Serpent River Watershed
State of the Environment Report

Prepared for:

Rio Algom Limited
And
Denison Mines Inc.
Elliot Lake, ON

Prepared by:

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July 2011

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EXECUTIVE SUMMARY

Uranium mining was undertaken in the Elliot Lake area of north eastern Ontario for approximately forty years. The mines generally operated from the late 1950's to the mid 1960's and again from the early 1970's until the early 1990's when most of the mines ceased operations. In total, there are eleven decommissioned mining operations and associated tailings management areas (TMAs) located in the Serpent River Watershed. The TMAs are in the long-term care and maintenance phase following closure that includes effluent treatment, source and watershed monitoring and TMA care and maintenance. All of the TMAs discharge to the Serpent River Watershed, except Pronto which discharges to the north shore of Lake Huron. The long-term care and maintenance of these sites is the responsibility of Rio Algom Limited and Denison Mines Inc.

As part of the closure and decommissioning process, Rio Algom and Denison developed a focused and integrated performance monitoring network. The comprehensive monitoring and management strategy clearly defined and delineated the purpose for all monitoring activities through three integrated program; the TMA operational monitoring program (TOMP), the source area monitoring program (SAMP) and the Serpent River watershed monitoring program (SRWMP).

The objective of this Serpent River Watershed State of the Environment Report was to integrate recent (2005 to 2009) monitoring data from the TOMP, SAMP, and SRWMP to provide an assessment of current TMA performance and the conditions in the downstream Serpent River Watershed relative to TMA sources.

In-Basin Quality

Since decommissioning, conditions in the TMA basins have improved and basin water quality is generally at or near Environmental Impact Statement (EIS)-predicted levels. Water quality has continued to improve in recent years (2003 to 2007) based on decreasing concentrations of radium-226, sulphate, and uranium, as well as increasing pH levels, at most TMAs. Exceptions were observed at Denison TMA-1 and Stanleigh TMA where radium-226 has been increasing in surface water at both TMAs, and pH has been decreasing at Denison TMA-1. While radium-226 concentrations were found to be decreasing over the past five years at most TMAs and remain within the range specified in the EIS sensitivity analysis, sulphate concentrations have also been decreasing and studies on radium release mechanisms suggest that decreases in sulphate over time may result radium release from the tailing to the overlying water column of the basins. In order to develop an understanding of the mechanisms controlling radium-226 releases to basin surface water, EcoMetrix was

retained to investigate radium-226 activities in solids (submerged tailings and treatment solids), porewater, and basin water at both the Quirke and Panel TMAs. These studies concluded that as aqueous sulphate concentrations decline, there is an increased dissolution of barium sulphate to which radium is associated, whereby radium is released from the tailings. Based on this assessment, the concentration of radium-226 in the porewater of flooded basins is not expected to exceed 5.5 Bq/L and the overlying water column is expected to remain below 1.8 Bq/L. It is expected that radium concentrations in porewater will stabilize over time once the dissolution of barium sulphate re-equilibrates with aqueous sulphate concentrations. Assuming there are no new sources of radium to the TMAs, radium concentrations in porewater should decline as the amount of soluble material in the tailings diffusion zone decreases. It is likely that the increases in radium-226 observed at Denison and Stanleigh TMA are associated with declining sulphate concentrations.

TMA Discharges

Primary mine discharges, which contribute the majority of chemical loadings to the receiving environment, have also been improving over time. Where trends were detected, radium-226, sulphate, and uranium concentrations decreased in TMA effluents. The only exception to this was at Stanleigh, where radium-226 concentrations have been increasing slightly in response to decreasing sulphate concentrations in the basin.

At some TMAs (Denison, Stanrock and Pronto), effluent pH showed a decreasing trend but this appeared to be associated with either changes in treatment or possibly the effect of higher flows in 2008 and 2009. In all cases, effluent pH remains circum neutral.

Trend analysis for 2003-2009 data indicated barium concentrations have been increasing at the primary discharge locations (CL-06, D2, D-3, P-14 and Q-28) of the flooded basins, but this was largely due to greater barium chloride use in 2008 and/or 2009 in response to increased flows. In all cases barium concentrations in discharges were well below toxicity thresholds.

Over the past five years, effluent quality has consistently achieved discharge criteria at all TMAs. With few exceptions, effluent has also been consistently non-lethal to *Daphnia magna* and rainbow trout with no mortality reported in semi-annual acute toxicity tests. Similarly, survival and reproduction of *Ceriodaphnia dubia* were not affected by exposure to 100% effluent in most tests conducted over the past five years at all TMAs.

Direct seepage releases from the TMAs to the receiving environment only occur in the Quirke Lake sub-watershed. While metal concentrations tend to be highest and pH lowest in these sources, their loads to the receiving environment are low compared to primary discharges and background (upstream) loads. As noted in the previous SOE report (Minnow 2009a), the radium load within the Serpent River downstream of the Denison TMA discharge (D-5) was substantially greater than the loading from the Denison TMA or the upstream watershed (D-4) suggesting a radium source within the river. In 2009, EcoMetrix conducted a study to investigate the difference in loadings within the River and found elevated radium-226 sediment concentrations (14 Bq/g) between stations D4 and D5. The barium and sulphate depth profiles in sediment and water (porewater and overlying water) mirrored the radium profiles, indicating that these profiles are likely caused by the settling/accumulation of historical treatment solids. The loadings from this area are consistent with the recovery of historically accumulated sediments releasing radium to the water column. Diffusion modelling indicated that radium-226 release from the sediment should decrease with time.

Watershed Conditions

The improvements within the TMAs were reflected in the downstream watershed. With few exceptions, mean surface water concentrations of mine related substances were less than the SRWMP benchmarks and, where concentrations exceeded the benchmark, they did not exceed toxicological thresholds. Furthermore, metal concentrations (cobalt, manganese, radium-226, sulphate and uranium) in surface water have been decreasing over time, and pH has been increasing.

In locations where sediment concentrations were above benchmarks, concentrations of barium, cobalt, iron, manganese and nickel appeared to decrease or remain stable over the past ten years (1999 to 2009). Statistical comparisons of 1999 versus 2009 sediment concentrations indicated few statistically significant differences (1999 vs. 2009), except: a) a significant increases in sediment iron and manganese concentrations in Quirke Lake; b) an increase in sediment radium-226 in McCabe Lake, and c) decreases in sediment cobalt, manganese, nickel and radium-226 concentrations in Hough Lake. Overall, the data indicate a very slow rate of change in sediment quality.

Sediment toxicity tests using *Hyalella azetca* showed reduced survival and growth in samples from Pecors, McCarthy and Nordic compared to reference lakes and laboratory control samples. These results did not correspond with sediment chemistry since McCarthy and Pecors lakes had some of the lowest sediment concentrations of mine-related substances. The observed response may be related to total organic carbon (TOC) which was much lower in McCarthy and Pecors lakes than in the lab control or the reference lake. Growth and survival of *Chironomus dilutus* did not differ between exposure and reference lakes.

The benthic invertebrate communities of all mine-exposed lakes were statistically different from reference lakes with respect to at least one of the benthic community metrics. The exposure areas showed a pattern of lower benthic invertebrate density and CA1 scores, along with higher CA2 and CA3 scores than the pooled reference areas, indicative of a mine-related signature. The communities in Quirke, McCabe, and May lakes showed more significant differences from the mean reference community than the other lakes (i.e., more metrics differed), but the magnitudes of difference were larger at Quirke and McCabe than May when differences were expressed as a percentage of the reference mean or the number of reference area standard deviations. The benthic communities in Elliot and McCarthy Lakes were most similar to the mean reference community, differing only with respect to CA-3 score.

It is clear that year-to-year variation is a significant component of community change in lake benthic communities, against which reference-exposure differences must be assessed in future years. Despite the variability among years, it appears that the significant pattern of deviations from reference mean values for the exposure lakes generally decreased through the three cycles of study, from 4 out of 5 metrics in 1999, to 3 out of 5 in 2004, and only 2 out of 5 metrics in 2009. These changing patterns of deviation are evidence in support of a hypothesis of gradual recovery from initial (1999) impact evaluation in exposure lakes. In most cases, the metrics for mine-exposed lakes fell within the reference lake range, especially when Rochester Lake was considered. Therefore, the patterns of effect suggested by the data in 2009 are based on relative small shifts away from the mean reference condition and may have little or no ecological consequence when considered in terms of the range of values exhibited by reference lakes in the area.

Risks to Wildlife and Humans

A special investigation was undertaken to better estimate dose and risk by making measurements to confirm or adjust assumptions used in previous dose and risk estimates. The data collected as part of the special investigation proved adequate to resolve the outstanding questions with respect to dose and risk estimates within the Serpent River Watershed. Dose estimates received by aquatic biota and riparian wildlife in the six watershed lakes were less than the respective UNSCEAR (1996) benchmarks of 10 mGy/d and 1 mGy/d. The incremental radiation doses received by generic human receptors (residing at the lake and consuming local fish and game) at the six watershed lakes, ranged from 0.023 to 0.288 mSv/a, all less than the public dose limit of 1 mSv/a. The calculated dose to a Serpent River First Nation harvester was 0.062 mSv/a (total) or 0.049 mSv/a (incremental) based on realistic use of the six watershed lakes, and 0.060 mSv/a (total) or

0.047 mSv/a (incremental) based on a projected future use scenario. All these doses are less than the public dose limit of 1 mSv/a (incremental).

Summary

In Summary, the TMAs are performing well in terms of meeting EIS predictions and reflecting improving conditions. The Serpent River Watershed is responding to these improvements, with water quality responding (improving) more rapidly than sediment and benthic invertebrates. Nevertheless, the benthic community has shown a pattern of improvement over the past ten years. Updated dose and risk estimates based on measured values indicate that dose is below established benchmarks for aquatic and riparian biota and humans.

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1.0 INTRODUCTION

1.1 Site and Program History

Uranium mining was undertaken in the Elliot Lake area of northeastern Ontario for approximately forty years. The mines generally operated from the late 1950's to the mid 1960's and again from the early 1970's until the early 1990's when most of the mines ceased operations (Table 1.1). In total, there are eleven decommissioned mining operations located in the Serpent River Watershed (Quirke I and Quirke II, Panel, Denison, Spanish-American, Can-met, Stanrock, Stanleigh, Milliken, Lacnor, Nordic, Buckles), and one other (Pronto) is located near the north shore of Lake Huron (Figure 1.1). Associated with the mine sites are eleven decommissioned tailings management areas (TMAs) of which seven are flooded (Denison TMA-1, Denison TMA-2, Panel, Quirke, Spanish-American, Milliken and Stanleigh) and four are vegetated (Lacnor, Nordic, Pronto and Stanrock). Tailings were also historically deposited in Buckles Creek adjacent to the Nordic TMA and Sheriff Creek adjacent to the Milliken mine. These areas are included within the licensed areas.

Final decommissioning and closure of the Quirke, Panel, Denison, Stanrock and Spanish-American properties was undertaken between 1992 and 1996. The Stanleigh Mine and the historic properties (*i.e.,* mine sites that operated in the 1950's and 1960's only; Table 1.1) were decommissioned from 1997 to 2000 and, in the case of Stanleigh, was not complete until 2002 (*i.e.,* when flooding was completed). The TMAs are currently in long-term care and maintenance following closure that includes effluent treatment, source and watershed monitoring and TMA care and maintenance. All of the TMAs discharge to the Serpent River Watershed, except Pronto which discharges to the north shore of Lake Huron. The long-term care and maintenance of these sites is the responsibility of Rio Algom Limited and Denison Mines Inc.

At the time of closure, each mine had its own environmental monitoring program conducted under an operating license from the Atomic Energy Control Board (AECB), the predecessor of the Canadian Nuclear Safety Commission (CNSC), and/or a Certificate of Approval (CofA) from the Ontario Ministry of the Environment (MOE). As part of the environmental approvals for the closure and decommissioning plans, Rio Algom and Denison evaluated their existing monitoring requirements in terms of their relevance to current and closure conditions. In 1997, the two companies began reviewing the existing environmental data, together with predicted changes associated with decommissioning, the latter of which was outlined in Environmental Impact Statements (EIS). The first outcome was the development of the Serpent River Watershed Monitoring Program (SRWMP) to replace the various mine-specific

Table 1.1: Elliot Lake mines - operating history, size and cover type.

Site [d]	Operating Period	TMA Tailings (million tonnes)	Area (ha)	Cover Type
Panel	Feb 1958 - June 1961; 1979 - Aug 1990	16.0	123	flooded
Denison (depostited in TMA-1 and TMA-2)	May 1957 - Apr 1992	59.7; 3	240	flooded
Lacnor	Sep 1957 - Jul 1960	2.7	27	vegetated
Milliken	Apr 1958 - June 1964	0.08 [a]	23.1	flooded
Nordic/Buckles [b]	Jan 1957 - Jul 1968	12.0	117.3	vegetated
Pronto	Aug 1958 - 1970	4.4 [c]	47	vegetated
Quirke	Sep 1956 - Feb 1961; Aug 1968 - 1992	46.0	192	flooded
Spanish-American	May 1958 - Feb. 1959	0.45	12	flooded
Stanleigh	Mar 1958 - June 1960; 1983 - June 1996	20.5	411	flooded
Stanrock and Canmet	1958 - late 1964 and Oct 1957 - Mar 1960	5.7	52	vegetated

Notes

[a] Majority of Milliken tailings (5.7 Mt) deposited at Stanleigh TMA, volume given for tailings deposited in Milliken TMA.

[b] Includes 0.04 Mt of contaminated sediment consisting of fine tailings and $Ba(Ra)SO_4$ in 10.3 ha Buckles Creek

[c] Includes 2.1Mt of uranium tailings and 2.3Mt of copper tailings

[d] Denison Mines Inc. owns the Denison and Stanrock properties and Rio Algom Limited owns the Quirke, Panel, Spanish-American, Lacnor, Nordic, Milliken, Stanleigh and Pronto properties.

Adopted from Table 5.2.2 CNSC, 2002.

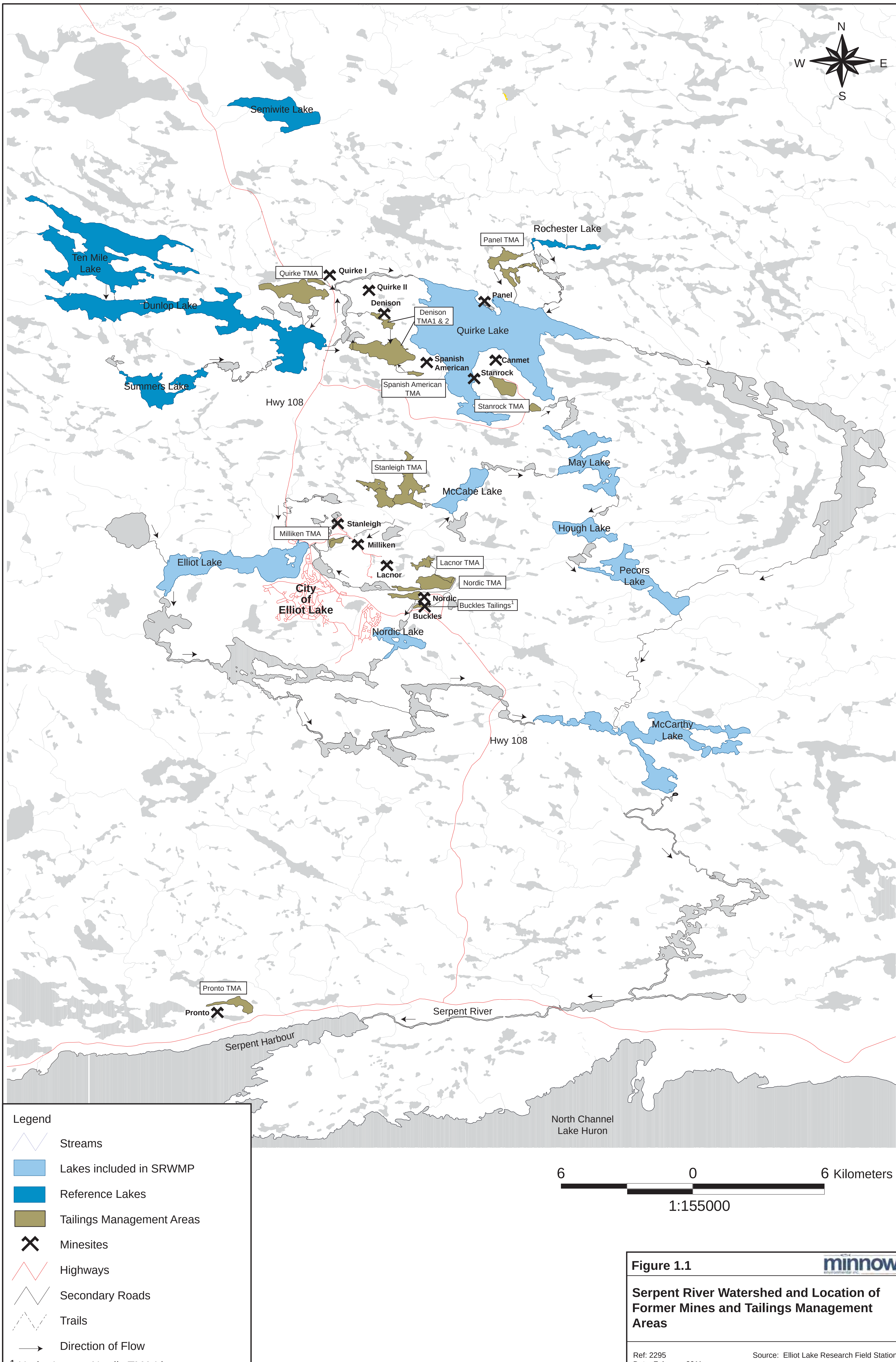

Figure 1.1

Serpent River Watershed and Location of Former Mines and Tailings Management Areas

Ref: 2295
Date: February 2011

Source: Elliot Lake Research Field Station

receiving environment monitoring programs with one comprehensive, harmonized watershed monitoring program. A companion program, the In-Basin Monitoring Program (IBMP), was also developed to assess the health risks to biota potentially feeding at each of the aquatic and vegetated TMAs. These programs were approved and implemented in 1999 (Beak, 1999a,b).

The Source Area Monitoring Program (SAMP) was the third program to evolve from the rationalization of the monitoring requirements associated with the licenses and certificates of approvals for the closed mines near Elliot Lake (Minnow 2002a). The purpose of the SAMP is to monitor the nature and quantity of constituents being discharged from the TMAs to the Serpent River Watershed (SRW). Therefore, the program focuses on monitoring stations that represent the final points of release from each TMA to the watershed. The SAMP was designed to complement the SRWMP and IBMP in terms of monitoring locations, variables and sampling frequency, and thus ensure that the overall monitoring framework is comprehensive and interpretable. The SAMP was approved in 2002 and implemented January 1, 2003.

The fourth and final program involved updating the monitoring requirements associated with internal TMA management, referred to as the TMA Operational Monitoring Program (TOMP; Minnow 2002b). The TOMP was designed to track TMA performance and support decisions regarding the management of the TMAs. The TOMP program was implemented concurrently with the SAMP in January 2003.

The end result of the rationalized monitoring programs for the Elliot Lake mine sites was the development of a comprehensive monitoring and management strategy that clearly defined and delineated the purpose for all monitoring activities. This ensured that all monitoring was objective-driven and would allow for modifications to be made over time in response to demonstrated conditions.

Each of the monitoring programs has been developed in consultation with and approved by the Elliot Lake Joint Review Group (JRG). The JRG is a multi-stakeholder committee comprised of representatives from the Canadian Nuclear Safety Commission (CNSC), Department of Fisheries and Oceans (DFO), Environment Canada (EC), Ontario Ministry of Environment (MOE), Ontario Ministry of Natural Resources (MNR), Ontario Ministry of Labour (MOL) and the Ontario Ministry of Northern Development, Mines and Forestry (MNDMF). The JRG continues to participate in the programs through the review of monitoring and design reports for the SAMP, the TOMP, and the SRWMP.

To date two SRWMP reports have been completed; the Cycle 1 report which captured the first year of water quality monitoring (1999 to 2000) as well as the first sediment and biological monitoring study implemented in 1999 (Minnow and Beak 2001) and the Cycle 2 report which presented the 2005 sediment and biological monitoring results as well as water quality data collected throughout the watershed during the first five years of the program (Minnow 2005). In 2008, Rio Algom and Denison mines prepared a “State of the Environment” (SOE) report (Minnow 2009a) which assessed conditions at each of the TMAs based on the SAMP, TOMP and IBMP and integrated the findings for the various TMAs with conditions observed in the watershed (SRWMP). This report captured data collected from the inception of these programs to the end of 2006. Based on the findings of the SOE report and previous SRWMP reports (Minnow 2005, Minnow and Beak 2001), the Cycle 3 SRWMP design was prepared along with revised SAMP and TOMP study designs (Minnow 2009b,c,d). The revised study designs were reviewed by the CNSC and JRG and approved in July 2009. Concurrent with the revised designs, the In-Basin Monitoring Program was discontinued as it had provided sufficient information to achieve its original objective. Therefore, the SRWMP, SAMP and TOMP are the monitoring programs that are currently in place at the closed Denison Mines Inc (DMI) and Rio Algom Limited (RAL) mines in Elliot Lake.

1.2 Project Background

To date the findings of the SRWMP have been reported separately and then summarized and referenced in a State of the Environment Report which provided details on the TMA performance and discharges. As the scope of the SRWMP retracts in response to improved conditions within the watershed, and the focus of the program shifts towards the source areas, the integration between the SRWMP, SAMP, and TOMP becomes more important. To better address the relationships between TMA performance, source area releases and watershed conditions it was agreed that one interpretive report be prepared which integrates the findings from all the three programs (SRWMP, SAMP and TOMP). This document; called the Serpent River Watershed State of the Environment Report, has been prepared to present and integrate the results of the three monitoring programs. The scope of the document includes:

- TMA performance (TOMP) for each TMA with a description of water management, water quality (surface, porewater and groundwater), reagent consumption, effluent compliance, and effluent toxicity;

- Source discharge concentrations and loads to the watershed from TMA effluent and seepage locations (SAMP) in terms of both spatial and temporal patterns;
- Conditions within the Serpent River Watershed based on water (2005-2009), sediment (2009), and benthic invertebrate (2009) monitoring results, including comparisons to previous study results and predictions, as well as recommendations for monitoring in subsequent cycles; and
- The findings of a special investigation conducted to better define dose and risk to human receptors.

1.3 Project Objectives and Approach

The objective of this Serpent River Watershed State of the Environment Report is to integrate recent monitoring data from the TOMP, SAMP and SRWMP to provide an assessment of current TMA performance and the conditions in the downstream Serpent River Watershed relative to TMA sources. In order to achieve this objective a number of goals were identified:

- Assess TMA performance relative to discharge criteria as well as performance objectives and predictions made in the Environmental Impact Statements (EIS);
- Evaluate mine sources (TMA releases) in terms of concentrations and loads to the Serpent River Watershed (SRW) and utilize trend analysis to anticipate future conditions in source contributions to the watershed; and
- Assess watershed conditions relative to TMA sources through water and sediment quality and benthic invertebrate community composition.

To meet the project objective and goals a weight of evidence approach was used that incorporated existing performance, trend analysis, loadings assessment and downstream conditions relative to established criteria and expected conditions (EIS predictions).

1.4 Report Organization

This report is organized in the following fashion. Section 2.0 presents the methodology used in the collection of samples and assessment of data. Section 3.0 presents the TMA performance for each TMA (TOMP) and Section 4.0 provides an assessment of TMA sources (SAMP) within sub-watersheds of the Serpent River so that multiple TMA sources to the same receiver may be considered together. The findings of the SRWMP are presented in Section 5.0. The updated risk assessment (special investigation) is summarized Section

6.0. Conclusions and recommendations based on the report are presented in Section 7.0. References cited throughout the report are provided in Section 8.0. Supporting information for the methods is provided in Appendix A. A complete data quality assessment for the TOMP, SAMP and SRWMP (2005 to 2009) is presented in Appendix B. Raw data and supporting information for the TOMP, SAMP and SRWMP are presented in Appendices C to E respectively. The results of the special investigation are presented in Appendix F.

2.0 METHODS

This report is a compilation of data associated with three monitoring programs implemented at the Elliot Lake closed mine sites – the Serpent River Watershed Monitoring Program (SRWMP), Source Area Monitoring Program (SAMP) and Tailings Operational Monitoring Program (TOMP). The data collected through these programs over the past five years (2005 to 2009) are assessed in detail herein, as well as older data, as appropriate, for the purpose of assessing temporal trends.

Methods employed for sample/data collection and analyses for all components of these programs are described in the following sections.

2.1 Sample/Data Collection

Surface water samples are collected under all three program (SRWMP, SAMP and TOMP), while groundwater and porewater samples are collected through TOMP only (Table 2.1). In addition, effluent samples are collected for toxicity testing as part of the SAMP. Other samples, such as sediment and benthic invertebrates, are collected as part of the SRWMP. Sampling methods are described below.

2.1.1 Water Chemistry and Toxicity

Water samples are collected under the SRWMP, SAMP and TOMP, with 16, 22, and 121 stations monitored, respectively (Table 2.2). Under these programs four types of water samples are collected:

- Influent and effluent samples at TMA treatment plants;
- Surface water samples within basins, at discharge points including seepages, and in the Serpent River watershed (Figure 2.1);
- Porewater within TMA basins ; and
- Groundwater outside of TMAs.

Specific monitoring variables for each station depend on the program objectives and station type. Station locations, monitoring frequency and variables for each program are listed in Tables 2.3, 2.4 and 2.5.

Collection of water samples is the responsibility of Denison Environmental Services (DES), which administers the operation and monitoring of the closed mines under contract to Rio Algom Limited and Denison Mines Inc. DES follows standard operating procedures (SOPs)

Table 2.1: Types of data collected through each sampling program.

Data Collected	Sampling Program		
	TOMP	SAMP	SRWMP
Water Quality			
Surface Water	x	x	x
Groundwater	x		
Porewater	x		
Water Flow	x	x	
Water Elevation	x		
Water Toxicity			
Acute Toxicity		x	
Sublethal Toxicity		x	
Sediment Characteristics			x
Sediment Chemistry			x
Benthic Invertebrates			x

Table 2.2: Current monitoring stations included in the SRWMP, SAMP and TOMP.[c]

	Serpent River Watershed Monitoring Program (SRWMP)[a]	Source Area Monitoring Program (SAMP)	TMA Operational Monitoring Program (TOMP)[b]			
			Effluent Control Point	Operational Data		
				Surface	Groundwater	Porewater
Panel	SR-01	P-02, P-03, P-05, P-11, P-14, and P-36	P-14	ECA-349, P-13, P-15, P-21, P-36	P-31, P-16 A, P-20,	
Quirke	Q-09, Q-20	ECA-398, Q-22, Q-23, Q-27, Q-28	Q-28	Q-03, Q-04P, Q-05, Q-24 (renamed Cell 16S), Q-29, Q-30 (renamed Cell 14), Q-47 (renamed Cell 15), and Q-48 (renamed Cell 17)	QPW1-1,4,8, 95QW-3A,C,D, 95QW-4, 95QW-5A,D	90DK-14-5 C; DK15-2 (A-D); DK15-4 (A-D); DK16-2 (A-D); DK17-2 (A-D)
Lacnor/Nordic	SC-01, SR-08	N-12	N-19	L-03, ECA-131, ECA-132, N-17, N-18, N-20, N-22, NWPH	M-12-1,3,6,9; M-13-1,3,6,9; M-14-1,3,6,9; 95N-4A,B; 95N-7A,B; 95N-11; 95N-12A,B; 95N-13A,C,E; 95N-14A,B,C; 95N-16A,C,E; 95N-17A,B,C	UW7(2,4,6), UW9(1-3)
Milliken	M-01	MPE	N/A			
Stanleigh	SR-06	CL-06	CL-06	CL-04, CL-05	SGW-3, SGW-4	
Spanish-American	N/A	N/A	N/A	ECA-128		
Pronto	N/A	LL-01, PR-01	PR-04	PR-02, PR-03		
Denison	D-5, D-6	D-2, D-3, D-9, D-16	D-2, D-3	D-1, D-22, D-25	BH91-D9A; BH91-DG4B; BH91-D1A,B; BH91-D3A,B	
Stanrock	DS-18	DS-4, DS-16	DS-4	DS-1, DS-2, DS-3, DS-5, DS-6	BH91-SG1A;BH91-SG3A,B; BH98-16A; BH98-15A	BH91-SG2A,D; PN-ST3-P3,5,6,8;
Reference	D4, P-22, SR-05, SR-14, SR-18, SR-19	SR-16, SR-17				
TOTAL STATIONS [d]	**16[a]**	**24**	**8[b]**	**34**	**56**	**25**

[a] SRWMP stations are not intended to be associated with a single source (TMA). Many stations integrate conditions from several TMAs.
[b] Includes some stations identifed as SAMP stations (i.e. stations that serve multiple purposes).
[c] Number of groundwater and porewater stations represents the number of wells monitored (i.e. A-C)

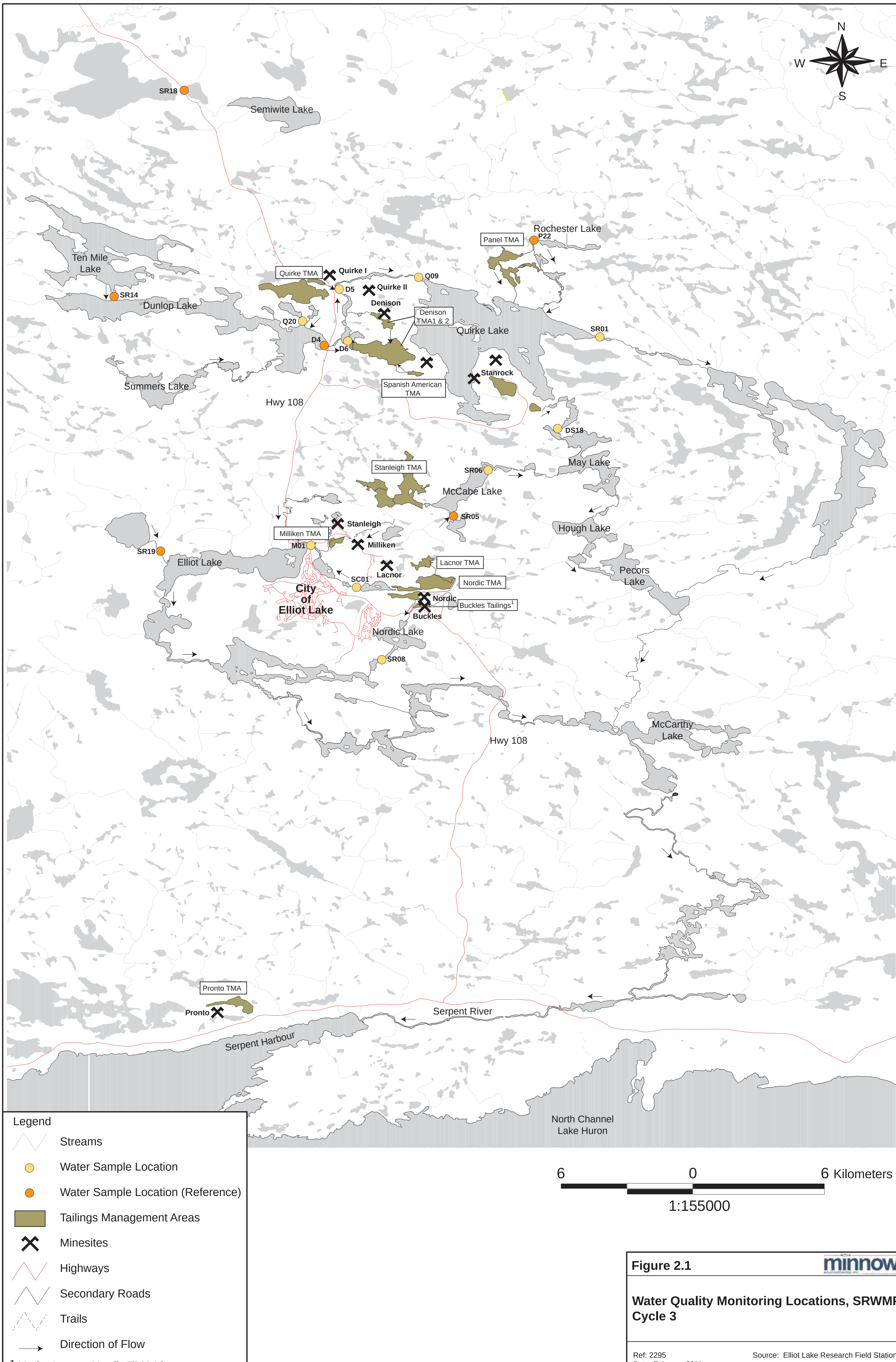

Figure 2.1

Water Quality Monitoring Locations, SRWMP Cycle 3

Ref: 2295
Date: February 2011

Source: Elliot Lake Research Field Station

Table 2.3: Current Cycle 3 SRWMP water quality sample locations and frequencies.

Station	Location / Description	Type	UTM (North)	UTM (East)	Current Frequency
D4	Dunlop Lake Outlet (Q-14)	reference	5148783	373383	S
P-22	Rochester Creek @ Rochester Lake Outlet	reference	5153231	382747	S
SR-05	Canyon Lake Outlet	reference	5141190	379159	Q
SR-14	Ten Mile Creek at Inlet to Dunlop Lake	reference	5151063	363621	A
SR-18	Outlet of Jim Christ Lake	reference	5160540	366863	S
SR-19	Inlet to Elliot Lake	reference	5139744	365666	Q
D-5	Serpent River between Denison and Quirke TMAs	exposed	5151274	374006	Q
D-6	Cinder Lake Outlet	exposed	5148477	374404	Q
DS-18	Halfmoon Lake Outlet	exposed	5145050	383761	Q
M-01	Sherriff Creek @ Highway 108	exposed	5139798	372727	Q
Q-09	Serpent River Below Quirke TMA Effluent	exposed	5152097	377264	Q
Q-20	Evans Lake Outlet to Dunlop Lake	exposed	5150036	372333	A
SC-01	Westner Lake Outlet	exposed	5137964	374604	A
SR-01	Quirke Lake Outlet	exposed	5149300	385824	A
SR-06	McCabe Lake Outlet	exposed	5143518	380551	S
SR-08	Nordic Lake Outlet	exposed	5133920	375365	Q
Total Samples/Analytes		27			44

M= Monthly, S=Semi-Annual, A=Annual, 0 = no sampling

Change in frequency occurred as of January 1, 2010

Table 2.4: Current Cycle 3 SAMP stations, substances and frequencies.

TMA	Location	Type	Description	Parameter[f]					
				flow	pH	Sulphate	Radium-226	SAMP metals[a]	toxicity
Denison	D-2[c]	Primary	Stollery Lake Outlet	D	W	M	M	M	2
	D-3[c]	Primary	TMA-2 Effluent at Denison Mine access road	D	W	M	M	M	
	D-9	Seepage	Seepage at Dam 17	Q	Q	Q	Q	Q	
	D-16	Seepage	Seepage at Dam 9	Q	Q	Q	Q	Q	
Quirke	ECA-398	Seepage	Quirke II north of access road	Q	Q	Q	Q	Q	
	Q-22	Drainage	Quirke II Drainage south of access road	Q	Q	Q	Q	Q	
	Q-23	Drainage	Swamp Outlet west of Dam K1	Q	Q	Q	Q	Q	
	Q-27	Seepage	Dam J Toe Seepage		Q	Q	Q	Q	
	Q-28[c,d]	Primary	Final Treated Effluent	W	W	M	M	M	2
Panel	P-02	Seepage	Downstream of Dam B	Q	Q	Q	Q	Q	
	P-03	Drainage	Beaver Pond C Outlet	Q	Q	Q	Q	Q	
	P-05	Drainage	Swamp Outlet north of Dam E		Q	Q	Q	Q	
	P-11	Drainage	Panel Creek Outlet at Quirke Lake	Q	Q	Q	Q	Q	
	P-14[b,c,d,e]	Primary	Final Treated Effluent	W	W	M	M	M	2
Stanrock	DS-4	Primary	Orient Lake Outlet (Final Point of Control)	W	W	M	M	M	2
	DS-16	Drainage	Quirke Lake Delta	Q	Q	Q	Q	Q	
Stanleigh	CL-06[c,d]	Primary	Final Treated Effluent	W	W	M	M	M	2
Milliken	MPE	Primary	Milliken Park Effluent		M	M	M	M	2
Nordic	N-12	Primary	Buckles Creek at Hwy. 108	M	M	M	M	M	2
Pronto	LL-01	Drainage	Pronto Creek at Inlet to Lake Lauzon	Q	Q	Q	Q	Q	
	PR-01	Primary	Pronto Discharge Channel at Highway 17	M	M	M	M	M	2

[a] SAMP metals - barium, cobalt, iron, manganese, uranium
[b] P-14 will revert to P-36 upon ETP shut down.
[c] This station is also TOMP effluent station and requirements will be harmonized to serve both programs
[d] Sampled when treatment plant is operating
[e] Flow is based on influent flow to the ETP at P-13.
[f] DOC and hardness have been added effective January 1, 2010
D =daily, W = weekly, M = monthly, 2 = twice per year, Q = quarterly

Table 2.5: Substances and frequency of TOMP data collected.

			Parameters and Frequencies											
TMA	TOMP Stations	Station Type/Purpose	Elevation	Flow	pH	Conductivity	Sulphate	Total radium-226	Lime or NaOH Consumption	Barium Chloride Consumption	TSS	Acidity	Iron	SAMP Metals[c]
Denison	D-1	Basin performance (primary), ETP operations	W	D	D		Q	M	M	M		Q		Q
Denison	D-22	ETP operations			W		Q	M		M		Q		Q
Denison	D-3	Effluent		D[d]	W		M	W			W			M[d]
Denison	D-2	Effluent		D[d]	W		M	W			W			M[d]
Denison	D-25	Basin performance (secondary)			S		S	S				S	S	
Denison	BH91-D1A,B, BH91-D3A,B, BH91-DG4B, BH91-D9A	Groundwater			A		A					A	A	
S.A.[h]	ECA-128	Basin performance (primary)	M[i]	Q	Q		Q	Q				Q		Q
Quirke	Q-05[j]	Basin performance (primary), ETP operations	W	D	M		Q	M	M	M		Q		Q
Quirke	Q-03[j]	ETP operations			W									
Quirke	Q-04P[j]	ETP operations			D									
Quirke	Q-28[j]	Effluent		W[d]	W		M	W			W			M[d]
Quirke	Q-29	Perimeter monitoring	W	W[i]										
Quirke	Cell 14, 15, 16S, 17	Basin performance (secondary)	M[i]		S		S	S				S	S	
Quirke	90DK-14-5C; DK15-2(A-D); DK15-4(A-D); DK16-2(A-D); DK17-2(A-D)	Porewater			A		A					A	A	
Quirke	QPW1-1,4,8; 95QW-3A,C,D; 95QW-4, 95QW-5A,D	Groundwater			A		A					A	A	
Panel	P-13[j]	Basin performance (primary), ETP operations	W	D	M		Q	M	M	M		Q		Q
Panel	ECA-349[j]	ETP operations			D									
Panel	P-14[j], P-36[j]	Effluent		-[f]	W		M	W			W			M[d]
Panel	P-15	Perimeter				M								
Panel	P-21	Basin performance (secondary)	M[j]		S		S	S				S	S	
Panel	P-16A, P-20, P-31	Groundwater			A		A					A	A	
Stanrock	DS-2	Basin performance (primary), ETP operations		D	D		Q	M	M	M		Q		Q
Stanrock	DS-3	ETP operations			D									
Stanrock	DS-4	Effluent		W[d]	W		M	W			W			M[d]
Stanrock	DS-1	Additional pH control, radium monitoring		W	W			Q						
Stanrock	DS-6	Additional pH control		W	W									
Stanrock	DS-5	Seepages and surface water internal to TMA		Q	Q	Q								
Stanrock	PN-ST3-P3,5,6,8; BH91-SG2A,D	Porewater			A		A					A	A	
Stanrock	BH91-SG1A, BH98-16A, BH98-15A, BH91-SG3A,B	Groundwater			A		A					A	A	
Stanleigh	CL-04[j]	Basin performance (primary), ETP operations	W	D	M		Q	M	M	M		Q		Q
Stanleigh	CL-05[j]	ETP Operations			D									
Stanleigh	CL-06[j]	Effluent		W[d]	W		M	W			W			M[d]
Stanleigh	SGW-3, SGW-4[e]	Groundwater			A		A					A	A	
Lacnor/Nordic	L-03	Basin performance (primary)	M[i]	Q	Q		Q	Q				Q		Q
Lacnor/Nordic	N-17	Basin performance (primary), ETP operations		D	M		Q	M	M			Q		Q
Lacnor/Nordic	N-18	ETP operations			D									
Lacnor/Nordic	N-19	Effluent		W	W		M	W			W			M
Lacnor/Nordic	N-22	Basin performance (secondary)		M[i]	S		S	S				S	S	S
Lacnor/Nordic	ECA-132	Basin performance (secondary)	M[i]	M[i]	M[i]		S	S				S	S	S
Lacnor/Nordic	NWPH	Basin performance (secondary)		M[i]	S		S	S				S	S	S
Lacnor/Nordic	ECA-131, N-20	Basin performance (secondary)			Q		Q	Q				Q		Q
Lacnor/Nordic	UW7-2,4,6; UW9-1,2,3	Porewater			A		A					A	A	
Lacnor/Nordic	M-12-1,3,6,9; M-13-1,3,6,9; M-14-1,3,6,9; 95N-4A,B; 95N-7A,B; 95N-11; 95N-12A,B; 95N-13A,C,E; 95N-14A,B,C; 95N-16A,C,E; 95N-17A,B,C	Groundwater			A[g]		A[g]					A[g]	A[g]	
Pronto	PR-02[j]	Basin performance (primary), ETP operations	W	D	M		Q	M	M	M		Q		Q
Pronto	PR-03[j]	ETP operations			D									
Pronto	PR-04[j]	Effluent		W	W		M	W			W			M

[a] D - Work days, W - Weekly, M - Monthly, S - Semi-annually, A - Annually, Q-Quarterly
[b] Also elevation
[c] SAMP metals are barium, cobalt, iron, manganese, and uranium
[d] Monitoring requirement of SAMP
[e] Relocated to Settling Pond Dam
[f] No flow monitoring at P-14 because <1% additional flow between P-13 and P-14
[g] A one-time modelling exercise was recommended by Ecometrix to confirm flow conditions and potentially modify future GW monitoring under TOMP. In the meantime, GW monitoring at Nordic will continue will cotinue at previously identified TOMP stations.
[h] Spanish-American
[i] During the snow-free period (April - November)
[j] Sampled when treatment plant is operating

that address all aspects of sample collection and management for the TOMP, SAMP and SRWMP from sample collection to laboratory submissions, data entry, validation and response. The SOPs ensure that that the data produced are consistent with the objectives of these programs, regulatory requirements, and industry standards (Table 2.6). The detailed SOPs are provided in their entirety in Appendix A. DES maintains contracts for various chemical analyses with SGS Laboratory, Becquerel and Aquatox Testing and Consulting Inc.

Water samples collected for chemical analyses were shipped to SGS Lakefield Research Limited in Lakefield, ON, for chemical analysis based on established methods. Water samples collected for toxicity testing were submitted to Aquatox Testing and Consulting Inc. (Aquatox) in Guelph, ON, for acute (*Daphnia magna* and rainbow trout) and sub lethal (*Ceriodaphnia dubia*) testing following Environment Canada (2000 a, b and 2007) methods.

2.1.2 Sediment Chemistry and Toxicity

Sediment samples were collected between September 14 and September 23, 2009 as part of the Cycle 3 SRWMP, consistent with the timing of previous field programs. The samples were collected from 13 lakes, five of which were reference (Figure 2.1). Five stations were sampled in each lake where benthic macroinvertebrate samples were also collected (Table 2.7 and Appendix Figures A.1 to A.13). This represents an increase from three stations per lake in past studies. Where possible, samples were collected from the same locations sampled in Cycles 1 and 2. The approximate location of each lake sample was identified on a bathymetric map prior to the field program. The station map, Cycle 1 and 2 station locations based on Global Positioning System (GPS) data, and a depth sounder were used to find the stations in the field. In order to achieve comparable substrate amongst sampling locations, two existing stations (DUL-09-01 and QL-09-5) were relocated as indicated on Appendix Figures A.1 and A.9 respectively. An average depth of 15 m was targeted for all lake sample locations, although some stations were positioned at depths slightly shallower or deeper to ensure that comparable substrates were sampled across lakes (Appendix Table A.1).

Two types of sediment samples were collected at each station: one for metal and radium-226 analysis and the other for analysis of total organic carbon (TOC) and particle size distribution. Sediment samples for analysis of metals and radium-226 were collected using a Tech-Op corer equipped with a 4-inch diameter lexan core tube. The use of the 4-inch corer necessitated taking a total of three to four cores (five cores were taken at one station in Pecors Lake) to meet minimum sample volume requirements for chemical analyses. The corer was deployed from a boat with care taken to control the rate of descent and to maintain

Table 2.6: List of Operating Procedures associated with the implementation of the SAMP and the TOMP.

Procedure Name	Operating Procedure Number
Control Limit Maintenance	PR8.7.2.02
Data Entry	PR8.7.3.01
Data Validation	PR8.7.3.02
Field Conductivity Determination	PR8.6.3.03
Field pH Determination	PR8.6.3.01
Field Sampling Quality Control	PR8.5.3.01
Flow Determination	PR8.6.4.02
Groundwater Sampling	PR8.6.2.01
Surface Water Grab Sampling	PR8.6.1.01
Toxicity Sampling	PR8.6.1.03
Water Quality Data Quality Assessment	PR8.5.4.01
Water Quality Assessment and Response Plan	PR8.0.0.01

Table 2.7: Cycle 3 sediment and benthic monitoring locations, number of stations and sediment parameters.

Station	Location/Description	Type	Number of Samples[1]	Parameters									Toxicity		Benthic Community
				Barium	Cobalt	iron	manganese	nickel	radium-226	uranium	TOC	Grain Size	*Hyallela azteca*	*Chironomus riparius*	
DUL	Dunlop Lake	Reference	5	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
TML	Ten Mile Lake	Reference	5	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔		✔
RL	Rochester Lake	Reference	5	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔		✔
SL	Semiwite Lake	Reference	5	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
SUL	Summers Lake	Reference	5	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔		✔
QL[2]	Quirke Lake	Exposure	5	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔		✔
ML	McCabe Lake	Exposure	5	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
MAL	May Lake	Exposure	5	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔		✔
HOL	Hough Lake	Exposure	5	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔		✔
PL	Pecors Lake	Exposure	5	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔		✔
EL	Elliot Lake	Exposure	5	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
NL	Nordic Lake	Exposure	5	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔		✔
MCL	McCarthy Lake	Exposure	5	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔		✔

[1] Three of the five stations were located at the same stations used in previous cycles with two additional stations placed at similar depth.

[2] No additional stations were added at Quirke Lake as it has had five stations in both previous cycles.

the corer in a vertical position during ascent. After it penetrated the sediment, the corer was carefully retrieved to the surface and an extruder was inserted into the bottom of the core tube to prevent any slippage. Core samples were rejected if there was any evidence of slippage, if there was any evidence that the core did not adequately penetrate the substrate, or if there was any evidence of disturbance of the sediment-water interface. The number of rejected cores, penetration depths and visible sediment characteristics (*i.e.*, the presence of epibenthic organisms or stratification) were recorded on field sheets.

Water in the core tube was decanted with a siphon hose prior to extruding sediments. Siphoning was stopped when there was approximately 2 to 3 cm of water remaining above the sediment surface. The core extruder was used to push sediments upwards towards the top of the core tube in a controlled fashion with care taken to minimize suspension of fines. In the event of suspension, momentum was stopped allowing the solids to re-settle. Once the sediment was near the top of the tube, an extrusion collar marked in 1-cm intervals was carefully aligned on the top of the tube and the sediment was extruded upwards to a depth of 1 cm. A core slicer (box design) was then carefully inserted between the tube and the collar, the collar removed and the sample transferred from the slicer to labelled Ziploc bags (double-bagged).

After sampling for metals and radium-226 was complete, additional sediment samples were collected for analysis of particle size and TOC using a petite ponar grab sampler. Surficial sediment (top 3 cm) was carefully removed from each of two intact grabs using a stainless steel spoon and composited into a Ziploc bag (double-bagged).

Sediment samples collected for the analysis of metals and radium-226 were submitted to Maxxam Analytics in Mississauga, ON, (Maxxam) where they were subsequently homogenized and dried, and a sub-sample (dry powder) was sent to Becquerel Laboratories, Mississauga, Ontario for radium-226 analysis. Sediments collected for metal content were digested using aqua regia (3:1 hydrochloric to nitric acid) and analyzed by inductively coupled plasma (ICP) (Table 2.8). Sediment samples for radium-226 analysis were digested using nitric, hydrochloric and hydrofluoric acids (which frees the radium-226 from the matrix for separation and analysis (MD-4871)) then analyzed for radium-226 activity using alpha spectroscopy (BQ-RAD-ALPHA).

Sediments collected for the analysis of particle size and TOC were also submitted to Maxxam. Particle size was analyzed using sieve and hydrometer methods while total organic carbon was analyzed using a Leco Carbon Analyzer (Table 2.8). Sediment was collected from one station at each of the 13 lakes for sediment toxicity testing using

Table 2.8: SRWMP sediment quality analytical methods.

Parameter (mg/kg)		Sediment Analytical Method	MDL
Particle Size	Particle Size (%)	Sieve and Hydrometer	0.1
TOC	Total Organic Carbon (%)	Leco Carbon Analyzer	0.1
Ba	Barium	ICP-AES	0.1
Co	Cobalt	ICP-AES	0.09
Fe	Iron	ICP-AES	0.2
Mn	Manganese	ICP-AES	0.03
Ni	Nickel	ICP-AES	0.1
Ur	Uranium	Flurometric AA	0.5
^{226}Ra	Radium-226 (Bq/kg)	Alpha Spectroscopy	5.0

AA - Atomic Absorption

ICP-AES - Inductively Coupled Plasma Atomic Emission Spectrometer

MDL - Method Detection Limit

Environment Canada (1997) methods for assessing 14-day survival and growth of *Hyalella azteca*. The selected station represented the location with the highest previously reported radium-226 concentration (Minnow 2005). Additional sediment samples collected from the same stations in McCabe, Elliot, Dunlop and Semiwite Lakes were tested for toxicity to *Chironomus dilutus* using a 10-day survival and growth test (Environment Canada 1997b). The chironomid tests were conducted to investigate observations in previous benthic surveys of fewer chironomid species in some lakes (McCabe and Elliot lakes), along with two reference lakes (Dunlop and Semiwite). Approximately 5-L of sediment was collected into a bucket by taking multiple grabs with a petite ponar. The samples were refrigerated at 4ºC and shipped to Aquatox in Guelph, Ontario for toxicity testing. Survival and growth were computed for samples from each lake and statistical comparisons were made among lakes and relative to a laboratory control (Appendix E).

2.1.3 Benthic Community Monitoring

Benthic macroinvertebrate samples were collected from 13 lakes (8 mine exposed and 5 reference) to assess potential impacts associated with the decommissioned mines (Figure 2.1; Appendix Figures A.1 to A.13). The samples were collected from the same locations as sediment samples (Section 2.1.2) so that the benthic communities could be considered relative to sediment composition and chemical quality. Each station was geographically referenced using a GPS (Appendix Table A.1).

To the extent possible, sampling methods employed in the 2009 Cycle 3 program were consistent with both the 2004 Cycle 2 and 1999 Cycle 1 program to allow for comparison of results between cycles. Five grab samples were composited at each station, as was done in Cycle 2, to provide a more representative sample (three grab samples were composited at each station in Cycle 1). Comparison of 2009 data to 2004 and 1999 was still possible as benthic invertebrate abundance data for all studies were expressed on a per m^2 basis.

The samples were collected using a petite ponar grab (0.023 m^2). Given the low productivity typical of profundal areas in lakes of the Canadian Shield, a small sieve size (250 μm) was used to optimize the number of individuals and taxa captured. The samples were transferred to a 250-micron sieve bag and rinsed with site water to remove sediment particles. Reduced samples were transferred to 1-L wide-mouth plastic jars and preserved with 100% buffered formaldehyde to a minimum level of 10% formalin within 8 hours of collection. An internal label was placed into each sample bottle to ensure correct sample identification.

All benthic samples (60) were submitted to Zaranko Environmental Assessment Services (ZEAS) in Nobleton, Ontario. The QA/QC procedures and methods for the benthic component are outlined in Section 2.3.

Upon arrival at the ZEAS laboratory, benthic samples were checked to ensure that they were adequately preserved in the field and clearly and correctly labelled. Prior to detailed sorting, the samples were washed free of formalin in a sieve of the appropriate size. At this time, a stain was added to the samples to aid in sorting recovery. No problems with preservation or sample labelling were reported. The material retained by the sieve was sorted with the aid of a stereomicroscope at a magnification of ten times. Benthic invertebrates were sorted from the debris into major taxonomic groups (*i.e.*, order or family levels) and placed in vials containing 70% ethanol. The benthic invertebrates were then identified to the lowest practical level, which in most cases was genus or species, and enumerated by a senior taxonomist.

2.1.4 Supporting Measurements Associated with Benthic Community Sampling

At each benthic community sample station, a number of supporting measurements were taken, both at the surface (30 cm below surface) and bottom (50 cm above bottom) of the water column, including temperature, dissolved oxygen, pH and conductivity (Appendix Table B.1). These measurements were made using a YSI 556 or a YSI 85 Multimeter. At Station 2 in each lake, a temperature and dissolved oxygen profile was taken at multiple depths from the surface to bottom of the water column to determine stratification conditions and the depth of the thermocline. Accuracy of the meters was assured by daily calibration and frequent verification to achieve performance specifications (Table 2.9). In any case where verification or calibration failed to meet known values, the meter/probe was either re-calibrated or replaced, if possible. All manufacturers' instructions for maintenance and calibration of multimeters were followed at all times. If meter failure occurred, backup procedures included the measurement of temperature using a thermometer, dissolved oxygen using a Hach Kit (which gives an estimation of dissolved oxygen concentration to ± 0.1 mg/L), and pH using pH strips. Any incidence of meter failure and the use of these backup measures were recorded on the field sheets (Appendix E). During the field program the conductivity measurement on the YSI 85 meter would not calibrate properly and therefore conductivity could not be measured at some lakes (Dunlop, McCabe, Quirke, Semiwite, and Ten Mile).

Other field observations included weather conditions, water depth, any deviations from standard sampling gear and conditions, details of unusual events and habitat conditions. A

Table 2.9: Data quality objectives and specifications for field equipment.

Equipment	Operator	Field pH			Conductivity (uS/cm)				Dissolved Oxygen (mg/L)				Temperature (°C)		
		MDL (DQO 0.1)	MDD (DQO 0.01)	Accuracy (DQO 10%)	MDL (DQO 0 uS/cm)	Measurement Range	MDD (DQO 1 uS/cm)	Accuracy (DQO 10%)	MDL (DQO 0 mg/L)	Measurement Range	MDD (DQO 0.01)	Accuracy (DQO 20%)	MDL (no DQO stipulated)	MDD (DQO 0.1)	Accuracy (DQO 20%)
Orion pH Meter	DES	0.01	0.01	± 0.01									1.0	-	± 0.01
Omega PHH-320	DES	0.01	0.01	± 0.02									1.0	-	± 0.05
YSI 85	Minnow/ DES	0.01	0.01	<20%[a]	0	0 to 499.9	0.1	0.5%	0	0 to 20	0.01	± 0.03	-5.0	0.1	± 0.4°C
					0	0 to 4,999	1.0	0.5%							
					0	0 to 49,999	10	0.5%							
					0	0 to 200,000	100	0.5%							
YSI 556	Minnow	0.01	0.01	<20%[a]	0	0 to 2,000	2	3%	0	0 to 20	0.01	<10%[b]	-5.0	0.1	± 0.1°C
					0	2,000 to 20,000	10	3%							
					0	20,000 to 100,000	50	4%							
Hach Kit	Minnow								0	0 to 10	0.1	± 0.1			

[a] Instrument accuracy reported as ±0.01 to 0.04 pH units, depending on model. Reported accuracy measurements greater than 3 mg/L. Lowest value measured between September 1999 and September 2004 was 3.2.

[b] Instrument accuracy reported as ±0.3 mg/L. Reported percentage assumes dissolved oxygen measurements greater than 3 mg/L. Lowest value measured between September 1999 and September 2004 was 6.5 mg/L.

DES - Denison Environmental Services

MDL - Method Detection Limit

MDD - Minimum Detectable Difference

DQO - Data Quality Objective

GPS was used to record the Universal Transverse Mercator (UTM; NAD 83) position of all stations (Appendix Table A.1).

2.2 Data Entry and Extraction

Water data generated through the various monitoring programs were entered into an electronic database (emLine). Data entered or imported with any values outside the established data quality assessment limits were highlighted. Prior to being accepted (*i.e.,* posted) in the database, any highlighted data were reviewed and validated through a QA process (see procedures PR8.7.3-01, PR8.7.3-02 and PR8.7.2-02 Appendix A).

Monthly and annual data reports were generated from the database to meet reporting requirements for various regulatory programs. The data retrieval is managed by Denison Environmental Services (DES), the care and maintenance contractor for both of the licensees. Retrieval methods and rationales employed by DES to satisfy data requests are described in Appendix A. The nature of the data retrieval request can affect the type and configuration of the data reported from the emLine system. For this reason, summary statistics presented in this report (e.g., sample sizes, annual means) may vary slightly from annual means presented in the Annual Operating, Care and Maintenance (OCM) Reports. For example, reported annual OCM averages are based on data collected solely for “regulated” monitoring and reporting; whereas the data extracted for this report included all available data (e.g., also “Internal” & “Special Project” data).

Data extracted from field sheets (SRWMP) were entered into Excel spreadsheets, and checked by a second person to assure no errors were made in the data entry process. Laboratory results for sediment samples were reviewed relative to submission Chain of Custodies (COCs), method detection limits (MDLs) and Data Quality Objectives (DQOs). Laboratory data was copied and/or entered into Excel spreadsheets, which again was checked and verified for accuracy by a second reviewer. Benthic invertebrate data was provided in Excel spreadsheets, so re-entering of data was not required. For the special investigation, all raw data was provided directly to EcoMetrix, where it was then entered into tables and used in the risk assessment (Appendix F).

2.3 Data Quality Control and Assessment

A variety of factors can influence the chemical measurements made in environmental monitoring and thus affect the accuracy and precision of the data. Inconsistencies in sampling or laboratory methods, use of instruments that are inadequately calibrated or which cannot measure to the desired level of accuracy and contamination of samples in the field or laboratory are just some of the potential factors that can lead to the reporting of data that do not accurately reflect actual environmental conditions. Depending on the magnitude of the problem, this has potential to affect the reliability of any conclusions made from the data. Therefore, it is important to ensure that monitoring programs incorporate appropriate steps to control the non-natural sources of data variability (*i.e.*, minimize the variability that does not reflect natural spatial and temporal variability in the environment) and thus assure the quality of the data.

There are data quality objectives (DQOs) and procedures (e.g. PR8.5.4-01 in Appendix A) for each of the monitoring programs (the SAMP, the TOMP and the SRWMP) to ensure data generated from these programs are representative of conditions at specific monitoring locations and times. DQOs are statements of desired sensitivity, precision and accuracy and are used to assess data acceptability. In other words, DQOs determine the level of confidence with which the data can be used to derive conclusions. DQOs previously established for the SAMP, TOMP and SRWMP (Tables 2.10 and 2.11) consider the intended use of the data and the technical feasibility of collecting data of such quality.

DQOs for water samples included negligible contaminant levels in all blanks and rinses, acceptable variability between field duplicates and laboratory replicate samples, efficient recovery from spikes and minimal bias in analytical estimates for certified reference materials. DQOs respecting field and laboratory duplicates, as well as matrix spike recoveries were also established for sediment samples.

Quality assurance/quality control (QA/QC) practices for benthic invertebrate sampling followed Environment Canada (2002) guidance for sub-sampling precision and sorting recovery. Duplicate sub-samples were analyzed for at least 10% of samples to verify that sub-sampling precision was within 20% (Table 2.10). Ten percent of the samples were also re-sorted to verify that less than 5% of total organisms were missed (sorting recovery).

Toxicity test QA/QC involved adherence to requirements defined in (Aquatox's) internal standard laboratory protocols and in toxicity methods (EPS 1/RM/32, Environment Canada 1997b; EPS 1/RM/33, Environment Canada 1997a). These pertained to aspects such as organism health/culturing, data entry, reference toxicant testing, control of test conditions, and report completeness. In addition, there were specific validity criteria specified by the test methods, such as minimal control organism mortality and achieving minimum organism growth requirements.

Table 2.10: Data quality objectives for the SRWMP.

Measurements	Units	Detection Limit	Field & Lab Blank Criterion	Analytical Precision (Duplicates)	Analytical Accuracy		Field Precision (Duplicates)
					Spike	CRM[b]	
Field Measurements							
pH	pH units	0.1	-	0.01 or 0.02[a]	-	-	10%
conductivity	μmho/cm	0.01	-	0.05[a]	-	-	10%
dissolved oxygen	mg/L	0.1	-	0.03[a]	-	-	20%
temperature	°C	0.1	-	0.01 or 0.05[a]	-	-	20%
flow	L/s	varies w method	-	0.1[a]	-	-	30%
Laboratory Water Chemistry							
barium	mg/L	0.005	0.01	10%	20%	20%	20%
cobalt	mg/L	0.0005	0.001	10%	20%	20%	20%
iron	mg/L	0.02	0.04	10%	20%	20%	20%
manganese	mg/L	0.002	0.004	10%	20%	20%	20%
radium-226	Bq/L	0.005	0.01	20%	20%	-	20%
sulphate	mg/L	0.1	0.2	10%	20%	20%	20%
uranium	mg/L	0.0005	0.001	10%	20%	20%	20%
Laboratory Sediment Chemistry							
barium	mg/kg	0.5	-	20%	30%	30%	40%
cobalt	mg/kg	0.2	-	20%	30%	30%	40%
iron	mg/kg	20	-	20%	30%	30%	40%
manganese	mg/kg	0.5	-	20%	30%	30%	40%
nickel	mg/kg	0.5	-	20%	30%	30%	40%
radium-226	Bq/kg	5	-	20%	30%	30%	40%
uranium	mg/kg	0.1	-	20%	30%	30%	40%
grain size	%	0.1	-	20%	30%	30%	40%
TOC	%	0.05	-	20%	30%	30%	40%
Benthos							
Organism Recovery		-	-	90%	-	-	-
Subsampling Precision		-	-	20%	-	-	-
Subsampling Accuracy				20%			
Sediment Toxicity							
Chironomus dilutus		-	70% control surv.	20% control CV	-	± 3 SD in ref tox	-
Hyalella azteca		-	70% control surv.	20% control CV	-	± 3 SD in ref tox	-

[a] Minimum Detectable Difference as identified in instrument manual rather than measurement of analytical precision using replicate samples.

[b] CRM (Certified Reference Material).

Table 2.11: Field and laboratory data quality objectives for SAMP/TOMP stations.

Parameter	Units	Receiving Environment Criteria		Targeted Detection Limit	Minimum Detectable Difference	Field Blank Criteria	Laboratory Blank Criteria	Field Precision	Laboratory Precision	Laboratory Spikes	Laboratory Accuracy (CRM)
Field Parameters											
Conductivity	µmho/cm	-	c	0.1	0.05	-	-	20%	-	-	-
Flow	L/s	-	c	method	method	-	-	-	-	-	-
pH	pH units	6.5 - 8.5	a	0.1	0.01 or 0.02	-	-	20%	-	-	-
Laboratory Parameters											
Acidity	mg/L	-	c	1.0	-	2	2	20%	10%	-	20%
Barium	mg/L	0.0531	b	0.005	-	0.01	0.01	20%	10%	20%	20%
Cobalt	mg/L	0.0009	a	0.0005	-	0.001	0.001	20%	10%	20%	20%
Iron	mg/L	0.87	b	0.02	-	0.04	0.04	20%	10%	20%	20%
Manganese	mg/L	0.8	d	0.002	-	0.004	0.004	20%	10%	20%	20%
Radium	Bq/L	1.0	a	0.005	-	0.01	0.01	20%	20%	20%	-
Sulphate	mg/L	100	d	0.1	-	0.2	0.2	20%	10%	20%	20%
TSS	mg/L	-	c	1	-	2	-	20%	10%	-	20%
Uranium	mg/L	0.005	a	0.0005	-	0.001	0.001	20%	10%	20%	20%

a - Provincial Water Quality Objectives

b - Cycle 2 SRWMP Benchmarks

c - no criteria set

d - British Columbia Water Quality Guidelines (BCMOE 2006)

e - Canadian Water Quality Guidelines (CCME 2003)

Data Quality Assessment (DQA) is the process of evaluating how well laboratory test results compare with pre-established DQOs and thus determines the confidence that can be placed in conclusions derived from the data. A comprehensive data quality assessment was undertaken for the SRWMP, SAMP and TOMP data and is presented in Appendix B.

2.4 Data Evaluation

Numerous types of data were compiled, synthesized and assessed for this project, including:

- Water quality data from TOMP and SAMP, including TMA surface water, seepage, porewater, groundwater, and effluent stations, as well as surface water quality data from SRWMP;
- Other data related to TMA management, including water levels and regent use;
- Effluent toxicity data;
- Flow data from TMA discharges, seepages and within the downstream receiving environment, which were used to compute loadings; and
- Sediment and biological data from the SRWMP.

The approaches followed for analysis of these different types of data are described below.

2.4.1 Water Samples

TMA porewater samples were collected annually, with some samples taken from multiple depths/horizons (typically labelled as A, B, C, D, etc.) per station. Each porewater sample was analyzed for pH, acidity, iron, and sulphate. Conductivity replaced sulphate measurement in 2003 until 2006, but conductivity was discontinued and sulphate analysis was resumed in 2007. All data were tabulated and presented in the appendix corresponding to each TMA. Trend analysis was completed, as described in Section 2.4.3. Significant trends were summarized in tables and all significant trends were plotted and presented in appendices.

Groundwater quality has been monitored on a yearly basis, typically at locations down-gradient of tailings dams. Samples were analyzed for pH, acidity, sulphate and iron. Consistent with porewater, sulphate replaced conductivity in 2007. Trend analysis was completed, as described in Section 2.4.3. Significant trends were summarized in tables and all significant trends were plotted and presented in appendices.

Surface water within the TMA and the SRW was monitored for substances and at frequencies that were specific to the objectives of each monitoring program (*i.e.*, TOMP, SAMP and SRWMP). Concentrations of all variables monitored within TMAs (*i.e.*, in basins), and in effluent, seepages, and downstream surface water stations were compared to SRWMP benchmarks for receiving water quality (described below). It is recognized that mine sources (effluent and seepage) are not expected to achieve criteria for receiving environment quality, but such comparisons were made to identify potential variables or sources of concern relative to the downstream receiving environment. Based on expected minimum 10-fold dilution downstream of the mine discharges, concentrations of 10x the appropriate receiving environment criteria were sometimes presented as the relevant basis for comparison of discharge water quality.

SRWMP benchmarks were based on water quality criteria for protection of aquatic life or the upper range of background (reference area) concentrations (except for pH for which the lower background range was relevant). Water quality criteria that were considered included Ontario's Provincial Water Quality Objectives (PWQO; OMOEE 1994) and Canadian Water Quality Guidelines (CWQG; CCME 2003). For manganese and sulphate, which have no PWQO or CWQG, British Columbia Water Quality Guidelines (BCWQG) were used (BCMOE 2006). The upper range of background concentrations was calculated as (mean + 1.699 * standard deviation; Appendix Table E.1). With the exception of pH, the highest value of the applicable water quality criteria and background concentration was selected as the benchmark for evaluation of water quality at mine-exposed stations (Table 2.12). To detect potential mine-related reductions in water pH, the lower PWQO limit of pH 6.5 was applied in data evaluation instead of the lower background value of 6.0, based on previous input from the CNSC.

2.4.2 Water Elevations and Effluent Treatment Efficacy

TMA elevations were assessed relative to operating levels specified in site-specific Operating Care and Maintenance Plans (Rio Algom sites) and Tailings Management Area Operating Manuals (Denison sites).

The TMA effluent treatment facilities in Elliot Lake neutralize acidity and remove metals through the addition of lime (in most cases) or caustic soda (sodium hydroxide). Barium chloride is also added at most treatment plants for removal of radium-226. Reagent use was evaluated relative to treated effluent volume to assess changes in reagent consumption over time.

Table 2.12: Serpent River receiving environment benchmarks, 2005-2009.

Station		Upper limit of Background[a]	Provincial Water Quality Objective
Barium	mg/L	0.047	-
Cobalt	mg/L	0.0007	0.0009
DOC	mg/L	5.6	
Iron	mg/L	0.47	0.30
Manganese	mg/L	0.098	-
pH	pH units	6.3	6.5
Radium	Bq/L	0.006	1.0
Sulphate[b]	mg/L	6.3	100
Uranium	mg/L	0.0006	0.005

Shaded value indicates selected benchmark.

[a] Upper limit of background based on data collected from reference stations 2005 - 2000 (Appendix Table E.1)

[b] BCMOE sulphate guideline used as there is no PWQO for sulphate (BCMOE 2006).

Routine toxicity testing is conducted as an additional measure of the quality of treated water released from the TMAs. Semi-annual acute lethality tests are performed using rainbow trout (Environment Canada 2000b) and *Daphnia magna* (Environment Canada 2000a), while 1-week survival and reproduction tests are performed using *Ceriodaphnia dubia* (Environment Canada 2007).

2.4.3 Trend Analysis

Analyses of temporal changes in water quality were performed on data from all surface water, seepage, porewater and groundwater stations. Specifically, trends were assessed for porewater and groundwater stations for the period 1990 to 2009 based on pH, sulphate and iron levels. While acidity is also measured in porewater and groundwater, changes in analytical methods in 2006 precluded the use of prior data and such that there were too few data to conduct trend analysis. Surface water and seepage quality trends during the period 2003-2009 were also assessed for all SAMP and TOMP locations based on radium-226, sulphate, uranium, pH, barium, cobalt, iron, manganese, and acidity (TOMP only). Trends were assessed for all SRWMP stations for the period 2000 to 2009 based on concentrations of pH, radium-226, sulphate, uranium, barium, cobalt, iron and manganese.

Prior to trend analysis, concentrations reported as less than the method detection limit (MDL) were replaced with concentrations representing one-half the MDL for that variable. In some cases, method detection limits varied over time (e.g., cobalt), which had the potential to alter or mask actual trends, so detectable concentrations that were less than the maximum MDL were also taken at half the maximum MDL. Abnormally high MDLs were not used as the maximum MDLs, but rather were removed prior to the trend analysis.

Station sampling frequency varied from annual to weekly, depending on the monitoring program and specific location being sampled (Tables 2.3, 2.4 and 2.5). For variables measured more frequently than annually, seasonal variability in concentrations needed to be considered in assessing trends over time. This necessitated that data for each variable and station be organized into common time periods across years, ranging from monthly to annual (depending on the monitoring frequency for each variable at each station), which are hereafter referred to as “seasons”. For stations sampled weekly, monthly averages were computed and months represented “seasons”. In some cases, data for two or more months were grouped into a “season” (if different months were sampled within a “season” in different years) and/or data were averaged (if multiple values existed within a defined “season” within a given year). Therefore, there were as few as one or as many as 12 “seasons” of data for a given variable and monitoring station. Trend analysis was performed if there were >7 years (SRWMP), or >5 years (SAMP and TOMP) of concentrations reported within a season.

Trends were separately analyzed for each season using Spearman rank correlation (r_s) between variable concentrations and years (SPSS 2006; McLeod et al., 1991). This identified any statistically-significant temporal trends within seasons. Rank correlations do not require normally distributed data, and a significant correlation does not necessarily imply a linear increasing or decreasing trend. However, results do indicate where a significant increase or decrease in concentration has occurred over time.

For locations and variables for which multiple seasons were assessed for significant correlations (trends), van Belle tests were applied to test for differences among seasonal trends, and test the common (combined) trend over all seasons. Van Belle and Hughes (1984) and Gilbert (1987) describe application of the tests to the Mann-Kendall statistic (S); Paine (1998) describes application of the tests to Spearman rank correlations (r_s). First, trend correlations for each season were divided by their standard errors (SE) to convert them to standard normal deviates (Z_i). For Spearman r_s, SE=$\frac{1}{\sqrt{n-1}}$, where n=the number of years included in the trend analysis, and:

$$Z_i = r_s\left(\sqrt{n-1}\right)$$

Trend Z values were then compared among the m seasons using van Belle tests for homogeneity of trends:

$$\chi^2_{\mathrm{H}} = \sum\left(Z_i - \overline{Z}\right)^2$$

with df=m–1 for χ^2_{H}. The common trend over all seasons was then tested using:

$$\chi^2_{\mathrm{T}} = \overline{Z}^2 m$$

with df=1 for χ^2_{T}. Mean trend correlations ($\bar{r}_s$) were then calculated by weighting r_s by1/SE= $\sqrt{n-1}$. Van Belle and Hughes (1984) suggest that common trends should not be tested when differences among seasons (*i.e.*, χ^2_{H}) are significant at p<0.01. In this study, common trends were tested and $\bar{r}_s$ calculated for all stations and variables, but cases where χ^2_{H} was significant at p<0.05 were noted. For (seasonal and common) trend analysis where the number of years was less than 10, the *p*-value was obtained from the table of critical values (Zar 1984). Common trends for each station and for each variable were tabulated with significant trends highlighted.

2.4.4 Loadings Estimates

Annual loadings (2005 to 2009) of various monitored variables were developed for:

- TMA direct (controlled) discharge locations;
- TMA seepage locations; and
- Downstream locations within the Serpent River Watershed.

Loadings were computed to compare contributions from background sources and TMAs, and to assess the relative contribution of each TMA and the cumulative loads at downstream locations throughout the watershed.

Loadings from TMA discharge locations were based on monitoring results (flow and concentration) for each year (2005 to 2009). Weekly flow and concentration data measured during discharge periods at the main TMA discharge locations (2005-2009) were used to calculate weekly loads (kg/wk or Bq/wk). Weekly loads were summed to estimate annual loads for each variable. In some instances, loads were computed by averaging concentrations for dates immediately before and after a date when flow but no concentration data were available.

Flows for seepage locations were based on either design flows reported in the EIS documents or mean flows from site monitoring data, whichever was higher[1] (Table 2.13). These flow rates were multiplied by mean annual concentrations (2005 to 2009) for the same station to roughly estimate annual loads for each variable.

Loadings were also estimated for 14 monitoring stations within the SRW which were located either upstream or downstream of various TMA sources. Loadings were estimated by pro-rating data from a Water Survey of Canada (WSC) flow gauging station (02CD006 Serpent River upstream of Quirke Lake) based on watershed areas. Watershed areas were taken from previously published reports or from historical WSC data for each of the downstream locations (Table 2.14). Mean annual flow was determined for each year (2005 to 2009) at

[1] The design flow was used at P-03 as it was believed to be more representative of annual average conditions.

Table 2.13: Non-point source discharge design and measured flow values.

TMA	SAMP Station	Purpose	Receiver	Design Flow (L/sec)	Measured Flow Data: Mean (L/sec)	Minimum (L/sec)	Maximum (L/sec)	SD	Count	Length of Record: Starting Date	Final Date	Design Flow Reference
Panel	P-02	Seepage from Dam B	Rochester Creek	2	0.8	0.1	5.0	1.1	42	9/12/1991	10/12/1994	Table 6.2.4 -Quirke & Panel EIS[b]
	P-03	Pond C discharge -SW	Rochester Creek	10.7	24.3	5.9	54.4	26.3	3	4/27/2009	10/26/2009	Table 6.2.4 -Quirke & Panel EIS[b]
	P-05	Drainage downstream of Dam E	Rochester Creek	8.03	no flow data							Table 6.2.4 -Quirke & Panel EIS[b]
	P-11	Site drainage	Panel Creek P-26	NA	21.8	0.0	155.8	34.04	20	1/24/2005	10/26/2009	
Quirke	ECA-398	Site drainage	Serpent River Upstream of Q-09	[d]	1.6	0.0	10.0	2.43	39	1/10/2005	10/13/2009	
	Q-22	Site drainage	Serpent River Upstream of Q-09	[d]	8.9	0.5	50.0	12.52	20	1/10/2005	10/13/2009	
	Q-23	Swamp Downstream of Dam K	Dunlop Lake	[d]	46.7	2.7	129.7	71.95	3	5/5/2009	10/21/2009	
	Q-27	Seepage from Dam J	Evans Lake	0.1	0.0	0.0	0.0	0.00	32	2/2/1991	2/3/2000	Table 6.2.2 -Quirke & Panel EIS[b]
Lacnor/Nordic[a]	All sources captured through monitoring at N-12 thus no non-point source discharge											
Milliken	All sources captured through monitoring at MPE thus no non-point source discharge											
Stanleigh[a]	All sources captured through monitoring at CL06 thus no non-point source discharge											
Spanish American	All sources captured through Denison TMA thus no non-point source discharge											
Pronto	LL-01	Upstream Source to Lake Lauzon	Lake Lauzon		10.1	1.1	30.0	8.85	23	1/5/2005	10/14/2009	
Denison	D-3	Lower Williams Lake Discharge	Serpent River Upstream of D-5	0.3	8.1	0.0	161.0	14.04	640	1/4/2005	12/29/2009	Table 6.2.2 -Denison & Stanrock EIS[c]
	D-9	Seepage at Dam 17	Quirke Lake	3.4	3.5	1.3	10.8	2.74	20	1/4/2005	10/6/2009	Table 6.2.2 -Denison & Stanrock EIS[c]
	D-16	Seepage at Dam 9	Quirke Lake	0.3	1.3	0.2	5.7	1.68	20	1/4/2005	10/6/2009	Table 6.2.2 -Denison & Stanrock EIS[c]
Stanrock	DS-16	Drainage from Dam G and J	Quirke Lake	0.7	4.0	0.0	57.8	6.46	308	1/4/2005	10/5/2009	Table 6.2.2 -(Dams B, C, D)Denison & Stanrock EIS[c]

[shaded box] shade denotes the flow values used for loading calculations presented within the SOE for seepage locations

[a] some Lacnor mine site, Stanleigh mine site and Stanleigh Dam A seepage reports to the MPE watershed but these are accounted for in MPE loadings from Milliken

[b]. Tables 6.2.2 and 6.2.4 (Rio Algom Limited 1995)

[c] - Table 6.2.2 - Estimated Long Term Values (Denison Mines Limited 1995)

[d] - specific predictions for seepage or runoff flow from these areas were not included in EIS but loadings considered representative of these areas were included in general TMA predictions.

NA - not available

Table 2.14: Watershed areas and prorated flow estimates[a] for stations within the Serpent River watershed, 2005 to 2009.

Station	Description	Watershed Area (Km^2)	Mean Flow (L/s)[a]						Drainage Area Source
			2005	2006	2007	2008	2009	Mean Annual Flow	
SR-01	Quirke Lake Outlet	319	3,280	4,238	3,182	5,661	5,376	4,348	WSC (02CD003)
M-01	Elliot Lake Inlet	18.56	191	247	185	329	313	253	Senes 2007[b]
Q-20	Evans Lake Outlet	1.08	11	14	11	19	18	15	S. Kam e-mail June 14th 2007
DS-18	Halfmoon Lake Outlet	11.6	119	154	116	206	196	158	Table 6.3.3 Denison & Stanrock EIS
SR-05	Canyon Lake Outlet	7.57	78	101	75	134	128	103	Topo map 41 J10
SR-06	McCabe Lake Outlet	32.8	337	436	327	582	553	447	Senes 2007[b]
SR-08	Nordic Lake Outlet	32.3	332	429	322	573	544	440	Senes 2007[b]
D-6	Outlet of Cinder Lake	4.13	42	55	41	73	70	56	Topo map 41 J10
D-4	Outlet of Dunlop Lake	109	1,121	1,448	1,087	1,934	1,837	1,486	WSC (02CD002)
MPE	Outlet of Sherriff Creek Park	13.5	138	179	134	239	227	183	Golder 2004
Q-09	Quirke Lake Inlet	157	1,614	2,086	1,566	2,786	2,646	2,140	WSC (02CD006)
	Serpent River @ Hwy 17	1350	13,263	16,346	12,092	23,558	22,753	17,602	WSC (02CD001)
D-5	Serpent River downstream of Denison	118	1,213	1,568	1,177	2,094	1,989	1,608	Table 6.3.3 Denison & Stanrock EIS
SC-01	Westner Lake Outlet	2.37	24	31	24	42	40	32	Golder Westner Lake Outlet Berm Report

WSC - Water Survey of Canada (Station Identification)

[a] Flows calculated based on mean annual flow data from Quirke Lake Inlet, Water Survey of Canada data.

[b] Data provided by Senes 2007 taken from EIS loading predictions.

each location and pro-rated flow estimates were multiplied by mean annual concentrations to roughly estimate annual loads at SRW monitoring stations.

2.4.5 Sediment Quality

Similar to the approach taken for water quality data, sediment quality data were analyzed to identify variables that were elevated relative to quality benchmarks and to identify locations with elevated concentrations. Spatial patterns were assessed relative to TMA discharges, and where possible, temporal changes were evaluated by comparing 2009 to 2004 and 1999 sediment data. Sediment data were also used in the assessment of the benthic macroinvertebrate communities to identify potential relationships between benthic community composition and sediment quality.

Sediment concentrations were compared to Ontario's Provincial Sediment Quality Guidelines (PSQG; OMOE 1993; iron, manganese), guidelines proposed by Thompson et al. (2005; nickel, uranium, radium-226) and upper background (reference area) concentrations. The upper range of background concentrations was defined as the mean (2009) + (2.145 * standard deviation).

2.4.6 Benthic Invertebrates

Benthic community data evaluation included

- Statistical comparisons of communities downstream of mine discharges relative to reference communities based on key benthic community metrics (density, number of taxa, and first three Correspondence Analysis (CA) axes);
- Correlation analysis of benthic metric and physical-chemical variables to identify potential relationships that might explain reference-exposure benthic community differences, and
- Comparison of Cycle 3 (2009) data to results from Cycles 1 (1999) and 2 (2004).

Benthic invertebrate community data were subjected to a data quality assessment to verify overall data quality prior to their use in data analysis (Appendix B).

Invertebrate density (individuals/m^2) was calculated based on the known area sampled (*i.e.*, 0.232 m^2). The benthic diversity metric "number of taxa" (also known as taxon richness) was calculated based on lowest-practical-level taxonomy, excluding any life stages that could not be conclusively identified as separate taxa.

Benthic invertebrate community structure was also assessed using a multivariate technique known as correspondence analysis (CA). CA extracts “axes”, representing weighted vectors of species abundances, which can be thought of as new variables summarizing community composition. The greatest variation among either taxa or stations is explained by the first axis, with other axes accounting for progressively less variation. The method is influenced by rare species, so those taxa occurring at ≤10% of stations are eliminated from the data sets before analysis, and interpretation of results must consider the potentially biasing effects of those taxa remaining which still are not present at most stations. After screening and data reduction, abundances were log10 (x+1) transformed. Scores for both taxa and stations were calculated using the ADE-4 statistical software package (Thioulouse et al. 1997) to evaluate the associations of organisms and stations.

All benthic invertebrate community metrics were summarized by separately reporting mean, minimum, maximum, standard deviation, standard error and sample size for each study area (*i.e*., lake).

Exploratory evaluation of relative densities, number of taxa and Correspondence Analysis results were used to identify the reference lakes which would best serve to identify any mine-related differences between mine-effluent-exposed and reference lakes. For the resulting reference/exposure comparisons, a pooled reference mean was calculated from the mean values of the reference lakes (n=4 lakes, omitting Rochester Lake for reasons described in Section 5.3.1), and these data were compared to mean values for each exposure lake (n=5 replicate stations) using *a priori*, user-defined contrasts in ANOVA. User-defined contrasts are tests of hypotheses constructed prior to Analysis of Variance (ANOVA). As such, these independent tests, which are conceptually similar to t-tests between two groups, are not adjusted for multiple comparisons, and are more powerful at detecting differences than are *post-hoc*, pair-wise comparisons, especially when many groups are compared *post-hoc*. Since the user-defined contrasts are *a priori* tests, their results trump those of ANOVA and *post-hoc*, pair-wise comparisons. Accordingly, and by convention, ANOVA results are not reported for these comparisons. For all comparisons between areas, heterogeneity of variances was tested with Levene’s test and, when necessary, tests that allow for unequal variances were used when comparing areas.

Benthic invertebrate community surveys in Canada are generally expected to have sufficient power to detect a difference (effect size) of ± two standard deviations (SDs) of the reference mean (Environment Canada 2002). Therefore, for each significant difference between reference and mine-exposed areas, the magnitude of the difference between area means was expressed as the number of reference mean SDs as follows:

magnitude of difference = (exposure mean – reference mean) / SD of the reference mean

Exposure means were also expressed as a percentage of the reference area mean to convey magnitudes of difference between areas.

Correlation analysis was carried out between the five primary benthic metrics (density, number of taxa, CA axes 1-3) and 13 habitat-related variables, including sediment concentrations of mine-indicator substances. With 65 simultaneous comparisons, correlations significant at the p-level of 0.05 should be interpreted cautiously, since several (5%) of the correlations could be expected to occur by chance alone. For this reason, correlations significant at a more stringent level of $p<0.001$ were also noted. All correlations significant at the unadjusted p-level of 0.05 were examined in scatter plots to verify the magnitude and significance of the relationships, which can be falsely inflated by the leveraging effect of outliers.

Ecological and habitat requirements of benthic taxa were considered in data interpretation as supported by standard references (e.g., Merritt and Cummins 1996; Weiderholm 1983; Wiggins 1996).

2.5 Special Investigation

A special investigation was undertaken to allow for better estimates of dose and risk by taking measurements to confirm or adjust assumptions made in previous dose and risk estimates. Risk assessments have been conducted in the watershed as part of the Environmental Assessments conducted in support of mine decommissioning (Rio Algom 1995, Denison Mines 1995, AECB 1997. CNSC 2002), the 1999 SRWMP (Minnow and Beak 2001) and the State of the Environment Report (Minnow 2009a). Within the receiving environment, estimates of dose and risk have been based on a number of assumptions with respect to:

- Secular equilibrium of lead-210 and polonium-210 with radium-226 in sediment.
- Negligible contribution of the thorium-232 decay chain to dose estimates;
- Bioaccumulation factors in fish;
- Resource use and consumption by local First Nations persons; and

- Occupancy of downstream lakes by waterfowl.

A detailed study was conducted in 2009 to confirm these assumptions and generate comprehensive dose estimates based on measured data. The study focused on six lakes for which human health risks were estimated as part of the SOE (Quirke, McCabe, Nordic, Elliot, May, and McCarthy). In each lake, water, sediment, forage fish, and macrophytes were sampled and analyzed for U-nat, Th-230, Ra-226, Po-210, Pb-210, Th-232, Th-228, and Ra-228 (*i.e.* both the uranium-238 and thorium-232 decay chains). A complete description of the methods employed in the collection of these samples is provided in Appendix F (EcoMetrix 2011a).

Dietary intake and usage by First Nations people was documented through a consumption survey conducted by SRFN fishers and hunters and their families (SRFN, 2010). Interviews were conducted with 21 fisher/hunter respondents selected to be representative of the community. Each respondent reported: number of household residents, annual household consumption of fish, waterfowl and other game (by species), and harvest distribution by species and location. Household consumption was divided by the number of household residents to estimate the annual consumption per person in each household. A detailed description of the survey is provided in Appendix F (EcoMetrix 2011a).

In addition, an assessment of waterfowl usage in the key lakes noted above (Quirke, McCabe, Nordic, Elliot, May, and McCarthy) was conducted in the fall of 2009 (i.e. when waterfowl are staging). Observations by field crew on the species and number of waterfowl present took place over one or two days per lake; the time required for completion of water, sediment, macrophyte, and fish collection. At Quirke Lake however, three days were spent collecting samples and therefore waterfowl observation was extended to three days. Field crews generally surveyed most of the area within each lake with the exception of McCarthy where access to a western portion of the lake was difficult due to the presence of a beaver dam.

The information from this study was used to update the human health risk assessment prepared for the SOE report, provide an estimate of dose and risk to aquatic biota and riparian wildlife within these lakes and address the specific assumptions used in previous dose estimates. A detailed description of the method used to estimate dose and risk to aquatic biota, riparian wildlife and human receptors is provided in Appendix F (EcoMetrix 2011a).

3.0 TMA PERFORMANCE

Within the Serpent River Watershed there are eleven TMA's, although one of these, Spanish American, discharges to the Denison TMA complex. TMAs have either a vegetative cover or a water cover, both of which are intended to inhibit oxidation and acidification of tails. In water-covered TMAs (flooded) excess water flows from the TMA to an effluent treatment plant prior to discharge. In vegetated TMAs, seepage from the TMA is collected in pond structures or ditches and treated prior to discharge.

The performance of the TMAs is monitored and assessed through the TMA Operational Monitoring Program (TOMP) which includes the assessment of:

- Water cover on flooded basins;
- Surface water quality within the basins;
- Porewater quality within the basins (where monitored);
- Groundwater quality down-gradient of the TMAs; and
- Treatment performance (reagent use and effluent compliance).

Releases to the environment are monitored under the Source Area Monitoring Program (SAMP) which captures site drainage, seepages, and final effluent. Releases are discussed in the context of common sub-watersheds within the SRW in Section 4.0.

Performance of each TMA is presented in the following sections.

3.1 Denison TMA

3.1.1 Basin History and Modifications

The Denison mine and mill operated from 1957 to 1992. Over this time, a total of 63 million tonnes of uranium ore were milled. Tailings were deposited into two bedrock-lined basins, TMA-1 (formerly Bear Cub Lake and Long Lake) and TMA-2 (formerly Upper Williams Lake). Tailings in TMA-2 are contained by an engineered dam to the northwest (Dam 1) and bedrock between TMA-2 and TMA-1 (Figure 3.1). TMA-2 was used from start-up until it was filled in the early 1960s. After TMA-2 was filled, tailings were discharged into the Bear Cub Lake basin, which eventually merged with the Long Lake basin to form TMA-1. Sixty million tonnes of tailings are contained in TMA-1 by five engineered perimeter dams (Dam 9, Dam 10, Dam 16, Dam 17 and Dam 18) representing a total area of approximately 240 ha (Figure 3.1). In general, the Denison TMAs were decommissioned as flooded tailings following mine closure in 1992, with decommissioning largely completed in late 1996. Specifically, from 1992 to 1995 beached tailings on the east side of TMA-1 were hydraulically dredged and

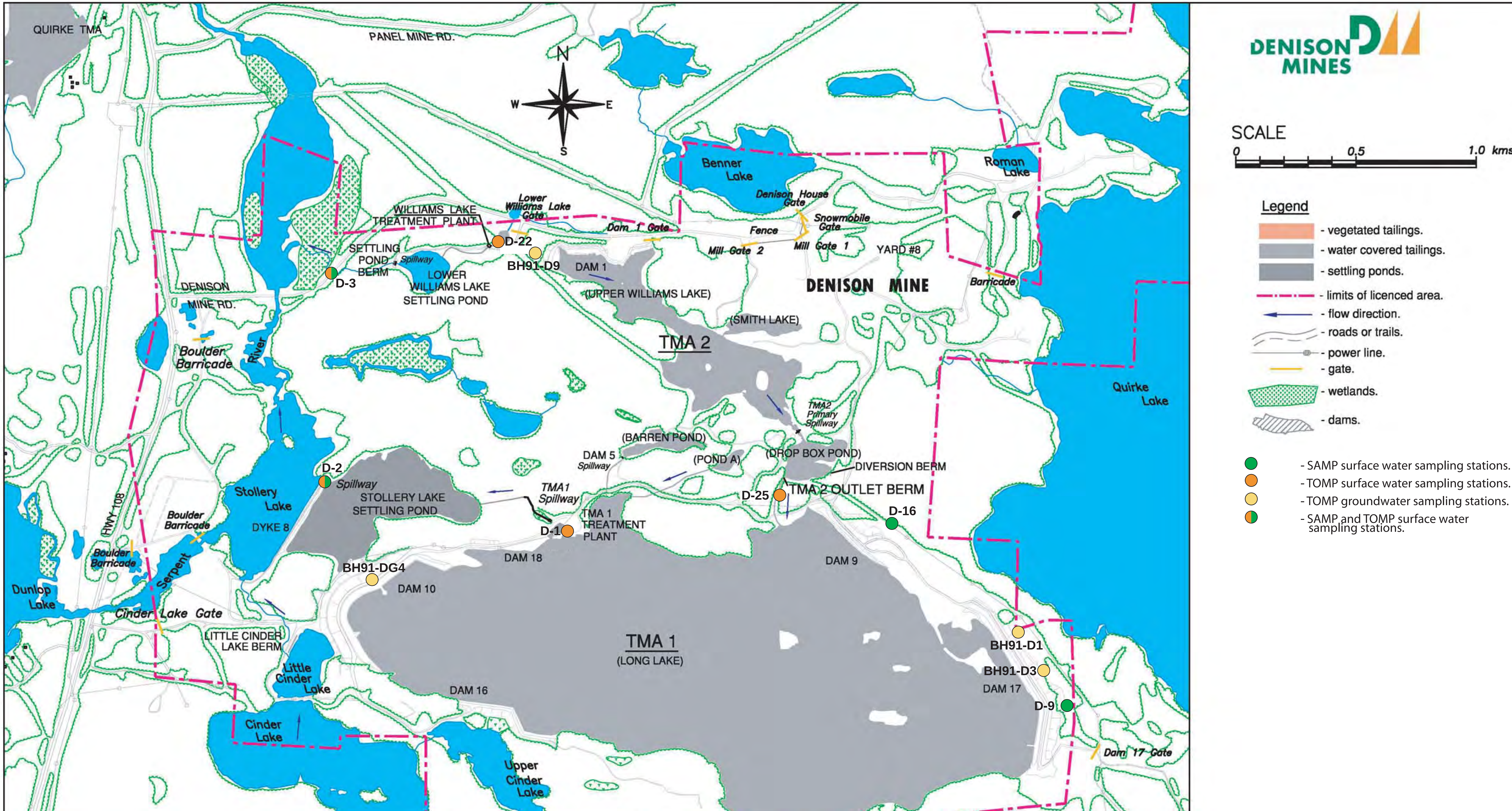

Figure 3.1

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Denison Site SAMP and TOMP Monitoring Stations

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placed into deeper areas on the west side of TMA-1. From 1993 to 1996, tailings from TMA-2 were hydraulically relocated to TMA-1 and to the underground workings, leaving a total of 3.3 million tonnes of tailings in TMA-2 within an area of 40 hectares. In addition, all tailings on the rock shoreline were washed into the TMA-2 basin in 1997. The Dam 10 stability and seepage reduction berms were completed by 1996. The stabilization of the remaining dams in TMA-1 for closure was also completed by 1996.

Effluent/decant from TMA-2 flows into TMA-1 via the TMA-2 spillway. Seepage from TMA-2 is treated at the Lower Williams Lake Treatment Plant and discharged to the Serpent River at D-3. The Denison Effluent Treatment Plant (ETP) is located on the north shore of TMA-1 where effluent is treated prior to discharge to Stollery Lake, which then discharges into the Serpent River (Figure 3.1).

Within the Denison TMA, surface water and ground water are monitored under the TOMP and the locations, substances and frequency monitored are specific to the station type (Table 3.1; Figure 3.1). Data from the TOMP stations are summarized in the following sections and presented in Appendix C (Appendix Tables C.1.2- C.1.8).

3.1.2 Water Management

Water cover at the Denison TMA is used to inhibit oxidation and acidification of tailings. Since 2005 (start of reporting period), water levels were consistently above the minimum operating level of 9144.5 ft (Figure 3.2). Water levels were highest in 2008 and 2009 due to higher precipitation in these years.

3.1.3 Basin Surface Water Quality

Surface water quality is monitored at three stations: the ETP influent from TMA 1 (D-1) and TMA 2 (D-22) and the overflow between TM2 and TMA 1 (D-25; Figure 3.1).

Since decommissioning (1992 to 1997), concentrations of radium-226, sulphate and uranium have decreased and pH has remained neutral (Figure 3.3). Concentrations of radium-226 and sulphate are near the 50-year post-decommissioning predictions (*i.e.* 2040) (Figure 3.3).

More recently (2003-2009), radium-226 has increased and pH decreased in Denison TMA-1 (Table 3.2). These trends appear to be attributed to a step change in 2008, which may be associated with the decrease in sulphate over time (i.e. since 2000) and/or the higher water levels in 2008 and 2009 (Appendix Figures C.1.1 and C.1.3) compared to a relatively dry

Table 3.1: TOMP monitoring stations, substances, and frequencies[a] at Denison TMA.

			Parameters and Frequencies[a]										
TMA	**TOMP Stations**	**Station Type/Purpose**	**Elevation**	**Flow**	**pH**	**Sulphate**	**Total radium-226**	**Lime or NaOH Consumption**	**Barium Chloride Consumption**	**TSS**	**Acidity**	**Iron**	**SAMP Metals[b]**
Denison	D-1	Basin performance (primary), ETP operations	W	D	D	Q	M	M	M		Q		Q
	D-22	ETP operations			W	Q	M		M		Q		Q
	D-3	Effluent		D[c]	W	M	W			W			M[d]
	D-2	Effluent		D[c]	W	M	W			W			M[d]
	D-25	Basin performance (secondary)			S	S	S				S	S	
	BH91-D1A,B, BH91-D3A,B, BH91-DG4B, BH91-D9A	Groundwater			A	A					A	A	

[a] D - Work days, W - Weekly, M - Monthly, S - Semi-annually, A - Annually, Q-Quarterly

[b] SAMP metals are barium, cobalt, iron, manganese, and uranium

[c] Monitoring requirement of SAMP

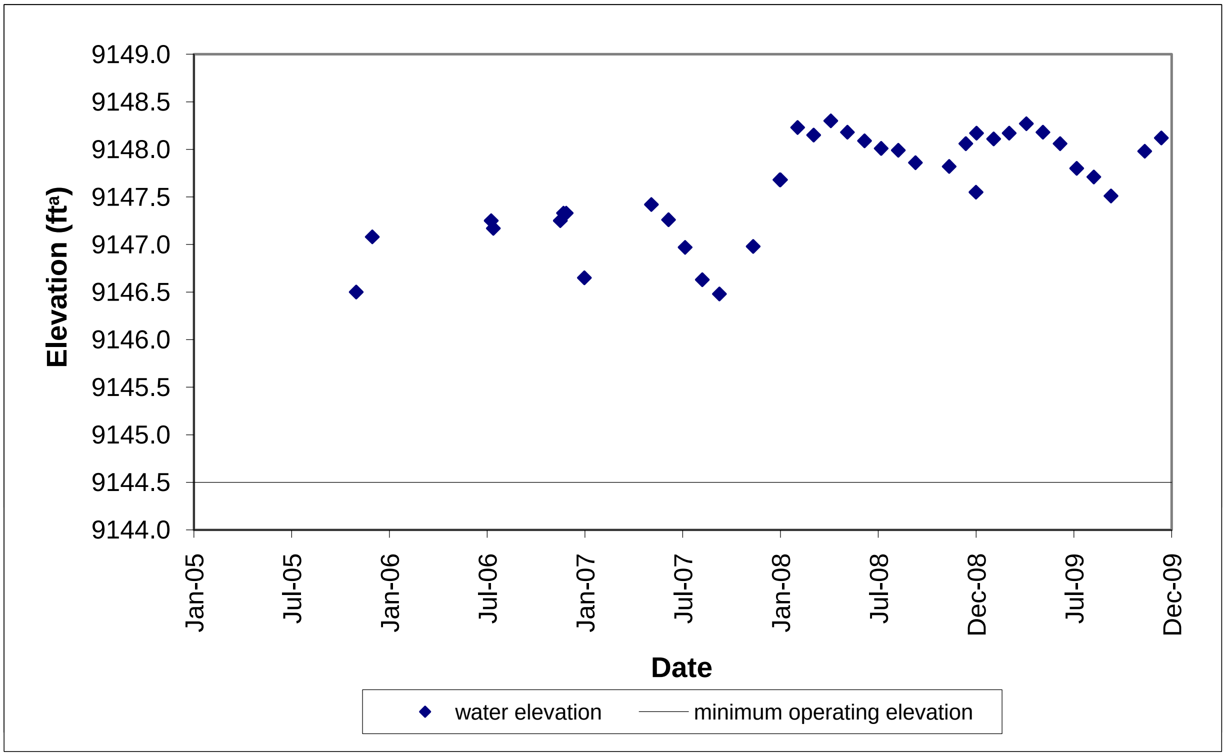


Figure 3.2: Water level at Denison TMA-1 relative to minimum operating elevation.

[a] Elevation is based on Denison Mine datum. Historically Quirke Lake was given an arbitrary elevation of 9,000 feet and all elevations are relative to that value.

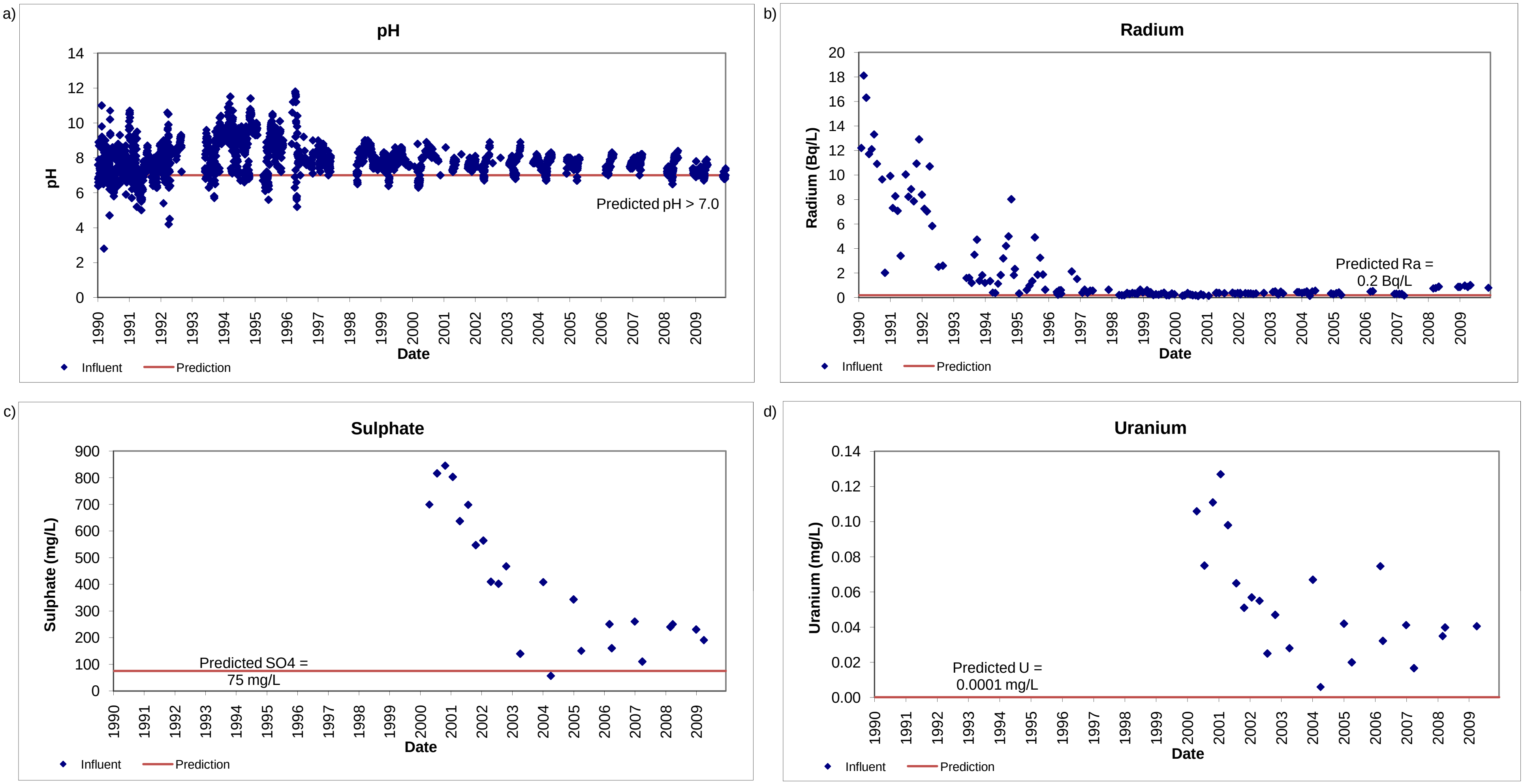


Figure 3.3: Water quality at the Denison TMA-1 ETP influent (D-1) relative to predictions for 50 years (2040) post-decomissioning.

Table 3.2: Summary of water quality trends[a] at TOMP monitoring stations, Denison TMA, 2003 to 2009.

Station ID	Type/Location	Number of Seasons Used in Common Trend[c]	Acidity	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium
D-1	TMA-1 Influent	1 to 4	-[b]	-	-	-0.559	-	-0.586	0.500	0.679	0.700
D-25	Spillway between TMA-1 and TMA-2	2	-	-	-	-	-	0.048	0.378	-	-
D-22	Influent to ETP at TMA-2	4 to 12	-	-	-	-0.016	-	-0.014	-0.267	-0.567	-[d]

(blue) decreasing trend, significant at $p<0.05$

(green) increasing trend, significant at $p<0.05$

[a] Based on rank correlation coefficients (rho) for common (combined) season trends, shown in table.

[b] "-" denotes that this parameter was not included in the trend analysis for that particular station due to insufficient data (e.g. there were <5 years worth of data for that parameter)

[c] Seasons used varied for substances based on suitability of data for trend analysis

[d] high MDLs for Uranium from 2003 to 2005 precluded ability to statistically assess trends at this station

2007. However, data during this period is limited due to minimal flows through the TMA[2] and additional data will be required to verify the trend and, if necessary, determine the cause. To address this issues, DMI has implemented additional monitoring in TMA-1 such that the basin water quality will be monitored (pH sulphate and radium-226) during periods of zero discharge. Radium-226 and pH levels at D-1 achieve PWQO before treatment and are much lower than values observed immediately following closure (Figure 3.3). Within TMA-2, radium-226 and sulphate concentrations have been decreasing over time (Table 3.2).

3.1.4 Groundwater Quality

Four locations (wells) are sampled annually for iron, pH, sulphate and acidity; two are located down-gradient of Dam 17 (BH91-D1 and BH91-D3), one is down-gradient of Dam 1 (BH91 D-9), and one is down-gradient of Dam 10 (BH91-DG4; Figure 3.1).

Down-gradient of Dam 17 at the east end of TMA-1 groundwater quality has significantly improved since decommissioning (1991-2009), with iron concentrations decreasing and pH levels increasing to neutral levels. However, down-gradient of Dam 10 at the west end of TMA-1, pH in groundwater has been decreasing (Table 3.3) consistent with pH in surface water within the basin (Station D-1, Table 3.2).

Down-gradient of Dam 1 in TMA 2 (BH91-D9A) groundwater quality has not improved over time, based on concentrations of iron that have significantly increased while pH levels have decreased (Table 3.3; Appendix Figure C.1.5).

3.1.5 Treatment Performance

The primary ETP for the Denison TMA is located at the outlet of TMA-1 with a second ETP at TMA-2 to treat seepage from this basin as well as from a historical tailings spill (Figure 3.1). The TMA-1 ETP uses both caustic soda and barium chloride to reduce acidity and radium-226, respectively. Generally, barium chloride and caustic soda consumption (kg/yr) was higher in 2008 and 2009, which is likely associated with lower pH and increased radim-226 in TMA-1 influent during this period. In addition, higher precipitation in these years caused the ETP to operate for more days which also contributed to the increase in reagent consumption (Figure 3.4). Caustic soda was not used in 2007 as no treatment for pH was required (pH was 7.8).

[2] Influent water chemistry is not monitored when the TMA is not discharging.

Table 3.3: Summary of water quality trends[ab] in TOMP groundwater in Denison TMA, 1991[d] to 2009.

Location	Station	Depth (m)	Dates	Iron	pH	Sulphate
Downgradient of Dam 1 (TMA-2)	BH91 D9A	22	1991-2009	0.913	-0.756	-[c]
Downgradient of Dam 10 (TMA-1)	BH91 DG4B	10.9	1996-2009	0.481	-0.736	-
Downgradient of Dam 17 (TMA-1)	BH91 D1B	45	1991-2009	-0.067	0.510	0.664
	BH91 D1A	66	1991-2009	-0.729	0.867	-0.582
Downgradient of Dam 11 (TMA-1)	BH91 D3B	21	1991-2009	-0.565	0.892	-0.515
	BH91 D3A	48	1991-2009	-0.511	0.804	-0.582

(blue) decreasing trend, significant at $p<0.05$

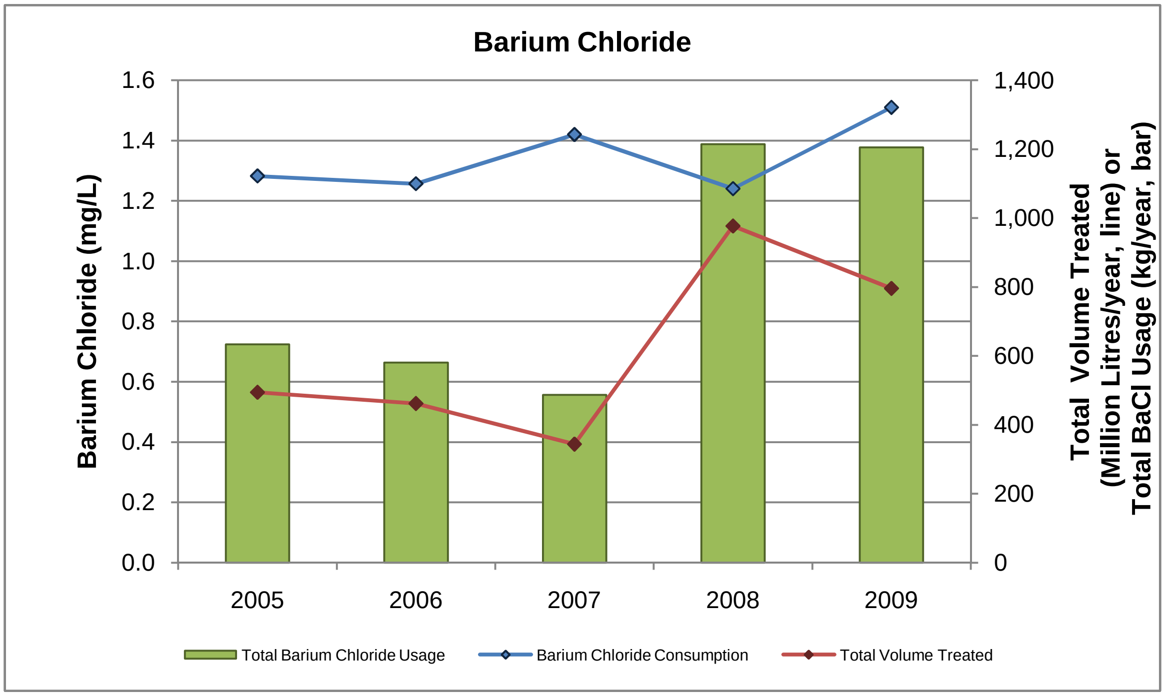
(green) increasing trend, significant at $p<0.05$

[a] Trends were not assessed for acidity because a change in analytical technique in 2006 meant that the data were not comparable before and after that time.

[b] Based on rank correlation coefficients (rho) for common (combined) season trends, shown in table.

[c] "-" denotes that this parameter was not included in the trend analysis for that particular station due to insufficient data (e.g. there were <5 years worth of data for that parameter)

[d] This is the earliest year included in the trend analysis, but not all stations have data going back to 1991.



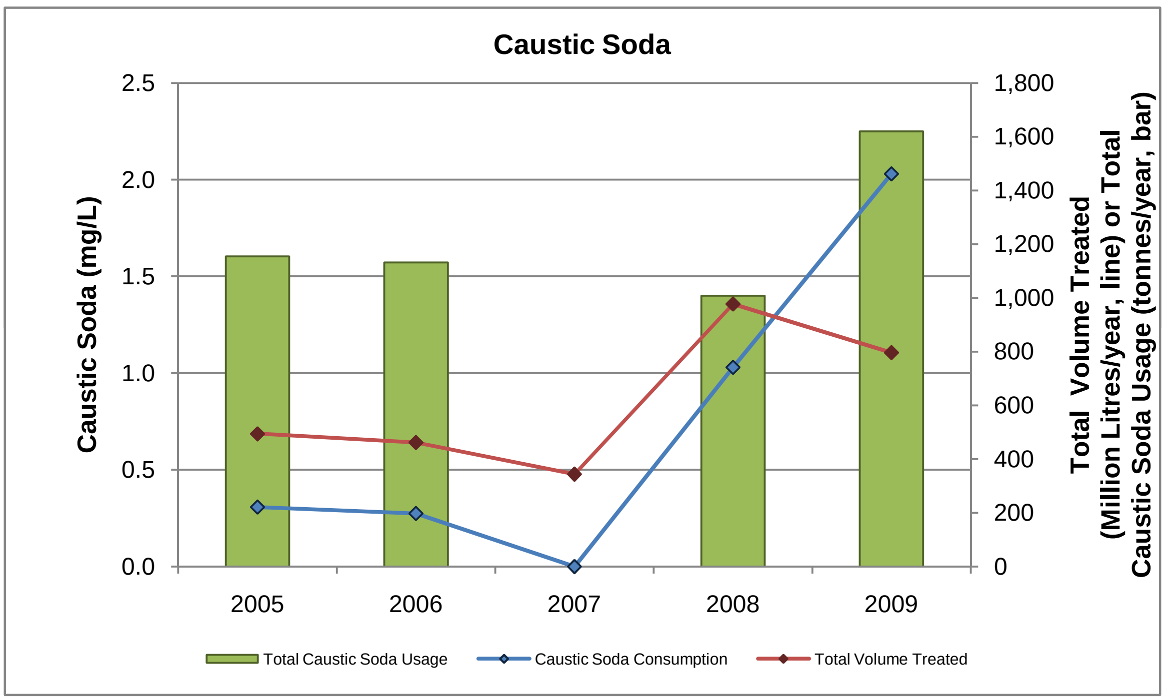


Figure 3.4: Comparison of total reagent consumed versus total volume treated at Denison TMA-1 from 2005-2009.

The historical spill and seepage from TMA-2 is treated with barium chloride to reduce radium-226 concentrations (currently no treatment for pH). Reagent use has been relatively stable over the past five years, likely associated with a stable vegetative cover, reductions in radium-226 concentrations in TMA-2 influent and that seepage flow rates are less influenced by precipitation (Figure 3.5).

Treated, effluent quality is monitored at the outlet of each ETP (TMA-1 is monitored at D-2 and TMA-2 is monitored at D-3) and over the past five years effluent quality has consistently achieved discharge criteria (Figures 3.6 and 3.7). While one radium-226 measurement at each location was greater than the monthly mean discharge criterion (Figures 3.6 and 3.7), the values were well below the individual grab sample criterion of 1.11 Bq/L (Appendix Table D.1.1).

Effluent has also been consistently non-lethal to *Daphnia magna* and rainbow trout, with no mortality reported in semi-annual acute toxicity tests (Table 3.4). Similarly, survival and reproduction of *Ceriodaphnia dubia* was not affected by exposure to 100% effluent in any tests conducted over the past five years (Table 3.4).

3.1.6 Summary

Water cover over tailings was consistently maintained at the Denison TMAs over the past five years. Since decommissioning, concentrations of radium-226, sulphate and uranium have decreased and are near the 50-year post decommissioning predictions (*i.e.* 2040). More recently sulphate and radium-226 concentrations have continued to decrease in TMA-2, but radium-226 has been increasing and pH decreasing in surface water at TMA-1. The trends at TMA-1 appear to be attributed to a step change in 2008, possibly related to decreases in sulphate over time and/or higher water levels in 2008 and 2009. However, additional data is required to verify the trend and, if required, determine the cause. Radium-226 and pH levels at D-1 achieve PWQO before treatment and are much lower than values observed immediately following closure. Groundwater down-gradient of the east end of TMA reflects improving conditions since decommissioning, based on decreasing iron concentrations and increasing pH. However, at the west end of TMA 1 and down-gradient of TMA-2, groundwater pH has been decreasing and iron increasing. Reagent use has increased in recent years reflecting increased radium-226 and decreased in pH in ETP influent, as well as the impact of higher flows in 2008 and 2009 necessitating a longer treatment period. Regardless, effluent quality has consistently achieved discharge criteria over the past five years and all tests to *Daphnia magna*, rainbow trout and *Ceriodaphnia dubia* were non-toxic.

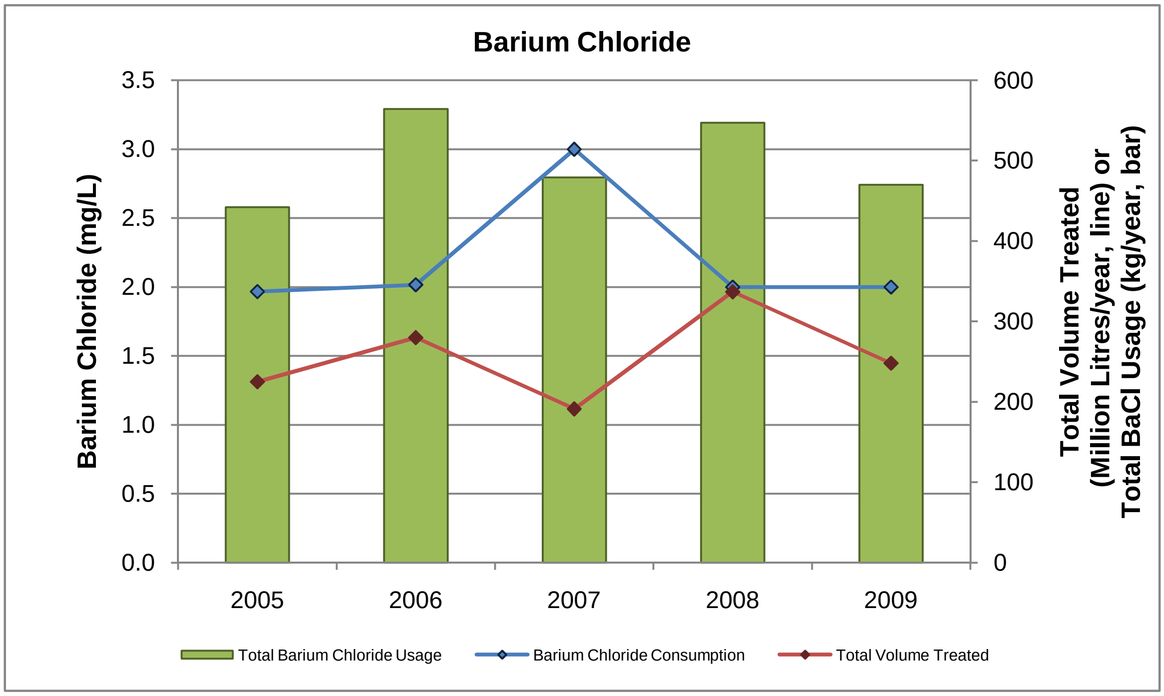


Figure 3.5: Comparison of total reagent consumed versus total volume treated at Denison TMA-2 from 2005-2009.

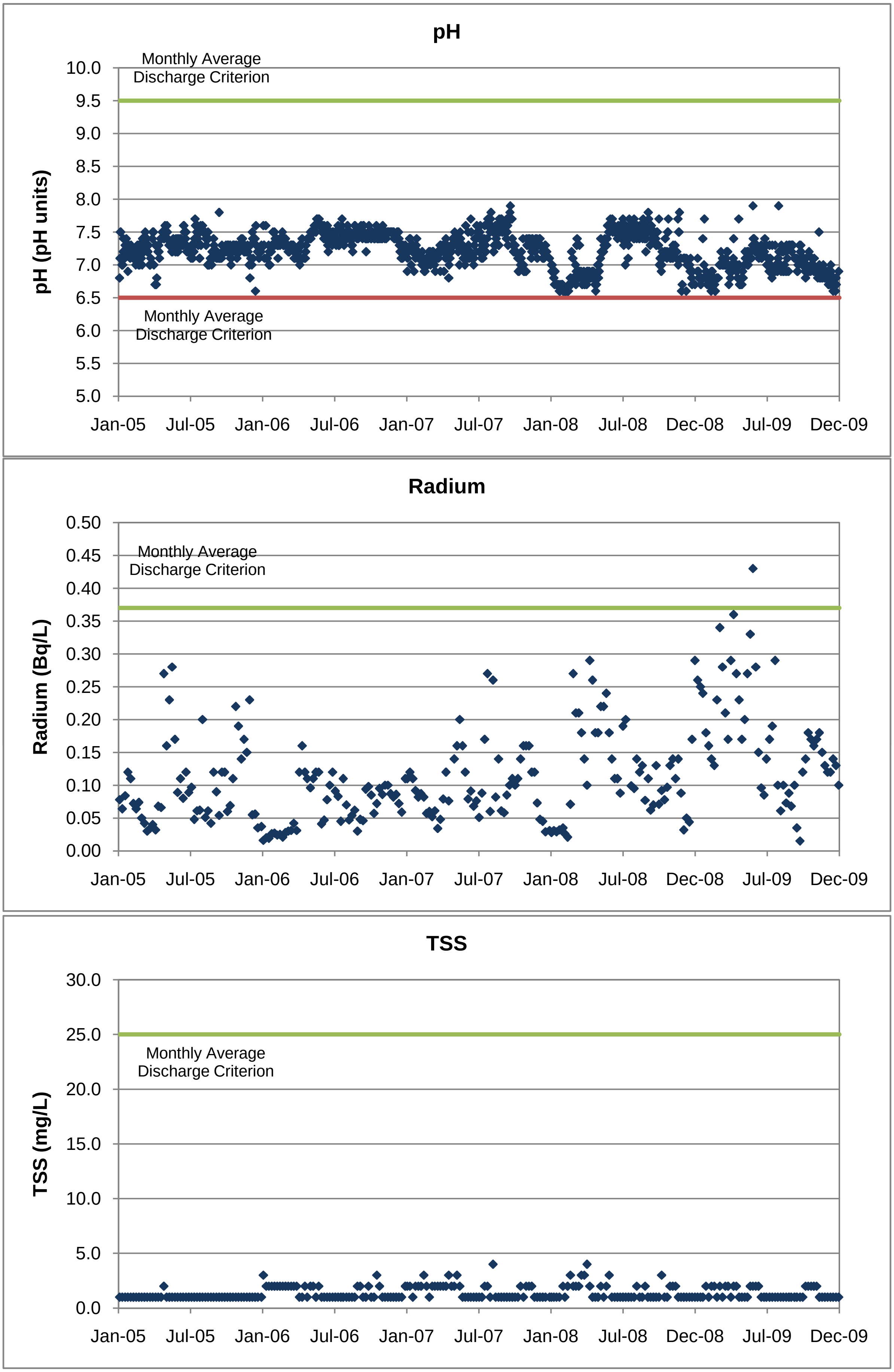
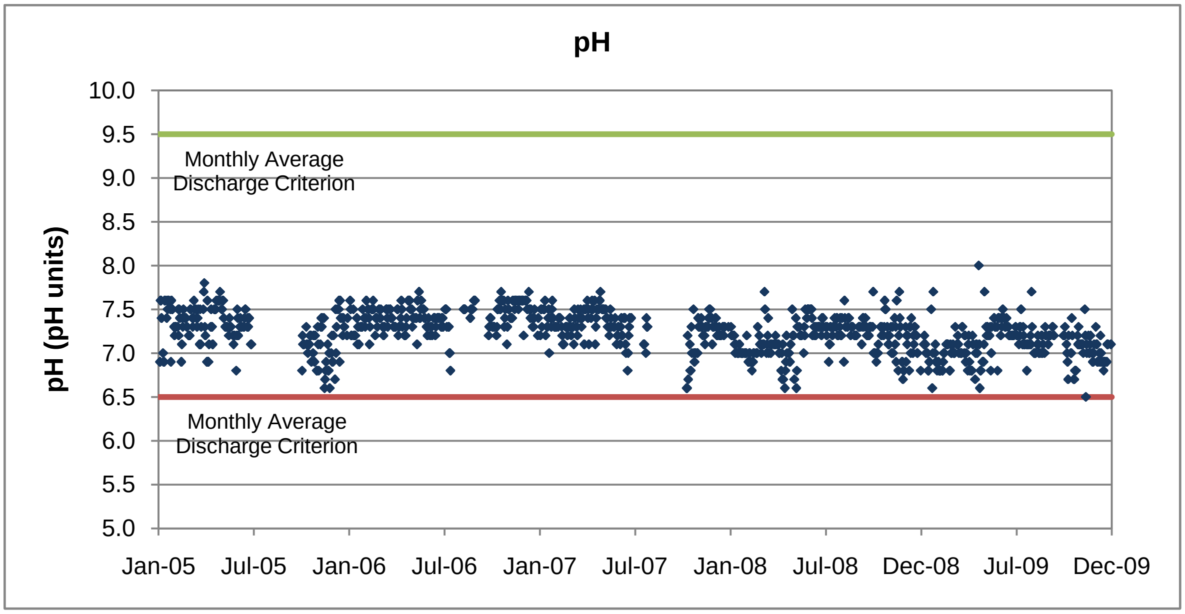
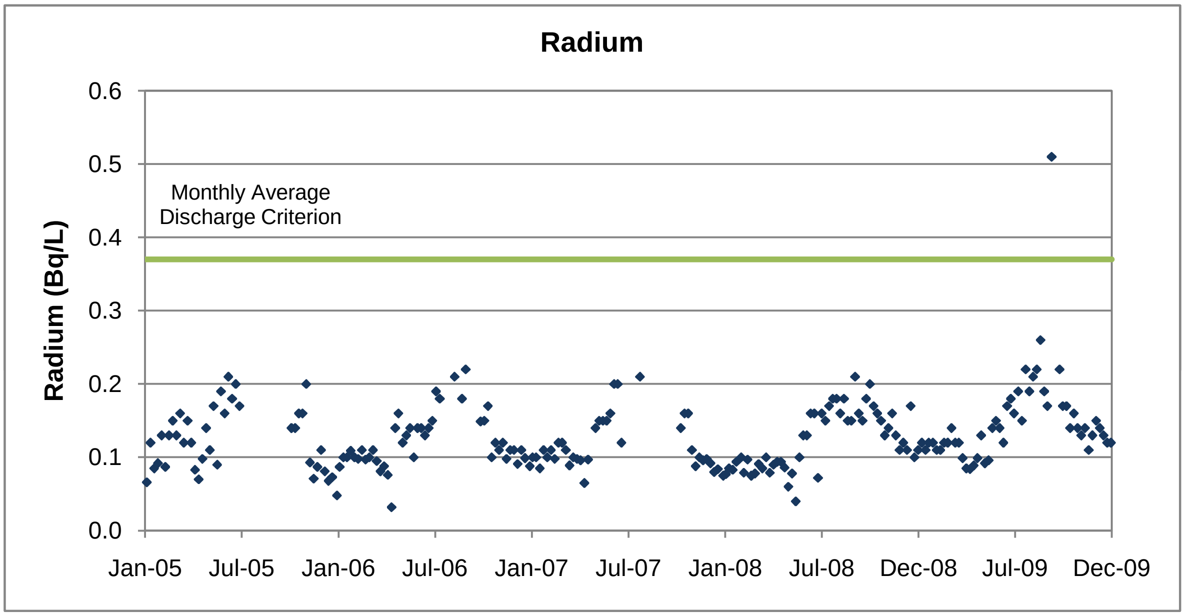


Figure 3.6: Effluent concentrations versus monthly average discharge criteria at Denison TMA station D-2.





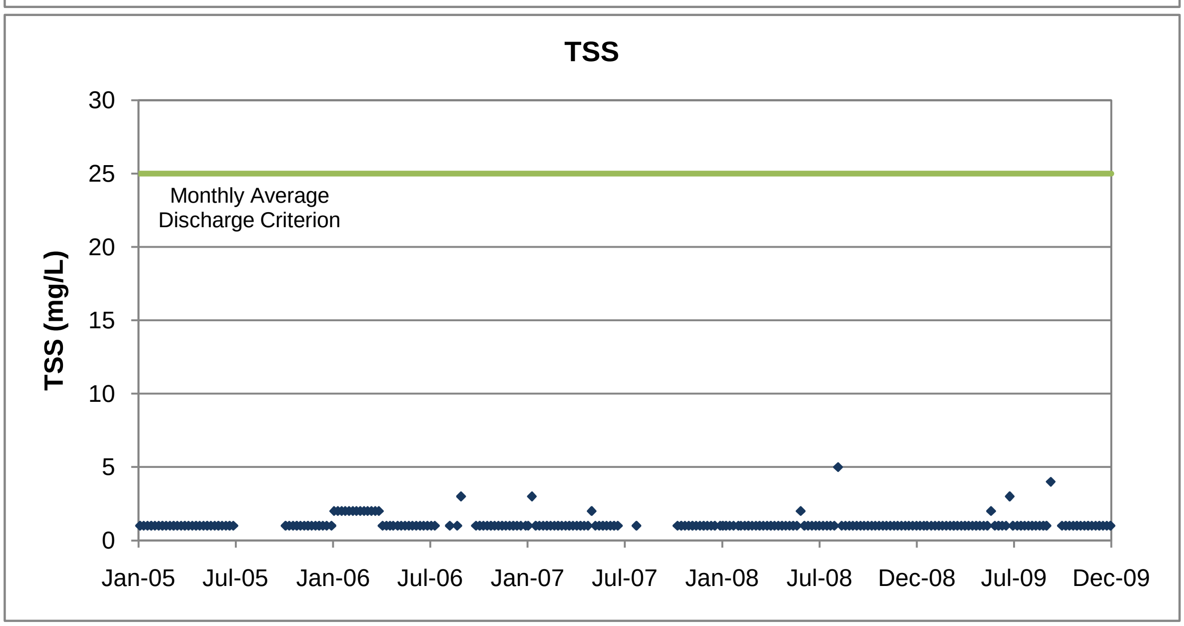


Figure 3.7: Effluent concentrations versus monthly average discharge criteria at Denison TMA station D-3.

Table 3.4: Toxicity test results for samples collected at Denison TMA station D-2, 2005 - 2009.

Sample Date (month-year)	Acute Toxicity (% mortality)		Survival and Reproduction (IC25[d] as % effluent)
	Daphnia magna [a]	rainbow trout [b]	*Ceriodaphnia dubia* [c]
May-05	0	0	100
November-05	0	0	100
May-06	0	0	100
December-06	0	0	100
June-07	0	0	100
October-07	0	0	100
June-08	0	0	100
October-08	0	0	100
May-09	0	0	100
October-09	0	0	100

[a] *Daphnia magna* 48-hr LC50 test (Environment Canada 2000a).

[b] Rainbow trout 96-hr LC50 test (Environment Canada 2000b).

[c] *Ceriodaphnia dubia* survival and reproduction test (Environment Canada 2007).

[d] Effluent concentration causing 25% inhibition relative to control organisms.

3.2 Spanish-American TMA

3.2.1 Basin History and Modifications

The Spanish-American mine and mill operated from 1958 to 1959. During that time the mine deposited approximately 0.45 million tonnes of tailings into the Spanish-American TMA.

In 1994, approximately 90,000 m^3 of exposed tailings beaches at the eastern end of Spanish-American TMA were relocated to the western end of the basin providing a nominal water cover depth of 0.9 m at the eastern perimeter and 1.5 m in the centre of the basin. Two engineered berms (North and South berms) were installed at the western outlet to flood the basin and confine the 10.92 ha Spanish-American TMA. Lime slurry was added to the basin during and after flooding (summers of 1994 to 1996) to achieve the target surface water pH of 7.0.

There is no ETP at the Spanish-American TMA. Drainage from the 37-hectare Spanish-American TMA watershed (owned by Rio Algom Limited), is monitored at station ECA-398 as it passes through the South Berm spillway to Denison TMA-1 (owned by Denison Mines Inc.; Figure 3.8). Station ECA-128 is monitored under the TOMP and the substances and frequency monitored are specific to the station type (Table 3.5; Figure 3.8). Data from ECA-128 are summarized in the following section and presented in Appendix C (Appendix Table C.2.1).

3.2.2 Basin Surface Water Quality

Surface water quality is monitored at the outlet of the Spanish American prior to its discharge to Denison TMA-1 (ECA-128). Effluent from the TMA is treated at Denison TMA-1 prior to discharge to the Serpent River Watershed. Routine monthly inspections of the Spanish American TMA indicate that the water cover in the TMA was consistently maintained and exposed tailing were not observed.

Over the past seven years (2003-2009), radium-226 has increased and pH and sulphate have decreased in the basin (Table 3.6). Increases in radium-226 concentration are likely associated with the decrease in sulphate concentrations within the basin and association of radium with residual iron hydroxides which are re-suspended and released during spring turn over as evidenced by elevated iron and radium in spring 2008 and 2009 samples (Appendix Table C.2.1). Work completed by EcoMetrix (Appendix G) indicates that as aqueous sulphate concentrations decline, there is an increased dissolution of barium sulphate to which radium is associated, whereby radium is released from the tailings. It is expected that radium concentrations in porewater will stabilize over time once the dissolution of barium

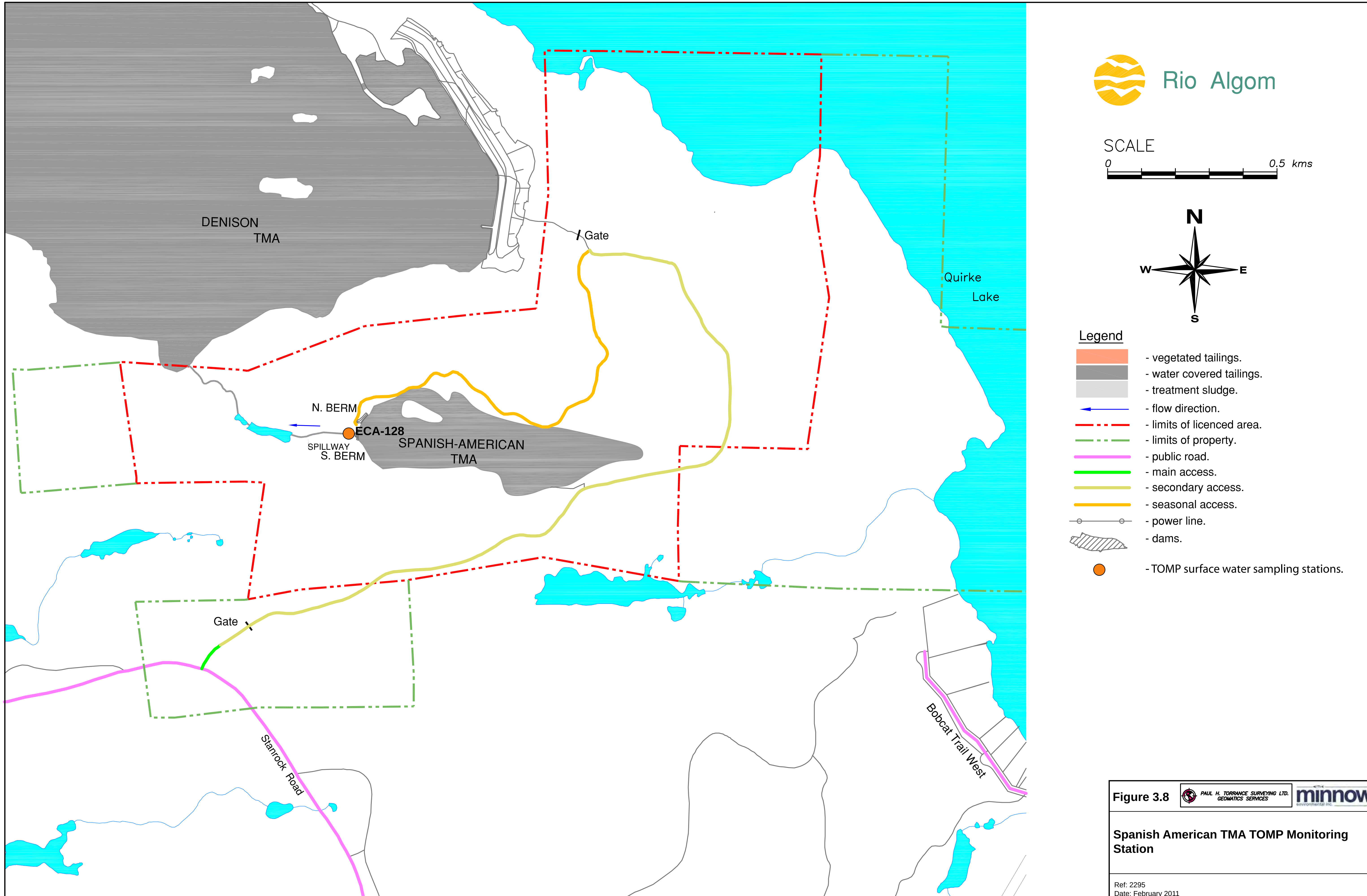


Figure 3.8

Spanish American TMA TOMP Monitoring Station

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Table 3.5: TOMP monitoring stations, substances, and frequencies[a] at Spanish American TMA.

			Parameters and Frequencies[a]										
TMA	TOMP Stations	Station Type/Purpose	Elevation	Flow	pH	Sulphate	Total radium-226	Lime or NaOH Consumption	Barium Chloride Consumption	TSS	Acidity	Iron	SAMP Metals[b]
Spanish American	ECA-128	Basin Performance	M[c]	Q	Q	Q	Q				Q		Q

[a] D - Work days, W - Weekly, M - Monthly, S - Semi-annually, A - Annually, Q-Quarterly

[b] SAMP metals are barium, cobalt, iron, manganese, and uranium

[c] During the snow-free period (April - November)

Table 3.6: Summary of water quality trends[a] at TOMP monitoring stations, Spanish American TMA, 2003 to 2009.

Station ID	Type/Location	Number of Seasons Used in Common Trend[c]	Acidity	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium
ECA-128	Sp. Am. TMA Effluent	3	-[b]	-	-	0.240	-	-0.478	0.578	-0.557	-0.204

(blue) decreasing trend, significant at $p<0.05$

(green) increasing trend, significant at $p<0.05$

[a] Based on rank correlation coefficients (rho) for common (combined) season trends, shown in table.

[b] "-" denotes that this parameter was not included in the trend analysis for that particular station due to insufficient data (e.g. there were <5 years worth of data for that parameter)

[c] Seasons used varied for substances based on suitability of data for trend analysis

sulphate re-equilibrates with aqueous sulphate concentrations. As there is no new source of radium to the TMA, radium concentrations in porewater and releases to surface water should decline as the amount of soluble material in the tailings diffusion zone decreases.

3.3 Quirke TMA

3.3.1 Basin History and Modifications

The Quirke TMA is located approximately 13 km north of the City of Elliot Lake and immediately north of Dunlop Lake. The Quirke mine and mill operated from 1956 to 1961, and again from 1968 to closure in 1990. Over this period, the Quirke mill produced approximately 42 million tonnes of tailings which along with four million tonnes of waste rock were deposited into the Quirke TMA.

The Quirke TMA was decommissioned as flooded tailings following mine closure in 1990 and covers a surface area of 192 ha. This TMA is composed of five terraced cells (Cells 14 to 18) within a bedrock-rimmed basin, separated by engineered, low-permeability dykes (Figure 3.9). Cell 14 at the west end of the basin was formed by raising Dyke 14 in 1991-1992 and provides a minimum 0.6 metre depth of water cover over the tailings. The downstream cells and dykes were constructed sequentially between 1994 and 1995. The last cell (Cell 18) is approximately 14 metres lower than Cell 14 creating a west to east cell-to-cell seepage gradient across the basin. Water is taken from Gravel Pit Lake to Cell 14 to replenish and maintain the water cover in Cell 14. In 1997 till blankets were applied to selected sections of the upstream sides of Dyke 14 and Dyke 15 to reduce the seepage flow. In the winter of 2003, a till blanket was extended across the entire length of Dyke 14 and a diffusion barrier was applied to 68% of Cell 14. The combined seepage from Cells 14 and 15 is approximately 45 L/sec with seepage from Cell 14 estimated at 35 L/sec (Golder 2011; Appendix H).

An *in-situ* lime addition program was initiated in 1995 whereby lime slurry is added to the cells on a seasonal basis to accelerate neutralization of historic acidity. Overflow from the Quirke TMA and its drainage basin is treated with lime (neutralization and metals removal) and barium chloride (radium removal) at the Quirke ETP prior to discharge into the Serpent River.

Within the TMA, surface water, porewater and ground water are monitored under the TOMP and the locations, substances and frequency monitored are specific to the station type (Table 3.7; Figure 3.9) Data from the TOMP stations are summarized in the following sections and presented in Appendix C (Appendix Tables C.3.2 – C.3.17).

Table 3.7: TOMP monitoring stations, substances, and frequencies[a] at Quirke TMA.

TOMP Stations	Station Type/Purpose	Parameters and Frequencies[a]										
		Elevation	Flow	pH	Sulphate	Total radium-226	Lime or NaOH Consumption	Barium Chloride Consumption	TSS	Acidity	Iron	SAMP Metals[b]
Q-05[d]	Basin performance (primary), ETP operations	W	D	M	Q	M	M	M		Q		Q
Q-03[d]	ETP operations			W								
Q-04P[d]	ETP operations			D								
Q-28[d]	Effluent		W[c]	W[c]	M[c]	W			W			M[c]
Q-29	Perimeter monitoring	W	W									
Cell 14, 15, 16S, 17	Basin performance (secondary)	M[e]		S	S	S				S	S	
90DK-14-5C; DK15-2(A-D); DK15-4(A-D); DK16-2(A-D); DK17-2(A-D)	Porewater			A	A					A	A	
QPW1-1,4,8; 95QW-3A,C,D; 95QW-4, 95QW-5A,D	Groundwater			A	A					A	A	

[a] D - Work days, W - Weekly, M - Monthly, S - Semi-annually, A - Annually, Q-Quarterly

[b] SAMP metals are barium, cobalt, iron, manganese, and uranium

[c] Monitoring requirement of SAMP

[d] Sampled when treatment plant is operating

[e] During the snow-free period (April - November)

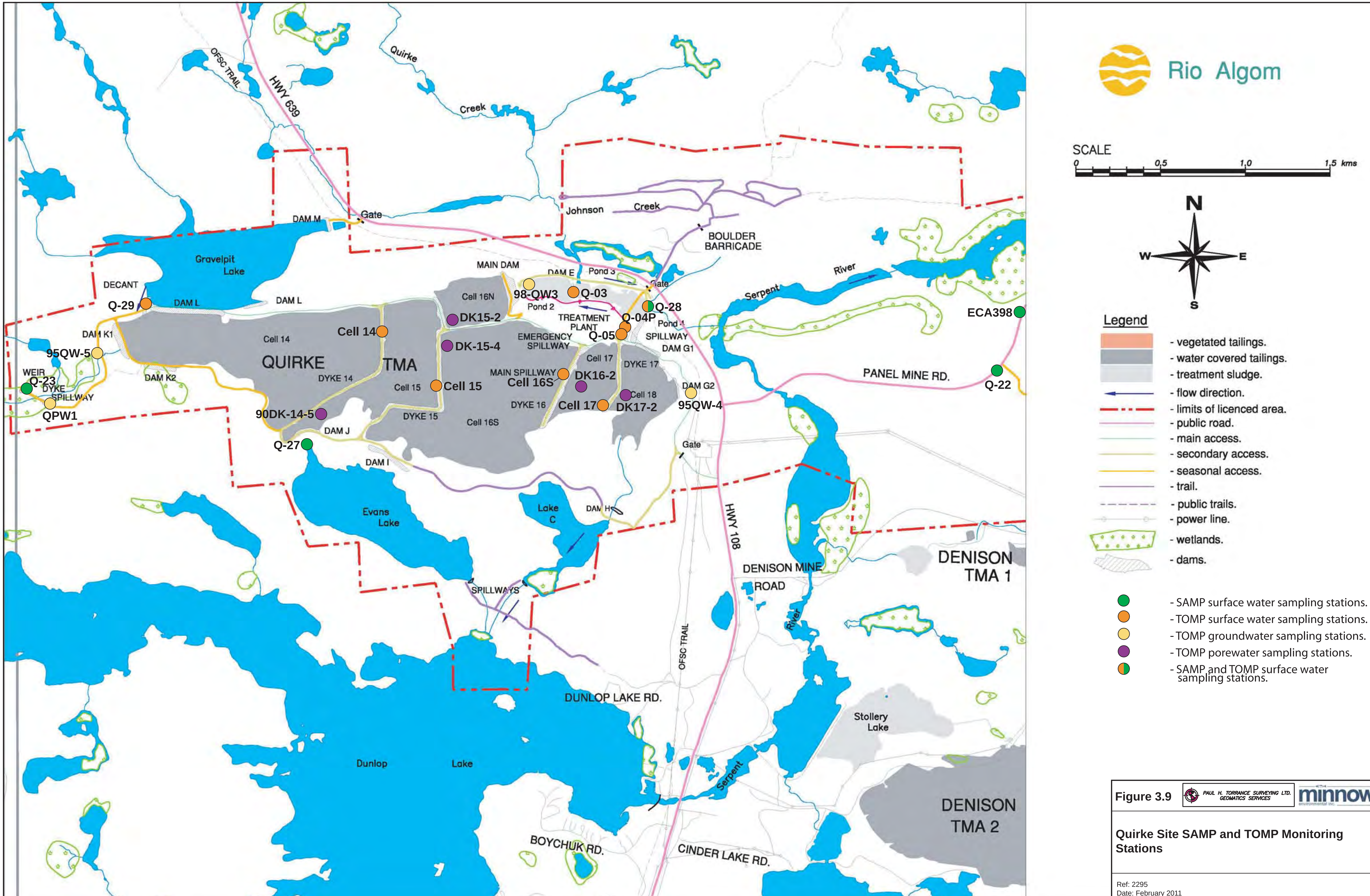


Figure 3.9

Quirke Site SAMP and TOMP Monitoring Stations

Ref: 2295
Date: February 2011

3.3.2 Water Management

Since the five cells of Quirke TMA are terraced, water elevations are lower in each progressive cell (Figure 3.10). Water from the first cell (Cell14) flows into the next cell until it reaches Cell 18 where it is treated prior to discharge to the Serpent River (Figure 3.10).

Application of the till blanket and diffusion barrier to Cell 14 in 2003 reduced seepage losses from Cell 14 from 50 L/s to 35 L/sec (Golder 2011; Appendix H) and following re-flooding of the cell in 2004, average water elevations within Cell 14 (2005 – 2009) have been maintained at 14 cm below the spillway overflow pipe (invert elevation of 377.77 masl) with a maximum depth below spillway elevation of 35 cm occurring in August of 2009. Water elevations in Cell 15 during the same time period have been maintained, on average, at 15 cm below the spillway overflow pipe (invert elevation of 373.74 masl) with a maximum depth below spillway elevation of 68 cm occurring in October of 2007. All other cells have remained at or above spillway invert elevation for the reporting period (Figure 3.10).

Since application of the till blanket and diffusion barrier to the cell margins, water elevation changes in Cell 14 do not result in exposure of tailings. However, prolonged periods of low precipitation can result in seasonal exposure of tailing in Cell 15. The lowest recorded water elevation (372.6 masl) occurred in April 2001 following a 1 in 50 year low precipitation event. EcoMetrix (2011b; Appendix H) was retained to assess potential acidity releases at elevations 0.5 m above and below this 1 in 50 year return event and determined:

- Annual acidity loadings from Cell 14 and Cell 15 are 1.14 and 0.88 tonnes of CaO per year and represent only 1% of the total annual Quirke lime consumption;
- Conservatively estimated acidity loads represent potential lime demands from 1 to 5 tonnes per year at Cell 15 water elevations of 373.0 masl and 372.0 masl respectively. These very conservative potential acidity loads are higher than acidity loads estimated from on-going monitoring data yet still represent only 1 to 3% of total annual lime consumption at the Quirke facility.

Water elevations in Cell 18 were consistently within the upper and lower operating limit for the TMA (Figure 3.10).

3.3.3 Basin Surface Water Quality

Basin surface water quality is monitored at five stations: the spillway of each cell (Cell 14, 15, 16S and 17) and at the ETP influent from Cell 18 (Q-05; Table 3.7; Figure 3.9).

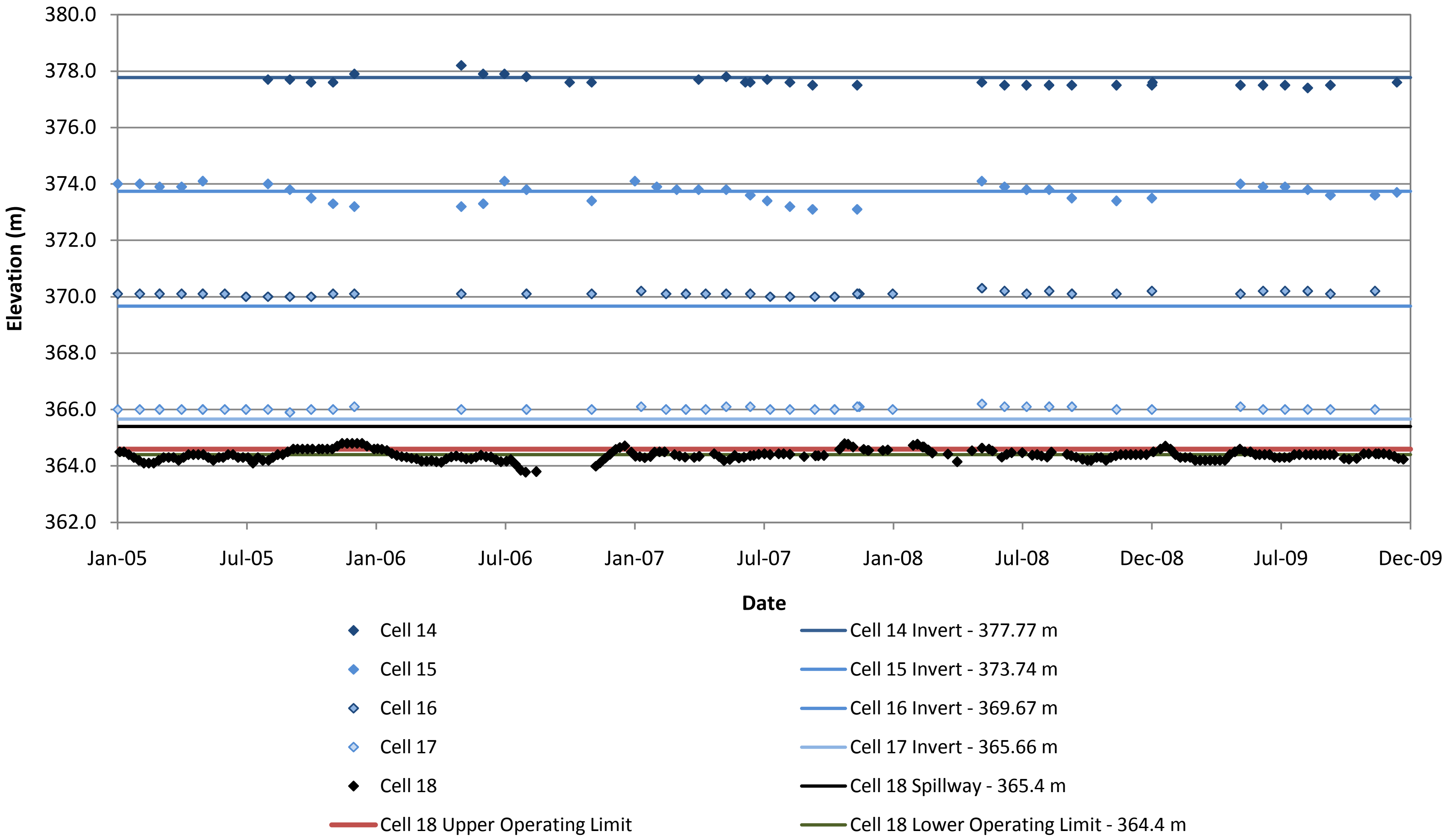


Figure 3.10: Water levels in cells of Quirke TMA.

Since decommissioning (1990 to 1996), treatment plant influent concentrations of sulphate and uranium have decreased, and pH has increased to near neutral levels (Figure 3.11). Concentrations of radium-226 increased slightly between 1992 and 2002 but have been relatively stable since then (Figure 3.11). Concentrations of radium-226, sulphate and uranium are approaching the 50 year post decommissioning predictions (*i.e.* 2040) (Figure 3.11).

More recently (2003-2009), surface water has continued to improve with significant reductions in acidity, sulphate and uranium and increased pH at Q-05 due to ongoing lime additions in Cell 16 and 17 (Table 3.8). Also acidity has decreased in Cell 14 in response to the diffusion barrier installed in 2003. During the installation, the water in the cell was drawn down and tailings were temporally exposed causing oxidation and acid production. After construction and cell re-flooding, the acid from oxidized tailings was flushed out and has slowly been reducing over time.

Although radium concentrations throughout the basin remain stable and within the EIS sensitivity analysis ranges (0.7 to 2.9 Bq/L), studies on radium release mechanisms suggest that the observed decreases in sulphate over time may result in increased radium concentrations within the basin. In order to develop an understanding of the mechanisms controlling radium-226 releases to basin surface water and to provide an upper bound radium-226 activity that may be observed in basin water, RAL retained EcoMetrix to investigate radium-226 activities in solids, porewater, and basin water in Cell 14. A complete description of the study findings is provided in Appendix G (EcoMetrix 2011c) and are summarized below:

- Barium concentrations and radium activities in porewater were well correlated, indicating that radium activities in porewater are controlled by similar mechanisms to the control of barium concentrations in porewater.
- The observed curvi-linear relationship between barium and sulphate porewater concentrations is consistent with the theoretical solubility of barium sulphate, whereby a decrease in sulphate porewater concentration will result in an increase in barium concentration in the porewater. Although the relationship was weaker for radium, it was evident that sulphate concentrations in porewater could also control for radium solubility in porewater.
- The concentration gradients between porewater and the overlying water column indicate an upward diffusion and mass transport of radium-226 from porewater to the

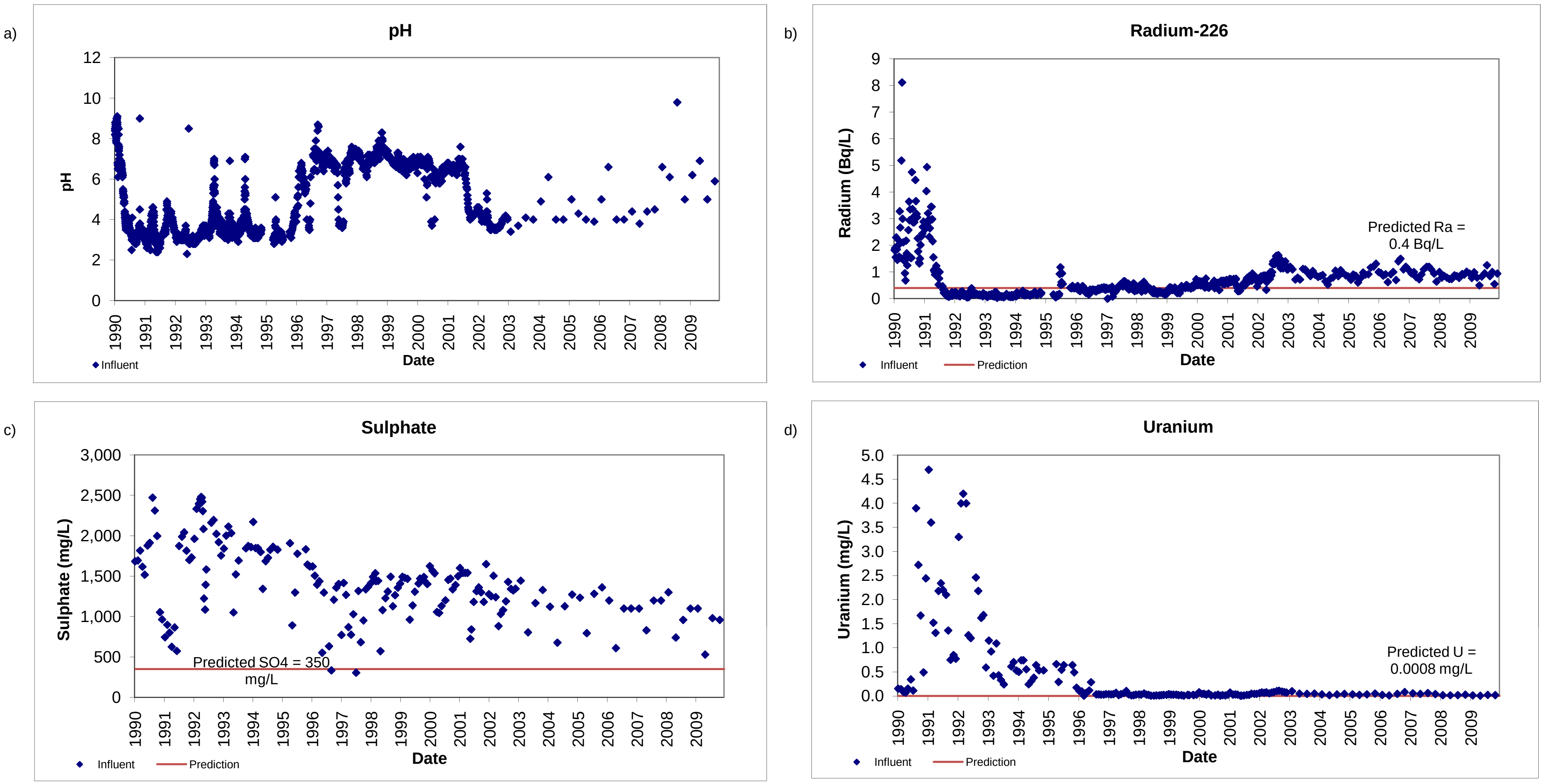


Figure 3.11: Water quality at the Quirke TMA ETP influent (Q-05) relative to predictions for 50 years (2040) post-decomissioning.

Table 3.8: Summary of water quality trends[a] for TOMP monitoring stations, Quirke TMA, 2003 to 2009.

Station ID	Type/Location	Number of Seasons Used in Common Trend[c]	Acidity	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium
Cell 14	Cell 14 at Spillway	1 to 2	-0.640	-[b]	-	-	-	0.200	0.036	-0.359	-
Cell 15	Cell 15 at Spillway	1 to 2	-	-	-	-	-	0.114	0.432	-0.500	-
Cell 16S	Cell 16S at Spillway	1 to 2	-	-	-	-	-	0.556	0.268	-0.872	-
Cell 17	Cell 17 at Spillway	1 to 2	-	-	-	-	-	0.438	0.089	-0.872	-
Q-05	Treatment Plant Influent	4 to 12	-0.710	-0.365	-0.366	-0.304	-0.219	0.718	-0.104	-0.574	-0.643

(blue) decreasing trend, significant at p<0.05

(green) increasing trend, significant at p<0.05

[a] Based on rank correlation coefficients (rho) for common (combined) season trends, shown in table.

[b] "-" denotes that this parameter was not included in the trend analysis for that particular station due to insufficient data (e.g. there were <5 years worth of data for that parameter)

[c] Seasons used varied for substances based on suitability of data for trend analysis.

overlying water. This is further supported by the close agreement between observed radium-226 activities in the basin water compared to the calculated activities using the diffusive flux measures determined from Cell 14 core samples.

- Mass transport theory indicates that the concentrations in the basin cannot exceed those in the porewater, assuming no flow through Cell 14. Therefore, sediment data indicate that under the study conditions, an upper boundary for radium activities in the basin water is about 1.5 Bq/L.

3.3.4 Porewater

Porewater is monitored annually for acidity, pH, iron and sulphate in each of the five dykes within the Quirke TMA (Table 3.7 and Figure 3.9).

Porewater at the Quirke TMA represents surface water flushing through the dykes, and so it is not surprising that porewater demonstrated similar trends to basin surface water. Sulphate and iron concentrations decreased over time (1990 to 2009) while pH increased at almost all locations and depths (Table 3.9; Appendix Figures C.3.1-C.3.10).

In shallow (3-5 m) and mid depth (6-10m) porewater samples, pH achieves levels predicted in the EIS for 2040 (*i.e.*, 50 year post-closure). In deeper (11-15m) porewater, pH is approaching the predicted level (Figure 3.12).

3.3.5 Groundwater Quality

Four locations (wells) are sampled annually for acidity, pH, iron and sulphate. One well is located at the east end of the TMA(QW4), one is down-gradient of the main dam (95QW3 A,C,D) at the north end of the TMA, and the other two are located down-gradient of Dam K1 at the west end of the TMA (95QW5 (A,D) and QPW1(1,4, 8); Figure 3.9).

At the north end of the TMA, down-gradient of the Main Dam (95QW3) a significant increase in pH and decrease in sulphate indicated improved ground water quality over time (Table 3.9). Down-gradient of Dam G-2 at the east end of the TMA (95QW-4) pH levels have significantly decreased and sulphate has increased over time, although pH remains near neutral and sulphate has not increased since 2005 (Table 3.9; Appendix Figure C.3.9). Similarly, down-gradient of Dam K1 (QPW1) iron and sulphate have been increasing in deeper wells with concentrations possibly stabilizing since 2005 (Table 3.9). These trends likely reflect the slow flushing of contaminants in the west end of the basin since flooding in 1990.

Table 3.9: Summary of water quality trends[ab] in TOMP porewater and groundwater in Quirke TMA, 1990[c] to 2009.

Type	Location	Station	Depth (m)	Dates	Iron	pH	Sulphate
porewater	cell 15 below dyke 15	DK14-5C	5.91	1991-2009	-0.482	0.600	-0.090
	cell 16 below dyke 15	DK15-2D	4.13	1995-2009	-0.975	0.798	-0.593
		DK15-2C	5.5	1995-2009	-0.988	0.763	-0.705
		DK15-2B	7.25	1995-2009	-0.981	0.720	-0.744
		DK15-2A	10.24	1995-2009	-0.952	0.768	-0.778
	cell 16S below dyke 15	DK15-4D	4.01	1995-2009	-0.969	0.900	-0.912
		DK15-4C	5.61	1995-2009	-0.974	0.846	-0.872
		DK15-4B	7.08	1995-2009	-0.987	0.677	-0.960
		DK15-4A	10.3	1995-2009	-0.987	0.639	-0.948
	cell 17 below dyke 16	DK16-2D	4.01	1995-2009	-0.930	0.752	-0.608
		DK16-2C	5.6	1995-2009	-0.887	0.682	-0.535
		DK16-2B	7.1	1995-2009	-0.987	0.785	-0.462
		DK16-2A	10.21	1995-2009	-0.130	-0.084	0.049
	cell 17 below dyke 17	DK17-2D	3.91	1995-2009	-0.705	0.746	0.117
		DK17-2C	5.57	1995-2009	-0.225	0.267	-0.486
		DK17-2B	7	1995-2009	0.090	0.459	-0.097
		DK17-2A	12.17	1995-2009	0.512	0.841	0.527
groundwater	downgradient of main dam	95QW3D	4.6	1995-2009	0.248	0.838	-0.455
		95QW3C	9	1995-2009	-0.301	0.871	-0.815
		95QW3A	20.7	1995-2009	-0.512	-0.121	-0.679
	downgradient of dam G2 at east end of TMA	95QW4	10	1995-2009	-0.258	-0.629	0.605
	downgradient of dam K1	95QW5D	4.3	1995-2009	-0.216	-0.311	-0.039
		95QW5A	9.75	1995-2009	0.279	-0.061	0.267
	downgradient of dam K1, upgradient of dyke 23	QPW1-1	2.1	1991-2008	0.221	-0.608	0.046
		QPW1-4	11.4	1990-2009	0.632	-0.323	0.141
		QPW1-8	23.9	1990-2009	0.603	-0.361	0.917

(blue) decreasing trend, significant at $p<0.05$

(green) increasing trend, significant at $p<0.05$

[a] Trends were not assessed for acidity because a change in analytical technique in 2006 meant that the data were not comparable before and after that time.

[b] Based on rank correlation coefficients (rho) for common (combined) season trends, shown in table.

[c] This is the earliest year included in the trend analysis, but not all stations have data going back to 1990.

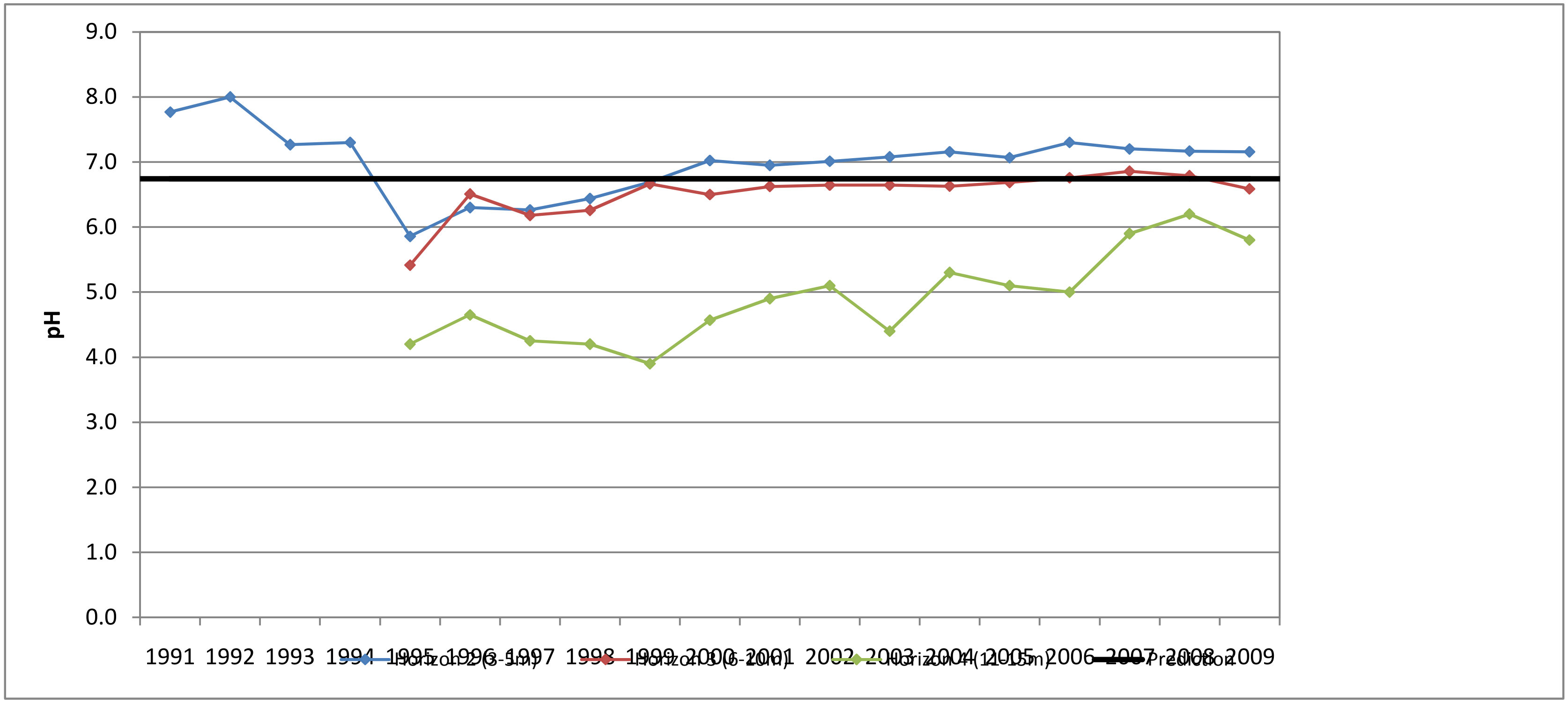


Figure 3.12: Comparison of mean porewater pH at various depths to EIS (2040) prediction, Quirke TMA, 1993-2009.

Horizon 2 - DK14-5C, DK15-2C, DK15-2D, DK15-4C, DK15-4D, DK16-2C, DK16-2D, DK17-2C, DK17-2D
Horizon 3 - DK15-2A, DK15-2B, DK15-4A, DK15-4B, DK16-2A, DK16-2B, DK17-2A, DK17-2B
Horizon 4 - DK17-2A

3.3.6 Treatment Performance

The Quirke TMA ETP is located at the spillway from Cell 18 (Figure 3.9). Treatment includes both lime and barium chloride to reduce acidity and radium-226 respectively. Combined annual lime consumption for both *in-situ* lime addition and treatment plant operations has remained relatively stable during the reporting period while the barium chloride consumption rate has declined from 1.2 to 0.6 mg/L (Figure 3.13).

Treated effluent quality is monitored at the outlet of the ETP settling pond (Q-28) and over the past five years has consistently achieved discharge criteria (Figure 3.14; Appendix Table C.3.1).

Effluent has also been consistently non-lethal to *Daphnia magna* and rainbow trout with no mortality reported in semi-annual acute toxicity tests (Table 3.10). Similarly, survival and reproduction of *Ceriodaphnia dubia* was not affected by exposure to 100% effluent in any of the tests conducted over the past five years (Table 3.10).

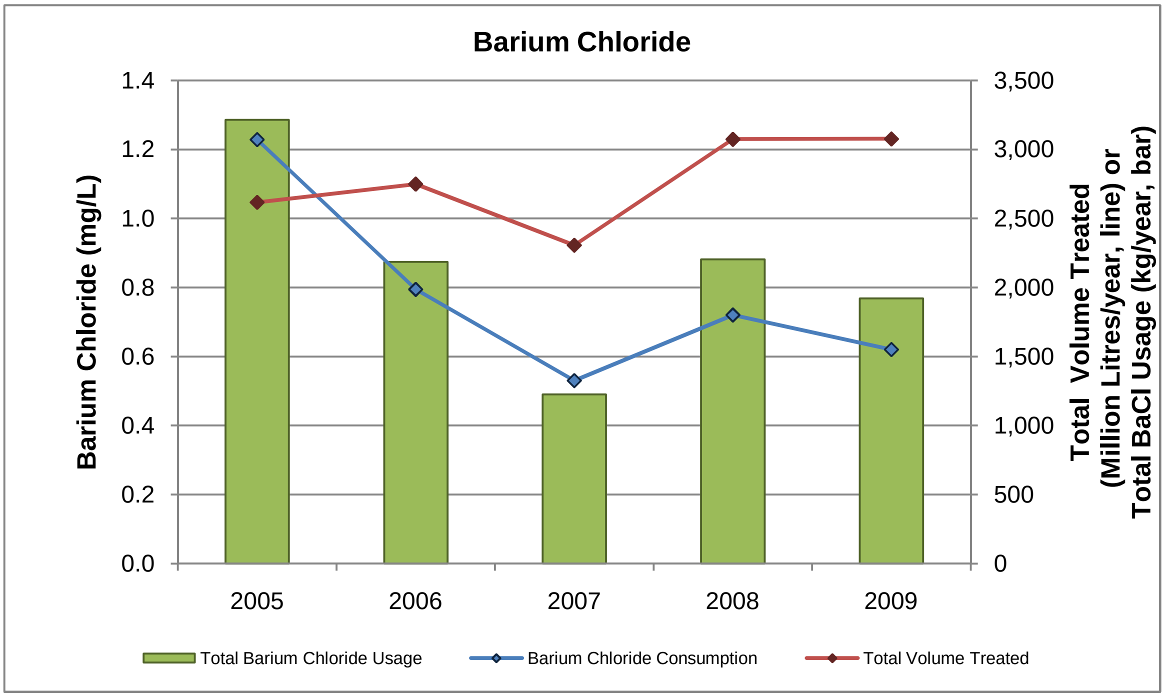
3.3.7 Summary

Tailings water cover in the Quirke TMA has been maintained, with water levels within operational range limits. In-basin surface water and porewater quality has been improving over time and generally achieves EIS predictions (*i.e.* the TMA is performing as anticipated). Groundwater down-gradient of the main dam has been improving over time, while the groundwater down-gradient of Dam K1 has shown decreasing pH and increasing concentrations of iron and sulphate. It is expected that these trends are representative of the initial flushing of historical porewaters from the TMA following flooding. In the past five years effluent quality consistently achieved discharge criteria and all tests to *Daphnia magna*, rainbow trout and *Ceriodaphnia dubia* were non-toxic. Overall, the Quirke TMA is performing well and conditions are improving over time.

3.4 Panel TMA

3.4.1 Basin History and Modifications

The Panel TMA is located 19 km northeast of the City of Elliot Lake, immediately north of Quirke Lake. The TMA is comprised of two bedrock-rimmed basins, the Main Basin and the South Basin, and contains a total of approximately 16 million tonnes of tailings and waste rock produced during two operating periods 1958 to 1961 and, following rehabilitation and upgrading, from 1979 to closure in 1991(Rio Algom 1995).



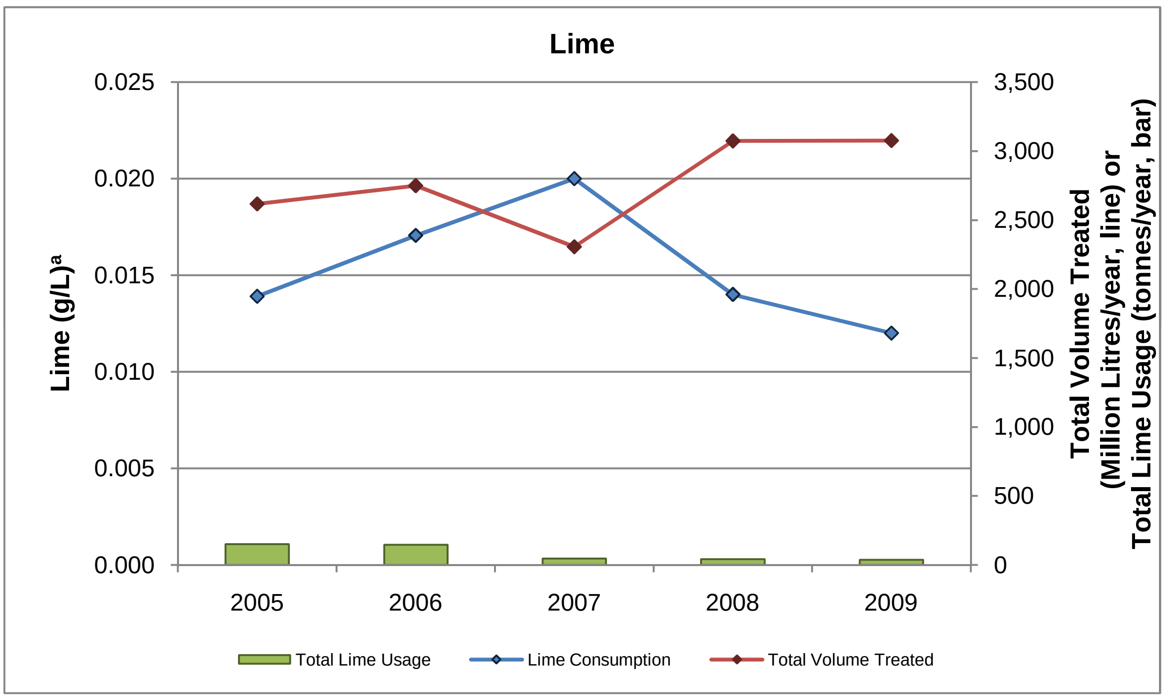


Figure 3.13: Comparison of total reagent consumed versus total volume treated at Quirke TMA from 2005-2009. [a] including in situ cell lime additions.

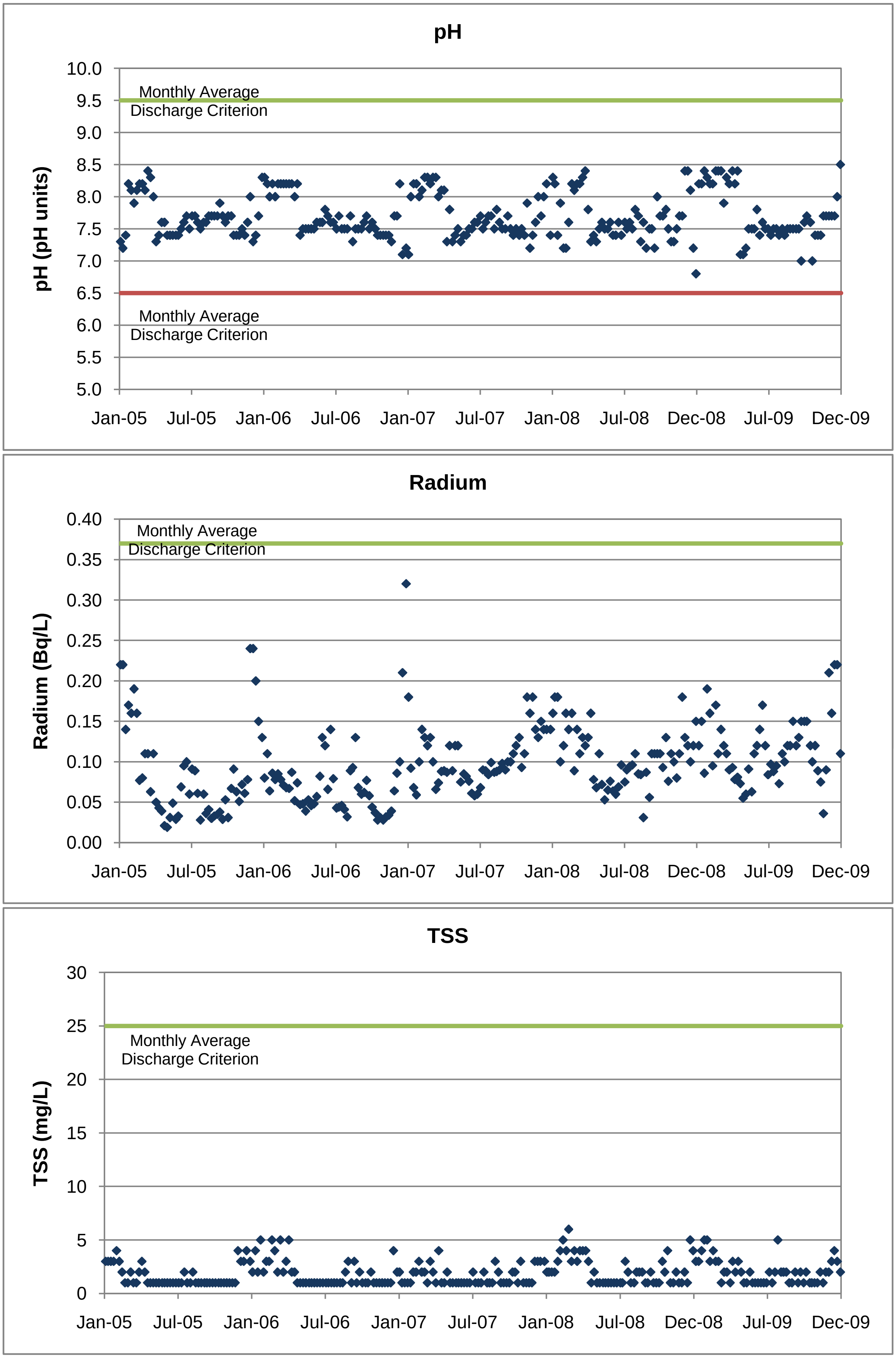


Figure 3.14: Effluent concentrations versus monthly average discharge criteria at Quirke TMA station Q-28.

Table 3.10: Toxicity test results for samples collected at Quirke TMA station Q-28, 2005 - 2009.

Sample Date (month-year)	Acute Toxicity (% mortality)		Survival and Reproduction (IC25[d] as % effluent)
	Daphnia magna [a]	rainbow trout [b]	*Ceriodaphnia dubia* [c]
May-05	0	20	100
November-05	0	0	100
May-06	0	0	100
November-06	0	0	100
May-07	3	0	100
November-07	0	0	100
May-08	0	0	100
November-08	0	0	100
May-09	0	0	100
November-09	0	0	100

[a] *Daphnia magna* 48-hr LC50 test (Environment Canada 2000a).

[b] Rainbow trout 96-hr LC50 test (Environment Canada 2000b).

[c] *Ceriodaphnia dubia* survival and reproduction test (Environment Canada 2007).

[d] Effluent concentration causing 25% inhibition relative to control organisms.

The Main Basin is contained by four engineered low-permeability dams (Dams B, D, E, and H) and has a total area of approximately 84 hectares (Figure 3.15). The South Basin, which contains a small quantity of tailings deposited in the late 1950s, is retained by two engineered low-permeability dams (Dams A and F) that have maintained the 39-ha basin in a flooded state since 1978 (Rio Algom 2000; Figure 3.15). Dam K and Berms W1, W2 and W3 were constructed in 1978 to divert run-off from the sub-watershed north of the Main Basin, east to Rochester Creek through Channel Y (Figure 3.15). Additional surface run-off is diverted away from the west side of the Main Basin to Panel Creek and Quirke Lake via Channel Z, which was also constructed in 1978 (Figure 3.15). This resulted in a drainage area of 177 hectares for the Main Basin. The South Basin, which receives inflow from the Main Basin, also receives surface water drainage from its own 119-ha watershed area.

Neutralization of tailing in the mill was practiced during all operational phases of the mine. Starting in 1974 and until construction of the new plant in 1981, lime and barium chloride were mixed in a small treatment plant adjacent to the mill and pumped to the basins via a two-inch line during the frost-free season. Treatment solids settled in what is now the South Basin and treated effluent was discharged to Rochester Creek via Dam A. As part of the 1978 facility upgrading, the current treatment plant and settling ponds were constructed in the vicinity of Dam F and treated effluent was directed towards Quirke Lake.

The Panel TMA was decommissioned through flooding, with the Main Basin draining into the South Basin via a spillway. The overflow from the South Basin enters the ETP where it is treated with a mixture of lime slurry and barium chloride to neutralize acidity and remove radium. The water level in the Main Basin reached its target elevation in 1994, after which lime slurry was added *in situ* on a seasonal basis (until 1999) to increase the pH in both basins on a seasonal basis. Rehabilitation of the Panel TMA was completed in 1999 with the construction of an overflow spillway at the west abutment of Dam F in the South Basin and the construction of an engineered earthfill dam at the outlet of Pond C to Rochester Creek (Pond C berm; Figure 3.15). Pond C contains a small volume of fine tailings and treatment solids and receives seepage from Dam A and run-off from its 65-ha drainage area.

Within the TMA, surface water and groundwater are monitored under the TOMP and the locations, substances and frequency monitored are specific to the station type (Table 3.11 and Figure 3.15). Data from the TOMP stations are summarized in the following sections and presented in Appendix C (Appendix Tables C.4.2-C.4.8).

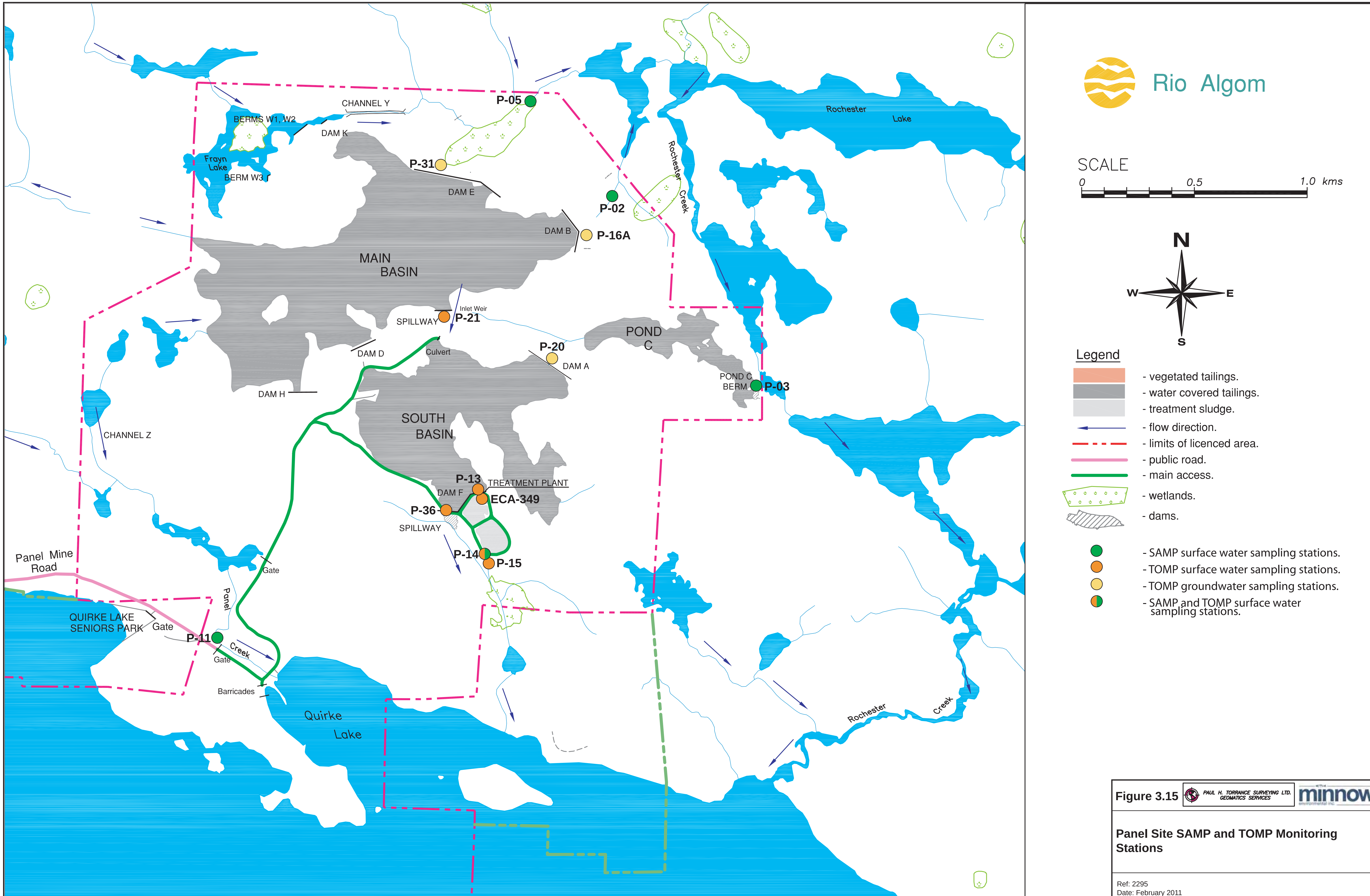


Figure 3.15 Panel Site SAMP and TOMP Monitoring Stations

Table 3.11: TOMP monitoring stations, substances, and frequencies[a] at Panel TMA.

		Parameters and Frequencies[a]											
TOMP Stations	Station Type/Purpose	Elevation	Flow	pH	Conductivity	Sulphate	Total radium-226	Lime or NaOH Consumption	Barium Chloride Consumption	TSS	Acidity	Iron	SAMP Metals[b]
P-13[f]	Basin performance (primary), ETP operations	W	D	M		Q	M	M	M		Q		Q
ECA-349[f]	ETP operations			D									
P-14[f], P-36[f]	Effluent		-[d]	W[c]		M[c]	W			W			M[c]
P-15	Perimeter				M								
P-21	Basin performance (secondary)	M[e]		S		S	S				S	S	
P-16A, P-20, P-31	Groundwater			A		A					A	A	

[a] D - Work days, W - Weekly, M - Monthly, S - Semi-annually, A - Annually, Q-Quarterly

[b] SAMP metals are barium, cobalt, iron, manganese, and uranium

[c] Monitoring requirement of SAMP

[d] No flow monitoring at P-14 because <1% additional flow between P-13 and P-14

[e] During the snow-free period (April - November)

[f] Sampled when treatment plant is operating

3.4.2 Water Management

Water levels are monitored in both the Main and South basins of the Panel TMA. The Main Basin water elevation is generally maintained above the spillway invert (393.2 m), although a bedrock outcrop down-gradient of the spillway tends to retain water in the spillway to an elevation above 393.4m (Figure 3.16). In the South Basin, an operating practice is used to maintain a consistent water elevation while minimizing treatment plant start and stop cycles. Generally water is drawn down in the fall to maximize winter storage capacity and avoid winter operation of the ETP (e.g., period when ETP is least efficient). At the time the last State of the Environment Report (Minnow 2009a) was prepared, Rio Algom established winter and summer operating elevations for the South Basin to minimize fluctuations in water elevations. In the fall/winter, a draw down elevation of 379.6 m is used with a restart target of 380.15 m (0.55 m fluctuation in water level) whereas in the summer the draw down elevation is 380.0 m with a restart target of 380.34 (0.34 m fluctuation). Since 2008, water levels in the South Basin have been more stable (Figure 3.16). Over the past five years, water levels in the Main Basin were maintained high enough to ensure consistent water cover of tailings (Figure 3.16).

3.4.3 Basin Surface Water Quality

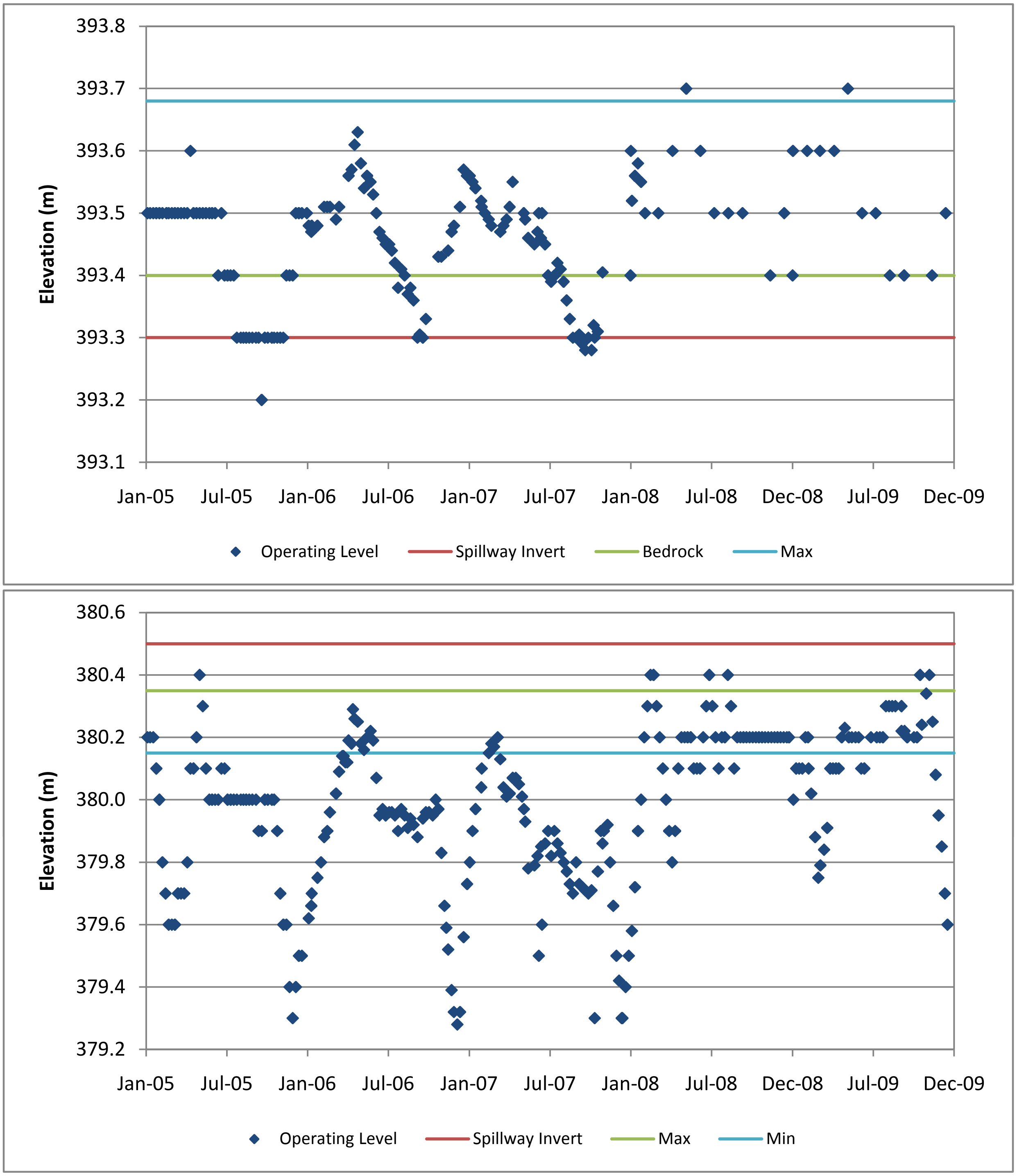
Surface water quality is monitored at five stations: the spillway of the Main Basin (P-21), the ETP influent (P-13) and effluent (P-14), the ETP pH probe (ECA-349) and the ETP settling pond underflow drainage (P-15; Table 3.11; Figure 3.15).

Since decommissioning (1990 to 1999) radium-226, sulphate and uranium concentrations have decreased and pH has increased to near neutral (Figure 3.17) such that concentrations are approaching the 50 year post decommissioning predictions (*i.e.* 2040) (Figure 3.17).

More recently (2003-2009) surface water has continued to improve with significant reductions in the concentrations of acidity, radium-226, sulphate and uranium and increased pH at the ETP influent (P-13; Table 3.12; Appendix Figure C.4.1) At the ETP influent, pH meets the discharge criterion and radium-226 concentrations are approaching the criterion (Appendix Figure C.4.1). At the outlet of the Main Basin both pH and radium-226 achieve discharge criteria prior to treatment (Appendix Table C.4.7).

While radium-226 concentrations were found to be decreasing over the past five years and remain within the range specified in EIS sensitivity analysis (0.4 to 1.4 Bq/L), sulphate has also been decreasing and studies on radium release mechanisms suggest that decreases in sulphate over time may result in radium release from the tailing to the overlying water column

a)



b)

Figure 3.16: Water level at Panel main basin (a) and south basin (b) relative to minimum operating elevation.

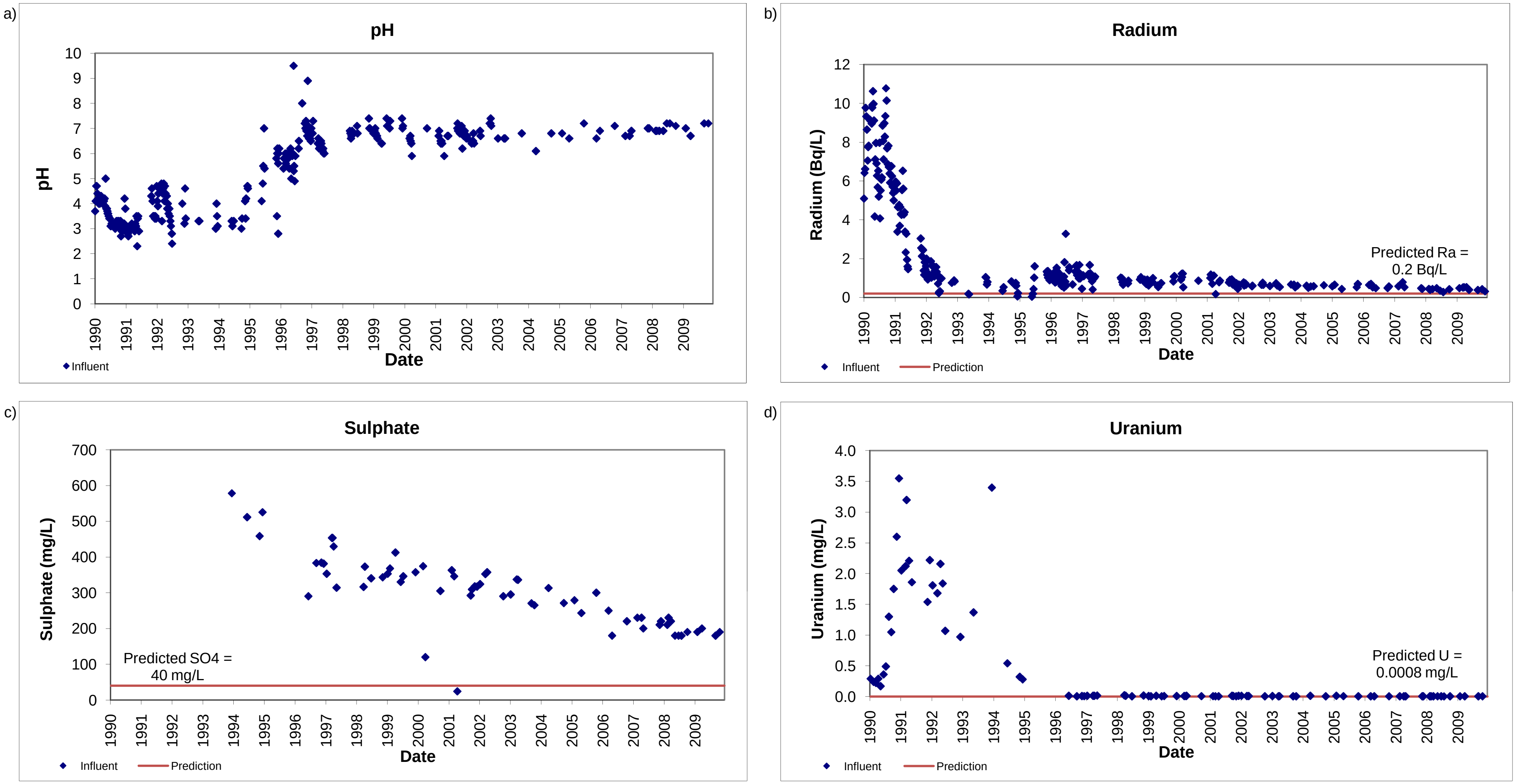


Figure 3.17: Water quality at the Panel TMA ETP influent (P-13) relative to predictions for 50 year (2040) post-decomissioning.

Table 3.12: Summary of water quality trends[a] for TOMP monitoring stations, Panel TMA, 2003 to 2009.

Station ID	Type/Location	Number of Seasons Used in Common Trend[c]	Acidity	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium
P-21	Main Basin Outflow	2	ND[b]	-[d]	-	-	-	-0.144	-0.171	-	-
P-13	ETP Influent	2 to 4	-0.870	0.510	-0.282	-0.331	0.276	0.741	-0.689	-0.904	-0.850

(blue) decreasing trend, significant at p<0.05

(green) increasing trend, significant at p<0.05

[a] Based on rank correlation coefficients (rho) for common (combined) season trends, shown in table.

[b] ND denotes that this parameter was not included in the trend analysis for that particular station due to >50% non-detectable concentrations in the samples available for the ana

[c] Seasons used varied for substances based on suitability of data for trend analysis.

[d] "-" denotes that this parameter was not included in the trend analysis for that particular station due to insufficient data (e.g. there were <5 years worth of data for that paramete

of the basin. In order to develop an understanding of the mechanisms controlling radium-226 releases to basin surface water, RAL retained EcoMetrix to investigate radium-226 activities in solids (submerged tailings and treatment solids), porewater, and basin water in the Panel TMA. A complete description of the study findings is provided in Appendix G (EcoMetrix 2011d) and summarized below:

- Barium concentrations and radium activities in porewater were correlated, suggesting that radium-226 may behave similarly to barium, although another secondary mechanism may also influence radium release from solids. A strong correlation between calcium and sulphate in the sediment indicates that gypsum is present. Therefore, the solubility of sulphate (present as gypsum) likely controls the release of radium (associated with barite) into porewater.

- A correlation between barium and sulphate suggests that barium (and therefore radium) release to porewater is controlled by the solubility of barite and the sulphate concentrations in the porewater. Correlations between radium and sulphate in porewater were relatively weak, however, when all data is combined (both Panel and Quirke cores from the EcoMetrix studies) a stronger relationship is evident, where radium begins to release from solids when sulphate in porewater decreases to below 250 mg/L.

- Sulphate concentrations in the TMA pore water were high (ranging 190 to 1,800 mg/L), and therefore radium release into pore water is expected to be low. Therefore, a conservative upper bound for pore water radium was suggested at 5.5 Bq/L, the maximum concentration observed in the 2006 Pond C sediment samples where sulphate concentrations in porewater were significantly lower (minimum observed concentration 75.3 mg/L) and are consistent with maximum concentrations observed at the Quirke TMA.

- Mass transport theory indicates that the concentrations in the basin cannot exceed those in the porewater. Therefore, diffusive flux indicates that based on a pore water upper bound of 5.5 Bq/L, an upper boundary for radium activities in the basin water is in the range of 0.65 to 1.79 Bq/L.

3.4.4 Groundwater Quality

Three locations (wells) are sampled annually for acidity, pH, iron and sulphate. Two wells are located in the Main Basin down-gradient of Dams E (P-31) and B (P-16A) and one is located down-gradient of Dam A (P-20) in the South Basin (Figure 3.15).

Since decommissioning, groundwater in the Main Basin down-gradient of Dam B (P-16A) showed a significant increase in sulphate and decrease in pH over time (1990-2009), although conditions have been stable or possibly improving since 2005 (Table 3.13; Appendix Figure C.4.2). These trends are representative of acidic waters from early decommissioning being flushed through the groundwater. No significant trends were found at the other groundwater station down-gradient of the Main Basin (P-31) although the data tend to reflect the same pattern. In the South Basin down-gradient of Dam A (P-20 – towards Pond C) sulphate in groundwater has decreased over time (Appendix Figure C.4.3) consistent with the trend observed in South Basin surface water (Table 3.12).

3.4.5 Treatment Performance

Surface water from the Panel Main Basin discharges to the South Basin. Overflow from the South Basin is treated at the ETP and associated settling ponds prior to discharge to the receiving environment (P-14; Figure 3.15). The TMA ETP uses both lime (used caustic soda 2003 to 2007) and barium chloride to reduce acidity and radium-226 levels, respectively. Reintroduction of lime as the neutralizing agent in 2007 has enabled reduction in the barium chloride addition rate by 0.5 mg/L although total consumption increased in 2008 and 2009 due to higher treatment volumes (Figure 3.18).

Treated effluent is monitored at the outlet of the ETP settling pond (P-14) and over, the past five years, effluent quality has consistently achieved discharge criteria (Figure 3.19; Appendix Table C.4.1). Effluent has also been consistently non-lethal to *Daphnia magna* and rainbow trout with no mortality reported in semi-annual acute toxicity tests (Table 3.14). Similarly, survival and reproduction of *Ceriodaphnia dubia* was not affected by exposure to 100% effluent in any tests conducted over the past five years (Table 3.14).

3.4.6 Summary

Tailings water cover at the Panel TMA has been maintained and since 2008, water levels within the South Basin have been more stable than in previous years. In-basin surface water quality has been improving over time and is near or achieving the 50-year EIS predictions (*i.e.* the TMA is performing as anticipated). Since decommissioning, groundwater down-gradient of the Main Basin showed a significant increase in sulphate and decrease in pH over time (1990-2009), although conditions have been stable or possibly improving since 2005. In the South Basin down-gradient of Dam A, groundwater sulphate has decreased over time consistent with the trend observed in surface water. In the past five years effluent quality consistently achieved discharge criteria and all tests to *Daphnia magna*, rainbow trout

Table 3.13: Summary of water quality trends[ab] in TOMP groundwater in Panel TMA, 1990[c] to 2009.

Location	Station	Depth (m)	Dates	Iron	pH	Sulphate
downgradient of dam A (south basin)	P-20	13.9	1990-2009	-0.374	-0.428	-0.902
downgradient of dam B (main basin)	P-16A	24.8	1990-2009	-0.086	-0.751	0.699
below dam E (main basin)	P-31	9.97	1996-2009	0.012	-0.332	0.169

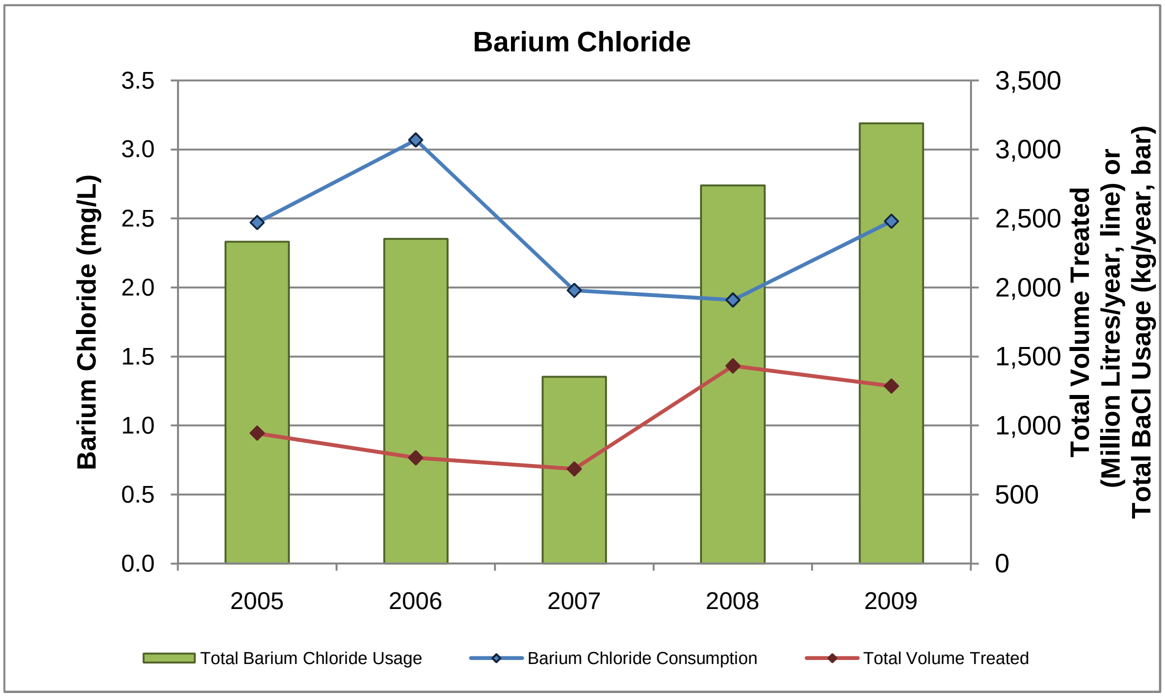
(blue) decreasing trend, significant at $p<0.05$

(green) increasing trend, significant at $p<0.05$

[a] Trends were not assessed for acidity because a change in analytical technique in 2006 meant that the data were not comparable before and after that time.

[b] Based on rank correlation coefficients (rho) for common (combined) season trends, shown in table.

[c] This is the earliest year included in the trend analysis, but not all stations have data going back to 1990.



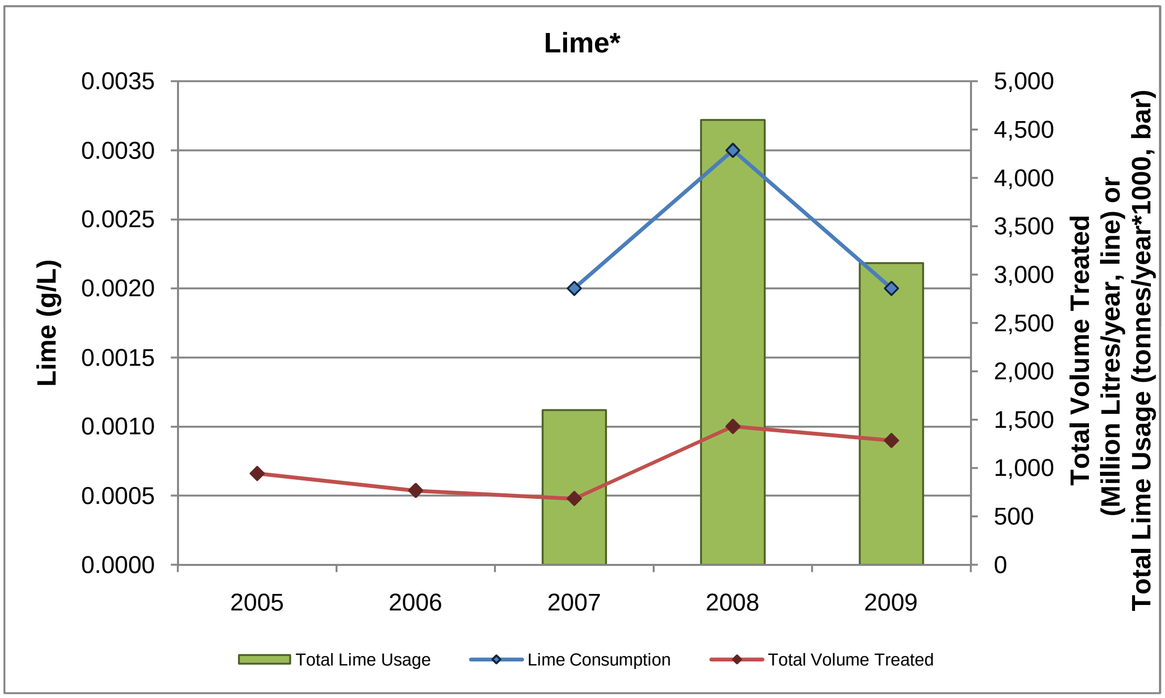


Figure 3.18: Comparison of total reagent consumed versus total volume treated at Panel TMA from 2005-2009 (* Caustic Soda in 2005 & 2006).

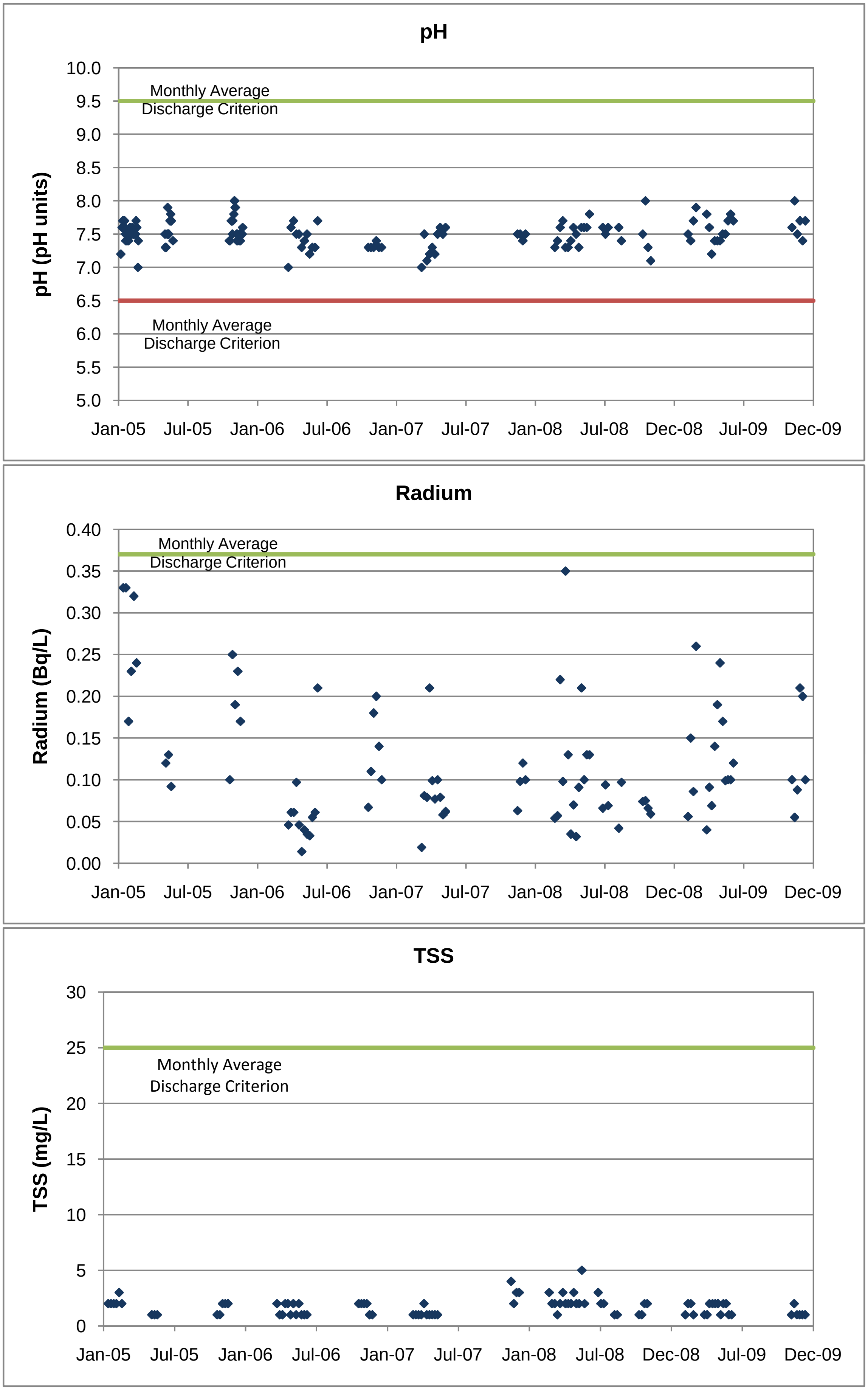


Figure 3.19: Effluent concentrations versus monthly average discharge criteria at Panel TMA station P-14.

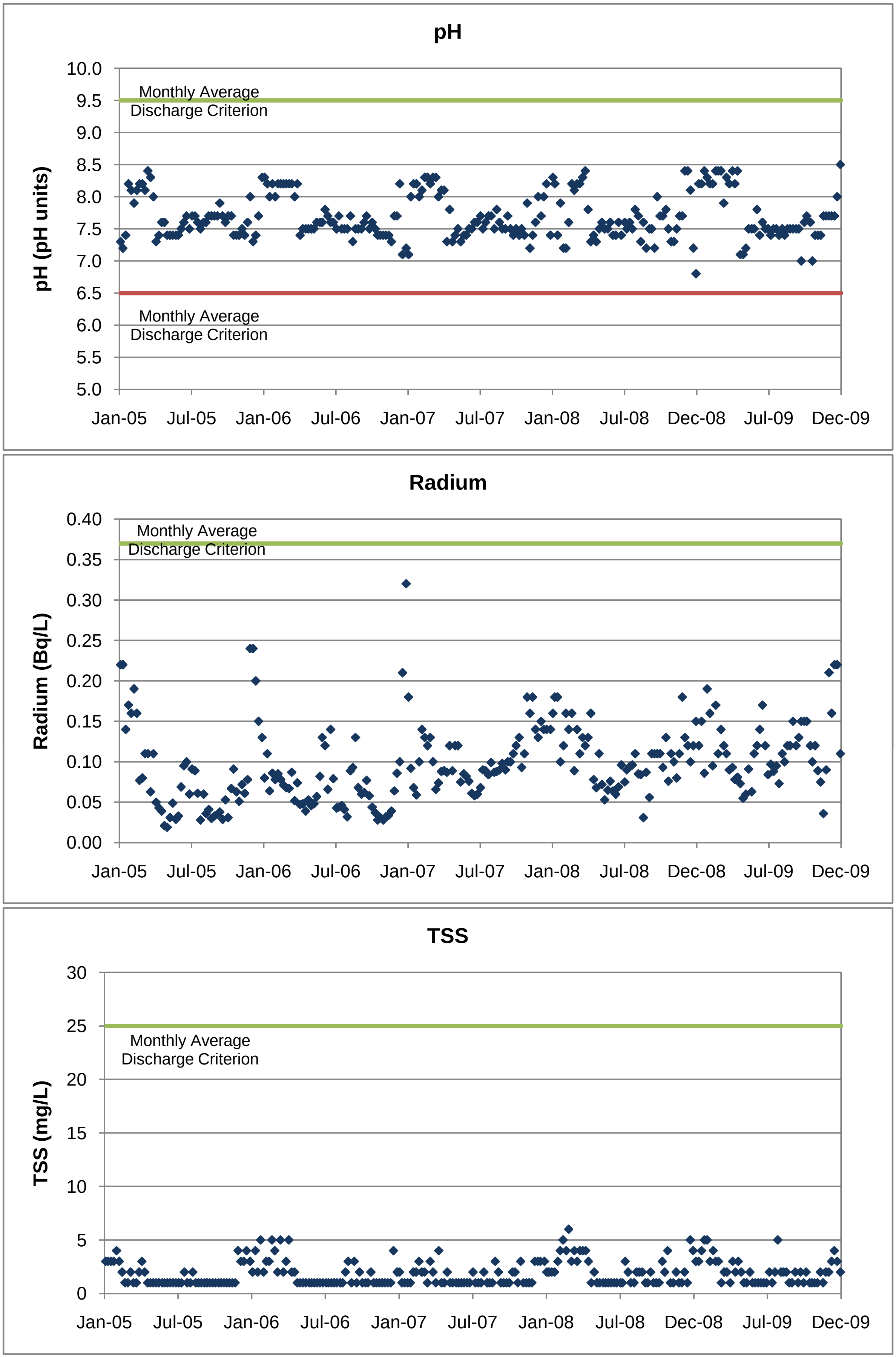


Figure 3.14: Effluent concentrations versus monthly average discharge criteria at Quirke TMA station Q-28.

and *Ceriodaphnia dubia* were non-toxic. Overall, the Panel TMA is performing well and conditions are improving over time.

3.5 Stanrock TMA

3.5.1 Basin History and Modifications

Stanrock Uranium Mines Limited and Can-met Exploration Limited began mining operations in early 1958. Both companies discharged their tailings to the natural basin of a small lake located immediately south of the mines that became the Stanrock TMA (Figure 3.20). On March 24, 1960, Can-met Exploration Limited amalgamated with Consolidated Denison Mines Limited and shortly thereafter operations at the Can-met mine were suspended. In 1964, underground operations at the Stanrock mine were also suspended, at which time the discharge of tailings ceased. Approximately 5.7 million tonnes of tailings were produced and stored within the 52-hectare Stanrock TMA over the course of mine operations.

Between 1964 and 1970, leaching solution, supplemented by water from Quirke Lake, was employed to leach uranium from the underground mine. The uranium-bearing liquor was processed in the mill ion exchange circuit to recover uranium, and then was returned underground. Excess solution was neutralized and discharged to the Stanrock TMA. In 1973, Denison Mines amalgamated with Stanrock Mines and, from 1978 to 1983, the Stanrock mine was re-established and underground development was carried out as part of an Ontario Hydro expansion. During this time, underground mine water was processed and neutralized mine water was discharged to the Stanrock TMA. A small amount of ore was processed in the Denison mill.

An "*In Situ* Management Plan" using a vegetation cover was chosen as the preferred option for decommissioning the Stanrock TMA. In accordance with the decommissioning plan, the following major activities were completed to decommission the Stanrock TMA between 1997 and 1999:

- Construction of a new rock cut spillway near Dam A;
- Construction of new low permeability engineered Dams A, B, C, and D;
- Reconstruction of Dam K and spillway to provide additional sludge storage capacity;
- Relocation of sludge within Moose Lake;
- Upgrading of Dam F to ensure long-term stability;
- Upgrading of Orient Lake outlet berm;

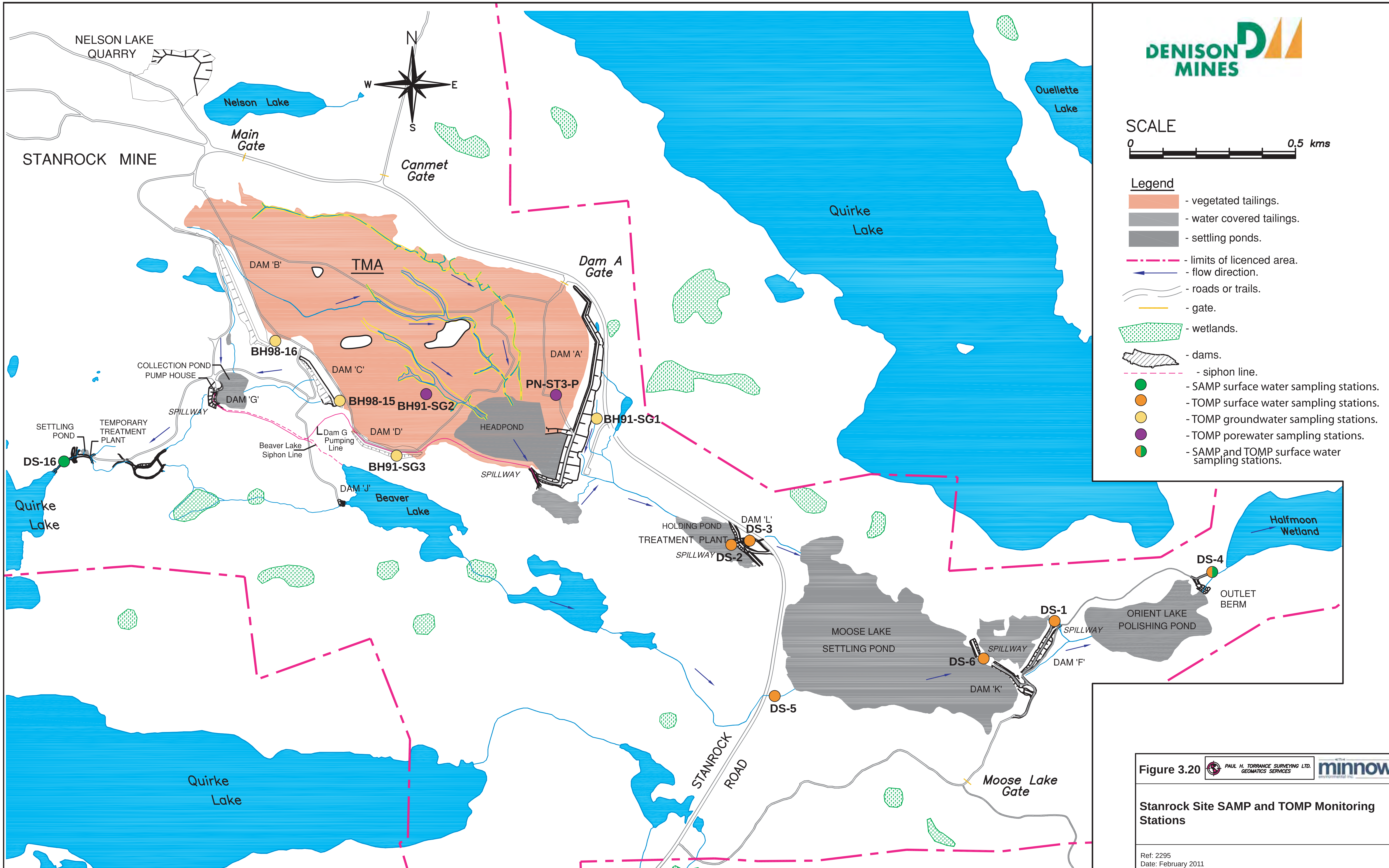


Figure 3.20 Stanrock Site SAMP and TOMP Monitoring Stations

- Remediation of spilled tailings;
- Establishment of rock lined channels on the Stanrock TMA for surface drainage;
- Vegetation of the tailings;
- Installation of new monitoring piezometers in the new dams and tailings to measure water levels; and
- Construction of a new water treatment plant that allowed for storage of untreated water and improved reagent mixing with untreated effluent.

In 1997 and 1998 new containment dams were constructed downstream of the existing structures. The dams incorporated a water retaining core of compacted till that is founded on bedrock. The bedrock foundation beneath the dam core was grouted to minimize seepage. Filters and drains were provided to prevent internal erosion and a build-up of porewater against the dam. Construction of the low permeability dams began in 1997 and was completed in 1998.

Approximately 40 ha of the Stanrock TMA were vegetated in 1998 with the remainder, in the area of the main headpond, being completed in 1999. Although there is a small headpond, water is generally not impounded in the TMA, but drains from the surface and passes through a spillway near Dam A to the Stanrock treatment plant. Seepage from Dams B and C is collected in the Dam G Collection Pond and pumped to the Dam A spillway where it flows downstream to the ETP holding pond for treatment at the ETP located to the southeast of the TMA (Figure 3.20). Treated effluent is discharged into the Moose Lake settling pond which flows into Orient Lake for further polishing and eventually to Halfmoon Lake, which is the first downstream receiver after the final point of control (DS-4, Orient Lake Outlet). Currently, DMI is in the process of replacing beaver dams at the outlet of Halfmoon Wetland with engineered berms to better contain treatment solids and tailings associated with an historical spill that occurred in 1964. The project is expected to be completed by the spring of 2011.

Since early 2005, Beaver Lake water, which receives seepage from Dam D, has been siphoned to the Dam G Collection Pond (and thereafter pumped to the ETP) to reduce untreated seepage overflow to Moose Lake.

In the summer of 2005, an issue arose regarding historic low pH water entering Quirke Lake from an area downstream of the Dam G Collection Pond. This area was a result of a historical tailings spill that occurred in 1964. In 2000, tailings were removed from Quirke

Lake and placed within the Stanrock TMA. In addition, the two tailings deposits (upper and lower) between Dam G and Quirke Lake were covered with a layer of sand and gravel to attenuate gamma and to raise the water table and saturate the tailings. The drainage pathway was directed around the two deposits in order to reduce the flushing of contaminants from the covered tailings.

Additional measures were taken in October of 2005 in order to address the low pH entering Quirke Lake at DS-16, which included the installation of a temporary sodium hydroxide treatment system located downstream of the outlet of the lower tailings deposit. A sludge collection basin was excavated in the lower tailings deposit immediately downstream of the sodium hydroxide addition point. Three concrete measuring weirs were also installed on the flow path between Dams G and J and Quirke Lake and a more rigorous sampling program was implemented. These measures were undertaken in order to better understand the mechanisms that were taking place in the area below Dam G, such that a final solution to deal with the low pH water could be determined. Based on the supplemental data obtained for this area, an improvement plan was designed and approved by the CNSC in consultation with other members of the Elliot Lake JRG. The improvement work involved the removal of tailings in the upper and lower wetland areas and construction of; fresh water diversions, a seepage collection pond, dam and spillway, and pumping station at the receiving end of the lower wetland to collect surface runoff and seepage water. This remedial work was completed in November of 2010. The water collected from these works is pumped to the Dam G Collection Pond and eventually through to the Dam A headpond. The water then drains through the spillway to the ETP for treatment, and discharge to Halfmoon Lake via the Moose Lake settling pond and Orient Lake polishing pond.

Based on the supplemental data obtained for this area, an improvement plan has been designed and is currently being reviewed by the Elliot Lake Joint Review Group. The proposed maintenance work will include removal of tailings in the upper and lower wetland areas and construction of a seepage collection pond, dam, and pumping station at the receiving end of the lower wetland to collect surface runoff and seepage water. These waters will be pumped to the Dam G Collection Pond and eventually through the Dam A spillway to the ETP for treatment, and discharge to Halfmoon Lake via the Moose Lake settling pond and Orient Lake polishing pond.

Within the TMA, surface water, porewater and ground water are monitored under the TOMP and the locations, substances and frequency monitored are specific to the station type (Table

3.15; Figure 3.20) Data from the TOMP stations are summarized in the following sections and presented in Appendix C (Appendix Tables C.5.2-C.5.12).

3.5.2 Basin Surface Water Quality

Stanrock is a vegetated TMA and as such there is no surface water within the TMA. Surface water runoff and seepage are collected in a holding pond and represent the influent to the ETP treatment plant (DS-2). In addition, water within downstream settling ponds (DS-6) and polishing ponds (DS-1), as well as the final effluent (DS-4), are monitored (Figure 3.20).

Since 2003, TMA water quality at the ETP influent has improved with significant reductions in radium-226 and sulphate (Table 3.16; Appendix Figure C.5.1). Influent radium-226 is now below the discharge criterion (0.37 Bq/L) but sulphate remains elevated and acidity continues to require treatment.

3.5.3 Porewater

Porewater is monitored annually at two locations in the Stanrock TMA: up-gradient of Dam A (PN-STP3) and up-gradient of Dam D (BH91SG2) (Table 3.15; Figure 3.20) for acidity, pH, iron and sulphate.

Up-gradient of Dam D, tailings porewater showed a significant increase in pH over time (1991 to 2009; Table 3.17; Appendix Figure C.5.5). Up-gradient of Dam A (PN-STP3) pH increased significantly in the shallow porewater (5.94 m), but decreased significantly over the same time at the deepest sampling depth (20.91 m; Table 3.17, Appendix Figure C.5.8). Iron increased significantly at both the shallow and deep sampling depths (Table 3.17; Appendix Figure C.5.7 and C.5.8). The increase in pH in shallower wells and the decrease in deeper wells likely reflect the on-going flushing of historic acidity from the tailing porewater over time.

Porewater pH at all depths except the deepest (>26 m) achieved the EIS predicted level for 2010, indicating that the TMA is performing as expected (Figure 3.21).

3.5.4 Groundwater Quality

Four groundwater locations are sampled annually for acidity, pH, iron and sulphate: one well is located down-gradient of each of the TMA Dams; A (BH91-SG1), B (BH98-16), C (BH98-15) and D (BH98-SG3 Figure 3.20).

Down-gradient of Dam A groundwater is assessed at 5.49m. Here both iron and pH levels have significantly increased over time (1991-2009; Table 3.17; Appendix Figure C.5.2)

Table 3.15: TOMP monitoring stations, substances, and frequencies[a] at Stanrock TMA.

		Parameters and Frequencies[a]										
TOMP Stations	**Station Type/Purpose**	**Flow**	**pH**	**Conductivity**	**Sulphate**	**Total radium-226**	**Lime or NaOH Consumption**	**Barium Chloride Consumption**	**TSS**	**Acidity**	**Iron**	**SAMP Metals[b]**
DS-2	Basin performance (primary), ETP operations	D	D		Q	M	M	M		Q		Q
DS-3	ETP operations		D									
DS-4	Effluent	W[c]	W		M	W			W			M[d]
DS-1	Additional pH control, radium monitoring	W	W			Q						
DS-6	Additional pH control	W	W									
DS-5	Seepages and surface water internal to TMA	Q	Q	Q								
PN-ST3-P3,5,6,8; BH91-SG2A,D	Porewater		A		A					A	A	
BH91-SG1A, BH98-16A, BH98-15A, BH91-SG3A,B	Groundwater		A		A					A	A	

[a] D - Work days, W - Weekly, M - Monthly, S - Semi-annually, A - Annually, Q-Quarterly

[b] SAMP metals are barium, cobalt, iron, manganese, and uranium

[c] Monitoring requirement of SAMP.

Table 3.16: Summary of water quality trends[a] for TOMP monitoring stations, Stanrock TMA, 2003 to 2009.

Station ID	Type/Location	Number of Seasons Used in Common Trend[b]	Acidity	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium
DS-2	Treatment Plant Influent	3 to 12	-0.130	0.364	0.221	0.142	0.311	-0.141	-0.458	-0.561	-0.253

(blue) decreasing trend, significant at $p<0.05$

(green) increasing trend, significant at $p<0.05$

[a] Based on rank correlation coefficients (rho) for common (combined) season trends, shown in table.

[b] Seasons used varied for substances based on suitability of data for trend analysis.

Table 3.17: Summary of water quality trends[ab] in TOMP porewater and groundwater in Stanrock TMA, 1991[d] to 2009.

Type	Location	Station	Depth (m)	Dates	Iron	pH	Sulphate
porewater	upgradient of dam D	BH91 SG2A	33.31	1991-2009	0.274	0.643	-[c]
	upgradient of dam A	PN-ST3-P5	2.64	1999-2009	0.800	0.420	-
		PN-ST3-P3	5.94	1991-2009	-0.103	0.508	-
		PN-ST3-P6	11.58	1991-2009	0.409	0.387	-
		PN-ST3-P8	20.91	1991-2009	0.932	-0.552	-
groundwater	downgradient of dam A	BH91 SG1A	5.49	1991-2009	0.631	0.764	-
	downgradient of dam B	BH98-16A	5.49	1999-2009	-0.764	0.019	-
	downgradient of dam C	BH98-15A	7.86	1999-2009	-0.300	0.583	-
	downgradient of dam D	BH91 SG3B	5.85	1999-2009	-0.067	-0.280	-
		BH91 SG3A	8.78	1999-2009	-0.939	-0.165	-

(blue) decreasing trend, significant at p<0.05

(green) increasing trend, significant at p<0.05

[a] Trends were not assessed for acidity because a change in analytical technique in 2006 meant that the data were not comparable before and after that time.

[b] Based on rank correlation coefficients (rho) for common (combined) season trends, shown in table.

[c] "-" denotes that this parameter was not included in the trend analysis for that particular station due to insufficient data (e.g. there were <5 years worth of data for that paramet

[d] This is the earliest year included in the trend analysis, but not all stations have data going back to 1991.

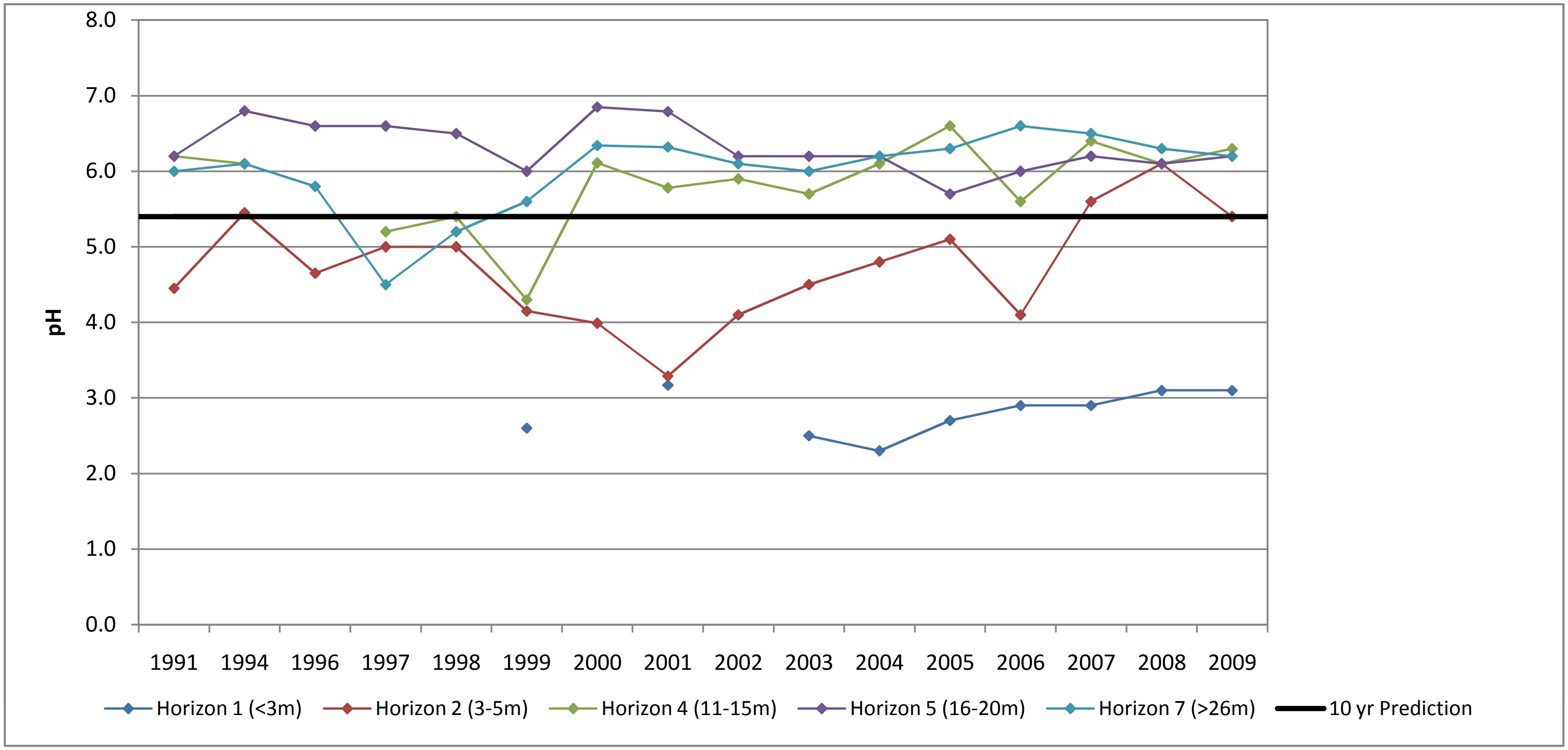


Figure 3.21: Comparison of mean porewater pH at various depths to EIS (2010) prediction, Stanrock TMA, 1991-2009.

Horizon 1 - PN-STP3-P5

Horizon 2 - PN-STP3-P3, BH91-SG2D

Horizon 4 - PN-STP3-P6

Horizon 5 - PN-ST3-P8

Horizon 7 - BH91-SG2A

consistent with porewater trends. Down-gradient of Dams B and D, iron concentrations significantly decreased (Table 3.17; Appendix Figures C.5.3 and C.5.4).

3.5.5 Treatment Performance

Water collected at Stanrock TMA is treated at the Stanrock ETP, then flows through a settling and polishing pond prior to discharge into Halfmoon Lake (Figure 3.20). Treatment includes both lime and barium chloride to reduce acidity and radium-226, respectively. Consistent with a reduction in radium-226 concentrations in the ETP influent, barium chloride consumption rates have decreased over the past five years, although the total usage has remained similar to other years likely due to higher treatment volumes in 2008 and 2009 (high precipitation years) (Figure 3.22). Lime usage was similar to previous years even though the volume treated in 2008 and 2009 was higher (Figure 3.22).

Following treatment, effluent quality is monitored at the outlet the polishing pond (DS-4). Over the past five years effluent quality has consistently achieved discharge criteria (Figure 3.23; Appendix Table C.5.1). Effluent has also been consistently non-lethal to *Daphnia magna* and rainbow trout with no mortality reported in semi-annual acute toxicity tests (Table 3.18). Similarly, survival and reproduction of *Ceriodaphnia dubia* was not affected by exposure to 100% effluent in any tests conducted over the past five years except for one sample collected in October 2007 (Table 3.18), in which reproduction was affected at an effluent concentration of 86%. However, it is expected that effluent concentrations would be diluted to less than 86% in the receiving environment.

3.5.6 Summary

Since 2003, TMA water quality at the ETP influent has improved with significant reductions in radium-226 and sulphate. Influent radium-226 is now below the discharge criterion (0.37 Bq/L) but sulphate remains elevated and pH continues to require treatment. Porewater pH has been increasing except at the deepest well and as a result, pH levels are for the most part, achieving levels predicted in the EIS for 2010. However, iron in porewater down-gradient of Dam A has been increasing over time, as has iron in groundwater down-gradient of Dam A. Groundwater down-gradient of Dams B and D showed a significant decrease in iron since decommissioning. Barium chloride consumption rate in the ETP has decreased over the past five years as a result on decreasing radium-226 concentrations in the ETP influent. Lime usage has remained stable. Effluent quality has consistently achieved discharge criteria over the past five years and has consistently been non-lethal to *Daphnia magna* and rainbow trout with no mortality reported in semi-annual acute toxicity tests.

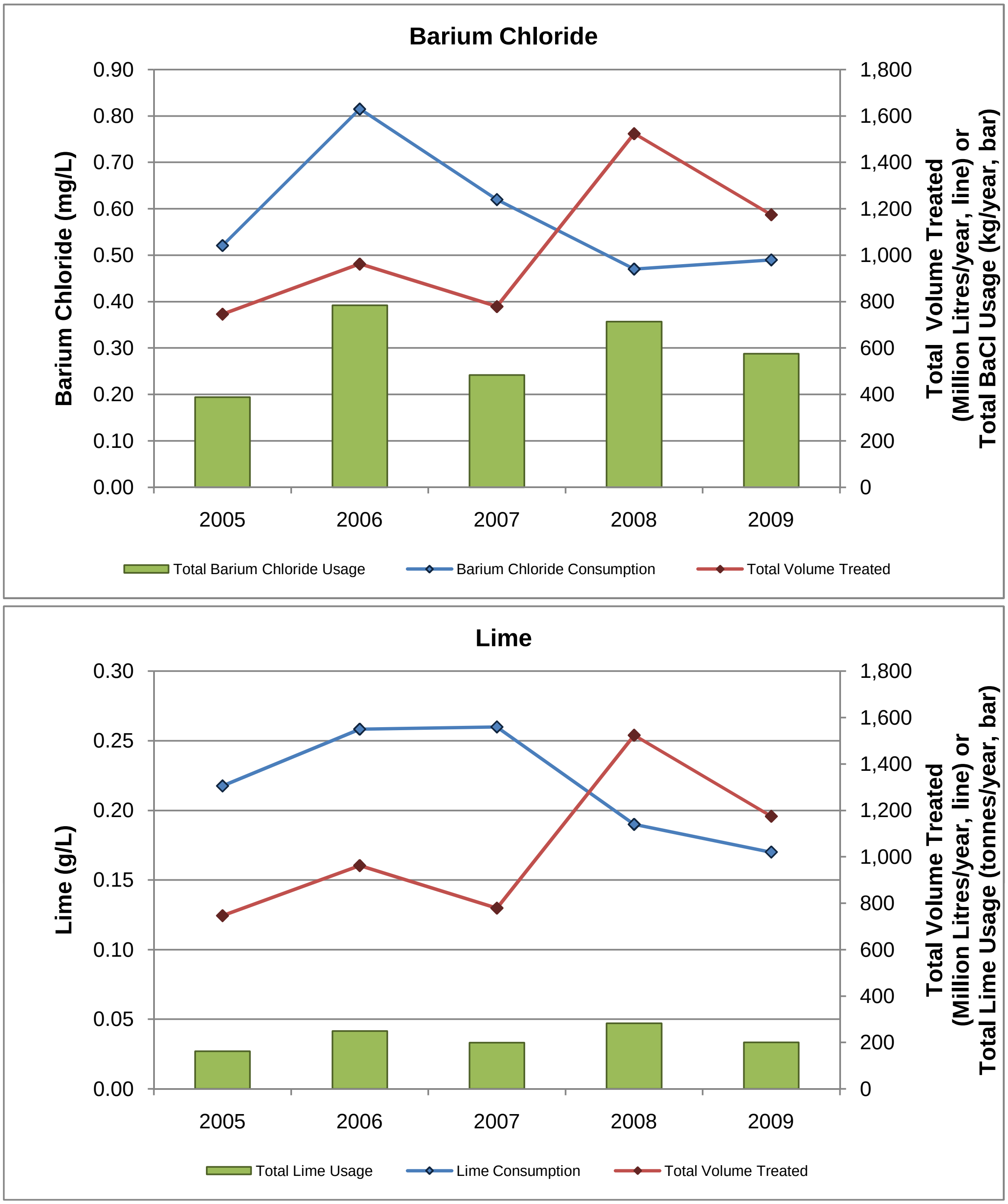


Figure 3.22: Comparison of total reagent consumed versus total volume treated at Stanrock TMA from 2005-2009.

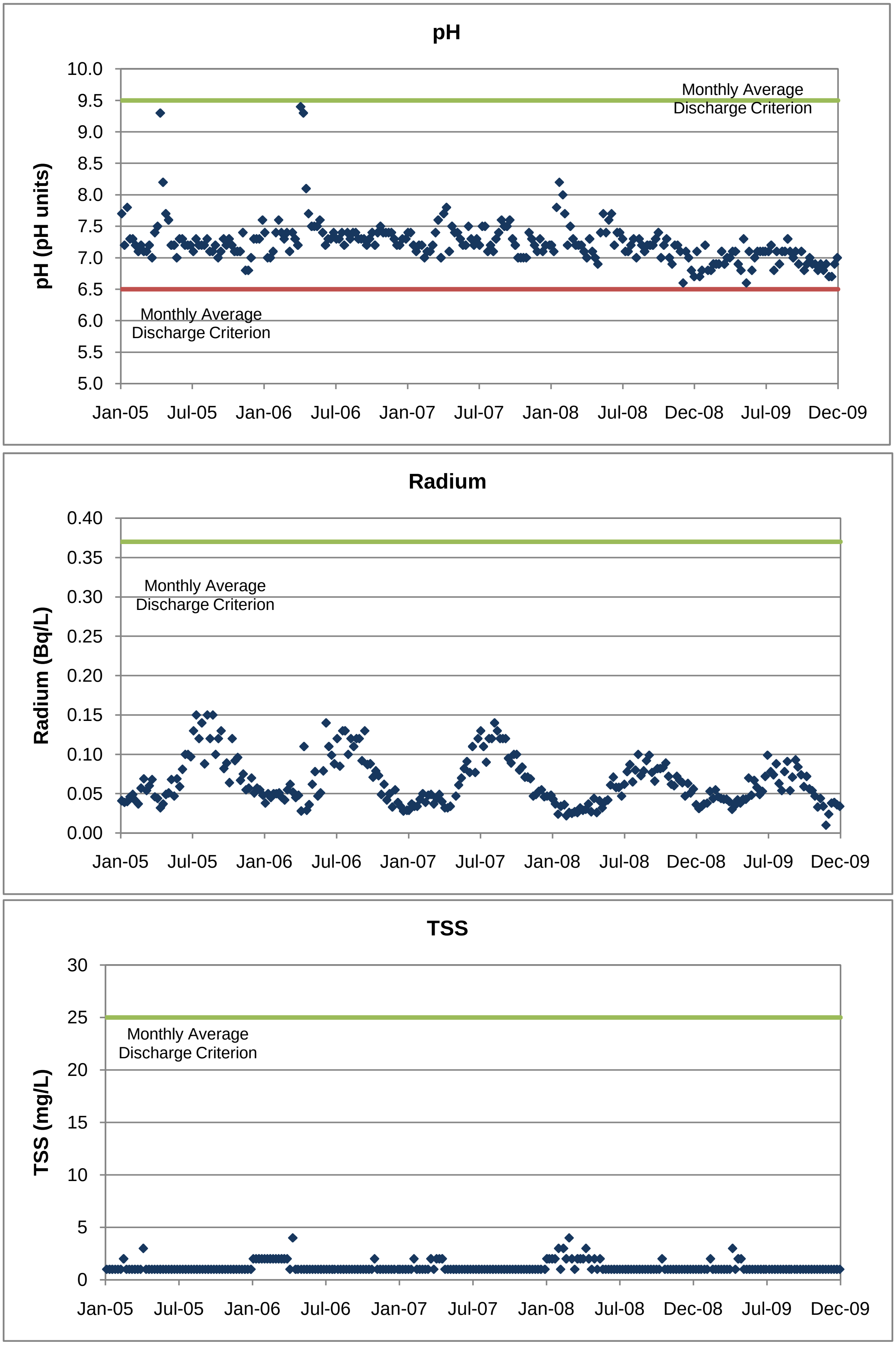


Figure 3.23: Effluent concentrations versus monthly average discharge criteria at Stanrock TMA station DS-4.

Table 3.18: Toxicity test results for samples collected at Stanrock TMA station DS-4, 2005 - 2009.

Sample Date (month-year)	Acute Toxicity (% mortality)		Survival and Reproduction (IC25[d] as % effluent)
	Daphnia magna [a]	**rainbow trout** [b]	***Ceriodaphnia dubia*** [c]
May-05	0	0	100
November-05	0	0	100
May-06	0	0	100
November-06	0	0	100
June-07	0	0	100
October-07	0	0	86
June-08	0	0	100
October-08	0	0	100
May-09	0	0	100
October-09	0	0	100

[a] *Daphnia magna* 48-hr LC50 test (Environment Canada 2000a).

[b] Rainbow trout 96-hr LC50 test (Environment Canada 2000b).

[c] *Ceriodaphnia dubia* survival and reproduction test (Environment Canada 2007).

[d] Effluent concentration causing 25% inhibition relative to control organisms.

Similarly, survival and reproduction of *Ceriodaphnia dubia* was not affected by exposure to 100% effluent in any tests except for slight reproductive impairment (IC25 86%) in one sample collected in October 2007.

3.6 Stanleigh TMA

3.6.1 Basin History and Modifications

The Stanleigh TMA is located 5 km north east of the City of Elliot Lake and contains 20 million tonnes of tailings from both the Milliken and Stanleigh mines and mills (Figure 3.24). During the initial operating period, 5.7 million tonnes were deposited in the west arm of the basin from the Milliken mill (1958 to 1964) and 1.7 million tonnes from the Stanleigh mill (1957 to 1960). In the mid 1960s, a lime and barium chloride treatment plant was constructed at the outlet of the West Arm with treatment solids settling in what is now the South Arm and treated effluent discharged to McCabe Lake through a concrete structure upstream of the current Dam B.

As part of the Stanleigh mill reactivation in the early 1980s, Dams 9, 10, R3 and R5 were constructed north and west of the basin to reduce the TMA watershed from 22 km^2 to 13.32 km^2. Five low-permeability engineered structures were constructed at bedrock lows around the basin to form the 350-ha TMA. During the second operating period an additional 12.8 million tonnes of tailings and waste rock were deposited in the basin, predominantly in the West Arm but also in the North Arm during later operating years.

An ETP was built at the TMA outlet in 1981, to treat effluent during operations. The ETP consisted of a reagent addition building and a filtration plant for treatment solids removal. Effluent from the Stanleigh TMA was treated and then discharged into McCabe Lake until 1998/1999, when, as part of the decommissioning of the Stanleigh Mine, the five perimeter dams were raised to allow flooding of the basin between 1998 and 2002. During this time, no treated effluent was discharged but the basin was neutralized by lime slurry addition to minimize acidity and metal concentrations.

Once treated effluent discharge resumed in 2003, water from the flooded TMA basin was siphoned over Dam B, and treated in the ETP prior to being released to McCabe Lake. The ETP operated for four to seven months per year depending upon the amount of snow and rainfall received. In 2007 the complex sand filtration treatment plant was replaced with a relatively simple conventional system similar to those used at all the other Rio Algom TMAs (e.g., Quirke, Panel, Nordic and Pronto). The new treatment system incorporates a Settling

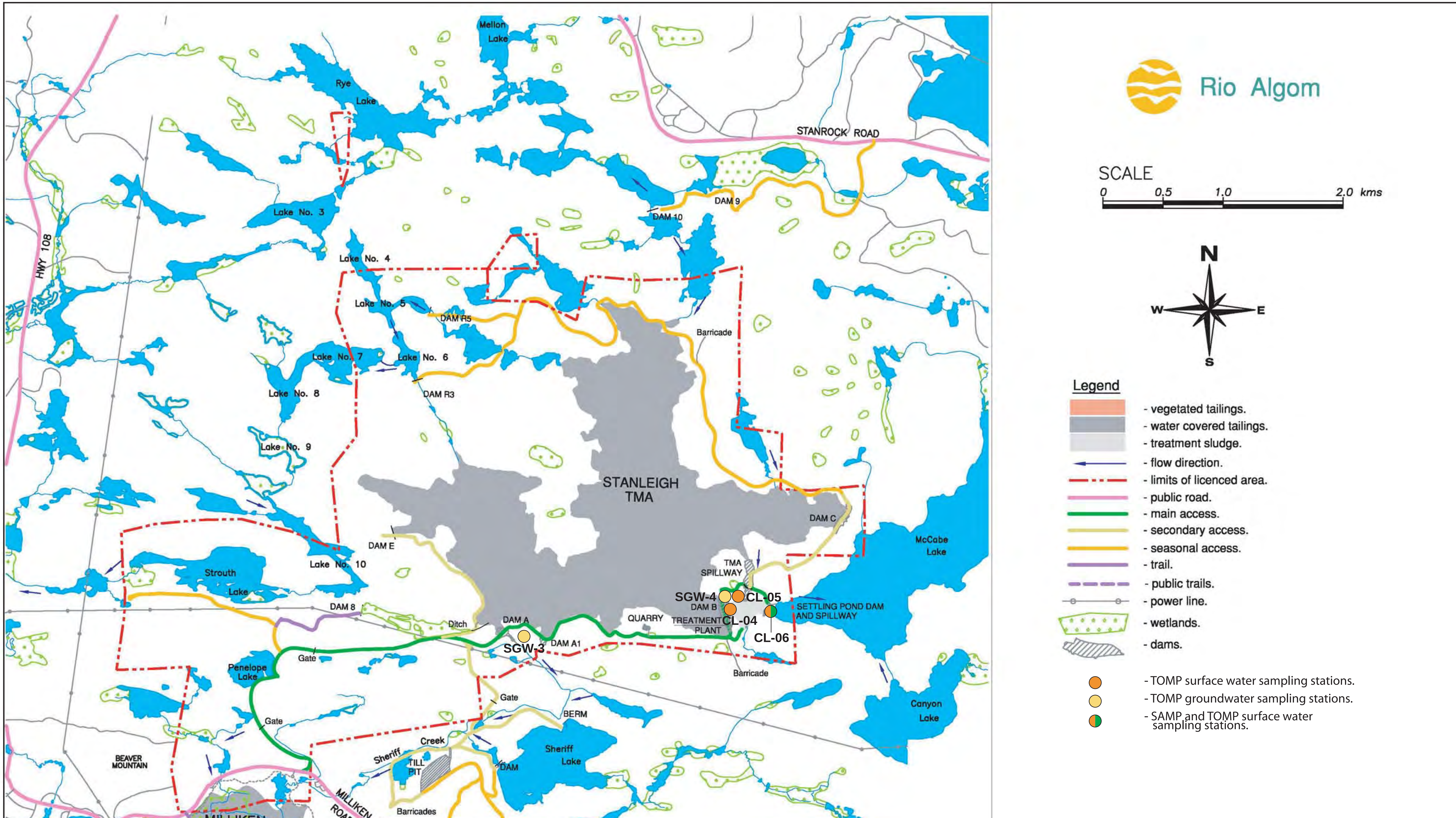


Figure 3.24 Stanleigh Site SAMP and TOMP Monitoring Stations

Ref: 2295
Date: February 2011

Pond for removal of solids created through the construction of the Settling Pond Dam downstream of the ETP

Within the TMA, surface water and groundwater are monitored under the TOMP and the locations, substances and frequency monitored are specific to the station type (Table 3.19 and Figure 3.24). Data from the TOMP stations are summarized in the following sections and presented in Appendix C (Appendix Tables C.6.2- C.6.5).

3.6.2 Water Management

Water levels within the flooded basin were consistently above the minimum operating level from 2005 to 2009 (Figure 3.25). In 2007, water in the TMA basin was drawn down to allow for the replacement of the ETP during the summer and fall of 2007. Increases in treatment volume and duration were required in the spring of 2008 to treat the water held in storage during the 2007 construction. By mid 2008 water levels within the TMA basin were within the established operating range (Figure 3.25).

3.6.3 Basin Surface Water Quality

Surface water quality is monitored at three stations within the TMA: the ETP Influent (CL-04) a pH probe in the ETP (CL-05) and final effluent (CL-06; Figure 3.24).

Concentrations of radium, sulphate and uranium have decreased and pH has increased to near neutral since basin flooding (Figure 3.26). Concentrations of sulphate and uranium are achieving 2012 predictions and radium-226 concentrations are near predicted values (Rio Algom 1997; Figure 3.26).

Surface water trends (2003-2009) indicate improvement based on significant reductions in acidity, iron, manganese, sulphate, and uranium in ETP influent (CL-04; Table 3.20; Appendix Figure C.6.1). Increases in radium-226 concentration since 2004 are likely associated with the decrease in sulphate concentrations within the basin. Work completed by EcoMetrix (Appendix G) indicates that as aqueous sulphate concentrations decline, there is an increased dissolution of barium sulphate to which radium is associated, whereby radium is released from the tailings. It is expected that radium concentrations in porewater will stabilize over time once the dissolution of barium sulphate re-equilibrates with aqueous sulphate concentrations. Assuming there is no new source of radium to the TMA, radium concentrations in porewater and releases to surface water should decline as the amount of soluble material in the tailings diffusion zone decreases.

Table 3.19: TOMP monitoring stations, substances, and frequencies[a] at Stanleigh TMA.

		Parameters and Frequencies[a]										
TOMP Stations	Station Type/Purpose	Elevation	Flow	pH	Sulphate	Total radium-226	Lime or NaOH Consumption	Barium Chloride Consumption	TSS	Acidity	Iron	SAMP Metals[b]
CL-04[e]	Basin performance (primary), ETP operations	W	D	M	Q	M	M	M		Q		Q
CL-05[e]	ETP Operations			D								
CL-06[d,e]	Effluent		W[c]	W[c]	M[c]	W			W			M[c]
SGW-3, SGW-4[d]	Groundwater			A	A					A	A	

[a] D - Work days, W - Weekly, M - Monthly, S - Semi-annually, A - Annually, Q-Quarterly

[b] Proposed SAMP metals are barium, cobalt, iron, manganese, and uranium

[c] Monitoring requirement of SAMP.

[d] Relocated to Settling Pond Dam.

[e] Sampled when treatment plant is operating.

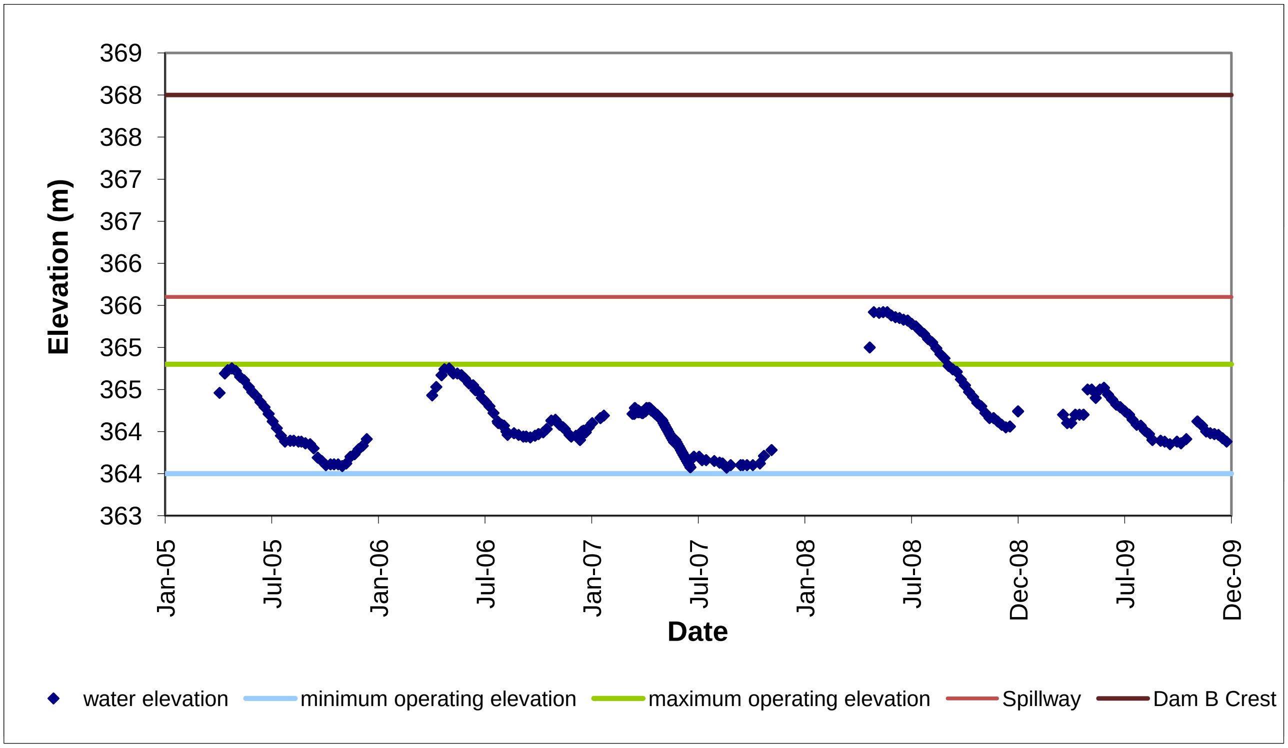


Figure 3.25: Water level at the Stanleigh TMA relative to minimum operating elevations.

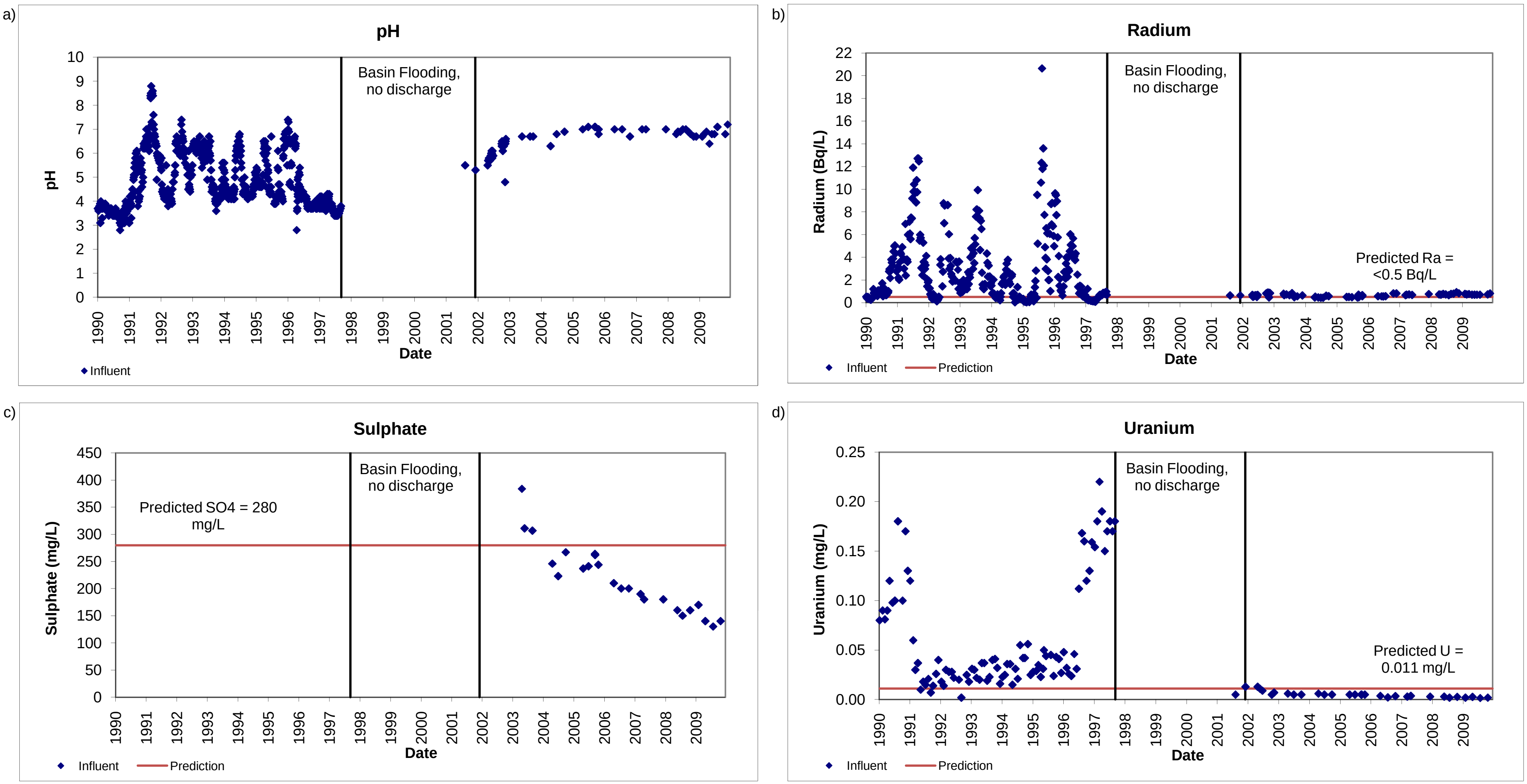


Figure 3.26: Water quality at the Stanleigh TMA ETP influent (CL-04) relative to predictions for 10 years (2012) post-decomissioning.

Table 3.20: Summary of water quality trends[a] for TOMP monitoring stations, Stanleigh TMA, 2003 to 2009.

Station ID	Type/Location	Number of Seasons Used in Common Trend[b]	Acidity	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium
CL-04	Treatment Plant Influent	3 to 7	-0.870	*-0.229* [c]	-0.455	0.764	-0.949	-0.150	0.454	-0.968	-0.702

(blue) decreasing trend, significant at p<0.05

(green) increasing trend, significant at p<0.05

[a] Based on rank correlation coefficients (rho) for common (combined) season trends, shown in table.

[b] Seasons used varied for substances based on suitability of data for trend analysis.

[c] Italic text mean monthly correlations significantly different, but common trend value provided.

Influent pH achieves discharge criteria however, basin water still requires treatment to achieve the discharge criterion for radium-226 (Appendix Table C.6.2).

3.6.4 Groundwater Quality

Two locations (wells) are sampled annually for acidity, pH, iron and sulphate: down-gradient of Dam A (SGW-3) and down-gradient of Dam B (SGW-4; Figure 3.24).

Over the past 10 years (1999-2009) ground water quality down gradient of Dam A (towards Sheriff Creek) has improved, with significant decreases in iron and sulphate concentrations and increases in pH reflecting similar trends observed within the basin for iron and sulphate (Table 3.21; Appendix Figure C.6.2). Groundwater quality downstream of Dam 3B has remained stable with neutral pH and low iron (>0.3 mg/L; Table 3.21).

3.6.5 Treatment Performance

Surface water from the Stanleigh Basin is treated at the ETP and associated settling ponds prior to discharge to the receiving environment (CL-06; Figure 3.24). Treatment includes both lime and barium chloride additions to reduce acidity and radium-226 respectively. Treatment volume and reagent use were higher in 2008 and 2009 relative to previous years because excess water accumulated in the basin during the ETP replacement and due to higher precipitation in those years (Figure 3.27). Lime and barium chloride consumption rates have increased following replacement of the ETP, but remain within the design range based on the Panel ETP which has similar influent.

Following treatment, effluent quality is monitored at the settling pond outlet (CL-06) and over the past five years effluent quality has consistently achieved discharge criteria (Figure 3.28; Appendix Table C.6.1). While individual radium-226 concentrations exceeded the grab sample action limit during spring turnover in 2008 and 2009, these values were below the grab sample criterion of 1.11 Bq/L (Appendix Table D.6.1). Since the commissioning of the new ETP, effluent has been consistently non-lethal to *Daphnia magna* and rainbow trout with no mortality reported in semi-annual acute toxicity tests (Table 3.22). Prior replacement of the ETP, three samples were found to be acutely toxic to *Daphnia magna* (November 2005 and 2006 and June 2007; Table 3.22). Reproduction of *Ceriodaphnia dubia* was not affected by exposure to 100% effluent in any of the tests conducted over the past five years (Table 3.22).

[3] This well was lost during the ETP construction in 2007 and therefore trends could only be assessed up to 2006.

Table 3.21: Summary of water quality trends[ab] in TOMP groundwater in Stanleigh TMA, 1999 to 2009.

Location	Station	Depth (m)	Dates	Iron	pH	Sulphate
downgradient dam A	SGW3	6.04	1999-2009	-0.955	0.954	-0.817
downgradient dam B[c]	SGW4	4.24	1999-2006	0.095	-0.452	-0.714

(blue) decreasing trend, significant at p<0.05

(green) increasing trend, significant at p<0.05

[a] Trends were not assessed for acidity because a change in analytical technique in 2006 meant that the data were not comparable before and after that time

[b] Based on rank correlation coefficients (rho) for common (combined) season trends, shown in table.

[c] SGW4 was lost during construction of the new Stanleigh TMA ETP and therefore the record of data ends in 2006.

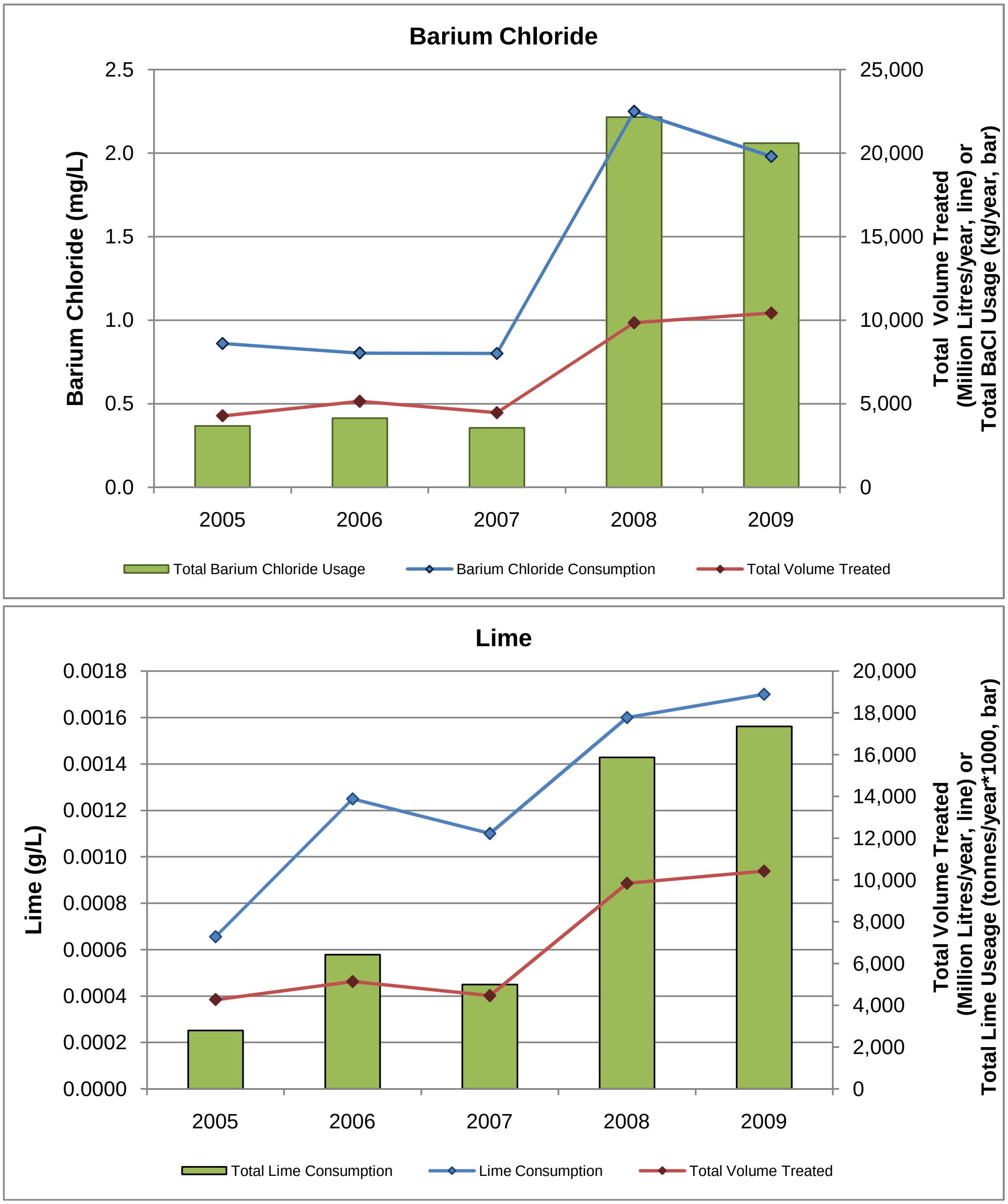


Figure 3.27: Comparison of total reagent consumed versus total volume treated at Stanleigh TMA from 2005-2009.

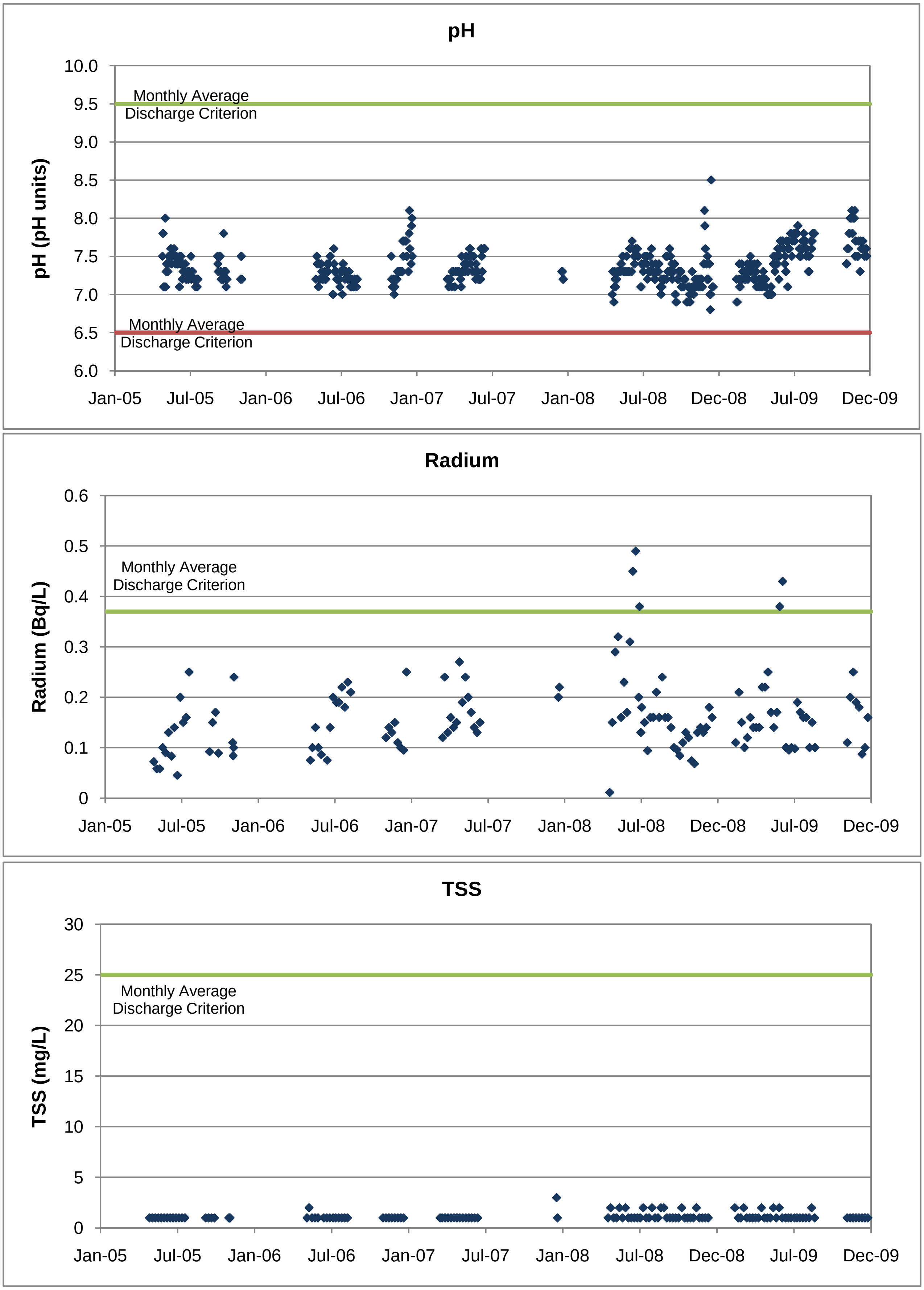


Figure 3.28: Effluent concentrations versus monthly average discharge criteria at Stanleigh TMA effluent station CL-06.

Table 3.22: Toxicity test results from samples collected at Stanleigh TMA station CL-06, 2005 - 2009.

Sample Date (month-year)	Acute Toxicity (% mortality)		Survival and Reproduction (IC25[d] as % effluent)
	Daphnia magna [a]	rainbow trout [b]	*Ceriodaphnia dubia* [c]
May-05	0	0	100
November-05	10	0	100
June-06	0	0	100
November-06	16.7	0	100
June-07	13	0	100
June-08	0	0	100
November-08	0	0	100
May-09	0	0	100
November-09	0	0	100

[a] *Daphnia magna* 48-hr LC50 test (Environment Canada 2000a).

[b] Rainbow trout 96-hr LC50 test (Environment Canada 2000b).

[c] *Ceriodaphnia dubia* survival and reproduction test (Environment Canada 2007).

[d] Effluent concentration causing 25% inhibition relative to control organisms.

3.6.6 Summary

Water levels within the flooded basin (2005 to 2009) were consistently above the minimum operating level from 2005 to 2009. In-basin surface water quality has been improving over time and generally achieves EIS predictions (*i.e.* the TMA is performing as anticipated). Over the past seven years (2003-2009) surface water has continued to improve with significant reductions in acidity, iron, manganese, sulphate and uranium in ETP influent. Radium-226 concentrations within the basin have been increasing over this same period in response to decreasing sulphate concentrations. It is expected that radium concentrations in porewater will stabilize over time once the dissolution of barium sulphate re-equilibrates with aqueous sulphate concentrations. Assuming there is no new source of radium in the TMA, radium concentrations in porewater should decline as the amount of soluble material in the tailings diffusion zone decreases. Groundwater conditions have either been stable (down-gradient of Dam B) or improving (down-gradient of Dam A) since TMA decommissioning. Since the commissioning of the new ETP effluent quality consistently achieved discharge criteria and all tests to *Daphnia magna*, rainbow trout and *Ceriodaphnia dubia* were non-toxic. Overall, the Stanleigh TMA is performing well.

3.7 Milliken TMA

3.7.1 Basin History and Modifications

The Milliken TMA is located 2 km northeast of the City of Elliot Lake and south of the Milliken Mine Road in an area locally referred to as the Sheriff Creek Sanctuary. The Milliken mine and mill operated from 1958 to 1964 and directed 5.7 million tonnes of tailings to the Stanleigh TMA. During this operating period an estimated 76,500 tonnes of tailings were released to Sheriff Creek in an area (17 ha) later rehabilitated to form the Milliken TMA. Remediation took place in the late 1970s by placing three feet of sandy gravel fill over a portion of the tailings to form playing fields and flooding the remaining tailings to form a wetland. In 1997, a berm was constructed at the outlet of the wetland to maintain water cover over the tailings. The resulting Sheriff Creek Sanctuary is now an important wildlife habitat area enjoyed by local naturalist groups.

Upstream of Sheriff Lake, Sheriff Creek receives drainage from a remediated tailings spill area down-gradient of Stanleigh TMA Dam A (see Stanleigh Section 3.5.1). Until its closure in 1996, the Stanleigh mine influenced the quality of water discharging from Penelope Lake, which drains into the north perimeter of the Milliken TMA (Figure 3.29). Similarly, the re-habilitated Lacnor Mine site, (closed in 1960 and rehabilitated in 1999), influences the quality of Lacnor Creek, which flows into the southeast corner of the TMA (Figure 3.29).

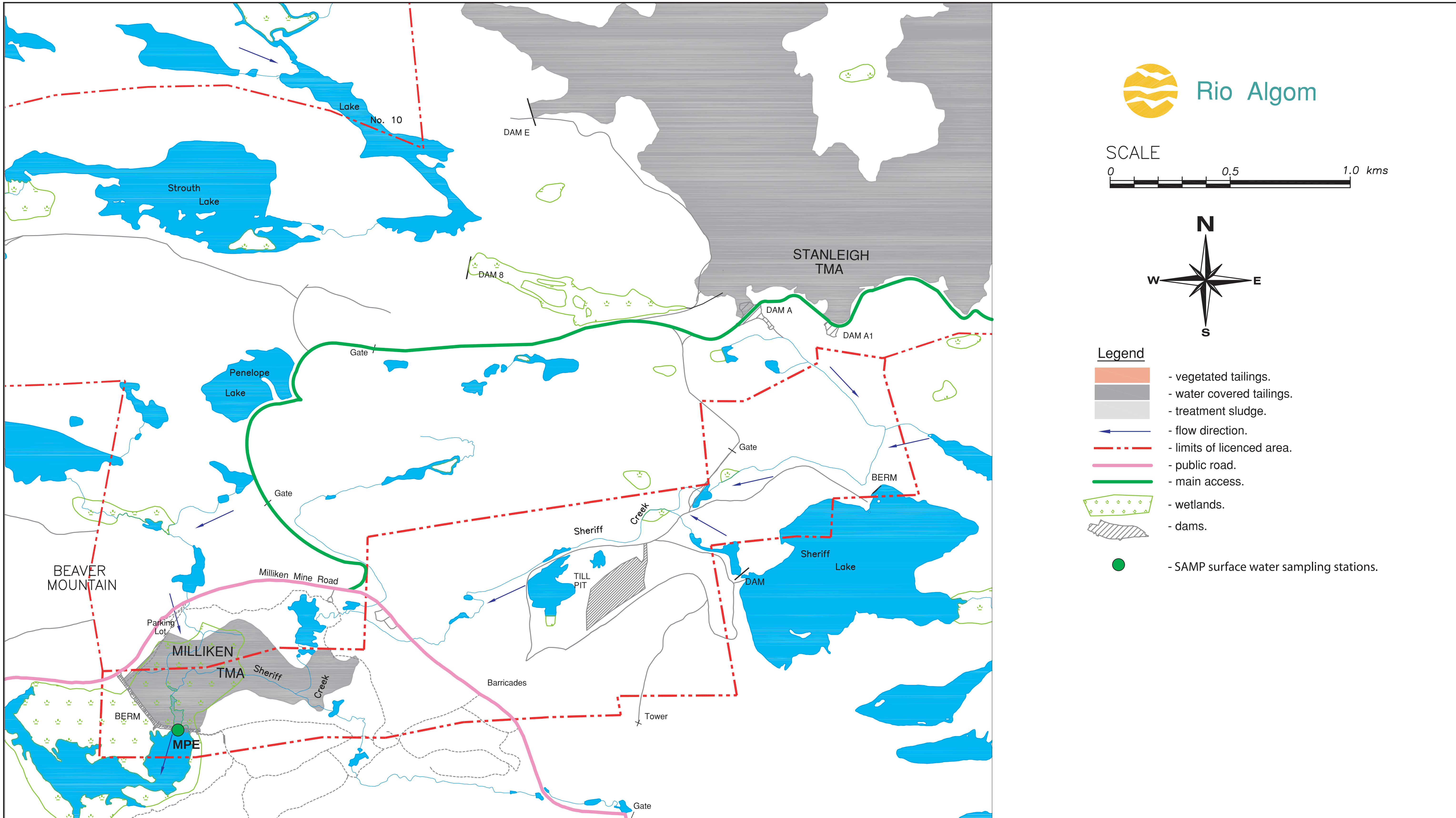


Figure 3.29 PAUL H. TORRANCE SURVEYING LTD. GEOMATICS SERVICES minnow

Milliken Site SAMP and TOMP Monitoring Stations

Ref: 2295
Date: February 2011

One monitoring station (MPE) was retained at the Milliken TMA outlet under the SAMP to track the combined inputs from all upstream sources and releases to the Serpent River Watershed (Appendix Table D.6.1).

3.7.2 Surface Water Quality and Discharge

Surface water quality is monitored at the outlet of the Milliken TMA (MPE) and reflects conditions within the TMA.

Effluent from the Milliken TMA discharges to a downstream wetland and joins the outflow from Horne Lake before entering Elliot Lake (Figure 3.29). Water quality at MPE generally meets receiving water criteria (see Section 4.3 for a discussion of discharge quality).

Since 2005, water samples collected at MPE have been non-toxic to both *Daphnia magna* and rainbow trout, with no mortality reported in semi-annual acute toxicity tests (Table 3.23). Similarly, survival and reproduction of *Ceriodaphnia dubia* were not affected by exposure to 100% effluent (Table 3.23).

3.8 Lacnor and Nordic TMAs

3.8.1 Basin History and Modifications

Lacnor TMA

The Lacnor TMA is located approximately 7 km east of the City of Elliot Lake and immediately north of the Nordic TMA. The Lacnor mine operated from 1957 to 1960 and milled approximately 2.7 million tonnes of ore. The resulting tailings were deposited in a natural valley 2 km east of the mill/mine and are contained by two pervious waste rock dams (Figure 3.30). The Lacnor TMA covers an area of 27 ha and has a watershed of 100 ha.

Following mine closure in 1960, decommissioning of the Lacnor TMA commenced, with re-vegetation efforts during the 1970s being a major component of the decommissioning plan. However, much of the seeding and planting on bare tailings failed over time due to acidic conditions (Rio Algom 2000). In 1998 and 1999, an engineered cover was placed over the tailings, which consisted of a layer of blast rock to form a capillary break and a layer of till at surface to serve as a growth medium. Limestone (200 kg/ha) was applied below the capillary break and fertilizer (500 kg/ha of 15-15-15) was applied prior to seeding. The cover areas were re-vegetated in 1999 through seeding of grasses and legumes and isolated tree plantings. Permanent rock channels were also installed to prevent erosion.

Seepage and runoff from the Lacnor TMA are collected in a holding pond at the east end of the TMA prior to discharge through a spillway to the Nordic Main TMA (Figure 3.30).

Table 3.23: Toxicity test results from samples collected at Milliken TMA station MPE, 2005 - 2009.

Sample Date (month-year)	Acute Toxicity (% mortality)		Survival and Reproduction (IC25[d] as % effluent)
	Daphnia magna [a]	rainbow trout [b]	*Ceriodaphnia dubia* [c]
May-05	0	0	100
November-05	0	0	100
May-06	0	0	100
November-06	0	0	100
May-07	0	0	100
November-07	0	0	100
May-08	0	0	100
November-08	0	0	100
May-09	0	0	100
November-09	0	0	100

[a] *Daphnia magna* 48-hr LC50 test (Environment Canada 2000a).

[b] Rainbow trout 96-hr LC50 test (Environment Canada 2000b).

[c] *Ceriodaphnia dubia* survival and reproduction test (Environment Canada 2007).

[d] Effluent concentration causing 25% inhibition relative to control organisms.

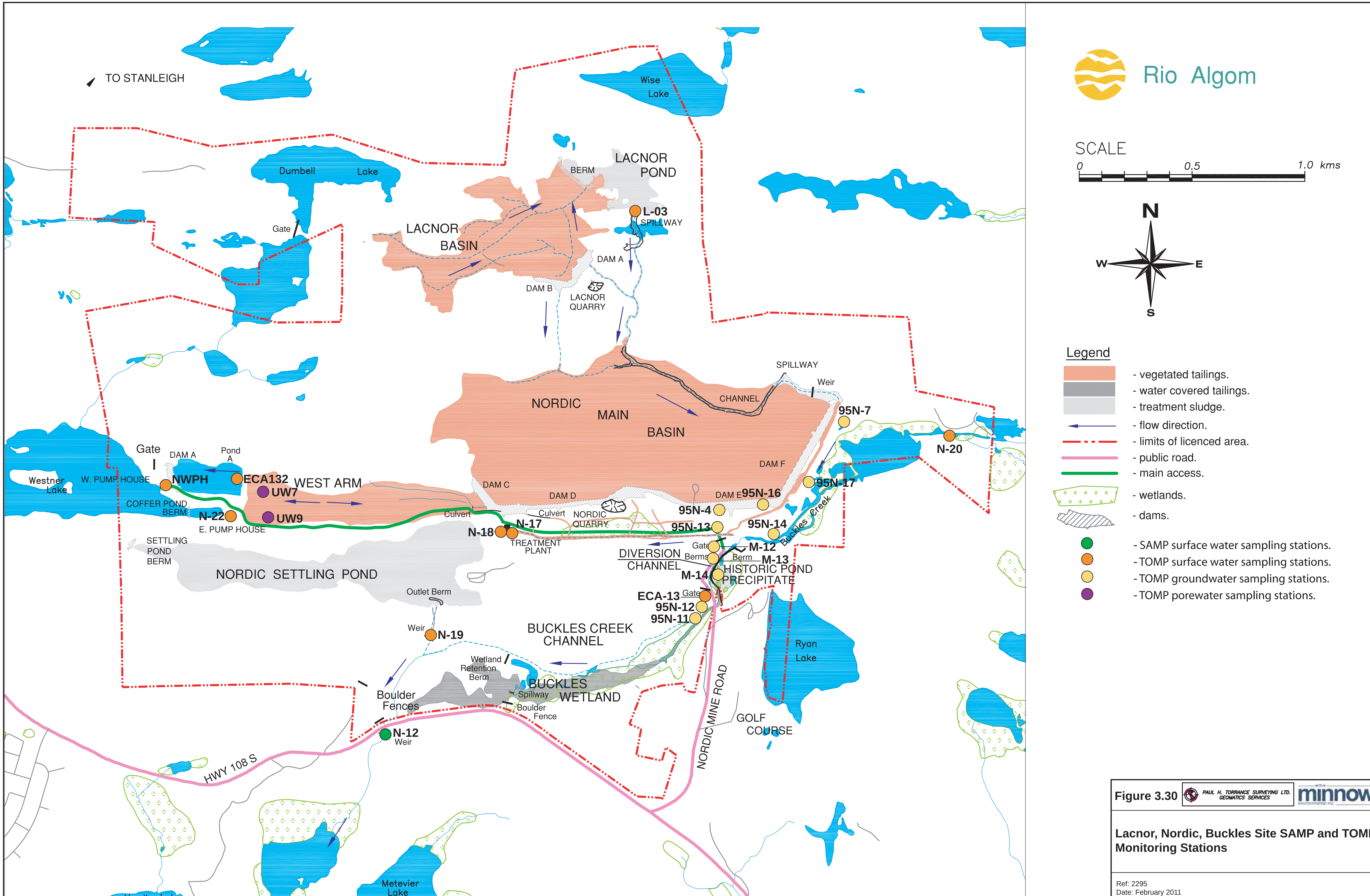


Figure 3.30

Lacnor, Nordic, Buckles Site SAMP and TOMP Monitoring Stations

Nordic TMA

The Nordic TMA is also located approximately 7 km east of the City of Elliot Lake immediately south of the Lacnor TMA. The Nordic mine operated from 1957 to 1968 and the Nordic mill produced approximately 12 million tonnes of tailings. Tailings were deposited to the Nordic TMA, which is composed of two areas (Nordic Main and Nordic West Arm) with a total area of approximately 107 hectares (Figure 3.30). Nordic Main is approximately 1,500 m long by 600 m wide and was constructed using mine waste embankments. Nordic West Arm is approximately 1,000 m long by 100 m wide.

The Nordic TMA was re-vegetated in the late 1970s (Rio Algom 2000). In 1998 and 1999, layers of rock (serving as a capillary break) and till were placed in areas of the West Arm which exhibited poor drainage and were prone to erosion, and thus tended to have relatively poor vegetative cover. These areas have been successfully re-vegetated

Seepage and runoff from Nordic Main are collected in a perimeter Effluent Collection Ditch (ECD) constructed in 1971. The ECD collects drainage from the Lacnor TMA at the north perimeter of Nordic Main which flows around the Nordic TMA to the Nordic ETP (located at the southwest corner of Nordic Main), for treatment prior to discharge into the Nordic Settling Pond (Figure 3.30). The ECD was lowered in 1994 and the Settling Pond was lowered by 0.6 m in 1997 to improve interception of tailings porewater and reduce groundwater contamination of Buckles Creek located south of Nordic Main. The treatment plant, where lime is added to neutralize acidity and remove metals (predominantly iron), was replaced in 1999. Treated effluent discharges to Buckles Creek and subsequently Nordic Lake (Figure 3.30).

The majority of seepage and runoff from the Nordic West Arm drains in an easterly direction and is directed by a series of ditches to the Nordic ETP for treatment. Runoff from the western portion of the Nordic West Arm is collected in Pond A, then pumped into the Nordic Settling Pond. The East and West Collection Ponds were constructed in 1989 to intercept seepage from Pond A and the West Arm, respectively, and pump it to the Settling Pond. In 2004, a coffer berm was constructed downstream of the East Collection Pond to facilitate removal of a small tailings spill discovered following the beaver dam break at the outlet of Westner Lake in 2003. In 2009, a pump well was installed in the Coffer Pond, and the pumping systems of Pond A, East Collection Pond and West Collection Pond were upgraded to manage a 1 in 100 year return, 15-day rain-on-snow design hydrological event.

During mine operations Buckles Creek was diverted to provide water for mining and milling and run-off from the Nordic Main was piped to the original Buckles Creek bed. From 1965 to 1975, barium chloride was used to treat the radium in Buckles Creek, with radium precipitates settling in a beaver pond (located by the mine road) and the creek bed. In the late 1970's, the precipitates were covered with fill and the Buckles Creek Channel was relocated to isolate the flow from historic deposits. Maintenance of the Buckles Creek Channel in 2005, included lining the section of channel above the point of confluence with the Nordic Settling Pond with rip rap and restoring the berm isolating the historic precipitate pond. Performance monitoring of diversion channel indicated that construction activities had lowered the creek elevation relative to the ECD resulting in increased groundwater seepage to Buckles Creek. Modifications to the diversion stream bed in 2006 reversed this flow restoring groundwater interception by the ECD as designed.

Monitoring station L-03 monitors releases from the Lacnor TMA to the Nordic TMA (Table 3.24). Within the Nordic TMA, surface water, porewater and groundwater are monitored under the TOMP and the locations, substances and frequency monitored are specific to the station type (Table 3.24 and Figure 3.30). Data from the TOMP stations are summarized in the following sections and presented in Appendix C (Appendix Tables C.7.2- C.7.23).

3.8.2 Basin Surface Water Quality

Surface water quality at the Lacnor/Nordic TMA is monitored at a number of stations to assess conditions associated with the various tailings deposits (Figure 3.30):

- Seepage and surface runoff from the Lacnor TMA are captured in the Lacnor Pond and is monitored at L-03 (Appendix Table C.7.4);
- Surface runoff from the Nordic TMA West Arm is collected in Pond A and monitored at ECA-132 with seepage from Pond A monitored at NWPH and seepage from the Nordic West Arm monitored in the East Seepage Collection Pond at N-22 (Appendix Tables C.7.3 and C.7.9 respectively);
- Seepage and runoff from the Nordic Main TMA and eastern sections of the West Arm of the Nordic TMA are monitored at the ETP influent (N-17; Appendix Table C.7.5); and
- Contributions from the Nordic Main TMA historic groundwater plume to Buckles Creek are monitored at ECA 131 (Appendix Table C.7.2).

Table 3.24: TOMP monitoring stations, substances, and frequencies[a] at Nordic TMA.

TOMP Stations	Station Type/Purpose	Elevation	Flow	pH	Sulphate	Total radium-226	Lime or NaOH Consumption	TSS	Acidity	Iron	SAMP Metals[b]
		Parameters and Frequencies[a]									
L-03	Basin performance (primary)	M[d]	Q	Q	Q	Q			Q		Q
N-17	Basin performance (primary), ETP operations		D	M	Q	M	M		Q		Q
N-18	ETP operations			D							
N-19	Effluent		W	W	M	W		W			M
N-22	Basin performance (secondary)		M[d]	S	S	S			S	S	S
ECA-132	Basin performance (secondary)	M[d]	M	M[d]	S	S			S	S	S
NWPH	Basin performance (secondary)		M	S	S	S			S	S	S
ECA-131, N-20	Basin performance (secondary)			Q	Q	Q			Q		Q
UW7-2,4,6; UW9-1,2,3	Porewater			A	A				A	A	
M-12-1,3,6,9; M-13-1,3,6,9; M-14-1,3,6,9; 95N-4A,B; 95N-7A,B; 95N-11; 95N-12A,B; 95N-13A,C,E; 95N-14A,B,C; 95N-16A,C,E; 95N-17A,B,C	Groundwater			A[c]	A[c]				A[c]	A[c]	

[a] D - Work days, W - Weekly, M - Monthly, S - Semi-annually, A - Annually, Q-Quarterly

[b] SAMP metals are barium, cobalt, iron, manganese, and uranium

[c] A one-time modelling exercise was recommended by Ecometrix to confirm flow conditions and potentially modify future GW monitoring under TOMP. In the GW monitoring at Nordic will continue will cotinue at previously identified TOMP stations.

[d] During the snow-free period (April - November)

Since 2003, sulphate concentrations at L-03 have decreased significantly (Table 3.25; Appendix Figure C.7.3). Currently surface water quality in the Lacnor Pond is acidic (pH < 3.5) with elevated iron (> 20 mg/L; Appendix Table C.7.4).

Surface water associated with the Nordic West Arm has also improved with significant reductions in radium-226 concentrations at the East Seepage Collection Pond (N-22) and decreasing acidity within Nordic Pond A (ECA-132; Table 3.25). Pond A was limed following the upgrading of Dam A in 2000 and the step change in acidity in 2006 is likely associated with the change in acidity analytical method in the same year.

Decreasing concentrations of acidity and radium-226 upstream of the Buckles Creek wetland (ECA-131; Table 3.25) are associated with: 1) remediation work conducted in 2005 to isolate the Wetland and Historic Precipitate Pond from the Diversion Channel, and 2) streambed modifications completed in 2006 which restored groundwater gradients towards the ECD and away from Buckles Creek.

Since 2003, water quality in the TMA influent (N-17) has significantly improved with decreasing concentrations of acidity, radium-226, sulphate, and uranium (Table 3.25; Appendix Figure C.7.4). Similarly, ETP effluent has also improved over the past seven years with significant decreases in cobalt, manganese and radium-226 and increased pH consistent with the upward adjustment of the treatment plant pH set point in 2004 (Table 3.25).

3.8.3 Porewater

Porewater is monitored annually for acidity, pH, iron and sulphate at two locations (north and south) in the west arm of the Nordic TMA (UW-7 and UW-9; Table 3.24; Figure 3.30).

Since 1993, iron has been significantly decreasing at both porewater locations. Iron concentrations at UW7 (shallowest depth) have decreased from about 2,000 mg/L in 1992 to about 500 mg/L in 2009 (Appendix Figure C.7.8). Sulphate was found to be significantly increasing at UW7-2 (8 m) (Table 3.26; Appendix Figure C.7.7).

Porewater pH at the north end of the West Arm (UW-7) has significantly increased in the deepest well and reflects a step change improvement following the upgrading of Dam A in 2000 (Table 3.26; Appendix Figure C.7.9). Similarly, porewater pH at the south end of the West Arm (UW9) has also been increasing over time and may also represent a response to the improvements in Dam A (Table 3.26 and Appendix Figure C.7.11). The pH in deep

Table 3.25: Summary of water quality trends[a] for TOMP monitoring stations, Lacnor/Nordic TMA, 2003 to 2009.

Station ID	Type/Location	Number of Seasons Used in Common Trend[c]	Acidity	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium
L-03	Lacnor Tailings Discharge	3	-[b]	-	-	-0.166	-	-0.426	-0.048	-0.713	0.338
ECA-132	Nordic Pond A upstream of Westner seepage	2	-0.870	-	-	-	-	*0.1*[d]	*0.245*	-	-
N-22	West Arm Pump Discharge (East Seepage Collection Pond)	2	-0.500	-	-	-	-	-0.198	-0.669	-	-
N-20	Buckles Creek Upstream of Nordic Plume	4	ND[e]	-	-	-	-	-0.083	-0.397	-	-
ECA-131	Buckles Creek at Mine Road	4	-0.540	-	-	-	-	0.070	-0.555	-	-
N-17	Treatment Plant Influent	4 to 12	-0.536	0.149	0.237	0.062	-0.018	-0.220	-0.325	-0.692	-0.696
N-19	Final Treated Effluent	12	-	0.083	-0.371	-0.004	-0.601	0.363	-0.530	-	-0.018

decreasing trend, significant at p<0.05

increasing trend, significant at p<0.05

[a] Based on rank correlation coefficients (rho) for common (combined) season trends, shown in table.

[b] "-" denotes that this parameter was not included in the trend analysis for that particular station due to insufficient data (e.g. there were <5 years worth of data for that parameter)

[c] Seasons used varied for substances based on suitability of data for trend analysis.

[d] Italic text mean monthly correlations significantly different, but common trend value provided.

[e] ND denotes that this parameter was not included in the trend analysis for that particular station due to >50% non-detectable concentrations in the samples available for the analysis.

Table 3.26: Summary of water quality trends[ab] in TOMP porewater and groundwater in Lacnor/Nordic TMA, 1993[c] to 2009.

Type	Location	Station	Depth (m)	Dates	Iron	pH	Sulphate
porewater	Nordic west arm, porewater north	UW7-4	5.14	1993-2009	-0.861	0.057	-0.409
		UW7-2	8.23	1993-2009	0.168	0.007	0.645
		UW7-6	16	1996-2009	-0.235	0.627	0.578
	Nordic west arm, porewater south	UW9-3	4.27	1993-2009	0.436	-0.401	0.518
		UW9-2	6.4	1993-2009	-0.175	0.615	-0.055
		UW9-1	8.53	1993-2009	-0.596	0.224	-0.155
groundwater	downgradient of ECD at northeast corner Nordic main	95N7B	3.69	1995-2009	-0.531	-0.600	0.429
		95N7A	7.72	1995-2009	-0.552	-0.613	-0.190
	downgradient of ECD at east perimeter Nordic main	95N17C	3.49	1995-2009	0.495	-0.656	-0.006
		95N17B	8.09	1995-2009	0.522	-0.500	-0.333
		95N17A	12.68	1995-2009	0.698	0.109	-0.491
	downgradient of ECD at southeast corner Nordic main	95N14C	3.49	1995-2009	0.402	-0.320	-0.610
		95N14B	7.6	1995-2009	0.354	-0.348	-0.176
		95N14A	11.39	1995-2009	-0.011	0.155	-0.486
	upgradient of ECD at head Nordic plume	95N13E	2.82	1995-2009	-0.886	0.641	-0.591
		95N13C	9.61	1995-2009	-0.886	0.624	-0.664
		95N13A	15.36	1995-2009	-0.845	0.197	-0.309
	upgradient of ECD at southeast corner Nordic main	95N16E	3.86	1995-2009	-0.825	0.705	-0.648
		95N16C	11.03	1995-2009	-0.986	0.810	-0.628
		95N16A	18.21	1995-2009	-0.848	0.498	-0.269
	upgradient of ECD at south perimeter Nordic main	95N4B	5.31	1995-2009	-0.839	-0.104	-0.452
		95N4A	9.91	1995-2009	-0.601	0.687	0.433
	downgradient of ECD, south of M-14; adjacent to ECA-131	95N12B	3.67	1995-2009	-0.560	-0.537	-0.707
		95N12A	6.87	1995-2009	-0.108	-0.274	-0.084
	downgradient of ECD, south of 95N-12	95N11	4.34	1995-2009	-0.699	-0.454	0.714
	downgradient of ECD south of 95N-13	M12-9	2.5	1994-2009	-0.797	0.781	-0.270
		M12-6	5.49	1993-2009	-0.868	0.804	-0.857
		M12-3	6.54	1993-2009	-0.775	0.587	-0.524
		M12-1	13.41	1993-2009	0.061	0.831	0.857
	downgradient of ECD south of M-12	M13-9	2.04	1993-2009	-0.742	-0.150	-0.719
		M13-6	5.46	1993-2009	-0.938	0.736	-0.967
		M13-3	6.43	1993-2009	-0.248	0.760	-0.733
		M13-1	11.46	1994-2009	0.110	0.219	-0.669
	downgradient of ECD south of M-13; west of historic precipitate pond	M14-9	1.8	1998-2009	-0.575	0.282	-0.975
		M14-6	3.84	1998-2009	-0.400	-0.604	-0.600
		M14-1	8.75	1998-2009	0.310	0.096	-0.359
		M14-3	12.83	1998-2009	-0.690	-0.222	-0.900

decreasing trend, significant at $p<0.05$

increasing trend, significant at $p<0.05$

[a] Trends were not assessed for acidity because a change in analytical technique in 2006 meant that the data were not comparable before and after that time.

[b] Based on rank correlation coefficients (rho) for common (combined) season trends, shown in table.

[c] This is the earliest year included in the trend analysis, but not all stations have data going back to 1993.

porewater has been near neutral since the step change but pH at other depth horizons has remained slightly acidic (Figure 3.31).

3.8.4 Groundwater Quality

Groundwater quality is monitored annually at several locations down-gradient of the Nordic TMA (Figure 3.30; Table 3.24) to assess the effectiveness of measures to remediate the plume migrating south from the Main Tailings Basin:

- The eastern perimeter and north east corner of the Nordic Main TMA are monitored at stations 95N-14, 95N-17 and 95N-7;
- The southern perimeter of the TMA, up gradient of the Effluent Collection Ditch (EDC), is monitored at stations 95N-4, 95N-13 and 95N-16; and
- Groundwater down-gradient of the Nordic Main TMA and ECD is monitored at wells M-12, M-13, M-14, 95N-12 and 95N-11.

Along the eastern perimeter of the Nordic TMA, groundwater pH has been decreasing over time with significant trends in the shallower groundwater at 95N7 (north east corner) and 95N17 (eastern perimeter; Table 3.26; Appendix Figures C.7.21 and C.7.22), although pH is near neutral along the eastern perimeter stations (95N17 and 95N14; Appendix Figure C.7.32; Appendix Tables C.7.21 and C.7.23) Iron increased in the deeper groundwater (12 m) along the eastern perimeter at 95N17A (Table 3.26; Appendix Figure C.7.31) although iron concentrations remain low (<5.0 mg/L).

Along the southern perimeter of the Nordic Main (95N-4, 95n-13 and 95N-16), groundwater quality has been improving over time indicating that the oxidation processes may have peaked and loadings are decreasing. At all three wells and at all depths, iron concentrations have decreased over time (1995 to 2009; Table 3.26). The most dramatic reduction in iron concentrations has occurred in the shallow (<5m) and mid depth (10m) wells (Appendix Figures C.7.19 to C.7.20 and C.7.25 to C.7.30). Consistent with the decrease in iron concentrations, pH levels have significantly increased in these same wells and are now near neutral along the southern perimeter (Table 3.26; Appendix Figures C.7.19, C.7.26, C.7.27, C.7.29 and C.7.30). Some improvements in sulphate concentrations have been noted as well, which are likely associated with lower oxidation of tailings (Table 3.26; Appendix Figures C.7.26, and C.7.30).

Remedial measures have been undertaken down-gradient of the Nordic Main TMA and ECD in order to reduce Nordic groundwater seepage to Buckles Creek. In 1994 the ECD was

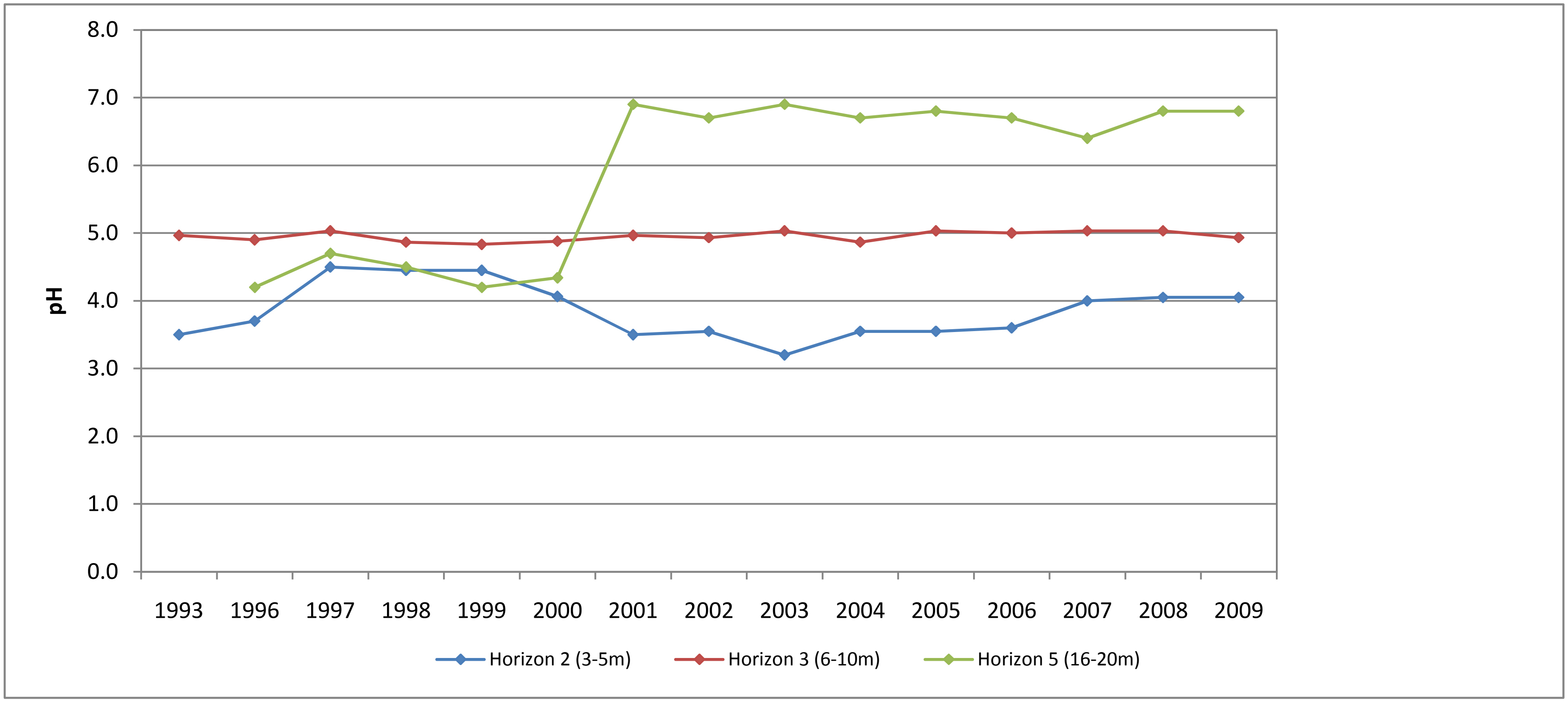


Figure 3.31: Comparison of porewater mean pH at various depths, Lacnor/Nordic TMA, 1993-2009.

Horizon 2 - UW7-4, UW9-3
Horizon 3 - UW7-2, UW9-2, UW9-1
Horizon 5 - UW7-6

lowered and in 1997 the Settling Pond was also lowered (0.6 m) to improve interception of porewater from the tailings and reduce seepage to Buckles Creek located immediately east and south of the Nordic TMA. These measures proved effective in improving groundwater quality down-gradient of the ECD, with significant reductions in iron and commensurate increases in pH at most locations (Table 3.26; Appendix Figures C.7.12-C.7.18 and C.7.23-C.7.24). Review of routine monitoring data including groundwater elevations and chemistry and the chemistry in Buckles Creek indicated that the ECD has effectively been capturing seepage from the TMA and shallow groundwater (EcoMetrix 2011e; Appendix I). In addition, sulphate concentrations have decreased in several wells over time (1993-2009; Table 3.26; Appendix Figures C.7.14, C.7.16 and C.7.17). Sulphate concentrations increased at one well ((M-12-1); however, this trend appears to be leveraged by one 1995 value (Appendix Figure C.7.12).

3.8.5 Treatment Performance

Effluent from the Nordic and Lacnor TMAs is treated at N-17 (ETP influent) and released at N-19, the compliance point for effluent treatment. Surface water affected by the Nordic and Lacnor TMAs, as well as Buckles Creek wetland (e.g. historical tailing deposit) is monitored downstream of N-19 at N-12, which flows into Nordic Lake (Figure 3.30). The ETP at Nordic uses lime to neutralize acidity and reduce metals (predominantly iron). Barium chloride is not required at the Nordic ETP because radium is co-precipitated with the iron hydroxides formed by lime addition. Total annual lime consumption has remained relatively stable over past five years with lower consumption rates (mg/L) observed during peak flow years (e.g. 2008; Figure 3.32).

Following treatment, effluent quality is monitored at the outlet of the Nordic Settling Pond (N-19). Over the past five years effluent quality has consistently achieved discharge criteria (Figure 3.33; Appendix Table C.7.1). Effluent has also been consistently non-lethal to *Daphnia magna* and rainbow trout with no mortality reported in semi-annual acute toxicity tests (Table 3.27). Similarly, survival and reproduction of *Ceriodaphnia dubia* was not affected by exposure to 100% effluent in any tests conducted over the past five years (Table 3.27).

3.8.6 Summary

Surface water quality has improved in all areas of the Lacnor/Nordic TMA with decreasing concentrations in acidity, radium-226 and sulphate. The improvements are the result of remedial measures implemented at the TMA and presumed lower oxidation rates within the

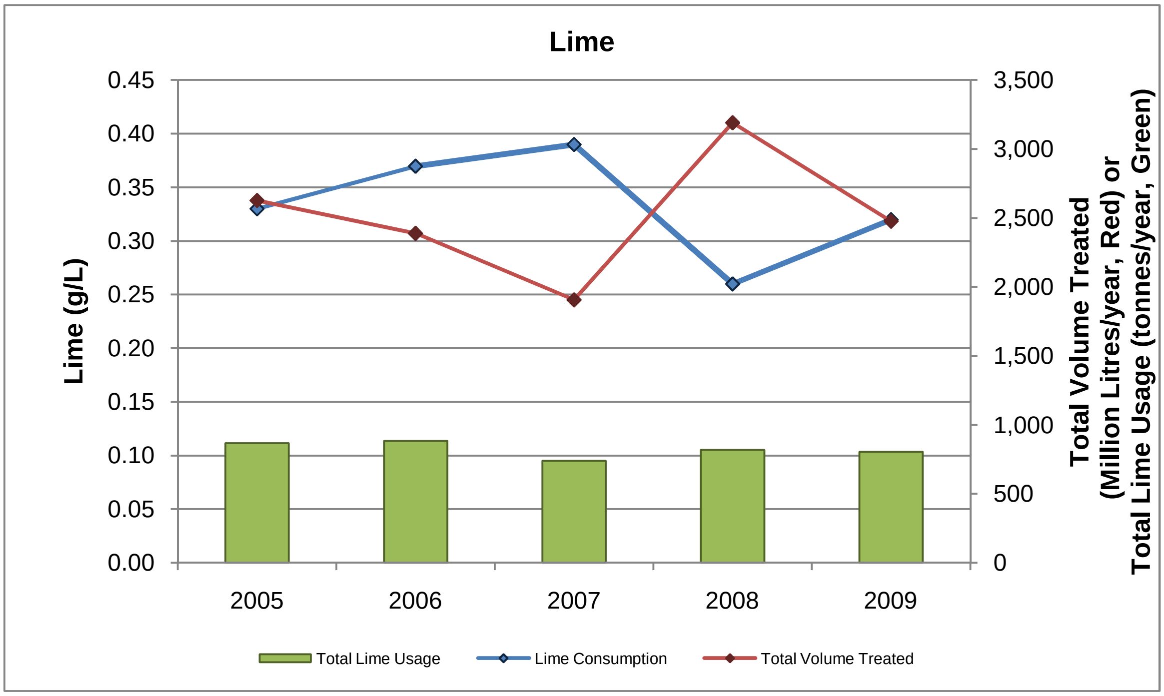


Figure 3.32: Comparison of total reagent consumed versus total volume treated at Nordic TMA from 2005-2009.

Figure 3.33: Effluent concentrations versus monthly average discharge criteria at Nordic TMA station N-19.

Table 3.27: Toxicity test results from samples collected at Lacnor/Nordic TMA station N-12, 2005 - 2009.

Sample Date (month-year)	Acute Toxicity (% mortality)		Survival and Reproduction (IC25[d] as % effluent)
	Daphnia magna [a]	rainbow trout [b]	*Ceriodaphnia dubia* [c]
May-05	0	0	100
November-05	0	0	100
May-06	0	0	100
November-06	0	0	100
May-07	0	0	100
November-07	0	0	100
May-08	0	0	100
November-08	0	0	100
May-09	0	0	100
November-09	0	0	100

[a] *Daphnia magna* 48-hr LC50 test (Environment Canada 2000a).

[b] Rainbow trout 96-hr LC50 test (Environment Canada 2000b).

[c] *Ceriodaphnia dubia* survival and reproduction test (Environment Canada 2007).

[d] Effluent concentration causing 25% inhibition relative to control organisms.

tailings. Porewater associated with the Nordic West Arm has either been stable or improved as indicated by decreasing iron concentrations and increasing pH levels. Groundwater down-gradient of the Nordic Main Basin has also significantly improved, reflecting remediation efforts in the ECD and settling pond and lower oxidation rates within the tails. In the past five years treated effluent consistently achieved discharge criteria and all tests to *Daphnia magna*, rainbow trout and *Ceriodaphnia dubia* were non-toxic. Overall, the Lacnor/Nordic TMA is performing well and conditions are improving over time.

3.9 Pronto TMA

3.9.1 Basin History and Modifications

The Pronto TMA is located on the north side of Highway 17, approximately 10 km east of Blind River. The Pronto mine operated from 1955 to 1960 and, over that period, the Pronto mill processed approximately 2.1 million tonnes of uranium ore. In 1960, the mill was converted to process copper ore from an adjacent mine and, from 1960 to 1970, produced approximately 2 million tonnes of copper tailings. In 2009, approximately 33,000 tonnes of rock fill from adjacent residential properties were relocated to the Pronto TMA. Tailings are located in a 47-hectare natural rock basin contained by Dam A, constructed of a glacial till core with a waste rock shell (Figure 3.34).

A high water table (close to the surface) at the Pronto TMA, serves to reduce acid generation (Rio Algom 2000). However, in the eastern portion of the TMA the saturation extended to surface which precluded traditional direct liming and seeding and as such a successful vegetative cover could not be maintained. To resolve this problem, rock-lined drainage ways were installed in the eastern portion of the TMA during the winter of 1999-2000. Then six tonnes/ha of limestone and 500 kg/ha fertilizer were applied to bare areas in the spring of 1999 and a 30-cm depth of biosolids (in the form of paper mill sludge) were spread over a 20.9-ha area from 1999 to 2001. These measures have been effective in maintaining a 100% vegetative cover following program completion in 2001.

The East and West Collection Ditches, upgraded in 1999, direct seepage and runoff from the TMA into the Holding Pond. Water from the Holding Pond is directed through the Pronto treatment plant at a rate of 100 to 200 L/s which operates for two to four months per year. Lime and barium chloride are added in the treatment plant to promote metals and radium precipitation in the Settling Pond prior to release of treated water to the Downstream Pond. The treatment plant, originally constructed in 1971, was upgraded in 1979 and 1993 prior to being replaced with the current structure in 1997. Dam F was constructed at the west end of

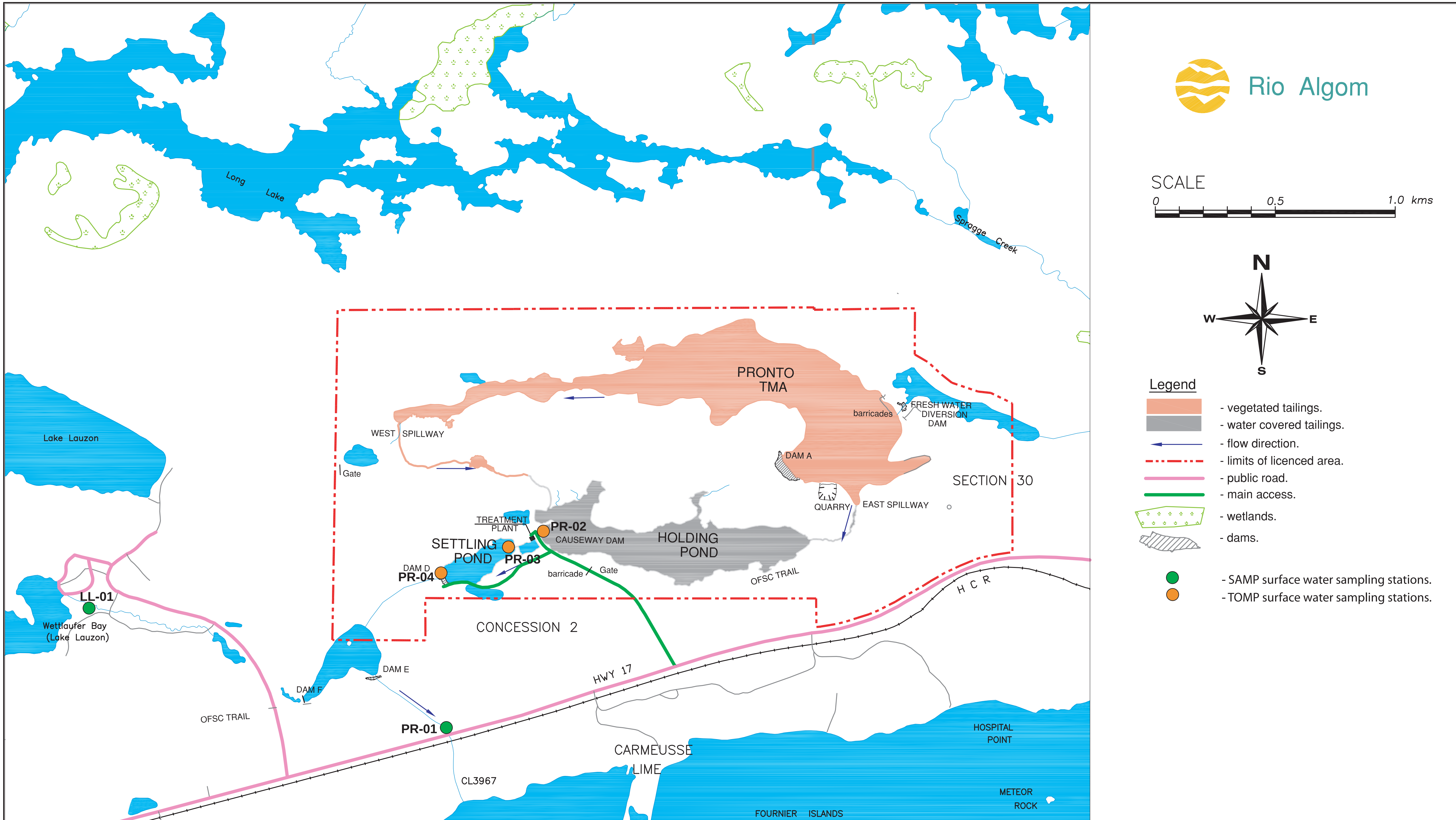


Figure 3.34

Pronto Site SAMP and TOMP Monitoring Stations

Ref: 2295
Date: February 2011

the Downstream Pond in the late 1970s and upgraded in 1998 and 2007 to direct flow away from Lake Lauzon towards Lake Huron via the Pronto Discharge Channel (Figure 3.34).

Within the TMA, surface water is monitored under the TOMP and the locations, substances and frequency monitored are specific to the station type (Table 3.28; Figure 3.34) Data from the TOMP stations are summarized in the following sections and presented in Appendix C (Appendix Tables C.8.2 – C.8.4).

3.9.2 Water Elevations

Operating elevations in the Holding Pond were established to ensure adequate storage capacity to contain and treat “the Timmins Storm” (193 mm in 12 hrs; elevation 196.5 m), and also provide adequate water cover to prevent freeze-up of the influent pipe (elevation 197.7 m). The water levels within the Holding Pond at the Pronto TMA are monitored regularly at PR-02 and have been maintained within the operating limits during routine operations (Figure 3.35). The Holding Pond has been drawn down below normal operating elevations on several occasions to facilitate construction activities including the treatment plant replacement in 1997, Causeway Dam upgrading in 1998, and the ATV trail re-routing in 2006.

3.9.3 Basin Surface Water Quality

Surface water quality at the Pronto TMA is monitored at three stations to assess conditions downstream of the tailings deposition area (Figure 3.34):

- Seepage and surface runoff for the Pronto TMA are captured in the Holding Pond which is monitored at PR-02 (Appendix Table C.8.2);
- pH within the ETP is monitored at PR-03 (Appendix Table C.8.3); and
- Final effluent is monitored at the outlet of the Pronto Settling Pond (PR-04; Appendix Table C.8.4).

Over the past twenty years, concentrations of radium-226 and uranium as well as pH levels have remained relatively stable, while some reduction in sulphate was observed in the past ten years (Figure 3.36). Similarly, over the past seven years, there were no significant trends detected in surface water with the exception of barium concentrations in final effluent associated with reductions in barium chloride use in the ETP (Table 3.29).

Table 3.28: TOMP monitoring stations, substances, and frequencies[a] at Pronto TMA.

TOMP Stations	Station Type/Purpose	Parameters and Frequencies[a]										
		Elevation	Flow	pH	Sulphate	Total radium-226	Lime or NaOH Consumption	Barium Chloride Consumption	TSS	Acidity	Iron	SAMP Metals[b]
PR-02[c]	Basin performance (primary), ETP operations	W	D	M	Q	M	M	M		Q		Q
PR-03[c]	ETP operations			D								
PR-04[c]	Effluent		W	W	M	W			W			M

[a] D - Work days, W - Weekly, M - Monthly, S - Semi-annually, A - Annually, Q-Quarterly

[b] SAMP metals are barium, cobalt, iron, manganese, and uranium

[c] Sampled when treatment plant is operating.

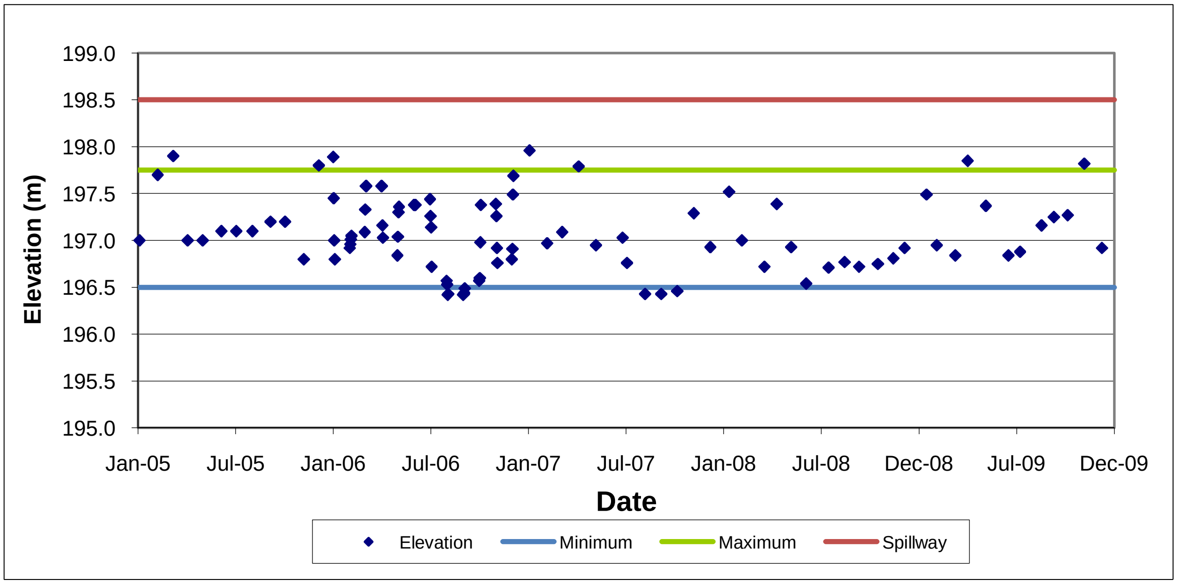


Figure 3.35: Water level at PR-02 relative to minimum operating elevation.

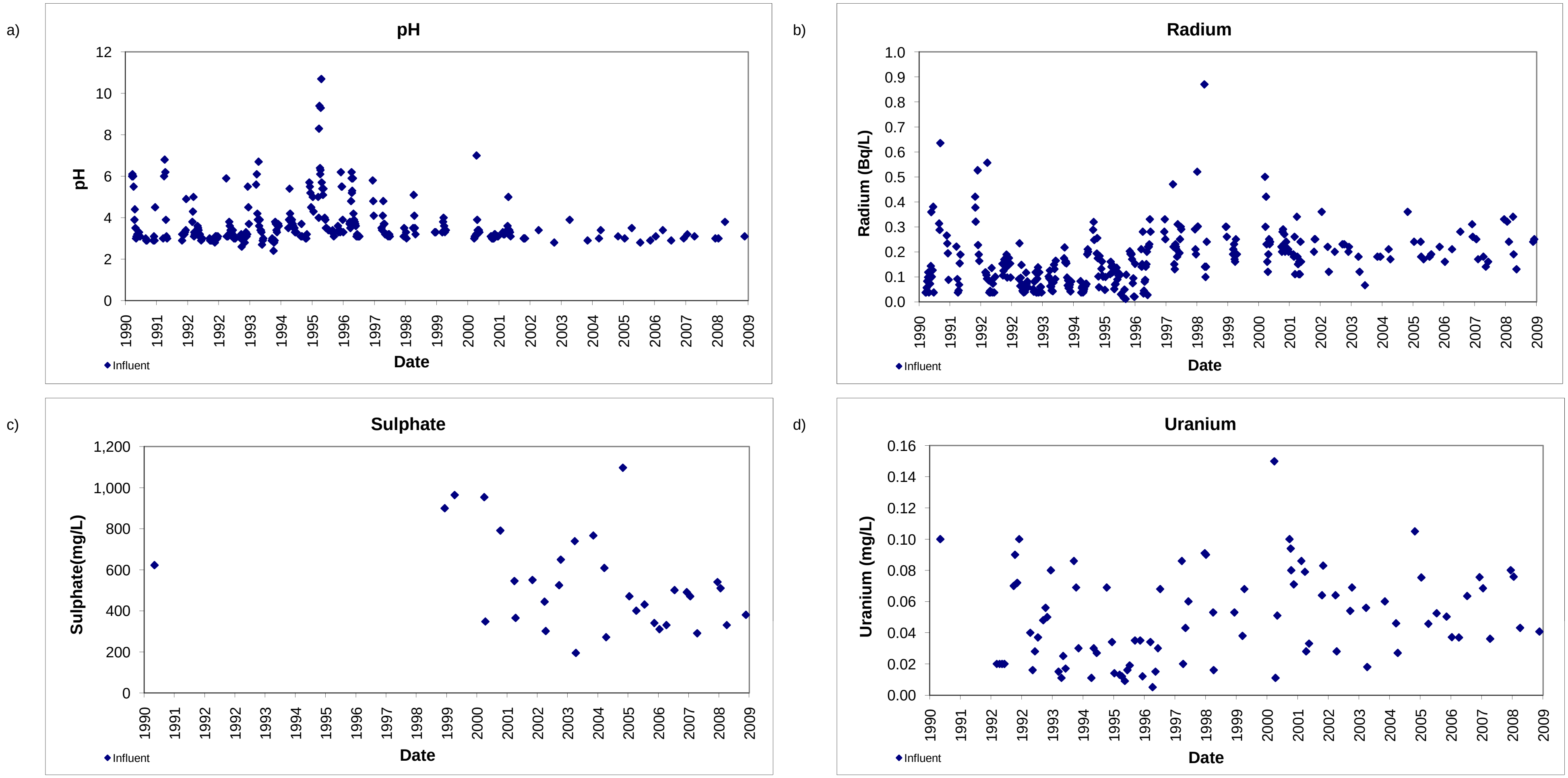


Figure 3.36: Water quality at the influent (PR-02) of the Pronto TMA treatment plant.

Table 3.29: Summary of water quality trends[a] for TOMP monitoring stations, Pronto TMA, 2003 to 2009.

Station ID	Type/Location	Number of Seasons Used in Common Trend[c]	Acidity	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium
PR-02	Treatment Plant Influent	3 to 6	-0.440	0.447	0.381	0.405	0.214	0.299	0.286	-0.094	0.298
PR-04	Final Treated Effluent	4 to 6	-[b]	-0.821	0.170	-0.267	-0.058	0.354	0.041	-	0.047

(blue) decreasing trend, significant at p<0.05

(green) increasing trend, significant at p<0.05

[a] Based on rank correlation coefficients (rho) for common (combined) season trends, shown in table.

[b] "-" denotes that this parameter was not included in the trend analysis for that particular station due to insufficient data (e.g. there were <5 years worth of data for that parameter)

[c] Seasons used varied for substances based on suitability of data for trend analysis.

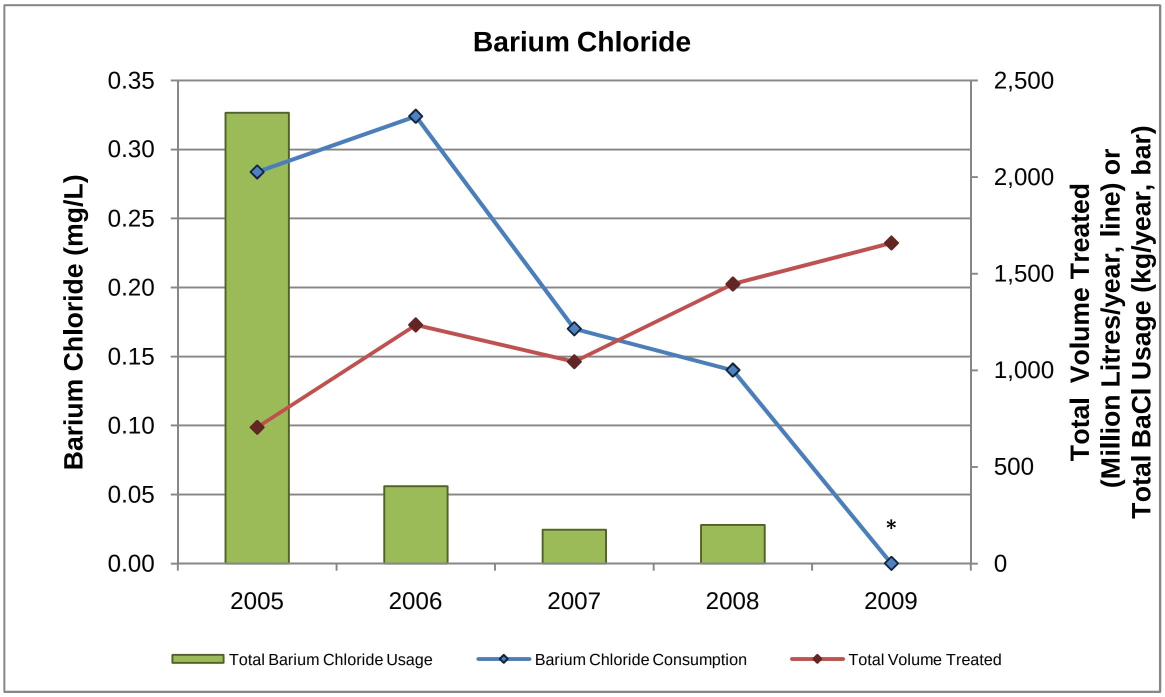
3.9.4 Treatment Performance

Effluent from the Pronto TMA is treated in an ETP downstream of the Holding Pond (PR-02) (ETP influent) and released at PR-04, the compliance point for effluent treatment. Treatment has included both lime and barium chloride to reduce acidity and radium-226 respectively. However, since 2005, the ETP has been reducing its barium chloride use and in 2009 it was not used in the treatment process because co-precipitation with lime was sufficient to reduce radium-226 levels to less than the discharge criterion (Figure 3.37; Table 3.29). The lime consumption rate has remained stable during the reporting period (Figure 3.37).

Following treatment, effluent quality is monitored at the outlet the Settling Pond (PR-04) and over the past five years effluent quality has consistently achieved discharge criteria (Figure 3.38; Appendix Table C.8.1). One iron concentration in a single grab sample exceeded the action limit of 1.0 mg/L and triggered implementation of a response plan that resulted in compliance with discharge criteria. Effluent has been consistently non-lethal to *Daphnia magna* and rainbow trout with no mortality reported in semi-annual acute toxicity tests (Table 3.30). Similarly, survival and reproduction of *Ceriodaphnia dubia* was not affected by exposure to 100% effluent in any tests conducted over the past five years (Table 3.30).

3.9.5 Summary

Water levels within the Holding Pond have been maintained above the minimum operating levels. Surface water quality has been consistent over time with the exception of decreasing barium concentrations in TMA effluent associated with reductions in barium chloride use in the ETP. The TMA has been reducing barium chloride use over the past five years with no barium chloride used in 2009, because lime precipitation proved adequate to reduce radium-226 concentrations below the discharge criterion. In the past five years treated effluent consistently achieved discharge criteria and all tests to *Daphnia magna*, rainbow trout and *Ceriodaphnia dubia* were non-toxic.



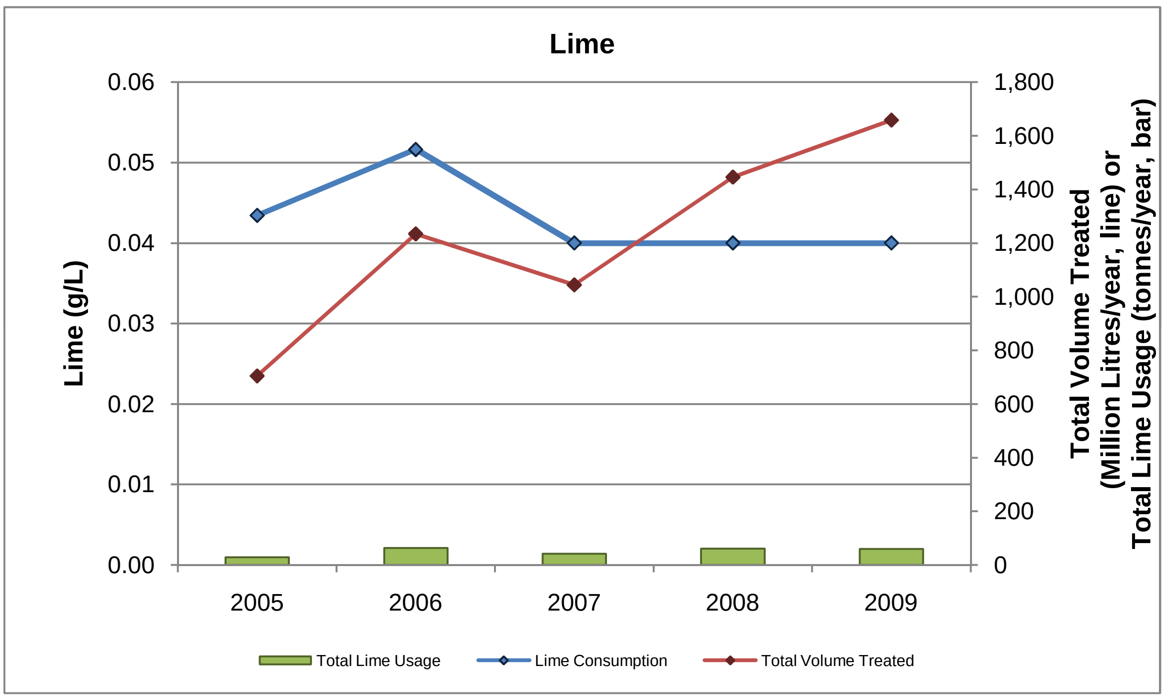


Figure 3.37: Comparison of total reagent consumed versus total volume treated at Pronto TMA from 2005-2009 (* no BaCl used in 2009).

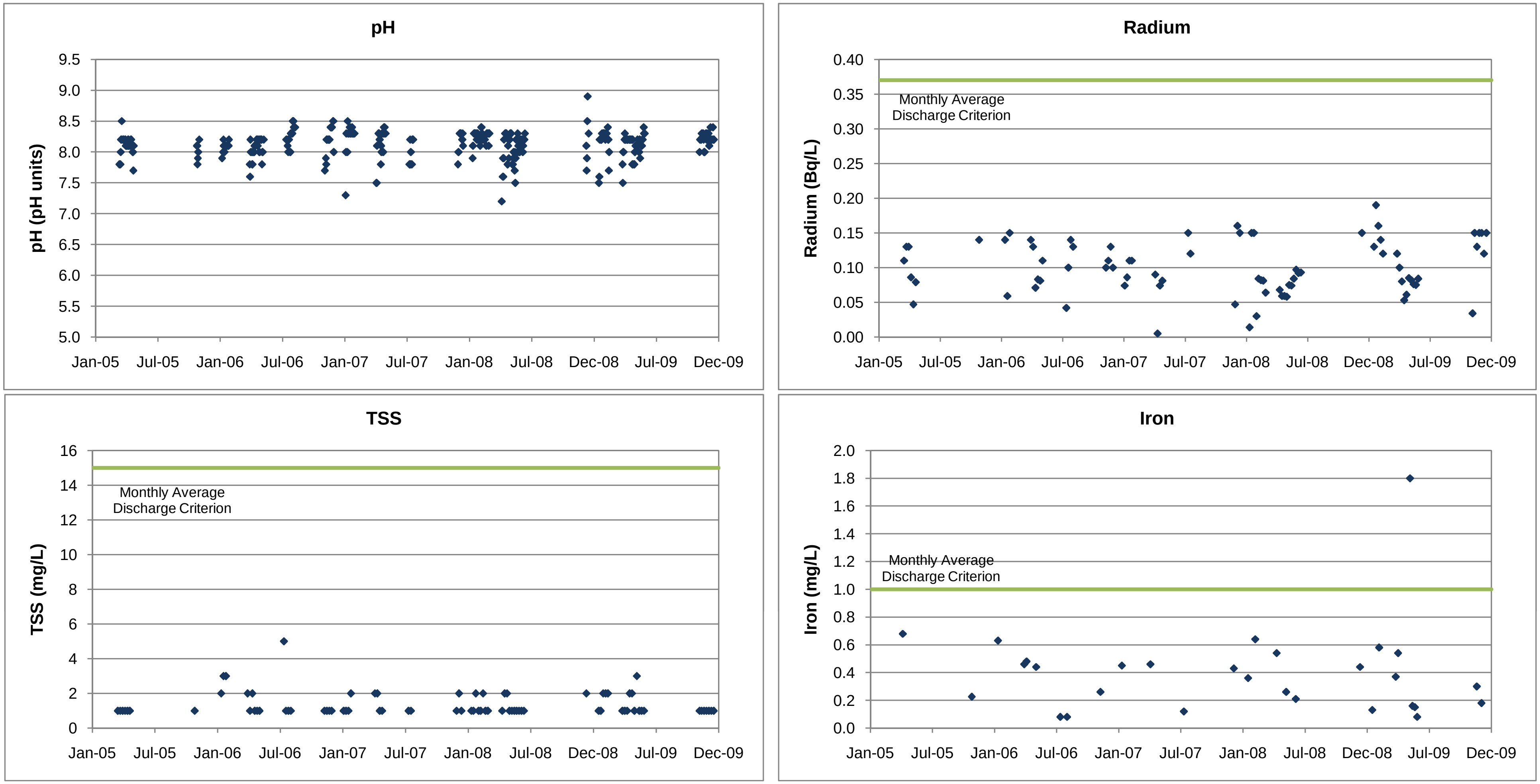


Figure 3.38: Effluent concentrations versus monthly average discharge criteria at Pronto TMA station PR-04.

Table 3.30: Toxicity test results from samples collected at Pronto TMA station PR-01, 2005 - 2009.

Sample Date (month-year)	Acute Toxicity (% mortality)		Survival and Reproduction (IC25[d] as % effluent)
	Daphnia magna [a]	rainbow trout [b]	*Ceriodaphnia dubia* [c]
April-05	0	0	100
October-05	0	0	100
April-06	0	0	100
November-06	0	0	100
April-07	0	0	100
December-07	0	0	100
May-08	0	0	100
December-08	0	0	100
April-09	0	0	100
November-09	3	0	100

[a] *Daphnia magna* 48-hr LC50 test (Environment Canada 2000a).

[b] Rainbow trout 96-hr LC50 test (Environment Canada 2000b).

[c] *Ceriodaphnia dubia* survival and reproduction test (Environment Canada 2007).

[d] Effluent concentration causing 25% inhibition relative to control organisms.

4.0 SOURCES TO THE WATERSHED

Mine releases to watershed, including effluent, seepage and site runoff are captured through the Source Area Monitoring Program (SAMP; Table 4.1). Data for each discharge are presented in Appendix D. Results are discussed below on a sub-watershed basis so that mine sources to the watershed may be considered cumulatively. Concentrations within mine releases have been compared to receiving water benchmarks[4] for the Serpent River Watershed (SRW). While mines sources are generally not expected to achieve standards for receiving environment quality, comparisons were made because in many instances mine effluents are at or approaching these standards. Based on watershed area ratios, a minimum 10-fold dilution is expected downstream of the mine discharges. Thus, a concentration of 10x the appropriate receiving environment criterion is a more relevant comparison for discharges and such values are also discussed as appropriate. Trend analysis was conducted on SAMP data since the inception of the program (2003 to 2009) to determine substances and locations reflecting statistically significant changes in concentrations.

4.1 Quirke Lake Sub-watershed Sources

Within the Quirke Lake sub-watershed there are primary (effluent) and secondary (seepage/runoff) discharges from three TMAs (Denison, Quirke and Panel; Figure 4.1) In addition, seepage form the Stanrock TMA also discharges to Quirke Lake, resulting in four TMA sources to the Quirke Lake sub-watershed. As part of the SRWMP, water quality is monitored both upstream and downstream of these sources (Figure 4.1).

4.1.1 Discharge Quality and Loads

With few exceptions, mean mine discharge concentrations (2005-2009) of cobalt, iron, manganese, radium-226, sulphate and uranium achieved PWQO or were less than 10 times PWQO in mine sources (Figure 4.2). Concentrations of barium and sulphate tended to be highest in the primary discharges while concentrations of metals (Co, Fe, Mn and U) were highest and pH lowest in secondary discharges (seepages) (Figure 4.2). The seepages with the highest concentrations were ECA 398 (cobalt, uranium and pH), DS-16 (cobalt, manganese), D-9 (cobalt, iron, and manganese), D-16 (manganese) and Q-23 (pH). While

[4] The Serpent River Watershed benchmarks are based on the upper limit of background or PWQO whichever is higher. For sulphate and manganese the BCMOE guideline was used as there is no PWQO for this substance.

Table 4.1: SAMP stations, parameters and frequencies[a].

TMA	Location	Type	Description	Parameter[b]					
				flow	pH	Sulphate	Radium-226	SAMP metals[c]	toxicity
Denison	D-2[d]	Primary	Stollery Lake Outlet	D	W	M	M	M	2
	D-3[d]	Primary	TMA-2 Effluent at Denison Mine access road	D	W	M	M	M	
	D-9	Seepage	Seepage at Dam 17	Q	Q	Q	Q	Q	
	D-16	Seepage	Seepage at Dam 9	Q	Q	Q	Q	Q	
Quirke	ECA-398	Seepage	Quirke II north of access road	Q	Q	Q	Q	Q	
	Q-22	Drainage	Quirke II Drainage south of access road	Q	Q	Q	Q	Q	
	Q-23	Drainage	Swamp Outlet west of Dam K1	Q	Q	Q	Q	Q	
	Q-27	Seepage	Dam J Toe Seepage		Q	Q	Q	Q	
	Q-28[d,e]	Primary	Final Treated Effluent	W	W	M	M	M	2
Panel	P-02	Seepage	Downstream of Dam B	Q	Q	Q	Q	Q	
	P-03	Drainage	Beaver Pond C Outlet	Q	Q	Q	Q	Q	
	P-05	Drainage	Swamp Outlet north of Dam E		Q	Q	Q	Q	
	P-11	Drainage	Panel Creek Outlet at Quirke Lake	Q	Q	Q	Q	Q	
	P-14[d,e,f,g]	Primary	Final Treated Effluent	W	W	M	M	M	2
Stanrock	DS-4	Primary	Orient Lake Outlet (Final Point of Control)	W	W	M	M	M	2
	DS-16	Drainage	Quirke Lake Delta	Q	Q	Q	Q	Q	
Stanleigh	CL-06[d,e]	Primary	Final Treated Effluent	W	W	M	M	M	2
Milliken	MPE	Primary	Milliken Park Effluent		M	M	M	M	2
Nordic	N-12	Primary	Buckles Creek at Hwy. 108	M	M	M	M	M	2
Pronto	LL-01	Drainage	Pronto Creek at Inlet to Lake Lauzon	Q	Q	Q	Q	Q	
	PR-01	Primary	Pronto Discharge Channel at Highway 17	M	M	M	M	M	2

[a] Frequencies: D =daily, W = weekly, M = monthly, 2 = twice per year, Q = quarterly

[b] DOC and hardness will be added to the SAMP program effective January 2010.

[c] SAMP metals - barium, cobalt, iron, manganese, uranium

[d] This station is also TOMP effluent station and requirements will be harmonized to serve both programs.

[e] Sampled when treatment plant is operating.

[f] P-14 will revert to P-36 upon ETP shut down.

[g] Flow will be based on influent flow to the ETP at P-13.

Figure 4.1

Quirke Lake Sub-watershed Mine Source and Receiving Environment Stations

Ref: 2295
Date: February 2011

Source: Elliot Lake Research Field Station

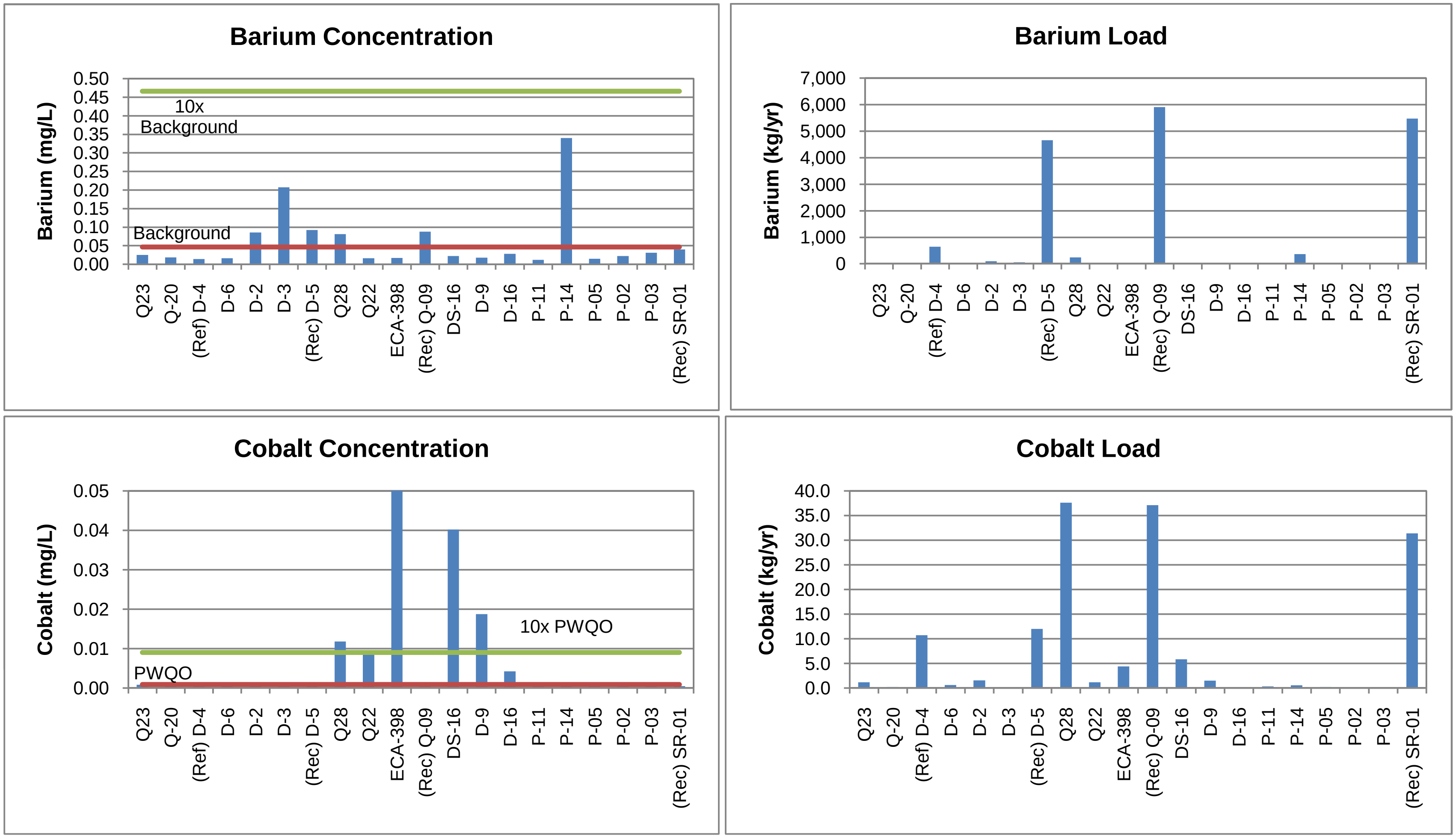


Figure 4.2: Mean concentrations and loads at monitoring stations upstream of Quirke Lake outlet, 2005-2009, (Rec) denotes receiving environment station, (Ref) denotes reference station.

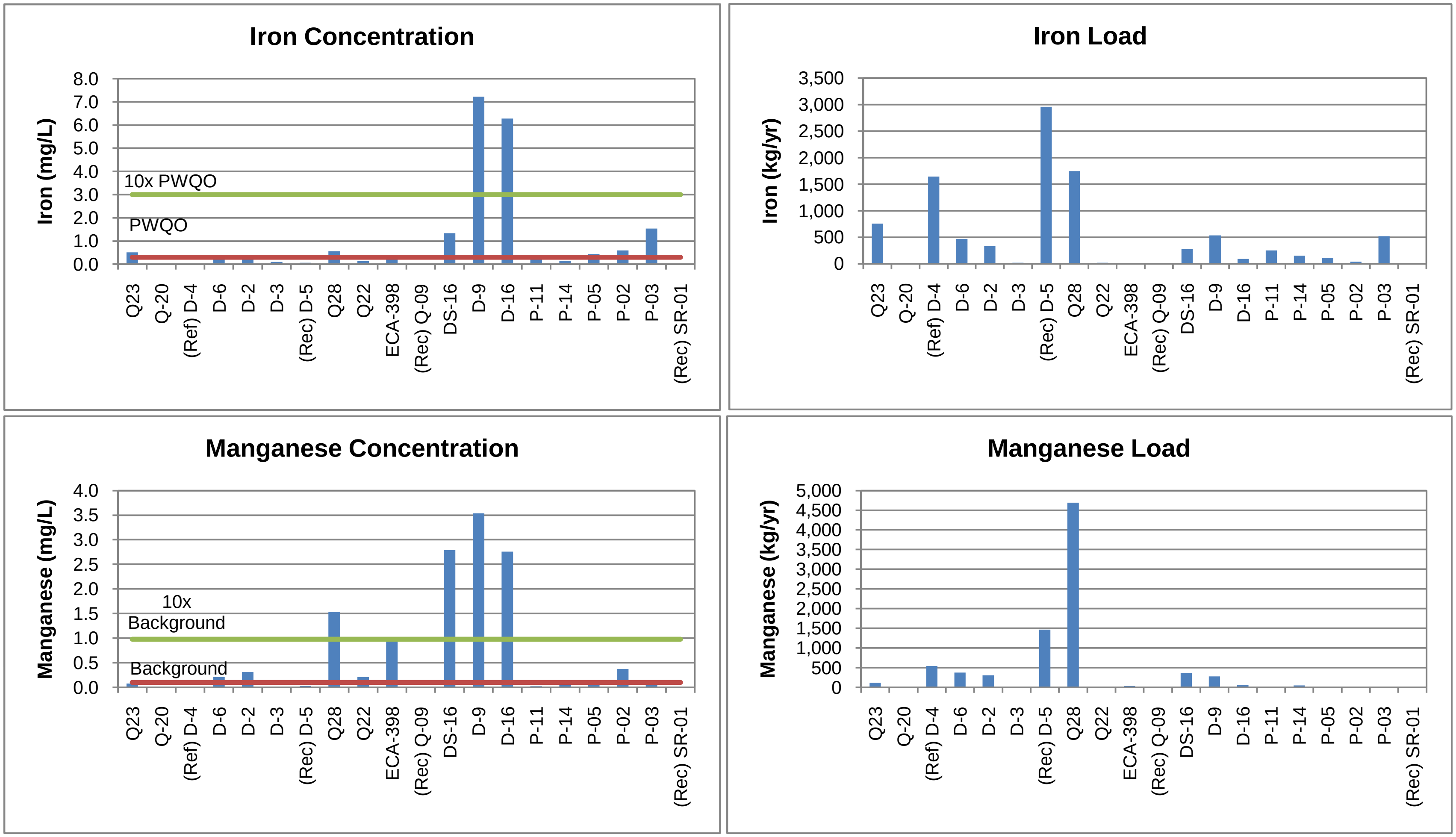


Figure 4.2: Mean concentrations and loads at monitoring stations upstream of Quirke Lake outlet, 2005-2009, (Rec) denotes receiving environment station, (Ref) denotes reference station.

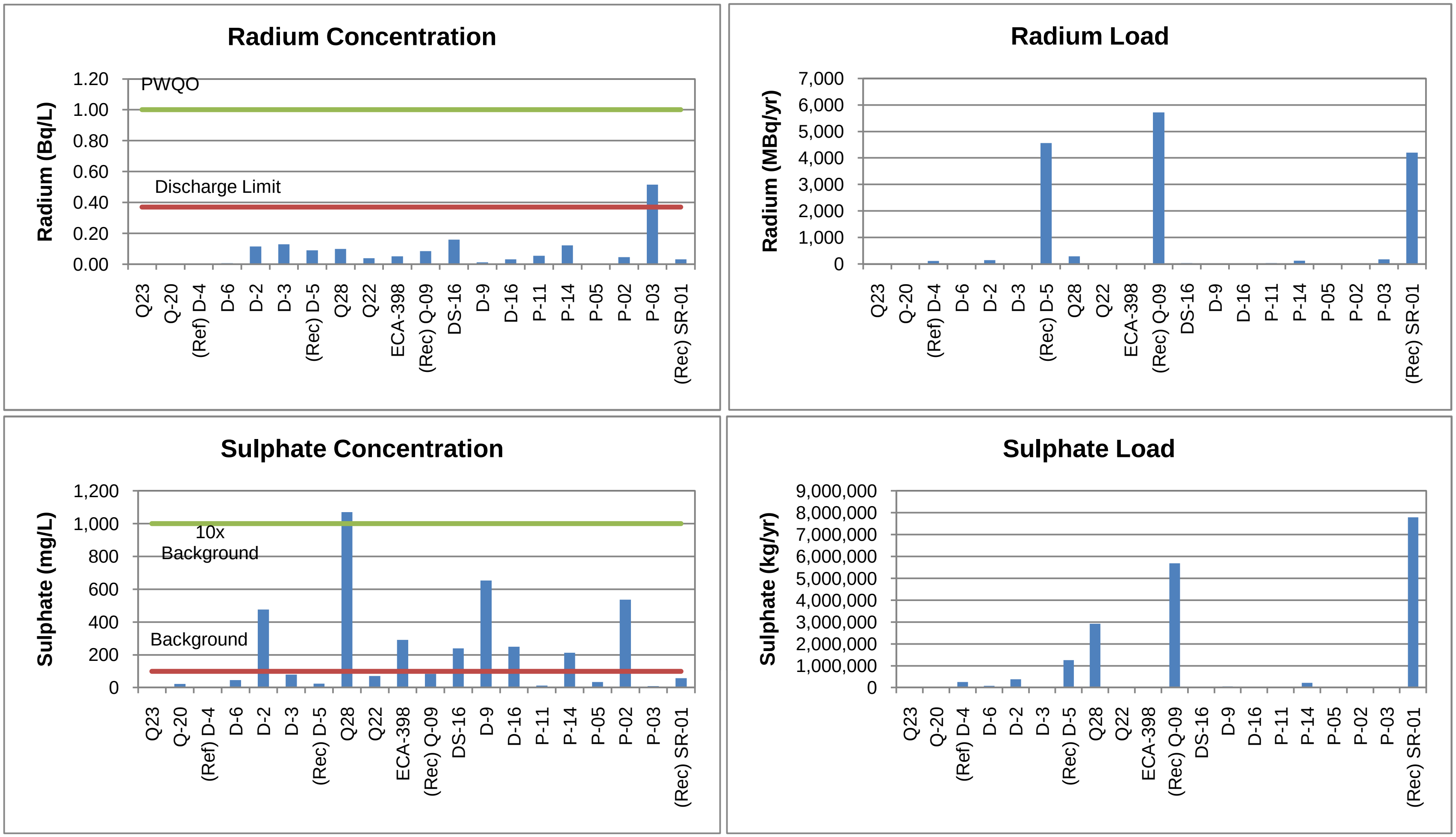


Figure 4.2: Mean concentrations and loads at monitoring stations upstream of Quirke Lake outlet, 2005-2009, (Rec) denotes receiving environment station, (Ref) denotes reference station.

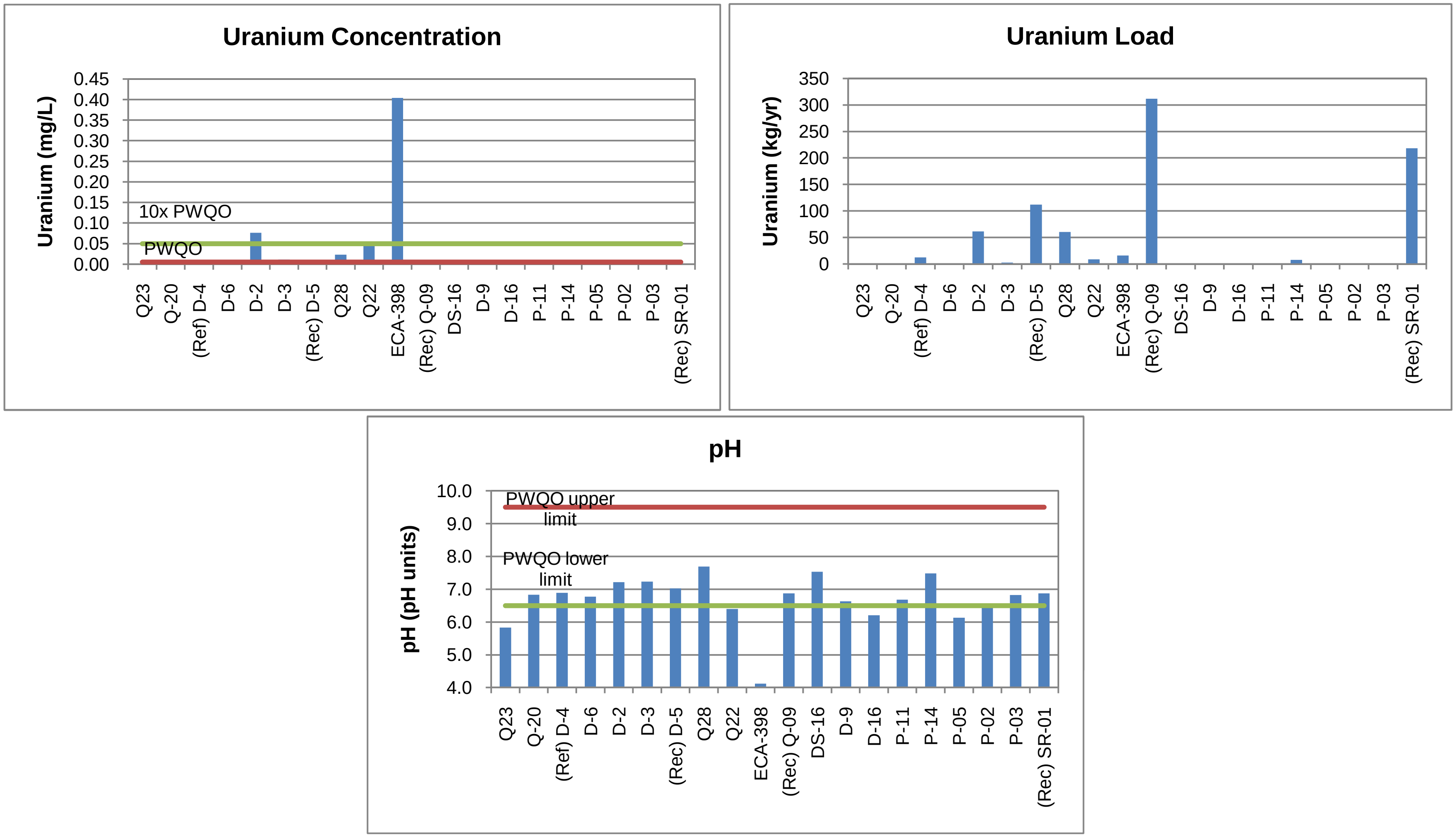


Figure 4.2: Mean concentrations and loads at monitoring stations upstream of Quirke Lake outlet, 2005-2009, (Rec) denotes receiving environment station, (Ref) denotes reference station.

these concentrations were high, the associated loadings contributed to the watershed were low compared to primary discharges and background (upstream) loads (Figure 4.2).

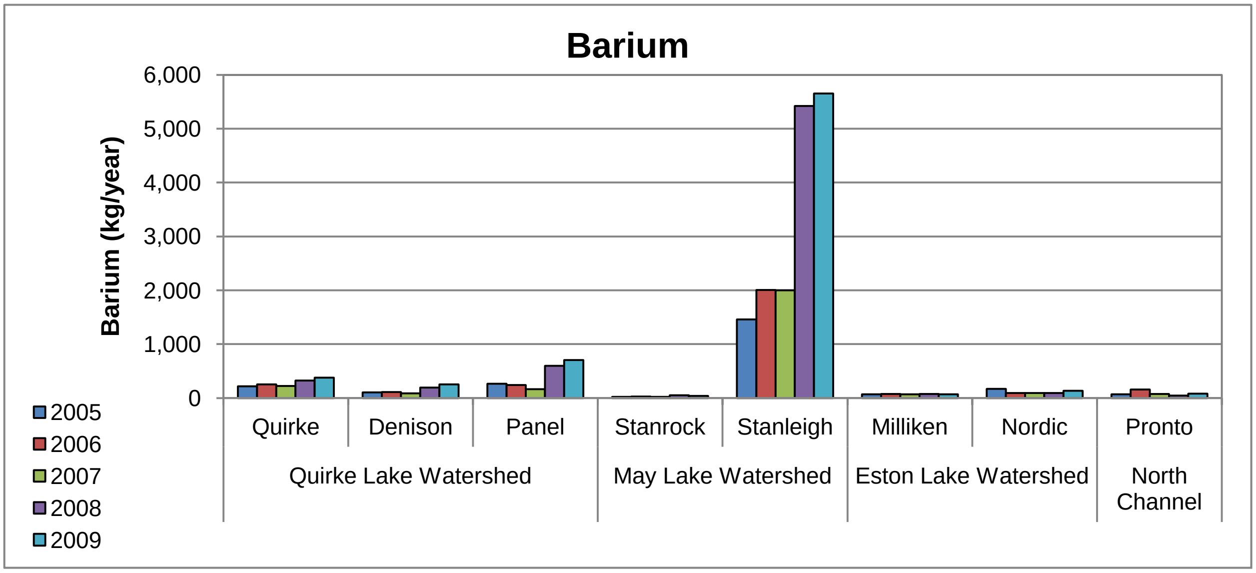
In terms of the relative loadings among TMAs within the Quirke Lake sub-watershed, the Quirke TMA tended to have highest loading of most metals (cobalt, manganese, sulphate and uranium), except for barium and radium-226, for which Panel TMA contributed slightly higher loads (Figure 4.3). Within Quirke TMA, 60 to 80% of annual loads were associated with the primary discharge (Appendix Figure D.2.1). At Panel, over 90% of barium load was from the primary discharge, whereas only 50% of the radium-226 load is from primary discharge with about 30% from Pond C (P-03) (Appendix Figure D.3.1).

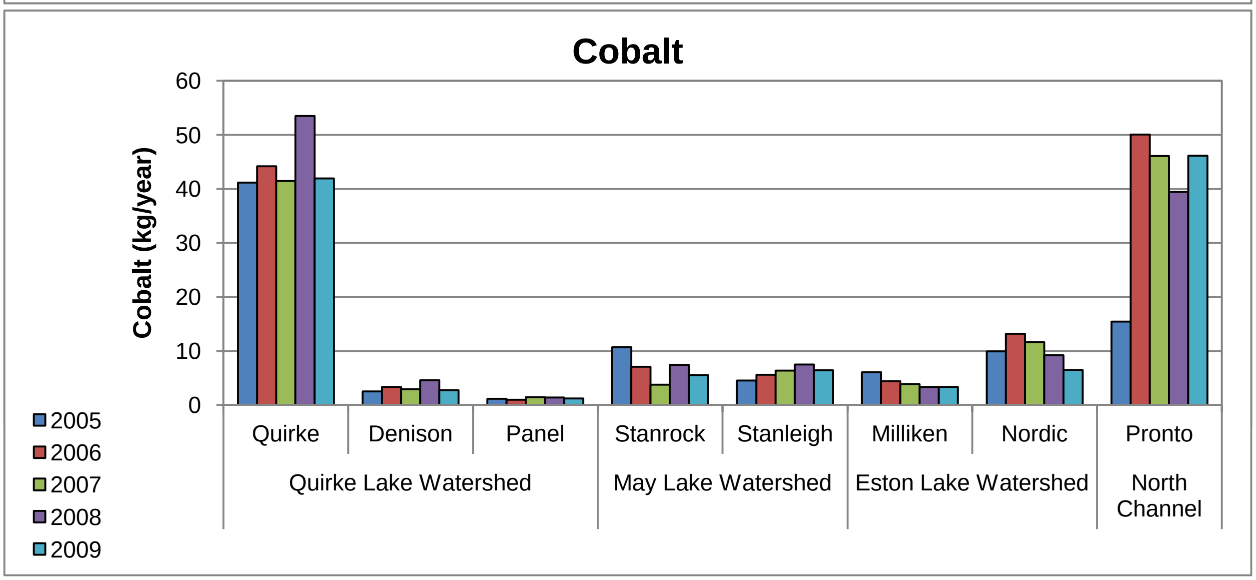
As noted in the previous SOE report (Minnow 2009a), the radium load within the Serpent River downstream of the Denison TMA discharge (D-5) was substantially greater than the loading from the Denison TMA (Figure 4.2) or upstream watershed (D-4) suggesting a radium source within the river. In 2009, EcoMetrix conducted a study to investigate the difference in loadings within the River (Appendix G). Sediment sampling conducted in 2009 found elevated radium-226 concentrations (14 Bq/g) between stations D4 and D5, which indicated a source of radium-226 in the Serpent River. The barium and sulphate depth profiles in sediment and water (porewater and overlying water) mirrored the radium profiles, indicating that these profiles are likely caused by the settling/accumulation of historical treatment solids. Modelling of radium releases (load) based on the diffusion and mass transport of radium from the sediment agreed well with those observed in this report (e.g., the modelled cumulative load was 3,420 MBq/a compared with 3,884 MBq/a calculated in this report), and agreed with loading averages from 2003 to 2006 (Minnow 2009a). These loadings are therefore consistent with the recovery of historically accumulated sediments releasing radium to the water column. Diffusion modelling indicated that radium-226 release from the sediment should decrease with time.

Loadings from all upstream mine sources do not result in concentrations in the receiving environment that are above SRW benchmarks (Figure 4.2).

4.1.2 Source Trends

Cobalt, manganese, sulphate, radium-226 and uranium concentrations have decreased or been stable over the past seven years in all discharges to Quirke Lake (Table 4.2). Barium concentrations increased over time at the primary discharge locations (D2, D-3, P-14 and Q-28) (Table 4.2) largely due to greater barium use in 2008 and/or 2009 in response to increased flows (Figure 4.4).





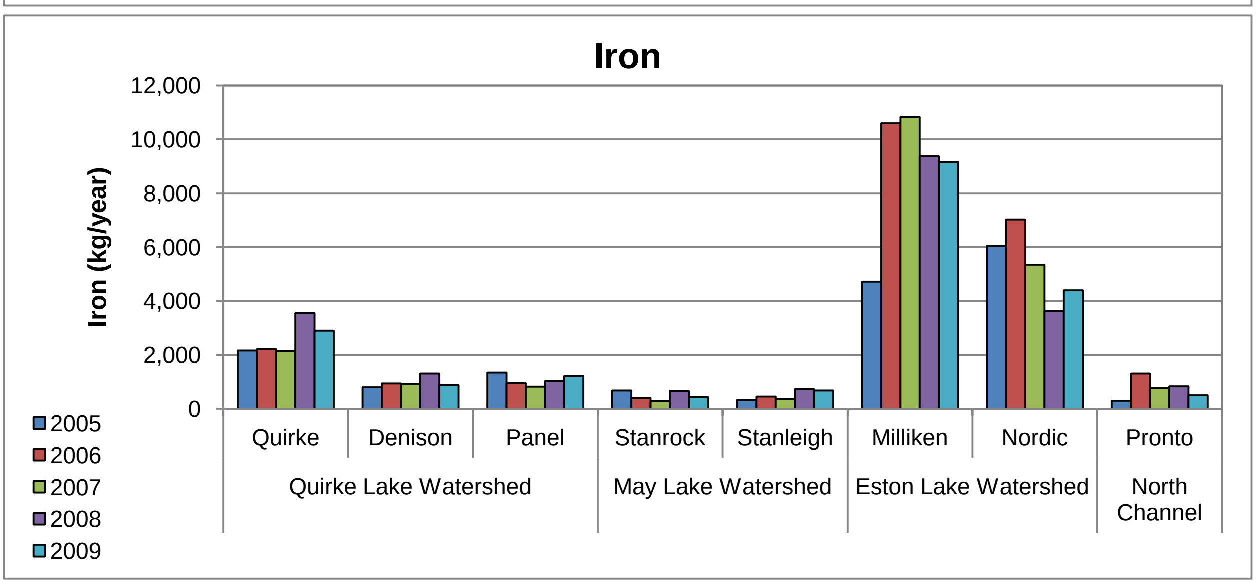
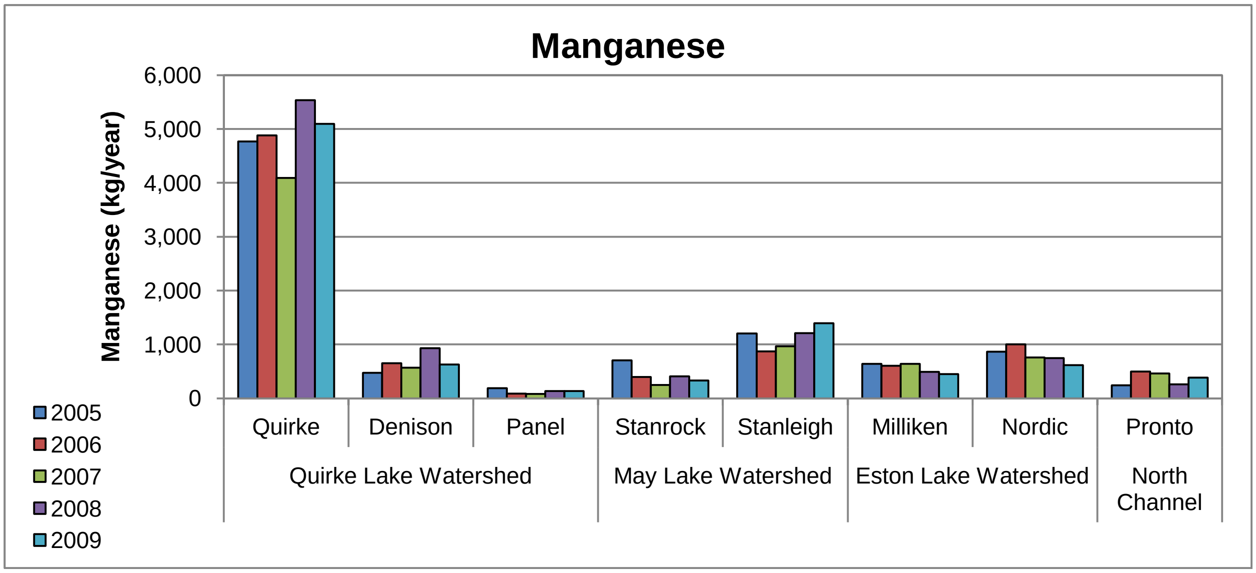
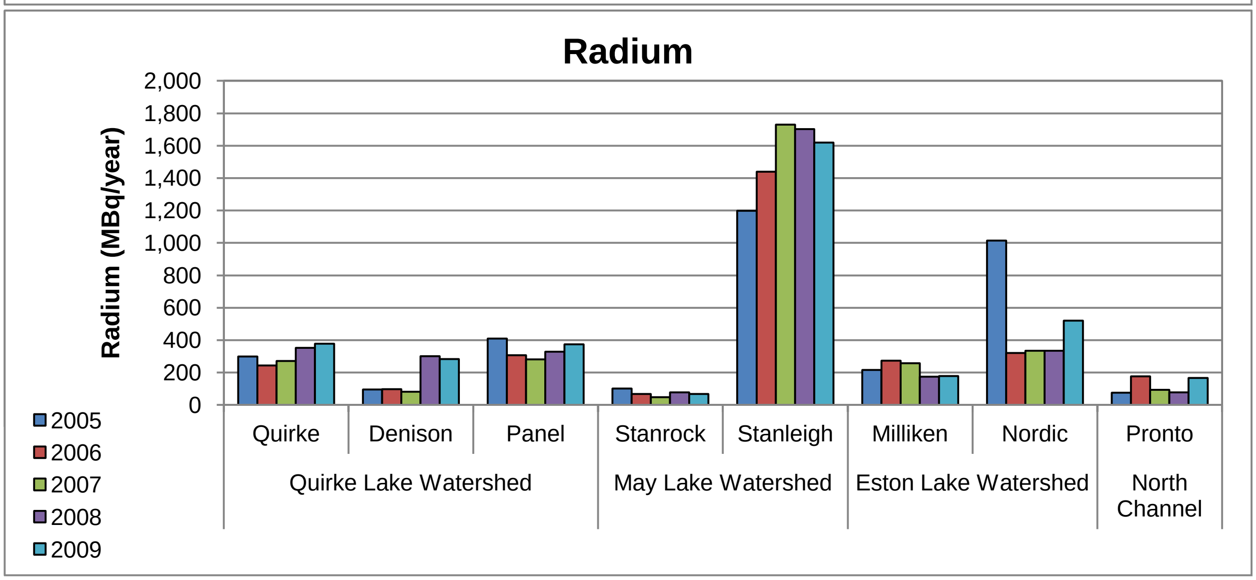


Figure 4.3: Annual TMA loadings by watershed (2005-2009).





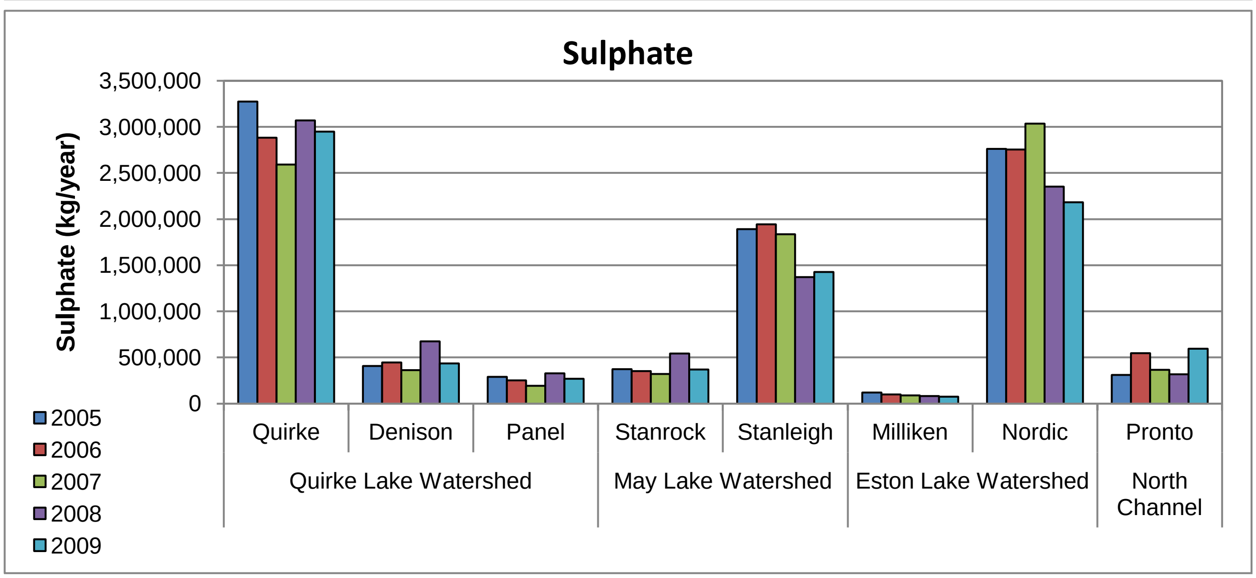


Figure 4.3: Annual TMA loadings by watershed (2005-2009).

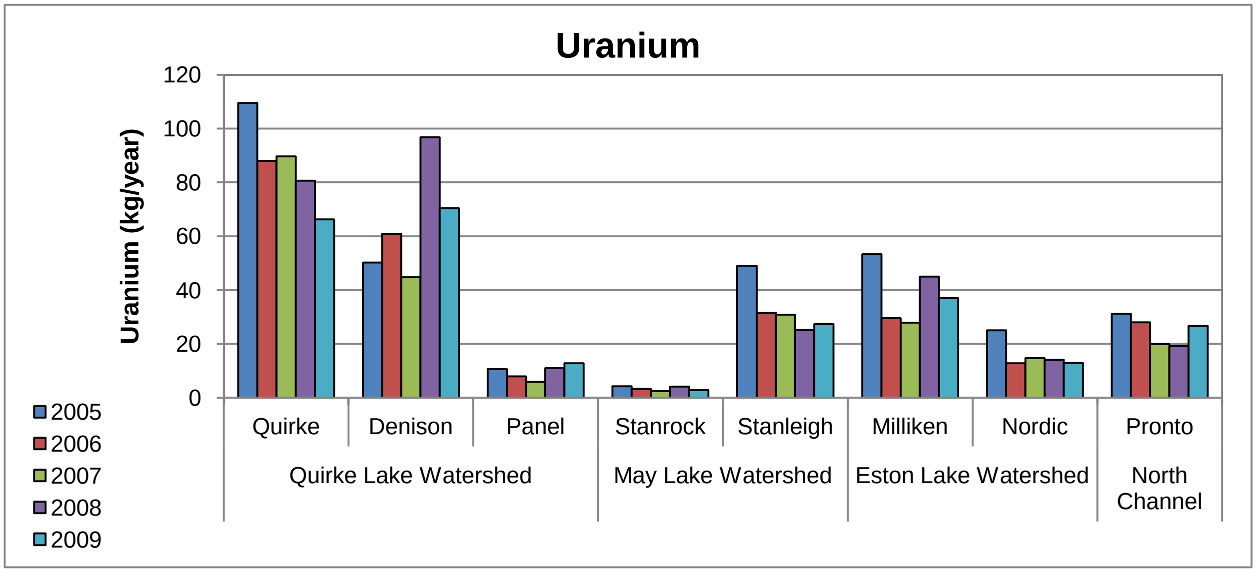


Figure 4.3: Annual TMA loadings by watershed (2005-2009).

Table 4.2: Summary of water quality trends[a] for SAMP water quality monitoring stations in Denison, Quirke, Panel, and Stanrock, 2003 to 2009.

TMA	Station ID	Type	Number of Seasons Used in Common Trend[d]	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium
Denison	D-2	Primary	12	0.313	-0.221	0.333	-0.352	-0.585	-0.080	-0.688	*-0.181*
	D-3	Primary	10 to 12	0.598	ND[c]	0.116	0.157	-0.597	0.170	-0.519	*-0.135*
	D-9	Seepage	4	*0.399*[b]	-0.715	-0.581	-0.036	0.332	*-0.303*	-0.170	-0.410
	D-16	Seepage	4	-0.270	-0.571	0.286	-0.071	0.628	-0.565	-0.393	ND
Quirke	ECA-398	Seepage	7	0.484	-0.624	0.017	-0.389	0.494	-0.416	-0.850	-0.909
	Q-22	Drainage	4	-0.131	-0.523	-0.307	-0.330	0.548	-0.402	-0.340	-0.652
	Q-23	Drainage	1 to 4	-0.232	0.102	0.081	-0.362	0.033	-0.927	-0.558	ND
	Q-27	Seepage	2 to 3	0.582	0.175	-0.260	0.069	-0.039	-0.275	0.315	-0.900
	Q-28	Primary	12	0.522	-0.401	0.391	-0.421	0.107	0.098	-0.704	-0.585
Panel	P-02	Seepage	2 to 4	-0.115	-0.366	-0.018	-0.304	0.426	-0.384	-0.875	-0.342
	P-03	Drainage	4	*0.139*	ND	*-0.265*	*-0.139*	-0.509	0.200	-0.143	ND
	P-05	Drainage	2 to 4	-0.248	0.004	0.045	-0.125	-0.356	-0.533	-0.192	ND
	P-11	Drainage	2 to 4	-0.158	-0.550	-0.246	-0.479	0.056	-0.568	-0.596	-0.205
	P-14	Primary	4 to 5	0.676	-0.386	-0.302	-0.226	-0.301	-0.701	-0.886	-0.612
Stanrock	DS-16	Drainage	1 to 4	-0.040	-0.804	-0.402	-0.580	0.777	-0.569	-0.453	-0.714

(blue) decreasing trend, significant at $p<0.05$

(green) increasing trend, significant at $p<0.05$

[a] Based on rank correlation coefficients (rho) for common (combined) seasonal trends, shown in table.

