Rose Creek	Reference	R	4,491	26	18.9	64.4	0.165	0.465	0.112	-0.198	-0.071	-0.139	0.546	-0.077	0.037	-0.057	.	.	.	.
R7a00	R7	2000	2000-Rose	Rose Creek	Reference	R	721	20	11.5	85.4	-0.209	0.080	-0.006	-0.028	-0.127	-0.219	0.023	-0.005	-0.094	-0.119	.	.	.	.
R7a02	R7	2002	2002-Rose	Rose Creek	Reference	R	2,352	21	12.8	77.9	-0.043	0.175	0.009	0.083	-0.169	-0.177	0.179	0.080	-0.195	-0.140	.	.	.	.
R7a04	R7	2004	2004-Rose	Rose Creek	Reference	R	11,577	32	15.6	74.0	-0.280	-0.189	-0.294	-0.117	-0.241	0.031	-0.255	-0.277	-0.168	0.172	.	.	.	.
R7a06	R7	2006	2006-Rose	Rose Creek	Reference	R	304	22	39.1	44.1	-0.062	0.329	-0.164	-0.355	0.288	0.207	0.257	-0.455	0.227	-0.229	.	.	.	.
R7b00	R7	2000	2000-Rose	Rose Creek	Reference	R	573	19	15.9	77.1	-0.147	0.069	0.094	0.146	-0.146	-0.109	0.027	0.179	-0.117	-0.031	.	.	.	.
R7b02	R7	2002	2002-Rose	Rose Creek	Reference	R	7,072	23	7.9	90.1	-0.168	0.019	0.145	0.144	0.007	-0.034	0.009	0.223	-0.048	-0.117	.	.	.	.
R7b04	R7	2004	2004-Rose	Rose Creek	Reference	R	9,900	29	14.6	79.4	-0.176	-0.338	-0.179	-0.133	-0.209	0.140	-0.230	-0.225	-0.013	0.461	.	.	.	.
R7b06	R7	2006	2006-Rose	Rose Creek	Reference	R	100	21	30.0	47.0	-0.254	0.075	-0.621	-0.545	0.722	0.339	-0.108	-0.855	0.448	-0.483	.	.	.	.
R7c00	R7	2000	2000-Rose	Rose Creek	Reference	R	3,261	25	16.3	78.0	-0.260	0.036	-0.111	0.070	-0.177	0.063	-0.076	-0.093	-0.211	-0.021	.	.	.	.
R7c02	R7	2002	2002-Rose	Rose Creek	Reference	R	1,493	23	24.3	67.7	-0.236	0.004	-0.061	0.030	-0.063	-0.108	-0.061	-0.019	-0.123	-0.199	.	.	.	.
R7c04	R7	2004	2004-Rose	Rose Creek	Reference	R	10,881	20	13.0	81.7	-0.255	-0.177	-0.277	0.041	-0.185	-0.210	-0.221	-0.096	-0.227	-0.133	.	.	.	.
R7c06	R7	2006	2006-Rose	Rose Creek	Reference	R	425	21	12.7	69.9	-0.149	0.110	-0.381	-0.435	0.478	0.423	-0.033	-0.622	0.387	-0.111	.	.	.	.
R8a06	R8	2006	2006-Rose	Rose Creek	Exposure	E	4,060	30	27.4	63.2	-0.021	0.443	0.248	-0.410	-0.060	0.118	0.473	-0.156	0.171	0.068	.	.	.	.
R8b06	R8	2006	2006-Rose	Rose Creek	Exposure	E	5,140	26	38.4	53.0	-0.105	0.474	0.216	-0.313	0.057	0.040	0.434	-0.111	0.191	-0.098	.	.	.	.
R8c06	R8	2006	2006-Rose	Rose Creek	Exposure	E	3,203	26	28.1	59.9	0.023	0.579	0.267	-0.294	0.023	0.010	0.600	-0.075	0.147	-0.077	.	.	.	.
V1a01	V1	2001	2001-Van	Vangorda Creek	Reference	R	65	9	73.9	26.2	0.254	0.527	-1.553	-0.350	0.205	0.039	.	.	.	.	-0.535	1.164	-0.398	-1.545
V1a03	V1	2003	2003-Van	Vangorda Creek	Reference	R	225	13	38.7	52.9	0.133	0.263	-0.222	-0.068	-0.256	-0.460	.	.	.	.	-0.047	0.569	0.049	0.228
V1a05	V1	2005	2005-Van	Vangorda Creek	Reference	R	472	20	67.8	30.3	0.813	-0.187	-0.287	-0.396	-0.057	-0.090	.	.	.	.	0.163	0.351	-0.029	-0.492
V1b01	V1	2001	2001-Van	Vangorda Creek	Reference	R	590	18	50.0	42.9	0.221	0.298	-0.233	-0.078	-0.185	-0.377	.	.	.	.	-0.056	0.505	-0.022	0.145
V1b03	V1	2003	2003-Van	Vangorda Creek	Reference	R	485	19	51.3	42.7	0.323	0.205	-0.291	0.003	-0.121	-0.338	.	.	.	.	-0.069	0.484	-0.029	0.067
V1b05	V1	2005	2005-Van	Vangorda Creek	Reference	R	4,412	20	61.7	36.3	0.812	-0.309	0.102	-0.316	-0.203	-0.298	.	.	.	.	0.385	0.332	-0.037	0.031
V1c01	V1	2001	2001-Van	Vangorda Creek	Reference	R	50	14	70.0	16.0	0.323	0.321	-0.634	-0.030	0.023	-0.181	.	.	.	.	-0.159	0.603	0.019	-0.113
V1c03	V1	2003	2003-Van	Vangorda Creek	Reference	R	295	15	26.8	57.0	0.284	0.286	-0.188	0.118	-0.177	-0.544	.	.	.	.	-0.145	0.445	0.130	0.399
V1c05	V1	2005	2005-Van	Vangorda Creek	Reference	R	608	18	68.3	29.3	0.758	-0.213	0.027	-0.430	-0.134	-0.293	.	.	.	.	0.394	0.455	-0.060	-0.100
V27a01	V27	2001	2001-Van	Vangorda Creek	Exposure	E	1,084	18	76.9	12.8	0.700	0.140	-0.058	-0.041	0.050	-0.413	.	.	.	.	-0.088	0.286	0.000	0.310
V27a03	V27	2003	2003-Van	Vangorda Creek	Exposure	E	521	20	78.3	14.6	0.464	0.277	-0.281	-0.013	-0.039	-0.439	.	.	.	.	-0.139	0.476	0.107	0.217
V27a05	V27	2005	2005-Van	Vangorda Creek	Exposure	E	2,856	23	86.0	12.3	0.807	-0.338	-0.007	-0.305	-0.179	0.020	.	.	.	.	0.457	0.138	-0.089	-0.100
V27b01	V27	2001	2001-Van	Vangorda Creek	Exposure	E	472	14	83.1	8.7	0.652	0.143	0.028	-0.026	0.091	-0.511	.	.	.	.	-0.085	0.297	-0.039	0.304
V27b03	V27	2003	2003-Van	Vangorda Creek	Exposure	E	480	21	88.8	6.9	0.493	0.241	-0.553	-0.133	0.129	-0.261	.	.	.	.	-0.267	0.407	0.266	-0.201
V27b05	V27	2005	2005-Van	Vangorda Creek	Exposure	E	1,668	16	81.7	14.3	1.026	-0.532	0.131	-0.281	-0.127	-0.214	.	.	.	.	0.458	0.185	0.116	-0.100
V27c01	V27	2001	2001-Van	Vangorda Creek	Exposure	E	2,125	22	73.1	19.3	0.577	0.172	-0.258	0.106	0.102	-0.228	.	.	.	.	-0.216	0.245	-0.036	0.048
V27c03	V27	2003	2003-Van	Vangorda Creek	Exposure	E	292	21	80.8	14.4	0.419	0.352	-0.623	-0.060	0.107	-0.272	.	.	.	.	-0.347	0.437	0.300	-0.234
V27c05	V27	2005	2005-Van	Vangorda Creek	Exposure	E	1,793	14	79.9	17.6	1.011	-0.508	0.001	-0.312	-0.114	-0.149	.	.	.	.	0.462	0.185	0.154	-0.147
V5a01	V5	2001	2001-Van	Vangorda Creek	Exposure	E	3,136	21	70.1	21.4	0.425	0.247	-0.484	0.490	0.361	0.413	.	.	.	.	-0.494	-0.264	0.198	-0.342
V5a03	V5	2003	2003-Van	Vangorda Creek	Exposure	E	1,984	27	58.2	27.8	0.456	0.228	-0.270	0.411	0.186	0.112	.	.	.	.	-0.330	-0.137	0.026	0.114
V5a05	V5	2005	2005-Van	Vangorda Creek	Exposure	E	4,317	19	32.5	59.8	1.051	-0.718	0.296	0.051	-0.208	0.066	.	.	.	.	0.497	-0.314	0.306	-0.090
V5b01	V5	2001	2001-Van	Vangorda Creek	Exposure	E	7,834	23	49.9	44.1	0.341	0.302	-0.458	0.502	0.470	0.452	.	.	.	.	-0.715	-0.440	0.147	-0.385
V5b03	V5	2003	2003-Van	Vangorda Creek	Exposure	E	659	20	64.0	27.8	0.421	0.247	-0.247	0.302	0.075	-0.122	.	.	.	.	-0.259	0.041	0.182	0.294
V5b05	V5	2005	2005-Van	Vangorda Creek	Exposure	E	4,127	22	23.6	67.6	1.148	-0.777	0.387	0.027	-0.111	0.115	.	.	.	.	0.598	-0.437	0.331	-0.046
V5c01	V5	2001	2001-Van	Vangorda Creek	Exposure	E	5,967	26	58.6	31.8	0.368	0.204	-0.141	0.508	0.082	0.132	.	.	.	.	-0.330	-0.150	0.079	0.173
V5c03	V5	2003	2003-Van	Vangorda Creek	Exposure	E	690	23	71.6	19.0	0.483	0.127	-0.239	0.328	0.190	0.040	.	.	.	.	-0.337	-0.157	0.225	0.283
V5c05	V5	2005	2005-Van	Vangorda Creek	Exposure	E	5,004	21	26.0	63.2	1.051	-0.639	0.159	0.183	-0.134	0.198	.	.	.	.	0.379	-0.419	0.398	-0.081
V8a01	V8	2001	2001-Van	Vangorda Creek	Exposure	E	2,077	27	24.9	72.2	0.637	-0.036	0.096	0.151	0.204	0.072	.	.	.	.	-0.110	-0.132	-0.439	0.051
V8a03	V8	2003	2003-Van	Vangorda Creek	Exposure	E	707	24	56.9	36.5	0.597	-0.097	-0.026	0.128	0.084	-0.009	.	.	.	.	-0.002	-0.118	-0.151	0.191
V8a05	V8	2005	2005-Van	Vangorda Creek	Exposure	E	3,079	26	34.9	60.3	0.840	-0.518	0.131	-0.124	0.005	0.280	.	.	.	.	0.399	-0.350	-0.347	-0.101
V8b01	V8	2001	2001-Van	Vangorda Creek	Exposure	E	384	17	21.1	78.4	0.856	-0.210	0.133	-0.083	0.436	0.220	.	.	.	.	-0.029	-0.254	-0.790	-0.158
V8b03	V8	2003	2003-Van	Vangorda Creek	Exposure	E	2,634	28	45.4	47.2	0.518	-0.021	-0.119	0.195	0.257	0.187	.	.	.	.	-0.303	-0.326	-0.065	0.209
V8b05	V8	2005	2005-Van	Vangorda Creek	Exposure	E	503	20	40.4	52.9	0.784	-0.381	0.102	-0.227	-0.051	0.180	.	.	.	.	0.326	-0.168	-0.099	0.046
V8c01	V8	2001	2001-Van	Vangorda Creek	Exposure	E	3,307	24	19.4	76.0	0.617	0.002	0.097	0.203	0.385	0.172	.	.	.	.	-0.173	-0.280	-0.569	0.000
V8c03	V8	2003	2003-Van	Vangorda Creek	Exposure	E	599	20	52.8	42.7	0.764	-0.062	-0.165	0.163	0.127	0.024	.	.	.	.	-0.035	-0.045	-0.033	0.236
V8c05	V8	2005	2005-Van	Vangorda Creek	Exposure	E	2,955	26	40.9	52.1	0.834	-0.526	0.142	-0.239	-0.170	0.184	.	.	.	.	0.510	-0.118	-0.212	-0.001