[b] Italic text mean monthly correlations significantly different, but common trend value provided.

[c] ND denotes that this parameter was not included in the trend analysis for that particular station due to >50% non-detectable concentrations in the samples available for the analy

[d] Seasons used varied for sbustances based on suitability of data for trend analysis.

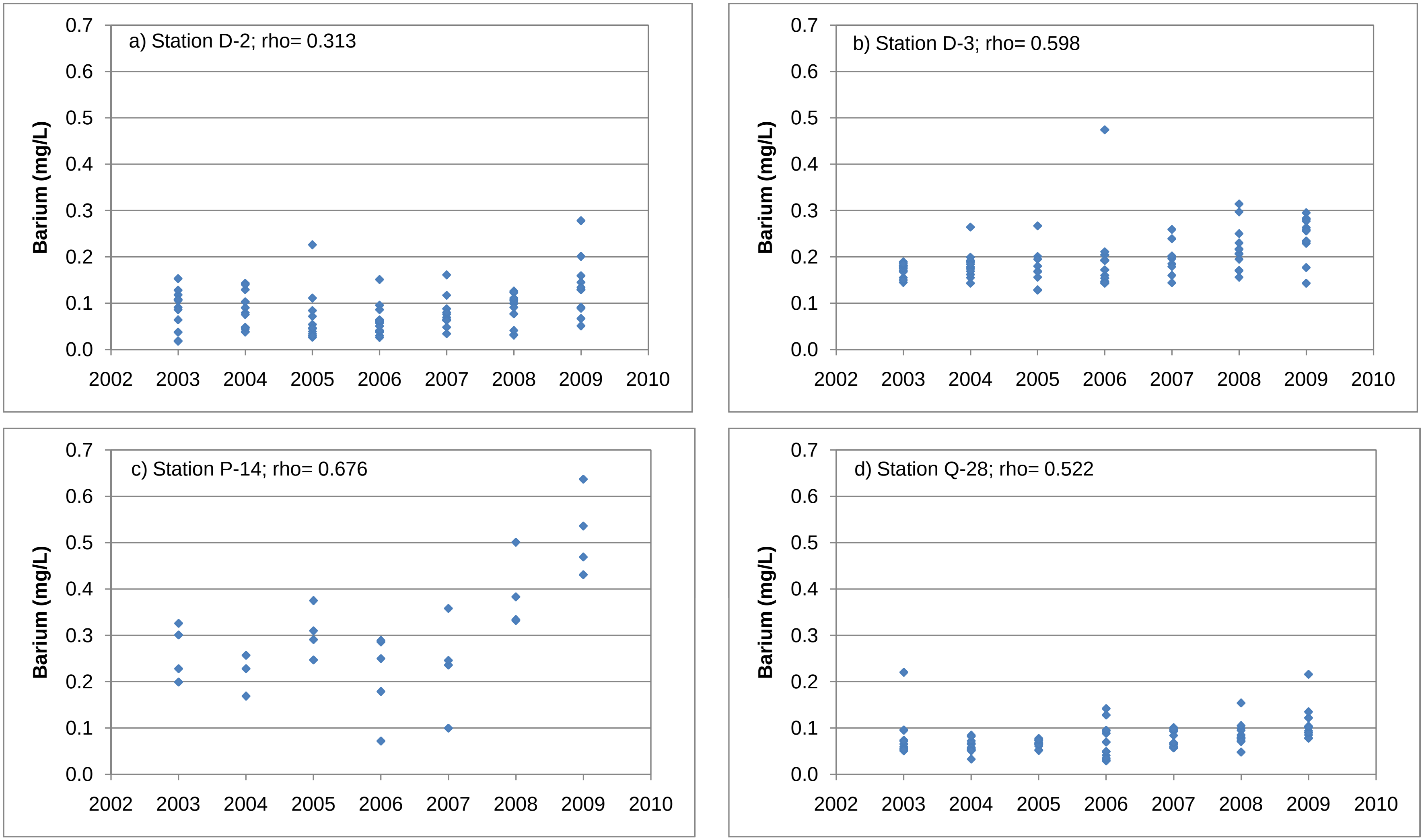


Figure 4.4: Significant common trends for barium from 2003 to 2009 at a) Station D-2, b) Station D-3, c) Station P-14, and d) Station Q-28, SAMP

Iron concentrations increased in the primary discharge at both Denison (D-2) and Quirke (Q-28) TMA from 2003 to 2009. Both trends were influenced by data from 2008 which may have reflected shorter retention times (*i.e.*, less settling of solids) in the settling ponds under the combined condition of ice cover and higher winter and early spring flows (Appendix Figures D.1.2 and D.2.6), as iron did not increase within either basin (D-1 and Q-05; Sections 3.1and 3.2). Despite the increasing trends, iron concentrations in effluent remained low (< 1.5 mg/L).

Discharge pH increased at all discharge locations except at Panel Pond C (P-03) and Denison primary discharge locations (D-2 and D-3; Table 4.2). The decrease in pH at the Denison TMA is largely due to a step change in ETP influent pH in 2008 and 2009, possibly associated with decreasing sulphate concentrations since 2000 and/or higher water levels in 2008 and 2009. At both of these locations, pH remains neutral and above the discharge criteria and PWQO.

Trends indicating improving water quality (decreasing metal concentrations and increasing pH) at DS-16 are associated with the installation of a treatment system in 2005.

4.2 May Lake Sub-watershed Sources

Within the May Lake sub-watershed there are two TMA's: Stanrock, with primary discharges to Halfmoon Lake, and Stanleigh, with primary discharges to McCabe Lake. There are no seepages from these TMAs that drain directly to the May Lake sub-watershed. Both Halfmoon and McCabe Lake drain to May Lake. As part of the SRWMP, water quality is monitored both upstream and downstream of the TMA sources (Figure 4.5).

4.2.1 Discharge Quality and Loads

Concentrations from source discharges are generally less than the SRW benchmarks with exception of barium at the Stanleigh discharge (CL-06) and sulphate at both Stanleigh and Stanrock TMA (DS-4) discharge (Figure 4.6). Barium concentrations in the Stanleigh TMA effluent (mean of 0.39 mg/L) are well below levels considered to be toxic to aquatic biota (>8 mg/L; WHO 2001; USEPA 2007). Similarly, sulphate concentrations in the Stanrock (<400 mg/L) and Stanleigh (<250 mg/L) discharges are less than concentrations that would be expected to be toxic to aquatic biota (about 500 mg/L; Mount and Gulley 1992; Singleton 2000; Davies 2007). Generally, concentrations in the immediate downstream receiving environment are less than the SRW benchmarks. Further downstream, water quality in May Lake consistently met the SRW benchmarks and so it was judged to meet acceptability

Figure 4.5

May Lake Sub-watershed Mine Source and Receiving Environment Stations

Ref: 2295
Date: February 2011
Source: Elliot Lake Research Field Station

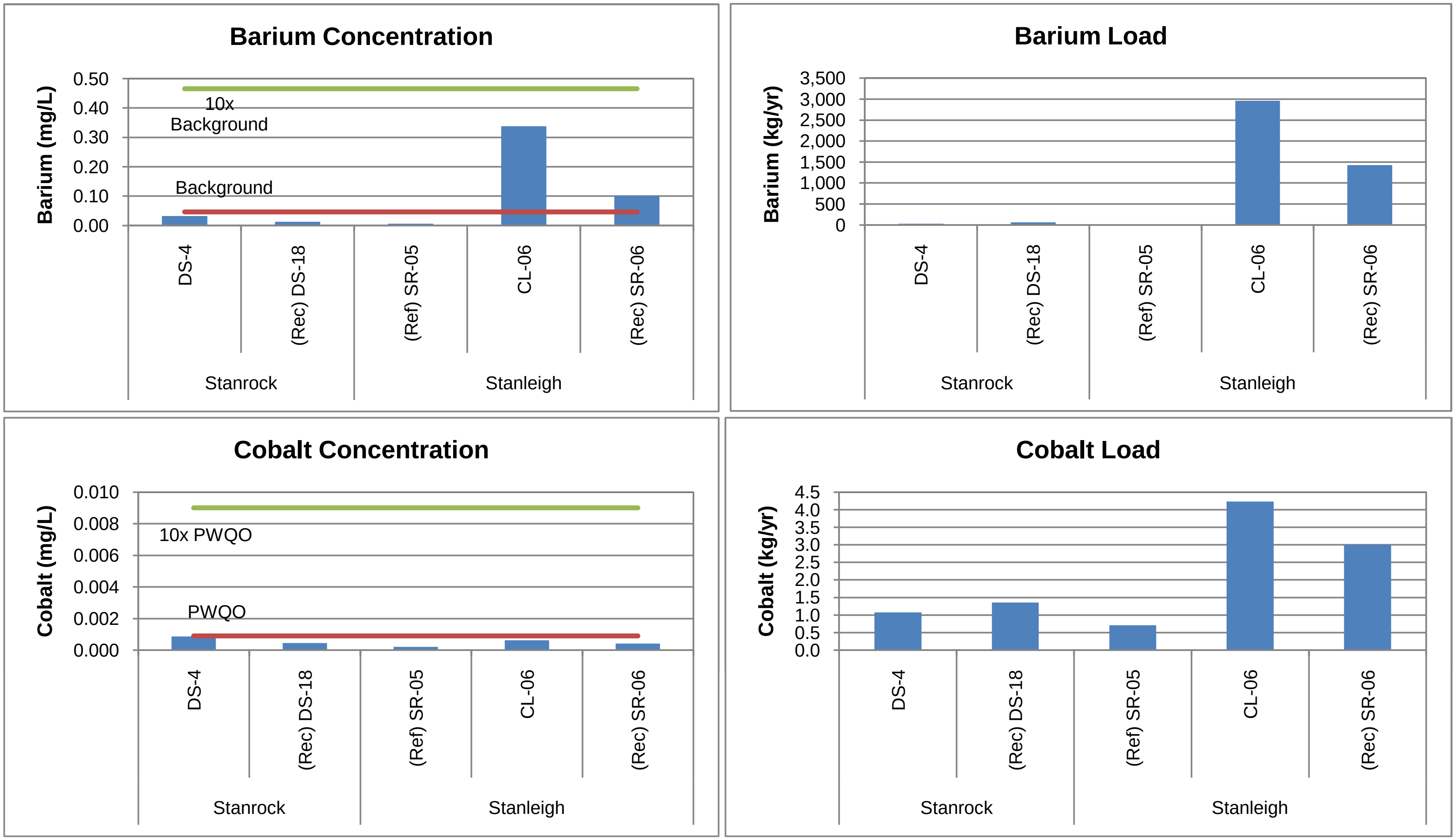


Figure 4.6: Mean concentrations and loads at monitoring stations downstream of Stanrock and Stanleigh TMAs, 2005-2009 (Rec) denotes receiving environment station, (Ref) denotes reference station.

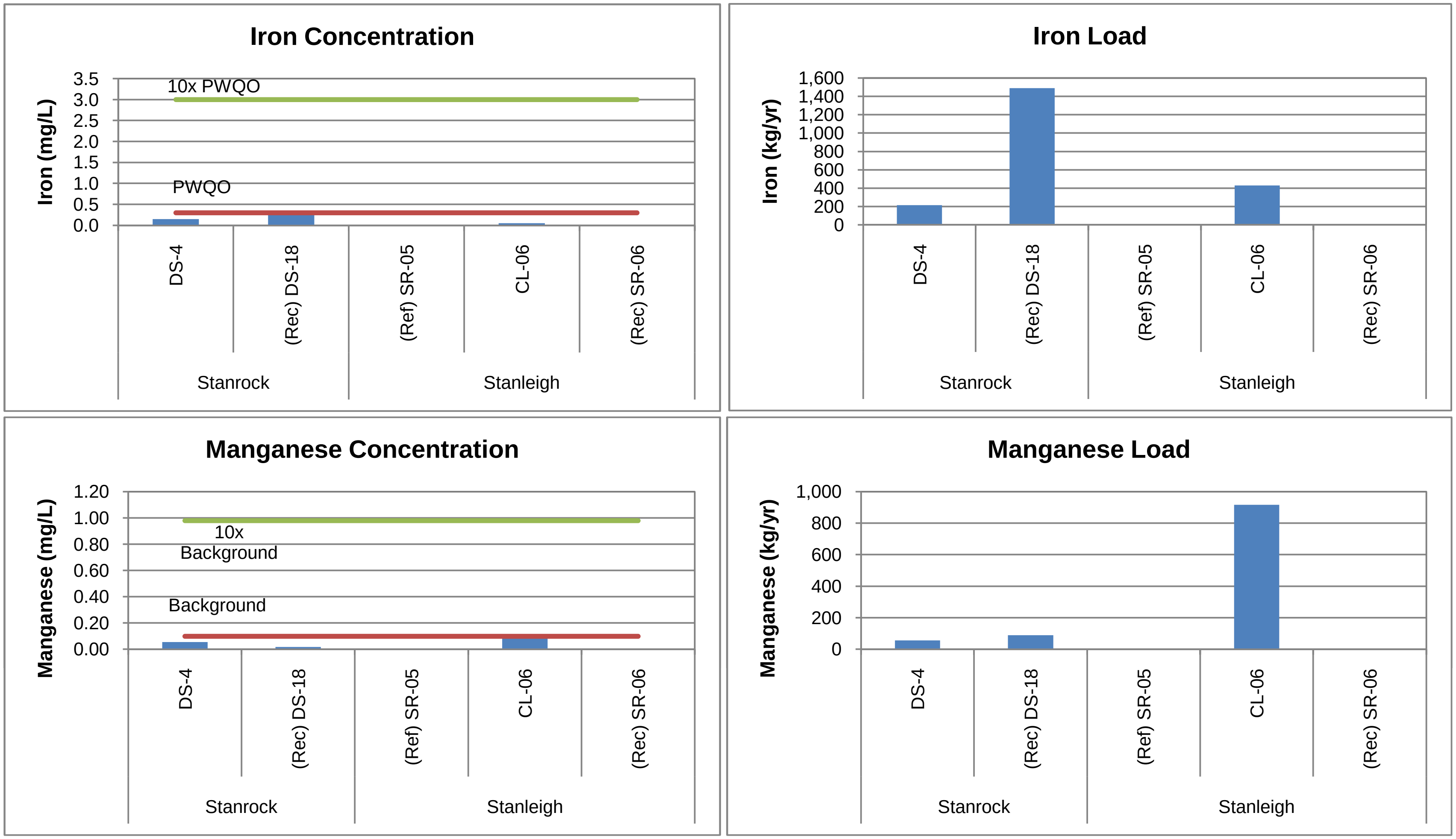


Figure 4.6: Mean concentrations and loads at monitoring stations downstream of Stanrock and Stanleigh TMAs, 2005-2009, (Rec) denotes receiving environment station, (Ref) denotes reference station. Iron and manganese not measured at SR-05 and SR-06.

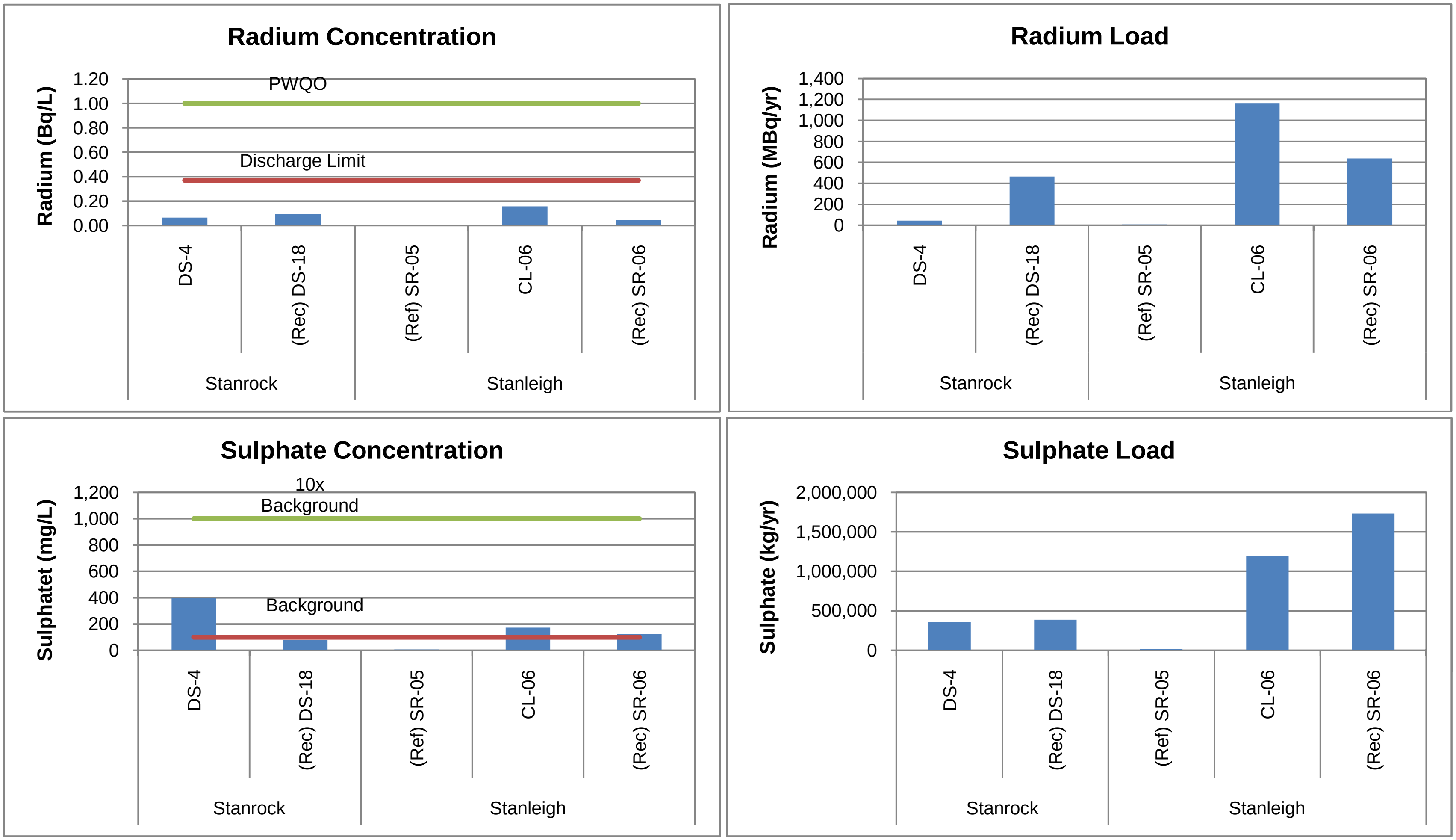


Figure 4.6: Mean concentrations and loads at monitoring stations downstream of Stanrock and Stanleigh TMAs, 2005-2009, (Rec) denotes receiving environment station, (Ref) denotes reference station.

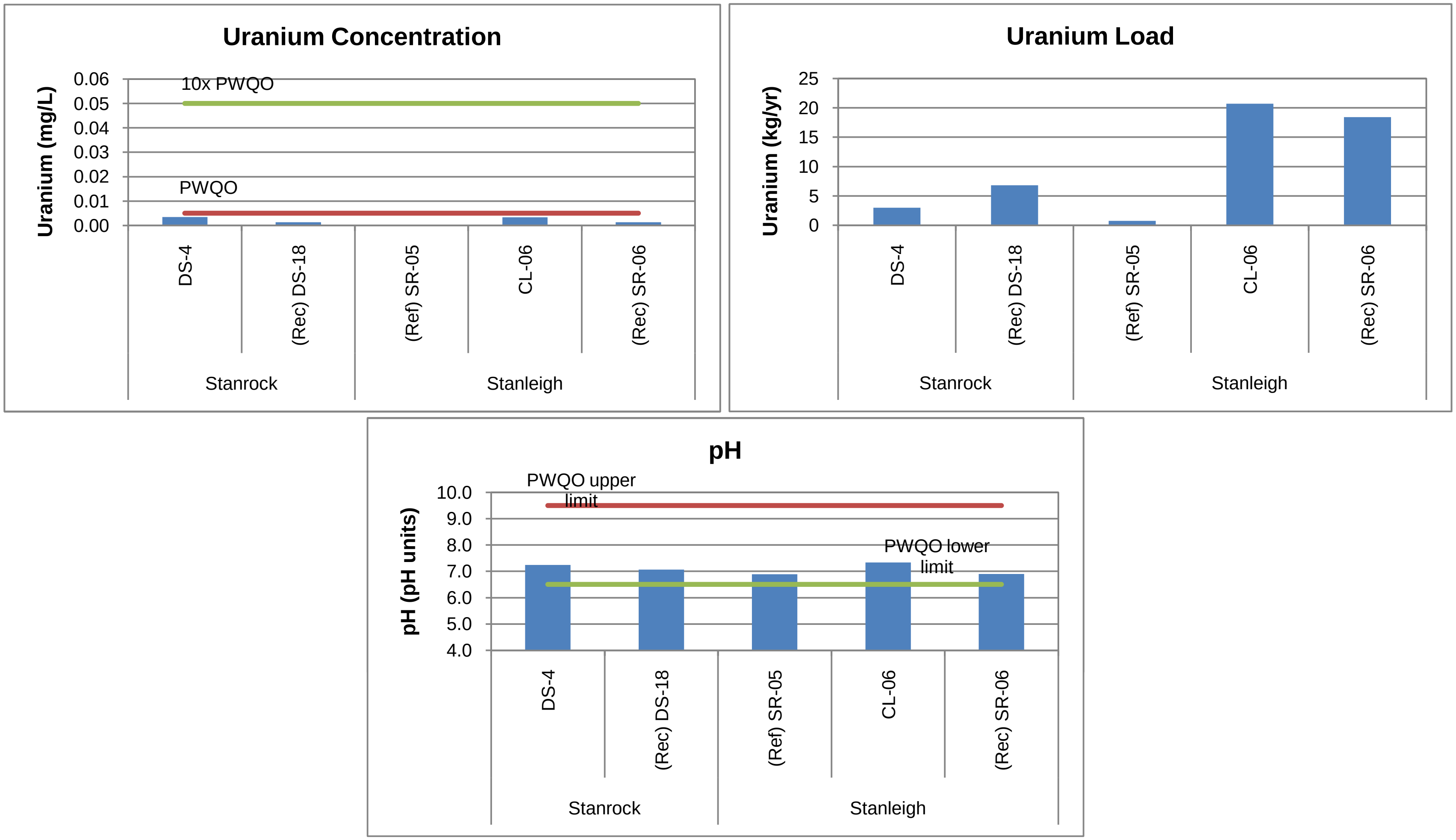


Figure 4.6: Mean concentrations and loads at monitoring stations downstream of Stanrock and Stanleigh TMAs, 2005-2009, (Rec) denotes receiving environment station, (Ref) denotes reference station.

criteria and removed as a SRWMP water quality station for the Cycle 3 Study Design (Minnow 2009b).

Loadings of most substances monitored are higher from the Stanleigh TMA than from the Stanrock TMA (Figure 4.6). However, water quality downstream in McCabe Lake achieves SRW benchmarks for all substances except barium and these concentrations remain well below toxicity thresholds.

4.2.2 Trends

Effluent concentrations of sulphate and manganese at the Stanleigh TMA have been decreasing over time (2003 to 2004) and uranium concentrations were so low in final effluent (more than 50% of values were less the MDL of 0.0005 mg/L) that trend analysis could not be conducted (Table 4.3). Consistent with ETP influent, effluent radium-226 and consequently barium concentrations have been increasing over the same period. The increase in radium concurrent with a decrease in sulphate concentrations within the basin is consistent with the work completed by EcoMetrix (Appendix G) which indicates that as aqueous sulphate concentrations decline, there is an increased dissolution of barium sulphate to which radium is associated, whereby radium is released from the tailings. It is expected that radium concentrations in porewater will stabilize over time once the dissolution of barium sulphate re-equilibrates with aqueous sulphate concentrations. Assuming there is no new source of radium to the TMA, radium concentrations in porewater should decline as the amount of soluble material in the tailings diffusion zone decreases. Radium-226 concentrations remain below the discharge criterion (0.37 Bq/L) and well below the PWQO (1.0 Bq/L).

Concentrations of radium-226, sulphate and uranium in effluent from the Stanrock TMA (DS-4) have been decreasing over time (Table 4.3). Barium concentrations in the Stanrock effluent exhibited a significant increasing trend but the increase is not associated with radium-226 concentrations as these have been decreasing over the same period. The trend in barium appears to be leveraged by 2008 when higher flows resulted in longer discharge periods (i.e. greater barium loading). Effluent pH has also been decreasing over the same period but remains neutral (Table 4.3; Appendix Figure D.4.2).

4.3 Esten Lake Sub-Watershed Sources

Within the Esten Lake sub-watershed, there are two TMA's: Milliken TMA, with primary discharges into Elliot Lake via Sherriff Creek, and Nordic TMA, with primary discharges into Nordic Lake via Buckles Creek. There are no seepages that drain directly to receiving

Table 4.3: Summary of water quality trends[a] for SAMP monitoring stations in Stanleigh and Stanrock, 2003 to 2009.

TMA	Station ID	Type	Number of Seasons Used in Common Trend[c]	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium
Stanleigh	CL-06	Primary	4 to 6	0.902	-0.391	0.415	-0.569	-0.024	0.618	-0.916	ND[b]
Stanrock	DS-4	Primary	7 to 12	0.451	0.151	0.097	-0.169	-0.238	-0.505	-0.241	-0.757

[blue] decreasing trend, significant at $p<0.05$

[green] increasing trend, significant at $p<0.05$

[a] Based on rank correlation coefficients (rho) for common (combined) seasonal trends, shown in table.

[b] ND denotes that this parameter was not included in the trend analysis for that particular station due to >50% non-detectable concentrations in the samples available for the a

[c] Seasons used varied for sbustances based on suitability of data for trend analysis.

environments. Both Elliot and Nordic Lakes drain to Esten Lake. Surface water is monitored downstream of both TMAs at the inlet to Elliot Lake (M-01) and the outlet of Nordic Lake (SR-08) respectively (Figure 4.7). Surface water was previously monitored further downstream of both discharges at the outlet of Depot Lake, but surface water quality was of sufficient quality that monitoring was discontinued at this location.

4.3.1 Discharge Quality and Loads

Concentrations of most substances in the Milliken and Nordic final discharges achieve receiving environment criteria (*i.e.*, below the SRW benchmarks; Figure 4.8). Only iron concentrations were greater than the SRW benchmark in both TMA effluents, but concentrations in the receiving environment were near or below the benchmark. Sulphate was elevated in the Nordic TMA effluent but substantially reduced in the downstream receiving environment to concentrations (250 mg/L), which would not be expected to affect freshwater biota; freshwater biota are usually unaffected by sulphate concentrations less than 500 mg/L at water hardness of at least 50 mg/L (Mount and Gulley 1992; Singleton 2000; Davies 2007).

With the exception of iron and uranium, Nordic TMA loads for all other measured substances were higher than from the Milliken TMA (Figure 4.8). Loadings from the Milliken TMA are likely over-estimated because flow at this location is prorated by drainage area (*i.e.*, measured concentrations are not synoptic with actual flows) but the highest concentrations occur under no flow conditions (due to re-mobilization of metals under anoxic conditions).

Other than sulphate concentration downstream of the Nordic TMA, loadings from these facilities are not resulting in concentrations in the receiving environments above SRW benchmarks.

4.3.2 Trends

Identified trends were indicative of improving water quality in mine discharges (Table 4.4). Where a trend was detected, concentrations of barium, cobalt, manganese, radium-226, sulphate and uranium were decreasing and pH was increasing. The trends at Nordic reflect improvements associated with the Buckles Creek diversion work conducted in 2005 and trends observed in the ETP influent (Appendix Figure C.7.4; Table 3.23).

4.4 Pronto

The Pronto TMA is outside the Serpent River Watershed and effluent from the TMA discharges to a drainage ditch that flows south and discharges into Lake Huron (Figure 4.9). Final effluent, monitored in the Discharge Channel at PR-01, reports directly to the North

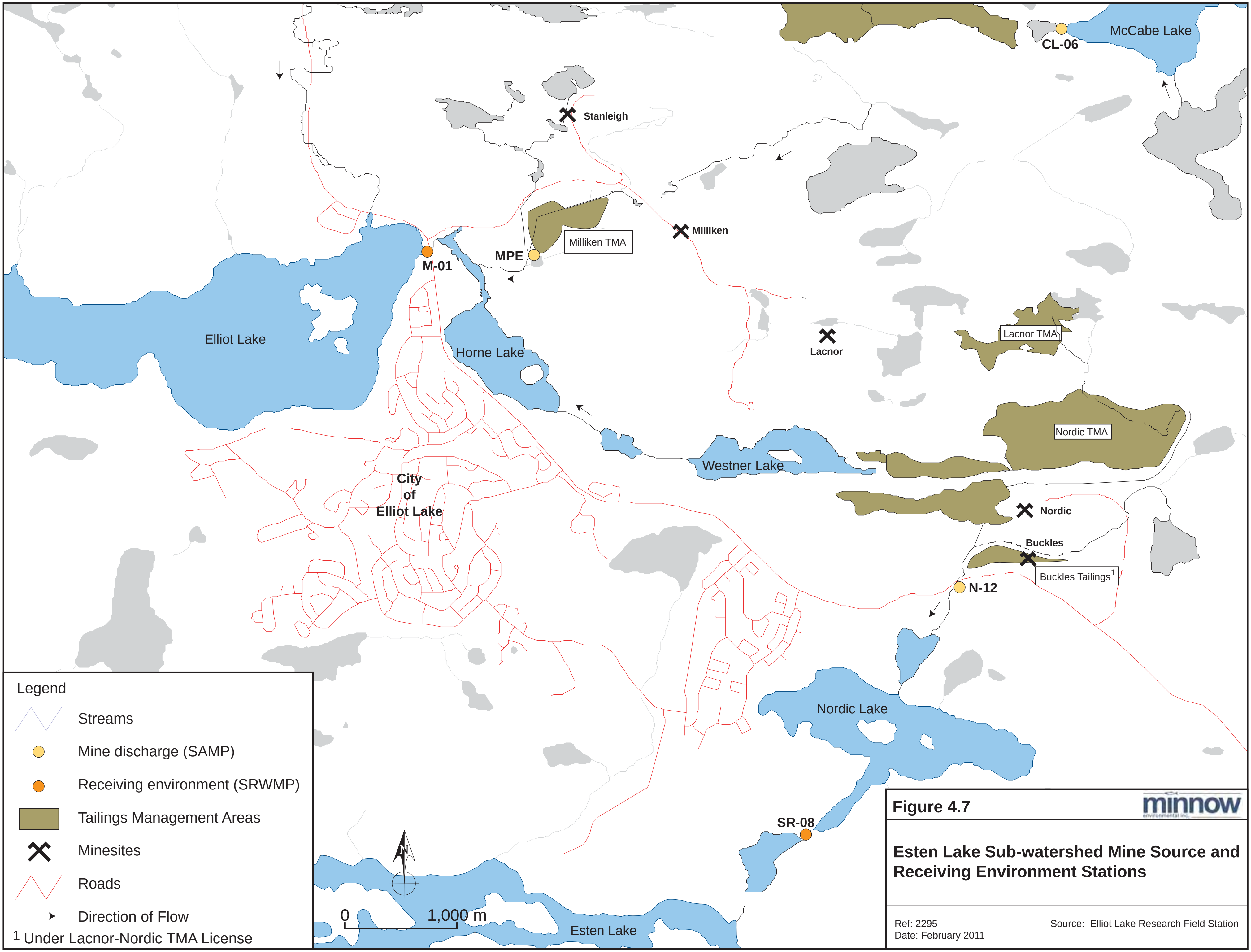


Figure 4.7

Esten Lake Sub-watershed Mine Source and Receiving Environment Stations

Ref: 2295
Date: February 2011

Source: Elliot Lake Research Field Station

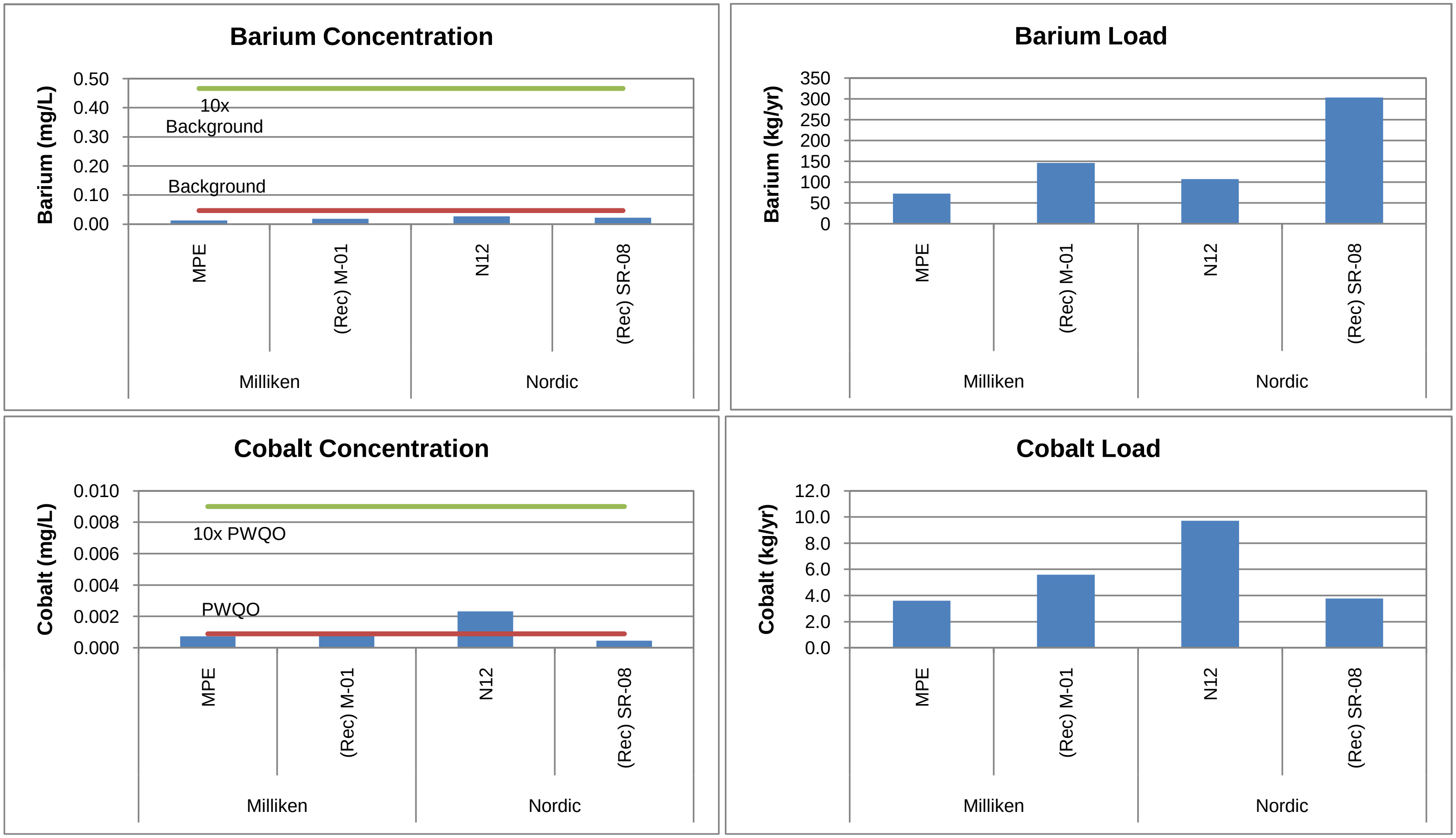


Figure 4.8: Mean concentrations and loads at monitoring stations downstream of Milliken and Nordic TMAs, 2005-2009, (Rec) denotes receiving environment station.

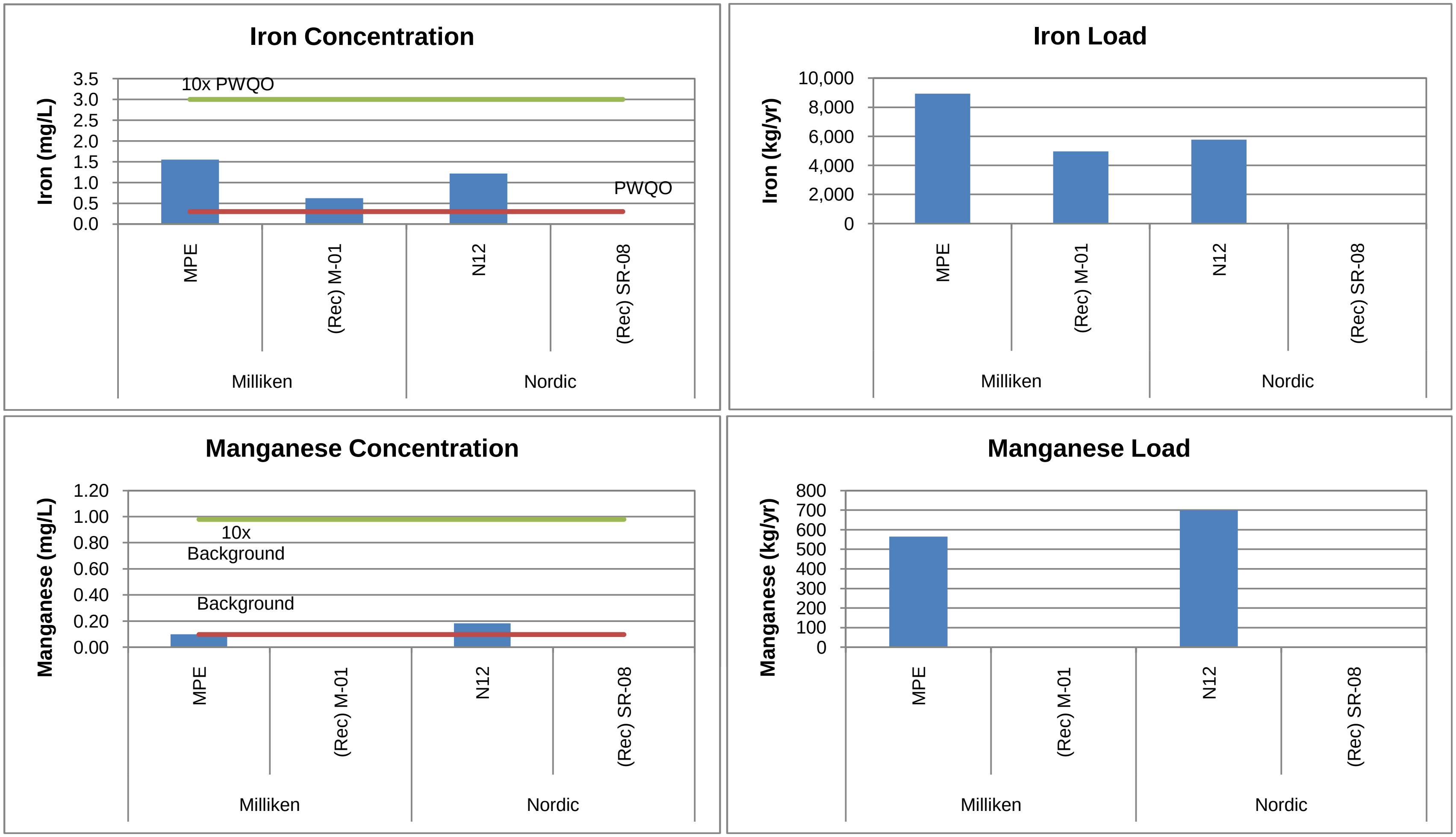


Figure 4.8: Mean concentrations and loads at monitoring stations downstream of Milliken and Nordic TMAs, 2005-2009, (Rec) denotes receiving environment station. Iron not measured at SR-08 and manganese not measured at M-01 and SR-08.

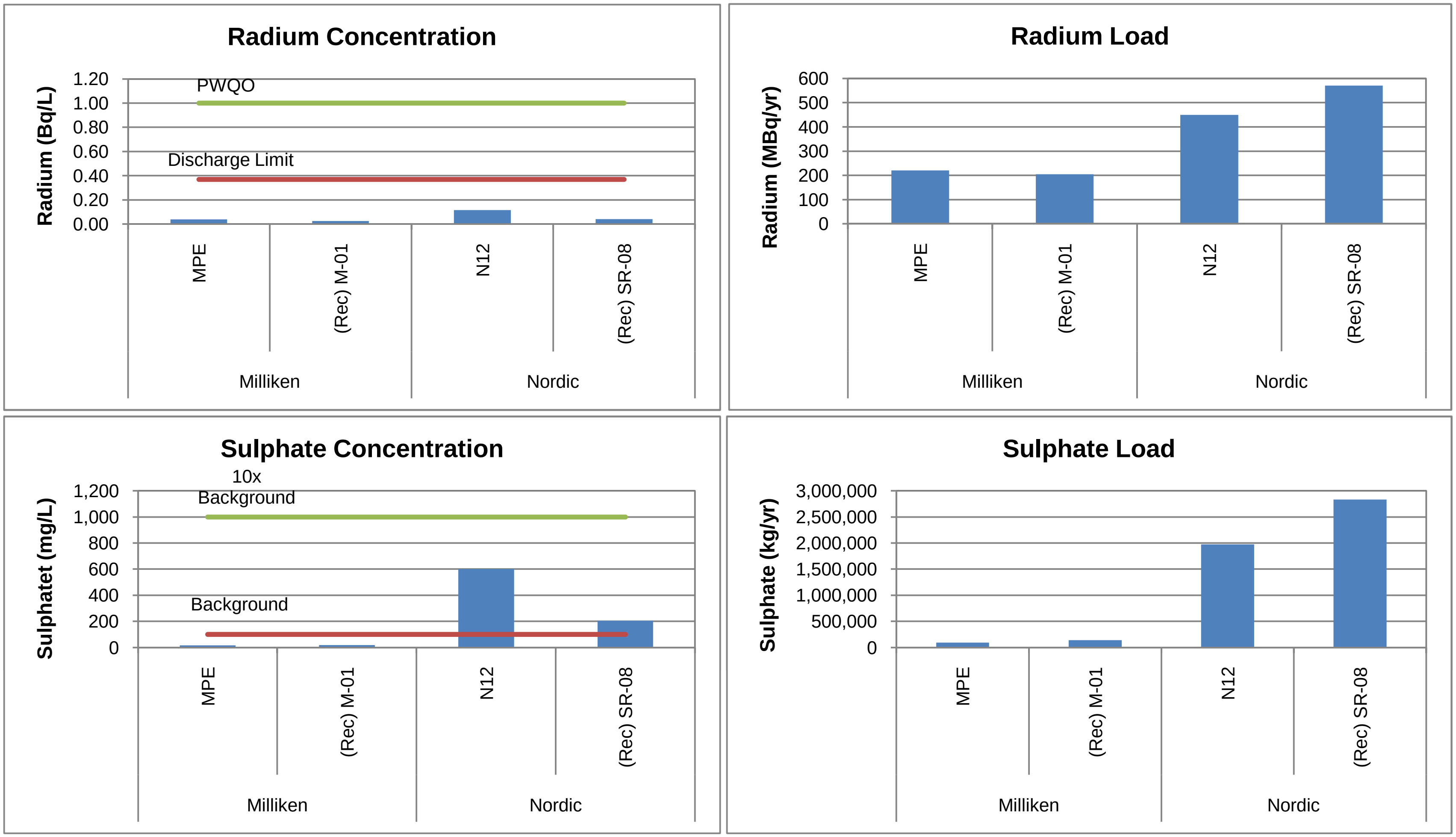


Figure 4.8: Mean concentrations and loads at monitoring stations downstream of Milliken and Nordic TMAs, 2005-2009, (Rec) denotes receiving environment station.

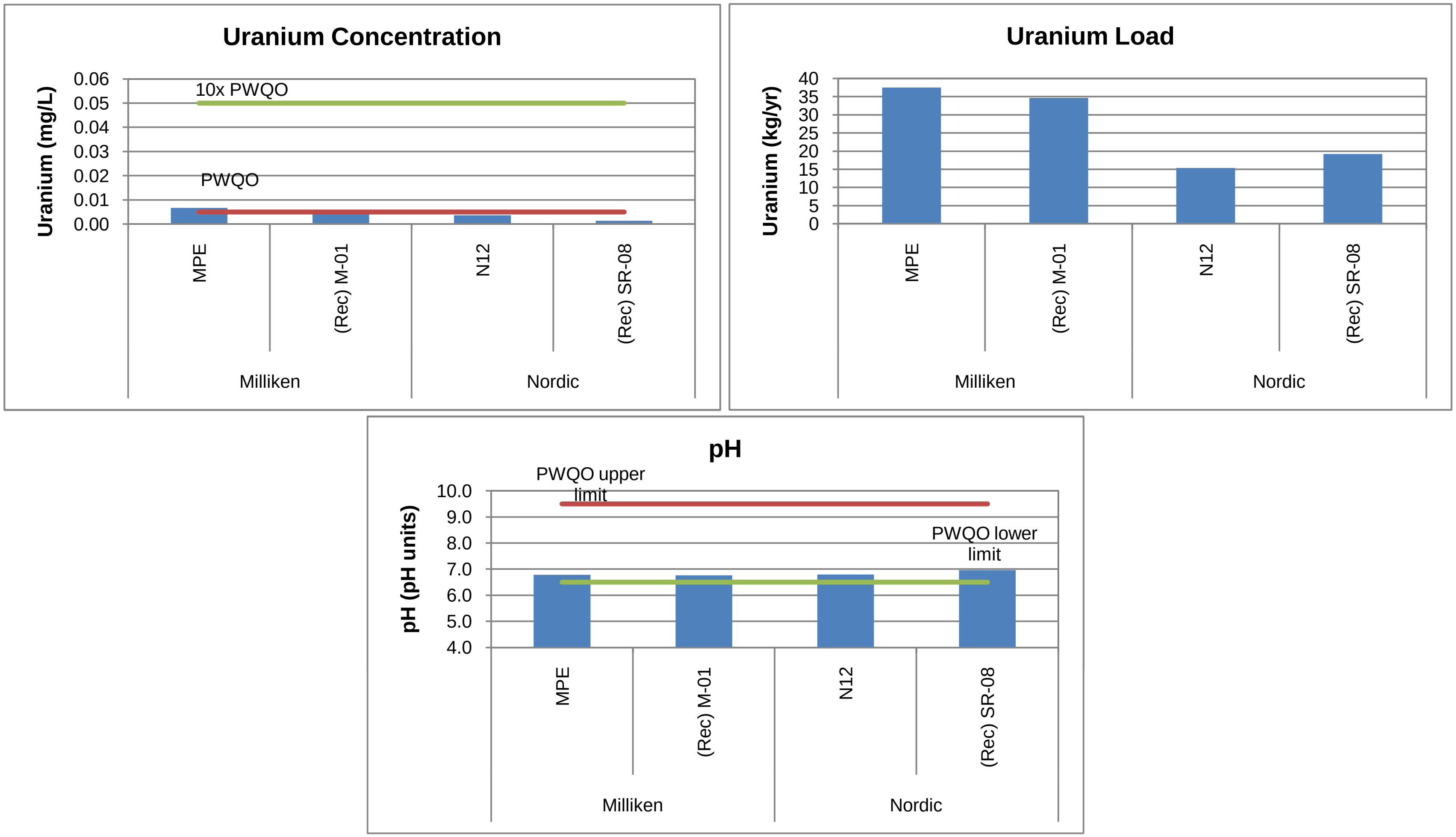


Figure 4.8: Mean concentrations and loads at monitoring stations downstream of Milliken and Nordic TMAs, 2005-2009, (Rec) denotes receiving environment station.

Table 4.4: Summary of water quality trends[a] for SAMP monitoring stations in Nordic and Milliken, 2003 to 2009.

TMA	Station ID	Type	Number of Seasons Used in Common Trend[c]	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium
Nordic	N-12	Primary	11 or 12	-0.593	-0.059	*-0.095*[b]	-0.108	0.581	-0.583	0.013	-0.528
Milliken	MPE	Primary	6 to 12	0.076	-0.496	-0.037	-0.271	0.258	-0.511	-0.630	0.009

(blue) decreasing trend, significant at p<0.05

(green) increasing trend, significant at p<0.05

[a] Based on rank correlation coefficients (rho) for common (combined) seasonal trends, shown in table.

[b] Italic text mean monthly correlations significantly different, but common trend value provided.

[c] Seasons used varied for sbustances based on suitability of data for trend analysis.

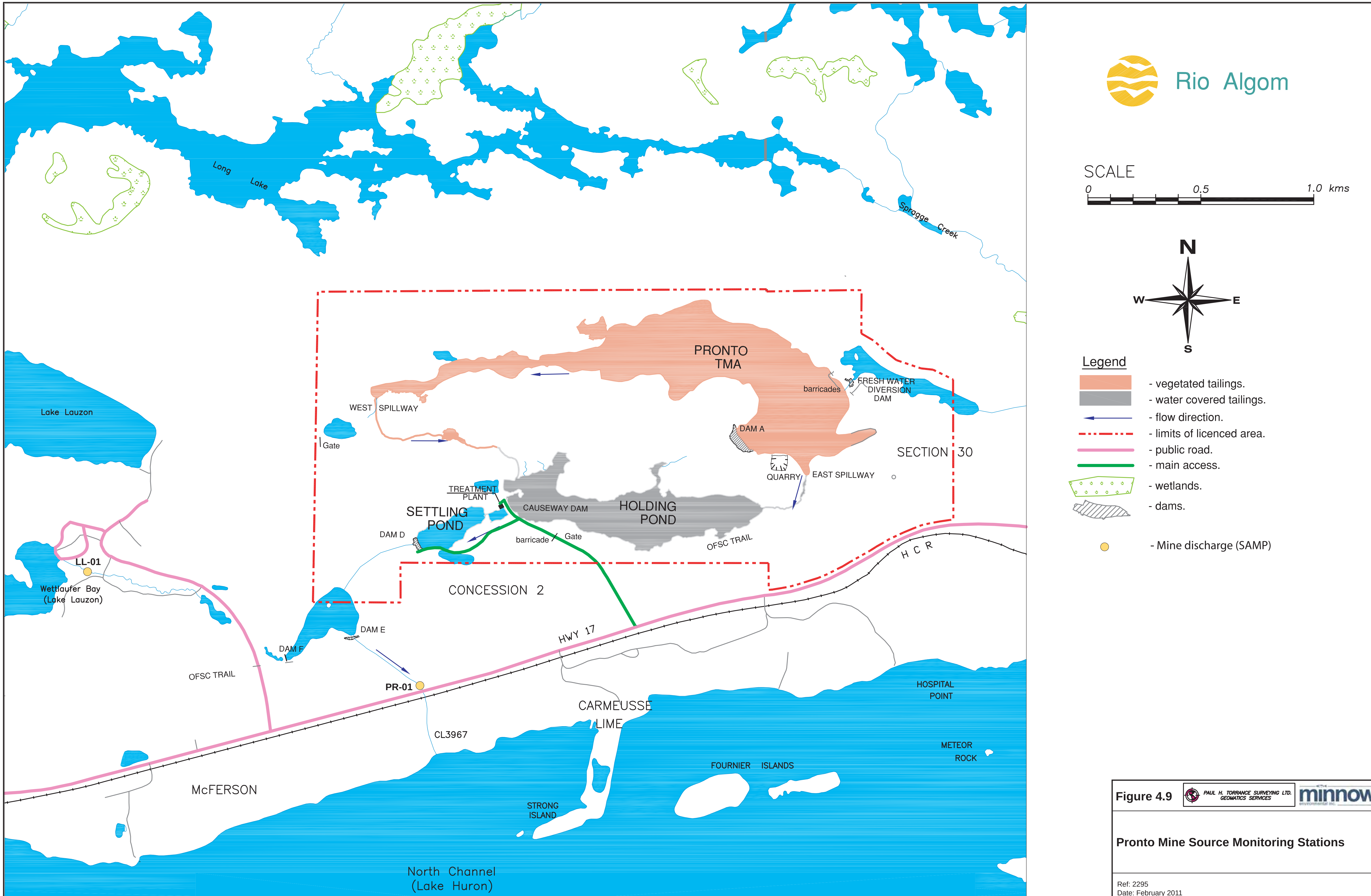


Figure 4.9

Pronto Mine Source Monitoring Stations

Ref: 2295
Date: February 2011

Channel of Lake Huron, whereas site drainage to Pronto Creek (LL-01) reports to Lake Lauzon. Water quality monitoring downstream of PR-01 (in Pronto discharge channel and Lake Huron) is not included in the receiving environment monitoring program (SRWMP) due to confounding influences immediately downstream of the TMA discharge, including a rail line, Highway 17, and drainage from a lime calcining plant which enters Lake Huron adjacent to the Pronto discharge channel. Therefore the discussion that follows is limited to discharge quality.

4.4.1 Water Quality and Trends

With the exception of cobalt and uranium, concentrations of other substances monitored at the primary discharge (PR-01) are approaching or below the SRW benchmarks (Figure 4.10). Mean cobalt concentrations at PR-01 are about twenty times the SRW benchmark (PWQO) but mean uranium concentrations are only about 3 times the benchmark. Drainage to Lake Lauzon achieves receiving environment criteria for all substances (Figure 4.10).

Loads from the primary discharge (PR-01) are substantially greater (about 8 to 10 times) greater than those to Lake Lauzon (Figure 4.10).

Concentrations of barium, manganese, radium-226, sulphate, and uranium in site drainage (LL-01) have been decreasing since 2007 and are associated with repairs to Dam F that same year (Table 4.5; Appendix Figure D.8.1).

Decreasing concentrations of barium in the primary discharge were associated with a reduction in the use of barium chloride for treatment; in 2009, the TMA stopped using barium chloride as influent concentrations of radium-226 were sufficiently low that both pH and radium-226 could be treated with lime. Effluent pH has also been decreasing over time but remains near neutral. (Appendix Figure D.8.2).

4.5 Summary

Generally, concentrations of mine related substances were at or near receiving environment benchmarks established for the SRW in mine discharges during the period 2005 to 2009. Few discharges had concentrations more than ten times the benchmark and those discharges that did, tended to be seepages with relatively low flow. Therefore, seepage loads were small relative to primary discharge and background loads. With few exceptions, loads from mine sources were not sufficient to cause mean receiving environment concentrations to be above SRW benchmarks. Trends in discharge quality tended to indicate improvements over time and were consistent with trends observed within the TMAs.

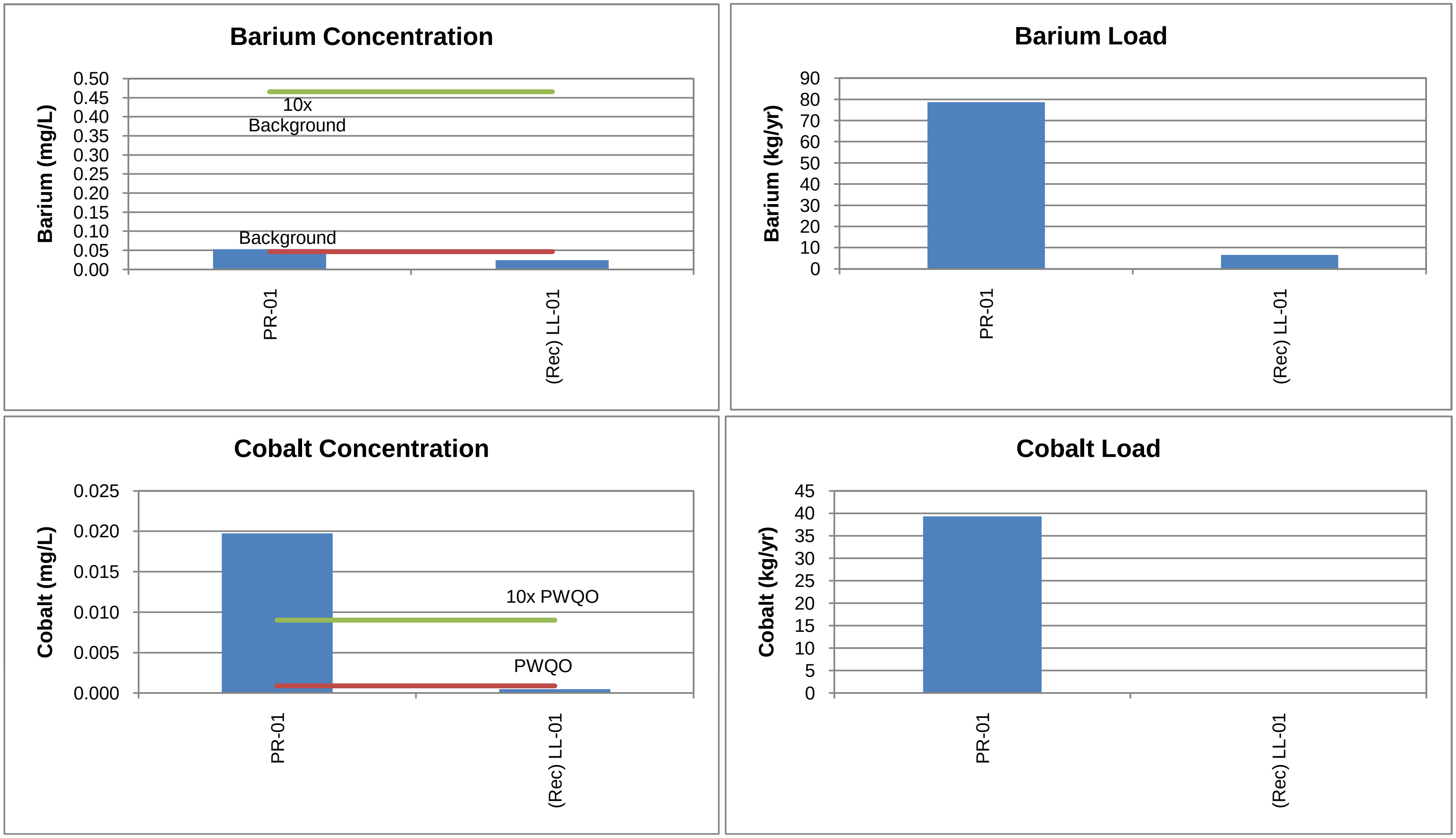


Figure 4.10: Mean concentrations and loads at monitoring stations downstream of Pronto TMA, 2005-2009, (Rec) denotes receiving environment station.

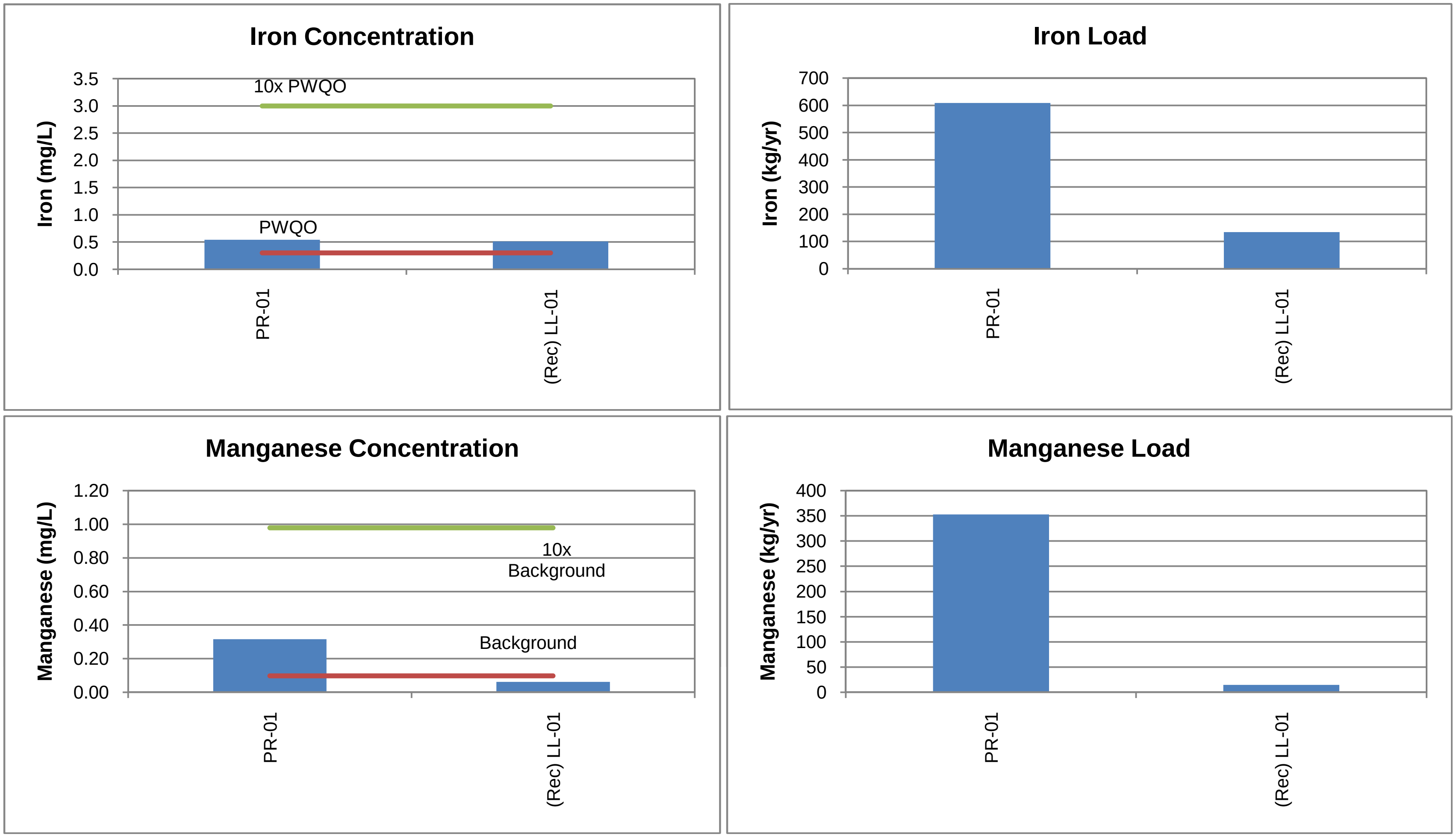


Figure 4.10: Mean concentrations and loads at monitoring stations downstream of Pronto TMA, 2005-2009, (Rec) denotes receiving environment station.

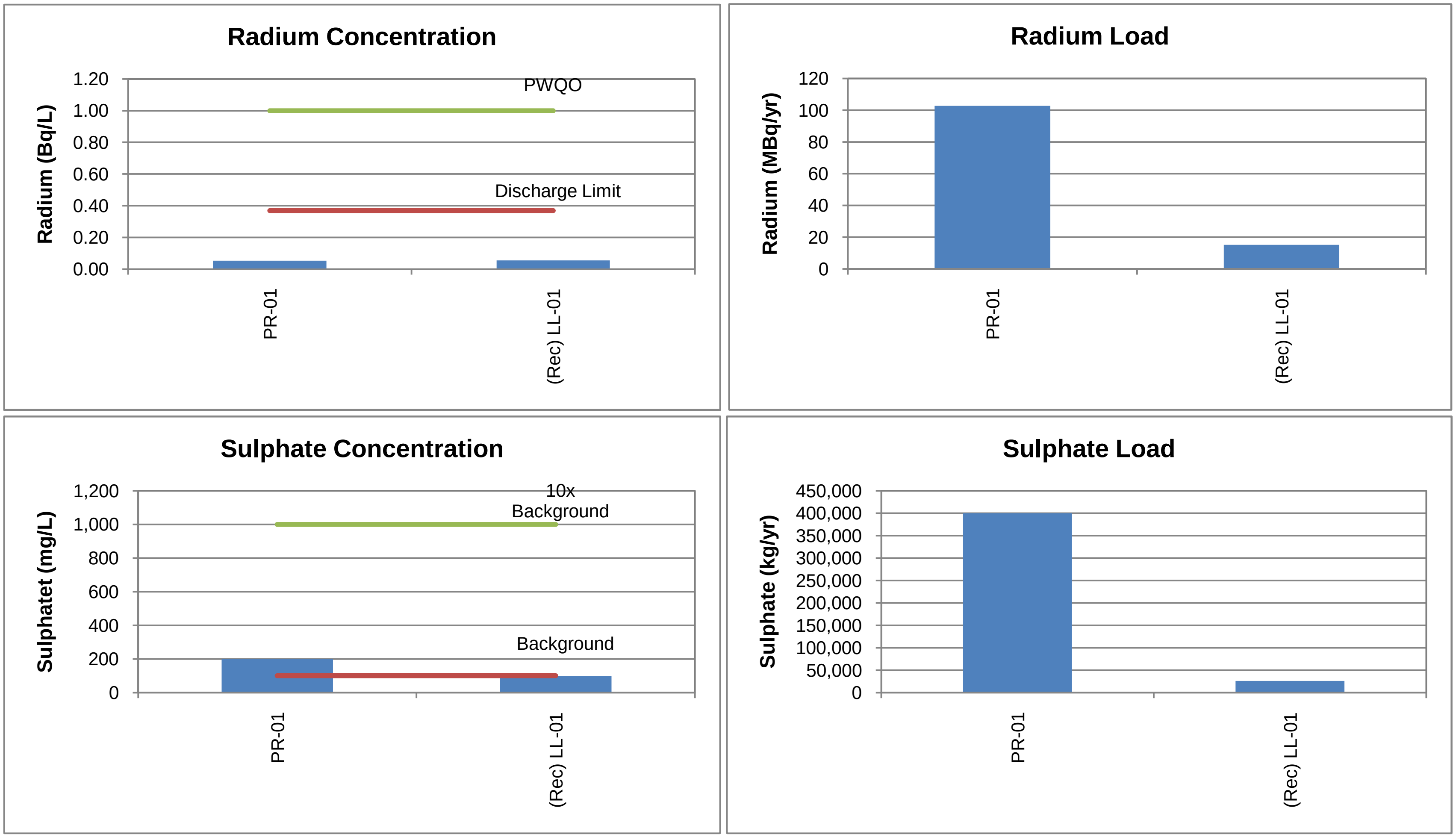
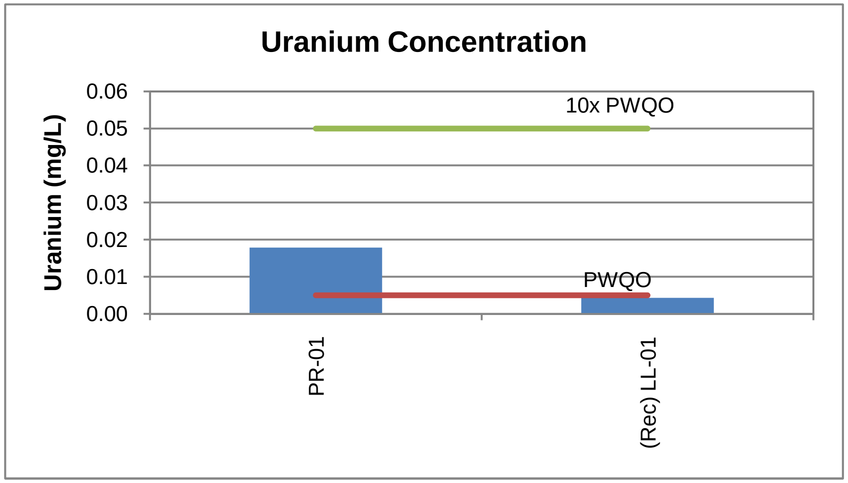
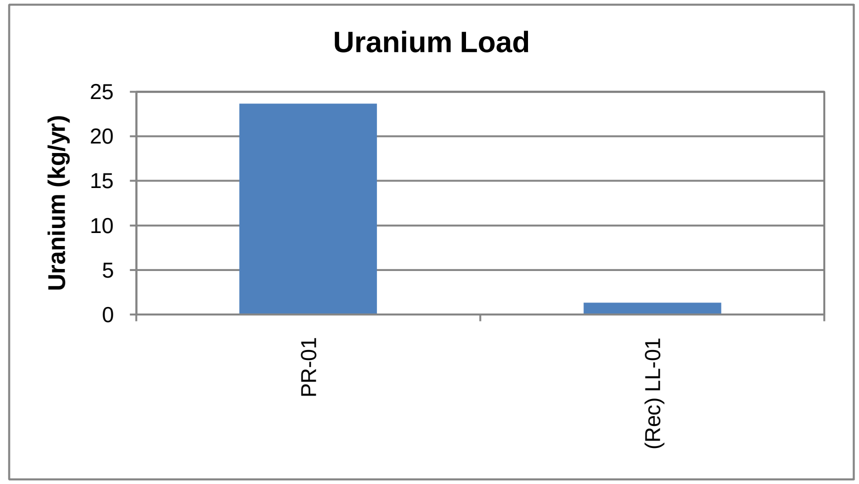


Figure 4.10: Mean concentrations and loads at monitoring stations downstream of Pronto TMA, 2005-2009, (Rec) denotes receiving environment station.





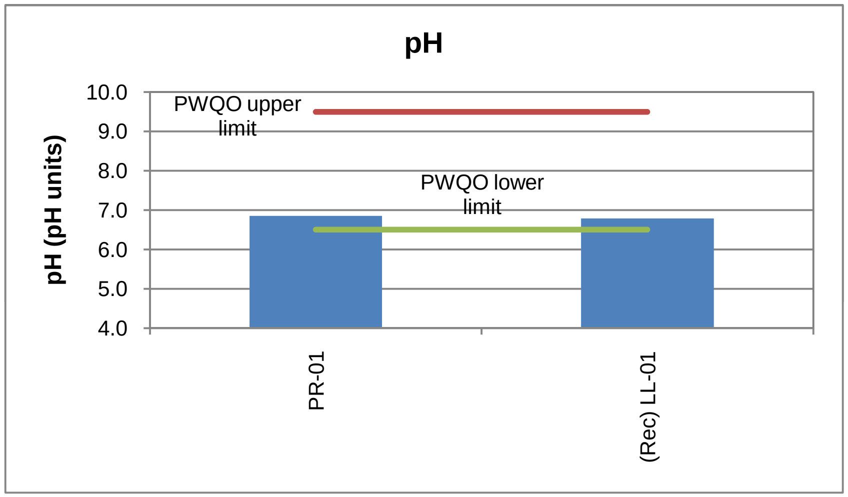


Figure 4.10: Mean concentrations and loads at monitoring stations downstream of Pronto TMA, 2005-2009, (Rec) denotes receiving environment station.

Table 4.5: Summary of water quality trends[a] for SAMP water quality monitoring stations in Pronto, 2003 to 2009.

TMA	Station ID	Type	Number of Seasons Used in Common Trend[c]	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium
Pronto	LL-01	Drainage	2 to 4	-0.604	ND[b]	-0.196	-0.500	-0.130	-0.652	-0.580	-0.862
	PR-01	Primary	12	-0.330	0.181	0.007	0.006	-0.255	0.163	-0.075	0.087

(blue) decreasing trend, significant at p<0.05

(green) increasing trend, significant at p<0.05

[a] Based on rank correlation coefficients (rho) for common (combined) seasonal trends, shown in table.

[b] ND denotes that this parameter was not included in the trend analysis for that particular station due to >50% non-detectable concentrations in the samples availab

[c] Seasons used varied for sbustances based on suitability of data for trend analysis.

5.0 SERPENT RIVER WATERSHED

5.1 Water Quality

With few exceptions, mean and median water concentrations (2005 to 2009) were less than SRWMP benchmarks for most substances (Table 5.1; Figure 5.1). Mean (<0.20 mg/L) and maximum (<0.35 mg/L) barium concentrations were above the benchmark (background) downstream of TMA treatment plant discharges (D-5, Q-09 and SR-06), but remained well below levels considered to be toxic to aquatic life (8.0 mg/L; WHO 2001 and USEPA 2007). Mean cobalt concentrations were only above the benchmark (PWQO) at SC-01 and then only in 2005. Since 2006, mean cobalt concentrations have been below PWQO at all stations with maximum concentrations being close to the PWQO (Figure 5.1). Mean iron and manganese concentrations continued to be higher than respective benchmarks (background) at M-01 and D-6 but have not been increasing over time (Table 5.2). Mean and median concentrations of sulphate were greater than the benchmark (B.C. Guideline for the protection of aquatic life) at SR-06 and SR-08. However, sulphate concentrations were generally less than 250 mg/L, and thus below levels expected to be toxic to freshwater biota (500mg/L - Mount and Gulley 1992; Singleton 2000; Davies 2007).

Temporally, metal concentrations have generally been decreasing downstream of the TMAs over time (2000-2009), while pH has been increasing. Specifically, where a trend was detected for cobalt, manganese, radium-226, sulphate and uranium, concentrations were significantly decreasing (Table 5.2). Concentrations of iron have been increasing at stations D-6 and DS-18, but a similar trend was not observed in the upstream TMA source (D-1 and DS-4; Sections 3.1.3 and 3.4.2 respectively) and 85% of the iron samples at these stations remained at or below the benchmark (Table 5.1).

At SR-06, barium concentrations have been increasing and pH decreasing. The increase in barium is associated with an increase in barium chloride use at the Stanleigh ETP. As iron and sulphate concentrations in the influent decrease, there are fewer solids to react with the barium chloride and form the precipitate that removes radium. Following construction of the new treatment plant, lime and barium chloride addition rates were increased based on operating experience under similar operating conditions at Panel. The decrease in pH reflected changes in operating conditions. Between 1998 and 2002 there was no discharge from the TMA and the lake reflected more alkaline conditions associated with ETP operations. In 2007, pH deceased when the new treatment plant was being constructed and there was no discharge from the TMA from June 15 to December 15, 2007 (Appendix Figure E.13).

Table 5.1: Percent of samples exceeding selected benchmarks (shaded values) at SRWMP stations, 2005-2009.

Station	# of Samples	Barium	Cobalt	Iron	Manganese	pH	Radium	Sulphate[b]	Uranium
		mg/L	mg/L	mg/L	mg/L	pH units	Bq/L	mg/L	mg/L
Upper limit of Background		**0.047**	**0.0007**	**0.47**	**0.098**	**6.3**	**0.006**	**6.3**	**0.0006**
PWQO[a]		**-**	**0.0009**	**0.30**	**-**	**6.5**	**1.0**	**100**	**0.005**
D-5	60	48%	0%	0%	0%	0%	0%	0%	5%
D-6	57	0%	5%	14%	65%	2%	0%	12%	0%
DS-18	60	0%	0%	15%	0%	0%	0%	20%	0%
M-01	50	0%	22%	56%	na	4%	0%	0%	24%
Q-09	60	52%	15%	na	na	0%	0%	17%	25%
Q-20	5	0%	20%	na	na	0%	0%	0%	0%
SC-01	16	0%	69%	0%	na	18%	0%	0%	0%
SR-01	5	0%	0%	na	na	0%	0%	0%	0%
SR-06	10	100%	0%	na	na	0%	0%	60%	0%
SR-08	60	0%	0%	na	na	2%	0%	97%	0%

[a] Provincial Water Quality Objectives (OMOEE 1994)

[b] Sulphate criterion based on BCMOE

na - Parameter not sampled at respective station.

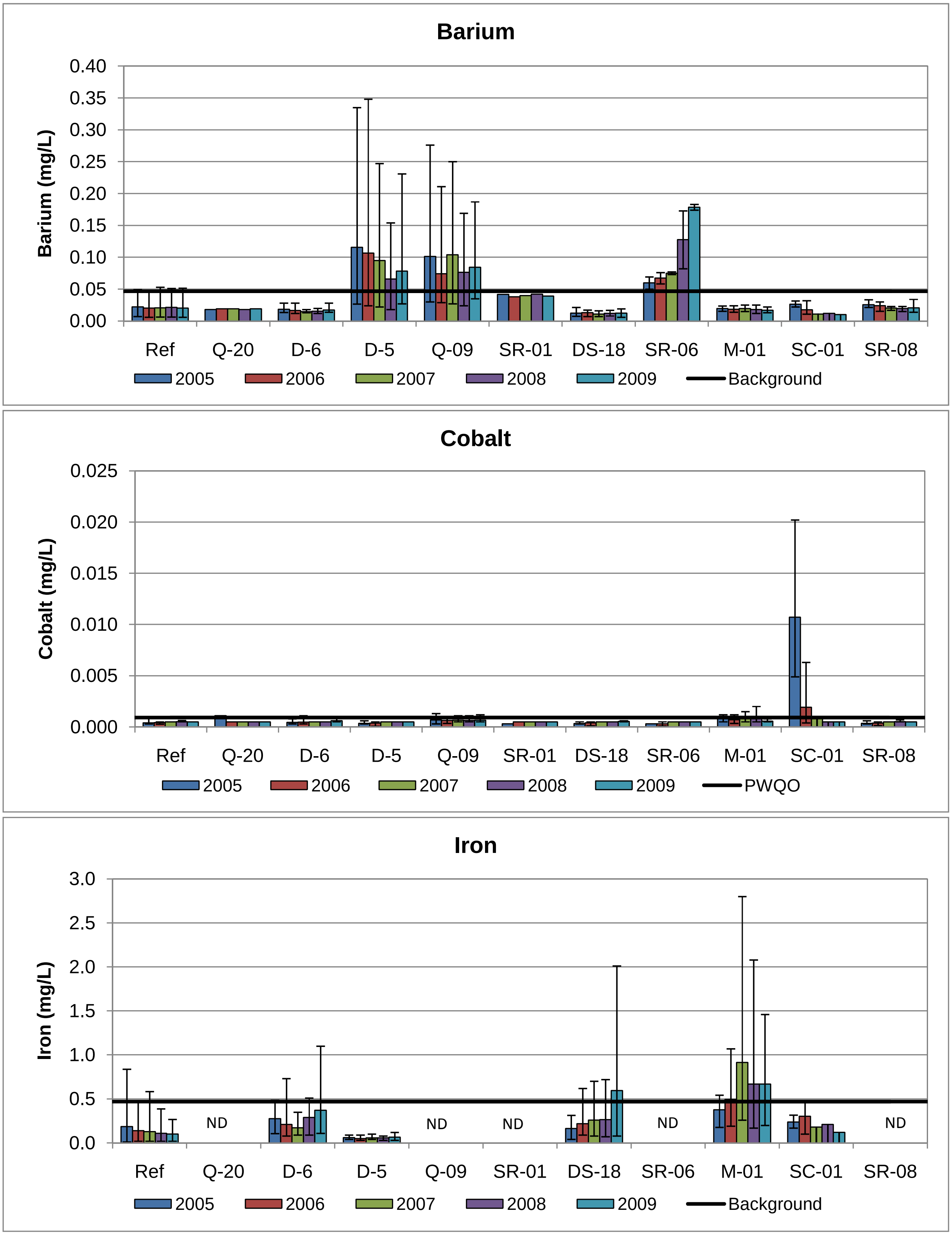
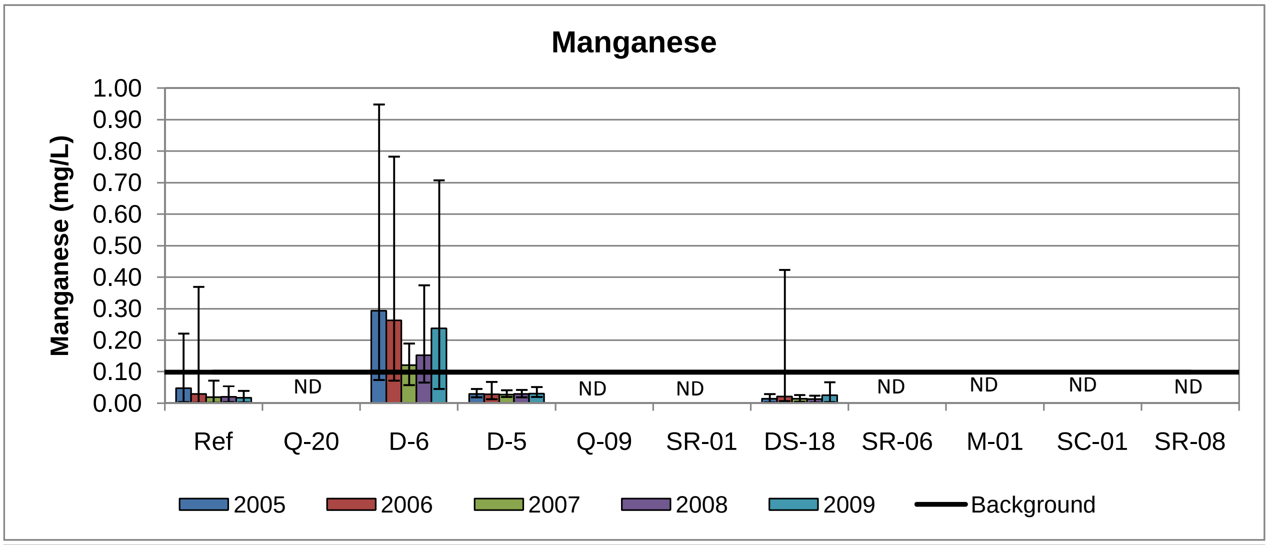
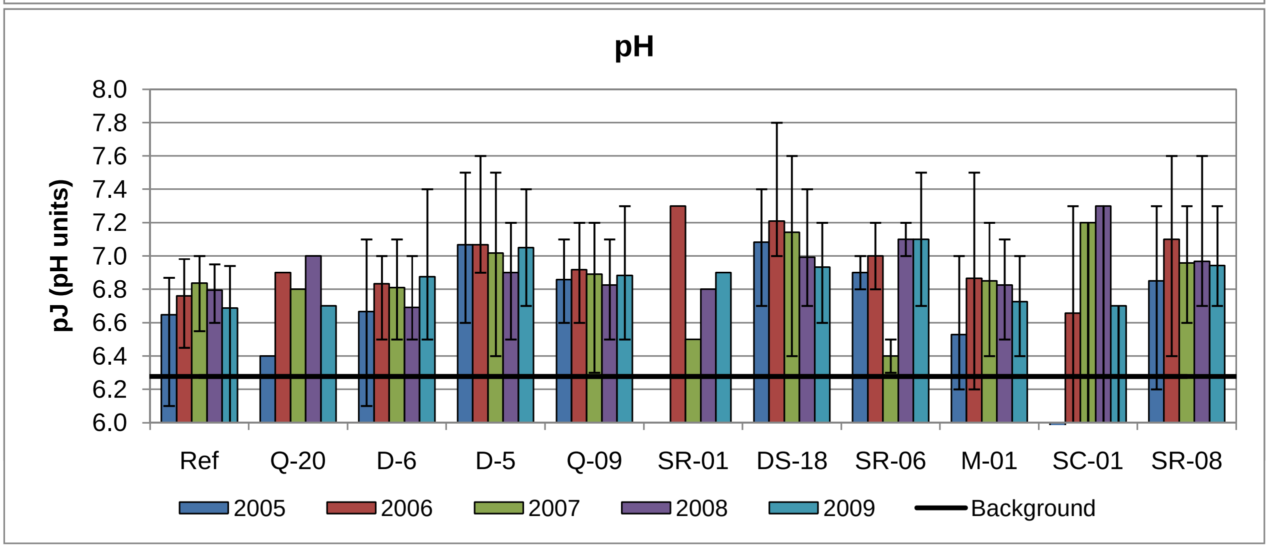


Figure 5.1: Mean, minimum and maximum water concentrations over time at mine exposed stations relative to pooled reference stations and water quality benchmarks. ND denotes no data available for that station.





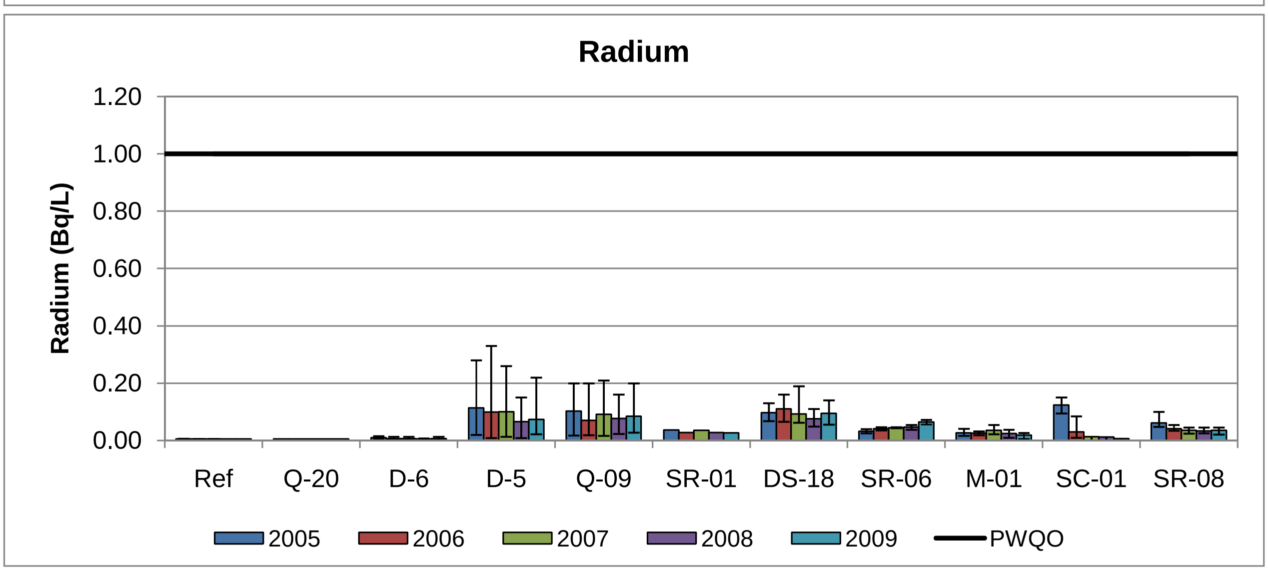
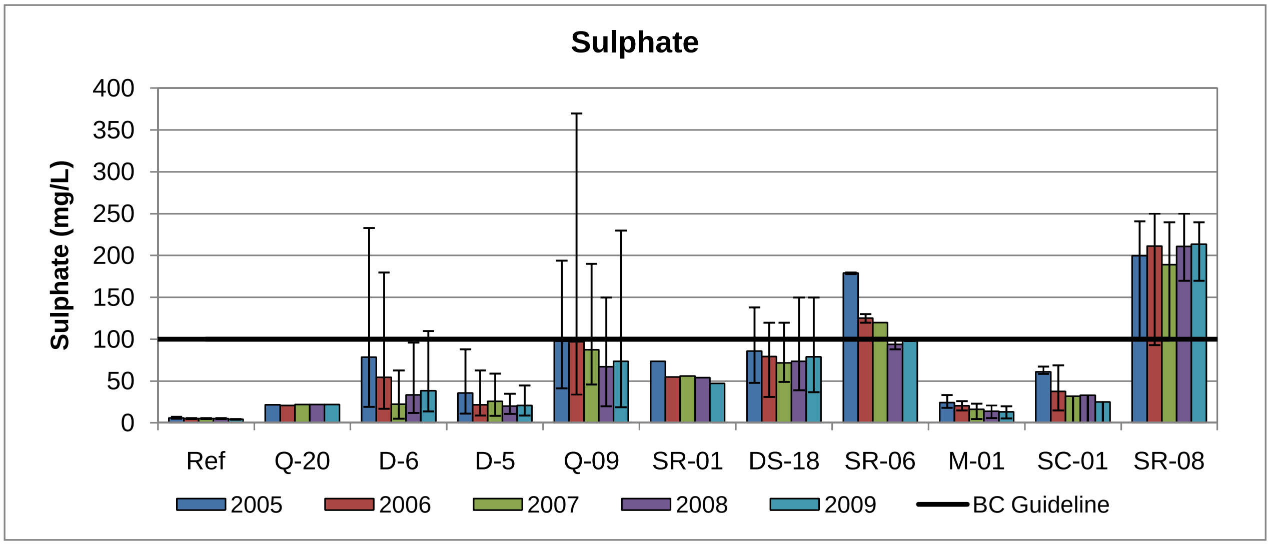


Figure 5.1: Mean, minimum and maximum water concentrations over time at mine exposed stations relative to pooled reference stations and water quality benchmarks. ND denotes no data available for that station.



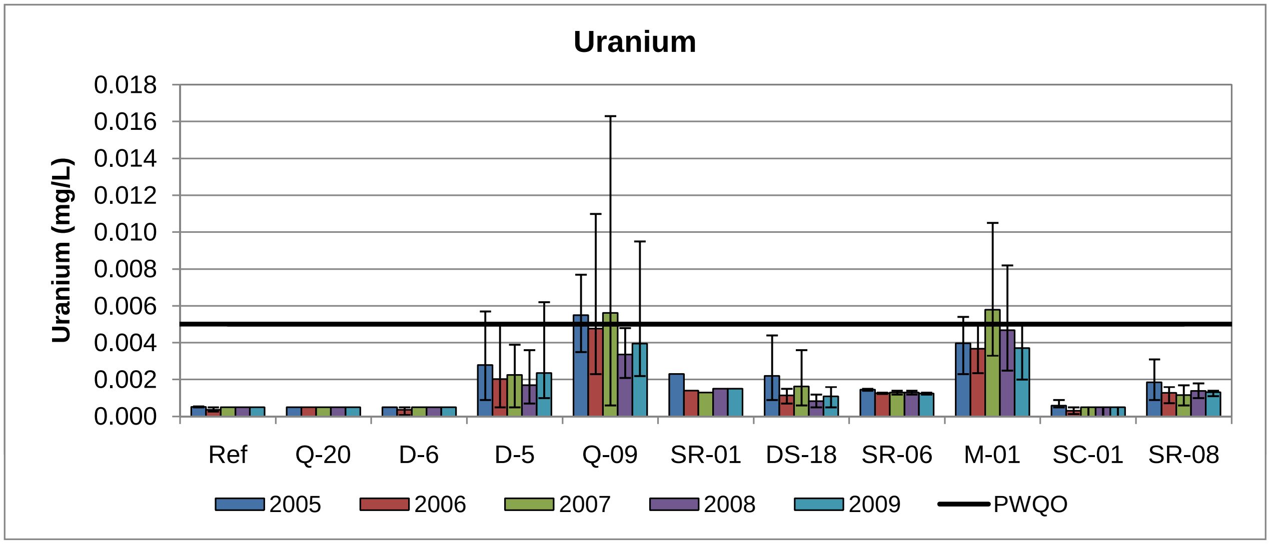


Figure 5.1: Mean, minimum and maximum water concentrations over time at mine exposed stations relative to pooled reference stations and water quality benchmarks. ND denotes no data available for that station.

Table 5.2: Summary of water quality trends[a] for Serpent River monitoring stations, 2000 to 2009.

Station ID	Number of Seasons Used in Common Trend[b]	Barium	Cobalt[c]	Iron[d,e]	Manganese[d]	pH[e]	Radium-226[c]	Sulphate	Uranium[c,e]
Reference Stations									
D-4	2	0.165	ND	0.645	0.621	-0.069	ND	-0.593	ND
P-22	2	0.435	ND	-	-	-0.038	ND	-0.515	ND
SR-05	10	-0.012	ND	-	-	0.070	ND	-0.786	ND
SR-14	1	-0.215	ND	-	-	0.0243	ND	-0.608	ND
SR-18	2	-0.099	ND	-	-	0.289	ND	-0.721	ND
SR-19	12	-0.191	ND	-	-	0.087	ND	-0.579	ND
Exposed Stations									
D-5	12	-0.124	ND	*-0.134*	-0.367	-0.011	-0.405	-0.412	*-0.276*
D-6	12	-0.093	ND	0.244	-0.046	*0.010*	-0.290	-0.258	ND
DS-18	12	-0.121	ND	0.368	-0.321	-0.084	-0.668	-0.442	-0.254
M01	10	-0.229	-0.219	-0.004	-	0.414	-0.660	-0.619	0.162
Q09	12	0.038	-0.292	-	-	-0.095	-0.374	-0.244	-0.379
Q20	1	0.622	ND	-	-	0.582	-0.834	-0.264	ND
SC-01	1 or 2	-0.360	ND	0.446	-	0.655	-0.739	-0.053	ND
SR-01	1	0.422	ND	-	-	0.387	-0.887	-0.967	-0.845
SR-06	2	0.984	ND	-	-	-0.572	0.394	-0.935	-0.977
SR08	12	0.172	ND	-	-	-0.076	-0.416	-0.539	-0.740

decreasing trend, significant at p<0.05

increasing trend, significant at p<0.05

[a] Based on rank correlation coefficients (rho) shown in table for common (combined) seasonal trends.

[b] Seasons used varied for substances based on suitability of data for trend analysis.

[c] ND denotes that this parameter was not included in the trend analysis for that particular station due to >50% non-detectable concentrations in the samples available for the analysis.

[d] "-" denotes that this parameter was not included in the trend analysis for that particular station due to the absence of data (e.g. there were <5 years worth of data for that parameter)

[e] Italic text mean monthly correlations were significantly different, but common trend value provided was not necessarily significant.

Water quality downstream of the TMAs is meeting EIS predictions. Recent concentrations of sulphate and radium-226 downstream of the TMAs were better than the 1999 cumulative predications or in the case of Stanleigh, the 2012 predicted values (Table 5.3). Observed trends reflected decreasing concentrations of both radium-226 and sulphate over time and therefore concentrations appear to be on target for achieving predicted values for 2099.

Generally, water quality downstream of the TMAs achieved receiving water criteria and is improving over time.

5.2 Sediment Quality

Substrate particle size characteristics were very consistent among lakes assessed within the SRWMP consisting of 10 to 15% clay, 45 to 50% silt and 30 to 35% sand (Figure 5.2). Sediment TOC ranged from about 4 % in McCarthy and Pecors lakes to a mean of 9% in the reference lakes (reference range 6.5 to 13.9).

Mean sediment metal concentrations downstream of the TMAs were typically less than the severe effect level (SEL) of the Provincial Sediment Quality Guideline's[5] but greater than the lower effect level (LEL) or background[6] concentrations (Table 5.4). The highest concentrations of most substances were found in McCabe Lake, where concentrations were above background and the LEL and, in the case of iron and manganese, higher than the SEL. Nordic Lake also had elevated concentrations of most substances relative to most other lakes assessed (Table 5.4). Typically Hough Lake had the lowest concentrations of the mine-exposed lakes, with concentrations of barium, cobalt, iron, manganese and uranium being below the background benchmark (Table 5.4).

In locations where sediment concentrations were above benchmarks, concentrations of barium, cobalt, iron, manganese and nickel appeared to decrease or remain stable over the past ten years (1999 to 2009) (Figure 5.3). However, statistical comparisons of 1999 versus 2009 sediment concentrations indicated few statistically significant differences (Appendix Table E.29). For example an apparent increase in nickel in McCabe Lake since 1999 was not significant (Appendix Table E.29). Similarly, uranium concentrations notably increased between 2004 and 2009 at all exposure locations, but there was no statistical difference in

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[5] The PSQG were used, where available, for all substances monitored except uranium and radium-226 which were compared to SEL and LEL values cited in Thompson et al. (2005)

[6] The SRWMP background values were typically greater than the LEL, and were greater than the SEL for iron and manganese.

Table 5.3: Concentration predictions at SRWMP stations compared to 2009 values.

TMA	Predicted vs Measured	Year	Sulphate (mg/L)	Radium-226 (Bq/L)	Uranium[a] (mg/L)
SR-01	Cumulative Prediction [b]	1999	173	0.067	-
	Current	2009	47	0.026	0.0015
	Cumulative Prediction [b]	2099	23	0.042	-
DS-18	Cumulative Prediction [b]	1999	215	0.170	-
	Current	2009	79	0.094	0.0011
	Cumulative Prediction [b]	2099	53	0.051	-
SR-06	Current	2009	99	0.064	0.0013
	2012[c] Prediction	2012	32	0.1	0.0029
	Cumulative Prediction [b]	2099	11	0.026	-

[a] Predicted uranium values converted from Bq/L to mg/L.

[b] Prediction values for 1999 and 2099 based on cummulative effects assessment (CNSC 2002).

[c] The 2012 prediceted value represents the 2005 year prediction presented in the CSR (1997) because delays in construction and flooding of the TMA caused a shift in the representative time line for the graphs of predicted concentrations.

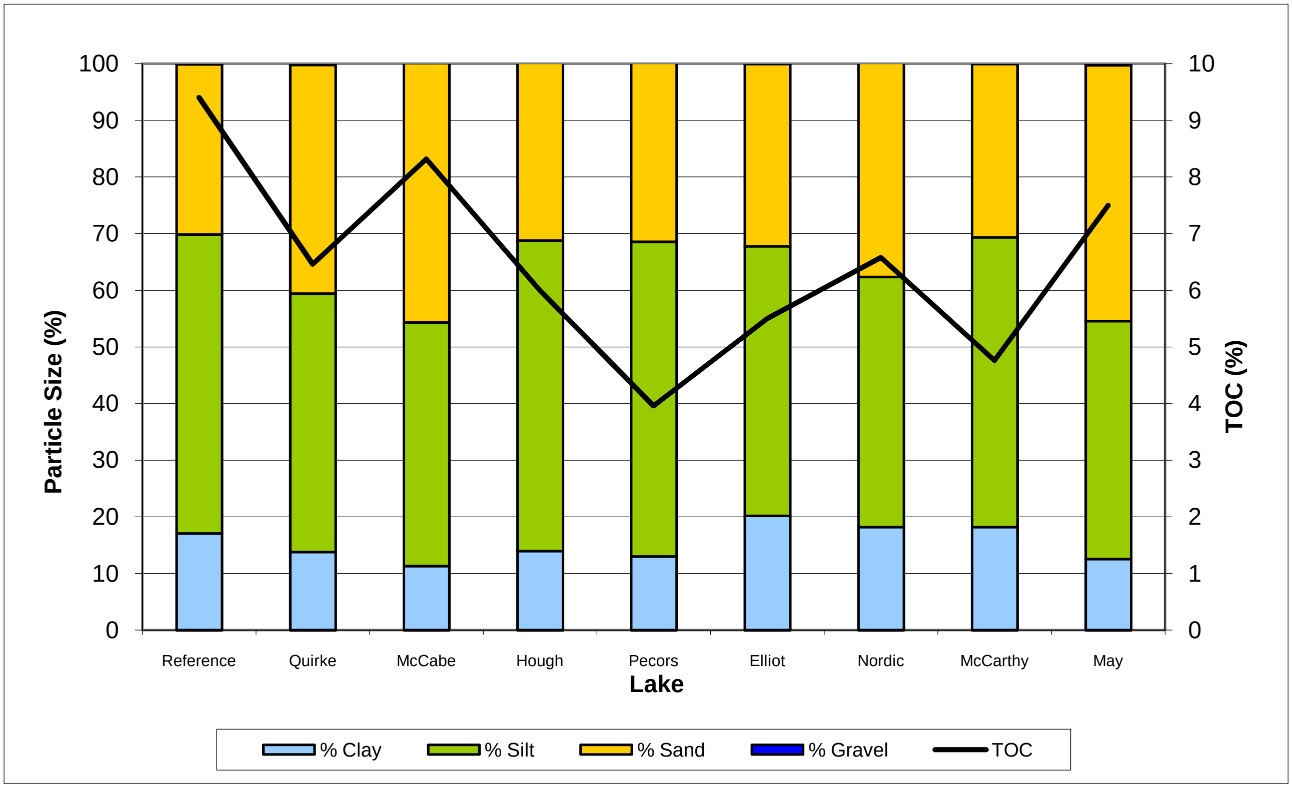


Figure 5.2: Sediment particle size distribution and total organic carbon content, SRWMP 2009.

Table 5.4: Summary of lake sediment quality relative to background concentrations and sediment quality guidelines, SRWMP 2009. Concentrations that were above background or LEL[a], whichever was higher, are highlighted in green. Values above the SEL[b] were highlighted in blue.

	Barium (mg/kg)				
Background	481				
LEL	-				
SEL	-				
	Lake	Mean	SD	Min	Max
Ranked Area Means	McCabe	2,090	1,879	380	4,200
	Quirke	706	430	240	1,400
	Semiwhite	432	112	310	560
	Nordic	294	98	130	390
	Elliot	218	65.0	130	300
	McCarthy	160	32.4	120	190
	May	143.2	67.6	96	260
	Rochester	138	21.7	110	160
	Dunlop	136	48.9	52	170
	Summers	98.6	13.5	86	120
	Pecors	98.0	17.6	75	120
	Ten Mile	81.6	24.7	51	110
	Hough	80.4	8.88	70	90

	Cobalt (mg/kg)				
Background	28.3				
LEL	-				
SEL	-				
	Lake	Mean	SD	Min	Max
Ranked Area Means	McCabe	175	82.0	76	290
	Nordic	109	49.0	25	150
	McCarthy	101	26.0	71	120
	Elliot	74	14.1	59	89
	Pecors	40	4.24	33	43
	Quirke	38.4	26.7	20	84
	May	31.8	10.7	21	49
	Hough	26.8	3.27	22	30
	Summers	19.6	8.20	10	30
	Rochester	19.0	4.06	13	24
	Dunlop	14.4	5.00	6.8	19
	Semiwhite	12.6	1.98	9.9	14
	Ten Mile	6.86	1.34	5.0	8.2

	Iron (mg/kg) [c]				
Background	54,783				
LEL	20,000				
SEL	40,000				
	Lake	Mean	SD	Min	Max
Ranked Area Means	McCabe	75,400	17,358	51,000	100,000
	May	73,600	15,805	59,000	100,000
	Nordic	69,000	27,902	33,000	110,000
	Quirke	57,800	11,584	42,000	68,000
	Elliot	52,000	9,460	10,000	63,000
	Hough	51,400	8,678	39,000	60,000
	McCarthy	49,800	12,276	33,000	65,000
	Semiwhite	34,400	13,088	20,000	49,000
	Pecors	33,400	10,359	18,000	43,000
	Rochester	30,800	10,849	24,000	50,000
	Dunlop	28,400	12,876	11,000	42,000
	Summers	28,400	11,675	17,000	46,000
	Ten Mile	9,700	1,034	8,200	11,000

	Manganese (mg/kg) [c]				
Background	6,918				
LEL	460				
SEL	1,100				
	Lake	Mean	SD	Min	Max
Ranked Area Means	Nordic	19,460	10,904	300	26,000
	McCabe	16,800	11,862	2,000	35,000
	McCarthy	12,360	3,694	8,000	16,000
	Elliot	10,760	6,163	3,000	18,000
	May	5,340	2,735	2,400	9,100
	Semiwhite	5,140	2,988	1,900	8,400
	Quirke	4,140	2,387	2,000	8,000
	Pecors	3,060	1,387	1,500	4,300
	Hough	2,880	606	2,000	3,400
	Dunlop	2,534	1,712	670	5,300
	Summers	1,384	981	290	2,600
	Rochester	710	112	590	850
	Ten Mile	518	141	340	1,060

	Nickel (mg/kg)				
Background	29.7				
LEL	23.4 [d]				
SEL	484 [d]				
	Lake	Mean	SD	Min	Max
Ranked Area Means	McCabe	100.8	36.4	68	160
	Elliot	53.6	5.37	47	59
	Nordic	44.0	6.82	37	52
	McCarthy	43.2	7.22	33	53
	Hough	40.2	3.03	37	45
	May	38.8	14.0	21	59
	Pecors	35.4	6.47	26	42
	Quirke	25.4	8.82	16	38
	Semiwhite	23.6	2.07	21	26
	Rochester	22.8	3.19	18	27
	Dunlop	21.4	5.46	12	26
	Summers	18.6	1.82	17	21
	Ten Mile	17.6	4.72	12	22

	Uranium (mg/kg)				
Background	6.50				
LEL	104.4 [d]				
SEL	5,874 [d]				
	Lake	Mean	SD	Min	Max
Ranked Area Means	Quirke	352	144	180	530
	McCabe	326	149	230	590
	Elliot	170	40.0	120	220
	Nordic	154	41.6	110	220
	McCarthy	138	27.7	110	180
	Pecors	114	11.4	100	130
	May	92.4	13.0	75	110
	Hough	87.4	5.32	78	91
	Rochester	5.04	1.79	3.1	7
	Semiwhite	4.16	0.439	3.6	4.8
	Dunlop	3.82	1.23	1.8	4.8
	Ten Mile	3.32	0.779	2.4	4.3
	Summers	2.70	0.235	2.4	2.9

	Ra-226 (Bq/g)				
Background	0.27				
LEL	0.6 [d]				
SEL	14.4 [d]				
	Lake	Mean	SD	Min	Max
Ranked Area Means	McCabe	13.8	1.30	12	15
	Nordic	4.78	1.68	2.3	6.8
	Quirke	3.64	2.26	1.1	7
	May	2.40	0.806	1.2	3.3
	Hough	1.90	0.367	1.6	2.5
	Elliot	1.592	0.364	0.96	1.9
	McCarthy	1.552	0.653	0.86	2.3
	Pecors	0.672	0.211	0.38	0.92
	Summers	0.158	0.0746	0.09	0.28
	Rochester	0.154	0.0546	0.10	0.24
	Semiwhite	0.154	0.0796	0.07	0.27
	Dunlop	0.088	0.0363	0.05	0.14
	Ten Mile	0.064	0.0230	0.04	0.1

(green) Selected background value or LEL (whichever was higher) or observed concentrations that exceeded selected background value or LEL.

(blue) SEL or concentrations that exceeded the SEL.

Bold text indicates reference lakes

[a] Lowest effect level, Ontario Provincial Sediment Quality Guidelines (OMOE 1993).

[b] Severe effect level, Ontario Provincial Sediment Quality Guidelines (OMOE 1993).

[c] Values not compared to SEL since upper range of background values exceeds SEL.

[d] Guidelines proposed by Thompson et al. (2005)

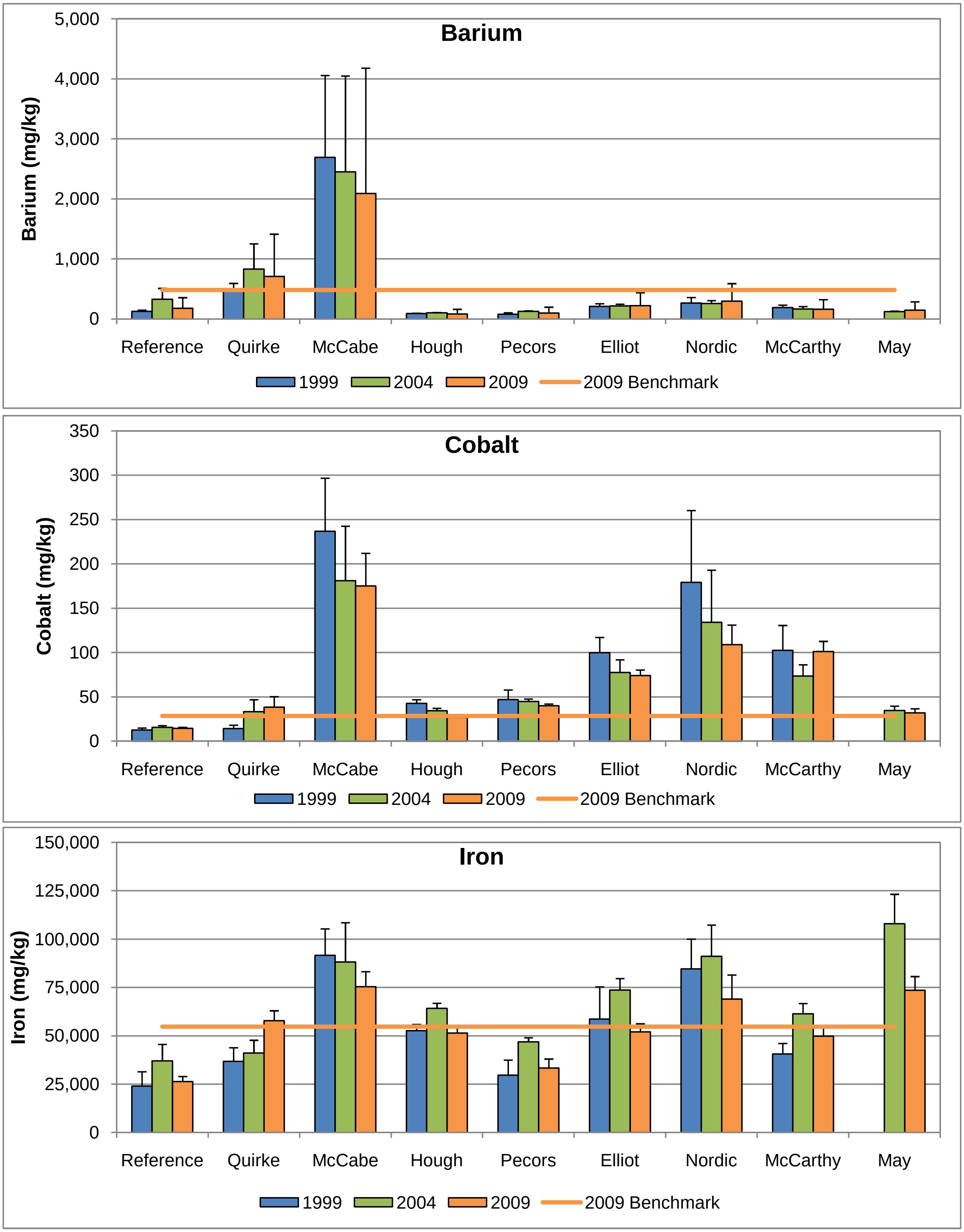
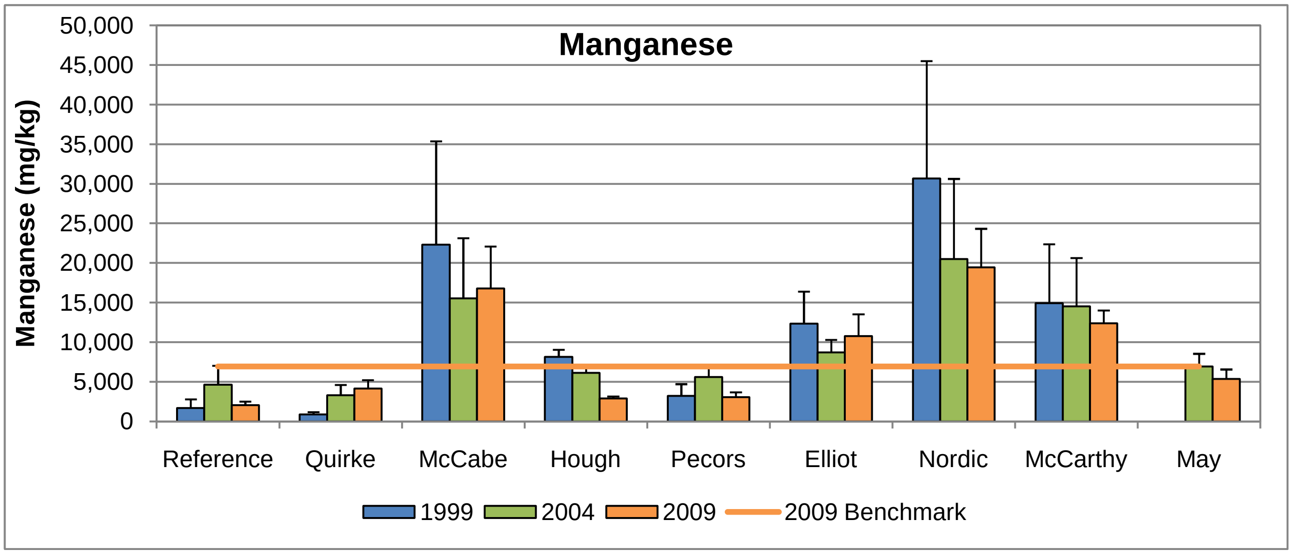
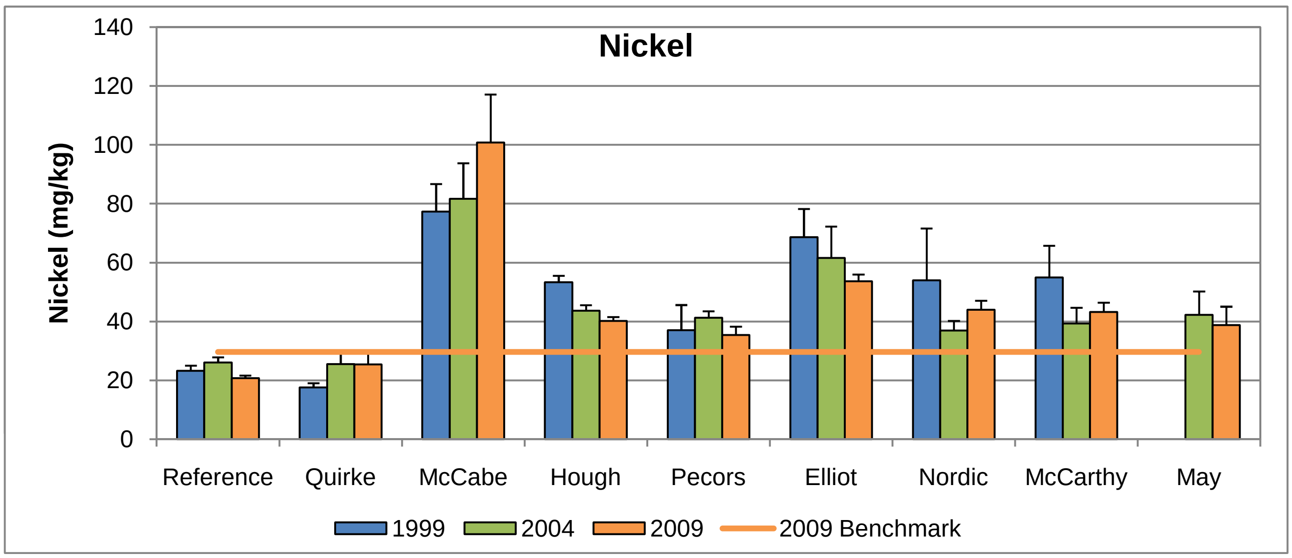


Figure 5.3: Mean lake sediment concentrations (± SE) for 1999 (cycle 1, n=3), 2004 (cycle 2, n=3), and 2009 (cycle 3, n=5).





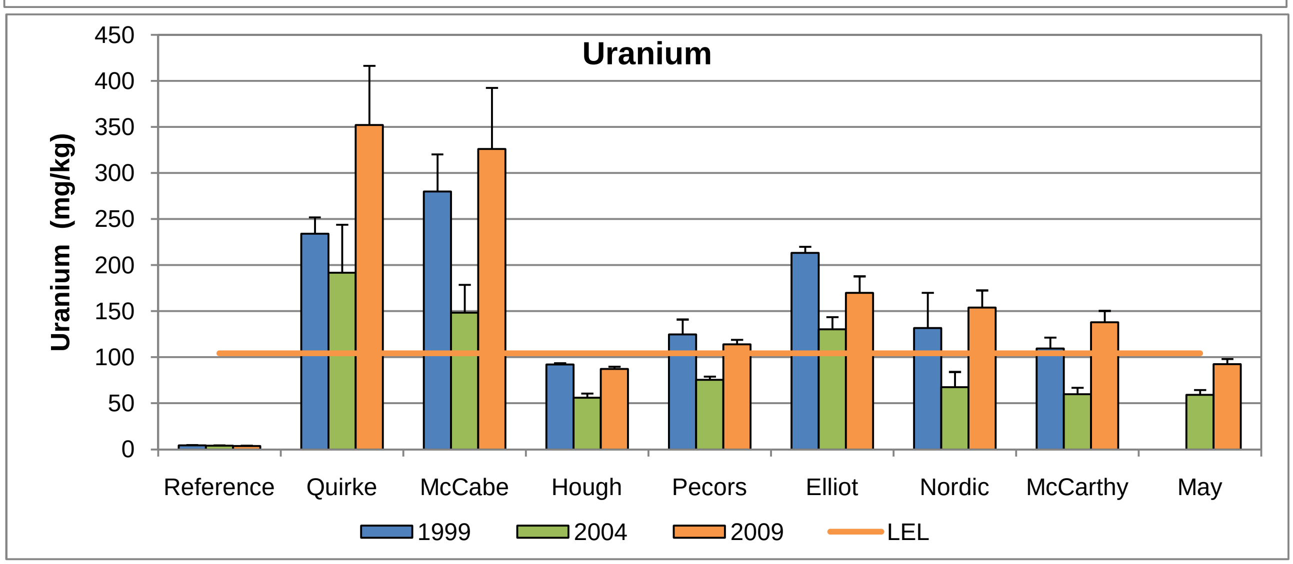


Figure 5.3: Mean lake sediment concentrations (± SE) for 1999 (cycle 1, n=3), 2004 (cycle 2, n=3), and 2009 (cycle 3, n=5).

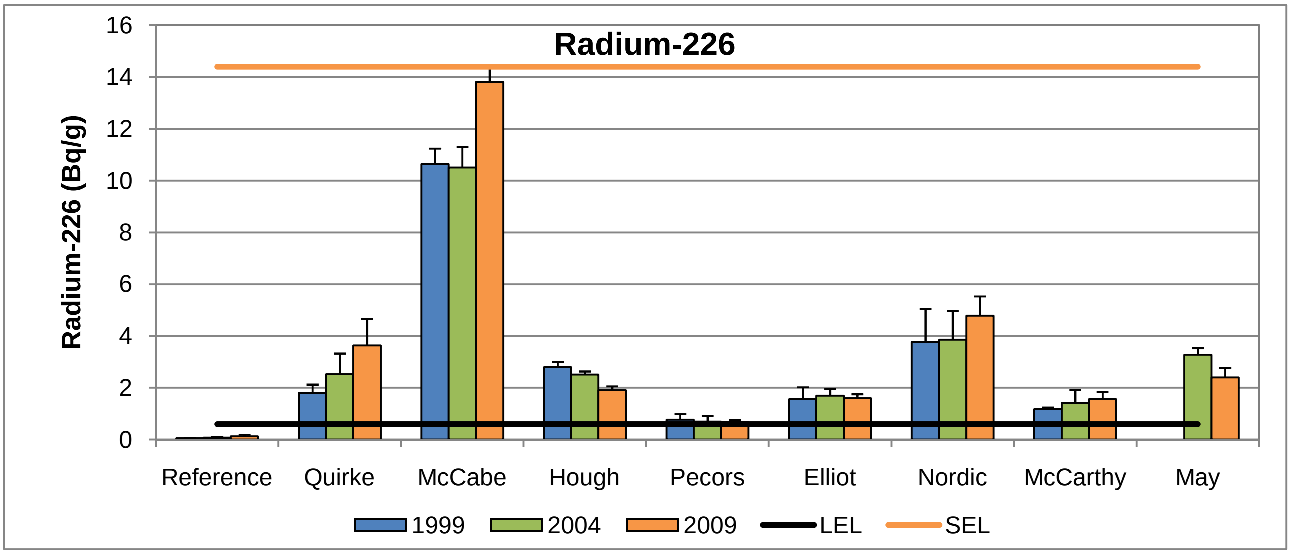


Figure 5.3: Mean lake sediment concentrations (± SE) for 1999 (cycle 1, n=3), 2004 (cycle 2, n=3), and 2009 (cycle 3, n=5).

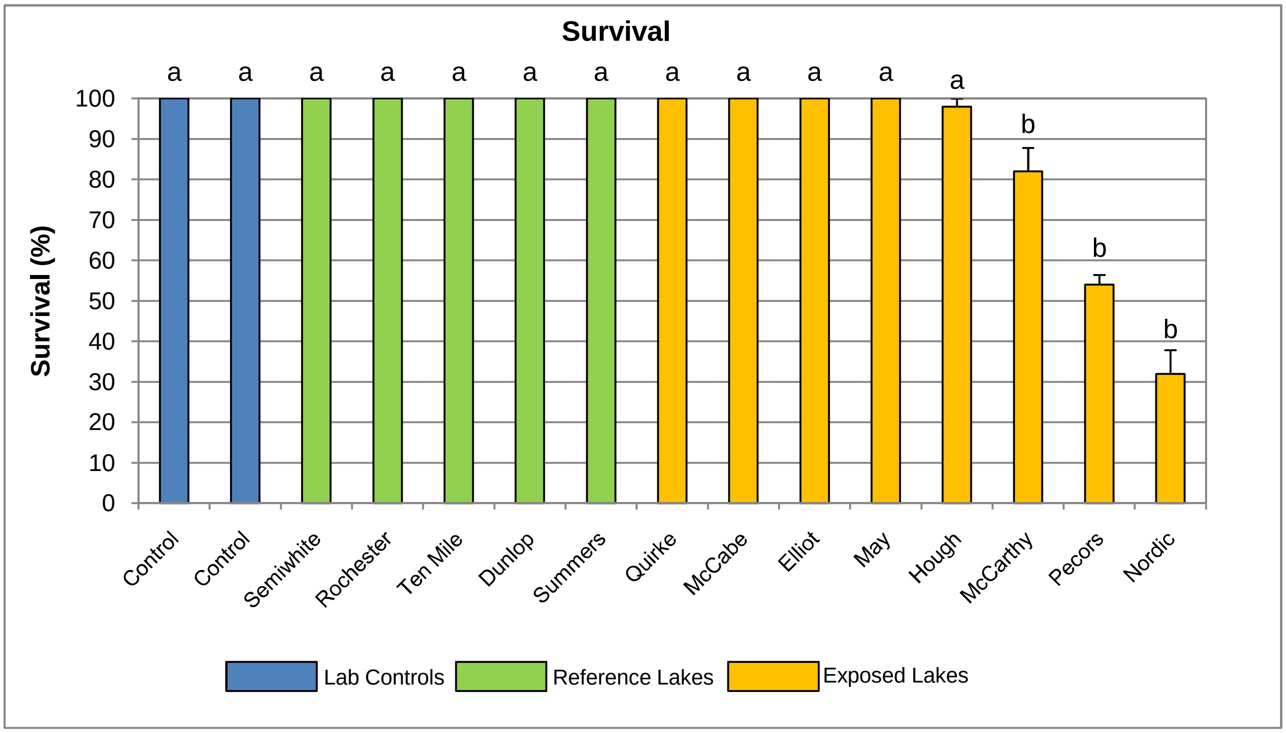
uranium concentrations between 1999 and 2009 in any of the lakes sampled (Appendix Table E.29). The only significant differences in mine-exposed lakes was an increase in iron and manganese in Quirke Lake, an increase in radium-226 in McCabe Lake and a decrease in cobalt, manganese, nickel and radium-226 concentrations in Hough Lake (1999 vs. 2009),. Overall, the data indicate a very slow rate of change in sediment quality.

Sediment quality was further assessed through toxicity testing using *Hyalella azteca* at all lakes monitored within the SRWMP and using *Chironomus dilutus* at selected lakes (Figures 5.4 and 5.5 respectively). Survival of *Hyalella azteca was* significantly reduced by exposure to sediments from McCarthy, Pecors and Nordic Lakes relative to the laboratory control and SRWMP reference lake sediments. In addition, sediment from these lakes and Quirke Lake produced statistically reduced growth in *Hyalella azteca* (Figure 5.4). These results did not correspond with sediment chemistry since McCarthy and Pecors lakes had some of the lowest sediment concentrations of mine-related substances. The observed response may be related to direct or indirect effects of TOC, which was lower in McCarthy and Pecors Lakes (4.6 and 5.5%) than in the lab control (8.9%) or the reference lakes (6.5 to 13%). Depending on the substance, TOC may influence the bioavailability of metals in sediment. Growth and survival of *Chironomus dilutus* did not differ between exposure and reference lakes (Figure 5.5).

5.3 Benthic Invertebrate Communities

5.3.1 Data Exploration

Raw benthic community data from 1999, 2004 and 2009 were combined for preliminary exploration of the data. Where taxonomy changed between years, taxa were, if necessary, collapsed to a coarser level of identification. Twenty-three taxa were retained and used in correspondence analysis (CA). The first three axes of the CA contained 36.2% of the total inertia (or variance) in the original benthic abundance data set (Appendix Table E.37b). The first axis explained 14.4% of the variance and summarized variation principally in the taxa *Rhyacodrilus montana* (an oligochaete worm), *Bezzia* (a “No-See-Um” biting midge), and immature tubificids both with, and without, diagnostic hair chaetae (Appendix Table E.37a). CA Axis-2 summarized 12.7% of the variation, and positive scores on this axis were characterized by high relative abundance of immature tubificids with hair chaetae as well as *Dicrotendipes* and *Paracladopelma* chironomids, while strongly negative scores were associated with immature tubificids without hair chaetae, *Chaoborus punctipennis*, and Harpacticoida (copepods). The third CA axis analysed explained 9.1% of the variation and principally described a continuum of higher abundance of *Pisidium* fingernail clams (low CA



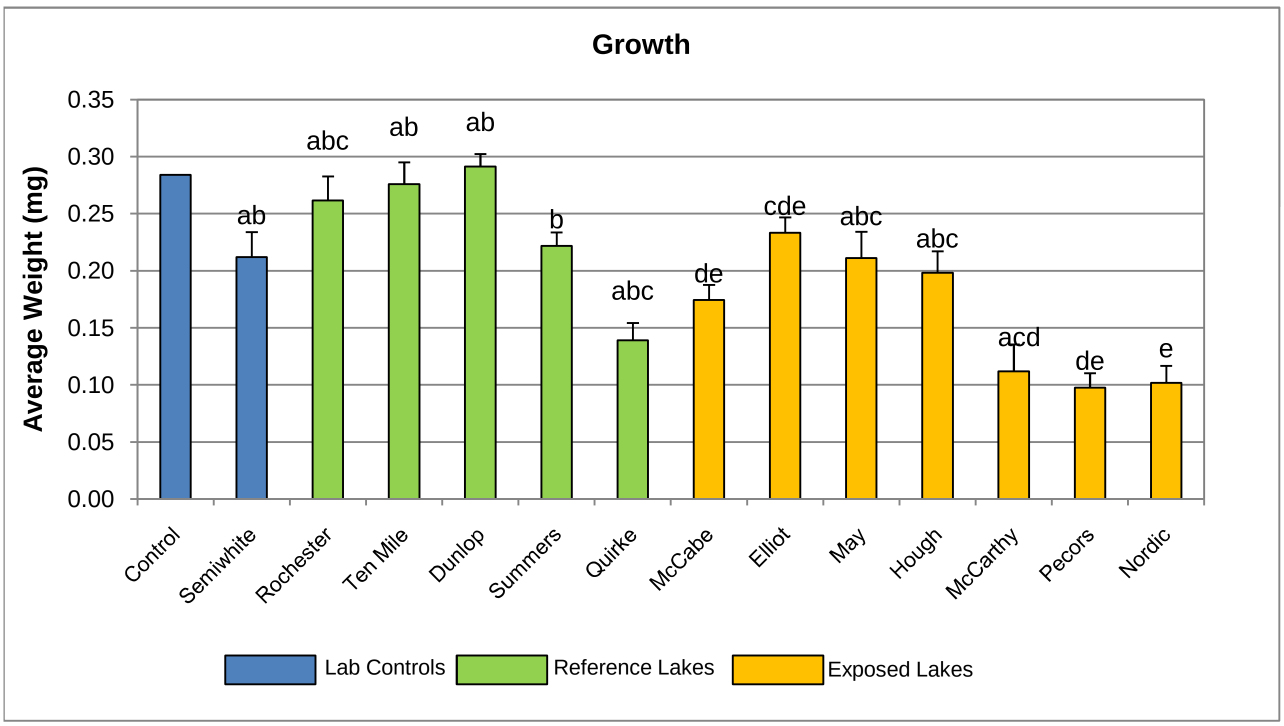


Figure 5.4: Survival and growth (+ SE) of *Hyalella azteca* exposed to sediment samples, SRWMP 2009. Lakes with similar letters above bars were not significantly different (p<0.05).

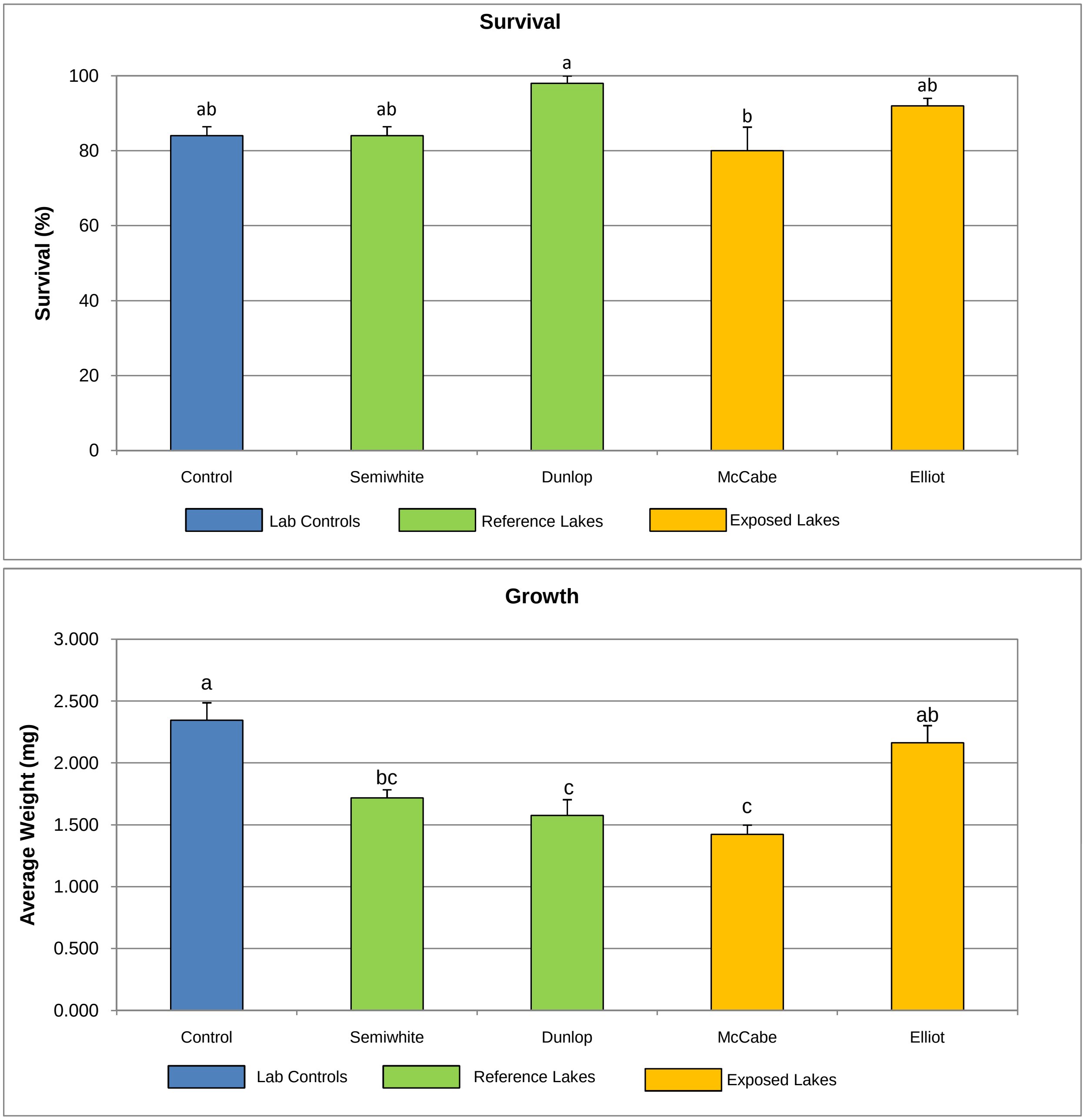


Figure 5.5: Survival and growth (+ SE) of *Chironomus dilutus* exposed to sediment samples, SRWMP 2009. Lakes with similar letters above bars were not significantly different ($p<0.05$).

Axis-2 scores) to higher abundance of immature tubificids lacking hair chaetae (positive CA Axis-2 scores; Appendix Table E.37a).

CA scores, plotted as means ± 95% confidence intervals for each lake and year, showed that reference area Rochester Lake (RL) had benthic invertebrate communities which, in all three sample years, were considerably different from other reference areas as summarized by CA axes 2 and 3 (Figure 5.6, Appendix Figure E.15). RL stations had very low CA Axis-2 scores, indicating high relative abundance of immature tubificids lacking hair chaetae, and also high relative abundance of the planktonic phantom midge *Chaoborus punctipennis* and harpacticoid copepods. Other reference lakes had low relative abundance of these taxa, and higher relative abundance of immature tubificids with hair chaetae, and of the chironomid larvae *Dicrotendipes* and *Paracladopelma*. Accordingly, these other reference lakes had higher CA Axis-2 scores than RL (Figure 5.6). On CA Axis-3, RL had higher values than other reference lakes, indicating again the dominance of immature tubificids lacking hair chaetae, whereas other reference lakes tended to have few of these tubificids, but higher relative abundance of *Pisidium* fingernail clams.

It may be relevant that RL had more organic sediments (14.2% TOC) and lower water column DO near the sediment-water interface (30%) than all other lakes (4.0-9.9% TOC and 46-132% DO) (Appendix Tables E.12 and E.31).

The clear difference between the benthic community found at RL and the benthic community in other reference lakes would inflate the variance around the means of the community metrics for reference lakes, resulting in a less rigorous test of the hypothesized differences between reference and exposure lakes in the study. Accordingly, a decision was made to remove RL stations from the reference lake data set for all comparisons with mine effluent exposure lakes. Therefore, for reference/exposure comparisons, a pooled reference mean was calculated from the mean values of the reference lakes (n=4 lakes, omitting RL as described above) in each study year, and these data were compared to mean values for each exposure lake (n=5 replicate stations) using *a priori*, user-defined contrasts in ANOVA.

5.3.2 Reference/Exposure Comparisons for 2009 Data

In 2009, the only exposure lake showing a statistically significant difference in benthic community density from the pooled reference community was Quirke Lake (Figure 5.7a), where density was reduced by less than two standard deviations (2SD) from the reference mean (Appendix Table E.43), which may not be biologically meaningful. It is noteworthy, however, that, while not statistically significant in individual comparisons (p>0.1), all exposure lakes except Pecors Lake (PL) had lower mean density than the reference mean (Appendix

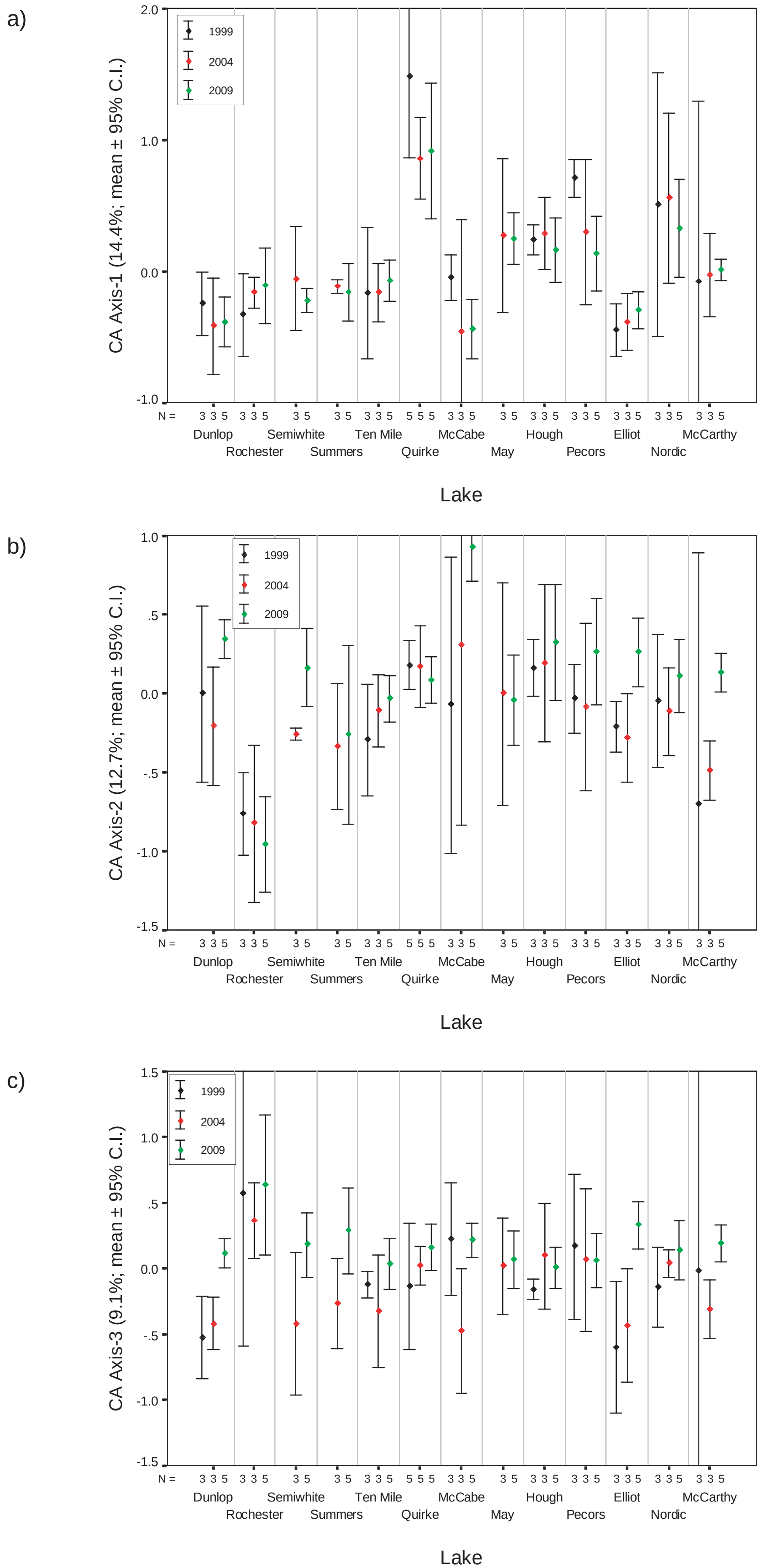


Figure 5.6: Exploratory correspondence analysis of benthic community data at Serpent River watershed areas: 1999, 2004, 2009.

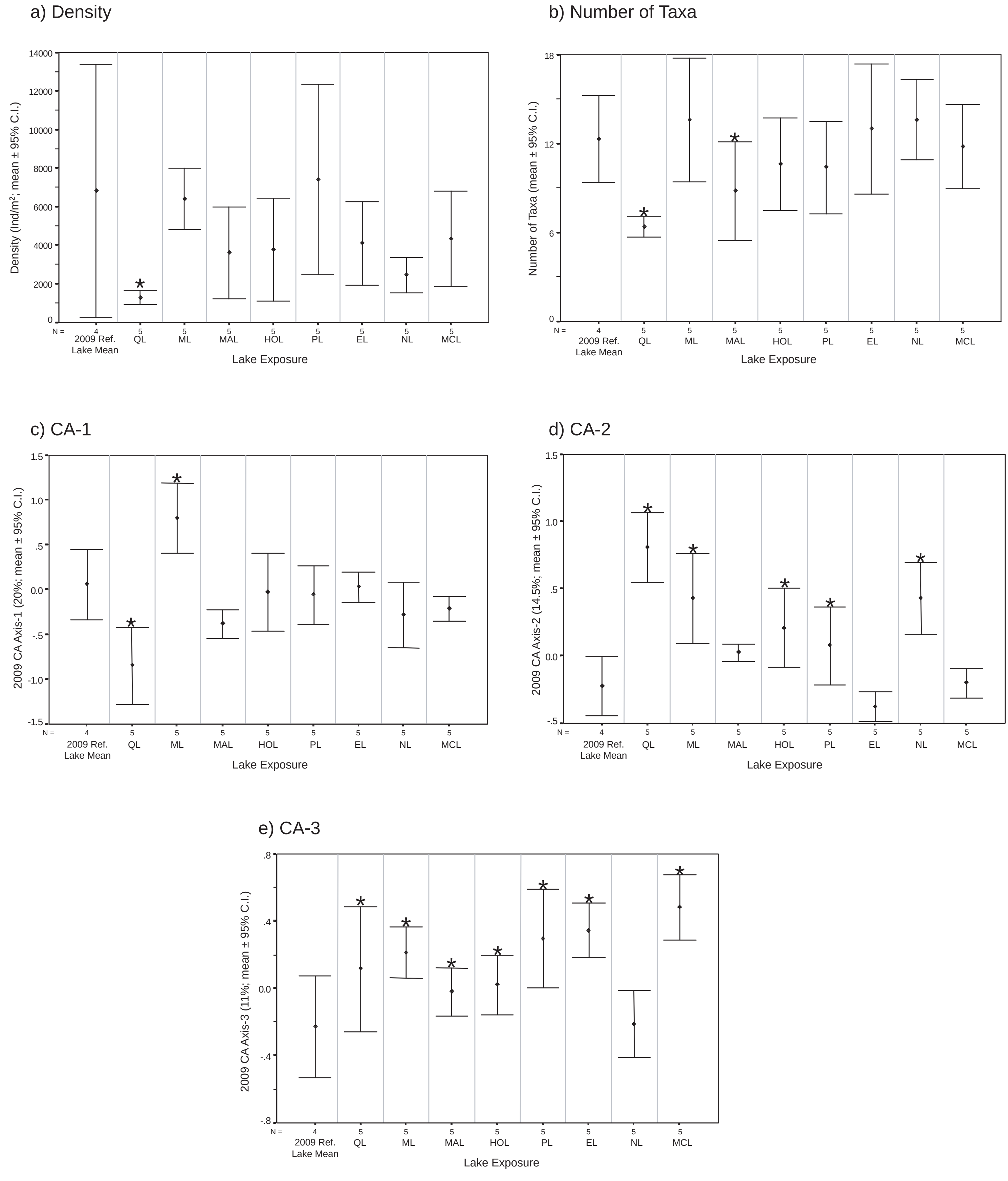


Figure 5.7: Benthic community characteristics in mine-exposed lakes of the Serpent River watershed relative to the pooled reference lakes. Asterisks (*) indicate exposure lakes that were statistically different from reference for each metric (p<0.1).

Table E.43). This pattern of differences, significant by Wilcoxon Signed ranks (WSR; $n = 8$; $p < 0.05$) test, suggests mild impairment of density may be characteristic of effluent exposed lakes.

Both Quirke Lake (QL) and May Lake (MAL) had significantly fewer benthic invertebrate taxa when compared to the reference lake mean, though only the difference at QL was more than 2SD from the reference mean (Appendix Table E.43). The pattern of differences (positive or negative change from reference) was not significant (WSR test, $n = 8$; $p > 0.05$).

CA of 2009 benthic abundance data explained 46.5% of the variance in abundance among stations (Appendix Table E.39a). In the exposure lakes, QL, MAL, and NL had significantly lower CA Axis-1 scores than the reference mean, with a departure of 3.7 SDs from the reference mean for QL, but less than 2 SDs for MAL and NL (Figure 5.7c; Appendix Table E.43). Low CA Axis-1 values indicated higher relative abundance of such taxa as the oligochaete worm *Rhyacodrilus montana* and midge larvae of the genus *Chironomus* (Appendix Table E.39a). In contrast, McCabe Lake (ML) had significantly higher CA Axis-1 scores than reference (3SD), indicating higher relative abundance than in reference of immature tubificids with hair chaetae, and of *Dicrotendipes* chironomids (Figure 5.7c; Appendix Table E.43). The other exposure lakes had mean CA Axis-1 values similar to reference.

All exposure areas, except Elliot Lake (EL) and McCarthy Lake (MCL) had CA Axis-2 values significantly higher than the pooled mean of the reference lakes, with all differences being more than 2SD from the reference mean except at May Lake (MAL) (Figure 5.7d; Appendix Table E.43). High values of CA Axis-2 indicated benthic communities with greater abundance of *Dicrotendipes* chironomids, and some oligochaete taxa (immature tubificids with hair chaetae, and *Rhyacodrilus montana*) (Appendix Table E.39a). The pattern of greater CA Axis-2 values at exposure lakes than the reference lakes was statistically significant (WSR test: $n = 8$; $p < 0.05$). The low CA-2 scores of reference, EL and MCL corresponded to higher abundance of the facultative planktonic predatory phantom midge larva *Chaoborus punticpennis* (Appendix Table E.39a).

All exposure areas with the exception of NL had significantly greater CA Axis-3 scores than the pooled reference lakes (Figure 5.7; Appendix Table E.43). Strongly positive scores on this axis were indicative of greater abundance of *Chaoborus punctipennis*, whereas strongly negative scores indicated greater abundance of harpacticoid copepods (Appendix Table E.39a). Only 4 exposure lakes (ML, PL, EL, MCL) differed from the reference area mean by more than 2 reference SDs (Appendix Table E.43), but overall, the pattern of differences from reference were uniformly positive across all exposure lakes, and therefore constituted a significant overall reference-exposure difference (Appendix Table E.43; WSR test, n = 8; $p < 0.05$).

In summary, the benthic invertebrate communities of all mine-exposed lakes were statistically different from the mean of reference lakes with respect to at least one of the benthic community metrics (Tables 5.5 and 5.6). The communities in Quirke, McCabe, and May lakes showed more significant differences from the mean reference community than the other lakes, but the magnitudes of difference were larger at Quirke and McCabe than May when differences were expressed as a percentage of the reference mean or the number of reference area standard deviations. The benthic communities in Elliot and McCarthy Lakes were most similar to the mean reference community, differing only with respect to CA-3. Overall, the exposure areas showed a pattern of lower benthic invertebrate density and CA1 scores, along with higher CA2 and CA3 scores than the pooled reference areas (Table 5.4), indicative of a mine-related signature.

5.3.3 Correlations between Benthic Metrics and Supporting Measures

A total of 26 correlations between habitat variables and benthic community characteristics were significant at $p<0.05$, but only nine were significant at a more stringent level of $p<0.001$ (Table 5.7). Most correlations were associated with one or more of four patterns (Appendix Figure E.18):

1. Influence of exposed Quirke Lake (QL) stations, which had relatively greater sample depth, secchi depth, and sediment uranium concentrations, and where mean benthic invertebrate density, number of taxa, and CA-1 scores were low and CA2 scores were high relative to the other reference and exposed lake benthic invertebrate communities.

2. Influence of reference Ten Mile Lake (TML) stations, which had relatively large station depth, Secchi depth, and sediment TOC, as well as low metal levels.

3. Influence of McCabe Lake stations (ML), which had highest or second highest mean sediment concentrations of all mine-related substances (radium-226, barium, cobalt, iron, manganese, nickel, uranium), and high scores on all three CA axes.

4. Generally higher sediment concentrations of mine-related substances, and higher water pH, along with higher CA2 and CA3 scores in mine-exposed compared to reference lakes.

Table 5.5: Summary of benthic community comparisons for 2009, showing the magnitude of difference from reference (as percent of reference mean) and differences that were statistically significant (shaded).

Lake	Code	Density	No. of Taxa	Correspondence Analysis (2009 data only)		
				CA1	CA2	CA3
Quirke	QL	-81	-48	-1521	456	150
McCabe	ML	-6	11	1231	289	193
May	MAL	-47	-28	-739	110	90
Hough	HOL	-45	-14	-150	191	109
Pecors	PL	8	-15	-200	133	229
Elliot	EL	-40	6	-53	-67	251
Nordic	NL	-64	11	-579	288	7
McCarthy	MCL	-37	-4	-463	11	311

Table 5.6: Summary of benthic community comparisons for 2009, showing lakes that differed differed signficantly from reference (√) and cases where such differences were more than two reference area standard deviations (# SDs in parentheses).

Lake	Code	Density	No. of Taxa	Correspondence Analysis (2009 data only)		
				CA1	CA2	CA3
Quirke	QL	✓	✓ (-3.2)	✓ (-3.7)	✓ (7.6)	✓
McCabe	ML			✓ (3.0)	✓ (4.8)	✓ (2.3)
May	MAL		✓	✓	✓	✓
Hough	HOL				✓ (3.2)	✓
Pecors	PL				✓ (2.2)	✓ (2.7)
Elliot	EL					✓ (3.0)
Nordic	NL			✓	✓ (4.8)	
McCarthy	MCL					✓ (3.7)

Table 5.7: Correlations between benthic metrics and sediment measures, SRWMP 2009.

		Barium (mg/kg)	Cobalt (mg/kg)	Iron (mg/kg)	Manganese (mg/kg)	Nickel (mg/kg)	Ra-226 (Bq/g)	Uranium (mg/kg)	TOC (%)	Depth (m)	Secchi Depth (m)	DO (% sat)	pH	Fines (%; silt + clay)
Density (Ind./m2)	Pearson Correlation	-0.006	-0.130	-0.375	-0.190	-0.067	-0.086	-0.285	-0.038	-0.186	0.016	0.204	-0.134	0.190
	Sig. (2-tailed)	0.9655	0.3235	0.0032	0.1456	0.6131	0.5117	0.0271	0.7709	0.1542	0.9029	0.1173	0.3312	0.1450
	N	60	60	60	60	60	60	60	60	60	60	60	55	60
Number of Taxa	Pearson Correlation	0.105	0.109	-0.141	0.118	0.104	0.112	-0.225	-0.084	-0.450	-0.336	-0.182	0.001	0.173
	Sig. (2-tailed)	0.4249	0.4069	0.2830	0.3710	0.4310	0.3929	0.0842	0.5224	0.0003	0.0087	0.1635	0.9932	0.1850
	N	60	60	60	60	60	60	60	60	60	60	60	55	60
2009 CA Axis-1 (20.0%)	Pearson Correlation	0.346	0.234	-0.092	0.141	0.381	0.347	-0.150	0.168	-0.496	-0.258	-0.087	-0.003	0.209
	Sig. (2-tailed)	0.0067	0.0722	0.4827	0.2829	0.0026	0.0066	0.2532	0.1997	0.0001	0.0469	0.5100	0.9815	0.1097
	N	60	60	60	60	60	60	60	60	60	60	60	55	60
2009 CA Axis-2 (14.5%)	Pearson Correlation	0.377	0.254	0.386	0.217	0.204	0.500	0.578	-0.163	0.435	0.328	0.213	0.492	-0.342
	Sig. (2-tailed)	0.0030	0.0500	0.0023	0.0961	0.1173	0.0000	0.0000	0.2147	0.0005	0.0106	0.1030	0.0001	0.0075
	N	60	60	60	60	60	60	60	60	60	60	60	55	60
2009 CA Axis-3 (11.%)	Pearson Correlation	0.127	0.384	0.331	0.265	0.371	0.213	0.411	-0.381	-0.049	-0.438	-0.413	0.212	-0.192
	Sig. (2-tailed)	0.3335	0.0025	0.0097	0.0405	0.0035	0.1026	0.0011	0.0027	0.7119	0.0005	0.0010	0.1204	0.1409
	N	60	60	60	60	60	60	60	60	60	60	60	55	60

(orange) Correlation is significant at the 0.0014 level (2-tailed, p = 0.05 adjusted for 35 simultaneous tests).
(yellow) Correlation is significant at the 0.05 level (2-tailed).
(grey) Correlation is significant at the 0.01 level (2-tailed).

Overall, the correlation analysis indicated that reference-exposure differences may be attributable to a combination of mine-related and/or non-mine-related factors and the specific causal factors likely differ among lakes.

5.3.4 Comparison of 2009 Benthic Metrics to Previous Years (1999, 2004)

Combining all reference and exposure station data within study years, excluding Rochester Lake, the five benthic community metrics (density, number of taxa, CA1, CA2, CA3) were tested by ANOVA across the three years for which data are available: 1999, 2004, 2009. Significant year-to-year variation was found for all five metrics (Appendix Table E.44). Pair-wise, post-hoc comparisons of year means indicated that benthic density increased monotonically over the 3 years, though only the comparison of 1999 to 2009 resulted in a significant post-hoc comparison (Figure 5.8a; Appendix Table E.45). Number of taxa was significantly lower in 1999 than in either 2004 or 2009, with the latter two years having similar numbers of taxa (Figure 5.8b).

In Correspondence Analysis (CA), CA Axis-1 score decreased monotonically over the three cycles of study (Figure 5.8c), but only the comparison of 1999 to 2009 was statistically significant ($p = 0.08$; Appendix Table E.45). This is supportive of a trend over these years from a community with high relative abundance of *Rhyacodrilus montana* and *Bezzia*, to a community more dominated by immature tubificids with hair chaetae, and by *Cyclocalyx* fingernail clams. CA Axis2 scores remained constant in 1999 and 2004, but decreased significantly in 2009, indicating a community shift from *Pisidium* and *Chaoborus* dominance in the former 2 years, to dominance by *Dicrotendipes* and *Paracladopelma* chironomids, along with immature tubificids with hair chaetae, and *Cyclocalyx* (Figure 5.8d). Year-to-year variation on CA Axis-3 scores also showed consistency between 1999 and 2004, again with a significant change in 2009. This trend indicated again a move towards a *Cyclocalyx* dominated community from one with higher relative abundance of immature tubificids with hair chaetae, *Dicrotendipes*, and *Pisidium*. The apparent contradictions in CA Axis-2 and CA Axis-3 represent, in the case of CA Axis-3, variation in the abundance of immature tubificids (+ hair chaetae) and *Dicrotendipes* that was not correlated with the abundance of *Cyclocalyx*.

For the five metrics considered above, the pattern of deviation from the reference mean in each year was then examined for the exposure lakes' means using Wilcoxon Signed Ranks (WSR) test. Differences between exposure lake means and the mean of four reference lakes were computed as positive or negative differences, and the ranked magnitudes were tested for non-randomness of pattern. The differences also were calculated as percent deviation from reference mean.

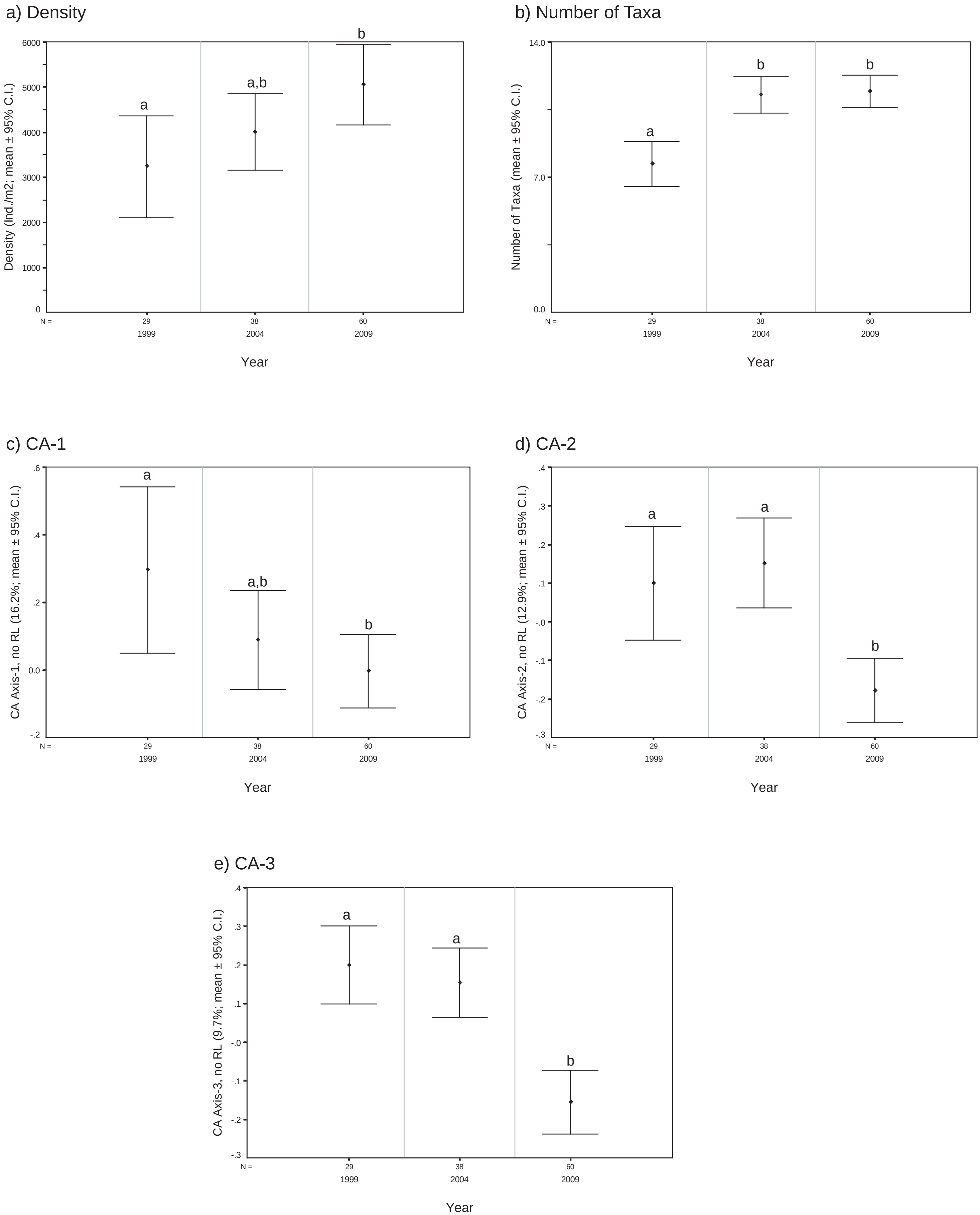


Figure 5.8: Benthic invertebrate community metrics for combined reference and exposure stations among years (1999, 2004, 2009). Years with similar letters were not significantly different ($p > 0.1$).

In 1999, density and number of taxa in seven exposure lakes was less than the reference mean values more often than would be expected by chance (WSR p = 0.078 and p = 0.031, respectively, Table 5.8). McCabe Lake (ML) was the only lake with a slightly greater mean density than the mean of the four reference lakes, and Hough, Pecors, and Quirke lakes all showed substantial decreases from reference mean density (Appendix Table E.46). Number of taxa was most decreased from reference in Pecors, Quirke, and Hough lakes, and only Elliot Lake had a very slight positive deviation from the reference mean. Scores on CA Axis-1 in 1999 showed significant positive deviation from reference mean in the suite of exposure lakes (WSR p = 0.047; Table 5.8), indicating an exposure community with high relative abundance of *Rhyacodrilus montana* and *Bezzia* compared to that found at reference lakes. Only Elliot Lake had CA Axis-1 scores disparate from other exposure lakes, in a negative deviation from reference mean. Quirke and Pecors lakes showed the greatest increase in CA Axis-1 scores when compared to reference (Appendix Table E.46). No reference-exposure differences were found by WSR for CA Axis-2 scores, but CA Axis-3 scores in the exposure lakes were less than the reference mean more often than expected (WSR p = 0.047). In total, 4 of 5 metrics examined by WSR tests showed significant patterns of deviation from the reference mean in 1999 (Table 5.8).

The second study year: 2004, all eight exposure lakes had lower mean density than the reference mean, again representing a significant pattern (WSR p = 0.008; Table 5.8; Appendix Table E.46). The largest deviations were noted at May, McCabe, and Pecors lakes (Appendix Table E.46). No significant pattern of deviation was found for number of taxa in 2004, and each exposure lake appeared to show improvement in deviation from reference mean over the 1999 data (Appendix Table E.46). Scores on CA Axis-1 continued to show significantly more positive deviations from reference mean than expected by chance (WSR p = 0.055; Table 5.8) though the magnitude of positive deviation from reference was reduced in most lakes (Appendix Table E.46). Exposure lakes also showed a pattern of significant negative deviation from reference mean for CA Axis-2 scores in 2004 (WSR p = 0.039), with only Elliot and McCarthy lakes showing small positive deviations from the reference mean (Appendix Table E.46). No significant pattern of deviations was detected for CA Axis-3 scores in 2004. In total, three of the five metrics examined by WSR tests showed significant patterns of deviation from the reference mean in 2004 (Table 5.8).

In 2009, density continued to show a pattern of significantly more and larger negative deviations from reference than would be expected by chance alone (WSR p = 0.023; Table 5.6). Only Pecors Lake showed a small positive deviation of 8% from reference mean density, whereas Quirke Lake (-81%) and Nordic Lake (-64%) showed substantial negative

Table 5.8. Benthic community metrics for which there was a significant pattern of increase (↑) or decrease (↓) among mine-exposed lakes relative to the reference mean (p<0.1).

Metric	1999	2004	2009
Density	↓	↓	↓
Number of Taxa	↓		
CA Axis 1[a]	↑	↑	
CA Axis 2		↓	↓
CA Axis 3	↓		
Total Metrics for Which Exposure Lakes Differed from Reference	**4**	**3**	**2**

[a] CA for all years and locations combined, except RL.

deviation from reference (Appendix Table E.46). Number of taxa showed no significant pattern of deviation from the reference mean in 2009, though Quirke Lake showed the greatest negative deviation from the reference mean (-48%; Appendix Table E.46). Likewise, there was no pattern of reference-exposure differences in CA Axis 1 scores in 2009, though here too Quirke Lake showed the greatest deviation from reference, at +522% (Appendix Table E.46). Exposure lakes continued to show a significant pattern of very strong negative deviations from reference for CA-2 in 2009 (WSR p = 0.023; Table 5.8), with a mean deviation of –635% across the set of exposure lakes (Appendix Table E.46). No differences between reference and exposure were noted by WSR test for CA Axis-3 scores in 2009. Overall, only two of five metrics tested showed reference-exposure patterns of deviation in this latest year of study.

It is clear that year-to-year variation is a significant component of community change in these lake benthic communities, against which reference-exposure differences must be assessed in future years. Despite the variability between years, it appears that the pattern of deviations from reference mean values for the exposure lakes generally decreased through the three cycles of study, from 4 out of 5 metrics in 1999, to 3 out of 5 in 2004, and to only 2 out of 5 metrics in 2009. These changing patterns of deviation are evidence in support of a hypothesis of gradual recovery from initial (1999) impact in exposure lakes, but indicate that small deviations from reference means persist in both the density and community structure of exposure lakes as of 2009.

Previous study reports were unable to conclusively identify mine-related impacts on benthic invertebrate communities for several reasons:

- The inclusion in previous studies of sampling areas representing a much broader range of habitat types (deep and shallow lakes plus erosional and depositional rivers) resulted in considerable data “noise” that obscured effects that were detectable in 2009 based on a greatly reduced data set focused on deep lakes only.
- Previous benthic assessments included the use of numerous metric which contributed to the data noise across the three types of habitat that were previously assessed.
- Removal of Rochester Lake shifted the reference mean value away from the exposure lake values and also reduced data noise (less variability associated with the reference lake mean).

- With the addition of data from 2009, temporal patterns could be investigated for the first time.
- Mine-related effects have been and continue to be very subtle.

Furthermore, comparison of the 2009 mean benthic community metrics for each mine-exposed lake relative to the mean and range of values represented by reference lakes, (including Rochester Lake) show that while statistical differences were detected between individual mine-exposed lakes and the combined reference lake mean (Table 5.6), in most cases, the metrics for mine-exposed lakes fell within the reference lake range, especially when Rochester Lake was considered (Table 5.9). Therefore, the patterns of effect suggested by the data in 2009 are based on relative small shifts away from the mean reference condition and may have little or no ecological consequence when considered in terms of the range of values exhibited by reference lakes in the area.

5.4 Summary

Water quality continues to improve in the Serpent River Watershed with metal concentrations in surface water decreasing over time and pH increasing. Where a trend was detected for cobalt, manganese, radium-226, sulphate and uranium, they were decreasing. With few exceptions, mean surface water concentrations of mine related substances are less than the SRWMP benchmark and where concentrations exceed the benchmark they do not exceed toxicological thresholds. While surface water quality has dramatically improved since decommissioning and the inception of the SRWMP, sediment is changing slowly with few statistical differences found between 1999 and 2009. Sediment toxicity results were not consistent with sediment chemistry showing reduced survival in lakes with some of the lowest sediment concentrations. Pecors, McCarthy and Nordic Lake had reduced survival and growth in test with Hyalella azetca. However, results of Chironomus dilutus test showed no difference between exposure and reference lakes measures for growth or survival

The benthic invertebrate communities of all mine-exposed lakes were statistically different from the mean of reference lake values with respect to at least one of the benthic community metrics. The exposure areas showed a pattern of lower benthic invertebrate density and CA1 scores, along with higher CA2 and CA3 scores than the pooled reference areas, indicative of a mine exposure signature. The communities in Quirke, McCabe, and May lakes showed more significant differences from the mean reference community than the other lakes (i.e., more metrics differed), but the magnitudes of difference were larger at Quirke and McCabe than May when differences were expressed as a percentage of the

Table 5.9: Comparison of 2009 benthic invertebrate communities to reference lake values including Rochester Lake.

Benthic Community Metric	Mean Values in Mine-Exposed Lakes		Reference Lakes Included in Statistical Evaluations[a]		Rochester Lake
			Mean, excl. Rochester	Range of Means	
Density (Ind./m2)	Quirke	1285	6826	2987-7406	866
	McCabe	6409			
	May	3600			
	Hough	3750			
	Pecors	7400			
	Elliot	4086			
	Nordic	2440			
	McCarthy	4334			
Number of Taxa	Quirke	6.40	12.3	11-15	6
	McCabe	13.60			
	May	8.80			
	Hough	10.60			
	Pecors	10.40			
	Elliot	13.00			
	Nordic	13.60			
	McCarthy	11.80			
CA Axis-1 all lakes 2009 (14.4%)[b]	Quirke	0.917	-0.21	-0.069 to -0.387	-0.111
	McCabe	-0.443			
	May	0.247			
	Hough	0.165			
	Pecors	0.134			
	Elliot	-0.299			
	Nordic	0.328			
	McCarthy	0.013			
CA Axis-2, all lakes 2009 (12.7%)[b]	Quirke	0.083	0.053	-263 to 0.346	-0.957
	McCabe	0.932			
	May	-0.043			
	Hough	0.323			
	Pecors	0.263			
	Elliot	0.262			
	Nordic	0.112			
	McCarthy	0.132			
CA Axis-3, all lakes 2009 (9.7%)[b]	Quirke	0.159	0.153	0.034-0.284	0.635
	McCabe	0.211			
	May	0.066			
	Hough	0.005			
	Pecors	0.059			
	Elliot	0.330			
	Nordic	0.137			
	McCarthy	0.187			

[a] Dunlop, Summers, Semiwhite, Ten Mile

[b] The CA results shown here were based on analysis that included Rochester Lake and thus differ from the CA results presented in Figure 5.7.

reference mean or the number of reference area standard deviations. The benthic communities in Elliot and McCarthy Lakes were most similar to the mean reference community, differing only with respect to CA-3 score. The pattern of deviations from reference mean values for the exposure lakes generally decreased through the three cycles of study, from 4 out of 5 metrics in 1999, to 3 out of 5 in 2004, and to only 2 out of 5 metrics in 2009. This supports a hypothesis of gradual recovery from initial (1999) impact in exposure lakes, but indicate that deviations from the reference means persist in both the density and community structure of exposure lakes as of 2009. Such differences were not detected in previous studies due to the “noise” associated with previous inclusion of reference Rochester Lake in the deep lake community evaluations, assessment of a larger suite of benthic community metrics, and from parallel assessments of shallow lakes as well as depositional and erosional stream habitats. Most important, is that metrics for mine exposed areas were generally within or near the range of reference lake values indicating that the detected reference exposure differences were minor and possibly of no ecological consequence. Therefore, the 2009 study design provides a sensitive measure by which to track on-going improvements within the watershed.

6.0 SPECIAL INVESTIGATION

The special investigation study was undertaken in six lakes of the Serpent River Watershed in 2009, in order to clarify several issues pertinent to estimation of radiological dose and risk to natural biota and humans utilizing the watershed lakes and to provide an updated estimate of dose and risk to biota and humans based on the data collected. The six lakes studied were McCabe, May, Elliot, Nordic, Quirke and McCarthy Lake. A complete description of the study findings is provided in Appendix F (EcoMetrix 2010).

Based on measures collected as part of this study several questions with respect to assumptions used in dose estimates were resolved, as follows:

- Lead-210 (Pb-210) and polonium-210 (Po-210) are at secular equilibrium in the lake sediments, as would be expected from their half-lives. The average Po/Pb ratio in sediments was 1.01, with a range from 0.87 to 1.18, and no upstream-downstream pattern.
- Radionuclides of the thorium-232 (Th-232) decay chain are clearly elevated above background in May and Quirke Lake sediments, although the Th-232 concentration is only about 1/10th of the Th-230 concentration. The contribution of the Th-232 decay chain to total dose was usually 10% or less, except for May Lake where 4 of 8 receptors had Th-232 decay chain contributions greater than 10%, and for aquatic plants where contributions exceeded 10% in most lakes and reached 25% in May Lake.
- Bioaccumulation factors (BAFs) derived from the flooded basins were generally similar to those derived from the watershed lakes for aquatic plants, although the U value was slightly lower in the basins, and the Pb value was slightly higher. Fish BAFs derived from the basins were consistently lower than those derived from the watershed lakes. Po-210 BAFs were not determined in either case due to non-detection of Po-210 in water; however, Po-210 in fish tissue was consistently higher than Pb-210, by a factor of 22 on average.
- The high observed Po/Pb ratio in fish indicates that fish to duck transfer factors for Po-210, previously determined in the flooded basins using a Pb BAF to estimate Po-210 in fish were most likely overestimated by at least a factor of 10. Correction for this error produces a transfer factor of 5.45 d/kg for fish-eating ducks, which is more in line with the Health Canada (2007) generic value of 2.5 for birds.

- A survey of fish and wildlife consumption by SRFN fishers and hunters and their families (SRFN, 2010) produced more realistic values for fish and wildlife intake rates than those used previously, and also indicated the fraction of harvest likely to come from the six watershed lakes and from Lake Huron. These data were utilized, along with measured radionuclide concentrations in the six lakes and Lake Huron, to estimate the dose received by SRFN members.

6.1 Ecological Dose and Risk

The radionuclide concentrations from the special investigation studies were utilized to calculate radiation doses received by aquatic biota and riparian wildlife in the six watershed lakes. The calculated doses to fish, aquatic plants and benthos were well below the UNSCEAR (1996) benchmark dose of 10 mGy/d. The largest doses to aquatic biota occurred at Quirke Lake, where the doses to fish, aquatic plants and benthos were 0.92, 2.61 and 0.256 mGy/d, respectively. For all aquatic biota, the largest component of dose was internal. The largest contributor to dose was generally Po-210 for fish and benthic invertebrates, while the dose was more evenly distributed for aquatic macrophytes, with Ra-226 and short-lived radon daughters usually making the largest contribution.

The radiation doses to riparian wildlife were less than the UNSCEAR (1996) benchmark dose of 1 mGy/d. The largest doses to riparian wildlife occurred at Quirke Lake, where the doses to mallard, scaup, merganser, muskrat and mink, were 0.263, 0.094, 0.793, 0.407 and 0.124 mGy/d, respectively. For all riparian biota, the largest component of dose was usually internal. The largest contributor to dose was Po-210 for waterfowl, and Ra-226 with short-lived radon daughters for muskrat. For mink, one or the other of these contributors was predominant.

6.2 Human Dose and Risk

The radionuclide concentrations from the special investigation studies were utilized to calculate radiation doses received by generic human receptors at the six watershed lakes (receptor assumed to reside there and take all fish and game from there). The calculated doses ranged from 0.036 to 0.301 mSv/a, all less than the public dose limit of 1 mSv/a, before background correction. Background dose from the same pathways was estimated at 0.013 mSv/a. Therefore, incremental doses ranged from 0.023 to 0.288 mSv/a. The smallest doses were at McCarthy, Elliot and Nordic lakes, whereas the largest dose was at Quirke Lake. The dose at Quirke Lake was dominated by consumption of mallard ducks, and was driven by the high concentration of Po-210 in aquatic macrophytes at Quirke Lake. However, macrophytes were collected in Quirke Lake from a former tailings deposition area near Panel Mine and thus likely over estimate typical macrophyte uptake within the lake. The estimated dose at Quirke Lake without the waterfowl component is 0.072 mSv/a (total) or 0.064 mSv/a (incremental).

The calculated dose to a Serpent River First Nation member was based on realistic use of the six watershed lakes, and of Lake Huron, as determined from the survey of harvesters (SRFN, 2010). Most of the harvest comes from Lake Huron. For an actual use scenario the dose was 0.062 mSv/a (total) or 0.049 mSv/a (incremental). For a future use scenario the dose was 0.060 mSv/a (total) or 0.047 mSv/a (incremental). All these doses are less than the public dose limit of 1 mSv/a (incremental). The use of Serpent Harbour water and sediment data to represent Lake Huron may overestimate the Lake Huron component of dose.

The contributions of water, fish, moose and waterfowl to the SRFN dose are approximately 28%, 37%, 25% and 10%, respectively, with slight variations between actual use and future use scenarios.

6.3 Summary

The data collected as part of the special investigation proved adequate to resolve the outstanding questions with respect to dose and risk estimates within the Serpent River Watershed. Dose estimates received by aquatic biota and riparian wildlife in the six watershed lakes were less than the UNSCEAR (1996) benchmarks of 10 mGy/d and 1 mGy/d respectively. The incremental radiation doses received by generic human receptors at the six watershed lakes (receptor assumed to reside there and take all fish and game from there), ranged from 0.023 to 0.288 mSv/a, all less than the public dose limit of 1 mSv/a. The calculated dose to a Serpent River First Nation harvester was 0.062 mSv/a (total) or 0.049 mSv/a (incremental) based on realistic use of the six watershed lakes, and 0.060 mSv/a (total) or 0.047 mSv/a (incremental).based on a future use scenario. All these doses are less than the public dose limit of 1 mSv/a (incremental).

7.0 CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

The objective of this Serpent River Watershed State of the Environment Report was to integrate recent monitoring data from the TOMP, SAMP, and SRWMP to provide an assessment of current TMA performance and the conditions in the downstream Serpent River Watershed relative to TMA sources. The report presents data from the 2009 SRWMP and TOMP and SAMP data for 2005 to 2009. Key conclusions drawn from the analysis and interpretation of the data are as follows:

In-Basin Quality

Since decommissioning, conditions in the TMA basins have improved and basin water quality is generally at or near EIS-predicted levels. Water quality has continued to improve in recent years (2003 to 2007) based on decreasing concentrations of radium-226, sulphate, and uranium, as well as increasing pH levels, at most TMAs. Exceptions were observed at Denison TMA-1 and Stanleigh TMA where radium-226 has been increasing in surface water at both TMAs, and pH has been decreasing at Denison TMA-1. The trends at Denison TMA-1 appear to be attributable to a step change that occurred in 2008, possibly associated with decreases in sulphate over time (i.e. since 2000) and/or the higher water levels in 2008 and 2009. At the Stanleigh TMA, increasing radium-226 concentrations since 2004 were associated with a decrease in sulphate concentrations within the basin; as aqueous sulphate concentrations decline, there is an increased dissolution of barium sulphate to which radium is associated, whereby radium is released from the tailings. It is expected that radium concentrations in porewater will stabilize over time once the dissolution of barium sulphate re-equilibrates with aqueous sulphate concentrations. Assuming there are no new sources of radium to the TMA, radium concentrations in porewater should decline as the amount of soluble material in the tailings diffusion zone decreases.

Generally, trends in porewater concentrations reflected those observed in surface water within the basins, but trends in groundwater were more variable. For example, at the Nordic TMA, groundwater has improved in response to remedial measures implemented over the past five years. By comparison, deep groundwater at Quirke and Panel TMAs continued to show increasing concentrations of sulphate and decreasing pH, likely associated with the historical plume of acidity and the slow rate of groundwater flow.

TMA Discharges

Primary mine discharges, which contribute the majority of chemical loadings to the receiving environment, have also been improving over time. Where trends were detected, radium-226, sulphate, and uranium concentrations decreased in TMA effluents. The only exception to this was at Stanleigh, where radium-226 concentrations have been increasing slightly in response to decreasing sulphate concentrations in the basin.

At some TMAs (Denison, Stanrock and Pronto), effluent pH showed a decreasing trend but this appeared to be associated with either changes in treatment or possibly the effect of higher flows in 2008 and 2009. In all cases, effluent pH remains circum neutral.

Trend analysis for 2003-2009 data indicated barium concentrations have been increasing at the primary discharge locations (CL-06, D2, D-3, P-14 and Q-28)of the flooded basins, but this was largely due to greater barium chloride use in 2008 and/or 2009 in response to increased flows. In all cases barium concentrations in discharges were well below toxicity thresholds.

Over, the past five years, effluent quality has consistently achieved discharge criteria at all TMAs. With few exceptions, effluent has also been consistently non-lethal to *Daphnia magna* and rainbow trout with no mortality reported in semi-annual acute toxicity tests. Similarly, survival and reproduction of *Ceriodaphnia dubia* were not affected by exposure to 100% effluent in most tests conducted over the past five years at all TMAs.

Direct seepage releases from the TMAs to the receiving environment, only occur in the Quirke Lake sub-watershed. While metal concentrations tend to be highest and pH lowest in these sources, their loads to the receiving environment are low compared to primary discharges and background (upstream) loads. As noted in the previous SOE report (Minnow 2009a), the radium load within the Serpent River downstream of the Denison TMA discharge (D-5) was substantially greater than the loading from the Denison TMA or the upstream watershed (D-4) suggesting a radium source within the river. In 2009, EcoMetrix conducted a study to investigate the difference in loadings within the River and found elevated radium-226 sediment concentrations (14 Bq/g) between stations D4 and D5. The barium and sulphate depth profiles in sediment and water (porewater and overlying water) mirrored the radium profiles, indicating that these profiles are likely caused by the settling/accumulation of historical treatment solids. The loadings from this area are consistent with the recovery of historically accumulated sediments releasing radium to the water column. Diffusion modelling indicated that radium-226 release from the sediment should decrease with time.

Watershed Conditions

The improvements within the TMAs were reflected in the downstream watershed. With few exceptions, mean surface water concentrations of mine related substances were less than the SRWMP benchmarks and, where concentrations exceeded the benchmark, they did not exceed toxicological thresholds. Furthermore, metal concentrations (cobalt, manganese, radium-226, sulphate and uranium) in surface water have been decreasing over time, and pH has been increasing.

In locations where sediment concentrations were above benchmarks, concentrations of barium, cobalt, iron, manganese and nickel appeared to decrease or remain stable over the past ten years (1999 to 2009). Statistical comparisons of 1999 versus 2009 sediment concentrations indicated few statistically significant differences (1999 vs. 2009), except: a) a significant increases in sediment iron and manganese concentrations in Quirke Lake; b) an increase in sediment radium-226 in McCabe Lake, and c) decreases in sediment cobalt, manganese, nickel and radium-226 concentrations in Hough Lake. Overall, the data indicate a very slow rate of change in sediment quality.

Sediment toxicity tests using *Hyalella azetca* showed reduced survival and growth in samples from Pecors, McCarthy and Nordic compared to reference lakes and laboratory control samples. These results did not correspond with sediment chemistry since McCarthy and Pecors lakes had some of the lowest sediment concentrations of mine-related substances. The observed response may be related to TOC which was much lower in McCarthy and Pecors lakes than in the lab control or the reference lake. Depending on the substance, TOC may influence the bioavailability of metals in sediment. Growth and survival of *Chironomus dilutus* did not differ between exposure and reference lakes (Figure 5.5).

The benthic invertebrate communities of all mine-exposed lakes were statistically different from reference lakes with respect to at least one of the benthic community metrics. The exposure areas showed a pattern of lower benthic invertebrate density and CA1 scores, along with higher CA2 and CA3 scores than the pooled reference areas, indicative of a mine-related signature. The communities in Quirke, McCabe, and May lakes showed more significant differences from the mean reference community than the other lakes (i.e., more metrics differed), but the magnitudes of difference were larger at Quirke and McCabe than May when differences were expressed as a percentage of the reference mean or the number of reference area standard deviations. The benthic communities in Elliot and McCarthy Lakes were most similar to the mean reference community, differing only with respect to CA-3 score.

It is clear that year-to-year variation is a significant component of community change in lake benthic communities, against which reference-exposure differences must be assessed in future years. Despite the variability among years, it appears that the significant pattern of deviations from reference mean values for the exposure lakes generally decreased through the three cycles of study, from 4 out of 5 metrics in 1999, to 3 out of 5 in 2004, and only 2 out of 5 metrics in 2009. These changing patterns of deviation are evidence in support of a hypothesis of gradual recovery from initial (1999) impact evaluation in exposure lakes, but indicate that deviations from reference means persist in both the density and community structure of exposure lakes as of 2009. However, in most cases, the metrics for mine-exposed lakes fell within the reference lake range, especially when Rochester Lake was considered. Therefore, the patterns of effect suggested by the data in 2009 are based on relative small shifts away from the mean reference condition and may have little or no ecological consequence when considered in terms of the range of values exhibited by reference lakes in the area.

Risks to Wildlife and Humans

A special investigation was undertaken to allow for better estimates of dose and risk by making measurements to confirm or adjust assumptions used in previous dose and risk estimates. The data collected as part of the special investigation proved adequate to resolve the outstanding questions with respect to dose and risk estimates within the Serpent River Watershed. Dose estimates received by aquatic biota and riparian wildlife in the six watershed lakes were less than the respective UNSCEAR (1996) benchmarks of 10 mGy/d and 1 mGy/d. The incremental radiation doses received by generic human receptors (residing at the lake and consuming local fish and game) at the six watershed lakes, ranged from 0.023 to 0.288 mSv/a, all less than the public dose limit of 1 mSv/a. The calculated dose to a Serpent River First Nation harvester was 0.062 mSv/a (total) or 0.049 mSv/a (incremental) based on realistic use of the six watershed lakes, and 0.060 mSv/a (total) or 0.047 mSv/a (incremental) based on a projected future use scenario. All these doses are less than the public dose limit of 1 mSv/a (incremental).

Summary

In Summary, the TMAs are performing well in terms of meeting EIS predictions and reflecting improving conditions. The Serpent River Watershed is responding to these improvements, with water quality responding (improving) more rapidly than sediment and benthic invertebrates. Nevertheless, the benthic community has shown a pattern of improvement over the past ten years. Updated dose and risk estimates based on measured values indicate that dose is below established benchmarks for aquatic and riparian biota and humans.

7.2 Recommendations

Based on the findings of this report the following recommendations are provided:

- The groundwater monitoring locations at the Nordic TMA should be rationalized to reflect improvements in groundwater interception as recommended in the EcoMetrix Nordic Groundwater Study (Appendix I).
- Conditions are expected to continue to improve, but the rate of change in sediment and benthic invertebrates is slow, so consideration should be given to reducing the frequency of monitoring to once every 10 years.
- When the next SRWMP is implemented the list of exposure lakes to be included should be reduced to remove those lakes showing limited or no effects on benthic invertebrates (Elliot, Hough and McCarthy).

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APPENDIX A

METHODS

STANDARD OPERATING PROCEDURES

Water Quality Assessment and Response Plan

Operating Procedure: PR8.0.0.01	Revision: 2011.01	Page 1 of 10
	Replaces: 2007.01	
Approved: February 18, 2011		Valid Until: February 18, 2016
Asset Owner	Reclamation Manager	Debbie Berthelot
	Denison Manager	Ian Ludgate
Document Reviewer	Environmental Coordinator	Andrea Conway
Document Owner	Compliance Coordinator	Valerie Kilp
Document Control	Document Clerk	Stacey Wood
Key Contacts	Environmental Manager	Mark Smith
	Operations Superintendent	Jacques Ribout

1 PURPOSE

The purpose of this procedure is to:

- Assure the timely development and implementation of investigative and mitigative measures in response to confirmed water quality trends identified through the Performance Monitoring Programs;
- Establish methods of data evaluation and trend confirmation that are consistent with regulatory requirements and corporate objectives;
- Assign responsibility for trend confirmation and response plan development and implementation.

2 APPLICATION

This procedure applies to all Rio Algom Limited and Denison Mines Inc. Elliot Lake performance monitoring data generated from any of the following programs:

- SRWMP: Serpent River Watershed Monitoring Program;
- SAMP: Source Area Monitoring Program;
- TOMP: Tailings Management Area (TMA) Operational Monitoring Program;

Final treated effluent action levels and response plans are documented in Section 7.4 of site-specific Operating, Care and Maintenance (OCM) Plans. Generic response plans for effluent treatment plant failure, poor effluent quality and high rates of seepage are documented in PL10.2.0.01 Emergency Response Plan with site-specific details provided in Section 10.2 of site-specific OCM Plans.

3 ROLES AND RESPONSIBILITIES

3.1 The Rio Algom Reclamation Manager and Denison Environmental Services Manager

The Rio Algom Reclamation Manager and Denison Environmental Services Manager have overall responsibility for the on-going operating, care and maintenance of the Rio Algom Limited (RAL) and Denison Mines Inc. (DMI) Elliot Lake Facilities including the Performance Monitoring Plan. Responsibilities specific to this procedure include:

- Final authorization of review and revisions of this procedure;
- Providing the Care and Maintenance Contractor with documentation that would affect change to this procedure;
- Regular review of "flagged data" points and confirmation of implementation and response to data validation procedures
- Review of annual program data assessment reports and directing the development and implementation of investigative and mitigative measures in response to confirmed water quality trends

3.2 Environmental Manager

The Environmental Manager has overall responsibility for ensuring that the Performance Monitoring Plan is implemented including water quality response plan implementation. Responsibilities specific to this procedure include:

- Confirming care and maintenance personnel participating in water quality response plan review, development and implementation are adequately trained and competent to perform assigned task;
- Confirming care and maintenance contractor and consultant conformance with this procedure or in the case of consultants their equivalent to this procedure
- Initiating review of annual program data assessment reports and managing the development and implementation of investigative and mitigative measures in response to confirmed water quality trends

3.3 Environmental Coordinator

The Environmental Coordinator is responsible for overseeing implementation of the data validation, data assessment and trend confirmation components of the Water Quality Response Plan. Responsibilities specific to this procedure include

- Confirming data quality assessment is conducted in accordance with PR8.5.4.01 Water Quality Data Quality Assessment;
- Confirming data validation is conducted in accordance with PR8.7.3.02 Data Validation Procedures;
- Reviewing data quality assessment and initiating response as required to emerging trends in consultation with Reclamation Manager and Environmental Manager;

- Reviewing monthly water quality reports and initiating response as required to emerging trends in consultation with Reclamation Manager and Environmental Manager
- Reviewing annual and five year data summaries for annual water quality reports and initiating response as required to emerging trends in consultation with Reclamation Manager and Environmental Manager
- Incorporating response plan progress reports as required in the Monthly Care and Maintenance Reports, Monthly Water Quality Reports, and the Annual SRWMP and OCM Reports;
- Assigning responsibility for completion of data quality assessment and data validation in accordance with relevant procedures;
- Assigning responsibility and confirming completion of response monitoring activities
- Informing care and maintenance contractor staff of changes to this procedure;
- Directing training of care and maintenance contractor staff involved in this procedure;
- Completing modifications to this procedure; and
- Conducting scheduled and unscheduled spot checks to verify care and maintenance contractor and consultant conformance with this procedure.

3.4 Compliance Coordinator

The Compliance Coordinator is responsible for supporting implementation of the Water Quality Response Plan Procedure. Responsibilities specific to this procedure include:

- Conducting data quality assessment in accordance with PR8.5.4.01 Water Quality Data Quality Assessment including preparation and maintenance of data assessment records and reports
- Conducting data validation in accordance with PR8.7.3.02 Data Validation including preparation and maintenance of data validation records and reports
- Compiling data for monthly water quality reports and visually reviewing data for emerging trends or outliers not captured in data validation; informing Environmental Coordinator of findings
- Compiling annual and five year data summaries for annual water quality reports and visually reviewing data for emerging trends or outliers not captured in data validation; informing Environmental Coordinator of findings
- Maintaining response plan records and reports
- Scheduling response monitoring field parameters, samples and analytes in the environmental database as directed by the Environmental Coordinator and in accordance with PR8.7.2.01 Scheduling.

3.5 Field Technician and Operators

Field Technicians, Operators or other contractors or consultants assigned performance or response monitoring responsibilities under the SRWMP, SAMP or TOMP programs are responsible for:

- Participating in and completing the training requirements including working knowledge of RG8.7.2.02 Control Limit Registry and PL10.2.0.01 Emergency Response Plan
- Completing response monitoring and associated activities as assigned
- Informing the Compliance Coordinator of flagged data during the data entry/importing phase in accordance with RG8.7.2.02 Control Limit Registry
- Informing the Environmental Coordinator of limit exceedances (compliance, action level, internal investigation) identified during the data entry/importing phase in accordance with RG8.7.2.02 Control Limit Registry

4 PROCEDURES

4.1 Water Quality Assessment

Water quality is routinely assessed in accordance with the following processes

- Data validation in accordance with PR8.7.3.02 Data Validation including preparation and maintenance of data validation records and reports. All data entered into the environmental database is validated with monthly "flagged data" compiled by the Compliance Coordinator and reviewed by the Environmental Coordinator who is responsible for initiating response as required to emerging trends in consultation with Reclamation Manager and Environmental Manager;
- Monthly compilation of year to date water quality results including visual review of data and identification of potential outliers or emerging trends. Data is compiled by the Compliance Coordinator and reviewed by the Environmental Coordinator who is responsible for initiating response as required to emerging trends in consultation with Reclamation Manager and Environmental Manager;
- Annual compilation of year to date water quality results and five year summary including visual review of data and identification of emerging trends. Data is compiled by the Compliance Coordinator and reviewed by the Environmental Coordinator who is responsible for initiating response as required to emerging trends in consultation with Reclamation Manager and Environmental Manager;
- Periodic statistical trend evaluation of data as part of the State of the Environment Report based on methodology presented in the associated Design Report.

4.2 Trend Identification

Identification of a water quality trend may result from:

- Trend evaluation conducted as part of the "Decision Path for Data Validation" as documented in PR8.7.3.02 Data Validation; or

- Trend identification conducted in accordance with Section 4.1 above.

4.2.1 Water quality trends identified by the Compliance Coordinator are to be reviewed by the Environmental Coordinator. The Environmental Coordinator is responsible for evaluating trends and initiating response as required to emerging trends in consultation with Reclamation Manager and Environmental Manager

4.3 Trend Confirmation

4.3.1 The Compliance Coordinator under the direction of the Environmental Coordinator and in consultation with the Rio RA and Den RA is responsible for confirming the water quality trend using the following weight-of-evidence approach as shown in Figure 4.1:

- Is the trend isolated to one chemical parameter? If more than one related parameter is showing a similar trend at the same location, then the trend is not likely the result of an analysis error.
- Is there a similar trend at upstream or downstream stations? Involvement of related stations may indicate an upset rather than an analysis or sampling error.
- Are there similar trends at non-related stations? If trends are only evident at related stations, trends under investigation are corroborated, if trends are evident at unrelated stations then sampling or analysis error is likely.
- Is the trend consistent with changes detected in upstream tailings management or source area water quality monitoring? If yes, the trend is corroborated.
- Is the trend consistent with forecast changes resulting from geochemical evolution of upstream sources? A positive answer supports the evidence of a confirmed trend.

4.3.2 The Environmental Coordinator is responsible for ensuring that confirmed trends are reported in the Monthly Water Quality Report.

4.4 Trend Evaluation

4.4.1 The Reclamation Manger and/or Environmental Manager are responsible for reviewing data compiled for the “weight of evidence” review of the trend and identifying requirements for additional investigation to evaluate the significance of any potential impact and possible remedial or mitigative measures as required.

4.4.2 Where additional investigation is required, the Reclamation Manager or Denison Environmental Services Manager are responsible for providing the required resources to conduct the investigation and notifying the Canadian Nuclear Safety Commission that the Response Plan as identified in Figure 4.2 has been triggered.

4.4.3 Where the trend is not mining related, or the “weight of evidence” approach confirms negligible impact, the Environmental Coordinator is responsible for incorporating the findings in the monthly and annual water quality reports.

Figure 4.1. Trend Evaluation

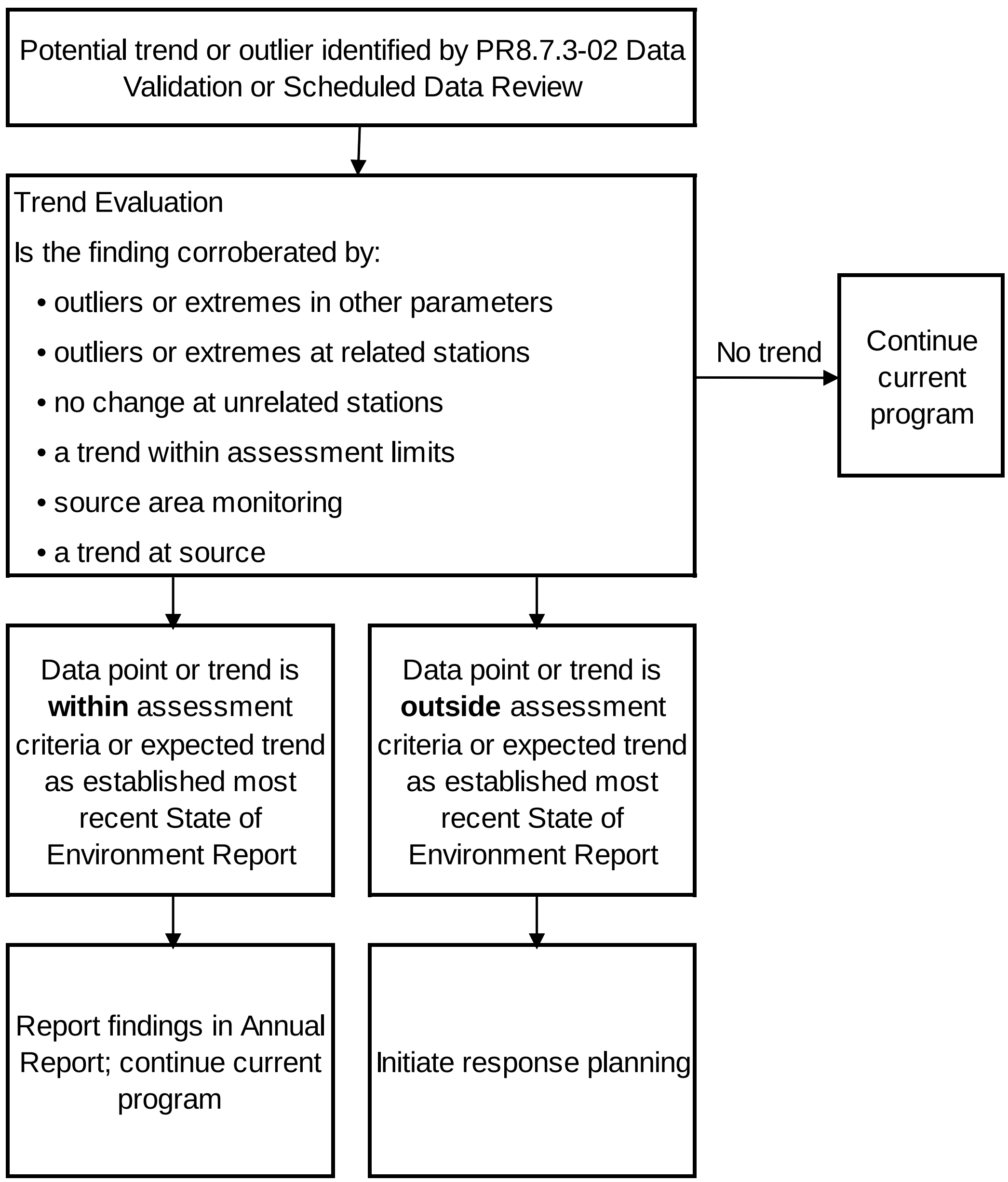
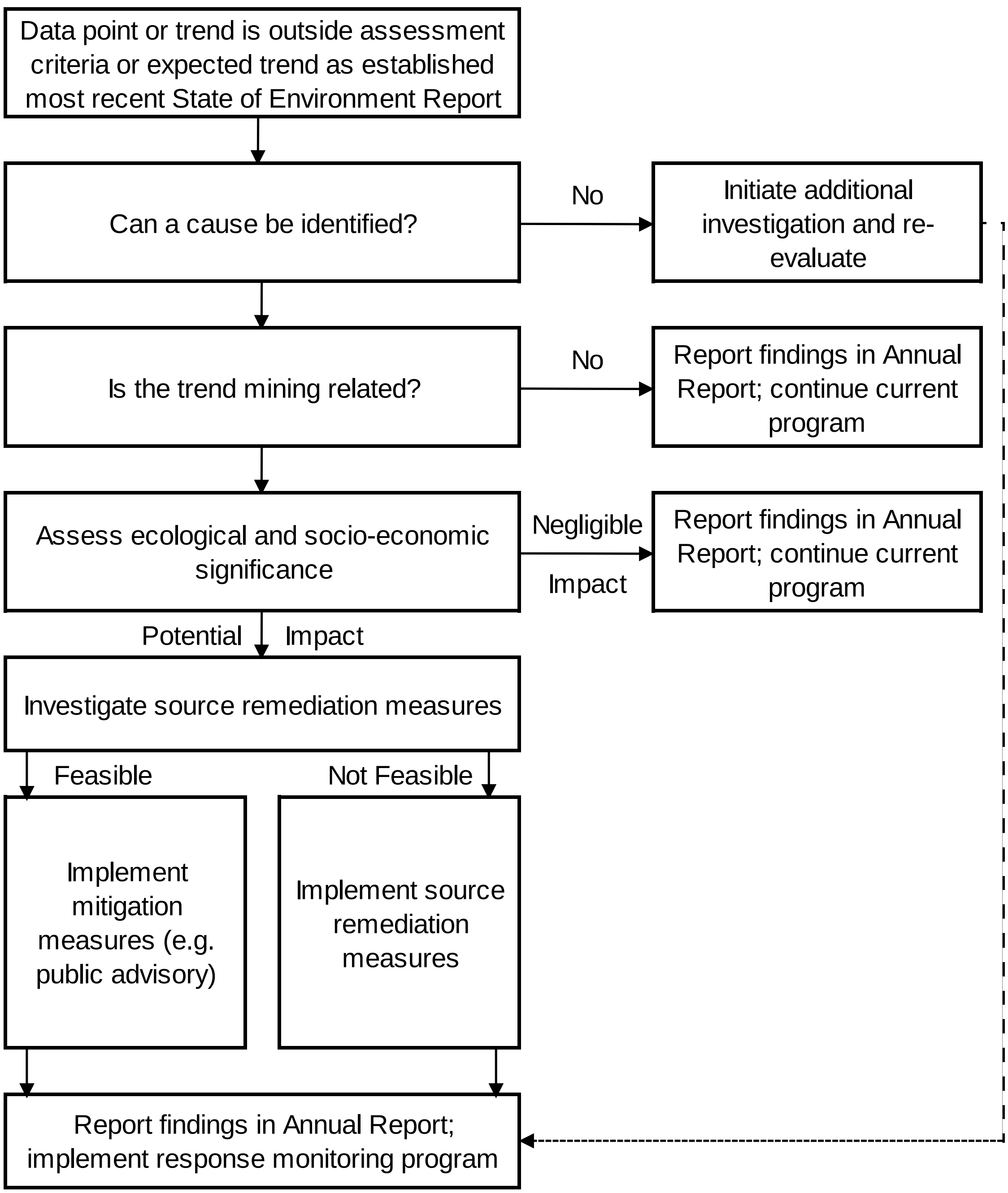


Figure 4.2. Environmental Response Plan Process



4.5 Response Implementation

4.5.1 Where the additional investigation confirms an increased contribution from an identifiable source that is having a significant impact on the downstream environment, the owner's Responsible Authority (Rio Algom Reclamation Manager or Denison Environmental Services Manager) is responsible for submitting to the CNSC an investigation summary that provides the following information:

- Summary of additional investigation findings;
- Recommended remedial and mitigative measures;
- Proposed implementation schedule; and
- Confirmation monitoring plan.

4.5.2 Where significant remedial and/or mitigative measures are implemented, the relevant Responsible Authority is responsible for ensuring the inclusion of a response plan within the relevant annual report that contains the following information:

- Summary of remedial and mitigative measures implemented;
- Results of confirmation monitoring;
- Continued confirmation monitoring program (if required); and
- Changes in operating procedures (if applicable).

4.5.3 The Environmental Coordinator is responsible for ensuring that updates on Response Plan implementation are included in monthly and annual water quality reports.

5 TRAINING

The Environmental Coordinator is responsible for confirming that all care and maintenance staff conducting performance monitoring meets the following minimum training requirements:

- Completion of documented review of this procedure and associated report forms;
- Completion of documented review of associated data validation procedures;
- Completion of documented on the job training for emLine database access and report generation
- Completion of documented review of RG8.7.2.02 Control Limit Registry and PL10.2.0.01 Emergency Response Plan

6 ADMINISTRATION

6.1 Procedure Review

Standard operating procedure documents are to be reviewed in accordance with the schedule and responsibilities identified in RG1.0.0.02 Operating Document Registry.

6.2 Program, Plan and Procedure Revisions

Document revisions identified during routine review, program modifications (e.g. program design or State of Environment Reports) and/or audit process are to be implemented in accordance with PR11.1.0.01 Operating Document Review and Revision Procedures.

7 RECORDS

Table 7.1. Companion Document Listing

Document Number	Document Name
Minnow, 2009a	Monitoring Framework for Closed Mines, Near Elliot Lake.
Minnow, 2009b	Serpent River Watershed Monitoring Program Cycle 3 Study Design
Minnow, 2009c	Source Area Monitoring Program, Revised Study Design
Minnow, 2009d	Tailings Management Area Operational Monitoring Program (TOMP) Revised Study Design
Minnow, 2011	Serpent River Watershed State of the Environment Report
	Site-specific Operating, Care and Maintenance Plans
RG1.0.0.02	Operating Document Registry
PR8.5.4.1	Water Quality Data Quality Assessment
RG8.5.2.01	Water Quality Monitoring Data Quality Objectives
PR8.7.2.01	Scheduling
RG8.7.2.01	Performance Monitoring Registry
RG8.7.2.02	Control Limit Registry
PR8.7.3.02	Data Validation Procedure
PL10.2.0.01	Emergency Response Plan
PR11.1.0.01	Operating Document Review and Revision Procedures

8 REVISION RECORD

Table 8.1. Revision Summary

Revision	Date	Purpose of Revision
2007.01	Aug 15, 2007	Update roles and responsibilities as well as procedure references, include all monitoring programs not just SRWMP, update formatting
2011.01	Feb. 18, 2011	Update roles and responsibilities, include data assessment section, separate trend evaluation from environmental response plan process in figures, revise number from 8.1.0.01 to 8.0.0.01 to reflect application to all monitoring programs

Field Sampling Quality Control

Operating Procedure: PR8.5.3.01	Revision: 2011.01	Page 1 of 6
	Replaces: 2007.01	
Approved: February 25, 2011		Valid Until: February 25, 2016
Asset Owner	Reclamation Manager	Debbie Berthelot
	Denison Manager	Ian Ludgate
Document Reviewer	Environmental Coordinator	Andrea Conway
Document Owner	Compliance Coordinator	Valerie Kilp
Document Control	Document Clerk	Stacey Wood
Key Contacts	Environmental Manager	Mark Smith
	Operations Superintendent	Jacques Ribout

1 PURPOSE

The purpose of this procedure is to:

- Assure the quality of the performance monitoring data while tracking and minimizing the effects of bias and imprecision in field sampling effort;
- Establish field sampling quality control (QC) measures that are consistent with regulatory requirements and corporate objectives; and
- Assign responsibility to ensure that field sampling quality control is conducted in accordance with license and performance monitoring program requirements.

2 APPLICATION

This procedure applies to field sampling at all Rio Algom Limited and Denison Mines Inc. Elliot Lake monitoring locations included in each of the following programs:

- SRWMP: Serpent River Watershed Monitoring Program;
- SAMP: Source Area Monitoring Program;
- TOMP: Tailings Management Area (TMA) Operational Monitoring Program.

Assessment of field sampling quality control results and performance is incorporated in PR8.5.4.01 Water Quality Data Quality Assessment.

3 ROLES AND RESPONSIBILITIES

3.1 The Rio Algom Reclamation Manager and Denison Environmental Services Manager

The Rio Algom Reclamation Manager and Denison Environmental Services Manager have overall responsibility for the on-going operating, care and maintenance of the Rio Algom Limited

(RAL) and Denison Mines Inc. (DMI) Elliot Lake Facilities including the Performance Monitoring Plan. Responsibilities specific to this procedure include:

- Final authorization of review and revisions of this procedure; and
- Providing the Care and Maintenance Contractor with documentation that would affect change to this procedure.

3.2 Environmental Manager

The Environmental Manager has overall responsibility for ensuring that the Performance Monitoring Plan is implemented including field sampling quality control. Responsibilities specific to this procedure include:

- Confirming care and maintenance personnel conducting performance monitoring sampling are adequately trained and competent to perform assigned task
- Confirming care and maintenance contractor and consultant conformance with this procedure or in the case of consultants their equivalent to this procedure

3.3 Environmental Coordinator

The Environmental Coordinator is responsible for overseeing implementation of the Field Sampling Quality Control Procedure. Responsibilities specific to this procedure include:

- Assigning responsibility for completion of field sampling quality control in accordance with this procedure;
- Informing care and maintenance contractor staff of changes to this procedure;
- Directing training of care and maintenance contractor staff involved in this procedure;
- Initiating and directing field sampling quality control modifications required in response to changes to this procedure;
- Initiating and reviewing modifications to this procedure; and
- Conducting scheduled and unscheduled spot checks to verify care and maintenance contractor and consultant conformance with this procedure.

3.4 Compliance Coordinator

The Compliance Coordinator is responsible for supporting implementation of the Field Sampling Quality Control Procedure. Responsibilities specific to this procedure include:

- Scheduling field blank and field duplicates in the environmental database in accordance with PR8.7.2.01: Scheduling;
- Generating data quality assessment reports for field quality control sampling in accordance with PR8.5.4.01 Water Quality Data Quality Assessment and reviewing results to identify appropriate field blank and field duplicate locations
- Reviewing and updating this procedure as assigned in RG1.0.0.02 Operating Document Registry

3.5 Field Technician and Operators

Field Technicians, Operators or other contractors or consultants assigned field sampling quality control sampling responsibilities under the SRWMP, SAMP or TOMP programs are responsible for:

- Conducting field sampling quality control sampling in accordance with this procedure and relevant sampling procedure: PR8.6.1.01 Surface Water Grab Sampling or PR8.6.2.01 Groundwater Sampling;
- Participating in and completing the training requirements

4 PROCEDURES

4.1 Quality Control Sample Types

Two types of field sampling quality control samples are collected:

- **Field Blanks**: A field blank is a sample of distilled/deionized water that is processed in the field in a manner identical to that used for the randomly selected sample location (eg. Through sampler/pump for groundwater and through depth sampler for depth samples). The field blank allows assessment for potential contamination of the sample by the bottle itself, preservatives, dust and sample handling.
- **Field Duplicates**: A field duplicate is a sample that is taken at the same time and location as a regular field sample (ie; side by side), where possible; at times low flows restrict the ability to sample using larger bottles. If a smaller container is required to decant, the smaller container volumes are divided between the original and the duplicate. The samples are prepared and analysed in an identical manner. The data from field duplicates reflect the natural spatial and/or temporal variability, as well as the variability associated with sample collection and handling methods.

4.2 Location Selection

4.2.1 Field blank and field duplicate samples are collected at pre-established stations. Stations have been selected to meet the criteria outlined below and are changed infrequently in order to establish high-low flag data set. Current and historic station designations for field blanks and field duplicates are documented in RG8.5.3.01 QA/QC Requirements Registry.

- Representative of the full performance monitoring parameter suite for designated QC purpose (SRWMP, SAMP, TOMP)
- Sampled at frequency that will generate data to meet 10% of total number of sample requirements; and
- Representative of field conditions and sampling protocols (e.g. use of sample collection devices)
- Representative of concentration range of analytes in the performance monitoring program

4.3 Scheduling

4.3.1 Quality Control (QC) samples will be applied to a minimum of 10% of the total number of samples required for each of SRWMP, SAMP and TOMP, as compiled in RG8.7.2.01 Performance Monitoring Registry.

4.3.2 The Compliance Coordinator is responsible for scheduling QC samples such that:

- Objectives are incorporated into the electronic schedule in accordance with PR8.7.2.01 Scheduling Procedure;
- Individual analytes are scheduled to reflect program specific Method Detection Limits (MDL's) as per RG8.5.2.01 Water Quality Monitoring Data Quality Objectives
- Field blank and field duplicate sample names and designations will be maintained in RG8.5.3.01 QA/QC Requirements Registry.

4.3.3 The Compliance Coordinator is responsible for ensuring any changes to QC sampling are incorporated into the schedule as per PR8.7.2.01 Scheduling Procedure.

4.4 Sampling

4.4.1 The Field Technician or other adequately trained personnel are responsible for collecting field QC samples in accordance with PR8.6.0.01 Surface Water Grab Sampling or 8.6.2.01 Groundwater Sampling Procedures.

4.4.2 Field blanks and field duplicates are collected in accordance with the sample collection method as scheduled in the Database.

4.5 Data Validation, Review and Reporting

4.5.1 The Compliance Coordinator is responsible for data validation and review of quality control samples in accordance with PR8.7.3.02 Data Validation Procedure.

4.5.2 The Compliance Coordinator is responsible for evaluating, reviewing and reporting field quality control sampling results in accordance with PR8.5.4.01 Water Quality Data Quality Assessment Procedure.

5 TRAINING

The Environmental Coordinator is responsible for confirming that all care and maintenance staff performing field sampling quality control meet the following minimum training requirements:

- Completion of documented review of this procedure and associated report forms;
- Completion of documented review of associated data validation procedures;
- Completion of documented on the job training for emLine database access and report generation; and
- Completion of location-specific on the job training with respect to access routes, communication locations and location-specific sampling requirements.

6 ADMINISTRATION

6.1 Procedure Review

Standard operating procedure documents are to be reviewed in accordance with the schedule and responsibilities identified in RG1.0.0.02 Operating Document Registry.

6.2 Program, Plan and Procedure Revisions

Document revisions identified during routine review, program modifications (e.g. program design or State of Environment Reports) and/or audit process are to be implemented in accordance with PR11.1.0.01 Operating Document Review and Revision Procedures.

7 RECORDS

Table 7.1. Companion Document Listing

Document Number	Document Name
Minnow, 2009a	Monitoring Framework for Closed Mines, Near Elliot Lake.
Minnow, 2009b	Serpent River Watershed Monitoring Program Cycle 3 Study Design
Minnow, 2009c	Source Area Monitoring Program, Revised Study Design
Minnow, 2009d	Tailings Management Area Operational Monitoring Program (TOMP) Revised Study Design
Minnow, 2011	Serpent River Watershed State of the Environment Report
RG1.0.0.02	Operating Document Registry
RG8.5.2.01	Water Quality Monitoring Data Quality Objectives
RG8.5.3.01	QA/QC Requirements Registry
PR8.5.4.01	Water Quality Data Quality Assessment
PR8.6.1.01	Surface Water Grab Sampling
PR8.6.2.01	Groundwater Sampling
PR8.7.2.01	Scheduling
RG8.7.2.01	Performance Monitoring Registry
PR8.7.3.02	Data Validation Procedure
PR11.1.0.01	Operating Document Review and Revision Procedures

8 REVISION RECORD

Table 8.1. Revision Summary

Revision	Date	Purpose of Revision
2005.02	Dec. 21, 2005	Update roles and responsibilities; reference groundwater procedures, remove Envista references
2006.01	Aug. 22, 2006	Include addition groundwater QA/QC locations
2007.01	Aug 30, 2007	Update roles and responsibilities as well as procedure references
2011.01	Feb. 18, 2011	Update roles and responsibilities, include Denison Mines to reflect common use of procedure; revised schedule requirement references to Cycle 3 Design and 2011 draft State of Environment Report

Water Quality Data Quality Assessment

Operating Procedure: PR8.5.4.01	Revision: 2011.01	Page 1 of 6
	Replaces: 2007.01	
Approved: February 16, 2011		Valid Until: February 16, 2016
Asset Owner	Reclamation Manager	Debbie Berthelot
	Denison Manager	Ian Ludgate
Document Reviewer	Environmental Coordinator	Andrea Conway
Document Owner	Compliance Coordinator	Valerie Kilp
Document Control	Document Clerk	Stacey Wood
Key Contacts	Environmental Manager	Mark Smith
	Operations Superintendent	Jacques Ribout

1 PURPOSE

The purpose of this procedure is to:

- Assure the quality of the monitoring programs while tracking and minimizing the effects of bias and imprecision in sampling effort;
- Control measurement errors to acceptable levels and to ensure that the data are useful and of known quality;
- Establish data quality assessment standards that are consistent with regulatory requirements and corporate objectives; and
- Assign responsibility to ensure that data quality assessment is conducted in accordance with license requirements.

2 APPLICATION

This procedure applies to data quality assessment of quality control (QC) sampling as per RG8.5.3-01 *Quality Control and Quality Assurance Registry* for each of the sampling programs including:

- SRWMP: Serpent River Watershed Monitoring Program;
- SAMP: Source Area Monitoring Program; and
- TOMP: Tailings Management Area (TMA) Operational Monitoring Program.

3 ROLES AND RESPONSIBILITIES

3.1 The Rio Algom Reclamation Manager and Denison Environmental Services Manager

The Rio Algom Reclamation Manager and Denison Environmental Services Manager have overall responsibility for the on-going operating, care and maintenance of the Rio Algom Limited (RAL) and Denison Mines Inc. (DMI) Elliot Lake Facilities including the Performance Monitoring Plan. Responsibilities specific to this procedure include:

- Final authorization of review and revisions of this procedure; and
- Providing the Care and Maintenance Contractor with documentation that would affect change to this procedure.

3.2 Environmental Manager

The Environmental Manager has overall responsibility for ensuring that the Performance Monitoring Plan is implemented including water quality data quality assessment. Responsibilities specific to this procedure include:

- Reviewing data quality assessment reports (e.g. RF8.5.4 series report forms Table 7.1, monthly reports, annual reports) and programs and managing modifications as required.
- Confirming care and maintenance contractor, data management supplier and analytical supplier conformance with this procedure

3.3 Environmental Coordinator

The Environmental Coordinator is responsible for overseeing implementation of the Water Quality Data Quality Assessment Procedure. Responsibilities specific to this procedure include:

- Assigning responsibility for completion of data quality assessment in accordance with this procedure;
- Informing care and maintenance contractor staff of changes to data quality assessment procedures;
- Directing training of care and maintenance contractor staff involved in data quality assessment;
- Initiating and directing data management and analytical services modifications required in response to changes to this procedure;
- Initiating and reviewing modifications to this procedure and associated registries and report forms;
- Developing and supervising responses to data that does not conform to the data quality objectives and communicating progress to Environmental Manager and Reclamation Manager; and
- Reviewing data quality assessment reports (e.g. RF8.5.4 series report forms Table 7.1, monthly reports, annual reports) and programs and initiating and supervising modifications as required.

3.4 Compliance Coordinator

The Environmental Coordinator is responsible for implementing the Water Quality Data Quality Assessment Procedure. Responsibilities specific to this procedure include:

- Conducting data quality assessment in accordance with this procedure;
- Reviewing and confirming that field and analytical results generated through the data quality assessment program are valid and entered into the data management system within 60 days of the sample date;
- Generating and reviewing data quality assessment reports using the report forms associated with this procedure (RF8.5.4 series indentified in Table 7.1) and initiating responses to data that does not conform to the data quality objectives;
- Reviewing laboratory quality control reports and initiating responses to data that does not conform to the data quality objectives;
- Implementing responses to data that does not conform to the data quality objectives as directed by the Environmental Coordinator;
- Preparing data quality assessment (field and laboratory) components of internal and annual water quality reports including reporting on the status of responses to data that does not conform to the data quality objectives; and
- Implementing modifications to this procedure and associated registries and report forms including updates triggered by changes to data quality objectives (DQO).

4 PROCEDURES

4.1 Scheduling

4.1.1 The Compliance Coordinator is responsible for ensuring that the minimum requirement of 10% is met for QA/QC on all Performance Monitoring Program requirements.

4.1.2 Quality control samples will be scheduled in accordance with RG8.7.2-01 *Performance Monitoring Registry*.

4.2 Supporting Reports/Forms

4.2.1 The Compliance Coordinator is responsible for ensuring that changes in Data Quality Objectives (DQO, RG8.5.3-01) are incorporated into the data quality assessment process and onto the appropriate forms and reports (RF8.5.4 series in Table 7.1).

4.2.2 The Compliance Coordinator is responsible for ensuring all emLine data quality assessment report forms are working correctly and initiating modifications with the data management service provider as required. EmLine report forms are maintained in the emLine data management system under the appropriate application (Rio/SRWMP/Denison) and can be accessed by the Reports/Report Manager when logged on to the emLine database. EmLine-generated data quality assessment reports are maintained for each of the RF8.5.4 series field DQA reports identified in Table 7.1 (e.g SRWMP, SAMP/TOMP and groundwater).

4.3 Data Validation and Review

4.3.1 The Compliance Coordinator is responsible for ensuring that all analyses on relevant field QC samples have been reported by the Laboratory within 60 days of sample date.

4.3.2 The Compliance Coordinator is responsible for ensuring the QA/QC data is validated and reviewed as per PR8.7.3-02 *Data Validation Procedures*, prior to issuing data quality assessment reports.

4.4 Report Preparation, Assessment and Reporting

4.4.1 The Compliance Coordinator is responsible for monthly and annual preparation of data quality assessment reports. Reports are accessed and data imported from the database using the following steps:

1. Log-on to emline;
2. Choose the Appropriate APPLICATION, Rio/SRWMP/Denison
3. Click on the REPORTS Tab at the top of the Page;
4. Click on REPORT MANAGER;
5. On this page you will select the appropriate DQA Report;
6. Select a date range (Year to Date);
7. Select VIEW REPORT at top of page;
8. Select SAVE report (rather than open) and save to the Annual Archive/Operating Program Records; Section 8 (enable macros)

4.4.2 The Compliance Coordinator will evaluate any field precision exceedances by evaluating trends, investigating sample conditions and possible sources of contamination or variability and requesting repeat analysis when it is deemed necessary. Repeat exceedances and trends are to be reviewed with the Environmental Coordinator for development and implementation of an appropriate response plan.

4.4.3 The Compliance Coordinator will evaluate any field blank exceedances by evaluating trends, investigating sample conditions and possible sources of contamination and requesting repeat analysis when it is deemed necessary. Repeat exceedances and trends are to be reviewed with the Environmental Coordinator for development and implementation of an appropriate response plan.

4.4.4 The Compliance Coordinator will evaluate any laboratory data quality objective exceedances by evaluating trends, requesting investigation of laboratory conditions and possible sources of contamination, or sample mixup and requesting repeat analysis and or follow-up when it is deemed necessary. Repeat exceedances and trends are to be reviewed with the Environmental Coordinator for development and implementation of an appropriate response plan.

4.4.5 On a monthly basis, the Compliance Coordinator will generate year to date data quality assessment report forms for inclusion as an attachment to the RAL Monthly Care and Maintenance Report. The Compliance Coordinator will also prepare the data quality assessment (field and laboratory) components of the monthly report including reporting on the status of responses to data that does not conform to the data quality objectives.

4.4.6 On an annual basis, the Compliance Coordinator will generate annual data quality assessment report forms for inclusion in the Annual SRWMP Water Quality Report or Annual Rio Algom or Denison Operating Care and Maintenance Reports as appropriate. The Compliance Coordinator will also prepare the data quality assessment (field and laboratory) components of these annual reports including reporting on the status of responses to data that does not conform to the data quality objectives and their potential impact on the interpretation of performance monitoring data.

5 TRAINING

The Environmental Coordinator is responsible for confirming that care and maintenance staff performing data quality assessments meets the following minimum training requirements:

- Completion of documented review of this procedure and associated report forms;
- Completion of documented review of associated data validation procedures;
- Completion of documented on the job training for emLine database access and report generation.

6 ADMINISTRATION

6.1 Procedure Review

Data quality assessment documents are to be reviewed in accordance with the schedule and responsibilities identified in RG1.0.0.02 *Operating Document Registry*.

6.2 Program, Plan and Procedure Revisions

Document revisions identified during routine review, program modifications (e.g. program design or State of Environment Reports) and/or audit process are to be implemented in accordance with PR11.1.0-01 *Rio Algom Limited General Operating Document Review and Revision Procedures*.

7 RECORDS

Table 7.1. Companion Document Listing

Document Number	Document Name
RG8.5.3-01	Quality Control and Quality Assurance Registry
RF8.5.4-01a	SRWMP DQA Field Precision
RF8.5.4-01b	SRWMP DQA Field Blank
RF8.5.4-02a	SAMP/TOMP DQA Field Precision
RF8.5.4-02b	SAMP/TOMP DQA Field Blank
RF8.5.4.03a	Groundwater DQA Field Precision
RF8.5.4.03b	Groundwater DQA Field Blank
RG8.7.2-01	Performance Monitoring Registry
PR8.7.3-02	Data Validation Procedures
	Rio Algom Limited Monthly Care and Maintenance Report
	SRWMP Annual Water Quality Report
	Rio Algom Limited Annual Operating Care and Maintenance Report
	Denison Mines Inc. Annual Operating Care and Maintenance Report
RG1.0.0.02	Operating Document Registry
PR11.1.0-01	Operating Document Review and Revision Procedure

8 REVISION RECORD

Table 8.1. Revision Summary

Revision	Date	Purpose of Revision
2005-01	Sept. 5, 2005	Update references to revised report form format based on consolidation of SAMP and TOMP DQA report forms
2007-01	Aug. 30, 2007	Update to reflect transition from Envista to emLine; include laboratory data quality assessment reviews, update roles and responsibilities
2011-01	Feb. 10, 2011	Update roles and responsibilities, include Denison Mines Reporting Requirements to reflect standardized data quality assessment programs; update associated report forms and data quality objectives based on Cycle 3 Design and 2011 draft State of Environment Report

Surface Water Grab Sampling

Operating Procedure: PR8.6.1.01	Revision: 2011.01	Page 1 of 6
	Replaces: 2007.01	
Approved: February 25, 2011		Valid Until: February 25, 2016
Asset Owner	Reclamation Manager	Debbie Berthelot
	Denison Manager	Ian Ludgate
Document Reviewer	Environmental Coordinator	Andrea Conway
Document Owner	Environmental Technician	Jody Stefanich
Document Control	Document Clerk	Stacey Wood
Key Contacts	Environmental Manager	Mark Smith
	Operations Superintendent	Jacques Ribout

1 PURPOSE

The purpose of this procedure is to:

- Establish a surface water grab sampling standard operating procedure that is consistent with regulatory requirements and standard industry protocols.

2 APPLICATION

This procedure applies to surface water grab sampling at all Rio Algom Limited and Denison Mines Inc. Elliot Lake monitoring locations included in each of the following programs:

- SRWMP: Serpent River Watershed Monitoring Program;
- SAMP: Source Area Monitoring Program;
- TOMP: Tailings Management Area (TMA) Operational Monitoring Program.

3 ROLES AND RESPONSIBILITIES

3.1 The Rio Algom Reclamation Manager and Denison Environmental Services Manager

The Rio Algom Reclamation Manager and Denison Environmental Services Manager have overall responsibility for the on-going operating, care and maintenance of the Rio Algom Limited (RAL) and Denison Mines Inc. (DMI) Elliot Lake Facilities including the Performance Monitoring Plan. Responsibilities specific to this procedure include:

- Final authorization of review and revisions of this procedure; and
- Providing the Care and Maintenance Contractor with documentation that would affect change to this procedure.

3.2 Environmental Manager

The Environmental Manager has overall responsibility for ensuring that the Performance Monitoring Plan is implemented including surface water grab sampling. Responsibilities specific to this procedure include:

- Confirming care and maintenance personnel conducting surface water grab sampling are adequately trained and competent to perform assigned task
- Confirming care and maintenance contractor and consultant conformance with this procedure or in the case of consultants their equivalent to this procedure

3.3 Environmental Coordinator

The Environmental Coordinator is responsible for overseeing implementation of the Surface Water Grab Sampling Procedure. Responsibilities specific to this procedure include:

- Assigning responsibility for completion of surface water grab sampling in accordance with this procedure;
- Informing care and maintenance contractor staff of changes to this procedure;
- Directing training of care and maintenance contractor staff involved in this procedure;
- Initiating and directing surface water grab sampling modifications required in response to changes to this procedure;
- Initiating and reviewing modifications to this procedure; and
- Conducting scheduled and unscheduled spot checks to verify care and maintenance contractor and consultant conformance with this procedure.

3.4 Compliance Coordinator

The Compliance Coordinator is responsible for supporting implementation of the Surface Water Grab Sampling Procedure. Responsibilities specific to this procedure include:

- Scheduling surface water grab samples in the environmental database in accordance with PR8.7.2.01: Scheduling.

3.5 Field Technician and Operators

Field Technicians, Operators or other contractors or consultants assigned surface water grab sampling responsibilities under the SRWMP, SAMP or TOMP programs are responsible for:

- Conducting surface water grab sampling in accordance with PR8.6.1.01 Surface Water Grab Sampling;
- Participating in and completing the training requirements;
- Reviewing and updating this procedure as assigned in RG1.0.0.02 Operating Document Registry

4 PROCEDURES

4.1 Location Selection

4.1.1 Samples are collected at pre-established stations. Stations were established to meet the following criteria and should only be collected as long as these conditions are satisfied:

- Safe access;
- Sample can be obtained without disturbing bottom sediments;
- Flow and/or mixing to ensure that the sample location is representative of the waterbody being sampled;
- The surface is free and clear of floating debris.

4.2 Scheduling

4.2.1 Surface water grab samples will be scheduled in the environmental database as required for each of SRWMP, SAMP and TOMP, as per the Cycle 3 Design documents and Canadian Nuclear Safety Commission program approval dated December 11, 2009.

4.2.2 The Compliance Coordinator is responsible for scheduling surface water grab samples such that:

- Requirements are incorporated into the environmental database Schedule in accordance with PR8.7.2.01: Scheduling;
- Individual analytes are scheduled to reflect program specific Method Detection Limits (MDL's) as per RG8.5.2.01: Water Quality Monitoring Data Quality Objectives;

4.2.3 The Compliance Coordinator is responsible for ensuring any changes to sampling programs are incorporated into the schedule as per PR8.7.2.01: Scheduling.

4.3 Sampling and Sample Delivery

4.3.1 The Field Technician, Operator or other adequately trained personnel shall conduct surface water grab samples in accordance with the following protocol:

- Obtain pre-washed High Density Polyethylene (HDPE) bottles in the appropriate volumetric sizes (2L, 4L);
- Prior to filling, the sampler shall triple rinse all sample containers using sample water, affix the lid and shake vigorously;
- If sample must be collected using a device other than the laboratory container the sampler shall triple rinse both the device and the sample container in the above fashion;
- Samples will be collected by immersing the sample container upside down to a depth of 20 cm (where possible) and returning bottle to the upright position until full;

- Laboratory containers will be filled completely where possible, and capped under water to ensure no residual airspace in the sample container and limit surface contamination;
- All reasonable efforts shall be taken to ensure samples are maintained at a consistent temperature, avoiding heating or freezing;
- When temperature change may be a factor due to sample delivery delays coolers will be used.

4.3.2 The sampler shall record any unusual sample conditions or observations in the waterproof field notebook at the time of sampling.

4.3.3 Upon arrival to the sample preparation room with the samples, the technician must prepare the samples for shipment in the following manner:

- Obtain the necessary bottles provided by the lab for the appropriate analysis to be performed on the sample;
- Ensure each bottle is labeled properly with the appropriate information (ie. Date, location of sample, analysis requested and person who collected the sample);
- Prior to separating the sample into the appropriate bottles, mix the sample by inverting the bottle upside down and back several times to ensure the sample is uniform throughout the bottle;
- Depending on the analysis required, the small bottles provided by the lab may contain preservative in them thus requiring the technician to take the appropriate safety precaution (ie. Safety glasses, rubber gloves) when decanting the sample;
- Carefully decant the sample into the small bottles leaving as little air space as possible without overflowing the sample container. Overflowing the containers that contain preservative can result in the sample not being preserved properly and may have impacts on the analysis being performed;
- Once the appropriate bottles have been filled, carefully place them into a cooler for shipment. Package the samples tightly together and add space filler if required to ensure there is no movement and possible damage to the samples. Place an appropriate amount of ice into the cooler to prevent the samples from overheating during the summer months and hot water bottles to prevent from freezing during the winter months;
- Prepare a chain of custody form in the data management system. Save the form in the public drive and email it to the laboratory as well as provide the chain of custody to the lab by printing a copy and inserting it into the cooler prior to shipment;
- Once all material is in the cooler, secure the lid and have the sample shipped to the appropriate lab.

4.4 Data Validation and Review

4.4.1 Data validation and review of surface water grab samples shall be conducted in accordance with PR8.7.3.02 Data Validation Procedure.

5 TRAINING

The Environmental Coordinator is responsible for confirming that care and maintenance staff performing surface water grab sampling meets the following minimum training requirements:

- Completion of documented review of this procedure and associated report forms;
- Completion of documented review of associated data validation procedures;
- Completion of documented on the job training for emLine database access and report generation; and
- Completion of location-specific on the job training with respect to access routes, communication locations and location-specific sampling requirements.

6 ADMINISTRATION

6.1 Procedure Review

Standard operating procedure documents are to be reviewed in accordance with the schedule and responsibilities identified in RG1.0.0.02 Operating Document Registry.

6.2 Program, Plan and Procedure Revisions

Document revisions identified during routine review, program modifications (e.g. program design or State of Environment Reports) and/or audit process are to be implemented in accordance with PR11.1.0-01 Operating Document Review and Revision Procedures.

7 RECORDS

Table 7.1. Companion Document Listing

Document Number	Document Name
Minnow, 2009a	Monitoring Framework for Closed Mines, Near Elliot Lake.
Minnow, 2009b	Serpent River Watershed Monitoring Program Cycle 3 Study Design
Minnow, 2009c	Source Area Monitoring Program, Revised Study Design
Minnow, 2009d	Tailings Management Area Operational Monitoring Program (TOMP) Revised Study Design
Minnow, 2011	Serpent River Watershed State of the Environment Report
RG1.0.0.02	Operating Document Registry
RG8.5.2.01	Water Quality Monitoring Data Quality Objectives
PR8.7.2.01	Scheduling
RG8.7.2-01	Performance Monitoring Registry
PR8.7.3.02	Data Validation Procedure
PR11.1.0.01	Operating Document Review and Revision Procedures

8 REVISION RECORD

Table 8.1. Revision Summary

Revision	Date	Purpose of Revision
2006-01	Dec. 21, 2006	Update roles and responsibilities; include sample preparation for shipment requirements
2007-01	Aug 31, 2007	Update roles and responsibilities as well as procedure references
2011-01	Feb. 18, 2011	Update roles and responsibilities, include Denison Mines to reflect common use of procedure; revised schedule requirement references to Cycle 3 Design and 2011 draft State of Environment Report

Toxicity Sampling

Operating Procedure: PR8.6.1.03	Revision: 2011.01	Page 1 of 6
	Replaces: 2007.01	
Approved: February 25, 2011		Valid Until: February 25, 2016
Asset Owner	Reclamation Manager	Debbie Berthelot
	Denison Manager	Ian Ludgate
Document Reviewer	Environmental Coordinator	Andrea Conway
Document Owner	Environmental Technician	Jody Stefanich
Document Control	Document Clerk	Stacey Wood
Key Contacts	Environmental Manager	Mark Smith
	Operations Superintendent	Jacques Ribout

1 Purpose

The purpose of this procedure is to:

- Establish a toxicity sampling standard operating procedure that is consistent with regulatory requirements and standard industry protocols.

2 Application

This procedure applies to toxicity sampling for the purpose of determining lethality or growth inhibition, at the following Elliot Lake monitoring locations:

- PR-01: Effluent Creek at Hwy 17
- N-12: Buckles Creek at Hwy 108
- MPE: Milliken Park Effluent
- P-14: Panel Final Discharge
- Q-28: Quirke Final Discharge
- CL-06: Stanleigh Final Discharge
- D-2: Stollery Lake Outlet
- DS-4: Orient Lake Outlet

3 Roles and Responsibilities

3.1 *The Rio Algom Reclamation Manager and Denison Environmental Services Manager*

The Rio Algom Reclamation Manager and Denison Environmental Services Manager have overall responsibility for the on-going operating, care and maintenance of the Rio Algom Limited

(RAL) and Denison Mines Inc. (DMI) Elliot Lake Facilities including the Performance Monitoring Plan. Responsibilities specific to this procedure include:

- Final authorization of review and revisions of this procedure; and
- Providing the Care and Maintenance Contractor with documentation that would affect change to this procedure.

3.2 Environmental Manager

The Environmental Manager has overall responsibility for ensuring that the Performance Monitoring Plan is implemented including toxicity sampling. Responsibilities specific to this procedure include:

- Confirming care and maintenance personnel conducting toxicity sampling are adequately trained and competent to perform assigned task; and
- Confirming care and maintenance contractor and consultant conformance with this procedure or in the case of consultants their equivalent to this procedure

3.3 Environmental Coordinator

The Environmental Coordinator is responsible for overseeing implementation of the Toxicity Sampling Procedure. Responsibilities specific to this procedure include:

- Assigning responsibility for completion of toxicity sampling in accordance with this procedure;
- Informing care and maintenance contractor staff of changes to this procedure;
- Directing training of care and maintenance contractor staff involved in this procedure;
- Initiating and directing toxicity sampling modifications required in response to changes to this procedure;
- Initiating and reviewing modifications to this procedure; and
- Conducting scheduled and unscheduled spot checks to verify care and maintenance contractor and consultant conformance with this procedure.

3.4 Compliance Coordinator

The Compliance Coordinator is responsible for supporting implementation of the Toxicity Sampling Procedure. Responsibilities specific to this procedure include:

- Scheduling toxicity samples in the environmental database in accordance with PR8.7.2.01: Scheduling;
- Ensuring sample containers and liners are available in sufficient supply at any given time; and
- Communicating with toxicity laboratory and confirming sample dates.

3.5 Field Technician and Operators

Field Technicians, Operators or other contractors or consultants assigned toxicity sampling responsibilities under the SRWMP, SAMP or TOMP programs are responsible for:

- Conducting toxicity sampling in accordance with PR8.6.1.03 Toxicity Sampling;
- Participating in and completing the training requirements;
- Reviewing and updating this procedure as assigned in RG1.0.0.02 Operating Document Registry; and
- Informing the Compliance Coordinator when pails and/or liner supplies are low.

4 PROCEDURES

4.1 Equipment

4.1.1 The following equipment is required for toxicity sampling:

- Toxicity pails, with lids (provided by toxicity laboratory);
- 3X collapsible containers provided by laboratory (various volumes have been supplied);
- 1 cooler;
- Toxicity pail liners (provided by toxicity laboratory);
- Nylon tie wraps;
- Labels;
- Chain of Custody Form (provided by toxicity laboratory);
- Secondary Container (if required to fill pails);
- Ice packs.

4.2 Scheduling

4.2.1 Toxicity samples will be scheduled in the environmental database as required for SAMP and TOMP, as per the Cycle 3 Design documents and Canadian Nuclear Safety Commission program approval dated December 11, 2009.

4.2.2 The Compliance Coordinator is responsible for scheduling toxicity samples such that:

- Requirements are incorporated into the environmental database Schedule in accordance with PR8.7.2.01: Scheduling;
- The toxicity sample is scheduled to coincide with the monthly water quality sample;
- Individual analytes are scheduled using the following naming conventions:
    - ToxRT: Rainbow Trout
    - ToxDM: Daphnia magna
    - ToxCD: *Ceriodaphnia dubia*.

4.2.3 The Compliance Coordinator is responsible for ensuring any changes to sampling programs are incorporated into the schedule as per PR8.7.2.01: Scheduling.

4.3 Sampling and Sample Delivery

4.3.1 The Compliance Coordinator shall ensure the following items are carried out in support of toxicity sampling:

- Check with laboratory that will be doing the toxicity testing to ensure that they are in a position to accept the samples. Optimally samples will be collected before Wednesday if possible;
- Ensure that sufficient sample containers are available to collect adequate sample as required:
  - ToxRT & ToxDM require one 25L pail;
  - ToxCD requires 3X collapsible containers (various volumes have been supplied)

4.3.2 The Field Technician, Operator or other adequately trained personnel shall collect toxicity samples in accordance with the following protocol:

- Confirm with Operator that the effluent to be sampled is representative of normal operating conditions;
- Sampling should not be conducted by persons having been in contact with lime dust, barium chloride, or other potentially toxic contaminants;
- Complete shipping labels, and affix to pails prior to sampling while pails are clean, dry and warm;
- During summer months insert a frozen ice pack in the cooler containing the collapsible containers to keep the sample cool during shipping;
- Install liner in pail without touching or reaching inside the liner. All manipulation shall be done by pulling on the exterior of the liner;
- Use a small volume of sample to rinse out the liner/collapsible containers and the container used for pouring;
- Collect sample to within 10 cm of the brim by either placing container directly in the stream flow or by using a second triple rinsed container to fill the pail;
- Before the liner is sealed, the sample should be visually inspected to ensure there is no visible contamination. If contamination is noted sample should be repeated in its entirety;
- Seal the liner by lifting the top and;
  - Twisting the liner beginning at the water surface, until all the excess is tightly twisted, to ensure no air enters the sample;
  - Fold twisted liner and tie shut with nylon tie-wrap;
  - Liner/collapsible container should be securely closed in this manner such that no water escapes and no air is present in the sample;

- Apply the lid securely onto the sample pail.

- All efforts shall be taken to ensure samples are maintained at a consistent temperature, avoiding heating or freezing during transportation.

4.3.3 The sampler shall record any unusual sample conditions or observations in the waterproof field notebook at the time of sampling.

4.3.4 The sampler, prior to shipment of the sample, shall verify that the container is properly labelled.

4.4 Data Validation and Review

Data validation and review of toxicity samples shall be conducted in accordance with PR8.7.3.02 Data Validation Procedure*.*

5 TRAINING

The Environmental Coordinator is responsible for confirming that care and maintenance staff performing toxicity sampling meet the following minimum training requirements:

- Completion of documented review of this procedure and associated report forms;
- Completion of documented review of associated data validation procedures;
- Completion of documented on the job training for emLine database access and report generation; and
- Completion of location-specific on the job training with respect to access routes, communication locations and location-specific sampling requirements.

6 ADMINISTRATION

6.1 Procedure Review

Standard operating procedure documents are to be reviewed in accordance with the schedule and responsibilities identified in RG1.0.0.02 Operating Document Registry.

6.2 Program, Plan and Procedure Revisions

Document revisions identified during routine review, program modifications (e.g. program design or State of Environment Reports) and/or audit process are to be implemented in accordance with PR11.1.0.01 Operating Document Review and Revision Procedures.

7 RECORDS

Table 7.1. Companion Document Listing

Document Number	Document Name
Minnow, 2009a	Monitoring Framework for Closed Mines, Near Elliot Lake.
Minnow, 2009c	Source Area Monitoring Program, Revised Study Design
Minnow, 2009d	Tailings Management Area Operational Monitoring Program (TOMP) Revised Study Design
Minnow, 2011	Serpent River Watershed State of the Environment Report
RG1.0.0.02	Operating Document Registry
RG8.5.2.01	Water Quality Monitoring Data Quality Objectives
PR8.7.2.01	Scheduling
RG8.7.2.01	Performance Monitoring Registry
PR8.7.3.02	Data Validation Procedure
PR11.1.0.01	Operating Document Review and Revision Procedures

8 REVISION RECORD

Table 8.1. Revision Summary

Revision	Date	Purpose of Revision
2003.02	July 23, 2003	Remove toxicity fat head minnows, add responsibility to Field Technician and update number formatting
2003.03	Oct. 16, 2003	Add use of ice pack and rinsing requirements
2004.01	Oct. 14, 2004	Update equipment; correct to Ceriodaphnia dubia
2005.01	Sept. 5, 2005	Update formatting to current standard
2007.01	Sept. 26, 2007	Update roles and responsibilities, remove reference to Envista as well as procedure references
2011.01	Feb. 18, 2011	Update roles and responsibilities, include Denison Mines to reflect common use of procedure; revised schedule requirement references to Cycle 3 Design and 2011 draft State of Environment Report

Groundwater Sampling

Operating Procedure: PR8.6.2.01	Revision: 2011.01	Page 1 of 8
	Replaces: 2007-01	
Approved: February 25, 2011		Valid Until: February 25, 2016
Asset Owner	Reclamation Manager	Debbie Berthelot
	Denison Manager	Ian Ludgate
Document Reviewer	Environmental Coordinator	Andrea Conway
Document Owner	Environmental Technician	Michael Lachance
Document Control	Document Clerk	Stacey Wood
Key Contacts	Environmental Manager	Mark Smith
	Operations Superintendent	Jacques Ribout

1 PURPOSE

The purpose of this procedure is to:

- Establish a groundwater sampling standard operating procedure that is consistent with regulatory requirements and standard industry protocols.

2 APPLICATION

This procedure applies to groundwater sampling at all Rio Algom Limited and Denison Mines Inc. Elliot Lake monitoring locations included in the Tailings Management Area (TMA) Operational Monitoring Program (TOMP).

3 ROLES AND RESPONSIBILITIES

3.1 The Rio Algom Reclamation Manager and Denison Environmental Services Manager

The Rio Algom Reclamation Manager and Denison Environmental Services Manager have overall responsibility for the on-going operating, care and maintenance of the Rio Algom Limited (RAL) and Denison Mines Inc. (DMI) Elliot Lake Facilities including the Performance Monitoring Plan. Responsibilities specific to this procedure include:

- Final authorization of review and revisions of this procedure; and
- Providing the Care and Maintenance Contractor with documentation that would affect change to this procedure.

3.2 Environmental Manager

The Environmental Manager has overall responsibility for ensuring that the Performance Monitoring Plan is implemented including groundwater sampling. Responsibilities specific to this procedure include:

- Confirming care and maintenance personnel conducting groundwater sampling are adequately trained and competent to perform assigned task
- Confirming care and maintenance contractor and consultant conformance with this procedure or in the case of consultants their equivalent to this procedure

3.3 Environmental Coordinator

The Environmental Coordinator is responsible for overseeing implementation of the Groundwater Sampling Procedure. Responsibilities specific to this procedure include:

- Assigning responsibility for completion of groundwater sampling in accordance with this procedure;
- Informing care and maintenance contractor staff of changes to this procedure;
- Directing training of care and maintenance contractor staff involved in this procedure;
- Initiating and directing groundwater sampling modifications required in response to changes to this procedure;
- Initiating and reviewing modifications to this procedure; and
- Conducting scheduled and unscheduled spot checks to verify care and maintenance contractor and consultant conformance with this procedure.

3.4 Compliance Coordinator

The Compliance Coordinator is responsible for supporting implementation of the Groundwater Sampling Procedure. Responsibilities specific to this procedure include:

- Scheduling groundwater samples in the environmental database in accordance with PR8.7.2.01: Scheduling.

3.5 Field Technician and Operators

Field Technicians, Operators or other contractors or consultants assigned groundwater sampling responsibilities under the SRWMP, SAMP or TOMP programs are responsible for:

- Conducting groundwater sampling in accordance with PR8.6.2.01 Groundwater Sampling;
- Participating in and completing the training requirements;
- Reviewing and updating this procedure as assigned in RG1.0.0.02 Operating Document Registry

4 PROCEDURES

4.1 Equipment

4.1.1 The following equipment is required for groundwater sampling:

1. Waterra Inertia Lift Pump (foot valve), generally for flushing well diameters greater than 1 inch with a head differential of greater than 30 feet;

2. Peristaltic Pump, generally for well diameters smaller than 1 inch and a head differential of ≈30 feet;
3. Tubing of various lengths and diameters as per section *Protocol: Sample Collection*;
4. 0.45µ pore, 700cm^2 In-line water filters for sample collection from peristaltic pump;
5. C-FLEX®TUBING L/S ®24 for use with peristaltic pump (reorder#06424-24);
6. Nitrogen gas cylinder, regulator, well cap adapter and tubing for wells greater than 100 feet or where necessary;
7. pH meter;
8. Minimum 200' Water level indicator tape;
9. 4L of 10% nitric acid (to flush tubing between wells);
10. 10L of distilled water (to flush tubing, rinse & wash down sampling equipment between wells);
11. 500ml squirt bottle w/ distilled water;
12. Graduated purge containers (various volumes: 2L, 4L, 10L, 20L)
13. Cooler and ice packs;
14. Pre-labeled volumetric sample bottles;
15. Paper towels/disposable wipes;
16. Field book;
17. Groundwater tool box w/ appropriate spare assorted connectors, Waterra foot valves and electrical tape (4 rolls minimum);
18. White paint marker, extra locks and oil for maintaining Piezometer I.D., proper security and lid function.

4.2 Scheduling

4.2.1 Groundwater samples will be scheduled in the environmental database as required for TOMP, as per the Cycle 3 Design documents and Canadian Nuclear Safety Commission program approval dated December 11, 2009.

4.2.2 The Compliance Coordinator is responsible for scheduling groundwater samples such that:

- Requirements are incorporated into the environmental database Schedule in accordance with PR8.7.2.01: Scheduling;
- Individual analytes are scheduled to reflect program specific Method Detection Limits (MDL's) as per RG8.5.2.01: Water Quality Monitoring Data Quality Objectives;

4.2.3 The Compliance Coordinator is responsible for ensuring any changes to sampling programs are incorporated into the schedule as per PR8.7.2.01: Scheduling.

4.3 Sampling

4.3.1 The Field Technician or other adequately trained personnel shall collect groundwater grab samples and prepare samples for shipping in accordance with the following protocols:

Protocol: Static Water Level Determination & Field Measurements

- Prior to disturbing the standing water in the well, the water level and borehole total depth must be measured and recorded;
- The reading is taken using the Solinst water level indicator or other similar device;
- Before placing the level indicator in the piezometer, first visually inspect the piezometer casing for damage and the probe tip for defects such as kinks or damage to the black protective coating or weighted assembly near the probe tip. The probe tip and line must be straight as possible to prevent snagging on the piezometer casing as it descends;
- Water level is indicated by a sharp but definite beep that can be verified by slowly moving the cable up and down the well or adjusting the instruments sensitivity. This will greatly reduce false readings. As the Solinst cable is being rewound care should be taken to gently wipe the cable and probe tip clean without damaging the marked intervals from the cable. The probe tip may need to be rinsed with distilled water to dislodge sediments;
- Record water level and total depth readings and calculate piezometer specific parameters on the Groundwater Instrumentation Field Inspection Form (RF8.6.2.01). There is a logical progression of data entry and calculations to be completed at time of sampling. These measurements provide a record of parameters to be entered into the Environmental Data Management System and calculations will determine the volume to be purged. The Field Technician will bring the previous year's completed field form binder to roughly verify results and proper piezometer function.

Protocol: Bottle Preparation

- Obtain analysis specific bottles in the appropriate volumetric size. Bottles are provided by the analytical lab and are sterile and precharged therefore, rinsing is not required.
- Prior to filling the sampler shall mark the piezometer identification number, date and sampler ID on each bottle and verify no defects to bottle or cap and liner.

Protocol: Well Flushing/Purging

- Standing water within the well casing must be removed prior to sampling;
- Three well volumes, the volume of water contained between the bottom of the well screen and the static water level within the well, should be removed where possible prior to sampling. Graduated purge containers of various sizes are available to ensure that the actual purged volume can be accurately recorded in the dedicated field binder;

- Wells that are slow to recharge and therefore preclude the flushing in the above manner, should be pumped dry and sampled when a sufficient amount of water has re-entered the well;
- Time elapsed should be noted if sufficient sample cannot be obtained in 8hrs. If the well does not recharge within 24hrs the instrument is considered dry and will be recorded as such in the Data Management System.

Protocol: Sample Collection

Current well diameters at the Elliot Lake sites include 2¼ inch, 1½ inch, ¾ inch, ½ inch and ⅜ inch:

- The 1½ and 2¼ inch monitoring wells are **purged** using a Waterra Inertia pumping system (foot valve) and **sampled** using the peristaltic pumping system with an in-line filter.
- In the cases where the head differential is $>30^{ft}$ after purging, the Waterra (provided 3 times the volume has been removed from the well through it) can be used to fill a clean 2L container and the Peristaltic system with clean tubing may be used for filtering the sample from that container into the appropriate volumetric bottles for analysis at the lab;
- The ¾ and ½ inch diameter are flushed and sampled using a peristaltic pump;
- The ⅜ inch monitoring wells are purged and sampled by connecting the peristaltic pump directly to the ⅜ inch well casing with the appropriate connector from the GW tool box;
- Monitoring wells greater than 100 feet will be purged and sampled using the Nitrogen gas method. Samples are recovered by placing a small diameter polyethylene hose into the piezometer lead pipe down to the bottom of the water zone. As gas is released from the supply bottle, pressure in the piezometer builds and displaces water through the well cap adapter that the gas line is passed through. The sample water is collected in a clean 2L bottle and filtered from that bottle with the peristaltic pump and in-line filter into the appropriate volumetric bottles for analysis at the lab. This is done in the same way as bullet point 1 of this sub-section;
- <u>ALL</u> samples will be filtered through an in-line, 0.45µ pore size, high flow GW filter (at least $700cm^2$ filter area) directly to the pre-labelled, precharged, volumetric sample bottles in the field using the peristaltic pumping system;
- As per the electronic schedule, pHf will be measured in the field using calibrated meters and recorded on the Groundwater Instrumentation Field Inspection Form (RF8.6.2.01) under the appropriate heading;
- Field parameters will be measured during sample collection by placing the probe into the 500ml sample container while the sample water is being pumped out. This will be the last of the 3 bottles to be filled for analysis;
- Water should be continuously pumped to the sample container while field measurements are being determined.

Protocol: In Field Sample Integrity

- Sample containers are filled completely leaving little to no residual air at the top of the container, where possible;
- The caps should be inspected to ensure the liners are in place. While sampling ensure the cap is stored in a clean and secure location to avoid contamination;
- All pumps and tubing used in groundwater sampling shall be flushed with 10% Nitric acid solution (4L) and distilled water (10L) between wells and wiped using paper towels or disposable wipes, to avoid sample contamination;
- Lines using Waterra foot valves cannot be flushed in this manner. However, if the piezometer is flushed and recharges instantly, the tubing is considered clean and sampling to a clean 2L intermediate sample container immediately following purging without removing the Waterra is permitted. This should only be done without removing the tubing from the piezometer casing as it may become contaminated upon removal. Once the sample water has been collected the peristaltic pump and in-line filter are used to fill the appropriate volumetric bottles for analysis at the lab;
- If the well does not recharge instantly, leave the Waterra line in and return at a later time to sample. Another option would be to use the peristaltic pump system with clean tubing upon return to collect the sample provided the head differential is $\approx 30^{ft}$;
- Once the sample has been properly collected store in a cooler with ice packs for transportation to the Sample Preparation Room to prepare for shipment;
- All reasonable efforts shall be taken to ensure samples are maintained at a consistent temperature, avoiding heating or freezing;
- When temperature change may be a factor due to sample delivery delays, coolers and ice packs will be used.

Protocol: Sample Preparation for Shipment

- Samples will be bottled in predetermined, pre-labelled and precharged sample bottles in the field for shipment.
- A corresponding chain of custody (C of C) can now be generated through the completion of the “Request for Lab Analysis” module in the Environmental Data Management System. Two “.PDF” format copies of the C of C file will be printed off; one for archiving at the office and one to be included in the sample cooler for shipment;
- An alternate C of C in “Tab Delimited” format will be e-mailed to the analytical lab for tracking purposes within their electronic system;
- Once the C of C form, samples, packing medium and ice packs have been placed in the cooler it is now ready to be sealed and delivered to the Office Administrator for final shipping preparation and notification to the courier;

- Field measurements can now be entered through the data entry process in the "Rapid Entry of Events and Measurements" modules in the Environmental Data Management System (see PR8.7.3.01 Data Entry Procedure).

4.3.2 The sampler shall record any unusual sample collection and filtration conditions or observations on the corresponding Groundwater Instrumentation Field Inspection Form (RF8.6.2.01) and incorporate it into the dedicated field binder.

4.4 Data Validation and Review

4.4.1 Data validation and review of groundwater samples shall be conducted in accordance with PR8.7.3.02 Data Validation Procedure*.*

5 TRAINING

The Environmental Coordinator is responsible for confirming that all care and maintenance staff performing groundwater sampling meets the following minimum training requirements:

- Completion of documented review of this procedure and associated report forms;
- Completion of documented review of associated data validation procedures;
- Completion of documented on the job training for emLine database access and report generation; and
- Completion of location-specific on the job training with respect to access routes, communication locations and location-specific sampling requirements.

6 ADMINISTRATION

6.1 Procedure Review

Standard operating procedure documents are to be reviewed in accordance with the schedule and responsibilities identified in RG1.0.0.02 Operating Document Registry.

6.2 Program, Plan and Procedure Revisions

Document revisions identified during routine review, program modifications (e.g. program design or State of Environment Reports) and/or audit process are to be implemented in accordance with PR11.1.0.01 Operating Document Review and Revision Procedures.

7 RECORDS

Table 7.1. Companion Document Listing

Document Number	Document Name
Minnow, 2009a	Monitoring Framework for Closed Mines, Near Elliot Lake.
Minnow, 2009d	Tailings Management Area Operational Monitoring Program (TOMP) Revised Study Design
Minnow, 2011	Serpent River Watershed State of the Environment Report
RG1.0.0.02	Operating Document Registry
RG8.5.2.01	Water Quality Monitoring Data Quality Objectives
RF8.6.2.01	Groundwater Instrumentation Field Inspection Form
PR8.7.2.01	Scheduling
RG8.7.2.01	Performance Monitoring Registry
PR8.7.3.01	Data Entry Procedure
PR8.7.3.02	Data Validation Procedure
PR11.1.0.01	Operating Document Review and Revision Procedures

8 REVISION RECORD

Table 8.1. Revision Summary

Revision	Date	Purpose of Revision
2003.01	Jan. 22, 2003	Procedure revisions to reflect current protocols
2005.01	Sept. 7, 2005	Incorporate use of report form; additional detail added to procedure for clarification
2006.01	Dec. 19, 2006	Procedure revisions to filtration and sample shipping resulting from change in analytical supplier
2007.01	Aug. 7, 2007	Include in-line filtration of samples; revise sample bottles and labelling
2011.01	Feb. 19, 2011	Update roles and responsibilities, include Denison Mines to reflect common use of procedure; revised schedule requirement references to Cycle 3 Design and 2011 draft State of Environment Report

Field pH Determination

Operating Procedure: PR8.6.3.01	Revision: 2011.01	
	Replaces: 2007.01	
Approved: February 18, 2011		Valid Until: February 18, 2016
Asset Owner	Reclamation Manager	Debbie Berthelot
	Denison Manager	Ian Ludgate
Document Reviewer	Environmental Coordinator	Andrea Conway
Document Owner	Environmental Technician	Jody Stefanich
Document Control	Document Clerk	Stacey Wood
Key Contacts	Environmental Manager	Mark Smith
	Operations Superintendent	Jacques Ribout

1 PURPOSE

The purpose of this procedure is to:

- Establish a field pH determination standard operating procedure that is consistent with regulatory requirements and standard industry protocols.

2 APPLICATION

This procedure applies to field pH determination at all Rio Algom Limited and Denison Mines Inc. Elliot Lake monitoring locations included in each of the following programs:

- SRWMP: Serpent River Watershed Monitoring Program;
- SAMP: Source Area Monitoring Program;
- TOMP: Tailings Management Area (TMA) Operational Monitoring Program.

3 ROLES AND RESPONSIBILITIES

The Rio Algom Reclamation Manager and Denison Environmental Services Manager

The Rio Algom Reclamation Manager and Denison Environmental Services Manager have overall responsibility for the on-going operating, care and maintenance of the Rio Algom Limited (RAL) and Denison Mines Inc. (DMI) Elliot Lake Facilities including the Performance Monitoring Plan. Responsibilities specific to this procedure include:

- Final authorization of review and revisions of this procedure; and
- Providing the Care and Maintenance Contractor with documentation that would affect change to this procedure.

Environmental Manager

The Environmental Manager has overall responsibility for ensuring that the Performance Monitoring Plan is implemented including field pH determination. Responsibilities specific to this procedure include:

- Confirming care and maintenance personnel conducting field pH determination are adequately trained and competent to perform assigned task
- Confirming care and maintenance contractor and consultant conformance with this procedure or in the case of consultants their equivalent to this procedure

Environmental Coordinator

The Environmental Coordinator is responsible for overseeing implementation of the Field pH Determination Procedure. Responsibilities specific to this procedure include:

- Assigning responsibility for completion of field pH determination in accordance with this procedure;
- Informing care and maintenance contractor staff of changes to this procedure;
- Directing training of care and maintenance contractor staff involved in this procedure;
- Initiating and directing field pH determination modifications required in response to changes to this procedure;
- Initiating and reviewing modifications to this procedure; and
- Conducting scheduled and unscheduled spot checks to verify care and maintenance contractor and consultant conformance with this procedure.

Compliance Coordinator

The Compliance Coordinator is responsible for supporting implementation of the Field pH Determination Procedure. Responsibilities specific to this procedure include:

- Scheduling field pH determinations in the environmental database in accordance with PR8.7.2.01: Scheduling.

Field Technician and Operators

Field Technicians, Operators or other contractors or consultants assigned field pH determination responsibilities under the SRWMP, SAMP or TOMP programs are responsible for:

- Conducting field pH determination in accordance with PR8.6.3.01 Field pH Determination;
- Participating in and completing the training requirements;
- Reviewing and updating this procedure as assigned in RG1.0.0.02 Operating Document Registry
- Maintaining calibration records and field logs.

4 PROCEDURES

Equipment

The following equipment is required for field pH determination:

- pH meter and carrying case;
- Manufacturers Instruction Manual;
- Calibration log;
- pH buffer solutions (at least two) in small sample containers;
- Distilled water;
- Batteries.

Scheduling

Field pH determination will be scheduled in the environmental database as required for each of SRWMP, SAMP and TOMP, as per the Cycle 3 Design documents and Canadian Nuclear Safety Commission program approval dated December 11, 2009.

The Compliance Coordinator is responsible for scheduling field pH determinations such that:

- Requirements are incorporated into the environmental database Schedule in accordance with PR8.7.2.01: Scheduling;
- Individual analytes are scheduled to reflect program specific Method Detection Limits (MDL's) as per RG8.5.2.01: Water Quality Monitoring Data Quality Objectives;

The Compliance Coordinator is responsible for ensuring any changes to sampling programs are incorporated into the schedule as per PR8.7.2.01: Scheduling.

Calibration

The Field Technician or other adequately trained personnel shall refer to manufacturer's instructions in the operation manual of the pH meter for specific calibration, storage and maintenance instructions.

A wide variety of pH meters and multimeters with pH probes are currently in use. The following are some general instructions to follow:

- Prior to use the Field Technician shall calibrate the meter using a minimum of two pH calibration standards;
- Calibration of the meter should be verified once every five samples;
- If meter readings do not meet precision and accuracy objectives specified in RG8.5.2.01 Data Quality Objectives*,* the meter must be re-calibrated

The Field Technician or other adequately trained personnel shall record the calibration record on RF 8.6.3.01 Field Instrument Calibration Records.

Field Instructions

The Field Technician or other adequately trained personnel shall obtain field pH measurements in accordance with the meter-specific operation manual in addition to following these general guidelines:

- Place the probe in the water and turn the meter on (depending on the meter minimal stirring of the probe may be required);
- Allow the meter reading to reach equilibrium;
- Record the reading in the dedicated waterproof field notebook;
- Record any unusual sample conditions or observations in the waterproof field notebook at the time of sampling;
- When the meter is not in use the probe should be stored according to manufacturer specifications.

Data Validation and Review

Data validation and review of surface water samples shall be conducted in accordance with PR8.7.3.02 Data Validation Procedure*.*

5 TRAINING

The Environmental Coordinator is responsible for confirming that all care and maintenance staff performing surface field pH determinations meets the following minimum training requirements:

- Completion of documented review of this procedure and associated report forms;
- Completion of documented review of associated data validation procedures;
- Completion of documented on the job training for emLine database access and report generation; and
- Completion of location-specific on the job training with respect to access routes, communication locations and location-specific sampling requirements.

6 ADMINISTRATION

Procedure Review

Standard operating procedure documents are to be reviewed in accordance with the schedule and responsibilities identified in RG1.0.0.02 Operating Document Registry.

Program, Plan and Procedure Revisions

Document revisions identified during routine review, program modifications (e.g. program design or State of Environment Reports) and/or audit process are to be implemented in accordance with PR11.1.0.01 Operating Document Review and Revision Procedures.

7 RECORDS

Table 7.1. Companion Document Listing

Document Number	Document Name
Minnow, 2009a	Monitoring Framework for Closed Mines, Near Elliot Lake.
Minnow, 2009b	Serpent River Watershed Monitoring Program Cycle 3 Study Design
Minnow, 2009c	Source Area Monitoring Program, Revised Study Design
Minnow, 2009d	Tailings Management Area Operational Monitoring Program (TOMP) Revised Study Design
Minnow, 2011	Serpent River Watershed State of the Environment Report
RG1.0.0.02	Operating Document Registry
RG8.5.2.01	Water Quality Monitoring Data Quality Objectives
RF8.6.3.01	Field Instrument Calibration Records
PR8.7.2.01	Scheduling
RG8.7.2.01	Performance Monitoring Registry
PR8.7.3.02	Data Validation Procedure
PR11.1.0.01	Operating Document Review and Revision Procedures

8 REVISION RECORD

Table 8.1. Revision Summary

Revision	Date	Purpose of Revision
2003.01	Jan 16, 2003	Correct typo to replace “toxicity” with field pH
2007.01	Sept. 7, 2007	Update roles and responsibilities, remove references to Envista and update procedure references
2011.01	Feb. 18, 2011	Update roles and responsibilities, include Denison Mines to reflect common use of procedure; revised schedule requirement references to Cycle 3 Design and 2011 draft State of Environment Report

Field Conductivity Determination

Operating Procedure: PR8.6.3.03	Revision: 2011.01	Page 1 of 5
	Replaces: 2007.01	
Approved: February 25, 2011		Valid Until: February 25, 2016
Asset Owner	Reclamation Manager	Debbie Berthelot
	Denison Manager	Ian Ludgate
Document Reviewer	Environmental Coordinator	Andrea Conway
Document Owner	Environmental Technician	Jody Stefanich
Document Control	Document Clerk	Stacey Wood
Key Contacts	Environmental Manager	Mark Smith
	Operations Superintendent	Jacques Ribout

1 PURPOSE

The purpose of this procedure is to:

- Establish a field conductivity determination standard operating procedure that is consistent with regulatory requirements and standard industry protocols.

2 APPLICATION

This procedure applies to field conductivity determinations at the following Elliot Lake monitoring locations:

- P-15: Panel Settling Pond Underflow Drainage

The procedure may also be applied to other field applications.

3 ROLES AND RESPONSIBILITIES

The Rio Algom Reclamation Manager and Denison Environmental Services Manager

The Rio Algom Reclamation Manager and Denison Environmental Services Manager have overall responsibility for the on-going operating, care and maintenance of the Rio Algom Limited (RAL) and Denison Mines Inc. (DMI) Elliot Lake Facilities including the Performance Monitoring Plan. Responsibilities specific to this procedure include:

- Final authorization of review and revisions of this procedure; and
- Providing the Care and Maintenance Contractor with documentation that would affect change to this procedure.

Environmental Manager

The Environmental Manager has overall responsibility for ensuring that the Performance Monitoring Plan is implemented including field conductivity determination. Responsibilities specific to this procedure include:

- Confirming care and maintenance personnel conducting field conductivity determinations are adequately trained and competent to perform assigned task; and
- Confirming care and maintenance contractor and consultant conformance with this procedure or in the case of consultants their equivalent to this procedure

Environmental Coordinator

The Environmental Coordinator is responsible for overseeing implementation of the Field Conductivity Determination Procedure. Responsibilities specific to this procedure include:

- Assigning responsibility for completion of field conductivity determination in accordance with this procedure;
- Informing care and maintenance contractor staff of changes to this procedure;
- Directing training of care and maintenance contractor staff involved in this procedure;
- Initiating and directing field conductivity determinaiton modifications required in response to changes to this procedure;
- Initiating and reviewing modifications to this procedure; and
- Conducting scheduled and unscheduled spot checks to verify care and maintenance contractor and consultant conformance with this procedure.

Compliance Coordinator

The Compliance Coordinator is responsible for supporting implementation of the Field Conductivity Determination Procedure. Responsibilities specific to this procedure include:

- Scheduling field conductivity determinations in the environmental database in accordance with PR8.7.2.01: Scheduling.

Field Technician and Operators

Field Technicians, Operators or other contractors or consultants assigned field conductivity determination responsibilities are responsible for:

- Conducting field conductivity determinations in accordance with PR8.6.3.03 Field Conductivity Determination;
- Maintaining calibration records and field logs;
- Participating in and completing the training requirements; and

- Reviewing and updating this procedure as assigned in RG1.0.0.02 Operating Document Registry.

4 PROCEDURES

Equipment

The following equipment is required for conductivity determination:

- Conductivity meter and carrying case;
- Manufacturers instruction manual;
- Calibration log;
- Distilled water;
- Spare batteries.

Scheduling

Field conductivity determinations will be scheduled in the environmental database as required for TOMP, as per the Cycle 3 Design documents and Canadian Nuclear Safety Commission program approval dated December 11, 2009.

The Compliance Coordinator is responsible for scheduling field conductivity determinations such that:

- Requirements are incorporated into the environmental database Schedule in accordance with PR8.7.2.01: Scheduling.

The Compliance Coordinator is responsible for ensuring any changes to sampling programs are incorporated into the schedule as per PR8.7.2.01: Scheduling.

Calibration

The Field Technician or other adequately trained personnel shall refer to manufacturer's instructions in the operation manual of the conductivity meter for specific calibration, storage and maintenance instructions.

A variety of conductivity meters and multi-meters are currently in use. The following are some general instructions to follow:

- System calibration is rarely required because conductivity meters are factory calibrated;
- On occasion it is prudent to check system calibration and make adjustments when necessary;
- Calibration and verification should be conducted as per manufacturer's instructions;
- If meter readings do not meet precision and accuracy objectives specified in RG8.5.2.01 Data Quality Objectives*,* the meter must be factory calibrated;
- Cleaning should be conducted in accordance with manufacturer's specifications.

The Field Technician or other adequately trained personnel shall record the calibration record on RF 8.6.3.01 Field Instrument Calibration Records.

Field Instructions

The Field Technician or other adequately trained personnel shall obtain conductivity measurements in accordance with the meter-specific operation manual in addition to following these general guidelines:

- Place the probe in the water and turn the meter on (depending on the meter minimal stirring or agitation of the probe may be required);
- Allow the meter reading to reach equilibrium;
- Record the reading in the dedicated waterproof field notebook;
- Record any unusual sample conditions or observations in the waterproof field notebook at the time of sampling;
- When the meter is not in use the probe should be stored according to manufacturer specifications.

Data Validation and Review

Data validation and review of field conductivity determinations shall be conducted in accordance with PR8.7.3.02 Data Validation Procedure.

5 TRAINING

The Environmental Coordinator is responsible for confirming that all care and maintenance staff performing field conductivity determinations meets the following minimum training requirements:

- Completion of documented review of this procedure and associated report forms;
- Completion of documented review of associated data validation procedures;
- Completion of documented on the job training for emLine database access and report generation; and
- Completion of location-specific on the job training with respect to access routes, communication locations and location-specific sampling requirements.

6 ADMINISTRATION

Procedure Review

Standard operating procedure documents are to be reviewed in accordance with the schedule and responsibilities identified in RG1.0.0.02 Operating Document Registry.

Program, Plan and Procedure Revisions

Document revisions identified during routine review, program modifications (e.g. program design or State of Environment Reports) and/or audit process are to be implemented in accordance with PR11.1.0.01 Operating Document Review and Revision Procedures.

7 RECORDS

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Minnow, 2011	Serpent River Watershed State of the Environment Report
RG1.0.0.02	Operating Document Registry
RG8.5.2.01	Water Quality Monitoring Data Quality Objectives
RF8.6.3.01	Field Instrument Calibration Records
PR8.7.2.01	Scheduling
RG8.7.2.01	Performance Monitoring Registry
PR8.7.3.02	Data Validation Procedure
PR11.1.0.01	Operating Document Review and Revision Procedures

8 REVISION RECORD

Table 8.1. Revision Summary

Revision	Date	Purpose of Revision
2003.01	Jan 15, 2003	Correct typo to replace “temperature” with conductivity
2005.01	Dec. 15, 2005	Correct additional typo to replace “temperature” with conductivity
2006.01	Nov 27, 2006	Update roles and responsibilities, remove reference to Envista as well as procedure references
2007.01	Sept. 11, 2007	Update roles and responsibilities; update companion document listing
2011.01	Feb. 18, 2011	Update roles and responsibilities, include Denison Mines to reflect common use of procedure; revised schedule requirement references to Cycle 3 Design and 2011 draft State of Environment Report

Flow Determination

Operating Procedure: PR8.6.4.02	Revision: 2011.01	Page 1 of 6
	Replaces: 2007.01	
Approved: February 18, 2011		Valid Until: February 18, 2016
Asset Owner	Reclamation Manager	Debbie Berthelot
	Denison Manager	Ian Ludgate
Document Reviewer	Environmental Coordinator	Andrea Conway
Document Owner	Environmental Technician	Jody Stefanich
Document Control	Document Clerk	Stacey Wood
Key Contacts	Environmental Manager	Mark Smith
	Operations Superintendent	Jacques Ribout

1 PURPOSE

The purpose of this procedure is to:

- Establish weir, staff gauge and instrumentation driven flow determination protocols that are consistent with regulatory requirements and standard industry practices;
- Assign responsibility to ensure that flow monitoring is conducted in accordance with license requirements and ISCO Open Channel Flow Measurement Handbook.

2 APPLICATION

This procedure applies to flow determination at all Rio Algom Limited and Denison Mines Inc. Elliot Lake monitoring locations included in each of the following programs:

- SRWMP: Serpent River Watershed Monitoring Program;
- SAMP: Source Area Monitoring Program;
- TOMP: Tailings Management Area (TMA) Operational Monitoring Program.

Location-specific flow monitoring requirements are documented in RG8.6.4.02 Flow Determination Registry. Flow determination at the Elliot Lake sites include:

- V-notch and flat rectangular weirs;
- Parshall flumes
- Staff gauge;
- Environment Canada flow station;
- MAG-X;
- Multi-ranger Plus (sonic level element).

3 ROLES AND RESPONSIBILITIES

The Rio Algom Reclamation Manager and Denison Environmental Services Manager

The Rio Algom Reclamation Manager and Denison Environmental Services Manager have overall responsibility for the on-going operating, care and maintenance of the Rio Algom Limited (RAL) and Denison Mines Inc. (DMI) Elliot Lake Facilities including the Performance Monitoring Plan. Responsibilities specific to this procedure include:

- Final authorization of review and revisions of this procedure; and
- Providing the Care and Maintenance Contractor with documentation that would affect change to this procedure.

Environmental Manager

The Environmental Manager has overall responsibility for ensuring that the Performance Monitoring Plan is implemented including flow determinations. Responsibilities specific to this procedure include:

- Confirming care and maintenance personnel conducting flow determinations are adequately trained and competent to perform assigned task
- Confirming care and maintenance contractor and consultant conformance with this procedure or in the case of consultants their equivalent to this procedure

Environmental Coordinator

The Environmental Coordinator is responsible for overseeing implementation of the Flow Determination Procedure. Responsibilities specific to this procedure include:

- Assigning responsibility for completion of flow determination in accordance with this procedure;
- Informing care and maintenance contractor staff of changes to this procedure;
- Directing training of care and maintenance contractor staff involved in this procedure;
- Initiating and directing flow determination modifications required in response to changes to this procedure;
- Initiating and reviewing modifications to this procedure; and
- Conducting scheduled and unscheduled spot checks to verify care and maintenance contractor and consultant conformance with this procedure.

Compliance Coordinator

The Compliance Coordinator is responsible for supporting implementation of the Flow Determination Procedure. Responsibilities specific to this procedure include:

- Scheduling flow determination in the environmental database in accordance with PR8.7.2.01: Scheduling.

Field Technician and Operators

Field Technicians, Operators or other contractors or consultants assigned flow determination responsibilities under the SRWMP, SAMP or TOMP programs are responsible for:

- Conducting flow determinations in accordance with PR8.6.4.02 Flow Determination;
- Participating in and completing the training requirements;
- Reporting any items requiring action to the Environmental Coordinator and entering into the Action Item Database
- Reviewing and updating this procedure as assigned in RG1.0.0.02 Operating Document Registry

4 PROCEDURES

Equipment and Preparation

The following equipment is required to determine flow measurements in open channels with existing flow measurement structures:

- Engineer's ruler;
- Waterproof Field notebook or daily ETP operation sheets.

Scheduling

Flow determinations will be scheduled in the environmental database as required for each of SRWMP, SAMP and TOMP, as per the Cycle 3 Design documents and Canadian Nuclear Safety Commission program approval dated December 11, 2009.

The Compliance Coordinator is responsible for scheduling flow determinations such that:

- Requirements are incorporated into the environmental database Schedule in accordance with PR8.7.2.01: Scheduling;
- The parameter code for flow is indicative of the specific parameter used to obtain the flow value as per RG8.6.4.02 Flow Determination Registry.
- Individual analytes are scheduled to reflect program specific Method Detection Limits (MDL's) as per RG8.5.2.01: Water Quality Monitoring Data Quality Objectives;

The Compliance Coordinator is responsible for ensuring any changes to sampling programs are incorporated into the schedule as per PR8.7.2.01: Scheduling.

Field Measurements

The Field Technician, Operator or person designated to determine flow shall obtain flow in the appropriate manner as indicated in RG8.6.4.02 Flow Determination Registry and record the measurement in the designated waterproof field notebook or on the appropriate Workday or Weekly Shut-Down inspections sheets (RF7.3.0.01 and RF7.3.0.02 series report forms).

The person designated to determine flow is responsible for:

- Inspecting the flow measurement structures (weirs) for damage, leakage, etc.;
- Removing obstructions prior to flow determination whereupon sufficient time must be allowed for flow to reach equilibrium (dependent on size of pondage immediately upstream);
- Ensuring Instrumentation is consistent with expected flows as observed on SCADA trends in conjunction with weather patterns (where applicable);
- Reporting any items requiring action to the Environmental Coordinator and entering into the Action Item Database.

The person designated to determine flow shall record any unusual conditions or observations, weather conditions and time designated waterproof field notebook or on the appropriate Workday or Weekly Shut-Down inspections sheets (RF7.3.0.01 and RF7.3.0.02 series report forms) at the time of monitoring. Record all raw field measurements and calculations.

Data Entry & Calculations

The Field Inspector, Operator or person designated to determine flow is responsible for entering data into environmental database as per PR8.7.3.01 Data Entry Procedure.

Data Validation and Review

Data validation and review of flow determinations shall be conducted in accordance with PR8.7.3.02 Data Validation Procedure*.*

5 TRAINING

The Environmental Coordinator is responsible for confirming that all care and maintenance staff performing flow monitoring meets the following minimum training requirements:

- Completion of documented review of this procedure and associated report forms;
- Completion of documented review of associated data validation procedures;
- Completion of documented on the job training for emLine database access and report generation; and
- Completion of location-specific on the job training with respect to access routes, communication locations and location-specific sampling requirements.

6 ADMINISTRATION

Procedure Review

Standard operating procedure documents are to be reviewed in accordance with the schedule and responsibilities identified in RG1.0.0.02 Operating Document Registry.

Program, Plan and Procedure Revisions

Document revisions identified during routine review, program modifications (e.g. program design or State of Environment Reports) and/or audit process are to be implemented in accordance with PR11.1.0.01 Operating Document Review and Revision Procedures.

7 RECORDS

Table 7.1. Companion Document Listing

Document Number	Document Name
Minnow, 2009a	Monitoring Framework for Closed Mines, Near Elliot Lake.
Minnow, 2009b	Serpent River Watershed Monitoring Program Cycle 3 Study Design
Minnow, 2009c	Source Area Monitoring Program, Revised Study Design
Minnow, 2009d	Tailings Management Area Operational Monitoring Program (TOMP) Revised Study Design
Minnow, 2011	Serpent River Watershed State of the Environment Report
	ISCO Open Channel Flow Measurement Handbook
RG1.0.0.02	Operating Document Registry
RF7.3.0.01	Site-specific Workday Inspection Record
RF7.3.0.02	Site-specific Weekly Shut-down Inspection Record
RG8.5.2.01	Water Quality Monitoring Data Quality Objectives
RG8.6.4.02	Flow Determination Registry
PR8.7.2.01	Scheduling
RG8.7.2.01	Performance Monitoring Registry
PR8.7.3.01	Data Entry Procedure
PR8.7.3.02	Data Validation Procedure
PR11.1.0.01	Operating Document Review and Revision Procedures

8 REVISION RECORD

Table 8.1. Revision Summary

Revision	Date	Purpose of Revision
2007.01	Sept. 20, 2007	Update roles and responsibilities as well as procedure references
2011.01	Feb. 18, 2011	Update roles and responsibilities, include Denison to reflect common use of procedure; revise schedule requirement references to Cycle 3 Design and 2011 draft State of Environment Report

Control Limit Maintenance

Operating Procedure: PR8.7.2.02	Revision: 2011.01	Page 1 of 6
	Replaces: 2007.01	
Approved: February 25, 2011		Valid Until: February 25, 2016
Asset Owner	Reclamation Manager	Debbie Berthelot
	Denison Manager	Ian Ludgate
Document Reviewer	Environmental Coordinator	Andrea Conway
Document Owner	Compliance Coordinator	Valerie Kilp
Document Control	Document Clerk	Stacey Wood
Key Contacts	Environmental Manager	Mark Smith
	Operations Superintendent	Jacques Ribout

1 PURPOSE

The purpose of this procedure is to:

- Establish control limits in the environmental database that are consistent with license and permit requirements, internal operating limits, environmental quality assessment criteria and data validation protocols;
- Establish on line notification and protocols for initial response to control limit exceedances; and
- Assign responsibility for control limit maintenance in the environmental database and supporting registry

2 APPLICATION

This procedure applies to all Rio Algom Limited and Denison Mines Inc. Elliot Lake performance monitoring data generated from any of the following programs:

- SRWMP: Serpent River Watershed Monitoring Program;
- SAMP: Source Area Monitoring Program;
- TOMP: Tailings Management Area (TMA) Operational Monitoring Program;

Field parameters, samples and analytes subject to control limits are scheduled in the environmental database in accordance with RG8.7.2.01 Performance Monitoring Registry.

Table 2.1 provides a summary of control limit designations, source documents, objective and data sets to which the control limits apply.

Final treated effluent control limit exceedance response plans are documented in Section 7.4 of site-specific Operating, Care and Maintenance (OCM) Plans. Generic response plans for effluent treatment plant failure, poor effluent quality and high rates of seepage are documented in PL10.2.0.01 Emergency Response Plan with site-specific details provided in Section 10.2 of site-specific OCM Plans.

Water quality assessment and response protocols are documented in PR8.0.0.01 Water Quality Assessment and Response Plans.

Table 2.1. Control Limit Designations

Control Limit Type	Source Documents	Objective	Applies to
Compliance Limits	Site-specficic OCM Plans, Certificate of Approvals Sewage	to provide immediate notification of compliance issue	Final point of control (CL-06, N-19, P14, PR-04, Q-28)
Action Levels	Site-specficic OCM Plans	to provide early warning of potential compliance issue	
Internal Investigation		to provide identification of upset or unusual operating conditions	
Data Validation	Performance monitoring current design documents	to provide automated approach to identification of outliers and potential data quality issues	All data entered into database
Evaluation Criteria	Performance monitoring current State of Environment Report		SRWMP water quality data; SAMP and TOMP surface water quality data at 10x criteria

3 Roles and Responsibilities

3.1 The Rio Algom Reclamation Manager and Denison Environmental Services Manager

The Rio Algom Reclamation Manager and Denison Environmental Services Manager have overall responsibility for the on-going operating, care and maintenance of the Rio Algom Limited (RAL) and Denison Mines Inc. (DMI) Elliot Lake Facilities including the Performance Monitoring Plan. Responsibilities specific to this procedure include:

- Final authorization of review and revisions of this procedure; and
- Providing the Care and Maintenance Contractor with documentation that would affect change to this procedure (e.g. changes to license or permit documents or other regulatory requirements).

3.2 Environmental Manager

The Environmental Manager has overall responsibility for ensuring that the Performance Monitoring Plan is implemented including control limit maintenance. Responsibilities specific to this procedure include:

- Confirming care and maintenance personnel participating in control limit maintenance and response initiations are adequately trained and competent to perform assigned tasks;
- Confirming care and maintenance contractor conformance with this procedure
- Confirming data management modifications required in response to changes to this procedure are completed and managing relationship (commercial and working) with database service provider.

3.3 Environmental Coordinator

The Environmental Coordinator is responsible for overseeing implementation of the Control Limit Procedure. Responsibilities specific to this procedure include

- Assigning responsibility for completion of control limit maintenance in accordance with this procedure;
- Informing care and maintenance contractor staff of changes to control limits and response initiation requirements;
- Directing training of care and maintenance contractor staff involved in control limit maintenance and response initiation;
- Initiating and directing data management modifications required in response to changes to this procedure including changes requiring database service provider support;
- Initiating and reviewing modifications to this procedure and associated registries and report forms;
- Developing and initiating responses to control limits as identified in RG8.7.2.01 Control Limit Registry and communicating progress to Environmental Manager and Reclamation Manager;
- Conducting scheduled and unscheduled spot checks to verify care and maintenance contractor and data management service provider conformance with this procedure.

3.4 Compliance Coordinator

The Compliance Coordinator is responsible for control limit maintenance. Responsibilities specific to this procedure include:

- Conducting data validation in accordance with PR8.7.3-02 Data Validation including confirmation that data validation control limits are functioning as designed

- Implementing modifications to this procedure and associated registries in accordance with RG1.0.0.01 Operating Document Registry

3.5 Field Technician and Operators

Field Technicians, Operators or other individuals assigned performance monitoring responsibilities under the SRWMP, SAMP or TOMP programs are responsible for:

- Participating in and completing the training requirements
- Responding to control limit excedances and associated activities as assigned
- Informing the Compliance Coordinator of data validation flags during the data entry/importing phase in accordance with RG8.7.2.02 Control Limit Registry
- Informing the Environmental Coordinator of control limit exceedances during the data entry/importing phase in accordance with RG8.7.2.02 Control Limit Registry

4 PROCEDURES

4.1 Control Limit Registry Maintenance

RG8.7.2-02 Control Limit Registry includes the following information required to maintain control limits in the environmental database:

- Control Limit Designations: documents the locations, message and response initiation requirements for each control limit type
- Compliance Limits: documents location and analyte specific compliance limits, action levels and internal investigation levels
- Data Validation: documents the number of rolling counts to be used in calculating data validation assessment limits for each sampling frequency
- Evaluation Criteria: documents the parameter-specific water quality environmental assessment criteria and associated references

4.1.1 The Rio Algom Reclamation Manager or Denison Environmental Services Manager as appropriate are responsible for notifying the Environmental Manager and Environmental Coordinator of changes to licenses and/or permits that would impact compliance limits, action limits and/or internal investigation levels

4.1.2 The Environmental Coordinator is responsible for reviewing performance monitoring design documents and periodic State of the Environment Reports to identify changes in evaluation criteria

4.1.3 The Environmental Coordinator is responsible for directing Compliance Coordinator modifications to RG8.7.2-02 Control Limit Registry originating from changes in source documents or regulatory requirements

4.2 Database Control Limit Maintenance

The Compliance Coordinator is responsible for configuring control limits in the environmental database in accordance with requirements documented in RG8.7.2-02 Control Limit Registry.

4.2.1 Station and parameter specific compliance limits, action levels and internal investigation level control limits are configured using the "Limit Group" function. To configure a station and parameter specific control limit:

- Log into em-Line and select the appropriate application in which the data will be validated (ie. Rio Algom Limited, Denison Mines Inc., or Serpent River Watershed Monitoring Project)
  - Select the Compliance Module: Limit Group;
  - Update and modify limits as necessary;
  - Click the Save button.

4.2.2 Data Validation Limits are station, parameter specific hi low limits which are configured under Station Limits. These limits are automatically calculated based on the statistical trends of historical data, to provide early notification of outliers or emerging trends during data entry/import and data quality assessment.

- A Control Limit Script provides the vehicle to flag any value outside +/- 3 Standard deviations of a given mean and is run on a nightly basis;
- In the Station Limits module, the station and parameter specific period is specified (ie daily, weekly monthly etc.) followed by the period be used in calculating the assessment limit (e.g. daily is 251);
- The Compliance Coordinator is responsible for conducting periodic checks to confirm that data validation control limits are functioning as designed.

5 TRAINING

The Environmental Coordinator is responsible for confirming that all care and maintenance staff conducting performance monitoring meets the following minimum training requirements:

- Completion of documented review of this procedure and associated report forms;
- Completion of documented on the job training for emLine database access and report generation; and
- Completion of documented review of RG8.7.2.02 Control Limit Registry

6 ADMINISTRATION

6.1 Procedure Review

Standard operating procedure documents are to be reviewed in accordance with the schedule and responsibilities identified in RG1.0.0.02 Operating Document Registry.

6.2 Program, Plan and Procedure Revisions

Document revisions identified during routine review, program modifications (e.g. program design or State of Environment Reports) and/or audit process are to be implemented in accordance with PR11.1.0-01 Operating Document Review and Revision Procedures.

7 RECORDS

Table 7.1. Companion Document Listing

Document Number	Document Name
Minnow, 2009a	Monitoring Framework for Closed Mines, Near Elliot Lake.
Minnow, 2011	Serpent River Watershed State of the Environment Report
	Site-specific OCM Plans
	Certificate of Approval Sewage: Stanleigh, Nordic and Pronto
RG1.0.0.02	Operating Document Registry
PR8.0.0.01	Water Quality Assessment and Response Plans
PR8.7.2.01	Scheduling
RG8.7.2-01	Performance Monitoring Registry
PR8.7.2.02	Control Limit Maintenance
RG8.7.2.02	Control Limit Registry
PR8.7.3-02	Data Validation
RF8.7.3.02	Flagged Data Report
PL10.2.0.01	Emergency Response Plan
PR11.1.0.01	Operating Document Review and Revision Procedures

8 REVISION RECORD

Table 8.1. Revision Summary

Revision	Date	Purpose of Revision
2007-01	Sept 27, 2007	Update roles and responsibilities as well as procedure references, update based on transition from Envista to emLine; include internal investigation limits
2011-01	Feb. 18, 2011	Update roles and responsibilities, add Table 2.1 to define control limit designations; eliminate reporting as this is addressed elsewhere

Data Entry

Operating Procedure: PR8.7.3.01	Revision: 2011.01	Page 1 of 8
	Replaces: 2007.01	
Approved: February 25, 2011		Valid Until: February 25, 2016
Asset Owner	Reclamation Manager	Debbie Berthelot
	Denison Manager	Ian Ludgate
Document Reviewer	Environmental Coordinator	Andrea Conway
Document Owner	Environmental Technician	Jody Stefanich
Document Control	Document Clerk	Stacey Wood
Key Contacts	Environmental Manager	Mark Smith
	Operations Superintendent	Jacques Ribout
	Compliance Coordinator	Valerie Kilp

1 PURPOSE

The purpose of this procedure is to:

- Assure that all data is entered into the Environmental Database in accordance with license requirements, PR8.7.2-01 Scheduling as well as any non-routine and internal samples;
- Assign responsibility to ensure that data entry will comply with license requirements.

2 APPLICATION

This procedure applies to all Rio Algom Limited and Denison Mines Inc. Elliot Lake performance monitoring data generated from any of the following programs:

- SRWMP: Serpent River Watershed Monitoring Program;
- SAMP: Source Area Monitoring Program;
- TOMP: Tailings Management Area (TMA) Operational Monitoring Program;
- Response monitoring

This procedure does not apply to data generated by outside consultants in support of the above programs.

3 ROLES AND RESPONSIBILITIES

3.1 The Rio Algom Reclamation Manager and Denison Environmental Services Manager

The Rio Algom Reclamation Manager and Denison Environmental Services Manager have overall responsibility for the on-going operating, care and maintenance of the Rio Algom Limited (RAL) and Denison Mines Inc. (DMI) Elliot Lake Facilities including the Performance Monitoring Plan. Responsibilities specific to this procedure include:

- Final authorization of review and revisions of this procedure; and
- Providing the Care and Maintenance Contractor with documentation that would affect change to this procedure.

3.2 Environmental Manager

The Environmental Manager has overall responsibility for ensuring that the Performance Monitoring Plan is implemented including performance monitoring data entry. Responsibilities specific to this procedure include:

- Confirming care and maintenance personnel conducting performance monitoring data entry are adequately trained and competent to perform assigned task
- Confirming care and maintenance contractor and consultant conformance with this procedure or in the case of consultants their equivalent to this procedure

3.3 Environmental Coordinator

The Environmental Coordinator is responsible for overseeing implementation of the Performance Monitoring Data Entry Procedure. Responsibilities specific to this procedure include:

- Assigning responsibility for completion of performance monitoring data entry in accordance with this procedure;
- Informing care and maintenance contractor staff of changes to this procedure;
- Directing training of care and maintenance contractor staff involved in this procedure;
- Initiating and directing performance monitoring data entry modifications required in response to changes to this procedure;
- Initiating and reviewing modifications to this procedure; and
- Conducting scheduled and unscheduled spot checks to verify care and maintenance contractor and consultant conformance with this procedure.

3.4 Compliance Coordinator

The Compliance Coordinator is responsible for supporting implementation of the Performance Monitoring Data Entry Procedure. Responsibilities specific to this procedure include:

- Scheduling performance monitoring field parameters, samples and analytes in the environmental database in accordance with PR8.7.2.01: Scheduling.
- Reviewing and updating this procedure as assigned in RG1.0.0.02 Operating Document Registry

3.5 Field Technician and Operators

Field Technicians, Operators or other contractors or consultants assigned performance monitoring data entry responsibilities under the SRWMP, SAMP or TOMP programs are responsible for:

- Conducting performance monitoring data entry in accordance with PR8.7.3.01 Performance Monitoring Data Entry;
- Participating in and completing the training requirements;
- Informing the Compliance Coordinator of flagged data during the data entry/importing phase in accordance with RG8.7.2.02 Control Limit Registry
- Informing the Environmental Coordinator of limit exceedances (compliance, action level, internal investigation) identified during the data entry/importing phase in accordance with RG8.7.2.02 Control Limit Registry
- Saving all importing data excel and pdf files Annual Archive/Analytical Results.

4 PROCEDURES

4.1 Scheduling

4.1.1 Field parameters, samples and analytes will be scheduled in the environmental database as required for each of SRWMP, SAMP and TOMP, as per the Cycle 3 Design documents and Canadian Nuclear Safety Commission program approval dated December 11, 2009. Additional performance monitoring requirements may arise from response monitoring programs and internal monitoring initiatives as identified by the Reclamation Manager and/or Environmental Manager.

4.1.2 The Compliance Coordinator is responsible for scheduling field parameters, samples and analytes such that:

- Requirements are incorporated into the environmental database Schedule in accordance with PR8.7.2.01: Scheduling;
- Individual analytes are scheduled to reflect program specific Method Detection Limits (MDL's) as per RG8.5.2.01: Water Quality Monitoring Data Quality Objectives;

4.1.3 The Compliance Coordinator is responsible for ensuring any changes to sampling programs are incorporated into the schedule as per PR8.7.2.01: Scheduling.

4.2 Data Entry Requirements

4.2.1 Field Technicians, Operators, and/or other designated personnel are responsible for entering/importing all data into the emLine database in accordance with requirements registered in RG8.7.2.01 Performance Monitoring Registry.

4.2.2 All data will be entered via import templates where possible, or manual entry for field parameters and unusual samples/analytes.

4.2.3 It is important to adhere to the following standards during unscheduled data entry to ensure consistency and accuracy of the data:

- Log on to the emLine database under Network I.D and password;
- Select the appropriate application in which the data will be entered (ie. Rio Algom Limited, Denison Mines Inc., or Serpent River Watershed Monitoring Project);
- Select the Rapid Entry of Events module;
- Use the drop down list to select the event type (water sample, field event) appropriate for the task performed;
- Enter the desired date range in which data will be entered and refresh the table;
- Under the default settings, select the magnifying glass located beside the station default, enter a code for the station required and refresh the screen;
- Select the desired station by clicking on the corresponding select button;
- Ensure the performed on date is the same date the event took place;
- Select “new” at the bottom of the screen to create the new event;
- Select “save” at the bottom of the screen to save the event into the database and record the generated Field # which will be required to create the measurement;
- Select “home” at the top of the screen to return to the home page;
- Select Rapid Entry of Measurements;
- Enter an appropriate date range for the data to be entered and refresh the screen;
- Under the defaults heading use the drop down list to select the parameter to be created;
- Ensure the “measured on” date corresponds with the date the parameter was measured on;
- Type in the previously recorded Field # which was generated when the event was created and saved in the Field # section;
- Select “new” at the bottom of the screen to create the measurement;
- Enter the data into the appropriate blank spaces and ensure the performed on date is the correct date in which the measurements took place;
- If qualifiers are required due to unusual circumstances observed, select the text or details symbol at the left side of the screen associated with the same location. There will be a drop down list in which to select the appropriate qualifier

- On this page you also assign a purpose and enter any comments if necessary;
- Select Return to Grid to continue entering data;
- Alterations must be made only as necessary and an audit trail provides a means of tracking altered data;
- Inform the Compliance Coordinator of flagged data as detailed in accordance with RG8.7.2.02 Control Limit Registry
- Inform the Environmental Coordinator of limit exceedances (compliance, action level, internal investigation) identified during the data entry/importing phase in accordance with RG8.7.2.02 Control Limit Registry

4.2.4 It is important to adhere to the following standards during scheduled data entry to ensure consistency and accuracy of the data:

- Log on to the emLine database under Network I.D and password;
- Select the appropriate application in which the data will be entered (ie. Rio Algom Limited, Denison Mines Inc., or Serpent River Watershed Monitoring Project);
- Select the Rapid Entry of Events module;
- Use the drop down list to select the event type (water sample, field event) appropriate for the task performed;
- Enter the desired date range in which data will be entered and refresh the table;
- Change the status for each location that is viewed as “pending” to “completed”. This can be done by using the drop down arrow provided. Ensure the date shown is the correct date that the event was completed;
- Save the completed events by selecting the “save” button at the bottom of the screen. Ensure that a field number is generated for each event that was marked as completed;
- Select the “home” icon at the top of the page. This will return the user to the main screen;
- Select Rapid Entry of Measurements;
- Use the drop down list to select the event type (water sample, field event) appropriate for the task performed
- Enter the desired date range in which data will be entered and refresh the table;
- Enter the data into the appropriate blank spaces and ensure the performed on date is the correct date in which the measurements took place;
- If qualifiers are required due to unusual circumstances observed, select the text or details symbol at the left side of the screen associated with the same location. There will be a drop down list in which to select the appropriate qualifier;
- On this page you also assign a purpose and enter any comments if necessary;
- Select the save button at the bottom of the screen;

- Select Return to Grid to continue entering data;
- Alterations must be made only as necessary and an audit trail provides a means of tracking altered data;
- Inform the Compliance Coordinator of flagged data as detailed in accordance with RG8.7.2.02 Control Limit Registry
- Inform the Environmental Coordinator of limit exceedances (compliance, action level, internal investigation) identified during the data entry/importing phase in accordance with RG8.7.2.02 Control Limit Registry

4.2.5 It is important to adhere to the following standards during importing of data to ensure consistency and accuracy of the data:

- Once the results have been received from the laboratory, save the excel and pdf files Annual Archive/Analytical Results for future reference and retrieval during the importing process;
- Log on to the emLine database under Network I.D and password;
- Select the Denison Environmental Services Application;
- Select importing;
- Under the tasks heading select “start a new import”;
- Under file format use the drop down arrow to select excel spreadsheet
- Under worksheet name in the filename of the data to be imported (EM LINE is the file name currently used for all files);
- Select the Upload File button associated with the filename and navigate through the system and select the file to be imported;
- Select the magnifying glass associated with the import class and select the measurement button;
- Select next at the bottom of the page, this will load all data on the file to the screen
- Select “import data” once file has been loaded successfully;
- Select “view warning” at the bottom of the page;
  - Inform the Compliance Coordinator of flagged data as detailed in accordance with RG8.7.2.02 Control Limit Registry
  - Inform the Environmental Coordinator of limit exceedances (compliance, action level, internal investigation) identified during the data entry/importing phase in accordance with RG8.7.2.02 Control Limit Registry
- Select “finish” to save the data into the database.

4.3 Data Validation and Review

Data validation and review of performance monitoring data shall be conducted in accordance with PR8.7.3.02 Data Validation Procedure.

5 TRAINING

The Environmental Coordinator is responsible for confirming that all care and maintenance staff conducting performance monitoring data entry meets the following minimum training requirements:

- Completion of documented review of this procedure and associated report forms;
- Completion of documented review of associated data validation procedures;
- Completion of documented on the job training for emLine database access and report generation

6 ADMINISTRATION

6.1 Procedure Review

Standard operating procedure documents are to be reviewed in accordance with the schedule and responsibilities identified in RG1.0.0.02 Operating Document Registry.

6.2 Program, Plan and Procedure Revisions

Document revisions identified during routine review, program modifications (e.g. program design or State of Environment Reports) and/or audit process are to be implemented in accordance with PR11.1.0-01 Operating Document Review and Revision Procedures.

7 RECORDS

Table 7.1. Companion Document Listing

Document Number	Document Name
Minnow, 2009a	Monitoring Framework for Closed Mines, Near Elliot Lake.
Minnow, 2009b	Serpent River Watershed Monitoring Program Cycle 3 Study Design
Minnow, 2009c	Source Area Monitoring Program, Revised Study Design
Minnow, 2009d	Tailings Management Area Operational Monitoring Program (TOMP) Revised Study Design
Minnow, 2011	Serpent River Watershed State of the Environment Report
RG1.0.0.02	Operating Document Registry
RG8.5.2.01	Water Quality Monitoring Data Quality Objectives
PR8.7.2.01	Scheduling
RG8.7.2-01	Performance Monitoring Registry
RG8.7.2.02	Control Limit Registry
PR8.7.3.02	Data Validation Procedure
PR11.1.0.01	Operating Document Review and Revision Procedures

8 REVISION RECORD

Table 8.1. Revision Summary

Revision	Date	Purpose of Revision
2007-01	Aug 15, 2007	Update roles and responsibilities as well as procedure references and remove references to Envista
2011-01	Feb. 18, 2011	Update roles and responsibilities, include Denison Mines to reflect common use of procedure; revised schedule requirement references to Cycle 3 Design and 2011 draft State of Environment Report

Data Validation

Operating Procedure: PR8.7.3.02	Revision: 2011.01	
	Replaces: 2007.01	
Approved: February 25, 2011		Valid Until: February 25, 2016
Asset Owner	Reclamation Manager	Debbie Berthelot
	Denison Manager	Ian Ludgate
Document Reviewer	Environmental Coordinator	Andrea Conway
Document Owner	Compliance Coordinator	Valerie Kilp
Document Control	Document Clerk	Stacey Wood
Key Contacts	Environmental Manager	Mark Smith
	Operations Superintendent	Jacques Ribout

1 PURPOSE

The purpose of this procedure is to:

- Assure the quality and accuracy of data entered in the environmental monitoring database by ensuring no major identifiable sampling, analysis or entry errors have occurred;
- Establish data validation standards that are consistent with program requirements and procedures; and
- Assign responsibility to ensure that data is validated in accordance program requirements and procedures and optimal environmental database functionality

2 APPLICATION

This procedure applies to all Rio Algom Limited and Denison Mines Inc. Elliot Lake performance monitoring data generated from any of the following programs:

- SRWMP: Serpent River Watershed Monitoring Program;
- SAMP: Source Area Monitoring Program;
- TOMP: Tailings Management Area (TMA) Operational Monitoring Program;

Field parameters, samples and analytes subject to data validation are scheduled in the environmental database in accordance with RG8.7.2.01 Performance Monitoring Registry.

3 ROLES AND RESPONSIBILITIES

3.1 The Rio Algom Reclamation Manager and Denison Environmental Services Manager

The Rio Algom Reclamation Manager and Denison Environmental Services Manager have overall responsibility for the on-going operating, care and maintenance of the Rio Algom Limited

(RAL) and Denison Mines Inc. (DMI) Elliot Lake Facilities including the Performance Monitoring Plan. Responsibilities specific to this procedure include:

- Final authorization of review and revisions of this procedure; and
- Providing the Care and Maintenance Contractor with documentation that would affect change to this procedure;

3.2 Environmental Manager

The Environmental Manager has overall responsibility for ensuring that the Performance Monitoring Plan is implemented including data validation. Responsibilities specific to this procedure include:

- Confirming care and maintenance personnel participating in data validation are adequately trained and competent to perform assigned task;
- Reviewing data validation reports and trends and managing modifications of associated procedures and training programs as required;
- Confirming care and maintenance contractor and consultant conformance with this procedure or in the case of consultants their equivalent to this procedure

3.3 Environmental Coordinator

The Environmental Coordinator is responsible for overseeing implementation of the Data Validation Procedure. Responsibilities specific to this procedure include

- Assigning responsibility for completion of data validation in accordance with this procedure;
- Informing care and maintenance contractor staff of changes to data quality assessment procedures;
- Directing training of care and maintenance contractor staff involved in data validation;
- Initiating and directing data management and analytical services modifications required in response to changes to this procedure;
- Initiating and reviewing modifications to this procedure and associated registries and report forms;
- Developing and supervising responses to data that does not conform to the data validation criteria and communicating progress to Environmental Manager and Reclamation Manager; and
- Reviewing data validation reports and programs and initiating and supervising modifications as required.
- Informing care and maintenance contractor staff of changes to this procedure;
- Conducting scheduled and unscheduled spot checks to verify care and maintenance contractor and consultant conformance with this procedure.

3.4 Compliance Coordinator

The Compliance Coordinator is responsible for implementation of the Data Validation Procedure. Responsibilities specific to this procedure include:

- Conducting data validation in accordance with PR8.7.3-02 Data Validation including preparation and maintenance of data validation records and reports
- Reviewing and posting data;
- Reviewing and confirming that field and analytical results are valid and entered into the data management system within 60 days of the sample date;
- Generating and reviewing data validation reports using the report forms associated with this procedure and initiating responses to data that does not conform to the data validation protocols
- Implementing responses to data that does not conform to the data quality objectives as directed by the Environmental Coordinator
- Preparing data validation components of internal and regulatory monthly and annual water quality reports including reporting on the status of responses to data that does not conform to the data validation protocols;
- Implementing modifications to this procedure and associated report forms in accordance with RG1.0.0.01 Operating Document Registry

3.5 Field Technician and Operators

Field Technicians, Operators or other individuals assigned performance monitoring responsibilities under the SRWMP, SAMP or TOMP programs are responsible for:

- Participating in and completing the training requirements
- Responding to data validation inquiries and associated activities as assigned
- Posting field data within one week of data collection
- Informing the Compliance Coordinator of flagged data during the data entry/importing phase in accordance with RG8.7.2.02 Control Limit Registry

4 PROCEDURES

4.1 Supporting Reports

4.1.1 The Compliance Coordinator is responsible for ensuring that changes in data validation procedures are incorporated into RF8.7.3.02 Flagged Data Report

4.1.2 The Compliance Coordinator is responsible for ensuring all environmental database data validation report forms are working correctly and initiating modifications with the data management service provider as required. Environmental data management report forms are maintained in the data management system under the appropriate application (Rio/SRWMP/Denison) and can be accessed by the Reports/Report Manager when logged on to the database.

Assessments limit calculations are documented in PR8.7.2.02 Control Limit Maintenance.

4.2 Data Validation Requirements

4.2.1 Any person entering data into the database, in accordance with PR8.7.3-01 Data Entry Procedures, is responsible for informing the Compliance Coordinator of flags during import and data entry, to ensure timely resolution of import and data validation issues.

4.2.2 All field data shall be reviewed and posted on at least a weekly basis by relevant field staff.

- Log into em-Line and select the appropriate application in which the data will be validated (ie. Rio Algom Limited, Denison Mines Inc., or Serpent River Watershed Monitoring Project)
- Select the Compliance Module: Review Measurements;
- Sort as desired (parameter, location etc.), to facilitate review of individual data;
- Review, trend data and either post or report any unusual flags to the Compliance Coordinator;
- Inform the Environmental Coordinator of limit exceedances (compliance, action level, internal investigation) identified during the data entry/importing phase in accordance with RG8.7.2.02 Control Limit Registry
- Click the Save button/

4.2.3 In order to ensure all data has been entered in compliance with the schedule requirements the data will first be reviewed and posted, by the Compliance Coordinator (or designate):

- Log into em-Line and select the appropriate application in which the data will be validated (ie. Rio Algom Limited, Denison Mines Inc., or Serpent River Watershed Monitoring Project)
- Select the Compliance Module: Review Measurements;
- Group by Limit types (go back about 2 months) and hit Refresh;
- Review and post limit groups with no exeedences; save after each one ;
- Report any Action, Compliance, High/Low Flags or Internal limit exeedences to Environmental Coordinator first before posting;
- As a check refresh by selecting the Status.

4.2.4 In order to ensure that all scheduled analytes have been completed, prior to the validation process:

- Select the Reports Module; Under Monitoring & Compliance select Schedule Compliance:
- Under Measurement Status, filter on Pending and Entered samples;
- View the Schedule Compliance Report; Print if desired;

- Contact the laboratory as required to address any outstanding issues.

4.2.5 The Compliance Coordinator is responsible for conducting data validation in the environmental monitoring database in accordance with this procedure.

- Log onto the environmental monitoring database and select Detailed Measurements under the Environmental Performance Module;
- Type in Station and Analyte (Parameter) and select date criteria (go back at least 5 years); View Report and review trend individually for each analyte.

4.2.6 The Compliance Coordinator is responsible for running RF8.7.3.02 Flagged Data Report on a monthly basis. This includes:

- Click on the Reports Tab along the top of the environmental database tool bar;
- Select the Report Manager under Other Reports;
- Select the Hi/Low Flag and set date criteria for the previous month only; View Report;
- Save the file to operating program records Section 8.7 when prompted; Open & Print.

4.2.7 Figure 4.1 Decision Path for Data Validation includes a detailed flow path for guidance/reference in decision making with respect to data validation of the data points generated in 4.2.6:

1. Flagged data points will be evaluated through trending in Detailed Measurements Reports to determine:
    - Whether they are in error; or
    - At the beginning of a gradual trend or shift in the system; or
    - The result of a system upset; or
    - Result of a lab or sampling error.
2. Where there is no readily identifiable factor causing a data point to be flagged, re-analysis or re-sampling will be conducted;
3. If the resulting second data point does not corroborate the first (ie: it is within the acceptable range of variability), the new data point will be accepted and the old one rejected from the database. Comments will be made in the comments section of the individual analytes;
4. If the second data point corroborates the first, the data will be accepted or rejected on the basis of trend evaluation as outlined in Figure 4.1;
    - If a trend is identified the data point will be accepted and a new assessment limit will automatically calculated in the database Limits as per PR8.7.2.02 Control Limit Maintenance Procedure.
    - If no trend is identified, (pending the database update) the data point will be isolated from the main database into a separate location where it will be stored but will not affect valid data and trends.

5. Include comments on the decision path, validation process on RF8.7.3-02 Flagged Data Report, included in the monthly Care and Maintenance Report
6. A summary of all rejected data will be provided with the data quality reporting in the Annual Water Quality Report.

5 TRAINING

The Environmental Coordinator is responsible for confirming that all care and maintenance staff conducting performance monitoring meets the following minimum training requirements:

- Completion of documented review of this procedure and associated report forms;
- Completion of documented on the job training for emLine database access and report generation
- Completion of documented review of RG8.7.2.02 Control Limit Registry

6 ADMINISTRATION

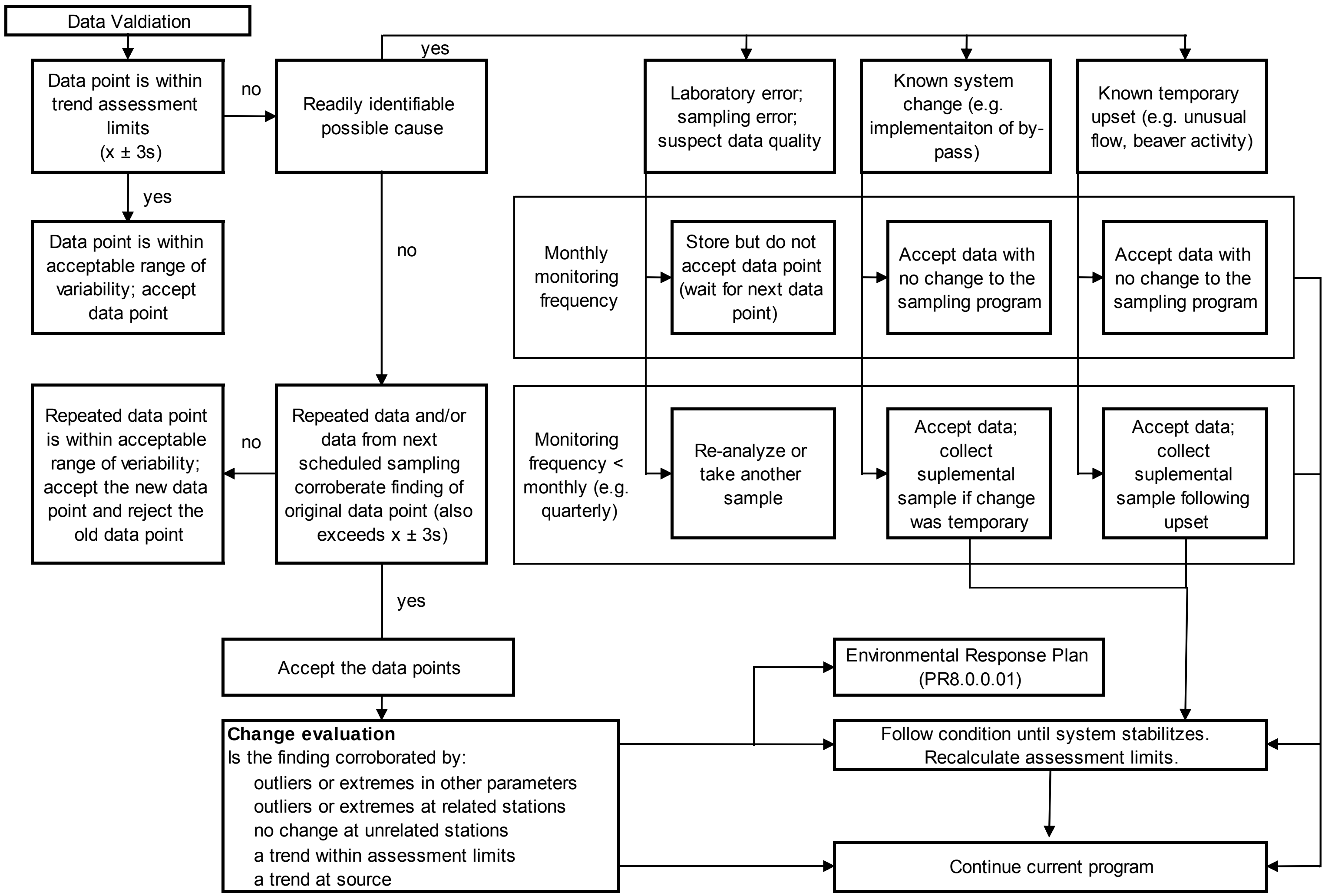
6.1 Procedure Review

Standard operating procedure documents are to be reviewed in accordance with the schedule and responsibilities identified in RG1.0.0.02 Operating Document Registry.

6.2 Program, Plan and Procedure Revisions

Document revisions identified during routine review, program modifications (e.g. program design or State of Environment Reports) and/or audit process are to be implemented in accordance with PR11.1.0-01 Operating Document Review and Revision Procedures.

Figure 4.1. Decision Path for Data Validation



7 RECORDS

Table 7.1. Companion Document Listing

Document Number	Document Name
Minnow, 2009a	Monitoring Framework for Closed Mines, Near Elliot Lake.
Minnow, 2011	Serpent River Watershed State of the Environment Report
RG1.0.0.02	Operating Document Registry
PR8.7.2.01	Scheduling
RG8.7.2-01	Performance Monitoring Registry
PR8.7.2.02	Control Limit Maintenance
RG8.7.2.02	Control Limit Registry
RF8.7.3.02	Flagged Data Report
PR11.1.0.01	Operating Document Review and Revision Procedures

8 REVISION RECORD

Table 8.1. Revision Summary

Revision	Date	Purpose of Revision
2007-01	Aug 15, 2007	Update roles and responsibilities as well as procedure references, update based on transition from Envista to emLine
2011-01	Feb. 18, 2011	Update roles and responsibilities, add supporting reports section; revise Fig 4.1 to align with Cycle 3 design

DATA RETRIEVAL PROTOCOL

Serpent River Watershed State of the Environment Report Data Retrieval Summary

Data Retrieval General:

The State of the Environment (SOE) Report data files were extracted from the emLine database using a number of different methods and rationale to satisfy each individual point outlined in various data requests from Minnow Environmental Inc. (Minnow). Retrieval methods and rationale employed by DES to satisfy the various data requests are described below. It should be noted that annual means calculated from data provided for the SOE report may not equal annual means presented in the Annual Operating, Care and Maintenance (OCM) Reports. Annual OCM reported averages are calculated using data collected for "regulated" sample results only; whereas the data extracted for the SOE report reflects all available data including "Internal" & "Special Project" data for averaging purposes. Data from 2005 to 2006 had already been downloaded for use in the SOE (Minnow 2008) and so retrieval of data was limited to data collected since the last SOE (i.e., 2007 to 2009)

Reagent Use & Treated Effluent Volume:

ETP Operating Summaries, running from January 1 2007 to December 31 2009, were pulled using the report form set up in emLine for the completion of the Annual Reports. It should be noted that 2009 was the first year that barium chloride was not used during treatment at the Pronto ETP.

Total flow data from these reports should not be used in the calculation of loadings as they are based on average monthly flows and not actual daily flows reported.

File: Minnow Request – Reagent Use07-09rev

Surface Water:

SAMP results were pulled from emLine using Cycle 3 locations and parameters, running from January 1 2007 to December 31 2009, using the SAMP purpose. In addition, TSS, Cu, Pb, Ni, Zn were requested to assess license discharge criteria. Any "<" symbols were segregated to a separate cell adjacent to the corresponding value to provide a workable spreadsheet. Each SAMP location was assigned to a separate worksheet.

File: Minnow Request – SAMP07-09rev

TOMP results were pulled from emLine using Cycle 3 locations and parameters, running from January 1 2007 to December 31 2009. Any "<" symbols were segregated to a separate cell adjacent to the corresponding value to provide a workable spreadsheet. Each TOMP location was assigned to a separate worksheet, with locations for each site segregated into individual files due to the large amounts of data.

File: TOMP_Denison07-09rev
TOMP_Milliken07-09rev
TOMP_Nordic07-09rev
TOMP_Panel07-09rev
TOMP_Pronto07-09rev
TOMP_Quirke07-09rev
TOMP_SpanAmerican07-09rev
TOMP_Stanleigh07-09rev
TOMP_Stanrock07-09rev

Groundwater:

Groundwater results were pulled from emLine using the Cycle3 locations and parameters, running from January 1 2007 to December 31 2009. Any “<” symbols were segregated to a separate cell adjacent to the corresponding value to provide a workable spreadsheet. Groundwater locations were grouped by site, with each site assigned to a separate worksheet.

File: Minnow Request – Groundwater07-09rev

SRWMP Data:

Water quality results for the SRWMP were pulled using the Cycle3 locations and parameters, running from January 1 2007 to December 31 2009, using the SWRMP purpose. All “<” symbols were segregated to a separate cell adjacent to the corresponding value to provide a workable spreadsheet. Each sample location was assigned to a separate worksheet.

File: Minnow Request – SRWMP07-09rev

Toxicity for SAMP Stations:

Toxicity results were pulled from emLine, running from January 1 2007 to December 31 2009, using the SAMP purpose. Each sample location was assigned to a separate worksheet.

File: Minnow Request – Toxicity07-09rev

Water Elevations for TMA’s:

For flooded basins water elevation data was pulled from emLine, running from January 1 2007 to December 31 2009. Each sample location was assigned to a separate worksheet.

File: Minnow Request – Basin Elevations07-09rev

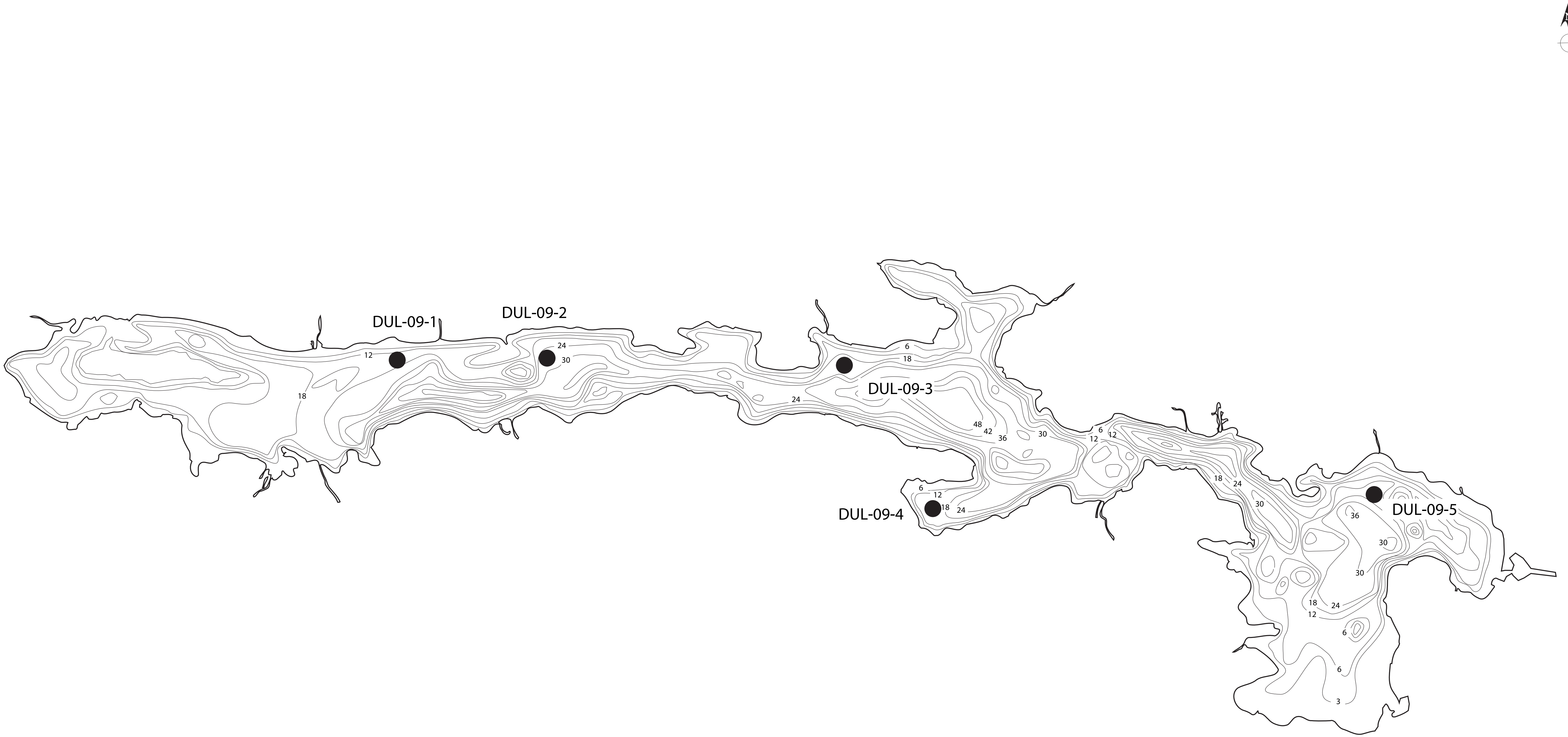
SAMPLING DEPTH AND UTM COORDINATES FOR SAMPLING STATIONS

Appendix Table A.1: Benthic and sediment monitoring station locations and depths sampled, SRWMP 2009.

Station	Station ID	Depth (m)	UTM (north)	UTM (east)
Dunlop Lake	DUL-09-1	15.1	5150897	364300
	DUL-09-2	15.3	5150867	365441
	DUL-09-3	15.0	5150805	367859
	DUL-09-4	15.0	5149613	368751
	DUL-09-5	15.1	5149642	372231
Elliot Lake	EL-09-1	15.2	5138606	367871
	EL-09-2	15.1	5138800	369733
	EL-09-3	15.5	5138518	371395
	EL-09-4	15.8	5138602	367248
	EL-09-5	15.3	5139414	367878
Hough Lake	HOL-09-1	14.8	5140440	384644
	HOL-09-2	15.0	5140550	385311
	HOL-09-3	16.0	5139975	385655
	HOL-09-4	15.8	5140037	385229
	HOL-09-5	14.7	5140470	384984
May Lake	MAL-09-1	15.0	5144773	384891
	MAL-09-2	14.8	5143310	384357
	MAL-09-3	15.1	5142843	386545
	MAL-09-4	14.8	5143297	385820
	MAL-09-5	14.8	5142155	386430
McCarthy Lake	MCL-09-1	15.4	5131182	389407
	MCL-09-2	15.3	5131187	388173
	MCL-09-3	15.0	5129043	388055
	MCL-09-4	14.9	5132124	388673
	MCL-09-5	15.1	5129917	387994
McCabe Lake	ML-09-1	15.1	5141695	378663
	ML-09-2	15.2	5142144	379486
	ML-09-3	14.6	5142813	380020
	ML-09-4	15.6	5142083	379158
	ML-09-5	15.1	5142095	379502
Nordic Lake	NL-09-1	13.0	5135447	376090
	NL-09-2	15.3	5135457	376825
	NL-09-3	14.7	5135080	377788
	NL-09-4	14.8	5135118	377372
	NL-09-5	15.3	5135284	377634
Pecors Lake	PL-09-1	14.2	5137281	388301
	PL-09-2	15.3	5138102	387594
	PL-09-3	14.8	5138969	386817
	PL-09-4	14.9	5137853	387251
	PL-09-5	15.0	5137064	389585
Quirke Lake	QL-09-1	21.0	5151261	378184
	QL-09-2	18.2	5150983	381098
	QL-09-3	20.6	5194960	384089
	QL-09-4	21.0	5148792	378194
	QL-09-5	23.2	5148765	380595
Rochester Lake	RL-09-1	15.2	5153617	383274
	RL-09-2	15.0	5153559	383590
	RL-09-3	14.7	5153407	385182
	RL-09-4	14.9	5153405	385386
	RL-09-5	15.1	5153495	383900
Semiwite Lake	SL-09-1	15.0	5159958	371505
	SL-09-2	15.0	5158814	371659
	SL-09-3	14.7	5159540	370832
	SL-09-4	15.2	5159406	372503
	SL-09-5	15.0	5159377	371917
Summers Lake	SUL-09-1	15.4	5146194	365726
	SUL-09-2	15.5	5146614	365068
	SUL-09-3	15.2	5147241	365543
	SUL-09-4	15.4	5147338	364872
	SUL-09-5	15.1	5146975	365065
Ten Mile Lake	TML-09-1	17.0	5152822	364205
	TML-09-2	18.3	5151602	363615
	TML-09-3	17.6	5152432	364966
	TML-09-4	17.6	5153825	360651
	TML-09-5	18.2	5152979	365447

All stations were sampled using a petite ponar. Benthic and sediment sampling consisted of 5 composites with an additional two composites for T.O.C. and grain size.

MAPS OF SRWMP LAKE SAMPLING LOCATIONS



0 400 1000km

depth contours in metres

Figure A.1

minnow

Dunlop Lake sample locations, September 2009.

Ref: 2295
Date: November 2010

Figure A.2

Elliot Lake sample locations, September 2009.

Ref: 2295
Date: November 2010

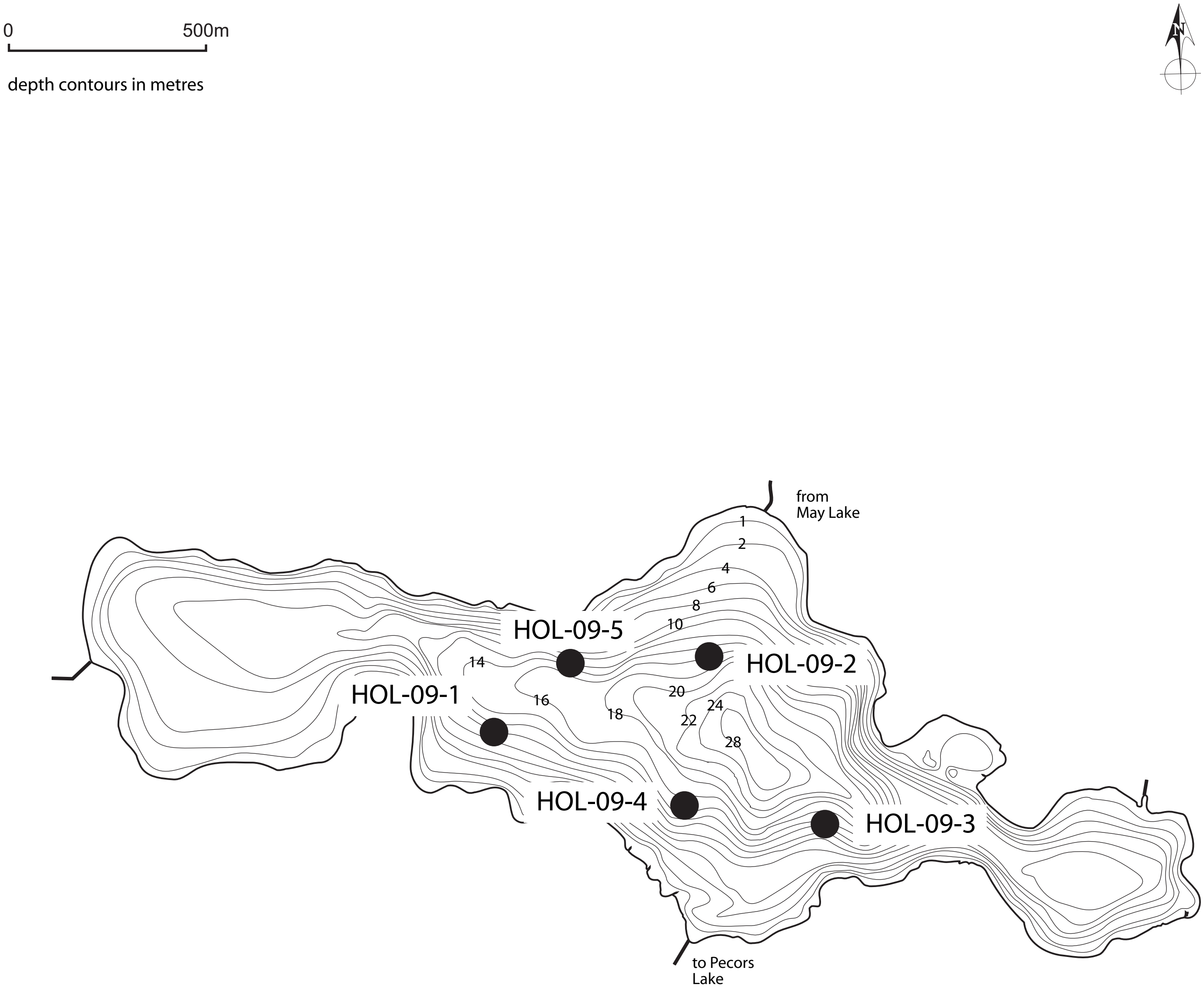


Figure A.3

Hough Lake sample locations, September 2009.

Ref: 2295
Date: November 2010

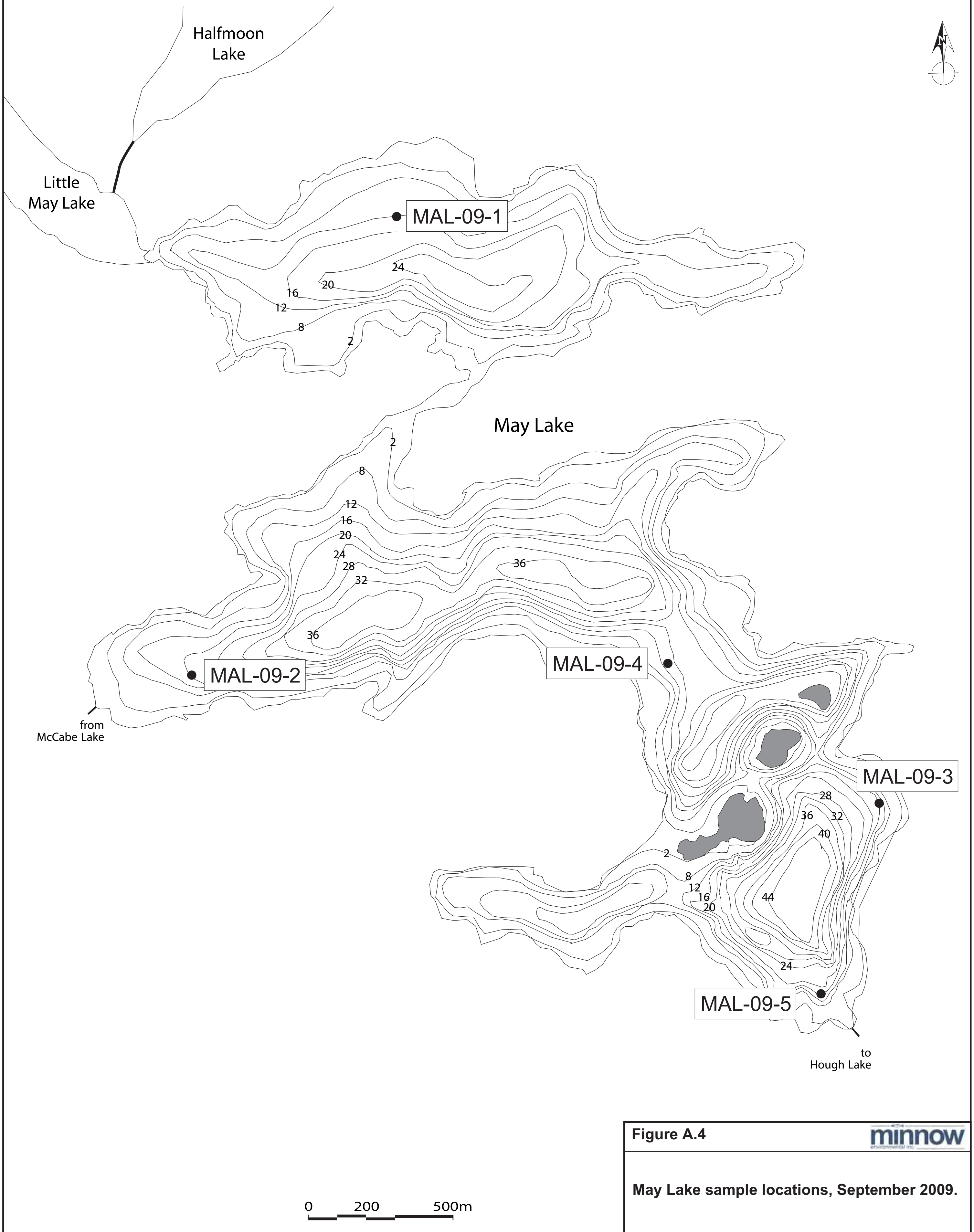


Figure A.4

May Lake sample locations, September 2009.

Ref: 2295
Date: November 2010

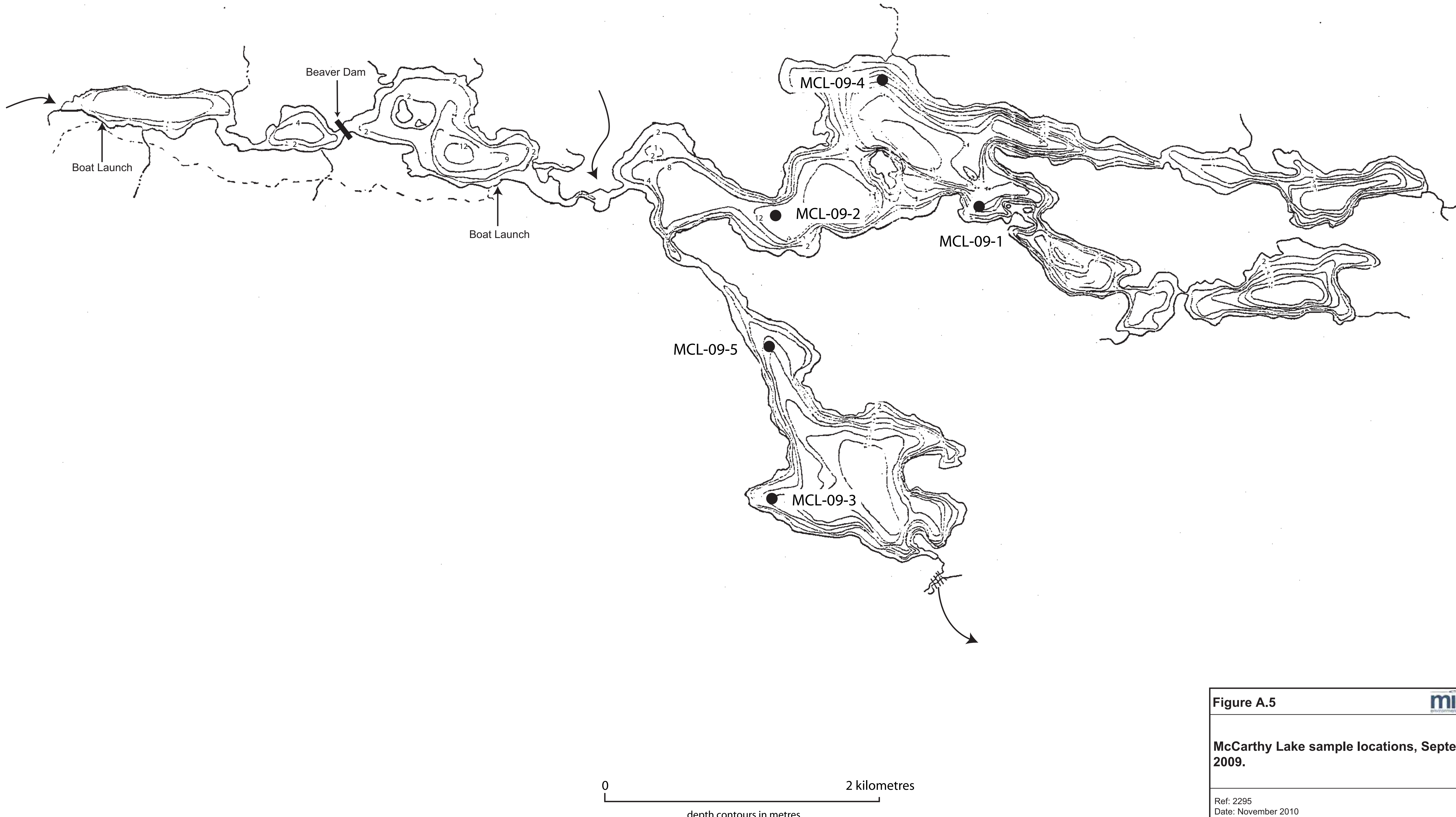


Figure A.5

McCarthy Lake sample locations, September 2009.

Ref: 2295
Date: November 2010

Figure A.6

minnow environmental inc.

McCabe Lake sample locations, September 2009.

Ref: 2295
Date: November 2010

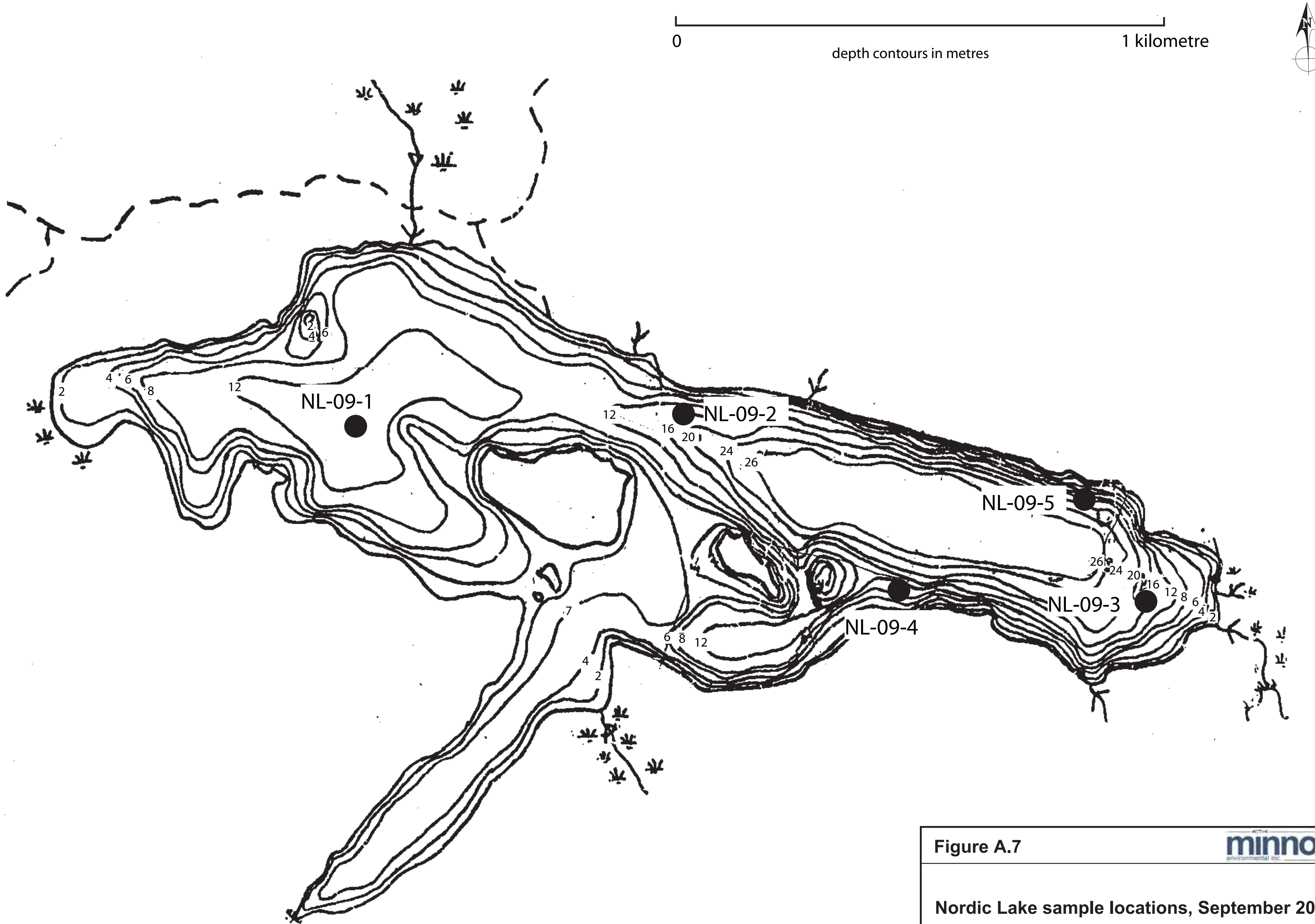


Figure A.7

minnow environmental inc.

Nordic Lake sample locations, September 2009.

Ref: 2295
Date: November 2010

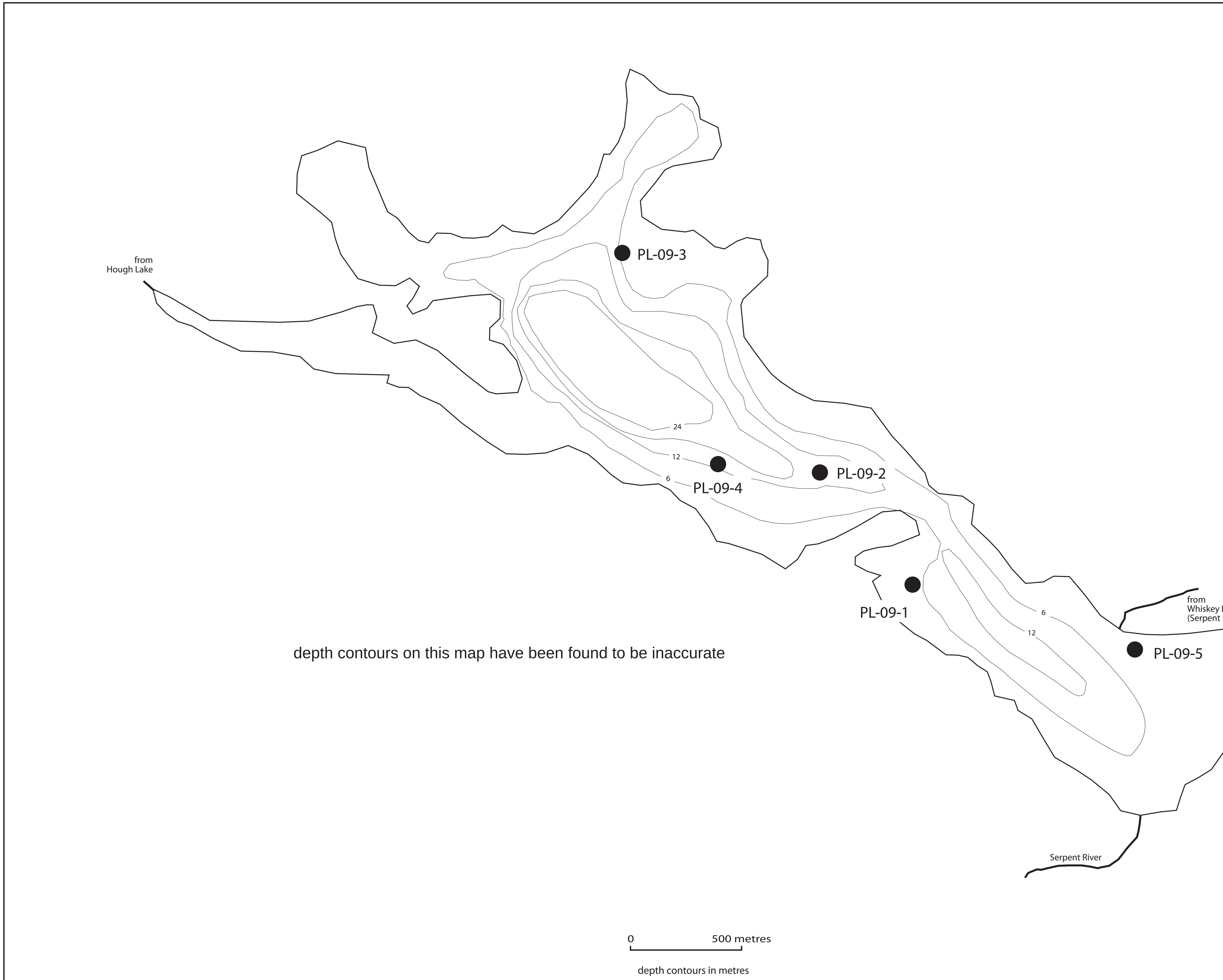


Figure A.8

Pecors Lake sample locations, September 2009.

Ref: 2295
Date: November 2010

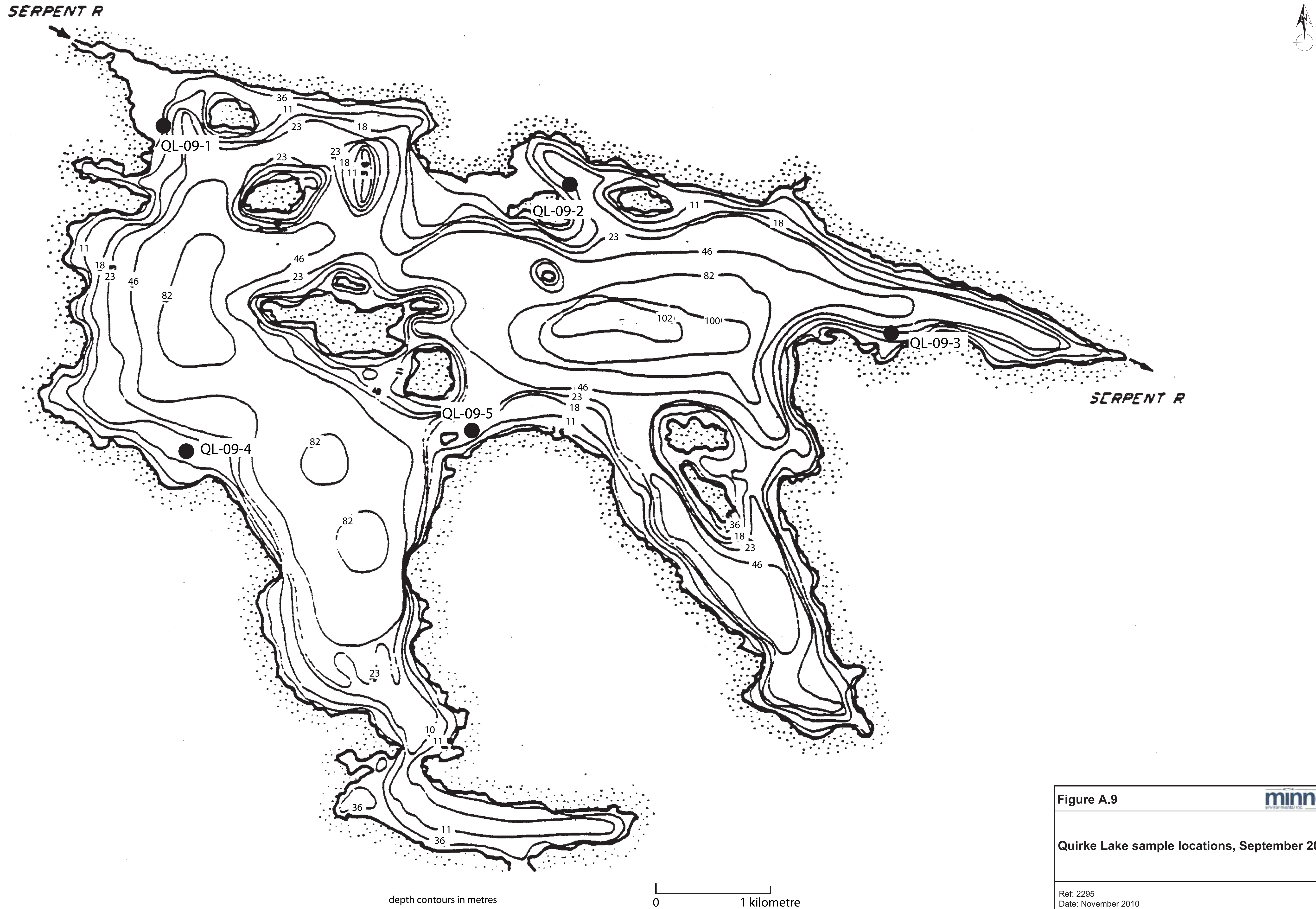


Figure A.9

Quirke Lake sample locations, September 2009.

Ref: 2295
Date: November 2010

Figure A.10

minnow

Rochester Lake sample locations, September 2009.

Ref: 2295
Date: November 2010

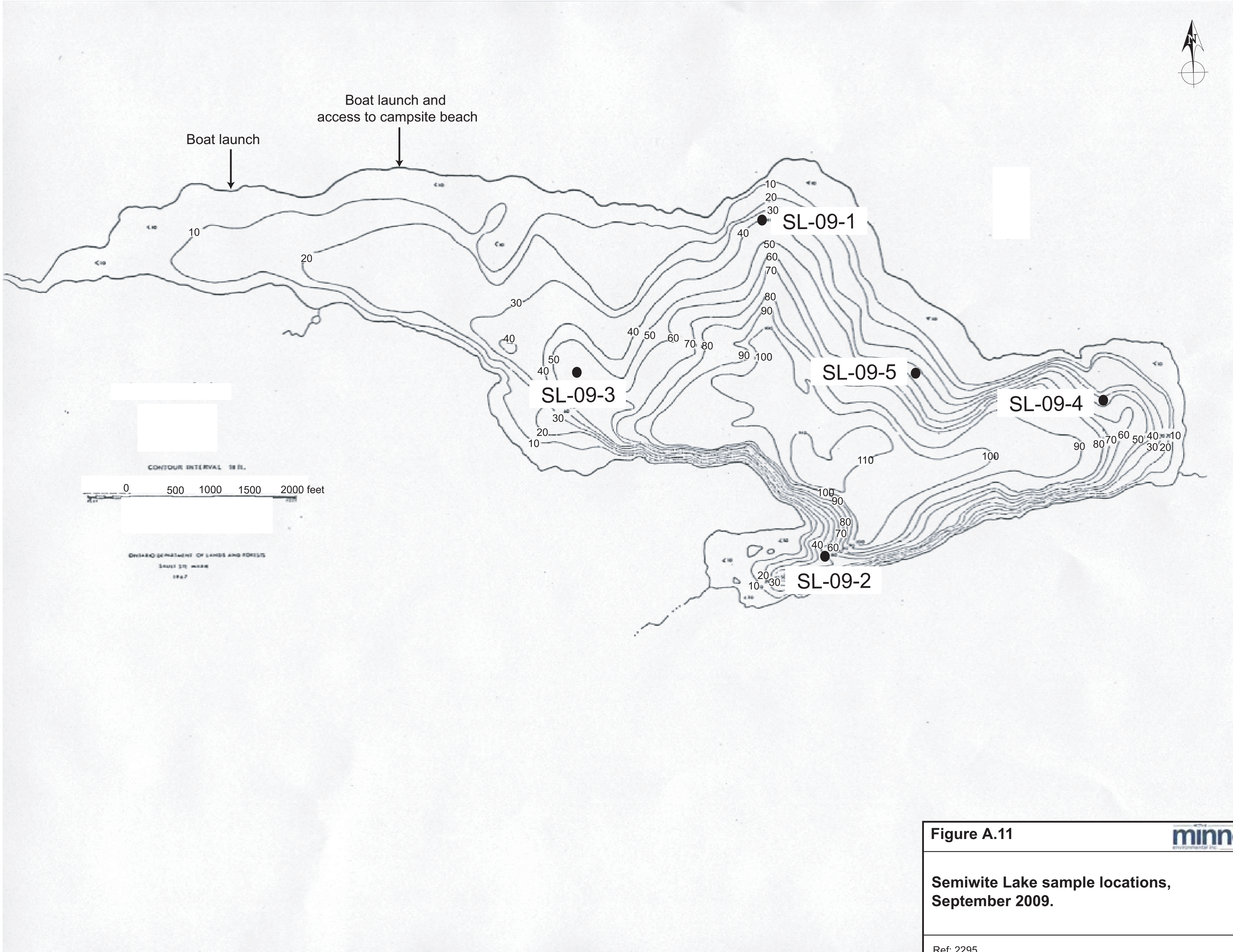


Figure A.11

minnow
environmental inc.

Semiwite Lake sample locations, September 2009.

Ref: 2295
Date: November 2010

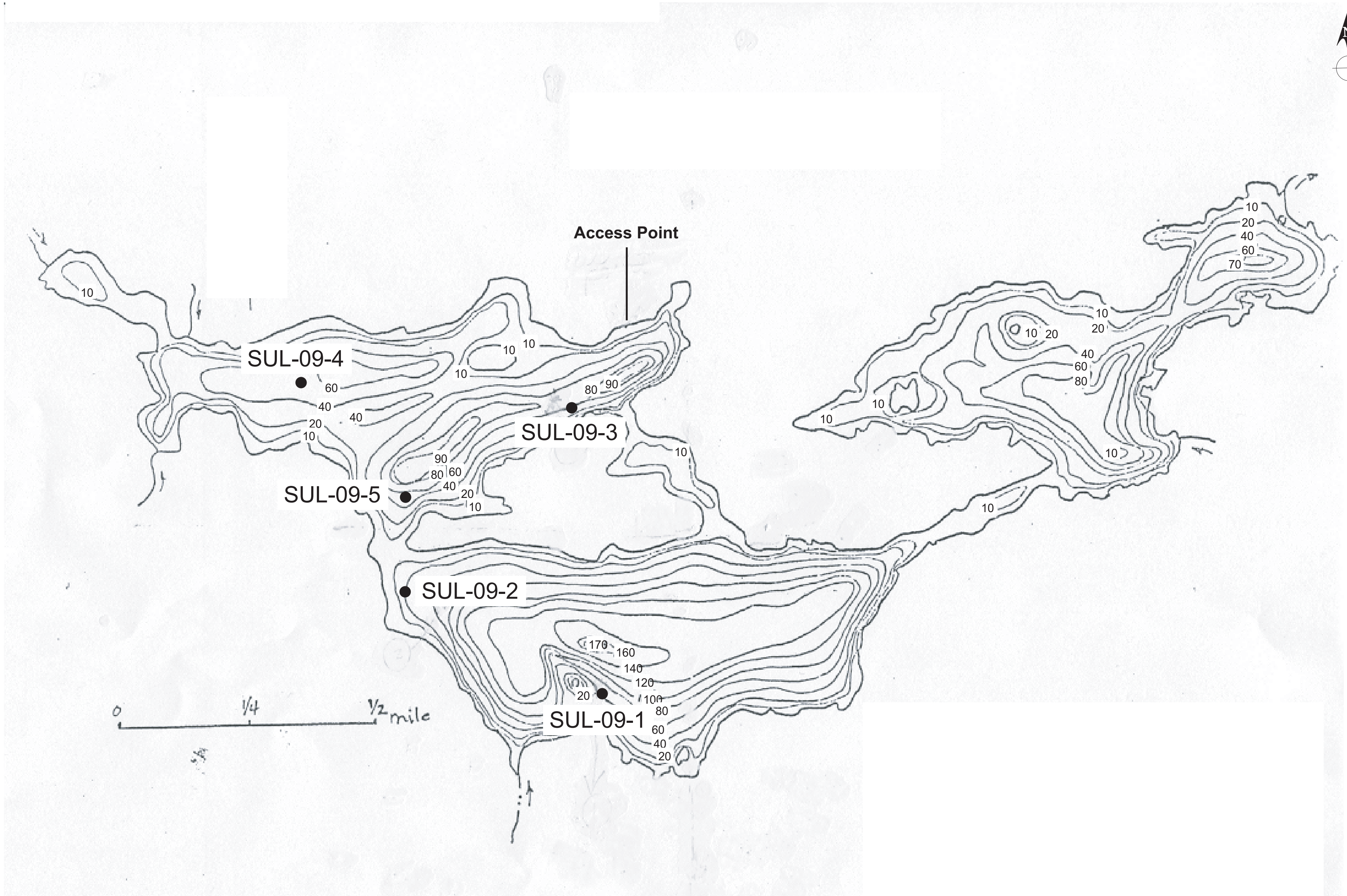
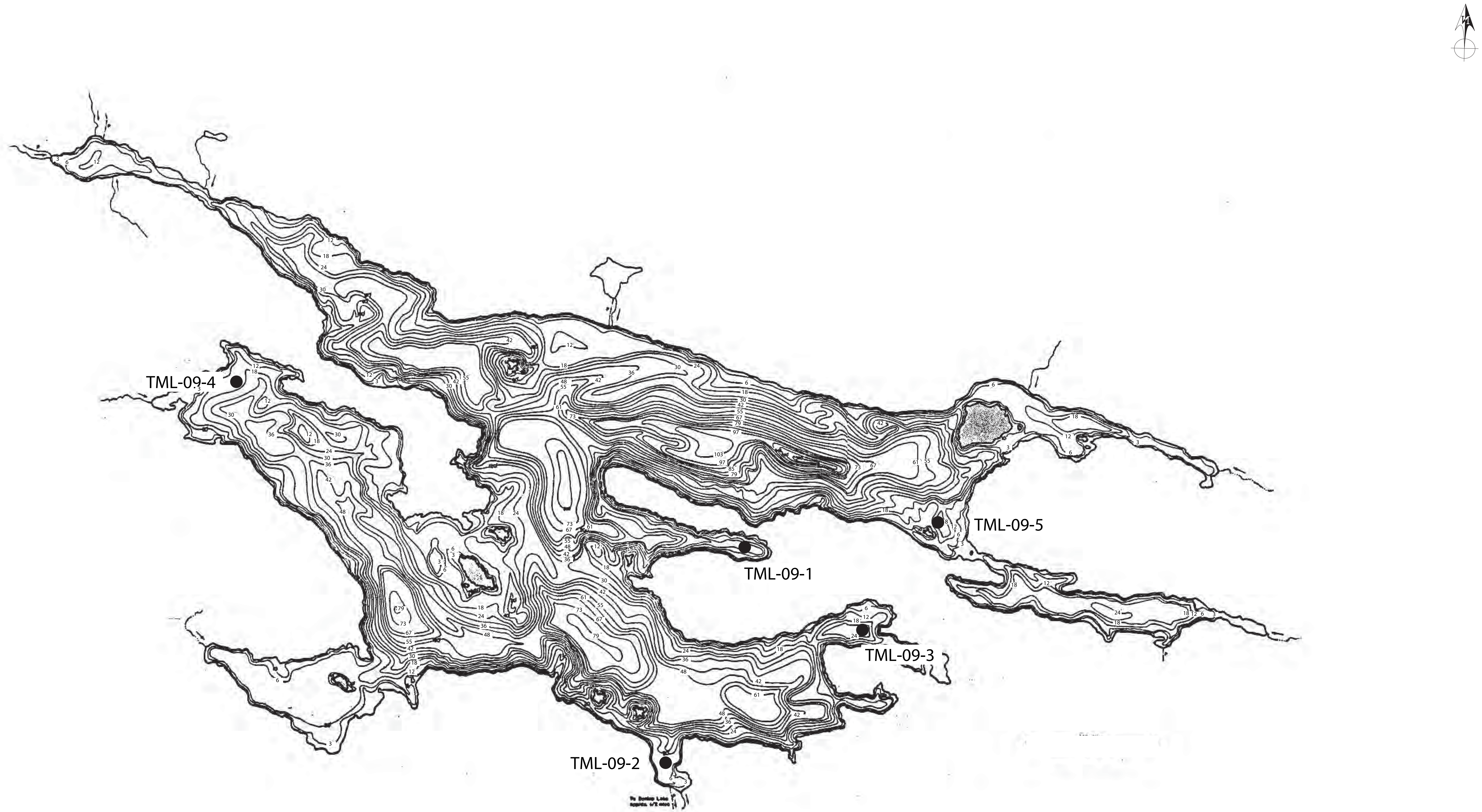


Figure A.12

minnow

Summers Lake sample locations, September 2009.

Ref: 2295
Date: November 2010



0 2 km

depth contours in metres

Figure A.13

minnow

Ten Mile Lake sample locations, September 2009.

Ref: 2295
Date: November 2010

APPENDIX B

DATA QUALITY ASSESSMENT

APPENDIX B: DATA QUALITY ASSESSMENT

B1.0 INTRODUCTION

Data Quality Assessment (DQA) was conducted on data collected under the TOMP, SAMP and SRWMP between January 2005 and December 2009. The objective of DQA is to define the overall quality of the data presented in the report, and, by extension, the confidence with which the data can be used to derive conclusions.

B1.1 Background

A variety of factors can influence the chemical and biological measurements made in an environmental study and thus affect the accuracy and/or precision of the data. Inconsistencies in sampling or laboratory methods, use of instruments that are inadequately calibrated or which cannot measure to the desired level of accuracy or precision, and contamination of samples in the field or laboratory are just some of the potential factors that can lead to the reporting of data that do not accurately reflect actual environmental conditions. Depending on the magnitude of the problem, inaccuracy or imprecision have the potential to affect the reliability of any conclusions made from the data. Therefore, it is important to ensure that monitoring programs incorporate appropriate steps to control the non-natural sources of data variability (i.e., minimize the variability that does not reflect natural spatial and temporal variability in the environment) and thus assure the quality of the data.

Data quality as a concept is meaningful only when it relates to the intended use of the data. That is, one must know the context in which the data will be interpreted in order to establish a relevant basis for judging whether or not the data set is adequate. Therefore, a quality management program was previously established for the TOMP, SAMP and SRWMP to ensure that the data produced would satisfy the objectives of the program.

The data quality assessment and validation processes for the SRWMP were prescribed in detail in the Serpent River Watershed and In-Basin “Implementation Document” (BEAK 1999). The data quality assessment and validation process was revised in 2002 following recommendations from the Cycle 1 SRWMP (Minnow and Beak 2001b). Standard Operating Procedures (SOPs) providing additional clarification and detail with respect to data quality evaluation procedures were then prepared (Minnow 2005). Similarly, data quality management plans were developed as part of the initial TOMP and SAMP programs (Minnow 2002 a, b) which were updated as part of the revised study designs (Minnow 2009 a, b). Data quality for data collected during Cycle 3 of the TOMP, SAMP and SRWMP (2005 to 2009) was assessed in accordance with the requirements outlined in the study designs and the results are presented in the following sections.

In brief, data quality assessment involved comparison of actual field and laboratory measurement performance to the data quality objectives (DQOs) established for the SRWMP, SAMP and TOMP (Appendix Tables B.1 and B.2). This included evaluation of analytical method detection limits, blank sample concentrations (field and laboratory), data precision (based on field and laboratory duplicate samples), and data accuracy (based on matrix spikes and certified reference material analyses). Data quality protocols and sampling were incorporated into all components of the SRWMP, SAMP and TOMP including water, sediment, and benthos and represented a minimum of 10 percent of the total samples submitted for analysis.

Programs involving a large amount of samples and analytes usually result in some results that exceed the DQOs. This is particularly so for multi-element scans (e.g., ICP scans for metals) since the analytical conditions are not necessarily optimal for every element included in the scan. Generally, scan results may be considered acceptable if no more than 20% of the parameters fail to meet the DQOs. Overall, the intent of comparing data to DQOs was not to reject any measurement that did not meet the DQO, but to ensure any questionable data received more scrutiny to determine what effect, if any, this had on interpretation of results within the context of this project.

B1.2 Water Sampling Program Administration

Water quality sampling is administered by Denison Environmental Services (DES) under contract to Rio Algom Limited and Denison Mines Inc. DES personnel are responsible for the scheduling of water sampling and quality assurance (QA) samples (field blanks and duplicates), the collection of samples, submission to the laboratory, data validation and water quality report preparation (monthly and annual reporting).

DES is also responsible for ensuring that all staff participating in the collection and handling of samples and data management for the SRWMP, SAMP and TOMP are adequately trained. In addition to the provision of standard operating procedures (SOPs) for each aspect of the program, DES maintains a training module on their database which tracks the completion of training for each employee by equipment or task.

Rio Algom Limited and Denison Mines Inc. have an Operating Document Registry which provides procedures and protocols to address all aspects of decommissioning operations and monitoring (Minnow 2005). DES staff use these protocols to implement the water quality monitoring component of the TOMP, SAMP and SRWMP. Standard Operating Procedures that provide further clarification and detail with respect to data quality evaluation procedures are provided (Appendix A –PR8.5.3-01, PR8.5.4-01 and PR8.7.3-02)

The water samples were analyzed by the Elliot Lake Research Field Station (ELRFS; Laurentian University, Sudbury, Ontario) until the end of 2005 and since January 2006 SGS Laboratories (Lakefield, Ontario) have conducted the water analysis. Both laboratories are accredited by the Canadian Association of Environmental and Analytical Laboratories (CAEAL). Since 2006, Becquerel Laboratories (Mississauga, Ontario) has been commissioned to analyze for radium-226 in water and sediment samples.

Prior to 2006, ELRFS laboratory entered laboratory results into a central database program (Envista) following internal QA review. As of January 2006, the data management software was changed to emLine and since that time SGS laboratories has entered the data into their laboratory information management system (LIMS) data management program and DES imports the data from LIMS into emLine. This minimizes data entry errors.

As per the TOMP, SAMP and SRWMP the laboratories were responsible for conducting QA analysis including laboratory blanks and duplicates, as well as Certified Reference Material (CRM) and spike sample recoveries. Each laboratory provided annual data quality reports in which they compare the performance of QA samples to the established data quality objectives (2005-2009 annual reports can be found at the end of this appendix). Due to a re-issue of results in 2006 and 2007, Becquerel Laboratories quality assurance reports are provided as separate files at the end of this appendix, while the reports from 2008 and 2009 from Becquerel Laboratories are summarized at the end of the 2008 and 2009 SGS reports, respectively. Detailed quality assurance reports are kept on file as part of the monitoring archives with DES and Rio Algom Ltd.

B1.3 Types of Quality Control Samples Collected

Several types of quality control (QC) samples were assessed based on samples collected (or prepared) in the field and laboratory. These samples, and a description of each, include the following:

- **Field Duplicates** are replicate samples collected from a selected field station using identical collection and handling methods that are then analyzed separately in the laboratory. The duplicate samples are handled and analyzed in an identical manner in the laboratory. The data from field duplicate samples reflect natural variability, as well as the variability associated with sample collection methods, and therefore provide a measure of field precision.

- **Laboratory Duplicates** are replicate sub-samples created in the laboratory from randomly selected field samples which are sub-sampled and then analyzed independently using identical analytical methods. The laboratory duplicate sample results reflect any variability introduced during laboratory sample handling and analysis and thus provide a measure of laboratory precision.

- **Spike Recovery Samples** are created in the laboratory by adding a known amount/concentration of a given analyte (or mixture of analytes) to a randomly selected test sample previously divided to create two sub-samples. The spiked and regular sub-samples are then analyzed in an identical manner. The spike recovery represents the difference between the measured spike amount (total amount in spiked sample minus amount in original sample) relative to the known spike amount (as a percentage). Two types of spike recovery samples are commonly analyzed. Spiked blanks are created using laboratory control materials whereas matrix spikes are created using field-collected samples. The analysis of spiked samples provides an indication of the accuracy of analytical results.

- **Certified Reference Materials and QC Standards** are samples containing known chemical concentrations that are processed and analyzed along with batches of environmental samples. The sample results are then compared to target results to provide a measure of analytical accuracy. The results are reported as the percent of the known amount that was recovered in the analysis.

Two types of QC were applied to benthic invertebrate community samples as follows:

- **Organism Recovery Checks** for benthic invertebrate community samples involve the re-processing of previously sorted material from a randomly selected sample to determine the number of invertebrates that were not recovered during the original sample processing. The reprocessing is conducted by an analyst not involved during the original processing to reduce any bias. This check allows the determination of accuracy through assessment of recovery efficiency.

- **Sub-Sampling Error** is assessed for studies in which benthic invertebrate community samples require sub-sampling (due to excessive sample volume and/or invertebrate density). By comparing the numbers of benthic invertebrates recovered between at least two sub-samples, this measure provides an evaluation of how effective the sub-sampling method was in evenly dividing the original sample. Therefore, sub-sampling error provides a measure of analytical accuracy and precision. The processing of entire benthic invertebrate community samples in representative sample fractions also allows an evaluation of sub-sampling accuracy.

B2.0 WATER SAMPLES

B2.1 Method Detection Limits

In general, the requested method detection limits (MDLs) were achieved for SRWMP, SAMP and TOMP for most parameters assessed during the 2005 to 2009 period (Tables B.3 and B.4). There were a few exceptions for cobalt, sulphate, TSS and uranium at only one or two stations within each program (Table B.5). In instances where requested MDLs were not achieved, the difference was generally minimal (i.e., sulphate, TSS), there was a suspected typographical error (i.e., cobalt), and/or the achieved MDL was at or below receiving environment water quality criteria (i.e., sulphate, TSS, uranium; Table B.5). Specifically, at SRWMP station P-01 and TOMP station DK16-2B, the sulphate MDL was five- and two-fold higher than requested, respectively; however, the achieved MDL was substantially lower than the receiving environment criteria. In SAMP, the achieved uranium MDL at station N-12 (2005) was an order of magnitude higher than the requested MDL; however, it was still equal to the receiving environment criteria. Achieved MDL for TSS at SAMP station D-2 (2006) and TOMP station Q-28 (2006) was two-fold higher than the requested MDL. However, given that the effluent discharge criteria is between 20 and 50 mg/L, the higher MDL did not affect the ability of the mine to determine compliance with effluent limits. The achieved MDL for cobalt at SAMP station D-2 (2005) was higher than both the requested MDL and the receiving environment criteria. This was likely a typographical error as the MDL in May and November 2005 was 0.0003 mg/L for all 2005 sampling at Station P-01. Therefore, despite some DQO exceedences for MDL, overall sample data for this project could be reliably interpreted relative to the objectives of each program.

B2.2 Field and Laboratory Blank Sample Analysis

Field Blanks

Analytical results for blank samples are considered acceptable when concentrations are below two times the requested MDL. However, in cases where the MDL exceeded acceptability criteria (e.g., sulphate in 2006 at SRWMP station P-01, Table B.6; uranium in 2005 at SAMP station N-12, Table B.7), blank results were not considered to exceed criteria because the true concentration is not known (i.e., the results were not detectable). There was one case where a detected concentration was >2 times the MDL in SAMP (e.g., sulphate; Table B.7), and numerous cases in TOMP (e.g., radium-226 in

Table B.8; acidity, iron, sulphate in Table B.9). In none of these cases would the field blank concentrations have any potential to confound the interpretation of results, as measured sample concentrations for these specific parameters were substantially higher.

Laboratory Blanks

Laboratory blank data were summarized as part of the annual quality control reports for 2005 (ELRFS) and 2006 to 2009 (SGS); however, data were not provided for individual laboratory blank samples (Table B.10). In addition, acidity and TSS were not analyzed in 2005. As a result, assessment and interpretation is limited to summarized data.

There were no mean laboratory blank concentrations that exceeded the program criteria. However, there were a few cases where individual concentrations of some parameters exceeded the program and lab criteria, including radium-226 in 2005, 2006 and 2007, as well as sulphate in 2005 (Table B.10). However, exceedences of radium-226 and sulphate in the laboratory blanks will not confound the interpretation of results, as measured concentrations from the programs are substantially higher. Overall, the laboratory blank data is acceptable for the objectives of these programs.

B2.3 Data Precision

Precision is based on the relative percent difference (RPD) between analytical results for samples collected side by side in the field, or samples split in the laboratory. The RPD is calculated by Minnow by taking the absolute difference between samples divided by the average of the samples, multiplied by 100. This method always produces a positive value even if the duplicate has a concentration less than the original (e.g. the value represents the percent difference between samples). Conversely, the laboratories produce values that can be positive or negative depending on the whether the concentration in the duplicate is greater than or less than the original. The problem with this latter approach is that when the results are averaged, extremely positive and extremely negative RPDs will cancel each other out to produce a mean RPD near 0%. An RPD near 0% suggests that duplicate samples are generally not different from the original sample, which may or may not actually be the case. Therefore, when the labs summarize the laboratory duplicate data (individual RPDs are not provided), it is difficult to interpret the mean RPDs.

Field Precision

Many duplicate water samples were collected in the field from 2005 to 2009 from SRWMP, SAMP, TOMP, and they generally showed fairly good agreement in analyte concentrations (Tables B.11 to B.15). These RPDs are calculated using Minnow's approach (absolute difference between samples). Most parameters with DQO exceedences could be considered isolated cases due to the low number of exceedences over the five-year sampling period: acidity (3 exceedences), barium (4), cobalt (2), iron (6), manganese (1 – probable typographical error), sulphate (2), and uranium (1; exceedences summarized in Table B.16). There were more DQO exceedences observed for radium-226 (30) and TSS (31; Table B.16). Despite RPD exceedences ranging from 22.2% to 100% for TSS, in all cases the high RPD was a result of concentrations being close to the detection limit. Conversely, only 5 exceedences for radium-226 can be explained by concentrations nearing the detection limit (28.6% to 50% RPD range) and all occurred in the SRWMP. The other 25 exceedences for radium-226 mainly occurred in SAMP (22.2% to 42.4% RPD range) and TOMP (20.4% to 32.9% RPD range) stations at concentrations orders of magnitude higher than the MDL. Three exceedences of radium-226 in SRWMP (27.7% to 57.1% RPD range) could also not be explained by concentrations near MDL. While most exceedences were between 20% and 30% for radium-226, and RPDs >30% were isolated cases, it would still be worth examining the field water sampling program to see if the sampling techniques can be augmented to reduce any field variability. It may also be possible that some of the "field variability" for radium-226 may be caused by analytical difficulties, as radium-226 was the only parameter to have any CRM DQO exceedences (Section B2.4), and the only parameter to have laboratory duplicate DQO exceedences not explained by concentrations near the MDL (next section). Overall, since most DQO exceedences in the field were isolated, the data suggest that reported sample data were reasonably precise representations of conditions at the time of sampling with some possible environmental variability or analytical difficulty for radium-226.

Laboratory Duplicate Samples

Overall, there is close agreement between original and duplicate water analysis in the laboratory for all parameters (Table B.17). Out of 6192 laboratory duplicate analyses, only 214 (3.5%) exceeded the program DQO of 10%. Of these, all parameter exceedences (except radium-226) are explained by detectable concentrations nearing the MDL. For radium-226, specifically, a total of 456 duplicate analyses were conducted by Becquerel Laboratories with a total of 42 DQO exceedences (9.2%). Of these, only 7 can be explained by concentrations nearing the MDL. This result in combination with the high occurrence of DQO exceedences for field duplicate samples for radium-226 suggest analytical difficulties are likely responsible for variability within results. In the 2006 and 2007 reports, Becquerel states that "the main challenge is in maintaining precision without incurring unreasonable expenditures of resources". In the 2008 and 2009 reports, they state "rush analyses present challenges in maintaining accuracy and precision" despite concluding that the QA data is satisfactory. It was 2008 and 2009 that contained the most DQO exceedences for radium-226 (15 exceedences each year). It is recommended that any analytical difficulties with radium-226 be discussed with Becquerel Laboratories, in order to identify opportunities to increase precision.

B2.4 Laboratory Data Accuracy

For the most part, analyte recoveries for spiked blank samples met the laboratory DQO of 70 - 130%; however, since laboratory results are summarized rather than presented individually, it is not possible to ascertain if the spiked blank samples met the program DQO of 80 - 120% (Table B.18). Barium recovery could be considered poor in 2006, where 44.5% of samples showed <70% recovery (lab DQO). That number would be expected to increase when using the program criteria (80 – 120% recovery). Again in the 2007 to 2009 reports, barium was the only parameter to have recoveries <70% (on average). The laboratory suggested these poor recoveries were a result of very low concentrations of barium being spiked into the blank. The concentrations of barium introduced into the blank samples were below the program method detection limit resulting in the reporting of "less than" results which in turn produced very low (or zero) percent recovery numbers. In the future spiked concentrations of all analytes should be at a level greater than the method detection limit in order to facilitate the calculation of meaningful percent recovery numbers. Recovery of certified reference material (CRM) met the DQO of 80 – 120% for all parameters except radium-226 (4,663 analyses). There were a few instances in 2006 and 2007 where recovery of radium-226 was outside of the program DQO for some individual samples. Originally, 8 of 95 samples (8.4%) in 2006 for radium-226 fell outside the DQO, but two were re-analyzed (considered non-conformances by the laboratory) and new results were within DQO.

These results in combination with the high RPDs in field and laboratory duplicates for radium-226 suggest that there may some challenges associated with the analysis of this particular parameter. Thus, opportunities should be identified either in the field or within the analytical technique so that more results achieve the program objectives.

B3.0 SEDIMENT SAMPLES

B3.1 Method Detection Limits

Target laboratory method detection limits (MDLs) for sediment sample analyses were established at levels below all potentially applicable sediment quality guidelines (Table B.20). Not all analyses achieved the target MDL (i.e., iron, manganese and radium-226). Each of these analytes were detectable in sediment samples (iron >8,200 mg/kg; manganese >290 mg/kg; radium-226 >40 Bq/kg) at concentrations much greater than the achieved MDLs, therefore these elevated MDLs did not compromise the intended use of the data.

B3.2 Laboratory Blank

No analytes were detected in the laboratory blanks (Table B.21), although as mentioned in Section B3.1, the MDLs for iron, manganese, and radium-226 were higher than the target MDL (Table B.20). However, since concentrations of these substances were so much higher in all lake samples, this does not affect the utility of the results. The laboratory blanks are considered acceptable.

B3.3 Data Precision

Field Duplicate Samples

There were some very minor exceedences of RPD of 40% in the particle size analysis, but only by 1 or 2% (Table B.22). Two duplicates had RPDs >40% for manganese at Stations SL-09-05 and SUL-09-03 and this may suggest somewhat higher environmental variability for this particular parameter. No other parameter exceeded the DQO, and overall, field precision is considered acceptable for the program objectives.

Laboratory Duplicate Samples

Most laboratory duplicate sediment analyses met the DQO of 20% (Tables B.23 and B.24). However, one radium-226 duplicate analysis returned a RPD of 33%, although concentrations are nearing the detection limit (Table B.23). As well, the QC batch number 1965516 of report MA9C6993 (McCarthy Lake) experienced a few laboratory duplicates where the relative percent difference was greater than 20% (barium, cobalt, iron, and manganese; Table B.24). However, considering all other quality control measures (e.g. laboratory blank, laboratory accuracy for this particular QC analysis), the overall data quality was considered acceptable and possibly the large RPD values associated with this one sample may suggest that these sediments were not sufficiently homogenized prior to sub-sampling.

B3.4 Data Accuracy

Recoveries of all analytes in spiked blank samples and QC standards met the respective data quality objectives with exception of one iron sample, but this was only 4% outside the DQO range and was an isolated case (Table B.25). Recoveries of all matrix spikes were within the DQO range of 70 - 130% (Table B.26). These data indicated acceptable analytical accuracy associated with the analysis of sediment samples.

B3.5 Toxicity

All toxicity test validity criteria specified in the test method cited in the Aquatox toxicity report were satisfied (see test reports provided in Appendix E).

B4.0 BENTHIC MACROINVERTEBRATE SAMPLES

B4.1 Organism Recovery

The objective for percent organism recovery was 95%, and there were four out of seven instances where this DQO was not met (i.e., HOL-09-01, PL-09-2, RL-09-3 and TML-09-5), but in all cases percent recovery was >90% and in most cases, the difference in number of organisms was only 12 (Table B.27). The overall percent recovery was 94.2%, which is only slightly less than the DQO. Therefore, percent recovery is considered acceptable.

B4.2 Sub-sampling Precision and Accuracy

Fractions sorted for each sample ranged from 1/8 to whole samples, with five samples chosen for sub-sampling (Table B.28). Precision and accuracy of the sub-sampled benthic invertebrate community samples met the DQO of 20% in all cases (Table B.29). Therefore, precision and accuracy are considered acceptable for the program objectives.

B5.0 DATA QUALITY STATEMENT

While there were some field blanks for the groundwater and porewater samples did not achieve the established DQO, the concentrations detected in actual field samples were substantially high enough that the low concentrations detected in the blank samples would not influence the interpretation of results. Most DQOs for surface water duplicate samples were considered acceptable, since in the few instances when concentrations exceeded the DQO they were near MDLs. There appeared to be some analytical difficulties with radium-226 that affected field precision results, laboratory precision results and recovery of CRM. This should be examined and discussed with the laboratory to identify opportunities to reduce variability and meet the program DQO for this parameter. The major problem with the laboratory QA reports, in general, is in their reporting and data summarization. For barium, the actual MDL is much lower than the target MDL and the spike concentration is also lower than the target MDL. Thus, reporting of this parameter is inaccurate, at present. As well, the laboratory's method of calculation for average RPD is misleading, as poor recovery can be masked by extreme positive and negative recovery values.

For sediment samples, high RPDs in field duplicates for manganese suggest some environmental variability. There were some issues with barium, cobalt, iron and manganese exceeding laboratory DQOs in laboratory duplicates of one sediment sample, but these are considered acceptable based on all other QA/QC data.

Benthic data quality was considered acceptable, although the percent organism recovery was a bit lower than the target DQO.

Overall, the majority of data quality analysis (with the exception of barium and radium-226 laboratory concerns, as mentioned above) was considered adequate to serve the project objectives.

Appendix Table B.1: Data quality objectives for the SRWMP.

Measurements	Units	Detection Limit	Field & Lab Blank Criterion	Analytical Precision (Duplicates)	Analytical Accuracy		Field Precision (Duplicates)
					Spike	CRM[b]	
Field Measurements							
pH	pH units	0.1	-	0.1[a]	-	-	10%
Conductivity	mS/cm	0.01	-	0.05[a]	-	-	10%
Dissolved oxygen	mg/L	0.01	-	0.05[a]	-	-	20%
Temperature	^{o}C	varies w method	-	0.1[a]	-	-	20%
Flow	L/s	varies w method	-	0.1[a]	-	-	30%
Laboratory Water Chemistry							
Barium	mg/L	0.005	0.01	10%	80 - 120%	80 - 120%	20%
Cobalt	mg/L	0.0005	0.001	10%	80 - 120%	80 - 120%	20%
Iron	mg/L	0.02	0.04	10%	80 - 120%	80 - 120%	20%
Manganese	mg/L	0.002	0.004	10%	80 - 120%	80 - 120%	20%
Radium-226	Bq/L	0.005	0.01	20%	80 - 120%	-	20%
Sulphate	mg/L	0.1	0.2	10%	80 - 120%	80 - 120%	20%
Uranium	mg/L	0.0005	0.001	10%	80 - 120%	80 - 120%	20%
Laboratory Sediment Chemistry							
Barium	mg/kg	0.5	-	20%	70 - 130%	70 - 130%	40%
Cobalt	mg/kg	0.2	-	20%	70 - 130%	70 - 130%	40%
Iron	mg/kg	20	-	20%	70 - 130%	70 - 130%	40%
Manganese	mg/kg	0.5	-	20%	70 - 130%	70 - 130%	40%
Nickel	mg/kg	0.5	-	20%	70 - 130%	70 - 130%	40%
Radium-226	Bq/kg	5	-	20%	70 - 130%	70 - 130%	40%
Uranium	mg/kg	0.1	-	20%	70 - 130%	70 - 130%	40%
Grain size	%	0.1	-	20%	70 - 130%	70 - 130%	40%
TOC	%	0.05	-	20%	70 - 130%	70 - 130%	40%
Benthos							
Organism Recovery		-	-	90%	-	-	-
Subsampling Precision		-	-	20%	-	-	-
Subsampling Accuracy				20%			
Sediment Toxicity							
Chironomus dilutus		-	70% control surv.	20% control CV	-	± 3 SD in ref tox	-
Hyalella azteca		-	70% control surv.	20% control CV	-	± 3 SD in ref tox	-

[a] Minimum Detectable Difference as identified in instrument manual rather than measurement of analytical precision using replicate samples.
[b] CRM (Certified Reference Material).

Appendix Table B.2: Field and laboratory data quality objectives for SAMP/TOMP stations.

Parameter	Units	Targeted Detection Limit	Minimum Detectable Difference	Field Blank Criteria	Laboratory Blank Criteria	Field Precision	Laboratory Precision	Laboratory Spikes	Laboratory Accuracy (CRM)
Field Parameters									
Flow	L/s	method	0.1	-	-	-	-	-	-
pH	pH units	0.1	0.01	-	-	20%	-	-	-
Laboratory Parameters									
Acidity	mg/L	2.0	-	2	2	20%	10%	-	80 - 120%
Barium	mg/L	0.005	-	0.01	0.01	20%	10%	80 - 120%	80 - 120%
Cobalt	mg/L	0.0005	-	0.001	0.001	20%	10%	80 - 120%	80 - 120%
Iron	mg/L	0.02	-	0.04	0.04	20%	10%	80 - 120%	80 - 120%
Manganese	mg/L	0.002	-	0.004	0.004	20%	10%	80 - 120%	80 - 120%
Radium-226	Bq/L	0.005	-	0.01	0.01	20%	10%	80 - 120%	80 - 120%
Sulphate	mg/L	0.1	-	0.2	0.2	20%	10%	80 - 120%	80 - 120%
TSS	mg/L	1	-	2	2	20%	-	-	-
Uranium	mg/L	0.0005	-	0.001	0.001	20%	10%	80 - 120%	80 - 120%

Appendix Table B.3: Field and laboratory method detection limits (MDLs) for SRWMP water quality analysis.

Parameter	Units	MDL Requested (DQO)	MDL Achieved
Field Instruments			
pH	pH units	0.1	0.1
Conductivity	uS/cm	0	0
Dissolved Oxygen	mg/L	0	0
Laboratory			
Barium	mg/L	0.005	0.001 - 0.005
Cobalt	mg/L	0.0005	0.0003 - 0.0005
Iron	mg/L	0.02	0.02
Manganese	mg/L	0.002	0.002
Radium-226	Bq/L	0.005	0.005
Sulphate	mg/L	0.1	0.1 - 0.5
Uranium	mg/L	0.0005	0.0005

(Shaded) MDL does not meet DQO

Appendix Table B.4: Field and laboratory method detection limits (MDLs) for SAMP and TOMP water quality analysis.

Parameter	Units	MDL Requested (DQO)	MDL Achieved
Field Instruments			
pH	pH units	0.1	0.1
Conductivity	uS/cm	0	0
Laboratory			
Acidity	mg/L	2	1
Barium	mg/L	0.005	0.001 - 0.005
Cobalt	mg/L	0.0005	0.0003 - 0.003
Iron	mg/L	0.02	0.02
Manganese	mg/L	0.002	0.002
Radium-226	Bq/L	0.005	0.005
Sulphate	mg/L	0.1	0.1 - 0.2
TSS	mg/L	1	1 - 2
Uranium	mg/L	0.0005	0.0005 - 0.005

[shaded box] MDL does not meet DQO

Appendix Table B.5: Specific method detection limits that did not meet data quality objectives, 2005 to 2009.

Program	Station	Date	Parameter	Units	MDL Requested (DQO)	MDL Achieved	Receiving Environment Criteria	Range in Discharge Criteria (Grab)
SRWMP	P-01	Jan-06	Sulphate	mg/L	0.1	0.5	100[a]	-
SAMP	N-12	Feb-05	Uranium	mg/L	0.0005	0.005	0.005[b]	-
		May-05	Uranium	mg/L	0.0005	0.005	0.005[b]	-
		Jul-05	Uranium	mg/L	0.0005	0.005	0.005[b]	-
		Aug-05	Uranium	mg/L	0.0005	0.005	0.005[b]	-
		Nov-05	Uranium	mg/L	0.0005	0.005	0.005[b]	-
	D-2	Aug-05	Cobalt	mg/L	0.0005	0.003	0.0009[b]	-
		Feb-06	TSS	mg/L	1	2	-	20-50
		Mar-06	TSS	mg/L	1	2	-	20-50
TOMP	Q-28	Jan-06	TSS	mg/L	1	2	-	20-50
		Feb-06	TSS	mg/L	1	2	-	20-50
		Mar-06	TSS	mg/L	1	2	-	20-50
	DK16-2B	Aug-07	Sulphate	mg/L	0.1	0.2	100[a]	-

[a] British Columbia Water Quality Guidelines (BCMOE 2006)

[b] Provincial Water Quality Objectives

"-" denotes that no criteria has been set

Appendix Table B.6: Field blanks for SRWMP 2005-2009.

Date	Units	Field Blank Criterion	P-01													
			Jan-05	Apr-05	Jul-05	Oct-05	Jan-06	Apr-06	May-06	Jul-06	Oct-06	Nov-06	Feb-07	Apr-07	May-07	Jul-07
Barium	mg/L	0.01	0.002	<0.001	<0.001	<0.001	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Cobalt	mg/L	0.001	<0.0003	<0.0003	<0.0003	<0.0003	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Iron	mg/L	0.04					<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Manganese	mg/L	0.004					<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
pH	pH units	-	5	5.5	5.1	5.4										
Radium-226	Bq/L	0.01	<0.005	<0.005	<0.005	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Sulphate	mg/L	0.2	<0.1	<0.1	<0.1	<0.1	<0.5	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Uranium	mg/L	0.001	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005

Date	Units	Field Blank Criterion	P-01													
			Oct-07	Nov-07	Jan-08	Apr-08	May-08	Aug-08	Oct-08	Jan-09	Apr-09	May-09	Jun-09	Jul-09	Aug-09	Oct-09
Barium	mg/L	0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Cobalt	mg/L	0.001	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Iron	mg/L	0.04	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Manganese	mg/L	0.004	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
pH	pH units	-														
Radium-226	Bq/L	0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Sulphate	mg/L	0.2	<0.1	0.2	<0.1	0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Uranium	mg/L	0.001	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005

Date	Units	Field Blank Criterion	D-5										
			May-05	Nov-05	May-06	Nov-06	May-07	Nov-07	May-08	Nov-08	Feb-09	Jun-09	Nov-09
Barium	mg/L	0.01	<0.001	<0.001	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Cobalt	mg/L	0.001	<0.0003	<0.0003	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Iron	mg/L	0.04	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Manganese	mg/L	0.004	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
pH	pH units	-	5.6	5									
Radium-226	Bq/L	0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Sulphate	mg/L	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Uranium	mg/L	0.001	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005

(light grey)	Field blank criterion not met
(dark grey)	Actual MDL does not meet target MDL

Appendix Table B.7: Field blanks in SAMP water samples from 2005-2009.

Date	Units	Field Blank Criterion	N-12											
			Feb-05	May-05	Aug-05	Nov-05	Feb-06	May-06	Aug-06	Nov-06	Feb-07	May-07	Aug-07	Nov-07
Barium	mg/L	0.01	0.001	<0.001	<0.001	<0.001	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Cobalt	mg/L	0.001	<0.0003	<0.0003	<0.0003	<0.0003	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Iron	mg/L	0.04	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	0.03	<0.02	<0.02	<0.02	<0.02
Manganese	mg/L	0.004	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.003
pH	-	-	4.7	5.6	5.6	5.5	5.6	5.4	5.6	5.3	5.3	5.3	5.3	5.3
Radium-226	Bq/L	0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Sulphate	mg/L	0.2					<0.1	<0.1	<0.1	0.4	<0.1	<0.1	<0.1	<0.1
Uranium	mg/L	0.001	<0.005	<0.005	<0.005	<0.005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005

Date	Units	Field Blank Criterion	N-12							
			Feb-08	May-08	Aug-08	Nov-08	Feb-09	May-09	Aug-09	Nov-09
Barium	mg/L	0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Cobalt	mg/L	0.001	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Iron	mg/L	0.04	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Manganese	mg/L	0.004	<0.002	<0.002	<0.002	<0.002	<0.002	0.004	<0.002	<0.002
pH	-	-	5.3	5.4	5.5	6	5.6	5.5	5.5	5.7
Radium-226	Bq/L	0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Sulphate	mg/L	0.2	0.1	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Uranium	mg/L	0.001	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005

Field blank criterion not met

Actual MDL does not meet target MDL

Appendix Table B.8: Field blanks for TOMP water samples from 2005-2009.

Date	Units	Field Blank Criterion	Q-28											
			Jan-05	Feb-05	Mar-05	Apr-05	May-05	Jun-05	Jul-05	Aug-05	Sep-05	Oct-05	Nov-05	Dec-05
Acidity	mg/L	2												
Barium	mg/L	0.01												
Cobalt	mg/L	0.001												
Iron	mg/L	0.04												
Manganese	mg/L	0.004												
pH	-	-	5.5	5.6	5.6	5.6	5.5	5.5	5.7	5.6	5.7	5.7	5.7	5.7
Radium-226	Bq/L	0.01	<0.005	0.006	0.011	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.005
Sulphate	mg/L	0.2												
TSS	mg/L	2	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Uranium	mg/L	0.001												

Date	Units	Field Blank Criterion	Q-28											
			Jan-06	Feb-06	Mar-06	Apr-06	May-06	Jun-06	Jul-06	Aug-06	Sep-06	Oct-06	Nov-06	Dec-06
Acidity	mg/L	2												
Barium	mg/L	0.01					<0.005						<0.005	
Cobalt	mg/L	0.001					<0.0005						<0.0005	
Iron	mg/L	0.04					<0.02						0.04	
Manganese	mg/L	0.004					<0.002						<0.002	
pH	-	-	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.6	5.5	5.5	5.5	5.5
Radium-226	Bq/L	0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Sulphate	mg/L	0.2					<0.1						<0.1	
TSS	mg/L	2	<2	<2	<2	<1	<1	<1	<1	<1	<1	<1	<1	<1
Uranium	mg/L	0.001					<0.0005						<0.0005	

Date	Units	Field Blank Criterion	Q-28											
			Jan-07	Feb-07	Mar-07	Apr-07	May-07	Jun-07	Jul-07	Aug-07	Sep-07	Oct-07	Nov-07	Dec-07
Acidity	mg/L	2												
Barium	mg/L	0.01					<0.005						<0.005	
Cobalt	mg/L	0.001					<0.0005						<0.0005	
Iron	mg/L	0.04					<0.02						<0.02	
Manganese	mg/L	0.004					<0.002						<0.002	
pH	-	-	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5
Radium-226	Bq/L	0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Sulphate	mg/L	0.2					<0.1						<0.1	
TSS	mg/L	2	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Uranium	mg/L	0.001					<0.0005						<0.0005	

Date	Units	Field Blank Criterion	Q-28											
			Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08	Jul-08	Aug-08	Sep-08	Oct-08	Nov-08	Dec-08
Acidity	mg/L	2												
Barium	mg/L	0.01					<0.005						<0.005	
Cobalt	mg/L	0.001					<0.0005						<0.0005	
Iron	mg/L	0.04					<0.02						<0.02	
Manganese	mg/L	0.004					<0.002						<0.002	
pH	-	-	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.1	5.5	5.5
Radium-226	Bq/L	0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Sulphate	mg/L	0.2					<0.1						<0.1	
TSS	mg/L	2	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Uranium	mg/L	0.001					<0.0005						<0.0005	

Date	Units	Field Blank Criterion	Q-28											
			Jan-09	Feb-09	Mar-09	Apr-09	May-09	Jun-09	Jul-09	Aug-09	Sep-09	Oct-09	Nov-09	Dec-09
Acidity	mg/L	2												
Barium	mg/L	0.01					<0.005						<0.005	
Cobalt	mg/L	0.001					<0.0005						<0.0005	
Iron	mg/L	0.04					<0.02						<0.02	
Manganese	mg/L	0.004					<0.002						<0.002	
pH	-	-	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.4	5.5	5.5
Radium-226	Bq/L	0.01	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Sulphate	mg/L	0.2					<0.1						<0.1	
TSS	mg/L	2	<1	1	<1	<1	<1	<1	<1	<1	<1	1	<1	<1
Uranium	mg/L	0.001					<0.0005						<0.0005	

(light grey) Field blank criterion not met
(dark grey) Actual MDL does not meet target MDL

Appendix Table B.9: Field blanks in TOMP porewater (PW) and groundwater (GW) from 2006-2009.

Date	Units	Field Blank Criterion	BH96-D10-13A (PW)				DK16-2B (PW)				P-34A (PW)			UW9-1 (PW)		
			Jul-06	Sep-07	Aug-08	Sep-09	Jun-06	Aug-07	Jul-08	Sep-09	Jun-06	Jul-08	Sep-09	Jun-06	Jul-08	Sep-09
Acidity	mg/L as CaCO3	4	1	4		3	3	2	5	6	3	3	3	2	9	5
Iron	mg/L	0.04	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	0.04	0.18	0.08	<0.02	<0.02	0.79	0.05	0.26
pH	pH units	-	5	5.7	5.7											
Sulphate	mg/L	0.2						<0.2	1.9	12		0.2	0.3		0.4	4.2

Date	Units	Field Blank Criterion	P-31 (GW)			SGW3 (GW)			95N-4A (GW)			95QW-5A (GW)			98-15A (GW)			
			Jun-06	Jul-08	Sep-09	Jun-06	Jul-08	Sep-09	Jun-06	Jul-08	Sep-09	Jun-06	Jul-08	Sep-09	Jul-06	Sep-07	Aug-08	Sep-09
Acidity	mg/L as CaCO3	4	2	4	3	4	3	35	1	3	11	2	3	6	5	3		27
Iron	mg/L	0.04	<0.02	0.03	0.14	0.14	<0.02	0.18	0.06	0.52	0.03	0.02	<0.02	0.27	0.23	0.09	<0.02	0.72
pH	pH units	-													5	6	5.5	
Sulphate	mg/L	0.2		0.5	2.8		1.5	7.7		0.1	4.8		0.5	8.9				

Field blank criterion not met

Actual MDL does not meet target MDL

Appendix Table B.10: Laboratory blank quality control results, 2005 to 2009.

Year	Description	Acidity	Barium	Cobalt	Iron	Manganese	Radium-226	Sulphate	TSS	Uranium
		mg/L	mg/L	mg/L	mg/L	mg/L	Bq/L	mg/L	mg/L	mg/L
	Program Criteria	4	0.01	0.001	0.04	0.004	0.01	0.2	2	0.001
	Lab Criteria	4	0.01	0.001	0.04	0.004	0.01	0.2	2	0.001
2005	Mean	-	0.00016	0.00006	0.00093	0.00005	0.0049	0.022	-	0.0005
	# above criteria	-	0	0	0	0	1	1	-	0
	% above criteria	-	0	0	0	0	0.95	5.26	-	0
	# samples	-	34	32	45	35	105	19	-	20
2006	Mean	2.07	0.00082	0.00008	0.00162	0.0003	<0.005	0.019	0.12	0.0001
	# above criteria	0	0	0	0	0	1	0	0	0
	% above criteria	0.0	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0
	# samples	36	131	134	129	129	95	135	156	133
2007	Mean	2.06	0.0023	0.00023	0.00909	0.0009	<0.005	0.045	0.44	0.0002
	# above criteria	0	0	0	0	0	2	0	0	0
	% above criteria	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0
	# samples	115	202	204	239	202	100	242	273	207
2008	Mean	1.71	0.00247	0.00025	0.00963	0.001	<0.005	0.050	0.50	0.0003
	# above criteria	0	0	0	0	0	0	0	0	0
	% above criteria	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	# samples	96	212	210	241	221	117	223	276	207
2009	Mean	1.87	0.00245	0.00025	0.01013	0.001	<0.005	0.012	0.509	0.00029
	# above criteria	0	0	0	0	0	0	0	0	0
	% above criteria	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	# samples	95	208	199	252	209	96	203	195	240

Mean blank concentration greater than Program criteria

Actual MDL does not meet target MDL

Appendix Table B.11: Field duplicates for SRWMP from 2005 to 2009.

Date	Units	Field Precision Criteria (%)	P-01											
			Jan-05			Apr-05			Jul-05			Oct-05		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20	0.024	0.023	4.3	0.024	0.013	59.5	0.019	0.019	0	0.01	0.01	0
Cobalt	mg/L	20	<0.0003	<0.0003	NC	<0.0003	<0.0003	NC	0.0003	0.0004	28.6	<0.0003	<0.0003	NC
Iron	mg/L	20	0.24	0.24	0	0.14	0.14	0	0.16	0.16	0	0.05	0.05	0
Managanese	mg/L	20	0.021	0.021	0	0.024	0.024	0	0.103	0.101	2	0.009	0.009	0
pH	-	10	6.8	6.8	0	6.4	6.4	0	6.6	6.6	0	6.9	6.9	0
Radium-226	Bq/L	20	0.038	0.033	14.1	0.008	0.006	28.6	0.01	0.018	57.1	0.01	0.01	0
Sulphate	mg/L	20	7.2	7.3	1.4	4.9	4.8	2.1	7.2	6.9	4.3	9	9	0
Uranium	mg/L	20	<0.0005	0.0005	NC	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC

Date	Units	Field Precision Criteria (%)	P-01											
			Jan-06			Apr-06			Jul-06			Oct-06		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20	0.018	0.018	0	0.015	0.0149	0.7	0.017	0.016	6.1	0.015	0.014	6.9
Cobalt	mg/L	20	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC
Iron	mg/L	20	0.14	0.14	0	0.12	0.12	0	0.08	0.07	13.3	0.13	0.12	8
Managanese	mg/L	20	0.0095	0.0095	0	0.012	0.0119	0.8	0.0294	0.0289	1.7	0.019	0.018	5.4
pH	-	10	7.1	7.1	0	6.7	6.7	0	6.8	6.8	0	6.7	6.7	0
Radium-226	Bq/L	20	<0.005	0.006	NC	0.005	<0.005	NC	0.01	0.007	35.3	0.011	0.008	31.6
Sulphate	mg/L	20	9.1	9	1.1	5.1	5.1	0	6.3	6.3	0	9	9	0
Uranium	mg/L	20	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC

Date	Units	Field Precision Criteria (%)	P-01											
			Feb-07			Apr-07			Jul-07			Oct-07		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20	0.017	0.017	0	0.016	0.015	6.5	0.015	0.015	0	0.015	0.015	0
Cobalt	mg/L	20	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC
Iron	mg/L	20	0.14	0.13	7.4	0.13	0.12	8	0.06	0.07	15.4	0.14	0.14	0
Managanese	mg/L	20	0.005	0.005	0	0.017	0.015	12.5	0.022	0.023	4.4	0.027	0.026	3.8
pH	-	10	6.5	6.6	1.5	6.8	6.8	0	7.2	7.2	0	6.5	6.5	0
Radium-226	Bq/L	20	<0.007	0.008	NC	0.006	<0.005	NC	0.011	0.009	20	0.013	0.013	0
Sulphate	mg/L	20	7.1	7.1	0	5.3	5.5	3.7	6.4	6.5	1.6	8.3	8.3	0
Uranium	mg/L	20	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC

Field Precision Criteria not met

NC = not calculated because the concentration from one or both samples was below detection

Appendix Table B.11: Field duplicates for SRWMP from 2005 to 2009.

Date	Units	Field Precision Criteria (%)	P-01											
			Jan-08			Apr-08			Aug-08			Oct-08		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20	0.017	0.017	0	0.014	0.014	0	0.014	0.014	0	0.016	0.016	0
Cobalt	mg/L	20	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC
Iron	mg/L	20	0.17	0.17	0	0.15	0.15	0	0.2	0.16	22.2	0.12	0.13	8
Managanese	mg/L	20	0.016	0.016	0	0.023	0.024	4.3	0.025	0.025	0	0.019	0.018	5.4
pH	-	10	6.8	6.8	0	6.9	6.9	0	6.8	6.8	0	7.3	7.3	0
Radium-226	Bq/L	20	0.01	0.006	50	<0.005	<0.005	NC	0.008	0.006	28.6	0.008	<0.005	NC
Sulphate	mg/L	20	6	5.7	5.1	4.5	4.6	2.2	4	3.9	2.5	5.3	5.3	0
Uranium	mg/L	20	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC

Date	Units	Field Precision Criteria (%)	P-01											
			Jan-09			Apr-09			Jul-09			Oct-09		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20	0.015	0.015	0	0.014	0.014	0	0.014	0.014	0	0.0132	0.0132	0
Cobalt	mg/L	20	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC
Iron	mg/L	20	0.24	0.22	8.7	0.18	0.18	0	0.11	0.11	0	0.33	0.32	3.1
Managanese	mg/L	20	0.016	0.014	13.3	0.023	0.025	8.3	0.025	0.025	0	0.0334	0.0322	3.7
pH	-	10	7.1	7.1	0	6.4	6.4	0	7.2	7.2	0	6.9	6.9	0
Radium-226	Bq/L	20	0.005	<0.005	NC	<0.005	<0.005	NC	0.005	<0.005	NC	<0.005	0.006	NC
Sulphate	mg/L	20	6.8	5	30.5	4.2	4.2	0	4.6	4.6	0	5.2	5.2	0
Uranium	mg/L	20	0.0005	<0.0005	NC	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC

Date	Units	Field Precision Criteria (%)	D-5											
			May-05			Nov-05			May-06			Nov-06		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20	0.044	0.045	2.2	0.107	0.106	0.9	0.0408	0.03894	4.7	0.039	0.04	2.5
Cobalt	mg/L	20	<0.0003	<0.0003	NC	<0.0003	<0.0003	NC	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC
Iron	mg/L	20	0.08	0.08	0	0.09	0.09	0.0	0.05	0.05	0.0	0.05	0.04	22.2
Manganese	mg/L	20	0.041	0.042	2.4	0.019	0.019	0.0	0.0272	0.0248	9.2	0.032	0.032	0.0
pH	-	10	7.2	7.2	0	7	7	0	6.9	6.9	0	6.9	6.9	0
Radium-226	Bq/L	20	0.055	0.065	16.7	0.15	0.15	0	0.03	0.043	35.6	0.041	0.036	13
Sulphate	mg/L	20	25.9	26.1	0.8	88	87.9	0.1	15	15	0	23	23	0
Uranium	mg/L	20	0.0022	0.0025	12.8	0.0057	0.0057	0	0.00167	0.00153	8.8	0.002	0.002	0

[shaded box] Field Precision Criteria not met

NC = not calculated because the concentration from one or both samples was below detection

Appendix Table B.11: Field duplicates for SRWMP from 2005 to 2009.

Date	Units	Field Precision Criteria (%)	D-5											
			May-07			Nov-07			May-08			Nov-08		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20	0.043	0.042	2.4	0.055	0.058	5.3	0.031	0.031	0	0.081	0.083	2.4
Cobalt	mg/L	20	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC
Iron	mg/L	20	0.05	0.06	18.2	0.05	0.06	18.2	0.06	0.06	0.0	0.07	0.07	0.0
Manganese	mg/L	20	0.032	0.031	3.2	0.031	0.034	9.2	0.026	0.026	0.0	0.034	0.035	2.9
pH	-	10	7.1	7.1	0	6.4	6.4	0	6.5	6.5	0	6.7	6.7	0
Radium-226	Bq/L	20	0.048	0.049	2.1	0.071	0.078	9.4	0.027	0.029	7.1	0.089	0.088	1.1
Sulphate	mg/L	20	19	19	0	28	27	3.6	14	14	0	34	34	0
Uranium	mg/L	20	0.002	0.0019	5.1	0.0021	0.0021	0	0.0013	0.0013	0	0.0021	0.0022	4.7

Date	Units	Field Precision Criteria (%)	D-5								
			May-09			Jun-09			Nov-09		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20	0.035	0.034	2.9	0.047	0.048	2.1	0.04547	0.03801	17.9
Cobalt	mg/L	20	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC	<0.0005	<0.0005	NC
Iron	mg/L	20	0.06	0.06	0.0	0.04	0.04	0.0	0.07	0.06	15.4
Manganese	mg/L	20	0.025	0.022	12.8	0.023	0.022	4.4	0.031	0.027	13.8
pH	-	10	7.4	7.3	1.4	7.3	7.2	1.4	7.2	7.2	0
Radium-226	Bq/L	20	0.037	0.028	27.7	0.051	0.053	3.8	0.035	0.034	2.9
Sulphate	mg/L	20	11	11	0	8.8	8.6	2.3	26	19	31.1
Uranium	mg/L	20	0.0012	0.0011	8.7	0.001	0.0009	10.5	0.0021	0.0014	40

(shaded) Field Precision Criteria not met

NC = not calculated because the concentration from one or both samples was below detection

Appendix Table B.12: Field duplicates for SAMP (Station N-12) from 2005 to 2009.

Date	Units	Field Precision Criteria (%)	N-12																	
			Jan-05			Feb-05			May-05			Jul-05			Aug-05			Nov-05		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20	0.046	0.049	6.3	0.051	0.045	12.5	0.033	0.032	3.1	0.027	0.027	0	0.094	0.088	6.6	0.018	0.023	24.4
Cobalt	mg/L	20	0.0035	0.0029	18.8	0.004	0.0038	5.1	0.0021	0.0022	4.7	0.0008	0.0007	13.3	0.0026	0.0024	8	0.0021	0.002	4.9
Iron	mg/L	20	2.17	2.11	2.8	1.68	1.61	4.3	0.75	0.75	0	0.76	0.75	1.3	2.46	2.44	0.8	1.09	1.11	1.8
Manganese	mg/L	20	0.181	0.0182	163	0.241	0.217	10.5	0.175	0.175	0	0.2	0.198	1	0.336	0.328	2.4.	0.184	0.182	1.1
pH	-	20	6.2	6.2	0	6.3	6.3	0	6.9	6.9	0	6.8	6.8	0	6.8	6.8	0	6.4	6.4	0
Radium-226	Bq/L	20	0.24	0.24	0	0.24	0.25	4.1	0.2	0.21	4.9	0.37	0.43	15	0.37	0.36	2.7	0.065	0.065	0
Sulphate	mg/L	20	387	388	0.3	403	420	4.1	672	661	1.7	1021	999	2.2	815	812	0.4	638	629	1.4
Uranium	mg/L	20	0.006	0.006	0	0.009	0.008	11.8	<0.005	<0.005	NC	<0.005	0.005	NC	0.005	0.006	18.2	<0.005	<0.005	NC

Date	Units	Field Precision Criteria (%)	N-12														
			May-06			Jun-06			Aug-06			Sep-06			Nov-06		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20	0.0216	0.0218	0.9	0.0257	0.0262	1.9	0.03	0.033	9.5	0.026	0.025	3.9	0.017	0.017	0
Cobalt	mg/L	20	0.00235	0.0022	6.6	0.00344	0.00344	0	0.0063	0.0052	19.1	0.0034	0.0036	5.7	0.0015	0.0015	0
Iron	mg/L	20	2.76	2.81	1.8	2.25	2.31	2.6	0.68	0.59	14.2	0.62	0.58	6.7	2.18	2.14	1.9
Manganese	mg/L	20	0.185	0.202	8.8	0.286	0.287	0.3	0.403	0.388	3.8	0.293	0.293	0	0.137	0.135	1.5
pH	-	20	6.7	6.8	1.5	6.6	6.6	0	7	7	0	6.9	6.9	0	6.5	6.6	1.5
Radium-226	Bq/L	20	0.069	0.067	2.9	0.094	0.09	4.3	0.12	0.11	8.7	0.065	0.088	30.1	0.053	0.052	1.9
Sulphate	mg/L	20	490	490	0	670	670	0	870	830	4.7	990	970	2	450	450	0
Uranium	mg/L	20	0.00256	0.00279	8.6	0.00296	0.00322	8.4	0.0037	0.0038	2.7	0.004	0.0041	2.5	0.0021	0.0022	4.7

Date	Units	Field Precision Criteria (%)	N-12																	
			Feb-07			May-07			Jun-07			Aug-07			Sep-07			Nov-07		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20	0.021	0.022	4.7	0.021	0.02	4.9	0.031	0.032	3.2	0.016	0.016	0	0.017	0.017	0	0.028	0.027	3.6
Cobalt	mg/L	20	0.0021	0.0021	0	0.0031	0.0021	38.5	0.003	0.003	0	0.0015	0.0015	0	0.0037	0.0038	2.7	0.0044	0.0046	4.4
Iron	mg/L	20	2.15	2.09	2.8	1.79	1.73	3.4	1.3	1.31	0.8	0.2	0.21	4.9	0.32	0.32	0	0.67	0.66	1.5
Manganese	mg/L	20	0.179	0.173	3.4	0.169	0.16	5.5	0.219	0.22	0.5	0.122	0.121	0.8	0.148	0.15	1.3	0.31	0.312	0.6
pH	-	20	6.7	6.7	0	7	7	0	7.1	7.1	0	7.5	7.5	0	7.5	7.5	0	6.7	6.7	0
Radium-226	Bq/L	20	0.072	0.065	10.2	0.076	0.07	8.2	0.12	0.12	0	0.067	0.06	11	0.06	0.061	1.7	0.084	0.088	4.7
Sulphate	mg/L	20	510	510	0	590	560	5.2	670	700	4.4	1000	1000	0	1000	1000	0	930	780	17.5
Uranium	mg/L	20	0.003	0.003	0	0.0024	0.0024	0	0.0033	0.0032	3.1	0.0032	0.0029	9.8	0.0051	0.0051	0	0.0041	0.0043	4.8

Field precision criteria not met

Actual MDL does not meet target MDL

NC= not calculated because the concentration from one or both samples was below detection

Appendix Table B.12: Field duplicates for SAMP (Station N-12) from 2005 to 2009.

Date	Units	Field Precision Criteria (%)	N-12																	
			Feb-08			May-08			Jun-08			Aug-08			Sep-08			Nov-08		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20	0.017	0.015	12.5	0.019	0.02	5.1	0.021	0.021	0	0.02	0.02	0	0.02	0.021	4.9	0.029	0.029	0
Cobalt	mg/L	20	0.0042	0.0038	10	0.0018	0.0018	0	0.0019	0.002	5.1	0.0012	0.0013	8	0.0012	0.0012	0	0.0025	0.0025	0
Iron	mg/L	20	2.31	2.26	2.2	0.67	0.66	1.5	0.61	0.67	9.4	0.33	0.33	0	0.44	0.45	2.2	0.46	0.46	0
Manganese	mg/L	20	0.169	0.149	12.6	0.106	0.108	1.9	0.167	0.178	6.4	0.165	0.17	3	0.149	0.153	2.6	0.258	0.255	1.2
pH	-	20	6.6	6.6	0	6.7	6.7	0	7.2	7.2	0	7.1	7.1	0	7	7	0	6.9	6.9	0
Radium-226	Bq/L	20	0.1	0.09	10.5	0.066	0.064	3.1	0.068	0.072	5.7	0.063	0.067	6.2	0.078	0.071	9.4	0.073	0.089	19.8
Sulphate	mg/L	20	290	290	0	330	370	11.4	490	490	0	870	830	4.7	880	860	2.3	850	860	1.2
Uranium	mg/L	20	0.0045	0.004	11.8	0.0028	0.0028	0	0.003	0.0031	3.3	0.0023	0.0025	8.3	0.0031	0.0032	3.2	0.0023	0.0025	8.3

Date	Units	Field Precision Criteria (%)	N-12																	
			Feb-09			May-09			Jun-09			Aug-09			Sep-09			Nov-09		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20	0.026	0.027	3.8	0.023	0.022	4.3	0.024	0.023	4.2	0.026	0.026	0.0	0.024	0.024	0.0	0.02	0.02	0
Cobalt	mg/L	20	0.002	0.0021	4.9	0.0011	0.0011	0.0	0.0013	0.0012	7.7	0.0011	0.0011	0.0	0.0015	0.0015	0.0	0.0013	0.0013	0
Iron	mg/L	20	1.85	1.88	1.6	0.82	0.74	9.8	0.85	0.78	8.2	0.51	0.51	0.0	0.29	0.28	3.4	0.48	0.47	2.1
Manganese	mg/L	20	0.202	0.228	12.1	0.106	0.102	3.8	0.132	0.128	3.0	0.117	0.116	0.9	0.147	0.152	3.4	0.094	0.096	2.1
pH	-	20	6.6	6.6	0	6.9	6.9	0.0	6.5	6.5	0.0	6.5	6.5	0.0	6.9	6.9	0.0	6.9	6.9	0
Radium-226	Bq/L	20	0.098	0.11	11.5	0.085	0.087	2.3	0.1	0.099	1.0	0.1	0.1	0.0	0.091	0.079	14.1	0.056	0.068	19.4
Sulphate	mg/L	20	660	660	0	330	330	0.0	470	460	2.2	640	650	1.6	820	810	1.2	360	360	0
Uranium	mg/L	20	0.0037	0.0038	2.7	0.0025	0.0025	0.0	0.0029	0.0028	3.4	0.0024	0.0025	4.2	0.0025	0.0024	4.0	0.0022	0.0022	0

Field precision criteria not met
Actual MDL does not meet target MDL
NC= not calculated because the concentration from one or both samples was below detection

Appendix Table B.13: Field duplicates for SAMP (Station D-2) from 2005 to 2009.

Date	Units	Field Precision Criteria (%)	D-2																				
			Feb-05			Mar-05			May-05			Aug-05			Oct-05			Nov-05			Dec-05		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20	0.072			0.034			0.111	0.121	8.6	0.039	0.041	5	0.046			0.084	0.089	5.8	0.03		
Cobalt	mg/L	20	0.0017			0.0016			0.0018	0.0021	15.4	<0.003	<0.003	NC	0.0005			0.0015	0.0016	6.5	0.0017		
Iron	mg/L	20	0.47			0.14			0.23	0.26	12.2	0.03	0.03	0	0.03			0.12	0.12	0	0.12		
Manganese	mg/L	20	0.392			0.43			0.402	0.43	6.7	0.035	0.037	5.6	0.164			0.318	0.328	3.1	0.359		
pH	-	20	7.1			7.2			7.3			7.5			7.3			7.2			7.4		
Radium (total)	Bq/L	20	0.064	0.077	18.4	0.03	0.035	15.4	0.23	0.24	4.3	0.051	0.054	5.7	0.069	0.083	18.4	0.17	0.17	0	0.056	0.042	28.6
TSS	mg/L	20	<1	<1	NC	<1	<1	NC	1	1	0	1	1	0	<1	<1	NC	<1	<1	NC	<1	<1	NC
Uranium	mg/L	20	0.064			0.087			0.085	0.087	2.3	0.08	0.08	0	0.104			0.115	0.112	2.6	0.115		

Date	Units	Field Precision Criteria (%)	D-2																										
			Feb-06			Mar-06			May-06			Jul-06			Aug-06			Sep-06			Oct-06			Nov-06			Dec-06		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20							0.151	0.11	31.4				0.041	0.046	11.5							0.086	0.092	6.7			
Cobalt	mg/L	20							0.00194	0.00198	2				0.0005	0.0005	0							0.0022	0.002	9.5			
Iron	mg/L	20							0.32	0.31	3.2				0.06	0.05	18.2							0.15	0.15	0			
Manganese	mg/L	20							0.397	0.419	5.4				0.094	0.096	2.1							0.425	0.418	1.7			
pH	-	20	7.3	7.3	0	7.3	7.3	0	7.5	7.5	0	7.6	7.6	0	7.4	7.4	0	7.5	7.5	0	7.4	7.4	0	7.5	7.5	0	7.4	7.4	0
Radium (total)	Bq/L	20	0.025	0.029	14.8	0.031	0.036	14.9	0.11	0.12	8.7	0.083	0.068	19.9	0.047	0.055	15.7	0.046	0.047	2.2	0.057	0.075	27.3	0.1	0.1	0	0.072	0.091	23.3
TSS	mg/L	20	<2	<2	NC	<2	<2	NC	2	2	0	<1	<1	0	1	1	0	1	1	0	1	1	0	<1	1	0	1	1	0
Uranium	mg/L	20							0.0697	0.0691	0.9				0.0852	0.0827	3							0.0979	0.0953	2.7			

Date	Units	Field Precision Criteria (%)	D-2																																				
			Jan-07			Feb-07			Mar-07			Apr-07			May-07			Jun-07			Jul-07			Aug-07			Sep-07			Oct-07			Nov-07			Dec-07		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20				0.069	0.071	2.9							0.117	0.122	4.2							0.065	0.055	16.7							0.161	0.118	30.8			
Cobalt	mg/L	20				0.0024	0.0026	8							0.0022	0.0022	0							0.001	0.001	0							0.002	0.0019	5.1			
Iron	mg/L	20				1	0.98	2							0.61	0.54	12.2							0.06	0.07	15.4							0.19	0.18	5.4			
Manganese	mg/L	20				0.396	0.415	4.7							0.481	0.467	3							0.313	0.316	1							0.479	0.459	4.3			
pH	-	20	7.4	7.4	0	7	7	0	7.1	7.1	0	7.4	7.4	0	7.4	7.4	0	7.7	7.7	0	7.3	7.3	0	7.3	7.3	0	7.7	7.7	0	7.1	7.1	0	7.2	7.2	0	7.1	7.1	0
Radium (total)	Bq/L	20	0.12	0.13	8	0.082	0.069	17.2	0.061	0.047	25.9	0.12	0.1	18.2	0.16	0.16	0	0.091	0.1	9.4	0.088	0.11	22.2	0.082	0.097	16.8	0.085	0.079	7.3	0.11	0.1	9.5	0.12	0.15	22.2	0.045	0.038	16.9
TSS	mg/L	20	2	2	0	3	3	0	2	2	0	2	2	0	3	1	100	1	<1	NC	1	1	0	1	1	0	1	<1	NC	<1	<1	NC	2	1	66.7	1	<1	NC
Uranium	mg/L	20				0.0508	0.0525	3.3							0.0613	0.0595	3							0.0859	0.0855	0.5							0.106	0.104	1.9			

Date	Units	Field Precision Criteria (%)	D-2																																				
			Jan-08			Feb-08			Mar-08			Apr-08			May-08			Jun-08			Jul-08			Aug-08			Sep-08			Oct-08			Nov-08			Dec-08		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20				0.032	0.032								0.126	0.117	7.4							0.1	0.1	0							0.111	0.111	0			
Cobalt	mg/L	20				0.0032	0.0031								0.0018	0.0018	0							0.0008	0.0008	0							0.0015	0.0015	0			
Iron	mg/L	20				1.35	1.35								0.34	0.33	3							0.07	0.07	0							0.14	0.15	6.9			
Manganese	mg/L	20				0.573	0.558								0.463	0.443	4.4							0.205	0.203	1							0.341	0.34	0.3			
pH	-	20	6.8	6.8	0	6.6	6.6	0	6.8	6.8	0	6.8	6.8	0	7.2	7.2	0	7.5	7.5	0	7.6	7.6	0	7.4	7.4	0	7.5	7.5	0	7.2	7.2	0	7.2	7.2	0	7.1	7.1	0
Radium (total)	Bq/L	20	0.031	0.021	38.5	0.021	0.025	17.4	0.21	0.19	10	0.29	0.25	14.8	0.22	0.25	12.8	0.11	0.12	8.7	0.2	0.2	0	0.12	0.078	42.4	0.062	0.069	10.7	0.078	0.082	5	0.11	0.11	0	0.05	0.038	27.3
TSS	mg/L	20	<1	1	NC	2	2	0	2	2	0	2	2	0	1	2	66.7	1	1	0	<1	<1	NC	1	1	0	1	1	0	1	1	0	2	2	0	<1	1	0
Uranium	mg/L	20				0.0605	0.059								0.0594	0.0584	1.7							0.0777	0.0762	1.9							0.103	0.102	1			

Date	Units	Field Precision Criteria (%)	D-2																																				
			Jan-09			Feb-09			Mar-09			Apr-09			May-09			Jun-09			Jul-09			Aug-09			Sep-09			Oct-09			Nov-09			Dec-09		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20				0.091	0.085	6.8							0.159	0.149	6.5							0.067	0.072	7.2							0.158	0.158	0			
Cobalt	mg/L	20				0.0018	0.0018	0							0.0015	0.0015	0							0.0008	0.0008	0							0.0015	0.0015	0			
Iron	mg/L	20				0.73	0.72	1.4							0.36	0.35	2.8							0.07	0.06	15.4							0.16	0.16	0			
Manganese	mg/L	20				0.394	0.376	4.7							0.375	0.367	2.2							0.191	0.188	1.6							0.298	0.298	0			
pH	-	20	6.8	6.8	0	6.9	6.9	0	7.1	7.1	0	6.9	6.9	0	7	7	0	7.2	7.2	0	7.3	7.3	0	7.2	7.2	0	7.1	7.1	0	6.9	6.9	0	7	7	0	6.7	6.7	0
Radium (total)	Bq/L	20	0.24	0.25	4.1	0.14	0.13	7.4	0.28	0.23	19.6	0.27	0.26	3.8	0.27	0.24	11.8	0.15	0.14	6.9	0.19	0.17	11.1	0.1	0.086	15.1	0.1	0.096	4.1	0.18	0.17	5.7	0.18	0.16	11.8	0.12	0.12	0
TSS	mg/L	20	1	1	0	2	2	0	1	1	0	2	2	0	1	2	66.7	2	1	66.7	1	1	0	<1	<1	NC	<1	<1	NC	2	2	0	1	1	0	1	1	0
Uranium	mg/L	20				0.0535	0.052	2.8							0.0529	0.0544	2.8							0.0854	0.0849	0.6							0.104	0.104	0			

Field precision criteria not met

Actual MDL does not meet target MDL

NC= not calculated because the concentration from one or both samples was below detection

Appendix Table B.14: Field duplicates for TOMP stations 2005 to 2009.

Date	Units	Field Precision Criteria (%)	Q-28																																			
			Jan-05			Feb-05			Mar-05			Apr-05			May-05			Jun-05			Jul-05			Aug-05			Sep-05			Oct-05			Nov-05			Dec-05		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20	0.065			0.069			0.074			0.067			0.077			0.073			0.066			0.061			0.052			0.053			0.065			0.074		
Cobalt	mg/L	20	0.02			0.021			0.0193			0.0155			0.0135			0.0065			0.0033			0.0029			0.0023			0.0022			0.008			0.0174		
Iron	mg/L	20	1.24			1.14			0.71			0.74			0.22			0.23			0.15			0.19			0.26			0.24			0.23			0.87		
Manganese	mg/L	20	2.32			2.24			3.17			1.81			1.69			1.16			0.722			0.661			0.538			0.449			1.47			2.49		
pH	-	20	7.3	7.3	0	7.9	7.9	0	8.1	8.1	0	7.3	7.3	0	7.4	7.4	0	7.5	7.5	0	7.7	7.7	0	7.6	7.6	0	7.7	7.7	0	7.7	7.7	0	7.5	7.2	4.1	7.3	7.3	0
Radium (total)	Bq/L	20	0.22	0.27	20.4	0.19	0.18	5.4	0.11	0.12	8.7	0.05	0.045	10.5	0.019	0.017	11.1	0.069	0.078	12.2	0.091	0.083	9.2	0.06	0.051	16.2	0.035	0.029	18.8	0.031	0.03	3.3	0.072	0.094	26.5	0.24		
Sulphate	mg/L	20	1279			1227			1321			1253			832			1009			1214			1258			1438			1596			1273			1329		
TSS	mg/L	20	3	3	0	3	3	0	2	1	66.7	3	2	40	<1	<1	NC	<1	<1	NC	1	1	0	1	1	0	<1	1	NC	1	1	0	1	1	0	3		
Uranium	mg/L	20	0.021			0.025			0.027			0.024			0.022			0.022			0.021			0.032			0.049			0.036			0.032			0.025		

Date	Units	Field Precision Criteria (%)	Q-28																																			
			Jan-06			Feb-06			Mar-06			Apr-06			May-06			Jun-06			Jul-06			Aug-06			Sep-06			Oct-06			Nov-06			Dec-06		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20													0.0886	0.0861	2.9																0.035	0.036	2.8			
Cobalt	mg/L	20													0.0194	0.0196	1																0.0092	0.0091	1.1			
Iron	mg/L	20													0.24	0.24	0																0.29	0.29	0			
Manganese	mg/L	20													1.81	1.82	0.6																1.57	1.29	19.6			
pH	-	20	8.2	8.2	0	8.2	8.2	0	8.2	8.2	0	7.4	7.4	0	7.5	7.5	0	7.8	7.8	0	7.5	7.5	0	7.7	7.7	0	7.5	7.5	0	7.6	7.6	0	7.4	7.4	0	7.7	7.7	0
Radium (total)	Bq/L	20	0.11	0.11	0	0.085	0.07	19.4	0.067	0.064	4.6	0.047	0.061	25.9	0.046	0.033	32.9	0.12	0.12	0	0.043	0.036	17.7	0.089	0.1	11.6	0.06	0.063	4.9	0.044	0.034	25.6	0.032	0.026	20.7	0.086	0.092	6.7
Sulphate	mg/L	20													740	800	7.8																1100	1100	0			
TSS	mg/L	20	4	5	22.2	3	5	50	2	3	40	5	4	22.2	1	2	66.7	1	1	0	<1	<1	NC	<1	1	NC	1	1	0	1	1	0	1	1	0	<1	1	NC
Uranium	mg/L	20													0.0154	0.0147	4.7																0.0486	0.0475	2.3			

Date	Units	Field Precision Criteria (%)	Q-28																																			
			Jan-07			Feb-07			Mar-07			Apr-07			May-07			Jun-07			Jul-07			Aug-07			Sep-07			Oct-07			Nov-07			Dec-07		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	RPD (%)	duplicate	RPD (%)	RPD (%)	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	RPD (%)	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20													0.084	0.083	1.2																0.068	0.069	1.5			
Cobalt	mg/L	20													0.0063	0.0063	0																0.0119	0.0123	3.3			
Iron	mg/L	20													0.17	0.17	0																0.36	0.36	0			
Manganese	mg/L	20													1.11	1.11	0																1.91	1.92	0.5			
pH	-	20	7.1	7.1	0	8.3	8.3	0	8.3	8.3	0	7.3	7.3	0	7.3	7.3	0	7.5	7.5	0	7.5	7.5	0	7.8	7.8	0	7.7	7.7	0	7.4	7.4	0	7.4	7.4	0	8	8	0
Radium (total)	Bq/L	20	0.18	0.19	5.4	0.13	0.13	0	0.066	0.064	3.1	0.087	0.11	23.4	0.075	0.078	3.9	0.061	0.06	1.7	0.09	0.091	1.1	0.088	0.095	7.7	0.1	0.1	0	0.13	0.12	8	0.18	0.19	5.4	0.14	0.17	19.4
Sulphate	mg/L	20													780	760	2.6																1200	1200	0			
TSS	mg/L	20	2	2	0	2	2	0	1	2	66.7	4	3	28.6	1	1	0	<1	1	NC	1	1	0	1	1	0	1	2	66.7	2	1	66.7	1	2	66.7	3	3	0
Uranium	mg/L	20													0.0208	0.0202	2.9																0.0242	0.0246	1.6			

Date	Units	Field Precision Criteria (%)	Q-28																																			
			Jan-08			Feb-08			Mar-08			Apr-08			May-08			Jun-08			Jul-08			Aug-08			Sep-08			Oct-08			Nov-08			Dec-08		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20													0.154	0.15	2.6																0.072	0.073	1.4			
Cobalt	mg/L	20													0.0071	0.0072	1.4																0.0069	0.0069	0			
Iron	mg/L	20													0.22	0.23	4.4																0.31	0.31	0			
Manganese	mg/L	20													1.09	1.08	0.9																1.22	1.21	0.8			
pH	-	20	7.4	7.4	0	7.6	7.6	0	8.2	8.2	0	7.4	7.4	0	7.5	7.5	0	7.4	7.4	0	7.6	7.6	0	7.3	7.3	0	7.5	7.5	0	7.8	7.8	0	7.5	7.5	0	8.4	8.4	0
Radium (total)	Bq/L	20	0.18	0.14	25	0.14	0.16	13.3	0.11	0.089	21.1	0.078	0.073	6.6	0.053	0.042	23.2	0.06	0.05	18.2	0.094	0.092	2.2	0.084	0.087	3.5	0.11	0.11	0	0.13	0.12	8	0.08	0.096	18.2	0.12	0.15	22.2
Sulphate	mg/L	20													560	660	16.4																1000	1100	9.5			
TSS	mg/L	20	2	3	40	5	4	22.2	4	2	66.7	3	2	40	1	1	0	1	<1	0	3	1	100	2	2	0	1	1	0	3	2	40	1	2	66.7	2	2	0
Uranium	mg/L	20													0.0114	0.0111	2.7																0.022	0.0219	0.5			

Date	Units	Field Precision Criteria (%)	Q-28																																			
			Jan-09			Feb-09			Mar-09			Apr-09			May-09			Jun-09			Jul-09			Aug-09			Sep-09			Oct-09			Nov-09			Dec-09		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20													0.135	0.137	1.5																0.09	0.091	1.1			
Cobalt	mg/L	20													0.0083	0.0081	2.4																0.0112	0.0114	1.8			
Iron	mg/L	20													0.25	0.25	0																0.66	0.65	1.5			
Manganese	mg/L	20													1.14	1.1	3.6																1.73	1.76	1.7			
pH	-	20	8.2	8.2	0	8.2	8.2	0	7.9	7.9	0	8.4	8.4	0	7.5	7.5	0	7.4	7.4	0	7.5	7.5	0	7.4	7.4	0	7.5	7.5	0	7.6	6.8	11.1	7.4	7.4	0	7.7	7.7	0
Radium (total)	Bq/L	20	0.15	0.13	14.3	0.095	0.088	7.7	0.12	0.13	8	0.081	0.096	16.9	0.091	0.094	3.2	0.14	0.16	13.3	0.088	0.11	22.2	0.1	0.11	9.5	0.13	0.15	14.3	0.12	0.11	8.7	0.075	0.077	2.6	0.22	0.19	14.6
Sulphate	mg/L	20													630	620	1.6																890	940	5.5			
TSS	mg/L	20	3	5	50	3	4	28.6	1	2	66.7	2	3	40	<1	<1	NC	<1	1	NC	1	2	66.7	2	1	66.7	1	1	0	1	1	0	2	2	0	4	3	28.6
Uranium	mg/L	20													0.0133	0.0132	0.8																0.0195	0.0201	3			

Field precision criteria not met

NC= not calculated because the concentration from one or both samples was below detection

Appendix Table B.15: Field duplicates for RioAlgom TOMP porewater and groundwater from 2006 to 2009.

Date	Units	Field Precision Criteria (%)	UW9-1											
			Jun-06			Jul-07			Jul-08			Sep-09		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
acidity	mg/L	20	3090	3050	1.3	3790	3750	1.1	3520	3540	0.6	2960	2900	2
iron	mg/L	20	1220	1150	5.9	1390	1350	2.9	1320	1270	3.9	953	973	2.1
pHf for blind[a]	-	20				3.89	3.91	0.5	3.97	4.01	1			
pHf for blank[a]	-	20				4.1	4.1	0	4.14	4.1	1	4.2	4.22	0.5
Sulphate	mg/L	20				4800	4800	0	5000	4300	15.1	4000	4200	4.9

Date	Units	Field Precision Criteria (%)	95N-4A											
			Jun-06			Jul-07			Jul-08			Sep-09		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
acidity	mg/L	20	2390	2400	0.4	2450	2440	0.4	2550	2650	3.8	2530	2530	0
iron	mg/L	20	1408	1494	5.9	1410	1440	2.1	1570	1570	0	1400	1340	4.4
pHf for blind[a]	-	20				5.6	5.57	0.2	4.3	4.34	1.4			
pHf for blank[a]	-	20				6.22	6.28	1	6.02	6.03	0.2	6.21	5.85	6
Sulphate	mg/L	20				4200	4200	0	4400	4200	4.7	4600	4600	0

Date	Units	Field Precision Criteria (%)	SGW3											
			Jun-06			Jul-07			Jul-08			Sep-09		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
acidity	mg/L	20	1860	1850	0.5	1630	1650	1.2	1470	1440	2.1	1300	1170	10.5
iron	mg/L	20	1030	1020	1	831	826	0.6	847	819	3.4	682	589	14.6
pHf for blind[a]	-	20				4.47	4.44	0.7	4.63	4.64	0.2			
pHf for blank[a]	-	20				4.84	4.85	0.2	4.92	4.93	0.2	4.89	5.14	5
Sulphate	mg/L	20				2800	2900	3.5	2600	3000	14.3	2400	2300	4.3

Date	Units	Field Precision Criteria (%)	95QW-5A											
			Jun-06			Jul-07			Jul-08			Sep-09		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
acidity	mg/L	20	22	21	4.7	7	8.5	19.4	29	20	36.7	39	22	55.7
iron	mg/L	20	14.4	14.4	0	15.9	15.9	0	24	21.8	9.6	12.5	15.2	19.5
pHf for blind[a]	-	20				5.88	5.85	0.5	6.23	6.33	1.6			
pHf for blank[a]	-	20				5.7	5.7	0	5.85	5.76	1.6	4.97	4.97	0
Sulphate	mg/L	20				770	760	1.3	670	720	7.2	640	670	4.6

Date	Units	Field Precision Criteria (%)	P-31											
			Jun-06			Jul-07			Jul-08			Sep-09		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
acidity	mg/L	20	<1	<1	NC	<1	<1	NC	<1	<1	NC	2	<1	NC
iron	mg/L	20	0.13	0.13	0	<0.02	0.03	NC	0.05	0.04	22.2	0.1	0.13	26.1
pHf for blind[a]	-	20				6.97	6.94	0.4	6.97	6.91	0.9			
pHf for blank[a]	-	20				6.7	6.7	0	6.5	6.53	0.5	6.47	6.47	0
Sulphate	mg/L	20				1100	1100	0	990	980	1	930	1100	16.7

Date	Units	Field Precision Criteria (%)	DK16-2B											
			Jun-06			Jul-07			Jul-08			Sep-09		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
acidity	mg/L	20	<1	<1	NC	<1	<1	NC	<1	<1	NC	2	<1	NC
iron	mg/L	20	0.1	0.09	10.5	0.03	0.04	28.6	0.02	<0.02	NC	<0.02	0.03	NC
pHf for blind[a]	-	20				8.3	8.51	2.1	8.2	8.33	1.8			
pHf for blank[a]	-	20				8.8	8.8	0	8.65	8.67	0.2	8.12	8.12	0
Sulphate	mg/L	20				1600	1600	0	1500	1500	0	1500	1600	6.5

Date	Units	Field Precision Criteria (%)	P-34A											
			Jun-06			Jul-07			Jul-08			Sep-09		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
acidity	mg/L	20	208	204	1.9	153	142	7.5	120	174	36.7	96	95	1
iron	mg/L	20	155	143	8.1	126	130	3.1	87.9	88	0.1	164	80.2	68.6
pHf for blind[a]	-	20				6.0	6.01	0.7	5.8	5.69	1.9			
pHf for blank[a]	-	20				6.6	6.6	0	6.55	6.57	0.3	6.49	6.49	0
Sulphate	mg/L	20				2800	2800	0	2700	2800	3.6	2700	2500	7.7

Date	Units	Field Precision Criteria (%)	BH96 D10 13A											
			Jul-06			Sep-07			Aug-08			Sep-09		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
acidity	mg/L	20												
iron	mg/L	20	0.13	0.11	16.7	3.19	3.09	3.2	3.54	3.55	0.3	3.75	3.9	3.9
pHf for blind[a]	-	20				7.7	7.7	0	7.71	7.74	0.4			
pHf for blank[a]	-	20												
Sulphate	mg/L	20	<1	<1	NC	<1	<1	NC	<1	<1	NC	<1	<1	NC

Date	Units	Field Precision Criteria (%)	98 15A								
			Jul-06			Sep-07			Aug-08		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	RPD (%)	duplicate	RPD (%)
acidity	mg/L	20	2510	2360	6.2	2460	2174	12.3	2200	2190	0.5
iron	mg/L	20	1260	1410	11.2	1560	1290	18.9	1360	1350	0.7
pH	-	20				5.9	5.9	0	6.1	6.11	0.2
Sulphate	mg/L	20									

(shaded) Field precision criteria not met

NC= not calculated because the concentration of one or both samples was below detection

[a] one pH measure was for the blind sample (duplicate) and one was taken for the blank sample

Appendix Table B.16: Summary of field duplicate results that exceeded the DQO.

Program	Station	Date	Parameter	Units	MDL	RPD (%)	Original Conc.	Duplicate Conc.
SRWMP	P-01	Apr-05	Barium	mg/L	0.005	59.5	0.024	0.013
		Apr-05	Radium-226	Bq/L	0.005	28.6	0.008	0.006
		Jul-05	Cobalt	mg/L	0.0005	28.6	0.003	0.0004
		Jul-05	Radium-226	Bq/L	0.005	57.1	0.01	0.018
		Jul-06	Radium-226	Bq/L	0.005	35.3	0.01	0.007
		Oct-06	Radium-226	Bq/L	0.005	31.6	0.011	0.008
		Jan-08	Radium-226	Bq/L	0.005	50	0.01	0.006
		Aug-08	Iron	mg/L	0.02	22.2	0.2	0.16
		Aug-08	Radium-226	Bq/L	0.005	28.6	0.008	0.006
		Jan-09	Sulphate	mg/L	0.1	30.5	6.8	5
	D-5	May-06	Radium-226	Bq/L	0.005	35.6	0.03	0.043
		Nov-06	Iron	mg/L	0.02	22.2	0.05	0.04
		May-09	Radium-226	Bq/L	0.005	27.7	0.037	0.028
		Nov-09	Sulphate	mg/L	0.1	31.1	26	19
		Nov-09	Uranium	mg/L	0.0005	40	0.0021	0.0014
SAMP	N-12	Jan-05	Manganese	mg/L	0.002	163	0.181	0.018
		Nov-05	Barium	mg/L	0.005	24.4	0.018	0.023
		Sep-06	Radium-226	Bq/L	0.005	30.1	0.065	0.088
		May-07	Cobalt	mg/L	0.0005	38.5	0.0031	0.0021
	D-2	Dec-05	Radium-226	Bq/L	0.005	28.6	0.056	0.042
		May-06	Barium	mg/L	0.005	31.4	0.151	0.11
		Oct-06	Radium-226	Bq/L	0.005	27.3	0.057	0.075
		Dec-06	Radium-226	Bq/L	0.005	23.3	0.072	0.091
		Mar-07	Radium-226	Bq/L	0.005	25.9	0.061	0.047
		May-07	TSS	mg/L	1	100	3	1
		Jul-07	Radium-226	Bq/L	0.005	22.2	0.088	0.11
		Nov-07	Barium	mg/L	0.005	30.8	0.161	0.118
		Nov-07	Radium-226	Bq/L	0.005	22.2	0.12	0.15
		Nov-07	TSS	mg/L	1	66.7	2	1
		Jan-08	Radium-226	Bq/L	0.005	38.5	0.031	0.021
		May-08	TSS	mg/L	1	66.7	1	2
		Aug-08	Radium-226	Bq/L	0.005	42.4	0.12	0.078
		Dec-08	Radium-226	Bq/L	0.005	27.3	0.05	0.038
		May-09	TSS	mg/L	1	66.7	1	2
		Jun-09	TSS	mg/L	1	66.7	2	1

Appendix Table B.16: Summary of field duplicate results that exceeded the DQO.

Program	Station	Date	Parameter	Units	MDL	RPD (%)	Original Conc.	Duplicate Conc.
TOMP	Q-28	Jan-05	Radium-226	Bq/L	0.005	20.4	0.22	0.27
		Mar-05	TSS	mg/L	1	66.7	2	1
		Apr-05	TSS	mg/L	1	40	3	2
		Nov-05	Radium-226	Bq/L	0.005	26.5	0.072	0.094
		Jan-06	TSS	mg/L	1	22.2	4	5
		Feb-06	TSS	mg/L	1	50	3	5
		Mar-06	TSS	mg/L	1	40	2	3
		Apr-06	Radium-226	Bq/L	0.005	25.9	0.047	0.061
		Apr-06	TSS	mg/L	1	22.2	5	4
		May-06	Radium-226	Bq/L	0.005	32.9	0.046	0.033
		May-06	TSS	mg/L	1	66.7	1	2
		Oct-06	Radium-226	Bq/L	0.005	25.6	0.044	0.034
		Nov-06	Radium-226	Bq/L	0.005	20.7	0.032	0.026
		Mar-07	TSS	mg/L	1	66.7	1	2
		Apr-07	Radium-226	Bq/L	0.005	23.4	0.087	0.11
		Apr-07	TSS	mg/L	1	28.6	4	3
		Sep-07	TSS	mg/L	1	66.7	1	2
		Oct-07	TSS	mg/L	1	66.7	2	1
		Nov-07	TSS	mg/L	1	66.7	1	2
		Jan-08	Radium-226	Bq/L	0.005	25	0.18	0.14
		Jan-08	TSS	mg/L	1	40	2	3
		Feb-08	TSS	mg/L	1	22.2	5	4
		Mar-08	Radium-226	Bq/L	0.005	21.1	0.11	0.089
		Mar-08	TSS	mg/L	1	66.7	4	2
		Apr-08	TSS	mg/L	1	40	3	2
		May-08	Radium-226	Bq/L	0.005	23.2	0.053	0.042
		Jul-08	TSS	mg/L	1	100	3	1
		Oct-08	TSS	mg/L	1	40	3	2
		Nov-08	TSS	mg/L	1	66.7	1	2
		Dec-08	Radium-226	Bq/L	0.005	22.2	0.12	0.15
		Jan-09	TSS	mg/L	1	50	3	5
		Feb-09	TSS	mg/L	1	28.6	3	4
		Mar-09	TSS	mg/L	1	66.7	1	2
		Apr-09	TSS	mg/L	1	40	2	3
		Jul-09	Radium-226	Bq/L	0.005	22.2	0.088	0.11
		Jul-09	TSS	mg/L	1	66.7	1	2
		Aug-09	TSS	mg/L	1	66.7	2	1
		Dec-09	TSS	mg/L	1	28.6	4	3
	95QW-5A	Jul-08	Acidity	mg/L	1	36.7	29	20
		Sep-09	Acidity	mg/L	1	55.7	39	22
	P-31	Jul-08	Iron	mg/L	0.02	22.2	0.05	0.04
		Sep-09	Iron	mg/L	0.02	26.1	0.1	0.13
	DK16-2B	Jul-07	Iron	mg/L	0.02	28.6	0.03	0.04
	P-34A	Jul-08	Acidity	mg/L	1	36.7	120	174
		Sep-09	Iron	mg/L	0.02	68.6	164	80.2

(shaded) Exceedence of DQO (20%) not explained by concentrations near MDL

Appendix Table B.17: Summary of laboratory duplicate results, 2005 to 2009.

Year	Description	Acidity	Barium	Cobalt	Iron	Manganese	Radium-226	Sulphate	TSS	Uranium	Total
		mg/L	mg/L	mg/L	mg/L	mg/L	Bq/L	mg/L	mg/L	mg/L	
	Program Criteria	10%	10%	10%	10%	10%	10%	10%	10%	10%	
	Lab Criteria	10%	10%	10%	10%	10%	10%	10%	10%	10%	
2005	Mean	-	2.57	4.05	2.28	1.87	5.33	0.78	-	3.93	-
	# above criteria	-	0	4	0	0	2	0	-	0	6
	% above criteria	-	0.0	18.2	0.0	0.0	4.1	0.0	-	0.0	3.1
	# samples	-	23	22	36	23	49	20	-	19	192
2006	Mean	2.125	-1.603	1.145	1.785	0.524	9.6	-0.282	-0.916	0.302	-
	# above criteria	1	7	8	16	3	7	1	8	2	53
	% above criteria	4.2	6.2	6.8	14.5	2.6	7.4	1.4	7.5	1.7	6.1
	# samples	24	113	117	110	116	95	73	107	116	871
2007	Mean	0.884	0.1	0.19	1.416	0.129	4.7	1.071	3.044	0.776	-
	# above criteria	5	0	0	4	4	3	6	28	0	50
	% above criteria	5.6	0.0	0.0	2.1	2.1	3.0	3.3	10.2	0.0	3.1
	# samples	89	202	191	188	195	99	180	274	207	1625
2008	Mean	0.975	-0.137	0.141	-0.195	0.181	1.8	-0.387	1.295	0.061	-
	# above criteria	0	4	3	10	3	15[a]	2	20	5	62
	% above criteria	0.0	1.9	1.5	4.2	1.3	12.8	1.0	8.2	0.0	3.6
	# samples	82	208	197	239	225	117	200	245	199	1712
2009	Mean	0.974	0.843	0.588	1.05	0.727	-1.2	-0.058	1.356	0.816	-
	# above criteria	1	1	1	11	1	15	0	0	13	43
	% above criteria	1.3	0.5	0.5	3.8	0.4	15.6	0.0	0.0	4.9	2.4
	# samples	77	221	215	287	224	96	213	193	266	1792
Total	# above criteria	7	12	16	41	11	42	9	56	20	214
	% above criteria	2.6	1.6	2.2	4.8	1.4	9.2	1.3	6.8	2.5	3.5
	# samples	272	767	742	860	783	456	686	819	807	6192

[Shaded box] Samples above lab and program criteria

[a] 5 is the number of cases >20% criteria used by the lab in 2008; however, based on Minnow calculation of RPD using 10% criteria, there were 15 above criteria (12.8%), with the highest RPD at 40%. With exception of this parameter in 2008, all other lab criteria was set at 10%.

Appendix Table B.18: Summary of laboratory matrix spike blank quality control results, 2005 to 2009.

Year	Description	Acidity	Barium	Cobalt	Iron	Manganese	Radium-226	Sulphate	TSS	Uranium	Total
		mg/L	mg/L	mg/L	mg/L	mg/L	Bq/L	mg/L	mg/L	mg/L	
	Program Criteria	80 - 120%	80 - 120%	80 - 120%	80 - 120%	80 - 120%	80 - 120%	80 - 120%	-	80 - 120%	
	Lab Criteria	70 - 130%	70 - 130%	70 - 130%	70 - 130%	70 - 130%	70 - 130%	70 - 130%	-	70 - 130%	
2005	Mean	-	87.7	84.6	96.6	87.0	99.5	99.7	-	105.7	-
	# above criteria	-	0	0	0	0	0	0	-	0	0
	% above criteria	-	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0
	# samples	-	17	18	27	17	73	23	-	17	192
2006	Mean	107.2	90.6	101.6	109.2	101.9	99.2	100.7[a]	-	101.9	-
	# above criteria	0	65	0	1	0	0	0	-	0	66
	% above criteria	0.0	44.5	0.0	0.8	0.0	0.0	0.0	-	0.0	6.8
	# samples	35	146	147	129	134	95	138	-	147	971
2007	Mean	109.7	66.0	102.3	109.9	104.5	102.1	100.1[a]	-	101.8	-
	# above criteria	0	13	0	0	0	0	0	-	0	13
	% above criteria	0.0	7.5	0.0	0.0	0.0	0.0	0.0	-	0.0	1.0
	# samples	92	173	175	210	154	99	345	-	54	1302
2008	Mean	112.0	67.3	101.2	107.8	99.4	97.7	100.1	-	100.9	-
	# above criteria	0	0	0	0	0	0[b]	0	-	0	0
	% above criteria	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0
	# samples	74	234	208	235	238	117	253	-	225	1584
2009	Mean	110.9	67.3	100.8	105.7	99.7	101.5	94.7	-	100.9	-
	# above criteria	0	0	0	0	0	0[b]	0	-	0	0
	% above criteria	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0
	# samples	48	229	206	286	217	96	333	-	227	1642
Total	# above criteria	0	78	0	1	0	0	0	-	0	79
	% above criteria	0	9.8	0	0.1	0	0	0	-	0	1.4
	# samples	249	799	754	887	760	480	1092	-	670	5691

(light grey) Mean spike recovery does not meet program DQO

(dark grey) Samples above lab criteria, but not necessarily above program criteria

[a] mean is calculated using the weighted means of SO_4 recovery with certified value of 4 and 100 mg/L

[b] this lab criteria was 80 - 120%, so met with program criteria as well

Appendix Table B.19: Summary of laboratory certified reference material (CRM) quality control results, 2005 to 2009.

Year	Description	Acidity	Barium	Cobalt	Iron	Manganese	Radium-226	Sulphate	TSS	Uranium	Total
		mg/L	mg/L	mg/L	mg/L	mg/L	Bq/L	mg/L	mg/L	mg/L	
	Program Criteria	80 - 120%	80 - 120%	80 - 120%	80 - 120%	80 - 120%	-	80 - 120%	-	80 - 120%	
	Lab Criteria	80 - 120%	80 - 120%	80 - 120%	80 - 120%	80 - 120%	80 - 120%	80 - 120%	-	80 - 120%	
2005	Mean	-	103.0	106.6	108.1	108.3	97.8	104.4	-	104.2	-
	# above criteria	-	0	0	0	0	0	0	-	0	0
	% above criteria	-	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0
	# samples	-	34	31	45	35	76	20	-	24	265
2006	Mean	102.1[a]	100	100	103.9	100	98.2[b]	100	-	100	-
	# above criteria	0	0	0	0	0	6	0	-	0	6
	% above criteria	0.0	0.0	0.0	0.0	0.0	6.3	0.0	-	0.0	1.6
	# samples	19	32	33	30	33	95	91	-	32	365
2007	Mean	102.0	100	100	102	100	95.5[b]	100.2	-	100	-
	# above criteria	0	0	0	0	0	8	0	-	0	8
	% above criteria	0.0	0.0	0.0	0.0	0.0	8.0	0.0	-	0.0	0.6
	# samples	99	185	185	112	192	100	194	-	189	1256
2008	Mean	102.1	100	100	100.7	100	102.4	101	-	100	-
	# above criteria	0	0	0	0	0	0	0	-	0	0
	% above criteria	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0
	# samples	117	223	216	264	239	117	207	-	214	1597
2009	Mean	102.9	100	100	100.1	100	102.4	101.4	-	100	-
	# above criteria	0	0	0	0	0	0	0	-	0	0
	% above criteria	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	0.0	0
	# samples	106	229	222	294	228	96	263	-	226	1664
Total	# above criteria	0	0	0	0	0	14	0	-	0	14
	% above criteria	0	0	0	0	0	3	0	-	0	0.3
	# samples	341	703	687	745	727	484	775	-	685	5147

(Shaded) Samples above lab criteria, but not necessarily above program criteria

[a] mean is calculated using the weighted means of CRM recovery

[b] this lab criteria was 90 - 110%

Appendix Table B.20: Target and achieved method detection limits (MDLs) for SRWMP sediment quality analysis.

Parameter	Units	Target MDL	Achieved MDL	LEL	SEL
Barium	mg/kg	0.5	0.5	-	-
Cobalt	mg/kg	0.2	0.1	-	-
Grain size	%	0.1	0.1	-	-
Iron	mg/kg	20	50	20000[a]	40000[a]
Manganese	mg/kg	0.5	1	460[a]	1100[a]
Nickel	mg/kg	0.5	0.5	23.4[b]	484[b]
Radium-226	Bq/kg	5	10	0.6[b]	14.4[b]
TOC	mg/kg	500	500	-	-
Uranium	mg/kg	0.1	0.05	104.4[b]	5874[b]

LEL - Lowest Effects Level

SEL - Severe Effects Level

[a] Provincial Sediment Quality Guidelines, MOE 1993

[b] Values used to screen lakes, based on Thompson et al. 2005

Target MDL not achieved (shaded cells)

Appendix Table B.21: Laboratory blank results associated with analyses of SRWMP sediment samples.

Parameter	Units	MDL	MA9C6924			MA9C6972	MA9C6911		MA9C6977	MA9C7001	MA9C6993	MA9C6996
Maxxam Analytics												
	QC Batch Number		1961646			1962983	1959556		1960614		1962311	1961821
Total Organic Carbon	mg/kg	500	ND			ND	ND		ND		ND	ND
	QC Batch Number		1962399	1966318	1965774	1963890	1963896	1965399	1964081	1965393	1965516	1966992
Barium (Ba)	ug/g	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cobalt (Co)	ug/g	0.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iron (Fe)	ug/g	50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Manganese (Mn)	ug/g	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nickel (Ni)	ug/g	0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Uranium (U)	ug/g	0.05	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Becquerel Laboratories												
Parameter	**QC Batch Numbers**		T09-01418	T09-01415	T09-01412	T09-01413						
			T09-01416	T09-01414	T09-01417							
Radium-226 (Ra-226)	Bq/g	0.01	ND	ND	ND	ND						

MDL - Method Detection Limit
ND - Not detected
Actual MDL does not meet target MDL

Appendix Table B.22: Field duplicate results for analysis of SRWMP sediment samples.

Parameter	Units	RDL	EL-09-03			NL-09-03			HOL-09-02			SL-09-01		
			Rep 1	Rep 2	RPD (%)	Rep 1	Rep 2	RPD (%)	Rep 1	Rep 2	RPD (%)	Rep 1	Rep 2	RPD (%)
Total Organic Carbon	mg/kg	500	50000	51000	2	62000	59000	5	67000	66000	2	66000	65000	2
Gravel	%	0.1	ND	ND	NC	ND	ND	NC	ND	ND	NC	ND	ND	NC
Sand	%	0.1	28	41	38	45	41	9	31	30	3	24	22	9
Silt	%	0.1	50	44	13	43	47	9	55	58	5	62	60	3
Clay	%	0.1	22	15	38	12	12	0	14	12	15	13	17	27

Parameter	Units	MDL	SUL-09-03			QL-09-02			MAL-09-02			MCL-09-03		
			Rep 1	Rep 2	RPD (%)	Rep 1	Rep 2	RPD (%)	Rep 1	Rep 2	RPD (%)	Rep 1	Rep 2	RPD (%)
Total Organic Carbon	mg/kg	500	110000	100000	10	72000	74000	3	94000	86000	9	38000	40000	5
Gravel	%	0.1							ND	ND	NC	ND	ND	NC
Sand	%	0.1							45	58	25	24	33	32
Silt	%	0.1							43	34	23	53	52	2
Clay	%	0.1							12	7.9	41	23	15	42

Parameter	Units	MDL	ML-09-02			NL-09-01			HOL-09-02			SL-09-05		
			Rep 1	Rep 2	RPD (%)	Rep 1	Rep 2	RPD (%)	Rep 1	Rep 2	RPD (%)	Rep 1	Rep 2	RPD (%)
Barium (Ba)	ug/g	0.5	1400	1000	33	130	120	8	72	72	0	540	720	29
Cobalt (Co)	ug/g	0.1	220	170	26	25	24	4	25	22	13	14	13	7
Iron (Fe)	ug/g	50	75000	65000	14	33000	42000	24	46000	49000	6	49000	53000	8
Manganese (Mn)	ug/g	1	35000	25000	33	300	350	15	2500	1800	33	8400	15000	56
Nickel (Ni)	ug/g	0.5	110	98	12	37	37	0	39	39	0	24	23	4
Radium-226	Ba/L	0.005	13	14	7	2.3	2.0	14	1.6	1.3	21	0.18	0.17	6
Uranium (U)	ug/g	0.05	280	270	4	110	99	11	91	96	5	4.1	4.1	0

Parameter	Units	MDL	SUL-09-03			QL-09-02		
			Rep 1	Rep 2	RPD (%)	Rep 1	Rep 2	RPD (%)
Barium (Ba)	ug/g	0.5	100	91	9	530	400	28
Cobalt (Co)	ug/g	0.1	30	29	3	26	28	7
Iron (Fe)	ug/g	50	46000	54000	16	49000	53000	8
Manganese (Mn)	ug/g	1	1100	1700	43	3100	3700	18
Nickel (Ni)	ug/g	0.5	20	17	16	24	23	4
Radium-226	Bq/L	0.005	0.28	0.19	38	2.2	2.8	24
Uranium (U)	ug/g	0.05	2.9	2.5	15	300	280	7

RPD - Relative Percent Difference
Rep - Replicate
ND - Not detected
NC - Not calculable as one or both concentrations are below MDL
Field precision criteria (<40%) not met
Actual MDL does not meet target MDL

Appendix Table B.23: Laboratory duplicate results for analysis of SRWMP sediment samples.

Parameter	Units	MDL	Maxxam Job	QC Batch	Sample	Original Sample	Laboratory Duplicate	RPD (%)
Total Organic Carbon	mg/kg	500	A9C7001	1962311	EL-09-01	37000	37000	0
			A9C6972	1962983	ML-09-01	86000	86000	0
			A9C6911	1959556	RL-09-01	98000	97000	1
			A9C6996	1961646	QL-09-03	22000	23000	4
				1961821	QL-09-02Z	74000	74000	0

Parameter	Units	MDL	Maxxam Job A9C7001			Maxxam Job A9C6924					
			QC Batch 1965399			QC Batch 1962399			QC Batch 1965774		
			Sample EL-09-05			Sample PL-09-04			Sample HOL-09-02Z		
			Original Sample	Laboratory Duplicate	RPD (%)	Original Sample	Laboratory Duplicate	RPD (%)	Original Sample	Laboratory Duplicate	RPD (%)
Acid Extractable Barium (Ba)	ug/g	0.5	200	220	10	110	110	0	72	74	3
Acid Extractable Cobalt (Co)	ug/g	0.1	89	97	9	39	41	5	22	22	0
Acid Extractable Iron (Fe)	ug/g	50	60000	64000	6	37000	38000	3	49000	48000	2
Acid Extractable Manganese (Mn)	ug/g	1	9000	9900	10	1500	1600	6	1800	1800	0
Acid Extractable Nickel (Ni)	ug/g	0.5	59	64	8	40	44	10	39	38	3
Acid Extractable Uranium (U)	ug/g	0.05	220	240	9	110	120	9	96	99	3

Parameter	Units	MDL	Becquerel Laboratories											
			QC Batch T09-01418 and T09-01416			QC Batch T09-01415 and T09-01414			QC Batch T09-01418 and T09-01416			QC Batch T09-01418 and T09-01416		
			Sample ID not provided			Sample ID not provided			Sample ID not provided			Sample ID not provided		
Radium-226 (Ra-226)	Bq/g	0.01	0.05	0.06	18	15	17	13	0.17	0.18	6	0.07	0.05	33

Field precision criteria (<20%) not met

Appendix Table B.24: Laboratory duplicate results (relative percent difference, RPD) for analysis of SRWMP sediment samples.

Parameter	MA9C6924			MA9C6972	MA9C6911		MA9C6977	MA9C7001	MA9C6993	MA9C6996
QC Batch Number	1961646			1962983	1959556		1960614		1962311	1961821
Total Organic Carbon	3.1			0.5	1.2		0.3		1.3	0.5
QC Batch Number	1962399	1965774	1966318	1963890	1963896	1965399	1964081	1965393	1965516	1966992
Barium (Ba)	2	2	12	6	1	6	0	7	37	0
Cobalt (Co)	6	2	12	4	4	9	4	1	48	14
Iron (Fe)	2	2				5			82	
Manganese (Mn)	5	2				10			43	
Nickel (Ni)	9	2	NC	6	12	8	5	4	15	0
Uranium (U)	2	3				8				

NC - Not calculated

[shaded] Laboratory precision criteria (<20%) not met

Appendix Table B.25: Recoveries (%) of quality control (QC) standards associated with SRWMP sediment analyses.

Parameter	**MA9C6924**			**MA9C6972**	**MA9C6911**		**MA9C6977**	**MA9C7001**	**MA9C6993**	**MA9C6996**
QC Batch Number	1961646			1962983	1959556		1960614		1962311	1961821
Total Organic Carbon	99			93	92		96		96	91
QC Batch Number	1962399	1965774	1966318	1963890	1963896	1965399	1964081	1965393	1965516	1966992
Barium (Ba)	101	100	102	103	99	95	94	100	99	98
Cobalt (Co)	101	106	105	107	105	100	97	101	105	102
Iron (Fe)	80	134	83	111	109	88	107	91	94	110
Manganese (Mn)	99	106	106	109	107	101	96	100	105	101
Nickel (Ni)	103	107	103	108	107	99	96	102	106	102
Uranium (U)	95	104	110	106	103	101	95	102	101	99

Parameter	**Becquerel Laboratories**			
QC Batch Number	T09-01418	T09-01415	T09-01412	T09-01413
	T09-01416	T09-01414	T09-01417	
Standard	DL1-A	DL1-A	CLV-1	DL1-A
Radium-226 (Ra-226)	88	89	100	94

[shaded cell] Analytical accuracy criteria (70 - 130%) not met

Appendix Table B.26: Recoveries (%) of matrix spikes for SRWMP sediment sample analyses.

Parameter	MA9C6924			MA9C6972	MA9C6911		MA9C6977	MA9C7001	MA9C6993	MA9C6996
	1962399	1965774	1966318	1963890	1963896	1965399	1964081	1965393	1965516	1966992
Maxxam Analytics										
Barium (Ba)	NC	NC	94	99	NC	NC	NC	NC	NC	92
Cobalt (Co)	NC	98	99	102	96	NC	102	86	97	92
Iron (Fe)	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Manganese (Mn)	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Nickel (Ni)	NC	NC	97	104	94	NC	102	NC	NC	93
Uranium (U)	NC	NC	103	98	96	NC	104	98	99	97

NC - Not calculated

[shaded box] Analytical accuracy criteria (70 - 130%) not met

Appendix Table B.27: Percent recovery of benthic macroinvertebrates from samples collected from Serpent River (2009).

Station	Number of Organisms Recovered in initial sort	Number of Organisms in Re-sort	Percent Recovery
DUL-09-5	223	232	96.1%
HOL-09-1	222	234	94.9%
MAL-09-4	227	239	95.0%
PL-09-2	326	348	93.7%
RL-09-3	88	96	91.7%
SL-09-5	171	178	96.1%
TML-09-5	143	155	92.3%
		Average % Recovery	94.2%

QA/QC Notes

Pupae were not counted toward total number of taxa unless they were the sole representative of their taxa group. Immatures were not counted toward total number of taxa unless they were the sole representative of their taxa group.

Appendix Table B.28: Sample fractions sorted from Serpent River (2009).

Station	Fraction Sorted (500 um)	Station	Fraction Sorted (500 um)	Station	Fraction Sorted (500 um)
DUL-09-1	1/4	MCL-09-3	1/2	QL-09-5	1/2
DUL-09-2	1/4	MCL-09-4	Whole	RL-09-1	Whole
DUL-09-3	1/4	MCL-09-5	1/2	RL-09-2	Whole
DUL-09-4	1/4	ML-09-1	1/4	RL-09-3	Whole
DUL-09-5	1/4	ML-09-2	1/8	RL-09-4	Whole
EL-09-1	Whole	ML-09-3	1/4	RL-09-5	1/2
EL-09-2	Whole	ML-09-4	1/8	SL-09-1	1/2
EL-09-3	Whole[a]	ML-09-5	1/16	SL-09-2	1/8
EL-09-4	1/2	NL-05-1	Whole	SL-09-3	1/4
EL-09-5	Whole	NL-05-2	Whole[a]	SL-09-4	1/8
HOL-09-1	Whole	NL-05-3	Whole	SL-09-5	1/4
HOL-09-2	1/4	NL-05-4	1/2	SUL-09-1	Whole
HOL-09-3	Whole[a]	NL-05-5	1/2	SUL-09-2	1/2
HOL-09-4	Whole	PL-09-1	1/4	SUL-09-3	1/4
HOL-09-5	1/2	PL-09-2	Whole[a]	SUL-09-4	1/2
MAL-09-1	Whole[a]	PL-09-3	1/2	SUL-09-5	1/2
MAL-09-2	Whole	PL-09-4	1/2	TML-09-1	1/8
MAL-09-3	1/2	PL-09-5	1/16	TML-09-2	1/8
MAL-09-4	Whole	QL-09-1	Whole	TML-09-3	1/2
MAL-09-5	1/2	QL-09-2	1/4	TML-09-4	1/2
MCL-09-1	1/2	QL-09-3	1/2	TML-09-5	1/8
MCL-09-2	1/2	QL-09-4	1/2		

[a] two halves sorted for subsampling error calculations.

Appendix Table B.29: Calculation of subsampling error for benthic macroinvertebrate samples from Serpent River (2009).

Station	Number of Whole Large Organisms *	Number of Organisms in Fraction 1	Number of Organisms in Fraction 2	Actual Density*	Precision	Accuracy
					%	%
EL-09-3	0	201	249	450	19.3	10.7
HOL-09-3	0	366	433	799	15.5	8.4
MAL-09-1	0	187	189	376	1.1	0.5
NL-05-2	0	131	153	284	14.4	7.7
PL-09-2	0	172	176	348	2.3	1.1

* whole large organisms excluded in calculations.
min = minimum absolute % error
max = maximum absolute % error

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1. INTRODUCTION

This report provides all QC sample results analyzed in this laboratory during the year of 2005 for Serpent River Watershed and In-basin Monitoring Program (SRWMP). Based on the Serpent River Watershed and In-basin Monitoring Program-Implementation Section 14, this assessment covers all 4 data quality indicators for each of 10 monitoring parameters.

1.1 Data Quality Indicators:

There are 4 QC data quality indicators**:**

- **Laboratory Reagent Blank**;
- **Duplicate precision**;
- **Spike accuracy**;
- **Certified reference material (CRM) accuracy**.

1.2 Mine Monitoring Parameters:

There are **10** monitoring parameters:

- **Mine Indicators, 4**: Radium-226, uranium, sulfate and iron.
- **Potential Mine Indicators, 5**: Barium, cobalt, manganese, selenium and silver.
- **Ancillary, 1:** Dissolved organic carbon (DOC).

1.3 References:

To prepare this report, the following data sources were used:

- 12 Analytical Data Quality Monthly Reports;
- Envista QC database;
- ELRFS Analytical Raw Data Worksheets;
- CAEAL Proficiency Test for 2005.

2. MAJOR ACHIEVEMENTS IN QUALITY CONTROL

2.1 In 2005, ELRFS had achieved CAEAL accreditation again including:

- Updated the Quality Manual and Standard Operating Procedures;
- Successfully completed the CAEAL site assessment and received approval of accreditation by CAEAL for the year of 2005;
- Acidity had received a new QC standard material and achieved a good CRM recovery;
- Updated Instrument Preventive Maintenance including:
  - Two Balances by accredited balance service, Mettler;
  - Replace IC column for DX-120;
  - Re-calibrate all micro-pipettes, digital pipettes and digital burets;
  - Updated all calibration standards and certified reference materials (CRM).

2.2 ELRFS has passed all PT tests for soil/sediment samples. For water samples, arsenic was failed in the October 2005 program due to a human mistake. The following parameters are awarded the PT recognition:

In water and wastewater: pH, Alkalinity, TSS, DOC;
Ag, Ba, Cd, Co, Cu, Fe, Mn, Ni, Pb, Se, U & Zn;
SO_4^{2-} & Cl.
In soils: As, Cd, Cu, Pb, Zn, Co and Ni

Note: Radium-226, acidity and TDS were awarded the accreditation but not the PT recognition since CAEAL does not have PT test programs for these parameters. From March 2006, the lab will participate PT test for TDS.

2.3 PT scores in 2005 for above 19 parameters in water and 7 elements in soil/sediments are provided as follows:

Test Parameter	Program	Method	Jan-2005 Soil	Mar-2005 Water	Jun-2005 Soil	Oct-2005 Water
PH	Water	Potontiometric		100		93
Alkalinity	Water	Potontiometric		100		81
Cd	Water	ICP-USN		95		84
Cu	Water	ICP-USN		80		88
Ni	Water	ICP-USN		100		88
Pb	Water	ICP-USN		100		87
Zn	Water	ICP-USN		95		84
Ag	Water	ICP-USN		75		83
Ba	Water	ICP-USN		95		90
Co	Water	ICP-USN		85		89
Fe	Water	ICP-USN		85		95
Mn	Water	ICP-USN		95		93
As	Water	Hydride AA		85		***68***
Se	Water	Hydride AA		80		93
U	Water	Fluorimetry		100		87
Chloride	Water	IC		100		78
Sulfate	Water	IC		100		74
DOC	Water	TOC Analyzer		100		87
TSS	Water	Gravimetric		100		98
As	Soil	Acid Extraction & Hydride AAS	100		100	
Cd	Soil	Acid Extraction & ICP-AES	100		100	
Co	Soil	Acid Extraction & ICP-AES	100		100	
Cu	Soil	Acid Extraction	90		85	

		& ICP-AES				
Pb	Soil	Acid Extraction & ICP-AES	85		95	
Ni	Soil	Acid Extraction & ICP-AES	95		100	
Zn	Soil	Acid Extraction & ICP-AES	95		100	

2.4 During the year of 2005, ELRFS has performed a total of **1,230** QA/QC analyses for the 10 monitoring parameters for SRWMP and In-Basis monitoring program, about **21.5%** of the Rio Algom/Denison total samples and analytes (Denison – 1,630 analytes; Rio Algom – 4,101 analytes). Details are provided below.

3 QC DATA QUALITY SUMMARY - ANNUAL AVERAGE

This report collected **1,230** analytical results for **40** quality control parameters (multiplication of quality indicators by monitoring parameters), calculated the annual average for reagent blank, duplicate precision, spike accuracy and CRM accuracy according to the project #2095 formulas (See **Ref.1**). The annual average results are then compared with the Target Data Quality Objectives (TDQO, see **Ref. 2**).

The explanations are made for any parameter in which the annual average results did not meet the TDQO requirements. If the individual result is over the target objective, it is called exceeding. The percentage of exceeding is counted as one of the quality performance indicators. The corrective actions and suggestions are also made after the explanations.

The annual average results for blanks, duplicate precision, spike accuracy and CRM accuracy are provided in Table 1-1, 1-2 and 1-3 below.

The detailed QC results for 40 individual QC parameters are provided in Table 2-1 to 2-10 in the Appendix.

Table 1-1 **MINE INDICATORS**
Annual Average of Data Quality Results - 2005

QC Parameter	Description	**Ra (T)** Bq/L	**Uranium** mg/L	**Sulfate** mg/L	**Iron** mg/L	Total
Reagent Blank	Criteria Average Result Exceeding % Exceeding Total Analyses	**0.01** 0.0049 1 0.95% 105	**0.001** 0.00045 0 0% 20	**0.2** 0.022 1 5.26% 19	**0.04** 0.00093 0 0% 45	- - *2* *1.1%* *189*
CRM Accuracy	Criteria Average Result Exceeding % Exceeding Total Analyses	**±20%** -2.20% 0 0% 76	**±20%** 4.17% 0 0% 24	**±20%** 4.44% 0 0% 20	**±20%** 8.10% 0 0% 45	- - *0* *0.6%* *165*
Spike Accuracy	Criteria Average Result Exceeding % Exceeding Total Analyses	**±30%** -0.49% 0 0% 73	**±30%** 5.65% 0 0% 17	**±30%** 0.34% 0 0% 23	**±30%** -3.40% 0 0% 27	- - *0* *0%* *140*
Duplicate Precision	Criteria Average Result Exceeding % Exceeding Total Analyses	**10%** 5.33% 2 4.1% 49	**10%** 3.93% 0 0% 19	**10%** 0.78% 0 0% 20	**10%** 2.28% 0 0% 36	- - *2* *1.6%* *124*
Total Analyses		***303***	***80***	***82***	***153***	***618***
Total Exceeding		***3***	***0***	***1***	***0***	***4***
% Exceeding		***1.0%***	***0%***	***1.2%***	***0%***	***0.6%***

Table 1-2 **POTENTIAL MINE INDICATORS**
Annual Average of Data Quality Results - 2005

QC Parameter	Description	**Barium** mg/L	**Cobalt** mg/L	**Manganese** mg/L	**Selenium** mg/L	**Silver** mg/L	*Total*
Reagent Blank	Criteria	**0.01**	**0.001**	**0.004**	**0.001**	**0.0001**	-
	Average Result	0.00016	0.00006	0.00005	0.00078	0.00003	-
	Exceeding	0	0	0	2	1	*3*
	% Exceeding	0%	0%	0%	9.5%	6.3%	*2.2%*
	Total Analyses	34	32	35	21	16	*138*
CRM Accuracy	Criteria	**±20%**	**±20%**	**±20%**	**±20%**	**±20%**	-
	Average Result	2.95%	6.61%	8.25%	6.03%	4.63%	-
	Exceeding	0	0	0	0	0	*0*
	% Exceeding	0%	0%	0%	0%	0%	*0%*
	Total Analyses	34	31	35	21	21	*142*
Spike Accuracy	Criteria	**±30%**	**±30%**	**±30%**	**±30%**	**±30%**	-
	Average Result	-12.3%	-15.38%	-13.04%	0.0%	-3.11%	-
	Exceeding	0	0	0	0	0	*0*
	% Exceeding	0%	0%	0%	0%	0%	*0%*
	Total Analyses	17	18	17	17	18	*87*
Duplicate Precision	Criteria	**10%**	**10%**	**10%**	**10%**	**10%**	-
	Average Result	2.57%	4.05%	1.87%	5.06%	5.74%	-
	Exceeding	0	4	0	3	4	*11*
	% Exceeding	0%	18.2%	0%	16.7%	22.2%	*10.6%*
	Total Analyses	23	22	23	18	18	*104*
Total Analyses		***108***	***103***	***110***	*77*	*73*	***471***
Total Exceeding		***0***	***4***	***0***	***5***	***5***	***14***
% Exceeding		***0%***	***3.9%***	***0%***	***6.5%***	***6.8%***	***3.0%***

Table 1-3 **ANCILLARY**
Annual Average of Data Quality Results - 2005

QC Parameter	Description	**DOC** mg/L
Reagent Blank	Criteria Average Result Exceeding % Exceeding Total Analyses	**1** 0.17 0 0% 26
CRM Accuracy	Criteria Average Result Exceeding % Exceeding Total Analyses	**±20%** -4.44% 0 0% 26
Spike Accuracy	Criteria Average Result Exceeding % Exceeding Total Analyses	**±30%** -4.64% 0 0% 40
Duplicate Precision	Criteria Average Result Exceeding % Exceeding Total Analyses	**10%** 5.70% 6 12.2% 49
Total Analyses		***141***
Total Exceeding		***6***
% Exceeding		***4.3%***

4. CONCLUSION AND SIGNIFICANT FINDINGS

4.1 It is concluded from the above tables that **the annual 2005 average QC results in all of 10 monitoring parameters for all of 4 required QC indicators have met the target data quality objectives (TDQO).**

4.2 **Significant findings:**

4.2.1 Overall performance of QC analyses is summarized in Table 3.

Table 3 Overall Quality Control Performance Summary

Item	QC Parameter	Total Analysis	Individual Exceeding	Blank Analysis	CRM Analysis	Spike Analysis	Duplicate Analysis
Mine Indicator	16	618	4	189	165	140	124
Potential Mine Indicator	20	471	14	138	142	87	104
Ancillary	4	141	6	26	26	40	49
Total	**40**	**1,230**	**24**	**353**	**333**	**267**	**277**
Total Analytes		5731					
Percentage		**21.5%**	**2.0%**	**28.7%**	**27.1%**	**21.7%**	**22.5%**

In this table, there are **1,230** QC samples analyzed for SRWMP in 2005, about **21.5%** of total effluent analyses for both companies (Rio: 4,101; Denison: 1,630). **24** individual QC samples exceeded the TDQO, about **2.0%** of total QC analyses.

In the four quality indicators, blank analysis has the highest percentage, 28.7%, of total QC analyses. CRM analysis has 27.1%; duplicate analysis 22.5%; and spike analyses 21.7%.

4.2.2 **Radium-226** was the mostly frequent analyzed monitoring parameters in the QC analysis. **Iron and DOC** are 12.4% and 11.5% respectively. See Table 4.

Table 4 The Most Frequently Analyzed Monitoring Parameters

No.	Monitoring Parameter	Total QC Samples Analyzed	Percentage
1	Radium-226	303	24.6%
2	Iron	153	12.4%
3	DOC	141	11.5%

4.2.3 The highest exceeding rates occurred in 3 monitoring parameters, i.e. **silver, selenium and DOC**, and in 4 QA/QC parameters, i.e. duplicates for silver, cobalt, selenium and DOC. Details are provided in Table 5.

Table 5 Individual Parameters with Highest Exceeding Rate

Item	Exceeding Number	Exceeding Percentage
Silver	5	6.8%
Selenium	5	6.5%
DOC	6	4.3%
Duplicate Analysis for Silver	4	22.2%
Duplicate Analysis for Cobalt	4	18.2%
Duplicate Analysis for Selenium	3	16.7%
Duplicate Analysis for DOC	6	12.2%

4.2.4 **Uranium, Iron, Barium, Manganese and Sulfate** have achieved the best QC performance with only 1 exceeding in the sulfate analysis. Uranium and sulfate have average accuracy of 0.34 to 5.65%; the average duplicate precision is 0.78 to 3.93%.

5. DETAILS OF EXCEEDING RESULTS IN DUPLICATE ANALYSIS

5.1 Radium-226

No.	Date	Sample ID	Code	1st Result, Bq/L	2nd Result , Bq/L	Average, Bq/L	Difference
1	2005.04.25	N-20	N05-50	0.0052	0.007	0.0061	**29.7%**
2	2005.09.22	Cell 14	Q05-127	0.437	0.395	0.416	**10.1%**

5.2 Cobalt

No.	Date	Sample ID	Code	1st Result, mg/L	2nd Result , mg/L	Average, mg/L	Difference
1	2005.02.07	DS-4	DS05-1	0.00074	0.00082	0.00078	**10.3%**
2	2005.06.23	D-2	D05-62	0.00062	0.00054	0.00058	**13.8%**
3	2005.11.10	D-2	D05-114	0.00048	0.00043	0.000455	**11.0%**
4	2005.12.12	Q-09	Rio05-95	0.00062	0.00070	0.00066	**12.1%**

5.3 Selenium

No.	Date	Sample ID	Code	1st Result, mg/L	2nd Result , mg/L	Average, mg/L	Difference
1	2005.08.12	SR-08	Rio05-53	0.00019	0.00023	0.00021	**19.1%**
2	2005.09.13	D-5	Den05-25	0.00007	0.00009	0.00008	**25.0%**
3	2005.11.23	PR-01	PR05-32	0.00048	0.00043	0.000455	**11.0%**

5.5 Silver

No.	Date	Sample ID	Code	1st Result, mg/L	2nd Result , mg/L	Average, mg/L	Difference
1	2005.03.02	DS-4	DS05-10	0.00323	0.00286	0.003045	**12.2%**
2	2005.05.03	DS-18	Den05-22	0.00027	0.00031	0.00029	**13.8%**
3	2005.06.14	P-14	P05-22	0.00041	0.00036	0.000385	**13.0%**
4	2005.06.24	SR-08	Rio05-50	0.00019	0.00022	0.000205	**14.6%**

5.6 DOC

No.	Date	Sample ID	Code	1st Result, mg/L	2nd Result , mg/L	Average, mg/L	Difference
1	2005.01.14	SR-19	Rio04-109	5.04	5.67	5.36	**11.7%**
2	2005.02.25	D-6	Den05-5	3.93	3.54	3.73	**10.5%**
3	2005.02.25	DS-18	Den05-6	2.166	1.941	2.054	**10.9%**
4	2005.04.30	DS-18	Den05-13	1.75	2.04	1.89	**15.3%**
4	2005.06.07	SR-06	Rio05-39	2.08	1.767	1.92	**16.3%**
4	2005.08.26	P-01	Rio05-66	3.133	2.827	2.98	**10.3%**

6. IMPLEMANTATION OF 2004 CORRECTIVE ACTIONS

6.1 Blank Sample Analysis for Silver

In 2005, the silver blank sample was pre-concentrated. This is the same procedure for samples to achieve lowest method detection limit, 0.00006 mg/L. The results are shown in Table 2-9. In the 16 blank samples, average result is 0.00003 mg/L. There was only 1 sample result, 0.00012 mg/L, exceeded the target value of 0.0001 mg/L. Compared to 2004 results, the average blank dropped almost 7 times. The percentage of exceeding dropped 6 times from 38.9% to 6.2% (see Table 6).

Table 6 Comparison of Blank Results for Silver

Description	**2004**	**2005**
Criteria, mg/L	0.0001	0.0001
Average Result, mg/L	0.00020	0.00003
Exceeding Number	14	1
% Exceeding	38.9%	6.2%
Total Analysis	36	16

6.2 Duplicate Analysis for Radium-226 and DOC

According to 2004 recommendations, all of low radioactivity samples and duplicate samples for radium-226 were counted twice or three times. The average precision is slightly higher than 2004. The exceeding percentage drops 5 times from 20.3% to 4.1% (see Table 7).

For DOC analysis, the numbers of duplicate samples did not increase. The QC performance for 2005 has not improved yet. The exceeding percentage is almost the same as 2004 (see Table 7).

Table 7 Comparison of Duplicate Analysis for Radium-226 and DOC

Description	Ra-226 for 2004	Ra-226 for 2005	DOC for 2004	DOC for 2005
Criteria	10%	10%	10%	10%
Average Result	6.51%	5.33%	4.55%	5.70%
Exceeding Number	13	2	7	6
% Exceeding	20.3%	4.1%	11.9%	12.2%
Total Analysis	64	49	59	49

7. CORRECTIVE ACTIONS

7.1 The highest exceeding frequency of duplicate analysis occurred in silver, cobalt, selenium and DOC. The reason is the lower concentrations in the SRWMP samples as seen in the Section 5.

To improve the duplicate performance, **the following corrective actions** should be taken:

- Repeat the analysis if the sample concentrations are too low.
- Perform more duplicate samples.
- Choose the duplicate samples that contain higher concentrations of the analyte.

8. REFERENCES

8.1 Minnow Proposal: **QA/QC Information, Serpent River Watershed Monitoring Program (Project No. 2095),** September 20 – October 3, 2004

8.2 **Data Quality Objective Table 2.1** 1999 SRWMP and In-basin document for Rio Algom Mines Ltd. and Denison Mines Ltd.

8.3 **Protocol for the Sampling and Analysis of Industrial/Municipal Wastewater,** Ontario, July 1999.

8.4 **Reference Methods for Sampling and Analysis of Metal Mining Effluents** Draft 3. Prepared by Peter Fowlie. January 1999.

8.5 Data **Quality Assessment and Reporting Procedure, QAP-6**. ELRFS Quality Manual

APPENDIX: SUMMARY OF DETAILED SRWMP QC DATA QUALITY RESULTS FOR THE YEAR OF 2005

See **Table 2-1 to Table 2-10 in the following pages**

Environmental Services

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DATE: *23 March 2007*

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1. BACKGROUND

SGS Environmental Services entered into an agreement with Denison Environmental Services for the analytical lab to provide analysis according to RFT #05-016. Please find below a summary of the laboratory quality management system, key actions taken by the laboratory for samples analysed during 2006, as well as a summary the significant findings and corrective actions taken.

2. QUALITY MANAGEMENT SYSTEM

SGS Environmental Services is accredited by the Standards Council of Canada (SCC) and by the Canadian Association for Environmental Analytical Laboratories (CAEAL), for specific environmental tests listed in the scope of accreditation. ISO/IEC 17025 addresses both quality management and the technical aspects of operating a testing laboratory.

The quality management system at SGS Environmental Services consists of a documented quality system, which is directed by the Quality Control Coordinator who is independent of the production area. All appropriate documentation (quality manual, methods, written instructions, standard operating procedures, and data approval criteria) is in place and includes both general and method specific quality control requirements.

The quality control procedures include duplicate samples, spiked blanks, spiked replicates, reagent/instrument blanks, preparation control samples, certified reference material analysis, and instrument control samples, as appropriate for the individual methods. Matrix matching of reference materials to samples is always attempted. Frequency of insertion of control samples is method specific and follows legislated guidelines. A summary of the quality control recoveries is presented in the tables following.

3. QUALITY CONTROL ANALYSIS

The analysis of quality control samples is method specific and includes duplicate samples, spiked blanks, spiked replicates, reagent/instrument blanks, preparation control samples, certified reference material analysis, and instrument control samples, as appropriate for the individual methods. Matrix matching of reference materials to samples is always attempted. Frequency of insertion of control samples is method specific and follows legislated guidelines and/or customer requirements. All QC analyses for Denison Environmental Services are tracked in unique files, specific to Denison Environmental Services. The samples are processed as part of our "worksheet" batch system and a compilation of all Denison Environmental Services QC data for the parameters tested during 2006 has been compiled below.

4. MAJOR ACHIEVEMENTS IN QUALITY CONTROL

- SGS Environmental Services performed 9809 analyses with 7028 QC checks, which represents 72% QC for sample analysis. This level of QC analysis exceeds the lab standard for QC insertion, which is generally at 20% insertion.
- Blank data values for acidity and DOC that exceeded the data quality objective represent data at or near the detection limit where the limit is +/- the detection limit. The supporting QC data within all runs was within data quality objective limits. **Corrective Action**: No further action required.
- All Certified Reference Material data values for samples processed in 2006 were within the data quality objective of +/- 20%. **Corrective Action**: N/A
- There were duplicate sample values outside of the data quality objective of +/- 10% observed. However, the duplicate values represent data at or near the detection limit where the repeatability is +/- the detection limit. The supporting QC data within all runs was within data quality objective limits. **Corrective Action**: No actual non-conformances occurred; the data is evaluated against current SGS Environmental Services limits, which are at or below DES limits and no further action is required; the LIMS data management program cannot be changed to accommodate a modified reporting limit.
- Spike blanks for Ba, Se, and Fe exceeded the data quality objectives. However, reporting limits for these elements for Denison Environmental Services exceed the standard reporting limits for SGS Environmental Services. Therefore, spike blanks are reported as 'less than' (<) detection limit and flagged as outliers/failures by our LIMS data management program. Results remain within data quality objectives for the method. **Corrective Action**: No actual non-conformances occurred; the data is evaluated against current SGS Environmental Services limits, which are at or below DES limits and no further action is required; the LIMS data management program cannot be changed to accommodate a modified reporting limit.
- Several spike duplicate results exceeded the data quality objectives for a number of elements. The Se results that were biased high had a (suspected) positive chloride interference in the matrix and a suspected contamination in the spike solution. A positive bias in the spike solutions in conjunction with non-detect values of Se in unknown samples does not have a significant impact on the final concentration, as opposed to a low bias, which would indicate incomplete recovery. This data set, along with all other spike duplicate results outside of the data quality objectives had supporting QC in the run that was within the limits required, therefore, data was accepted. **Corrective Action:** When the concerns with Se were first identified, SGS Environmental Services confirmed all positive results by ICP-MS and AA Hydride Generation, (which eliminated the interference). A new (higher concentration) spiking solution was ordered and a new ICP-MS CRI was commissioned for use in January 2007. As a result, interference effects for Se at these detection limits will be eliminated.

5. QC DATA QUALITY SUMMARY

Blank Data:

Parameter	Unit	Required Limit	Mean Blank Result	Number of Blanks	Number greater than Limit	Number Outside +/- Detection Limit
Acidity	mg/L as CaCO3	2	2.07356	36	6	0
Ag	mg/L	0.0001	0.00001	133	0	0
Alkalinity	mg/L as CaCO3	2	0.28000	5	0	0
As	mg/L	0.0005	0.00005	55	0	0
Ba	mg/L	0.005	0.00082	131	0	0
Co	mg/L	0.0005	0.00008	134	0	0
Cu	mg/L	0.0001	0.00014	79	0	0
DOC	mg/L	0.5	0.12788	32	1	0
Fe	mg/L	0.02	0.00162	129	0	0
Mn	µg/L	0.002	0.00033	129	0	0
Ni	µg/L	0.002	0.00032	78	0	0
Pb	µg/L	0.00002	0.00007	75	0	0
Se	µg/L	0.0005	0.00003	131	0	0
SO4	mg/L	0.1	0.01852	135	0	0
Total Suspended Solids	mg/L	1	0.11502	156	0	0
U	µg/L	0.0005	0.00007	133	0	0
Zn	µg/L	0.001	0.00015	79	0	0

CRM Data:

Parameter	Unit	Certified Value	Lower Limit (at 20% Rel. Error)	Upper limit (at 20 % Rel. Error)	Number of CRM's	Mean Value	Precision (%RSD)	Accuracy (% Rel error)	Number QC CRM outside of DQO
DOC	mg/L	25	20	30	24	25.98	3.74	-3.93	0
pH	units	4	3.2	4.8	7	4.00	0.40	-0.04	0
Acidity	mg/L as CaCO3	50	40	60	12	48.95	1.41	2.10	0
Acidity	mg/L as CaCO3	10	8	12	7	10.94	2.94	-9.37	0
Ag	mg/L	0.1	0.08	0.12	31	0.10	3.42	-0.83	0
Alkalinity	mg/L as CaCO3	47.2	37.8	56.6	8	48.53	1.42	-2.82	0
As	mg/L	0.1	0.08	0.12	31	0.10	5.90	1.21	0
Ba	mg/L	0.1	0.08	0.12	32	0.10	4.00	-3.21	0
Co	mg/L	0.1	0.08	0.12	33	0.10	4.40	-1.85	0
Cu	mg/L	0.1	0.08	0.12	35	0.10	3.64	-0.45	0
DOC	mg/L	10	8	12	16	10.49	4.05	-4.92	0
Fe	mg/L	500	400	600	30	519.46	2.41	-3.89	0
Mn	µg/L	0.1	0.08	0.12	33	0.10	4.06	-1.91	0
Ni	µg/L	0.1	0.08	0.12	32	0.10	3.22	1.22	0
Pb	µg/L	0.1	0.08	0.12	32	0.10	2.97	-0.52	0
Se	µg/L	0.1	0.08	0.12	32	0.10	5.76	0.75	0
SO4	mg/L	5	4	6	91	5.00	2.01	0.08	0
U	µg/L	0.1	0.08	0.12	32	0.10	4.14	-1.02	0
Zn	µg/L	0.1	0.08	0.12	33	0.10	3.68	-0.95	0

Duplicate Data:

Parameter	unit	Expected Recovery (Rel %)	Lower Limit (Rel %)	Upper Limit (Rel %)	Number of Duplicates	Mean (% Rel Error)	Number Duplicate samples outside of DQO	Number Duplicate samples outside of DQO (at 10x LOQ)
Acidity	% Rec.	100	90	110	24	2.125	1	0
Ag	% Rec.	100	90	110	112	2.045	4	0
Alkalinity	% Rec.	100	90	110	7	0.667	1	0
As	% Rec.	100	90	110	40	5.256	16	0
Ba	% Rec.	100	90	110	113	-1.603	7	0
Co	% Rec.	100	90	110	117	1.145	8	0
Cu	% Rec.	100	90	110	58	6.902	22	0
DOC	% Rec.	100	90	110	23	1.540	8	0
Fe	% Rec.	100	90	110	110	1.785	16	0
Mn	% Rec.	100	90	110	116	0.524	3	0
Ni	% Rec.	100	90	110	55	-1.159	18	0
Pb	% Rec.	100	90	110	60	1.144	21	0
pH	% Rec.	100	90	110	4	94.238	4	0
Se	% Rec.	100	90	110	89	2.047	18	0
S	% Rec.	100	90	110	73	-0.282	1	0
Tot Suspended Solids	% Rec.	100	90	110	107	-0.916	8	0
U	% Rec.	100	90	110	116	0.302	2	0
Zn	% Rec.	100	90	110	58	-1.345	15	0

Spike Blank Data:

Parameter	Unit	Certified Value	Lower Limit (at 30% Rel. Error)	Upper limit (at 30 % Rel error)	Number of Spike Blank's	Mean % Recovery	Mean Precision (%)	Number Spike Blank outside of DQO	Number Spike Blank outside of SGS QC protocols and below Denison MDL
Acidity	mg/L as CaCO3	10	7	13	35	107.22	0.517	0	0
Ag	mg/L	0.00016	0.000112	0.00021	139	102.01	0.000	0	0
Alkalinity	mg/L as CaCO3	9.4	6.58	12.2	7	102.29	0.281	0	0
As	mg/L	0.0064	0.00448	0.00832	69	99.91	0.000	0	0
Ba	mg/L	0.004	0.0028	0.0052	146	90.59	0.000	65	0
Co	mg/L	0.002	0.0014	0.0026	147	101.63	0.000	0	0
Cu	mg/L	0.0016	0.00112	0.00208	92	112.22	0.000	0	0
DOC	mg/L	20	14	26	56	99.16	0.722	0	0
Fe	mg/L	0.1	0.07	0.13	129	109.21	0.006	1	0
Mn	µg/L	0.0032	0.00224	0.00416	134	101.85	0.000	0	0
Ni	µg/L	0.0048	0.00336	0.00624	89	102.96	0.000	0	0
Pb	µg/L	0.0032	0.00224	0.00416	68	109.13	0.000	0	0
Se	µg/L	0.0008	0.00056	0.00104	115	104.76	0.000	3	3
SO4	mg/L	4	2.8	5.2	108	100.64	0.103	0	0
SO4	mg/L	100	70	130	30	101.05	9.863	0	0
U	µg/L	0.0008	0.00056	0.00104	147	101.85	0.000	0	0
Zn	µg/L	0.0056	0.00392	0.00728	62	114.94	0.000	0	0

Spike Duplicate Data:

Parameter	Unit	Certified Value	Lower Limit (at 30% Rel. Error)	Upper limit (at 30 % Rel error)	Number of Spike Blank's	Mean % Recovery	Precision (%RSD)	Number Spike Blank outside of DQO	Number Spike Dup. outside of SGS QC protocols and below Denison MDL
Ag	µg/L	0.16	0.112	0.208	116	94.58	0.02	6	0
As	µg/L	6.4	4.48	8.32	53	104.11	0.64	0	0
Ba	µg/L	4	2.8	5.2	98	93.15	1.05	20	0
Co	µg/L	2	1.4	2.6	133	101.08	0.21	1	0
Cu	µg/L	1.6	1.12	2.08	74	106.64	0.18	5	0
DOC	mg/L	100	70	130	44	99.01	6.55	0	0
Fe	mg/L	0.1	0.07	0.13	112	110.13	0.01	3	1
Mn	µg/L	3.2	2.24	4.16	74	99.30	0.94	14	0
Ni	µg/L	4.8	3.36	6.24	71	96.42	1.16	3	0
Pb	µg/L	3.2	2.24	4.16	79	111.61	0.30	6	0
Se	µg/L	0.8	0.56	1.04	87	110.50	0.29	36	18
SO4	mg/L	100	70	130	92	99.92	6.47	0	0
U	µg/L	0.8	0.56	1.04	111	104.53	0.11	7	2
Zn	µg/L	5.6	3.92	7.28	63	114.46	1.15	15	5

QC Frequency:

Total Number of Blanks	1783
Total Number of CRM	919
Total Number of Duplicates	1400
Total Number of Spike Blank	1573
Total Number of Spike Duplicates:	1353
Sum of QC Insertion	**7028**
Total Analysis:	**9809**

6. CONCLUSION & SIGNIFICANT FINDINGS

SGS Environmental Services analyzed QC samples for this project beyond the lab standard of 20% QC insertion. While some of the data points exceeded the data quality objectives, the additional QC samples analyzed supported the data values and data was released on this basis.

SGS Environmental Services remains committed to delivering data that meets and/or exceeds the data quality objectives for Denison Environmental Services and staff will continue to work closely with Denison Environmental Services staff to ensure all objectives are achieved in 2007.

7. CORRECTIVE ACTIONS & IMPLEMENTATION OF CORRECTIVE ACTIONS

- Discrepancies in Ag analysis in solution were noted between SGS Environmental Services and the previous laboratory used by Denison Environmental Services. SGS Environmental Services Ag data was consistently lower than previous reports. Upon discussion with Denison Environmental Services it became apparent that there were differences in the analytical instrumentation previously in use. SGS Environmental Services uses a quadruple inductively coupled plasma mass spectrometer (ICP-MS) whereas previous data was generated by inductively coupled plasma optical emission spectrometer (ICP-OES) with ultrasonic nebulization (USN). While both techniques are good there are certain advantages of ICP-MS when compared to ICP-OES with USN. ICP-MS is a more sensitive technique, having a much lower analytical sensitivity, which is relatively interference free for silver, while ICP-OES with USN is not as sensitive, and can exhibit more background interferences which may have lead to higher analytical results (possibly due to sulphate concentrations). **Corrective Action:** Based on the above technical information, it was determined that the analysis for silver would be done by ICP-MS.
- Several spike duplicate results exceeded the data quality objectives for a number of elements. The Se results that were biased high had a (suspected) positive chloride interference in the matrix and a suspected contamination in the spike solution. A positive bias in the spike solutions in conjunction with non-detect values of Se in unknown samples does not have a significant impact on the final concentration, as opposed to a low bias, which would indicate incomplete recovery. This data set, along with all other spike duplicate results outside of the data quality objectives had supporting QC in the run that was within the limits required, therefore, data was accepted. **Corrective Action:** When the concerns with Se were first identified, SGS Environmental Services confirmed all positive results by ICP-MS and AA Hydride Generation, (which eliminated the interference). A new (higher concentration) spiking solution was ordered and a

new ICP-MS CRI was commissioned for use in January 2007. As a result, interference effects for Se at these detection limits will be eliminated.

- The required limit for lead was previously listed as 0.00002 mg/L, with a mean data blank value of 0.00008 mg/L. Therefore, at least one of the blank results did not meet the data quality objectives **Corrective Action**: The required reporting limit has been updated to the Denison Environmental Services limit of 0.0005 mg/L with the mean data blank value of 0.00008 mg/L falling well below the required limit.
- Denison Environmental Services report CA11555-SEP06 was issued with incorrect values for SO4. The samples were run with a 100X dilution but the factor was omitted when entered into the sequence. The error was not noticed during the calculation stage and was reported 100X lower than the actual results. **Corrective Action:** The error was documented as per the requirements of our Quality Management System, which the technician signed. The data for SO4 was re-issued under report CA10079-NOV06.
- During the review of Denison Environmental Services QC files, it was noted that the limits for acidity reflected the standard lab data quality objectives of +/- 20%. **Corrective Action:** No values for acidity exceeded +/- 10%. The limits in the LIMS program have been updated to +/- 10%.
- Denison Environmental Services notified SGS Environmental Services of a deviation from required MDL values. It was noted by SGS Environmental Services that chain of custody forms for the October submissions came in for SRWMP requiring the 0.00006 mg/L MDL while in November the submission was for NORDIC requiring the 0.0001 mg/L MDL. **Corrective Action:** SGS Environmental Services logs in samples as per the charge code on the submission forms. Unfortunately this is a required process prior to the import of the EMLINE file. No further action required.
- Based on correspondence received from Denison Environmental Services, an in-house study was done that compared acidity data from reports generated at SGS with those from another laboratory previously used by Denison Environmental Services. There was a notable difference in analytical values between historical values analyzed in 2005 and results generated from the same sampling sites in 2006 (see Addendum 2). **Corrective Action**: SGS performed a series of re-assays to ascertain the reasons for the discrepancies. Three different circumstances were identified as contributing factors to the discrepancy in data.
    - Data provided to SGS by Denison Environmental Services did not match data originally reported by SGS. A review of the original Certificate's analysis identified transcription errors. However, the errors occurred after the data had been released to the company managing the information for Denison Environmental Services, and as such no corrective action taken.
    - Data provided to Denison Environmental Services was reported low due to a software issue with the Mantec™ auto-titration system used by SGS Environmental Services. Specifically, samples that reach the maximum

amount of titrant (set at 50 mL to prevent the over-titration of samples resulting in a spill of material on the instrument) are not flagged as incomplete and are reported as <1 mg/L. Results of <1 mg/L, however, require laboratory technicians to identify and re-assay the samples that were incomplete and which require a smaller aliquot. **Corrective actions:** Quality action Forms 1297, 1308, and 1309 were created within the quality system, where possible all of the effected samples were re-assayed, all technicians involved with the determination were instructed, and re-trained on how to avoid the problem.

- Data provided from Denison Environmental Services generally showed an overall bias when compared to the SGS Environmental Services data. It was determined that SGS and the original testing laboratory used two (slightly) different methods for the determination of acidity. It is believed that this difference in methodology resulted in the higher bias of the original 2005 results. SGS follows the standard methods procedure 2310B (APHA, 2005). The primary difference between the two methodologies is that SGS performs an "oxidation step" as per 2310B (the samples are titrated to a pH of 3.9 with 0.02 N sulfuric acid, add 5 drops of hydrogen peroxide and boiled before titrating to a pH of 8.3 with 0.02 N sodium hydroxide), whereas the methodology used by the original laboratory did not carry out the oxidation step. Further research suggests that the differences in the amount of H2CO3, Fe+2, and Fe+3 resulted in the bias of the data. The Statement: *"For samples containing hydrolyzable metals, the addition of H2SO4 acid serves to convert HCO3 into H2CO3 which allows CO2 to degass rapidly upon boiling so CO2-derived acidity is intentionally not measured. The addition of H2O2 causes oxidation of Fe +2 and Mn +2 so that they can be precipitated as oxides or hydroxides during the titration"* (C.S. Kirby, C.A. Cravotta III, applied geochemistry, 2005) helps explain the complexity of the analysis and the distinct bias between the two data sets. **Corrective actions:** SGS performed a number of re-assays to determine if the above changes in methodology contributed to the bias in data. (Addendum 3). The results demonstrated the bias when samples that were titrated "oxidized" and not "oxidized" supporting the above arguments. No further action is necessary. SGS will continue to run acidities according to the established method.

8. SUBCONTRACT LAB INFORMATION

A full report will be provided by the subcontract lab for all analyses performed. A summary of the information included in the subcontract lab reports is below.

Analytical Parameter	Blank Result Bq/L	Number of Blanks	CRM accuracy %	Numbers of CRMs
DQO	-	-	+- 10	-

Ra-226	< 0.005	89	2.9	91

Analytical Parameter	Spike accuracy %	Number of Spikes	Precision %	Number of Duplicates
DQO	+/- 30		10	
Ra-226	+0.8	89	8.6	89

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Annual Quality Assessment Report for 2006

Introduction

The following samples were used for quality control in 2006. A set of control samples was included with each set of 20 or fewer samples.

Reagent Blanks

Reagent blanks were aliquots of deionized water that were processed in the same way as samples, using the same tracers, carriers and other reagents.

Duplicates

Duplicate samples were replicate aliquots of a sample from each analysis run, and were processed in the same way as other samples.

While samples from Dennison Mines were limited to a 500 mL volume, some duplicates were from samples submitted by other clients.

Analyte Spikes

A solution of Ra-226 was prepared by dissolving and diluting a portion of the Canmet CRM BL-3. A one-millilitre aliquot of this solution was added to a second aliquot of sample to test recoveries. Each aliquot added contained 0.109 Bq of Ra-226.

While samples from Dennison Mines were limited to a 500 mL volume, some spiked samples were prepared from samples submitted by other clients.

It should be noted that Barium-133 is added to every aliquot as a tracer, in order to measure the chemical yield of Ra-226 for each individual sample.

Check Standards

Several check standards were using during 2006.

RA226.012
: A portion of Canmet CRM DH1-A was dissolved and diluted with dilute nitric acid.

R63
: This was a solution obtained from Environmental Research Associates in a performance evaluation trial. It was used as a temporary check standard until a standard solution was received.

R59
: This was a solution obtained from Environmental Research Associates in a performance evaluation trial. It was used as a temporary check standard until a standard solution was received.

RA226.013
: This was a solution prepared from the spike solution. It was used as a temporary check standard until a standard solution was received.

RA226.015
: A calibrated solution of Ra-226 was obtained from Isotope Products Laboratories and used to prepare this check standard. The standard was checked against Canmet CRM DL1-A.

Major Achievements in Quality Control

Sample identification was placed under stricter control, with all containers and prepared sources labelled.

Ongoing improvements in precision were obtained through mechanical sample changing during yield determination and adjustment of counting times. Sample aliquot size was increased for the same reason.

QC Data Quality Summary

Analytical Parameter	Blank Result Bq/l	Number of Blanks	CRM accuracy %	Numbers of CRMs
DQO			+- 10	
Ra-226	< 0.005	95	-1.8	95

Analytical Parameter	Spike accuracy %	Number of Spikes	Precision %	Number of Duplicates
DQO	+- 30		10	
Ra-226	-0.8	95	9.6	95

Notes: CRM accuracy and Spike accuracy values are averages. The values above are percent differences from the expected values. If means are computed for absolute deviations, that for the CRM becomes 4.6% and that for the spike becomes 4.7%.

The precision value is the mean of the absolute percent differences for duplicate results above 10 times the detection limit. If all duplicates involving positive original results are included, this mean becomes 19%. It should be noted that precision is expected to become worse as the detection limit is approached.

Blank: One positive blank result was obtained.

CRM: 6 CRM results differed from the expected value by more than 10 percent. The maximum deviation was +16 percent.

Spike: The maximum deviation was –28 %.

Duplicate: Of the 95 duplicate sets run, 37 gave positive results. 27 duplicates gave results greater than 10 times the detection limit: of these, 7 duplicates differed by more than 10 percent. The maximum deviation was +53%.

Conclusion and Significant Findings

Accuracy and recovery are satisfactory, as shown in the summary section. The main challenge is in maintaining precision without incurring unreasonable expenditures of resources.

Corrective Actions

Two samples were interchanged during analysis**.** They were re-analyzed and the new results reported.

Erratic results were found for the first and last few aliquots of check standards. Arrangements have been made to prepare and characterize check standards in advance of previous ones running out.

Appendix Raw QC Data negative values signify upper limits

Blank	Standard	Standard Value	Standard Result	Original	Duplicate	Spike % Recovery
-0.005	RA226.012	0.94	0.86	0.011	0.007	104
-0.005	RA226.012	0.94	0.94	-0.005	-0.005	99
-0.005	RA226.012	0.94	0.98	0.009	0.007	102
-0.005	RA226.012	0.94	0.90	0.023	0.019	94
-0.005	RA226.012	0.94	0.95	-0.005	-0.005	91
-0.005	RA226.012	0.94	0.94	-0.005	-0.005	105
-0.005	RA226.012	0.94	0.88	-0.005	-0.005	104
-0.005	RA226.012	0.94	0.89	0.011	0.016	102
-0.005	RA226.012	0.94	0.95	-0.005	-0.005	101
-0.005	RA226.012	0.94	0.93	-0.005	-0.005	103
-0.005	RA226.012	0.94	0.86	0.005	-0.005	97
-0.005	RA226.012	0.94	0.88	-0.005	-0.005	94
-0.005	RA226.012	0.94	0.88	-0.005	-0.005	98
-0.005	RA226.012	0.94	0.92	-0.005	-0.005	106
-0.005	RA226.012	0.94	0.87	-0.005	-0.005	100
-0.005	RA226.012	0.94	0.91	0.026	0.022	95
-0.005	RA226.012	0.94	0.89	-0.005	-0.005	116
-0.005	RA226.012	0.94	0.95	-0.005	-0.005	100
-0.005	RA226.012	0.94	0.88	0.026	0.031	113
-0.005	RA226.012	0.94	0.94	-0.005	-0.005	100
-0.005	RA226.012	0.94	0.92	0.016	0.014	108
-0.005	RA226.012	0.94	0.90	0.13	0.14	110
-0.005	RA226.012	0.94	0.95	-0.005	-0.005	101
-0.005	RA226.012	0.94	1.05	-0.005	-0.005	101
-0.005	RA226.012	0.94	0.98	-0.005	-0.005	103
-0.005	RA226.012	0.94	0.93	0.11	0.11	96
-0.005	RA226.012	0.94	0.95	-0.005	-0.005	100
-0.005	RA226.012	0.94	0.97	-0.005	-0.005	95
-0.005	RA226.012	0.92	0.97	-0.005	-0.005	95
-0.005	RA226.012	0.94	0.93	1.2	1.0	95
-0.005	RA226.012	0.94	0.91	-0.005	-0.005	95
-0.005	RA226.012	0.94	0.87	-0.005	-0.005	97
-0.005	RA226.012	0.94	0.92	-0.005	-0.005	93
-0.005	RA226.012	0.94	0.83	-0.005	-0.005	97
-0.005	RA226.012	0.94	0.90	-0.005	-0.005	102
-0.005	RA226.012	0.94	0.96	0.71	0.72	97
-0.005	RA226.012	0.94	0.86	0.011	0.007	104
-0.005	RA226.012	0.94	0.94	-0.005	-0.005	99
-0.005	RA226.012	0.94	0.98	0.009	0.007	102
-0.005	RA226.012	0.94	0.90	0.023	0.019	94
-0.005	RA226.012	0.94	0.95	-0.005	-0.005	91
-0.005	RA226.012	0.94	0.94	-0.005	-0.005	105
-0.005	RA226.012	0.94	0.88	-0.005	-0.005	104
-0.005	RA226.012	0.94	0.89	0.011	0.016	102
-0.005	RA226.012	0.94	0.90	0.94	0.90	104
-0.005	RA226.012	0.94	0.87	0.39	0.37	101
-0.005	RA226.012	0.94	0.90	0.13	0.14	110
-0.004	RA226.012	0.94	1.00	0.14	0.15	102
-0.005	RA226.012	0.94	0.89	-0.005	-0.005	100

Blank	Standard	Standard Value	Standard Result	Original	Duplicate	Spike % Recovery
-0.005	RA226.012	0.94	0.89	-0.005	-0.005	100
-0.005	RA226.012	0.94	0.93	-0.005	-0.005	108
-0.005	RA226.012	0.94	0.98	-0.005	-0.005	104
-0.005	RA226.012	0.94	0.88	-0.005	-0.005	94
-0.005	RA226.012	0.94	0.89	-0.005	-0.005	99
-0.005	RA226.012	0.94	0.86	-0.005	-0.005	103
-0.005	RA226.012	0.94	0.95	-0.005	-0.005	102
-0.005	RA226.012	0.94	0.89	-0.005	-0.005	94
-0.005	RA226.012	0.94	0.94	-0.005	-0.005	109
-0.005	RA226.012	0.94	0.89	-0.005	-0.005	99
-0.005	RA226.012	0.94	0.95	-0.005	-0.005	101
-0.005	RA226.012	0.94	0.85	-0.005	-0.005	97
-0.005	RA226.012	0.94	1.00	0.14	0.15	102
-0.005	RA226.012	0.94	0.90	-0.005	-0.005	88
-0.005	RA226.012	0.94	0.89	-0.005	-0.005	101
-0.005	RA226.012	0.94	1.04	-0.005	-0.005	98
-0.005	RA226.012	0.94	0.97	-0.005	-0.005	91
-0.005	RA226.012	0.94	0.85	0.068	0.062	93
-0.005	RA226.012	0.94	0.94	-0.005	-0.005	102
-0.005	RA226.012	0.94	0.92	0.22	0.27	102
-0.005	RA226.012	0.94	0.84	1.4	1.3	97
-0.005	RA226.012	0.94	0.95	0.055	0.059	104
-0.005	R63	0.31	0.28	-0.005	-0.005	97
-0.005	R63	0.31	0.29	0.18	0.18	103
-0.005	R63	0.31	0.28	-0.005	-0.005	97
-0.005	R63	0.31	0.32	-0.005	-0.005	98
-0.005	R63	0.31	0.31	-0.005	-0.005	103
-0.005	R63	0.31	0.31	-0.005	-0.005	97
-0.005	R59	0.36	0.37	-0.005	-0.005	94
-0.005	R59	0.36	0.37	0.071	0.065	106
-0.005	R59	0.36	0.34	-0.005	-0.005	101
-0.005	R59	0.36	0.37	0.34	0.31	72
-0.005	R59	0.36	0.32	0.008	0.007	87
-0.005	RA226.012	0.94	0.95	-0.005	-0.005	102
0.006	R59	0.34	0.29	0.072	0.11	98
-0.005	R59	0.34	0.33	-0.006	0.009	89
-0.005	RA226.013	1.00	1.02	0.44	0.47	110
-0.005	RA226.013	1.00	1.10	0.028	0.035	108
-0.005	RA226.013	1.00	1.03	0.51	0.45	115
-0.005	RA226.013	1.00	0.94	0.03	0.031	99
-0.005	RA226.013	1.00	1.16	1.20	1.3	88
-0.005	RA226.015	0.96	1.00	-0.005	-0.005	99
-0.005	RA226.015	0.96	0.98	0.096	0.094	90
-0.005	RA226.015	0.96	0.93	0.13	0.13	86
-0.005	RA226.015	0.96	0.97	0.039	0.035	92
-0.005	RA226.015	0.96	1.02	0.34	0.36	91
-0.005	RA226.015	0.96	0.98	0.096	0.107	98
-0.005	RA226.015	0.96	0.97	0.15	0.13	101
-0.005	RA226.015	0.96	0.88	0.029	0.057	96
-0.005	RA226.015	0.96	0.95	0.019	0.021	100
-0.005	RA226.015	0.96	0.95	0.13	0.14	97
-0.005	RA226.015	0.96	0.88	-0.005	0.007	99

SGS

Environmental Services

REPORT CODE: *DEN-ANN07*

REPORT TITLE: *Annual Quality Assessment Report*

REVISION: *1.1*

ISSUED BY:

Quality Control Coordinator,
SGS Environmental Services

AUTHORIZED BY:

Technical Manager,
SGS Environmental Services

DATE: *26 February 2008*

Table of Contents

1. BACKGROUND

SGS Environmental Services entered into an agreement with Denison Environmental Services for the analytical lab to provide analysis according to RFT #05-016. Please find below a summary of the laboratory quality management system, key actions taken by the laboratory for samples analysed during 2007, as well as a summary the significant findings and corrective actions taken.

2. QUALITY MANAGEMENT SYSTEM

SGS Environmental Services is accredited by the Standards Council of Canada (SCC) and by the Canadian Association for Environmental Analytical Laboratories (CAEAL), for specific environmental tests listed in the scope of accreditation. ISO/IEC 17025 addresses both quality management and the technical aspects of operating a testing laboratory.

The quality management system at SGS Environmental Services consists of a documented quality system, which is directed by the Quality Control Coordinator who is independent of the production area. All appropriate documentation (quality manual, methods, written instructions, standard operating procedures, and data approval criteria) is in place and includes both general and method specific quality control requirements.

The quality control procedures include duplicate samples, spiked blanks, spiked replicates, reagent/instrument blanks, preparation control samples, certified reference material analysis, and instrument control samples, as appropriate for the individual methods. Matrix matching of reference materials to samples is always attempted. Frequency of insertion of control samples is method specific and follows legislated guidelines. A summary of the quality control recoveries is presented in the tables following.

3. QUALITY CONTROL ANALYSIS

The analysis of quality control samples is method specific and includes duplicate samples, spiked blanks, spiked replicates, reagent/instrument blanks, preparation control samples, certified reference material analysis, and instrument control samples, as appropriate for the individual methods. Matrix matching of reference materials to samples is always attempted. Frequency of insertion of control samples is method specific and follows legislated guidelines and/or customer requirements. All QC analyses for Denison Environmental Services are tracked in unique files, specific to Denison Environmental Services. The samples are processed as part of our "worksheet" batch system and a compilation of all Denison Environmental Services QC data for the parameters tested during 2007 has been compiled below.

4. MAJOR ACHIEVEMENTS IN QUALITY CONTROL

- SGS Environmental Services performed 18054 analyses with 11221 QC checks, which represents 62% QC for sample analysis. This level of QC analysis exceeds the lab standard for QC insertion, which is generally 20%.
- All blank data results were within the data quality objectives, with the exception of 2 elevated results for copper, (as noted in the September report). **Corrective Action**: the Cu results were reported in LIMS numbers CA10235-SEP07, and CA10234-SEP07. While 2 results were reported as elevated, only one was analyzed but reported twice. The samples are disposed of, making a re-assay impossible. All other QC in the report was acceptable; therefore, the results were accepted and no further action was taken.
- All Certified Reference Material data values in the SGS system for samples processed in 2007 were within the data quality objectives. **Corrective Action**: N/A
- All data for Ra226 has been excluded from this report pending clarification from the subcontract lab. **Corrective Action**: N/A
- Thirteen spike blanks for Ba exceeded the data quality objectives. However, reporting limits for this element for Denison Environmental Services exceeds the standard reporting limit for SGS Environmental Services. Therefore, spike blanks are reported as 'less than' (<) detection limit and flagged as outliers/failures by our LIMS data management program. Results remain within data quality objectives for the method. **Corrective Action**: No actual non-conformances occurred; the data is evaluated against current SGS Environmental Services limits, which are at or below DES limits and no further action is required; the LIMS data management program cannot be changed to accommodate a modified reporting limit.
- No spike duplicate results exceeded the data quality objectives. **Corrective Action:** N/A

5. QC DATA QUALITY SUMMARY

Blank Data:

Parameter	Unit	Required Limit	Mean Blank Result	Number of Blanks	Number greater than Limit	Number Outside +/- Limit
Acidity	mg/L as CaCO3	2	2.06128	115	34	0
Ag	mg/L	0.0001	0.08337	204	0	0
Alkalinity	mg/L as CaCO3	2	7.00000	7	0	0
As	mg/L	0.0005	---	0	0	0
Ba	mg/L	0.005	0.00230	202	0	0
Co	mg/L	0.0005	0.00023	204	0	0
Cu	mg/L	0.0001	0.00039	54	2	2
DOC	mg/L	0.5	0.22608	120	0	0
Fe	mg/L	0.02	0.00909	239	0	0
Mn	mg/L	0.002	0.00088	202	0	0
Ni	mg/L	0.002	0.00093	55	0	0
Pb	mg/L	0.00002	0.00023	55	0	0
Se	mg/L	0.0005	0.00019	214	1	0
SO4	mg/L	0.1	0.04502	242	1	0
Total Suspended Solids	mg/L	1	0.43913	273	0	0
U	mg/L	0.0005	0.00023	207	0	0
Zn	mg/L	0.001	0.00046	55	0	0

CRM Data:

Parameter	Unit	Certified Value	Lower Limit (at 20% Rel. Error)	Upper limit (at 20 % Rel. Error)	Number of CRM's	Mean Value	Precision (%RSD)	Accuracy (% Rel error)	Number QC CRM outside of DQO
Acidity	mg/L as CaCO3	50	40	60	99	50.98	2.31	-1.95	0
Acidity	mg/L as CaCO3	10	8	12	0	---	---	---	0
Ag	mg/L	0.1	0.08	0.12	186	0.10	2.45	-1.94	0
Alkalinity	mg/L as CaCO3	47.2	37.8	56.6	6	48.63	4.37	-2.75	0
As	mg/L	0.1	0.08	0.12	4	0.10	6.34	1.14	0
Ba	mg/L	0.1	0.08	0.12	185	0.10	3.18	-0.94	0
Co	mg/L	0.1	0.08	0.12	185	0.10	3.31	-2.10	0
Cu	mg/L	0.1	0.08	0.12	51	0.10	2.62	-2.08	0
DOC	mg/L	10	8	12	125	9.74	4.43	2.55	0
Fe	mg/L	500	400	600	112	509.83	10.84	1.72	0
Mn	mg/L	0.1	0.08	0.12	192	0.10	3.89	-0.90	0
Ni	mg/L	0.1	0.08	0.12	51	0.10	3.14	-1.14	0
Pb	mg/L	0.1	0.08	0.12	50	0.10	2.25	-0.58	0
Se	mg/L	0.1	0.08	0.12	188	0.10	4.67	1.37	0
SO4	mg/L	5	4	6	194	5.01	2.60	-0.24	0
U	mg/L	0.1	0.08	0.12	189	0.10	3.83	-1.05	0
Zn	mg/L	0.1	0.08	0.12	186	0.10	3.40	-2.04	0

Duplicate Data:

Parameter	unit	Expected Recovery (Rel %)	Lower Limit (Rel %)	Upper Limit (Rel %)	Number of Duplicates	Mean (% Rel Error)	Number Duplicate samples outside of DQO	Number Duplicate samples outside of DQO (at 10x LOQ)
Acidity	% Rec.	100	90	110	89	0.884	5	0
Ag	% Rec.	100	90	110	184	0.072	0	0
Alkalinity	% Rec.	100	90	110	6	0.000	0	0
As	% Rec.	100	90	110	17	1.235	1	0
Ba	% Rec.	100	90	110	202	0.100	0	0
Co	% Rec.	100	90	110	191	0.190	0	0
Cu	% Rec.	100	90	110	52	3.090	14	0
DOC	% Rec.	100	90	110	113	2.528	11	0
Fe	% Rec.	100	90	110	188	1.416	4	0
Mn	% Rec.	100	90	110	195	0.129	4	0
Ni	% Rec.	100	90	110	54	-0.678	11	0
Pb	% Rec.	100	90	110	47	0.597	4	0
pH	% Rec.	100	90	110	26	0.077	0	0
Se	% Rec.	100	90	110	191	-0.264	7	0
S	% Rec.	100	90	110	180	1.071	6	0
Tot Suspended Solids	% Rec.	100	90	110	274	3.044	28	0
U	% Rec.	100	90	110	207	0.776	0	0
Zn	% Rec.	100	90	110	46	2.742	10	0

Spike Blank Data:

Parameter	Unit	Certified Value	Lower Limit (at 30% Rel. Error)	Upper limit (at 30 % Rel error)	Number of Spike Blank's	Mean % Recovery	Mean Precision (%)	Number Spike Blank outside of DQO
Acidity	mg/L as CaCO3	10	7	13	62	109.68	0.34	0
Ag	mg/L	0.00016	0.000112	0.00021	171	109.04	0.00	0
Alkalinity	mg/L as CaCO3	9.4	6.58	12.2	4	101.06	---	0
As	mg/L	0.0064	0.00448	0.00832	4	102.14	0.00	0
Ba	mg/L	0.004	0.0028	0.0052	173	65.95	0.00	13
Co	mg/L	0.002	0.0014	0.0026	175	102.25	0.00	0
Cu	mg/L	0.0016	0.00112	0.00208	42	112.05	0.00	0
DOC	mg/L	20	14	26	141	98.30	1.39	0
Fe	mg/L	0.1	0.07	0.13	210	412.84	0.05	0
Mn	mg/L	0.0032	0.00224	0.00416	154	104.50	0.00	0
Ni	mg/L	0.0048	0.00336	0.00624	48	104.10	0.00	0
Pb	mg/L	0.0032	0.00224	0.00416	39	109.25	0.00	0
Se	mg/L	0.0008	0.00056	0.00104	166	101.78	0.00	0
SO4	mg/L	4	2.8	5.2	206	99.67	0.14	0
SO4	mg/L	100	70	130	139	100.64	0.00	0
U	mg/L	0.0008	0.00056	0.00104	54	101.76	0.00	0
Zn	mg/L	0.0056	0.00392	0.00728	5	119.94	0.00	0

Spike Duplicate Data:

Parameter	Unit	Certified Value	Lower Limit (at 30% Rel. Error)	Upper limit (at 30 % Rel error)	Number of Spike Blank's	Mean % Recovery	Precision (%RSD)	Number Spike Blank outside of DQO
Ag	µg/L	0.16	0.112	0.208	209	96.42	0.01	0
As	µg/L	6.4	4.48	8.32	0	---	---	0
Ba	µg/L	4	2.8	5.2	189	99.96	0.14	0
Co	µg/L	2	1.4	2.6	204	101.09	0.07	0
Cu	µg/L	1.6	1.12	2.08	48	101.97	0.11	0
DOC	mg/L	100	70	130	117	94.98	7.39	0
Fe	mg/L	0.1	0.07	0.13	187	106.71	0.01	0
Mn	mg/L	3.2	2.24	4.16	169	102.22	0.15	0
Ni	mg/L	4.8	3.36	6.24	51	99.04	0.16	0
Pb	mg/L	3.2	2.24	4.16	44	106.99	0.16	0
Se	mg/L	0.8	0.56	1.04	197	98.94	0.56	0
SO4	mg/L	100	70	130	190	99.69	5.13	0
U	mg/L	0.8	0.56	1.04	86	101.43	0.07	0
Zn	mg/L	5.6	3.92	7.28	11	96.22	1.06	0

QC Frequency:

Total Number of Blanks	2283
Total Number of CRM	2151
Total Number of Duplicates	2495
Total Number of Spike Blank	1874
Total Number of Spike Duplicates:	2418
Sum of QC Insertion	**11221**
Total Analysis:	**18054**

6. CONCLUSION & SIGNIFICANT FINDINGS

SGS Environmental Services analyzed QC samples for this project beyond the lab standard of 20% QC insertion. Where the data quality objectives were exceeded, the additional QC samples analyzed within the run supported the data values and data was released on this basis.

SGS Environmental Services remains committed to delivering data that meets and/or exceeds the data quality objectives for Denison Environmental Services and staff will continue to work closely with Denison Environmental Services staff to ensure all objectives are achieved in 2008.

7. CORRECTIVE ACTIONS & IMPLEMENTATION OF CORRECTIVE ACTIONS

- None

8. SUBCONTRACT LAB INFORMATION

A full report has been provided by the subcontract lab and is included as Addendum A of this report.

9. HISTORY OF REVISIONS

1. *26 February 2008*: removed Ra226 data pending review of data by the subcontract lab; the annual report submitted to SGS was inconsistent with the monthly data and non-conformance information contained in the monthly reports; all other amendments are identified by highlighting throughout the document. *Note: as per the request of the client, all highlighting has been removed.*

10. ADDENDUM A - SUBCONTRACT LAB INFORMATION

This section has been intentionally removed from the report pending revision of the QC data.

Becquerel Laboratories Inc.
6790 Kitimat Rd., Unit 4
Mississauga, Ontario
Canada, L5N 5L9
Phone: (905) 826-3080
FAX: (905) 826-4151

Date: 09-Jan-2008

Annual Quality Assessment Report for 2007

Introduction

The number of samples analyzed was 794.

The following samples were used for quality control in 2007. A set of control samples was included with each set of 20 or fewer samples.

Reagent Blanks

Reagent blanks were aliquots of deionized water that were processed in the same way as samples, using the same tracers, carriers and other reagents.

Duplicates

Duplicate samples were replicate aliquots of a sample from each analysis run, and were processed in the same way as other samples.

Analyte Spikes

A solution of Ra-226 was prepared by dissolving and diluting a portion of the Canmet CRM BL-3. A one-millilitre aliquot of this solution was added to a second aliquot of sample to test recoveries. Each aliquot added contained 0.109 Bq of Ra-226.

It should be noted that Barium-133 is added to every aliquot as a tracer, in order to measure the chemical yield of Ra-226 for each individual sample.

Check Standards

Several check standards were using during 2007.

RA226.15, RA226.16, RA226.19, RA226.20

A calibrated solution of Ra-226 was obtained from Isotope Products Laboratories and used to prepare these check standards.

Major Achievements in Quality Control

Precision, as measured by duplicate analyses, improved over that found in 2006.

Eight new alpha-particle spectrometers were purchased and installed.

Expermental trials were initiated with the object of reducing processing times, reducing mtrix effects and improving the quality of alpha-particle spectra. These trials are ongoing.

QC Data Quality Summary

Analytical Parameter	Blank Result Bq/l	Number of Blanks	CRM accuracy %	Numbers of CRMs
DQO			+- 10	
Ra-226	< 0.005	100	-0.5	100

Analytical Parameter	Spike accuracy %	Number of Spikes	Precision %	Number of Duplicates
DQO	+- 30		10	
Ra-226	+2.1	99	4.7	99

Notes: CRM accuracy and Spike accuracy values are averages. The values above are percent differences from the expected values. If means are computed for absolute deviations, that for the CRM becomes 4.8% and that for the spike becomes 4.8%.

The precision value is the mean of the absolute percent differences for duplicate results above 10 times the detection limit. If all duplicates involving positive original results are included, this mean becomes 9.1%. It should be noted that precision is expected to become worse as the detection limit is approached.

Blank: Two positive blank results, of 0.008 and 0.015 Bq/l, were obtained.

CRM: 8 CRM results differed from the expected value by more than 10 percent. The maximum deviation was -33 %.

Two of these were treated as non-conformances, were investigated by reanalyses, and were superseded by new results within limits.

Spike: The maximum deviation was +21 %.

Duplicate: Of the 99 duplicate sets run, 95 gave positive results. 72 duplicates gave results greater than 10 times the detection limit: of these, 3 duplicates differed by more than 10 percent. The maximum deviation was +14%.

Conclusion and Significant Findings

Accuracy and recovery are satisfactory, as shown in the summary section. The main challenge is in maintaining precision without incurring unreasonable expenditures of resources.

Corrective Actions

A sample originally reported as < 0.006 Bq/l was recounted and reported as < 0.005 Bq/l.

In one run, the duplicate failed to agree. The run was repeated and gave a satisfactory duplicate result.

A positive blank result of 0.008 Bq/l was found in one run. A second blank and samples giving results less than 0.1 Bq/l were reanalyzed.

A positive blank was obtained. The blank and samples giving values of 0.1 Bq/l or less were rerun.

On two occasions, a low CRM result was obtained. The CRM and a sample giving a positive result were rerun to demonstrate that the problem with the standard was not general.

For batch T07-00827.0, a duplicate was drawn from the second of the two bottles submitted for a sample. That duplicate result was in poor agreement with the original result. A second duplicate was drawn from the first bottle and gave much better agreement.

Appendix Raw QC Data negative values signify upper limits

Blank	Standard	Standard Value	Standard Result	Original	Duplicate	Spike % Recovery
-0.005	RA226.15	0.96	0.90	0.64	0.65	96
-0.005	RA226.15	0.96	0.90	0.32	0.33	89
-0.005	RA226.15	0.96	0.90	0.029	0.025	101
-0.005	RA226.15	0.96	0.96	0.11	0.11	106
-0.005	RA226.15	0.96	0.90	0.55	0.50	104
-0.005	RA226.15	0.96	0.91	0.79	0.79	99
-0.005	RA226.15	0.96	0.93	0.53	0.58	106
-0.005	RA226.15	0.96	0.87	0.038	0.030	102
-0.005	RA226.15	0.96	0.95	0.11	0.10	96
-0.005	RA226.15	0.96	1.05	0.023	0.026	105
-0.005	RA226.15	0.96	0.97	0.11	0.10	91
-0.005	RA226.15	0.96	0.97	-0.005	-0.005	109
-0.005	RA226.15	0.96	1.00	0.073	0.079	103
-0.005	RA226.15	0.96	0.90	0.55	0.54	108
-0.005	RA226.15	0.96	0.94	0.087	0.078	100
-0.005	RA226.15	0.96	0.94	0.94	0.98	106
-0.005	RA226.15	0.96	1.00	0.073	0.079	103
-0.005	RA226.15	0.96	0.95	0.30	0.27	96
-0.005	RA226.15	0.96	0.89	0.081	0.076	92
-0.005	RA226.15	0.96	0.90	0.066	0.063	96
-0.005	RA226.16	0.90	0.89	-0.005	-0.005	96
-0.005	RA226.16	0.90	0.91	0.58	0.57	105
-0.005	RA226.16	0.90	0.95	0.041	0.042	96
-0.005	RA226.16	0.90	0.95	0.019	0.020	102
-0.005	RA226.16	0.90	0.93	0.28	0.28	98
-0.005	RA226.16	0.90	0.93	0.029	0.029	98
-0.005	RA226.16	0.90	0.87	0.67	0.067	98
-0.005	RA226.16	0.90	0.93	0.088	0.087	106
-0.005	RA226.16	0.90	0.96	0.21	0.21	101
-0.005	RA226.16	0.90	0.99	0.079	0.078	102
-0.005	RA226.16	0.90	0.86	0.42	0.38	107
-0.005	RA226.16	0.90	0.94	0.20	0.18	93
-0.005	RA226.16	0.90	0.95	0.15	0.16	99
-0.005	RA226.16	0.90	0.94	-0.005	-0.005	99
-0.005	RA226.16	0.90	1.00	0.008	0.008	97
-0.005	RA226.16	0.90	0.99	0.035	0.030	106
-0.005	RA226.16	0.90	1.00	0.79	0.79	107
-0.005	RA226.16	0.90	0.92	0.021	0.029	101
-0.005	RA226.16	0.90	0.96	0.12	0.12	105
-0.005	RA226.16	0.90	0.93	0.75	0.75	104
-0.005	RA226.16	0.90	0.97	0.60	0.60	105
-0.005	RA226.16	0.90	0.92	0.21	0.21	99
-0.005	RA226.16	0.90	0.93	0.75	0.75	104
-0.005	RA226.16	0.90	0.97	1.14	1.14	108
-0.005	RA226.16	0.90	0.95	0.73	0.69	108
-0.005	RA226.16	0.90	0.99	0.20	0.21	100
-0.005	RA226.16	0.90	0.95	0.062	0.060	104
-0.005	RA226.16	0.90	1.00	0.037	0.034	106
-0.005	RA226.16	0.90	0.98	0.25	0.25	103

Blank	Standard	Standard Value	Standard Result	Original	Duplicate	Spike % Recovery
-0.005	RA226.18	1.00	0.99	0.70	0.69	107
-0.005	RA226.18	1.00	0.94	-0.005	-0.005	102
-0.005	RA226.18	1.00	1.00	0.10	0.11	110
-0.005	RA226.18	1.00	0.90	0.048	0.043	100
-0.005	RA226.18	1.00	0.96	0.60	0.60	97
-0.005	RA226.18	1.00	0.94	0.076	0.076	100
-0.005	RA226.18	1.00	0.90	0.051	0.053	112
-0.005	RA226.18	1.00	0.97	1.05	0.95	114
-0.005	RA226.18	1.00	1.00	0.28	0.25	105
-0.005	RA226.18	1.00	0.95	0.046	0.040	99
-0.005	RA226.18	1.00	0.95	0.12	0.12	103
-0.005	RA226.18	1.00	0.90	0.056	0.061	100
-0.005	RA226.18	1.00	0.97	0.16	0.15	101
-0.005	RA226.18	1.00	1.01	0.099	0.098	104
-0.005	RA226.18	1.00	0.98	0.12	0.13	105
-0.005	RA226.18	1.00	0.99	0.087	0.080	102
-0.005	RA226.18	1.00	0.97	0.61	0.59	100
-0.005	RA226.18	1.00	1.00	1.19	1.12	107
-0.005	RA226.18	1.00	0.98	0.038	0.038	104
-0.005	RA226.18	1.00	1.01	0.073	0.073	109
-0.005	RA226.18	1.00	1.06	0.031	0.030	83
-0.005	RA226.19	1.00	0.98	0.12	0.11	98
-0.005	RA226.19	1.00	1.01	0.49	0.45	105
-0.005	RA226.19	1.00	0.93	1.2	1.2	117
-0.005	RA226.19	1.00	0.96	0.089	0.094	102
-0.005	RA226.19	1.00	0.93	0.065	0.071	114
-0.005	RA226.19	1.00	0.98	0.047	0.049	102
-0.005	RA226.19	1.00	0.95	0.14	0.14	102
-0.005	RA226.19	1.00	0.98	0.54	0.50	103
-0.005	RA226.19	1.00	0.95	0.010	-0.010	104
-0.005	RA226.19	1.00	1.02	0.013	0.006	90
-0.005	RA226.19	1.00	0.95	0.087	0.081	94
-0.005	RA226.19	1.00	0.96	0.007	0.010	111
-0.005	RA226.19	1.00	1.00	0.16	0.17	108
0.006	RA226.19	1.00	0.96	0.036	0.038	102
-0.005	RA226.19	1.00	0.96	0.071	0.071	97
-0.005	RA226.19	1.00	0.93	0.054	0.053	103
-0.005	RA226.19	1.00	0.92	0.097	0.090	99
-0.005	RA226.19	1.00	0.93	0.51	0.47	100
-0.005	RA226.19	1.00	1.01	0.35	0.033	98
-0.005	RA226.19	1.00	0.94	0.046	0.046	113
-0.005	RA226.19	1.00	0.93	0.12	0.11	109
-0.005	RA226.19	1.00	0.99	1.05	1.06	102
-0.005	RA226.19	1.00	1.04	0.032	0.039	121
-0.005	RA226.19	1.00	0.90	0.47	0.48	96
-0.005	RA226.20	0.90	0.97	0.13	0.12	100
-0.005	RA226.20	0.90	0.95	0.80	0.76	97
-0.005	RA226.20	0.90	0.96	0.26	0.24	99
-0.005	RA226.20	0.90	0.84	0.010	0.006	98
-0.005	RA226.20	0.90	0.84	0.022	0.026	90
0.008						
0.015						

Environmental Services

REPORT CODE: *DEN-ANN08*

REPORT TITLE: *Annual Quality Assessment Report*

REVISION: *1.1*

ISSUED BY:

Quality Coordinator, Canadian Operations - SGS Environmental Services

AUTHORIZED BY:

Technical Manager,
SGS Environmental Services

DATE: *18 Mar. 2009*

Table of Contents

1. BACKGROUND

SGS Environmental Services entered into an agreement with Denison Environmental Services for the analytical lab to provide analysis according to RFT #05-016. Below is a summary of the laboratory quality management system, key actions taken by the laboratory for samples analyzed during 2008, as well as a summary of the significant findings and the corrective actions implemented.

2. QUALITY MANAGEMENT SYSTEM

SGS Environmental Services is accredited to ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation (CALA), for specific tests listed in the scope of accreditation. ISO/IEC 17025 addresses both quality management and the technical aspects of operating a testing laboratory.

The quality management system at SGS Environmental Services consists of a documented quality system, which is directed by the Quality Coordinator who is independent of the production area. All appropriate documentation (quality manual, methods, written instructions, standard operating procedures, and data approval criteria) is in place and includes both general and method specific quality control requirements.

The quality control procedures include duplicate samples, spiked blanks, spiked replicates, reagent/instrument blanks, preparation control samples, certified reference material analysis, and instrument control samples, as appropriate for the individual methods. Matrix matching of reference materials to samples is always attempted. Frequency of insertion of control samples is method specific and follows legislated guidelines. A summary of the quality control recoveries is presented in the tables following.

3. QUALITY CONTROL PARAMETERS

The analysis of quality control samples is method specific and includes duplicate samples, spiked blanks, spiked replicates, reagent/instrument blanks, preparation control samples, certified reference material analysis, and instrument control samples, as appropriate for the individual methods. Matrix matching of reference materials to samples is always attempted. Frequency of insertion of control samples is method specific and follows legislated guidelines and/or customer requirements. All QC analyses for Denison Environmental Services are tracked in unique files, specific to Denison Environmental Services. The samples are processed as part of our "worksheet" batch system and a compilation of all Denison Environmental Services QC data for the parameters tested during 2008 has been compiled below.

4. MAJOR ACHIEVEMENTS IN QUALITY CONTROL

- SGS Environmental Services performed 10505 analyses with 11191 QC checks, which represents 107% QC for sample analysis. This level of QC is significantly higher than the lab standard, which is generally 20%.
- All blank data results were within the data quality objectives. **Corrective Action**: N/A
- All CRM data results were within the data quality objectives. **Corrective Action**: N/A
- No duplicate value exceeded the data quality objectives. **Corrective Action:** N/A
- No spike blanks exceeded the data quality objectives. **Corrective Action**: N/A
- No spike duplicates fell outside of the data quality objectives. **Corrective Action**: N/A

5. QC DATA SUMMARY

5.1. Blank Data

Parameter	Unit	Required Limit	Mean Blank Result	Number of Blanks	Number greater than Limit	Number Outside +/- Limit
Acidity	mg/L as CaCO3	2	1.71276	96	10	0
Ag	mg/L	0.0001	0.00004	207	0	0
Alkalinity	mg/L as CaCO3	2	1.00000	5	0	0
As	mg/L	0.0005	---	0	0	0
Ba	mg/L	0.005	0.00247	212	0	0
Co	mg/L	0.0005	0.00025	210	0	0
Cu	mg/L	0.0001	0.00025	65	0	0
DOC	mg/L	0.5	0.00025	85	0	0
Fe	mg/L	0.02	0.00963	241	0	0
Mn	mg/L	0.002	0.00100	221	0	0
Ni	mg/L	0.002	0.00100	60	0	0
Pb	mg/L	0.00002	0.00004	59	0	0
Se	mg/L	0.0005	0.00022	220	1	0
SO4	mg/L	0.1	0.05041	223	0	0
Total Suspended Solids	mg/L	1	0.50403	276	0	0
U	mg/L	0.0005	0.00025	207	0	0
Zn	mg/L	0.001	0.00050	69	0	0

5.2. *CRM Data*

Parameter	Unit	Certified Value	Lower Limit (at 20% Rel. Error)	Upper limit (at 20 % Rel. Error)	Number of CRM's	Mean Value	Precision (%RSD)	Accuracy (% Rel error)	Number QC CRM outside of DQO
Acidity	mg/L as CaCO3	50	40	60	117	51.07	1.98	-2.13	0
Acidity	mg/L as CaCO3	10	8	12	0	---	---	---	0
Ag	mg/L	0.1	0.08	0.12	212	0.10	2.62	0.02	0
Alkalinity	mg/L as CaCO3	47.2	37.8	56.6	4	47.50	2.11	-1.69	0
As	mg/L	0.1	0.08	0.12	0	---	---	---	0
Ba	mg/L	0.1	0.08	0.12	223	0.10	3.00	-0.27	0
Co	mg/L	0.1	0.08	0.12	216	0.10	2.73	-1.54	0
Cu	mg/L	0.1	0.08	0.12	69	0.10	2.39	-0.49	0
DOC	mg/L	10	8	12	93	9.58	4.85	4.19	0
Fe	mg/L	500	400	600	264	503.40	1.97	-0.68	0
Mn	mg/L	0.1	0.08	0.12	239	0.10	2.38	-0.50	0
Ni	mg/L	0.1	0.08	0.12	66	0.10	2.54	-0.94	0
Pb	mg/L	0.1	0.08	0.12	68	0.10	2.64	0.62	0
Se	mg/L	0.1	0.08	0.12	234	0.10	3.73	0.42	0
SO4	mg/L	5	4	6	207	5.05	2.80	-0.95	0
U	mg/L	0.1	0.08	0.12	214	0.10	2.93	-0.07	0
Zn	mg/L	0.1	0.08	0.12	79	0.10	1.94	-0.90	0

5.3. Duplicate Data

Parameter	unit	Expected Recovery (Rel %)	Lower Limit (Rel %)	Upper Limit (Rel %)	Number of Duplicates	Mean (% Rel Error)	Number Duplicate samples outside of DQO	Number Duplicate samples outside of DQO (at 10x LOQ)
Acidity	% Rec.	100	90	110	82	0.975	0.000	0
Ag	% Rec.	100	90	110	192	0.000	0.000	0
Alkalinity	% Rec.	100	90	110	5	2.500	0.000	0
As	% Rec.	100	90	110	0	---	0.000	0
Ba	% Rec.	100	90	110	208	-0.137	0.333	0
Co	% Rec.	100	90	110	197	0.141	0.250	0
Cu	% Rec.	100	90	110	65	-0.274	0.000	0
DOC	% Rec.	100	90	110	75	1.659	0.500	0
Fe	% Rec.	100	90	110	239	-0.195	0.833	0
Mn	% Rec.	100	90	110	225	0.181	0.250	0
Ni	% Rec.	100	90	110	63	-0.028	0.000	0
Pb	% Rec.	100	90	110	61	0.518	0.250	0
pH	% Rec.	100	90	110	27	3.762	0.000	0
Se	% Rec.	100	90	110	207	-0.220	0.083	0
S	% Rec.	100	90	110	200	-0.387	0.167	0
Total Suspended Solids	% Rec.	100	90	110	245	1.295	1.667	0
U	% Rec.	100	90	110	199	0.061	0.417	0
Zn	% Rec.	100	90	110	68	2.490	0.167	0

5.4. *Spike Blank Data*

Parameter	Unit	Certified Value	Lower Limit (at 30% Rel. Error)	Upper limit (at 30 % Rel error)	Number of Spike Blank's	Mean % Recovery	Mean Precision (%)	Number Spike Blank outside of DQO
Acidity	mg/L as CaCO3	10	7	13	74	112.03	0.37	0
Ag	mg/L	0.00016	0.000112	0.00021	207	104.60	0.00	0
Alkalinity	mg/L as CaCO3	9.4	6.58	12.2	2	101.06	---	0
As	mg/L	0.0064	0.00448	0.00832	0	---	0.00	0
Ba	mg/L	0.004	0.0028	0.0052	234	67.39	0.00	0
Co	mg/L	0.002	0.0014	0.0026	208	101.24	0.00	0
Cu	mg/L	0.0016	0.00112	0.00208	61	111.39	0.00	0
DOC	mg/L	20	14	26	108	96.84	0.74	0
Fe	mg/L	0.1	0.07	0.13	235	107.82	0.00	0
Mn	mg/L	0.0032	0.00224	0.00416	238	99.38	0.07	0
Ni	mg/L	0.0048	0.00336	0.00624	67	102.91	0.00	0
Pb	mg/L	0.0032	0.00224	0.00416	75	106.85	0.00	0
Se	mg/L	0.0008	0.00056	0.00104	232	100.40	0.05	0
SO4	mg/L	4	2.8	5.2	248	99.98	0.05	0
SO4	mg/L	100	70	130	5	107.50	0.07	0
U	mg/L	0.0008	0.00056	0.00104	225	100.89	0.01	0
Zn	mg/L	0.0056	0.00392	0.00728	44	106.46	0.001	0

5.5. *Spike Duplicate Data*

Parameter	Unit	Certified Value	Lower Limit (at 30% Rel. Error)	Upper limit (at 30 % Rel error)	Number of Spiked Duplicates	Mean % Recovery	Precision (%RSD)	Number Spike Blank outside of DQO
Ag	µg/L	0.16	0.112	0.208	202	96.11	0.01	0
As	µg/L	6.4	4.48	8.32	0	---	---	0
Ba	µg/L	4	2.8	5.2	171	99.40	0.08	0
Co	µg/L	2	1.4	2.6	198	100.45	0.05	0
Cu	µg/L	1.6	1.12	2.08	67	101.61	0.07	0
DOC	mg/L	100	70	130	97	92.90	6.42	0
Fe	mg/L	0.1	0.07	0.13	205	103.20	0.01	0
Mn	mg/L	3.2	2.24	4.16	135	99.89	0.12	0
Ni	mg/L	4.8	3.36	6.24	63	97.76	0.10	0
Pb	mg/L	3.2	2.24	4.16	62	101.54	0.15	0
Se	mg/L	0.8	0.56	1.04	161	100.87	0.05	0
SO4	mg/L	100	70	130	211	99.72	5.41	0
U	mg/L	0.8	0.56	1.04	189	100.64	0.03	0
Zn	mg/L	5.6	3.92	7.28	38	105.71	0.33	0

5.6. *QC Frequency*

Total Number of Blanks:	2456
Total Number of CRM:	2305
Total Number of Duplicates:	2358
Total Number of Spike Blank:	2263
Total Number of Spike Duplicates:	1799
Sum of QC Insertion:	11181
Total Analysis:	10505

6. CONCLUSION & SIGNIFICANT FINDINGS

SGS Environmental Services analyzed QC samples for this project beyond the lab standard of 20% QC insertion. Where the data quality objectives were exceeded, the additional QC samples analyzed within the run supported the data values and data was released on this basis.

SGS Environmental Services remains committed to delivering data that meets and/or exceeds the data quality objectives for Denison Environmental Services and staff will continue to work closely with Denison Environmental Services staff to ensure all objectives are achieved in 2009.

7. CORRECTIVE ACTIONS & IMPLEMENTATION OF CORRECTIVE ACTIONS

- As a result of a sampling error, two TSS values were switched in report CA10256-APR08. **Corrective Action**: Lab staff confirmed that a labeling error occurred; the results in the report were revised and the report was re-issued.
- There was a transcription error in the dilution column for SO4 in report CA10381-JUL08. **Corrective Action**: Lab staff confirmed that a transcription error was made; the results in the report were revised and the report was re-issued.
- The required detection limit for reporting TSS results is 1 mg/L; however, in reports, CA10482-JUL08, CA10484-JUL08 and CA10485-JUL08, results were (incorrectly) reported as <2 mg/L. **Corrective Action:** All affected reports have been revised and reissued with the appropriate reporting levels.
- In report, CA10549-AUG08 results were reported as <2 mg/L due to insufficient volume of sample being processed. **Corrective Action:** For clean samples, 600mL is required to achieve a 1mg/L reporting limit. Only 500mL of sample was provided, therefore, the lab was unable to filter the required 600mL to achieve a < 1mg/L result.
- A number of selenium (Se) results (by ICP-MS) were flagged for re-analysis and the results of the re-analysis were below detection and inconsistent with the original data in some of the September reports. Specifically, CA10305-SEP08, CA10137-SEP08,

CA10377-SEP08 and CA10139-SEP08. Those reports indicated Se was present in the sample, (which was not expected). Re-analysis of the samples for Se was performed under the following certificates of analysis; CA10188-NOV08, CA10187-NOV08 and CA10186-NOV08 and the re-assay values were all below the reporting detection limit. An investigation into the discrepancies was done. **Corrective Action**: Chloride is a direct positive interference for Se when analyzed by ICP-MS due to the formation of an Argon/Chloride complex. While the samples likely did not contain a significant amount of chloride, chloride may have been present within the sample introduction system prior to analysis. The re-analysis was performed using on the same instrument (ICP-MS with the CRI matrix elimination system) after confirming that no chloride was present in the system.

8. SUBCONTRACT LAB INFORMATION

A full report has been provided by the subcontract lab and is included as Addendum A of this report.

Addendum A

Becquerel Laboratories Inc. Phone: (905) 826-3080
6790 Kitimat Rd., Unit 4 FAX: (905) 826-4151
Mississauga, Ontario
Canada, L5N 5L9

Date: 11-Mar-2009

Annual Quality Assessment Report for 2008

Introduction

The number of samples analyzed was 894.

The following samples were used for quality control in 2008. A set of control samples was included with each set of 20 or fewer samples.

Reagent Blanks

Reagent blanks were aliquots of deionized water that were processed in the same way as samples, using the same tracers, carriers and other reagents.

Duplicates

Duplicate samples were replicate aliquots of a sample from each analysis run, and were processed in the same way as other samples.

Analyte Spikes

A solution of Ra-226 was prepared by dissolving and diluting a portion of the Canmet CRM BL-3. A one-millilitre aliquot of this solution was added to a second aliquot of sample to test recoveries. Each aliquot added contained 0.109 Bq of Ra-226.

It should be noted that Barium-133 is added to every aliquot as a tracer, in order to measure the chemical yield of Ra-226 for each individual sample.

Check Standards

Several check standards were using during 2008.

RA226.20, RA226.21, RA226.22, RA226.23,RA226.24 and RA226.25.

A calibrated solution of Ra-226 was obtained from Isotope Products Laboratories and used to prepare these check standards.

Major Achievements in Quality Control

Equipment changes now permit chemical yields to be determined more quickly and with lower uncertainty.

The format used for QC reports was changed to meet requirements.

A trial of precision showed that precision is stable and mainly controlled by counting statistics.

QC Data Quality Summary

Analytical Parameter	Blank Result (Bq/l)	Number of Blanks	CRM Accuracy (%)	Numbers of CRMs
DQO			+- 20	
Ra-226	< 0.005	117	+2.4	117

Analytical Parameter	Spike accuracy (%)	Number of Spikes	Precision (%)	Number of Duplicates
DQO	+- 20		+-20	
Ra-226	-0.3	117	+1.8	117

Notes: CRM accuracy and Spike accuracy values are averages. The values above are percent differences from the expected values. If means are computed for absolute deviations, that for the CRM becomes 3.5% and that for the spike becomes 5.8%.

The precision value is the mean of the percent differences for duplicate results. If absolute differences are used, this mean becomes 7.7%. It should be noted that precision is expected to become worse as the detection limit is approached.

Blank: No positive blank results were obtained.

CRM: No CRM results differed from the expected value by more than 20 percent. The maximum deviation was +19.8 %.

Spike: No spike recovery deviated from 100% by more than 20%. The maximum deviation was -19 %.

Duplicate: Of the 117 duplicate sets run, 110 gave positive results. Of these, 5 duplicates differed by more than 20%. The maximum deviation was +50% for an original value of 0.006 Bq/l.

98 duplicates gave results greater than 10 times the detection limit: of these, 1 duplicate differed by more than 20 percent. The maximum deviation was +22%.

Conclusion and Significant Findings

Accuracy and recovery are satisfactory, as shown in the summary section. Rush analyses present challenges in maintaining accuracy and precision.

Corrective Actions

Sample 3 of batch T08-00088.0 was retested at the client's request, and found to give a lower result than that originally reported.

Investigation revealed an instrument malfunction that had been remedied shortly after the original measurement. No other samples of this or other submissions were affected.

Raw QC Data *(Note: negative values signify upper limits)*

Blank	Standard	Standard Result	Standard Value	Original	Duplicate	Spike % Recovery
-0.005	RA226.20	0.87	0.90	0.77	0.75	82
-0.005	RA226.20	0.92	0.90	0.18	0.18	95
-0.005	RA226.20	0.93	0.90	0.009	0.01	105
-0.005	RA226.20	0.98	0.90	0.023	0.018	101
-0.005	RA226.20	0.98	0.90	1.01	0.903	101
-0.005	RA226.20	0.90	0.90	0.25	0.23	106
-0.005	RA226.20	0.99	0.90	0.023	0.023	92
-0.005	RA226.20	0.90	0.90	0.56	0.55	105
-0.005	RA226.20	0.96	0.90	0.036	0.029	89
-0.005	RA226.20	0.92	0.90	0.21	0.19	81
-0.005	RA226.20	0.92	0.90	0.17	0.16	92
-0.005	RA226.20	0.95	0.90	0.79	0.77	87
-0.005	RA226.20	0.97	0.90	0.70	0.73	87
-0.005	RA226.20	0.91	0.90	0.11	0.11	93
-0.005	RA226.21	0.91	0.91	0.078	0.071	84
-0.005	RA226.21	0.91	0.91	0.016	0.011	95
-0.005	RA226.21	0.89	0.91	0.057	0.062	89
-0.005	RA226.21	0.87	0.91	0.11	0.11	94
-0.005	RA226.21	0.95	0.91	0.74	0.66	98
-0.005	RA226.21	0.89	0.91	0.031	0.039	89
-0.005	RA226.21	0.97	0.91	0.017	0.019	95
-0.005	RA226.21	0.90	0.91	0.39	0.32	81
-0.005	RA226.21	0.94	0.91	0.079	0.085	100
-0.005	RA226.21	0.92	0.91	0.13	0.12	106
-0.005	RA226.21	0.93	0.91	0.1	0.11	90
-0.005	RA226.21	0.86	0.91	0.43	0.43	96
-0.005	RA226.21	0.89	0.91	0.77	0.74	100
-0.005	RA226.21	0.96	0.91	0.073	0.074	92
-0.005	RA226.21	0.89	0.91	0.74	0.7	91
-0.005	RA226.21	0.99	0.91	0.086	0.085	92
-0.005	RA226.21	0.93	0.91	0.068	0.069	109

-0.005	RA226.21	0.94	0.91	0.011	0.012	104
-0.005	RA226.21	1.04	0.91	-0.005	-0.006	95
-0.005	RA226.21	0.88	0.91	0.06	0.065	95
-0.005	RA226.21	0.86	0.91	0.42	0.44	97
-0.005	RA226.22	0.93	0.91	0.52	0.53	110
-0.005	RA226.22	0.92	0.91	0.072	0.071	97
-0.005	RA226.22	0.94	0.91	0.47	0.47	101
-0.005	RA226.22	0.90	0.91	0.88	0.91	99
-0.005	RA226.22	0.91	0.91	0.086	0.085	97
-0.005	RA226.22	0.92	0.91	0.94	1.01	98
-0.005	RA226.22	0.91	0.91	0.48	0.44	100
-0.005	RA226.22	0.93	0.91	0.13	0.12	104
-0.005	RA226.22	0.92	0.91	0.072	0.076	95
-0.005	RA226.22	0.94	0.91	0.78	0.74	110
-0.005	RA226.22	0.91	0.91	0.05	0.05	100
-0.01	RA226.22	0.98	0.91	0.31	0.27	118
-0.005	RA226.22	0.92	0.91	0.29	0.3	103
-0.005	RA226.22	0.97	0.91	0.45	0.48	107
-0.005	RA226.22	0.96	0.91	0.35	0.35	105
-0.005	RA226.22	0.90	0.91	0.2	0.2	91
-0.005	RA226.22	0.90	0.91	0.25	0.25	103
-0.005	RA226.22	0.92	0.91	0.74	0.72	101
-0.005	RA226.23	0.94	0.91	0.75	0.69	102
-0.005	RA226.23	0.91	0.91	0.15	0.16	97
-0.005	RA226.23	0.95	0.91	0.092	0.088	105
-0.01	RA226.23	0.97	0.91	0.09	0.11	93
-0.005	RA226.23	0.91	0.91	0.3	0.32	103
-0.005	RA226.23	0.96	0.91	0.096	0.096	105
-0.005	RA226.23	0.93	0.91	0.054	0.057	104
-0.005	RA226.23	0.87	0.91	0.14	0.12	88
-0.005	RA226.23	0.90	0.91	0.106	0.091	115
-0.01	RA226.23	0.93	0.91	-0.01	-0.01	102
-0.005	RA226.23	0.90	0.91	0.67	0.68	93
-0.005	RA226.23	0.96	0.91	0.28	0.29	101
-0.005	RA226.23	0.87	0.91	0.23	0.24	95

-0.005	RA226.23	0.97	0.91	0.29	0.28	104
-0.005	RA226.23	1.00	0.91	0.34	0.32	105
-0.005	RA226.23	0.95	0.91	0.59	0.62	103
-0.01	RA226.23	0.90	0.91	0.24	0.24	98
-0.005	RA226.23	1.00	0.91	0.066	0.069	98
-0.005	RA226.23	0.95	0.91	0.006	0.009	104
-0.005	RA226.23	0.92	0.91	0.052	0.052	90
-0.005	RA226.23	0.93	0.91	0.15	0.16	106
-0.005	RA226.23	0.89	0.91	-0.01	-0.01	97
-0.005	RA226.23	0.92	0.91	-0.005	-0.005	96
-0.005	RA225.24	0.88	0.91	0.35	0.33	104
-0.005	RA225.24	0.91	0.91	0.79	0.77	90
-0.005	RA225.24	0.93	0.91	0.16	0.16	104
-0.005	RA225.24	0.91	0.91	0.1	0.098	117
-0.005	RA225.24	0.92	0.91	0.027	0.028	110
-0.005	RA225.24	0.98	0.91	0.037	0.036	99
-0.005	RA225.24	0.94	0.91	0.46	0.44	111
-0.005	RA225.24	0.92	0.91	0.007	-0.005	112
-0.005	RA225.24	0.95	0.91	0.18	0.18	104
-0.005	RA225.24	0.99	0.91	0.96	0.94	94
-0.005	RA225.24	0.96	0.91	0.047	0.046	100
-0.005	RA225.24	0.91	0.91	0.19	0.21	100
-0.005	RA225.24	0.91	0.91	0.8	0.83	104
-0.005	RA225.24	0.92	0.91	0.51	0.47	100
-0.005	RA225.24	1.09	0.91	0.12	0.13	105
-0.005	RA225.24	0.91	0.91	0.4	0.41	99
-0.005	RA225.24	0.93	0.91	1	0.94	93
-0.005	RA225.24	0.91	0.91	0.42	0.43	99
-0.005	RA225.24	0.90	0.91	0.076	0.078	90
-0.005	RA225.24	0.92	0.91	0.64	0.59	108
-0.005	RA225.24	0.94	0.91	0.15	0.14	100
-0.005	RA225.24	0.93	0.91	0.066	0.064	105
-0.005	RA225.24	0.97	0.91	0.52	0.59	95
-0.005	RA225.24	0.90	0.91	0.059	0.056	98
-0.005	RA225.24	0.97	0.91	0.073	0.077	104

-0.005	RA225.24	0.86	0.91	0.089	0.081	100
-0.005	RA225.24	0.91	0.91	0.95	0.87	101
-0.005	RA225.24	0.91	0.91	0.08	0.085	101
-0.007	RA226.25	0.92	0.91	0.14	0.13	98
-0.005	RA226.25	0.93	0.91	0.13	0.14	106
-0.005	RA226.25	0.99	0.91	1.24	1.24	101
-0.005	RA226.25	0.97	0.91	0.99	0.9	93
-0.005	RA226.25	0.90	0.91	-0.005	-0.005	109
-0.005	RA226.25	0.90	0.91	0.17	0.16	100
-0.005	RA226.25	0.96	0.91	0.11	0.11	107
-0.005	RA226.25	0.93	0.91	0.18	0.18	113
-0.005	RA226.25	0.97	0.91	0.45	0.46	104
-0.005	RA226.25	0.99	0.91	0.84	0.82	106
-0.005	RA226.25	0.94	0.91	0.16	0.17	107
-0.005	RA226.25	0.93	0.91	0.33	0.35	111
-0.005	RA226.25	0.97	0.91	0.17	0.16	110

SGS

Environmental Services

REPORT CODE: *DEN-ANN09*

REPORT TITLE: *Annual Quality Assessment Report*

REVISION: *1.2*

ISSUED BY:

Quality Coordinator, Canadian Operations - SGS Environmental Services

AUTHORIZED BY:

Technical Manager,
SGS Environmental Services

DATE: *10 Mar. 2010*

Table of Contents

1. BACKGROUND

SGS Environmental Services entered into an agreement with Denison Environmental Services for the analytical lab to provide analysis according to RFT #05-016. Below is a summary of the laboratory quality management system, key actions taken by the laboratory for samples analyzed during 2009, as well as a summary of the significant findings and the corrective actions implemented.

2. QUALITY MANAGEMENT SYSTEM

SGS Environmental Services is accredited to ISO/IEC 17025 by the Canadian Association for Laboratory Accreditation (CALA), for specific tests listed in the scope of accreditation. ISO/IEC 17025 addresses both quality management and the technical aspects of operating a testing laboratory.

The quality management system at SGS Environmental Services consists of a documented quality system, which is directed by the Quality Coordinator who is independent of the production area. All appropriate documentation (quality manual, methods, written instructions, standard operating procedures, and data approval criteria) is in place and includes both general and method specific quality control requirements.

The quality control procedures include duplicate samples, spiked blanks, spiked replicates, reagent/instrument blanks, preparation control samples, certified reference material analysis, and instrument control samples, as appropriate for the individual methods. Matrix matching of reference materials to samples is always attempted. Frequency of insertion of control samples is method specific and follows legislated guidelines. A summary of the quality control recoveries is presented in the tables following.

3. QUALITY CONTROL PARAMETERS

The analysis of quality control samples is method specific and includes duplicate samples, spiked blanks, spiked replicates, reagent/instrument blanks, preparation control samples, certified reference material analysis, and instrument control samples, as appropriate for the individual methods. Matrix matching of reference materials to samples is always attempted. Frequency of insertion of control samples is method specific and follows legislated guidelines and/or customer requirements. All QC analyses for Denison Environmental Services are tracked in unique files, specific to Denison Environmental Services. The samples are processed as part of our "worksheet" batch system and a compilation of all Denison Environmental Services QC data for the parameters tested during 2009 has been compiled below.

4. MAJOR ACHIEVEMENTS IN QUALITY CONTROL

- SGS Environmental Services performed 10505 analyses with 11748 QC checks, which represents 112% QC for sample analysis. This level of QC is significantly higher than the lab standard, which is generally 20%.
- All blank data results were within the data quality objectives. **Corrective Action:** N/A
- All CRM data results were within the data quality objectives. **Corrective Action:** N/A
- No duplicate value exceeded the data quality objectives. **Corrective Action:** N/A
- No spike blanks exceeded the data quality objectives. **Corrective Action:** N/A
- No spike duplicates fell outside of the data quality objectives. **Corrective Action:** N/A

5. QC DATA SUMMARY

5.1. Blank Data

Parameter	Unit	Required Detection Limit	Mean Blank Result	Number of Blanks	Number greater than Limit	Number Outside SGS Quality Limit (+/- Detection Limit)
Acidity	mg/L as CaCO3	2	1.87329	95	27	0
Ag	mg/L	0.0001	0.00004	200	0	0
Alkalinity	mg/L as CaCO3	2	1.00000	3	0	0
As	mg/L	0.0005	xxx	0	0	0
Ba	mg/L	0.005	0.00245	208	0	0
Co	mg/L	0.0005	0.00025	199	0	0
Cu	mg/L	0.0001	0.00025	72	0	0
DOC	mg/L	0.5	0.19198	172	1	0
Fe	mg/L	0.02	0.01013	252	2	0
Mn	mg/L	0.002	0.00100	209	0	0
Ni	mg/L	0.002	0.00100	70	0	0
Pb	mg/L	0.00002	0.00020	69	0	0
Se	mg/L	0.0005	0.00195	123	58	0
SO4	mg/L	0.1	0.01239	203	0	0
Total Suspended Solids	mg/L	1	0.50860	193	1	0
U	mg/L	0.0005	0.00029	240	91	0
Zn	mg/L	0.001	0.00047	106	2	0

5.2. CRM Data

Parameter	Unit	Certified Value	Lower Limit (at 20% Rel. Error)	Upper limit (at 20 % Rel. Error)	Number of CRM's	Mean Value	Precision (%RSD)	Accuracy (% Rel error)	Number QC CRM outside of DQO
Acidity	mg/L as CaCO3	50	40	60	106	51.47	2.27	-2.93	0
Ag	mg/L	0.1	0.08	0.12	220	0.10	2.82	0.02	0
Alkalinity	mg/L as CaCO3	47.2	37.8	56.6	1	49.00	2.11	---	0
As	mg/L	0.1	0.08	0.12	0	---	---	---	0
Ba	mg/L	0.1	0.08	0.12	229	0.10	2.45	-1.88	0
Co	mg/L	0.1	0.08	0.12	222	0.10	2.46	-1.60	0
Cu	mg/L	0.1	0.08	0.12	77	0.10	1.73	-1.68	0
DOC	mg/L	10	8	12	213	9.78	4.49	2.18	0
Fe	mg/L	500	400	600	294	500.72	2.33	-0.14	0
Mn	mg/L	0.1	0.08	0.12	228	0.10	2.62	-1.63	0
Ni	mg/L	0.1	0.08	0.12	74	0.10	1.90	-2.14	0
Pb	mg/L	0.1	0.08	0.12	76	0.10	2.02	-0.70	0
Se	mg/L	0.1	0.08	0.12	193	0.10	4.07	-1.17	0
SO4	mg/L	5	4	6	263	5.07	3.23	-1.50	0
U	mg/L	0.1	0.08	0.12	226	0.10	2.67	-1.64	0
Zn	mg/L	0.1	0.08	0.12	76	0.10	1.98	-1.77	0

5.3. *Duplicate Data*

Parameter	unit	Expected Recovery (Rel %)	Lower Limit (Rel %)	Upper Limit (Rel %)	Number of Duplicates	Mean (% Rel Error)	Number Duplicate samples outside of DQO (at 10x LOQ)
Acidity	% Rec.	100	90	110	77	0.974	0
Ag	% Rec.	100	90	110	200	-0.025	0
Alkalinity	% Rec.	100	90	110	4	-0.333	0
As	% Rec.	100	90	110	0	---	0
Ba	% Rec.	100	90	110	221	0.843	0
Co	% Rec.	100	90	110	215	0.588	0
Cu	% Rec.	100	90	110	74	0.383	0
DOC	% Rec.	100	90	110	193	2.096	0
Fe	% Rec.	100	90	110	287	1.050	0
Mn	% Rec.	100	90	110	224	0.727	0
Ni	% Rec.	100	90	110	71	-0.030	0
Pb	% Rec.	100	90	110	72	0.416	0
pH	% Rec.	100	90	110	28	0.129	0
Se	% Rec.	100	90	110	150	0.098	0
S	% Rec.	100	90	110	213	-0.058	0
Total Suspended Solids	% Rec.	100	90	110	193	1.356	0
U	% Rec.	100	90	110	266	0.816	0
Zn	% Rec.	100	90	110	121	0.879	0

5.4. *Spike Blank Data*

Parameter	Unit	Certified Value	Lower Limit (at 30% Rel. Error)	Upper limit (at 30 % Rel error)	Number of Spike Blank's	Mean % Recovery	Mean Precision (%)	Number Spike Blank outside of DQO
Acidity	mg/L as CaCO3	10	7	13	48	110.93	109.79	0
Ag	mg/L	0.00016	0.000112	0.00021	202	101.98	0.00	0
Alkalinity	mg/L as CaCO3	9.4	6.58	12.2	2	97.98	---	0
As	mg/L	0.0064	0.00448	0.00832	2	105.00	0.00	0
Ba	mg/L	0.004	0.0028	0.0052	229	67.34	0.00	0
Co	mg/L	0.002	0.0014	0.0026	206	100.81	0.00	0
Cu	mg/L	0.0016	0.00112	0.00208	67	109.96	0.00	0
DOC	mg/L	20	14	26	227	96.86	0.96	0
Fe	mg/L	0.1	0.07	0.13	286	105.68	0.01	0
Mn	mg/L	0.0032	0.00224	0.00416	217	99.66	0.06	0
Ni	mg/L	0.0048	0.00336	0.00624	72	102.86	0.00	0
Pb	mg/L	0.0032	0.00224	0.00416	81	104.65	0.00	0
Se	mg/L	0.0008	0.00056	0.00104	123	109.48	0.07	0
SO4	mg/L	4	2.8	5.2	272	92.25	0.07	0
SO4	mg/L	100	70	130	61	105.55	4.44	0
U	mg/L	0.0008	0.00056	0.00104	227	100.85	0.00	0
Zn	mg/L	0.0056	0.00392	0.00728	71	108.24	0.000	0

5.5. *Spike Duplicate Data*

Parameter	Unit	Certified Value	Lower Limit (at 30% Rel. Error)	Upper limit (at 30 % Rel error)	Number of Spiked Duplicates	Mean % Recovery	Precision (%RSD)	Number Spike Blank outside of DQO
Ag	µg/L	0.16	0.112	0.208	200	97.32	0.01	0
As	µg/L	6.4	4.48	8.32	0	---	---	0
Ba	µg/L	4	2.8	5.2	170	99.36	0.18	0
Co	µg/L	2	1.4	2.6	194	99.62	0.10	0
Cu	µg/L	1.6	1.12	2.08	58	100.86	0.08	0
DOC	mg/L	100	70	130	208	90.53	6.85	0
Fe	mg/L	0.1	0.07	0.13	196	101.11	0.01	0
Mn	mg/L	3.2	2.24	4.16	116	100.49	0.13	0
Ni	mg/L	4.8	3.36	6.24	60	98.61	0.15	0
Pb	mg/L	3.2	2.24	4.16	65	102.15	0.13	0
Se	mg/L	0.8	0.56	1.04	91	88.19	0.05	0
SO4	mg/L	100	70	130	201	93.27	5.56	0
U	mg/L	0.8	0.56	1.04	193	1140.84	0.03	0
Zn	mg/L	5.6	3.92	7.28	71	96.15	0.38	0

5.6. *QC Frequency*

Total Number of Blanks	2425
Total Number of CRM	2498
Total Number of Duplicates	2609
Total Number of Spike Blank	2393
Total Number of Spike Duplicates	1823
Sum of QC Insertion:	**11748**
Total Analysis:	**10505**

6. CONCLUSION & SIGNIFICANT FINDINGS

SGS Environmental Services analyzed QC samples for this project beyond the lab standard of 20% QC insertion. Where the data quality objectives were exceeded, the additional QC samples analyzed within the run supported the data values and data was released on this basis.

SGS Environmental Services remains committed to delivering data that meets and/or exceeds the data quality objectives for Denison Environmental Services and staff will continue to work closely with Denison Environmental Services staff to ensure all objectives are achieved in 2009.

7. CORRECTIVE ACTIONS & IMPLEMENTATION OF CORRECTIVE ACTIONS

- SGS was contacted by Denison Environmental Services regarding report, CA10225-JAN09. The metal results appeared to be lower than expected values, when compared to the historical values over the last five years. **Corrective Action:** The lab was unable to identify a root cause for this incident; however, the re-assay data showed the SO4 and metals back in line with expected results.
- During the dilution process in analyzing for SO4 on sample D-14 (August 11) there was an instrument failure that resulted in a backwash of dilution water into the sample bottle. As this was the only unpreserved sample portion for this set of bottles another sample was requested. **Corrective Action**: An additional sample was submitted and processed.

8. SUBCONTRACT LAB INFORMATION

A full report has been provided by the subcontract lab and is included as Addendum A of this report.

Addendum A

Environmental Services

Becquerel Laboratories Inc. Phone: (905) 826-3080
6790 Kitimat Rd., Unit 4 FAX: (905) 826-4151
Mississauga, Ontario
Canada, L5N 5L9

Date: 05-Jan-2010

Annual Quality Assessment Report for 2009

Introduction

The number of samples analyzed was 798.

The following samples were used for quality control in 2009. A set of control samples was included with each set of 20 or fewer samples.

Reagent Blanks:

Reagent blanks were aliquots of deionized water that were processed in the same way as samples, using the same tracers, carriers and other reagents.

Duplicates:

Duplicate samples were replicate aliquots of a sample from each analysis run, and were processed in the same way as other samples.

Analyte Spikes:

A solution of Ra-226 was prepared by dissolving and diluting a portion of the Canmet CRM BL-3. A one-millilitre aliquot of this solution was added to a second aliquot of sample to test recoveries. Each aliquot added contained 0.109 Bq of Ra-226.

It should be noted that Barium-133 is added to every aliquot as a tracer, in order to measure the chemical yield of Ra-226 for each individual sample.

Check Standards:

Several check standards were using during 2009.

RA226.25, RA226.26, RA226.27, RA226.28,RA226.29 and RA226.30.

A calibrated solution of Ra-226 was obtained from Isotope Products Laboratories and used to prepare these check standards.

Major Achievements in Quality Control

Steps were taken to improve the resolution of alpha spectra by reducing the mass of prepared samples. If too much material is present on prepared sources, alpha spectra become smeared. This is particularly problematic for the complex spectra due to the presence of Ra-224 in some samples.

Procedures were modified to guard against sample mix-ups.

QC Data Quality Summary

Analytical Parameter	Blank Result Bq/l	Number of Blanks	CRM accuracy %	Numbers of CRMs
DQO			+- 20	
Ra-226	< 0.005	96	+2.4	96

Analytical Parameter	Spike accuracy %	Number of Spikes	Precision %	Number of Duplicates
DQO	+- 20		+-10	
Ra-226	+1.5	96	-1.2	96

Notes: CRM accuracy and Spike accuracy values are averages. The values above are percent differences from the expected values. If means are computed for absolute deviations, that for the CRM becomes 4.7% and that for the spike becomes 5.2%.

The precision value is the mean of the percent differences for duplicate results. If absolute differences are used, this mean becomes 5.8%. It should be noted that precision is expected to become worse as the detection limit is approached.

Blank: One positive blank result of 0.006 Bq/l was obtained.

CRM: No CRM results differed from the expected value by more than 20 percent. The maximum deviation was +12 %.

Spike: No spike recovery deviated from 100% by more than 20%. The maximum deviation was -16 %.

Duplicate: Of the 96 duplicate sets run, 94 gave positive results. Of these, 15 duplicates differed by more than 10%. The maximum deviation was -16% for an original value of 0.12 Bq/l.

91 duplicates gave results greater than 10 times the detection limit: of these, 14 duplicates differed by more than 10 percent. The maximum deviation was -16%.

Conclusion and Significant Findings

Accuracy and recovery are satisfactory, as shown in the summary section. Rush analyses present challenges in maintaining accuracy and precision.

Corrective Actions

Results were reissued for batches T09-00653.1 and T0900671.0 after an error in computation was corrected.

Samples were reanalyzed and results were reissued for batch T09-00925.0 after requested re-analyses revealed a sample mix-up.

Results were reissued for batch T09-01720.0 after one sample was reanalyzed when a sample mix-up was detected.

Appendix: Raw QC Data (Negative Values Signify Upper Limits)

Blank	Standard	Standard Value	Standard Result	Original	Duplicate	Spike % Recovery
-0.005	RA226.25	0.91	1.00	2.1	2.2	105
-0.005	RA226.25	0.91	0.96	0.1	0.11	99
-0.005	RA226.25	0.91	0.91	0.038	0.036	111
-0.005	RA226.25	0.91	0.98	0.34	0.33	110
-0.005	RA226.25	0.91	0.92	0.86	0.75	100
-0.005	RA226.25	0.91	0.92	0.32	0.32	92
-0.005	RA226.26	0.91	0.98	0.2	0.2	104
-0.005	RA226.26	0.91	0.92	0.16	0.16	101
-0.005	RA226.26	0.91	1.02	0.12	0.12	107
-0.005	RA226.26	0.91	1.01	0.78	0.82	95
-0.005	RA226.26	0.91	0.86	0.11	0.094	97
-0.005	RA226.26	0.91	0.95	0.79	0.83	104
-0.005	RA226.26	0.91	0.99	0.48	0.47	102
-0.005	RA226.26	0.91	0.93	0.086	0.087	104

-0.005	RA226.26	0.91	0.92	0.15	0.15	99
-0.005	RA226.26	0.91	0.92	0.26	0.26	108
-0.006	RA226.26	0.91	0.93	-0.008	0.005	84
-0.005	RA226.26	0.92	0.95	0.14	0.13	102
-0.005	RA226.26	0.92	0.88	0.12	0.1	100
-0.005	RA26.26	0.92	1.00	0.99	0.93	103
-0.005	RA226.26	0.92	0.99	0.1	0.1	108
-0.005	RA226.26	0.92	0.91	0.11	0.1	95
-0.005	RA226.26	0.92	0.91	0.14	0.14	104
-0.005	RA226.26	0.92	0.92	0.09	0.092	98
-0.005	RA226.26	0.92	0.87	0.51	0.52	100
-0.005	RA226.26	0.92	0.94	0.14	0.15	108
-0.005	RA226.26	0.92	0.93	0.081	0.083	100
-0.005	RA226.26	0.92	0.94	0.53	0.5	111
-0.005	RA226.26	0.92	0.95	0.79	0.83	99
-0.005	RA226.26	0.92	0.84	0.073	0.082	112
-0.005	RA226.26	0.92	0.95	0.099	0.094	111
-0.005	RA226.26	0.92	0.93	0.055	0.055	99
-0.005	RA226.27	0.92	0.91	0.06	0.067	110
-0.005	RA226.27	0.92	0.92	0.29	0.27	95
-0.005	RA226.27	0.92	0.95	0.085	0.085	95
-0.005	RA226.27	0.92	0.92	0.091	0.080	90
-0.005	RA226.27	0.92	0.82	0.71	0.68	105
-0.005	RA226.27	0.92	0.97	0.41	0.39	108
-0.007	RA226.27	0.92	0.89	0.063	0.059	103
-0.005	RA226.27	0.92	0.98	0.11	0.11	106
-0.007	RA226.27	0.92	0.94	0.11	0.099	106
-0.005	RA226.27	0.92	0.89	0.61	0.61	88
-0.005	RA226.27	0.92	0.97	0.12	0.13	94
-0.005	RA226.27	0.92	0.98	0.12	0.1	111
-0.005	RA226.27	0.92	0.96	0.72	0.65	95
-0.005	RA226.27	0.92	0.90	0.1	0.092	103
-0.005	RA226.27	0.92	0.96	0.83	0.86	101
-0.006	RA226.27	0.92	0.99	0.095	0.097	112
-0.005	RA226.27	0.92	0.95	0.096	0.088	105

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-0.006	RA226.27	0.92	0.99	0.095	0.097	112
-0.005	RA226.27	0.92	0.96	0.085	0.079	105
-0.005	RA226.28	0.92	0.98	0.084	0.084	98
-0.005	RA226.28	0.92	1.03	0.16	0.17	105
-0.005	RA226.28	0.92	0.98	0.097	0.105	95
-0.005	RA226.28	0.92	0.97	0.18	0.17	111
-0.005	RA226.28	0.92	0.94	0.95	0.84	104
-0.005	RA226.28	0.92	0.92	1.6	1.8	105
-0.005	RA226.28	0.92	0.94	0.027	0.029	98
-0.005	RA226.28	0.92	0.95	0.056	0.053	106
-0.005	RA226.28	0.92	0.90	0.073	0.061	106
-0.005	RA226.28	0.92	0.90	0.11	0.1	107
-0.005	RA226.28	0.92	1.00	0.1	0.11	104
-0.005	RA226.28	0.92	0.90	1.3	1.2	96
-0.005	RA226.28	0.92	0.87	0.71	0.63	106
-0.005	RA226.28	0.92	0.97	1.93	1.86	96
-0.005	RA226.28	0.92	0.83	0.12	0.13	104
-0.005	RA226.28	0.92	0.87	0.26	0.25	110
-0.005	RA226.28	0.92	0.92	0.12	0.14	97
-0.005	RA226.28	0.92	0.86	0.186	0.18	94
-0.007	RA226.28	0.92	0.99	0.013	0.011	99
-0.005	RA226.28	0.92	0.95	0.169	0.163	114
-0.005	RA226.29	0.92	0.86	0.12	0.11	101
-0.005	RA226.29	0.92	0.91	0.053	0.054	97
-0.005	RA226.29	0.92	0.96	2.79	2.78	103
-0.005	RA226.29	0.92	0.89	0.15	0.16	107
-0.005	RA226.29	0.92	0.93	0.38	0.35	109
-0.005	RA226.29	0.92	0.95	0.15	0.16	103
-0.005	RA226.29	0.92	0.96	0.17	0.18	105
-0.005	RA226.29	0.92	1.03	0.15	0.16	99
-0.005	RA226.29	0.92	0.93	-0.005	-0.005	100
-0.005	RA226.29	0.92	0.95	0.12	0.12	93
-0.005	RA226.29	0.92	0.97	0.35	0.34	102
-0.005	RA226.29	0.92	0.97	0.16	0.15	104

-0.006	RA226.29	0.92	0.88	0.12	0.12	89
-0.005	RA226.29	0.92	1.01	0.14	0.14	97
-0.005	RA226.29	0.92	0.92	0.089	0.09	94
-0.005	RA226.29	0.92	0.93	0.83	0.78	101
0.006	RA226.30	0.92	0.95	0.74	0.73	104
-0.007	RA226.30	0.92	0.82	0.055	0.063	93
-0.005	RA226.30	0.92	0.96	0.2	0.21	98
-0.005	RA226.30	0.92	0.90	0.86	0.83	97
-0.006	RA226.30	0.92	1.01	0.15	0.14	90
-0.005	RA226.30	0.92	0.97	0.12	0.11	101
-0.005	RA226.30	0.92	1.02	0.81	0.9	91
-0.005	RA226.30	0.92	1.03	0.21	0.21	100
-0.005	RA226.30	0.92	1.01	0.22	0.23	94

APPENDIX C

TOMP Water Quality Data

APPENDIX C.1
Denison TMA

Appendix Table C.1.1: Denison final points of control (D-2, D-3) discharge criteria.

Parameter	Units	Discharge Criteria	
		Grab Sample[a]	Monthly Mean[b]
Dissolved Radium-226 [c]	Bq/L	1.11	0.37
pH	pH units	5.5 – 9.5	6.5 – 9.5
Total Suspended Solids	mg/L	50.0	25.0

[a]Samples to be collected during periods of discharge.
[b]Arithmetic mean of twelve consecutive samples.
[c] Discharge criteria are for dissolved radium-226, while measured and reported values are for total radium-226.

Appendix Table C.1.2: Water quality at station D-1 from 2005 to 2009.

Date	Acidity (mg/L)	Ba (mg/L)	Co (mg/L)	Fe (mg/L)	Mn (mg/L)	pH[a]	Ra (Bq/L)	SO4 (mg/L)	U (mg/L)
1/11/2005				0.03		7.5	0.26	343	0.042
2/15/2005						7.6	0.34		
3/15/2005						7.9	0.41		
4/12/2005				0.169		7.7	0.21	150	0.02
3/14/2006				0.07		7.4	0.48	250	0.0747
4/11/2006						7.6	0.52	160	0.0322
4/12/2006				0.169		7.3			
12/19/2006						7.4	0.28		
1/9/2007	1	0.013	0.00025	0.07	0.014	7.8	0.300	260.0	
2/13/2007						7.8	0.290		
3/13/2007						8.1	0.280		
4/10/2007	1	0.011	0.00025	0.040	0.023	7.7	0.150	110.0	
3/11/2008	1	0.029	0.0009	0.08	0.061	7.1	0.740	240.0	
4/8/2008	1	0.032	0.0009	0.08	0.058	7.0	0.770	250.0	
5/13/2008						8.1	0.880		
12/23/2008						7.3	0.860		
1/13/2009	1	0.035	0.00025	0.020	0.010	7.3	0.860	230.0	
3/10/2009						7.1	0.970		
4/14/2009	1	0.037	0.0006	0.100	0.075	7.0	0.870	190.0	0.0406
5/12/2009						7.3	1.000		
12/8/2009						6.9	0.790		
Number	6	6	6	10	6	437	20	10	5
Minimum	1	0.011	0.00025	0.020	0.010	6.5	0.15	110	0.02
Maximum	1	0.037	0.0009	0.169	0.075	8.4	1	343	0.0747
Mean	1	0.026	0.00053	0.083	0.040	7.5	0.563	218	0.0419
Median	1	0.031	0.00043	0.075	0.041	7.5	0.500	235	0.0406
10th Perc.	1	0.012	0.00025	0.029	0.012	7	0.255	146	0.0249

[a] pH measures shown only for dates when other substances were measured but summary statistics reflect all measured values.

[shaded box] Concentration below maximum MDL.

Appendix Table C.1.3: Water quality at station D-22 from 2005 to 2009.

Date	Ba (mg/L)	Co (mg/L)	Fe (mg/L)	Mn (mg/L)	pH[a]	Ra (Bq/L)	SO4 (mg/L)	U (mg/L)
1/11/2005			0.32		6.9	0.47	105	**0.005**
2/15/2005					6.6	0.14		
3/29/2005					6.6	0.05		
4/19/2005			0.189		7.1	0.24	99.5	**0.005**
5/10/2005					7	0.33		
6/14/2005					6.7	1.29		
9/27/2005					6.6	1		
10/11/2005			2.37		6.4	0.97	258	**0.005**
11/15/2005					6.7	0.11		
12/13/2005					6.5	0.65		
1/10/2006			1.69		6.5	0.57	190	0.0014
2/14/2006					6.6	0.058		
3/14/2006					6.8	0.53		
4/11/2006			0.14		7	0.1	58	0.00056
5/9/2006					7	0.32		
6/13/2006					6.9	0.9		
7/11/2006			4.38		6.8	0.026	160	0.0035
8/8/2006					6.9	0.9		
10/10/2006			1.8		6.9	0.5	200	0.0018
11/14/2006					7.2	0.11		
12/12/2006					7.1	0.085		
1/9/2007	0.022	< 0.0005	0.23	0.096	6.9	0.150	96.0	0.00025
2/13/2007					6.5	1.000		
3/13/2007					6.1	0.750		
4/10/2007	0.021	0.0006	0.10	0.098	6.9	0.089	66.0	0.00025
5/8/2007					6.8	0.350		
6/12/2007					6.9	0.510		
9/18/2007					6.7	1.900		
10/9/2007	0.036	0.0006	0.32	0.145	6.5	0.350	180.0	0.0006
11/13/2007					7.0	0.130		
12/11/2007					6.7	0.054		
1/8/2008	0.015	0.0007	0.33	0.137	6.7	0.089	63.0	0.00025
2/12/2008					6.7	0.110		
3/11/2008					6.5	0.057		
4/8/2008	0.015	< 0.0005	0.22	0.065	6.9	0.010	18.0	0.0007
5/13/2008					7.0	0.070		
6/10/2008					6.9	0.240		
7/8/2008	0.038	< 0.0005	2.19	0.113	6.8	0.650	100.0	0.0019
8/12/2008					6.9	0.340		
9/9/2008					6.7	1.300		
10/14/2008	0.049	< 0.0005	4.24	0.182	6.8	1.000	230.0	0.0018
11/11/2008					7.1	0.400		
12/9/2008					6.9	0.160		
1/13/2009	0.023	< 0.0005	0.21	0.123	6.8	0.035	57.0	0.0008
2/10/2009					6.6	0.180		
3/10/2009					6.7	0.100		
4/14/2009	0.016	< 0.0005	0.21	0.099	6.9	0.038	33.0	0.00025
5/12/2009					6.8	0.190		
6/9/2009					7.0	0.190		
7/14/2009	0.082	0.0006	13.60	0.511	6.6	1.800	89.0	0.0047
8/11/2009					6.4	1.900		
9/8/2009					6.6	2.800		
10/13/2009	0.031	0.0007	1.78	0.279	6.7	0.350	160.0	0.0018

Appendix Table C.1.3: Water quality at station D-22 from 2005 to 2009.

Date	Ba (mg/L)	Co (mg/L)	Fe (mg/L)	Mn (mg/L)	pH[a]	Ra (Bq/L)	SO4 (mg/L)	U (mg/L)
11/10/2009					6.6	0.130		
12/8/2009					6.9	0.210		
Number	11	11	18	11	235	55	18	18
Minimum	0.015	0.0005	0.1	0.065	6.1	0.01	18	0.00025
Maximum	0.082	0.0007	13.6	0.511	7.3	2.8	258	0.005
Mean	0.032	0.0006	1.91	0.168	6.8	0.491	120	0.0020
Median	0.023	0.0005	0.33	0.123	6.8	0.240	99.8	0.0016
10th Perc.	0.015	0.0005	0.17	0.096	6.5	0.055	49.8	0.0003

[a] pH measures shown only for dates when other substances were measured but summary statistics reflect all measure values.

Concentration below maximum MDL.

Bold concentrations deleted from statistical analysis due to unreasonably high MDLs.

Appendix Table C.1.4: Water quality at station D-25 from 2005 to 2009.

Date	Acidity (mg/L)	pH[a]	Ra (Bq/L)
4/12/2005		7.2	0.17
10/11/2005		6.5	0.56
4/11/2006		7.1	0.14
10/10/2006		7.4	0.3
4/10/2007	0.5	7.4	0.240
10/9/2007	0.5	6.7	0.340
4/8/2008	0.5	7.0	0.470
10/14/2008	0.5	6.9	0.440
4/14/2009	0.5	7.2	0.410
10/13/2009	0.5	7.2	0.290
Number	6	22	10
Minimum	0.5	6.5	0.14
Maximum	0.5	7.5	0.56
Mean	0.5	7.1	0.336
Median	0.5	7.2	0.320
10th Perc.	0.5	6.9	0.167

[a] pH measures shown only for dates when other substances were measured but summary statistics reflect all measured values.

(shaded) Concentration below maximum MDL.

Appendix Table C.1.5: Water quality at groundwater station BH91 DG4B from 2005 to 2009.

Date	Acidity (mg/L)	Fe (mg/L)	pH	SO4 (mg/L)
7/1/2005	87	29.08	6.7	
7/1/2006	0.5	21	6.8	
9/12/2007	0.5	22.30	6.7	
7/30/2008	0.5	21.30	6.6	1100.0
8/18/2009	0.5	2.48	6.3	810.0
Number	5	5	5	2
Minimum	0.5	2.48	6.3	810
Maximum	87	29.08	6.8	1100
Mean	18	19.23	6.6	955.0
Median	0.5	21.30	6.7	955.0
10th Perc.	0.5	9.89	6.4	839.0

Concentration below maximum MDL. (shaded cells)

Appendix Table C.1.6: Water quality for station B91-D1A and B from 2005 to 2009.

Site	Date	Acidity (mg/L)	Fe (mg/L)	pH	SO4 (mg/L)
BH91-D1A	8/2/2005	158	80.44	7.1	
	7/12/2006	63	60.30	7.1	
	9/13/2007	54	58.50	7.2	
	8/13/2008	30	49.70	7.2	450.0
	8/27/2009	29	44.50	6.7	810.0
BH91-D1A Summary	Number	5	5	5	2
	Minimum	29.0	44.5	6.7	450.0
	Maximum	158.0	80.4	7.2	810.0
	Mean	66.8	58.69	7.1	630.0
	Median	54.0	58.50	7.1	630.0
	10th Perc.	29.4	46.58	6.9	486.0
BH91-D1B	8/2/2005	0.5	0.03	8.4	
	7/14/2006	0.5	0.09	7.6	
	8/13/2008	0.5	0.09	8.1	450.0
	8/31/2009	0.5	0.09	7.8	480.0
BH91-D1B Summary	Number	4	4	4	2
	Minimum	0.5	0.0	7.6	450.0
	Maximum	0.5	0.1	8.4	480.0
	Mean	0.5	0.08	8.0	465.0
	Median	0.5	0.09	8.0	465.0
	10th Perc.	0.5	0.05	7.7	453.0

(shaded cell) Concentration below maximum MDL.

Appendix Table C.1.7: Water quality at station BH91-D3 A and B from 2005 to 2009.

Site	Date	Acidity (mg/L)	Fe (mg/L)	pH	SO4 (mg/L)
BH91-D3A	8/4/2005	2260	924.20	7.4	
	7/14/2006	1050	630.00	6.8	
	9/12/2007	956	536.00	7.0	
	8/15/2008	663	407.00	7.0	2300.0
	8/27/2009	650	407.00	6.7	2200.0
BH91-D3A Summary	Number	5	5	5	2
	Minimum	650	407.0	6.7	2200.0
	Maximum	2260	924.2	7.4	2300.0
	Mean	1116	580.84	7.0	2250.0
	Median	956	536.00	7.0	2250.0
	10th Perc.	655	407.00	6.7	2210.0
BH91-D3B	7/25/2005	1357	742.00	6.0	
	7/17/2006	1040	591.00	5.8	
	9/11/2007	923	504.00	5.9	
	8/15/2008	825	461.00	6.0	2300.0
	8/27/2009	712	442.00	6.5	2100.0
BH91-D3B Summary	Number	5	5	5	2
	Minimum	712.0	442.0	5.8	2100.0
	Maximum	1357.0	742.0	6.5	2300.0
	Mean	971	548.00	6.0	2200.0
	Median	923	504.00	6.0	2200.0
	10th Perc.	757	449.60	5.8	2120.0

Concentration below maximum MDL.

Appendix Table C.1.8: Water quality for station BH91 D9 A from 2005 to 2009.

Date	Acidity (mg/L)	Fe (mg/L)	pH	SO4 (mg/L)
8/1/2005	310	242	6.3	
7/1/2006	212	222	6.5	
5/1/2007		238.00	6.3	1900.0
9/5/2007	211	237.00	6.6	
8/18/2008	232	254.00	6.3	1900.0
8/12/2009	239	251	6.4	1900
Number	5	6	6	3
Minimum	211	222	6.3	1900
Maximum	310	254	6.6	1900
Mean	241	240.67	6.4	1900
Median	232	240.00	6.35	1900
10th Perc.	211	229.50	6.3	1900

Concentration below maximum MDL.

Appendix Table C.1.9: Summary of seasonal trends for station D-1, 2003 - 2009.

Season	Spearman rho	Fe	pH	Ra-226	Sulphate	Uranium
February	Correlation Coefficient		-0.6			
	Sig. (2-tailed)		0.208			
	N		6			
March	Correlation Coefficient		-0.535714	0.3571429		
	Sig. (2-tailed)		0.2152175	0.4316114		
	N		7	7		
April	Correlation Coefficient	-0.559	-0.285714	0.6428571	0.6785714	0.7
	Sig. (2-tailed)	ns	0.5345092	0.1193924	ns	ns
	N	7	7	7	7	5
December	Correlation Coefficient		-1	0.5		
	Sig. (2-tailed)		0.000001	0.3910022		
	N		5	5		

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

"ns" denotes not significant.

Significant trend where $p<0.05$.

Appendix Table C.1.10: Summary of seasonal trends for station D-22, 2003 - 2009.

Season	Spearman rho	Fe	pH	Ra-226	Sulphate	Uranium*
January	Correlation Coefficient	-0.821	0.1853123	-0.9642857	-0.89285714	
	Sig. (2-tailed)	0.023	0.6907778	0.00045415	0.006807187	
	N	7	7	7	7	
February	Correlation Coefficient		0.6785714	-0.2857143		
	Sig. (2-tailed)		0.0937503	0.53450923		
	N		7	7		
March	Correlation Coefficient		-0.090094	-0.25		
	Sig. (2-tailed)		0.8476721	0.58872445		
	N		7	7		
April	Correlation Coefficient	-0.143	0.1071429	-0.8468812	-0.42857143	
	Sig. (2-tailed)	0.787	0.8191509	0.01619713	0.337368311	
	N	6	7	7	7	
May	Correlation Coefficient		-0.321429	0.10714286		
	Sig. (2-tailed)		0.482072	0.81915086		
	N		7	7		
June	Correlation Coefficient		0.4364358	-0.1428571		
	Sig. (2-tailed)		0.3275825	0.7599453		
	N		7	7		
July	Correlation Coefficient	0.700	-0.342356	0.5	-0.9	
	Sig. (2-tailed)	0.188	0.4522512	0.39100222	0.037386073	
	N	5	7	5	5	
August	Correlation Coefficient		0.1	0.1		
	Sig. (2-tailed)		0.8728886	0.87288857		
	N		5	5		
September	Correlation Coefficient		-0.464286	-0.4285714		
	Sig. (2-tailed)		0.2939341	0.39650146		
	N		7	6		
October	Correlation Coefficient	0.321	-0.126131	-0.1801875	-0.10714286	
	Sig. (2-tailed)	0.482	0.7875722	0.69904577	0.819150856	
	N	7	7	7	7	
November	Correlation Coefficient		-0.464286	-0.0545545		
	Sig. (2-tailed)		0.2939341	0.90752321		
	N		7	7		
December	Correlation Coefficient		0.1482499	-0.5585812		
	Sig. (2-tailed)		0.7510798	0.19245253		
	N		7	7		

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

"ns" denotes not significant.

[shaded box] Significant trend where $p<0.05$.

Appendix Table C.1.11: Summary of seasonal trends for station D-25, 2003 - 2009.

Season	Spearman rho	pH	Ra-226
April	Correlation Coefficient	0.34551166	0.540562478
	Sig. (2-tailed)	0.44781622	0.210289253
	N	7	7
October	Correlation Coefficient	-0.25	0.216224991
	Sig. (2-tailed)	0.58872445	0.641445509
	N	7	7

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

"ns" denotes not significant.

Significant trend where p<0.05.

Appendix Table C.1.12: Summary of annual trends for Denison groundwater stations.

Station	Spearman rho	Iron	pH	Sulphate
BH91-DG-4B	Correlation Coefficient	0.481318681	-0.735539981	
	Sig. (2-tailed)	0.081418295	0.004163708	
	N	14	13	
BH91-D-9A	Correlation Coefficient	0.913108501	-0.755788725	
	Sig. (2-tailed)	0.000001	0.000707595	
	N	16	16	
BH91-D-1A	Correlation Coefficient	-0.72941176	0.866690445	-0.58181818
	Sig. (2-tailed)	0.001343079	1.40017E-05	0.0604199
	N	16	16	11
BH91-D-1B	Correlation Coefficient	-0.06674582	0.510342528	0.66363636
	Sig. (2-tailed)	0.820651404	0.051924812	0.02598413
	N	14	15	11
BH91-D-3A	Correlation Coefficient	-0.51066975	0.803552941	-0.58181818
	Sig. (2-tailed)	0.043245015	0.000176938	0.0604199
	N	16	16	11
BH91-D-3B	Correlation Coefficient	-0.56470588	0.892478851	-0.51515152
	Sig. (2-tailed)	0.022663205	7.6612E-06	0.12755287
	N	16	15	10

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

"ns" denotes not significant.

[shaded box] Significant trend where p<0.05.

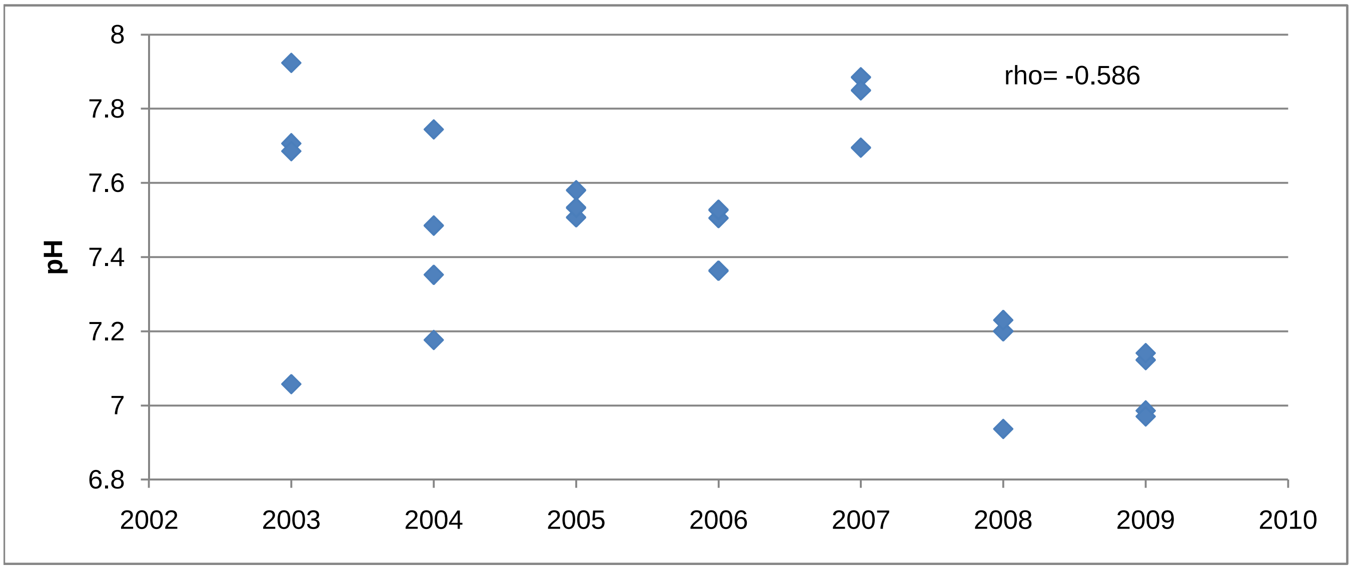
Appendix Table C.1.13: Summary of seasonal trends for station ECA-128, 2003 - 2009.

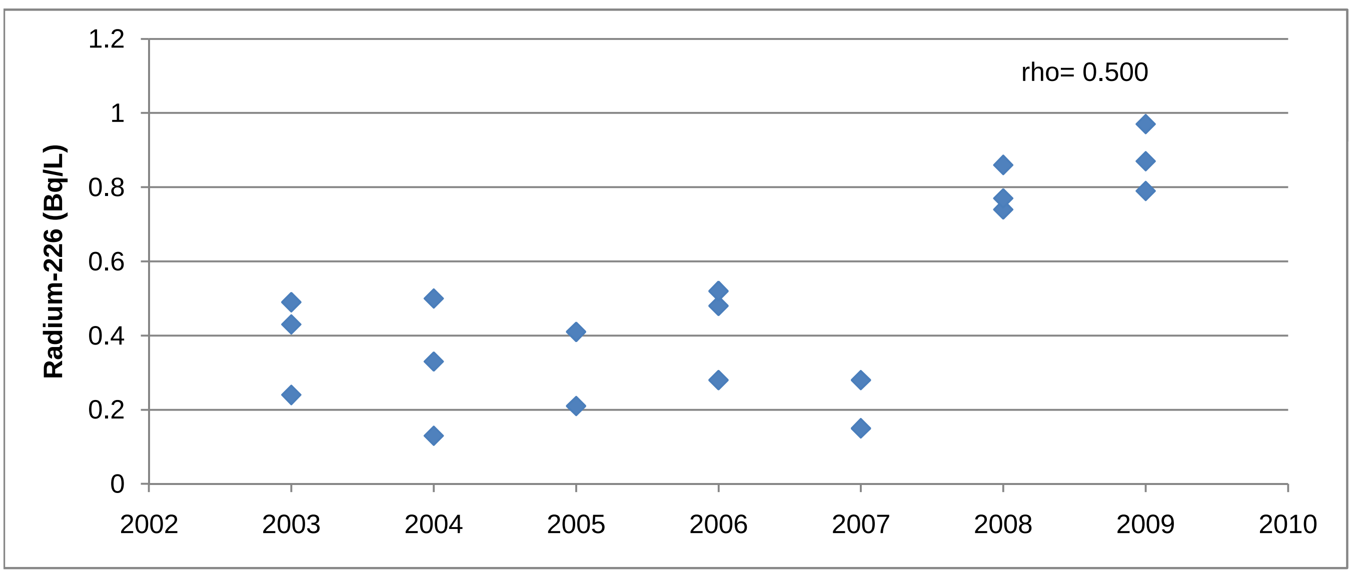
Season	Spearman rho	Fe	pH	Ra-226	Sulphate	Uranium
January	Correlation Coefficient	0.541	-0.9009375	0.05405625	-0.892857143	-0.77480622
	Sig. (2-tailed)	0.210	0.0056206	0.90836528	0.006807187	0.040769463
	N	7	7	7	7	7
April/May	Correlation Coefficient	0.536	0.1091089	0.78571429	0.214285714	0.036037499
	Sig. (2-tailed)	0.215	0.8158715	0.03623846	0.644511581	0.938860561
	N	7	7	7	7	7
October/November	Correlation Coefficient	-0.357	-0.6428571	0.89285714	-0.991031209	0.126131245
	Sig. (2-tailed)	0.432	0.1193924	0.00680719	1.45613E-05	0.787572159
	N	7	7	7	7	7

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

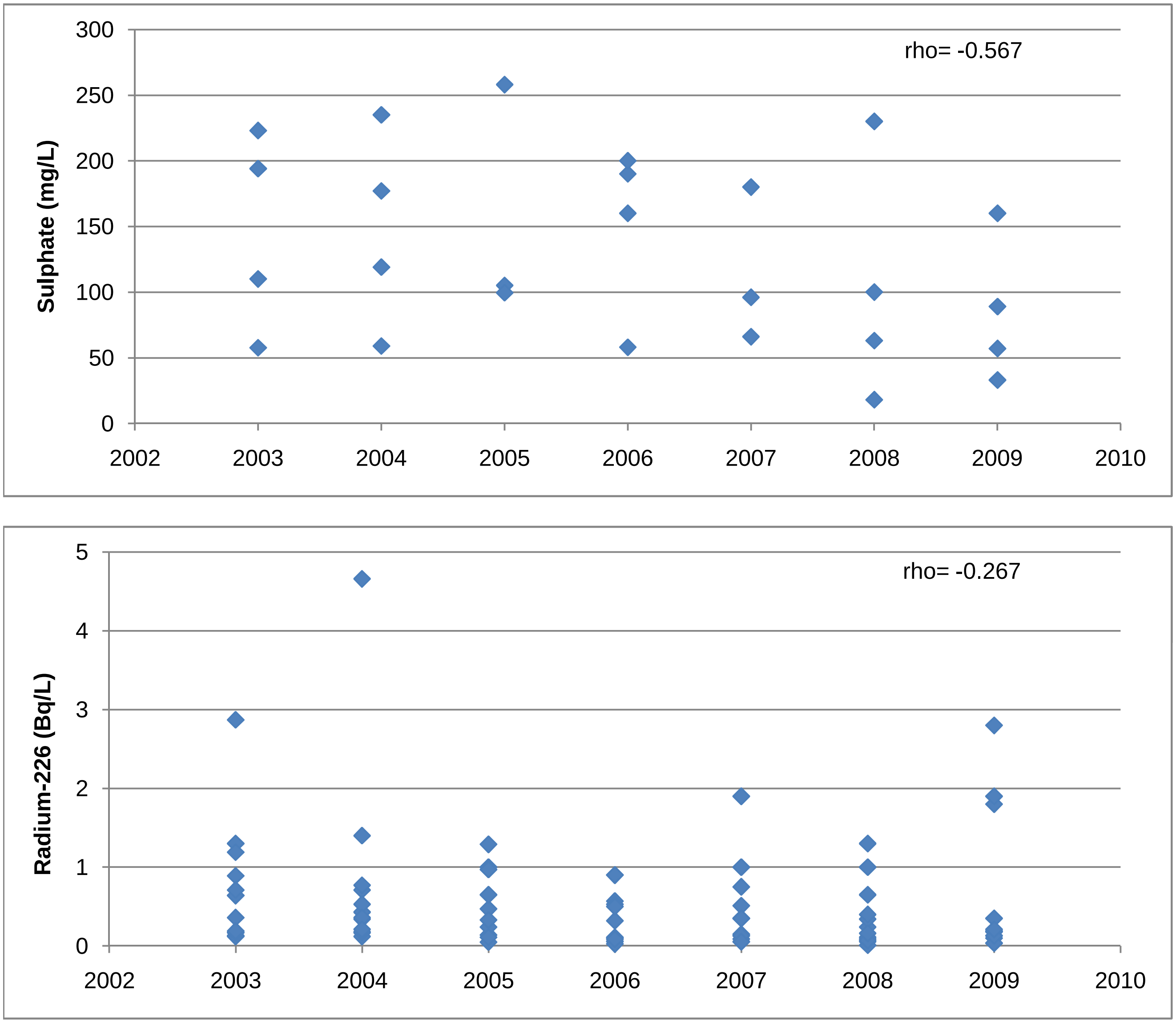
"ns" denotes not significant.

[shaded box] Significant trend where p<0.05.

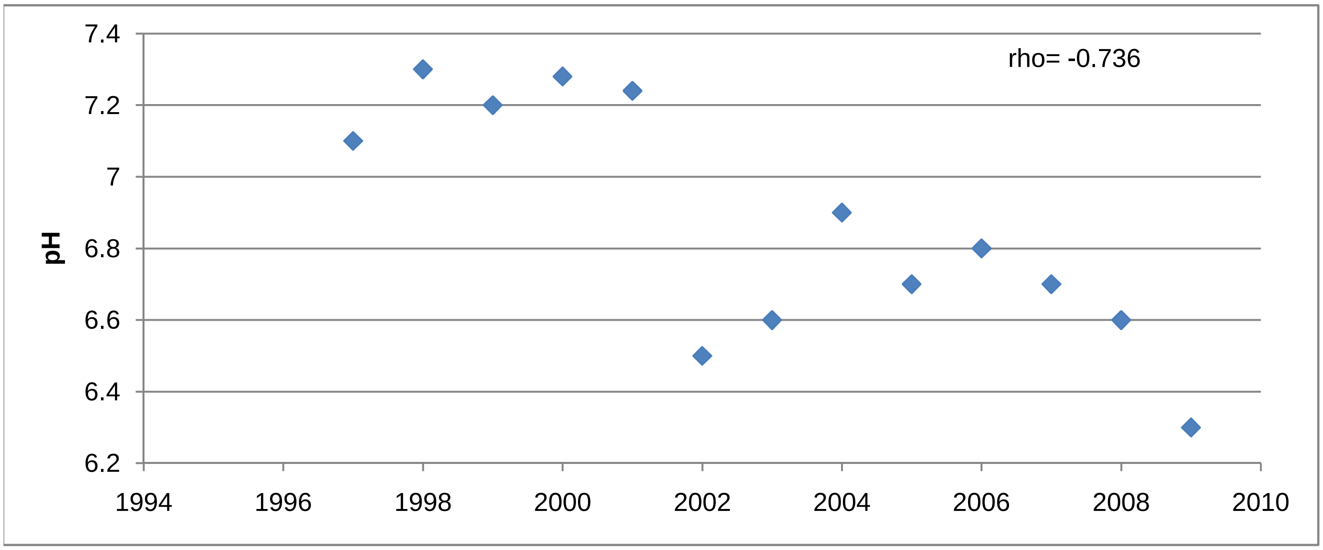




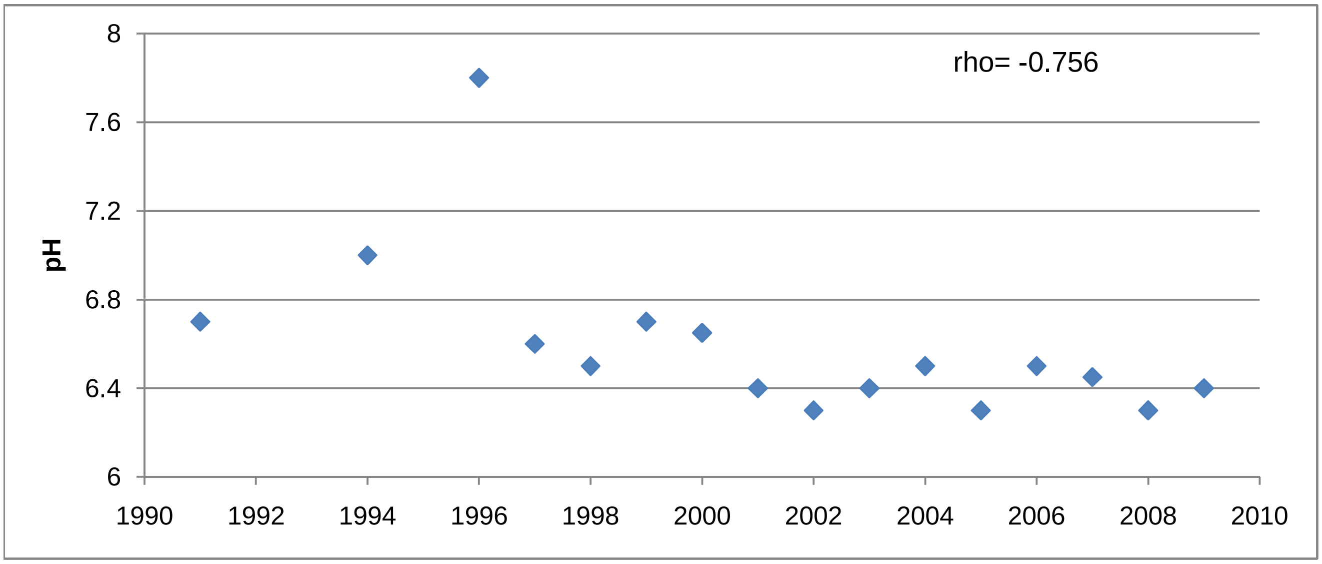
Appendix Figure C.1.1: Significant common (average) trends observed for pH and radium-226 over all seasons at station D-1, 2003 to 2009.

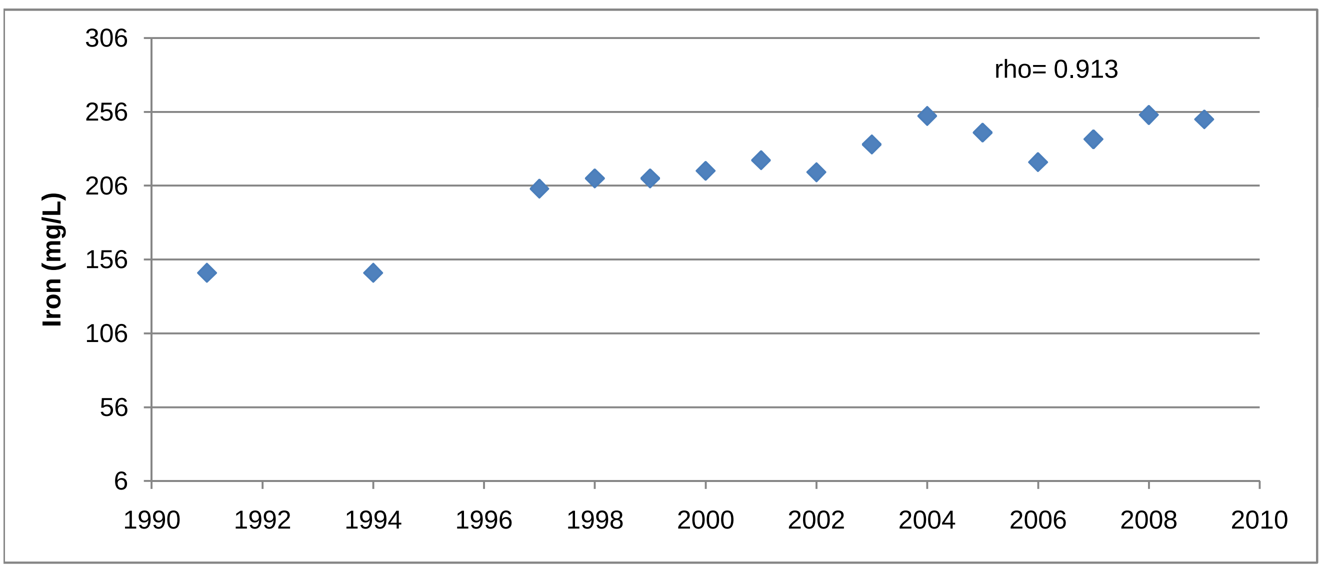


Appendix Figure C.1.2: Significant common (average) trends observed for sulphate and radium-226 over all seasons at station D-22, 2003 to 2009.

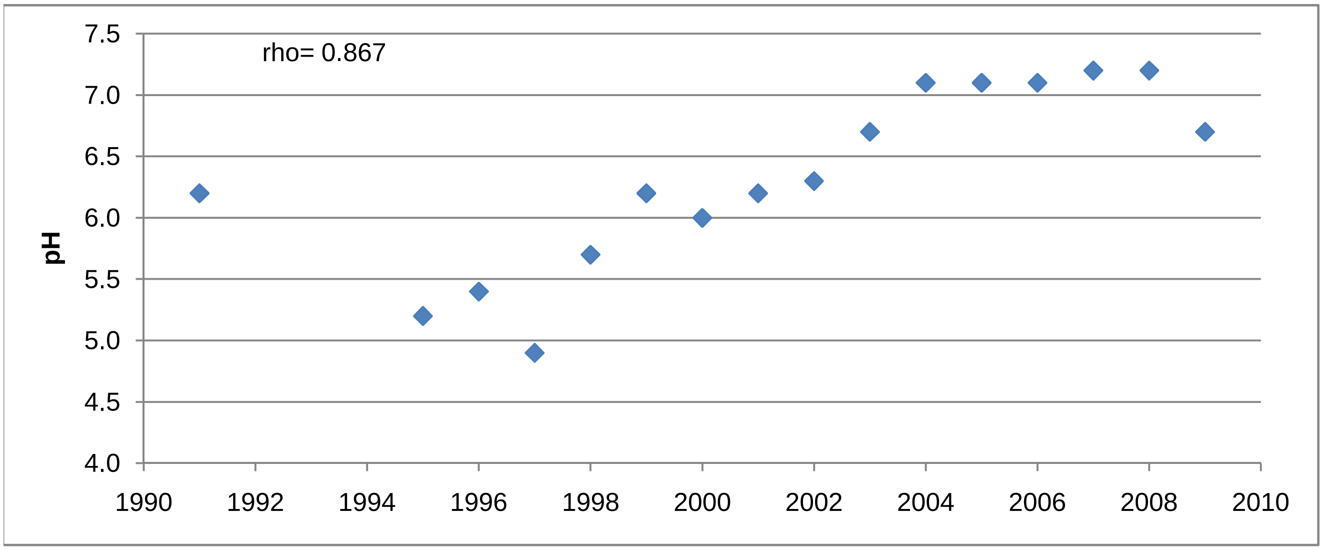


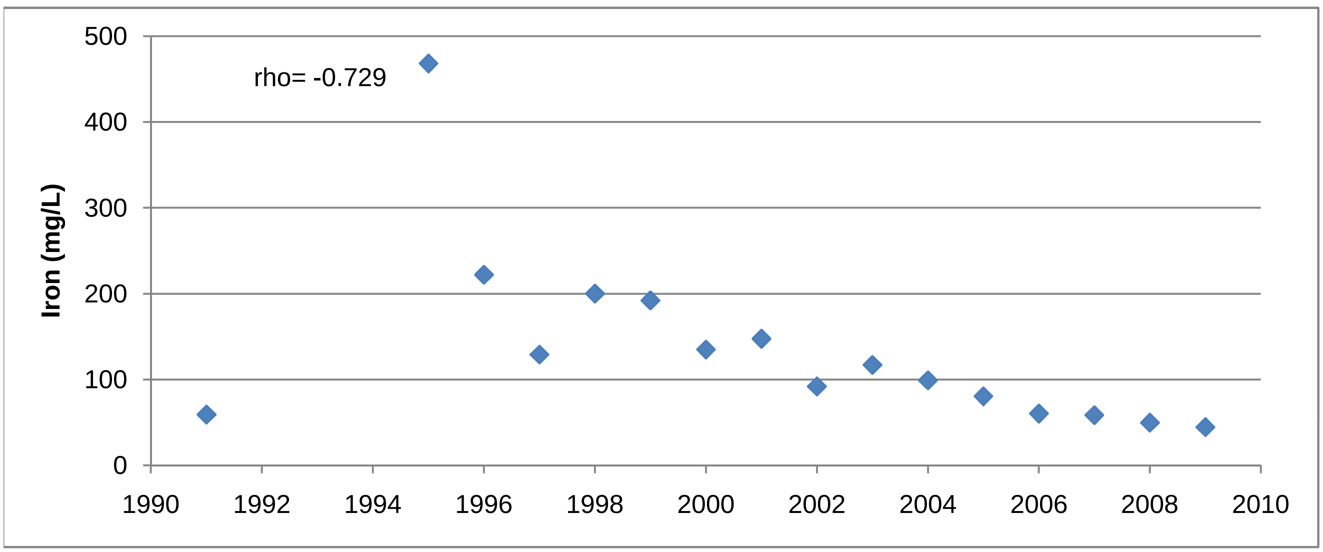
Appendix Figure C.1.3: Significant trends observed for pH at station BH91-DG-4B, 1997 to 2009.



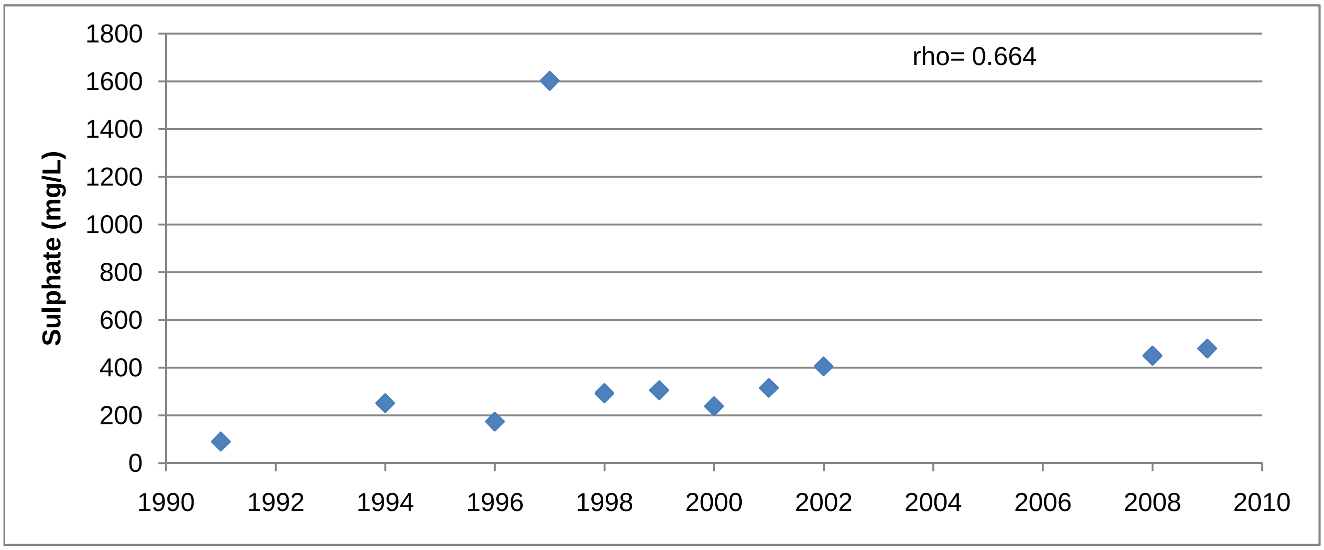


Appendix Figure C.1.4: Significant trends observed for pH and iron at station BH91-D9A, 1991 to 2009.

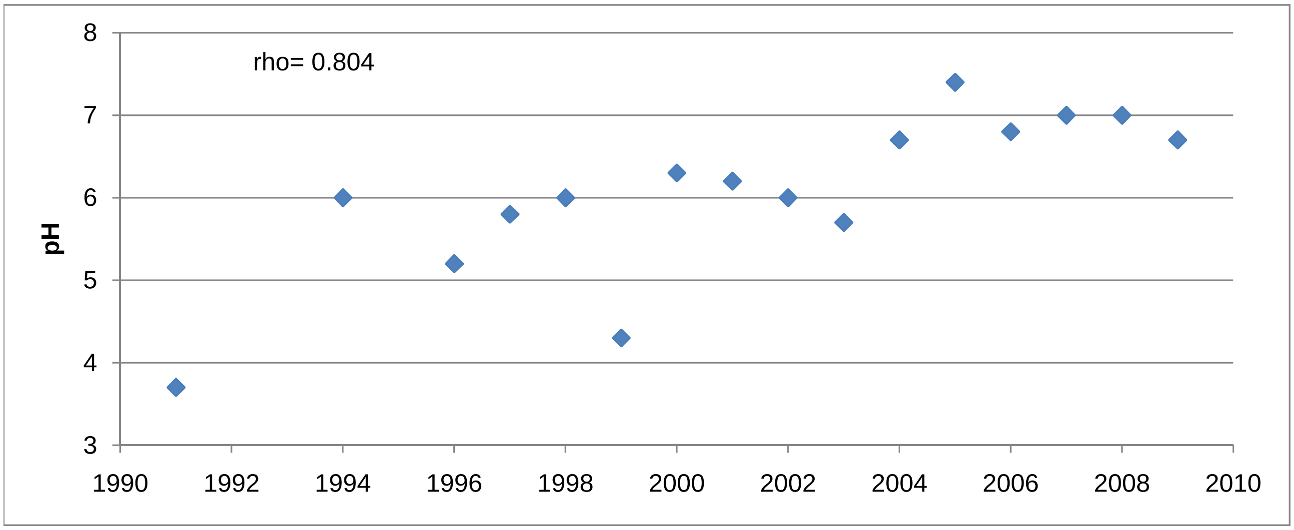


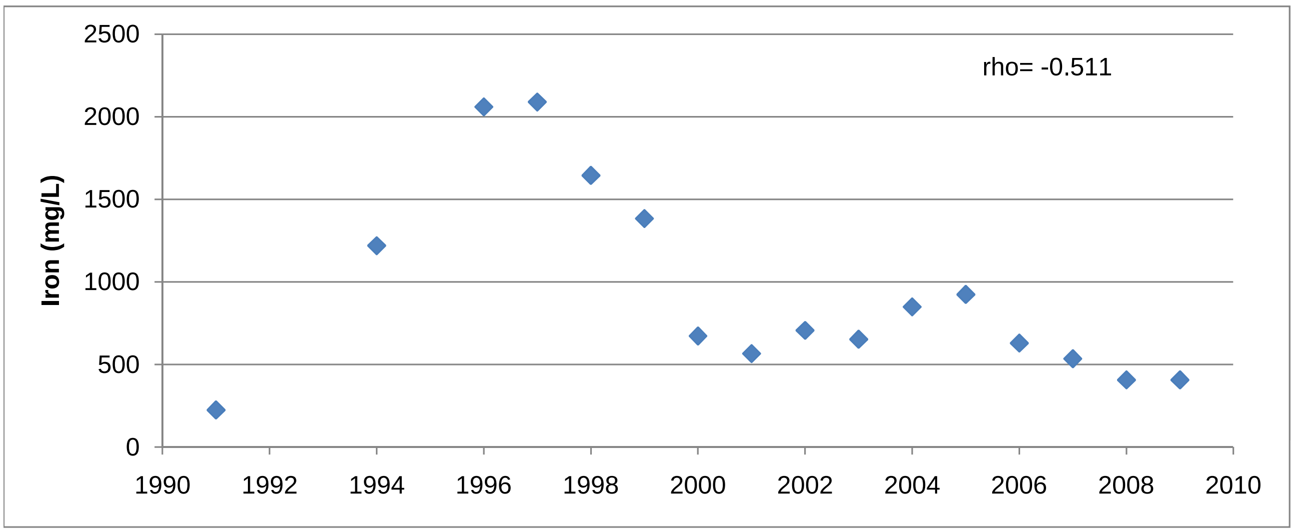


Appendix Figure C.1.5: Significant trends observed for pH and iron at station BH91-D1A, 1991 to 2009.

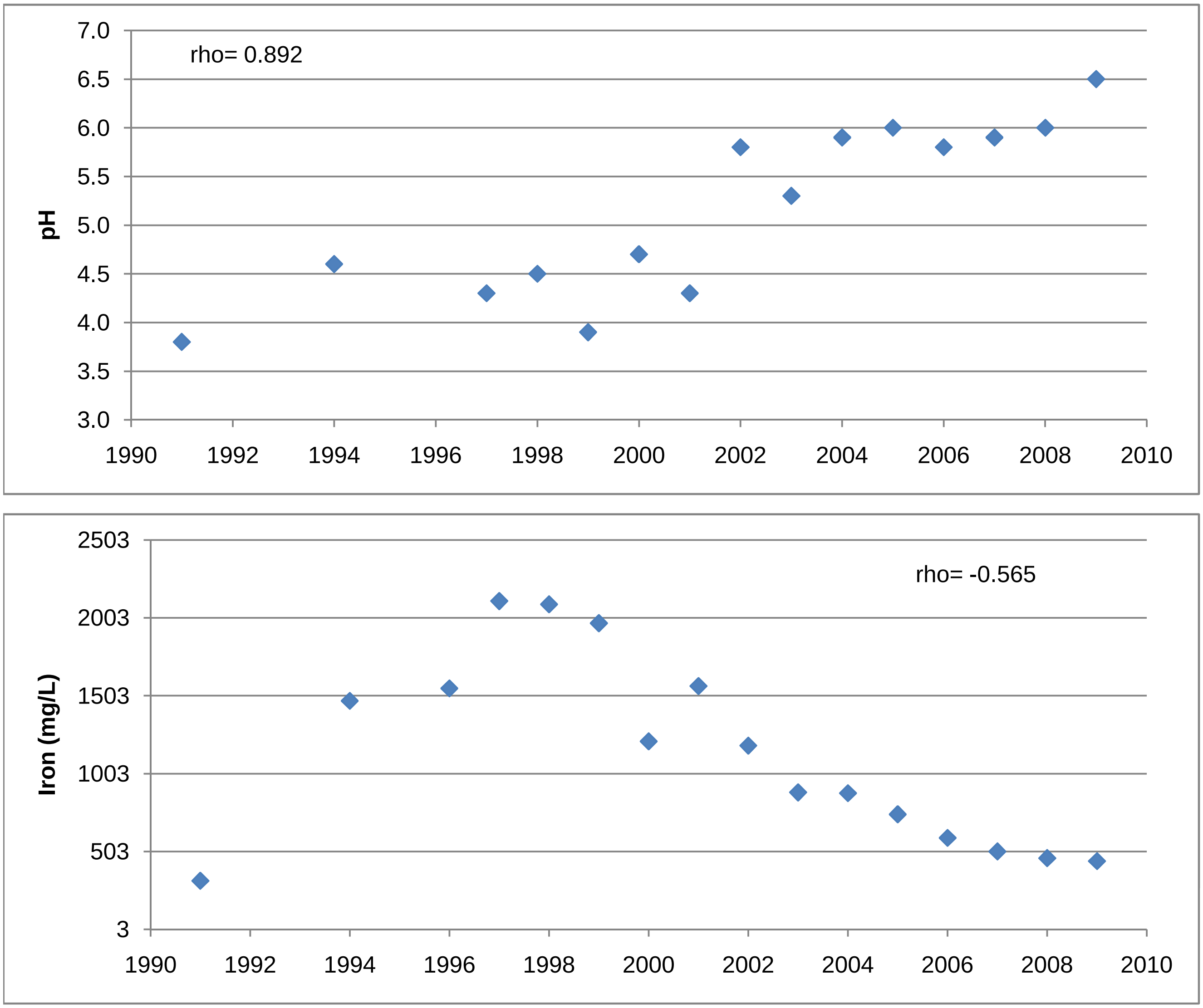


Appendix Figure C.1.6: Significant trends observed for sulphate at station BH91-D1B, 1991 to 2009.

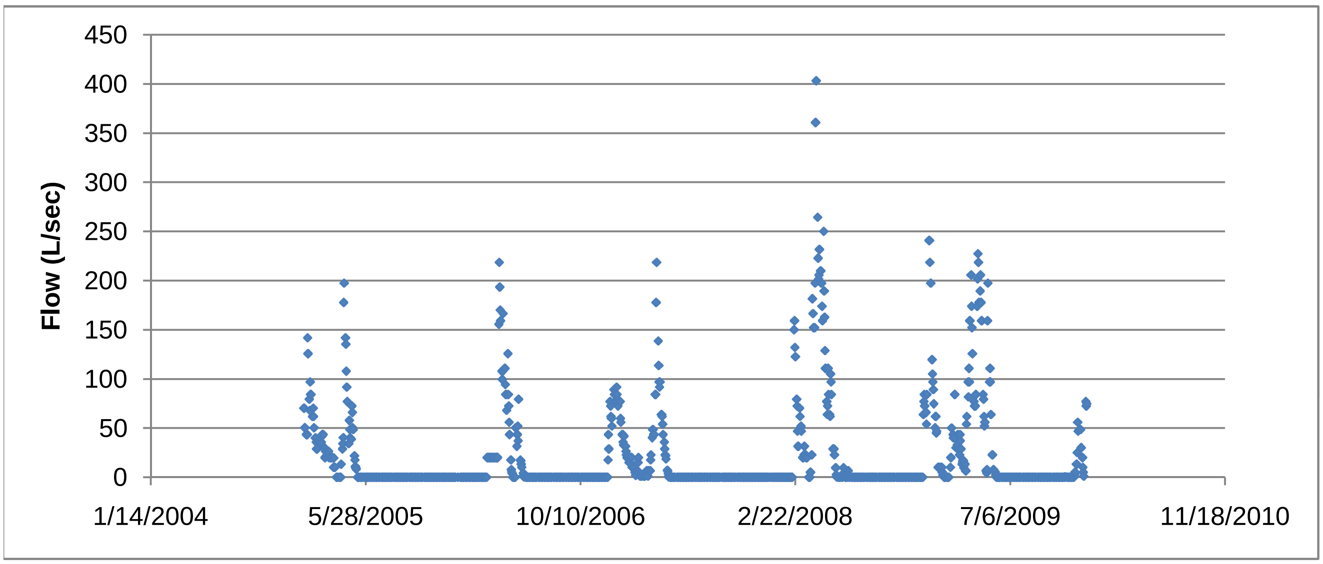




Appendix Figure C.1.7: Significant trends observed for pH and iron at station BH91-D3A, 1991 to 2009.



Appendix Figure C.1.8: Significant trends observed for pH and iron at station BH91-D3B, 1991 to 2009.



Appendix Figure C.1.9: Flow at station D-1 from 2005 to 2009.

APPENDIX C.2
Spanish American TMA

Appendix Table C.2.1: Water quality at station ECA-128 from 2005 to 2009.

Date	Ba (mg/L)	Co (mg/L)	Fe (mg/L)	Mn (mg/L)	pH	Ra (Bq/L)	SO4 (mg/L)	U (mg/L)
1/11/2005	0.026	0.00025	0.032	0.005	7.2	0.86	112	0.01
4/14/2005	0.007	0.0004	0.072	0.024	7.3	0.24	17.7	**0.005**
11/28/2005	0.034	0.00025	0.063	0.007	6.9	0.91	103	0.007
1/10/2006	0.032	0.00025	0.03	0.007	7.1	0.8	93	0.0068
4/18/2006	0.027	0.00025	0.15	0.033	7.4	0.95	56	0.00431
10/19/2006	0.031	0.00025	0.06	0.023	7.7	0.92	71	0.006
1/9/2007	0.028	0.0010	0.09	0.032	7.0	0.590	53.0	0.0044
4/10/2007	0.014	0.0006	0.34	0.035	7.2	0.320	21.0	0.0017
11/15/2007	0.032	0.00025	0.09	0.015	7.6	1.030	71.0	0.0065
1/17/2008	0.024	0.0012	0.13	0.045	6.7	0.590	46.0	0.0034
4/30/2008	0.035	0.00025	0.35	0.130	7.4	1.470	54.0	0.0052
7/8/2008	0.031	0.00025	0.05	0.017	8.3	0.820	54.0	0.005
11/19/2008	0.031	0.00025	0.04	0.009	7.5	0.990	64.0	0.0071
1/8/2009	0.032	0.0005	0.08	0.019	7.0	0.790	58.0	0.0058
5/7/2009	0.033	0.0006	0.30	0.109	7.3	1.300	39.0	0.0056
8/6/2009	0.033	0.00025	0.06	0.029	7.4	0.920	45.0	0.0046
10/14/2009	0.043	0.00025	0.05	0.010	7.2	1.000	52.0	0.0048
Number	17	17	17	17	17	17	17	17
Minimum	0.007	0.00025	0.03	0.005	6.7	0.24	17.7	0.0017
Maximum	0.043	0.0012	0.35	0.13	8.3	1.47	112	0.01
Mean	0.029	0.00041	0.12	0.032	7.3	0.853	59.4	0.0055
Median	0.031	0.00025	0.07	0.023	7.3	0.910	54.0	0.0052
10th Perc.	0.02	0.00025	0.04	0.007	7.0	0.482	31.8	0.0039

(shaded) Concentration below maximum MDL.

Bold concentrations not used in statistics due to abnormally high MDL.

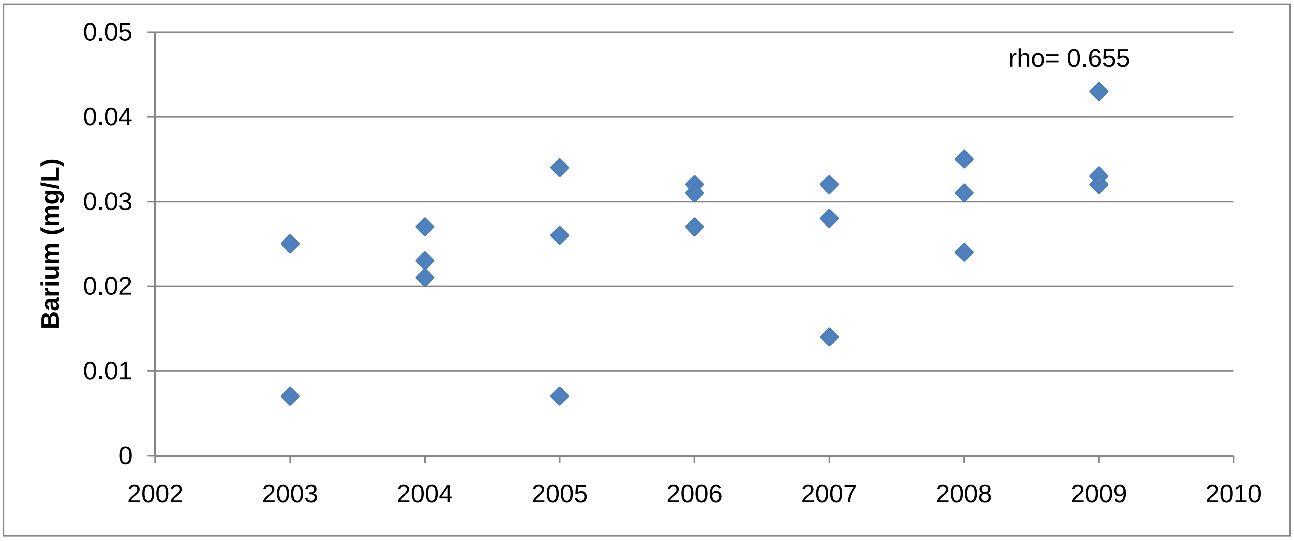
Appendix Table C.2.2: Summary of seasonal trends for station ECA-128, 2003 - 2009.

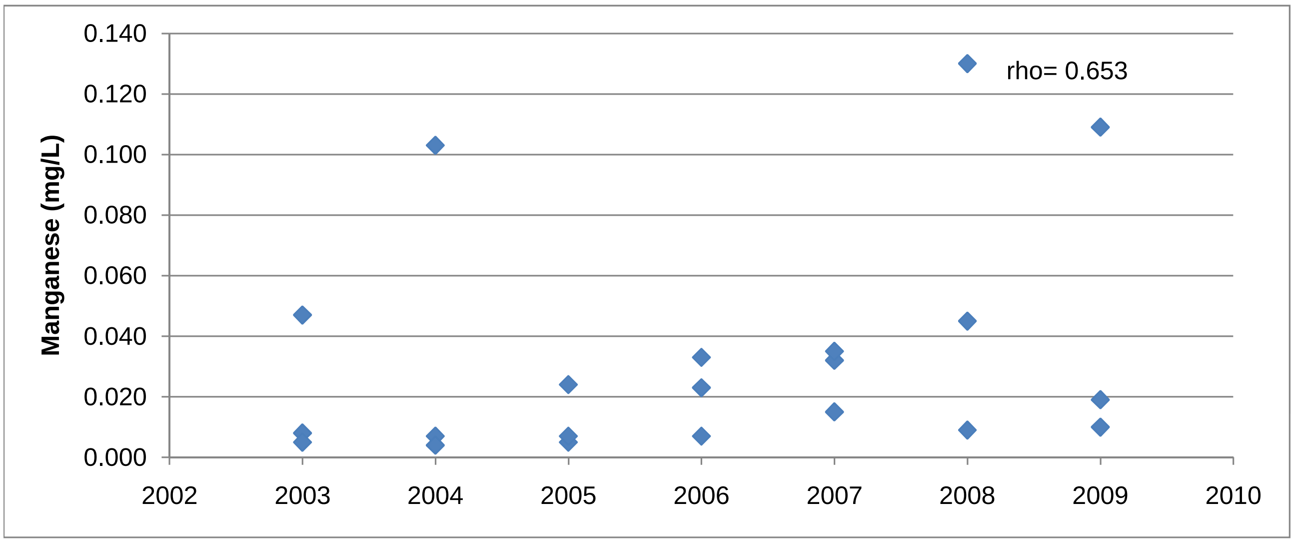
Season	Spearman rho	Ba	Co	Fe	Mn	pH	Ra-226	Sulphate	Uranium
January	Correlation Coefficient	0.487	-	0.541	0.613	-0.9009375	0.05405625	-0.892857143	-0.77480622
	Sig. (2-tailed)	0.268	-	0.210	0.144	0.0056206	0.90836528	0.006807187	0.040769463
	N	7	-	7	7	7	7	7	7
April/May	Correlation Coefficient	0.757	-0.112	0.536	0.703	0.1091089	0.78571429	0.214285714	0.036037499
	Sig. (2-tailed)	0.049	0.811	0.215	0.078	0.8158715	0.03623846	0.644511581	0.938860561
	N	7	7	7	7	7	7	7	7
October/November	Correlation Coefficient	0.721	-	-0.357	0.643	-0.6428571	0.89285714	-0.991031209	0.126131245
	Sig. (2-tailed)	0.068	-	0.432	0.119	0.1193924	0.00680719	1.45613E-05	0.787572159
	N	7	-	7	7	7	7	7	7

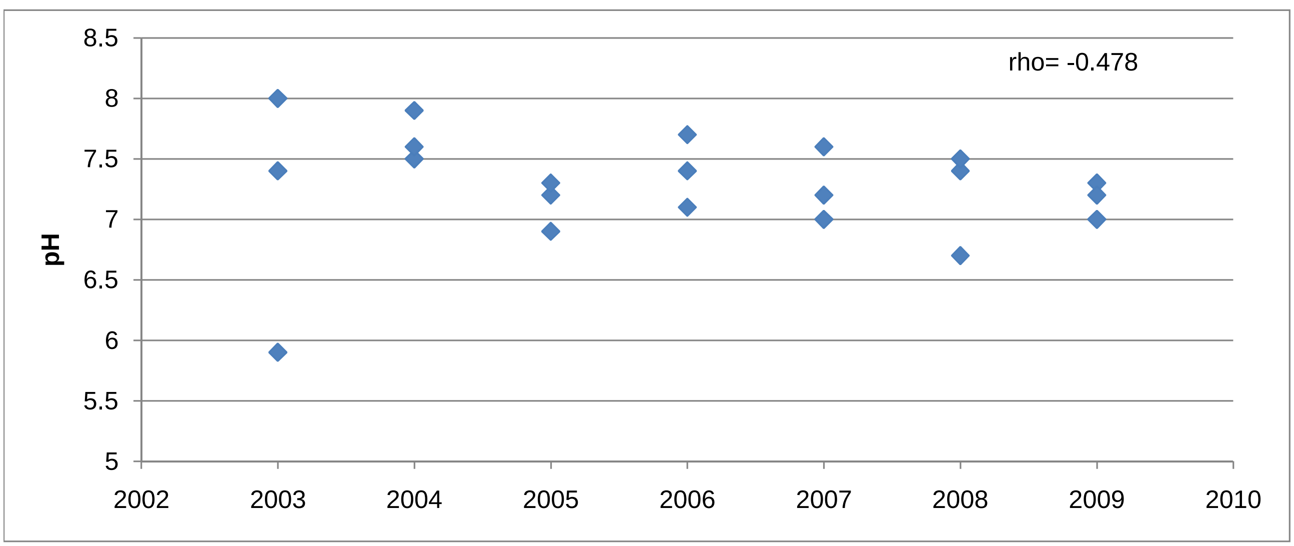
Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

"ns" denotes not significant.

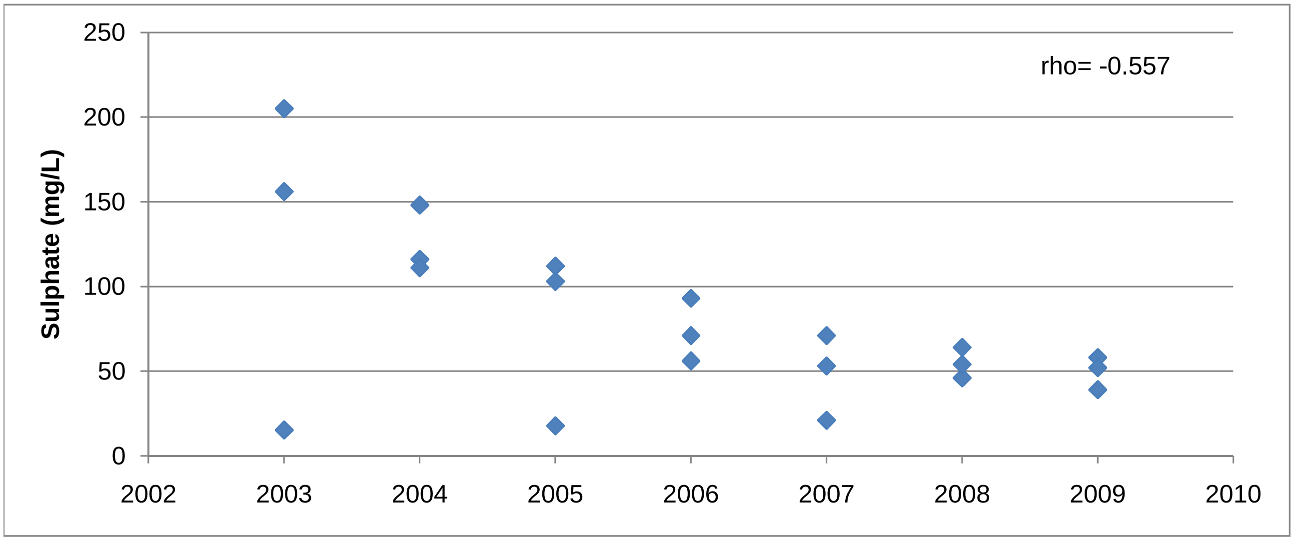
[shaded box] Significant trend where p<0.05.

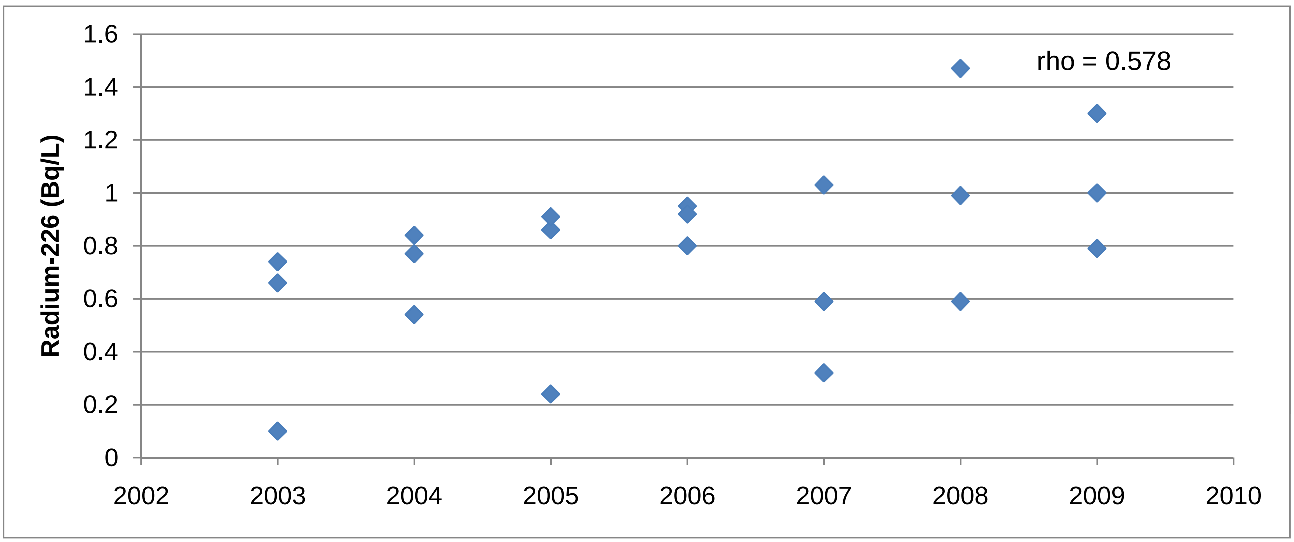




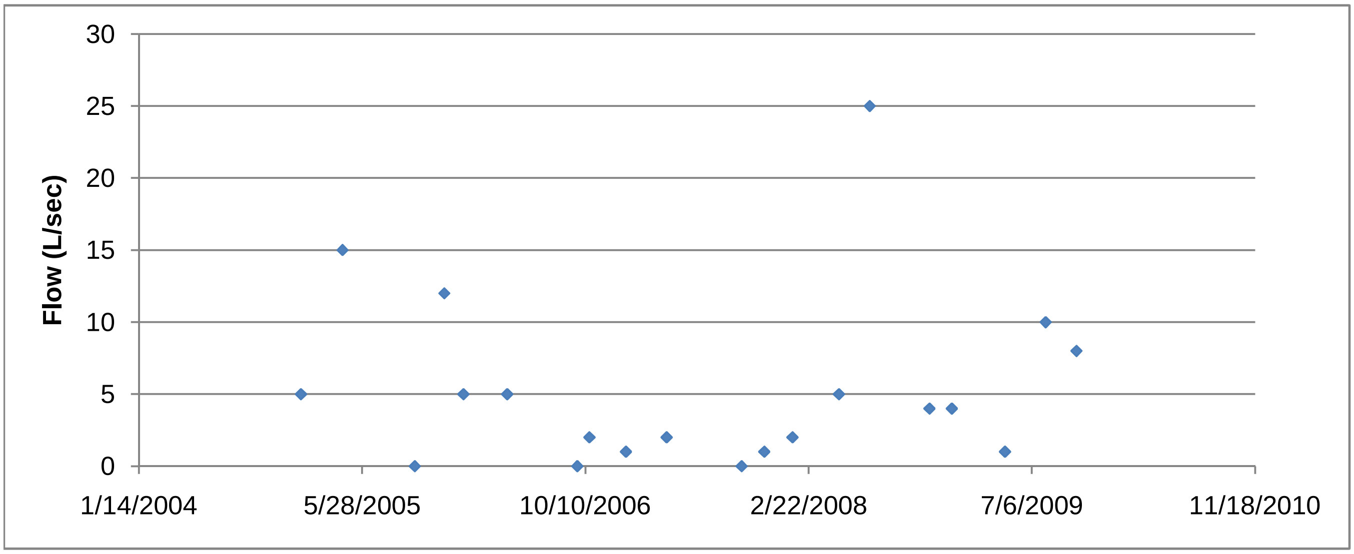


Appendix Figure C.2.1: Significant common (average) trends observed for barium, manganese, pH, sulphate and radium-226 over all seasons at station ECA-128, 2003 to 2009.





Appendix Figure C.2.1: Significant common (average) trends observed for barium, manganese, pH, sulphate and radium-226 over all seasons at station ECA-128, 2003 to 2009.



Appendix Figure C.2.2: Flow at station ECA-128 from 2005 to 2009.

APPENDIX C.3
Quirke TMA

Appendix Table C.3.1: Quirke final point of control discharge criteria (Q-28).

Parameter[f]	Units	Discharge Criteria			Action Level	Internal Investigation
		Grab Sample[a]	Monthly Mean[b,d]	Composite [e]		
pH	pH units	5.5-9.5	6.5-9.5	6.0-9.5	<6.5 or >8.5	<7.0 or >8.0
Total Suspended Solids	mg/L	50	25	37.5	30	7.5
Dissolved Radium-226[c,d,g]	Bq/L	1.11	0.37	0.74	0.37	0.20

[a]Samples to be collected during periods of discharge.
[b]Arithmetic mean of twelve consecutive samples.
[c]The radium-226 criteria are waived if total radium-226 average loading < 30 Bq/s.
[d] Discharge criteria are for dissolved radium-226, while measured and reported values are for total radium-226.
[e] Consists of 3 equal volumes collected at equal time intervals over a 7 to 24 hour period.
[f] Copper, lead, nickel and zinc monitoring discontinued in January 2010 as per regulatory approval of Cycle 3 design.
[g] Radium-226 criterion are waived if total radium-226 average annual loading is < 30 Bq/s.

Appendix Table C.3.2: Water quality at station Q-03 from 2005 to 2009.

Date	pH	Date	pH	Date	pH	Date	pH	Date	pH
1/3/2005	7.8	5/18/2005	7.8	10/5/2005	8.9	9/11/2006	8.6	7/14/2008	8.5
1/4/2005	7.8	5/19/2005	8	10/6/2005	8.9	9/18/2006	8.6	7/21/2008	8.6
1/5/2005	8	5/20/2005	7.9	10/7/2005	8.8	9/25/2006	8.3	7/28/2008	8.6
1/6/2005	7.6	5/24/2005	8.3	10/11/2005	8.7	10/2/2006	8.5	8/5/2008	8.7
1/7/2005	7.8	5/25/2005	8.3	10/12/2005	8.8	10/10/2006	8.6	8/11/2008	8.3
1/10/2005	7.8	5/26/2005	8.4	10/13/2005	8.7	10/16/2006	8.1	8/18/2008	8.5
1/11/2005	8	5/27/2005	8.2	10/14/2005	8.9	10/23/2006	8.5	8/25/2008	8.5
1/12/2005	8	5/30/2005	8.4	10/17/2005	8.4	10/30/2006	8.6	9/2/2008	8.4
1/13/2005	7.9	5/31/2005	8	10/18/2005	8.4	11/6/2006	8.5	9/8/2008	8.5
1/14/2005	7.9	6/1/2005	7.6	10/19/2005	8.5	11/13/2006	8.5	9/15/2008	8.6
1/17/2005	8.3	6/2/2005	7.6	10/20/2005	8.5	11/20/2006	8.7	9/22/2008	8.5
1/18/2005	8.3	6/3/2005	8.4	10/21/2005	8.6	11/27/2006	8.7	9/29/2008	8.8
1/19/2005	8.3	6/6/2005	8.6	10/24/2005	8.3	12/4/2006	8.5	10/6/2008	8.8
1/20/2005	8.6	6/7/2005	8.6	10/25/2005	8.3	12/11/2006	8.7	10/14/2008	8.6
1/21/2005	8.6	6/8/2005	8.5	10/26/2005	8.4	12/18/2006	7.1	10/20/2008	8.8
1/24/2005	8.2	6/9/2005	8.6	10/27/2005	8.2	12/27/2006	8.5	10/27/2008	8.3
1/25/2005	8.3	6/10/2005	8.6	10/28/2005	8.1	1/2/2007	8.2	11/3/2008	8.4
1/26/2005	8.3	6/13/2005	8.7	10/31/2005	8.5	1/8/2007	8.7	11/10/2008	8.7
1/27/2005	8.3	6/14/2005	8.7	11/1/2005	8.5	1/15/2007	8.6	11/17/2008	8.7
1/28/2005	8.2	6/15/2005	8.7	11/2/2005	8.5	1/22/2007	8.6	11/24/2008	8.9
1/31/2005	8.3	6/16/2005	8.7	11/3/2005	8.5	1/29/2007	8.4	12/1/2008	8.8
2/1/2005	8.3	6/17/2005	8.7	11/4/2005	8.6	2/5/2007	8.7	12/8/2008	8.5
2/2/2005	8.3	6/20/2005	8.7	11/7/2005	8.6	2/12/2007	8.8	12/15/2008	8.6
2/3/2005	8.3	6/21/2005	8.7	11/8/2005	8.6	2/19/2007	8.6	12/22/2008	8.8
2/4/2005	8.2	6/22/2005	8.5	11/9/2005	8.4	2/26/2007	8.4	12/29/2008	6.6
2/7/2005	8.5	6/23/2005	8.5	11/10/2005	8.3	3/5/2007	8.6	1/5/2009	8.5
2/8/2005	8.5	6/24/2005	8.5	11/11/2005	8.5	3/12/2007	8.6	1/12/2009	8.5
2/9/2005	8.5	6/27/2005	8.5	11/14/2005	8	3/19/2007	8.4	1/19/2009	8.6
2/10/2005	8.5	6/28/2005	8.6	11/15/2005	8.2	3/26/2007	8.7	1/26/2009	8.6
2/11/2005	8.5	6/29/2005	8.6	11/16/2005	8.2	4/2/2007	8.7	2/2/2009	8.6
2/14/2005	8.2	6/30/2005	8.6	11/17/2005	8.2	4/9/2007	8.7	2/9/2009	8.7
2/15/2005	8.3	7/4/2005	8.6	11/18/2005	8.2	4/16/2007	8.5	2/17/2009	8.7
2/16/2005	8.3	7/5/2005	8.6	11/21/2005	8.8	4/23/2007	8.3	2/23/2009	8.7
2/17/2005	8.3	7/6/2005	8.6	11/22/2005	8.8	4/30/2007	8.3	3/2/2009	8.7
2/18/2005	8.6	7/7/2005	8.6	11/23/2005	8.4	5/7/2007	8.4	3/9/2009	8.7
2/21/2005	8.7	7/8/2005	8.6	11/24/2005	8.6	5/14/2007	8.3	3/16/2009	8.7
2/22/2005	8.7	7/11/2005	8.7	11/25/2005	8.7	5/22/2007	8.6	3/23/2009	8.6
2/23/2005	8.7	7/12/2005	8.6	11/28/2005	8.5	5/28/2007	8.4	3/31/2009	8.5
2/24/2005	8.7	7/13/2005	8.5	11/29/2005	8.5	6/4/2007	8.5	4/6/2009	8.4
2/25/2005	8.7	7/14/2005	8.5	11/30/2005	8.5	6/11/2007	8.5	4/13/2009	8.5
2/28/2005	8.7	7/15/2005	8.4	12/1/2005	8.1	6/18/2007	8.6	4/20/2009	8.5
3/1/2005	8.7	7/18/2005	8.4	12/2/2005	8.1	6/25/2007	8.6	4/27/2009	8.2
3/2/2005	8.7	7/19/2005	8.4	12/5/2005	8	7/3/2007	8.6	5/4/2009	8.1
3/3/2005	8.6	7/20/2005	8.4	12/6/2005	8	7/9/2007	8.6	5/11/2009	8.5
3/4/2005	8.4	7/21/2005	8.4	12/7/2005	8.2	7/16/2007	8.6	5/19/2009	8.4
3/7/2005	8.3	7/22/2005	8.4	12/8/2005	8.1	7/23/2007	8.7	5/25/2009	8.5
3/8/2005	8.3	7/25/2005	8.4	12/9/2005	8.2	7/30/2007	8.7	6/1/2009	8.7
3/9/2005	8.7	7/26/2005	8.4	12/12/2005	8.4	8/7/2007	8.6	6/8/2009	8.6
3/10/2005	8.6	7/27/2005	8.5	12/13/2005	8.5	8/13/2007	8.8	6/15/2009	8.6
3/11/2005	8.6	7/28/2005	8.3	12/14/2005	8.4	8/20/2007	8.7	6/22/2009	8.5
3/14/2005	8.5	7/29/2005	8.3	12/15/2005	8.5	8/27/2007	8.7	6/29/2009	8.6
3/15/2005	8.5	8/2/2005	8.4	12/16/2005	8.5	9/4/2007	8.7	7/6/2009	8.6
3/16/2005	8.5	8/3/2005	8.4	12/19/2005	8.8	9/10/2007	8.7	7/13/2009	8.6
3/17/2005	8.6	8/4/2005	8.4	12/20/2005	8.8	9/17/2007	8.7	7/20/2009	8.6
3/18/2005	8.6	8/5/2005	8.4	12/21/2005	8.7	9/24/2007	8.7	7/27/2009	8.6
3/21/2005	8.7	8/8/2005	8.1	12/22/2005	8.8	10/1/2007	8.8	8/4/2009	8.5

Appendix Table C.3.2: Water quality at station Q-03 from 2005 to 2009.

Date	pH	Date	pH	Date	pH	Date	pH	Date	pH
3/22/2005	8.7	8/9/2005	8.1	12/23/2005	8.5	10/9/2007	8.8	8/10/2009	8.6
3/23/2005	8.7	8/10/2005	8.2	12/28/2005	8.7	10/15/2007	8.8	8/17/2009	8.5
3/24/2005	8.7	8/11/2005	8.2	12/29/2005	8.7	10/22/2007	8.8	8/24/2009	8.5
3/28/2005	8.2	8/12/2005	8.2	12/30/2005	8.6	10/29/2007	8.6	8/31/2009	8.8
3/29/2005	8.2	8/15/2005	8	1/3/2006	8.7	11/5/2007	8.3	9/8/2009	8.5
3/30/2005	8.3	8/16/2005	8	1/9/2006	8.5	11/12/2007	8.5	9/15/2009	8.3
3/31/2005	8	8/17/2005	8.1	1/16/2006	8.7	11/19/2007	8.7	9/21/2009	9.0
4/1/2005	7.9	8/18/2005	8.2	1/23/2006	8.4	11/26/2007	8.5	9/29/2009	8.9
4/4/2005	7.9	8/19/2005	8.5	1/30/2006	8.5	12/3/2007	8.5	10/5/2009	8.8
4/5/2005	8.6	8/22/2005	8.7	2/6/2006	8.7	12/10/2007	8.5	10/13/2009	8.9
4/6/2005	8.7	8/23/2005	8.7	2/13/2006	8.5	12/17/2007	8.6	10/19/2009	8.9
4/7/2005	8.4	8/24/2005	8.7	2/20/2006	8.4	12/24/2007	8.5	10/26/2009	8.6
4/8/2005	8.5	8/25/2005	8.8	2/27/2006	8.5	1/2/2008	8.6	11/2/2009	8.4
4/11/2005	8.3	8/26/2005	8.9	3/6/2006	8.5	1/7/2008	8.4	11/9/2009	8.4
4/12/2005	8.5	8/29/2005	8.5	3/13/2006	8.2	1/14/2008	8.0	11/16/2009	8.2
4/13/2005	8.7	8/30/2005	8.5	3/20/2006	8.2	1/21/2008	8.6	11/23/2009	8.5
4/14/2005	8.8	8/31/2005	8.6	3/27/2006	8.4	1/29/2008	8.1	11/30/2009	8.6
4/15/2005	8.8	9/1/2005	8.8	4/3/2006	7.8	2/4/2008	7.8	12/7/2009	8.0
4/18/2005	8.5	9/2/2005	8.8	4/10/2006	8.5	2/11/2008	8.5	12/14/2009	8.7
4/19/2005	8.1	9/6/2005	8.8	4/17/2006	8.1	2/19/2008	8.6	12/21/2009	8.5
4/20/2005	7.7	9/7/2005	8.8	4/24/2006	7.9	2/25/2008	8.3	12/29/2009	8.7
4/21/2005	7.7	9/8/2005	8.8	5/1/2006	7.8	3/3/2008	8.5	**Number**	461
4/22/2005	7.7	9/9/2005	8.8	5/8/2006	8	3/10/2008	8.6	**Minimum**	6.6
4/25/2005	8	9/12/2005	8.9	5/15/2006	8	3/17/2008	8.5	**Maximum**	9.0
4/26/2005	8	9/13/2005	8.8	5/23/2006	8.2	3/24/2008	8.5	**Mean**	8.5
4/27/2005	8.2	9/14/2005	8.8	5/29/2006	8.5	3/31/2008	8.0	**Median**	8.5
4/28/2005	8	9/15/2005	8.8	6/5/2006	8.6	4/7/2008	7.8	**10th Perc.**	8
4/29/2005	8.3	9/16/2005	8.9	6/12/2006	8.6	4/14/2008	8.5		
5/2/2005	8	9/19/2005	8.9	6/19/2006	8.6	4/21/2008	8.1		
5/3/2005	8	9/20/2005	8.9	6/26/2006	8.5	4/28/2008	8.3		
5/4/2005	8.4	9/21/2005	8.9	7/4/2006	8.3	5/5/2008	8.7		
5/5/2005	8	9/22/2005	8.9	7/10/2006	8.3	5/12/2008	8.5		
5/6/2005	8	9/23/2005	8.9	7/17/2006	8.3	5/20/2008	8.6		
5/9/2005	8.3	9/26/2005	8.8	7/24/2006	8.5	5/26/2008	8.6		
5/10/2005	8.5	9/27/2005	8.8	7/31/2006	8.4	6/2/2008	8.3		
5/11/2005	8.4	9/28/2005	8.8	8/8/2006	8.2	6/9/2008	8.7		
5/12/2005	8.2	9/29/2005	8.8	8/14/2006	8.2	6/16/2008	8.6		
5/13/2005	8.3	9/30/2005	8.7	8/21/2006	8.3	6/23/2008	8.5		
5/16/2005	7.8	10/3/2005	8.9	8/28/2006	8.6	7/2/2008	8.5		
5/17/2005	8	10/4/2005	8.9	9/5/2006	8.6	7/7/2008	8.5		

Appendix Table C.3.3: Water quality at station Q-04P from 2005 to 2009.

Date	pH	Date	pH	Date	pH	Date	pH	Date	pH	Date	pH	Date	pH	Date	pH	Date	pH	Date	pH	Date	pH	Date	pH	Date	pH	Date	pH
1/4/2005	9.4	5/19/2005	9.8	10/6/2005	10	2/23/2006	9.2	7/12/2006	9.6	11/28/2006	10	4/17/2007	9.5	9/4/2007	10.4	1/22/2008	9.4	6/9/2008	10.0	10/27/2008	10.3	3/16/2009	9.3	7/31/2009	10.4	12/17/2009	9.2
1/5/2005	9.2	5/20/2005	9.8	10/7/2005	9.9	2/24/2006	9.2	7/13/2006	9.4	11/29/2006	9.3	4/18/2007	9.5	9/5/2007	10.4	1/23/2008	9.4	6/10/2008	9.9	10/28/2008	10.3	3/17/2009	9.1	8/4/2009	10.3	12/18/2009	9.2
1/6/2005	9.2	5/24/2005	9.8	10/11/2005	10	2/27/2006	9.2	7/14/2006	9.2	11/30/2006	9.6	4/19/2007	8.3	9/6/2007	10.5	1/24/2008	9.4	6/11/2008	9.9	10/29/2008	10.2	3/18/2009	9.1	8/5/2009	10.3	12/21/2009	9.2
1/7/2005	9.3	5/25/2005	9.7	10/12/2005	9.9	2/28/2006	9.1	7/17/2006	9.4	12/1/2006	9.6	4/20/2007	9.6	9/7/2007	10.4	1/25/2008	9.3	6/12/2008	9.9	10/30/2008	10.2	3/19/2009	9.1	8/6/2009	10.2	12/22/2009	9.1
1/10/2005	9.3	5/26/2005	9.7	10/13/2005	10	3/1/2006	9.1	7/18/2006	9.4	12/4/2006	9.7	4/23/2007	9.6	9/10/2007	10.6	1/28/2008	9.3	6/13/2008	9.9	10/31/2008	10.2	3/20/2009	9.3	8/7/2009	10.3	12/23/2009	9.3
1/11/2005	9.3	5/27/2005	9.9	10/14/2005	10	3/2/2006	9.1	7/19/2006	9.4	12/5/2006	9.6	4/24/2007	9.7	9/11/2007	10.6	1/29/2008	9.3	6/16/2008	9.9	11/3/2008	10.2	3/23/2009	9.3	8/10/2009	10.2	12/24/2009	9.5
1/12/2005	9.3	5/30/2005	9.8	10/17/2005	10	3/3/2006	9.2	7/20/2006	9.4	12/6/2006	9.6	4/25/2007	9.6	9/12/2007	10.6	1/30/2008	9.2	6/17/2008	9.7	11/4/2008	10.4	3/24/2009	9.2	8/11/2009	10.2	12/29/2009	9.4
1/13/2005	9.3	5/31/2005	9.7	10/18/2005	10.1	3/6/2006	9.1	7/21/2006	9.4	12/7/2006	9.6	4/26/2007	9.9	9/13/2007	10.4	1/31/2008	9.3	6/18/2008	9.7	11/5/2008	10.4	3/25/2009	9.2	8/12/2009	10.0	12/30/2009	9.3
1/14/2005	9.3	6/1/2005	9.9	10/19/2005	10	3/7/2006	9.2	7/24/2006	9.5	12/8/2006	9.6	4/27/2007	9.9	9/14/2007	10.6	2/1/2008	9.1	6/19/2008	9.7	11/6/2008	10.3	3/26/2009	9.1	8/13/2009	9.9	12/31/2009	9.3
1/17/2005	9.3	6/2/2005	9.7	10/20/2005	10.2	3/8/2006	9.2	7/25/2006	9.4	12/11/2006	9.6	4/30/2007	9.7	9/17/2007	10.5	2/4/2008	9.1	6/20/2008	9.7	11/7/2008	10.3	3/27/2009	9.1	8/14/2009	9.7		
1/18/2005	9.3	6/3/2005	9.9	10/21/2005	10	3/9/2006	9.2	7/26/2006	9.3	12/12/2006	9.4	5/1/2007	9.7	9/18/2007	10.6	2/5/2008	9.1	6/23/2008	9.8	11/10/2008	10.3	3/30/2009	9.2	8/17/2009	9.8		
1/19/2005	9.3	6/6/2005	9.8	10/24/2005	9.8	3/10/2006	9.2	7/27/2006	9.4	12/13/2006	9.2	5/2/2007	9.8	9/19/2007	10.6	2/6/2008	9.1	6/24/2008	9.8	11/11/2008	10.3	3/31/2009	9.2	8/18/2009	9.9		
1/20/2005	9.3	6/7/2005	9.8	10/25/2005	10	3/13/2006	9.2	7/28/2006	10.5	12/14/2006	8.9	5/3/2007	9.8	9/20/2007	10.6	2/7/2008	9.2	6/25/2008	9.8	11/12/2008	10.1	4/1/2009	9.4	8/19/2009	9.8		
1/21/2005	9.3	6/8/2005	9.8	10/26/2005	10	3/14/2006	9.2	7/31/2006	10.4	12/15/2006	8.8	5/4/2007	9.8	9/21/2007	10.6	2/8/2008	9.2	6/26/2008	9.8	11/13/2008	10.1	4/2/2009	9.3	8/20/2009	9.9		
1/24/2005	9.2	6/9/2005	9.9	10/27/2005	9.9	3/15/2006	9.2	8/1/2006	10.4	12/18/2006	8.9	5/7/2007	9.7	9/24/2007	10.6	2/11/2008	9.3	6/27/2008	9.8	11/14/2008	10.1	4/3/2009	9.1	8/21/2009	9.9		
1/25/2005	9.2	6/10/2005	9.9	10/28/2005	9.8	3/16/2006	9.2	8/2/2006	9.3	12/19/2006	8.9	5/8/2007	10.6	9/25/2007	10.6	2/12/2008	9.2	7/1/2008	9.8	11/17/2008	10.1	4/6/2009	9.3	8/24/2009	9.9		
1/26/2005	9.2	6/13/2005	9.9	10/31/2005	10	3/17/2006	9.2	8/3/2006	9.2	12/20/2006	9	5/9/2007	10.5	9/26/2007	10.6	2/13/2008	9.2	7/2/2008	9.8	11/18/2008	10.1	4/7/2009	9.2	8/25/2009	9.8		
1/27/2005	9.2	6/14/2005	9.8	11/1/2005	10.1	3/20/2006	9.2	8/4/2006	9.2	12/21/2006	9	5/10/2007	10.5	9/27/2007	10.7	2/14/2008	9.2	7/3/2008	9.8	11/19/2008	10.1	4/8/2009	9.3	8/26/2009	9.9		
1/28/2005	9.2	6/15/2005	9.8	11/2/2005	10.1	3/21/2006	9.3	8/8/2006	9.3	12/22/2006	9	5/11/2007	10.5	9/28/2007	10.7	2/15/2008	9.1	7/4/2008	9.8	11/20/2008	10.1	4/9/2009	9.3	8/27/2009	9.9		
1/31/2005	9.2	6/16/2005	9.8	11/3/2005	10.1	3/22/2006	9.3	8/9/2006	9.1	12/27/2006	9	5/14/2007	10.4	10/1/2007	10.7	2/19/2008	9.1	7/7/2008	9.7	11/21/2008	9.9	4/13/2009	9.3	8/28/2009	9.9		
2/1/2005	9.3	6/17/2005	9.8	11/4/2005	10.1	3/23/2006	9.3	8/10/2006	9.1	12/28/2006	8.9	5/15/2007	10.3	10/2/2007	10.7	2/20/2008	9.2	7/8/2008	9.8	11/24/2008	9.8	4/14/2009	9.4	8/31/2009	10.0		
2/2/2005	9.3	6/20/2005	9.8	11/7/2005	10	3/24/2006	9.1	8/11/2006	9.1	12/29/2006	8.9	5/16/2007	10.2	10/3/2007	10.7	2/21/2008	9.2	7/9/2008	9.8	11/25/2008	9.6	4/15/2009	9.3	9/1/2009	10.0		
2/3/2005	9.3	6/21/2005	9.8	11/8/2005	10	3/27/2006	9.1	8/14/2006	9.1	1/2/2007	9.0	5/17/2007	10.5	10/4/2007	10.7	2/22/2008	9.2	7/10/2008	9.8	11/26/2008	9.5	4/16/2009	9.3	9/2/2009	9.9		
2/4/2005	9.2	6/22/2005	9.8	11/9/2005	10	3/28/2006	9.1	8/15/2006	9.1	1/3/2007	8.9	5/18/2007	10.5	10/5/2007	10.7	2/25/2008	9.1	7/11/2008	9.8	11/27/2008	9.6	4/17/2009	9.3	9/3/2009	9.7		
2/7/2005	9.2	6/23/2005	9.8	11/10/2005	10	3/29/2006	9.1	8/16/2006	9	1/4/2007	9.6	5/22/2007	10.5	10/9/2007	10.6	2/26/2008	9.2	7/14/2008	9.8	11/28/2008	9.5	4/20/2009	9.4	9/4/2009	9.7		
2/8/2005	9.3	6/24/2005	9.8	11/11/2005	10.1	3/30/2006	9	8/17/2006	9.2	1/5/2007	9.7	5/23/2007	10.5	10/10/2007	10.5	2/27/2008	9.2	7/15/2008	9.8	12/1/2008	9.3	4/21/2009	9.4	9/8/2009	9.7		
2/9/2005	9.3	6/27/2005	9.8	11/14/2005	10	3/31/2006	9.3	8/18/2006	9.1	1/8/2007	9.7	5/24/2007	10.3	10/11/2007	10.6	2/28/2008	9.1	7/16/2008	9.8	12/2/2008	9.2	4/22/2009	9.3	9/9/2009	9.6		
2/10/2005	9.3	6/28/2005	9.8	11/15/2005	10	4/3/2006	9.2	8/21/2006	9.1	1/9/2007	9.3	5/25/2007	10.3	10/12/2007	10.6	2/29/2008	9.0	7/17/2008	9.8	12/3/2008	9.4	4/23/2009	9.3	9/10/2009	9.8		
2/11/2005	9.3	6/29/2005	9.8	11/16/2005	10	4/4/2006	9.2	8/22/2006	9.1	1/10/2007	9.4	5/28/2007	10.3	10/15/2007	10.7	3/3/2008	9.1	7/18/2008	9.8	12/4/2008	9.3	4/24/2009	8.2	9/11/2009	9.8		
2/14/2005	9.3	6/30/2005	9.8	11/17/2005	10	4/5/2006	9.2	8/23/2006	9.1	1/11/2007	9.3	5/29/2007	10.4	10/16/2007	10.7	3/4/2008	9.2	7/21/2008	9.8	12/5/2008	9.2	4/27/2009	9.3	9/14/2009	9.8		
2/15/2005	9.3	7/4/2005	9.8	11/18/2005	10	4/6/2006	9.2	8/24/2006	9.1	1/12/2007	9.3	5/30/2007	10.4	10/17/2007	10.7	3/5/2008	9.2	7/22/2008	9.8	12/8/2008	9.4	4/28/2009	9.3	9/15/2009	9.8		
2/16/2005	9.2	7/5/2005	9.7	11/21/2005	10	4/7/2006	9.2	8/25/2006	10.3	1/15/2007	9.3	5/31/2007	10.2	10/18/2007	10.7	3/6/2008	9.2	7/23/2008	9.8	12/9/2008	9.4	4/29/2009	9.3	9/16/2009	9.8		
2/17/2005	9.7	7/6/2005	9.7	11/22/2005	9.7	4/10/2006	9.2	8/28/2006	10.2	1/16/2007	9.3	6/1/2007	10.2	10/19/2007	10.6	3/7/2008	9.1	7/24/2008	9.8	12/10/2008	9.3	4/30/2009	9.4	9/17/2009	9.8		
2/18/2005	9.7	7/7/2005	9.7	11/23/2005	9.7	4/11/2006	9.2	8/29/2006	10.5	1/17/2007	9.3	6/4/2007	10.2	10/22/2007	10.7	3/10/2008	9.1	7/25/2008	9.8	12/11/2008	9.4	5/1/2009	9.5	9/18/2009	10.1		
2/21/2005	9.6	7/8/2005	9.8	11/24/2005	9.5	4/12/2006	9.4	8/30/2006	10.6	1/18/2007	9.3	6/5/2007	10.3	10/23/2007	10.3	3/11/2008	9.1	7/28/2008	9.8	12/12/2008	9.4	5/4/2009	9.2	9/21/2009	10.1		
2/22/2005	9.4	7/11/2005	9.8	11/25/2005	9.3	4/13/2006	9.3	8/31/2006	10.6	1/19/2007	9.3	6/6/2007	10.5	10/24/2007	9.7	3/12/2008	9.2	7/29/2008	9.8	12/15/2008	9.4	5/5/2009	9.5	9/22/2009	10.1		
2/23/2005	9.4	7/12/2005	10	11/28/2005	9.3	4/17/2006	9.4	9/1/2006	10.6	1/22/2007	9.4	6/7/2007	10.4	10/25/2007	9.5	3/13/2008	9.1	7/30/2008	9.8	12/16/2008	9.4	5/6/2009	9.4	9/23/2009	9.9		
2/24/2005	9.4	7/13/2005	10.2	11/29/2005	9.3	4/18/2006	9.4	9/5/2006	10.1	1/23/2007	9.3	6/8/2007	10.4	10/26/2007	9.4	3/14/2008	9.1	7/31/2008	9.8	12/17/2008	9.1	5/7/2009	9.4	9/24/2009	10.1		
2/25/2005	9.4	7/14/2005	10.2	11/30/2005	9.3	4/19/2006	9.4	9/6/2006	10.2	1/24/2007	9.3	6/11/2007	10.4	10/29/2007	9.4	3/17/2008	9.2	8/1/2008	9.8	12/18/2008	9.2	5/8/2009	9.4	9/25/2009	10.0		
2/28/2005	9.4	7/15/2005	10.3	12/1/2005	9.3	4/20/2006	9.5	9/7/2006	10.1	1/25/2007	9.3	6/12/2007	10.4	10/30/2007	9.4	3/18/2008	9.0	8/5/2008	9.8	12/19/2008	9.3	5/11/2009	9.5	9/28/2009	10.1		
3/1/2005	9.2	7/18/2005	10.3	12/2/2005	9.4	4/21/2006	9.4	9/8/2006	10	1/26/2007	9.2	6/13/2007	10.4	10/31/2007	9.2	3/19/2008	9.1	8/6/2008	9.8	12/22/2008	9.3	5/12/2009	9.5	9/29/2009	10.2		
3/2/2005	9.2	7/19/2005	10.2	12/5/2005	9.2	4/24/2006	9.4	9/11/2006	10.1	1/29/2007	9.1	6/14/2007	10.4	11/1/2007	9.2	3/20/2008	9.2	8/7/2008	9.8	12/23/2008	9.2	5/13/2009	9.5	9/30/2009	9.9		
3/3/2005	9.2	7/20/2005	10.3	12/6/2005	9.3	4/25/2006	9.4	9/12/2006	10.1	1/30/2007	9.2	6/15/2007	10.3	11/2/2007	9.3	3/24/2008	9.1	8/8/2008	9.6	12/24/2008	9.2	5/14/2009	9.6	10/1/2009	10.0		
3/4/2005	9.2	7/21/2005	10.3	12/7/2005	9.3	4/26/2006	9.4	9/13/2006	10.2	1/31/2007	9.2	6/18/2007	10.4	11/5/2007	9.5	3/25/2008	9.1	8/11/2008	9.8	12/29/2008	8.7	5/15/2009	9.6	10/2/2009	10.0		
3/7/2005	9.2	7/22/2005	10.3	12/8/2005	9.4	4/27/2006	9.4	9/14/2006	9.8	2/1/2007	9.3	6/19/2007	10.4	11/6/2007	9.6	3/26/2008	9.0	8/12/2008	9.5	12/30/2008	9.2	5/19/2009	9.7	10/5/2009	9.9		
3/8/2005	9.4	7/25/2005	10.3	12/9/2005	9.4	4/28/2006	9.4	9/15/2006	10.1	2/2/2007	9.3	6/20/2007	10.3	11/7/2007	9.5	3/27/2008	9.1	8/13/2008	9.7	12/31/2008	9.2	5/20/2009	9.6	10/6/2009	9.9		
3/9/2005	9.3	7/26/2005	10.3	12/12/2005	9.4	5/1/2006	9.4	9/18/2006	10.4	2/5/2007	9.4	6/21/2007	10.3	11/8/2007	9.7	3/28/2008	9.1	8/14/2008	9.6	1/2/2009	9.0	5/21/2009	9.5	10/7/2009	10.0		
3/10/2005	9.3	7/27/2005	10.3	12/13/2005	9.3	5/2/2006	9.4	9/19/2006	10.1	2/6/2007	9.3	6/22/2007	10.5	11/9/2007	9.5	3/31/2008	9.1	8/15/2008	9.5	1/5/2009	9.1	5/22/2009	9.5	10/8/2009	9.8		
3/11/2005	9.3	7/28/2005	10.4	12/14/2005	9.3	5/3/2006	9.4	9/20/2006	10.7	2/7/2007	9.3	6/25/2007	10.5	11/12/2007	9.5	4/1/2008	9.1	8/18/2008	9.6	1/6/2009	9.1	5/25/2009	9.5	10/9/2009	9.9		
3/14/2005	9.2	7/29/2005	10.2	12/15/2005	9.2	5/4/2006	9.5	9/21/2006	10.7	2/8/2007	9.4	6/26/2007	10.3	11/13/2007	9.5	4/2/2008	9.1	8/19/2008	9.7	1/7/2009	9.0	5/26/2009	9.6	10/13/2009	10.0		
3/15/2005	9.3	8/2/2005	10.3	12/16/2005	9.2	5/5/2006	9.5	9/22/2006	10.8	2/9/2007	9.2	6/27/2007	10.5	11/14/2007	9.5	4/3/2008	9.1	8/20/2008	9.7	1/8/2009	9.1	5/27/2009	9.5	10/14/2009	10.0		
3/16/2005	9.3	8/3/2005	10.3	12/19/2005	9.2	5/8/2006	9.6	9/25/2006	10	2/12/2007	9.3	6/28/2007	10.6	11/15/2007	9.5	4/4/2008	9.1	8/21/2008	9.7	1/9/2009	9.1	5/28/2009	9.6	10/15/2009	10.0		
3/17/2005	9.3	8/4/2005	10.3	12/20/2005	9.3	5/9/2006	9.6	9/26/2006	10.8	2/13/2007	9.2	6/29/2007	10.7	11/16/2007	9.4	4/7/2008	9.1	8/22/2008	9.6	1/12/2009	9.1	5/29/2009	9.5	10/16/2009	9.9		
3/18/2005	9.2	8/5/2005	10.3	12/21/2005	9.3	5/10/2006	9.6	9/27/2006	10.6	2/14/2007	9.2	7/3/2007	10.4	11/19/2007	9.6	4/8/2008	9.4	8/25/2008	9.6	1/13/2009	9.1	6/1/2009	9.6	10/19/2009	10.5		
3/21/2005	9.2	8/8/2005	10.3	12/22/2005	9.3	5/11/2006	9.6	9/28/2006	10.8	2/15/2007	9.2	7/4/2007	10.4	11/20/2007	9.3	4/9/2008	9.3	8/26/2008	9.5	1/14/2009	9.1	6/2/2009	9.6	10/20/2009	10.5		
3/22/2005	9.2	8/9/2005	10.4	12/23/2005	9.3	5/12/2006	9.7	9/29/2006	10.8	2/16/2007	9.3	7/5/2007	10.5	11/21/2007	9.4	4/10/2008	9.3	8/27/2008	9.5	1/15/2009	9.1	6/3/2009	9.6	10/21/2009	9.9		
3/23/2005	9.1	8/10/2005	10.2	12/28/2005	9.4	5/15/2006	9.7	10/2/2006	10.8	2/19/2007	9.3	7/6/2007	10.5	11/22/2007	9.4	4/11/2008	9.3	8/28/2008	9.5	1/16/2009	9.2	6/4/2009	9.6	10/22/2009	10.0		
3/24/2005	9.2	8/11/2005	10.6	12/29/2005	9.3	5/16/2006	9.7	10/3/2006	10.8	2/20/2007	9.3	7/9/2007	10.4	11/23/2007	9.4	4/14/2008	9.4	8/29/2008	9.6	1/19/2009	9.1	6/5/2009	9.6	10/23/2009	10.0		
3/28/2005	9.2	8/12/2005	10.5	12/30/2005	9.3	5/17/2006	9.7	10/4/2006	10.8	2/21/2007	9.3	7/10/2007	10.5	11/26/2007	9.4	4/15/2008	9.4	9/2/2008	9.6	1/20/2009	8.8	6/8/2009	9.6	10/26/2009	10.0		
3/29/2005	9.3	8/15/2005	10.8	1/3/2006	9.3	5/18/2006	9.7	10/5/2006	10.8	2/22/2007	9.3	7/11/2007	10.4	11/27/2007	9.3	4/16/2008	9.4	9/3/2008	9.5	1/21/2009	9.0	6/9/2009	9.7	10/27/2009	10.0		
3/30/2005	9.2	8/16/2005	10.8	1/4/2006	9.3	5/19/2006	9.7	10/6/2006	10.8	2/23/2007	9.3	7/12/2007	10.5	11/28/2007	9.3	4/17/2008	9.4	9/4/2008	9.5	1/22/2009	8.9	6/10/2009	9.7	10/28/2009	10.0		

Appendix Table C.3.3: Water quality at station Q-04P from 2005 to 2009.

Date	pH	Date	pH	Date	pH	Date	pH	Date	pH	Date	pH	Date	pH	Date	pH	Date	pH	Date	pH	Date	pH	Date	pH	Date	pH	Date	pH
3/31/2005	9.3	8/17/2005	10.8	1/5/2006	9.4	5/23/2006	9.7	10/10/2006	10.6	2/26/2007	9.3	7/13/2007	10.5	11/29/2007	9.2	4/18/2008	9.4	9/5/2008	9.6	1/23/2009	9.0	6/11/2009	9.7	10/29/2009	10.0		
4/1/2005	9.5	8/18/2005	10.8	1/6/2006	9.3	5/24/2006	9.7	10/11/2006	10.7	2/27/2007	9.3	7/16/2007	10.5	11/30/2007	9.3	4/21/2008	9.4	9/8/2008	9.7	1/26/2009	9.1	6/12/2009	9.6	10/30/2009	9.9		
4/4/2005	9.5	8/19/2005	10.8	1/9/2006	9.3	5/25/2006	9.7	10/12/2006	10.6	2/28/2007	9.3	7/17/2007	10.3	12/3/2007	9.3	4/22/2008	9.5	9/9/2008	9.7	1/27/2009	9.0	6/15/2009	9.5	11/2/2009	9.9	**Number**	1257
4/5/2005	9.5	8/22/2005	10.9	1/10/2006	9.3	5/26/2006	9.7	10/13/2006	10.6	3/1/2007	9.3	7/18/2007	10.5	12/4/2007	9.3	4/23/2008	9.5	9/10/2008	9.7	1/28/2009	9.0	6/16/2009	9.5	11/3/2009	9.9	**Minimum**	8.2
4/6/2005	9.5	8/23/2005	10.8	1/11/2006	9.3	5/29/2006	9.7	10/16/2006	10.7	3/2/2007	9.3	7/19/2007	10.5	12/5/2007	9.2	4/24/2008	9.8	9/11/2008	9.7	1/29/2009	9.0	6/17/2009	9.5	11/4/2009	9.9	**Maximum**	11.2
4/7/2005	9.5	8/24/2005	10.8	1/12/2006	9.2	5/30/2006	9.7	10/17/2006	10.8	3/5/2007	9.3	7/20/2007	10.4	12/6/2007	9.1	4/25/2008	9.7	9/12/2008	9.6	1/30/2009	9.0	6/18/2009	9.6	11/5/2009	9.9	**Mean**	9.7
4/8/2005	9.5	8/25/2005	10.8	1/13/2006	9.2	5/31/2006	9.7	10/18/2006	10.8	3/6/2007	9.3	7/23/2007	10.6	12/7/2007	9.1	4/28/2008	9.7	9/15/2008	9.7	2/2/2009	9.0	6/19/2009	9.6	11/6/2009	9.5	**Median**	9.6
4/11/2005	9.6	8/26/2005	10.8	1/16/2006	9.3	6/1/2006	9.7	10/19/2006	10.8	3/7/2007	9.2	7/24/2007	10.6	12/10/2007	9.4	4/29/2008	9.6	9/16/2008	9.7	2/3/2009	9.0	6/22/2009	9.5	11/9/2009	9.5	**10th Perc.**	9.2
4/12/2005	9.7	8/29/2005	10.8	1/17/2006	9.3	6/2/2006	9.7	10/20/2006	10.8	3/8/2007	9.2	7/25/2007	10.6	12/11/2007	9.0	4/30/2008	9.6	9/17/2008	9.7	2/4/2009	9.1	6/23/2009	9.5	11/10/2009	9.4		
4/13/2005	9.6	8/30/2005	10.9	1/18/2006	9.2	6/5/2006	9.7	10/23/2006	10.6	3/9/2007	9.2	7/26/2007	10.6	12/12/2007	9.1	5/1/2008	9.7	9/18/2008	9.7	2/5/2009	9.3	6/24/2009	10.2	11/11/2009	9.3		
4/14/2005	9.6	8/31/2005	10.9	1/19/2006	9.2	6/6/2006	9.7	10/24/2006	10.7	3/12/2007	9.2	7/27/2007	10.6	12/13/2007	9.1	5/2/2008	9.9	9/19/2008	9.8	2/6/2009	9.2	6/25/2009	10.2	11/12/2009	9.3		
4/15/2005	9.6	9/1/2005	10.9	1/20/2006	9.3	6/7/2006	9.7	10/25/2006	10.6	3/13/2007	9.2	7/30/2007	10.6	12/14/2007	9.0	5/5/2008	9.6	9/22/2008	9.7	2/9/2009	9.1	6/26/2009	10.3	11/13/2009	9.3		
4/18/2005	9.6	9/2/2005	10.9	1/23/2006	9.3	6/8/2006	9.7	10/26/2006	10.7	3/14/2007	9.2	7/31/2007	10.6	12/17/2007	9.2	5/6/2008	9.5	9/23/2008	10.1	2/10/2009	9.0	6/29/2009	10.3	11/16/2009	9.3		
4/19/2005	9.7	9/6/2005	11.2	1/24/2006	9.3	6/9/2006	9.7	10/27/2006	10.6	3/15/2007	9.2	8/1/2007	10.4	12/18/2007	9.0	5/7/2008	9.4	9/24/2008	10.1	2/11/2009	9.0	6/30/2009	10.3	11/17/2009	9.4		
4/20/2005	9.7	9/7/2005	10.9	1/25/2006	9.3	6/12/2006	9.6	10/30/2006	10.4	3/16/2007	9.2	8/2/2007	10.5	12/19/2007	9.0	5/8/2008	9.4	9/25/2008	10.0	2/12/2009	9.3	7/2/2009	10.4	11/18/2009	9.4		
4/21/2005	9.7	9/8/2005	10.7	1/26/2006	9.3	6/13/2006	9.6	10/31/2006	10.4	3/19/2007	9.2	8/3/2007	10.5	12/20/2007	9.0	5/9/2008	9.4	9/26/2008	10.1	2/13/2009	9.0	7/3/2009	10.2	11/19/2009	9.3		
4/22/2005	9.6	9/9/2005	10.6	1/27/2006	9.3	6/14/2006	9.7	11/1/2006	10.3	3/20/2007	9.2	8/7/2007	10.4	12/21/2007	9.0	5/12/2008	9.4	9/29/2008	10.0	2/17/2009	9.2	7/6/2009	10.2	11/20/2009	9.4		
4/25/2005	9.7	9/12/2005	10.6	1/30/2006	9.3	6/15/2006	9.6	11/2/2006	10.4	3/21/2007	9.3	8/8/2007	10.4	12/24/2007	9.1	5/13/2008	9.3	9/30/2008	10.0	2/18/2009	9.2	7/7/2009	10.3	11/23/2009	9.4		
4/26/2005	9.7	9/13/2005	10.6	1/31/2006	9.2	6/16/2006	9.7	11/3/2006	10.4	3/22/2007	9.3	8/9/2007	10.4	12/27/2007	9.3	5/14/2008	9.4	10/1/2008	10.2	2/19/2009	9.4	7/8/2009	10.3	11/24/2009	9.4		
4/27/2005	9.7	9/14/2005	10.6	2/1/2006	9.3	6/19/2006	9.7	11/6/2006	10.4	3/23/2007	9.3	8/10/2007	10.3	12/28/2007	9.5	5/15/2008	9.5	10/2/2008	10.4	2/20/2009	9.3	7/9/2009	10.2	11/25/2009	9.2		
4/28/2005	9.7	9/15/2005	10.6	2/2/2006	9.3	6/20/2006	9.6	11/7/2006	8.7	3/26/2007	9.4	8/13/2007	10.6	12/31/2007	9.3	5/16/2008	9.5	10/3/2008	10.3	2/23/2009	9.3	7/10/2009	10.2	11/26/2009	9.4		
4/29/2005	9.7	9/16/2005	10.7	2/3/2006	9.2	6/21/2006	9.7	11/8/2006	10.4	3/27/2007	9.4	8/14/2007	10.6	1/2/2008	9.3	5/20/2008	9.5	10/6/2008	10.4	2/24/2009	9.2	7/13/2009	10.2	11/27/2009	9.4		
5/2/2005	9.6	9/19/2005	10.7	2/6/2006	9.2	6/22/2006	9.7	11/9/2006	10.4	3/28/2007	9.4	8/15/2007	10.5	1/3/2008	9.5	5/21/2008	9.3	10/7/2008	10.4	2/25/2009	9.2	7/14/2009	10.2	11/30/2009	9.3		
5/3/2005	9.6	9/20/2005	10.7	2/7/2006	9.2	6/23/2006	9.9	11/10/2006	10.3	3/29/2007	9.4	8/16/2007	10.5	1/4/2008	9.3	5/22/2008	9.3	10/8/2008	10.4	2/26/2009	9.2	7/15/2009	10.2	12/1/2009	9.2		
5/4/2005	9.6	9/21/2005	10.7	2/8/2006	9.2	6/26/2006	9.9	11/13/2006	10.3	3/30/2007	9.5	8/17/2007	10.6	1/7/2008	9.1	5/23/2008	9.4	10/9/2008	10.4	2/27/2009	9.3	7/16/2009	10.2	12/2/2009	9.4		
5/5/2005	9.6	9/22/2005	10.7	2/9/2006	9.2	6/27/2006	9.8	11/14/2006	10.3	4/2/2007	9.4	8/20/2007	10.5	1/8/2008	9.1	5/26/2008	9.4	10/10/2008	10.5	3/2/2009	9.2	7/17/2009	10.2	12/3/2009	9.3		
5/6/2005	9.6	9/23/2005	10.6	2/10/2006	9.3	6/28/2006	9.9	11/15/2006	10.3	4/3/2007	9.4	8/21/2007	10.7	1/9/2008	9.2	5/27/2008	9.5	10/14/2008	10.4	3/3/2009	9.2	7/20/2009	10.2	12/4/2009	9.3		
5/9/2005	9.6	9/26/2005	10.6	2/13/2006	9.2	6/29/2006	9.9	11/16/2006	10.2	4/4/2007	9.4	8/22/2007	10.7	1/10/2008	9.4	5/28/2008	9.5	10/15/2008	10.3	3/4/2009	9.2	7/21/2009	10.1	12/7/2009	9.3		
5/10/2005	9.7	9/27/2005	10.6	2/14/2006	9.3	6/30/2006	9.8	11/17/2006	10.4	4/5/2007	9.4	8/23/2007	10.6	1/11/2008	9.4	5/29/2008	9.5	10/16/2008	10.1	3/5/2009	9.3	7/22/2009	10.1	12/8/2009	9.2		
5/11/2005	9.6	9/28/2005	10.2	2/15/2006	9.2	7/4/2006	9.9	11/20/2006	10.4	4/9/2007	9.4	8/24/2007	10.6	1/14/2008	9.4	5/30/2008	9.5	10/17/2008	10.2	3/6/2009	9.2	7/23/2009	10.2	12/9/2009	9.2		
5/12/2005	9.5	9/29/2005	10.3	2/16/2006	9.2	7/5/2006	9.9	11/21/2006	10.2	4/10/2007	9.4	8/27/2007	10.5	1/15/2008	9.3	6/2/2008	9.6	10/20/2008	10.3	3/9/2009	9.3	7/24/2009	10.2	12/10/2009	9.2		
5/13/2005	9.5	9/30/2005	10.3	2/17/2006	9.2	7/6/2006	9.9	11/22/2006	10	4/11/2007	9.4	8/28/2007	10.6	1/16/2008	9.3	6/3/2008	10.0	10/21/2008	10.3	3/10/2009	9.3	7/27/2009	10.3	12/11/2009	9.2		
5/16/2005	9.4	10/3/2005	10.3	2/20/2006	9.2	7/7/2006	9.8	11/23/2006	9.9	4/12/2007	9.4	8/29/2007	10.6	1/17/2008	9.4	6/4/2008	10.0	10/22/2008	10.2	3/11/2009	9.3	7/28/2009	10.3	12/14/2009	9.2		
5/17/2005	9.8	10/4/2005	10.1	2/21/2006	9.2	7/10/2006	9.8	11/24/2006	9.9	4/13/2007	9.5	8/30/2007	10.6	1/18/2008	9.3	6/5/2008	10.0	10/23/2008	10.3	3/12/2009	9.3	7/29/2009	10.3	12/15/2009	9.3		
5/18/2005	9.8	10/5/2005	9.9	2/22/2006	9.2	7/11/2006	9.8	11/27/2006	10	4/16/2007	9.5	8/31/2007	10.5	1/21/2008	9.3	6/6/2008	10.0	10/24/2008	10.3	3/13/2009	9.3	7/30/2009	10.2	12/16/2009	9.2		

Appendix Table C.3.4: Water quality data for station Q-05 from 2005 to 2009.

Date	Acidity (mg/L)	Ba (mg/L)	Co (mg/L)	Fe (mg/L)	Mn (mg/L)	pH	Ra-226 (Bq/L)	SO4 (mg/L)	U (mg/L)
1/6/2005							0.84		
2/10/2005	23	0.0146	0.023	3.15	2.18	5	0.71	1235	0.032
3/10/2005							0.91		
4/9/2005							0.86		
5/5/2005	16	0.0204	0.0173	2.52	1.74	4.3	0.61	794	0.022
6/9/2005							0.78		
7/7/2005							0.98		
8/4/2005	33	0.0146	0.018	5.25	2.58	4	0.91	1283	0.033
9/8/2005							0.92		
10/6/2005							1.17		
11/10/2005	21	0.0167	0.0193	1.65	2.59	3.9	1.21	1360	0.049
12/8/2005							1.31		
1/10/2006							1		
2/6/2006	20	0.016	0.0267	2.48	2.64	5	0.96	1200	0.0186
3/6/2006							0.87		
4/3/2006							0.92		
5/1/2006	5	0.0121	0.0123	2.19	1.3	6.6	0.62	610	0.00806
6/5/2006							0.92		
7/4/2006							1		
8/8/2006	24	0.016	0.0208	0.78	2.78	4	0.7	1100	0.0395
9/5/2006							1.4		
10/2/2006							1.5		
11/6/2006	23	0.018	0.0309	2.38	3.2	4	1.1	1100	0.0778
12/4/2006							1.2		
1/2/2007							1.100		
2/12/2007	17	0.015	0.0288	3.43	2.490	4.4	0.940	1100.0	0.0534
3/12/2007							1.000		
4/9/2007							0.810		
5/14/2007	20	0.013	0.0245	2.23	2.060	3.8	0.730	830.0	0.0394
6/11/2007							0.910		
7/9/2007							1.100		
8/13/2007	27	0.016	0.0296	2.03	3.480	4.4	1.200	1200.0	0.059
9/10/2007							1.200		
10/9/2007							1.100		
11/12/2007	16	0.016	0.0227	1.15	2.610	4.5	0.940	1200.0	0.038
12/10/2007							0.640		
1/14/2008							1.000		
2/11/2008	4	0.014	0.0261	1.93	2.140	6.6	0.790	1300.0	0.0125
3/10/2008							0.860		
4/14/2008							0.790		
5/12/2008	8	0.012	0.0175	3.06	1.720	6.1	0.740	740.0	0.0123
6/9/2008							0.740		
7/14/2008							0.880		
8/11/2008	12	0.014	0.0168	1.14	2.090	9.8	0.850	960.0	0.0168
9/8/2008							0.780		
10/15/2008							0.930		
11/10/2008	18	0.016	0.0166	2.01	2.340	5.0	0.910	1100.0	0.0236
12/8/2008							1.010		
1/12/2009							0.940		
2/9/2009	1	0.015	0.0216	2.05	1.910	6.2	0.780	1100.0	0.0112
3/9/2009							0.990		
4/13/2009							0.790		
5/11/2009	4	0.012	0.0109	1.76	1.130	6.9	0.500	530.0	0.0045
6/8/2009							0.830		
7/13/2009							0.950		
8/10/2009	12	0.015	0.0201	0.66	2.420	5.0	1.260	980.0	0.0202
9/15/2009							0.850		
10/14/2009							1.000		
11/9/2009	8	0.015	0.0150	1.26	2.040	5.9	0.550	960.0	0.0156
12/14/2009							0.940		
Number	20	20	20	20	20	20	60	20	20
Minimum	1	0.012	0.0109	0.66	1.13	3.8	0.5	530	0.0045
Maximum	33	0.0204	0.0309	5.25	3.48	9.8	1.5	1360	0.0778
Mean	16	0.0151	0.0209	2.16	2.272	5.3	0.929	1034	0.0293
Median	17	0.0150	0.0205	2.04	2.260	5.0	0.920	1100	0.0228
10th Perc.	4.0	0.0121	0.0147	1.10	1.678	4.0	0.709	727	0.0109

Appendix Table C.3.5: Water quality data for station Cell 14 from 2005 to 2009.

Date	Acidity (mg/L)	Conductivity (µmho/cm)	Fe (mg/L)	pH	Ra (Bq/L)	SO4 (mg/L)
4/13/2005	6	38		6.5	0.19	
8/10/2005		69.1		7.1		
8/17/2005	2				0.45	18.3
9/14/2005	2	57		7	0.42	19.3
10/12/2005	3	48.8		7.4	0.31	22
11/16/2005	3	39		6.8	0.38	20
12/14/2005	3	45		7.2	0.38	21.9
5/10/2006	0.5	42		7	0.22	15
6/14/2006	2	43		6.8	0.32	21
7/12/2006	0.5	48		7.1	0.36	12
8/9/2006	1	44		7.8	0.34	13
10/11/2006	0.5	36.8		7.1	0.49	13
11/8/2006	3	34		6.5	0.31	13
3/14/2007	0.5	41		6.2	0.38	16
5/10/2007	0.5	32		6.8	0.290	10.0
8/8/2007	1	44		7.0	0.320	12.0
11/14/2007	0.5	55		6.2	0.410	16.0
2/13/2008	0.5	30	0.31	6.6	0.190	8.6
5/15/2008	0.5	29	0.06	6.9	0.250	9.7
8/13/2008	0.5	42	0.04	7.1	0.360	18.0
11/12/2008	0.5	54	0.06	6.7	0.550	15.0
5/21/2009	0.5	39	0.08	6.5	0.350	11.0
11/12/2009	2	51	0.14	6.8	0.690	15.0
Number	22	22	6	22	22	21
Minimum	0.5	29	0.04	6.2	0.19	8.6
Maximum	6	69.1	0.31	7.8	0.69	22
Mean	1.5	43.7	0.12	6.9	0.362	15.2
Median	0.75	42.5	0.07	6.9	0.355	15.0
10th Perc.	0.5	32.2	0.05	6.5	0.223	10

(shaded) Concentration below maximum MDL.

Appendix Table C.3.6: Water quality data for station Cell 15 from 2005 to 2009.

Date	Acidity (mg/L)	Conductivity (µmho/cm)	Fe (mg/L)	pH	Ra-226 (Bq/L)	SO4 (mg/L)
4/13/2005	3	17		6	0.05	
8/10/2005		826		6.9		
8/17/2005	3				0.4	515
10/12/2005	5	784		6.8	0.33	730
5/10/2006	0.5	682		6.7	0.34	470
8/9/2006	2	832		7.5	0.22	490
11/8/2006	4	672		6.5	0.2	580
3/14/2007	0.5	412		6.2	0.64	310
5/10/2007	0.5	686		6.8	0.32	430
8/8/2007	4	1071		7	0.2	640
11/14/2007	2	1236		6.7	0.35	740
2/13/2008	0.5	45	1.07	6.6	0.25	8.7
5/15/2008	0.5	616	0.58	6.9	0.32	380
8/13/2008	0.5	852	0.41	7.0	0.20	480
11/12/2008	0.5	765	1.1	6.7	0.26	690
5/21/2009	0.5	751	0.67	6.6	0.40	440
11/12/2009	0.5	885	0.83	6.9	0.36	560
Number	16	16	6	16	16	15
Minimum	0.5	17	0.41	6	0.05	8.7
Maximum	5	1236	1.1	7.5	0.64	740
Mean	1.7	696	0.78	6.7	0.303	498
Median	0.5	758	0.75	6.8	0.32	490
10th Perc.	0.5	229	0.50	6.4	0.2	338

(Shaded cell) Concentration below maximum MDL.

Appendix Table C.3.7: Water quality data for station Cell 16S from 2005 to 2009.

Date	Acidity (mg/L)	Conductivity (μmho/cm)	Iron (mg/L)	pH	Ra-226 (Bq/L)	SO4 (mg/L)
4/13/2005	7	94		5.5	0.044	
8/10/2005		1663		6.4		
8/17/2005	7				0.74	1245
10/12/2005	5	1421		7.8	0.61	1697
5/10/2006	14	1367		4.2	0.63	1000
8/9/2006	10	1742		7.3	0.71	1100
11/8/2006	17	1136		4.5	0.6	1100
3/14/2007	20	1203		4	0.73	1100
5/10/2007	24	1463		4	0.65	960
8/8/2007	9	1837		6.8	0.61	1200
11/14/2007	4	1358		6.9	0.78	1200
2/13/2008	3	1113	2.65	6.5	0.81	1100
5/15/2008	13	1265	3.85	6.2	0.57	990
8/13/2008	4	1591	0.69	7.0	0.59	910
11/12/2008	0.5	1438	1.49	7.3	0.63	1000
5/21/2009	8	1411	2.61	6.4	0.61	940
11/12/2009	0.5	1397	1.68	8.0	0.48	1000
Number	16	16	6	16	16	15
Minimum	0.5	94	0.69	4	0.044	910
Maximum	24	1837	3.85	8	0.81	1697
Mean	9	1344	2.16	6.2	0.612	1103
Median	7.5	1404	2.15	6.45	0.620	1100
10th Perc.	1.75	1125	1.09	4.1	0.525	948

(shaded) Concentration below maximum MDL.

Appendix Table C.3.8: Water quality data for station Cell 17 from 2005 to 2009.

Date	Acidity (mg/L)	Conductivity (µmho/cm)	Fe (mg/L)	pH	Ra (Bq/L)	SO4 (mg/L)
4/13/2005	8	212		6	0.15	
8/10/2005		1752		7.2		
8/17/2005	6				1.28	1422
10/12/2005	9	1538		6.5	1.5	1768
5/10/2006	26	1496		3.9	1.2	1100
8/9/2006	24	1873		7.1	1.2	1200
11/8/2006	20	1217		4	1.3	1200
3/14/2007	19	1212		4	0.93	1200
5/10/2007	18	1502		4.1	1.1	980
8/8/2007	0.5	1976		7.7	1.4	1400
11/14/2007	7	1370		6.9	1.05	1200
2/13/2008	3	1110	2.38	6.2	0.700	1100
5/15/2008	16	1311	3.87	4.9	0.940	930
8/13/2008	0.5	1641	0.37	8.8	0.530	980
11/12/2008	0.5	1527	1.52	7.0	1.200	880
5/21/2009	12	1399	3.31	4.9	1.400	980
11/12/2009	2	1403	1.82	7.5	0.690	1100
Number	16	16	6	16	16	15
Minimum	0.5	212	0.37	3.9	0.15	880
Maximum	26	1976	3.87	8.8	1.5	1768
Mean	10.7	1409	2.21	6.0	1.036	1163
Median	8.5	1450	2.10	6.4	1.150	1100
10th Perc.	0.5	1161	0.95	4.0	0.610	950

(shaded box) Concentration below maximum MDL.

Appendix Table C.3.9: Water quality at station DK145C (Depth 5.91 m).

Date	Acidity (mg/L)	Conductivity (µmho/cm)	Fe (mg/L)	pH	SO4 (mg/L)
7/1/2005	13.00	2884	0.08	8.10	
6/1/2006	0.50	2387	0.01	8.00	
8/24/2007	0.50		0.10	8.20	1800
7/24/2008	0.50		0.04	8.10	1700
6/15/2009	0.50		0.04	7.90	1600
Number	5	2	5	5	3
Minimum	0.50	2387	0.01	7.9	1600
Maximum	13.00	2884	0.10	8.2	1800
Mean	3.0	2636	0.05	8.06	1700
Median	0.50	2636	0.04	8.10	1700
10th Perc.	0.50	2437	0.02	7.94	1620

[shaded cell] Concentration below maximum MDL.

Appendix Table C.3.10: Water quality at station DK-15-2 A, B, C, D from 2005 to 2009.

Site	Date	Acidity (mg/L)	Conductivity (µmho/cm)	Fe (mg/L)	pH	SO4 (mg/L)
DK-15-2A	7/1/2005	2510	3236	717	6.0	
	6/1/2006	2290	2595	656	6.0	
	8/7/2007	1110		555	6.1	2400
	7/21/2008	976		579	6.0	2300
	6/17/2009	996		571	6.1	2300
DK-15-2A Summary	Number	5	2	5	5.0	3
	Minimum	976	2595	555	6.0	2300
	Maximum	2510	3236	717	6.1	2400
	Mean	1576	2916	616	6.0	2333
	Median	1110	2916	579	6.0	2300
	10th Perc.	984	2659	561	6.0	2300
DK-15-2B	7/1/2005	2370	3279	695	5.9	
	6/1/2006	1210	2571	638	6.2	
	8/7/2007	1070		547	6.1	2400
	7/21/2008	840		474	5.9	2300
	6/17/2009	1010		537	5.9	2200
DK-15-2B Summary	Number	5	2	5	5.0	3
	Minimum	840	2571	474	5.9	2200
	Maximum	2370	3279	695	6.2	2400
	Mean	1300	2925	578	6.0	2300
	Median	1070	2925	547	5.9	2300
	10th Perc.	908	2642	499	5.9	2220
DK-15-2C	7/1/2005	2260	3263	699	5.9	
	6/1/2006	2420	2484	591	6.1	
	8/7/2007	1100		557	6.0	2400
	7/21/2008	805		490	5.9	2200
	6/17/2009	864		473	5.9	2100
DK-15-2C Summary	Number	5	2	5	5.0	3
	Minimum	805	2484	473	5.9	2100
	Maximum	2420	3263	699	6.1	2400
	Mean	1490	2874	562	6.0	2233
	Median	1100	2874	557	5.9	2200
	10th Perc.	829	2562	480	5.9	2120
DK-15-2D	7/1/2005	2120	3077	541	6.5	
	6/1/2006	1780	2336	411	6.5	
	8/7/2007	848		417	6.4	2200
	7/21/2008	711		400	6.4	2000
	6/17/2009	719		363	6.4	1900
DK-15-2D Summary	Number	5	2	5	5.0	3
	Minimum	711	2336	363	6.4	1900
	Maximum	2120	3077	541	6.5	2200
	Mean	1236	2707	426	6.4	2033
	Median	848	2707	411	6.4	2000
	10th Perc.	714	2410	378	6.4	1920

Appendix Table C.3.11: Water quality at DK15-4 A, B, C, D from 2005 to 2009.

Site	Date	Acidity (mg/L)	Conductivity (µmho/cm)	Fe (mg/L)	pH	SO4 (mg/L)
DK15-4A	Jul-05	2260.00	2799.00	327.40	6.4	
	Jun-06	401.00	2088.00	251.00	6.3	
	Aug-07	412.00		257.00	6.5	1800.00
	Jul-08	348.00		212.00	6.5	1800.00
	Jun-09	317.00		226.00	6.5	1700.00
DK15-4A Summary	Number	5	2	5	5.0	3
	Minimum	317	2088	212	6.3	1700
	Maximum	2260	2799	327	6.5	1800
	Mean	747.60	2443.50	254.68	6.4	1766.67
	Median	401.00	2443.50	251.00	6.5	1800.00
	10th Perc.	329.40	2159.10	217.60	6.3	1720.00
DK15-4B	Jul-05	1840.00	2955.00	382.60	6.2	
	Jun-06	483.00	2163.00	295.00	6.4	
	Aug-07	463.00		300.00	6.5	1900.00
	Jul-08	392.00		249.00	6.4	1900.00
	Jun-09	412.00		285.00	6.3	1800.00
DK15-4B Summary	Number	5	2	5	5.0	3
	Minimum	392	2163	249	6.2	1800
	Maximum	1840	2955	383	6.5	1900
	Mean	718.00	2559.00	302.32	6.4	1866.67
	Median	463.00	2559.00	295.00	6.4	1900.00
	10th Perc.	400.00	2242.20	263.40	6.2	1820.00
DK15-4C	Jul-05	665.00	2985.00	383.00	6.20	
	Jun-06	494.00	2200.00	297.00	6.30	
	Aug-07	487.00		306.00	6.40	2000.00
	Jul-08	447.00		278.00	6.40	1900.00
	Jun-09	494.00		325.00	6.30	2000.00
DK15-4C Summary	Number	5	2	5	5.0	3
	Minimum	447	2200	278	6.2	1900
	Maximum	665	2985	383	6.4	2000
	Mean	517.40	2592.50	317.80	6.3	1966.67
	Median	494.00	2592.50	306.00	6.3	2000.00
	10th Perc.	463.00	2278.50	285.60	6.2	1920.00
DK15-4D	Jul-05	701.00	3034.00	411.50	6.10	
	Jun-06	1310.00	2336.00	321.00	6.10	
	Aug-07	486.00		314.00	6.30	2000.00
	Jul-08	506.00		304.00	6.40	2000.00
	Jun-09	505.00		330.00	6.30	1900.00
DK15-4D Summary	Number	5	2	5	5.0	3
	Minimum	486	2336	304	6.1	1900
	Maximum	1310	3034	412	6.4	2000
	Mean	701.60	2685.00	336.10	6.2	1966.67
	Median	506.00	2685.00	321.00	6.3	2000.00
	10th Perc.	493.60	2405.80	308.00	6.1	1920.00

Appendix Table C.3.12: Water quality at station DK16-2 A, B, C, D from 2005 to 2009.

Site	Date	Acidity (mg/L)	Conductivity (µmho/cm)	Fe (mg/L)	pH	SO4 (mg/L)
DK16-2A	7/1/2005	217.00	2555.00	100.30	6.90	
	6/1/2006	66.00	1945.00	58.80	7.00	
	8/8/2007	62.00		57.60	7.10	1700.00
	7/24/2008	29.00		58.10	7.10	1600.00
	7/1/2009	18.00		50.80	6.90	1600.00
DK-16-2A Summary	Number	5	2	5	5.0	3
	Minimum	18	1945.00	51	6.9	1600.00
	Maximum	217	2555.00	100	7.1	1700.00
	Mean	78.40	2250.00	65.12	7.00	1633.33
	Median	62.00	2250.00	58.10	7.00	1600.00
	10th Perc.	22.40	2006.00	53.52	6.90	1600.00
DK16-2B	7/1/2005	0.50	2322.00	0.21	8.40	
	6/1/2006	0.50	1790.00	0.10	8.70	
	8/28/2007	0.50		0.03	8.80	1600.00
	7/24/2008	0.50		0.02	8.70	1500.00
	7/1/2009	2.00		0.01	7.80	1500.00
DK-16-2B Summary	Number	5	2	5	5.0	3
	Minimum	1	1790.00	0	7.8	1500.00
	Maximum	2	2322.00	0	8.8	1600.00
	Mean	0.80	2056.00	0.07	8.48	1533.33
	Median	0.50	2056.00	0.03	8.70	1500.00
	10th Perc.	0.50	1843.20	0.01	8.04	1500.00
DK16-2C	7/1/2005	19.00	2330.00	4.44	6.10	
	6/1/2006	15.00	1788.00	4.80	7.20	
	8/8/2007	15.00		4.84	6.50	1600.00
	7/28/2008	12.00		4.79	6.20	1500.00
	7/1/2009	15.00		4.34	6.50	1500.00
DK-16-2C Summary	Number	5	2	5	5.0	3
	Minimum	12	1788.00	4	6.1	1500.00
	Maximum	19	2330.00	5	7.2	1600.00
	Mean	15.20	2059.00	4.64	6.50	1533.33
	Median	15.00	2059.00	4.79	6.50	1500.00
	10th Perc.	13.20	1842.20	4.38	6.14	1500.00
DK16-2D	7/1/2005	201.00	2360.00	9.45	4.90	
	6/1/2006	32.00	1833.00	9.18	5.60	
	8/8/2007	30.00		8.98	5.20	1600.00
	7/28/2008	30.00		10.60	5.30	1500.00
	7/1/2009	15.00		10.30	5.30	1500.00
DK-16-2D Summary	Number	5	2	5	5.0	3
	Minimum	15	1833.00	9	4.9	1500.00
	Maximum	201	2360.00	11	5.6	1600.00
	Mean	61.60	2096.50	9.70	5.26	1533.33
	Median	30.00	2096.50	9.45	5.30	1500.00
	10th Perc.	21.00	1885.70	9.06	5.02	1500.00

Concentration below maximum MDL. (shaded cells)

Appendix Table C.3.13: Water quality at station DK17-2 A, B, C, D from 2005 to 2009.

Site	Date	Acidity (mg/L)	Conductivity (µmho/cm)	Fe (mg/L)	pH	SO4 (mg/L)
DK17-2A	7/1/2005	2284.00	5120.00	1286.00	5.10	
	6/1/2006	2590.00	3976.00	1160.00	5.00	
	8/13/2007	2340.00		1490.00	5.90	4600.00
	7/18/2008	0.50		1410.00	6.20	4000.00
	7/6/2009	2180.00		1240.00	5.80	3900.00
DK-17-2A Summary	Number	5	2	5	5.0	3
	Minimum	0.50	3976.00	1160.00	5.00	3900.00
	Maximum	2590.00	5120.00	1490.00	6.20	4600.00
	Mean	1878.90	4548.00	1317.20	5.60	4166.67
	Median	2284.00	4548.00	1286.00	5.80	4000.00
	10th Perc.	872.30	4090.40	1192.00	5.04	3920.00
DK17-2B	7/1/2005	369.00	3481.00	212.60	7.00	
	6/1/2006	267.00	2732.00	216.00	6.70	
	8/13/2007	351.00		315.00	6.90	2500.00
	7/18/2008	429.00		296.00	6.90	2100.00
	7/6/2009	451.00		285.00	6.60	2100.00
DK-17-2B Summary	Number	5	2	5	5.0	3
	Minimum	267.00	2732.00	212.60	6.60	2100.00
	Maximum	451.00	3481.00	315.00	7.00	2500.00
	Mean	373.40	3106.50	264.92	6.82	2233.33
	Median	369.00	3106.50	285.00	6.90	2100.00
	10th Perc.	300.60	2806.90	213.96	6.64	2100.00
DK17-2C	7/1/2005	0.50	2682.00	0.05	9.50	
	6/1/2006	0.50	2221.00	0.12	9.60	
	8/10/2007	0.50		0.03	9.70	1500.00
	7/18/2008	0.50		0.08	9.70	1500.00
	7/6/2009	0.50		0.06	9.60	1400.00
DK-17-2C Summary	Number	5	2	5	5.0	3
	Minimum	0.50	2221.00	0.03	9.50	1400.00
	Maximum	0.50	2682.00	0.12	9.70	1500.00
	Mean	0.50	2451.50	0.07	9.62	1466.67
	Median	0.50	2451.50	0.06	9.60	1500.00
	10th Perc.	0.50	2267.10	0.04	9.54	1420.00
DK17-2D	7/1/2005	0.50	2557.00	1.78	10.30	
	6/1/2006	0.50	2056.00	1.23	10.30	
	8/10/2007	0.50		0.11	10.10	1500.00
	7/18/2008	0.50		0.10	10.10	1500.00
	7/6/2009	0.50		0.05	10.20	1500.00
DK-17-2D Summary	Number	5	2	5	5.0	3
	Minimum	0.50	2056.00	0.05	10.10	1500.00
	Maximum	0.50	2557.00	1.78	10.30	1500.00
	Mean	0.50	2306.50	0.65	10.20	1500.00
	Median	0.50	2306.50	0.11	10.20	1500.00
	10th Perc.	0.50	2106.10	0.07	10.10	1500.00

(Shaded cell) Concentration below maximum MDL.

Appendix Table C.3.14: Water quality at station QPW1 1, 4, 8 from 2005 to 2009.

Site	Date	Acidity (mg/L)	Conductivity (µmho/cm)	Fe (mg/L)	pH	SO4 (mg/L)
QPW1-1	6/1/2005	44	150	13.48	6.1	2.5
	7/1/2006	0.5	100.4	1.89	6.2	36
	8/16/2007	0.5		13.30	6.3	2.5
	7/18/2008	0.5		15.20	6.5	2.5
QPW1-1 Summary	Number	4	2	4	4.0	4
	Minimum	0.5	100.4	1.89	6.1	2.5
	Maximum	44	150	15.20	6.5	36.0
	Mean	11.4	125.2	10.97	6.3	10.9
	Median	0.5	125.2	13.39	6.3	2.5
	10th Perc.	0.5	105.4	5.31	6.1	2.5
QPW1-4	6/1/2005	31	358.8	5.39	6.2	52.1
	7/1/2006	0.5	170.9	4.93	7	50
	8/17/2007	0.5		5.03	6.7	54.0
	7/18/2008	0.5		4.15	6.6	56.0
	7/7/2009	0.5		3.27	6.7	63.0
QPW1-4 Summary	Number	5	2	5	5.0	5
	Minimum	0.5	171	3.27	6.2	50.0
	Maximum	31	359	5.39	7.0	63.0
	Mean	6.6	264.9	4.55	6.6	55.0
	Median	0.5	264.9	4.93	6.7	54.0
	10th Perc.	0.5	189.7	3.62	6.4	50.8
QPW1-8	6/1/2005	36	853	16.18	7.6	268
	7/1/2006	0.5	515	16.8	7.1	260
	8/17/2007	0.5		16.60	7.1	270.0
	7/21/2008	0.5		17.60	7.0	270.0
	7/8/2009	0.5		17.70	7.0	280.0
QPW1-8 Summary	Number	5	2	5	5.0	5
	Minimum	0.5	515	16.18	7.0	260.0
	Maximum	36	853	17.70	7.6	280.0
	Mean	7.6	684	16.98	7.2	269.6
	Median	0.5	684	16.80	7.1	270.0
	10th Perc.	0.5	549	16.35	7.0	263.2

(shaded) Concentration below maximum MDL.

Appendix Table C.3.15: Water quality at station 95QW-3 A, C, D from 2005 to 2009.

Site	Date	Acidity (mg/L)	Conductivity (µmho/cm)	Fe (mg/L)	pH	SO4 (mg/L)
95QW-3A	7/1/2005	532	2721	280	6.4	
	6/1/2006	360	2056	236	6.2	
	8/14/2007	325		229.00	6.3	1800.0
	7/23/2008	296		230.00	6.3	1600.0
	7/13/2009	252		179.00	6.0	1600.0
95QW-3A Summary	Number	5	2	5	5.0	3
	Minimum	252	2056	179.00	6.0	1600.0
	Maximum	532	2721	280.00	6.4	1800.0
	Mean	353	2389	230.80	6.2	1666.7
	Median	325	2389	230.00	6.3	1600.0
	10th Perc.	270	2123	199.00	6.1	1600.0
95QW-3C	7/1/2005	566	2679	292.1	6.1	
	6/1/2006	384	2106	237	6	
	8/14/2007	343		235.00	6.2	1700.0
	7/23/2008	308		226.00	6.2	1500.0
	7/9/2009	332		203.00	6.1	1500.0
95QW-3C Summary	Number	5	2	5	5.0	3
	Minimum	308	2106	203.00	6.0	1500.0
	Maximum	566	2679	292.10	6.2	1700.0
	Mean	387	2393	238.62	6.1	1566.7
	Median	343	2393	235.00	6.1	1500.0
	10th Perc.	318	2163	212.20	6.0	1500.0
95QW-3D	7/1/2005	510	2568	215.6	4.9	
	6/1/2006	320	1913	162	4.8	
	8/14/2007	302		167.00	5.3	1600.0
	7/23/2008	251		141.00	4.8	1400.0
	7/13/2009	267		13.50	4.5	1500.0
95QW-3D Summary	Number	5	2	5	5.0	3
	Minimum	251	1913	13.50	4.5	1400.0
	Maximum	510	2568	215.60	5.3	1600.0
	Mean	330	2241	139.82	4.9	1500.0
	Median	302	2241	162.00	4.8	1500.0
	10th Perc.	257	1979	64.50	4.6	1420.0

Appendix Table C.3.16: Water quality at station 95QW-4 from 2005 to 2009.

Date	Acidity (mg/L)	Conductivity (µmho/cm)	Fe (mg/L)	pH	SO4 (mg/L)
7/1/2005	10	1926	0.197	7.5	1103
6/1/2006	0.5	1345	0.2	7.2	1000
8/13/2007	0.5		0.01	7.5	1100.0
7/29/2008	0.5		0.01	7.3	1000.0
7/14/2009	0.5		0.01	7.0	960.0
Number	5	2	5	5	5
Minimum	0.5	1345	0.01	7.0	960.0
Maximum	10	1926	0.200	7.5	1103.0
Mean	2.4	1636	0.085	7.3	1032.6
Median	0.5	1636	0.010	7.3	1000.0
10th Perc.	0.5	1403	0.010	7.1	976.0

[shaded box] Concentration below maximum MDL.

Appendix Table C.3.17: Water quality at station 95QW-5 A, D from 2005 to 2009.

Site	Date	Acidity (mg/L)	Conductivity (μmho/cm)	Fe (mg/L)	pH	SO4 (mg/L)
95QW-5A	7/1/2005	54	1111	12.89	5.7	608
	6/1/2006	22	751	14.4	6	500
	8/28/2007	7		15.90	5.7	770.0
	7/29/2008	29		24.00	5.8	670.0
	7/14/2009	42		18.30	5.6	700.0
95QW-5A Summary	Number	5	2	5	5	5
	Minimum	7	751	12.89	5.6	500
	Maximum	54	1111	24.00	6.0	770.0
	Mean	31	931	17.10	5.8	649.6
	Median	29	931	15.90	5.7	670.0
	10th Perc.	13	787	13.49	5.6	543.2
95QW-5D	7/1/2005	17	197.1	0.142	6.4	8.51
	6/1/2006	0.5	57.6	0.04	5.8	8.1
	8/21/2007	0.5		0.01	6.2	9.2
	7/28/2008	0.5		0.04	6.2	7.3
	7/14/2009	0.5		0.67	6.0	22.0
95QW-5D Summary	Number	5	2	5	5	5
	Minimum	0.5	57.6	0.01	5.8	7.3
	Maximum	17.0	197.1	0.67	6.4	22.0
	Mean	3.8	127.4	0.18	6.1	11.0
	Median	0.5	127.4	0.04	6.2	8.5
	10th Perc.	0.5	71.6	0.02	5.9	7.6

(shaded) Concentration below maximum MDL.

Appendix Table C.3.18: Summary of seasonal trends for station Q-05, 2003 - 2009.

Season	Spearman rho	Acidity	Barium	Cobalt	Iron	Manganese	pH	Ra-226	Sulphate	Uranium
January	Correlation Coefficient							0.03637		
	Sig. (2-tailed)							0.938298		
	N							7		
February	Correlation Coefficient	-0.9910312	-0.180187	-0.428571	-0.321	-0.535714286	0.738769	-0.464286	-0.50452498	-0.75
	Sig. (2-tailed)	1.4561E-05	0.699046	0.337368	0.482	0.215217456	0.057858	0.293934	0.248203114	0.052181
	N	7	7	7	7	7	7	7	7	7
March	Correlation Coefficient							-0.285714		
	Sig. (2-tailed)							0.534509		
	N							7		
April	Correlation Coefficient							0.306319		
	Sig. (2-tailed)							0.504027		
	N							7		
May	Correlation Coefficient	-0.7142857	-0.198206	-0.285714	-0.75	-0.23424374	0.612637	-0.285714	-0.39285714	-0.678571
	Sig. (2-tailed)	0.07134356	0.670085	0.534509	0.052	0.613155037	0.143589	0.534509	0.38331687	0.09375
	N	7	7	7	7	7	7	7	7	7
June	Correlation Coefficient							0.428571		
	Sig. (2-tailed)							0.337368		
	N							7		
July	Correlation Coefficient							-0.285714		
	Sig. (2-tailed)							0.534509		
	N							7		
August	Correlation Coefficient	-0.3783937	-0.162169	-0.178571	0	0.25	0.704187	0.178571	-0.57142857	-0.464286
	Sig. (2-tailed)	0.4026022	0.7283	0.701658	1	0.588724448	0.07735	0.701658	0.180201989	0.293934
	N	7	7	7	7	7	7	7	7	7
September	Correlation Coefficient							-0.306319		
	Sig. (2-tailed)							0.504027		
	N							7		
October	Correlation Coefficient							0.035714		
	Sig. (2-tailed)							0.939408		
	N							7		
November	Correlation Coefficient	-0.7567875	-0.918956	-0.571429	-0.143	-0.357142857	0.815374	-0.714286	-0.82886247	-0.678571
	Sig. (2-tailed)	0.0489051	0.003437	0.180202	0.76	0.431611352	0.025399	0.071344	0.021173516	0.09375
	N	7	7	7	7	7	7	7	7	7
December	Correlation Coefficient							0.107143		
	Sig. (2-tailed)							0.819151		
	N							7		

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

"ns" denotes not significant.

(shaded) Significant trend where $p<0.05$.

Appendix Table C.3.19: Summary of seasonal trends for station Cell 14, 2003 - 2009.

Season	Spearman rho	Acidity	pH	Ra-226	Sulphate
April/May	Correlation Coefficient	-0.78811041	0.5766	-0.14285714	
	Sig. (2-tailed)	0.0352827	0.175382	0.7599453	
	N	7	7	7	
October/November	Correlation Coefficient	-0.47809144	-0.212512	0.23190841	-0.359092423
	Sig. (2-tailed)	0.33750186	0.686031	0.65837357	ns
	N	6	6	6	5

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

"ns" denotes not significant.

[shaded box] Significant trend where p<0.05.

Appendix Table C.3.20: Summary of seasonal trends for station Cell 15, 2003 - 2009.

Season	Spearman rho	pH	Ra-226	Sulphate
April/May	Correlation Coefficient	0.75	0.774806218	
	Sig. (2-tailed)	0.052181	0.040769463	
	N	7	7	
October/November	Correlation Coefficient	-0.52254	0.090093746	-0.5
	Sig. (2-tailed)	0.228878	0.84767208	ns
	N	7	7	5

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

ns denotes not significant.

[shaded box] Significant trend where $p<0.05$.

Appendix Table C.3.21: Summary of seasonal trends for station cell 16S, 2003 - 2009.

Season	Spearman rho	pH	Ra-226	Sulphate
April/May	Correlation Coefficient	0.678571429	0.571428571	
	Sig. (2-tailed)	0.093750254	0.180201989	
	N	7	7	
October/November	Correlation Coefficient	0.432449982	-0.035714286	-0.872081599
	Sig. (2-tailed)	0.332526778	0.939408205	ns
	N	7	7	5

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

"ns" denotes not significant.

Significant trend where p<0.05.

Appendix Table C.3.22: Summary of seasonal trends for station Cell 17, 2003 - 2009.

Season	Spearman rho	pH	Ra-226	Sulphate
April/May	Correlation Coefficient	0.126131245	0.714285714	
	Sig. (2-tailed)	0.787572159	0.071343561	
	N	7	7	
October/November	Correlation Coefficient	0.75	-0.535714286	-0.872081599
	Sig. (2-tailed)	0.0521814	0.215217456	ns
	N	7	7	5

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

"ns" denotes not significant.

Significant trend where p<0.05.

Appendix Table C.3.23: Summary of seasonal trends for Quirke porewater stations.

Station	Spearman rho	year	Iron	pH	Sulphate
DK14-5C	Correlation Coefficient	1	-0.481870745	0.600005822	-0.09011
	Sig. (2-tailed)	.	0.050	0.006611653	0.759339
	N	19	17	19	14
DK15-2A	Correlation Coefficient	1	-0.951648352	0.768111124	-0.778119
	Sig. (2-tailed)	.	0.000001	0.000823998	<0.05
	N	15	14	15	10
DK15-2B	Correlation Coefficient	1	-0.981233636	0.71997752	-0.743864
	Sig. (2-tailed)	.	0.000001	0.001117719	0.005541
	N	17	15	17	12
DK15-2C	Correlation Coefficient	1	-0.988382879	0.762554193	-0.705267
	Sig. (2-tailed)	.	0.000001	0.000371771	0.010405
	N	17	15	17	12
DK15-2D	Correlation Coefficient	1	-0.97469806	0.798250355	-0.592986
	Sig. (2-tailed)	.	0.000001	0.000210004	0.042136
	N	16	14	16	12
DK15-4A	Correlation Coefficient	1	-0.986813187	0.638972902	-0.948333
	Sig. (2-tailed)	.	0.000001	0.010337612	<0.001
	N	15	14	15	10
DK15-4B	Correlation Coefficient	1	-0.986813187	0.676935009	-0.960491
	Sig. (2-tailed)	.	0.000001	0.00557341	<0.001
	N	15	14	15	10
DK15-4C	Correlation Coefficient	1	-0.974084393	0.845689324	-0.871706
	Sig. (2-tailed)	.	0.000001	1.9007E-05	0.00022
	N	17	15	17	12
DK15-4D	Correlation Coefficient	1	-0.969230769	0.900119544	-0.911858
	Sig. (2-tailed)	.	0.000001	4.83567E-06	<0.001
	N	15	14	15	10
DK16-2A	Correlation Coefficient	1	-0.12967033	-0.084381834	0.048632
	Sig. (2-tailed)	.	0.658619276	0.764947218	ns
	N	15	14	15	10
DK16-2B	Correlation Coefficient	1	-0.986813187	0.784571524	-0.462008
	Sig. (2-tailed)	.	0.000001	0.000533034	ns
	N	15	14	15	10
DK16-2C	Correlation Coefficient	1	-0.886689205	0.68157533	-0.534957
	Sig. (2-tailed)	.	2.38375E-05	0.005137708	ns
	N	15	14	15	10
DK16-2D	Correlation Coefficient	1	-0.92967033	0.752017036	-0.607906
	Sig. (2-tailed)	.	1.49953E-06	0.001221688	ns
	N	15	14	15	10
DK17-2A	Correlation Coefficient	1	0.512087912	0.840788465	0.527273
	Sig. (2-tailed)	.	0.061198486	8.62861E-05	ns
	N	15	14	15	10
DK17-2B	Correlation Coefficient	1	0.09010989	0.459226419	-0.097265
	Sig. (2-tailed)	.	0.759338838	0.085069234	ns
	N	15	14	15	10
DK17-2C	Correlation Coefficient	1	-0.225167757	0.266677489	-0.486324
	Sig. (2-tailed)	.	0.438947765	0.336658217	ns
	N	15	14	15	10
DK17-2D	Correlation Coefficient	1	-0.705494505	0.745747004	0.116573
	Sig. (2-tailed)	.	0.004819558	0.001413349	ns
	N	15	14	15	10

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

"ns" denotes not significant.

[shaded box] Significant trend where $p<0.05$.

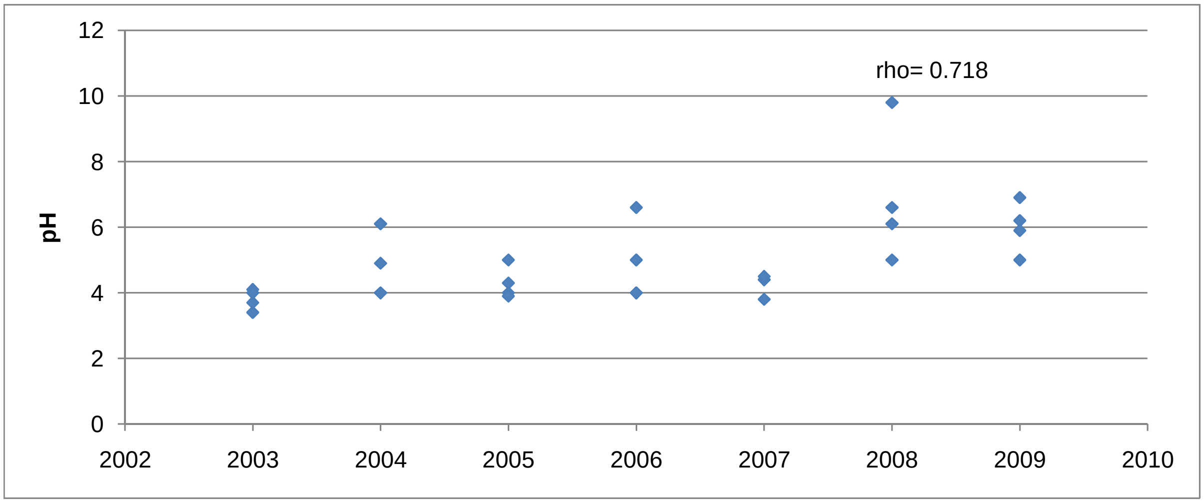
Appendix Table C.3.24: Summary of seasonal trends for Quirke groundwater stations.

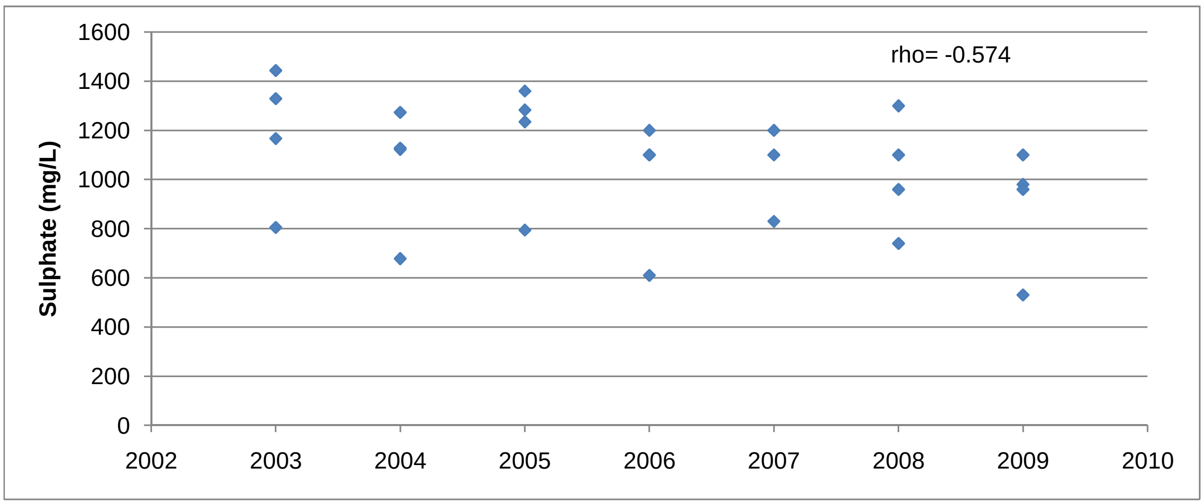
Station	Spearman rho	Iron	pH	Sulphate
95QW3-A	Correlation Coefficient	-0.512088	-0.121261263	-0.67881725
	Sig. (2-tailed)	0.061198	0.666836279	0.02163658
	N	14	15	11
95QW3-C	Correlation Coefficient	-0.301099	0.871097856	-0.81549187
	Sig. (2-tailed)	0.295514	2.36081E-05	0.00221629
	N	14	15	11
95QW3-D	Correlation Coefficient	0.248352	0.83787184	-0.45454545
	Sig. (2-tailed)	0.39192	9.63748E-05	0.16014544
	N	14	15	11
95QW4	Correlation Coefficient	-0.258084	-0.628769645	0.60522753
	Sig. (2-tailed)	0.373005	0.012044345	0.02839544
	N	14	15	13
95QW5-A	Correlation Coefficient	0.279121	-0.061263747	0.26685032
	Sig. (2-tailed)	0.333845	0.828292933	0.37813584
	N	14	15	13
95QW5-D	Correlation Coefficient	-0.21586	-0.310877667	-0.03846154
	Sig. (2-tailed)	0.458586	0.259403688	0.9007243
	N	14	15	13
QPW1-1	Correlation Coefficient	0.220588	-0.608109944	0.04583492
	Sig. (2-tailed)	0.394889	0.009599956	0.87114732
	N	17	17	15
QPW1-4	Correlation Coefficient	0.631942	-0.323354212	0.14145588
	Sig. (2-tailed)	0.002798	0.164326334	0.57555494
	N	20	20	18
QPW1-8	Correlation Coefficient	0.603008	-0.361305133	0.9168819
	Sig. (2-tailed)	0.004887	0.117540533	0.000001
	N	20	20	18

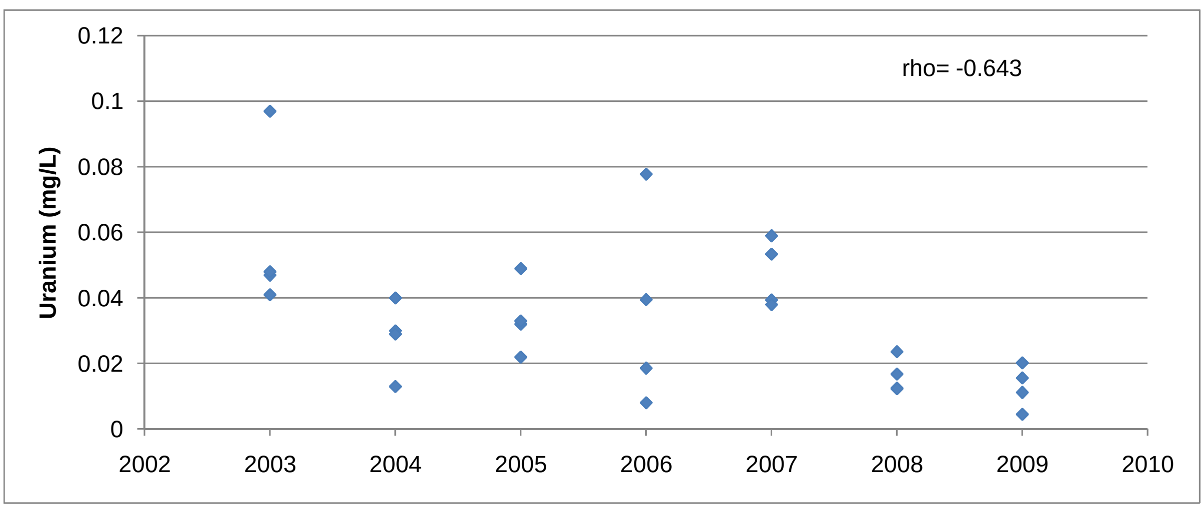
Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

"ns" denotes not significant.

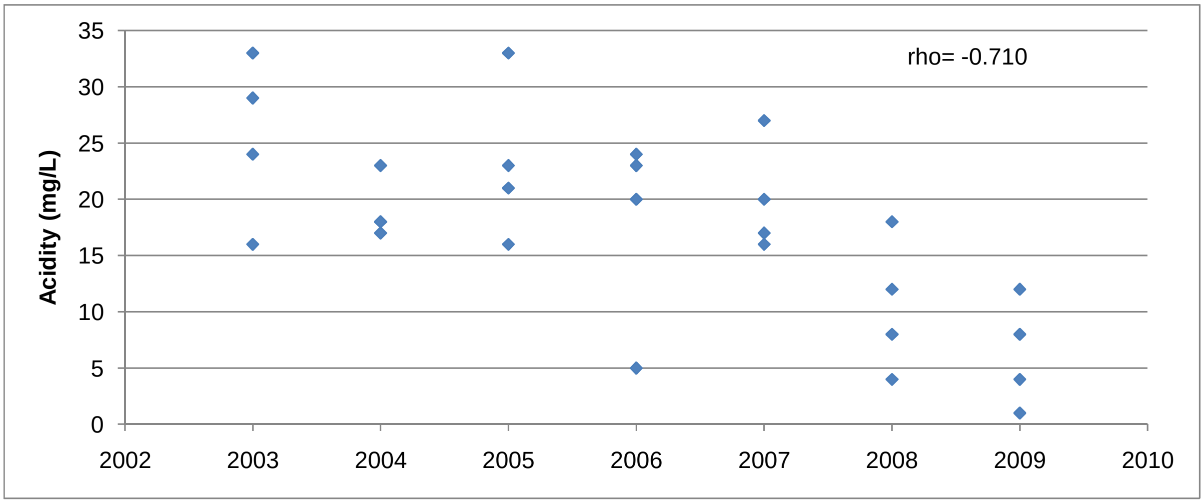
[shaded box] Significant trend where p<0.05.



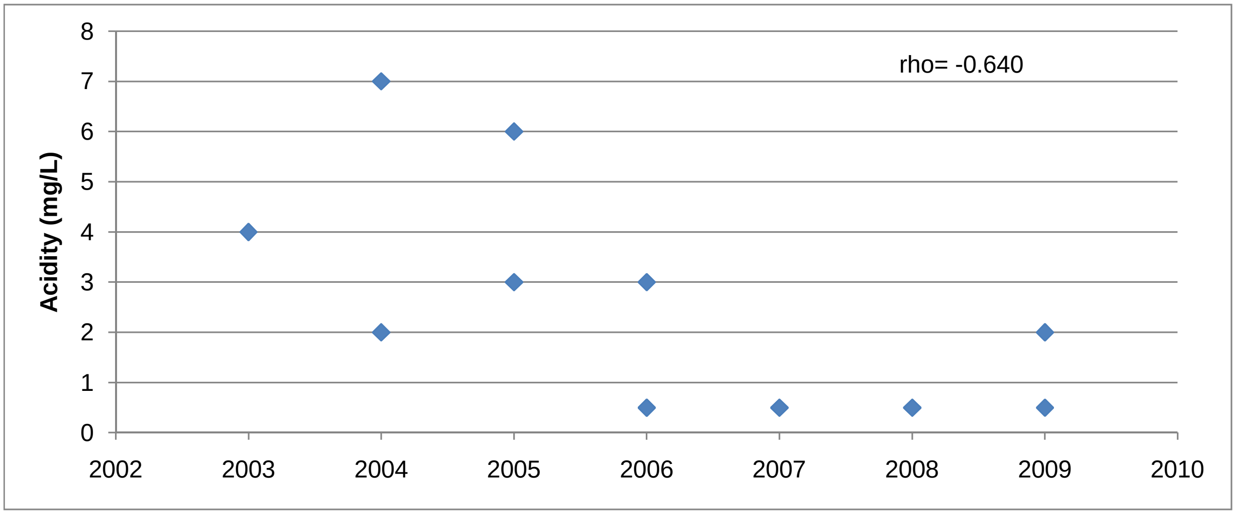




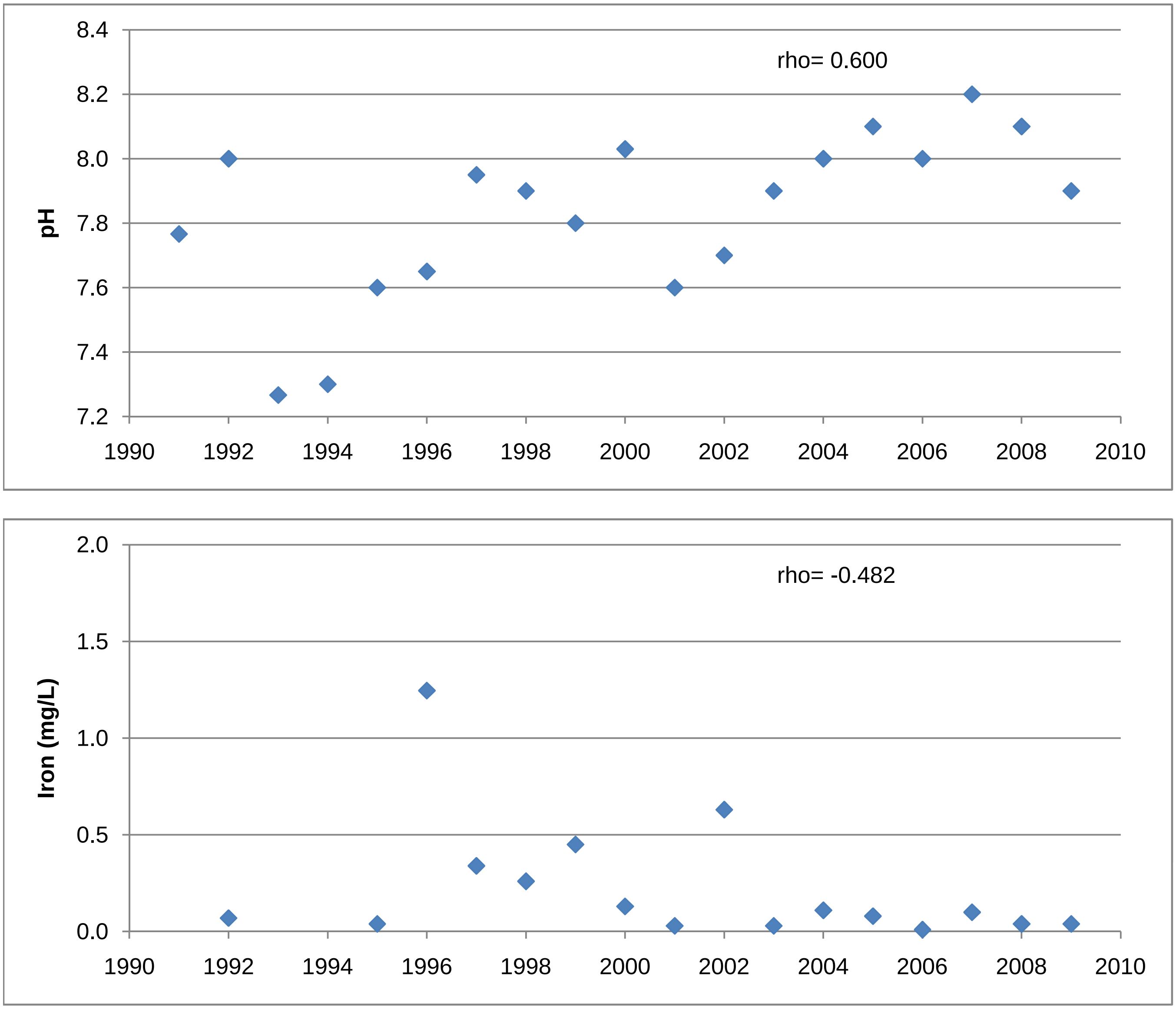
Appendix Figure C.3.1: Significant common (average) trends observed for pH, sulphate, uranium and acidity over all seasons at station Q-05, 2003 to 2009.



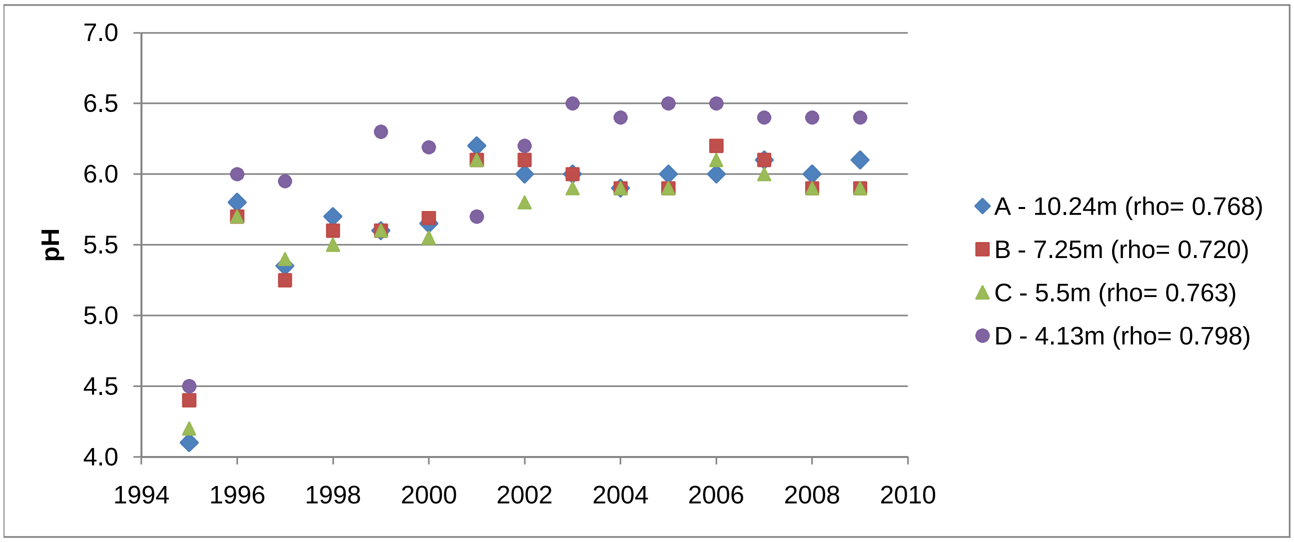
Appendix Figure C.3.1: Significant common (average) trends observed for pH, sulphate, uranium and acidity over all seasons at station Q-05, 2003 to 2009.

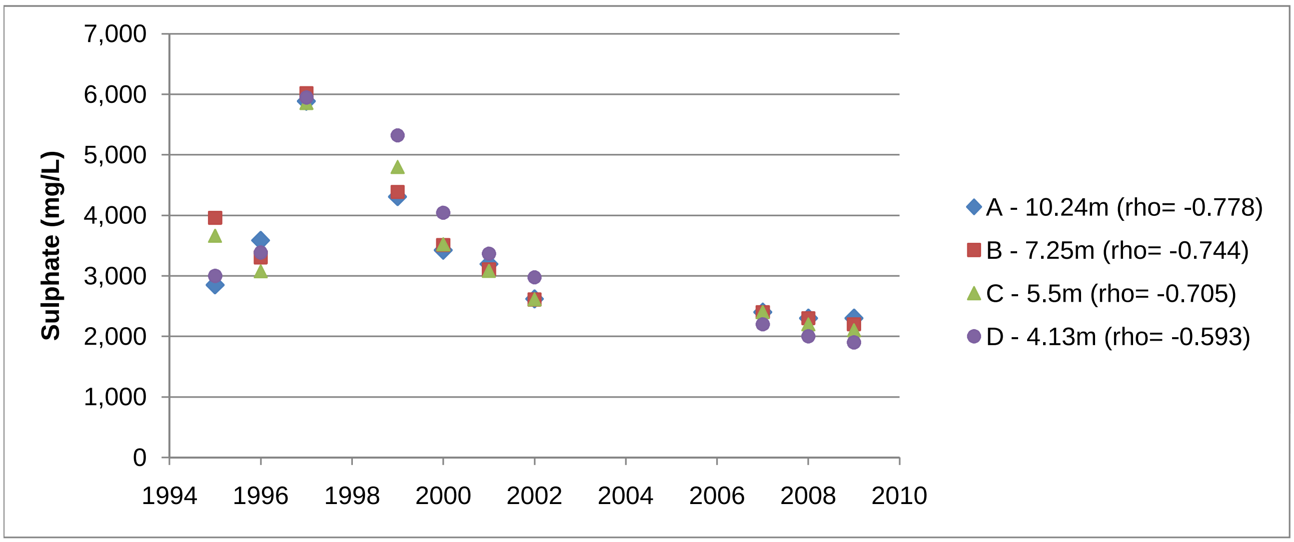


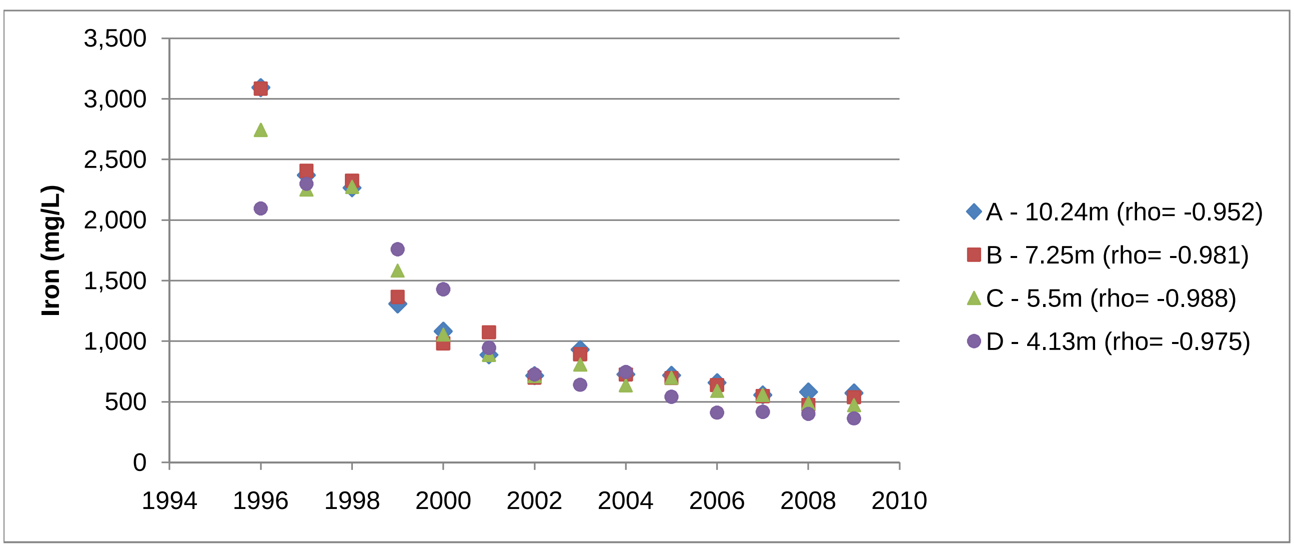
Appendix Figure C.3.2: Significant common (average) trends observed for acidity over all seasons at station Cell 14, 2003 to 2009.



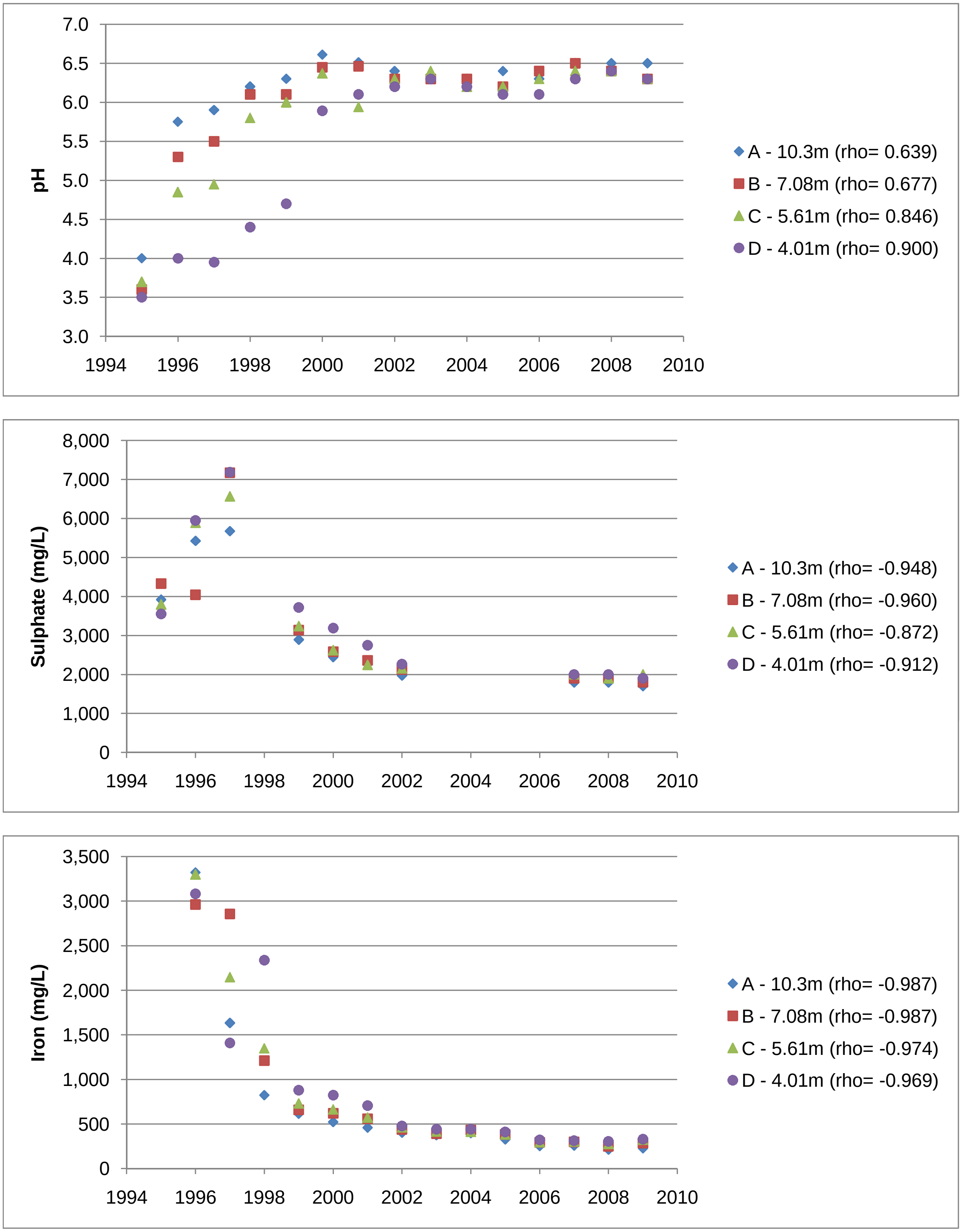
Appendix Figure C.3.3: Significant trends observed for pH, and iron at station DK14-5 C, 1991 to 2009.