Table C.3: Descriptive statistics for benthic metrics at Rose and Vangorda Creeks, combined stations and years with

		n	Mean	Std. Deviation	Std. Error	95% Conf. Int. for Mea	
						Lower Bound	Upper Bo
Number of Individuals	Rose Creek	84	4980.179	6160.005	672.112	3643.375	631
	Vangorda Creek	36	1901.556	1892.038	315.340	1261.382	254
	Total	120	4056.592	5433.809	496.037	3074.390	503
Number of Taxa (LPL, collapsed)	Rose Creek	84	25.952	5.729	0.625	24.709	2
	Vangorda Creek	36	20.250	4.410	0.735	18.758	2
	Total	120	24.242	5.958	0.544	23.165	2
EPT (percent)	Rose Creek	84	27.944	16.852	1.839	24.287	3
	Vangorda Creek	36	56.336	21.005	3.501	49.229	6
	Total	120	36.461	22.328	2.038	32.426	4
Chironomids (percent)	Rose Creek	84	57.260	17.899	1.953	53.376	6
	Vangorda Creek	36	37.086	20.766	3.461	30.060	4
	Total	120	51.208	20.892	1.907	47.432	5
Faro CA Axis-1 (19.2 %)	Rose Creek	84	-0.204	0.199	0.022	-0.247	-
	Vangorda Creek	36	0.618	0.266	0.044	0.528	
	Total	120	0.043	0.438	0.040	-0.036	
Faro CA Axis-2 (10.4 %)	Rose Creek	84	0.046	0.302	0.033	-0.020	
	Vangorda Creek	36	-0.041	0.353	0.059	-0.161	
	Total	120	0.020	0.319	0.029	-0.038	
Faro CA Axis-3 (6.9 %)	Rose Creek	84	0.019	0.253	0.028	-0.036	
	Vangorda Creek	36	-0.153	0.346	0.058	-0.270	-
	Total	120	-0.033	0.293	0.027	-0.086	
Faro CA Axis-4 (6.7 %)	Rose Creek	84	-0.047	0.252	0.027	-0.102	
	Vangorda Creek	36	0.010	0.258	0.043	-0.077	
	Total	120	-0.030	0.254	0.023	-0.076	

Table C.4: ANOVA of benthic metrics at Rose and Vangorda Creeks, combined stations and years within areas, 2000 - 2006.

Source	Dependent Variable	F	p-value	Power
CREEK	Number of Individuals[a]	8.60623	0.00403	0.82887
	Number of Taxa (LPL, collapsed)	28.40103	0.00000	0.99956
	EPT (percent)[a]	61.43963	0.00000	1.00000
	Chironomids (percent)	29.03639	0.00000	0.99964
	Faro CA Axis-1 (19.2 %)[a]	348.69368	0.00000	1.00000
	Faro CA Axis-2 (10.4 %)	1.90516	0.17011	0.27773
	Faro CA Axis-3 (6.9 %)	9.24408	0.00291	0.85443
	Faro CA Axis-4 (6.7 %)	1.26778	0.26247	0.20062

[a] variable variance significantly heterogenous by Levene's test, could not be remedied by transformation.

Table C.5: Correspondence analysis of all Rose and Vangorda Creek samples, 2000 - 2006.

	CA Axis-1 (19.2 %)	CA Axis-2 (10.4 %)	CA Axis-3 (6.9 %)	CA Axis-4 (6.7 %)	CA Axis-5 (5.8 %)	CA Axis-6 (5.5 %)
Eigenvalue	0.1775	0.0959	0.0636	0.0616	0.0539	0.0508
Relative Inertia (variance explained)	0.1919	0.1037	0.0687	0.0666	0.0583	0.0549
Cumulative Inertia	0.1919	0.2956	0.3643	0.4310	0.4893	0.5442

Table C.6: Taxon scores from CA of all Rose and Vangorda Creek stations, 2000 - 2006.