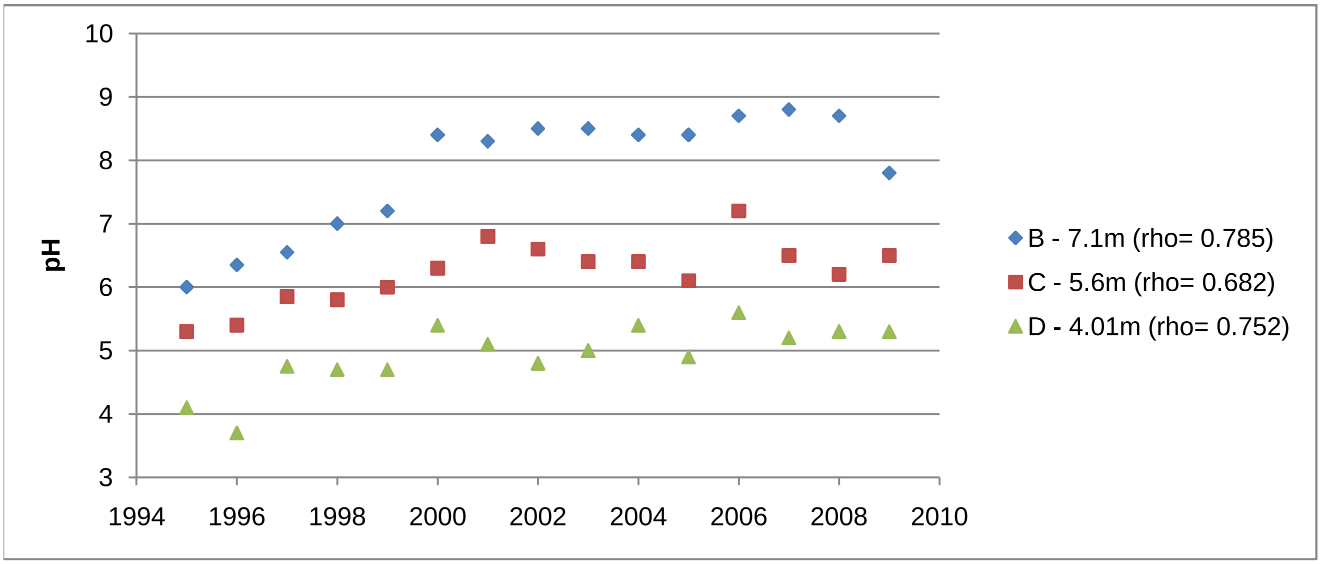


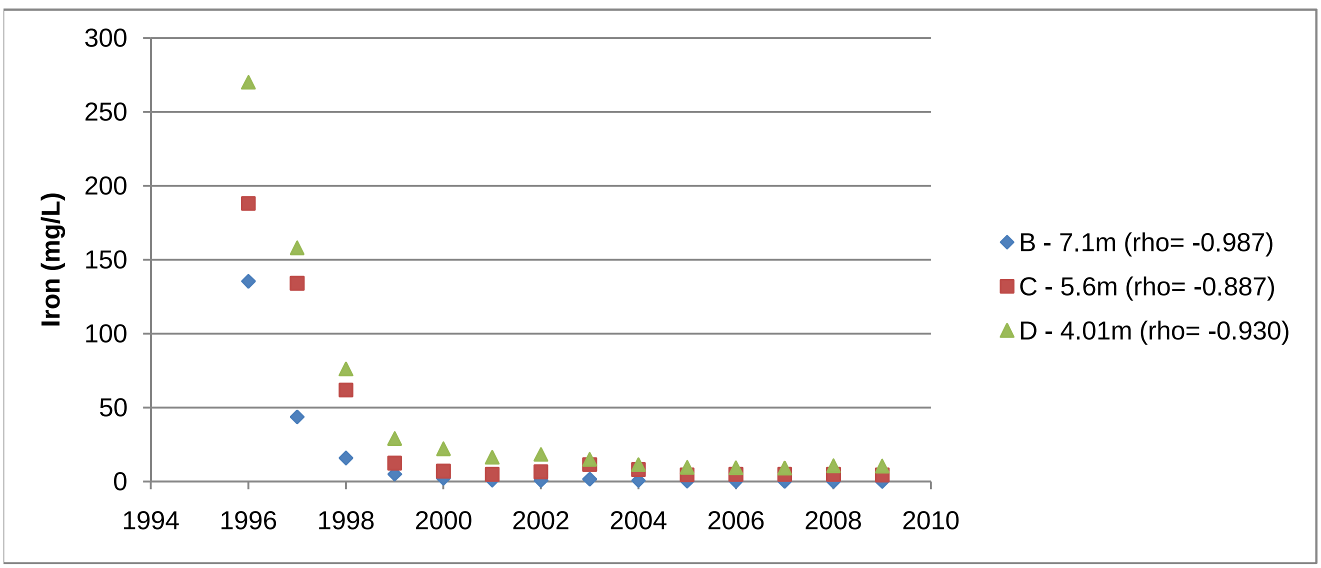


Appendix Figure C.3.4: Significant trends observed for pH, sulphate, and iron at station DK15-2 A, B, C, D, 1995 to 2009.

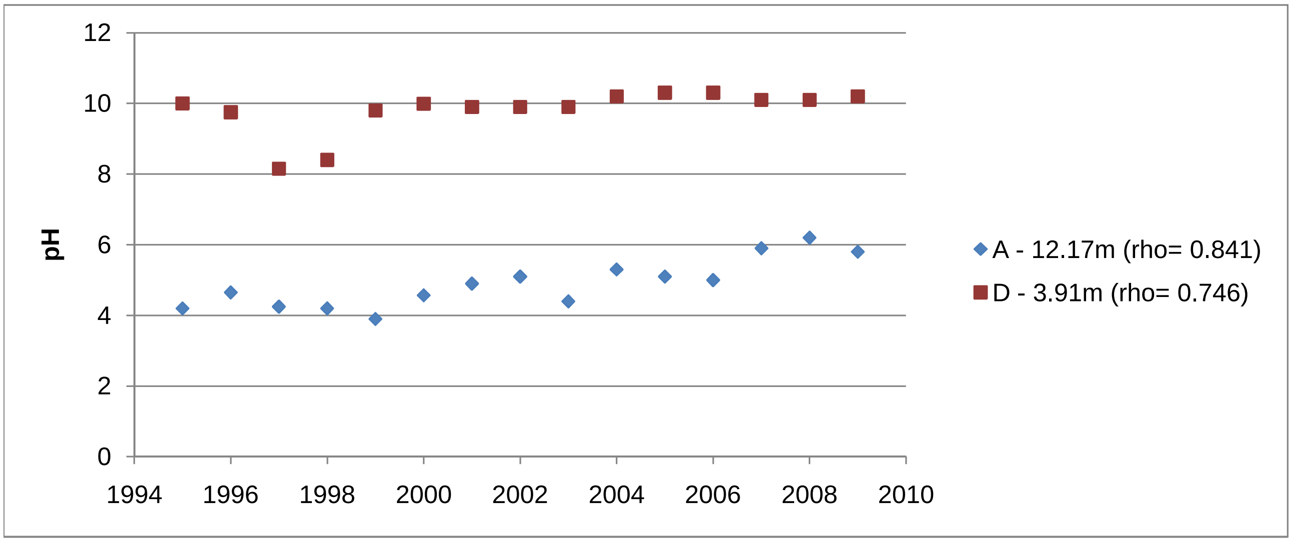


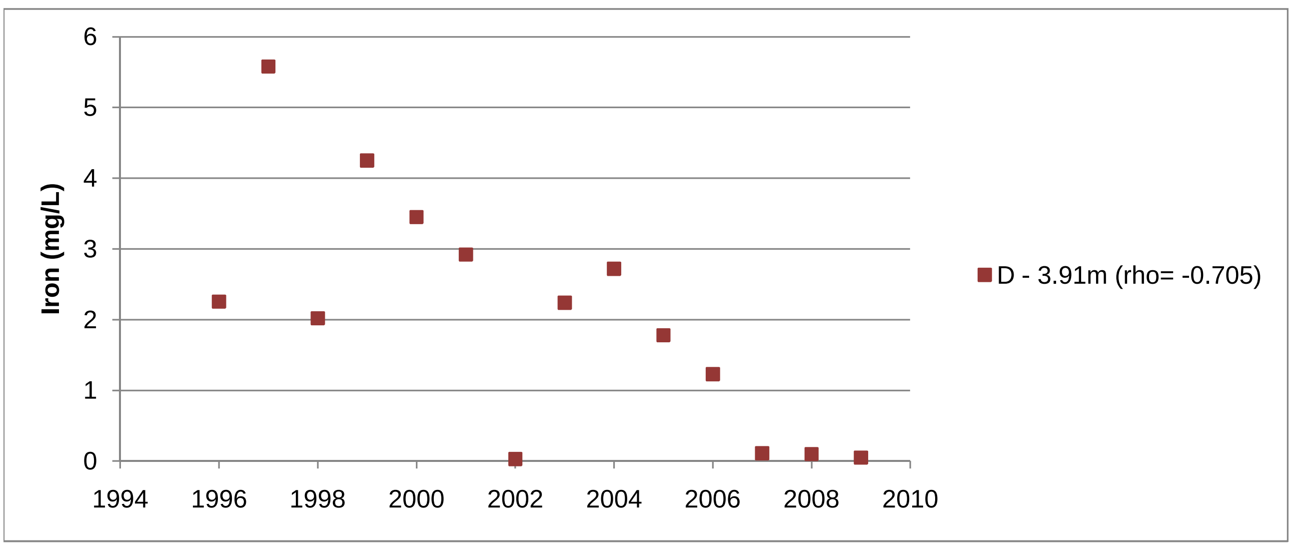
Appendix Figure C.3.5: Significant trends observed for pH, sulphate, and iron at station DK15-4 A, B, C, D, 1995 to 2009.



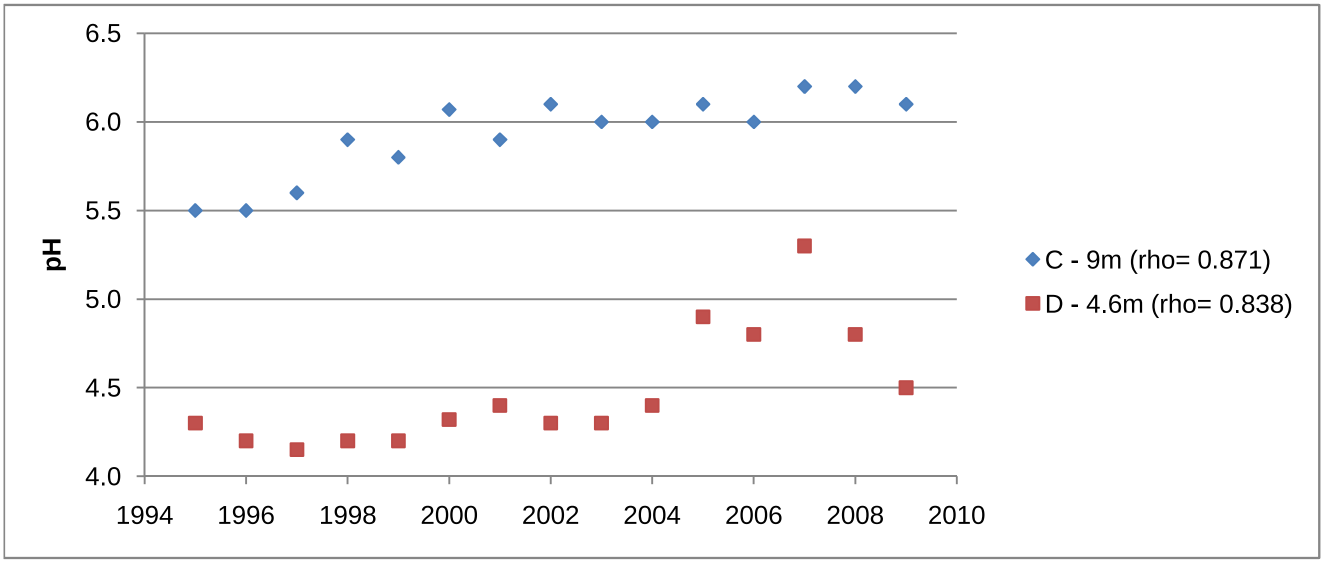


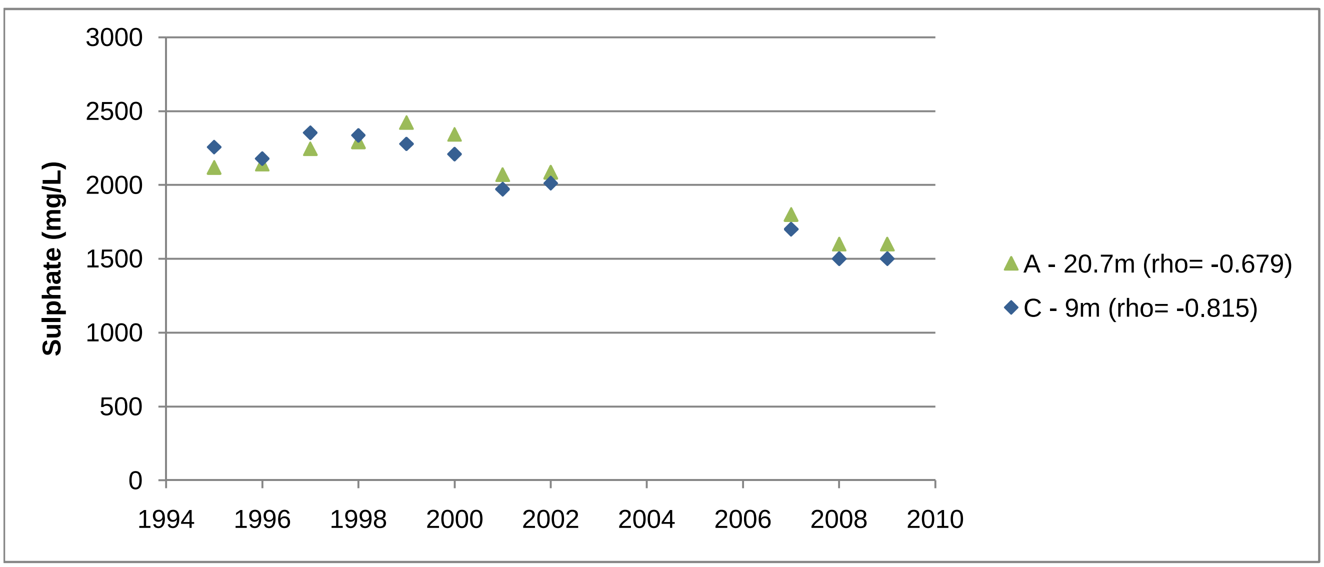
Appendix Figure C.3.6: Significant trends observed for pH and iron at station DK16-2 B, C, D, 1995 to 2009.



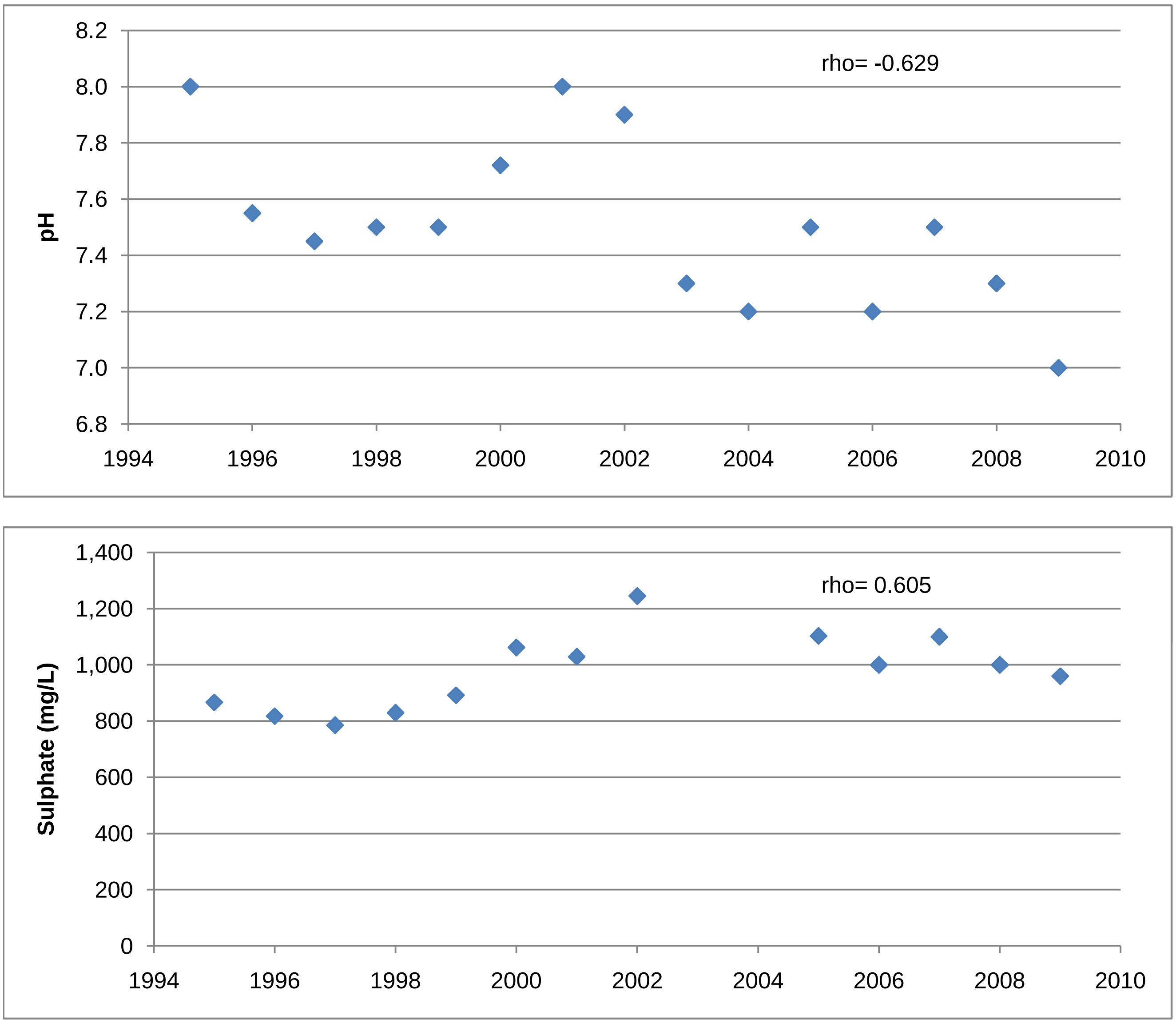


Appendix Figure C.3.7: Significant trends observed for pH and iron at station DK17-2 A, D, 1995 to 2009.

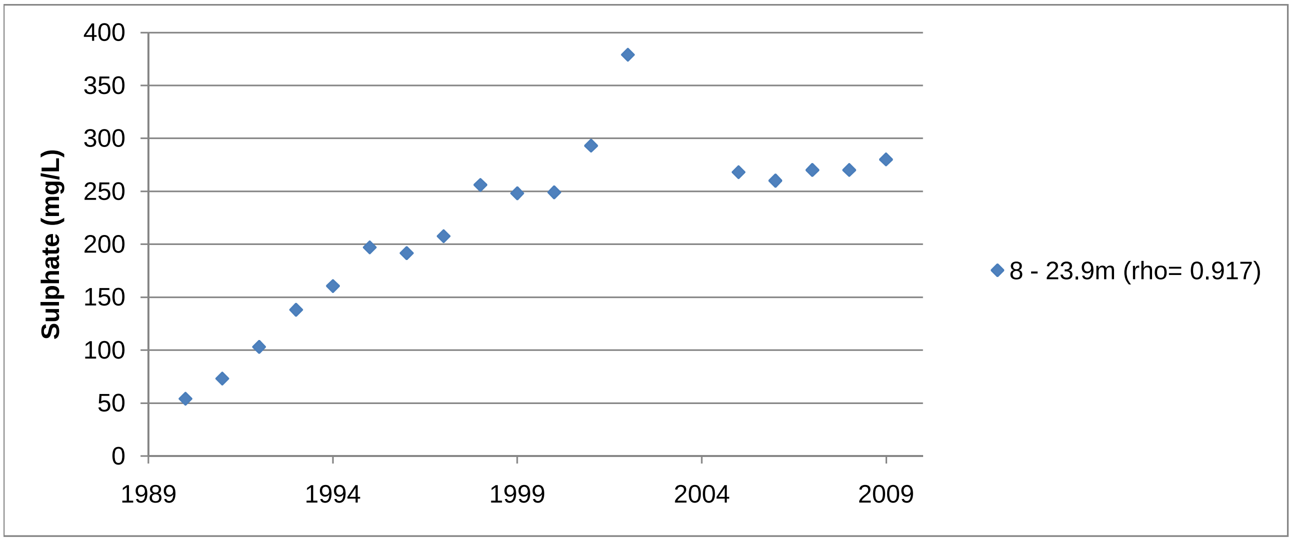


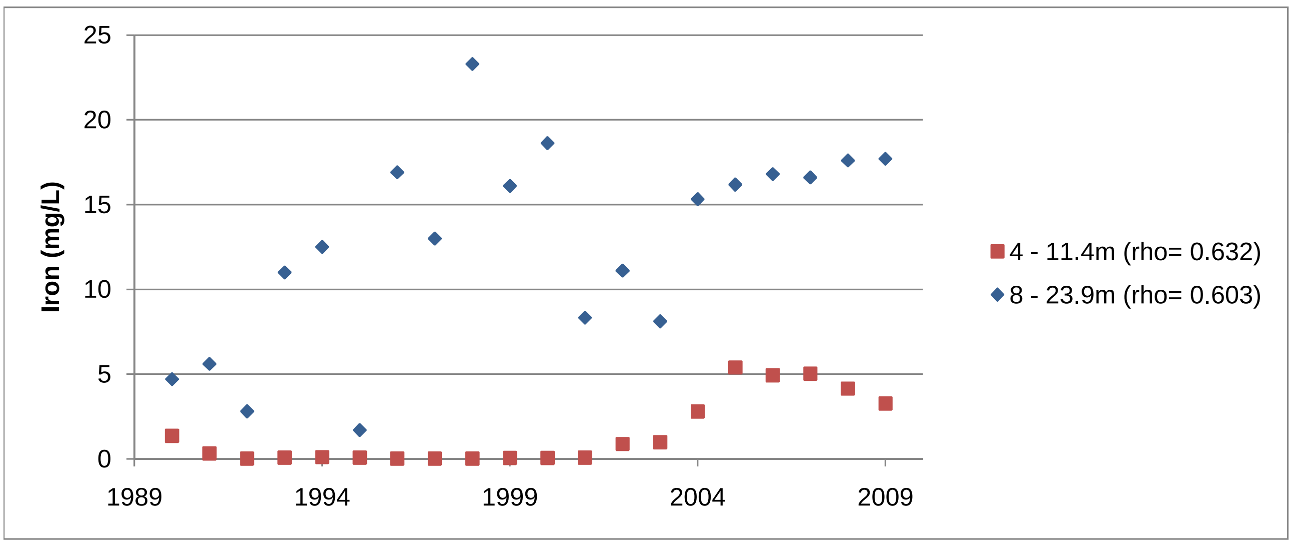


Appendix Figure C.3.8: Significant trends observed for pH and sulphate at station 95QW-3 A, C, D, 1995 to 2009.

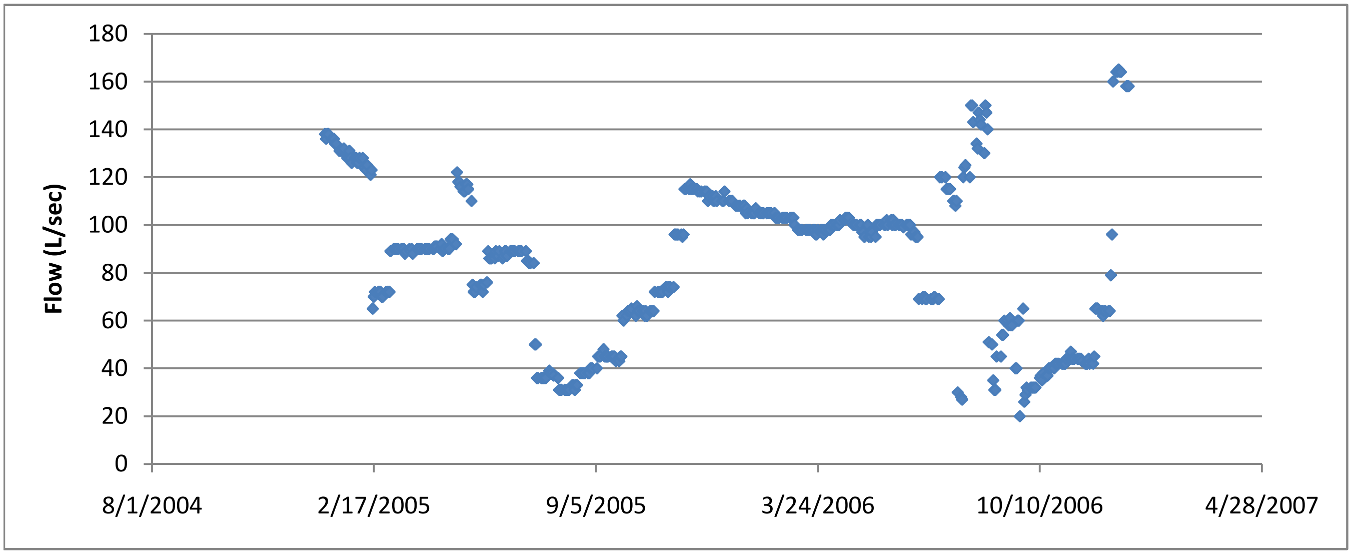


Appendix Figure C.3.9: Significant trends observed for pH and sulphate at station 95QW-4, 1995 to 2009.

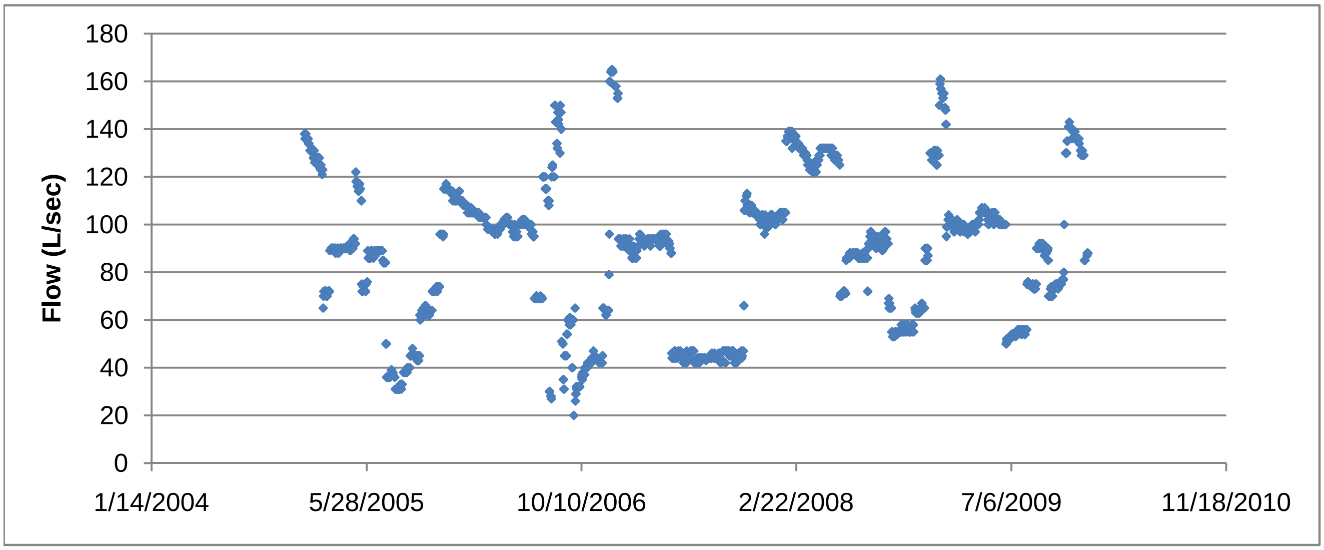




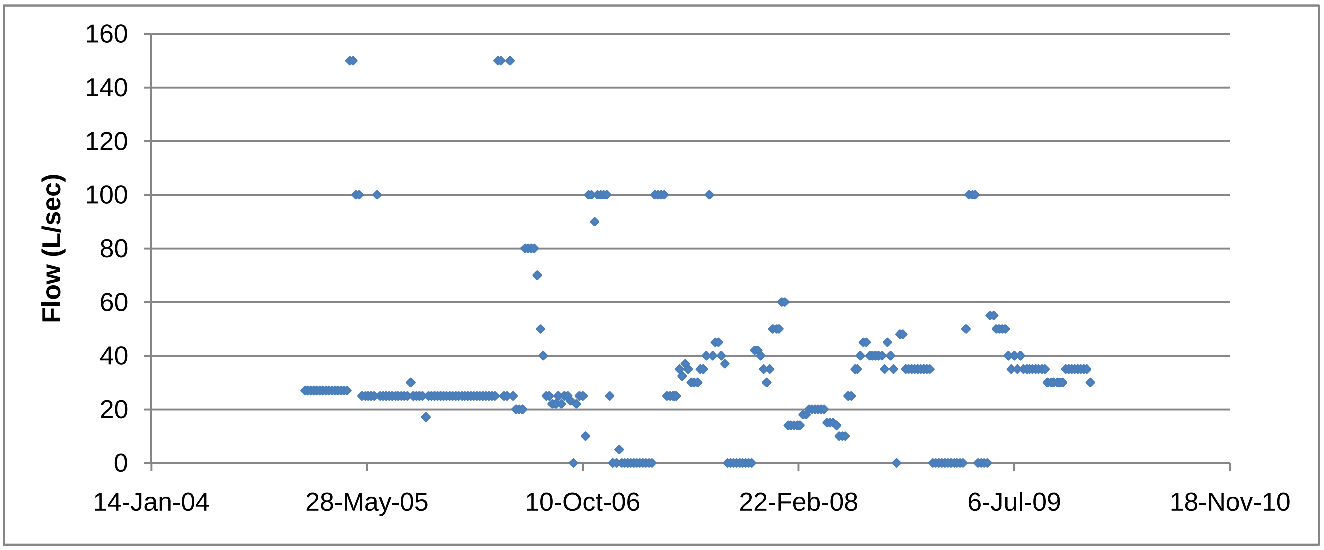
Appendix Figure C.3.10: Significant trends observed for iron and sulphate at station QPW1-4 and -8, 1990 to 2009.



Appendix Figure C.3.11: Flows at Station CL-05 from 2006 to 2007.



Appendix Figure C.3.12: Flows at station Q-05 from 2005 to 2009.



Appendix Figure C.3.13: Flows at station Q-29 from 2005 to 2009.

APPENDIX C.4
Panel TMA

Appendix Table C.4.1: Panel final point of control (P-14) discharge criteria.

Parameter[f]	Units	Discharge Criteria			Action Level	Internal Investigation
		Grab Sample[a]	Monthly Mean[b]	Composite [e]		
pH	pH units	5.5-9.5	6.5-9.5	6.0-9.5	<6.5 or >8.5	<7.0 or >8.0
Dissolved Radium-226 [c,d]	Bq/L	1.11	0.37	0.74	0.37	0.20
Total Suspended Solids	mg/L	50	25	37.5	30	7.5

[a]Samples to be collected during periods of discharge.
[b]Arithmetic mean of twelve consecutive samples.
[c] The radium-226 criteria are waived if total radium-226 average loading < 12 Bq/s.
[d] Discharge criteria are for dissolved radium-226, while measured and reported values are for total radium-226.
[e] Consists of 3 equal volumes collected at equal intervals over a 7 to 24 hour period.
[f] Copper, lead, nickel and zinc monitoring discontinued in January 2010 as per regulatory approval of Cycle 3 design.
[g] Radium-226 criterion are waived if total radium-226 average annual loading is < 12 Bq/s.

Appendix Table C.4.2: Water quality at station ECA-349 from 2005 to 2009.

Date	pH	Date	pH	Date	pH	Date	pH	Date	pH
1/6/2005	8.6	4/19/2006	7.8	4/16/2007	7.6	4/29/2008	8.2	4/21/2009	8.2
1/7/2005	8.6	4/20/2006	8.1	4/17/2007	7.8	4/30/2008	8.1	4/22/2009	8.2
1/10/2005	8.5	4/21/2006	8.1	4/18/2007	7.9	5/1/2008	8	4/23/2009	8
1/11/2005	8.5	4/24/2006	8	4/19/2007	7.7	5/2/2008	8.1	4/24/2009	8.2
1/12/2005	8.5	4/25/2006	7.8	4/20/2007	7.8	5/5/2008	8.1	4/27/2009	8.1
1/13/2005	8.5	4/26/2006	7.8	4/23/2007	8.7	5/6/2008	8.1	4/28/2009	8.2
1/14/2005	8.4	4/27/2006	8	4/24/2007	7.5	5/7/2008	8.2	4/29/2009	8.2
1/17/2005	8.4	4/28/2006	8.3	4/25/2007	8.3	5/8/2008	8.1	4/30/2009	8.2
1/18/2005	8.2	5/1/2006	7.9	4/26/2007	8	5/9/2008	8.3	5/1/2009	8.1
1/19/2005	8.2	5/2/2006	8.2	4/27/2007	8.3	5/12/2008	8.2	5/4/2009	8.6
1/20/2005	8	5/3/2006	8.2	4/30/2007	8.8	5/13/2008	8	5/5/2009	8.6
1/21/2005	8.2	5/4/2006	8	5/1/2007	7.7	5/14/2008	8	5/6/2009	8.2
1/24/2005	8	5/5/2006	7.7	5/2/2007	9	5/15/2008	8	5/7/2009	8.3
1/25/2005	8	5/8/2006	8.2	5/3/2007	8.5	5/16/2008	8	5/8/2009	8.2
1/26/2005	7.9	5/9/2006	7.9	5/4/2007	8	5/20/2008	8.4	5/11/2009	8.4
1/27/2005	7.9	5/10/2006	7.9	5/7/2007	7.9	5/21/2008	8.3	5/12/2009	8.2
1/28/2005	7.9	5/11/2006	7.9	5/8/2007	8.3	5/22/2008	8.2	5/13/2009	8.5
1/31/2005	8.3	5/12/2006	8	5/9/2007	8.4	5/23/2008	8.3	5/14/2009	8.3
2/1/2005	8.3	5/15/2006	8	5/10/2007	8.3	5/26/2008	8.2	5/15/2009	8.7
2/2/2005	8.3	5/16/2006	7.9	5/11/2007	8.4	6/24/2008	8.5	5/19/2009	8.6
2/3/2005	8.3	5/17/2006	8	5/14/2007	7.6	6/25/2008	8.5	5/20/2009	8.5
2/4/2005	8.2	5/18/2006	7.7	5/15/2007	7.9	6/26/2008	8.2	5/21/2009	8.5
2/7/2005	8	5/19/2006	7.9	5/16/2007	7.9	6/27/2008	8.2	5/22/2009	8.7
2/8/2005	8	5/23/2006	7.9	11/9/2007	8	7/1/2008	8.2	5/25/2009	8.7
2/9/2005	7.9	5/24/2006	7.9	11/12/2007	8	7/2/2008	8.3	5/26/2009	8.8
2/10/2005	8	5/25/2006	7.9	11/13/2007	8.1	7/3/2008	8.2	5/27/2009	8.6
2/11/2005	8	5/26/2006	7.9	11/14/2007	8.6	7/4/2008	8.1	5/28/2009	8.7
2/14/2005	8.2	5/29/2006	7.8	11/15/2007	8.4	7/7/2008	8.4	5/29/2009	8.7
2/15/2005	8.3	5/30/2006	8	11/16/2007	8.2	7/8/2008	8.4	6/1/2009	8.4
2/16/2005	8	5/31/2006	8	11/19/2007	8.5	7/9/2008	8.4	6/2/2009	8.5
2/17/2005	8.1	6/1/2006	7.9	11/20/2007	8.3	7/10/2008	8.2	6/3/2009	8.5
2/18/2005	8.2	6/2/2006	7.8	11/21/2007	8.5	8/6/2008	8.2	6/4/2009	8.5
2/21/2005	7.4	6/5/2006	8.2	11/22/2007	8.5	8/7/2008	8.1	6/5/2009	8.7
2/22/2005	7.9	6/6/2006	8.2	11/23/2007	8.5	8/8/2008	8.3	6/8/2009	8.8
5/2/2005	8.7	6/7/2006	8.2	11/26/2007	8.5	8/11/2008	8.1	6/9/2009	8.7
5/3/2005	8.7	6/8/2006	8.2	11/27/2007	8.5	8/12/2008	7.6	6/10/2009	8.7
5/4/2005	8.7	6/9/2006	8	11/28/2007	8.5	8/13/2008	8.3	11/2/2009	8.4
5/5/2005	8.6	10/17/2006	7.8	11/29/2007	8.4	8/14/2008	7.8	11/3/2009	8.8
5/6/2005	8.7	10/18/2006	8.2	11/30/2007	8.5	8/15/2008	8.2	11/4/2009	8.7
5/9/2005	8.7	10/19/2006	8.2	12/3/2007	7.8	8/18/2008	8	11/5/2009	8.8
5/10/2005	8.9	10/20/2006	8.2	12/4/2007	8.1	10/8/2008	8	11/6/2009	8.8
5/11/2005	8.8	10/23/2006	8.2	12/5/2007	8	10/9/2008	8.5	11/9/2009	8.8
5/12/2005	8.8	10/24/2006	8.3	12/6/2007	8.1	10/10/2008	8.5	11/10/2009	8.9
5/13/2005	8.9	10/25/2006	8.2	12/7/2007	8.2	10/14/2008	8.6	11/11/2009	9
5/16/2005	8.6	10/26/2006	8.2	12/10/2007	8.8	10/15/2008	8.6	11/12/2009	8.5
5/17/2005	8.6	10/27/2006	8.2	2/14/2008	7.9	10/16/2008	8.9	11/13/2009	8.5
5/18/2005	8.9	10/31/2006	8.2	2/15/2008	7.8	10/17/2008	8.6	11/16/2009	8.5
5/19/2005	8.7	11/1/2006	8.2	2/19/2008	7.7	10/20/2008	8.6	11/17/2009	8.8
5/20/2005	8.5	11/2/2006	8.2	2/20/2008	7.5	10/21/2008	8.4	11/18/2009	8.9
10/17/2005	8.6	11/3/2006	8.2	2/21/2008	7.5	10/22/2008	8.6	11/19/2009	8.8
10/18/2005	8.8	11/6/2006	8.2	2/22/2008	7.5	10/23/2008	8.5	11/20/2009	8.9
10/19/2005	8.8	11/7/2006	8.3	2/25/2008	7.6	10/24/2008	8.5	11/23/2009	8.4
10/20/2005	8.8	11/8/2006	8.2	2/26/2008	8	10/27/2008	7.3	11/24/2009	8.4
10/21/2005	8.8	11/9/2006	8.1	2/27/2008	8.2	10/28/2008	8.8	11/25/2009	8.4
10/24/2005	8.7	11/10/2006	7.9	2/28/2008	7.9	10/29/2008	8.8	11/26/2009	8.4

Appendix Table C.4.2: Water quality at station ECA-349 from 2005 to 2009.

Date	pH	Date	pH	Date	pH	Date	pH	Date	pH
10/25/2005	8.7	11/13/2006	7.8	2/29/2008	8.2	10/30/2008	8.6	11/27/2009	8.4
10/26/2005	8.7	11/14/2006	8	3/3/2008	8.7	10/31/2008	8.5	11/30/2009	8.2
10/27/2005	8.6	11/15/2006	7.9	3/4/2008	8.1	11/3/2008	8.4	12/1/2009	8.1
10/28/2005	8.8	11/16/2006	7.9	3/5/2008	8	11/4/2008	8.4	12/2/2009	8.1
10/31/2005	8.5	11/17/2006	7.8	3/6/2008	8.1	2/3/2009	7.8	12/3/2009	8.2
11/1/2005	8.6	11/20/2006	8.1	3/7/2008	8	2/4/2009	8.2	12/4/2009	8.2
11/2/2005	8.5	11/21/2006	7.9	3/10/2008	7.8	2/5/2009	8.3	12/7/2009	8.1
11/3/2005	8.5	11/22/2006	7.8	3/11/2008	7.9	2/6/2009	7.9	12/8/2009	8.2
11/4/2005	8.5	11/23/2006	8	3/12/2008	8	2/9/2009	7.9	12/9/2009	8.2
11/7/2005	8.5	11/24/2006	7.9	3/13/2008	8	2/10/2009	7.9	12/10/2009	8.2
11/8/2005	8.5	11/27/2006	8	3/14/2008	8	2/11/2009	8.4	12/11/2009	8.2
11/9/2005	8.5	11/28/2006	8	3/17/2008	8	2/12/2009	8	12/14/2009	8
11/10/2005	8.5	11/29/2006	8	3/18/2008	8	2/13/2009	7.6	12/15/2009	8.2
11/11/2005	8.5	3/6/2007	8.1	3/19/2008	8	2/17/2009	8.4	**Number**	452
11/14/2005	8.5	3/7/2007	8	3/20/2008	7.8	2/18/2009	8.1	**Minimum**	7.3
11/15/2005	8.5	3/8/2007	8	3/24/2008	8.2	2/19/2009	8.4	**Maximum**	9
11/16/2005	8.5	3/9/2007	8	3/25/2008	8.2	2/20/2009	7.8	**Mean**	8.195575
11/17/2005	8.6	3/12/2007	7.8	3/26/2008	7.8	2/23/2009	8	**Median**	8.2
11/18/2005	8.6	3/13/2007	7.8	3/27/2008	7.8	2/24/2009	8	**10th Percentile**	7.8
11/21/2005	8.6	3/14/2007	7.9	3/28/2008	7.5	2/25/2009	8		
11/22/2005	8.6	3/15/2007	8	3/31/2008	7.8	2/26/2009	8.2		
11/23/2005	8.6	3/16/2007	7.9	4/1/2008	8	3/23/2009	7.3		
3/22/2006	8	3/19/2007	7.8	4/2/2008	7.8	3/24/2009	8.8		
3/23/2006	7.8	3/20/2007	7.8	4/3/2008	8	3/25/2009	8.7		
3/24/2006	8.4	3/21/2007	7.7	4/4/2008	8.4	3/26/2009	8.2		
3/27/2006	8.4	3/22/2007	7.8	4/7/2008	8.4	3/27/2009	8.2		
3/28/2006	8.4	3/23/2007	7.7	4/8/2008	8.5	3/30/2009	8.2		
3/29/2006	8.4	3/26/2007	7.6	4/9/2008	8.5	3/31/2009	8.3		
3/30/2006	8.4	3/27/2007	7.6	4/10/2008	8.5	4/1/2009	8.1		
3/31/2006	8.1	3/28/2007	7.5	4/11/2008	8.5	4/2/2009	8.2		
4/3/2006	8	3/29/2007	7.7	4/14/2008	8	4/3/2009	8.2		
4/4/2006	8.1	3/30/2007	7.7	4/15/2008	8.2	4/6/2009	8		
4/5/2006	8	4/2/2007	7.6	4/16/2008	8.1	4/7/2009	7.9		
4/6/2006	8.1	4/3/2007	7.6	4/17/2008	8.2	4/8/2009	7.9		
4/7/2006	8.6	4/4/2007	7.6	4/18/2008	7.5	4/9/2009	8		
4/10/2006	8.2	4/5/2007	7.7	4/21/2008	8.1	4/13/2009	7.8		
4/11/2006	7.7	4/9/2007	7.7	4/22/2008	7.7	4/14/2009	8.1		
4/12/2006	7.8	4/10/2007	7.7	4/23/2008	8	4/15/2009	8		
4/13/2006	7.8	4/11/2007	7.6	4/24/2008	8	4/16/2009	8.1		
4/17/2006	7.4	4/12/2007	7.6	4/25/2008	7.8	4/17/2009	8		
4/18/2006	7.8	4/13/2007	7.6	4/28/2008	8	4/20/2009	8.2		

Appendix Table C.4.3: Water quality at station P-13 from 2005 to 2009.

Date	Acidity (mg/L)	Ba (mg/L)	Co (mg/L)	Fe (mg/L)	Mn (mg/L)	pH	Ra (Bq/L)	SO4 (mg/L)	TSS (mg/L)	U (mg/L)
1/13/2005							0.570			
2/10/2005	3	0.019	0.0006	0.450	0.041	6.8	0.650	279		0.011
5/5/2005	3	0.031	0.0014	0.810	0.114	6.6	0.430	243		0.006
10/27/2005	2	0.016	0.00015	0.150	0.015	7.2	0.520	300		0.0025
11/10/2005							0.690			
3/23/2006	0.5	0.024	0.0009	0.410	0.079	6.6	0.640	250		0.005
4/13/2006							0.690			
5/4/2006	0.5	0.022	0.0015	0.730	0.096	6.9	0.530	180		0.0053
6/8/2006							0.480			
10/26/2006	0.5	0.022	0.0006	0.300	0.032	7.1	0.490	220		0.0039
11/9/2006							0.560			
1/4/2007	0.5	0.059	0.0007	0.550	0.050	6.7	0.550	220	1	0.0043
2/1/2007	0.5	0.024	0.0009	0.560	0.057	6.7	0.550	220	1	0.0051
3/1/2007	0.5	0.044	0.0007	0.650	0.067	6.7	0.580	230	3	0.0037
4/19/2007	0.5	0.043	0.0006	0.290	0.058	6.7	0.790	230	1	0.0043
5/10/2007	0.5	0.034	0.0013	0.330	0.096	6.9	0.520	200	1	0.0038
6/7/2007	0.5	0.021	0.0014	1.140	0.147	7.0	0.600	220	2	0.0032
7/5/2007	0.5	0.025	0.0094	2.180	0.817	6.9	1.000	220	5	0.0028
8/2/2007	0.5	0.017	0.00025	0.500	0.032	6.4	0.430	210	1	0.002
9/6/2007	0.5	0.019	0.00025	0.090	0.020	7.4	0.490	230	2	0.0026
10/4/2007	0.5	0.022	0.00025	0.080	0.018	7.1	0.540	220	2	0.0031
11/1/2007	0.5	0.022	0.00025	0.130	0.025	7.2	0.500	220	2	0.0039
11/22/2007	0.5	0.031	0.0006	0.460	0.025	7.0	0.470	210	2	0.0047
12/6/2007	0.5	0.034	0.00025	0.240	0.021	7.0	0.440	220	2	0.0044
1/3/2008	0.5	0.024	0.00025	0.450	0.027	6.9	0.500	230	2	0.0041
2/7/2008	0.5	0.315	0.0006	0.460	0.041	6.9	0.500	220	2	0.0041
2/21/2008	0.5	0.064	0.0006	0.230	0.045	6.9	0.440	210	1	0.005
3/6/2008	0.5	0.026	0.0005	0.240	0.043	6.9	0.400	230	0.5	0.005
4/3/2008	0.5	0.067	0.0006	0.320	0.056	6.9	0.430	220	1	0.0053
5/1/2008	0.5	0.019	0.0018	0.550	0.178	6.9	0.420	180	2	0.0055
5/22/2008	0.5	0.018	0.0015	0.550	0.149	6.9	0.480	180	2	0.0055
7/3/2008	0.5	0.017	0.00025	0.100	0.023	7.2	0.350	180	2	0.0032
8/7/2008	0.5	0.013	0.00025	0.070	0.020	7.2	0.280	180	1	0.0022
10/9/2008	0.5	0.016	0.00025	0.090	0.020	7.2	0.400	190	2	0.0028
10/16/2008	0.5	0.02	0.00025	0.130	0.029	7.1	0.420	190	2	0.003
11/13/2008	0.5	0.019	0.00025	0.110	0.019	7.2	0.440	180	2	0.0038
2/12/2009	0.5	0.033	0.00025	0.100	0.031	7.0	0.480	190	2	0.0033
3/26/2009							0.510		0.5	
4/8/2009	0.5	0.024	0.00025	0.170	0.081	6.7	0.530	200	0.5	0.0041
5/7/2009							0.520		0.5	
6/4/2009							0.390		1	
9/16/2009	0.5	0.014	0.00025	0.100	0.032	7.2	0.380	180	2	0.0029
11/5/2009	0.5	0.017	0.00025	0.050	0.014	7.2	0.420	190	1	0.004
12/10/2009							0.310		1	
Number	35	35	35	35	35	35	44	35	33	35
Minimum	0.5	0.013	0.00015	0.05	0.014	6.4	0.28	180	0.5	0.002
Maximum	3	0.315	0.0094	2.18	0.817	7.4	1	300	5	0.011
Mean	0.7	0.035	0.00086	0.39	0.075	6.9	0.507	213.5	1.6	0.0042
Median	0.5	0.022	0.00060	0.30	0.041	6.9	0.495	220.0	2.0	0.004
10th Percentile	0.5	0.016	0.00025	0.09	0.019	6.7	0.393	180.0	0.6	0.0027

(Shaded) Concentration below maximum MDL.

Appendix Table C.4.4: Water quality at station P-15 from 2005 to 2009.

Date	Conductivity (µmho/cm)	Date	Conductivity (µmho/cm)
1/6/2005	434	7/5/2007	436.7
2/18/2005	373.7	8/2/2007	593.0
3/11/2005	420	9/6/2007	490.0
4/7/2005	312.3	10/4/2007	522.0
5/5/2005	347.5	11/1/2007	450.7
6/9/2005	388.4	12/6/2007	418.5
7/12/2005	465	1/24/2008	345.9
8/4/2005	534	2/28/2008	412.5
9/9/2005	504	3/25/2008	421.8
10/14/2005	486	4/24/2008	305.5
11/17/2005	403.8	5/9/2008	331.2
12/8/2005	434.4	6/4/2008	349.3
1/23/2006	481	7/7/2008	354.6
2/2/2006	477	8/12/2008	347.7
3/13/2006	478	9/17/2008	386.7
4/13/2006	352.7	10/16/2008	400.5
5/4/2006	395.8	11/6/2008	405.1
6/6/2006	412.3	12/5/2008	293.3
7/6/2006	436.9	1/12/2009	418.2
8/22/2006	491	2/23/2009	387.5
9/7/2006	512	3/16/2009	450.4
10/26/2006	423.6	4/15/2009	378.4
11/30/2006	390.6	5/20/2009	344.8
12/18/2006	387.3	6/4/2009	382.5
1/4/2007	419.8	7/3/2009	399.7
2/2/2007	441.3	8/21/2009	418.4
3/1/2007	442.4	9/10/2009	444.1
4/19/2007	382.5	10/26/2009	439.8
5/3/2007	379.3	11/23/2009	412.3
6/7/2007	419.4	12/17/2009	417.7
Number			60
Minimum			293.3
Maximum			593
Mean			416.4
Median			418.0
10th Percentile			347.3

Appendix Table C.4.5: Water quality at station P-16A from 2005 to 2009.

Date	Acidity (mg/L)	Fe (mg/L)	pH	SO4 (mg/L)
7/1/2005	32	0.271	6.6	1,172
6/1/2006	0.5	0.19	6.6	1,200
7/30/2007	0.5	0.07	6.8	1200.0
7/14/2008	0.5	0.25	6.5	1100.0
9/3/2009	0.5	0.38	7.2	1100.0
Number	5	5	5	5
Minimum	0.5	0.07	6.5	1100
Maximum	32	0.38	7.2	1200.0
Mean	6.8	0.23	6.7	1154.4
Median	0.5	0.25	6.6	1172.0
10th Percentile	0.5	0.12	6.5	1100.0

(Shaded) Concentration below maximum MDL.

Appendix Table C.4.6: Water quality at station P-20 from 2005 to 2009.

Date	Acidity (mg/L)	Conductivity (μmho/cm)	Fe (mg/L)	pH	SO4 (mg/L)
7/1/2005	24.00	1298.00	1.10	7.1	
6/1/2006	0.50	1271.00	1.37	7	
7/31/2007	0.50		2.84	7.2	460.00
7/15/2008	0.50		3.58	6.8	390.00
6/15/2009	0.50		2.71	6.9	310.00
Number	5	2	5	5	3
Minimum	0.50	1271.00	1.10	6.8	310.00
Maximum	24.00	1298.00	3.58	7.2	460.00
Mean	5.20	1284.50	2.32	7.0	386.67
Median	0.50	1284.50	2.71	7.0	390.00
10th Percentile	0.50	1273.70	1.21	6.8	326.00

[shaded box] Concentration below maximum MDL.

Appendix Table C.4.7: Water quality at station P-21 from 2005 to 2009.

Date	Acidity (mg/L)	Ba (mg/L	Co (mg/L)	Fe (mg/L)	Mn (mg/L)	pH	Ra (Bq/L)	SO4 (mg/L)	TSS (mg/L)	U (mg/L)
4/18/2005	5					6.0	0.015			
12/1/2005	3					7.4	0.150			
4/25/2006	0.5					7.0	0.130			
12/18/2006	0.5					7.0	0.110			
1/4/2007	0.5	0.015	0.0025	0.01	0.01	7.1	0.140	300	1.0	0.0079
2/1/2007	0.5	0.015	0.00025	0.03	0.01	7.2	0.140	310	1.0	0.0081
3/1/2007	0.5	0.014	0.00025	0.01	0.01	7.2	0.120	320	1	0.0059
4/19/2007	1	0.0025	0.00025	0.05	0.02	6.1	0.024	36	0.5	0.0009
5/3/2007	0.5	0.013	0.00025	0.07	0.02	7.2	0.150	280	1	0.0067
6/7/2007	0.5	0.013	0.0014	0.06	0.01	6.9	0.140	290	0.5	0.0068
7/5/2007	0.5	0.014	0.0012	0.06	0.02	7.6	0.150	300	2	0.0070
8/2/2007	0.5	0.013	0.00025	0.03	0.01	7.7	0.110	280	1	0.0056
9/6/2007	0.5	0.013	0.00025	0.11	0.02	7.6	0.140	320	0.5	0.0089
10/4/2007	0.5	0.014	0.00025	0.06	0.02	7.0	0.150	310	1	0.0068
11/1/2007	0.5	0.014	0.0018	0.04	0.03	7.0	0.140	300	1	0.0076
12/6/2007	0.5	0.014	0.0005	0.05	0.02	7.2	0.130	300	1	0.0082
1/3/2008	0.5	0.014	0.00025	0.02	0.02	6.9	0.130	400	0.5	0.0081
4/3/2008	0.5					6.9	0.130			
11/6/2008	0.5					6.9	0.120			
4/15/2009	0.5			0.03		6.9	0.120	240		
11/23/2009	0.5			0.04		6.8	0.120	250		
Number	21	13	13	15	13	21	21	15	13	13
Minimum	0.5	0.0025	0.00025	0.01	0.007	6	0.015	36	0.5	0.0009
Maximum	5	0.015	0.0025	0.11	0.027	7.7	0.15	400	2	0.0089
Mean	0.9	0.013	0.00072	0.04	0.02	7.0	0.122	282	0.9	0.0068
Median	0.5	0.014	0.00025	0.04	0.017	7	0.13	300	1	0.007
10th Percentile	0.5	0.013	0.00025	0.01	0.0096	6.8	0.11	244	0.5	0.00566

[shaded box] Concentration below maximum MDL.

Appendix Table C.4.8: Water quality at station P-31 from 2005 to 2009.

Date	Acidity (mg/L)	Conductivity (µmho/cm)	Fe (mg/L)	pH	SO4 (mg/L)
7/1/2005	24.00	2136.00	0.22	6.6	1171.00
6/1/2006	0.50	2112.00	0.13	6.5	1100.00
7/30/2007	0.50		0.01	6.7	1100.00
7/15/2008	0.50		0.05	6.5	990.00
6/11/2009	0.50		0.10	6.8	930.00
Number	5	2	5	5	5
Minimum	0.50	2112.00	0.01	6.5	930.00
Maximum	24.00	2136.00	0.22	6.8	1171.00
Mean	5.20	2124.00	0.10	6.6	1058.20
Median	0.50	2124.00	0.10	6.6	1100.00
10th Percentile	0.50	2114.40	0.03	6.5	954.00

[shaded box] concentration below maximum MDL.

Appendix Table C.4.9: Summary of seasonal trends for station P-13, 2003 - 2009.

Season	Spearman rho	Acidity	Barium	Cobalt	Iron	Manganese	pH	Ra-226	Sulphate	Uranium
January/February	Correlation Coefficient	-0.89442719	0.6	-0.66688593	-0.3	0.1	0.9	-0.8720816	-0.974679434	-0.9
	Sig. (2-tailed)	0.041	0.285	0.219	0.624	0.873	0.037	0.054	0.005	0.037
	N	5	5	5	5	5	5	5	5	5
March	Correlation Coefficient							-0.88571429		
	Sig. (2-tailed)							0.019		
	N							6		
April	Correlation Coefficient	-0.78262379	0.6	-0.35909242	-0.7	0.6	0.7181848	-0.2	-1	-0.8
	Sig. (2-tailed)	0.118	0.285	0.553	0.188	0.285	0.172	0.704	0.000	0.104
	N	5	5	5	5	5	5	6	5	5
May	Correlation Coefficient							-0.54056248		
	Sig. (2-tailed)							0.210		
	N							7		
June	Correlation Coefficient							-0.7		
	Sig. (2-tailed)							0.188		
	N							5		
October	Correlation Coefficient	-0.9258201	0.34786262	0.13093073	-0.02857143	0.142857143	0.6179144	-0.82857143	-0.753702346	
	Sig. (2-tailed)	0.008	0.499	0.805	0.957	0.787	0.191	0.042	0.084	
	N	6	6	6	6	6	6	6	6	
November	Correlation Coefficient							-0.82857143		
	Sig. (2-tailed)							0.042		
	N							6		

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

"ns" denotes not significant.

[shaded box] Significant trend where p<0.05.

Appendix Table C.4.10: Seasonal trend Spearman correlation for TOMP station P-21, 2003 - 2009.

Season	Spearman rho	pH	Ra-226
April	Correlation Coefficient	0.490990253	0.432449982
	Sig. (2-tailed)	0.263	0.333
	N	7	7
Oct/Nov/Dec	Correlation Coefficient	-0.778311782	-0.774806218
	Sig. (2-tailed)	0.039	0.041
	N	7	7

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

"ns" denotes not significant.

[shaded box] Significant trend where $p<0.05$.

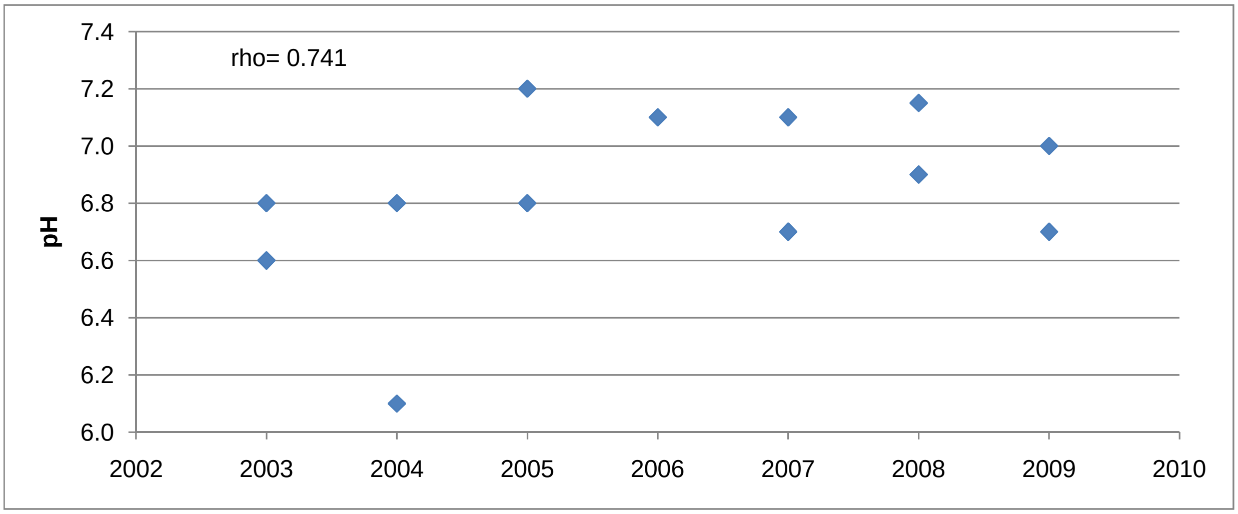
Appendix Table C.4.11: Summary of seasonal trends for Panel groundwater stations, 2003 - 2009.

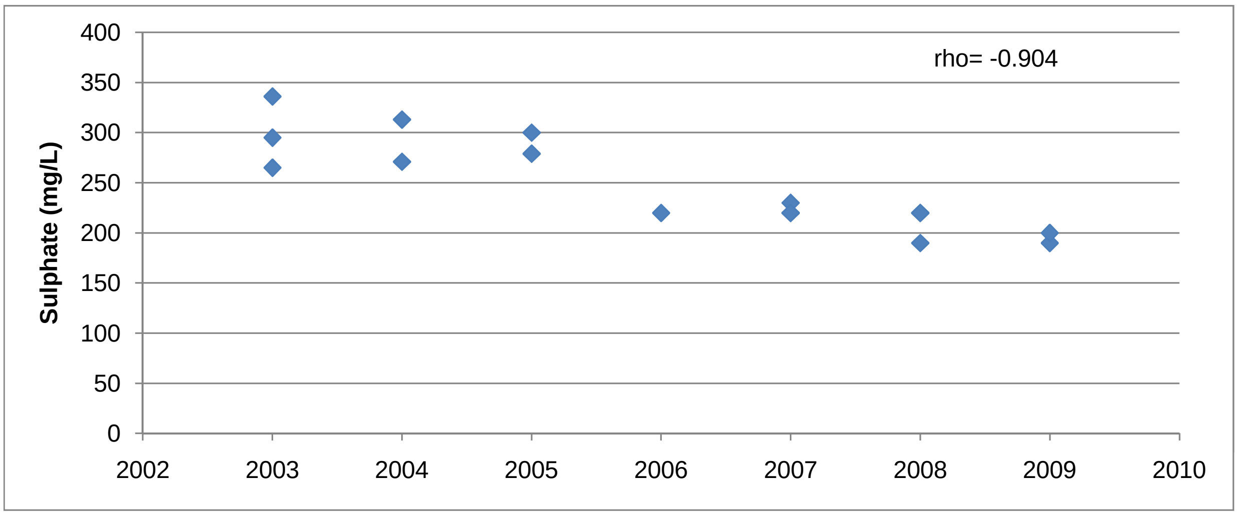
Station	Spearman rho	Iron	pH	Sulphate
P-16A	Correlation Coefficient	-0.085714	-0.751333	0.69938054
	Sig. (2-tailed)	0.719366	0.000134	0.00123679
	N	20	20	18
P-20	Correlation Coefficient	-0.374436	-0.428494	-0.9029412
	Sig. (2-tailed)	0.103841	0.05943	1.6777E-06
	N	20	20	16
P-31	Correlation Coefficient	0.012158	-0.332486	0.16868694
	Sig. (2-tailed)	ns	ns	ns
	N	10	10	8

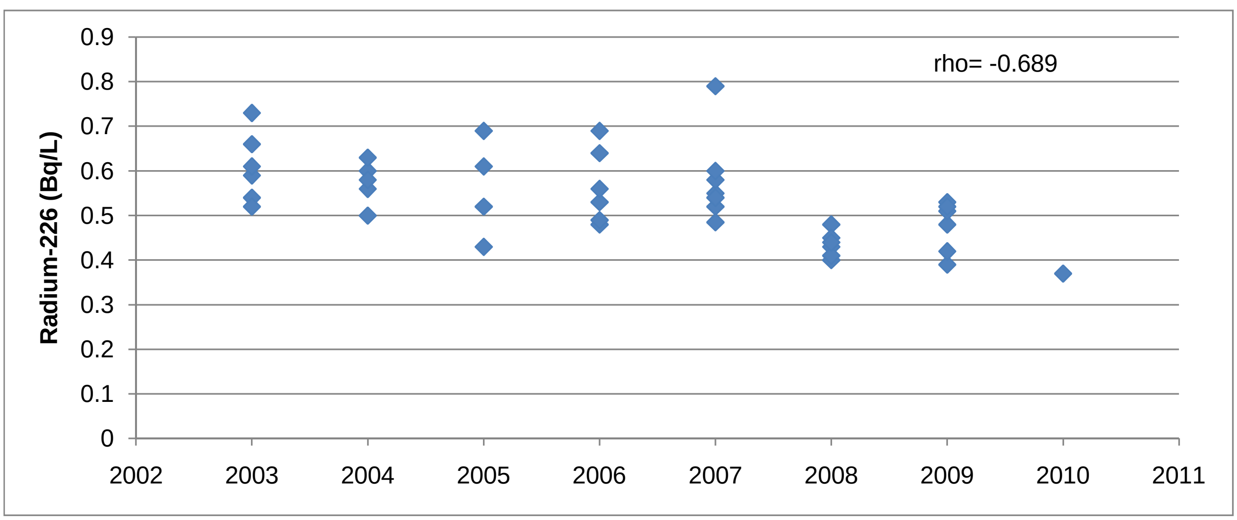
Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

"ns" denotes not significant.

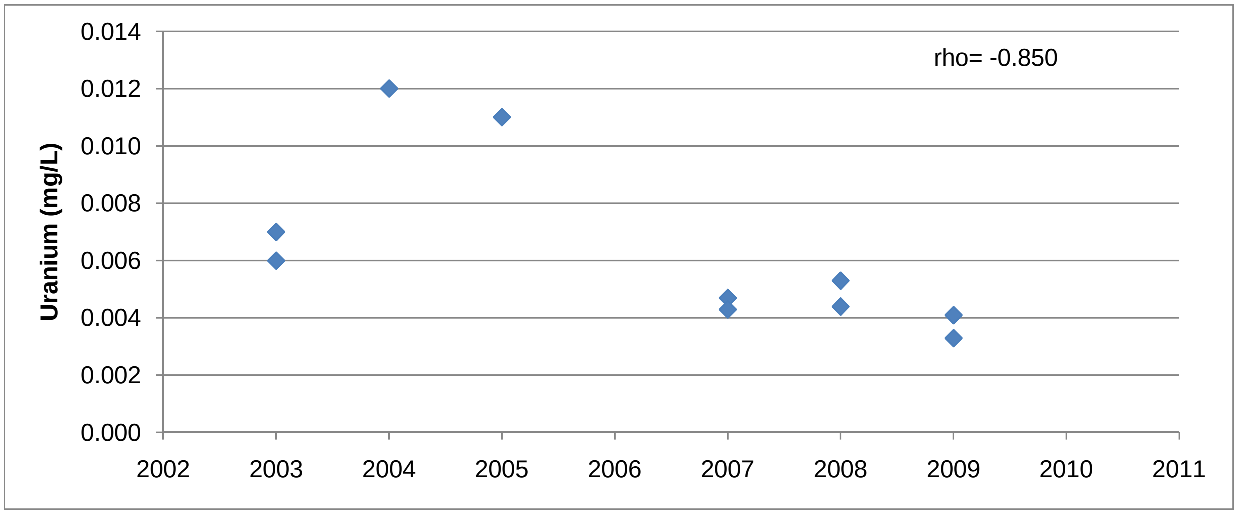
[shaded box] Significant trend where p<0.05.

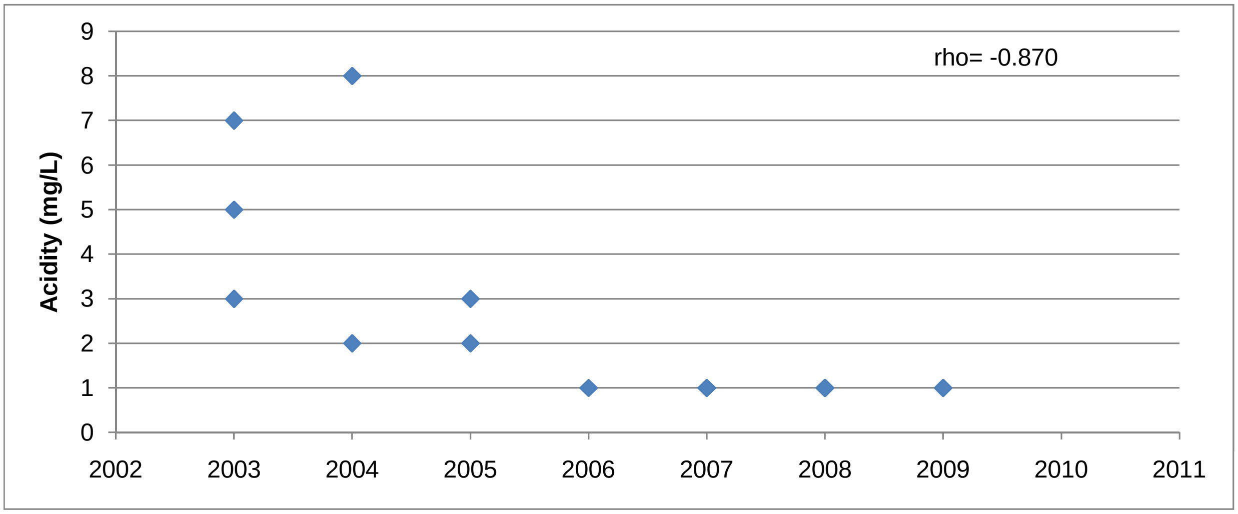




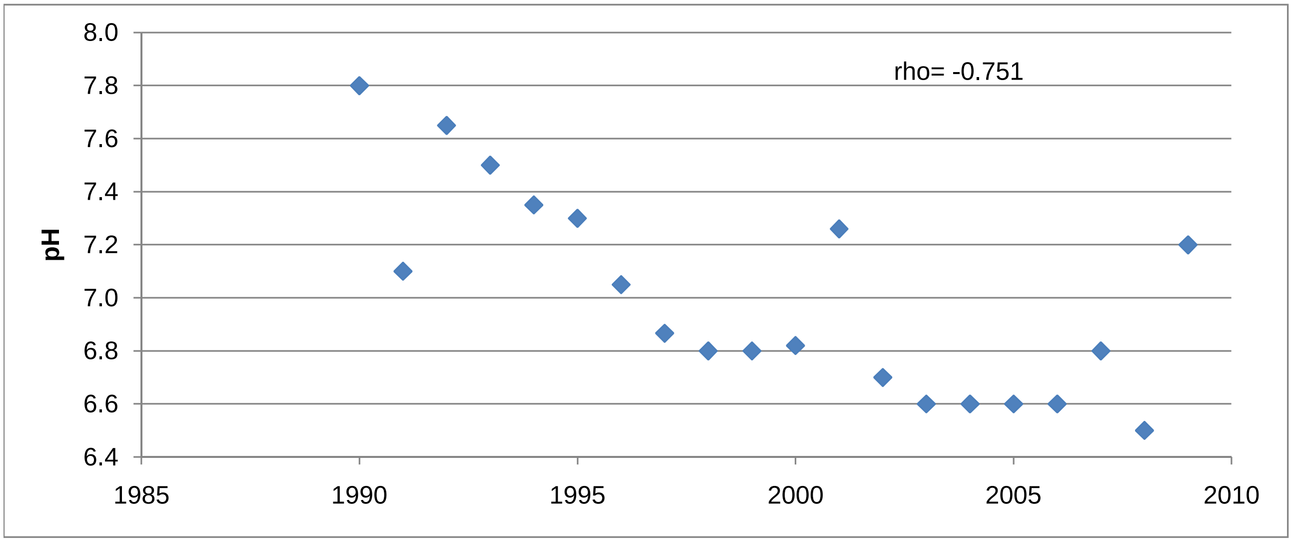


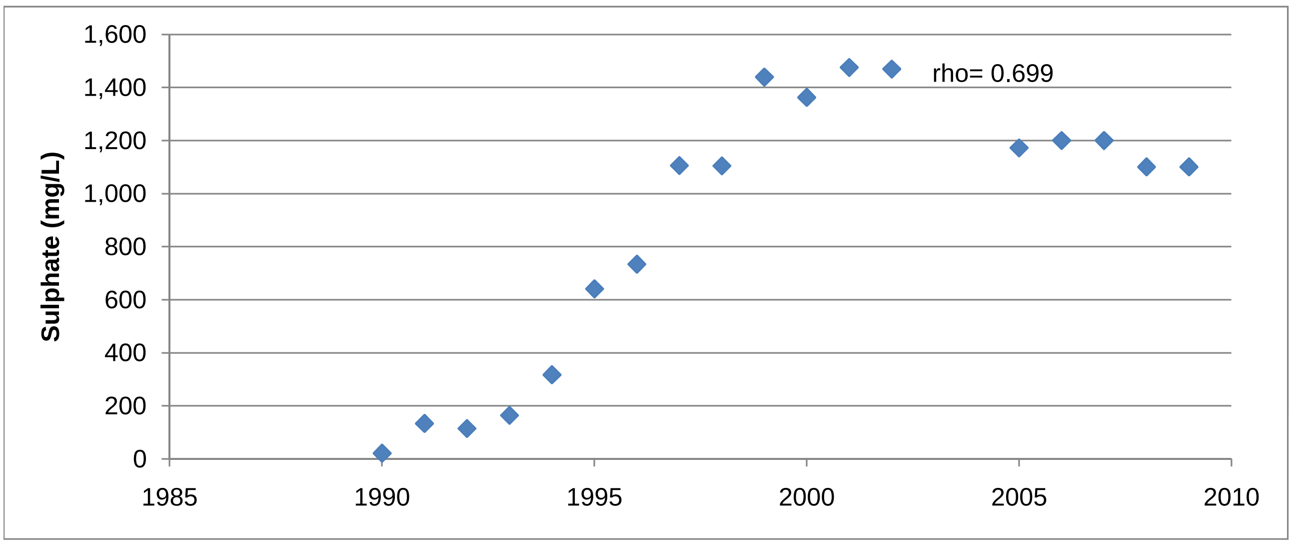
Appendix Figure C.4.1: Significant common (average) trends for pH, sulphate, radium-226, uranium and acidity over all seasons at station P-13, 2003 to 2009.



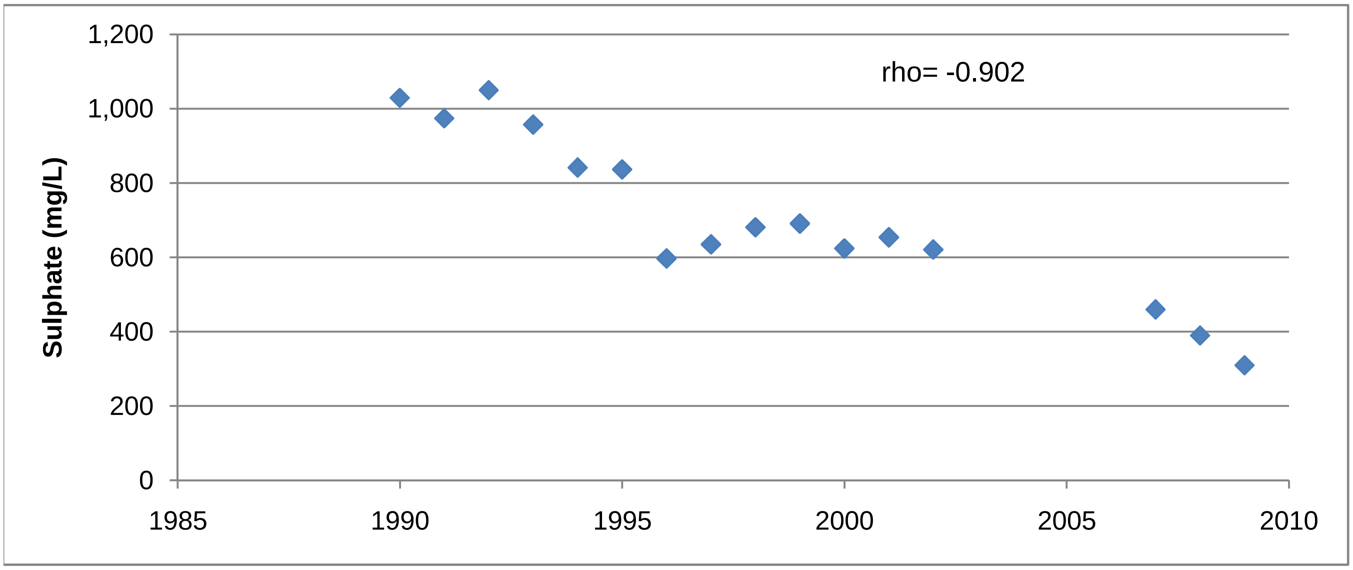


Appendix Figure C.4.1: Significant common (average) trends for pH, sulphate, radium-226, uranium and acidity over all seasons at station P-13, 2003 to 2009.

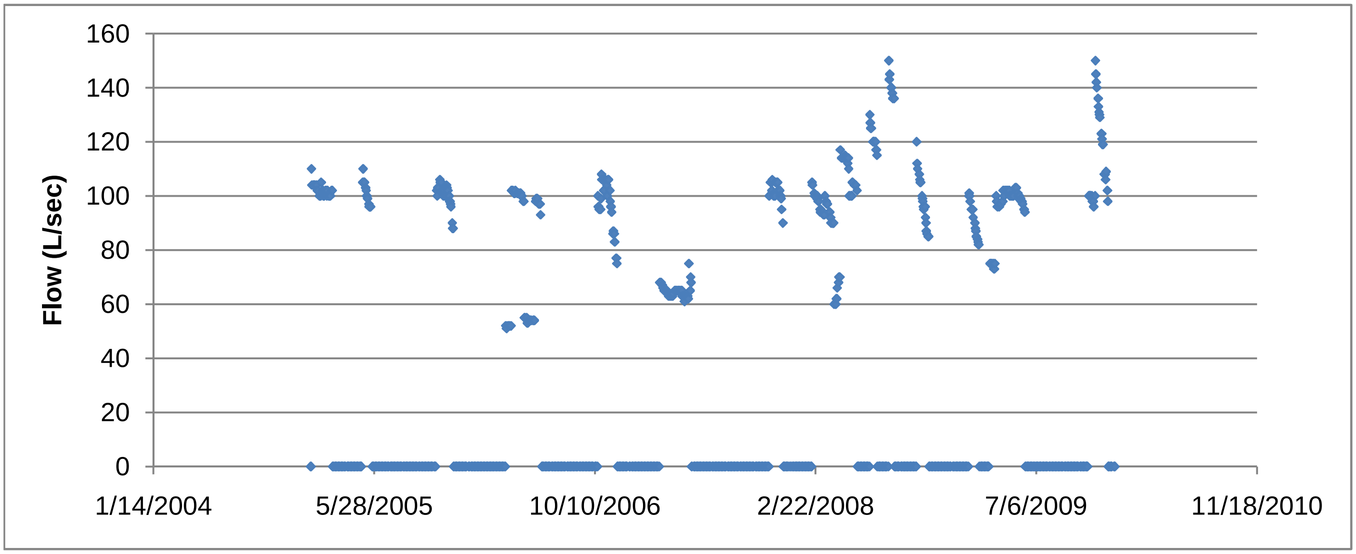




Appendix Figure C.4.2: Significant trends observed for pH and sulphate at station P-16A, 1990 to 2009.



Appendix Figure C.4.3: Significant trends observed for sulphate at station P-20, 1990 to 2009.



Appendix Figure C.4.4: Flows at station P-13 from 2005 to 2009.

APPENDIX C.5
Stanrock TMA

Appendix Table C.5.1: Stanrock final point of control (DS-4) discharge criteria.

Parameter	Units	Discharge Criteria	
		Grab Sample[a]	Monthly Mean[b]
pH	pH units	5.5-9.5	6.5-9.5
Dissolved Radium-226 [c]	Bq/L	1.11	0.37
Total Suspended Solids	mg/L	50.0	25.0

[a]Samples to be collected during periods of discharge.
[b]Arithmetic mean of twelve consecutive samples.
[c]Discharge criteria are for dissolved radium-226, while measured and reported values are for total radium-226.

Appendix Table C.5.2: Water quality at station DS-1, 2005 - 2009.

Date	pH[a]	Ra (Bq/L)
3/15/2005	7.2	0.069
6/14/2005	7.8	0.018
9/13/2005	7.4	0.029
12/13/2005	8.7	0.029
3/14/2006	7.8	0.015
6/13/2006	7.9	0.033
9/12/2006	7.7	0.037
12/12/2006	7.4	0.014
3/13/2007	7.1	0.028
6/12/2007	7.6	0.037
9/11/2007	7.8	0.044
12/11/2007	7.7	0.025
3/11/2008	8.0	0.020
6/10/2008	7.5	0.026
9/9/2008	7.6	0.025
12/9/2008	7.1	0.018
3/10/2009	7.1	0.016
6/9/2009	7.1	0.028
9/8/2009	7.2	0.021
12/8/2009	6.8	0.015
Number	1225	20
Minimum	6.4	0.014
Maximum	10.6	0.069
Mean	7.5	0.027
Median	7.5	0.026
10th Percentile	7.0	0.015

[a] pH measures shown only for dates when other substances were measured but summary statistics reflect all measured values.

Appendix Table C.5.3: Water quality at station DS-2, 2005 - 2009.

Date	Acidity (mg/L)	Ba (mg/L)	Co (mg/L)	Fe (mg/L)	Mn (mg/L)	pH[a]	Ra (Bq/L)	Sulphate (mg/L)	U (mg/L)
1/14/2005						3.1	0.29		
4/12/2005						3.5	0.093		
6/15/2005	565	0.0099	0.127	69.4	4.2	2.7	0.2	2592	0.049
7/20/2005						2.5	0.2		
8/9/2005						2.6	0.24		
11/10/2005						2.6	0.16		
12/13/2005	570	0.0194	0.196	100.9	1.89	2.9	0.28	1465	0.169
3/14/2006	580	0.009	0.31	192.0	3.95	3	0.12	1200	0.179
4/11/2006						3.2	0.023		
6/13/2006						2.6	0.14		
10/11/2006						2.8	0.11		
11/14/2006	451	0.007	0.16	77.6	2.56	2.9	0.096	890	0.0816
12/12/2006						3	0.13		
1/9/2007						3.2	0.140		
2/20/2007						3.0	0.081		
3/13/2007	315	0.013	0.1680	91.6	4.480	2.9	0.100	1000.0	0.0624
4/12/2007						3.1	0.140		
6/12/2007	444	0.006	0.1570	78.1	4.040	2.6	0.100	1000.0	0.0840
10/9/2007						2.9	0.091		
11/13/2007						2.9	0.120		
12/18/2007	572	0.014	0.2730	117.0	2.620	2.7	0.097	1100.0	0.1300
1/8/2008						2.9	0.050		
2/12/2008						2.9	0.098		
3/13/2008	360	0.014	0.1800	99.7	2.550	2.9	0.110	520.0	0.085
4/8/2008						4.3	0.025		
5/13/2008						3.0	0.110		
6/10/2008	225	0.012	0.1200	57.9	1.780	2.8	0.120	670.0	0.0452
7/9/2008						2.7	0.160		
8/26/2008						2.7	0.100		
9/9/2008	323	0.009	0.1270	64.0	2.890	2.8	0.081	960.0	0.039
11/11/2008						2.9	0.070		
12/9/2008	417	0.011	0.1680	85.4	2.530	2.8	0.110	940.0	0.066
3/10/2009	446	0.03	0.2150	151.0	3.520	2.9	0.450	920.0	0.0713
4/14/2009						3.2	0.200		
5/12/2009						2.9	0.130		
6/9/2009	280	0.013	0.1290	50.4	1.720	2.8	0.240	730.0	0.0551
12/8/2009	362	0.016	0.1260	74.9	2.230	2.8	0.190	760.0	0.0470
Number	14	14	14	14	14	499	37	14	14
Minimum	225	0.006	0.1200	50.4	1.72	2.3	0.023	520	0.039
Maximum	580	0.03	0.3100	192	4.48	5.8	0.450	2592	0.179
Mean	422	0.013	0.1754	93.6	2.926	3.0	0.140	1053.4	0.083
Median	431	0.013	0.1640	81.8	2.590	2.9	0.120	950.0	0.069
10th Percentile	291	0.008	0.1263	59.7	1.813	2.7	0.077	688.0	0.046

Appendix Table C.5.4: Water quality at station DS-3, 2005 - 2009.

Date	pH	Date	pH	Date	pH	Date	pH	Date	pH	Date	pH	Date	pH	Date	pH
1/1/2005	10.2	11/13/2007	11.3	11/28/2005	10.3	4/25/2008	10.8	7/27/2006	9.5	12/12/2008	11.2	2/20/2007	9.9	6/8/2009	11.0
1/4/2005	11	11/19/2007	11.7	11/29/2005	11.5	4/28/2008	10.8	8/2/2006	9.8	12/15/2008	10.6	2/28/2007	9.9	6/9/2009	10.7
1/5/2005	10.6	11/20/2007	11.6	11/30/2005	10.3	4/29/2008	10.8	8/3/2006	9.5	12/16/2008	10.6	3/1/2007	10.1	6/16/2009	11.0
1/11/2005	10.7	11/21/2007	11.5	12/1/2005	10.7	4/30/2008	10.7	8/4/2006	9.6	12/17/2008	10.6	3/9/2007	10.1	6/17/2009	10.7
1/12/2005	10.5	11/23/2007	11.4	12/2/2005	10.7	5/1/2008	10.5	8/14/2006	9.7	12/18/2008	11.2	3/13/2007	10.1	7/3/2009	10.8
1/13/2005	10.5	12/6/2007	10.4	12/5/2005	10.8	5/6/2008	10.9	8/15/2006	9.6	12/19/2008	12.0	3/14/2007	10.0	7/7/2009	10.9
1/14/2005	11.1	12/7/2007	10.4	12/8/2005	10.5	5/7/2008	10.7	8/23/2006	10.3	12/22/2008	11.5	3/20/2007	10.1	7/8/2009	10.8
1/20/2005	10.8	12/18/2007	10.8	12/9/2005	10.1	5/8/2008	10.6	8/24/2006	10	12/23/2008	11.5	3/21/2007	10.1	7/9/2009	10.8
2/1/2005	11.1	12/19/2007	11.2	12/13/2005	10.8	5/9/2008	10.6	9/26/2006	10	12/24/2008	12.0	3/22/2007	10.7	7/28/2009	10.8
2/14/2005	10.8	12/21/2007	10.5	12/14/2005	11.5	5/12/2008	10.8	9/27/2006	10	12/29/2008	11.2	3/23/2007	10.7	7/29/2009	11.0
2/15/2005	10.9	12/24/2007	10.2	12/16/2005	10	5/13/2008	10.6	9/28/2006	10.5	12/30/2008	11.0	3/26/2007	10.9	7/30/2009	11.1
3/23/2005	11.4	12/27/2007	10.4	12/19/2005	10	5/14/2008	10.6	9/29/2006	10.4	12/31/2008	10.8	3/27/2007	10.8	8/14/2009	10.8
3/30/2005	11.6	12/28/2007	9.6	12/20/2005	10.5	5/15/2008	10.6	10/3/2006	10.4	1/5/2009	11.0	3/28/2007	11.1	8/24/2009	11.0
3/31/2005	11.5	1/2/2008	10.8	12/21/2005	10.5	5/16/2008	10.6	10/4/2006	10.4	1/6/2009	11.0	3/29/2007	10.9	8/25/2009	10.8
4/1/2005	11.6	1/3/2008	10.8	1/12/2006	10.3	5/22/2008	10.5	10/11/2006	10.6	1/15/2009	10.7	3/30/2007	10.8	10/2/2009	10.8
4/4/2005	11.5	1/7/2008	11.1	1/13/2006	11	5/23/2008	10.5	10/12/2006	10.8	1/16/2009	10.8	4/2/2007	10.4	10/5/2009	10.8
4/5/2005	11.5	1/8/2008	11.2	2/2/2006	10	6/3/2008	10.8	10/13/2006	10.8	1/20/2009	9.0	4/3/2007	10.2	10/6/2009	10.8
4/6/2005	11.9	1/9/2008	10.5	2/3/2006	10	6/4/2008	10.5	10/16/2006	10.5	1/21/2009	11.0	4/4/2007	10.2	10/7/2009	10.7
4/7/2005	11.5	1/10/2008	10.7	2/10/2006	10.2	6/10/2008	10.6	10/17/2006	10.7	2/6/2009	10.8	4/5/2007	10.1	10/8/2009	10.7
4/8/2005	10.8	1/11/2008	10.9	2/23/2006	10.2	6/11/2008	10.4	10/18/2006	10.6	2/12/2009	10.9	4/11/2007	10.2	10/21/2009	10.8
4/11/2005	11	1/17/2008	10.0	3/3/2006	10.2	6/12/2008	10.4	10/19/2006	10.6	2/13/2009	10.6	4/12/2007	10.2	10/22/2009	10.5
4/12/2005	11.2	1/18/2008	10.1	3/8/2006	10.2	6/16/2008	10.8	10/20/2006	10.7	2/19/2009	10.6	4/13/2007	10.1	10/23/2009	10.7
4/15/2005	11	1/22/2008	10.1	3/9/2006	10.1	6/17/2008	10.5	10/23/2006	10.7	2/20/2009	10.3	4/19/2007	10.0	10/26/2009	10.5
4/18/2005	11.4	1/23/2008	10.2	3/10/2006	10	6/18/2008	10.5	10/24/2006	10.5	3/5/2009	10.3	4/20/2007	9.9	10/27/2009	10.5
4/19/2005	11.4	1/25/2008	10.4	3/14/2006	10.7	6/23/2008	10.6	10/25/2006	10.9	3/6/2009	10.5	4/27/2007	10.4	10/28/2009	10.5
4/21/2005	10.7	1/28/2008	10.2	3/15/2006	10.6	6/24/2008	10.5	11/1/2006	10.7	3/9/2009	10.5	5/1/2007	10.5	10/29/2009	10.5
4/22/2005	11.4	1/29/2008	10.0	3/16/2006	10.1	6/25/2008	10.3	11/2/2006	10.7	3/10/2009	11.0	5/2/2007	10.6	10/30/2009	10.5
4/26/2005	10.2	1/30/2008	10.3	3/17/2006	10.1	6/26/2008	10.4	11/3/2006	10.7	3/13/2009	10.3	6/4/2007	10.5	11/2/2009	10.6
4/27/2005	10.3	1/31/2008	10.4	3/22/2006	10.8	6/27/2008	10.5	11/9/2006	10.9	3/16/2009	10.2	6/5/2007	10.6	11/3/2009	10.8
4/28/2005	10.2	2/1/2008	10.4	3/23/2006	10.5	7/3/2008	10.7	11/14/2006	10.9	3/17/2009	10.5	6/12/2007	10.8	11/4/2009	10.6
4/29/2005	10.3	2/6/2008	10.4	3/24/2006	12	7/4/2008	10.4	11/15/2006	10.6	3/18/2009	10.8	6/13/2007	10.5	11/5/2009	11.0
5/12/2005	10.1	2/7/2008	10.4	3/27/2006	10.8	7/9/2008	11.0	11/16/2006	10.7	3/19/2009	10.8	7/16/2007	10.8	11/6/2009	10.7
5/20/2005	9.8	2/8/2008	10.1	3/28/2006	10.6	7/10/2008	11.0	11/17/2006	10.5	3/20/2009	10.8	8/31/2007	11.0	11/10/2009	10.6
5/26/2005	9.8	2/12/2008	10.4	3/29/2006	10.5	7/11/2008	10.9	11/23/2006	10.7	3/24/2009	10.8	9/27/2007	10.8	11/13/2009	11.0
5/27/2005	10.4	2/13/2008	10.4	3/30/2006	11.5	7/21/2008	10.9	11/24/2006	10.5	3/25/2009	10.8	9/28/2007	10.9	11/24/2009	11.0
6/2/2005	9.8	2/20/2008	10.4	3/31/2006	11.2	7/22/2008	10.9	11/27/2006	10.6	3/26/2009	10.8	10/9/2007	11.0	11/25/2009	10.7
6/3/2005	9.7	2/21/2008	10.4	4/3/2006	11.1	7/23/2008	10.9	11/28/2006	10.8	3/27/2009	10.5	10/10/2007	11.0	11/27/2009	10.9
6/9/2005	9.7	2/22/2008	10.3	4/4/2006	11.5	7/24/2008	10.7	11/29/2006	10.7	3/31/2009	10.5	10/19/2007	11.0	12/1/2009	10.9
6/10/2005	10.3	2/26/2008	10.5	4/5/2006	11	7/25/2008	10.9	11/30/2006	10.6	4/1/2009	10.4	10/22/2007	11.0	12/2/2009	10.9
6/15/2005	10.5	2/27/2008	10.4	4/6/2006	10.2	8/6/2008	10.9	12/1/2006	11.2	4/2/2009	10.8	10/23/2007	10.8	12/3/2009	10.9
6/16/2005	10.85	3/6/2008	10.3	4/7/2006	10	8/7/2008	10.7	12/7/2006	10.7	4/3/2009	10.5	10/24/2007	10.6	12/4/2009	10.9
7/5/2005	9.8	3/7/2008	10.6	4/10/2006	10	8/8/2008	10.7	12/11/2006	10.5	4/6/2009	10.5	10/25/2007	11.1	12/8/2009	10.9
7/6/2005	9.8	3/13/2008	10.6	4/11/2006	10.1	8/14/2008	10.0	12/12/2006	10.7	4/7/2009	10.1	10/29/2007	11.1	12/11/2009	10.9
7/15/2005	8.5	3/14/2008	10.1	4/12/2006	10.4	8/15/2008	10.9	12/13/2006	10.8	4/8/2009	10.7	10/30/2007	11.1	12/15/2009	11.0
7/20/2005	8.5	3/26/2008	10.2	4/13/2006	10.4	8/25/2008	9.8	12/14/2006	10.8	4/9/2009	10.8	10/31/2007	11.2	12/16/2009	10.8
7/22/2005	8.3	3/27/2008	10.3	4/17/2006	11.1	8/26/2008	11.0	12/15/2006	10.8	4/13/2009	10.6	11/2/2007	11.0	12/18/2009	11.0
7/26/2005	8.6	3/31/2008	10.8	4/24/2006	10.5	9/4/2008	10.5	12/18/2006	10.9	4/14/2009	10.5	11/6/2007	11.1	12/21/2009	11.0
7/28/2005	9.1	4/1/2008	10.8	4/25/2006	10.2	9/5/2008	11.2	12/19/2006	10.9	4/15/2009	10.3	11/7/2007	11.2	12/22/2009	11.0
7/29/2005	8.7	4/2/2008	10.7	5/11/2006	10.3	9/9/2008	10.0	12/20/2006	11.7	4/16/2009	10.3	11/8/2007	11.2	12/29/2009	11.0
8/9/2005	9.2	4/3/2008	10.7	5/12/2006	10.1	9/10/2008	11.0	1/2/2007	10.8	4/30/2009	10.6	11/9/2007	11.2	12/30/2009	11.3
9/1/2005	10	4/4/2008	10.7	5/15/2006	10.1	9/18/2008	9.8	1/3/2007	10.7	5/1/2009	10.6	11/12/2007	11.4	12/31/2009	11.6
9/2/2005	9.9	4/7/2008	10.5	5/18/2006	9.8	9/19/2008	10.0	1/4/2007	10.6	5/7/2009	10.8	Number			492
9/20/2005	10.5	4/8/2008	10.8	5/19/2006	9.7	10/1/2008	10.8	1/8/2007	10.6	5/8/2009	11.1	Minimum			8.3
9/22/2005	10.6	4/9/2008	10.2	6/6/2006	10	10/2/2008	10.5	1/9/2007	10.5	5/12/2009	11.1	Maximum			12.3
10/13/2005	10.8	4/10/2008	9.0	6/7/2006	9.8	11/10/2008	10.6	1/12/2007	10.7	5/13/2009	11.5	Mean			10.6
10/27/2005	10.8	4/11/2008	10.4	6/13/2006	9.8	11/11/2008	10.5	1/17/2007	10.8	5/14/2009	11.1	Median			10.7
11/9/2005	11.3	4/14/2008	10.8	6/14/2006	9.7	11/13/2008	10.7	1/18/2007	10.7	5/15/2009	10.2	10th Percentile			10.0
11/10/2005	11.1	4/15/2008	10.8	6/22/2006	9.6	11/14/2008	10.7	1/24/2007	10.8	5/19/2009	10.7				
11/11/2005	9.8	4/16/2008	10.6	6/23/2006	9.6	11/27/2008	10.5	1/25/2007	10.9	5/20/2009	10.5				
11/14/2005	10.8	4/17/2008	10.3	6/29/2006	9.5	11/28/2008	10.8	1/30/2007	10.0	5/21/2009	10.5				
11/15/2005	10.8	4/18/2008	10.6	7/6/2006	9.8	12/2/2008	11.1	2/1/2007	10.0	5/22/2009	10.6				
11/16/2005	11	4/21/2008	9.9	7/7/2006	9.5	12/4/2008	11.6	2/2/2007	10.1	5/28/2009	11.0				
11/17/2005	10.5	4/22/2008	10.7	7/10/2006	12.3	12/5/2008	11.6	2/8/2007	10.0	5/29/2009	11.0				
11/21/2005	11	4/23/2008	11.2	7/11/2006	12	12/9/2008	10.8	2/9/2007	10.1	6/2/2009	10.9				
11/22/2005	11.5	4/24/2008	11.0	7/26/2006	9.8	12/11/2008	11.6	2/19/2007	10.2	6/3/2009	10.8				

Appendix Table C.5.5: Water quality at station DS-5, 2005 - 2009.

Date	pH[a]	Conductivity (µmho/cm)
3/15/2005	3.2	629
12/13/2005	3.5	231.3
3/14/2006	4	199.7
12/12/2006	3.5	108.1
6/9/2009	6.5	69.5
9/8/2009	5.5	695
12/8/2009	4.5	6950
Number	74	7
Minimum	3.1	69.5
Maximum	6.5	6950
Mean	3.5	1269
Median	3.4	231.3
10th Percentile	3.2	92.66

[a] pH measures shown only for dates when other substances were measured but summary statistics reflect all measured values.

Appendix Table C.5.6: Water quality at station DS-6, 2005 - 2009.

Date	pH	Date	pH	Date	pH	Date	pH
1/4/2005	8.8	12/21/2005	9.2	11/7/2006	7.6	3/10/2009	8
1/5/2005	8.8	12/22/2005	9	11/8/2006	7.6	3/17/2009	7.3
1/6/2005	8.8	12/23/2005	9.1	11/9/2006	7.5	3/24/2009	7.2
1/7/2005	8.7	12/28/2005	9.2	11/10/2006	7.6	3/31/2009	7.5
1/10/2005	8.8	12/29/2005	9	11/13/2006	7.6	4/7/2009	8.2
1/11/2005	8.9	1/13/2006	9	11/14/2006	7.7	4/14/2009	6.9
1/12/2005	8.8	1/16/2006	8.9	11/15/2006	7.6	4/21/2009	6.9
1/13/2005	8.8	1/17/2006	9.1	11/16/2006	7.6	4/28/2009	9.3
1/14/2005	8.8	1/18/2006	9	11/17/2006	7.6	5/5/2009	9.1
1/17/2005	9	1/19/2006	9	11/20/2006	7.8	5/19/2009	8
1/18/2005	8.9	1/20/2006	9	11/21/2006	7.7	5/26/2009	7.9
1/19/2005	8.7	1/23/2006	9	11/22/2006	7.7	6/2/2009	7.5
1/20/2005	9	1/24/2006	9	11/23/2006	7.7	6/9/2009	7.5
1/21/2005	9.1	1/25/2006	8.8	11/24/2006	7.7	6/16/2009	7.6
1/24/2005	8.8	1/31/2006	9.2	11/27/2006	7.7	7/28/2009	7.6
1/25/2005	8.8	2/1/2006	9.3	11/28/2006	7.4	8/4/2009	8.7
1/26/2005	8.7	2/2/2006	9.3	11/29/2006	7.5	10/27/2009	7.1
1/27/2005	8.6	2/3/2006	9.1	11/30/2006	7.5	11/3/2009	7.1
2/2/2005	8.6	2/6/2006	9.3	12/1/2006	7.8	11/10/2009	7.2
2/3/2005	8.7	2/7/2006	9	12/4/2006	7.8	11/17/2009	7
2/4/2005	8.7	2/8/2006	9.1	12/5/2006	8	12/1/2009	6.9
2/7/2005	8.5	2/9/2006	8.8	12/6/2006	7.7	12/8/2009	6.9
2/8/2005	8.7	2/13/2006	9.2	12/7/2006	7.8	12/15/2009	6.8
2/9/2005	8.6	2/14/2006	9.2	12/8/2006	7.8	12/22/2009	6.9
2/10/2005	8.3	2/15/2006	9.2	12/11/2006	7.8	12/29/2009	6.9
2/11/2005	8	3/9/2006	8.8	12/12/2006	7.6	**Number**	313
2/14/2005	8.1	3/10/2006	8.8	12/13/2006	7.5	**Minimum**	4.5
2/15/2005	8.5	3/13/2006	7.8	12/14/2006	7.4	**Maximum**	10.6
2/16/2005	8.4	3/14/2006	9.1	12/15/2006	7.4	**Mean**	8.2
2/17/2005	8.5	3/15/2006	8.8	12/18/2006	7	**Median**	8.1
2/18/2005	8.5	3/16/2006	9.1	12/19/2006	7.1	**10th Percentile**	7.22
2/21/2005	8.7	3/17/2006	8.9	12/20/2006	6.8		
2/22/2005	8.8	3/20/2006	7.5	12/21/2006	7		
2/23/2005	8.7	3/21/2006	7.4	12/22/2006	7		
3/1/2005	8.6	3/22/2006	7.3	12/28/2006	7.5		
3/2/2005	8.7	3/23/2006	7.8	12/29/2006	7.6		
3/15/2005	8.7	3/24/2006	7.9	1/2/2007	7.3		
3/29/2005	8.9	3/27/2006	7.2	1/9/2007	7.3		
3/30/2005	8.9	3/28/2006	7.6	1/16/2007	8		
3/31/2005	8.8	3/29/2006	7.5	1/23/2007	7		
4/1/2005	8.1	3/30/2006	7.4	1/30/2007	7.6		
4/4/2005	5.7	3/31/2006	7.2	2/6/2007	7.4		
4/5/2005	4.5	4/3/2006	9.6	2/20/2007	7.7		
4/6/2005	4.8	4/4/2006	9.6	3/13/2007	7.6		
4/7/2005	6.5	4/5/2006	10	3/27/2007	7		
4/8/2005	10.6	4/6/2006	10	4/3/2007	9.4		
4/11/2005	7.5	4/7/2006	9.8	4/10/2007	7.7		
4/12/2005	8.9	4/10/2006	8.6	4/17/2007	8		
4/13/2005	7.9	4/11/2006	8.2	4/24/2007	8.8		
4/14/2005	7.4	4/12/2006	7.8	10/23/2007	8.2		
4/15/2005	7.6	4/13/2006	7.2	10/30/2007	8.4		
4/18/2005	8.3	4/17/2006	8.8	11/6/2007	8.1		
4/19/2005	7.7	4/18/2006	8.5	11/13/2007	8.5		
4/20/2005	10.1	4/19/2006	9.3	11/20/2007	8.1		
4/21/2005	10	4/20/2006	9.2	11/27/2007	8.6		
4/22/2005	9.9	4/21/2006	9.4	12/4/2007	8.6		
4/25/2005	9.8	4/24/2006	9.6	12/11/2007	8.6		
4/26/2005	9.7	4/25/2006	9.6	12/28/2007	8		
4/27/2005	9.7	4/26/2006	9.4	1/2/2008	7.8		
4/28/2005	9.6	4/27/2006	9.4	1/8/2008	7.4		

Appendix Table C.5.6: Water quality at station DS-6, 2005 - 2009.

Date	pH	Date	pH	Date	pH	Date	pH
4/29/2005	9.5	4/28/2006	9.4	1/15/2008	9		
5/2/2005	9.2	5/12/2006	8.3	1/22/2008	9		
5/3/2005	9.2	5/15/2006	8.1	1/31/2008	9.3		
5/4/2005	9.1	5/16/2006	7.8	2/5/2008	9.1		
5/5/2005	9	5/17/2006	7.9	2/19/2008	9		
5/27/2005	8	5/18/2006	7.9	2/26/2008	8.1		
5/31/2005	8	5/19/2006	7.9	3/4/2008	8.2		
6/7/2005	7.8	5/23/2006	8.5	3/11/2008	8.5		
6/8/2005	7.8	8/4/2006	8.2	3/18/2008	8.1		
6/16/2005	8.3	8/8/2006	8	4/1/2008	8.4		
6/17/2005	8.2	8/9/2006	7.9	4/8/2008	7.4		
11/16/2005	7.7	9/29/2006	7.9	4/15/2008	7.6		
11/17/2005	7.5	10/2/2006	7.6	4/22/2008	8.3		
11/18/2005	7.4	10/3/2006	7.6	4/29/2008	9.1		
11/21/2005	7.2	10/4/2006	7.9	5/6/2008	8.6		
11/22/2005	7.5	10/5/2006	7.8	5/13/2008	8.3		
11/23/2005	8.9	10/6/2006	7.8	5/20/2008	8.1		
11/24/2005	9	10/11/2006	7.7	5/27/2008	7.9		
11/25/2005	9.1	10/12/2006	7.7	6/3/2008	8		
11/28/2005	9.1	10/13/2006	7.7	6/10/2008	7.8		
11/29/2005	9.3	10/16/2006	7.8	6/17/2008	7.9		
11/30/2005	9.1	10/17/2006	7.8	6/24/2008	8		
12/1/2005	9.2	10/18/2006	7.6	7/1/2008	8.4		
12/2/2005	9.2	10/19/2006	7.6	7/8/2008	8.2		
12/5/2005	9	10/20/2006	7.8	7/22/2008	8.9		
12/6/2005	9.1	10/23/2006	7.7	11/18/2008	7.6		
12/7/2005	9.2	10/24/2006	7.8	11/25/2008	7.1		
12/8/2005	9.1	10/25/2006	7.6	12/2/2008	7.2		
12/9/2005	9.2	10/26/2006	7.6	12/9/2008	7.1		
12/12/2005	9.2	10/27/2006	7.5	12/16/2008	7.3		
12/13/2005	9.2	10/30/2006	7.6	12/23/2008	7		
12/14/2005	9.2	10/31/2006	7.7	12/30/2008	6.6		
12/15/2005	9	11/1/2006	7.7	1/6/2009	8.8		
12/16/2005	9.1	11/2/2006	7.7	1/20/2009	7.8		
12/19/2005	9.1	11/3/2006	7.6	2/11/2009	7.5		
12/20/2005	9.1	11/6/2006	7.6	2/17/2009	8		

Appendix Table C.5.7: Water quality at station BH91 SG1A, 2005 to 2009.

Date	Acidity (mg/L)	Conductivity (µmho/cm)	Fe (mg/L)	pH	Sulphate (mg/L)
8/1/2005	3590	4488	1746	3.70	
7/1/2006	3110	5840	2030	3.90	
9/19/2007	4600		2970	4.10	
8/11/2008	5230		2680	4.10	7000
8/24/2009	4920		2310	4.20	6100
Number	5	2	5	5	2
Minimum	3110	4488	1746	3.70	6100
Maximum	5230	5840	2970	4.20	7000
Mean	4290	5164	2347	4.00	6550
Median	4600	5164	2310	4.10	6550
10th Percentile	3302	4623	1860	3.78	6190

Appendix Table C.5.8: Water quality at wtation BH91-SG-3A and B, 2005 to 2009.

Site	Date	Acidity (mg/L)	Conductivity (µmho/cm)	Fe (mg/L)	pH	SO4 (mg/L)
BH91-SG3A	8/1/2005	4030.00	4750.00	1877.00	4.1	
	7/1/2006	3230.00	4610.00	1415.00	4.2	
	9/13/2007	961.00		1420.00	4.1	
	8/7/2008	0.50		564.00	3.5	2900.00
	8/25/2009	2650.00		1190.00	4.1	3800.00
BH91-SG3A Summary	Number	5	2	5	5	2
	Minimum	0.50	4610.00	564.00	3.5	2900.00
	Maximum	4030.00	4750.00	1877.00	4.2	3800.00
	Mean	2174.30	4680.00	1293.20	4.0	3350.00
	Median	2650.00	4680.00	1415.00	4.1	3350.00
	10th Percentile	384.70	4624.00	814.40	3.7	2990.00
BH91-SG3B	8/1/2005	3090.00	3705.00	865.50	3.2	
	7/1/2006	2280.00	3945.00	751.00	3.1	
	9/19/2007	1570.00		643.00	3.1	
	8/7/2008	139.00		1080.00	4.2	4400.00
	8/25/2009	0.50		500.00	3.7	2400.00
BH91-SG3B Summary	Number	5	2	5	5	2
	Minimum	0.50	3705.00	500.00	3.1	2400.00
	Maximum	3090.00	3945.00	1080.00	4.2	4400.00
	Mean	1415.90	3825.00	767.90	3.5	3400.00
	Median	1570.00	3825.00	751.00	3.2	3400.00
	10th Percentile	55.90	3729.00	557.20	3.1	2600.00

	Concentration below maximum MDL.

Appendix Table C.5.9: Water quality at wtation BH98-15A, 2005 to 2009.

Date	Acidity (mg/L)	Conductivity (µmho/cm)	Fe (mg/L)	pH	SO4 (mg/L)
8/1/2005	3430	5000	1950	5.8	
7/1/2006	2510	3899	1260	5.8	
9/19/2007	2460		1560.00	5.9	
8/12/2008	2200		1360.00	6.1	3600.0
8/25/2009	2000		1310.00	6.0	3600.0
Number	5	2	5	5	2
Minimum	2000	3899	1260	5.8	3600.0
Maximum	3430	5000	1950	6.1	3600.0
Mean	2520	4450	1488.00	5.9	3600.0
Median	2460	4450	1360.00	5.9	3600.0
10th Percentile	2080	4009	1280.00	5.8	3600.0

Appendix Table C.5.10: Water quality at station BH98-16A, 2005 to 2009.

Date	Acidity (mg/L)	Conductivity (µmho/cm)	Fe (mg/L)	pH	SO4 (mg/L)
8/1/2005	4020	5020	2165	5.9	
7/1/2006	4220	4940	1770	5.7	
9/19/2007	3030		2140.00	5.7	
8/7/2008	541		2170.00	5.6	5400.0
8/19/2009	3120		2060.00	5.8	4800.0
Number	5	2	5	5	2
Minimum	541	4940	1770	5.6	4800.0
Maximum	4220	5020	2170.00	5.9	5400.0
Mean	2986	4980	2061.00	5.7	5100.0
Median	3120	4980	2140.00	5.7	5100.0
10th Percentile	1537	4948	1886.00	5.6	4860.0

Appendix Table C.5.11: Water quality at station PN-ST3-P3, 5, 6, and 8, 2005 to 2009.

Site	Date	Acidity (mg/L)	Conductivity (µmho/cm)	Iron (mg/L)	pH
PN-ST3-P3	8/1/2005	2120	2845	1000	5.1
	7/1/2006	1420	2737	725	4.1
	9/20/2007	1410	3485	808	5.6
	8/7/2008	1370	2611	787	6.1
	8/26/2009	1340	2027	647	5.4
PN-ST3-P3 Summary	Number	5	5	5	5.0
	Minimum	1340	2027	647	4.1
	Maximum	2120	3485	1000	6.1
	Mean	1532	2741	793	5.3
	Median	1410	2737	787	5.4
	10th Perc.	1352	2261	678	4.5
PN-ST3-P5	8/1/2005	2070	3568	606	2.7
	7/1/2006	1570	3846	585	2.9
	9/21/2007	1520	3950	613	2.9
	8/8/2008	0.50	3083	733	3.1
	8/26/2009	1530	2939	583	3.1
PN-ST3-P5 Summary	Number	5	5	5	5.0
	Minimum	1	2939	583	2.7
	Maximum	2070	3950	733	3.1
	Mean	1338	3477	624	2.9
	Median	1530	3568	606	2.9
	10th Perc.	608	2997	584	2.8
PN-ST3-P6	8/1/2005	2920	3454	1545	6.6
	7/1/2006	1480	2848	765	5.6
	9/20/2007	2410	4525	1570	6.4
	8/7/2008	1060	3024	1370	6.1
	8/26/2009	2760	2073	1300	6.3
PN-ST3-P6 Summary	Number	5	5	5	5.0
	Minimum	1060	2073	765	5.6
	Maximum	2920	4525	1570	6.6
	Mean	2126	3185	1310	6.2
	Median	2410	3024	1370	6.3
	10th Perc.	1228	2383	979	5.8
PN-ST3-P8	8/1/2005	4850	5820	2795	5.7
	7/1/2006	3980	5570	2280	6
	9/20/2007	4270	7330	2710	6.2
	8/8/2008	4240	4730	2410	6.1
	8/26/2009	4880	3873	2450	6.2
PN-ST3-P8 Summary	Number	5	5	5	5.0
	Minimum	3980	3873	2280	5.7
	Maximum	4880	7330	2795	6.2
	Mean	4444	5465	2529	6.0
	Median	4270	5570	2450	6.1
	10th Perc.	4084	4216	2332	5.8

[shaded box] Concentration below maximum MDL.

Appendix Table C.5.12: Water quality at station BH91-SG2A, 2005 to 2009.

Date	Acidity (mg/L)	Conductivity (µmho/cm)	Fe (mg/L)	pH
8/1/2005	3260	4260	1705	6.3
7/1/2006	2260	4180	1441	6.6
9/21/2007	2600	5860	1570	6.5
8/26/2008	3290	4052	1600	6.3
8/24/2009	2670	3574	1620	6.2
Number	5	5	5	5
Minimum	2260	3574	1441	6.2
Maximum	3290	5860	1705	6.6
Mean	2816	4385	1587	6.4
Median	2670	4180	1600	6.3
10th Percentile	2396	3765	1493	6.2

Appendix Table C.5.13: Summary of seasonal trends for station DS-2, 2003 - 2009.

Season	Spearman rho	Acidity	Barium	Cobalt	Iron	Manganese	pH	Ra-226	Sulphate	Uranium
January	Correlation Coefficient						0.314286			
	Sig. (2-tailed)						0.544093			
	N						6			
February	Correlation Coefficient						0.126131			
	Sig. (2-tailed)						0.787572			
	N						7			
March	Correlation Coefficient	0.3714286	0.8285714	0.6	0.6	0.542857143	-0.57143	-0.0579771	-0.25714286	0.0857143
	Sig. (2-tailed)	0.4684781	0.0415627	0.208	0.208	0.265702624	0.180202	0.91313179	0.62278717	0.8717434
	N	6	6	6	6	6	7	6	6	6
April	Correlation Coefficient						0.214286	-0.4642857		
	Sig. (2-tailed)						0.644512	0.29393411		
	N						7	7		
May	Correlation Coefficient						0.714286			
	Sig. (2-tailed)						0.071344			
	N						7			
June	Correlation Coefficient	-0.9	-0.1	-0.5	-0.6	-0.4	-0.45047	-0.3714286	-0.6	-0.5
	Sig. (2-tailed)	0.0373861	0.8728886	0.391002	0.285	0.504631575	0.310429	0.46847813	0.28475698	0.3910022
	N	5	5	5	5	5	7	6	5	5
July	Correlation Coefficient						-0.25226			
	Sig. (2-tailed)						0.585241			
	N						7			
August	Correlation Coefficient						-0.54056			
	Sig. (2-tailed)						0.210289			
	N						7			
September	Correlation Coefficient						-0.25714			
	Sig. (2-tailed)						0.622787			
	N						6			
October	Correlation Coefficient						0.214286			
	Sig. (2-tailed)						0.644512			
	N						7			
November	Correlation Coefficient						-0.46429	-0.8857143		
	Sig. (2-tailed)						0.293934	0.01884548		
	N						7	6		
December	Correlation Coefficient	0.0579771	0.3142857	0.485714	0.257	0.714285714	-0.71429	-0.504525	-0.82857143	-0.3714286
	Sig. (2-tailed)	0.9131318	0.5440933	0.328723	0.623	0.110787172	0.071344	0.24820311	0.04156268	0.4684781
	N	6	6	6	6	6	7	7	6	6

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

"ns" denotes not significant.

Significant trend where p<0.05.

Appendix Table C.5.14: Summary of trends for Stanrock porewater stations.

Station	Spearman rho	Iron	pH
PN-ST3-P3	Correlation Coefficient	-0.102941	0.508129
	Sig. (2-tailed)	0.70441	0.044474
	N	16	16
PN-ST3-P5	Correlation Coefficient	0.8	0.420183
	Sig. (2-tailed)	<0.05	0.260159
	N	9	9
PN-ST3-P6	Correlation Coefficient	0.408824	0.387099
	Sig. (2-tailed)	0.115888	0.154025
	N	16	15
PN-ST3-P8	Correlation Coefficient	0.932353	-0.551992
	Sig. (2-tailed)	0.000001	0.026628
	N	16	16
BH91-SG2-A	Correlation Coefficient	0.273529	0.643071
	Sig. (2-tailed)	0.305323	0.007206
	N	16	16

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

"ns" denotes not significant.

[shaded cell] Significant trend where p<0.05.

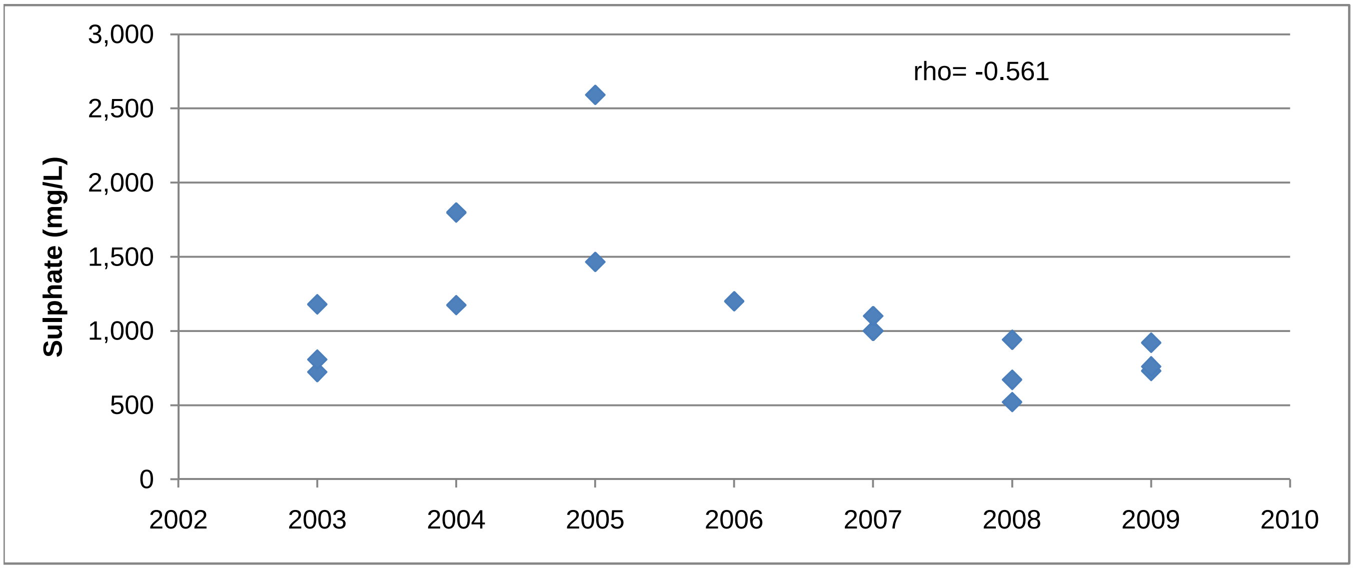
Appendix Table C.5.15: Summary of trends for Stanrock groundwater stations.

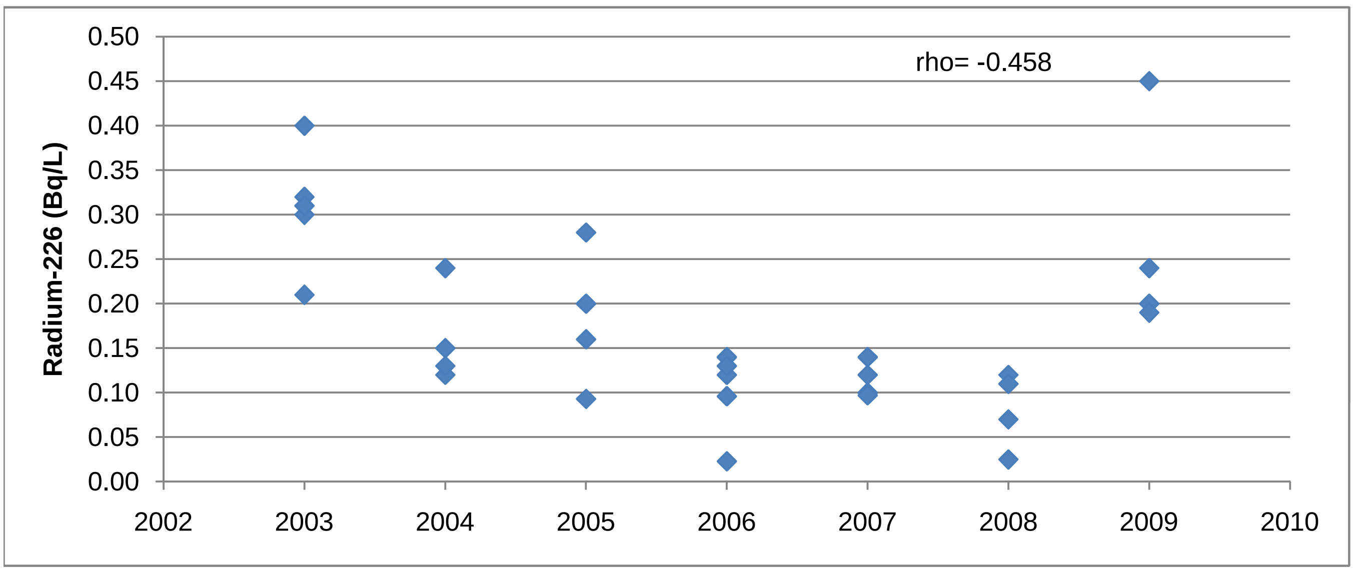
Station	Spearman rho	pH	Iron
BH91-SG1A	Correlation Coefficient	0.76431903	0.630769231
	Sig. (2-tailed)	0.00145676	0.015578224
	N	14	14
BH91-SG3A	Correlation Coefficient	-0.1652668	-0.939393939
	Sig. (2-tailed)	ns	<0.001
	N	10	10
BH91-SG3B	Correlation Coefficient	-0.280493	-0.066666667
	Sig. (2-tailed)	ns	ns
	N	10	10
BH98-15A	Correlation Coefficient	0.58343338	-0.3
	Sig. (2-tailed)	0.05953902	0.370083122
	N	11	11
BH98-16A	Correlation Coefficient	0.01852169	-0.763636364
	Sig. (2-tailed)	ns	0.00623306
	N	10	11

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

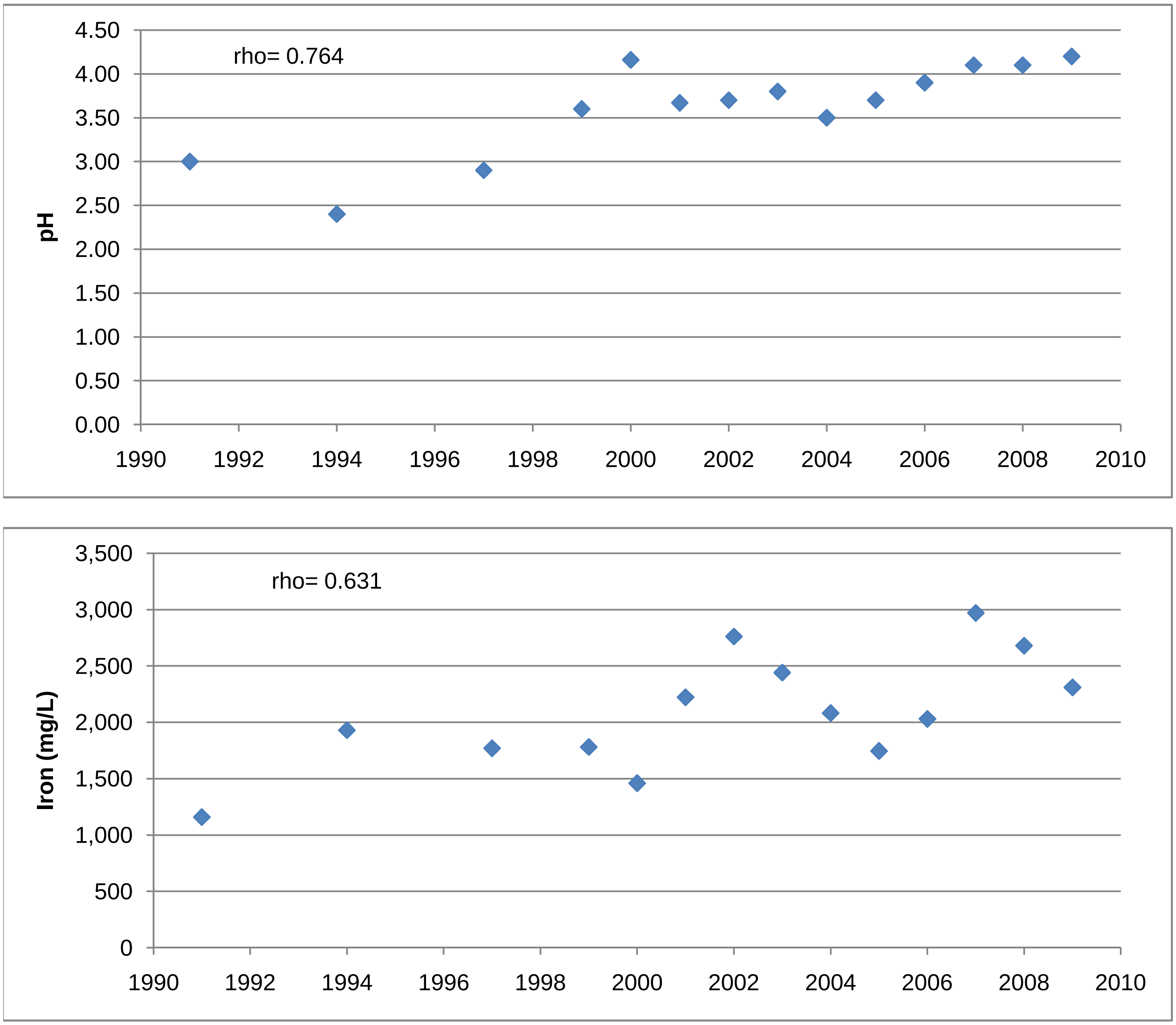
"ns" denotes not significant.

[shaded box] Significant trend where p<0.05.

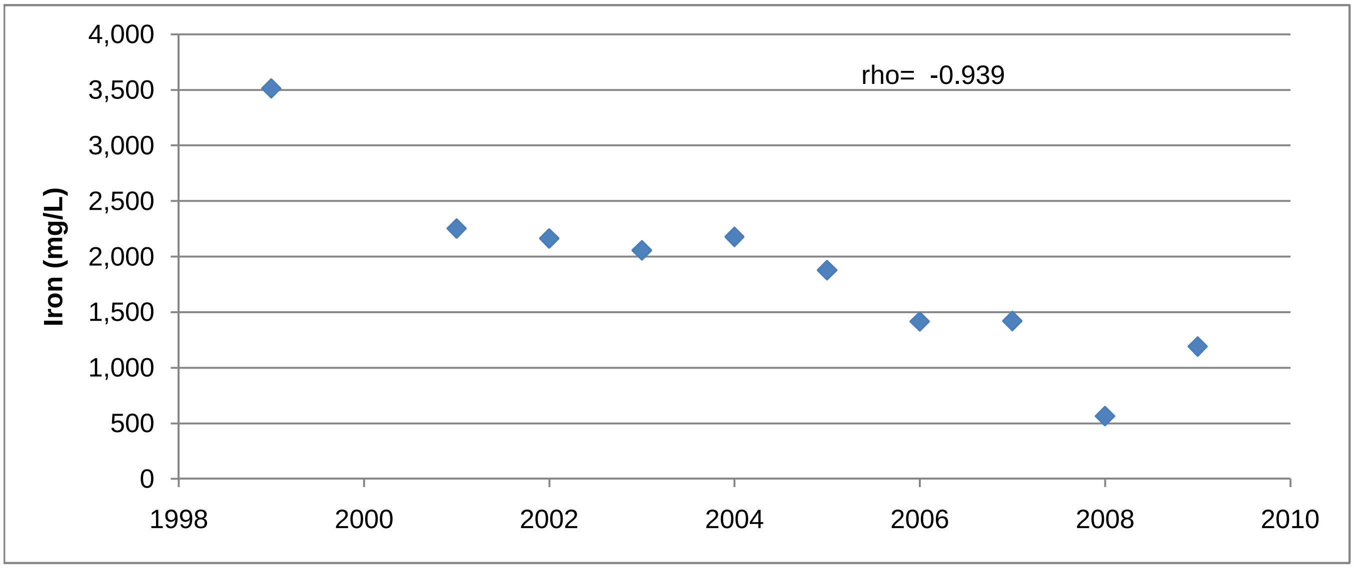




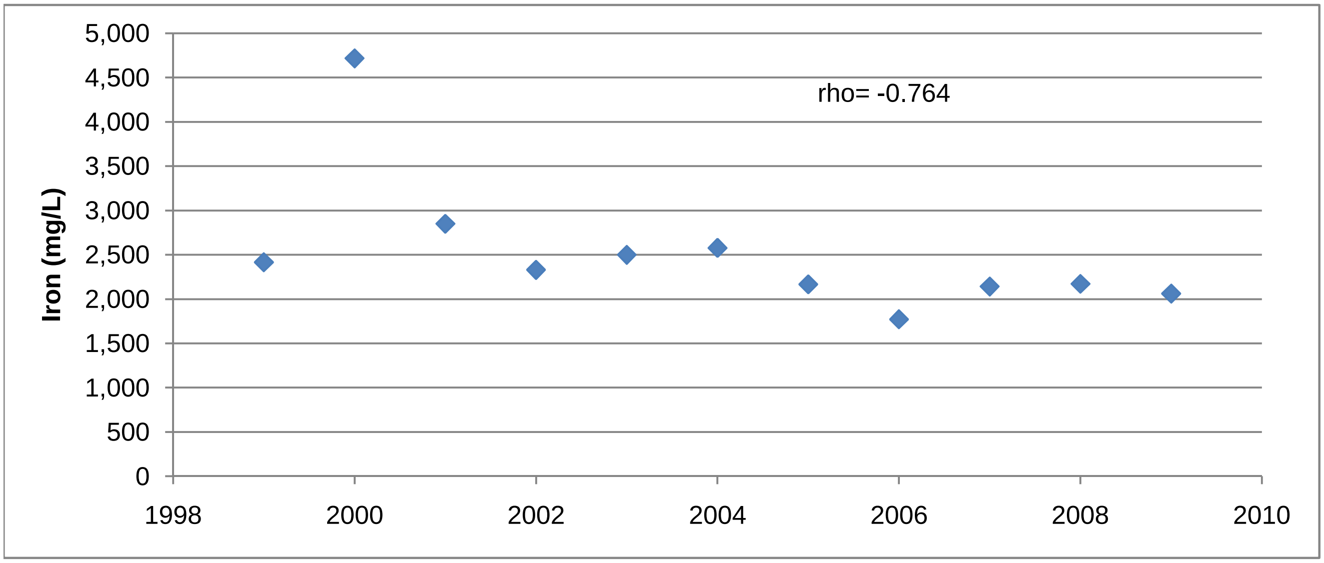
Appendix Figure C.5.1: Significant common (average) trends observed for sulphate and radium-226 over all seasons at station DS-2, 2003 to 2009.



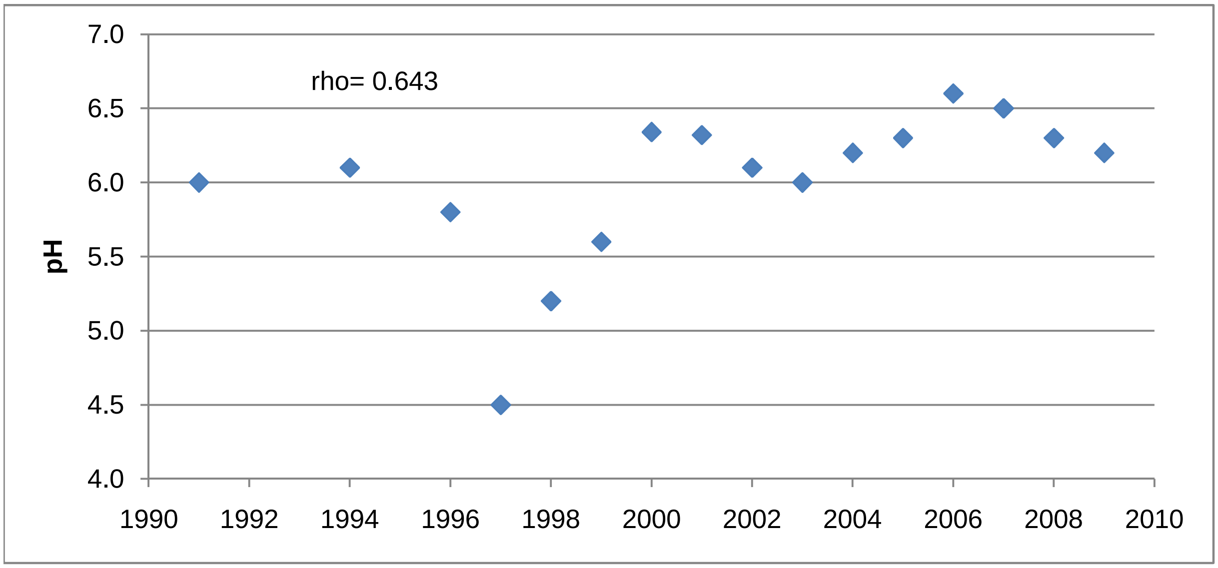
Appendix Figure C.5.2: Significant trends observed for pH and iron at station BH91 SG1A, 1991 to 2009.



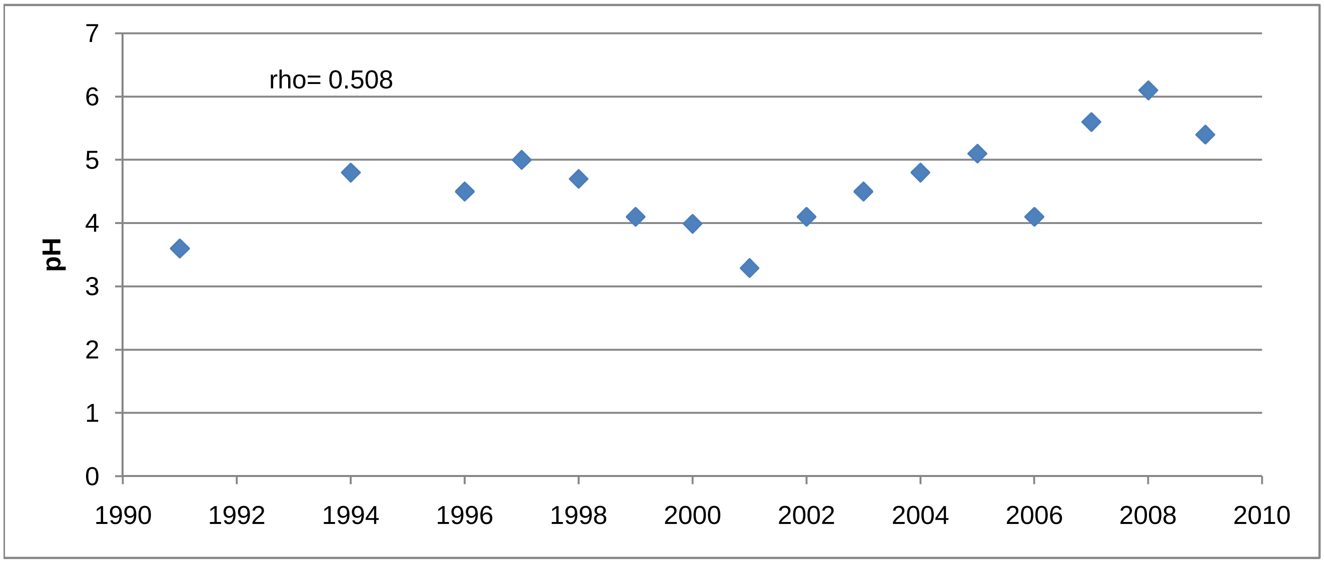
Appendix Figure C.5.3: Significant trends observed for iron at station BH91-SG3A, 1999 to 2009.



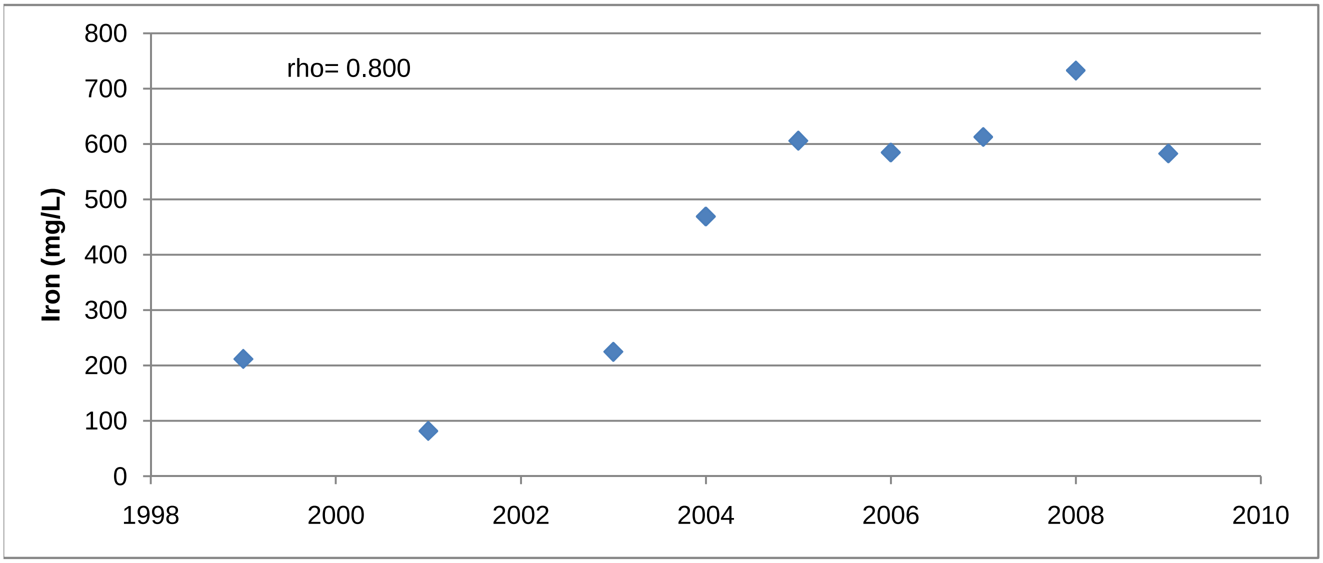
Appendix Figure C.5.4: Significant trends observed for iron at station BH98-16A, 1999 to 2009.



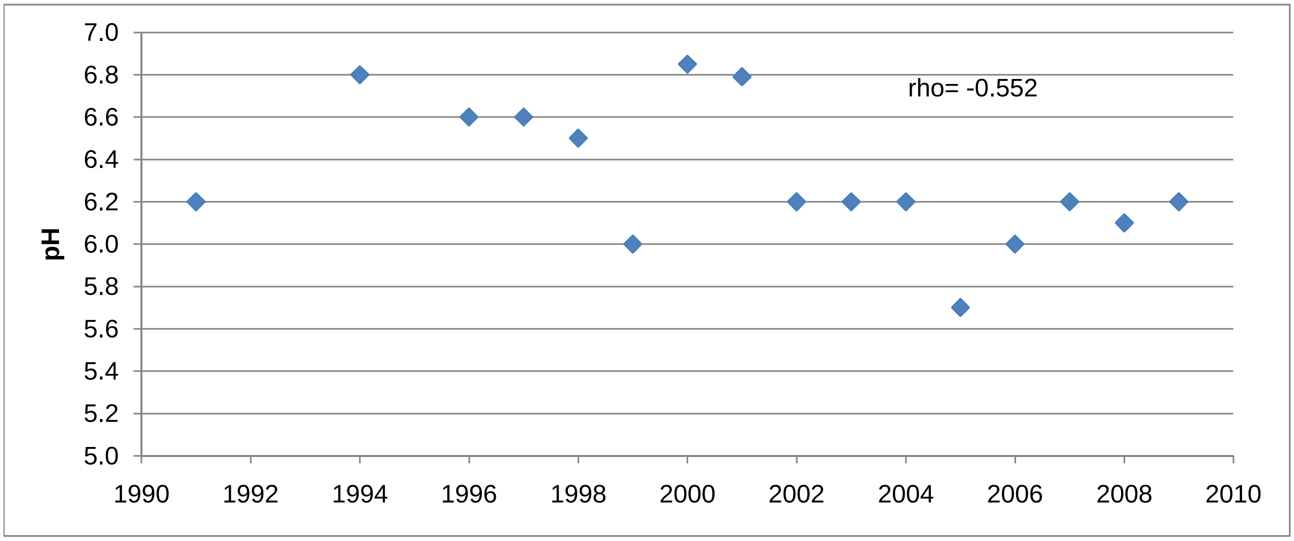
Appendix Figure C.5.5: Significant trends observed for pH at station BH91-SG2A, 1991 to 2009.

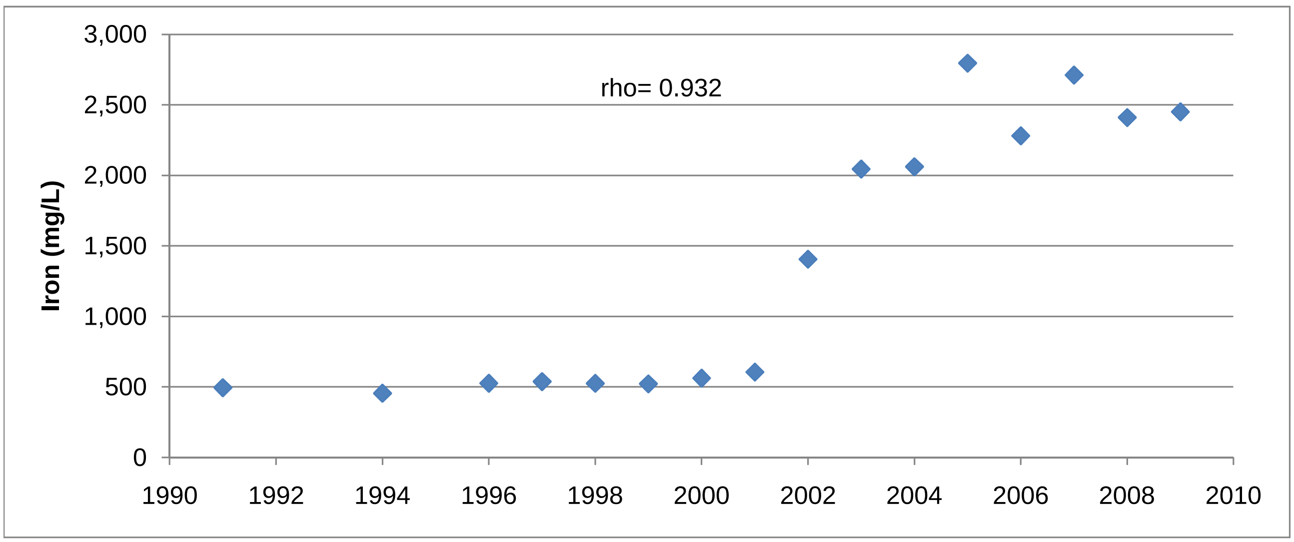


Appendix Figure C.5.6: Significant trends observed for pH at station PN-ST3-P3, 1991 to 2009.

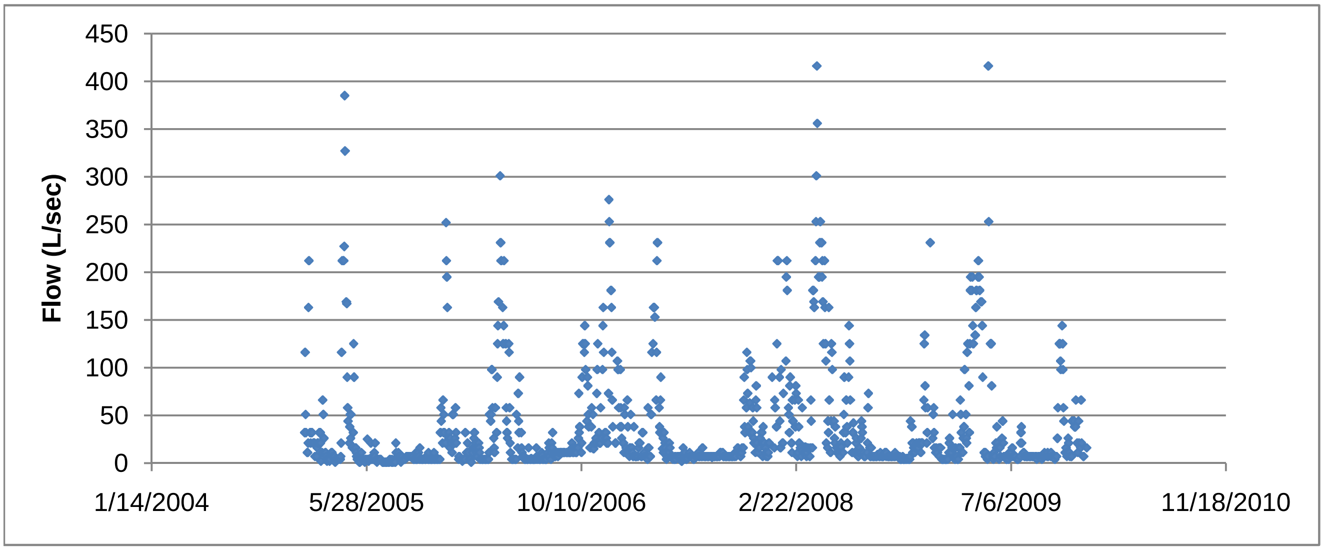


Appendix Figure C.5.7: Significant trends observed for iron at station PN-ST3-P5, 1999 to 2009.

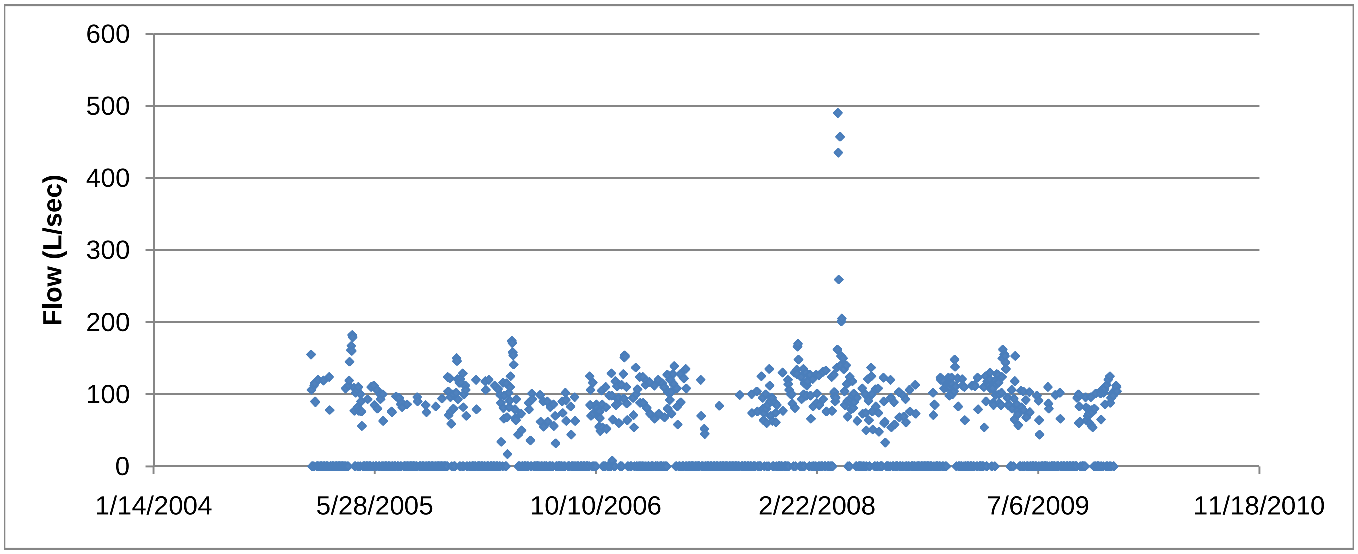




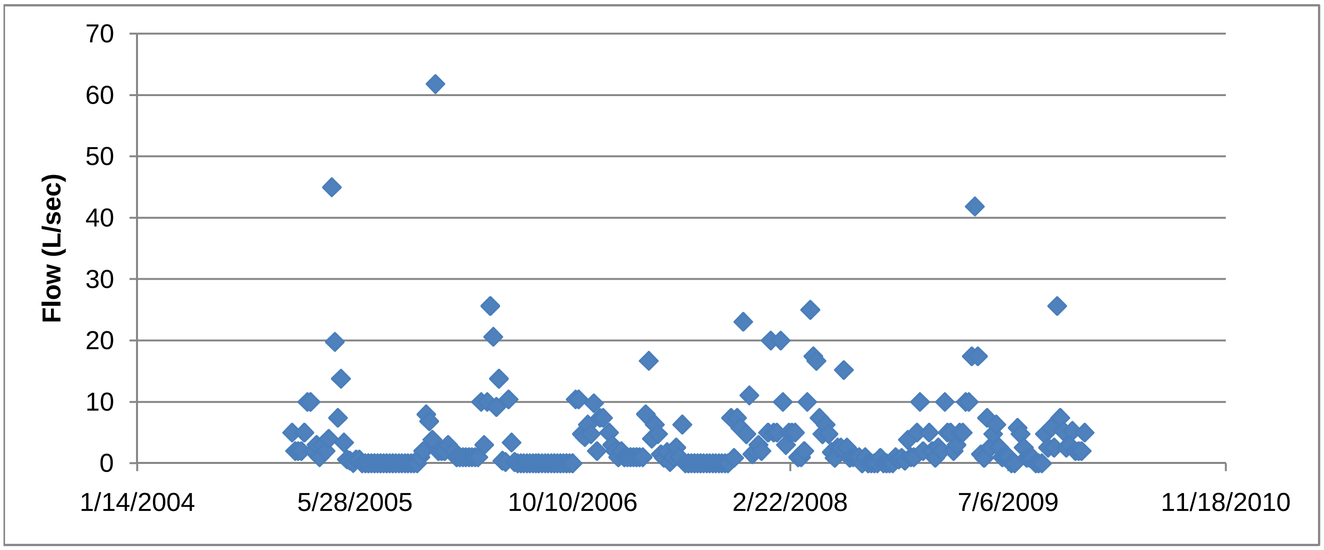
Appendix Figure C.5.8: Significant trends observed for pH and iron at station PN-ST3-P8, 1991 to 2009.



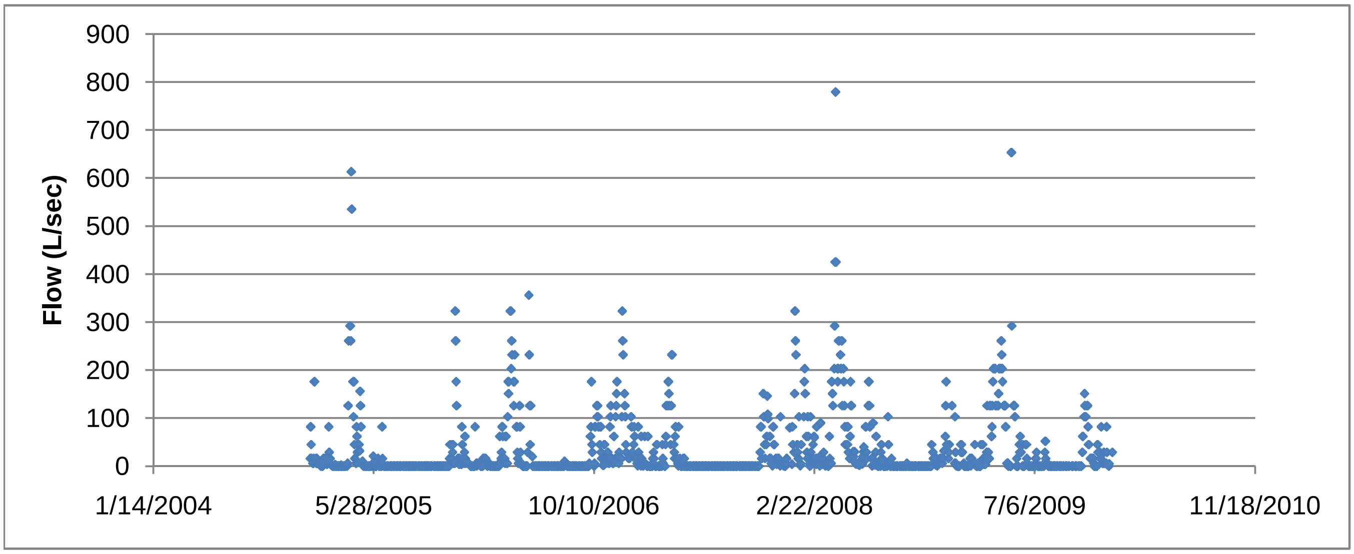
Appendix Figure C.5.9: Flows at station DS-1 from 2005 to 2009.



Appendix Figure C.5.10: Flows at station DS-2 from 2005 to 2009.



Appendix Figure C.5.11: Flows at station DS-5 from 2005 to 2009.



Appendix Figure C.5.12: Flows at station DS-6 from 2005 to 2009.

APPENDIX C.6
Stanleigh TMA

Appendix Table C.6.1: Stanleigh final point of control (CL-06) discharge criteria.

Parameter[c]	Units	Discharge Criteria		Action Level	Internal Investigation
		Grab Sample[a]	Monthly Mean[b]		
pH	pH units	5.5-9.5	6.5-9.5	<6.5 or >8.5	<7.0 or >8.0
Total Radium-226	Bq/L	1.11	0.37	0.37	0.20
Total Suspended Solids	mg/L	50	25	30	7.5

[a]Samples to be collected during periods of discharge.
[b]Arithmetic mean of twelve consecutive samples.
[c] Copper, lead, nickel and zinc monitoring discontinued in January 2010 as per regulatory approval of Cycle 3 design

Appendix Table C.6.2: Water quality at station CL-04, 2005 to 2009.

Date	Acidity (mg/L)	Ba (mg/L)	Co (mg/L)	Fe (mg/L)	Mn (mg/L)	pH	Ra-226 (Bq/L)	Sulphate (mg/L)	U (mg/L)
5/4/2005	3	0.0427	0.0016	0.108	0.296	7	0.51	237	0.0025
6/1/2005							0.51		
7/6/2005	2	0.0221	0.00025	0.042	0.223	7.1	0.5	241	0.0025
9/7/2005							0.46		
9/21/2005	3	0.03	0.0007	0.052	0.242		0.71	264	0.0025
9/22/2005	3	0.0286	0.00025	0.047	0.171		0.49	262	0.005
9/23/2005	3	0.0298	0.00025	0.049	0.187		0.53	262	0.0025
11/1/2005							0.64		
11/2/2005	4	0.0396	0.0007	0.138	0.254	7	0.59	244	0.0025
11/3/2005							0.66		
11/4/2005							0.68		
5/5/2006	0.5	0.0288	0.00135	0.090	0.266	7	0.58	210	0.00381
6/14/2006							0.57		
7/6/2006							0.56		
8/2/2006	0.5	0.0312	0.00025	0.040	0.143	7	0.58	200	0.0023
11/1/2006	0.5	0.035	0.001	0.140	0.198	6.7	0.82	200	0.0035
12/6/2006							0.82		
3/21/2007	0.5	0.041	0.0013	0.080	0.183	7.0	0.670	190.0	0.0029
4/4/2007							0.720		
5/2/2007	0.5	0.032	0.0015	0.110	0.200	7.0	0.740	180.0	0.0038
6/6/2007							0.700		
12/19/2007	0.5	0.034	0.0009	0.090	0.131	7.0	0.770	180.0	0.003
4/17/2008						6.8	0.740		
5/7/2008						6.9	0.720		
6/4/2008	0.5	0.028	0.0013	0.100	0.156	6.9	0.780	160.0	0.0031
7/2/2008						7.0	0.740		
7/7/2008				0.070					
8/6/2008	0.5	0.031	0.00025	0.140	0.119	7.0	0.670	150.0	0.002
9/3/2008						6.9	0.790		
10/1/2008						6.8	0.800		
11/5/2008	0.5	0.032	0.0029	0.100	0.137	6.7	0.950	160.0	0.0027
12/3/2008						6.7	0.840		
2/11/2009	0.5	0.038	0.0008	0.060	0.138	6.7	0.790	170.0	0.002
3/4/2009						6.8	0.740		
4/1/2009						6.9	0.770		
5/6/2009	0.5	0.03	0.0014	0.150	0.177	6.4	0.710	140.0	0.0027
6/3/2009						6.8	0.720		
7/2/2009						6.8	0.710		
8/6/2009	0.5	0.04	0.00025	0.050	0.121	7.1	0.710	130.0	0.0016
11/4/2009	0.5	0.032	0.0009	0.110	0.159	6.8	0.740	140.0	0.002
12/2/2009						7.2	0.820		
Number	19	19	19	20	19	27	40	19	19
Minimum	0.5	0.022	0.00025	0.040	0.119	6.4	0.460	130.0	0.0016
Maximum	4	0.043	0.0029	0.150	0.296	7.2	0.950	264.0	0.005
Mean	1.3	0.033	0.0009	0.088	0.184	6.9	0.689	195.8	0.0028
Median	0.5	0.032	0.0009	0.090	0.177	6.9	0.710	190.0	0.0025
10th Perc.	0.5	0.028	0.00025	0.047	0.129	6.7	0.510	140.0	0.002

Concentration below maximum MDL. (shaded cells)

Appendix Table C.6.3: Water quality at station CL-05, 2007 to 2009.

Date	pH	Date	pH	Date	pH	Date	pH
12/5/2007	8.5	6/5/2009	8.8	3/31/2009	8.6	8/12/2009	9.3
12/6/2007	8.5	6/8/2009	8.7	4/1/2009	8.6	8/13/2009	9.2
12/7/2007	8.5	6/9/2009	8.8	4/2/2009	8.7	8/14/2009	9.2
12/10/2007	8.6	6/10/2009	9.0	4/3/2009	8.4	8/17/2009	9.3
12/11/2007	8.5	6/11/2009	9.1	4/6/2009	8.5	11/3/2009	9.3
12/13/2007	8.5	6/12/2009	8.9	4/7/2009	8.4	11/4/2009	9.3
12/14/2007	8.5	6/15/2009	8.8	4/8/2009	8.4	11/5/2009	9.3
12/17/2007	8.6	6/16/2009	8.8	4/9/2009	8.6	11/6/2009	9.1
12/18/2007	8.5	6/17/2009	8.8	4/13/2009	8.3	11/9/2009	9.2
12/19/2007	8.6	6/18/2009	8.8	4/14/2009	8.5	11/10/2009	9.2
12/20/2007	8.5	6/19/2009	8.8	4/15/2009	8.5	11/11/2009	9.2
2/9/2009	8.5	6/22/2009	8.8	4/16/2009	8.4	11/12/2009	9.0
2/10/2009	8.5	6/23/2009	8.9	4/17/2009	8.6	11/13/2009	8.9
2/11/2009	8.5	6/24/2009	8.9	4/20/2009	8.5	11/16/2009	9.3
2/12/2009	8.4	6/25/2009	9.0	4/21/2009	8.4	11/17/2009	9.0
2/13/2009	8.4	6/26/2009	9.2	4/22/2009	8.3	11/18/2009	9.2
2/17/2009	8.7	6/29/2009	9.1	4/23/2009	8.3	11/19/2009	8.8
2/18/2009	8.6	6/30/2009	9.1	4/24/2009	8.7	11/20/2009	9.0
2/19/2009	8.5	7/2/2009	9.1	4/27/2009	8.3	11/23/2009	8.9
2/20/2009	8.5	7/3/2009	9.1	4/28/2009	8.3	11/24/2009	9.1
2/23/2009	8.6	7/6/2009	9.0	4/29/2009	8.4	11/25/2009	9.0
2/24/2009	8.6	7/7/2009	9.1	4/30/2009	8.3	11/26/2009	9.0
2/25/2009	8.6	7/8/2009	9.0	5/1/2009	8.3	11/27/2009	8.9
2/26/2009	8.6	7/9/2009	9.0	5/4/2009	8.5	11/30/2009	8.9
2/27/2009	8.6	7/10/2009	9.2	5/5/2009	8.8	12/1/2009	9.0
3/2/2009	8.5	7/13/2009	8.9	5/6/2009	8.8	12/2/2009	9.0
3/3/2009	8.4	7/14/2009	9.2	5/7/2009	8.9	12/3/2009	9.0
3/4/2009	8.4	7/15/2009	9.1	5/8/2009	9.1	12/4/2009	9.0
3/5/2009	8.5	7/16/2009	9.1	5/11/2009	8.9	12/7/2009	9.0
3/6/2009	8.4	7/17/2009	9.1	5/12/2009	8.9	12/8/2009	8.7
3/9/2009	8.5	7/20/2009	9.3	5/13/2009	8.9	12/9/2009	8.7
3/10/2009	8.6	7/21/2009	9.3	5/14/2009	9.2	12/10/2009	8.6
3/11/2009	8.6	7/22/2009	9.3	5/15/2009	9.4	12/11/2009	8.6
3/12/2009	8.5	7/23/2009	9.3	5/19/2009	9.1	12/14/2009	8.5
3/13/2009	8.6	7/24/2009	9.3	5/20/2009	9.0	12/15/2009	8.5
3/16/2009	8.5	7/27/2009	9.3	5/21/2009	9.1	12/16/2009	8.5
3/17/2009	8.5	7/28/2009	9.3	5/22/2009	9.1	12/17/2009	8.4
3/18/2009	8.5	7/29/2009	9.2	5/25/2009	9.1	12/18/2009	8.4
3/19/2009	8.6	7/30/2009	9.1	5/26/2009	9.3	12/21/2009	8.4
3/20/2009	8.8	7/31/2009	9.2	5/27/2009	9.2	12/22/2009	8.4
3/23/2009	8.4	8/4/2009	9.3	5/28/2009	8.9	Number	178
3/24/2009	8.4	8/5/2009	9.1	5/29/2009	9.2	Minimum	8.3
3/25/2009	8.5	8/6/2009	9.2	6/1/2009	9.0	Maximum	9.4
3/26/2009	8.5	8/7/2009	9.3	6/2/2009	9.2	Mean	8.8
3/27/2009	8.4	8/10/2009	9.2	6/3/2009	9.0	Median	8.8
3/30/2009	9.0	8/11/2009	9.1	6/4/2009	9.0	10th Perc.	8.4

Appendix Table C.6.4: Water quality at station SGW3, 2005 to 2009.

Date	Acidity (mg/L)	Fe (mg/L)	pH	Sulphate (mg/L)
6/1/2005	3640.00	1154.00	4.6	8029.00
6/1/2006	930.00	1030.00	4.9	3100.00
7/25/2007	1630.00	831.00	4.8	2800.00
7/11/2008	1470.00	847.00	4.9	2600.00
8/10/2009	1220.00	560.00	4.9	2300.00
Number	5	5	5.0	5
Minimum	930.00	560.00	4.6	2300.00
Maximum	3640.00	1154.00	4.9	8029.00
Mean	1778.00	884.40	4.8	3765.80
Median	1470.00	847.00	4.9	2800.00
10th Perc.	1046.00	668.40	4.68	2420.00

Appendix Table C.6.5: Water quality at station SGW4 , 2005 and 2006.

Date	pH	Acidity (mg/L)	SO4 (mg/L)	Fe (mg/L)
Jun-05	7.4	8	266	0.056
Jun-06	7.1	0.5	230	0.24
Oct-06	7.5	0.5	520	0.12
Number	3	3	3	3
Minimum	7.1	0.5	230	0.056
Maximum	7.5	8	520	0.24
Mean	7.3	3.0	339	0.1
Median	7.4	0.5	266	0.12
10th Perc.	7.2	0.5	237	0.1

(shaded box) Concentration below maximum MDL.

Appendix Table C.6.6: Summary of trends for station CL-04, 2003 - 2009.

Season	Spearman rho	Acidity	Barium	Cobalt	Iron	Manganese	pH	Ra-226	Sulphate	Uranium
April	Correlation Coefficient							0		
	Sig. (2-tailed)							1		
	N							5		
May (April/May for some)	Correlation Coefficient	-0.92582	-0.657143	-0.828571	0.828	-1	-0.894427	0.607143	-1	-0.6377481
	Sig. (2-tailed)	0.00805	0.156175	0.041563	0.042	0.000001	0.040519	0.148231	0.000001	0.1730711
	N	6	6	6	6	6	5	7	6	6
June	Correlation Coefficient							0.392857		
	Sig. (2-tailed)							0.383317		
	N							7		
July	Correlation Coefficient							0.6		
	Sig. (2-tailed)							0.208		
	N							6		
August (July/August for some)	Correlation Coefficient	-0.894427	0.9	-0.707107	0.621	-0.9	0.527046	0	-0.9	-0.9746794
	Sig. (2-tailed)	0.040519	0.037386	0.18169	0.188	0.037386073	0.361455	1	0.03738607	0.0048182
	N	5	5	5	6	5	5	5	5	5
October/November	Correlation Coefficient	-0.782624	-0.811679	0.142857	0.828	-0.942857143	-0.091077	0.828571	-1	-0.5217939
	Sig. (2-tailed)	0.117614	0.049858	0.787172	0.042	0.004804665	0.863763	0.041563	0.000001	0.2883432
	N	5	6	6	6	6	6	6	5	6
December	Correlation Coefficient							0.666886		
	Sig. (2-tailed)							0.218894		
	N							5		

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

"ns" denotes not significant.

[shaded box] Significant trend where p<0.05.

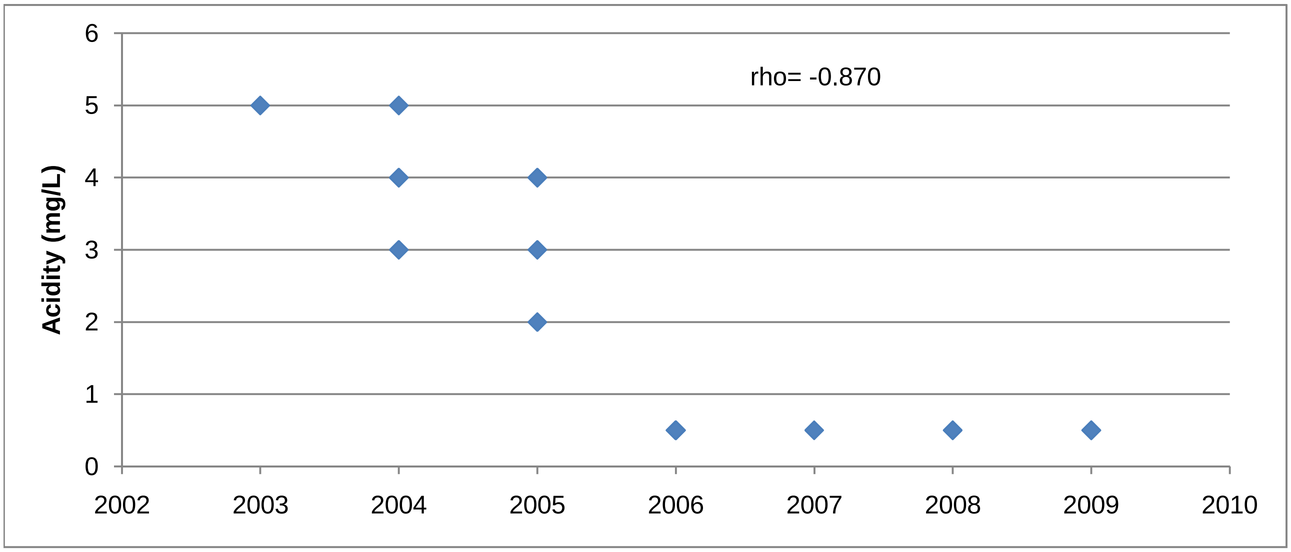
Appendix Table C.6.7: Summary of trends for Stanleigh groundwater stations, 2003 - 2009.

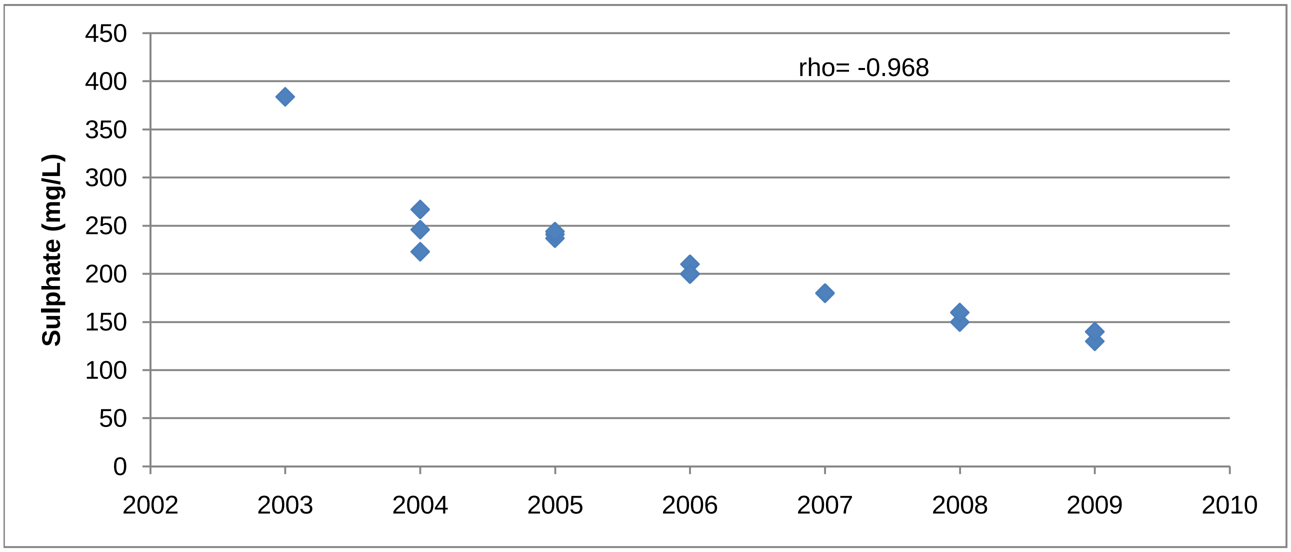
Station	Spearman rho	Iron	pH	Sulphate
SGW-3	Correlation Coefficient	-0.954545455	0.954008224	-0.81666667
	Sig. (2-tailed)	5.0E-06	5.3E-06	<0.05
	N	11	11	9
SGW-4	Correlation Coefficient	0.095238095	-0.452380952	-0.71428571
	Sig. (2-tailed)	ns	ns	ns
	N	8	8	6

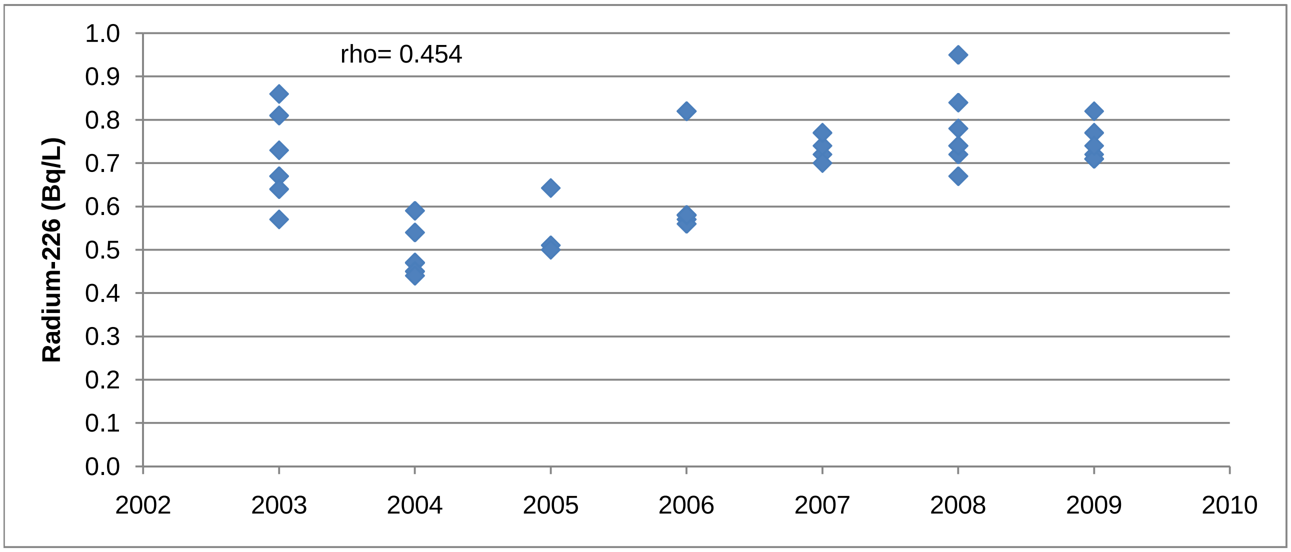
Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

"ns" denotes not significant.

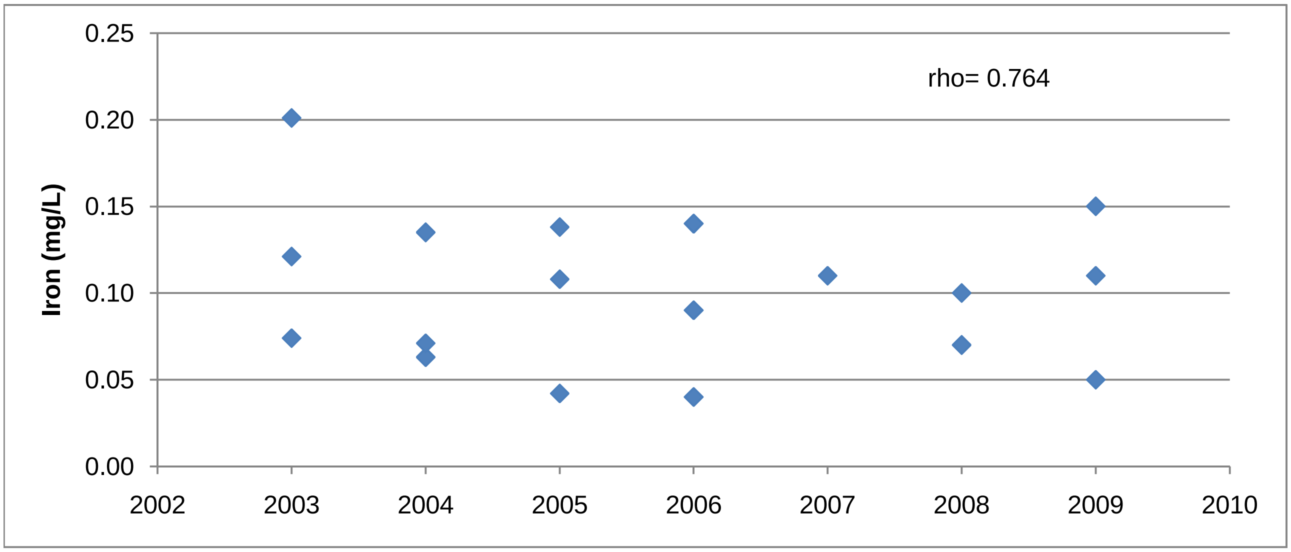
(shaded) Significant trend where p<0.05.

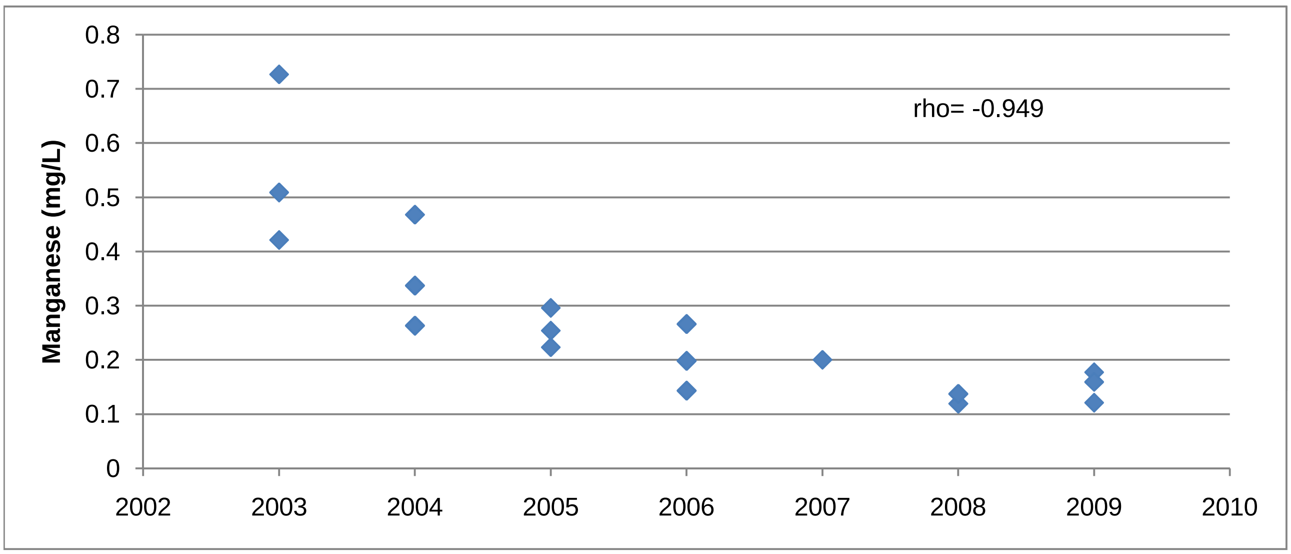


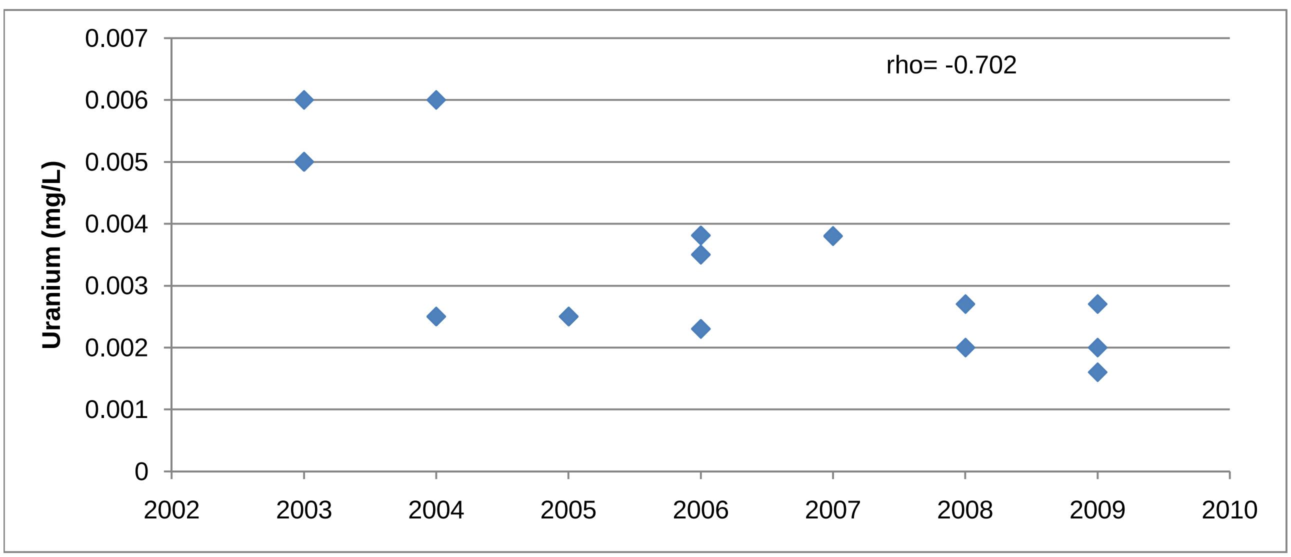




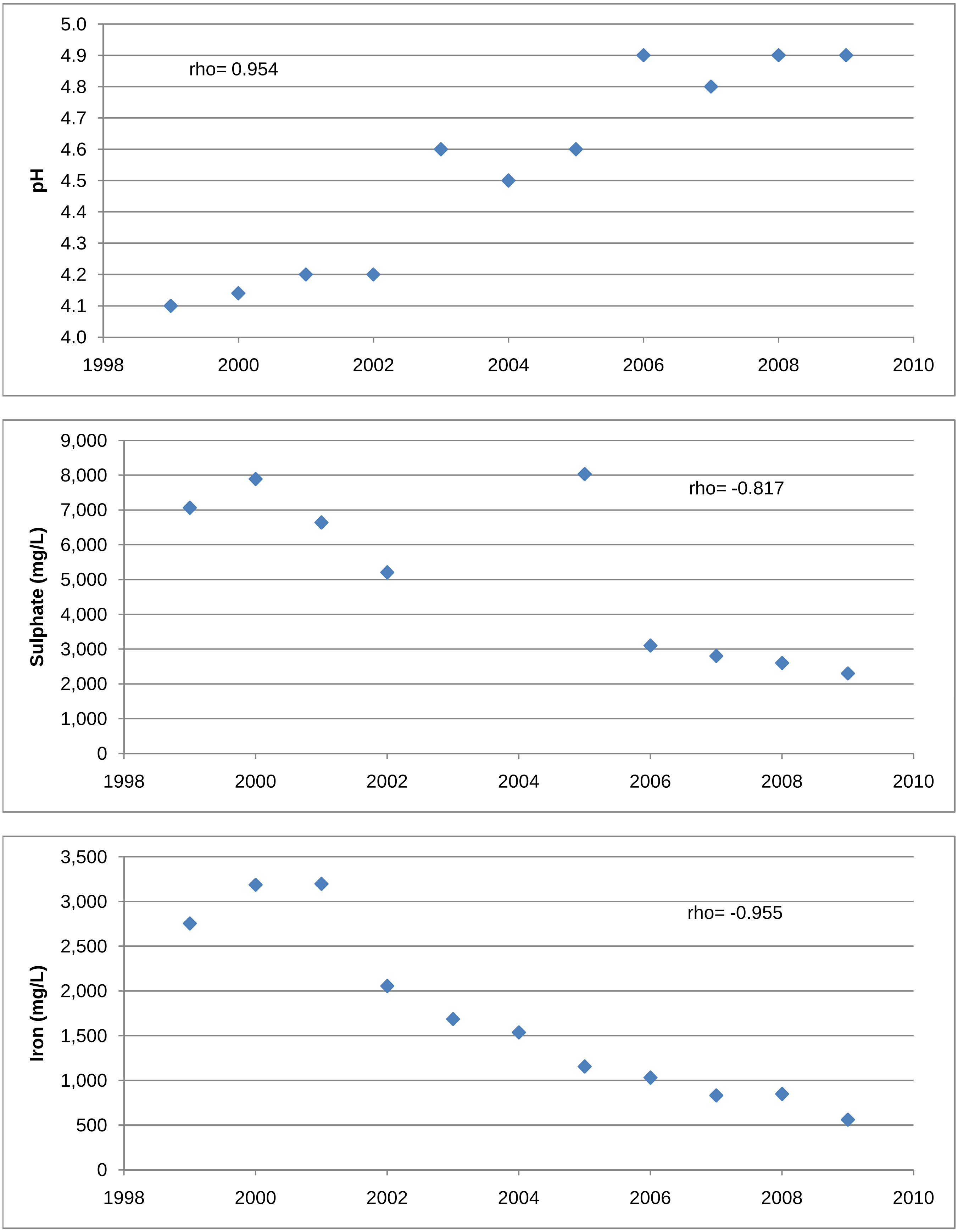
Appendix Figure C.6.1: Significant common (average) trends observed for acidity, sulphate, radium-226, manganese and uranium over all seasons at station CL-04, 2003 to 2009.



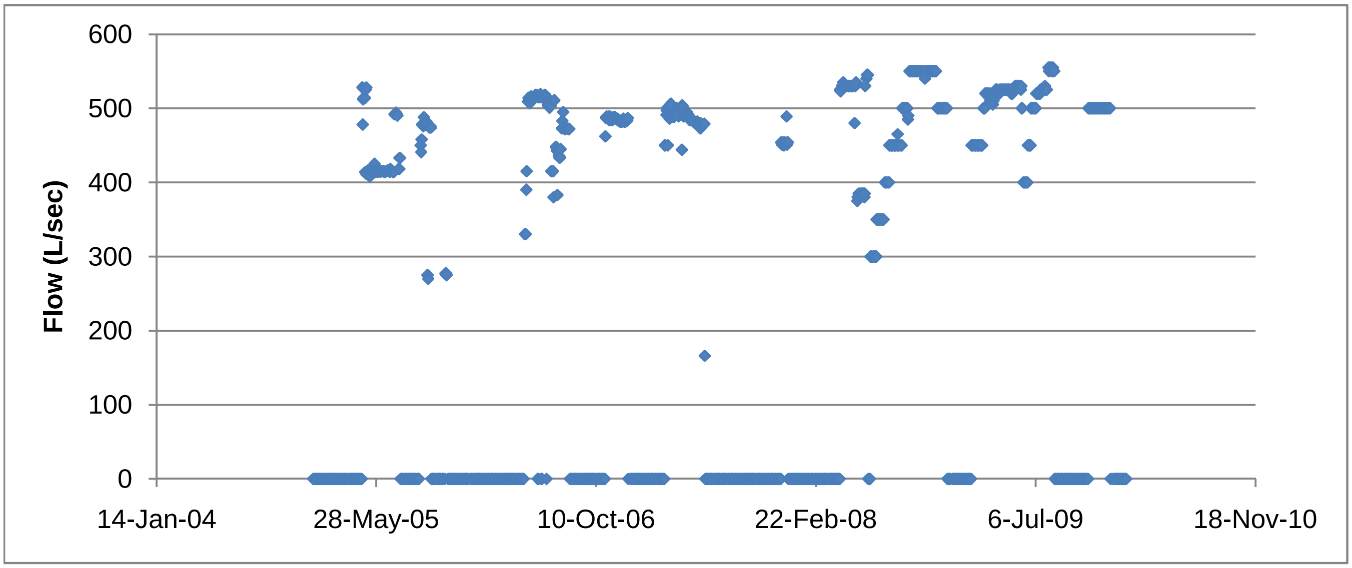




Appendix Figure C.6.1: Significant common (average) trends observed for acidity, sulphate, radium-226, manganese and uranium over all seasons at station CL-04, 2003 to 2009.



Appendix Figure C.6.2: Significant trends observed for pH, sulphate and iron at station SGW-3, 1999-2009.



Appendix Figure C.6.3: Flows at station CL-04 from 2005 to 2009.

APPENDIX C.7
Lacnor/Nordic TMA

Appendix Table C.7.1: Nordic final point of control (N-19) discharge criteria.

Parameter	Units	Discharge Criteria[d]		Action Level	Internal Investigation
		Grab Sample [a]	Mean [b]		
pH	pH units	5.5-9.5	6.0-9.0	<6.5 or >9.0	<7.0 or >8.5
Total Suspended Solids	mg/L	20	10	10	7.5
Total Radium-226	Bq/L	1.10	0.37	0.37	0.20
Iron	mg/L	10	1.0[c]	5.0	2.0

[a]Samples to be collected during periods of discharge.
[b]Arithmetic mean of twelve consecutive samples.
[c] Arithmetic mean of all grab samples collected during calendar month.
[d] Discharge criteria revised as per December 2009 CofA amendment as these are generally more restrictive than CNSC license.

Appendix Table C.7.2: Water quality at station ECA-131 from 2005 to 2009.

Date	Acidity (mg/L)	Conductivity (µmho/cm)	Ba (mg/L)	Fe (mg/L)	pH	Ra-226 (Bq/L)	Sulphate (mg/L)	TSS (mg/L)
1/5/2005	12	40.9			6.5	0.019		
3/21/2005	12	36.8	0.012	1.83	6.5	0.012	13.8	
4/4/2005	8	33.1	0.010	0.96	6.0	0.009	9.6	
5/2/2005	10	43.4	0.018	2.66	6.0	0.030	21.2	
6/6/2005	11	133.5	0.030	2.92	5.9	0.140	49.1	
7/4/2005	13	195.2	0.065	1.72	6.4	0.170	80.7	
11/21/2005	9	31.7	0.013	1.63	6.1	0.006	14.3	
1/3/2006	4	38.9	0.012	3.02	6.4	0.011	19.0	
2/6/2006	1	40.0	0.012	2.79	6.5	0.007	18.0	
3/8/2006	0.5	31.4	0.009	1.92	6.3	0.0025	13.0	
4/5/2006	2	20.1	0.012	0.82	6.2	0.007	8.4	
5/6/2006	11	118.5	0.015	9.25	6.2	0.013	56.0	
6/5/2006	0.5	252.2	0.032	20.8	6.1	0.087	120.0	
7/4/2006	41	1498.0	0.051	42	6.3	0.110	260.0	
8/10/2006	199	1131.0	0.046	116	6.1	0.110	880.0	
9/5/2006	154	1742.0	0.046	116	5.7	0.065	870.0	
10/5/2006	26	306.9	0.030	30.4	6.3	0.048	170.0	
11/6/2006	0.5	23.5	0.008	0.87	6.4	0.0025	7.1	
12/4/2006	0.5	22.9	0.010	1.15	6.7	0.0025	9.0	
1/8/2007	0.5	20.7	0.010	0.57	6.5	0.007	6.7	0.5
4/4/2007	0.5	19.8	0.009	0.78	6.7	0.097	7.1	1
1/15/2008	0.5	19.8	0.009	0.33	6.2	0.0025	6.1	0.5
4/16/2008	0.5	17.8	0.011	0.46	6.0	0.0025	6.8	1
5/5/2008	0.5	27.2	0.010	0.63	7.0	0.0025	7.4	2
6/2/2008	0.5	35.9	0.013	1.14	6.7	0.009	7.8	3
7/2/2008	0.5	56.1	0.028	6.03	6.3	0.036	26.0	11
11/26/2008	0.5	27.2	0.009	1.35	6.8	0.007	8.5	1
12/17/2008	0.5	21.8	0.009	0.53	6.9	0.006	0.1	0.5
1/7/2009	0.5	20.3	0.009	0.32	7.1	0.0025	4.4	0.5
2/2/2009	0.5	26.7	0.011	0.72	6.6	0.006	5.2	0.5
3/4/2009	0.5	26.2	0.010	0.66	6.5	0.0025	4.9	0.5
4/6/2009	3	19.2	0.011	0.33	6.4	0.0025	4.9	1
5/4/2009	0.5	22.7	0.010	0.65	6.9	0.015	6.3	2
6/3/2009	0.5	33.1	0.016	0.76	6.5	0.013	7.0	3
7/6/2009	0.5	111.9	0.026	5.56	6.6	0.022	26.0	12
8/5/2009	0.5	52.3	0.016	2.6	6.5	0.0025	9.1	7
10/7/2009	21	411.5	0.035	26.8	6.1	0.069	230.0	13
11/2/2009	0.5	18.3	0.008	0.47	6.9	0.0025	4.0	1
12/7/2009	0.5	31.8	0.008	0.77	6.9	0.0025	6.1	1
Number	41	41	40	40	41	41	40	22
Minimum	0.5	17.8	0.008	0.32	5.7	0.0025	0.1	0.5
Maximum	199	1742	0.065	116	7.1	0.17	880	13
Mean	13	166	0.018	10.2	6.4	0.0284	75	2.9
Median	0.5	31.8	0.012	1.1	6.4	0.0070	8.75	1
10th Perc.	0.5	19.8	0.009	0.457	6.0	0.0025	4.9	0.5

(shaded) Concentration below maximum MDL.

Appendix Table C.7.3: Water quality at station ECA-132, 2005 to 2009.

Date	Acidity (mg/L)	Ba (mg/L)	Co (mg/L)	Fe (mg/L)	Mn (mg/L)	pH	Ra-226 (Bq/L)	SO4 (mg/L)	U (mg/L)
4/6/2005	10					6.5	0.22		
10/5/2005	3					7.7	0.48		
5/3/2006	1					7	0.87		
11/1/2006	1					7.3	0.51		
5/2/2007	0.5					6.9	0.750		
11/7/2007	0.5					6.6	0.350		
5/7/2008	0.5	0.024	0.0053	1.07	0.167	7.0	0.850	81	0.004
11/5/2008	0.5	0.023	0.00025	0.14	0.004	7.1	0.400	100	0.004
5/31/2009	0.5	0.025	0.0057	0.86	0.212	6.9	0.890	86	0.0017
11/30/2009	0.5	0.026	0.0011	0.60	0.041	7.5	0.470	110	0.0048
Number	10	4	4	4	4	10	10	4	4
Minimum	0.5	0.023	0.0003	0.14	0.004	6.5	0.22	81	0.002
Maximum	10	0.026	0.0057	1.07	0.212	7.7	0.890	110	0.005
Mean	1.8	0.025	0.0031	0.67	0.106	7.1	0.579	94	0.004
Median	0.5	0.025	0.0032	0.73	0.104	7.0	0.495	93	0.004
10th Perc.	0.5	0.023	0.0005	0.28	0.015	6.59	0.337	83	0.002

(shaded box) Concentration below maximum MDL.

Appendix Table C.7.4: Water quality at station L-03, 2005 to 2009.

Date	Acidity (mg/L)	Ba (mg/L)	Co (mg/L)	Fe (mg/L)	Mn (mg/L)	pH	Ra-226 (Bq/L)	Sulphate (mg/L)	U (mg/L)
1/6/2005				30.06		3.2	0.61	1254	0.043
4/19/2005				12.24		3.5	0.26	216	0.012
11/28/2005				38.3		2.5	0.89	1348	0.058
1/19/2006				32.1		2.7	0.93	690	0.0596
4/18/2006				20.3		3.4	0.31	200	0.0437
10/19/2006				34.8		3	0.8	490	0.0669
1/3/2007	129	0.014	0.0323	36.6	0.431	3.4	0.370	750.0	0.0487
4/5/2007	61	0.008	0.0160	18.2	0.238	3.3	0.200	150.0	0.0245
11/22/2007	203	0.018	0.0395	39.5	1.350	2.8	0.860	620.0	0.0591
2/4/2008	128	0.014	0.0351	33.9	0.359	3.1	0.400	310.0	0.0789
4/30/2008	97	0.014	0.0297	21.6	0.388	3.1	0.340	260.0	0.0469
7/3/2008	176	0.018	0.0480	27.0	0.813	2.8	0.490	480.0	0.0713
1/8/2009	101	0.016	0.0276	26.5	0.387	3.2	0.340	300.0	0.0794
5/7/2009	130	0.013	0.0335	26.9	0.576	3.0	0.420	340.0	0.0408
7/2/2009	161	0.015	0.0358	20.8	0.730	2.9	0.490	410.0	0.041
10/8/2009	193	0.017	0.0376	36.2	1.150	2.9	0.790	540.0	0.0452
Number	10	10	10	16	10	16	16	16	16
Minimum	61	0.008	0.0160	12.2	0.238	2.5	0.200	150	0.012
Maximum	203	0.018	0.0480	39.5	1.350	3.5	0.93	1348	0.0794
Mean	138	0.015	0.0335	28.4	0.642	3.1	0.531	522	0.0512
Median	129.5	0.015	0.0343	28.5	0.504	3.1	0.455	445	0.0478
10th Perc.	93.4	0.013	0.0264	19.3	0.347	2.8	0.285	208	0.0327

Appendix Table C.7.5: Water quality at station N-17, 2005 to 2009.

Date	Acidity (mg/L)	Ba (mg/L)	Co (mg/L)	Fe (mg/L)	Mn (mg/L)	pH	Sulphate (mg/L)	Ra-226 (Bq/L)	U (mg/L)
1/19/2005	1030	0.0164	0.0855	262.4	1.35	4.3	1611	0.19	0.087
2/23/2005								0.2	
3/23/2005								0.16	
4/20/2005	541	0.0166	0.082	203.1	1.13	3.7	1265	0.3	0.078
5/18/2005								0.11	
6/22/2005								0.12	
7/20/2005	808	0.0213	0.125	420	2.1	4.7	1904	0.085	0.071
8/17/2005								0.16	
9/21/2005								0.1	
10/19/2005	800	0.014	0.109	299	1.44	3.6	2633	0.18	0.117
11/23/2005								0.25	
12/14/2005								0.13	
1/11/2006								0.077	
2/1/2006	588	0.006	0.153	331	1.84	4.8	1400	0.1	0.0588
3/1/2006								0.059	
4/5/2006								0.28	
5/3/2006	473	0.0144	0.119	244	1.58	4.2	1000	0.15	0.11
6/7/2006								0.07	
7/5/2006								0.078	
8/2/2006	543	0.007	0.112	287	1.72	3.5	1200	0.074	0.0627
9/6/2006								0.15	
10/4/2006								0.11	
11/1/2006	547	0.009	0.117	209	1.52	3.8	1100	0.16	0.0483
12/6/2006								0.21	
1/3/2007								0.240	
2/7/2007	790	0.017	0.1210	376	1.720	5.2	1400.0	0.086	0.0554
3/7/2007								0.110	
4/4/2007								0.270	
5/2/2007	516	0.017	0.1240	292	1.480	4.1	1200.0	0.140	0.0721
6/6/2007								0.100	
7/4/2007								0.051	
8/1/2007	676	0.019	0.1360	376	1.810	5.0	1500.0	0.083	0.0539
9/5/2007								0.094	
10/3/2007								0.130	
11/7/2007	623	0.017	0.1140	297	1.590	3.5	1200.0	0.190	0.0654
12/5/2007								0.082	
1/2/2008								0.180	
2/6/2008	333	0.014	0.0708	158	0.970	3.4	810.0	0.250	0.0596
3/5/2008				246				0.110	
4/2/2008				193				0.380	
5/7/2008	321	0.017	0.0826	182	1.110	3.3	770.0	0.180	0.0543
6/4/2008				279				0.086	
7/2/2008				286				0.069	
8/6/2008	601	0.017	0.1250	331	1.780	4.8	1200.0	0.094	0.0527
9/3/2008				257				0.072	
10/1/2008				368				0.071	
11/5/2008	682	0.018	0.1150	383	1.780	4.4	1500.0	0.077	0.0454
12/3/2008				277				0.069	
1/7/2009								0.170	
2/4/2009	533	0.015	0.0996	320	1.600	3.8	1100.0	0.074	0.0421
3/4/2009								0.072	
4/1/2009								0.370	
5/6/2009	378	0.015	0.0761	173	0.988	5.8	770.0	0.170	0.043
6/3/2009								0.140	
7/2/2009								0.230	
8/6/2009	425	0.018	0.0864	236	1.250	4.2	990.0	0.082	0.0397
9/2/2009								0.080	
10/7/2009								0.220	
11/4/2009	316	0.017	0.0576	114	1.010	3.4	680.0	0.240	0.0421
12/2/2009								0.180	
Number	20	20	20	27	20	20	20	60	20
Minimum	316	0.006	0.0576	114	0.970	3.3	680	0.051	0.0397
Maximum	1030	0.021	0.1530	420	2.100	5.8	2633	0.380	0.1170
Mean	576	0.015	0.1055	274	1.488	4.2	1261.7	0.146	0.0629
Median	545	0.017	0.1130	279	1.550	4.2	1200.0	0.125	0.0571
10th Perc.	332	0.009	0.0756	178	1.008	3.4	770.0	0.072	0.0421

Appendix Table C.7.6: Water quality at station N-18, 2005 to 2009.

Date	pH	Date	pH	Date	pH	Date	pH	Date	pH
1/4/2005	10.9	5/19/2005	11.2	10/6/2005	10.5	2/23/2006	10.7	7/12/2006	10.6
1/5/2005	10.9	5/20/2005	11.1	10/7/2005	11	2/24/2006	10.4	7/13/2006	10.6
1/6/2005	10.9	5/24/2005	11.4	10/11/2005	10.8	2/27/2006	10.6	7/14/2006	10.5
1/7/2005	10.4	5/25/2005	11.1	10/12/2005	10.5	2/28/2006	10.5	7/17/2006	10.7
1/10/2005	10.8	5/26/2005	11.1	10/13/2005	10.5	3/1/2006	10.5	7/18/2006	10.7
1/11/2005	10.8	5/27/2005	11.2	10/14/2005	10.6	3/2/2006	10.7	7/19/2006	10.7
1/12/2005	10.8	5/30/2005	11.1	10/17/2005	10.8	3/3/2006	10.5	7/20/2006	10.8
1/13/2005	10.4	5/31/2005	11.1	10/18/2005	10.8	3/6/2006	10.7	7/21/2006	10.6
1/14/2005	10.9	6/1/2005	11.1	10/19/2005	10.7	3/7/2006	10.5	7/24/2006	10.4
1/17/2005	10.8	6/2/2005	11	10/20/2005	10.7	3/8/2006	10.4	7/25/2006	10.6
1/18/2005	10.8	6/3/2005	11	10/21/2005	10.7	3/9/2006	10.4	7/26/2006	10.1
1/19/2005	10.4	6/6/2005	10.7	10/24/2005	11.1	3/10/2006	10.4	7/27/2006	10.4
1/20/2005	10.4	6/7/2005	11.2	10/25/2005	10.7	3/13/2006	10.3	7/28/2006	10.2
1/21/2005	10.4	6/8/2005	11.2	10/26/2005	10.6	3/14/2006	10.6	7/31/2006	10.4
1/24/2005	10.6	6/9/2005	11.2	10/27/2005	10.6	3/15/2006	10.3	8/1/2006	10.8
1/25/2005	10.5	6/10/2005	11.2	10/28/2005	10.9	3/16/2006	10.6	8/2/2006	10.3
1/26/2005	10.9	6/13/2005	11.2	10/31/2005	10.7	3/17/2006	10.6	8/3/2006	10.3
1/27/2005	10.8	6/14/2005	11.2	11/1/2005	10.7	3/20/2006	10.5	8/4/2006	10.5
1/28/2005	10.8	6/15/2005	10.9	11/2/2005	11	3/21/2006	10.5	8/8/2006	10.6
1/31/2005	11.2	6/16/2005	11.2	11/3/2005	11	3/22/2006	9.3	8/9/2006	10.4
2/1/2005	10.9	6/17/2005	11.2	11/4/2005	11	3/23/2006	9.4	8/10/2006	10.7
2/2/2005	10.9	6/20/2005	11	11/7/2005	11	3/24/2006	9.4	8/11/2006	10.7
2/3/2005	11.1	6/21/2005	10.8	11/8/2005	10.9	3/27/2006	9.4	8/14/2006	10.7
2/4/2005	10.9	6/22/2005	11	11/9/2005	10.9	3/28/2006	9.3	8/15/2006	10.5
2/7/2005	10.8	6/23/2005	11	11/10/2005	10.9	3/29/2006	9.3	8/16/2006	10.6
2/8/2005	10.9	6/24/2005	11	11/11/2005	10.7	3/30/2006	9.3	8/17/2006	10.8
2/9/2005	10.9	6/27/2005	10.8	11/14/2005	10.1	3/31/2006	8.9	8/18/2006	10.5
2/10/2005	10.9	6/28/2005	10.9	11/15/2005	10.8	4/3/2006	8.6	8/21/2006	10.3
2/11/2005	10.7	6/29/2005	10.7	11/16/2005	10.8	4/4/2006	9.3	8/22/2006	10.5
2/14/2005	10.8	6/30/2005	10.4	11/17/2005	10.7	4/5/2006	9.3	8/23/2006	10.5
2/15/2005	10.8	7/4/2005	11	11/18/2005	10.9	4/6/2006	9.7	8/24/2006	10.3
2/16/2005	10.8	7/5/2005	10.9	11/21/2005	10.7	4/7/2006	9.3	8/25/2006	10.3
2/17/2005	11.1	7/6/2005	11	11/22/2005	10.8	4/10/2006	9.3	8/28/2006	10.5
2/18/2005	11.1	7/7/2005	11	11/23/2005	10.8	4/11/2006	9.8	8/29/2006	10.5
2/21/2005	11.2	7/8/2005	11.1	11/24/2005	10.8	4/12/2006	9.1	8/30/2006	10.7
2/22/2005	11	7/11/2005	11.2	11/25/2005	10.8	4/13/2006	8.8	8/31/2006	10.7
2/23/2005	10.8	7/12/2005	10.9	11/28/2005	10.7	4/17/2006	9.2	9/1/2006	10.7
2/24/2005	10.8	7/13/2005	11.1	11/29/2005	9.3	4/18/2006	10.1	9/5/2006	10.6
2/25/2005	10.9	7/14/2005	11.1	11/30/2005	9.4	4/19/2006	10.1	9/6/2006	10.8
2/28/2005	11.1	7/15/2005	10.6	12/1/2005	9.9	4/20/2006	10.1	9/7/2006	10.8
3/1/2005	11.1	7/18/2005	10.7	12/2/2005	10.9	4/21/2006	10.5	9/8/2006	10.8
3/2/2005	11	7/19/2005	11	12/5/2005	11.2	4/24/2006	9.7	9/11/2006	10.8
3/3/2005	11.2	7/20/2005	11	12/6/2005	11	4/25/2006	10.3	9/12/2006	10.7
3/4/2005	11.2	7/21/2005	11.2	12/7/2005	10.8	4/26/2006	10.4	9/13/2006	10.8
3/7/2005	11	7/22/2005	11.3	12/8/2005	9.7	4/27/2006	10.3	9/14/2006	10.9
3/8/2005	11.4	7/25/2005	11	12/9/2005	9.4	4/28/2006	10.6	9/15/2006	11
3/9/2005	11.4	7/26/2005	11.1	12/12/2005	9.5	5/1/2006	10.5	9/18/2006	10.9

Appendix Table C.7.6: Water quality at station N-18, 2005 to 2009.

Date	pH	Date	pH	Date	pH	Date	pH	Date	pH
3/10/2005	11.5	7/27/2005	11	12/13/2005	9.7	5/2/2006	10.6	9/19/2006	10.7
3/11/2005	11.3	7/28/2005	11	12/14/2005	9.7	5/3/2006	10.6	9/20/2006	10.6
3/14/2005	11.1	7/29/2005	10.6	12/15/2005	9.9	5/4/2006	10.4	9/21/2006	10.9
3/15/2005	11.2	8/2/2005	11	12/16/2005	9.6	5/5/2006	10.7	9/22/2006	10.9
3/16/2005	11.1	8/3/2005	10.9	12/19/2005	9.9	5/8/2006	10.6	9/25/2006	10.9
3/17/2005	11	8/4/2005	11	12/20/2005	9.9	5/9/2006	10.6	9/26/2006	10.9
3/18/2005	11.1	8/5/2005	11.3	12/21/2005	9.9	5/10/2006	10.6	9/27/2006	10.6
3/21/2005	11.3	8/8/2005	10.8	12/22/2005	10.4	5/11/2006	10.2	9/28/2006	10.9
3/22/2005	11.3	8/9/2005	10.9	12/23/2005	10.6	5/12/2006	10	9/29/2006	10.8
3/23/2005	11.3	8/10/2005	10.9	12/28/2005	10.7	5/15/2006	9.7	10/2/2006	10.9
3/24/2005	11.2	8/11/2005	10.9	12/29/2005	11	5/16/2006	9.7	10/3/2006	10.8
3/28/2005	10.8	8/12/2005	11	12/30/2005	10.7	5/17/2006	10.6	10/4/2006	10.8
3/29/2005	11.3	8/15/2005	10.7	1/3/2006	10.5	5/18/2006	10.6	10/5/2006	10.9
3/30/2005	10.9	8/16/2005	11.2	1/4/2006	10.4	5/19/2006	10.6	10/6/2006	10.7
3/31/2005	10.5	8/17/2005	10.7	1/5/2006	10.5	5/23/2006	10.6	10/10/2006	10.7
4/1/2005	10.2	8/18/2005	11.2	1/6/2006	10.6	5/24/2006	10.3	10/11/2006	10.7
4/4/2005	8.9	8/19/2005	10.8	1/9/2006	10.6	5/25/2006	10.6	10/12/2006	10.7
4/5/2005	9.2	8/22/2005	10.9	1/10/2006	10.6	5/26/2006	10.3	10/13/2006	10.9
4/6/2005	9.4	8/23/2005	11.1	1/11/2006	10.6	5/29/2006	10.2	10/16/2006	10.6
4/7/2005	8.9	8/24/2005	11.2	1/12/2006	10.5	5/30/2006	10.6	10/17/2006	10.7
4/8/2005	9.2	8/25/2005	11.1	1/13/2006	10.5	5/31/2006	11	10/18/2006	10.6
4/11/2005	10.7	8/26/2005	10.9	1/16/2006	10.4	6/1/2006	10.6	10/19/2006	10.6
4/12/2005	10.4	8/29/2005	11.1	1/17/2006	10.4	6/2/2006	10.6	10/20/2006	9.5
4/13/2005	10.7	8/30/2005	11.2	1/18/2006	10.4	6/5/2006	10.6	10/23/2006	10.9
4/14/2005	10.6	8/31/2005	11	1/19/2006	10.3	6/6/2006	10.6	10/24/2006	10.7
4/15/2005	10.6	9/1/2005	10.8	1/20/2006	10.5	6/7/2006	10.3	10/25/2006	10.9
4/18/2005	10.7	9/2/2005	10.8	1/23/2006	10.6	6/8/2006	10.6	10/26/2006	10.9
4/19/2005	10.9	9/6/2005	10.9	1/24/2006	10.4	6/9/2006	10.5	10/27/2006	11
4/20/2005	10.9	9/7/2005	10.9	1/25/2006	10.5	6/12/2006	10.6	10/30/2006	10.9
4/21/2005	11	9/8/2005	11.2	1/26/2006	10.6	6/13/2006	10.6	10/31/2006	10.9
4/22/2005	10.9	9/9/2005	11.1	1/27/2006	10.3	6/14/2006	10.4	11/1/2006	10.9
4/25/2005	11.2	9/12/2005	11.4	1/30/2006	10.3	6/15/2006	10.5	11/2/2006	10.9
4/26/2005	11	9/13/2005	11.1	1/31/2006	10.5	6/16/2006	10.5	11/3/2006	11
4/27/2005	11.2	9/14/2005	11	2/1/2006	10.5	6/19/2006	10.4	11/6/2006	10.8
4/28/2005	11	9/15/2005	11.1	2/2/2006	10.8	6/20/2006	10.5	11/7/2006	10.6
4/29/2005	11	9/16/2005	11.2	2/3/2006	10.6	6/21/2006	10.6	11/8/2006	10.6
5/2/2005	11.2	9/19/2005	11	2/6/2006	10.5	6/22/2006	10.5	11/9/2006	10.6
5/3/2005	11.2	9/20/2005	10.9	2/7/2006	10.5	6/23/2006	10.5	11/10/2006	10.6
5/4/2005	11.2	9/21/2005	10.7	2/8/2006	10.5	6/26/2006	10.6	11/13/2006	10.6
5/5/2005	11	9/22/2005	10.6	2/9/2006	10.7	6/27/2006	10.4	11/14/2006	10.6
5/6/2005	11	9/23/2005	10.7	2/10/2006	10.7	6/28/2006	10.4	11/15/2006	10.6
5/9/2005	10.9	9/26/2005	10.6	2/13/2006	10.4	6/29/2006	10.4	11/16/2006	10.6
5/10/2005	10.9	9/27/2005	10.6	2/14/2006	10.5	6/30/2006	10.6	11/17/2006	10.6
5/11/2005	11.1	9/28/2005	10.9	2/15/2006	10.6	7/4/2006	10.7	11/20/2006	10.9
5/12/2005	11	9/29/2005	10.5	2/16/2006	10.6	7/5/2006	10.5	11/21/2006	10.9
5/13/2005	11.1	9/30/2005	10.9	2/17/2006	10.3	7/6/2006	10.6	11/22/2006	11
5/16/2005	10.9	10/3/2005	10.8	2/20/2006	10.6	7/7/2006	10.7	11/23/2006	10.7
5/17/2005	10.9	10/4/2005	10.6	2/21/2006	10.5	7/10/2006	10.5	11/24/2006	10.8
5/18/2005	10.9	10/5/2005	10.5	2/22/2006	10.7	7/11/2006	10.4	11/27/2006	10.8

Appendix Table C.7.6: Water quality at station N-18, 2005 to 2009.

Date	pH	Date	pH	Date	pH	Date	pH	Date	pH
11/28/2006	10.6	4/17/2007	10.5	9/4/2007	10.7	1/22/2008	9.7	6/9/2008	10.4
11/29/2006	10.6	4/18/2007	10.5	9/5/2007	10.5	1/23/2008	8.9	6/10/2008	10.1
11/30/2006	10.7	4/19/2007	10.5	9/6/2007	10.4	1/24/2008	9.2	6/11/2008	10.3
12/1/2006	10.8	4/20/2007	10.3	9/7/2007	10.4	1/25/2008	9	6/12/2008	10.3
12/4/2006	10.7	4/23/2007	10.4	9/10/2007	10.6	1/28/2008	8.9	6/13/2008	9.8
12/5/2006	11	4/24/2007	10.6	9/11/2007	10.7	1/29/2008	9.1	6/16/2008	10.2
12/6/2006	10.8	4/25/2007	10.6	9/12/2007	10.7	1/30/2008	8.1	6/17/2008	10.5
12/7/2006	10.9	4/26/2007	10.7	9/13/2007	10.5	1/31/2008	7.8	6/18/2008	10.5
12/8/2006	10.9	4/27/2007	10.7	9/14/2007	10.3	2/1/2008	7.8	6/19/2008	10.4
12/11/2006	10.9	4/30/2007	10.6	9/17/2007	10.5	2/4/2008	8.4	6/20/2008	10.4
12/12/2006	10.7	5/1/2007	10.4	9/18/2007	10.7	2/5/2008	8.5	6/23/2008	10
12/13/2006	8.8	5/2/2007	10.6	9/19/2007	10.5	2/6/2008	8.7	6/24/2008	10.4
12/14/2006	8.9	5/3/2007	10.5	9/20/2007	10.1	2/7/2008	8.5	6/25/2008	10.5
12/15/2006	9.6	5/4/2007	10.5	9/21/2007	10.3	2/8/2008	8.7	6/26/2008	10.2
12/18/2006	10.3	5/7/2007	10.6	9/24/2007	10.1	2/11/2008	8.7	6/27/2008	10.4
12/19/2006	10.5	5/8/2007	10.6	9/25/2007	10.5	2/12/2008	8.5	7/1/2008	10.4
12/20/2006	10.6	5/9/2007	10.7	9/26/2007	10.7	2/13/2008	8.8	7/2/2008	10.4
12/21/2006	10.5	5/10/2007	10.6	9/27/2007	10.7	2/14/2008	9.1	7/3/2008	10
12/22/2006	11	5/11/2007	10.6	9/28/2007	10.6	2/15/2008	9.3	7/4/2008	10.1
12/27/2006	9.9	5/14/2007	10.6	10/1/2007	10.5	2/19/2008	8.3	7/7/2008	10.6
12/28/2006	10.2	5/15/2007	10.7	10/2/2007	10.5	2/20/2008	8.5	7/8/2008	10
12/29/2006	10.2	5/16/2007	10.6	10/3/2007	10.5	2/21/2008	8.5	7/9/2008	10.1
1/2/2007	9.6	5/17/2007	10.6	10/4/2007	10.3	2/22/2008	8.3	7/10/2008	10.1
1/3/2007	9.6	5/18/2007	10.6	10/5/2007	10.7	2/25/2008	8.3	7/11/2008	10.4
1/4/2007	10.1	5/22/2007	10.7	10/9/2007	10.6	2/26/2008	8.3	7/14/2008	10.6
1/5/2007	10.1	5/23/2007	10.9	10/10/2007	11.7	2/27/2008	9.1	7/15/2008	10.1
1/8/2007	10.2	5/24/2007	10.5	10/11/2007	12.2	2/28/2008	9.2	7/16/2008	10.1
1/9/2007	10.2	5/25/2007	10.6	10/12/2007	10.5	2/29/2008	9.2	7/17/2008	10.2
1/10/2007	10.2	5/28/2007	10.6	10/15/2007	10.5	3/3/2008	8.6	7/18/2008	10.1
1/11/2007	10.1	5/29/2007	10.6	10/16/2007	10.5	3/4/2008	9.4	7/21/2008	10.4
1/12/2007	10.2	5/30/2007	10.7	10/17/2007	10.1	3/5/2008	9.5	7/22/2008	10.2
1/15/2007	10.2	5/31/2007	10.7	10/18/2007	10.9	3/6/2008	9.5	7/23/2008	10.5
1/16/2007	10.2	6/1/2007	10.6	10/19/2007	10.5	3/7/2008	9.4	7/24/2008	10.6
1/17/2007	10.2	6/4/2007	10.5	10/22/2007	10.5	3/10/2008	9.4	7/25/2008	10.6
1/18/2007	10.6	6/5/2007	10.5	10/23/2007	10.4	3/11/2008	9.4	7/28/2008	10.4
1/19/2007	10.5	6/6/2007	10.6	10/24/2007	10.5	3/12/2008	9.6	7/29/2008	10.5
1/22/2007	10.6	6/7/2007	10.6	10/25/2007	10.6	3/13/2008	9.6	7/30/2008	10.5
1/23/2007	10.6	6/8/2007	10.6	10/26/2007	10.6	3/14/2008	10	7/31/2008	10.4
1/24/2007	10.6	6/11/2007	10.4	10/29/2007	10.5	3/17/2008	10.1	8/1/2008	10.5
1/25/2007	10.5	6/12/2007	10.6	10/30/2007	10.4	3/18/2008	9.8	8/5/2008	10.2
1/26/2007	10.5	6/13/2007	10.6	10/31/2007	10.5	3/19/2008	9.8	8/6/2008	10.4
1/29/2007	10.4	6/14/2007	10.6	11/1/2007	10.5	3/20/2008	10.2	8/7/2008	10.4
1/30/2007	10.5	6/15/2007	10.5	11/2/2007	10.5	3/24/2008	10.1	8/8/2008	10.2
1/31/2007	10.5	6/18/2007	10.8	11/5/2007	10.5	3/25/2008	9.9	8/11/2008	10.5
2/1/2007	10.6	6/19/2007	10	11/6/2007	10.6	3/26/2008	10.1	8/12/2008	10.6
2/2/2007	10.5	6/20/2007	11	11/7/2007	10.5	3/27/2008	9.9	8/13/2008	10.5
2/5/2007	10.6	6/21/2007	10.1	11/8/2007	10.7	3/28/2008	9.8	8/14/2008	10.5

Appendix Table C.7.6: Water quality at station N-18, 2005 to 2009.

Date	pH	Date	pH	Date	pH	Date	pH	Date	pH
2/6/2007	10.5	6/22/2007	10.6	11/9/2007	10.5	3/31/2008	9.9	8/15/2008	10.6
2/7/2007	10.5	6/25/2007	10.4	11/12/2007	10.3	4/1/2008	7.9	8/18/2008	10.5
2/8/2007	10.5	6/26/2007	10.5	11/13/2007	10.7	4/2/2008	8.3	8/19/2008	10.5
2/9/2007	10.5	6/27/2007	10.7	11/14/2007	10.7	4/3/2008	8.3	8/20/2008	10.5
2/12/2007	10.5	6/28/2007	10.5	11/15/2007	10.7	4/4/2008	8.3	8/21/2008	10.7
2/13/2007	10.6	6/29/2007	10.5	11/16/2007	10.6	4/7/2008	8.7	8/22/2008	10.5
2/14/2007	10.5	7/3/2007	10.7	11/19/2007	10.5	4/8/2008	8.7	8/25/2008	10.5
2/15/2007	10.5	7/4/2007	10.7	11/20/2007	10.5	4/9/2008	8.1	8/26/2008	10.6
2/16/2007	10.7	7/5/2007	10.7	11/21/2007	10.6	4/10/2008	7.8	8/27/2008	10.6
2/19/2007	10.8	7/6/2007	10.6	11/22/2007	10.3	4/11/2008	8.2	8/28/2008	10.5
2/20/2007	10.7	7/9/2007	10.5	11/23/2007	10.2	4/14/2008	8.7	8/29/2008	10.3
2/21/2007	10.6	7/10/2007	10.5	11/26/2007	10.7	4/15/2008	8.7	9/2/2008	10.6
2/22/2007	10.7	7/11/2007	10.5	11/27/2007	10.7	4/16/2008	8.7	9/3/2008	10.5
2/23/2007	10.7	7/12/2007	10.5	11/28/2007	10.6	4/17/2008	8.4	9/4/2008	10.5
2/26/2007	10.7	7/13/2007	10.5	11/29/2007	10.2	4/18/2008	8.5	9/5/2008	10.5
2/27/2007	10.7	7/16/2007	10.6	11/30/2007	10.5	4/21/2008	8.8	9/8/2008	10.4
2/28/2007	10.5	7/17/2007	10.6	12/3/2007	10.3	4/22/2008	9.1	9/9/2008	10.4
3/1/2007	10.5	7/18/2007	10.7	12/4/2007	10.3	4/23/2008	9.4	9/10/2008	10.7
3/2/2007	10.5	7/19/2007	10.7	12/5/2007	10.1	4/24/2008	9.8	9/11/2008	10.3
3/5/2007	10.7	7/20/2007	10.3	12/6/2007	10.1	4/25/2008	9.7	9/12/2008	10.2
3/6/2007	10.6	7/23/2007	10.5	12/7/2007	10.1	4/28/2008	8.7	9/15/2008	9.3
3/7/2007	10.7	7/24/2007	10.5	12/10/2007	10.1	4/29/2008	9.3	9/16/2008	10.5
3/8/2007	10.6	7/25/2007	10.5	12/11/2007	10.2	4/30/2008	9.5	9/17/2008	10.5
3/9/2007	10.7	7/26/2007	10.5	12/12/2007	9.6	5/1/2008	9.8	9/18/2008	10.6
3/12/2007	10.7	7/27/2007	10.5	12/13/2007	9.4	5/2/2008	9.6	9/19/2008	10.5
3/13/2007	10.5	7/30/2007	10.5	12/14/2007	9.3	5/5/2008	9.8	9/22/2008	10.7
3/14/2007	10.5	7/31/2007	10.5	12/17/2007	9.4	5/6/2008	10.2	9/23/2008	10.6
3/15/2007	10.6	8/1/2007	10.5	12/18/2007	9.4	5/7/2008	9.5	9/24/2008	10.6
3/16/2007	10.6	8/2/2007	10.5	12/19/2007	9.7	5/8/2008	9.7	9/25/2008	10.6
3/19/2007	10.6	8/3/2007	10.6	12/20/2007	9.6	5/9/2008	9.3	9/26/2008	10.8
3/20/2007	10.7	8/7/2007	10.6	12/21/2007	9.5	5/12/2008	9.6	9/29/2008	10.5
3/21/2007	10.7	8/8/2007	10.5	12/24/2007	8.6	5/13/2008	10.4	9/30/2008	10.6
3/22/2007	10.4	8/9/2007	10.4	12/27/2007	9.1	5/14/2008	10.4	10/1/2008	10.6
3/23/2007	10.5	8/10/2007	10.7	12/28/2007	9.1	5/15/2008	9.5	10/2/2008	10.7
3/26/2007	9.4	8/13/2007	10.8	12/31/2007	9.1	5/16/2008	10	10/3/2008	10.6
3/27/2007	9.5	8/14/2007	10.8	1/2/2008	9.2	5/20/2008	10.1	10/6/2008	10.5
3/28/2007	8.6	8/15/2007	10.8	1/3/2008	9.2	5/21/2008	10.6	10/7/2008	10.3
3/29/2007	9.8	8/16/2007	10.8	1/4/2008	8.9	5/22/2008	10	10/8/2008	10.4
3/30/2007	10.5	8/17/2007	10.8	1/7/2008	8.9	5/23/2008	9.3	10/9/2008	10.5
4/2/2007	10.5	8/20/2007	10.8	1/8/2008	8.6	5/26/2008	9.9	10/10/2008	10.7
4/3/2007	10.4	8/21/2007	10.8	1/9/2008	8.4	5/27/2008	10.7	10/14/2008	10.5
4/4/2007	8.7	8/22/2007	10.7	1/10/2008	8.4	5/28/2008	10.7	10/15/2008	10.5
4/5/2007	9.3	8/23/2007	10.4	1/11/2008	9.2	5/29/2008	10.4	10/16/2008	10.4
4/9/2007	9.7	8/24/2007	10.3	1/14/2008	9.7	5/30/2008	10.5	10/17/2008	10.6
4/10/2007	9.7	8/27/2007	10.8	1/15/2008	9.6	6/2/2008	10.3	10/20/2008	10.3
4/11/2007	9.7	8/28/2007	10.4	1/16/2008	9.7	6/3/2008	10.5	10/21/2008	10.4
4/12/2007	9.7	8/29/2007	10.4	1/17/2008	9.3	6/4/2008	10.5	10/22/2008	10.6
4/13/2007	9.7	8/30/2007	10.4	1/18/2008	9.4	6/5/2008	10.5	10/23/2008	10.6
4/16/2007	10	8/31/2007	10.5	1/21/2008	9.7	6/6/2008	10.5	10/24/2008	10.3

Appendix Table C.7.6: Water quality at station N-18, 2005 to 2009.

Date	pH	Date	pH	Date	pH	Date	pH
10/27/2008	10.6	3/16/2009	9.3	7/31/2009	10.2	12/17/2009	10.2
10/28/2008	10.7	3/17/2009	9	8/4/2009	10.3	12/18/2009	10
10/29/2008	10.7	3/18/2009	9	8/5/2009	10.3	12/21/2009	10.2
10/30/2008	10.5	3/19/2009	8.9	8/6/2009	10.5	12/22/2009	10.3
10/31/2008	10.4	3/20/2009	8.9	8/7/2009	10.2	12/23/2009	10.3
11/3/2008	10.6	3/23/2009	9	8/10/2009	10.5	12/24/2009	10
11/4/2008	10.6	3/24/2009	9	8/11/2009	10.5	12/29/2009	10.1
11/5/2008	10.5	3/25/2009	8.9	8/12/2009	10.2	12/30/2009	10.1
11/6/2008	10.2	3/26/2009	8.9	8/13/2009	10.2	12/31/2009	10.5
11/7/2008	10.5	3/27/2009	8.9	8/14/2009	10.2		
11/10/2008	10.7	3/30/2009	8.7	8/17/2009	10.1		
11/11/2008	10.7	3/31/2009	8.4	8/18/2009	10.4		
11/12/2008	10.7	4/1/2009	8.4	8/19/2009	10.5		
11/13/2008	10.3	4/2/2009	8.4	8/20/2009	10.5		
11/14/2008	10.4	4/3/2009	8.6	8/21/2009	10.3		
11/17/2008	10.5	4/6/2009	8.4	8/24/2009	10.2		
11/18/2008	10.5	4/7/2009	8.7	8/25/2009	10.3		
11/19/2008	10.5	4/8/2009	8.4	8/26/2009	10.1		
11/20/2008	10.5	4/9/2009	8.5	8/27/2009	9.8		
11/21/2008	10.5	4/13/2009	8.7	8/28/2009	10.3		
11/24/2008	10.2	4/14/2009	8.4	8/31/2009	10.3		
11/25/2008	10.5	4/15/2009	8.6	9/1/2009	10.3		
11/26/2008	10.4	4/16/2009	8.5	9/2/2009	10.3		
11/27/2008	10.4	4/17/2009	8.6	9/3/2009	10.3		
11/28/2008	10.2	4/20/2009	8.5	9/4/2009	10.3		
12/1/2008	10.3	4/21/2009	8.5	9/8/2009	10.1		
12/2/2008	10.3	4/22/2009	8.7	9/9/2009	10.3		
12/3/2008	10.6	4/23/2009	8.4	9/10/2009	10.3		
12/4/2008	10.5	4/24/2009	8.6	9/11/2009	10.1		
12/5/2008	10.4	4/27/2009	9.6	9/14/2009	10.1		
12/8/2008	10.3	4/28/2009	9.5	9/15/2009	10.3		
12/9/2008	10.6	4/29/2009	9.5	9/16/2009	10.3		
12/10/2008	10.7	4/30/2009	9.6	9/17/2009	10.3		
12/11/2008	10.6	5/1/2009	9.5	9/18/2009	10.5		
12/12/2008	10.6	5/4/2009	9.4	9/21/2009	10.1		
12/15/2008	10.3	5/5/2009	10.2	9/22/2009	10.3		
12/16/2008	10.4	5/6/2009	9.8	9/23/2009	10.3		
12/17/2008	10.2	5/7/2009	9.9	9/24/2009	10.3		
12/18/2008	10	5/8/2009	9.9	9/25/2009	10.4		
12/19/2008	10.1	5/11/2009	10.2	9/28/2009	10.3		
12/22/2008	9.9	5/12/2009	10.2	9/29/2009	10.5		
12/23/2008	10.1	5/13/2009	10.4	9/30/2009	10.5		
12/24/2008	10	5/14/2009	8.4	10/1/2009	10.4		
12/29/2008	8.8	5/15/2009	8.8	10/2/2009	10.3		
12/30/2008	9	5/19/2009	10	10/5/2009	10.1		
12/31/2008	9.3	5/20/2009	10.1	10/6/2009	10.2		
1/2/2009	10.1	5/21/2009	10.4	10/7/2009	10.3		

Appendix Table C.7.6: Water quality at station N-18, 2005 to 2009.

Date	pH	Date	pH	Date	pH	Date	pH
1/5/2009	9.8	5/22/2009	10.2	10/8/2009	10.6	**Number**	1257
1/6/2009	10	5/25/2009	10.2	10/9/2009	10.3	**Minimum**	7.8
1/7/2009	9	5/26/2009	10	10/13/2009	10.3	**Maximum**	12.2
1/8/2009	9.1	5/27/2009	10.1	10/14/2009	10.4	**Mean**	10.3
1/9/2009	9.1	5/28/2009	10.2	10/15/2009	10.4	**Median**	10.5
1/12/2009	9	5/29/2009	10.2	10/16/2009	10.4	**10th Perc.**	9.2
1/13/2009	9.1	6/1/2009	10.3	10/19/2009	10.6		
1/14/2009	9	6/2/2009	10	10/20/2009	10.5		
1/15/2009	9.2	6/3/2009	10.3	10/21/2009	10.3		
1/16/2009	9.2	6/4/2009	10.1	10/22/2009	10.2		
1/19/2009	9	6/5/2009	10.2	10/23/2009	10.2		
1/20/2009	9	6/8/2009	10.1	10/26/2009	10.5		
1/21/2009	9.5	6/9/2009	9.8	10/27/2009	10.3		
1/22/2009	9.6	6/10/2009	10	10/28/2009	10.2		
1/23/2009	9.7	6/11/2009	10	10/29/2009	10.4		
1/26/2009	9.7	6/12/2009	10	10/30/2009	10.1		
1/27/2009	9.5	6/15/2009	10.1	11/2/2009	9.8		
1/28/2009	9	6/16/2009	10.1	11/3/2009	10.2		
1/29/2009	9	6/17/2009	10.2	11/4/2009	10.1		
1/30/2009	9	6/18/2009	10.2	11/5/2009	9.9		
2/2/2009	9	6/19/2009	10.2	11/6/2009	10.2		
2/3/2009	9	6/22/2009	10	11/9/2009	10		
2/4/2009	9.1	6/23/2009	10.1	11/10/2009	10.2		
2/5/2009	9.2	6/24/2009	10.1	11/11/2009	10		
2/6/2009	9.2	6/25/2009	9.8	11/12/2009	10		
2/9/2009	9	6/26/2009	10	11/13/2009	10		
2/10/2009	9	6/29/2009	10.1	11/16/2009	10.2		
2/11/2009	9	6/30/2009	10.1	11/17/2009	10.2		
2/12/2009	9	7/2/2009	9.9	11/18/2009	10.2		
2/13/2009	9.1	7/3/2009	10	11/19/2009	10.2		
2/17/2009	9.2	7/6/2009	10	11/20/2009	10.1		
2/18/2009	8.9	7/7/2009	10	11/23/2009	10.2		
2/19/2009	8.9	7/8/2009	10	11/24/2009	10.1		
2/20/2009	9.1	7/9/2009	9.9	11/25/2009	10.1		
2/23/2009	9	7/10/2009	10.1	11/26/2009	10.1		
2/24/2009	9.2	7/13/2009	10	11/27/2009	10.2		
2/25/2009	8.9	7/14/2009	10	11/30/2009	9.8		
2/26/2009	8.9	7/15/2009	10.1	12/1/2009	9.9		
2/27/2009	9.1	7/16/2009	10	12/2/2009	9.9		
3/2/2009	9.2	7/17/2009	10	12/3/2009	10.2		
3/3/2009	9.3	7/20/2009	10.1	12/4/2009	10.2		
3/4/2009	9.3	7/21/2009	10.1	12/7/2009	10.4		
3/5/2009	9.1	7/22/2009	10.1	12/8/2009	10		
3/6/2009	9.1	7/23/2009	10.1	12/9/2009	10		
3/9/2009	9.1	7/24/2009	9.8	12/10/2009	10		
3/10/2009	9.2	7/27/2009	10	12/11/2009	10		
3/11/2009	9.1	7/28/2009	10.2	12/14/2009	9.9		
3/12/2009	9.1	7/29/2009	10.6	12/15/2009	9.9		
3/13/2009	9.2	7/30/2009	10.4	12/16/2009	10		

Appendix Table C.7.7: Water quality at station N-19, 2005 to 2009.

Date	Ba (mg/L)	Co (mg/L)	Fe (mg/L)	Mn (mg/L)	pH	Ra-226 (Bq/L)	Sulphate (mg/L)	TSS (mg/L)	U (mg/L)
1/5/2005	0.0124	0.0061	0.931	0.312	6.8	0.094		0.5	0.008
1/12/2005					6.8	0.084		1	
1/19/2005					6.8	0.098		3	
1/26/2005					6.8	0.085		1	
2/2/2005					6.8	0.097		1	
2/9/2005	0.0133	0.0085	0.859	0.365	6.8	0.11		0.5	0.007
2/16/2005					6.8	0.085		0.5	
2/23/2005					6.8	0.099		0.5	
3/2/2005					6.8	0.091		1	
3/9/2005	0.0142	0.0064	0.839	0.333	6.8	0.11		1	0.01
3/16/2005					6.8	0.075		0.5	
3/23/2005					6.8	0.063		0.5	
3/30/2005					6.8	0.11		0.5	
4/6/2005	0.009	0.0071	1.090	0.252	7.5	0.14		2	0.005
4/13/2005					8	0.059		0.5	
4/20/2005					7.2	0.079		2	
4/27/2005					7.5	0.092		0.5	
5/4/2005	0.0136	0.0034	0.230	0.299	7.7	0.071		0.5	0.0025
5/11/2005					7.4	0.082		1	
5/18/2005					7.5	0.059		5	
5/25/2005					7.5	0.089		0.5	
6/1/2005					7.6	0.074		0.5	
6/8/2005	0.0129	0.0024	0.055	0.284	7.4	0.089		0.5	0.0025
6/15/2005					7.5	0.07		0.5	
6/22/2005					7.6	0.063		0.5	
6/29/2005					7.8	0.068		0.5	
7/6/2005	0.0125	0.0006	0.074	0.172	7.8	0.058		0.5	0.006
7/13/2005					7.9	0.059		1	
7/20/2005					7.7	0.058		0.5	
7/27/2005					7.6	0.053		0.5	
8/3/2005	0.0064	0.0008	0.075	0.135	7.7	0.053		0.5	0.012
8/10/2005					7.7	0.059		0.5	
8/17/2005					7.8	0.036		0.5	
8/24/2005					7.8	0.05		0.5	
8/31/2005					7.8	0.06		0.5	
9/7/2005	0.0081	0.0011	0.162	0.137	7.7	0.036		0.5	0.006
9/14/2005					7.7	0.042		0.5	
9/21/2005					8	0.036		1	
9/28/2005					8	0.045		0.5	
10/5/2005	0.0077	0.0009	0.101	0.122	7.3	0.041		0.5	0.008
10/12/2005					7.1	0.046		1	
10/19/2005					7.5	0.042		1	
10/26/2005					7.4	0.049		0.5	
11/2/2005					7.5	0.046		0.5	
11/9/2005	0.008	0.0011	0.146	0.132	7.5	0.056		1	0.0025
11/16/2005					7.5	0.047		2	
11/23/2005					7.5	0.065		0.5	
11/30/2005					7.3	0.12		1	
12/7/2005	0.01	0.0009	0.198	0.117	8.8	0.095		1	0.009
12/14/2005					8.2	0.086		0.5	
12/21/2005					7.7	0.062		0.5	
12/28/2005					7.4	0.071		0.5	
1/3/2006	0.012	0.0027	0.110	0.239	7.5	0.074	1100	0.5	0.0038
1/11/2006					7.7	0.064		2	
1/18/2006					7.6	0.059		4	
1/25/2006					7.6	0.056		3	
2/1/2006	0.011	0.0022	0.220	0.229	7.6	0.071	1200	0.5	0.004
2/8/2006					7.6	0.054		0.5	
2/15/2006					7.6	0.058		3	
2/22/2006					7.6	0.046		0.5	
3/1/2006	0.012	0.0022	0.200	0.224	7.6	0.05	1000	2	0.0036
3/8/2006					7.6	0.058		0.5	
3/15/2006					7.4	0.057		0.5	

Appendix Table C.7.7: Water quality at station N-19, 2005 to 2009.

Date	Ba (mg/L)	Co (mg/L)	Fe (mg/L)	Mn (mg/L)	pH	Ra-226 (Bq/L)	Sulphate (mg/L)	TSS (mg/L)	U (mg/L)
3/22/2006					8	0.083		0.5	
3/29/2006					8	0.14		5	
4/5/2006	0.0111	0.00373	0.910	0.146	7.8	0.098	390	1	0.00951
4/12/2006					8.4	0.036		1	
4/19/2006					7.5	0.069		2	
4/26/2006					7.6	0.068		1	
5/3/2006	0.0113	0.00213	0.170	0.172	7.5	0.068	900	1	0.00438
5/10/2006					7.6	0.071		2	
5/17/2006					7.5	0.08		1	
5/24/2006					7.5	0.071		1	
5/31/2006					7.6	0.072		0.5	
6/7/2006	0.0127	0.00177	0.160	0.154	7.6	0.067	950	1	0.00411
6/14/2006					7.5	0.086		0.5	
6/21/2006					7.5	0.071		1	
6/28/2006					7.6	0.074		0.5	
7/5/2006	0.0132	0.00138	0.280	0.126	7.4	0.069	990	0.5	0.00339
7/12/2006					7.5	0.055		1	
7/19/2006					7.5	0.054		1	
7/26/2006									
8/2/2006	0.0129	0.0023	0.320	0.198	7.3	0.099	910	0.5	0.004
8/10/2006	0.011	0.0013	0.220	0.117	7.4	0.059	1000	1	0.003
8/16/2006					7.6	0.046		2	
8/23/2006					7.2	0.046		2	
8/30/2006					7.2	0.056		1	
9/6/2006	0.011	0.0013	0.360	0.127	7.5	0.053	950	3	0.0031
9/13/2006					7.4	0.043		1	
9/20/2006					7.2	0.041		1	
9/27/2006					7.6	0.047		1	
10/4/2006	0.008	0.0014	0.430	0.109	7.1	0.043		1	0.0031
10/11/2006					7.3	0.032		2	
10/18/2006					7.7	0.051		1	
10/25/2006					7.3	0.057		1	
11/1/2006	0.011	0.0017		0.149	7.3	0.055		1	0.0037
11/8/2006	0.011	0.0017	0.450	0.141	7.4	0.05		1	0.0038
11/15/2006					7.4	0.035		1	
11/22/2006					7.4	0.063		1	
11/29/2006					7.2	0.057		1	
12/6/2006	0.012	0.0023	0.310	0.135	7.7	0.11		1	0.0039
12/13/2006					8	0.056		1	
12/20/2006					7.6	0.099		2	
12/27/2006					8.5	0.09		1	
1/3/2007	0.008	0.0017	0.66	0.054	8.8	0.058	600.0	1	0.0042
1/10/2007					7.2	0.097		6	
1/17/2007					7.7	0.093		3	
1/24/2007					7.2	0.078		2	
1/31/2007					7.3	0.073		2	
2/7/2007	0.012	0.0026	0.50	0.139	7.2	0.068	960.0	1	0.0044
2/14/2007					7.3	0.072		2	
2/21/2007					7.3	0.066		0.5	
2/28/2007					7.3	0.062		1	
3/7/2007	0.012	0.0023	0.23	0.134	7.3	0.065	960.0	1	0.0035
3/14/2007					7.2	0.066		1	
3/21/2007					7.2	0.066		2	
3/28/2007					8.9	0.030		0.5	
4/4/2007	0.008	0.0014	0.30	0.047	8.6	0.050	400.0	1	0.0052
4/11/2007					8.6	0.072		0.5	
4/18/2007					7.7	0.062		1	
4/25/2007					7.5	0.065		1	
5/2/2007	0.013	0.0025	0.27	0.124	7.4	0.064	900.0	1	0.0037
5/9/2007					7.5	0.069		1	
5/16/2007					7.5	0.074		1	
5/23/2007					7.2	0.062		0.5	
5/30/2007					7.5	0.079		0.5	

Appendix Table C.7.7: Water quality at station N-19, 2005 to 2009.

Date	Ba (mg/L)	Co (mg/L)	Fe (mg/L)	Mn (mg/L)	pH	Ra-226 (Bq/L)	Sulphate (mg/L)	TSS (mg/L)	U (mg/L)
6/6/2007	0.013	0.0022	0.26	0.103	7.6	0.073	980.0	2	0.003
6/13/2007					7.8	0.071		1	
6/20/2007					7.7	0.057		0.5	
6/27/2007					7.5	0.062		0.5	
7/4/2007	0.012	0.0015	0.09	0.091	7.5	0.081	1000.0	1	0.0028
7/11/2007					7.7	0.064		1	
7/18/2007					7.6	0.049		1	
7/25/2007					7.5	0.048		1	
8/1/2007	0.011	0.0012	0.23	0.091	7.6	0.049	1100.0	1	0.0031
8/8/2007					7.5	0.049		1	
8/15/2007					7.6	0.049		2	
8/22/2007					7.7	0.043		1	
8/29/2007					7.5	0.039		1	
9/5/2007	0.009	0.0008	0.12	0.086	7.1	0.037	1100.0	0.5	0.0027
9/12/2007					7.7	0.038		0.5	
9/19/2007					7.5	0.044		1	
9/26/2007					7.7	0.043		1	
10/3/2007	0.011	0.0013	0.17	0.084	7.5	0.053	1100.0	1	0.0027
10/10/2007					7.2	0.044		1	
10/17/2007					7.4	0.038		1	
10/24/2007					7.5	0.046		1	
10/31/2007					7.3	0.045		0.5	
11/7/2007	0.010	0.0018	0.28	0.116	7.0	0.046	1100.0	1	0.0026
11/14/2007					7.4	0.046		0.5	
11/21/2007					7.4	0.055		1	
11/28/2007					7.6	0.050		1	
12/5/2007	0.011	0.0016	0.16	0.122	7.7	0.051	1000.0	0.5	0.0027
12/12/2007					8.2	0.048		1	
12/19/2007					8.5	0.060		1	
12/27/2007					8.7	0.130		1	
1/2/2008	0.012	0.0016	0.53	0.124	8.5	0.110	890.0	2	0.0097
1/9/2008					7.4	0.140		3	
1/16/2008					7.6	0.082		0.5	
1/23/2008					8.2	0.086		1	
1/31/2008					8.0	0.084		2	
2/6/2008	0.013	0.0084	4.31	0.245	7.9	0.170	690.0	7	0.0102
2/13/2008					7.4	0.120		3	
2/20/2008					8.0	0.100		3	
2/27/2008					7.5	0.110		4	
3/5/2008	0.012	0.0050	1.55	0.269	7.2	0.080	930.0	2	0.0093
3/12/2008					7.6	0.069		2	
3/19/2008					7.5	0.071		5	
3/26/2008					7.7	0.072		2	
4/2/2008	0.015	0.0048	1.92	0.266	7.4	0.075	970.0	3	0.0066
4/9/2008					7.3	0.095		1	
4/16/2008					7.5	0.068		2	
4/23/2008					7.2	0.068		2	
4/30/2008					7.5	0.068		1	
5/7/2008	0.012	0.0027	0.28	0.153	7.2	0.061	730.0	2	0.0049
5/14/2008					7.5	0.086		1	
5/21/2008					7.5	0.083		0.5	
5/28/2008					7.5	0.089		1	
6/4/2008	0.013	0.0023	0.17	0.152	7.6	0.074	780.0	1	0.0044
6/11/2008					7.6	0.072		0.5	
6/18/2008					7.5	0.070		1	
6/25/2008					7.6	0.066		1	
7/2/2008	0.012	0.0017	0.22	0.133	7.4	0.062	800.0	1	0.0031
7/9/2008					7.4	0.066		0.5	
7/16/2008					7.6	0.068		1	
7/23/2008					7.5	0.054		1	
7/30/2008					7.6	0.065		1	
8/6/2008	0.014	0.0024	0.23	0.203	7.5	0.055	820.0	2	0.0033
8/13/2008					7.7	0.039		0.5	

Appendix Table C.7.7: Water quality at station N-19, 2005 to 2009.

Date	Ba (mg/L)	Co (mg/L)	Fe (mg/L)	Mn (mg/L)	pH	Ra-226 (Bq/L)	Sulphate (mg/L)	TSS (mg/L)	U (mg/L)
8/20/2008					7.5	0.051		1	
8/27/2008					7.4	0.048		1	
9/3/2008	0.012	0.0014	0.25	0.150	7.4	0.052	850.0	2	0.0028
9/10/2008					7.5	0.045		1	
9/17/2008					7.0	0.038		2	
9/24/2008					7.4	0.047		1	
10/1/2008	0.013	0.0017	0.24	0.119	7.5	0.051	970.0	1	0.0029
10/8/2008					7.4	0.053		1	
10/15/2008					7.1	0.052		1	
10/22/2008					7.5	0.053		1	
10/29/2008					7.1	0.050		1	
11/5/2008	0.013	0.0027	0.34	0.146	7.4	0.049	1000.0	1	0.0028
11/12/2008					7.4	0.049		1	
11/19/2008					7.5	0.050		2	
11/26/2008					7.2	0.047		1	
12/3/2008	0.025	0.0028	0.38	0.140	7.7	0.044	970.0	1	0.0028
12/10/2008					7.6	0.058		1	
12/17/2008					7.4	0.110		3	
12/24/2008					7.6	0.100		1	
12/29/2008					8.5	0.092		1	
1/7/2009	0.012	0.0008	0.43	0.041	8.4	0.100	870.0	3	0.0061
1/14/2009					8.5	0.074		2	
1/21/2009					8.2	0.070		2	
1/28/2009					8.2	0.062		0.5	
2/4/2009	0.013	0.0034	0.45	0.196	7.8	0.066	1000.0	2	0.0054
2/11/2009					7.7	0.069		2	
2/18/2009					7.5	0.073		1	
2/25/2009					7.5	0.066		0.5	
3/4/2009	0.016	0.0023	0.28	0.168	7.5	0.059	950.0	1	0.0039
3/11/2009					7.4	0.074		1	
3/18/2009					7.3	0.054		0.5	
3/25/2009					7.5	0.094		1	
4/1/2009	0.015	0.0020	0.49	0.111	7.7	0.087	750.0	1	0.0102
4/8/2009					7.6	0.077		1	
4/15/2009					7.7	0.088		1	
4/22/2009					7.4	0.054		3	
4/29/2009					7.3	0.060		1	
5/6/2009	0.013	0.0025	0.23	0.118	7.5	0.054	830.0	1	0.0049
5/13/2009					7.5	0.069		1	
5/20/2009					7.5	0.080		0.5	
5/27/2009					7.6	0.091		0.5	
6/3/2009	0.013	0.0017	0.17	0.132	7.6	0.080	750.0	1	0.0041
6/11/2009					7.4	0.091		1	
6/18/2009					7.4	0.069		1	
6/24/2009					7.5	0.076		1	
7/2/2009	0.016	0.0014	0.21	0.122	7.5	0.060	770.0	1	0.0033
7/8/2009					7.5	0.064		1	
7/15/2009					7.4	0.064		1	
7/22/2009					7.4	0.056		1	
7/29/2009					7.5	0.059		1	
8/6/2009	0.014	0.0017	0.23	0.124	7.5	0.057	820.0	1	0.003
8/12/2009					7.5	0.048		1	
8/19/2009					7.5	0.058		1	
8/26/2009					7.5	0.056		1	
9/2/2009	0.012	0.0017	0.34	0.147	7.5	0.057	940.0	1	0.0027
9/9/2009					7.5	0.053		1	
9/16/2009					7.5	0.057		1	
9/21/2009					7.0	0.057		2	
9/30/2009					7.6	0.062		0.5	
10/7/2009	0.013	0.0015	0.19	0.172	7.5	0.047	930.0	1	0.0025
10/14/2009					7.2	0.058		0.5	
10/20/2009					7.1	0.049		2	
10/28/2009					7.3	0.057		1	

Appendix Table C.7.7: Water quality at station N-19, 2005 to 2009.

Date	Ba (mg/L)	Co (mg/L)	Fe (mg/L)	Mn (mg/L)	pH	Ra-226 (Bq/L)	Sulphate (mg/L)	TSS (mg/L)	U (mg/L)
11/4/2009	0.012	0.0025	0.25	0.180	7.5	0.057	850.0	1	0.0043
11/11/2009					7.5	0.067		1	
11/18/2009					7.5	0.063		0.5	
11/25/2009					7.5	0.055		1	
12/2/2009	0.012	0.0021	0.29	0.159	7.4	0.077	850.0	1	0.0036
12/9/2009					7.3	0.057		0.5	
12/16/2009					7.3	0.057		0.5	
12/23/2009					7.2	0.055		1	
12/30/2009					7.0	0.058		0.5	
Number	62	62	61	62	260	260	46	260	62
Minimum	0.0064	0.0006	0.055	0.041	6.8	0.030	390.0	0.5	0.0025
Maximum	0.025	0.0085	4.31	0.365	8.9	0.170	1200.0	7	0.0120
Mean	0.012	0.0024	0.43	0.159	7.5	0.067	897.8	1.2	0.0047
Median	0.012	0.0019	0.25	0.140	7.5	0.062	935.0	1.0	0.0039
10th Perc.	0.008	0.0011	0.12	0.092	7.2	0.045	740.0	0.5	0.0027

(shaded cell) Concentration below maximum MDL.

Appendix Table C.7.8: Water quality at station N-20, 2005 to 2009.

Date	Acidity (mg/L)	Ba (mg/L)	Fe (mg/L)	pH	Ra-226 (Bq/L)	Sulphate (mg/L)	TSS (mg/L)
1/5/2005	9			6.2	0.013		
4/14/2005	6			6.6	0.006		
7/6/2005	7			6.7	0.008		
10/4/2005	16			5.9	0.007		
1/3/2006	0.5	0.01	0.51	6.6	0.0025	6.1	
2/6/2006	0.5	0.009	0.38	6.6	0.0025	5.3	
3/8/2006	0.5	0.008	0.29	6.5	0.006	4.5	
4/5/2006	0.5	0.0101	0.13	6.3	0.0025	5.4	
5/1/2006	0.5	0.0103	0.28	6.3	0.005	5.4	
6/5/2006	0.5	0.0106	0.65	6.5	0.007	4.1	
7/4/2006	0.5	0.0088	0.95	6.6	0.006	3.5	
8/10/2006	0.5	0.008	0.92	6.5	0.007	3.7	2
9/5/2006	0.5	0.012	0.9	6.2	0.0025	4.1	
10/5/2006	0.5	0.012	0.52	6.3	0.007	5.1	
11/6/2006	0.5	0.008	0.45	6.3	0.0025	4.3	
12/4/2006	0.5	0.008	0.42	6.3	0.006	4.8	
1/8/2007	0.5	0.011	0.27	6.3	0.007	4.9	0.5
4/4/2007	0.5	0.01	0.1	6.7	0.009	4.4	1
11/5/2007	0.5	0.009	0.52	6.0	0.008	4.9	2
1/15/2008	0.5	0.009	0.22	6.2	0.0025	5.7	0.5
4/16/2008	0.5	0.01	0.19	6.0	0.0025	5.1	0.5
7/2/2008	0.5	0.01	0.67	6.5	0.0025	4	2
10/1/2008	0.5	0.01	1.29	6.5	0.007	3.2	1
1/7/2009	0.5	0.01	0.41	6.6	0.0025	4.4	0.5
5/4/2009	0.5	0.012	0.35	6.3	0.009	4.5	1
7/6/2009	0.5	0.008	0.75	6.6	0.0025	3.8	1
10/7/2009	0.5	0.008	0.63	6.5	0.003	3.5	1
Number	27	23	23	27	27	23	12
Minimum	0.5	0.008	0.1	5.9	0.0025	3.2	0.5
Maximum	16	0.012	1.29	6.7	0.013	6.1	2
Mean	2	0.010	0.5	6.4	0.005	4.6	1
Median	0.5	0.01	0.45	6.5	0.006	4.5	1
10th Perc.	0.5	0.008	0.20	6.1	0.0025	3.5	0.5

Concentration below maximum MDL. (shaded cells)

Appendix Table C.7.9: Water quality at station N-22, 2005 to 2009.

Date	Acidity (mg/L)	Ba (mg/L)	Co (mg/L)	Fe (mg/L)	Mn (mg/L)	pH	Ra-226 (Bq/L)	SO4 (mg/L)	U (mg/L)
4/6/2005	377					3	0.39		
10/5/2005	602					2.9	0.67		
5/3/2006	378					3	0.22		
11/1/2006	525					2.9	0.37		
5/2/2007	414					2.8	0.320		
11/7/2007	647					2.7	0.500		
5/7/2008	332	0.012	0.148	81.80	0.431	2.7	0.130	780	0.0574
11/5/2008	669	0.019	0.208	274.00	0.609	2.9	0.500	1500	0.0359
5/6/2009	322	0.013	0.165	73.90	0.346	2.8	0.130	740	0.0562
11/4/2009	49	0.01	0.0304	13.20	0.147	4.0	0.044	740	0.0078
Number	10	4	4	4	4	10	10	4	4
Minimum	49	0.010	0.030	13.2	0.147	2.7	0.044	740	0.008
Maximum	669	0.019	0.208	274.0	0.609	4	0.670	1500	0.057
Mean	432	0.014	0.138	110.7	0.383	3.0	0.327	940	0.039
Median	396	0.013	0.157	77.9	0.389	2.9	0.345	760	0.046
10th Perc.	295	0.011	0.066	31.4	0.207	2.7	0.1214	740	0.016

Appendix Table C.7.10: Water quality at station NWPH, 2007 to 2009.

Date	Acidity (mg/L)	Ba (mg/L)	Co (mg/L)	Fe (mg/L)	Mn (mg/L)	pH (pH units)	Ra (mg/L)	SO4 (mg/L)	U (mg/L)
1/5/2005		0.02	0.0032	9.34	0.331	6.5	0.29	327	0.0025
2/9/2005		0.022	0.0032	8.42	0.315	6.5	0.22	289	0.006
3/9/2005		0.02	0.0027	9.79	0.298	6.6	0.24	327	0.0025
4/6/2005		0.015	0.0019	2.17	0.12	6.8	0.17	164	0.0025
5/4/2005		0.055	0.0016	4.3	0.133	6.6	0.12	201	0.0025
6/8/2005		0.018	0.0015	4.5	0.177	6.4	0.18	263	0.0025
7/6/2005		0.021	0.0005	1.7	0.098	6.6	0.23	231	0.0025
8/3/2005		0.025	0.0021	9.11	0.25	6.4	0.44	312	0.0025
9/7/2005		0.025	0.0024	13.35	0.294	6.6	0.5	316	0.0025
10/5/2005		0.017	0.0015	8.12	0.198	6.2	0.6	303	0.0025
11/9/2005		0.025	0.0028	12.8	0.317	6.8	0.48	300	0.0025
12/7/2005		0.019	0.0027	10.47	0.306	6.6	0.33	328	0.0025
1/3/2006		0.026	0.0037	13	0.376	6.5	0.33	340	0.0007
2/6/2006		0.025	0.0032	11.8	0.369	6.9	0.34	360	0.0008
3/6/2006		0.023	0.0031	11.6	0.367	6.6	0.28	320	0.0008
4/3/2006		0.021	0.0024	3.59	0.155	6.5	0.18	170	0.0007
5/1/2006		0.023	0.001	1.05	0.058	6.6	0.17	130	0.0007
6/5/2006		0.028	0.0016	5.78	0.169	6.5	0.24	210	0.0009
7/4/2006		0.027	0.002	6.84	0.213	6.7	0.34	220	0.0006
8/8/2006		0.029	0.0024	10.3	0.255	6.4	0.46	230	0.0009
9/5/2006		0.028	0.0022	12.1	0.271	6.4	0.56	250	0.0009
10/2/2006		0.026	0.0024	13.5	0.271	6.4	0.44	260	0.0008
11/6/2006		0.024	0.0028	9.86	0.323	6.4	0.3	280	0.0006
12/4/2006		0.025	0.0028	11.5	0.308	6.4	0.36	290	0.0008
1/2/2007		0.021	0.0011	3.21	0.112	6.6	0.27	190	0.0008
2/5/2007		0.02	0.0027	11.5	0.316	6.5	0.27	280	0.001
3/5/2007		0.02	0.0018	7	0.188	6.4	0.19	230	0.001
4/2/2007		0.02	0.0018	5.15	0.155	6.2	0.23	170	0.0009
5/7/2007		0.028	0.0007	0.49	0.026	6.5	0.12	100	0.0006
6/4/2007		0.031	0.0015	3.89	0.139	6.2	0.25	170	0.0008
7/3/2007		0.029	0.0013	4.43	0.139	6.2	0.5	200	0.0122
8/7/2007		0.02	0.0012	6.04	0.182	6.2	0.36	220	0.0008
9/4/2007		0.011	0.00025	0.2	0.028	6.5	0.016	32	0.00025
10/1/2007		0.026	0.0017	9.57	0.225	6.2	0.6	240	0.0008
11/5/2007		0.027	0.0026	10.7	0.311	7.1	0.52	270	0.0008
12/3/2007		0.025	0.0028	11.5	0.355	6.9	0.37	290	0.0009
1/7/2008		0.026	0.0033	9.5	0.351	6.5	0.35	300	0.0007
2/4/2008		0.019	0.0017	7.01	0.208	6.5	0.21	230	0.001
3/3/2008	0.5	0.021	0.0017	7.53	0.195	6.5	0.22	200	0.001
4/7/2008	0.5	0.017	0.0016	5.49	0.162	6.4	0.14	170	0.0009
5/5/2008	0.5	0.023	0.001	2.3	0.067	6.7	0.15	120	0.001
6/2/2008	0.5	0.032	0.0008	1.68	0.062	6.3	0.25	120	0.0007

Appendix Table C.7.10: Water quality at station NWPH, 2007 to 2009.

Date	Acidity (mg/L)	Ba (mg/L)	Co (mg/L)	Fe (mg/L)	Mn (mg/L)	pH (pH units)	Ra (mg/L)	SO4 (mg/L)	U (mg/L)
7/7/2008	0.5	0.035	0.0007	1.68	0.063	6.5	0.31	130	0.0006
8/5/2008	0.5	0.045	0.002	9.04	0.222	6.2	0.54	190	0.0009
9/2/2008	19	0.028	0.0026	8.8	0.294	6.3	0.23	210	0.0009
10/6/2008	0.5	0.031	0.0026	11	0.282	6.4	0.48	260	0.001
11/3/2008	0.5	0.031	0.0026	10.6	0.306	6.8	0.5	270	0.0009
12/1/2008	0.5	0.029	0.0025	10.1	0.289	6.4	0.45	280	0.001
2/28/2009	0.5	0.028	0.0028	9.35	0.319	6.2	0.31	320	0.001
5/31/2009	0.5	0.027	0.0022	1.07	0.044	6.9	0.11	110	0.0012
8/31/2009	0.5	0.03	0.0012	3.72	0.157	6.6	0.36	170	0.0006
11/4/2009	0.5	0.03	0.0024	8.48	0.278	6.6	0.35	230	0.0009
Number	14	52	52	52	52	52	52	52	52
Minimum	0.5	0.011	0.00025	0.20	0.026	6.2	0.016	32	0.00025
Maximum	19	0.055	0.0037	13.50	0.376	7.1	0.600	360	0.01220
Mean	1.8	0.025	0.0021	7.42	0.220	6.5	0.316	233	0.00150
Median	0.5	0.025	0.0022	8.45	0.224	6.5	0.305	231	0.00090
10th Perc.	0.5	0.019	0.0010	1.68	0.063	6.2	0.152	130	0.00061

(shaded) Concentration below maximum MDL.

Appendix Table C.7.11: Water quality at Station UW7-2, -4, -6, 2005 to 2009.

Site	Date	Acidity (mg/L)	Fe (mg/L)	pH	Sulphate (mg/L)
UW7-2	6/1/2005	430	204	7.0	
	5/1/2006	0.50	190	6.8	
	7/24/2007	0.50	223	6.9	3700
	7/10/2008	0.50	213	7.0	4200
	8/4/2009	0.50	192	6.6	3500
UW7-2 Summary	Number	5	5	5.0	3
	Minimum	0.50	190	6.6	3500
	Maximum	430	223	7.0	4200
	Mean	86	204	6.9	3800
	Median	0.50	204	6.9	3700
	10th Perc.	0.50	191	6.7	3540
UW7-4	6/1/2005	3060	1213	5.1	
	5/1/2006	1690	950	4.9	
	7/24/2007	1120	684	5.3	2800
	7/10/2008	1100	587	5.5	3200
	7/28/2009	1800	513	5.3	2300
UW7-4 Summary	Number	5	5	5.0	3
	Minimum	1100	513	4.9	2300
	Maximum	3060	1213	5.5	3200
	Mean	1754	789	5.2	2767
	Median	1690	684	5.3	2800
	10th Perc.	1108	543	5.0	2400
UW7-6	6/1/2005	690	77	6.8	
	5/1/2006	0.50	80	6.7	
	4/30/2007		101	6.4	2000
	7/24/2007	0.50	100	6.8	2100
	7/28/2009	0.50	78	6.8	2000
UW7-6 Summary	Number	4	5	5.0	3
	Minimum	0.50	77	6.4	2000
	Maximum	690	101	6.8	2100
	Mean	173	87	6.7	2033
	Median	0.50	80	6.8	2000
	10th Perc.	0.50	77	6.5	2000

(Shaded cell) Concentration below maximum MDL.

Appendix Table C.7.12: Water quality at station UW9-1, -2, -3, 2005 to 2009.

Site	Date	Acidity (mg/L)	Fe (mg/L)	pH	Sulphate (mg/L)
UW9-1	6/1/2005	4080.00	1260.00	4.2	
	6/1/2006	3090.00	1220.00	4.2	
	7/24/2007	3790.00	1390.00	4.1	4800.00
	7/10/2008	3520.00	1320.00	4.1	5000.00
	8/4/2009	576.00	1288.00	4.2	4100.00
UW9-1 Summary	Number	5	5	5.0	3
	Minimum	576.0	1220	4.1	4100.00
	Maximum	4080.00	1390.00	4.2	5000.00
	Mean	3011.20	1295.60	4.2	4633.33
	Median	3520.00	1288.00	4.2	4800.00
	10th Perc.	1581.60	1236.00	4.1	4240.00
UW9-2	6/1/2005	4540.00	1159.00	3.9	
	6/1/2006	3310.00	1130.00	4.0	
	7/24/2007	3750.00	1260.00	4.1	5000.00
	7/10/2008	3130.00	1120.00	4.0	4600.00
	8/4/2009	1150.00	774.00	4.0	3100.00
UW9-2 Summary	Number	5	5	5.0	3
	Minimum	1150.00	774.00	3.9	3100.00
	Maximum	4540.00	1260.00	4.1	5000.00
	Mean	3176.00	1088.60	4.0	4233.33
	Median	3310.00	1130.00	4.0	4600.00
	10th Perc.	1942.00	912.40	3.9	3400.00
UW9-3	6/1/2005	3280.00	709.10	2.0	
	6/1/2006	2180.00	690.00	2.3	
	7/24/2007	1390.00	422.00	2.7	2600.00
	7/10/2008	1440.00	471.00	2.6	2800.00
	8/4/2009	870.00	486.00	2.8	2500.00
UW9-3 Summary	Number	5	5	5.0	3
	Minimum	870.00	422.00	2.0	2500.00
	Maximum	3280.00	709.10	2.8	2800.00
	Mean	1832.00	555.62	2.5	2633.33
	Median	1440.00	486.00	2.6	2600.00
	10th Perc.	1078.00	441.60	2.1	2520.00

Concentration below maximum MDL.

Appendix Table C.7.13: Water quality at station M12-1,-3,-6,-9, 2005 to 2009.

Station	Date	Acidity (mg/L)	Fe (mg/L)	pH	Sulphate (mg/L)
M12-1	6/1/2005	5430	2652	6.1	
	5/1/2006	3800	2120	6.2	
	7/10/2007	4060	1900	5.9	6500
	6/24/2008	3760	2380	6.2	6800
	8/5/2009	4140	2350	6.1	6700
M12-1 Summary	Number	5	5	5.0	3
	Minimum	3760	1900	5.9	6500
	Maximum	5430	2652	6.2	6800
	Mean	4238	2280	6.1	6667
	Median	4060	2350	6.1	6700
	10th Perc.	3776	1988	6.0	6540
M12-3	6/1/2005	1880	603	5.9	
	5/1/2006	164	89	6	
	7/10/2007	3310	1690	5.8	4700
	6/24/2008	142	87	6.1	390
	8/5/2009	681	191	5.8	1200
M12-3 Summary	Number	5	5	5.0	3
	Minimum	142	87	5.8	390
	Maximum	3310	1690	6.1	4700
	Mean	1235	532	5.9	2097
	Median	681	191	5.9	1200
	10th Perc.	151	88	5.8	552
M12-6	6/1/2005	74	36	5.9	
	5/1/2006	69	47	6	
	7/12/2007	27	42	6.2	260
	6/24/2008	95	56	5.9	360
	8/5/2009	64	48	6.2	330
M12-6 Summary	Number	5	5	5.0	3
	Minimum	27	36	5.9	260
	Maximum	95	56	6.2	360
	Mean	66	46	6.0	317
	Median	69	47	6.0	330
	10th Perc.	42	38	5.9	274
M12-9	6/1/2005	124	4	4.5	
	5/1/2006	4	1	5.1	
	7/12/2007	5	2	5.2	130
	6/24/2008	10	2	5.2	200
	8/5/2009	21	9	5.0	200
M12-9 Summary	Number	5	5	5.0	3
	Minimum	4	1	4.5	130
	Maximum	124	9	5.2	200
	Mean	33	3	5.0	177
	Median	10	2	5.1	200
	10th Perc.	4	1	4.7	144

Appendix Table C.7.14: Water quality at station M13-1,-3,-6,-9, 2005 to 2009.

Station	Date	Acidity (mg/L)	Fe (mg/L)	pH	Sulphate (mg/L)
M13-1	6/1/2005	4280	1847	6.1	9147
	5/1/2006	3020	1730	6	5000
	7/5/2007	3330	1970	5.7	5400
	6/16/2008	3040	1760	5.8	5000
	7/29/2009	2960	1580	5.9	4600
M13-1 Summary	Number	5	5	5	5
	Minimum	2960	1580	5.7	4600
	Maximum	4280	1970	6.1	9147
	Mean	3326	1777	5.9	5829
	Median	3040	1760	5.9	5000
	10th Perc.	2984	1640	5.7	4760
M13-2	6/1/2005	3140	1332	6.3	7434
	5/1/2006	2030	1220	6.4	4500
	7/5/2007	2160	1660	6.2	4000
	6/17/2008	24	53	6.6	120
	7/29/2009	14	38	6.5	66
M13-3 Summary	Number	5	5	5	5
	Minimum	14	38	6.2	66
	Maximum	3140	1660	6.6	7434
	Mean	1474	861	6.4	3224
	Median	2030	1220	6.4	4000
	10th Perc.	18	44	6.2	88
M13-3	6/1/2005	270	141	6.3	742
	5/1/2006	50	38	6.5	110
	7/5/2007	6	18	6.3	41
	6/17/2008	4	17	6.2	19
	7/29/2009	13	17	6.2	26
M13-6 Summary	Number	5	5	5	5
	Minimum	4	17	6.2	19
	Maximum	270	141	6.5	742
	Mean	69	46	6.3	188
	Median	13	18	6.3	41
	10th Perc.	5	17	6.2	22
M13-4	6/1/2005	26	2.23	5.2	20
	5/1/2006	5	2.01	5.5	23
	7/6/2007	29	4.49	5.4	26
	6/17/2008	4	3.68	5.5	23
	8/4/2009	6	3.76	5.4	17
M13-9 Summary	Number	5	5	5	5
	Minimum	4	2.01	5.2	17
	Maximum	29	4.49	5.5	26
	Mean	14	3.23	5.4	22
	Median	6	3.68	5.4	23
	10th Perc.	4	2.10	5.3	18

Appendix Table C.7.15: Water quality at station M14-1,-3,-6,-9, 2005 to 2009.

Station	Date	Acidity (mg/L)	Fe (mg/L)	pH	Sulphate (mg/L)
M14-1	Jun-05	3780	1335	6.5	9065
	May-06	775	449	6.5	2000
	7/6/2007	2840	394	6.0	5500
	6/18/2008	2680	1890	6.4	5300
	8/6/2009	2930	1820	6.1	5300
M14-1 Summary	Number	5	5	5.0	5
	Minimum	775	394	6.0	2000
	Maximum	3780	1890	6.5	9065
	Mean	2601	1178	6.3	5433
	Median	2840	1335	6.4	5300
	10th Perc.	1537	416	6.0	3320
M14-3	Jun-05	905	534	6.6	3387
	May-06	520	355	6.5	2600
	7/9/2007	600	371	6.2	2900
	6/18/2008	468	426	6.5	2500
	8/6/2009	494	440	6.3	2300
M14-3 Summary	Number	5	5	5.0	5
	Minimum	468	355	6.2	2300
	Maximum	905	534	6.6	3387
	Mean	597	425	6.4	2737
	Median	520	426	6.5	2600
	10th Perc.	478	361	6.2	2380
M14-6	Jun-05	1480	339	6.6	2193
	May-06	636	387	6.5	2200
	7/9/2007	1440	1410	5.9	2500
	6/18/2008	265	199	6.3	590
	8/6/2009	10	27	6.3	60
M14-6 Summary	Number	5	5	5.0	5
	Minimum	10	27	5.9	60
	Maximum	1480	1410	6.6	2500
	Mean	766	472	6.3	1509
	Median	636	339	6.3	2193
	10th Perc.	112	96	6.1	272
M14-9	Jun-05	45	6.4	5.7	9.6
	May-06	0.5	3.1	6	8.2
	4/30/2007		4.98	6.4	6.6
	7/9/2007	0.5	2.95	6.0	4.8
	6/19/2008	0.5	4.95	6.0	3.6
M14-9 Summary	Number	4.0	5	5.0	5.0
	Minimum	0.5	3.0	5.7	3.6
	Maximum	45	6.4	6.4	9.6
	Mean	11.6	4.5	6.0	6.6
	Median	0.5	5.0	6.0	6.6
	10th Perc.	0.5	3.0	5.8	4.1

Concentration below maximum MDL. (shaded cells)

Appendix Table C.7.16: Water quality at station 95N4 A,B, 2005 to 2009.

Station	Date	Acidity (mg/L)	Fe (mg/L)	pH	Sulphate (mg/L)
95N4-A	6/1/2005	3540	1582	5.7	7767
	6/1/2006	2390	1408	6	
	7/18/2007	2450	1410	6.2	4200
	7/9/2008	2550	1570	6.0	4400
	9/11/2009	2530	1400	6.2	4600
95N4-A Summary	Number	5	5	5	4
	Minimum	2390	1400	5.7	4200
	Maximum	3540	1582	6.2	7767
	Mean	2692	1474	6.0	5242
	Median	2530	1410	6.0	4500
	10th Perc.	2414	1403	5.8	4260
95N4-B	6/1/2005	3280	1418	5.3	9721
	6/1/2006	2280	1271	5.4	
	7/18/2007	2290	1290	5.4	3600
	7/9/2008	2420	1360	5.2	3700
	9/11/2009	2490	1130	4.8	3600
95N4-B Summary	Number	5	5	5	4
	Minimum	2280	1130	4.8	3600
	Maximum	3280	1418	5.4	9721
	Mean	2552	1294	5.2	5155
	Median	2420	1290	5.3	3650
	10th Perc.	2284	1186	5.0	3600

Appendix Table C.7.17: Water quality at station 95N-7A, B, 2005 to 2009.

Station	Date	Acidity (mg/L)	Fe (mg/L)	pH	Sulphate (mg/L)
95N-7A	6/1/2005	27	0.501	3.4	
	5/1/2006	19	0.23	4.6	
	7/17/2007	9	0.09	4.6	35.0
	7/3/2008	10	0.06	4.8	36.0
	7/22/2009	11	0.32	4.8	29.0
95N-7A Summary	Number	5	5	5	3
	Minimum	9	0.060	3.4	29.0
	Maximum	27	0.501	4.8	36.0
	Mean	15	0.240	4.4	33.3
	Median	11	0.230	4.6	35.0
	10th Perc.	9	0.072	3.9	30.2
95N-7B	6/1/2005	100	22.16	4.4	
	5/1/2006	133	21.6	4.5	
	7/17/2007	55	10.30	4.7	150.0
	7/3/2008	67	18.40	4.9	200.0
	7/22/2009	58	15.00	4.6	160.0
95N-7B Summary	Number	5	5	5	3
	Minimum	55	10.30	4.4	150.0
	Maximum	133	22.16	4.9	200.0
	Mean	83	17.49	4.6	170.0
	Median	67	18.40	4.6	160.0
	10th Perc.	56	12.18	4.4	152.0

Appendix Table C.7.18: Water quality at station 95N-11, 2005 to 2009.

Date	Acidity (mg/L)	Fe (mg/L)	pH	Sulphate (mg/L)
6/1/2005	24	2.94	5	
5/1/2006	13	1.66	5.1	
7/13/2007	37	4.94	5.0	440.0
7/8/2008	38	0.33	4.8	370.0
7/28/2009	21	0.11	5.1	210.0
Number	5	5	5	3
Minimum	13	0.11	4.8	210.0
Maximum	38	4.94	5.1	440.0
Mean	27	2.00	5.0	340.0
Median	24	1.66	5.0	370.0
10th Perc.	16	0.20	4.9	242.0

Appendix Table C.7.19: Water quality at station 95N12-A,-B, 2005 to 2009.

Station	Date	Acidity (mg/L)	Fe (mg/L)	pH	Sulphate (mg/L)
95N12-A	6/1/2005	12	3.6	7	
	5/1/2006	0.5	2.9	6.9	
	7/23/2007	0.5	6.49	7.1	17.0
	7/8/2008	0.5	6.82	6.6	24.0
	7/28/2009	0.5	6.74	6.7	19.0
95N12-A Summary	Number	5	5	5	3
	Minimum	0.5	2.9	6.6	17.0
	Maximum	12.0	6.82	7.1	24.0
	Mean	2.8	5.32	6.9	20.0
	Median	0.5	6.49	6.9	19.0
	10th Perc.	0.5	3.21	6.6	17.4
95N12-B	6/1/2005	13	3.17	6.8	
	5/1/2006	0.5	1.18	6.8	
	7/23/2007	0.5	5.64	7.0	17.0
	7/8/2008	0.5	6.27	6.8	21.0
	7/28/2009	0.5	5.46	6.6	18.0
95N12-B Summary	Number	5	5	5	3
	Minimum	0.5	1.18	6.6	17.0
	Maximum	13.0	6.27	7.0	21.0
	Mean	3.0	4.34	6.8	18.7
	Median	0.5	5.46	6.8	18.0
	10th Perc.	0.5	1.98	6.7	17.2

(Shaded) Concentration below maximum MDL.

Appendix Table C.7.20: Water quality at station 95N13-A,-C,-E, 2005 to 2009.

Station	Date	Acidity (mg/L)	Fe (mg/L)	pH	Sulphate (mg/L)
95N13-A	6/1/2005	2680	1167	6.3	7313
	5/1/2006	1520	1120	6.3	3900
	7/16/2007	1490	879	6.5	3300
	6/25/2008	1400	1010	6.1	3400
	7/28/2009	1580	903	6.0	3200
95N13-A Summary	Number	5	5	5	5
	Minimum	1400	879	6.0	3200
	Maximum	2680	1167	6.5	7313
	Mean	1734	1016	6.2	4223
	Median	1520	1010	6.3	3400
	10th Perc.	1436	889	6.0	3240
95N13-C	6/1/2005	2750	1277	6.4	7025
	5/1/2006	1220	860	6.3	3700
	7/16/2007	1400	848	6.4	4500
	6/25/2008	1320	980	6.4	3300
	7/28/2009	1620	981	6.2	3400
95N13-C Summary	Number	5	5	5	5
	Minimum	1220	848	6.2	3300
	Maximum	2750	1277	6.4	7025
	Mean	1662	989	6.3	4385
	Median	1400	980	6.4	3700
	10th Perc.	1260	853	6.2	3340
95N13-E	6/1/2005	3120	1357	5	7930
	5/1/2006	1320	680	4.6	2000
	7/16/2007	2260	1194	5.4	3900
	6/25/2008	1450	877	6.0	3100
	7/28/2009	991	977	5.9	3400
95N-13E Summary	Number	5	5	5	5
	Minimum	991	680	4.6	2000
	Maximum	3120	1357	6.0	7930
	Mean	1828	1017	5.4	4066
	Median	1450	977	5.4	3400
	10th Perc.	1123	759	4.8	2440

Appendix Table C.7.21: Water quality at station 95N14-A,-B,-C, 2005 to 2009.

Station	Date	Acidity (mg/L)	Fe (mg/L)	pH	Sulphate (mg/L)
95N14-A	6/1/2005	27	11.0	7	6.9
	6/1/2006	0.5	6.4	6.8	5.7
	7/13/2007	0.5	8.28	7.3	3.9
	6/26/2008	0.5	9.01	6.8	6.9
	7/22/2009	0.5	7.93	6.7	5.2
95N14-A Summary	Number	5	5	5.0	5
	Minimum	1	6	6.7	4
	Maximum	27	11	7.3	7
	Mean	6	9	6.9	6
	Median	1	8	6.8	6
	10th Perc.	1	7	6.7	4
95N14-B	6/1/2005	6	1.96	7.6	5.14
	6/1/2006	0.5	0.89	7.1	2.1
	7/13/2007	0.5	2.64	7.8	2.3
	6/26/2008	0.5	3.74	6.9	3.2
	7/22/2009	0.5	4.93	6.9	2.0
95N14-B Summary	Number	5	5	5.0	5
	Minimum	1	1	6.9	2
	Maximum	6	5	7.8	5
	Mean	2	3	7.3	3
	Median	1	3	7.1	2
	10th Perc.	1	1	6.9	2
95N14-C	6/1/2005	9	4.67	7.4	0.25
	6/1/2006	0.5	0.78	7	0.25
	7/13/2007	0.5	6.09	7.6	0.25
	6/26/2008	0.5	4.91	7.1	0.6
	7/22/2009	0.5	5.20	7.0	0.25
95N14-C Summary	Number	5	5	5.0	5
	Minimum	1	1	7.0	0
	Maximum	9	6	7.6	1
	Mean	2	4	7.2	0
	Median	1	5	7.1	0
	10th Perc.	1	2	7.0	0

(shaded) Concentration below maximum MDL.

Appendix Table C.7.22: Lacnor Nordic groundwater station 95N16A, 2005 to 2009.

Station	Date	Acidity (mg/L)	Fe (mg/L)	pH	Sulphate (mg/L)
95N16-A	6/1/2005	1260	412	6.40	4063
	5/1/2006	432	299	6.40	2400
	7/17/2007	453	307	6.60	2400
	7/3/2008	463	341	6.60	2400
	7/23/2009	420	307	6.40	2400
95N16-A Summary	Number	5	5	5	5
	Minimum	420	299	6.40	2400
	Maximum	1260	412	6.60	4063
	Mean	606	333	6.48	2733
	Median	453	307	6.40	2400
	10th Perc.	425	302	6.40	2400
95N16-C	6/1/2005	1460	497	6.5	3774
	5/1/2006	566	353	6.5	2500
	7/17/2007	398	279	6.7	2400
	7/3/2008	326	281	6.6	2500
	7/23/2009	269	231	6.4	2400
95N16-C Summary	Number	5	5	5	5
	Minimum	269	231	6.4	2400
	Maximum	1460	497	6.7	3774
	Mean	604	328	6.5	2715
	Median	398	281	6.5	2500
	10th Perc.	292	250	6.4	2400
95N16-E	6/1/2005	2480	964	6.3	5469
	5/1/2006	1520	900	6.3	3100
	7/17/2007	1380	762	6.3	2900
	7/3/2008	1560	946	6.3	3300
	7/23/2009	419	957	6.0	3200
95N16-E Summary	Number	5	5	5	5
	Minimum	419	762	6.0	2900
	Maximum	2480	964	6.3	5469
	Mean	1472	906	6.2	3594
	Median	1520	946	6.3	3200
	10th Perc.	803	817	6.1	2980

Appendix Table C.7.23: Water quality at station 95N17-A,-B,-C, 2005 to 2009.

Station	Date	Acidity (mg/L)	Fe (mg/L)	pH	Sulphate (mg/L)
95N17-A	6/1/2005	12	3.91	7.2	9.38
	5/1/2006	0.5	2.65	6.8	8.9
	7/13/2007	0.5	3.56	7.4	8.6
	7/2/2008	0.5	3.12	7.0	9.1
	7/21/2009	0.5	3.26	6.8	9.8
95N17-A Summary	Number	5	5	5.0	5
	Minimum	1	3	6.8	9
	Maximum	12	4	7.4	10
	Mean	3	3	7.0	9
	Median	1	3	7.0	9
	10th Perc.	1	3	6.8	9
95N17-B	6/1/2005	21	6.74	6.8	4.03
	5/1/2006	0.5	2.94	6.7	5.5
	7/13/2007	0.5	6.17	7.2	8.7
	7/2/2008	0.5	5.50	6.8	6.0
	7/21/2009	0.5	8.45	6.6	1.3
95N17-B Summary	Number	5	5	5.0	5
	Minimum	1	3	6.6	1
	Maximum	21	8	7.2	9
	Mean	5	6	6.8	5
	Median	1	6	6.8	6
	10th Perc.	1	4	6.6	2
95N17-C	6/1/2005	19	6.53	6.6	8.4
	5/1/2006	0.5	3.64	6.5	6.3
	7/13/2007	0.5	6.92	6.9	5.4
	7/2/2008	0.5	6.24	6.6	6.2
	7/21/2009	0.5	8.69	6.4	2.5
95N17-C Summary	Number	5	5	5.0	5
	Minimum	1	4	6.4	3
	Maximum	19	9	6.9	8
	Mean	4	6	6.6	6
	Median	1	7	6.6	6
	10th Perc.	1	5	6.4	4

(Shaded cell) Concentration below maximum MDL.

Appendix Table C.7.24: Summary of trends for station ECA-131, 2003 to 2009.

Season	Spearman rho	Acidity	pH	Ra-226
January	Correlation Coefficient	-0.852437	-0.180187	-0.9549937
	Sig. (2-tailed)	0.0148141	0.699046	0.00080554
	N	7	7	7
April	Correlation Coefficient	-0.763763	0.145479	-0.5946187
	Sig. (2-tailed)	0.0456591	0.755633	0.15908999
	N	7	7	7
July	Correlation Coefficient	-0.463817	0.507093	-0.6571429
	Sig. (2-tailed)	0.3541643	0.304559	0.15617493
	N	6	6	6
October/November	Correlation Coefficient	-0.028989	-0.173931	0.02857143
	Sig. (2-tailed)	0.9565294	0.741734	0.95715452
	N	6	6	6

(Shaded) Significant correlation at $p<0.05$.

Appendix Table C.7.25: Summary of trends for station ECA-132, 2003 to 2009.

Season	Spearman rho	Acidity	pH	Ra-226
April/May	Correlation Coefficient	-0.842041	0.727393	0.882919
	Sig. (2-tailed)	0.01746	0.063935	0.00845
	N	7	7	7
October/November	Correlation Coefficient	-0.898177	-0.52736	-0.392857
	Sig. (2-tailed)	0.006011	0.223837	0.383317
	N	7	7	7

(shaded) Significant correlation at $p<0.05$.

Appendix Table C.7.26: Summary of trends for station L-03, 2003 to 2009.

Season	Spearman rho	Iron	pH	Ra-226	Sulphate	Uranium
January/February	Correlation Coefficient	-0.321	0.090924	-0.7142857	-0.92857143	0.21428571
	Sig. (2-tailed)	0.482	0.84628	0.07134356	0.002519472	0.64451158
	N	7	7	7	7	7
April/May	Correlation Coefficient	0.071	-0.90924	0.44474959	-0.39285714	0.53571429
	Sig. (2-tailed)	0.879	0.004537	0.31737194	0.38331687	0.21521746
	N	7	7	7	7	7
October/November	Correlation Coefficient	-0.257	-0.46382	0.14285714	-0.82857143	0.25714286
	Sig. (2-tailed)	0.623	0.354164	0.78717201	0.041562682	0.62278717
	N	6	6	6	6	6

(shaded box) Significant correlation at $p<0.05$.

Appendix Table C.7.27: Summary of trends for station N-17, 2003 to 2009.

Season	Spearman rho	Acidity	Barium	Cobalt	Iron	Manganese	pH	Ra-226	Sulphate	Uranium
January	Correlation Coefficient							0.306319		
	Sig. (2-tailed)							0.504027		
	N							7		
February	Correlation Coefficient							-0.21429		
	Sig. (2-tailed)							0.644512		
	N							7		
January/February	Correlation Coefficient	-0.64286	-0.42857	-0.03571	-0.286	-0.428571429	-0.71429		-0.84688	-0.85714
	Sig. (2-tailed)	0.119392	0.337368	0.939408	0.535	0.337368311	0.071344		0.016197	0.013697
	N	7	7	7	7	7	7		7	7
March	Correlation Coefficient							-0.32733		
	Sig. (2-tailed)							0.473597		
	N							7		
April	Correlation Coefficient							-0.03571		
	Sig. (2-tailed)							0.939408		
	N							7		
May	Correlation Coefficient							-0.35714		
	Sig. (2-tailed)							0.431611		
	N							7		
April/May	Correlation Coefficient	-0.14286	0.126131	0.5	0.393	0.357142857	0.321429		-0.37839	-0.28571
	Sig. (2-tailed)	0.759945	0.787572	0.25317	0.383	0.431611352	0.482072		0.402602	0.534509
	N	7	7	7	7	7	7		7	7
June	Correlation Coefficient							-0.39641		
	Sig. (2-tailed)							0.378635		
	N							7		
July	Correlation Coefficient							-0.17857		
	Sig. (2-tailed)							0.701658		
	N							7		
August	Correlation Coefficient							-0.42857		
	Sig. (2-tailed)							0.337368		
	N							7		
July/August	Correlation Coefficient	-0.60714	0.321429	0.342356	0.071	-0.035714286	0		-0.82886	-0.96429
	Sig. (2-tailed)	0.148231	0.482072	0.452251	0.879	0.939408205	1		0.021174	0.000454
	N	7	7	7	7	7	7		7	7
September	Correlation Coefficient							-0.71429		
	Sig. (2-tailed)							0.071344		
	N							7		
October	Correlation Coefficient							-0.42857		
	Sig. (2-tailed)							0.337368		
	N							7		
November	Correlation Coefficient							-0.48651		
	Sig. (2-tailed)							0.268249		
	N							7		
October/November	Correlation Coefficient	-0.75	0.5766	0.142857	0.071	0.035714286	-0.48651		-0.71429	-0.67857
	Sig. (2-tailed)	0.052181	0.175382	0.759945	0.879	0.939408205	0.268249		0.071344	0.09375
	N	7	7	7	7	7	7		7	7
December	Correlation Coefficient							-0.64286		
	Sig. (2-tailed)							0.119392		
	N							7		

Significant correlation at $p<0.05$.

Appendix Table C.7.28: Summary of trends for station N-19, 2003 to 2009

Season	Spearman rho	Barium	Cobalt	Iron	Manganese	pH	Ra-226	TSS	Uranium
January	Correlation Coefficient	-0.81537	-0.85714	0.286	-0.92857143	0.892857	-0.35714	0.642857	-0.28571
	Sig. (2-tailed)	0.025399	0.013697	0.535	0.002519472	0.006807	0.431611	0.119392	0.534509
	N	7	7	7	7	7	7	7	7
February	Correlation Coefficient	-0.55858	0	0.464	-0.71428571	0.774806	-0.14286	0.756787	-0.18019
	Sig. (2-tailed)	0.192453	1	0.294	0.071343561	0.040769	0.759945	0.048905	0.699046
	N	7	7	7	7	7	7	7	7
March	Correlation Coefficient	-0.07412	-0.25226	0.429	-0.71428571	0.5	-0.78571	0	-0.25
	Sig. (2-tailed)	0.874507	0.585241	0.337	0.071343561	0.25317	0.036238	1	0.588724
	N	7	7	7	7	7	7	7	7
April	Correlation Coefficient	0.345512	-0.5	-0.571	-0.21428571	0.25	-0.67857	-0.43644	-0.03571
	Sig. (2-tailed)	0.447816	0.25317	0.18	0.644511581	0.588724	0.09375	0.327582	0.939408
	N	7	7	7	7	7	7	7	7
May	Correlation Coefficient	0.327327	-0.65465	0.144	-0.85714286	0.504525	-0.60714	-0.79282	0.181848
	Sig. (2-tailed)	0.473597	0.110567	0.758	0.013697327	0.248203	0.148231	0.033444	0.696364
	N	7	7	7	7	7	7	7	7
June	Correlation Coefficient	0.889499	-0.32143	-0.306	-0.78571429	0.214286	-0.57143	0.163663	-0.42857
	Sig. (2-tailed)	0.007339	0.482072	0.504	0.036238463	0.644512	0.180202	0.725862	0.337368
	N	7	7	7	7	7	7	7	7
July	Correlation Coefficient	0.054554	-0.32434	0.071	-0.82142857	0.357143	-0.28571	0.828862	0.414431
	Sig. (2-tailed)	0.907523	0.477885	0.879	0.023448808	0.431611	0.534509	0.021174	0.355269
	N	7	7	7	7	7	7	7	7
August	Correlation Coefficient	0.400066	-0.32143	0.111	-0.53571429	0.306319	-0.67857	0.522544	0.306319
	Sig. (2-tailed)	0.373847	0.482072	0.812	0.215217456	0.504027	0.09375	0.228878	0.504027
	N	7	7	7	7	7	7	7	7
September	Correlation Coefficient	-0.01802	-0.14415	0.357	-0.46428571	-0.03571	-0.39286	0.727393	0.345512
	Sig. (2-tailed)	0.969415	0.757818	0.432	0.293934108	0.939408	0.383317	0.063935	0.447816
	N	7	7	7	7	7	7	7	7
October	Correlation Coefficient	0.472805	-0.35714	-0.464	-0.53571429	0.392857	-0.28571	-0.34236	0.111187
	Sig. (2-tailed)	0.283962	0.431611	0.294	0.215217456	0.383317	0.534509	0.452251	0.812407
	N	7	7	7	7	7	7	7	7
November	Correlation Coefficient	-0.14286	-0.28571	-0.571	-0.35714286	0.198206	-0.75	-0.73422	0.324337
	Sig. (2-tailed)	0.759945	0.534509	0.18	0.431611352	0.670085	0.052181	0.060247	0.477885
	N	7	7	7	7	7	7	7	7
December	Correlation Coefficient	0.111187	-0.42857	0	-0.28571429	0	-0.82143	0.109109	-0.71429
	Sig. (2-tailed)	0.812407	0.337368	1	0.534509229	1	0.023449	0.815871	0.071344
	N	7	7	7	7	7	7	7	7

(shaded) Significant correlation at $p<0.05$.

Appendix Table C.7.29: Summary of trends for station N-20, 2003 to 2009.

Season	Spearman rho	pH	Ra-226
January	Correlation Coefficient	-0.532312	-0.774827
	Sig. (2-tailed)	0.218709	0.04076
	N	7	7
April/May	Correlation Coefficient	-0.259437	0.302372
	Sig. (2-tailed)	0.574237	0.509819
	N	7	7
July	Correlation Coefficient	0.529641	-0.794461
	Sig. (2-tailed)	0.279826	0.059028
	N	6	6
October/November	Correlation Coefficient	-0.018019	-0.355529
	Sig. (2-tailed)	0.969415	0.433847
	N	7	7

(shaded) Significant correlation at p<0.05.

Appendix Table C.7.30: Summary of trends for station N-22, 2003 to 2009.

Season	Spearman rho	pH	Acidity	Ra-226
April/May	Correlation Coefficient	-0.692345	-0.678571	-0.846881
	Sig. (2-tailed)	0.084724	0.09375	0.016197
	N	7	7	7
October/November	Correlation Coefficient	0.2965	-0.321429	-0.49099
	Sig. (2-tailed)	0.518477	0.482072	0.263194
	N	7	7	7

(shaded) Significant correlation at $p<0.05$.

Appendix Table C.7.31: Summary of trends for Lacnor/Nordic porewater stations, 2003 to 2009.

Station	Spearman rho	Iron	pH	Sulphate
UW7-2	Correlation Coefficient	0.167857143	0.007274	0.64545455
	Sig. (2-tailed)	0.549855554	0.979474	0.0319628
	N	15	15	11
UW7-4	Correlation Coefficient	-0.860714286	0.057348	-0.4090909
	Sig. (2-tailed)	3.80553E-05	0.839131	0.21154501
	N	15	15	11
UW7-6	Correlation Coefficient	-0.235164835	0.626705	0.57751027
	Sig. (2-tailed)	0.418333896	0.016468	ns
	N	14	14	10
UW9-1	Correlation Coefficient	-0.596428571	0.224271	-0.1545455
	Sig. (2-tailed)	0.018931925	0.421651	0.65003397
	N	15	15	11
UW9-2	Correlation Coefficient	-0.175	0.614701	-0.0545455
	Sig. (2-tailed)	0.532748148	0.014748	0.87344658
	N	15	15	11
UW9-3	Correlation Coefficient	0.435714286	-0.401436	0.51818182
	Sig. (2-tailed)	0.104493357	0.138047	0.10249154
	N	15	15	11

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

"ns" denotes not significant.

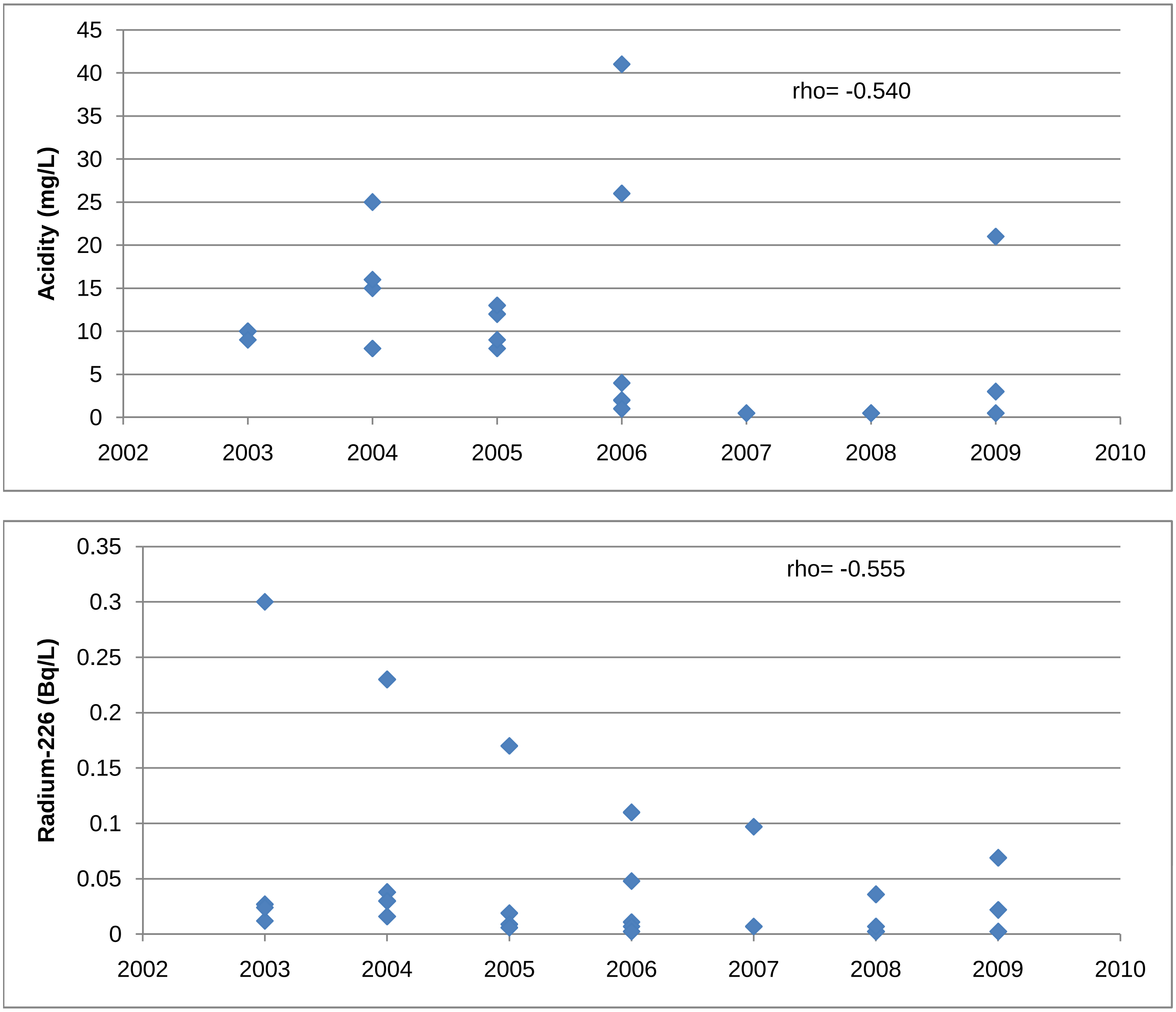
[shaded box] Significant trend where p<0.05.

Appendix Table C.7.32: Summary of trends for Lacnor/Nordic groundwater stations.

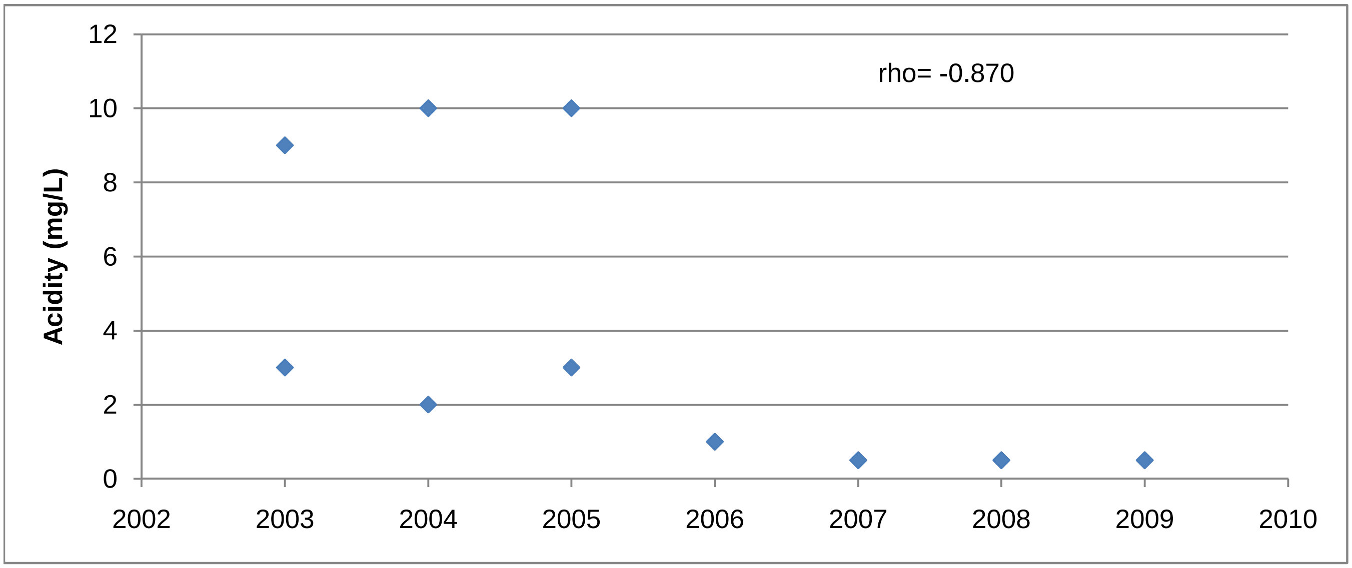
Station	Spearman rho	Iron	pH	Sulphate
M12-1	Correlation Coefficient	0.060714286	0.831132	0.85714286
	Sig. (2-tailed)	0.829812095	0.000123	0.00653002
	N	15	15	8
M12-3	Correlation Coefficient	-0.775	0.587213	-0.5238095
	Sig. (2-tailed)	0.000689645	0.02136	0.18272075
	N	15	15	8
M12-6	Correlation Coefficient	-0.868131868	0.804011	-0.8571429
	Sig. (2-tailed)	5.67982E-05	0.000529	0.01369733
	N	14	14	7
M12-9	Correlation Coefficient	-0.796703297	0.78119	-0.2702812
	Sig. (2-tailed)	0.001113653	0.001616	0.55773075
	N	13	13	7
M13-1	Correlation Coefficient	0.10989011	0.218844	-0.6694619
	Sig. (2-tailed)	0.7208098	0.472555	ns
	N	13	13	9
M13-23	Correlation Coefficient	-0.248351648	0.759914	-0.7333333
	Sig. (2-tailed)	0.391919539	0.001611	<0.05
	N	14	14	9
M13-6	Correlation Coefficient	-0.938461538	0.735923	-0.9666667
	Sig. (2-tailed)	0.000001	0.002695	<0.001
	N	14	14	9
M13-9	Correlation Coefficient	-0.741758242	-0.150009	-0.7185758
	Sig. (2-tailed)	0.003701314	0.624734	<0.05
	N	13	13	8
M14-1	Correlation Coefficient	0.30952381	0.096393	-0.3590924
	Sig. (2-tailed)	ns	ns	ns
	N	8	8	5
M14-3	Correlation Coefficient	-0.69047619	-0.222375	-0.9
	Sig. (2-tailed)	ns	ns	ns
	N	8	8	5
M14-6	Correlation Coefficient	-0.4	-0.604392	-0.6
	Sig. (2-tailed)	ns	ns	ns
	N	9	9	5
M14-9	Correlation Coefficient	-0.574860606	0.282256	-0.9746794
	Sig. (2-tailed)	ns	ns	ns
	N	8	8	5
95N4-A	Correlation Coefficient	-0.601398601	0.686778	0.43333333
	Sig. (2-tailed)	0.038588453	0.013623	ns
	N	12	12	9
95N4-B	Correlation Coefficient	-0.839160839	-0.103975	-0.4518868
	Sig. (2-tailed)	0.000642826	0.747776	ns
	N	12	12	9
95N7-A	Correlation Coefficient	-0.552447552	-0.613309	-0.1904762
	Sig. (2-tailed)	0.062511483	0.033937	ns
	N	12	12	8
95N7-B	Correlation Coefficient	-0.531468531	-0.599671	0.42857143
	Sig. (2-tailed)	0.075362335	0.039299	ns
	N	12	12	8

Appendix Table C.7.32: Summary of trends for Lacnor/Nordic groundwater stations.

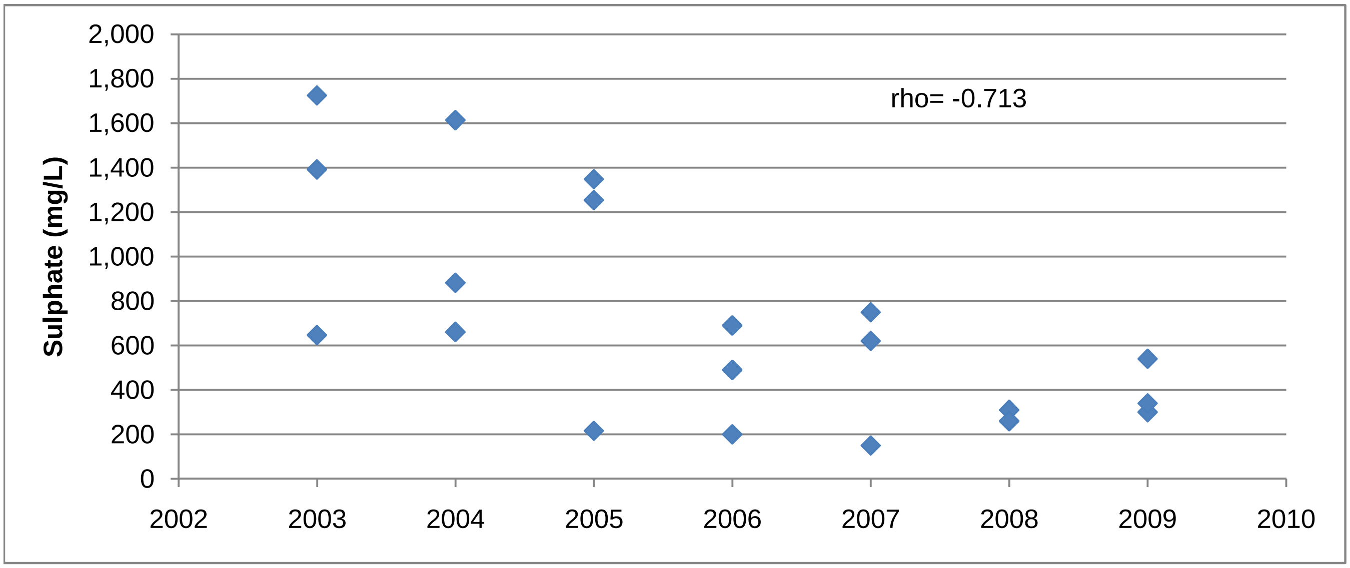
Station	Spearman rho	Iron	pH	Sulphate
95N11	Correlation Coefficient	-0.699300699	-0.454309	0.71428571
	Sig. (2-tailed)	0.011374199	0.118862	ns
	N	12	13	7
95N12-A	Correlation Coefficient	-0.107692308	-0.273967	0.08368274
	Sig. (2-tailed)	0.714030809	0.343219	ns
	N	14	14	9
95N12-B	Correlation Coefficient	-0.56043956	-0.536899	-0.7065995
	Sig. (2-tailed)	0.046345906	0.058505	ns
	N	13	13	8
95N13-A	Correlation Coefficient	-0.844885	0.196689	-0.3090909
	Sig. (2-tailed)	0.000142726	0.500338	0.35502844
	N	14	14	11
95N13-C	Correlation Coefficient	-0.885714286	0.623664	-0.6636364
	Sig. (2-tailed)	2.504E-05	0.017158	0.02598413
	N	14	14	11
95N13-E	Correlation Coefficient	-0.885714286	0.640894	-0.5909091
	Sig. (2-tailed)	2.504E-05	0.013521	0.0555756
	N	14	14	11
95N14-A	Correlation Coefficient	-0.010989011	0.155274	-0.486259
	Sig. (2-tailed)	0.97025839	0.596079	0.12937217
	N	14	14	11
95N14-B	Correlation Coefficient	0.353846154	-0.34774	-0.1757576
	Sig. (2-tailed)	0.214539871	0.223112	ns
	N	14	14	10
95N14-C	Correlation Coefficient	0.402197802	-0.319598	-0.6102572
	Sig. (2-tailed)	0.15397443	0.265335	ns
	N	14	14	9
95N16-A	Correlation Coefficient	-0.847637027	0.498261	-0.2688813
	Sig. (2-tailed)	0.000497797	0.099215	ns
	N	12	12	10
95N16-C	Correlation Coefficient	-0.986013986	0.809879	-0.6280605
	Sig. (2-tailed)	0.000001	0.001408	ns
	N	12	12	10
95N16-E	Correlation Coefficient	-0.825174825	0.704686	-0.6484848
	Sig. (2-tailed)	0.000951363	0.010497	<0.05
	N	12	12	10
95N17-A	Correlation Coefficient	0.697802198	0.109265	-0.4909091
	Sig. (2-tailed)	0.008000717	0.710019	ns
	N	13	14	10
95N17-B	Correlation Coefficient	0.521978022	-0.500154	-0.3333333
	Sig. (2-tailed)	0.067291712	0.068556	ns
	N	13	14	10
95N17-C	Correlation Coefficient	0.494505495	-0.655612	-0.0062531
	Sig. (2-tailed)	0.085823531	0.010909	ns
	N	13	14	10



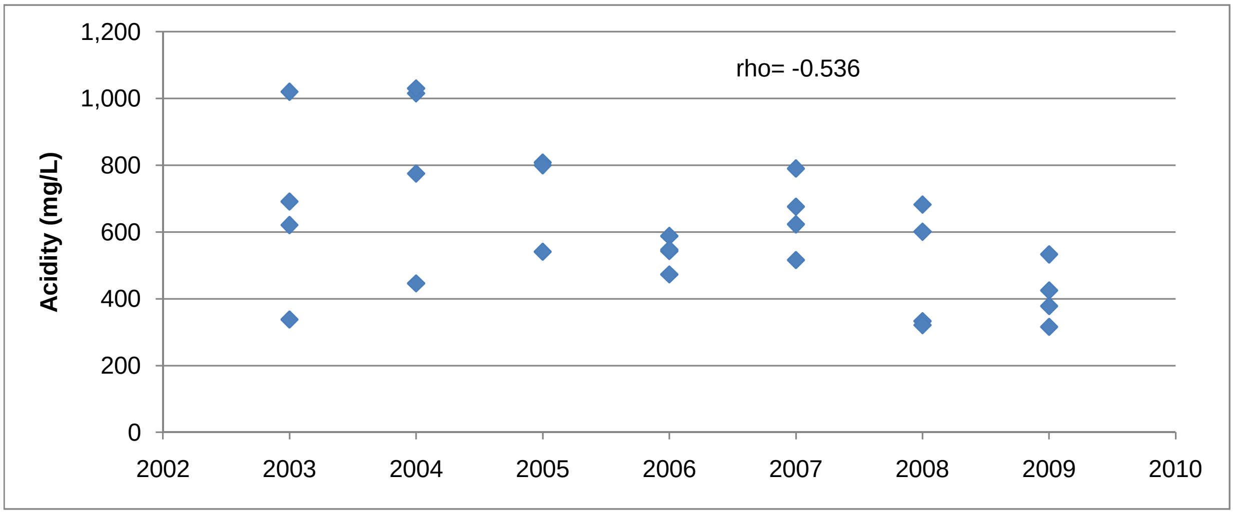
Appendix Figure C.7.1: Significant common (average) trends observed for acidity and radium-226 over all seasons at station ECA-131, 2003 to 2009.

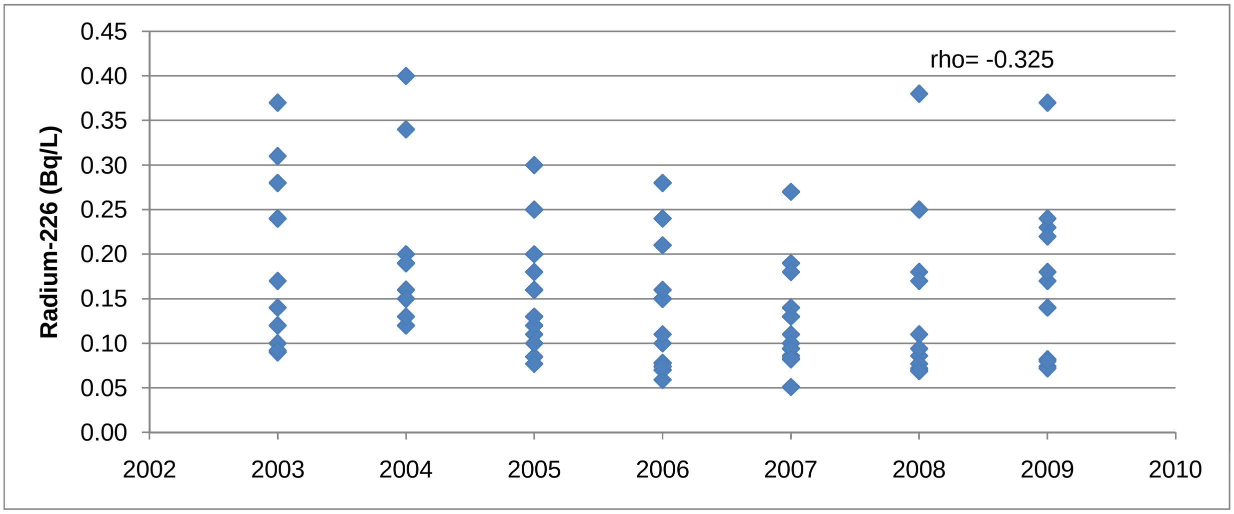


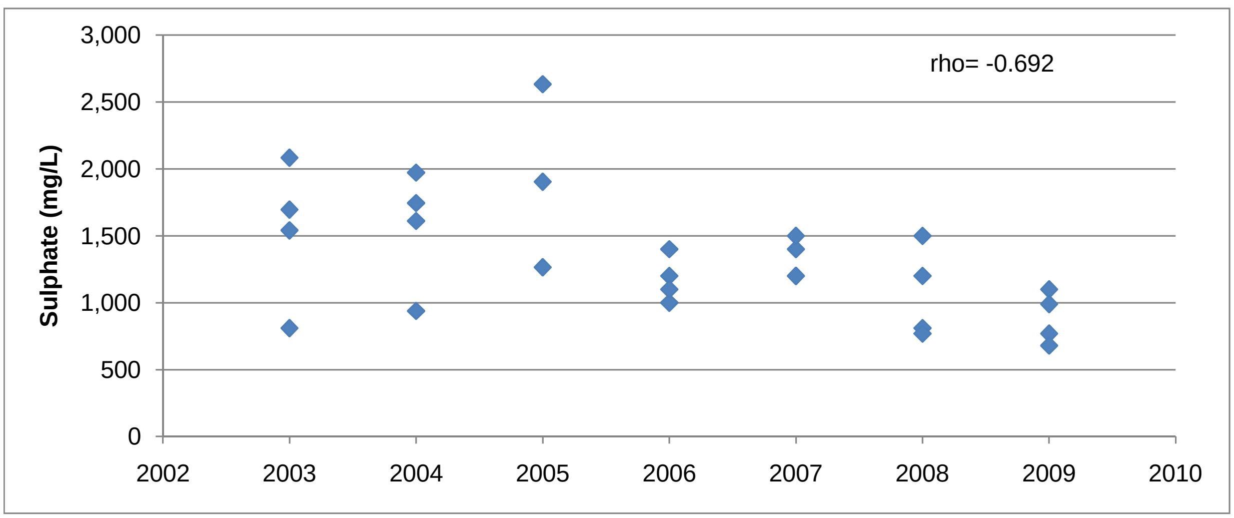
Appendix Figure C.7.2: Significant common (average) trends observed for acidity over all seasons at station ECA-132, 2003 to 2009.



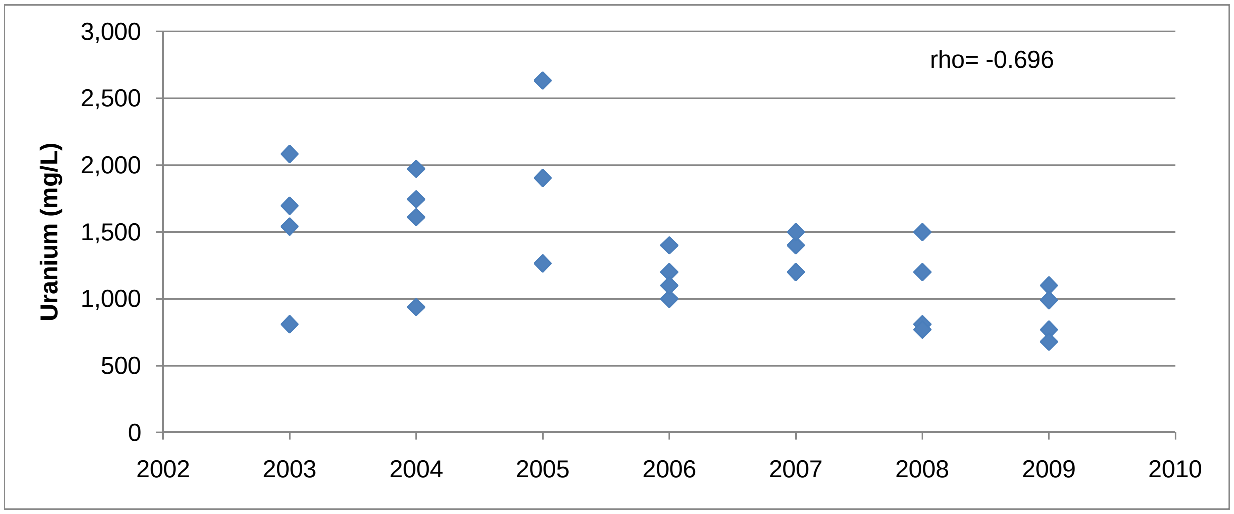
Appendix Figure C.7.3: Significant common (average) trends observed for sulphate over all seasons at station L-03, 2003 to 2009.



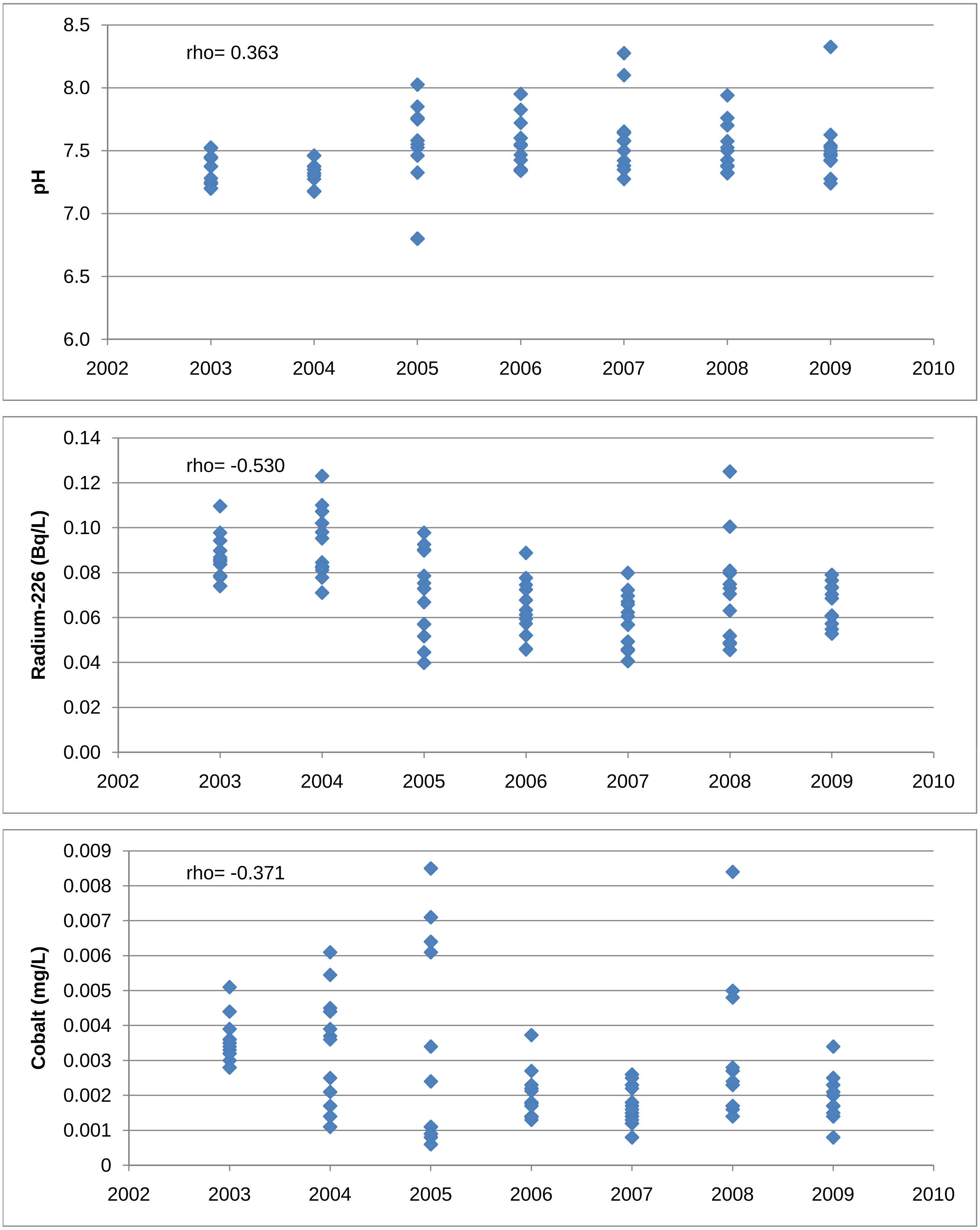




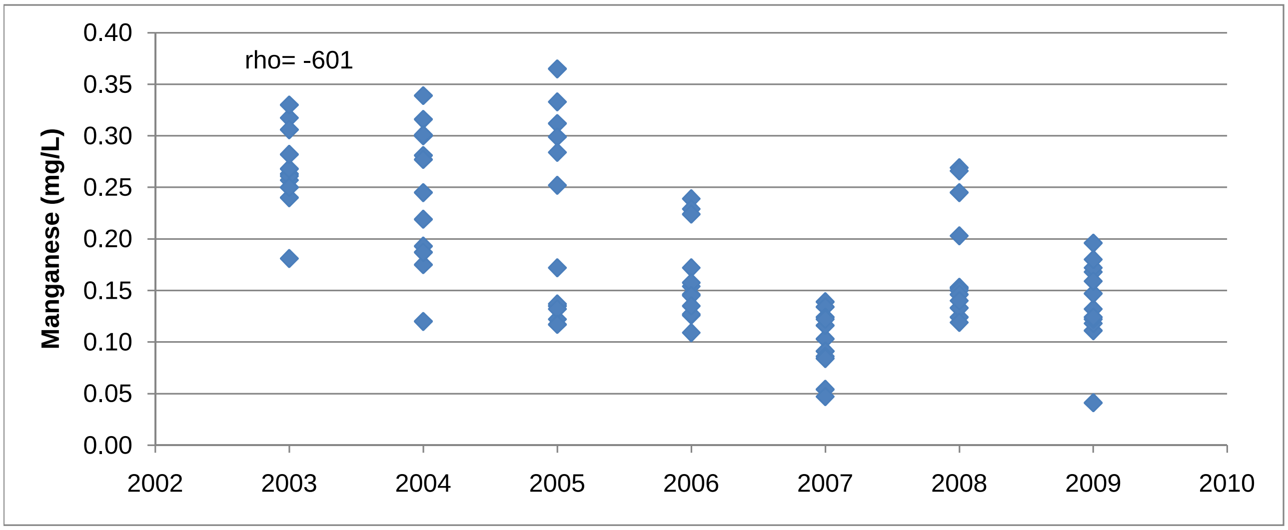
Appendix Figure C.7.4: Significant common (average) trends observed for acidity, radium-226, sulphate and uranium over all seasons at station N-17, 2003 to 2009.



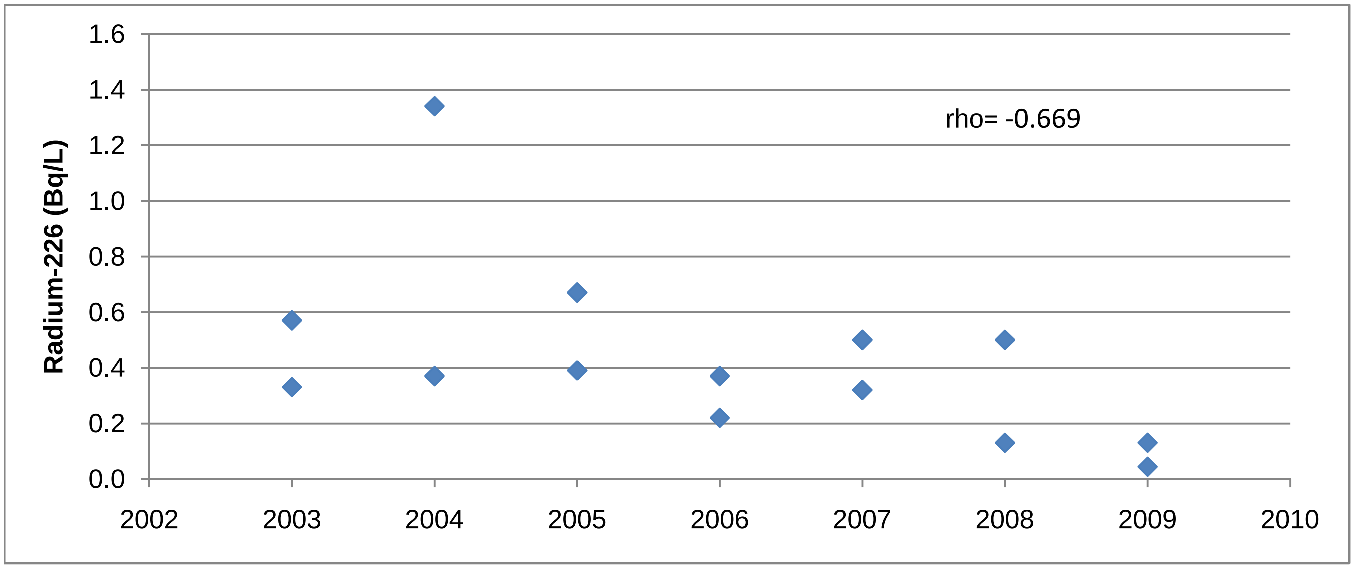
Appendix Figure C.7.4: Significant common (average) trends observed for acidity, radium-226, sulphate and uranium over all seasons at station N-17, 2003 to 2009.



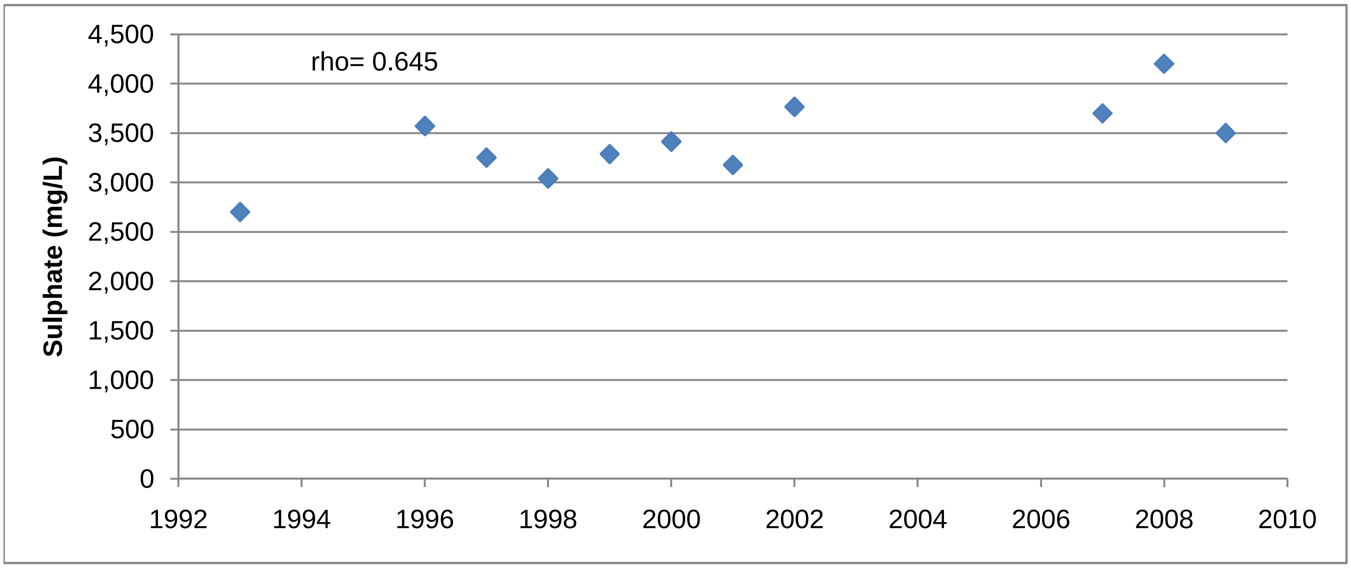
Appendix Figure C.7.5: Significant common (average) trends observed for pH, radium-226, cobalt, and manganese over all seasons at station ECA-131, 2003 to 2009.



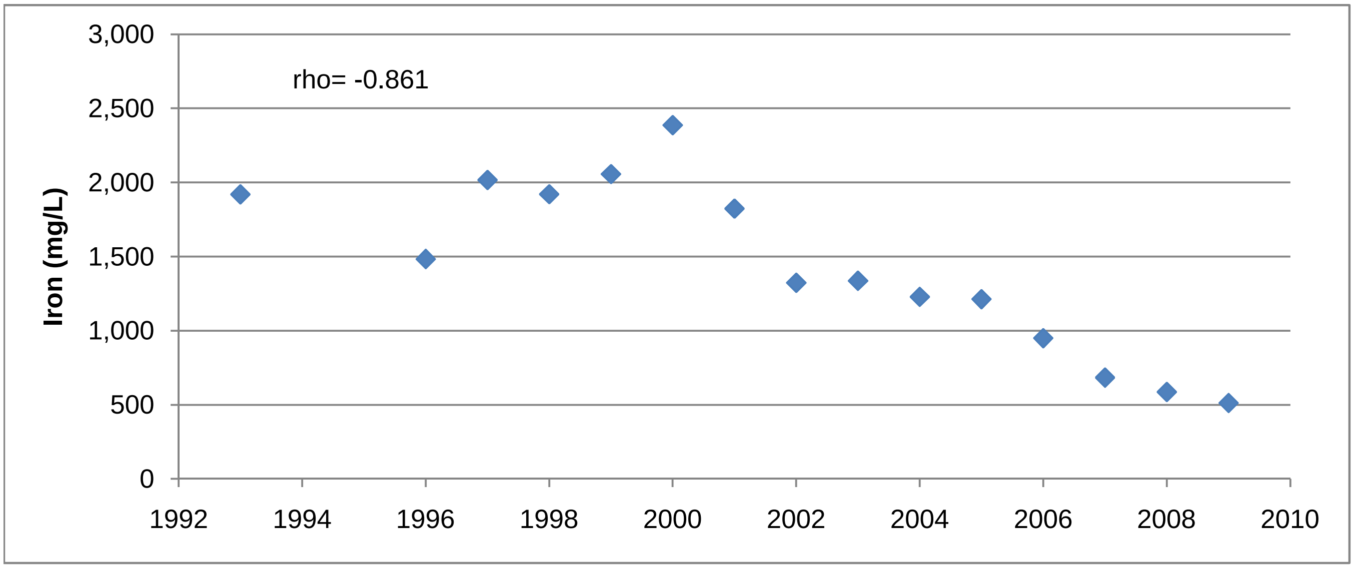
Appendix Figure C.7.5: Significant common (average) trends observed for pH, radium-226, cobalt, and manganese over all seasons at station ECA-131, 2003 to 2009.



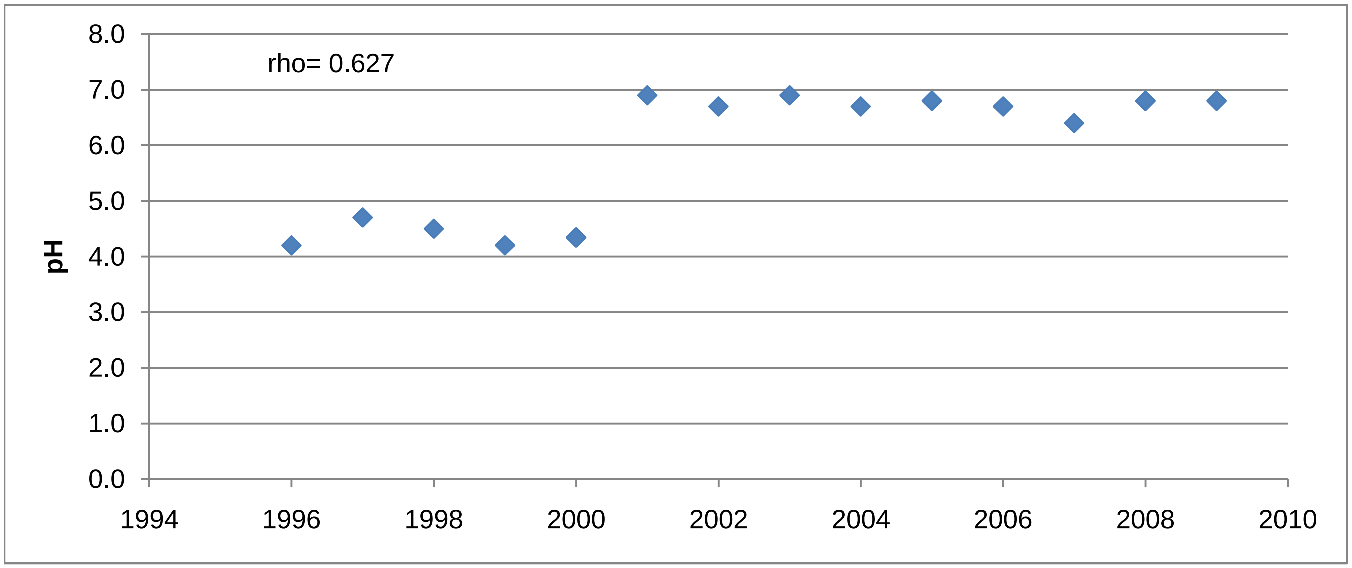
Appendix Figure C.7.6: Significant common (average) trends observed for radium-226 over all seasons at station N-22, 2003 to 2009.



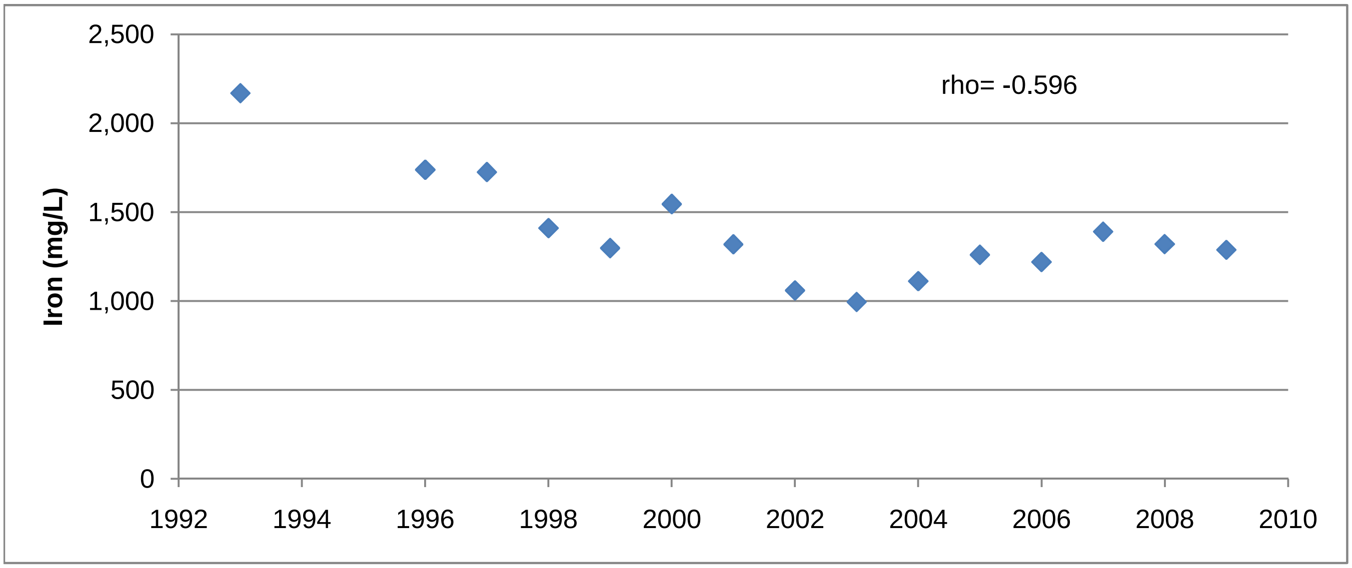
Appendix Figure C.7.7: Significant trends observed for sulphate at station UW7-2, 1993 to 2009.



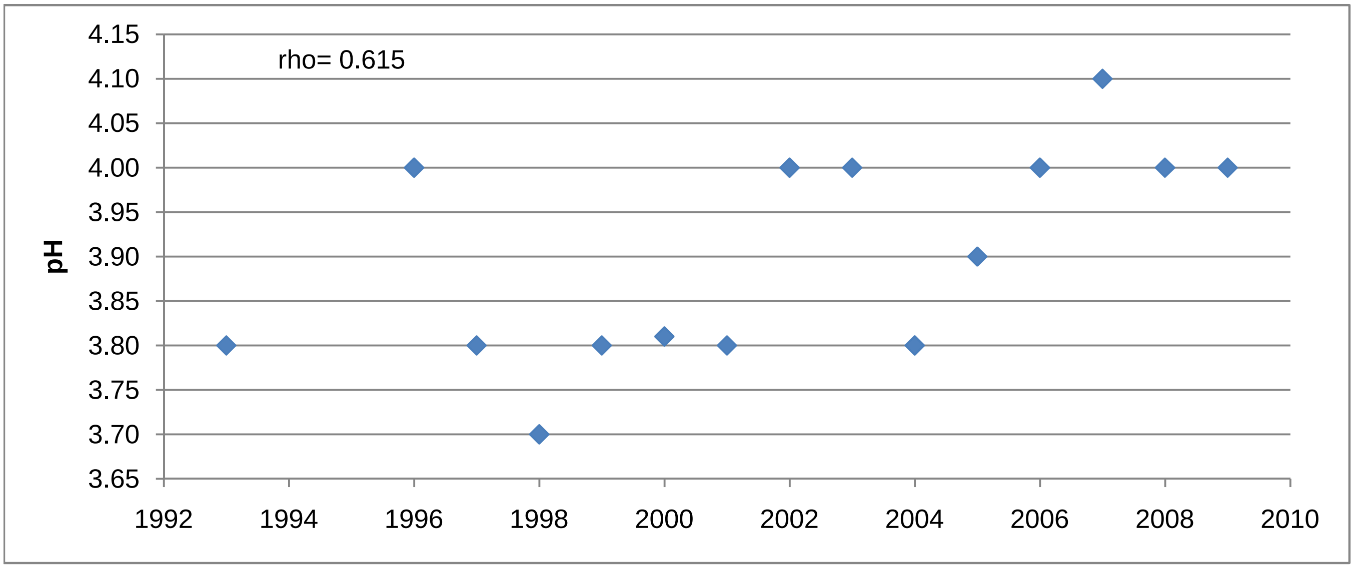
Appendix Figure C.7.8: Significant trends observed for iron at station UW7-4, 1993 to 2009.



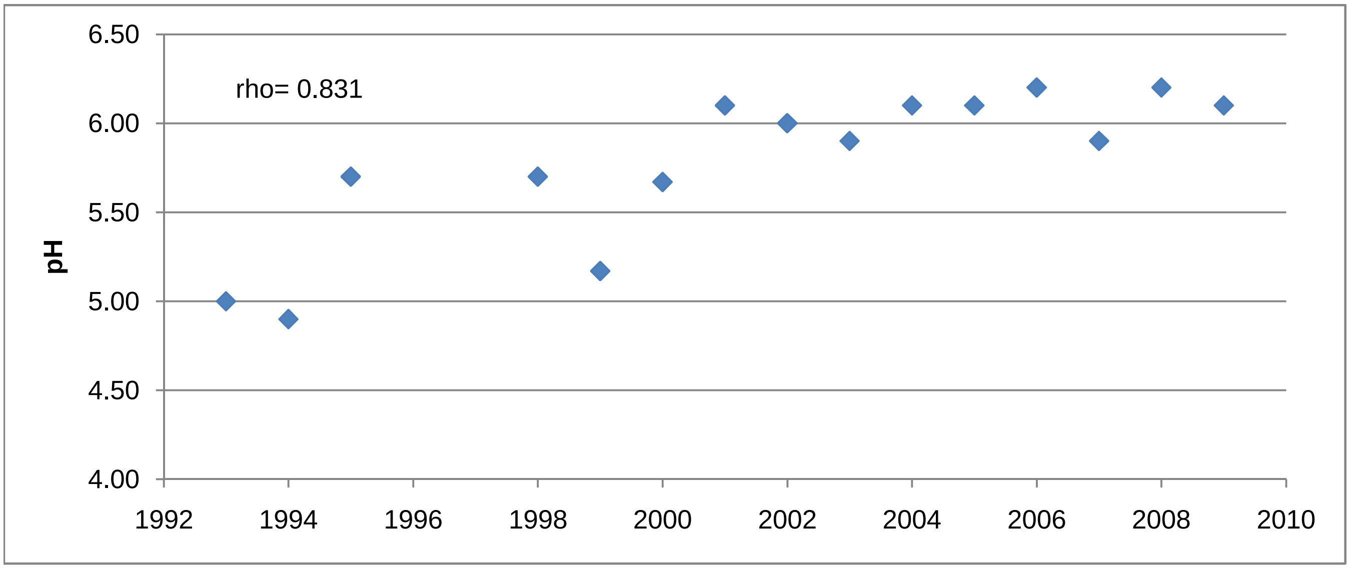
Appendix Figure C.7.9: Significant trends observed for pH at station UW7-6, 1996 to 2009.

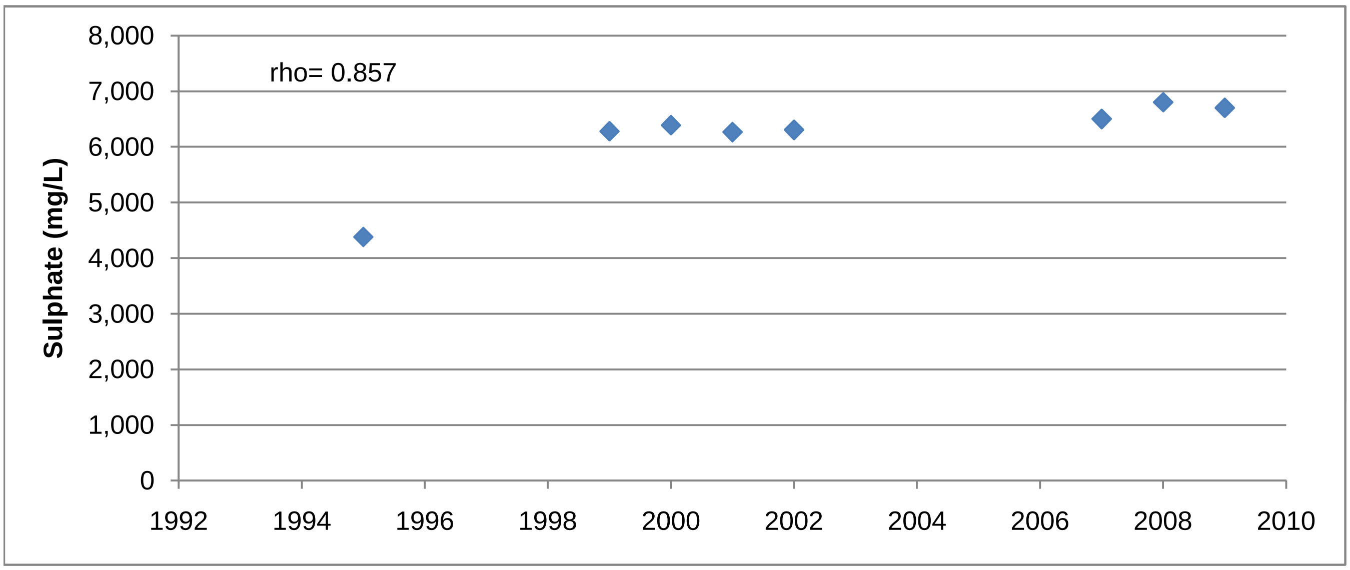


Appendix Figure C.7.10: Significant trends observed for iron at station UW9-1, 1993 to 2009.

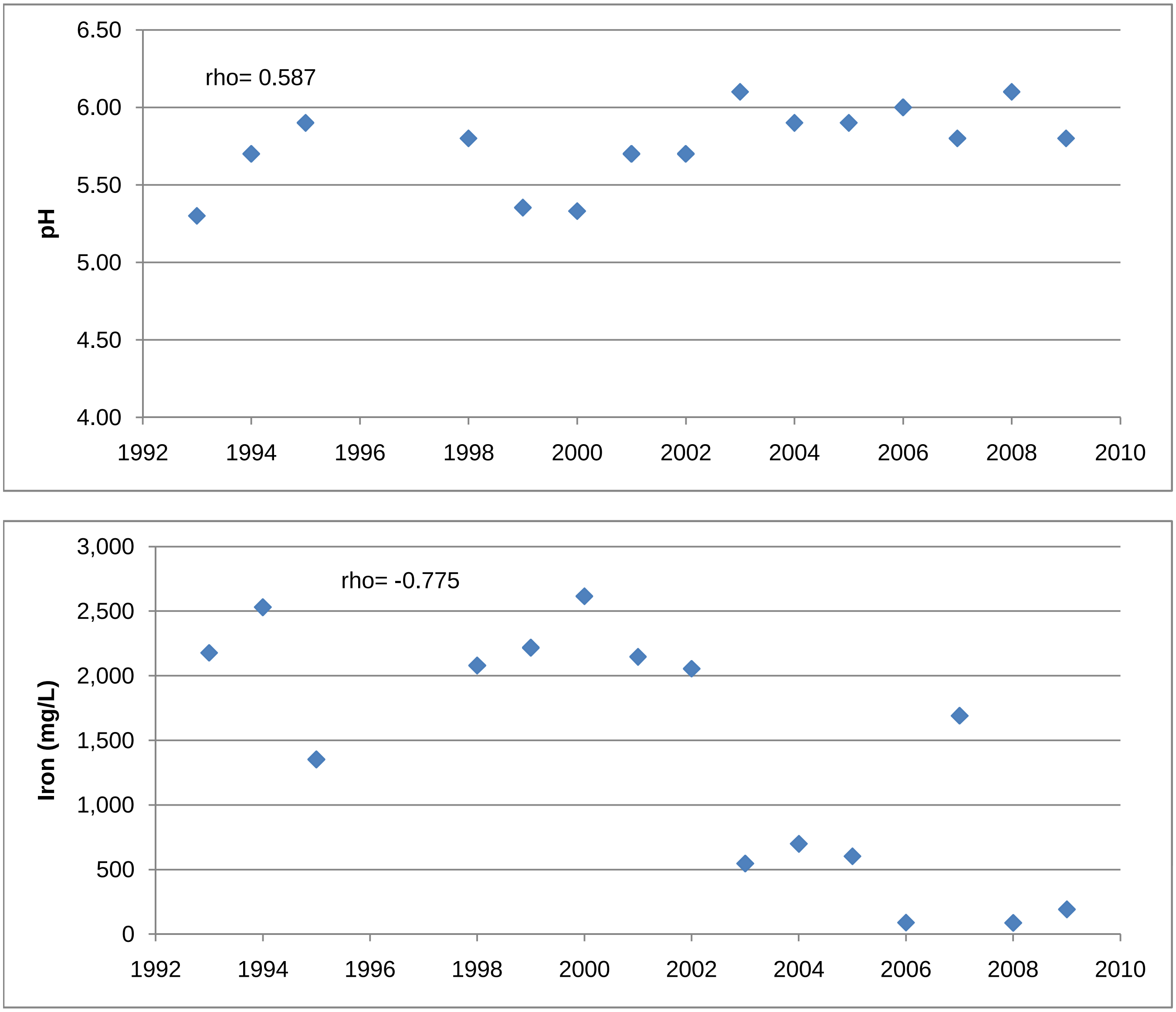


Appendix Figure C.7.11: Significant trends observed for pH at station UW9-2, 1993 to 2009.

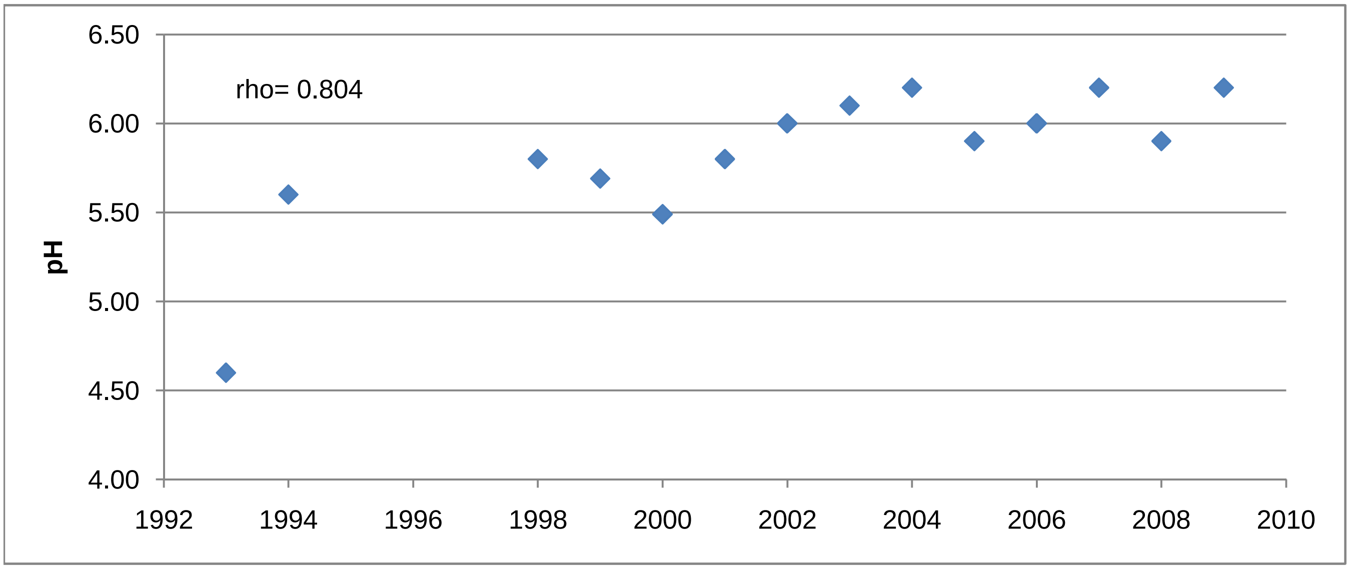


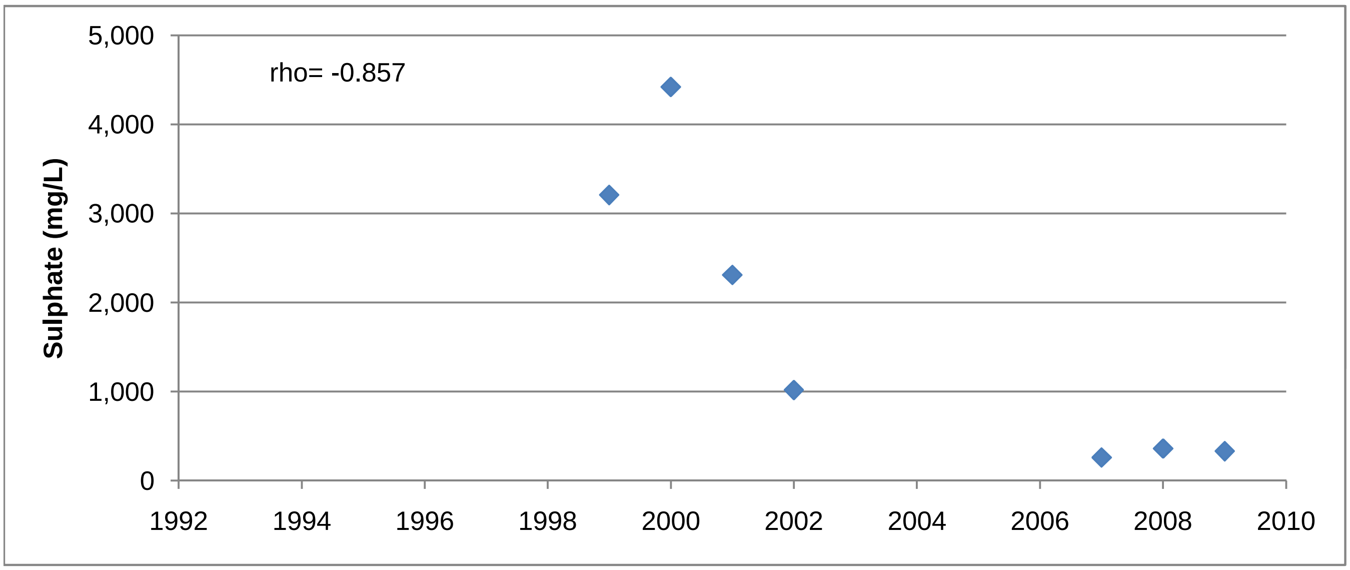


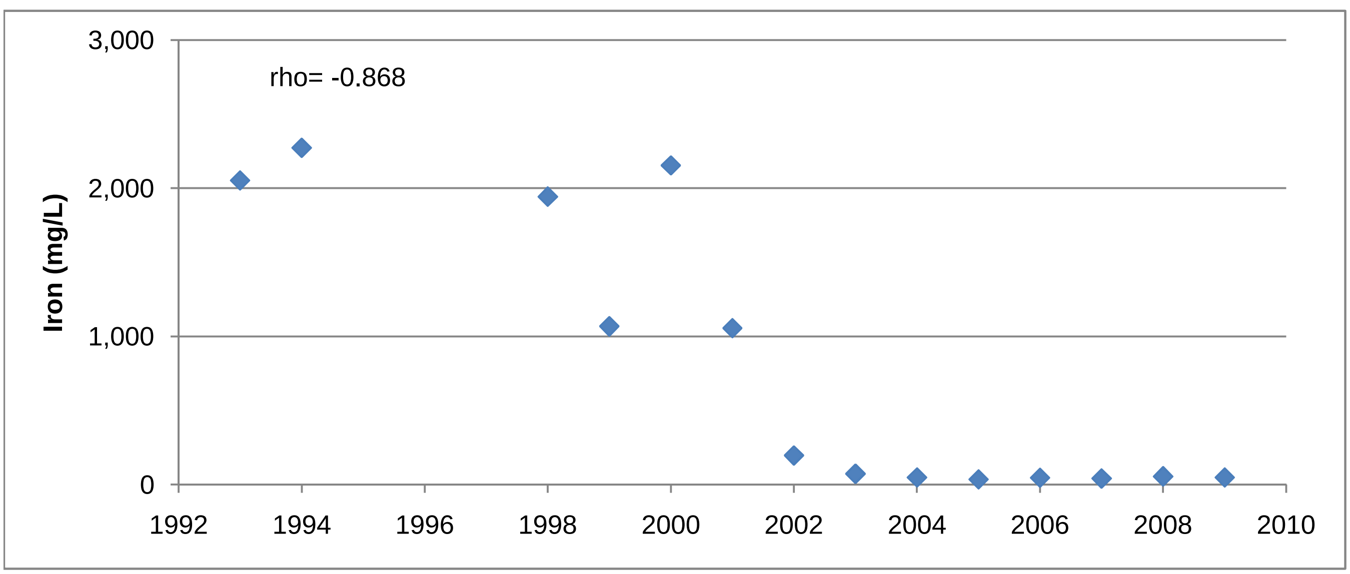
Appendix Figure C.7.12: Significant trends observed for pH and sulphate at station M12-1, 1993 to 2009.



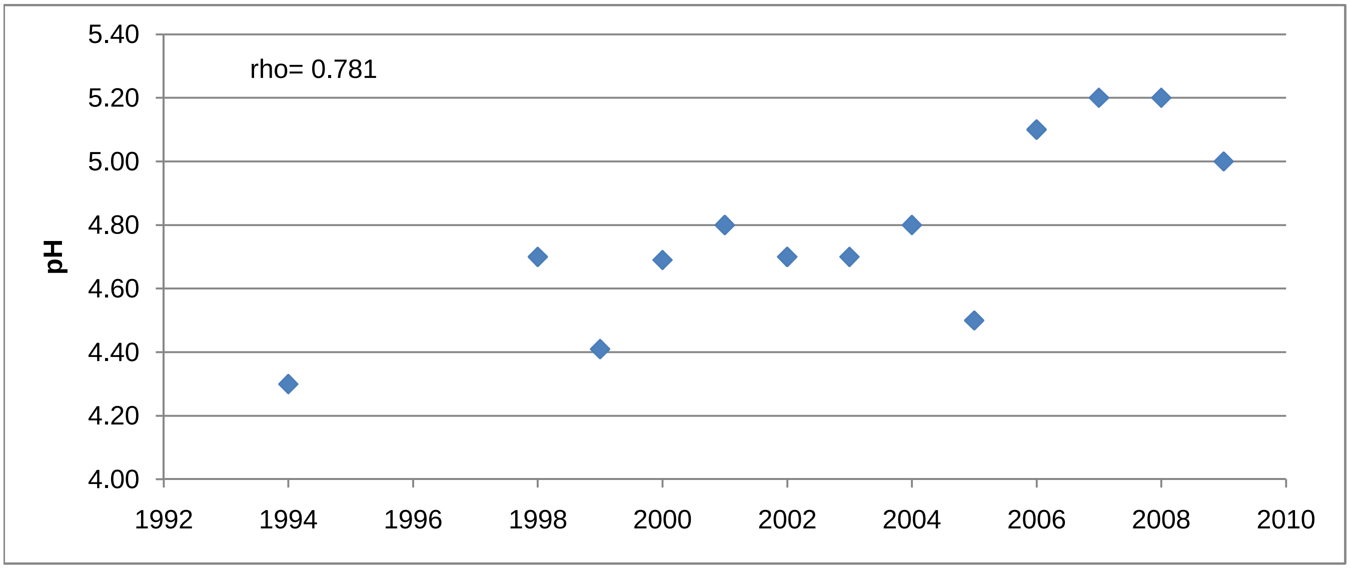
Appendix Figure C.7.13: Significant trends observed for pH and iron at station M12-3, 1993 to 2009.

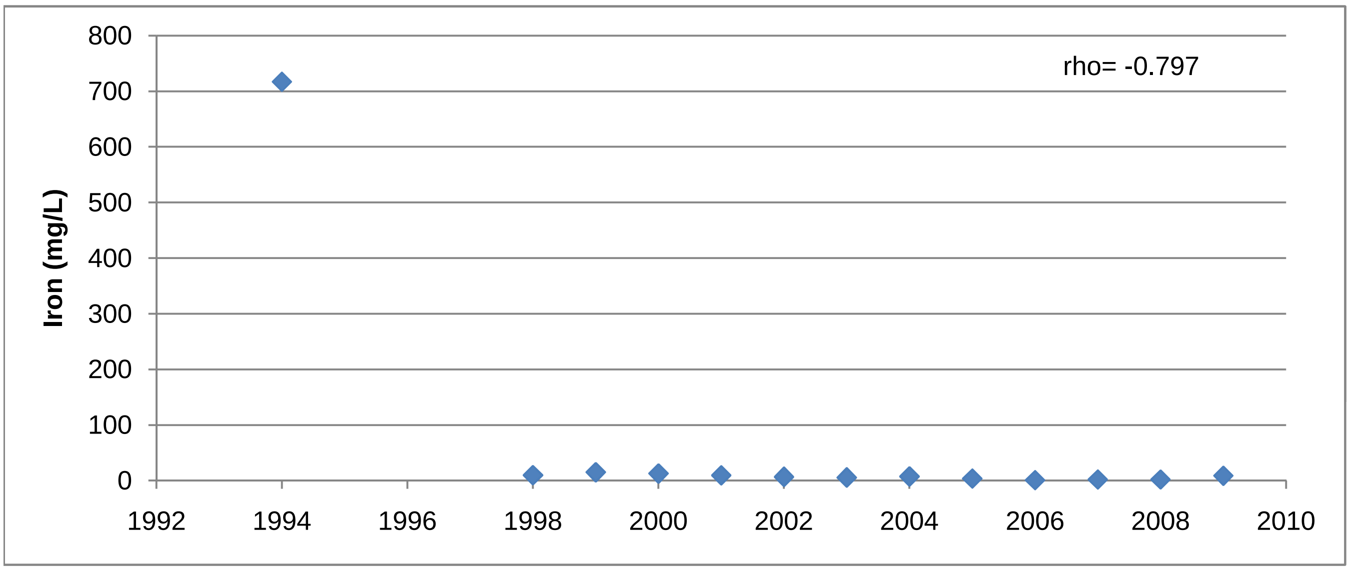




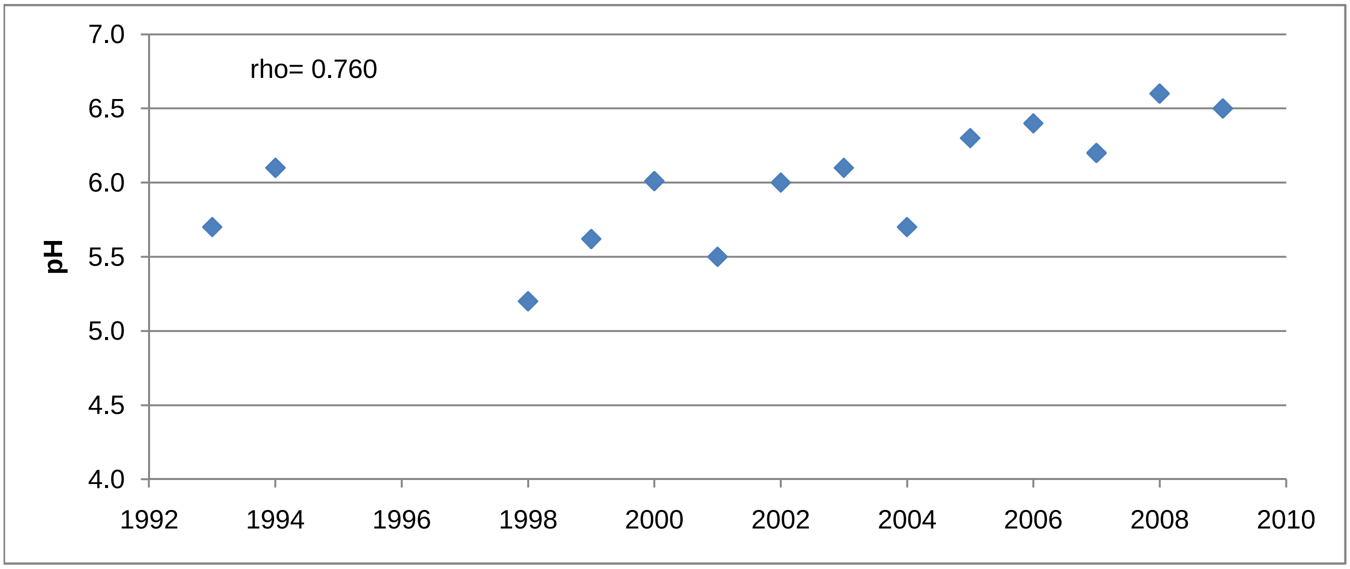


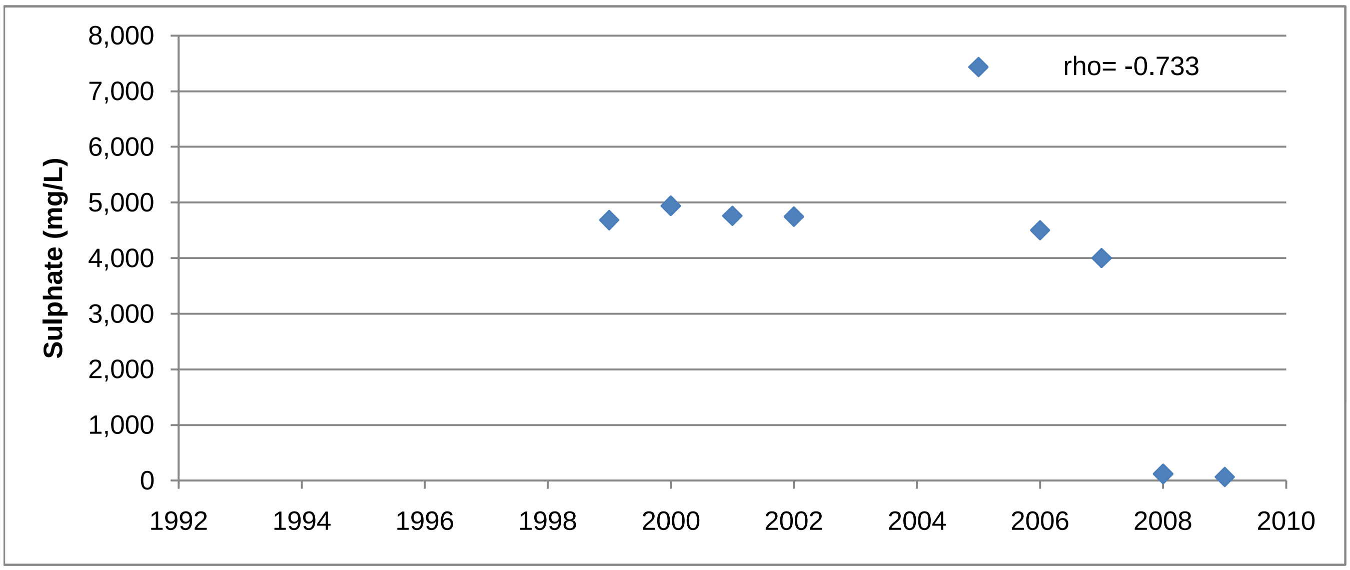
Appendix Figure C.7.14: Significant trends observed for pH, sulphate and iron at station M12-6, 1993 to 2009.



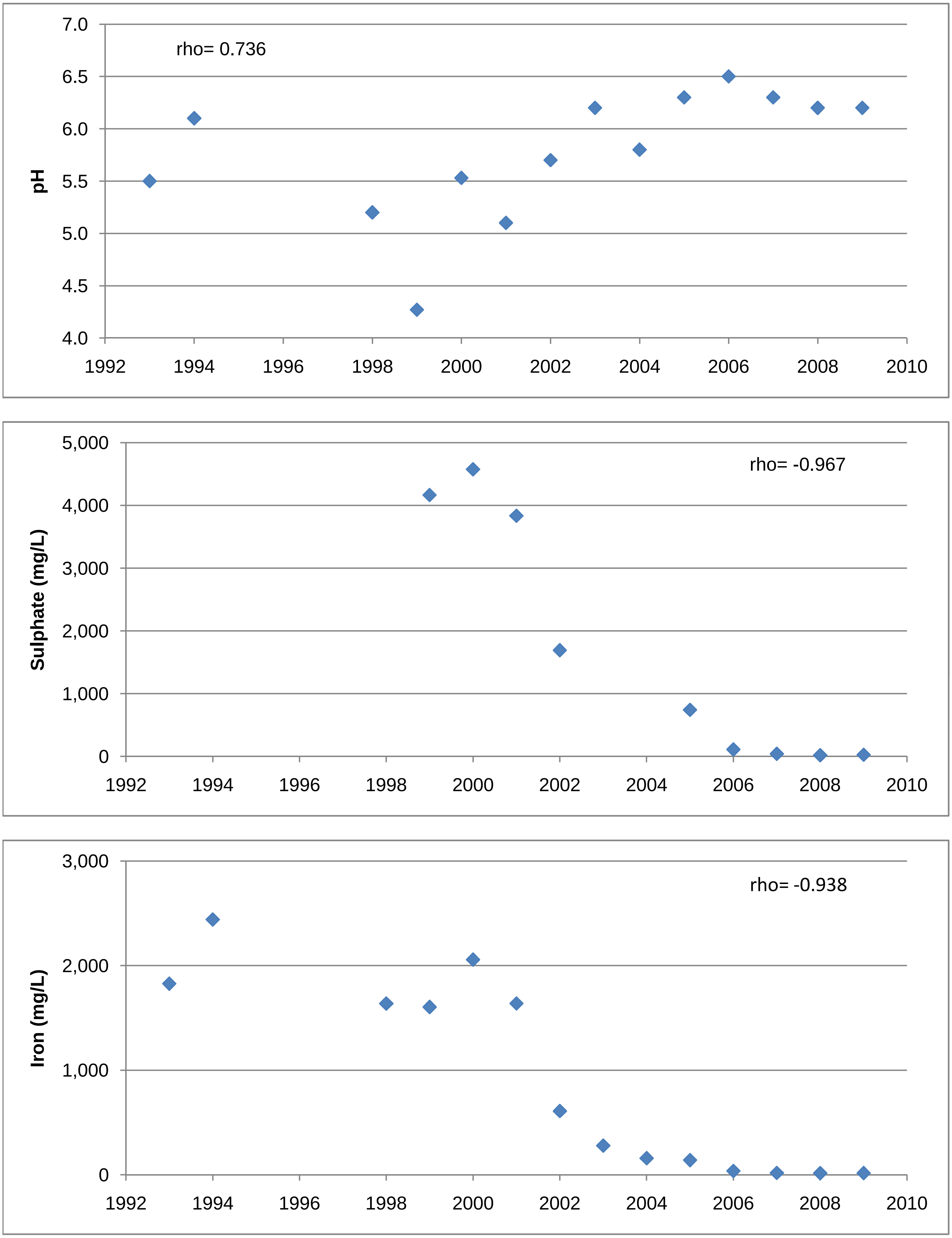


Appendix Figure C.7.15: Significant trends observed for pH and iron at station M12-9, 1994 to 2009.

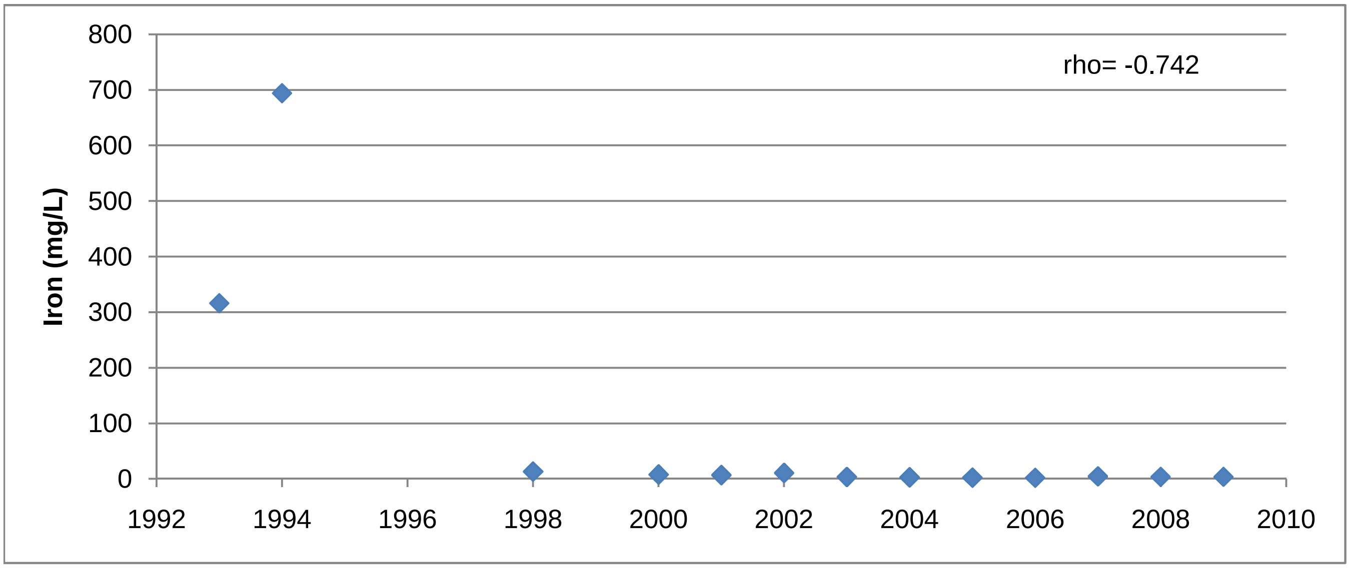




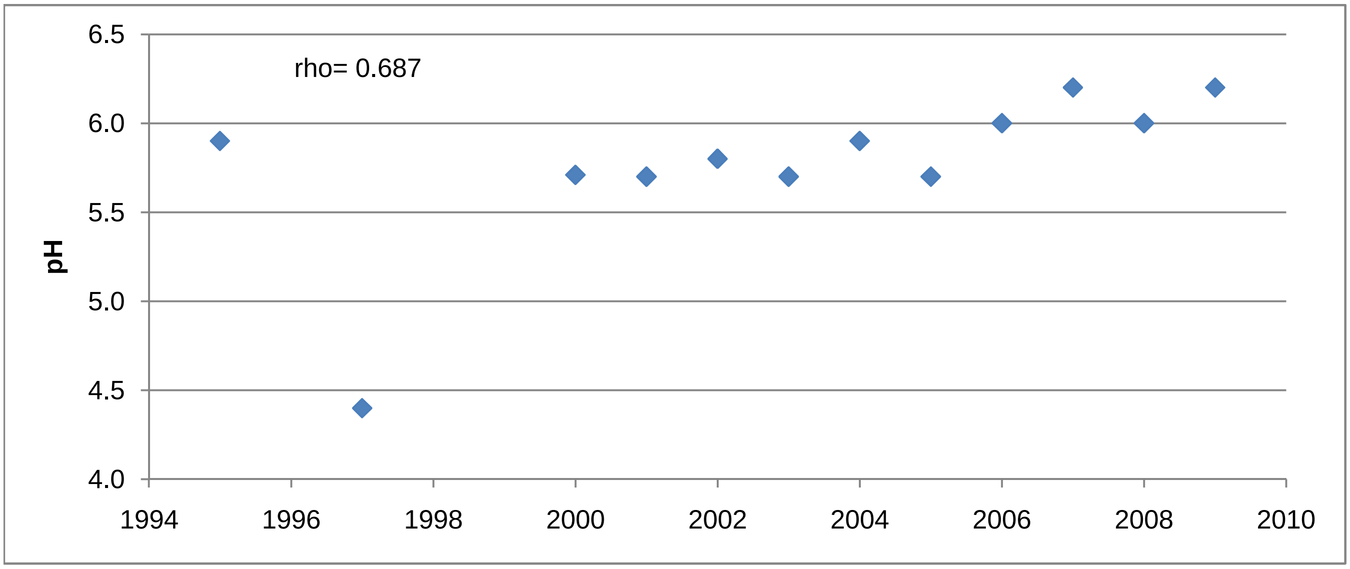
Appendix Figure C.7.16: Significant trends observed for pH and sulphate at station M13-3, 1993 (or 1999) to 2009.

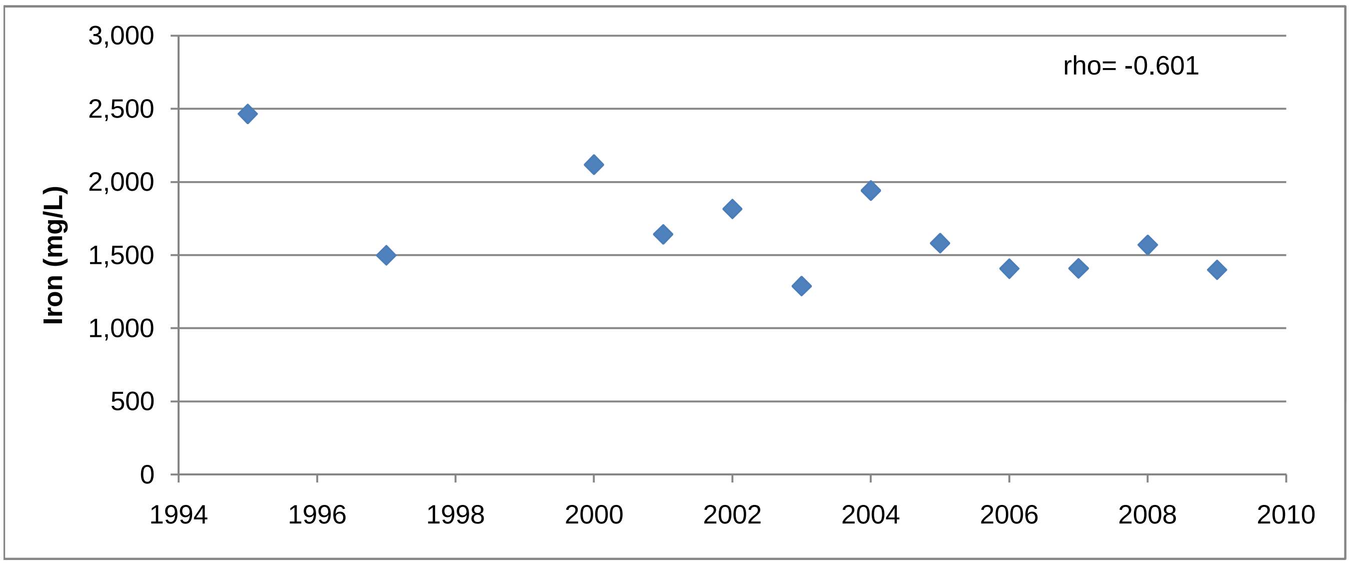


Appendix Figure C.7.17: Significant trends observed for pH, sulphate and iron at station M13-6, 1993 (or 1999) to 2009.

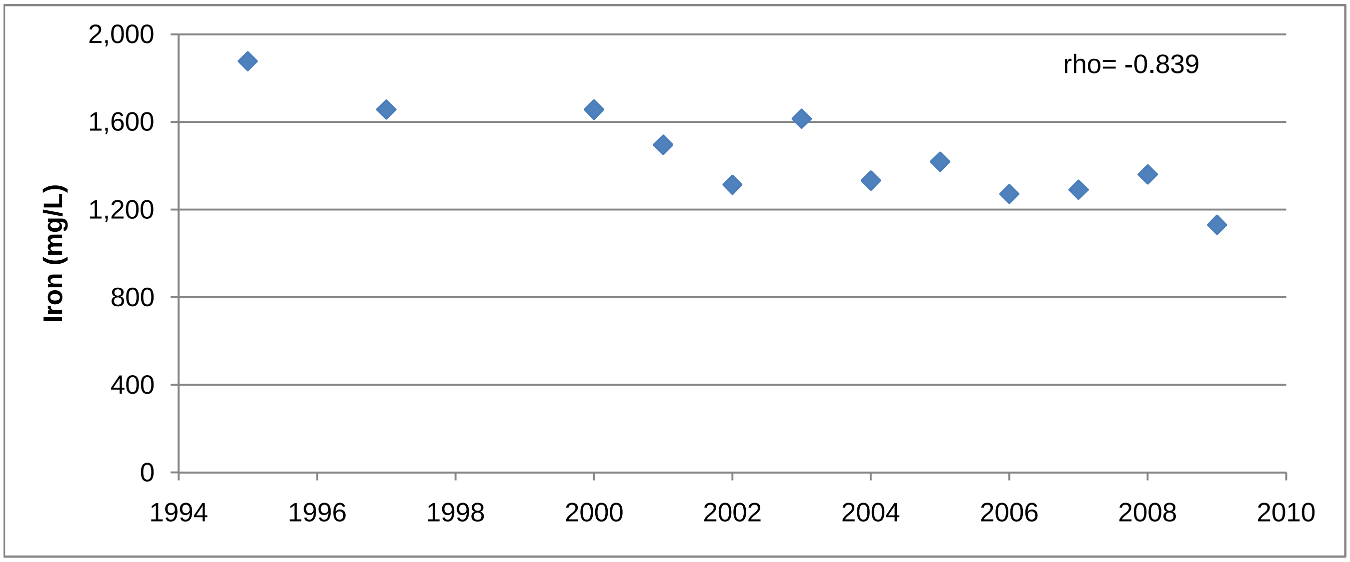


Appendix Figure C.7.18: Significant trends observed for iron at station M13-9, 1993 to 2009.

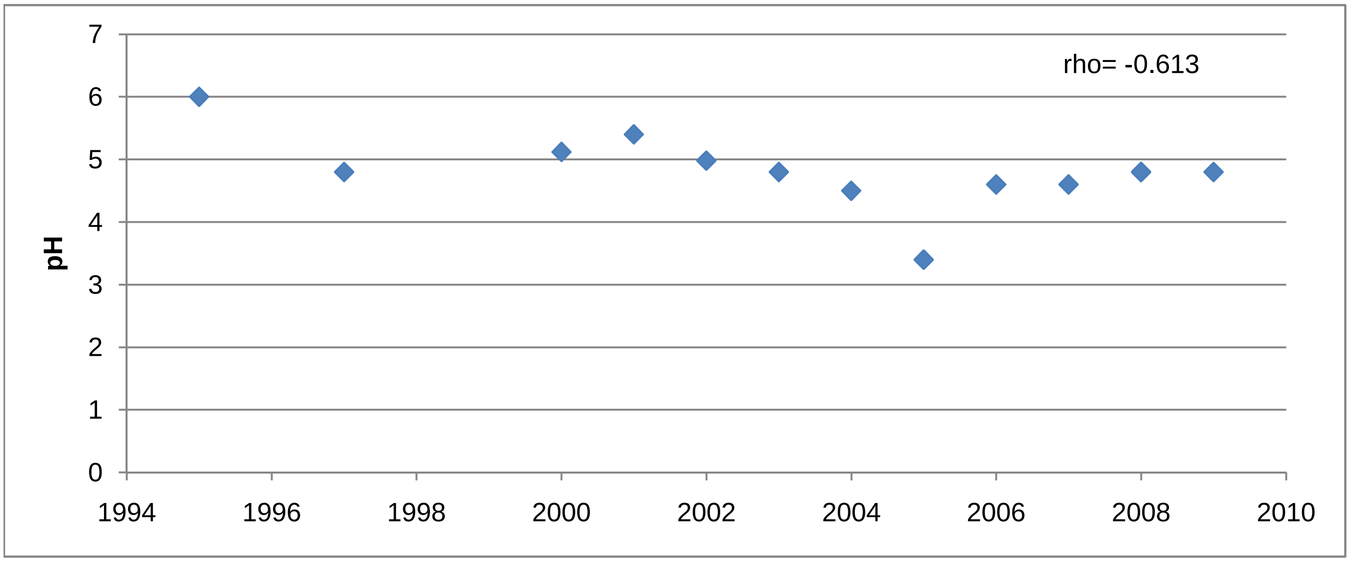




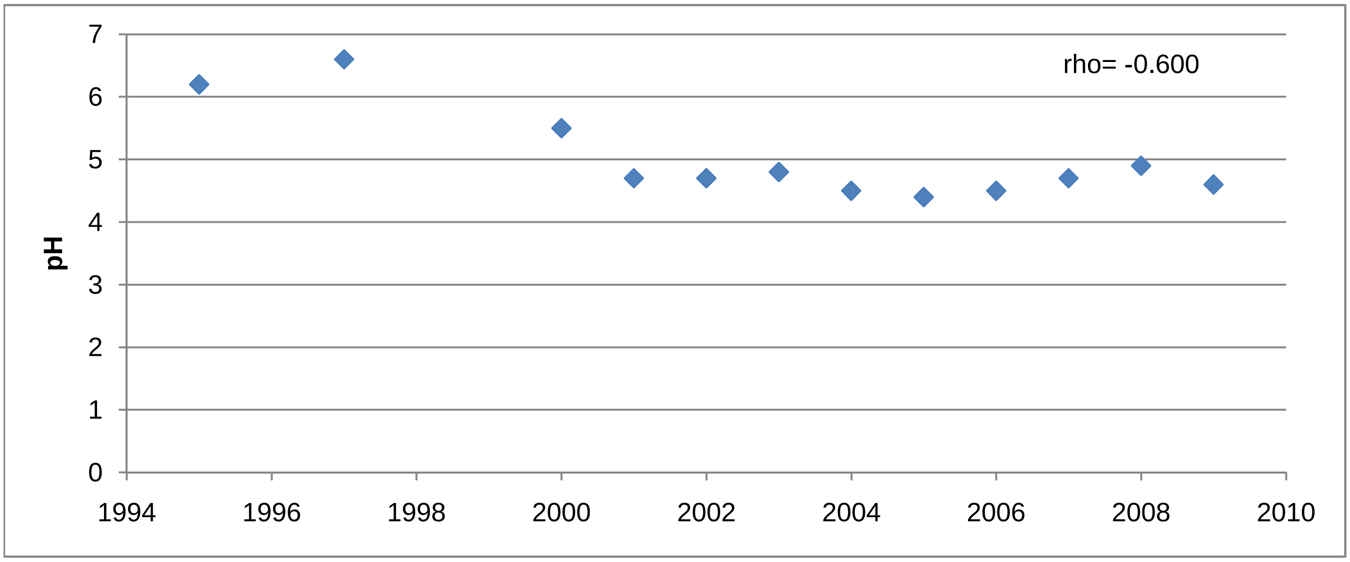
Appendix Figure C.7.19: Significant trends observed for pH and iron at station 95N4-A, 1995 to 2009.



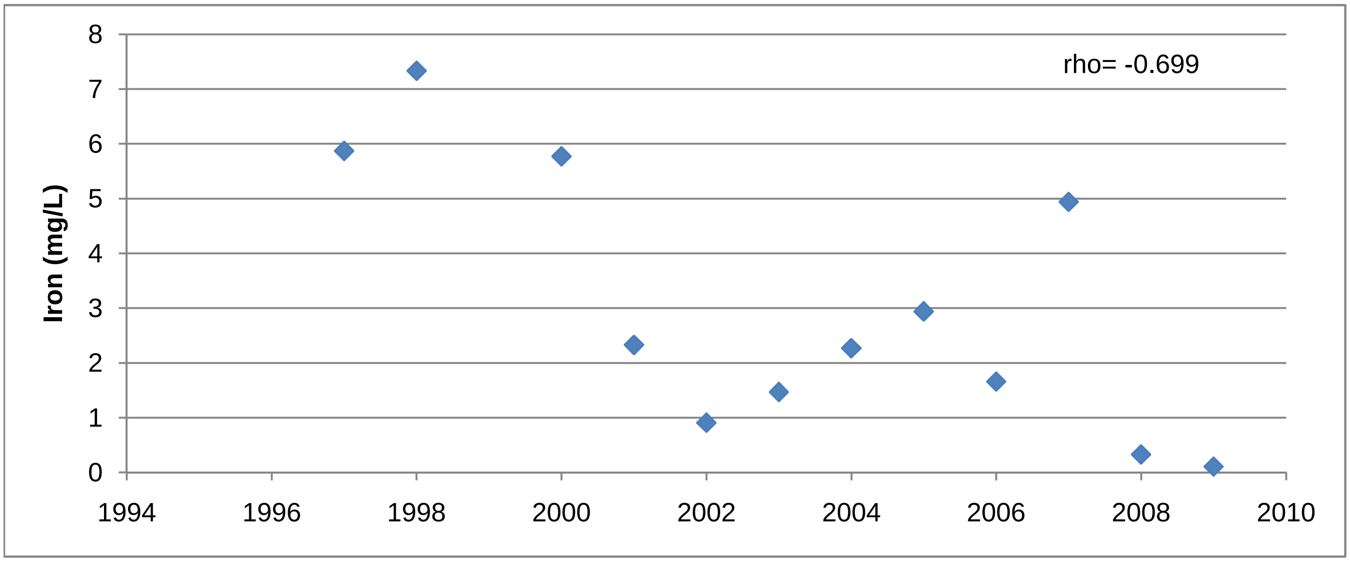
Appendix Figure C.7.20: Significant trends observed for iron at station 95N4-B, 1995 to 2009.



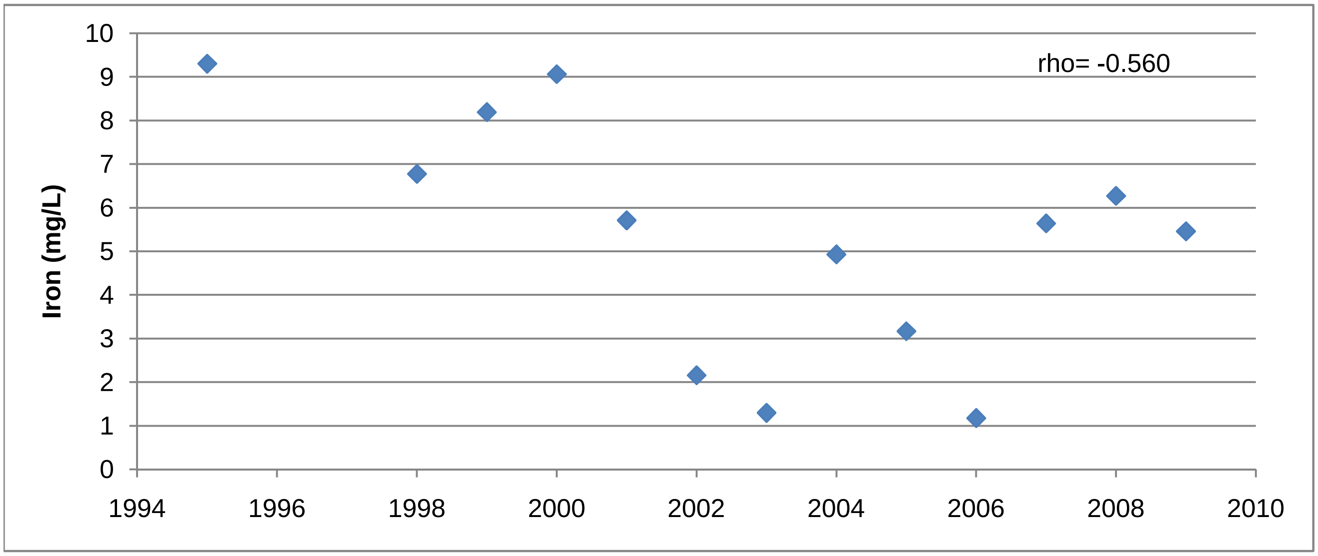
Appendix Figure C.7.21: Significant trends observed for pH at station 95N7-A, 1995 to 2009.



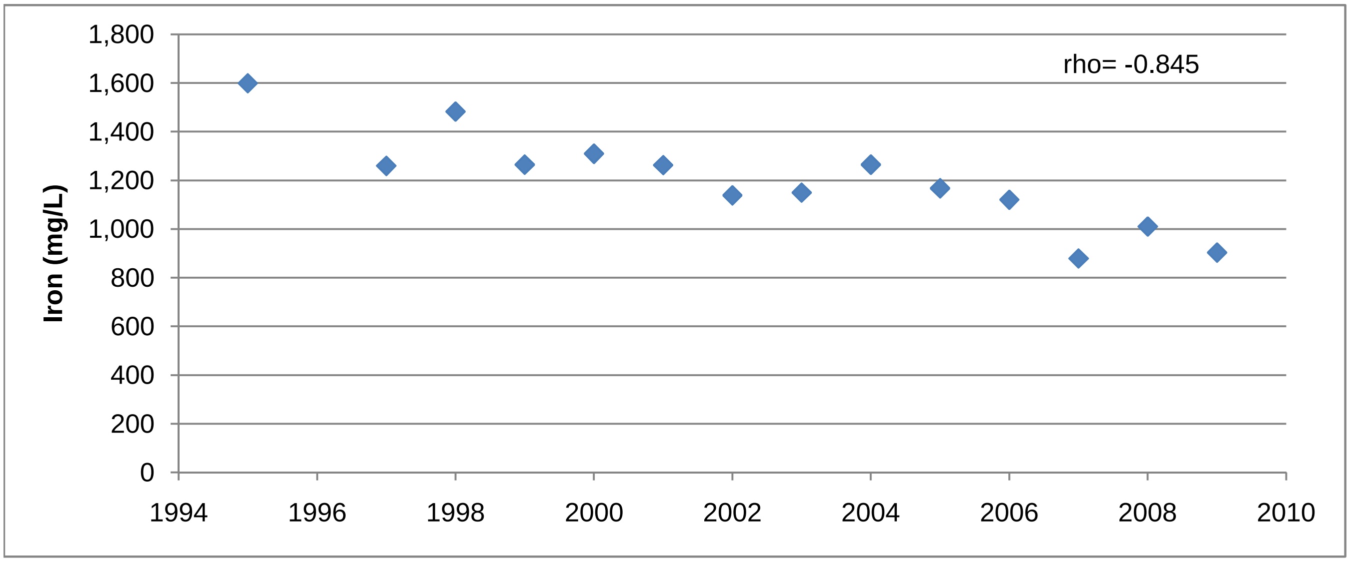
Appendix Figure C.7.22: Significant trends observed for pH at station 95N7-B, 1995 to 2009.



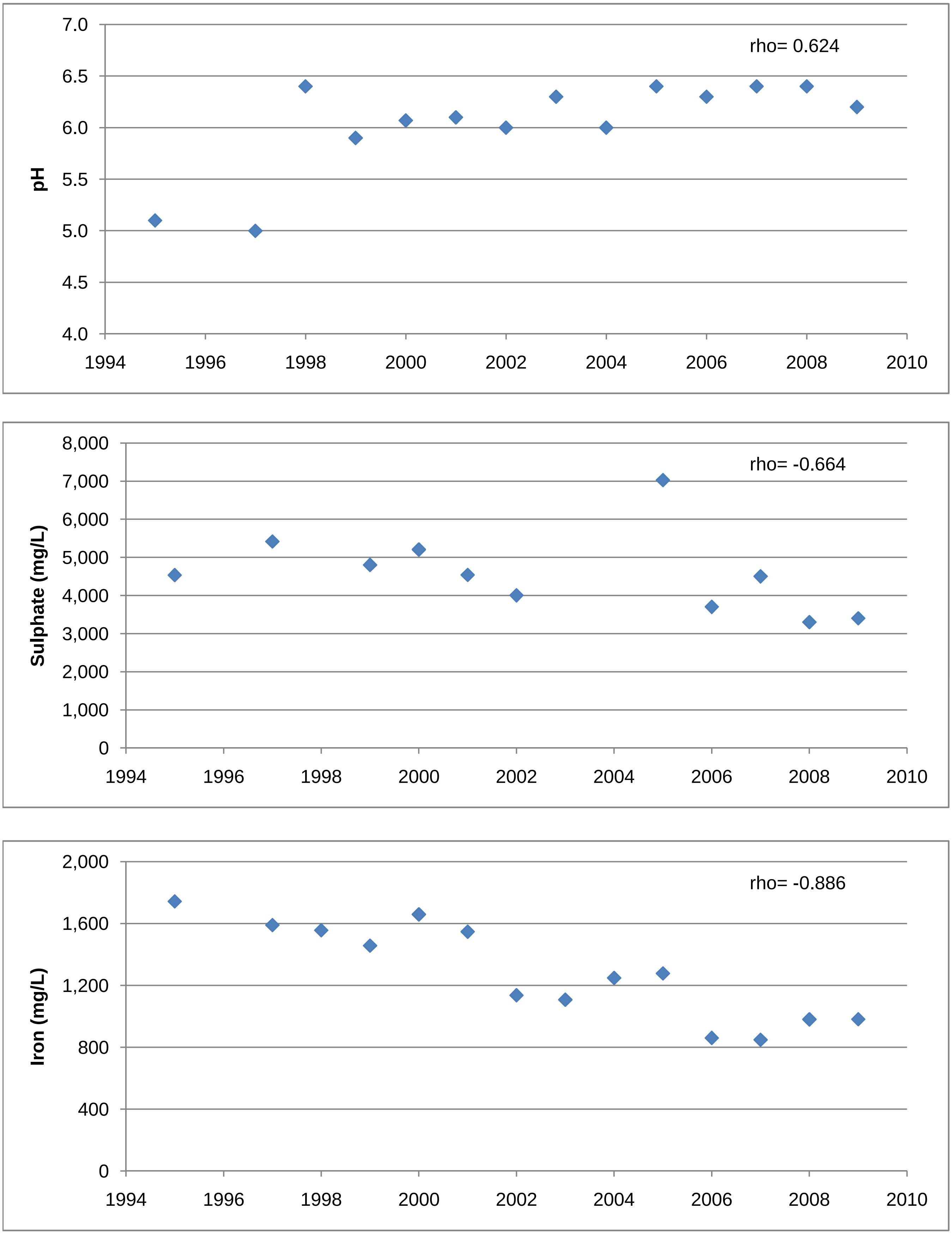
Appendix Figure C.7.23: Significant trends observed for iron at station 95N11, 1995 to 2009.



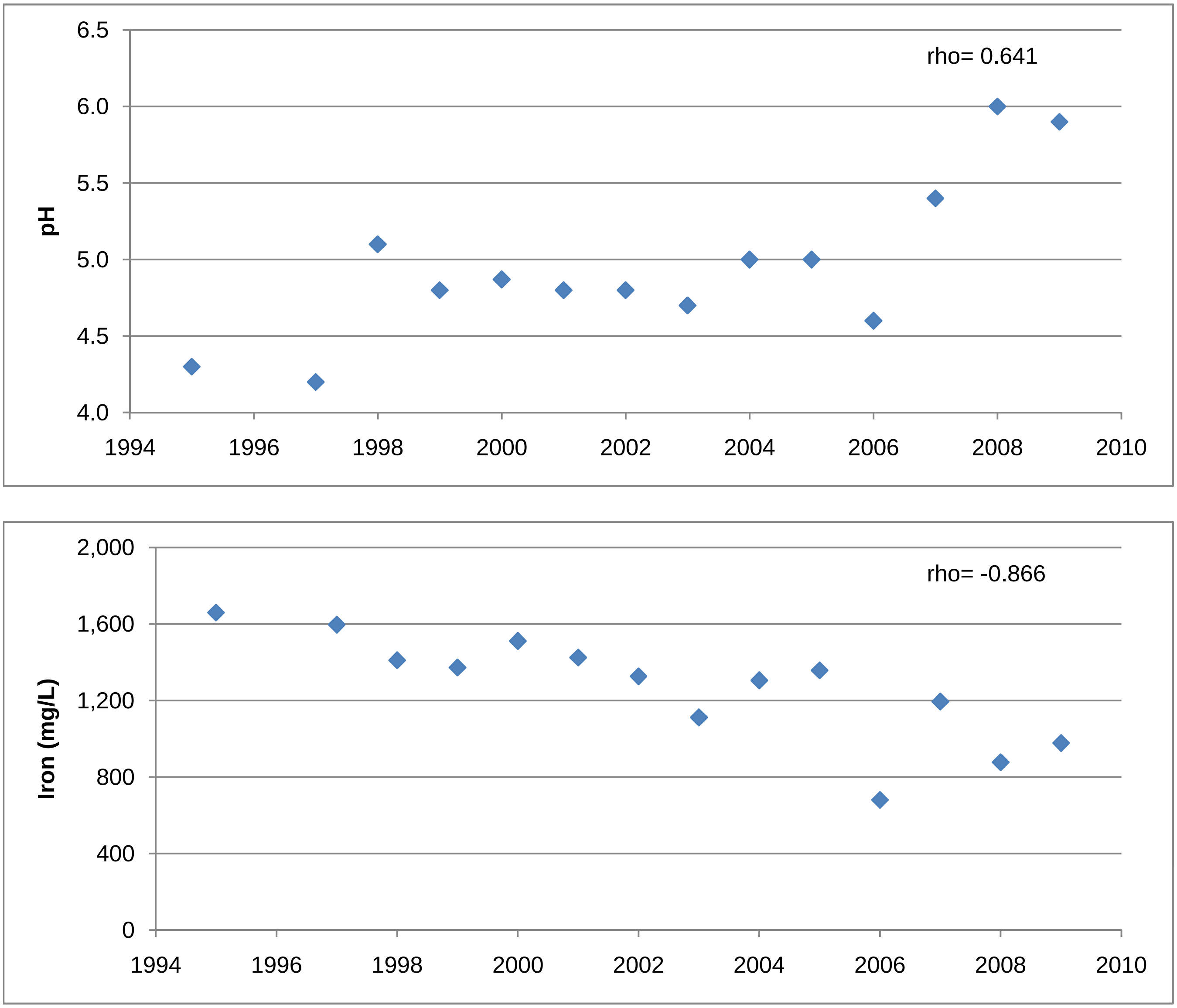
Appendix Figure C.7.24: Significant trends observed for iron at station 95N12-B, 1995 to 2009.



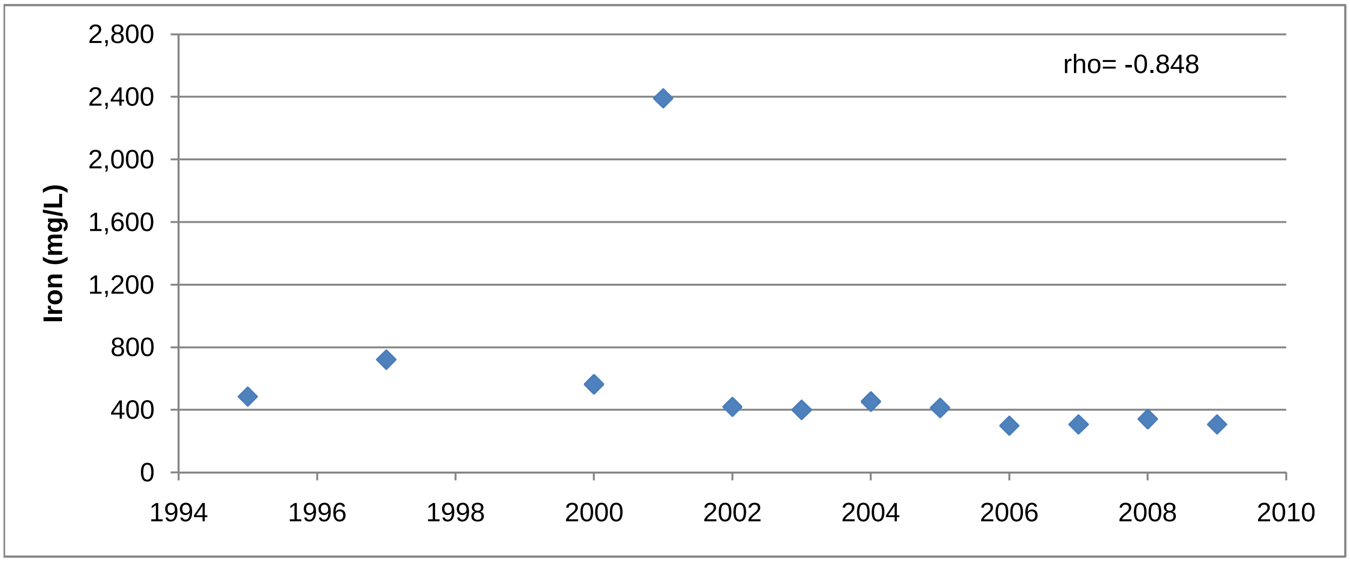
Appendix Figure C.7.25: Significant trends observed for iron at station 95N13-A, 1995 to 2009.



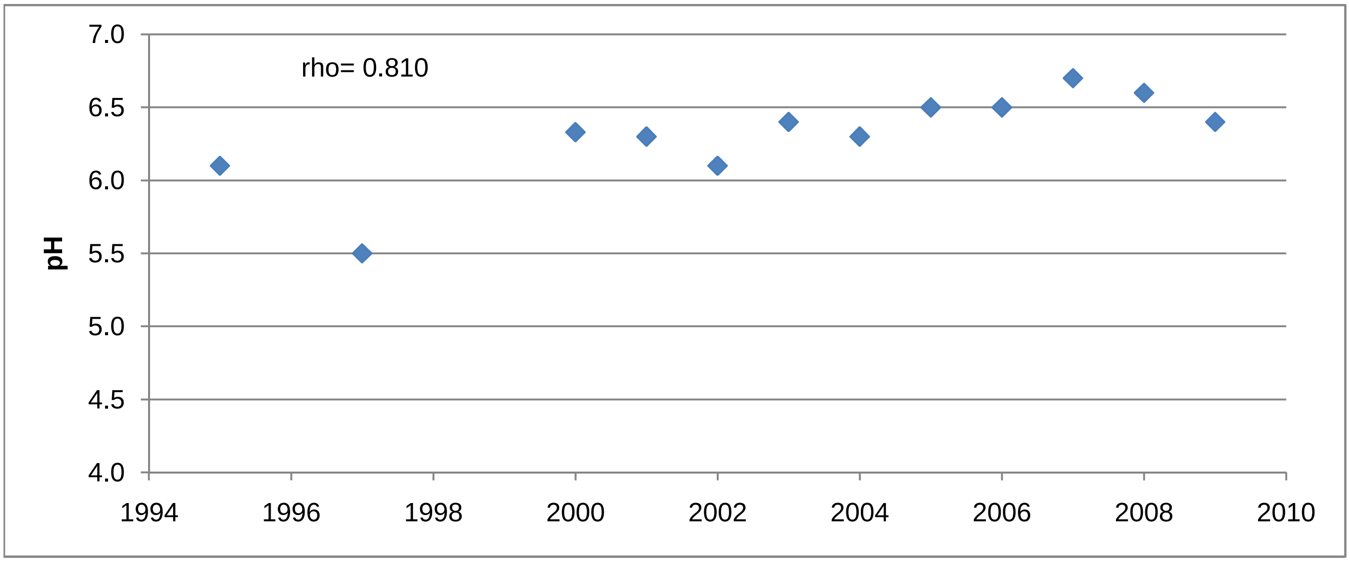
Appendix Figure C.7.26: Significant trends observed for pH, sulphate and iron at station 95N13-C, 1995 to 2009.

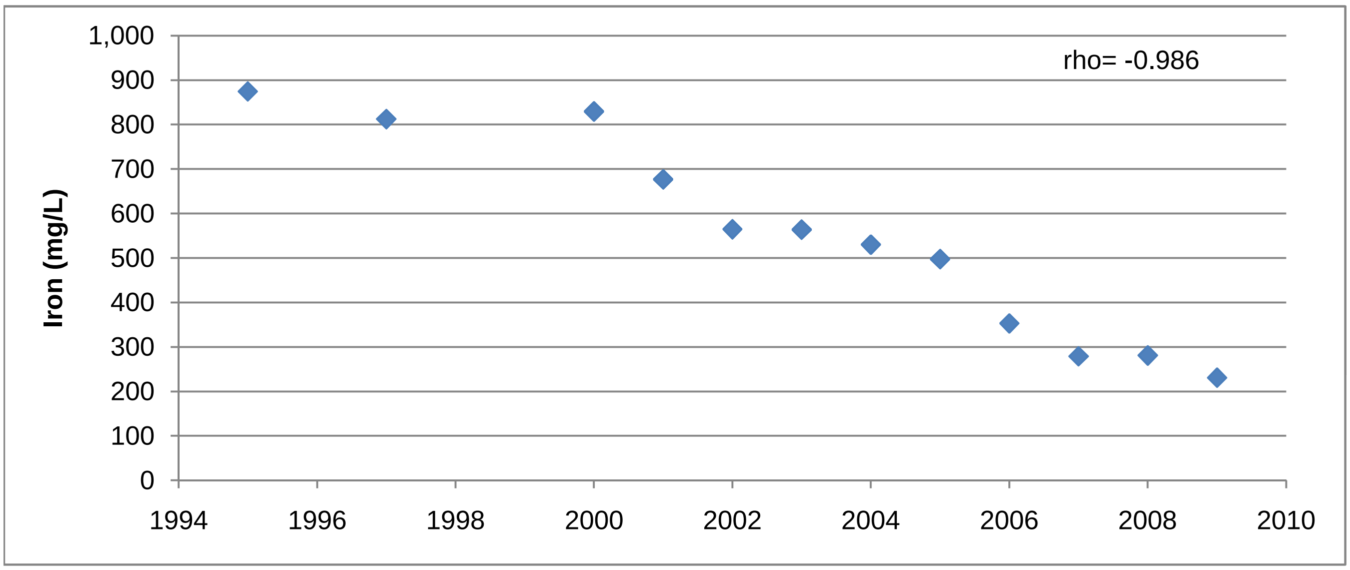


Appendix Figure C.7.27: Significant trends observed for pH and iron at station 95N13-E, 1995 to 2009.

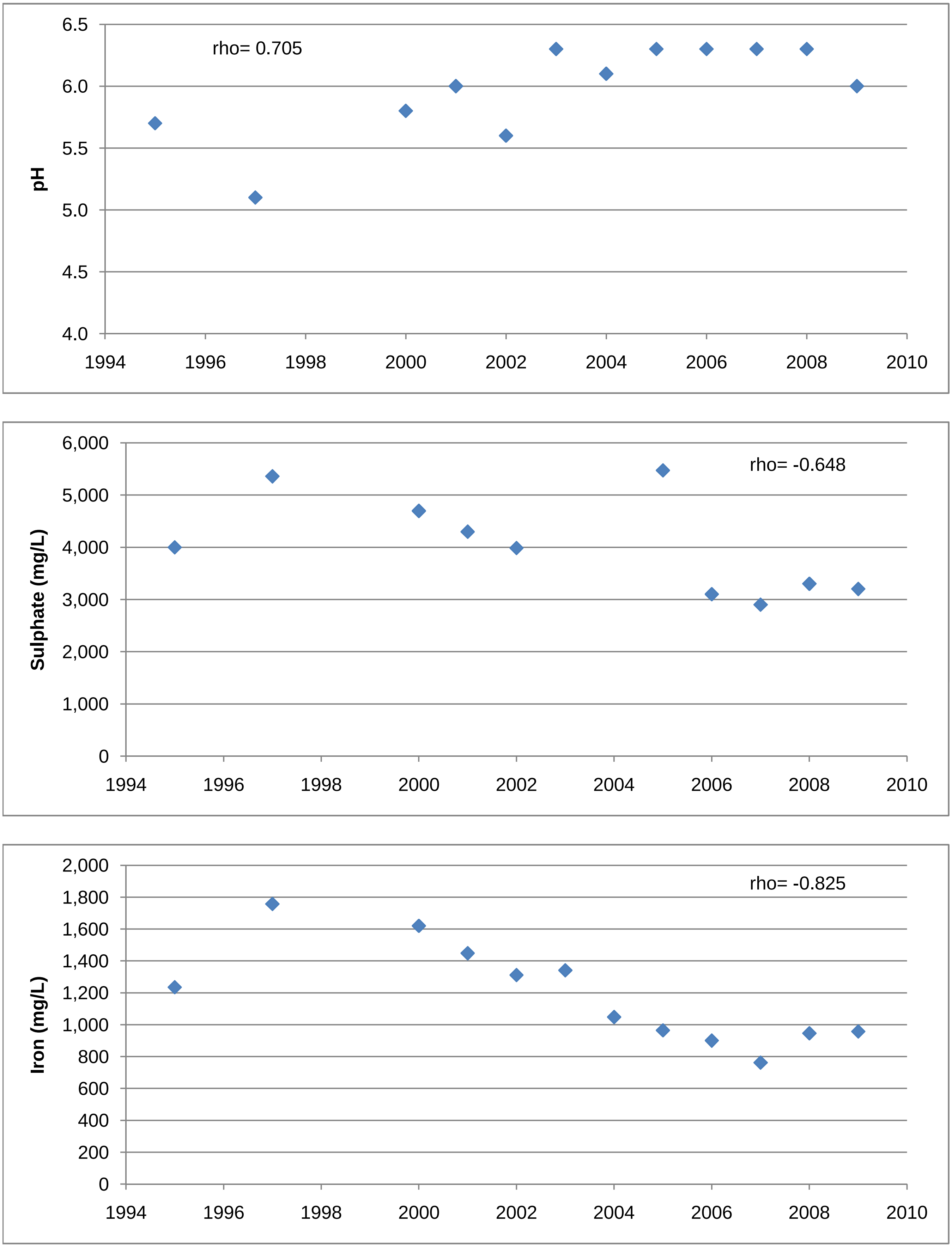


Appendix Figure C.7.28: Significant trends observed for iron at station 95N16-A, 1995 to 2009.

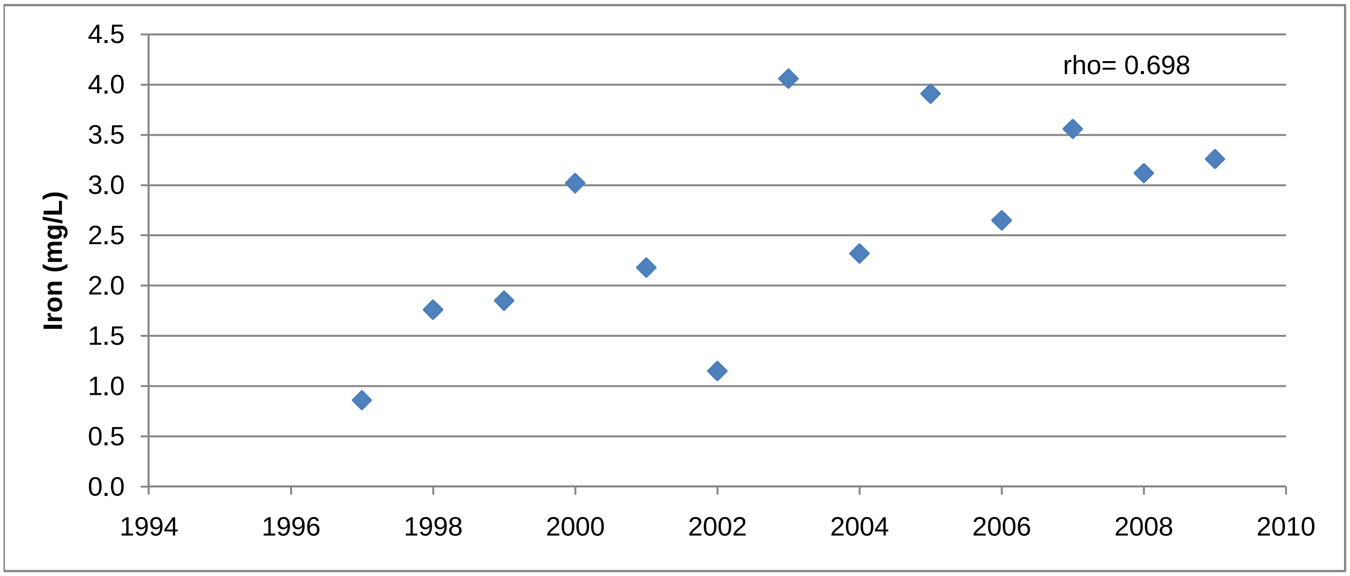




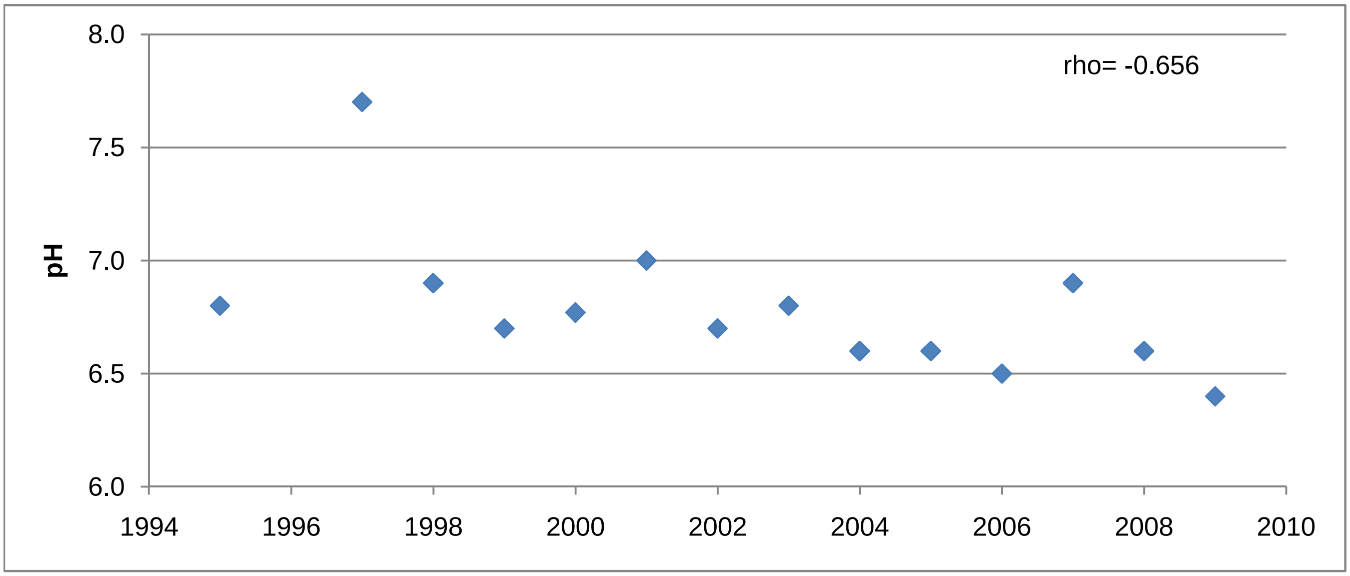
Appendix Figure C.7.29: Significant trends observed for pH and iron at station 95N16-C, 1995 to 2009.



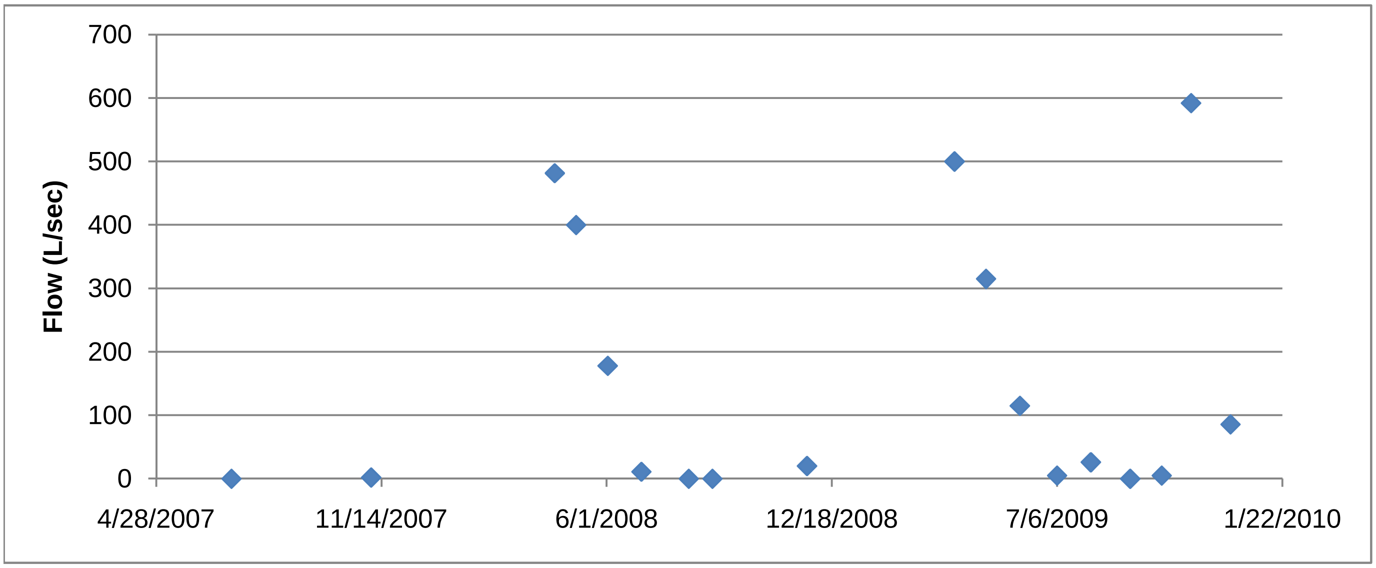
Appendix Figure C.7.30: Significant trends observed for pH, sulphate and iron at station 95N16-E, 1995 to 2009.



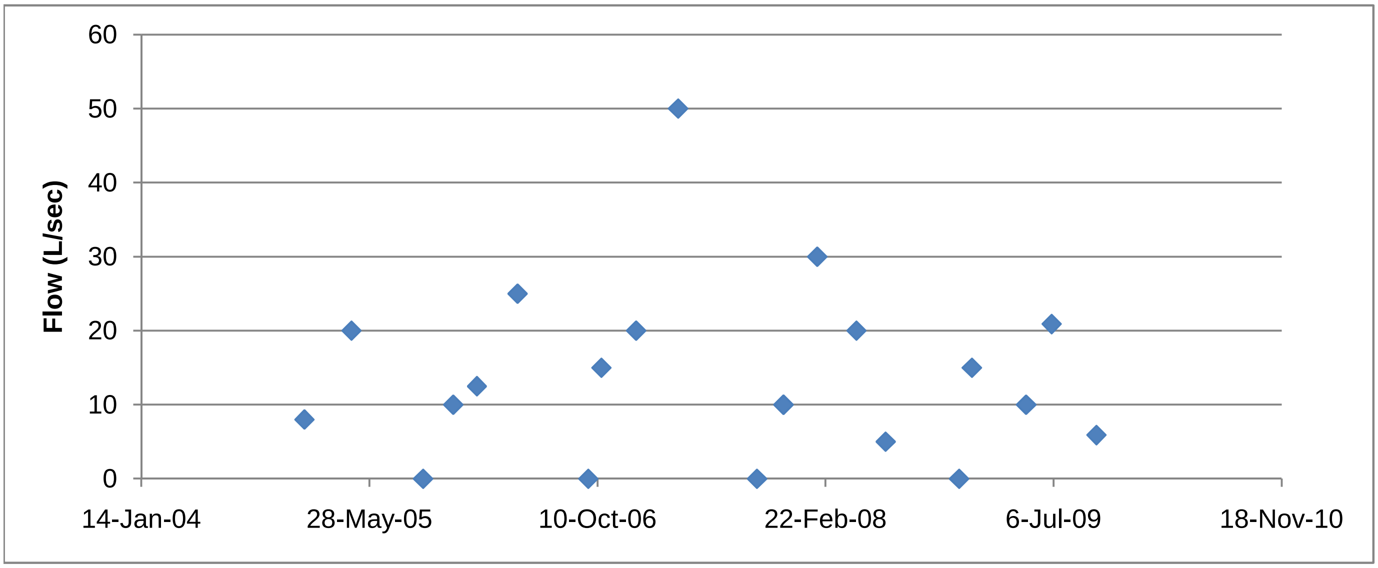
Appendix Figure C.7.31: Significant trends observed for iron at station 95N17-A, 1997 to 2009.



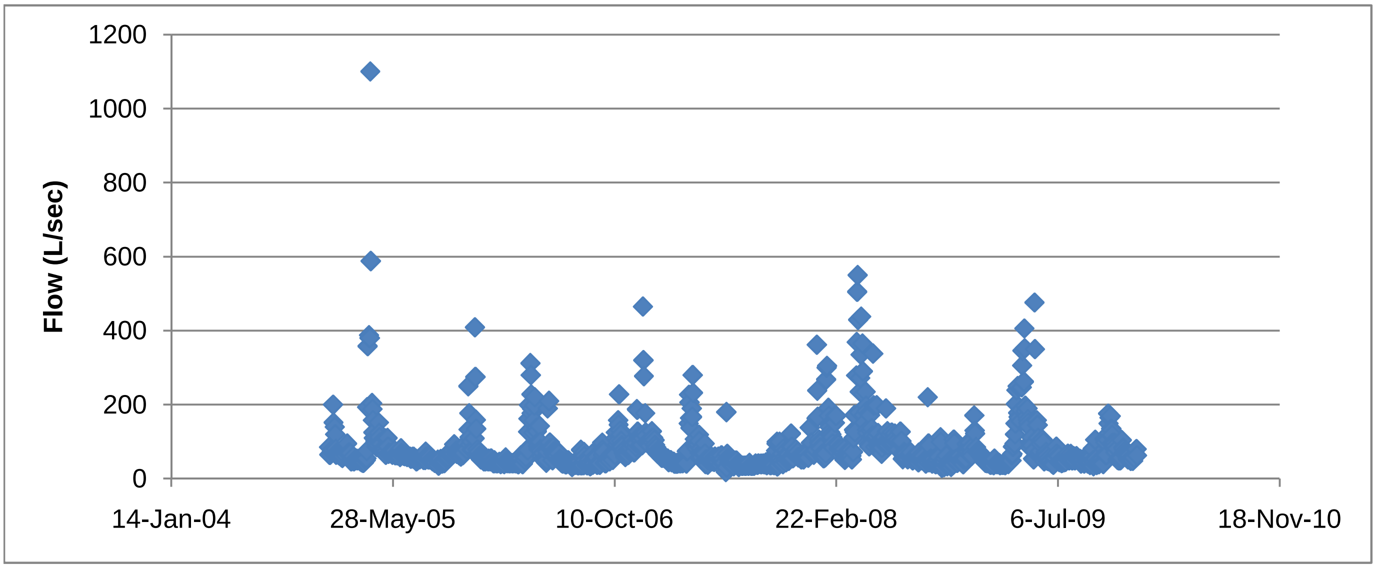
Appendix Figure C.7.32: Significant trends observed for pH at station 95N17-C, 1995 to 2009.



Appendix Figure C.7.33: Flows at station ECA-131 from 2007 to 2009.



Appendix Figure C.7.34: Flows at station L-03 from 2005 to 2009.



Appendix Figure C.7.35: Flows at station N-17 from 2005 to 2009.

APPENDIX C.8
Pronto TMA

Appendix Table C.8.1: Pronto final point of control (PR-04) discharge criteria.

Parameter[d]	Units	Discharge Criteria		Action Level	Internal Investigation
		Grab Sample[a]	Monthly Mean[b]		
pH	pH units	6.0-9.5		<6.5 or >9.0	<7.0 or >8.5
Dissolved Radium-226 [c]	Bq/L	1.10	0.37	0.37	0.20
Iron	mg/L	-	1.0	1.00	0.50
Total Suspended Solids	mg/L	-	15	10	7.5

[a] Samples to be collected during periods of discharge.
[b] Arithmetic mean of all grab samples collected within a given month.
[c] Discharge criteria are for dissolved radium-226, Action level and Internal Investigation based on total Radium-226. Measured and reported values are for total radium-226.
[d] Copper, lead, nickel and zinc monitoring discontinued in January 2010 as per regulatory approval of Cycle 3 design

Appendix Table C.8.2: Water quality at station PR-02, 2005 to 2009.

Date	Acidity (mg/L)	Ba (mg/L)	Co (mg/L)	Fe (mg/L)	Mn (mg/L)	pH	Ra-226 (Bq/L)	Sulphate (mg/L)	U (mg/L)
3/16/2005	171	0.00025	0.00015	8.95	0.0002	3	0.21	608	0.046
4/6/2005	137	0.0229	0.0666	4.54	0.278	3.4	0.17	271	0.027
10/26/2005	129	0.0216	0.124	6.49	0.635	3.1	0.36	1097	0.105
1/11/2006	85	0.031	0.289	12	0.799	3	0.24	470	0.0754
3/29/2006							0.24		
4/5/2006	45	0.0317	0.269	14.3	0.663	3.5	0.18	400	0.0457
5/3/2006							0.17		
7/13/2006	72	0.0293	0.204	5.56	0.613	2.8	0.18	430	0.0524
8/2/2006							0.19		
11/8/2006	59	0.028	0.139	7.99	0.5	2.9	0.22	340	0.0503
1/10/2007	50	0.026	0.1240	10.5	0.403	3.1	0.160	310.0	0.0371
4/4/2007	40	0.035	0.1300	16	0.485	3.4	0.210	330.0	0.0369
7/11/2007	76	0.033	0.1540	6.51	0.708	2.9	0.280	500.0	0.0635
11/28/2007							0.310		
12/5/2007	91	0.028	0.3160	12.1	0.814	3	0.260	490.0	0.0756
1/16/2008	89	0.028	0.3210	13.8	0.721	3.2	0.250	470.0	0.0685
2/6/2008							0.170		
4/9/2008	48	0.029	0.2080	11.8	0.438	3.1	0.180	290.0	0.0361
5/7/2008							0.140		
6/4/2008							0.160		
12/10/2008	96	0.031	0.2350	12.6	0.765	3	0.330	540.0	0.0801
1/15/2009	86	0.033	0.2260	18.7	0.751	3	0.320	510.0	0.0759
2/4/2009							0.240		
3/25/2009							0.340		
4/1/2009	70	0.031	0.2540	17	0.456	3.8	0.190	330.0	0.0431
5/6/2009							0.130		
11/18/2009	61	0.030	0.1490	9.070	0.615	3.1	0.240	380.0	0.0407
12/2/2009							0.250		
Number	17	17	17	17	17	17	28	17	17
Minimum	40	0.00025	0.00015	4.54	0.0002	2.8	0.13	271	0.027
Maximum	171	0.035	0.321	18.7	0.814	3.8	0.36	1097	0.105
Mean	83	0.02757	0.1888	11.05	0.567	3.1	0.226	456.8	0.0564
Median	76	0.02930	0.2040	11.80	0.615	3.1	0.215	430.0	0.0503
10th Perc.	46.8	0.02238	0.1010	6.12	0.353	2.9	0.160	302.0	0.0366

(Shaded cell) Concentration below maximum MDL.

Appendix Table C.8.3: Water quality at station PR-03, 2005 to 2009.

Date	pH	Date	pH	Date	pH	Date	pH
3/10/2005	8.2	8/1/2006	9.3	1/22/2008	8.3	1/30/2009	8.6
3/11/2005	8.2	8/2/2006	9.3	1/23/2008	8.3	2/2/2009	8.4
3/14/2005	8	8/3/2006	9.1	1/24/2008	8.3	2/3/2009	8.4
3/15/2005	8.4	8/4/2006	9.3	1/25/2008	8.5	2/4/2009	8.5
3/16/2005	8.4	11/2/2006	9.2	1/28/2008	8.6	2/5/2009	8.5
3/17/2005	8.3	11/3/2006	9.2	1/29/2008	8.5	2/6/2009	8.5
3/18/2005	8.3	11/6/2006	9	1/30/2008	8.5	2/9/2009	8.4
3/21/2005	8.3	11/7/2006	9.1	1/31/2008	8.5	2/10/2009	8.5
3/22/2005	8.3	11/8/2006	9.3	2/1/2008	8.4	2/11/2009	8.1
3/23/2005	8.4	11/9/2006	9	2/4/2008	8.5	2/12/2009	8.2
3/24/2005	8.4	11/10/2006	9	2/5/2008	8.5	2/13/2009	8.2
3/28/2005	8.6	11/13/2006	9	2/6/2008	8.4	3/23/2009	8.2
3/29/2005	8.7	11/14/2006	9	2/7/2008	8.5	3/24/2009	8.0
3/30/2005	8.6	11/15/2006	9.2	2/8/2008	8.5	3/25/2009	8.3
3/31/2005	8.6	11/16/2006	9.3	2/11/2008	8.6	3/26/2009	8.4
4/1/2005	7.6	11/17/2006	9.2	2/12/2008	8.6	3/27/2009	8.5
4/4/2005	8.8	11/20/2006	9.3	2/13/2008	8.6	3/30/2009	8.8
4/5/2005	8.8	11/21/2006	9.3	2/14/2008	8.6	3/31/2009	8.6
4/6/2005	8.6	11/22/2006	9.4	2/15/2008	8.6	4/1/2009	8.3
4/7/2005	8.5	11/23/2006	9.4	2/19/2008	8.4	4/2/2009	8.2
4/8/2005	8.6	11/24/2006	9	2/20/2008	8.5	4/3/2009	8.2
4/11/2005	8.8	11/27/2006	9	2/21/2008	8.6	4/6/2009	8.4
4/12/2005	8.8	11/28/2006	9	2/22/2008	8.6	4/7/2009	8.3
4/13/2005	8.8	11/29/2006	9	2/25/2008	8.8	4/8/2009	8.4
4/14/2005	8.8	1/2/2007	8.3	2/26/2008	8.8	4/9/2009	8.3
4/15/2005	8.8	1/3/2007	8.3	2/27/2008	8.8	4/13/2009	8.4
4/18/2005	9.3	1/4/2007	8.6	2/28/2008	8.8	4/14/2009	8.4
4/19/2005	9	1/5/2007	8.7	4/3/2008	8.0	4/15/2009	8.5
4/20/2005	8.6	1/8/2007	8.7	4/4/2008	8.8	4/16/2009	8.6
4/21/2005	8.8	1/9/2007	9.0	4/7/2008	8.6	4/17/2009	8.6
10/20/2005	8.8	1/10/2007	8.8	4/8/2008	8.6	4/20/2009	8.4
10/21/2005	8.8	1/11/2007	8.6	4/9/2008	8.3	4/21/2009	8.4
10/24/2005	8.8	1/12/2007	8.9	4/10/2008	8.1	4/22/2009	8.4
10/25/2005	8.9	1/15/2007	8.8	4/11/2008	8.4	4/23/2009	8.6
10/26/2005	8.9	1/16/2007	8.7	4/14/2008	8.5	4/24/2009	8.0
10/27/2005	8.3	1/17/2007	8.6	4/15/2008	8.5	4/27/2009	8.5
10/28/2005	8.9	1/18/2007	8.7	4/16/2008	8.5	4/28/2009	8.8
1/4/2006	8.5	1/19/2007	8.6	4/17/2008	8.8	4/29/2009	9.1
1/5/2006	8.3	1/22/2007	8.6	4/18/2008	8.6	4/30/2009	9.0
1/6/2006	8.4	1/23/2007	8.6	4/21/2008	8.4	5/1/2009	9.2
1/9/2006	8.4	1/24/2007	8.6	4/22/2008	8.4	5/4/2009	9.0
1/10/2006	8.4	1/25/2007	8.6	4/23/2008	8.6	5/5/2009	9.0
1/11/2006	8.4	1/26/2007	8.6	4/24/2008	9.1	5/6/2009	9.0

Appendix Table C.8.3: Water quality at station PR-03, 2005 to 2009.

Date	pH	Date	pH	Date	pH	Date	pH
1/12/2006	8.4	1/29/2007	8.6	4/25/2008	9.6	5/7/2009	9.2
1/13/2006	8.4	4/2/2007	7.8	4/28/2008	9.1	5/8/2009	9.0
1/16/2006	8.3	4/3/2007	8.1	4/29/2008	8.6	5/11/2009	9.0
1/17/2006	8.3	4/4/2007	8.3	4/30/2008	8.6	5/12/2009	9.2
1/18/2006	8.3	4/5/2007	8.4	5/1/2008	8.6	5/13/2009	9.2
1/19/2006	8.3	4/9/2007	8.4	5/2/2008	8.6	5/14/2009	9.2
1/20/2006	8.3	4/10/2007	8.5	5/5/2008	8.8	5/15/2009	9.3
1/23/2006	8.3	4/11/2007	8.5	5/6/2008	9.0	5/19/2009	9.3
1/24/2006	8.4	4/12/2007	8.5	5/7/2008	9.1	5/20/2009	9.3
1/25/2006	8.4	4/13/2007	8.5	5/8/2008	9.0	5/21/2009	9.2
1/26/2006	8.4	4/16/2007	10.1	5/9/2008	9.1	5/22/2009	9.2
3/27/2006	8.2	4/17/2007	9.0	5/12/2008	9.0	5/25/2009	9.3
3/28/2006	8	4/18/2007	9.0	5/13/2008	9.2	5/26/2009	9.5
3/29/2006	8.2	4/19/2007	9.0	5/14/2008	9.2	5/27/2009	9.0
3/30/2006	8.4	4/20/2007	9.2	5/15/2008	9.2	5/28/2009	9.2
3/31/2006	8.2	4/23/2007	9.2	5/16/2008	9.2	11/4/2009	8.9
4/3/2006	8.1	4/24/2007	9.0	5/20/2008	9.2	11/5/2009	8.7
4/4/2006	8.1	4/25/2007	9.1	5/21/2008	9.2	11/6/2009	8.7
4/5/2006	8.3	4/26/2007	9.0	5/22/2008	9.2	11/9/2009	8.7
4/6/2006	8.2	4/27/2007	9.0	5/23/2008	9.4	11/10/2009	8.8
4/7/2006	8.3	7/4/2007	8.5	5/26/2008	9.2	11/11/2009	8.8
4/10/2006	8.3	7/5/2007	8.6	5/27/2008	9.5	11/12/2009	8.8
4/11/2006	8.4	7/6/2007	8.4	5/28/2008	9.4	11/13/2009	8.8
4/12/2006	8.4	7/9/2007	8.7	5/29/2008	9.5	11/16/2009	8.8
4/13/2006	8.4	7/10/2007	9.2	5/30/2008	9.5	11/17/2009	8.7
4/17/2006	8.6	7/11/2007	9.2	6/2/2008	9.6	11/18/2009	8.8
4/18/2006	8.6	7/12/2007	8.6	6/3/2008	9.5	11/19/2009	8.8
4/19/2006	8.6	7/13/2007	8.6	6/4/2008	9.6	11/20/2009	8.8
4/20/2006	8.6	7/16/2007	9.2	6/5/2008	9.5	11/23/2009	8.8
4/21/2006	8.6	7/17/2007	9.3	6/6/2008	9.6	11/24/2009	9.0
4/24/2006	8.2	7/18/2007	9.5	6/9/2008	9.8	11/25/2009	8.8
4/25/2006	8.4	7/19/2007	9.5	6/10/2008	10.0	11/26/2009	8.8
4/26/2006	8.2	11/26/2007	8.6	6/11/2008	10.0	11/27/2009	9.1
4/27/2006	8.4	11/27/2007	8.6	12/2/2008	8.8	11/30/2009	8.6
4/28/2006	8.6	11/28/2007	8.5	12/3/2008	8.8	12/1/2009	9.0
5/1/2006	8.6	11/29/2007	8.5	12/4/2008	8.8	12/2/2009	8.8
5/2/2006	8.6	11/30/2007	8.5	12/5/2008	9.1	12/3/2009	8.8
5/3/2006	8.3	12/3/2007	8.5	12/8/2008	8.8	12/4/2009	8.7
5/4/2006	8.6	12/4/2007	8.5	12/9/2008	8.5	12/7/2009	9.2
5/5/2006	8.8	12/5/2007	8.6	12/10/2008	9.2	12/8/2009	9.0
7/11/2006	8.6	12/6/2007	8.5	12/11/2008	9.2	12/9/2009	9.0
7/12/2006	8.6	12/7/2007	8.3	12/12/2008	9.3	12/10/2009	9.0
7/13/2006	8.6	12/10/2007	8.3	1/13/2009	8.5	12/11/2009	9.1

Appendix Table C.8.3: Water quality at station PR-03, 2005 to 2009.

Date	pH	Date	pH	Date	pH	Date	pH
7/14/2006	8.8	12/11/2007	8.3	1/14/2009	8.9	12/14/2009	9.0
7/17/2006	8.8	12/12/2007	8.3	1/15/2009	8.9	12/15/2009	9.0
7/18/2006	8.9	12/13/2007	8.3	1/16/2009	8.8	12/16/2009	9.0
7/19/2006	9	1/9/2008	8.3	1/19/2009	8.6	12/17/2009	9.0
7/20/2006	8.8	1/10/2008	8.3	1/20/2009	8.6	**Number**	384
7/21/2006	8.8	1/11/2008	8.5	1/21/2009	8.5	**Minimum**	7.6
7/24/2006	9	1/14/2008	8.5	1/22/2009	8.7	**Maximum**	10.1
7/25/2006	9.2	1/15/2008	8.5	1/23/2009	8.7	**Mean**	8.7
7/26/2006	9.2	1/16/2008	8.5	1/26/2009	8.7	**Median**	8.6
7/27/2006	9.3	1/17/2008	8.5	1/27/2009	8.8	**10th Perc**	8.3
7/28/2006	9.4	1/18/2008	8.5	1/28/2009	8.5		
7/31/2006	9.2	1/21/2008	8.5	1/29/2009	8.6		

Appendix Table C.8.4: Water quality at station PR-04, 2005 to 2009.

Date	Ba (mg/L)	Co (mg/L)	Fe (mg/L)	Mn (mg/L)	pH[a]	Ra-226 (Bq/L)	Sulphate (mg/L)	TSS (mg/L)	U (mg/L)
3/16/2005					8.2	0.11		1	
3/23/2005					8.2	0.13		1	
3/30/2005					8.1	0.13		1	
4/6/2005	0.135	0.0184	0.679	0.177	8.1	0.086		0.5	0.016
4/13/2005					8.2	0.047		0.5	
4/20/2005					8	0.079		0.5	
10/26/2005	0.0914	0.028	0.226	0.373	7.8	0.14	680	0.5	0.014
1/11/2006	0.089	0.0945	0.63	0.526	8.1	0.14	480		0.0232
1/18/2006					8.1	0.059		3	
1/25/2006					8.1	0.15		3	
3/29/2006	0.095	0.0681	0.46	0.468	7.6	0.14		2	0.036
4/5/2006	0.0509	0.0663	0.48	0.418	7.8	0.13	400	1	0.026
4/12/2006					8.1	0.071		2	
4/19/2006					8.2	0.083		1	
4/26/2006					8	0.081		1	
5/3/2006	0.119	0.0239	0.44	0.202	7.8	0.11	340	1	0.00396
7/13/2006	0.0329	0.00872	0.08	0.0652	8.2	0.042	340	5	0.0136
7/19/2006					8	0.1		1	
7/26/2006					8.3	0.14		1	
8/2/2006	0.0721	0.00512	0.08	0.0775	8.5	0.13	420	0.5	0.00508
11/8/2006	0.045	0.0247	0.26	0.231	8.2	0.1		1	0.0168
11/15/2006					8.2	0.11		0.5	
11/22/2006					8.4	0.13		1	
11/29/2006					8	0.1		0.5	
1/3/2007					7.3	0.074		1	
1/10/2007	0.112	0.0223	0.45	0.208	8.3	0.086	270.0	1	0.0115
1/17/2007					8.4	0.110		1	
1/24/2007					8.3	0.110		2	
4/4/2007	0.029	0.0254	0.46	0.246	7.5	0.090	270.0	2	0.0244
4/11/2007					8.3	0.0025		2	
4/18/2007					8.0	0.074		0.5	
4/25/2007					8.4	0.081		1	
7/11/2007	0.024	0.0292	0.12	0.295	8.2	0.150	450.0	0.5	0.0125
7/18/2007					8.2	0.120		0.5	
11/28/2007					7.8	0.047		1	
12/5/2007	0.022	0.0525	0.43	0.380	8.3	0.160	480.0	2	0.0117
12/12/2007					8.3	0.150		0.5	
1/10/2008					7.9	0.014		0.5	
1/16/2008	0.024	0.0676	0.36	0.410	8.3	0.150	470.0	0.5	0.0196
1/23/2008					8.3	0.150		2	
1/31/2008					8.2[a]	0.030		0.5	
2/6/2008	0.019	0.0518	0.64	0.186	8.3	0.084	270.0	1	0.0127
2/13/2008					8.2	0.082		2	
2/20/2008					8.3	0.081		1	
2/27/2008					8.3	0.064		1	
4/9/2008	0.029	0.0324	0.54	0.142	7.6	0.068	270.0	1	0.0178
4/16/2008					8.3	0.059		2	
4/23/2008					8.1	0.059		2	
4/30/2008					8.3	0.058		0.5	
5/7/2008	0.021	0.0366	0.26	0.198	7.8	0.075	300.0	1	0.005
5/14/2008					7.5	0.074		1	
5/21/2008					8.3	0.084		1	
5/28/2008					8.2	0.097		1	
6/4/2008	0.023	0.0184	0.21	0.150	8.2	0.092	330.0	1	0.0031
6/11/2008					8.3	0.093		1	
12/10/2008	0.025	0.0482	0.44	0.395	7.9	0.150	540.0	2	0.019
1/15/2009	0.033	0.0297	0.13	0.302	7.6	0.130	470.0	0.5	0.0222
1/21/2009					8.2	0.190		1	
1/28/2009					8.3	0.160		2	
2/4/2009	0.023	0.0698	0.58	0.370	8.3	0.140	430.0	2	0.0188
2/11/2009					8.2	0.120		2	
3/25/2009	0.027	0.0417	0.37	0.322	7.5	0.120	360.0	1	0.0269

Appendix Table C.8.4: Water quality at station PR-04, 2005 to 2009.

Date	Ba (mg/L)	Co (mg/L)	Fe (mg/L)	Mn (mg/L)	pH[a]	Ra-226 (Bq/L)	Sulphate (mg/L)	TSS (mg/L)	U (mg/L)
4/1/2009	0.022	0.0524	0.54	0.244	8.2	0.100	330.0	1	0.0194
4/8/2009					8.2	0.080		1	
4/15/2009					8.2	0.053		2	
4/22/2009					7.8	0.061		2	
4/29/2009					8.0	0.085		1	
5/6/2009	0.027	0.0288	1.8	0.142	8.1	0.082	290.0	3	0.0084
5/13/2009			0.16		8.2	0.076		1	
5/20/2009			0.15		8.1	0.075		1	
5/27/2009			0.08		8.3	0.084		0.5	
11/5/2009					8.0	0.034		1	
11/11/2009					8.3	0.150		1	
11/18/2009	0.026	0.0335	0.3	0.344	8.0	0.130	380.0	0.5	0.0086
11/25/2009					8.2	0.150		1	
12/2/2009	0.026	0.0130	0.18	0.198	8.2	0.150	370.0	1	0.0057
12/9/2009					8.2	0.120		0.5	
12/16/2009					8.2	0.150		0.5	
Number	26	26	29	26	366	78	23	77	26
Minimum	0.019	0.00512	0.08	0.0652	7.2	0.0025	270	0.5	0.0031
Maximum	0.135	0.0945	1.8	0.526	8.9	0.19	680	5	0.036
Mean	0.048	0.0381	0.40	0.272	8.1	0.100	389	1.2	0.0155
Median	0.028	0.0311	0.37	0.245	8.2	0.095	370	1.0	0.0150
10th Perc.	0.022	0.0157	0.11	0.142	7.8	0.057	270	0.5	0.00504

[a] pH measures shown only for dates when other substances were measured but summary statistics reflect all measured values.

(shaded) Concentration below maximum MDL.

Appendix Table C.8.5: Summary of seasonal trends for station PR-02, 2003 - 2009.

Season	Spearman rho	Acidity	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium
January	Correlation Coefficient							-0.1		
	Sig. (2-tailed)							0.872888572		
	N							5		
January/March	Correlation Coefficient	-0.21429	0.428571	0.214286	0.214	-0.107142857	0.33541		-0.10811	0.428571
	Sig. (2-tailed)	0.644512	0.337368	0.644512	0.645	0.819150856	0.581091		0.817533	0.337368
	N	7	7	7	7	7	5		7	7
February/March	Correlation Coefficient							0.257142857		
	Sig. (2-tailed)							0.622787172		
	N							6		
April	Correlation Coefficient	-0.64286	0.678571	0.5	0.571	0.571428571	-0.11119	0.854686737	0.43245	0.642857
	Sig. (2-tailed)	0.119392	0.09375	0.25317	0.18	0.180201989	0.812407	0.014273916	0.332527	0.119392
	N	7	7	7	7	7	7	7	7	7
May/June	Correlation Coefficient							-0.4		
	Sig. (2-tailed)							0.504631575		
	N							5		
October/November	Correlation Coefficient							0.371428571		
	Sig. (2-tailed)							0.468478134		
	N							6		
October/November/ December	Correlation Coefficient	-0.46429	0.234244	0.428571	0.429	0.178571429	0.679156		-0.60714	-0.17857
	Sig. (2-tailed)	0.293934	0.613155	0.337368	0.337	0.701657943	0.093357		0.148231	0.701658
	N	7	7	7	7	7	7		7	7
December	Correlation Coefficient							0.6		
	Sig. (2-tailed)							0.28475698		
	N							5		

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

"ns" denotes not significant.

Significant trend where p<0.05.

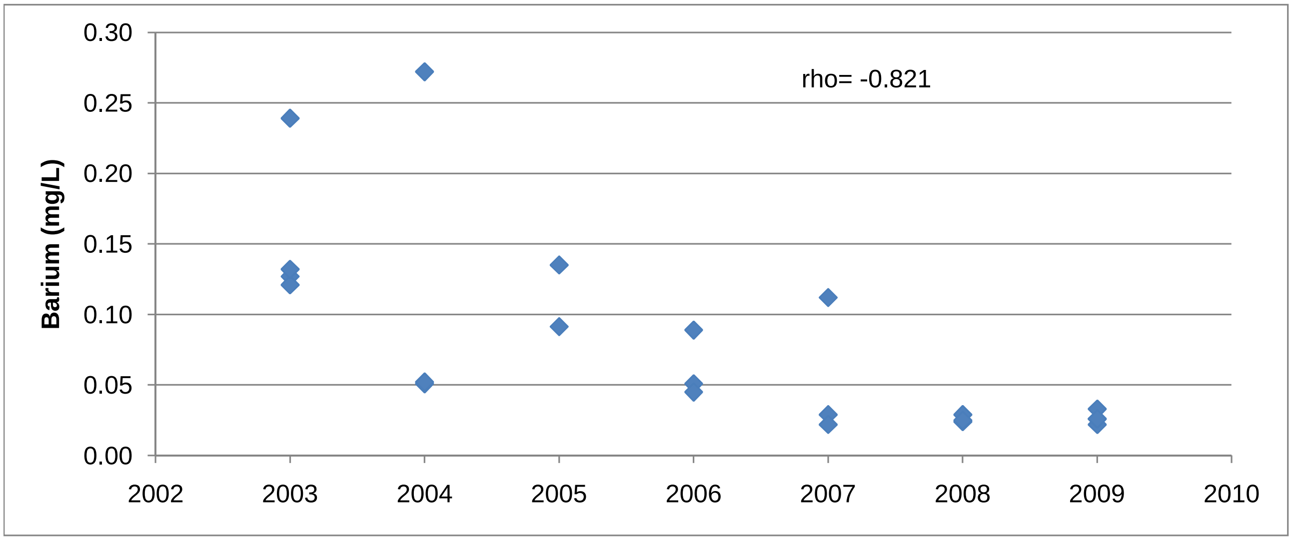
Appendix Table C.8.6: Summary of seasonal trends for station PR-04, 2003 - 2009.

Season	Spearman rho	Barium	Cobalt	Iron	Manganese	pH	Radium-226	TSS	Uranium
January	Correlation Coefficient	-0.8	-0.3	-0.7	-0.6	0.6	0	-0.8	-0.6
	Sig. (2-tailed)	0.104088	0.623838	0.188	0.28475698	0.284757	1	0.104088	0.284757
	N	5	5	5	5	5	5	5	5
February/March	Correlation Coefficient					0.542857	0.657142857	0.028989	
	Sig. (2-tailed)					0.265703	0.156174927	0.956529	
	N					6	6	6	
April	Correlation Coefficient	-0.954994	0.342356	-0.595	0.126131245	-0.214286	-0.321428571	-0.270281	0.571429
	Sig. (2-tailed)	0.000806	0.452251	0.159	0.787572159	0.644512	0.482072038	0.557731	0.180202
	N	7	7	7	7	7	7	7	7
May/June	Correlation Coefficient					0.8	-0.2	0.67082	
	Sig. (2-tailed)					0.104088	0.747060078	0.21517	
	N					5	5	5	
October/Nov	Correlation Coefficient	-0.9	0.8	0.9	0.3	0.485714	-0.428571429	0.542857	0.1
	Sig. (2-tailed)	0.037386	0.104088	0.037	0.623837665	0.328723	0.396501458	0.265703	0.872889
	N	5	5	5	5	6	6	6	5
December	Correlation Coefficient	-0.6	-0.2	-0.6	-0.1	0	0.6	-0.1	0
	Sig. (2-tailed)	0.284757	0.74706	0.285	0.872888572	1	0.28475698	0.872889	1
	N	5	5	5	5	5	5	5	5

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

"ns" denotes not significant.

[shaded box] Significant trend where p<0.05.



Appendix Figure C.8.1: Significant common (average) trends observed for barium over all seasons at station PR-04, 2003 to 2009.

APPENDIX D

SAMP Water Quality Data

APPENDIX D.1
Denison and Spanish American TMA

Appendix Table D.1.1: Water quality at station D-2 from 2005 - 2009.

Date	Ba (mg/L)	Co (mg/L)	Cu (mg/L)	Fe (mg/L)	Mn (mg/L)	Ni (mg/L)	Pb (mg/L)	pH[a]	Ra (Bq/L)	SO4 (mg/L)	TSS (mg/L)	U (mg/L)	Zn (mg/L)
1/4/2005								6.8	0.078		< 1		
1/11/2005	0.0541	0.0015	0.002	0.26	0.266	0.002	< 0.0006	7	0.064	476	1	0.063	0.002
1/18/2005								7.3	0.084		1		
1/25/2005								6.9	0.12		1		
2/1/2005								7.2	0.11		1		
2/8/2005								7.1	0.072		< 1		
2/15/2005	0.0716	0.0017	0.003	0.465	0.392	0.0026	< 0.0006	7.1	0.064	523	< 1	0.064	0.001
2/22/2005								7.3	0.074		< 1		
3/1/2005								7.2	0.05		< 1		
3/8/2005								7.3	0.042		< 1		
3/15/2005	0.0337	0.0016	< 0.001	0.145	0.43	0.0029	< 0.0006	7.2	0.03	570	< 1	0.087	0.003
3/22/2005								7	0.034		< 1		
3/29/2005								7.5	0.04		< 1		
4/5/2005								7.3	0.032		< 1		
4/12/2005	0.226	0.0007	< 0.001	0.124	0.137	0.0014	< 0.0006	7.3	0.068	165	< 1	0.022	0.003
4/19/2005								7.4	0.066		1		
4/26/2005								7.4	0.27		2		
5/3/2005								7.4	0.16		1		
5/10/2005	0.111	0.0018	< 0.001	0.233	0.402	0.0022	< 0.0006	7.3	0.23	536	1	0.085	0.002
5/17/2005								7.3	0.28		< 1		
5/24/2005								7.3	0.17		< 1		
5/31/2005								7.4	0.089		< 1		
6/7/2005								7.4	0.11		< 1		
6/14/2005	0.0453	0.0006	< 0.001	0.042	0.142	0.0018	< 0.0006	7.3	0.08	563	< 1	0.072	< 0.001
6/21/2005								7.5	0.12		1		
6/28/2005								7.2	0.089		1		
7/5/2005								7.3	0.097		< 1		
7/12/2005	0.0264	< 0.0003	< 0.001	0.012	0.0205	< 0.0003	< 0.0006	7.3	0.048	595	< 1	0.065	0.007
7/19/2005								7.6	0.061		< 1		
7/26/2005								7.1	0.062		1		
8/2/2005								7.6	0.2		< 1		
8/9/2005	0.0387	< 0.0003	< 0.001	0.026	0.0354	< 0.0003	< 0.0006	7.5	0.051	612	1	0.08	0.003
8/16/2005								7.5	0.061		< 1		
8/23/2005								7.1	0.042		< 1		
8/30/2005								7.4	0.12		< 1		
9/6/2005								7.1	0.09		< 1		
9/13/2005	0.0455	< 0.0003	< 0.001	0.033	0.0591	0.0017	< 0.0006	7.8	0.054	682	< 1	0.095	0.009
9/20/2005								7.3	0.12		< 1		
9/27/2005								7.2	0.12		1		
10/4/2005								7.3	0.06		< 1		
10/11/2005	0.0463	0.0005	< 0.001	0.033	0.164	0.0025	< 0.0006	7.3	0.069	757	< 1	0.104	0.008
10/18/2005								7.3	0.11		1		
10/25/2005								7.3	0.22		< 1		
11/1/2005								7.3	0.19		< 1		
11/8/2005								7.4	0.14		< 1		
11/15/2005	0.084	0.0015	< 0.001	0.118	0.318	0.0032	< 0.0006	7.2	0.17	661	< 1	0.115	0.002
11/22/2005								7.2	0.15		< 1		
11/29/2005								7	0.23		< 1		
12/6/2005								7.5	0.055		< 1		
12/13/2005	0.0296	0.0017	< 0.001	0.119	0.359	0.0038	< 0.0006	7.4	0.056	628	< 1	0.115	0.001
12/20/2005								7.2	0.035		< 1		
12/29/2005								7.3	0.037		< 1		
1/3/2006								7.6	0.016		< 3		
1/10/2006	0.026	0.0023	0.001	0.12	0.376	0.005	< 0.0002	7.1	0.02	630	< 2	0.0926	0.002
1/17/2006								7	0.019		< 2		
1/24/2006								7.3	0.026		2		
1/31/2006								7.5	0.027		< 2		
2/7/2006								7.3	0.024		< 2		
2/14/2006	0.03	0.0019	< 0.0008	0.15	0.389	0.007	< 0.0002	7.3	0.025	580	< 2	0.0912	0.004
2/21/2006								7.4	0.021		< 2		
2/28/2006								7.4	0.028		< 2		
3/7/2006								7.2	0.03		2		
3/14/2006	0.038	0.002	< 0.0008	0.1	0.518	0.005	< 0.0002	7.3	0.031	570	< 2	0.0932	0.003
3/21/2006								7.2	0.042		< 2		
3/28/2006								7.1	0.031		< 2		
4/4/2006								7.3	0.12		< 1		
4/11/2006	0.0955	0.00125	0.0007	0.23	0.209	0.0023	< 0.0005	7.4	0.16	210	1	0.0314	0.0026
4/18/2006								7.1	0.12		2		
4/24/2006								7.4	0.11		1		
5/2/2006								7.5	0.096		2		
5/9/2006	0.151	0.00194	0.0008	0.32	0.397	0.0037	0.00042	7.5	0.11	460	2	0.0697	0.0048
5/16/2006								7.5	0.12		< 1		
5/23/2006								7.7	0.12		2		
5/30/2006								7.6	0.041		< 1		

Appendix Table D.1.1: Water quality at station D-2 from 2005 - 2009.

Date	Ba (mg/L)	Co (mg/L)	Cu (mg/L)	Fe (mg/L)	Mn (mg/L)	Ni (mg/L)	Pb (mg/L)	pH[a]	Ra (Bq/L)	SO4 (mg/L)	TSS (mg/L)	U (mg/L)	Zn (mg/L)
6/6/2006								7.6	0.047		< 1		
6/13/2006	0.0606	0.00095	0.0007	0.07	0.289	0.0029	0.00033	7.4	0.078	480	1	0.0661	0.0006
6/20/2006								7.4	0.1		1		
6/27/2006								7.5	0.12		1		
7/4/2006								7.5	0.091		1		
7/11/2006	0.0571	0.0009	0.0011	0.07	0.301	0.004	< 0.0005	7.6	0.083	500	< 1	0.0751	0.003
7/18/2006								7.5	0.045		< 1		
7/24/2006								7.5	0.11		1		
8/1/2006								7.5	0.07		1		
8/8/2006	0.041	0.0005	0.0155	0.06	0.094	0.005	0.001	7.4	0.047	530	1	0.0852	0.013
8/15/2006								7.3	0.054		1		
8/22/2006								7.6	0.062		1		
8/29/2006								7.5	0.03		2		
9/5/2006								7.5	0.048		2		
9/12/2006	0.0506	0.0005	0.0013	0.06	0.12	0.0065	0.0006	7.5	0.046	570	1	0.0984	0.0012
9/19/2006								7.4	0.094		1		
9/26/2006								7.5	0.098		2		
10/3/2006								7.4	0.085		1		
10/10/2006	0.064	0.0008	0.0007	0.06	0.217	0.005	< 0.0005	7.4	0.057	620	1	0.103	0.003
10/17/2006								7.5	0.072		3		
10/24/2006								7.5	0.095		2		
10/31/2006								7.4	0.086		1		
11/7/2006								7.5	0.1		< 1		
11/14/2006	0.086	0.0022	0.0006	0.15	0.425	0.008	0.0005	7.5	0.1	570	< 1	0.0979	0.005
11/21/2006								7.5	0.087		< 1		
11/28/2006								7.5	0.082		1		
12/5/2006								7.4	0.086		1		
12/12/2006	0.062	0.0027	0.001	0.15	0.459	0.008	0.0016	7.4	0.072	590	1	0.0901	0.003
12/19/2006								7.3	0.059		< 1		
12/28/2006								7.3	0.11		2		
1/2/2007								6.9	0.110				
1/9/2007	0.088	0.0015		0.58	0.231			7.4	0.120	330.0		0.0466	
1/16/2007								7.2	0.110				
1/23/2007								7.1	0.092				
1/30/2007								7.2	0.082				
2/6/2007								7.1	0.087				
2/13/2007	0.069	0.0024		1.00	0.396			7.0	0.082	460.0		0.0508	
2/20/2007								7.1	0.057				
2/27/2007								7.1	0.060				
3/6/2007								7.1	0.052				
3/13/2007	0.048	0.0034		1.29	0.582			7.1	0.061	540.0		0.0611	
3/20/2007								7.2	0.034				
3/27/2007								6.9	0.048				
4/3/2007								7.3	0.079				
4/10/2007	0.076	0.0014		0.37	0.240			7.4	0.120	260.0		0.0309	
4/17/2007								6.8	0.076				
5/1/2007								7.4	0.140				
5/8/2007	0.117	0.0022		0.61	0.481			7.4	0.160	480.0		0.0613	
5/15/2007								7.4	0.200				
5/22/2007								7.2	0.160				
5/29/2007								7.1	0.120				
6/5/2007								7.5	0.079				
6/12/2007	0.063	0.0016		0.11	0.471			7.7	0.091	500.0		0.0875	
6/19/2007								7.0	0.068				
6/26/2007								7.4	0.076				
7/3/2007								7.2	0.051				
7/10/2007	0.064	0.0007		0.03	0.137			7.3	0.088	550.0		0.0692	
7/17/2007								7.6	0.170				
7/24/2007								7.6	0.270				
7/31/2007								7.5	0.060				
8/7/2007								7.5	0.260				
8/14/2007	0.065	0.0010		0.06	0.313			7.3	0.082	600.0		0.0859	
8/21/2007								7.3	0.140				
8/28/2007								7.6	0.061				
9/4/2007								7.6	0.058				
9/11/2007	0.063	0.0012		0.08	0.322			7.7	0.085	550.0		0.0957	
9/18/2007								7.7	0.100				
9/25/2007								7.4	0.110				
10/2/2007								7.3	0.100				
10/9/2007	0.080	0.0014		0.07	0.370			7.1	0.110	600.0		0.0993	
10/16/2007								7.0	0.140				
10/23/2007								7.0	0.160				
10/30/2007								6.9	0.160				
11/6/2007								7.3	0.160				

Appendix Table D.1.1: Water quality at station D-2 from 2005 - 2009.

Date	Ba (mg/L)	Co (mg/L)	Cu (mg/L)	Fe (mg/L)	Mn (mg/L)	Ni (mg/L)	Pb (mg/L)	pH[a]	Ra (Bq/L)	SO4 (mg/L)	TSS (mg/L)	U (mg/L)	Zn (mg/L)
11/13/2007	0.161	0.0020		0.19	0.479			7.2	0.120	560.0		0.1060	
11/20/2007								7.3	0.120				
11/27/2007								7.1	0.073				
12/4/2007								7.4	0.048				
12/11/2007	0.034	0.0021		0.10	0.501			7.1	0.045	580.0		0.1010	
12/18/2007								7.3	0.029				
12/28/2007								7.1	0.031				
1/2/2008								7.0	0.028				
1/8/2008	0.031	0.0023		0.58	0.524			6.8	0.031	490.0		0.0750	
1/15/2008								6.7	0.029				
1/22/2008								6.6	0.032				
1/31/2008								6.6	0.035				
2/5/2008								6.6	0.026				
2/12/2008	0.032	0.0032		1.35	0.573			6.6	0.021	500.0		0.0605	
2/19/2008								6.8	0.071				
2/26/2008								6.8	0.270				
3/4/2008								6.7	0.210				
3/11/2008	0.077	0.0016		0.84	0.369			6.8	0.210	240.0		0.0441	
3/18/2008								6.8	0.180				
3/25/2008								6.8	0.140				
4/1/2008								6.9	0.100				
4/8/2008	0.099	0.0018		0.52	0.311			6.8	0.290	310.0		0.0455	
4/15/2008								6.9	0.260				
4/22/2008								6.8	0.180				
4/29/2008								6.9	0.180				
5/6/2008								7.4	0.220				
5/13/2008	0.126	0.0018		0.34	0.463			7.2	0.220	360.0		0.0594	
5/20/2008								7.3	0.240				
5/27/2008								7.6	0.180				
6/3/2008								7.6	0.140				
6/10/2008	0.123	0.0013		0.14	0.350			7.5	0.110	380.0		0.0574	
6/17/2008								7.4	0.110				
6/24/2008								7.6	0.088				
7/1/2008								7.7	0.190				
7/8/2008	0.107	0.0015		0.07	0.322			7.6	0.200	390.0		0.0697	
7/22/2008								7.6	0.099				
7/29/2008								7.7	0.095				
8/5/2008								7.4	0.140				
8/12/2008	0.100	0.0008		0.07	0.205			7.4	0.120	440.0		0.0777	
8/19/2008								7.5	0.130				
8/26/2008								7.4	0.077				
9/2/2008								7.5	0.110				
9/9/2008	0.105	0.0011		0.11	0.230			7.5	0.062	490.0		0.0817	
9/16/2008								7.4	0.070				
9/23/2008								7.3	0.130				
9/30/2008								7.7	0.071				
10/7/2008								7.0	0.092				
10/14/2008	0.091	0.0012		0.14	0.319			7.2	0.078	500.0		0.1030	
10/21/2008								7.2	0.097				
10/28/2008								7.2	0.130				
11/4/2008								7.1	0.140				
11/11/2008	0.111	0.0015		0.14	0.341			7.2	0.110	510.0		0.1030	
11/18/2008								7.0	0.140				
11/25/2008								7.1	0.088				
12/2/2008								7.1	0.032				
12/9/2008	0.041	0.0019		0.08	0.340			7.1	0.050	560.0		0.1000	
12/16/2008								7.0	0.044				
12/23/2008								6.7	0.170				
12/30/2008								6.7	0.290				
1/6/2009								7.1	0.260				
1/13/2009	0.145	0.0007		0.35	0.147			6.8	0.240	290.0		0.0498	
1/19/2009								7.4	0.240				
1/27/2009								6.9	0.180				
2/3/2009								6.8	0.160				
2/10/2009	0.091	0.0018		0.73	0.394			6.9	0.140	380.0		0.0535	
2/17/2009								6.8	0.130				
2/24/2009								6.8	0.230				
3/3/2009								7.0	0.340				
3/10/2009	0.129	0.0013		0.54	0.288			7.1	0.280	310.0		0.0485	
3/17/2009								7.0	0.210				
3/24/2009								7.0	0.170				
3/31/2009								6.9	0.290				
4/7/2009								7.4	0.360				
4/14/2009	0.278	0.0010		0.32	0.181			6.9	0.270	200.0		0.0362	

Appendix Table D.1.1: Water quality at station D-2 from 2005 - 2009.

Date	Ba (mg/L)	Co (mg/L)	Cu (mg/L)	Fe (mg/L)	Mn (mg/L)	Ni (mg/L)	Pb (mg/L)	pH[a]	Ra (Bq/L)	SO4 (mg/L)	TSS (mg/L)	U (mg/L)	Zn (mg/L)
4/21/2009								7.0	0.230				
4/28/2009								6.7	0.170				
5/5/2009								7.0	0.200				
5/12/2009	0.159	0.0015		0.36	0.375			7.0	0.270	310.0		0.0529	
5/19/2009								7.2	0.330				
5/26/2009								7.9	0.430				
6/2/2009								7.3	0.280				
6/9/2009	0.129	0.0012		0.16	0.285			7.2	0.150	360.0		0.0659	
6/16/2009								7.3	0.096				
6/23/2009								7.2	0.085				
6/29/2009								7.3	0.140				
7/7/2009								7.3	0.170				
7/14/2009	0.201	0.0009		0.07	0.203			7.3	0.190	390.0		0.0732	
7/21/2009								7.3	0.290				
7/28/2009								7.1	0.100				
8/4/2009								7.0	0.061				
8/11/2009	0.067	0.0008		0.07	0.191			7.2	0.100	400.0		0.0854	
8/18/2009								7.2	0.073				
8/25/2009								7.3	0.088				
8/31/2009								7.3	0.068				
9/8/2009	0.051	0.0006		0.06	0.124			7.1	0.100	430.0		0.0924	
9/14/2009								7.1	0.035				
9/22/2009								7.1	0.015				
9/29/2009								7.1	0.120				
10/6/2009								6.8	0.140				
10/13/2009	0.134	0.0018		0.19	0.357			6.9	0.180	460.0		0.1130	
10/20/2009								7.0	0.170				
10/27/2009								6.9	0.160				
11/3/2009								6.9	0.170				
11/10/2009								7.0	0.180				
11/17/2009								6.8	0.150				
11/24/2009								6.8	0.130				
12/1/2009								6.9	0.120				
12/8/2009	0.089	0.0026		0.16	0.343			6.7	0.120	450.0		0.1060	
12/15/2009								6.6	0.140				
12/22/2009								6.8	0.130				
12/29/2009								6.9	0.100				
Number	59	59	24	59	59	24	24	657	259	59	104	59	24
Minimum	0.026	0.0003	0.0006	0.012	0.0205	0.0003	0.0002	6.6	0.015	165	1	0.022	0.0006
Maximum	0.278	0.0034	0.0155	1.35	0.582	0.008	0.0016	7.9	0.430	757	3	0.1150	0.013
Mean	0.0851	0.0014	0.0017	0.255	0.310	0.0036	0.0006	7.3	0.115	479	1	0.0764	0.004
Median	0.0716	0.0015	0.0010	0.140	0.322	0.0031	0.0006	7.3	0.100	500	1	0.0777	0.003
10th Perc.	0.0334	0.0006	0.0007	0.056	0.134	0.0015	0.0002	7.0	0.034	306	1	0.0464	0.001

a pH measures shown only for dates when other substances were measured but summary statistics reflect all measured values.

Appendix Table D.1.2: Water quality at station D-3 from 2005 to 2009.

Date	Ba (mg/L)	Co (mg/L)	Cu (mg/L)	Fe (mg/L)	Mn (mg/L)	Ni (mg/L)	Pb (mg/L)	pH	Ra (Bq/L)	SO4 (mg/L)	TSS (mg/L)	U (mg/L)	Zn (mg/L)
1/4/2005								6.9	0.066		< 1		
1/11/2005	0.201	< 0.0003	< 0.001	0.034	0.0016	0.0006	< 0.0006	6.9	0.12	98.5	< 1	0.008	0.002
1/18/2005								7.6	0.085		< 1		
1/25/2005								6.9	0.092		< 1		
2/1/2005								7.2	0.13		< 1		
2/8/2005								7.5	0.087		< 1		
2/15/2005	0.195	< 0.0003	< 0.001	0.034	0.0041	0.0005	< 0.0006	7.1	0.13	92.4	< 1	0.018	0.001
2/22/2005								7.4	0.15		< 1		
3/1/2005								7.2	0.13		< 1		
3/8/2005								7.3	0.16		< 1		
3/15/2005	0.169	< 0.0003	< 0.001	0.033	0.0029	< 0.0003	< 0.0006	7.4	0.12	128	< 1	0.024	0.001
3/22/2005								7.5	0.15		< 1		
3/29/2005								7.7	0.12		< 1		
4/5/2005								7.6	0.083		< 1		
4/12/2005	0.267	< 0.0003	< 0.001	0.056	0.0045	0.0004	< 0.0006	7.5	0.07	42.1	< 1	< 0.005	< 0.001
4/19/2005								7.5	0.098		< 1		
4/26/2005								7.6	0.14		< 1		
5/3/2005								7.5	0.11		< 1		
5/10/2005	0.18	< 0.0003	< 0.001	0.03	0.0049	< 0.0003	< 0.0006	7.3	0.17	81.1	< 1	0.006	< 0.001
5/17/2005								7.4	0.09		< 1		
5/24/2005								7.2	0.19		< 1		
5/31/2005								7.2	0.16		< 1		
6/7/2005								7.4	0.21		< 1		
6/14/2005	0.156	0.0003	< 0.001	0.084	0.0244	0.0008	< 0.0006	7.3	0.18	85.6	< 1	0.008	< 0.001
6/21/2005								7.4	0.2		< 1		
6/28/2005								7.1	0.17		< 1		
10/4/2005								7.2	0.14		< 1		
10/11/2005	0.168	< 0.0003	< 0.001	0.002	0.005	0.0011	< 0.0006	7.3	0.14	121	< 1	0.013	0.006
10/18/2005								7.2	0.16		< 1		
10/25/2005								7.2	0.16		< 1		
11/1/2005								6.8	0.2		< 1		
11/8/2005								7.3	0.093		< 1		
11/15/2005	0.128	< 0.0003	< 0.001	0.048	0.0031	0.0007	< 0.0006	6.6	0.071	109	< 1	0.014	0.002
11/22/2005								6.8	0.087		< 1		
11/29/2005								7.2	0.11		1		
12/6/2005								7.5	0.081		< 1		
12/13/2005	0.129	< 0.0003	< 0.001	0.021	0.0016	0.0009	< 0.0006	7.6	0.068	97.2	< 1	0.01	0.001
12/20/2005								7.2	0.073		< 1		
12/29/2005								7.4	0.048		< 1		
1/3/2006								7.6	0.087		< 2		
1/10/2006	0.143	< 0.0003	0.001	< 0.02	0.0015	< 0.001	< 0.0002	7.2	0.1	110	< 2	0.0155	< 0.001
1/17/2006								7.1	0.1		< 2		
1/24/2006								7.3	0.109		2		
1/31/2006								7.4	0.1		< 2		
2/7/2006								7.5	0.098		< 2		
2/14/2006	0.147	< 0.0003	< 0.0008	< 0.02	0.0009	0.001	< 0.0002	7.5	0.11	120	< 2	0.0352	0.002
2/21/2006								7.4	0.097		< 2		
2/28/2006								7.5	0.1		< 2		
3/7/2006								7.3	0.11		< 2		
3/14/2006	0.16	< 0.0003	0.0029	0.11	0.0837	0.001	< 0.0002	7.5	0.095	130	< 2	0.0162	0.006
3/21/2006								7.5	0.081		< 2		
3/28/2006								7.3	0.088		< 2		
4/4/2006								7.5	0.076		< 1		
4/11/2006	0.474	0.00007	0.0006	0.05	0.00535	0.0008	< 0.0005	7.6	0.032	47	< 1	0.00135	0.0012
4/18/2006								7.2	0.14		< 1		
4/24/2006								7.6	0.16		< 1		
5/2/2006								7.3	0.12		< 1		
5/9/2006	0.193	0.00015	0.0005	0.03	0.00459	< 0.0007	0.00059	7.4	0.13	86	1	0.00611	0.004
5/16/2006								7.4	0.14		< 1		
5/23/2006								7.5	0.1		< 1		
5/30/2006								7.3	0.14		< 1		
6/6/2006								7.3	0.14		< 1		
6/13/2006	0.154	0.00024	0.001	0.07	0.0212	< 0.0007	0.00007	7.4	0.13	61	< 1	0.00611	0.0057
6/20/2006								7.4	0.14		< 1		
6/27/2006								7.4	0.15		< 1		
7/4/2006								7.5	0.19		< 1		
7/11/2006	0.144	0.001	0.0023	0.61	0.0777	< 0.002	< 0.0005	7.3	0.18	42	1	0.0065	0.004
8/8/2006	0.204	< 0.0005	0.0008	0.21	0.043	< 0.002	< 0.0005	7.5	0.21	77	< 1	0.0095	0.001
8/22/2006								7.5	0.18		1		
8/29/2006								7.6	0.22		3		
9/26/2006								7.3	0.149		< 1		
10/3/2006								7.3	0.15		< 1		
10/10/2006	0.172	< 0.0005	0.0007	< 0.02	0.003	< 0.002	< 0.0005	7.2	0.17	99	< 1	0.0116	0.005
10/17/2006								7.5	0.1		< 1		

Appendix Table D.1.2: Water quality at station D-3 from 2005 to 2009.

Date	Ba (mg/L)	Co (mg/L)	Cu (mg/L)	Fe (mg/L)	Mn (mg/L)	Ni (mg/L)	Pb (mg/L)	pH	Ra (Bq/L)	SO4 (mg/L)	TSS (mg/L)	U (mg/L)	Zn (mg/L)
10/24/2006								7.6	0.12		< 1		
10/31/2006								7.3	0.11		< 1		
11/7/2006								7.4	0.12		< 1		
11/14/2006	0.192	< 0.0005	0.0007	< 0.02	< 0.002	< 0.002	< 0.0005	7.5	0.098	91	< 1	0.0159	< 0.001
11/21/2006								7.5	0.11		< 1		
11/28/2006								7.6	0.11		< 1		
12/5/2006								7.6	0.091		< 1		
12/12/2006	0.211	< 0.0005	0.0006	< 0.02	< 0.002	< 0.002	0.0013	7.5	0.11	85	< 1	0.0071	< 0.001
12/19/2006								7.4	0.099		< 1		
12/28/2006								7.2	0.088		< 1		
1/9/2007	0.259	< 0.0005		0.03	< 0.002			7.5	0.100	67.0		0.0036	
2/13/2007	0.160	< 0.0005		0.03	0.004			7.2	0.098	95.0		0.0119	
3/13/2007	0.185	< 0.0005		0.06	0.004			7.3	0.089	92.0		0.0221	
4/10/2007	0.196	< 0.0005		0.03	0.002			7.5	0.065	48.0		0.0016	
5/8/2007	0.239	< 0.0005		< 0.02	0.004			7.4	0.150	110.0		0.0095	
6/12/2007	0.179	< 0.0005		0.24	0.036			7.4	0.200	67.0		0.0100	
10/9/2007	0.200	< 0.0005		< 0.02	< 0.002			6.6	0.140	110.0		0.0125	
11/13/2007	0.202	< 0.0005		< 0.02	< 0.002			7.1	0.100	100.0		0.0161	
12/11/2007	0.144	< 0.0005		< 0.02	< 0.002			7.2	0.080	100.0		0.0185	
1/8/2008	0.207	< 0.0005		0.08	0.010			7.2	0.085	81.0		0.0046	
2/12/2008	0.230	< 0.0005		0.05	0.002			6.9	0.097	74.0		0.0034	
3/11/2008	0.171	< 0.0005		0.02	< 0.002			7.1	0.085	94.0		0.0082	
4/8/2008	0.314	< 0.0005		0.17	0.046			7.0	0.094	41.0		0.0021	
5/13/2008	0.156	< 0.0005		0.03	0.003			7.2	0.040	37.0		0.0030	
6/10/2008	0.250	< 0.0005		0.03	0.005			7.2	0.160	63.0		0.0050	
7/8/2008	0.170	0.0007		0.30	0.065			7.1	0.150	33.0		0.0036	
8/12/2008	0.297	< 0.0005		0.11	0.016			7.3	0.180	58.0		0.0074	
9/9/2008	0.217	0.0006		0.31	0.051			7.3	0.160	52.0		0.0098	
10/14/2008	0.206	< 0.0005		0.33	0.038			7.3	0.160	58.0		0.0160	
11/11/2008	0.216	< 0.0005		0.18	0.015			7.1	0.160	78.0		0.0202	
12/9/2008	0.195	< 0.0005		0.04	0.005			7.3	0.110	96.0		0.0268	
1/13/2009	0.295	< 0.0005		0.08	0.007			6.8	0.110	78.0		0.0047	
2/10/2009	0.263	< 0.0005		0.08	0.012			6.8	0.110	100.0		0.0166	
3/10/2009	0.233	< 0.0005		0.04	0.016			7.1	0.120	110.0		0.0271	
4/14/2009	0.258	< 0.0005		0.11	0.014			7.0	0.089	37.0		0.0014	
5/12/2009	0.143	< 0.0005		0.09	0.011			7.3	0.096	34.0		0.0024	
6/9/2009	0.229	< 0.0005		0.09	0.011			7.3	0.120	53.0		0.0053	
7/14/2009	0.177	0.0008		1.07	0.101			7.3	0.150	32.0		0.0033	
8/11/2009	0.281	< 0.0005		0.42	0.043			7.2	0.220	54.0		0.0097	
9/8/2009								7.3	0.510				
9/29/2009	0.256	< 0.0005		0.05	0.010			7.2		53.0		0.0150	
10/13/2009	0.234	< 0.0005		0.06	0.008			7.0	0.140	80.0		0.0198	
11/10/2009	0.283	< 0.0005		0.05	0.004			7.2	0.140	70.0		0.0089	
12/8/2009	0.277	< 0.0005		0.05	0.008			6.9	0.140	78.0		0.0103	
Number	53	53	20	53	53	20	20	538	117	53	84	53	20
Minimum	0.128	0.00007	0.0005	0.002	0.0009	0.0003	0.00007	6.6	0.032	32	1	0.00135	0.001
Maximum	0.474	0.001	0.0029	1.07	0.101	0.002	0.0013	7.8	0.51	130	3	0.0352	0.006
Mean	0.210	0.0005	0.0010	0.11	0.016	0.001	0.0005	7.3	0.126	78.0	1	0.0109	0.002
Median	0.200	0.0005	0.0010	0.05	0.005	0.0009	0.0006	7.3	0.120	80	1	0.0095	0.001
10th Perc.	0.145	0.0003	0.0006	0.02	0.002	0.0004	0.0002	7.0	0.081	41.2	1	0.0031	0.001

[a] pH measures shown only for dates when other substances were measured but summary statistics reflect all measured values.

Appendix Table D.1.3: Water quality at station D-9 from 2005 to 2009.

Date	Ba (mg/L)	Co (mg/L)	Fe (mg/L)	Mn (mg/L)	pH	Ra (Bq/L)	SO4 (mg/L)	U (mg/L)
1/4/2005	0.0155	0.0216	7.25	2.75	6.6	0.007	577	0.009
4/13/2005	0.0107	0.0098	2.79	1.65	6.5	< 0.005	346	0.006
7/5/2005	0.0158	0.0303	13.68	5.64	6.0	0.02	1011	0.008
10/4/2005	0.0218	0.0256	13.75	4.78	6.6	0.031	1122	0.014
1/3/2006	0.016	0.0271	15.8	4.43	6.8	0.023	730	0.0174
4/12/2006	0.0089	0.00588	1.69	0.84	6.9	0.006	150	0.00265
7/4/2006	0.022	0.0332	14.5	5.42	6.5	0.015	940	0.013
10/3/2006	0.021	0.0216	8.32	3.96	6.8	0.013	760	0.009
1/2/2007	0.015	0.0170	5.88	2.95	7.1	0.007	540	0.0083
4/3/2007	0.011	0.0084	3.02	1.45	6.8	0.008	220	0.0038
7/3/2007	0.022	0.0344	8.24	6.85	6.2	0.013	960	0.0068
10/2/2007	0.024	0.0245	9.04	4.70	6.5	0.012	950	0.0072
1/14/2008	0.013	0.0108	3.38	2.08	6.8	0.008	440	0.0064
4/29/2008	0.019	0.0081	1.69	1.59	6.7	0.007	320	0.0042
7/1/2008	0.020	0.0191	5.38	3.82	6.7	0.009	650	0.0066
10/7/2008	0.022	0.0221	9.86	4.44	6.4	0.014	800	0.0076
1/6/2009	0.017	0.0128	4.67	3.35	7.1	< 0.005	560	0.0069
5/5/2009	0.021	0.0091	2.41	2.02	6.6	0.009	450	0.0058
7/7/2009	0.020	0.0176	5.75	3.91	6.5	0.009	760	0.0071
10/6/2009	0.022	0.0162	7.25	4.13	6.5	0.006	790	0.0070
Number	20	20	20	20	20	20	20	20
Minimum	0.0089	0.00588	1.69	0.84	6	0.005	150	0.00265
Maximum	0.024	0.0344	15.8	6.85	7.1	0.031	1122	0.0174
Mean	0.0179	0.0188	7.22	3.538	6.6	0.011	653.8	0.0078
Median	0.0195	0.0184	6.57	3.865	6.6	0.009	690.0	0.0071
10th Perc.	0.0110	0.0084	2.34	1.576	6.4	0.006	310.0	0.0042

Appendix Table D.1.4: Water quality at station D-16 from 2005 to 2009.

Date	Ba (mg/L)	Co (mg/L)	Fe (mg/L)	Mn (mg/L)	pH	Ra (Bq/L)	SO4 (mg/L)	U (mg/L)
1/4/2005	0.0238	0.0025	0.111	0.927	6.1	0.017	237	< 0.005
4/13/2005	0.029	0.0034	0.072	1.160	5.9	0.016	223	< 0.005
7/5/2005	0.051	0.0157	12.74	6.060	6.3	0.073	363	< 0.005
10/4/2005	0.0323	0.0024	5.53	2.690	6.1	0.050	354	< 0.005
1/3/2006	0.027	0.0019	0.21	1.260	6.2	0.009	310	< 0.0002
4/12/2006	0.0265	0.00543	0.14	1.420	5.8	0.026	180	0.00014
7/4/2006	0.033	0.0099	24	7.000	6.4	0.093	300	0.0007
10/3/2006	0.024	0.0016	3.43	1.830	6.3	0.023	260	< 0.0005
1/2/2007	0.015	0.0015	0.20	0.813	6.3	0.009	160	< 0.0005
4/3/2007	0.021	0.0037	0.18	1.680	6.2	0.019	150	< 0.0005
7/3/2007	0.041	0.0091	15.70	6.440	6.1	0.039	420	0.0009
10/3/2007	0.041	0.0037	17.30	3.900	6.3	0.056	350	0.0006
1/14/2008	0.021	0.0026	0.16	1.020	6.0	0.014	190	< 0.0005
4/29/2008	0.023	0.0019	0.13	0.566	6.1	0.011	120	< 0.0005
7/1/2008	0.026	0.0059	11.30	5.200	6.3	0.024	220	< 0.0005
10/7/2008	0.033	0.0040	13.80	3.860	6.2	0.043	230	< 0.0005
1/6/2009	0.021	0.0012	0.28	1.130	6.5	0.016	220	< 0.0005
5/5/2009	0.023	0.0013	0.20	0.559	6.1	0.011	170	< 0.0005
7/7/2009	0.030	0.0053	16.60	5.140	6.5	0.037	240	0.0005
10/6/2009	0.029	0.0018	3.53	2.510	6.5	0.030	290	< 0.0005
Number	20	20	20	20	20	20	20	20
Minimum	0.015	0.0012	0.072	0.559	5.8	0.009	120	0.00014
Maximum	0.051	0.0157	24	7	6.5	0.093	420	0.005
Mean	0.0285	0.0042	6.28	2.758	6.2	0.0308	249.4	0.00140
Median	0.0268	0.0030	1.86	1.755	6.2	0.0235	233.5	0.00050
10th Perc.	0.021	0.0015	0.13	0.788	6.0	0.0108	159.0	0.00047

Appendix Table D.1.5a: Summary of Annual Plant Operations and Discharge at Denison TMA-1, 2005-2009.

ITEM	2005	2006	2007	2008	2009
PLANT OPERATIONS					
Operating Days	114	87	84	97	135
Maximum Daily Plant Flow (L/s @ D-1)	197	219	219	403	227
Minimum Daily Plant Flow (L/s @ D-1)	0	0	0	0	0
Monthly Average Daily Plant Flow (L/s @ D-1)	50	61	47	117	68
Total Volume Treated (ML)	494	462	344	977	796
Barium Chloride Consumption					
Total (kg/month)	634	580	487	1214	1205
Monthly Average (mg/L)	1.3	1.3	1.42	1.24	1.51
Caustic Soda Consumption					
Total (kg/month)	152	127	0.00	1008.00	1620.00
Monthly Average (mg/L)	0.31	0.27	0.00	1.03	2.03
DAM 10 SEEPAGE					
Discharge Days	365	365	365	366	365
Max Daily Seepage Flow (L/s @ D-13,D-14,D-19)	24	24	35.00	22	20
Min Daily Seepage Flow (L/s @ D-13,D-14,D-19)	19	18	19.00	20	15
Monthly Seepage Flow (L/s @ D-13,D-14,D-19)	21	21	23.00	21	19
Total Volume (ML)	660	670	717.00	663	536
Site Total Including ETP Operations (ML)	-	-	1061.00	1640	1392
***EFFLUENT**					
Discharge Days	365	365	365	366	365
Maximum Daily Discharge Flow (L/s @ D-2)	173	194	194	367	314
Minimum Daily Discharge Flow (L/s @ D-2)	1	1	1	2	2
Monthly Average Daily Discharge Flow (L/s @ D-2)	23	24	20	44	36
Total Annual Volume Discharged (ML)	715	744	637	1404	1144

* Influent flows based on daily monitoring requirements as per TOMP

* Effluent flows based on weekly monitoring requirement as per SAMP

Appendix Table D.1.5b: Summary of Annual Plant Operations and Discharge at Denison TMA-2, 2005-2009.

ITEM	2005	2006	2007	2008	2009
PLANT OPERATIONS					
Operating Days	288	315	302	366	357
Maximum Daily Plant Flow (L/s @ D-3)	161	75	78	199	81
Minimum Daily Plant Flow (L/s @ D-3)	0	0	0	1	1
Monthly Average Daily Plant Flow (L/s @ D-3)	9.0	10	7	11	8
Total Volume Treated (ML)	225	280	191	337	248
Barium Chloride Consumption					
Total (kg/month)	442	564	479	547	470
Monthly Average (mg/L)	2.0	2.0	3.00	2.00	2.00
Caustic Soda Consumption					
Total (kg/month)	0	0	0.00	0.00	0.00
Monthly Average (mg/L)	0	0	0.00	0.00	0.00
***EFFLUENT**					
Discharge Days	268	308	267	366	352
Maximum Daily Discharge Flow (L/s @ D-3)	161	75	78	199	81
Minimum Daily Discharge Flow (L/s @ D-3)	0	0	0	1	1
Monthly Average Daily Discharge Flow (L/s @ D-3)	9.7	10	8	11	8
Total Annual Volume Discharged (ML)	224	279	182	337	249

* Influent flows based on daily monitoring requirements as per TOMP

* Effluent flows based on weekly monitoring requirement as per SAMP

Appendix Table D.1.6: Mean annual discharge and seepage loadings from Denison TMA, 2005 - 2009.

Station		Drainage Type	Mean Annual Discharge (m^3)		Sulphate (kg/yr)	Radium (MBq/yr)	Uranium (kg/yr)	Barium (kg/yr)	Cobalt (kg/yr)	Iron (kg/yr)	Manganese (kg/yr)
Serpent River Drainage	D-4	Outlet of Dunlop Lake	46,644,865	Mean	250,343	117	12	648	11	1,646	539
				S.D.	20,235	0.0	5	35	2	806	154
	D-6	Outlet of Cinder Lake	1,767,370	Mean	80,357	10	0.5	29	0.6	466	377
				S.D.	38,540	3	0.0	3	0.1	136	131
	D-2	ETP Discharge	801,628	Mean	384,970	144	61	94	1.5	332	303
				S.D.	115,895	105	20	60	0.7	247	138
	D-3	Seepage from TMA 2	255,905	Mean	19,411	26	2.7	53	0.1	17	3.4
				S.D.	3,901	5.4	0.3	16	0.0	12	2.8
	D-5	Serpent River d/s of Denison	50,496,276	Mean	1,253,233	4,557	112	4,659	12	2,959	1,465
				S.D.	332,793	1,013	20	1,023	1.5	288	60
	Q-09	Quirke Lake Intlet	67,185,723	Mean	5,684,136	5,718	312	5,909	37		
				S.D.	926,920	866	66	931	4.7		
Quirke Lake Drainage	D-9	Seepage from Dam 17	109,288	Mean	52,368	1.0	0.7	1.7	1.5	536	278
				S.D.	3,898	0.2	0.1	0.3	0.2	134	12
	D-16	Seepage from Dam 9	42,463	Mean	8,222	0.9	0.0	1.1	0.1	88	66
				S.D.	4,180	0.5	0.0	0.6	0.1	31	31
	SR-01	Outlet of Quirke Lake	136,511,119	Mean	7,792,055	4,205	218	5,477	31		
				S.D.	1,335,662	665	55	231	6		

MBq/yr = Million Bequerels per year

Appendix Table D.1.7: Summary of seasonal trends for station D-2, 2003 to 2009.

Season	Spearman rho	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium
January	Correlation Coefficient	0.607143	-0.54554	0.558581	-0.535714286	-0.82143	0.5	-0.75	-0.535714
	Sig. (2-tailed)	0.148231	0.205282	0.192453	0.215217456	0.023449	0.25317	0.0521814	0.2152175
	N	7	7	7	7	7	7	7	7
February	Correlation Coefficient	0.535714	0.035714	0.821429	-0.285714286	-0.71429	0.71428571	-0.678571	-0.785714
	Sig. (2-tailed)	0.215217	0.939408	0.023449	0.534509229	0.071344	0.07134356	0.0937503	0.0362385
	N	7	7	7	7	7	7	7	7
March	Correlation Coefficient	0.892857	-0.45047	0.5	-0.642857143	-0.85714	0.42857143	-0.738769	-0.535714
	Sig. (2-tailed)	0.006807	0.310429	0.25317	0.119392373	0.013697	0.33736831	0.0578585	0.2152175
	N	7	7	7	7	7	7	7	7
April	Correlation Coefficient	0.178571	-0.07143	0.571429	0.321428571	-0.35714	0.46428571	0.1785714	0.5585812
	Sig. (2-tailed)	0.701658	0.879048	0.180202	0.482072038	0.431611	0.29393411	0.7016579	0.1924525
	N	7	7	7	7	7	7	7	7
May	Correlation Coefficient	0.392857	-0.81084	0.75	-0.714285714	-0.60714	-0.21428571	-0.928571	-0.357143
	Sig. (2-tailed)	0.383317	0.026916	0.052181	0.071343561	0.148231	0.64451158	0.0025195	0.4316114
	N	7	7	7	7	7	7	7	7
June	Correlation Coefficient	0.142857	-0.42857	0.464286	-0.428571429	-0.64286	-0.17857143	-0.75	-0.178571
	Sig. (2-tailed)	0.759945	0.337368	0.293934	0.337368311	0.119392	0.70165794	0.0521814	0.7016579
	N	7	7	7	7	7	7	7	7
July	Correlation Coefficient	0.25	-0.27028	0.074125	-0.464285714	-0.14286	-0.28571429	-0.738769	0.25
	Sig. (2-tailed)	0.588724	0.557731	0.874507	0.293934108	0.759945	0.53450923	0.0578585	0.5887244
	N	7	7	7	7	7	7	7	7
August	Correlation Coefficient	-0.28571	-0.41443	-0.32733	-0.428571429	-0.45047	-0.57142857	-0.75	0.6785714
	Sig. (2-tailed)	0.534509	0.355269	0.473597	0.337368311	0.310429	0.18020199	0.0521814	0.0937503
	N	7	7	7	7	7	7	7	7
September	Correlation Coefficient	0.107143	-0.09009	0.054056	-0.178571429	-0.21429	-0.85714286	-0.714286	-0.678571
	Sig. (2-tailed)	0.819151	0.847672	0.908365	0.701657943	0.644512	0.01369733	0.0713436	0.0937503
	N	7	7	7	7	7	7	7	7
October	Correlation Coefficient	0.450469	-0.14286	0.428571	-0.392857143	-0.71429	-0.46428571	-0.821429	-0.5766
	Sig. (2-tailed)	0.310429	0.759945	0.337368	0.38331687	0.071344	0.29393411	0.0234488	0.1753818
	N	7	7	7	7	7	7	7	7
November	Correlation Coefficient	0.657143	-0.17393	0.314286	-0.6	-0.67857	-0.42857143	-0.942857	-0.657143
	Sig. (2-tailed)	0.156175	0.741734	0.544093	0.208	0.09375	0.33736831	0.0048047	0.1561749
	N	6	6	6	6	7	7	6	6
December	Correlation Coefficient	-0.14286	0.714286	-0.21429	0.107142857	-0.82143	-0.07142857	-0.642857	0.6071429
	Sig. (2-tailed)	0.759945	0.071344	0.644512	0.819150856	0.023449	0.87904819	0.1193924	0.1482312
	N	7	7	7	7	7	7	7	7

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

ns denotes not significant.

[shaded box] Significant trend where $p<0.05$.

Appendix Table D.1.8: Summary of seasonal trends for station D-3, 2003 to 2009.

Season	Spearman rho	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium
January	Correlation Coefficient	0.75	.	0.018019	0.28571429	-0.714286	-0.10714286	-0.75	-0.842041
	Sig. (2-tailed)	0.052181	.	0.969415	0.53450923	0.071344	0.819150856	0.0521814	0.01746
	N	7	7	7	7	7	7	7	7
February	Correlation Coefficient	0.702731	.	0.214286	-0.14285714	-0.678571	-0.42857143	-0.25	-0.571429
	Sig. (2-tailed)	0.078237	.	0.644512	0.7599453	0.09375	0.337368311	0.58872445	0.180202
	N	7	7	7	7	7	7	7	7
March	Correlation Coefficient	0.678571	.	-0.357143	-0.21428571	-0.75	-0.28571429	-0.5	-0.214286
	Sig. (2-tailed)	0.09375	.	0.431611	0.64451158	0.052181	0.534509229	0.25317	0.644512
	N	7	7	7	7	7	7	7	7
April	Correlation Coefficient	0.535714	-0.612372	-0.142857	0	-0.321429	0.142857143	-0.8571429	-0.612372
	Sig. (2-tailed)	0.215217	0.143811	0.759945	1	0.482072	0.7599453	0.01369733	0.143811
	N	7	7	7	7	7	7	7	7
May	Correlation Coefficient	0.535714	-0.612372	-0.142857	0	-0.321429	0.142857143	-0.8571429	-0.612372
	Sig. (2-tailed)	0.215217	0.143811	0.759945	1	0.482072	0.7599453	0.01369733	0.143811
	N	7	7	7	7	7	7	7	7
June	Correlation Coefficient	0.607143	.	0.535714	0.28571429	-0.678571	0.428571429	-0.5357143	-0.178571
	Sig. (2-tailed)	0.148231	.	0.215217	0.53450923	0.09375	0.337368311	0.21521746	0.701658
	N	7	7	7	7	7	7	7	7
July	Correlation Coefficient	-0.1	0.666886	0.9	0.9	-0.3	0.666885929	-1	-0.872082
	Sig. (2-tailed)	0.872889	0.218894	0.037386	0.03738607	0.623838	0.218893981	0.000001	0.053854
	N	5	5	5	5	5	5	5	5
August	Correlation Coefficient	0.9	-0.353553	0	-0.10259784	-0.7	0	-0.4	-0.1
	Sig. (2-tailed)	0.037386	0.559404	1	0.86959792	0.18812	1	0.50463158	0.872889
	N	5	5	5	5	5	5	5	5
September	Correlation Coefficient					-0.7	0.359092423		
	Sig. (2-tailed)					0.18812	0.552814747		
	N					5	5		
October	Correlation Coefficient	0.714286	.	0.378394	0.42857143	-0.678571	0.540562478	-0.3928571	0.892857
	Sig. (2-tailed)	0.071344	.	0.402602	0.33736831	0.09375	0.210289253	0.38331687	0.006807
	N	7	7	7	7	7	7	7	7
November	Correlation Coefficient	0.857143	.	0.090094	0.0727393	-0.558581	0.285714286	-0.5225437	0.234244
	Sig. (2-tailed)	0.013697	.	0.847672	0.87684036	0.192453	0.534509229	0.22887788	0.613155
	N	7	7	7	7	7	7	7	7
December	Correlation Coefficient	0.321429	.	-0.090094	0.30631874	-0.75	0.392857143	0.28571429	0.785714
	Sig. (2-tailed)	0.482072	.	0.847672	0.50402701	0.052181	0.38331687	0.53450923	0.036238
	N	7	7	7	7	7	7	7	7

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

ns denotes not significant.

(shaded) Significant trend where p<0.05.

Appendix Table D.1.9: Summary of seasonal trends for station D-9, 2003 to 2009.

Season	Spearman rho	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium
January	Correlation Coefficient	-0.60714	-0.92857	-0.85714	-0.57142857	0.844357	-0.72074997	-0.78571	-0.85714
	Sig. (2-tailed)	0.148231	0.002519	0.013697	0.180201989	0.016849	0.067634995	0.036238	0.013697
	N	7	7	7	7	7	7	7	7
April/May	Correlation Coefficient	0.774806	-0.43245	-0.25226	0.607142857	-0.03706	0.926561646	0.5	0.222718
	Sig. (2-tailed)	0.040769	0.332527	0.585241	0.148231161	0.937124	0.002697476	0.25317	0.63121
	N	7	7	7	7	7	7	7	7
July	Correlation Coefficient	0.581914	-0.64286	-0.82143	-0.42857143	0.738769	-0.95499371	-0.39286	-0.32143
	Sig. (2-tailed)	0.170495	0.119392	0.023449	0.337368311	0.057858	0.000805535	0.383317	0.482072
	N	7	7	7	7	7	7	7	7
October	Correlation Coefficient	0.846881	-0.85714	-0.39286	0.25	-0.21822	-0.46428571	0	-0.68471
	Sig. (2-tailed)	0.016197	0.013697	0.383317	0.588724448	0.638299	0.293934108	1	0.089666
	N	7	7	7	7	7	7	7	7

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).
ns denotes not significant.
[shaded] Significant trend where p<0.05.

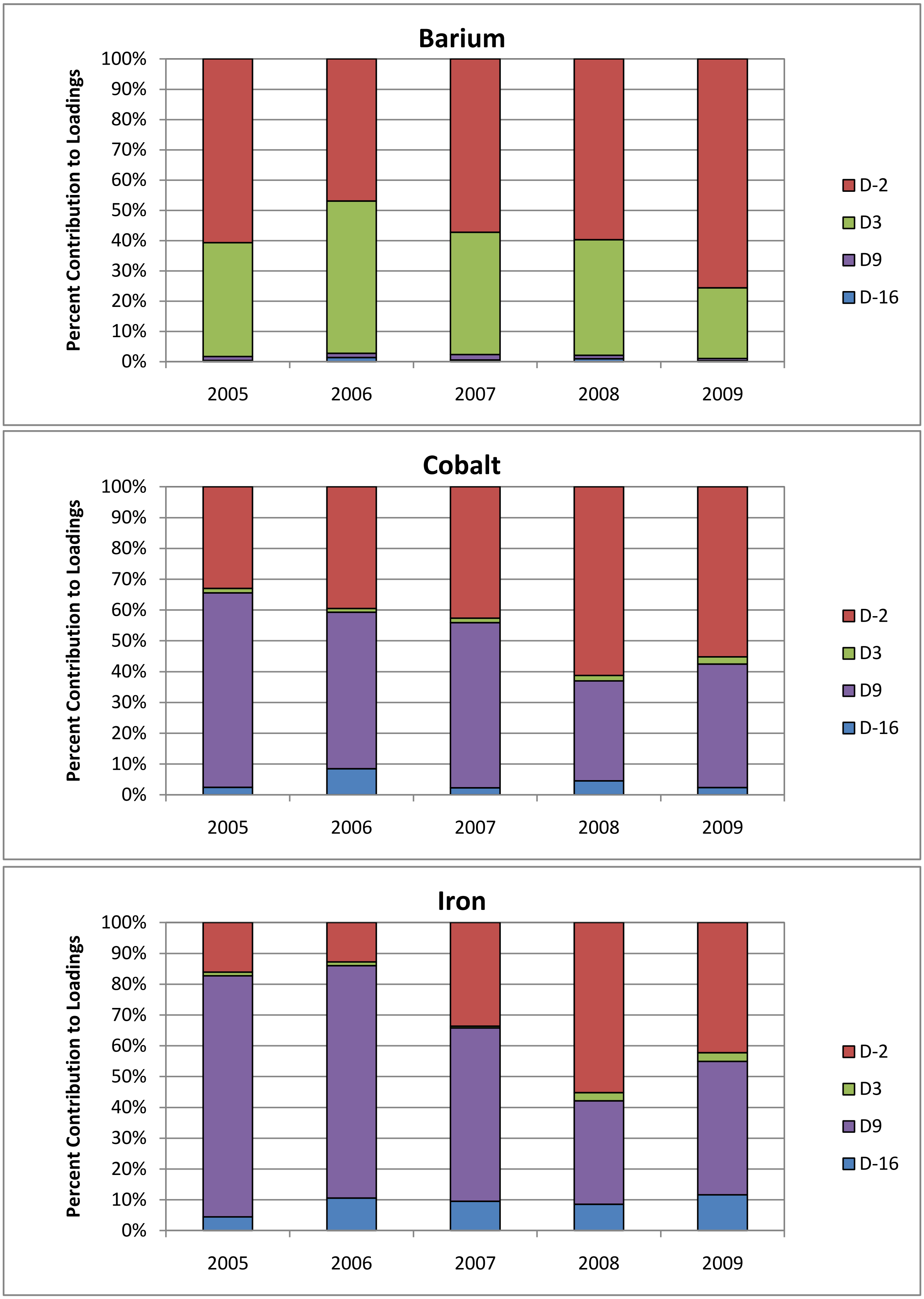
Appendix Table D.1.10: Summary of seasonal trends for station D-16, 2003 to 2009.

Season	Spearman rho	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate
January	Correlation Coefficient	-0.84688	-0.25	0.107143	-0.321428571	0.363696	-0.66669372	-0.75
	Sig. (2-tailed)	0.016197	0.588724	0.819151	0.482072038	0.422582	0.10192046	0.052181
	N	7	7	7	7	7	7	7
April/May	Correlation Coefficient	-0.16217	-0.89286	0.285714	-0.75	0.846881	-0.85468674	-0.28571
	Sig. (2-tailed)	0.7283	0.006807	0.534509	0.0521814	0.016197	0.014273916	0.534509
	N	7	7	7	7	7	7	7
July	Correlation Coefficient	-0.32143	-0.78571	0.357143	0.357142857	0.672838	-0.59461873	-0.42857
	Sig. (2-tailed)	0.482072	0.036238	0.431611	0.431611352	0.097649	0.159089994	0.337368
	N	7	7	7	7	7	7	7
October	Correlation Coefficient	0.25	-0.35714	0.392857	0.428571429	0.630062	-0.14285714	-0.10714
	Sig. (2-tailed)	0.588724	0.431611	0.383317	0.337368311	0.12936	0.7599453	0.819151
	N	7	7	7	7	7	7	7

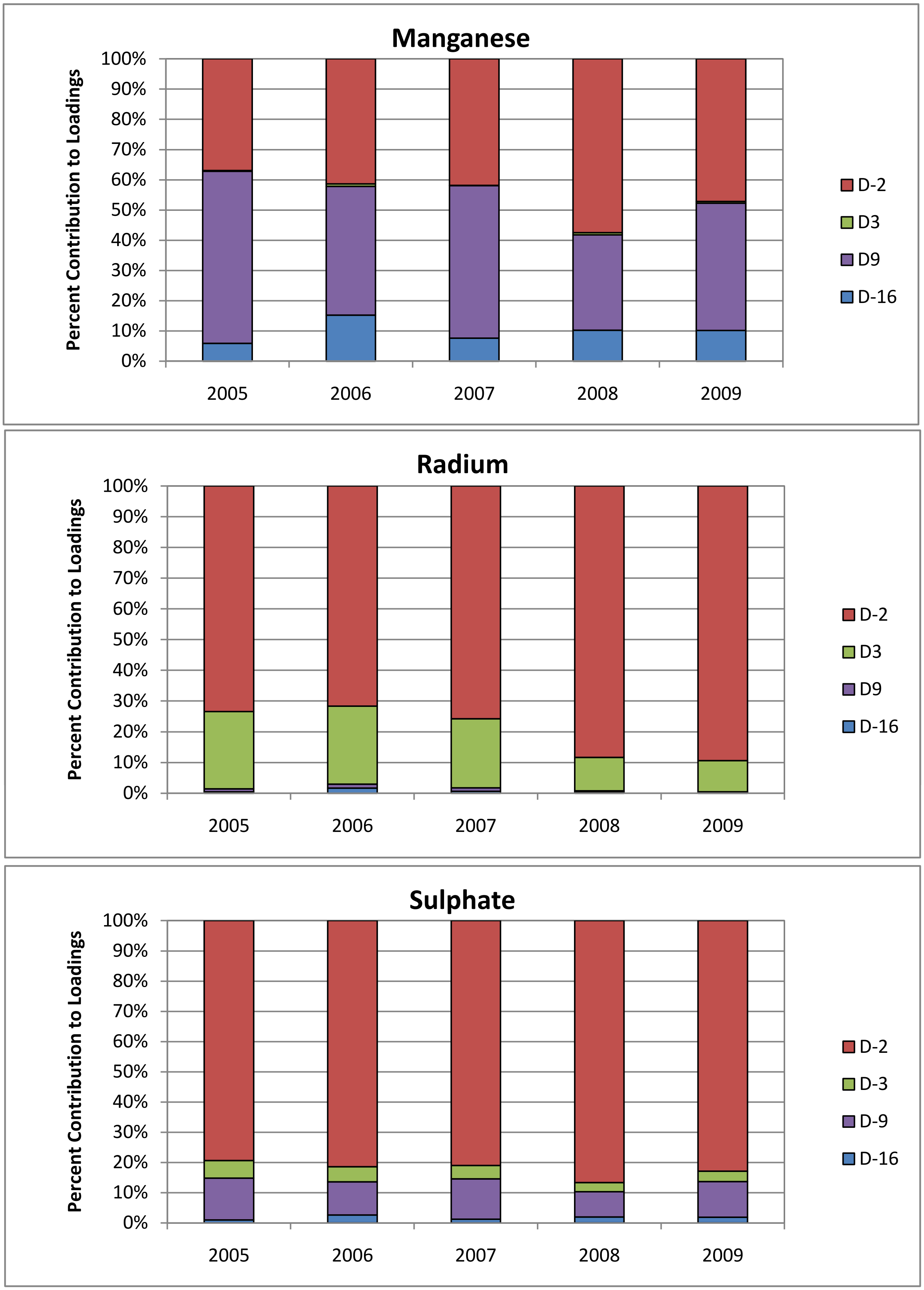
Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

ns denotes not significant.

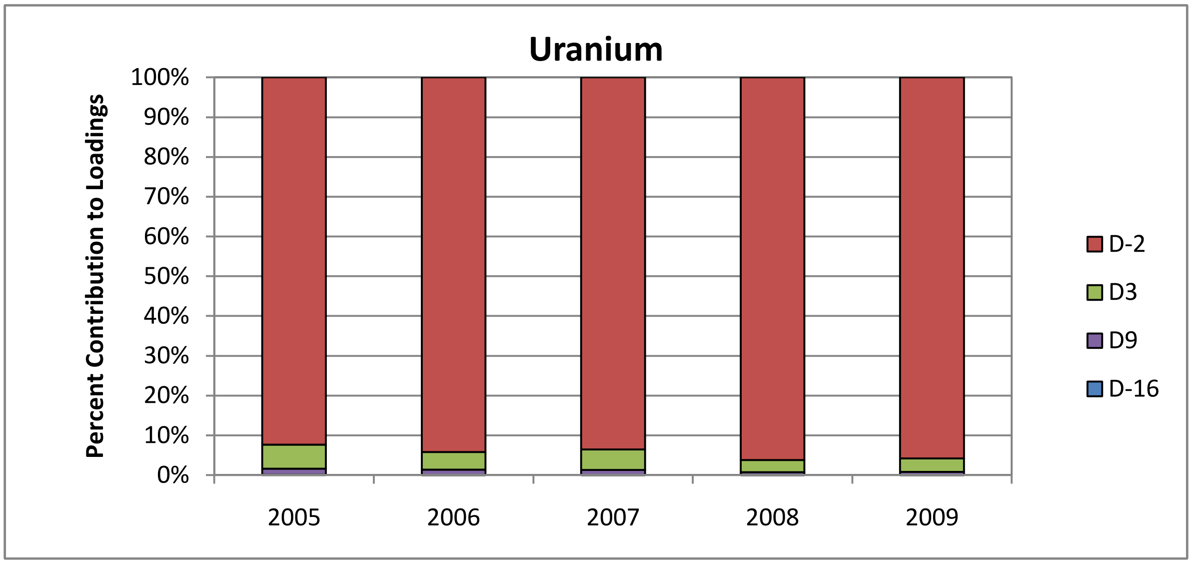
(shaded) Significant trend where p<0.05.



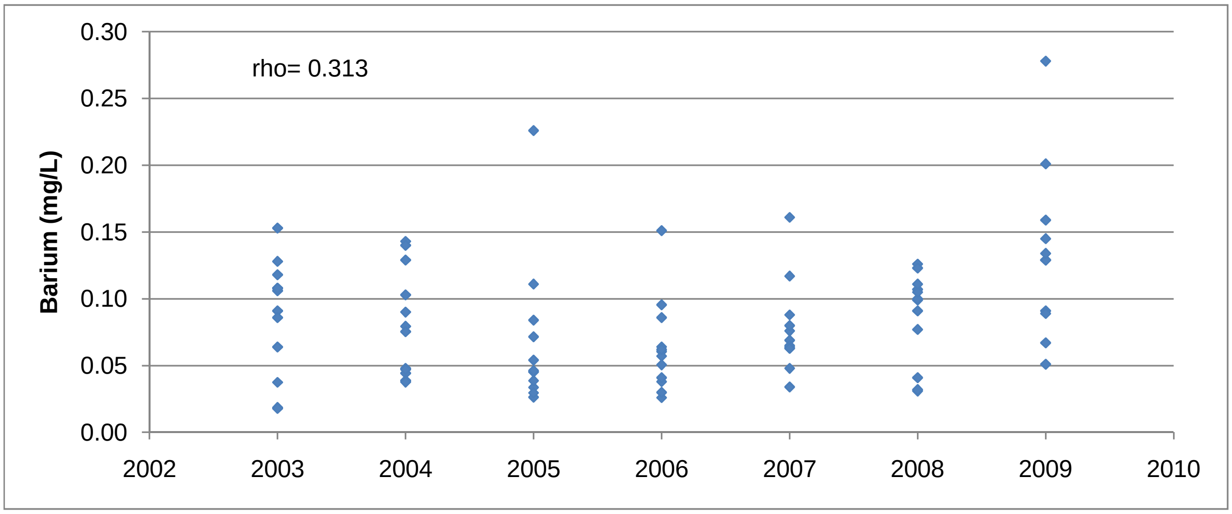
Appendix Figure D.1.1: Percent contribution to loads from Denison TMA discharge points.

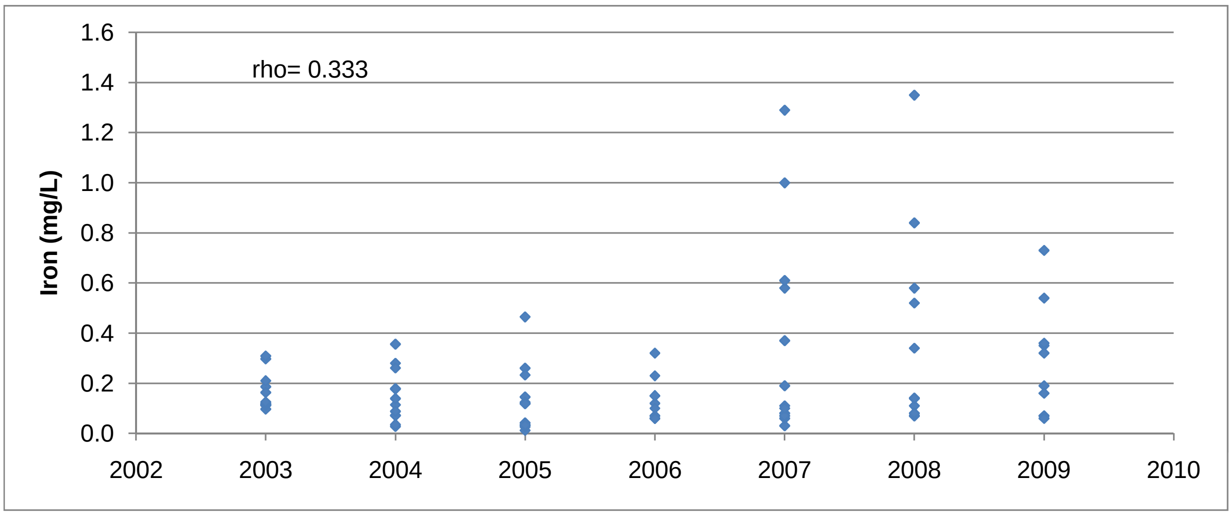


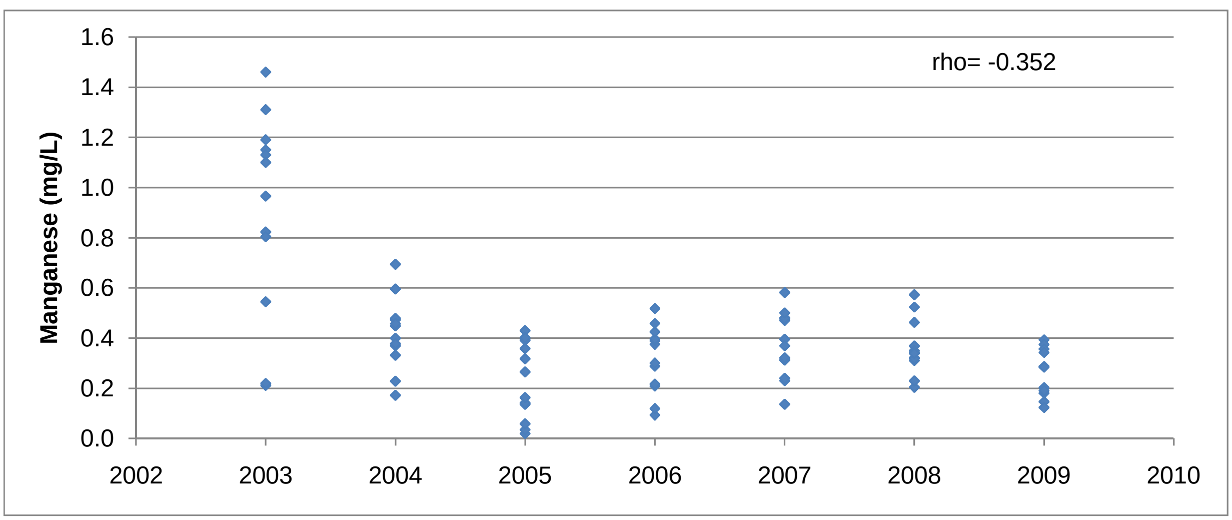
Appendix Figure D.1.1: Percent contribution to loads from Denison TMA discharge points.



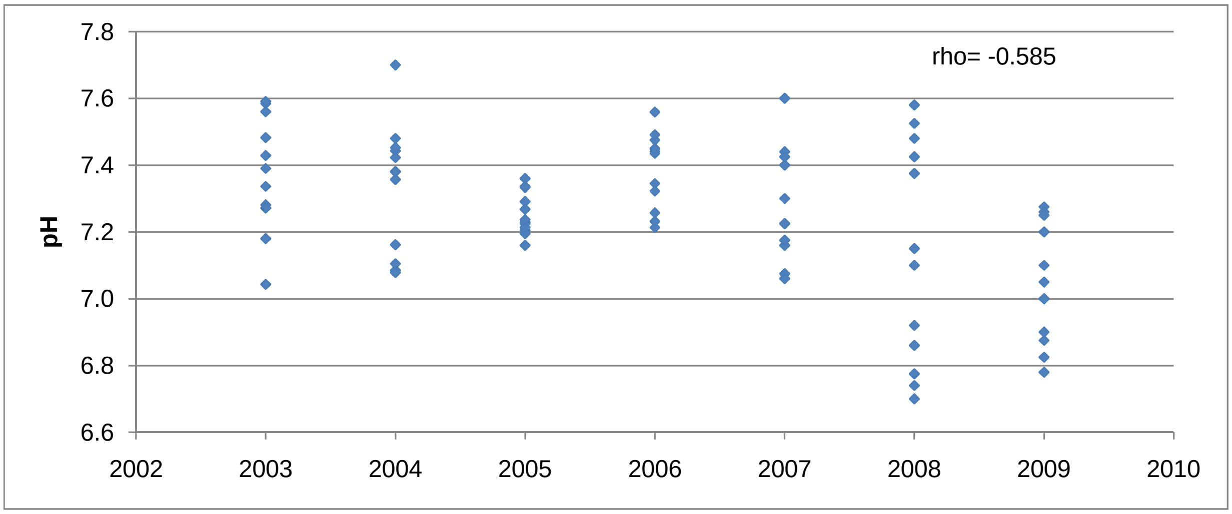
Appendix Figure D.1.1: Percent contribution to loads from Denison TMA discharge points.

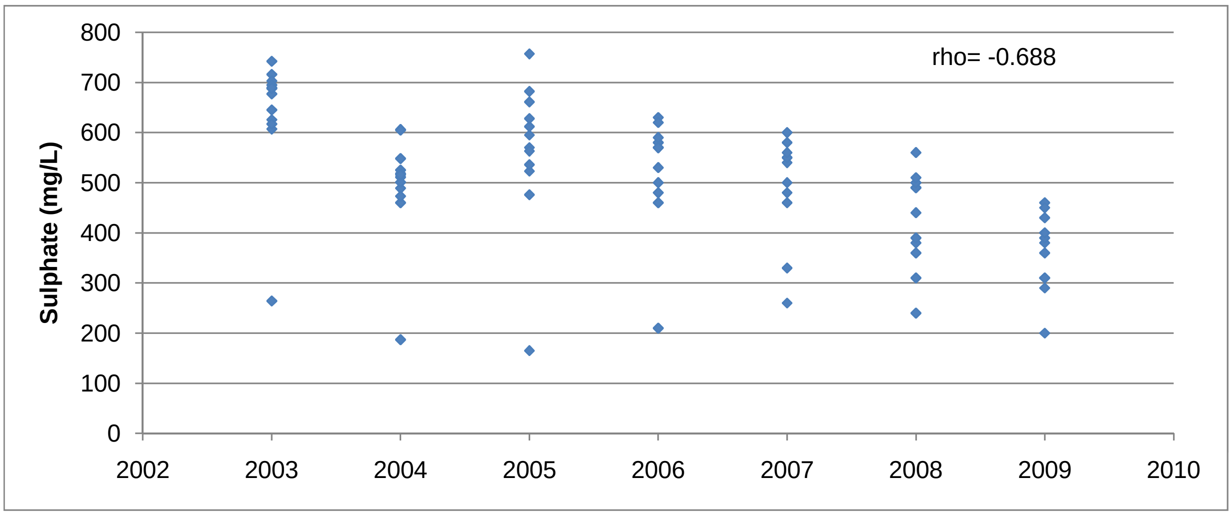




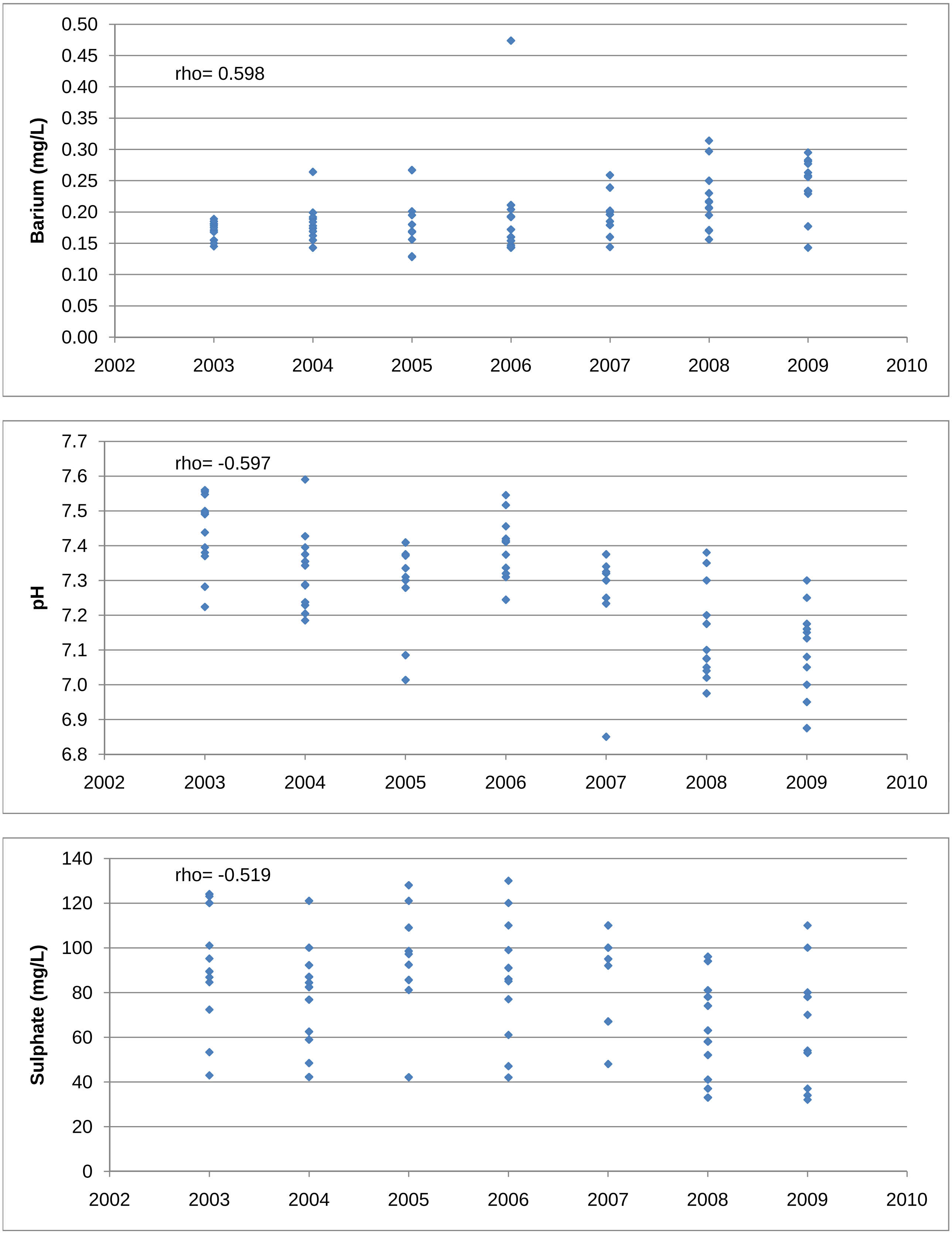


Appendix Figure D.1.2: Significant common (average) trends observed for barium, iron, manganese, pH and sulphate over all seasons at station D-2, 2003 to 2009.

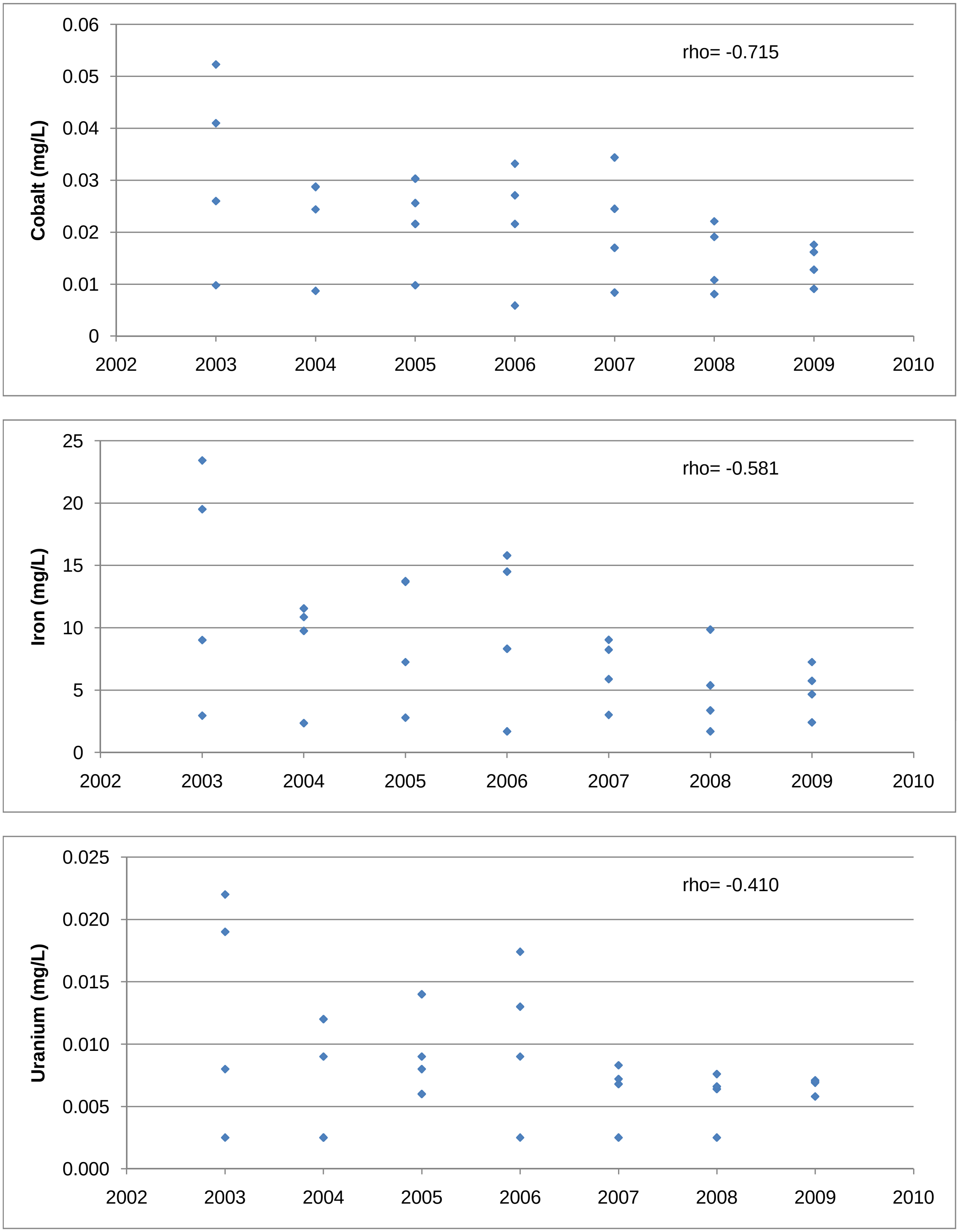




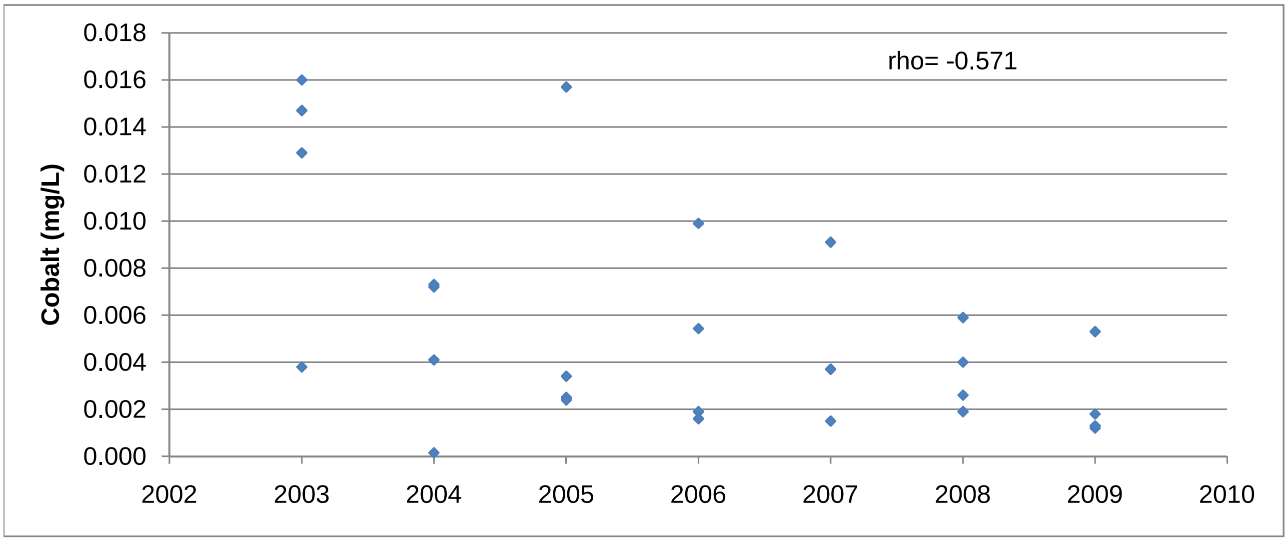
Appendix Figure D.1.2: Significant common (average) trends observed for barium, iron, manganese, pH and sulphate over all seasons at station D-2, 2003 to 2009.

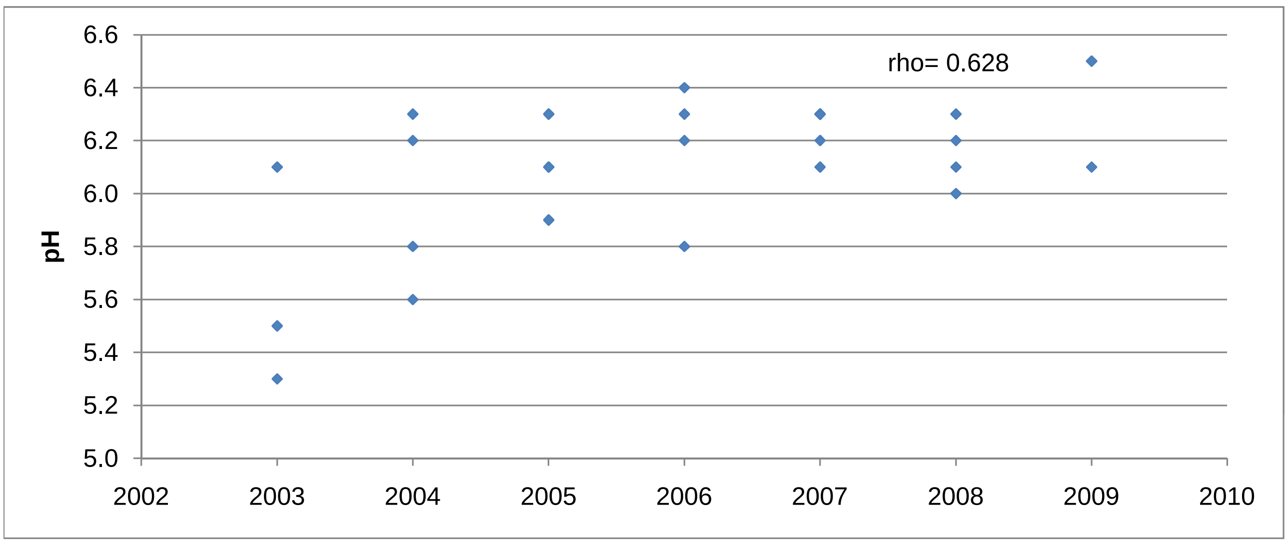


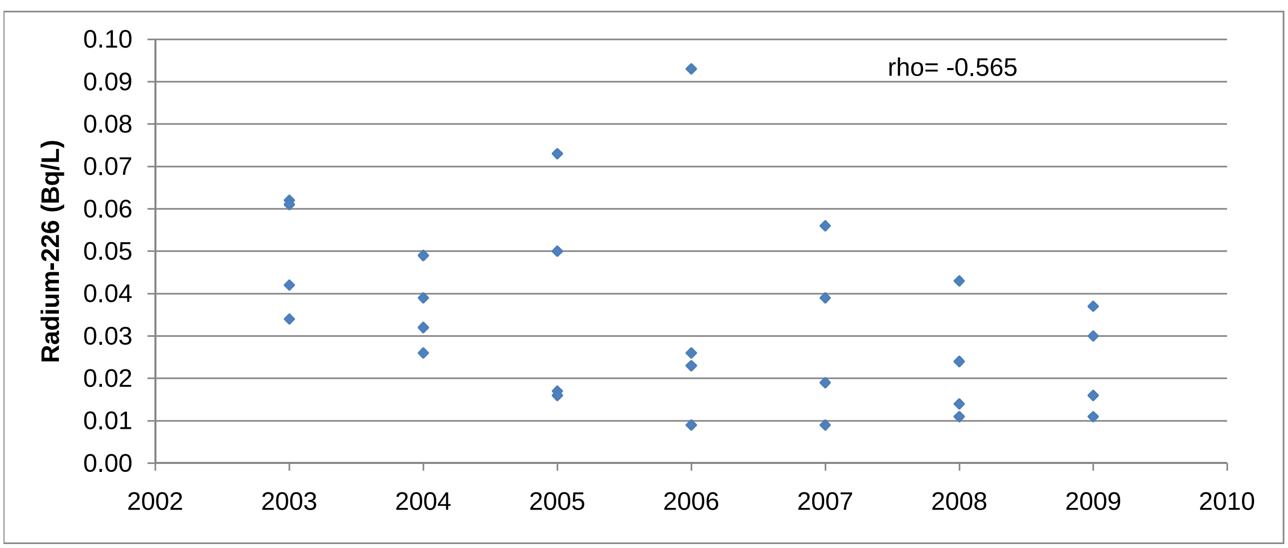
Appendix Figure D.1.3: Significant common (average) trends observed for barium, pH and sulphate over all seasons at station D-3, 2003 to 2009.



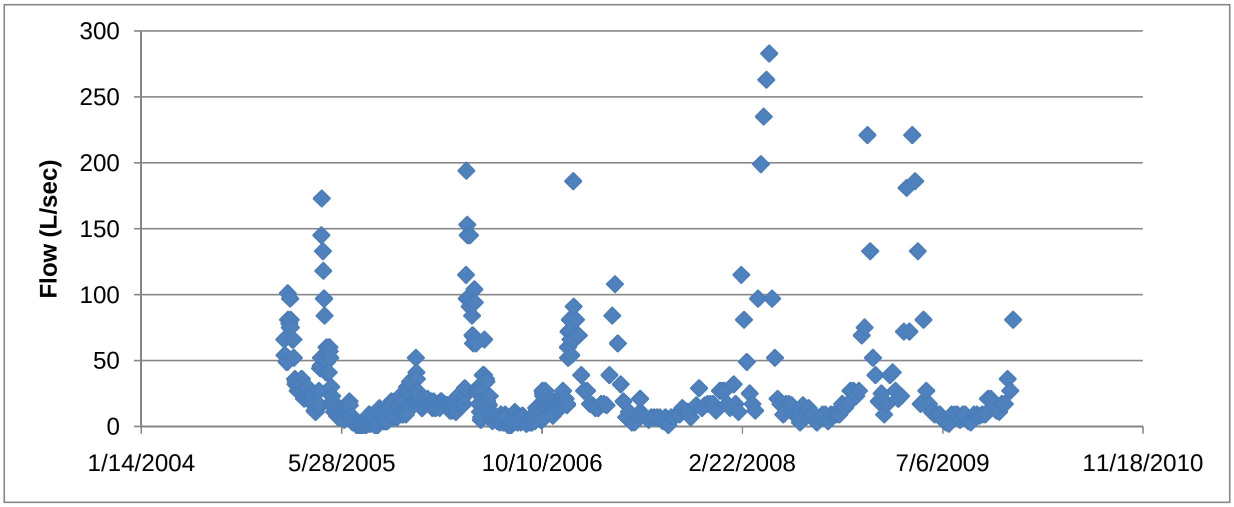
Appendix Figure D.1.4: Significant common (average) trends observed for cobalt, iron and uranium over all seasons at station D-9, 2003 to 2009.



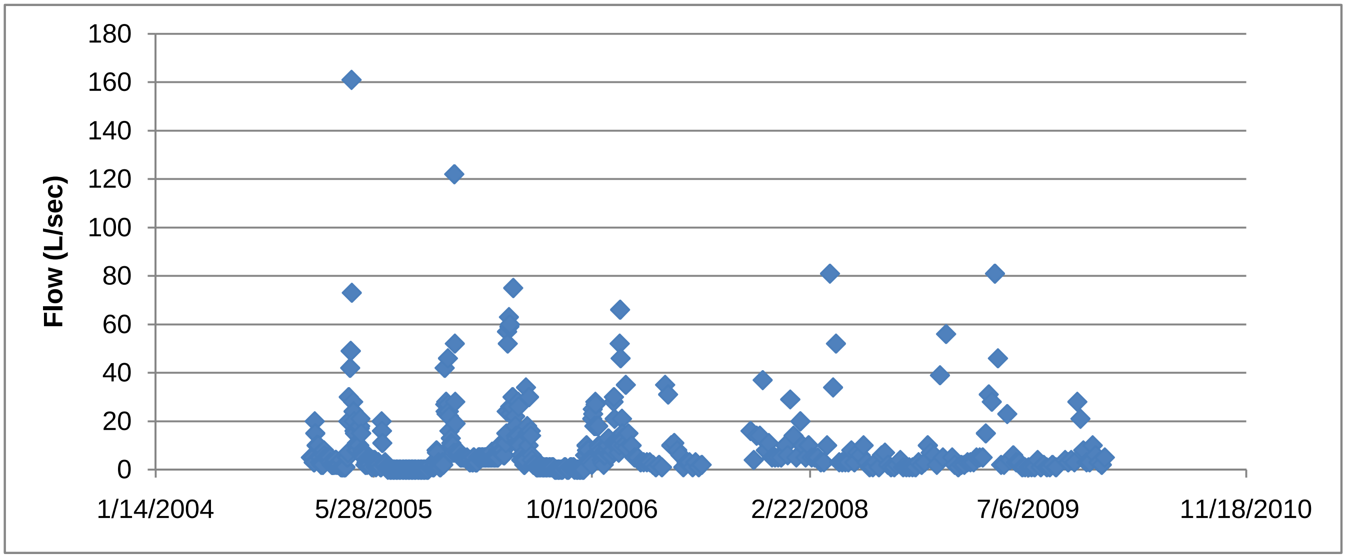




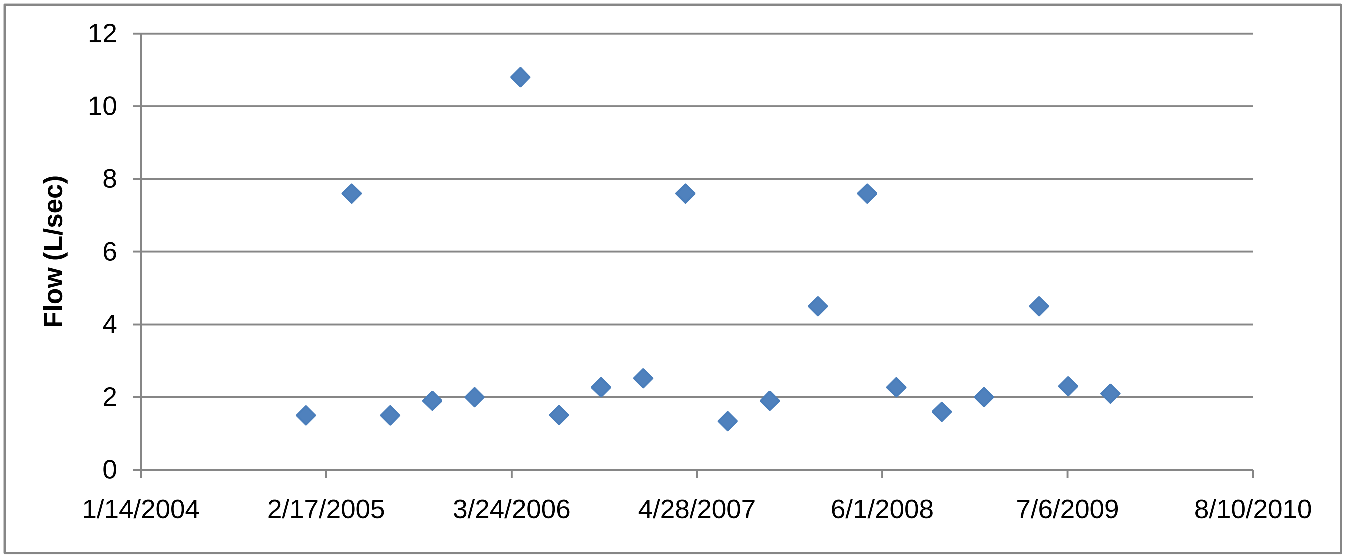
Appendix Figure D.1.5: Significant common (average) trends observed for cobalt, pH and radium-226 over all seasons at station D-16, 2003 to 2009.



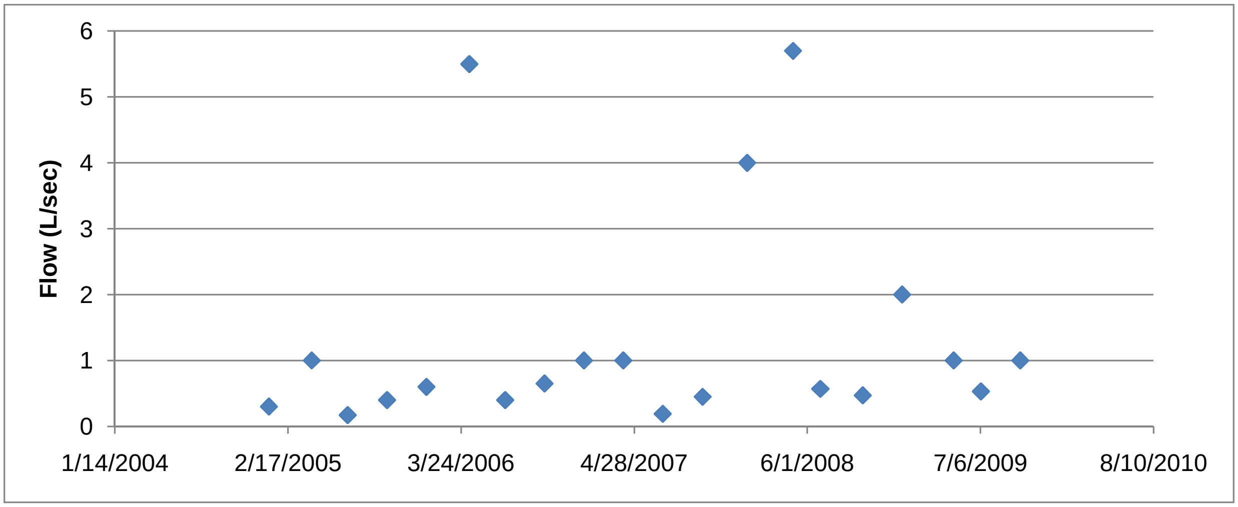
Appendix Figure D.1.6: Flows at station D-2 from 2005 to 2009.



Appendix Figure D.1.7: Flows at station D-3 from 2005 to 2009.



Appendix Figure D.1.8: Flows at station D-9 from 2005 to 2009.



Appendix Figure D.1.9: Flows at station D-16 from 2005 to 2009.

APPENDIX D.2
Quirke TMA

Appendix Table D.2.1: Water quality at station ECA-398 from 2005 to 2009.

Date	Ag (mg/L)	Ba (mg/L)	Co (mg/L)	Conductivity (µmho/cm)	Fe (mg/L)	Mn (mg/L)	pH	Ra (Bq/L)	Se (mg/L)	SO4 (mg/L)	U (mg/L)
1/10/2005	0.0008	0.012	0.109	341.3	0.148	1.03	4	0.063	< 0.0003	441	0.489
2/14/2005	0.0013	0.013	0.115	315.6	0.175	1.04	4	0.12	< 0.0003	392	0.52
3/14/2005	< 0.0006	0.0118	0.111	333.5	0.156	1.22	4.1	0.074	< 0.0003	396	0.433
4/11/2005	0.00026	0.012	0.0738	233	0.174	0.585	4	0.087	0.0009	377	0.341
5/9/2005	0.00015	0.0207	0.115	342.5	0.177	0.925	3.9	0.044	0.0007	343	0.476
6/13/2005	0.00025	0.0134	0.0855	485	0.147	0.897	4	0.057	0.0003	414	0.545
11/16/2005	0.00013	0.023	0.173	457	0.288	1.41	3.8	0.11	0.0004	588	0.755
12/12/2005	0.00014	0.0117	0.0053	83.6	0.058	0.0724	6.4	0.031	0.0005	51.7	0.026
1/9/2006	< 0.0001	0.012	0.152	349.8	0.19	1.36	4.1	0.036	0.0023	360	0.498
2/13/2006	< 0.0001	0.012	0.127	349.5	0.2	1.25	4.2	0.021	0.001	390	0.457
3/13/2006	< 0.0001	0.012	0.122	373.7	0.2	1.32	4.1	0.022	0.0009	380	0.441
4/10/2006	< 0.0001	0.0142	0.115	308	0.22	0.728	4	0.042	0.001	210	0.374
5/8/2006	< 0.0001	0.0146	0.104	340.2	0.17	0.811	4.1	0.045	0.0009	240	0.41
6/12/2006	< 0.0001	0.0171	0.122	405.4	0.27	1	4.1	0.025	< 0.0004	280	0.464
11/13/2006	< 0.0001	0.016	0.151	395.1	0.24	1.28	4.1	0.044	< 0.0004	330	0.486
12/11/2006	< 0.0001	0.017	0.137	339.8	0.2	1.08	4.1	0.039	< 0.0004	310	0.484
1/8/2007		0.016	0.1170		0.20	0.831	4.1	0.043		300.0	0.4080
2/12/2007		0.017	0.1070		0.17	1.070	4.2	0.029		290.0	0.3870
3/12/2007		0.017	0.1250		0.18	1.220	4.3	0.027		330.0	0.4480
4/9/2007		0.016	0.1010		0.17	0.848	4.1	0.036		220.0	0.3650
5/3/2007		0.014	0.1030		0.16	0.898	4.0	0.062		250.0	0.3650
6/11/2007		0.019	0.1150		0.20	1.120	4.0	0.047		280.0	0.4190
10/9/2007		0.025	0.1230		0.28	1.290	3.9	0.092		350.0	0.5600
1/14/2008		0.020	0.1310		0.21	0.914	3.9	0.055		260.0	0.4540
4/14/2008		0.020	0.0960		0.23	0.640	4.0	0.055		210.0	0.3410
7/7/2008		0.023	0.1010		0.34	0.897	4.0	0.053		250.0	0.3970
11/20/2008		0.019	0.1110		0.28	1.480	4.1	0.044		290.0	0.3920
1/12/2009		0.016	0.0958		0.21	1.020	4.2	0.038		240.0	0.2890
4/13/2009		0.015	0.0872		0.18	0.744	4.0	0.088		170.0	0.2510
7/13/2009		0.026	0.0828		0.27	0.894	4.3	0.028		220.0	0.2940
10/13/2009		0.023	0.1060		0.39	1.310	4.0	0.040		290.0	0.3730
Number	16	31	31	16	31	31	31	31	16	31	31
Minimum	0.0001	0.0117	0.0053	83.6	0.058	0.0724	3.8	0.021	0.0003	51.7	0.026
Maximum	0.0013	0.026	0.173	485	0.39	1.48	6.4	0.12	0.0023	588	0.755
Mean	0.0003	0.017	0.1103	340.8	0.21	1.006	4.1	0.052	0.0007	304.9	0.4175
Median	0.0001	0.016	0.1110	341.9	0.20	1.020	4.1	0.044	0.0005	290.0	0.4190
10th Perc.	0.0001	0.012	0.0855	270.5	0.16	0.728	3.9	0.027	0.0003	210.0	0.2940

Appendix Table D.2.2: Water quality at station Q-22 from 2005 to 2009.

Date	Ag (mg/L)	Ba (mg/L)	Co (mg/L)	Conductivity (µmho/cm)	Fe (mg/L)	Mn (mg/L)	pH	Ra (Bq/L)	Se (mg/L)	SO4 (mg/L)	U (mg/L)
1/10/2005	< 0.0006	0.012	0.0045	78.1	0.062	0.076	6.6	0.03	0.0003	46.5	0.044
4/11/2005	< 0.00006	0.0063	0.0023	36.2	0.05	0.0288	6.1	0.027	< 0.0003	23.7	0.026
7/11/2005	0.00025	0.0168	0.0169	261.5	0.175	0.425	6	0.061	< 0.0003	151	0.111
10/11/2005	0.00011	0.0174	0.0124	191.9	0.145	0.439	6	0.052	< 0.0003	109	0.069
1/9/2006	< 0.0001	0.012	0.0048	75.2	0.06	0.0782	6.7	0.029	0.0008	44	0.0325
4/10/2006	< 0.0001	0.0113	0.00685	74.6	0.06	0.0617	6.4	0.025	0.0008	39	0.0465
7/17/2006	< 0.0001	0.029	0.0235	293.5	0.38	0.585	6	0.066	< 0.0004	160	0.103
10/10/2006	< 0.0001	0.019	0.015	184.3	0.19	0.376	6.2	0.05	< 0.0004	100	0.0695
1/8/2007		0.012	0.0036		0.06	0.045	6.9	0.019		34.0	0.0274
4/9/2007		0.011	0.0036		0.04	0.048	7.0	0.018		31.0	0.0298
7/9/2007		0.042	0.0204		0.22	0.540	5.7	0.081		180.0	0.0899
10/9/2007		0.021	0.0055		0.15	0.154	6.1	0.062		71.0	0.0634
1/14/2008		0.010	0.0026		0.05	0.028	6.8	0.018		24.0	0.0225
4/14/2008		0.009	0.0036		0.04	0.036	6.5	0.014		25.0	0.0282
7/7/2008		0.019	0.0057		0.17	0.108	6.4	0.036		54.0	0.0396
10/8/2008		0.027	0.0187		0.48	0.637	6.2	0.061		130.0	0.0656
1/12/2009		0.011	0.0032		0.08	0.063	6.5	0.015		31.0	0.0235
4/13/2009		0.012	0.0044		0.06	0.055	6.8	0.024		29.0	0.0269
7/13/2009		0.021	0.0103		0.10	0.252	6.5	0.038		93.0	0.0458
10/13/2009		0.016	0.0054		0.19	0.157	6.6	0.033		50.0	0.0410
Number	8	20	20	8	20	20	20	20	8	20	20
Minimum	0.00006	0.0063	0.0023	36.2	0.04	0.028	5.7	0.014	0.0003	23.7	0.0225
Maximum	0.0006	0.042	0.0235	293.5	0.48	0.637	7	0.081	0.0008	180	0.111
Mean	0.00018	0.017	0.0087	149.4	0.14	0.210	6.4	0.038	0.0005	71.3	0.0503
Median	0.00010	0.014	0.0055	131.2	0.09	0.093	6.5	0.032	0.0004	48.3	0.0425
10th Perc.	0.000088	0.010	0.0031	63.1	0.05	0.035	6.0	0.018	0.0003	24.9	0.0258

Appendix Table D.2.3: Water quality at station Q-23 from 2005 to 2009.

Date	Ag (mg/L)	Ba (mg/L)	Co (mg/L)	Conductivity (µmho/cm)	Fe (mg/L)	Mn (mg/L)	pH	Ra (Bq/L)	Se (mg/L)	SO4 (mg/L)	U (mg/L)
1/20/2005	< 0.0006	0.0277	0.0006	25.2	0.349	0.108	5.8	0.013	< 0.0003	8.08	< 0.005
4/21/2005	0.00012	0.0186	0.0005	18.2	0.199	0.0482	5.9	0.007	0.0004	4.86	< 0.005
10/20/2005	< 0.00006	0.0223	0.0005	22.8	0.375	0.0631	6	< 0.005	< 0.0003	4.66	< 0.005
1/19/2006	< 0.0001	0.036	0.001	30.9	0.56	0.116	5.8	0.005	< 0.0004	6.6	< 0.0005
4/20/2006	< 0.0001	0.0218	< 0.0005	18.3	0.15	0.0302	5.8	< 0.005	< 0.0004	4.4	< 0.0005
8/28/2006	< 0.0001	0.033	0.0015	31.5	1.07	0.194	5.9	< 0.005	< 0.0004	2.4	< 0.0005
10/19/2006	< 0.0001	0.026	0.0008	16	0.18	0.043	5.5	< 0.005	< 0.0004	5.4	< 0.0005
1/17/2007		0.027	0.0006		0.33	0.031	5.8	< 0.005		5.2	< 0.0005
4/19/2007		0.022	< 0.0005		0.21	0.032	6.1	0.008		4.8	< 0.0005
7/31/2007		0.028	0.0016		1.10	0.183	5.9	< 0.005		2.3	< 0.0005
10/17/2007		0.026	0.0006		0.44	0.046	5.8	0.005		3.9	< 0.0005
1/17/2008		0.025	0.0007		0.36	0.059	5.7	< 0.005		5.6	< 0.0005
4/22/2008		0.017	0.0006		0.12	0.031	5.6	< 0.005		4.0	< 0.0005
7/10/2008		0.034	0.0022		1.40	0.186	5.7	< 0.005		2.1	< 0.0005
10/8/2008		0.029	0.0009		0.89	0.096	6.1	< 0.005		1.6	< 0.0005
2/5/2009		0.027	0.0010		0.79	0.095	6.2	< 0.005		4.7	< 0.0005
5/5/2009		0.021	0.0007		0.19	0.025	5.8	< 0.005		4.6	< 0.0005
7/22/2009		0.025	0.0009		0.89	0.099	5.7	< 0.005		1.8	< 0.0005
10/21/2009		0.020	< 0.0005		0.33	0.023	5.6	< 0.005		7.9	< 0.0005
Number	7	19	19	7	19	19	19	19	7	19	19
Minimum	0.00006	0.017	0.0005	16	0.12	0.023	5.5	0.005	0.0003	1.6	0.0005
Maximum	0.0006	0.036	0.0022	31.5	1.4	0.194	6.2	0.013	0.0004	8.08	0.005
Mean	0.00017	0.026	0.0009	23.3	0.523	0.079	5.8	0.006	0.0004	4.47	0.0012
Median	0.00010	0.026	0.0007	22.8	0.360	0.059	5.8	0.005	0.0004	4.66	0.0005
10th Perc.	0.00008	0.020	0.0005	17.3	0.174	0.029	5.6	0.005	0.0003	2.04	0.0005

Appendix Table D.2.4: Water quality at station Q-27 from 2005 to 2009.

Date	Ag (mg/L)	Ba (mg/L)	Co (mg/L)	Conductivity (µmho/cm)	Fe (mg/L)	Mn (mg/L)	pH	Ra (Bq/L)	Se (mg/L)	SO4 (mg/L)	U (mg/L)
1/23/2003	< 0.0006	0.0901	0.0271	241.5	43.05	3.58	6.2	0.009	< 0.0003	172	< 0.005
4/24/2003	< 0.0006	0.0716	0.0493	332.4	14.87	2.99	5.2	0.018	< 0.0003	321	0.007
7/24/2003	< 0.0006	0.0549	0.011	212.8	0.593	0.918	5.9	0.009	0.0004	78	< 0.005
10/22/2003	< 0.0006	0.103	0.0391	364.3	29	3.69	6	0.029	< 0.0003	233	< 0.005
1/22/2004	< 0.0006	0.0766	0.0206	110.6	27.82	1.63	6.1	0.021	< 0.0003	65.1	0.006
4/22/2004	0.0013	0.0702	0.0425	334.2	14.97	2.82	5.3	0.016	< 0.0003	309	< 0.005
7/22/2004	< 0.0006	0.0613	0.0208	338.6	22.78	2.12	5.9	0.011	< 0.0003	166	< 0.005
10/20/2004	0.0014	0.0726	0.016	335.5	10.44	2.03	5.7	0.01	< 0.0003	229	< 0.005
1/20/2005	0.0012	0.0682	0.0368	312.3	37.69	2.82	5.7	0.03	< 0.0003	267	0.01
4/21/2005	0.00032	0.0764	0.0527	491	21.99	3.6	6.9	0.012	< 0.0003	367	< 0.005
10/20/2005	0.00068	0.0884	0.0186	445.3	18.55	2.98	5.7	0.019	0.0007	345	< 0.005
1/19/2006	< 0.0001	0.077	0.0265	232.7	28.9	2.86	5.2	0.009	< 0.0004	190	0.0031
4/20/2006	< 0.0001	0.0841	0.0556	483	23.8	4.01	5.4	0.018	< 0.0004	330	0.00411
7/20/2006	< 0.0001	0.081	0.0152	267.3	20.1	1.63	6.1	0.012	< 0.0004	120	0.0012
10/19/2006	< 0.0001	0.119	0.0481	489	27.2	3.39	6.3	0.02	< 0.0004	330	0.0018
1/17/2007		0.079	0.0413		25.70	3.250	5.9	0.012		260.0	0.0027
4/19/2007		0.076	0.0526		22.00	3.230	5.5	0.009		320.0	0.0034
10/17/2007		0.209	0.0402		21.00	4.350	5.7	0.032		370.0	0.0017
1/17/2008		0.105	0.0449		21.30	3.270	5.5	0.011		340.0	0.0019
4/22/2008		0.130	0.0329		11.70	2.280	5.4	0.008		210.0	0.0013
8/14/2008		0.110	0.0330		22.70	2.640	5.8	0.014		260.0	0.0018
11/20/2008		0.095	0.0168		16.50	2.280	6.0	0.010		180.0	0.0016
5/5/2009		0.090	0.0439		18.30	3.240	5.4	0.008		370.0	0.0025
11/19/2009		0.130	0.0306		22.80	3.030	5.8	0.021		270.0	0.0016
Number	15	24	24	15	24	24	24	24	15	24	24
Minimum	0.0001	0.0549	0.011	110.6	0.593	0.918	5.2	0.008	0.0003	65.1	0.0012
Maximum	0.0014	0.209	0.0556	491	43.05	4.35	6.9	0.032	0.0007	370	0.01
Mean	0.00059	0.092	0.0340	332.7	21.82	2.860	5.8	0.015	0.0004	254.3	0.0038
Median	0.00060	0.083	0.0349	334.2	22.00	2.985	5.8	0.012	0.0003	263.5	0.0038
10th Perc.	0.00010	0.069	0.0162	220.8	12.65	1.750	5.3	0.009	0.0003	133.8	0.0016

Appendix Table D.2.5: Water quality at station Q-28 from 2005 to 2009.

Date	Acidity (mg/L)	Ag (mg/L)	Ba (mg/L)	Co (mg/L)	Conductivity (µmho/cm)	Cu (mg/L)	Fe (mg/L)	Mn (mg/L)	Ni (mg/L)	Pb (mg/L)	pH	Ra (Bq/L)	Se (mg/L)	SO4 (mg/L)	TSS (mg/L)	U (mg/L)	Zn (mg/L)
1/4/2005		0.0025	0.065	0.02	1064	0.01	1.24	2.32	0.0134	0.0059	7.3	0.22	< 0.0003	1279	3	0.021	0.005
1/10/2005					1139						7.2	0.22			3		
1/17/2005					1233						7.4	0.14			3		
1/24/2005					1332						8.2	0.17			3		
1/31/2005					1212						8.1	0.16			4		
2/7/2005		0.0016	0.0686	0.021	1097	0.02	1.14	2.24	0.014	0.0069	7.9	0.19	< 0.0003	1227	3	0.025	0.003
2/14/2005					1271						8.1	0.16			2		
2/21/2005					1168						8.2	0.077			1		
2/28/2005					1126						8.2	0.08			1		
3/7/2005		0.002	0.0741	0.0193	1586	< 0.001	0.715	3.17	0.0153	0.0046	8.1	0.11	< 0.0003	1321	2	0.027	0.003
3/14/2005					1138						8.4	0.11			1		
3/21/2005					1466						8.3	0.063			1		
3/28/2005					1263						8	0.11			2		
4/4/2005		0.00146	0.0673	0.0155	1111	< 0.001	0.739	1.81	0.0108	0.0016	7.3	0.05	0.0009	1253	3	0.024	0.002
4/11/2005					942						7.4	0.043			2		
4/18/2005					1164						7.6	0.039			1		
4/25/2005					979						7.6	0.021			< 1		
5/2/2005		0.00058	0.0775	0.0135	919	< 0.001	0.215	1.69	0.0097	< 0.0006	7.4	0.019	0.0008	832	< 1	0.022	0.002
5/9/2005					1325						7.4	0.031			< 1		
5/16/2005					949						7.4	0.049			1		
5/24/2005					1302						7.4	0.029			< 1		
5/30/2005					1305						7.4	0.033			< 1		
6/6/2005		0.0008	0.0731	0.0065	1465	< 0.001	0.235	1.16	0.0096	0.0018	7.5	0.069	0.0003	1009	< 1	0.022	0.001
6/13/2005					1627						7.6	0.095			1		
6/20/2005					1431						7.7	0.1			1		
6/27/2005					1687						7.5	0.06			1		
7/4/2005		0.00145	0.0664	0.0033	1594	0.015	0.154	0.722	0.0054	< 0.0006	7.7	0.091	0.0004	1214	1	0.021	0.006
7/11/2005					1765						7.7	0.089			1		
7/18/2005					1795						7.6	0.061			2		
7/25/2005					1850						7.5	0.028			1		
8/2/2005		0.0007	0.0611	0.0029	1793	< 0.001	0.189	0.661	0.0041	< 0.0006	7.6	0.06	0.0006	1258	1	0.032	0.005
8/8/2005					1843						7.6	0.036			2		
8/15/2005					1689						7.7	0.041			1		
8/22/2005					1589						7.7	0.03			1		
8/29/2005					1751						7.7	0.033			1		
9/6/2005		0.00151	0.0516	0.0023	1771	< 0.001	0.26	0.538	0.0031	< 0.0006	7.7	0.035	0.0008	1438	< 1	0.049	0.01
9/12/2005					1774						7.9	0.038			1		
9/19/2005					1757						7.7	0.029			1		
9/26/2005					1651						7.6	0.053			< 1		
10/3/2005		0.00139	0.0528	0.0022	1575	< 0.001	0.238	0.449	0.0035	< 0.0006	7.7	0.031	0.0009	1596	1	0.036	0.011
10/11/2005					1470						7.7	0.067			< 1		
10/17/2005					1345						7.4	0.091			1		
10/24/2005					1244						7.4	0.063			1		
10/31/2005					1382						7.4	0.051			1		
11/7/2005	6	0.00055	0.0645	0.008	1310	< 0.001	0.234	1.47	0.0079	< 0.0006	7.5	0.072	< 0.0003	1273	1	0.032	0.004
11/14/2005					1117						7.4	0.061			1		
11/21/2005					1135						7.6	0.078			1		
11/28/2005					1209						8	0.24			4		
12/5/2005	6	0.0016	0.0743	0.0174	1206	0.002	0.868	2.49	0.0136	< 0.0006	7.3	0.24	0.0011	1329	3	0.025	0.004
12/12/2005					1167						7.4	0.2			3		
12/19/2005					1167						7.7	0.15			4		
12/28/2005					1162						8.3	0.13			3		
1/3/2006					1165						8.3	0.08			< 2		
1/10/2006		< 0.0001	0.142	0.0187	1095	0.0012	0.97	2.45	0.014	0.0041	8.2	0.11	0.0011	1200	4	0.0163	0.002
1/16/2006					1149						8	0.064			2		
1/23/2006					1133						8.2	0.086			5		
1/30/2006					1342						8	0.078			2		
2/6/2006		< 0.0001	0.128	0.0193	1094	0.001	0.8	2.15	0.017	0.004	8.2	0.085	0.0019	1200	3	0.0179	0.004
2/13/2006					1111						8.2	0.078			3		
2/20/2006					1144						8.2	0.071			5		
2/27/2006					1128						8.2	0.068			4		
3/6/2006		< 0.0001	0.094	0.0186	1102	0.004	0.77	2.05	0.014	0.0055	8.2	0.067	< 0.0004	1100	2	0.0183	0.006
3/13/2006					1198						8.2	0.087			5		
3/20/2006					1156						8	0.052			< 2		
3/27/2006					1145						8.2	0.074			3		
4/3/2006		< 0.0001	0.0698	0.0196	1008	0.0019	0.94	2.27	0.0135	0.00183	7.4	0.047	0.0009	990	5	0.0201	0.0071
4/10/2006					1055						7.5	0.048			2		
4/17/2006					955						7.5	0.039			2		
4/24/2006					1032						7.5	0.053			1		
5/1/2006		< 0.0001	0.0886	0.0194	1065	0.0009	0.24	1.81	0.0114	< 0.0005	7.5	0.046	< 0.0004	740	1	0.0154	0.0035
5/8/2006					982						7.5	0.048			< 1		
5/15/2006					998						7.6	0.057			1		
5/23/2006					1027						7.6	0.082			1		
5/29/2006					1055						7.6	0.13			1		
6/5/2006		< 0.0001	0.0953	0.00547	1504	0.0011	0.22	1.04	0.0072	< 0.0005	7.8	0.12	< 0.0004	910	1	0.0148	0.0043
6/12/2006					1334						7.7	0.066			1		
6/19/2006					1572						7.6	0.14			1		
6/26/2006					1517						7.6	0.079			< 1		
7/4/2006		< 0.0001	0.0491	0.00512	1629	0.0013	0.19	1.13	0.0059	< 0.0005	7.5	0.043	< 0.0004	990	< 1	0.018	0.0025
7/10/2006					1621						7.7	0.044			1		
7/17/2006					1711						7.5	0.046			1		
7/24/2006					1741						7.5	0.041			1		
7/31/2006					1756						7.5	0.032			1		
8/8/2006		< 0.0001	0.041	0.0071	1721	0.0007	0.19	1.61	0.0095	< 0.0005	7.7	0.089	< 0.0004	1100	< 1	0.0216	0.0015
8/14/2006					1781						7.3	0.093			1		
8/21/2006					1698						7.5	0.13			2		
8/28/2006					1721						7.5	0.068			3		
9/5/2006		< 0.0001	0.029	0.0047	1780	0.0005	0.32	1.32	0.011	< 0.0005	7.5	0.06	< 0.0004	1300	1	0.0227	0.004
9/12/2006					1820						7.6	0.062			3		
9/18/2006					1748						7.7	0.077			1		
9/25/2006					1438						7.5	0.058			2		
10/2/2006		< 0.0001	0.031	0.0041	1411	0.0007	0.44	0.778	0.005	< 0.0005	7.6	0.044	< 0.0004	1100	1	0.0357	0.008
10/10/2006					1370						7.5	0.037			1		

Appendix Table D.2.5: Water quality at station Q-28 from 2005 to 2009.

Date	Acidity (mg/L)	Ag (mg/L)	Ba (mg/L)	Co (mg/L)	Conductivity (μmho/cm)	Cu (mg/L)	Fe (mg/L)	Mn (mg/L)	Ni (mg/L)	Pb (mg/L)	pH	Ra (Bq/L)	Se (mg/L)	SO4 (mg/L)	TSS (mg/L)	U (mg/L)	Zn (mg/L)
10/16/2006					1264						7.4	0.028			1		
10/23/2006					1203						7.4	0.031			2		
10/30/2006					1152						7.4	0.028			1		
11/6/2006		< 0.0001	0.035	0.0092	1285	0.0007	0.29	1.57	0.009	< 0.0005	7.4	0.032	< 0.0004	1100	1	0.0486	0.001
11/13/2006					1336						7.4	0.034			1		
11/20/2006					1370						7.3	0.039			< 1		
11/27/2006					1242						7.7	0.064			< 1		
12/4/2006		< 0.0001	0.049	0.0128	1145	0.0009	0.49	1.5	0.01	0.0006	7.7	0.086	< 0.0004	1100	< 1	0.0331	0.005
12/11/2006					1184						8.2	0.1			1		
12/18/2006					1124						7.1	0.21			4		
12/27/2006					1183						7.2	0.32			2		
1/2/2007			0.093	0.0260			0.96	2.320			7.1	0.180		1200.0		0.0303	
1/8/2007											8.0	0.092					
1/15/2007											8.2	0.068					
1/22/2007											8.2	0.059					
1/29/2007											8.0	0.100					
2/5/2007											8.1	0.140					
2/12/2007			0.101	0.0226			0.76	2.290			8.3	0.130		1100.0		0.0303	
2/19/2007											8.3	0.120					
2/26/2007											8.2	0.130					
3/5/2007											8.3	0.100					
3/12/2007			0.096	0.0282			0.60	2.510			8.3	0.066		1200.0		0.0356	
3/19/2007											8.0	0.074					
3/26/2007											8.1	0.088					
4/2/2007											8.1	0.089					
4/9/2007			0.064	0.0210			0.60	2.310			7.3	0.087		940.0		0.0383	
4/16/2007											7.8	0.120					
4/23/2007											7.3	0.089					
4/30/2007											7.4	0.120					
5/7/2007											7.5	0.120					
5/14/2007			0.084	0.0063			0.17	1.110			7.3	0.075		780.0		0.0208	
5/22/2007											7.4	0.085					
5/28/2007											7.4	0.082					
6/4/2007											7.5	0.076					
6/11/2007			0.057	0.0032			0.19	0.552			7.5	0.061		930.0		0.0291	
6/18/2007											7.6	0.058					
6/25/2007											7.6	0.060					
7/3/2007											7.7	0.068					
7/9/2007			0.067	0.0031			0.26	0.415			7.5	0.090		1100.0		0.0388	
7/16/2007											7.6	0.089					
7/23/2007											7.7	0.084					
7/30/2007											7.7	0.099					
8/7/2007											7.5	0.087					
8/13/2007			0.058	0.0028			0.33	0.444			7.8	0.088		1300.0		0.0356	
8/20/2007											7.6	0.090					
8/27/2007											7.5	0.098					
9/4/2007											7.5	0.090					
9/10/2007			0.065	0.0031			0.38	0.516			7.7	0.100		1200.0		0.0327	
9/17/2007											7.5	0.100					
9/24/2007											7.4	0.110					
10/1/2007											7.5	0.120					
10/9/2007			0.060	0.0036			0.34	0.521			7.4	0.130		1100.0		0.0302	
10/15/2007											7.5	0.093					
10/22/2007											7.4	0.110					
10/29/2007											7.9	0.180					
11/5/2007											7.2	0.160					
11/12/2007			0.068	0.0119			0.36	1.910			7.4	0.180		1200.0		0.0242	
11/19/2007											7.6	0.140					
11/26/2007											8.0	0.130					
12/3/2007											7.7	0.150					
12/10/2007			0.097	0.0191			0.93	2.390			8.0	0.140		1200.0		0.0219	
12/17/2007											8.2	0.140					
12/27/2007											7.4	0.140					
1/2/2008											8.3	0.160					
1/7/2008											8.2	0.180					
1/14/2008			0.099	0.0228			1.34	2.320			7.4	0.180		1200.0		0.0243	
1/21/2008											7.9	0.100					
1/29/2008											7.2	0.120					
2/4/2008											7.2	0.160					
2/11/2008			0.095	0.0257			1.51	2.110			7.6	0.140		1000.0		0.0163	
2/19/2008											8.2	0.160					
2/25/2008											8.1	0.089					
3/3/2008											8.2	0.140					
3/10/2008			0.048	0.0244			1.24	2.240			8.2	0.110		980.0		0.0153	
3/17/2008											8.3	0.130					
3/24/2008											8.4	0.120					
3/31/2008											7.8	0.130					
4/7/2008											7.3	0.160					
4/14/2008			0.105	0.0227			1.25	2.180			7.4	0.078		900.0		0.0227	
4/21/2008											7.3	0.068					
4/28/2008											7.5	0.110					
5/5/2008											7.6	0.072					
5/12/2008			0.154	0.0071			0.22	1.090			7.5	0.053		560.0		0.0114	
5/20/2008											7.5	0.065					
5/26/2008											7.6	0.076					
6/2/2008											7.4	0.064					
6/9/2008			0.080	0.0067			0.24	1.220			7.4	0.060		880.0		0.0107	
6/16/2008											7.6	0.069					
6/23/2008											7.4	0.096					
7/2/2008											7.6	0.075					
7/7/2008											7.5	0.090					
7/14/2008			0.085	0.0052			0.26	0.986			7.6	0.094		990.0		0.0151	
7/21/2008											7.5	0.096					

Appendix Table D.2.5: Water quality at station Q-28 from 2005 to 2009.

Date	Acidity (mg/L)	Ag (mg/L)	Ba (mg/L)	Co (mg/L)	Conductivity (µmho/cm)	Cu (mg/L)	Fe (mg/L)	Mn (mg/L)	Ni (mg/L)	Pb (mg/L)	pH	Ra (Bq/L)	Se (mg/L)	SO4 (mg/L)	TSS (mg/L)	U (mg/L)	Zn (mg/L)
7/28/2008											7.8	0.110					
8/5/2008											7.7	0.085					
8/11/2008			0.079	0.0053			0.38	0.957			7.3	0.084		910.0		0.0169	
8/18/2008											7.6	0.031					
8/25/2008											7.2	0.087					
9/2/2008											7.5	0.056					
9/8/2008			0.078	0.0069			0.27	1.300			7.5	0.110		1000.0		0.0142	
9/15/2008											7.2	0.110					
9/22/2008											8.0	0.110					
9/29/2008											7.7	0.110					
10/6/2008											7.7	0.093					
10/14/2008			0.077	0.0054			0.48	1.090			7.8	0.130		1100.0		0.0210	
10/20/2008											7.5	0.076					
10/27/2008											7.3	0.110					
11/3/2008											7.3	0.100					
11/10/2008			0.072	0.0069			0.31	1.220			7.5	0.080		1000.0		0.0220	
11/17/2008											7.7	0.110					
11/24/2008											7.7	0.180					
12/1/2008											8.4	0.130					
12/8/2008			0.071	0.0143			0.66	2.130			8.4	0.120		1100.0		0.0168	
12/15/2008											8.1	0.100					
12/22/2008											7.2	0.120					
12/29/2008											6.8	0.150					
1/5/2009											8.2	0.120					
1/12/2009			0.216	0.0220			1.09	2.940			8.2	0.150		1000.0		0.0188	
1/19/2009											8.4	0.086					
1/26/2009											8.3	0.190					
2/2/2009											8.2	0.160					
2/9/2009			0.101	0.0178			0.86	1.820			8.2	0.095		1100.0		0.0138	
2/17/2009											8.4	0.170					
2/23/2009											8.4	0.110					
3/2/2009											8.4	0.140					
3/9/2009			0.122	0.0212			1.06	2.210			7.9	0.120		1100.0		0.0180	
3/16/2009											8.3	0.110					
3/23/2009											8.2	0.090					
3/31/2009											8.4	0.093					
4/6/2009											8.2	0.078					
4/13/2009			0.094	0.0137			0.77	1.860			8.4	0.081		840.0		0.0160	
4/20/2009											7.1	0.073					
4/27/2009											7.1	0.055					
5/4/2009											7.2	0.060					
5/11/2009			0.135	0.0083			0.25	1.140			7.5	0.091		630.0		0.0133	
5/19/2009											7.5	0.063					
5/25/2009											7.5	0.110					
6/1/2009											7.8	0.120					
6/8/2009			0.104	0.0044			0.16	1.060			7.4	0.140		890.0		0.0114	
6/15/2009											7.6	0.170					
6/22/2009											7.5	0.120					
6/29/2009											7.5	0.084					
7/6/2009											7.4	0.097					
7/13/2009			0.085	0.0031			0.37	0.507			7.5	0.088		980.0		0.0171	
7/20/2009											7.5	0.095					
7/27/2009											7.4	0.073					
8/4/2009											7.5	0.110					
8/10/2009			0.078	0.0039			0.38	0.587			7.4	0.100		920.0		0.0167	
8/17/2009											7.5	0.120					
8/24/2009											7.5	0.120					
8/31/2009											7.5	0.150					
9/8/2009											7.5	0.120					
9/15/2009			0.078	0.0035			0.37	0.745			7.5	0.130		1100.0		0.0172	
9/21/2009											7.0	0.150					
9/29/2009											7.6	0.150					
10/5/2009											7.7	0.150					
10/14/2009			0.090	0.0064			0.34	1.080			7.6	0.120		1000.0		0.0176	
10/19/2009											7.0	0.100					
10/26/2009											7.4	0.120					
11/2/2009											7.4	0.089					
11/9/2009			0.090	0.0112			0.66	1.730			7.4	0.075		890.0		0.0195	
11/16/2009											7.7	0.036					
11/23/2009											7.7	0.090					
11/30/2009											7.7	0.210					
12/7/2009											7.7	0.160					
12/14/2009			0.103	0.0138			1.07	1.960			7.7	0.220		1000.0		0.0133	
12/21/2009											8.0	0.220					
12/29/2009											8.5	0.110					
Number	2	24	60	60	104	24	60	60	24	24	261	261	24	60	104	60	24
Minimum	6	0.0001	0.029	0.0022	919	0.0005	0.154	0.415	0.0031	0.0005	6.8	0.019	0.0003	560	1	0.0107	0.001
Maximum	6	0.0025	0.216	0.0282	1850	0.02	1.51	3.17	0.017	0.0069	8.5	0.32	0.0019	1596	5	0.049	0.011
Mean	6	0.0007	0.082	0.0118	1345	0.0029	0.56	1.536	0.0099	0.0019	7.7	0.098	0.000604	1069.7	2	0.0231	0.004
Median	6	0.0003	0.078	0.0088	1268	0.0010	0.38	1.535	0.0099	0.0006	7.6	0.090	0.0004	1100	1	0.0210	0.004
10th Perc.	6	0.0001	0.049	0.0031	1055	0.0007	0.19	0.536	0.0044	0.0005	7.3	0.041	0.0003	876	1	0.0142	0.002

Appendix Table D.2.6: Summary of Annual Plant Operations and Discharge at Quirke, 2005-2009.

ITEM	2005	2006	2007	2008	2009
PLANT OPERATIONS					
Operating Days	365	365	365	366	365
Maximum Daily Plant Flow (L/s @ Q-05)	138	165	155	139	161
Minimum Daily Plant Flow (L/s @ Q-05)	31	20	42	53	50
Monthly Average Daily Plant Flow (L/s @ Q-05)	83	87	73	97	98
Total Volume Treated (ML)	2617	2749	2306	3075	3077
Annual Average Treatment Rate (L/s)	-	-	73	97	98
Barium Chloride Consumption					
Total (kg/yr)	3215	2185	1225	2203	1920
Monthly Average (mg/L)	1.23	0.79	0.53	0.72	0.62
Lime Consumption					
Dry (tonne/yr)	36	47	45.7	42.2	37.2
Average (g/L)	0.014	0.017	0.020	0.014	0.012
BASIN NEUTRALIZATION					
Lime Consumption					
Cell 16S total dry tonnes/yr	107	46	84.87	54.14	54.17
Cell 16N total dry tonnes/yr	0	48	47.28	88.79	67.27
Cell 17 total dry tonnes/yr	7.0	5.0	6.40	5.07	3.61
Site total including ETP Operations (tonnes)	151	145	184.28	190.20	162.25
***EFFLUENT**					
Discharge Days	365	365	365	366	365
Maximum Daily Discharge Flow (L/s @ Q-28)	138	164	153	139	155
Minimum Daily Discharge Flow (L/s @ Q-28)	31	28	42	53	52
Monthly Average Daily Discharge Flow (L/s @ Q-28)	83	86	73	98	98
Total Annual Volume Discharged (ML)	2617	2715	2301	3108	3078
Annual Average Discharge Rate (L/s)	-	-	73	98	98

* Influent flows based on daily monitoring requirements as per TOMP

* Effluent flows based on weekly monitoring requirement as per SAMP

Appendix Table D.2.7: Mean annual discharge and seepage loadings from Quirke TMA, 2005 - 2009.

Station	Drainage Type	Mean Annual Discharge (m^3)		Sulphate (kg/yr)	Radium (MBq/yr)	Uranium (kg/yr)	Barium (kg/yr)	Cobalt (kg/yr)	Iron (kg/yr)	Manganese (kg/yr)
Q-23	Seepage from Dam J	1,472,731	Mean	6,684	5.93	1.0	38	1.2	754	116
			S.D.	1,387	3.10	1.5	3.8	0.3	203	22
Q-27	Swamp Downstream of Dam K	3,154	Mean	916	0.05	0.01	0.3	0.1	71	10
			S.D.	132	0.01	0.00	0.1	0.0	10	1.1
D-4	Dunlop Lake Outlet	46,644,865	Mean	250,343	117	12	648	11	1,646	539
			S.D.	20,235	0.0	5	35	2.1	806	154
D-5	Serpent River d/s of Denison	50,496,276	Mean	1,253,233	4,557	112	4,659	12	2,959	1,465
			S.D.	332,793	1,013	20	1,023	1.5	288	60
Q-28	Controlled Discharge	2,762,554	Mean	2,924,343	294	60	238	38	1,748	4,692
			S.D.	244,660	58	9.1	72	5.0	474	519
ECA-398	Site Drainage	49,811	Mean	12,070	2.47	16.3	0.7	4.4	9.2	38
			S.D.	5,857	1.47	5.2	0.2	1.0	1.8	5.5
Q-22	Site Drainage	281,459	Mean	9,617	6.88	9.0	2.9	1.2	18	18
			S.D.	3,452	3.58	4.1	1.1	0.5	7.4	5.2
All Quirke Sources				**2,953,630**	**309**	**87**	**279**	**44**	**2,600**	**4,874**
Q-09	Serpent River u/s of Quirke Lake	67,185,723	Mean	5,684,136	5,718	312	5,909	37		
			S.D.	926,920	866	66	931	5		

MBq/yr = Million Bequerels per year

Appendix Table D.2.8: Summary of seasonal trends for station ECA-398, 2003 to 2009.

Season	Spearman rho	Barium	Cobalt	Iron	Manganese	pH	Sulphate	Radium-226	Uranium
January	Correlation Coefficient	0.673633	-0.53571	0.198206	-0.75	0.532312	-1	-0.396412484	-0.928571
	Sig. (2-tailed)	0.097104	0.215217	0.670085	0.0521814	0.218709	0.000001	0.37863471	0.0025195
	N	7	7	7	7	7	7	7	7
February	Correlation Coefficient	0.410391	-0.7	-0.7	-0.5	0.790569	-0.9	-0.153896753	-1
	Sig. (2-tailed)	0.492536	0.18812	0.18812	0.391002219	0.111367	0.0373861	0.804828817	0.000001
	N	5	5	5	5	5	5	5	5
March	Correlation Coefficient	0.205196	-0.46169	-0.2	-0.615587011	0.359092	-1	-0.5	-0.6
	Sig. (2-tailed)	0.740582	0.433766	0.74706	0.26899777	0.552815	0.000001	0.391002219	0.284757
	N	5	5	5	5	5	5	5	5
April	Correlation Coefficient	0.75	-0.64286	0.214286	-0.464285714	0.534522	-0.8288625	-0.214285714	-0.846881
	Sig. (2-tailed)	0.052181	0.119392	0.644512	0.293934108	0.216437	0.0211735	0.644511581	0.0161971
	N	7	7	7	7	7	7	7	7
May	Correlation Coefficient	-0.2	-0.4	-0.97468	0.3	0.782624	-0.5	-0.3	-1
	Sig. (2-tailed)	0.74706	0.504632	0.004818	0.623837665	0.117614	0.3910022	0.623837665	0.000001
	N	5	5	5	5	5	5	5	5
June/July	Correlation Coefficient	0.857143	-0.60714	0.594619	-0.270281239	0.318105	-0.8829187	-0.75	-1
	Sig. (2-tailed)	0.013697	0.148231	0.15909	0.557730749	0.486872	0.0084503	0.0521814	0.000001
	N	7	7	7	7	7	7	7	7
October/November	Correlation Coefficient	0.504525	-0.96429	0.630656	-0.357142857	0.224544	-0.8108437	-0.540562478	-0.964286
	Sig. (2-tailed)	0.248203	0.000454	0.128888	0.431611352	0.628339	0.0269163	0.210289253	0.0004541
	N	7	7	7	7	7	7	7	7

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

ns denotes not significant.

[shaded box] Significant trend where p<0.05.

Appendix Table D.2.9: Summary of seasonal trends for station Q-22, 2003 to 2009.

Season	Spearman rho	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium
January	Correlation Coefficient	-0.70419	-0.92857	-0.45047	-0.85714286	0.414431	-0.96428571	-0.964286	-0.964286
	Sig. (2-tailed)	0.07735	0.002519	0.310429	0.013697327	0.355269	0.000454149	0.0004541	0.0004541
	N	7	7	7	7	7	7	7	7
April	Correlation Coefficient	-0.42857	-0.37839	-0.65465	-0.39285714	0.727393	-0.78571429	-0.464286	-0.5
	Sig. (2-tailed)	0.337368	0.402602	0.110567	0.38331687	0.063935	0.036238463	0.2939341	0.25317
	N	7	7	7	7	7	7	7	7
July	Correlation Coefficient	0.214286	-0.64286	-0.28571	-0.35714286	0.741249	0.035714286	-0.14415	-0.75
	Sig. (2-tailed)	0.644512	0.119392	0.534509	0.431611352	0.056577	0.939408205	0.7578179	0.0521814
	N	7	7	7	7	7	7	7	7
October	Correlation Coefficient	0.392857	-0.14286	0.162169	0.285714286	0.309142	0.142857143	0.2142857	-0.392857
	Sig. (2-tailed)	0.383317	0.759945	0.7283	0.534509229	0.499899	0.7599453	0.6445116	0.3833169
	N	7	7	7	7	7	7	7	7

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

ns denotes not significant.

[shaded cell] Significant trend where $p<0.05$.

Appendix Table D.2.10: Summary of seasonal trends for station Q-23, 2003 to 2009.

Season	Spearman rho	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate
January/February	Correlation Coefficient	-0.396412484	0.527359901	0.142857143	-0.214285714	-0.185312329	-0.926561646	-0.75
	Sig. (2-tailed)	0.37863471	0.223836601	0.7599453	0.644511581	0.690777796	<0.05	0.0521814
	N	7	7	7	7	7	7	7
April/May	Correlation Coefficient	-0.642857143	-0.163663418	0.321428571	-0.535714286	0.363696484		-0.678571429
	Sig. (2-tailed)	0.119392373	0.725862474	0.482072038	0.215217456	0.422581508		0.093750254
	N	7	7	7	7	7		7
July/August	Correlation Coefficient	0.085714286	-0.405839725	-0.2	-0.885714286	0.478091444		-0.942857143
	Sig. (2-tailed)	0.87174344	0.424662508	0.704	0.018845481	0.337501857		0.004804665
	N	6	6	6	6	6		6
October	Correlation Coefficient	0.054056248	0.407687124	0.035714286	0.142857143	-0.48650623		0.107142857
	Sig. (2-tailed)	0.908365283	0.363942484	0.939408205	0.7599453	0.268248562		0.819150856
	N	7	7	7	7	7		7

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

ns denotes not significant.

[shaded cell] Significant trend where $p<0.05$.

Appendix Table D.2.11: Summary of seasonal trends for station Q-27, 2003 to 2009.

Season	Spearman rho	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium
January	Correlation Coefficient	0.371429	0.714286	-0.82857	0.142857143	-0.71429	0	0.7714286	-0.9
	Sig. (2-tailed)	0.468478	0.110787	0.041563	0.787172012	0.110787	1	0.0723965	0.037386
	N	6	6	6	6	6	6	6	5
April/May	Correlation Coefficient	0.821429	-0.21429	0.107143	0.071428571	0.44475	-0.836501913	0.1428571	-0.9
	Sig. (2-tailed)	0.023449	0.644512	0.819151	0.879048193	0.317372	0.01897126	0.7599453	0.037386
	N	7	7	7	7	7	7	7	5
October/November	Correlation Coefficient	0.535714	0.071429	-0.10714	0	0.09356	0.036037499	0.0714286	
	Sig. (2-tailed)	0.215217	0.879048	0.819151	1	0.841862	0.938860561	0.8790482	
	N	7	7	7	7	7	7	7	

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

ns denotes not significant.

[shaded] Significant trend where p<0.05.

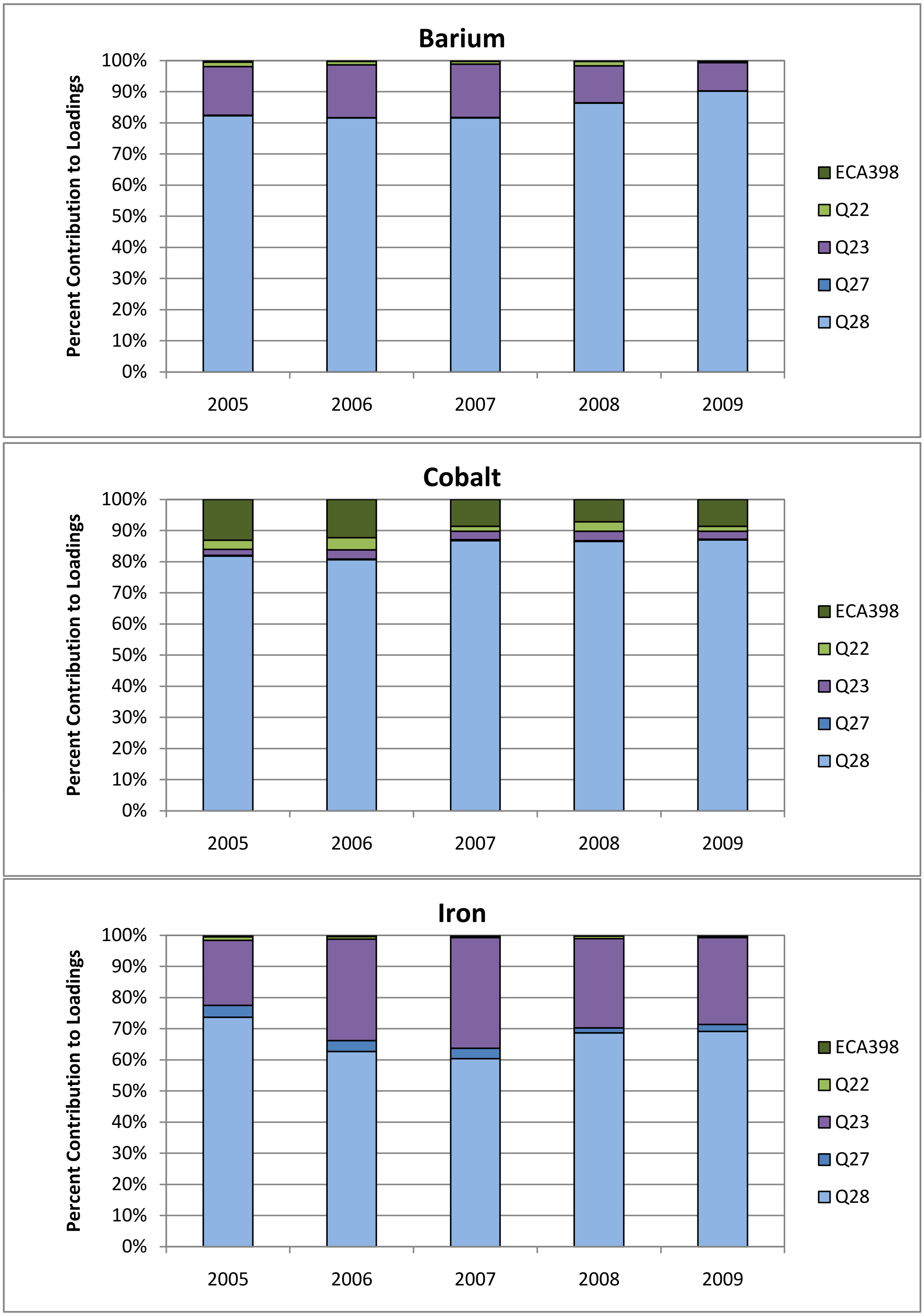
Appendix Table D.2.12: Summary of seasonal trends for station Q-28, 2003 to 2009.

Season	Spearman rho	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium
January	Correlation Coefficient	0.142857	-0.42857	0.571429	0.037062466	0.178571	-0.57142857	-0.592999	-0.5
	Sig. (2-tailed)	0.759945	0.337368	0.180202	0.937124009	0.701658	0.180201989	0.1605219	0.25317
	N	7	7	7	7	7	7	7	7
February	Correlation Coefficient	0.43245	-0.35714	0.428571	-0.785714286	0.357143	0.107142857	-0.828862	-0.892857
	Sig. (2-tailed)	0.332527	0.431611	0.337368	0.036238463	0.431611	0.819150856	0.0211735	0.0068072
	N	7	7	7	7	7	7	7	7
March	Correlation Coefficient	0.428571	-0.21429	0.392857	-0.642857143	0.75	-0.39285714	-0.846881	-0.738769
	Sig. (2-tailed)	0.337368	0.644512	0.383317	0.119392373	0.052181	0.38331687	0.0161971	0.0578585
	N	7	7	7	7	7	7	7	7
April	Correlation Coefficient	0.321429	-0.60714	-0.07143	-0.607142857	-0.05455	0.357142857	-0.964286	-0.702731
	Sig. (2-tailed)	0.482072	0.148231	0.879048	0.148231161	0.907523	0.431611352	0.0004541	0.0782375
	N	7	7	7	7	7	7	7	7
May	Correlation Coefficient	0.892857	-0.75	0.142857	-0.75	-0.03604	0.714285714	-0.714286	-0.571429
	Sig. (2-tailed)	0.006807	0.052181	0.759945	0.0521814	0.938861	0.071343561	0.0713436	0.180202
	N	7	7	7	7	7	7	7	7
June	Correlation Coefficient	0.535714	-0.37839	-0.25	-0.090093746	0.054056	0.107142857	-0.392857	-0.571429
	Sig. (2-tailed)	0.215217	0.402602	0.588724	0.84767208	0.908365	0.819150856	0.3833169	0.180202
	N	7	7	7	7	7	7	7	7
July	Correlation Coefficient	0.738769	-0.72075	0.666694	-0.678571429	0.071429	-0.35714286	-0.900937	-0.540562
	Sig. (2-tailed)	0.057858	0.067635	0.10192	0.093750254	0.879048	0.431611352	0.0056206	0.2102893
	N	7	7	7	7	7	7	7	7
August	Correlation Coefficient	0.428571	-0.53571	0.666694	-0.678571429	0	0.25	-0.5	-0.392857
	Sig. (2-tailed)	0.337368	0.215217	0.10192	0.093750254	1	0.588724448	0.25317	0.3833169
	N	7	7	7	7	7	7	7	7
September	Correlation Coefficient	0.738769	-0.10714	0.321429	-0.071428571	-0.52254	0.714285714	-0.928571	-0.5
	Sig. (2-tailed)	0.057858	0.819151	0.482072	0.879048193	0.228878	0.071343561	0.0025195	0.25317
	N	7	7	7	7	7	7	7	7
October	Correlation Coefficient	0.678571	-0.14286	0.792825	-0.357142857	0	0.535714286	-0.815374	-0.428571
	Sig. (2-tailed)	0.09375	0.759945	0.033444	0.431611352	1	0.215217456	0.0253992	0.3373683
	N	7	7	7	7	7	7	7	7
November	Correlation Coefficient	0.75	-0.21429	0.535714	-0.285714286	0.558581	0.5	-0.714286	-0.678571
	Sig. (2-tailed)	0.052181	0.644512	0.215217	0.534509229	0.192453	0.253169995	0.0713436	0.0937503
	N	7	7	7	7	7	7	7	7
December	Correlation Coefficient	0.178571	-0.35714	0.5	-0.144149994	-0.07143	-0.78571429	-0.252262	-0.5
	Sig. (2-tailed)	0.701658	0.431611	0.25317	0.757817936	0.879048	0.036238463	0.5852411	0.25317
	N	7	7	7	7	7	7	7	7

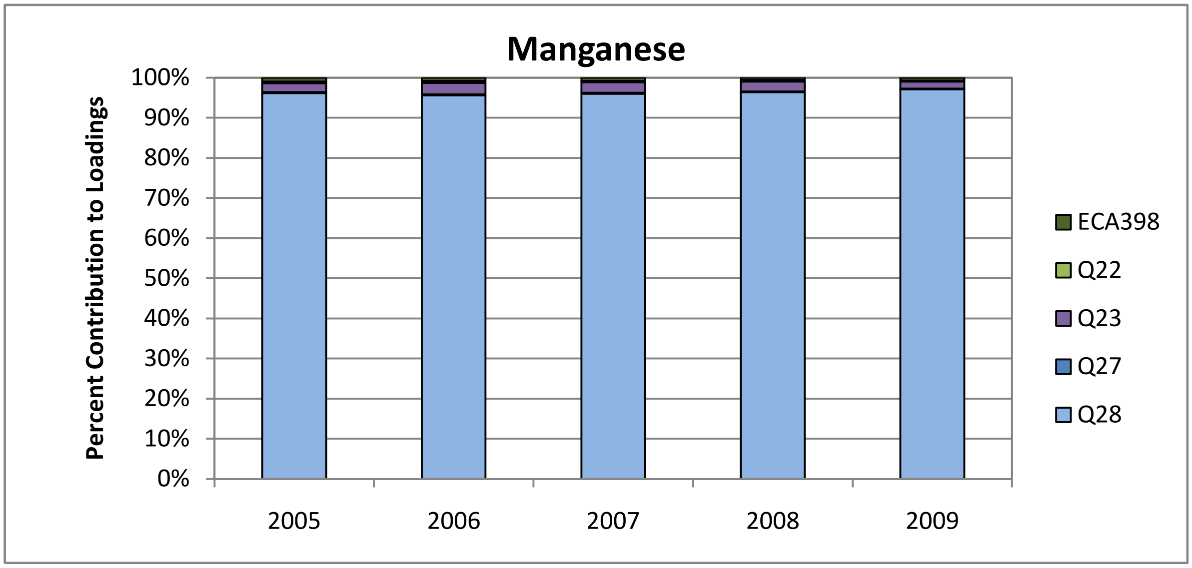
Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

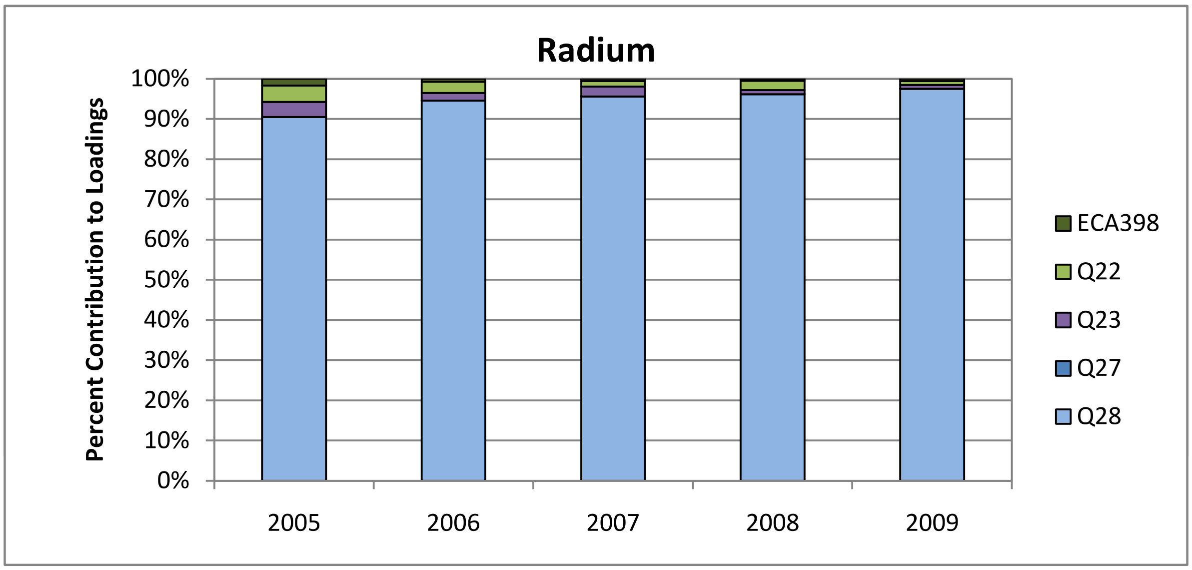
ns denotes not significant.

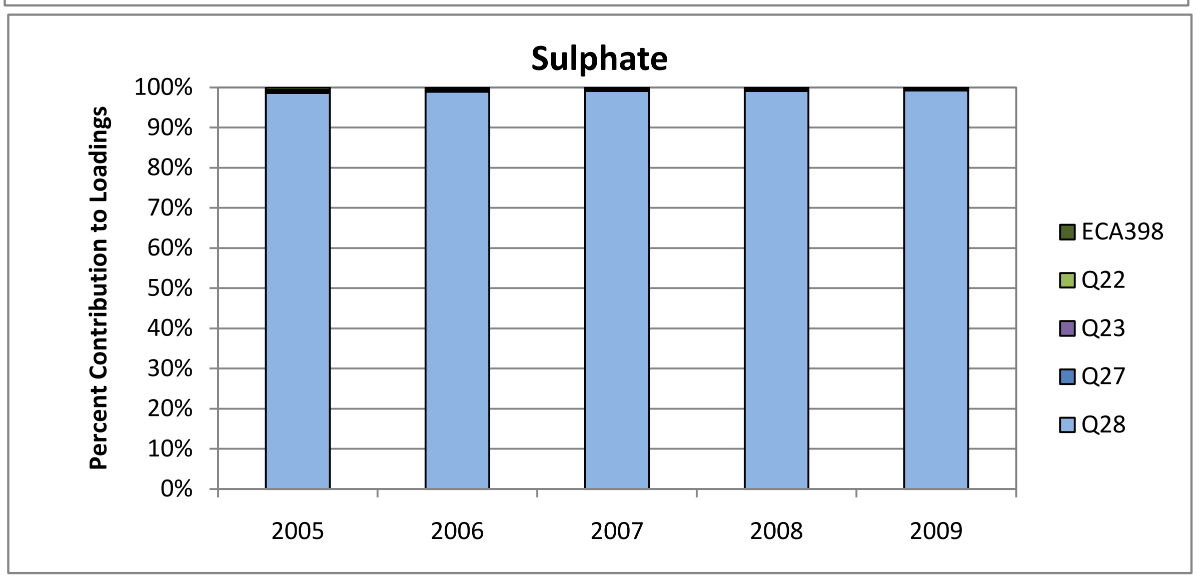
[shaded cell] Significant trend where p<0.05.



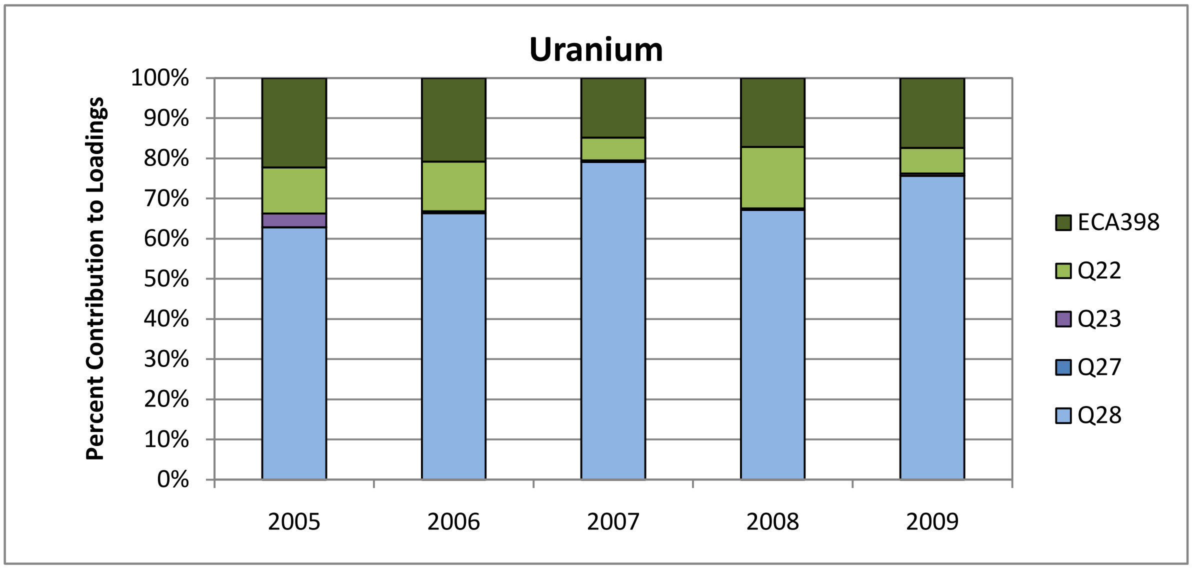
Appendix Figure D.2.1: Percent contribution to loads from Quirke TMA discharge points.



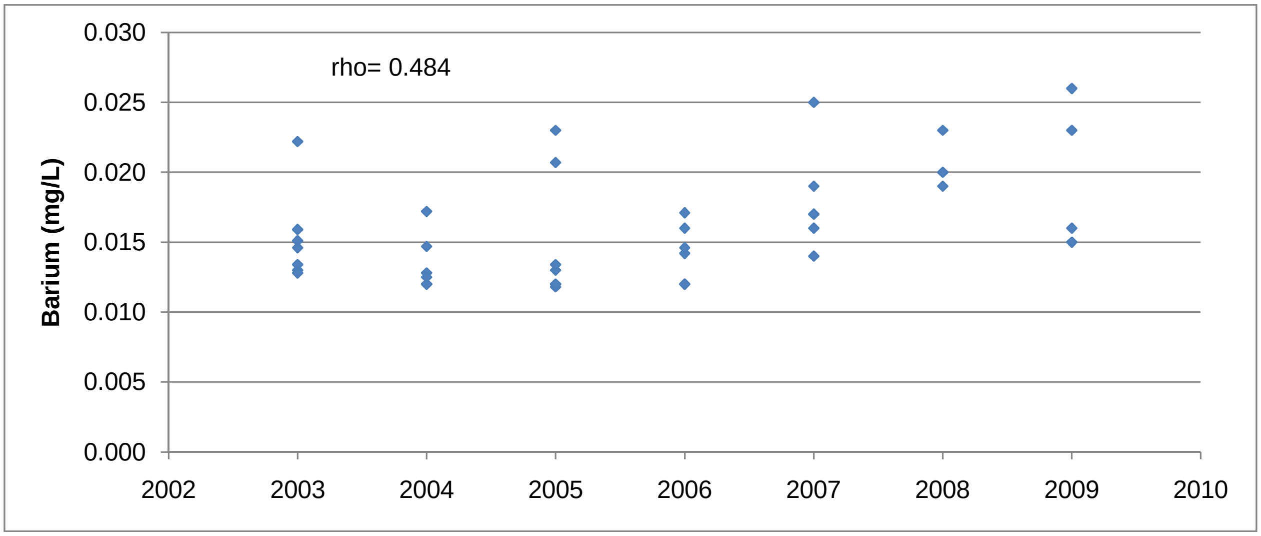


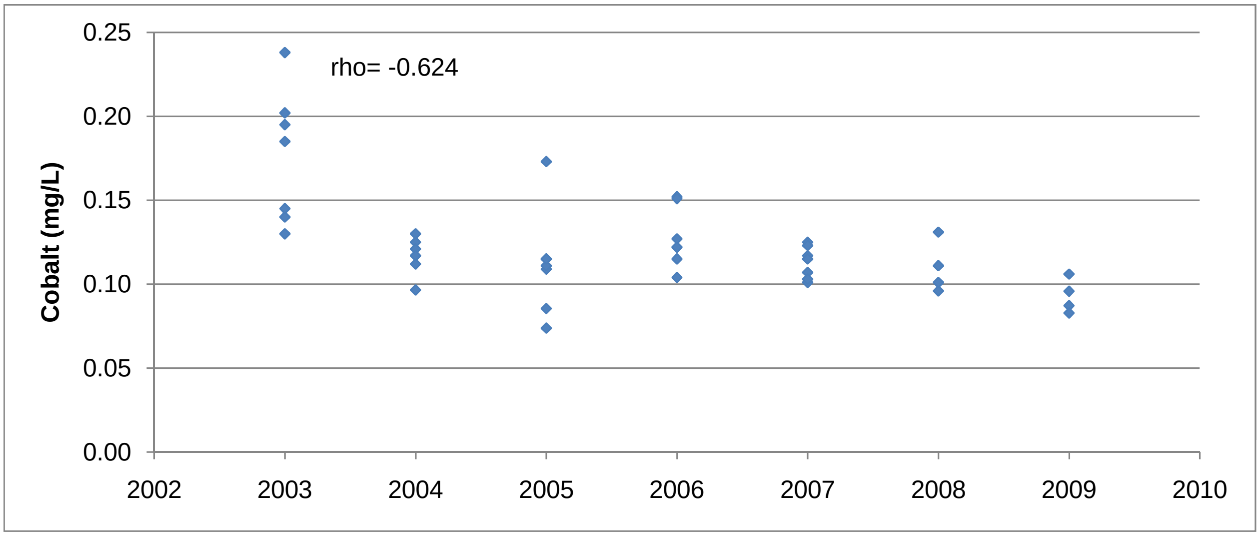


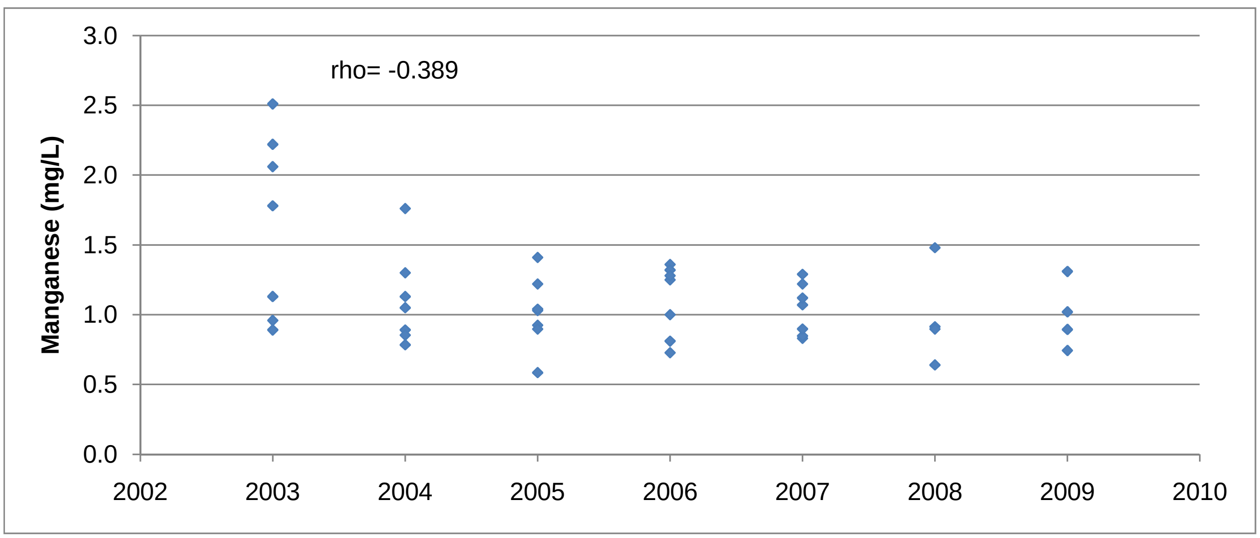
Appendix Figure D.2.1: Percent contribution to loads from Quirke TMA discharge points.



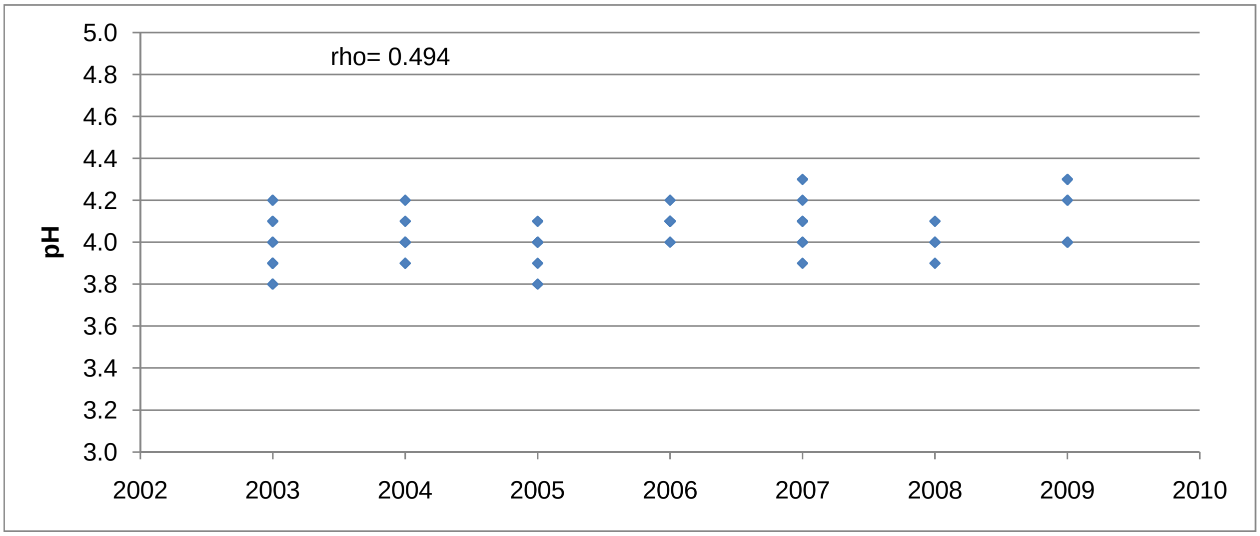
Appendix Figure D.2.1: Percent contribution to loads from Quirke TMA discharge points.

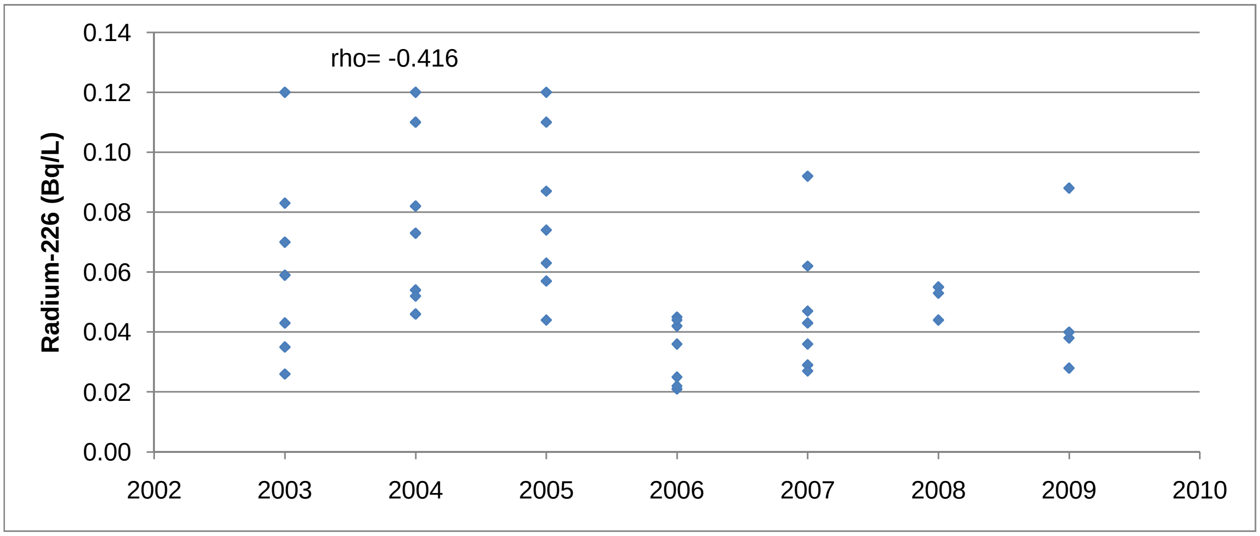


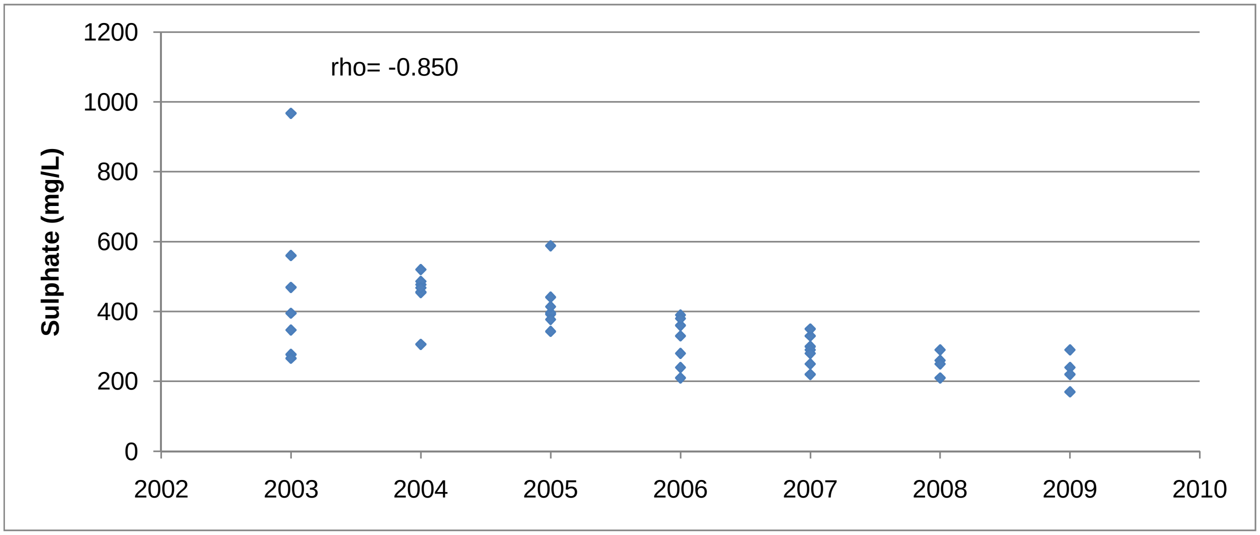




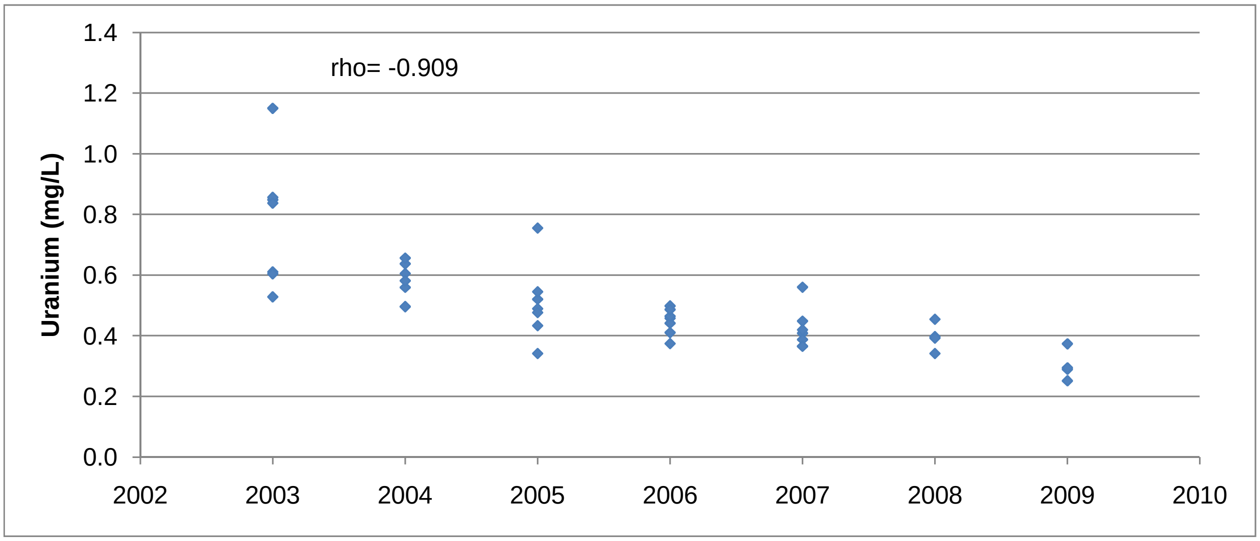
Appendix Figure D.2.2: Significant common (average) trends observed for barium, cobalt, manganese, pH, radium-226, sulphate and uranium over all seasons at station ECA-398, 2003 to 2009.



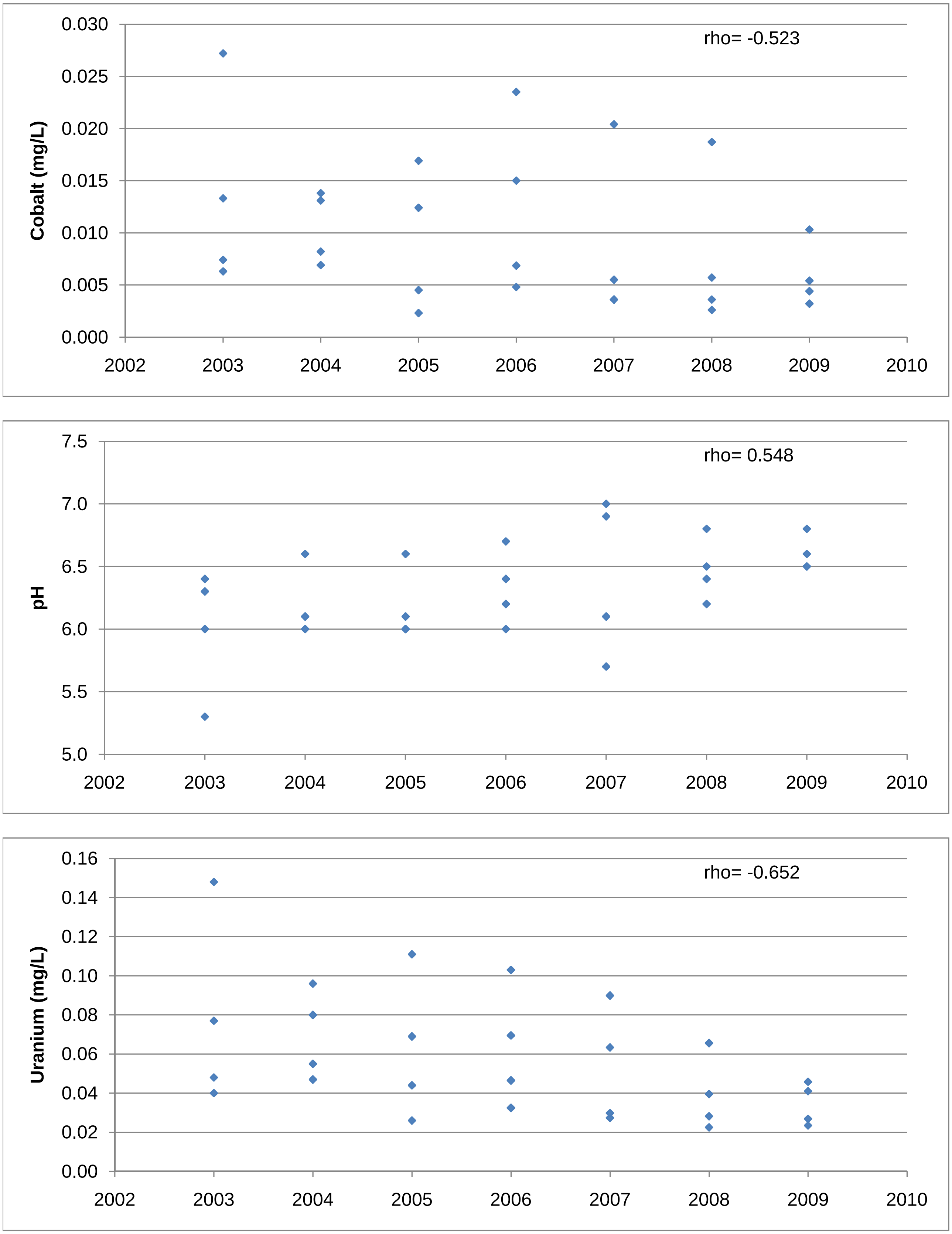




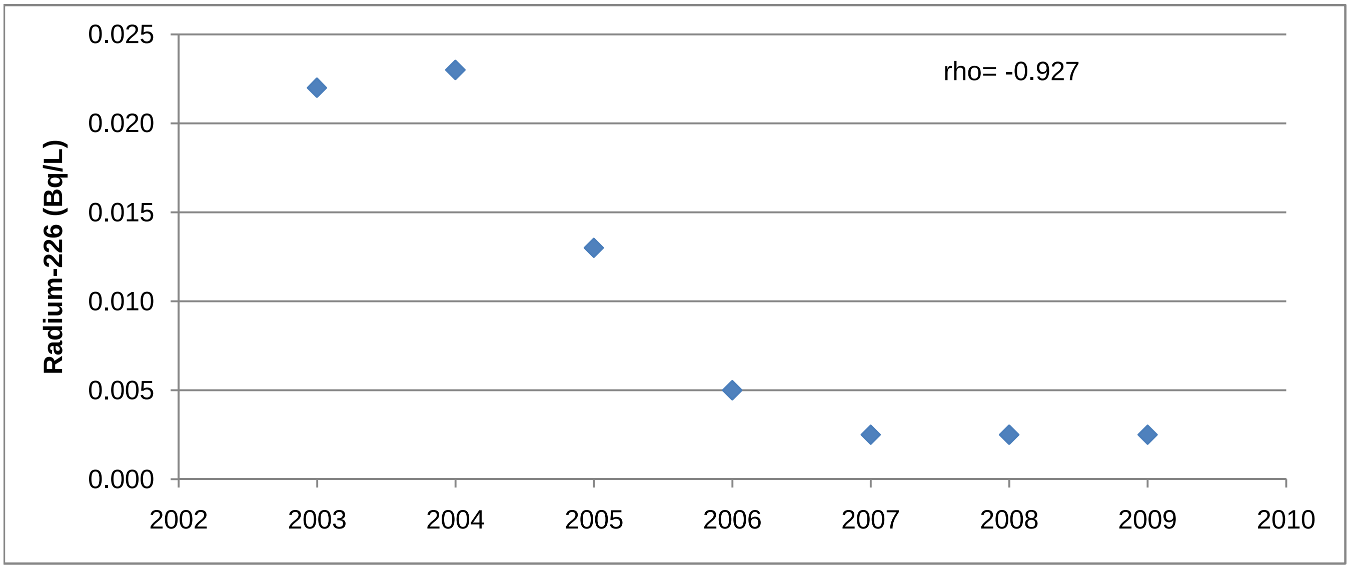
Appendix Figure D.2.2: Significant common (average) trends observed for barium, cobalt, manganese, pH, radium-226, sulphate and uranium over all seasons at station ECA-398, 2003 to 2009.

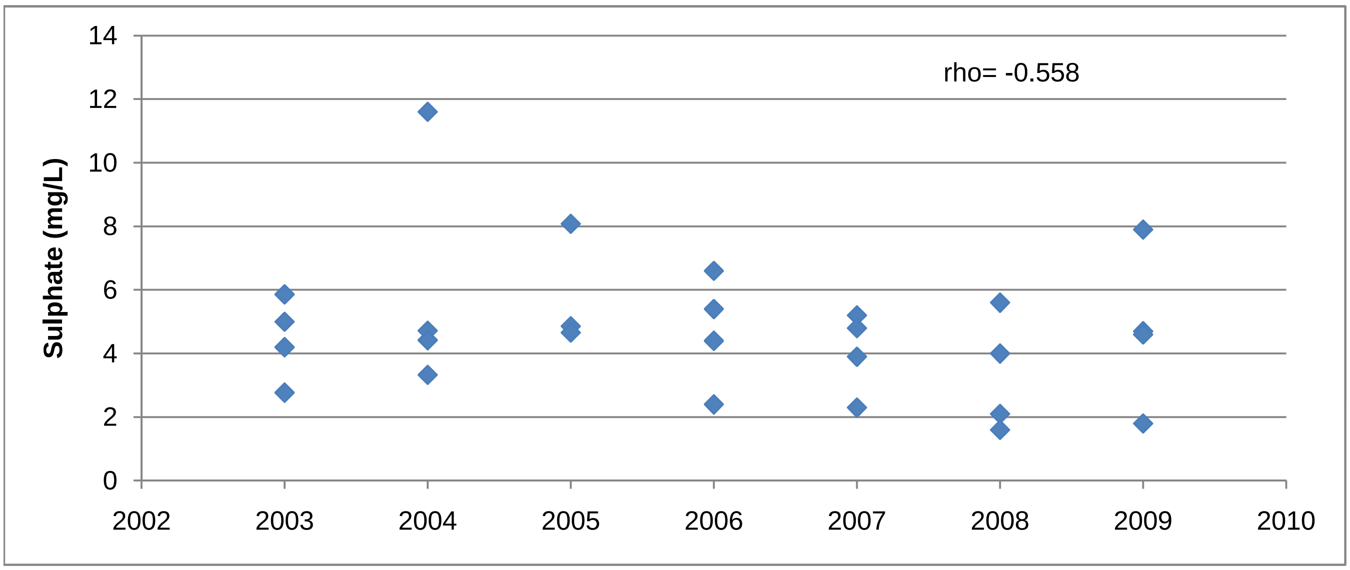


Appendix Figure D.2.2: Significant common (average) trends observed for barium, cobalt, manganese, pH, radium-226, sulphate and uranium over all seasons at station ECA-398, 2003 to 2009.

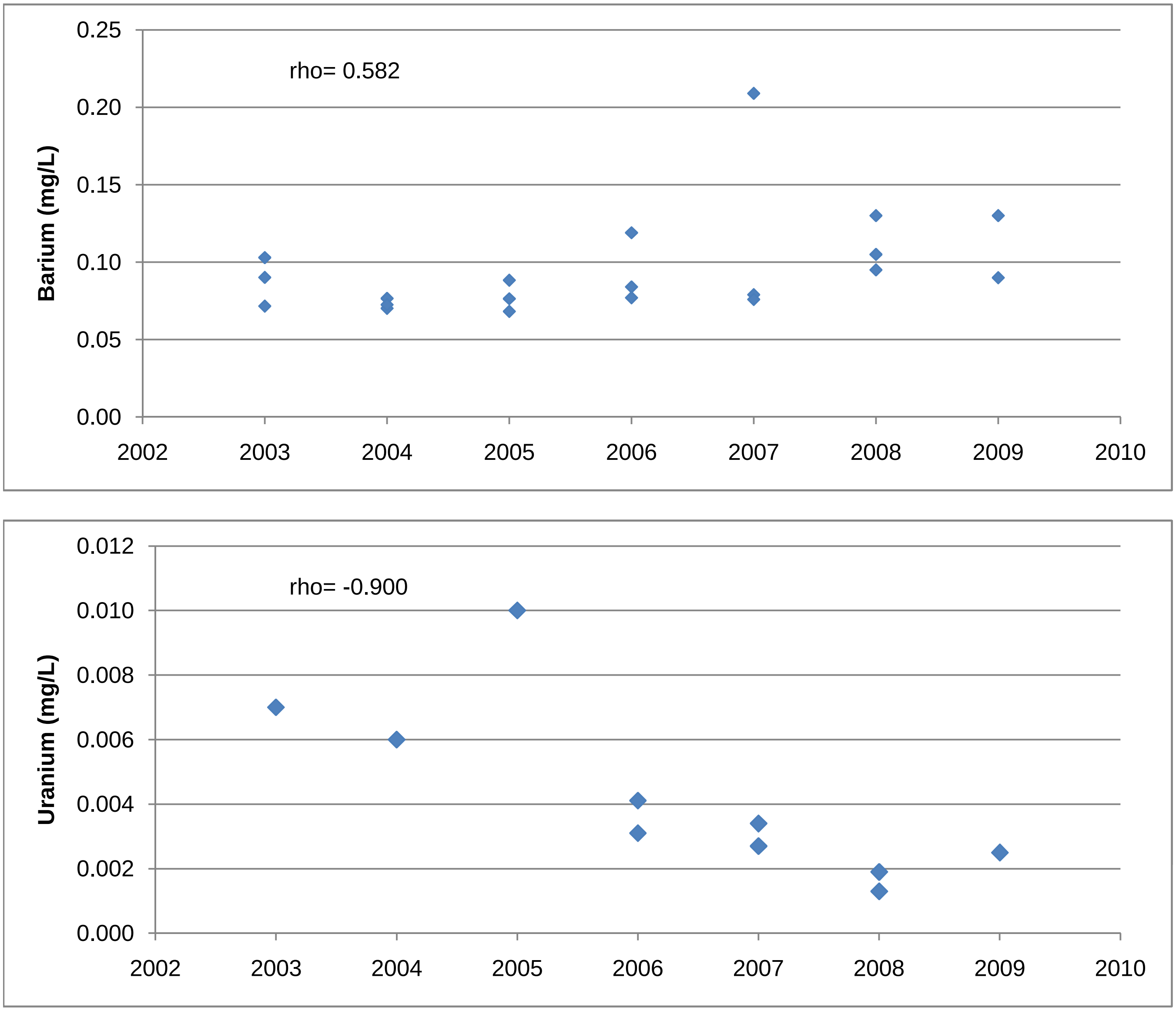


Appendix Figure D.2.3: Significant common (average) trends observed for cobalt, pH, and uranium over all seasons at station Q-22, 2003 to 2009.

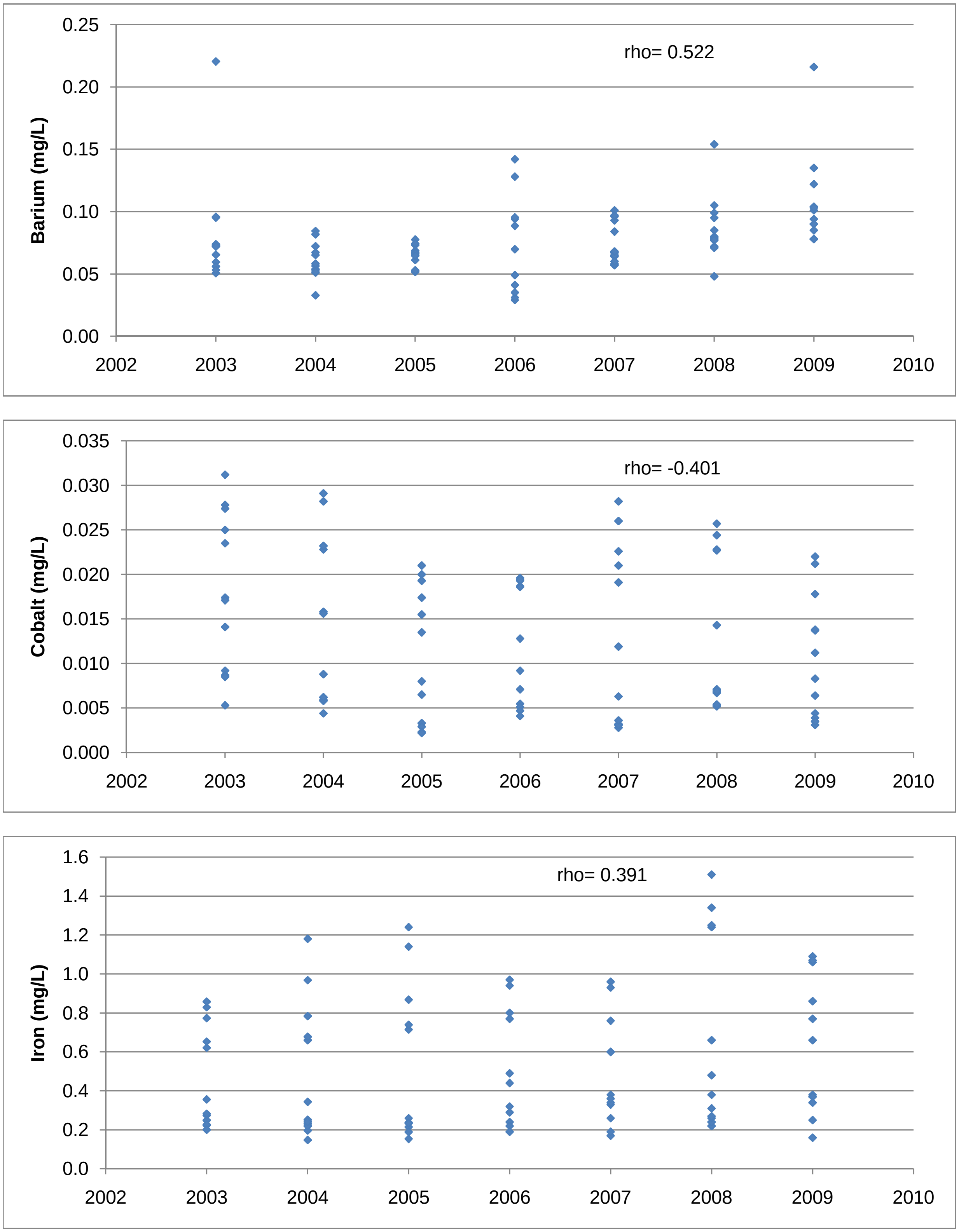




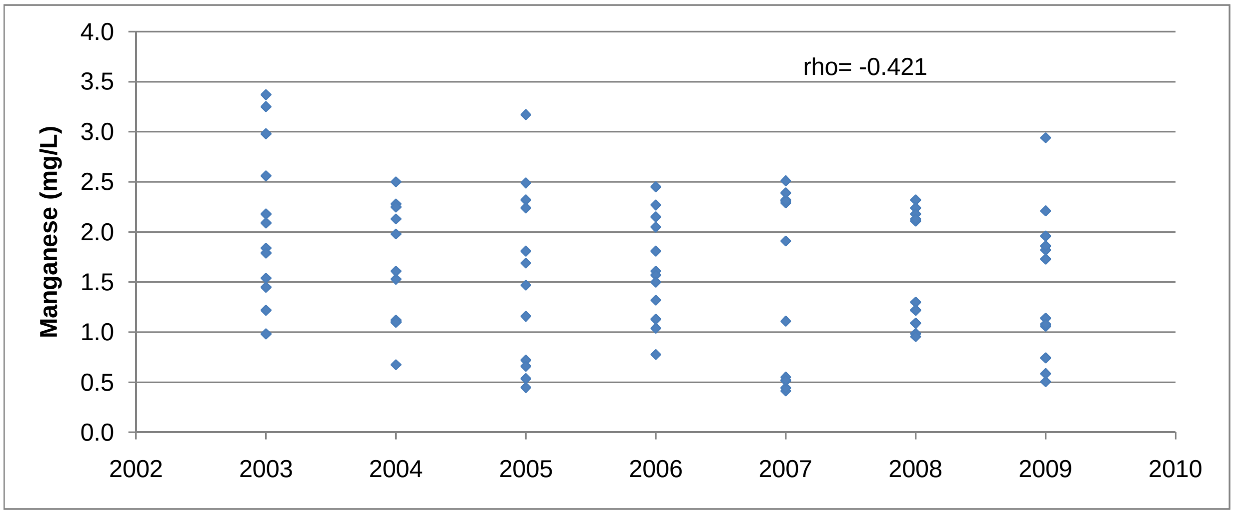
Appendix Figure D.2.4: Significant common (average) trends observed for radium-226 and sulphate over all seasons at station Q-23, 2003 to 2009.

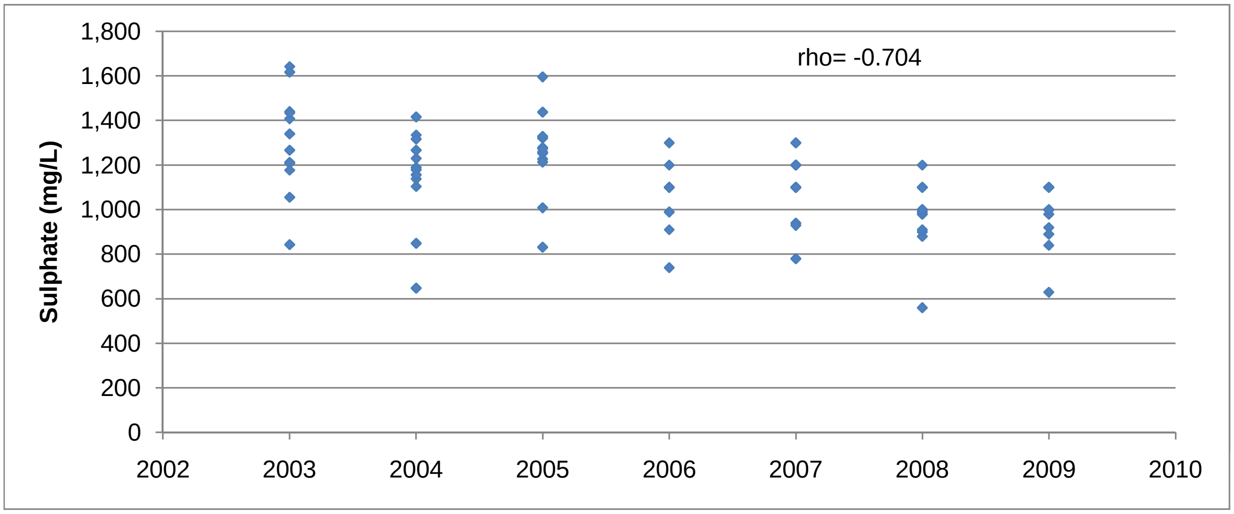


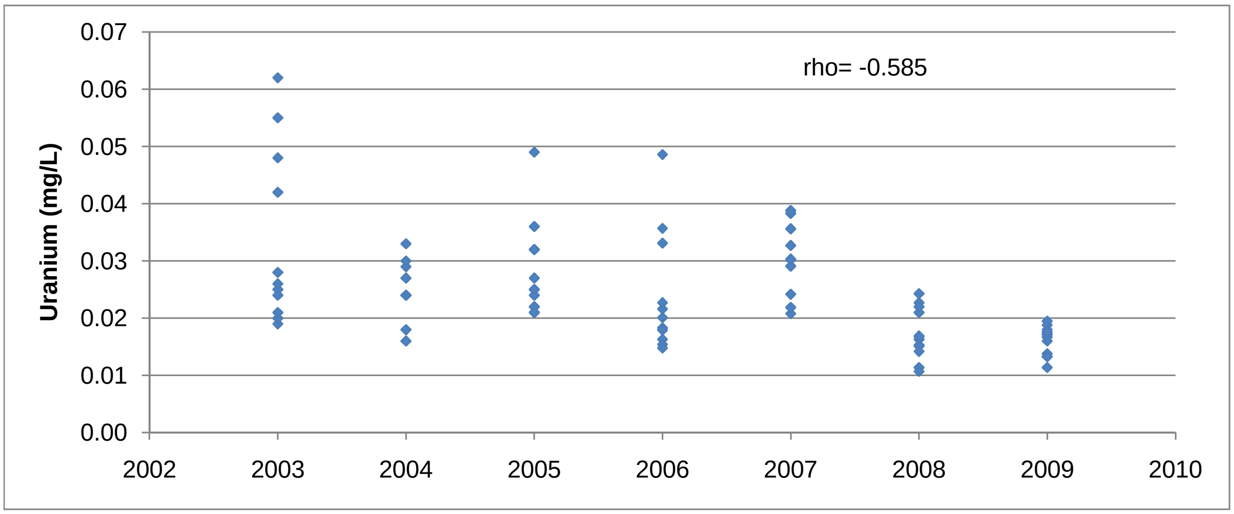
Appendix Figure D.2.5: Significant common (average) trends observed for barium and uranium over all seasons at station Q-27, 2003 to 2009.



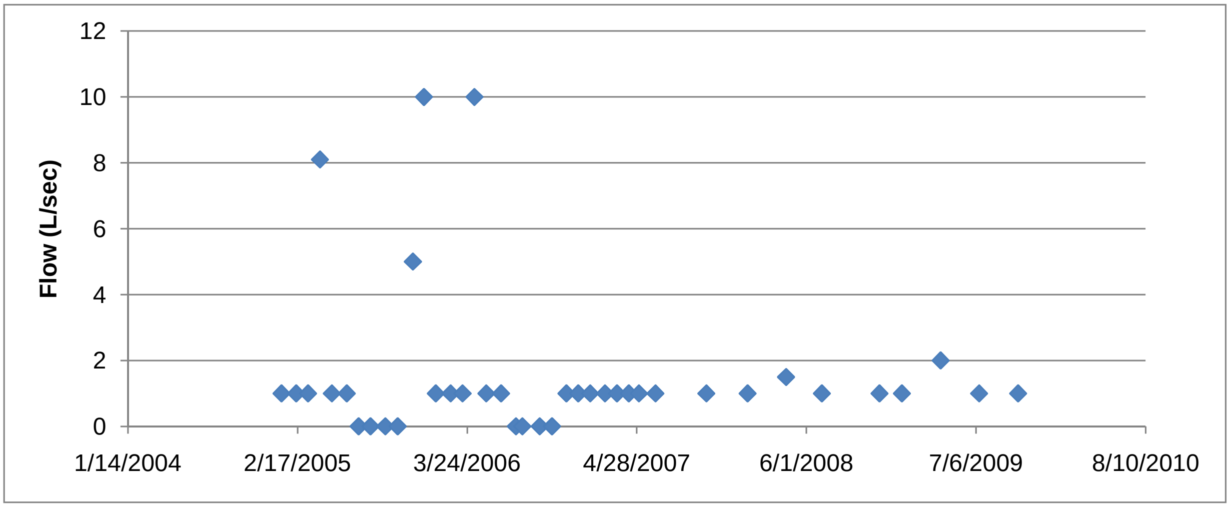
Appendix Figure D.2.6: Significant common (average) trends observed for barium, cobalt, iron, manganese, sulphate and uranium over all seasons at station Q-28, 2003 to 2009.



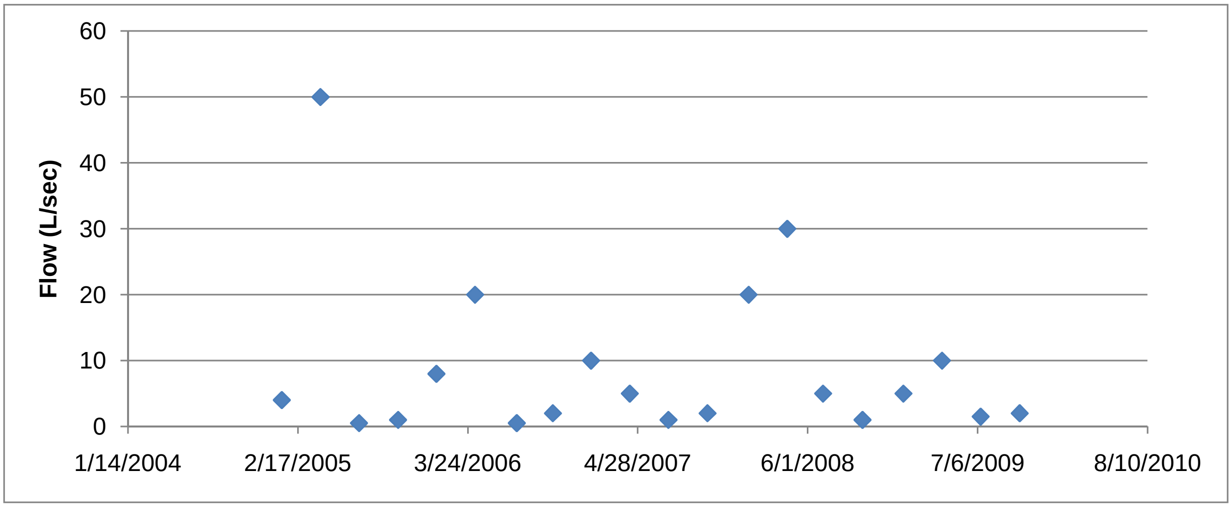




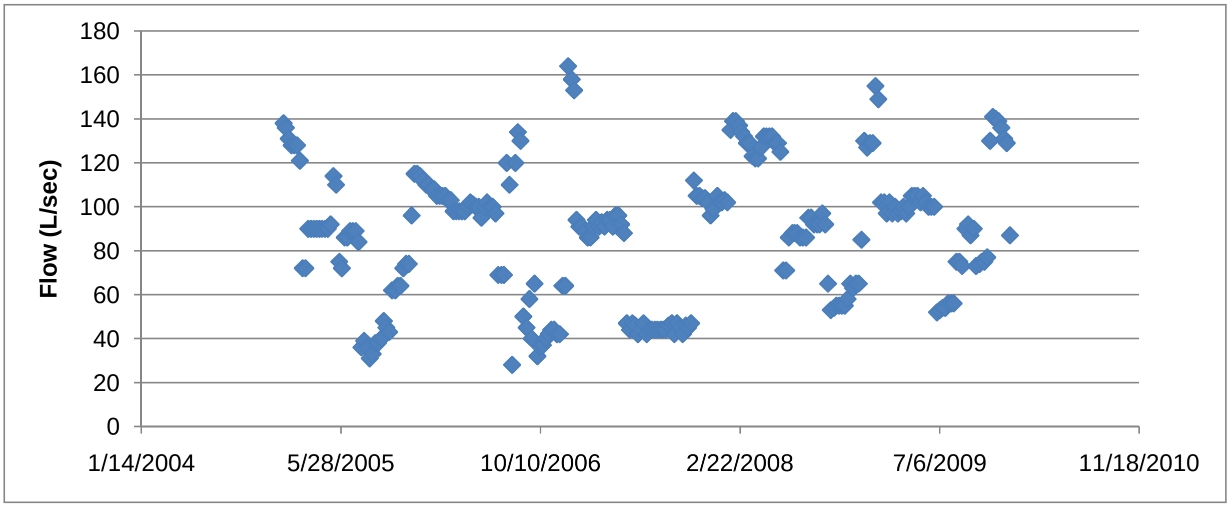
Appendix Figure D.2.6: Significant common (average) trends observed for barium, cobalt, iron, manganese, sulphate and uranium over all seasons at station Q-28, 2003 to 2009.



Appendix Figure D.2.7: Flows at station ECA-398 from 2005 to 2009.



Appendix Figure D.2.8: Flows at station Q-22 from 2005 to 2009.



Appendix Figure D.2.9: Flows at station Q-28 from 2005 to 2009.

APPENDIX D.3
Panel TMA

Appendix Table D.3.1: Water quality at station P-02 from 2005 to 2009.

Date	Ag (mg/L)	Ba (mg/L)	Co (mg/L)	Conductivity (µmho/cm)	Fe (mg/L)	Mn (mg/L)	pH	Ra (Bq/L)	Se (mg/L)	SO4 (mg/L)	U (mg/L)
1/24/2005	0.0016	0.0303	0.0008	662	0.151	0.0551	6.2	0.046	< 0.0003	748	0.006
4/25/2005	0.00164	0.0229	0.0005	657	0.154	0.037	6.2	0.093	0.0006	575	< 0.005
7/25/2005	0.00108	0.0246	0.0072	1168	0.732	5.74	6.2	0.08	0.002	726	< 0.005
11/28/2005	0.00082	0.0207	0.0016	723	2.89	0.237	6.5	0.053	< 0.0003	746	0.008
1/23/2006	< 0.0001	0.021	0.0013	689	0.94	0.142	6.3	0.025	0.0018	750	0.0032
4/25/2006	< 0.0001	0.0225	< 0.0005	640	0.04	0.00937	6.4	0.038	0.002	430	0.00053
7/25/2006	< 0.0001	0.021	0.0007	1057	0.72	0.06	6.9	0.039	< 0.0004	660	0.0016
10/24/2006	< 0.0001	0.023	0.0014	670	0.98	0.184	6.6	0.031	0.0006	570	0.0033
1/22/2007		0.020	0.0012		0.52	0.091	6.5	0.023		630.0	0.0028
4/23/2007		0.021	0.0015		0.77	0.160	6.5	0.040		530.0	0.0026
7/23/2007		0.021	< 0.0005		0.15	0.047	6.3	0.056		460.0	0.0007
10/22/2007		0.022	0.0007		0.34	0.096	6.1	0.036		520.0	0.0024
1/24/2008		0.021	0.0008		0.70	0.095	6.3	0.028		580.0	0.0033
5/8/2008		0.022	< 0.0005		0.10	0.038	6.4	0.052		350.0	0.0009
7/15/2008		0.025	0.0006		0.60	0.091	6.4	0.112		490.0	0.0020
10/16/2008		0.026	0.0006		0.31	0.062	6.5	0.023		490.0	0.0033
1/12/2009		0.023	0.0009		0.75	0.111	6.3	0.033		490.0	0.0039
4/27/2009		0.016	0.0006		0.41	0.068	6.4	0.029		250.0	0.0013
7/27/2009		0.023	< 0.0005		0.10	0.023	6.8	0.046		360.0	0.0009
10/26/2009		0.022	0.0008		0.44	0.099	6.8	0.027		370.0	0.0038
Number	8	20	20	8	20	20	20	20	8	20	20
Minimum	0.0001	0.016	0.0005	640	0.04	0.00937	6.1	0.023	0.0003	250	0.00053
Maximum	0.00164	0.0303	0.0072	1168	2.89	5.74	6.9	0.112	0.002	750	0.008
Mean	0.0007	0.022	0.0012	783	0.59	0.372	6.4	0.046	0.0010	536.3	0.00303
Median	0.0005	0.022	0.0008	680	0.48	0.091	6.4	0.039	0.0006	525.0	0.00300
10th Perc.	0.0001	0.021	0.0005	652	0.10	0.036	6.2	0.025	0.0003	359.0	0.00088

Appendix Table D.3.2: Water quality at station P-03 from 2005 to 2009.

Date	Ag (mg/L)	Ba (mg/L)	Co (mg/L)	Conductivity (µmho/cm)	Fe (mg/L)	Mn (mg/L)	pH	Ra (Bq/L)	Se (mg/L)	SO4 (mg/L)	U (mg/L)
1/24/2005	< 0.0006	0.0537	0.0014	69.5	1.76	0.25	6.3	0.63	0.0003	10.4	< 0.005
4/25/2005	0.0001	0.0415	0.0006	59	6.93	0.151	6.6	0.91	0.0008	6.93	< 0.005
7/25/2005	0.00012	0.0239	< 0.0003	82.3	1.65	0.0109	7.2	0.48	< 0.0003	5.13	< 0.005
10/24/2005	0.00007	0.019	< 0.0003	75.4	0.258	0.0026	7.1	0.38	0.0006	6.31	< 0.005
1/23/2006	< 0.0001	0.046	< 0.0005	74.7	0.99	0.107	6.6	0.64	0.0014	10	< 0.0005
4/25/2006	< 0.0001	0.0404	< 0.0005	68.4	4.24	0.0833	6.9	0.76	0.0012	6.8	< 0.0005
7/25/2006	< 0.0001	0.026	< 0.0005	88.3	1.05	0.005	7.3	0.46	< 0.0004	5	< 0.0005
10/24/2006	< 0.0001	0.025	< 0.0005	58.9	0.37	0.004	7.3	0.47	< 0.0004	6.2	< 0.0005
1/22/2007		0.029	< 0.0005		0.64	0.042	6.5	0.354		8.3	< 0.0005
4/23/2007		0.039	< 0.0005		2.01	0.066	6.9	0.740		6.1	< 0.0005
7/23/2007		0.025	< 0.0005		0.77	0.007	7.0	0.400		5.0	< 0.0005
10/22/2007		0.035	< 0.0005		0.34	0.004	6.6	0.540		6.3	< 0.0005
1/24/2008		0.036	0.0006		0.92	0.107	6.4	0.610		8.6	< 0.0005
5/8/2008		0.026	< 0.0005		2.21	0.016	6.8	0.470		9.5	< 0.0005
7/15/2008		0.023	< 0.0005		1.38	0.008	7.5	0.369		5.8	< 0.0005
4/27/2009		0.018	0.0006		1.64	0.063	6.2	0.290		16.0	< 0.0005
7/27/2009		0.029	< 0.0005		0.87	0.007	6.9	0.490		18.0	< 0.0005
10/26/2009		0.030	< 0.0005		0.32	0.005	6.8	0.430		13.0	< 0.0005
Number	8	18	18	8	18	18	18	18	8	18	18
Minimum	0.00007	0.018	0.0003	58.9	0.258	0.0026	6.2	0.29	0.0003	5	0.0005
Maximum	0.0006	0.0537	0.0014	88.3	6.93	0.25	7.5	0.91	0.0014	18	0.005
Mean	0.00016	0.0314	0.0005	72.1	1.57	0.052	6.8	0.524	0.0007	8.52	0.0015
Median	0.0001	0.0290	0.0005	72.1	1.02	0.013	6.9	0.475	0.0005	6.87	0.0005
10th Perc.	0.00009	0.0218	0.0004	59.0	0.33	0.004	6.4	0.365	0.0003	5.09	0.0005

Appendix Table D.3.3: Water quality at station P-05 from 2005 to 2009.

Date	Ba (mg/L)	Co (mg/L)	Fe (mg/L)	Mn (mg/L)	pH	Ra (Bq/L)	SO4 (mg/L)	U (mg/L)
1/24/2005	0.018	0.0007	0.526	0.0486	6	0.005	11.4	< 0.005
4/25/2005	0.0119	< 0.0003	0.173	0.0237	6.3	0.006	30	< 0.005
7/25/2005	0.0179	0.001	1.25	0.181	6.4	< 0.005	50.9	< 0.005
10/24/2005	0.0237	0.0004	0.093	0.0388	6.2	0.01	112	< 0.005
1/23/2006	0.015	0.0009	0.76	0.165	6.3	0.005	58	< 0.0005
4/25/2006	0.0105	< 0.0005	0.19	0.0204	6.3	< 0.005	16	< 0.0005
7/25/2006	0.01	0.0006	0.42	0.072	6.5	< 0.005	63	< 0.0005
10/24/2006	0.009	< 0.0005	0.2	0.022	6.1	< 0.005	19	< 0.0005
1/22/2007	0.014	0.0006	0.32	0.121	6.4	< 0.005	30.0	< 0.0005
4/23/2007	0.013	0.0012	0.23	0.081	6.1	0.006	23.0	< 0.0005
7/23/2007	0.035	0.0026	0.52	0.211	6.0	0.008	77.0	< 0.0005
10/22/2007	0.022	0.0019	0.53	0.106	5.2	0.009	35.0	< 0.0005
1/24/2008	0.011	0.0008	0.25	0.061	5.8	< 0.005	30.0	< 0.0005
5/8/2008	0.010	0.0005	0.21	0.042	6.0	< 0.005	18.0	< 0.0005
7/15/2008	0.014	0.0008	1.09	0.068	6.0	< 0.005	18.0	< 0.0005
10/16/2008	0.020	0.0008	0.51	0.090	6.5	0.006	46.0	< 0.0005
1/12/2009	0.009	0.0005	0.47	0.036	6.2	< 0.005	18.0	< 0.0005
4/27/2009	0.006	< 0.0005	0.31	0.018	6.1	< 0.005	6.3	< 0.0005
7/27/2009	0.008	< 0.0005	0.46	0.023	6.5	< 0.005	15.0	< 0.0005
10/26/2009	0.014	0.0007	0.34	0.057	5.8	< 0.005	22.0	< 0.0005
Number	20	20	20	20	20	20	20	20
Minimum	0.006	0.0003	0.093	0.018	5.2	0.005	6.3	0.0005
Maximum	0.035	0.0026	1.25	0.211	6.5	0.01	112	0.005
Mean	0.015	0.0008	0.44	0.074	6.1	0.006	34.9	0.0014
Median	0.014	0.0007	0.38	0.059	6.2	0.005	26.5	0.0005
10th Perc.	0.009	0.0005	0.19	0.022	5.8	0.005	14.6	0.0005

Appendix Table D.3.4: Water quality at station P-11 from 2005 to 2009.

Date	Ba (mg/L)	Co (mg/L)	Fe (mg/L)	Mn (mg/L)	pH	Ra (Bq/L)	SO4 (mg/L)	U (mg/L)
1/27/2003	0.0138	0.0008	1.47	0.127	6.8	0.055	13.6	< 0.005
4/28/2003	0.0092	< 0.0003	0.271	0.0317	6.6	0.037	7.18	< 0.005
7/28/2003	0.0082	< 0.0003	0.905	0.0407	6.8	0.075	14.4	< 0.005
10/27/2003	0.01	0.0003	0.324	0.022	6.9	0.067	13	< 0.005
1/26/2004	0.0148	0.0008	0.661	0.0947	6.7	0.074	12	< 0.005
4/26/2004	0.0092	< 0.0003	0.162	0.0142	6.8	0.042	11.5	< 0.005
7/26/2004	0.0106	< 0.0003	0.706	0.0381	6.8	0.046	9.19	< 0.005
10/25/2004	0.0103	0.0008	0.353	0.032	6.8	0.07	14.4	< 0.005
1/24/2005	0.0146	0.0008	0.449	0.0368	6	0.046	11.5	0.006
4/25/2005	0.0104	< 0.0003	0.31	0.0176	6.8	0.052	8.52	< 0.005
10/24/2005	0.0135	0.0019	0.338	0.025	6.3	0.12	30	< 0.005
1/23/2006	0.012	0.0007	0.34	0.0402	7.1	0.057	13	0.0008
4/25/2006	0.0111	< 0.0005	0.16	0.0112	6.9	0.04	8.3	0.00096
8/21/2006	0.026	< 0.0005	0.1	0.015	6.9	0.12	36	0.0005
10/24/2006	0.012	0.0007	0.3	0.016	6.7	0.062	13	0.0016
1/22/2007	0.012	0.0006	0.21	0.026	6.8	0.047	11.0	0.0010
4/23/2007	0.011	< 0.0005	0.14	0.009	6.7	0.050	8.1	0.0010
7/23/2007	0.011	< 0.0005	0.34	0.013	7.0	0.050	5.9	0.0010
10/22/2007	0.017	0.0014	0.63	0.024	6.5	0.100	19.0	0.0038
1/24/2008	0.010	< 0.0005	0.22	0.016	6.3	< 0.005	9.1	0.0011
5/8/2008	0.011	< 0.0005	0.16	0.013	6.6	0.038	9.5	0.0010
7/15/2008	0.012	< 0.0005	0.57	0.027	6.9	0.041	8.5	0.0010
10/16/2008	0.013	0.0007	0.90	0.029	7.1	0.047	8.0	0.0012
1/12/2009	0.009	< 0.0005	0.40	0.029	6.7	0.040	7.9	0.0010
4/27/2009	0.009	< 0.0005	0.24	0.013	6.2	0.031	5.8	0.0012
7/27/2009	0.008	< 0.0005	0.57	0.020	7.0	0.039	4.0	0.0008
10/26/2009	0.010	< 0.0005	0.38	0.025	6.8	0.046	8.1	0.0014
Number	27	27	27	27	27	27	27	27
Minimum	0.008	0.0003	0.1	0.009	6	0.005	4	0.0005
Maximum	0.026	0.0019	1.47	0.127	7.1	0.12	36	0.006
Mean	0.012	0.0006	0.43	0.030	6.7	0.055	11.87	0.0028
Median	0.011	0.0005	0.34	0.025	6.8	0.047	9.50	0.0014
10th Perc.	0.009	0.0003	0.16	0.013	6.3	0.038	6.67	0.0009

Appendix Table D.3.5: Water quality at station P-14 from 2005 to 2009.

Date	pH[a]	TSS (mg/L)	SO4 (mg/L)	Ra (Bq/L)	U (mg/L)	Ba (mg/L)	Co (mg/L)	Cu (mg/L)	Fe (mg/L)	Mn (mg/L)	Ni (mg/L)	Pb (mg/L)	Zn (mg/L)
1/13/2005	7.7	2	262	0.33	0.01	0.239	0.0006	0.003	0.234	0.0355	0.0014	0.0009	0.004
1/20/2005	7.4	2		0.33									
1/27/2005	7.4	2		0.17									
2/3/2005	7.5	2		0.23									
2/10/2005	7.5	3	267	0.32	0.009	0.375	0.0006	0.006	0.238	0.0423	0.0016	0.0006	0.004
2/17/2005	7.6	2		0.24									
5/5/2005	7.3	< 1		0.12									
5/12/2005	7.5	1		0.13									
5/19/2005	7.7	< 1	233	0.092	0.009	0.31	0.0009	< 0.001	0.207	0.0754	0.0023	0.0008	0.006
10/20/2005	7.4	< 1		0.1									
10/27/2005	7.5	1	303	0.25	0.011	0.247	< 0.0003	< 0.001	0.043	0.0118	0.0009	< 0.0006	0.002
11/3/2005	7.9	2		0.19									
11/10/2005	7.4	2	243	0.23	< 0.005	0.291	< 0.0003	< 0.001	0.081	0.0176	0.0017	0.0007	0.004
11/17/2005	7.4	2		0.17									
3/23/2006	7	< 2	260	0.046	0.0109	0.072	< 0.0005	0.0014	0.13	0.0317	0.003	< 0.0005	0.004
3/30/2006	7.6	1		0.061									
4/6/2006	7.7	1	230	0.061	0.00795	0.179	0.0007	0.0019	0.23	0.0602	0.0024	0.00078	0.005
4/13/2006	7.5	2		0.097									
4/20/2006	7.5	2		0.046									
4/27/2006	7.3	1		0.014									
5/4/2006	7.4	2	180	0.04	0.00748	0.286	0.0012	0.0013	0.27	0.0756	0.0024	0.00251	0.0056
5/11/2006	7.5	1		0.035									
5/18/2006	7.2	2		0.033									
5/25/2006	7.3	1		0.055									
6/1/2006	7.3	1		0.061									
6/8/2006	7.7	1	210	0.21	0.0058	0.309	0.00056	0.001	0.06	0.0473	< 0.002	< 0.0005	0.0045
10/19/2006	7.3	2		0.067									
10/26/2006	7.3	2	210	0.11	0.0094	0.289	< 0.0005	0.0014	0.09	0.016	< 0.002	0.0009	0.002
11/2/2006	7.3	2		0.18									
11/9/2006	7.4	2	220	0.2	0.0058	0.25	< 0.0005	0.0006	0.12	0.016	< 0.002	0.0013	0.001
11/16/2006	7.3	1		0.14									
11/23/2006	7.3	1		0.1									
3/8/2007	7.0		220.0	0.019	0.0057	0.100	< 0.0005		0.09	0.020			
3/15/2007	7.5			0.081									
3/22/2007	7.1			0.079									
3/29/2007	7.2			0.210									
4/5/2007	7.3			0.099									
4/12/2007	7.2			0.077									
4/19/2007	7.5		210.0	0.100	0.0070	0.236	< 0.0005		0.17	0.044			
4/26/2007	7.6			0.079									
5/3/2007	7.5			0.058									
5/10/2007	7.6		200.0	0.062	0.0060	0.246	0.0009		0.21	0.062			
11/15/2007	7.5			0.063									
11/22/2007	7.5		220.0	0.098	0.0074	0.358	0.0005		0.15	0.019			
11/29/2007	7.4			0.120									
12/6/2007	7.5		210.0	0.100	0.0051	0.313	0.0005		0.14	0.021			
2/21/2008	7.3		210.0	0.054	0.0057	0.361	0.0007		0.15	0.043			
2/28/2008	7.4			0.057									
3/6/2008	7.6		230.0	0.220	0.0056	0.501	0.0005		0.14	0.038			
3/13/2008	7.7			0.098									
3/20/2008	7.3			0.350									
3/27/2008	7.3			0.130									
4/3/2008	7.4		220.0	0.035	0.0067	0.332	0.0005		0.16	0.097			
4/10/2008	7.6			0.070									
4/17/2008	7.5			0.032									
4/24/2008	7.3			0.091									
5/1/2008	7.6		170.0	0.210	0.0072	0.454	0.0014		0.32	0.146			
5/8/2008	7.6			0.100									
5/15/2008	7.6			0.130									
5/22/2008	7.8		190.0	0.130	0.0074	0.214	0.0013		0.33	0.124			
6/26/2008	7.6			0.066									
7/3/2008	7.5		190.0	0.094	0.0070	0.513	< 0.0005		0.07	0.021			
7/10/2008	7.6			0.069									
8/7/2008	7.6		170.0	0.042	0.0093	0.330	< 0.0005		0.03	0.017			
8/14/2008	7.4			0.097									
10/9/2008	7.5		190.0	0.074	0.0133	0.264	< 0.0005		0.03	0.009			
10/16/2008	8.0		190.0	0.075	0.0061	0.502	< 0.0005		0.05	0.016			
10/23/2008	7.3			0.066									
10/30/2008	7.1			0.059									
2/5/2009	7.5			0.056									
2/12/2009	7.4		190.0	0.150	0.0041	0.640	< 0.0005		0.09	0.028			
2/19/2009	7.7			0.086									
2/26/2009	7.9			0.260									
3/26/2009	7.8		200.0	0.040	0.0057	0.536	< 0.0005		0.10	0.054			
4/2/2009	7.6			0.091									

Appendix Table D.3.5: Water quality at station P-14 from 2005 to 2009.

Date	pH[a]	TSS (mg/L)	SO4 (mg/L)	Ra (Bq/L)	U (mg/L)	Ba (mg/L)	Co (mg/L)	Cu (mg/L)	Fe (mg/L)	Mn (mg/L)	Ni (mg/L)	Pb (mg/L)	Zn (mg/L)
4/8/2009	7.2		190.0	0.069	0.0048	0.637	< 0.0005		0.12	0.068			
4/16/2009	7.4			0.140									
4/23/2009	7.4			0.190									
4/30/2009	7.4			0.240									
5/7/2009	7.5		151.0	0.170	0.0057	0.469	0.0012		0.30	0.156			
5/14/2009	7.5			0.099									
5/21/2009	7.7			0.100									
5/28/2009	7.8			0.100									
6/4/2009	7.7		160.0	0.120	0.0054	0.514	< 0.0005		0.19	0.085			
11/5/2009	7.6		170.0	0.100	0.0162	0.431	< 0.0005		0.03	0.010			
11/12/2009	8.0			0.055									
11/19/2009	7.5			0.088									
11/26/2009	7.7			0.210									
12/3/2009	7.4			0.200									
12/10/2009	7.7		180.0	0.100	0.0043	0.557	< 0.0005		0.07	0.020			
Number	149	32	32	90	32	32	32	11	32	32	11	11	11
Minimum	7	1	151	0.014	0.0041	0.072	0.0003	0.0006	0.03	0.009	0.0009	0.0005	0.001
Maximum	8	3	303	0.35	0.0162	0.64	0.0014	0.006	0.33	0.156	0.003	0.00251	0.006
Mean	7.5	2	209	0.119	0.0074	0.355	0.0006	0.0018	0.15	0.048	0.002	0.0009	0.004
Median	7.5	2	210	0.099	0.0069	0.322	0.0005	0.0013	0.14	0.037	0.002	0.0008	0.004
10th Perc.	7.3	1	170	0.046	0.0050	0.216	0.0005	0.0010	0.04	0.016	0.001	0.0005	0.002

[a] pH measures shown only for dates when other substances were measured but summary statistics reflect all measured values.

Appendix Table D.3.6: Summary of Annual Plant Operations and Discharge at Panel, 2005-2009.

ITEM	2005	2006	2007	2008	2009
PLANT OPERATIONS					
Operating Days	108	126	104	161	146
Maximum Daily Plant Flow (L/s @ P-13)	110	108	106	150	150
Minimum Daily Plant Flow (L/s @ P-13)	0	0	0	0	0
Monthly Average Daily Plant Flow (L/s @ P-13)	101	70	76	103	101
Total Volume Treated (ML)	944	766	684	1432	1285
Annual Average Treatment Rate (L/s)			76	103	102
Barium Chloride Consumption					
Total (kg/yr)	2332	2352	1354	2740	3190
Monthly Average (mg/L)	2.5	3.1	1.98	1.91	2.48
Caustic Soda Consumption					
total kg/year	3524	2485	0.00	0.00	0.00
monthly average mg/litre	3.7	3.2	0.00	0.00	0.00
Lime Consumption					
Dry (tonne/yr)	0.0	0.0	1.60	4.60	3.12
Average (g/L)	0.0	0.0	0.002	0.003	0.002
***EFFLUENT**					
Discharge Days	105	125	102	159	143
Maximum Daily Discharge Flow (L/s @ P-14)	105	106	102	143	142
Minimum Daily Discharge Flow (L/s @ P-14)	0	0	0	0	0
Monthly Average Daily Discharge Flow (L/s @ P-14)	101	67	75	100	101
Total Annual Volume Discharged (ML)	916	721	664	1369	1268
Annual Average Discharge Rate (L/s)	29	23	75	100	103

* Influent flows based on daily monitoring requirements as per TOMP
* Effluent flows based on weekly monitoring requirement as per SAMP

Appendix Table D.3.7: Mean annual discharge and seepage loadings from Panel TMA, 2005 - 2009.

Station	Drainage Type	Mean Annual Discharge (m^3)		Sulphate (kg/yr)	Radium (MBq/yr)	Uranium (kg/yr)	Barium (kg/yr)	Cobalt (kg/yr)	Iron (kg/yr)	Manganese (kg/yr)
Q-09	Quirke Lake Inflet	67,185,723	Mean	5,684,136	5,718	312	5,909	37		
			S.D.	926,920	866	66	931	4.7		
P-14	Controlled Discharge	2,106,605	Mean	212,889	126	7.9	370	0.5	152	51
			S.D.	53,487	52	2.6	239	0.2	45	29
P-02	Seepage from Dam B	63,072	Mean	33,822	2.9	0.2	1.41	0.1	37	23
			S.D.	7,898	0.95	0.1	0.1	0.1	15	40
P-03	Pond C Discharge	337,435	Mean	2,986	174	0.2	10.5	0.1	520	17
			S.D.	1,299	27	0.3	1.31	0.0	236.4	11
P-05	Seepage from Dam E	253,234	Mean	8,845	1.1	0.2	3.70	0.2	112	19
			S.D.	3,467	0.44	0.25	1.22	0.1	16.2	9
P-11	Site Drainage	687,485	Mean	7,043	36	1.2	7.8	0.3	249	14
			S.D.	3,644	24	0.8	5.0	0.2	216	13
			All Panel Sources	**265,586**	**340**	**10**	**393**	**1.2**	**1,070**	**125**
SR-01	Outlet of Quirke Lake	136,511,119	Mean	7,792,055	4205	218	5,477	31		
			S.D.	1,335,662	665	55	231	6		

MBq/yr = Million Bequerels per year

Appendix Table D.3.8: Summary of seasonal trends for station P-02, 2003 to 2009.

Season	Spearman rho	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium
January	Correlation Coefficient	-0.61264	-0.12613	0.035714	0.035714286	0.039406	-0.57142857	-0.857143	-0.463817
	Sig. (2-tailed)	0.143589	0.787572	0.939408	0.939408205	0.933155	0.18020199	0.0136973	0.3541643
	N	7	7	7	7	7	7	7	6
April/May	Correlation Coefficient	-0.25	-0.46849	-0.03571	-0.321428571	0.692345	-0.42857143	-0.75	
	Sig. (2-tailed)	0.588724	0.288997	0.939408	0.482072038	0.084724	0.33736831	0.0521814	
	N	7	7	7	7	7	7	7	
July	Correlation Coefficient	0.185312	-0.69102	-0.25	-0.75	0.600099	-0.17857143	-0.928571	
	Sig. (2-tailed)	0.690778	0.08557	0.588724	0.0521814	0.154291	0.70165794	0.0025195	
	N	7	7	7	7	7	7	7	
October/November	Correlation Coefficient	0.216225	-0.17857	0.178571	-0.178571429	0.370625	-0.35714286	-0.964286	-0.205196
	Sig. (2-tailed)	0.641446	0.701658	0.701658	0.701657943	0.413116	0.43161135	0.0004541	0.7405819
	N	7	7	7	7	7	7	7	5

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).
ns denotes not significant.
[shaded] Significant trend where p<0.05.

Appendix Table D.3.9: Summary of seasonal trends for station P-03, 2003 to 2009.

Season	Spearman rho	Barium	Iron	Manganese	pH	Radium-226	Sulphate
January	Correlation Coefficient	-0.54286	-0.88571	-0.37685117	-0.65714	0.14285714	-0.88571
	Sig. (2-tailed)	0.265703	0.018845	0.46148284	0.156175	0.78717201	0.018845
	N	6	6	6	6	6	6
April/May	Correlation Coefficient	-0.42857	-0.82143	-0.85714286	-0.10911	-0.42857143	0.321429
	Sig. (2-tailed)	0.337368	0.023449	0.013697327	0.815871	0.33736831	0.482072
	N	7	7	7	7	7	7
July	Correlation Coefficient	0.75	-0.03571	-0.05455447	-0.53571	0.36037499	0.018019
	Sig. (2-tailed)	0.052181	0.939408	0.907523209	0.215217	0.42714881	0.969415
	N	7	7	7	7	7	7
October	Correlation Coefficient	0.771429	0.714286	0.794461347	-0.77143	0.77142857	-0.08571
	Sig. (2-tailed)	0.072397	0.110787	0.0590276	0.072397	0.0723965	0.871743
	N	6	6	6	6	6	6

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

ns denotes not significant.

[shaded box] Significant trend where p<0.05.

Appendix Table D.3.10: Summary of seasonal trends for station P-05, 2003 to 2009.

Season	Spearman rho	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate
January	Correlation Coefficient	-0.991031209	-0.785714	-0.857143	-0.75	-0.218218	-0.95431352	-0.126131
	Sig. (2-tailed)	1.45613E-05	0.036238	0.013697	0.0521814	0.638299	0.00083601	0.787572
	N	7	7	7	7	7	7	7
April/May	Correlation Coefficient	0	-0.205832	0.107143	-0.321428571	-0.377964		-0.035714
	Sig. (2-tailed)	1	0.657923	0.819151	0.482072038	0.40318		0.939408
	N	7	7	7	7	7		7
July	Correlation Coefficient	-0.071428571	0.259437	0.392857	-0.035714286	-0.256978		-0.285714
	Sig. (2-tailed)	0.879048193	0.574237	0.383317	0.939408205	0.578001		0.534509
	N	7	7	7	7	7		7
October	Correlation Coefficient	0.071428571	0.748705	0.535714	0.607142857	-0.571429	-0.1111874	-0.321429
	Sig. (2-tailed)	0.879048193	0.05282	0.215217	0.148231161	0.180202	0.81240702	0.482072
	N	7	7	7	7	7	7	7

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

ns denotes not significant.

[shaded box] Significant trend where $p<0.05$.

Appendix Table D.3.11: Summary of seasonal trends for station P-11, 2003 to 2009.

Season	Spearman rho	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium
January	Correlation Coefficient	-0.88292	-0.95431	-0.75	-0.85714286	-0.16366	-0.71428571	-0.8928571	-0.205196
	Sig. (2-tailed)	0.00845	0.000836	0.052181	0.013697327	0.725862	0.071343561	0.0068072	ns
	N	7	7	7	7	7	7	7	5
April/May	Correlation Coefficient	0.109109		-0.43245	-0.66669372	-0.43644	-0.28571429	-0.25	
	Sig. (2-tailed)	0.815871		0.332527	0.10192046	0.327582	0.534509229	0.5887244	
	N	7		7	7	7	7	7	
July/August	Correlation Coefficient	-0.02857		-0.46382	-0.54285714	0.83666	-0.71428571	-0.7714286	
	Sig. (2-tailed)	0.957155		0.354164	0.265702624	0.037841	0.110787172	0.0723965	
	N	6		6	6	6	6	6	
October	Correlation Coefficient	0.180187	-0.14548	0.642857	0.144149994	0.054056	-0.57142857	-0.4865062	
	Sig. (2-tailed)	0.699046	0.755633	0.119392	0.757817936	0.908365	0.180201989	0.2682486	
	N	7	7	7	7	7	7	7	

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

ns denotes not significant.

[shaded box] Significant trend where $p<0.05$.

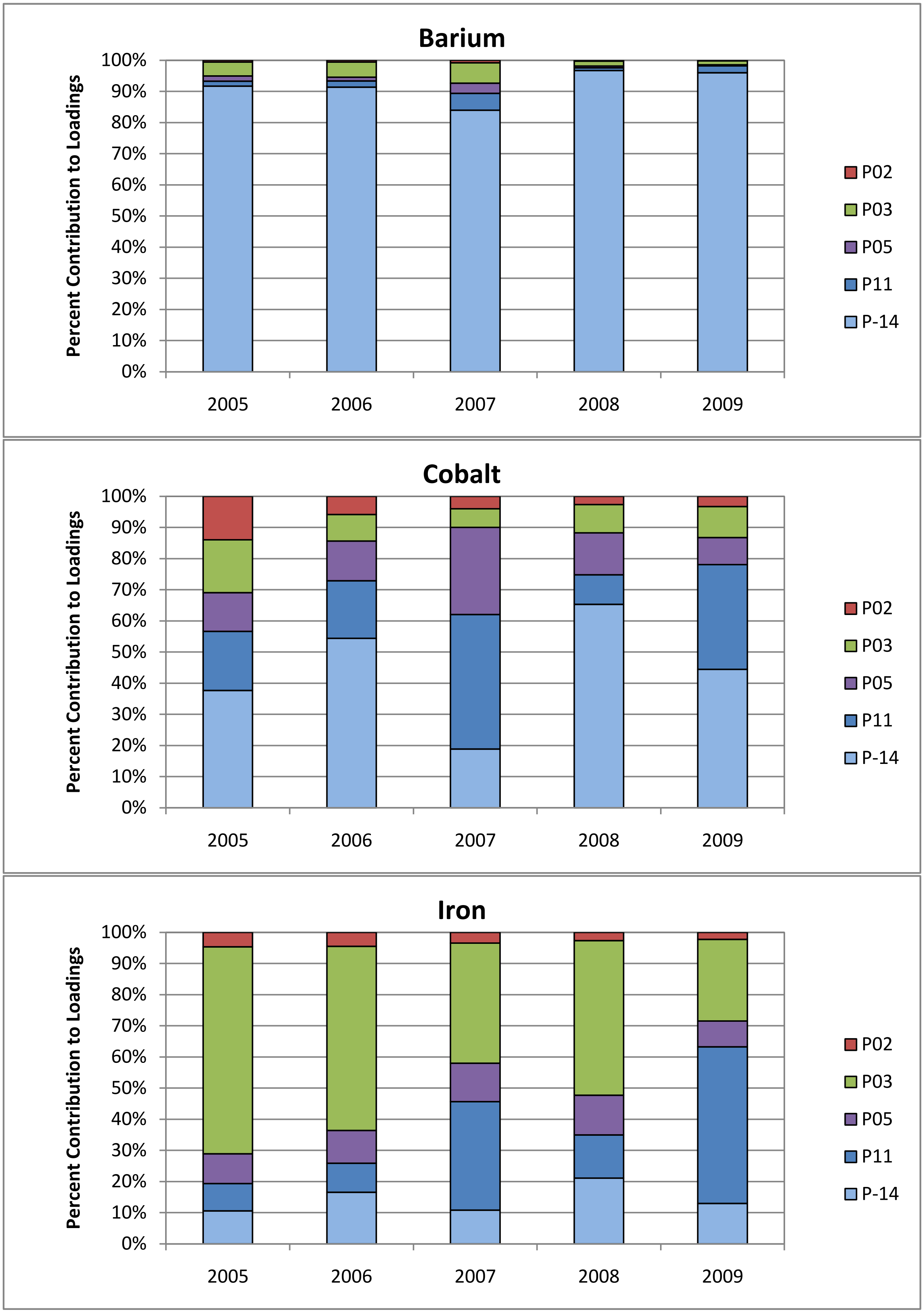
Appendix Table D.3.12: Summary of seasonal trends for station P-14, 2003 to 2009.

Season	Spearman rho	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium
February/March	Correlation Coefficient	0.7	-0.44721	-0.5	0.3	-0.35714	-0.77142857	-0.9	-0.71818
	Sig. (2-tailed)	0.18812	0.450185	0.391002	0.623837665	0.431611	0.072396501	0.037386	0.171795
	N	5	5	5	5	7	6	5	5
April	Correlation Coefficient	0.714286	-0.61791	-0.65714	0.485714286	-0.31887	-0.48571429	-0.94286	-0.94286
	Sig. (2-tailed)	0.110787	0.191094	0.156175	0.328723032	0.537901	0.328723032	0.004805	0.004805
	N	6	6	6	6	6	6	6	6
May	Correlation Coefficient	0.5	-0.07485	0.178571	0.535714286	0.035714	-0.42857143	-0.90094	-0.96429
	Sig. (2-tailed)	0.25317	0.87329	0.701658	0.215217456	0.939408	0.337368311	0.005621	0.000454
	N	7	7	7	7	7	7	7	7
October	Correlation Coefficient	0.9		0	0.410391341	-0.8	-1	-0.7	-0.71818
	Sig. (2-tailed)	0.037386		1	0.492535782	0.104088	0.000001	0.18812	0.171795
	N	5		5	5	5	5	5	5
November	Correlation Coefficient	0.6	-0.44721	-0.6	-0.7	-0.14286	-0.9	-0.97468	0.4
	Sig. (2-tailed)	0.284757	0.450185	0.284757	0.188120404	0.787172	0.037386073	0.004818	0.504632
	N	5	5	5	5	6	5	5	5

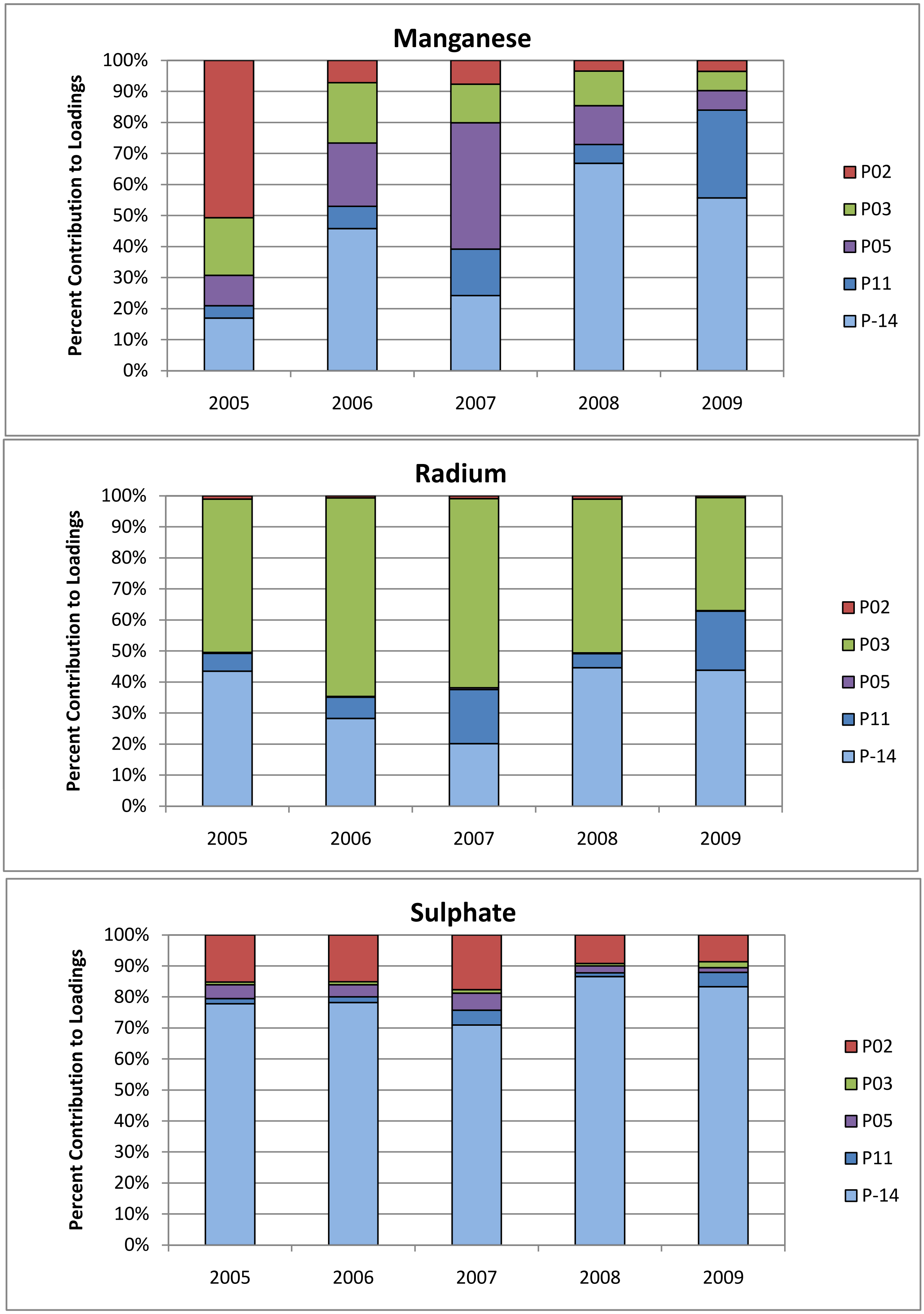
Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

ns denotes not significant.

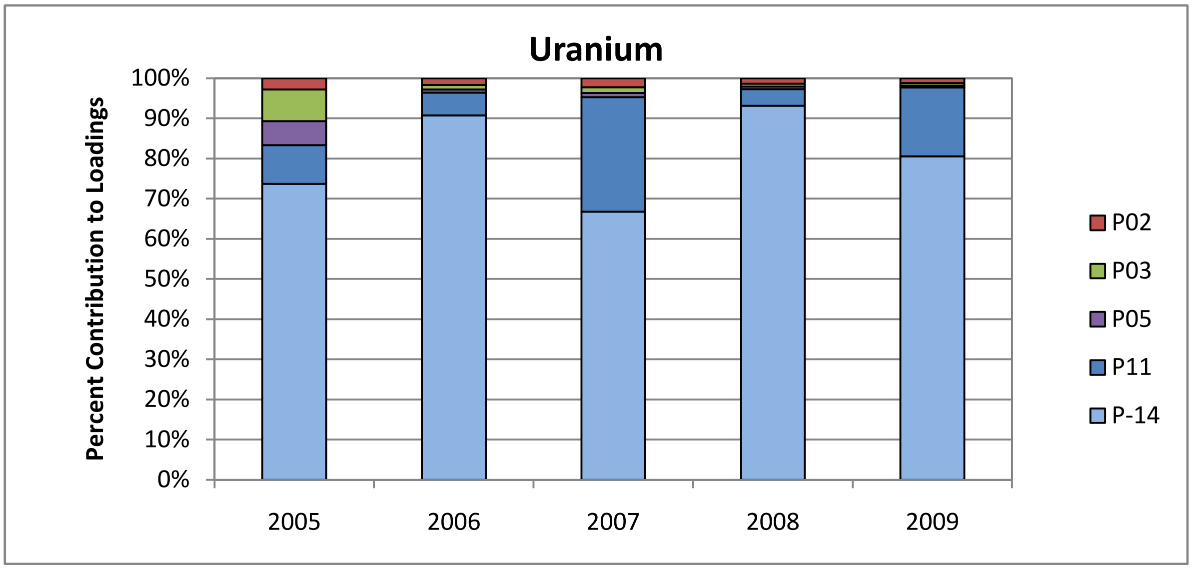
(shaded) Significant trend where p<0.05.



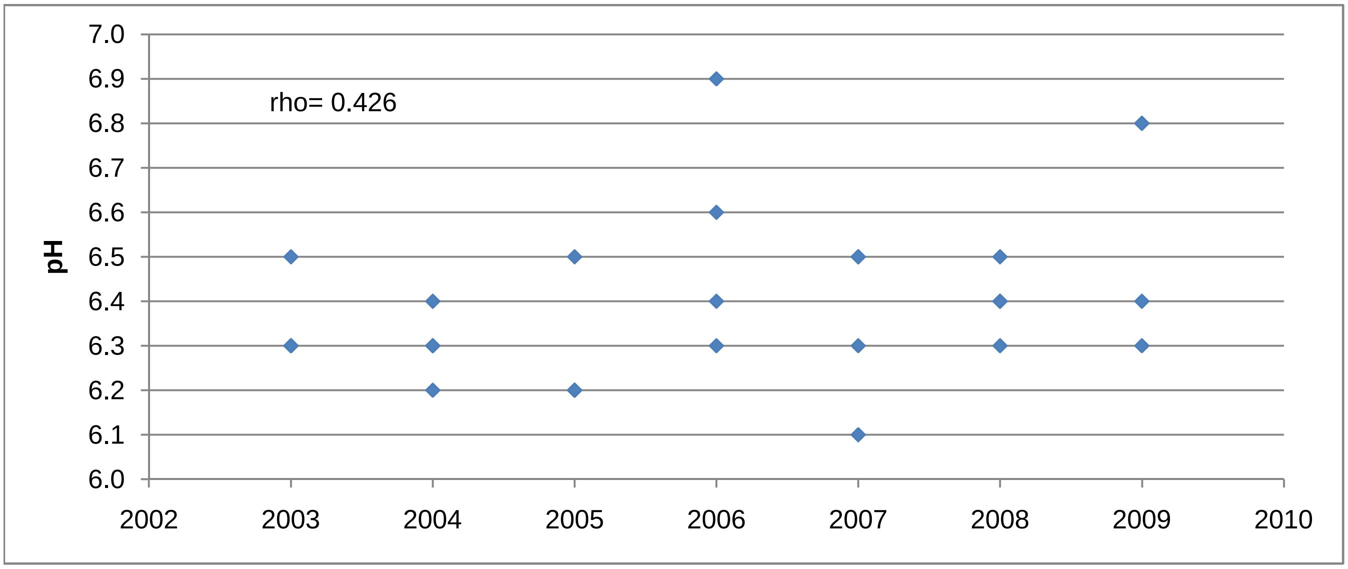
Appendix Figure D.3.1: Percent contribution to loads from Panel TMA discharge points.

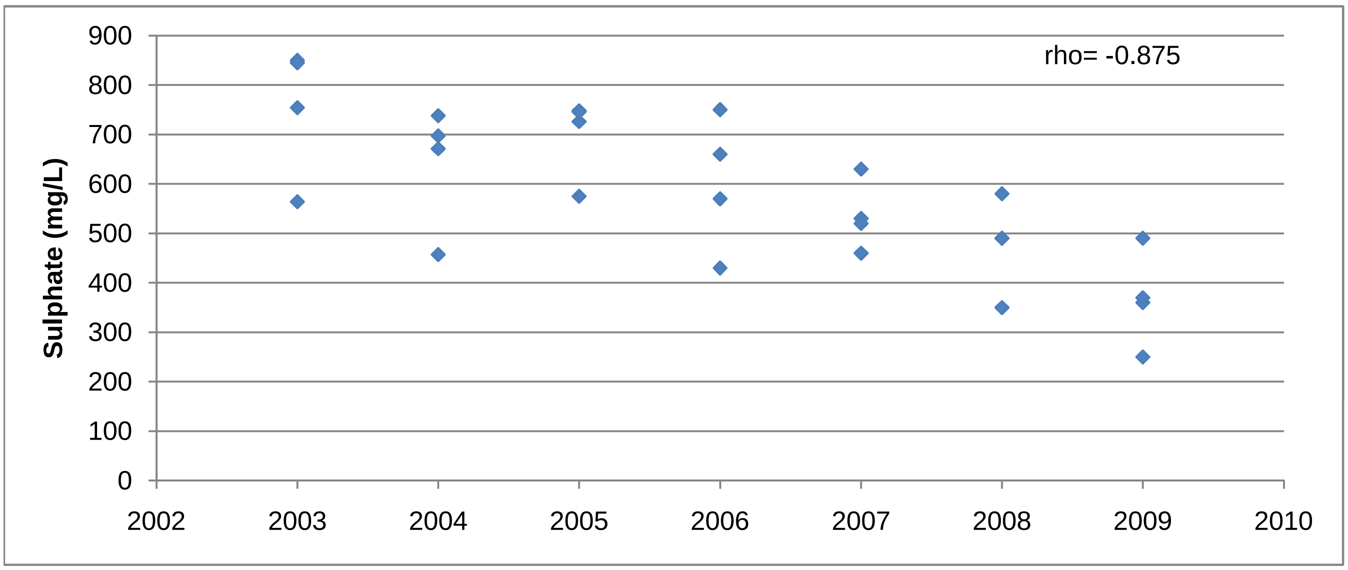


Appendix Figure D.3.1: Percent contribution to loads from Panel TMA discharge points.

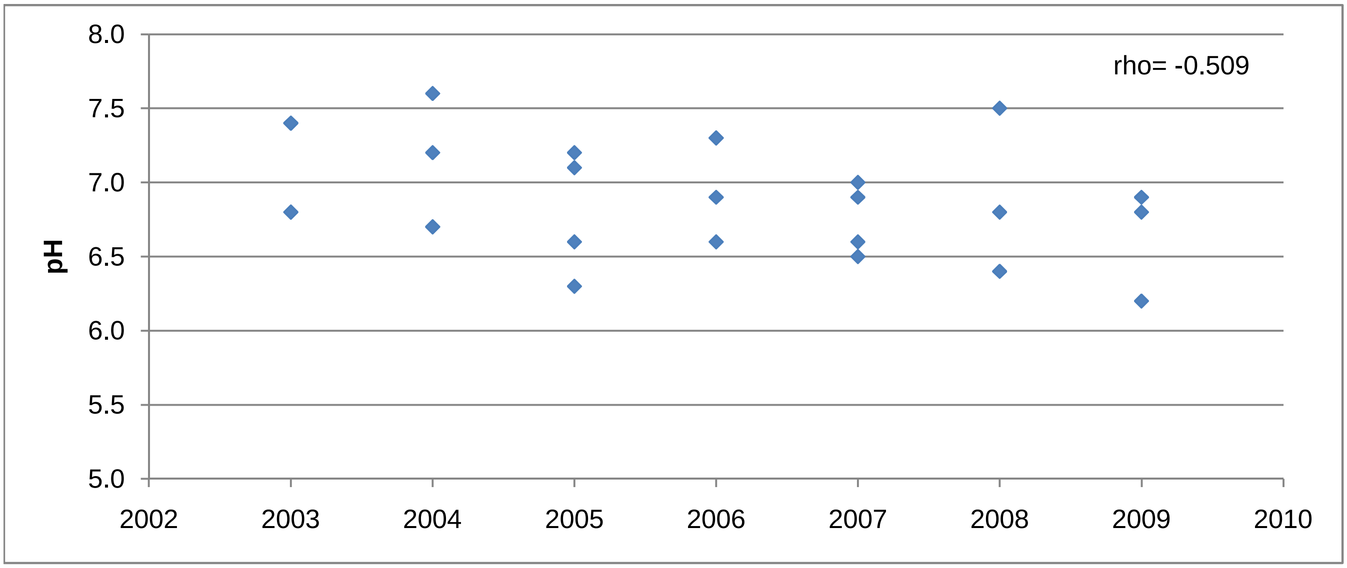


Appendix Figure D.3.1: Percent contribution to loads from Panel TMA discharge points.

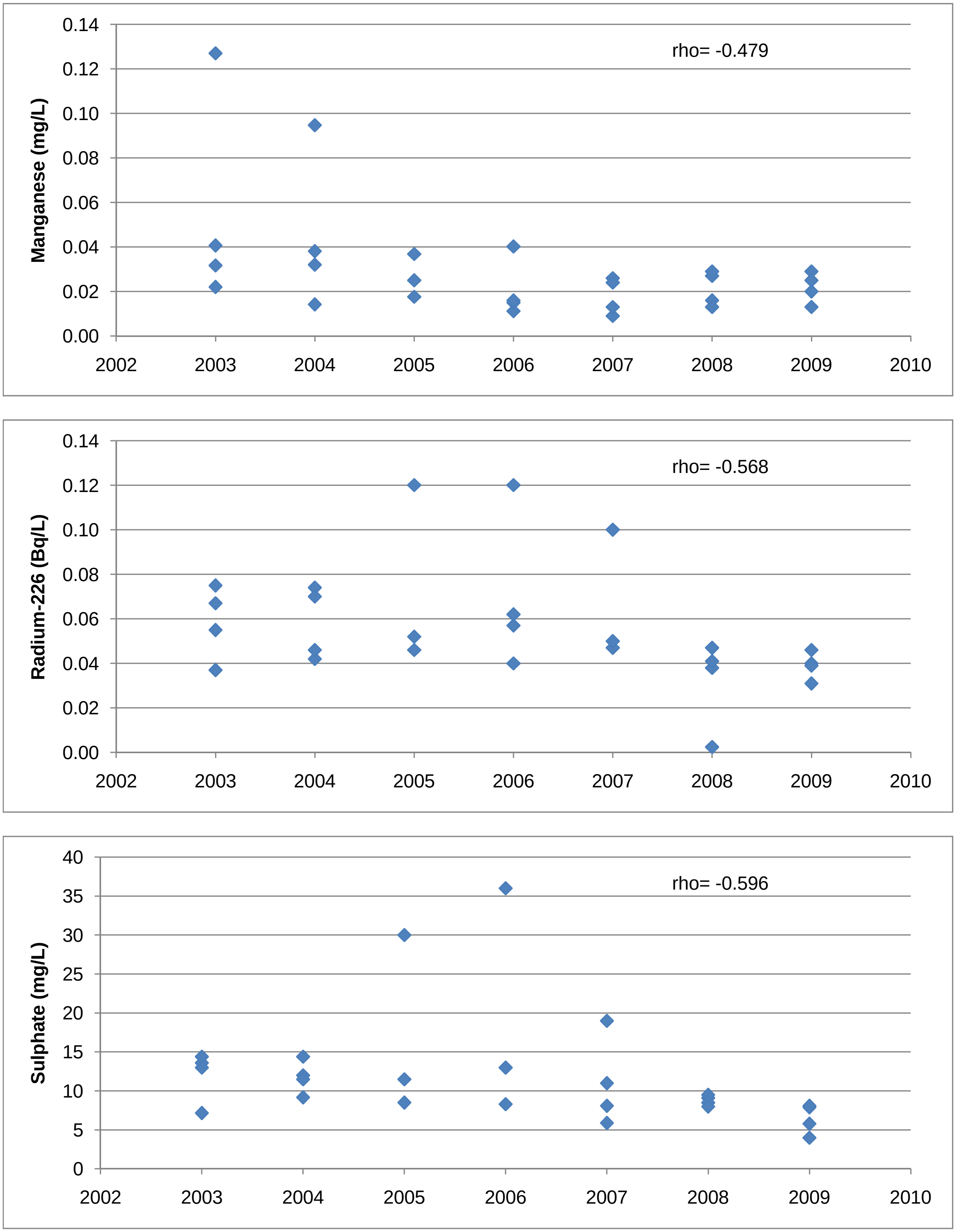




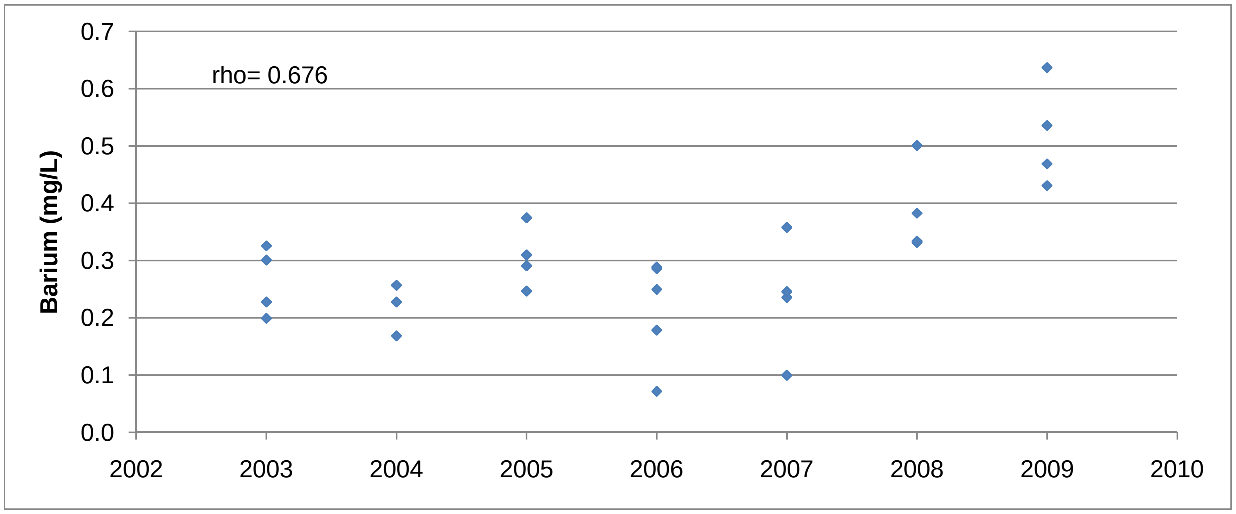
Appendix Figure D.3.2: Significant common (average) trends observed for pH and sulphate over all seasons at station P-02, 2003 to 2009.

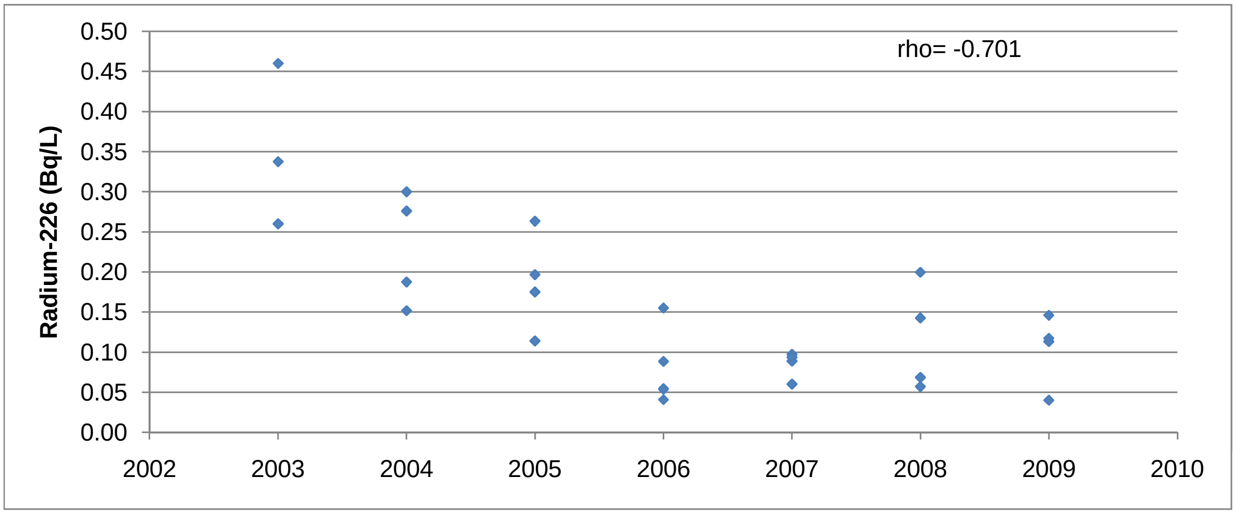


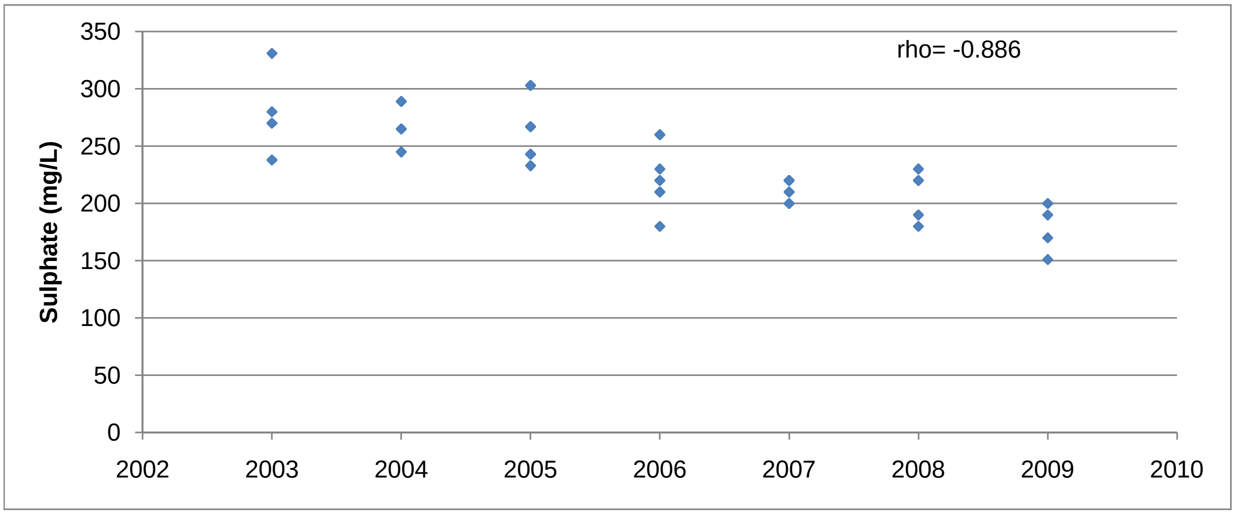
Appendix Figure D.3.3: Significant common (average) trends observed for pH over all seasons at station P-03, 2003 to 2009.



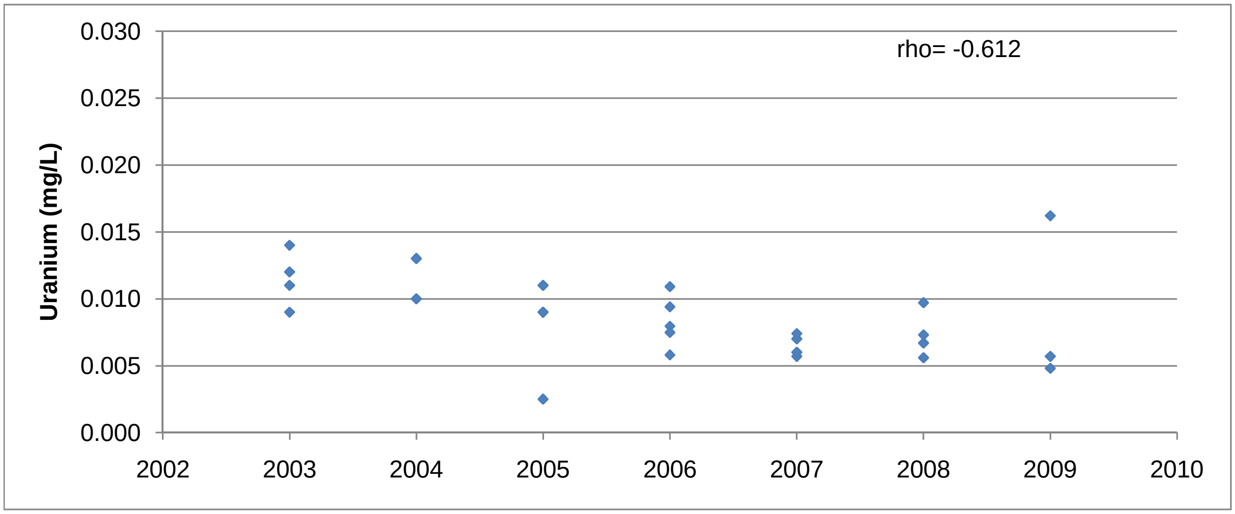
Appendix Figure D.3.4: Significant common (average) trends observed for manganese, radium-226 and sulphate over all seasons at station P-11, 2003 to 2009.



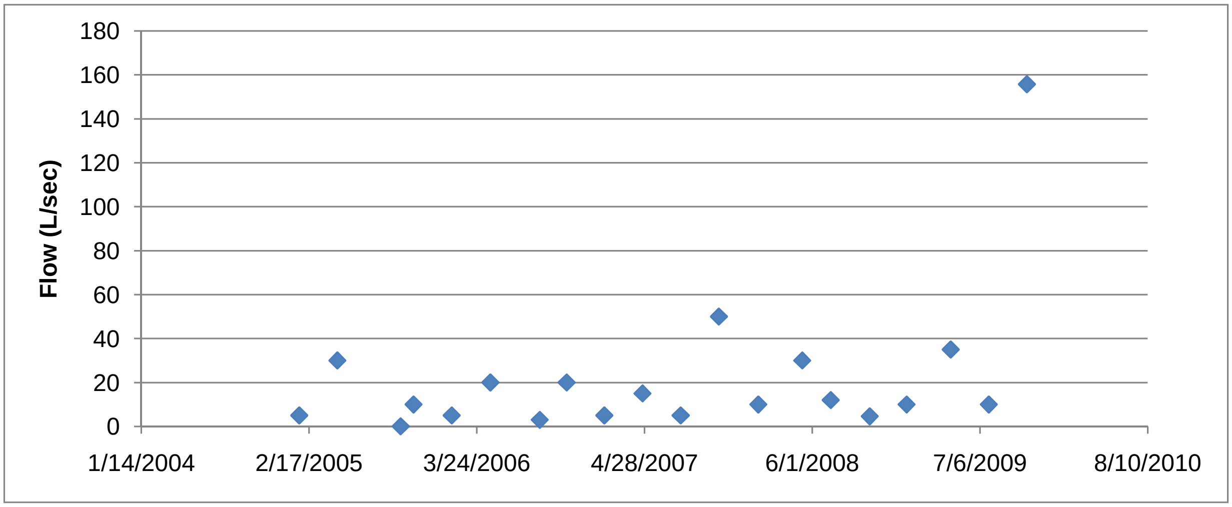




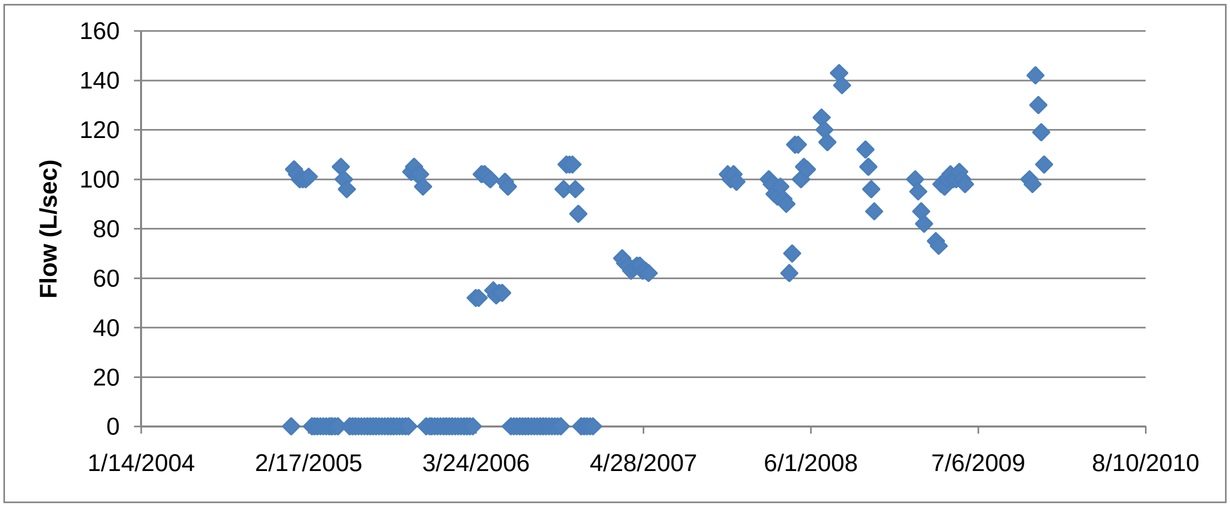
Appendix Figure D.3.5: Significant common (average) trends observed for barium, radium-226, sulphate and uranium over all seasons at station P-14, 2003 to 2009.



Appendix Figure D.3.5: Significant common (average) trends observed for barium, radium-226, sulphate and uranium over all seasons at station P-14, 2003 to 2009.



Appendix Figure D.3.6: Flows at station P-11 from 2005 to 2009.



Appendix Figure D.3.7: Flows at station P-14 from 2005 to 2009.

APPENDIX D.4
Stanrock TMA

Appendix Table D.4.1: Water quality at station DS-4 from 2005 to 2009.

Date	Ba (mg/L)	Co (mg/L)	Cu (mg/L)	Fe (mg/L)	Mn (mg/L)	Ni (mg/L)	Pb (mg/L)	pH[a]	Ra (Bq/L)	SO4 (mg/L)	TSS (mg/L)	U (mg/L)	Zn (mg/L)
1/4/2005	0.0225	0.0008	< 0.001	0.203	0.0402	0.001	< 0.0006	7.7	0.041	400	1	0.006	0.003
1/11/2005								7.2	0.039		< 1		
1/18/2005								7.8	0.04		1		
1/25/2005								7.3	0.046		1		
2/1/2005								7.3	0.049		< 1		
2/8/2005	0.0254	0.001	< 0.001	0.273	0.0648	0.001	< 0.0006	7.2	0.041	448	1	0.008	0.002
2/15/2005								7.1	0.037		2		
2/22/2005								7.2	0.057		1		
3/1/2005								7.1	0.069		1		
3/8/2005	0.0231	0.001	< 0.001	0.253	0.0863	0.0014	< 0.0006	7.1	0.054	492	< 1	0.009	0.002
3/15/2005								7.2	0.06		< 1		
3/22/2005								7	0.068		< 1		
3/29/2005								7.4	0.046		< 1		
4/5/2005	0.0381	0.0033	< 0.001	0.844	0.143	0.0027	< 0.0006	7.5	0.044	450	3	0.006	0.005
4/12/2005								9.3	0.032		< 1		
4/19/2005								8.2	0.037		< 1		
4/26/2005								7.7	0.049		< 1		
5/3/2005	0.0356	0.001	< 0.001	0.083	0.0613	0.0015	< 0.0006	7.6	0.051	300	< 1	< 0.005	< 0.001
5/10/2005								7.2	0.068		< 1		
5/17/2005								7.2	0.047		< 1		
5/24/2005								7	0.069		< 1		
5/31/2005								7.3	0.059		< 1		
6/7/2005	0.0264	0.0004	< 0.001	0.034	0.015	< 0.0003	< 0.0006	7.3	0.081	321	< 1	< 0.005	0.0183
6/14/2005								7.2	0.1		< 1		
6/21/2005								7.2	0.1		< 1		
6/28/2005								7.2	0.097		< 1		
7/5/2005	0.0239	< 0.0003	< 0.001	0.046	0.0256	0.0003	< 0.0006	7.1	0.13	359	< 1	< 0.005	0.008
7/12/2005								7.3	0.15		< 1		
7/19/2005								7.2	0.12		< 1		
7/26/2005								7.2	0.14		< 1		
8/2/2005	0.028	< 0.0003	< 0.001	0.031	0.0461	< 0.0003	< 0.0006	7.2	0.088	392	< 1	< 0.005	0.005
8/9/2005								7.3	0.15		< 1		
8/16/2005								7.1	0.12		< 1		
8/23/2005								7.1	0.15		< 1		
8/30/2005								7.2	0.1		< 1		
9/6/2005	0.0265	< 0.0003	< 0.001	0.058	0.106	< 0.0003	< 0.0006	7	0.12	445	< 1	< 0.005	0.009
9/13/2005								7.1	0.13		< 1		
9/20/2005								7.3	0.082		< 1		
9/27/2005								7.2	0.089		< 1		
10/4/2005	0.0177	< 0.0003	< 0.001	0.038	0.0408	0.001	< 0.0006	7.3	0.064	487	< 1	< 0.005	0.009
10/11/2005								7.2	0.12		< 1		
10/18/2005								7.1	0.092		< 1		
10/25/2005								7.1	0.096		< 1		
11/1/2005								7.1	0.067		< 1		
11/8/2005	0.0171	< 0.0003	< 0.001	0.049	0.0224	< 0.0003	< 0.0006	7.4	0.075	412	< 1	< 0.005	0.001
11/15/2005								6.8	0.055		< 1		
11/22/2005								6.8	0.057		< 1		
11/29/2005								7	0.07		< 1		
12/6/2005	0.0225	0.0004	< 0.001	0.175	0.0364	0.0006	< 0.0006	7.3	0.051	391	< 1	< 0.005	< 0.001
12/13/2005								7.3	0.057		< 1		
12/20/2005								7.3	0.055		< 1		
12/28/2005								7.6	0.048		< 1		
1/3/2006	0.024	0.0007	0.0007	0.13	0.058	0.001	< 0.0002	7.4	0.038	390	< 2	0.0042	0.001
1/10/2006								7	0.05		< 2		
1/17/2006								7	0.045		< 2		
1/24/2006								7.1	0.05		2		
1/31/2006								7.4	0.05		< 2		
2/7/2006	0.025	0.0005	0.0018	0.11	0.0468	0.001	< 0.0002	7.6	0.051	430	< 2	0.0046	0.002
2/14/2006								7.4	0.045		< 2		
2/21/2006								7.3	0.042		< 2		
2/28/2006								7.4	0.055		< 2		
3/7/2006	0.026	0.0004	< 0.0008	0.1	0.062	0.001	< 0.0002	7.1	0.062	420	< 2	0.0046	0.002
3/14/2006								7.4	0.052		< 2		
3/21/2006								7.3	0.045		< 2		
3/28/2006								7.2	0.048		< 2		
4/4/2006	0.031	0.00176	0.0014	0.41	0.107	0.0027	0.00005	9.4	0.028	360	1	0.0033	0.0049
4/11/2006								9.3	0.11		4		
4/18/2006								8.1	0.029		1		
4/24/2006								7.7	0.036		1		
5/2/2006	0.051	0.0007	0.0009	0.06	0.053	0.001	< 0.0005	7.5	0.062	260	1	0.0022	0.002
5/9/2006								7.5	0.078		< 1		
5/16/2006								7.5	0.047		1		
5/23/2006								7.6	0.051		1		
5/30/2006								7.4	0.079		< 1		

Appendix Table D.4.1: Water quality at station DS-4 from 2005 to 2009.

Date	Ba (mg/L)	Co (mg/L)	Cu (mg/L)	Fe (mg/L)	Mn (mg/L)	Ni (mg/L)	Pb (mg/L)	pH[a]	Ra (Bq/L)	SO4 (mg/L)	TSS (mg/L)	U (mg/L)	Zn (mg/L)
6/6/2006	0.0386	0.0003	0.0006	0.01	0.0485	0.0009	0.00009	7.2	0.14	360	< 1	0.00166	0.001
6/13/2006								7.3	0.11		< 1		
6/20/2006								7.3	0.099		< 1		
6/27/2006								7.4	0.088		< 1		
7/4/2006	0.04	0.0002	0.0005	0.03	0.039	0.002	< 0.0005	7.3	0.12	390	< 1	0.0023	0.001
7/11/2006								7.3	0.085		1		
7/18/2006								7.4	0.13		< 1		
7/24/2006								7.2	0.13		< 1		
8/1/2006	0.0338	< 0.0005	0.0006	0.05	0.0271	< 0.002	< 0.0005	7.4	0.1	390	< 1	0.00308	0.0068
8/8/2006								7.3	0.12		< 1		
8/15/2006								7.4	0.11		< 1		
8/22/2006								7.4	0.12		< 1		
8/29/2006								7.3	0.12		1		
9/5/2006	0.031	< 0.0005	0.0022	0.09	0.079	< 0.002	< 0.0005	7.3	0.092	420	< 1	0.0029	< 0.001
9/12/2006								7.3	0.13		< 1		
9/19/2006								7.2	0.087		< 1		
9/26/2006								7.3	0.088		1		
10/3/2006	0.027	< 0.0005	0.0005	0.08	0.014	< 0.002	0.0007	7.4	0.071	420	< 1	0.0045	0.001
10/10/2006								7.2	0.079		< 1		
10/17/2006								7.4	0.073		1		
10/24/2006								7.5	0.049		1		
10/31/2006								7.4	0.062		2		
11/7/2006	0.025	< 0.0005	< 0.0005	0.14	0.027	< 0.002	< 0.0005	7.4	0.042	420	< 1	0.0039	0.001
11/14/2006								7.4	0.05		1		
11/21/2006								7.4	0.033		1		
11/28/2006								7.3	0.055		1		
12/5/2006	0.023	0.0009	0.0012	0.23	0.041	< 0.002	< 0.0005	7.2	0.039	480	1	0.00367	0.003
12/12/2006								7.2	0.034		1		
12/19/2006								7.3	0.028		1		
12/28/2006								7.3	0.029		1		
1/9/2007	0.028	0.0013		0.24	0.060			7.4	0.037	420.0		0.0028	
2/13/2007	0.028	0.0010		0.13	0.061			7.0	0.039	480.0		0.0031	
3/13/2007	0.027	0.0011		0.20	0.064			7.4	0.044	490.0		0.0033	
4/10/2007	0.047	0.0012		0.28	0.065			7.8	0.032	280.0		0.0017	
5/8/2007	0.036	0.0006		0.07	0.059			7.4	0.061	370.0		0.0019	
6/5/2007	0.034	0.0006		0.04	0.029			7.5	0.077	390.0		0.0022	
7/10/2007	0.032	0.0005		0.03	0.044			7.5	0.110	430.0		0.0029	
8/14/2007	0.030	< 0.0005		0.08	0.114			7.3	0.130	450.0		0.0019	
9/11/2007	0.028	< 0.0005		0.09	0.081			7.5	0.095	430.0		0.0028	
10/9/2007	0.025	< 0.0005		0.14	0.027			7.0	0.080	430.0		0.0038	
11/13/2007	0.025	0.0008		0.24	0.033			7.3	0.047	430.0		0.0041	
12/11/2007	0.024	< 0.0005		0.17	0.034			7.1	0.046	440.0		0.0039	
1/8/2008	0.022	0.0009		0.32	0.051			7.1	0.037	460.0		0.0032	
2/12/2008	0.031	0.0011		0.24	0.054			7.2	0.026	410.0		0.0023	
3/11/2008	0.027	0.0008		0.18	0.067			7.2	0.032	430.0		0.0022	
4/8/2008	0.030	0.0011		0.33	0.082			7.3	0.027	440.0		0.0025	
5/13/2008	0.066	0.0007		0.16	0.052			7.7	0.040	310.0		0.0018	
6/10/2008	0.055	0.0005		0.06	0.043			7.2	0.058	360.0		0.0018	
7/8/2008	0.049	< 0.0005		0.05	0.034			7.1	0.078	360.0		0.0017	
8/12/2008	0.039	< 0.0005		0.05	0.032			7.3	0.073	390.0		0.0025	
9/9/2008	0.035	0.0015		0.09	0.093			7.2	0.077	420.0		0.0027	
10/14/2008	0.032	< 0.0005		0.15	0.049			7.2	0.089	400.0		0.0034	
11/11/2008	0.039	0.0015		0.12	0.094			7.2	0.072	410.0		0.0034	
12/9/2008	0.033	0.0022		0.10	0.045			7.1	0.063	160.0		0.0042	
1/13/2009	0.027	0.0012		0.20	0.066			6.7	0.034	410.0		0.0029	
2/11/2009	0.032	0.0011		0.14	0.084			6.8	0.044	470.0		0.0030	
3/10/2009	0.033	0.0027		0.23	0.088			7.1	0.043	450.0		0.0041	
4/14/2009	0.039	0.0023		0.34	0.084			7.1	0.042	300.0		0.0021	
5/12/2009	0.051	0.0011		0.06	0.052			6.6	0.070	230.0		0.0011	
6/9/2009	0.054	0.0017		0.10	0.049			7.1	0.049	360.0		0.0024	
7/14/2009	0.042	< 0.0005		0.04	0.031			7.2	0.074	390.0		0.0017	
8/11/2009	0.035	< 0.0005		0.04	0.027			7.1	0.078	370.0		0.0025	
9/8/2009	0.034	< 0.0005		0.04	0.055			7.0	0.093	400.0		0.0019	
10/13/2009	0.030	< 0.0005		0.07	0.030			6.9	0.056	380.0		0.0032	
11/10/2009	0.024	0.0008		0.17	0.026			6.8	0.044	390.0		0.0023	
12/8/2009	0.026	0.0011		0.21	0.036			6.7	0.038	390.0		0.0027	
Number	60	60	24	60	60	24	24	261	140	60	104	60	24
Minimum	0.0171	0.0002	0.0005	0.01	0.014	0.0003	0.00005	6.6	0.026	160	1	0.0011	0.001
Maximum	0.066	0.0033	0.0022	0.844	0.143	0.0027	0.0007	9.4	0.15	492	4	0.009	0.0183
Mean	0.032	0.0009	0.0010	0.15	0.055	0.001	0.0005	7.2	0.070	396.1	1	0.0034	0.004
Median	0.030	0.0007	0.0010	0.11	0.050	0.001	0.0006	7.2	0.061	405.0	1	0.0031	0.002
10th Perc.	0.023	0.0003	0.0005	0.04	0.027	0.0003	0.0002	6.9	0.037	309.0	1	0.0018	0.001

[a] pH measures shown only for dates when other substances were measured but summary statistics reflect all measured values.

Appendix Table D.4.2: Water quality at station DS-16 from 2005 to 2009.

Date	Ba (mg/L)	Co (mg/L)	Fe (mg/L)	Mn (mg/L)	pH[a]	Ra (Bq/L)	SO4 (mg/L)	U (mg/L)
1/4/2005	0.0237	0.049	1.44	2.47	3.6	0.23	274	0.006
4/12/2005	0.0165	0.0273	1.19	1.66	3.7	0.21	154	< 0.005
7/5/2005	0.0247	0.0718	2.44	6.52	3.9	0.43	302	< 0.005
10/22/2005	0.0137	0.0691	3.25	5.05	6.8	0.28	463	< 0.005
11/9/2005	0.0077	0.0105	0.702	0.829	8.3	0.089	289	< 0.005
1/3/2006	0.029	0.0838	0.39	4.84	6.7	0.26	290	0.0004
4/4/2006	0.0202	0.0264	1.18	1.36	8.8	0.098	73	0.00115
7/4/2006	0.026	0.0416	0.81	3.31	7.3	0.032	290	0.0009
10/3/2006	0.028	0.054	0.62	4.04	6.9	0.23	410	0.001
1/2/2007	0.027	0.0197	0.72	1.420	8.9	0.009	130.0	0.0015
4/3/2007	0.021	0.0200	1.49	1.280	9.0	0.089	110.0	0.0013
7/3/2007	0.022	0.0786	0.05	5.320	6.9	0.068	380.0	0.0019
10/9/2007	0.028	0.0503	1.10	3.420	6.7	0.340	270.0	0.0012
1/14/2008	0.016	0.0366	1.19	2.010	6.6	0.110	130.0	0.0016
4/7/2008	0.014	0.0171	1.18	0.913	6.5	0.067	65.0	0.0013
7/7/2008	0.018	0.0098	0.54	0.773	8.7	0.092	190.0	0.0006
10/6/2008	0.014	0.0491	1.31	2.770	6.9	0.024	290.0	0.0016
1/5/2009	0.025	0.0453	1.01	2.990	9.0	0.180	200.0	0.0009
4/7/2009	0.018	0.0219	1.50	1.330	8.9	0.099	81.0	0.0013
7/6/2009	0.022	0.0195	0.65	1.800	8.2	0.170	230.0	0.0007
10/5/2009	0.049	0.0481	5.86	5.020	7.1	0.340	470.0	0.0015
Number	21	21	21	21	315	21	21	21
Minimum	0.0077	0.0098	0.05	0.773	3.6	0.009	65.0	0.0004
Maximum	0.049	0.0838	5.86	6.52	9.4	0.43	470.0	0.006
Mean	0.022	0.0405	1.36	2.815	7.4	0.164	242.4	0.0021
Median	0.022	0.0416	1.18	2.470	7.2	0.110	270.0	0.0013
10th Perc.	0.014	0.0171	0.54	0.913	6.6	0.032	81.0	0.0007

[a] pH measures shown only for dates when other substances were measured but summary statistics reflect all measured values.

Appendix Table D.4.3: Summary of Annual Plant Operations and Discharge at Stanrock, 2005-2009.

ITEM	2005	2006	2007	2008	2009
PLANT OPERATIONS					
Operating Days	84	122	93	151	138
Maximum Daily Plant Flow (L/s @ DS-2)	182	174	139	490	162
Minimum Daily Plant Flow (L/s @ DS-2)	56	7.9	0	0	0
Monthly Average Daily Plant Flow (L/s @ DS-2)	103	91	97	117	98
Total Volume Treated (ML)	746	963	779	1524	1174
Barium Chloride Consumption					
Total (kg/month)	388	785	484	714	575
Monthly Average (mg/L)	0.52	0.82	0.62	0.47	0.49
Lime Consumption					
Total Dry (tonne/month)	162	249	199.54	282.18	200.58
Monthly Average (g/L)	0.22	0.26	0.26	0.19	0.17
ORIENT CREEK					
Discharge Days	226	214	259.00	299	323
Max Daily Flow (L/s @ DS-5)	62	26	23.10	25	41.8
Min Daily Flow (L/s @ DS-5)	0	0	0.00	0	0
Monthly Average Daily Flow (L/s @ DS-5)	7.0	5.7	3.90	5.2	5.7
Total Volume (ML)	137	105	86.20	135.3	159.3
Site Total Including ETP Operations (ML)	884	1068	865.50	1659.1	1333
NEUTRALIZATION					
Lime Consumption					
Beaver Lake Total Dry (tonnes/month)	0	0	0	0	0
Site Total Including ETP Operations	162	249	199.50	282.2	200.58
Caustic Soda Consumption					
Orient Creek Total (kg/month)	1782	0	0.00	0	0
Sodium Carbonate Consumption					
Orient Creek Total (kg/month)	0	0	0.00	50	0
Moose Lake (DS-1 & DS-6) Total (kg/month)	1625	0	0.00	300	0
***EFFLUENT**					
Discharge Days	365	365	365	366	365
Maximum Daily Discharge Flow (L/s @ DS-4)	254	211	120	254	254
Minimum Daily Discharge Flow (L/s @ DS-04)	1	1	1	3	1
Monthly Average Daily Discharge Flow (L/s @ DS-04)	21	27	22	40	33
Total Annual Volume Discharged (ML)	676	862	705	1253	1037

* Influent flows based on daily monitoring requirements as per TOMP

* Effluent flows based on weekly monitoring requirement as per SAMP

Appendix Table D.4.4: Mean annual discharge and seepage loadings from Stanrock TMA, 2005 - 2009.

Station		Drainage Type	Mean Annual Discharge (m^3)		Sulphate (kg/yr)	Radium (MBq/yr)	Uranium (kg/yr)	Barium (kg/yr)	Cobalt (kg/yr)	Iron (kg/yr)	Manganese (kg/yr)
May Lake Drainage	DS-4	Controlled Discharge	912,248	Mean	357,215	44	3.0	29	1.1	214	56
				S.D.	93,637	8.4	0.5	12	0.5	67	19
	DS-18	Halfmoon Lake Outlet	4,964,041	Mean	386,335	466	6.8	60	1.4	1,489	89
				S.D.	28,065	61	2.7	3.9	0.3	841	27
Quirke Lake Drainage	Q-09	Inlet to Quirke Lake	67,185,723	Mean	5,684,136	5,718	312	5,909	37		
				S.D.	926,920	866	66	931	4.7		
	DS-16	Seepage from Dam G and J	127,577	Mean	34,521	28	0.4	4.01	5.8	276	361
				S.D.	31,119	22	0.4	0.90	2.6	110	173
	SR-01	Outlet of Quirke Lake	136,511,119	Mean	7,792,055	4205	218	5,477	31		
				S.D.	1,335,662	665	55	231	6		

MBq/yr = Million Bequerels per year

Appendix Table D.4.5: Summary of seasonal trends for station DS-4, 2003 to 2009.

Season	Spearman rho	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium
January	Correlation Coefficient	-0.57143	0.321429	0.5	-0.357142857	-0.14286	-0.9549937	-0.1071429	-0.882919
	Sig. (2-tailed)	0.180202	0.482072	0.25317	0.431611352	0.759945	0.00080554	0.81915086	0.0084503
	N	7	7	7	7	7	7	7	7
February	Correlation Coefficient	0.75	0.3304	-0.01802	-0.357142857	-0.07207	-0.8571429	0.14285714	-0.942857
	Sig. (2-tailed)	0.052181	0.469202	0.969415	0.431611352	0.877959	0.01369733	0.7599453	0.0048047
	N	7	7	7	7	7	7	7	6
March	Correlation Coefficient	0.882919	0.357143	0.392857	0	-0.19821	-0.9285714	-0.3928571	-0.785714
	Sig. (2-tailed)	0.00845	0.431611	0.383317	1	0.670085	0.00251947	0.38331687	0.0362385
	N	7	7	7	7	7	7	7	7
April	Correlation Coefficient	-0.57143	-0.42857	0.178571	-0.607142857	-0.42857	-0.5357143	0.46428571	-0.7
	Sig. (2-tailed)	0.180202	0.337368	0.701658	0.148231161	0.337368	0.21521746	0.29393411	0.1881204
	N	7	7	7	7	7	7	7	5
May	Correlation Coefficient	0.270281	-0.5766	-0.34236	-0.95499371	0.126131	0.32142857	0.07142857	
	Sig. (2-tailed)	0.557731	0.175382	0.452251	0.000805535	0.787572	0.48207204	0.87904819	
	N	7	7	7	7	7	7	7	
June	Correlation Coefficient	0.714286	0.370625	0.321429	0	0.214286	-0.5	-0.2223748	-0.463817
	Sig. (2-tailed)	0.071344	0.413116	0.482072	1	0.644512	0.25317	0.63174934	0.3541643
	N	7	7	7	7	7	7	7	6
July	Correlation Coefficient	0.642857	0.204124	0.309142	-0.071428571	-0.01871	-0.4642857	-0.0180187	
	Sig. (2-tailed)	0.119392	0.660642	0.499899	0.879048193	0.968239	0.29393411	0.96941539	
	N	7	7	7	7	7	7	7	
August	Correlation Coefficient	0.785714		0.381881	0.035714286	-0.05455	-0.5	-0.6126375	
	Sig. (2-tailed)	0.036238		0.397917	0.939408205	0.907523	0.25317	0.14358858	
	N	7		7	7	7	7	7	
September	Correlation Coefficient	0.678571	0.408248	0.333562	0.178571429	0.035714	-0.8571429	-0.4364358	
	Sig. (2-tailed)	0.09375	0.363217	0.464697	0.701657943	0.939408	0.01369733	0.3275825	
	N	7	7	7	7	7	7	7	
October	Correlation Coefficient	0.821429		0	0.428571429	-0.75679	-0.3928571	-0.6785714	
	Sig. (2-tailed)	0.023449		1	0.337368311	0.048905	0.38331687	0.09375025	
	N	7		7	7	7	7	7	
November	Correlation Coefficient	0.630656	0.83666	-0.21429	0.214285714	-0.78571	-0.2857143	-0.6785714	-0.9
	Sig. (2-tailed)	0.128888	0.018927	0.644512	0.644511581	0.036238	0.53450923	0.09375025	0.0373861
	N	7	7	7	7	7	7	7	5
December	Correlation Coefficient	0.392857	0	-0.67857	-0.535714286	-0.77481	-0.1071429	-0.4285714	-0.6
	Sig. (2-tailed)	0.383317	1	0.09375	0.215217456	0.040769	0.81915086	0.33736831	0.284757
	N	7	7	7	7	7	7	7	5

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

ns denotes not significant.

[shaded cell] Significant trend where p<0.05.

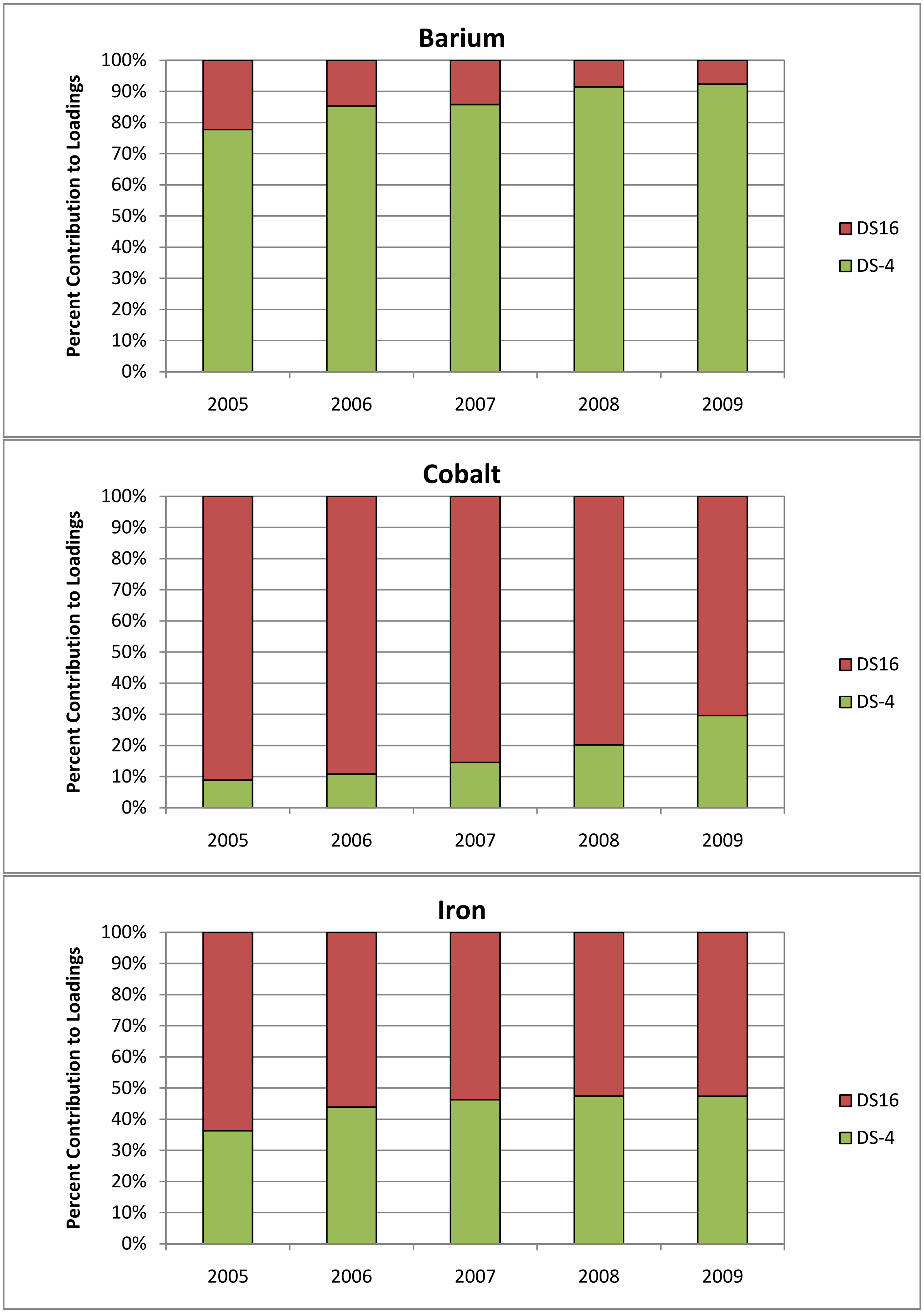
Appendix Table D.4.6: Summary of seasonal trends for station DS-16, 2003 to 2009.

Season	Spearman rho	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium
January	Correlation Coefficient	-0.32143	-0.75	-0.67857	-0.60714286	0.75	-0.821428571	-0.81084	-0.71429
	Sig. (2-tailed)	0.482072	0.052181	0.09375	0.148231161	0.052181	0.023448808	0.026916	ns
	N	7	7	7	7	7	7	7	7
April	Correlation Coefficient	0.25	-0.85714	-0.21622	-0.78571429	0.678571	-0.666693722	-0.57143	
	Sig. (2-tailed)	0.588724	0.013697	0.641446	0.036238463	0.09375	0.10192046	0.180202	
	N	7	7	7	7	7	7	7	
July	Correlation Coefficient	-0.50452	-0.71429	-0.75	-0.57142857	0.892857	-0.607142857	-0.5	
	Sig. (2-tailed)	0.248203	0.071344	0.052181	0.180201989	0.006807	0.148231161	0.25317	
	N	7	7	7	7	7	7	7	
October	Correlation Coefficient	0.414431	-0.89286	0.035714	-0.35714286	0.785714	-0.180187493	0.071429	
	Sig. (2-tailed)	0.355269	0.006807	0.939408	0.431611352	0.036238	0.699045774	0.879048	
	N	7	7	7	7	7	7	7	

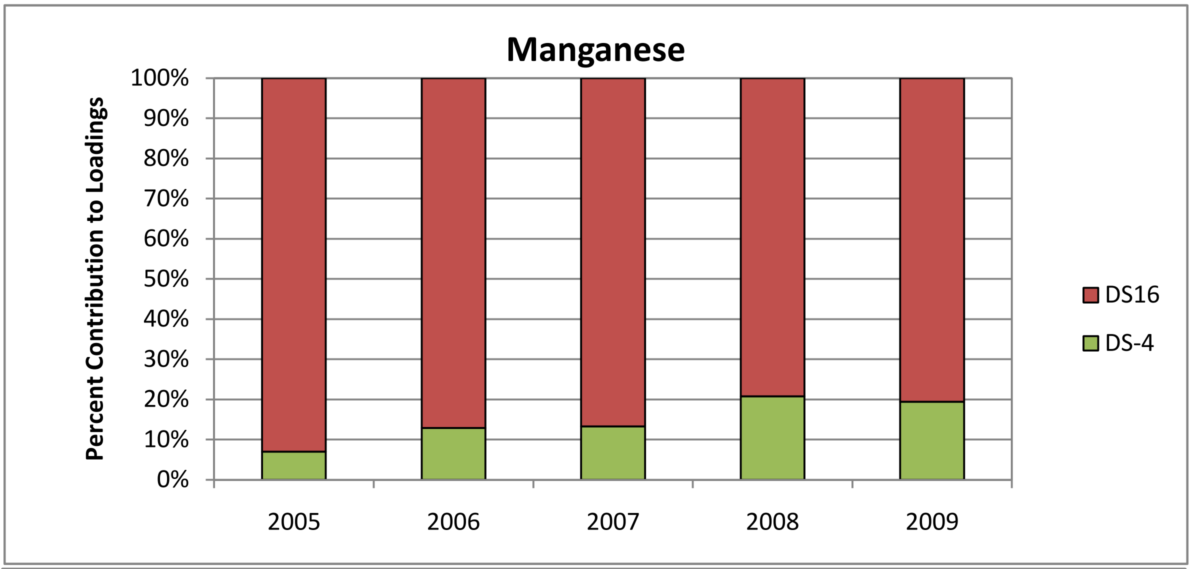
Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

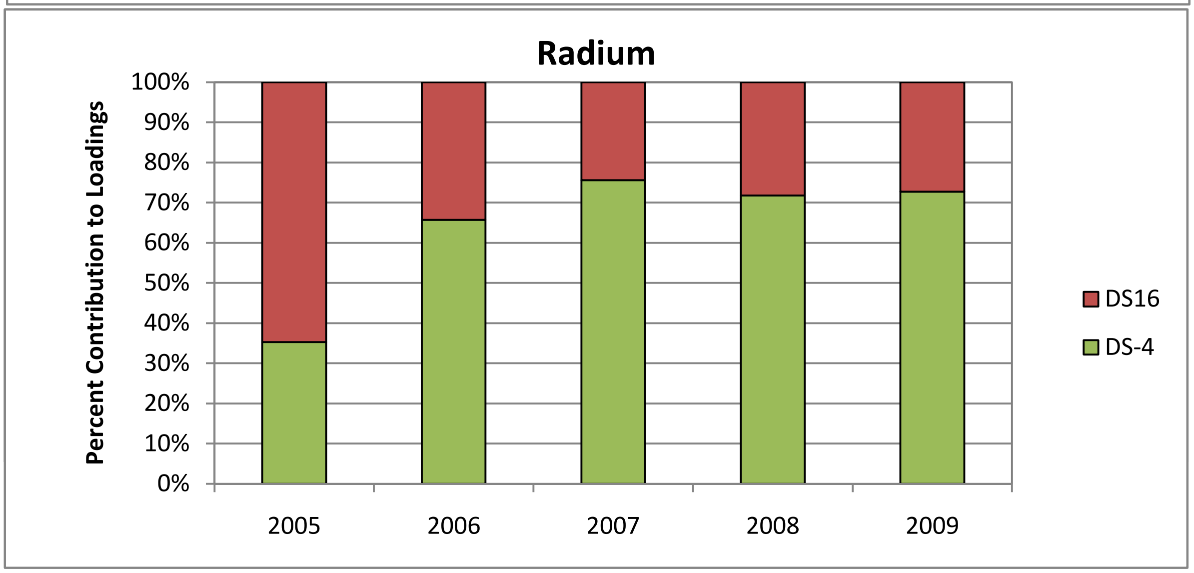
ns denotes not significant.

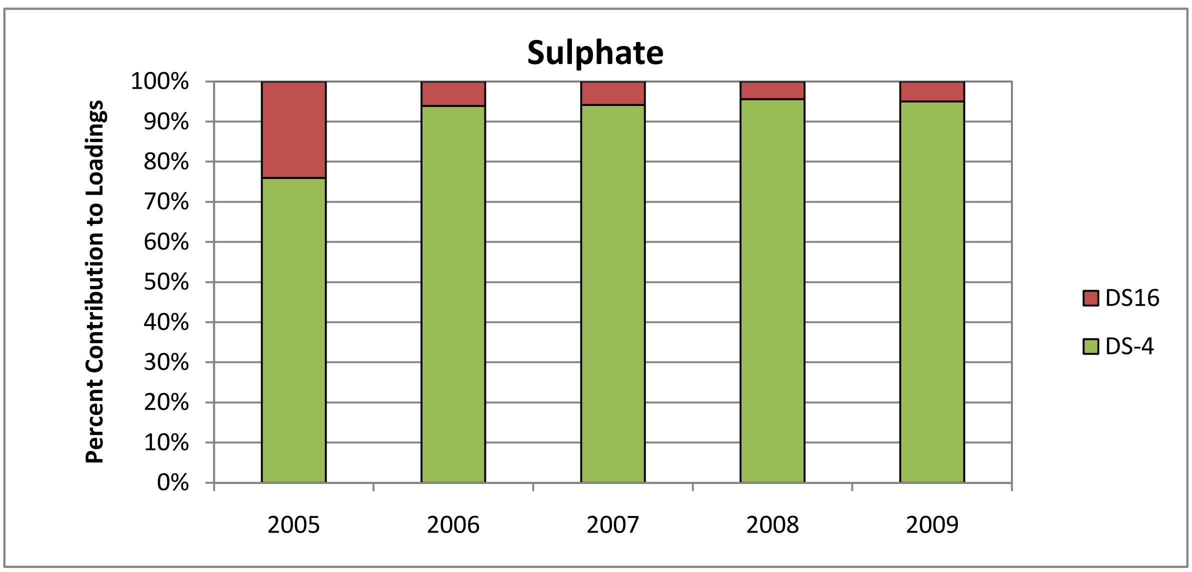
[shaded cell] Significant trend where p<0.05.



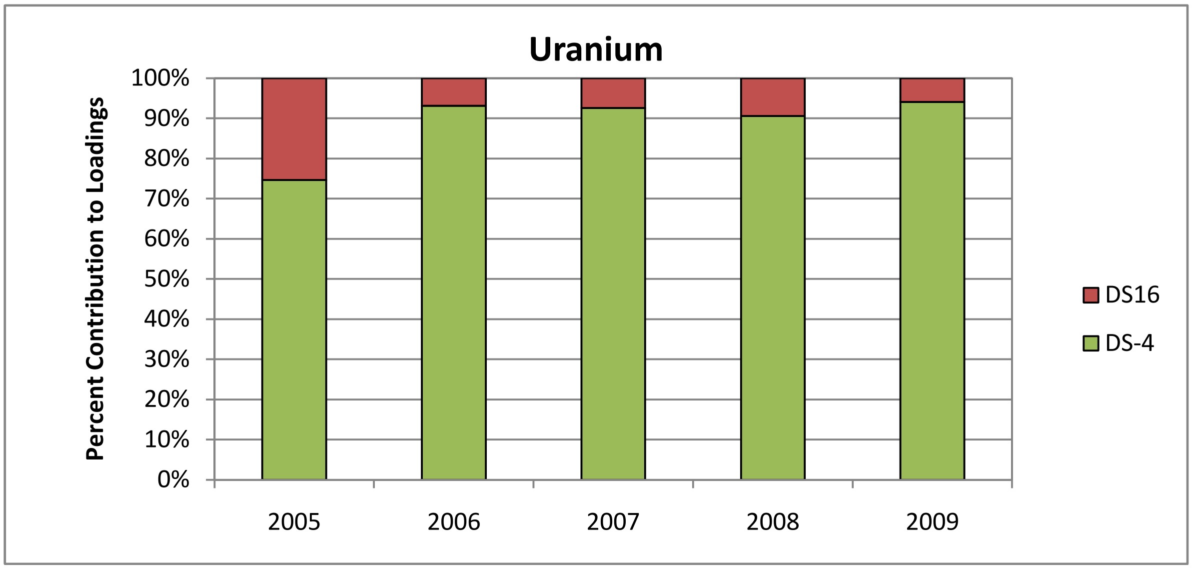
Appendix Figure D.4.1: Percent contribution to loads from Stanrock TMA discharge points.



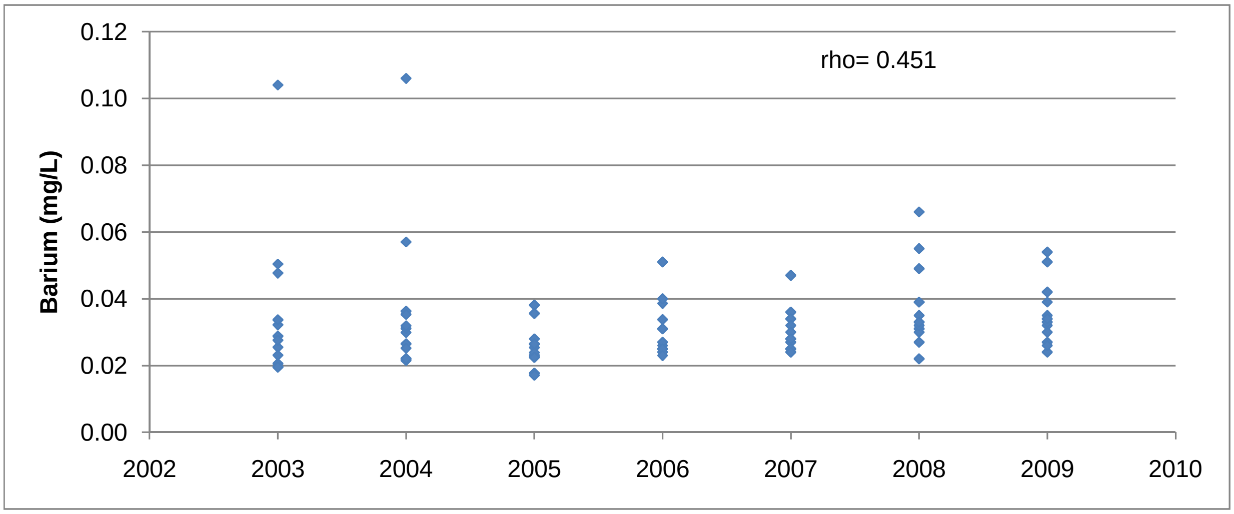


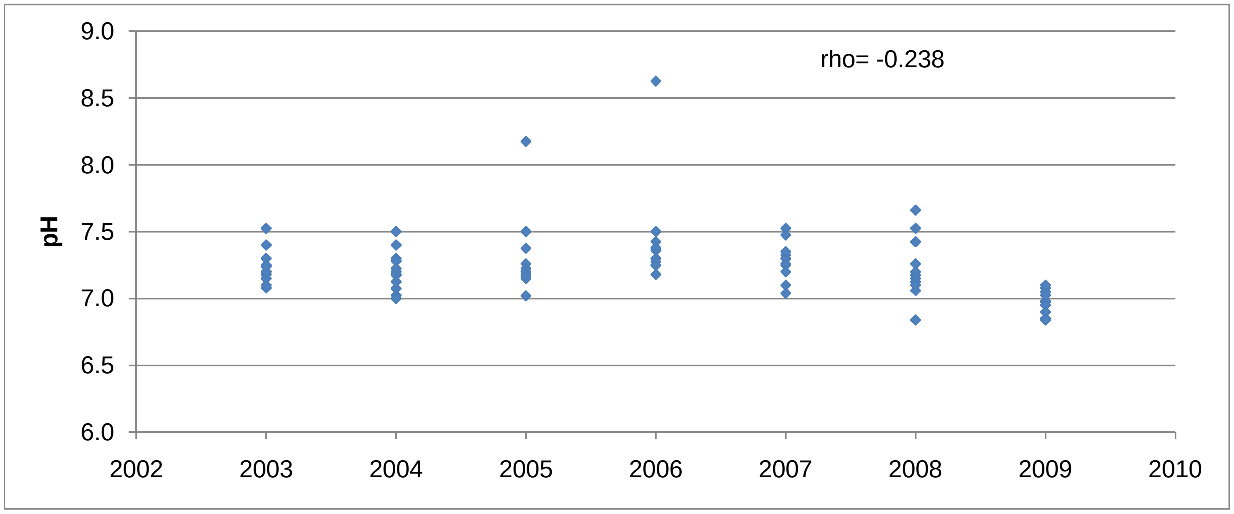


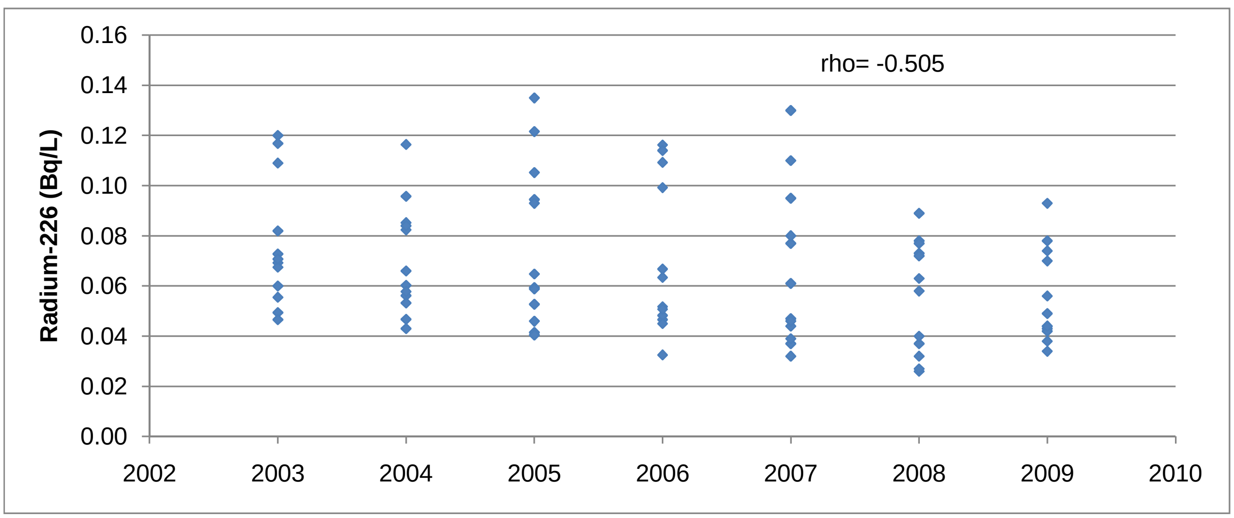
Appendix Figure D.4.1: Percent contribution to loads from Stanrock TMA discharge points.



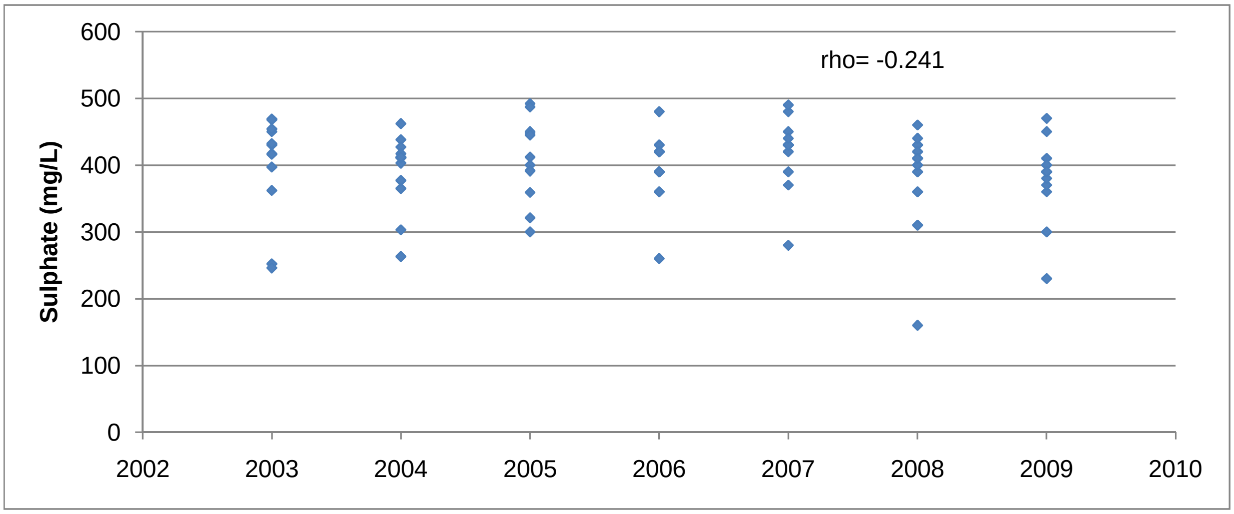
Appendix Figure D.4.1: Percent contribution to loads from Stanrock TMA discharge points

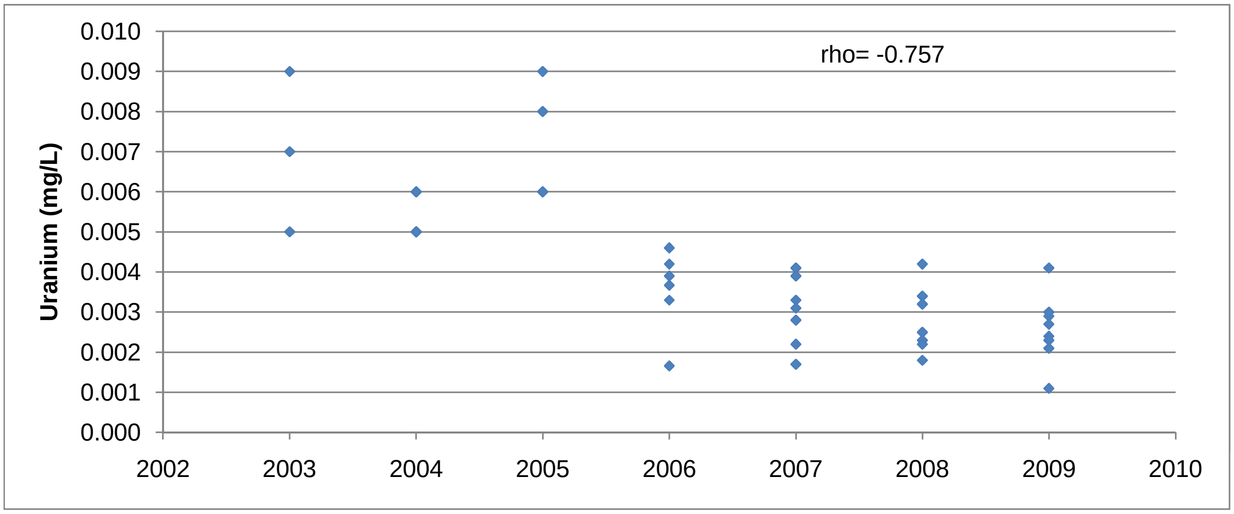




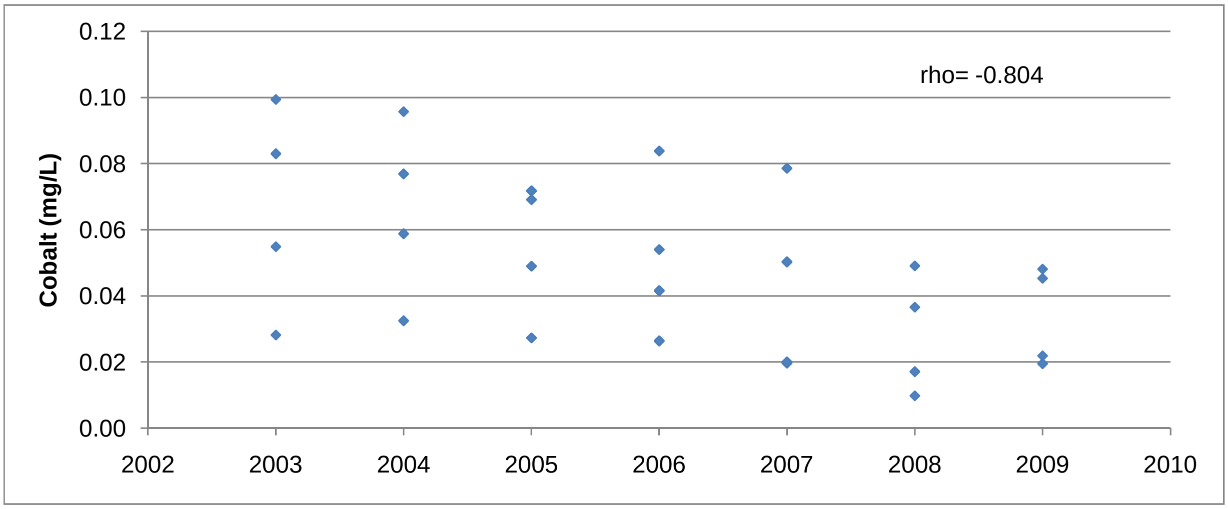


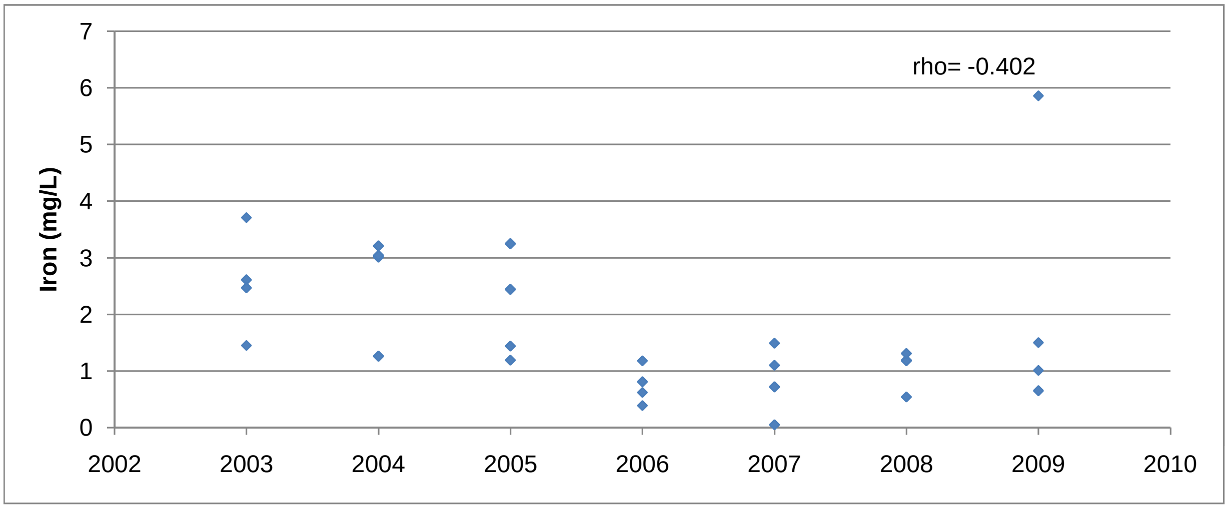
Appendix Figure D.4.2: Significant common (average) trends observed for barium, pH, radium-226, sulphate and uranium over all seasons at station DS-4, 2003 to 2009.