	CA Axis-1 (19.2 %)	CA Axis-2 (10.4 %)	CA Axis-3 (6.9 %)	CA Axis-4 (6.7 %)	CA Axis-5 (5.8 %)	CA Axis-6 (5.5 %)
Ameletus sp	0.0537	0.2443	-1.4974	-0.3545	0.4335	0.3464
Baetis sp	0.0680	-0.0002	0.0768	-0.0010	-0.0113	-0.1155
Drunella doddsi	-0.3638	0.4775	0.1839	-0.5008	-0.1724	0.0635
Drunella flavilinea	-0.1791	0.7807	0.7122	-0.6628	-0.1077	0.5781
Drunella grandis	-0.4176	0.4059	0.0215	-0.4100	-0.2949	0.5281
Ephemerella sp	-0.6365	-0.2290	-0.1240	0.1120	-0.4115	0.1646
Seratella tibialis+sp	-0.4780	0.3012	0.5998	0.6199	-0.0677	0.5074
Heptagenia sp	-0.9225	-0.7606	-0.5067	-0.8010	1.5868	0.4218
Epeorus (Iron) sp	0.2175	0.1448	-0.4022	-0.1021	-0.3056	-0.1592
Cinygmula sp	0.1194	0.1621	-0.2744	-0.0969	-0.0547	0.0544
Rhithrogena sp	0.0422	0.3868	-0.4722	-0.4048	-0.2295	-0.2872
Capnia sp	0.3600	0.0604	-0.4284	0.0804	0.1240	0.2885
Isoperla sp	-0.4393	-0.0049	0.5302	-0.0749	0.3445	-0.0427
Megarcys sp	0.5321	0.5328	-0.1983	-0.0369	-0.0921	-0.2268
Podmosta sp	-0.1206	0.7639	1.4177	-0.2779	-0.0336	0.8115
Skwala curvata	-0.4342	0.1442	0.0538	0.2459	-0.1226	0.1080
Skwala paralella	-0.2556	0.5689	0.3804	-0.5623	0.3780	0.1726
Taenionema sp	0.3439	0.0245	0.1585	-0.0229	0.0603	0.1537
Sweltsa sp gp	0.3878	0.3913	-0.7252	0.5341	0.4911	0.3982
Zapada sp	0.2112	-0.0111	-0.0761	-0.0116	-0.0001	-0.0882
Brachycentrus sp	-0.5459	-0.0344	0.4786	0.2935	0.2502	-0.7439
Dicosmoecus sp	-0.3437	0.0121	-0.3922	-0.3779	0.6890	0.4948
Arctopsyche+Hydrosychidae J	0.3227	-0.0143	-0.0375	-0.1000	-0.0354	-0.1524
sum Rhyacophilidae	0.5257	-0.1167	0.0049	0.0941	0.1973	-0.1988
Mallochohelia sp	-0.8642	-0.9389	0.4973	-0.1598	1.2047	-0.8953
Brillia sp	1.6320	-0.7321	0.2680	-0.1921	0.0867	0.0525
Cardiocladius sp	-0.1830	-0.0013	0.0108	-0.1826	-0.0903	-0.0784
Cricotopus sp	0.0243	-0.0362	-0.0340	-0.0889	0.0247	0.0003
Diamesa sp	-0.1176	0.1454	0.1398	0.0592	-0.0077	-0.1043
Eukiefferiella sp	0.0334	0.0308	0.0224	0.1134	-0.1050	-0.0641
Euryhapsis sp	0.0467	0.3971	0.3018	0.0215	0.6297	0.4612
Micropsectra sp	-0.6482	-0.9059	-0.1261	-0.1614	0.3790	0.1672
Rheotanytarsus sp	-0.6456	-0.1953	0.0859	0.0928	-0.0941	0.0738
Thienemanniella sp	-0.3785	-0.4403	0.0627	-0.6455	-0.7342	0.8396
Thienemannimyia sp	-0.8851	-0.7394	-0.1620	-0.2361	0.6636	-0.2385
Chelifera	0.2858	-0.9332	0.3181	0.1760	-0.1072	0.2701
Pericoma sp (Psychodidae)	0.1119	0.0236	0.1138	0.7369	-0.0077	0.3435
Prosimulium L+P	0.4388	0.4177	-0.1729	0.2821	-0.0075	-0.3578
Cnephia sp	2.0085	-1.3880	0.5437	-0.5623	-0.5151	0.1044
Simulium L+P	-0.0438	0.5194	0.2787	0.1397	0.0375	-0.2184
Dicranota sp	0.4489	0.0039	-0.0321	0.7533	0.2115	0.6747
Hydracarina (all)	-0.1554	0.0357	0.0347	-0.1178	0.0278	-0.0285
Enchytraeidae	-0.2749	-0.1552	0.2313	0.5244	0.1641	0.1832
Chaetogaster sp	-0.8683	-0.7323	-0.3415	0.2245	-0.3073	-0.1740
Nematoda	-0.3183	-0.1571	0.0182	0.4479	-0.3558	0.0652

Table C.7: Descriptive statistics for benthic metrics at Rose Creek stations, even years, 2000 - 2006.

a) Metrics by station

		n	Mean	Std. Deviation	Std. Error	95% C. I. for Mean Lower Bound	95% C. I. for Mean Upper Bound	Minimum	Maximum
Number of Individuals	R1	12	7,259	7,256	2,095	2,648	11,869	648	21,292
	R2	12	4,856	5,749	1,660	1,203	8,509	143	18,632
	R3	12	4,563	4,919	1,420	1,437	7,688	17	16,464
	R4	9	1,495	693	231	963	2,028	203	2,549
	R5	12	7,164	10,096	2,915	749	13,579	174	27,448
	R6	12	4,810	5,616	1,621	1,242	8,378	37	18,411
	R7	12	4,055	4,499	1,299	1,196	6,914	100	11,577
	R8	3	4,134	971	560	1,723	6,546	3,203	5,140
	Total	84	4,980	6,160	672	3,643	6,317	17	27,448
Number of Taxa (LPL, collapsed)	R1	12	30	5.3	1.5	26	33	21	40
	R2	12	27	3.8	1.1	25	29	18	33
	R3	12	21	6.0	1.7	18	25	5	27
	R4	9	27	2.9	1.0	25	29	24	32
	R5	12	27	6.4	1.8	23	31	19	39
	R6	12	26	7.5	2.2	22	31	14	40
	R7	12	23	3.9	1.1	21	25	19	32
	R8	3	27	2.3	1.3	22	33	26	30
	Total	84	26	5.7	0.6	25	27	5	40
EPT (percent)	R1	12	18.6	6.4	1.8	14.6	22.7	12.0	32.4
	R2	12	30.1	16.2	4.7	19.8	40.3	4.4	58.2
	R3	12	39.9	27.5	7.9	22.5	57.4	6.2	84.8
	R4	9	32.7	16.3	5.4	20.2	45.2	9.1	61.5
	R5	12	23.8	10.1	2.9	17.4	30.2	13.1	46.0
	R6	12	33.0	16.4	4.7	22.6	43.4	16.2	66.3
	R7	12	17.8	8.9	2.6	12.1	23.5	7.9	39.1
	R8	3	31.3	6.2	3.6	16.0	46.6	27.4	38.4
	Total	84	27.9	16.9	1.8	24.3	31.6	4.4	84.8
Chironomids (percent)	R1	12	70.6	7.9	2.3	65.6	75.6	51.1	81.7
	R2	12	53.1	15.6	4.5	43.2	63.0	26.8	73.5
	R3	12	37.4	18.0	5.2	26.0	48.9	10.1	60.5
	R4	9	48.7	15.6	5.2	36.7	60.8	25.9	79.4
	R5	12	61.1	9.2	2.7	55.3	67.0	41.4	73.2
	R6	12	54.7	18.3	5.3	43.1	66.3	22.0	75.7
	R7	12	72.7	14.1	4.1	63.7	81.6	44.1	90.1
	R8	3	58.7	5.2	3.0	45.7	71.7	53.0	63.2
	Total	84	57.3	17.9	2.0	53.4	61.1	10.1	90.1
Rose CA Axis-1 (15.2 %)	R1	12	0.09	0.26	0.08	-0.08	0.25	-0.31	0.44
	R2	12	-0.34	0.35	0.10	-0.56	-0.12	-0.70	0.23
	R3	12	0.11	0.27	0.08	-0.06	0.28	-0.46	0.43
	R4	9	-0.04	0.39	0.13	-0.34	0.26	-0.63	0.45
	R5	12	-0.07	0.31	0.09	-0.27	0.13	-0.55	0.38
	R6	12	0.26	0.25	0.07	0.10	0.42	-0.09	0.59
	R7	12	-0.04	0.16	0.05	-0.14	0.06	-0.26	0.26
	R8	3	0.50	0.09	0.05	0.29	0.72	0.43	0.60
	Total	84	0.01	0.34	0.04	-0.06	0.09	-0.70	0.60
Rose CA Axis-2 (9.6 %)	R1	12	0.16	0.15	0.04	0.07	0.26	-0.02	0.39
	R2	12	0.11	0.18	0.05	-0.01	0.22	-0.26	0.31
	R3	12	0.28	0.18	0.05	0.17	0.39	-0.04	0.49
	R4	9	-0.20	0.27	0.09	-0.40	0.01	-0.53	0.22
	R5	12	-0.18	0.30	0.09	-0.37	0.01	-0.63	0.23
	R6	12	-0.17	0.22	0.06	-0.31	-0.04	-0.59	0.12
	R7	12	-0.18	0.33	0.09	-0.39	0.03	-0.85	0.22
	R8	3	-0.11	0.04	0.02	-0.21	-0.01	-0.16	-0.08
	Total	84	-0.02	0.29	0.03	-0.09	0.04	-0.85	0.49
Rose CA Axis-3 (8.7 %)	R1	12	0.11	0.18	0.05	-0.01	0.22	-0.13	0.37
	R2	12	0.30	0.17	0.05	0.19	0.41	-0.07	0.60
	R3	12	-0.01	0.29	0.08	-0.20	0.18	-0.54	0.34
	R4	9	-0.05	0.21	0.07	-0.21	0.12	-0.28	0.24
	R5	12	-0.10	0.21	0.06	-0.23	0.03	-0.40	0.20
	R6	12	-0.17	0.15	0.04	-0.27	-0.08	-0.43	0.06
	R7	12	-0.01	0.23	0.07	-0.16	0.14	-0.23	0.45
	R8	3	0.17	0.02	0.01	0.11	0.22	0.15	0.19
	Total	84	0.02	0.25	0.03	-0.04	0.07	-0.54	0.60
Rose CA Axis-4 (7.0 %)	R1	12	0.30	0.24	0.07	0.14	0.45	-0.16	0.71
	R2	12	-0.16	0.10	0.03	-0.22	-0.10	-0.39	-0.03
	R3	12	-0.11	0.09	0.03	-0.17	-0.05	-0.26	0.07
	R4	9	-0.07	0.20	0.07	-0.23	0.08	-0.30	0.32
	R5	12	-0.02	0.16	0.05	-0.12	0.08	-0.27	0.18
	R6	12	-0.08	0.13	0.04	-0.16	0.01	-0.28	0.17
	R7	12	-0.08	0.23	0.07	-0.22	0.07	-0.48	0.46
	R8	3	-0.04	0.09	0.05	-0.26	0.19	-0.10	0.07
	Total	84	-0.03	0.22	0.02	-0.08	0.02	-0.48	0.71