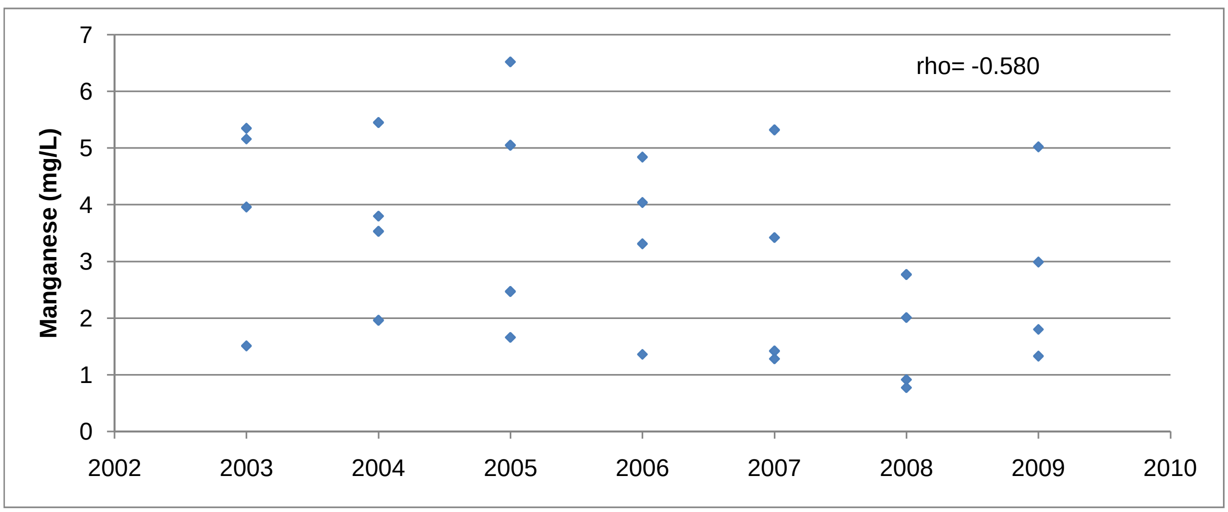




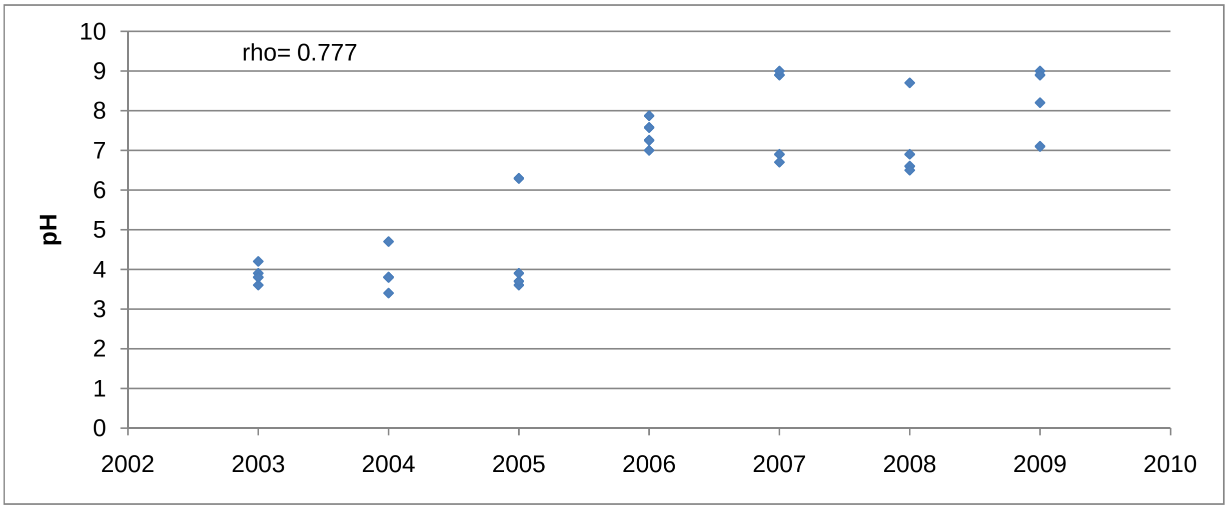
Appendix Figure D.4.2: Significant common (average) trends observed for barium, pH, radium-226, sulphate and uranium over all seasons at station DS-4, 2003 to 2009.

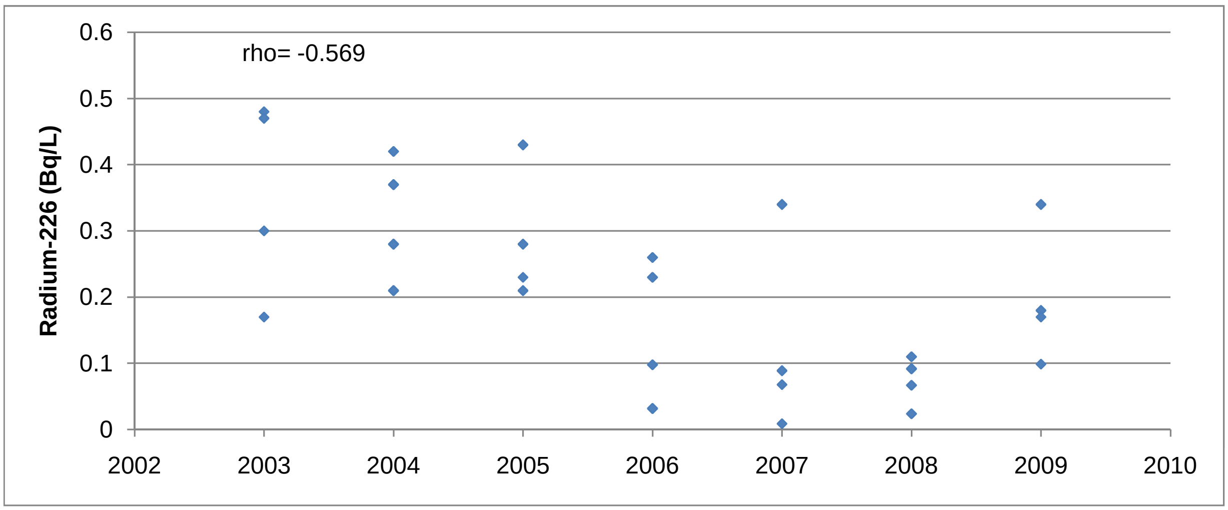


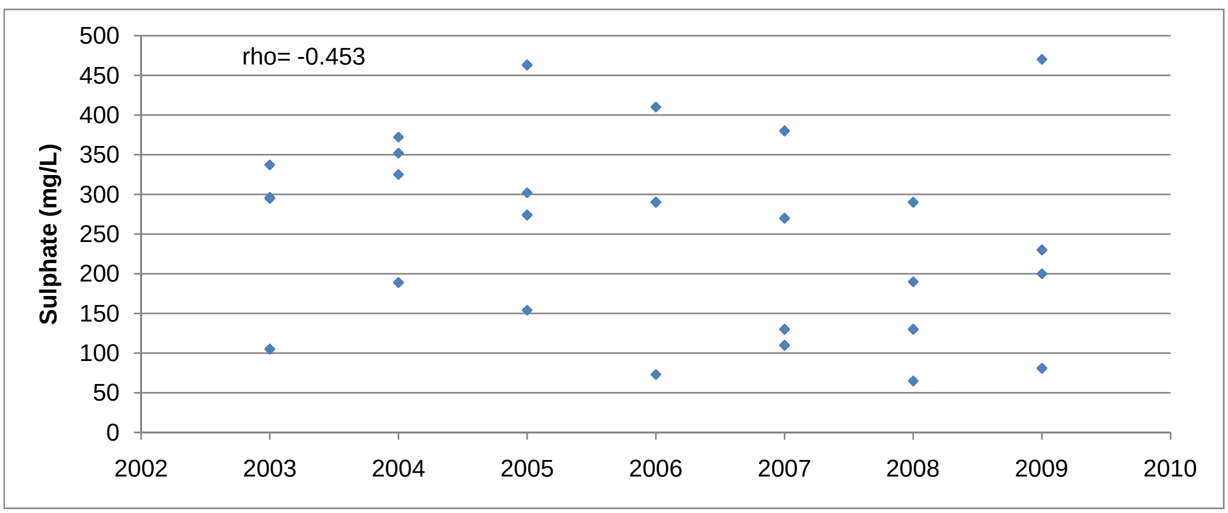




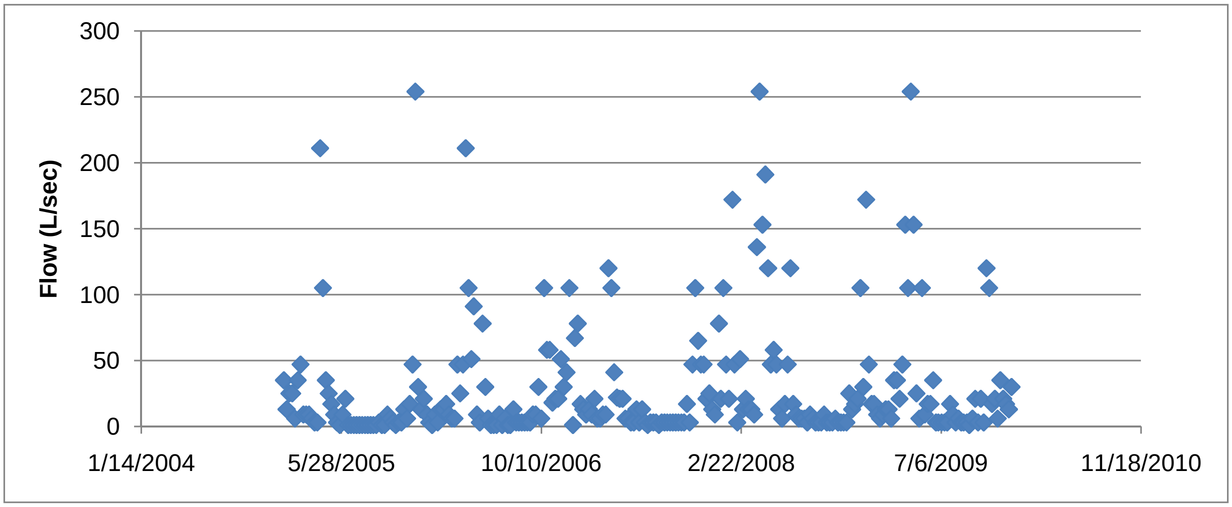
Appendix Figure D.4.3: Significant common (average) trends observed for cobalt, iron, manganese, pH, radium-226 and sulphate over all seasons at station DS-16, 2003 to 2009.



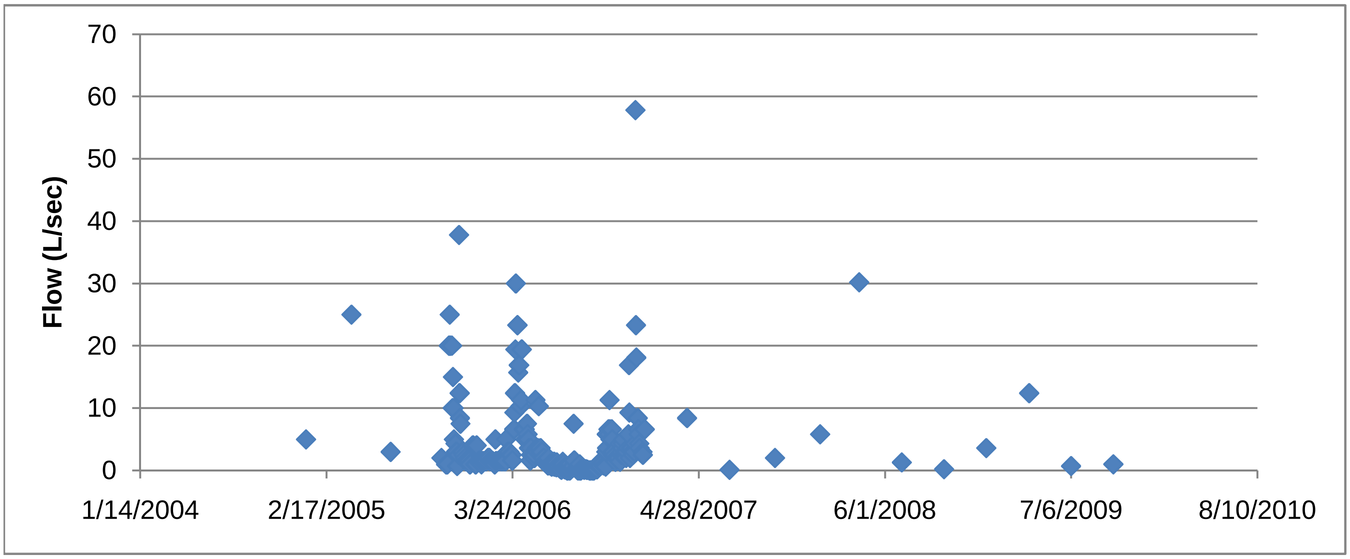




Appendix Figure D.4.3: Significant common (average) trends observed for cobalt, iron, manganese, pH, radium-226 and sulphate over all seasons at station DS-16, 2003 to 2009.



Appendix Figure D.4.4: Flows at station DS-4 from 2005 to 2009.



Appendix Figure D4.5: Flows at station DS-16 from 2005 to 2009.

APPENDIX D.5
Stanleigh TMA

Appendix Table D.5.1: Water quality at station CL-06 from 2005 to 2009.

Date	Ba (mg/L)	Co (mg/L)	Cu (mg/L)	Fe (mg/L)	Mn (mg/L)	Ni (mg/L)	Pb (mg/L)	pH[a]	Ra (Bq/L)	SO4 (mg/L)	TSS (mg/L	U (mg/L)	Zn (mg/L)
4/27/2005								7.8	0.072		< 1		
5/4/2005								7.1	0.058		< 1		
5/11/2005	0.147	0.0008	< 0.001	0.03	0.188	0.0031	< 0.0006	7.5	0.058	175	< 1	< 0.005	0.001
5/18/2005								7.4	0.1		< 1		
5/25/2005								7.5	0.09		< 1		
6/1/2005								7.4	0.13		< 1		
6/8/2005	0.165	0.0006	< 0.001	0.026	0.161	0.0036	< 0.0006	7.4	0.083	200	< 1	< 0.005	0.001
6/15/2005								7.3	0.14		< 1		
6/22/2005								7.2	0.045		< 1		
6/29/2005								7.3	0.2		< 1		
7/6/2005	0.147	< 0.0003	< 0.001	0.03	0.105	0.0016	< 0.0006	7.3	0.15	179	< 1	< 0.005	0.007
7/13/2005								7.2	0.16		< 1		
7/20/2005								7.2	0.25		< 1		
9/7/2005	0.165	< 0.0003	< 0.001	0.035	0.0838	0.002	< 0.0006	7.4	0.092	172	< 1	< 0.005	0.01
9/14/2005								7.3	0.15		< 1		
9/21/2005								7.8	0.17		< 1		
9/28/2005								7.2	0.089		< 1		
11/1/2005								7.2	0.11		< 1		
11/2/2005	0.122	< 0.0003	< 0.001	0.042	0.0761	0.0024	< 0.0006	7.5	0.084	240	< 1	< 0.005	0.004
11/3/2005								7.5	0.1		< 1		
11/4/2005								7.2	0.24		< 1		
5/5/2006	0.168	0.00071	0.0005	0.04	0.166	0.0034	0.00052	7.4	0.075	210	< 1	0.00415	0.0019
5/10/2006								7.4	0.1		< 2		
5/17/2006								7.2	0.14		< 1		
5/24/2006								7.2	0.1		< 1		
5/31/2006								7.3	0.086		< 1		
6/14/2006	0.232	< 0.0005	0.0006	0.02	0.0561	0.0022	< 0.0005	7.6	0.075	190	< 1	0.00291	0.0015
6/21/2006								7.2	0.14		1		
6/28/2006								7.2	0.2		< 1		
7/6/2006	0.24	< 0.0005	0.0009	0.04	0.058	0.003	0.0007	7.4	0.19	190	< 1	0.0026	0.003
7/12/2006								7.3	0.19		1		
7/19/2006								7.2	0.22		< 1		
7/26/2006								7.1	0.18		< 1		
8/2/2006	0.261	< 0.0005	0.0009	0.03	0.0416	< 0.002	< 0.0005	7.1	0.23	200	< 1	0.0022	0.0027
8/9/2006								7.2	0.21		< 1		
11/1/2006	0.191	0.0006	0.0011	0.07	0.146	0.004	0.0034	7.2	0.12	200	< 1	0.0035	0.002
11/8/2006								7.1	0.14		< 1		
11/15/2006								7.3	0.13		1		
11/22/2006								7.3	0.15		< 1		
11/29/2006								7.5	0.11		< 1		
12/6/2006	0.135	0.0006	0.0014	0.08	0.065	0.004	0.0049	7.7	0.1	200	< 1	0.004	0.006
12/13/2006								7.8	0.095		< 1		
12/20/2006								8	0.25		< 1		
3/16/2007								7.2	0.120				
3/21/2007	0.209	0.0007		0.05	0.109			7.2	0.240	200.0		0.0032	
3/28/2007								7.3	0.130				
4/4/2007	0.183	0.0008		<0.02	0.119			7.3	0.160	190.0		0.0034	
4/11/2007								7.3	0.140				
4/18/2007								7.1	0.150				
4/25/2007								7.4	0.270				
5/2/2007	0.208	0.0006		0.04	0.099			7.4	0.190	180.0		0.0034	
5/9/2007								7.6	0.240				
5/16/2007								7.3	0.200				
5/23/2007								7.2	0.170				
5/30/2007								7.2	0.140				
6/6/2007	0.217	<0.0005		0.04	0.067			7.6	0.130	180.0		0.0026	
6/13/2007								7.6	0.150				
12/19/2007								7.3	0.220				
4/17/2008	0.022	<0.0005		0.09	0.083			7.0	0.011	11.0		<0.0005	
4/23/2008								7.3	0.150				
4/30/2008								7.3	0.290				
5/7/2008	0.830	0.0011		0.14	0.193			7.3	0.320	150.0		0.0049	
5/14/2008								7.3	0.160				
5/21/2008								7.3	0.230				
5/28/2008								7.3	0.170				
6/4/2008	0.864	0.0011		0.05	0.147			7.7	0.310	160.0		0.0034	
6/11/2008								7.5	0.450				
6/18/2008								7.5	0.490				
6/25/2008								7.1	0.200				
7/2/2008	0.750	0.0009		0.06	0.157			7.4	0.180	150.0		0.0030	
7/9/2008								7.4	0.150				
7/16/2008								7.3	0.094				
7/23/2008								7.3	0.160				

Appendix Table D.5.1: Water quality at station CL-06 from 2005 to 2009.

Date	Ba (mg/L)	Co (mg/L)	Cu (mg/L)	Fe (mg/L)	Mn (mg/L)	Ni (mg/L)	Pb (mg/L)	pH[a]	Ra (Bq/L)	SO4 (mg/L)	TSS (mg/L	U (mg/L)	Zn (mg/L)
7/30/2008								7.2	0.160				
8/6/2008	0.681	<0.0005		0.06	0.091			7.3	0.210	150.0		0.0022	
8/13/2008								7.0	0.160				
8/20/2008								7.2	0.240				
8/27/2008								7.5	0.160				
9/3/2008	0.688	<0.0005		0.05	0.070			7.6	0.160	160.0		0.0020	
9/10/2008								7.3	0.140				
9/17/2008								7.0	0.100				
9/24/2008								7.3	0.096				
10/1/2008	0.543	<0.0005		0.07	0.130			7.1	0.084	160.0		0.0023	
10/8/2008								7.2	0.110				
10/15/2008								6.9	0.130				
10/22/2008								6.9	0.120				
10/29/2008								7.1	0.074				
11/5/2008	0.254	0.0010		0.08	0.121			7.1	0.068	160.0		0.0022	
11/12/2008								7.1	0.130				
11/19/2008								7.2	0.140				
11/26/2008								8.1	0.130				
12/3/2008	0.350	0.0008		0.07	0.120			7.5	0.140	160.0		0.0026	
12/10/2008								6.8	0.180				
12/17/2008								7.1	0.160				
2/11/2009	0.337	0.0006		0.05	0.130			7.2	0.110	170.0		0.0028	
2/19/2009								7.1	0.210				
2/25/2009								7.2	0.150				
3/4/2009	0.430	0.0005		0.04	0.136			7.3	0.100	170.0		0.0026	
3/11/2009								7.2	0.120				
3/18/2009								7.3	0.160				
3/25/2009								7.2	0.140				
4/1/2009	0.445	0.0006		0.07	0.128			7.1	0.140	140.0		0.0023	
4/8/2009								7.2	0.140				
4/15/2009								7.1	0.220				
4/22/2009								7.1	0.220				
4/29/2009								7.0	0.250				
5/6/2009	0.576	0.0008		0.13	0.169			7.1	0.170	130.0		0.0029	
5/13/2009								7.4	0.140				
5/20/2009								7.4	0.170				
5/27/2009								7.6	0.380				
6/3/2009	1.160	0.0010		0.08	0.170			7.7	0.430	190.0		0.0029	
6/11/2009								7.3	0.100				
6/18/2009								7.6	0.095				
6/24/2009								7.8	0.100				
7/2/2009	0.703	0.0008		0.05	0.158			7.7	0.098	130.0		0.0023	
7/8/2009								7.8	0.190				
7/15/2009								7.6	0.170				
7/22/2009								7.7	0.160				
7/29/2009								7.6	0.160				
8/6/2009	0.558	<0.0005		0.04	0.078			7.3	0.100	120.0		0.0021	
8/12/2009								7.6	0.150				
8/19/2009								7.8	0.100				
11/4/2009	0.386	<0.0005		0.08	0.200			7.4	0.110	120.0		0.0044	
11/11/2009								7.8	0.200				
11/18/2009								7.8	0.250				
11/25/2009								7.5	0.190				
12/2/2009	0.603	0.0006		0.09	0.109			7.5	0.180	140.0		0.0029	
12/9/2009								7.7	0.087				
12/16/2009								7.6	0.100				
12/23/2009								7.5	0.160				
Number	33	26	11	32	33	11	11	272	130	33	43	32	11
Minimum	0.022	0.0003	0.0005	0.02	0.0416	0.0016	0.0005	6.8	0.011	11	1	0.002	0.001
Maximum	1.16	0.0011	0.0014	0.14	0.2	0.004	0.0049	8.1	0.49	240	2	0.005	0.01
Mean	0.393	0.0007	0.0009	0.06	0.119	0.0028	0.0012	7.3	0.159	166.0	1	0.0033	0.004
Median	0.261	0.0006	0.0010	0.05	0.12	0.003	0.0006	7.3	0.150	170.0	1	0.0029	0.0027
10th Perc.	0.147	0.0004	0.0006	0.03	0.065	0.0020	0.0005	7.1	0.087	130.0	1	0.0022	0.001

[a] pH measures shown only for dates when other substances were measured but summary statistics reflect all measured values.

Appendix Table D.5.2: Summary of Annual Plant Operations and Discharge at Stanleigh , 2005-2009.

ITEM	2005	2006	2007	2008	2009
PLANT OPERATIONS					
Operating Days	115	143	108	239	240
Maximum Daily Plant Flow (L/s @ CL-04)	528	519	506	550	555
Minimum Daily Plant Flow (L/s @ CL-04)	0	0	0	0	0
Monthly Average Daily Plant Flow (L/s @ CL-04)	430	416	478	477	503
Total Volume Treated (ML)	4271	5139	4462	9842	10428
Annual Average Treatment Rate (L/s)	-	-	478	477	503
Barium Chloride Consumption					
Total (kg/yr)	3675	4128	3548	22155	20600
Monthly Average (mg/L)	0.86	0.80	0.80	2.25	1.98
Lime Consumption					
Dry (tonne/yr)	2.8	6.4	5.00	15.87	17.36
Average (g/L)	0.00066	0.0012	0.0011	0.0016	0.0017
***EFFLUENT**					
Discharge Days	115	143	97	239	241
Maximum Daily Discharge Flow (L/s @ CL-06)	528	517	504	550	555
Minimum Daily Discharge Flow (L/s @ CL-06)	0	0	0	0	0
Monthly Average Daily Discharge Flow (L/s @ CL-06)	430	425	486	474	490
Total Annual Volume Discharged (ML)	4271	5247	4071	9788	10194
Annual Average Discharge Rate (L/s)	-	-	486	474	490

* Influent flows based on daily monitoring requirements as per TOMP
* Effluent flows based on weekly monitoring requirement as per SAMP

Appendix Table D.5.3: Mean annual discharge loadings from Stanleigh TMA, 2005 - 2009.

Station	Drainage Type	Mean Annual Discharge (m^3)		Sulphate (kg/yr)	Radium (MBq/yr)	Uranium (kg/yr)	Barium (kg/yr)	Cobalt (kg/yr)	Iron (kg/yr)	Manganese (kg/yr)
CL-06	Controlled Discharge	9,795,082	Mean	1,192,891	1,164	21	2,963	4.2	428	915.6
			S.D.	342,799	581	7.8	2,752	2.2	318	473.4
SR-06	Outlet of McCabe Lake	14,036,253	Mean	1,732,074	639	18	1,426	3.0		
			S.D.	474,189	163	1.1	710.0	0.7		

MBq/yr = Million Bequerels per year

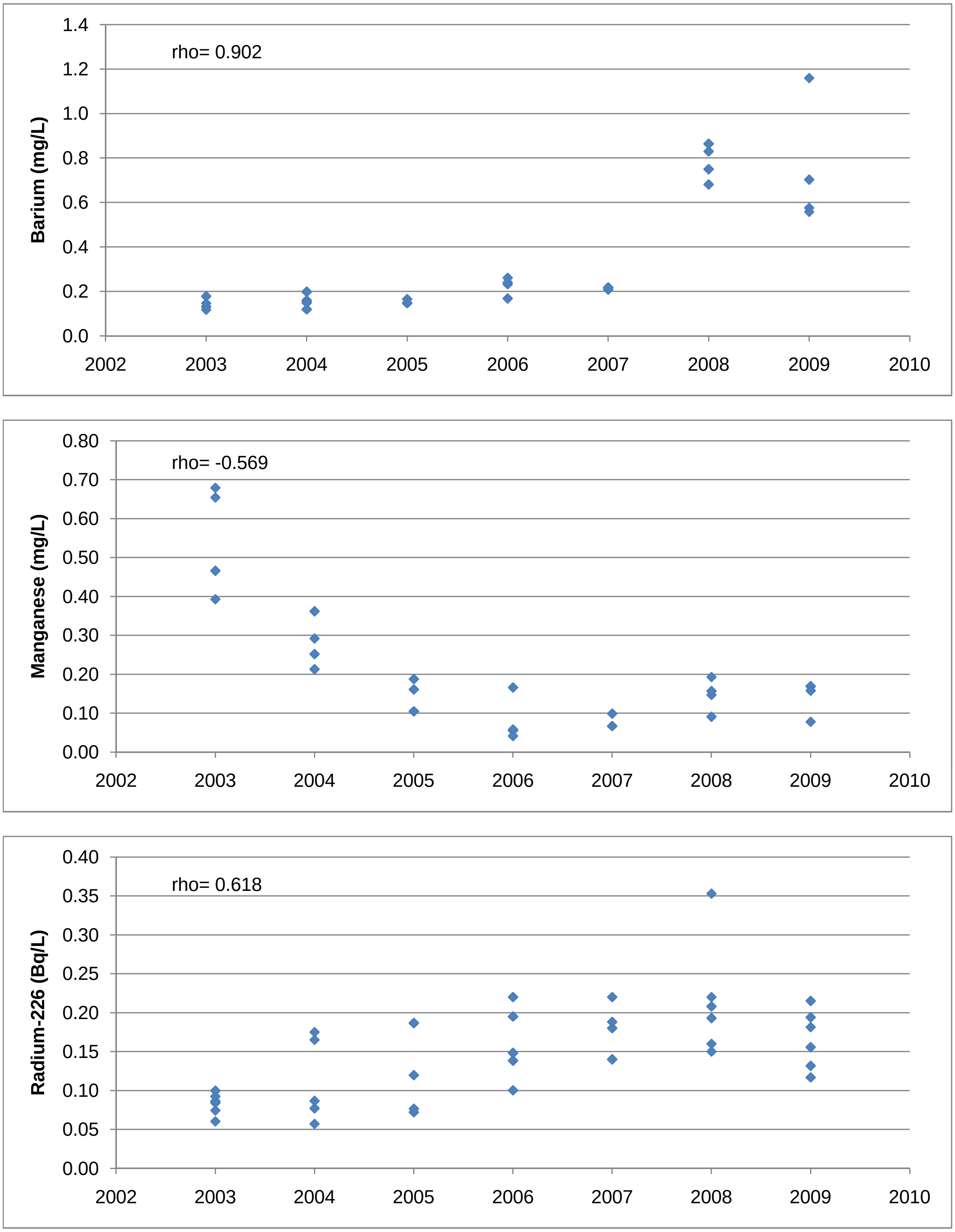
Appendix Table D.5.4: Summary of seasonal trends for station CL-06, 2003 to 2009.

Season	Spearman rho	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate
April	Correlation Coefficient					-0.371429	0.771428571	
	Sig. (2-tailed)					0.468478	0.072396501	
	N					6	6	
May	Correlation Coefficient	0.964286	-0.540562	0.378394	-0.607142857	-0.464286	0.821428571	-0.8928571
	Sig. (2-tailed)	0.000454	0.210289	0.402602	0.148231161	0.293934	0.023448808	0.0068072
	N	7	7	7	7	7	7	7
June	Correlation Coefficient	0.857143	-0.126131	0.428571	-0.5	0.49099	0.964285714	-0.8468812
	Sig. (2-tailed)	0.013697	0.787572	0.337368	0.253169995	0.263194	0.000454149	0.0161971
	N	7	7	7	7	7	7	7
July	Correlation Coefficient	0.885714	-0.235396	0.542857	-0.485714286	0.2	0.428571429	-0.9428571
	Sig. (2-tailed)	0.018845	0.653428	0.265703	0.328723032	0.704	0.396501458	0.0048047
	N	6	6	6	6	6	6	6
August	Correlation Coefficient	0.9	-0.707107	0.3	-0.7	0.2	0.3	-1
	Sig. (2-tailed)	0.037386	0.18169	0.623838	0.188120404	0.74706	0.623837665	0.000001
	N	5	5	5	5	5	5	5
December	Correlation Coefficient					-0.2	0.3	
	Sig. (2-tailed)					0.74706	0.623837665	
	N					5	5	

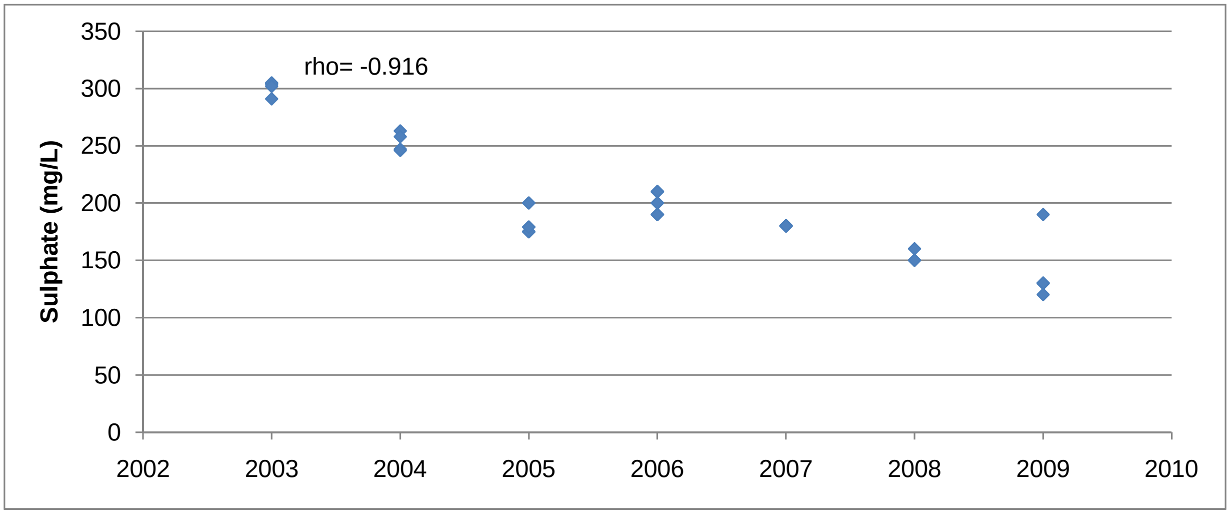
Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

ns denotes not significant.

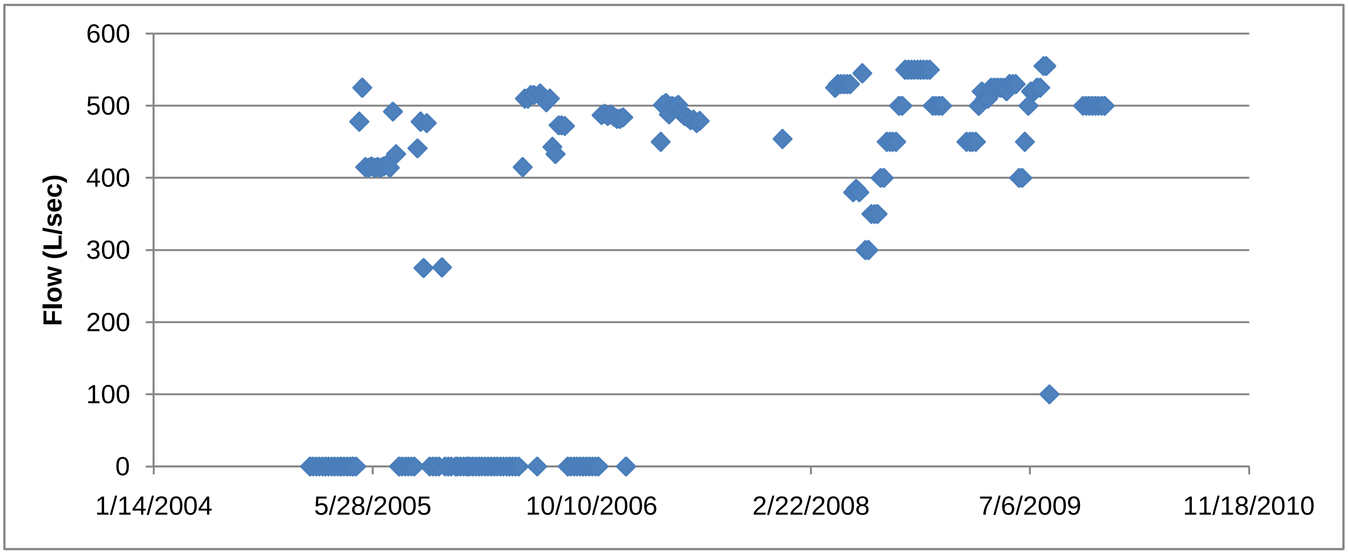
[shaded cell] Significant trend where p<0.05.



Appendix Figure D.5.1: Significant common (average) trends observed for barium, manganese, radium-226 and sulphate over all seasons at station CL-06, 2003 to 2009.



Appendix Figure D.5.1: Significant common (average) trends observed for barium, manganese, radium-226 and sulphate over all seasons at station CL-06, 2003 to 2009.



Appendix Figure D.5.2: Flows at station CL-06 from 2005 to 2009.

APPENDIX D.6
Milliken TMA

Appendix Table D.6.1: Water quality at station MPE from 2005 to 2009.

Date	Ba (mg/L)	Co (mg/L)	Fe (mg/L)	Mn (mg/L)	pH[a]	Ra (Bq/L)	SO4 (mg/L)	U (mg/L)
1/12/2005	0.0106	0.0007	0.484	0.0825	6.2	0.02	19.4	0.011
2/16/2005	0.0119	0.0012	0.539	0.0872	6.8	0.029	19.8	0.013
3/16/2005	0.0126	0.0012	0.862	0.153	6.9	0.042	22.1	0.016
4/13/2005	0.0066	0.00025	0.21	0.0306	7.2	0.022	11.3	0.006
5/11/2005	0.0129	0.00025	0.687	0.0698	7.3	0.034	18	
6/16/2005	0.0164	0.0012	3.14	0.288	6.9	0.065	15.8	
11/23/2005	0.0174	0.0022	0.274	0.0931	6.1	0.058	36.2	
12/14/2005	0.0106	0.0011	0.364	0.085	6.5	0.031	23.5	0.013
1/11/2006	0.014	0.0012	0.83	0.124	6.7	0.042	22	0.0078
2/15/2006	0.015	0.001	1.03	0.124	6.7	0.033	23	0.0122
3/8/2006	0.015	0.0018	0.74	0.138	6.8	0.032	26	0.0132
4/12/2006	0.0091	0.0006	0.14	0.0272	6.8	0.022	12	0.00548
5/10/2006	0.0168	0.00025	0.19	0.0354	6.7	0.059	20	0.00319
6/14/2006	0.0145	0.00074	2.82	0.124	6.8	0.087	15	0.00267
7/12/2006	0.0118	0.00025	4.83	0.13	6.5	0.059	14	0.00183
8/9/2006	0.013	0.0007	5.09	0.282	6.7	0.081	12	0.0016
9/13/2006	0.014	0.00025	4.7	0.137	6.9	0.07	11	0.0023
10/11/2006	0.013	0.00025	1.11	0.056	7	0.038	21	0.0014
11/22/2006	0.012	0.00025	0.33	0.034	6.9	0.021	18	0.0055
12/13/2006	0.009	0.0006	0.26	0.046	7.1	0.027	13	0.0043
1/10/2007	0.010	0.0007	0.24	0.046	7.0	0.031	13.0	0.0067
2/14/2007	0.013	0.0009	0.80	0.108	6.5	0.028	18.0	0.0105
3/14/2007	0.015	0.0013	0.81	0.150	6.6	0.097	26.0	0.0082
4/11/2007	0.009	0.0005	0.15	0.026	7.2	0.025	11.0	0.0053
5/9/2007	0.013	0.00025	0.51	0.063	7.0	0.041	17.0	0.0026
6/12/2007	0.014	0.0008	2.00	0.129	6.9	0.047	15.0	0.0032
7/11/2007	0.012	0.0009	4.70	0.274	6.4	0.080	12.0	0.0026
8/8/2007	0.008	0.00025	4.16	0.164	6.4	0.035	11.0	0.0012
9/12/2007	0.011	0.00025	4.72	0.141	6.7	0.037	6.7	0.0013
10/10/2007	0.014	0.00025	3.60	0.108	6.8	0.045	8.4	0.0016
11/14/2007	0.015	0.00025	0.30	0.029	6.5	0.050	24.0	0.0015
12/12/2007	0.013	0.00025	0.59	0.098	6.5	0.022	22.0	0.0135
1/9/2008	0.010	0.0009	0.35	0.062	6.5	0.024	16.0	0.0086
2/14/2008	0.011	0.00025	0.32	0.036	6.8	0.013	17.0	0.0144
3/12/2008	0.012	0.0005	0.40	0.067	6.7	0.015	17.0	0.0132
4/9/2008	0.011	0.0008	0.25	0.045	6.7	0.018	16.0	0.0247
5/14/2008	0.013	0.00025	0.38	0.040	7.2	0.025	16.0	0.0077
6/4/2008	0.014	0.00025	0.69	0.071	7.5	0.044	17.0	0.0027
7/9/2008	0.011	0.00025	3.04	0.042	6.5	0.039	12.0	0.0019
8/13/2008	0.014	0.0005	6.04	0.234	6.6	0.067	8.9	0.0016
10/8/2008	0.015	0.00025	3.40	0.063	7.1	0.031	8.6	0.0021
11/12/2008	0.014	0.00025	1.76	0.064	6.5	0.031	15.0	0.0018
12/10/2008	0.014	0.0007	1.28	0.210	6.8	0.028	15.0	0.0073
1/14/2009	0.012	0.00025	0.45	0.059	6.9	0.016	16.0	0.0121
2/11/2009	0.017	0.0010	1.26	0.160	6.6	0.039	18.0	0.0131
3/11/2009	0.014	0.0008	1.25	0.142	6.6	0.045	19.0	0.0115
4/8/2009	0.010	0.0005	0.18	0.031	6.5	0.019	12.0	0.0106
5/13/2009	0.013	0.00025	0.56	0.043	7.4	0.028	14.0	0.0045
6/10/2009	0.013	0.00025	0.80	0.065	7.2	0.038	14.0	0.0028
7/8/2009	0.015	0.0007	4.19	0.099	6.7	0.077	9.3	0.0051
8/12/2009	0.011	0.00025	2.74	0.110	6.9	0.038	9.9	0.0019
9/9/2009	0.011	0.00025	3.47	0.084	6.9	0.021	8.1	0.0019
10/7/2009	0.012	0.00025	3.26	0.065	7.2	0.020	6.5	0.0021
11/4/2009	0.009	0.00025	0.35	0.028	7.0	0.018	11.0	0.0039
12/3/2009	0.012	0.00025	0.57	0.047	6.8	0.014	15.0	0.0077
Number	55	55	55	55	239	55	55	52
Minimum	0.0066	0.00025	0.14	0.026	5.8	0.013	6.5	0.0012
Maximum	0.0174	0.0022	6.04	0.288	7.5	0.097	36.2	0.0247
Mean	0.013	0.00059	1.60	0.097	6.78	0.039	15.79	0.0066
Median	0.013	0.00050	0.80	0.083	6.8	0.033	15	0.0052
10th Perc.	0.009	0.00025	0.24	0.032	6.5	0.018	9.06	0.0016

[a] pH measures shown only for dates when other substances were measured but summary statistics reflect all measured values.

(shaded cell) Concentration below maximum MDL.

Appendix Table D.6.2: Mean annual discharge and seepage loadings from Milliken TMA, 2005 - 2009.

Station	Drainage Type	Mean Annual Discharge (m^3)		Sulphate (kg/yr)	Radium (MBq/yr)	Uranium (kg/yr)	Barium (kg/yr)	Cobalt (kg/yr)	Iron (kg/yr)	Manganese (kg/yr)
SC-01	Westner Lake Outlet	1,014,205	Mean	38,223	37	0.3	16	2.8	213	
			S.D.	13,911	50	0.1	7	4.5	69	
MPE	Discharge	5,759,999	Mean	92,732	221	37	72	3.6	8,938	564
			S.D.	17,714	45	8.9	2	1.5	2,468	90
M-01	Sheriff Creek Park Dam	7,942,465	Mean	140,018	205	35	146	5.6	4,955	
			S.D.	37,625	50	7.1	8	1.6	1,620	

MBq/yr = Million Bequerels per year

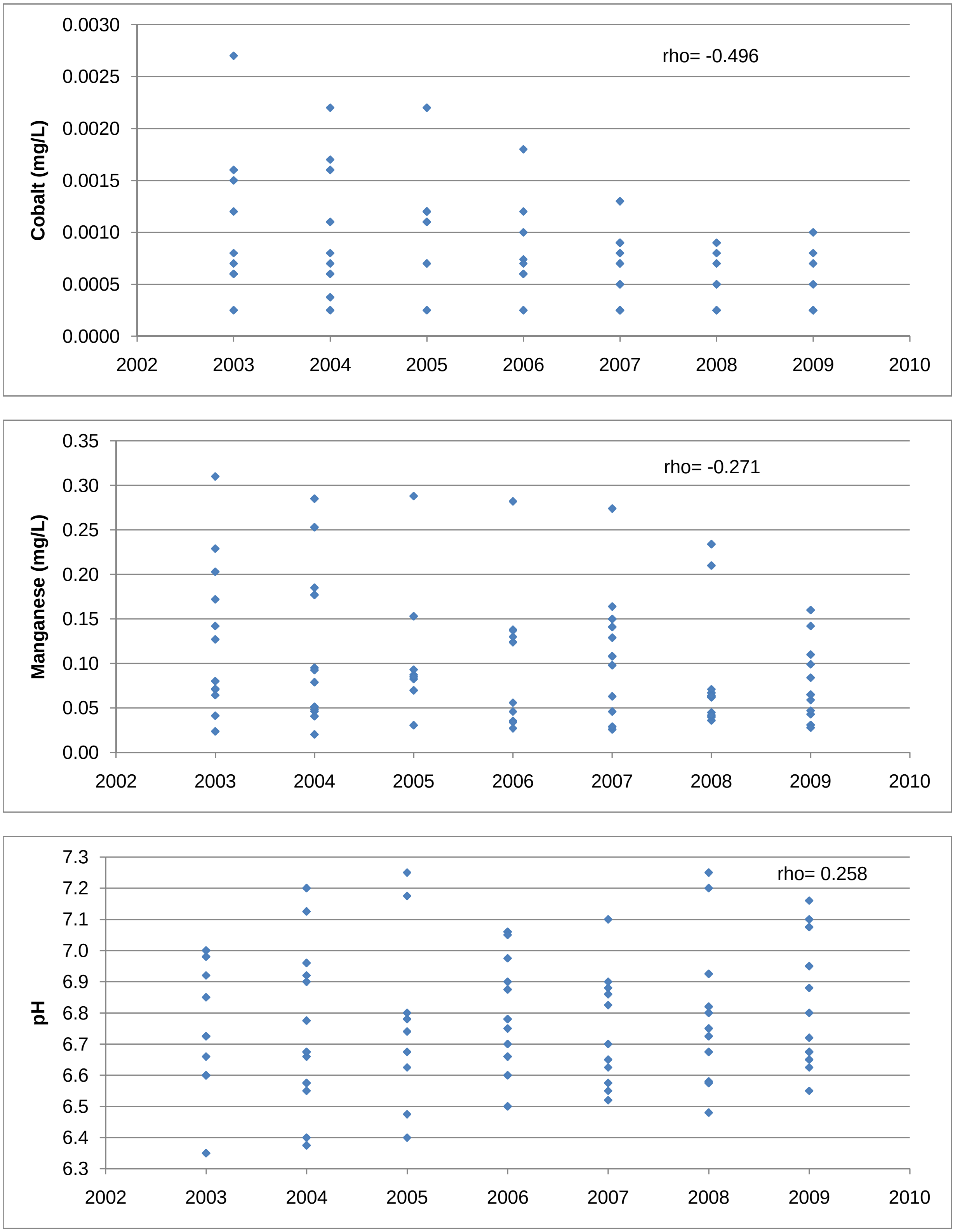
Appendix Table D.6.3: Summary of seasonal trends for station MPE, 2003 to 2009.

Season	Spearman rho	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium
January	Correlation Coefficient	-0.63066	-0.75679	-0.82143	-0.85714286	0.666694	-0.78571429	-0.8468812	-0.2571429
	Sig. (2-tailed)	0.128888	0.048905	0.023449	0.013697327	0.10192	0.03623846	0.01619713	0.62278717
	N	7	7	7	7	7	7	7	6
February	Correlation Coefficient	-0.07143	-0.81084	-0.5	-0.5	0.763763	-0.35714286	-0.8728716	0.54285714
	Sig. (2-tailed)	0.879048	0.026916	0.25317	0.253169995	0.045659	0.43161135	0.01032342	0.26570262
	N	7	7	7	7	7	7	7	6
March	Correlation Coefficient	-0.30632	-0.78571	-0.42857	-0.82142857	0.5766	-0.10714286	-0.6666937	-0.072075
	Sig. (2-tailed)	0.504027	0.036238	0.337368	0.023448808	0.175382	0.81915086	0.10192046	0.87795925
	N	7	7	7	7	7	7	7	7
April	Correlation Coefficient	-0.35714	-0.36037	-0.53571	-0.32142857	-0.07143	-0.84688121	-0.1261312	0.5
	Sig. (2-tailed)	0.431611	0.427149	0.215217	0.482072038	0.879048	0.01619713	0.78757216	0.39100222
	N	7	7	7	7	7	7	7	5
May	Correlation Coefficient	0.704187		0.285714	0.142857143	0.054056	-0.71428571	-0.8829187	
	Sig. (2-tailed)	0.07735		0.534509	0.7599453	0.908365	0.07134356	0.00845034	
	N	7		7	7	7	7	7	
June	Correlation Coefficient	0.270281	-0.41443	-0.42857	-0.53571429	0.5	-0.42857143	-0.4144312	
	Sig. (2-tailed)	0.557731	0.355269	0.337368	0.215217456	0.25317	0.33736831	0.35526894	
	N	7	7	7	7	7	7	7	
July	Correlation Coefficient	0.542857	0.27323	0.2	-0.31428571	-0.29096	-0.14285714	-0.8116794	
	Sig. (2-tailed)	0.265703	0.600355	0.704	0.544093294	0.526695	0.78717201	0.04985759	
	N	6	6	6	6	7	6	6	
August	Correlation Coefficient	0.085714	-0.72471	0.028571	-0.48571429	0.485714	-0.28988552	-0.3714286	
	Sig. (2-tailed)	0.871743	0.103243	0.957155	0.328723032	0.328723	0.57735179	0.46847813	
	N	6	6	6	6	6	6	6	
September	Correlation Coefficient	-0.56429	-0.35355	0.7	0.4	0.6	-0.7	-0.9	
	Sig. (2-tailed)	0.321723	0.559404	0.18812	0.504631575	0.208	0.1881204	0.03738607	
	N	5	5	5	5	6	5	5	
October	Correlation Coefficient	0.6		0.714286	0.142857143	0.428571	-0.88571429	-0.7714286	
	Sig. (2-tailed)	0.208		0.110787	0.787172012	0.396501	0.01884548	0.0723965	
	N	6		6	6	6	6	6	
November	Correlation Coefficient	-0.03571	-0.20412	0	-0.10714286	-0.14286	-0.53571429	-0.5357143	-0.7142857
	Sig. (2-tailed)	0.939408	0.660642	1	0.819150856	0.759945	0.21521746	0.21521746	0.11078717
	N	7	7	7	7	7	7	7	6
December	Correlation Coefficient	0.642857	-0.74558	0.571429	0.142857143	-0.41443	-0.35714286	-0.4144312	0.10714286
	Sig. (2-tailed)	0.119392	0.054379	0.180202	0.7599453	0.355269	0.43161135	0.35526894	0.81915086
	N	7	7	7	7	7	7	7	7

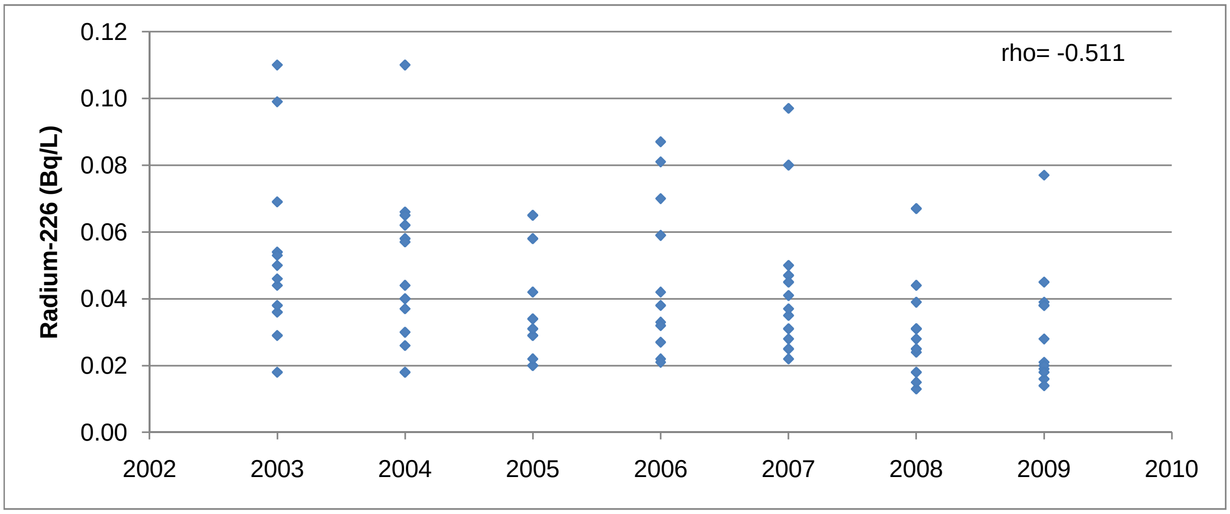
Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

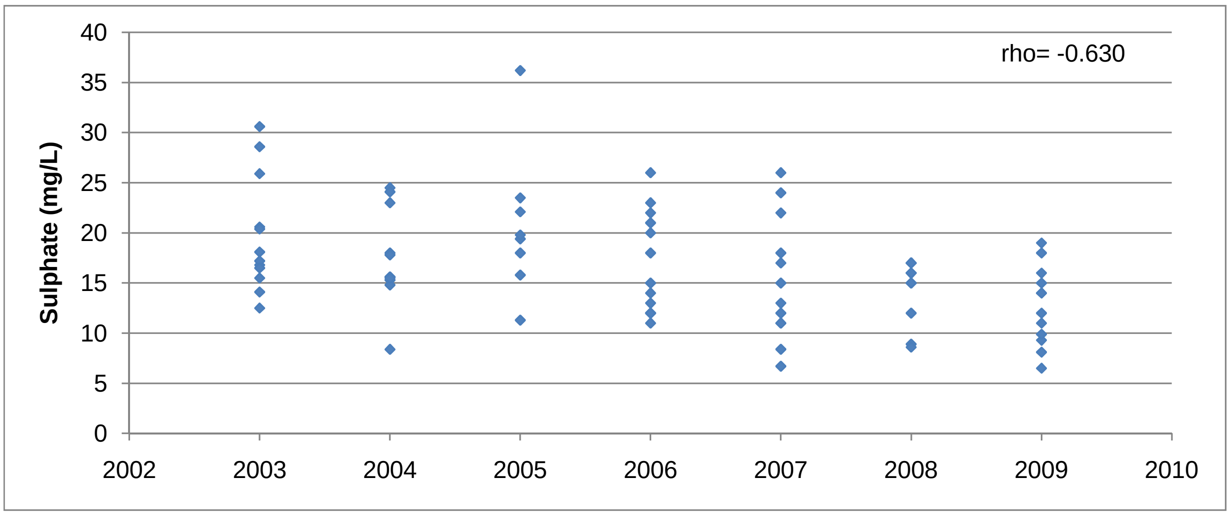
ns denotes not significant.

[shaded box] Significant trend where p<0.05.



Appendix Figure D.6.1: Significant common (average) trends observed for cobalt, manganese, pH, radium-226 and sulphate over all seasons at station MPE, 2003 to 2009.





Appendix Figure D.6.1: Significant common (average) trends observed for cobalt, manganese, pH, radium-226 and sulphate over all seasons at station MPE, 2003 to 2009.

APPENDIX D.7
Lacnor/Nordic TMA

Appendix Table D.7.1: Water quality at station N-12 from 2005 to 2009.

Date	Ba (mg/L)	Co (mg/L)	Fe (mg/L)	Mn (mg/L)	pH[a]	Ra (Bq/L)	SO4 (mg/L)	U (mg/L)
1/4/2005	0.0463	0.0035	2.17	0.181	6.2	0.24	387	0.006
1/17/2005	0.0362	0.0052	3.82	0.224	6.2	0.22	357	0.006
2/7/2005	0.0515	0.004	1.68	0.241	6.3	0.24	403	0.009
2/21/2005	0.0404	0.0026	1.22	0.196	6.1	0.18	324	0.008
3/14/2005	0.0466	0.0041	1.804	0.3019	6.3	0.29	578	
3/21/2005	0.0455	0.0034	2.82	0.255	6.3	0.29	404	0.006
4/4/2005	0.0264	0.0007	0.707	0.0868	7	0.17	238	0.006
4/18/2005	0.0443	0.0009	0.773	0.0732	6.3	0.3	209	
5/2/2005	0.0327	0.0021	0.75	0.175	6.9	0.2	672	
5/16/2005	0.052	0.0019	0.824	0.185	6.7	0.17	755	0.006
6/6/2005	0.0539	0.0012	1.45	0.136	6.6	0.49	776	0.005
6/20/2005	0.0366	0.001	0.694	0.175	6.7	0.29	945	0.007
7/4/2005	0.0274	0.0008	0.762	0.2	6.8	0.37	1021	
7/18/2005	0.0291	0.0022	1	0.28	6.5	0.32	1029	0.005
8/2/2005	0.0938	0.0026	2.46	0.336	6.8	0.37	815	0.005
9/6/2005	0.0303	0.0021	0.585	0.239	6.9	0.1	1066	
10/3/2005	0.0159	0.0015	0.774	0.166	6.8	0.071	995	
11/21/2005	0.0179	0.0021	1.09	0.184	6.4	0.065	638	
12/12/2005	0.0128	0.0012	0.978	0.126	6.7	0.045	420	
1/3/2006	0.02	0.0029	2.24	0.256	6.5	0.066	590	0.0024
2/6/2006	0.019	0.0024	1.98	0.245	6.7	0.044	620	0.0023
3/8/2006	0.017	0.0019	1.51	0.205	6.6	0.049	510	0.002
4/5/2006	0.015	0.00315	1.11	0.129	6.7	0.069	170	0.0034
5/1/2006	0.0216	0.00235	2.76	0.185	6.7	0.069	490	0.00256
6/5/2006	0.0257	0.00344	2.25	0.286	6.6	0.094	670	0.00296
7/4/2006	0.0261	0.00359	0.86	0.245	6.9	0.11	910	0.00356
8/10/2006	0.03	0.0063	0.68	0.403	7	0.12	870	0.0037
9/5/2006	0.026	0.0034	0.62	0.293	6.9	0.065	990	0.004
10/5/2006	0.027	0.0034	1.79	0.259	6.9	0.094	850	0.0039
11/6/2006	0.017	0.0015	2.18	0.137	6.5	0.053	450	0.0021
12/4/2006	0.016	0.0019	1.34	0.116	7.1	0.05	460	0.0022
1/8/2007	0.018	0.0030	3.00	0.126	6.6	0.070	300.0	0.0035
2/7/2007	0.021	0.0021	2.15	0.179	6.7	0.072	510.0	0.0030
3/7/2007	0.026	0.0021	2.44	0.197	6.9	0.080	640.0	0.0030
3/28/2007					7.3	0.084		
4/4/2007	0.021	0.0021	1.79	0.101	7.2		180.0	0.0029
5/7/2007	0.021	0.0031	1.79	0.169	7.0	0.076	590.0	0.0024
6/6/2007	0.031	0.0030	1.30	0.219	7.1	0.120	670.0	0.0033
7/4/2007	0.021	0.0024	0.23	0.184	7.4	0.079	950.0	0.0039
8/1/2007	0.016	0.0015	0.20	0.122	7.5	0.067	1000.0	0.0032
9/5/2007	0.017	0.0037	0.32	0.148	7.5	0.060	1000.0	0.0051
10/3/2007	0.019	0.0031	0.32	0.188	7.0	0.086	980.0	0.0038
11/5/2007	0.028	0.0044	0.67	0.310	6.7	0.084	930.0	0.0041
12/4/2007	0.014	0.0016	0.50	0.140	6.8	0.045	600.0	0.0021
1/15/2008	0.013	0.0012	0.54	0.087	6.8	0.056	260.0	0.0038
2/6/2008	0.017	0.0042	2.31	0.169	6.6	0.100	290.0	0.0045
3/5/2008	0.022	0.0029	1.70	0.209	6.5	0.068	440.0	0.0046
4/16/2008	0.017	0.0020	0.78	0.098	6.4	0.060	150.0	0.0043
5/5/2008	0.019	0.0018	0.67	0.106	6.7	0.066	330.0	0.0028
6/2/2008	0.021	0.0019	0.61	0.167	7.2	0.068	490.0	0.0030
7/2/2008	0.025	0.0018	0.27	0.186	6.7	0.088	660.0	0.0028
8/13/2008	0.020	0.0012	0.33	0.165	7.1	0.063	870.0	0.0023
9/3/2008	0.020	0.0012	0.44	0.149	7.0	0.078	880.0	0.0031
10/1/2008	0.024	0.0014	0.33	0.161	6.7	0.100	880.0	0.0025
11/3/2008	0.029	0.0025	0.46	0.258	6.9	0.073	850.0	0.0023
12/17/2008	0.023	0.0033	1.54	0.291	6.8	0.099	370.0	0.0029
1/7/2009	0.017	0.0010	0.81	0.101	7.1	0.072	300.0	0.0025
2/2/2009	0.026	0.0020	1.85	0.202	6.6	0.098	660.0	0.0037
3/4/2009	0.032	0.0024	2.27	0.238	6.9	0.130	630.0	0.0033

Appendix Table D.7.1: Water quality at station N-12 from 2005 to 2009.

Date	Ba (mg/L)	Co (mg/L)	Fe (mg/L)	Mn (mg/L)	pH[a]	Ra (Bq/L)	SO4 (mg/L)	U (mg/L)
4/6/2009	0.021	0.0013	0.87	0.104	6.3	0.095	170.0	0.0046
5/4/2009	0.023	0.0011	0.82	0.106	6.9	0.085	330.0	0.0025
6/3/2009	0.024	0.0013	0.85	0.132	6.5	0.100	470.0	0.0029
7/6/2009	0.034	0.0015	0.70	0.149	7.2	0.150	700.0	0.0031
8/5/2009	0.026	0.0011	0.51	0.117	6.5	0.100	640.0	0.0024
9/9/2009	0.024	0.0015	0.29	0.147	6.9	0.091	820.0	0.0025
10/7/2009	0.096	0.0022	1.96	0.190	6.8	0.370	510.0	0.0037
11/2/2009	0.020	0.0013	0.48	0.094	6.9	0.056	360.0	0.0022
12/7/2009	0.022	0.0012	0.70	0.112	6.7	0.085	410.0	0.0021
Number	67	67	67	67	261	67	67	59
Minimum	0.0128	0.0007	0.2	0.0732	6	0.044	150	0.002
Maximum	0.096	0.0063	3.82	0.403	7.5	0.49	1066	0.009
Mean	0.028	0.0023	1.23	0.184	6.8	0.128	603.5	0.0037
Median	0.024	0.0021	0.86	0.179	6.8	0.086	600.0	0.0033
10th Perc.	0.017	0.0012	0.33	0.103	6.5	0.056	278.0	0.0023

[a] pH measures shown only for dates when other substances were measured but summary statistics reflect all measured values.

Appendix Table D.7.2: Summary of Annual Plant Operations and Discharge at Nordic, 2005-2009.

ITEM	2005	2006	2007	2008	2009
PLANT OPERATIONS					
Operating Days	365	365	365	366	365
Maximum Daily Plant Flow (L/s @ N-17)	1100	465	280	550	476
Minimum Daily Plant Flow (L/s @ N-17)	35	32	18	29	34
Monthly Average Daily Plant Flow (L/s @ N-17)	83	76	60	101	79
Total Volume Treated (ML)	2626	2388	1906	3190	2477
Annual Average Treatment Rate (L/s)	-	-	60	101	79
Lime Consumption					
Dry (tonne/yr)	867	883	738.90	818.59	803.81
Average (g/L)	0.33	0.37	0.39	0.26	0.32
***EFFLUENT**					
Discharge Days	365	365	365	366	365
Maximum Daily Discharge Flow (L/s @ N-19)	1100	465	280	550	476
Minimum Daily Discharge Flow (L/s @ N-19)	35	32	18	29	34
Monthly Average Daily Discharge Flow (L/s @ N-19)	83	76	60	101	79
Total Annual Volume Discharged (ML)	2626	2388	1906	3190	2477
Annual Average Discharge Rate (L/s)	-	-	60	101	79

* Influent flows based on daily monitoring requirements as per TOMP
* Effluent flows based on weekly monitoring requirement as per SAMP

Appendix Table D.7.3: Mean annual loadings from Lacnor and Nordic TMAs, 2005 - 2009.

Station	Drainage Type	Mean Annual Discharge (m^3)		Sulphate (kg/yr)	Radium (MBq/yr)	Uranium (kg/yr)	Barium (kg/yr)	Cobalt (kg/yr)	Iron (kg/yr)	Manganese (kg/yr)
N-12	Combined Site Discharge	4,361,429	Mean	1,976,100	450	15	107	10	5,763	699
			S.D.	300,651	215	4	32	3	1,040	168
SR-08	Outlet of Nordic Lake	13,822,286	Mean	2,831,726	571	19	303	4		
			S.D.	141,117	160	4	37	1		

MBq/yr = Million Bequerels per year

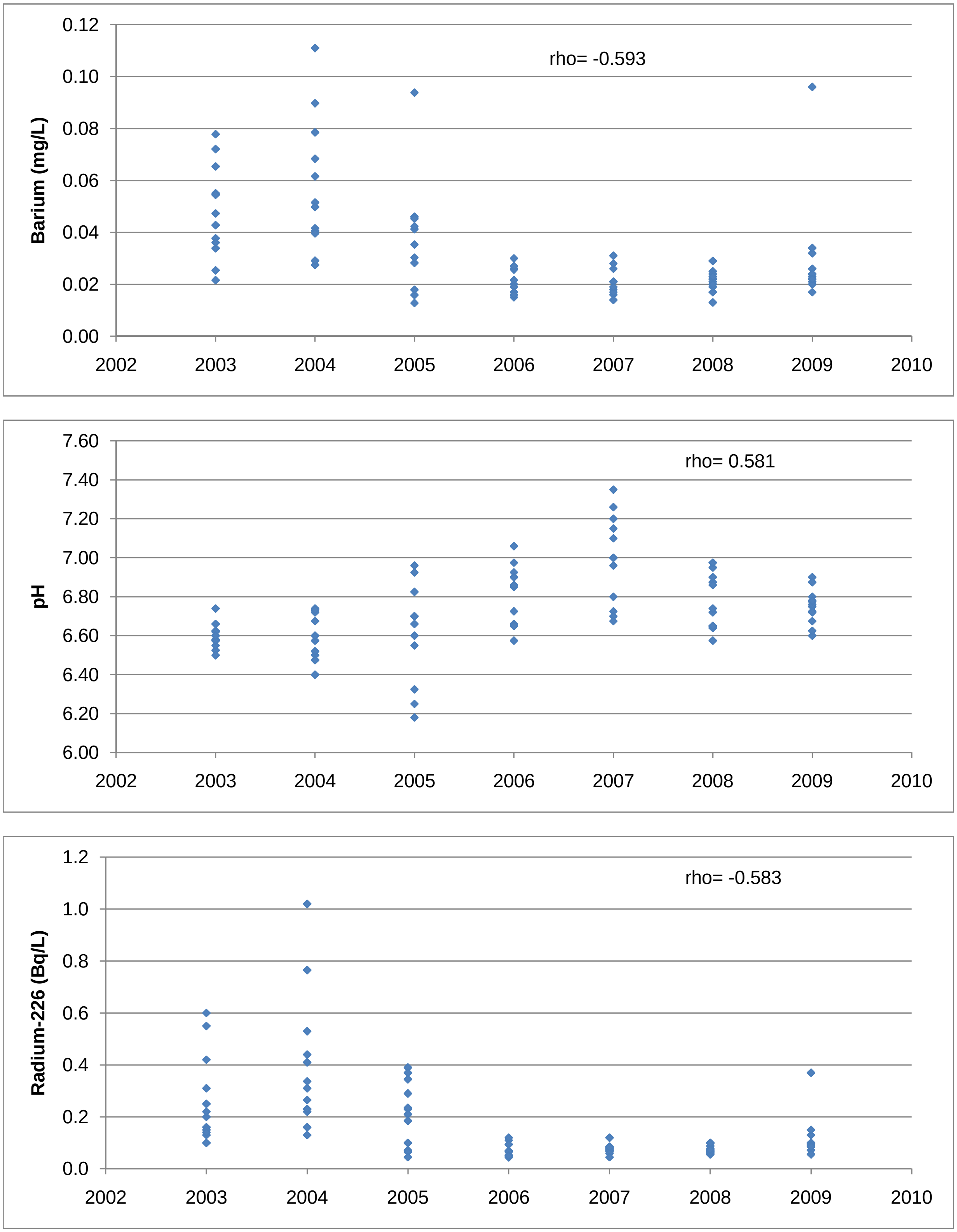
Appendix Table D.7.4: Summary of seasonal trends for station N-12, 2003 to 2009.

Season	Spearman rho	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium
January	Correlation Coefficient	-0.96429	-0.39286	0.107143	-0.642857143	0.642857	-0.60714286	-0.6847125	-0.6
	Sig. (2-tailed)	0.000454	0.383317	0.819151	0.119392373	0.119392	0.148231161	0.0896665	0.208
	N	7	7	7	7	7	7	7	6
February	Correlation Coefficient	-0.60714	0.142857	0.785714	-0.678571429	0.535714	-0.57142857	0.1785714	-0.1
	Sig. (2-tailed)	0.148231	0.759945	0.036238	0.093750254	0.215217	0.180201989	0.7016579	0.8728886
	N	7	7	7	7	7	7	7	5
March	Correlation Coefficient	-0.57143	0	0.071429	-0.571428571	0.5	-0.57142857	0.3214286	-0.1
	Sig. (2-tailed)	0.180202	1	0.879048	0.180201989	0.25317	0.180201989	0.482072	0.8728886
	N	7	7	7	7	7	7	7	5
April	Correlation Coefficient	-0.5766	-0.12613	0.214286	0.642857143	0.678571	-0.6	-0.8468812	-0.1
	Sig. (2-tailed)	0.175382	0.787572	0.644512	0.119392373	0.09375	0.208	0.0161971	0.8728886
	N	7	7	7	7	7	6	7	5
May	Correlation Coefficient	-0.67857	0.25	0.535714	0.342356236	0.882919	-0.71428571	-0.0900937	-0.5
	Sig. (2-tailed)	0.09375	0.588724	0.215217	0.452251222	0.00845	0.071343561	0.8476721	0.3910022
	N	7	7	7	7	7	7	7	5
June	Correlation Coefficient	-0.82143	0.607143	-0.07143	0.5	0.821429	-0.67857143	0.2702812	-0.7
	Sig. (2-tailed)	0.023449	0.148231	0.879048	0.253169995	0.023449	0.093750254	0.5577307	0.1881204
	N	7	7	7	7	7	7	7	5
July	Correlation Coefficient	-0.60714	-0.2965	-0.85714	-0.392857143	0.678571	-0.75	-0.0714286	-0.8696566
	Sig. (2-tailed)	0.148231	0.518477	0.013697	0.38331687	0.09375	0.0521814	0.8790482	0.0243769
	N	7	7	7	7	7	7	7	6
August	Correlation Coefficient	-0.75	-0.78571	-0.75	-0.642857143	0.5766	-0.85714286	0.3243375	-0.9428571
	Sig. (2-tailed)	0.052181	0.036238	0.052181	0.119392373	0.175382	0.013697327	0.4778855	0.0048047
	N	7	7	7	7	7	7	7	6
September	Correlation Coefficient	-0.82143	-0.03604	-0.89286	-0.214285714	0.535714	-0.64285714	0.3214286	-0.6
	Sig. (2-tailed)	0.023449	0.938861	0.006807	0.644511581	0.215217	0.119392373	0.482072	0.284757
	N	7	7	7	7	7	7	7	5
October	Correlation Coefficient	0	0.071429	0.035714	0.357142857	0.509175	-0.07142857	0	
	Sig. (2-tailed)	1	0.879048	0.939408	0.431611352	0.243146	0.879048193	1	
	N	7	7	7	7	7	7	7	
November	Correlation Coefficient	-0.39286	-0.14548	-0.64286	0	0.180187	-0.57142857	-0.0357143	-0.4
	Sig. (2-tailed)	0.383317	0.755633	0.119392	1	0.699046	0.180201989	0.9394082	0.5046316
	N	7	7	7	7	7	7	7	5
December	Correlation Coefficient	-0.32143	0	0.321429	0	0.428571	-0.36037499	0.4642857	-0.7650369
	Sig. (2-tailed)	0.482072	1	0.482072	1	0.337368	0.427148809	0.2939341	0.0763256
	N	7	7	7	7	7	7	7	6

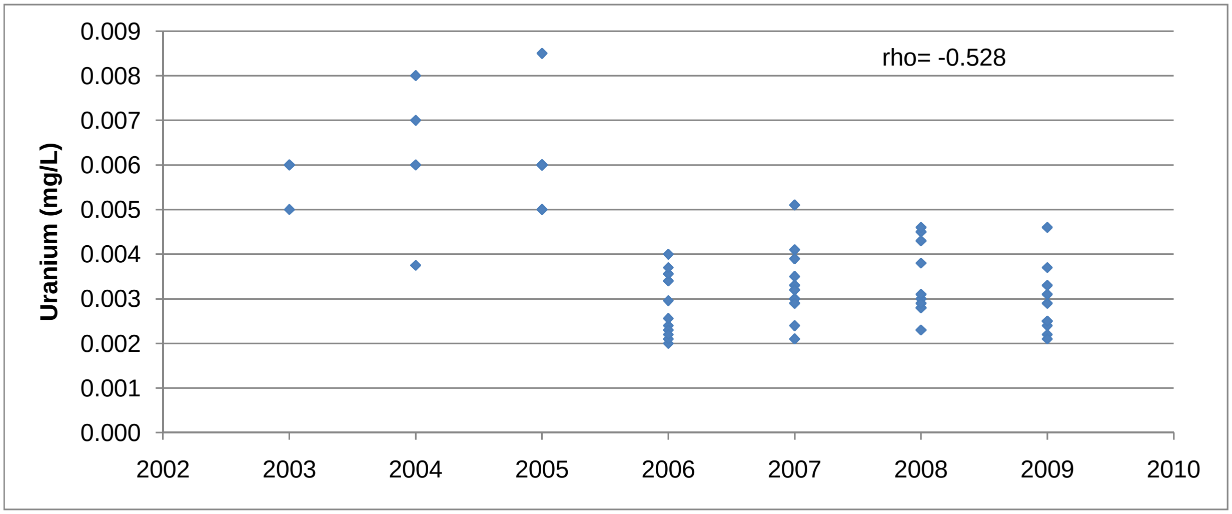
Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

ns denotes not significant.

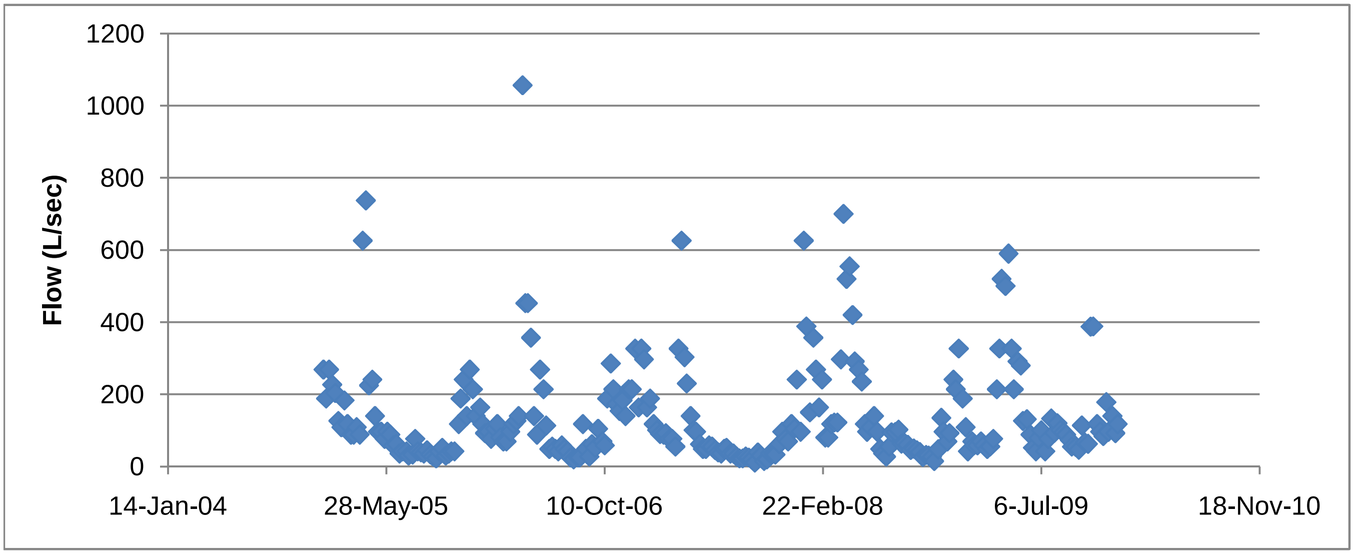
[shaded box] Significant trend where p<0.05.



Appendix Figure D.7.1: Significant common (average) trends observed for barium, pH, radium-226 and uranium over all seasons at station N-12, 2003 to 2009.



Appendix Figure D.7.1: Significant common (average) trends observed for barium, pH, radium-226 and uranium over all seasons at station N-12, 2003 to 2009.



Appendix Figure D.7.2: Flows at station N-12 from 2005 to 2009.

APPENDIX D.8
Pronto TMA

Appendix Table D.8.1: Water quality at station LL-01 from 2005 to 2009.

Date	Ba (mg/L)	Co (mg/L)	Fe (mg/L)	Mn (mg/L)	pH	Ra (Bq/L)	SO4 (mg/L)	TSS (mg/L)	U (mg/L)
1/5/2005	0.0357	0.0004	0.442	0.107	6.4	0.092	176		< 0.005
4/6/2005	0.0137	0.0005	0.444	0.0633	6.5	0.044	42.9		< 0.005
7/6/2005	0.0217	< 0.0003	0.297	0.0273	7.2	0.045	99		0.006
10/4/2005	0.0271	< 0.0003	0.491	0.0663	6.9	0.08	112		< 0.005
1/12/2006	0.06	< 0.0005	0.23	0.0446	6.9	0.14	310		0.0111
4/12/2006	0.0244	0.00053	0.52	0.0475	6.8	0.07	66		0.00214
7/12/2006	0.0269	< 0.0005	0.29	0.0179	7.1	0.065	140		0.00201
9/20/2006	0.046	< 0.0005	0.2	0.034	6.8	0.14	350	1	0.0029
10/11/2006	0.044	< 0.0005	0.26	0.027	7.1	0.13	280	2	0.009
11/8/2006	0.041	< 0.0005	0.15	0.019		0.088	230	1	0.0279
12/13/2006	0.018	0.0006	0.53	0.04		0.034	67	4	0.0021
1/10/2007	0.032	0.0006	0.30	0.052	6.8	0.063	150.0		0.0033
4/11/2007	0.029	0.0006	0.39	0.053	7.0	0.050	100.0		0.0048
7/11/2007	0.034	0.0005	0.59	0.092	7.0	0.094	160.0		0.0044
10/10/2007	0.027	< 0.0005	0.86	0.133	6.7	0.087	98.0		0.0043
1/9/2008	0.013	0.0006	0.59	0.087	6.5	0.035	19.0		0.0026
4/9/2008	0.010	< 0.0005	0.48	0.027	6.7	0.012	9.8		0.0018
7/9/2008	0.017	< 0.0005	1.27	0.132	6.7	0.024	14.0		0.0019
10/8/2008	0.018	< 0.0005	0.25	0.036	7.0	0.018	45.0		0.0017
1/14/2009	0.017	< 0.0005	0.39	0.037	6.7	0.027	36.0		0.0019
4/8/2009	0.011	< 0.0005	0.26	0.021	6.7	0.018	15.0		0.0016
7/8/2009	0.013	< 0.0005	1.43	0.131	6.7	0.025	8.8		0.0015
10/14/2009	0.018	< 0.0005	0.46	0.038	6.6	0.030	22.0		0.0028
Number	23.0	23.0	23.0	23.0	21.0	23.0	23.0	4.0	23.0
Minimum	0.01	0.0003	0.15	0.0179	6.4	0.012	8.8	1	0.0015
Maximum	0.06	0.0006	1.43	0.133	7.2	0.14	350	4	0.0279
Mean	0.026	0.0005	0.48	0.058	6.8	0.061	111	2	0.0048
Median	0.024	0.0005	0.44	0.045	6.8	0.050	98	2	0.0029
10th Perc.	0.013	0.0004	0.23	0.022	6.5	0.019	14.2	1	0.0017

Appendix Table D.8.2: Water quality at station PR-01 from 2005 to 2009.

Date	Ba (mg/L)	Co (mg/L)	Fe (mg/L)	Mn (mg/L)	pH[a]	Ra (Bq/L)	SO4 (mg/L)	U (mg/L)
1/12/2005	0.0347	0.0142	0.25	0.138	6.2	0.037	152	< 0.005
2/16/2005	0.0415	0.0112	0.323	0.389	6.5	0.031	94.2	0.01
3/16/2005	0.0699	0.0292	0.107	0.354	7	0.082	390	0.017
4/13/2005	0.0371	0.0044	0.148	0.0516	6.9	0.03	163	0.008
5/16/2005	0.0383	0.0053	0.302	0.0755	6.8	0.021	54.5	0.007
6/15/2005	0.0593	0.0134	0.817	0.397	7	0.04	52.6	0.016
8/10/2005	0.0543	0.0084	0.467	0.0979	6.9	0.032	52.2	0.005
9/14/2005	0.0932	0.0115	0.352	1.48	7	0.04	45.2	0.053
10/26/2005	0.0611	0.0043	0.111	0.0922	7.2	0.046	262	0.085
11/16/2005	0.0387	0.0037	0.163	0.0366	7	0.032	160	0.008
12/14/2005	0.0454	0.0132	0.256	0.187	6.5	0.044	194	0.011
1/12/2006	0.087	0.0473	0.11	0.271	7.1	0.11	490	0.0151
2/15/2006	0.069	0.0209	0.18	0.243	6.7	0.042	250	0.0111
3/8/2006	0.047	0.0166	0.27	0.267	7.1	0.039	130	0.0092
4/12/2006	0.0866	0.016	0.14	0.095	6.9	0.058	210	0.00767
5/10/2006	0.0924	0.00947	0.11	0.112	6.7	0.07	280	0.00437
7/12/2006	0.0693	0.0185	1.05	0.136	6.4	0.044		0.0159
8/9/2006	0.096	0.0242	2.58	0.658	6.6	0.14	350	0.004
9/13/2006	0.073	0.0337	2.57	1	7	0.076	74	0.028
10/11/2006	0.039	0.016	1.92	0.419	6.9	0.028	9.4	0.0118
11/8/2006	0.068	0.0427	0.47	0.307	7.2	0.07	300	0.0298
11/22/2006	0.052	0.0259	0.3	0.221	7.1	0.091	370	0.006
12/13/2006	0.025	0.0125	0.57	0.126	6.8	0.027	66	0.004
1/10/2007	0.091	0.0191	0.17	0.164	6.8	0.078	320.0	0.0096
2/14/2007	0.093	0.0482	3.23	0.850	6.6	0.086	220.0	0.0473
3/14/2007	0.090	0.1300	2.80	1.780	6.7	0.034	110.0	0.0242
4/11/2007	0.034	0.0173	0.13	0.147	7.0	0.064	280.0	0.0182
5/9/2007	0.037	0.0112	0.89	0.174	6.8	0.050	56.0	0.0133
6/12/2007	0.054	0.0091	1.62	0.255	7.2	0.040	12.0	0.0187
7/11/2007	0.092	0.0562	0.59	0.387	7.0	0.130	400.0	0.0236
8/8/2007	0.096	0.0144	0.34	0.442	6.9	0.120	470.0	0.0221
9/12/2007	0.131	0.0137	0.68	0.668	7.1	0.074	300.0	0.0703
10/10/2007	0.035	0.0333	0.54	0.218	6.7	0.028	65.0	0.0051
11/14/2007	0.031	0.0162	0.32	0.123	6.7	0.020	120.0	0.0065
12/5/2007	0.024	0.0422	0.24	0.225	6.9	0.079	460.0	0.0179
1/9/2008	0.016	0.0213	0.33	0.114	6.5	0.023	91.0	0.0066
2/13/2008	0.018	0.0416	0.34	0.135	6.9	0.054	240.0	0.0112
3/12/2008	0.022	0.0251	0.26	0.183	6.7	0.030	170.0	0.0077
4/9/2008	0.021	0.0197	0.39	0.145	6.6	0.027	100.0	0.0088
5/14/2008	0.024	0.0110	0.18	0.070	6.8	0.047	230.0	0.0046
6/4/2008	0.029	0.0081	0.22	0.074	7.3	0.067	300.0	0.0035
7/9/2008	0.064	0.0215	0.51	0.932	6.9	0.061	190.0	0.0168
8/13/2008	0.095	0.0106	0.41	1.010	7.1	0.055	260.0	0.0291
9/10/2008	0.088	0.0078	0.33	0.429	7.1	0.054	260.0	0.0322
10/15/2008	0.067	0.0052	0.31	0.191	7.0	0.052	190.0	0.0302
11/12/2008	0.047	0.0065	0.27	0.144	6.7	0.024	140.0	0.0289
12/10/2008	0.043	0.0109	0.17	0.090	6.9	0.070	380.0	0.0661
1/14/2009	0.044	0.0189	0.33	0.244	6.7	0.064	300.0	0.0284
2/10/2009	0.026	0.0450	0.06	0.254	6.5	0.088	400.0	0.0167
3/11/2009	0.030	0.0179	0.22	0.183	6.5	0.053	150.0	0.0108
4/8/2009	0.020	0.0278	0.16	0.127	7.0	0.061	180.0	0.0087
5/13/2009	0.027	0.0041	0.07	0.038	7.4	0.068	280.0	0.0039
6/10/2009	0.024	0.0039	0.44	0.054	7.0	0.018	38.0	0.0083
7/8/2009	0.040	0.0075	0.54	0.293	6.7	0.028	28.0	0.0189
8/12/2009	0.052	0.0113	0.50	0.445	7.0	0.016	12.0	0.0140
9/9/2009	0.053	0.0091	0.40	0.578	6.8	0.037	12.0	0.0245
10/14/2009	0.044	0.0055	0.39	0.094	6.7	0.029	18.0	0.0041
11/18/2009	0.037	0.0125	0.07	0.148	6.6	0.079	330.0	0.0101
12/17/2009	0.025	0.0064	0.06	0.104	6.6	0.075	370.0	0.0073
Number	59	59	59	59	252	59	58	59
Minimum	0.016	0.0037	0.06	0.0366	6.2	0.016	9.4	0.0035
Maximum	0.131	0.13	3.23	1.78	7.4	0.14	490	0.085
Mean	0.053	0.0199	0.54	0.316	6.9	0.054	200.5	0.0178
Median	0.045	0.0142	0.32	0.187	6.9	0.050	190.0	0.0112
10th Perc.	0.024	0.0053	0.11	0.075	6.6	0.026	35.0	0.0046

[a] pH measures shown only for dates when other substances were measured but summary statistics reflect all measured values.

Appendix Table D.8.3: Summary of Annual Plant Operations and Discharge at Pronto, 2005-2009.

ITEM	2005	2006	2007	2008	2009
PLANT OPERATIONS					
Operating Days	60	122	90	134	146
Maximum Daily Plant Flow (L/s @ PR-02)	175	217	167	186	208
Minimum Daily Plant Flow (L/s @ PR-02)	0	0	0	0	0
Monthly Average Daily Plant Flow (L/s @ PR-02)	136	117	134	125	131
Total Volume Treated (ML)	704	1235	1044	1446	1659
Annual Average Treatment Rate (L/s)	-	-	134	125	132
Barium Chloride Consumption					
Total (kg/yr)	200	400	175	200	0
Monthly Average (mg/L)	0.28	0.32	0.17	0.14	0.00
Lime Consumption					
Dry (tonne/yr)	29	64	41.84	60.48	60.11
Average (g/L)	0.042	0.052	0.04	0.04	0.04
***EFFLUENT**					
Discharge Days	57	120	86	130	145
Maximum Daily Discharge Flow (L/s @ PR-04)	175	217	167	186	208
Minimum Daily Discharge Flow (L/s @ PR-04)	0	0	0	0	0
Monthly Average Daily Discharge Flow (L/s @ PR-04)	136	116	135	125	131
Total Annual Volume Discharged (ML)	671	1204	1001	1403	1645
Annual Average Discharge Rate (L/s)	-	-	135	125	131

* Influent flows based on daily monitoring requirements as per TOMP

* Effluent flows based on weekly monitoring requirement as per SAMP

Appendix Table D.8.4: Mean annual discharge and seepage loadings from Pronto TMA, 2005 - 2009.

Station	Drainage Type	Mean Annual Discharge (m^3)		Sulphate (kg/yr)	Radium (MBq/yr)	Uranium (kg/yr)	Barium (kg/yr)	Cobalt (kg/yr)	Iron (kg/yr)	Manganese (kg/yr)
PR-01	Controlled Discharge	1,822,781	Mean	400,185	103	24	79	39	609	352
			S.D.	126,415	45	5	37	14	357	119
LL-01	Upstream Source to Lake Lauzon	320,022	Mean	26,197	15	1.4	6.6	0.1	135	14.6
			S.D.	32,856	14.9	1.6	5.7	0.1	72	6.5
			All Pronto Sources	**426,382**	**118**	**25**	**85**	**39**	**744**	**367**

MBq/yr = Million Bequerels per year

Appendix Table D.8.5: Summary of seasonal trends for station LL-01, 2003 to 2009.

Season	Spearman rho	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium
January	Correlation Coefficient	-0.82143		-0.07143	-0.82142857	-0.34236	-0.89285714	-0.607143	-0.8285714
	Sig. (2-tailed)	0.023449		0.879048	0.023448808	0.452251	0.006807187	0.1482312	0.0415627
	N	7		7	7	7	7	7	6
April	Correlation Coefficient	-0.39286		-0.42857	-0.92857143	0.407687	-0.64285714	-0.464286	
	Sig. (2-tailed)	0.383317		0.337368	0.002519472	0.363942	0.119392373	0.2939341	
	N	7		7	7	7	7	7	
July	Correlation Coefficient	-0.57143		0	0.071428571	-0.2965	-0.64285714	-0.5	-0.9
	Sig. (2-tailed)	0.180202		1	0.879048193	0.518477	0.119392373	0.25317	0.0373861
	N	7		7	7	7	7	7	5
October	Correlation Coefficient	-0.63066		-0.28571	-0.32142857	-0.2883	-0.42857143	-0.75	
	Sig. (2-tailed)	0.128888		0.534509	0.482072038	0.530651	0.337368311	0.0521814	
	N	7		7	7	7	7	7	

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

ns denotes not significant.

[shaded cell] Significant trend where p<0.05.

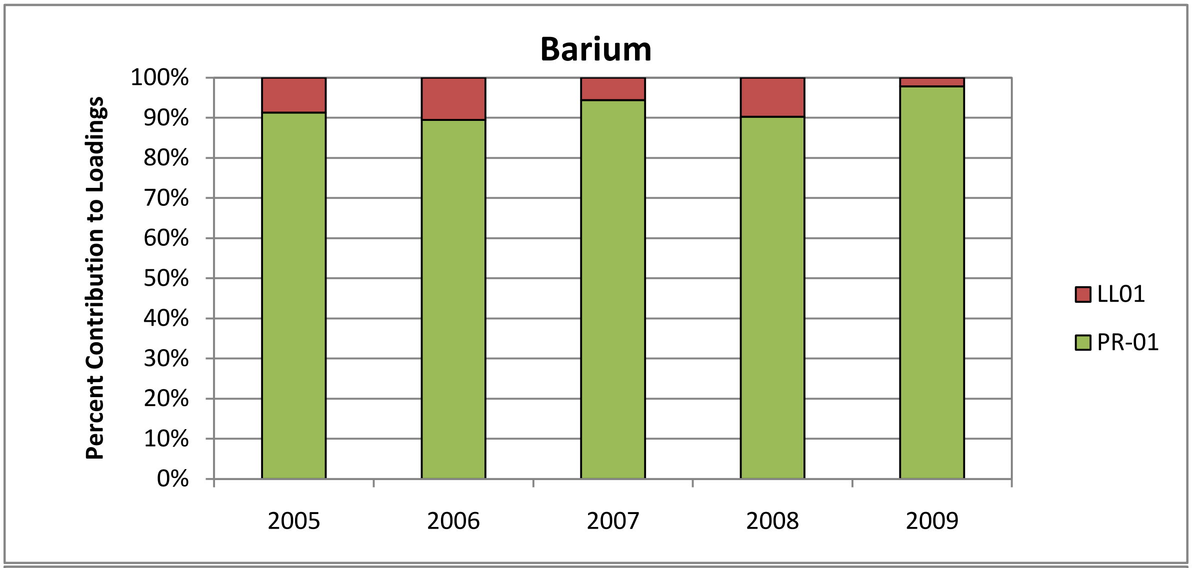
Appendix Table D.8.6: Summary of seasonal trends for station PR-01, 2003 to 2009.

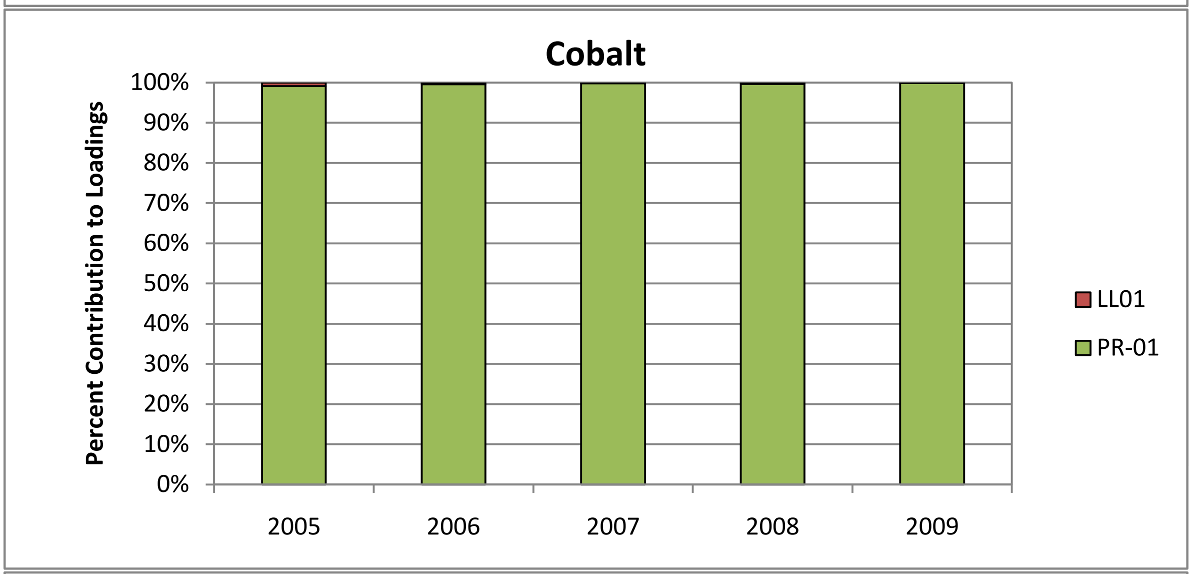
Season	Spearman rho	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium
January	Correlation Coefficient	-0.21429	0.342356	0.666694	-0.285714286	0.142857	0.142857143	-0.64285714	-0.0857143
	Sig. (2-tailed)	0.644512	0.452251	0.10192	0.534509229	0.759945	0.7599453	0.11939237	0.87174344
	N	7	7	7	7	7	7	7	6
February	Correlation Coefficient	-0.39286	0.607143	0.107143	-0.392857143	0.178571	0.714285714	-0.21428571	0.10714286
	Sig. (2-tailed)	0.383317	0.148231	0.819151	0.38331687	0.701658	0.071343561	0.64451158	0.81915086
	N	7	7	7	7	7	7	7	7
March	Correlation Coefficient	-0.42857	0.214286	0.178571	-0.630656224	-0.78571	0.035714286	-0.28571429	-0.0714286
	Sig. (2-tailed)	0.337368	0.644512	0.701658	0.128887696	0.036238	0.939408205	0.53450923	0.87904819
	N	7	7	7	7	7	7	7	7
April	Correlation Coefficient	-0.92857	0.857143	-0.14286	0.678571429	-0.71429	0.535714286	0.17857143	0.21428571
	Sig. (2-tailed)	0.002519	0.013697	0.759945	0.093750254	0.071344	0.215217456	0.70165794	0.64451158
	N	7	7	7	7	7	7	7	7
May	Correlation Coefficient	-0.5	0.522544	-0.53571	0.25	-0.12613	0.642857143	0.45046873	-0.4642857
	Sig. (2-tailed)	0.25317	0.228878	0.215217	0.588724448	0.787572	0.119392373	0.3104293	0.29393411
	N	7	7	7	7	7	7	7	7
June	Correlation Coefficient	-0.65714	0.2	-0.02857	0.028571429	0.054056	0.231908414	-0.14285714	-0.5
	Sig. (2-tailed)	0.156175	0.704	0.957155	0.957154519	0.908365	0.658373571	0.78717201	0.39100222
	N	6	6	6	6	7	6	6	5
July	Correlation Coefficient	0.142857	0.257143	-0.02857	0.657142857	-0.03571	-0.31428571	0.1	0.7
	Sig. (2-tailed)	0.787172	0.622787	0.957155	0.156174927	0.939408	0.544093294	0.87288857	0.1881204
	N	6	6	6	6	7	6	5	5
August	Correlation Coefficient	0.306319	-0.32143	-0.32143	0.214285714	-0.30632	0.071428571	0	0.53571429
	Sig. (2-tailed)	0.504027	0.482072	0.482072	0.644511581	0.504027	0.879048193	1	0.21521746
	N	7	7	7	7	7	7	7	7
September	Correlation Coefficient	-0.14286	-0.28571	0.214286	-0.285714286	-0.25	-0.01801875	-0.03571429	0.46428571
	Sig. (2-tailed)	0.759945	0.534509	0.644512	0.534509229	0.588724	0.969415387	0.93940821	0.29393411
	N	7	7	7	7	7	7	7	7
October	Correlation Coefficient	-0.25	0.178571	0.571429	0.142857143	-0.66669	-0.05405625	-0.46428571	-0.4285714
	Sig. (2-tailed)	0.588724	0.701658	0.180202	0.7599453	0.10192	0.908365283	0.29393411	0.39650146
	N	7	7	7	7	7	7	7	6
November	Correlation Coefficient	-0.14286	0.142857	-0.32143	0.25	-0.09009	-0.25	0.07142857	0.42857143
	Sig. (2-tailed)	0.759945	0.759945	0.482072	0.588724448	0.847672	0.588724448	0.87904819	0.39650146
	N	7	7	7	7	7	7	7	6
December	Correlation Coefficient	-0.73877	-0.53571	-0.28571	-0.5	-0.46429	0.180187493	0.10714286	0.11595421
	Sig. (2-tailed)	0.057858	0.215217	0.534509	0.253169995	0.293934	0.699045774	0.81915086	0.82684821
	N	7	7	7	7	7	7	7	6

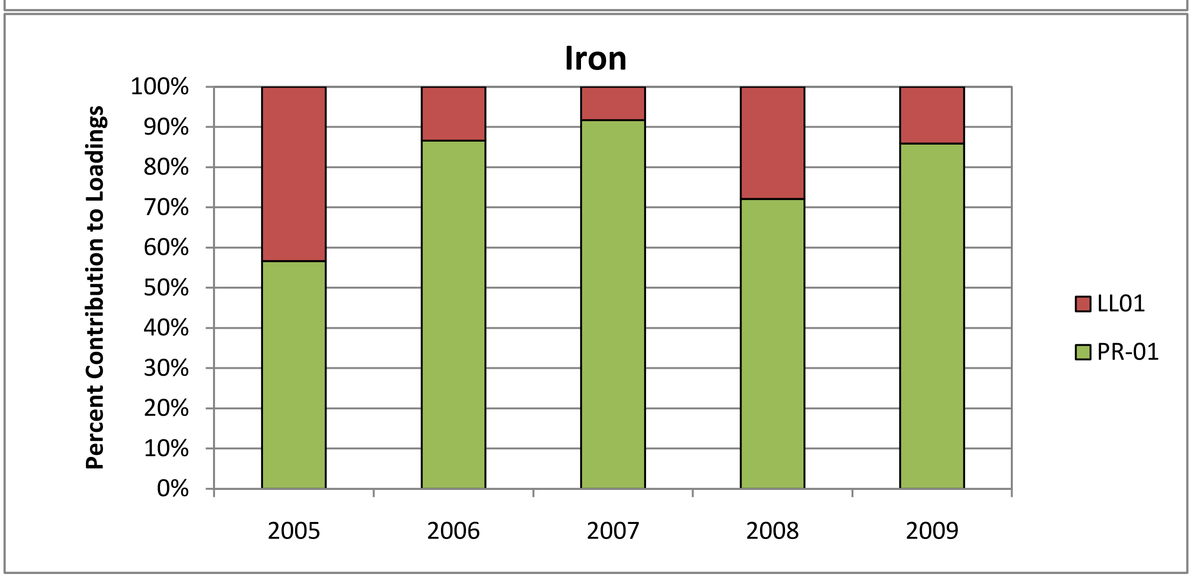
Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

ns denotes not significant.

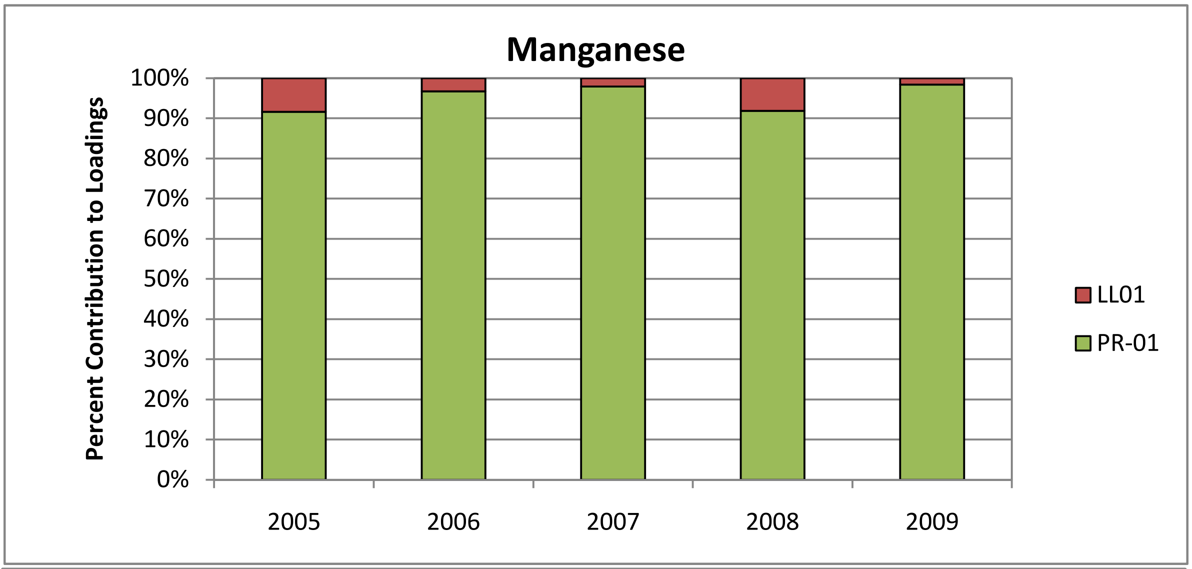
(shaded) Significant trend where p<0.05.

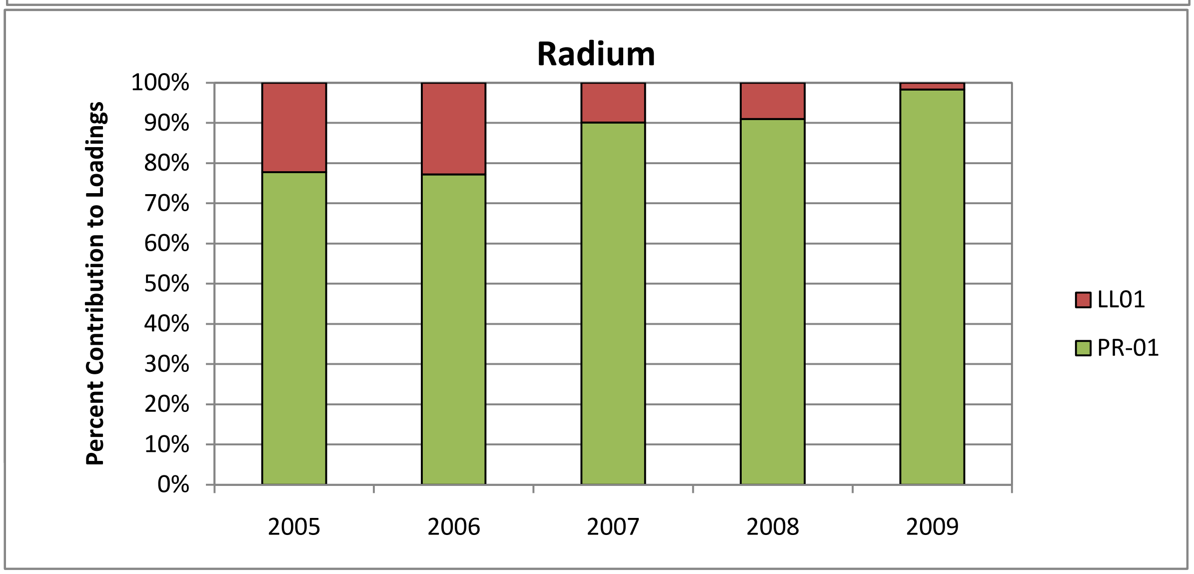


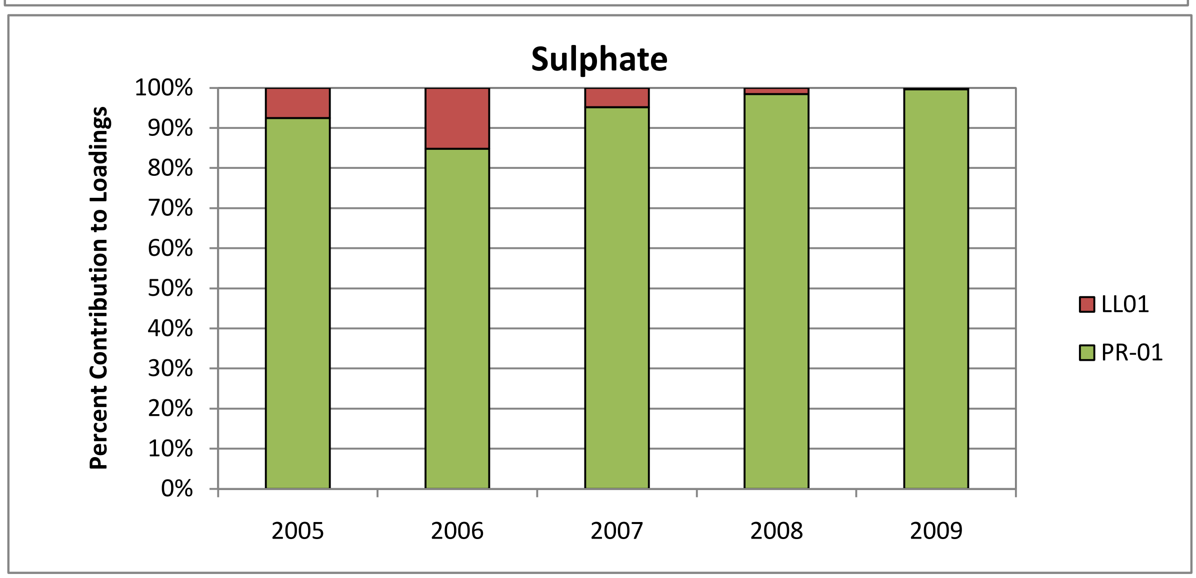




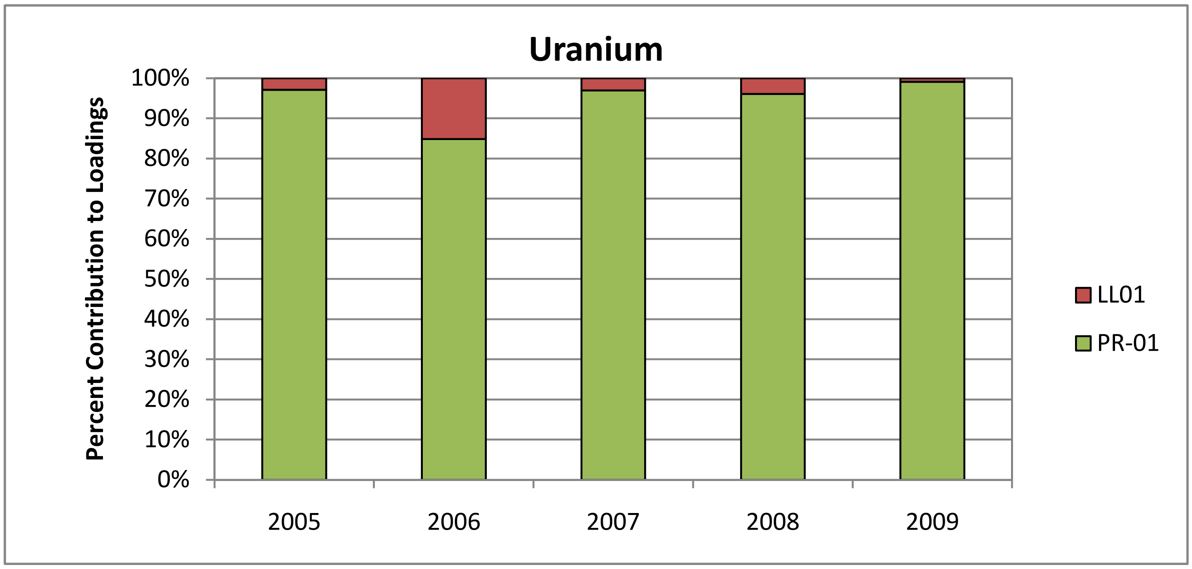
Appendix Figure D.8.1: Percent contribution to loads from Pronto TMA discharge points.



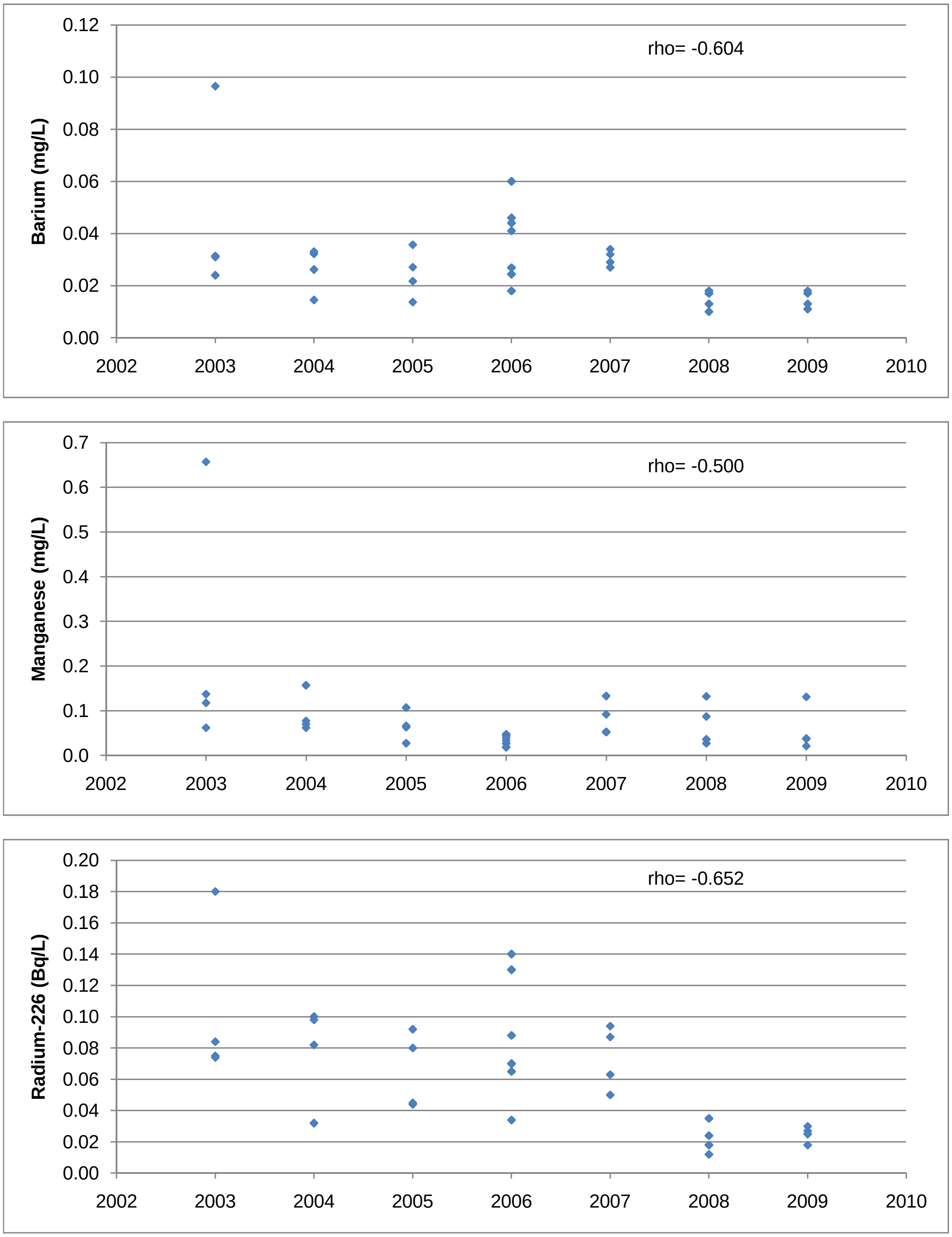




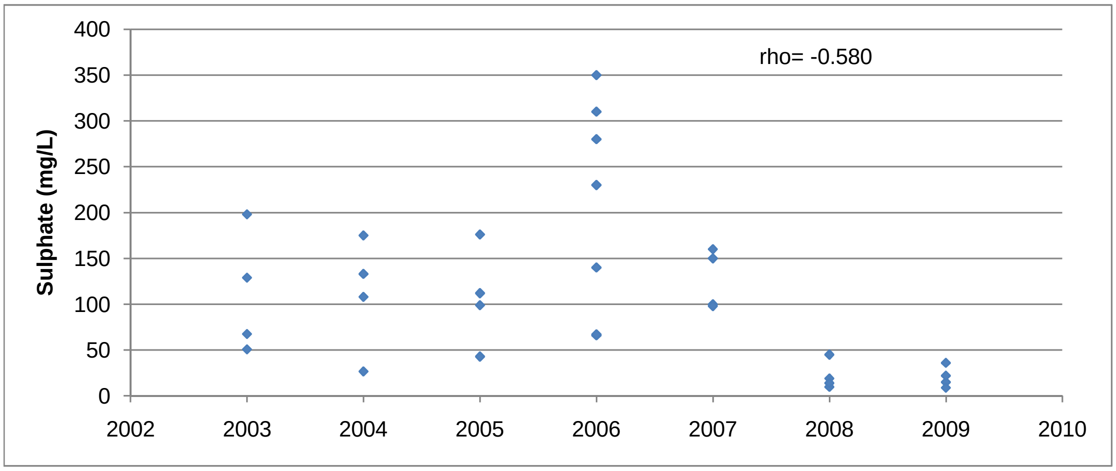
Appendix Figure D.8.1: Percent contribution to loads from Pronto TMA discharge points.

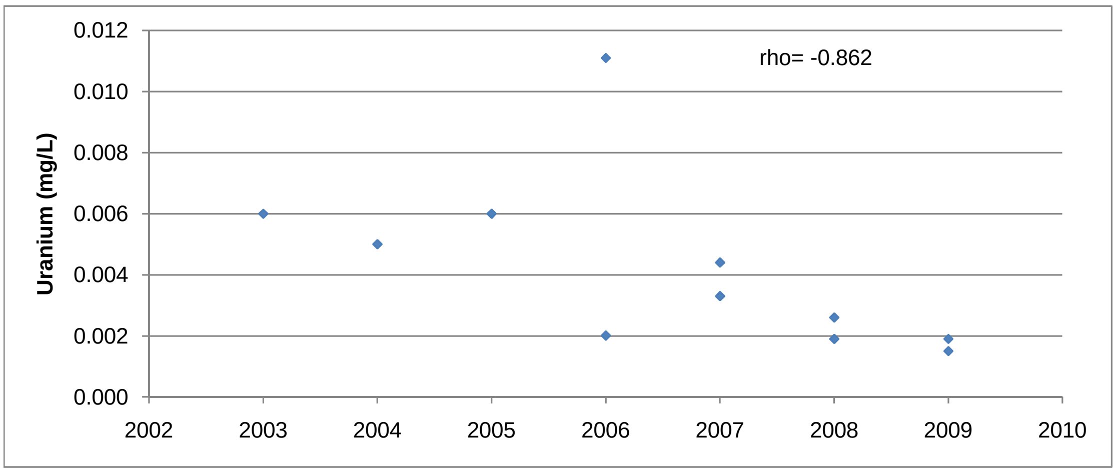


Appendix Figure D.8.1: Percent contribution to loads from Pronto TMA discharge points.

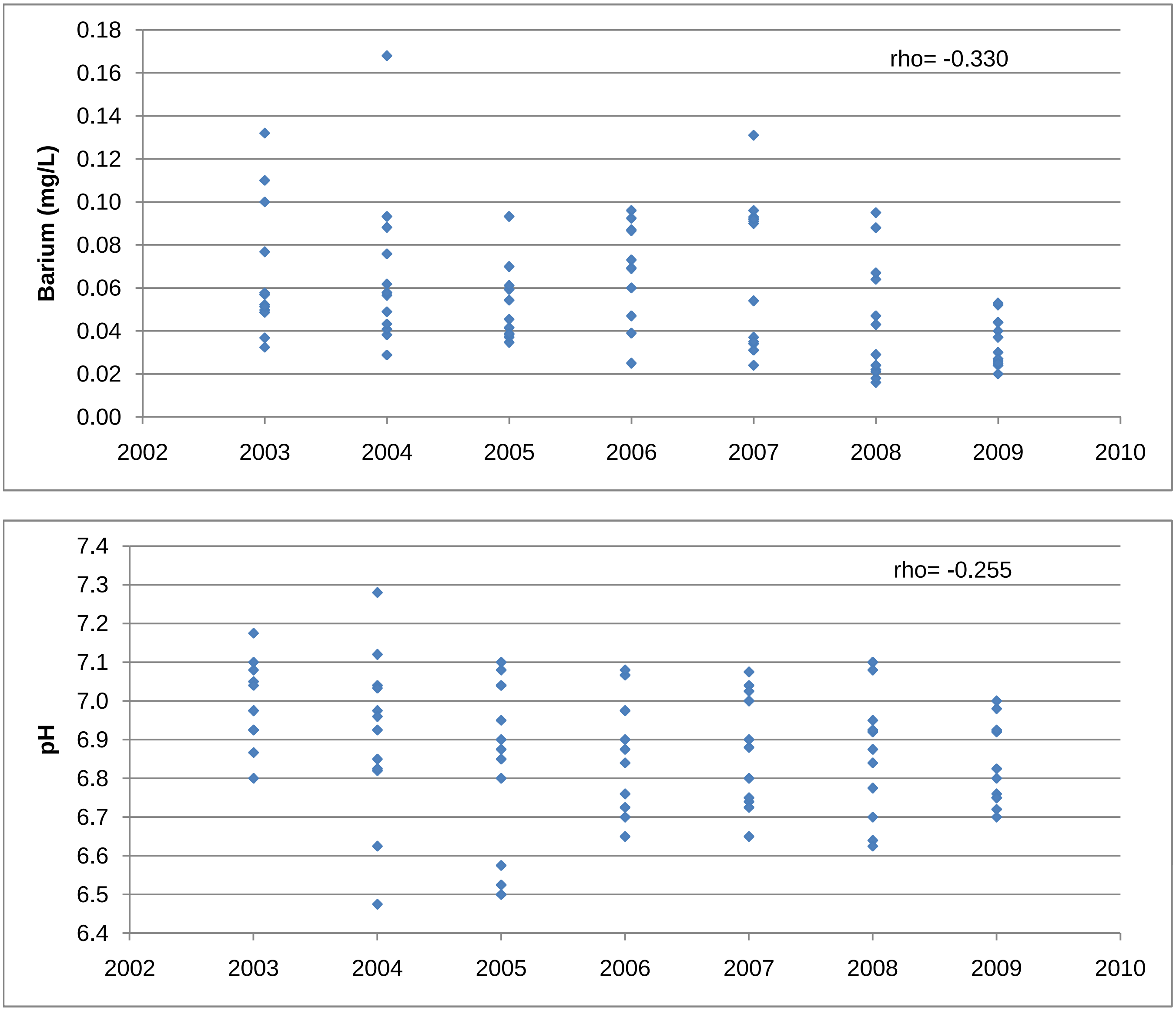


Appendix Figure D.8.2: Significant common (average) trends observed for barium, manganese, radium-226, sulphate and uranium over all seasons at station LL-01, 2003 to 2009.

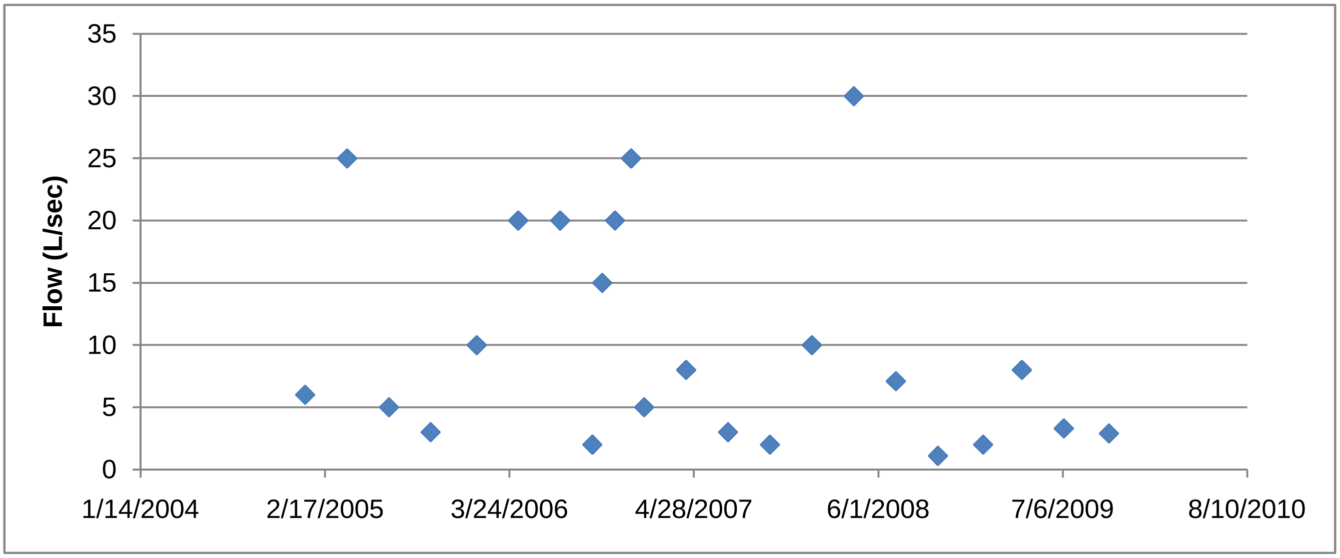




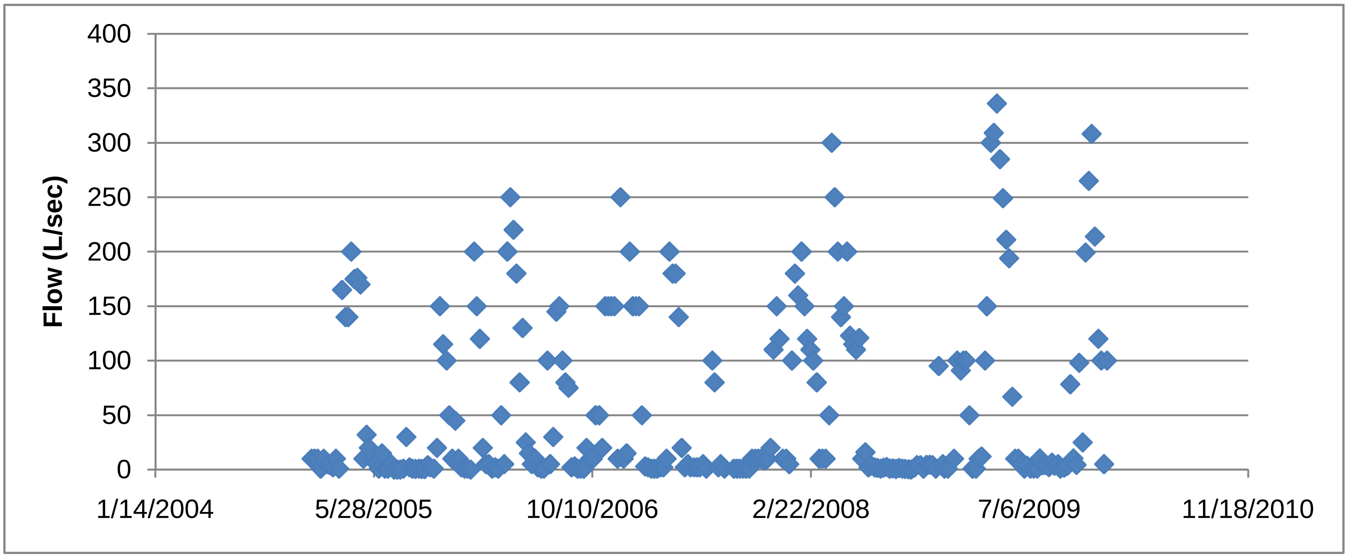
Appendix Figure D.8.2: Significant common (average) trends observed for barium, manganese, radium-226, sulphate and uranium over all seasons at station LL-01, 2003 to 2009.



Appendix Figure D.8.3: Significant common (average) trends observed for barium and pH over all seasons at station PR-01, 2003 to 2009.



Appendix Figure D.8.4: Flows at Station LL-01 from 2005 to 2009.



Appendix Figure D.8.5: Flows at station PR-01 from 2005 to 2009.

APPENDIX E

SRWMP Water Quality Data

Appendix Table E.1: Background station water quality and 95% confidence limit [a], SRWMP 2009.

Station	Date	Barium	Cobalt	Iron	Manganese	pH	Radium	Sulphate	Uranium
		mg/L	mg/L	mg/L	mg/L	pH units	Bq/L	mg/L	mg/L
D-4	4-Apr-05	0.0142	< 0.0003	0.0128	0.006	6.7	< 0.005	5.73	< 0.0005
D-4	3-Oct-05	0.0135	< 0.0003	0.02	0.0118	6.8	< 0.005	6.34	0.0006
D-4	3-Apr-06	0.0153	< 0.0005	0.02	0.00667	6.9	< 0.005	5.6	0.00005
D-4	2-Oct-06	0.013	< 0.0005	0.07	0.027	7.0	< 0.005	5.3	< 0.0005
D-4	2-Apr-07	0.014	< 0.0005	0.03	0.01	7.0	< 0.005	5.1	< 0.0005
D-4	1-Oct-07	0.012	< 0.0005	0.03	0.011	6.9	< 0.005	5.3	< 0.0005
D-4	7-Apr-08	0.014	< 0.0005	0.03	0.007	6.9		5.7	< 0.0005
D-4	1-Oct-08	0.013	< 0.0005	0.02	0.011	7.0	< 0.005	4.9	< 0.0005
D-4	6-Apr-09	0.015	< 0.0005	0.02	0.006	6.8	< 0.005	5.3	< 0.0005
D-4	5-Oct-09	0.015	< 0.0005	0.1	0.019	6.9	< 0.005	4.4	< 0.0005
P-22	28-Mar-05	0.0317	< 0.0003	0.20	0.013	7.5	< 0.005	6.2	< 0.0005
P-22	17-Nov-05	0.0127	< 0.0003	0.22	0.048	6.1	< 0.005	4.5	< 0.0005
P-22	13-Mar-06	0.021	< 0.0003	0.22	0.028	6.5	< 0.005	7.0	< 0.0002
P-22	31-Oct-06	0.018	< 0.0005	0.25	0.067	6.4	< 0.005	4.4	< 0.0005
P-22	12-Mar-07	0.021	< 0.0005	0.14	0.010	6.4	< 0.005	5.4	< 0.0005
P-22	23-Oct-07	0.015	< 0.0005	0.03	0.011	6.7	< 0.005	4.6	< 0.0005
P-22	25-Mar-08	0.021	< 0.0005	0.21	0.013	6.4	< 0.005	5.5	< 0.0005
P-22	22-Oct-08	0.02	< 0.0005	0.09	0.025	6.8	< 0.005	3.7	< 0.0005
P-22	16-Mar-09	0.022	< 0.0005	0.28	0.013	6.2	< 0.005	4.5	< 0.0005
P-22	21-Sep-09	0.015	< 0.0005	0.08	0.017	5.7	< 0.005	3.2	< 0.0005
SR-05	4-Jan-05	0.0116	< 0.0003	0.02	0.010	6.8	< 0.005	5.6	< 0.0005
SR-05	17-Feb-05	0.0092	< 0.0003	0.03	0.008	7.1	0.009	5.9	< 0.0005
SR-05	17-Mar-05	0.007	< 0.0003	0.01	0.004	7.2	< 0.005	6.1	< 0.0005
SR-05	19-May-05	0.0091	< 0.0003	0.03	0.026	6.9	< 0.005	5.3	< 0.0005
SR-05	16-Jun-05	0.0067	< 0.0003	0.03	0.043	7.0	0.006	5.7	< 0.0005
SR-05	19-Jul-05	0.0074	< 0.0003	0.03	0.034	6.8	< 0.005	5.6	< 0.0005
SR-05	11-Aug-05	0.0064	< 0.0003	0.02	0.023	6.7	< 0.005	5.5	< 0.0005
SR-05	8-Sep-05	0.0052	< 0.0003	0.01	0.015	6.7	< 0.005	5.9	< 0.0005
SR-05	20-Oct-05	0.0046	< 0.0003	0.02	0.004	6.3	< 0.005	6.8	< 0.0005
SR-05	1-Nov-05	0.0049	< 0.0003	0.01	0.006	7.2	< 0.005	5.6	< 0.0005
SR-05	19-Jan-06	0.006	< 0.0003	0.03	0.005	6.5	< 0.005	5.7	< 0.0002
SR-05	16-Feb-06	0.006	< 0.0003	0.02	0.003	7.3	< 0.005	5.2	< 0.0002
SR-05	7-Mar-06	0.006	< 0.0003	0.02	0.002	6.9	< 0.005	5.3	< 0.0002
SR-05	26-Apr-06	0.00635	< 0.0005	0.02	0.008	7.1	< 0.005	4.8	< 0.0005
SR-05	16-May-06	0.00588	< 0.0005	0.02	0.010	7.0	< 0.005	4.7	< 0.0005
SR-05	20-Jun-06	0.0063	0.00006	0.02	0.024	6.4	< 0.005	5.0	< 0.0005
SR-05	20-Jul-06	0.006	< 0.0003	0.03	0.016	6.8	< 0.005	5.2	< 0.0002
SR-05	9-Aug-06	0.007	< 0.0005	0.03	0.033	7.7	< 0.005	4.8	< 0.0005
SR-05	14-Sep-06	0.005	< 0.0005	0.02	0.011	7.1	< 0.005	4.9	< 0.0005
SR-05	18-Oct-06	0.005	< 0.0005	0.04	0.021	7.2	< 0.005	4.6	< 0.0005
SR-05	22-Nov-06	0.006	< 0.0005	0.07	0.022	6.8	< 0.005	4.5	< 0.0005
SR-05	29-Jan-07	0.007	< 0.0005	0.03	0.013	6.7	< 0.005	5.9	< 0.0005
SR-05	20-Feb-07	0.007	< 0.0005	0.02	0.008	6.3	< 0.005	5.0	< 0.0005
SR-05	12-Mar-07	0.007	< 0.0005	0.02	0.007	6.5	< 0.005	5.3	< 0.0005
SR-05	10-May-07	0.006	< 0.0005	0.02	0.023	6.2	< 0.005	5.0	< 0.0005
SR-05	26-Jun-07	0.007	< 0.0005	0.05	0.036	6.8	< 0.005	4.7	< 0.0005
SR-05	27-Jul-07	0.007	< 0.0005	0.02	0.037	7.0	< 0.005	4.7	< 0.0005
SR-05	21-Aug-07	0.006	< 0.0005	0.02	0.016	7.2	< 0.005	5.2	< 0.0005
SR-05	25-Sep-07	0.006	< 0.0005	0.02	0.015	7.1	< 0.005	4.8	< 0.0005
SR-05	17-Oct-07	< 0.005	< 0.0005	0.02	0.009	7.1	< 0.005	4.7	< 0.0005
SR-05	7-Nov-07	< 0.005	< 0.0005	0.05	0.012	6.7	< 0.005	4.7	< 0.0005
SR-05	24-Jan-08	0.006	< 0.0005	0.04	0.012	6.6	< 0.005	5.1	< 0.0005
SR-05	21-Feb-08	0.006	< 0.0005	0.04	0.008	7.0	< 0.005	5.2	< 0.0005
SR-05	27-Mar-08	0.007	< 0.0005	0.02	0.005	7.0	< 0.005	5.2	< 0.0005
SR-05	15-May-08	0.006	< 0.0005	0.03	0.022	6.9	< 0.005	4.5	< 0.0005
SR-05	24-Jun-08	0.006	< 0.0005	0.02	0.021	6.7	< 0.005	4.6	< 0.0005
SR-05	22-Jul-08	0.007	< 0.0005	0.04	0.050	6.7	< 0.005	4.6	< 0.0005
SR-05	21-Aug-08	0.007	< 0.0005	0.07	0.059	7.0	< 0.005	4.6	< 0.0005
SR-05	18-Sep-08	0.006	< 0.0005	0.04	0.028	7.2	< 0.005	4.9	< 0.0005
SR-05	6-Oct-08	0.005	< 0.0005	0.03	0.014	7.2	< 0.005	4.5	< 0.0005
SR-05	5-Nov-08	0.006	< 0.0005	0.02	0.009	6.6	< 0.005	4.5	< 0.0005
SR-05	21-Jan-09	0.006	< 0.0005	0.03	0.011	6.7	< 0.005	4.7	< 0.0005
SR-05	19-Feb-09	0.006	< 0.0005	0.02	0.018	7.2	< 0.005	4.9	< 0.0005
SR-05	12-Mar-09	0.008	< 0.0005	0.02	0.007	7.1	< 0.005	4.9	< 0.0005
SR-05	26-May-09	0.006	< 0.0005	0.02	0.018	7.0	< 0.005	4.4	< 0.0005
SR-05	16-Jun-09	0.006	< 0.0005	0.03	0.031	7.3	< 0.005	4.5	< 0.0005
SR-05	20-Jul-09	0.006	< 0.0005	0.03	0.044	6.8	< 0.005	4.5	< 0.0005
SR-05	13-Aug-09	0.006	< 0.0005	0.04	0.038	6.9	< 0.005	4.4	< 0.0005
SR-05	26-Sep-09	0.006	< 0.0005	0.02	0.020	6.7	< 0.005	4.3	< 0.0005
SR-05	15-Oct-09	< 0.005	< 0.0005	0.02	0.013	6.7	< 0.005	4.3	< 0.0005
SR-05	5-Nov-09	0.006	< 0.0005	0.07	0.030	7.0	< 0.005	4.0	< 0.0005

Appendix Table E.1: Background station water quality and 95% confidence limit [a], SRWMP 2009.

Station	Date	Barium	Cobalt	Iron	Manganese	pH	Radium	Sulphate	Uranium
		mg/L	mg/L	mg/L	mg/L	pH units	Bq/L	mg/L	mg/L
SR-14	24-Sep-05	0.0085	< 0.0003	0.01	0.004	6.1	< 0.005	5.8	< 0.0005
SR-14	23-Oct-06	0.008	< 0.0005	< 0.02	< 0.002	6.8	< 0.005	5.0	< 0.0005
SR-14	15-Oct-07	0.008	< 0.0005	< 0.02	< 0.002	7.0	< 0.005	5.0	< 0.0005
SR-14	22-Oct-08	0.014	< 0.0005	< 0.02	0.004	6.6	< 0.005	4.9	< 0.0005
SR-14	20-Oct-09	0.008	< 0.0005	< 0.02	0.003	6.8	< 0.005	4.7	< 0.0005
SR-18	5-Apr-05	0.0537	< 0.0003	0.04	0.006	6.5	0.008	6.8	< 0.0005
SR-18	3-Oct-05	0.0449	< 0.0003	0.00	0.009	6.8	< 0.005	8.0	< 0.0005
SR-18	17-Apr-06	0.0455	0.00005	0.03	0.009	6.3	< 0.005	5.5	0.00006
SR-18	2-Oct-06	0.051	< 0.0005	0.03	0.012	6.8	< 0.005	6.1	< 0.0005
SR-18	2-Apr-07	0.053	< 0.0005	0.04	0.005	6.8	< 0.005	5.6	< 0.0005
SR-18	1-Oct-07	0.053	< 0.0005	< 0.02	0.007	7.1	0.006	6.1	< 0.0005
SR-18	14-Apr-08	0.05	< 0.0005	0.04	0.008	6.7	< 0.005	6.1	< 0.0005
SR-18	1-Oct-08	0.052	< 0.0005	0.02	0.012	7.1	< 0.005	5.5	< 0.0005
SR-18	16-Apr-09	0.05	< 0.0005	0.04	0.006	6.4	< 0.005	3.9	< 0.0005
SR-18	5-Oct-09	0.053	< 0.0005	0.06	0.014	6.9	< 0.005	5.5	< 0.0005
SR-19	17-Jan-05	0.0522	0.0018	0.30	0.030	6.4	< 0.005	5.8	0.0005
SR-19	21-Feb-05	0.0268	< 0.0003	0.24	0.024	6.5	0.005	6.0	< 0.0005
SR-19	21-Mar-05	0.0235	< 0.0003	0.25	0.027	7.1	< 0.005	6.1	< 0.0005
SR-19	18-Apr-05	0.0186	< 0.0003	0.10	0.017	6.5	< 0.005	4.6	< 0.0005
SR-19	16-May-05	0.0204	< 0.0003	0.16	0.033	7.3	< 0.005	5.2	< 0.0005
SR-19	20-Jun-05	0.0273	0.0006	0.73	0.103	6.9	0.007	5.0	< 0.0005
SR-19	18-Jul-05	0.0538	0.0024	2.27	0.884	6.7	< 0.005	3.9	< 0.0005
SR-19	15-Aug-05	0.0371	0.0009	1.67	0.310	6.6	< 0.005	4.5	< 0.0005
SR-19	19-Sep-05	0.0572	0.0019	2.68	0.998	6.5	< 0.005	3.7	< 0.0005
SR-19	17-Oct-05	0.0276	0.0006	1.38	0.189	6.7	0.007	5.6	< 0.0005
SR-19	21-Nov-05	0.0161	< 0.0003	0.14	0.017	6.3	< 0.005	5.7	< 0.0005
SR-19	12-Dec-05	0.0207	0.0004	0.12	0.020	7.1	< 0.005	5.9	< 0.0005
SR-19	17-Jan-06	0.024	< 0.0003	0.26	0.028	6.4	< 0.005	5.6	< 0.0002
SR-19	20-Feb-06	0.024	< 0.0003	0.26	0.026	7.0	< 0.005	5.7	< 0.0002
SR-19	20-Mar-06	0.022	< 0.0003	0.22	0.022	7.0	< 0.005	5.6	< 0.0002
SR-19	17-Apr-06	0.0183	0.0001	0.10	0.013	6.5	< 0.005	4.0	< 0.0005
SR-19	15-May-06	0.0206	0.00012	0.18	0.024	7.1	< 0.005	4.5	0.00006
SR-19	19-Jun-06	0.0298	0.00077	0.90	0.301	7.3	< 0.007	4.5	0.00006
SR-19	17-Jul-06	0.041	0.0009	1.58	0.348	7.2	< 0.005	4.0	< 0.0002
SR-19	14-Aug-06	0.029	< 0.0005	0.90	0.077	6.2	< 0.005	4.4	< 0.0005
SR-19	18-Sep-06	0.031	< 0.0005	0.77	0.105	6.8	< 0.005	4.5	< 0.0005
SR-19	16-Oct-06	0.019	< 0.0005	0.21	0.017	6.6	< 0.005	4.3	< 0.0005
SR-19	16-Nov-06	0.019	< 0.0005	0.21	0.018	6.9	< 0.005	4.5	< 0.0005
SR-19	11-Dec-06	0.02	< 0.0005	0.18	0.016	7.0	< 0.005	5.0	< 0.0005
SR-19	15-Jan-07	0.021	< 0.0005	0.12	0.015	7.1	< 0.005	5.2	< 0.0005
SR-19	19-Feb-07	0.023	< 0.0005	0.23	0.022	7.1	< 0.005	6.0	< 0.0005
SR-19	15-Mar-07	0.025	< 0.0005	0.39	0.039	7.1	< 0.005	5.4	< 0.0005
SR-19	16-Apr-07	0.02	< 0.0005	0.10	0.011	7.0	< 0.005	4.7	< 0.0005
SR-19	14-May-07	0.024	< 0.0005	0.21	0.049	6.8	< 0.005	4.6	< 0.0005
SR-19	18-Jun-07	0.031	< 0.0005	0.67	0.197	6.6	< 0.005	4.4	< 0.0005
SR-19	16-Jul-07	0.03	< 0.0005	0.89	0.103	6.8	< 0.005	3.7	< 0.0005
SR-19	20-Aug-07	0.035	< 0.0005	1.72	0.238	6.7	< 0.005	3.3	< 0.0005
SR-19	17-Sep-07	0.031	< 0.0005	1.50	0.097	6.8	< 0.005	4.2	< 0.0005
SR-19	11-Oct-07	0.027	< 0.0005	0.70	0.051	6.5	< 0.005	6.1	< 0.0005
SR-19	19-Nov-07	0.022	< 0.0005	0.25	0.020	6.5	< 0.005	4.9	< 0.0005
SR-19	17-Dec-07	0.022	< 0.0005	0.22	0.020	6.8	0.005	5.2	< 0.0005
SR-19	21-Jan-08	0.022	< 0.0005	0.17	0.010	6.8	< 0.005	5.6	< 0.0005
SR-19	19-Feb-08	0.02	< 0.0005	0.19	0.012	7.0	< 0.005	4.7	< 0.0005
SR-19	18-Mar-08	0.021	< 0.0005	0.20	0.015	7.0	< 0.005	5.2	< 0.0005
SR-19	21-Apr-08	0.019	< 0.0005	0.10	0.016	6.7	< 0.005	4.1	< 0.0005
SR-19	20-May-08	0.019	< 0.0005	0.13	0.025	6.9	< 0.005	4.8	< 0.0005
SR-19	16-Jun-08	0.025	< 0.0005	0.41	0.071	6.6	< 0.005	4.3	< 0.0005
SR-19	14-Jul-08	0.027	< 0.0005	0.56	0.107	6.6	< 0.005	4.5	< 0.0005
SR-19	18-Aug-08	0.03	< 0.0005	0.78	0.101	6.9	< 0.005	4.1	< 0.0005
SR-19	15-Sep-08	0.033	< 0.0005	0.88	0.147	6.7	< 0.005	4.1	< 0.0005
SR-19	2-Oct-08	0.027	< 0.0005	0.76	0.063	7.0	< 0.005	4.5	< 0.0005
SR-19	18-Nov-08	0.021	< 0.0005	0.25	0.024	6.6	< 0.005	4.8	< 0.0005
SR-19	22-Dec-08	0.019	0.002	0.23	0.060	7.1	< 0.005	5.0	< 0.0005
SR-19	21-Jan-09	0.02	< 0.0005	0.24	0.012	6.6	< 0.005	5.1	< 0.0005
SR-19	17-Feb-09	0.021	< 0.0005	0.26	0.014	6.8	< 0.005	4.8	< 0.0005
SR-19	16-Mar-09	0.022	< 0.0005	0.26	0.015	6.7	< 0.005	4.6	< 0.0005
SR-19	7-Apr-09	0.019	< 0.0005	0.15	0.018	6.7	< 0.005	4.7	< 0.0005
SR-19	19-May-09	0.02	< 0.0005	0.11	0.017	7.0	< 0.005	4.4	< 0.0005
SR-19	15-Jun-09	0.024	< 0.0005	0.22	0.059	6.8	< 0.005	4.7	< 0.0005
SR-19	20-Jul-09	0.026	< 0.0005	0.40	0.099	7.1	< 0.005	4.5	< 0.0005
SR-19	17-Aug-09	0.025	< 0.0005	0.43	0.072	7.1	< 0.005	4.3	< 0.0005
SR-19	10-Sep-09	0.026	< 0.0005	0.43	0.095	7.1	< 0.005	3.5	< 0.0005
SR-19	19-Oct-09	0.023	< 0.0005	0.30	0.018	6.9	< 0.005	4.1	< 0.0005
SR-19	16-Nov-09	0.02	< 0.0005	0.18	0.029	7.3	< 0.005	4.4	< 0.0005
SR-19	3-Dec-09	0.02	< 0.0005	0.22	0.023	7.1	< 0.005	4.0	< 0.0005

Appendix Table E.1: Background station water quality and 95% confidence limit [a], SRWMP 2009.

Station	Date	Barium	Cobalt	Iron	Manganese	pH	Radium	Sulphate	Uranium
		mg/L	mg/L	mg/L	mg/L	pH units	Bq/L	mg/L	mg/L
Annual Means									
D-4	**2005**	0.014	0.0003	0.02	0.009	6.8	0.005	6.0	0.0006
	2006	0.014	0.0005	0.05	0.017	7.0	0.005	5.5	0.0003
	2007	0.013	0.0005	0.03	0.011	7.0	0.005	5.2	0.0005
	2008	0.014	0.0005	0.03	0.009	7.0	0.005	5.3	0.0005
	2009	0.015	0.0005	0.06	0.013	6.9	0.005	4.9	0.0005
P-22	**2005**	0.022	0.0003	0.2	0.0	6.8	0.005	5.4	0.0005
	2006	0.020	0.0004	0.24	0.048	6.5	0.005	5.7	0.0004
	2007	0.018	0.0005	0.09	0.011	6.6	0.005	5.0	0.0005
	2008	0.021	0.0005	0.15	0.019	6.6	0.005	4.6	0.0005
	2009	0.019	0.0005	0.18	0.015	6.0	0.005	3.9	0.0005
SR-05	**2005**	0.007	0.0003	0.02	0.017	6.9	0.006	5.8	0.0005
	2006	0.006	0.0004	0.03	0.014	7.0	0.005	5.0	0.0004
	2007	0.006	0.0005	0.03	0.018	6.8	0.005	5.0	0.0005
	2008	0.006	0.0005	0.04	0.023	6.9	0.005	4.8	0.0005
	2009	0.006	0.0005	0.03	0.023	6.9	0.005	4.5	0.0005
SR-14	**2005**	0.009	0.0003	0.01	0.004	6.1	0.005	5.8	0.0005
	2006	0.008	0.0005	0.02	0.002	6.8	0.005	5.0	0.0005
	2007	0.008	0.0005	0.02	0.002	7.0	0.005	5.0	0.0005
	2008	0.014	0.0005	0.02	0.004	6.6	0.005	4.9	0.0005
	2009	0.008	0.0005	0.02	0.003	6.8	0.005	4.7	0.0005
SR-18	**2005**	0.049	0.0003	0.02	0.008	6.7	0.007	7.4	0.0005
	2006	0.048	0.0003	0.03	0.011	6.6	0.005	5.8	0.0003
	2007	0.053	0.0005	0.03	0.006	7.0	0.006	5.9	0.0005
	2008	0.051	0.0005	0.03	0.010	6.9	0.005	5.8	0.0005
	2009	0.052	0.0005	0.05	0.010	6.7	0.005	4.7	0.0005
SR-19	**2005**	0.032	0.0008	0.84	0.221	6.7	0.005	5.2	0.0005
	2006	0.025	0.0004	0.48	0.083	6.8	0.005	4.7	0.0003
	2007	0.026	0.0005	0.58	0.072	6.8	0.005	4.8	0.0005
	2008	0.024	0.0006	0.39	0.054	6.8	0.005	4.6	0.0005
	2009	0.022	0.0005	0.27	0.039	6.9	0.005	4.4	0.0005
Benchmark Calculation (t-statistic = 1.699)									
Mean of Means		0.021	0.0005	0.13	0.027	6.7	0.005	5.2	0.0005
SD of Means		0.015	0.0001	0.20	0.042	0.2	0.000	0.7	0.0001
Upper limit of Background		**0.047**	**0.0007**	**0.47**	**0.098**	**6.3**	**0.006**	**6.3**	**0.0006**
PWQO		**-**	**0.0009**	**0.30**	**-**	**6.5**	**1.0**	**100**	**0.005**

[a] Upper background limit calculated as mean of annual means plus *t* * standard deviation except for pH where lower 95% confidence limit was calculated (mean - t * standard deviation).
Shaded value indicates benchmark used for screening.

Appendix Table E.2: Water quality data for station D-5, SRWMP 2005-2009.

Station	Date	Barium mg/L	Cobalt mg/L	Iron mg/L	Manganese mg/L	pH pH units	Radium Bq/L	Sulphate mg/L	Uranium mg/L
Benchmark		**0.047**	**0.0009**	**0.47**	**0.098**	**6.3**	**1.0**	**100**	**0.005**
D-5	4-Jan-05	0.0306	0.0006	0.041	0.0299	7.5	0.029	25.9	0.003
D-5	8-Feb-05	0.0301	< 0.0003	0.05	0.027	7	0.023	19.2	0.002
D-5	7-Mar-05	0.027	< 0.0003	0.042	0.025	7.3	0.035	23.3	0.0015
D-5	4-Apr-05	0.0325	< 0.0003	0.042	0.0398	6.6	0.029	32.2	0.0028
D-5	2-May-05	0.0444	< 0.0003	0.079	0.0411	7.2	0.055	25.9	0.0022
D-5	6-Jun-05	0.116	< 0.0003	0.069	0.0452	7	0.099	11.2	0.0015
D-5	4-Jul-05	0.151	0.0005	0.048	0.0276	7.1	0.14	18.4	0.0016
D-5	2-Aug-05	0.335	< 0.0003	0.055	0.0224	7	0.24	34	0.0026
D-5	6-Sep-05	0.31	< 0.0003	0.09	0.0246	7.1	0.26	69.8	0.0057
D-5	3-Oct-05	0.178	< 0.0003	0.076	0.0225	6.8	0.28	66.9	0.004
D-5	7-Nov-05	0.107	< 0.0003	0.087	0.0188	7	0.15	88	0.0057
D-5	5-Dec-05	0.0265	< 0.0003	0.047	0.0313	7.2	0.02	16	0.0009
D-5	4-Jan-06	0.024	< 0.0003	0.03	0.0184	7.6	0.017	8.9	0.0005
D-5	6-Feb-06	0.025	< 0.0003	0.03	0.0273	6.9	0.012	16	0.0014
D-5	6-Mar-06	0.024	< 0.0003	0.03	0.0249	7.3	0.009	15	0.0013
D-5	3-Apr-06	0.0324	0.00022	0.05	0.0507	6.9	0.018	27	0.00287
D-5	2-May-06	0.0408	< 0.0005	0.05	0.0272	6.9	0.03	15	0.00167
D-5	5-Jun-06	0.0793	0.00013	0.07	0.0466	7	0.095	9.9	0.00141
D-5	4-Jul-06	0.175	0.000074	0.07	0.0253	7.1	0.16	11	0.00189
D-5	1-Aug-06	0.148	< 0.0005	0.06	0.022	7.5	0.14	21	0.0018
D-5	11-Sep-06	0.348	< 0.0005	0.03	0.013	6.9	0.33	33	0.0031
D-5	2-Oct-06	0.316	< 0.0005	0.09	0.022	6.9	0.31	63	0.005
D-5	13-Nov-06	0.039	< 0.0005	0.05	0.032	6.9	0.041	23	0.002
D-5	5-Dec-06	0.027	< 0.0005	0.04	0.028	6.9	0.024	16	0.0014
D-5	3-Jan-07	0.0240	< 0.0005	0.04	0.024	7	0.015	23	0.0023
D-5	6-Feb-07	0.0240	< 0.0005	0.04	0.022	7.1	0.019	13	0.0012
D-5	5-Mar-07	0.0220	< 0.0005	0.05	0.021	7.2	0.013	16	0.0012
D-5	2-Apr-07	0.0300	< 0.0005	0.1	0.042	7	0.027	26	0.0024
D-5	2-May-07	0.0430	< 0.0005	0.05	0.032	7.1	0.048	19	0.002
D-5	7-Jun-07	0.1060	< 0.0005	0.08	0.038	7.1	0.1	20	0.0025
D-5	9-Jul-07	0.1770	< 0.0005	0.05	0.03	7.2	0.17	28	0.0021
D-5	7-Aug-07	0.1710	< 0.0005	0.05	0.022	7.1	0.26	24	0.0034
D-5	4-Sep-07	0.2470	< 0.0005	0.04	0.026	7.5	0.23	45	0.0035
D-5	1-Oct-07	0.209	< 0.0005	0.05	0.02	6.8	0.23	59	0.0039
D-5	6-Nov-07	0.055	< 0.0005	0.05	0.031	6.4	0.071	28	0.0021
D-5	6-Dec-07	0.029	0.0005	0.1	0.024	6.7	0.02	8.7	< 0.0005
D-5	7-Jan-08	0.023	< 0.0005	0.03	0.025	7	0.009	14	0.0012
D-5	4-Feb-08	0.018	< 0.0005	0.05	0.019	6.9	0.015	14	0.001
D-5	3-Mar-08	0.024	< 0.0005	0.06	0.023	6.8	0.015	19	0.0017
D-5	7-Apr-08	0.032	< 0.0005	0.08	0.043	6.9	0.035	35	0.0036
D-5	1-May-08	0.031	< 0.0005	0.06	0.026	6.5	0.027	14	0.0013
D-5	4-Jun-08	0.069	< 0.0005	0.06	0.038	7	0.074	11	0.0013
D-5	1-Jul-08	0.096	< 0.0005	0.07	0.041	6.8	0.1	13	0.0014
D-5	12-Aug-08	0.094	< 0.0005	0.07	0.025	6.8	0.1	30	0.0024
D-5	2-Sep-08	0.136	< 0.0005	0.04	0.023	7.2	0.14	18	0.0017
D-5	1-Oct-08	0.154	< 0.0005	0.06	0.024	7.2	0.15	24	0.002
D-5	3-Nov-08	0.081	< 0.0005	0.07	0.034	6.7	0.089	34	0.0021
D-5	1-Dec-08	0.034	< 0.0005	0.05	0.027	7	0.029	13	0.0007
D-5	5-Jan-09	0.043	< 0.0005	0.07	0.048	7.1	0.038	36	0.005
D-5	3-Feb-09	0.027	< 0.0005	0.07	0.026	6.9	0.022	14	0.0014
D-5	2-Mar-09	0.031	< 0.0005	0.07	0.031	7	0.023	25	0.0027
D-5	6-Apr-09	0.052	< 0.0005	0.12	0.052	6.7	0.052	45	0.0062
D-5	6-May-09	0.035	< 0.0005	0.06	0.025	7.4	0.037	11	0.0012
D-5	2-Jun-09	0.047	< 0.0005	0.04	0.023	7.3	0.051	8.8	0.001
D-5	6-Jul-09	0.138	< 0.0005	0.07	0.034	7.1	0.14	14	0.0018
D-5	6-Aug-09	0.123	< 0.0005	0.05	0.029	7	0.12	15	0.0015
D-5	8-Sep-09	0.137	< 0.0005	0.03	0.022	7.1	0.12	16	0.0015
D-5	5-Oct-09	0.231	< 0.0005	0.09	0.02	6.8	0.22	26	0.0025
D-5	2-Nov-09	0.045	< 0.0005	0.07	0.031	7.2	0.035	26	0.0021
D-5	7-Dec-09	0.031	< 0.0005	0.05	0.027	7	0.025	14	0.0013
Count		60	60	60	60	60	60	60	60
Minimum		0.018	0.0001	0.03	0.013	6.4	0.009	8.7	0.0005
Maximum		0.348	0.0006	0.12	0.052	7.6	0.330	88.0	0.0062
Mean		0.092	0.0004	0.06	0.029	7.0	0.090	24.8	0.0022
Median		0.045	0.0005	0.05	0.027	7.0	0.050	19.6	0.0019
10th Percentile		0.024	0.0003	0.04	0.021	6.8	0.015	11.0	0.0012

Note: Shaded values exceed benchmark.

Appendix Table E.3: Water quality data for station D-6, SRWMP 2005-2009.

Station	Date	Barium mg/L	Cobalt mg/L	Iron mg/L	Manganese mg/L	pH pH units	Radium Bq/L	Sulphate mg/L	Uranium mg/L
Benchmark		**0.047**	**0.0009**	**0.47**	**0.098**	**6.3**	**1.0**	**100**	**0.005**
D-6	10-Jan-05	0.022	0.0004	0.121	0.0888	7	0.008	19.1	< 0.0005
D-6	14-Feb-05	0.0178	< 0.0003	0.178	0.126	6.3	< 0.005	20.3	0.0005
D-6	14-Mar-05	0.0162	< 0.0003	0.186	0.135	6.8	0.015	26.2	< 0.0005
D-6	11-Apr-05	0.0163	0.0007	0.471	0.234	6.9	0.015	33.1	< 0.0005
D-6	9-May-05	0.0192	< 0.0003	0.252	0.202	6.9	0.006	39.7	< 0.0005
D-6	13-Jun-05	0.0144	< 0.0003	0.269	0.234	6.6	< 0.005	48.9	< 0.0005
D-6	11-Jul-05	0.02	0.0007	0.452	0.631	6.8	0.011	122	< 0.0005
D-6	8-Aug-05	0.0182	0.0004	0.355	0.362	6.5	0.011	103	0.0005
D-6	12-Sep-05	0.0283	0.0008	0.486	0.948	6.4	0.011	233	< 0.0005
D-6	11-Oct-05	0.0214	0.0004	0.263	0.399	6.1	0.012	204	< 0.0005
D-6	14-Nov-05	0.0152	< 0.0003	0.179	0.074	6.6	0.007	74.5	< 0.0005
D-6	12-Dec-05	0.0136	< 0.0003	0.105	0.0924	7.1	< 0.005	19.9	< 0.0005
D-6	9-Jan-06	0.015	< 0.0003	0.12	0.13	6.7	< 0.005	27	< 0.0002
D-6	13-Feb-06	0.014	< 0.0003	0.1	0.0974	6.9	< 0.005	18	< 0.0002
D-6	13-Mar-06	0.014	< 0.0003	0.14	0.123	6.5	< 0.005	21	< 0.0002
D-6	10-Apr-06	0.015	0.00036	0.12	0.114	6.8	0.005	18	0.00017
D-6	8-May-06	0.0152	0.00034	0.2	0.205	6.8	0.005	32	0.00009
D-6	12-Jun-06	0.0131	0.00031	0.28	0.255	7	0.005	44	0.00037
D-6	11-Jul-06	0.012	< 0.0005	0.2	0.0977	7	< 0.005	31	< 0.0005
D-6	1-Aug-06	0.028	0.0011	0.73	1.29	7	0.011	180	< 0.0005
D-6	11-Sep-06	0.025	0.0005	0.35	0.604	6.8	0.013	160	< 0.0005
D-6	10-Oct-06	0.018	< 0.0005	0.12	0.093	6.7	0.008	83	< 0.0005
D-6	13-Nov-06	0.014	< 0.0005	0.08	0.072	6.9	< 0.005	21	< 0.0005
D-6	11-Dec-06	0.014	< 0.0005	0.08	0.076	6.9	< 0.005	17	< 0.0005
D-6	8-Jan-07	0.0140	< 0.0005	0.100	0.0730	6.6	< 0.005	14.0	< 0.0005
D-6	12-Feb-07	0.0150	< 0.0005	0.170	0.1330	6.6	0.005	20.0	< 0.0005
D-6	12-Mar-07	0.0150	< 0.0005	0.150	0.1520	6.5	< 0.005	20.0	< 0.0005
D-6	9-Apr-07	0.0160	< 0.0005	0.150	0.1640	7.0	0.007	18.0	< 0.0005
D-6	2-May-07	0.0150	< 0.0005	0.210	0.1590	6.7	0.007	22.0	< 0.0005
D-6	11-Jun-07	0.0130	< 0.0005	0.350	0.1900	6.9	0.007	5.0	< 0.0005
D-6	9-Oct-07	0.0180	< 0.0005	0.200	0.0810	6.9	0.013	63.0	< 0.0005
D-6	13-Nov-07	0.0130	< 0.0005	0.130	0.0580	7.0	0.007	23.0	< 0.0005
D-6	10-Dec-07	0.0140	< 0.0005	0.090	0.0740	7.1	< 0.005	17.0	< 0.0005
D-6	14-Jan-08	0.0150	< 0.0005	0.090	0.1080	6.7	0.007	16.0	< 0.0005
D-6	11-Feb-08	0.016	< 0.0005	0.15	0.066	6.6	< 0.005	12.0	< 0.0005
D-6	10-Mar-08	0.016	< 0.0005	0.24	0.099	6.5	< 0.005	16.0	< 0.0005
D-6	14-Apr-08	0.016	< 0.0005	0.34	0.141	6.7	< 0.005	17.0	< 0.0005
D-6	12-May-08	0.014	< 0.0005	0.2	0.13	6.6	< 0.005	19.0	< 0.0005
D-6	9-Jun-08	0.012	< 0.0005	0.2	0.087	6.6	< 0.005	17.0	< 0.0005
D-6	7-Jul-08	0.014	< 0.0005	0.51	0.174	6.7	< 0.005	23.0	< 0.0005
D-6	12-Aug-08	0.015	< 0.0005	0.39	0.151	6.6	0.005	33.0	< 0.0005
D-6	9-Sep-08	0.016	< 0.0005	0.47	0.266	6.8	< 0.005	67.0	< 0.0005
D-6	1-Oct-08	0.019	0.0005	0.49	0.375	6.7	0.007	96.0	< 0.0005
D-6	11-Nov-08	0.02	< 0.0005	0.28	0.146	6.8	< 0.005	66.0	< 0.0005
D-6	9-Dec-08	0.013	< 0.0005	0.11	0.08	7	< 0.005	20.0	< 0.0005
D-6	13-Jan-09	0.014	< 0.0005	0.13	0.079	6.9	< 0.005	15.0	0.0005
D-6	10-Feb-09	0.016	0.0006	0.2	0.122	6.7	0.005	18.0	< 0.0005
D-6	10-Mar-09	0.015	< 0.0005	0.22	0.124	6.9	< 0.005	17.0	< 0.0005
D-6	6-Apr-09	0.016	< 0.0005	0.16	0.098	6.8	< 0.005	14.0	< 0.0005
D-6	19-May-09	0.014	< 0.0005	0.13	0.07	7.4	< 0.005	15.0	< 0.0005
D-6	9-Jun-09	0.015	< 0.0005	0.32	0.283	7	0.007	26.0	< 0.0005
D-6	13-Jul-09	0.019	0.001	1.1	0.659	6.9	0.013	44.0	< 0.0005
D-6	11-Aug-09	0.018	0.0006	0.82	0.378	6.5	< 0.005	49.0	< 0.0005
D-6	22-Sep-09	0.028	0.001	0.8	0.708	6.8	0.009	110.0	< 0.0005
D-6	13-Oct-09	0.023	< 0.0005	0.29	0.188	7	0.012	98.0	< 0.0005
D-6	2-Nov-09	0.015	< 0.0005	0.11	0.046	6.7	< 0.005	31.0	< 0.0005
D-6	3-Dec-09	0.015	< 0.0005	0.18	0.092	6.9	< 0.005	24.0	< 0.0005
Count		57	57	57	57	57	57	57	57
Minimum		0.012	0.0003	0.08	0.046	6.1	0.005	5.0	0.0001
Maximum		0.028	0.0011	1.10	1.290	7.4	0.015	233.0	0.0005
Mean		0.017	0.0005	0.27	0.218	6.8	0.007	46.7	0.0005
Median		0.015	0.0005	0.20	0.130	6.8	0.005	23.0	0.0005
10th Percentile		0.013	0.0003	0.10	0.074	6.5	0.005	15.6	0.0004

Note: Shaded values exceed benchmark.

Appendix Table E.4: Water quality data for station DS-18, SRWMP 2005-2009.

Station	Date	Barium mg/L	Cobalt mg/L	Iron mg/L	Manganese mg/L	pH pH units	Radium Bq/L	Sulphate mg/L	Uranium mg/L
Benchmark		**0.047**	**0.0009**	**0.47**	**0.098**	**6.3**	**1.0**	**100**	**0.005**
DS-18	18-Jan-05	0.0213	0.0004	0.31	0.030	7.1	0.100	138.0	0.0012
DS-18	22-Feb-05	0.0153	< 0.0003	0.24	0.019	6.7	0.100	107.0	0.0011
DS-18	22-Mar-05	0.0111	< 0.0003	0.25	0.019	7.1	0.083	74.3	0.0009
DS-18	19-Apr-05	0.0154	0.0003	0.23	0.023	7.0	0.130	130.0	0.0015
DS-18	17-May-05	0.015	< 0.0003	0.09	0.005	7.1	0.097	125.0	0.0013
DS-18	14-Jun-05	0.0128	< 0.0003	0.13	0.012	7.2	0.120	81.1	0.0019
DS-18	19-Jul-05	0.0099	< 0.0003	0.13	0.011	7.4	0.080	59.2	0.0023
DS-18	16-Aug-05	0.0074	< 0.0003	0.09	0.010	7.4	0.084	48.1	0.0025
DS-18	20-Sep-05	0.0077	< 0.0003	0.10	0.009	7.1	0.075	49.7	0.0037
DS-18	18-Oct-05	0.0078	< 0.0003	0.04	0.003	6.9	0.068	60.6	0.0044
DS-18	22-Nov-05	0.0088	< 0.0003	0.13	0.005	6.7	0.110	64.1	0.0036
DS-18	20-Dec-05	0.0151	0.0005	0.22	0.030	7.3	0.120	94.5	0.0019
DS-18	17-Jan-06	0.016	0.0005	0.34	0.052	7.0	0.130	100.0	0.0011
DS-18	21-Feb-06	0.016	0.0004	0.27	0.054	7.3	0.150	110.0	0.0011
DS-18	14-Mar-06	0.015	0.0005	0.62	0.058	7.2	0.110	80.0	0.0013
DS-18	18-Apr-06	0.0172	0.00038	0.16	0.014	7.2	0.100	98.0	0.00122
DS-18	16-May-06	0.0157	0.00012	0.09	0.007	7.4	0.110	88.0	0.001
DS-18	20-Jun-06	0.0134	0.00016	0.13	0.011	7.2	0.120	76.0	0.00092
DS-18	18-Jul-06	0.012	< 0.0003	0.23	0.014	7.2	0.100	55.0	0.0013
DS-18	15-Aug-06	0.008	< 0.0005	0.15	0.008	7.8	0.066	38.0	0.0015
DS-18	19-Sep-06	0.007	< 0.0005	0.13	0.008	7.0	0.068	31.0	0.0014
DS-18	17-Oct-06	0.012	< 0.0005	0.17	0.009	7.1	0.110	54.0	0.0013
DS-18	21-Nov-06	0.014	< 0.0005	0.14	0.008	7.0	0.160	120.0	0.0008
DS-18	18-Dec-06	0.012	< 0.0005	0.19	0.016	7.1	0.095	100.0	0.0007
DS-18	16-Jan-07	0.0110	< 0.0005	0.43	0.017	7.1	0.062	76.0	0.0006
DS-18	20-Feb-07	0.0120	< 0.0005	0.70	0.025	6.9	0.091	74.0	0.0007
DS-18	20-Mar-07	0.0130	< 0.0005	0.48	0.026	7.4	0.094	90.0	0.0006
DS-18	17-Apr-07	0.0120	< 0.0005	0.30	0.017	6.4	0.081	78.0	0.0006
DS-18	15-May-07	0.0150	< 0.0005	0.25	0.014	7.0	0.120	55.0	0.0013
DS-18	19-Jun-07	0.0100	< 0.0005	0.21	0.014	7.2	0.099	86.0	0.0014
DS-18	17-Jul-07	0.0080	< 0.0005	0.08	0.007	7.4	0.077	71.0	0.0024
DS-18	22-Aug-07	0.0070	< 0.0005	0.10	0.008	7.4	0.073	55.0	0.0029
DS-18	19-Sep-07	0.0080	< 0.0005	0.13	0.007	7.6	0.065	49.0	0.0036
DS-18	11-Oct-07	0.0090	< 0.0005	0.09	0.005	7.1	0.079	51.0	0.0031
DS-18	20-Nov-07	0.0160	< 0.0005	0.16	0.011	7.2	0.190	120.0	0.0017
DS-18	17-Dec-07	0.0110	< 0.0005	0.19	0.024	7.0	0.080	54.0	0.0007
DS-18	15-Jan-08	0.0130	< 0.0005	0.30	0.024	6.8	0.110	150.0	0.0009
DS-18	19-Feb-08	0.0120	< 0.0005	0.50	0.020	6.7	0.078	100.0	0.0009
DS-18	18-Mar-08	0.0110	< 0.0005	0.72	0.022	6.8	0.072	85.0	0.0008
DS-18	15-Apr-08	0.0170	< 0.0005	0.27	0.023	6.8	0.058	110.0	0.0007
DS-18	20-May-08	0.0160	< 0.0005	0.22	0.007	7.0	0.095	73.0	0.0005
DS-18	17-Jun-08	0.0140	< 0.0005	0.32	0.011	7.0	0.100	58.0	0.0008
DS-18	15-Jul-08	0.0130	< 0.0005	0.16	0.009	7.1	0.075	79.0	0.0010
DS-18	19-Aug-08	0.0090	< 0.0005	0.12	0.007	7.3	0.058	49.0	0.0012
DS-18	16-Sep-08	0.008	< 0.0005	0.11	0.006	7.4	0.049	39.0	0.0009
DS-18	28-Oct-08	0.009	< 0.0005	0.08	0.003	7.1	0.052	41.0	0.0006
DS-18	18-Nov-08	0.009	< 0.0005	0.07	0.006	6.9	0.061	48.0	0.0008
DS-18	16-Dec-08	0.012	< 0.0005	0.31	0.020	7.0	0.100	49.0	0.0008
DS-18	13-Jan-09	0.013	0.0006	1.56	0.051	6.7	0.087	83.0	0.0015
DS-18	17-Feb-09	0.014	0.0006	2.01	0.054	6.7	0.120	85.0	0.0016
DS-18	17-Mar-09	0.014	0.0006	1.62	0.067	6.9	0.130	110.0	0.0014
DS-18	7-Apr-09	0.015	0.0006	0.52	0.044	6.7	0.079	150.0	0.0012
DS-18	26-May-09	0.019	< 0.0005	0.31	0.012	6.6	0.110	86.0	0.0006
DS-18	16-Jun-09	0.013	< 0.0005	0.20	0.010	7.2	0.099	72.0	0.0006
DS-18	21-Jul-09	0.009	< 0.0005	0.18	0.009	7.0	0.074	49.0	0.0011
DS-18	18-Aug-09	0.008	< 0.0005	0.19	0.010	7.2	0.060	38.0	0.0011
DS-18	22-Sep-09	0.008	< 0.0005	0.14	0.014	7.2	0.068	37.0	0.0016
DS-18	19-Oct-09	0.006	< 0.0005	0.08	0.004	6.9	0.055	39.0	0.001
DS-18	17-Nov-09	0.016	< 0.0005	0.14	0.011	7.0	0.140	120.0	0.0008
DS-18	17-Dec-09	0.013	< 0.0005	0.18	0.023	7.1	0.110	79.0	< 0.0005
Count		60	60	60	60	60	60	60	60
Minimum		0.006	0.0001	0.04	0.003	6.4	0.049	31.0	0.0005
Maximum		0.021	0.0006	2.01	0.067	7.8	0.190	150.0	0.0044
Mean		0.012	0.0005	0.30	0.018	7.1	0.094	77.8	0.0014
Median		0.012	0.0005	0.19	0.012	7.1	0.095	76.0	0.0011
10th Percentile		0.008	0.0003	0.09	0.006	6.7	0.061	40.8	0.0006

Note: Shaded values exceed benchmark.

Appendix Table E.5: Water quality data for station M-01, SRWMP 2005-2009.

Station	Date	Barium mg/L	Cobalt mg/L	Iron mg/L	pH pH units	Radium Bq/L	Sulphate mg/L	Uranium mg/L
Benchmark		**0.047**	**0.0009**	**0.47**	**6.3**	**1.0**	**100**	**0.005**
M-01	17-Jan-05	0.0236	0.0006	0.392	6.3	0.016	20.6	0.0052
M-01	21-Feb-05	0.0187	0.0008	0.542	6.2	0.019	21	0.0049
M-01	21-Mar-05	0.0185	0.0008	0.491	6.5	0.021	26.2	0.004
M-01	18-Apr-05	0.0155	0.0009	0.38	6.4	0.041	18	0.0028
M-01	16-May-05	0.023	0.0012	0.357	6.8	0.023	25.2	0.0023
M-01	21-Nov-05	0.017	0.0005	0.177	6.5	0.028	33.4	0.0032
M-01	12-Dec-05	0.0193	0.001	0.295	7	0.038	26.2	0.0054
M-01	17-Jan-06	0.022	0.0011	0.55	6.2	0.023	26	0.0038
M-01	20-Feb-06	0.018	0.0007	0.76	6.6	0.027	24	0.0049
M-01	20-Mar-06	0.022	0.0012	0.52	6.7	0.032	25	0.005
M-01	17-Apr-06	0.0152	0.00074	0.19	6.9	0.021	15	0.00269
M-01	15-May-06	0.0176	0.00034	0.23	7	0.027	20	0.00235
M-01	19-Jun-06	0.0242	0.00073	1.07	7.5	0.028	19	0.00341
M-01	16-Oct-06	0.016	< 0.0005	0.56	6.8	0.026	18	0.0032
M-01	16-Nov-06	0.014	< 0.0005	0.32	7.3	0.027	19	0.0034
M-01	11-Dec-06	0.016	< 0.0005	0.24	6.8	0.019	19	0.0043
M-01	15-Jan-07	0.0160	0.0007	0.390	7.0	0.038	18.0	0.0052
M-01	19-Feb-07	0.0210	0.0011	0.740	6.9	0.028	23.0	0.0045
M-01	15-Mar-07	0.0190	0.0012	0.930	6.8	0.029	23.0	0.0064
M-01	16-Apr-07	0.0150	0.0006	0.260	6.9	0.022	16.0	0.0033
M-01	16-Jul-07	0.0200	0.0005	0.860	7.2	0.046	10.0	0.0105
M-01	27-Aug-07	0.0160	0.0008	2.800	6.7	0.031	4.6	0.0081
M-01	24-Sep-07	0.0240	0.0014	1.140	6.4	0.047	10.0	0.0058
M-01	24-Oct-07	0.025	0.0015	0.86	6.9	0.054	14.0	0.0062
M-01	19-Nov-07	0.019	0.0009	0.76	6.9	0.032	21.0	0.0041
M-01	17-Dec-07	0.02	0.0005	0.4	6.8	0.027	21.0	0.0038
M-01	21-Jan-08	0.016	0.0005	0.33	6.5	0.023	21.0	0.0055
M-01	19-Feb-08	0.015	0.0005	0.29	6.7	0.017	17.0	0.0047
M-01	18-Mar-08	0.019	0.0009	0.41	6.9	0.017	18.0	0.0046
M-01	21-Apr-08	0.012	< 0.0005	0.17	6.9	0.022	9.4	0.0025
M-01	20-May-08	0.017	< 0.0005	0.26	7.0	0.021	15.0	0.0033
M-01	16-Jun-08	0.018	0.0005	0.77	7.1	0.023	13.0	0.004
M-01	14-Jul-08	0.021	0.0016	2.08	6.5	0.038	5.9	0.0082
M-01	18-Aug-08	0.025	0.001	1.04	6.8	0.035	11.0	0.006
M-01	15-Sep-08	0.023	0.002	0.71	7.0	0.034	15.0	0.0069
M-01	2-Oct-08	0.016	< 0.0005	0.78	6.9	0.023	9.5	0.0043
M-01	17-Nov-08	0.016	0.0006	0.52	7.0	0.022	18.0	0.0031
M-01	17-Dec-08	0.018	0.0006	0.65	6.6	0.01	16.0	0.0031
M-01	21-Jan-09	0.017	0.0005	0.46	6.7	0.018	20.0	0.0037
M-01	17-Feb-09	0.018	0.0008	0.55	6.7	0.014	20.0	0.0033
M-01	16-Mar-09	0.018	0.0007	0.61	6.4	0.017	18.0	0.0038
M-01	8-Apr-09	0.014	0.0006	0.3	6.5	0.025	14.0	0.0047
M-01	19-May-09	0.016	< 0.0005	0.2	6.8	0.015	12.0	0.0033
M-01	15-Jun-09	0.022	0.0006	0.78	7.0	0.021	11.0	0.0037
M-01	20-Jul-09	0.017	< 0.0005	1.46	6.9	0.017	8.1	0.0042
M-01	17-Aug-09	0.02	< 0.0005	1.38	6.9	0.026	6.9	0.005
M-01	10-Sep-09	0.018	< 0.0005	0.95	6.7	0.017	5.4	0.0037
M-01	19-Oct-09	0.016	< 0.0005	0.65	6.6	< 0.005	13.7	0.002
M-01	11-Nov-09	0.013	< 0.0005	0.26	6.6	0.019	13.0	0.0034
M-01	3-Dec-09	0.014	< 0.0005	0.42	6.9	0.023	15.0	0.0037
Count		50	50	50	50	50	50	50
Minimum		0.012	0.0003	0.17	6.2	0.005	4.6	0.0020
Maximum		0.025	0.0020	2.80	7.5	0.054	33.4	0.0105
Mean		0.018	0.0008	0.64	6.8	0.025	16.8	0.0044
Median		0.018	0.0006	0.53	6.8	0.023	18.0	0.0040
10th Percentile		0.015	0.0005	0.24	6.4	0.017	9.3	0.0028

Note: Shaded values exceed benchmark.

Appendix Table E.6: Water quality data for station Q-09, SRWMP 2005-2009.

Station	Date	Barium mg/L	Cobalt mg/L	pH pH units	Radium Bq/L	Sulphate mg/L	Uranium mg/L
Benchmark		**0.047**	**0.0009**	**6.3**	**1.0**	**100**	**0.005**
Q-09	4-Jan-05	0.0355	0.001	7.1	0.039	67.9	0.0062
Q-09	8-Feb-05	0.0362	0.001	6.9	0.018	79.9	0.0039
Q-09	7-Mar-05	0.0321	0.0006	7	0.027	78.5	0.0037
Q-09	4-Apr-05	0.033	0.0008	6.6	0.049	41.4	0.0038
Q-09	2-May-05	0.0598	0.0013	7	0.097	61	0.0051
Q-09	6-Jun-05	0.129	0.0003	7	0.16	61	0.0065
Q-09	4-Jul-05	0.164	0.0003	6.9	0.17	69	0.0035
Q-09	2-Aug-05	0.276	0.0005	6.9	0.2	94.1	0.0076
Q-09	6-Sep-05	0.21	0.0006	6.8	0.17	181	0.007
Q-09	3-Oct-05	0.146	< 0.0003	6.7	0.18	189	0.0077
Q-09	7-Nov-05	0.0627	0.0007	6.6	0.094	194	0.0073
Q-09	5-Dec-05	0.03	0.0008	6.8	0.031	56.4	0.0037
Q-09	4-Jan-06	0.029	0.001	7.2	0.019	58	0.0023
Q-09	6-Feb-06	0.03	0.0008	6.9	0.025	76	0.0029
Q-09	6-Mar-06	0.029	0.0009	7	0.024	76	0.0033
Q-09	3-Apr-06	0.0335	0.00094	6.6	0.03	41	0.00394
Q-09	2-May-06	0.04689	0.00064	6.9	0.055	34	0.00323
Q-09	5-Jun-06	0.0934	0.00041	7	0.12	37	0.00299
Q-09	4-Jul-06	0.211	0.000354	7	0.2	38	0.00497
Q-09	1-Aug-06	0.149	< 0.0005	7	0.12	76	0.0037
Q-09	11-Sep-06	0.104	< 0.0005	6.9	0.085	260	0.0109
Q-09	2-Oct-06	0.091	0.0006	6.8	0.087	370	0.011
Q-09	13-Nov-06	0.04	< 0.0005	6.8	0.045	50	0.0042
Q-09	5-Dec-06	0.031	< 0.0005	6.9	0.026	49	0.0038
Q-09	3-Jan-07	0.0270	0.0009	7.0	0.027	67.0	0.0035
Q-09	6-Feb-07	0.0280	0.0009	6.9	0.018	61.0	0.0031
Q-09	5-Mar-07	0.0270	0.0011	6.9	0.016	79.0	0.0036
Q-09	2-Apr-07	0.0320	0.0008	6.9	0.037	59.0	0.0044
Q-09	2-May-07	0.0460	< 0.0005	6.9	0.043	46.0	0.0034
Q-09	7-Jun-07	0.1100	< 0.0005	6.9	0.100	63.0	0.0050
Q-09	9-Jul-07	0.2460	< 0.0005	7.1	0.200	61.0	0.0047
Q-09	7-Aug-07	0.2330	0.0005	7.0	0.210	91.0	0.0163
Q-09	4-Sep-07	0.2500	< 0.0005	7.2	0.210	180.0	0.0081
Q-09	1-Oct-07	0.1660	< 0.0005	6.9	0.140	190.0	0.0101
Q-09	6-Nov-07	0.0540	< 0.0005	6.3	0.066	93.0	0.0046
Q-09	6-Dec-07	0.027	< 0.0005	6.7	0.028	59.0	0.0006
Q-09	7-Jan-08	0.027	0.0006	6.8	0.024	55.0	0.0032
Q-09	4-Feb-08	0.024	0.0007	6.7	0.029	41.0	0.0021
Q-09	3-Mar-08	0.029	0.001	6.8	0.023	65.0	0.0031
Q-09	7-Apr-08	0.031	0.0011	6.9	0.035	62.0	0.0047
Q-09	1-May-08	0.037	< 0.0005	6.5	0.032	20.0	0.0024
Q-09	4-Jun-08	0.084	0.0006	7.0	0.1	59.0	0.0033
Q-09	1-Jul-08	0.118	< 0.0005	6.7	0.11	40.0	0.0028
Q-09	12-Aug-08	0.121	< 0.0005	6.8	0.12	65.0	0.0043
Q-09	2-Sep-08	0.169	< 0.0005	6.9	0.16	110.0	0.0033
Q-09	1-Oct-08	0.152	< 0.0005	7.1	0.16	150.0	0.0048
Q-09	3-Nov-08	0.087	< 0.0005	6.9	0.085	74.0	0.0035
Q-09	1-Dec-08	0.039	0.0006	6.8	0.042	66.0	0.0029
Q-09	5-Jan-09	0.042	0.0008	7.0	0.038	69.0	0.0053

Appendix Table E.6: Water quality data for station Q-09, SRWMP 2005-2009.

Station	Date	Barium mg/L		Cobalt mg/L	pH pH units	Radium Bq/L	Sulphate mg/L	Uranium mg/L
Benchmark		**0.047**		**0.0009**	**6.3**	**1.0**	**100**	**0.005**
Q-09	3-Feb-09	0.035		0.0012	6.7	0.028	90.0	0.0028
Q-09	2-Mar-09	0.036		0.0008	6.8	0.032	78.0	0.0038
Q-09	6-Apr-09	0.042		0.0008	6.7	0.05	58.0	0.0057
Q-09	6-May-09	0.042	<	0.0005	6.8	0.048	19.0	0.0025
Q-09	2-Jun-09	0.056	<	0.0005	7.3	0.07	30.0	0.0024
Q-09	6-Jul-09	0.179	<	0.0005	7.0	0.18	58.0	0.0043
Q-09	6-Aug-09	0.163	<	0.0005	6.5	0.16	50.0	0.0029
Q-09	8-Sep-09	0.187	<	0.0005	7.0	0.2	100.0	0.0033
Q-09	5-Oct-09	0.141		0.0007	6.8	0.14	230.0	0.0095
Q-09	2-Nov-09	0.052	<	0.0005	7.0	0.035	40.0	0.0027
Q-09	7-Dec-09	0.036		0.0006	7.0	0.039	60.0	0.0022
Count		60		60	60	60	60	60
Minimum		0.024		0.0003	6.3	0.016	19.0	0.0006
Maximum		0.276		0.0013	7.3	0.210	370.0	0.0163
Mean		0.088		0.0007	6.9	0.085	84.6	0.0046
Median		0.049		0.0006	6.9	0.053	64.0	0.0038
10th Percentile		0.029		0.0005	6.7	0.024	39.8	0.0025

Note: Shaded values exceed benchmark.

Appendix Table E.7: Water quality data for station Q-20, SRWMP 2005-2009.

Station	Date	Barium mg/L	Cobalt mg/L	pH pH units	Radium Bq/L	Sulphate mg/L	Uranium mg/L
Benchmark		**0.047**	**0.0009**	**6.3**	**1.0**	**100**	**0.005**
Q-20	30-Sep-05	0.0181	0.0011	6.4	0.005	21.6	< 0.0005
Q-20	17-Oct-06	0.019	< 0.0005	6.9	< 0.005	21	< 0.0005
Q-20	21-Nov-07	0.0190	< 0.0005	6.8	< 0.005	22.0	< 0.0005
Q-20	7-Oct-08	0.0180	< 0.0005	7.0	< 0.005	22.0	< 0.0005
Q-20	8-Oct-09	0.019	< 0.0005	6.7	< 0.005	22.0	< 0.0005
Count		5	5	5	5	5	5
Minimum		0.018	0.0005	6.4	0.005	21.0	0.0005
Maximum		0.019	0.0011	7.0	0.005	22.0	0.0005
Mean		0.019	0.0006	6.8	0.005	21.7	0.0005
Median		0.019	0.0005	6.8	0.005	22.0	0.0005
10th Percentile		0.018	0.0005	6.5	0.005	21.2	0.0005

Note: Shaded values exceed benchmark.

Appendix Table E.8: Water quality data for station SC-01, SRWMP 2005-2009.

Station	Date	Barium mg/L	Cobalt mg/L	Iron mg/L	pH pH units	Radium Bq/L	Sulphate mg/L	Uranium mg/L
Benchmark		**0.047**	**0.0009**	**0.47**	**6.3**	**1.0**	**100**	**0.005**
SC-01	8-Jun-05	0.0263	0.0202	0.316	4.8	0.12	59.2	0.0009
SC-01	17-Aug-05	0.0291	0.0145	0.204		0.13	58.6	0.0006
SC-01	7-Sep-05	0.0314	0.0126	0.193		0.15	62.5	< 0.0005
SC-01	5-Oct-05	0.0238	0.0062	0.17		0.13	67.6	< 0.0005
SC-01	9-Nov-05	0.0223	0.0049	0.227		0.12	58.5	< 0.0005
SC-01	21-Dec-05	0.0254	0.0058	0.309		0.095	58.8	< 0.0005
SC-01	9-Mar-06	0.032	0.0063	0.46	6.4	0.085	69	0.0004
SC-01	6-Apr-06	0.0175	0.00218	0.1	5.9	0.026	15	0.00013
SC-01	28-Apr-06	0.0201	0.00236	0.32	6.5		38	0.0002
SC-01	16-May-06	0.0171	0.00119	0.22	7.3	0.03	36	0.0002
SC-01	19-Jun-06	0.0144	0.00039	0.32	6.8	< 0.01	37	0.00022
SC-01	18-Oct-06	0.011	< 0.0005	0.38	7.1	0.015	35	< 0.0005
SC-01	22-Nov-06	0.012	< 0.0005	0.32	6.6	0.013	33	< 0.0005
SC-01	15-Nov-07	0.011	0.001	0.18	7.2	0.013	32.0	< 0.0005
SC-01	19-Nov-08	0.012	< 0.0005	0.21	7.3	0.012	33.0	< 0.0005
SC-01	21-Oct-09	0.01	< 0.0005	0.12	6.7	0.006	25.0	< 0.0005
Count		16	16	16	11	15	16	16
Minimum		0.010	0.0004	0.10	4.8	0.006	15.0	0.0001
Maximum		0.032	0.0202	0.46	7.3	0.150	69.0	0.0009
Mean		0.020	0.0050	0.25	6.6	0.064	44.9	0.0004
Median		0.019	0.0023	0.22	6.7	0.030	37.5	0.0005
10th Percentile		0.011	0.0005	0.15	5.9	0.011	28.5	0.0002

Note: Shaded values exceed benchmark.

Appendix Table E.9: Water quality data for station SR-01, SRWMP 2005-2009.

Station	Date	Barium mg/L		Cobalt mg/L	pH pH units	Radium Bq/L	Sulphate mg/L	Uranium mg/L
Benchmark		**0.047**		**0.0009**	**6.3**	**1.0**	**100**	**0.005**
SR-01	24-Sep-05	0.0416	<	0.0003		0.037	73.4	0.0023
SR-01	23-Oct-06	0.038	<	0.0005	7.3	0.028	55	0.0014
SR-01	22-Oct-07	0.04	<	0.0005	6.5	0.035	56.0	0.0013
SR-01	16-Oct-08	0.042	<	0.0005	6.8	0.028	54.0	0.0015
SR-01	20-Oct-09	0.039	<	0.0005	6.9	0.026	47.0	0.0015
Count		5		5	4	5	5	5
Minimum		0.038		0.0003	6.5	0.026	47.0	0.0013
Maximum		0.042		0.0005	7.3	0.037	73.4	0.0023
Mean		0.040		0.0005	6.9	0.031	57.1	0.0016
Median		0.040		0.0005	6.9	0.028	55.0	0.0015
10th Percentile		0.038		0.0004	6.6	0.027	49.8	0.0013

Note:Shaded values exceed benchmark.

Appendix Table E.10: Water quality data for station SR-06, SRWMP 2005-2009.

Station	Date	Barium mg/L	Cobalt mg/L	pH pH units	Radium Bq/L	Sulphate mg/L	Uranium mg/L
Benchmark		**0.047**	**0.0009**	**6.3**	**1.0**	**100**	**0.005**
SR-06	19-May-05	0.0499	< 0.0003	6.8	0.025	180	0.0015
SR-06	1-Nov-05	0.0694	< 0.0003	7	0.04	178	0.0014
SR-06	16-May-06	0.0584	0.00009	7.2	0.035	120	0.00122
SR-06	22-Nov-06	0.076	< 0.0005	6.8	0.046	130	0.0013
SR-06	10-May-07	0.0770	< 0.0005	6.3	0.043	120.0	0.0014
SR-06	7-Nov-07	0.0730	< 0.0005	6.5	0.046	120.0	0.0012
SR-06	15-May-08	0.0820	< 0.0005	7.0	0.038	88.0	0.0012
SR-06	6-Oct-08	0.1730	< 0.0005	7.2	0.054	100.0	0.0014
SR-06	26-May-09	0.1740	< 0.0005	6.7	0.056	100.0	0.0012
SR-06	15-Oct-09	0.183	< 0.0005	7.5	0.072	98.0	0.0013
Count		10	10	10	10	10	10
Minimum		0.050	0.0001	6.3	0.025	88.0	0.0012
Maximum		0.183	0.0005	7.5	0.072	180.0	0.0015
Mean		0.102	0.0004	6.9	0.046	123.4	0.0013
Median		0.077	0.0005	6.9	0.045	120.0	0.0013
10th Percentile		0.058	0.0003	6.5	0.034	97.0	0.0012

Note: Shaded values exceed benchmark.

Appendix Table E.11: Water quality data for station SR-08, SRWMP 2005-2009.

Station	Date	Barium mg/L	Cobalt mg/L	pH pH units	Radium Bq/L	Sulphate mg/L	Uranium mg/L
Benchmark		**0.047**	**0.0009**	**6.3**	**1.0**	**100**	**0.005**
SR-08	17-Jan-05	0.0334	< 0.0003	6.9	0.067	208	0.0013
SR-08	21-Feb-05	0.0329	0.0005	6.5	0.1	206	0.0012
SR-08	21-Mar-05	0.0274	< 0.0003	6.6	0.052	210	0.0014
SR-08	18-Apr-05	0.0213	0.0006	6.2	0.072	101	0.0009
SR-08	16-May-05	0.0229	< 0.0003	6.9	0.05	172	0.0014
SR-08	20-Jun-05	0.0248	< 0.0003	7.3	0.058	192	0.0031
SR-08	18-Jul-05	0.0256	0.0004	6.9	0.062	195	0.0019
SR-08	15-Aug-05	0.0234	< 0.0003	6.9	0.049	207	0.0022
SR-08	19-Sep-05	0.026	< 0.0003	6.9	0.063	224	0.0026
SR-08	17-Oct-05	0.0217	< 0.0003	7.1	0.061	241	0.0019
SR-08	21-Nov-05	0.0213	0.0003	7	0.053	214	0.0018
SR-08	12-Dec-05	0.0252	0.0004	7	0.048	229	0.0026
SR-08	16-Jan-06	0.028	< 0.0003	6.7	0.048	240	0.0013
SR-08	20-Feb-06	0.03	< 0.0003	7.1	0.039	240	0.0013
SR-08	20-Mar-06	0.028	< 0.0003	6.8	0.042	210	0.0012
SR-08	17-Apr-06	0.0155	0.00049	6.9	0.038	93	0.00073
SR-08	15-May-06	0.0219	0.00014	7.5	0.038	180	0.00108
SR-08	19-Jun-06	0.0217	0.00021	7.5	0.037	210	0.00124
SR-08	17-Jul-06	0.025	< 0.0003	7.4	0.041	220	0.0012
SR-08	14-Aug-06	0.023	< 0.0005	6.4	0.034	220	0.0013
SR-08	18-Sep-06	0.024	< 0.0005	6.8	0.04	220	0.0015
SR-08	16-Oct-06	0.024	< 0.0005	7.2	0.054	210	0.0016
SR-08	16-Nov-06	0.023	< 0.0005	7.6	0.044	240	0.0014
SR-08	11-Dec-06	0.025	< 0.0005	7.3	0.04	250	0.0014
SR-08	15-Jan-07	0.0200	0.0005	7.3	0.039	200.0	0.0010
SR-08	19-Feb-07	0.0200	< 0.0005	6.9	0.024	190.0	0.0010
SR-08	15-Mar-07	0.0200	< 0.0005	6.9	0.034	210.0	0.0010
SR-08	16-Apr-07	0.0170	< 0.0005	6.6	0.035	140.0	0.0008
SR-08	14-May-07	0.0200	< 0.0005	6.9	0.033	190.0	0.0010
SR-08	18-Jun-07	0.0200	< 0.0005	6.9	0.035	200.0	0.0012
SR-08	16-Jul-07	0.0210	< 0.0005	7.2	0.036	210.0	0.0013
SR-08	20-Aug-07	0.0190	< 0.0005	7.2	0.038	230.0	0.0015
SR-08	17-Sep-07	0.0170	< 0.0005	6.9	0.026	100.0	0.0006
SR-08	11-Oct-07	0.022	< 0.0005	6.8	0.042	120.0	0.001
SR-08	19-Nov-07	0.023	< 0.0005	7.0	0.045	240.0	0.0017
SR-08	17-Dec-07	0.023	< 0.0005	6.9	0.038	240.0	0.0017
SR-08	21-Jan-08	0.019	< 0.0005	6.8	0.038	210.0	0.0014
SR-08	19-Feb-08	0.017	0.0007	6.8	0.025	170.0	0.0013
SR-08	18-Mar-08	0.02	0.0005	6.8	0.04	200.0	0.0012
SR-08	21-Apr-08	0.015	0.0005	6.7	0.027	250.0	0.001
SR-08	20-May-08	0.018	< 0.0005	7.0	0.031	190.0	0.0012
SR-08	16-Jun-08	0.018	< 0.0005	7.0	0.027	190.0	0.0012
SR-08	14-Jul-08	0.019	< 0.0005	6.9	0.029	200.0	0.0013
SR-08	18-Aug-08	0.021	< 0.0005	7.0	0.031	200.0	0.0012
SR-08	15-Sep-08	0.021	< 0.0005	7.6	0.045	220.0	0.0016
SR-08	2-Oct-08	0.021	< 0.0005	7.1	0.028	220.0	0.0017
SR-08	18-Nov-08	0.021	< 0.0005	7.1	0.043	240.0	0.0018
SR-08	16-Dec-08	0.023	< 0.0005	6.8	0.036	240.0	0.0016
SR-08	21-Jan-09	0.02	< 0.0005	7.0	0.041	240.0	0.0014

Appendix Table E.11: Water quality data for station SR-08, SRWMP 2005-2009.

Station	Date	Barium mg/L		Cobalt mg/L	pH pH units	Radium Bq/L	Sulphate mg/L	Uranium mg/L
Benchmark		**0.047**		**0.0009**	**6.3**	**1.0**	**100**	**0.005**
SR-08	17-Feb-09	0.02	<	0.0005	6.8	0.044	230.0	0.0014
SR-08	16-Mar-09	0.02	<	0.0005	6.8	0.037	220.0	0.0014
SR-08	7-Apr-09	0.019		0.0005	6.7	0.045	170.0	0.0012
SR-08	19-May-09	0.02	<	0.0005	6.8	0.034	190.0	0.0012
SR-08	15-Jun-09	0.021	<	0.0005	6.8	0.036	210.0	0.0012
SR-08	20-Jul-09	0.02	<	0.0005	6.9	0.027	210.0	0.0014
SR-08	17-Aug-09	0.018	<	0.0005	7.1	0.021	220.0	0.0014
SR-08	10-Sep-09	0.034	<	0.0005	7.3	0.037	220.0	0.0013
SR-08	19-Oct-09	0.014	<	0.0005	7.1	0.033	210.0	0.0011
SR-08	16-Nov-09	0.02	<	0.0005	7.3	0.028	230.0	0.0014
SR-08	3-Dec-09	0.02	<	0.0005	6.7	0.04	210.0	0.0013
Count		60		60	60	60	60	60
Minimum		0.014		0.0001	6.2	0.021	93.0	0.0006
Maximum		0.034		0.0007	7.6	0.100	250.0	0.0031
Mean		0.022		0.0005	7.0	0.041	204.9	0.0014
Median		0.021		0.0005	6.9	0.039	210.0	0.0013
10th Percentile		0.018		0.0003	6.7	0.027	170.0	0.0010

Note: Shaded values exceed benchmark.

Appendix Table E.12: Field measurements collected at lake stations, SRWMP 2009.

Lake	Station	Depth	Secchi Depth	Temperature	Dissolved Oxygen		pH	Conductivity
		m	m	ºC	mg/L	% saturation	pH units	uS/cm
Reference								
Dunlop (DUL)	1	14.6	7.00	10.05	8.41	74.6	5.22	.
	2	14.8	7.55	10.85	10.38	94.0	4.94	.
	3	14.5	7.55	9.92	10.10	89.5	4.90	.
	4	14.5	7.40	9.85	10.35	91.5	4.98	.
	5	14.6	7.20	9.57	9.24	80.9	5.21	.
Ten Mile (TML)	1	16.5	11.00	8.60	15.02	128.8	5.49	.
	2	17.8	10.60	8.69	15.51	132.5	5.99	.
	3	17.1	10.00	10.13	14.75	131.1	5.51	.
	4	17.1	10.65	8.61	15.41	132.8	5.82	.
	5	17.7	11.60	8.70	15.64	134.2	6.20	.
Rochester (RL)	1	14.7	4.72	6.60	5.65	46.6	5.24	15.2
	2	14.5	4.71	5.90	4.03	32.4	4.38	15.3
	3	14.2	4.15	5.20	2.96	23.8	5.27	17.0
	4	14.4	4.15	5.10	2.20	17.6	5.21	17.7
	5	14.6	4.43	6.40	3.90	32.5	5.29	15.5
Summers (SUL)	1	14.9	6.95	6.90	8.94	73.6	4.69	12.0
	2	15.0	7.46	6.70	8.85	72.3	4.73	12.1
	3	14.7	7.16	8.20	7.71	65.9	5.38	12.4
	4	14.9	6.88	9.00	4.85	42.4	4.78	13.7
	5	14.6	6.80	7.90	6.84	58.0	4.10	12.6
Semiwhite (SL)	1	14.5	6.80	8.33	9.20	78.4	5.06	.
	2	14.5	7.15	8.40	9.39	80.1	4.51	.
	3	14.2	8.50	8.85	9.07	78.3	5.20	.
	4	14.7	7.22	8.96	9.88	85.7	4.95	.
	5	14.5	7.54	8.42	9.46	82.2	5.12	.
Exposed								
Quirke (QL)	1	20.5	11.50	7.42	14.72	122.6	5.75	.
	2	17.7	7.75	7.02	12.33	101.7	5.19	.
	3	20.1	8.50	9.63	13.15	115.9	6.13	.
	4	20.5	11.50	6.79	15.20	124.4	5.66	.
	5	22.7	9.85	10.51	13.52	123.1	5.62	.
Elliott (EL)	1	14.7	5.25	8.96	8.51	73.5	5.48	87.0
	2	14.6	5.68	9.76	8.52	75.0	5.15	.
	3	15.0	5.88	8.86	7.80	67.3	5.00	74.0
	4	15.3	5.90	8.71	9.04	78.1	5.53	66.0
	5	14.8	5.65	10.48	9.10	81.5	6.27	59.0
Hough (HOL)	1	14.3	7.63	8.20	7.44	63.6	6.83	110.4
	2	14.5	8.91	8.30	6.84	57.7	.	110.7
	3	15.5	7.55	7.80	7.36	62.7	6.28	109.2
	4	15.3	7.84	8.20	7.17	62.5	6.33	110.1
	5	14.2	7.95	8.50	7.61	65.3	6.28	111.0
May (MAL)	1	14.5	7.85	8.70	7.98	70.7	6.32	125.8
	2	14.3	6.61	7.60	8.67	72.5	.	136.8
	3	14.6	7.50	7.50	8.86	74.5	6.53	137.8
	4	14.3	7.53	7.70	8.63	75.3	6.42	136.5
	5	14.3	8.26	7.60	8.74	73.0	6.43	138.2

Appendix Table E.12: Field measurements collected at lake stations, SRWMP 2009.

Lake	Station	Depth	Secchi Depth	Temperature	Dissolved Oxygen		pH	Conductivity
Exposed								
McCabe (ML)	1	14.6	6.40	10.15	9.17	81.6	6.29	.
	2	14.7	6.65	10.76	8.51	75.8	6.45	.
	3	14.1	6.63	12.15	6.44	60.1	6.58	.
	4	15.1	6.66	11.10	8.93	81.3	6.62	.
	5	14.6	6.66	9.68	8.10	72.2	6.54	.
McCarthy (MCL)	1	14.9	5.67	7.00	6.96	58.2	6.13	67.5
	2	14.8	5.46	7.10	2.81	23.4	5.61	70.1
	3	14.5	5.39	8.10	6.11	52.4	6.96	80.4
	4	14.4	5.88	8.20	5.14	44.9	5.91	70.0
	5	14.6	5.86	8.30	6.21	53.1	5.82	80.1
Nordic (NL)	1	12.5	7.45	8.60	4.74	41.1	6.63	435.6
	2	14.8	6.88	7.30	6.51	54.4	6.37	424.1
	3	14.2	7.58	7.90	7.30	61.9	6.58	427.4
	4	14.3	7.30	8.00	6.70	57.3	6.61	428.8
	5	14.8	8.42	6.60	6.27	51.6	6.43	424.4
Pecors (PL)	1	13.7	6.75	10.80	8.07	72.9	.	89.6
	2	14.8	7.88	7.10	7.46	61.4	7.00	88.7
	3	13.5	8.36	7.50	7.51	63.3	6.85	88.2
	4	14.4	8.50	7.40	8.10	67.2	.	88.4
	5	14.5	6.78	9.50	8.16	71.6	.	87.7

Appendix Table E.13: Summary of seasonal trends for station D-4, 2000 to 2009.

Season	Spearman rho	Barium	Iron	Manganese	pH	Sulphate
April	Correlation Coefficient	0.162169	0.691023	0.684712472	0.236403	-0.785714
	Sig. (2-tailed)	0.7283	0.08557	0.089666453	0.60979	0.036238
	N	7	7	7	7	7
Sept/Oct	Correlation Coefficient	0.167668	0.604392	0.562884343	-0.351573	-0.426782
	Sig. (2-tailed)	0.691465	0.084721	0.146331533	0.393106	0.251957
	N	8	9	8	8	9

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

"ns" denotes not significant.

[shaded box] Significant trend where $p<0.05$.

Appendix Table E.14: Summary of seasonal trends for station P-22, 2000 to 2009.

Season	Spearman rho	Barium	pH	Sulphate
March/May	Correlation Coefficient	0.68103286	-0.106302	-0.20060883
	Sig. (2-tailed)	0.03015088	0.770074	0.578406145
	N	10	10	10
Sept/Oct/Nov	Correlation Coefficient	0.18845072	0.030395	-0.83030303
	Sig. (2-tailed)	0.60209475	0.933572	0.002940227
	N	10	10	10

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

"ns" denotes not significant.

[shaded box] Significant trend where p<0.05.

Appendix Table E.15: Summary of seasonal trends for station SR-05, 2000 to 2009.

Season	Spearman rho	Barium	pH	Sulphate
January	Correlation Coefficient	-0.018406	-0.054711	-0.668696098
	Sig. (2-tailed)	0.95975	0.880676	0.034509542
	N	10	10	10
February	Correlation Coefficient	0.050855	0.066946	-0.786617764
	Sig. (2-tailed)	0.896623	0.864127	0.011909212
	N	9	9	9
March	Correlation Coefficient	0.443898	-0.118661	-0.376572334
	Sig. (2-tailed)	0.231337	0.761084	0.317822682
	N	9	9	9
May	Correlation Coefficient	0.06749	0.067074	-0.951515152
	Sig. (2-tailed)	0.853037	0.853933	2.27985E-05
	N	10	10	10
June	Correlation Coefficient	-0.267478	0.413376	-0.903030303
	Sig. (2-tailed)	0.454986	0.235062	0.000343612
	N	10	10	10
July	Correlation Coefficient	-0.335372	-0.07528	-0.857146817
	Sig. (2-tailed)	0.343468	0.836255	0.00152784
	N	10	10	10
August	Correlation Coefficient	-0.21541	0.460157	-0.890909091
	Sig. (2-tailed)	0.550053	0.180833	0.000542144
	N	10	10	10
September	Correlation Coefficient	0.468979	0.356965	-0.844988706
	Sig. (2-tailed)	0.171528	0.311263	0.002085797
	N	10	10	10
October	Correlation Coefficient	-0.218857	0.268298	-0.757575758
	Sig. (2-tailed)	0.54353	0.453553	0.011143447
	N	10	10	10
November	Correlation Coefficient	-0.061546	-0.69697	-0.796356262
	Sig. (2-tailed)	0.865877	0.025097	0.005836997
	N	10	10	10

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

"ns" denotes not significant.

Significant trend where p<0.05.

Appendix Table E.16: Summary of seasonal trends for station SR-14, 2000 to 2009.

Season	Spearman rho	Barium	pH	Sulphate
Sept/Oct/Nov	Correlation Coefficient	-0.21474	0.024316	-0.607906
	Sig. (2-tailed)	ns	ns	ns
	N	10	10	10

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

"ns" denotes not significant.

(shaded cell)	Significant trend where p<0.05.

Appendix Table E.17: Summary of seasonal trends for station SR-18, 2003 to 2009.

Season	Spearman's rho	Barium	pH	Sulphate
April	Correlation Coefficient	-0.522544	0.522544	-0.75
	Sig. (2-tailed)	0.228878	0.228878	0.052181
	N	7	7	7
Sept/Oct combined	Correlation Coefficient	0.324337	0.056136	-0.691023
	Sig. (2-tailed)	0.477885	0.904851	0.08557
	N	7	7	7

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

"ns" denotes not significant.

[shaded box] Significant trend where p<0.05.

Appendix Table E.18: Summary of seasonal trends for station SR-19, 2003 to 2009.

Season	Spearman rho	Barium	pH	Sulphate
January	Correlation Coefficient	-0.857143	-0.218218	-0.936975
	Sig. (2-tailed)	0.013697	0.638299	0.00185103
	N	7	7	7
February	Correlation Coefficient	-0.357143	-0.059108	-0.7142857
	Sig. (2-tailed)	0.431611	0.89983	0.07134356
	N	7	7	7
March	Correlation Coefficient	-0.270281	-0.545545	-0.8214286
	Sig. (2-tailed)	0.557731	0.205282	0.02344881
	N	7	7	7
April	Correlation Coefficient	0.306319	0.872872	0.25226249
	Sig. (2-tailed)	0.504027	0.010323	0.58524109
	N	7	7	7
May	Correlation Coefficient	-0.571429	-0.306319	-0.6785714
	Sig. (2-tailed)	0.180202	0.504027	0.09375025
	N	7	7	7
June	Correlation Coefficient	0	-0.702731	-0.6785714
	Sig. (2-tailed)	1	0.078237	0.09375025
	N	7	7	7
July	Correlation Coefficient	0.035714	-0.054056	-0.4144312
	Sig. (2-tailed)	0.939408	0.908365	0.35526894
	N	7	7	7
August	Correlation Coefficient	-0.270281	0.5766	-0.8214286
	Sig. (2-tailed)	0.557731	0.175382	0.02344881
	N	7	7	7
September	Correlation Coefficient	-0.738769	0.763763	-0.7027312
	Sig. (2-tailed)	0.057858	0.045659	0.07823745
	N	7	7	7
October	Correlation Coefficient	0.090094	0.630656	-0.2857143
	Sig. (2-tailed)	0.847672	0.128888	0.53450923
	N	7	7	7
November	Correlation Coefficient	0.607143	0.270281	-0.4285714
	Sig. (2-tailed)	0.148231	0.557731	0.33736831
	N	7	7	7
December	Correlation Coefficient	-0.270281	-0.18712	-0.72075
	Sig. (2-tailed)	0.557731	0.687867	0.06763499
	N	7	7	7

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

"ns" denotes not significant.

Significant trend where p<0.05.

Appendix Table E.19: Summary of seasonal trends for station D-5, 2000 to 2009.

Season	Spearman rho	Barium	Iron	Manganese	pH	Radium-226	Sulphate	Uranium
January	Correlation Coefficient	0.35259	0.01824	-0.260606061	0.22843	-0.200608829	-0.1337392	0.1030303
	Sig. (2-tailed)	0.31766	0.96012	0.467089054	0.52557	0.578406145	0.71262222	0.7769985
	N	10	10	10	10	10	10	10
February	Correlation Coefficient	-0.00606	0.40245	-0.539393939	-0.40363	-0.757575758	-0.5714312	-0.270801
	Sig. (2-tailed)	0.98674	0.24891	0.107593188	0.24739	0.011143447	0.08441186	0.4491852
	N	10	10	10	10	10	10	10
March	Correlation Coefficient	-0.05471	0.59575	-0.696969697	0.33131	-0.454545455	-0.4559292	-0.188451
	Sig. (2-tailed)	0.88068	0.06916	0.025096676	0.3497	0.18690481	0.18539676	0.6020948
	N	10	10	10	10	10	10	10
April	Correlation Coefficient	0.29697	0.4303	0.212121212	0.30582	0.553194045	0.16363636	0.6242424
	Sig. (2-tailed)	0.4047	0.21449	0.556305775	0.39015	0.097168791	0.65147734	0.0537178
	N	10	10	10	10	10	10	10
May	Correlation Coefficient	-0.22424	0.38415	-0.393939394	0.11113	-0.36969697	-0.6484848	0.3829805
	Sig. (2-tailed)	0.5334	0.27308	0.259997767	0.75988	0.293050075	0.04254013	0.274673
	N	10	10	10	10	10	10	10
June	Correlation Coefficient	-0.52727	-0.44985	-0.158055441	0.43286	-0.609767433	-0.547115	-0.620064
	Sig. (2-tailed)	0.11731	0.19208	0.662762297	0.21148	0.061239771	0.10167803	0.0558226
	N	10	10	10	10	10	10	10
July	Correlation Coefficient	-0.35758	-0.61968	-0.187878788	-0.29389	-0.844988706	-0.3454545	-0.725623
	Sig. (2-tailed)	0.31038	0.05602	0.60321761	0.40982	0.002085797	0.32822651	0.0175281
	N	10	10	10	10	10	10	10
August	Correlation Coefficient	-0.89091	-0.74772	-0.036474333	-0.39513	-0.818181818	-0.6848485	-0.717329
	Sig. (2-tailed)	0.00054	0.0129	0.92031846	0.25843	0.00381492	0.0288828	0.0195283
	N	10	10	10	10	10	10	10
September	Correlation Coefficient	-0.50303	-0.88416	-0.575757576	0.28747	-0.624242424	-0.6727273	-0.672727
	Sig. (2-tailed)	0.13833	0.00068	0.081552815	0.42059	0.053717767	0.03304122	0.0330412
	N	10	10	10	10	10	10	10
October	Correlation Coefficient	0.6	-0.40122	-0.322189938	-0.18749	0.151976386	-0.2242424	-0.224242
	Sig. (2-tailed)	0.06669	0.2505	0.363927076	0.60399	0.675124332	0.53340056	0.5334006
	N	10	10	10	10	10	10	10
November	Correlation Coefficient	0.04242	-0.10366	-0.662617043	-0.23928	-0.21276694	-0.1515152	-0.258492
	Sig. (2-tailed)	0.90736	0.77566	0.036806402	0.50552	0.555075996	0.67606518	0.4708403
	N	10	10	10	10	10	10	10
December	Correlation Coefficient	-0.21212	-0.231	-0.778119096	-0.31487	-0.670744177	-0.6686961	-0.741645
	Sig. (2-tailed)	0.55631	0.52079	0.008033138	0.37555	0.033758137	0.03450954	0.0140752
	N	10	10	10	10	10	10	10

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

"ns" denotes not significant.

(shaded) Significant trend where p<0.05.

Appendix Table E.20: Summary of seasonal trends for station D-6, 2000 to 2009.

Season	Spearman rho	Barium	Iron	Manganese	pH	Radium-226	Sulphate
January	Correlation Coefficient	-0.39757	-0.18788	-0.236363636	-0.51243	-0.369786998	-0.490909
	Sig. (2-tailed)	0.25523	0.60322	0.510885318	0.12992	0.292923368	0.1496557
	N	10	10	10	10	10	10
February	Correlation Coefficient	0.49848	0.51064	0.284848485	-0.63416	-0.190128171	-0.656538
	Sig. (2-tailed)	0.14252	0.1315	0.425038155	0.04894	0.598805795	0.0392044
	N	10	10	10	10	10	10
March	Correlation Coefficient	-0.43161	0.75758	0.090909091	0.10037	-0.224899695	-0.006061
	Sig. (2-tailed)	0.21295	0.01114	0.802771731	0.78263	0.532169527	0.9867429
	N	10	10	10	10	10	10
April	Correlation Coefficient	-0.27609	0.17576	0.182371663	0.50924	-0.412356495	-0.583589
	Sig. (2-tailed)	0.44001	0.62719	0.614067751	0.13274	0.236334758	0.0765377
	N	10	10	10	10	10	10
May	Correlation Coefficient	-0.32318	-0.22493	-0.296969697	0.21952	-0.765563379	-0.563636
	Sig. (2-tailed)	0.36237	0.53212	0.404701671	0.54229	0.009848581	0.089724
	N	10	10	10	10	10	10
June	Correlation Coefficient	-0.40606	0.10303	0.03030303	0.43562	-0.059005294	-0.589668
	Sig. (2-tailed)	0.24428	0.777	0.933772958	0.20826	0.871374368	0.0727859
	N	10	10	10	10	10	10
July	Correlation Coefficient	-0.03571	0.39286	0.142857143	0.72075	0	-0.142857
	Sig. (2-tailed)	0.93941	0.38332	0.7599453	0.06763	1	0.7599453
	N	7	7	7	7	7	7
August	Correlation Coefficient	-0.07207	0.57143	-0.071428571	-0.03858	-0.450468731	-0.142857
	Sig. (2-tailed)	0.87796	0.1802	0.879048193	0.93456	0.310429302	0.7599453
	N	7	7	7	7	7	7
September	Correlation Coefficient	0.31429	0.77143	0.314285714	0.88041	0.029424494	-0.085714
	Sig. (2-tailed)	0.54409	0.0724	0.544093294	0.0206	0.955875996	0.8717434
	N	6	6	6	6	6	6
October	Correlation Coefficient	0.79499	0.61088	0.166666667	-0.11918	0.502096445	0.5333333
	Sig. (2-tailed)	0.01044	0.08054	0.66823104	0.76007	0.168397435	0.1392269
	N	9	9	9	9	9	9
November	Correlation Coefficient	-0.08368	-0.11667	-0.433333333	-0.57635	-0.710496168	0.2092069
	Sig. (2-tailed)	0.83051	0.76501	0.243952436	0.10429	0.031939472	0.5890472
	N	9	9	9	9	9	9
December	Correlation Coefficient	-0.5228	-0.21212	-0.612121212	-0.5672	-0.703272404	-0.413376
	Sig. (2-tailed)	0.12103	0.55631	0.059972142	0.08727	0.023269515	0.235062
	N	10	10	10	10	10	10

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

"ns" denotes not significant.

(shaded box) Significant trend where p<0.05.

Appendix Table E.21: Summary of seasonal trends for station DS-18, 2000 to 2009.

Season	Spearman rho	Barium	Iron	Manganese	pH	Radium-226	Sulphate	Uranium
January	Correlation Coefficient	0.18237	0.73333	0.054545455	-0.38895	-0.534956878	0.06666667	-0.2317116
	Sig. (2-tailed)	0.61407	0.0158	0.881036181	0.26663	0.11108833	0.85481309	0.5194793
	N	10	10	10	10	10	10	10
February	Correlation Coefficient	0.38906	0.84242	-0.418181818	-0.63591	-0.371958134	0.12727273	-0.0186989
	Sig. (2-tailed)	0.26648	0.00222	0.229112841	0.04812	0.289876582	0.72605701	0.95911037
	N	10	10	10	10	10	10	10
March	Correlation Coefficient	-0.30909	0.39394	-0.563636364	0.15291	-0.49240349	-0.2242424	-0.7575758
	Sig. (2-tailed)	0.38484	0.26	0.089724028	0.67322	0.148230415	0.53340056	0.01114345
	N	10	10	10	10	10	10	10
April	Correlation Coefficient	-0.01818	0.28485	-0.43030303	-0.00627	-0.863225872	-0.4741663	-0.2317116
	Sig. (2-tailed)	0.96024	0.42504	0.214492333	0.98628	0.001293815	0.16619193	0.5194793
	N	10	10	10	10	10	10	10
May	Correlation Coefficient	0.58967	0.52727	-0.024316222	0.16052	-0.486324435	-0.6606061	0.1590281
	Sig. (2-tailed)	0.07279	0.11731	0.946839705	0.65777	0.154079965	0.03758838	0.66079105
	N	10	10	10	10	10	10	10
June	Correlation Coefficient	-0.33333	0.53939	-0.27963655	0.22628	-0.774136285	-0.5757576	-0.3865322
	Sig. (2-tailed)	0.34659	0.10759	0.43392584	0.52959	0.00858089	0.08155281	0.26986858
	N	10	10	10	10	10	10	10
July	Correlation Coefficient	-0.57576	0.22424	-0.231004107	-0.06314	-0.978727925	-0.5272727	-0.0487814
	Sig. (2-tailed)	0.08155	0.5334	0.520791533	0.86242	0.000001	0.11730807	0.89354426
	N	10	10	10	10	10	10	10
August	Correlation Coefficient	-0.47417	0.33333	-0.660578259	-0.32411	-0.963262697	-0.4863244	-0.2500046
	Sig. (2-tailed)	0.16619	0.34659	0.037599266	0.3609	7.6231E-06	0.15407997	0.48603365
	N	10	10	10	10	10	10	10
September	Correlation Coefficient	-0.25234	0.18237	-0.393939394	0.21474	-0.874654547	-0.5151515	-0.0243907
	Sig. (2-tailed)	0.48184	0.61407	0.259997767	0.55132	0.00092586	0.12755287	0.94667708
	N	10	10	10	10	10	10	10
October	Correlation Coefficient	-0.6687	-0.03647	-0.757575758	0.11843	-0.820672484	-0.9030303	-0.1272727
	Sig. (2-tailed)	0.03451	0.92032	0.011143447	0.74454	0.003621706	0.00034361	0.72605701
	N	10	10	10	10	10	10	10
November	Correlation Coefficient	0.15854	-0.15806	-0.48024538	-0.02493	-0.378055809	-0.4724282	-0.5169843
	Sig. (2-tailed)	0.66178	0.66276	0.16006701	0.9455	0.281411116	0.16796856	0.12596958
	N	10	10	10	10	10	10	10
December	Correlation Coefficient	-0.13982	0.54605	0.333333333	-0.43835	-0.478787879	-0.662617	-0.617763
	Sig. (2-tailed)	0.70006	0.10248	0.346593507	0.20509	0.161522928	0.0368064	0.05700443
	N	10	10	10	10	10	10	10

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

"ns" denotes not significant.

Significant trend where p<0.05.

Appendix Table E.22: Summary of seasonal trends for station M-01, 2000 to 2009.

Season	Spearman rho	Barium	Cobalt	Iron	pH	Radium-226	Sulphate	Uranium
January	Correlation Coefficient	-0.06079	-0.25	-0.21212	0.44928	-0.597572085	-0.6930123	0.407296714
	Sig. (2-tailed)	0.86751	0.48603	0.55631	0.1927	0.068089787	0.02629288	0.24271027
	N	10	10	10	10	10	10	10
February	Correlation Coefficient	-0.37806	-0.52929	-0.05455	0.32827	-0.790277207	-0.8181818	0.268297671
	Sig. (2-tailed)	0.28141	0.11565	0.88104	0.35442	0.006514224	0.00381492	0.453552732
	N	10	10	10	10	10	10	10
March	Correlation Coefficient	0.08511	-0.25078	0.26061	0.47562	-0.717328542	-0.4756186	0.753802874
	Sig. (2-tailed)	0.81517	0.48465	0.46709	0.16472	0.019528343	0.16471615	0.011794786
	N	10	10	10	10	10	10	10
April	Correlation Coefficient	-0.57143	-0.45069	-0.53939	0.41539	-0.603669759	-0.5393939	0.449850102
	Sig. (2-tailed)	0.08441	0.19114	0.10759	0.23256	0.064605278	0.10759319	0.192075697
	N	10	10	10	10	10	10	10
May	Correlation Coefficient	-0.21667	-0.26892	-0.56667	0.6514	-0.9	-0.4333333	-0.560674364
	Sig. (2-tailed)	0.57551	0.48412	0.11163	0.05735	0.000943062	0.24395244	0.116326795
	N	9	9	9	9	9	9	9
June	Correlation Coefficient	0.39286	-0.12729	0.55858	0.81084	-0.892857143	-0.6428571	0.642857143
	Sig. (2-tailed)	0.38332	0.78565	0.19245	0.02692	0.006807187	0.11939237	0.119392373
	N	7	7	7	7	7	7	7
July	Correlation Coefficient	-0.35714	0.0241	0.2381	0.35714	-0.666666667	-0.6904762	0.409668289
	Sig. (2-tailed)	0.38512	0.95483	0.57016	0.38512	0.070987654	0.05799032	0.313487214
	N	8	8	8	8	8	8	8
October	Correlation Coefficient	-0.2724	0.15526	0.16667	0.46169	-0.483333333	-0.7	-0.066666667
	Sig. (2-tailed)	0.47825	0.68998	0.66823	0.21091	0.187469855	0.03576957	0.864689785
	N	9	9	9	9	9	9	9
November	Correlation Coefficient	-0.49091	-0.09909	0.17576	0.08511	-0.32317674	-0.4787879	-0.509240789
	Sig. (2-tailed)	0.14966	0.78535	0.62719	0.81517	0.362374972	0.16152293	0.132742676
	N	10	10	10	10	10	10	10
December	Correlation Coefficient	-0.32121	-0.33141	0.04242	0.192	-0.672727273	-0.7212121	-0.115151515
	Sig. (2-tailed)	0.36547	0.34955	0.90736	0.59515	0.033041223	0.01857316	0.751419652
	N	10	10	10	10	10	10	10

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

"ns" denotes not significant.

[shaded box] Significant trend where $p<0.05$.

Appendix Table E.23: Summary of seasonal trends for station Q-09, 2000 to 2009.

Season	Spearman rho	Barium	Cobalt	pH	Radium-226	Sulphate	Uranium
January	Correlation Coefficient	-0.19453	-0.43903	-0.05628	-0.76969697	-0.7333333	-0.5272727
	Sig. (2-tailed)	0.59021	0.2043	0.87728	0.009221953	0.0158006	0.11730807
	N	10	10	10	10	10	10
February	Correlation Coefficient	0.49091	0.03659	-0.55936	-0.455929158	-0.3212121	-0.823186
	Sig. (2-tailed)	0.14966	0.92008	0.09272	0.185396764	0.3654683	0.00343394
	N	10	10	10	10	10	10
March	Correlation Coefficient	0.41464	-0.17073	0.11657	-0.660606061	-0.1030303	-0.7575758
	Sig. (2-tailed)	0.23349	0.63722	0.74843	0.037588378	0.7769985	0.01114345
	N	10	10	10	10	10	10
April	Correlation Coefficient	-0.15152	-0.23839	0.11767	0.006097674	-0.3575758	-0.030303
	Sig. (2-tailed)	0.67607	0.50717	0.74612	0.986661833	0.3103761	0.93377296
	N	10	10	10	10	10	10
May	Correlation Coefficient	-0.44242	-0.59024	0.01235	-0.672727273	-0.5030303	-0.1393939
	Sig. (2-tailed)	0.20042	0.07244	0.97299	0.033041223	0.1383337	0.70093188
	N	10	10	10	10	10	10
June	Correlation Coefficient	-0.07879	0.3371	0.42521	-0.2697529	-0.0545455	-0.2727273
	Sig. (2-tailed)	0.82872	0.34083	0.22057	0.451011775	0.8810362	0.44583834
	N	10	10	10	10	10	10
July	Correlation Coefficient	-0.18788	-0.76409	-0.06155	-0.680854209	-0.2969697	-0.218846
	Sig. (2-tailed)	0.60322	0.01008	0.86588	0.030211171	0.4047017	0.54355092
	N	10	10	10	10	10	10
August	Correlation Coefficient	-0.74545	0.06742	-0.69547	-0.589668377	-0.3939394	-0.4909091
	Sig. (2-tailed)	0.01333	0.85319	0.02555	0.072785937	0.2599978	0.14965567
	N	10	10	10	10	10	10
September	Correlation Coefficient	0.06667	-0.40837	0.01703	-0.217575126	-0.1166667	-0.6975036
	Sig. (2-tailed)	0.86469	0.27519	0.96533	0.573874658	0.7650079	0.03672232
	N	9	9	9	9	9	9
October	Correlation Coefficient	0.72121	-0.36111	-0.07409	0.326192451	0.3939394	0.5045616
	Sig. (2-tailed)	0.01857	0.30526	0.83882	0.357652225	0.2599978	0.13694197
	N	10	10	10	10	10	10
November	Correlation Coefficient	0.44242	-0.68279	-0.06487	-0.2	-0.4133758	-0.4060606
	Sig. (2-tailed)	0.20042	0.02956	0.85868	0.579584	0.235062	0.24428229
	N	10	10	10	10	10	10
December	Correlation Coefficient	0.12727	-0.29143	-0.30773	-0.291794661	-0.0181818	-0.7112495
	Sig. (2-tailed)	0.72606	0.41395	0.38705	0.413326603	0.9602404	0.02109093
	N	10	10	10	10	10	10

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

"ns" denotes not significant.

[shaded] Significant trend where p<0.05.

Appendix Table E.24: Summary of seasonal trends for station Q-20, 2000 to 2009.

Season	Spearman rho	Barium	pH	Radium-226	Sulphate
Sept/Oct/Nov	Correlation Coefficient	0.621612	0.581534	-0.833508753	-0.26382354
	Sig. (2-tailed)	ns	ns	<0.05	ns
	N	10	10	10	10

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

"ns" denotes not significant.

(shaded box) Significant trend where p<0.05.

Appendix Table E.25: Summary of seasonal trends for station SC-01, 2000 to 2009.

Season	Spearman rho	Barium	Iron	pH	Radium-226	Sulphate
October	Correlation Coefficient		0.285714			-0.14285714
	Sig. (2-tailed)		0.534509			0.7599453
	N		7			7
November	Correlation Coefficient	-0.36037	0.607143	0.654654	-0.738768719	0.0360375
	Sig. (2-tailed)	ns	0.148231	ns	ns	0.93886056
	N	7	7	7	7	7

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

"ns" denotes not significant.

Significant trend where $p<0.05$.

Appendix Table E.26: Summary of seasonal trends for station SR-01, 2000 to 2009.

Season	Spearman's rho	Barium	pH	Radium-226	Sulphate	Uranium
Sept/Oct	Correlation Coefficient	-0.2142857	0.1428571	-0.887037053	-0.96666667	-0.8451957
	Sig. (2-tailed)	ns	ns	<0.05	<0.001	<0.05
	N	7	7	9	9	9

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

"ns" denotes not significant.

[shaded box] Significant trend where p<0.05.

Appendix Table E.27: Summary of seasonal trends for station SR-06, 2000 to 2009.

Season	Spearman rho	Barium	pH	Radium-226	Sulphate	Uranium
May	Correlation Coefficient	1	-0.252338	0.376901437	-0.91185832	-0.95733487
	Sig. (2-tailed)	0.000	0.481837	0.283003365	0.000237144	1.37676E-05
	N	10	10	10	10	10
November	Correlation Coefficient	0.964286	-0.964286	0.414431233	-0.96428571	-1
	Sig. (2-tailed)	0.000454	0.000454	0.355268944	0.000454149	0.000001
	N	7	7	7	7	7

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

"ns" denotes not significant.

[shaded box] Significant trend where $p<0.05$.

Appendix Table E.28: Summary of seasonal trends for station SR-08, 2000 to 2009.

Season	Spearman rho	Barium	pH	Radium-226	Sulphate	Uranium
January	Correlation Coefficient	0.21277	-0.23461	-0.31611088	-0.6443799	-0.798795
	Sig. (2-tailed)	0.55508	0.51412	0.373561333	0.04431151	0.00558
	N	10	10	10	10	10
February	Correlation Coefficient	0.21277	-0.31487	-0.03039528	-0.8060606	-0.784198
	Sig. (2-tailed)	0.55508	0.37555	0.933571725	0.00486206	0.007245
	N	10	10	10	10	10
March	Correlation Coefficient	0.27609	0.42023	-0.43030303	-0.7323944	-0.697277
	Sig. (2-tailed)	0.44001	0.2266	0.214492333	0.01600434	0.025005
	N	10	10	10	10	10
April	Correlation Coefficient	0.13939	0.23243	-0.49090909	-0.0545455	-0.243162
	Sig. (2-tailed)	0.70093	0.51816	0.149655673	0.88103618	0.498434
	N	10	10	10	10	10
May	Correlation Coefficient	0.41945	-0.35586	-0.37690144	-0.7791998	-0.742387
	Sig. (2-tailed)	0.22755	0.31288	0.283003365	0.00788889	0.013928
	N	10	10	10	10	10
June	Correlation Coefficient	-0.01824	-0.21342	-0.26060606	-0.6930123	-0.865096
	Sig. (2-tailed)	0.96012	0.55384	0.467089054	0.02629288	0.001227
	N	10	10	10	10	10
July	Correlation Coefficient	0.05455	-0.00627	-0.84242424	-0.4316129	-0.847577
	Sig. (2-tailed)	0.88104	0.98628	0.002220031	0.21294529	0.001956
	N	10	10	10	10	10
August	Correlation Coefficient	-0.16364	0.06294	-0.70909091	-0.6322218	-0.8997
	Sig. (2-tailed)	0.65148	0.86287	0.021665923	0.0498461	0.000392
	N	10	10	10	10	10
September	Correlation Coefficient	0.58359	0.45544	-0.2969697	-0.5337825	-0.830303
	Sig. (2-tailed)	0.07654	0.18593	0.404701671	0.11202517	0.00294
	N	10	10	10	10	10
October	Correlation Coefficient	0.09091	-0.2539	-0.01823717	-0.2674784	-0.51672
	Sig. (2-tailed)	0.80277	0.47904	0.960119464	0.45498601	0.126197
	N	10	10	10	10	10
November	Correlation Coefficient	0.06079	-0.04893	-0.51515152	-0.3497196	-0.801257
	Sig. (2-tailed)	0.86751	0.89322	0.12755287	0.32188624	0.005329
	N	10	10	10	10	10
December	Correlation Coefficient	0.19453	-0.65036	-0.70517043	-0.547115	-0.857147
	Sig. (2-tailed)	0.59021	0.04175	0.022737737	0.10167803	0.001528
	N	10	10	10	10	10

Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

"ns" denotes not significant.

[shaded cell] Significant trend where $p<0.05$.

Appendix Table E.29: T-test results for comparison of 1999 and 2009 SRWMP parameters.

Lake		Barium		Cobalt		Iron		Manganese		Nickel		Uranium		Ra-226	
		mg/kg		mg/kg		mg/kg		mg/kg		mg/kg		mg/kg		Bq/g	
		2009	1999	2009	1999	2009	1999	2009	1999	2009	1999	2009	1999	2009	1999
Reference	**Mean**	177	126	14.5	12.7	26,340	24,011	2,057	1,674	20.8	23.2	3.8	4.4	0.12	0.05
	SD	142	49	6.5	5.1	13,260	15,012	2,266	2,413	4.2	5.1	1.3	1.2	0.07	0.02
	t-test	**0.298**		**0.454**		**0.665**		**0.672**		**0.168**		**0.203**		**0.004**	
Quirke	**Mean**	706	470	38.4	14.2	57,800	36,800	4,140	886	25.4	17.6	352	234	3.64	1.81
	SD	430	273	26.7	8.6	11,584	15,802	2,387	672	8.8	3.2	144	40	2.26	0.71
	t-test	**0.331**		**0.089**		**0.043**		**0.019**		**0.100**		**0.116**		**0.122**	
Elliott	**Mean**	218	207	74.0	99.7	52,000	58,667	10,760	12,333	53.6	68.7	170	213	1.59	1.56
	SD	65	80	14.1	30.0	9,460	28,937	6,163	7,024	5.4	16.6	40	12	0.36	0.80
	t-test	**0.833**		**0.142**		**0.638**		**0.750**		**0.098**		**0.125**		**0.944**	
Nordic	**Mean**	294	262	109.0	179.0	69,000	84,667	19,460	30,667	44.0	54.0	154	132	4.78	3.77
	SD	98	162	49.0	140.7	27,902	26,558	10,904	25,697	6.8	30.5	42	66	1.68	2.22
	t-test	**0.733**		**0.331**		**0.464**		**0.409**		**0.487**		**0.572**		**0.487**	
McCarthy	**Mean**	160	190	101.0	102.3	49,800	40,667	12,360	14,907	43.2	55.0	138	109	1.55	1.18
	SD	32	69	26.0	49.0	12,276	9,292	3,694	12,921	7.2	18.7	28	21	0.65	0.11
	t-test	**0.425**		**0.961**		**0.313**		**0.680**		**0.237**		**0.178**		**0.376**	
Hough	**Mean**	80	87	26.8	42.7	51,400	52,667	2,880	8,133	40.2	53.3	87	92	1.90	2.79
	SD	9	13	3.3	7.0	8,678	5,508	606	1,589	3.0	3.8	5	3	0.37	0.37
	t-test	**0.398**		**0.004**		**0.831**		**0.000**		**0.002**		**0.227**		**0.016**	
Pecors	**Mean**	98	79	40.0	47.0	33,400	29,667	3,060	3,233	35.4	37.0	114	125	0.67	0.77
	SD	18	41	4.2	18.7	10,359	13,503	1,387	2,542	6.5	14.9	11	28	0.21	0.37
	t-test	**0.381**		**0.431**		**0.672**		**0.902**		**0.836**		**0.468**		**0.649**	
McCabe	**Mean**	2,090	2,690	175.2	236.7	75,400	91,667	16,800	22,333	100.8	77.3	326	280	13.80	10.65
	SD	1,879	2,366	82.0	104.1	17,358	23,629	11,862	22,591	36.4	16.3	149	70	1.30	1.03
	t-test	**0.703**		**0.386**		**0.301**		**0.657**		**0.343**		**0.640**		**0.012**	

[shaded] Indicates comparison was statistically significant at $p<0.05$.

Appendix Table E.30: Reference sediment concentrations relative to guidelines, SRWMP 2009.

Parameter		Barium	Cobalt	Iron	Manganese	Nickel	Uranium	TOC	Ra-226
Units		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%	Bq/g
PSQG[a]	**LEL**	-	-	20,000	460	16	-	1	-
	SEL	-	-	40,000	1100	75	-	10	-
CNSC[b]	**LEL**	-	-	-	-	23.4	104.4	-	0.6
	SEL	-	-	-	-	484	5874.1	-	14.4
Rochester (RL)	1	110	13	27,000	590	18	3.1	9.8	0.1
	2	130	18	50,000	790	23	4.1	12	0.17
	3	160	21	28,000	710	23	6.9	16	0.14
	4	160	24	25,000	850	27	7.0	18	0.24
	5	130	19	24,000	610	23	4.1	15	0.12
Semiwhite (SL)	1	390	14	34,000	5,200	25	4.8	6.6	0.16
	2	360	11	23,000	2,400	21	4.3	7.6	0.09
	3	560	14	46,000	7,800	26	4.0	7	0.27
	4	310	9.9	20,000	1,900	22	3.6	7	0.07
	5	540	14	49,000	8,400	24	4.1	6.7	0.18
Dunlop (DL)	1	170	18	35,000	5,300	24	4.4	11	0.07
	2	140	12	19,000	1,800	22	4.8	8.6	0.07
	3	150	16	35,000	2,300	23	3.5	6.2	0.14
	4	52	6.8	11,000	670	12	1.8	3.6	0.05
	5	170	19	42,000	2,600	26	4.6	9.2	0.11
Ten Mile (TML)	1	110	7.2	10,000	560	22	3.8	13	0.1
	2	95	7.9	11,000	660	21	4.3	10	0.06
	3	51	5.0	8,200	340	12	2.4	9	0.07
	4	61	6.0	9,300	630	13	2.7	3.6	0.05
	5	91	8.2	10,000	400	20	3.4	5.4	0.04
Summers (SUL)	1	120	26	34,000	2,600	21	2.9	8.7	0.17
	2	99	15	21,000	2,200	17	2.5	9.3	0.11
	3	100	30	46,000	1,100	20	2.9	11	0.28
	4	86	10	17,000	290	18	2.8	11	0.14
	5	88	17	24,000	730	17	2.4	9.6	0.09
Reference Mean		177	14.5	26,340	2,057	20.8	3.8	9.4	0.12
Standard Deviation		142	6.45	13,260	2,266	4.16	1.3	3.5	0.07
Upper Background Concentration[e]		**481**	**28.3**	**54,783**	**6,918**	**29.7**	**6.5**	**17.0**	**0.27**

[a] Provincial Sediment Qulaity Guidelines (PSQGs). Lowest Effect Level (LEL) and Severe Effects Level (SEL) (MOE 1993)

[b] Thompson *et al*., 2005

[c] Anon, 1988

[d] Uranium value derived from site specific data (Minnow and Beak 2001) and Radium-226 value also derived from site specific data (Minnow 2009c)

[e] Upper background concentration based on the following equation = mean + (2.145 x SD)

Appendix Table E.31: Particle size distribution and TOC content in lake sediments, SRWMP 2009.

Lake	Sample	TOC (%)	% Gravel	% Sand	% Silt	% Clay
Reference						
Rochester	1	9.8	*0.1*	22	65	13
	2	12.0	*0.1*	44	43	13
	3	16.0	*0.1*	36	40	24
	4	18.0	0.3	41	40	18
	5	15.0	*0.1*	33	43	25
	mean	14.2	0.14	35.2	46.2	18.6
Semiwhite	1	6.6	*0.1*	24	62	13
	2	7.6	*0.1*	24	60	16
	3	7.0	*0.1*	32	55	12
	4	7.0	*0.1*	25	61	14
	5	6.7	*0.1*	28	60	12
	mean	7.0	0.1	26.6	59.6	13.4
Dunlop	1	11.0	*0.1*	25	56	19
	2	8.6	*0.1*	27	57	15
	3	6.2	*0.1*	30	59	11
	4	3.6	*0.1*	17	74	8.9
	5	9.2	*0.1*	28	55	18
	mean	7.7	0.1	25.4	60.2	14.38
Ten Mile	1	13.0	*0.1*	28	48	24
	2	10.0	*0.1*	23	51	26
	3	9.0	*0.1*	26	48	26
	4	3.6	*0.1*	32	55	13
	5	5.4	*0.1*	28	58	14
	mean	8.2	0.1	27.4	52	20.6
Summers	1	8.7	*0.1*	38	45	17
	2	9.3	*0.1*	36	45	19
	3	11.0	*0.1*	35	47	18
	4	11.0	*0.1*	44	42	14
	5	9.6	*0.1*	24	52	24
	mean	9.9	0.1	35.4	46.2	18.4
Exposed						
Quirke	1	9.6	*0.1*	45	39	16
	2	7.2	*0.1*	27	57	16
	3	2.2	*0.1*	43	50	7.2
	4	7.5	*0.1*	41	40	19
	5	5.8	*0.1*	46	42	11
	mean	6.5	0.1	40.4	45.6	13.84
Elliott	1	3.7	*0.1*	39	46	15
	2	6.6	*0.1*	29	47	24
	3	5.0	*0.1*	28	50	22
	4	5.6	*0.1*	42	44	15
	5	6.6	*0.1*	23	51	25
	mean	5.5	0.1	32.2	47.6	20.2

Appendix Table E.31: Particle size distribution and TOC content in lake sediments, SRWMP 2009.

Lake	Sample	TOC (%)	% Gravel	% Sand	% Silt	% Clay
Exposed						
Nordic	1	7.6	*0.1*	18	46	36
	2	5.7	*0.1*	43	46	12
	3	6.2	*0.1*	45	43	12
	4	6.8	*0.1*	43	42	15
	5	6.6	*0.1*	40	44	16
	mean	6.6	0.1	37.8	44.2	18.2
McCarthy	1	5.5	*0.1*	38	51	11
	2	5.5	*0.1*	35	47	18
	3	3.8	*0.1*	24	53	23
	4	5.3	*0.1*	30	47	23
	5	3.7	*0.1*	26	58	16
	mean	4.8	0.1	30.6	51.2	18.2
Hough	1	5.4	*0.1*	38	51	12
	2	6.7	*0.1*	31	55	14
	3	6.2	*0.1*	34	52	13
	4	6.2	*0.1*	28	57	16
	5	5.5	*0.1*	26	59	15
	mean	6.0	0.1	31.4	54.8	14
Pecors	1	4.0	*0.1*	26	63	12
	2	4.6	*0.1*	22	61	17
	3	3.5	*0.1*	28	56	16
	4	5.0	*0.1*	31	54	15
	5	2.7	*0.1*	51	44	5.1
	mean	4.0	0.1	31.6	55.6	13.02
McCabe	1	8.6	*0.1*	46	42	12
	2	8.0	*0.1*	45	47	7.7
	3	9.7	*0.1*	42	42	17
	4	8.3	0.1	47	41	12
	5	7.0	*0.1*	49	43	8.1
	mean	8.3	0.1	45.8	43	11.36
May	1	8.0	*0.1*	38	44	18
	2	9.4	*0.1*	45	43	12
	3	7.1	*0.1*	52	39	8.3
	4	6.6	*0.1*	51	32	17
	5	6.4	0.2	40	52	7.7
	mean	7.5	0.12	45.2	42	12.6

italics indicate less than detection

Appendix Table E.32: Lake sediment concentrations, SRWMP 2009.

Parameter		Barium	Cobalt	Iron	Manganese	Nickel	Uranium	TOC	Ra-226
Units		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	%	Bq/g
Quirke (QL)	1	1,400	40	64,000	4,800	30	470	9.6	7
	2	530	26	49,000	3,100	24	300	7.2	2.2
	3	240	22	42,000	2,800	16	180	2.2	1.1
	4	610	20	66,000	2,000	19	280	7.5	3.5
	5	750	84	68,000	8,000	38	530	5.8	4.4
Elliott (EL)	1	300	80	50,000	18,000	49	120	3.7	1.7
	2	200	59	63,000	7,800	55	200	6.6	1.7
	3	130	59	40,000	3,000	47	150	5	0.96
	4	260	83	47,000	16,000	58	160	5.6	1.7
	5	200	89	60,000	9,000	59	220	6.6	1.9
Nordic (NL)	1	130	25	33,000	300	37	110	7.6	2.3
	2	330	130	75,000	24,000	50	150	5.7	5.3
	3	320	110	59,000	26,000	38	130	6.2	4.1
	4	390	130	68,000	21,000	52	220	6.8	6.8
	5	300	150	110,000	26,000	43	160	6.6	5.4
McCarthy (MCL)	1	180	120	56,000	16,000	53	180	5.5	2.3
	2	180	120	52,000	14,000	41	130	5.5	1.2
	3	130	71	43,000	8,000	44	120	3.8	0.86
	4	190	120	65,000	15,000	45	150	5.3	2.2
	5	120	74	33,000	8,800	33	110	3.7	1.2
Hough (HOL)	1	86	29	55,000	3,300	41	89	5.4	1.7
	2	72	25	46,000	2,500	39	91	6.7	1.6
	3	84	28	57,000	3,200	39	90	6.2	2.5
	4	90	30	60,000	3,400	45	89	6.2	2.0
	5	70	22	39,000	2,000	37	78	5.5	1.7
Pecors (PL)	1	96	43	41,000	4,300	32	120	4	0.58
	2	120	42	43,000	4,000	42	110	4.6	0.82
	3	89	33	28,000	1,600	37	100	3.5	0.66
	4	110	39	37,000	1,500	40	110	5	0.92
	5	75	43	18,000	3,900	26	130	2.7	0.38
McCabe (ML)	1	470	290	100,000	18,000	160	590	8.6	15
	2	1,400	220	75,000	35,000	110	280	8	13
	3	4,200	76	51,000	2,000	68	230	9.7	12
	4	4,000	150	74,000	15,000	85	270	8.3	15
	5	380	140	77,000	14,000	81	260	7	14
May (MAL)	1	100	25	100,000	2,400	21	75	8	3.3
	2	260	49	75,000	9,100	59	110	9.4	1.2
	3	120	31	67,000	5,600	39	97	7.1	2.5
	4	140	33	67,000	6,600	43	94	6.6	2.9
	5	96	21	59,000	3,000	32	86	6.4	2.1

Table E.33: Benthic macroinvertebrates collected from SRWMP lakes, 2009.

Station	DUL-09					ELO-09					HOL-09				
Replicate	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
ROUNDWORMS															
P. Nemata	20	60	316	384	20	-	-	1	-	-	3	4	-	-	-
ANNELIDS															
P. Annelida															
WORMS															
Cl. Oligochaeta															
F. Naididae															
Nais variabilis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Slavina appendiculata	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Tubificidae															
Limnodrilus hoffmeisteri	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Limnodrilus udekemianus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhyacodrilus montana	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Tubifex tubifex	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
immatures with hair chaetae	8	4	-	20	-	-	-	-	-	-	-	-	-	-	6
immatures without hair chaetae	-	4	-	-	-	1	3	4	-	2	-	-	-	-	-
ARTHROPODS															
P. Arthropoda															
MITES															
Cl. Arachnida															
O. Acarina	-	4	12	4	12	1	-	1	8	-	3	-	3	1	-
HARPACTICOIDS															
O. Harpacticoida	8	12	4	140	48	-	-	-	-	1	-	-	-	-	-
SEED SHRIMPS															
Cl. Ostracoda	532	1028	628	524	132	12	35	21	74	67	76	148	405	62	176
WATER SCUDS															
O. Amphipoda															
F. Hyalellidae															
Hyalella	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-
F. Pontoporeiidae															
Diporeia	-	-	-	-	-	1	4	1	8	5	-	-	-	-	-
OPOSSUM SHRIMPS															
O. Mysidacea															
Mysis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
INSECTS															
Cl. Insecta															
BEETLES															
O. Coleoptera															
F. Dytiscidae															
immature	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MAYFLIES															
O. Ephemeroptera															
F. Caenidae															
Caenis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Ephemeridae															
Hexagenia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Leptophlebiidae															
immature	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
O. Megaloptera															
ALDERFLIES															
F. Sialidae															
Sialis	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CADDISFLIES															
O. Trichoptera															
F. Leptoceridae															
Triaenodes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Phryganeidae															
Agrypnia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
immature	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUE FLIES															
O. Diptera															
BITING-MIDGE															
F. Ceratopogonidae															
Bezzia	-	-	-	-	4	-	-	-	-	-	1	-	-	-	-
Mallochohelea	-	-	4	-	-	-	-	-	-	1	-	-	-	-	2
Probezzia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PHANTOM MIDGE															
F. Chaoboridae															
Chaoborus flavicans	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chaoborus punctipennis	-	-	-	-	-	1	7	5	-	2	-	-	-	-	-
MIDGES															
F. Chironomidae															
chironomid pupae	-	**4**	-	**4**	**4**	-	**6**	**6**	**4**	**1**	**49**	**28**	**36**	**19**	**36**
S.F. Chironominae															
Chironomus	-	-	-	-	-	-	-	-	-	-	-	-	4	2	-
Cladopelma	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Dicrotendipes	-	-	-	-	-	-	-	-	-	-	1	-	-	-	2
Micropsectra	96	68	44	128	40	31	43	28	98	36	50	172	192	34	140
Microtendipes	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-
Nilothauma	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Pagastiella	-	-	4	-	-	-	-	-	-	3	-	-	-	-	-
Paracladopelma	-	-	-	4	-	-	-	1	-	-	3	-	-	1	4
Polypedilum halterale	-	-	-	-	-	-	-	-	-	-	-	4	1	-	-
Polypedilum scalaenum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polypedilum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sergentia	60	32	80	36	4	-	8	8	-	34	3	24	10	9	8
Stempellina	-	4	8	-	4	-	-	-	-	-	-	-	-	-	-
Stempellinella	-	24	8	-	-	-	-	-	-	-	-	-	-	-	-
Stictochironomus	24	4	36	20	156	30	111	108	54	141	2	-	13	3	4
Tanytarsus	40	36	44	8	12	-	27	3	12	9	-	-	21	-	40
Tribelos	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
S.F. Diamesinae															
Protanypus	-	4	4	12	8	4	2	5	-	1	7	4	1	1	-
S.F. Orthocladiinae															
Cricotopus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Heterotanytarsus	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-
Heterotrissocladius	-	84	68	128	92	40	105	122	254	111	33	68	109	49	68
Paracladius	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Parakiefferiella	-	-	48	-	-	-	-	-	-	-	-	-	-	-	-
Psectrocladius	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S.F. Tanypodinae															
Ablabesmyia	-	-	8	-	-	-	-	-	-	1	1	-	-	-	-
Procladius	24	120	72	40	60	-	8	1	12	2	2	-	3	-	-
MOLLUSCS															
P. Mollusca															
SNAILS															
Cl. Gastropoda															
F. Planorbidae															
Menetus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLAMS															
Cl. Bivalvia															
F. Sphaeriidae															
Cyclocalyx	352	280	192	196	328	20	171	134	152	133	-	-	-	-	-
TOTAL NUMBER OF ORGANISMS	1164	1784	1584	1648	928	141	531	450	676	551	234	452	799	181	490
TOTAL NUMBER OF TAXA [a]	10	18	19	14	15	10	13	16	9	17	13	8	12	9	12

[a] Bold entries excluded from taxa count

Table E.33: Benthic macroinvertebrates collected from SRWMP lakes, 2009.

Station	MAL-09					MCL-09					ML-09				
Replicate	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
ROUNDWORMS															
P. Nemata	-	-	-	4	-	-	-	-	-	-	4	8	8	48	1
ANNELIDS															
P. Annelida															
WORMS															
Cl. Oligochaeta															
F. Naididae															
Nais variabilis	-	-	-	-	-	-	-	-	-	-	-	8	-	-	-
Slavina appendiculata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Tubificidae															
Limnodrilus hoffmeisteri	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Limnodrilus udekemianus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhyacodrilus montana	-	-	-	-	-	8	-	-	-	2	-	-	-	-	-
Tubifex tubifex	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
immatures with hair chaetae	-	-	-	-	-	-	-	-	-	-	-	24	8	24	32
immatures without hair chaetae	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-
ARTHROPODS															
P. Arthropoda															
MITES															
Cl. Arachnida															
O. Acarina	15	24	2	3	-	4	-	12	1	14	-	-	4	-	6
HARPACTICOIDS															
O. Harpacticoida	4	-	-	-	-	-	-	-	-	30	-	-	-	-	-
SEED SHRIMPS															
Cl. Ostracoda	20	158	336	122	90	146	48	168	54	262	260	192	352	248	165
WATER SCUDS															
O. Amphipoda															
F. Hyalellidae															
Hyalella	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Pontoporeiidae															
Diporeia	-	-	-	-	-	28	2	-	11	-	-	-	-	-	-
OPOSSUM SHRIMPS															
O. Mysidacea															
Mysis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
INSECTS															
Cl. Insecta															
BEETLES															
O. Coleoptera															
F. Dytiscidae															
immature	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MAYFLIES															
O. Ephemeroptera															
F. Caenidae															
Caenis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Ephemeridae															
Hexagenia	-	-	2	-	-	-	-	-	-	-	-	2	-	8	-
F. Leptophlebiidae															
immature	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-
O. Megaloptera															
ALDERFLIES															
F. Sialidae															
Sialis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CADDISFLIES															
O. Trichoptera															
F. Leptoceridae															
Triaenodes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
F. Phryganeidae															
Agrypnia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
immature	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUE FLIES															
O. Diptera															
BITING-MIDGE															
F. Ceratopogonidae															
Bezzia	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Mallochohelea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Probezzia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PHANTOM MIDGE															
F. Chaoboridae															
Chaoborus flavicans	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chaoborus punctipennis	-	-	-	-	-	8	4	6	6	6	-	-	-	-	-
MIDGES															
F. Chironomidae															
chironomid pupae	**6**	**21**	**26**	**10**	**14**	**4**	**8**	**4**	**11**	**8**	-	-	**16**	**32**	**48**
S.F. Chironominae															
Chironomus	70	4	10	5	-	-	2	36	-	-	-	-	-	8	-
Cladopelma	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dicrotendipes	-	-	-	-	-	-	-	-	-	-	-	8	8	8	2
Micropsectra	12	202	296	31	30	182	44	26	141	122	76	-	4	-	2
Microtendipes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nilothauma	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Pagastiella	-	-	-	-	-	-	-	-	6	-	-	-	-	-	-
Paracladopelma	-	-	-	-	-	-	-	-	-	2	4	-	-	8	-
Polypedilum halterale	-	-	-	3	-	-	-	-	-	-	-	-	-	24	-
Polypedilum scalaenum	-	-	-	-	-	-	-	-	-	-	-	-	8	8	-
Polypedilum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Sergentia	221	42	6	7	-	28	68	30	66	60	-	-	12	-	4
Stempellina	-	-	-	-	-	-	-	-	-	-	-	8	-	8	128
Stempellinella	-	-	-	-	-	-	-	-	-	-	-	56	44	16	98
Stictochironomus	-	8	14	13	10	2	-	2	-	-	-	-	-	-	-
Tanytarsus	-	-	-	9	-	58	-	20	12	46	20	16	12	8	77
Tribelos	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S.F. Diamesinae															
Protanypus	5	-	4	4	12	4	4	20	-	12	4	-	4	-	1
S.F. Orthocladiinae															
Cricotopus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15
Heterotanytarsus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Heterotrissocladius	21	36	54	20	50	178	2	194	14	70	108	64	20	64	122
Paracladius	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Parakiefferiella	-	-	2	2	-	2	-	-	-	-	-	48	-	32	130
Psectrocladius	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7
S.F. Tanypodinae															
Ablabesmyia	-	-	-	-	-	-	-	-	-	2	-	-	-	8	-
Procladius	2	-	-	-	-	8	-	-	-	4	8	56	80	56	59
MOLLUSCS															
P. Mollusca															
SNAILS															
Cl. Gastropoda															
F. Planorbidae															
Menetus	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-
CLAMS															
Cl. Bivalvia															
F. Sphaeriidae															
Cyclocalyx	-	-	-	-	-	28	6	38	17	78	132	104	220	112	51
TOTAL NUMBER OF ORGANISMS	376	495	752	239	208	688	188	556	340	720	616	594	800	720	954
TOTAL NUMBER OF TAXA [a]	9	7	10	14	6	14	9	11	11	15	9	13	14	17	21

[a] Bold entries excluded from taxa count

Table E.33: Benthic macroinvertebrates collected from SRWMP lakes, 2009.

Station	NL-05					PL-09					QL-09				
Replicate	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
ROUNDWORMS															
P. Nemata	1	-	4	4	-	-	-	2	-	-	-	4	-	-	-
ANNELIDS															
P. Annelida															
WORMS															
Cl. Oligochaeta															
F. Naididae															
Nais variabilis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Slavina appendiculata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Tubificidae															
Limnodrilus hoffmeisteri	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Limnodrilus udekemianus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhyacodrilus montana	-	2	30	-	-	-	-	-	-	16	1	-	2	-	10
Tubifex tubifex	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
immatures with hair chaetae	5	-	-	-	4	-	-	-	-	-	-	-	-	-	-
immatures without hair chaetae	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ARTHROPODS															
P. Arthropoda															
MITES															
Cl. Arachnida															
O. Acarina	1	4	13	4	10	4	4	6	10	16	1	-	-	-	-
HARPACTICOIDS															
O. Harpacticoida	1	5	9	6	-	-	-	-	-	16	-	-	-	-	-
SEED SHRIMPS															
Cl. Ostracoda	32	57	33	48	96	140	26	210	110	144	35	4	2	-	6
WATER SCUDS															
O. Amphipoda															
F. Hyalellidae															
Hyalella	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Pontoporeiidae															
Diporeia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
OPOSSUM SHRIMPS															
O. Mysidacea															
Mysis	-	-	-	-	-	-	-	-	-	-	-	-	2	-	2
INSECTS															
Cl. Insecta															
BEETLES															
O. Coleoptera															
F. Dytiscidae															
immature	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
MAYFLIES															
O. Ephemeroptera															
F. Caenidae															
Caenis	-	2	-	2	-	-	-	-	-	-	-	-	-	-	-
F. Ephemeridae															
Hexagenia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Leptophlebiidae															
immature	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
O. Megaloptera															
ALDERFLIES															
F. Sialidae															
Sialis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CADDISFLIES															
O. Trichoptera															
F. Leptoceridae															
Triaenodes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Phryganeidae															
Agrypnia	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
immature	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TRUE FLIES															
O. Diptera															
BITING-MIDGE															
F. Ceratopogonidae															
Bezzia	2	1	1	2	2	-	-	-	-	-	-	-	-	-	-
Mallochohelea	-	-	1	-	-	-	-	2	-	-	-	-	-	-	-
Probezzia	10	3	-	-	4	-	-	-	-	-	-	-	-	-	-
PHANTOM MIDGE															
F. Chaoboridae															
Chaoborus flavicans	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Chaoborus punctipennis	-	-	-	-	-	-	4	6	-	-	-	-	-	-	-
MIDGES															
F. Chironomidae															
chironomid pupae	**3**	**14**	**1**	**8**	**4**	**8**	**4**	**2**	-	-	**11**	**12**	**22**	**10**	**8**
S.F. Chironominae															
Chironomus	91	11	14	2	2	-	2	-	-	-	57	40	32	20	6
Cladopelma	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dicrotendipes	-	-	-	-	-	4	1	-	-	-	-	-	-	-	-
Micropsectra	6	42	37	22	122	124	190	388	382	304	1	4	10	2	4
Microtendipes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nilothauma	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pagastiella	-	-	-	-	-	-	-	-	-	64	-	-	-	-	-
Paracladopelma	-	1	1	-	-	-	-	-	4	-	-	4	-	-	-
Polypedilum halterale	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-
Polypedilum scalaenum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polypedilum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sergentia	2	-	15	4	2	-	2	16	2	16	-	-	-	2	-
Stempellina	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stempellinella	-	-	-	-	-	-	-	-	-	16	-	-	-	-	-
Stictochironomus	-	23	1	2	-	-	-	-	-	-	-	-	-	-	-
Tanytarsus	5	12	-	12	16	28	-	172	-	64	-	-	-	2	-
Tribelos	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S.F. Diamesinae															
Protanypus	-	4	1	6	-	4	16	6	4	-	1	-	-	2	2
S.F. Orthocladiinae															
Cricotopus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Heterotanytarsus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Heterotrissocladius	2	102	76	204	128	396	99	78	138	896	76	32	76	140	94
Paracladius	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Parakiefferiella	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Psectrocladius	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S.F. Tanypodinae															
Ablabesmyia	-	-	-	-	-	-	-	-	-	16	-	-	-	-	-
Procladius	-	-	-	-	-	4	-	6	6	16	-	-	-	-	-
MOLLUSCS															
P. Mollusca															
SNAILS															
Cl. Gastropoda															
F. Planorbidae															
Menetus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLAMS															
Cl. Bivalvia															
F. Sphaeriidae															
Cyclocalyx	-	-	-	-	-	-	-	8	50	-	-	-	-	-	-
TOTAL NUMBER OF ORGANISMS	165	284	238	326	390	712	348	905	706	1584	183	100	146	178	132
TOTAL NUMBER OF TAXA [a]	15	15	15	13	10	8	9	14	9	12	7	6	6	6	7

[a] Bold entries excluded from taxa count

Table E.33: Benthic macroinvertebrates collected from SRWMP lakes, 2009.

Station	RL-09					SL-09					SUL-09				
Replicate	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
ROUNDWORMS															
P. Nemata	-	1	-	1	-	-	16	4	56	20	2	-	-	-	-
ANNELIDS															
P. Annelida															
WORMS															
Cl. Oligochaeta															
F. Naididae															
Nais variabilis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Slavina appendiculata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Tubificidae															
Limnodrilus hoffmeisteri	-	17	-	-	-	2	-	-	-	-	1	-	-	-	-
Limnodrilus udekemianus	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-
Rhyacodrilus montana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tubifex tubifex	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
immatures with hair chaetae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
immatures without hair chaetae	-	29	-	-	-	8	-	-	-	-	-	-	-	8	-
ARTHROPODS															
P. Arthropoda															
MITES															
Cl. Arachnida															
O. Acarina	-	-	2	-	-	4	-	-	8	20	9	2	4	6	6
HARPACTICOIDS															
O. Harpacticoida	46	22	22	20	96	76	-	-	8	4	-	-	72	46	2
SEED SHRIMPS															
Cl. Ostracoda	7	2	1	-	-	8	16	80	72	84	12	2	132	-	-
WATER SCUDS															
O. Amphipoda															
F. Hyalellidae															
Hyalella	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Pontoporeiidae															
Diporeia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
OPOSSUM SHRIMPS															
O. Mysidacea															
Mysis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
INSECTS															
Cl. Insecta															
BEETLES															
O. Coleoptera															
F. Dytiscidae															
immature	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MAYFLIES															
O. Ephemeroptera															
F. Caenidae															
Caenis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Ephemeridae															
Hexagenia	-	-	-	-	-	-	-	-	2	1	-	-	-	-	-
F. Leptophlebiidae															
immature	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
O. Megaloptera															
ALDERFLIES															
F. Sialidae															
Sialis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CADDISFLIES															
O. Trichoptera															
F. Leptoceridae															
Triaenodes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Phryganeidae															
Agrypnia	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1
immature	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-
TRUE FLIES															
O. Diptera															
BITING-MIDGE															
F. Ceratopogonidae															
Bezzia	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-
Mallochohelea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Probezzia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PHANTOM MIDGE															
F. Chaoboridae															
Chaoborus flavicans	-	-	-	-	-	2	-	4	-	-	-	-	-	-	-
Chaoborus punctipennis	-	-	-	2	-	-	-	-	-	-	-	4	-	16	2
MIDGES															
F. Chironomidae															
chironomid pupae	-	-	-	-	-	-	-	-	-	-	**1**	**2**	-	-	-
S.F. Chironominae															
Chironomus	10	33	6	1	36	2	8	8	-	-	9	-	4	16	6
Cladopelma	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dicrotendipes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Micropsectra	-	-	1	-	-	350	184	164	64	424	16	2	196	72	114
Microtendipes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nilothauma	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pagastiella	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Paracladopelma	-	1	-	-	-	-	-	-	8	-	-	-	-	-	-
Polypedilum halterale	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-
Polypedilum scalaenum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polypedilum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sergentia	28	22	61	3	20	48	16	52	16	8	140	160	96	94	100
Stempellina	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-
Stempellinella	-	-	-	-	-	-	-	28	8	-	-	-	-	-	-
Stictochironomus	-	-	-	-	-	34	48	16	72	28	56	18	48	-	16
Tanytarsus	-	-	-	-	-	-	-	8	8	-	-	-	-	-	-
Tribelos	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S.F. Diamesinae															
Protanypus	1	-	-	-	-	2	-	-	-	-	1	-	-	-	-
S.F. Orthocladiinae															
Cricotopus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Heterotanytarsus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Heterotrissocladius	-	-	-	-	-	10	16	52	16	28	20	18	28	-	36
Paracladius	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Parakiefferiella	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Psectrocladius	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S.F. Tanypodinae															
Ablabesmyia	-	-	-	-	-	-	8	-	-	-	-	-	-	-	-
Procladius	2	-	3	2	-	42	24	36	56	52	5	20	16	8	38
MOLLUSCS															
P. Mollusca															
SNAILS															
Cl. Gastropoda															
F. Planorbidae															
Menetus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLAMS															
Cl. Bivalvia															
F. Sphaeriidae															
Cyclocalyx	-	-	-	-	-	34	24	12	56	40	8	8	8	-	-
TOTAL NUMBER OF ORGANISMS	94	127	96	29	152	624	360	464	458	709	283	238	608	266	323
TOTAL NUMBER OF TAXA [a]	6	8	7	6	3	15	10	12	15	11	14	10	11	8	11

[a] Bold entries excluded from taxa count

Table E.33: Benthic macroinvertebrates collected from SRWMP lakes, 2009.

Station	TML-09				
Replicate	1	2	3	4	5
ROUNDWORMS					
P. Nemata	16	64	32	26	80
ANNELIDS					
P. Annelida					
WORMS					
Cl. Oligochaeta					
F. Naididae					
Nais variabilis	-	-	-	-	-
Slavina appendiculata	-	-	-	-	-
F. Tubificidae					
Limnodrilus hoffmeisteri	-	-	-	-	-
Limnodrilus udekemianus	-	-	-	-	-
Rhyacodrilus montana	-	-	-	-	-
Tubifex tubifex	-	-	-	-	-
immatures with hair chaetae	-	-	-	-	-
immatures without hair chaetae	-	-	-	-	-
ARTHROPODS					
P. Arthropoda					
MITES					
Cl. Arachnida					
O. Acarina	8	8	2	4	16
HARPACTICOIDS					
O. Harpacticoida	248	424	128	64	176
SEED SHRIMPS					
Cl. Ostracoda	152	304	86	222	80
WATER SCUDS					
O. Amphipoda					
F. Hyalellidae					
Hyalella	-	-	-	-	-
F. Pontoporeiidae					
Diporeia	-	-	-	-	-
OPOSSUM SHRIMPS					
O. Mysidacea					
Mysis	-	-	-	-	-
INSECTS					
Cl. Insecta					
BEETLES					
O. Coleoptera					
F. Dytiscidae					
immature	-	-	-	-	-
MAYFLIES					
O. Ephemeroptera					
F. Caenidae					
Caenis	-	-	-	-	-
F. Ephemeridae					
Hexagenia	-	-	-	-	-
F. Leptophlebiidae					
immature	-	-	-	-	-
O. Megaloptera					
ALDERFLIES					
F. Sialidae					
Sialis	-	-	-	-	-
CADDISFLIES					
O. Trichoptera					
F. Leptoceridae					
Triaenodes	-	-	-	-	-
F. Phryganeidae					
Agrypnia	-	-	-	-	-
immature	-	-	-	-	-
TRUE FLIES					
O. Diptera					
BITING-MIDGE					
F. Ceratopogonidae					
Bezzia	-	-	-	-	-
Mallochohelea	-	-	-	-	-
Probezzia	-	-	-	-	-
PHANTOM MIDGE					
F. Chaoboridae					
Chaoborus flavicans	-	-	-	-	-
Chaoborus punctipennis	-	-	-	-	-
MIDGES					
F. Chironomidae					
chironomid pupae	-	-	-	**12**	**8**
S.F. Chironominae					
Chironomus	-	-	-	44	8
Cladopelma	-	-	-	-	-
Dicrotendipes	-	-	-	4	-
Micropsectra	120	16	28	58	160
Microtendipes	-	-	-	-	-
Nilothauma	-	-	-	-	-
Pagastiella	-	-	-	-	-
Paracladopelma	-	-	-	-	64
Polypedilum halterale	-	-	-	-	-
Polypedilum scalaenum	-	-	-	-	-
Polypedilum	-	-	-	-	-
Sergentia	8	-	4	12	24
Stempellina	-	-	-	-	-
Stempellinella	-	8	-	-	-
Stictochironomus	136	-	72	64	24
Tanytarsus	48	8	-	8	-
Tribelos	-	-	-	-	-
S.F. Diamesinae					
Protanypus	8	-	4	6	8
S.F. Orthocladiinae					
Cricotopus	-	-	-	-	-
Heterotanytarsus	-	-	-	-	-
Heterotrissocladius	8	96	20	166	512
Paracladius	48	80	4	12	80
Parakiefferiella	-	-	-	-	-
Psectrocladius	-	-	-	-	-
S.F. Tanypodinae					
Ablabesmyia	-	-	-	-	-
Procladius	16	16	16	66	-
MOLLUSCS					
P. Mollusca					
SNAILS					
Cl. Gastropoda					
F. Planorbidae					
Menetus	-	-	-	-	-
CLAMS					
Cl. Bivalvia					
F. Sphaeriidae					
Cyclocalyx	-	-	-	14	-
TOTAL NUMBER OF ORGANISMS	816	1024	396	782	1240
TOTAL NUMBER OF TAXA [a]	12	10	11	15	12

[a] Bold entries excluded from taxa count

Appendix Table E.34: Supporting Habitat Measures for Benthic Community Stations, 1999, 2004, 2009.

Station	lake	Lake	Exposure Status	Year	Barium (mg/kg)	Cobalt (mg/kg)	Iron (mg/kg)	Manganese (mg/kg)	Nickel (mg/kg)	Ra-226 (Bq/g)	Uranium (mg/kg)	TOC (%)	Depth (m)	Secchi Depth (m)	Water Temperature (°C)	DO (mg/L)	DO (% sat)	pH	Cond (µS/cm)	RedOx (mV)	Fines (%; silt + clay)	log10 (1 + Barium (mg/kg))	log10 (1 + Cobalt (mg/kg))	log10 (1 + Iron (mg/kg))	log10 (1 + Manganese (mg/kg))	log10 (1 + Nickel (mg/kg))	log10 (1 + Ra-226 (Bq/g))	log10 (1 + Uranium (mg/kg))
DUL1-99	DUL	Dunlop	Reference	1999	97	9	18000	670	22	0.0425	3.7	12	14	.	17	6.6	.	.	.	.	.	.	.	.	.	.	.	.
DUL2-99	DUL	Dunlop	Reference	1999	200	22	43000	7500	29	0.0998	4.8	9.4	17.7	6.6	8.7	7.62	.	.	.	.	.	.	.	.	.	.	.	.
DUL3-99	DUL	Dunlop	Reference	1999	86	10	16000	3600	16	0.0504	2.3	5.4	18	.	12.7	0.65	.	.	.	.	.	.	.	.	.	.	.	.
TML1-99	TML	Ten Mile	Reference	1999	90	8	11000	210	21	0.0435	5.1	9.4	17	.	10.4	11.8	.	.	.	.	.	.	.	.	.	.	.	.
TML2-99	TML	Ten Mile	Reference	1999	60	9	8100	270	15	0.0346	4.4	4.7	18	9.6	7.2	11.95	.	.	.	.	.	.	.	.	.	.	.	.
TML3-99	TML	Ten Mile	Reference	1999	110	8	12000	700	26	0.0596	4.5	13	17	.	8.7	11.37	100	7.9	28	-285	45	2.0453	0.9542	4.0792	2.8457	1.4314	0.0251	0.7404
RL1-99	RL	Rochester	Reference	1999	140	15	50000	630	25	0.0479	3.4	13	17	.	9.8	1.1	10	6.52	24.9	19	69	2.1492	1.2041	4.699	2.8	1.415	0.0203	0.6435
RL2-99	RL	Rochester	Reference	1999	170	14	24000	630	27	0.04	5.4	16	8	.	14.8	6.1	62	6.48	22.6	24	82	2.233	1.1761	4.3802	2.8	1.4472	0.017	0.8062
RL3-99	RL	Rochester	Reference	1999	180	19	34000	860	28	0.0594	6.3	17	17	4.25	6.6	3.7	32	6.47	29.7	19	85	2.2577	1.301	4.5315	2.935	1.4624	0.0251	0.8633
QL1-99	QL	Quirke	Exposure	1999	850	12	31000	440	18	2.5562	250	6.6	17	.	12.5	10.55	102	7.23	290	-116	71.3	2.9299	1.1139	4.4914	2.6444	1.2788	0.551	2.3997
QL2-99	QL	Quirke	Exposure	1999	460	28	61000	1800	21	1.9353	230	6.6	17	13.1	10.3	10.32	95	6.47	290	-37	50	2.6637	1.4624	4.7853	3.2555	1.3424	0.4677	2.3636
QL3-99	QL	Quirke	Exposure	1999	170	9	24000	510	13	0.8589	180	1.2	16	.	12.9	10.68	104	6.89	290	-221	42	2.233	1	4.3802	2.7084	1.1461	0.2693	2.2577
QL4-99	QL	Quirke	Exposure	1999	260	6	24000	280	16	1.3188	220	4.8	16.5	.	16.2	8.97	95	8.39	288	-172	44	2.4166	0.8451	4.3802	2.4487	1.2304	0.3653	2.3444
QL5-99	QL	Quirke	Exposure	1999	610	16	44000	1400	20	2.3641	290	7.8	16.5	.	12.1	10.85	112	6.7	288	-156	61	2.786	1.2304	4.6435	3.1464	1.3222	0.5269	2.4639
EL1-99	EL	Elliot	Exposure	1999	290	130	92000	19000	86	2.4791	220	7.9	17	.	6.7	1.15	9	6.61	56.1	-109	46	2.4639	2.1173	4.9638	4.2788	1.9395	0.5415	2.3444
EL2-99	EL	Elliot	Exposure	1999	200	99	40000	13000	67	1.0331	200	8.6	16	5.7	7.2	0.22	1	6.63	59.9	-87	73.1	2.3032	2	4.6021	4.114	1.8325	0.3082	2.3032
EL3-99	EL	Elliot	Exposure	1999	130	70	44000	5000	53	1.1754	220	7.5	17	.	7	5.77	49	6.69	56.4	-140	56	2.1173	1.8513	4.6435	3.6991	1.7324	0.3375	2.3444
HOL1-99	HOL	Hough	Exposure	1999	100	42	50000	9100	56	2.7571	89	7.9	17.5	.	6.4	4.1	34	.	625	-43	61	2.0043	1.6335	4.699	3.9591	1.7559	0.5749	1.9542
HOL2-99	HOL	Hough	Exposure	1999	74	36	49000	6300	49	2.4363	92	7.7	17	9.7	6.5	4.7	39	.	626	-83	51	1.8751	1.5682	4.6902	3.7994	1.699	0.5361	1.9685
HOL3-99	HOL	Hough	Exposure	1999	88	50	59000	9000	55	3.1716	95	6.6	17	.	5.1	2.3	18	.	646	-74	61	1.9494	1.7076	4.7709	3.9543	1.7482	0.6203	1.9823
ML1-99	ML	McCabe	Exposure	1999	370	270	100000	46000	66	11.1249	250	11	14	.	12.4	10.1	98	6.86	757	-177	0.3	2.5694	2.433	5	4.6628	1.8261	1.0837	2.3997
ML2-99	ML	McCabe	Exposure	1999	5100	320	110000	20000	96	11.3566	360	9.8	14	4.5	12.9	8.85	87	6.72	768	-99	33	3.7077	2.5065	5.0414	4.3011	1.9868	1.0919	2.5575
ML3-99	ML	McCabe	Exposure	1999	2600	120	65000	1000	70	9.4606	230	2.1	14	.	15.3	2.2	23	6.73	761	-222	48	3.4151	2.0828	4.8129	3.0004	1.8513	1.0196	2.3636
MCL1-99	MCL	McCarthy	Exposure	1999	270	47	30000	720	38	1.2998	88	7	13.5	.	6.1	0.05	0	.	135.3	-218	93.7	2.433	1.6812	4.4771	2.8579	1.5911	0.3617	1.9494
MCL2-99	MCL	McCarthy	Exposure	1999	150	140	45000	18000	52	1.106	110	4.8	14	5.38	7.3	0.28	2	6.01	125.2	72	83	2.179	2.1492	4.6532	4.2553	1.7243	0.3235	2.0453
MCL3-99	MCL	McCarthy	Exposure	1999	150	120	47000	26000	75	1.1255	130	5.2	16.5	.	5.7	0.6	5	5.87	133	104	78	2.179	2.0828	4.6721	4.415	1.8808	0.3275	2.1173
NL1-99	NL	Nordic	Exposure	1999	76	17	54000	1000	20	1.2087	55	3.6	12	.	7.8	9.54	82	7.13	548	-317	63	1.8865	1.2553	4.7324	3.0004	1.3222	0.3441	1.7482
NL2-99	NL	Nordic	Exposure	1999	340	250	100000	45000	79	4.922	170	7.8	16	6.5	4.5	2.3	18	6.75	505	-212	75.5	2.5328	2.3997	5	4.6532	1.9031	0.7725	2.233
NL3-99	NL	Nordic	Exposure	1999	370	270	100000	46000	63	5.1643	170	9.3	16.5	.	5.1	0.8	6	7.15	503	-124	80	2.5694	2.433	5	4.6628	1.8062	0.7899	2.233
PL1-99	PL	Pecors	Exposure	1999	94	32	30000	1000	43	0.9724	94	4.8	15	.	6.8	7.06	64	6.99	458	-77	86.6	1.9777	1.5185	4.4771	3.0004	1.6435	0.295	1.9777
PL2-99	PL	Pecors	Exposure	1999	110	68	43000	6000	48	0.9884	150	5.5	16	8.75	.	.	.	.	.	44	82.3	2.0453	1.8388	4.6335	3.7782	1.6902	0.2985	2.179
PL3-99	PL	Pecors	Exposure	1999	33	41	16000	2700	20	0.3425	130	2.1	17	.	.	.	.	.	.	-101	72	1.5315	1.6232	4.2041	3.4315	1.3222	0.1279	2.1173
DUL1-04	DUL	Dunlop	Reference	2004	121.4279	8.4997	16916.89	471.5818	23.8606	0.0572	4.9	12	13.6	7.59	12.22	10.67	100.5	6.8	26	176.5	88	2.0879	0.9777	4.2283	2.6745	1.3955	0.0242	0.7709
DUL2-04	DUL	Dunlop	Reference	2004	339.0671	20.7119	76964.6	5181.8893	30.9701	0.1399	3.7	9.8	19.5	8.71	8.13	9.31	78.6	5.88	26	58.3	90	2.5316	1.3367	4.8863	3.7146	1.5047	0.0569	0.6721
DUL3-04	DUL	Dunlop	Reference	2004	192.9242	19.2431	40314.587	5596.7477	36.5986	0.0921	4	8.9	14	7.26	11.65	10.91	99.7	6.51	25	23.1	94	2.2876	1.3063	4.6055	3.748	1.5752	0.0383	0.699
TML1-04	TML	Ten Mile	Reference	2004	111.12	10.3321	14784.9	601.835	22.3397	0.0513	6.1	12	17.5	8.5	7.45	13.01	109.2	6.29	21	136.1	67	2.0497	1.0543	4.1698	2.7802	1.3681	0.0217	0.8513
TML2-04	TML	Ten Mile	Reference	2004	62.6997	7.6378	10812.7	257.8275	17.1326	0.0369	3.6	2.2	17.5	10.01	8.64	14.23	121.7	7.23	21	240.1	52	1.8041	0.9364	4.034	2.413	1.2585	0.0157	0.6628
TML3-04	TML	Ten Mile	Reference	2004	97.1135	9.5086	16386.336	370.5453	27.0975	0.0456	4.8	7.5	15.4	9.04	18.49	10.11	107.9	6.55	27	107.7	78	1.9917	1.0215	4.2145	2.57	1.4487	0.0194	0.7634
RL1-04	RL	Rochester	Reference	2004	141.1251	14.0788	40486.159	574.5312	25.3101	0.0597	4.3	13	14.9	3.9	5.34	6.1	48.2	6.58	16	55.1	90	2.1527	1.1784	4.6073	2.7601	1.4201	0.0252	0.7243
RL2-04	RL	Rochester	Reference	2004	166.5335	23.1629	31833.067	772.5639	27.8754	0.0607	5.5	16	14.9	3.95	5.41	2.53	20	6.33	25	18.1	96	2.2241	1.3831	4.5029	2.8885	1.4605	0.0256	0.8129
RL3-04	RL	Rochester	Reference	2004	197.905	21.0495	31006.584	872.2167	33.4397	0.0713	7.9	16	14.9	4	4.42	4.92	38	7	32	39.9	90	2.2986	1.3434	4.4915	2.9411	1.5371	0.0299	0.9494
SUL1-04	SUL	Summers	Reference	2004	132.4446	18.544	24058.318	6763.3313	22.4186	0.0558	1.5	11	15	5.98	6.69	12.04	98.3	5.55	12	107.4	94	2.1253	1.291	4.3813	3.8302	1.3696	0.0236	0.3979
SUL2-04	SUL	Summers	Reference	2004	131.2128	23.3452	34624.455	5251.4863	23.4344	0.0612	2.1	9.6	14	6.25	5.46	9.66	76.5	5.22	12	55.7	97	2.1213	1.3864	4.5394	3.7204	1.388	0.0258	0.4914
SUL3-04	SUL	Summers	Reference	2004	95.0782	18.5185	23505.645	1596.0586	20.6675	0.0445	3.4	10	15	6.16	8.36	11.26	95.4	6.05	13	44.5	95	1.9826	1.2904	4.3712	3.2033	1.3358	0.0189	0.6435
SL1-04	SL	Semiwhite	Reference	2004	826.3287	11.2573	60822.029	8767.8713	26.2611	0.1277	3.6	6.95	14.4	6.82	8.87	11.25	94.9	6.56	23	125	94.5	2.9177	1.0884	4.7841	3.9429	1.4355	0.0522	0.6628
SL2-04	SL	Semiwhite	Reference	2004	914.1192	12.0367	58830.211	14519.729	28.4177	0.1235	1.6	8	15.5	6.47	6.92	8.48	69.7	5.68	21	46.6	96	2.9615	1.1152	4.7696	4.162	1.4686	0.0506	0.415
SL3-04	SL	Semiwhite	Reference	2004	1344.4345	15.3177	73234.413	22429.057	26.0392	0.1865	0.4	7.7	12.5	6.45	8.74	12.21	98.7	6.09	23	17.8	88	3.1289	1.2127	4.8647	4.3508	1.432	0.0743	0.1461
QL1-04	QL	Quirke	Exposure	2004	2449.8774	32.6297	59823.9	3471.0849	29.9895	5.1573	381.5	8.8	18.2	12.91	12.27	11.28	106	6.82	152	74.2	87	3.3893	1.5267	4.7769	3.5406	1.4912	0.7894	2.5826
QL2-04	QL	Quirke	Exposure	2004	390.9805	19.6002	41089.897	2154.9324	21.2908	1.4897	126.8	3.6	16	10.14	7.64	12.63	105.2	6.51	125	169.9	86	2.5933	1.3139	4.6137	3.3336	1.3481	0.3961	2.1065
QL3-04	QL	Quirke	Exposure	2004	115.6493	8.155	19635.145	782.98	9.4665	0.6319	74.2	1.6	18.5	9.88	7.31	5.43	104	6.72	136	227.9	57	2.0669	0.9617	4.2931	2.8943	1.0198	0.2127	1.8762
QL4-04	QL	Quirke	Exposure	2004	371.6757	21.3841	36887.79	2546.0208	19.5452	1.8186	171.1	4.5	.	.	.	.	.	.	.	.	67	2.5713	1.3499	4.5669	3.406	1.3127	0.45	2.2358
QL5-04	QL	Quirke	Exposure	2004	876.1043	84.6797	49262.833	8452.0493	36.4405	3.4959	203.1	3.1	.	.	.	.	.	.	.	.	66	2.9431	1.9329	4.6925	3.927	1.5733	0.6528	2.3098
EL1-04	EL	Elliot	Exposure	2004	226.3341	100.5553	66909.6	7038.7471	78.7511	2.0268	154.4	5.4	14.6	5.63	7.76	9.05	76.1	6.87	64	-13.5	85	2.3567	2.0067	4.8255	3.8476	1.9017	0.481	2.1915
EL2-04	EL	Elliot	Exposure	2004	263.7089	80.8674	85325.025	11886.341	64.0578	1.8519	109.1	6.5	14.9	5.25	7.55	7.53	63	6.68	62	80.6	87	2.4228	1.9131	4.9311	4.0751	1.8133	0.4551	2.0418
EL3-04	EL	Elliot	Exposure	2004	160.8886	51.4064	67948.514	7146.1087	41.9044	1.1776	127.7	6.05	14.9	5.63	7.7	8.21	69.2	6.94	62	88.6	90	2.2092	1.7194	4.8322	3.8541	1.6325	0.338	2.1096
HOL1-04	HOL	Hough	Exposure	2004	109.5407	39.5852	69324.444	7924.9383	47.4272	2.7379	50.9	6.1	15.9	7.63	7.23	12.01	96.7	6.76	171	67	77	2.0435	1.6084	4.8409	3.8991	1.6851	0.5726	1.7152
HOL2-04	HOL	Hough	Exposure	2004	95.2124	32.6008	62732.267	5994.3098	41.2047	2.4839	52.2	5.8	15.5	8.38	7.3	9.17	76.1	6.53	166	38	76	1.9832	1.5263	4.7975	3.7778	1.6254	0.5421	1.7259
HOL3-04	HOL	Hough	Exposure	2004	101.1774	31.1315	60640.591	4462.6821	42.3069	2.2897	65.3	5.5	15	7.25	10.58	11.31	100.4	7	182	103	75	2.0094	1.5069	4.7828	3.6497	1.6366	0.5172	1.8215
MAL1-04	MAL	May	Exposure	2004	118.9082	30.1836	138034.74	4402.4814	26.3027	3.404	55.3	8.4	14.6	8.88	7.38	11.42	95.8	6.66	127	37.1	81	2.0788	1.4939	5.14	3.6438	1.4362	0.6438	1.7505
MAL2-04	MAL	May	Exposure	2004	114.8681	29.1311	97068.042	6436.223	52.1424	2.7819	70.1	9.9	14.6	9.13	6.06	12.7	102.2	6.92	196	202.6	66	2.064	1.479	4.9871	3.8087	1.7254	0.5777	1.8519
MAL3-04	MAL	May	Exposure	2004	134.5019	44.4147	88938.404	9938.6017	48.2076	3.6453	52	7.8	14.6	10.9	7.2	14.37	118.3	7.14	206	274.8	82	2.1319	1.6572	4.9491	3.9974	1.692	0.667	1.7243
ML1-04	ML	McCabe	Exposure	2004	2037.1501	269.5743	112294.2	26134.788	103.1694	13.8287	107.1	10	14	6.75	11.06	9.01	78.9	6.89	27	-22.6	83	3.3092	2.4323	5.0504	4.4172	2.0177	1.1711	2.0338
ML2-04	ML	McCabe	Exposure	2004	6021.8541	210.5578	106117.15	19704.62	80.5409	11.5498	130	8.7	14.5	6.75	9.8	4.11	33	6.13	27	57.7	77	3.7798	2.3254	5.0258	4.2946	1.9114	1.0986	2.1173
ML3-04	ML	McCabe	Exposure	2004	709.9153	62.7304	48253.114	765.6502	61.2656	11.3135	207.7	12	14.5	8.35	11.15	7.58	66.9	6.33	27	48.1	88	2.8518	1.8043	4.6835	2.8846	1.7942	1.0904	2.3195
MCL1-04	MCL	McCarthy	Exposure	2004	246.5407	96.6992	70947	26127.842	49.5114	2.4042	45.4	6.7	15.2	5.6	6.84	10.22	84.4	6.87	85	223.7	86	2.3936	1.9899	4.8509	4.4171	1.7034	0.532	1.6665
MCL2-04	MCL	McCarthy	Exposure	2004	109.3775	53.1524	52527.933	5379.7885	31.5144	0.766	65.7	4.9	14.9	6.13	7.51	10.59	88.7	6.55	80	89.3	94	2.0429	1.7336	4.7204	3.7308	1.5121	0.247	1.8241
MCL3-04	MCL	McCarthy	Exposure	2004	139.1844	70.5199	60174.638	12079.778	36.9915	1.075	68.2	4.7	14.9	6.5	6.56	11.01	89.3	6.93	94	157.9	91	2.1467	1.8544	4.7794	4.0821	1.5797	0.317	1.8401
NL1-04	NL	Nordic	Exposure	2004	152.975	19.6704	59982	524.357	32.1756	2.1236	96.7	7.2	13.5	7.3	8.13	11.03	88.1	7.19	46	-24.5	93	2.1875	1.3153	4.778	2.7205	1.5208	0.4947	1.9899
NL2-04	NL	Nordic	Exposure	2004	313.4627	214.5075	114119.4	33717.413	43.3333	3.5086	38.5	6.6	15.5	8.37	6.48	8.44	68.6	6.48	42	-29.4	82	2.4976	2.3335	5.0574	4.5279	1.6467	0.654	1.5966
NL3-04	NL	Nordic	Exposure	2004	297.7248	168.2365	98868.356	27194.238	35.3701	5.8984	66.9	6.3	15.3	10.67	7.09	11.18	95.5	6.62	45	45.8	81	2.4753	2.2285	4.9951	4.4345	1.5607	0.8387	1.8319

Appendix Table E.34: Supporting Habitat Measures for Benthic Community Stations, 1999, 2004, 2009.

Station	lake	Lake	Exposure Status	Year	Barium (mg/kg)	Cobalt (mg/kg)	Iron (mg/kg)	Manganese (mg/kg)	Nickel (mg/kg)	Ra-226 (Bq/g)	Uranium (mg/kg)	TOC (%)	Depth (m)	Secchi Depth (m)	Water Temperature (°C)	DO (mg/L)	DO (% sat)	pH	Cond (µS/cm)	RedOx (mV)	Fines (%; silt + clay)	log10 (1 + Barium (mg/kg))	log10 (1 + Cobalt (mg/kg))	log10 (1 + Iron (mg/kg))	log10 (1 + Manganese (mg/kg))	log10 (1 + Nickel (mg/kg))	log10 (1 + Ra-226 (Bq/g))	log10 (1 + Uranium (mg/kg))
PL1-04	PL	Pecors	Exposure	2004	108.4242	41.3963	43115	3410.9304	39.5018	0.2881	80.5	3.7	14.9	6.25	6.07	8.87	71.4	6.7	127	147.7	85	2.0391	1.6273	4.6346	3.533	1.6075	0.1099	1.9112
PL2-04	PL	Pecors	Exposure	2004	145.65	51.2981	49972.255	7028.042	45.2239	1.0954	68.2	4.6	14.9	7.8	5.77	9.09	72.7	6.68	125	129	88	2.1663	1.7185	4.6987	3.8469	1.6649	0.3213	1.8401
PL3-04	PL	Pecors	Exposure	2004	125.4195	47.6728	48903.316	8016.9796	38.1043	0.7256	72.2	4.3	14.9	8.85	9.46	9.38	82.1	6.63	114	213.8	87	2.1018	1.6873	4.6893	3.9041	1.5922	0.2369	1.8645
DUL1-09	DUL	Dunlop	Reference	2009	170	18	35000	5300	24	0.07	4.4	11	14.6	7	10.05	8.41	74.6	5.22	.	.	75	2.233	1.2788	4.5441	3.7244	1.3979	0.0294	0.7324
DUL2-09	DUL	Dunlop	Reference	2009	140	12	19000	1800	22	0.07	4.8	8.6	14.8	7.55	10.85	10.38	94	4.94	.	.	72	2.1492	1.1139	4.2788	3.2555	1.3617	0.0294	0.7634
DUL3-09	DUL	Dunlop	Reference	2009	150	16	35000	2300	23	0.14	3.5	6.2	14.5	7.55	9.92	10.1	89.5	4.9	.	.	70	2.179	1.2304	4.5441	3.3619	1.3802	0.0569	0.6532
DUL4-09	DUL	Dunlop	Reference	2009	52	6.8	11000	670	12	0.05	1.8	3.6	14.5	7.4	9.85	10.35	91.5	4.98	.	.	82.9	1.7243	0.8921	4.0414	2.8267	1.1139	0.0212	0.4472
DUL5-09	DUL	Dunlop	Reference	2009	170	19	42000	2600	26	0.11	4.6	9.2	14.6	7.2	9.57	9.24	80.9	5.21	.	.	73	2.233	1.301	4.6233	3.4151	1.4314	0.0453	0.7482
TML1-09	TML	Ten Mile	Reference	2009	110	7.2	10000	560	22	0.1	3.8	13	16.5	11	8.6	15.02	128.8	5.49	.	.	72	2.0453	0.9138	4	2.749	1.3617	0.0414	0.6812
TML2-09	TML	Ten Mile	Reference	2009	95	7.9	11000	660	21	0.06	4.3	10	17.8	10.6	8.69	15.51	132.5	5.99	.	.	77	1.9823	0.9494	4.0414	2.8202	1.3424	0.0253	0.7243
TML3-09	TML	Ten Mile	Reference	2009	51	5	8200	340	12	0.07	2.4	9	17.1	10	10.13	14.75	131.1	5.51	.	.	74	1.716	0.7782	3.9139	2.5328	1.1139	0.0294	0.5315
TML4-09	TML	Ten Mile	Reference	2009	61	6	9300	630	13	0.05	2.7	3.6	17.1	10.65	8.61	15.41	132.8	5.82	.	.	68	1.7924	0.8451	3.9685	2.8	1.1461	0.0212	0.5682
TML5-09	TML	Ten Mile	Reference	2009	91	8.2	10000	400	20	0.04	3.4	5.4	17.7	11.6	8.7	15.64	134.2	6.2	.	.	72	1.9638	0.9638	4	2.6031	1.3222	0.017	0.6435
RL1-09	RL	Rochester	Reference	2009	110	13	27000	590	18	0.1	3.1	9.8	14.7	4.72	6.6	5.65	46.6	5.24	15.2	.	78	2.0453	1.1461	4.4314	2.7716	1.2788	0.0414	0.6128
RL2-09	RL	Rochester	Reference	2009	130	18	50000	790	23	0.17	4.1	12	14.5	4.71	5.9	4.03	32.4	4.38	15.3	.	56	2.1173	1.2788	4.699	2.8982	1.3802	0.0682	0.7076
RL3-09	RL	Rochester	Reference	2009	160	21	28000	710	23	0.14	6.9	16	14.2	4.15	5.2	2.96	23.8	5.27	17	.	64	2.2068	1.3424	4.4472	2.8519	1.3802	0.0569	0.8976
RL4-09	RL	Rochester	Reference	2009	160	24	25000	850	27	0.24	7	18	14.4	4.15	5.1	2.2	17.6	5.21	17.7	.	58	2.2068	1.3979	4.398	2.9299	1.4472	0.0934	0.9031
RL5-09	RL	Rochester	Reference	2009	130	19	24000	610	23	0.12	4.1	15	14.6	4.43	6.4	3.9	32.5	5.29	15.5	.	68	2.1173	1.301	4.3802	2.786	1.3802	0.0492	0.7076
SUL1-09	SUL	Summers	Reference	2009	120	26	34000	2600	21	0.17	2.9	8.7	14.9	6.95	6.9	8.94	73.6	4.69	12	.	62	2.0828	1.4314	4.5315	3.4151	1.3424	0.0682	0.5911
SUL2-09	SUL	Summers	Reference	2009	99	15	21000	2200	17	0.11	2.5	9.3	15	7.46	6.7	8.85	72.3	4.73	12.1	.	64	2	1.2041	4.3222	3.3426	1.2553	0.0453	0.5441
SUL3-09	SUL	Summers	Reference	2009	100	30	46000	1100	20	0.28	2.9	11	14.7	7.16	8.2	7.71	65.9	5.38	12.4	.	65	2.0043	1.4914	4.6628	3.0418	1.3222	0.1072	0.5911
SUL4-09	SUL	Summers	Reference	2009	86	10	17000	290	18	0.14	2.8	11	14.9	6.88	9	4.85	42.4	4.78	13.7	.	56	1.9395	1.0414	4.2305	2.4639	1.2788	0.0569	0.5798
SUL5-09	SUL	Summers	Reference	2009	88	17	24000	730	17	0.09	2.4	9.6	14.6	6.8	7.9	6.84	58	4.1	12.6	.	76	1.9494	1.2553	4.3802	2.8639	1.2553	0.0374	0.5315
SL1-09	SL	Semiwhite	Reference	2009	390	14	34000	5200	25	0.16	4.8	6.6	14.5	6.8	8.33	9.2	78.4	5.06	.	.	75	2.5922	1.1761	4.5315	3.7161	1.415	0.0645	0.7634
SL2-09	SL	Semiwhite	Reference	2009	360	11	23000	2400	21	0.09	4.3	7.6	14.5	7.15	8.4	9.39	80.1	4.51	.	.	76	2.5575	1.0792	4.3617	3.3804	1.3424	0.0374	0.7243
SL3-09	SL	Semiwhite	Reference	2009	560	14	46000	7800	26	0.27	4	7	14.2	8.5	8.85	9.07	78.3	5.2	.	.	67	2.749	1.1761	4.6628	3.8922	1.4314	0.1038	0.699
SL4-09	SL	Semiwhite	Reference	2009	310	9.9	20000	1900	22	0.07	3.6	7	14.7	7.22	8.96	9.88	85.7	4.95	.	.	75	2.4928	1.0374	4.3011	3.279	1.3617	0.0294	0.6628
SL5-09	SL	Semiwhite	Reference	2009	540	14	49000	8400	24	0.18	4.1	6.7	14.5	7.54	8.42	9.46	82.2	5.12	.	.	72	2.7332	1.1761	4.6902	3.9243	1.3979	0.0719	0.7076
QL1-09	QL	Quirke	Exposure	2009	1400	40	64000	4800	30	7	470	9.6	20.5	11.5	7.42	14.72	122.6	5.75	.	.	55	3.1464	1.6128	4.8062	3.6813	1.4914	0.9031	2.673
QL2-09	QL	Quirke	Exposure	2009	530	26	49000	3100	24	2.2	300	7.2	17.7	7.75	7.02	12.33	101.7	5.19	.	.	73	2.7251	1.4314	4.6902	3.4915	1.3979	0.5051	2.4786
QL3-09	QL	Quirke	Exposure	2009	240	22	42000	2800	16	1.1	180	2.2	20.1	8.5	9.63	13.15	115.9	6.13	.	.	57.2	2.382	1.3617	4.6233	3.4473	1.2304	0.3222	2.2577
QL4-09	QL	Quirke	Exposure	2009	610	20	66000	2000	19	3.5	280	7.5	20.5	11.5	6.79	15.2	124.4	5.66	.	.	59	2.786	1.3222	4.8196	3.3012	1.301	0.6532	2.4487
QL5-09	QL	Quirke	Exposure	2009	750	84	68000	8000	38	4.4	530	5.8	22.7	9.85	10.51	13.52	123.1	5.62	.	.	53	2.8756	1.9294	4.8325	3.9031	1.5911	0.7324	2.7251
EL1-09	EL	Elliot	Exposure	2009	300	80	50000	18000	49	1.7	120	3.7	14.7	5.25	8.96	8.51	73.5	5.48	87	.	61	2.4786	1.9085	4.699	4.2553	1.699	0.4314	2.0828
EL2-09	EL	Elliot	Exposure	2009	200	59	63000	7800	55	1.7	200	6.6	14.6	5.68	9.76	8.52	75	5.15	.	.	71	2.3032	1.7782	4.7993	3.8922	1.7482	0.4314	2.3032
EL3-09	EL	Elliot	Exposure	2009	130	59	40000	3000	47	0.96	150	5	15	5.88	8.86	7.8	67.3	5	74	.	72	2.1173	1.7782	4.6021	3.4773	1.6812	0.2923	2.179
EL4-09	EL	Elliot	Exposure	2009	260	83	47000	16000	58	1.7	160	5.6	15.3	5.9	8.71	9.04	78.1	5.53	66	.	59	2.4166	1.9243	4.6721	4.2041	1.7709	0.4314	2.2068
EL5-09	EL	Elliot	Exposure	2009	200	89	60000	9000	59	1.9	220	6.6	14.8	5.65	10.48	9.1	81.5	6.27	59	.	76	2.3032	1.9542	4.7782	3.9543	1.7782	0.4624	2.3444
HOL1-09	HOL	Hough	Exposure	2009	86	29	55000	3300	41	1.7	89	5.4	14.3	7.63	8.2	7.44	63.6	6.83	110.4	.	63	1.9395	1.4771	4.7404	3.5186	1.6232	0.4314	1.9542
HOL2-09	HOL	Hough	Exposure	2009	72	25	46000	2500	39	1.6	91	6.7	14.5	8.91	8.3	6.84	57.7	.	110.7	.	69	1.8633	1.415	4.6628	3.3981	1.6021	0.415	1.9638
HOL3-09	HOL	Hough	Exposure	2009	84	28	57000	3200	39	2.5	90	6.2	15.5	7.55	7.8	7.36	62.7	6.28	109.2	.	65	1.9294	1.4624	4.7559	3.5053	1.6021	0.5441	1.959
HOL4-09	HOL	Hough	Exposure	2009	90	30	60000	3400	45	2	89	6.2	15.3	7.84	8.2	7.17	62.5	6.33	110.1	.	73	1.959	1.4914	4.7782	3.5316	1.6628	0.4771	1.9542
HOL5-09	HOL	Hough	Exposure	2009	70	22	39000	2000	37	1.7	78	5.5	14.2	7.95	8.5	7.61	65.3	6.28	111	.	74	1.8513	1.3617	4.5911	3.3012	1.5798	0.4314	1.8976
MAL1-09	MAL	May	Exposure	2009	100	25	100000	2400	21	3.3	75	8	14.5	7.85	8.7	7.98	70.7	6.32	125.8	.	62	2.0043	1.415	5	3.3804	1.3424	0.6335	1.8808
MAL2-09	MAL	May	Exposure	2009	260	49	75000	9100	59	1.2	110	9.4	14.3	6.61	7.6	8.67	72.5	.	136.8	.	55	2.4166	1.699	4.8751	3.9591	1.7782	0.3424	2.0453
MAL3-09	MAL	May	Exposure	2009	120	31	67000	5600	39	2.5	97	7.1	14.6	7.5	7.5	8.86	74.5	6.53	137.8	.	47.3	2.0828	1.5051	4.8261	3.7483	1.6021	0.5441	1.9912
MAL4-09	MAL	May	Exposure	2009	140	33	67000	6600	43	2.9	94	6.6	14.3	7.53	7.7	8.63	75.3	6.42	136.5	.	49	2.1492	1.5315	4.8261	3.8196	1.6435	0.5911	1.9777
MAL5-09	MAL	May	Exposure	2009	96	21	59000	3000	32	2.1	86	6.4	14.3	8.26	7.6	8.74	73	6.43	138.2	.	59.7	1.9868	1.3424	4.7709	3.4773	1.5185	0.4914	1.9395
ML1-09	ML	McCabe	Exposure	2009	470	290	100000	18000	160	15	590	8.6	14.6	6.4	10.15	9.17	81.6	6.29	.	.	54	2.673	2.4639	5	4.2553	2.2068	1.2041	2.7716
ML2-09	ML	McCabe	Exposure	2009	1400	220	75000	35000	110	13	280	8	14.7	6.65	10.76	8.51	75.8	6.45	.	.	54.7	3.1464	2.3444	4.8751	4.5441	2.0453	1.1461	2.4487
ML3-09	ML	McCabe	Exposure	2009	4200	76	51000	2000	68	12	230	9.7	14.06	6.63	12.15	6.44	60.1	6.58	.	.	59	3.6234	1.8865	4.7076	3.3012	1.8388	1.1139	2.3636
ML4-09	ML	McCabe	Exposure	2009	4000	150	74000	15000	85	15	270	8.3	15.1	6.66	11.1	8.93	81.3	6.62	.	.	53	3.6022	2.179	4.8692	4.1761	1.9345	1.2041	2.433
ML5-09	ML	McCabe	Exposure	2009	380	140	77000	14000	81	14	260	7	14.6	6.66	9.68	8.1	72.2	6.54	.	.	51.1	2.5809	2.1492	4.8865	4.1462	1.9138	1.1761	2.4166
MCL1-09	MCL	McCarthy	Exposure	2009	180	120	56000	16000	53	2.3	180	5.5	14.9	5.67	7	6.96	58.2	6.13	67.5	.	62	2.2577	2.0828	4.7482	4.2041	1.7324	0.5185	2.2577
MCL2-09	MCL	McCarthy	Exposure	2009	180	120	52000	14000	41	1.2	130	5.5	14.8	5.46	7.1	2.81	23.4	5.61	70.1	.	65	2.2577	2.0828	4.716	4.1462	1.6232	0.3424	2.1173
MCL3-09	MCL	McCarthy	Exposure	2009	130	71	43000	8000	44	0.86	120	3.8	14.5	5.39	8.1	6.11	52.4	6.96	80.4	.	76	2.1173	1.8573	4.6335	3.9031	1.6532	0.2695	2.0828
MCL4-09	MCL	McCarthy	Exposure	2009	190	120	65000	15000	45	2.2	150	5.3	14.4	5.88	8.2	5.14	44.9	5.91	70	.	70	2.281	2.0828	4.8129	4.1761	1.6628	0.5051	2.179
MCL5-09	MCL	McCarthy	Exposure	2009	120	74	33000	8800	33	1.2	110	3.7	14.6	5.86	8.3	6.21	53.1	5.82	80.1	.	74	2.0828	1.8751	4.5185	3.9445	1.5315	0.3424	2.0453
NL1-09	NL	Nordic	Exposure	2009	130	25	33000	300	37	2.3	110	7.6	12.5	7.45	8.6	4.74	41.1	6.63	435.6	.	82	2.1173	1.415	4.5185	2.4786	1.5798	0.5185	2.0453
NL2-09	NL	Nordic	Exposure	2009	330	130	75000	24000	50	5.3	150	5.7	14.8	6.88	7.3	6.51	54.4	6.37	424.1	.	58	2.5198	2.1173	4.8751	4.3802	1.7076	0.7993	2.179
NL3-09	NL	Nordic	Exposure	2009	320	110	59000	26000	38	4.1	130	6.2	14.2	7.58	7.9	7.3	61.9	6.58	427.4	.	55	2.5065	2.0453	4.7709	4.415	1.5911	0.7076	2.1173
NL4-09	NL	Nordic	Exposure	2009	390	130	68000	21000	52	6.8	220	6.8	14.3	7.3	8	6.7	57.3	6.61	428.8	.	57	2.5922	2.1173	4.8325	4.3222	1.7243	0.8921	2.3444
NL5-09	NL	Nordic	Exposure	2009	300	150	110000	26000	43	5.4	160	6.6	14.8	8.42	6.6	6.27	51.6	6.43	424.4	.	60	2.4786	2.179	5.0414	4.415	1.6435	0.8062	2.2068
PL1-09	PL	Pecors	Exposure	2009	96	43	41000	4300	32	0.58	120	4	13.7	6.75	10.8	8.07	72.9	.	89.6	.	75	1.9868	1.6435	4.6128	3.6336	1.5185	0.1987	2.0828
PL2-09	PL	Pecors	Exposure	2009	120	42	43000	4000	42	0.82	110	4.6	14.8	7.88	7.1	7.46	61.4	7	88.7	.	78	2.0828	1.6335	4.6335	3.6022	1.6335	0.2601	2.0453
PL3-09	PL	Pecors	Exposure	2009	89	33	28000	1600	37	0.66	100	3.5	13.5	8.36	7.5	7.51	63.3	6.85	88.2	.	72	1.9542	1.5315	4.4472	3.2044	1.5798	0.2201	2.0043
PL4-09	PL	Pecors	Exposure	2009	110	39	37000	1500	40	0.92	110	5	14.4	8.5	7.4	8.1	67.2	.	88.4	.	69	2.0453	1.6021	4.5682	3.1764	1.6128	0.2833	2.0453
PL5-09	PL	Pecors	Exposure	2009	75	43	18000	3900	26	0.38	130	2.7	14.5	6.775	9.5	8.16	71.6	.	87.7	.	49.1	1.8808	1.6435	4.2553	3.5912	1.4314	0.1399	2.1173

Appendix Table E.35: Univariate Statistics for Supporting Habitat Metrics at SRWMP Lakes, 2009.

						95% Confidence Interval for Mean			
		n	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
Barium (mg/kg)	Dunlop	5	136.400	48.937	21.885	75.637	197.163	52.000	170.000
	Rochester	5	138.000	21.679	9.695	111.081	164.919	110.000	160.000
	Semiwhite	5	432.000	111.669	49.940	293.344	570.656	310.000	560.000
	Summers	5	98.600	13.520	6.046	81.812	115.388	86.000	120.000
	Ten Mile	5	81.600	24.674	11.034	50.963	112.237	51.000	110.000
	Quirke	5	706.000	430.384	192.473	171.608	1240.392	240.000	1400.000
	McCabe	5	2090.000	1879.149	840.381	-243.271	4423.271	380.000	4200.000
	May	5	143.200	67.611	30.236	59.250	227.150	96.000	260.000
	Hough	5	80.400	8.877	3.970	69.378	91.422	70.000	90.000
	Pecors	5	98.000	17.621	7.880	76.121	119.879	75.000	120.000
	Elliot	5	218.000	64.962	29.052	137.340	298.660	130.000	300.000
	Nordic	5	294.000	97.622	43.658	172.787	415.213	130.000	390.000
	McCarthy	5	160.000	32.404	14.491	119.765	200.235	120.000	190.000
Cobalt (mg/kg)	Dunlop	5	14.360	5.005	2.238	8.146	20.574	6.800	19.000
	Rochester	5	19.000	4.062	1.817	13.956	24.044	13.000	24.000
	Semiwhite	5	12.580	1.983	0.887	10.118	15.042	9.900	14.000
	Summers	5	19.600	8.204	3.669	9.414	29.786	10.000	30.000
	Ten Mile	5	6.860	1.341	0.600	5.195	8.525	5.000	8.200
	Quirke	5	38.400	26.661	11.923	5.296	71.504	20.000	84.000
	McCabe	5	175.200	82.007	36.675	73.374	277.026	76.000	290.000
	May	5	31.800	10.733	4.800	18.473	45.127	21.000	49.000
	Hough	5	26.800	3.271	1.463	22.738	30.862	22.000	30.000
	Pecors	5	40.000	4.243	1.897	34.732	45.268	33.000	43.000
	Elliot	5	74.000	14.071	6.293	56.528	91.472	59.000	89.000
	Nordic	5	109.000	49.041	21.932	48.108	169.892	25.000	150.000
	McCarthy	5	101.000	26.038	11.645	68.669	133.331	71.000	120.000
Iron (mg/kg)	Dunlop	5	28400.000	12876.335	5758.472	12411.919	44388.081	11000.000	42000.000
	Rochester	5	30800.000	10848.963	4851.804	17329.233	44270.767	24000.000	50000.000
	Semiwhite	5	34400.000	13088.163	5853.204	18148.900	50651.100	20000.000	49000.000
	Summers	5	28400.000	11674.759	5221.111	13903.872	42896.128	17000.000	46000.000
	Ten Mile	5	9700.000	1034.408	462.601	8415.613	10984.387	8200.000	11000.000
	Quirke	5	57800.000	11584.472	5180.734	43415.978	72184.022	42000.000	68000.000
	McCabe	5	75400.000	17357.995	7762.731	53847.202	96952.798	51000.000	100000.000
	May	5	73600.000	15805.062	7068.239	53975.423	93224.577	59000.000	100000.000
	Hough	5	51400.000	8677.557	3880.722	40625.390	62174.610	39000.000	60000.000
	Pecors	5	33400.000	10358.571	4632.494	20538.135	46261.865	18000.000	43000.000
	Elliot	5	52000.000	9460.444	4230.839	40253.307	63746.693	40000.000	63000.000
	Nordic	5	69000.000	27901.613	12477.981	34355.572	103644.428	33000.000	110000.000
	McCarthy	5	49800.000	12275.993	5489.991	34557.342	65042.658	33000.000	65000.000
Manganese (mg/kg)	Dunlop	5	2534.000	1711.952	765.608	408.331	4659.669	670.000	5300.000
	Rochester	5	710.000	112.250	50.200	570.624	849.376	590.000	850.000
	Semiwhite	5	5140.000	2987.976	1336.263	1429.938	8850.062	1900.000	8400.000
	Summers	5	1384.000	981.035	438.732	165.884	2602.116	290.000	2600.000
	Ten Mile	5	518.000	141.492	63.277	342.314	693.686	340.000	660.000
	Quirke	5	4140.000	2387.048	1067.520	1176.088	7103.912	2000.000	8000.000
	McCabe	5	16800.000	11861.703	5304.715	2071.750	31528.250	2000.000	35000.000
	May	5	5340.000	2734.593	1222.947	1944.554	8735.446	2400.000	9100.000
	Hough	5	2880.000	605.805	270.924	2127.793	3632.207	2000.000	3400.000
	Pecors	5	3060.000	1386.723	620.161	1338.156	4781.844	1500.000	4300.000
	Elliot	5	10760.000	6163.441	2756.374	3107.078	18412.922	3000.000	18000.000
	Nordic	5	19460.000	10904.494	4876.638	5920.282	32999.718	300.000	26000.000
	McCarthy	5	12360.000	3694.320	1652.150	7772.896	16947.104	8000.000	16000.000
Nickel (mg/kg)	Dunlop	5	21.400	5.459	2.441	14.622	28.178	12.000	26.000
	Rochester	5	22.800	3.194	1.428	18.834	26.766	18.000	27.000
	Semiwhite	5	23.600	2.074	0.927	21.025	26.175	21.000	26.000
	Summers	5	18.600	1.817	0.812	16.344	20.856	17.000	21.000
	Ten Mile	5	17.600	4.722	2.112	11.737	23.463	12.000	22.000
	Quirke	5	25.400	8.820	3.945	14.448	36.352	16.000	38.000
	McCabe	5	100.800	36.424	16.289	55.574	146.026	68.000	160.000
	May	5	38.800	14.043	6.280	21.364	56.236	21.000	59.000
	Hough	5	40.200	3.033	1.356	36.434	43.966	37.000	45.000
	Pecors	5	35.400	6.465	2.891	27.372	43.428	26.000	42.000
	Elliot	5	53.600	5.367	2.400	46.937	60.263	47.000	59.000
	Nordic	5	44.000	6.819	3.050	35.533	52.467	37.000	52.000
	McCarthy	5	43.200	7.225	3.231	34.229	52.171	33.000	53.000
Ra-226 (Bq/g)	Dunlop	5	0.088	0.036	0.016	0.043	0.133	0.050	0.140
	Rochester	5	0.154	0.055	0.024	0.086	0.222	0.100	0.240
	Semiwhite	5	0.154	0.080	0.036	0.055	0.253	0.070	0.270
	Summers	5	0.158	0.075	0.033	0.065	0.251	0.090	0.280
	Ten Mile	5	0.064	0.023	0.010	0.035	0.093	0.040	0.100
	Quirke	5	3.640	2.259	1.010	0.835	6.445	1.100	7.000
	McCabe	5	13.800	1.304	0.583	12.181	15.419	12.000	15.000
	May	5	2.400	0.806	0.361	1.399	3.401	1.200	3.300
	Hough	5	1.900	0.367	0.164	1.444	2.356	1.600	2.500
	Pecors	5	0.672	0.211	0.094	0.411	0.933	0.380	0.920
	Elliot	5	1.592	0.364	0.163	1.140	2.044	0.960	1.900
	Nordic	5	4.780	1.684	0.753	2.689	6.871	2.300	6.800
	McCarthy	5	1.552	0.653	0.292	0.741	2.363	0.860	2.300
Uranium (mg/kg)	Dunlop	5	3.820	1.234	0.552	2.288	5.352	1.800	4.800
	Rochester	5	5.040	1.791	0.801	2.816	7.264	3.100	7.000
	Semiwhite	5	4.160	0.439	0.196	3.615	4.705	3.600	4.800
	Summers	5	2.700	0.235	0.105	2.409	2.991	2.400	2.900
	Ten Mile	5	3.320	0.779	0.348	2.353	4.287	2.400	4.300
	Quirke	5	352.000	144.118	64.452	173.054	530.946	180.000	530.000
	McCabe	5	326.000	148.762	66.528	141.288	510.712	230.000	590.000
	May	5	92.400	13.012	5.819	76.244	108.556	75.000	110.000
	Hough	5	87.400	5.320	2.379	80.795	94.005	78.000	91.000
	Pecors	5	114.000	11.402	5.099	99.843	128.157	100.000	130.000
	Elliot	5	170.000	40.000	17.889	120.333	219.667	120.000	220.000
	Nordic	5	154.000	41.593	18.601	102.355	205.645	110.000	220.000
	McCarthy	5	138.000	27.749	12.410	103.545	172.455	110.000	180.000

Appendix Table E.35: Univariate Statistics for Supporting Habitat Metrics at SRWMP Lakes, 2009.

						95% Confidence Interval for Mean			
		n	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
Sediment TOC (%)	Dunlop	5	7.720	2.873	1.285	4.153	11.287	3.600	11.000
	Rochester	5	14.160	3.260	1.458	10.112	18.208	9.800	18.000
	Semiwhite	5	6.980	0.390	0.174	6.496	7.464	6.600	7.600
	Summers	5	9.920	1.038	0.464	8.631	11.209	8.700	11.000
	Ten Mile	5	8.200	3.739	1.672	3.557	12.843	3.600	13.000
	Quirke	5	6.460	2.742	1.226	3.055	9.865	2.200	9.600
	McCabe	5	8.320	0.978	0.437	7.105	9.535	7.000	9.700
	May	5	7.500	1.229	0.550	5.974	9.026	6.400	9.400
	Hough	5	6.000	0.543	0.243	5.326	6.674	5.400	6.700
	Pecors	5	3.960	0.907	0.406	2.834	5.086	2.700	5.000
	Elliot	5	5.500	1.217	0.544	3.989	7.011	3.700	6.600
	Nordic	5	6.580	0.709	0.317	5.700	7.460	5.700	7.600
	McCarthy	5	4.760	0.926	0.414	3.610	5.910	3.700	5.500
Depth (m)	Dunlop	5	14.600	0.122	0.055	14.448	14.752	14.500	14.800
	Rochester	5	14.480	0.192	0.086	14.241	14.719	14.200	14.700
	Semiwhite	5	14.480	0.179	0.080	14.258	14.702	14.200	14.700
	Summers	5	14.820	0.164	0.073	14.616	15.024	14.600	15.000
	Ten Mile	5	17.240	0.527	0.236	16.585	17.895	16.500	17.800
	Quirke	5	20.300	1.778	0.795	18.093	22.507	17.700	22.700
	McCabe	5	14.612	0.371	0.166	14.151	15.073	14.060	15.100
	May	5	14.400	0.141	0.063	14.224	14.576	14.300	14.600
	Hough	5	14.760	0.598	0.268	14.017	15.503	14.200	15.500
	Pecors	5	14.180	0.554	0.248	13.492	14.868	13.500	14.800
	Elliot	5	14.880	0.277	0.124	14.535	15.225	14.600	15.300
	Nordic	5	14.120	0.947	0.424	12.944	15.296	12.500	14.800
	McCarthy	5	14.640	0.207	0.093	14.383	14.897	14.400	14.900
Secchi Depth (m)	Dunlop	5	7.340	0.238	0.107	7.044	7.636	7.000	7.550
	Rochester	5	4.432	0.283	0.126	4.081	4.783	4.150	4.720
	Semiwhite	5	7.442	0.647	0.289	6.638	8.246	6.800	8.500
	Summers	5	7.050	0.265	0.119	6.721	7.379	6.800	7.460
	Ten Mile	5	10.770	0.587	0.262	10.041	11.499	10.000	11.600
	Quirke	5	9.820	1.708	0.764	7.699	11.941	7.750	11.500
	McCabe	5	6.600	0.112	0.050	6.460	6.740	6.400	6.660
	May	5	7.550	0.608	0.272	6.795	8.305	6.610	8.260
	Hough	5	7.976	0.546	0.244	7.298	8.654	7.550	8.910
	Pecors	5	7.653	0.845	0.378	6.604	8.702	6.750	8.500
	Elliot	5	5.672	0.262	0.117	5.347	5.997	5.250	5.900
	Nordic	5	7.526	0.565	0.253	6.825	8.227	6.880	8.420
	McCarthy	5	5.652	0.224	0.100	5.374	5.930	5.390	5.880
DO (% sat)	Dunlop	5	86.100	8.100	3.622	76.043	96.157	74.600	94.000
	Rochester	5	30.580	10.933	4.889	17.005	44.155	17.600	46.600
	Semiwhite	5	80.940	3.097	1.385	77.094	84.786	78.300	85.700
	Summers	5	62.440	12.797	5.723	46.550	78.330	42.400	73.600
	Ten Mile	5	131.880	2.044	0.914	129.342	134.418	128.800	134.200
	Quirke	5	117.540	9.449	4.226	105.807	129.273	101.700	124.400
	McCabe	5	74.200	8.811	3.940	63.260	85.140	60.100	81.600
	May	5	73.200	1.794	0.802	70.972	75.428	70.700	75.300
	Hough	5	62.360	2.830	1.266	58.846	65.874	57.700	65.300
	Pecors	5	67.280	5.017	2.244	61.051	73.509	61.400	72.900
	Elliot	5	75.080	5.324	2.381	68.470	81.690	67.300	81.500
	Nordic	5	53.260	7.792	3.485	43.584	62.936	41.100	61.900
	McCarthy	5	46.400	13.706	6.129	29.382	63.418	23.400	58.200
pH	Dunlop	5	5.050	0.153	0.069	4.860	5.240	4.900	5.220
	Rochester	5	5.078	0.391	0.175	4.592	5.564	4.380	5.290
	Semiwhite	5	4.968	0.272	0.122	4.631	5.305	4.510	5.200
	Summers	5	4.736	0.454	0.203	4.173	5.299	4.100	5.380
	Ten Mile	5	5.802	0.307	0.137	5.421	6.183	5.490	6.200
	Quirke	5	5.670	0.336	0.150	5.253	6.087	5.190	6.130
	McCabe	5	6.496	0.131	0.059	6.333	6.659	6.290	6.620
	May	4	6.425	0.086	0.043	6.288	6.562	6.320	6.530
	Hough	4	6.430	0.268	0.134	6.004	6.856	6.280	6.830
	Pecors	2	6.925	0.106	0.075	5.972	7.878	6.850	7.000
	Elliot	5	5.486	0.491	0.220	4.876	6.096	5.000	6.270
	Nordic	5	6.524	0.117	0.052	6.379	6.669	6.370	6.630
	McCarthy	5	6.086	0.523	0.234	5.437	6.735	5.610	6.960
Fines (%; silt + clay)	Dunlop	5	74.580	4.988	2.231	68.386	80.774	70.000	82.900
	Rochester	5	64.800	8.786	3.929	53.890	75.710	56.000	78.000
	Semiwhite	5	73.000	3.674	1.643	68.438	77.562	67.000	76.000
	Summers	5	64.600	7.266	3.250	55.578	73.622	56.000	76.000
	Ten Mile	5	72.600	3.286	1.470	68.519	76.681	68.000	77.000
	Quirke	5	59.440	7.910	3.537	49.618	69.262	53.000	73.000
	McCabe	5	54.360	2.926	1.309	50.727	57.993	51.100	59.000
	May	5	54.600	6.434	2.877	46.611	62.589	47.300	62.000
	Hough	5	68.800	4.817	2.154	62.819	74.781	63.000	74.000
	Pecors	5	68.620	11.416	5.105	54.445	82.795	49.100	78.000
	Elliot	5	67.800	7.396	3.308	58.617	76.983	59.000	76.000
	Nordic	5	62.400	11.104	4.966	48.612	76.188	55.000	82.000
	McCarthy	5	69.400	5.899	2.638	62.075	76.725	62.000	76.000

Appendix Table E.36: Working file of benthic community abundance for all years, after re-attribution and taxon collapse, (organisms/m^2).

	DUL1-99	DUL2-99	DUL3-99	TML1-99	TML2-99	TML3-99	RL1-99	RL2-99	RL3-99	QL1-99	QL2-99	QL3-99	QL4-99	QL5-99	EL1-99	EL2-99	EL3-99	HOL1-99	HOL2-99	HOL3-99	ML1-99	ML2-99	ML3-99	MCL1-99	MCL2-99	MCL3-99	NL1-99	NL2-99	NL3-99	PL1-99	PL2-99	PL3-99	DUL1-04	DUL2-04	DUL3-04	TML1-04	TML2-04	TML3-04
Hydra	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P. Nemata	290	29	362	43	29	87	-	-	-	-	-	-	58	-	29	493	-	145	29	14	-	-	-	29	-	-	232	-	-	-	-	-	17	35	409	139	270	339
Cl. Turbellaria indeterminate	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	-	17	-
Nais variabilis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Slavina appendiculata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stylaria lacustris	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ilyodrilus templetoni	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Limnodrilus hoffmeisteri	-	-	-	-	-	-	-	812	-	-	-	-	-	-	29	-	-	-	-	-	-	-	-	29	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Limnodrilus udekemianus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhyacodrilus montana	-	-	-	-	-	-	-	-	-	130	14	43	58	58	-	-	-	-	-	-	-	-	-	-	14	14	58	29	-	-	-	29	-	-	-	-	-	-
Tubifex tubifex	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
immatures with hair chaetae	-	58	130	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	26	35	17	-	-	-
immatures without hair chaetae	-	-	-	-	-	-	-	1797	-	-	-	-	-	-	-	29	-	-	-	-	-	-	-	29	-	-	-	-	-	-	-	-	-	-	-	-	-	-
O. Acarina	29	87	116	43	14	-	14	14	43	-	-	-	-	-	-	58	-	-	-	-	58	-	623	29	14	87	-	29	58	-	-	232	9	-	-	-	70	-
O. Harpacticoida	-	116	-	565	130	812	536	174	116	14	-	-	-	-	-	0	-	-	-	-	-	-	-	1884	29	-	-	-	174	-	-	116	96	174	330	1043	374	557
Cl. Ostracoda	1507	2783	406	348	159	188	449	130	58	14	29	-	-	-	14	232	696	754	377	420	8116	2565	-	-	870	1565	6348	812	2464	319	43	406	174	2487	2887	1322	617	661
Crangonyx	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hyalella	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Diaporeia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Monoporeia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	58	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mysis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
O. Collembola	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Dytiscidae immature	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Optioservus larvae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Caenis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hexagenia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eurylophella	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stenonema femoratum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Leptophlebiidae immature	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Pyralidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sialis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Coenagrionidae immature	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cheumatopsyche	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydropsyche (indeterminate)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mystacides	-	-	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oecetis	-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ceraclea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Triaenodes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chimarra	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Agrypnia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fabria	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bezzia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mallochohelea	-	-	87	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	29	-	-	-	-	-	-
Probezzia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sphaeromias	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	29	0	-	-	-	-	-	-	-	-	-	-
Chaoborus flavicans	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chaoborus punctipennis	-	-	-	-	-	-	43	1348	14	-	-	-	-	-	14	-	72	-	-	-	-	-	-	493	72	14	-	-	-	-	-	-	35	-	-	-	-	-
Chironomus	29	522	-	58	72	-	-	739	58	754	290	14	-	-	-	-	-	-	14	-	43	333	116	-	29	-	-	-	-	58	43	-	104	70	43	-	70	-
Cladotanytarsus	-	-	29	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cladopelma	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dicrotendipes	-	-	-	-	-	-	-	43	-	14	14	-	-	-	-	-	-	-	-	-	-	58	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Micropsectra	3130	4232	1623	145	159	-	-	-	-	1899	1464	3913	623	493	101	87	145	145	58	246	-	-	-	-	1101	420	580	638	1014	72	-	928	-	104	826	8557	252	3061
Microtendipes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nilothauma	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pagastiella	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Paracladopelma	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Paralauterborniella	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Paratanytarsus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	58	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polypedilum (includes P. halterale, P. flavum, P. scalaenum, and genus ID)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	29	232	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sergentia	348	174	43	87	101	-	1246	-	159	-	-	-	-	-	58	377	826	159	-	72	681	43	-	14	551	29	1536	377	1188	-	-	-	17	730	-	70	304	-
Stempellina	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stempellinella	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stictochironomus	-	-	-	145	-	29	-	-	-	-	-	-	-	-	87	174	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	348	600	139	157	417
Tanytarsus	1652	-	304	-	-	58	-	14	-	-	-	-	-	-	246	2783	275	-	29	-	333	406	-	-	-	87	-	-	58	-	-	-	174	-	70	1043	-	1043
Tribelos	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potthastia	-	-	14	-	-	-	-	-	-	-	-	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Protanypus	-	29	29	-	14	-	-	-	-	-	-	-	14	-	-	-	-	-	-	-	-	-	-	-	14	87	-	-	29	58	-	-	-	-	61	139	9	35
S.F. Orthocladiinae (including Cricotopus, Heterotanytarsus, Heterotrissocladius, Paracladius, Parakiefferiella, Psectrocladius, Zalutschia, and indeterminate that could not be attributed)	-	116	232	28	29	58	-	246	-	14	14	29	174	-	29	87	72	72	43	58	87	-	-	-	29	188	29	232	-	29	43	841	-	-	104	766	495	347
Ablabesmyia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	-	-	-
Procladius	696	1478	159	174	130	72	101	58	58	-	-	-	-	-	246	319	101	-	-	-	29	87	116	-	-	-	-	-	-	-	-	-	200	174	435	696	200	104
Zavrelimyia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hemerodromia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Simuliidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Menetus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cyclocalyx	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pisidium	174	1710	478	14	14	-	-	-	-	-	-	-	-	-	710	725	261	-	-	-	-	-	-	-	203	580	-	-	-	-	-	-	157	209	1000	70	35	52
Sphaerium nitidum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix Table E.36: Working file of benthic community abundance for all years, after re-attribution and taxon collapse, (organisms/m^2).

	RL1-04	RL2-04	RL3-04	SUL1-04	SUL2-04	SUL3-04	SL1-04	SL2-04	SL3-04	QL1-04	QL2-04	QL3-04	QL4-04	QL5-04	EL1-04	EL2-04	EL3-04	HOL1-04	HOL2-04	HOL3-04	MAL1-04	MAL2-04	MAL3-04	ML1-04	ML2-04	ML3-04	MCL1-04	MCL2-04	MCL3-04	NL1-04	NL2-04	NL3-04	PL1-04	PL2-04	PL3-04	DUL1-09	DUL2-09	DUL3-09
Hydra	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P. Nemata	0	17	0	139	304	43	96	870	157	35	-	-	26	-	17	-	17	17	-	-	-	-	-	35	-	-	-	-	-	17	9	70	-	9	52	174	522	2748
Cl. Turbellaria indeterminate	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nais variabilis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Slavina appendiculata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	70	-
Stylaria lacustris	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ilyodrilus templetoni	-	-	-	-	-	-	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Limnodrilus hoffmeisteri	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Limnodrilus udekemianus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhyacodrilus montana	-	-	-	-	-	-	17	104	-	-	-	139	139	35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	35	226	-	-	-	-	-	-
Tubifex tubifex	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
immatures with hair chaetae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	-	-	-	-	-	-	-	-	-	139	-	-	-	-	-	-	-	-	-	-	70	35	-
immatures without hair chaetae	-	-	-	-	-	-	-	-	104	-	-	-	-	-	-	26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	35	-
O. Acarina	-	17	17	104	17	52	278	-	52	-	-	9	-	35	-	-	52	17	9	35	9	113	52	-	35	183	104	9	52	-	9	17	52	17	87	0	35	104
O. Harpacticoida	1374	1913	504	157	-	452	174	70	-	-	-	-	-	139	26	17	-	-	-	-	17	9	-	-	-	-	9	35	9	-	9	122	35	-	35	70	104	35
Cl. Ostracoda	130	35	-	783	452	122	400	104	678	348	235	913	96	313	243	522	43	1861	1391	1339	652	461	1443	939	0	270	1113	774	2730	3391	3452	4209	1183	478	261	4626	8939	5461
Crangonyx	-	-	-	-	-	-	-	-	-	-	-	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hyalella	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	35
Diaporeia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	157	235	313	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Monoporeia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mysis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
O. Collembola	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Dytiscidae immature	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Optioservus larvae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Caenis	-	-	-	-	-	-	-	-	-	35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hexagenia	-	-	-	-	-	-	-	-	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eurylophella	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stenonema femoratum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Leptophlebiidae immature	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Pyralidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	-	-	-	-	-	-	-
Sialis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Coenagrionidae immature	-	-	-	-	-	-	-	-	-	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cheumatopsyche	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	-	-	-	-	-	-	-	9	-	-	-	-	-	-	-	-	-
Hydropsyche (indeterminate)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	-	-	-	-	-	34	-	-	-	-	9	44	-	-	-	-	-	-	-	-	-
Mystacides	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oecetis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ceraclea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Triaenodes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chimarra	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	-	-	-	-	-	-	-	-	-
Agrypnia	-	-	-	-	-	-	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fabria	-	-	-	-	-	-	-	-	-	-	-	-	-	35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bezzia	-	-	-	-	-	-	-	-	-	35	9	9	-	-	-	-	-	-	26	-	-	-	17	-	-	-	-	-	-	17	9	-	-	-	-	-	-	-
Mallochohelea	-	-	-	-	-	-	-	-	-	-	9	43	-	-	-	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	52	-	-	-	-	-	35
Probezzia	-	-	-	-	-	-	-	-	-	-	-	104	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sphaeromias	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chaoborus flavicans	-	-	-	-	-	-	-	35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17	-	-	-	-	-	-
Chaoborus punctipennis	9	-	-	87	-	26	-	-	-	-	-	-	-	-	296	217	287	-	-	-	-	-	-	-	-	-	183	26	35	-	9	-	-	-	-	-	-	-
Chironomus	61	139	17	87	26	17	-	35	87	139	9	-	52	104	-	-	9	87	-	70	304	-	-	-	-	-	-	78	43	278	43	70	17	930	17	-	-	-
Cladotanytarsus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cladopelma	-	-	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dicrotendipes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	9	-	-	-	35	-	-	-	-	-	-	-	-	-	-	17	-	-	-
Micropsectra	-	-	-	1096	452	1087	1200	591	3670	974	470	2304	600	2609	835	226	374	800	1443	887	52	339	991	104	35	313	1183	339	2191	70	374	1113	1687	26	470	835	591	383
Microtendipes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nilothauma	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pagastiella	-	-	-	-	-	-	-	-	-	-	-	9	9	-	9	-	-	17	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	35
Paracladopelma	-	-	-	-	-	-	-	-	-	-	-	-	9	-	-	-	-	-	-	9	-	-	-	35	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Paralauterborniella	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Paratanytarsus	-	-	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polypedilum (includes P. halterale, P. flavum, P. scalaenum, and genus ID)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sergentia	374	574	96	2191	2104	2087	713	243	226	35	-	-	-	-	-	96	43	174	191	113	530	43	-	70	-	800	122	217	383	904	17	139	330	-	-	522	278	696
Stempellina	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	35	70
Stempellinella	-	-	-	-	-	-	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	209	70
Stictochironomus	-	-	-	626	1026	26	470	383	835	-	-	-	-	-	113	1330	61	17	-	-	-	9	17	-	-	-	35	-	35	-	9	-	-	-	-	209	35	313
Tanytarsus	87	-	-	-	-	-	-	104	17	-	-	-	-	-	52	235	670	-	87	-	9	78	-	104	-	278	-	9	-	191	-	-	-	-	-	348	313	383
Tribelos	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potthastia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Protanypus	9	-	-	35	-	9	17	-	-	-	17	78	52	-	9	17	9	52	9	17	17	-	-	-	-	70	9	43	26	-	9	-	17	-	17	-	35	35
S.F. Orthocladiinae (including Cricotopus, Heterotanytarsus, Heterotrissocladius, Paracladius, Parakiefferiella, Psectrocladius, Zalutschia, and indeterminate that could not be attributed)	-	-	-	365	730	165	539	-	2713	870	348	1261	1217	1774	61	557	435	278	200	113	43	17	157	35	-	-	-	17	148	-	87	70	70	148	765	-	765	1008
Ablabesmyia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	-	-	-	-	-	-	-	-	-	-	-	9	-	-	-	-	-	-	70
Procladius	9	35	9	52	70	296	365	174	417	-	-	-	-	35	43	43	70	17	17	-	-	-	-	104	313	139	-	-	-	-	-	-	17	-	17	209	1043	626
Zavrelimyia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17	-	-	-	-	-	-	-	-
Hemerodromia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Simuliidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Menetus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cyclocalyx	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3061	2435	1670
Pisidium	-	-	-	174	104	26	522	696	1148	-	-	-	-	-	452	609	539	-	-	-	-	-	-	1983	-	165	104	78	157	-	-	-	17	-	-	-	-	-
Sphaerium nitidum	-	-	-	-	-	-	-	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix Table E.36: Working file of benthic community abundance for all years, after re-attribution and taxon collapse, (organisms/m^2).

	DUL4-09	DUL5-09	TML1-09	TML2-09	TML3-09	TML4-09	TML5-09	RL1-09	RL2-09	RL3-09	RL4-09	RL5-09	SUL1-09	SUL2-09	SUL3-09	SUL4-09	SUL5-09	SL1-09	SL2-09	SL3-09	SL4-09	SL5-09	QL1-09	QL2-09	QL3-09	QL4-09	QL5-09	EL1-09	EL2-09	EL3-09	EL4-09	EL5-09	HOL1-09	HOL2-09	HOL3-09	HOL4-09	HOL5-09	MAL1-09
Hydra	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0
P. Nemata	3339	174	139	557	278	226	696	-	9	-	9	-	17	-	-	-	-	-	139	35	487	174	-	35	-	-	-	-	-	9	0	0	26	35	0	0	0	0
Cl. Turbellaria indeterminate	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0
Nais variabilis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0
Slavina appendiculata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0
Stylaria lacustris	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0
Ilyodrilus templetoni	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0
Limnodrilus hoffmeisteri	-	-	-	-	-	-	-	-	148	-	-	-	9	-	-	-	-	17	-	-	-	-	-	-	-	-	-	-	-	9	0	0	0	0	0	0	0	0
Limnodrilus udekemianus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0
Rhyacodrilus montana	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	9	-	17	-	87	-	-	0	0	9	0	0	0	0	0	0
Tubifex tubifex	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0
immatures with hair chaetae	174	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	52	0
immatures without hair chaetae	-	-	-	-	-	-	-	-	252	-	-	-	-	-	-	70	-	70	-	-	-	-	-	-	-	-	-	9	26	35	0	17	0	0	0	0	0	0
O. Acarina	35	104	70	70	17	35	139	-	-	17	-	-	78	17	35	52	52	35	-	-	70	174	9	-	-	-	-	9	-	9	70	0	26	0	26	9	0	130
O. Harpacticoida	1217	417	2157	3687	1113	557	1530	400	191	191	174	835	-	0	626	400	17	661	-	-	70	35	-	-	-	-	-	-	-	-	0	9	0	0	0	0	0	35
Cl. Ostracoda	4557	1148	1322	2643	748	1930	696	61	17	9	-	-	104	17	1148	-	-	70	139	696	626	730	304	35	17	-	52	104	304	183	643	583	661	1287	3522	539	1530	174
Crangonyx	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0
Hyalella	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0
Diaporeia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	35	9	70	43	0	0	0	0	0	0
Monoporeia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0
Mysis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17	-	17	-	-	0	0	0	0	0	0	0	0	0
O. Collembola	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0
F. Dytiscidae immature	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0
Optioservus larvae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0
Caenis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0
Hexagenia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17	9	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0
Eurylophella	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0
Stenonema femoratum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0
F. Leptophlebiidae immature	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0
F. Pyralidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0
Sialis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	9	0	0	0
F. Coenagrionidae immature	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0
Cheumatopsyche	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0
Hydropsyche (indeterminate)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0
Mystacides	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0
Oecetis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0
Ceraclea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0
Triaenodes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0
Chimarra	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0
Agrypnia	-	-	-	-	-	-	-	-	-	-	-	-	9	17	-	-	9	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0
Fabria	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0
Bezzia	-	35	-	-	-	-	-	-	-	-	-	-	-	-	35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	9	0	0	0	0	0
Mallochohelea	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17	-	-	-	-	-	-	-	-	-	-	-	-	0	0	9	0	0	0	0	17	0
Probezzia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0
Sphaeromias	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0
Chaoborus flavicans	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17	-	35	-	-	-	-	-	-	-	-	-	0	0	0	0	0	0	0	0	0
Chaoborus punctipennis	-	-	-	-	-	-	-	-	-	-	17	-	-	35	-	139	17	-	-	-	-	-	-	-	-	-	-	9	61	43	0	17	0	0	0	0	0	0
Chironomus	-	-	-	-	-	383	70	87	287	52	9	313	78	-	35	139	52	17	70	70	-	-	496	348	278	174	52	-	-	-	-	-	-	-	35	17	-	609
Cladotanytarsus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cladopelma	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17	-
Dicrotendipes	-	-	-	-	-	35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17	-
Micropsectra	1113	348	1043	139	243	504	1391	-	-	9	-	-	139	17	1704	626	991	3043	1600	1426	557	3687	9	35	87	17	35	270	374	243	852	313	435	1496	1670	296	1217	104
Microtendipes	-	35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nilothauma	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	-	-	-	-	-	-	-	-	-
Pagastiella	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	26	-	-	-	-	-	-
Paracladopelma	35	-	-	-	-	-	557	-	9	-	-	-	-	-	-	-	-	-	-	-	70	-	-	35	-	-	-	-	-	9	-	-	26	-	-	9	35	-
Paralauterborniella	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Paratanytarsus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polypedilum (includes P. halterale, P. flavum, P. scalaenum, and genus ID)	-	-	-	-	-	-	-	-	-	-	-	-	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	35	9	-	-	-
Sergentia	313	35	70	-	35	104	209	243	191	530	26	174	1217	1391	835	817	870	417	139	452	139	70	-	-	-	17	-	-	70	70	-	296	26	209	87	78	70	1922
Stempellina	-	35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stempellinella	-	-	-	70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	243	70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stictochironomus	174	1357	1183	-	626	557	209	-	-	-	-	-	487	157	417	-	139	296	417	139	626	243	-	-	-	-	-	261	965	939	470	1226	17	-	113	26	35	-
Tanytarsus	70	104	417	70	-	70	-	-	-	-	-	-	-	-	-	-	-	-	-	70	70	-	-	-	-	17	-	-	235	26	104	78	-	-	183	-	348	-
Tribelos	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17	-
Potthastia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Protanypus	104	70	70	-	35	52	70	9	-	-	-	-	9	-	-	-	-	17	-	-	-	-	9	-	-	17	17	35	17	43	-	9	61	35	9	9	-	43
S.F. Orthocladiinae (including Cricotopus, Heterotanytarsus, Heterotrissocladius, Paracladius, Parakiefferiella, Psectrocladius, Zalutschia, and indeterminate that could not be attributed)	1113	800	487	1531	209	1547	5148	-	-	-	-	-	174	157	243	0	313	87	139	452	139	243	661	278	661	1217	817	348	913	1061	2209	965	287	591	948	426	591	183
Ablabesmyia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	70	-	-	-	-	-	-	-	-	-	-	-	-	9	9	-	-	-	-	-
Procladius	348	522	139	139	139	574	-	17	0	26	17	0	43	174	139	70	330	365	209	313	487	452	-	-	-	-	-	-	70	9	104	17	17	-	26	-	-	17
Zavrelimyia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hemerodromia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Simuliidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Menetus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cyclocalyx	1704	2852	-	-	-	122	-	-	-	-	-	-	70	70	70	-	-	296	209	104	487	348	-	-	-	-	-	174	1487	1165	1322	1157	-	-	-	-	-	-
Pisidium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sphaerium nitidum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix Table E.36: Working file of benthic community abundance for all years, after re-attribution and taxon collapse, (organisms/m^2).

	MAL2-09	MAL3-09	MAL4-09	MAL5-09	ML1-09	ML2-09	ML3-09	ML4-09	ML5-09	MCL1-09	MCL2-09	MCL3-09	MCL4-09	MCL5-09	NL1-09	NL2-09	NL3-09	NL4-09	NL5-09	PL1-09	PL2-09	PL3-09	PL4-09	PL5-09
Hydra	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P. Nemata	0	0	35	-	35	70	70	417	9	-	-	-	-	-	9	-	35	35	-	-	-	17	-	-
Cl. Turbellaria indeterminate	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nais variabilis	0	0	0	-	-	70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Slavina appendiculata	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stylaria lacustris	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ilyodrilus templetoni	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Limnodrilus hoffmeisteri	0	0	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Limnodrilus udekemianus	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhyacodrilus montana	0	0	0	-	-	-	-	-	-	70	-	-	-	17	-	17	261	-	-	-	-	-	-	139
Tubifex tubifex	0	0	0	-	-	-	-	-	-	-	-	-	-	-	9	-	-	-	-	-	-	-	-	-
immatures with hair chaetae	0	0	0	-	-	209	70	209	278	-	-	-	-	-	43	-	-	-	35	-	-	-	-	-
immatures without hair chaetae	0	0	43	-	-	-	-	-	-	-	-	-	-	-	17	-	-	-	-	-	-	-	-	-
O. Acarina	209	17	26	-	-	-	35	-	52	35	-	104	9	122	9	35	113	35	87	35	35	52	87	139
O. Harpacticoida	0	0	0	-	-	-	-	-	-	-	-	-	-	261	9	43	78	52	-	-	-	-	-	139
Cl. Ostracoda	1374	2922	1061	783	2261	1670	3061	2157	1435	1270	417	1461	470	2278	278	496	287	417	835	1217	226	1826	957	1252
Crangonyx	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hyalella	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Diaporeia	0	0	0	-	-	-	-	-	-	243	17	-	96	-	-	-	-	-	-	-	-	-	-	-
Monoporeia	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mysis	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
O. Collembola	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Dytiscidae immature	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	9	-	-	-	-	-	-	-
Optioservus larvae	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Caenis	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	17	-	17	-	-	-	-	-	-
Hexagenia	0	17	0	-	-	17	-	70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eurylophella	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stenonema femoratum	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Leptophlebiidae immature	0	0	0	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Pyralidae	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sialis	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
F. Coenagrionidae immature	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cheumatopsyche	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydropsyche (indeterminate)	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mystacides	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Oecetis	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ceraclea	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Triaenodes	0	0	0	-	-	-	-	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chimarra	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Agrypnia	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	-	-
Fabria	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bezzia	0	0	0	-	-	-	-	-	-	-	-	-	9	-	17	9	9	17	17	-	-	-	-	-
Mallochohelea	0	0	0	-	-	-	-	-	9	-	-	-	-	-	-	-	9	-	-	-	-	17	-	-
Probezzia	0	0	0	-	-	-	-	-	-	-	-	-	-	-	87	26	-	-	35	-	-	-	-	-
Sphaeromias	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chaoborus flavicans	0	0	0	-	-	-	-	-	-	-	-	-	-	-	-	9	-	-	-	-	-	-	-	-
Chaoborus punctipennis	0	0	0	-	-	-	-	-	-	70	35	52	52	52	-	-	-	-	-	-	35	52	-	-
Chironomus	35	87	43	-	-	-	-	70	-	-	17	313	-	-	791	96	122	17	17	-	17	-	-	-
Cladotanytarsus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cladopelma	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dicrotendipes	-	-	-	-	-	70	70	70	17	-	-	-	-	-	-	-	-	-	-	35	9	-	-	-
Micropsectra	1757	2574	270	261	661	-	35	-	17	1583	383	226	1226	1061	52	365	322	191	1061	1078	1652	3374	3322	2643
Microtendipes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nilothauma	-	-	-	-	-	-	-	-	17	-	-	-	-	-	9	-	-	-	-	-	-	-	-	-
Pagastiella	-	-	-	-	-	-	-	-	-	-	-	-	52	-	-	-	-	-	-	-	-	-	-	557
Paracladopelma	-	-	-	-	35	-	-	70	-	-	-	-	-	17	-	9	9	-	-	-	-	-	35	-
Paralauterborniella	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Paratanytarsus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Polypedilum (includes P. halterale, P. flavum, P. scalaenum, and genus ID)	-	-	26	-	-	0	70	279	17	-	-	-	-	-	-	-	-	-	-	-	-	17	-	-
Sergentia	365	52	61	-	-	0	104	-	35	243	591	261	574	522	17	0	130	35	17	0	17	139	17	139
Stempellina	-	-	-	-	-	70	-	70	1113	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Stempellinella	-	-	-	-	-	487	383	139	852	-	-	-	-	-	-	-	-	-	-	-	-	-	-	139
Stictochironomus	70	122	113	87	-	-	-	-	-	17	-	17	-	-	-	200	9	17	-	-	-	-	-	-
Tanytarsus	-	-	78	-	174	139	104	70	670	504	-	174	104	400	43	104	-	104	139	243	-	1496	-	557
Tribelos	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potthastia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Protanypus	-	35	35	104	35	0	35	-	9	35	35	174	-	104	-	35	9	52	-	35	139	52	35	-
S.F. Orthocladiinae (including Cricotopus, Heterotanytarsus, Heterotrissocladius, Paracladius, Parakiefferiella, Psectrocladius, Zalutschia, and indeterminate that could not be attributed)	313	487	191	435	939	974	174	835	2382	1565	17	1687	122	609	17	887	661	1774	1113	3443	861	678	1200	7791
Ablabesmyia	-	-	-	-	-	-	-	70	-	-	-	-	-	17	-	-	-	-	-	-	-	-	-	139
Procladius	-	-	-	-	70	487	696	487	513	70	-	-	-	35	-	-	-	-	-	35	-	52	52	139
Zavrelimyia	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-
Hemerodromia	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-
Simuliidae	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-	-	-	-	-	-
Menetus	-	-	-	-	-	-	-	-	-	-	-	-	-	17	-	-	-	-	-	-	-	-	-	-
Cyclocalyx	-	-	-	-	1148	904	1913	974	443	243	52	330	148	678	-	-	-	-	-	-	-	70	435	-
Pisidium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sphaerium nitidum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix Table E.37a: Taxon scores from correspondence analysis of benthic abundance data at SRWMP stations: 1999, 2004, and 2009.

	CA Axis-1 (14.4%)	CA Axis-2 12.7%)	CA Axis-3 (9.1%)	CA Axis-4 (8.9%)	CA Axis-5 (7.6%)
P. Nemata	-0.206	0.116	-0.210	0.217	0.298
Rhyacodrilus montana	1.908	0.061	-0.296	-0.193	-0.640
immatures with hair chaetae	-0.958	1.150	-0.142	1.301	-0.573
immatures without hair chaetae	-0.772	-0.860	1.493	-0.693	-1.198
O. Acarina	0.026	-0.158	0.065	0.023	0.131
O. Harpacticoida	-0.183	-0.756	0.283	0.334	0.357
Cl. Ostracoda	0.117	0.102	-0.030	0.030	0.021
Bezzia	0.789	0.440	0.311	-0.034	0.383
Chaoborus punctipennis	-0.496	-0.828	0.210	-0.734	-0.925
Chironomus	0.481	-0.418	0.409	0.561	-0.051
Dicrotendipes	-0.093	1.087	0.602	1.149	-1.295
Micropsectra	0.326	0.095	-0.143	-0.149	-0.015
Paracladopelma	0.099	0.759	0.550	0.292	0.226
Sergentia	-0.094	-0.314	0.039	0.015	0.148
Stictochironomus	-0.311	0.018	-0.133	-0.474	0.382
Tanytarsus	-0.400	0.315	-0.217	0.004	-0.270
Protanypus	0.208	0.110	-0.056	-0.284	0.029
S.F. Orthocladiinae (including Cricotopus, Heterotanytarsus, Heterotrissocladius, Paracladius, Parakiefferiella, Psectrocladius, Zalutschia, and indeterminate that could not be attributed)	0.284	0.244	0.033	-0.132	-0.003
Procladius	-0.504	0.008	-0.099	0.225	0.083
Cyclocalyx	-0.628	0.913	0.598	-0.579	0.173
Pisidium	-0.475	-0.548	-1.298	0.069	-0.477

Organism contributing to positive load on CA axis.
Organism contributing to negative load on CA axis.

Appendix Table E.37b: Eigenvalues and inertia from correspondence analysis of benthic abundance data at SRWMP stations: 1999, 2004, and 2009.

	CA Axis-1 (14.4%)	CA Axis-2 12.7%)	CA Axis-3 (9.1%)	CA Axis-4 (8.9%)	CA Axis-5 (7.6%)
Eigenvalue	0.17458	0.15456	0.11053	0.10766	0.092305
Relative Inertia, percent	14.35	12.71	9.09	8.85	7.59
Cumulative Inertia, percent	14.35	27.06	36.15	45	52.59

Appendix Table E.38a: Taxon scores from correspondence analysis of benthic abundance data at SRWMP stations: 1999, 2004, and 2009. (Rochester Lake excluded)

	CA Axis-1 (16.2%)	CA Axis-2 (12.9%)	CA Axis-3 (9.7%)	CA Axis-4 (7.8%)
P. Nemata	-0.248	-0.023	0.234	-0.108
Rhyacodrilus montana	1.787	-0.108	0.142	1.459
immatures with hair chaetae	-1.090	-1.083	1.204	0.403
O. Acarina	0.048	0.125	-0.065	-0.193
O. Harpacticoida	-0.092	0.447	0.023	-0.167
Cl. Ostracoda	0.098	-0.092	0.023	-0.089
Bezzia	0.708	-0.514	-0.217	-0.925
Chaoborus punctipennis	-0.312	0.970	-0.566	0.651
Chironomus	0.642	-0.045	0.390	-0.495
Dicrotendipes	-0.188	-1.540	1.051	0.347
Micropsectra	0.282	0.016	-0.052	0.082
Paracladopelma	-0.009	-0.944	-0.053	-0.205
Sergentia	-0.062	0.229	-0.091	-0.116
Stictochironomus	-0.320	0.233	-0.388	-0.155
Tanytarsus	-0.452	-0.132	0.143	0.204
Protanypus	0.173	0.004	-0.254	-0.008
S.F. Orthocladiinae (including Cricotopus, Heterotanytarsus, Heterotrissocladius, Paracladius, Parakiefferiella, Psectrocladius, Zalutschia, and indeterminate that could not be attributed)	0.238	-0.180	-0.115	-0.031
Procladius	-0.539	-0.003	0.190	0.043
Cyclocalyx	-0.721	-0.777	-0.890	0.346
Pisidium	-0.449	1.063	0.792	0.346

(blue) Organism contributing to positive load on CA axis.
(pink) Organism contributing to negative load on CA axis.

Appendix Table E.38b: Eigenvalues and inertia from correspondence analysis of benthic abundance data at SRWMP stations: 1999, 2004, and 2009. (Rochester Lake excluded)

	CA Axis-1 (16.2%)	CA Axis-2 (12.9%)	CA Axis-3 (9.7%)	CA Axis-4 (7.8%)
Eigenvalue	0.17616	0.141	0.1062	0.085535
Relative Inertia, percent	16.15	12.93	9.74	7.84
Cumulative Inertia, percent	16.15	29.08	38.82	46.66

Appendix Table E.39a: Taxon scores from correspondence analysis of benthic abundance data at SRWMP stations: 2009. (Rochester Lake excluded)

	2009 CA Axis-1 (20.0%)	2009 CA Axis-2 (14.5%)	2009 CA Axis-3 (11.%)	2009 CA Axis-4 (8.6%)
P. Nemata	0.485	0.074	-0.595	0.049
Rhyacodrilus montana	-1.439	1.027	0.397	-1.837
immatures with hair chaetae	1.467	1.062	0.173	-0.114
O. Acarina	-0.175	-0.102	-0.121	-0.030
O. Harpacticoida	-0.079	-0.298	-0.853	-0.450
Cl. Ostracoda	0.020	0.119	0.049	0.046
Bezzia	-0.351	0.451	-0.555	-0.287
Chaoborus punctipennis	-0.410	-0.899	1.210	-0.037
Chironomus	-0.827	0.615	-0.099	0.394
Dicrotendipes	1.351	1.164	0.624	0.281
Micropsectra	-0.203	-0.057	0.046	0.092
Paracladopelma	0.179	0.601	-0.428	0.533
Sergentia	-0.146	-0.281	0.045	0.108
Stictochironomus	-0.051	-0.447	-0.203	0.154
Tanytarsus	0.367	0.113	0.229	-0.289
Protanypus	-0.236	0.006	0.170	0.195
S.F. Orthocladiinae (including Cricotopus, Heterotanytarsus, Heterotrissocladius, Paracladius, Parakiefferiella, Psectrocladius, Zalutschia, and indeterminate that could not be attributed)	-0.149	0.186	0.105	0.052
Procladius	0.424	-0.252	-0.090	-0.197
Cyclocalyx	0.506	-0.331	0.302	-0.112

Organism contributing to positive load on CA axis. (blue: Axis-1 immatures with hair chaetae, Dicrotendipes; Axis-2 Rhyacodrilus montana, immatures with hair chaetae, Dicrotendipes; Axis-3 Chaoborus punctipennis)

Organism contributing to negative load on CA axis. (pink: Axis-1 Rhyacodrilus montana, Chironomus; Axis-2 Chaoborus punctipennis; Axis-3 O. Harpacticoida; Axis-4 Rhyacodrilus montana)

Appendix Table E.39b: Eigenvalues and inertia from correspondence analysis of benthic abundance data at SRWMP stations: 2009. (Rochester Lake excluded)

	2009 CA Axis-1 (20.0%)	2009 CA Axis-2 (14.5%)	2009 CA Axis-3 (11.%)	2009 CA Axis-4 (8.6%)
Eigenvalue	0.16725	0.12146	0.0997	0.072146
Relative Inertia, percent	0.2001	0.1453	0.1193	0.0863
Cumulative Inertia, percent	0.2001	0.3455	0.4648	0.5511

Appendix Table E.40: Benthic community metrics by stations, 1999, 2004, 2009.

													CA-All Years, including RL					CA- All Years, excluding RL				CA, 2009 data only			
Station	lake	Lake	Exposure Status	Exposure	Lake Exposure	Replicate	Year	Lab calc. Density, before removal of non-aquatics	Lab calc. Number of Taxa	Density (Ind./m2)	Number of Taxa before Collapsing Taxa and Merging of Years	Number of Taxa	CA Axis-1 (14.4%)	CA Axis-2 12.7%)	CA Axis-3 (9.1%)	CA Axis-4 (8.9%)	CA Axis-5 (7.6%)	CA Axis-1, no RL (16.2%)	CA Axis-2, no RL (12.9%)	CA Axis-3, no RL (9.7%)	CA Axis-4, no RL (7.8%)	2009 CA Axis-1 (20.0%)	2009 CA Axis-2 (14.5%)	2009 CA Axis-3 (11.%)	2009 CA Axis-4 (8.6%)
DUL1-99	DUL	Dunlop	Reference	Ref.	DUL Ref.	1	1999	7855	9	7855	9	9	-0.2369	-0.0997	-0.5514	0.2417	-0.0656	-0.254	0.274	0.467	-0.003	.	.	.	.
DUL2-99	DUL	Dunlop	Reference	Ref.	DUL Ref.	2	1999	11392	12	11392	13	12	-0.1541	-0.1643	-0.3905	0.4925	-0.0686	-0.15	0.22	0.597	-0.07	.	.	.	.
DUL3-99	DUL	Dunlop	Reference	Ref.	DUL Ref.	3	1999	4069	15	4069	16	15	-0.3485	0.2532	-0.641	0.3527	-0.2145	-0.42	0.02	0.604	0.197	.	.	.	.
TML1-99	TML	Ten Mile	Reference	Ref.	TML Ref.	1	1999	1650	11	1650	12	11	-0.1192	-0.3864	-0.1442	0.2067	0.3604	-0.087	0.378	0.164	-0.315	.	.	.	.
TML2-99	TML	Ten Mile	Reference	Ref.	TML Ref.	2	1999	865	11	865	12	11	0.0079	-0.3654	-0.1469	0.3043	0.21	0.036	0.316	0.268	-0.264	.	.	.	.
TML3-99	TML	Ten Mile	Reference	Ref.	TML Ref.	3	1999	1304	6	1304	7	7	-0.3874	-0.1293	-0.0769	0.2079	0.4473	-0.405	0.159	0.088	-0.181	.	.	.	.
RL1-99	RL	Rochester	Reference	Ref.	RL Ref.	1	1999	2389	6	2389	6	6	-0.4092	-0.8215	0.2347	0.0714	0.0722	.	.	.	.	.	.	.	.
RL2-99	RL	Rochester	Reference	Ref.	RL Ref.	2	1999	5375	11	5375	11	11	-0.4017	-0.6431	1.1017	-0.0178	-1.2467	.	.	.	.	.	.	.	.
RL3-99	RL	Rochester	Reference	Ref.	RL Ref.	3	1999	506	7	506	7	7	-0.1849	-0.8278	0.369	0.3301	0.0763	.	.	.	.	.	.	.	.
QL1-99	QL	Quirke	Exposure	Exp. 1	QL Exp. 1	1	1999	3027	7	3027	8	7	1.2249	0.0064	0.2609	0.5499	-0.668	1.216	-0.392	0.569	0.528	.	.	.	.
QL2-99	QL	Quirke	Exposure	Exp. 1	QL Exp. 1	2	1999	1854	6	1854	7	6	1.0937	0.253	0.2571	0.5515	-0.7499	1.071	-0.587	0.605	0.32	.	.	.	.
QL3-99	QL	Quirke	Exposure	Exp. 1	QL Exp. 1	3	1999	4041	6	4041	7	6	1.6058	0.1	-0.1794	-0.1497	-0.4885	1.527	-0.148	0.13	0.895	.	.	.	.
QL4-99	QL	Quirke	Exposure	Exp. 1	QL Exp. 1	4	1999	999	6	999	7	5	1.1795	0.3274	-0.3968	-0.3135	-0.2092	1.038	-0.16	-0.012	0.891	.	.	.	.
QL5-99	QL	Quirke	Exposure	Exp. 1	QL Exp. 1	5	1999	667	2	667	3	2	2.2825	0.2077	-0.6125	-0.507	-0.8657	2.094	-0.088	0.076	2.148	.	.	.	.
EL1-99	EL	Elliot	Exposure	Exp. 6	EL Exp. 6	1	1999	1563	11	1563	11	11	-0.5083	-0.1965	-0.8031	-0.188	-0.2571	-0.521	0.618	0.258	0.31	.	.	.	.
EL2-99	EL	Elliot	Exposure	Exp. 6	EL Exp. 6	2	1999	5451	12	5451	13	12	-0.4748	-0.1545	-0.4003	-0.1323	-0.1996	-0.431	0.363	0.299	0.057	.	.	.	.
EL3-99	EL	Elliot	Exposure	Exp. 6	EL Exp. 6	3	1999	2693	10	2693	11	10	-0.3578	-0.2815	-0.6004	-0.1937	-0.5177	-0.347	0.598	0.176	0.399	.	.	.	.
HOL1-99	HOL	Hough	Exposure	Exp. 4	HOL Exp. 4	1	1999	1333	5	1333	6	5	0.1955	0.1157	-0.1875	0.0065	0.2902	0.14	-0.026	0.012	-0.189	.	.	.	.
HOL2-99	HOL	Hough	Exposure	Exp. 4	HOL Exp. 4	2	1999	709	6	709	7	6	0.2406	0.2454	-0.1268	0.176	0.0014	0.204	-0.206	0.24	-0.194	.	.	.	.
HOL3-99	HOL	Hough	Exposure	Exp. 4	HOL Exp. 4	3	1999	853	5	853	6	5	0.286	0.1239	-0.1643	-0.0699	0.2145	0.23	-0.033	-0.051	-0.151	.	.	.	.
ML1-99	ML	McCabe	Exposure	Exp. 2	ML Exp. 2	1	1999	9434	9	9434	10	8	-0.0257	-0.0285	0.0281	0.2289	0.0179	-0.019	-0.041	0.147	-0.279	.	.	.	.
ML2-99	ML	McCabe	Exposure	Exp. 2	ML Exp. 2	2	1999	3926	9	3926	10	8	-0.1256	0.2812	0.2815	0.8826	-0.6272	-0.121	-0.599	0.776	-0.126	.	.	.	.
ML3-99	ML	McCabe	Exposure	Exp. 2	ML Exp. 2	3	1999	855	3	855	3	3	0.0088	-0.4741	0.3574	0.7422	0.2052	0.119	0.097	0.45	-0.727	.	.	.	.
MCL1-99	MCL	McCarthy	Exposure	Exp. 8	MCL Exp. 8	1	1999	2521	8	2521	8	8	-0.7136	-1.4082	0.9173	-0.4035	-0.6491	-0.357	1.186	-0.397	0.212	.	.	.	.
MCL2-99	MCL	McCarthy	Exposure	Exp. 8	MCL Exp. 8	2	1999	2969	11	2969	12	11	0.2796	-0.5415	-0.3302	-0.1371	-0.3975	0.329	0.642	0.098	0.351	.	.	.	.
MCL3-99	MCL	McCarthy	Exposure	Exp. 8	MCL Exp. 8	3	1999	3230	10	3230	11	10	0.2054	-0.1527	-0.6496	-0.2929	-0.5023	0.18	0.471	0.133	0.522	.	.	.	.
NL1-99	NL	Nordic	Exposure	Exp. 7	NL Exp. 7	1	1999	9363	7	9363	8	7	0.6791	0.065	-0.2657	-0.0534	0.0168	0.602	-0.015	0.057	0.401	.	.	.	.
NL2-99	NL	Nordic	Exposure	Exp. 7	NL Exp. 7	2	1999	2842	6	2842	7	6	0.7988	0.0349	-0.1438	-0.191	-0.0865	0.733	-0.006	-0.107	0.369	.	.	.	.
NL3-99	NL	Nordic	Exposure	Exp. 7	NL Exp. 7	3	1999	5072	7	5072	8	7	0.0463	-0.2416	-0.023	0.0145	0.2126	0.046	0.229	-0.1	-0.159	.	.	.	.
PL1-99	PL	Pecors	Exposure	Exp. 5	PL Exp. 5	1	1999	579	5	579	6	5	0.6478	0.0668	0.1065	0.0303	-0.0066	0.651	-0.152	0.01	-0.367	.	.	.	.
PL2-99	PL	Pecors	Exposure	Exp. 5	PL Exp. 5	2	1999	129	3	129	3	3	0.704	-0.0619	0.4127	0.4663	-0.0363	0.777	-0.281	0.304	-0.701	.	.	.	.
PL3-99	PL	Pecors	Exposure	Exp. 5	PL Exp. 5	3	1999	2842	7	2842	8	7	0.765	-0.1037	-0.0215	-0.061	0.0239	0.719	0.064	-0.07	0.302	.	.	.	.
DUL1-04	DUL	Dunlop	Reference	Ref.	DUL Ref.	1	2004	1009	11	1009	11	11	-0.58	-0.3457	-0.3508	0.5593	-0.401	-0.525	0.406	0.684	0.158	.	.	.	.
DUL2-04	DUL	Dunlop	Reference	Ref.	DUL Ref.	2	2004	4375	11	4375	11	11	-0.3776	-0.2329	-0.4004	0.4661	0.1158	-0.363	0.31	0.543	-0.12	.	.	.	.
DUL3-04	DUL	Dunlop	Reference	Ref.	DUL Ref.	3	2004	6809	15	6809	16	14	-0.2912	-0.046	-0.509	0.2513	0.0349	-0.312	0.243	0.444	-0.007	.	.	.	.
TML1-04	TML	Ten Mile	Reference	Ref.	TML Ref.	1	2004	13993	13	13993	13	12	-0.2018	-0.0865	-0.3976	-0.0228	0.1606	-0.236	0.281	0.105	0.004	.	.	.	.
TML2-04	TML	Ten Mile	Reference	Ref.	TML Ref.	2	2004	2949	16	2949	17	15	-0.0586	-0.2124	-0.132	0.165	0.3298	-0.053	0.229	0.129	-0.29	.	.	.	.
TML3-04	TML	Ten Mile	Reference	Ref.	TML Ref.	3	2004	6668	11	6668	12	10	-0.2264	-0.0307	-0.4537	-0.0487	0.1725	-0.267	0.272	0.124	0.014	.	.	.	.
RL1-04	RL	Rochester	Reference	Ref.	RL Ref.	1	2004	2053	8	2053	8	8	-0.2096	-0.6659	0.2667	0.2868	0.0271	.	.	.	.	.	.	.	.
RL2-04	RL	Rochester	Reference	Ref.	RL Ref.	2	2004	2730	7	2730	7	7	-0.1132	-0.7603	0.3337	0.6709	0.518	.	.	.	.	.	.	.	.
RL3-04	RL	Rochester	Reference	Ref.	RL Ref.	3	2004	677	7	677	7	7	-0.1599	-1.0496	0.4913	0.7026	0.5797	.	.	.	.	.	.	.	.
SUL1-04	SUL	Summers	Reference	Ref.	SUL Ref.	1	2004	5931	14	5931	15	13	-0.1224	-0.4173	-0.2314	-0.0969	0.0521	-0.079	0.535	0.001	-0.085	.	.	.	.
SUL2-04	SUL	Summers	Reference	Ref.	SUL Ref.	2	2004	5294	11	5294	12	10	-0.0955	-0.1478	-0.421	-0.0184	0.2336	-0.103	0.331	0.147	-0.203	.	.	.	.
SUL3-04	SUL	Summers	Reference	Ref.	SUL Ref.	3	2004	4408	13	4408	13	13	-0.1391	-0.4381	-0.1531	-0.0002	0.11	-0.101	0.494	0.016	-0.088	.	.	.	.
SL1-04	SL	Semiwhite	Reference	Ref.	SL Ref.	1	2004	4860	14	4860	15	14	0.0257	-0.2444	-0.4783	-0.0603	0.1516	0.002	0.433	0.123	0.121	.	.	.	.
SL2-04	SL	Semiwhite	Reference	Ref.	SL Ref.	2	2004	3488	13	3488	14	13	0.0461	-0.2743	-0.6094	0.1097	-0.0271	0.03	0.446	0.398	0.327	.	.	.	.
SL3-04	SL	Semiwhite	Reference	Ref.	SL Ref.	3	2004	10217	14	10217	15	14	-0.2375	-0.2593	-0.1828	-0.1256	-0.1934	-0.132	0.34	0.263	-0.11	.	.	.	.
QL1-04	QL	Quirke	Exposure	Exp. 1	QL Exp. 1	1	2004	2575	8	2575	9	8	0.6109	0.123	0.1354	0.1509	0.2543	0.591	-0.224	0.057	-0.653	.	.	.	.
QL2-04	QL	Quirke	Exposure	Exp. 1	QL Exp. 1	2	2004	1289	8	1289	9	8	0.751	0.2992	0.0777	-0.1381	0.1125	0.694	-0.291	-0.149	-0.473	.	.	.	.
QL3-04	QL	Quirke	Exposure	Exp. 1	QL Exp. 1	3	2004	5304	11	5304	12	10	1.1804	0.3286	-0.1618	-0.3517	-0.1706	1.062	-0.239	-0.184	0.423	.	.	.	.
QL4-04	QL	Quirke	Exposure	Exp. 1	QL Exp. 1	4	2004	2574	10	2574	11	10	1.0707	0.2792	-0.025	-0.0183	-0.1593	0.989	-0.33	0.07	0.4	.	.	.	.
QL5-04	QL	Quirke	Exposure	Exp. 1	QL Exp. 1	5	2004	5149	9	5149	10	9	0.683	-0.1748	0.0778	0.1818	-0.0014	0.675	0.02	0.129	0.121	.	.	.	.
EL1-04	EL	Elliot	Exposure	Exp. 6	EL Exp. 6	1	2004	2322	14	2322	14	14	-0.4472	-0.1853	-0.5687	-0.1448	-0.4057	-0.444	0.537	0.197	0.402	.	.	.	.
EL2-04	EL	Elliot	Exposure	Exp. 6	EL Exp. 6	2	2004	4217	14	4217	15	14	-0.4257	-0.4049	-0.2365	-0.4868	-0.471	-0.327	0.645	-0.066	0.274	.	.	.	.
EL3-04	EL	Elliot	Exposure	Exp. 6	EL Exp. 6	3	2004	3018	19	3018	20	18	-0.2892	-0.2522	-0.4941	-0.2554	-0.3524	-0.269	0.558	0.073	0.237	.	.	.	.
HOL1-04	HOL	Hough	Exposure	Exp. 4	HOL Exp. 4	1	2004	3719	14	3719	15	14	0.2277	-0.0186	-0.0182	-0.005	0.2396	0.219	0.022	-0.044	-0.329	.	.	.	.
HOL2-04	HOL	Hough	Exposure	Exp. 4	HOL Exp. 4	2	2004	3652	13	3652	14	12	0.2194	0.3785	0.021	0.0798	-0.1165	0.141	-0.365	0.061	-0.2	.	.	.	.
HOL3-04	HOL	Hough	Exposure	Exp. 4	HOL Exp. 4	3	2004	2776	12	2776	13	12	0.4143	0.214	0.2809	0.2848	-0.118	0.394	-0.396	0.144	-0.289	.	.	.	.
MAL1-04	MAL	May	Exposure	Exp. 3	MAL Exp. 3	1	2004	1651	11	1651	11	11	0.2943	-0.2716	0.1851	0.2177	0.1349	0.341	0.092	0.057	-0.412	.	.	.	.
MAL2-04	MAL	May	Exposure	Exp. 3	MAL Exp. 3	2	2004	1121	9	1121	10	9	0.024	-0.0296	-0.0993	-0.113	0.1767	0	0.12	-0.13	-0.144	.	.	.	.
MAL3-04	MAL	May	Exposure	Exp. 3	MAL Exp. 3	3	2004	2884	11	2884	12	10	0.4976	0.292	-0.0274	-0.2996	0.3138	0.426	-0.164	-0.295	-0.486	.	.	.	.
ML1-04	ML	McCabe	Exposure	Exp. 2	ML Exp. 2	1	2004	3479	10	3479	11	10	-0.2849	0.2733	-0.5464	0.4305	-0.4592	-0.357	-0.1	0.724	0.223	.	.	.	.
ML2-04	ML	McCabe	Exposure	Exp. 2	ML Exp. 2	2	2004	870	5	870	6	4	-0.8535	0.7834	-0.2603	1.2407	-0.3568	-0.975	-0.725	1.138	0.352	.	.	.	.
ML3-04	ML	McCabe	Exposure	Exp. 2	ML Exp. 2	3	2004	2314	8	2314	9	8	-0.2354	-0.1369	-0.6249	-0.0135	-0.1306	-0.263	0.398	0.255	0.102	.	.	.	.
MCL1-04	MCL	McCarthy	Exposure	Exp. 8	MCL Exp. 8	1	2004	2888	9	2888	10	9	-0.1757	-0.5592	-0.4069	-0.421	-0.2707	-0.118	0.834	-0.158	0.21	.	.	.	.
MCL2-04	MCL	McCarthy	Exposure	Exp. 8	MCL Exp. 8	2	2004	1660	12	1660	13	12	0.0351	-0.4907	-0.2331	-0.0306	-0.2531	0.099	0.562	0.111	0.005	.	.	.	.
MCL3-04	MCL	McCarthy	Exposure	Exp. 8	MCL Exp. 8	3	2004	6019	17	6019	18	15	0.0546	-0.4086	-0.2862	-0.1992	-0.1388	0.101	0.558	-0.019	-0.029	.	.	.	.
NL1-04	NL	Nordic	Exposure	Exp. 7	NL Exp. 7	1	2004	5094	8	5094	9	8	0.2666	0.0003	0.0723	0.291	0.1266	0.276	-0.12	0.2	-0.559	.	.	.	.
NL2-04	NL	Nordic	Exposure	Exp. 7	NL Exp. 7	2	2004	4333	16	4333	17	16	0.6473	-0.126	0.0495	-0.1318	-0.0352	0.641	0.09	-0.12	0.043	.	.	.	.
NL3-04	NL	Nordic	Exposure	Exp. 7	NL Exp. 7	3	2004	6505	11	6505	12	11	0.7631	-0.2228	-0.0083	0.1758	0.0333	0.751	0.078	0.148	0.23	.	.	.	.
PL1-04	PL	Pecors	Exposure	Exp. 5	PL Exp. 5	1	2004	3582	10	3582	11	10	0.1385	-0.2995	-0.1825	0.1096	0.1118	0.153	0.31	0.127	-0.197	.	.	.	.
PL2-04	PL	Pecors	Exposure	Exp. 5	PL Exp. 5	2	2004	1643	7	1643	8	6	0.5519	-0.0853	0.2279	0.3952	0.0968	0.601	-0.142	0.279	-0.596	.	.	.	.
PL3-04	PL	Pecors	Exposure	Exp. 5	PL Exp. 5	3	2004	1773	10	1773	11	10	0.1972	0.1265	0.1521	0.3857	-0.0402	0.171	-0.261	0.273	-0.197	.	.	.	.
DUL1-09	DUL	Dunlop	Reference	Ref.	DUL Ref.	1	2009	10124	10	10124	10	10	-0.6042	0.474	0.0422	0.0761	0.2164	-0.679	-0.35	-0.085	0.166	0.595	-0.155	-0.147	-0.205
DUL2-09	DUL	Dunlop	Reference	Ref.	DUL Ref.	2	2009	15514	18	15514	19	17	-0.4598	0.2807	0.2491	-0.0763	0.0178	-0.463	-0.294	-0.119	0.081	0.411	-0.093	-0.125	-0.152
DUL3-09	DUL	Dunlop	Reference	Ref.	DUL Ref.	3	2009	13777	19	13777	19	18	-0.3001	0.2686	0.0236	-0.2069	0.3506	-0.359	-0.133	-0.316	-0.022	0.242	-0.265	-0.179	-0.081

Appendix Table E.40: Benthic community metrics by stations, 1999, 2004, 2009.