Table C.7: Descriptive statistics for benthic metrics at Rose Creek stations, even years, 2000 - 2006.

b) Metrics for stations combined within reference versus exposure areas

		n	Mean	Std. Deviation	Std. Error	95% C. I. for Mean Lower Bound	95% C. I. for Mean Upper Bound	Minimum	Maximum
Number of Individuals	Reference	36	5,374	5,895	982	3,380	7,369	37	21,292
	Exposure	48	4,684	6,397	923	2,827	6,542	17	27,448
	Total	84	4,980	6,160	672	3,643	6,317	17	27,448
Number of Taxa (LPL, collapsed)	Reference	36	26	6.2	1.0	24	28	14	40
	Exposure	48	26	5.4	0.8	24	27	5	39
	Total	84	26	5.7	0.6	25	27	5	40
EPT (percent)	Reference	36	23.2	13.1	2.2	18.7	27.6	7.9	66.3
	Exposure	48	31.5	18.5	2.7	26.2	36.9	4.4	84.8
	Total	84	27.9	16.9	1.8	24.3	31.6	4.4	84.8
Chironomids (percent)	Reference	36	66.0	15.9	2.7	60.6	71.4	22.0	90.1
	Exposure	48	50.7	16.6	2.4	45.9	55.5	10.1	79.4
	Total	84	57.3	17.9	2.0	53.4	61.1	10.1	90.1
Rose CA Axis-1 (15.2 %)	Reference	36	0.102	0.254	0.042	0.016	0.188	-0.310	0.590
	Exposure	48	-0.052	0.378	0.055	-0.162	0.057	-0.696	0.600
	Total	84	0.014	0.338	0.037	-0.059	0.087	-0.696	0.600
Rose CA Axis-2 (9.6 %)	Reference	36	-0.064	0.286	0.048	-0.161	0.033	-0.855	0.395
	Exposure	48	0.008	0.298	0.043	-0.079	0.094	-0.634	0.488
	Total	84	-0.023	0.293	0.032	-0.087	0.041	-0.855	0.488
Rose CA Axis-3 (8.7 %)	Reference	36	-0.026	0.220	0.037	-0.100	0.048	-0.435	0.448
	Exposure	48	0.049	0.266	0.038	-0.028	0.126	-0.537	0.603
	Total	84	0.017	0.248	0.027	-0.037	0.071	-0.537	0.603
Rose CA Axis-4 (7.0 %)	Reference	36	0.047	0.269	0.045	-0.044	0.138	-0.483	0.711
	Exposure	48	-0.089	0.143	0.021	-0.130	-0.047	-0.389	0.325
	Total	84	-0.030	0.216	0.024	-0.077	0.016	-0.483	0.711

Table C.8: ANOVA of benthic metrics at Rose Creek Stations, even years, 2000 - 2006.

a) Based on individual stations

Source	Dependent Variable	F	p-value	Power
STATION	Number of Individuals	3.3389	0.0048	0.9367
	Number of Taxa (LPL, collapsed)	4.5818	0.0004	0.9876
	EPT (percent)	7.4716	0.0000	0.9999
	Chironomids (percent)	13.4330	0.0000	1.0000
	Rose CA Axis-1 (15.2 %)	13.7437	0.0000	1.0000
	Rose CA Axis-2 (9.6 %)	22.0698	0.0000	1.0000
	Rose CA Axis-3 (8.7 %)	23.1912	0.0000	1.0000
	Rose CA Axis-4 (7.0 %)	12.2090	0.0000	1.0000
YEAR	Number of Individuals	24.6101	0.0000	1.0000
	Number of Taxa (LPL, collapsed)	6.9372	0.0005	0.9710
	EPT (percent)	7.3217	0.0003	0.9778
	Chironomids (percent)	5.5153	0.0022	0.9247
	Rose CA Axis-1 (15.2 %)	33.3672	0.0000	1.0000
	Rose CA Axis-2 (9.6 %)	35.7826	0.0000	1.0000
	Rose CA Axis-3 (8.7 %)	61.9036	0.0000	1.0000
	Rose CA Axis-4 (7.0 %)	9.3412	0.0000	0.9950
STATION * YEAR	Number of Individuals	11.6196	0.0000	1.0000
	Number of Taxa (LPL, collapsed)	2.2225	0.0131	0.9581
	EPT (percent)	7.0212	0.0000	1.0000
	Chironomids (percent)	3.6235	0.0001	0.9989
	Rose CA Axis-1 (15.2 %)	3.6542	0.0001	0.9990
	Rose CA Axis-2 (9.6 %)	4.4330	0.0000	0.9999
	Rose CA Axis-3 (8.7 %)	3.4710	0.0002	0.9983
	Rose CA Axis-4 (7.0 %)	1.8519	0.0436	0.9068

b) Based on combined stations within reference and exposure areas.

Source	Dependent Variable	F	p-value	Power
AREA	Number of Individuals	0.0136	0.9074	0.0515
(Reference: R1, R6, R7	Number of Taxa (LPL, collapsed)	0.0929	0.7613	0.0604
versus	EPT (percent)	8.5191	0.0046	0.8217
Exposure stations)	Chironomids (percent)	21.8229	0.0000	0.9960
	Rose CA Axis-1 (15.2 %)	7.8708	0.0064	0.7910
	Rose CA Axis-2 (9.6 %)	3.0005	0.0873	0.4015
	Rose CA Axis-3 (8.7 %)	1.6421	0.2039	0.2443
	Rose CA Axis-4 (7.0 %)	9.7967	0.0025	0.8708
YEAR	Number of Individuals	7.8331	0.0001	0.9862
	Number of Taxa (LPL, collapsed)	3.7181	0.0149	0.7873
	EPT (percent)	2.4732	0.0680	0.5929
	Chironomids (percent)	1.9561	0.1277	0.4858
	Rose CA Axis-1 (15.2 %)	14.8622	0.0000	1.0000
	Rose CA Axis-2 (9.6 %)	10.7502	0.0000	0.9986
	Rose CA Axis-3 (8.7 %)	17.4627	0.0000	1.0000
	Rose CA Axis-4 (7.0 %)	5.1097	0.0028	0.9083
AREA * YEAR	Number of Individuals	2.4166	0.0729	0.5819
	Number of Taxa (LPL, collapsed)	0.0661	0.9777	0.0613
	EPT (percent)	8.0733	0.0001	0.9885
	Chironomids (percent)	3.9127	0.0118	0.8097
	Rose CA Axis-1 (15.2 %)	0.9493	0.4212	0.2501
	Rose CA Axis-2 (9.6 %)	0.1027	0.9583	0.0678
	Rose CA Axis-3 (8.7 %)	2.2242	0.0922	0.5431
	Rose CA Axis-4 (7.0 %)	0.8936	0.4485	0.2369

Table C.9: Tamhane's T2 Post-hoc Tests[a] between Rose Creek Stations, even years, 2000 - 2006.