													CA-All Years, including RL					CA- All Years, excluding RL				CA, 2009 data only			
Station	lake	Lake	Exposure Status	Exposure	Lake Exposure	Replicate	Year	Lab calc. Density, before removal of non-aquatics	Lab calc. Number of Taxa	Density (Ind./m2)	Number of Taxa before Collapsing Taxa and Merging of Years	Number of Taxa	CA Axis-1 (14.4%)	CA Axis-2 12.7%)	CA Axis-3 (9.1%)	CA Axis-4 (8.9%)	CA Axis-5 (7.6%)	CA Axis-1, no RL (16.2%)	CA Axis-2, no RL (12.9%)	CA Axis-3, no RL (9.7%)	CA Axis-4, no RL (7.8%)	2009 CA Axis-1 (20.0%)	2009 CA Axis-2 (14.5%)	2009 CA Axis-3 (11.%)	2009 CA Axis-4 (8.6%)
DUL4-09	DUL	Dunlop	Reference	Ref.	DUL Ref.	4	2009	14331	14	14331	15	14	-0.3658	0.4246	0.1079	0.1326	0.2739	-0.439	-0.361	-0.064	0.016	0.42	0.011	-0.297	-0.048
DUL5-09	DUL	Dunlop	Reference	Ref.	DUL Ref.	5	2009	8071	15	8071	16	15	-0.2064	0.2801	0.1355	-0.2578	0.441	-0.266	-0.173	-0.424	-0.175	0.148	-0.253	-0.31	-0.181
TML1-09	TML	Ten Mile	Reference	Ref.	TML Ref.	1	2009	7097	12	7097	12	11	-0.1524	-0.072	-0.1131	-0.0603	0.3635	-0.178	0.168	-0.11	-0.165	0.045	-0.254	-0.411	-0.139
TML2-09	TML	Ten Mile	Reference	Ref.	TML Ref.	2	2009	8906	10	8906	10	9	-0.1127	-0.0902	-0.0523	0.2455	0.3219	-0.138	0.084	0.128	-0.164	0.173	-0.069	-0.617	-0.349
TML3-09	TML	Ten Mile	Reference	Ref.	TML Ref.	3	2009	3443	11	3443	11	10	-0.1096	-0.1571	-0.071	-0.0351	0.5179	-0.127	0.218	-0.135	-0.257	0.014	-0.312	-0.586	-0.056
TML4-09	TML	Ten Mile	Reference	Ref.	TML Ref.	4	2009	6800	15	6800	16	14	-0.1302	0.157	0.1987	0.1504	0.124	-0.15	-0.22	-0.004	-0.142	0.128	0.04	-0.188	0.058
TML5-09	TML	Ten Mile	Reference	Ref.	TML Ref.	5	2009	10785	12	10785	13	11	0.1578	-0.0086	0.2057	0.1167	0.4634	0.144	-0.077	-0.099	-0.412	-0.195	0.099	-0.591	0.311
RL1-09	RL	Rochester	Reference	Ref.	RL Ref.	1	2009	817	6	817	6	6	0.0046	-0.7478	0.3812	0.5684	0.4066	.	.	.	.	.	.	.	.
RL2-09	RL	Rochester	Reference	Ref.	RL Ref.	2	2009	1104	8	1104	8	8	-0.2384	-0.9095	1.3352	0.2547	-0.3374	.	.	.	.	.	.	.	.
RL3-09	RL	Rochester	Reference	Ref.	RL Ref.	3	2009	834	7	834	7	7	-0.0186	-0.7337	0.3228	0.5346	0.4097	.	.	.	.	.	.	.	.
RL4-09	RL	Rochester	Reference	Ref.	RL Ref.	4	2009	252	6	252	6	6	-0.4457	-1.0806	0.3784	0.3388	0.0822	.	.	.	.	.	.	.	.
RL5-09	RL	Rochester	Reference	Ref.	RL Ref.	5	2009	1322	3	1322	3	3	0.1427	-1.314	0.7598	0.9588	0.5367	.	.	.	.	.	.	.	.
SUL1-09	SUL	Summers	Reference	Ref.	SUL Ref.	1	2009	2460	14	2460	15	14	-0.0694	0.1055	0.1377	-0.1945	0.3786	-0.084	-0.066	-0.329	-0.25	-0.136	-0.196	-0.081	0.269
SUL2-09	SUL	Summers	Reference	Ref.	SUL Ref.	2	2009	2069	10	2069	11	10	-0.3995	0.0083	0.1739	-0.5595	0.1047	-0.403	0.151	-0.654	0.146	-0.014	-0.691	0.398	0.049
SUL3-09	SUL	Summers	Reference	Ref.	SUL Ref.	3	2009	5287	11	5287	11	11	0.0245	-0.0287	0.2576	-0.083	0.4693	0.017	-0.026	-0.319	-0.409	-0.189	-0.207	-0.38	-0.07
SUL4-09	SUL	Summers	Reference	Ref.	SUL Ref.	4	2009	2313	8	2313	8	8	-0.2903	-1.0074	0.746	-0.1184	-0.477	0.024	0.67	-0.093	-0.097	-0.509	-0.533	0.009	-0.057
SUL5-09	SUL	Summers	Reference	Ref.	SUL Ref.	5	2009	2807	11	2807	11	11	-0.0633	-0.3943	0.1061	-0.1082	0.1447	-0.013	0.375	-0.191	-0.175	-0.357	-0.413	-0.011	0.113
SL1-09	SL	Semiwhite	Reference	Ref.	SL Ref.	1	2009	5425	15	5425	15	15	-0.2741	-0.1814	0.5311	-0.3103	0.116	-0.162	0.021	-0.397	-0.15	-0.096	-0.371	-0.25	-0.028
SL2-09	SL	Semiwhite	Reference	Ref.	SL Ref.	2	2009	3131	10	3131	10	10	-0.1476	0.2474	0.1078	-0.178	0.3857	-0.184	-0.175	-0.291	-0.146	0.035	-0.186	-0.141	0.224
SL3-09	SL	Semiwhite	Reference	Ref.	SL Ref.	3	2009	4035	12	4035	12	12	-0.1543	0.2514	0.0466	-0.1226	0.2332	-0.193	-0.174	-0.192	-0.091	0.054	-0.11	-0.008	0.117
SL4-09	SL	Semiwhite	Reference	Ref.	SL Ref.	4	2009	3985	15	3985	15	15	-0.3135	0.3194	0.1441	-0.1147	0.4346	-0.378	-0.241	-0.303	-0.083	0.267	-0.211	-0.359	0.003
SL5-09	SL	Semiwhite	Reference	Ref.	SL Ref.	5	2009	6165	11	6165	11	11	-0.2326	0.1828	0.0758	-0.2104	0.4559	-0.282	-0.078	-0.358	-0.079	0.159	-0.359	-0.294	-0.048
QL1-09	QL	Quirke	Exposure	Exp. 1	QL Exp. 1	1	2009	1593	7	1593	8	7	0.9688	-0.017	0.1732	0.1552	-0.1616	0.98	-0.181	0.141	-0.086	-0.948	0.801	0.17	-0.079
QL2-09	QL	Quirke	Exposure	Exp. 1	QL Exp. 1	2	2009	870	6	870	7	6	0.5213	0.2724	0.3703	0.4652	0.2017	0.512	-0.517	0.259	-0.559	-0.374	0.81	-0.407	0.747
QL3-09	QL	Quirke	Exposure	Exp. 1	QL Exp. 1	3	2009	1268	6	1268	7	6	1.269	0.014	0.1254	0.1584	-0.3182	1.264	-0.229	0.232	0.204	-1.161	0.991	0.229	-0.366
QL4-09	QL	Quirke	Exposure	Exp. 1	QL Exp. 1	4	2009	1546	6	1546	7	6	0.4636	0.0177	0.1585	0.0974	-0.082	0.484	-0.131	0.059	-0.332	-0.611	0.465	0.219	0.424
QL5-09	QL	Quirke	Exposure	Exp. 1	QL Exp. 1	5	2009	1147	7	1147	8	7	1.3644	0.13	-0.0322	-0.0904	-0.3824	1.307	-0.225	0.069	0.571	-1.151	0.961	0.364	-0.761
EL1-09	EL	Elliot	Exposure	Exp. 6	EL Exp. 6	1	2009	1228	10	1228	10	10	-0.1959	0.2311	0.4409	-0.9259	-0.1293	-0.14	-0.119	-0.875	0.177	-0.124	-0.423	0.42	0.198
EL2-09	EL	Elliot	Exposure	Exp. 6	EL Exp. 6	2	2009	4618	13	4618	14	13	-0.4587	0.1823	0.3616	-0.7589	-0.2466	-0.419	-0.073	-0.687	0.299	0.094	-0.494	0.509	-0.01
EL3-09	EL	Elliot	Exposure	Exp. 6	EL Exp. 6	3	2009	3914	16	3914	17	16	-0.3662	0.2091	0.4393	-0.6874	-0.1326	-0.322	-0.155	-0.671	0.165	0.062	-0.373	0.3	0.153
EL4-09	EL	Elliot	Exposure	Exp. 6	EL Exp. 6	4	2009	5879	9	5879	10	9	-0.2692	0.5678	0.087	-0.493	0.2269	-0.358	-0.34	-0.552	0.114	0.198	-0.264	0.164	-0.072
EL5-09	EL	Elliot	Exposure	Exp. 6	EL Exp. 6	5	2009	4792	17	4792	18	17	-0.2045	0.1221	0.3191	-0.6593	-0.1594	-0.169	-0.059	-0.613	0.38	-0.091	-0.336	0.329	-0.31
HOL1-09	HOL	Hough	Exposure	Exp. 4	HOL Exp. 4	1	2009	2035	13	2035	14	13	0.2023	0.4426	0.1174	0.068	0.1461	0.116	-0.439	-0.03	-0.297	0.085	0.26	-0.167	0.324
HOL2-09	HOL	Hough	Exposure	Exp. 4	HOL Exp. 4	2	2009	3931	8	3931	8	7	0.3258	0.1611	-0.1616	-0.1708	0.196	0.263	-0.042	-0.139	-0.13	-0.159	0.035	0.007	0.311
HOL3-09	HOL	Hough	Exposure	Exp. 4	HOL Exp. 4	3	2009	6950	12	6950	13	12	0.0957	0.0922	-0.0878	-0.1078	0.1131	0.071	-0.009	-0.079	-0.195	-0.199	0.005	0.079	0.169
HOL4-09	HOL	Hough	Exposure	Exp. 4	HOL Exp. 4	4	2009	1574	9	1574	10	9	0.3396	0.1271	0.1187	-0.108	0.248	0.314	-0.136	-0.195	-0.353	-0.39	0.145	-0.038	0.509
HOL5-09	HOL	Hough	Exposure	Exp. 4	HOL Exp. 4	5	2009	4259	12	4259	13	12	-0.1375	0.7905	0.0364	0.4235	-0.3483	-0.25	-0.758	0.392	0.133	0.515	0.59	0.219	0.241
MAL1-09	MAL	May	Exposure	Exp. 3	MAL Exp. 3	1	2009	3269	9	3269	10	9	0.2593	-0.3377	0.2116	0.2327	0.2302	0.308	0.14	0.03	-0.444	-0.489	0.056	-0.182	0.227
MAL2-09	MAL	May	Exposure	Exp. 3	MAL Exp. 3	2	2009	4306	7	4306	8	7	0.2967	-0.0819	0.0291	-0.1116	0.2531	0.302	0.086	-0.158	-0.377	-0.445	-0.029	-0.024	0.364
MAL3-09	MAL	May	Exposure	Exp. 3	MAL Exp. 3	3	2009	6539	10	6539	11	9	0.3646	-0.0016	0.0128	-0.1755	0.2136	0.361	0.031	-0.186	-0.349	-0.482	0.059	0.032	0.442
MAL4-09	MAL	May	Exposure	Exp. 3	MAL Exp. 3	4	2009	2078	14	2078	15	13	-0.0234	-0.0963	0.2576	-0.2572	-0.1231	0.11	0.009	-0.077	-0.27	-0.207	0.062	-0.064	0.27
MAL5-09	MAL	May	Exposure	Exp. 3	MAL Exp. 3	5	2009	1809	6	1809	7	6	0.34	0.3043	-0.1807	-0.5412	0.2258	0.264	-0.053	-0.421	-0.132	-0.287	-0.039	0.127	0.371
ML1-09	ML	McCabe	Exposure	Exp. 2	ML Exp. 2	1	2009	5358	9	5358	9	9	-0.1642	0.7741	0.1717	-0.2479	0.1507	-0.286	-0.632	-0.378	0.153	0.335	0.085	0.083	0.075
ML2-09	ML	McCabe	Exposure	Exp. 2	ML Exp. 2	2	2009	5167	13	5167	13	12	-0.6718	1.1873	0.2155	0.6324	-0.4863	-0.816	-1.174	0.473	0.439	1.203	0.613	0.327	-0.154
ML3-09	ML	McCabe	Exposure	Exp. 2	ML Exp. 2	3	2009	6959	14	6959	15	14	-0.4492	0.8132	0.1781	0.337	-0.2587	-0.557	-0.791	0.185	0.27	0.769	0.297	0.269	-0.031
ML4-09	ML	McCabe	Exposure	Exp. 2	ML Exp. 2	4	2009	6265	17	6265	18	15	-0.4547	1.0476	0.3873	0.7398	-0.3143	-0.567	-1.169	0.484	0.16	0.901	0.774	0.075	0.154
ML5-09	ML	McCabe	Exposure	Exp. 2	ML Exp. 2	5	2009	8294	21	8294	22	18	-0.4776	0.839	0.103	0.3874	-0.301	-0.589	-0.784	0.267	0.29	0.768	0.37	0.306	-0.116
MCL1-09	MCL	McCarthy	Exposure	Exp. 8	MCL Exp. 8	1	2009	5983	14	5983	15	13	0.1035	0.21	-0.0006	-0.5031	-0.2408	0.049	-0.038	-0.438	0.568	-0.232	-0.14	0.555	-0.494
MCL2-09	MCL	McCarthy	Exposure	Exp. 8	MCL Exp. 8	2	2009	1634	9	1634	10	9	0.0497	-0.0199	0.2915	-0.4587	-0.1581	0.071	0.057	-0.559	0.133	-0.356	-0.294	0.63	0.309
MCL3-09	MCL	McCarthy	Exposure	Exp. 8	MCL Exp. 8	3	2009	4834	11	4834	12	11	-0.0166	0.1047	0.2356	-0.3733	-0.0899	-0.008	-0.043	-0.449	0.019	-0.273	-0.133	0.457	0.196
MCL4-09	MCL	McCarthy	Exposure	Exp. 8	MCL Exp. 8	4	2009	2958	11	2958	12	11	-0.0723	0.231	0.2034	-0.5161	-0.1485	-0.103	-0.088	-0.579	0.148	-0.089	-0.3	0.538	-0.079
MCL5-09	MCL	McCarthy	Exposure	Exp. 8	MCL Exp. 8	5	2009	6260	15	6260	16	15	0.0006	0.1318	0.2058	-0.2893	-0.0643	-0.037	-0.088	-0.41	0.346	-0.134	-0.144	0.225	-0.372
NL1-09	NL	Nordic	Exposure	Exp. 7	NL Exp. 7	1	2009	1433	15	1433	16	15	-0.0119	0.0269	0.4529	0.5147	-0.2797	0.121	-0.367	0.533	-0.465	-0.038	0.675	-0.279	0.035
NL2-09	NL	Nordic	Exposure	Exp. 7	NL Exp. 7	2	2009	2470	15	2470	16	15	0.5064	0.1176	0.0917	-0.0677	0.1292	0.471	-0.143	-0.108	-0.142	-0.507	0.362	-0.204	-0.244
NL3-09	NL	Nordic	Exposure	Exp. 7	NL Exp. 7	3	2009	2072	15	2072	16	15	0.7504	-0.0498	0.113	0.0745	0.1508	0.721	-0.079	-0.009	-0.004	-0.675	0.456	-0.322	-0.489
NL4-09	NL	Nordic	Exposure	Exp. 7	NL Exp. 7	4	2009	2833	13	2833	14	13	0.2156	0.0339	0.031	-0.0181	0.2876	0.193	-0.02	-0.096	-0.413	-0.22	0.105	-0.325	0.001
NL5-09	NL	Nordic	Exposure	Exp. 7	NL Exp. 7	5	2009	3391	10	3391	11	10	0.1784	0.4309	-0.0045	0.3302	-0.1082	0.118	-0.42	0.286	-0.25	0.008	0.534	0.062	-0.003
PL1-09	PL	Pecors	Exposure	Exp. 5	PL Exp. 5	1	2009	6191	8	6191	9	8	0.1093	0.5353	-0.0213	0.1529	-0.4094	0.018	-0.493	0.215	0.121	0.257	0.375	0.367	0.062
PL2-09	PL	Pecors	Exposure	Exp. 5	PL Exp. 5	2	2009	3026	9	3026	10	9	0.3139	0.0191	0.1809	-0.1127	-0.4485	0.322	-0.044	-0.098	0.047	-0.329	0.113	0.584	0.384
PL3-09	PL	Pecors	Exposure	Exp. 5	PL Exp. 5	3	2009	7868	14	7868	15	14	-0.1802	0.2062	-0.0076	-0.352	-0.1334	-0.221	-0.027	-0.336	0.228	0.063	-0.253	0.415	-0.049
PL4-09	PL	Pecors	Exposure	Exp. 5	PL Exp. 5	4	2009	6140	9	6140	9	9	0.0302	0.5603	0.2765	-0.2864	0.2338	-0.064	-0.494	-0.487	0.011	0.041	-0.027	0.108	0.22
PL5-09	PL	Pecors	Exposure	Exp. 5	PL Exp. 5	5	2009	13773	12	13773	12	12	0.3969	-0.0037	-0.1342	-0.0066	-0.078	0.34	0.021	0.034	0.379	-0.331	0.169	0.002	-0.825

Appendix Table E.41: Summary statistics for benthic metrics at SRWMP lakes, 2009.

						95% Confidence Interval for Mean			
		n	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
Density (Ind./m2)	Dunlop	5	12363.400	3131.917	1400.636	8474.612	16252.188	8071.000	15514.000
	Rochester	5	865.800	401.560	179.583	367.198	1364.402	252.000	1322.000
	Semiwhite	5	4548.200	1221.868	546.436	3031.051	6065.349	3131.000	6165.000
	Summers	5	2987.200	1313.119	587.245	1356.747	4617.653	2069.000	5287.000
	Ten Mile	5	7406.200	2731.104	1221.387	4015.086	10797.314	3443.000	10785.000
	mean of 4 Ref. Lakes (no RL)	4	6826.250	4120.040	2060.020	270.347	13382.153	2987.200	12363.400
	Quirke	5	1284.800	297.717	133.143	915.135	1654.465	870.000	1593.000
	McCabe	5	6408.600	1277.069	571.123	4822.909	7994.291	5167.000	8294.000
	May	5	3600.200	1921.580	859.357	1214.243	5986.157	1809.000	6539.000
	Hough	5	3749.800	2133.544	954.150	1100.655	6398.945	1574.000	6950.000
	Pecors	5	7399.600	3969.109	1775.040	2471.300	12327.900	3026.000	13773.000
	Elliot	5	4086.200	1745.999	780.835	1918.255	6254.145	1228.000	5879.000
	Nordic	5	2439.800	743.173	332.357	1517.029	3362.571	1433.000	3391.000
	McCarthy	5	4333.800	1991.360	890.563	1861.200	6806.400	1634.000	6260.000
Number of Taxa	Dunlop	5	14.800	3.114	1.393	10.930	18.670	10.000	18.000
	Rochester	5	6.000	1.871	0.837	3.680	8.320	3.000	8.000
	Semiwhite	5	12.600	2.302	1.030	9.740	15.460	10.000	15.000
	Summers	5	10.800	2.168	0.970	8.110	13.490	8.000	14.000
	Ten Mile	5	11.000	1.871	0.837	8.680	13.320	9.000	14.000
	mean of 4 Ref. Lakes (no RL)	4	12.300	1.851	0.926	9.350	15.250	11.000	15.000
	Quirke	5	6.400	0.548	0.245	5.720	7.080	6.000	7.000
	McCabe	5	13.600	3.362	1.503	9.430	17.770	9.000	18.000
	May	5	8.800	2.683	1.200	5.470	12.130	6.000	13.000
	Hough	5	10.600	2.510	1.122	7.480	13.720	7.000	13.000
	Pecors	5	10.400	2.510	1.122	7.280	13.520	8.000	14.000
	Elliot	5	13.000	3.536	1.581	8.610	17.390	9.000	17.000
	Nordic	5	13.600	2.191	0.980	10.880	16.320	10.000	15.000
	McCarthy	5	11.800	2.280	1.020	8.970	14.630	9.000	15.000
CA Axis-1 (14.4%)	Dunlop	5	-0.387	0.153	0.068	-0.577	-0.198	-0.604	-0.206
	Rochester	5	-0.111	0.232	0.104	-0.399	0.176	-0.446	0.143
	Semiwhite	5	-0.224	0.073	0.033	-0.315	-0.134	-0.314	-0.148
	Summers	5	-0.160	0.177	0.079	-0.380	0.061	-0.400	0.025
	Ten Mile	5	-0.069	0.128	0.057	-0.229	0.090	-0.152	0.158
	mean of 4 Ref. Lakes (no RL)	4	-0.210	0.134	0.067	-0.424	0.003	-0.387	-0.069
	Quirke	5	0.917	0.415	0.186	0.402	1.433	0.464	1.364
	McCabe	5	-0.443	0.181	0.081	-0.669	-0.218	-0.672	-0.164
	May	5	0.247	0.157	0.070	0.053	0.442	-0.023	0.365
	Hough	5	0.165	0.196	0.088	-0.079	0.409	-0.138	0.340
	Pecors	5	0.134	0.230	0.103	-0.152	0.420	-0.180	0.397
	Elliot	5	-0.299	0.112	0.050	-0.438	-0.159	-0.459	-0.196
	Nordic	5	0.328	0.300	0.134	-0.045	0.701	-0.012	0.750
	McCarthy	5	0.013	0.067	0.030	-0.070	0.096	-0.072	0.104
CA Axis-2 12.7%)	Dunlop	5	0.346	0.096	0.043	0.226	0.465	0.269	0.474
	Rochester	5	-0.957	0.244	0.109	-1.260	-0.654	-1.314	-0.734
	Semiwhite	5	0.164	0.199	0.089	-0.083	0.411	-0.181	0.319
	Summers	5	-0.263	0.457	0.204	-0.831	0.304	-1.007	0.106
	Ten Mile	5	-0.034	0.119	0.053	-0.182	0.114	-0.157	0.157
	mean of 4 Ref. Lakes (no RL)	4	0.053	0.262	0.131	-0.364	0.470	-0.263	0.346
	Quirke	5	0.083	0.119	0.053	-0.065	0.232	-0.017	0.272
	McCabe	5	0.932	0.178	0.079	0.712	1.153	0.774	1.187
	May	5	-0.043	0.231	0.103	-0.330	0.244	-0.338	0.304
	Hough	5	0.323	0.296	0.132	-0.045	0.690	0.092	0.791
	Pecors	5	0.263	0.272	0.122	-0.075	0.601	-0.004	0.560
	Elliot	5	0.262	0.175	0.078	0.045	0.480	0.122	0.568
	Nordic	5	0.112	0.188	0.084	-0.121	0.345	-0.050	0.431
	McCarthy	5	0.132	0.100	0.045	0.008	0.255	-0.020	0.231
CA Axis-3 (9.1%)	Dunlop	5	0.112	0.090	0.040	0.001	0.223	0.024	0.249
	Rochester	5	0.635	0.428	0.192	0.104	1.167	0.323	1.335
	Semiwhite	5	0.181	0.199	0.089	-0.066	0.428	0.047	0.531
	Summers	5	0.284	0.264	0.118	-0.044	0.612	0.106	0.746
	Ten Mile	5	0.034	0.156	0.070	-0.159	0.227	-0.113	0.206
	mean of 4 Ref. Lakes (no RL)	4	0.153	0.106	0.053	-0.017	0.322	0.034	0.284
	Quirke	5	0.159	0.144	0.064	-0.019	0.337	-0.032	0.370
	McCabe	5	0.211	0.107	0.048	0.079	0.343	0.103	0.387
	May	5	0.066	0.175	0.078	-0.152	0.284	-0.181	0.258
	Hough	5	0.005	0.125	0.056	-0.151	0.160	-0.162	0.119
	Pecors	5	0.059	0.166	0.074	-0.147	0.265	-0.134	0.277
	Elliot	5	0.330	0.145	0.065	0.149	0.510	0.087	0.441
	Nordic	5	0.137	0.183	0.082	-0.090	0.364	-0.005	0.453
	McCarthy	5	0.187	0.111	0.050	0.050	0.325	-0.001	0.292
CA Axis-1, no RL (16.2%)	Dunlop	5	-0.441	0.154	0.069	-0.632	-0.250	-0.679	-0.266
	Rochester	0	.	.	.	.	.	.	.
	Semiwhite	5	-0.240	0.090	0.040	-0.351	-0.128	-0.378	-0.162
	Summers	5	-0.092	0.179	0.080	-0.314	0.131	-0.403	0.024
	Ten Mile	5	-0.090	0.132	0.059	-0.254	0.074	-0.178	0.144
	mean of 4 Ref. Lakes (no RL)	4	-0.216	0.166	0.083	-0.480	0.048	-0.441	-0.090
	Quirke	5	0.909	0.396	0.177	0.418	1.401	0.484	1.307
	McCabe	5	-0.563	0.188	0.084	-0.797	-0.329	-0.816	-0.286
	May	5	0.269	0.095	0.043	0.151	0.387	0.110	0.361
	Hough	5	0.103	0.221	0.099	-0.172	0.378	-0.250	0.314
	Pecors	5	0.079	0.246	0.110	-0.226	0.384	-0.221	0.340
	Elliot	5	-0.282	0.122	0.054	-0.432	-0.131	-0.419	-0.140
	Nordic	5	0.325	0.265	0.118	-0.004	0.653	0.118	0.721
	McCarthy	5	-0.006	0.070	0.031	-0.092	0.081	-0.103	0.071

Appendix Table E.41: Summary statistics for benthic metrics at SRWMP lakes, 2009.

						95% Confidence Interval for Mean			
		n	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
CA Axis-2, no RL (12.9%)	Dunlop	5	-0.262	0.104	0.046	-0.391	-0.133	-0.361	-0.133
	Rochester	0	.	.	.	.	.	.	.
	Semiwhite	5	-0.129	0.102	0.046	-0.256	-0.002	-0.241	0.021
	Summers	5	0.221	0.306	0.137	-0.159	0.600	-0.066	0.670
	Ten Mile	5	0.035	0.181	0.081	-0.190	0.259	-0.220	0.218
	mean of 4 Ref. Lakes (no RL)	4	-0.034	0.209	0.104	-0.366	0.298	-0.262	0.221
	Quirke	5	-0.257	0.151	0.067	-0.444	-0.069	-0.517	-0.131
	McCabe	5	-0.910	0.247	0.110	-1.217	-0.603	-1.174	-0.632
	May	5	0.043	0.074	0.033	-0.049	0.134	-0.053	0.140
	Hough	5	-0.277	0.318	0.142	-0.672	0.118	-0.758	-0.009
	Pecors	5	-0.207	0.262	0.117	-0.533	0.118	-0.494	0.021
	Elliot	5	-0.149	0.113	0.051	-0.290	-0.009	-0.340	-0.059
	Nordic	5	-0.206	0.178	0.080	-0.427	0.015	-0.420	-0.020
	McCarthy	5	-0.040	0.059	0.026	-0.114	0.034	-0.088	0.057
CA Axis-3, no RL (9.7%)	Dunlop	5	-0.202	0.160	0.071	-0.400	-0.003	-0.424	-0.064
	Rochester	0	.	.	.	.	.	.	.
	Semiwhite	5	-0.308	0.078	0.035	-0.405	-0.212	-0.397	-0.192
	Summers	5	-0.317	0.212	0.095	-0.580	-0.054	-0.654	-0.093
	Ten Mile	5	-0.044	0.108	0.048	-0.178	0.090	-0.135	0.128
	mean of 4 Ref. Lakes (no RL)	4	-0.218	0.127	0.064	-0.420	-0.015	-0.317	-0.044
	Quirke	5	0.152	0.092	0.041	0.038	0.266	0.059	0.259
	McCabe	5	0.206	0.351	0.157	-0.230	0.642	-0.378	0.484
	May	5	-0.162	0.167	0.075	-0.370	0.045	-0.421	0.030
	Hough	5	-0.010	0.233	0.104	-0.300	0.279	-0.195	0.392
	Pecors	5	-0.134	0.281	0.126	-0.484	0.215	-0.487	0.215
	Elliot	5	-0.680	0.121	0.054	-0.830	-0.529	-0.875	-0.552
	Nordic	5	0.121	0.280	0.125	-0.226	0.469	-0.108	0.533
	McCarthy	5	-0.487	0.077	0.034	-0.582	-0.392	-0.579	-0.410
2009 CA Axis-1 (20.0%)	Dunlop	5	0.363	0.173	0.078	0.148	0.578	0.148	0.595
	Rochester	0	.	.	.	.	.	.	.
	Semiwhite	5	0.084	0.137	0.061	-0.086	0.254	-0.096	0.267
	Summers	5	-0.241	0.194	0.087	-0.482	0.000	-0.509	-0.014
	Ten Mile	5	0.033	0.142	0.064	-0.144	0.210	-0.195	0.173
	mean of 4 Ref. Lakes (no RL)	4	0.060	0.247	0.124	-0.334	0.454	-0.241	0.363
	Quirke	5	-0.849	0.347	0.155	-1.279	-0.419	-1.161	-0.374
	McCabe	5	0.795	0.313	0.140	0.407	1.183	0.335	1.203
	May	5	-0.382	0.128	0.057	-0.540	-0.224	-0.489	-0.207
	Hough	5	-0.030	0.348	0.156	-0.462	0.403	-0.390	0.515
	Pecors	5	-0.060	0.261	0.117	-0.383	0.264	-0.331	0.257
	Elliot	5	0.028	0.134	0.060	-0.138	0.194	-0.124	0.198
	Nordic	5	-0.286	0.297	0.133	-0.655	0.082	-0.675	0.008
	McCarthy	5	-0.217	0.107	0.048	-0.350	-0.084	-0.356	-0.089
2009 CA Axis-2 (14.5%)	Dunlop	5	-0.151	0.115	0.051	-0.294	-0.008	-0.265	0.011
	Rochester	0	.	.	.	.	.	.	.
	Semiwhite	5	-0.247	0.114	0.051	-0.389	-0.106	-0.371	-0.110
	Summers	5	-0.408	0.213	0.095	-0.672	-0.144	-0.691	-0.196
	Ten Mile	5	-0.099	0.179	0.080	-0.322	0.124	-0.312	0.099
	mean of 4 Ref. Lakes (no RL)	4	-0.226	0.136	0.068	-0.442	-0.010	-0.408	-0.099
	Quirke	5	0.806	0.209	0.093	0.546	1.065	0.465	0.991
	McCabe	5	0.428	0.270	0.121	0.092	0.763	0.085	0.774
	May	5	0.022	0.051	0.023	-0.042	0.085	-0.039	0.062
	Hough	5	0.207	0.237	0.106	-0.087	0.501	0.005	0.590
	Pecors	5	0.075	0.234	0.104	-0.215	0.365	-0.253	0.375
	Elliot	5	-0.378	0.087	0.039	-0.486	-0.270	-0.494	-0.264
	Nordic	5	0.426	0.213	0.095	0.162	0.691	0.105	0.675
	McCarthy	5	-0.202	0.087	0.039	-0.310	-0.095	-0.300	-0.133
2009 CA Axis-3 (11.%)	Dunlop	5	-0.212	0.086	0.039	-0.319	-0.105	-0.310	-0.125
	Rochester	0	.	.	.	.	.	.	.
	Semiwhite	5	-0.210	0.138	0.062	-0.382	-0.039	-0.359	-0.008
	Summers	5	-0.013	0.278	0.124	-0.358	0.332	-0.380	0.398
	Ten Mile	5	-0.479	0.182	0.081	-0.704	-0.253	-0.617	-0.188
	mean of 4 Ref. Lakes (no RL)	4	-0.229	0.191	0.096	-0.533	0.076	-0.479	-0.013
	Quirke	5	0.115	0.301	0.134	-0.258	0.488	-0.407	0.364
	McCabe	5	0.212	0.123	0.055	0.059	0.365	0.075	0.327
	May	5	-0.022	0.115	0.051	-0.164	0.120	-0.182	0.127
	Hough	5	0.020	0.143	0.064	-0.157	0.197	-0.167	0.219
	Pecors	5	0.295	0.237	0.106	0.001	0.589	0.002	0.584
	Elliot	5	0.344	0.130	0.058	0.183	0.506	0.164	0.509
	Nordic	5	-0.214	0.162	0.072	-0.414	-0.013	-0.325	0.062
	McCarthy	5	0.481	0.156	0.070	0.288	0.674	0.225	0.630

Appendix Table E.42: Levene's homogeneity of variance tests for user-defined contrast tests between reference lake means and each exposure Lake, 2009.

	Levene Statistic	df1	df2	Sig.
Density (Ind./m2)	2.345	8	35	0.039
Number of Taxa	1.333	8	35	0.260
CA Axis-1, no RL (16.2%)	3.532	8	35	0.004
CA Axis-2, no RL (12.9%)	4.854	8	35	0.000
CA Axis-3, no RL (9.7%)	1.800	8	35	0.110
Barium (mg/kg)	30.136	8	35	0.000
Cobalt (mg/kg)	5.707	8	35	0.000
Iron (mg/kg)	0.755	8	35	0.643
Manganese (mg/kg)	2.667	8	35	0.021
Nickel (mg/kg)	4.889	8	35	0.000
Ra-226 (Bq/g)	4.004	8	35	0.002
Uranium (mg/kg)	6.604	8	35	0.000
TOC (%)	1.837	8	35	0.103
Depth (m)	2.209	8	35	0.051
Secchi Depth (m)	5.311	8	35	0.000
Water Temperature (°C)	5.105	8	35	0.000
DO (% sat)	3.352	8	35	0.006
pH	1.424	8	30	0.227
Fines (%; silt + clay)	1.031	8	35	0.432

Significant at p-value = 0.05

Table E.43: User-defined contrast tests between reference lake means and each exposure lake, 2009.

		Contrast	Sig. (2-tailed)	Effect Size (# ref. SDs)	Variation from ref. Mean (%)
Density (Ind./m2)	Does not assume equal variances	Ref. Means(-RL) vs. QL	0.07410	-1.34	-81.2
		Ref. Means(-RL) vs. ML	0.85602	-0.10	-6.1
		Ref. Means(-RL) vs. MAL	0.22116	-0.78	-47.3
		Ref. Means(-RL) vs. HOL	0.24253	-0.75	-45.1
		Ref. Means(-RL) vs. PL	0.83952	0.14	8.4
		Ref. Means(-RL) vs. EL	0.28371	-0.67	-40.1
		Ref. Means(-RL) vs. NL	0.12180	-1.06	-64.3
		Ref. Means(-RL) vs. MCL	0.32735	-0.60	-36.5
Number of Taxa	Assume equal variances	Ref. Means(-RL) vs. QL	0.00143	-3.19	-48.0
		Ref. Means(-RL) vs. ML	0.45067	0.70	10.6
		Ref. Means(-RL) vs. MAL	0.04753	-1.89	-28.5
		Ref. Means(-RL) vs. HOL	0.32534	-0.92	-13.8
		Ref. Means(-RL) vs. PL	0.27248	-1.03	-15.4
		Ref. Means(-RL) vs. EL	0.68375	0.38	5.7
		Ref. Means(-RL) vs. NL	0.45067	0.70	10.6
		Ref. Means(-RL) vs. MCL	0.77095	-0.27	-4.1
2009 CA Axis-1 (20.0%)	Assume equal variances	Ref. Means(-RL) vs. QL	0.00001	-3.67	-1520.9
		Ref. Means(-RL) vs. ML	0.00016	2.97	1230.9
		Ref. Means(-RL) vs. MAL	0.01556	-1.79	-739.3
		Ref. Means(-RL) vs. HOL	0.61022	-0.36	-149.5
		Ref. Means(-RL) vs. PL	0.49585	-0.48	-200.1
		Ref. Means(-RL) vs. EL	0.85513	-0.13	-53.5
		Ref. Means(-RL) vs. NL	0.05414	-1.40	-579.3
		Ref. Means(-RL) vs. MCL	0.12037	-1.12	-462.8
2009 CA Axis-2 (14.5%)	Assume equal variances	Ref. Means(-RL) vs. QL	0.00000	7.60	456.1
		Ref. Means(-RL) vs. ML	0.00001	4.82	289.1
		Ref. Means(-RL) vs. MAL	0.05521	1.83	109.6
		Ref. Means(-RL) vs. HOL	0.00142	3.19	191.5
		Ref. Means(-RL) vs. PL	0.02124	2.22	133.3
		Ref. Means(-RL) vs. EL	0.23310	-1.12	-67.1
		Ref. Means(-RL) vs. NL	0.00001	4.81	288.5
		Ref. Means(-RL) vs. MCL	0.84861	0.18	10.6
2009 CA Axis-3 (11.%)	Assume equal variances	Ref. Means(-RL) vs. QL	0.00798	1.80	150.3
		Ref. Means(-RL) vs. ML	0.00095	2.30	192.8
		Ref. Means(-RL) vs. MAL	0.09991	1.08	90.3
		Ref. Means(-RL) vs. HOL	0.04940	1.30	108.8
		Ref. Means(-RL) vs. PL	0.00013	2.74	229.2
		Ref. Means(-RL) vs. EL	0.00004	2.99	250.7
		Ref. Means(-RL) vs. NL	0.90355	0.08	6.5
		Ref. Means(-RL) vs. MCL	0.00000	3.71	310.5
Barium (mg/kg)	Does not assume equal variances	Ref. Means(-RL) vs. QL	0.05270	3.15	277.2
		Ref. Means(-RL) vs. ML	0.08605	11.54	1016.8
		Ref. Means(-RL) vs. MAL	0.64415	-0.27	-23.5
		Ref. Means(-RL) vs. HOL	0.28598	-0.65	-57.0
		Ref. Means(-RL) vs. PL	0.35917	-0.54	-47.6
		Ref. Means(-RL) vs. EL	0.74302	0.19	16.5
		Ref. Means(-RL) vs. NL	0.30750	0.65	57.1
		Ref. Means(-RL) vs. MCL	0.76574	-0.16	-14.5
Cobalt (mg/kg)	Does not assume equal variances	Ref. Means(-RL) vs. QL	0.10333	4.77	187.6
		Ref. Means(-RL) vs. ML	0.01141	30.81	1212.4
		Ref. Means(-RL) vs. MAL	0.01488	3.51	138.2
		Ref. Means(-RL) vs. HOL	0.00722	2.56	100.7
		Ref. Means(-RL) vs. PL	0.00021	5.07	199.6
		Ref. Means(-RL) vs. EL	0.00022	11.54	454.3
		Ref. Means(-RL) vs. NL	0.01161	18.21	716.5
		Ref. Means(-RL) vs. MCL	0.00125	16.68	656.6
Iron (mg/kg)	Assume equal variances	Ref. Means(-RL) vs. QL	0.00267	3.04	129.1
		Ref. Means(-RL) vs. ML	0.00002	4.68	198.9
		Ref. Means(-RL) vs. MAL	0.00003	4.51	191.8
		Ref. Means(-RL) vs. HOL	0.01361	2.44	103.8
		Ref. Means(-RL) vs. PL	0.42252	0.76	32.4
		Ref. Means(-RL) vs. EL	0.01177	2.50	106.1
		Ref. Means(-RL) vs. NL	0.00011	4.08	173.5
		Ref. Means(-RL) vs. MCL	0.01991	2.29	97.4
Manganese (mg/kg)	Does not assume equal variances	Ref. Means(-RL) vs. QL	0.27260	0.87	72.9
		Ref. Means(-RL) vs. ML	0.05205	7.17	601.8
		Ref. Means(-RL) vs. MAL	0.10506	1.47	123.1
		Ref. Means(-RL) vs. HOL	0.66834	0.24	20.3
		Ref. Means(-RL) vs. PL	0.59619	0.33	27.8
		Ref. Means(-RL) vs. EL	0.03563	4.17	349.5
		Ref. Means(-RL) vs. NL	0.02341	8.50	712.9
		Ref. Means(-RL) vs. MCL	0.00178	4.96	416.3

Significant at p-value = 0.1

Effect size more than 2.0 ref. SDs

Table E.43: User-defined contrast tests between reference lake means and each exposure lake, 2009.

		Contrast	Sig. (2-tailed)	Effect Size (# ref. SDs)	Variation from ref. Mean (%)
Nickel (mg/kg)	Does not assume equal variances	Ref. Means(-RL) vs. QL	0.27701	1.87	25.1
		Ref. Means(-RL) vs. ML	0.00763	29.54	396.6
		Ref. Means(-RL) vs. MAL	0.04054	6.79	91.1
		Ref. Means(-RL) vs. HOL	0.00002	7.30	98.0
		Ref. Means(-RL) vs. PL	0.00388	5.54	74.4
		Ref. Means(-RL) vs. EL	0.00002	12.22	164.0
		Ref. Means(-RL) vs. NL	0.00059	8.70	116.7
		Ref. Means(-RL) vs. MCL	0.00099	8.40	112.8
Ra-226 (Bq/g)	Does not assume equal variances	Ref. Means(-RL) vs. QL	0.02514	74.59	3037.9
		Ref. Means(-RL) vs. ML	0.00002	289.65	11796.6
		Ref. Means(-RL) vs. MAL	0.00311	48.34	1969.0
		Ref. Means(-RL) vs. HOL	0.00034	37.76	1537.9
		Ref. Means(-RL) vs. PL	0.00320	11.77	479.3
		Ref. Means(-RL) vs. EL	0.00070	31.24	1272.4
		Ref. Means(-RL) vs. NL	0.00344	98.72	4020.7
		Ref. Means(-RL) vs. MCL	0.00778	30.40	1237.9
Uranium (mg/kg)	Does not assume equal variances	Ref. Means(-RL) vs. QL	0.00567	548.65	9957.1
		Ref. Means(-RL) vs. ML	0.00835	507.72	9214.3
		Ref. Means(-RL) vs. MAL	0.00010	139.96	2540.0
		Ref. Means(-RL) vs. HOL	0.00000	132.09	2397.1
		Ref. Means(-RL) vs. PL	0.00003	173.96	3157.1
		Ref. Means(-RL) vs. EL	0.00074	262.13	4757.1
		Ref. Means(-RL) vs. NL	0.00127	236.94	4300.0
		Ref. Means(-RL) vs. MCL	0.00041	211.75	3842.9
TOC (%)	Assume equal variances	Ref. Means(-RL) vs. QL	0.05568	-1.40	-21.3
		Ref. Means(-RL) vs. ML	0.89696	0.09	1.4
		Ref. Means(-RL) vs. MAL	0.42928	-0.56	-8.6
		Ref. Means(-RL) vs. HOL	0.01721	-1.77	-26.9
		Ref. Means(-RL) vs. PL	0.00003	-3.40	-51.7
		Ref. Means(-RL) vs. EL	0.00414	-2.17	-33.0
		Ref. Means(-RL) vs. NL	0.07377	-1.30	-19.8
		Ref. Means(-RL) vs. MCL	0.00041	-2.76	-42.0
Depth (m)	Assume equal variances	Ref. Means(-RL) vs. QL	0.00000	3.83	32.8
		Ref. Means(-RL) vs. ML	0.24462	-0.51	-4.4
		Ref. Means(-RL) vs. MAL	0.12866	-0.68	-5.8
		Ref. Means(-RL) vs. HOL	0.36224	-0.40	-3.4
		Ref. Means(-RL) vs. PL	0.06009	-0.84	-7.2
		Ref. Means(-RL) vs. EL	0.48109	-0.31	-2.6
		Ref. Means(-RL) vs. NL	0.04806	-0.89	-7.6
		Ref. Means(-RL) vs. MCL	0.26443	-0.49	-4.2
Secchi Depth (m)	Does not assume equal variances	Ref. Means(-RL) vs. QL	0.19765	0.95	20.5
		Ref. Means(-RL) vs. ML	0.17518	-0.88	-19.0
		Ref. Means(-RL) vs. MAL	0.55278	-0.34	-7.4
		Ref. Means(-RL) vs. HOL	0.85870	-0.10	-2.1
		Ref. Means(-RL) vs. PL	0.62922	-0.28	-6.1
		Ref. Means(-RL) vs. EL	0.06513	-1.41	-30.4
		Ref. Means(-RL) vs. NL	0.53644	-0.36	-7.7
		Ref. Means(-RL) vs. MCL	0.06422	-1.42	-30.7
Water Temperature (°C)	Does not assume equal variances	Ref. Means(-RL) vs. QL	0.55334	-0.58	-6.3
		Ref. Means(-RL) vs. ML	0.02070	2.03	21.9
		Ref. Means(-RL) vs. MAL	0.12266	-1.06	-11.5
		Ref. Means(-RL) vs. HOL	0.28056	-0.66	-7.2
		Ref. Means(-RL) vs. PL	0.68184	-0.39	-4.2
		Ref. Means(-RL) vs. EL	0.40729	0.55	5.9
		Ref. Means(-RL) vs. NL	0.09969	-1.20	-13.0
		Ref. Means(-RL) vs. MCL	0.10659	-1.14	-12.4
DO (% sat)	Does not assume equal variances	Ref. Means(-RL) vs. QL	0.16120	0.92	30.1
		Ref. Means(-RL) vs. ML	0.35910	-0.55	-17.9
		Ref. Means(-RL) vs. MAL	0.32939	-0.58	-19.0
		Ref. Means(-RL) vs. HOL	0.15379	-0.95	-31.0
		Ref. Means(-RL) vs. PL	0.21592	-0.78	-25.5
		Ref. Means(-RL) vs. EL	0.37884	-0.52	-16.9
		Ref. Means(-RL) vs. NL	0.08334	-1.26	-41.0
		Ref. Means(-RL) vs. MCL	0.05082	-1.49	-48.6
pH	Assume equal variances	Ref. Means(-RL) vs. QL	0.02793	1.15	10.3
		Ref. Means(-RL) vs. ML	0.00000	2.94	26.4
		Ref. Means(-RL) vs. MAL	0.00001	2.79	25.0
		Ref. Means(-RL) vs. HOL	0.00001	2.80	25.1
		Ref. Means(-RL) vs. PL	0.00000	3.87	34.8
		Ref. Means(-RL) vs. EL	0.14156	0.75	6.8
		Ref. Means(-RL) vs. NL	0.00000	3.00	27.0
		Ref. Means(-RL) vs. MCL	0.00027	2.05	18.4
Fines (%; silt + clay)	Assume equal variances	Ref. Means(-RL) vs. QL	0.02556	-2.62	-16.5
		Ref. Means(-RL) vs. ML	0.00200	-3.76	-23.6
		Ref. Means(-RL) vs. MAL	0.00227	-3.71	-23.3
		Ref. Means(-RL) vs. HOL	0.63759	-0.53	-3.4
		Ref. Means(-RL) vs. PL	0.61261	-0.57	-3.6
		Ref. Means(-RL) vs. EL	0.50497	-0.76	-4.8
		Ref. Means(-RL) vs. NL	0.08975	-1.96	-12.4
		Ref. Means(-RL) vs. MCL	0.72386	-0.40	-2.5

Significant at p-value = 0.1

Effect size more than 2.0 ref. SDs

Appendix Table E.44: Benthic Analyses - ANOVA results testing differences between 3 sample years, SRWMP.

Dependent Variable	Mean Square	F (ANOVA)	p-value	Observed Power
Density (Ind./m2)	34604219.4160	3.6080	0.030000	0.6580
Number of Taxa	152.5830	16.1100	0.000000	1.0000
CA Axis-1, no RL (16.2%)	0.8730	3.6830	0.028000	0.6680
CA Axis-2, no RL (12.9%)	1.5230	12.7560	0.000000	0.9960
CA Axis-3, no RL (9.7%)	1.7330	20.3480	0.000000	1.0000

Significant at p-value = 0.1

Appendix Table E.45: Post-hoc pairwise comparisons between 3 study years, SRWMP.

						post-hoc multiple comparison test		
Dependent Variable	Levene's Test[1]	(I) YEAR	(J) YEAR	Mean Difference (I-J)	Std. Error	p-value adjusted for all possible pairwise comparisons	Lower 95% CL	Upper 95% CL
Density (Ind./m2)	Bonferroni	1999	2004	-766.463	763.659	0.952475	-2619.782	1086.856
		1999	2009	-1806.271	700.444	0.033252	-3506.173	-106.369
		2004	2009	-1039.808	642.094	0.323705	-2598.101	518.485
Number of Taxa	Bonferroni	1999	2004	-3.570	0.759	0.000020	-5.415	-1.732
		1999	2009	-3.760	0.696	0.000001	-5.450	-2.071
		2004	2009	-0.190	0.638	1.000000	-1.735	1.362
CA Axis-1, no RL (16.2%)	Tamhane	1999	2004	0.206	0.140	0.381478	-0.141	0.553
		1999	2009	0.299	0.132	0.084308	-0.030	0.628
		2004	2009	0.093	0.090	0.667440	-0.127	0.313
CA Axis-2, no RL (12.9%)	Bonferroni	1999	2004	-0.052	0.085	1.000000	-0.259	0.155
		1999	2009	0.278	0.078	0.001575	0.089	0.468
		2004	2009	0.331	0.072	0.000029	0.157	0.504
CA Axis-3, no RL (9.7%)	Bonferroni	1999	2004	0.046	0.072	1.000000	-0.129	0.220
		1999	2009	0.355	0.066	0.000001	0.195	0.515
		2004	2009	0.310	0.061	0.000003	0.163	0.456

[1] if variances found to be significantly heterogenous, post-hoc test was Tamhane's T2, and contrast test was t-test for unequal variances. Otherwise, Bonferroni post-hoc and t-test for equal variances were used.

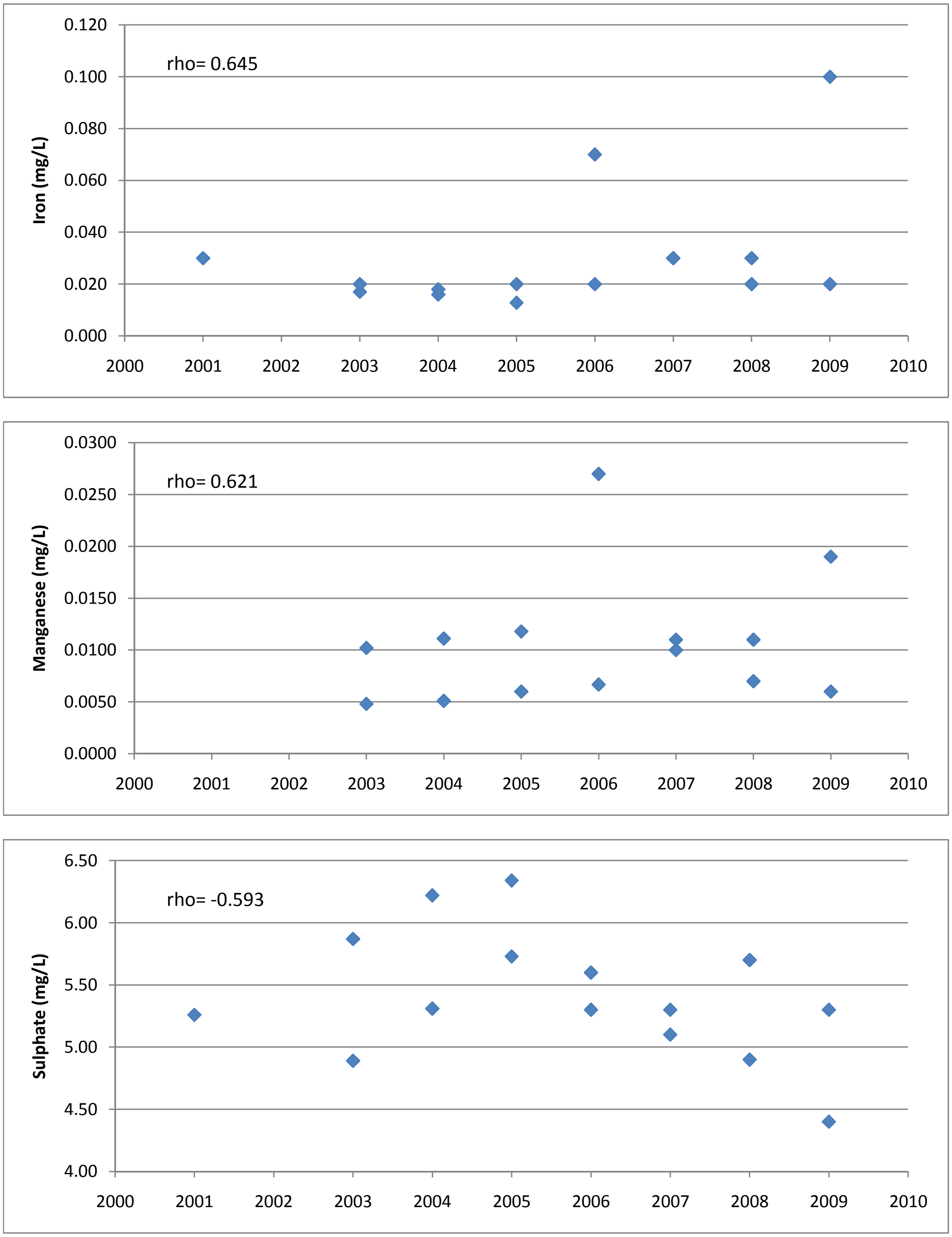
(yellow) Significant at p-value 0.05

(gray) Significant at p-value = 0.1

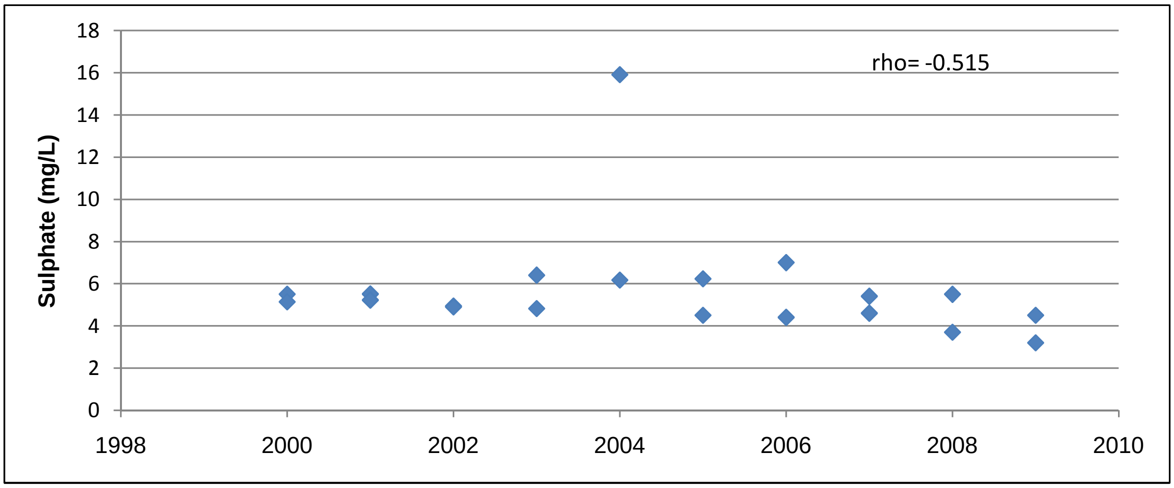
Appendix Table E.46: Exposure lake mean benthic community metrics expressed as percentages of reference lake means for 1999, 2004, and 2009 surveys.

Lake	Code	Density			Number of Taxa			CA-Axis 1*			CA Axis 2*			CA Axis 3*		
		1999	2004	2009	1999	2004	2009	1999	2004	2009	1999	2004	2009	1999	2004	2009
Quirke	QL	-53	-42	-81	-52	-28	-48	751	550	522	-221	-159	-654	-25	-106	170
McCabe	ML	5	-62	-6	-42	-41	11	97	-198	-161	-179	-140	-2573	26	184	195
May	MAL		-68	-47		-20	-28		243	225		-96	225		-149	25
Hough	HOL	-79	-42	-45	-51	1	-14	190	241	148	-139	-168	-713	-82	-78	95
Pecors	PL	-74	-60	8	-54	-31	-15	435	273	137	-154	-109	-509	-78	-9	38
Elliot	EL	-28	-45	-40	1	23	6	-103	-94	-31	131	61	-338	-33	-73	-212
Nordic	NL	27	-9	-64	-38	-7	11	316	412	251	-70	-96	-504	-114	-69	156
McCarthy	MCL	-36	-40	-37	-11	-4	-4	124	115	97	236	81	-17	-115	-109	-124
MEAN		**-36**	**-46**	**-39**	**-37**	**-14**	**-10**	**301**	**220**	**148**	**-71**	**-84**	**-635**	**-57**	**-55**	**43**

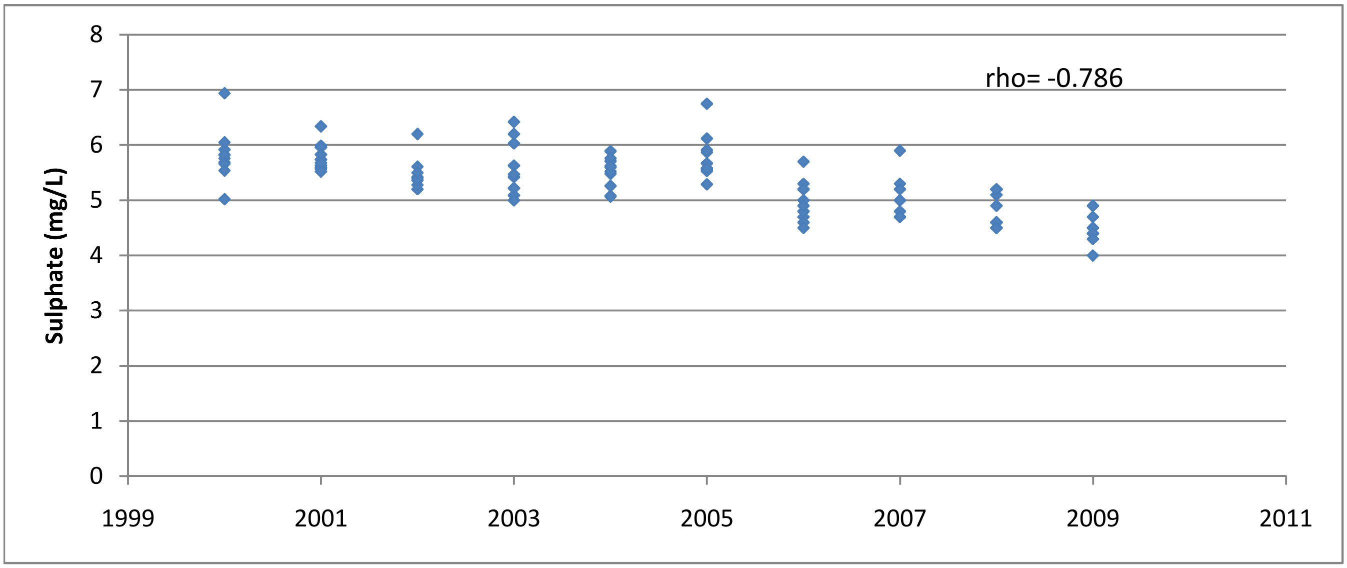
* CA for all years and areas combined.



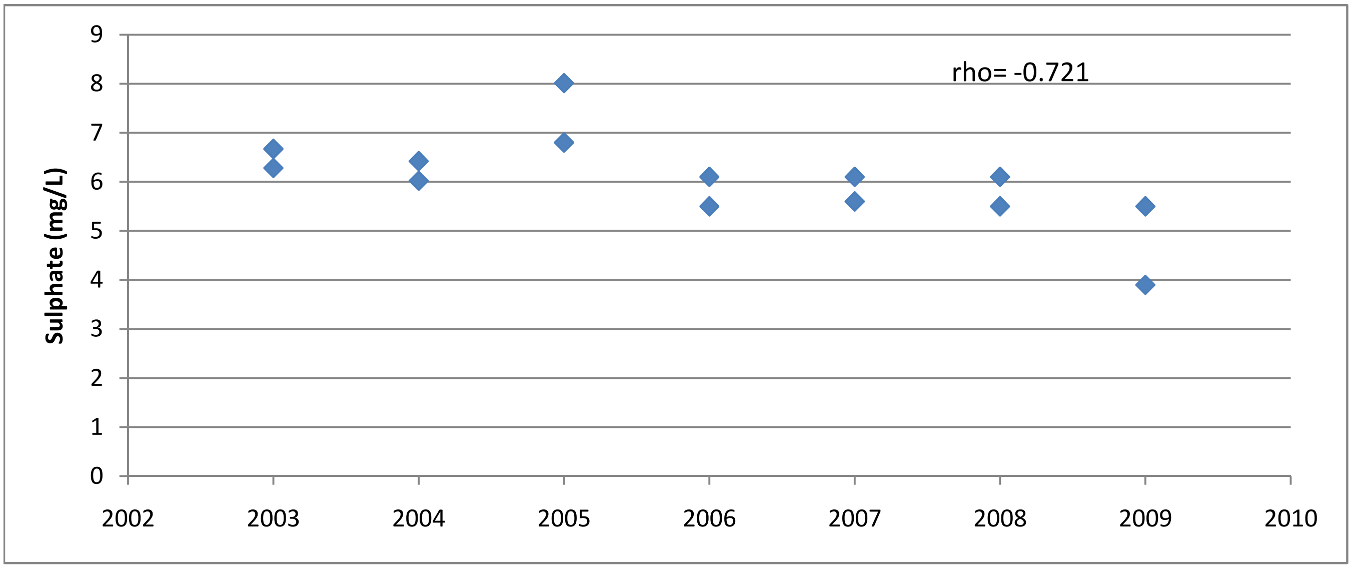
Appendix Figure E.1: Significant common (average) trends observed for iron, manganese and sulphate, over all seasons at Station D-4, 2001 to 2009.



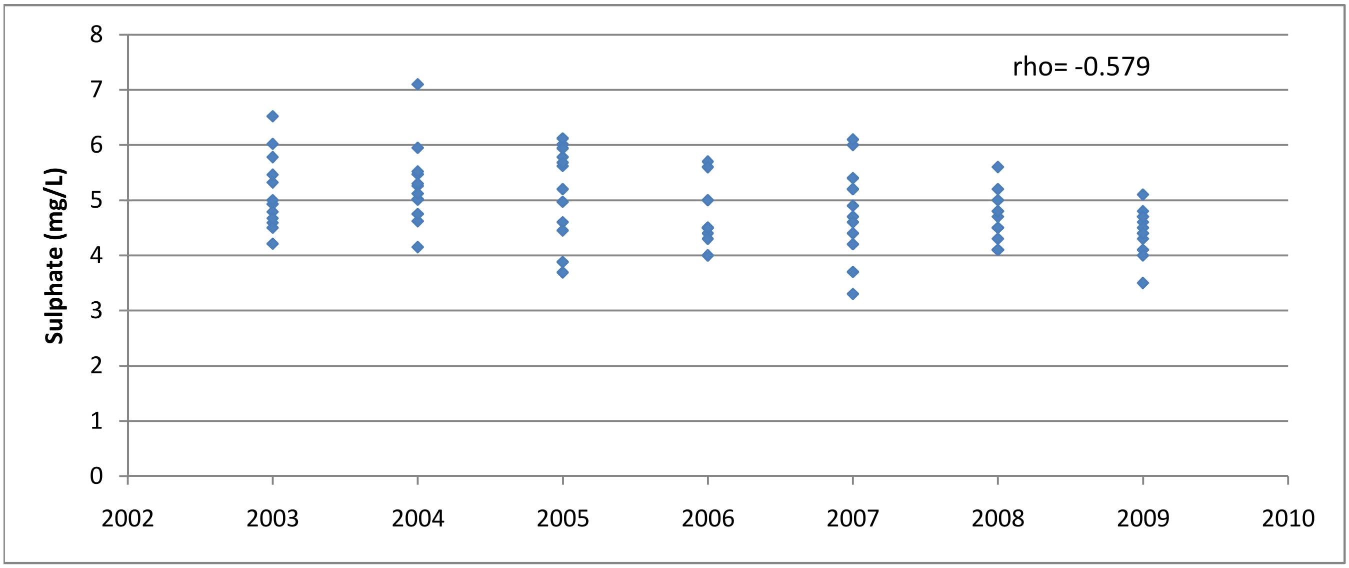
Appendix Figure E.2: Significant common (average) trends observed for sulphate over all seasons at Station P-22, 2000-2009.



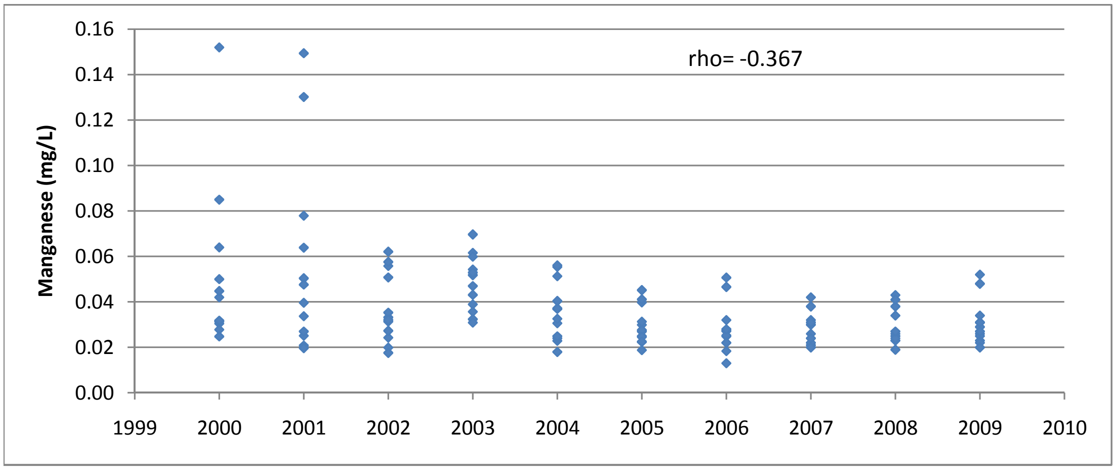
Appendix Figure E.3: Significant common (average) trends observed for sulphate over all seasons at Station SR-05, 2000 to 2009.

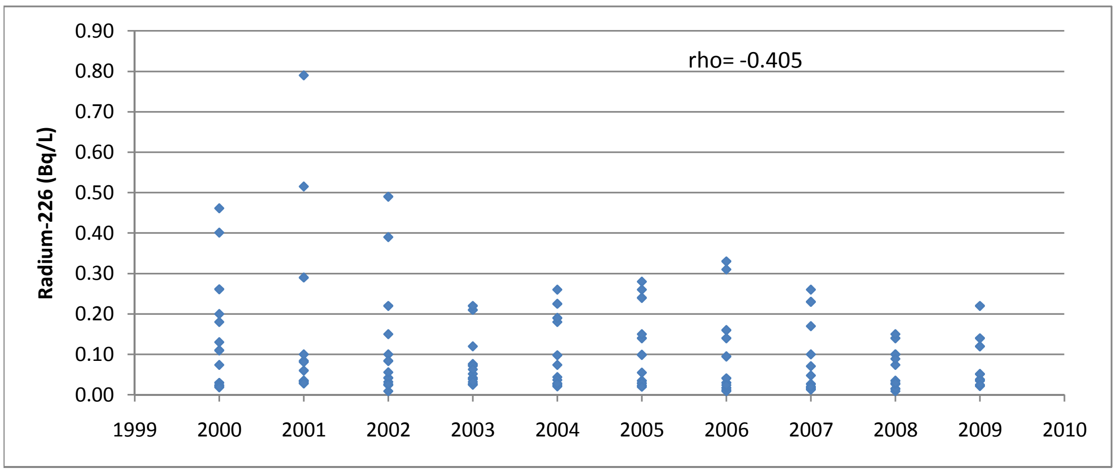


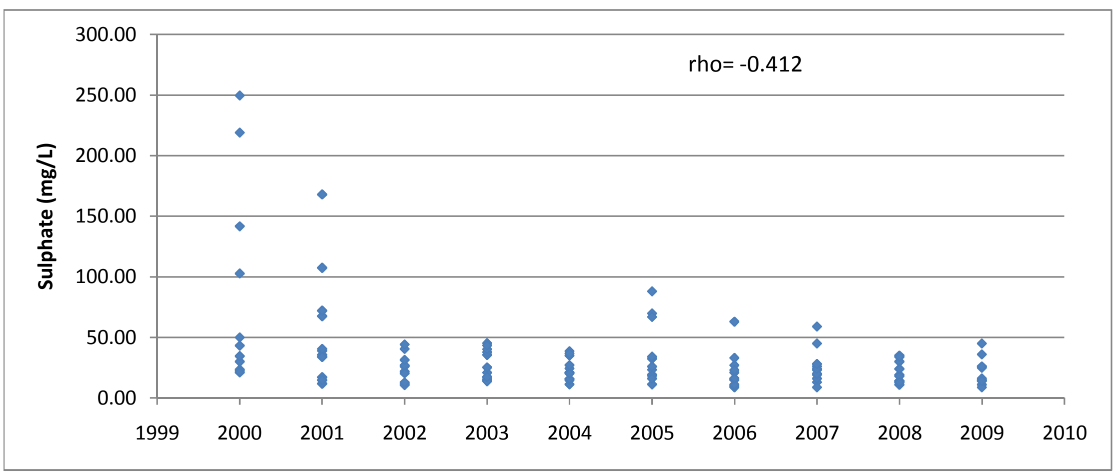
Appendix Figure E.4: Significant common (average) trends observed for sulphate over all seasons at Station SR-18, 2003 to 2009.



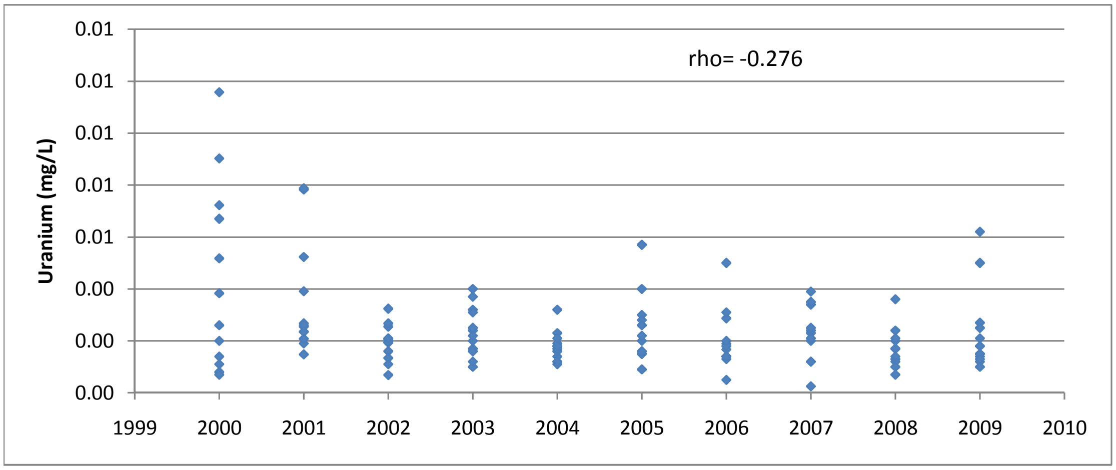
Appendix Figure E.5: Significant common (average) trends observed for sulphate over all seasons at Station SR-19, 2003 to 2009.



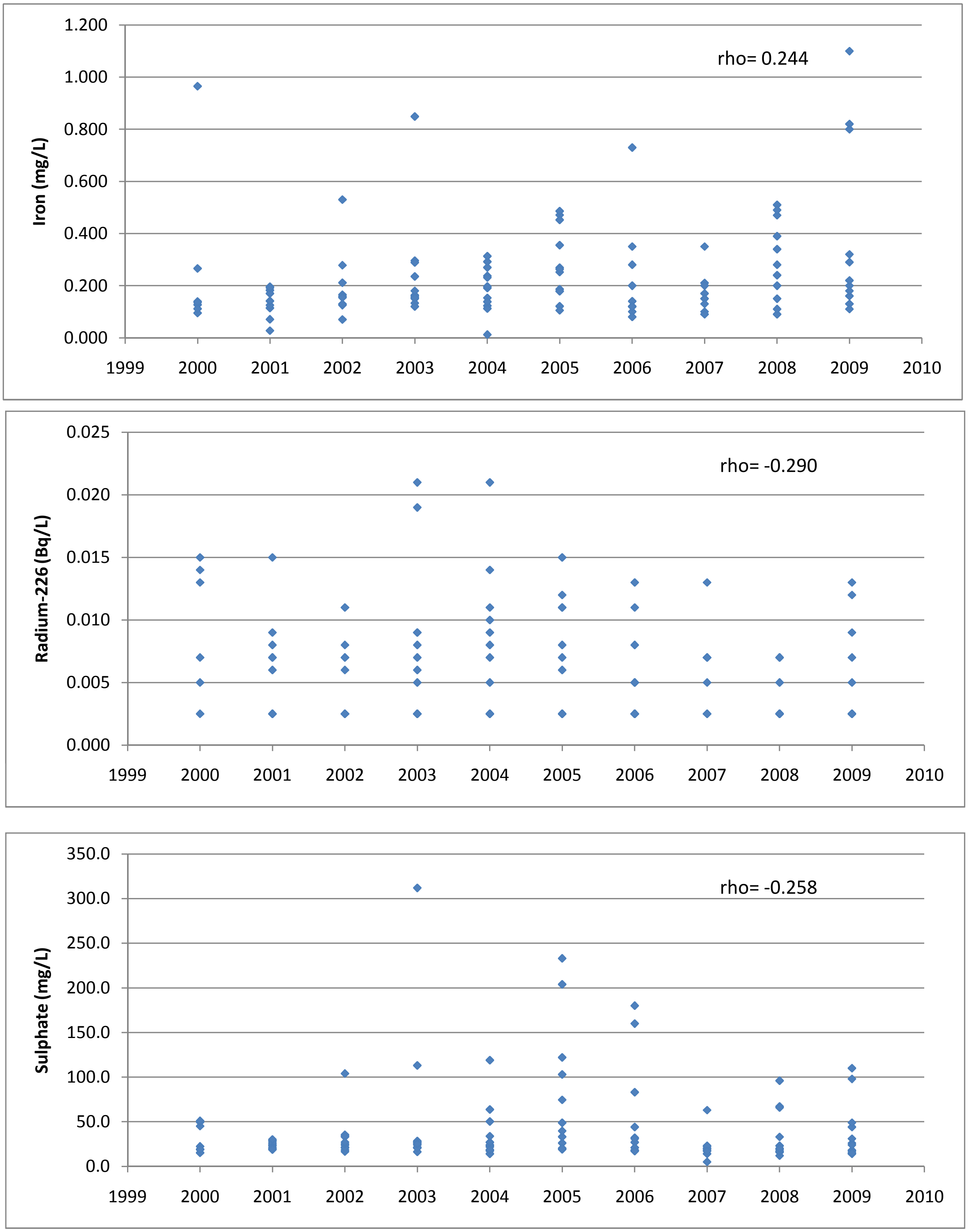




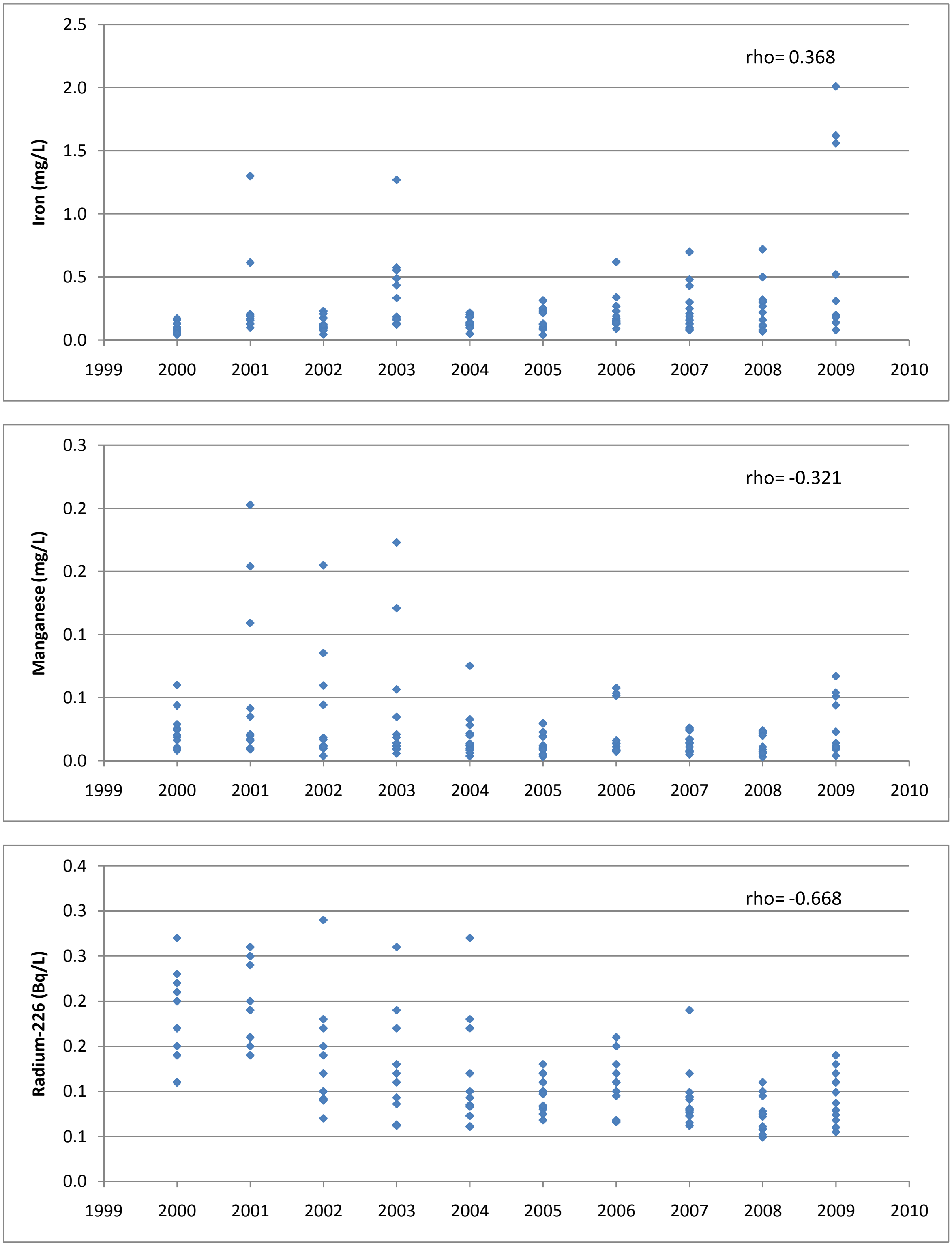
Appendix Figure E.6: Significant common (average) trends observed for manganese, radium-226, sulphate and uranium over all seasons at Station D-5, 2000 to 2009.



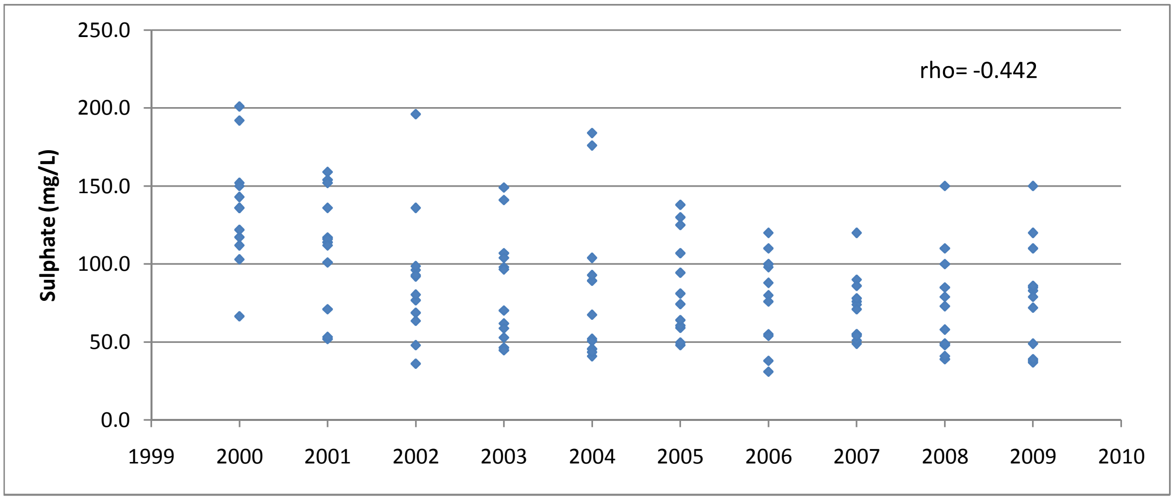
Appendix Figure E.6: Significant common (average) trends observed for manganese, radium-226, sulphate and uranium over all seasons at Station D-5, 2000 to 2009.

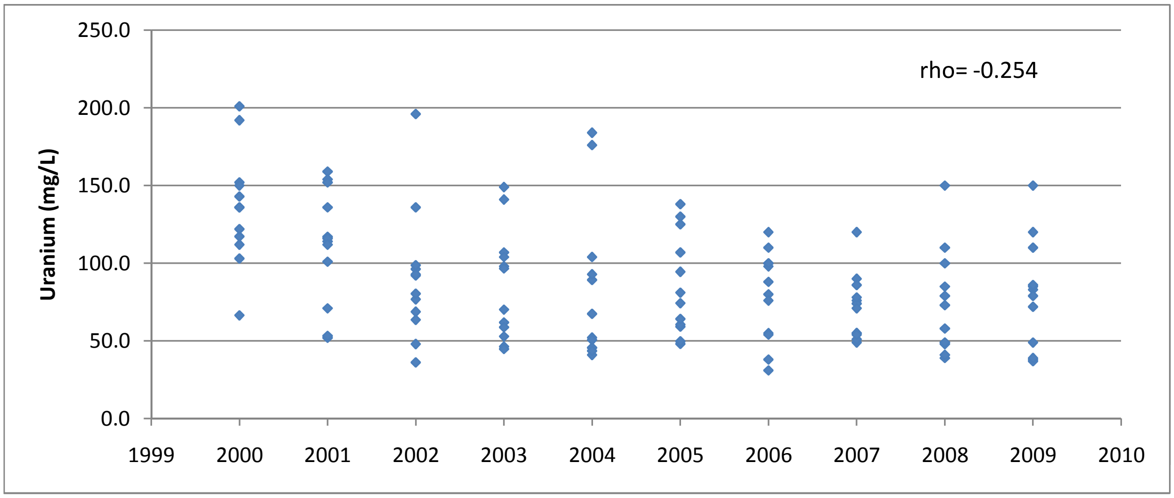


Appendix Figure E.7: Significant common (average) trends observed for iron, radium-226 and sulphate over all seasons at Station D-6, 2000 to 2009.

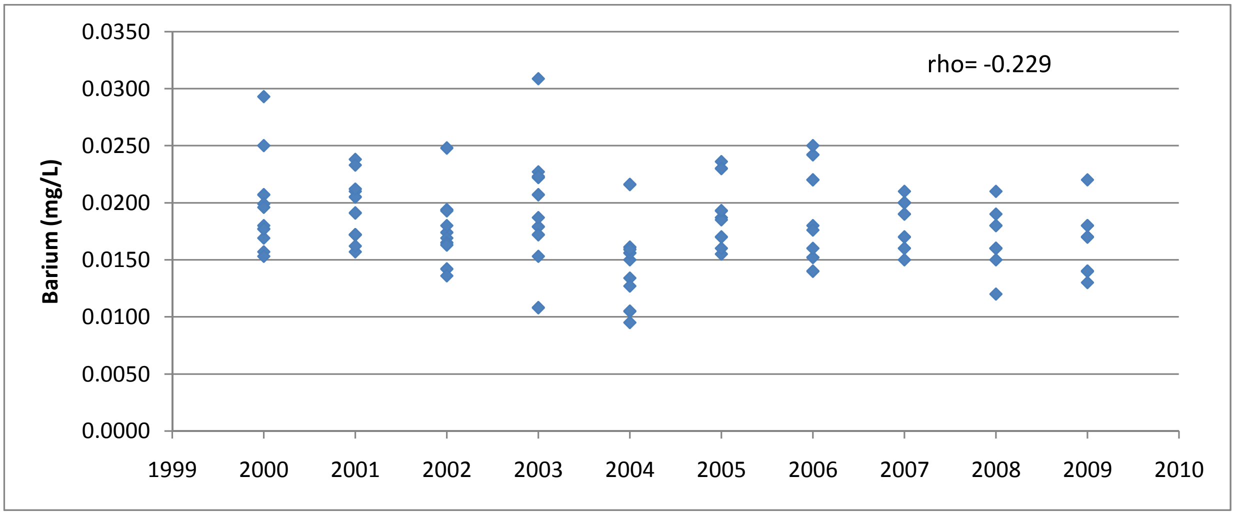


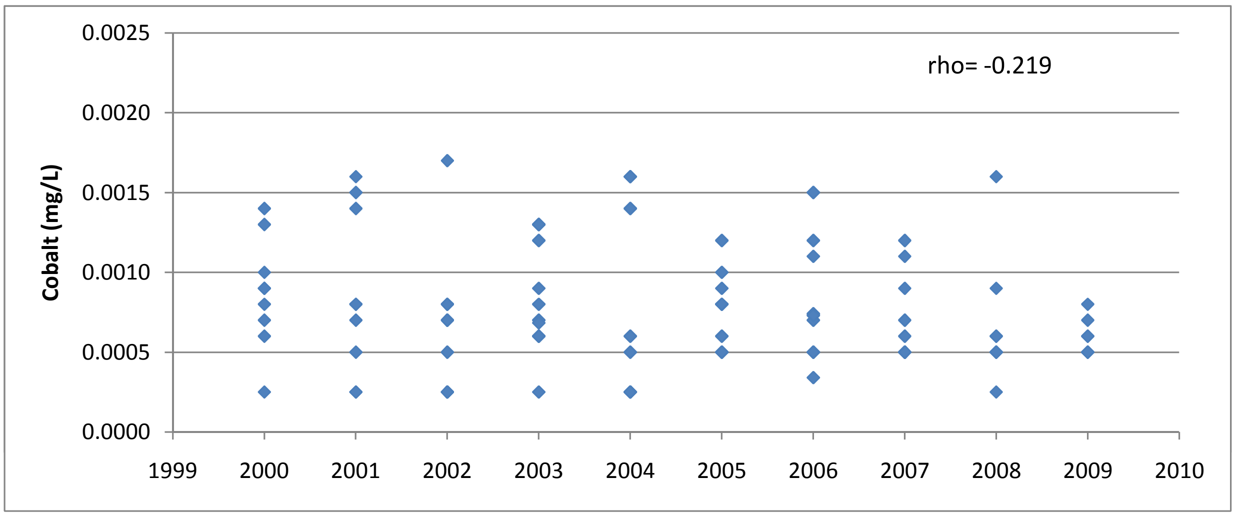
Appendix Figure E.8: Significant common (average) trends observed for iron, manganese, radium-226, sulphate and uranium over all seasons at Station DS-18, 2000 to 2009.

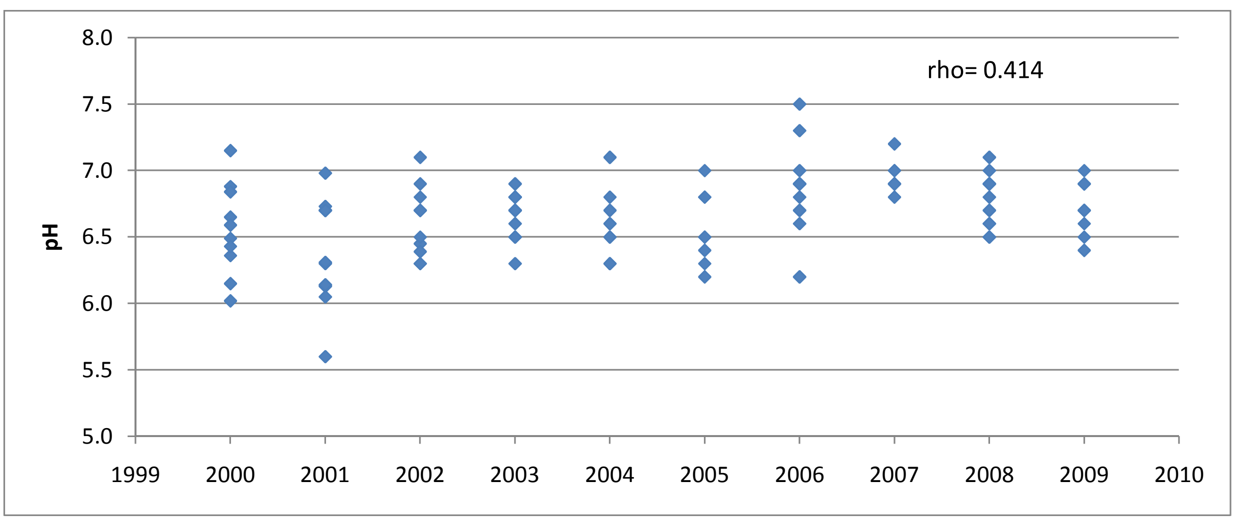




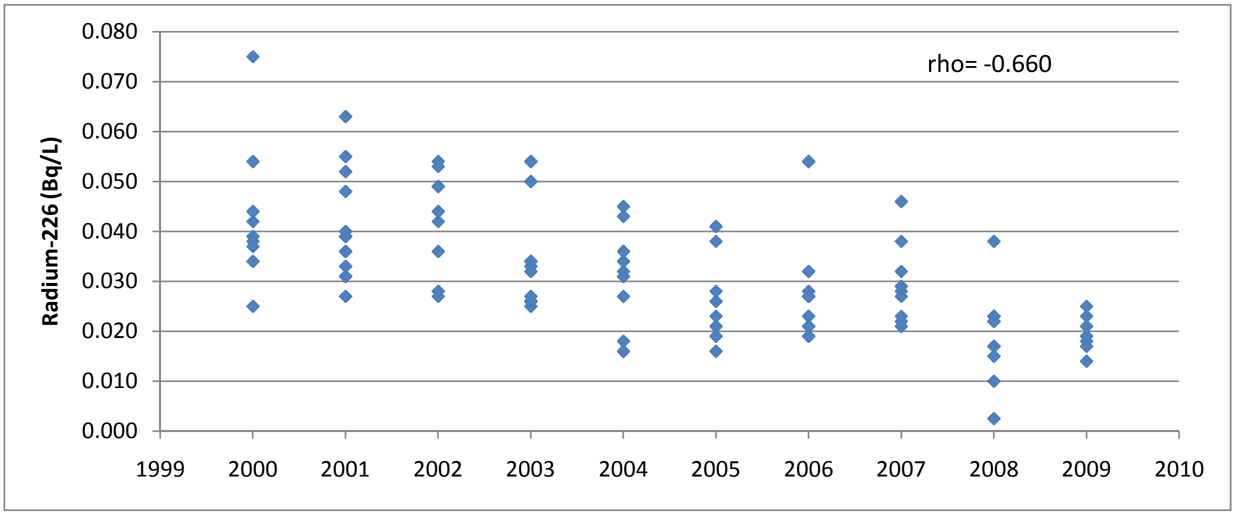
Appendix Figure E.8: Significant common (average) trends observed for iron, manganese, radium-226, sulphate and uranium over all seasons at Station DS-18, 2000 to 2009.

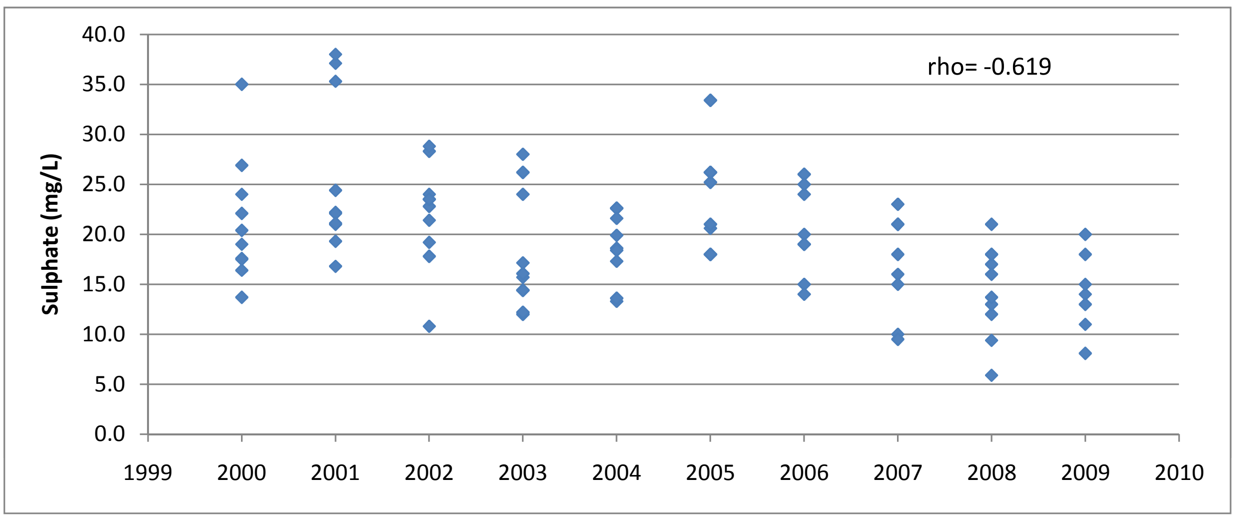




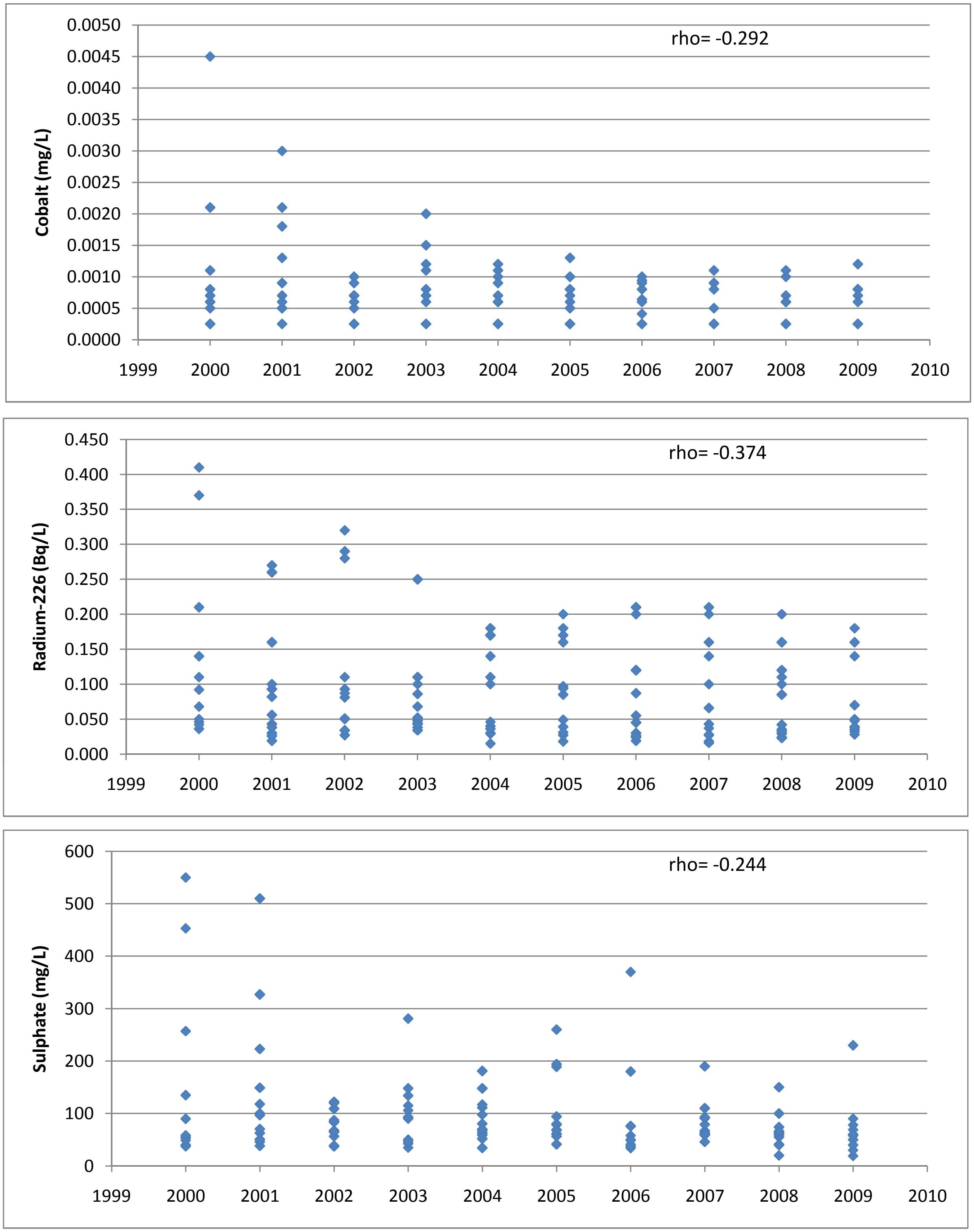


Appendix Figure E.9: Significant common (average) trends observed for barium, cobalt, pH, radium-226 and sulphate over all seasons at Station M01, 2000 to 2009.

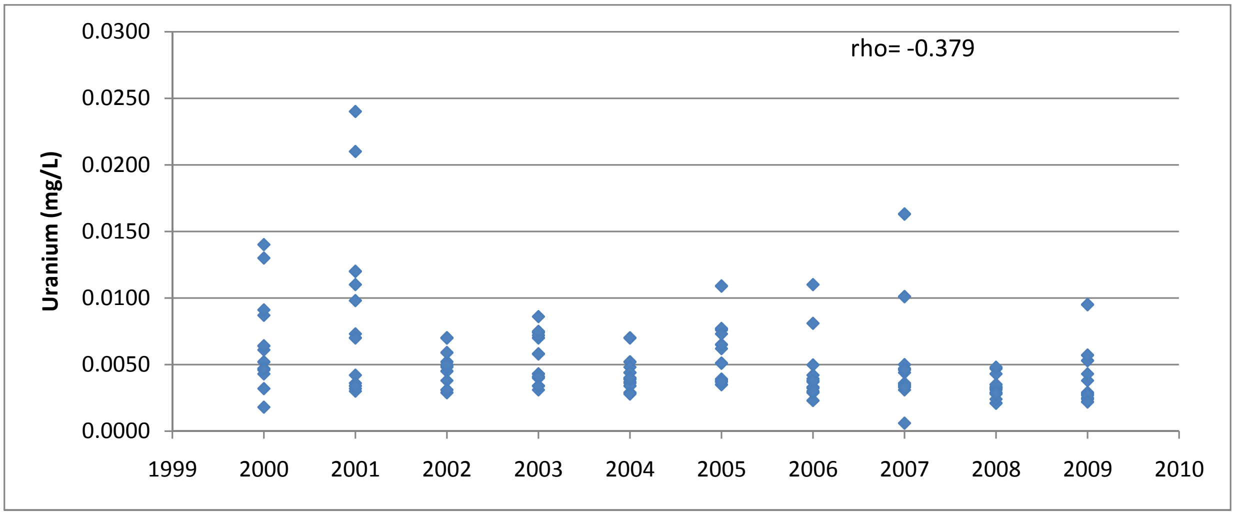




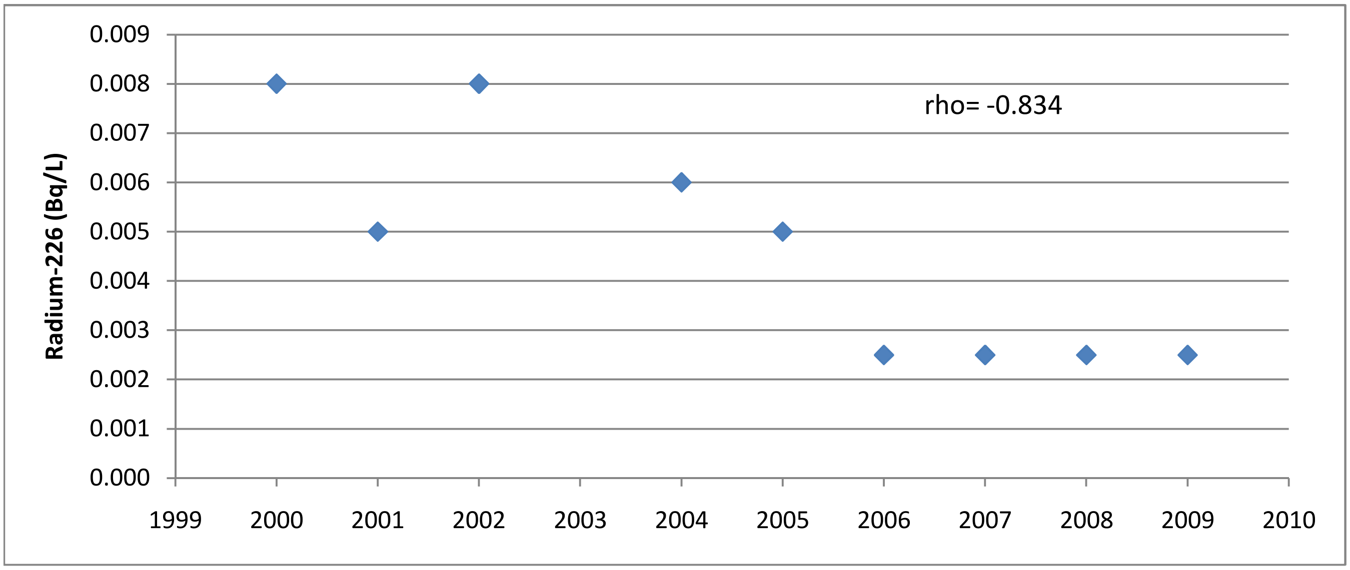
Appendix Figure E.9: Significant common (average) trends observed for barium, cobalt, pH, radium-226 and sulphate over all seasons at Station M01, 2000 to 2009.



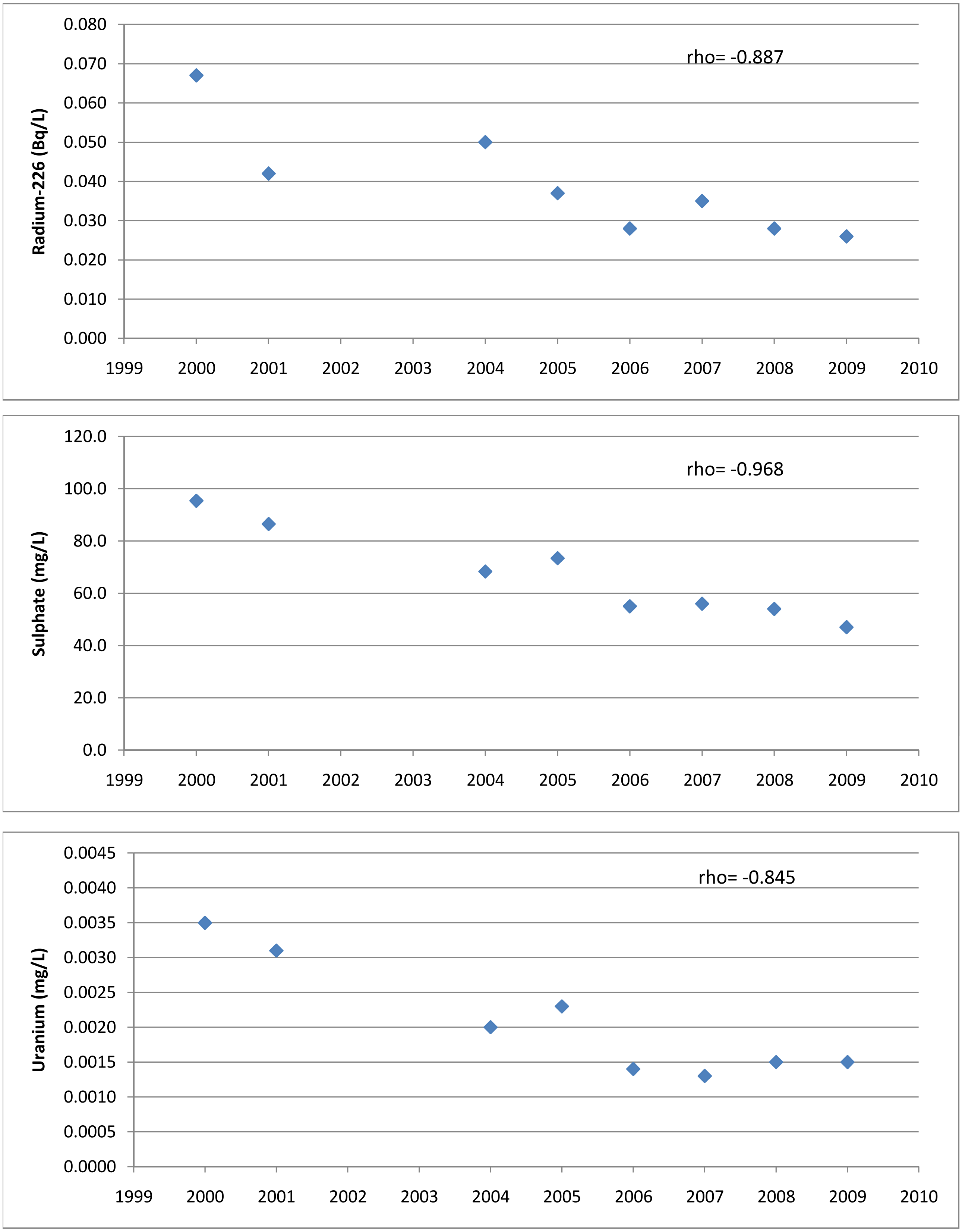
Appendix Figure E.10: Significant common (average) trends observed for cobalt, radium-226, sulphate and uranium over all seasons at Station Q-09, 2000 to 2009.



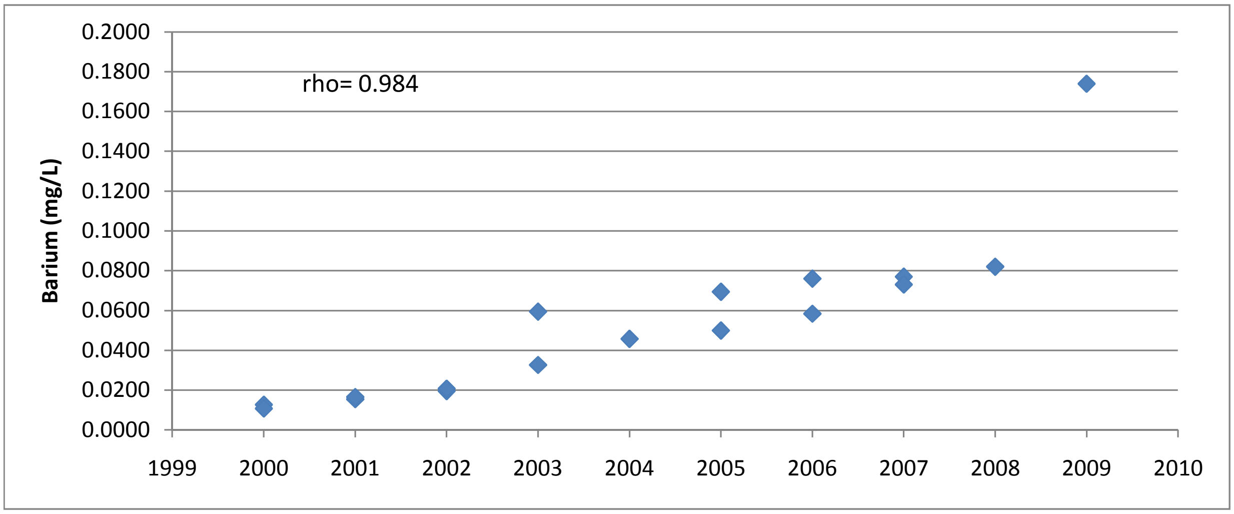
Appendix Figure E.10: Significant common (average) trends observed for cobalt, radium-226, sulphate and uranium over all seasons at Station Q-09, 2000 to 2009.

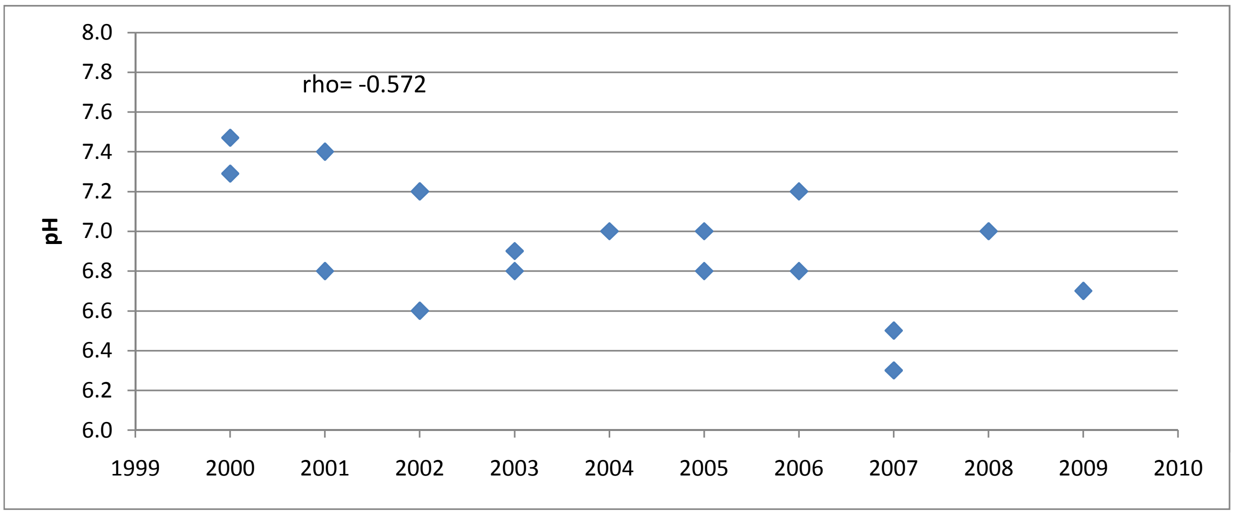


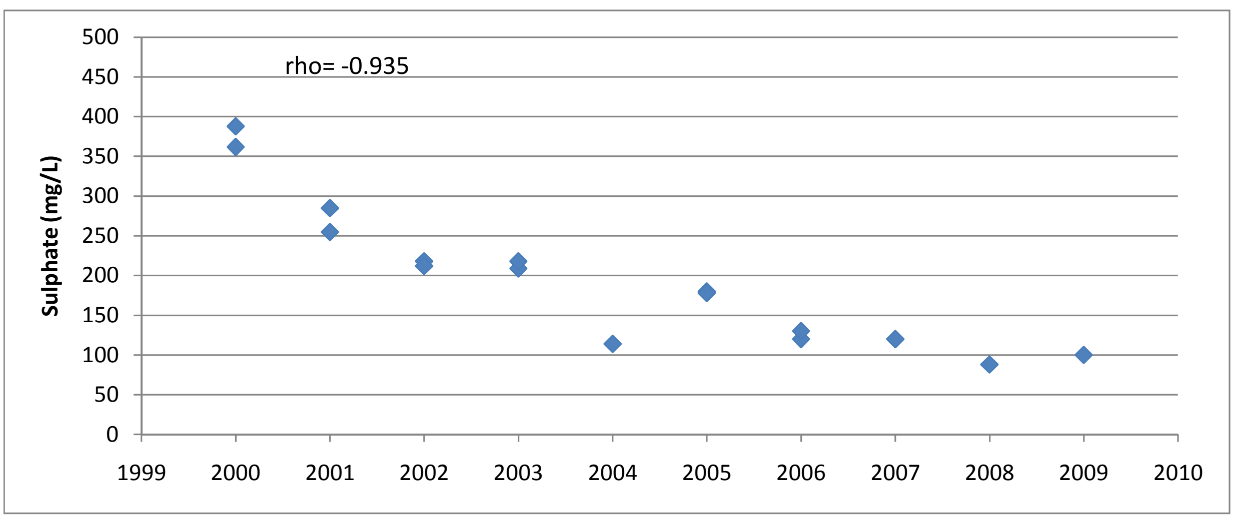
Appendix Figure E.11: Significant trends observed for radium-226 at Station Q-20, 2000 to 2009.



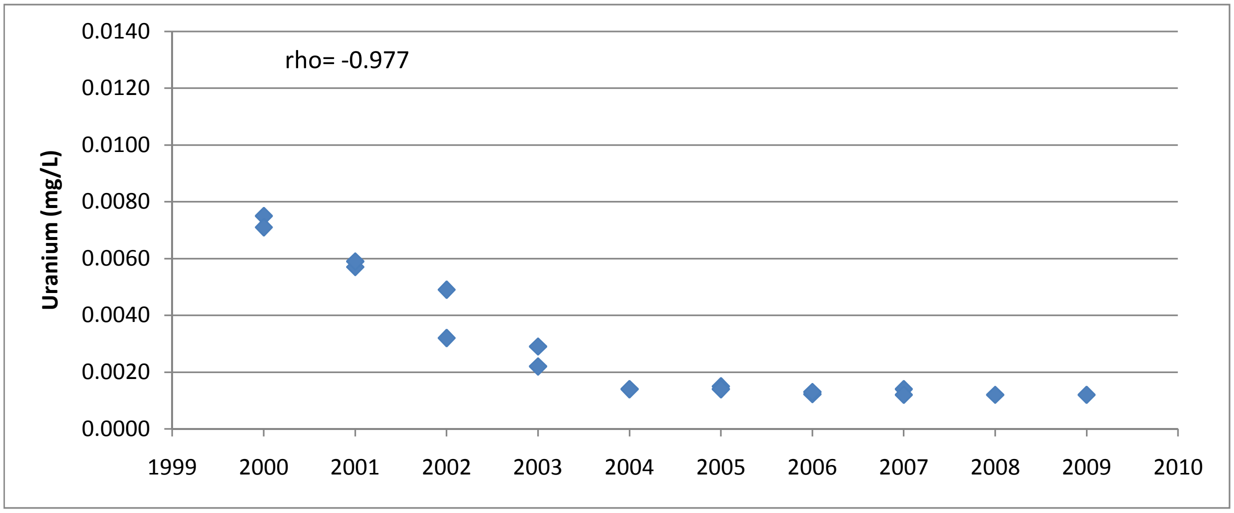
Appendix Figure E.12: Significant trends observed for radium-226, sulphate and uranium at Station SR-01, 2000 to 2009.



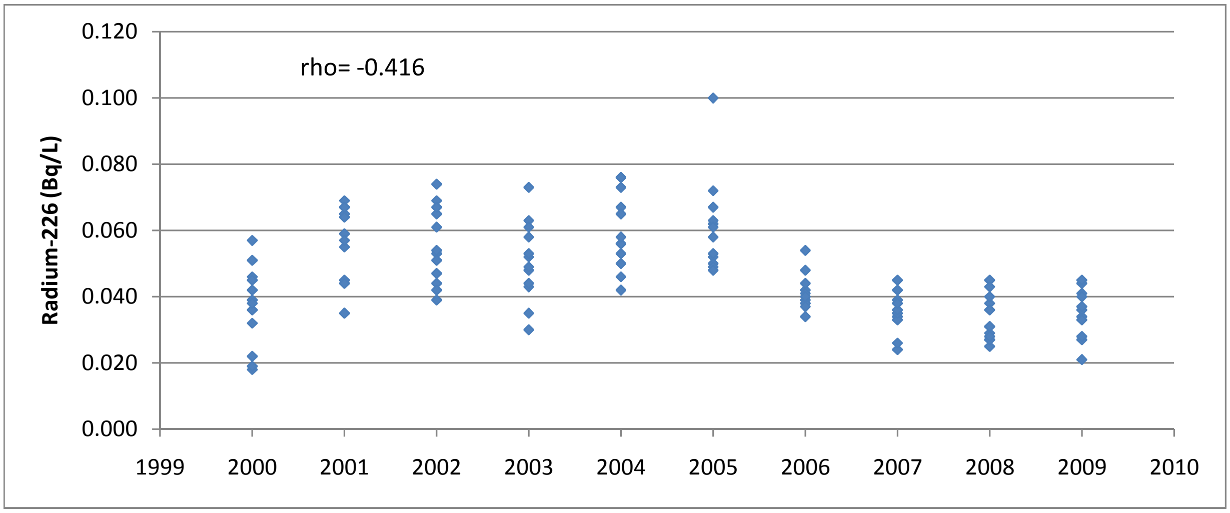


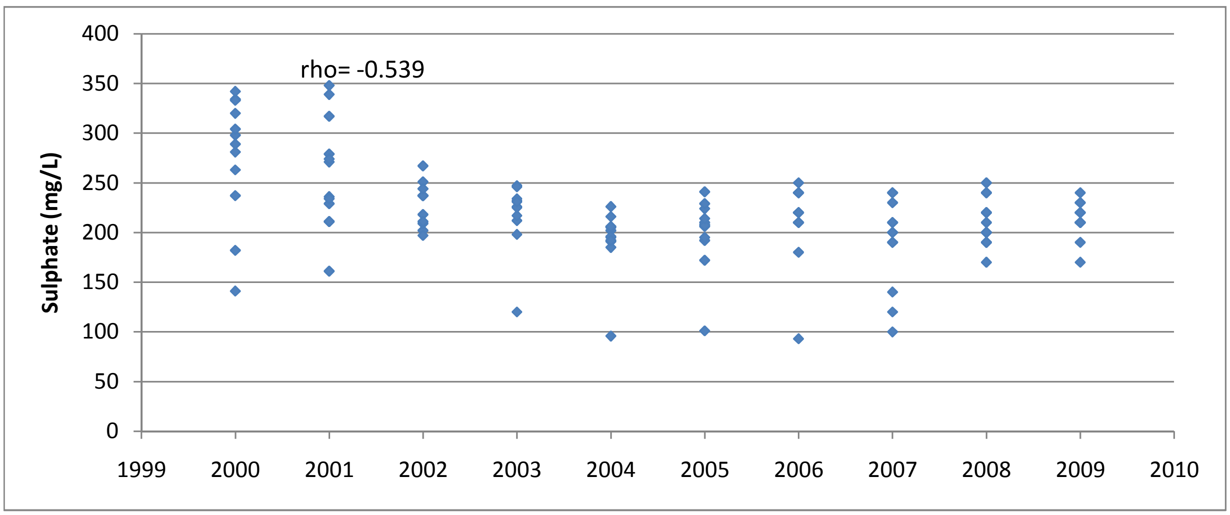


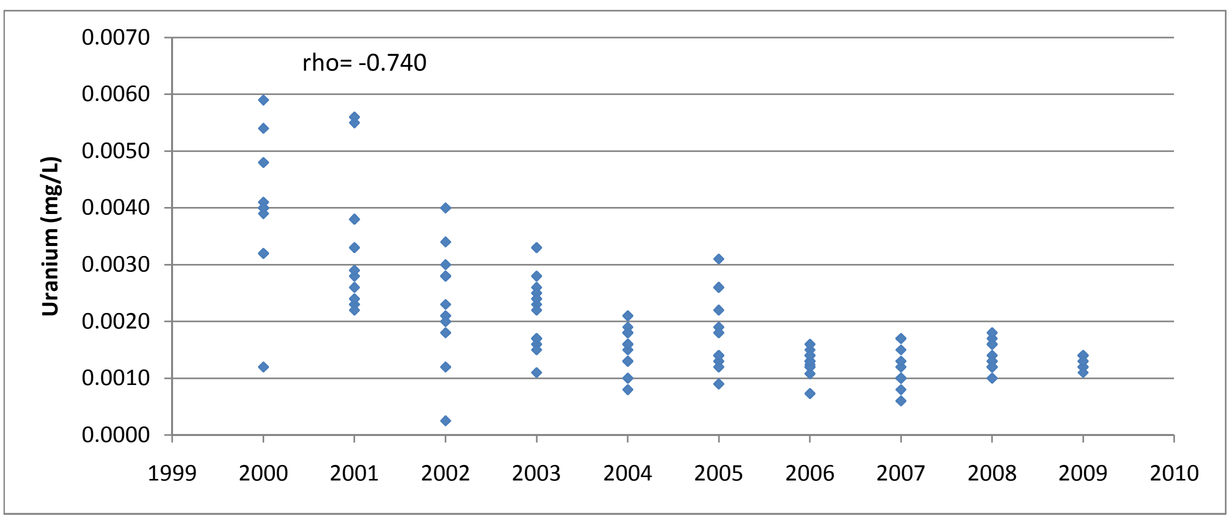
Appendix Figure E.13: Significant common (average) trends observed for barium, pH, sulphate and uranium over all seasons at Station SR-06, 2000 to 2009.



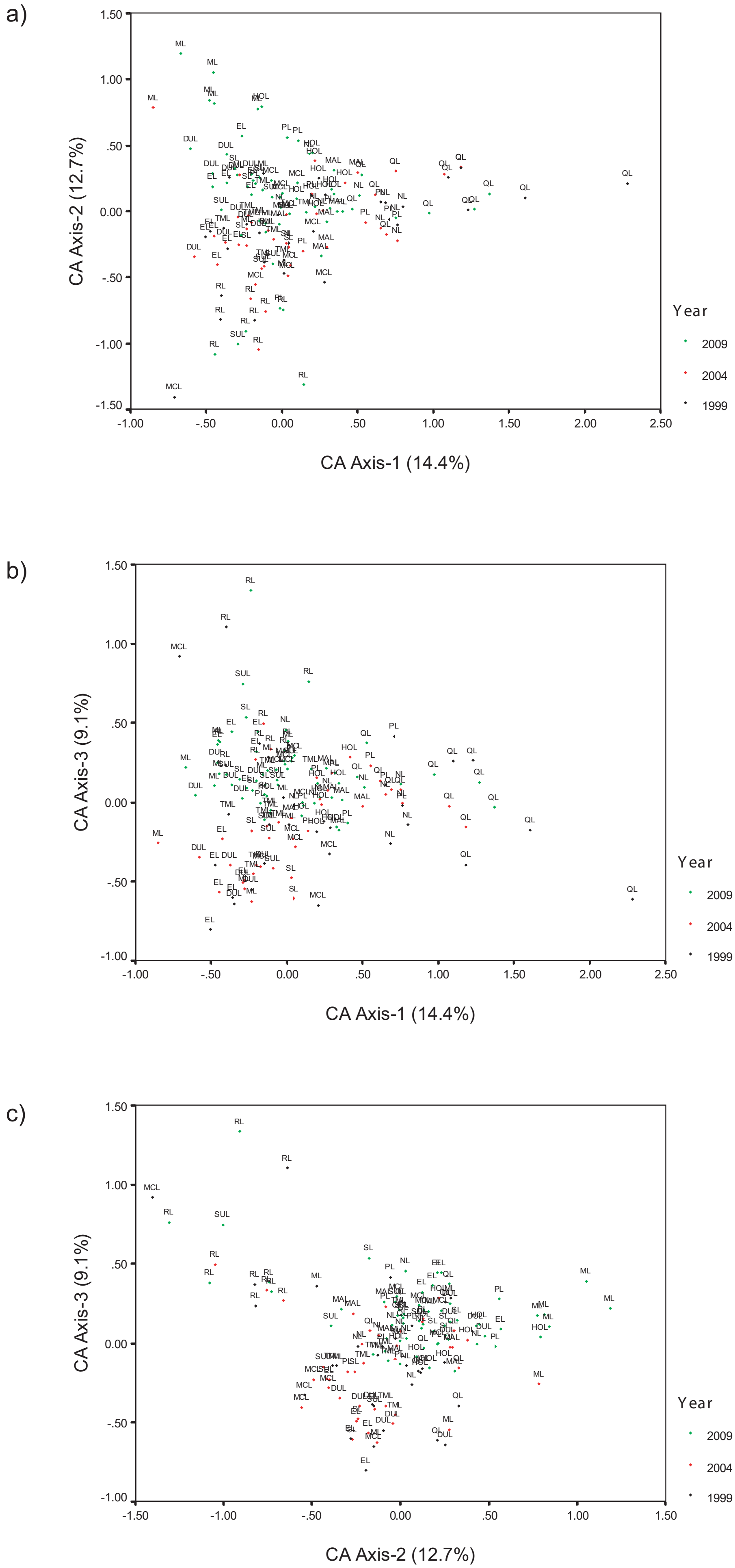
Appendix Figure E.13: Significant common (average) trends observed for barium, pH, sulphate and uranium over all seasons at Station SR-06, 2000 to 2009.



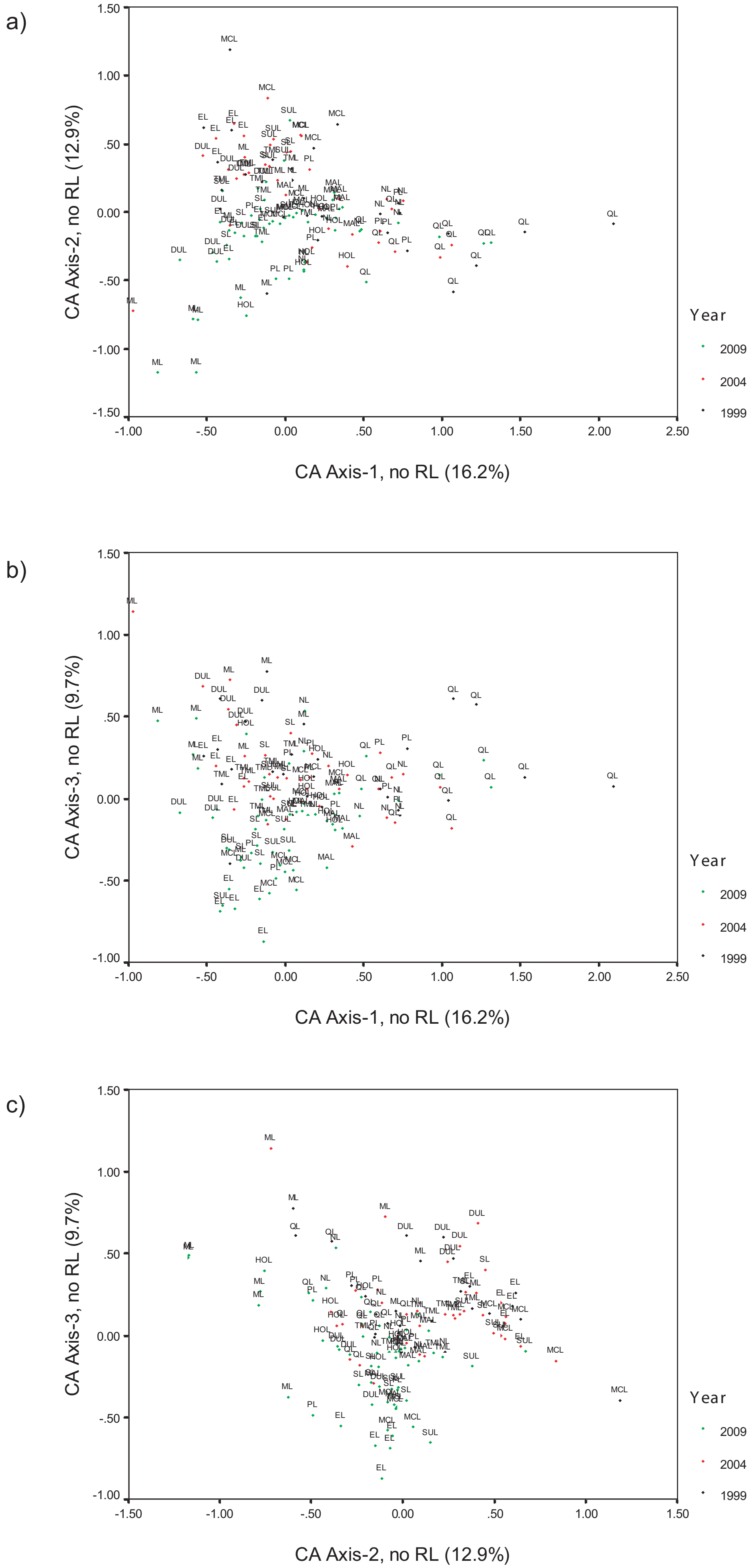




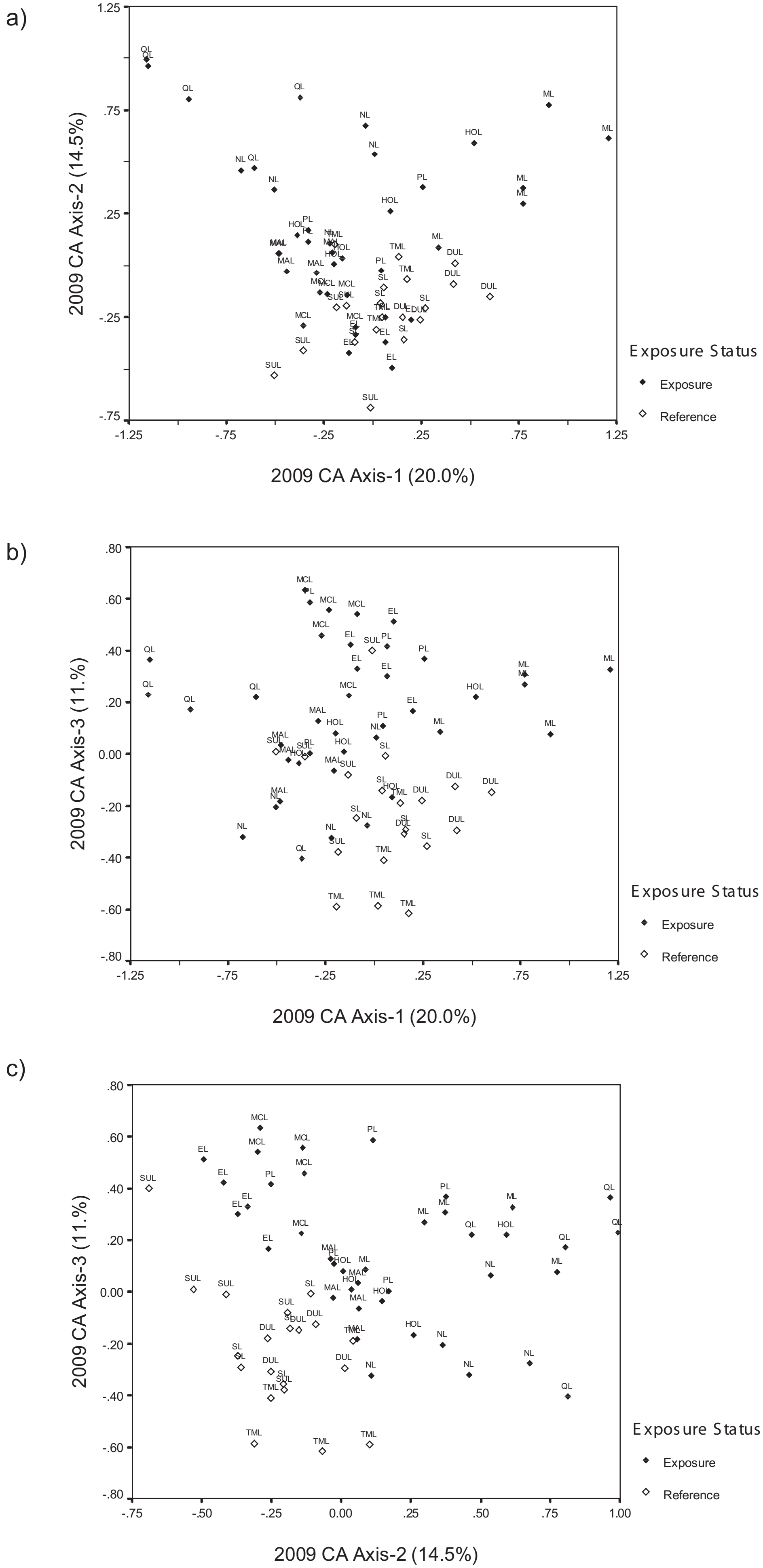
Appendix Figure E.14: Significant common (average) trends observed for radium-226, sulphate, and uranium over all seasons at Station SR-08, 2000 to 2009.



Appendix Figure E.15: Correspondence analysis at SRWMP stations including RL: 1999, 2004, 2009.



Appendix Figure E.16: Correspondence analysis at SRWMP stations excluding RL: 1999, 2004, 2009.



Appendix Figure E.17: Correspondence analysis at SRWMP stations, 2009 only, excluding RL.

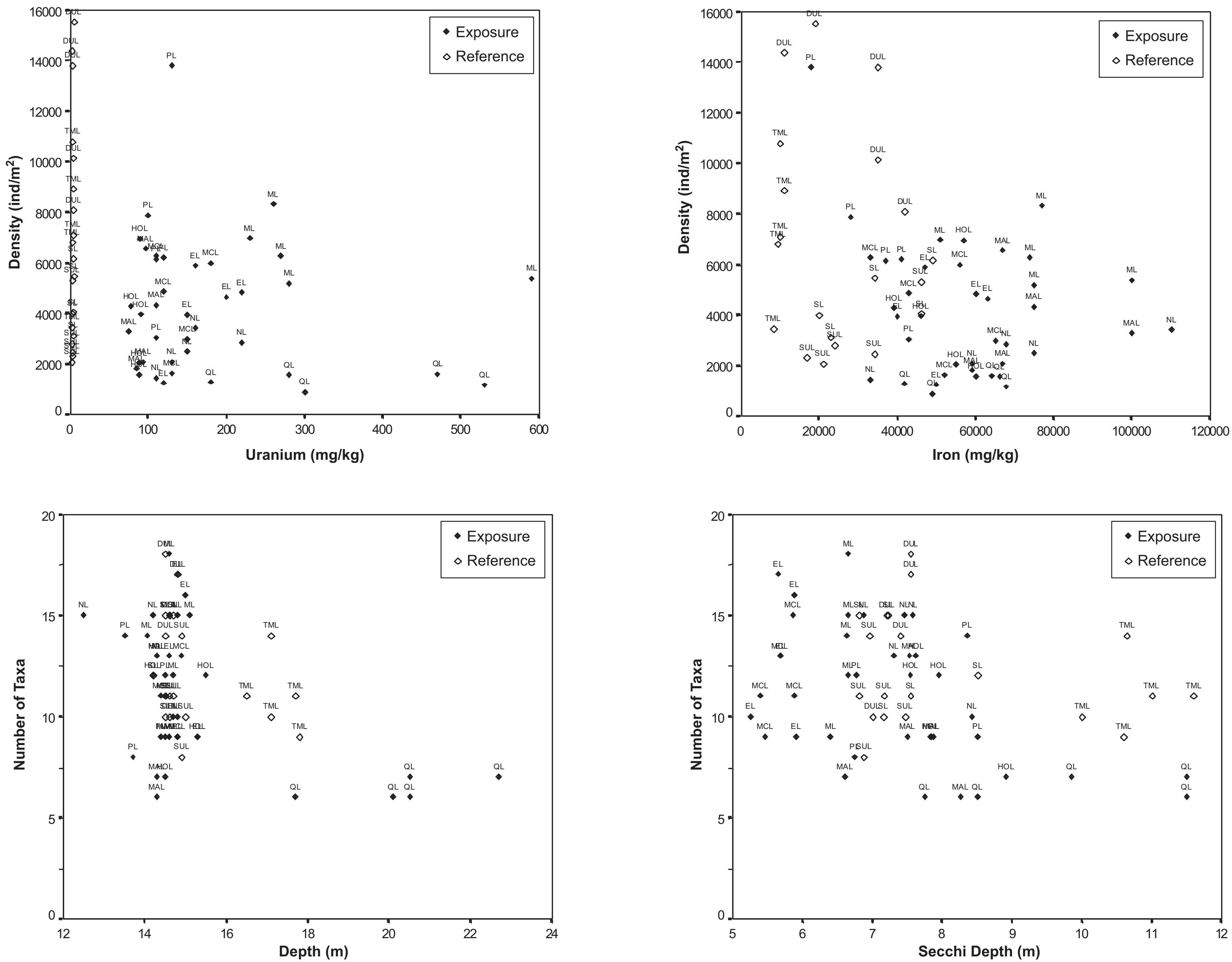
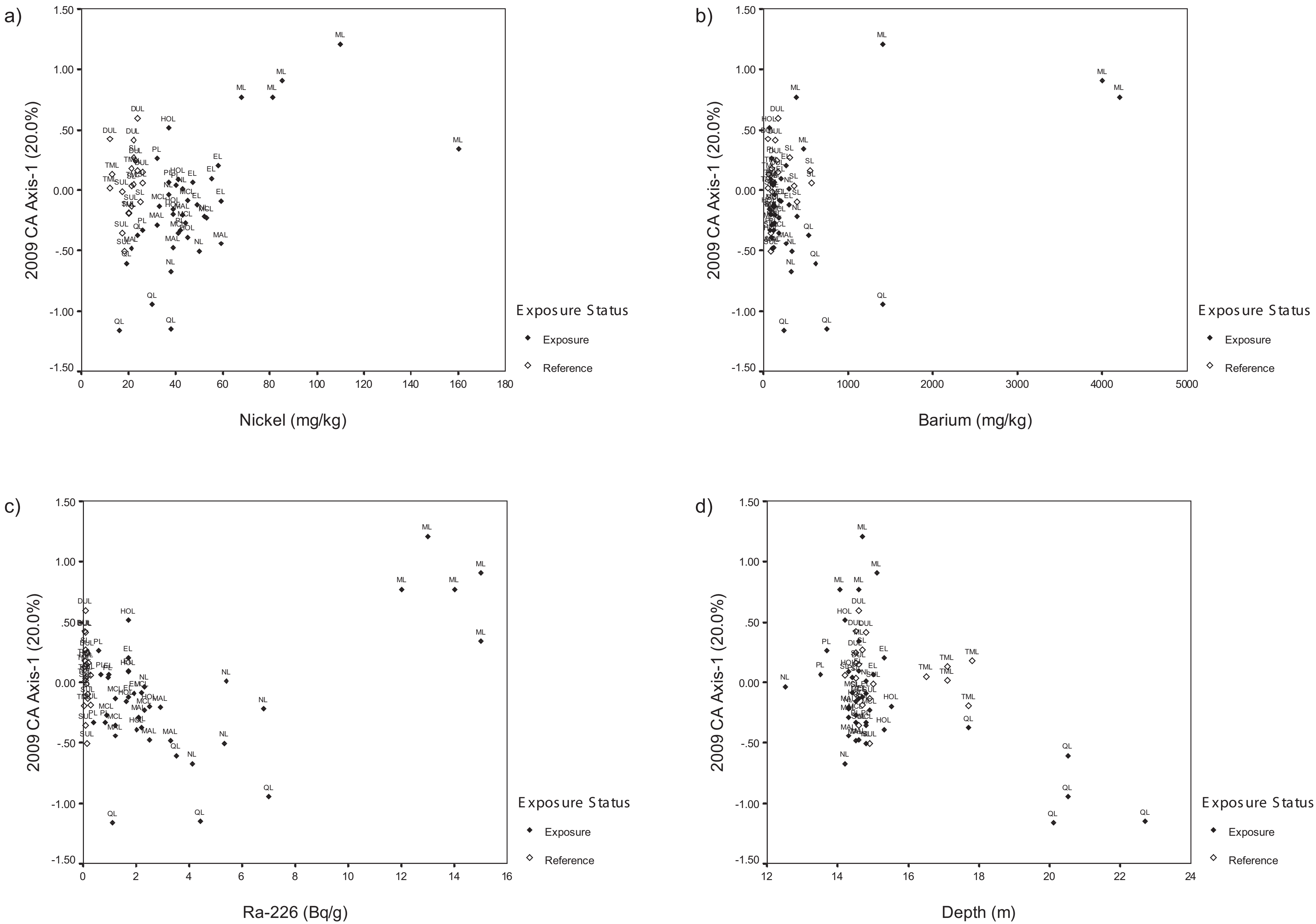
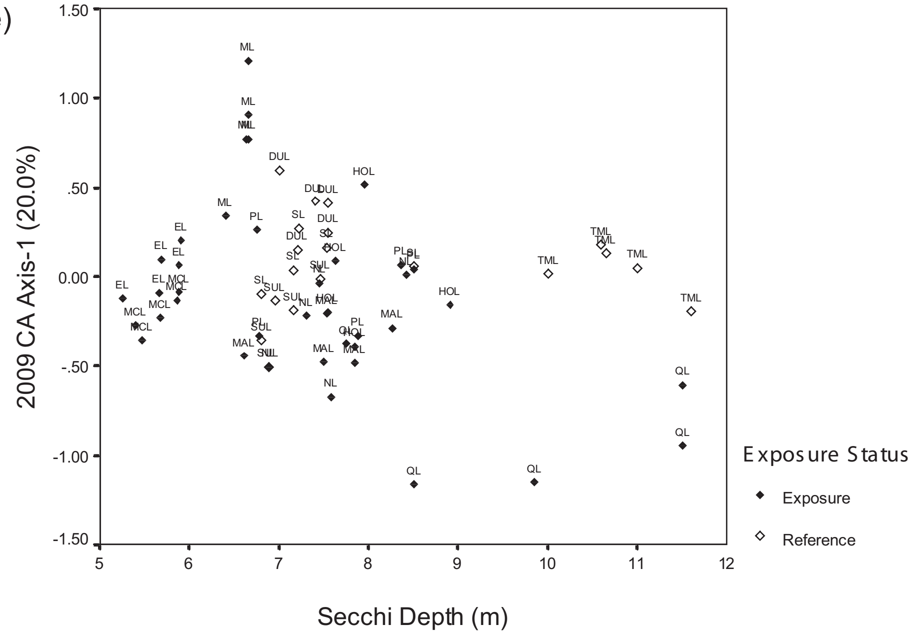


Figure E.18: Significant correlations between benthic community metrics and supporting habitat data.

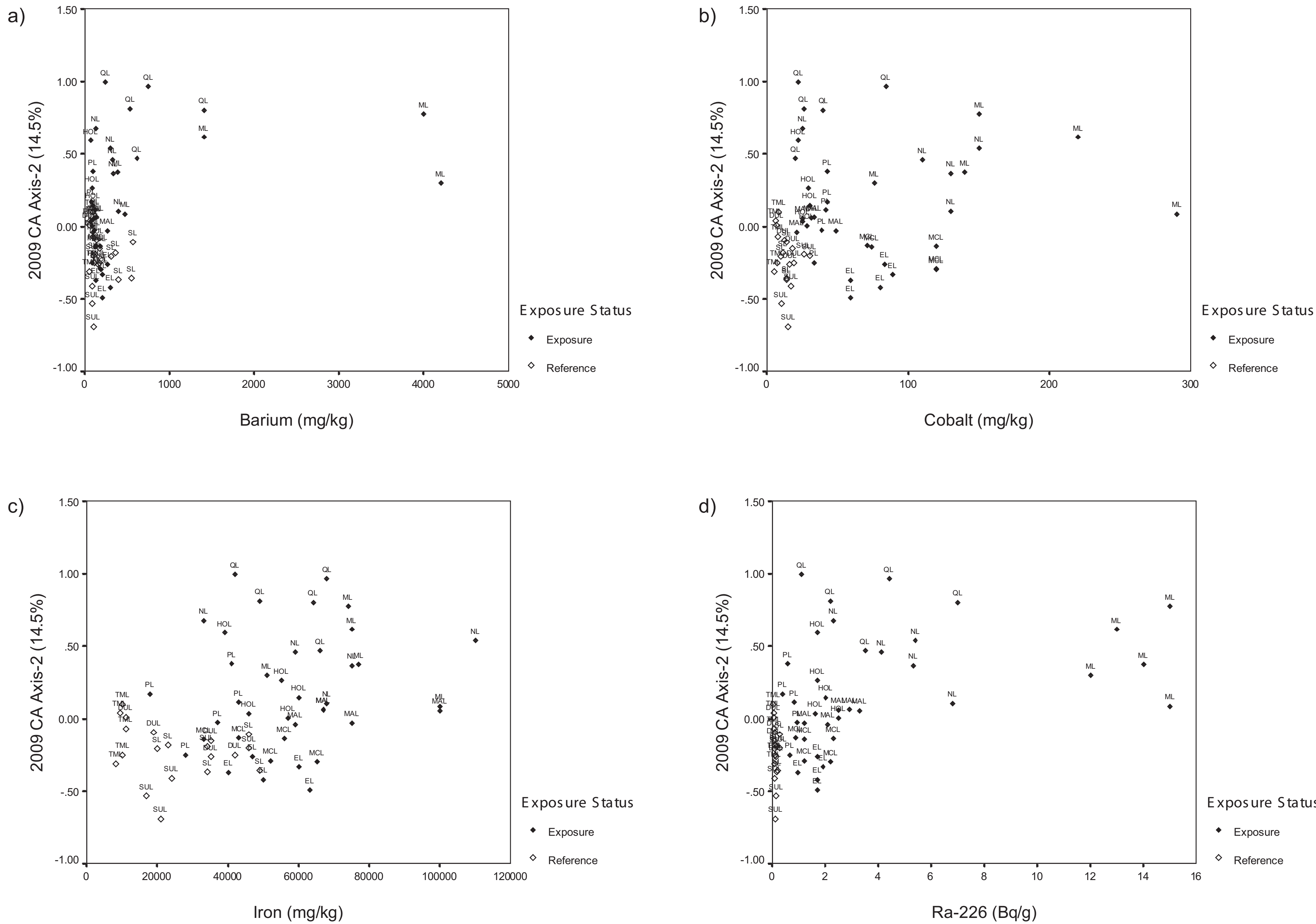


Appendix Figure E.19: Correlations at SRWMP, excluding RL, 2009.

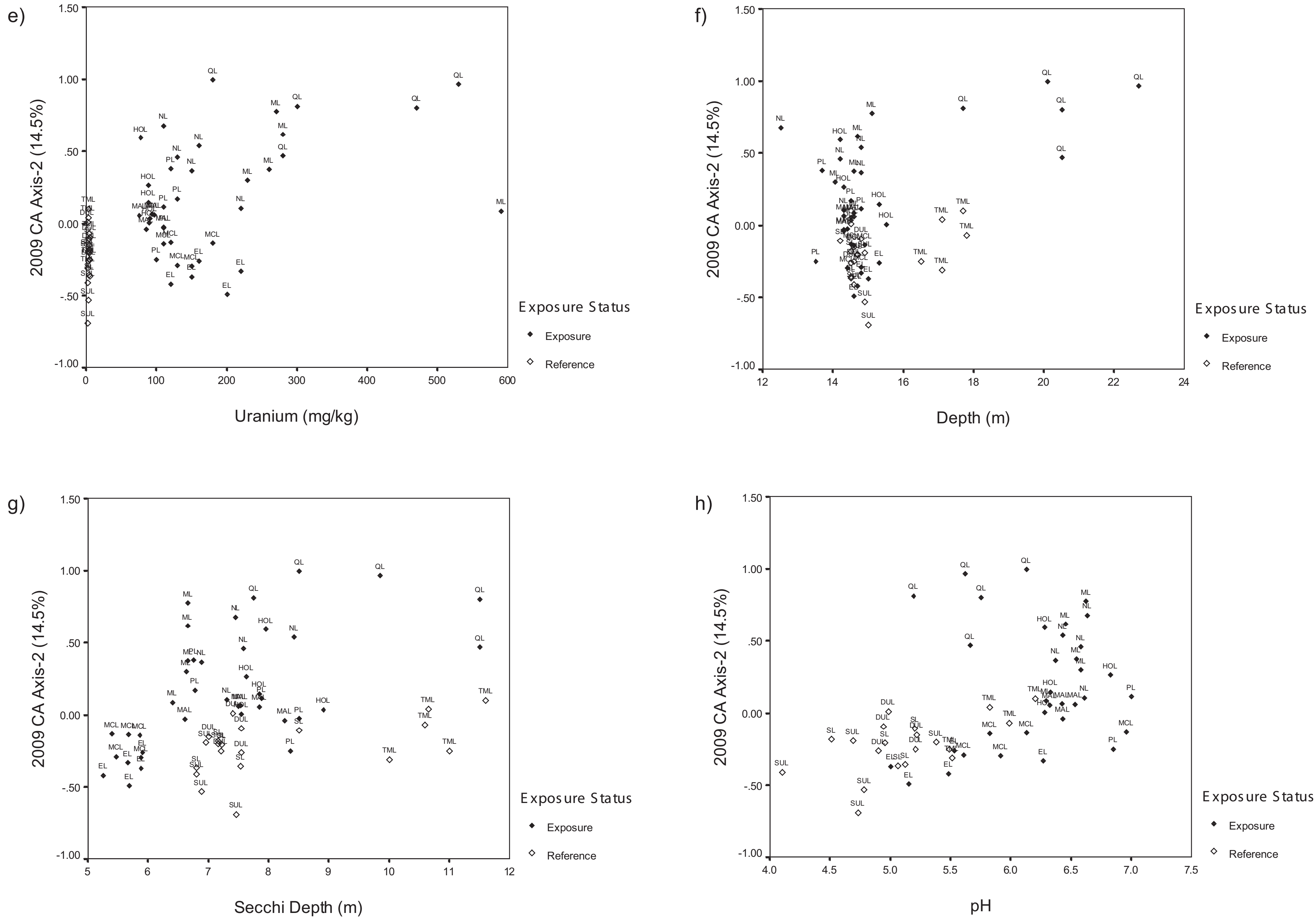
e)



Appendix Figure E.19: Correlations at SRWMP, excluding RL, 2009.

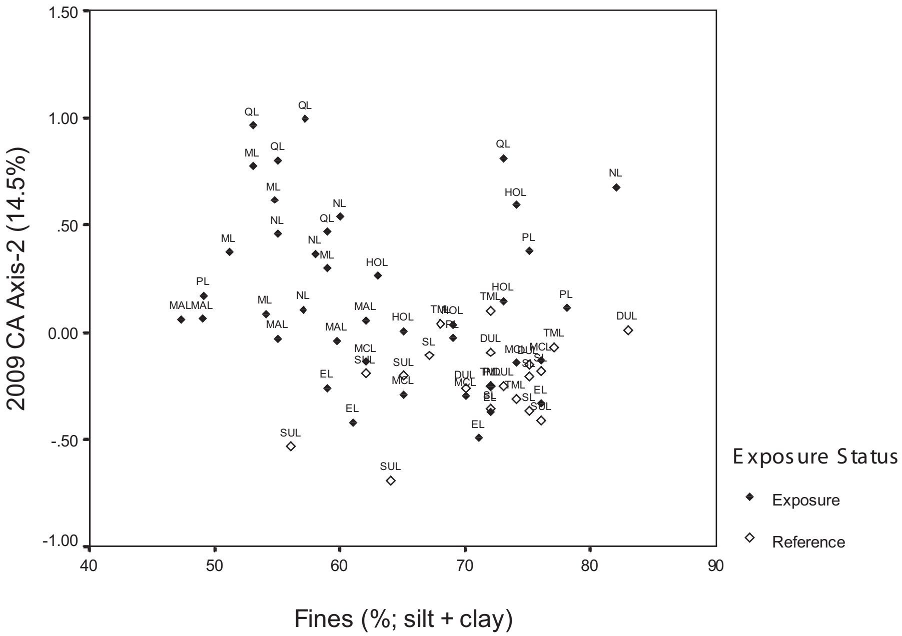


Appendix Figure E.20: Correlations at SRWMP, excluding RL, 2009.

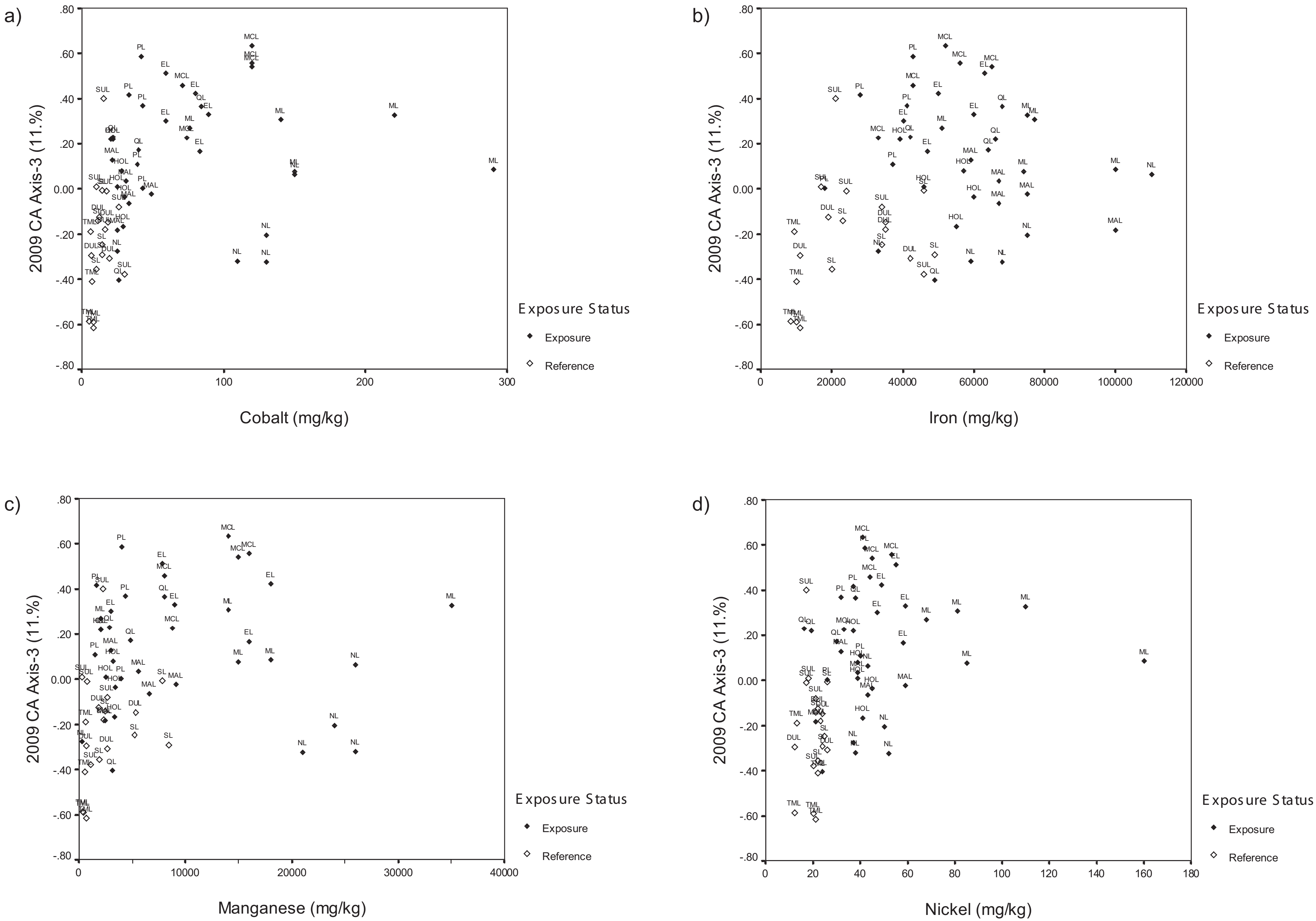


Appendix Figure E.20: Correlations at SRWMP, excluding RL, 2009.

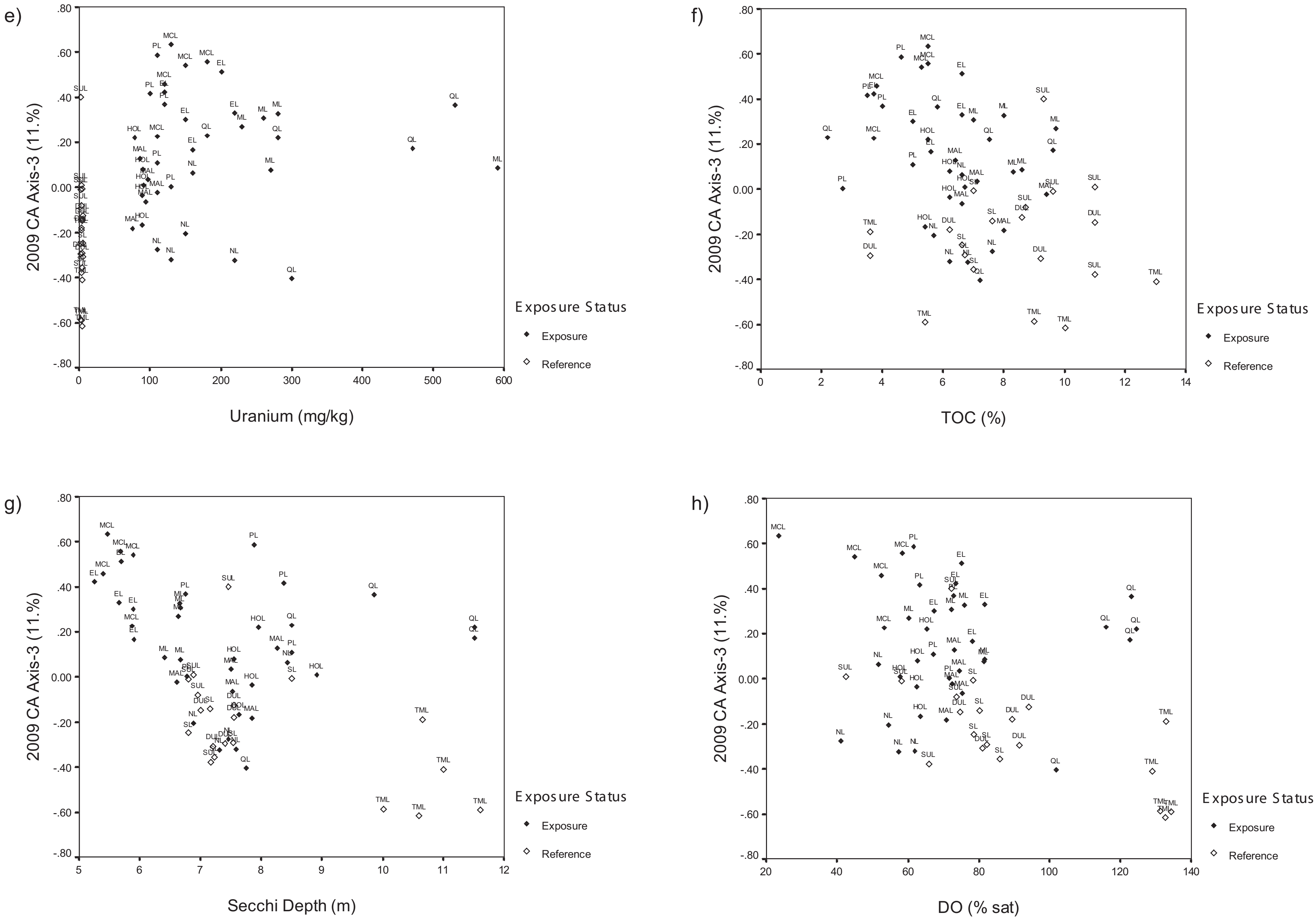
i)



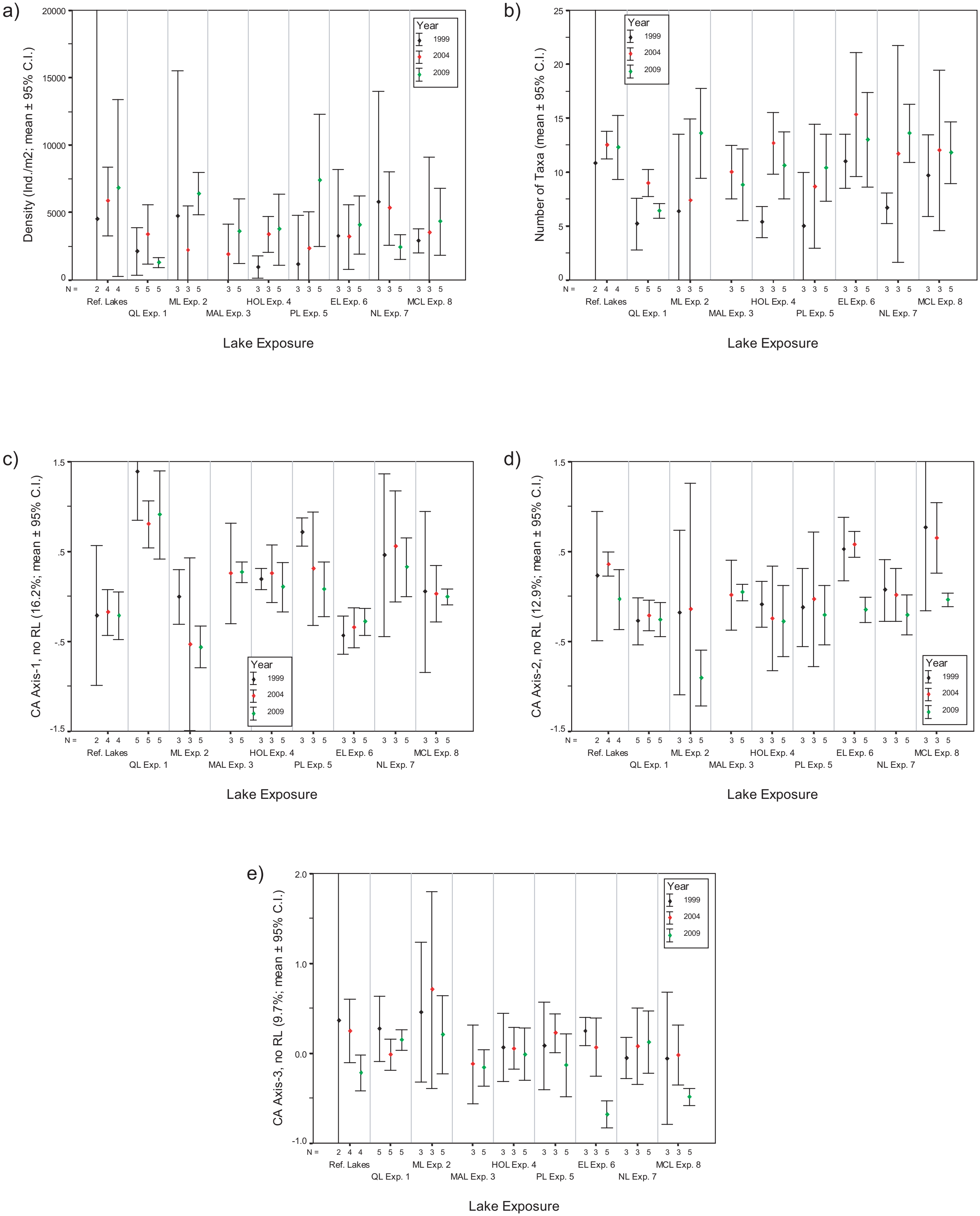
Appendix Figure E.20: Correlations at SRWMP, excluding RL, 2009.



Appendix Figure E.21: Correlations at SRWMP, excluding RL, 2009.



Appendix Figure E.21: Correlations at SRWMP, excluding RL, 2009.



Appendix Figure E.22: Lake benthic community characteristics over time: 1999, 2004, 2009.

LABORATORY REPORTS

AquaTox Testing & Consulting Inc.
11B Nicholas Beaver Rd.
RR 3
Guelph ON N1H 6H9
Tel: (519) 763-4412 Fax: (519) 763-4419

SAMPLE IDENTIFICATION

Work Order:	215904	Shipped By:	Rabbex/Rd
Company :	Minnow Environmental Inc. (BMS Corp.)	Date Received :	2009-09-25
Location :	Georgetown ON	Time Received :	10:25
Sampling Method :	P. Ponar	Date Tested :	2009-10-01
Sampled By :	C. R	Lab Storage:	4±2 °C
Sample Volume:	1 x 5 L pail		

Test Method : Test for Survival and Growth in Sediment Using the Freshwater Amphipod *Hyalella azteca*. Environment Canada, Conservation and Protection. Ottawa, Ontario. Report EPS 1/RM/33, December, 1997.

SAMPLE SUMMARY

Sample Number	Sample Name	Description	Sample Date	Sample Time	Temp. on Arrival
-	Control	Fine brown organic sediment; no odour.	2009-05-25	12:00	-
25651	QL-09-01	Black colour, no odour.	2009-09-22	Not given	8.0 °C
25652	SL-09-01	Black colour, no odour.	2009-09-17	Not given	8.0 °C
25653	ML-09-01	Black colour, low odour.	2009-09-18	Not given	8.0 °C
25654	TML-09-01	Black colour, low odour.	2009-09-19	Not given	8.0 °C
25655	EL-09-01	Black colour, low odour.	2009-09-14	Not given	8.0 °C
25656	DUL-09-01	Black colour, low odour.	2009-09-15	Not given	8.0 °C
25657	MCL-09-01	Black colour, low odour.	2009-09-22	Not given	8.0 °C
25658	RL-09-01	Black colour, low odour.	2009-09-21	Not given	8.0 °C
25659	MAL-09-03	Black colour, low odour.	2009-09-20	Not given	8.0 °C
25660	HOL-09-01	Light black colour, low odour.	2009-09-17	Not given	8.0 °C
25661	PL-09-02	Grey colour, no odour.	2009-09-16	Not given	8.0 °C
25662	SUL-09-02	Black colour, low odour.	2009-09-19	Not given	8.0 °C
25663	NL-09-03	Black colour, low odour.	2009-09-18	Not given	8.0 °C

RESULTS

Survival Data (Treatment Average Survival, %)[1]

NL-09-03	PL-09-02	MCL-09-01	HOL-09-01	Control	QL-09-01	SL-09-01	ML-09-01	TML-09-01	EL-09-01	DUL-09-01	RL-09-01	MAL-09-03	SUL-09-02
32	54	82	98	100	100	100	100	100	100	100	100	100	100

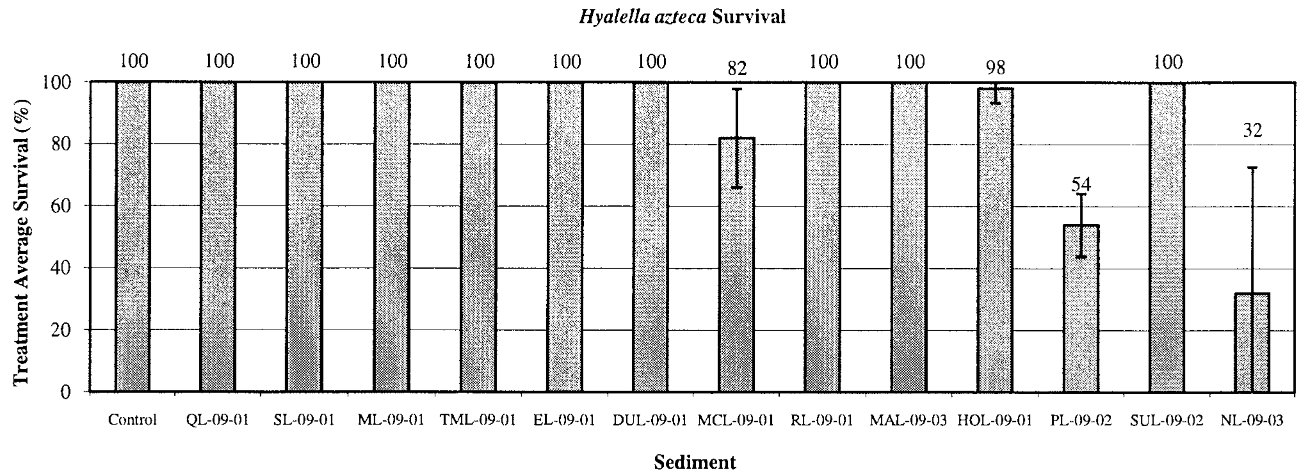
[1] **Tukey-Kramer Test (CETIS)[a]**: Samples sharing the same line are not significantly different from one another (i.e. they are considered to be homogenous, that is, from the same population) (α =0.05). The data sets did not meet the assumptions for normality and/or homogeneity of variance. Under these conditions a non-parametric test should be employed. However, the statistical analyses required by Environment Canada did not yield results that could be considered logical or meaningful. As an alternative, analyses were performed using the parametric test (Tukey-Kramer), recognizing that statistical assumptions have not been met.

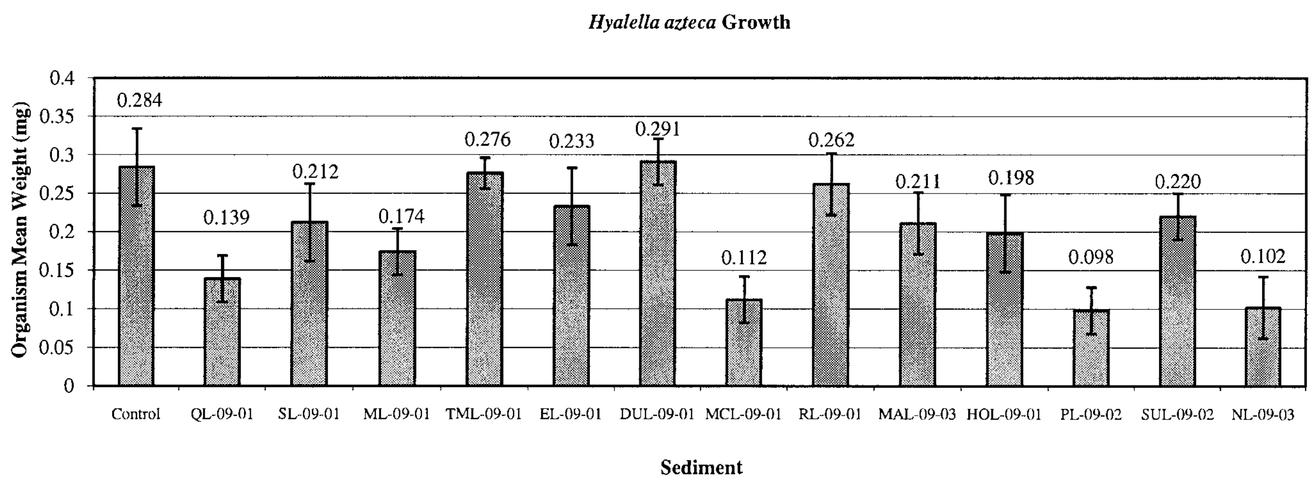
Growth Data (Treatment Average Weight, mg)[2]

PL-09-02	NL-09-03	MCL-09-01	QL-09-01	ML-09-01	HOL-09-01	MAL-09-03	SL-09-01	SUL-09-02	EL-09-01	RL-09-01	TML-09-01	Control	DUL-09-01
0.098	0.102	0.112	0.139	0.174	0.198	0.211	0.212	0.222	0.233	0.262	0.276	0.284	0.291

[2] **Tukey-Kramer Test (CETIS)[a]**: Samples sharing the same line are not significantly different from one another (i.e. they are considered to be homogenous, that is, from the same population) (α =0.05). All data sets met the assumptions for normality and homogeneity of variance.

Work Order : 215904





SEDIMENT CHARACTERISTICS

Sample Number	Sample Name	TOC (mg/kg)	Moisture Content (%)	Particle Size (%) Gravel	Sand	Silt	Clay
–	Control	89000	72	0	0.9	98.2	1
25651	QL-09-01	96000	89	ND	45	39	16
25652	SL-09-01	66000	86	ND	24	62	13
25653	ML-09-01	86000	91	ND	46	42	12
25654	TML-09-01	130000	90	ND	28	48	24
25655	EL-09-01	37000	79	ND	39	46	15
25656	DUL-09-01	110000	92	ND	25	56	19
25657	MCL-09-01	55000	82	ND	38	51	11
25658	RL-09-01	98000	88	ND	22	65	13
25659	MAL-09-03	71000	83	ND	52	39	8
25660	HOL-09-01	54000	80	ND	38	51	12
25661	PL-09-02	46000	79	ND	22	61	17
25662	SUL-09-02	93000	87	ND	36	45	19
25663	NL-09-03	62000	79	ND	45	43	12

ND = Not Detected

Work Order : 215904

TEST CONDITIONS

Test Organism:	*Hyalella azteca*	Test Type:	Static
Organism Batch :	Ha09-09	Test Vessel:	300 mL pyrex beaker
Source:	In-house culture	Sediment Depth:	Approx. 3.5 cm
Life Stage on Test Day 0 :	2-9 days old	Sediment Volume:	100 mL per replicate
Organism Mortality Rate :	0% (in 48 h preceding test)	Overlying Water Volume:	175 mL per replicate
Samples per Treatment :	1	Control/Test Water:	Well water (no additional chemicals)
Number of Replicates:	5	Control Sediment:	Long Point, Lake Erie
Organisms per Replicate:	10	Test Aeration :	Yes (all replicates)
Organisms per Treatment:	50	Test Aeration Rate :	2-3 bubbles per second
Feed Type:	YCT (Batch 09-07)	Photoperiod (light/dark) :	16 h / 8 h
Feeding Rate (per replicate):	~2.7 mg dry solids daily	Light Intensity :	965 - 994 lux
Test Duration :	14 days	Test Method Deviations :	None

COPPER (as COPPER SULPHAtE) REFERENCE TOXICANT DATA

Test Date :	2009-10-22	Historical Mean LC50 :	148 µg/L
Test Duration :	96 hours	Warning Limits (± 2 SD) :	93 - 233 µg/L
LC50 (95% conf. limits):	134 µg/L (108 - 166)	Statistical Method :	Spearman-Kärber(CETIS)[a]
		Test Conducted By :	JGG/AS

The reference toxicant test was conducted as a water only test, as specified in the test method.

COMMENTS

The results reported relate only to the samples tested.
All test validity criteria as specified in the test method cited in this report were satisfied.
No organisms exhibiting unusual appearance, behavior, or undergoing unusual treatment were used in the test.

REFERENCES

[a] CETIS, © 2001-2007. Comprehensive Environmental Toxicity Information System. Tidepool Scientific Software, McKinleyville, Calif. 95519 [Program on disk and printed User's Guide].

[d] West, Inc. and D. Gulley. 1996. Toxstat Release 3.5. Western Ecosystems Technology. Cheyenne, WY, U.S.A.

Date: ____________________
yyyy-mm-dd

Approved by: ____________________
Project Manager

Work Order : 215904

Hyalella azteca Survival Data

Sample	Replicate	Number of Survivors (n=10)	Surviving Organisms (%)	Treatment Average Survival (%)	Standard Deviation	CV (%)
Control 2	A	10	100	100	0.0	0.0
	B	10	100			
	C	10	100			
	D	10	100			
	E	10	100			
Control 3	A	10	100	100	0.0	0.0
	B	10	100			
	C	10	100			
	D	10	100			
	E	10	100			
25651 **QL-09-01**	A	10	100	100	0.0	0.0
	B	10	100			
	C	10	100			
	D	10	100			
	E	10	100			
25652 **SL-09-01**	A	10	100	100	0.0	0.0
	B	10	100			
	C	10	100			
	D	10	100			
	E	10	100			
25653 **ML-09-01**	A	10	100	100	0.0	0.0
	B	10	100			
	C	10	100			
	D	10	100			
	E	10	100			
25654 **TML-09-01**	A	10	100	100	0.0	0.0
	B	10	100			
	C	10	100			
	D	10	100			
	E	10	100			
25655 **EL-09-01**	A	10	100	100	0.0	0.0
	B	10	100			
	C	10	100			
	D	10	100			
	E	10	100			
25656 **DUL-09-01**	A	10	100	100	0.0	0.0
	B	10	100			
	C	10	100			
	D	10	100			
	E	10	100			
25657 **MCL-09-01**	A	7	70	82	13.0	15.9
	B	7	70			
	C	10	100			
	D	9	90			
	E	8	80			
25658 **RL-09-01**	A	10	100	100	0.0	0.0
	B	10	100			
	C	10	100			
	D	10	100			
	E	10	100			
25659 **MAL-09-03**	A	10	100	100	0.0	0.0
	B	10	100			
	C	10	100			
	D	10	100			
	E	10	100			
25660 **HOL-09-01**	A	10	100	98	4.5	4.6
	B	10	100			
	C	10	100			
	D	9	90			
	E	10	100			
25661 **PL-09-02**	A	6	60	54	5.5	10.1
	B	6	60			
	C	5	50			
	D	5	50			
	E	5	50			
25662 **SUL-09-02**	A	10	100	100	0.0	0.0
	B	10	100			
	C	10	100			
	D	10	100			
	E	10	100			
25663 **NL-09-03**	A	2	20	32	13.0	40.7
	B	2	20			
	C	4	40			
	D	5	50			
	E	3	30			

Data Reviewed By: KEH
Date: 2009-11-05

Work Order : 215904

Hyalella azteca Weight Data

Sample	Replicate	Foil Weight (mg)	Dry Weigt of Foil + Organisms (mg)	Number of Organisms Weighed	Mean Dry Weight of Organisms (mg)	Treatment Mean Dry Weight (mg)	Standard Deviation	CV (%)
	A	422.51	424.89	11	0.216	0.284	0.05	17.5
Control	B	416.57	419.68	10	0.311			
	C	414.74	417.22	10	0.248			
	D	418.67	421.82	10	0.315			
	E	421.40	424.72	10	0.332			
	A	425.46	427.10	10	0.164	0.139	0.03	21.3
	B	425.74	426.77	10	0.103			
25651	C	416.86	418.37	10	0.151			
QL-09-01	D	426.15	427.27	10	0.112			
	E	426.66	428.32	10	0.166			
	A	412.12	413.98	10	0.186	0.212	0.05	22.3
	B	424.96	426.62	10	0.166			
25652	C	421.01	423.39	10	0.238			
SL-09-01	D	414.35	416.23	10	0.188			
	E	423.48	426.30	10	0.282			
	A	425.16	426.82	10	0.166	0.174	0.03	17.2
	B	419.20	420.68	10	0.148			
25653	C	430.37	432.07	10	0.170			
ML-09-01	D	415.61	417.23	10	0.162			
	E	415.82	418.08	10	0.226			
	A	417.69	420.67	10	0.298	0.276	0.02	8.9
	B	412.26	414.60	10	0.234			
25654	C	424.51	427.31	10	0.280			
TML-09-01	D	408.75	411.57	10	0.282			
	E	415.89	418.75	10	0.286			
	A	420.92	423.49	10	0.257	0.233	0.05	22.1
	B	417.44	419.73	10	0.229			
25655	C	413.22	414.86	10	0.164			
EL-09-01	D	414.44	417.47	10	0.303			
	E	428.39	430.53	10	0.214			
	A	419.22	422.34	10	0.312	0.291	0.03	9.0
	B	424.42	427.28	10	0.286			
25656	C	421.05	424.21	10	0.316			
DUL-09-01	D	421.99	424.49	10	0.250			
	E	412.65	415.58	10	0.293			
	A	418.61	419.45	7	0.120	0.112	0.03	25.5
	B	425.32	426.42	7	0.157			
25657	C	422.57	423.45	10	0.088			
MCL-09-01	D	420.59	421.39	9	0.089			
	E	422.04	422.88	8	0.105			
	A	417.34	419.28	10	0.194	0.262	0.04	16.2
	B	408.18	411.16	10	0.298			
25658	C	418.35	421.11	10	0.276			
RL-09-01	D	415.68	418.16	10	0.248			
	E	418.62	421.54	10	0.292			
	A	412.70	414.42	10	0.172	0.211	0.04	20.1
	B	422.73	424.75	10	0.202			
25659	C	422.16	424.97	10	0.281			
MAL-09-03	D	417.77	419.93	10	0.216			
	E	414.48	416.33	10	0.185			
	A	420.84	422.78	10	0.194	0.198	0.05	26.9
	B	421.19	422.32	10	0.113			
25660	C	414.15	416.73	10	0.258			
HOL-09-01	D	415.28	417.24	9	0.218			
	E	418.12	420.20	10	0.208			
	A	409.43	410.09	6	0.110	0.098	0.03	34.3
	B	414.25	414.78	6	0.088			
25661	C	420.98	421.20	5	0.044			
PL-09-02	D	423.48	424.06	5	0.116			
	E	415.30	415.95	5	0.130			
	A	417.69	420.12	10	0.243	0.222	0.03	15.3
	B	413.90	416.10	10	0.220			
25662	C	426.59	428.65	10	0.206			
SUL-09-02	D	421.36	424.00	10	0.264			
	E	417.62	419.38	10	0.176			
	A	426.62	426.94	2	0.160	0.102	0.04	36.9
	B	418.85	419.04	2	0.095			
25663	C	424.24	424.57	4	0.082			
NL-09-03	D	419.81	420.37	5	0.112			
	E	423.88	424.06	3	0.060			

Data Reviewed By: KEH
Date: 2009-11-05

Hyalella azteca **Sediment Test Data**

Work Order :	215904
Sample Number :	**Control**
Species:	*Hyalella azteca*
Organism Batch :	Ha09-09
Sediment pH:	6.7
Pore Water pH:	7.2
Pore Water Ammonia (mg/L) :	0.8
Sample Treatment:	Dry sieved (2 mm)
Time Start:	10:55

Test Day	Day	Date	Temp. (°C)	Replicate	D.O. (mg/L)	Test Fed? (Y/N)	Analyst(s)	Conductivity (μmhos/cm)	pH	Hardness (mg/l as $CaCO_3$)	Total Ammonia (mg/L)	Unionized Ammonia (mg/L)
0	Thurs	2009-10-01	23.0	Composite	8.4	Y	JGG/NK	803	8.3	400	0.20	0.02
1	Fri	2009-10-02	23.0	A	7.6	Y	JGG	–	–	–	–	–
2	Sat	2009-10-03	24.0	–	–	Y	KEH	–	–	–	–	–
3	Sun	2009-10-04	24.0	–	–	Y	KEH	–	–	–	–	–
4	Mon	2009-10-05	23.0	B	8.0	Y	JGG	–	–	–	–	–
5	Tues	2009-10-06	23.0	–	–	Y	KEH	–	–	–	–	–
6	Wed	2009-10-07	23.0	C	7.9	Y	JGG	–	–	–	–	–
7	Thurs	2009-10-08	23.0	–	–	Y	JGG	–	–	–	–	–
8	Fri	2009-10-09	23.0	D	8.1	Y	JGG	–	–	–	–	–
9	Sat	2009-10-10	23.0	–	–	Y	JGG	–	–	–	–	–
10	Sun	2009-10-11	23.0	–	–	Y	JGG	–	–	–	–	–
11	Mon	2009-10-12	23.0	E	8.1	Y	LB	–	–	–	–	–
12	Tues	2009-10-13	23.0	–	–	Y	JGG	–	–	–	–	–
13	Wed	2009-10-14	23.0	A	7.7	Y	JGG	–	–	–	–	–
14	Thurs	2009-10-15	23.0	Composite	8.3	N	JGG/LB	1005	8.3	500	0.40	0.04

"–" = not measured/not required

Data Reviewed By: KEH
Date: 2009-11-20

Hyalella azteca **Sediment Test Data**

Work Order :	215904
Sample Number :	**25651**
Species:	*Hyalella azteca*
Organism Batch :	Ha09-09
Sediment pH:	6.7
Pore Water pH:	7.0
Pore Water Ammonia (mg/L) :	0.8
Sample Treatment:	Hand homogenized
Time Start:	10:35

Test Day	Day	Date	Temp. (°C)	Replicate	D.O. (mg/L)	Test Fed? (Y/N)	Analyst(s)	Conductivity (µmhos/cm)	pH	Hardness (mg/l as $CaCO_3$)	Total Ammonia (mg/L)	Unionized Ammonia (mg/L)
0	Thurs	2009-10-01	23.0	Composite	8.4	Y	JGG/NK	461	8.4	230	0.55	0.06
1	Fri	2009-10-02	23.0	A	7.5	Y	JGG	–	–	–	–	–
2	Sat	2009-10-03	24.0	–	–	Y	KEH	–	–	–	–	–
3	Sun	2009-10-04	24.0	–	–	Y	KEH	–	–	–	–	–
4	Mon	2009-10-05	23.0	B	7.8	Y	JGG	–	–	–	–	–
5	Tues	2009-10-06	23.0	–	–	Y	KEH	–	–	–	–	–
6	Wed	2009-10-07	23.0	C	7.9	Y	JGG	–	–	–	–	–
7	Thurs	2009-10-08	23.0	–	–	Y	JGG	–	–	–	–	–
8	Fri	2009-10-09	23.0	D	7.9	Y	JGG	–	–	–	–	–
9	Sat	2009-10-10	23.0	–	–	Y	JGG	–	–	–	–	–
10	Sun	2009-10-11	23.0	–	–	Y	JGG	–	–	–	–	–
11	Mon	2009-10-12	23.0	E	7.5	Y	LB	–	–	–	–	–
12	Tues	2009-10-13	23.0	–	–	Y	JGG	–	–	–	–	–
13	Wed	2009-10-14	23.0	A	7.7	Y	JGG	–	–	–	–	–
14	Thurs	2009-10-15	23.0	Composite	7.7	N	JGG/LB	458	7.9	160	0.70	0.03

"–" = not measured/not required

Data Reviewed By: KEH
Date: 2009-11-05

Hyalella azteca Sediment Test Data

Work Order :	215904
Sample Number :	**25652**
Species:	*Hyalella azteca*
Organism Batch :	Ha09-09
Sediment pH:	6.0
Pore Water pH:	5.7
Pore Water Ammonia (mg/L) :	1.1
Sample Treatment:	Hand homogenized
Time Start:	10:40

Test Day	Day	Date	Temp. (°C)	Replicate	D.O. (mg/L)	Test Fed? (Y/N)	Analyst(s)	Conductivity (μmhos/cm)	pH	Hardness (mg/l as $CaCO_3$)	Total Ammonia (mg/L)	Unionized Ammonia (mg/L)
0	Thurs	2009-10-01	23.0	Composite	8.5	Y	JGG/NK	449	8.3	220	0.55	0.05
1	Fri	2009-10-02	23.0	A	7.7	Y	JGG	–	–	–	–	–
2	Sat	2009-10-03	24.0	–	–	Y	KEH	–	–	–	–	–
3	Sun	2009-10-04	24.0	–	–	Y	KEH	–	–	–	–	–
4	Mon	2009-10-05	23.0	B	8.1	Y	JGG	–	–	–	–	–
5	Tues	2009-10-06	23.0	–	–	Y	KEH	–	–	–	–	–
6	Wed	2009-10-07	23.0	C	8.2	Y	JGG	–	–	–	–	–
7	Thurs	2009-10-08	23.0	–	–	Y	JGG	–	–	–	–	–
8	Fri	2009-10-09	23.0	D	7.8	Y	JGG	–	–	–	–	–
9	Sat	2009-10-10	23.0	–	–	Y	JGG	–	–	–	–	–
10	Sun	2009-10-11	23.0	–	–	Y	JGG	–	–	–	–	–
11	Mon	2009-10-12	23.0	E	8.2	Y	LB	–	–	–	–	–
12	Tues	2009-10-13	23.0	–	–	Y	JGG	–	–	–	–	–
13	Wed	2009-10-14	23.0	A	8.2	Y	JGG	–	–	–	–	–
14	Thurs	2009-10-15	23.0	Composite	8.1	N	JGG/LB	398	7.9	140	6.70	0.25

"–" = not measured/not required

Data Reviewed By: KEH
Date: 2009-11-05

***Hyalella azteca* Sediment Test Data**

Work Order :	215904
Sample Number :	**25653**
Species:	*Hyalella azteca*
Organism Batch :	Ha09-09
Sediment pH:	6.5
Pore Water pH:	7.0
Pore Water Ammonia (mg/L) :	0.7
Sample Treatment:	Hand homogenized
Time Start:	10:45

Test Day	Day	Date	Temp. (°C)	Replicate	D.O. (mg/L)	Test Fed? (Y/N)	Analyst(s)	Conductivity (μmhos/cm)	pH	Hardness (mg/l as $CaCO_3$)	Total Ammonia (mg/L)	Unionized Ammonia (mg/L)
0	Thurs	2009-10-01	23.0	Composite	8.5	Y	JGG/NK	532	8.4	340	0.35	0.04
1	Fri	2009-10-02	23.0	A	7.7	Y	JGG	–	–	–	–	–
2	Sat	2009-10-03	24.0	–	–	Y	KEH	–	–	–	–	–
3	Sun	2009-10-04	24.0	–	–	Y	KEH	–	–	–	–	–
4	Mon	2009-10-05	23.0	B	8.2	Y	JGG	–	–	–	–	–
5	Tues	2009-10-06	23.0	–	–	Y	KEH	–	–	–	–	–
6	Wed	2009-10-07	23.0	C	7.8	Y	JGG	–	–	–	–	–
7	Thurs	2009-10-08	23.0	–	–	Y	JGG	–	–	–	–	–
8	Fri	2009-10-09	23.0	D	7.5	Y	JGG	–	–	–	–	–
9	Sat	2009-10-10	23.0	–	–	Y	JGG	–	–	–	–	–
10	Sun	2009-10-11	23.0	–	–	Y	JGG	–	–	–	–	–
11	Mon	2009-10-12	23.0	E	8.2	Y	LB	–	–	–	–	–
12	Tues	2009-10-13	23.0	–	–	Y	JGG	–	–	–	–	–
13	Wed	2009-10-14	23.0	A	7.5	Y	JGG	–	–	–	–	–
14	Thurs	2009-10-15	23.0	Composite	7.7	N	JGG/LB	527	8.0	250	0.50	0.02

"–" = not measured/not required

Data Reviewed By: KEH
Date: 2009-11-05

Hyalella azteca **Sediment Test Data**

Work Order :	215904
Sample Number :	**25654**
Species:	*Hyalella azteca*
Organism Batch :	Ha09-09
Sediment pH:	6.2
Pore Water pH:	6.9
Pore Water Ammonia (mg/L) :	0.3
Sample Treatment:	Hand homogenized
Time Start:	10:50

Test Day	Day	Date	Temp. (°C)	Replicate	D.O. (mg/L)	Test Fed? (Y/N)	Analyst(s)	Conductivity (µmhos/cm)	pH	Hardness (mg/l as $CaCO_3$)	Total Ammonia (mg/L)	Unionized Ammonia (mg/L)
0	Thurs	2009-10-01	23.0	Composite	8.5	Y	JGG/NK	413	8.3	230	0.35	0.03
1	Fri	2009-10-02	23.0	A	7.3	Y	JGG	–	–	–	–	–
2	Sat	2009-10-03	24.0	–	–	Y	KEH	–	–	–	–	–
3	Sun	2009-10-04	24.0	–	–	Y	KEH	–	–	–	–	–
4	Mon	2009-10-05	23.0	B	8.2	Y	JGG	–	–	–	–	–
5	Tues	2009-10-06	23.0	–	–	Y	KEH	–	–	–	–	–
6	Wed	2009-10-07	23.0	C	8.0	Y	JGG	–	–	–	–	–
7	Thurs	2009-10-08	23.0	–	–	Y	JGG	–	–	–	–	–
8	Fri	2009-10-09	23.0	D	7.6	Y	JGG	–	–	–	–	–
9	Sat	2009-10-10	23.0	–	–	Y	JGG	–	–	–	–	–
10	Sun	2009-10-11	23.0	–	–	Y	JGG	–	–	–	–	–
11	Mon	2009-10-12	23.0	E	7.8	Y	LB	–	–	–	–	–
12	Tues	2009-10-13	23.0	–	–	Y	JGG	–	–	–	–	–
13	Wed	2009-10-14	23.0	A	8.0	Y	JGG	–	–	–	–	–
14	Thurs	2009-10-15	23.0	Composite	8.1	N	JGG/LB	391	8.3	170	4.30	0.38

"–" = not measured/not required

Data Reviewed By: KEH
Date: 2009-11-05

***Hyalella azteca* Sediment Test Data**

Work Order :	215904
Sample Number :	**25655**
Species:	*Hyalella azteca*
Organism Batch :	Ha09-09
Sediment pH:	6.2
Pore Water pH:	5.6
Pore Water Ammonia (mg/L) :	0.6
Sample Treatment:	Hand homogenized
Time Start:	11:00

Test Day	Day	Date	Temp. (°C)	Replicate	D.O. (mg/L)	Test Fed? (Y/N)	Analyst(s)	Conductivity (µmhos/cm)	pH	Hardness (mg/l as $CaCO_3$)	Total Ammonia (mg/L)	Unionized Ammonia (mg/L)
0	Thurs	2009-10-01	23.0	Composite	8.6	Y	JGG/NK	487	8.3	210	0.50	0.04
1	Fri	2009-10-02	23.0	A	7.5	Y	JGG	–	–	–	–	–
2	Sat	2009-10-03	24.0	–	–	Y	KEH	–	–	–	–	–
3	Sun	2009-10-04	24.0	–	–	Y	KEH	–	–	–	–	–
4	Mon	2009-10-05	23.0	B	8.1	Y	JGG	–	–	–	–	–
5	Tues	2009-10-06	23.0	–	–	Y	KEH	–	–	–	–	–
6	Wed	2009-10-07	23.0	C	7.9	Y	JGG	–	–	–	–	–
7	Thurs	2009-10-08	23.0	–	–	Y	JGG	–	–	–	–	–
8	Fri	2009-10-09	23.0	D	7.9	Y	JGG	–	–	–	–	–
9	Sat	2009-10-10	23.0	–	–	Y	JGG	–	–	–	–	–
10	Sun	2009-10-11	23.0	–	–	Y	JGG	–	–	–	–	–
11	Mon	2009-10-12	23.0	E	8.1	Y	LB	–	–	–	–	–
12	Tues	2009-10-13	23.0	–	–	Y	JGG	–	–	–	–	–
13	Wed	2009-10-14	23.0	A	7.6	Y	JGG	–	–	–	–	–
14	Thurs	2009-10-15	23.0	Composite	8.1	N	JGG/LB	447	7.6	160	1.90	0.04

"–" = not measured/not required

Data Reviewed By: KEH
Date: 2009-11-05

Hyalella azteca **Sediment Test Data**

Work Order : 215904
Sample Number : **25656**
Species: *Hyalella azteca*
Organism Batch : Ha09-09
Sediment pH: 6.1
Pore Water pH: 5.6
Pore Water Ammonia (mg/L) : 0.3
Sample Treatment: Hand homogenized
Time Start: 11:05

Test Day	Day	Date	Temp. (°C)	Replicate	D.O. (mg/L)	Test Fed? (Y/N)	Analyst(s)	Conductivity (µmhos/cm)	pH	Hardness (mg/l as $CaCO_3$)	Total Ammonia (mg/L)	Unionized Ammonia (mg/L)
0	Thurs	2009-10-01	23.0	Composite	8.6	Y	JGG/NK	392	8.2	200	0.45	0.03
1	Fri	2009-10-02	23.0	A	7.6	Y	JGG	–	–	–	–	–
2	Sat	2009-10-03	24.0	–	–	Y	KEH	–	–	–	–	–
3	Sun	2009-10-04	24.0	–	–	Y	KEH	–	–	–	–	–
4	Mon	2009-10-05	23.0	B	7.7	Y	JGG	–	–	–	–	–
5	Tues	2009-10-06	23.0	–	–	Y	KEH	–	–	–	–	–
6	Wed	2009-10-07	23.0	C	7.5	Y	JGG	–	–	–	–	–
7	Thurs	2009-10-08	23.0	–	–	Y	JGG	–	–	–	–	–
8	Fri	2009-10-09	23.0	D	7.4	Y	JGG	–	–	–	–	–
9	Sat	2009-10-10	23.0	–	–	Y	JGG	–	–	–	–	–
10	Sun	2009-10-11	23.0	–	–	Y	JGG	–	–	–	–	–
11	Mon	2009-10-12	23.0	E	8.3	Y	JGG	–	–	–	–	–
12	Tues	2009-10-13	23.0	–	–	Y	JGG	–	–	–	–	–
13	Wed	2009-10-14	23.0	A	8.0	Y	JGG	–	–	–	–	–
14	Thurs	2009-10-15	23.0	Composite	8.1	N	JGG/LB	382	7.9	150	3.70	0.14

"–" = not measured/not required

Data Reviewed By: KEH
Date: 2009-11-05

***Hyalella azteca* Sediment Test Data**

Work Order :	215904
Sample Number :	**25657**
Species:	*Hyalella azteca*
Organism Batch :	Ha09-09
Sediment pH:	6.2
Pore Water pH:	6.6
Pore Water Ammonia (mg/L) :	2.8
Sample Treatment:	Hand homogenized
Time Start:	11:10

Test Day	Day	Date	Temp. (°C)	Replicate	D.O. (mg/L)	Test Fed? (Y/N)	Analyst(s)	Conductivity (µmhos/cm)	pH	Hardness (mg/l as $CaCO_3$)	Total Ammonia (mg/L)	Unionized Ammonia (mg/L)
0	Thurs	2009-10-01	23.0	Composite	8.5	Y	JGG/NK	473	8.3	270	0.85	0.08
1	Fri	2009-10-02	23.0	A	7.7	Y	JGG	–	–	–	–	–
2	Sat	2009-10-03	24.0	–	–	Y	KEH	–	–	–	–	–
3	Sun	2009-10-04	24.0	–	–	Y	KEH	–	–	–	–	–
4	Mon	2009-10-05	23.0	B	7.7	Y	JGG	–	–	–	–	–
5	Tues	2009-10-06	23.0	–	–	Y	KEH	–	–	–	–	–
6	Wed	2009-10-07	23.0	C	7.2	Y	JGG	–	–	–	–	–
7	Thurs	2009-10-08	23.0	–	–	Y	JGG	–	–	–	–	–
8	Fri	2009-10-09	23.0	D	7.9	Y	JGG	–	–	–	–	–
9	Sat	2009-10-10	23.0	–	–	Y	JGG	–	–	–	–	–
10	Sun	2009-10-11	23.0	–	–	Y	JGG	–	–	–	–	–
11	Mon	2009-10-12	23.0	E	8.3	Y	LB	–	–	–	–	–
12	Tues	2009-10-13	23.0	–	–	Y	JGG	–	–	–	–	–
13	Wed	2009-10-14	23.0	A	8.3	Y	JGG	–	–	–	–	–
14	Thurs	2009-10-15	23.0	Composite	8.0	N	JGG/LB	409	7.5	170	0.70	0.01

"–" = not measured/not required

Data Reviewed By: KEH
Date: 2009-11-05

Hyalella azteca Sediment Test Data

Work Order : 215904
Sample Number : **25658**
Species: *Hyalella azteca*
Organism Batch : Ha09-09
Sediment pH: 6.1
Pore Water pH: 5.9
Pore Water Ammonia (mg/L) : 4.5
Sample Treatment: Hand homogenized
Time Start: 11:15

Test Day	Day	Date	Temp. (°C)	Replicate	D.O. (mg/L)	Test Fed? (Y/N)	Analyst(s)	Conductivity (µmhos/cm)	pH	Hardness (mg/l as $CaCO_3$)	Total Ammonia (mg/L)	Unionized Ammonia (mg/L)
0	Thurs	2009-10-01	23.0	Composite	8.4	Y	JGG/NK	385	8.2	170	0.30	0.02
1	Fri	2009-10-02	23.0	A	7.6	Y	JGG	–	–	–	–	–
2	Sat	2009-10-03	24.0	–	–	Y	KEH	–	–	–	–	–
3	Sun	2009-10-04	24.0	–	–	Y	KEH	–	–	–	–	–
4	Mon	2009-10-05	23.0	B	8.0	Y	JGG	–	–	–	–	–
5	Tues	2009-10-06	23.0	–	–	Y	KEH	–	–	–	–	–
6	Wed	2009-10-07	23.0	C	7.6	Y	JGG	–	–	–	–	–
7	Thurs	2009-10-08	23.0	–	–	Y	JGG	–	–	–	–	–
8	Fri	2009-10-09	23.0	D	8.0	Y	JGG	–	–	–	–	–
9	Sat	2009-10-10	23.0	–	–	Y	JGG	–	–	–	–	–
10	Sun	2009-10-11	23.0	–	–	Y	JGG	–	–	–	–	–
11	Mon	2009-10-12	23.0	E	8.0	Y	LB	–	–	–	–	–
12	Tues	2009-10-13	23.0	–	–	Y	JGG	–	–	–	–	–
13	Wed	2009-10-14	23.0	A	8.1	Y	JGG	–	–	–	–	–
14	Thurs	2009-10-15	23.0	Composite	8.1	N	JGG/LB	281	7.5	130	1.55	0.02

"–" = not measured/not required

Data Reviewed By: KEH
Date: 2009-11-05

Hyalella azteca Sediment Test Data

Work Order :	215904
Sample Number :	**25659**
Species:	*Hyalella azteca*
Organism Batch :	Ha09-09
Sediment pH:	6.4
Pore Water pH:	7.0
Pore Water Ammonia (mg/L) :	2.3
Sample Treatment:	Hand homogenized
Time Start:	11:25

Test Day	Day	Date	Temp. (°C)	Replicate	D.O. (mg/L)	Test Fed? (Y/N)	Analyst(s)	Conductivity (μmhos/cm)	pH	Hardness (mg/l as $CaCO_3$)	Total Ammonia (mg/L)	Unionized Ammonia (mg/L)
0	Thurs	2009-10-01	23.0	Composite	8.4	Y	JGG/NK	482	8.4	220	0.75	0.08
1	Fri	2009-10-02	23.0	A	7.7	Y	JGG	–	–	–	–	–
2	Sat	2009-10-03	24.0	–	–	Y	KEH	–	–	–	–	–
3	Sun	2009-10-04	24.0	–	–	Y	KEH	–	–	–	–	–
4	Mon	2009-10-05	23.0	B	8.2	Y	JGG	–	–	–	–	–
5	Tues	2009-10-06	23.0	–	–	Y	KEH	–	–	–	–	–
6	Wed	2009-10-07	23.0	C	8.0	Y	JGG	–	–	–	–	–
7	Thurs	2009-10-08	23.0	–	–	Y	JGG	–	–	–	–	–
8	Fri	2009-10-09	23.0	D	7.9	Y	JGG	–	–	–	–	–
9	Sat	2009-10-10	23.0	–	–	Y	JGG	–	–	–	–	–
10	Sun	2009-10-11	23.0	–	–	Y	JGG	–	–	–	–	–
11	Mon	2009-10-12	23.0	E	8.2	Y	LB	–	–	–	–	–
12	Tues	2009-10-13	23.0	–	–	Y	JGG	–	–	–	–	–
13	Wed	2009-10-14	23.0	A	8.2	Y	JGG	–	–	–	–	–
14	Thurs	2009-10-15	23.0	Composite	7.8	N	JGG/LB	314	7.8	200	0.60	0.02

"–" = not measured/not required

Data Reviewed By: KEH
Date: 2009-11-05

Hyalella azteca **Sediment Test Data**

Work Order :	215904
Sample Number :	**25660**
Species:	*Hyalella azteca*
Organism Batch :	Ha09-09
Sediment pH:	6.7
Pore Water pH:	6.9
Pore Water Ammonia (mg/L) :	2.0
Sample Treatment:	Hand homogenized
Time Start:	11:30

Test Day	Day	Date	Temp. (°C)	Replicate	D.O. (mg/L)	Test Fed? (Y/N)	Analyst(s)	Conductivity (µmhos/cm)	pH	Hardness (mg/l as $CaCO_3$)	Total Ammonia (mg/L)	Unionized Ammonia (mg/L)
0	Thurs	2009-10-01	23.0	Composite	8.3	Y	JGG/NK	488	8.4	210	0.50	0.06
1	Fri	2009-10-02	23.0	A	7.7	Y	JGG	–	–	–	–	–
2	Sat	2009-10-03	24.0	–	–	Y	KEH	–	–	–	–	–
3	Sun	2009-10-04	24.0	–	–	Y	KEH	–	–	–	–	–
4	Mon	2009-10-05	23.0	B	8.3	Y	JGG	–	–	–	–	–
5	Tues	2009-10-06	23.0	–	–	Y	KEH	–	–	–	–	–
6	Wed	2009-10-07	23.0	C	7.9	Y	JGG	–	–	–	–	–
7	Thurs	2009-10-08	23.0	–	–	Y	JGG	–	–	–	–	–
8	Fri	2009-10-09	23.0	D	8.0	Y	JGG	–	–	–	–	–
9	Sat	2009-10-10	23.0	–	–	Y	JGG	–	–	–	–	–
10	Sun	2009-10-11	23.0	–	–	Y	JGG	–	–	–	–	–
11	Mon	2009-10-12	23.0	E	8.3	Y	LB	–	–	–	–	–
12	Tues	2009-10-13	23.0	–	–	Y	JGG	–	–	–	–	–
13	Wed	2009-10-14	23.0	A	6.8	Y	JGG	–	–	–	–	–
14	Thurs	2009-10-15	23.0	Composite	8.0	N	JGG/LB	433	7.9	200	0.45	0.02

"–" = not measured/not required

Data Reviewed By: KEH
Date: 2009-11-05

Hyalella azteca **Sediment Test Data**

Work Order :	215904
Sample Number :	**25661**
Species:	*Hyalella azteca*
Organism Batch :	Ha09-09
Sediment pH:	6.3
Pore Water pH:	6.6
Pore Water Ammonia (mg/L) :	1.8
Sample Treatment:	Hand homogenized
Time Start:	11:35

Test Day	Day	Date	Temp. (°C)	Replicate	D.O. (mg/L)	Test Fed? (Y/N)	Analyst(s)	Conductivity (µmhos/cm)	pH	Hardness (mg/l as $CaCO_3$)	Total Ammonia (mg/L)	Unionized Ammonia (mg/L)
0	Thurs	2009-10-01	23.0	Composite	8.4	Y	JGG/NK	487	8.4	230	0.50	0.06
1	Fri	2009-10-02	23.0	A	7.6	Y	JGG	–	–	–	–	–
2	Sat	2009-10-03	24.0	–	–	Y	KEH	–	–	–	–	–
3	Sun	2009-10-04	24.0	–	–	Y	KEH	–	–	–	–	–
4	Mon	2009-10-05	23.0	B	7.7	Y	JGG	–	–	–	–	–
5	Tues	2009-10-06	23.0	–	–	Y	KEH	–	–	–	–	–
6	Wed	2009-10-07	23.0	C	7.7	Y	JGG	–	–	–	–	–
7	Thurs	2009-10-08	23.0	–	–	Y	JGG	–	–	–	–	–
8	Fri	2009-10-09	23.0	D	7.8	Y	JGG	–	–	–	–	–
9	Sat	2009-10-10	23.0	–	–	Y	JGG	–	–	–	–	–
10	Sun	2009-10-11	23.0	–	–	Y	JGG	–	–	–	–	–
11	Mon	2009-10-12	23.0	E	7.3	Y	LB	–	–	–	–	–
12	Tues	2009-10-13	23.0	–	–	Y	JGG	–	–	–	–	–
13	Wed	2009-10-14	23.0	A	7.6	Y	JGG	–	–	–	–	–
14	Thurs	2009-10-15	23.0	Composite	8.1	N	JGG/LB	484	8.0	230	0.55	0.03

"–" = not measured/not required

Data Reviewed By: KEH
Date: 2009-11-05

Hyalella azteca **Sediment Test Data**

Work Order : 215904
Sample Number : **25662**
Species: *Hyalella azteca*
Organism Batch : Ha09-09
Sediment pH: 5.5
Pore Water pH: 5.9
Pore Water Ammonia (mg/L) : 2.3
Sample Treatment: Hand homogenized
Time Start: 11:40

Test Day	Day	Date	Temp. (°C)	Replicate	D.O. (mg/L)	Test Fed? (Y/N)	Analyst(s)	Conductivity (μmhos/cm)	pH	Hardness (mg/l as $CaCO_3$)	Total Ammonia (mg/L)	Unionized Ammonia (mg/L)
0	Thurs	2009-10-01	23.0	Composite	8.3	Y	JGG/NK	410	8.3	240	0.75	0.07
1	Fri	2009-10-02	23.0	A	7.6	Y	JGG	–	–	–	–	–
2	Sat	2009-10-03	24.0	–	–	Y	KEH	–	–	–	–	–
3	Sun	2009-10-04	24.0	–	–	Y	KEH	–	–	–	–	–
4	Mon	2009-10-05	23.0	B	8.1	Y	JGG	–	–	–	–	–
5	Tues	2009-10-06	23.0	–	–	Y	KEH	–	–	–	–	–
6	Wed	2009-10-07	23.0	C	7.9	Y	JGG	–	–	–	–	–
7	Thurs	2009-10-08	23.0	–	–	Y	JGG	–	–	–	–	–
8	Fri	2009-10-09	23.0	D	7.9	Y	JGG	–	–	–	–	–
9	Sat	2009-10-10	23.0	–	–	Y	JGG	–	–	–	–	–
10	Sun	2009-10-11	23.0	–	–	Y	JGG	–	–	–	–	–
11	Mon	2009-10-12	23.0	E	8.0	Y	LB	–	–	–	–	–
12	Tues	2009-10-13	23.0	–	–	Y	JGG	–	–	–	–	–
13	Wed	2009-10-14	23.0	A	8.0	Y	JGG	–	–	–	–	–
14	Thurs	2009-10-15	23.0	Composite	8.2	N	JGG/LB	347	8.0	160	5.35	0.25

"–" = not measured/not required

Data Reviewed By: YEH
Date: 2009-11-05

***Hyalella azteca* Sediment Test Data**

Work Order :	215904
Sample Number :	**25663**
Species:	*Hyalella azteca*
Organism Batch :	Ha09-09
Sediment pH:	6.9
Pore Water pH:	6.8
Pore Water Ammonia (mg/L) :	2.0
Sample Treatment:	Hand homogenized
Time Start:	11:45

Test Day	Day	Date	Temp. (°C)	Replicate	D.O. (mg/L)	Test Fed? (Y/N)	Analyst(s)	Conductivity (µmhos/cm)	pH	Hardness (mg/l as $CaCO_3$)	Total Ammonia (mg/L)	Unionized Ammonia (mg/L)
0	Thurs	2009-10-01	23.0	Composite	8.3	Y	JGG/NK	609	8.4	370	0.50	0.06
1	Fri	2009-10-02	23.0	A	7.6	Y	JGG	–	–	–	–	–
2	Sat	2009-10-03	24.0	–	–	Y	KEH	–	–	–	–	–
3	Sun	2009-10-04	24.0	–	–	Y	KEH	–	–	–	–	–
4	Mon	2009-10-05	23.0	B	8.2	Y	JGG	–	–	–	–	–
5	Tues	2009-10-06	23.0	–	–	Y	KEH	–	–	–	–	–
6	Wed	2009-10-07	23.0	C	8.1	Y	JGG	–	–	–	–	–
7	Thurs	2009-10-08	23.0	–	–	Y	JGG	–	–	–	–	–
8	Fri	2009-10-09	23.0	D	7.8	Y	JGG	–	–	–	–	–
9	Sat	2009-10-10	23.0	–	–	Y	JGG	–	–	–	–	–
10	Sun	2009-10-11	23.0	–	–	Y	JGG	–	–	–	–	–
11	Mon	2009-10-12	23.0	E	8.0	Y	JGG	–	–	–	–	–
12	Tues	2009-10-13	23.0	–	–	Y	JGG	–	–	–	–	–
13	Wed	2009-10-14	23.0	A	6.3	Y	JGG	–	–	–	–	–
14	Thurs	2009-10-15	23.0	Composite	8.1	N	JGG/LB	686	8.1	330	0.80	0.05

"–" = not measured/not required

Data Reviewed By: KEH
Date: 2009-11-05

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Chironomus dilutus Test Report

Survival and Growth

SAMPLE IDENTIFICATION

Work Order:	215904	Shipped By:	Rabbex/Rd
Company :	Minnow Environmental Inc. (BMS Corp.)	Date Received :	2009-09-25
Location :	Georgetown ON	Time Received :	10:25
Sampling Method :	P. Ponar	Date Tested :	2009-10-06
Sampled By :	C. R	Lab Storage:	4±2 °C
Sample Volume:	1 x 5L pail		

Test Method : Test for Survival and Growth in Sediment Using the larvae of Freshwater Midges (*Chironomus tentans* or *Chironomus riparius*). Environment Canada, Conservation and Protection. Ottawa, Ontario. Report EPS 1/RM/32, December, 1997.

SAMPLE SUMMARY

Sample Number	Sample Name	Description	Sample Date	Sample Time	Temp. on Arrival
-	Control	Fine brown organic sediment; no odour.	2009-05-25	12:00	-
25652	SL-09-01	Black colour, no odour.	2009-09-17	Not given	8.0 °C
25653	ML-09-01	Black colour, low odour.	2009-09-18	Not given	8.0 °C
25655	EL-09-01	Black colour, low odour.	2009-09-14	Not given	8.0 °C
25656	DUL-09-01	Black colour, low odour.	2009-09-15	Not given	8.0 °C

RESULTS

Survival Data (Treatment Average Survival, %)[1]

ML-09-01	Control	SL-09-01	EL-09-01	DUL-09-01
80	84	84	92	98

[1] **Tukey-Kramer Test (CETIS)[a]:** Samples sharing the same line are not significantly different from one another (i.e. they are considered to be homogenous, that is, from the same population) (α =0.05). All data sets met the assumptions for normality and homogeneity of variance.

Growth Data (Treatment Average Weight, mg)[2]

ML-09-01	DUL-09-01	SL-09-01	EL-09-01	Control
1.423	1.576	1.718	2.163	2.344

[2] **Tukey-Kramer Test (CETIS)[a]:** Samples sharing the same line are not significantly different from one another (i.e. they are considered to be homogenous, that is, from the same population) (α =0.05). All data sets met the assumptions for normality and homogeneity of variance.

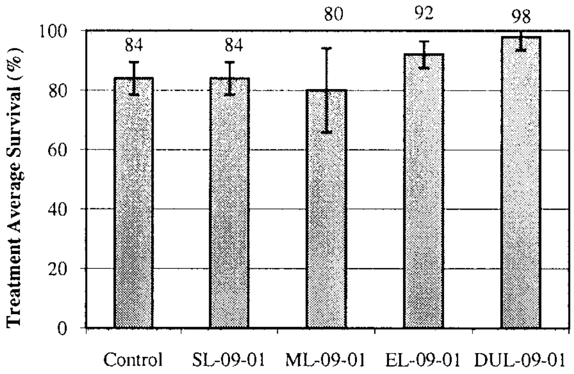
POTASSIUM CHLORIDE REFERENCE TOXICANT DATA

Test Date :	2009-10-09	Historical Mean LC50 :	3685 mg/L
Test Duration :	96 hours	Warning Limits (± 2 SD) :	1127 - 6803 mg/L
LC50 (95% confidence limits):	4665 mg/L (3764 - 5783)	Statistical Method :	Spearman-Kärber (CETIS) a
		Test Conducted By :	JGG

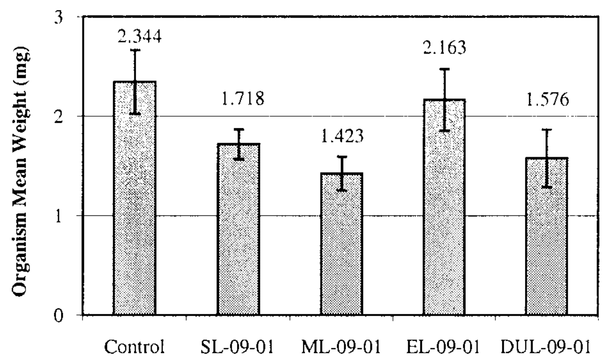
The reference toxicant test was conducted as a water only test, as specified in the test method.

Work Order : 215904

Chironomus dilutus Survival



Chironomus dilutus Growth



SEDIMENT CHARACTERISTICS

Sample Number	Sample Name	TOC (mg/kg)	Moisture Content (%)	Particle Size (%)			
				Gravel	Sand	Silt	Clay
–	Control	89000	72	0	0.9	98.2	1
25652	SL-09-01	66000	86	ND	24	62	13
25653	ML-09-01	86000	91	ND	46	42	12
25655	EL-09-01	37000	79	ND	39	46	15
25656	DUL-09-01	110000	92	ND	25	56	19

ND = Not Detected

TEST CONDITIONS

Test Organism:	*Chironomus dilutus*	Test Type:	Static
Organism Batch :	Ct09-09	Test Vessel:	300 mL pyrex beaker
Source:	In-house culture	Sediment Depth:	Approx. 3.5 cm
Source Location :	Guelph ON	Sediment Volume:	100 mL per replicate
Mean Head Capsule Width :	0.37 mm	Overlying Water Volume:	175 mL per replicate
Range of Head Capsule Widths :	0.28 - 0.51 mm	Control/Test Water:	Well water (no additional chemicals)
Life Stage on Test Day 0 :	3rd Instar	Control Sediment:	Long Point, Lake Erie
Samples per Treatment :	1	Test Aeration :	Yes (all replicates)
Number of Replicates:	5	Test Aeration Rate :	2-3 bubbles per second
Organisms per Replicate:	10	Photoperiod (light/dark) :	16 h / 8 h
Organisms per Treatment:	50	Light Intensity :	893 - 945 lux
Feed Type:	Tetramin flakes in R.O. water	Test Duration :	10 days
Feeding Rate (per replicate):	~6 mg dry solids daily	Test Method Deviations :	None

COMMENTS

The results reported relate only to the samples tested.
All test validity criteria as specified in the test method cited in this report were satisfied.
No organisms exhibiting unusual appearance, behavior, or undergoing unusual treatment were used in the test.

REFERENCES

[a] CETIS, © 2001-2007. Comprehensive Environmental Toxicity Information System. Tidepool Scientific Software, McKinleyville, Calif. 95519 [Program on disk and printed User's Guide].

[b] Stephan, C. E. 1977. Methods for calculating an LC50. P. 65-84 In: P.L. Mayer and J. L. Hamelink (eds.), Aquatic Toxicology and Hazard Evaluation. Amer. Soc. Testing and Materials, Philadelphia PA. ASTM STP 634.

Date: ______________________
yyyy-mm-dd

Approved by: ______________________
Project Manager

Work Order : 215904

Chironomus dilutus Survival Data

Sample	Replicate	Number of Survivors (n=10)	Surviving Organisms (%)	Treatment Average Survival (%)	Standard Deviation	CV (%)
	A	8	80	84	5.5	6.5
Control	B	9	90			
	C	8	80			
	D	8	80			
	E	9	90			
	A	8	80	84	5.5	6.5
25652	B	8	80			
SL-09-01	C	8	80			
	D	9	90			
	E	9	90			
	A	7	70	80	14.1	17.7
25653	B	9	90			
ML-09-01	C	7	70			
	D	7	70			
	E	10	100			
	A	9	90	92	4.5	4.9
25655	B	9	90			
EL-09-01	C	9	90			
	D	9	90			
	E	10	100			
	A	10	100	98	4.5	4.6
25656	B	9	90			
DUL-09-01	C	10	100			
	D	10	100			
	E	10	100			

Data Reviewed By: YEH
Date: 2009-11-13

Work Order : 215904

Chironomus dilutus Weight Data

Sample	Replicate	Foil Weight (mg)	Dry Weigt of Foil + Organisms (mg)	Number of Organisms Weighed	Mean Dry Weight of Organisms (mg)	Treatment Mean Dry Weight (mg)	Standard Deviation	CV (%)
	A	808.52	830.75	8	2.779	2.344	0.32	13.6
Control	B	801.95	821.05	9	2.122			
	C	809.06	829.65	8	2.574			
	D	806.20	823.85	8	2.206			
	E	811.85	830.18	9	2.037			
	A	808.72	821.09	8	1.546	1.718	0.15	8.6
25652	B	797.04	810.02	8	1.623			
SL-09-01	C	801.04	816.39	8	1.919			
	D	800.97	816.27	9	1.700			
	E	808.54	824.78	9	1.804			
	A	796.97	807.12	7	1.450	1.423	0.17	11.8
25653	B	800.77	813.66	9	1.432			
ML-09-01	C	796.15	804.77	7	1.231			
	D	808.03	819.78	7	1.679			
	E	813.45	826.70	10	1.325			
	A	803.72	825.95	9	2.470	2.163	0.31	14.3
25655	B	802.29	824.31	9	2.447			
EL-09-01	C	804.85	823.64	9	2.088			
	D	796.73	815.61	9	2.098			
	E	803.07	820.22	10	1.715			
	A	793.61	806.21	10	1.260	1.576	0.29	18.2
25656	B	803.42	820.54	9	1.902			
DUL-09-01	C	824.12	840.19	10	1.607			
	D	816.36	834.36	10	1.800			
	E	819.10	832.20	10	1.310			

Data Reviewed By: VEH
Date: 2009-11-13

Chironomus dilutus Sediment Test Data

Work Order :	215904
Sample Number :	**Control**
Species:	*Chironomus dilutus*
Organism Batch :	Ct09-09
Sediment pH:	6.7
Pore Water pH:	7.2
Pore Water Ammonia (mg/L) :	0.8
Sample Treatment:	Dry sieved (2 mm)
Time Start:	10:00

Test Day	Day	Date	Temp. (°C)	Replicate	D.O. (mg/L)	Test Fed? (Y/N)	Analyst(s)	Conductivity (μmhos/cm)	pH	Hardness (mg/l as $CaCO_3$)	Total Ammonia (mg/L)	Unionized Ammonia (mg/L)
0	Tues	2009-10-06	24.0	Composite	8.1	Y	JGG	774	8.4	360	0.20	0.02
1	Wed	2009-10-07	24.0	A	8.0	Y	JGG	–	–	–	–	–
2	Thurs	2009-10-08	24.0	–	–	Y	JGG	–	–	–	–	–
3	Fri	2009-10-09	24.0	B	8.0	Y	JGG	–	–	–	–	–
4	Sat	2009-10-10	24.0	–	–	Y	JGG	–	–	–	–	–
5	Sun	2009-10-11	24.0	–	–	Y	JGG	–	–	–	–	–
6	Mon	2009-10-12	24.0	C	8.0	Y	LB	–	–	–	–	–
7	Tues	2009-10-13	24.0	–	–	Y	JGG	–	–	–	–	–
8	Wed	2009-10-14	24.0	D	7.9	Y	JGG	–	–	–	–	–
9	Thurs	2009-10-15	24.0	–	–	Y	JGG	–	–	–	–	–
10	Fri	2009-10-16	24.0	Composite	8.0	N	LB	1005	8.2	580	0.35	0.03

"–" = not measured/not required

Data Reviewed By: KH
Date: 2009-11-13

Chironomus dilutus **Sediment Test Data**

Work Order :	215904
Sample Number :	**25652**
Species:	*Chironomus dilutus*
Organism Batch :	Ct09-09
Sediment pH:	6.0
Pore Water pH:	5.7
Pore Water Ammonia (mg/L) :	1.1
Sample Treatment:	Hand homogenization
Time Start:	10:25

Test Day	Day	Date	Temp. (°C)	Replicate	D.O. (mg/L)	Test Fed? (Y/N)	Analyst(s)	Conductivity (μmhos/cm)	pH	Hardness (mg/l as $CaCO_3$)	Total Ammonia (mg/L)	Unionized Ammonia (mg/L)
0	Tues	2009-10-06	24.0	Composite	8.2	Y	JGG	475	8.3	220	0.45	0.04
1	Wed	2009-10-07	24.0	A	8.0	Y	JGG	–	–	–	–	–
2	Thurs	2009-10-08	24.0	–	–	Y	JGG	–	–	–	–	–
3	Fri	2009-10-09	24.0	B	7.9	Y	JGG	–	–	–	–	–
4	Sat	2009-10-10	24.0	–	–	Y	JGG	–	–	–	–	–
5	Sun	2009-10-11	24.0	–	–	Y	JGG	–	–	–	–	–
6	Mon	2009-10-12	24.0	C	7.7	Y	JGG	–	–	–	–	–
7	Tues	2009-10-13	24.0	–	–	Y	JGG	–	–	–	–	–
8	Wed	2009-10-14	24.0	D	7.9	Y	JGG	–	–	–	–	–
9	Thurs	2009-10-15	24.0	–	–	Y	JGG	–	–	–	–	–
10	Fri	2009-10-16	24.0	Composite	8.0	N	LB	361	7.6	120	8.55	0.17

"–" = not measured/not required

Data Reviewed By: YEH
Date: 2009-11-13

Chironomus dilutus **Sediment Test Data**

Work Order :	215904
Sample Number :	**25653**
Species:	*Chironomus dilutus*
Organism Batch :	Ct09-09
Sediment pH:	6.5
Pore Water pH:	7.0
Pore Water Ammonia (mg/L) :	0.7
Sample Treatment:	Hand homogenization
Time Start:	10:35

Test Day	Day	Date	Temp. (°C)	Replicate	D.O. (mg/L)	Test Fed? (Y/N)	Analyst(s)	Conductivity (µmhos/cm)	pH	Hardness (mg/l as $CaCO_3$)	Total Ammonia (mg/L)	Unionized Ammonia (mg/L)
0	Tues	2009-10-06	24.0	Composite	8.3	Y	JGG	556	8.3	180	0.30	0.03
1	Wed	2009-10-07	24.0	A	8.0	Y	JGG	–	–	–	–	–
2	Thurs	2009-10-08	24.0	–	–	Y	JGG	–	–	–	–	–
3	Fri	2009-10-09	24.0	B	7.9	Y	JGG	–	–	–	–	–
4	Sat	2009-10-10	24.0	–	–	Y	JGG	–	–	–	–	–
5	Sun	2009-10-11	24.0	–	–	Y	JGG	–	–	–	–	–
6	Mon	2009-10-12	24.0	C	8.0	Y	LB	–	–	–	–	–
7	Tues	2009-10-13	24.0	–	–	Y	JGG	–	–	–	–	–
8	Wed	2009-10-14	24.0	D	7.9	Y	JGG	–	–	–	–	–
9	Thurs	2009-10-15	24.0	–	–	Y	JGG	–	–	–	–	–
10	Fri	2009-10-16	24.0	Composite	7.9	N	LB	627	8.0	130	3.70	0.19

"–" = not measured/not required

Data Reviewed By: YH
Date: 2009-11-13

Chironomus dilutus **Sediment Test Data**

Work Order :	215904
Sample Number :	**25655**
Species:	*Chironomus dilutus*
Organism Batch :	Ct09-09
Sediment pH:	6.2
Pore Water pH:	5.6
Pore Water Ammonia (mg/L) :	0.6
Sample Treatment:	Hand homogenization
Time Start:	11:15

Test Day	Day	Date	Temp. (°C)	Replicate	D.O. (mg/L)	Test Fed? (Y/N)	Analyst(s)	Conductivity (µmhos/cm)	pH	Hardness (mg/l as $CaCO_3$)	Total Ammonia (mg/L)	Unionized Ammonia (mg/L)
0	Tues	2009-10-06	24.0	Composite	8.3	Y	JGG	494	8.3	210	0.50	0.05
1	Wed	2009-10-07	24.0	A	8.0	Y	JGG	–	–	–	–	–
2	Thurs	2009-10-08	24.0	–	–	Y	JGG	–	–	–	–	–
3	Fri	2009-10-09	24.0	B	8.0	Y	JGG	–	–	–	–	–
4	Sat	2009-10-10	24.0	–	–	Y	JGG	–	–	–	–	–
5	Sun	2009-10-11	24.0	–	–	Y	JGG	–	–	–	–	–
6	Mon	2009-10-12	24.0	C	7.7	Y	JGG	–	–	–	–	–
7	Tues	2009-10-13	24.0	–	–	Y	JGG	–	–	–	–	–
8	Wed	2009-10-14	24.0	D	7.8	Y	JGG	–	–	–	–	–
9	Thurs	2009-10-15	24.0	–	–	Y	JGG	–	–	–	–	–
10	Fri	2009-10-16	24.0	Composite	7.8	N	LB	476	7.7	180	4.20	0.11

"–" = not measured/not required

Data Reviewed By: YKH
Date: 2009-11-13

Chironomus dilutus **Sediment Test Data**

Work Order :	215904
Sample Number :	**25656**
Species:	*Chironomus dilutus*
Organism Batch :	Ct09-09
Sediment pH:	6.1
Pore Water pH:	5.6
Pore Water Ammonia (mg/L) :	0.3
Sample Treatment:	Hand homogenization
Time Start:	11:35

Test Day	Day	Date	Temp. (°C)	Replicate	D.O. (mg/L)	Test Fed? (Y/N)	Analyst(s)	Conductivity (µmhos/cm)	pH	Hardness (mg/l as $CaCO_3$)	Total Ammonia (mg/L)	Unionized Ammonia (mg/L)
0	Tues	2009-10-06	24.0	Composite	8.3	Y	JGG	399	8.1	170	0.40	0.02
1	Wed	2009-10-07	24.0	A	8.0	Y	JGG	–	–	–	–	–
2	Thurs	2009-10-08	24.0	–	–	Y	JGG	–	–	–	–	–
3	Fri	2009-10-09	24.0	B	7.9	Y	JGG	–	–	–	–	–
4	Sat	2009-10-10	24.0	–	–	Y	JGG	–	–	–	–	–
5	Sun	2009-10-11	24.0	–	–	Y	JGG	–	–	–	–	–
6	Mon	2009-10-12	24.0	C	7.8	Y	LB	–	–	–	–	–
7	Tues	2009-10-13	24.0	–	–	Y	JGG	–	–	–	–	–
8	Wed	2009-10-14	24.0	D	7.6	Y	JGG	–	–	–	–	–
9	Thurs	2009-10-15	24.0	–	–	Y	JGG	–	–	–	–	–
10	Fri	2009-10-16	24.0	Composite	7.9	N	LB	355	7.6	150	8.25	0.17

"–" = not measured/not required

Data Reviewed By: VEH
Date: 2009-11-13

CHAIN OF CUSTODY RECORD

AQUATOX

AquaTox Work Order No. 215904

Shipping Address: AquaTox Testing & Consulting Inc.
11B Nicholas Beaver Road, RR #3
Guelph, Ontario Canada N1H 6H9

Voice: (519) 763-4412 **Fax:** (519) 763-4419

P.O. Number:	2295
Field Sampler Name (print):	Cynthia Russel
Signature:	Cynthia Russel
Affiliation:	Minnow Environmental
Sample Storage (prior to shipping):	Refridgerated
Custody Relinquished by:	
Date/Time Shipped:	

Client:	Minnow Environmental Inc. 2 Lamb Street Georgetown, ON L7G 3M9
Phone:	(905) 873-3371 x22
Fax:	(905) 873-6370
Contact:	Cynthia Russel

Date Collected (yyyy-mm-dd)	Time Collected (e.g. 14:30, 24 hr clock)	Sample Name	AquaTox Sample Number	Temp. on arrival	*Hyalella azteca* 14-d Survival and Growth	*Chironomus sp.* 10-d Survival and Growth	*Hexagenia limbata* 21-d Survival and Growth	Fathead Minnow 21-d Survival and Bioaccumulation	Microtox Solid Phase	Other (please specify below)	Grab	Composite	# of Containers and Volume (eg. one 6 L pail; one 20 L pail etc.)
2009/09/22		QL-09-01 ✓	25651	8.0	X								
09/09/17		SL-09-01 ✓	25652	↓	X	X							
09/09/18		ML-09-01 ✓	25653		X	X							
09/09/19		TML-09-01	25654		X								
09/09/14		EL-09-01	25655		X	X							
09/09/15		DUL-09-01 ✓	25656		X	X							
09/09/22		MCL-09-01 ✓	25657		X								
09/09/21		RL-09-01 ✓	25658		X								
09/09/20		MAL-09-03 ✓	25659		X								
09/09/17		HOL-09-01	25660	↓	X								

For Lab Use Only
Received by: [illegible]
Date: 2009-09-25
Time: [illegible]
Storage Location: [illegible]
Storage Temp. (°C): [illegible]

2009-09-28

Please list any special requests or instructions:
sample type > P. ponar from container label(s)

APPENDIX F

SPECIAL INVESTIGATION STUDIES
DOSE AND RISK

SPECIAL INVESTIGATIONS 2009 – IMPLICATIONS FOR RADIOLOGICAL DOSE AND RISK CALCULATIONS

Report prepared for:

DENISON MINES INC.
8 Kilborn Way
Elliot Lake, Ontario
P5A 2T1

and

RIO ALGOM LIMITED
P.O. Box 38
Elliot Lake, Ontario
P5A 2J6

Report prepared by:

ECOMETRIX INCORPORATED
6800 Campobello Road
Mississauga, Ontario
L5N 2L8

Ref. 10-1705
February 2011

SPECIAL INVESTIGATIONS 2009 – IMPLICATIONS FOR RADIOLOGICAL DOSE AND RISK CALCULATIONS

Donald R. Hart, Ph.D.
Senior Ecotoxicologist

Rina Parker
Risk Assessment Specialist

EXECUTIVE SUMMARY

A number of special investigation studies were undertaken in the Serpent River Watershed in 2009, in order to clarify several issues pertinent to estimation of radiological dose and risk to natural biota and humans utilizing the watershed lakes.

Studies were undertaken by Minnow Environmental Inc. (Minnow, 2011) to:

- Measure radionuclides in tissues of aquatic plants and forage fish of six key lakes in the watershed downstream of former uranium mining areas,
- Measure radionuclides in water and sediments at the plant and fish collection locations, and
- Survey the presence of waterfowl species in the six key lakes.

The six lakes studied were McCabe, May, Elliot, Nordic, Quirke and McCarthy Lake.

Studies were undertaken by the Serpent River First Nation (SRFN, 2010) to determine the amounts of local fish and wildlife consumption by the SRFN community, and the harvest locations, with specific reference to the six key lakes.

The present study makes use of the special investigation data to address several previously identified questions, and to estimate radiological doses associated with the measured radionuclide concentrations in the six key lakes. The specific questions were:

- Are Pb-210 and Po-210 at secular equilibrium in the lake sediments, as assumed in previous lake studies?
- Are radionuclides of the Th-232 decay chain elevated in lake sediments, and do they contribute appreciably to dose?
- Are bioaccumulation factors (BAFs) derived from the flooded basins for aquatic plants and forage fish representative for the watershed lakes?

The questions were resolved, as follows:

- Pb-210 and Po-210 are at secular equilibrium in the lake sediments, as would be expected from their half-lives. The average Po/Pb ratio in sediments was 1.01, with a range from 0.87 to 1.18, and no upstream-downstream pattern.
- Radionuclides of the Th-232 decay chain are clearly elevated above background in May and Quirke Lake sediments, although the Th-232 concentration is only about 1/10th of the Th-230 concentration. The contribution of the Th-232 decay chain to

total dose was usually 10% or less, except for May Lake where 4 of 8 receptors had Th-232 decay chain contributions greater than 10%, and for aquatic plants where contributions exceeded 10% in most lakes and reached 25% in May Lake.

- Bioaccumulation factors (BAFs) derived from the flooded basins were generally similar to those derived from the watershed lakes for aquatic plants, although the U value was slightly lower in the basins, and the Pb value was slightly higher. Fish BAFs derived from the basins were consistently lower than those derived from the watershed lakes. Po-210 BAFs were not determined in either case due to non-detection of Po-210 in water; however, Po-210 in fish tissue was consistently higher than Pb-210, by a factor of 22 on average.

The high observed Po/Pb ratio in fish indicates that fish to duck transfer factors for Po-210, previously determined in the flooded basins using a Pb BAF to estimate Po-210 in fish, were most likely overestimated by at least a factor of 10. Correction for this error produces a transfer factor of 5.45 d/kg for fish-eating ducks, which is more in line with the Health Canada (2007) generic value of 2.5 for birds.

A survey of fish and wildlife consumption by SRFN fishers and hunters and their families (SRFN, 2010) produced more realistic values for fish and wildlife intake rates than those used previously, and also indicated the fraction of harvest likely to come from the six watershed lakes and from Lake Huron. These data were utilized, along with measured radionuclide concentrations in the six lakes and Lake Huron, to estimate the dose received by SRFN members.

Using the special investigations data, radiation doses to ecological receptors and human receptors using the watershed were calculated.

Ecological Dose and Risk

The calculated doses to fish, aquatic plants and benthos were well below the UNSCEAR (1996) benchmark dose of 10 mGy/d. The largest doses to aquatic biota occurred at Quirke Lake, where the doses to fish, aquatic plants and benthos were 0.92, 2.61 and 0.256 mGy/d, respectively. For all aquatic biota, the largest component of dose was internal. The largest contributor to dose was generally Po-210 for fish and benthic invertebrates, while the dose was more evenly distributed for aquatic macrophytes, with Ra-226 and short-lived radon daughters usually making the largest contribution.

The radiation doses to riparian wildlife were less than the UNSCEAR (1996) benchmark dose of 1 mGy/d. The largest doses to riparian wildlife occurred at Quirke Lake, where the doses to mallard, scaup, merganser, muskrat and mink, were 0.263, 0.094, 0.793, 0.407 and 0.124 mGy/d, respectively. For all riparian biota, the largest component of dose was usually internal. The largest contributor to dose was Po-210 for waterfowl, and Ra-226 with short-lived radon daughters for muskrat. For mink, one or the other of these contributors (Ra-226 or Po-210) was predominant.

Human Dose and Risk

The radionuclide concentrations from the special investigation studies were utilized to calculate radiation doses received by generic human receptors at the six watershed lakes (receptor assumed to reside there and take all fish and game from there). The calculated doses ranged from 0.036 to 0.301 mSv/a, all less than the public dose limit of 1 mSv/a, before background correction. Background dose from the same pathways was estimated at 0.013 mSv/a. Therefore, incremental doses ranged from 0.023 to 0.288 mSv/a. The smallest doses were at McCarthy, Elliot and Nordic lakes, whereas the largest dose was at Quirke Lake. The dose at Quirke Lake was dominated by consumption of mallard ducks, and was driven by the high concentration of Po-210 in aquatic macrophytes at Quirke Lake.

Macrophytes were collected in Quirke Lake from a former tailings deposition area near Panel Mine and likely over-estimate typical macrophyte uptake within the lake. Moreover, cottage residents at Quirke Lake do not use the lake for duck hunting. The estimated dose at Quirke Lake without the waterfowl component is 0.072 mSv/a (total) or 0.064 mSv/a (incremental).

The calculated dose to a Serpent River First Nation member was based on realistic use of the six watershed lakes, and of Lake Huron, as determined from the survey of households (SRFN, 2010). Most of the harvest comes from Lake Huron. For an actual use scenario the dose was 0.062 mSv/a (total) or 0.049 mSv/a (incremental). For a future use scenario the dose was 0.060 mSv/a (total) or 0.047 mSv/a (incremental). All these doses are less than the public dose limit of 1 mSv/a (incremental). The use of Serpent Harbour water and sediment data to represent Lake Huron may overestimate the Lake Huron component of dose.

The contributions of water, fish, moose and waterfowl to dose are approximately 28%, 37%, 25% and 10%, respectively, with slight variations between actual use and future use scenarios.

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1.0 INTRODUCTION

A number of special investigation studies were undertaken in the Serpent River Watershed in 2009, in order to clarify several issues pertinent to estimation of radiological dose and risk to natural biota and humans utilizing the watershed lakes.

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- Are radionuclides of the Th-232 decay chain elevated in lake sediments, and do they contribute appreciably to dose?
- Are bioaccumulation factors (BAFs) derived from the flooded basins for aquatic plants and forage fish representative for the watershed lakes?

Special investigation methods are outlined in Section 2, including the media sampling and analysis methods, SRFN survey methods, and use of the data in dose calculations. The analysis results are presented and answers to the specific questions posed, and dose calculations based on the special investigations data are presented in Section 3. A summary of study findings is presented in Section 4.

2.0 METHODS

2.1 Media Sampling and Analysis

Field sample collection and assessment of waterfowl was conducted by Minnow personnel at all six lakes from September 14 – 22, 2009. Sample locations within each lake were recorded by GPS (**Table 2.1**) and noted on maps (see **Figures 1 – 6**). All water, sediment, macrophyte and fish samples collected were analyzed for radionuclides by Becquerel Laboratories in Mississauga. Analysis request forms and all raw data files are appended with field sheets (Appendices A and B). In addition to sample data, standard laboratory quality assurance/quality control data were collected and reported by Becquerel.

Areas selected for sampling were located in close proximity, whenever possible, to tailings management areas (TMAs) or effluent pathways. A few exceptions should be noted. McCabe Lake had macrophytes located in the most eastern end of the lake but none in close proximity to the TMA; therefore, samples from McCabe lake were mostly collected in the east end except for one fish sample which was obtained in close proximity to the TMA. For May Lake, macrophytes, water and sediment samples were collected near the inflow from McCabe Lake while fish were sampled within the central basin (to capture the influence of Stanleigh and Stanrock).

The sampling area in Quirke Lake was in an area of historical tailings deposition associated with the Panel TMA and is probably not representative of the lake as a whole.

2.1.1 Water

One water sample per lake (**Figures 1 – 6**) was collected into a 1 liter amber glass bottle containing 10 mL of concentrated nitric acid as preservative. Water samples were collected approximately 30 cm below the surface of the water. Following collection, samples were refrigerated until submission to the laboratory.

2.1.2 Sediment

In the original study design, sediment samples were to be collected by core at locations previously showing highest Ra-226 concentrations in each lake, methods which are consistent with the sediment component of the Serpent River Watershed Monitoring Program. Prior to the initiation of field sampling for the Special Investigation, Minnow in conjunction with the CNSC modified the study design so that sediment sampling would take place in close proximity to macrophyte collection locations. The change in sampling design was considered beneficial since the sediment data would be more amenable to an assessment of possible links between measures of radioactivity in sediment and in macrophytes.

Sediment samples for radionuclide analyses were collected at depths ranging from 0.8 to 1.8 meters using a 15.24 cm x 15.24 cm stainless steel petite ponar grab (0.023 m^2 total sampling area). Although the original study design involved sediment sampling by core, sediments in the vicinity of the macrophytes tended to be too compact for effective coring, therefore collection by ponar was used instead. A composite sediment sample was created by collecting the top 3 cm of sediment from each of two acceptable grabs (i.e., ponar half to completely full) with a spoon. Samples were collected into labelled plastic Ziploc bags. Following collection, all sediment samples were placed into a cooler and stored in a refrigerator until submission to the laboratory. They were dried and weighed prior to analysis and results were reported on a dry weight basis.

2.1.3 Macrophytes

The dominant macrophyte species in each lake were sampled for analysis of radionuclides. At least five samples were collected from each lake with the exception of Quirke Lake where four samples were collected (**Table 2.2**). At each lake, an effort was made to collect a variety of plant parts (leaves and stems, roots, seedheads) from emergent, submergent and floating macrophytes. Samples consisted of composites of identified plant parts (e.g., stems, roots, etc.) from individual species with the exception of one sample from McCabe Lake which was a composite of one to two species collected as whole plants. For laboratory analyses of radionuclides, a minimum of approximately 5 grams wet weight was required per sample. Each plant was identified and individual samples placed in labelled Ziplock bags. Samples were kept frozen until submission to the laboratory. They were dried and weighed prior to analysis and results were reported on a dry weight basis.

2.1.4 Fish

As part of the Special Investigation, fish were collected in each lake by either minnow trapping (2 traps per set) or seine netting (≥ 1 hauls per area). Three composite samples of 4 to 25 fish (depending on fish size) per lake were submitted for radionuclide analyses (**Table 2.2**; Appendix Table C.1). Samples consisted of a composite of one species of small-bodied forage fish with the exception of a sample collected from Elliot Lake which was a composite of two species and a sample from McCarthy Lake which consisted of smallmouth bass. All sampled fish were identified and placed in labelled Ziplock bags. Samples were frozen until submission to the laboratory. They were weighed fresh and homogenized prior to analysis and results were reported on a fresh weight basis.

2.1.5 Waterfowl

The assessment of waterfowl within the six lakes was undertaken in the fall, a time of year when waterfowl are normally staging. Observations by field crew on the species and number of waterfowl present took place over one or two days per lake; the time required for completion of water, sediment, macrophyte, and fish collection (**Table 2.2**). At Quirke Lake however, three days were spent collecting samples and therefore waterfowl observation was extended to three days. Field crews generally surveyed most of the area within each lake with the exception of McCarthy where access to a western portion of the lake was difficult due to the presence of a beaver dam (**Table 2.3**).

2.2 Survey of Fish and Wildlife Consumption

The survey of fish and wildlife consumption by SRFN fishers and hunters and their families was conducted by a survey team of SRFN members working with a Rio Algom representative (SRFN, 2010). Interviews were conducted with 21 fisher/hunter respondents selected to be representative of the community. Each respondent reported: number of household residents, annual household consumption of fish, waterfowl and other game (by species), and harvest distribution by species and location. Household consumption was divided by the number of household residents to estimate the annual consumption per person in each household.

Consumption was sometimes reported in meals per unit time. A meal was assumed to be 0.227 kg, using the size for a meal of fish from the Guide to Eating Ontario Sport Fish (MOE, 2009). Consumption was sometimes reported in animals per unit time. The corresponding mass consumed was calculated using a typical mass of consumable tissue for each animal species as determined by the Harvester Elder for the project (SRFN, 2010).

All 21 respondents reported fish consumption. They also provided a breakdown of their harvest by species and location (the six watershed lakes, Lake Huron and other). Three (3) respondents reported waterfowl consumption. They too provided a breakdown by species and location. Fifteen (15) respondents reported moose consumption, and provided a breakdown by location. These harvest taxa are of particular interest due to their aquatic or riparian habits. Smaller amounts of deer and upland game are also consumed and were included in the survey.

In addition to the current distribution of harvest among lakes, an estimate of the potential future distribution of harvest was made by the SRFN Land and Resources Committee. This estimate considered the potential for future increased usage of the six watershed lakes for fish and game harvesting.

2.3 Use of Special Investigations Data

2.3.1 Radiochemical Data

The water and sediment data consisted of one sample result for each medium at each lake location (samples coincident with macrophyte nearshore sampling locations). The sediment values were consistently above detection limit (except for several Ra-228 values) and were used directly in dose calculations. The missing Ra-228 values in sediment were assumed to be equal to the parent Th-232 concentrations, based on the average Ra/Th ratio of 0.99 when both isotopes were detectable in sediment.

The water values were always less than detection limit for Th-230, Po-210, Th-232, Ra-228 and Th-228, and occasionally less than detection limit for Ra-226 and Pb-210. Therefore, in these situations, either the detection limit value was used as a water concentration, or a lower water concentration was estimated from the sediment concentration using a sediment/water partition coefficient (PC). The PC values for Ra and Pb were taken from the average of lake PC values where the radionuclide was detected in both water and sediment. The PC value for Th was taken as 1/5th of the previously determined PC for Th in flooded basins (i.e. 1/5th of 246000 L/kg, Minnow and BEAK 2001). The flooded basin PC value was similar in magnitude to PCs measured in lake depositional basins for other radionuclides (Minnow, 2005a); however, the nearshore sediments of the 2009 study were coarser and had lower PCs, by an average factor of 0.21. The PC value used for Po was twice the Pb value, based on flooded basin studies.

The macrophyte data consisted of 4 to 6 samples from each lake. The average dry weight concentration for each radionuclide in each lake was determined, using detection limits as concentrations for non-detect samples. These concentrations were converted to a fresh weight basis assuming a dry/fresh weight ratio of 0.25. Unat, Ra-226, Pb-210 and Po-210 were detectable in all samples. Other radionuclides were usually detectable in at least some samples from each lake; however, there were some lakes in which all samples were non-detect for these other radionuclides. In these situations, either the detection limit value was used as a macrophyte concentration, or a lower macrophyte concentration was estimated using a water to plant bioaccumulation factor (BAF). The BAF values for Ra and Th were taken from the average of lake BAFs (on a fresh weight basis) where the radionuclide was detected in both water and macrophyte.

The forage fish data consisted of 2 to 3 whole fish samples from each lake. The average fresh weight concentration for each radionuclide in each lake was determined, using detection limits as concentrations for non-detect samples. Unat, Ra-226 and Po-210 were detectable in all samples. Th-232 was not detectable in any sample. Other radionuclides were detectable in at least some samples from some lakes; however, there were some lakes in which all samples were non-detect for these other radionuclides. In these situations, either the detection limit value was used as a fish concentration, or a lower fish concentration was estimated using a water to fish BAF. The BAF values for Ra, Th and Pb were taken from the average of lake BAFs (on a fresh weight basis) where the radionuclide was detected in both water and fish.

2.3.2 Fish and Wildlife Consumption Data

The dose calculations for SRFN members included contributions from fish, waterfowl and moose consumption, since these aquatic or riparian taxa are potentially associated with the watershed lakes of interest. Average per-person consumption rates for these taxa (12.7, 0.37 and 12.1 kg/a, respectively) were taken from the SRFN (2010) report. Fish were modelled as generic sport fish. Waterfowl were modelled as mallard ducks, since this species accounts for most of the waterfowl consumption.

The fish, waterfowl and moose consumption was apportioned to harvest locations as reported in the SRFN survey. At present, fish are taken mainly from Lake Huron (73%) and also from Elliot Lake (1%) and McCarthy Lake (0.2%). Waterfowl are taken entirely from Lake Huron (100%). Moose are taken from the vicinity of Lake Huron (20%), and from Elliot Lake, McCarthy Lake, Nordic Lake and Quirke Lake (5% each).

In a "future use" scenario, fish harvest was apportioned to Lake Huron (66%), Elliot Lake (3%), McCarthy Lake (2%) and Quirke Lake (2.5%), as estimated by the SRFN Land and Resources Committee. Waterfowl harvest was apportioned to Lake Huron (65%), Elliot Lake (2.5%), McCarthy Lake (5%), May Lake (2.5%), and Nordic Lake (5%). Moose harvest was apportioned to Lake Huron (20%), Elliot Lake (5%), McCarthy Lake (10%), McCabe Lake (2.5%), May Lake (5%), Nordic Lake (5%) and Quirke Lake (2.5%).

Total water consumption (1.5 L/day, Health Canada, 1995) was apportioned to watershed lakes using the fish consumption percentages, and the remainder (i.e. most of the water consumed) was assumed to be taken from Lake Huron.

2.4 Dose Calculations for Natural Biota and Humans

Concentrations of radionuclides in water, sediment, forage fish and aquatic macrophytes were measured (or estimated if necessary) as described in Section 2.3.1. The Unat [1] measurements in ug/L or ug/g were converted to Bq/L or Bq/kg assuming equal activity of U-238 and U-234. Th-234 was assumed to have the same activity concentration in sediment as U-238, and partitioned to water and biota as Th. Rn-222 (with short-lived progeny) was assumed to have the same concentration in sediment and water as Ra-226, but with activity equal 10% of Ra-226 in fish, plants and invertebrates. This percentage is for fish bone (Lucas et al., 1979) and is considered to be conservative for soft tissues, which lose ingrown Rn more rapidly.

2.4.1 Radionuclide Concentrations in Benthic Invertebrates

Since radionuclide concentrations in benthic invertebrates were not measured in the 2009 lake studies, these concentrations were estimated from the concentrations in water using BAFs derived from the flooded basin studies (Minnow and BEAK 2001b). The BAF for Th was estimated as the Unat value. The BAF for Po was taken as 20,000 L/kg (fresh weight), a generic value from Health Canada (2007, draft). The values used are listed in **Table 2.4**.

2.4.2 Radionuclide Concentrations in Sport Fish

Concentrations of U_{nat} and Ra-226 in sportfish were estimated using BAFs from Quirke Lake, Elliot Lake and McCarthy Lake (Minnow, 2005a). Average values for U_{nat} and Ra-226

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[1] U_{nat} is primarily U-238 by mass, but contains 12.3 Bq/mg of U-238 and an equal activity of U-234.

were 11.4 and 19.1 L/kg, respectively. For other radionuclides, which were not measured in sport fish, the sport fish BAFs were assumed to be proportional to the forage fish BAFs. For example, from the sportfish BAF_u of 11.4 L/kg for U_{nat} (Minnow, 2005a), the BAF_{Th}:BAF_u ratio for forage fish (218/478) was applied, to estimate a sportfish BAF_{Th} of 5.2. This method provided sportfish BAFs for all radionuclides except Po-210, and the BAFs were used to estimate fish flesh concentrations from water concentrations in each lake. For Po-210, a Po/Pb ratio of 9 for fish flesh (IAEA, 2010) was used to estimate Po-210 from Pb-210 in sportfish at each lake.

2.4.3 Radionuclide Concentrations in Riparian Wildlife

Radionuclide concentrations in riparian wildlife (ducks, muskrat, mink, moose) were estimated using transfer factors (d/kg), which represent the fraction of daily activity intake (Bq/d) transferred to body tissue activity. The daily activity intake was computed as a sum of intakes via water, sediment and food pathways. The overall equation for activity transfer from these media to riparian wildlife tissue is as follows:

$$C_{rw} = (C_w I_w + C_f I_f + C_s I_s) * F_{ing} * OF$$

where:

where:	C_{rw}	=	activity concentration in riparian wildlife (Bq/kg)
	C_w	=	activity concentration in water (Bq/L)
	I_w	=	water intake rate (L/d)
	C_f	=	activity concentration in food (Bq/kg fw)
	I_f	=	food intake rate (kg fw/d)
	C_s	=	activity concentration in sediment (Bq/kg dw)
	I_s	=	incidental ingestion of sediment (kg dw/d)
	F_{ing}	=	ingestion transfer factor (d/kg)
	OF	=	occupancy factor

Intake rates of water, food and sediment are listed in **Table 2.5**. Water and food intakes are body weight dependent, and are calculated using allometric equations (U.S. EPA, 1993). Sediment intake is 2% of dry weight food intake for dabbler ducks, and negligible for fish ducks (U.S. EPA, 1993). We have assumed 0.2% for the latter. For muskrat and moose, we assume a generic 7% of dry weight food intake (CCME, 1996). For mink, sediment intake is negligible (Sample and Suter, 1994), but is conservatively assumed here to be 1% of dry weight food intake.

The predominant food type was assumed to represent 100% of the dietary intake, as a simplifying assumption. Thus, mallards and muskrats consume aquatic plants, scaup consume benthic invertebrates, and merganser and mink consume fish. Moose consume aquatic plants mainly in the summer months when they are readily available, and woody browse is the dominant food in all seasons (MacCracken *et al.*, 1997). As an annual average, 12% of the moose diet was considered to be aquatic plants from the watershed lakes.

The occupancy factor was considered to be 0.5 for waterfowl, since they are migratory and spend half the year far away from the Serpent River Watershed. For mammalian wildlife, an occupancy factor of 1.0 was assumed.

Transfer factors (F_{ing}) were whole body values, appropriate for obtaining whole body concentrations and whole body doses. Transfer factors tend to vary among species as an inverse ¾ power of body weight (Beresford *et al.*, 2004). Hart and Burt (2006) gathered U, Ra, Pb and Po transfer factors from the literature for small and large mammalian herbivores, and found body weight relationships that were consistent with the ¾ power rule. Based on these relationships, transfer factors were calculated for muskrat, moose and mink, as outlined in **Table 2.5**.

For waterfowl, transfer factors (F_{ing}) were derived from whole body concentrations of young-of-year ducks that were collected at the TMA basins (Minnow, 2005b), and assumed to be feeding there, on fish or aquatic plants from the basins (**Table 2.6**). The transfer factors were higher for the piscivores, because radionuclide concentrations in the fish were much lower than those in aquatic plants. The duck tissue concentrations did not vary substantially according to feeding habits.

The Po-210 value for herbivorous ducks was 4.62 d/kg, similar to the Health Canada (2007) generic bird value of 2.5 d/kg. However, the Po-210 value estimated for piscivorous ducks was much larger (54.5 d/kg). Since the Po-210 was not actually measured in the fish, but was estimated using the Pb BAF, it is likely (based on Po/Pb ratios from the present study) that the Po-210 in basin fish was at least 10 times higher, and the duck transfer factor at least 10 times lower, or about 5.45 d/kg. This value was used in the present study.

While whole body concentrations are appropriate for calculating dose to biota, concentrations in meat are needed for calculating dose to human consumers of ducks and moose. The meat concentrations are two to three times lower, depending on the radionuclide. An average meat to whole body ratio for each radionuclide was obtained from the data for ducks in TMA basins (Minnow, 2005b), and this was used to estimate meat concentrations from whole body concentrations.

Concentrations of short-lived Rn daughters in riparian wildlife were assumed to be one-third of the Ra-226 concentrations. This ratio applies to mammalian bone, and is conservative for soft tissues such as meat, which lose ingrown Rn more rapidly.

2.4.4 Dose to Aquatic Biota

The radiation dose to aquatic biota was calculated for both external and internal pathways. Sediment exposure was assumed to be the dominant external dose pathway. Water immersion was considered to be trivial in comparison. The combined external and internal dose was calculated as follows:

$$D_{ab} = C_s \bullet DCF_s \bullet OF_s + C_i \bullet DCF_i$$

where:
- D_{ab} = radiation dose to aquatic biota (Gy/a)
- C_s = activity concentration in sediment (Bq/kg ww)
- DCF_s = dose coefficient for sediment exposure (Gy/a per Bq/kg ww)
- C_i = activity concentration in body (Bq/kg fw)
- DCF_i = internal dose coefficient (Gy/a per Bq/kg fw)
- OF_s = occupancy factor for sediment

Concentration in sediment (C_s) was determined as described in Section 2.3.1. The concentration in the body (C_i) was determined for aquatic biota using bioaccumulation factors as described in Sections 2.4.1 and 3.3.

The external dose coefficient (DCF_s) was half Amiro's (1997) value for full immersion in sediment, in order to represent a half immersion (or semi-infinite) exposure situation (**Table 2.7**). Short-lived daughters were included in each coefficient, assuming that daughters were in secular equilibrium with the parent. The occupancy factor for sediment was 0.5 for fish and plants, assuming half of the fish's time on sediment, and only the root portion of the plant on sediment. Benthic invertebrates were assumed to reside full-time on or in sediment.

The internal dose coefficient (**Table 2.7**) was also taken from Amiro (1997), and also included short-lived daughter contributions to dose. However, Amiro provides no adjustment for radiation quality (greater effectiveness of alpha radiation). UNSCEAR (1996) indicates that a quality factor of 5 to 10 may be appropriate for the non-stochastic endpoints relevant to protection of plant and animal populations. We have applied a factor of 10 to the internal absorbed dose from alpha emitters, to produce a "gamma-equivalent" dose estimate.

2.4.5 Dose to Riparian Wildlife

The radiation dose to riparian wildlife (ducks, muskrat, mink) was calculated for both external and internal pathways, using methods similar to those described above for aquatic biota, except for consideration of seasonal occupancy by waterfowl. Thus,

$$D_{rw} = C_s \bullet DCF_s \bullet OF_s + C_i \bullet DCF_i$$

where: D_{rw} = radiation dose to riparian wildlife (Gy/a), and
other terms are as defined above.

Radionuclide concentration in the body (C_i) was determined for riparian wildlife using intake rates and transfer factors as described in Section 2.4.3. The occupancy factor for sediment was 0.5 for waterfowl, assuming they spend half their time on sediment, and 1 for muskrat and mink. The assumption is conservative for waterfowl, which spend considerable time on water or in air, well away from sediment.

2.4.6 Dose to Human Receptors

The radiation dose was calculated for three human receptors: 1) a generic human residing at each lake, 2) a SRFN member with present day usage of multiple watershed lakes as described in Section 2.3.2, and 3) a SRFN member under a “future use” scenario as described in Section 2.3.2. The dose was calculated for ingestion pathways, assuming consumption of drinking water and sportfish from the lake, and of waterfowl (mallard) and moose that feed on aquatic plants in the lake.

For the generic human, the adult water intake of 1.5 L/d (Health Canada, 1995) was assumed to occur 365 days per year. This was assumed to all come from the lake under assessment, as would occur for example for an Elliot Lake resident. The generic adult was assigned a fish consumption rate of 8 g/d, which is the U.S. EPA (1997) recommended value for non-aboriginal fishermen. This is an annual average consumption rate, and was assumed to occur 365 days per year (2.92 kg/a). Based on information from a local sportsman, the average duck hunter would consume approximately 2 kg of duck meat each year. 50% was assumed to come from the lake under assessment. This is conservative for the watershed lakes considered since they contain very little marshy habitat that would be favoured by waterfowl. The same intake rate and local fraction was assumed for moose meat. The 50% fraction is conservative since moose home ranges are on the order of 25 km^2 (Leptich and Gilbert, 1989) and since there are many small lakes in the area that are not mine influenced.

For the SRFN members, the adult water intake of 1.5 L/d (Health Canada, 1995) was assumed to occur 365 days per year. This was apportioned across lakes as described in Section 2.3.2, with most of the water coming from Lake Huron. The duck and moose meat consumption rates were taken from the SRFN (2010) survey and apportioned across lakes as described in Section 2.3.2.

Using these ingestion rates, the dose to human receptors was calculated as follows:

$$D_h = (C_w \bullet I_w + C_f \bullet I_f + C_d \bullet I_d + C_m \bullet I_m) \bullet DCF_i$$

where:
- D_h = human radiation dose (Sv/a)
- C_w = activity concentration in water (Bq/L)
- I_w = water intake rate (L/a)
- C_f = activity concentration in sportfish flesh (Bq/kg fw)

C_d = activity concentration in duck meat (Bq/kg fw)
I_d = local duck meat intake rate (kg fw/a)
C_m = activity concentration in moose meat (Bq/kg fw)
I_m = local moose meat intake rate (kg fw/a)
DCF_i = ingestion dose coefficient (Sv/Bq)

Ingestion dose coefficients were taken from ICRP Publication 72 (ICRP, 1996) (**Table 2.8**). They include dose contributions from short-lived daughters that may grow in over a lifetime following radionuclide ingestion.

2.4.7 Dose Limits and Benchmarks

The dose limit for people (members of the public) is 1 mSv/a, as recommended in ICRP Publication 60 (ICRP, 1991). This is an incremental dose. Background radiation exposure, including natural and anthropogenic sources, is typically about 2 mSv/a.

The human doses calculated for lakes in the Serpent River Watershed include a natural background component. Therefore, the background component must be removed before comparison to the public dose limit.

There is no regulatory dose limit for non-human biota; however, UNSCEAR (1996) recommends a radiation dose benchmark of 1 mGy/d for terrestrial animals, and 10 mGy/d for plants and aquatic biota. These dose rates are considered to be protective of natural populations. They are based on consideration of radiation effects on population relevant endpoints, such as reproductive endpoints. Since the supporting literature generally involves exposure to gamma radiation, the dose benchmarks may be considered to be gamma-equivalent values.

For this assessment, human dose estimates in excess of the ICRP dose limit, and natural biota dose estimates in excess of UNSCEAR dose benchmarks, were considered to be indicators of human or ecological concern that should trigger further investigative action.

Table 2.1: UTM coordinates (Zone 17) for Special Investigation, September 2009

Date sampled	Sample Type	Sample ID	Map ID	Northing	Easting	NAD
16-Sep	water	EL-09-SI	see map	5139752	372526	83
16-Sep	sediment	EL-09-SI	see map	5139752	372526	83
16-Sep	macrophytes	EL-09-E1 to EL-09-E5	see map	5139704	372538	83
14-Sep		n/a	MT1	5139720	372538	83
14-Sep	fish	EL-F1	MT2	5139600	372494	83
14-Sep	fish	EL-F1	MT3	5138857	370356	83
16-Sep	fish	n/a	MT4	5139752	372526	83
16-Sep	fish	n/a	MT5	5139704	372538	83
16-Sep	fish	EL-F2, EL-F3	MT6	5139604	372498	83
20-Sep	water	MAL-09-SI	see map	5143150	384049	83
20-Sep	sediment	MAL-09-SI	see map	5143168	384082	83
20-Sep	macrophytes	MAL-09-M1 to MAL-09-M5	see map	5143124	384002	83
20-Sep	fish	n/a	MT1	5144194	385074	83
20-Sep	fish	n/a	MT2	5144041	386259	83
20-Sep	fish	MAL-F1 to MAL-F3	MT3	5144080	385969	83
22-Sep	water	MCL-09-SI	see map	5131422	386108	83
22-Sep	sediment	MCL-09-SI	see map	5131376	385960	83
22-Sep	macrophytes	MCL-09-M1 to MCL-09-M3 & MCL-09-M6	MCL-09-M1 to MCL-09-M3 & MCL-09-M6	5131381	385958	83
22-Sep	macrophytes	MCL-09-M4, MCL-09-M5	MCL-09-M4, MCL-09-M5	5131422	386108	83
20-Sep	fish[a]	MCL-F1, MCL-F2	SN	5131422	386108	83
18-Sep	water	NL-09-SI	see map	5135858	376211	27
18-Sep	sediment	NL-09-SI	see map	5135853	376224	27
18-Sep	macrophytes	NL-09-N1 to NL-09-N5	see map	5135858	376211	27
18-Sep	fish	NL-F1 to NL-F3	SN	5135878	376212	27
18-Sep	fish	n/a	MT1	5135884	376232	27
18-Sep	fish	n/a	MT2	5135217	376176	27
18-Sep	fish	n/a	MT3	5135217	376584	27

Table 2.1: UTM coordinates (Zone 17) for Special Investigation, September 2009 (Con't)

Date sampled	Sample Type	Sample ID	Map ID	Northing	Easting	NAD
22-Sep	water	QL-09-SI	see map	5150766	380616	83
22-Sep	sediment	QL-09-SI	see map	5150768	380613	83
22-Sep	macrophytes	QL-09-01, QL-09-03	QL-09-01, QL-09-03	5151899	377825	83
22-Sep		QL-09-02, QL-09-04	QL-09-02, QL-09-04	5150768	380613	83
22-Sep		n/a	MT1	5150926	380964	83
22-Sep	fish	QL-F1 to QL-F3	MT2	5150768	380613	83
22-Sep		n/a	MT3	5150756	380564	83
18-Sep	water	ML-09-SI	see map	5142144	379486	83
26-Sep	sediment	ML-09-SI	see map	5143319	379965	83
19-Sep	macrophytes	ML-09-ML1, ML-09-ML2	ML-09-ML1, ML-09-ML2	5143091	379906	83
19-Sep		ML-09-ML3 & ML-09-ML5	ML-09-ML3 & ML-09-ML5	5143318	379898	83
19-Sep		ML-09-ML4	ML-09-ML4	5141280	379074	83
19-Sep	fish	ML-F2[b], ML-F3	MT1	5142121	378826	83
19-Sep		ML-F3	MT2	5141727	378204	83
19-Sep		ML-F1, ML-F2, ML-F3	MT3	5142780	380542	83
19-Sep		ML-F2	MT4	5142101	379893	83

NAD – North American Datum
[a] fish tissue sample MCL-F3 lost during processing at the laboratory
[b] sample a composite of 12 fish from minnow traps MT1, MT3 and/or MT4
n/a – not applicable; any fish captured from these locations were not retained for radionuclide analyses

Table 2.2: Characteristics of macrophyte and fish samples collected from lakes, September 14 -22

Lake	Sample type	Macrophyte						Fish		
	Sample No.	1	2	3	4	5	6	1	2	3
Elliot Lake	Species	sedge	arum	tape grass	pond lily	arum	-	yellow perch	yellow perch	2 yellow perch, 3 pumpkinseed sunfish
	Macrophyte structure/ No. of fish[a]	roots	leaves and stems	leaves	leaves and stems	seed heads	-	5	4	5
May Lake	Species	quillwort	floating leaf pondweed	white water lily	soft-stem bulrush	chara	-	common shiner	common shiner	common shiner
	Macrophyte structure/ Number of organisms	leaves and stems	leaves and stems	leaves and stems	roots	leaves	-	10	10	10
McCarthy Lake	Species	white water lily	tape grass	large leaf pondweed	burreed	water shield	fern pondweed	smallmouth bass	pumpkinseed sunfish	yellow perch
	Macrophyte structure/ Number of organisms	leaves and stems	leaves and stems	leaves and stems	leaves and stems	leaves and stems	leaves and stems	5	20	8
Nordic Lake	Species	floating leaf pondweed	burreed (stiff leaf)	white water lily	burreed (soft leaf)	arum	-	golden shiner	common shiner	golden shiner
	Macrophyte structure/ Number of organisms	leaves and stems	seed head	leaves and stems	leaves and stems	leaves and stems	-	6	6	6
Quirke Lake	Species	pond lily	broad leaf arrowhead	floating pondweed	cattail	-	-	common shiner	mimic shiner	mimic shiner
	Macrophyte structure/ Number of organisms	leaves and stems	leaves, stems, roots	leaves, stems, seeds	roots	-	-	~15	~25	~25
McCabe Lake	Species	sedge	sedge	quilwort and/or lobelia	white water lily	bulrush	-	lake chub	northern redbelly dace	pumpkinseed sunfish
	Macrophyte structure/ Number of organisms	roots	seeds	whole plant	leaves and stems	whole plant	-	10	12	8

[a] - number in composite sample

Table 2 3: Observations of waterfowl and other birds, September 14 - 22.

Lake	Species/Number Observed	Waterfowl and Other Birds					
Elliot Lake	Species	Cormorant	Seagull	Canada goose	Common merganser		
	Number observed	2	>10	>10	6		
May Lake	Species	Common merganser	Hooded merganser	Loon			
	Number observed	8	1	1			
McCabe Lake	Species	Seagull	Common merganser				
	Number observed	10	6 – 9				
McCarthy Lake	Species	Canada goose	black mallard	eagle	gull	loon	hooded merganser
	Number observed	14	10	1	1	1	1
Nordic Lake	Species	Cormorant	gull				
	Number observed	12	2				
Quirke Lake	Species	Common merganser	Seagull				
	Number observed	~7	6				

Table 2.4: Bioaccumulation Factors Used for Benthic Invertebrates from Flooded Basin Studies

	U	Th	Ra	Pb	Po
Benthic Invertebrate BAF (L/kg) (fresh weight)[1]	276	276	486	3,643	20,000

[1] Based on flooded basin studies (Minnow and BEAK, 2001); Po value from Health Canada (2007)

Table 2.5: Intake Rates Of Water, Food and Sediment, and Occupancy Factors Used For Riparian Wildlife Species

Parameter	Units	Mallard	Scaup	Merganser	Muskrat	Mink	Moose
Body weight	kg	1.134	0.815	1.723	1.415	1.354	400
Intake of water[1]	L/d	0.065	0.051	0.085	0.135	0.142	21.8
Intake of sediment[2]	kg/d	1.26E-3	1.02E-3	0.17E-3	7.44E-3	0.48E-3	0.057
Intake of plant[3]	kg/d	0.252	-	-	0.425	-	3.3
Intake of invertebrates[3]	kg/d	-	0.204	-	-	-	-
Intake of fish[3]	kg/d	-	-	0.331	-	0.19	-
Occupancy factor	-	0.5	0.5	0.5	1.0	1.0	1.0

[1] Based on allometric equations from U.S. EPA (1993).
[2] Calculated as a percentage of dry food intake (U.S. EPA, 1993; Sample and Suter, 1994; CCME, 1996) on a dry weight of sediment basis.
[3] Based on allometric equations from U.S. EPA (1993), converted to a fresh weight basis; moose value is the aquatic plant portion (12%) of total dietary intake (MacCracken *et al.*, 1997).

Table 2.6: Transfer Factors Used for Calculating Radionuclide Concentrations in Riparian Wildlife Tissues

F_{ing} (d/kg) for	U	Th	Ra	Pb	Po
Mallard[1]	0.008	0.05	0.046	0.162	4.62
Scaup[1]	0.008	0.496	0.423	0.162	4.62
Merganser[1]	0.163	4.89	3.91	1.99	5.45*
Muskrat[2]	0.077	0.031	0.694	0.462	0.540
Mink[2]	0.080	0.032	0.717	0.478	0.558
Moose[2]	0.0011	0.0004	0.0101	0.0067	0.0078
Meat:Whole Body Ratio[3]	0.50	0.63	0.37	0.38	0.59

[1] Based on in-basin plant, fish and duck tissue data (Minnow, 2005b), and adult feed intake rates. * Po value of 54.5 was based on estimated Po in fish using a Pb BAF; based on Po/Pb ratio in present study, Po in fish was at least 10 times higher; therefore, Po F_{ing} for merganser was reduced 10-fold.
[2] Based on allometric equations using ¾ power rule (Hart and Burt, 2006).
[3] Based on meat:whole body ratio for in-basin ducks (Minnow, 2005b).

Table 2.7: Dose Coefficients Used for Aquatic Biota and Riparian Wildlife

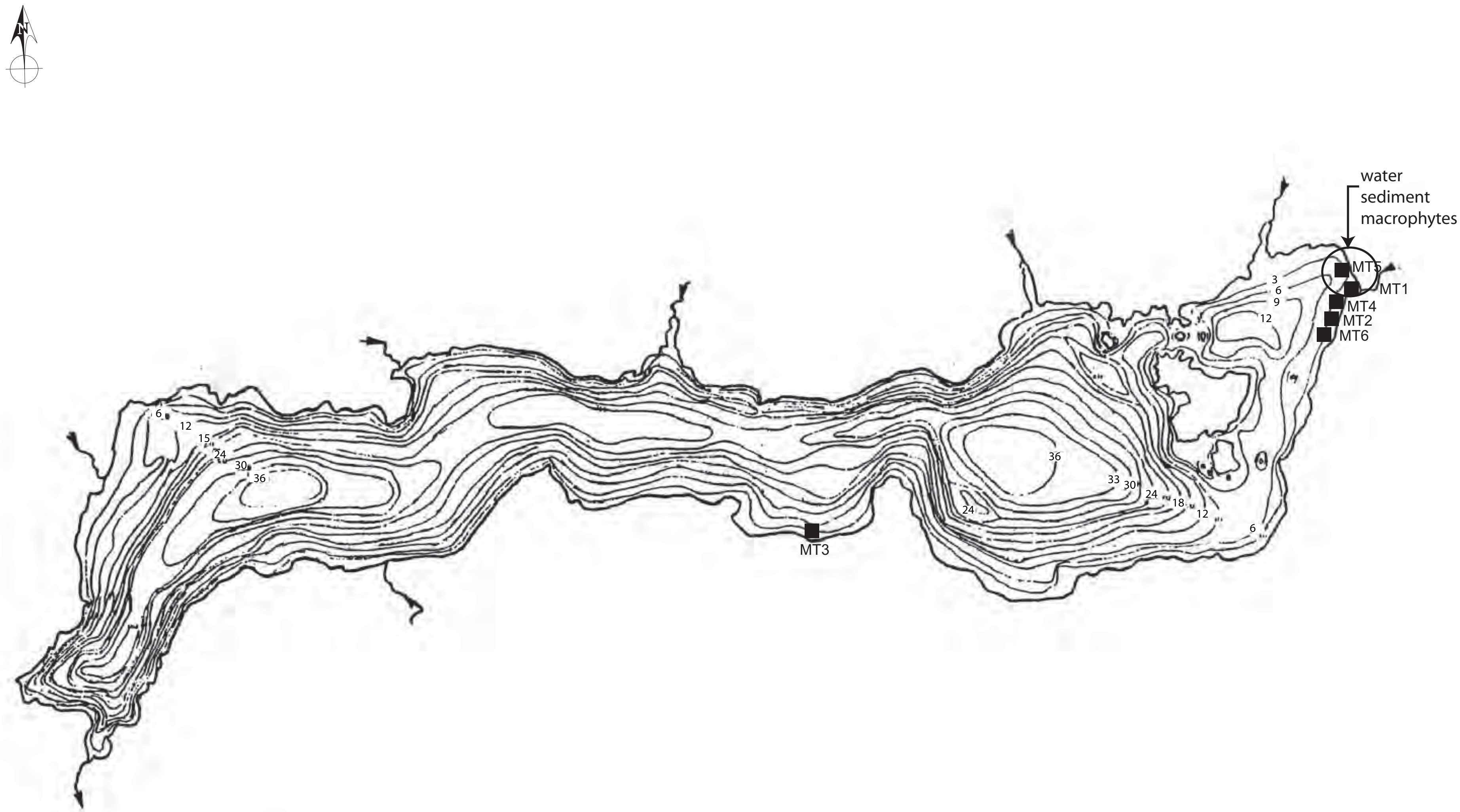
Dose Coefficient	Units	U-238/234	Th-234⁺	Th-230	Ra-226	Rn-222⁺	Pb-210⁺	Po-210
External - sediment[1]	Gy/a per Bq/kg ww	5.40E-8	1.53E-5	5.35E-8	2.40E-7	6.70E-5	4.56E-6	2.58E-10
Internal - ingestion[2]	Gy/a per Bq/kg fw	2.31E-5	4.56E-6	2.41E-5	2.46E-5	1.12E-4	2.19E-6	2.73E-5

[1] Values from Amiro (1997) converted to wet weight sediment and divided by 2 to represent a semi-infinite exposure situation; "+" indicates daughters are included.
[2] Values from Amiro (1997) assuming complete absorption of all energy released in tissues; "+" indicates daughters are included.

Table 2.8: Dose Coefficients Used for Human Receptors

Dose Coefficient	Units	U-238/234	Th-234⁺	Th-230	Ra-226	Rn-222⁺	Pb-210⁺	Po-210
Internal - ingestion[1]	Sv/Bq	4.7E-8	3.4E-9	2.1E-7	2.8E-7	2.5E-10	6.91E-7	1.2E-6

[1] Values from ICRP Publication 72 (ICRP, 1996); "+" indicates daughters are included.



■ minnow trap

0 — 2 kilometers

depth contours in metres

Figure 1

minnow

Elliot Lake Sample Locations, September 2009

Ref: 2308
Date: February 2010

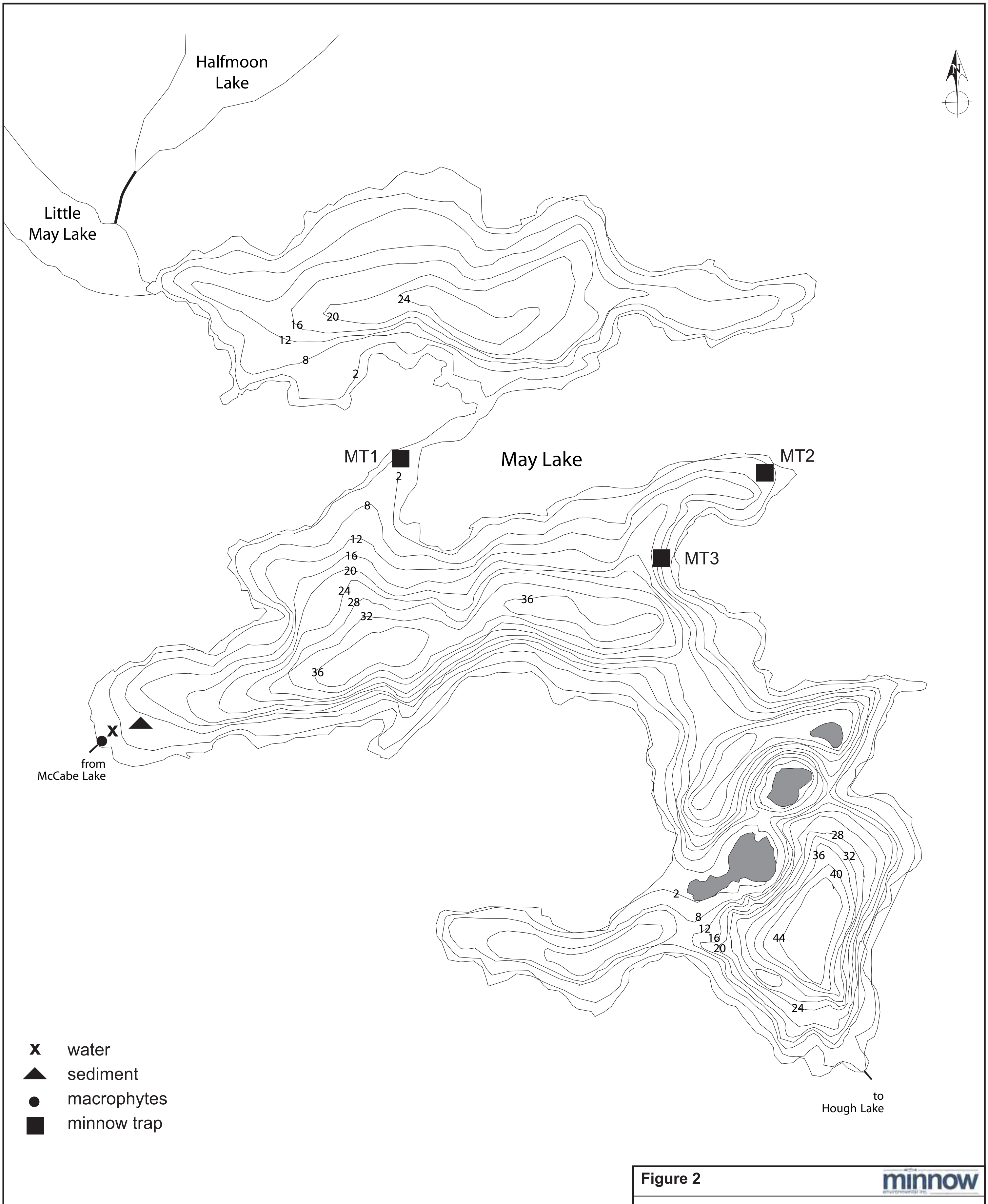
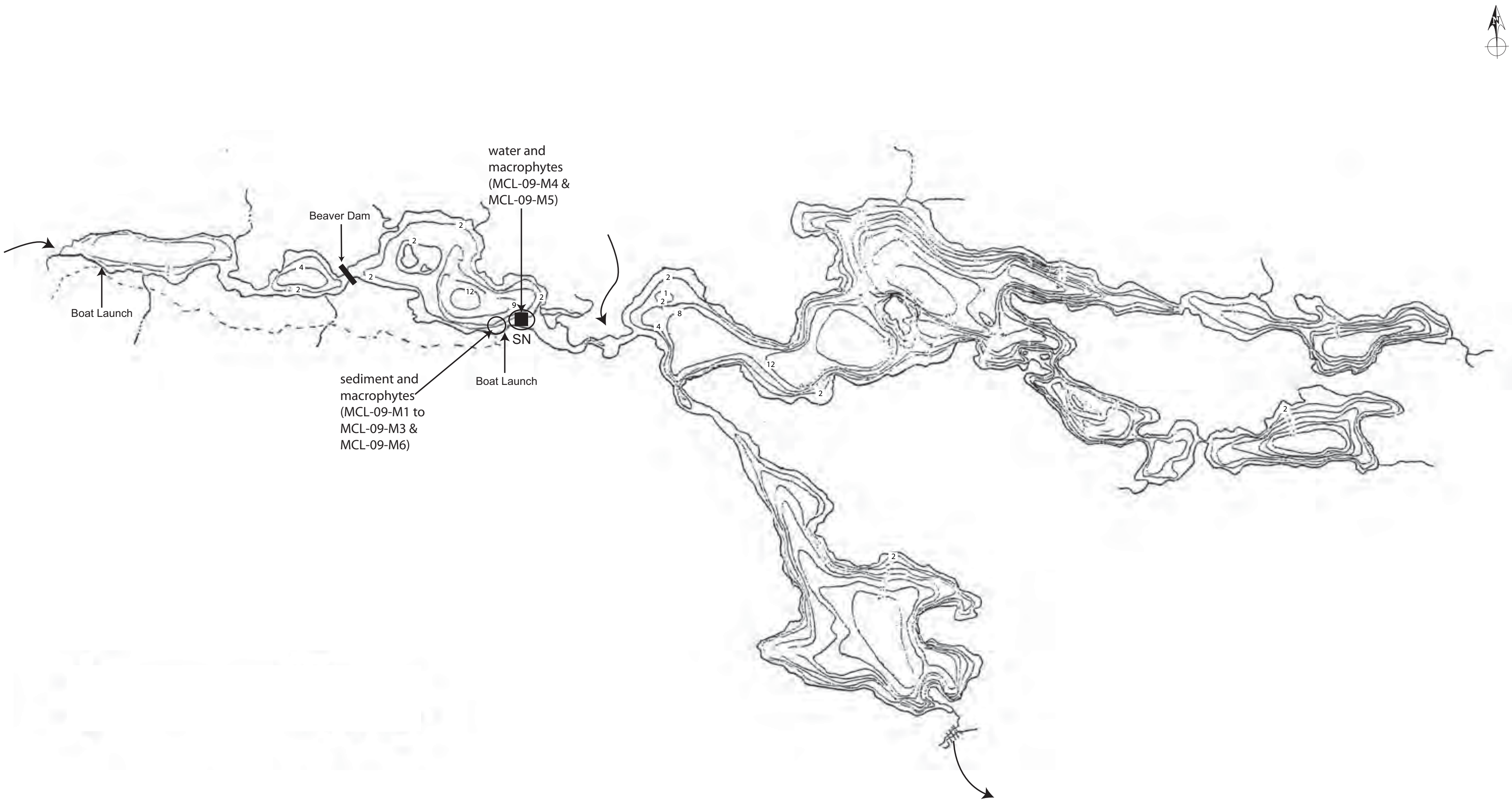


Figure 2

May Lake Sample Locations, September 2009

Ref: 2308
Date: February 2010



seine netting

0 2 kilometres

depth contours in metres

Figure 3

minnow environmental inc.

McCarthy Lake Sample Locations, September 2009

Ref: 2308
Date: February 2010

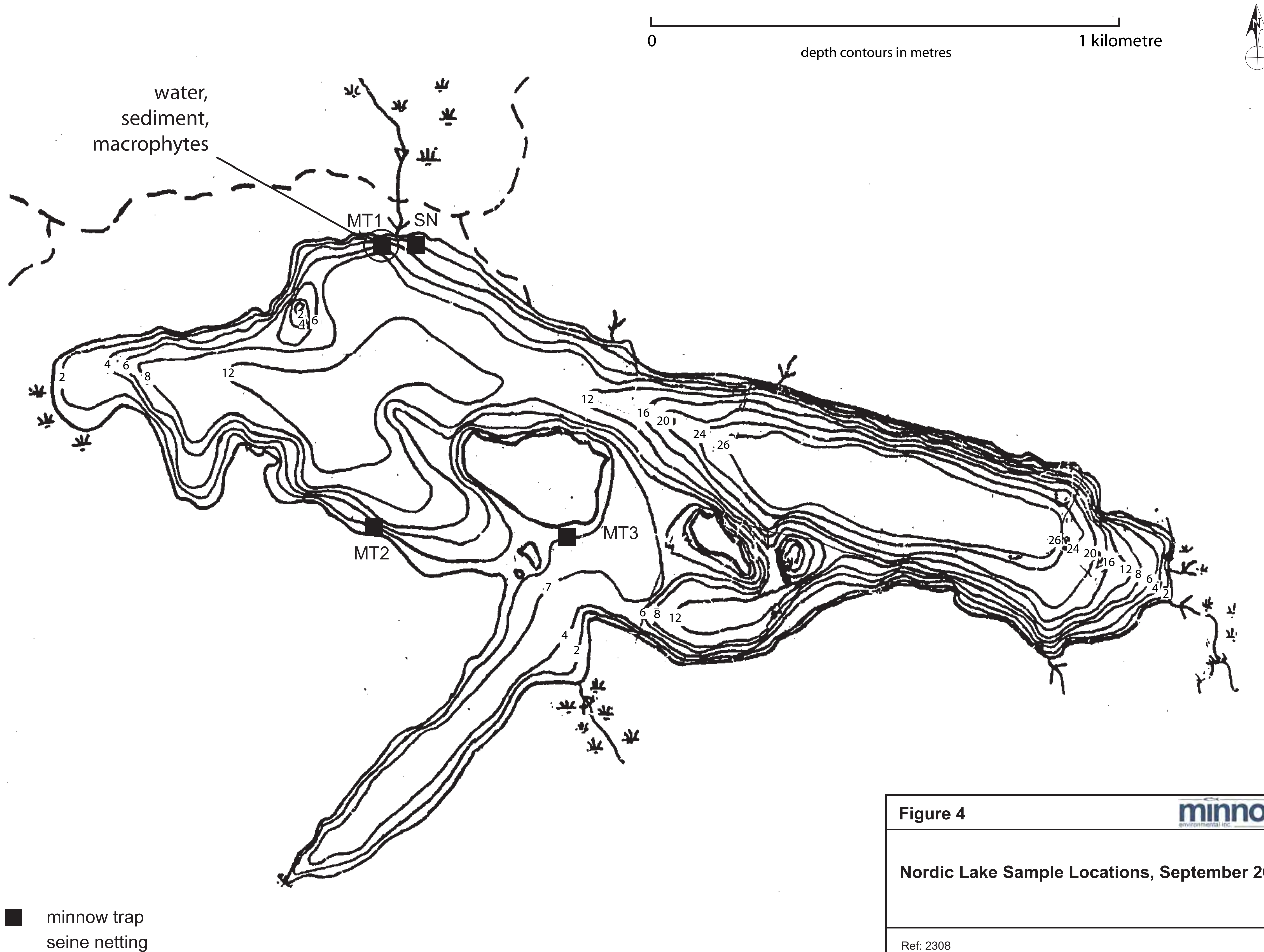


Figure 4

minnow environmental inc.

Nordic Lake Sample Locations, September 2009

Ref: 2308
Date: February 2010

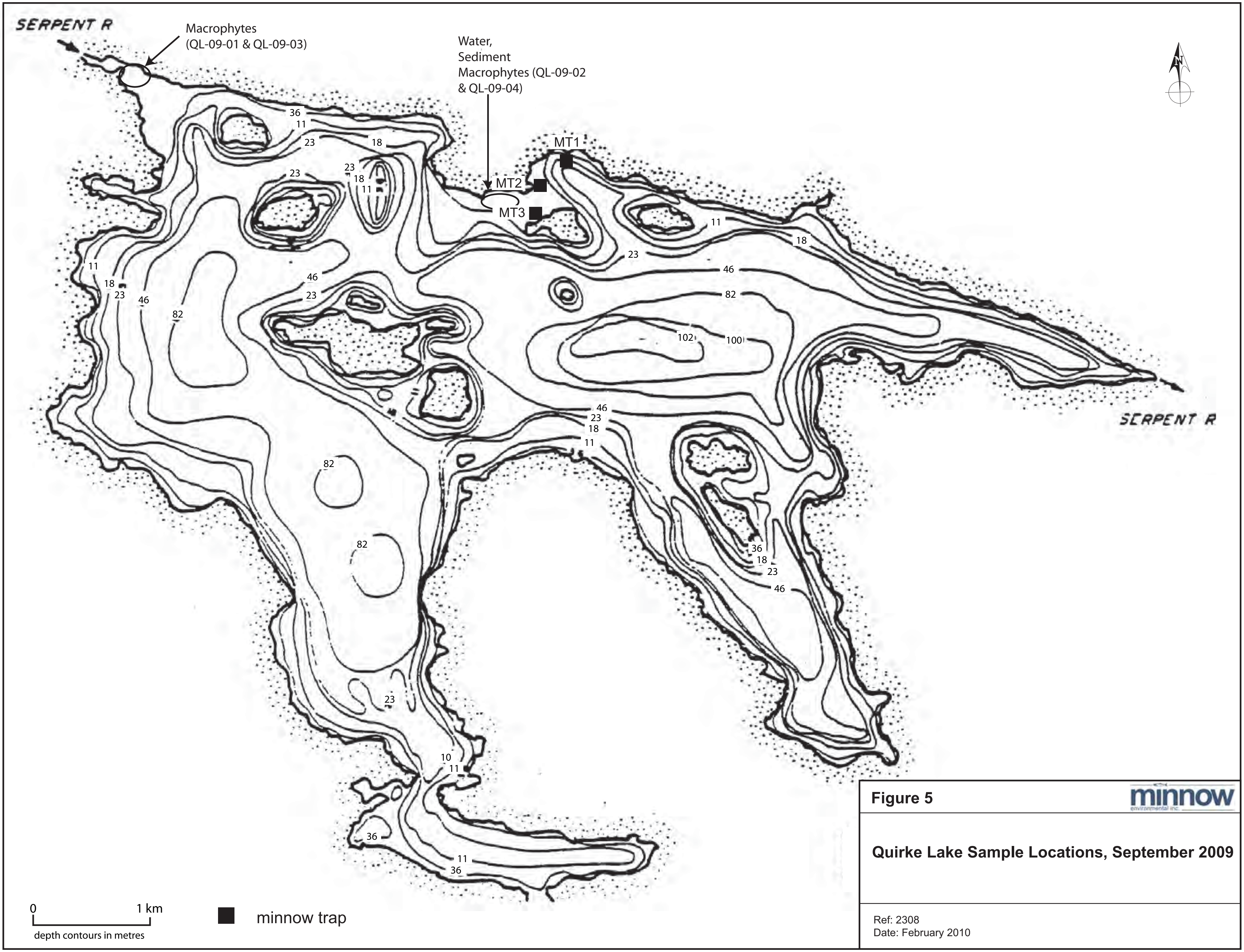
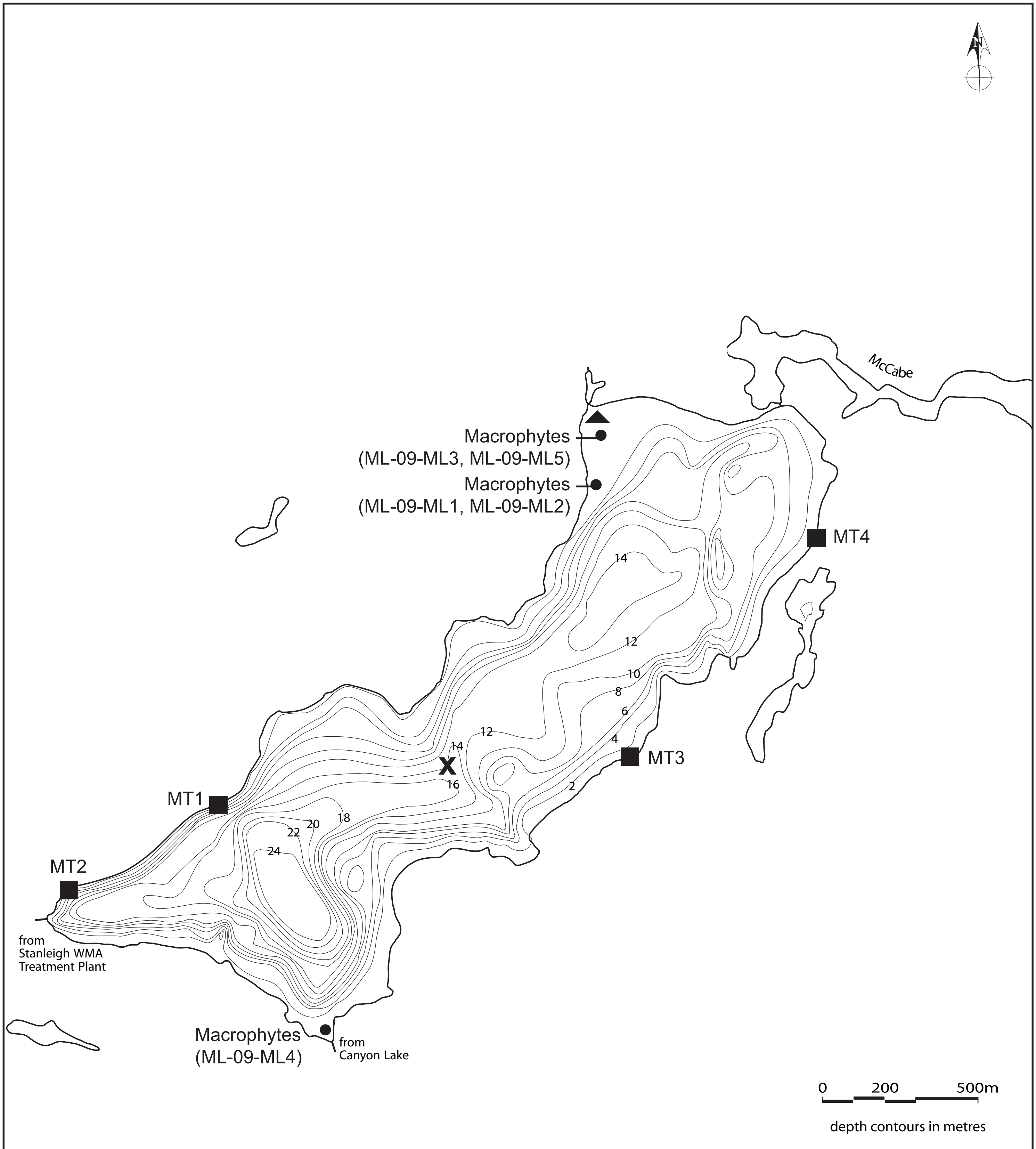


Figure 5

Quirke Lake Sample Locations, September 2009

Ref: 2308
Date: February 2010



x water
▲ sediment
● macrophytes
■ minnow trap

Figure 6

minnow environmental inc.

McCabe Lake Sample Locations, September 2009

Ref: 2308
Date: February 2010

3.0 RESULTS

3.1 Secular Equilibrium of Pb-210 and Po-210 in Sediment

The measured activity concentrations of Pb-210 and Po-210 in lake sediments, and the Po/Pb ratios, are presented for each watershed lake in **Table 3.1**. The average ratio is 1.01. The ratios vary from 0.87 to 1.18, with no upstream-downstream pattern. This supports the notion of secular equilibrium between these radionuclides in lake sediments.

Secular equilibrium is expected based on the half lives of parent (Pb-210, 22.3 years) and daughter (Po-210, 138.4 days). Following Brodsky (1982), these half lives dictate that secular equilibrium is reached after about 2 years in undisturbed sediment. Any process acting to disturb secular equilibrium would have to act on a shorter timeframe.

3.2 Th-232 Decay Chain Radionuclides

The measured activity concentrations of U-238 and Th-232 decay chain radionuclides in lake sediments are shown in **Table 3.2**. Concentrations are generally quite low for the Th-232 decay chain relative to the U-238 decay chain, with the exception of May Lake, which had the highest concentrations of Th-232, Ra-228 and Th-228. May Lake also had the highest concentration of Th-230 (elevated at least 6-fold relative to other U-238 series radionuclides). In contrast, the McCabe Lake sediment was depleted in Th-230. This suggests the possibility that thorium was selectively deposited further downstream. McKee et al. (1996) also found higher levels of Th-230 and Th-232 in May Lake as compared to McCabe Lake. This may be due to preferential flushing of Th from McCabe Lake during the historical period of depressed pH, with deposition further downstream.

In Quirke, Elliot, McCabe and May lakes the Th-232 concentrations were approximately $1/10^{th}$ of the Th-230 concentrations. They were clearly elevated (relative to background) in both Quirke and May lakes. Natural background for Th-232 in soil is in the range of 11 to 64 Bq/kg (mean 30 Bq/kg) (UNSCEAR, 2000). EcoMetrix (2005) found background levels of about 27 Bq/kg in Lake Ontario nearshore sediments.

The Th-232 decay chain generally makes a minor contribution to dose as compared to the U-238 chain. It usually accounts for 10% or less of the estimated total dose for a given receptor at any lake. Exceptions are May Lake, where the Th-232 chain accounts for more than 10% for 4 out of 8 aquatic/riparian receptors; and aquatic plants in general, where the contribution usually exceeds 10% and ranges up to 25% in May Lake. Dose estimates are presented in detail in subsequent sections.

3.3 Bioaccumulation Factors for Aquatic Biota

Bioaccumulation factors (BAFs) for aquatic biota were calculated from the lake water concentrations and the lake average whole fish or aquatic macrophyte tissue concentrations, where both were available. The lake water concentrations from the 2009 studies are shown in **Table 3.3**. Whole fish concentrations on a fresh weight basis are shown in **Table 3.4**. Aquatic macrophyte concentrations on a dry weight basis are shown in **Table 3.5**. These were converted to a fresh weight basis (**Table 3.6**) assuming a 75% water content in tissue. This value is in the range given by the U.S. EPA (1993) for emergent macrophytes, while submerged macrophytes typically have about 85% moisture. The 75% value is consistent with the assumption used to convert dry weight food intakes by wildlife to fresh weight intakes.

The BAFs computed from these data are shown by lake in **Table 3.7** for whole forage fish, and in **Table 3.8** for aquatic macrophytes. The average value across lakes was used where needed to estimate tissue concentrations. No BAFs were computed for Po-210, Th-232, Ra-228 or Th-228 due to non-detection in water. A BAF is not needed for Po-210 since this radionuclide was always detected in tissue. For Th and Ra isotopes the BAFs computed from Th-230 and Ra-226 data were utilized.

Table 3.9 compares the average BAFs from studies in the flooded basins (Minnow and BEAK 2001b) with those from the present study of watershed lakes. The comparison indicates that BAFs for forage fish are consistently higher in the lakes, while BAFs for aquatic macrophytes are generally similar, but 3 times higher in the lakes for U, and 5 times lower in the lakes for Pb. The higher forage fish BAFs in the lakes may be related to lower hardness in the lakes, higher productivity in the lakes, lower contaminant concentrations in the lakes, or a combination of factors.

3.4 Doses to Aquatic Biota

The calculated doses to aquatic biota (fish, aquatic plants, benthos) for the six watershed lakes considered are summarized in **Table 3.10**. The detailed dose calculations are presented in Appendix D.

All of the calculated doses to fish, aquatic plants and benthos were well below the UNSCEAR (1996) benchmark dose of 10 mGy/d. The largest doses to aquatic biota occurred at Quirke Lake, where the doses to fish, aquatic plants and benthos were 0.92, 2.61 and 0.256 mGy/d, respectively. For all aquatic biota, the largest component of dose was internal. The largest contributor to dose was generally Po-210 for fish and benthic invertebrates, while the dose was more evenly distributed for aquatic macrophytes, with Ra-226 and short-lived radon daughters usually making the largest contribution.

3.5 Doses to Riparian Wildlife

The calculated doses to waterfowl (scaup, mallard, merganser), muskrat and mink for the six watershed lakes considered are summarized in **Table 3.11**. The detailed dose calculations are presented in Appendix D.

All of the calculated doses were less than the UNSCEAR (1996) benchmark dose of 1 mGy/d. The largest doses to riparian wildlife occurred at Quirke Lake, where the doses to mallard, scaup, merganser, muskrat and mink, were 0.263, 0.094, 0.793, 0.407 and 0.124 mGy/d, respectively. For all riparian biota, the largest component of dose was usually internal. The largest contributor to dose was Po-210 for waterfowl, and Ra-226 with short-lived radon daughters for muskrat. For mink, one or the other of these contributors was predominant.

3.6 Doses to Generic Humans

The calculated doses to generic human receptors from consuming water, fish and game at the six watershed lakes considered, are summarized in **Table 3.12**. The detailed dose calculations are presented in Appendix D.

Total doses to generic human receptors at the six lakes ranged from 0.036 to 0.301 mSv/a, all less than the public dose limit of 1 mSv/a, before background correction. Background dose from the same pathways was estimated at 0.013 mSv/a. Therefore, incremental doses ranged from 0.023 to 0.288 mSv/a. The smallest doses were at McCarthy, Elliot and Nordic lakes, whereas the largest dose was at Quirke Lake. The dose at Quirke Lake was dominated by consumption of mallard ducks, and was driven by the high concentration of Po-210 in aquatic macrophytes at Quirke Lake.

It should be noted that the generic human as modeled here (resident on the lake, taking fish and game only from that lake) may exist as such at Elliot Lake, but not at Quirke Lake. The estimated dose at Elliot Lake is 0.036 mSv/a (total) or 0.023 mSv/a (incremental), and the largest dose contribution is from drinking water. There are full-time cottage residents on the south shore of Quirke Lake who use the lake for drinking water and fishing, but not for duck hunting. A more realistic dose for these residents (without the waterfowl component) is 0.072 mSv/a (total) or 0.064 mSv/a (incremental)..

3.7 Doses to SRFN Members

The calculated dose to a Serpent River First Nation member was based on realistic use of the six watershed lakes, and of Lake Huron, as determined from the survey of households (SRFN, 2010). The doses for “actual use” and “future use” scenarios are summarized in **Table 3.13**. The detailed dose calculations are presented in Appendix D.

The dose for the actual use scenario was 0.062 mSv/a (total) or 0.049 mSv/a (incremental). The dose for the future use scenario was 0.060 mSv/a (total) or 0.047 mSv/a (incremental). All these doses are less than the public dose limit of 1 mSv/a (incremental).

The future use scenario involves slightly more use of some watershed lakes, and slightly less use of Lake Huron. However, moose harvest from Quirke Lake was lower in the future use scenario than at present. The use of Serpent Harbour water and sediment data to represent Lake Huron may overestimate the Lake Huron component of dose; sediment concentrations in the Harbour are slightly higher than those in McCarthy Lake, while many areas in Lake Huron probably have lower concentrations.

The contributions of water, fish, moose and waterfowl to dose are approximately 28%, 37%, 25% and 10%, respectively, with slight variations between actual use and future use scenarios.

3.8 Comparison to EIS Dose Predictions

The EIS documents supporting mine decommissioning have predicted human doses, and in some cases ecological doses, that were expected to arise from watershed concentrations of radionuclides ten years after site closure. These dose predictions are incremental values. Predictions cited as cumulative effects (reflecting releases from all upstream closed mines) for this timeframe are approximately comparable to dose estimates made in the current assessment using concentration data from the special investigations.

Table 3.14 shows EIS dose predictions for riparian wildlife near McCabe Lake, as compared to doses calculated in the present study, after correction for background. **Table 3.15** shows EIS dose predictions for humans near each lake, as compared to the generic human doses calculated in the present study, after background correction.

Table 3.1: Po/Pb Ratio in Lake Sediments

Lake	Pb-210 Bq/kg	Po-210 Bq/kg	Po/Pb Ratio
Quirke	2300	2600	1.13
Elliot	760	740	0.97
Nordic	310	270	0.87
McCabe	2500	2400	0.96
May	660	780	1.18
McCarthy	490	450	0.92
Average			1.01

Table 3.2: Measured Activity Concentrations of U-238 and Th-232 Decay Chain Radionuclides in Lake Sediments

Lake	U Bq/kg	Th-230 Bq/kg	Ra-226 Bq/kg	Pb-210 Bq/kg	Po-210 Bq/kg	Th-232 Bq/kg	Ra-228 Bq/kg	Th-228 Bq/kg
Quirke	2189.4	2700	2200	2300	2600	260	350	370
Elliot	3321	1040	630	760	740	80	< 100	170
Nordic	393.6	50	370	310	270	20	< 100	60
McCabe	738	430	2000	2500	2400	40	< 100	80
May	393.6	5100	220	660	780	780	500	660
McCarthy	639.6	50	440	490	450	14	< 100	60

Table 3.3: Measured Activity Concentrations of U-238 and Th-232 Decay Chain Radionuclides in Lake Water

Lake	U Bq/L	Th-230 Bq/L	Ra-226 Bq/L	Pb-210 Bq/L	Po-210 Bq/L	Th-232 Bq/L	Ra-228 Bq/L	Th-228 Bq/L
Quirke	0.0640	< 0.01	0.05	0.06	< 0.01	< 0.01	< 0.1	< 0.01
Elliot	0.0418	< 0.01	< 0.01	0.03	< 0.01	< 0.01	< 0.1	< 0.01
Nordic	0.0394	< 0.01	0.03	0.03	< 0.01	< 0.01	< 0.1	< 0.01
McCabe	0.0295	< 0.01	0.06	0.03	< 0.01	< 0.01	< 0.1	< 0.01
May	0.0369	< 0.01	0.05	< 0.02	< 0.01	< 0.01	< 0.1	< 0.01
McCarthy	0.0123	< 0.01	< 0.01	0.03	< 0.01	< 0.01	< 0.1	< 0.01

Table 3.4: Average Activity Concentrations of U-238 and Th-232 Decay Chain Radionuclides in Whole Forage Fish (fresh weight)

Lake	U Bq/kg	Th-230 Bq/kg	Ra-226 Bq/kg	Pb-210 Bq/kg	Po-210 Bq/kg	Th-232 Bq/kg	Ra-228 Bq/kg	Th-228 Bq/kg
Quirke	63.55	22.000	59.667	30.000	1006.67	< 5	*106.667*	*4.667*
Elliot	14.92	*4.333*	11.000	< 20	29.000	< 5	*116.667*	< 5
Nordic	4.51	< 5	10.333	< 20	396.667	< 5	< 100	< 5
McCabe	11.40	< 5	21.667	*36.667*	503.333	< 5	*223.333*	< 5
May	5.41	*5.000*	13.000	*23.333*	453.333	< 5	*143.333*	*5.667*
McCarthy	10.70	< 5	9.000	< 20	56.000	< 5	< 100	< 5

Note: values in italics contain some detects and some non-detects taken at face value

Table 3.5: Average Activity Concentrations of U-238 and Th-232 Decay Chain Radionuclides in Aquatic Macrophytes (dry weight)

Lake	U Bq/kg	Th-230 Bq/kg	Ra-226 Bq/kg	Pb-210 Bq/kg	Po-210 Bq/kg	Th-232 Bq/kg	Ra-228 Bq/kg	Th-228 Bq/kg
Quirke	5864.03	2435.25	1850.00	1927.50	2137.50	310.250	515.000	282.750
Elliot	85.02	*16.000*	108.000	46.000	19.200	*5.000*	< 100	*7.400*
Nordic	61.35	< 5	134.800	59.200	35.800	< 5	< 100	*6.200*
McCabe	160.88	437.600	584.000	339.400	318.600	*70.400*	*346.000*	*137.000*
May	247.82	*126.000*	437.400	335.400	340.200	*24.200*	*212.000*	*55.400*
McCarthy	181.14	< 5	171.333	91.000	49.167	*5.333*	*111.667*	< 5

Note: values in italics contain some detects and some non-detects taken at face value

Table 3.6: Average Activity Concentrations of U-238 and Th-232 Decay Chain Radionuclides in Aquatic Macrophytes (fresh weight 75% moisture assumed)

Lake	U Bq/kg	Th-230 Bq/kg	Ra-226 Bq/kg	Pb-210 Bq/kg	Po-210 Bq/kg	Th-232 Bq/kg	Ra-228 Bq/kg	Th-228 Bq/kg
Quirke	1466.01	608.81	462.50	481.88	534.38	77.56	128.75	70.69
Elliot	21.25	*4.00*	27.00	11.50	4.80	*1.25*	< 25	*1.85*
Nordic	15.34	< 1.25	33.70	14.80	8.95	< 1.25	< 25	*1.55*
McCabe	40.22	109.40	146.00	84.85	79.65	*17.60*	*86.50*	*34.25*
May	61.96	*31.50*	109.35	83.85	85.05	*6.05*	*53.00*	*13.85*
McCarthy	45.28	< 1.25	42.83	22.75	12.29	*1.33*	*27.92*	< 1.25

Note: values in italics contain some detects and some non-detects taken at face value

Table 3.7: Bioaccumulation Factors for Whole Forage Fish in Watershed Lakes (fresh weight)

Lake	U L/kg	Th-230 L/kg	Ra-226 L/kg	Pb-210 L/kg
Quirke	994	401	1193	500
Elliot	357	205		
Nordic	115		344	
McCabe	386		361	1222
May	147	48	260	
McCarthy	870			
Average	478	218	540	861

Note: Th-230 in water estimated from sediment

Table 3.8: Bioaccumulation Factors for Aquatic Macrophytes in Watershed Lakes (fresh weight)

Lake	U	Th-230	Ra-226	Pb-210
	L/kg	L/kg	L/kg	L/kg
Quirke	22921	11094	9250	8031
Elliot	508	946		383
Nordic	390		1123	493
McCabe	1363	12517	2433	2828
May	1679	304	2187	
McCarthy	3682			758
Average	5090	6215	3748	2499

Note: Th-230 in water estimated from sediment

Table 3.9: Comparison of Basin and Lake Bioaccumulation Factors for Forage Fish and Aquatic Macrophytes

	U	Th	Ra	Pb	Po
Forage Fish					
Basin average	31.3	80	112	227	227 *
Lake average	478	218	540	861	-
Lake/basin	15.3	2.7	4.8	3.8	-
Macrophyte					
Basin average	1602	6445	2812	11411	11411 *
Lake average	5090	6215	3748	2499	-
Lake/basin	3.2	1.0	1.3	0.2	-

* Po BAF was assumed equal to Pb value

Table 3.10: Radiation Doses to Aquatic Biota at Six Lakes in the Serpent River Watershed

		Dose by Radionuclide (mGy/d)										
Location	Receptor	U-238/U-234	Th-234+	Th-230	Ra-226	Rn-222+	Pb-210+	Po-210	Th-232	Ra-228+	Th-228+	Total
Quirke Lake	Forage Fish	4.02E-02	2.35E-03	1.45E-02	4.03E-02	3.85E-02	1.62E-03	7.53E-01	6.52E-04	3.78E-03	2.56E-02	9.20E-01
	Aquatic Plant	9.28E-01	4.02E-03	4.02E-01	3.12E-01	1.62E-01	4.32E-03	4.00E-01	4.38E-02	4.21E-03	3.46E-01	2.61E+00
	Benthic Invertebrate	1.12E-02	4.67E-03	1.86E-03	1.65E-02	4.78E-02	4.18E-03	1.50E-01	8.26E-04	3.48E-03	1.60E-02	2.56E-01
Elliot Lake	Forage Fish	9.47E-03	3.57E-03	2.87E-03	7.43E-03	9.16E-03	5.95E-04	2.17E-02	2.01E-04	2.67E-03	5.00E-03	6.27E-02
	Aquatic Plant	1.35E-02	6.10E-03	2.65E-03	1.82E-02	1.41E-02	5.44E-04	3.55E-03	7.06E-04	6.38E-04	9.83E-03	6.98E-02
	Benthic Invertebrate	7.35E-03	7.08E-03	1.84E-03	3.32E-03	1.31E-02	1.60E-03	1.50E-01	2.54E-04	8.10E-04	7.33E-03	1.92E-01
Nordic Lake	Forage Fish	2.86E-03	4.23E-04	1.47E-04	6.98E-03	6.57E-03	3.14E-04	2.97E-01	5.01E-05	1.14E-04	1.77E-03	3.16E-01
	Aquatic Plant	9.71E-03	7.23E-04	4.17E-03	2.27E-02	1.37E-02	2.82E-04	6.69E-03	1.43E-03	2.16E-04	7.99E-03	6.77E-02
	Benthic Invertebrate	6.88E-03	8.39E-04	1.86E-04	9.85E-03	1.13E-02	1.04E-03	1.50E-01	6.36E-05	2.10E-04	2.59E-03	1.83E-01
McCabe Lake	Forage Fish	7.22E-03	7.94E-04	1.26E-03	1.47E-02	2.50E-02	1.78E-03	3.76E-01	1.00E-04	4.55E-03	2.35E-03	4.27E-01
	Aquatic Plant	2.55E-02	1.36E-03	7.22E-02	9.85E-02	6.32E-02	2.07E-03	5.96E-02	3.97E-03	8.69E-04	6.70E-02	3.22E-01
	Benthic Invertebrate	5.17E-03	1.57E-03	1.60E-03	1.98E-02	4.57E-02	3.78E-03	1.50E-01	1.27E-04	4.00E-04	3.45E-03	2.27E-01
May Lake	Forage Fish	3.43E-03	4.23E-04	3.34E-03	8.77E-03	6.01E-03	5.52E-04	3.39E-01	1.24E-03	5.23E-03	3.27E-02	4.01E-01
	Aquatic Plant	3.92E-02	7.23E-04	2.08E-02	7.37E-02	3.56E-02	9.15E-04	6.36E-02	3.42E-03	3.47E-03	7.25E-02	3.14E-01
	Benthic Invertebrate	6.45E-03	8.39E-04	1.90E-03	1.64E-02	1.15E-02	1.24E-03	1.50E-01	1.57E-03	5.81E-03	2.39E-02	2.19E-01
McCarthy Lake	Forage Fish	6.78E-03	6.88E-04	1.47E-04	6.08E-03	6.80E-03	4.26E-04	4.19E-02	3.51E-05	7.44E-05	1.77E-03	6.47E-02
	Aquatic Plant	2.87E-02	1.17E-03	4.17E-03	2.89E-02	1.72E-02	4.42E-04	9.19E-03	7.53E-04	6.13E-04	3.72E-02	1.28E-01
	Benthic Invertebrate	2.16E-03	1.36E-03	1.86E-04	3.30E-03	9.57E-03	1.27E-03	1.50E-01	4.45E-05	1.42E-04	2.59E-03	1.70E-01
Background	Forage Fish	5.21E-03	4.23E-04	5.77E-04	2.19E-03	2.60E-03	1.35E-04	7.12E-02	3.51E-05	7.31E-05	4.12E-04	8.29E-02
	Aquatic Plant	5.55E-02	7.23E-04	1.64E-02	1.52E-02	8.50E-03	1.84E-04	7.70E-03	9.98E-04	1.03E-04	8.68E-03	1.14E-01
	Benthic Invertebrate	3.01E-03	8.39E-04	7.32E-04	1.98E-03	4.10E-03	3.28E-04	3.76E-02	4.45E-05	1.41E-04	6.04E-04	4.94E-02

Table 3.11: Radiation Doses to Riparian Wildlife at Six Lakes in the Serpent River Watershed

		Dose by Radionuclide (mGy/d)										
Location	**Receptor**	**U-238/U-234**	**Th-234+**	**Th-230**	**Ra-226**	**Rn-222+**	**Pb-210+**	**Po-210**	**Th-232**	**Ra-228**	**Th-228**	**Total**
Quirke Lake	Mallard	8.96E-04	1.16E-03	2.61E-03	1.88E-03	1.26E-02	7.79E-04	2.38E-01	2.82E-04	8.66E-04	3.70E-03	2.63E-01
	Scaup	2.20E-05	1.15E-03	5.53E-04	1.06E-03	1.15E-02	7.41E-04	7.51E-02	7.96E-05	8.56E-04	2.44E-03	9.35E-02
	Merganser	1.12E-03	1.20E-03	1.25E-02	2.66E-02	4.64E-02	7.80E-04	6.81E-01	5.88E-04	2.20E-03	2.06E-02	7.93E-01
	Muskrat	3.12E-02	2.32E-03	5.70E-03	9.96E-02	1.56E-01	2.05E-03	9.95E-02	6.09E-04	2.48E-03	7.85E-03	4.07E-01
	Mink	6.78E-04	2.29E-03	1.35E-04	6.06E-03	2.84E-02	1.46E-03	8.03E-02	7.83E-06	1.99E-03	3.11E-03	1.24E-01
Elliot Lake	Mallard	3.51E-05	1.76E-03	4.22E-05	1.28E-04	3.05E-03	2.39E-04	3.68E-03	6.15E-06	1.96E-04	7.56E-04	9.89E-03
	Scaup	2.60E-05	1.75E-03	2.70E-04	2.44E-04	3.21E-03	2.49E-04	7.18E-02	2.45E-05	1.96E-04	1.12E-03	7.89E-02
	Merganser	2.97E-04	1.82E-03	2.60E-03	4.95E-03	9.64E-03	2.78E-04	1.98E-02	1.81E-04	1.67E-03	3.98E-03	4.53E-02
	Muskrat	1.67E-03	3.52E-03	2.00E-04	7.58E-03	1.61E-02	5.04E-04	3.04E-03	2.01E-05	4.70E-04	1.65E-03	3.48E-02
	Mink	2.47E-04	3.48E-03	3.54E-05	1.18E-03	7.36E-03	4.87E-04	2.45E-03	2.41E-06	7.00E-04	1.39E-03	1.73E-02
Nordic Lake	Mallard	1.19E-05	2.08E-04	2.76E-05	1.44E-04	1.89E-03	9.88E-05	4.49E-03	9.44E-06	4.93E-05	2.96E-04	6.87E-03
	Scaup	7.71E-06	2.08E-04	1.79E-05	4.84E-04	2.35E-03	1.08E-04	7.10E-02	6.12E-06	4.94E-05	3.95E-04	7.42E-02
	Merganser	8.23E-05	2.16E-04	1.32E-04	4.60E-03	7.98E-03	1.37E-04	2.68E-01	4.53E-05	5.98E-05	1.40E-03	2.81E-01
	Muskrat	4.64E-04	4.17E-04	6.26E-05	8.00E-03	1.43E-02	2.18E-04	2.35E-03	2.14E-05	1.34E-04	6.43E-04	2.58E-02
	Mink	5.58E-05	4.13E-04	1.75E-06	1.05E-03	4.81E-03	2.05E-04	3.15E-02	6.03E-07	9.97E-05	4.90E-04	3.80E-02
McCabe Lake	Mallard	2.91E-05	3.91E-04	4.67E-04	6.40E-04	1.00E-02	7.93E-04	3.99E-02	2.60E-05	1.01E-04	7.51E-04	5.31E-02
	Scaup	8.49E-06	3.89E-04	1.54E-04	1.17E-03	1.07E-02	7.93E-04	7.47E-02	1.22E-05	9.79E-05	5.26E-04	8.86E-02
	Merganser	2.05E-04	4.05E-04	1.14E-03	9.94E-03	2.27E-02	8.56E-04	3.41E-01	9.05E-05	2.92E-03	1.87E-03	3.81E-01
	Muskrat	1.11E-03	7.82E-04	1.01E-03	3.60E-02	6.75E-02	1.71E-03	2.09E-02	5.75E-05	3.98E-04	1.60E-03	1.31E-01
	Mink	1.33E-04	7.74E-04	1.51E-05	2.52E-03	2.17E-02	1.59E-03	4.04E-02	1.21E-06	7.88E-04	6.53E-04	6.85E-02
May Lake	Mallard	3.99E-05	2.08E-04	2.57E-04	4.34E-04	1.60E-03	2.17E-04	3.87E-02	3.80E-05	1.22E-03	3.15E-03	4.59E-02
	Scaup	7.37E-06	2.08E-04	9.62E-04	7.43E-04	2.02E-03	2.13E-04	7.19E-02	1.93E-04	1.26E-03	4.11E-03	8.16E-02
	Merganser	9.78E-05	2.16E-04	4.06E-03	5.74E-03	8.84E-03	2.53E-04	3.06E-01	1.18E-03	3.03E-03	2.62E-02	3.56E-01
	Muskrat	1.43E-03	4.17E-04	1.08E-03	2.25E-02	3.27E-02	5.25E-04	1.69E-02	1.51E-04	2.79E-03	6.87E-03	8.54E-02
	Mink	6.44E-05	4.13E-04	1.08E-04	1.25E-03	3.72E-03	4.26E-04	3.61E-02	1.91E-05	2.82E-03	5.47E-03	5.04E-02
McCarthy Lake	Mallard	3.15E-05	3.38E-04	2.76E-05	1.83E-04	2.26E-03	1.56E-04	6.33E-03	5.05E-06	3.72E-05	4.80E-04	9.85E-03
	Scaup	5.57E-06	3.37E-04	1.79E-05	2.13E-04	2.30E-03	1.64E-04	7.13E-02	4.29E-06	3.43E-05	3.95E-04	7.48E-02
	Merganser	1.91E-04	3.51E-04	1.32E-04	4.04E-03	7.52E-03	1.93E-04	3.80E-02	3.17E-05	3.82E-05	1.40E-03	5.19E-02
	Muskrat	1.18E-03	6.78E-04	6.26E-05	1.01E-02	1.78E-02	3.43E-04	3.46E-03	1.18E-05	2.30E-04	1.03E-03	3.48E-02
	Mink	1.23E-04	6.70E-04	1.75E-06	9.43E-04	5.31E-03	3.18E-04	4.53E-03	4.22E-07	6.90E-05	4.90E-04	1.24E-02
Background	Mallard	5.40E-05	2.08E-04	1.09E-04	9.38E-05	9.25E-04	5.62E-05	4.87E-03	6.61E-06	3.43E-05	1.12E-04	6.47E-03
	Scaup	3.52E-06	2.08E-04	7.05E-05	1.13E-04	9.52E-04	5.64E-05	1.80E-02	4.29E-06	3.43E-05	9.21E-05	1.96E-02
	Merganser	1.44E-04	2.16E-04	5.21E-04	1.46E-03	2.79E-03	6.33E-05	6.44E-02	3.17E-05	3.74E-05	3.27E-04	7.00E-02
	Muskrat	1.89E-03	4.17E-04	2.46E-04	5.08E-03	8.54E-03	1.27E-04	2.29E-03	1.50E-05	7.99E-05	2.39E-04	1.89E-02
	Mink	8.51E-05	4.13E-04	6.91E-06	3.44E-04	2.06E-03	1.12E-04	7.58E-03	4.22E-07	6.89E-05	1.14E-04	1.08E-02

Table 3.12: Radiation Doses to Generic Human at Six Lakes in the Serpent River Watershed

	Dose Component (mSv/a)					Dose Component (%)				
Location	Water	Fish	Moose	Mallard	Total	Water	Fish	Moose	Mallard	Total
Quirke Lake	4.38E-02	1.10E-02	1.70E-02	2.29E-01	3.01E-01	14.53%	3.64%	5.63%	76.19%	100.00%
Elliot Lake	2.34E-02	8.26E-03	7.28E-04	3.62E-03	3.60E-02	64.96%	22.96%	2.02%	10.05%	100.00%
Nordic Lake	2.44E-02	8.47E-03	5.65E-04	4.37E-03	3.78E-02	64.52%	22.41%	1.50%	11.58%	100.00%
McCabe Lake	2.95E-02	8.93E-03	3.91E-03	3.86E-02	8.09E-02	36.49%	11.04%	4.83%	47.65%	100.00%
May Lake	6.30E-02	1.20E-02	3.30E-03	3.74E-02	1.16E-01	54.48%	10.34%	2.86%	32.31%	100.00%
McCarthy Lake	2.02E-02	8.07E-03	9.70E-04	6.21E-03	3.55E-02	56.99%	22.76%	2.74%	17.51%	100.00%
Background	5.61E-03	1.98E-03	4.53E-04	4.72E-03	1.28E-02	43.98%	15.48%	3.55%	36.99%	100.00%

Table 3.13: Radiation Doses to Serpent River First Nations Harvester

	Dose Component (mSv/a)					Dose Component (%)				
Scenario	Water	Fish	Moose	Mallard	Total	Water	Fish	Moose	Mallard	Total
Actual Lake Use	1.67E-02	2.20E-02	1.56E-02	7.41E-03	6.17E-02	27.14%	35.59%	25.25%	12.02%	100.00%
Future Lake Use	1.76E-02	2.24E-02	1.42E-02	5.39E-03	5.97E-02	29.53%	37.61%	23.82%	9.04%	100.00%

Table 3.14: Comparison of EIS Dose Predictions for Riparian Wildlife Near McCabe Lake with Current Dose Estimates

Receptor	EIS Prediction [1]	Current Assessment [2]
Scaup	0.0025 mGy/d	0.069 mGy/d
Merganser	0.013 mGy/d	0.311 mGy/d
Mallard	0.05 mGy/d	0.047 mGy/d
Muskrat	0.38 mGy/d	0.112 mGy/d

[1] EIS prediction assumes biota resident on TMA; doses do not include a radiation quality factor, but are mainly from external sediment exposure; scaup and merganser exposures reduced by use of lower site and sediment occupancy factors relative to mallard

[2] for wildlife receptor as described in this report; doses corrected for background

Table 3.15: Comparison of EIS Dose Predictions for Humans at Selected Locations with Current Dose Estimates

Receptor	EIS Prediction [1]	Current Assessment [2]
Quirke Lake	0.079 mSv/a (no duck consumption)	0.288 mSv/a 0.064 mSv/a w/o ducks
McCabe Lake	0.121 mSv/a	0.068 mSv/a
May Lake	0.147 mSv/a	0.024 mSv/a
Elliot Lake	0.0131 mSv/a	0.023 mSv/a
Nordic Lake	0.0503 mSv/a	0.025 mSv/a
McCarthy Lake	0.0563 mSv/a	0.023 mSv/a

[1] from Senes (1995) (Quirke), CNSC (2002) (Nordic), Senes (1996) (others); pathways assumptions vary; doses are incremental

[2] for generic human receptor as described in this report; doses corrected for background

4.0 SUMMARY

A number of special investigation studies were undertaken in six lakes of the Serpent River Watershed in 2009, in order to clarify several issues pertinent to estimation of radiological dose and risk to natural biota and humans utilizing the watershed lakes. The six lakes studied were McCabe, May, Elliot, Nordic, Quirke and McCarthy Lake. The questions were resolved, as follows:

- Pb-210 and Po-210 are at secular equilibrium in the lake sediments, as would be expected from their half-lives. The average Po/Pb ratio in sediments was 1.01, with a range from 0.87 to 1.18, and no upstream-downstream pattern.

- Radionuclides of the Th-232 decay chain are clearly elevated above background in May and Quirke Lake sediments, although the Th-232 concentration is only about 1/10th of the Th-230 concentration. The contribution of the Th-232 decay chain to total dose was usually 10% or less, except for May Lake where 4 of 8 receptors had Th-232 decay chain contributions greater than 10%, and for aquatic plants where contributions exceeded 10% in most lakes and reached 25% in May Lake.

- Bioaccumulation factors (BAFs) derived from the flooded basins were generally similar to those derived from the watershed lakes for aquatic plants, although the U value was slightly lower in the basins, and the Pb value was slightly higher. Fish BAFs derived from the basins were consistently lower than those derived from the watershed lakes. Po-210 BAFs were not determined in either case due to non-detection of Po-210 in water; however, Po-210 in fish tissue was consistently higher than Pb-210, by a factor of 22 on average.

The high observed Po/Pb ratio in fish indicates that fish to duck transfer factors for Po-210, previously determined in the flooded basins using a Pb BAF to estimate Po-210 in fish, were most likely overestimated by at least a factor of 10. Correction for this error produces a transfer factor of 5.45 d/kg for fish-eating ducks, which is more in line with the Health Canada (2007) generic value of 2.5 for birds.

A survey of fish and wildlife consumption by SRFN fishers and hunters and their families (SRFN, 2010) produced more realistic values for fish and wildlife intake rates than those used previously, and also indicated the fraction of harvest likely to come from the six watershed lakes and from Lake Huron. These data were utilized, along with measured radionuclide concentrations in the six lakes and Lake Huron, to estimate the dose received by SRFN members.

4.1 Ecological Dose and Risk

The radionuclide concentrations from the special investigation studies were utilized to calculate radiation doses received by aquatic biota and riparian wildlife in the six watershed lakes. The calculated doses to fish, aquatic plants and benthos were well below the UNSCEAR (1996) benchmark dose of 10 mGy/d. The largest doses to aquatic biota occurred at Quirke Lake, where the doses to fish, aquatic plants and benthos were 0.92, 2.61 and 0.256 mGy/d, respectively. For all aquatic biota, the largest component of dose was internal. The largest contributor to dose was generally Po-210 for fish and benthic invertebrates, while the dose was more evenly distributed for aquatic macrophytes, with Ra-226 and short-lived radon daughters usually making the largest contribution.

The radiation doses to riparian wildlife were less than the UNSCEAR (1996) benchmark dose of 1 mGy/d. The largest doses to riparian wildlife occurred at Quirke Lake, where the doses to mallard, scaup, merganser, muskrat and mink, were 0.263, 0.094, 0.793, 0.407 and 0.124 mGy/d, respectively. For all riparian biota, the largest component of dose was usually internal. The largest contributor to dose was Po-210 for waterfowl, and Ra-226 with short-lived radon daughters for muskrat. For mink, one or the other of these contributors was predominant.

4.2 Human Dose and Risk

The radionuclide concentrations from the special investigation studies were utilized to calculate radiation doses received by generic human receptors at the six watershed lakes (receptor assumed to reside there and take all fish and game from there). The calculated doses ranged from 0.036 to 0.301 mSv/a, all less than the public dose limit of 1 mSv/a, before background correction. Background dose from the same pathways was estimated at 0.013 mSv/a. Therefore, incremental doses ranged from 0.023 to 0.288 mSv/a. The smallest doses were at McCarthy, Elliot and Nordic lakes, whereas the largest dose was at Quirke Lake. The dose at Quirke Lake was dominated by consumption of mallard ducks, and was driven by the high concentration of Po-210 in aquatic macrophytes at Quirke Lake.

Macrophytes were collected in Quirke Lake from a former tailings deposition area near Panel Mine and likely over-estimate typical macrophyte uptake within the lake. Moreover, cottage residents at Quirke Lake do not use the lake for duck hunting. The estimated dose at Quirke Lake without the waterfowl component is 0.072 mSv/a (total) or 0.064 mSv/a (incremental).

The calculated dose to a Serpent River First Nation member was based on realistic use of the six watershed lakes, and of Lake Huron, as determined from the survey of households (SRFN, 2010). Most of the harvest comes from Lake Huron. For an actual use scenario the dose was 0.062 mSv/a (total) or 0.049 mSv/a (incremental). For a future use scenario the dose was 0.060 mSv/a (total) or 0.047 mSv/a (incremental). All these doses are less than the public dose limit of 1 mSv/a (incremental). The use of Serpent Harbour water and sediment data to represent Lake Huron may overestimate the Lake Huron component of dose.

The contributions of water, fish, moose and waterfowl to the SRFN dose are approximately 28%, 37%, 25% and 10%, respectively, with slight variations between actual use and future use scenarios.

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APPENDIX A

Field Sheets

minnow environmental inc.

Special Investigation Fieldsheet

MINNOW ENVIRONMENTAL INCORPORATED

2 Lamb Street
Georgetown, Ontario L7G 3M9

Telephone: (905) 873 - 3371
Facsimilie: (905) 873 - 6370

Client: Rio Algom/Denison
Date/Time: Sept 14 & 16/2009
Lake: Elliot Lake
Northing: } see below
Easting:

Project Name/Number: SRWMP - 2308
Field Crew: CR/CS

submitted as

WATER
Water sample collected and preserved ☑

Northing: 5139752
Easting: 0372526
EL-SI
To be reported as EL-09 SI

SEDIMENT
Core / (Ponar)
Depth of sediment sampled: 2-3cm
Water depth(m): 1.5m
Northing: 5139752
Easting: 0372526
} EL-09-SI

FISH

Sample ID	# in Composite	Species in Composite	
EL-Fish-1	5	5 YP	EL-F1
EL-Fish # 2	4	4 YP	EL-F2
Fish 3	5	2 YP - 3 Pumpkin	EL-F3

Field collection sheets completed ❑

MACROPHYTES
Sample Area: Elliot Lake @ Inlets
Northing: 5139704
Easting: 0372538
} see & MT set 4 & 5 for all

Sample ID	Species	Structure Sampled	
EL-Pond Lily	Pond lilly	leaves & Stems	EL-09-E4
EL-Carex (1)	~~Carex~~ Arrum	seed Heads	EL-09-E5
EL-Sedge	Sedge	Roots	EL-09-E1
EL-Carex (2)	~~Carex~~ Arrum	leaves & stems	EL-09-E2
EL-Tape grass	Tape Grass	leaves	EL-09-E3

- saw cormorant (2), seagulls (+10), Canada geese (+10) and mergansers (6)

minnow environmental inc.	MINNOW ENVIRONMENTAL INCORPORATED	
Minnow Trapping	2 Lamb Street Georgetown, Ontario L7G 3M9	Telephone: (905) 873-3371 Facsimilie: (905) 873-6370

Client: Rio Dev Project Name/Number: 2308

Waterbody: Elliot Lake Field Crew: CR CS

SET # 1 # of TRAPS 2 UTM: 5139720N, 372538

Set Easting: 0823929.1 Northing: 4623565 Map Datum: 83

Set Depth Range: 0.7 to 0.7 m Location/Configuration Marked on Map: (YES) NO

General Observations: in grass

Set Date/Time: 840am Sept 14 Lift Date/Time: 6:18pm Sept 14

Total Fishing Time: 9.63 h

Fish Species	Number Caught	Number Sampled/ Retained	Number Released into Lake Pitama	Mortalities
Ø				

SET # 2 # of TRAPS 2 UTM: 5139600N 372494E

Set Easting: 0823931.0 Northing: 4623626 Map Datum: 83

Set Depth Range: 1.1 to 1.2 m Location/Configuration Marked on Map: (YES) NO

General Observations:

Set Date/Time: 850 am Sept 14 Lift Date/Time: Sept 14 615pm

Total Fishing Time: 9.42 h

Fish Species	Number Caught	Number Sampled/ Retained	Number Released Alive	Mortalities
YP	4	4	Ø	Ø

Signature:

minnow environmental inc. Minnow Trapping (con't)	MINNOW ENVIRONMENTAL INCORPORATED
	2 Lamb Street — Telephone: (905) 873-3771
	Georgetown, Ontario L7G 3M9 — Facsimilie: (905) 873-6370

Client: Rio / Den Project Name/Number: 2308
Waterbody: elliot Lake Field Crew: CR CS

SET # 3 # of TRAPS 2 UTM- 5138857N, 370356E
Set Easting: 082 41.623 Northing: 4623.271 Map Datum: 83
Set Depth Range: 1.2 to 1.2 m Location/Configuration Marked on Map: (YES) / NO
General Observations: lilly pads & grass some rocks
Set Date/Time: 1140am Sept 14 Lift Date/Time: 6:02pm Sept 14
Total Fishing Time: 6.37 h

Fish Species	Number Caught	Number Sampled/ Retained	~~Number Released into Lake Pitama~~	Mortalities
YP	1	1		

SET # ______ # of TRAPS ______
Set Easting: ______ Northing: ______ Map Datum: ______
Set Depth Range: ______ to ______ m Location/Configuration Marked on Map: YES / NO
General Observations: ______
Set Date/Time: ______ Lift Date/Time: ______
Total Fishing Time: ______ h

Fish Species	Number Caught	Number Sampled/ Retained	Number Released Alive	Mortalities

Signature: ______

minnow environmental inc.

Minnow Trapping (con't)

MINNOW ENVIRONMENTAL INCORPORATED

2 Lamb Street
Georgetown, Ontario L7G 3M9
Telephone: (905) 873-3771
Facsimilie: (905) 873-6370

Client: Rio/Den
Project Name/Number: 2308
Waterbody: Elliot Lake
Field Crew: CK CS

SET # ~~3~~ 4
# of TRAPS 2
Set Easting: 17T0372526 Northing: 5139752 Map Datum: ____
Set Depth Range: 0.7 to 0.7 m Location/Configuration Marked on Map: YES / NO (circled)
General Observations: weedy.
Set Date/Time: Sept 16 415pm Lift Date/Time: Sept 16 630pm
Total Fishing Time: 2.25 h

Fish Species	Number Caught	Number Sampled/ Retained	Number Released into Lake Pitama	Mortalities
Ø				

SET # 5
# of TRAPS 2
Set Easting: 17T0372538 Northing: 5139704 Map Datum: 83
Set Depth Range: 0.8 to 0.8 m Location/Configuration Marked on Map: YES / NO
General Observations: weeds
Set Date/Time: Sept 16 420pm Lift Date/Time: Sept 16 / 630pm
Total Fishing Time: 2.17 h

Fish Species	Number Caught	Number Sampled/ Retained	Number Released Alive	Mortalities
Ø				

Signature: ____________

minnow environmental inc. — Minnow Trapping	MINNOW ENVIRONMENTAL INCORPORATED
	2 Lamb Street · Georgetown, Ontario L7G 3M9 · Telephone: (905) 873-3371 · Facsimile: (905) 873-6370

Client: Rio / Pen Project Name/Number: 2308
Waterbody: Elliot L. Field Crew: ____

SET # 6 # of TRAPS ____
Set Easting: 17T 0372498 Northing: 5139604 Map Datum: 83
Set Depth Range: 1.3 to ____ m Location/Configuration Marked on Map: YES / NO (NO circled)
General Observations: ~~17T 0372498~~ near Park
Set Date/Time: Sept 16 4:25pm Lift Date/Time: Sept 16 6:28pm
Total Fishing Time: 2.05 h

Fish Species	Number Caught	Number Sampled/ Retained	Number Released into Lake Pitama	Mortalities
Pumpkinseed	III			
YP	~~IIII~~ I			

SET # ____ # of TRAPS ____
Set Easting: ____ Northing: ____ Map Datum: ____
Set Depth Range: ____ to ____ m Location/Configuration Marked on Map: YES / NO
General Observations: ____
Set Date/Time: ____ Lift Date/Time: ____
Total Fishing Time: ____ h

Fish Species	Number Caught	Number Sampled/ Retained	Number Released Alive	Mortalities

Signature: ____

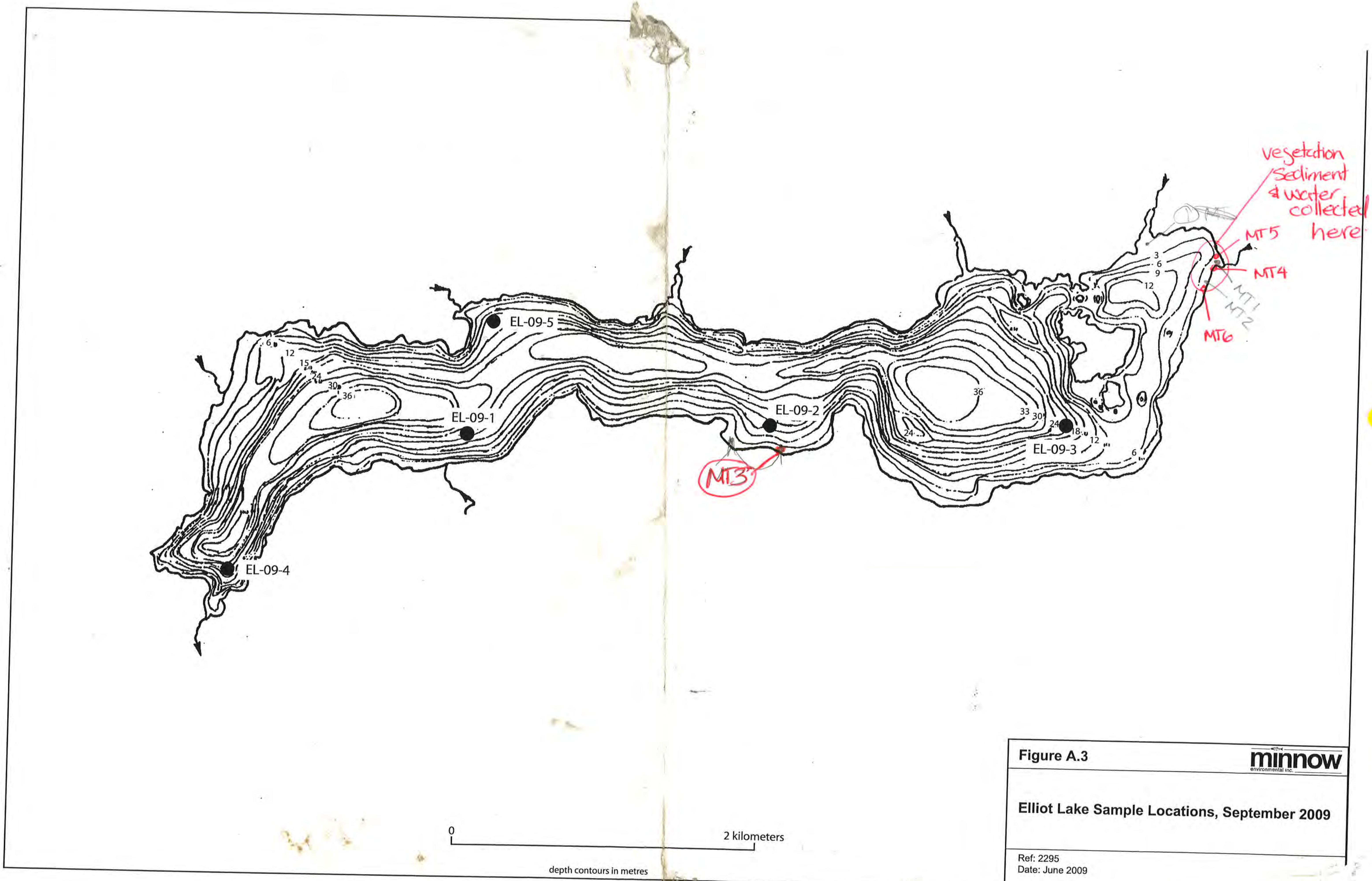


Figure A.3

minnow environmental inc.

Elliot Lake Sample Locations, September 2009

Ref: 2295
Date: June 2009

minnow environmental inc.

Special Investigation Fieldsheet

MINNOW ENVIRONMENTAL INCORPORATED

2 Lamb Street
Georgetown, Ontario L7G 3M9
Telephone: (905) 873 - 3371
Facsimilie: (905) 873 - 6370

Client: Rio Algom/Denison
Project Name/Number: SRWMP - 2308
Date/Time: SEPT 20
Field Crew: PL/CS
Lake: MAY
Northing: } see below
Easting:

NAD 83

WATER

Water sample collected and preserved ☑

Northing: 384 049
Easting: 5 143 150

→ taken @ sed, plants area

SEDIMENT

Core / Ponar
Water depth(m): 1.5
Depth of sediment sampled: ~ 6-7 cm (grab)
top 3 cm using ponar = sampled material
Northing: 384 092
Easting: 5 143 169

FISH all taken from MT3

Sample ID	# in Composite	Species in Composite
MAL-09-F1	10	Common shiner
MAL-09-F2	10	" "
MAL-09-F3	10	" "

Field collection sheets completed ☐

MACROPHYTES

Sample Area: ____________
Northing: 384 002
Easting: 5 143 124

Sample ID	Species	Structure Sampled
MAL-09-M1	Bullwort	stems/leaves
MAL-09-M2	Flat-leaf pondweed	" "
MAL-09-M3	White pond lily	" "
MAL-09-M4	soft-stem bulrush	roots
MAL-09-M5	Chara	leaves

8 common mergansers
1 Hooded mergansers
1 loon.

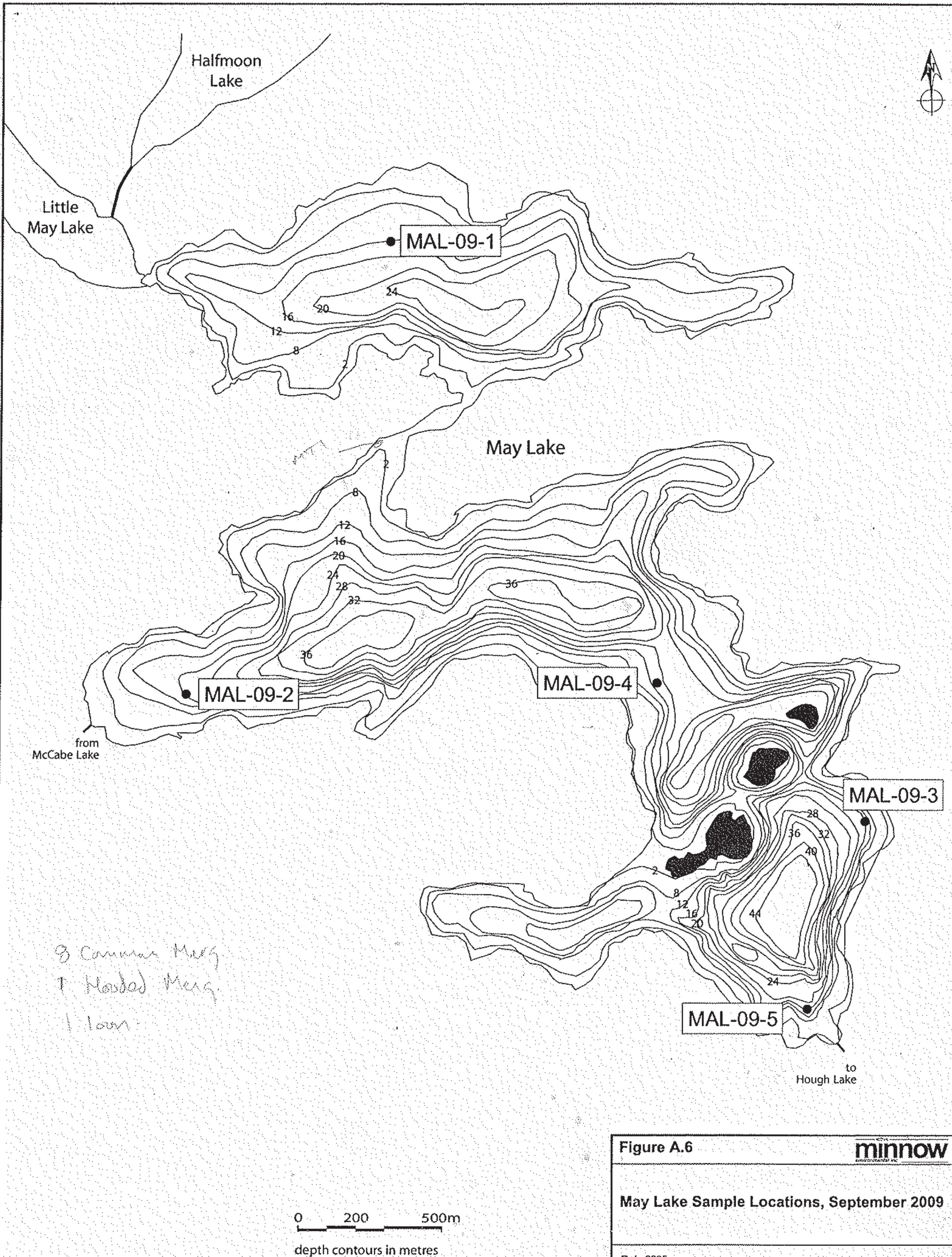


Figure A.6

minnow

May Lake Sample Locations, September 2009

Ref: 2295
Date: June 2009

minnow environmental inc.	**MINNOW ENVIRONMENTAL INCORPORATED**	
Minnow Trapping	2 Lamb Street Georgetown, Ontario L7G 3M9	Telephone: (905) 873-3371 Facsimilie: (905) 873-6370

Client: Rio / DENISON Project Name/Number: 2308

Waterbody: MAY LK Field Crew: PL / CS

SET # MT 1 # of TRAPS 2

Set Easting: 385 074 Northing: 5 144 194 Map Datum: NAD83

Set Depth Range: 0.4 to 0.6 m Location/Configuration Marked on Map: (YES) NO

General Observations: @ beaver lodge entrance

Set Date/Time: Sept 20/09 9:30 Lift Date/Time: Sept 20/09 17:35

Total Fishing Time: 8.08 h

Fish Species	Number Caught	Number Sampled/ Retained	Number Released ~~into Lake Pitama~~	Mortalities
Common Shiner	35+28+9+47+1 = (120)	Ø	120	
Creek Chub	16+8+2 (26)	Ø	26	
White Sucker	1+1 (2)	Ø	2	
NRBD	3+6+6 (15)	Ø	15	
BSB	1 (1)	Ø	1	

SET # MT 2 # of TRAPS 2

Set Easting: 386 259 Northing: 5 144 041 Map Datum: 83

Set Depth Range: 0.5 to ______ m Location/Configuration Marked on Map: YES / NO

General Observations: in weed, in shallow bay

Set Date/Time: Sept 20/9:45 Lift Date/Time: Sept 20 17:20

Total Fishing Time: 7.58 h

Fish Species	Number Caught	Number Sampled/ Retained	Number Released Alive	Mortalities
Creek Chub	13	Ø	13	—
Common Shiner	23	Ø	23	—

Signature: PL

minnow environmental inc.

Minnow Trapping (con't)

MINNOW ENVIRONMENTAL INCORPORATED

2 Lamb Street

Georgetown, Ontario L7G 3M9

Telephone: (905) 873-3771

Facsimilie: (905) 873-6370

Client: Richardson

Project Name/Number: 2308

Waterbody: MAY Lake

Field Crew: PL/CS

SET # MT 3. # of TRAPS 2

Set Easting: 385 969 Northing: 5144080 Map Datum: NAD 83

Set Depth Range: 0.3 to 0.7 m Location/Configuration Marked on Map: YES / NO

General Observations: @ beaver lodge

Set Date/Time: Sept 20 10:00 Lift Date/Time: Sept 20 17:15

Total Fishing Time: 7.25 h

Fish Species	Number Caught	Number Sampled/ Retained	Number Released into ~~Lake Pitama~~	Mortalities
Common Shiner	232+20= (252)	30	222	–
Lake Chub	1 + Ø = (1)	Ø	1	–
Creek Chub	1 +13 = (14)	Ø	14	–

SET # ______ # of TRAPS ______

Set Easting: ______ Northing: ______ Map Datum: ______

Set Depth Range: ______ to ______ m Location/Configuration Marked on Map: YES / NO

General Observations: ______

Set Date/Time: ______ Lift Date/Time: ______

Total Fishing Time: ______ h

Fish Species	Number Caught	Number Sampled/ Retained	Number Released Alive	Mortalities

Signature: [signature]

minnow environmental inc. Special Investigation Fieldsheet	MINNOW ENVIRONMENTAL INCORPORATED 2 Lamb Street — Telephone: (905) 873 - 3371 Georgetown, Ontario L7G 3M9 — Facsimilie: (905) 873 - 6370

Client: Rio Algom/Denison
Project Name/Number: SRWMP - 2308
Date/Time: Sept 18, 19, 26
Field Crew: KC/CR/CW
Lake: McCabe Lake
Northing: } see below
Easting:

WATER

Water sample collected and preserved ☑

Northing: 51 42 144
Easting: 03 79 486

SEDIMENT

Core / (Ponar) Water depth(m): 0.8m Northing: 514 3319
Depth of sediment sampled: top 2cm Easting: 0379965

FISH

Sample ID	# in Composite	Species in Composite
ML-F1	10 (23.41g)	Lake Chub*
ML-F2	12 (21.64g)	Norther R.B Dace
ML-F3	8 (23.92g)	Pumpkinseed

*note LC stomachs are full of cat food

Field collection sheets completed ❑

? also sampled in white sucker (10) see 2297 notes.

MACROPHYTES

Sample Area: ______ Northing: ______ Easting: ______ } see map attached.

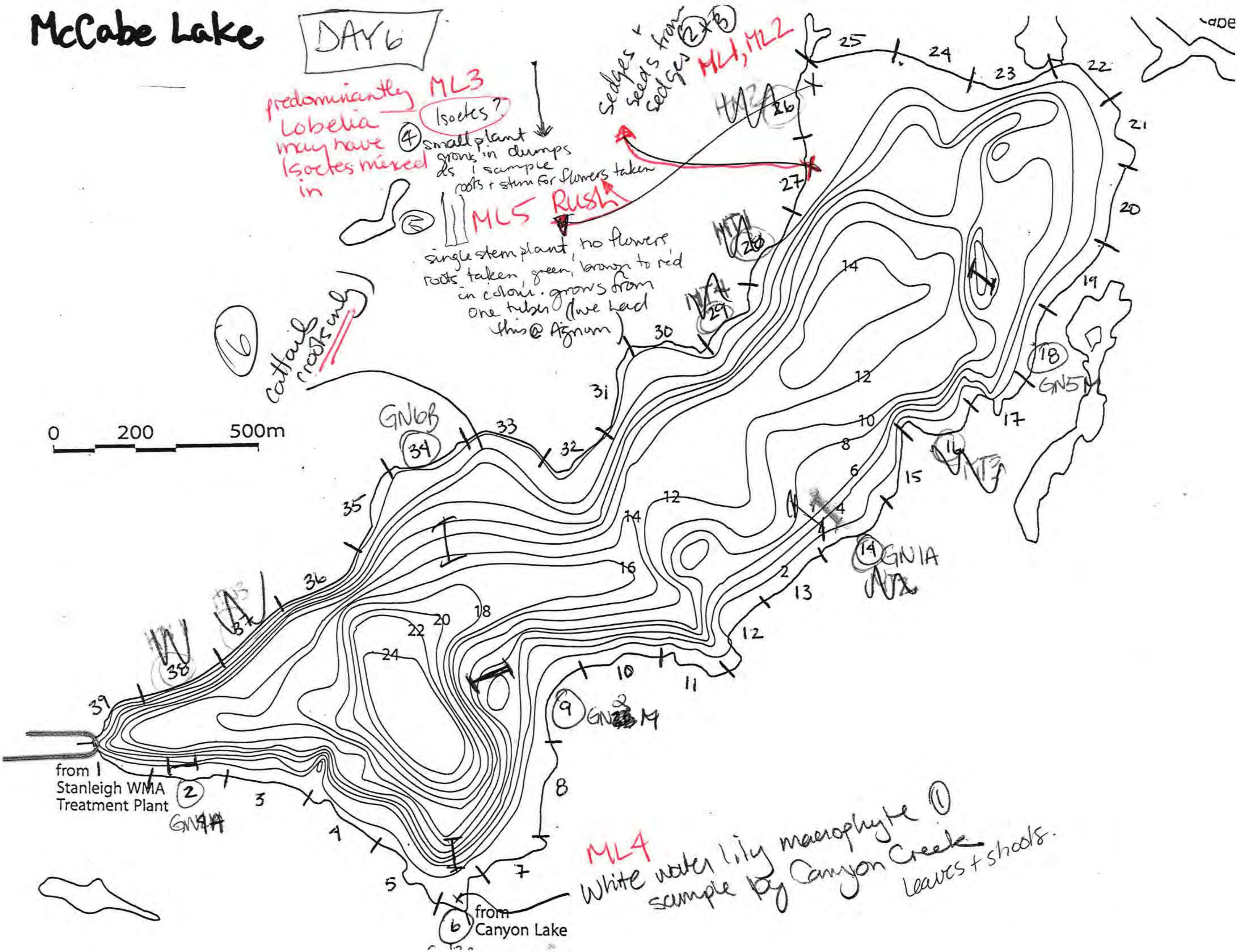
Sample ID	Species	Structure Sampled
ML-09-ML1	Sedge	Roots
ML-09 ML2	Sedge	Seeds
ML-09-ML3	Quilwort/Lobelia	whole plant
ML-09-ML4	White Water Lily	stems & leaves
ML-09-ML5	Rush	whole plant

I also sampled cattails for you - roots only

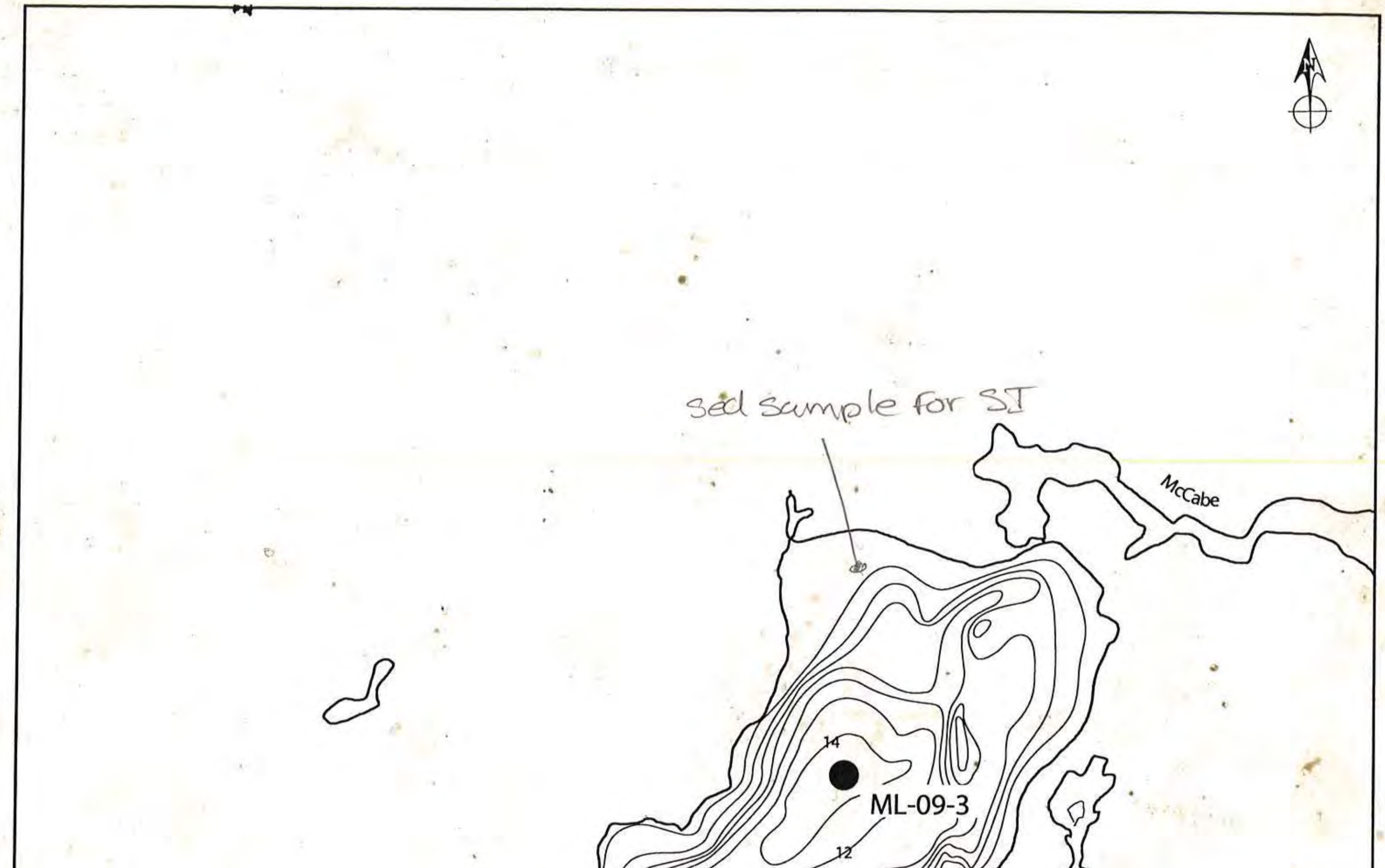
ML3 - sample is likely Lobelia sp may have quilwort → Isoetes sp. mixed in with it

- 10- seagulls
- 6-8 Common merganser ♀ (adult) plus juveniles

McCabe Lake



DAY 6
predominantly Lobelia may have Isoetes mixed in
ML3
Isoetes?
small plant grows in clumps
1 sample
roots + stem for flowers taken
ML5 RUSH
single stem plant, no flowers
roots taken green, brown to red in colour. grows from one tuber (we had this @ Agnew)
sedges + seeds from sedges 2×3
ML1, ML2
cattails rocks only
GN6B
GN5M
GN1A
0 200 500m
from Stanleigh WMA Treatment Plant
from Canyon Lake
ML4
White water lily macrophyte
sample by Canyon Creek
leaves + shoots.



- mergansers (4-5)
- sea gulls.
-

Figure A.7

minnow environmental inc.

McCabe Lake Sample Locations, September 2009

Ref: 2295
Date: June 2009

minnow environmental inc. Special Investigation Fieldsheet	MINNOW ENVIRONMENTAL INCORPORATED 2 Lamb Street Georgetown, Ontario L7G 3M9 Telephone: (905) 873 - 3371 Facsimilie: (905) 873 - 6370

Client: Rio Algom/Denison
Date/Time: Sept 20 & 22
Lake: McCarthy
Northing:
Easting:
} see below

Project Name/Number: SRWMP - 2308
Field Crew: PC/CS

WATER

Water sample collected and preserved ☑

Northing: 386108
Easting: 5131922
> MCL-09-SI

SEDIMENT

Core / Ponar
Water depth(m): 1.1
Depth of sediment sampled: top 3cm, grab up to 6cm

Northing: 385960
Easting: 5131376
> MCL-09-SI

FISH

Sample ID	# in Composite	Species in Composite
MCL-F1	5	Smallmouth bass
MCL-F2	20	Pumpkinseed
MCL-F3	8	Yellow Perch

Field collection sheets completed ☐

MACROPHYTES

Sample Area: Boat launch

	#2 (samples 4,5)	(samples 1-3)
Northing:	386108	385958
Easting:	5131922	5131381

Sample ID	Species	Structure Sampled
MCL-09-M1	white lily	leaf & stem
MCL-09-M2	tapegrass	"
MCL-09-M3	large leaf pondweed	leaf & stem
MCL-09-M4	burreed	"
MCL-09-M5	water shield	leaf & stem
MCL-09-M6	fern pondweed	" " "

Water Birds

14 Canadian geese
10 black mallards
1 Eagle
1 gull
1 loon
1 hoodie

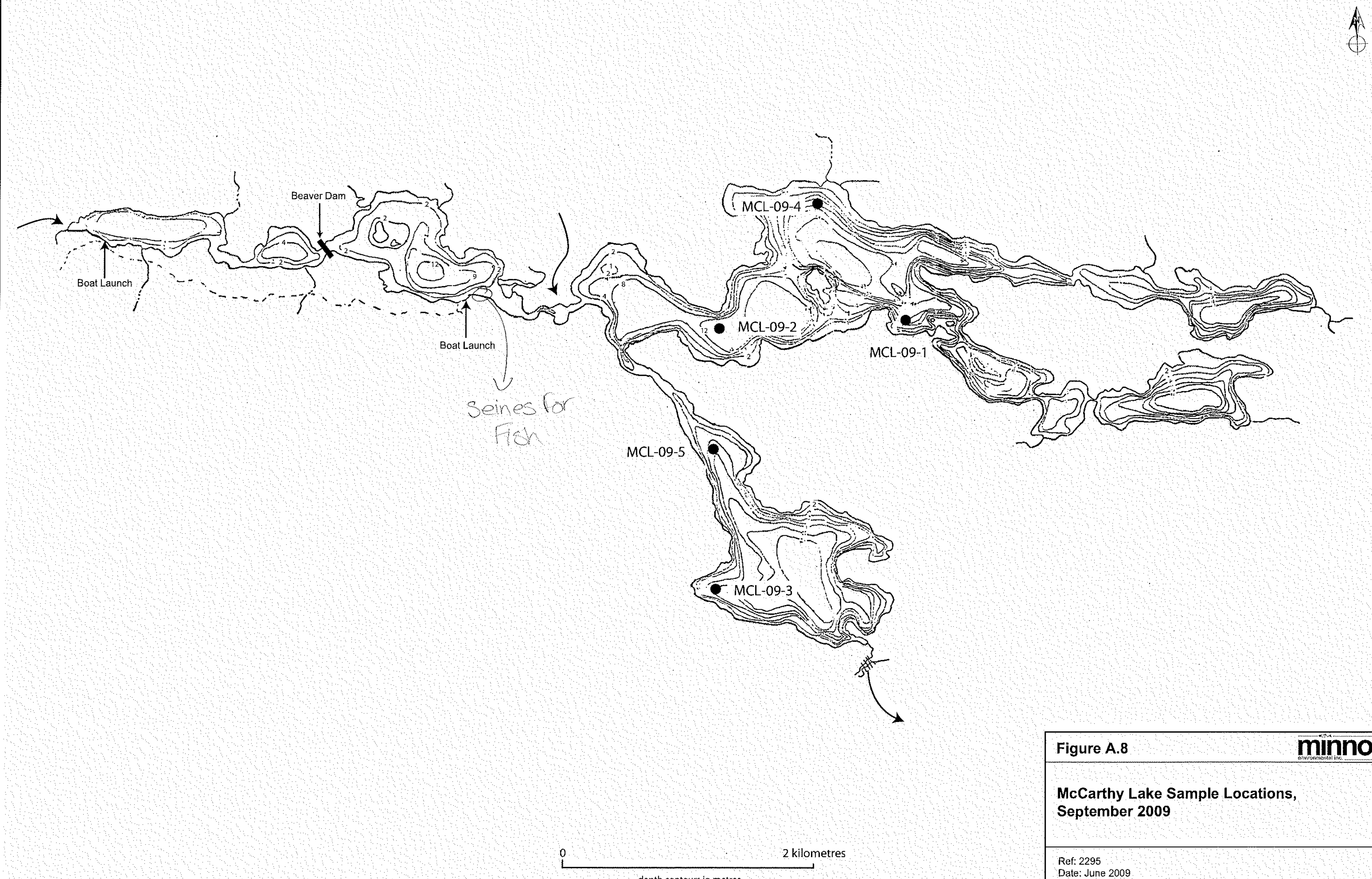


Figure A.8

McCarthy Lake Sample Locations, September 2009

Ref: 2295
Date: June 2009

minnow environmental inc.

MINNOW ENVIRONMENTAL INCORPORATED
2 Lamb Street
Georgetown, Ontario L7G 3M9
Telephone: (905) 873 - 3371
Facsimilie: (905) 873 - 6370

Special Investigation Fieldsheet

Client: Rio Algom/Denison
Project Name/Number: SRWMP - 2308
Date/Time: Sept 18/09
Field Crew: PL/CS
Lake: NORDIC
Northing: } see below
Easting:

WATER
Water sample collected and preserved ☒
Northing: same as macrophytes
Easting:

SEDIMENT
Core / Ponar
Water depth(m): 1.8 m
Northing: 376 229
Depth of sediment sampled: top 3 cm (grabs ~5 cm worth of material)
Easting: 5 135 853

Submitted as NL-09-SI

FISH

Sample ID	# in Composite	Species in Composite
NL 09 F1	6	Golden Shiner
NL 09 F2	6	Common Shiner
NL 09 F3	6	Golden Shiner

NL-F1
NL-F2
NL-F3

Field collection sheets completed ☒

MACROPHYTES
Sample Area: @ launch area
Northing: 0376211
Easting: 5135858

Sample ID	Species	Structure Sampled
NL-09-Pdw)	Floating lf Pdw)	leaf & stem
NL-09-Burreed	Burreed (stiff leaf)	seed head
NL-09-lily	white lily	leaf & stem
NL-09-Burreed lf	Burreed (soft leaf)	leaf & stem
NL 09-Calla	Calla	leaf & stem

Submitted as
NL-09-N1
NL-09-N2
NL-09-N3
NL-09-N4
NL-09-N5

12 cormorants
2 gulls

minnow environmental inc.

Seine Netting (con't)

MINNOW ENVIRONMENTAL INCORPORATED

2 Lamb Street
Georgetown, Ontario L7G 3M9

Telephone: (905) 873-3371
Facsimile: (905) 873-6370

Client: Rio/Denison
Project Name/Number: 2308
Waterbody: Nordic
Field Crew: PL/CS

HAUL # 1
Date/Time: Sept 18/09 ~17:20

Net Length/Height: 50' x 3'
Mesh Size(s): 1/8"
UTM Easting: 376 212
Northing: 5 135 878
Map Datum: NAD27

Seine net haul distance (m): ~50' loop from shore
Depth Range: 0.1 to 0.5 m
Location/Configuration Marked on Lake Map: YES (NO) at access area
Observations: through brush & lilies over hard silt substrate - visually ID'd fish before seine

Fish Species	Number Caught	Number Sampled	Number Released Alive	Mortalities
Common shiner	10	6	4	–
Golden shiner	14	12	2	–

HAUL # ______
Date/Time: ______

Net Length/Height: ______
Mesh Size(s): ______
UTM Easting: ______
Northing: ______
Map Datum: ______

Seine net haul distance (m): ______
Depth Range: ____ to ____ m
Location/Configuration Marked on Lake Map: YES NO
Observations: ______

Fish Species	Number Caught	Number Sampled	Number Released Alive	Mortalities

Signature: PL

minnow environmental inc. Minnow Trapping	MINNOW ENVIRONMENTAL INCORPORATED 2 Lamb Street Telephone: (905) 873-3371 Georgetown, Ontario L7G 3M9 Facsimilie: (905) 873-6370

Client: Rio/Denison Project Name/Number: 2308
Waterbody: Nordic Field Crew: PL/CS

SET # NL-1 # of TRAPS 2
Set Easting: 0376232 Northing: 5135884 Map Datum: 27 NAD
Set Depth Range: 0.5 to ____ m Location/Configuration Marked on Map: YES / NO
General Observations: near access, shallow inlet next to burreed
Set Date/Time: Sept 18 8:35 Lift Date/Time: Sept 18 16:45
Total Fishing Time: 8.17 h

Fish Species	Number Caught	Number Sampled/ Retained	Number Released into Lake Pitama	Mortalities
NO CATCH				

SET # NL-2 # of TRAPS 2
Set Easting: 376176 Northing: 5135217 Map Datum: NAD 27
Set Depth Range: 0.4 to ____ m Location/Configuration Marked on Map: YES / NO
General Observations: next to bullrush, rocky shore
Set Date/Time: Sept 18 8:45 Lift Date/Time: Sept 18 16:45
Total Fishing Time: 8.00 h

Fish Species	Number Caught	Number Sampled/ Retained	Number Released Alive	Mortalities
NO	CATCH			

Signature: PL

minnow environmental inc.

Minnow Trapping (con't)

MINNOW ENVIRONMENTAL INCORPORATED

2 Lamb Street
Georgetown, Ontario L7G 3M9
Telephone: (905) 873-3771
Facsimilie: (905) 873-6370

Client: Rio / Denison
Waterbody: Nordic
Project Name/Number: 2308
Field Crew: PL / CS

SET # MT-3 # of TRAPS 2
Set Easting: 376 584 Northing: 5 135 217 Map Datum: NAD 27
Set Depth Range: 0.6 to ____ m Location/Configuration Marked on Map: YES / NO
General Observations: in lilies next to bulrush
Set Date/Time: Sept 18 8:55 Lift Date/Time: Sept 18 16:45
Total Fishing Time: 7.83 h

Fish Species	Number Caught	Number Sampled/ Retained	Number Released into Lake Pitama	Mortalities
		No catch		

SET # ____ # of TRAPS ____
Set Easting: ____ Northing: ____ Map Datum: ____
Set Depth Range: ____ to ____ m Location/Configuration Marked on Map: YES / NO
General Observations: ____
Set Date/Time: ____ Lift Date/Time: ____
Total Fishing Time: ____ h

Fish Species	Number Caught	Number Sampled/ Retained	Number Released Alive	Mortalities

Signature: [signature]

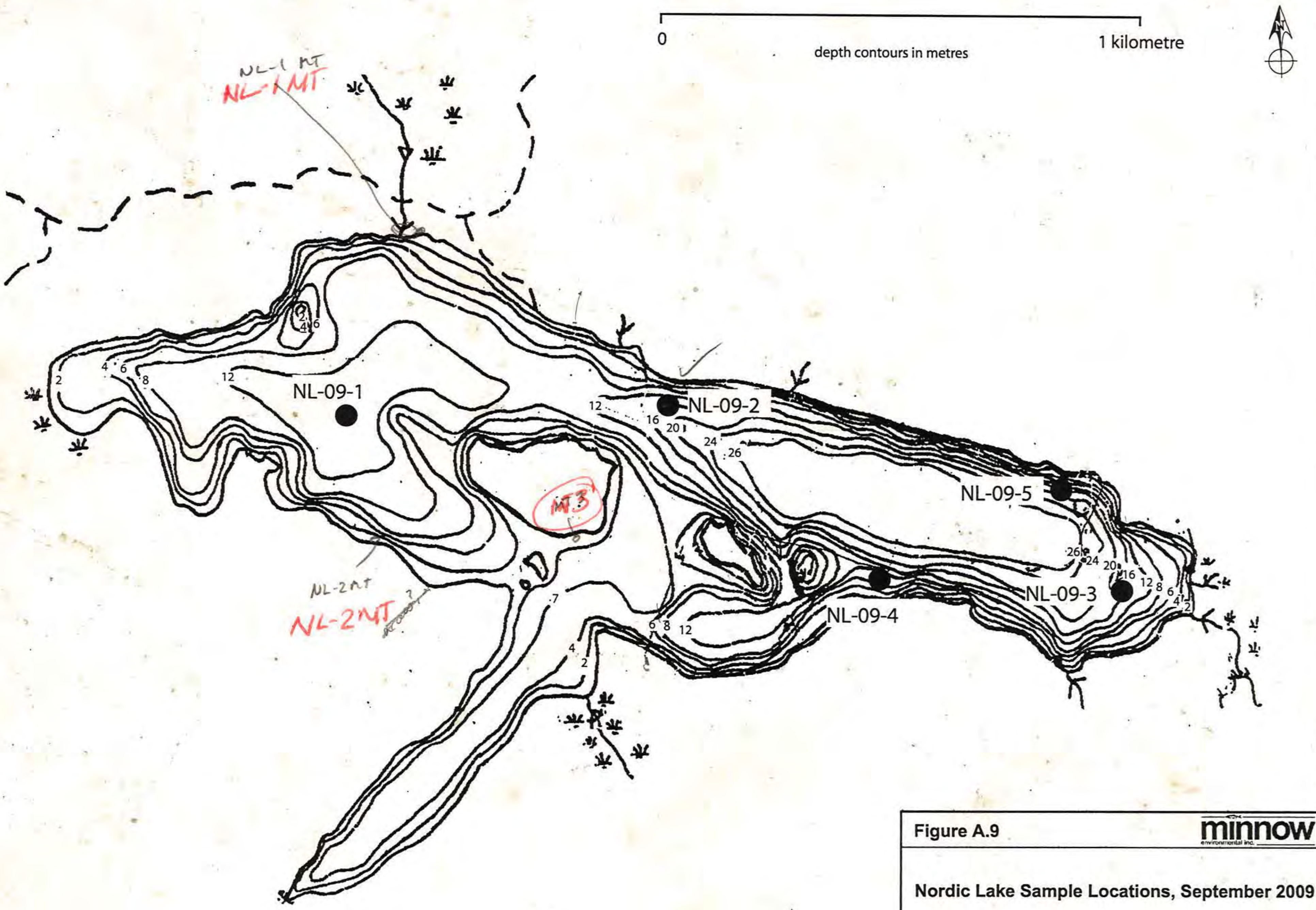


Figure A.9	minnow environmental inc.
Nordic Lake Sample Locations, September 2009	
Ref: 2295 Date: June 2009	

minnow environmental inc. **Special Investigation Fieldsheet**	**MINNOW ENVIRONMENTAL INCORPORATED** 2 Lamb Street — Telephone: (905) 873 - 3371 Georgetown, Ontario L7G 3M9 — Facsimilie: (905) 873 - 6370

Client: Rio Algom/Denison
Date/Time: Sept 20 -
Lake: Quirke Lake
Northing:
Easting:

Project Name/Number: SRWMP - 2308
Field Crew: CR ML

WATER
Water sample collected and preserved ☑

Northing: 5150766
Easting: 0380676

Submitted as QL-SI-1
report as QL-09-SI

SEDIMENT
Core / (Ponar)
Depth of sediment sampled: 3-5cm
Water depth(m): 1m

Northing: 5150768
Easting: 0380613
> QL-09-SI

FISH

Sample ID	# in Composite	Species in Composite
QL-Fish1	~15	Common Shinner
QL-Fish2	~25	Mimic Shinner
QL-Fish3	~25	Mimic Shinner

> QL-F1
QL-F2
- QL-F3

Field collection sheets completed ☑

MACROPHYTES
Sample Area: Quirke near Panel mill
Northing: 5150768
Easting: 0380613

	Sample ID	Species	Structure Sampled	
QL-09-01	QL-09-01	Pond lilly / Arrowhead	leaves & Stems	— collected at inlet to Quirke
QL-09-02	QL-09-02	Broadleafs	leaves/stems, roots	
QL-09-03	QL-09-03	Floating Pondweed	leaves, stems, seeds	— " "
QL-09-04	QL-09-04	Cattails	Roots	

Plants, Fish, most Sed & water taken at small wetland to west of old Panel mill site - Seds stained Orange.

→ Saw common merganser & seagulls
1 adult ♀ + 5 juv in inlet of SR.

minnow environmental inc.

Minnow Trapping

MINNOW ENVIRONMENTAL INCORPORATED

2 Lamb Street
Georgetown, Ontario L7G 3M9
Telephone: (905) 873-3371
Facsimilie: (905) 873-6370

Client: Rio/Den
Waterbody: Quirke Lake
Project Name/Number: 2308
Field Crew: CB/MT

SET # 1
# of TRAPS 2
Set Easting: 380964
Northing: 5150926
Map Datum: 83
Set Depth Range: 1 to 1 m
Location/Configuration Marked on Map: YES / NO (circled: NO)
General Observations: rocks & weeds
Set Date/Time: Sept 22 840 am
Lift Date/Time: Sept 22 530pm
Total Fishing Time: 8.83 h

Fish Species	Number Caught	Number Sampled/ Retained	Number Released into Lake Pitama	Mortalities
Ø				

SET # 2
# of TRAPS 2
Set Easting: 0380613
Northing: 5150768
Map Datum: 83
Set Depth Range: 0.6 to 0.8 m
Location/Configuration Marked on Map: YES / NO (circled: NO)
General Observations: Cattails & Rocks
Set Date/Time: Sept 22. 850am
Lift Date/Time: Sept 22 510 pm
Total Fishing Time: 8.67 h

Fish Species	Number Caught	Number Sampled/ Retained	Number Released Alive	Mortalities
R.B	2	2	Ø	
~~Golden~~ Common Shiner	~~HHH~~ HHH HHH HHH			
mimic shiner	16, 11, 21, 5			

Signature: ______________________

minnow environmental inc. — Minnow Trapping (con't)	MINNOW ENVIRONMENTAL INCORPORATED 2 Lamb Street — Telephone: (905) 873-3771 Georgetown, Ontario L7G 3M9 — Facsimilie: (905) 873-6370

Client: Rio/Den Project Name/Number: 2308
Waterbody: Quirke Field Crew: CR ML

SET # 3 **# of TRAPS** 2
Set Easting: 0380564 Northing: 5150756 Map Datum: 83
Set Depth Range: 0.8 to 0.8 m Location/Configuration Marked on Map: YES / NO
General Observations:
Set Date/Time: Sept 22/ 9am Lift Date/Time: Sept 22/ 5pm
Total Fishing Time: 8.00 h

Fish Species	Number Caught	Number Sampled/ Retained	~~Number Released into Lake Pitama~~	Mortalities
Mimic shiner	2	2	Ø	Ø

SET # ______ **# of TRAPS** ______
Set Easting: ______ Northing: ______ Map Datum: ______
Set Depth Range: ______ to ______ m Location/Configuration Marked on Map: YES / NO
General Observations:
Set Date/Time: ______ Lift Date/Time: ______
Total Fishing Time: ______ h

Fish Species	Number Caught	Number Sampled/ Retained	Number Released Alive	Mortalities

Signature: ______

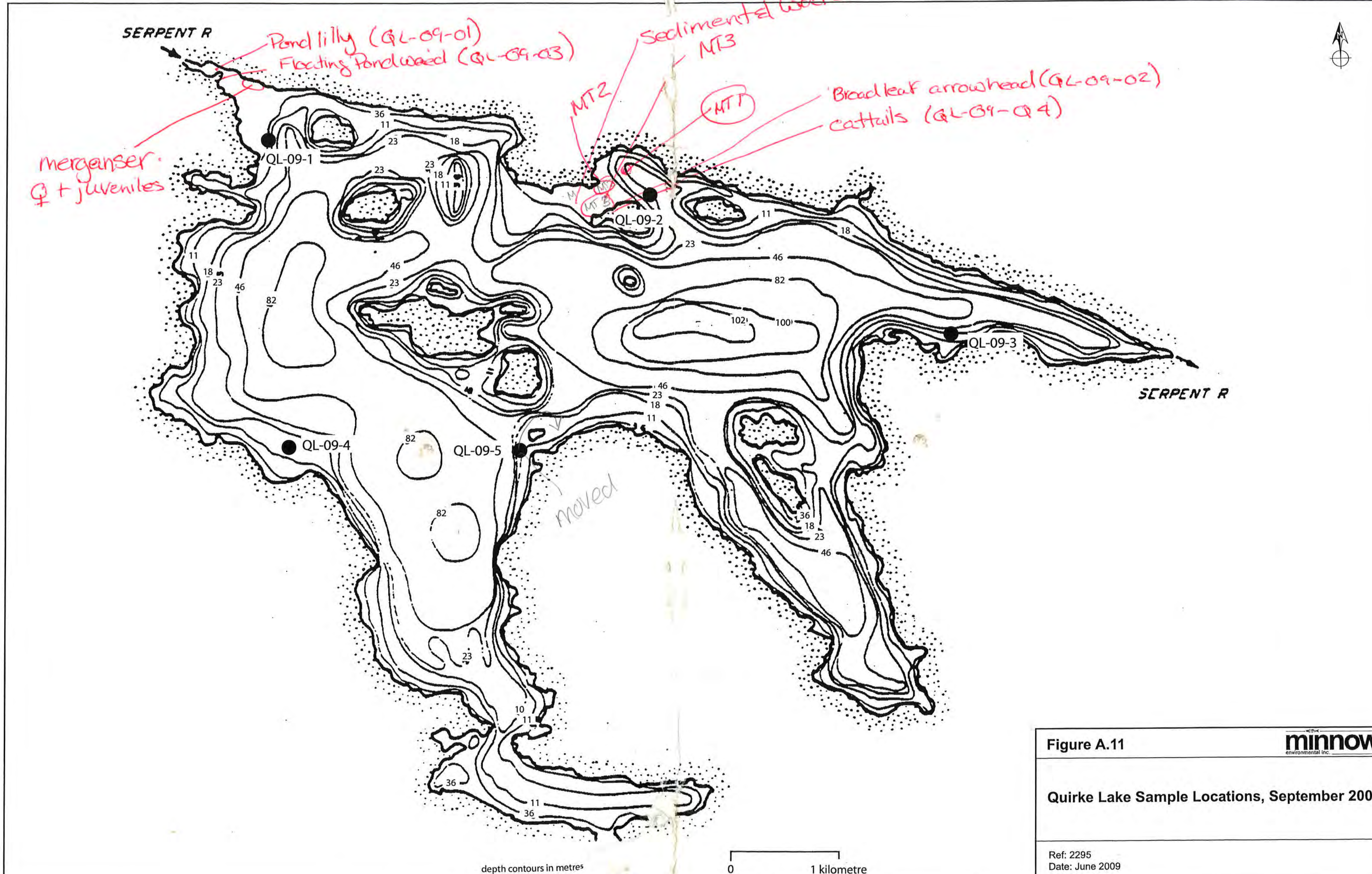


Figure A.11

minnow environmental inc.