Dependent Variable	Station (I)	Station (J)	Mean Diff. (I-J)	p-value	95% C. I. Lower Bound	Upper Bound
Number of Individuals	R1	R2	2402.58	1.00000	-7129.96	11935.13
		R3	2696.08	0.99995	-6435.01	11827.17
		R4	5763.36	0.41617	-2768.53	14295.25
		R5	94.17	1.00000	-12794.20	12982.53
		R6	2448.75	1.00000	-7012.88	11910.38
		R7	3203.67	0.99863	-5763.08	12170.41
		R8	3124.25	0.99536	-5450.39	11698.89
	R2	R3	293.50	1.00000	-7467.77	8054.77
		R4	3360.78	0.86555	-3396.28	10117.83
		R5	-2308.42	1.00000	-14615.99	9999.16
		R6	46.17	1.00000	-8171.87	8264.20
		R7	801.08	1.00000	-6721.44	8323.61
		R8	721.67	1.00000	-6141.57	7584.91
	R3	R4	3067.28	0.79590	-2712.89	8847.45
		R5	-2601.92	1.00000	-14697.28	9493.44
		R6	-247.33	1.00000	-7898.74	7404.07
		R7	507.58	1.00000	-6315.86	7331.03
		R8	428.17	1.00000	-5527.97	6384.30
	R4	R5	-5669.19	0.89785	-17545.31	6206.93
		R6	-3314.61	0.85632	-9915.12	3285.90
		R7	-2559.69	0.89337	-7845.49	2726.10
		R8	-2639.11	0.53989	-10113.61	4835.39
	R5	R6	2354.58	1.00000	-9913.85	14623.02
		R7	3109.50	0.99999	-8906.89	15125.89
		R8	3030.08	0.99999	-8848.72	14908.89
	R6	R7	754.92	1.00000	-6650.03	8159.86
		R8	675.50	1.00000	-6040.02	7391.02
	R7	R8	-79.42	1.00000	-5594.53	5435.69
Number of Taxa (LPL, collapsed)	R1	R2	2.50	0.99807	-4.28	9.28
		R3	8.17	0.05138	-0.03	16.36
		R4	2.36	0.99864	-4.29	9.01
		R5	2.58	0.99994	-5.92	11.09
		R6	3.25	0.99941	-6.24	12.74
		R7	6.58	0.06684	-0.24	13.41
		R8	2.25	0.99995	-6.94	11.44
	R2	R3	5.67	0.29286	-1.75	13.09
		R4	-0.14	1.00000	-5.44	5.16
		R5	0.08	1.00000	-7.72	7.89
		R6	0.75	1.00000	-8.21	9.71
		R7	4.08	0.37321	-1.49	9.66
		R8	-0.25	1.00000	-10.34	9.84
	R3	R4	-5.81	0.23192	-13.12	1.51
		R5	-5.58	0.65483	-14.51	3.34
		R6	-4.92	0.92651	-14.75	4.91
		R7	-1.58	1.00000	-9.05	5.88
		R8	-5.92	0.47608	-15.24	3.41
	R4	R5	0.22	1.00000	-7.49	7.93
		R6	0.89	1.00000	-8.01	9.79
		R7	4.22	0.25546	-1.16	9.60
		R8	-0.11	1.00000	-11.23	11.00
	R5	R6	0.67	1.00000	-9.38	10.71
		R7	4.00	0.90137	-3.84	11.84
		R8	-0.33	1.00000	-9.81	9.15
	R6	R7	3.33	0.99708	-5.66	12.32
		R8	-1.00	1.00000	-11.15	9.15
	R7	R8	-4.33	0.77767	-14.27	5.60

Table C.9: Tamhane's T2 Post-hoc Tests[a] between Rose Creek Stations, even years, 2000 - 2006.

Dependent Variable	Station (I)	Station (J)	Mean Diff. (I-J)	p-value	95% C. I. Lower Bound	Upper Bound
EPT (percent)	R1	R2	-11.44	0.66463	-30.55	7.67
		R3	-21.30	0.46998	-53.61	11.00
		R4	-14.07	0.62089	-38.23	10.08
		R5	-5.14	0.98991	-17.63	7.34
		R6	-14.37	0.30715	-33.71	4.97
		R7	0.82	1.00000	-10.56	12.20
		R8	-12.66	0.74173	-51.68	26.36
	R2	R3	-9.86	0.99995	-43.55	23.82
		R4	-2.64	1.00000	-28.91	23.63
		R5	6.29	0.99983	-13.69	26.28
		R6	-2.93	1.00000	-26.44	20.58
		R7	12.26	0.62370	-7.36	31.88
		R8	-1.23	1.00000	-26.19	23.74
	R3	R4	7.23	1.00000	-27.80	42.25
		R5	16.16	0.89342	-16.30	48.62
		R6	6.93	1.00000	-26.82	40.68
		R7	22.12	0.42741	-10.25	54.50
		R8	8.64	0.99999	-25.30	42.58
	R4	R5	8.93	0.99476	-15.28	33.14
		R6	-0.29	1.00000	-26.67	26.09
		R7	14.89	0.56760	-9.21	39.00
		R8	1.41	1.00000	-26.40	29.23
	R5	R6	-9.23	0.96537	-29.41	10.96
		R7	5.96	0.98508	-7.83	19.76
		R8	-7.52	0.99268	-34.57	19.53
	R6	R7	15.19	0.28114	-4.64	35.02
		R8	1.71	1.00000	-23.34	26.75
	R7	R8	-13.48	0.60530	-42.71	15.75
Chironomids (percent)	R1	R2	17.50	0.08423	-1.28	36.28
		R3	33.19	0.00089	11.76	54.63
		R4	21.87	0.07314	-1.30	45.03
		R5	9.46	0.31368	-3.01	21.93
		R6	15.92	0.33094	-5.77	37.61
		R7	-2.08	1.00000	-19.20	15.03
		R8	11.90	0.54701	-12.10	35.89
	R2	R3	15.69	0.60870	-8.77	40.15
		R4	4.37	1.00000	-20.95	29.68
		R5	-8.04	0.98652	-27.19	11.12
		R6	-1.58	1.00000	-26.23	23.07
		R7	-19.58	0.10405	-41.11	1.94
		R8	-5.60	0.99998	-27.72	16.51
	R3	R4	-11.33	0.98582	-38.09	15.44
		R5	-23.73	0.02414	-45.43	-2.03
		R6	-17.28	0.56428	-43.51	8.96
		R7	-35.28	0.00077	-58.85	-11.71
		R8	-21.30	0.10605	-45.16	2.56
	R4	R5	-12.40	0.79789	-35.64	10.83
		R6	-5.95	1.00000	-32.87	20.97
		R7	-23.95	0.06045	-48.50	0.61
		R8	-9.97	0.97926	-35.39	15.45
	R5	R6	6.46	0.99993	-15.49	28.40
		R7	-11.55	0.55058	-29.13	6.04
		R8	2.43	1.00000	-19.52	24.39
	R6	R7	-18.00	0.31382	-41.78	5.77
		R8	-4.02	1.00000	-28.07	20.02
	R7	R8	13.98	0.43347	-7.31	35.27

Table C.9: Tamhane's T2 Post-hoc Tests[a] between Rose Creek Stations, even years, 2000 - 2006.

Dependent Variable	Station (I)	Station (J)	Mean Diff. (I-J)	p-value	95% C. I. Lower Bound	95% C. I. Upper Bound
Rose CA Axis-1 (15.2 %)	R1	R2	0.43	0.07516	-0.02	0.88
		R3	-0.02	1.00000	-0.40	0.36
		R4	0.12	1.00000	-0.46	0.71
		R5	0.16	0.99708	-0.26	0.58
		R6	-0.17	0.96134	-0.54	0.20
		R7	0.13	0.99296	-0.19	0.45
		R8	-0.42	0.02127	-0.78	-0.05
	R2	R3	-0.45	0.05575	-0.91	0.01
		R4	-0.30	0.91364	-0.92	0.31
		R5	-0.27	0.82615	-0.75	0.21
		R6	-0.60	0.00279	-1.05	-0.16
		R7	-0.30	0.35928	-0.72	0.12
		R8	-0.84	0.00014	-1.29	-0.40
	R3	R4	0.15	1.00000	-0.44	0.73
		R5	0.18	0.98696	-0.24	0.60
		R6	-0.15	0.99338	-0.53	0.22
		R7	0.15	0.96747	-0.18	0.48
		R8	-0.39	0.03454	-0.77	-0.02
	R4	R5	0.04	1.00000	-0.56	0.64
		R6	-0.30	0.85799	-0.88	0.29
		R7	0.00	1.00000	-0.58	0.58
		R8	-0.54	0.08979	-1.13	0.05
	R5	R6	-0.33	0.22299	-0.75	0.08
		R7	-0.03	1.00000	-0.41	0.34
		R8	-0.58	0.00309	-0.98	-0.17
	R6	R7	0.30	0.06267	-0.01	0.61
		R8	-0.24	0.42984	-0.60	0.12
	R7	R8	-0.54	0.00619	-0.91	-0.18
Rose CA Axis-2 (9.6 %)	R1	R2	0.06	1.00000	-0.18	0.30
		R3	-0.12	0.91359	-0.35	0.12
		R4	0.36	0.08845	-0.03	0.75
		R5	0.34	0.07669	-0.02	0.71
		R6	0.34	0.00754	0.06	0.61
		R7	0.34	0.11784	-0.04	0.73
		R8	0.28	0.00232	0.09	0.47
	R2	R3	-0.18	0.50246	-0.44	0.08
		R4	0.30	0.26258	-0.09	0.70
		R5	0.29	0.28305	-0.09	0.66
		R6	0.28	0.06889	-0.01	0.57
		R7	0.29	0.36972	-0.11	0.68
		R8	0.22	0.05810	0.00	0.44
	R3	R4	0.48	0.01105	0.08	0.88
		R5	0.46	0.00698	0.09	0.83
		R6	0.46	0.00036	0.17	0.75
		R7	0.46	0.01265	0.07	0.86
		R8	0.40	0.00023	0.18	0.61
	R4	R5	-0.02	1.00000	-0.47	0.44
		R6	-0.02	1.00000	-0.43	0.39
		R7	-0.02	1.00000	-0.49	0.45
		R8	-0.08	1.00000	-0.48	0.31
	R5	R6	-0.01	1.00000	-0.39	0.38
		R7	0.00	1.00000	-0.46	0.46
		R8	-0.07	1.00000	-0.43	0.29
	R6	R7	0.01	1.00000	-0.40	0.41
		R8	-0.06	1.00000	-0.32	0.20
	R7	R8	-0.07	1.00000	-0.45	0.32

Table C.9: Tamhane's T2 Post-hoc Tests[a] between Rose Creek Stations, even years, 2000 - 2006.

Dependent Variable	Station (I)	Station (J)	Mean Diff. (I-J)	p-value	95% C. I. Lower Bound	95% C. I. Upper Bound
Rose CA Axis-3 (8.7 %)	R1	R2	-0.19	0.29114	-0.45	0.06
		R3	0.12	0.99973	-0.24	0.48
		R4	0.15	0.94777	-0.18	0.48
		R5	0.21	0.36782	-0.08	0.49
		R6	0.28	0.01323	0.04	0.52
		R7	0.12	0.99625	-0.19	0.42
		R8	-0.06	0.99978	-0.27	0.15
	R2	R3	0.31	0.13798	-0.05	0.67
		R4	0.35	0.03094	0.02	0.68
		R5	0.40	0.00116	0.12	0.68
		R6	0.47	0.00001	0.24	0.71
		R7	0.31	0.03573	0.01	0.61
		R8	0.13	0.48519	-0.07	0.33
	R3	R4	0.04	1.00000	-0.36	0.44
		R5	0.09	1.00000	-0.28	0.46
		R6	0.16	0.95659	-0.19	0.52
		R7	0.00	1.00000	-0.38	0.39
		R8	-0.18	0.81825	-0.52	0.17
	R4	R5	0.05	1.00000	-0.29	0.40
		R6	0.13	0.99175	-0.20	0.45
		R7	-0.04	1.00000	-0.39	0.32
		R8	-0.22	0.36842	-0.54	0.11
	R5	R6	0.07	0.99999	-0.20	0.34
		R7	-0.09	0.99999	-0.41	0.23
		R8	-0.27	0.02601	-0.52	-0.02
	R6	R7	-0.16	0.82070	-0.45	0.13
		R8	-0.34	0.00019	-0.53	-0.16
	R7	R8	-0.18	0.47299	-0.46	0.09
Rose CA Axis-4 (7.0 %)	R1	R2	0.46	0.00067	0.17	0.75
		R3	0.41	0.00222	0.12	0.70
		R4	0.37	0.03454	0.02	0.72
		R5	0.32	0.03548	0.01	0.62
		R6	0.37	0.00579	0.08	0.67
		R7	0.38	0.02041	0.04	0.72
		R8	0.33	0.09448	-0.04	0.70
	R2	R3	-0.05	0.99903	-0.19	0.09
		R4	-0.09	0.99973	-0.39	0.21
		R5	-0.14	0.35086	-0.34	0.05
		R6	-0.09	0.91979	-0.25	0.08
		R7	-0.08	0.99984	-0.35	0.19
		R8	-0.13	0.96852	-0.67	0.42
	R3	R4	-0.04	1.00000	-0.34	0.26
		R5	-0.09	0.93341	-0.29	0.10
		R6	-0.04	1.00000	-0.20	0.13
		R7	-0.03	1.00000	-0.30	0.24
		R8	-0.08	0.99990	-0.65	0.50
	R4	R5	-0.05	1.00000	-0.37	0.26
		R6	0.00	1.00000	-0.30	0.31
		R7	0.01	1.00000	-0.34	0.35
		R8	-0.04	1.00000	-0.42	0.35
	R5	R6	0.06	0.99999	-0.15	0.27
		R7	0.06	1.00000	-0.23	0.35
		R8	0.02	1.00000	-0.37	0.40
	R6	R7	0.00	1.00000	-0.28	0.28
		R8	-0.04	1.00000	-0.47	0.39
	R7	R8	-0.04	1.00000	-0.41	0.32

[a]All variables had significant heterogeneity by Levene's test, requiring this Post-hoc pair-wise test.

Table C.10: Correspondence Analysis of Rose Creek, even years, 2000 - 2006.

	CA Axis-1 (15.2 %)	CA Axis-2 (9.6 %)	CA Axis-3 (8.7 %)	CA Axis-4 (7.0 %)
Eigenvalue	0.1071	0.0673	0.0612	0.0492
Relative Inertia (variance explained)	0.1524	0.0959	0.0871	0.0701
Cumulative Inertia	0.1524	0.2483	0.3354	0.4055

Table C.11: Taxon scores from CA of Rose Creek, even years, 2000 - 2006.

	CA Axis-1 (15.2 %)	CA Axis-2 (9.6 %)	CA Axis-3 (8.7 %)	CA Axis-4 (7.0 %)
Ameletus sp	-0.2790	-1.2464	0.1750	0.0300
Baetis sp	0.0442	0.1296	0.0180	-0.0124
Drunella doddsi	0.3937	-0.3057	0.0936	-0.0735
Drunella flavilinea	0.8232	-0.1938	0.3977	0.5296
Drunella grandis	0.2880	-0.4352	-0.0830	0.2058
Ephemerella sp	-0.3736	-0.0865	-0.3504	0.2591
Seratella tibialis+sp	0.2002	0.5836	-0.2785	-0.0007
Heptageneia sp	-0.9971	-0.7144	1.1517	-0.7824
Epeorus (Iron) sp	0.1622	-0.5181	-0.3351	0.0495
Cinygmula sp	0.1360	-0.2861	-0.1150	-0.0707
Rhithrogena sp	0.3055	-0.5633	-0.1935	-0.2683
Capnia sp	0.0892	-0.5181	-0.1642	-0.1422
Isoperla sp	-0.0322	0.3532	0.4271	-0.0074
Megarcys sp	0.8993	-0.1244	-0.2007	-0.1642
Podmosta sp	0.9273	0.5285	0.6837	1.3067
Skwala curvata	0.0926	0.0586	-0.2696	-0.0574
Skwala paralella	0.5071	-0.2169	0.5026	-0.2801
Taenionema sp	0.2046	0.0333	0.1476	0.2824
Sweltsa sp gp	0.1566	-0.2896	-0.2316	-0.3722
Zapada sp	0.0288	0.0154	-0.0087	-0.0517
Brachycentrus sp	-0.0899	0.6401	0.1838	-0.3494
Dicosmoecus sp	-0.2061	-0.6529	0.5497	-0.1443
Arctopsyche+Hydrosychidae J	0.1340	-0.0769	-0.0056	-0.1263
sum Rhyacophilidae	0.0029	0.2842	0.2983	-0.0496
Mallochohelia sp	-0.9331	0.5937	1.2271	-0.0142
Brillia sp	0.6910	0.1751	0.8376	1.1269
Cardiocladius sp	-0.0307	-0.0562	0.0403	0.0439
Cricotopus sp	-0.0228	-0.1072	0.0612	-0.0237
Diamesa sp	0.0923	0.1504	0.0619	0.0785
Eukiefferiella sp	0.0505	0.1240	-0.1481	-0.0519
Euryhapsis sp	0.4244	0.1555	0.4671	-0.1912
Micropsectra sp	-1.0917	-0.1544	0.3542	0.2314
Rheotanytarsus sp	-0.3089	0.0965	-0.0987	0.0136
Thienemanniella sp	-0.3668	-0.5170	-0.0345	1.3982
Thienemannimyia sp	-0.8944	-0.0643	0.5340	-0.3370
Chelifera	-0.5152	0.1383	-0.0875	0.0002
Pericoma sp (Psychodidae)	0.0767	0.4594	-0.4497	-0.0541
Prosimulium L+P	0.5132	0.1451	-0.3050	-0.2363
Simulium L+P	0.5017	0.2741	0.0308	-0.0475
Dicranota sp	0.1805	0.2542	-0.3622	0.2039
Hydracarina (all)	0.0065	-0.0485	0.1037	-0.0643
Enchytraeidae	-0.2659	0.5131	-0.0458	0.0178
Chaetogaster sp	-0.8877	0.0107	-0.3558	-0.0378
Nematoda	-0.2483	0.2414	-0.4836	0.0855

Table C.12: Descriptive statistics for benthic metrics at Vangorda Creek, odd years, 2001 - 2005.

Descriptives

		n	Mean	Std. Deviation	Std. Error	95% C. I. for Mean		Minimum	
						Lower Bound	Upper Bound		
Number of Individuals	V1	9	800	1,370	457	-253	1,854	50	
	V27	9	1,255	901	300	562	1,947	292	
	V5	9	3,746	2,399	800	1,902	5,591	659	
	V8	9	1,805	1,242	414	850	2,760	384	
	Total	36	1,902	1,892	315	1,261	2,542	50	
Number of Taxa (LPL, collapsed)	V1	9	16	3.7	1.2	13	19	9	
	V27	9	19	3.4	1.1	16	21	14	
	V5	9	22	2.7	0.9	20	24	19	
	V8	9	24	3.7	1.2	21	26	17	
	Total	36	20	4.4	0.7	19	22	9	
EPT (percent)	V1	9	56.5	16.0	5.3	44.2	68.8	26.8	
	V27	9	80.9	4.7	1.6	77.3	84.6	73.1	
	V5	9	50.5	18.7	6.2	36.2	64.8	23.6	
	V8	9	37.4	13.5	4.5	27.1	47.8	19.4	
	Total	36	56.3	21.0	3.5	49.2	63.4	19.4	
Chironomids (percent)	V1	9	37.0	13.1	4.4	26.9	47.1	16.0	
	V27	9	13.4	3.9	1.3	10.4	16.5	6.9	
	V5	9	40.3	18.9	6.3	25.7	54.8	19.0	
	V8	9	57.6	15.1	5.0	46.0	69.2	36.5	
	Total	36	37.1	20.8	3.5	30.1	44.1	6.9	
Vangorda CA Axis-1 (21.1 %)	V1	9	-0.008	0.290	0.097	-0.231	0.215	-0.535	
	V27	9	0.026	0.335	0.112	-0.231	0.284	-0.347	
	V5	9	-0.110	0.473	0.158	-0.474	0.254	-0.715	
	V8	9	0.065	0.279	0.093	-0.150	0.279	-0.303	
	Total	36	-0.007	0.344	0.057	-0.123	0.110	-0.715	
Vangorda CA Axis-2 (17.7 %)	V1	9	0.545	0.248	0.083	0.355	0.736	0.332	
	V27	9	0.295	0.121	0.040	0.202	0.388	0.138	
	V5	9	-0.253	0.166	0.055	-0.380	-0.126	-0.440	
	V8	9	-0.199	0.106	0.035	-0.281	-0.117	-0.350	
	Total	36	0.097	0.377	0.063	-0.030	0.225	-0.440	
Vangorda CA Axis-3 (9.7 %)	V1	9	-0.042	0.146	0.049	-0.154	0.070	-0.398	
	V27	9	0.086	0.138	0.046	-0.020	0.192	-0.089	
	V5	9	0.210	0.120	0.040	0.118	0.302	0.026	
	V8	9	-0.301	0.258	0.086	-0.499	-0.103	-0.790	
	Total	36	-0.011	0.254	0.042	-0.097	0.074	-0.790	
Vangorda CA Axis-4 (9.4 %)	V1	9	-0.153	0.579	0.193	-0.598	0.291	-1.545	
	V27	9	0.011	0.216	0.072	-0.155	0.177	-0.234	
	V5	9	-0.009	0.248	0.083	-0.199	0.181	-0.385	
	V8	9	0.053	0.137	0.046	-0.053	0.158	-0.158	
	Total	36	-0.025	0.334	0.056	-0.138	0.088	-1.545	

Table C.13: ANOVA of benthic metrics at Vangorda Creek Stations, odd years, 2001 - 2005.

Source	Dependent Variable	F	p-value	Power
STATION	Number of Individuals	9.9728	0.0002	0.9937
	Number of Taxa (LPL, collapsed)	8.4743	0.0005	0.9830
	EPT (percent)	58.5069	0.0000	1.0000
	Chironomids (percent)	66.3445	0.0000	1.0000
	Vangorda CA Axis-1 (21.1 %)	3.1542	0.0433	0.6567
	Vangorda CA Axis-2 (17.7 %)	74.4667	0.0000	1.0000
	Vangorda CA Axis-3 (9.7 %)	33.2484	0.0000	1.0000
	Vangorda CA Axis-4 (9.4 %)	0.7570	0.5292	0.1873
YEAR	Number of Individuals	7.5320	0.0029	0.9133
	Number of Taxa (LPL, collapsed)	0.5793	0.5679	0.1349
	EPT (percent)	2.0210	0.1545	0.3753
	Chironomids (percent)	5.3385	0.0121	0.7895
	Vangorda CA Axis-1 (21.1 %)	102.2121	0.0000	1.0000
	Vangorda CA Axis-2 (17.7 %)	6.3315	0.0062	0.8573
	Vangorda CA Axis-3 (9.7 %)	14.7347	0.0001	0.9972
	Vangorda CA Axis-4 (9.4 %)	2.9127	0.0737	0.5152
STATION * YEAR	Number of Individuals	2.2641	0.0714	0.6732
	Number of Taxa (LPL, collapsed)	0.9594	0.4729	0.3035
	EPT (percent)	16.3681	0.0000	1.0000
	Chironomids (percent)	17.2692	0.0000	1.0000
	Vangorda CA Axis-1 (21.1 %)	3.3178	0.0160	0.8552
	Vangorda CA Axis-2 (17.7 %)	2.3511	0.0628	0.6926
	Vangorda CA Axis-3 (9.7 %)	3.5811	0.0112	0.8844
	Vangorda CA Axis-4 (9.4 %)	1.4934	0.2227	0.4682

Table C.14: Post-hoc Tests[a] between Vangorda Creek Stations, odd years, 2000 - 2006.

Dependent Variable		(I) Station ID	(J) Station ID	Mean Difference (I-J)	Sig.	95% Confidence Interval Lower Bound	Upper Bound
Number of Individuals	Tamhane	V1	V27	-454.333	0.96193	-2129.274	1220.607
			V5	-2946.222	0.04216	-5808.443	-84.002
			V8	-1004.778	0.54446	-2855.407	845.851
		V27	V5	-2491.889	0.08701	-5266.760	282.982
			V8	-550.444	0.88154	-2104.126	1003.237
		V5	V8	1941.444	0.27451	-887.144	4770.033
Number of Taxa (LPL, collapsed)	Bonferroni	V1	V27	-2.556	0.73451	-7.085	1.974
			V5	-6.222	0.00308	-10.752	-1.693
			V8	-7.333	0.00043	-11.863	-2.804
		V27	V5	-3.667	0.17786	-8.196	0.863
			V8	-4.778	0.03395	-9.307	-0.248
		V5	V8	-1.111	1.00000	-5.641	3.419
EPT (percent)	Tamhane	V1	V27	-24.452	0.00932	-42.880	-6.024
			V5	5.992	0.97915	-18.650	30.633
			V8	19.086	0.08588	-1.892	40.063
		V27	V5	30.443	0.00626	8.957	51.930
			V8	43.537	0.00002	27.992	59.083
		V5	V8	13.094	0.49974	-10.220	36.408
Chironomids (percent)	Tamhane	V1	V27	23.604	0.00307	8.466	38.743
			V5	-3.222	0.99895	-26.633	20.189
			V8	-20.541	0.04298	-40.586	-0.496
		V27	V5	-26.827	0.01564	-48.614	-5.039
			V8	-44.146	0.00008	-61.517	-26.774
		V5	V8	-17.319	0.25673	-41.667	7.029
Vangorda CA Axis-1 (21.1 %)	Bonferroni	V1	V27	-0.034	1.00000	-0.502	0.434
			V5	0.102	1.00000	-0.366	0.570
			V8	-0.073	1.00000	-0.541	0.395
		V27	V5	0.136	1.00000	-0.332	0.604
			V8	-0.039	1.00000	-0.506	0.429
		V5	V8	-0.175	1.00000	-0.643	0.293
Vangorda CA Axis-2 (17.7 %)	Bonferroni	V1	V27	0.250	0.02223	0.026	0.475
			V5	0.798	0.00000	0.574	1.023
			V8	0.744	0.00000	0.520	0.969
		V27	V5	0.548	0.00000	0.323	0.773
			V8	0.494	0.00000	0.269	0.719
		V5	V8	-0.054	1.00000	-0.279	0.171
Vangorda CA Axis-3 (9.7 %)	Tamhane	V1	V27	-0.128	0.36747	-0.329	0.072
			V5	-0.252	0.00653	-0.441	-0.062
			V8	0.259	0.12200	-0.048	0.566
		V27	V5	-0.124	0.30892	-0.307	0.060
			V8	0.387	0.01066	0.082	0.692
		V5	V8	0.511	0.00119	0.210	0.812
Vangorda CA Axis-4 (9.4 %)	Bonferroni	V1	V27	-0.164	1.00000	-0.614	0.286
			V5	-0.144	1.00000	-0.595	0.306
			V8	-0.206	1.00000	-0.656	0.244
		V27	V5	0.020	1.00000	-0.431	0.470
			V8	-0.042	1.00000	-0.492	0.409
		V5	V8	-0.061	1.00000	-0.512	0.389

[a]variables with significant heterogeneity by Levene's test, required Tamhane's test, others use Bonferroni Post-hoc pair-wise test.

Table C.15: Correspondence Analysis of Vangorda Creek, odd years, 2001 - 2005.

	CA Axis-1 (21.1 %)	CA Axis-2 (17.7 %)	CA Axis-3 (9.7 %)	CA Axis-4 (9.4 %)
Eigenvalue	0.1305	0.1093	0.0601	0.0578
Relative Inertia (variance explained)	0.2112	0.1769	0.0973	0.0935
Cumulative Inertia	0.2112	0.3881	0.4854	0.5789

Table C.16: Taxon scores from CA of Vangorda Creek, odd years, 2001 - 2005.

	CA Axis-1 (21.1 %)	CA Axis-2 (17.7 %)	CA Axis-3 (9.7 %)	CA Axis-4 (9.4 %)
Ameletus sp	-1.1191	0.4107	0.4656	-1.7926
Baetis sp	0.1013	0.1225	-0.0199	-0.0122
Epeorus (Iron) sp	0.0298	0.3350	0.2851	0.3070
Cinygmula sp	-0.1386	0.2481	0.2078	-0.0234
Rhithrogena sp	-0.1475	0.9959	-0.2649	-0.3371
Capnia sp	-0.2267	-0.2361	-0.0689	-0.0963
Isoperla sp	0.5853	-0.2227	-0.7135	-0.0398
Megarcys sp	-0.0300	0.4479	0.1706	0.0435
Taenionema sp	0.0090	-0.2113	-0.2752	0.1512
Sweltsa sp gp	-0.7843	-0.0802	-0.1631	-0.4273
Zapada sp	0.0431	0.1619	0.0137	-0.0413
Dicosmoecus sp	-1.2103	-0.8264	0.3419	0.0195
Arctopsyche+Hydrosychidae J	0.1857	0.1676	0.2436	0.0407
sum Rhyacophilidae	0.0279	0.0269	0.2109	0.0413
Brillia sp	0.5044	-0.2109	-0.2749	-0.0108
Cardiocladius sp	0.2817	0.6033	-0.2969	-0.2480
Cricotopus sp	0.0770	-0.0628	-0.0268	0.0092
Diamesa sp	-0.2970	0.0741	0.0932	0.2549
Eukiefferiella sp	0.0253	0.0240	0.0431	0.0347
Euryhapsis sp	-0.6362	-0.7662	-0.7632	-0.4830
Micropsectra sp	-0.0334	-0.7665	-1.6485	0.0769
Thienemanniella sp	1.2415	-0.3255	-0.8221	-0.2207
Chelifera	1.1108	-1.0256	0.5633	-0.1223
Pericoma sp (Psychodidae)	-0.2890	-0.7531	0.2633	-0.1372
Prosimulium L+P	-0.3843	0.1858	-0.0860	0.4395
Cnephia sp	1.1734	-0.2754	0.3154	-0.3189
Simulium L+P	-0.6758	0.0751	-0.1555	0.2746
Dicranota sp	-0.3915	-0.8763	0.2400	-0.1968
Hydracarina (all)	0.1001	0.0723	0.0231	0.1739
Enchytraeidae	-0.3221	-0.4650	-0.0602	0.6750
Nematoda	-0.1998	-0.4138	0.4296	0.0669

Table C.17: Correlations of community structure CA scores with sample year at Faro Creeks.

		Sample Year
Faro Combined CA Axis-1 (19.2 %)	Pearson Correlation	0.1260
	Sig. (2-tailed)	0.1690
	n	120
Faro Combined CA Axis-2 (10.4 %)	Pearson Correlation	-0.1000
	Sig. (2-tailed)	0.2770
	n	120
Faro Combined CA Axis-3 (6.9 %)	Pearson Correlation	0.0320
	Sig. (2-tailed)	0.7270
	n	120
Faro Combined CA Axis-4 (6.7 %)	Pearson Correlation	-0.6680
	Sig. (2-tailed)	0.0000
	n	120
Faro Combined CA Axis-5 (5.8 %)	Pearson Correlation	0.1500
	Sig. (2-tailed)	0.1020
	n	120
Faro Combined CA Axis-6 (5.5 %)	Pearson Correlation	0.1060
	Sig. (2-tailed)	0.2490
	n	120
Rose Combined CA Axis-1 (15.2 %)	Pearson Correlation	0.1550
	Sig. (2-tailed)	0.1600
	n	84
Rose Combined CA Axis-2 (9.6 %)	Pearson Correlation	-0.5140
	Sig. (2-tailed)	0.0000
	n	84
Rose Combined CA Axis-3 (8.7 %)	Pearson Correlation	0.5760
	Sig. (2-tailed)	0.0000
	n	84
Rose Combined CA Axis-4 (7.0 %)	Pearson Correlation	0.0550
	Sig. (2-tailed)	0.6200
	n	84
Vangorda Combined CA Axis-1 (21.1 %	Pearson Correlation	0.8040
	Sig. (2-tailed)	0.0000
	n	36
Vangorda Combined CA Axis-2 (17.7 %	Pearson Correlation	-0.1590
	Sig. (2-tailed)	0.3540
	n	36
Vangorda Combined CA Axis-3 (9.7 %)	Pearson Correlation	0.3100
	Sig. (2-tailed)	0.0660
	n	36
Vangorda Combined CA Axis-4 (9.4 %)	Pearson Correlation	0.0340
	Sig. (2-tailed)	0.8430
	n	36

Table C.18: Variance components (as proportions) of metrics for monitoring stations at Faro mine.

Vangorda Creek	Station	Year	Station*Year	Error
Number of Individuals	0.32	0.16	0.16	0.37
Number of Taxa (LPL, collapsed)	0.47	-0.02	-0.01	0.56
EPT (percent)	0.49	-0.12	0.53	0.10
Chironomids (percent)	0.50	-0.09	0.50	0.09
Vangorda CA Axis-1 (21.1 %)	0.00	0.82	0.08	0.10
Vangorda CA Axis-2 (17.7 %)	0.82	0.03	0.05	0.10
Vangorda CA Axis-3 (9.7 %)	0.54	0.15	0.14	0.16
Rose Creek	Station	Year	Station*Year	Error
Number of Individuals	-0.19	0.15	0.81	0.23
Number of Taxa (LPL, collapsed)	0.12	0.12	0.22	0.54
EPT (percent)	0.00	0.01	0.66	0.33
Chironomids (percent)	0.32	0.03	0.30	0.35
Rose CA Axis-1 (15.2 %)	0.23	0.35	0.19	0.23
Rose CA Axis-2 (9.6 %)	0.31	0.30	0.20	0.19
Rose CA Axis-3 (8.7 %)	0.29	0.43	0.12	0.16

NOTE: For the ANOVA and MINQUE methods, negative variance component estimates may occur. Some possible reasons for their occurrence are: (a) the specified model is not the correct model, or (b) the true value of the variance equals zero.