Quirke Lake Sample Locations, September 2009

Ref: 2295
Date: June 2009

APPENDIX B

Radionuclide Analysis Results

ANALYSIS REPORT

Becquerel Laboratories Inc.
6790 Kitimat Rd., Unit 4
Mississauga, Ontario
Canada, L5N 5L9

Phone: (905) 826-3080
FAX: (905) 826-4151

Batch: T09-01349.0

Date: 04-Nov-2009

Minnow Environmental

2 Lamb St
Georgetown, ON, L7G 3M9

attn: Cynthia Russel

Phone: (905) 873-3371
FAX: (905) 567-6805

Client Ref.2308

6 water samples   Received: 30-Sep-2009

Results of Analysis

Sample	Test		Result	Std Dev	Units	Date	Method
MAL-09-SI	Pb-210	<	0.02		Bq/l	16-Oct-2009	GFPC
MCL-09-SI	Pb-210		0.03	0.01	Bq/l	14-Oct-2009	GFPC
QL-09-SI	Pb-210		0.06	0.01	Bq/l	14-Oct-2009	GFPC
NL-09-ST	Pb-210		0.03	0.01	Bq/l	14-Oct-2009	GFPC
EL-09-SI	Pb-210		0.03	0.01	Bq/l	14-Oct-2009	GFPC
ML-09-SI	Pb-210		0.03	0.01	Bq/l	14-Oct-2009	GFPC
MAL-09-SI	Po-210	<	0.01		Bq/l	08-Oct-2009	ALPHA
MCL-09-SI	Po-210	<	0.01		Bq/l	08-Oct-2009	ALPHA
QL-09-SI	Po-210	<	0.01		Bq/l	08-Oct-2009	ALPHA
NL-09-ST	Po-210	<	0.01		Bq/l	08-Oct-2009	ALPHA
EL-09-SI	Po-210	<	0.01		Bq/l	08-Oct-2009	ALPHA
ML-09-SI	Po-210	<	0.01		Bq/l	08-Oct-2009	ALPHA
MAL-09-SI	Ra-226		0.05	0.01	Bq/l	10-Oct-2009	ALPHA
MCL-09-SI	Ra-226	<	0.01		Bq/l	10-Oct-2009	ALPHA
QL-09-SI	Ra-226		0.05	0.01	Bq/l	10-Oct-2009	ALPHA
NL-09-ST	Ra-226		0.03	0.01	Bq/l	10-Oct-2009	ALPHA
EL-09-SI	Ra-226	<	0.01		Bq/l	10-Oct-2009	ALPHA
ML-09-SI	Ra-226		0.06	0.01	Bq/l	10-Oct-2009	ALPHA
MAL-09-SI	Ra-228	<	0.1		Bq/l	16-Oct-2009	GAMMA
MCL-09-SI	Ra-228	<	0.1		Bq/l	20-Oct-2009	GAMMA
QL-09-SI	Ra-228	<	0.1		Bq/l	22-Oct-2009	GAMMA
NL-09-ST	Ra-228	<	0.1		Bq/l	02-Nov-2009	GAMMA
EL-09-SI	Ra-228	<	0.1		Bq/l	24-Oct-2009	GAMMA
ML-09-SI	Ra-228	<	0.1		Bq/l	26-Oct-2009	GAMMA

ANALYSIS REPORT

Becquerel Laboratories Inc.
6790 Kitimat Rd., Unit 4
Mississauga, Ontario
Canada, L5N 5L9

Phone: (905) 826-3080
FAX: (905) 826-4151

Batch: T09-01349.0

Date: 04-Nov-2009

Results of Analysis

Sample	Test		Result	Std Dev	Units	Date	Method
MAL-09-SI	Th-228	<	0.01		Bq/l	07-Oct-2009	ALPHA
MCL-09-SI	Th-228	<	0.01		Bq/l	07-Oct-2009	ALPHA
QL-09-SI	Th-228	<	0.01		Bq/l	07-Oct-2009	ALPHA
NL-09-ST	Th-228	<	0.01		Bq/l	07-Oct-2009	ALPHA
EL-09-SI	Th-228	<	0.01		Bq/l	07-Oct-2009	ALPHA
ML-09-SI	Th-228	<	0.01		Bq/l	07-Oct-2009	ALPHA
MAL-09-SI	Th-230	<	0.01		Bq/l	07-Oct-2009	ALPHA
MCL-09-SI	Th-230	<	0.01		Bq/l	07-Oct-2009	ALPHA
QL-09-SI	Th-230	<	0.01		Bq/l	07-Oct-2009	ALPHA
NL-09-ST	Th-230	<	0.01		Bq/l	07-Oct-2009	ALPHA
EL-09-SI	Th-230	<	0.01		Bq/l	07-Oct-2009	ALPHA
ML-09-SI	Th-230	<	0.01		Bq/l	07-Oct-2009	ALPHA
MAL-09-SI	Th-232	<	0.01		Bq/l	07-Oct-2009	ALPHA
MCL-09-SI	Th-232	<	0.01		Bq/l	07-Oct-2009	ALPHA
QL-09-SI	Th-232	<	0.01		Bq/l	07-Oct-2009	ALPHA
NL-09-ST	Th-232	<	0.01		Bq/l	07-Oct-2009	ALPHA
EL-09-SI	Th-232	<	0.01		Bq/l	07-Oct-2009	ALPHA
ML-09-SI	Th-232	<	0.01		Bq/l	07-Oct-2009	ALPHA
MAL-09-SI	Uranium		1.5	0.2	ppb	02-Nov-2009	NAA
MCL-09-SI	Uranium		0.5	0.2	ppb	02-Nov-2009	NAA
QL-09-SI	Uranium		2.6	0.2	ppb	02-Nov-2009	NAA
NL-09-ST	Uranium		1.6	0.3	ppb	02-Nov-2009	NAA
EL-09-SI	Uranium		1.7	0.3	ppb	02-Nov-2009	NAA
ML-09-SI	Uranium		1.2	0.3	ppb	02-Nov-2009	NAA

ANALYSIS REPORT

Becquerel Laboratories Inc.
6790 Kitimat Rd., Unit 4
Mississauga, Ontario
Canada, L5N 5L9

Phone: (905) 826-3080
FAX: (905) 826-4151

Batch: T09-01349.0

Date: 04-Nov-2009

Methods:	ALPHA	BQ-RAD-ALPHA	alpha-particle spectrometry
	GFPC	BQ-RAD-GFPC	gas-flow proportional counting
	GAMMA	BQ-RAD-GAMMA	gamma-ray spectrometry
	NAA	BQ-NAA-1	neutron activation analysis

Units:	Bq/l	Becquerels per litre
	ppb	micrograms per litre

These results relate only to the samples analysed and only to the items tested.

04-Nov-2009 approved by: ______________________________
Donald D. Burgess PhD
Senior Scientist, Division Supervisor

QUALITY REPORT

Becquerel Laboratories Inc.
6790 Kitimat Rd., Unit 4
Mississauga, Ontario
Canada, L5N 5L9

Phone: (905) 826-3080
FAX: (905) 826-4151

Batch: T09-01349.0

Date: 04-Nov-2009

Standards

Standard	Analyte	Units	Result	Expected Result
TH230.11	Th-230	Bq/l	0.94	0.85
RA226.29	Ra-226	Bq/l	1.03	0.92
PB210.09	Pb-210	Bq/l	0.86	0.80
DH1-A	Ra-228	Bq/g	3.49	3.69
PB210.09	Po-210	Bq/l	0.71	0.89
U standard	Uranium	ppb	238	300

Blanks

Analyte	Units	Result
Th-232	Bq/l	< 0.01
Th-230	Bq/l	< 0.01
Th-228	Bq/l	< 0.02
Po-210	Bq/l	< 0.01
Ra-226	Bq/l	< 0.01
Pb-210	Bq/l	< 0.03
Ra-228	Bq/l	< 0.3

Duplicates

Analyte	Units	Result	Duplicate
Ra-226	Bq/l	0.15	0.16
Ra-228	Bq/l		ISS
Pb-210	Bq/l		ISS
Po-210	Bq/l		ISS
Th-230	Bq/l		ISS
Uranium	ppb		ISS

ISS insufficient sample

ANALYSIS REPORT

Becquerel Laboratories Inc.
6790 Kitimat Rd., Unit 4
Mississauga, Ontario
Canada, L5N 5L9

Phone: (905) 826-3080
FAX: (905) 826-4151

Batch: T09-01352.0

Date: 09-Nov-2009

Minnow Environmental

2 Lamb St
Georgetown, ON, L7G 3M9

attn: Cynthia Russel

Phone: (905) 873-3371
FAX: (905) 567-6805

Client Ref.2308

6 sed/soil samples

Received: 30-Sep-2009

Results of Analysis

Sample	Test		Result	Std Dev	Units	Date	Method
QL-09-SI	Pb-210		2.3	0.1	Bq/g	02-Nov-2009	GFPC
NL-09-SI	Pb-210		0.31	0.02	Bq/g	02-Nov-2009	GFPC
MCL-09-SI	Pb-210		0.49	0.03	Bq/g	02-Nov-2009	GFPC
MAL-09-SI	Pb-210		0.66	0.04	Bq/g	02-Nov-2009	GFPC
EL-09-SI	Pb-210		0.76	0.03	Bq/g	02-Nov-2009	GFPC
ML-09-SI	Pb-210		2.5	0.1	Bq/g	02-Nov-2009	GFPC
QL-09-SI	Po-210		2.6	0.1	Bq/g	27-Oct-2009	ALPHA
NL-09-SI	Po-210		0.27	0.02	Bq/g	27-Oct-2009	ALPHA
MCL-09-SI	Po-210		0.45	0.03	Bq/g	27-Oct-2009	ALPHA
MAL-09-SI	Po-210		0.78	0.04	Bq/g	27-Oct-2009	ALPHA
EL-09-SI	Po-210		0.74	0.03	Bq/g	27-Oct-2009	ALPHA
ML-09-SI	Po-210		2.4	0.1	Bq/g	28-Oct-2009	ALPHA
QL-09-SI	Ra-226		2.2	0.1	Bq/g	03-Nov-2009	ALPHA
NL-09-SI	Ra-226		0.37	0.02	Bq/g	03-Nov-2009	ALPHA
MCL-09-SI	Ra-226		0.44	0.02	Bq/g	03-Nov-2009	ALPHA
MAL-09-SI	Ra-226		0.22	0.01	Bq/g	03-Nov-2009	ALPHA
EL-09-SI	Ra-226		0.63	0.03	Bq/g	03-Nov-2009	ALPHA
ML-09-SI	Ra-226		2.0	0.1	Bq/g	03-Nov-2009	ALPHA
QL-09-SI	Ra-228		0.35	0.04	Bq/g	23-Oct-2009	GAMMA
NL-09-SI	Ra-228	<	0.1		Bq/g	23-Oct-2009	GAMMA
MCL-09-SI	Ra-228	<	0.1		Bq/g	24-Oct-2009	GAMMA
MAL-09-SI	Ra-228		0.5	0.1	Bq/g	24-Oct-2009	GAMMA
EL-09-SI	Ra-228	<	0.1		Bq/g	24-Oct-2009	GAMMA
ML-09-SI	Ra-228	<	0.1		Bq/g	24-Oct-2009	GAMMA

ANALYSIS REPORT

Becquerel Laboratories Inc.
6790 Kitimat Rd., Unit 4
Mississauga, Ontario
Canada, L5N 5L9

Phone: (905) 826-3080
FAX: (905) 826-4151

Batch: T09-01352.0

Date: 09-Nov-2009

Results of Analysis

Sample	Test	Result	Std Dev	Units	Date	Method
QL-09-SI	Th-228	0.37	0.05	Bq/g	03-Nov-2009	ALPHA
NL-09-SI	Th-228	0.06	0.01	Bq/g	03-Nov-2009	ALPHA
MCL-09-SI	Th-228	0.06	0.01	Bq/g	03-Nov-2009	ALPHA
MAL-09-SI	Th-228	0.66	0.03	Bq/g	03-Nov-2009	ALPHA
EL-09-SI	Th-228	0.17	0.02	Bq/g	03-Nov-2009	ALPHA
ML-09-SI	Th-228	0.08	0.01	Bq/g	03-Nov-2009	ALPHA
QL-09-SI	Th-230	2.7	0.3	Bq/g	03-Nov-2009	ALPHA
NL-09-SI	Th-230	0.05	0.01	Bq/g	03-Nov-2009	ALPHA
MCL-09-SI	Th-230	0.05	0.01	Bq/g	03-Nov-2009	ALPHA
MAL-09-SI	Th-230	5.1	0.2	Bq/g	03-Nov-2009	ALPHA
EL-09-SI	Th-230	1.04	0.08	Bq/g	03-Nov-2009	ALPHA
ML-09-SI	Th-230	0.43	0.04	Bq/g	03-Nov-2009	ALPHA
QL-09-SI	Th-232	0.26	0.04	Bq/g	03-Nov-2009	ALPHA
NL-09-SI	Th-232	0.02	0.01	Bq/g	03-Nov-2009	ALPHA
MCL-09-SI	Th-232	0.014	0.004	Bq/g	03-Nov-2009	ALPHA
MAL-09-SI	Th-232	0.78	0.04	Bq/g	03-Nov-2009	ALPHA
EL-09-SI	Th-232	0.08	0.01	Bq/g	03-Nov-2009	ALPHA
ML-09-SI	Th-232	0.04	0.01	Bq/g	03-Nov-2009	ALPHA
QL-09-SI	Uranium	89	3	ppm	20-Nov-2009	NAA
NL-09-SI	Uranium	16	1	ppm	20-Nov-2009	NAA
MCL-09-SI	Uranium	26	1	ppm	20-Nov-2009	NAA
MAL-09-SI	Uranium	16	1	ppm	20-Nov-2009	NAA
EL-09-SI	Uranium	135	4	ppm	20-Nov-2009	NAA
ML-09-SI	Uranium	30	1	ppm	20-Nov-2009	NAA

ANALYSIS REPORT

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Batch: T09-01352.0

Date: 09-Nov-2009

Methods:	ALPHA	BQ-RAD-ALPHA	alpha-particle spectrometry
	GAMMA	BQ-RAD-GAMMA	gamma-ray spectrometry
	GFPC	BQ-RAD-GFPC	gas-flow proportional counting
	NAA	BQ-NAA-1	neutron activation analysis

Units:	Bq/g	Becquerels per gram
	ppm	micrograms per gram

These results relate only to the samples analysed and only to the items tested.
Ra-228 was estimated from Ac-228.

06-Nov-2009 approved by: ______________________________
Donald D. Burgess PhD
Senior Scientist, Division Supervisor

Becquerel LABORATORIES

QUALITY REPORT

Becquerel Laboratories Inc.
6790 Kitimat Rd., Unit 4
Mississauga, Ontario
Canada, L5N 5L9

Phone: (905) 826-3080
FAX: (905) 826-4151

Batch: T09-01352.0

Date: 09-Nov-2009

Standards

Standard	Analyte	Units	Result	Expected Result
DL1-A	Ra-226	Bq/g	1.26	1.30
DL1-A	Th-230	Bq/g	0.033	1.40
DL1-A	Pb-210	Bq/g	1.52	1.40
DL1-A	Po-210	Bq/g	1.27	1.40
DL1-A	Th-230	Bq/g	1.36	1.43
DL1-A	Th-232	Bq/g	0.27	0.33
DL1-A	Th-228	Bq/g	0.35	0.33
DH1-A	Ra-228	Bq/g	3.68	3.69
UTS-2	Uranium	ppm	55	56

Blanks

Analyte	Units	Result
Ra-226	Bq/g	< 0.01
Th-230	Bq/g	< 0.09
Th-232	Bq/g	< 0.01
Th-228	Bq/g	< 0.09
Pb-210	Bq/g	< 0.1
Po-210	Bq/g	< 0.01
Ra-228	Bq/g	< 0.1

QUALITY REPORT

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Phone: (905) 826-3080
FAX: (905) 826-4151

Batch: T09-01352.0

Date: 09-Nov-2009

Duplicates

Analyte	Units	Result	Duplicate
Ra-226	Bq/g	0.44	0.39
Pb-210	Bq/g	0.49	0.51
Po-210	Bq/g	0.45	0.48
Ra-228	Bq/g	0.35	0.32
Th-230	Bq/g	0.05	0.03
Th-232	Bq/g	0.01	0.02
Th-228	Bq/g	0.06	0.06
Uranium	ppm	16	16

ANALYSIS REPORT

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Phone: (905) 826-3080
FAX: (905) 826-4151

Batch: T09-01350.0

Date: 13-Nov-2009

Minnow Environmental

2 Lamb St
Georgetown, ON, L7G 3M9

attn: Cynthia Russel

Phone: (905) 873-3371
FAX: (905) 567-6805

Client Ref.2308

17 tissue samples

Received: 30-Sep-2009

Results of Analysis

Sample	Test		Result	Std Dev	Units	Date	Method
EL-F1	Pb-210	<	0.02		Bq/g	22-Oct-2009	GFPC
EL-F2	Pb-210	<	0.02		Bq/g	22-Oct-2009	GFPC
EL-F3	Pb-210	<	0.02		Bq/g	22-Oct-2009	GFPC
QL-F1	Pb-210		0.02	0.003	Bq/g	22-Oct-2009	GFPC
QL-F2	Pb-210		0.04	0.003	Bq/g	22-Oct-2009	GFPC
QL-F3	Pb-210		0.03	0.003	Bq/g	22-Oct-2009	GFPC
NL-F1	Pb-210	<	0.02		Bq/g	22-Oct-2009	GFPC
NL-F2	Pb-210	<	0.02		Bq/g	22-Oct-2009	GFPC
NL-F3	Pb-210	<	0.02		Bq/g	22-Oct-2009	GFPC
MAL-F1	Pb-210		0.02	0.004	Bq/g	23-Oct-2009	GFPC
MAL-F2	Pb-210	<	0.02		Bq/g	23-Oct-2009	GFPC
MAL-F3	Pb-210		0.03	0.005	Bq/g	23-Oct-2009	GFPC
ML-F1	Pb-210		0.03	0.007	Bq/g	23-Oct-2009	GFPC
ML-F2	Pb-210	<	0.02		Bq/g	23-Oct-2009	GFPC
ML-F3	Pb-210		0.06	0.007	Bq/g	23-Oct-2009	GFPC
MCL-F1	Pb-210	<	0.02		Bq/g	23-Oct-2009	GFPC
MCL-F2	Pb-210	<	0.02		Bq/g	02-Nov-2009	GFPC
EL-F1	Po-210		0.025	0.004	Bq/g	16-Oct-2009	ALPHA
EL-F2	Po-210		0.022	0.002	Bq/g	16-Oct-2009	ALPHA
EL-F3	Po-210		0.040	0.003	Bq/g	16-Oct-2009	ALPHA
QL-F1	Po-210		0.89	0.06	Bq/g	16-Oct-2009	ALPHA
QL-F2	Po-210		0.93	0.07	Bq/g	16-Oct-2009	ALPHA
QL-F3	Po-210		1.2	0.1	Bq/g	16-Oct-2009	ALPHA
NL-F1	Po-210		0.25	0.02	Bq/g	16-Oct-2009	ALPHA
NL-F2	Po-210		0.26	0.02	Bq/g	16-Oct-2009	ALPHA
NL-F3	Po-210		0.68	0.04	Bq/g	16-Oct-2009	ALPHA

ANALYSIS REPORT

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6790 Kitimat Rd., Unit 4
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Phone: (905) 826-3080
FAX: (905) 826-4151

Batch: T09-01350.0

Date: 13-Nov-2009

Results of Analysis

Sample	Test	Result	Std Dev	Units	Date	Method
MAL-F1	Po-210	0.47	0.03	Bq/g	16-Oct-2009	ALPHA
MAL-F2	Po-210	0.46	0.03	Bq/g	16-Oct-2009	ALPHA
MAL-F3	Po-210	0.43	0.03	Bq/g	16-Oct-2009	ALPHA
ML-F1	Po-210	0.32	0.02	Bq/g	16-Oct-2009	ALPHA
ML-F2	Po-210	0.66	0.04	Bq/g	16-Oct-2009	ALPHA
ML-F3	Po-210	0.53	0.03	Bq/g	16-Oct-2009	ALPHA
MCL-F1	Po-210	0.10	0.01	Bq/g	16-Oct-2009	ALPHA
MCL-F2	Po-210	0.012	0.002	Bq/g	27-Oct-2009	ALPHA
EL-F1	Ra-226	0.009	0.001	Bq/g	23-Oct-2009	ALPHA
EL-F2	Ra-226	0.012	0.001	Bq/g	23-Oct-2009	ALPHA
EL-F3	Ra-226	0.012	0.001	Bq/g	23-Oct-2009	ALPHA
QL-F1	Ra-226	0.039	0.001	Bq/g	23-Oct-2009	ALPHA
QL-F2	Ra-226	0.070	0.003	Bq/g	23-Oct-2009	ALPHA
QL-F3	Ra-226	0.070	0.003	Bq/g	23-Oct-2009	ALPHA
NL-F1	Ra-226	0.008	0.001	Bq/g	23-Oct-2009	ALPHA
NL-F2	Ra-226	0.014	0.001	Bq/g	23-Oct-2009	ALPHA
NL-F3	Ra-226	0.009	0.001	Bq/g	23-Oct-2009	ALPHA
MAL-F1	Ra-226	0.014	0.001	Bq/g	23-Oct-2009	ALPHA
MAL-F2	Ra-226	0.009	0.002	Bq/g	23-Oct-2009	ALPHA
MAL-F3	Ra-226	0.016	0.001	Bq/g	23-Oct-2009	ALPHA
ML-F1	Ra-226	0.019	0.002	Bq/g	23-Oct-2009	ALPHA
ML-F2	Ra-226	0.029	0.002	Bq/g	23-Oct-2009	ALPHA
ML-F3	Ra-226	0.017	0.001	Bq/g	23-Oct-2009	ALPHA
MCL-F1	Ra-226	0.003	0.001	Bq/g	23-Oct-2009	ALPHA
MCL-F2	Ra-226	0.015	0.001	Bq/g	03-Nov-2009	ALPHA
EL-F1	Ra-228	< 0.1		Bq/g	15-Oct-2009	GAMMA
EL-F2	Ra-228	< 0.1		Bq/g	17-Oct-2009	GAMMA
EL-F3	Ra-228	0.15	0.05	Bq/g	19-Oct-2009	GAMMA
QL-F1	Ra-228	< 0.1		Bq/g	16-Oct-2009	GAMMA
QL-F2	Ra-228	< 0.1		Bq/g	18-Oct-2009	GAMMA
QL-F3	Ra-228	0.12	0.04	Bq/g	19-Oct-2009	GAMMA
NL-F1	Ra-228	< 0.1		Bq/g	16-Oct-2009	GAMMA

ANALYSIS REPORT

Becquerel Laboratories Inc. Phone: (905) 826-3080 Batch: T09-01350.0

6790 Kitimat Rd., Unit 4 FAX: (905) 826-4151
Mississauga, Ontario
Canada, L5N 5L9

Date: 13-Nov-2009

Results of Analysis

Sample	Test		Result	Std Dev	Units	Date	Method
NL-F2	Ra-228	<	0.1		Bq/g	14-Oct-2009	GAMMA
NL-F3	Ra-228	<	0.1		Bq/g	11-Oct-2009	GAMMA
MAL-F1	Ra-228	<	0.1		Bq/g	19-Oct-2009	GAMMA
MAL-F2	Ra-228		0.13	0.05	Bq/g	20-Oct-2009	GAMMA
MAL-F3	Ra-228	<	0.2		Bq/g	26-Oct-2009	GAMMA
ML-F1	Ra-228	<	0.1		Bq/g	21-Oct-2009	GAMMA
ML-F2	Ra-228		0.35	0.09	Bq/g	26-Oct-2009	GAMMA
ML-F3	Ra-228		0.22	0.06	Bq/g	30-Oct-2009	GAMMA
MCL-F1	Ra-228	<	0.1		Bq/g	15-Oct-2009	GAMMA
MCL-F2	Ra-228	<	0.1		Bq/g	24-Oct-2009	GAMMA
EL-F1	Th-228	<	0.005		Bq/g	23-Oct-2009	ALPHA
EL-F2	Th-228	<	0.005		Bq/g	23-Oct-2009	ALPHA
EL-F3	Th-228	<	0.005		Bq/g	23-Oct-2009	ALPHA
QL-F1	Th-228		0.003	0.001	Bq/g	23-Oct-2009	ALPHA
QL-F2	Th-228		0.006	0.001	Bq/g	23-Oct-2009	ALPHA
QL-F3	Th-228	<	0.005		Bq/g	23-Oct-2009	ALPHA
NL-F1	Th-228	<	0.005		Bq/g	23-Oct-2009	ALPHA
NL-F2	Th-228	<	0.005		Bq/g	23-Oct-2009	ALPHA
NL-F3	Th-228	<	0.005		Bq/g	24-Oct-2009	ALPHA
MAL-F1	Th-228		0.007	0.001	Bq/g	24-Oct-2009	ALPHA
MAL-F2	Th-228	<	0.005		Bq/g	24-Oct-2009	ALPHA
MAL-F3	Th-228	<	0.005		Bq/g	24-Oct-2009	ALPHA
ML-F1	Th-228	<	0.005		Bq/g	25-Oct-2009	ALPHA
ML-F2	Th-228	<	0.005		Bq/g	25-Oct-2009	ALPHA
ML-F3	Th-228	<	0.005		Bq/g	25-Oct-2009	ALPHA
MCL-F1	Th-228	<	0.005		Bq/g	25-Oct-2009	ALPHA
MCL-F2	Th-228	<	0.005		Bq/g	29-Oct-2009	ALPHA
EL-F1	Th-230	<	0.005		Bq/g	23-Oct-2009	ALPHA
EL-F2	Th-230	<	0.005		Bq/g	23-Oct-2009	ALPHA
EL-F3	Th-230	<	0.003		Bq/g	23-Oct-2009	ALPHA
QL-F1	Th-230		0.010	0.001	Bq/g	23-Oct-2009	ALPHA
QL-F2	Th-230		0.033	0.002	Bq/g	23-Oct-2009	ALPHA

ANALYSIS REPORT

6790 Kitimat Rd., Unit 4 FAX: (905) 826-4151
Mississauga, Ontario
Canada, L5N 5L9

Date: 13-Nov-2009

Results of Analysis

Sample	Test	Result	Std Dev	Units	Date	Method
QL-F3	Th-230	0.023	0.002	Bq/g	23-Oct-2009	ALPHA
NL-F1	Th-230	< 0.005		Bq/g	23-Oct-2009	ALPHA
NL-F2	Th-230	< 0.005		Bq/g	23-Oct-2009	ALPHA
NL-F3	Th-230	< 0.005		Bq/g	24-Oct-2009	ALPHA
MAL-F1	Th-230	0.005	0.001	Bq/g	24-Oct-2009	ALPHA
MAL-F2	Th-230	< 0.005		Bq/g	24-Oct-2009	ALPHA
MAL-F3	Th-230	< 0.005		Bq/g	24-Oct-2009	ALPHA
ML-F1	Th-230	< 0.005		Bq/g	25-Oct-2009	ALPHA
ML-F2	Th-230	< 0.005		Bq/g	25-Oct-2009	ALPHA
ML-F3	Th-230	< 0.005		Bq/g	25-Oct-2009	ALPHA
MCL-F1	Th-230	< 0.005		Bq/g	25-Oct-2009	ALPHA
MCL-F2	Th-230	< 0.005		Bq/g	29-Oct-2009	ALPHA
EL-F1	Th-232	< 0.005		Bq/g	23-Oct-2009	ALPHA
EL-F2	Th-232	< 0.005		Bq/g	23-Oct-2009	ALPHA
EL-F3	Th-232	< 0.005		Bq/g	23-Oct-2009	ALPHA
QL-F1	Th-232	< 0.005		Bq/g	23-Oct-2009	ALPHA
QL-F2	Th-232	< 0.005		Bq/g	23-Oct-2009	ALPHA
QL-F3	Th-232	< 0.005		Bq/g	23-Oct-2009	ALPHA
NL-F1	Th-232	< 0.005		Bq/g	23-Oct-2009	ALPHA
NL-F2	Th-232	< 0.005		Bq/g	23-Oct-2009	ALPHA
NL-F3	Th-232	< 0.005		Bq/g	24-Oct-2009	ALPHA
MAL-F1	Th-232	< 0.005		Bq/g	24-Oct-2009	ALPHA
MAL-F2	Th-232	< 0.005		Bq/g	24-Oct-2009	ALPHA
MAL-F3	Th-232	< 0.005		Bq/g	24-Oct-2009	ALPHA
ML-F1	Th-232	< 0.005		Bq/g	25-Oct-2009	ALPHA
ML-F2	Th-232	< 0.005		Bq/g	25-Oct-2009	ALPHA
ML-F3	Th-232	< 0.005		Bq/g	25-Oct-2009	ALPHA
MCL-F1	Th-232	< 0.005		Bq/g	25-Oct-2009	ALPHA
MCL-F2	Th-232	< 0.005		Bq/g	29-Oct-2009	ALPHA

ANALYSIS REPORT

Becquerel Laboratories Inc.
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Mississauga, Ontario
Canada, L5N 5L9

Phone: (905) 826-3080
FAX: (905) 826-4151

Batch: T09-01350.0

Date: 13-Nov-2009

Results of Analysis

Sample	Test	Result	Std Dev	Units	Date	Method
EL-F1	Uranium	460	40	ppb	13-Nov-2009	NAA
EL-F2	Uranium	550	41	ppb	13-Nov-2009	NAA
EL-F3	Uranium	810	51	ppb	13-Nov-2009	NAA
QL-F1	Uranium	1650	57	ppb	13-Nov-2009	NAA
QL-F2	Uranium	3200	110	ppb	13-Nov-2009	NAA
QL-F3	Uranium	2900	100	ppb	13-Nov-2009	NAA
NL-F1	Uranium	140	54	ppb	13-Nov-2009	NAA
NL-F2	Uranium	160	33	ppb	13-Nov-2009	NAA
NL-F3	Uranium	250	60	ppb	13-Nov-2009	NAA
MAL-F1	Uranium	240	48	ppb	13-Nov-2009	NAA
MAL-F2	Uranium	280	69	ppb	13-Nov-2009	NAA
MAL-F3	Uranium	140	53	ppb	13-Nov-2009	NAA
ML-F1	Uranium	440	59	ppb	13-Nov-2009	NAA
ML-F2	Uranium	520	79	ppb	13-Nov-2009	NAA
ML-F3	Uranium	430	73	ppb	13-Nov-2009	NAA
MCL-F1	Uranium	150	31	ppb	13-Nov-2009	NAA
MCL-F2	Uranium	720	27	ppb	13-Nov-2009	NAA

Methods:	GAMMA	BQ-RAD-GAMMA	gamma-ray spectrometry
	ALPHA	BQ-RAD-ALPHA	alpha-particle spectrometry
	GFPC	BQ-RAD-GFPC	gas-flow proportional counting
	NAA	BQ-NAA-1	neutron activation analysis

Units:	Bq/g	Becquerels per gram
	ppb	micrograms per kilogram

These results relate only to the samples analysed and only to the items tested.
Sample MCL-F3 was lost during dissolution.

13-Nov-2009 approved by: ______________________________
Donald D. Burgess PhD
Senior Scientist, Division Supervisor

QUALITY REPORT

Becquerel Laboratories Inc.
6790 Kitimat Rd., Unit 4
Mississauga, Ontario
Canada, L5N 5L9

Phone: (905) 826-3080
FAX: (905) 826-4151

Batch: T09-01350.0

Date: 13-Nov-2009

Standards

Standard	Analyte	Units	Result	Expected Result
DH1-A	Ra-228	Bq/g	3.32	3.69
RA226.29	Ra-226	Bq/l	0.82	0.92
TH230.11	Th-230	Bq/l	0.94	0.85
PB210.09	Pb-210	Bq/l	0.89	0.80
PB210.09	Po-210	Bq/l	0.73	0.89
DL1-A	Pb-210	Bq/g	1.52	1.30
DL1-A	Uranium	ppb	118	116

Blanks

Analyte	Units	Result
Ra-228	Bq/g	< 0.1
Ra-226	Bq/g	< 0.005
Th-232	Bq/g	< 0.005
Th-230	Bq/g	< 0.005
Th-228	Bq/g	< 0.005
Pb-210	Bq/g	< 0.006
Po-210	Bq/g	< 0.005

Duplicates

Analyte	Units	Result	Duplicate
Ra-228	Bq/g	< 0.1	< 0.1
Ra-226	Bq/g	0.070	0.065
Th-232	Bq/g	< 0.005	< 0.005
Th-230	Bq/g	0.033	0.030
Th-228	Bq/g	0.006	0.005
Pb-210	Bq/g	0.02	0.02
Po-210	Bq/g	0.93	0.88

ANALYSIS REPORT

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Phone: (905) 826-3080
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Batch: T09-01351.0

Date: 02-Dec-2009

Minnow Environmental

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Phone: (905) 873-3371
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Client Ref.2308

30 vegetation samples Received: 30-Sep-2009

Results of Analysis

Sample	Test	Result	Std Dev	Units	Date	Method
MCL-09-M1	Pb-210	0.056	0.004	Bq/g	18-Nov-2009	GFPC
MCL-09-M2	Pb-210	0.13	0.01	Bq/g	18-Nov-2009	GFPC
MCL-09-M3	Pb-210	0.12	0.01	Bq/g	18-Nov-2009	GFPC
MCL-09-M4	Pb-210	0.066	0.006	Bq/g	18-Nov-2009	GFPC
MCL-09-M5	Pb-210	0.064	0.004	Bq/g	18-Nov-2009	GFPC
MCL-09-M6	Pb-210	0.11	0.02	Bq/g	18-Nov-2009	GFPC
QL-09-Q1	Pb-210	0.13	0.01	Bq/g	18-Nov-2009	GFPC
QL-09-Q2	Pb-210	2.1	0.1	Bq/g	24-Nov-2009	GFPC
QL-09-Q3	Pb-210	0.38	0.01	Bq/g	18-Nov-2009	GFPC
QL-09-Q4	Pb-210	5.1	0.2	Bq/g	18-Nov-2009	GFPC
EL-09-E1	Pb-210	0.072	0.004	Bq/g	18-Nov-2009	GFPC
EL-09-E2	Pb-210	0.064	0.006	Bq/g	19-Nov-2009	GFPC
EL-09-E3	Pb-210	0.054	0.006	Bq/g	19-Nov-2009	GFPC
EL-09-E4	Pb-210	0.025	0.003	Bq/g	19-Nov-2009	GFPC
EL-09-E5	Pb-210	0.015	0.003	Bq/g	19-Nov-2009	GFPC
NL-09-N1	Pb-210	0.16	0.01	Bq/g	19-Nov-2009	GFPC
NL-09-N2	Pb-210	0.010	0.003	Bq/g	19-Nov-2009	GFPC
NL-09-N3	Pb-210	0.030	0.003	Bq/g	19-Nov-2009	GFPC
NL-09-N4	Pb-210	0.041	0.003	Bq/g	19-Nov-2009	GFPC
NL-09-N5	Pb-210	0.055	0.004	Bq/g	19-Nov-2009	GFPC
ML-09-ML1	Pb-210	0.27	0.01	Bq/g	19-Nov-2009	GFPC
ML-09-ML2	Pb-210	0.28	0.01	Bq/g	19-Nov-2009	GFPC
ML-09-ML3	Pb-210	0.90	0.03	Bq/g	24-Nov-2009	GFPC
ML-09-ML4	Pb-210	0.057	0.004	Bq/g	19-Nov-2009	GFPC
ML-09-ML5	Pb-210	0.19	0.01	Bq/g	19-Nov-2009	GFPC
MAL-09-M1	Pb-210	0.50	0.02	Bq/g	19-Nov-2009	GFPC
MAL-09-M2	Pb-210	0.21	0.01	Bq/g	19-Nov-2009	GFPC

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Results of Analysis

Sample	Test		Result	Std Dev	Units	Date	Method
MAL-09-M3	Pb-210		0.047	0.004	Bq/g	20-Nov-2009	GFPC
MAL-09-M4	Pb-210		0.81	0.05	Bq/g	24-Nov-2009	GFPC
MAL-09-M5	Pb-210		0.11	0.01	Bq/g	20-Nov-2009	GFPC
MCL-09-M1	Po-210		0.017	0.003	Bq/g	12-Nov-2009	ALPHA
MCL-09-M2	Po-210		0.078	0.007	Bq/g	12-Nov-2009	ALPHA
MCL-09-M3	Po-210		0.086	0.005	Bq/g	12-Nov-2009	ALPHA
MCL-09-M4	Po-210		0.033	0.003	Bq/g	12-Nov-2009	ALPHA
MCL-09-M5	Po-210		0.030	0.002	Bq/g	12-Nov-2009	ALPHA
MCL-09-M6	Po-210		0.051	0.007	Bq/g	12-Nov-2009	ALPHA
QL-09-Q1	Po-210		0.13	0.01	Bq/g	13-Nov-2009	ALPHA
QL-09-Q2	Po-210		2.9	0.1	Bq/g	17-Nov-2009	ALPHA
QL-09-Q3	Po-210		0.42	0.02	Bq/g	13-Nov-2009	ALPHA
QL-09-Q4	Po-210		5.1	0.3	Bq/g	13-Nov-2009	ALPHA
EL-09-E1	Po-210		0.036	0.005	Bq/g	13-Nov-2009	ALPHA
EL-09-E2	Po-210		0.017	0.005	Bq/g	13-Nov-2009	ALPHA
EL-09-E3	Po-210		0.019	0.004	Bq/g	13-Nov-2009	ALPHA
EL-09-E4	Po-210		0.014	0.001	Bq/g	16-Nov-2009	ALPHA
EL-09-E5	Po-210		0.010	0.002	Bq/g	13-Nov-2009	ALPHA
NL-09-N1	Po-210		0.11	0.01	Bq/g	13-Nov-2009	ALPHA
NL-09-N2	Po-210	<	0.002		Bq/g	13-Nov-2009	ALPHA
NL-09-N3	Po-210		0.020	0.001	Bq/g	14-Nov-2009	ALPHA
NL-09-N4	Po-210		0.026	0.002	Bq/g	15-Nov-2009	ALPHA
NL-09-N5	Po-210		0.021	0.002	Bq/g	15-Nov-2009	ALPHA
ML-09-ML1	Po-210		0.28	0.01	Bq/g	15-Nov-2009	ALPHA
ML-09-ML2	Po-210		0.34	0.01	Bq/g	16-Nov-2009	ALPHA
ML-09-ML3	Po-210		0.69	0.04	Bq/g	17-Nov-2009	ALPHA
ML-09-ML4	Po-210		0.063	0.003	Bq/g	16-Nov-2009	ALPHA
ML-09-ML5	Po-210		0.22	0.01	Bq/g	16-Nov-2009	ALPHA
MAL-09-M1	Po-210		0.54	0.03	Bq/g	17-Nov-2009	ALPHA
MAL-09-M2	Po-210		0.18	0.01	Bq/g	17-Nov-2009	ALPHA
MAL-09-M3	Po-210		0.045	0.005	Bq/g	17-Nov-2009	ALPHA
MAL-09-M4	Po-210		0.88	0.08	Bq/g	17-Nov-2009	ALPHA
MAL-09-M5	Po-210		0.056	0.007	Bq/g	17-Nov-2009	ALPHA

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Sample	Test		Result	Std Dev	Units	Date	Method
MCL-09-M1	Ra-226		0.018	0.001	Bq/g	29-Nov-2009	ALPHA
MCL-09-M2	Ra-226		0.20	0.01	Bq/g	29-Nov-2009	ALPHA
MCL-09-M3	Ra-226		0.34	0.01	Bq/g	29-Nov-2009	ALPHA
MCL-09-M4	Ra-226		0.11	0.01	Bq/g	29-Nov-2009	ALPHA
MCL-09-M5	Ra-226		0.20	0.01	Bq/g	29-Nov-2009	ALPHA
MCL-09-M6	Ra-226		0.16	0.01	Bq/g	30-Nov-2009	ALPHA
QL-09-Q1	Ra-226		0.60	0.02	Bq/g	30-Nov-2009	ALPHA
QL-09-Q2	Ra-226		1.6	0.1	Bq/g	30-Nov-2009	ALPHA
QL-09-Q3	Ra-226		1.4	0.1	Bq/g	30-Nov-2009	ALPHA
QL-09-Q4	Ra-226		3.8	0.1	Bq/g	30-Nov-2009	ALPHA
EL-09-E1	Ra-226		0.10	0.01	Bq/g	30-Nov-2009	ALPHA
EL-09-E2	Ra-226		0.086	0.005	Bq/g	30-Nov-2009	ALPHA
EL-09-E3	Ra-226		0.26	0.02	Bq/g	30-Nov-2009	ALPHA
EL-09-E4	Ra-226		0.050	0.004	Bq/g	01-Dec-2009	ALPHA
EL-09-E5	Ra-226		0.044	0.003	Bq/g	30-Nov-2009	ALPHA
NL-09-N1	Ra-226		0.27	0.01	Bq/g	30-Nov-2009	ALPHA
NL-09-N2	Ra-226		0.005	0.001	Bq/g	30-Nov-2009	ALPHA
NL-09-N3	Ra-226		0.087	0.004	Bq/g	30-Nov-2009	ALPHA
NL-09-N4	Ra-226		0.23	0.01	Bq/g	01-Dec-2009	ALPHA
NL-09-N5	Ra-226		0.082	0.007	Bq/g	01-Dec-2009	ALPHA
ML-09-ML1	Ra-226		0.28	0.02	Bq/g	01-Dec-2009	ALPHA
ML-09-ML2	Ra-226		0.40	0.02	Bq/g	01-Dec-2009	ALPHA
ML-09-ML3	Ra-226		0.92	0.04	Bq/g	30-Nov-2009	ALPHA
ML-09-ML4	Ra-226		0.22	0.01	Bq/g	01-Dec-2009	ALPHA
ML-09-ML5	Ra-226		1.1	0.1	Bq/g	01-Dec-2009	ALPHA
MAL-09-M1	Ra-226		1.34	0.1	Bq/g	01-Dec-2009	ALPHA
MAL-09-M2	Ra-226		0.18	0.01	Bq/g	01-Dec-2009	ALPHA
MAL-09-M3	Ra-226		0.079	0.006	Bq/g	01-Dec-2009	ALPHA
MAL-09-M4	Ra-226		0.53	0.02	Bq/g	01-Dec-2009	ALPHA
MAL-09-M5	Ra-226		0.058	0.007	Bq/g	01-Dec-2009	ALPHA
MCL-09-M1	Ra-228	<	0.1		Bq/g	23-Oct-2009	GAMMA
MCL-09-M2	Ra-228		0.11	0.02	Bq/g	22-Oct-2009	GAMMA
MCL-09-M3	Ra-228		0.15	0.03	Bq/g	23-Oct-2009	GAMMA

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Sample	Test		Result	Std Dev	Units	Date	Method
MCL-09-M4	Ra-228	<	0.1		Bq/g	22-Oct-2009	GAMMA
MCL-09-M5	Ra-228		0.11	0.02	Bq/g	24-Oct-2009	GAMMA
MCL-09-M6	Ra-228	<	0.1		Bq/g	23-Oct-2009	GAMMA
QL-09-Q1	Ra-228		0.13	0.02	Bq/g	24-Oct-2009	GAMMA
QL-09-Q2	Ra-228		0.48	0.02	Bq/g	23-Oct-2009	GAMMA
QL-09-Q3	Ra-228		0.45	0.03	Bq/g	24-Oct-2009	GAMMA
QL-09-Q4	Ra-228		1.0	0.1	Bq/g	24-Oct-2009	GAMMA
EL-09-E1	Ra-228	<	0.1		Bq/g	25-Oct-2009	GAMMA
EL-09-E2	Ra-228	<	0.1		Bq/g	24-Oct-2009	GAMMA
EL-09-E3	Ra-228	<	0.1		Bq/g	25-Oct-2009	GAMMA
EL-09-E4	Ra-228	<	0.1		Bq/g	25-Oct-2009	GAMMA
EL-09-E5	Ra-228	<	0.1		Bq/g	25-Oct-2009	GAMMA
NL-09-N1	Ra-228	<	0.1		Bq/g	26-Oct-2009	GAMMA
NL-09-N2	Ra-228	<	0.1		Bq/g	25-Oct-2009	GAMMA
NL-09-N3	Ra-228	<	0.1		Bq/g	26-Oct-2009	GAMMA
NL-09-N4	Ra-228	<	0.1		Bq/g	26-Oct-2009	GAMMA
NL-09-N5	Ra-228	<	0.1		Bq/g	27-Oct-2009	GAMMA
ML-09-ML1	Ra-228	<	0.1		Bq/g	26-Oct-2009	GAMMA
ML-09-ML2	Ra-228		0.27	0.03	Bq/g	26-Oct-2009	GAMMA
ML-09-ML3	Ra-228		0.74	0.03	Bq/g	27-Oct-2009	GAMMA
ML-09-ML4	Ra-228		0.10	0.02	Bq/g	27-Oct-2009	GAMMA
ML-09-ML5	Ra-228		0.52	0.03	Bq/g	27-Oct-2009	GAMMA
MAL-09-M1	Ra-228		0.66	0.06	Bq/g	30-Oct-2009	GAMMA
MAL-09-M2	Ra-228	<	0.1		Bq/g	27-Oct-2009	GAMMA
MAL-09-M3	Ra-228	<	0.1		Bq/g	28-Oct-2009	GAMMA
MAL-09-M4	Ra-228	<	0.1		Bq/g	30-Oct-2009	GAMMA
MAL-09-M5	Ra-228	<	0.1		Bq/g	30-Oct-2009	GAMMA
MCL-09-M1	Th-228	<	0.005		Bq/g	25-Nov-2009	ALPHA
MCL-09-M2	Th-228		0.015	0.002	Bq/g	26-Nov-2009	ALPHA
MCL-09-M3	Th-228		0.018	0.001	Bq/g	26-Nov-2009	ALPHA
MCL-09-M4	Th-228		0.006	0.001	Bq/g	26-Nov-2009	ALPHA
MCL-09-M5	Th-228		0.009	0.001	Bq/g	26-Nov-2009	ALPHA
MCL-09-M6	Th-228		0.008	0.004	Bq/g	26-Nov-2009	ALPHA

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Sample	Test		Result	Std Dev	Units	Date	Method
QL-09-Q1	Th-228		0.020	0.002	Bq/g	27-Nov-2009	ALPHA
QL-09-Q2	Th-228		0.27	0.01	Bq/g	27-Nov-2009	ALPHA
QL-09-Q3	Th-228		0.071	0.005	Bq/g	27-Nov-2009	ALPHA
QL-09-Q4	Th-228		0.77	0.03	Bq/g	27-Nov-2009	ALPHA
EL-09-E1	Th-228		0.014	0.001	Bq/g	30-Nov-2009	ALPHA
EL-09-E2	Th-228		0.004	0.001	Bq/g	30-Nov-2009	ALPHA
EL-09-E3	Th-228		0.009	0.002	Bq/g	01-Dec-2009	ALPHA
EL-09-E4	Th-228	<	0.005		Bq/g	01-Dec-2009	ALPHA
EL-09-E5	Th-228	<	0.005		Bq/g	01-Dec-2009	ALPHA
NL-09-N1	Th-228		0.007	0.002	Bq/g	01-Dec-2009	ALPHA
NL-09-N2	Th-228	<	0.005		Bq/g	01-Dec-2009	ALPHA
NL-09-N3	Th-228		0.009	0.002	Bq/g	01-Dec-2009	ALPHA
NL-09-N4	Th-228	<	0.005		Bq/g	01-Dec-2009	ALPHA
NL-09-N5	Th-228	<	0.005		Bq/g	01-Dec-2009	ALPHA
ML-09-ML1	Th-228		0.007	0.002	Bq/g	01-Dec-2009	ALPHA
ML-09-ML2	Th-228		0.12	0.01	Bq/g	01-Dec-2009	ALPHA
ML-09-ML3	Th-228		0.23	0.01	Bq/g	01-Dec-2009	ALPHA
ML-09-ML4	Th-228		0.023	0.003	Bq/g	01-Dec-2009	ALPHA
ML-09-ML5	Th-228		0.098	0.007	Bq/g	01-Dec-2009	ALPHA
MAL-09-M1	Th-228		0.12	0.01	Bq/g	01-Dec-2009	ALPHA
MAL-09-M2	Th-228	<	0.012		Bq/g	01-Dec-2009	ALPHA
MAL-09-M3	Th-228	<	0.005		Bq/g	01-Dec-2009	ALPHA
MAL-09-M4	Th-228		0.027	0.004	Bq/g	01-Dec-2009	ALPHA
MAL-09-M5	Th-228	<	0.005		Bq/g	01-Dec-2009	ALPHA
MCL-09-M1	Th-230	<	0.005		Bq/g	25-Nov-2009	ALPHA
MCL-09-M2	Th-230	<	0.005		Bq/g	26-Nov-2009	ALPHA
MCL-09-M3	Th-230	<	0.005		Bq/g	26-Nov-2009	ALPHA
MCL-09-M4	Th-230	<	0.005		Bq/g	26-Nov-2009	ALPHA
MCL-09-M5	Th-230	<	0.005		Bq/g	26-Nov-2009	ALPHA
MCL-09-M6	Th-230	<	0.005		Bq/g	26-Nov-2009	ALPHA
QL-09-Q1	Th-230		0.031	0.003	Bq/g	27-Nov-2009	ALPHA
QL-09-Q2	Th-230		2.8	0.1	Bq/g	27-Nov-2009	ALPHA
QL-09-Q3	Th-230		0.21	0.01	Bq/g	27-Nov-2009	ALPHA

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Sample	Test		Result	Std Dev	Units	Date	Method
QL-09-Q4	Th-230		6.7	0.3	Bq/g	27-Nov-2009	ALPHA
EL-09-E1	Th-230		0.053	0.003	Bq/g	30-Nov-2009	ALPHA
EL-09-E2	Th-230		0.010	0.001	Bq/g	30-Nov-2009	ALPHA
EL-09-E3	Th-230		0.007	0.002	Bq/g	01-Dec-2009	ALPHA
EL-09-E4	Th-230	<	0.005		Bq/g	01-Dec-2009	ALPHA
EL-09-E5	Th-230	<	0.005		Bq/g	01-Dec-2009	ALPHA
NL-09-N1	Th-230		0.011	0.003	Bq/g	01-Dec-2009	ALPHA
NL-09-N2	Th-230	<	0.005		Bq/g	01-Dec-2009	ALPHA
NL-09-N3	Th-230	<	0.005		Bq/g	01-Dec-2009	ALPHA
NL-09-N4	Th-230	<	0.005		Bq/g	01-Dec-2009	ALPHA
NL-09-N5	Th-230	<	0.005		Bq/g	01-Dec-2009	ALPHA
ML-09-ML1	Th-230		0.022	0.003	Bq/g	01-Dec-2009	ALPHA
ML-09-ML2	Th-230		0.39	0.01	Bq/g	01-Dec-2009	ALPHA
ML-09-ML3	Th-230		1.44	0.06	Bq/g	01-Dec-2009	ALPHA
ML-09-ML4	Th-230		0.046	0.004	Bq/g	01-Dec-2009	ALPHA
ML-09-ML5	Th-230		0.29	0.01	Bq/g	01-Dec-2009	ALPHA
MAL-09-M1	Th-230		0.51	0.03	Bq/g	01-Dec-2009	ALPHA
MAL-09-M2	Th-230		0.011	0.005	Bq/g	01-Dec-2009	ALPHA
MAL-09-M3	Th-230		0.005	0.002	Bq/g	01-Dec-2009	ALPHA
MAL-09-M4	Th-230		0.099	0.007	Bq/g	01-Dec-2009	ALPHA
MAL-09-M5	Th-230	<	0.005		Bq/g	01-Dec-2009	ALPHA
MCL-09-M1	Th-232	<	0.005		Bq/g	25-Nov-2009	ALPHA
MCL-09-M2	Th-232		0.007	0.001	Bq/g	26-Nov-2009	ALPHA
MCL-09-M3	Th-232	<	0.005		Bq/g	26-Nov-2009	ALPHA
MCL-09-M4	Th-232	<	0.005		Bq/g	26-Nov-2009	ALPHA
MCL-09-M5	Th-232	<	0.005		Bq/g	26-Nov-2009	ALPHA
MCL-09-M6	Th-232	<	0.005		Bq/g	26-Nov-2009	ALPHA
QL-09-Q1	Th-232		0.005	0.001	Bq/g	27-Nov-2009	ALPHA
QL-09-Q2	Th-232		0.40	0.02	Bq/g	27-Nov-2009	ALPHA
QL-09-Q3	Th-232		0.026	0.003	Bq/g	27-Nov-2009	ALPHA
QL-09-Q4	Th-232		0.81	0.04	Bq/g	27-Nov-2009	ALPHA
EL-09-E1	Th-232		0.005	0.001	Bq/g	30-Nov-2009	ALPHA
EL-09-E2	Th-232	<	0.005		Bq/g	30-Nov-2009	ALPHA

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Sample	Test		Result	Std Dev	Units	Date	Method
EL-09-E3	Th-232	<	0.005		Bq/g	01-Dec-2009	ALPHA
EL-09-E4	Th-232	<	0.005		Bq/g	01-Dec-2009	ALPHA
EL-09-E5	Th-232	<	0.005		Bq/g	01-Dec-2009	ALPHA
NL-09-N1	Th-232	<	0.005		Bq/g	01-Dec-2009	ALPHA
NL-09-N2	Th-232	<	0.005		Bq/g	01-Dec-2009	ALPHA
NL-09-N3	Th-232	<	0.005		Bq/g	01-Dec-2009	ALPHA
NL-09-N4	Th-232	<	0.005		Bq/g	01-Dec-2009	ALPHA
NL-09-N5	Th-232	<	0.005		Bq/g	01-Dec-2009	ALPHA
ML-09-ML1	Th-232	<	0.005		Bq/g	01-Dec-2009	ALPHA
ML-09-ML2	Th-232		0.069	0.005	Bq/g	01-Dec-2009	ALPHA
ML-09-ML3	Th-232		0.22	0.01	Bq/g	01-Dec-2009	ALPHA
ML-09-ML4	Th-232		0.005	0.001	Bq/g	01-Dec-2009	ALPHA
ML-09-ML5	Th-232		0.053	0.005	Bq/g	01-Dec-2009	ALPHA
MAL-09-M1	Th-232		0.09	0.01	Bq/g	01-Dec-2009	ALPHA
MAL-09-M2	Th-232	<	0.007		Bq/g	01-Dec-2009	ALPHA
MAL-09-M3	Th-232	<	0.005		Bq/g	01-Dec-2009	ALPHA
MAL-09-M4	Th-232		0.014	0.003	Bq/g	01-Dec-2009	ALPHA
MAL-09-M5	Th-232	<	0.005		Bq/g	01-Dec-2009	ALPHA
MCL-09-M1	Uranium		1.38	0.05	ppm	23-Nov-2009	NAA
MCL-09-M2	Uranium		13.2	0.4	ppm	23-Nov-2009	NAA
MCL-09-M3	Uranium		9.1	0.2	ppm	23-Nov-2009	NAA
MCL-09-M4	Uranium		6.8	0.2	ppm	23-Nov-2009	NAA
MCL-09-M5	Uranium		5.0	0.1	ppm	23-Nov-2009	NAA
MCL-09-M6	Uranium		8.7	0.2	ppm	23-Nov-2009	NAA
QL-09-Q1	Uranium		20.5	0.6	ppm	23-Nov-2009	NAA
QL-09-Q2	Uranium		369	11	ppm	23-Nov-2009	NAA
QL-09-Q3	Uranium		94	3	ppm	23-Nov-2009	NAA
QL-09-Q4	Uranium		470	14	ppm	23-Nov-2009	NAA
EL-09-E1	Uranium		5.1	0.1	ppm	23-Nov-2009	NAA
EL-09-E2	Uranium		0.93	0.04	ppm	23-Nov-2009	NAA
EL-09-E3	Uranium		7.0	0.2	ppm	23-Nov-2009	NAA
EL-09-E4	Uranium		1.65	0.05	ppm	23-Nov-2009	NAA
EL-09-E5	Uranium		2.6	0.1	ppm	23-Nov-2009	NAA

ANALYSIS REPORT

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6790 Kitimat Rd., Unit 4
Mississauga, Ontario
Canada, L5N 5L9

Phone: (905) 826-3080
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Batch: T09-01351.0

Date: 02-Dec-2009

Results of Analysis

Sample	Test	Result	Std Dev	Units	Date	Method
NL-09-N1	Uranium	8.1	0.2	ppm	23-Nov-2009	NAA
NL-09-N2	Uranium	0.06	0.01	ppm	23-Nov-2009	NAA
NL-09-N3	Uranium	1.16	0.04	ppm	23-Nov-2009	NAA
NL-09-N4	Uranium	2.7	0.1	ppm	23-Nov-2009	NAA
NL-09-N5	Uranium	0.45	0.03	ppm	23-Nov-2009	NAA
ML-09-ML1	Uranium	7.7	0.2	ppm	23-Nov-2009	NAA
ML-09-ML2	Uranium	7.5	0.2	ppm	23-Nov-2009	NAA
ML-09-ML3	Uranium	8.3	0.2	ppm	23-Nov-2009	NAA
ML-09-ML4	Uranium	1.8	0.1	ppm	23-Nov-2009	NAA
ML-09-ML5	Uranium	7.4	0.2	ppm	23-Nov-2009	NAA
MAL-09-M1	Uranium	9.0	0.2	ppm	23-Nov-2009	NAA
MAL-09-M2	Uranium	5.1	0.1	ppm	23-Nov-2009	NAA
MAL-09-M3	Uranium	4.4	0.1	ppm	23-Nov-2009	NAA
MAL-09-M4	Uranium	31	1	ppm	23-Nov-2009	NAA
MAL-09-M5	Uranium	0.87	0.03	ppm	23-Nov-2009	NAA

Methods:	ALPHA	BQ-RAD-ALPHA	alpha-particle spectrometry
	GAMMA	BQ-RAD-GAMMA	gamma-ray spectrometry
	GFPC	BQ-RAD-GFPC	gas-flow proportional counting
	NAA	BQ-NAA-1	neutron activation analysis

Units:	Bq/g	Becquerels per gram
	ppm	micrograms per gram

These results relate only to the samples analysed and only to the items tested.

02-Dec-2009 approved by: ______________________________
Donald D. Burgess PhD
Senior Scientist, Division Supervisor

QUALITY REPORT

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Standards

Standard	Analyte	Units		Result	Expected Result
CLV-1	Th-232	Bq/g	<	0.005	0.002
CLV-1	Th-232	Bq/g	<	0.005	0.002
CLV-1	Th-230	Bq/g		0.28	0.31
CLV-1	Th-230	Bq/g		0.29	0.31
CLV-1	Th-228	Bq/g		0.007	0.002
CLV-1	Th-228	Bq/g		0.007	0.002
CLV-1	Ra-226	Bq/g		0.54	0.70
CLV-1	Ra-226	Bq/g		0.60	0.70
DH1-A	Ra-228	Bq/g		3.43	3.69
DH1-A	Ra-228	Bq/g		3.46	3.69
CLV-1	Pb-210	Bq/g		0.62	0.66
CLV-1	Pb-210	Bq/g		0.51	0.66
CLV-1	Po-210	Bq/g		0.59	0.66
CLV-1	Po-210	Bq/g		0.61	0.66
CLV-1	U-238	Bq/g		0.95	1.06

Blanks

Analyte	Units		Result
Th-232	Bq/g	<	0.005
Th-232	Bq/g	<	0.005
Th-230	Bq/g	<	0.005
Th-230	Bq/g	<	0.005
Th-228	Bq/g	<	0.005
Th-228	Bq/g	<	0.005
Ra-226	Bq/g	<	0.005
Ra-226	Bq/g	<	0.005
Ra-228	Bq/g	<	0.1
Ra-228	Bq/g	<	0.1
Pb-210	Bq/g	<	0.01
Pb-210	Bq/g	<	0.01
Po-210	Bq/g	<	0.005
Po-210	Bq/g	<	0.005

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Duplicates

Analyte	Units	Result	Duplicate
Th-232	Bq/g	0.22	0.23
Th-232	Bq/g	< 0.007	< 0.005
Th-230	Bq/g	1.44	1.62
Th-230	Bq/g	0.011	0.023
Th-228	Bq/g	0.23	0.24
Th-228	Bq/g	< 0.012	< 0.005
Ra-226	Bq/g	0.92	1.00
Ra-226	Bq/g	0.18	0.17
Ra-228	Bq/g		iss
Ra-228	Bq/g		iss
Pb-210	Bq/g	0.13	0.10
Pb-210	Bq/g	0.21	0.20
Po-210	Bq/g	0.13	0.13
Po-210	Bq/g	0.18	0.19

iss insufficient sample

APPENDIX C

Fish Collections

Appendix C.1: Fish collected for radionuclide analyses as part of the Special Investigation, September 2009.

Lake	Sample ID	Date sampled	Map ID	Number of traps or seine hauls	Species	Number collected
Elliot Lake	n/a	14-Sep	MT1	2	n/a	n/a
	EL-F1	14-Sep	MT2	2	yellow perch	4
		14-Sep	MT3	2	yellow perch	1
	n/a	16-Sep	MT4	2	n/a	n/a
	n/a	16-Sep	MT5	2	n/a	n/a
	EL-F2	16-Sep	MT6	2	yellow perch	4
	EL-F3				pumpkinseed sunfish	3
					yellow perch	2
May Lake	n/a	20-Sep	MT1	2	n/a	n/a
	n/a	20-Sep	MT2	2	n/a	n/a
	MAL-F1	20-Sep	MT3	2	common shiner	10
	MAL-F2				common shiner	10
	MAL-F3				common shiner	10
McCarthy Lake[a]	MCL-F1	20-Sep	SN	4	small mouth bass	5
	MCL-F2				pumpkinseed sunfish	20
Nordic Lake	NL-F1	18-Sep	SN	1	golden shiner	6
	NL-F2				common shiner	6
	NL-F3				golden shiner	6
	n/a	18-Sep	MT1	2	n/a	n/a
	n/a	18-Sep	MT2	2	n/a	n/a
	n/a	18-Sep	MT3	2	n/a	n/a
Quirke Lake	n/a	22-Sep	MT1	2	n/a	n/a
	QL-F1	22-Sep	MT2	2	common shiner	n/a
	QL-F2			2	mimic shiner	n/a
	QL-F3			2	mimic shiner	n/a
	n/a	22-Sep	MT3	2	n/a	n/a
McCabe Lake	ML-F2[b]	19-Sep	MT1	3	northern redbelly dace	7
	ML-F3			3	pumpkinseed sunfish	2
	ML-F3	19-Sep	MT2	3	pumpkinseed sunfish	5
	ML-F1	19-Sep	MT3	3	lake chub	10
	ML-F2			3	northern redbelly dace	5
	ML-F3			3	pumpkinseed sunfish	1
	ML-F2	19-Sep	MT4	3	northern redbelly dace	2

[a] fish tissue sample MCL-F3 lost during processing at the lab

[b] sample a composite of 12 fish from minnow traps MT1, MT3 and/or MT4

n/a - not applicable; any fish captured from these locations were not retained for radionuclide analyses

APPENDIX D

Detailed Dose Calculations

Ecological Dose Calculations - Aquatic Biota - Background

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	Th-228+	TOTAL
Water conc.	Bq/L	0.0172	0.0040	0.0040	0.006	0.006	0.005	0.003	0.0003	0.0005	0.0003	
Sed to water PC	L/kg (dw)	11442	49200	49200	29100	29100	34733	69467	49200	29100	49200	
Sediment conc.	Bq/kg (dw)	196.8	196.8	196.8	174.6	174.6	174.6	174.6	14	14	14	
Sediment conc.	Bq/kg (ww)	20	20	20	17	17	17	17	1	1	1	
Wat to fish BAF	L/kg (fw)	478	218	218	540	-	861	-	218	540	218	
Fish tissue conc.	Bq/kg (fw)	8.23	0.872	0.872	3.24	0.324	4.33	95.22	0.06	0.26	0.06	
Wat to aquatic plant BAF	L/kg (fw)	5090	6215	6215	3748	-	2499	-	6215	3748	6215	
Aquatic plant conc.	Bq/kg (fw)	87.65	24.86	24.86	22.49	2.25	12.56	10.30	1.77	1.80	1.77	
Wat to benthos BAF	L/kg (fw)	276	276	276	486	-	3643	20000	276	486	276	
Benthos conc.	Bq/kg (fw)	4.75	1.10	1.10	2.92	0.29	18.31	50.27	0.08	0.23	0.08	
Int. DCF tissue	Gy/a per Bq/kg (fw)	2.31E-05	4.56E-06	2.41E-05	2.46E-05	1.12E-04	2.19E-06	2.73E-05	2.06E-05	7.12E-06	1.77E-04	
Ext. DCF sediment	Gy/a per Bq/kg (ww)	5.40E-08	1.53E-05	5.35E-08	2.4E-07	6.70E-05	4.56E-06	2.58E-10	4.67E-08	3.55E-05	5.81E-05	
Ext. dose sediment (OFs .5)	mGy/d	1.45E-06	4.12E-04	1.44E-06	5.74E-06	1.60E-03	1.09E-04	6.17E-09	8.95E-08	6.81E-05	1.11E-04	2.31E-03
Int. abs. dose fish	mGy/d	5.21E-04	1.09E-05	5.76E-05	2.18E-04	9.94E-05	2.59E-05	7.12E-03	3.50E-06	5.07E-06	3.01E-05	8.09E-03
Int. abs dose plant	mGy/d	5.55E-03	3.11E-04	1.64E-03	1.52E-03	6.90E-04	7.53E-05	7.70E-04	9.98E-05	3.52E-05	8.57E-04	1.15E-02
Int. abs dose benthos	mGy/d	3.01E-04	1.38E-05	7.29E-05	1.97E-04	8.95E-05	1.10E-04	3.76E-03	4.43E-06	4.56E-06	3.81E-05	4.59E-03
RBE alpha	-	10	1	10	10	10	1	10	10	1	10	
γ eq. . dose fish	mGy/d	5.21E-03	4.23E-04	5.77E-04	2.19E-03	2.60E-03	1.35E-04	7.12E-02	3.51E-05	7.31E-05	4.12E-04	8.29E-02
γ eq. dose plant	mGy/d	5.55E-02	7.23E-04	1.64E-02	1.52E-02	8.50E-03	1.84E-04	7.70E-03	9.98E-04	1.03E-04	8.68E-03	1.14E-01
γ eq. . dose benthos	mGy/d	3.01E-03	8.39E-04	7.32E-04	1.98E-03	4.10E-03	3.28E-04	3.76E-02	4.45E-05	1.41E-04	6.04E-04	4.94E-02

(shaded) value from lake measurement(s) (green font= LT; blue font= average contains a LT used at face value)

red font — PC or BAF based on Lake measurements

blue font — BAF based on in-basin measurements

green font — BAF from literature

Ecological Dose Calculations - Riparian Wildlife - Background

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	Th-228+	TOTAL
Water conc.	Bq/L	0.01722	0.0040	0.004	0.006	0.006	0.005	0.003	0.0003	0.0005	0.0003	
Sed to water PC	L/kg (dw)	11442	49200	49200	29100	29100	34733	69467	49200	29100	49200	
Sediment conc.	Bq/kg (dw)	196.8	196.8	196.8	174.6	174.6	174.6	174.6	14	14	14	
Sediment conc.	Bq/kg (ww)	20	20	20	17	17	17	17	1	1	1	
Wat to fish BAF	L/kg (fw)	478	218	218	540	-	861	-	218	540	218	
Fish tissue conc.	Bq/kg (fw)	8.23	0.87	0.87	3.24	0.32	4.33	95.22	0.062	0.26	0.062	
Wat to aquatic plant BAF	L/kg (fw)	5090	6215	6215	3748	-	2499	-	6215	3748	6215	
Aquatic plant conc.	Bq/kg (fw)	87.65	24.86	24.86	22.49	2.25	12.56	10.30	1.77	1.80	1.77	
Wat to benthos BAF	L/kg (fw)	276	276	276	486	-	3643	20000	276	486	276	
Benthos conc.	Bq/kg (fw)	4.75	1.10	1.10	2.92	0.29	18.31	50.27	0.08	0.23	0.079	
Ing. TF mallard	d/kg	0.008	0.050	0.050	0.046	-	0.162	4.62	0.050	0.046	0.050	
Ing. TF scaup	d/kg	0.008	0.496	0.496	0.423	-	0.162	4.62	0.496	0.423	0.496	
Ing. TF merganser	d/kg	0.163	4.89	4.89	3.91	-	1.99	5.45	4.894	3.910	4.894	
Ing. TF muskrat	d/kg	0.077	0.031	0.031	0.694	-	0.462	0.540	0.031	0.694	0.031	
Ing. TF mink	d/kg	0.080	0.032	0.032	0.717	-	0.478	0.558	0.032	0.717	0.032	
Int. DCF tissue	Gy/a per Bq/kg (fw)	2.31E-05	4.56E-06	2.41E-05	2.46E-05	1.12E-04	2.19E-06	2.73E-05	2.06E-05	7.12E-06	1.77E-04	
Ext. DCF sediment	Gy/a per Bq/kg (ww)	5.40E-08	1.53E-05	5.35E-08	2.4E-07	6.70E-05	4.56E-06	2.58E-10	4.67E-08	3.55E-05	5.81E-05	
Ext. dose sediment (OF_s .5)	mGy/d	7.27E-07	2.06E-04	7.21E-07	2.87E-06	8.01E-04	5.45E-05	3.09E-09	4.47E-08	3.40E-05	5.57E-05	1.16E-03
Int. abs. dose mallard	mGy/d	5.33E-06	2.04E-06	1.08E-05	9.09E-06	1.24E-05	1.64E-06	4.87E-04	6.56E-07	2.11E-07	5.64E-06	5.35E-04
Int. abs. dose scaup	mGy/d	2.79E-07	1.32E-06	6.97E-06	1.10E-05	1.51E-05	1.90E-06	1.80E-03	4.24E-07	2.56E-07	3.64E-06	1.84E-03
Int. abs. dose merganser	mGy/d	1.43E-05	9.84E-06	5.20E-05	1.45E-04	1.99E-04	8.72E-06	6.44E-03	3.16E-06	3.37E-06	2.72E-05	6.90E-03
Int. abs. dose muskrat	mGy/d	1.89E-04	4.63E-06	2.45E-05	5.08E-04	6.93E-04	1.84E-05	2.29E-04	1.49E-06	1.18E-05	1.28E-05	1.69E-03
Int. abs. dose mink	mGy/d	8.37E-06	1.03E-07	5.46E-07	3.38E-05	4.62E-05	2.59E-06	7.58E-04	3.32E-08	7.84E-07	2.85E-07	8.51E-04
RBE alpha	-	10	1	10	10	10	1	10	10	1	10	
γ eq. dose mallard	mGy/d	5.40E-05	2.08E-04	1.09E-04	9.38E-05	9.25E-04	5.62E-05	4.87E-03	6.61E-06	3.43E-05	1.12E-04	6.47E-03
γ eq. dose scaup	mGy/d	3.52E-06	2.08E-04	7.05E-05	1.13E-04	9.52E-04	5.64E-05	1.80E-02	4.29E-06	3.43E-05	9.21E-05	1.96E-02
γ eq. dose merganser	mGy/d	1.44E-04	2.16E-04	5.21E-04	1.46E-03	2.79E-03	6.33E-05	6.44E-02	3.17E-05	3.74E-05	3.27E-04	7.00E-02
γ eq. dose muskrat	mGy/d	1.89E-03	4.17E-04	2.46E-04	5.08E-03	8.54E-03	1.27E-04	2.29E-03	1.50E-05	7.99E-05	2.39E-04	1.89E-02
γ eq. dose mink	mGy/d	8.51E-05	4.13E-04	6.91E-06	3.44E-04	2.06E-03	1.12E-04	7.58E-03	4.22E-07	6.89E-05	1.14E-04	1.08E-02

		Mallard	Scaup	Merganser	Muskrat	Mink		Moose
Body weight	kg	1.134	0.815	1.723	1.415	1.354		400
Ing. water	L/d	0.065	0.051	0.085	0.135	0.142		21.8
Ing. sediment	kg/d (dw)	0.00126	0.00102	0.00017	0.00744	0.000475		0.057
Ing. plant	kg/d (fw)	0.252			0.425			3.3
Ing. benthos	kg/d (fw)		0.204					
Ing. fish	kg/d (fw)			0.331		0.19		
Occupancy factor	-	0.5	0.5	0.5	1.0	1.0		1.0

Human Dose Calculations - Generic Adult - Background

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	TH228+	TOTAL
Water conc.	Bq/L	0.01722	0.0040	0.004	0.006	0.006	0.005027	0.003	0.0003	0.0005	0.0003	
Wat to fish BAF	L/kg (fw)	11.4	5.2	5.2	19.1	-	30.5	171.9	5.2	19.1	5.2	
Sport fish tissue conc.	Bq/kg (fw)	0.196	0.021	0.021	0.115	0.011	0.153	0.432	0.001	0.009	0.001	
Moose wb conc.	Bq/kg (fw)	0.33	0.037	0.037	0.85	0.26	0.35	0.34	0.003	0.068	0.003	
Moose meat conc.	Bq/kg (fw)	0.17	0.024	0.024	0.32	0.095	0.13	0.20	0.002	0.025	0.002	
Mallard duck wb conc.	Bq/kg (fw)	0.084	0.16	0.16	0.13	0.040	0.27	6.51	0.012	0.011	0.012	
Mallard duck meat conc.	Bq/kg (fw)	0.042	0.10	0.10	0.050	0.015	0.10	3.84	0.007	0.004	0.007	
Ingestion rate water	L/a	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	
Ingestion rate fish	kg/a	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	
Ingestion rate moose	kg/a	1	1	1	1	1	1	1	1	1	1	
Ingestion rate mallard	kg/a	1	1	1	1	1	1	1	1	1	1	
Exposure via water	Bq/a	9.43	2.19	2.19	3.29	3.29	2.75	1.38	0.16	0.26	0.16	
Exposure via fish	Bq/a	0.57	0.06	0.06	0.33	0.03	0.45	1.26	0.00	0.03	0.00	
Exposure via moose	Bq/a	0.17	0.02	0.02	0.32	0.09	0.13	0.20	0.00	0.03	0.00	
Exposure via mallard	Bq/a	0.04	0.10	0.10	0.05	0.01	0.10	3.84	0.01	0.00	0.01	
Ingestion DCF adult	Sv/Bq	4.70E-08	3.40E-09	2.10E-07	2.80E-07	2.50E-10	6.91E-07	1.20E-06	2.30E-07	6.90E-07	7.20E-08	
Dose via water	mSv/a	4.43E-04	7.45E-06	4.60E-04	9.20E-04	8.21E-07	1.90E-03	1.65E-03	3.58E-05	1.82E-04	1.12E-05	5.61E-03
Dose via fish	mSv/a	2.69E-05	2.06E-07	1.28E-05	9.37E-05	8.37E-09	3.09E-04	1.51E-03	9.94E-07	1.85E-05	3.11E-07	1.98E-03
Dose via moose	mSv/a	7.78E-06	8.00E-08	4.94E-06	8.82E-05	2.36E-08	9.07E-05	2.43E-04	3.85E-07	1.74E-05	1.20E-07	4.53E-04
Dose via mallard	mSv/a	1.98E-06	3.50E-07	2.16E-05	1.40E-05	3.74E-09	7.19E-05	4.61E-03	1.69E-06	2.76E-06	5.28E-07	4.72E-03
Total ingestion dose	mSv/a	4.80E-04	8.08E-06	4.99E-04	1.12E-03	8.57E-07	2.37E-03	8.02E-03	3.89E-05	2.20E-04	1.22E-05	1.28E-02

Ecological Dose Calculations - Aquatic Biota - Elliot Lake

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	Th-228+	TOTAL
Water conc.	Bq/L	0.04182	0.0338	0.01	0.01	0.01	0.03	0.01	0.0016	0.0034	0.0035	
Sed to water PC	L/kg (dw)	79412	49200	49200	23517	23517	25333	50666	49200	23517	49200	
Sediment conc.	Bq/kg (dw)	3321	1660.5	1040	630	630	760	740	80	80	170	
Sediment conc.	Bq/kg (ww)	332	166	104	63	63	76	74	8	8	17	
Wat to fish BAF	L/kg (fw)	478	218	218	540	-	861	-	218	540	218	
Fish tissue conc.	Bq/kg (fw)	14.9241	7.3575	4.33	11	1.1	20	29	0.35	116.7	0.75	
Wat to aquatic plant BAF	L/kg (fw)	5090	6215	6215	3748	-	2499	-	6215	3748	6215	
Aquatic plant conc.	Bq/kg (fw)	21.279	209.76	4.0	27	2.70	11.5	4.75	1.25	12.75	1.75	
Wat to benthos BAF	L/kg (fw)	276	276	276	486	-	3643	20000	276	486	276	
Benthos conc.	Bq/kg (fw)	11.54	9.32	2.76	4.86	0.49	109.29	200.00	0.45	1.65	0.95	
Int. DCF tissue	Gy/a per Bq/kg (fw)	2.31E-05	4.56E-06	2.41E-05	2.46E-05	1.12E-04	2.19E-06	2.73E-05	2.06E-05	7.12E-06	1.77E-04	
Ext. DCF sediment	Gy/a per Bq/kg (ww)	5.40E-08	1.53E-05	5.35E-08	2.4E-07	6.70E-05	4.56E-06	2.58E-10	4.67E-08	3.55E-05	5.81E-05	
Ext. dose sediment (OFs .5)	mGy/d	2.45E-05	3.48E-03	7.62E-06	2.07E-05	5.78E-03	4.75E-04	2.62E-08	5.11E-07	3.89E-04	1.35E-03	1.15E-02
Int. abs. dose fish	mGy/d	9.45E-04	9.19E-05	2.86E-04	7.41E-04	3.38E-04	1.20E-04	2.17E-03	2.00E-05	2.28E-03	3.65E-04	7.35E-03
Int. abs dose plant	mGy/d	1.35E-03	2.62E-03	2.64E-04	1.82E-03	8.28E-04	6.89E-05	3.55E-04	7.05E-05	2.49E-04	8.48E-04	8.47E-03
Int. abs dose benthos	mGy/d	7.30E-04	1.16E-04	1.82E-04	3.28E-04	1.49E-04	6.55E-04	1.50E-02	2.53E-05	3.23E-05	4.62E-04	1.76E-02
RBE alpha	-	10	1	10	10	10	1	10	10	1	10	
γ eq. . dose fish	mGy/d	9.47E-03	3.57E-03	2.87E-03	7.43E-03	9.16E-03	5.95E-04	2.17E-02	2.01E-04	2.67E-03	5.00E-03	6.27E-02
γ eq. dose plant	mGy/d	1.35E-02	6.10E-03	2.65E-03	1.82E-02	1.41E-02	5.44E-04	3.55E-03	7.06E-04	6.38E-04	9.83E-03	6.98E-02
γ eq. . dose benthos	mGy/d	7.35E-03	7.08E-03	1.84E-03	3.32E-03	1.31E-02	1.60E-03	1.50E-01	2.54E-04	8.10E-04	7.33E-03	1.92E-01

Ecological Dose Calculations - Riparian Wildlife - Elliot Lake

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	Th-228+	TOTAL
Water conc.	Bq/L	0.04182	0.0338	0.01	0.01	0.01	0.03	0.01	0.0016	0.0034	0.0035	
Sed to water PC	L/kg (dw)	79412	49200	49200	23517	23517	25333	50666	49200	23517	49200	
Sediment conc.	Bq/kg (dw)	3321	1660.5	1040	630	630	760	740	80	80	170	
Sediment conc.	Bq/kg (ww)	332	166	104	63	63	76	74	8	8	17	
Wat to fish BAF	L/kg (fw)	478	218	218	540	-	861	-	218	540	218	
Fish tissue conc.	Bq/kg (fw)	14.924082	7.3575	4.33	11	1.1	20.00	29	0.35	116.7	0.75	
Wat to aquatic plant BAF	L/kg (fw)	5090	6215	6215	3748	-	2499	-	6215	3748	6215	
Aquatic plant conc.	Bq/kg (fw)	21.279	209.76	4	27	2.70	11.5	4.75	1.25	12.75	1.75	
Wat to benthos BAF	L/kg (fw)	276	276	276	486	-	3643	20000	276	486	276	
Benthos conc.	Bq/kg (fw)	11.54	9.32	2.76	4.86	0.49	109.29	200.00	0.45	1.65	0.95	
Ing. TF mallard	d/kg	0.008	0.050	0.050	0.046	-	0.162	4.62	0.050	0.046	0.050	
Ing. TF scaup	d/kg	0.008	0.496	0.496	0.423	-	0.162	4.62	0.496	0.423	0.496	
Ing. TF merganser	d/kg	0.163	4.89	4.89	3.91	-	1.99	5.45	4.894	3.910	4.894	
Ing. TF muskrat	d/kg	0.077	0.031	0.031	0.694	-	0.462	0.540	0.031	0.694	0.031	
Ing. TF mink	d/kg	0.080	0.032	0.032	0.717	-	0.478	0.558	0.032	0.717	0.032	
Int. DCF tissue	Gy/a per Bq/kg (fw)	2.31E-05	4.56E-06	2.41E-05	2.46E-05	1.12E-04	2.19E-06	2.73E-05	2.06E-05	7.12E-06	1.77E-04	
Ext. DCF sediment	Gy/a per Bq/kg (ww)	5.40E-08	1.53E-05	5.35E-08	2.4E-07	6.70E-05	4.56E-06	2.58E-10	4.67E-08	3.55E-05	5.81E-05	
Ext. dose sediment (OF_s .5)	mGy/d	1.23E-05	1.74E-03	3.81E-06	1.04E-05	2.89E-03	2.37E-04	1.31E-08	2.56E-07	1.95E-04	6.77E-04	5.77E-03
Int. abs. dose mallard	mGy/d	2.28E-06	1.72E-05	3.84E-06	1.17E-05	1.60E-05	1.87E-06	3.68E-04	5.89E-07	1.48E-06	7.97E-06	4.31E-04
Int. abs. dose scaup	mGy/d	1.37E-06	1.11E-05	2.66E-05	2.33E-05	3.18E-05	1.12E-05	7.18E-03	2.42E-06	1.73E-06	4.42E-05	7.34E-03
Int. abs. dose merganser	mGy/d	2.84E-05	8.31E-05	2.60E-04	4.94E-04	6.75E-04	4.03E-05	1.98E-03	1.81E-05	1.48E-03	3.30E-04	5.39E-03
Int. abs. dose muskrat	mGy/d	1.65E-04	3.91E-05	1.92E-05	7.56E-04	1.03E-03	2.92E-05	3.04E-04	1.96E-06	8.14E-05	3.00E-05	2.46E-03
Int. abs. dose mink	mGy/d	2.23E-05	8.72E-07	2.77E-06	1.16E-04	1.58E-04	1.19E-05	2.45E-04	1.90E-07	3.11E-04	3.47E-06	8.70E-04
RBE alpha	-	10	1	10	10	10	1	10	10	1	10	
γ eq. dose mallard	mGy/d	3.51E-05	1.76E-03	4.22E-05	1.28E-04	3.05E-03	2.39E-04	3.68E-03	6.15E-06	1.96E-04	7.56E-04	9.89E-03
γ eq. dose scaup	mGy/d	2.60E-05	1.75E-03	2.70E-04	2.44E-04	3.21E-03	2.49E-04	7.18E-02	2.45E-05	1.96E-04	1.12E-03	7.89E-02
γ eq. dose merganser	mGy/d	2.97E-04	1.82E-03	2.60E-03	4.95E-03	9.64E-03	2.78E-04	1.98E-02	1.81E-04	1.67E-03	3.98E-03	4.53E-02
γ eq. dose muskrat	mGy/d	1.67E-03	3.52E-03	2.00E-04	7.58E-03	1.61E-02	5.04E-04	3.04E-03	2.01E-05	4.70E-04	1.65E-03	3.48E-02
γ eq. dose mink	mGy/d	2.47E-04	3.48E-03	3.54E-05	1.18E-03	7.36E-03	4.87E-04	2.45E-03	2.41E-06	7.00E-04	1.39E-03	1.73E-02

		Mallard	Scaup	Merganser	Muskrat	Mink		Moose
Body weight	kg	1.134	0.815	1.723	1.415	1.354		400
Ing. water	L/d	0.065	0.051	0.085	0.135	0.142		21.8
Ing. sediment	kg/d (dw)	0.00126	0.00102	0.00017	0.00744	0.000475		0.057
Ing. plant	kg/d (fw)	0.252			0.425			3.3
Ing. benthos	kg/d (fw)		0.204					
Ing. fish	kg/d (fw)			0.331		0.19		
Occupancy factor	-	0.5	0.5	0.5	1.0	1.0		1.0

Human Dose Calculations - Generic Adult - Elliot Lake

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	TH228+	TOTAL
Water conc.	Bq/L	0.04182	0.0338	0.01	0.01	0.01	0.03	0.01	0.0016	0.0034	0.0035	
Wat to fish BAF	L/kg (fw)	11.4	5.2	5.2	19.1	-	30.5	171.9	5.2	19.1	5.2	
Sport fish tissue conc.	Bq/kg (fw)	0.477	0.175	0.052	0.191	0.019	0.914	1.719	0.008	0.065	0.018	
Moose wb conc.	Bq/kg (fw)	0.29	0.32	0.03	1.26	0.38	0.55	0.45	0.00	0.47	0.01	
Moose meat conc.	Bq/kg (fw)	0.14	0.20	0.02	0.47	0.14	0.21	0.27	0.002	0.17	0.004	
Mallard duck wb conc.	Bq/kg (fw)	0.04	1.38	0.06	0.17	0.05	0.31	4.92	0.01	0.08	0.02	
Mallard duck meat conc.	Bq/kg (fw)	0.02	0.87	0.04	0.06	0.02	0.12	2.90	0.01	0.028	0.01	
Ingestion rate water	L/a	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	
Ingestion rate fish	kg/a	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	
Ingestion rate moose	kg/a	1	1	1	1	1	1	1	1	1	1	
Ingestion rate mallard	kg/a	1	1	1	1	1	1	1	1	1	1	
Exposure via water	Bq/a	22.90	18.48	5.48	5.48	5.48	16.43	5.48	0.89	1.86	1.89	
Exposure via fish	Bq/a	1.39	0.51	0.15	0.56	0.06	2.67	5.02	0.02	0.19	0.05	
Exposure via moose	Bq/a	0.14	0.20	0.02	0.47	0.14	0.21	0.27	0.00	0.17	0.00	
Exposure via mallard	Bq/a	0.02	0.87	0.04	0.06	0.02	0.12	2.90	0.01	0.03	0.01	
Ingestion DCF adult	Sv/Bq	4.70E-08	3.40E-09	2.10E-07	2.80E-07	2.50E-10	6.91E-07	1.20E-06	2.30E-07	6.90E-07	7.20E-08	
Dose via water	mSv/a	1.08E-03	6.28E-05	1.15E-03	1.53E-03	1.37E-06	1.14E-02	6.57E-03	2.05E-04	1.29E-03	1.36E-04	2.34E-02
Dose via fish	mSv/a	6.54E-05	1.74E-06	3.19E-05	1.56E-04	1.39E-08	1.84E-03	6.02E-03	5.68E-06	1.31E-04	3.78E-06	8.26E-03
Dose via moose	mSv/a	6.73E-06	6.75E-07	3.85E-06	1.31E-04	3.51E-08	1.44E-04	3.21E-04	5.05E-07	1.20E-04	2.82E-07	7.28E-04
Dose via mallard	mSv/a	8.46E-07	2.95E-06	7.70E-06	1.80E-05	4.83E-09	8.19E-05	3.48E-03	1.51E-06	1.94E-05	7.46E-07	3.62E-03
Total ingestion dose	mSv/a	1.15E-03	6.82E-05	1.19E-03	1.84E-03	1.42E-06	1.34E-02	1.64E-02	2.12E-04	1.56E-03	1.41E-04	3.60E-02

Human Dose Calculations - SRFN Adult - Elliot Lake

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	TH228+	TOTAL
Water conc.	Bq/L	0.04182	0.0338	0.01	0.01	0.01	0.03	0.01	0.0016	0.0034	0.0035	
Wat to fish BAF	L/kg (fw)	11.4	5.2	5.2	19.1	-	30.5	171.9	5.2	19.1	5.2	
Sport fish tissue conc.	Bq/kg (fw)	0.477	0.175	0.052	0.191	0.019	0.914	1.719	0.008	0.065	0.018	
Moose wb conc.	Bq/kg (fw)	0.29	0.32	0.03	1.26	0.38	0.55	0.45	0.00	0.47	0.01	
Moose meat conc.	Bq/kg (fw)	0.14	0.20	0.02	0.47	0.14	0.21	0.27	0.002	0.28	0.004	
Mallard duck wb conc.	Bq/kg (fw)	0.04	1.38	0.06	0.17	0.05	0.31	4.92	0.01	0.08	0.02	
Mallard duck meat conc.	Bq/kg (fw)	0.02	0.87	0.04	0.06	0.02	0.12	2.90	0.01	0.04	0.01	
Ingestion rate water	L/a	16.425	16.425	16.425	16.425	16.425	16.425	16.425	16.425	16.425	16.425	
Ingestion rate fish	kg/a	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	0.38	
Ingestion rate moose	kg/a	0.605	0.605	0.605	0.605	0.605	0.605	0.605	0.605	0.605	0.605	
Ingestion rate mallard	kg/a	0.0093	0.0093	0.0093	0.0093	0.0093	0.0093	0.0093	0.0093	0.0093	0.0093	
Exposure via water	Bq/a	0.69	0.55	0.16	0.16	0.16	0.49	0.16	0.03	0.06	0.06	
Exposure via fish	Bq/a	0.18	0.07	0.02	0.07	0.01	0.35	0.65	0.00	0.02	0.01	
Exposure via moose	Bq/a	0.09	0.12	0.01	0.28	0.08	0.13	0.16	0.00	0.17	0.00	
Exposure via mallard	Bq/a	0.00	0.01	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	
Ingestion DCF adult	Sv/Bq	4.70E-08	3.40E-09	2.10E-07	2.80E-07	2.50E-10	6.91E-07	1.20E-06	2.30E-07	6.90E-07	7.20E-08	
Dose via water	mSv/a	3.23E-05	1.88E-06	3.45E-05	4.60E-05	4.11E-08	3.41E-04	1.97E-04	6.14E-06	3.86E-05	4.09E-06	7.01E-04
Dose via fish	mSv/a	8.54E-06	2.27E-07	4.16E-06	2.04E-05	1.82E-09	2.41E-04	7.86E-04	7.41E-07	1.71E-05	4.93E-07	1.08E-03
Dose via moose	mSv/a	4.07E-06	4.08E-07	2.33E-06	7.93E-05	2.12E-08	8.72E-05	1.94E-04	2.86E-07	1.16E-04	1.60E-07	4.84E-04
Dose via mallard	mSv/a	7.83E-09	2.73E-08	7.12E-08	1.67E-07	4.47E-11	7.57E-07	3.22E-05	1.31E-08	2.86E-07	6.46E-09	3.36E-05
Total ingestion dose	mSv/a	4.49E-05	2.55E-06	4.11E-05	1.46E-04	6.42E-08	6.69E-04	1.21E-03	7.18E-06	1.72E-04	4.75E-06	2.30E-03

Human Dose Calculations - SRFN Adult - Elliot Lake

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	TH228+	TOTAL
Water conc.	Bq/L	0.04182	0.0338	0.01	0.01	0.01	0.03	0.01	0.0016	0.0034	0.0035	
Wat to fish BAF	L/kg (fw)	11.4	5.2	5.2	19.1	-	30.5	171.9	5.2	19.1	5.2	
Sport fish tissue conc.	Bq/kg (fw)	0.477	0.175	0.052	0.191	0.019	0.914	1.719	0.008	0.065	0.018	
Moose wb conc.	Bq/kg (fw)	0.29	0.32	0.03	1.26	0.38	0.55	0.45	0.00	0.47	0.01	
Moose meat conc.	Bq/kg (fw)	0.14	0.20	0.02	0.47	0.14	0.21	0.27	0.002	0.28	0.004	
Mallard duck wb conc.	Bq/kg (fw)	0.04	1.38	0.06	0.17	0.05	0.31	4.92	0.01	0.08	0.02	
Mallard duck meat conc.	Bq/kg (fw)	0.02	0.87	0.04	0.06	0.02	0.12	2.90	0.01	0.04	0.01	
Ingestion rate water	L/a	5.475	5.475	5.475	5.475	5.475	5.475	5.475	5.475	5.475	5.475	
Ingestion rate fish	kg/a	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	
Ingestion rate moose	kg/a	0.605	0.605	0.605	0.605	0.605	0.605	0.605	0.605	0.605	0.605	
Ingestion rate mallard	kg/a	0	0	0	0	0	0	0	0	0	0	
Exposure via water	Bq/a	0.23	0.18	0.05	0.05	0.05	0.16	0.05	0.01	0.02	0.02	
Exposure via fish	Bq/a	0.06	0.02	0.01	0.02	0.00	0.12	0.22	0.00	0.01	0.00	
Exposure via moose	Bq/a	0.09	0.12	0.01	0.28	0.08	0.13	0.16	0.00	0.17	0.00	
Exposure via mallard	Bq/a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Ingestion DCF adult	Sv/Bq	4.70E-08	3.40E-09	2.10E-07	2.80E-07	2.50E-10	6.91E-07	1.20E-06	2.30E-07	6.90E-07	7.20E-08	
Dose via water	mSv/a	1.08E-05	6.28E-07	1.15E-05	1.53E-05	1.37E-08	1.14E-04	6.57E-05	2.05E-06	1.29E-05	1.36E-06	2.34E-04
Dose via fish	mSv/a	2.85E-06	7.58E-08	1.39E-06	6.79E-06	6.06E-10	8.02E-05	2.62E-04	2.47E-07	5.69E-06	1.64E-07	3.59E-04
Dose via moose	mSv/a	4.07E-06	4.08E-07	2.33E-06	7.93E-05	2.12E-08	8.72E-05	1.94E-04	2.86E-07	1.16E-04	1.60E-07	4.84E-04
Dose via mallard	mSv/a	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total ingestion dose	mSv/a	1.77E-05	1.11E-06	1.52E-05	1.01E-04	3.55E-08	2.81E-04	5.22E-04	2.58E-06	1.35E-04	1.69E-06	1.08E-03

Ecological Dose Calculations - Aquatic Biota - May Lake

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	Th-228+	TOTAL
Water conc.	Bq/L	0.0369	0.004	0.01	0.05	0.05	0.019	0.01	0.01	0.10	0.01	
Sed to water PC	L/kg (dw)	10667	49200	49200	4400	4400	34733	69466	49200	4400	49200	
Sediment conc.	Bq/kg (dw)	393.6	196.8	5100	220	220	660	780	780	500	660	
Sediment conc.	Bq/kg (ww)	39	20	510	22	22	66	78	78	50	66	
Wat to fish BAF	L/kg (fw)	478	218	218	540	-	861	-	218	540	218	
Fish tissue conc.	Bq/kg (fw)	5.412	0.872	5	13	1.3	23.333	453.333	2.18	143.33	5.667	
Wat to aquatic plant BAF	L/kg (fw)	5090	6215	6215	3748	-	2499	-	6215	3748	6215	
Aquatic plant conc.	Bq/kg (fw)	61.9551	24.86	31.5	109.35	10.94	83.85	85.05	6.05	53	13.875	
Wat to benthos BAF	L/kg (fw)	276	276	276	486	-	3643	20000	276	486	276	
Benthos conc.	Bq/kg (fw)	10.18	1.10	2.76	24.30	2.43	69.22	200.00	2.76	48.60	2.76	
Int. DCF tissue	Gy/a per Bq/kg (fw)	2.31E-05	4.56E-06	2.41E-05	2.46E-05	1.12E-04	2.19E-06	2.73E-05	2.06E-05	7.12E-06	1.77E-04	
Ext. DCF sediment	Gy/a per Bq/kg (ww)	5.40E-08	1.53E-05	5.35E-08	2.4E-07	6.70E-05	4.56E-06	2.58E-10	4.67E-08	3.55E-05	5.81E-05	
Ext. dose sediment (OF_s .5)	mGy/d	2.91E-06	4.12E-04	3.74E-05	7.23E-06	2.02E-03	4.12E-04	2.76E-08	4.98E-06	2.43E-03	5.25E-03	1.06E-02
Int. abs. dose fish	mGy/d	3.43E-04	1.09E-05	3.30E-04	8.76E-04	3.99E-04	1.40E-04	3.39E-02	1.23E-04	2.80E-03	2.75E-03	4.17E-02
Int. abs dose plant	mGy/d	3.92E-03	3.11E-04	2.08E-03	7.37E-03	3.36E-03	5.02E-04	6.36E-03	3.41E-04	1.03E-03	6.72E-03	3.20E-02
Int. abs dose benthos	mGy/d	6.45E-04	1.38E-05	1.82E-04	1.64E-03	7.46E-04	4.15E-04	1.50E-02	1.56E-04	9.48E-04	1.34E-03	2.10E-02
RBE alpha	-	10	1	10	10	10	1	10	10	1	10	
γ eq. . dose fish	mGy/d	3.43E-03	4.23E-04	3.34E-03	8.77E-03	6.01E-03	5.52E-04	3.39E-01	1.24E-03	5.23E-03	3.27E-02	4.01E-01
γ eq. dose plant	mGy/d	3.92E-02	7.23E-04	2.08E-02	7.37E-02	3.56E-02	9.15E-04	6.36E-02	3.42E-03	3.47E-03	7.25E-02	3.14E-01
γ eq. . dose benthos	mGy/d	6.45E-03	8.39E-04	1.90E-03	1.64E-02	1.15E-02	1.24E-03	1.50E-01	1.57E-03	5.81E-03	2.39E-02	2.19E-01

Ecological Dose Calculations - Riparian Wildlife - May Lake

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	Th-228+	TOTAL
Water conc.	Bq/L	0.0369	0.004	0.01	0.05	0.05	0.019	0.01	0.01	0.10	0.01	
Sed to water PC	L/kg (dw)	10667	49200	49200	4400	4400	34733	69466	49200	4400	49200	
Sediment conc.	Bq/kg (dw)	393.6	196.8	5100	220	220	660	780	780	500	660	
Sediment conc.	Bq/kg (ww)	39	20	510	22	22	66	78	78	50	66	
Wat to fish BAF	L/kg (fw)	478	218	218	540	-	861	-	218	540	218	
Fish tissue conc.	Bq/kg (fw)	5.412	0.872	5	13	1.3	23.333	453.333	2.18	143.33	5.667	
Wat to aquatic plant BAF	L/kg (fw)	5090	6215	6215	3748	-	2499	-	6215	3748	6215	
Aquatic plant conc.	Bq/kg (fw)	61.9551	24.86	31.5	109.35	10.94	83.85	85.05	6.05	53	13.875	
Wat to benthos BAF	L/kg (fw)	276	276	276	486	-	3643	20000	276	486	276	
Benthos conc.	Bq/kg (fw)	10.18	1.10	2.76	24.30	2.43	69.22	200.00	2.76	48.60	2.76	
Ing. TF mallard	d/kg	0.008	0.050	0.050	0.046	-	0.162	4.62	0.050	0.046	0.050	
Ing. TF scaup	d/kg	0.008	0.496	0.496	0.423	-	0.162	4.62	0.496	0.423	0.496	
Ing. TF merganser	d/kg	0.163	4.89	4.89	3.91	-	1.99	5.45	4.894	3.910	4.894	
Ing. TF muskrat	d/kg	0.077	0.031	0.031	0.694	-	0.462	0.540	0.031	0.694	0.031	
Ing. TF mink	d/kg	0.080	0.032	0.032	0.717	-	0.478	0.558	0.032	0.717	0.032	
Int. DCF tissue	Gy/a per Bq/kg (fw)	2.31E-05	4.56E-06	2.41E-05	2.46E-05	1.12E-04	2.19E-06	2.73E-05	2.06E-05	7.12E-06	1.77E-04	
Ext. DCF sediment	Gy/a per Bq/kg (ww)	5.40E-08	1.53E-05	5.35E-08	2.4E-07	6.70E-05	4.56E-06	2.58E-10	4.67E-08	3.55E-05	5.81E-05	
Ext. dose sediment (OF_s .5)	mGy/d	1.45E-06	2.06E-04	1.87E-05	3.62E-06	1.01E-03	2.06E-04	1.38E-08	2.49E-06	1.22E-03	2.63E-03	5.29E-03
Int. abs. dose mallard	mGy/d	3.84E-06	2.04E-06	2.38E-05	4.30E-05	5.87E-05	1.06E-05	3.87E-03	3.55E-06	6.25E-06	5.27E-05	4.08E-03
Int. abs. dose scaup	mGy/d	5.92E-07	1.32E-06	9.43E-05	7.40E-05	1.01E-04	7.16E-06	7.19E-03	1.90E-05	4.31E-05	1.49E-04	7.68E-03
Int. abs. dose merganser	mGy/d	9.63E-06	9.84E-06	4.04E-04	5.73E-04	7.83E-04	4.67E-05	3.06E-02	1.18E-04	1.82E-03	2.36E-03	3.68E-02
Int. abs. dose muskrat	mGy/d	1.43E-04	4.63E-06	1.04E-04	2.25E-03	3.07E-03	1.12E-04	1.69E-03	1.46E-05	3.55E-04	1.61E-04	7.91E-03
Int. abs. dose mink	mGy/d	6.15E-06	1.03E-07	7.10E-06	1.25E-04	1.70E-04	1.36E-05	3.61E-03	1.41E-06	3.84E-04	2.15E-05	4.34E-03
RBE alpha	-	10	1	10	10	10	1	10	10	1	10	
γ eq. dose mallard	mGy/d	3.99E-05	2.08E-04	2.57E-04	4.34E-04	1.60E-03	2.17E-04	3.87E-02	3.80E-05	1.22E-03	3.15E-03	4.59E-02
γ eq. dose scaup	mGy/d	7.37E-06	2.08E-04	9.62E-04	7.43E-04	2.02E-03	2.13E-04	7.19E-02	1.93E-04	1.26E-03	4.11E-03	8.16E-02
γ eq. dose merganser	mGy/d	9.78E-05	2.16E-04	4.06E-03	5.74E-03	8.84E-03	2.53E-04	3.06E-01	1.18E-03	3.03E-03	2.62E-02	3.56E-01
γ eq. dose muskrat	mGy/d	1.43E-03	4.17E-04	1.08E-03	2.25E-02	3.27E-02	5.25E-04	1.69E-02	1.51E-04	2.79E-03	6.87E-03	8.54E-02
γ eq. dose mink	mGy/d	6.44E-05	4.13E-04	1.08E-04	1.25E-03	3.72E-03	4.26E-04	3.61E-02	1.91E-05	2.82E-03	5.47E-03	5.04E-02

		Mallard	Scaup	Merganser	Muskrat	Mink		Moose
Body weight	kg	1.134	0.815	1.723	1.415	1.354		400
Ing. water	L/d	0.065	0.051	0.085	0.135	0.142		21.8
Ing. sediment	kg/d (dw)	0.00126	0.00102	0.00017	0.00744	0.000475		0.057
Ing. plant	kg/d (fw)	0.252			0.425			3.3
Ing. benthos	kg/d (fw)		0.204					
Ing. fish	kg/d (fw)			0.331		0.19		
Occupancy factor	-	0.5	0.5	0.5	1.0	1.0		1.0

Human Dose Calculations - Generic Adult - May Lake

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	TH228+	TOTAL
Water conc.	Bq/L	0.0369	0.004	0.01	0.05	0.05	0.0190	0.01	0.01	0.10	0.01	
Water to fish BCF	L/kg (fw)	11.4	5.2	5.2	19.1	-	30.5	171.9	5.2	19.1	5.2	
Sport fish tissue conc.	Bq/kg (fw)	0.421	0.021	0.052	0.955	0.096	0.579	1.719	0.052	1.910	0.052	
Moose wb conc.	Bq/kg (fw)	0.25	0.04	0.16	3.78	1.13	2.11	2.54	0.03	2.08	0.03	
Moose meat conc.	Bq/kg (fw)	0.13	0.02	0.10	1.40	0.42	0.80	1.50	0.02	0.77	0.02	
Mallard duck wb conc.	Bq/kg (fw)	0.06	0.16	0.36	0.64	0.19	1.77	51.80	0.06	0.32	0.11	
Mallard duck meat conc.	Bq/kg (fw)	0.03	0.10	0.23	0.24	0.07	0.67	30.56	0.04	0.12	0.07	
Ingestion rate water	L/a	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	
Ingestion rate fish	kg/a	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	
Ingestion rate moose	kg/a	1	1	1	1	1	1	1	1	1	1	
Ingestion rate mallard	kg/a	1	1	1	1	1	1	1	1	1	1	
Exposure via water	Bq/a	20.20	2.19	5.48	27.38	27.38	10.40	5.48	5.48	54.75	5.48	
Exposure via fish	Bq/a	1.23	0.06	0.15	2.79	0.28	1.69	5.02	0.15	5.58	0.15	
Exposure via moose	Bq/a	0.13	0.02	0.10	1.40	0.42	0.80	1.50	0.02	0.77	0.02	
Exposure via mallard	Bq/a	0.03	0.10	0.23	0.24	0.07	0.67	30.56	0.04	0.12	0.07	
Ingestion DCF adult	Sv/Bq	4.70E-08	3.40E-09	2.10E-07	2.80E-07	2.50E-10	6.91E-07	1.20E-06	2.30E-07	6.90E-07	7.20E-08	
Dose via water	mSv/a	9.50E-04	7.45E-06	1.15E-03	7.67E-03	6.84E-06	7.19E-03	6.57E-03	1.26E-03	3.78E-02	3.94E-04	6.30E-02
Dose via fish	mSv/a	5.77E-05	2.06E-07	3.19E-05	7.81E-04	6.97E-08	1.17E-03	6.02E-03	3.49E-05	3.85E-03	1.09E-05	1.20E-02
Dose via moose	mSv/a	5.89E-06	8.00E-08	2.09E-05	3.92E-04	1.05E-07	5.54E-04	1.80E-03	3.75E-06	5.30E-04	1.52E-06	3.30E-03
Dose via mallard	mSv/a	1.43E-06	3.50E-07	4.77E-05	6.61E-05	1.77E-08	4.66E-04	3.67E-02	9.12E-06	8.19E-05	4.93E-06	3.74E-02
Total ingestion dose	mSv/a	1.01E-03	8.08E-06	1.25E-03	8.90E-03	7.04E-06	9.38E-03	5.11E-02	1.31E-03	4.22E-02	4.12E-04	1.16E-01

Human Dose Calculations - SRFN Adult - May Lake

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	TH228+	TOTAL
Water conc.	Bq/L	0.0369	0.004	0.01	0.05	0.05	0.0190	0.01	0.01	0.10	0.01	
Water to fish BCF	L/kg (fw)	11.4	5.2	5.2	19.1	-	30.5	171.9	5.2	19.1	5.2	
Sport fish tissue conc.	Bq/kg (fw)	0.421	0.021	0.052	0.955	0.096	0.579	1.719	0.052	1.910	0.052	
Moose wb conc.	Bq/kg (fw)	0.25	0.04	0.16	3.78	1.13	2.11	2.54	0.03	2.08	0.03	
Moose meat conc.	Bq/kg (fw)	0.13	0.02	0.10	1.40	0.42	0.80	1.50	0.02	0.77	0.02	
Mallard duck wb conc.	Bq/kg (fw)	0.06	0.16	0.36	0.64	0.19	1.77	51.80	0.06	0.32	0.11	
Mallard duck meat conc.	Bq/kg (fw)	0.03	0.10	0.23	0.24	0.07	0.67	30.56	0.04	0.12	0.07	
Ingestion rate water	L/a	0	0	0	0	0	0	0	0	0	0	
Ingestion rate fish	kg/a	0	0	0	0	0	0	0	0	0	0	
Ingestion rate moose	kg/a	0.605	0.605	0.605	0.605	0.605	0.605	0.605	0.605	0.605	0.605	
Ingestion rate mallard	kg/a	0.0093	0.0093	0.0093	0.0093	0.0093	0.0093	0.0093	0.0093	0.0093	0.0093	
Exposure via water	Bq/a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Exposure via fish	Bq/a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Exposure via moose	Bq/a	0.08	0.01	0.06	0.85	0.25	0.48	0.91	0.01	0.46	0.01	
Exposure via mallard	Bq/a	0.00	0.00	0.00	0.00	0.00	0.01	0.28	0.00	0.00	0.00	
Ingestion DCF adult	Sv/Bq	4.70E-08	3.40E-09	2.10E-07	2.80E-07	2.50E-10	6.91E-07	1.20E-06	2.30E-07	6.90E-07	7.20E-08	
Dose via water	mSv/a	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dose via fish	mSv/a	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dose via moose	mSv/a	3.56E-06	4.84E-08	1.26E-05	2.37E-04	6.35E-08	3.35E-04	1.09E-03	2.27E-06	3.21E-04	9.18E-07	2.00E-03
Dose via mallard	mSv/a	1.32E-08	3.24E-09	4.41E-07	6.11E-07	1.64E-10	4.31E-06	3.39E-04	8.44E-08	7.57E-07	4.56E-08	3.45E-04
Total ingestion dose	mSv/a	3.57E-06	5.16E-08	1.31E-05	2.38E-04	6.37E-08	3.39E-04	1.43E-03	2.35E-06	3.21E-04	9.64E-07	2.34E-03

Human Dose Calculations - SRFN Adult - May Lake

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	TH228+	TOTAL
Water conc.	Bq/L	0.0369	0.004	0.01	0.05	0.05	0.0190	0.01	0.01	0.10	0.01	
Water to fish BCF	L/kg (fw)	11.4	5.2	5.2	19.1	-	30.5	171.9	5.2	19.1	5.2	
Sport fish tissue conc.	Bq/kg (fw)	0.421	0.021	0.052	0.955	0.096	0.579	1.719	0.052	1.910	0.052	
Moose wb conc.	Bq/kg (fw)	0.25	0.04	0.16	3.78	1.13	2.11	2.54	0.03	2.08	0.03	
Moose meat conc.	Bq/kg (fw)	0.13	0.02	0.10	1.40	0.42	0.80	1.50	0.02	0.77	0.02	
Mallard duck wb conc.	Bq/kg (fw)	0.06	0.16	0.36	0.64	0.19	1.77	51.80	0.06	0.32	0.11	
Mallard duck meat conc.	Bq/kg (fw)	0.03	0.10	0.23	0.24	0.07	0.67	30.56	0.04	0.12	0.07	
Ingestion rate water	L/a	0	0	0	0	0	0	0	0	0	0	
Ingestion rate fish	kg/a	0	0	0	0	0	0	0	0	0	0	
Ingestion rate moose	kg/a	0	0	0	0	0	0	0	0	0	0	
Ingestion rate mallard	kg/a	0	0	0	0	0	0	0	0	0	0	
Exposure via water	Bq/a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Exposure via fish	Bq/a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Exposure via moose	Bq/a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Exposure via mallard	Bq/a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Ingestion DCF adult	Sv/Bq	4.70E-08	3.40E-09	2.10E-07	2.80E-07	2.50E-10	6.91E-07	1.20E-06	2.30E-07	6.90E-07	7.20E-08	
Dose via water	mSv/a	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dose via fish	mSv/a	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dose via moose	mSv/a	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dose via mallard	mSv/a	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total ingestion dose	mSv/a	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Ecological Dose Calculations - Aquatic Biota - McCabe Lake

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	Th-228+	TOTAL
Water conc.	Bq/L	0.02952	0.0075	0.00874	0.06	0.06	0.03	0.01	0.0008	0.0012	0.0016	
Sed to water PC	L/kg (dw)	25000	49200	49200	33333	33333	83333	166666	49200	33333	49200	
Sediment conc.	Bq/kg (dw)	738	369	430	2000	2000	2500	2400	40	40	80	
Sediment conc.	Bq/kg (ww)	74	37	43	200	200	250	240	4	4	8	
Wat to fish BAF	L/kg (fw)	478	218	218	540	-	861	-	218	540	218	
Fish tissue conc.	Bq/kg (fw)	11.39792	1.635	1.9053	21.667	2.1667	36.667	503.333	0.18	223.333	0.35	
Wat to aquatic plant BAF	L/kg (fw)	5090	6215	6215	3748	-	2499	-	6215	3748	6215	
Aquatic plant conc.	Bq/kg (fw)	40.221	46.61	109.4	146	14.60	84.85	79.65	7.04	34.6	13.7	
Wat to benthos BAF	L/kg (fw)	276	276	276	486	-	3643	20000	276	486	276	
Benthos conc.	Bq/kg (fw)	8.15	2.07	2.41	29.16	2.92	109.29	200.00	0.22	0.58	0.45	
Int. DCF tissue	Gy/a per Bq/kg (fw)	2.31E-05	4.56E-06	2.41E-05	2.46E-05	1.12E-04	2.19E-06	2.73E-05	2.06E-05	7.12E-06	1.77E-04	
Ext. DCF sediment	Gy/a per Bq/kg (ww)	5.40E-08	1.53E-05	5.35E-08	2.4E-07	6.70E-05	4.56E-06	2.58E-10	4.67E-08	3.55E-05	5.81E-05	
Ext. dose sediment (OF_s .5)	mGy/d	5.45E-06	7.73E-04	3.15E-06	6.58E-05	1.84E-02	1.56E-03	8.48E-08	2.56E-07	1.95E-04	6.37E-04	2.08E-02
Int. abs. dose fish	mGy/d	7.21E-04	2.04E-05	1.26E-04	1.46E-03	6.65E-04	2.20E-04	3.76E-02	1.00E-05	4.36E-03	1.72E-04	4.09E-02
Int. abs dose plant	mGy/d	2.55E-03	5.82E-04	7.22E-03	9.84E-03	4.48E-03	5.08E-04	5.96E-03	3.97E-04	6.75E-04	6.64E-03	3.11E-02
Int. abs dose benthos	mGy/d	5.16E-04	2.59E-05	1.59E-04	1.97E-03	8.95E-04	6.55E-04	1.50E-02	1.27E-05	1.14E-05	2.18E-04	1.92E-02
RBE alpha	-	10	1	10	10	10	1	10	10	1	10	
γ eq. . dose fish	mGy/d	7.22E-03	7.94E-04	1.26E-03	1.47E-02	2.50E-02	1.78E-03	3.76E-01	1.00E-04	4.55E-03	2.35E-03	4.27E-01
γ eq. dose plant	mGy/d	2.55E-02	1.36E-03	7.22E-02	9.85E-02	6.32E-02	2.07E-03	5.96E-02	3.97E-03	8.69E-04	6.70E-02	3.22E-01
γ eq. . dose benthos	mGy/d	5.17E-03	1.57E-03	1.60E-03	1.98E-02	4.57E-02	3.78E-03	1.50E-01	1.27E-04	4.00E-04	3.45E-03	2.27E-01

Ecological Dose Calculations - Riparian Wildlife - McCabe Lake

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	Th-228+	TOTAL
Water conc.	Bq/L	0.02952	0.0075	0.0087	0.06	0.0600	0.03	0.01	0.0008	0.0012	0.0016	
Sed to water PC	L/kg (dw)	25000	49200	49200	33333	33333	83333	166666	49200	33333	49200	
Sediment conc.	Bq/kg (dw)	738	369	430	2000	2000	2500	2400	40	40	80	
Sediment conc.	Bq/kg (ww)	74	37	43	200	200	250	240	4	4	8	
Wat to fish BAF	L/kg (fw)	478	218	218	540	-	861	-	218	540	218	
Fish tissue conc.	Bq/kg (fw)	11.40	1.635	1.905	21.667	2.1667	36.667	503.333	0.18	223.333	0.35	
Wat to aquatic plant BAF	L/kg (fw)	5090	6215	6215	3748	-	2499	-	6215	3748	6215	
Aquatic plant conc.	Bq/kg (fw)	40.221	46.61	109.4	146	14.60	84.85	79.65	7.04	34.6	13.7	
Wat to benthos BAF	L/kg (fw)	276	276	276	486	-	3643	20000	276	486	276	
Benthos conc.	Bq/kg (fw)	8.15	2.07	2.41	29.16	2.92	109.29	200.00	0.22	0.58	0.45	
Ing. TF mallard	d/kg	0.008	0.050	0.050	0.046	-	0.162	4.62	0.050	0.046	0.050	
Ing. TF scaup	d/kg	0.008	0.496	0.496	0.423	-	0.162	4.62	0.496	0.423	0.496	
Ing. TF merganser	d/kg	0.163	4.89	4.89	3.91	-	1.99	5.45	4.894	3.910	4.894	
Ing. TF muskrat	d/kg	0.077	0.031	0.031	0.694	-	0.462	0.540	0.031	0.694	0.031	
Ing. TF mink	d/kg	0.080	0.032	0.032	0.717	-	0.478	0.558	0.032	0.717	0.032	
Int. DCF tissue	Gy/a per Bq/kg (fw)	2.31E-05	4.56E-06	2.41E-05	2.46E-05	1.12E-04	2.19E-06	2.73E-05	2.06E-05	7.12E-06	1.77E-04	
Ext. DCF sediment	Gy/a per Bq/kg (ww)	5.40E-08	1.53E-05	5.35E-08	2.4E-07	6.70E-05	4.56E-06	2.58E-10	4.67E-08	3.55E-05	5.81E-05	
Ext. dose sediment (OF_s .5)	mGy/d	2.73E-06	3.87E-04	1.58E-06	3.29E-05	9.18E-03	7.81E-04	4.24E-08	1.28E-07	9.73E-05	3.18E-04	1.08E-02
Int. abs. dose mallard	mGy/d	2.64E-06	3.83E-06	4.66E-05	6.07E-05	8.29E-05	1.19E-05	3.99E-03	2.58E-06	3.92E-06	4.32E-05	4.25E-03
Int. abs. dose scaup	mGy/d	5.77E-07	2.47E-06	1.52E-05	1.14E-04	1.56E-04	1.20E-05	7.47E-03	1.21E-06	6.60E-07	2.08E-05	7.80E-03
Int. abs. dose merganser	mGy/d	2.02E-05	1.85E-05	1.14E-04	9.91E-04	1.35E-03	7.49E-05	3.41E-02	9.04E-06	2.82E-03	1.55E-04	3.96E-02
Int. abs. dose muskrat	mGy/d	1.10E-04	8.69E-06	1.01E-04	3.60E-03	4.91E-03	1.51E-04	2.09E-03	5.72E-06	2.03E-04	9.59E-05	1.13E-02
Int. abs. dose mink	mGy/d	1.27E-05	1.94E-07	1.19E-06	2.45E-04	3.35E-04	2.34E-05	4.04E-03	9.49E-08	5.94E-04	1.63E-06	5.25E-03
RBE alpha	-	10	1	10	10	10	1	10	10	1	10	
γ eq. dose mallard	mGy/d	2.91E-05	3.91E-04	4.67E-04	6.40E-04	1.00E-02	7.93E-04	3.99E-02	2.60E-05	1.01E-04	7.51E-04	5.31E-02
γ eq. dose scaup	mGy/d	8.49E-06	3.89E-04	1.54E-04	1.17E-03	1.07E-02	7.93E-04	7.47E-02	1.22E-05	9.79E-05	5.26E-04	8.86E-02
γ eq. dose merganser	mGy/d	2.05E-04	4.05E-04	1.14E-03	9.94E-03	2.27E-02	8.56E-04	3.41E-01	9.05E-05	2.92E-03	1.87E-03	3.81E-01
γ eq. dose muskrat	mGy/d	1.11E-03	7.82E-04	1.01E-03	3.60E-02	6.75E-02	1.71E-03	2.09E-02	5.75E-05	3.98E-04	1.60E-03	1.31E-01
γ eq. dose mink	mGy/d	1.33E-04	7.74E-04	1.51E-05	2.52E-03	2.17E-02	1.59E-03	4.04E-02	1.21E-06	7.88E-04	6.53E-04	6.85E-02

		Mallard	Scaup	Merganser	Muskrat	Mink		Moose
Body weight	kg	1.134	0.815	1.723	1.415	1.354		400
Ing. water	L/d	0.065	0.051	0.085	0.135	0.142		21.8
Ing. sediment	kg/d (dw)	0.00126	0.00102	0.00017	0.00744	0.000475		0.057
Ing. plant	kg/d (fw)	0.252			0.425			3.3
Ing. benthos	kg/d (fw)		0.204					
Ing. fish	kg/d (fw)			0.331		0.19		
Occupancy factor	-	0.5	0.5	0.5	1.0	1.0		1.0

Human Dose Calculations - Generic Adult - McCabe Lake

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	TH228+	TOTAL
Water conc.	Bq/L	0.02952	0.0075	0.0087	0.06	0.0600	0.03	0.01	0.0008	0.0012	0.0016	
Wat to fish BAF	L/kg (fw)	11.4	5.2	5.2	19.1	-	30.5	171.9	5.2	19.1	5.2	
Sport fish tissue conc.	Bq/kg (fw)	0.337	0.039	0.045	1.146	0.115	0.914	1.719	0.004	0.023	0.008	
Moose wb conc.	Bq/kg (fw)	0.19	0.07	0.15	6.03	1.81	2.84	3.12	0.01	1.18	0.02	
Moose meat conc.	Bq/kg (fw)	0.10	0.04	0.10	2.23	0.67	1.08	1.84	0.01	0.44	0.01	
Mallard duck wb conc.	Bq/kg (fw)	0.04	0.31	0.71	0.90	0.27	1.98	53.37	0.05	0.20	0.09	
Mallard duck meat conc.	Bq/kg (fw)	0.02	0.19	0.44	0.33	0.10	0.75	31.49	0.03	0.07	0.06	
Ingestion rate water	L/a	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	
Ingestion rate fish	kg/a	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	
Ingestion rate moose	kg/a	1	1	1	1	1	1	1	1	1	1	
Ingestion rate mallard	kg/a	1	1	1	1	1	1	1	1	1	1	
Exposure via water	Bq/a	16.16	4.11	4.79	32.85	32.85	16.43	5.48	0.45	0.66	0.89	
Exposure via fish	Bq/a	0.98	0.11	0.13	3.35	0.33	2.67	5.02	0.01	0.07	0.02	
Exposure via moose	Bq/a	0.10	0.04	0.10	2.23	0.67	1.08	1.84	0.01	0.44	0.01	
Exposure via mallard	Bq/a	0.02	0.19	0.44	0.33	0.10	0.75	31.49	0.03	0.07	0.06	
Ingestion DCF adult	Sv/Bq	4.70E-08	3.40E-09	2.10E-07	2.80E-07	2.50E-10	6.91E-07	1.20E-06	2.30E-07	6.90E-07	7.20E-08	
Dose via water	mSv/a	7.60E-04	1.40E-05	1.00E-03	9.20E-03	8.21E-06	1.14E-02	6.57E-03	1.02E-04	4.53E-04	6.41E-05	2.95E-02
Dose via fish	mSv/a	4.62E-05	3.87E-07	2.79E-05	9.37E-04	8.37E-08	1.84E-03	6.02E-03	2.84E-06	4.62E-05	1.78E-06	8.93E-03
Dose via moose	mSv/a	4.54E-06	1.50E-07	2.04E-05	6.25E-04	1.67E-07	7.45E-04	2.21E-03	1.48E-06	3.00E-04	9.04E-07	3.91E-03
Dose via mallard	mSv/a	9.81E-07	6.57E-07	9.34E-05	9.33E-05	2.50E-08	5.21E-04	3.78E-02	6.64E-06	5.13E-05	4.05E-06	3.86E-02
Total ingestion dose	mSv/a	8.11E-04	1.52E-05	1.15E-03	1.09E-02	8.49E-06	1.45E-02	5.26E-02	1.13E-04	8.51E-04	7.08E-05	8.09E-02

Human Dose Calculations - SRFN Adult - McCabe Lake

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	TH228+	TOTAL
Water conc.	Bq/L	0.02952	0.0075	0.0087	0.06	0.0600	0.03	0.01	0.0008	0.0012	0.0016	
Wat to fish BAF	L/kg (fw)	11.4	5.2	5.2	19.1	-	30.5	171.9	5.2	19.1	5.2	
Sport fish tissue conc.	Bq/kg (fw)	0.337	0.039	0.045	1.146	0.115	0.914	1.719	0.004	0.023	0.008	
Moose wb conc.	Bq/kg (fw)	0.19	0.07	0.15	6.03	1.81	2.84	3.12	0.01	1.18	0.02	
Moose meat conc.	Bq/kg (fw)	0.10	0.04	0.10	2.23	0.67	1.08	1.84	0.01	0.44	0.01	
Mallard duck wb conc.	Bq/kg (fw)	0.04	0.31	0.71	0.90	0.27	1.98	53.37	0.05	0.20	0.09	
Mallard duck meat conc.	Bq/kg (fw)	0.02	0.19	0.44	0.33	0.10	0.75	31.49	0.03	0.07	0.06	
Ingestion rate water	L/a	0	0	0	0	0	0	0	0	0	0	
Ingestion rate fish	kg/a	0	0	0	0	0	0	0	0	0	0	
Ingestion rate moose	kg/a	0.3025	0.3025	0.3025	0.3025	0.3025	0.3025	0.3025	0.3025	0.3025	0.3025	
Ingestion rate mallard	kg/a	0	0	0	0	0	0	0	0	0	0	
Exposure via water	Bq/a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Exposure via fish	Bq/a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Exposure via moose	Bq/a	0.03	0.01	0.03	0.67	0.20	0.33	0.56	0.00	0.13	0.00	
Exposure via mallard	Bq/a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Ingestion DCF adult	Sv/Bq	4.70E-08	3.40E-09	2.10E-07	2.80E-07	2.50E-10	6.91E-07	1.20E-06	2.30E-07	6.90E-07	7.20E-08	
Dose via water	mSv/a	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dose via fish	mSv/a	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dose via moose	mSv/a	1.37E-06	4.54E-08	6.17E-06	1.89E-04	5.06E-08	2.25E-04	6.68E-04	4.48E-07	9.09E-05	2.73E-07	1.18E-03
Dose via mallard	mSv/a	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total ingestion dose	mSv/a	1.37E-06	4.54E-08	6.17E-06	1.89E-04	5.06E-08	2.25E-04	6.68E-04	4.48E-07	9.09E-05	2.73E-07	1.18E-03

Human Dose Calculations - SRFN Adult - McCabe Lake

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	TH228+	TOTAL
Water conc.	Bq/L	0.02952	0.0075	0.00874	0.06	0.060001	0.03	0.01	0.0008	0.0012	0.0016	
Wat to fish BAF	L/kg (fw)	11.4	5.2	5.2	19.1	-	30.5	171.9	5.2	19.1	5.2	
Sport fish tissue conc.	Bq/kg (fw)	0.337	0.039	0.045	1.146	0.115	0.914	1.719	0.004	0.023	0.008	
Moose wb conc.	Bq/kg (fw)	0.19	0.07	0.15	6.03	1.81	2.84	3.12	0.01	1.18	0.02	
Moose meat conc.	Bq/kg (fw)	0.10	0.04	0.10	2.23	0.67	1.08	1.84	0.01	0.44	0.01	
Mallard duck wb conc.	Bq/kg (fw)	0.04	0.31	0.71	0.90	0.27	1.98	53.37	0.05	0.20	0.09	
Mallard duck meat conc.	Bq/kg (fw)	0.02	0.19	0.44	0.33	0.10	0.75	31.49	0.03	0.07	0.06	
Ingestion rate water	L/a	0	0	0	0	0	0	0	0	0	0	
Ingestion rate fish	kg/a	0	0	0	0	0	0	0	0	0	0	
Ingestion rate moose	kg/a	0	0	0	0	0	0	0	0	0	0	
Ingestion rate mallard	kg/a	0	0	0	0	0	0	0	0	0	0	
Exposure via water	Bq/a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Exposure via fish	Bq/a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Exposure via moose	Bq/a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Exposure via mallard	Bq/a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Ingestion DCF adult	Sv/Bq	4.70E-08	3.40E-09	2.10E-07	2.80E-07	2.50E-10	6.91E-07	1.20E-06	2.30E-07	6.90E-07	7.20E-08	
Dose via water	mSv/a	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dose via fish	mSv/a	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dose via moose	mSv/a	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dose via mallard	mSv/a	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total ingestion dose	mSv/a	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Ecological Dose Calculations - Aquatic Biota - McCarthy Lake

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	Th-228+	TOTAL
Water conc.	Bq/L	0.0123	0.0065	0.0010	0.01	0.01	0.03	0.01	0.0003	0.0006	0.0012	
Sed to water PC	L/kg (dw)	52000	49200	49200	23517	23517	16333	32666	49200	23517	49200	
Sediment conc.	Bq/kg (dw)	639.6	319.8	50	440	440	490	450	14	14	60	
Sediment conc.	Bq/kg (ww)	64	32	5	44	44	49	45	1	1	6	
Wat to fish BCF	L/kg (fw)	478	218	218	540	-	861	-	218	540	218	
Fish tissue conc.	Bq/kg (fw)	10.701	1.417	0.2215	9	0.9	20	56	0.062	0.3215	0.27	
Wat to aquatic plant BCF	L/kg (fw)	5090	6215	6215	3748	-	2499	-	6215	3748	6215	
Aquatic plant conc.	Bq/kg (fw)	45.284	40.40	6.32	42.833	4.28	22.75	12.292	1.333	27.917	7.579	
Wat to benthos BCF	L/kg (fw)	276	276	276	486	-	3643	20000	276	486	276	
Benthos conc.	Bq/kg (fw)	3.39	1.79	0.28	4.86	0.49	109.29	200.00	0.08	0.29	0.34	
Int. DCF tissue	Gy/a per Bq/kg (fw)	2.31E-05	4.56E-06	2.41E-05	2.46E-05	1.12E-04	2.19E-06	2.73E-05	2.06E-05	7.12E-06	1.77E-04	
Ext. DCF sediment	Gy/a per Bq/kg (ww)	5.40E-08	1.53E-05	5.35E-08	2.4E-07	6.70E-05	4.56E-06	2.58E-10	4.67E-08	3.55E-05	5.81E-05	
Ext. dose sediment (OF_s .5)	mGy/d	4.73E-06	6.70E-04	3.66E-07	1.45E-05	4.04E-03	3.06E-04	1.59E-08	8.95E-08	6.81E-05	4.78E-04	5.58E-03
Int. abs. dose fish	mGy/d	6.77E-04	1.77E-05	1.46E-05	6.07E-04	2.76E-04	1.20E-04	4.19E-03	3.50E-06	6.27E-06	1.29E-04	6.04E-03
Int. abs dose plant	mGy/d	2.87E-03	5.05E-04	4.17E-04	2.89E-03	1.31E-03	1.36E-04	9.19E-04	7.52E-05	5.45E-04	3.67E-03	1.33E-02
Int. abs dose benthos	mGy/d	2.15E-04	2.24E-05	1.85E-05	3.28E-04	1.49E-04	6.55E-04	1.50E-02	4.43E-06	5.64E-06	1.63E-04	1.65E-02
RBE alpha	-	10	1	10	10	10	1	10	10	1	10	
γ eq. . dose fish	mGy/d	6.78E-03	6.88E-04	1.47E-04	6.08E-03	6.80E-03	4.26E-04	4.19E-02	3.51E-05	7.44E-05	1.77E-03	6.47E-02
γ eq. dose plant	mGy/d	2.87E-02	1.17E-03	4.17E-03	2.89E-02	1.72E-02	4.42E-04	9.19E-03	7.53E-04	6.13E-04	3.72E-02	1.28E-01
γ eq. . dose benthos	mGy/d	2.16E-03	1.36E-03	1.86E-04	3.30E-03	9.57E-03	1.27E-03	1.50E-01	4.45E-05	1.42E-04	2.59E-03	1.70E-01

Ecological Dose Calculations - Riparian Wildlife - McCarthy Lake

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	Th-228+	TOTAL
Water conc.	Bq/L	0.0123	0.0065	0.0010	0.01	0.01	0.03	0.01	0.0003	0.0006	0.0012	
Sed to water PC	L/kg (dw)	52000	49200	49200	23517	23517	16333	32666	49200	23517	49200	
Sediment conc.	Bq/kg (dw)	639.6	319.8	50	440	440	490	450	14	14	60	
Sediment conc.	Bq/kg (ww)	64	32	5	44	44	49	45	1	1	6	
Wat to fish BCF	L/kg (fw)	478	218	218	540	-	861	-	218	540	218	
Fish tissue conc.	Bq/kg (fw)	10.701	1.417	0.2215447	9	0.9	20	56	0.062	0.3214696	0.27	
Wat to aquatic plant BCF	L/kg (fw)	5090	6215	6215	3748	-	2499	-	6215	3748	6215	
Aquatic plant conc.	Bq/kg (fw)	45.284295	40.40	6.32	42.83325	4.28	22.75	12.29175	1.33325	27.91675	7.579268	
Wat to benthos BCF	L/kg (fw)	276	276	276	486	-	3643	20000	276	486	276	
Benthos conc.	Bq/kg (fw)	3.39	1.79	0.28	4.86	0.49	109.29	200.00	0.08	0.29	0.34	
Ing. TF mallard	d/kg	0.008	0.050	0.050	0.046	-	0.162	4.62	0.050	0.046	0.050	
Ing. TF scaup	d/kg	0.008	0.496	0.496	0.423	-	0.162	4.62	0.496	0.423	0.496	
Ing. TF merganser	d/kg	0.163	4.89	4.89	3.91	-	1.99	5.45	4.894	3.910	4.894	
Ing. TF muskrat	d/kg	0.077	0.031	0.031	0.694	-	0.462	0.540	0.031	0.694	0.031	
Ing. TF mink	d/kg	0.080	0.032	0.032	0.717	-	0.478	0.558	0.032	0.717	0.032	
Int. DCF tissue	Gy/a per Bq/kg (fw)	2.31E-05	4.56E-06	2.41E-05	2.46E-05	1.12E-04	2.19E-06	2.73E-05	2.06E-05	7.12E-06	1.77E-04	
Ext. DCF sediment	Gy/a per Bq/kg (ww)	5.40E-08	1.53E-05	5.35E-08	2.4E-07	6.70E-05	4.56E-06	2.58E-10	4.67E-08	3.55E-05	5.81E-05	
Ext. dose sediment (OF_s .5)	mGy/d	2.36E-06	3.35E-04	1.83E-07	7.23E-06	2.02E-03	1.53E-04	7.95E-09	4.47E-08	3.40E-05	2.39E-04	2.79E-03
Int. abs. dose mallard	mGy/d	2.92E-06	3.32E-06	2.74E-06	1.75E-05	2.39E-05	3.08E-06	6.33E-04	5.01E-07	3.15E-06	2.42E-05	7.15E-04
Int. abs. dose scaup	mGy/d	3.21E-07	2.14E-06	1.77E-06	2.06E-05	2.81E-05	1.10E-05	7.13E-03	4.24E-07	3.03E-07	1.56E-05	7.21E-03
Int. abs. dose merganser	mGy/d	1.89E-05	1.60E-05	1.32E-05	4.03E-04	5.50E-04	4.00E-05	3.80E-03	3.16E-06	4.15E-06	1.16E-04	4.96E-03
Int. abs. dose muskrat	mGy/d	1.17E-04	7.53E-06	6.22E-06	1.00E-03	1.37E-03	3.69E-05	3.46E-04	1.17E-06	1.62E-04	5.48E-05	3.11E-03
Int. abs. dose mink	mGy/d	1.18E-05	1.68E-07	1.39E-07	9.28E-05	1.27E-04	1.16E-05	4.53E-04	3.32E-08	9.48E-07	1.22E-06	6.98E-04
RBE alpha	-	10	1	10	10	10	1	10	10	1	10	
γ eq. dose mallard	mGy/d	3.15E-05	3.38E-04	2.76E-05	1.83E-04	2.26E-03	1.56E-04	6.33E-03	5.05E-06	3.72E-05	4.80E-04	9.85E-03
γ eq. dose scaup	mGy/d	5.57E-06	3.37E-04	1.79E-05	2.13E-04	2.30E-03	1.64E-04	7.13E-02	4.29E-06	3.43E-05	3.95E-04	7.48E-02
γ eq. dose merganser	mGy/d	1.91E-04	3.51E-04	1.32E-04	4.04E-03	7.52E-03	1.93E-04	3.80E-02	3.17E-05	3.82E-05	1.40E-03	5.19E-02
γ eq. dose muskrat	mGy/d	1.18E-03	6.78E-04	6.26E-05	1.01E-02	1.78E-02	3.43E-04	3.46E-03	1.18E-05	2.30E-04	1.03E-03	3.48E-02
γ eq. dose mink	mGy/d	1.23E-04	6.70E-04	1.75E-06	9.43E-04	5.31E-03	3.18E-04	4.53E-03	4.22E-07	6.90E-05	4.90E-04	1.24E-02

		Mallard	Scaup	Merganser	Muskrat	Mink		Moose
Body weight	kg	1.134	0.815	1.723	1.415	1.354		400
Ing. water	L/d	0.065	0.051	0.085	0.135	0.142		21.8
Ing. sediment	kg/d (dw)	0.00126	0.00102	0.00017	0.00744	0.000475		0.057
Ing. plant	kg/d (fw)	0.252			0.425			3.3
Ing. benthos	kg/d (fw)		0.204					
Ing. fish	kg/d (fw)			0.331		0.19		
Occupancy factor	-	0.5	0.5	0.5	1.0	1.0		1.0

Human Dose Calculations - Generic Adult - McCarthy Lake

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	TH228+	TOTAL
Water conc.	Bq/L	0.0123	0.0065	0.001016	0.01	0.01	0.03	0.01	0.0003	0.0006	0.0012	
Water to fish BCF	L/kg (fw)	11.4	5.2	5.2	19.1	-	30.5	171.9	5.2	19.1	5.2	
Sport fish tissue conc.	Bq/kg (fw)	0.140	0.034	0.005	0.191	0.019	0.914	1.719	0.001	0.011	0.006	
Moose wb conc.	Bq/kg (fw)	0.20	0.06	0.009	1.68	0.50	0.69	0.52	0.002	0.94	0.011	
Moose meat conc.	Bq/kg (fw)	0.10	0.04	0.006	0.62	0.19	0.26	0.31	0.001	0.35	0.007	
Mallard duck wb conc.	Bq/kg (fw)	0.05	0.27	0.04	0.26	0.08	0.51	8.47	0.01	0.16	0.05	
Mallard duck meat conc.	Bq/kg (fw)	0.02	0.17	0.03	0.10	0.03	0.20	5.00	0.01	0.06	0.03	
Ingestion rate water	L/a	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	
Ingestion rate fish	kg/a	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	
Ingestion rate moose	kg/a	1	1	1	1	1	1	1	1	1	1	
Ingestion rate mallard	kg/a	1	1	1	1	1	1	1	1	1	1	
Exposure via water	Bq/a	6.73	3.56	0.56	5.48	5.48	16.43	5.48	0.16	0.33	0.67	
Exposure via fish	Bq/a	0.41	0.10	0.02	0.56	0.06	2.67	5.02	0.004	0.03	0.02	
Exposure via moose	Bq/a	0.10	0.04	0.01	0.62	0.19	0.26	0.31	0.001	0.35	0.007	
Exposure via mallard	Bq/a	0.02	0.17	0.03	0.10	0.03	0.20	5.00	0.01	0.06	0.03	
Ingestion DCF adult	Sv/Bq	4.70E-08	3.40E-09	2.10E-07	2.80E-07	2.50E-10	6.91E-07	1.20E-06	2.30E-07	6.90E-07	7.20E-08	
Dose via water	mSv/a	3.17E-04	1.21E-05	1.17E-04	1.53E-03	1.37E-06	1.14E-02	6.57E-03	3.58E-05	2.25E-04	4.81E-05	2.02E-02
Dose via fish	mSv/a	1.92E-05	3.36E-07	3.24E-06	1.56E-04	1.39E-08	1.84E-03	6.02E-03	9.94E-07	2.29E-05	1.33E-06	8.07E-03
Dose via moose	mSv/a	4.81E-06	1.30E-07	1.26E-06	1.74E-04	4.67E-08	1.82E-04	3.67E-04	3.02E-07	2.40E-04	5.16E-07	9.70E-04
Dose via mallard	mSv/a	1.08E-06	5.69E-07	5.49E-06	2.69E-05	7.22E-09	1.35E-04	6.00E-03	1.29E-06	4.13E-05	2.26E-06	6.21E-03
Total ingestion dose	mSv/a	3.42E-04	1.31E-05	1.27E-04	1.89E-03	1.44E-06	1.35E-02	1.90E-02	3.84E-05	5.29E-04	5.22E-05	3.55E-02

Human Dose Calculations - SRFN Adult - McCarthy Lake

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	TH228+	TOTAL
Water conc.	Bq/L	0.0123	0.0065	0.001016	0.01	0.01	0.03	0.01	0.0003	0.0006	0.0012	
Water to fish BCF	L/kg (fw)	11.4	5.2	5.2	19.1	-	30.5	171.9	5.2	19.1	5.2	
Sport fish tissue conc.	Bq/kg (fw)	0.140	0.034	0.005	0.191	0.019	0.914	1.719	0.001	0.011	0.006	
Moose wb conc.	Bq/kg (fw)	0.20	0.06	0.009	1.68	0.50	0.69	0.52	0.002	0.94	0.011	
Moose meat conc.	Bq/kg (fw)	0.10	0.04	0.006	0.62	0.19	0.26	0.31	0.001	0.35	0.007	
Mallard duck wb conc.	Bq/kg (fw)	0.05	0.27	0.04	0.26	0.08	0.51	8.47	0.01	0.16	0.05	
Mallard duck meat conc.	Bq/kg (fw)	0.02	0.17	0.03	0.10	0.03	0.20	5.00	0.01	0.06	0.03	
Ingestion rate water	L/a	10.95	10.95	10.95	10.95	10.95	10.95	10.95	10.95	10.95	10.95	
Ingestion rate fish	kg/a	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	
Ingestion rate moose	kg/a	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	1.21	
Ingestion rate mallard	kg/a	0.0185	0.0185	0.0185	0.0185	0.0185	0.0185	0.0185	0.0185	0.0185	0.0185	
Exposure via water	Bq/a	0.13	0.07	0.01	0.11	0.11	0.33	0.11	0.00	0.01	0.01	
Exposure via fish	Bq/a	0.04	0.01	0.00	0.05	0.00	0.23	0.44	0.00	0.00	0.00	
Exposure via moose	Bq/a	0.12	0.05	0.01	0.75	0.23	0.32	0.37	0.00	0.42	0.01	
Exposure via mallard	Bq/a	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.00	0.00	
Ingestion DCF adult	Sv/Bq	4.70E-08	3.40E-09	2.10E-07	2.80E-07	2.50E-10	6.91E-07	1.20E-06	2.30E-07	6.90E-07	7.20E-08	
Dose via water	mSv/a	6.33E-06	2.42E-07	2.34E-06	3.07E-05	2.74E-08	2.27E-04	1.31E-04	7.17E-07	4.50E-06	9.61E-07	4.04E-04
Dose via fish	mSv/a	1.67E-06	2.92E-08	2.82E-07	1.36E-05	1.21E-09	1.60E-04	5.24E-04	8.64E-08	1.99E-06	1.16E-07	7.02E-04
Dose via moose	mSv/a	5.82E-06	1.57E-07	1.52E-06	2.11E-04	5.65E-08	2.21E-04	4.44E-04	3.65E-07	2.90E-04	6.25E-07	1.17E-03
Dose via mallard	mSv/a	2.00E-08	1.05E-08	1.02E-07	4.98E-07	1.34E-10	2.49E-06	1.11E-04	2.38E-08	7.63E-07	4.18E-08	1.15E-04
Total ingestion dose	mSv/a	1.38E-05	4.39E-07	4.24E-06	2.56E-04	8.52E-08	6.11E-04	1.21E-03	1.19E-06	2.97E-04	1.74E-06	2.40E-03

Human Dose Calculations - SRFN Adult - McCarthy Lake

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	TH228+	TOTAL
Water conc.	Bq/L	0.0123	0.0065	0.001016	0.01	0.01	0.03	0.0100	0.0003	0.0006	0.0012	
Water to fish BCF	L/kg (fw)	11.4	5.2	5.2	19.1	-	30.5	171.9	5.2	19.1	5.2	
Sport fish tissue conc.	Bq/kg (fw)	0.140	0.034	0.005	0.191	0.019	0.914	1.719	0.001	0.011	0.006	
Moose wb conc.	Bq/kg (fw)	0.20	0.06	0.009	1.68	0.50	0.69	0.52	0.002	0.94	0.011	
Moose meat conc.	Bq/kg (fw)	0.10	0.04	0.006	0.62	0.19	0.26	0.31	0.001	0.35	0.007	
Mallard duck wb conc.	Bq/kg (fw)	0.05	0.27	0.04	0.26	0.08	0.51	8.47	0.01	0.16	0.05	
Mallard duck meat conc.	Bq/kg (fw)	0.02	0.17	0.03	0.10	0.03	0.20	5.00	0.01	0.06	0.03	
Ingestion rate water	L/a	1.095	1.095	1.095	1.095	1.095	1.095	1.095	1.095	1.095	1.095	
Ingestion rate fish	kg/a	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	
Ingestion rate moose	kg/a	0.605	0.605	0.605	0.605	0.605	0.605	0.605	0.605	0.605	0.605	
Ingestion rate mallard	kg/a	0	0	0	0	0	0	0	0	0	0	
Exposure via water	Bq/a	0.01	0.01	0.00	0.01	0.01	0.03	0.01	0.00	0.00	0.00	
Exposure via fish	Bq/a	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.00	0.00	0.00	
Exposure via moose	Bq/a	0.06	0.02	0.00	0.38	0.11	0.16	0.18	0.00	0.21	0.00	
Exposure via mallard	Bq/a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Ingestion DCF adult	Sv/Bq	4.70E-08	3.40E-09	2.10E-07	2.80E-07	2.50E-10	6.91E-07	1.20E-06	2.30E-07	6.90E-07	7.20E-08	
Dose via water	mSv/a	6.33E-07	2.42E-08	2.34E-07	3.07E-06	2.74E-09	2.27E-05	1.31E-05	7.17E-08	4.50E-07	9.61E-08	4.04E-05
Dose via fish	mSv/a	1.67E-07	2.92E-09	2.82E-08	1.36E-06	1.21E-10	1.60E-05	5.24E-05	8.64E-09	1.99E-07	1.16E-08	7.02E-05
Dose via moose	mSv/a	2.91E-06	7.86E-08	7.59E-07	1.05E-04	2.83E-08	1.10E-04	2.22E-04	1.82E-07	1.45E-04	3.12E-07	5.87E-04
Dose via mallard	mSv/a	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total ingestion dose	mSv/a	3.71E-06	1.06E-07	1.02E-06	1.10E-04	3.11E-08	1.49E-04	2.87E-04	2.63E-07	1.46E-04	4.20E-07	6.98E-04

Ecological Dose Calculations - Aquatic Biota - Nordic Lake

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	Th-228+	TOTAL
Water conc.	Bq/L	0.0394	0.004	0.0010	0.03	0.0300	0.03	0.01	0.0004	0.0016	0.0012	
Sed to water PC	L/kg (dw)	10000	49200	49200	12333	12333	10333	20666	49200	12333	49200	
Sediment conc.	Bq/kg (dw)	393.6	196.8	50	370	370	310	270	20	20	60	
Sediment conc.	Bq/kg (ww)	39	20	5	37	37	31	27	2	2	6	
Wat to fish BAF	L/kg (fw)	478	218	218	540	-	861	-	218	540	218	
Fish tissue conc.	Bq/kg (fw)	4.5099	0.872	0.2215	10.333	1.0333	20	396.667	0.09	0.88	0.27	
Wat to aquatic plant BAF	L/kg (fw)	5090	6215	6215	3748	-	2499	-	6215	3748	6215	
Aquatic plant conc.	Bq/kg (fw)	15.3381	24.86	6.32	33.7	3.37	14.8	8.95	2.53	6.08	1.55	
Wat to benthos BAF	L/kg (fw)	276	276	276	486	-	3643	20000	276	486	276	
Benthos conc.	Bq/kg (fw)	10.86	1.10	0.28	14.58	1.46	109.29	200.00	0.11	0.79	0.34	
Int. DCF tissue	Gy/a per Bq/kg (fw)	2.31E-05	4.56E-06	2.41E-05	2.46E-05	1.12E-04	2.19E-06	2.73E-05	2.06E-05	7.12E-06	1.77E-04	
Ext. DCF sediment	Gy/a per Bq/kg (ww)	5.40E-08	1.53E-05	5.35E-08	2.4E-07	6.70E-05	4.56E-06	2.58E-10	4.67E-08	3.55E-05	5.81E-05	
Ext. dose sediment (OF_s .5)	mGy/d	2.91E-06	4.12E-04	3.66E-07	1.22E-05	3.40E-03	1.94E-04	9.54E-09	1.28E-07	9.73E-05	4.78E-04	4.59E-03
Int. abs. dose fish	mGy/d	2.85E-04	1.09E-05	1.46E-05	6.96E-04	3.17E-04	1.20E-04	2.97E-02	5.00E-06	1.71E-05	1.29E-04	3.13E-02
Int. abs dose plant	mGy/d	9.71E-04	3.11E-04	4.17E-04	2.27E-03	1.03E-03	8.87E-05	6.69E-04	1.43E-04	1.19E-04	7.51E-04	6.77E-03
Int. abs dose benthos	mGy/d	6.88E-04	1.38E-05	1.85E-05	9.83E-04	4.47E-04	6.55E-04	1.50E-02	6.33E-06	1.54E-05	1.63E-04	1.79E-02
RBE alpha	-	10	1	10	10	10	1	10	10	1	10	
γ eq. . dose fish	mGy/d	2.86E-03	4.23E-04	1.47E-04	6.98E-03	6.57E-03	3.14E-04	2.97E-01	5.01E-05	1.14E-04	1.77E-03	3.16E-01
γ eq. dose plant	mGy/d	9.71E-03	7.23E-04	4.17E-03	2.27E-02	1.37E-02	2.82E-04	6.69E-03	1.43E-03	2.16E-04	7.99E-03	6.77E-02
γ eq. . dose benthos	mGy/d	6.88E-03	8.39E-04	1.86E-04	9.85E-03	1.13E-02	1.04E-03	1.50E-01	6.36E-05	2.10E-04	2.59E-03	1.83E-01

Ecological Dose Calculations - Riparian Wildlife - Nordic Lake

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	Th-228+	TOTAL
Water conc.	Bq/L	0.03936	0.004	0.0010	0.03	0.0300	0.03	0.01	0.0004	0.0016	0.0012	
Sed to water PC	L/kg (dw)	10000	49200	49200	12333	12333	10333	20666	49200	12333	49200	
Sediment conc.	Bq/kg (dw)	393.6	196.8	50	370	370	310	270	20	20	60	
Sediment conc.	Bq/kg (ww)	39	20	5	37	37	31	27	2	2	6	
Wat to fish BAF	L/kg (fw)	478	218	218	540	-	861	-	218	540	218	
Fish tissue conc.	Bq/kg (fw)	4.5099	0.872	0.2215447	10.333	1.0333	20	396.667	0.09	0.88	0.27	
Wat to aquatic plant BAF	L/kg (fw)	5090	6215	6215	3748	-	2499	-	6215	3748	6215	
Aquatic plant conc.	Bq/kg (fw)	15.3381	24.86	6.32	33.7	3.37	14.8	8.95	2.53	6.08	1.55	
Wat to benthos BAF	L/kg (fw)	276	276	276	486	-	3643	20000	276	486	276	
Benthos conc.	Bq/kg (fw)	10.86	1.10	0.28	14.58	1.46	109.29	200.00	0.11	0.79	0.34	
Ing. TF mallard	d/kg	0.008	0.050	0.050	0.046	-	0.162	4.62	0.050	0.046	0.050	
Ing. TF scaup	d/kg	0.008	0.496	0.496	0.423	-	0.162	4.62	0.496	0.423	0.496	
Ing. TF merganser	d/kg	0.163	4.89	4.89	3.91	-	1.99	5.45	4.894	3.910	4.894	
Ing. TF muskrat	d/kg	0.077	0.031	0.031	0.694	-	0.462	0.540	0.031	0.694	0.031	
Ing. TF mink	d/kg	0.080	0.032	0.032	0.717	-	0.478	0.558	0.032	0.717	0.032	
Int. DCF tissue	Gy/a per Bq/kg (fw)	2.31E-05	4.56E-06	2.41E-05	2.46E-05	1.12E-04	2.19E-06	2.73E-05	2.06E-05	7.12E-06	1.77E-04	
Ext. DCF sediment	Gy/a per Bq/kg (ww)	5.40E-08	1.53E-05	5.35E-08	2.4E-07	6.70E-05	4.56E-06	2.58E-10	4.67E-08	3.55E-05	5.81E-05	
Ext. dose sediment (OF_s .5)	mGy/d	1.45E-06	2.06E-04	1.83E-07	6.08E-06	1.70E-03	9.68E-05	4.77E-09	6.39E-08	4.86E-05	2.39E-04	2.01E-03
Int. abs. dose mallard	mGy/d	1.04E-06	2.04E-06	2.74E-06	1.38E-05	1.89E-05	2.00E-06	4.49E-04	9.38E-07	6.96E-07	5.67E-06	4.89E-04
Int. abs. dose scaup	mGy/d	6.25E-07	1.32E-06	1.77E-06	4.78E-05	6.53E-05	1.09E-05	7.10E-03	6.06E-07	7.48E-07	1.56E-05	7.23E-03
Int. abs. dose merganser	mGy/d	8.09E-06	9.84E-06	1.32E-05	4.60E-04	6.28E-04	3.98E-05	2.68E-02	4.52E-06	1.12E-05	1.16E-04	2.80E-02
Int. abs. dose muskrat	mGy/d	4.61E-05	4.63E-06	6.22E-06	7.98E-04	1.09E-03	2.38E-05	2.35E-04	2.13E-06	3.70E-05	1.65E-05	2.20E-03
Int. abs. dose mink	mGy/d	5.29E-06	1.03E-07	1.39E-07	1.04E-04	1.41E-04	1.13E-05	3.15E-03	4.75E-08	2.46E-06	1.22E-06	3.41E-03
RBE alpha	-	10	1	10	10	10	1	10	10	1	10	
γ eq. dose mallard	mGy/d	1.19E-05	2.08E-04	2.76E-05	1.44E-04	1.89E-03	9.88E-05	4.49E-03	9.44E-06	4.93E-05	2.96E-04	6.87E-03
γ eq. dose scaup	mGy/d	7.71E-06	2.08E-04	1.79E-05	4.84E-04	2.35E-03	1.08E-04	7.10E-02	6.12E-06	4.94E-05	3.95E-04	7.42E-02
γ eq. dose merganser	mGy/d	8.23E-05	2.16E-04	1.32E-04	4.60E-03	7.98E-03	1.37E-04	2.68E-01	4.53E-05	5.98E-05	1.40E-03	2.81E-01
γ eq. dose muskrat	mGy/d	4.64E-04	4.17E-04	6.26E-05	8.00E-03	1.43E-02	2.18E-04	2.35E-03	2.14E-05	1.34E-04	6.43E-04	2.58E-02
γ eq. dose mink	mGy/d	5.58E-05	4.13E-04	1.75E-06	1.05E-03	4.81E-03	2.05E-04	3.15E-02	6.03E-07	9.97E-05	4.90E-04	3.80E-02

		Mallard	Scaup	Merganser	Muskrat	Mink		Moose
Body weight	kg	1.134	0.815	1.723	1.415	1.354		400
Ing. water	L/d	0.065	0.051	0.085	0.135	0.142		21.8
Ing. sediment	kg/d (dw)	0.00126	0.00102	0.00017	0.00744	0.000475		0.057
Ing. plant	kg/d (fw)	0.252			0.425			3.3
Ing. benthos	kg/d (fw)		0.204					
Ing. fish	kg/d (fw)			0.331		0.19		
Occupancy factor	-	0.5	0.5	0.5	1.0	1.0		1.0

Human Dose Calculations - Generic Adult - Nordic Lake

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	TH228+	TOTAL
Water conc.	Bq/L	0.03936	0.004	0.0010	0.03	0.0300	0.03	0.01	0.0004	0.0016	0.0012	
Wat to fish BAF	L/kg (fw)	11.4	5.2	5.2	19.1	-	30.5	171.9	5.2	19.1	5.2	
Sport fish tissue conc.	Bq/kg (fw)	0.449	0.021	0.005	0.573	0.057	0.914	1.719	0.002	0.031	0.006	
Moose wb conc.	Bq/kg (fw)	0.08	0.04	0.01	1.34	0.40	0.45	0.35	0.00	0.21	0.00	
Moose meat conc.	Bq/kg (fw)	0.04	0.02	0.01	0.50	0.15	0.17	0.21	0.00	0.08	0.00	
Mallard duck wb conc.	Bq/kg (fw)	0.02	0.16	0.04	0.21	0.06	0.33	6.00	0.02	0.04	0.01	
Mallard duck meat conc.	Bq/kg (fw)	0.01	0.10	0.03	0.08	0.02	0.13	3.54	0.01	0.01	0.01	
Ingestion rate water	L/a	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	
Ingestion rate fish	kg/a	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	
Ingestion rate moose	kg/a	1	1	1	1	1	1	1	1	1	1	
Ingestion rate mallard	kg/a	1	1	1	1	1	1	1	1	1	1	
Exposure via water	Bq/a	21.55	2.19	0.56	16.43	16.43	16.43	5.48	0.22	0.89	0.67	
Exposure via fish	Bq/a	1.31	0.06	0.02	1.67	0.17	2.67	5.02	0.01	0.09	0.02	
Exposure via moose	Bq/a	0.04	0.02	0.01	0.50	0.15	0.17	0.21	0.00	0.08	0.00	
Exposure via mallard	Bq/a	0.01	0.10	0.03	0.08	0.02	0.13	3.54	0.01	0.01	0.01	
Ingestion DCF adult	Sv/Bq	4.70E-08	3.40E-09	2.10E-07	2.80E-07	2.50E-10	6.91E-07	1.20E-06	2.30E-07	6.90E-07	7.20E-08	
Dose via water	mSv/a	1.01E-03	7.45E-06	1.17E-04	4.60E-03	4.11E-06	1.14E-02	6.57E-03	5.12E-05	6.13E-04	4.81E-05	2.44E-02
Dose via fish	mSv/a	6.16E-05	2.06E-07	3.24E-06	4.68E-04	4.18E-08	1.84E-03	6.02E-03	1.42E-06	6.24E-05	1.33E-06	8.47E-03
Dose via moose	mSv/a	1.91E-06	8.00E-08	1.26E-06	1.39E-04	3.73E-08	1.18E-04	2.49E-04	5.50E-07	5.47E-05	1.55E-07	5.65E-04
Dose via mallard	mSv/a	3.87E-07	3.50E-07	5.49E-06	2.13E-05	5.70E-09	8.75E-05	4.25E-03	2.41E-06	9.11E-06	5.31E-07	4.37E-03
Total ingestion dose	mSv/a	1.08E-03	8.08E-06	1.27E-04	5.23E-03	4.19E-06	1.34E-02	1.71E-02	5.56E-05	7.39E-04	5.01E-05	3.78E-02

Human Dose Calculations - SRFN Adult - Nordic Lake

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	TH228+	TOTAL
Water conc.	Bq/L	0.03936	0.004	0.0010	0.03	0.0300	0.03	0.01	0.0004	0.0016	0.0012	
Wat to fish BAF	L/kg (fw)	11.4	5.2	5.2	19.1	-	30.5	171.9	5.2	19.1	5.2	
Sport fish tissue conc.	Bq/kg (fw)	0.449	0.021	0.005	0.573	0.057	0.914	1.719	0.002	0.031	0.006	
Moose wb conc.	Bq/kg (fw)	0.08	0.04	0.01	1.34	0.40	0.45	0.35	0.00	0.21	0.00	
Moose meat conc.	Bq/kg (fw)	0.04	0.02	0.01	0.50	0.15	0.17	0.21	0.00	0.08	0.00	
Mallard duck wb conc.	Bq/kg (fw)	0.02	0.16	0.04	0.21	0.06	0.33	6.00	0.02	0.04	0.01	
Mallard duck meat conc.	Bq/kg (fw)	0.01	0.10	0.03	0.08	0.02	0.13	3.54	0.01	0.01	0.01	
Ingestion rate water	L/a	0	0	0	0	0	0	0	0	0	0	
Ingestion rate fish	kg/a	0	0	0	0	0	0	0	0	0	0	
Ingestion rate moose	kg/a	0.605	0.605	0.605	0.605	0.605	0.605	0.605	0.605	0.605	0.605	
Ingestion rate mallard	kg/a	0.0185	0.0185	0.0185	0.0185	0.0185	0.0185	0.0185	0.0185	0.0185	0.0185	
Exposure via water	Bq/a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Exposure via fish	Bq/a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Exposure via moose	Bq/a	0.02	0.01	0.00	0.30	0.09	0.10	0.13	0.00	0.05	0.00	
Exposure via mallard	Bq/a	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	
Ingestion DCF adult	Sv/Bq	4.70E-08	3.40E-09	2.10E-07	2.80E-07	2.50E-10	6.91E-07	1.20E-06	2.30E-07	6.90E-07	7.20E-08	
Dose via water	mSv/a	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dose via fish	mSv/a	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dose via moose	mSv/a	1.16E-06	4.84E-08	7.59E-07	8.42E-05	2.25E-08	7.15E-05	1.51E-04	3.33E-07	3.31E-05	9.40E-08	3.42E-04
Dose via mallard	mSv/a	7.15E-09	6.48E-09	1.02E-07	3.94E-07	1.05E-10	1.62E-06	7.86E-05	4.45E-08	1.69E-07	9.82E-09	8.09E-05
Total ingestion dose	mSv/a	1.16E-06	5.49E-08	8.61E-07	8.46E-05	2.26E-08	7.31E-05	2.29E-04	3.77E-07	3.33E-05	1.04E-07	4.23E-04

Human Dose Calculations - SRFN Adult - Nordic Lake

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	TH228+	TOTAL
Water conc.	Bq/L	0.03936	0.004	0.0010	0.03	0.0300	0.03	0.01	0.0004	0.0016	0.0012	
Wat to fish BAF	L/kg (fw)	11.4	5.2	5.2	19.1	-	30.5	171.9	5.2	19.1	5.2	
Sport fish tissue conc.	Bq/kg (fw)	0.449	0.021	0.005	0.573	0.057	0.914	1.719	0.002	0.031	0.006	
Moose wb conc.	Bq/kg (fw)	0.08	0.04	0.01	1.34	0.40	0.45	0.35	0.00	0.21	0.00	
Moose meat conc.	Bq/kg (fw)	0.04	0.02	0.01	0.50	0.15	0.17	0.21	0.00	0.08	0.00	
Mallard duck wb conc.	Bq/kg (fw)	0.02	0.16	0.04	0.21	0.06	0.33	6.00	0.02	0.04	0.01	
Mallard duck meat conc.	Bq/kg (fw)	0.01	0.10	0.03	0.08	0.02	0.13	3.54	0.01	0.01	0.01	
Ingestion rate water	L/a	0	0	0	0	0	0	0	0	0	0	
Ingestion rate fish	kg/a	0	0	0	0	0	0	0	0	0	0	
Ingestion rate moose	kg/a	0.605	0.605	0.605	0.605	0.605	0.605	0.605	0.605	0.605	0.605	
Ingestion rate mallard	kg/a	0	0	0	0	0	0	0	0	0	0	
Exposure via water	Bq/a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Exposure via fish	Bq/a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Exposure via moose	Bq/a	0.02	0.01	0.00	0.30	0.09	0.10	0.13	0.00	0.05	0.00	
Exposure via mallard	Bq/a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Ingestion DCF adult	Sv/Bq	4.70E-08	3.40E-09	2.10E-07	2.80E-07	2.50E-10	6.91E-07	1.20E-06	2.30E-07	6.90E-07	7.20E-08	
Dose via water	mSv/a	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dose via fish	mSv/a	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dose via moose	mSv/a	1.16E-06	4.84E-08	7.59E-07	8.42E-05	2.25E-08	7.15E-05	1.51E-04	3.33E-07	3.31E-05	9.40E-08	3.42E-04
Dose via mallard	mSv/a	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total ingestion dose	mSv/a	1.16E-06	4.84E-08	7.59E-07	8.42E-05	2.25E-08	7.15E-05	1.51E-04	3.33E-07	3.31E-05	9.40E-08	3.42E-04

Ecological Dose Calculations - Aquatic Biota - Quirke Lake

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	Th-228+	TOTAL
Water conc.	Bq/L	0.0640	0.02225	0.01	0.05	0.05	0.06	0.01	0.0053	0.0080	0.0075	
Sed to water PC	L/kg (dw)	34231	49200	49200	44000	44000	38333	76666	49200	44000	49200	
Sediment conc.	Bq/kg (dw)	2189.4	1094.7	2700	2200	2200	2300	2600	260	350	370	
Sediment conc.	Bq/kg (ww)	219	109	270	220	220	230	260	26	35	37	
Wat to fish BAF	L/kg (fw)	478	218	218	540	-	861	-	218	540	218	
Fish tissue conc.	Bq/kg (fw)	63.55	4.8505	22	59.67	5.9667	30	1006.67	1.15	106.67	4.67	
Wat to aquatic plant BAF	L/kg (fw)	5090	6215	6215	3748	-	2499	-	6215	3748	6215	
Aquatic plant conc.	Bq/kg (fw)	1466.01	138.28	608.81	462.5	46.25	481.875	534.375	77.56	128.75	70.69	
Wat to benthos BAF	L/kg (fw)	276	276	276	486	-	3643	20000	276	486	276	
Benthos conc.	Bq/kg (fw)	17.65	6.14	2.76	24.30	2.43	218.58	200.00	1.46	3.87	2.08	
Int. DCF tissue	Gy/a per Bq/kg (fw)	2.31E-05	4.56E-06	2.41E-05	2.46E-05	1.12E-04	2.19E-06	2.73E-05	2.06E-05	7.12E-06	1.77E-04	
Ext. DCF sediment	Gy/a per Bq/kg (ww)	5.40E-08	1.53E-05	5.35E-08	2.4E-07	6.70E-05	4.56E-06	2.58E-10	4.67E-08	3.55E-05	5.81E-05	
Ext. dose sediment (OF_s .5)	mGy/d	1.62E-05	2.29E-03	1.98E-05	7.23E-05	2.02E-02	1.44E-03	9.19E-08	1.66E-06	1.70E-03	2.95E-03	2.87E-02
Int. abs. dose fish	mGy/d	4.02E-03	6.06E-05	1.45E-03	4.02E-03	1.83E-03	1.80E-04	7.53E-02	6.50E-05	2.08E-03	2.26E-03	9.13E-02
Int. abs dose plant	mGy/d	9.28E-02	1.73E-03	4.02E-02	3.12E-02	1.42E-02	2.89E-03	4.00E-02	4.38E-03	2.51E-03	3.43E-02	2.64E-01
Int. abs dose benthos	mGy/d	1.12E-03	7.67E-05	1.82E-04	1.64E-03	7.46E-04	1.31E-03	1.50E-02	8.23E-05	7.54E-05	1.01E-03	2.12E-02
RBE alpha	-	10	1	10	10	10	1	10	10	1	10	
γ eq. . dose fish	mGy/d	4.02E-02	2.35E-03	1.45E-02	4.03E-02	3.85E-02	1.62E-03	7.53E-01	6.52E-04	3.78E-03	2.56E-02	9.20E-01
γ eq. dose plant	mGy/d	9.28E-01	4.02E-03	4.02E-01	3.12E-01	1.62E-01	4.32E-03	4.00E-01	4.38E-02	4.21E-03	3.46E-01	2.61E+00
γ eq. . dose benthos	mGy/d	1.12E-02	4.67E-03	1.86E-03	1.65E-02	4.78E-02	4.18E-03	1.50E-01	8.26E-04	3.48E-03	1.60E-02	2.56E-01

Ecological Dose Calculations - Riparian Wildlife - Quirke Lake

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	Th-228+	TOTAL
Water conc.	Bq/L	0.06396	0.02225	0.01	0.05	0.05	0.06	0.01	0.0053	0.0080	0.0075	
Sed to water PC	L/kg (dw)	34231	49200	49200	44000	44000	38333	76666	49200	44000	49200	
Sediment conc.	Bq/kg (dw)	2189.4	1094.7	2700	2200	2200	2300	2600	260	350	370	
Sediment conc.	Bq/kg (ww)	219	109	270	220	220	230	260	26	35	37	
Wat to fish BAF	L/kg (fw)	478	218	218	540	-	861	-	218	540	218	
Fish tissue conc.	Bq/kg (fw)	63.55	4.8505	22	59.67	5.9667	30	1006.67	1.15	106.67	4.67	
Wat to aquatic plant BAF	L/kg (fw)	5090	6215	6215	3748	-	2499	-	6215	3748		
Aquatic plant conc.	Bq/kg (fw)	1466.01	138.28	608.81	462.5	46.25	481.875	534.375	77.5625	128.75	70.69	
Wat to benthos BAF	L/kg (fw)	276	276	276	486	-	3643	20000	276	486	276	
Benthos conc.	Bq/kg (fw)	17.65	6.14	2.76	24.30	2.43	218.58	200.00	1.46	3.87	2.08	
Ing. TF mallard	d/kg	0.008	0.050	0.050	0.046	-	0.162	4.62	0.050	0.046	0.050	
Ing. TF scaup	d/kg	0.008	0.496	0.496	0.423	-	0.162	4.62	0.496	0.423	0.496	
Ing. TF merganser	d/kg	0.163	4.89	4.89	3.91	-	1.99	5.45	4.894	3.910	4.894	
Ing. TF muskrat	d/kg	0.077	0.031	0.031	0.694	-	0.462	0.540	0.031	0.694	0.031	
Ing. TF mink	d/kg	0.080	0.032	0.032	0.717	-	0.478	0.558	0.032	0.717	0.032	
Int. DCF tissue	Gy/a per Bq/kg (fw)	2.31E-05	4.56E-06	2.41E-05	2.46E-05	1.12E-04	2.19E-06	2.73E-05	2.06E-05	7.12E-06	1.77E-04	
Ext. DCF sediment	Gy/a per Bq/kg (ww)	5.40E-08	1.53E-05	5.35E-08	2.4E-07	6.70E-05	4.56E-06	2.58E-10	4.67E-08	3.55E-05	5.81E-05	
Ext. dose sediment (OF_s .5)	mGy/d	8.09E-06	1.15E-03	9.89E-06	3.62E-05	1.01E-02	7.19E-04	4.59E-08	8.31E-07	8.51E-04	1.47E-03	1.43E-02
Int. abs. dose mallard	mGy/d	8.88E-05	1.14E-05	2.60E-04	1.84E-04	2.52E-04	6.02E-05	2.38E-02	2.82E-05	1.47E-05	2.22E-04	2.50E-02
Int. abs. dose scaup	mGy/d	1.39E-06	7.34E-06	5.43E-05	1.03E-04	1.40E-04	2.27E-05	7.51E-03	7.87E-06	4.73E-06	9.62E-05	7.95E-03
Int. abs. dose merganser	mGy/d	1.11E-04	5.48E-05	1.25E-03	2.65E-03	3.63E-03	6.16E-05	6.81E-02	5.88E-05	1.35E-03	1.91E-03	7.92E-02
Int. abs. dose muskrat	mGy/d	3.12E-03	2.58E-05	5.68E-04	9.96E-03	1.36E-02	6.15E-04	9.95E-03	6.07E-05	7.76E-04	4.90E-04	3.92E-02
Int. abs. dose mink	mGy/d	6.62E-05	5.75E-07	1.15E-05	5.99E-04	8.18E-04	1.95E-05	8.03E-03	6.17E-07	2.86E-04	1.64E-05	9.85E-03
RBE alpha	-	10	1	10	10	10	1	10	10	1	10	
γ eq. dose mallard	mGy/d	8.96E-04	1.16E-03	2.61E-03	1.88E-03	1.26E-02	7.79E-04	2.38E-01	2.82E-04	8.66E-04	3.70E-03	2.63E-01
γ eq. dose scaup	mGy/d	2.20E-05	1.15E-03	5.53E-04	1.06E-03	1.15E-02	7.41E-04	7.51E-02	7.96E-05	8.56E-04	2.44E-03	9.35E-02
γ eq. dose merganser	mGy/d	1.12E-03	1.20E-03	1.25E-02	2.66E-02	4.64E-02	7.80E-04	6.81E-01	5.88E-04	2.20E-03	2.06E-02	7.93E-01
γ eq. dose muskrat	mGy/d	3.12E-02	2.32E-03	5.70E-03	9.96E-02	1.56E-01	2.05E-03	9.95E-02	6.09E-04	2.48E-03	7.85E-03	4.07E-01
γ eq. dose mink	mGy/d	6.78E-04	2.29E-03	1.35E-04	6.06E-03	2.84E-02	1.46E-03	8.03E-02	7.83E-06	1.99E-03	3.11E-03	1.24E-01

		Mallard	Scaup	Merganser	Muskrat	Mink		Moose
Body weight	kg	1.134	0.815	1.723	1.415	1.354		400
Ing. water	L/d	0.065	0.051	0.085	0.135	0.142		21.8
Ing. sediment	kg/d (dw)	0.00126	0.00102	0.00017	0.00744	0.000475		0.057
Ing. plant	kg/d (fw)	0.252			0.425			3.3
Ing. benthos	kg/d (fw)		0.204					
Ing. fish	kg/d (fw)			0.331		0.19		
Occupancy factor	-	0.5	0.5	0.5	1.0	1.0		1.0

Human Dose Calculations - Generic Adult - Quirke Lake

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	TH228+	TOTAL
Water conc.	Bq/L	0.06396	0.02225	0.01	0.05	0.05	0.06	0.01	0.0053	0.0080	0.0075	
Wat to fish BAF	L/kg (fw)	11.4	5.2	5.2	19.1	-	30.5	171.9	5.2	19.1	5.2	
Sport fish tissue conc.	Bq/kg (fw)	0.729	0.116	0.052	0.955	0.096	1.827	1.719	0.027	0.152	0.039	
Moose wb conc.	Bq/kg (fw)	5.46	0.21	2.38	16.69	5.01	11.54	14.91	0.30	4.49	0.28	
Moose meat conc.	Bq/kg (fw)	2.73	0.13	1.50	6.18	1.85	4.39	8.80	0.19	1.66	0.18	
Mallard duck wb conc.	Bq/kg (fw)	1.40	0.91	3.94	2.73	0.82	10.05	318.74	0.50	0.75	0.46	
Mallard duck meat conc.	Bq/kg (fw)	0.70	0.57	2.48	1.01	0.30	3.82	188.06	0.31	0.28	0.29	
Ingestion rate water	L/a	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	
Ingestion rate fish	kg/a	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	
Ingestion rate moose	kg/a	1	1	1	1	1	1	1	1	1	1	
Ingestion rate mallard	kg/a	1	1	1	1	1	1	1	1	1	1	
Exposure via water	Bq/a	35.02	12.18	5.48	27.38	27.38	32.85	5.48	2.89	4.36	4.12	
Exposure via fish	Bq/a	2.13	0.34	0.15	2.79	0.28	5.34	5.02	0.08	0.44	0.11	
Exposure via moose	Bq/a	2.73	0.13	1.50	6.18	1.85	4.39	8.80	0.19	1.66	0.18	
Exposure via mallard	Bq/a	0.70	0.57	2.48	1.01	0.30	3.82	188.06	0.31	0.28	0.29	
Ingestion DCF adult	Sv/Bq	4.70E-08	3.40E-09	2.10E-07	2.80E-07	2.50E-10	6.91E-07	1.20E-06	2.30E-07	6.90E-07	7.20E-08	
Dose via water	mSv/a	1.65E-03	4.14E-05	1.15E-03	7.67E-03	6.84E-06	2.27E-02	6.57E-03	6.65E-04	3.01E-03	2.96E-04	4.38E-02
Dose via fish	mSv/a	1.00E-04	1.15E-06	3.19E-05	7.81E-04	6.97E-08	3.69E-03	6.02E-03	1.85E-05	3.06E-04	8.22E-06	1.10E-02
Dose via moose	mSv/a	1.28E-04	4.45E-07	3.15E-04	1.73E-03	4.63E-07	3.03E-03	1.06E-02	4.32E-05	1.15E-03	1.27E-05	1.70E-02
Dose via mallard	mSv/a	3.30E-05	1.95E-06	5.21E-04	2.83E-04	7.59E-08	2.64E-03	2.26E-01	7.23E-05	1.92E-04	2.08E-05	2.29E-01
Total ingestion dose	mSv/a	1.91E-03	4.50E-05	2.02E-03	1.05E-02	7.45E-06	3.21E-02	2.49E-01	7.99E-04	4.65E-03	3.38E-04	3.01E-01

Human Dose Calculations - SRFN Adult - Quirke Lake

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	TH228+	TOTAL
Water conc.	Bq/L	0.06396	0.02225	0.01	0.05	0.05	0.06	0.01	0.0053	0.0080	0.0075	
Wat to fish BAF	L/kg (fw)	11.4	5.2	5.2	19.1	-	30.5	171.9	5.2	19.1	5.2	
Sport fish tissue conc.	Bq/kg (fw)	0.729	0.116	0.052	0.955	0.096	1.827	1.719	0.027	0.152	0.039	
Moose wb conc.	Bq/kg (fw)	5.46	0.21	2.38	16.69	5.01	11.54	14.91	0.30	4.49	0.28	
Moose meat conc.	Bq/kg (fw)	2.73	0.13	1.50	6.18	1.85	4.39	8.80	0.19	1.66	0.18	
Mallard duck wb conc.	Bq/kg (fw)	1.40	0.91	3.94	2.73	0.82	10.05	318.74	0.50	0.75	0.46	
Mallard duck meat conc.	Bq/kg (fw)	0.70	0.57	2.48	1.01	0.30	3.82	188.06	0.31	0.28	0.29	
Ingestion rate water	L/a	13.6875	13.6875	13.6875	13.6875	13.6875	13.6875	13.6875	13.6875	13.6875	13.6875	
Ingestion rate fish	kg/a	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	
Ingestion rate moose	kg/a	0.3025	0.3025	0.3025	0.3025	0.3025	0.3025	0.3025	0.3025	0.3025	0.3025	
Ingestion rate mallard	kg/a	0	0	0	0	0	0	0	0	0	0	
Exposure via water	Bq/a	0.88	0.30	0.14	0.68	0.68	0.82	0.14	0.07	0.11	0.10	
Exposure via fish	Bq/a	0.23	0.04	0.02	0.30	0.03	0.58	0.55	0.01	0.05	0.01	
Exposure via moose	Bq/a	0.83	0.04	0.45	1.87	0.56	1.33	2.66	0.06	0.50	0.05	
Exposure via mallard	Bq/a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Ingestion DCF adult	Sv/Bq	4.70E-08	3.40E-09	2.10E-07	2.80E-07	2.50E-10	6.91E-07	1.20E-06	2.30E-07	6.90E-07	7.20E-08	
Dose via water	mSv/a	4.11E-05	1.04E-06	2.87E-05	1.92E-04	1.71E-07	5.68E-04	1.64E-04	1.66E-05	7.51E-05	7.41E-06	1.09E-03
Dose via fish	mSv/a	1.09E-05	1.25E-07	3.47E-06	8.49E-05	7.58E-09	4.01E-04	6.55E-04	2.01E-06	3.33E-05	8.94E-07	1.19E-03
Dose via moose	mSv/a	3.88E-05	1.35E-07	9.52E-05	5.23E-04	1.40E-07	9.17E-04	3.19E-03	1.31E-05	3.47E-04	3.84E-06	5.13E-03
Dose via mallard	mSv/a	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total ingestion dose	mSv/a	9.08E-05	1.29E-06	1.27E-04	8.00E-04	3.19E-07	1.89E-03	4.01E-03	3.17E-05	4.56E-04	1.21E-05	7.42E-03

Human Dose Calculations - SRFN Adult - Quirke Lake

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	TH228+	TOTAL
Water conc.	Bq/L	0.06396	0.02225	0.01	0.05	0.05	0.06	0.01	0.0053	0.0080	0.0075	
Wat to fish BAF	L/kg (fw)	11.4	5.2	5.2	19.1	-	30.5	171.9	5.2	19.1	5.2	
Sport fish tissue conc.	Bq/kg (fw)	0.729	0.116	0.052	0.955	0.096	1.827	1.719	0.027	0.152	0.039	
Moose wb conc.	Bq/kg (fw)	5.46	0.21	2.38	16.69	5.01	11.54	14.91	0.30	4.49	0.28	
Moose meat conc.	Bq/kg (fw)	2.73	0.13	1.50	6.18	1.85	4.39	8.80	0.19	1.66	0.18	
Mallard duck wb conc.	Bq/kg (fw)	1.40	0.91	3.94	2.73	0.82	10.05	318.74	0.50	0.75	0.46	
Mallard duck meat conc.	Bq/kg (fw)	0.70	0.57	2.48	1.01	0.30	3.82	188.06	0.31	0.28	0.29	
Ingestion rate water	L/a	0	0	0	0	0	0	0	0	0	0	
Ingestion rate fish	kg/a	0	0	0	0	0	0	0	0	0	0	
Ingestion rate moose	kg/a	0.605	0.605	0.605	0.605	0.605	0.605	0.605	0.605	0.605	0.605	
Ingestion rate mallard	kg/a	0	0	0	0	0	0	0	0	0	0	
Exposure via water	Bq/a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Exposure via fish	Bq/a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Exposure via moose	Bq/a	1.65	0.08	0.91	3.74	1.12	2.65	5.32	0.11	1.01	0.11	
Exposure via mallard	Bq/a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Ingestion DCF adult	Sv/Bq	4.70E-08	3.40E-09	2.10E-07	2.80E-07	2.50E-10	6.91E-07	1.20E-06	2.30E-07	6.90E-07	7.20E-08	
Dose via water	mSv/a	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dose via fish	mSv/a	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dose via moose	mSv/a	7.76E-05	2.69E-07	1.90E-04	1.05E-03	2.80E-07	1.83E-03	6.39E-03	2.61E-05	6.94E-04	7.68E-06	1.03E-02
Dose via mallard	mSv/a	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total ingestion dose	mSv/a	7.76E-05	2.69E-07	1.90E-04	1.05E-03	2.80E-07	1.83E-03	6.39E-03	2.61E-05	6.94E-04	7.68E-06	1.03E-02

Ecological Dose Calculations - Aquatic Biota - Lake Huron (Serpent Harbour)

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	Th-228+	TOTAL
Water conc.	Bq/L	0.0246	0.0079	0.0079	0.013	0.013	0.018	0.009	0.0007	0.0007	0.0030	
Sed to water PC	L/kg (dw)	31500	49200	49200	47738	47738	34733	69466	49200	47738	49200	
Sediment conc.	Bq/kg (dw)	774.9	387.45	387.5	620.6	620.6	620.6	620.6	35	35	150	
Sediment conc.	Bq/kg (ww)	77	39	39	62	62	62	62	4	4	15	
Wat to fish BAF	L/kg (fw)	478	218	218	540	-	861	-	218	540	218	
Fish tissue conc.	Bq/kg (fw)	11.76	1.72	1.72	7.02	0.702	15.38	338.45	0.16	0.40	0.66	
Wat to aquatic plant BAF	L/kg (fw)	5090	6215	6215	3748	-	2499	-	6215	3748	6215	
Aquatic plant conc.	Bq/kg (fw)	125.21	48.94	48.94	48.72	4.87	44.65	44.65	4.42	2.75	18.95	
Wat to benthos BAF	L/kg (fw)	276	276	276	486	-	3643	20000	276	486	276	
Benthos conc.	Bq/kg (fw)	6.79	2.17	2.17	6.32	0.63	65.09	178.68	0.20	0.36	0.84	
Int. DCF tissue	Gy/a per Bq/kg (fw)	2.31E-05	4.56E-06	2.41E-05	2.46E-05	1.12E-04	2.19E-06	2.73E-05	2.06E-05	7.12E-06	1.77E-04	
Ext. DCF sediment	Gy/a per Bq/kg (ww)	5.40E-08	1.53E-05	5.35E-08	2.4E-07	6.70E-05	4.56E-06	2.58E-10	4.67E-08	3.55E-05	5.81E-05	
Ext. dose sediment (OF_s .5)	mGy/d	5.73E-06	8.12E-04	2.84E-06	2.04E-05	5.70E-03	3.88E-04	2.19E-08	2.24E-07	1.70E-04	1.19E-03	8.29E-03
Int. abs. dose fish	mGy/d	7.44E-04	2.14E-05	1.13E-04	4.73E-04	2.15E-04	9.22E-05	2.53E-02	8.75E-06	7.72E-06	3.22E-04	2.73E-02
Int. abs dose plant	mGy/d	7.92E-03	6.11E-04	3.23E-03	3.28E-03	1.50E-03	2.68E-04	3.34E-03	2.50E-04	5.36E-05	9.18E-03	2.96E-02
Int. abs dose benthos	mGy/d	4.30E-04	2.72E-05	1.44E-04	4.26E-04	1.94E-04	3.90E-04	1.34E-02	1.11E-05	6.95E-06	4.08E-04	1.54E-02
RBE alpha	-	10	1	10	10	10	1	10	10	1	10	
γ eq. . dose fish	mGy/d	7.45E-03	8.34E-04	1.14E-03	4.75E-03	7.85E-03	4.80E-04	2.53E-01	8.77E-05	1.78E-04	4.42E-03	2.80E-01
γ eq. dose plant	mGy/d	7.93E-02	1.42E-03	3.23E-02	3.29E-02	2.06E-02	6.55E-04	3.34E-02	2.50E-03	2.24E-04	9.30E-02	2.96E-01
γ eq. . dose benthos	mGy/d	4.31E-03	1.65E-03	1.44E-03	4.30E-03	1.33E-02	1.17E-03	1.34E-01	1.11E-04	3.47E-04	6.47E-03	1.67E-01

Ecological Dose Calculations - Riparian Wildlife - Lake Huron (Serpent Harbour)

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	Th-228+	TOTAL
Water conc.	Bq/L	0.0246	0.0079	0.0079	0.013	0.0130	0.0179	0.0089	0.0007	0.0007	0.0030	
Sed to water PC	L/kg (dw)	31500	49200	49200	47738	47738	34733	69466	49200	47738	49200	
Sediment conc.	Bq/kg (dw)	774.9	387.45	387.45	620.6	620.6	620.6	620.6	35	35	150	
Sediment conc.	Bq/kg (ww)	77	39	39	62	62	62	62	4	4	15	
Wat to fish BAF	L/kg (fw)	478	218	218	540	-	861	-	218	540	218	
Fish tissue conc.	Bq/kg (fw)	11.76	1.72	1.72	7.02	0.702	15.38	338.45	0.16	0.40	0.66	
Wat to aquatic plant BAF	L/kg (fw)	5090	6215	6215	3748	-	2499	-	6215	3748		
Aquatic plant conc.	Bq/kg (fw)	125.21	48.94	48.94	48.72	4.87	44.65	44.65	4.42	2.75	18.95	
Wat to benthos BAF	L/kg (fw)	276	276	276	486	-	3643	20000	276	486	276	
Benthos conc.	Bq/kg (fw)	6.79	2.17	2.17	6.32	0.63	65.09	178.68	0.20	0.36	0.84	
Ing. TF mallard	d/kg	0.008	0.050	0.050	0.046	-	0.162	4.62	0.050	0.046	0.050	
Ing. TF scaup	d/kg	0.008	0.496	0.496	0.423	-	0.162	4.62	0.496	0.423	0.496	
Ing. TF merganser	d/kg	0.163	4.89	4.89	3.91	-	1.99	5.45	4.894	3.910	4.894	
Ing. TF muskrat	d/kg	0.077	0.031	0.031	0.694	-	0.462	0.540	0.031	0.694	0.031	
Ing. TF mink	d/kg	0.080	0.032	0.032	0.717	-	0.478	0.558	0.032	0.717	0.032	
Int. DCF tissue	Gy/a per Bq/kg (fw)	2.31E-05	4.56E-06	2.41E-05	2.46E-05	1.12E-04	2.19E-06	2.73E-05	2.06E-05	7.12E-06	1.77E-04	
Ext. DCF sediment	Gy/a per Bq/kg (ww)	5.40E-08	1.53E-05	5.35E-08	2.4E-07	6.70E-05	4.56E-06	2.58E-10	4.67E-08	3.55E-05	5.81E-05	
Ext. dose sediment (OF_s .5)	mGy/d	2.86E-06	4.06E-04	1.42E-06	1.02E-05	2.85E-03	1.94E-04	1.10E-08	1.12E-07	8.51E-05	5.97E-04	4.14E-03
Int. abs. dose mallard	mGy/d	7.76E-06	4.02E-06	2.13E-05	2.02E-05	2.76E-05	5.83E-06	2.08E-03	1.64E-06	3.29E-07	6.04E-05	2.23E-03
Int. abs. dose scaup	mGy/d	5.19E-07	2.60E-06	1.37E-05	2.74E-05	3.75E-05	6.74E-06	6.41E-03	1.06E-06	4.48E-07	3.90E-05	6.54E-03
Int. abs. dose merganser	mGy/d	2.08E-05	1.94E-05	1.02E-04	3.20E-04	4.38E-04	3.10E-05	2.29E-02	7.91E-06	5.23E-06	2.91E-04	2.41E-02
Int. abs. dose muskrat	mGy/d	2.88E-04	9.12E-06	4.82E-05	1.18E-03	1.62E-03	6.54E-05	9.52E-04	3.72E-06	1.93E-05	1.37E-04	4.32E-03
Int. abs. dose mink	mGy/d	1.31E-05	2.04E-07	1.08E-06	7.88E-05	1.08E-04	9.22E-06	2.69E-03	8.31E-08	1.29E-06	3.06E-06	2.91E-03
RBE alpha	-	10	1	10	10	10	1	10	10	1	10	
γ eq. dose mallard	mGy/d	8.05E-05	4.10E-04	2.14E-04	2.12E-04	3.12E-03	2.00E-04	2.08E-02	1.65E-05	8.54E-05	1.20E-03	2.63E-02
γ eq. dose scaup	mGy/d	8.06E-06	4.09E-04	1.39E-04	2.84E-04	3.22E-03	2.01E-04	6.41E-02	1.07E-05	8.56E-05	9.87E-04	6.94E-02
γ eq. dose merganser	mGy/d	2.11E-04	4.25E-04	1.03E-03	3.21E-03	7.22E-03	2.25E-04	2.29E-01	7.92E-05	9.03E-05	3.51E-03	2.45E-01
γ eq. dose muskrat	mGy/d	2.88E-03	8.21E-04	4.85E-04	1.19E-02	2.19E-02	4.53E-04	9.52E-03	3.75E-05	1.90E-04	2.56E-03	5.07E-02
γ eq. dose mink	mGy/d	1.37E-04	8.12E-04	1.36E-05	8.08E-04	6.77E-03	3.97E-04	2.69E-02	1.05E-06	1.71E-04	1.22E-03	3.73E-02

		Mallard	Scaup	Merganser	Muskrat	Mink		Moose
Body weight	kg	1.134	0.815	1.723	1.415	1.354		400
Ing. water	L/d	0.065	0.051	0.085	0.135	0.142		21.8
Ing. sediment	kg/d (dw)	0.00126	0.00102	0.00017	0.00744	0.000475		0.057
Ing. plant	kg/d (fw)	0.252			0.425			3.3
Ing. benthos	kg/d (fw)		0.204					
Ing. fish	kg/d (fw)			0.331		0.19		
Occupancy factor	-	0.5	0.5	0.5	1.0	1.0		1.0

Human Dose Calculations - Generic Adult - Lake Huron (Serpent Harbour)

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	TH228+	TOTAL
Water conc.	Bq/L	0.0246	0.0079	0.0079	0.013	0.013	0.0179	0.0089	0.0007	0.0007	0.0030	
Wat to fish BAF	L/kg (fw)	11.4	5.2	5.2	19.1	-	30.5	171.9	5.2	19.1	5.2	
Sport fish tissue conc.	Bq/kg (fw)	0.280	0.041	0.041	0.248	0.025	0.544	1.536	0.004	0.014	0.016	
Moose wb conc.	Bq/kg (fw)	0.50	0.07	0.20	1.98	0.60	1.23	1.43	0.02	0.11	0.08	
Moose meat conc.	Bq/kg (fw)	0.25	0.05	0.13	0.73	0.22	0.47	0.84	0.01	0.04	0.05	
Mallard duck wb conc.	Bq/kg (fw)	0.12	0.32	0.32	0.30	0.09	0.97	27.81	0.03	0.02	0.12	
Mallard duck meat conc.	Bq/kg (fw)	0.06	0.20	0.20	0.11	0.03	0.37	16.41	0.02	0.01	0.08	
Ingestion rate water	L/a	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	
Ingestion rate fish	kg/a	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	
Ingestion rate moose	kg/a	1	1	1	1	1	1	1	1	1	1	
Ingestion rate mallard	kg/a	1	1	1	1	1	1	1	1	1	1	
Exposure via water	Bq/a	13.47	4.31	4.31	7.12	7.12	9.78	4.89	0.39	0.40	1.67	
Exposure via fish	Bq/a	0.82	0.12	0.12	0.73	0.07	1.59	4.48	0.01	0.04	0.05	
Exposure via moose	Bq/a	0.25	0.05	0.13	0.73	0.22	0.47	0.84	0.01	0.04	0.05	
Exposure via mallard	Bq/a	0.06	0.20	0.20	0.11	0.03	0.37	16.41	0.02	0.01	0.08	
Ingestion DCF adult	Sv/Bq	4.70E-08	3.40E-09	2.10E-07	2.80E-07	2.50E-10	6.91E-07	1.20E-06	2.30E-07	6.90E-07	7.20E-08	
Dose via water	mSv/a	6.33E-04	1.47E-05	9.05E-04	1.99E-03	1.78E-06	6.76E-03	5.87E-03	8.96E-05	2.77E-04	1.20E-04	1.67E-02
Dose via fish	mSv/a	3.85E-05	4.06E-07	2.51E-05	2.03E-04	1.81E-08	1.10E-03	5.38E-03	2.48E-06	2.82E-05	3.33E-06	6.78E-03
Dose via moose	mSv/a	1.18E-05	1.57E-07	2.67E-05	2.06E-04	5.51E-08	3.22E-04	1.01E-03	2.65E-06	2.86E-05	3.55E-06	1.61E-03
Dose via mallard	mSv/a	2.88E-06	6.89E-07	4.26E-05	3.10E-05	8.31E-09	2.55E-04	1.97E-02	4.21E-06	4.31E-06	5.65E-06	2.00E-02
Total ingestion dose	mSv/a	6.86E-04	1.59E-05	1.00E-03	2.43E-03	1.86E-06	8.44E-03	3.19E-02	9.89E-05	3.38E-04	1.33E-04	4.51E-02

Human Dose Calculations - SRFN Adult - Lake Huron (Serpent Harbour)

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	TH228+	TOTAL
Water conc.	Bq/L	0.0246	0.0079	0.0079	0.013	0.013	0.0179	0.0089	0.0007	0.0007	0.0030	
Wat to fish BAF	L/kg (fw)	11.4	5.2	5.2	19.1	-	30.5	171.9	5.2	19.1	5.2	
Sport fish tissue conc.	Bq/kg (fw)	0.280	0.041	0.041	0.248	0.025	0.544	1.536	0.004	0.014	0.016	
Moose wb conc.	Bq/kg (fw)	0.50	0.07	0.20	1.98	0.60	1.23	1.43	0.02	0.11	0.08	
Moose meat conc.	Bq/kg (fw)	0.25	0.05	0.13	0.73	0.22	0.47	0.84	0.01	0.04	0.05	
Mallard duck wb conc.	Bq/kg (fw)	0.12	0.32	0.32	0.30	0.09	0.97	27.81	0.03	0.02	0.12	
Mallard duck meat conc.	Bq/kg (fw)	0.06	0.20	0.20	0.11	0.03	0.37	16.41	0.02	0.01	0.08	
Ingestion rate water	L/a	506.438	506.438	506.438	506.438	506.438	506.438	506.438	506.438	506.438	506.438	
Ingestion rate fish	kg/a	8.38	8.38	8.38	8.38	8.38	8.38	8.38	8.38	8.38	8.38	
Ingestion rate moose	kg/a	2.42	2.42	2.42	2.42	2.42	2.42	2.42	2.42	2.42	2.42	
Ingestion rate mallard	kg/a	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	
Exposure via water	Bq/a	12.46	3.99	3.99	6.58	6.58	9.05	4.52	0.36	0.37	1.54	
Exposure via fish	Bq/a	2.35	0.34	0.34	2.08	0.21	4.56	12.87	0.03	0.12	0.13	
Exposure via moose	Bq/a	0.61	0.11	0.31	1.78	0.53	1.13	2.04	0.03	0.10	0.12	
Exposure via mallard	Bq/a	0.01	0.05	0.05	0.03	0.01	0.09	3.95	0.00	0.00	0.02	
Ingestion DCF adult	Sv/Bq	4.70E-08	3.40E-09	2.10E-07	2.80E-07	2.50E-10	6.91E-07	1.20E-06	2.30E-07	6.90E-07	7.20E-08	
Dose via water	mSv/a	5.86E-04	1.36E-05	8.38E-04	1.84E-03	1.65E-06	6.26E-03	5.43E-03	8.29E-05	2.56E-04	1.11E-04	1.54E-02
Dose via fish	mSv/a	1.10E-04	1.17E-06	7.21E-05	5.83E-04	5.20E-08	3.15E-03	1.54E-02	7.13E-06	8.10E-05	9.57E-06	1.95E-02
Dose via moose	mSv/a	2.86E-05	3.81E-07	6.47E-05	4.97E-04	1.33E-07	7.80E-04	2.44E-03	6.40E-06	6.91E-05	8.59E-06	3.90E-03
Dose via mallard	mSv/a	6.93E-07	1.66E-07	1.02E-05	7.46E-06	2.00E-09	6.14E-05	4.74E-03	1.01E-06	1.04E-06	1.36E-06	4.82E-03
Total ingestion dose	mSv/a	7.25E-04	1.53E-05	9.85E-04	2.93E-03	1.83E-06	1.02E-02	2.81E-02	9.74E-05	4.07E-04	1.31E-04	4.36E-02

Human Dose Calculations - SRFN Adult - Lake Huron (Serpent Harbour)

Parameter	Units	U238/234	TH234+	TH230	RA226	RN222+	PB210+	PO210	TH232	RA228+	TH228+	TOTAL
Water conc.	Bq/L	0.0246	0.0079	0.0079	0.013	0.013	0.0179	0.0089	0.0007	0.0007	0.0030	
Wat to fish BAF	L/kg (fw)	11.4	5.2	5.2	19.1	-	30.5	171.9	5.2	19.1	5.2	
Sport fish tissue conc.	Bq/kg (fw)	0.280	0.041	0.041	0.248	0.025	0.544	1.536	0.004	0.014	0.016	
Moose wb conc.	Bq/kg (fw)	0.50	0.07	0.20	1.98	0.60	1.23	1.43	0.02	0.11	0.08	
Moose meat conc.	Bq/kg (fw)	0.25	0.05	0.13	0.73	0.22	0.47	0.84	0.01	0.04	0.05	
Mallard duck wb conc.	Bq/kg (fw)	0.12	0.32	0.32	0.30	0.09	0.97	27.81	0.03	0.02	0.12	
Mallard duck meat conc.	Bq/kg (fw)	0.06	0.20	0.20	0.11	0.03	0.37	16.41	0.02	0.01	0.08	
Ingestion rate water	L/a	540.93	540.93	540.93	540.93	540.93	540.93	540.93	540.93	540.93	540.93	
Ingestion rate fish	kg/a	9.27	9.27	9.27	9.27	9.27	9.27	9.27	9.27	9.27	9.27	
Ingestion rate moose	kg/a	2.42	2.42	2.42	2.42	2.42	2.42	2.42	2.42	2.42	2.42	
Ingestion rate mallard	kg/a	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	
Exposure via water	Bq/a	13.31	4.26	4.26	7.03	7.03	9.67	4.83	0.38	0.40	1.65	
Exposure via fish	Bq/a	2.60	0.38	0.38	2.30	0.23	5.04	14.24	0.03	0.13	0.15	
Exposure via moose	Bq/a	0.61	0.11	0.31	1.78	0.53	1.13	2.04	0.03	0.10	0.12	
Exposure via mallard	Bq/a	0.02	0.08	0.08	0.04	0.01	0.14	6.07	0.01	0.00	0.03	
Ingestion DCF adult	Sv/Bq	4.70E-08	3.40E-09	2.10E-07	2.80E-07	2.50E-10	6.91E-07	1.20E-06	2.30E-07	6.90E-07	7.20E-08	
Dose via water	mSv/a	6.25E-04	1.45E-05	8.95E-04	1.97E-03	1.76E-06	6.68E-03	5.80E-03	8.85E-05	2.74E-04	1.19E-04	1.65E-02
Dose via fish	mSv/a	1.22E-04	1.29E-06	7.97E-05	6.45E-04	5.75E-08	3.49E-03	1.71E-02	7.89E-06	8.96E-05	1.06E-05	2.15E-02
Dose via moose	mSv/a	2.86E-05	3.81E-07	6.47E-05	4.97E-04	1.33E-07	7.80E-04	2.44E-03	6.40E-06	6.91E-05	8.59E-06	3.90E-03
Dose via mallard	mSv/a	1.07E-06	2.55E-07	1.58E-05	1.15E-05	3.07E-09	9.45E-05	7.28E-03	1.56E-06	1.59E-06	2.09E-06	7.41E-03
Total ingestion dose	mSv/a	7.77E-04	1.64E-05	1.05E-03	3.12E-03	1.95E-06	1.10E-02	3.26E-02	1.04E-04	4.34E-04	1.40E-04	4.93E-02

APPENDIX G

RADIUM RELEASE STUDIES

Radium-226 Release Controls in Cell 14 At Quirke

EcoMetrix Incorporated

CYCLE III SPECIAL STUDIES – RADIUM-226 RELEASE CONTROLS IN CELL 14 AT QUIRKE

Report prepared for:

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Elliot Lake, ON

Report prepared by:

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Ref. 09-1662:1
February 2011

EcoMetrix INCORPORATED

CYCLE III SPECIAL STUDIES – RADIUM-226 RELEASE CONTROLS IN CELL 14 AT QUIRKE

Erin Clyde, M.Sc.
Project Manager

Ronald V. Nicholson, Ph.D.
Project Principal

EXECUTIVE SUMMARY

The Quirke Site (the Site) is a decommissioned uranium mine property located approximately 13 km north of the City of Elliot Lake and immediately north of Dunlop Lake. The Site is own and managed by Rio Algom Limited (RAL).

EcoMetrix Incorporated (EcoMetrix) was retained by RAL to complete a directed study that focused on the release of Ra-226 from the submerged tailings to the basin water in Cell 14 at the Quirke Tailings Management Area (TMA).

The main objectives of this investigation were to evaluate Ra-226 activities in solids, porewater and basin water to develop an understanding of the controls on Ra-226 releases to the basin water in Cell 14 in order to address the uncertainties related to the release of Ra-226 to the basin water that arose from the inconsistencies between the results from routine monitoring and those from the Martin *et al.* (2003) study. Another objective was to provide reasonable estimates for Ra-226 activities that may be observed in the basin water.

The investigation focused on Ra-226 activities in the solids, porewater and basin water in Cell 14 of the Quirke TMA to fill knowledge gaps and bound uncertainties related to the release of Ra-226 to the basin waters in Cell 14 that arose from inconsistencies between the results from routine monitoring and those from the Martin *et al*. (2003) study. It was understood that any release of Ra-226 to the basin water would be initiated in the solid phase but that the release from solids would be reflected by activities/concentrations in the porewater before eventual release to the overlying water.

Four stations were sampled in Cell 14 in September 2009 to obtain representative samples to quantify activities/concentrations of Ra-226 and other constituents that can potentially play a role in Ra-226 mobility in the tailings basin.

The Ra-226 activities as high as 70 Bq/L in porewater and 30 Bq/L in basin water measured in Cell 14 by Martin et al. (2003) were not observed in this investigation or during routine monitoring in the Quirke TMA. Although, field observations, together with TOC contents, suggested there could be a potential for sulphate reduction in the top portions of the tailings at QC14-2, there was no evidence of the consequential high release of Ra-226 to porewater in this study. The Ra-226 activities in the top samples at QC15-2 were 3.6 and 2.8 Bq/L.

Two mechanisms that could potentially control Ra-226 and barium activities/concentrations in the porewater, sorption and solubility controls were considered in this study. The first mechanism, sorption, can be represented by a Kd model and assumes that Ra-226 is distributed between solids and water so that the activities in the water are linearly correlated to the activities in the solids. The second mechanism, solubility, assumes that barium, for example, is distributed between the solids and water on the basis of thermodynamic solubility. The solubility model infers that the concentration of a constituent in the water is independent of the content in the solids, but will depend on the concentration of the companion ion in the water phase. These two models may not be mutually exclusive, and therefore, both mechanisms may influence Ra-226 and barium activities/concentrations in porewater.

Plots for Ra-226 and barium activities/concentrations in solids and porewater showed that the sorption equilibrium, or Kd, model does not dominate the solids-porewater interactions in Cell 14.

Strong correlations between Ra-226 and barium in both the tailings solids and porewater support a similar mechanism for the formation of Ra-226 and barium in solids and suggest that solubility equilibrium controls Ra-226 and barium activities/concentrations in porewater.

The inverse relationship between Ra-226 and calcium indicated that Ra-226 activities in the porewater are not directly controlled by gypsum dissolution as the conceptual model in the EIS suggests. Instead, the inverse correlation between Ra-226 and calcium results from indirect controls by gypsum related to the linkage between high calcium and sulphate in the presence of gypsum. The sulphate concentrations control the Ra-226 activities in porewater and therefore, the presence of gypsum in the tailings solids indirectly controls the Ra-226 activities. This does not contradict the conceptual model in the EIS but provides a refinement of the interpretation of the model.

Inverse correlations between barium and sulphate and between Ra-226 and sulphate indicated that the solubility of a solid sulphate phase controls the concentrations of barium and the activity of Ra-226 in water that is in contact with the tailings solids. The theoretical solubility of barium and sulphate in equilibrium with $BaSO_4$ solids provided further evidence that barium concentrations, and therefore Ra-226 activities, are controlled by sulphate concentrations.

Solubility theory suggested that barium and Ra-226 activities will increase as sulphate concentrations decrease. Results from Cell 14 showed Ra-226 activities between 3 and 7 Bq/L in porewaters associated with sulphate concentrations below 30 mg/L. Radium-226 activities in porewater did not exceed 5 Bq/L in the top portions of the tailings, the primary location where the transfer of Ra-226 from porewater to basin water is controlled.

The theoretical solubility of $BaSO_4$, together with the strong correlation between Ra-226 and barium in porewater were used to predict Ra-226 activities in porewater. A Ra-226 activity of 4 Bq/L in porewater was predicted for a sulphate concentration of 5 mg/L. This result is consistent with the measured porewater data from Cell 14 that exhibited Ra-226 activities of 4.1 and 3.4 Bq/L when sulphate concentrations were 6 and 7 mg/L, respectively. A maximum Ra-226 activity of 5 Bq/L measured in the top portions of the tailings porewater in Cell 14 provides a reasonable upper limit for Ra-226 activities that could be anticipated in submerged tailings porewater, for existing conditions.

Concentration gradients between Ra-226 activities in the porewater and basin imply upward diffusion and mass transport of Ra-226 from porewater to the overlying water. In Cell 14 there are no up-gradient cells and therefore diffusive transport is the primary mechanism for Ra-226 release to the basin water.

A total Ra-226 load and activity of 666 MBq/a was calculated for diffusive flux assuming an average porewater activity for Ra-226 of 3.6 Bq/L. This diffusive load agrees well with the Ra-226 load of 579 MBq/a estimated from routine monitoring data. Radium-226 activities in the basin water in Cell 14 resulting from diffusive flux were estimated to be in the range of 0.27 to 0.76 Bq/L. These values were consistent with the range of annual average values from the routine monitoring data of 0.34 to 0.52 Bq/L. The load and activity calculations provided strong evidence that releases of Ra-226 from porewater to basin water are controlled by diffusive flux.

A range for Ra-226 activities of 0.42 to 1.15 Bq/L in basin water was predicted for a condition with Ra-226 activities of 5 Bq/L in porewater. These calculations provide an indication of Ra-226 activities that could be observed if porewater activities in the upper few centimetres of tailings approach maximum values that were observed in Cell 14 during this study.

As a sensitivity exercise, the Ra-226 activity in porewater was estimated for a sulphate concentration of 0.5 mg/L. Based on the solubility of $BaSO_4$ and the relationship between radium activities and barium concentrations, the predicted Ra-226 activity was 15 Bq/L. Furthermore, Ra-226 activities in basin water were predicted by assuming that porewater activities of 15 Bq/L and 5 Bq/L occurred over 25 and 75% of the tailings area in Cell 14, respectively. If this type of condition was to develop, the predicted Ra-226 activities in basin water were in the range of 0.67 to 1.87 Bq/L, for these assumptions. These calculations provide an indication for Ra-226 activities that could be observed in basin water for the Ra-226 activities in porewater either observed or assumed in this study, if pockets of sulphate reducing conditions were to develop in Cell 14 and sulphate concentrations of less than 1 mg/L occurred in the porewater.

Although possible, it is unlikely that significant areas of sulphate reduction could occur without an accumulation of organic material at the surface of the tailings that would also act as a diffusion barrier in the long term. An organic layer would mitigate the diffusive flux of Ra-226 by acting as a physical barrier by decreasing concentration gradients, as well as a chemical barrier by sorbing Ra-226 to the carbon solids. Therefore, in the long term, the risk of highly elevated Ra-226 activities in tailings porewater and basin wateras a result of sulphate reduction is considered to be very low.

There is no evidence of highly elevated levels in the basin or tailings porewater as of 2009. The monitoring program is considered to be more than adequate to detect any major changes in Ra-226 levels or possible geochemical conditions in the tailings porewater and the risk of abrupt changes is very low to non-existent.

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1.0 INTRODUCTION

The Quirke Site is a decommissioned uranium mine property located approximately 13 km north of the City of Elliot Lake and immediately north of Dunlop Lake (**Figure 1.1**). The Site is owned and managed by Rio Algom Limited (RAL).

EcoMetrix Incorporated (EcoMetrix) was retained by RAL to complete a directed study that focused on the release of Ra-226 from the submerged tailings to the basin water in Cell 14 at the Quirke Tailings Management Area (TMA).

Routine monitoring at the Quirke Mine Site is conducted as three directed studies. The Serpent River Watershed Monitoring Program (SRWMP) is a comprehensive watershed monitoring program that was implemented to replace the various, mine-specific environmental monitoring programs at each mine site. The Source Area Monitoring Program (SAMP) was developed to monitor the nature and quantity of constituents that discharge from the TMAs to the Serpent River Watershed. The TMA Operational Monitoring Program (TOMP) was designed to evaluate the performance of the TMAs.

EcoMetrix completed performance evaluations of the SAMP and TOMP data (EcoMetrix, 2008). As part of the review, and where appropriate, special studies were suggested to complement the monitoring programs as well as to refine our understanding of the long-term performances of the tailings facilities. It was recommended that a special study be conducted, at the Quirke TMA to address the uncertainty related to the release of Ra-226 to the basin water that arose from inconsistencies between the results from routine monitoring and those from other studies in Quirke Cell 14, specifically Martin *et al*. (2003).

1.1 Objectives and Scope of Work

The main objectives of this investigation were to evaluate Ra-226 activities in solids, porewater and basin water to develop an understanding of the controls on Ra-226 releases to the basin water in Cell 14 in order to address the uncertainties related to the release of Ra-226 to the basin water that arose from the inconsistencies between the results from routine monitoring and those from the Martin *et al.* (2003) study. Another objective was to provide reasonable estimates for Ra-226 activities that may be observed in the basin water.

The scope of work for this investigation included the following:

- review of routine monitoring data from the Quirke TMA, as well as previous studies related Ra-226 releases in Cell 14;
- collection of core samples and analysis of solids, porewater and basin water from four locations within Cell 14;

- data assessment of constituents that theoretically play a role in Ra-226 mobility;
- assessment of Ra-226 and other constituent activity/concentrations in the solids, porewater and basin water to understand controls for Ra-226 release to the basin water; and
- assessment of ranges of Ra-226 activities that could develop in the basin Cell 14 surface water associated with a range of Ra-226 activities in porewater.

2.0 BACKGROUND

The following section provides background information on the Quirke TMA, a discussion of the theoretical controls on Ra-226 release to overlying waters, a summary of previous studies conducted on Cell 14 relating to the release of Ra-226 as well as a summary of relevant trends observed for the routine monitoring at the Quirke TMA.

2.1 Quirke TMA Tailings and Configuration

The Quirke mine and mill operated from 1956 to 1961, and in 1968 the mine was re-opened and operated until closure in August, 1990. The Quirke mill produced approximately 42 million tonnes of tailings that were placed in the TMA.

The milling process consisted of a hot dilute sulphuric acid leach followed by removal of the uranium via precipitation of ammonium diuranate (yellow cake). The acidic wastes (i.e., tailings) generated during the milling process were neutralized with lime to pH values of 8.5 to 10.5 prior to discharge to the tailings basin (Rio Algom, 1995).

The Quirke Tailings Management Area (TMA) consists of five terraced flooded cells (Cells 14 to 18) within a bedrock-rimmed basin, separated by engineered, low permeability dykes that were constructed on the existing tailings (**Figure 2.1**). Upon closure, the tailings cells were flooded by raising the original dams to mitigate acid generation. Cell 14 was flooded by raising Dyke 14 between 1991 and 1992. Downstream of Cell 14, Cells 15 and 16 were flooded in 1994 by raising Dykes 15 and 16 and Cell 17 was flooded in 1995 by raising Dyke 17 (Golder, 1996).

A total elevation change of 14 m exists between Cell 14 and Cell 18, the final downstream cell. **Figure 2.2** provides a schematic of the cross-sectional profile of the Quirke TMA and the flow conditions within the flooded basin. The changes in water elevations across the TMA induced subsurface flow (seepage) through the tailings below the internal dykes.

2.2 Conceptual Model for Ra-226 Release

As part of the Environmental Impact Statement (EIS) for the Quirke Mine predictive model simulations using the Uranium Tailings Assessment Program (UTAP.3) were performed to predict future Ra-226 activities and sulphate concentrations in the porewater and basin water in the Quirke TMA. The model predicted Ra-226 activities of 0.5 and 1.5 Bq/L in the porewater after approximately 50 and 100 years, respectively. The predicted Ra-226 activities in the basin water were 0.4 and 0.5 Bq/L after 50 and 100 years. Model sensitivity analysis predicted a range in Ra-226 activities between 0.7 and 2.9 Bq/L in the basin at the Quirke TMA. The model predicted sulphate concentrations that remained at 1,600 and 350 mg/L in the porewater and basin water, respectively, for the first 100 years. After approximately 300 years, sulphate concentrations were predicted to decline to 100 and 50 mg/L in the porewater and basin water, respectively (Rio Algom, 1995).

The Ra-226 activities predicted in porewater and basin water were explained by the following conceptual model. Ra-226 activities in the Quirke basin are related to sulphate because the source of Ra-226 is the dissolution of Ra-226 bearing sulphate precipitates, such as gypsum ($CaSO_4 \cdot 2H_2O$) and barite ($BaSO_4$). In the first 300 years, the major source of Ra-226 in the porewater and basin water were expected to be controlled by the dissolution of gypsum that contains co-precipitated Ra-226 ($Ca,RaSO_4 \cdot 2H_2O$). Once gypsum is depleted from the solids after approximately 300 years, the Ra-226 activities in solution were expected to be controlled by the dissolution of barite that contains co-precipitated Ra-226 ($Ba,RaSO_4$) (SENES, 1992). Therefore, solubility theory suggests that the Ra-226 activities will be depressed if sulphate concentrations remain high, near gypsum solubility for example, and could increase when sulphate concentrations decline.

2.3 Previous Studies in Cell 14

Peacey *et al*. (2002) observed an increase in Ra-226 from 0.7 Bq/L to 2.5 Bq/L in the basin water of Cell 14 from 1992 to 1999. The increase in concentrations was accompanied by an increase in Ra-226 loads to the overlying water, and a decrease in sulphate loads. The primary mechanism was attributed to the diffusive flux of Ra-226 from porewater to the overlying basin water. These observations are consistent with the conceptual model for Ra-226.

Martin *et al*. (2003) reported on a field investigation in Cell 14 completed in July 2000. Peeper techniques, together with coring, were used to evaluate the direction of Ra-226 fluxes. Sampling was conducted at 4 sampling stations along a transect in Cell 14 at water depths between 0.43 and 2.70 m. Peepers were installed at stations Q1, Q3 and Q5, and cores were collected from Q1, Q3 and Q6.

The relevant findings from Martin *et al*. (2003) include the following:

- uniform concentration gradients between the porewater and basin water were observed at Q1 and Q3 corresponding to an area with shallow water depths of approximately 0.50 m and devoid of vegetation. A maximum Ra-226 activity of 5 Bq/L at 5 cm below the sediment-water interface was observed and Ra-226 activities decreased to 0.5 Bq/L in the water column above the tailings. Radium-226 activities in the basin waters at those locations were hypothesized to be controlled by the dissolution of $Ba,RaSO_4$.

- Ra-226 activities as high as 70 Bq/L in porewater that decreased to 30 Bq/L in the water column were reported at station Q5 in a deeper area of the cell with a water depth of 2.70 m. At this station extensive macrophyte beds were observed. It was hypothesized that the macrophytes inhibit water circulation, creating anoxic conditions at the surface-water interface. The elevated Ra-226 activities were interpreted to be controlled by anaerobic decomposition of sulphate phases by sulphate reducing bacteria, thereby releasing Ba and Ra-226 that diffused upward into the overlying water.

2.4 Diffusion Barrier Implementation

In response to the previous studies that indicated increasing Ra-226 activities in the basin water of Cell 14, RAL initiated a study on the potential effectiveness of placing a diffusion barrier over the tailings to reduce the flux of Ra-226 into the water column. Expected Ra-226 activities in the basin water were modeled for varying depths of cover over the tailings (SENES, 2003). Initial activities were selected to be 5 Bq/L in porewater and 0.61 Bq/L in basin water. High and low monthly flow rates were considered by analysing eight years of data from 1995 to 2002. The average for June represented the high flow and that for February represented the low flow months. The model predicted that with no cover applied the Ra-226 activities in the overlying basin water would be 0.59 Bq/L and 1.8 Bq/L for high and low flow conditions, respectively. The predicted activities in the basin water were 0.07 Bq/L for high flow and 0.23 Bq/L for low conditions if a 5 cm cover was constructed. The model was also used to predict the effectiveness of 10 and 15 cm thick covers. The results from the 10 and 15 cm cover scenarios predicated Ra-226 activities in the basin water that ranged from 0.03 to 0.16 Bq/L and 0.03 to 0.12 Bq/L, respectively, suggesting that there would be very little added benefit by increasing the barrier thickness above 10 cm.

In the winter of 2004, Cell 14 was dewatered and a 10 cm thick diffusion barrier consisting of sand was applied to 68% the cell to reduce the diffusive flux of Ra-226 from the tailings to the basin water. The remaining 32% of the deeper centre portions of the cell were not covered as they were inaccessible due to soft ground conditions even during freeze-up after dewatering of Cell 14. At that time, the till blanket initially placed in 1997 to reduce seepage from Cell 14 to Cell 15, was extended (**Figure 2.3**) to reduce seepage from the cell and to help maintain the water cover over the tailings. A schematic illustrating the extent of the diffusion barrier and till blanket is provided in **Figure 2.3**. The area in the vicinity of station Q5 with the reported Ra-226 activities of 70 Bq/L in tailings porewater in the Martin *et al*. (2003) study was not covered.

2.5 Routine Monitoring Data

This Section discusses the routine monitoring of basin water and porewater in each cell at the Quirke TMA. The locations of the routine monitoring stations are illustrated in **Figure 2.1**. The complete data sets are provided in **Appendix 1**.

2.5.1 Basin Surface Water Quality

Ra-226 and sulphate concentrations in the outflow from each cell are presented as time trend plots in **Figure 2.4**

Closure of the Quirke mill and flooding of the Quirke TMA (early 1990s) reduced Ra-226 activities upstream of the treatment plant by nearly an order of magnitude (**Figure 2.4**). Following installation of the diffusion barrier in Cell 14 in 2003, radium concentrations in Cell 14 declined from highs of 2.3 Bq/L in 2002 to a maximum of 0.69 Bq/L observed in November 2009. The maximum Ra-226 activities have remained lower than those observed prior to the diffusion barrier application.

Radium activities in Cells 15 and 16 have remained less than 0.8 Bq/L, with maximum activities in Cells 17 and 18 remaining below 1.5 Bq/L since the early 1990s. There are no statistically significant trends in basin surface water Ra-226 activities at the Quirke TMA since the TOMP was initiated in 2003 (Minnow, 2011).

Sulphate concentrations less than 20 mg/L in Cell 14 increase to 1,500 mg/L in Cell 18 reflecting continued flushing of historic oxidation products from the tailings. **Figure 2.4** indicates a long-term decreasing trend in sulphate concentrations in Cell 18 that has been statistically confirmed for the TOMP reporting period (Minnow, 2011).

2.5.2 Porewater in Basin Piezometers

Quirke porewater monitoring stations are located on the downstream side of the internal dykes as shown in **Figure 2.1**. Radium activities in porewater were determined annually for the period 1995 through 2003 and as part of the radium studies in 2010. A summary of the Ra-226 activities measured in the porewater from the downstream piezometers is provided in **Table 2.1**.

Radium-226 activities in the porewater in Cell 15 are represented by piezometer nest DK14-5 that is located along the downstream side of Dyke 14. The Ra-226 activities in the porewater ranged between 0.22 and 3.3 Bq/L, with an average value of 1.6 Bq/L.

The porewater quality in Cell 16 is represented by piezometer nests DK15-2 and DK15-4. The minimum and maximum Ra-226 activities measured in these wells were 0.23 and 4.2 Bq/L, respectively. The average Ra-226 activity in the porewater from Cell 16 was 2.9 Bq/L.

The porewater quality in Cell 17 is represented by piezometer nest DK16-2. The Ra-226 activities in the porewater in Cell 17 were in the range of 3.2 to 14 Bq/L, with an average of 7.9 Bq/L.

Radium-226 activities in porewater in Cell 18 are represented by piezometer nest DK17-2. The minimum and maximum Ra-226 activities in Cell 18 were 1.0 and 6.6 Bq/L, respectively. The average Ra-226 activity measured in Cell 18 was 4.0 Bq/L.

3.0 SAMPLE COLLECTION AND PROCESSING

Sampling was conducted at four stations in Cell 14 to obtain representative samples to quantify activities/concentrations of Ra-226 and other constituents that theoretically could play a role in Ra-226 mobility within the tailings basin. The sample stations were located in areas that were not influenced by either the till blanket or the diffusion barrier and that were located in the vicinity of the sample stations presented in Martin *et al.* (2003). A site map illustrating the sampling locations is provided in **Figure 3.1**.

3.1 Sediment Samples

Sediment samples were collected at each of the four stations using a 4-inch K-B coring device. At each location a total of four cores were collected to achieve sufficient sample volume for porewater extraction from the sediments.

The cores were sectioned at 2.5 to 5 cm intervals to depths of 10 to 20 cm. The intervals from the core sets from each sampling station were composited and placed into dedicated Ziploc bags and stored at 4°C until the porewater samples were extracted.

After the porewater was extracted (described in **Section 3.2**) the sediment samples were placed into dedicated Ziploc bags and stored at 4°C until analysed. Tailings samples were submitted to SGS Lakefield Laboratories for chemical analysis that included Ra-226, metals, major ions, as well as, sulphur and carbon series. Radium-226 analyses were completed by Becquerel Laboratories under subcontract to SGS Lakefield.

3.2 Porewater Samples

Porewater samples were extracted from the core samples in a field-based laboratory facility within 24 hours of collection. Each 5 cm interval from the composited core sets collected at each sampling station were transferred into 750 mL centrifuge bottles. The samples were centrifuged at approximately 3500 rpm for 45 to 50 minutes. After centrifugation, the porewater was decanted and filtered through a 0.45μm nylon filter. The pH of the filtered porewater samples was measured and recorded. The samples were then transferred into sample bottles supplied by SGS Lakefield and samples to be analysed for metals and Ra-226 were preserved with nitric acid. All samples were stored at 4°C until analysis.

Porewater samples were sent to SGS Lakefield Laboratories for chemical analysis of Ra-226, metals, major ions, sulphate, dissolved organic carbon (DOC) and acidity. Radium-226 was analysed by Becquerel Laboratories under subcontract to SGS Lakefield. Becquerel required 200 mL of sample to attain a detection limit of 0.01 Bq/L by alpha spectroscopy.

3.3 Basin Surface Water Samples

Basin water samples were collected at each of the four stations from the top of the water column and at the sediment/water interface. The sediment/water interface samples were collected and composited by siphoning the water above the solids in the core tubes.

All water samples were field filtered through a 0.45 µm nylon filter and the pH of the basin water samples was measured and recorded. Water samples were then transferred into sample bottles supplied by SGS Lakefield and samples to be analysed for metals and Ra-226 were preserved with nitric acid. All samples were stored at 4°C until analysis.

Basin water samples were sent to SGS Lakefield Laboratories for chemical analysis of Ra-226, metals, major ions, sulphate, dissolved organic carbon and acidity. Radium-226 analyses were completed by Becquerel Laboratories under subcontract to SGS Lakefield.

3.4 Field Observations

At the time of sample collection field observations did not indicate the presences of any macrophytes at any of the sampling stations. One dissolved oxygen measurement with a value of 8.25 mg/L was taken at the bottom of the water column at QC14-2. There were no notable hydrogen sulphide (H_2S) odours detected in most of core samples at the time of core sample processing. However, a faint H_2S odour was noted in the samples from the top 5 cm at QC14-2, as well as in the replicate core sets, Core09-EC-2 collected at the same location. Photographs of the core samples collected at sampling stations QC14-1 and QC14-2 are provided in **Figure 3.2**. The photograph of the cores collected at QC14-2 show a black layer in the top 5 cm. The organic carbon content of this layer, as shown in the results, was not markedly different from those in the other cores at similar depths.

4.0 QUALITY ASSURANCE/QUALITY CONTROL

The field campaign that was conducted by EcoMetrix personnel in September 2009 included the collection of samples from three different decommissioned mine sites (Panel, Quirke and Denison) in the Elliot Lake area. The field campaign was carried out to help gain a further understanding of the knowledge gaps identified in the Cycle III SAMP and TOMP performance evaluation (EcoMetrix, 2008).

A detailed quality assessment (DQA) was completed by EcoMetrix to evaluate the quality of the data collected during Cycle III Special Studies Field Campaign. Similar sampling methods and procedures were used at each mine site therefore the data quality assessment incorporated all of the QA/QC data collected during the field sampling campaign. This section provides a summary of the QA/QC for selected constituents that are discussed in this report. Data quality results for the selected constituents are summarized in **Tables 4.1 to 4.3**. Data quality results for all of the constituents analysed and for duplicates and replicates from all studies are provided **Appendix 2**.

The precision of the duplicate and replicate samples were evaluated by calculating the relative percent difference (RPD) as follows:

$$RPD = \frac{2|C_1 - C_2|}{C_1 + C_2} \times 100\%$$

where: C_1 = sample concentration; and

C_2 = replicate (or duplicate) concentration.

The Data Quality Objectives (DQO) for solids samples were less than or equal to a RPD value of 40%. The DQO for water samples were less than or equal to a RPD value of 20%.

For duplicate/replicate samples having concentrations less than five times the detection limit, the DQO was the absolute difference (AD) between the sample and duplicate/replicate that should not have been greater than the detection limit value.

Blind duplicates and replicates of solids and water samples, as well as laboratory blank sample (distilled water), were submitted to SGS Lakefield. Duplicate samples were labeled as EC-1 and replicate samples were labeled as EC-2. The duplicate samples are split samples of solids, porewater or basin water collected from a selected core section or sampling station. The solids replicate samples are replicate core sets from sampling station QC14-2 and were sectioned in accordance with study protocols. Replicate water samples were collected from porewater generated from replicate core sections or from replicate basin water sampling. The calculated RPD or AD values for selected constituents are presented in **Tables 4.1 to 4.2**.

4.1 Solids Sample Data Quality Assessment

The DQA for selected constituents in field duplicates from Cores 09-PSB-2 and 09-SR-4 are summarized in **Table 4.1a**. On average, the DQO of 40% was achieved for all selected constituents (Ra-226, barium, calcium, sulphate and total organic carbon), with the exception of three exceedances observed in the Core09-PSB-2 duplicate. Calcium and barium that had RPD values less than 55% and sulphate had an AD value of 0.3. As these values were only marginally above the DQOs, there are no impacts on the interpretation of the results.

The DQA for selected constituents in replicate core section intervals of Core09-QC14-2 (0-2.5), (2.5-5) and (5-7.5) are summarized in **Table 4.1b**. On average, the DQO of 40% was achieved for all selected constituents, except for Ra-226 where the average RPD was 48%. For Ra-226 the DQO of 40% was exceeded twice with RPD values of 73% and 48%. For barium the DQO was exceeded twice with RPD values of 51% and 60%. As these values were only marginally above the DQOs, there are no impacts on the interpretation of the results.

4.2 Water Sample Data Quality Assessment

Two duplicate and 5 replicate water samples were collected and analysed. The duplicate and replicate RPD values were compared to a DQO of ≤20%. The DQA for selected constituents in the water samples are presented in **Tables 4.2 a and b**.

When basin water samples were analysed for total organic carbon (TOC) and dissolved organic carbon (DOC) it was noted by SGS Lakefield that higher DOC concentrations were measured than TOC concentrations (Chris Sullivan pers. Comm., 2009). Upon further investigation, the source of this discrepancy was found. The basin water samples were collected in sample bottles that were previously acidified with nitric acid in preparation for storage of samples for metals analysis. The bottles were rinsed three times in the field before collection of the samples. However, this rinsing was insufficient to remove all traces of nitric acid. As a result, the dissolved organic carbon concentrations measured in the samples more likely represent total organic carbon concentrations. Therefore, during this study the DOC values are referred to as organic carbon (OC). In the context of this investigation and the use of the data for interpretation of Ra-226 mobility, this small bias in OC concentrations was not considered to be important because these differences do not change the interpretation or conclusions of this study.

As shown on **Table 4.2a**, the DQO of 20% in duplicate water samples was achieved for Ra-226, barium and calcium. Duplicate water samples are sample splits of basin water or porewater extracted from sectioned cores. The Ra-266 duplicate sample for PW09-EC-1 (5-10) is PW09-QC14-4 (0-5). The barium and calcium duplicate sample for PW09-EC-1

(5-10) is PW09-QC14-3 (0-5). Sulphate and OC duplicates were not analysed because of insufficient sample volume.

As shown on **Table 4.2b**, the DQO of 20% in replicate water samples was achieved on average for Ra-226, barium and calcium, with one DQO exceedance for Ra-226 with an RPD value of 22% in a replicate porewater sample. The average RPD of 21% for sulphate is marginally above the DQO. One DQO exceedance for sulphate had an RPD 40% in a replicate porewater sample. The average RPD value for organic carbon was 32%. Three of the four samples exceeded the DQO of 20%, with a maximum RPD of 50%. However, in the context of this investigation and the use of the OC data for interpretation of Ra-226 mobility, the DQO exceedences in basin water were not considered to be important.

4.3 Blank Sample Data Quality Assessment

One blank sample was subjected to the porewater extraction process that included centrifugation followed by filtration to determine potential for cross-contamination between samples. The results for selected constituents in the blank are provided **Table 4.3**. The Ra-226 activities and sulphate concentrations were below detection limits of 0.01 Bq/L and 2 mg/L, respectively. The calcium concentration in the blank sample was 0.03 mg/L and met the DQO of 0.06 mg/L. The dissolved barium concentration in the blank was 0.00216 mg/L and exceeded the DQO of 0.00002 mg/L. The OC concentration in the blank sample was 2.4 mg/L and marginally exceeded the DQO of 2.0 mg/L.

Barium concentrations measured in most of the water samples for the DQA (**Table 4.3**) are at least two orders of magnitude greater than the barium concentration measured in the blank. Therefore, the barium concentration that may be attributed to cross-contamination was negligible. The source of OC in the blank is not known. However, the average concentration of OC in all of the water samples was approximately 14 mg/L, therefore carry over or cross contamination was not expected to affect the interpretation of the data in this investigation.

4.4 Laboratory Quality Assurance and Quality Control

Laboratory Quality Assurance/Quality Control (QA/QC) included analysis of laboratory blanks and laboratory duplicate sample analyses. The Certificates of Analysis, including internal laboratory QA/QC results, are provided in **Appendix 3** and indicate that the data have acceptable accuracy and precision.

5.0 RESULTS OF FIELD SAMPLING

Select results from the September 2009 field sampling program are presented in **Figures 5.1 and 5.2** and are summarized in **Tables 5.1 to 5.3**. Concentrations of selected metals in the solids are provided in **Figure 5.1** as depth profiles at each of the sampling stations in Cell 14. **Figure 5.2** presents depth profiles for the porewaters that correspond to the solids samples, as well as the basin water samples collected at each sampling station. The basin water samples plotted above the surface water interface are not to scale. The actual depths for these samples below surface are provided in **Table 5.3**. The analytical data for all of the constituents are provided as Certificates of Analysis in **Appendix 3**.

5.1 Solids Samples

The results for selected constituents from the solids analyses are presented in **Table 5.1**.

Radium-226 activities in the solids generally ranged from 9.0 to 24 Bq/g. The upper two sections of Core09-QC14-2 had values below this range with Ra-226 activities of 4.3 and 6.5 Bq/g, respectively. Similar trends were observed for barium where concentrations in the solids generally ranged from 280 to 660 mg/kg, with values below this range of 150 and 220 mg/kg reported for the same upper two sections of Core09-QC14-2.

Calcium concentrations in solids generally ranged from 150 to 15,000 mg/kg with lower concentrations observed in the mid-basin profiles at QC14-2 and QC14-3 relative to the more distal samples at QC14-1 and QC14-4. The calcium concentrations at QC14-2 and QC14-3 ranged from 59 to 1,300 mg/kg, while the concentrations at QC14-1 and QC14-4 ranged from 1,400 to 19,000 mg/kg.

Sulphate concentrations in the solids generally ranged from 0.1% to 3.6%. The trends observed for calcium concentrations were also observed for sulphate concentrations where lower concentrations were observed in the mid-basin profiles at QC14-2 and QC14-3 compared to the more distal samples at QC14-1 and QC14-4. The sulphate concentrations measured at QC14-2 and QC14-3 ranged from less than detection limit of 0.1 to 0.3%, while the concentrations at QC-14-1 and QC14-4 ranged from 0.2 to 3.6%.

Total organic carbon (TOC) concentrations were similar among all sample stations. The highest TOC concentrations were measured in the upper portions of the solids (0 to 5 cm) and ranged from 0.29 to 0.68%. At all of the stations the TOC contents decreased with depth to values ranging from 0.07 to 0.11%. Field observations indicated a faint H_2S odour and a black layer in the top samples collected at QC14-2 even though TOC was present in all samples.

Depth profiles for Ra-226, barium, calcium, sulphate and TOC in the solids are presented in **Figure 5.1**. The depth profiles for Ra-226 and barium show similar trends where the activities/concentrations were generally lower in the upper portions of solids and decreased with depth.

The depth profiles for sulphate at QC14-1 and QC14-4 exhibited the lowest concentrations measured in the top portions of the solids that increased with depth. Maximum sulphate concentrations were measured in the 5 to 10 cm interval at QC14-1 and in the 10 to 15 cm interval at QC14-4. The trends for sulphate concentrations at QC14-2 and QC14-3 were generally uniform with depth. The depth profiles for calcium concentrations at each station exhibited similar trends to those observed for sulphate.

Depth profiles for TOC were consistent among the sample stations where the highest contents were measured in the top portions of the solids and the lowest contents were measured at depth.

5.2 Porewater and Basin Water Samples

The results for selected constituents in porewater and basin water samples are presented in **Tables 5.2 and 5.3**.

Radium-226 activities in the porewaters generally ranged from 0.42 to 4.8 Bq/L. The lower two sections of core 09-QC14-2 had values above this range with Ra-226 activities of 5.9 and 6.9 Bq/L, respectively. Similar trends were observed for barium where concentrations generally ranged from 0.02 to 0.33 mg/L with values above this range of 0.519 and 0.499 Bq/L reported for the same lower two sections of core 09-QC14-2.

Calcium concentrations in porewater were in the range of 6 to 530 mg/L with lower concentrations observed in the mid-basin profiles at QC14-2 and QC14-3 relative to the more distal samples at QC14-1 and QC14-4. The calcium concentrations at QC14-2 and QC14-3 ranged from 5.7 to 97.4 mg/L, while the concentrations at QC14-1 and QC14-4 ranged from 195 to 536 mg/L.

The trends for sulphate concentrations in porewater were similar to those observed for calcium, with the lowest sulphate concentrations in the mid-basin profiles at QC14-2 and QC14-3 compared to more distal samples collected at QC14-1 and QC14-4. The sulphate concentrations at QC14-2 and QC14-3 ranged 6 to 240 mg/L, while the concentrations at QC14-1 and QC14-4 ranged from 560 to 1,500 mg/L. Where there was inadequate sample volume for sulphate analysis in porewaters by ion chromatography, concentrations were calculated from sulphur concentrations reported in the ICP results (**Table 5.3**).

Organic carbon (OC) concentrations in the porewater ranged from 2.8 to 28 mg/L with concentrations generally decreasing with depth. The highest OC concentrations were measured at QC14-2 and ranged from 28 mg/L in the uppermost porewater sample (0 to 2.5 cm) to 17.9 mg/L in the 5 to 7.5 cm sample interval.

Radium-226 activities and barium and calcium concentrations in the basin waters were similar among sample stations with moderately elevated Ra-226 in bottom samples adjacent to the solids-water interface. The Ra-226 activities in the basin waters ranged from 0.71 to 1.0 Bq/L with average activities of 0.77 Bq/L in the top samples compared to average activities of 0.95 Bq/L in the bottom samples. Barium concentrations ranged from 0.099 to 0.116 mg/L and calcium concentrations were between 5.55 and 6.24 mg/L. Sulphate concentrations in the basin waters were similar at all sample stations with marginally higher sulphate concentrations measured at the top of the water column. The sulphate concentrations measured at the top of the water column ranged from 54 to 72 mg/L, while sulphate concentrations measured at the tailings-water interface ranged from 25 to 35 mg/L. Organic carbon concentrations in the basin waters ranged from 13.3 to 19.4 mg/L and were consistent between top and bottom samples and among sample stations.

Depth profiles for Ra-226, barium, calcium, sulphate and OC in porewater and basin water are presented in **Figure 5.2**. The basin water samples represent the top and bottom of the water column and are not plotted to scale. The actual depths below the water surface for each basin water sample are presented in **Table 5.3**.

The Ra-226 and barium depth concentration profiles within tailings generally exhibited similar trends with the highest activities/concentrations measured in the porewater in the 0 to 5 cm depth interval, with the exception of samples collected at QC14-2. The highest Ra-226 activities and barium concentrations in the porewater were measured depth at QC14-2.

Depth profiles for sulphate and calcium in porewater exhibited similar trends where the lowest concentrations were measured in the 0 to 5 cm interval and the highest concentrations were measured at depth. The sulphate and calcium concentrations measured in samples at QC14-2 were similar below a depth of 2.5 cm.

With the exception of QC14-2, the concentrations of OC in porewater samples were lower than those in the water column.

6.0 DISCUSSION

This phase of the Cycle III Special Studies was completed to fill knowledge gaps and bound uncertainties related to the release of Ra-226 to the basin waters in Cell 14 that arose from inconsistencies between the results from routine monitoring and those from the Martin *et al*. (2003) study. The investigation focused on Ra-226 activities in the solids, porewater and basin water in Cell 14 of the Quirke TMA. This approach was taken because it was understood that any release of Ra-226 to the basin water would be initiated in the solid phase but that the release from solids would be reflected by activities/concentrations in the porewater before eventual release to the overlying water.

6.1 Comparison of Current Study Results with those from Martin et al. (2003)

The study by Martin et al. (2003) implied that Ra-226 activities in water could increase substantially above the maximum values of 7 Bq/L in porewater and 1 Bq/L in basin water observed in the current study. Martin et al. reported a Ra-226 activity of 70 Bq/L in porewater and 30 Bq/L in the basin water samples above the tailings interface.

The high Ra-226 activities in porewater and basin water reported in Martin et al. (2003) were attributed to anoxic conditions that lead to bacterial sulphate reduction. Sulphate concentrations of 0.5 mg/L were reported in the porewater with the highest Ra-226 activities. It was concluded that the low sulphate concentrations resulted in the dissolution of $BaSO_4$, thereby releasing Ra-226 into the porewater with subsequent diffusion into the overlying basin water. As shown in **Figure 2.4**, Ra-226 activities in Cell 14 basin water have never exceeded a value of 2.5 Bq/L and have not been above 1 Bq/L since 2004.

In the current investigation, the TOC contents in the solids ranged 0.07% at depth to 0.7% at the tailings-water interface. These values suggest that adequate reduction potential, as organic carbon, was available in the solids to reduce sulphate and release Ra-226. Field observations indicated a faint H_2S odour and a black layer in the top samples collected at QC14-2. The results from TOC analysis on solids showed that the TOC value in the top layer of that core sample was similar to those in other cores. The field observations, together with the TOC results, suggest that there is a potential for sulphate reduction in the top portions of the tailings at this sampling location. However, the sulphate reduction release mechanism and its consequential high Ra-226 release to porewater were not supported by the measured Ra-226 activities in this study. The Ra-226 activities measured in the top samples at QC15-2 were 3.6 and 2.8 Bq/L. The Ra-226 results from the current investigation are more consistent with the Ra-226 activities for the near shore, oxidized sampling sites in Cell 14 reported by Martin et al. (2003).

One distinct difference in conditions that was observed in this investigation was the absence of macrophytes observed during the Martin *et al*. (2003) investigation.

Reconnaissance prior to sampling in 2009 found macrophytes only along the shoreline in Cell 14 and not in the deeper water zones. The macropytes may represent a linkage to sulphate reduction if dead and decaying root matter represented the organic carbon that played a role in sulphate reduction. This would limit sulphate reduction to areas in the basin that can support such macrophyte growth. These zones would likely be limited to pockets or small areas.

One consideration for the Martin *et al*. (2003) study relates to quality control for Ra-226 activities in porewater that were measured on samples that were less than 10 mL in volume. The analysis for Ra-226 on water samples usually requires sample volumes of a few hundred millilitres.

Regardless of the sample size, however, the chemical and Ra-226 results appear to be consistent in the Martin *et al*. (2003) study. The results in that study also show an excellent linear correlation between barium concentrations and Ra-226 activities in water that exhibited an R^2 value of 0.99 and a slope of about 17. The slope is almost a factor of 2 higher than that found in this study as discussed later in this section. However, the data also represent a difference of 7 years of flooded conditions over which the concentrations and activities have been declining in the Quirke TMA.

6.2 Solids and Porewater Interactions

Two likely mechanisms that can potentially control Ra-226 and barium activities/concentrations in the porewater include sorption and solubility.

The first mechanism, sorption, is commonly been used to quantify solids-water interactions and can be represented by a distribution coefficient (or Kd with units of L/kg). The Kd can be defined as the activities/concentrations in the solids phase (Bq/kg or mg/kg) divided by the respective activities/concentrations in porewater (Bq/L or mg/L). The Kd model assumes that Ra-226, for example, is distributed between solid and water on the basis of equilibrium sorption reactions. This infers that, for any Kd value, higher activities/concentrations in the solid phase will be reflected by higher activities/concentrations in the porewater.

The second mechanism, solubility, can control concentrations or activities in the porewater and can be quantified by thermodynamic equilibrium reactions. Solubility equilibrium controls assume that barium, for example, is distributed between the solids and water on the basis of solubility theory. This approach infers that activities/concentrations in the porewater are controlled by the dissolution of a solid phase, for example $BaSO_4$, to maintain equilibrium for constituents in the porewater and is consistent with EIS conceptual model. The solubility model infers that the activity/concentration of a constituent in the water is independent of the content in the solids, but will depend on the concentration of another constituent in the water phase that is also present in the solid phase.

The sorption, or Kd, model and the solubility model may not be mutually exclusive in some environments, therefore, it is important to consider both approaches when understanding Ra-226 release in submerged tailings.

The activities of Ra-226 in the solids and associated porewater ranged from 4 to 24 Bq/g and from 0.42 to 6.9 Bq/L, respectively (**Figures 5.1 and 5.2**). The ranges in activities provide a strong basis to interpret relationships between the solids contents and concentrations in porewater.

6.2.1 Evidence of Sorption Equilibrium Controls

Plots of Ra-226 activities in solids versus their respective Ra-226 activities in porewater are shown in **Figure 6.1a**. The plot shows that higher activities in the solids did not necessarily correlate with higher activities in the porewater, as illustrated by the negative slope of the regression line in **Figure 6.1a**.

Similar regression plots for barium are provided in **Figure 6.1b**. The regression line exhibited a negative slope, indicating that higher concentrations of barium in solids did not correlate with higher concentrations in porewater. This result is consistent with the regression plot for Ra-226 data.

These results suggest that sorption equilibrium controls do not appear to control the tailings solids-porewater system in Cell 14. However, the similar relationships observed for Ra-226 and barium suggest that a similar mechanism, for example solubility, may be acting to control the activities/concentrations in porewater.

Although the Kd model does not appear to dominate the tailings solids-porewater system in Cell 14, sorption equilibrium controls on Ra-226 and barium activities/concentrations may exist for other geologic materials, as shown in the investigation on Serpent River sediments (EcoMetrix, 2011). Therefore, Kd relationships should not be completely dismissed from the interpretation of Ra-226 controls.

6.2.2 Evidence of Solubility Equilibrium Controls

Correlations between barium and sulphate in porewater were examined. The observed concentrations of these constituents were also compared to theoretical solubility values. Together with strong correlations between Ra-226 activities and barium concentrations in porewater, the evidence supports a solubility control on Ra-226 as discussed in more detail in the following discussion.

6.2.2.1 Correlations in Solids

Selected relationships between constituents in the solids, for example Ra-226 and barium, are presented in **Figure 6.2**.

Radium-226 and barium in the tailings exhibited correlations with an R^2 value of 0.91 as shown in **Figure 6.2a**. This relationship suggests a similar mechanism for the accumulation of Ra-226 and barium in the solids. This is expected because chemically Ra-226 behaves similarly to barium.

The correlation between calcium and sulphate with an R^2 value of 0.99 confirms the presence of gypsum ($CaSO_4{\cdot}2H_2O$) and indicates that the dominant form of sulphate in the tailings solids is gypsum (**Figure 6.2b**). Gypsum would have formed in the tailings in the mill when lime was added to neutralize the effluent prior to release to Cell 14.

No correlation between barium and sulphate (R^2=0.02) was observed in the tailings solids (**Figure 6.2c**). There is a lack of correlation between barium and sulphate because most of the sulphate is in the form of gypsum, resulting in only trace amounts of $BaSO_4$ in the tailings solids compared to the percentage quantities of gypsum that are present. Any correlation between barium and sulphate that theoretically exists because of the presence of $BaSO_4$ solids is lost because of the dominance of gypsum in the solids.

Because calcium is strongly correlated with sulphate, the absence of a correlation between barium and sulphate translates to an absence of a correlation between calcium and barium (R^2=0.03) (**Figure 6.2d**).

Because Ra-226 behaves similarly to barium, the absence of correlations between barium and other constituents agreed with the absence of correlations for Ra-226 and the same constituents (**Figures 6.2 e and f**). The lack of correlations between Ra-226 and sulphate (R^2=0.09) and between Ra-226 and calcium (R^2=0.11) can be explained by the dominance of gypsum in the solids that was described above for the poor correlation between barium and sulphate.

6.2.2.2 Correlations in Porewater

Selected relationships between activities/concentrations of constituents in porewater are presented in **Figure 6.3**.

The correlation between Ra-226 and barium in the porewater had an R^2 value of 0.85 (**Figure 6.3a**). The strong correlation suggests that Ra-226 in porewater behaves similarly to barium in porewater and indicates that a similar mechanism for control on Ra-226 and barium activities/concentrations. This is supported by other correlations between barium and other constituents that are similar to those between Ra-226 and the same constituents.

The plot for barium and sulphate in porewater shows an inverse relationship that is non-linear and that is consistent with solubility control by a solid phase. The solid green curve in **Figure 6.3b** represents the theoretical solubility of barium and sulphate in equilibrium with $BaSO_4$ solids and shows a reasonable fit to the data, when sulphate concentrations were below 50 mg/L. This curve represents an equilibrium condition mathematically as;

$K_{sp}=[Ba^{2+}][SO_4^{2-}]$ in which the K_{sp} is the solubility product that is a constant. The solubility relationship was solved using MINTEQ (Gustafsson, 2010) for solutions corresponding to the water chemistry associated with the low sulphate values observed in porewater samples. The concentrations of barium and sulphate are inversely correlated so that as the concentration of one constituent increases, the other decreases.

The correlation plot for Ra-226 and sulphate shows an inverse trend that is similar to that for barium and sulphate (**Figure 6.3e**). The molar ratio of barium to Ra-226 is approximately $2x10^9$ indicating that only trace concentrations of Ra-226 compared to barium in the porewater and by inference, the Ra-226 in the sulphate solids should be 9 orders of magnitude lower than that of barium. Because Ra-226 is a trace constituent compared to barium, it is incorporated into a solid phase only by ionic substitution and therefore should not practically affect the solubility of the solid phase.

The correlation plot for Ra-226 and calcium (**Figure 6.3f**) shows an inverse trend that is similar to the correlation plot for Ra-226 and sulphate (**Figures 6.3e**). The conceptual model in the EIS suggested that the control on Ra-226 activities in porewater is gypsum dissolution. If Ra-226 activities were controlled by gypsum dissolution a positive slope of the regression line in **Figure 6.3f** would be expected, however, this relationship is not evident from the data. However, the negative correlation between Ra-226 and calcium results from indirect controls by gypsum. When gypsum is present, calcium and sulphate concentrations are high. The inverse correlation of Ra-226 and sulphate was discussed above. The inverse correlation between Ra-226 and calcium is therefore related to the linkage between high calcium and high sulphate in the presence of gypsum and it is the high sulphate that controls Ra-226 to lower values in porewater. This does not contradict the conceptual model in the EIS but provides a refinement of the interpretation of the model.

6.3 Implications of Low Sulphate Concentrations in Solids and Porewater

A conceptual model for the release of Ra-226 from Ba,RaSO4 solids suggests that when sulphate concentrations in water decrease, barium concentrations, and therefore Ra-226 activities, will increase. This would occur as a result of the dissolution of Ba,RaSO4 to re-establish equilibrium with the lower sulphate concentrations.

The sulphate concentrations are low in solids from Core09-QC14-2 and Core09-QC14-3 (0.1 to 0.3% sulphate). This would imply that little to no gypsum is present in the tailings in these areas of the basin. The reason for the removal of gypsum from these samples is not obvious. Sampling stations QC-14-2 and QC14-3 are located in the central part of Cell 14 and the low gypsum contents could be related to the re-suspension of solids during tailings relocation prior to flooding of the basin and subsequent settling in the central deeper areas of the basin. When particles are re-suspended, gypsum can dissolve depleting calcium and sulphate. Therefore, the solids that settle in the deeper areas of Cell 14 may be expected to have low calcium and sulphate concentrations.

The low sulphate concentrations in the solids have resulted in low sulphate concentrations in the porewater at QC14-2 and QC14-3. The sulphate concentrations in the porewaters ranged from 13 to 32 mg/L at QC-14-2 and from 5.6 to 18 mg/L at QC14-3. The conceptual model would suggest that these tailings should exhibit the highest barium concentrations and Ra-226 activities in porewater samples from this investigation. The data confirm that the highest barium concentrations and Ra-226 activities were measured in these tailings samples. Barium concentrations ranged from 0.13 to 0.52 mg/L and Ra-226 activities ranged from 2.6 to 6.9 Bq/L.

Scatter plots for barium and sulphate, Ra-226 and sulphate and for barium and Ra-226 in porewater with low sulphate concentrations of less than 35 mg/L are presented in **Figure 6.4**. The plot for barium and Ra-226 in porewater with low sulphate concentrations (**Figure 6.4a**) retains a strong correlation (R^2=0.83) similar to that for all of the data (**Figure 6.3**). These data suggest that when sulphate is flushed from the tailings and sulphate concentrations are as low as 5 mg/L, the maximum corresponding Ra-226 activities in porewater are in the range of 3 to 7 Bq/L. Although there are no correlations between either barium or Ra-226 and sulphate, the concentrations of barium predicted by the theoretical solubility of $BaSO_4$ shown as the solid green line in **Figure 6.4b**, are similar to the observed values.

6.4 Controls on Ra-226 Activities in Porewater

Similar relationships between Ra-226 and barium were observed for both the water-solids partitioning, or Kd, plots and the solubility correlation plots. These relationships provide strong support that similar mechanisms are acting to control Ra-226 and barium activities/concentration in porewater.

Inverse correlations between barium and sulphate provide strong support for solubility controls on barium in porewater and indicated that the solubility of a sulphate bearing solid phase controls barium concentrations in porewater. The theoretical solubility curve for barium and sulphate in equilibrium with $BaSO_4$ provided strong evidence that the dissolution of $BaSO_4$ controls barium concentrations in porewater. Collectively, these results suggest that sulphate concentrations in porewater control the solubility of $Ba,RaSO_4$ solids and therefore control the barium and Ra-226 concentrations/activities in the porewaters associated with $Ba,RaSO_4$

Sulphate values that represent background concentrations in the Serpent River Watershed are in the range of 5 to 10 mg/L (Minnow, 2008) and it is anticipated that the lowest sulphate concentrations will remain within this range. The theoretical solubility curve predicted barium concentrations in porewater of about 0.4 when sulphate concentrations were 5 mg/L.

Because of the strong relationship between Ra-226 and barium, the theoretical solubility of $BaSO_4$ can be used to predict Ra-226 activities in porewater. The slope of the regression line in **Figure 6.3a** represents the average Ra-226 to barium ratio in porewater represented by the slope that has a value of approximately 10. Using this relationship and a barium concentration of 0.4 mg/L estimated from the $BaSO_4$ theoretical solubility curve for a sulphate concentration of 5 mg/L (**Figures 6.3c**), the predicted Ra-226 activity in porewater is approximately 4 Bq/L. This result is consistent with the measured porewater data from Cell 14 that exhibited Ra-226 activities of 4.1 and 3.4 Bq/L when sulphate concentrations were 5.6 and 6.8 mg/L, respectively.

Overall, the results from Cell 14 showed Ra-226 activities in porewaters in the range of 3 to 7 Bq/L that were associated with sulphate concentrations in porewater below 35 mg/L. The release of Ra-226 will only effectively take place from the porewater near the tailings-water interface to the overlying basin water. The Ra-226 concentrations measured in the top portions of the porewater (0 to 5 cm) were in the range of approximately 3 to 5 Bq/L.

The maximum Ra-226 activity of 5 Bq/L measured in the top portions of the tailings porewater in Cell 14 provides a reasonable upper-bound for Ra-226 activities that could be expected in submerged tailings porewater for the existing conditions noted during this study.

The Martin et al. (2003) study assumed a sulphate concentration of 0.5 mg/L for porewaters collected in the deeper anoxic zones. If the Ra-226 activity in porewater is estimated from $BaSO_4$ solubility curve and the Ra-226 to barium ratio, the predicted activity in porewater is approximately 15 Bq/L.

6.5 Porewater and Basin Water Interactions

The Ra-226 activities in porewater provide insight into the potential for release to the basin water. At the Quirke TMA there are potential sources of Ra-226. The first is porewater in the tailings that releases Ra-226 to surface water by diffusion. Because diffusion is controlled by concentration gradients, the activities in the basin waters will always be less than those in the porewater even when there is little flow in the basin. The second source of Ra-226 is seepage flow beneath the internal dykes at the Quirke TMA. Downward seepage on the upstream sides of the internal dykes results in upward flow on the downstream sides, thereby displacing the tailings porewater into the water column. There are no cells upstream of Cell 14, therefore seepage flow or advective transport of Ra-226 does not apply to Cell 14. However, advective transport of Ra-226 in the downstream cells may be important. Regardless of the transport mechanism, the Ra-226 activities in porewater represent the source of Ra-226 activities that affect the activities in the basin. Therefore, these data assist in reducing uncertainty in estimates of Ra-226 activities and loads associated with outflows from Cell 14.

The release of Ra-226 from porewater to the basin water by diffusion is supported by the data that show Ra-226 activities in the porewater that are greater than those in the overlying basin water (**Figure 5.2**). Porewater activities in the top 5 cm of the tailings were in the range of 3 to 5 Bq/L and the basin water activities ranged from 0.7 to 1 Bq/L. These results indicate that a concentration gradient has developed and imply upward diffusion and mass transport of Ra-226 from the porewater to the overlying basin water.

6.6 Water Balance and Ra-226 Loads for the Quirke TMA

A water balance was completed to estimate Ra-226 loads from the monitoring data for the Quirke TMA. The observed Ra-226 loads were calculated for comparison with Ra-226 loads calculated in terms of diffusive flux (**Section 6.7**) to verify whether the observed Ra-226 loads could be explained by Ba,$RaSO_4$ dissolution and subsequent diffusion from porewater to the basin water.

Annual flow rates were calculated to develop a mass balance for Ra-226 loads from each Cell and the overall Quirke TMA. The estimated flow rates were based on measured flows into and out of the Quirke TMA from 2006 to 2009, as well as the estimated natural inputs to each cell. The Ra-226 loads were calculated from the estimated flow rates and the routine monitoring data for the period of 2006 through 2009. The results for the estimated flow rates are presented in **Tables 6.1** and Ra-226 activities from routine monitoring are presented in **Table 6.2**. The estimated loads are presented in **Table 6.3**.

6.6.1 Water Balance

The annual flow rate for Cell 14 is dependent on the input from Gravel Pit Lake (Q-29) and the net natural input (NNI) that represents precipitation and runoff minus evaporation. The annual flow rate for each consecutive downstream cell is maintained by the inflow from the previous cell and the NNI. The NNI for the entire TMA was estimated from the average annual outflow from the Quirke TMA at Cell 18 (Q-05) less the average annual input from Gravel Pit Lake (Q-29). The values used for the average annual flows from Gravel Pit Lake (Q-29) and Cell 18 (Q-05) represent the average measured flow rates from 2006 through 2009. The flow rates for the 2006 through 2009 time period were considered for this investigation to remain consistent with the SOE (Minnow, 2011).

The NNI for each cell was calculated as the fraction of the total NNI based on the percentage of the watershed each cell represents. The flow rates for each cell were calculated as the total input to the Cell plus the respective NNI. Calculated annual flow rates for each cell are presented in **Table 6.1**.

6.6.2 Ra-226 Loads

Radium-226 loads were calculated for each cell using the estimated flow rates and average Ra-226 activities from **Tables 6.1 and 6.2**. Radium-226 loads for each cell were calculated as follows:

$$L = Q \bullet C_{BW} \quad \text{Eq. (1)}$$

Where: L = Load (MBq/a);

Q = Flow (m^3/a); and

C_{BW} = Ra-226 activity in the basin water (Bq/L)

The cumulative Ra-226 loads, together with their respective incremental loads for each cell are presented in **Table 6.3**. The incremental loads of Ra-226 represent the differences between the Ra-226 entering and/or exiting the cell.

The Ra-226 load from Cell 14 was approximately 580 MBq/a. The total load from Cell 15 was 560 MBq/a, suggesting that either there was no net release of Ra-226 or that there may have been a small amount of removal of Ra-226 in Cell 15. The total Ra-226 loads from Cells 16 and 17 were 1,560 and 2,650 MB/a. The incremental loads for Cells 16 and 17 were 1,000 and 1,080 MBq/a, while the total Ra-226 load entering the Quirke effluent treatment plant (ETP) from Cell 18 was estimated to be 2,590 MBq/a. The incremental load for Cell 18 was -54 MBq/a. The negative values for the incremental Ra-226 loads in Cell 18 may be the result of variability in the actual flow rates compared to the annual values that were used or may reflect a small removal in Cell 18 resulting from settling of solids formed during *in-situ* lime addition in Cell 17.

The results for the incremental Ra-226 load calculations indicate that the majority of the Ra-226 loads from the Quirke TMA originate from Cells 16 and 17. The Ra-226 load from Cell 14 represents about one fifth of the total, while Cells 15 and 18 represent little to no contributions to the overall Ra-226 loads for the entire Quirke TMA.

The Ra-226 loads exiting Cells 16 and 17 are about 2 times higher than those exiting their respective upstream cells. The data show average Ra-226 activities in the porewater and basin water in Cells 16 and 17 with values that are about 2 to 3 times higher than the average values in their respective upstream cells (**Tables 2.1 and 6.2**). These results indicate that the loads from Cells 16 and 17 are consistent with Ra-226 contributions from porewater that is flushing from the tailings near the upstream dykes.

The activities for Ra-226 in porewater seepage that enters a cell were monitored annually between 1995 and 2003 and as part of the Ra-226 studies in 2010 by piezometers down-gradient of the dykes. The piezometer nest at DK16-2 was observed to have the highest

Ra-226 activities in the 1990s, as shown for DK16-2B in **Figure 6.5**. The highest activity of 14 Bq/L observed in 1998 have likely discharged to Cell 17 and the most recent sample in 2010 had a value of about 6.5 Bq/L that is more consistent with porewater values observed near the tailings surface in this investigation. The overall trend of declining Ra-226 activities over time is observed for most piezometers and the trend is consistent with the conceptual model shown in **Figure 2.2**.

6.7 Ra-226 Flux and Loads in Cell 14

The load from Cell 14 related to the diffusive flux of Ra-226 from the tailings was calculated to verify whether the load calculated for Cell 14 in **Section 6.6.2** could be explained by diffusion from porewater to the basin water. The results from the calculations are presented in **Table 6.4**.

Radium-226 loads in terms of diffusive flux were calculated as follows:

$$L = F \bullet A \qquad \text{Eq. (2)}$$

Where: L = Load (MBq/a);

F = Mass Flux (Bq/m^2•a);

A = Surface area over which the diffusion is taking place (m^2).

The total surface area of Cell 14 is 630,000 m^2 (Golder, 1994). Because the diffusion barrier plus the till seepage blanket covers 68% of Cell 14, the surface area for diffusion was adjusted to 210,000 m^2 representing only the area for which diffusion will take place through the tailings directly to the water column.

The mass flux was calculated as follows:

$$F = -D_e \bullet \frac{\partial C}{\partial z} \qquad \text{Eq (3)}$$

Where: F = Mass Flux (Bq/m^2•a);

D_e = effective diffusion coefficient in the tailings porewater (m^2/a);

∂C = change in Ra-226 activity over the interface (Bq/L); and

∂z = interface thickness (m).

Typical values for diffusion coefficients (D) for aqueous solutions in a porous medium, neglecting porosity, were obtained from the literature (Spitz and Moreno, 1996). An average value of 8.43×10^{-10} m^2/s (2.66×10^{-2} m^2/a) was considered reasonable for this investigation. In porous media, such as tailings, the effective diffusion is smaller than that in pure aqueous solution because ions follow a longer path of diffusion through the pore spaces and do not migrate through the solid particles. Therefore, an effective diffusion coefficient, D_e, should be used for tailings and can be represented by:

$$D_e = D \bullet \eta$$

Where: η = porosity

With a porosity in the tailings of 0.45 (SENES, 2003), the value of D_e becomes 3.79×10^{-10} m^2/s (1.20×10^{-2} m^2/a).

The change in Ra-226 activity across the interface, or concentration gradient, was estimated from the 2009 sampling data and represents the concentration in porewater from the top 2.5 to 5 cm of the tailings, minus the concentration at the bottom of the water column. Interface thickness values equal to the sample interval thickness of the uppermost solids samples were considered for the calculation of gradients. These intervals were 0.025 m for QC14-2 and 0.05 m for all other stations. Sensitivity on the interface thickness was tested using conservative values of 0.01 and 0.03 m. The interface thickness of 0.01 was considered to represent a conservative upper value for the calculation of gradients.

The loads for Ra-226 for Cell 14 ranged from 659 to 166 MBq/a for interface thicknesses between 0.01 and 0.05 m (**Table 6.4**). The estimated Ra-226 activities in the basin water were in the range of 0.42 and 0.11 Bq/L for the assumed interface thicknesses.

When an interface thickness of 0.01 m was used to calculate the diffusive flux, the load from Cell 14 was 659 MBq/a and this value agrees well with the measured load value of 579 MBq/a in **Table 6.3**. The Ra-226 activity calculated with an interface value of 0.01 m was 0.42 Bq/L. This value agrees well with the average Ra-226 activity of 0.37 Bq/L from routine monitoring at the outflow from Cell 14 for the 2006 through 2009 time period (**Table 6.2**). These results indicate that the Ra-226 activities measured in the outflow from Cell 14 are consistent with Ra-226 resulting from a diffusive flux in the tailings porewater to the basin water.

6.7.1 Estimated Ranges in Ra-226 Activities

The diffusive flux calculations provided strong evidence that upward diffusion of Ra-226 is the primary mechanism for Ra-226 release to the basin water. Sensitivity on flow through Cell 14 was also tested to provide an estimate for the ranges in Ra-226 activities that may be anticipated in the basin waters as a result of natural variations in flow rates in the basins. The residence time in Cell 14 is about 3 months (SENES, 2003). It is expected that it will require approximately three cell volumes of flow for the Ra-226 activities in the basin water to be substantially shifted from current values either by changes in the water balance in the basin or loading of Ra-226 from the porewater in the submerged tailings. Three cell volumes represent a total time of about 9 months. Therefore, an averaging period of 9 months in Cell 14 can be considered for variations in flow to the basin. Flow at the Quirke TMA is measured at the inflow from Gravel Pit Lake (Q-29) and at the outflow from Cell 18 (Q-05). The monthly flow rates are presented in **Figure 6.5** as a time-trend plot for the period of 1997, after all of the cells were flooded, through 2009. **Figure 6.5** also shows the 9-month moving averages for flow data, at Q-29 and Q-05 as well as the difference between the measured flows, at Q-05 minus those Q-29 at that represents the NNI into the TMA. The 9-month moving averages from Q-29 and the NNI were used to determine representative minimum and maximum flow rates for the Quirke TMA. The high and low values for the 9-month moving average for Q-29 were 48 and 25 L/s, respectively. The high and low values for the 9-month moving average for the NNI were 100 and 10 L/s, respectively.

Figure 6.5 exhibits some higher and lower values than those used in this assessment, however, some of these fluctuations are not representative of normal flow conditions. The lowest flow rate was determined from the lowest observed 9-month moving average from 2000 to 2001 because that time period represented a 1 in 50 year return drought event (Pers. Comm., Golder, 2011). The highest flow rate was observed in 2004, however, the value was considered not to be representative of maximum flow rates because the flow rates represent higher the re-flooding of Cell 14 after the construction of the diffusion barrier in 2003. Instead, the maximum flow from 2002 was used to calculate the activities in **Table 6.5**.

The loads and activities were calculated using an interface thickness of 0.01 m. The estimated Ra-226 activities for the 9-month average high and low flows in Cell 14 were 0.27 and 0.76 Bq/L, respectively (**Table 6.5**). These values were similar to the range of annual average values from the routine monitoring data that ranged from 0.34 to 0.52 Bq/L between 2006 and 2009 (**Table 6.2**).

These results provide further support that Ra-226 activities measured in the outflow from the Quirke TMA are consistent with Ra-226 loads resulting from diffusive flux in the porewater to the basin water with variations that are consistent with natural variations in the flow within the basins.

Similar calculations were performed for an estimated maximum Ra-226 activity of 5 Bq/L in the porewater of the submerged solids measured in this study. With an activity of 5 Bq/L in porewater, the expected Ra-226 activities resulting from diffusive flux could be in the range of 0.42 to 1.15 Bq/L as shown in **Table 6.6**. These calculations provide an indication of Ra-226 activities that could be observed if porewater concentrations near the tailings-water interface approach the maximum values that were observed in Cell 14 from this study.

As a sensitivity exercise, calculations were performed to assess a potential range of Ra-226 activities in basin water assuming that pockets of sulphate reduction with Ra-226 activities of 15 Bq/L in porewater developed over 25% of the area of Cell 14. The calculations were performed with a porewater activity of 5 Bq/L for the remaining 75% of the cell area. With these conditions, an anticipated range in Ra-226 activities that could potentially develop from diffusive flux could be in the range of 0.67 to 1.87 Bq/L as shown in **Table 6.7**. If pockets with sulphate reducing conditions were to develop in Cell 14, these calculations provide an indication of Ra-226 activities that could be observed in the basin water for the Ra-226 activities in porewater either observed or assumed in this study.

6.8 Risk Related to Sulphate Reduction

The results of this investigation indicate that the Ra-226 activities in porewater near the tailings-water interface controls the activities in the basin water at the Quirke TMA. With sulphate concentrations as low as 5 mg/L, a value below background values in the Serpent River Watershed, the Ra-226 activities in porewater are constrained to values of less than 5 Bq/L as a result of $BaSO_4$ solubility control. In turn, the limit of 5 Bq/L of Ra-226 in porewater, the corresponding activity in Cell 14 basin water was predicted to be in the range of 0.4 to 1.1 Bq/L. The results of an investigation in 2000, reported by Martin *et al*. (2003), however, suggested that if sulphate reduction lowers sulphate concentrations below 0.5 mg/L, Ra-226 activities as high as 70 Bq/L may occur in tailings porewater. The Ra-226 solubility model proposed in this report does not negate the possibility that such high Ra-226 values can occur. However, it is appropriate to discuss the context of such elevated values and the probability that those values will occur over the long term in the Quirke TMA.

First, concentrations of sulphate below 1 mg/L will likely be attainable only if the solids do not contain gypsum, or sulphate. Any gypsum in the solids would need to be balanced by an organic carbon source to act as the energy or electron source for sulphate reduction so that 1% sulphate would require 0.25% carbon, based on the stoichiometry of the sulphate reduction reaction. In addition, a conversion of sulphate in solids would result in an equivalent mass of sulphide, or H_2S, in the porewater. The tailings porewater has long residence times so that the sulphide would accumulate rather than being replaced and sulphide levels would quickly become toxic to the sulphate reducing bacteria.

Some of the tailings in Cell 14 were found to contain little or no sulphate in the solids, at Core09-QC14-2 and Core09-QC14-3, for example. Even though there was organic carbon present and sulphide odour was present at one of those sites, sulphate maintained above 5 mg/L in the porewater. These observations suggest that special conditions may be required to induce substantial sulphate reduction.

In the long term, deposition of organic matter in the basins is inevitable. Natural processes over time result in sediment accumulation in lakes and similar processes will prevail in the tailings basins. While organic matter may increase the risk of sulphate reduction at the organic-tailings interface, it may not necessarily do so any more than what was observed in this study. The accumulation of the organic layer will also result in the formation of a diffusion barrier over the tailings. This layer will reduce the flux into the water column in two ways. First, the layer will act as a physical barrier that will reduce concentration gradients and thus the diffusive flux. The organics will also sorb Ra-226 and further retard transport through the organic layer into the water column. Investigation of Serpent River sediments suggest that a Kd value as high as 1,300 L/kg may apply to Ra-226 in organic rich sediments. This sorption capacity is very large and has the ability to substantially attenuate Ra-226 transport through the organic layer.

It can be shown with the currently proposed model that a sulphate concentration of 0.5 Bq/L in porewater, the corresponding Ra-226 activities would be constrained to 15 Bq/L assuming the Ra-226 to barium ratio of 10 found in this study. If the ratio of 17 found in the Martin *et al*. (2003) study is used, the Ra-226 activity in porewater would be almost a factor of two higher or about 30 Bq/L. It is not likely that sulphate reduction resulting in such low sulphate concentrations would occur basin-wide. It is more probable that extreme sulphate reduction would occur locally as a result of local accumulation of unique organic matter, for example. Calculations in **Section 6.7** of this report demonstrated that the development of low sulphate zones in limited areas of the tailings in Cell 14 can result in incremental increases of Ra-226 in basin water. However, these increases were on the order of terms of percent.

The risks related to sulphate reduction are therefore considered to be limited. If sulphate reduction is related to macrophyte growth in deeper areas of the basins, these can be monitored for such growth and the hypothesis tested. There is no evidence of highly elevated levels in the basin or tailings porewater as of 2009. The monitoring program is considered to be more than adequate to detect any major changes in Ra-226 levels or possible conditions in the tailings porewater and the risk of abrupt changes is very low to non-existent.

7.0 SUMMARY OF CONCLUSIONS

The main objectives of this investigation were to evaluate Ra-226 activities in solids, porewater and basin water to develop an understanding of the controls on Ra-226 releases to the basin water in Cell 14 in order to address the uncertainties related to the release of Ra-226 to the basin water that arose from the inconsistencies between the results from routine monitoring and those from the Martin *et al.* (2003) study. Another objective was to provide reasonable estimates for Ra-226 activities that may be observed in the basin water.

Four stations were sampled in Cell 14 at the Quirke TMA in September 2009 to obtain representative samples of Ra-226 and other constituents that theoretically can play a role in Ra-226 mobility in basin waters.

The Ra-226 activities as high as 70 Bq/L in porewater measured in Cell 14 by Martin *et al*. (2003) were not observed in this investigation or during routine monitoring in the Quirke TMA. Although, field observations, together with TOC contents, suggested there could be a potential for sulphate reduction in the top portions of the tailings at QC14-2, there was no evidence of the consequential high release of Ra-226 to porewater in this study. The Ra-226 activities in the top samples at QC15-2 were 3.6 and 2.8 Bq/L.

Two mechanisms that can potentially control Ra-226 and barium activities/concentrations in porewater, sorption and solubility, were evaluated. Water-solids partitioning plots showed that the sorption equilibrium, or Kd, model does not control the solids-porewater interactions in Cell 14.

Strong correlations between Ra-226 and barium in both the tailings solids and porewater support a similar mechanism for the formation of Ra-226 and barium in solids and suggest that solubility equilibrium controls the Ra-226 activities and barium concentrations in porewater.

The inverse relationship between Ra-226 and calcium indicated that Ra-226 activities in the porewater are not directly controlled by gypsum dissolution as the conceptual model in the EIS suggests. Instead, the inverse correlation between Ra-226 and calcium results from indirect controls by gypsum related to the linkage between high calcium and sulphate in the presence of gypsum. The sulphate concentrations control the Ra-226 activities in porewater and therefore, the presence of gypsum in the tailings solids indirectly controls the Ra-226 activities. This does not contradict the conceptual model in the EIS but provides a refinement of the interpretation of the model.

Inverse correlations between barium and sulphate and between Ra-226 and sulphate indicated that the solubility of a solid sulphate phase controls the concentrations of barium and the activity of Ra-226 in water that is in contact with the tailings solids. The theoretical solubility of barium and sulphate in equilibrium with $BaSO_4$ solids provided further evidence that barium concentrations, and therefore Ra-226 activities, are controlled by sulphate concentrations.

The theoretical solubility of $BaSO_4$ was used to predict Ra-226 activities in porewater. The slope of the regression line for Ra-226 and barium in porewater indicated a Ra-226 to barium ratio of approximately 10. Using this relationship and a sulphate concentration of 5 mg/L the $BaSO_4$ theoretical solubility curve predicts a barium concentration of 0.4 mg/L. A Ra-226 activity of 4 Bq/L in porewater is estimated from the Ra-226 to barium ratio. This result is consistent with the measured porewater data from Cell 14 that exhibited Ra-226 activities of 4.1 and 3.4 Bq/L when sulphate concentrations were 5.6 and 6.8 mg/L, respectively.

The maximum Ra-226 activity of 5 Bq/L measured in the top portions of the tailings porewater in Cell 14 provides a reasonable upper limit for Ra-226 activities that could be anticipated in submerged tailings porewater, existing conditions noted during this study.

The Martin et al. (2003) study assumed a sulphate concentration of 0.5 mg/L for porewaters collected in the deeper anoxic zones. If the Ra-226 activity in porewater is estimated from $BaSO_4$ solubility curve and the Ra-226 to barium ratio, the predicted activity in porewater is approximately 15 Bq/L.

Concentration gradients between Ra-226 activities in the porewater and basin imply upward diffusion and mass transport of Ra-226 from porewater to the overlying water. In Cell 14 there are no up-gradient cells and therefore diffusive transport is the primary mechanism for Ra-226 release to the basin water.

Radium-226 loads and activities estimated from diffusive flux calculations agreed well with observed Ra-226 loads and activities from routine monitoring. These results provided further evidence that releases of Ra-226 from porewater to overlying basin water are controlled by diffusive flux.

A range for Ra-226 activities of 0.42 to 1.15 Bq/L in basin water was predicted for a condition with assumed Ra-226 activities of 5 Bq/L in porewater near the tailings-water interface. These calculations provide an indication of Ra-226 activities that could be observed if porewater activities approach maximum values that were observed in Cell 14 during this study.

As a sensitivity exercise, the Ra-226 activity in porewater was estimated for a sulphate concentration of 0.5 mg/L. Based on the solubility of $BaSO_4$ and the relationship between radium activities and barium concentrations, the predicted Ra-226 activity was 15 Bq/L. Furthermore, Ra-226 activities in basin water were predicted by assuming that porewater activities of 15 Bq/L and 5 Bq/L occurred over 25 and 75% of the tailings area in Cell 14, respectively. If this type of condition was to develop, the predicted Ra-226 activities in basin water were in the range of 0.67 to 1.87 Bq/L, for these assumptions. These calculations provide an indication for Ra-226 activities that could be observed in basin water for the Ra-226 activities in porewater either observed or assumed in this study, if pockets of sulphate reducing conditions were to develop in Cell 14 and sulphate concentrations of less than 1 mg/L occurred in the porewater.

Although possible, it is unlikely that significant areas of sulphate reduction could occur without an accumulation of organic material at the surface of the tailings that would also act as a diffusion barrier in the long term. An organic layer would mitigate the diffusive flux of Ra-226 by acting as a physical barrier by decreasing concentration gradients, as well as a chemical barrier by sorbing Ra-226 to the carbon solids. Therefore, in the long term, the risk of highly elevated Ra-226 activities in tailings porewater associated with sulphate reduction is considered to be very low.

There is no evidence of highly elevated levels in the basin or tailings porewater as of 2009. The monitoring program is considered to be more than adequate to detect any major changes in Ra-226 levels or possible conditions in the tailings porewater and the risk of abrupt changes is very low to non-existent.

8.0 REFERENCES

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TABLES

Table 2.1: Summary of Ra-226 Activities in Porewater at the Quirke TMA

Statistic	Radium-226 (Bq/L)
Cell 15	
Minimum	0.22
Maximum	3.3
Mean	1.6
Count	53
Cell 16	
Minimum	0.23
Maximum	4.2
Mean	2.9
Count	56
Cell 17	
Minimum	3.2
Maximum	14.4
Mean	7.9
Count	32
Cell 18	
Minimum	0.99
Maximum	6.6
Mean	4.0
Count	32

Table 4.1a: Data Quality Assessment Summary for Selected Constituents in Solids - Duplicate Samples

		Parameter				
		Radium-226	Barium	Calcium	Sulphate	Total Organic Carbon
		(Bq/g)	(mg/kg)	(mg/kg)	(%)	(%)
Method Detection Limit		0.01	0.05	1	0.1	0.01
RPD Data Quality Objective		≤ 40%	≤ 40%	≤ 40%	≤ 40%	≤ 40%
Sample ID	CORE 09-PSB-2 (5-10)	4.5	160	7,600	0.6	9.78
Replicate ID	CORE 09-EC-1 (0-5)	4.1	94	4,600	0.3	10.5
RPD (%) or AD		9	**52**	**49**	**0.3**	7
Sample ID	CORE 09-SR-4 (10-15)	2.1	440	7,300	0.2	16.8
Replicate ID	CORE 09-EC-1 (5-10)	1.6	450	7,400	0.1	16.7
RPD (%) or AD		27	2	1	0.1	1
Average RPD or AD		***18***	***27***	***25***	***0.2***	***4***
Count		*3*	*3*	*3*	*3*	*3*

Notes:

RPD - relative percent difference; is calculated for analytes with concentrations greater than or equal to five times the detection limit and should be less than or equal to 40%

AD - absolute difference; for samples having concentrations less than five times the detection limit, the difference between the sample and duplicate, or difference between the sample or duplicate and the detection limit if either the sample or duplicate analyte concentration is below detection limit; should not be greater then the detection limit

BD - Sample and/or replicate had analyte concentrations below detection limit

"--" Indicates parameter was not measured

Boldface type and shaded indicates that Data Quality Objective was not achieved

Table 4.1b: Data Quality Assessment Summary for Selected Constituents in Solids - Replicate Samples

		Parameter				
		Radium-226	**Barium**	**Calcium**	**Sulphate**	**Total Organic Carbon**
		(Bq/g)	(mg/kg)	(mg/kg)	(%)	(%)
Method Detection Limit		0.01	0.05	1	0.1	0.01
RPD Data Quality Objective		≤ 40%	≤ 40%	≤ 40%	≤ 40%	≤ 40%
Sample ID	CORE 09-QC14-2 (0-2.5)	4.3	150	190	0.1	0.519
Replicate ID	CORE 09-EC-2 (0-2.5)	7.0	280	230	0.1	0.617
RPD (%) or AD		**48**	**60**	19	0	17
Sample ID	CORE 09-QC14-2 (2.5-5)	6.5	220	130	0.1	0.289
Replicate ID	CORE 09-EC-2 (2.5-5)	8.3	370	110	0.1	0.206
RPD (%) or AD		24	**51**	17	0	34
Sample ID	CORE 09-QC14-2 (5-7.5)	9.3	330	79	0.1	0.121
Replicate ID	CORE 09-EC-2 (5-7.5)	20.0	310	63	0.1	0.090
RPD (%) or AD		**73**	6	23	0	29
Average RPD or AD		***48***	***39***	***19***	***0***	***27***
Count		*3*	*3*	*3*	*3*	*3*

Notes:

RPD - relative percent difference; is calculated for analytes with concentrations greater than or equal to five times the detection limit and should be less than or equal to 40%

AD - absolute difference; for samples having concentrations less than five times the detection limit, the difference between the sample and duplicate, or difference between the sample or duplicate and the detection limit if either the sample or duplicate analyte concentration is below detection limit; should not be greater then the detection limit

BD - Sample and/or replicate had analyte concentrations below detection limit

"--" Indicates parameter was not measured

Boldface type and shaded indicates that Data Quality Objective was not achieved

Table 4.2a: Data Quality Assessment Summary for Selected Constituents in Water - Duplicate Samples

		Parameter				
		Radium-226	**Barium**	**Calcium**	**Sulphate**	**Organic Carbon[1]**
		(Bq/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
Method Detection Limit		0.01	0.00001	0.03	0.2	0.2
RPD Data Quality Objective		≤ 20%	≤ 20%	≤ 20%	≤ 20%	≤ 20%
Sample ID	SW09-SR-4B	0.30	0.222	11.2	25	2.0
Duplicate ID	PW09-EC-1 (0-5)	0.30	0.221	11.4	--	--
RPD (%) or AD		0	0	2	--	--
Sample ID	PW09-QC14-3 (0-5)	--	0.333	6.12	54	15.1
Duplicate ID	PW09-QC14-4 (0-5)	4.1	--	--	560	9.3
Duplicate ID	PW09-EC-1 (5-10)	4.7	0.335	6.06	--	--
RPD (%) or AD		14	1	1	--	--
Average RPD or AD		***7***	***1***	***1***	**--**	**--**
Count		*2*	*2*	*2*	--	--

Notes:
RPD - relative percent difference; is calculated for analytes with concentrations greater than or equal to five times the detection limit and should be less than or equal to 20%
AD - absolute difference; for samples having concentrations less than five times the detection limit, the difference between the sample and duplicate, or difference between the sample or duplicate and the detection limit if either the sample or duplicate analyte concentration is below detection limit; should not be greater then the detection limit
BD - Sample and/or replicate had analyte concentrations below detection limit
"--" Indicates parameter was not analysed because of insufficient sample volume
Boldface type and shaded indicates that Data Quality Objective was not achieved

Table 4.2b: Data Quality Assessment Summary for Selected Constituents in Water - Replicate Samples

		Parameter				
		Radium-226	**Barium**	**Calcium**	**Sulphate**	**Organic Carbon[1]**
		(Bq/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
Method Detection Limit		0.01	0.00001	0.03	0.2	0.2
RPD Data Quality Objective		≤ 20%	≤ 20%	≤ 20%	≤ 20%	≤ 20%
Sample ID	SW09-QC14-2T	0.82	0.104	5.69	72	72
Replicate ID	SW09-EC-2T	0.78	0.108	5.69	85	85
RPD (%) or AD		5	4	0	17	17
Sample ID	SW09-QC14-2B	0.91	0.108	5.55	32	19.4
Replicate ID	SW09-EC-2B	0.85	0.114	5.63	36	11.7
RPD (%) or AD		7	5	1	12	**50**
Sample ID	PW09-QC14-2 (0-2.5)	3.6	0.309	8.79	32	28
Replicate ID	PW09-EC-2 (0-2.5)	2.9	0.285	7.28	27	19
RPD (%) or AD		**22**	8	19	17	**38**
Sample ID	PW09-QC14-2 (2.5-5)	2.8	0.308	5.68	12	18.3
Replicate ID	PW09-EC-2 (2.5-5)	3.3	0.337	5.35	18	14.3
RPD (%) or AD		16	9	6	**40**	**25**
Sample ID	PW09-QC14-2 (5-7.5)	5.9	0.519	6.06	12	17.9
Replicate ID	PW09-EC-2 (5-7.5)	5.4	0.487	5.54	--	--
RPD (%) or AD		9	6	9	--	--
Average RPD or AD		***12***	***7***	***7***	***21***	***32***
Count		*5*	*5*	*5*	*4*	*4*

Notes:

[1] Organic Carbon RPD calculated from dissolved organic carbon value from SW09-QC14-2B and total organic carbon value from SW09-EC-2B

RPD - relative percent difference; is calculated for analytes with concentrations greater than or equal to five times the detection limit and should be less than or equal to 20%

AD - absolute difference; for samples having concentrations less than five times the detection limit, the difference between the sample and duplicate, or difference between the sample or duplicate and the detection limit if either the sample or duplicate analyte concentration is below detection limit; should not be greater then the detection limit

BD - Sample and/or replicate had analyte concentrations below detection limit

"--" Indicates parameter was not analysed because of insufficient sample volume

Boldface type and shaded indicates that Data Quality Objective was not achieved

Table 4.3: Data Quality Assessment Summary for Selected Constituents in Blank Sample

Analysis	Units	Detection Limit	Data Quality Objective	Blank 1
Radium-226	Bq/L	0.01	0.02	<0.01
Barium	mg/L	0.00001	0.00002	**0.00216**
Calcium	mg/L	0.03	0.06	0.03
Sulphate	mg/L	2	4	<2
Organic Carbon	mg/L	1.0	2.0	**2.4**

Notes:
Boldface type and shaded indicates that Data Quality Objective was not achieved

Table 5.1: Summary of Selected Constituents in Tailings Solids from Cell 14 Sampled in September 2009

Sample ID	Depth Interval (cm)	Radium-226	Barium	Calcium Sulphate		Total Organic Carbon
		(Bq/g)	(mg/kg)	(mg/kg)	(%)	(%)
CORE 09-QC14-1	(0-5)	19	550	2,400	0.6	0.490
	(5-10)	13	340	8,900	2.2	0.114
	(10-15)	9.7	280	4,900	1.2	0.065
CORE 09-QC14-2	(0-2.5)	4.3	150	190	0.1	0.519
	(2.5-5)	6.5	220	130	0.1	0.289
	(5-7.5)	9.3	330	79	0.1	0.121
	(7.5-10)	9.0	320	59	0.1	0.086
CORE 09-QC14-3	(0-5)	16	540	350	<0.1	0.617
	(5-10)	22	640	710	0.2	0.136
	(10-15)	24	660	940	0.3	0.112
	(15-20)	23	630	1,300	0.3	0.097
CORE 09-QC14-4	(0-5)	16	570	1,400	0.2	0.683
	(5-10)	17	560	9,900	1.9	0.188
	(10-15)	22	580	19,000	3.6	0.178
	(15-20)	19	470	16,000	3.1	0.109

Table 5.2: Summary of Selected Constituents in Porewater in Cell 14 Sampled in September 2009

Sample ID	Depth Interval (cm)	Radium-226	Barium	Calcium	Sulphate	Organic Carbon
		(Bq/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
PW09-QC14-1	(0-5)	1.8	0.058	290	*726*	NA
PW09-QC14-1	(5-10)	1.4	0.028	516	*1,188*	NA
PW09-QC14-1	(10-15)	0.97	0.021	532	1,500	4.7
PW09-QC14-2	(0-2.5)	3.6	0.309	8.79	32	28
PW09-QC14-2	(2.5-5)	2.8	0.308	5.68	12	18.3
PW09-QC14-2	(5-7.5)	5.9	0.519	6.06	12	17.9
PW09-QC14-2	(7.5-10)	6.9	0.499	6.44	*13*	NA
PW09-QC14-3	(0-5)	4.1	0.333	6.12	5.6	3.5
PW09-QC14-3	(5-10)	3.4	0.233	8.51	6.8	3.2
PW09-QC14-3	(10-15)	2.6	0.131	15.5	18	2.8
PW09-QC14-3	(15-20)	2.5	0.076	97.4	240	3.8
PW09-QC14-4	(0-5)	4.8	0.231	195	560	9.3
PW09-QC14-4	(5-10)	1.6	0.066	536	1,400	6.6
PW09-QC14-4	(10-15)	2.2	0.033	527	1,400	7.3
PW09-QC14-4	(15-20)	0.42	0.020	519	1,400	4.0

Notes:
PW - Porewater - Depth refers to "below solids-water interface"
NA - Not Analysed
Italicized sulphate concentrations indicates values estimated from the total sulphur concentrations from the ICP-MS scan

Table 5.3: Summary of Selected Constituents in Basin Water in Cell 14 Sampled in September 2009

Sample ID	Depth Below Surface	Radium-226	Barium	Calcium	Sulphate	Organic Carbon
	(m)	(Bq/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)
SW09-QC14-1T	0	0.77	0.109	5.72	55	13.3
SW09-QC14-1B	2.5	1.0	0.116	6.24	32	18.5
SW09-QC14-2T	0	0.82	0.104	5.69	72	14.4
SW09-QC14-2B	3.1	0.91	0.108	5.55	32	19.4
SW09-QC14-3T	0	0.71	0.105	5.59	54	15.1
SW09-QC14-3B	3.1	0.95	0.105	5.69	35	16.0
SW09-QC14-4T	0	0.79	0.099	5.63	57	13.4
SW09-QC14-4B	2.5	0.95	0.109	5.67	25	14.2

Notes:
SW - Basin Water - Depth refers to "below surface"

Table 6.1: Water Balance Calculations for the Quirke TMA

Quirke TMA Characteristics		
Annual Flow at Q-29[a]	(m^3/a)	1,053,077
Annual Flow at Q-05[b]	(m^3/a)	2,786,883
TMA Flow Q-05 to Q-29	(m^3/a)	1,733,806
Watershed Surface Area	(ha)	292
Cell Characteristics		
Cell 14		
Watershed Surface Area	(ha)	86
NNI[c]	(m^3/a)	510,641
Flow	**(m^3/a)**	**1,563,718**
Cell 15		
Watershed Surface Area	(ha)	40
NNI[c]	(m^3/a)	237,508
Flow	**(m^3/a)**	**1,801,226**
Cell 16		
Watershed Surface Area	(ha)	102
NNI[c]	(m^3/a)	605,645
Flow	**(m^3/a)**	**2,406,871**
Cell 17		
Watershed Surface Area	(ha)	19
NNI[c]	(m^3/a)	112,816
Flow	**(m^3/a)**	**2,519,687**
Cell 18		
Watershed Surface Area	(ha)	45
NNI[c]	(m^3/a)	267,196
Flow	**(m^3/a)**	**2,786,883**

Notes:
[a] Q-29 represents inflow from Gravel Pit Lake (Average from 2006 to 2009)
[b] Q-05 represents outflow from Cell 18 (Average from 2006 to 2009)
[c] NNI = Net Natural Input (Precipitation + Runoff - Evaporation)
Surface Area values from CCL (1999)

Table 6.2: Average Radium-226 Activities (Bq/L) at the Outflow from Cells at the Quirke TMA

Year	Cell 14		Cell 15		Cell 16		Cell 17		Cell 18 (Q-05)	
	Average	Count	Average	Count	Average	Count	Average	Count	Average	Count
2006	0.35	5	0.25	3	0.65	3	1.23	3	1.02	12
2007	0.35	4	0.38	4	0.69	4	1.12	4	0.97	12
2008	0.34	4	0.26	4	0.65	4	0.84	4	0.86	12
2009	0.52	2	0.38	2	0.55	2	1.05	2	0.87	12
Average for 2006 through 2009	**0.37**	**15**	**0.31**	**13**	**0.65**	**13**	**1.05**	**13**	**0.93**	**48**

Note:
All Ra-226 activities are reported in Bq/L

Table 6.3: Radium-226 Loads at the Quirke TMA

	Radium-226 Activities in Basin Waters[a]	Flow Rate (m^3/a)[a,b]	Ra-226 Load (MBq/a)	Incremental Ra-226 Load (MBq/a)
Cell 14				
Average	0.37	1,563,718	579	579
Count	15	--	--	--
Cell 15				
Average	0.31	1,801,226	558	-20
Count	13	--	--	--
Cell 16				
Average	0.65	2,406,871	1,564	1,006
Count	13	--	--	--
Cell 17				
Average	1.05	2,519,687	2,646	1,081
Count	13	--	--	--
Cell 18				
Average	0.93	2,786,883	2,592	-54
Count	48	--	--	--

Notes:

[a] Average Ra-226 activity for 2006 through 2009 from routine monitoring (Table 6.2)

[b] Average flow rate for 2006 through 2009 from routine monitoring (Table 6.1)

Table 6.4: Ra-226 Fluxes, Loads and Activities in Cell 14 for Different Interface Thicknesses

Calculation	Units	Sample ID	Interface Thickness (m)		
			0.01	0.03	0.05
Activity	(Bq/L)	QC14-1	Basin Water[a]		1.0
			Porewater		1.8
		QC14-2	Basin Water[a]		0.91
			Porewater		3.6
		QC14-3	Basin Water[a]		0.95
			Porewater		4.1
		QC14-4	Basin Water[a]		0.95
			Porewater		4.8
Concentration Gradient	(Bq/L•m)	QC14-1	80	27	16
		QC14-2[a]	269	90	108
		QC14-3	315	105	63
		QC14-4	385	128	77
		Average	***262***	***87***	***66***
Flux	(MBq/m2•a)	QC14-1	9.58E-04	3.19E-04	1.92E-04
		QC14-2	3.22E-03	1.07E-03	1.29E-03
		QC14-3	3.77E-03	1.26E-03	7.54E-04
		QC14-4	4.61E-03	1.54E-03	9.22E-04
		Average	***3.14E-03***	***1.05E-03***	***7.89E-04***
Diffusive Load to Basin Water	(MBq/a)	***Average***	***659***	***220***	***166***
Calculated Activities in Basin Water	(Bq/L)	***Average***	***0.42***	***0.14***	***0.11***

Notes:
[a] Basin water activities are samples from the solids-water interface (Table 5.3)
[b] Top most sample from 0 to 2.5 cm interval giving an interface thickness of of 0.025 m for the 0.05 m interface thickness assessment
Area of uncovered tailings was 210,000 m^2 or 32% of the total area of 630,000 m^2 (Golder, 1994)
Average flow value for Cell 14 from Table 6.1

Table 6.5: Predicted Range of Ra-226 Activities in Basin Water Based on Average Porewater Activities and a Range of Flow Rates

Calculation	Units	Flow (m^3/a)[a]	
		2,444,201	881,884
Activity	(Bq/L)	Basin Water[a]	0.95
		Porewater[c]	3.6
Concentration Gradient	(Bq/L•m)	***265***	***265***
Flux	(MBq/m2•a)	3.17E-03	3.17E-03
Diffusive Load to Basin Water	(MBq/a)	***666***	***666***
Calculated Activities in Basin Water	(Bq/L)	***0.27***	***0.76***

Notes:

[a] Flow values represent the high and low 9-month moving averages from Figure 6.5

[b] Average basin water activity at the solids-water interface (Table 5.3)

[c] Average tailings porewater activities (Table 5.2)

Area of uncovered tailings was 210,000 m^2 or 32% of the total area of 630,000 m^2 (Golder, 1994)

Interface thickness equals 0.01 m

Table 6.6: Predicted Range of Ra-226 Activities in Basin Water Based on a Porewater Activity of 5 Bq/L

Calculation	Units	Flow (m^3/a)[a]	
		2,444,201	881,884
Activity	(Bq/L)	Basin Water[a]	0.95
		Porewater[c]	5
Concentration Gradient	(Bq/L•m)	***405***	***405***
Flux	(MBq/m2•a)	4.85E-03	4.85E-03
Diffusive Load to Basin Water	(MBq/a)	***1,018***	***1,018***
Calculated Activities in Basin Water	(Bq/L)	***0.42***	***1.15***

Notes:

[a] Flow values represent the high and low 9-month moving averages from Figure 6.5

[b] Average basin water activity from the solids-water interface (Table 5.3)

[c] Average tailings porewater activities (Table 5.2)

Area of uncovered tailings was 210,000 m^2 or 32% of the total area of 630,000 m^2 (Golder, 1994)

Interface thickness equals 0.01 m

Table 6.7: Predicted Range of Ra-226 Activities in Basin Water Based on a Porewater Activity of 15 Bq/L

Calculation	Units	Flow (m^3/a)[a]	
		2,444,201	881,884
Activity	(Bq/L)	Basin Water[a]	0.95
		Porewater[c]	5
		Basin Water[a]	0.95
		Porewater[d]	15
Concentration Gradient[e]	(Bq/L•m)	***655***	***655***
Flux	(MBq/m2•a)	7.84E-03	7.84E-03
Diffusive Load to Basin Water	(MBq/a)	***1,647***	***1,647***
Calculated Activities in Basin Water	(Bq/L)	***0.67***	***1.87***

Notes:

[a] Flow values represent the high and low 9-month moving averages from Figure 6.5

[b] Maximum Predicted Ra-226 Activity in Basin Water Based on a Porewater Activity of 5 Bq/L (Table 6.6)

[c] Average tailings porewater activities (Table 5.2)

[d] Ra-226 activity in porewater estimated from the Barium-Ra-226 regression and $BaSO_4$ solubility (Figure 6.3)

[e] Weighted average with Ra-226 of 5 and 15 Bq/L representing 75 and 25%

Area of uncovered tailings was 210,000 m^2 or 32% of the total area of 630,000 m^2 (Golder, 1994)

Interface thickness equals 0.01 m

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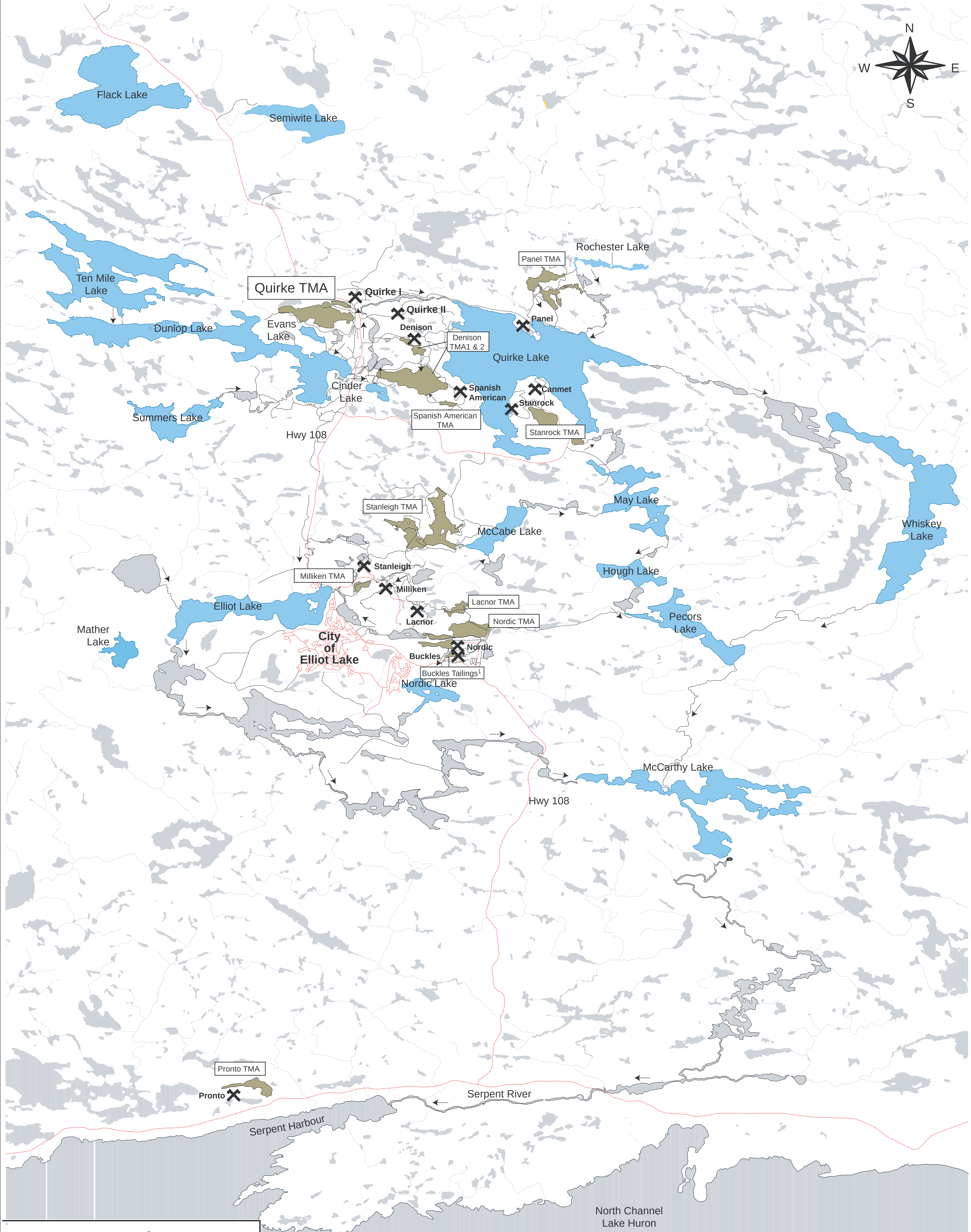
FIGURES



Legend

- Streams
- Lakes included in SRWMP
- Tailings Management Areas
- Minesites
- Highways
- Secondary Roads
- Trails
- Direction of Flow

6 0 6 Kilometers

1:155000

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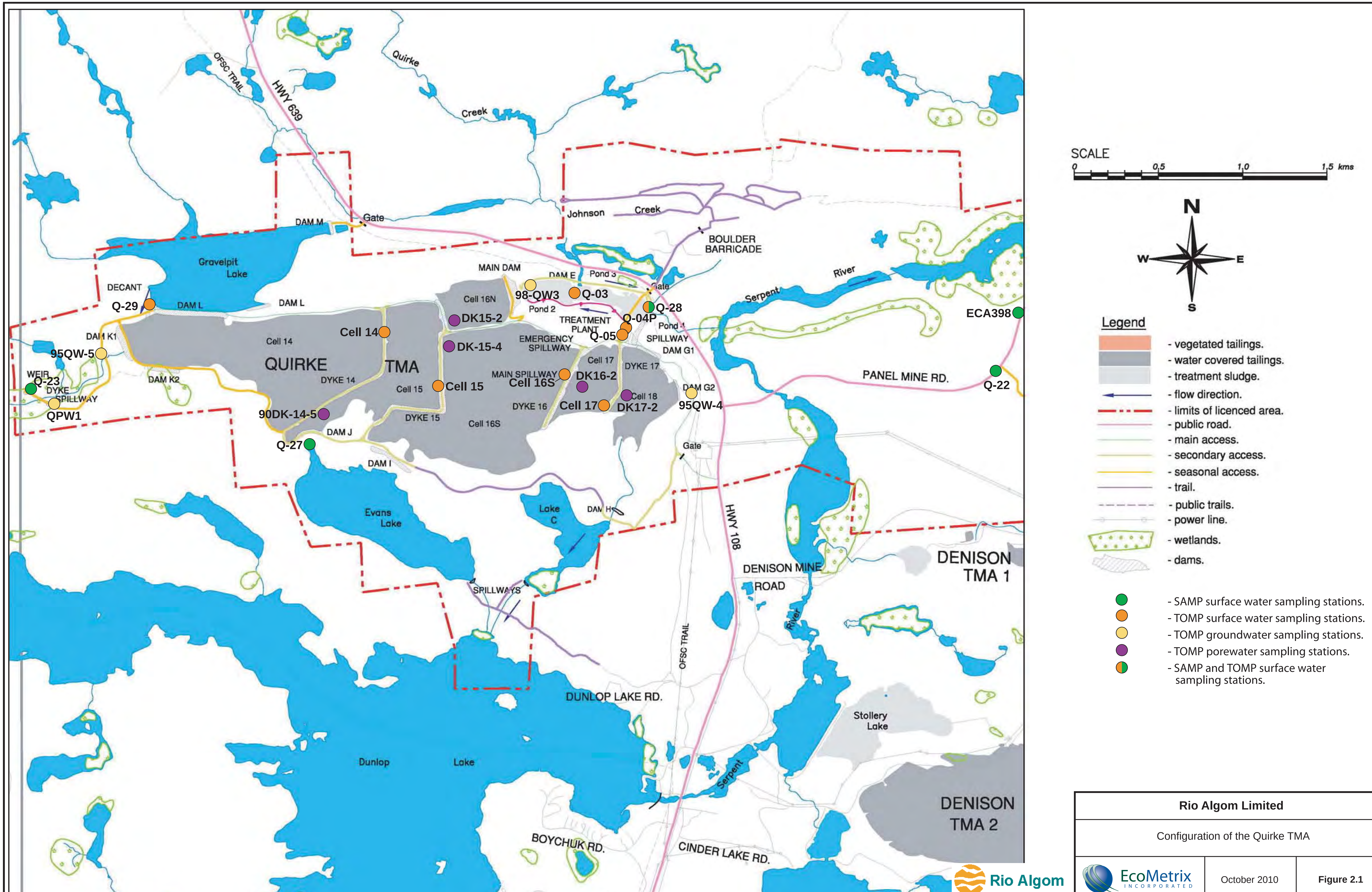
General Site Location of the Quirke Mine and Tailings Management Area

Rio Algom | EcoMetrix INCORPORATED | February 2011 | **Figure 1.1**



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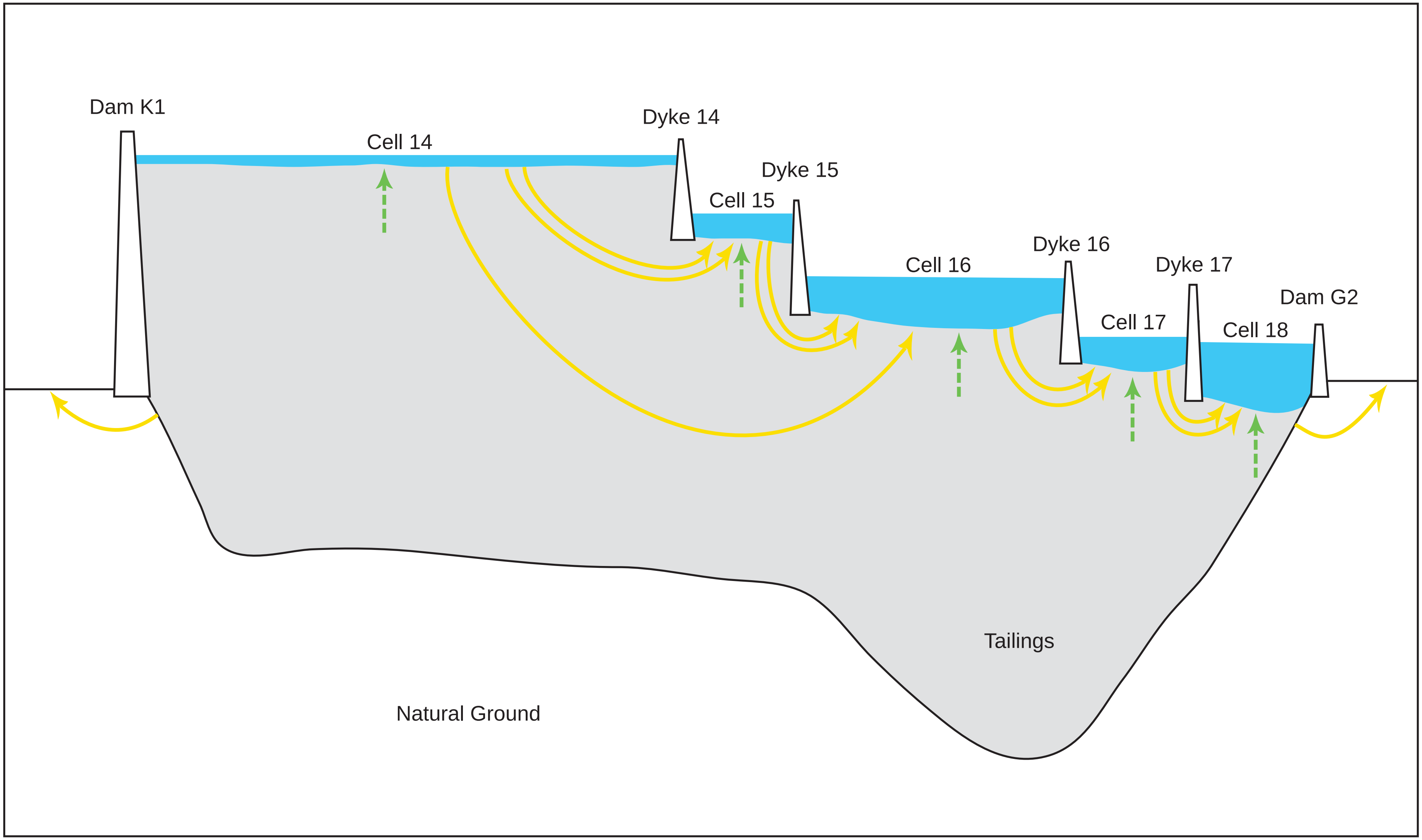
Configuration of the Quirke TMA

October 2010

Figure 2.1



Tailings
Water
Seepage
Diffusion

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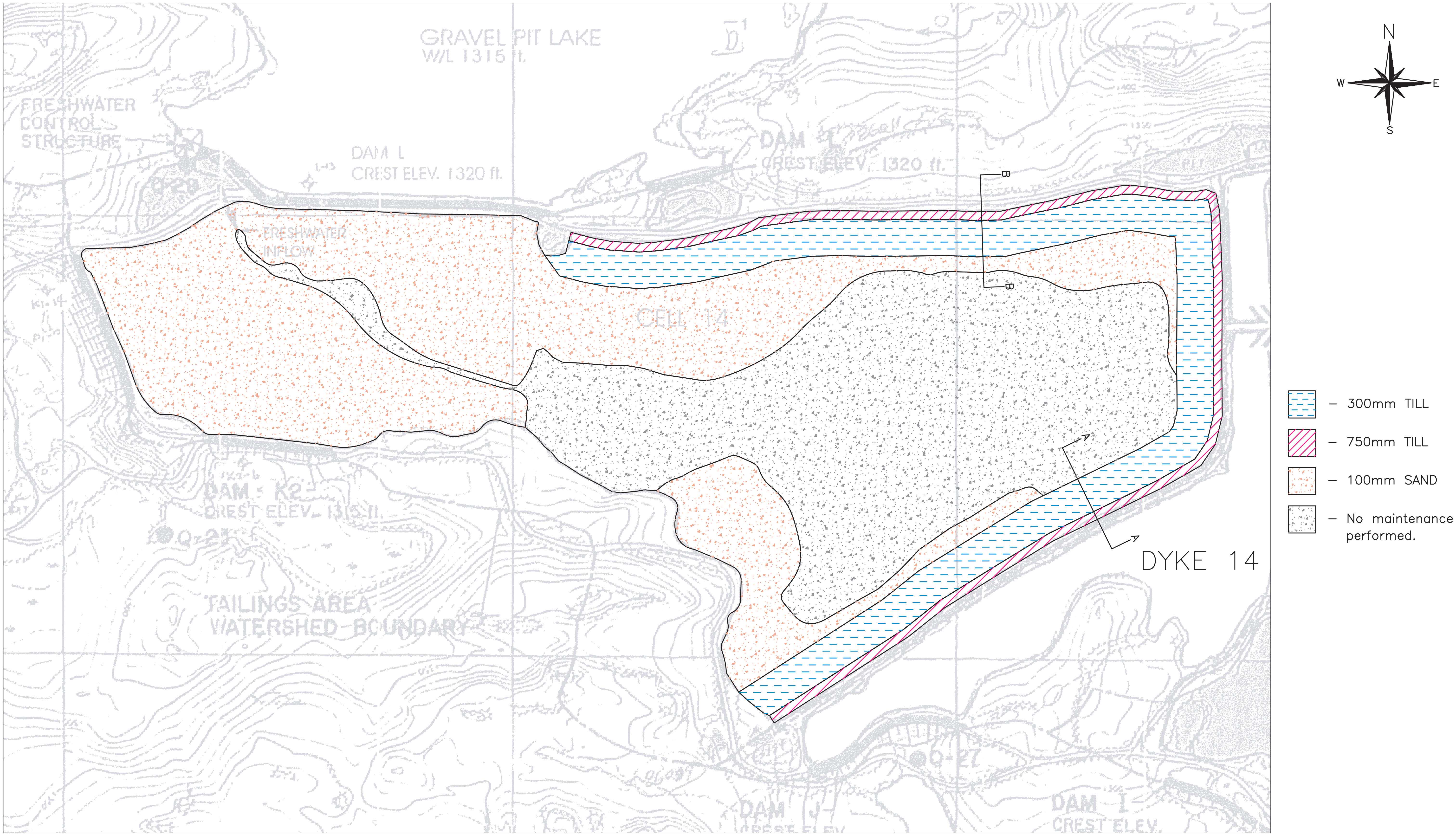
Schematic Cross-section Flow Conditions in the Flooded Tailings at the Quirke TMA

EcoMetrix INCORPORATED | January 2011 | **Figure 2.2**



Approximate Areas

300mm TILL	– 9.4 ha.
750mm TILL	– 2.3 ha.
100mm SAND	– 27.2 ha.
No Maintenance	– 23.4 ha.

SCALE
0 50 100 150 200 250 metres

NOTE: MAINTENANCE WAS COMPLETED THROUGH THE SUMMER OF 2004.

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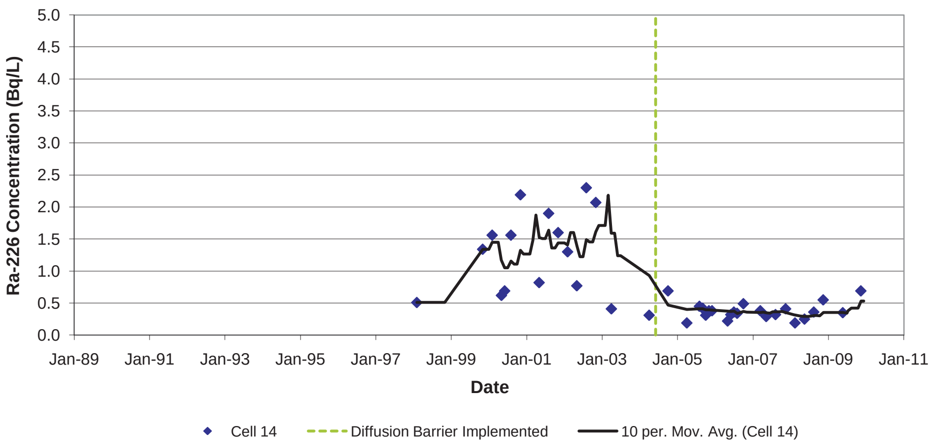
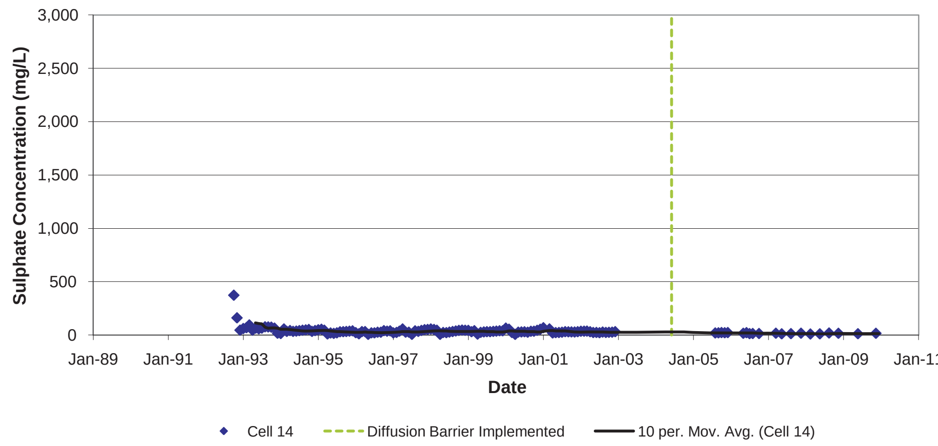
Extent of Till Blankets and Diffusion Barrier

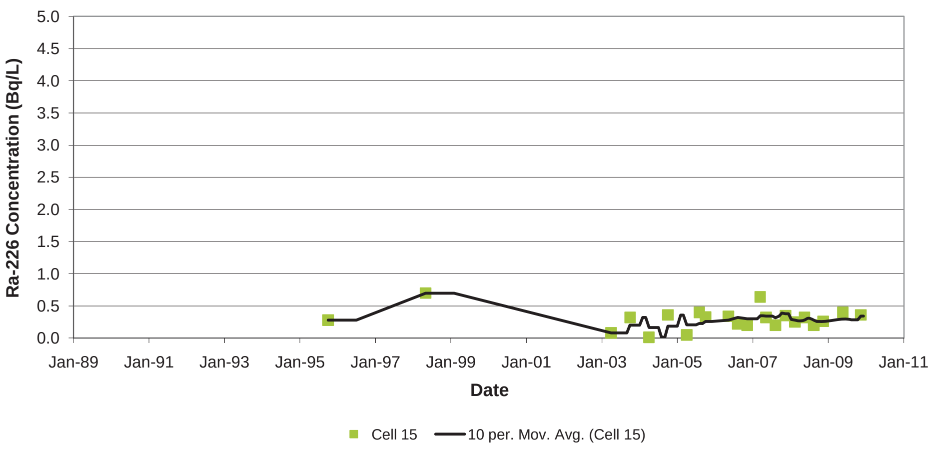
EcoMetrix INCORPORATED | February 2011 | **Figure 2.3**

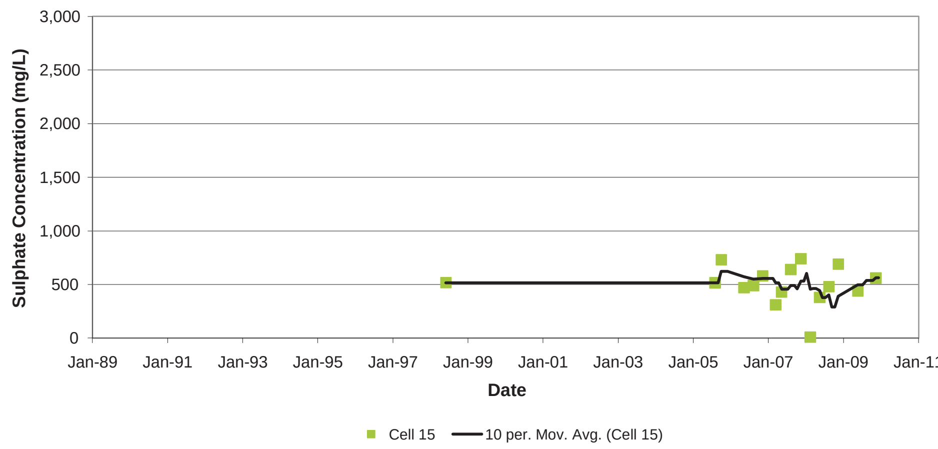
Cell 14





Cell 15





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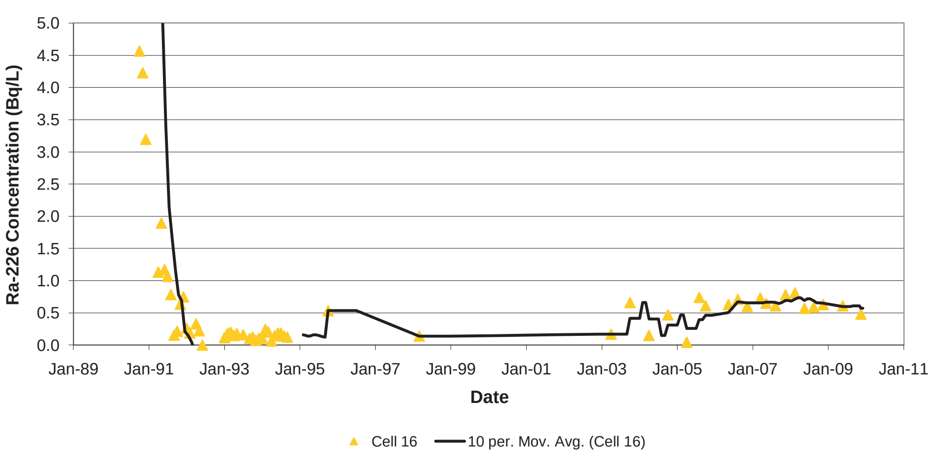
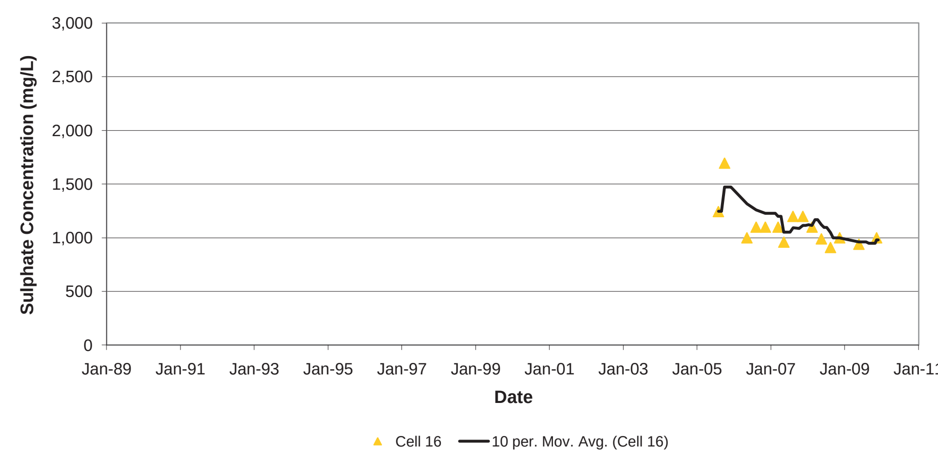
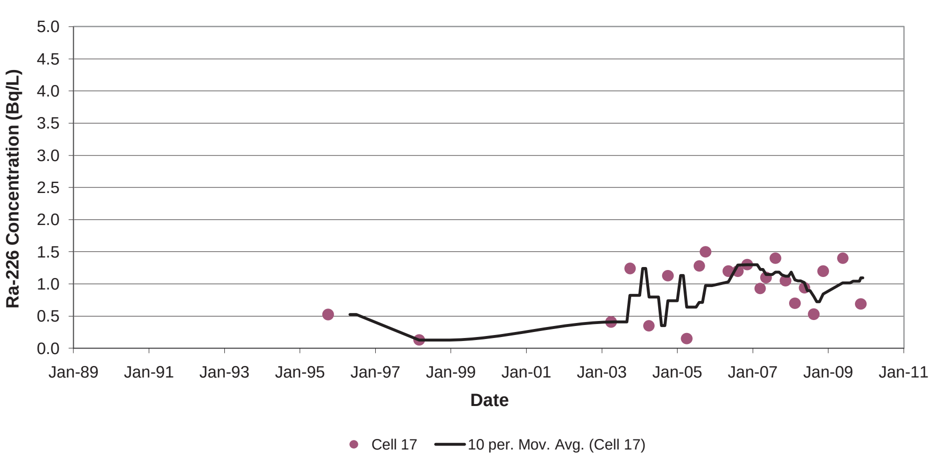
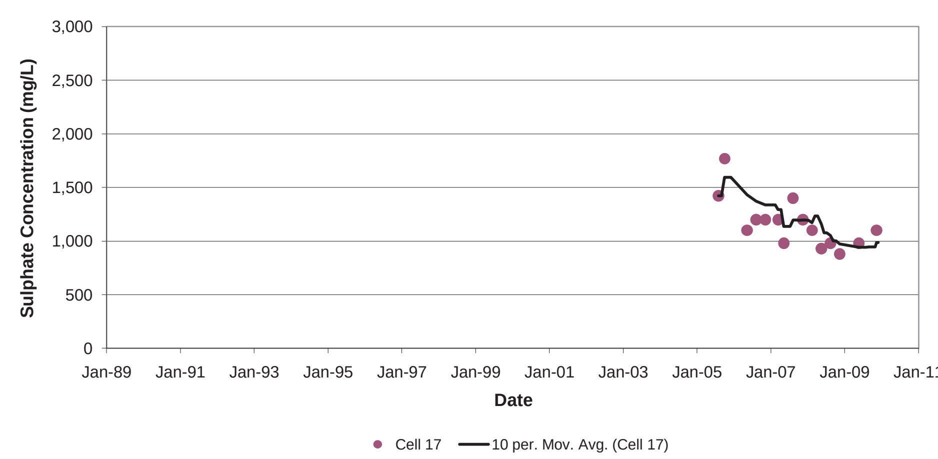


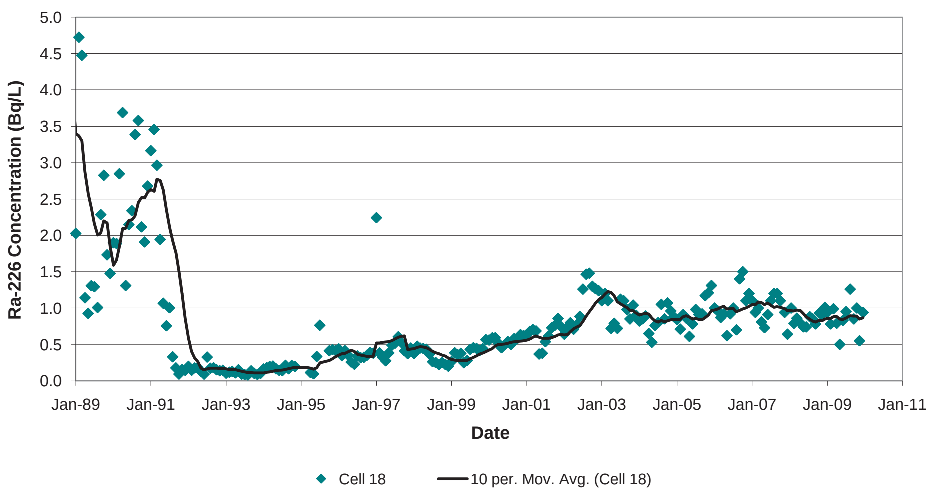


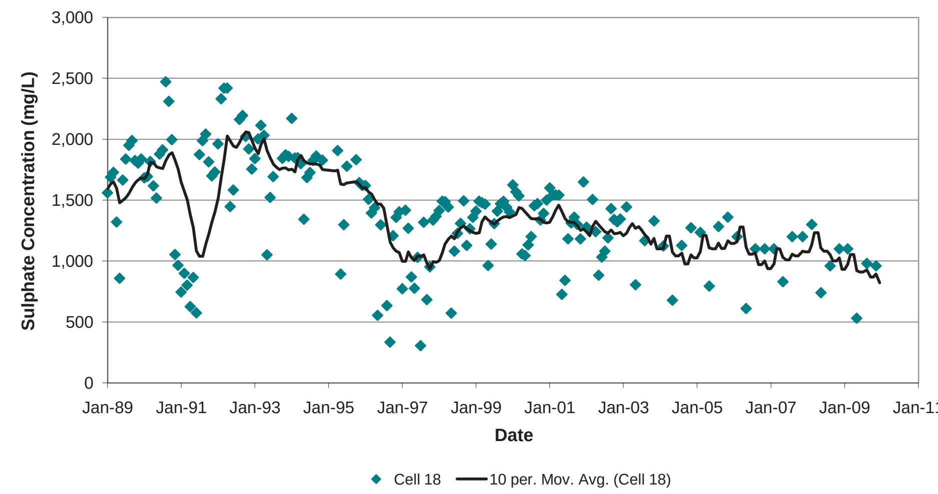
Cell 17





Cell 18





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Routine Monitoring Data from the Quirke TMA

Rio Algom | EcoMetrix INCORPORATED | February 2011 | **Figure 2.4**

N

0 500 m

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Quirke Cell 14 Sample Stations

EcoMetrix INCORPORATED | February 2011 | **Figure 3.1**

Core09-QC14-1

Core09-QC14-2

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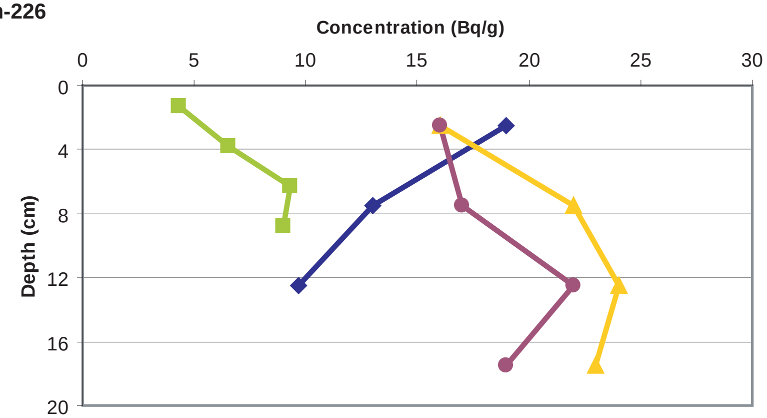
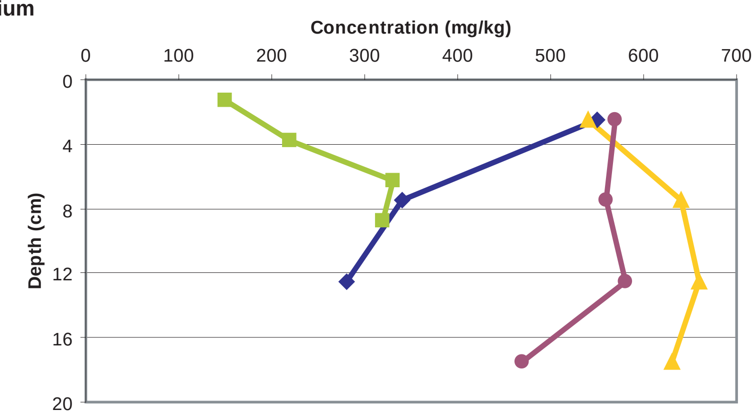
Photographs of Core09-QC14-1
and Core09-QC14-2

Rio Algom | EcoMetrix INCORPORATED | February 2011 | **Figure 3.2**

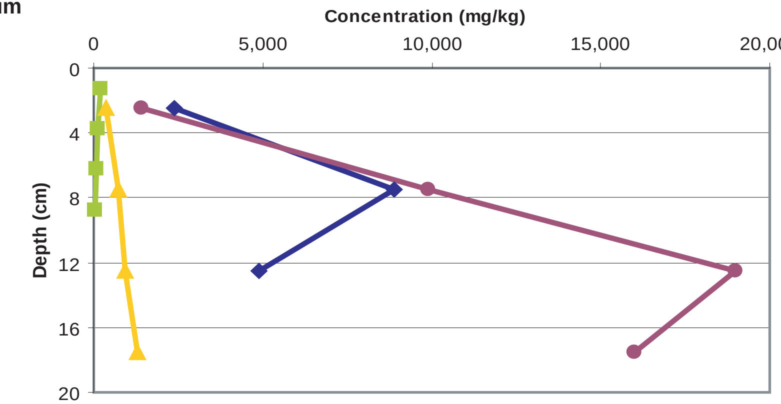
Radium-226



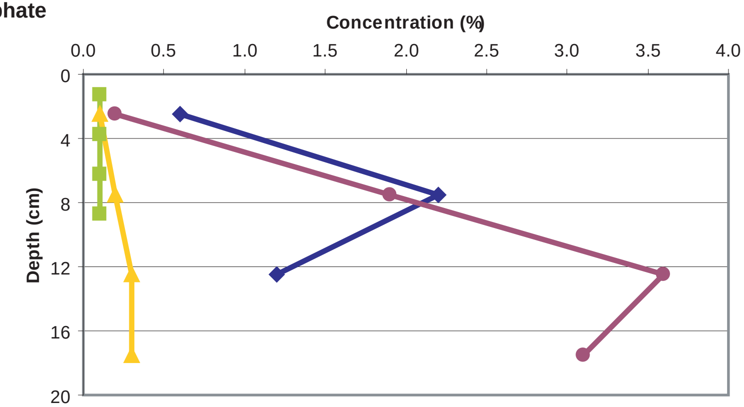
Barium



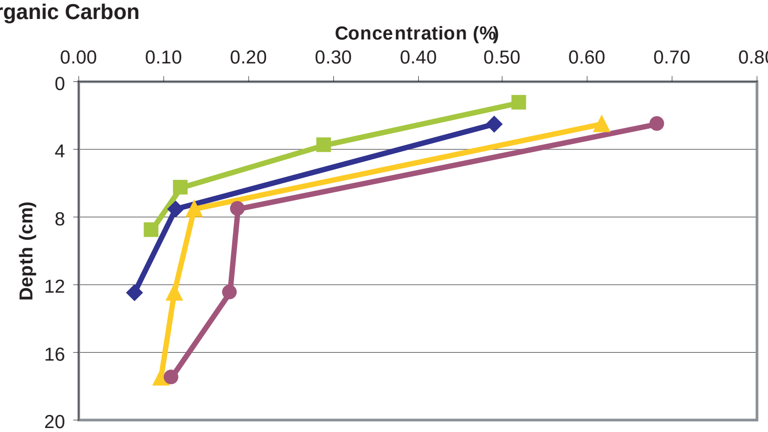
Calcium



Sulphate



Total Organic Carbon



QC14-1 QC14-2 QC14-3 QC14-4

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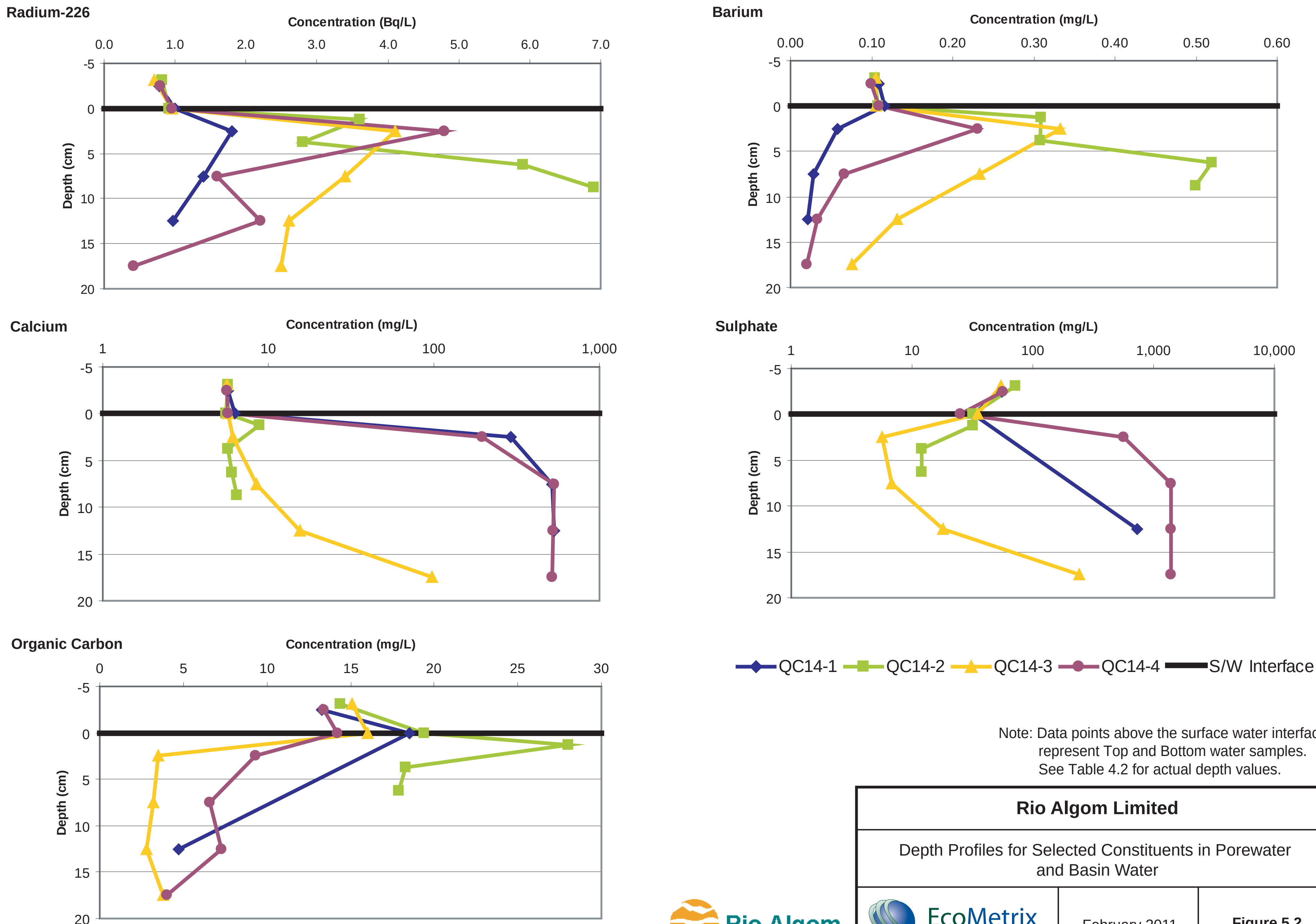
Depth Profiles for Selected Constituents in Tailings Solids

EcoMetrix INCORPORATED | February 2011 | **Figure 5.1**



Note: Data points above the surface water interface represent Top and Bottom water samples. See Table 4.2 for actual depth values.

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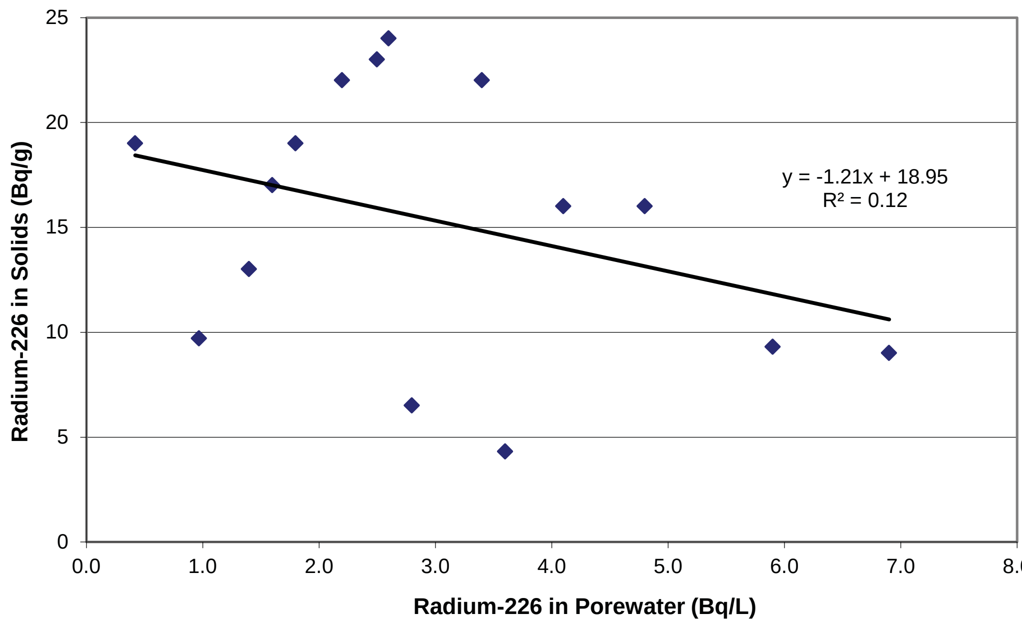
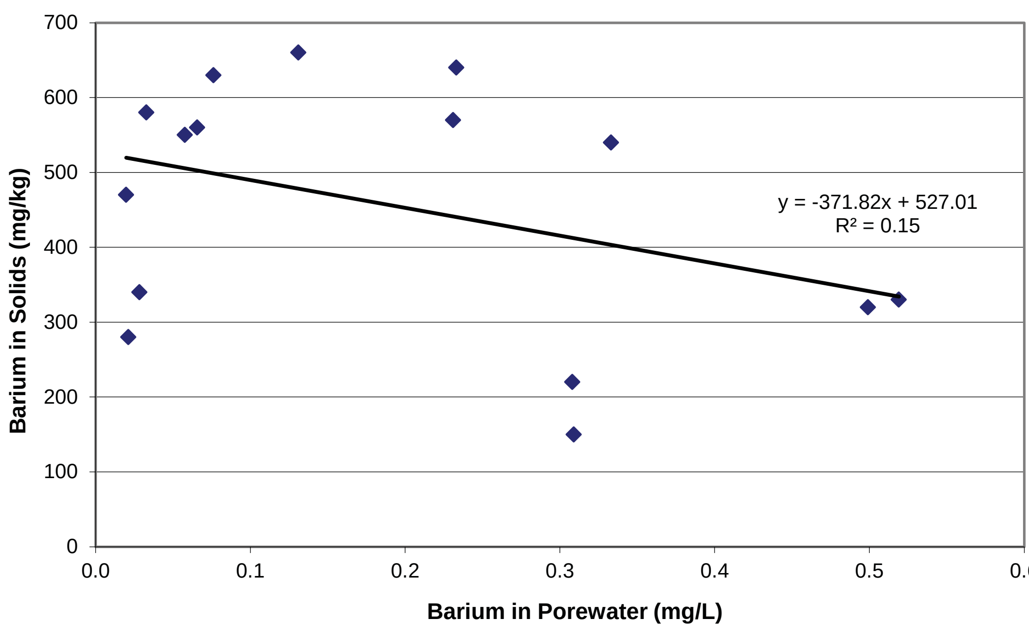
Depth Profiles for Selected Constituents in Porewater and Basin Water

Rio Algom | EcoMetrix Incorporated | February 2011 | **Figure 5.2**

a)



b)



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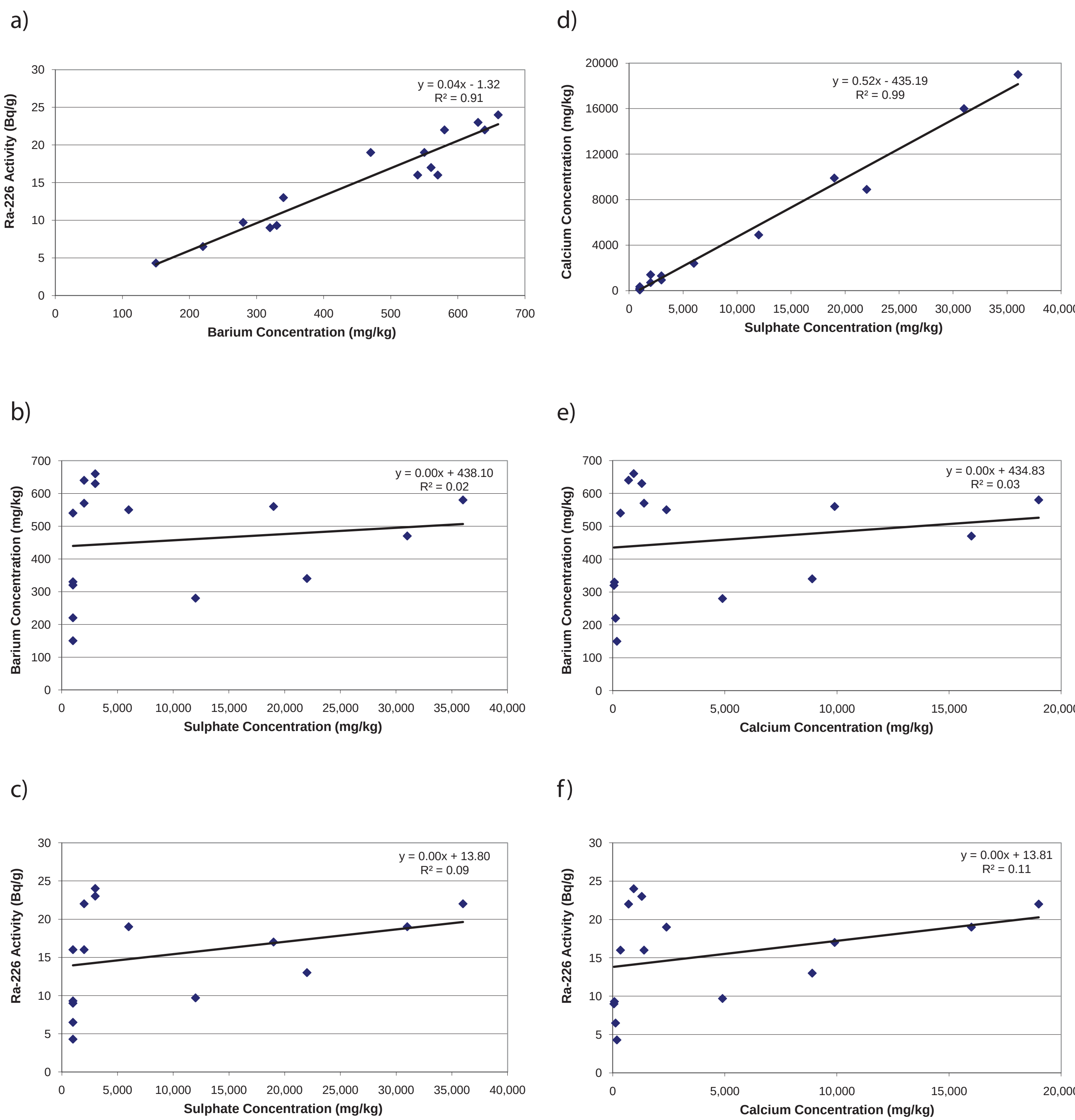
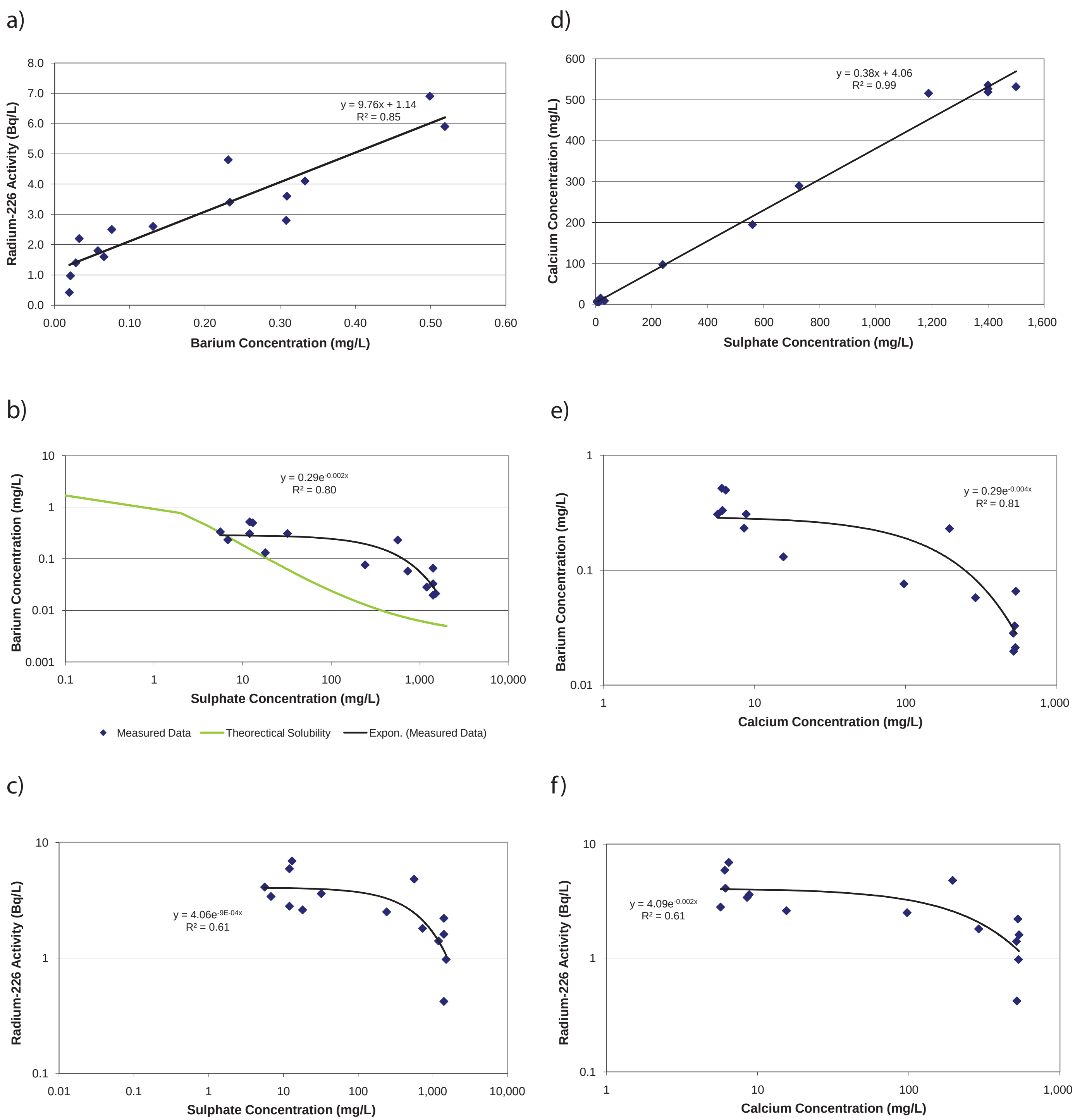
Water-Solids Partitioning Plots for Ra-226 and Barium		
EcoMetrix INCORPORATED	February 2011	**Figure 6.1**



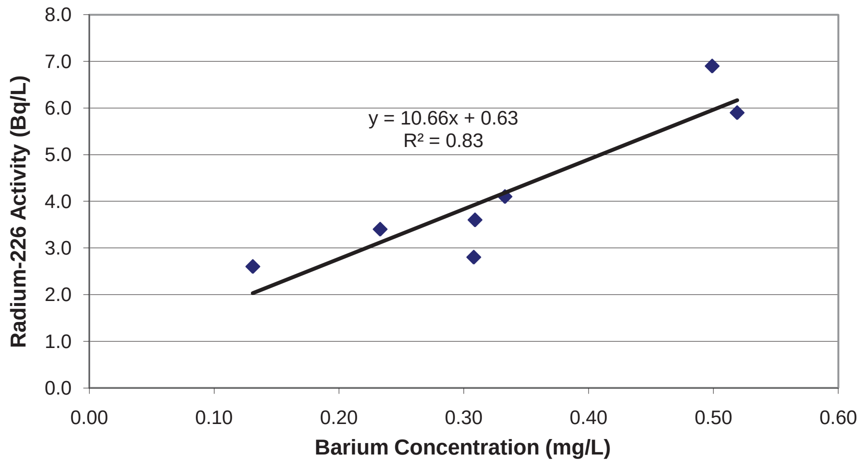
Rio Algom Limited		
Correlation Plots for Selected Constituents in Tailings Solids		
EcoMetrix INCORPORATED	February 2011	**Figure 6.2**

Rio Algom

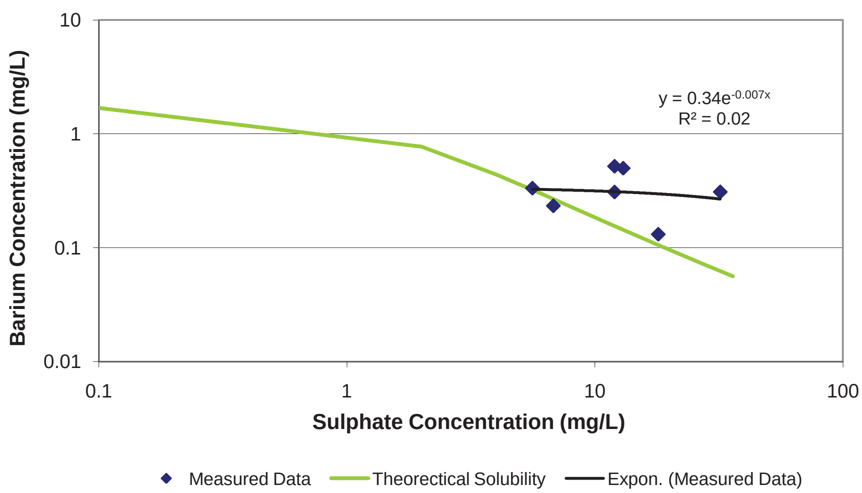


Rio Algom Limited		
Correlation Plots for Selected Constituents in Porewater		
EcoMetrix INCORPORATED	February 2011	Figure 6.3

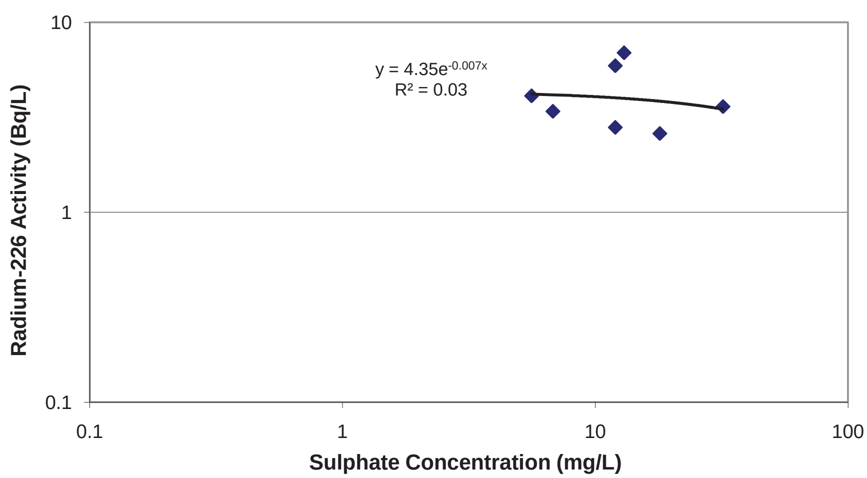
a)



b)



c)



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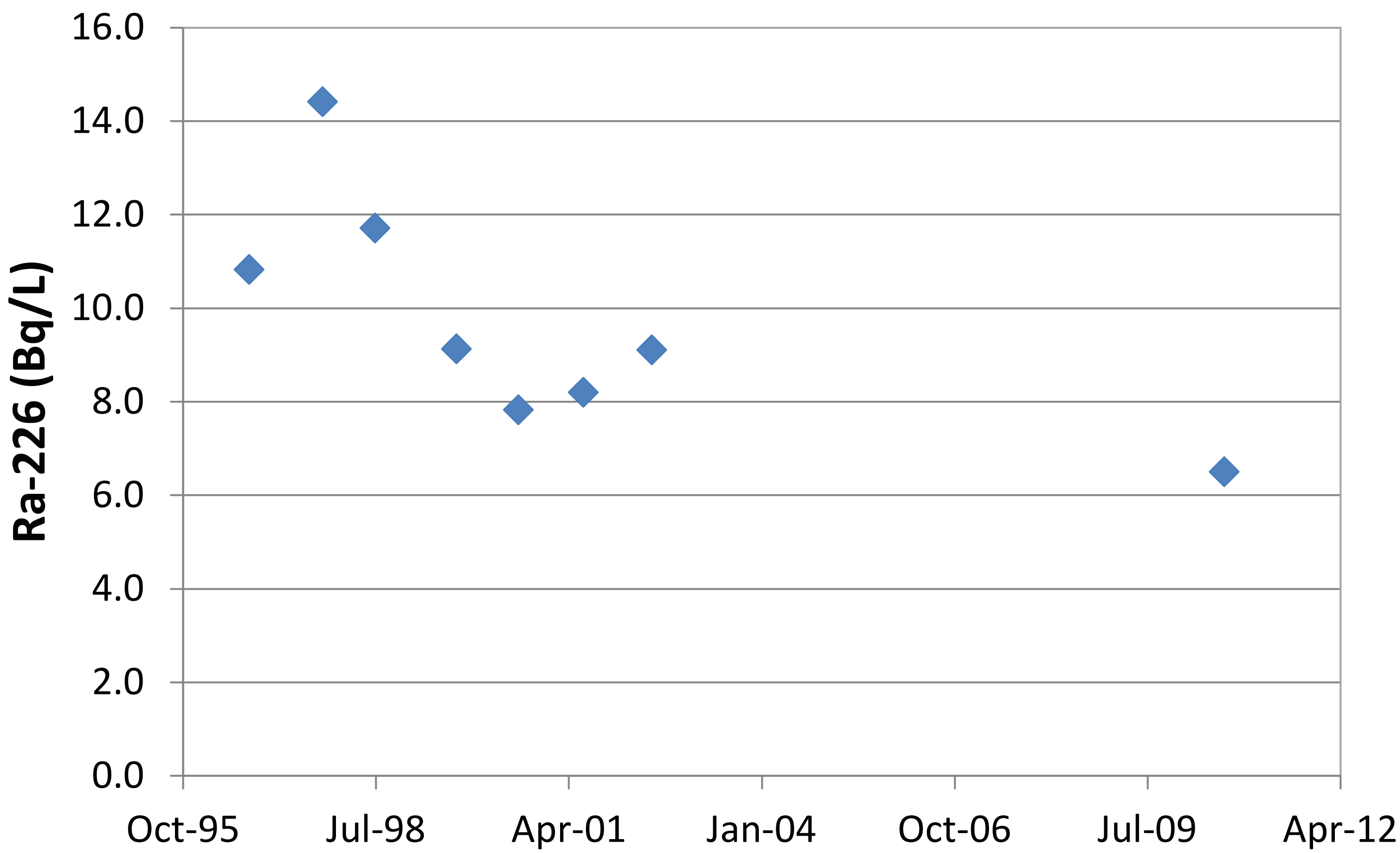
Rio Algom Limited		
Scatter Plots for Ra-226 and Barium, Barium and Sulphate, and Ra-226 and Sulphate in Low Sulphate Tailings Porewater		
EcoMetrix INCORPORATED	February 2011	**Figure 6.4**



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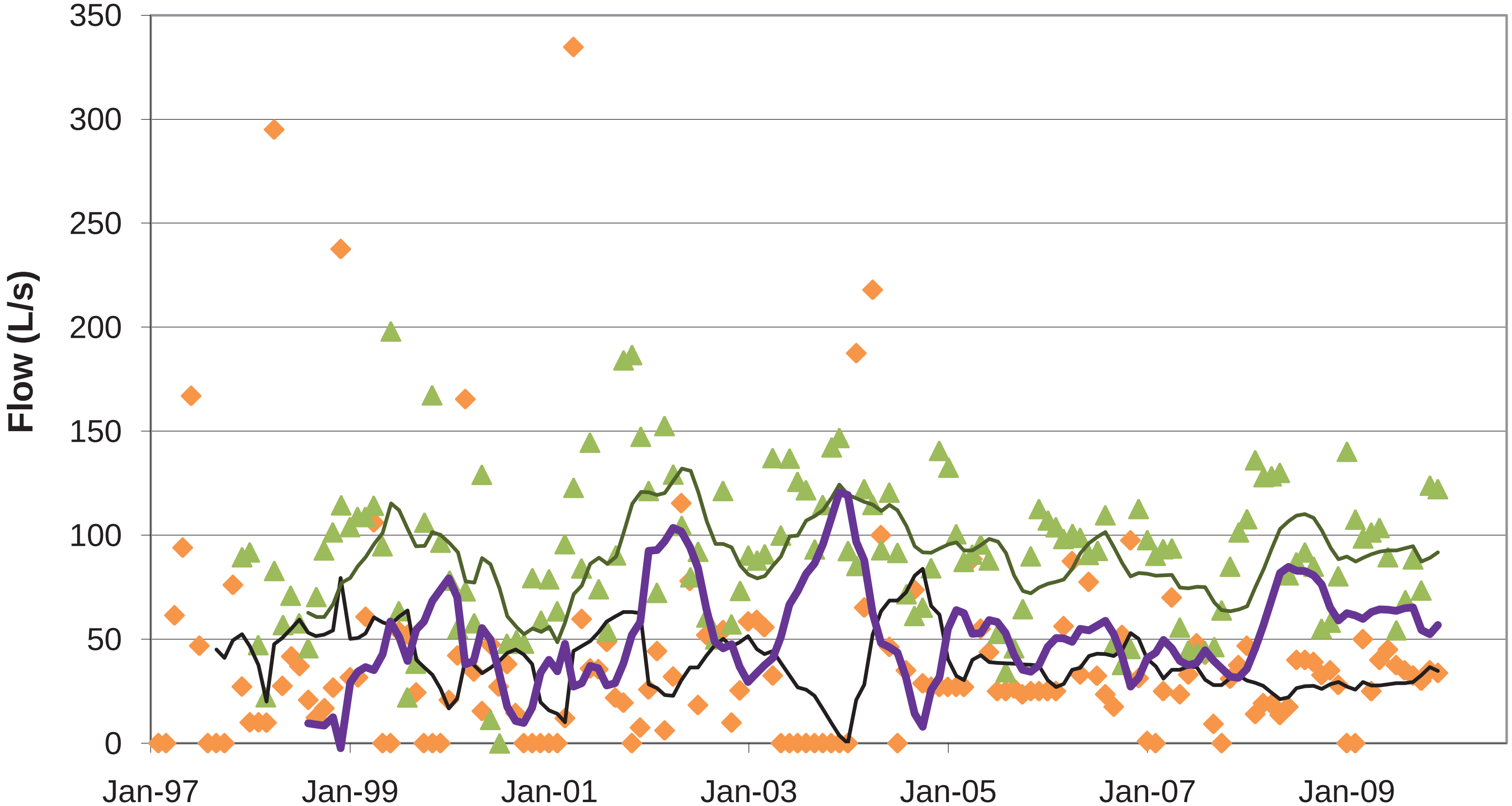
Rio Algom Limited		
Time-Trend Plot for Radium-226 Activities in Porewater in Piezometer DK16-2		
EcoMetrix INCORPORATED	February 2011	**Figure 6.5**



Flow at Q-29
Flow at Q-05
9-Month Moving Average for Flow at Q-29
9-Month Moving Average for Flow at Q-05
9-Month Moving Average for Net Natural Input (Q-05 minus Q-29)

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Monthly Flow Data at the Quirke TMA		
EcoMetrix INCORPORATED	February 2011	**Figure 6.6**

APPENDIX 1

Compilation of Routine Monitoring Data at the Quirke TMA

Table A1.1: Flow Data for Cell 14 Inflow from Gravel Pit Lake Quirke TMA (Q-29)

1997		1998		1999		2000		2001		2002		2003		2004		2005		2006		2007		2008		2009	
Date	Flow	Date	Flow	Date	Flow	Date	Flow	Date	Flow	Date	Flow	Date	Flow	Date	Flow	Date	Flow	Date	Flow	Date	Flow	Date	Flow	Date	Flow
	(L/s)		(L/s)		(L/s)		(L/s)		(L/s)		(L/s)		(L/s)		(L/s)		(L/s)		(L/s)		(L/s)		(L/s)		(L/s)
1-Jan-97	36.0	2-Jan-98	10	4-Jan-99	86	5-Jan-00	15	2-Jan-01	0	1-Jan-02	50	6-Jan-03	60	5-Jan-04	0	4-Jan-05	27	3-Jan-06	25	2-Jan-07	5	2-Jan-08	50	5-Jan-09	0
1-Feb-97	0.0	6-Jan-98	10	5-Jan-99	83	7-Jan-00	20	5-Jan-01	0	4-Jan-02	48	13-Jan-03	60	12-Jan-04	0	10-Jan-05	27	9-Jan-06	25	8-Jan-07	0	7-Jan-08	50	12-Jan-09	0
1-Mar-97	0.0	9-Jan-98	10	8-Jan-99	19	11-Jan-00	20	9-Jan-01	0	8-Jan-02	45	20-Jan-03	57	19-Jan-04	0	17-Jan-05	27	16-Jan-06	25	15-Jan-07	0	14-Jan-08	60	19-Jan-09	0
1-Apr-97	61.5	13-Jan-98	10	12-Jan-99	15.2	14-Jan-00	23	12-Jan-01	0	11-Jan-02	10	27-Jan-03	57	26-Jan-04	0	24-Jan-05	27	23-Jan-06	25	22-Jan-07	0	21-Jan-08	60	26-Jan-09	0
1-May-97	94.0	16-Jan-98	10	15-Jan-99	15.2	18-Jan-00	23	16-Jan-01	0	15-Jan-02	10	3-Feb-03	54	2-Feb-04	300	31-Jan-05	27	30-Jan-06	25	29-Jan-07	0	29-Jan-08	14	2-Feb-09	0
1-Jun-97	167.0	20-Jan-98	10	19-Jan-99	15.2	21-Jan-00	23	19-Jan-01	0	18-Jan-02	18	10-Feb-03	63	9-Feb-04	220	7-Feb-05	27	6-Feb-06	25	5-Feb-07	0	4-Feb-08	14	9-Feb-09	0
1-Jul-97	46.9	23-Jan-98	10	22-Jan-99	15.2	25-Jan-00	21	23-Jan-01	0	22-Jan-02	17	17-Feb-03	60	16-Feb-04	140	14-Feb-05	27	13-Feb-06	25	12-Feb-07	0	11-Feb-08	14	17-Feb-09	0
1-Aug-97	0.0	27-Jan-98	10	26-Jan-99	17.1	28-Jan-00	21	26-Jan-01	0	25-Jan-02	17	24-Feb-03	60	23-Feb-04	90	21-Feb-05	27	20-Feb-06	25	19-Feb-07	0	19-Feb-08	14	23-Feb-09	0
1-Sep-97	0.0	30-Jan-98	10	29-Jan-99	19	1-Feb-00	21.1	30-Jan-01	0	29-Jan-02	17.1	3-Mar-03	60	1-Mar-04	26	28-Feb-05	27	27-Feb-06	25	26-Feb-07	0	25-Feb-08	14	2-Mar-09	0
1-Oct-97	0.0	3-Feb-98	10	2-Feb-99	19	4-Feb-00	21.07	2-Feb-01	0	1-Feb-02	17	10-Mar-03	55	8-Mar-04	70	7-Mar-05	27	6-Mar-06	25	5-Mar-07	0	3-Mar-08	18	9-Mar-09	0
1-Nov-97	76.1	10-Feb-98	10	3-Feb-99	19.1	8-Feb-00	21.07	6-Feb-01	0	5-Feb-02	57	17-Mar-03	48	15-Mar-04	70	14-Mar-05	27	13-Mar-06	25	12-Mar-07	0	10-Mar-08	18	16-Mar-09	50
4-Dec-97	68	13-Feb-98	10	5-Feb-99	19	11-Feb-00	21.07	9-Feb-01	0	8-Feb-02	59	24-Mar-03	45	22-Mar-04	60	21-Mar-05	27	20-Mar-06	25	19-Mar-07	0	17-Mar-08	20	23-Mar-09	100
5-Dec-97	20	17-Feb-98	10	9-Feb-99	19	15-Feb-00	19.03	13-Feb-01	0	12-Feb-02	60	31-Mar-03	75	29-Mar-04	100	28-Mar-05	27	27-Mar-06	150	26-Mar-07	100	24-Mar-08	20	31-Mar-09	100
18-Dec-97	19	25-Feb-98	10	12-Feb-99	19	18-Feb-00	19.03	16-Feb-01	0	15-Feb-02	60	7-Apr-03	90	5-Apr-04	139.8	4-Apr-05	27	3-Apr-06	150	2-Apr-07	100	31-Mar-08	20	6-Apr-09	100
23-Dec-97	19	26-Feb-98	10	16-Feb-99	21.1	22-Feb-00	19.03	20-Feb-01	0	19-Feb-02	63	14-Apr-03	40	12-Apr-04	132	11-Apr-05	27	10-Apr-06	25	9-Apr-07	100	7-Apr-08	20	13-Apr-09	0
30-Dec-97	10	4-Mar-98	9	19-Feb-99	51	25-Feb-00	21.07	23-Feb-01	0	22-Feb-02	21	21-Apr-03	0	19-Apr-04	300	18-Apr-05	150	17-Apr-06	25	16-Apr-07	100	14-Apr-08	20	20-Apr-09	0
		6-Mar-98	10	23-Feb-99	51	29-Feb-00	216.97	27-Feb-01	0	26-Feb-02	17	28-Apr-03	0	26-Apr-04	300	25-Apr-05	150	24-Apr-06	150	23-Apr-07	25	21-Apr-08	20	27-Apr-09	0
		11-Mar-98	10	26-Feb-99	66	3-Mar-00	216.97	2-Mar-01	0	1-Mar-02	17	5-May-03	0	3-May-04	120	2-May-05	100	1-May-06	25	30-Apr-07	25	28-Apr-08	15	4-May-09	0
		18-Mar-98	10	2-Mar-99	66	7-Mar-00	216	6-Mar-01	0	5-Mar-02	19	12-May-03	0	10-May-04	150	9-May-05	100	8-May-06	20	7-May-07	25	5-May-08	15	11-May-09	55
		20-Mar-98	10	5-Mar-99	75.9	10-Mar-00	216.97	9-Mar-01	0	8-Mar-02	19	20-May-03	0	17-May-04	0	16-May-05	25	15-May-06	20	10-May-07	0	12-May-08	15	19-May-09	55
		25-Mar-98	10	9-Mar-99	66	14-Mar-00	216.97	13-Mar-01	0	12-Mar-02	0	26-May-03	0	25-May-04	100	24-May-05	25	23-May-06	20	14-May-07	25	20-May-08	14	25-May-09	50
		1-Apr-98	150	12-Mar-99	66	17-Mar-00	216.97	16-Mar-01	0	15-Mar-02	0	2-Jun-03	0	31-May-04	150	30-May-05	25	29-May-06	80	22-May-07	35	26-May-08	10	1-Jun-09	50
		3-Apr-98	340	16-Mar-99	57	21-Mar-00	216.97	20-Mar-01	0	19-Mar-02	0	9-Jun-03	0	7-Jun-04	75	6-Jun-05	25	5-Jun-06	80	28-May-07	32.38	2-Jun-08	10	8-Jun-09	50
		8-Apr-98	340	19-Mar-99	57	24-Mar-00	69	23-Mar-01	0	22-Mar-02	0	16-Jun-03	0	14-Jun-04	55	13-Jun-05	25	12-Jun-06	80	4-Jun-07	37	9-Jun-08	10	15-Jun-09	50
		10-Apr-98	340	23-Mar-99	54	28-Mar-00	69	27-Mar-01	50	26-Mar-02	0	23-Jun-03	0	21-Jun-04	55	20-Jun-05	100	19-Jun-06	80	11-Jun-07	35	16-Jun-08	25	22-Jun-09	40
		16-Apr-98	340	26-Mar-99	51	31-Mar-00	50	30-Mar-01	58	28-Mar-02	0	1-Jul-03	0	28-Jun-04	0	27-Jun-05	25	26-Jun-06	70	18-Jun-07	30	23-Jun-08	25	29-Jun-09	35
		17-Apr-98	340	30-Mar-99	54	4-Apr-00	45	3-Apr-01	127.5	2-Apr-02	0	7-Jul-03	0	5-Jul-04	0	4-Jul-05	25	4-Jul-06	50	25-Jun-07	30	2-Jul-08	35	6-Jul-09	40
		21-Apr-98	340	1-Apr-99	66.13	7-Apr-00	48	6-Apr-01	300	5-Apr-02	0	14-Jul-03	0	12-Jul-04	0	11-Jul-05	25	10-Jul-06	40	3-Jul-07	30	7-Jul-08	35	13-Jul-09	35
		27-Apr-98	170	6-Apr-99	112	11-Apr-00	96.8	10-Apr-01	300	9-Apr-02	0	21-Jul-03	0	19-Jul-04	0	18-Jul-05	25	17-Jul-06	25	9-Jul-07	35	14-Jul-08	40	20-Jul-09	40
		1-May-98	0	8-Apr-99	127	14-Apr-00	51	13-Apr-01	300	12-Apr-02	0	28-Jul-03	0	26-Jul-04	0	25-Jul-05	25	24-Jul-06	25	16-Jul-07	35	21-Jul-08	45	27-Jul-09	35
		5-May-98	0	9-Apr-99	136	18-Apr-00	0	17-Apr-01	450	16-Apr-02	0	5-Aug-03	0	3-Aug-04	35	2-Aug-05	25	31-Jul-06	22	23-Jul-07	40	28-Jul-08	45	4-Aug-09	35
		7-May-98	0	13-Apr-99	144	25-Apr-00	0	20-Apr-01	450	19-Apr-02	50	11-Aug-03	0	9-Aug-04	35	8-Aug-05	25	8-Aug-06	22	30-Jul-07	100	5-Aug-08	40	10-Aug-09	35
		8-May-98	0	15-Apr-99	139	28-Apr-00	0	24-Apr-01	450	23-Apr-02	50	18-Aug-03	0	16-Aug-04	35	15-Aug-05	25	14-Aug-06	25	7-Aug-07	40	11-Aug-08	40	17-Aug-09	35
		13-May-98	50	19-Apr-99	250	2-May-00	0	27-Apr-01	300	26-Apr-02	95	25-Aug-03	0	23-Aug-04	35	22-Aug-05	25	21-Aug-06	22	13-Aug-07	45	18-Aug-08	40	24-Aug-09	35.0
		15-May-98	50	20-Apr-99	148	5-May-00	0	1-May-01	79.23	30-Apr-02	93	2-Sep-03	0	30-Aug-04	35	29-Aug-05	25	28-Aug-06	25	20-Aug-07	45	25-Aug-08	40	31-Aug-09	35.0
		19-May-98	50	23-Apr-99	45.4	9-May-00	0	4-May-01	79	3-May-02	170	8-Sep-03	0	7-Sep-04	100	6-Sep-05	30	5-Sep-06	25	27-Aug-07	40	2-Sep-08	40	8-Sep-09	35.0
		22-May-98	47	27-Apr-99	0	12-May-00	0	8-May-01	79	7-May-02	170	15-Sep-03	0	13-Sep-04	95	12-Sep-05	25	11-Sep-06	23.19	4-Sep-07	37	8-Sep-08	35	15-Sep-09	35.0
		26-May-98	40	30-Apr-99	0	16-May-00	0	11-May-01	0	10-May-02	93	22-Sep-03	0	20-Sep-04	50	19-Sep-05	25	18-Sep-06	0	10-Sep-07	0	15-Sep-08	45	21-Sep-09	30.0
		29-May-98	38	3-May-99	0	19-May-00	0	15-May-01	0	17-May-02	100	29-Sep-03	0	27-Sep-04	50	26-Sep-05	25	25-Sep-06	22	17-Sep-07	0	22-Sep-08	40	29-Sep-09	30.0
		3-Jun-98	40	4-May-99	0	23-May-00	0	18-May-01	0	21-May-02	100	6-Oct-03	0	4-Oct-04	30	3-Oct-05	25	2-Oct-06	25	24-Sep-07	0	29-Sep-08	35	5-Oct-09	30.0
		5-Jun-98	40	7-May-99	0	26-May-00	82	22-May-01	0	24-May-02	100	14-Oct-03	0	12-Oct-04	30	11-Oct-05	17.1	10-Oct-06	25	1-Oct-07	0	6-Oct-08	0	14-Oct-09	30.0
		9-Jun-98	40	11-May-99	0	30-May-00	56.9	25-May-01	300	28-May-02	100	20-Oct-03	0	18-Oct-04	28	17-Oct-05	25	16-Oct-06	10	9-Oct-07	0	14-Oct-08	48	19-Oct-09	30.0
		12-Jun-98	37	14-May-99	0	2-Jun-00	54	29-May-01	0	31-May-02	90	27-Oct-03	0	25-Oct-04	27	24-Oct-05	25	23-Oct-06	100	15-Oct-07	0	20-Oct-08	48	26-Oct-09	30.0
		16-Jun-98	42.6	18-May-99	0	6-Jun-00	51	1-Jun-01	0	4-Jun-02	54	3-Nov-03	0	1-Nov-04	27	31-Oct-05	25	30-Oct-06	100	22-Oct-07	0	27-Oct-08	35	2-Nov-09	35.0
		19-Jun-98	42.6	21-May-99	0	9-Jun-00	48	5-Jun-01	110	7-Jun-02	50	10-Nov-03	0	8-Nov-04	27	7-Nov-05	25	6-Nov-06	90	29-Oct-07	0	3-Nov-08	35	9-Nov-09	35.0
		23-Jun-98	42.7	26-May-99	0	13-Jun-00	48	8-Jun-01	108	11-Jun-02	51	17-Nov-03	0	15-Nov-04	27	14-Nov-05	25	13-Nov-06	100	5-Nov-07	0	10-Nov-08	35	16-Nov-09	35.0
		26-Jun-98	45	28-May-99	0	16-Jun-00	45.4	12-Jun-01	105	14-Jun-02	51	24-Nov-03	0	22-Nov-04	27	21-Nov-05	25	20-Nov-06	100	12-Nov-07	42	17-Nov-08	35	23-Nov-09	35.0
		30-Jun-98	45.4	1-Jun-99	0	20-Jun-00	45	15-Jun-01	0	18-Jun-02	107	1-Dec-03	0	29-Nov-04	27	28-Nov-05	25	27-Nov-06	100	19-Nov-07	42	24-Nov-08	35	30-Nov-09	35.0
		3-Jul-98	46	4-Jun-99	0	23-Jun-00	40	19-Jun-01	0	21-Jun-02	107	8-Dec-03	0	6-Dec-04	27	5-Dec-05	25	4-Dec-06	100	26-Nov-07	40	1-Dec-08	35	7-Dec-09	35.0
		7-Jul-98	42.7	8-Jun-99	0	27-Jun-00	48	22-Jun-01	0	25-Jun-02	100	15-Dec-03	0	13-Dec-04	27	12-Dec-05	25	11-Dec-06	25	3-Dec-07	35	8-Dec-08	35	14-Dec-09	35.0
		10-Jul-98	42.7	11-Jun-99	0	30-Jun-00	48	26-Jun-01	0	28-Jun-02	104	22-Dec-03	0	20-Dec-04	27	19-Dec-05	25	18-Dec-06	0	10-Dec-07	30	15-Dec-08	35	21-Dec-09	35.0
		14-Jul-98	40	14-Jun-99	0	4-Jul-00	40	29-Jun-01	0	2-Jul-02	0	29-Dec-03	0			26-Dec-05	25	27-Dec-06	0	17-Dec-07	35	22-Dec-08	35	29-Dec-09	30.0
		17-Jul-98	37.4	15-Jun-99	0	7-Jul-00	32.38	3-Jul-01	0	5-Jul-02	0									24-Dec-07	50	29-Dec-08	0		
		21-Jul-98	34.9	18-Jun-99	0	11-Jul-00	27.6	6-Jul-01	0	9-Jul-02	0														
		24-Jul-98	32	22-Jun-99	0	14-Jul-00	0	10-Jul-01	0	12-Jul-02	0														
		28-Jul-98	30	30-Jun-99	0	18-Jul-00	30	13-Jul-01	55	16-Jul-02	0														
		31-Jul-98	27.6	2-Jul-99	0	21-Jul-00	30	17-Jul-01	55	19-Jul-02	0														
		4-Aug-98	23	6-Jul-99	0	25-Jul-00	30	20-Jul-01	55	23-Jul-02	56.9														
		7-Aug-98	25	9-Jul-99	75	28-Jul-00	27.6	24-Jul-01	50	26-Jul-02	54														
		11-Aug-98	23.2	12-Jul-99	72	1-Aug-00	25	27-Jul-01	50	30-Jul-02	54														
		14-Aug-98	21.1	13-Jul-99	72	4-Aug-00	25	31-Jul-01	55	2-Aug-02	54														
		19-Aug-98	19	16-Jul-99	70	8-Aug-00	24	3-Aug-01	0	6-Aug-02	51														
		21-Aug-98	19	20-Jul-99	66	11-Aug-00	23	7-Aug-01	50	9-Aug-02	54														
		25-Aug-98	19	23-Jul-99	63	15-Aug-00	50	10-Aug-01	50	13-Aug-02	54														
		28-Aug-98	17	27-Jul-99	60	18-Aug-00	50	14-Aug-01	63	16-Aug-02	51														
		1-Sep-98	15.2	30-Jul-99	60	23-Aug-00	50	17-Aug-01	50	20-Aug-02	51														
		4-Sep-98	15.2	3-Aug-99	60	25-Aug-00	50	21-Aug-01	55	23-Aug-02	51														
		9-Sep-98	14	9-Aug-99	60	29-Aug-00	45	24-Aug-01	60	27-Aug-02	51														
		11-Sep-98	11	17-Aug-99	54	1-Sep-00	40	28-Aug-01	55	30-Aug-02	51														
		15-Sep-98	11.7	20-Aug-99	50	5-Sep-00	40	31-Aug-01	55	3-Sep-02	51														
		18-Sep-98	11.7	24-Aug-99	50	8-Sep-00	0	4-Sep-01	0	6-Sep-02	54														
		22-Sep-98	10	27-Aug-99	48	12-Sep-00	0	7-Sep-01	0	10-Sep-02	54														
		25-Sep-98	10	31-Aug-99	43	15-Sep-00	0	11-Sep-01	0	13-Sep-02	54														
		29-Sep-98	11.7	3-Sep-99	40	19-Sep-00	0	14-Sep-01	0	17-Sep-02	50														
		2-Oct-98	10	7-Sep-99	37	22-Sep-00	0	18-Sep-01	0	20-Sep-02	50														
		6-Oct-98	10	10-Sep-99	32	26-Sep-00	0	21-Sep-01	0	24-Sep-02	54														
		9-Oct-98	17.1	14-Sep-99	31	29-Sep-00	50	25-Sep-01	0	27-Sep-02	50														
		13-Oct-98	19	17-Sep-99	30	3-Oct-00	0	28-Sep-01	175	1-Oct-02	57														
		16-Oct-98	19	21-Sep-99	25	6-Oct-00	0	2-Oct-01	0	4-Oct-02	57														
		20-Oct-98	19	24-Sep-99	0	10-Oct-00	0	5-Oct-01	0	8-Oct-02	69														
		23-Oct-98	19	28-Sep-99	0	13-Oct-00	0	9-Oct-01	0	11-Oct-02	54														
		27-Oct-98	19	1-Oct-99	0	17-Oct-00	0	12-Oct-01	0	15-Oct-02	54														
		30-Oct-98	19	5-Oct-99	0	20-Oct-00	0	16-Oct-01	175	18-Oct-02	51														
		3-Nov-98	19	8-Oct-99	0	24-Oct-00	0	19-Oct-01	0	22-Oct-02	51														
		11-Nov-98	21.1	12-Oct-99	0	27-Oct-00	0	23-Oct-01	0	25-Oct-02	51														
		12-Nov-98	23	15-Oct-99	0	31-Oct-00	0	26-Oct-01	0	29-Oct-02	45														
		13-Nov-98	25.4	19-Oct-99	0	3-Nov-00	0	30-Oct-01	0	1-Nov-02	10														
		17-Nov-98	30	22-Oct-99	0	7-Nov-00	0	2-Nov-01	0	5-Nov-02	9														
		20-Nov-98	30	26-Oct-99	0	10-Nov-00	0	6-Nov-01	0	8-Nov-02	10														
		24-Nov-98	32.4	29-Oct-99	0	14-Nov-00	0	9-Nov-01	0	12-Nov-02	10														
		27-Nov-98	32.4	2-Nov-99	0	17-Nov-00	0	13-Nov-01	0	15-Nov-02	10														
		1-Dec-98	37.4	5-Nov-99	0	21-Nov-00	0	16-Nov-01	0	19-Nov-02	10														
		4-Dec-98	100	9-Nov-99	0	24-Nov-00	0	20-Nov-01	0	22-Nov-02	10														
		8-Dec-98	500	12-Nov-99	0	28-Nov-00	0	23-Nov-01	0	26-Nov-02	10														
		11-Dec-98	500	16-Nov-99	0	1-Dec-00	0	27-Nov-01	0	29-Nov-02	10														
		15-Dec-98	500	19-Nov-99	0	5-Dec-00	0	30-Nov-01	0	3-Dec-02	10														
		18-Dec-98	160	23-Nov-99	0	8-Dec-00	0	4-Dec-01	0	6-Dec-02	10														
		22-Dec-98	135.7	26-Nov-99	0	12-Dec-00	0	7-Dec-01	0	10-Dec-02	10														
		29-Dec-98	108	30-Nov-99	0	15-Dec-00	0	11-Dec-01	0	13-Dec-02	10														
		31-Dec-98	97	3-Dec-99	0	19-Dec-00	0	14-Dec-01	0	17-Dec-02	10														
				7-Dec-99	0	22-Dec-00	0	18-Dec-01	0	20-Dec-02	10														
				10-Dec-99	0	27-Dec-00	0	21-Dec-01	20	24-Dec-02	56														
				14-Dec-99	0	29-Dec-00	0	25-Dec-01	20	27-Dec-02	56														
				17-Dec-99	0			28-Dec-01	20	31-Dec-02	56														
				21-Dec-99	0																				
				22-Dec-99	0																				
				24-Dec-99	0																				
				28-Dec-99	0																				
				31-Dec-99	0																				

Table A1.2: Flow Data for Cell 18 Inflow to the Effluent Treatment Plant (Q-05)

1997		1998		1999		2000		2001		2002		2003		2004		2005		2006		2007		2008		2009	
Date	Flow	Date	Flow	Date	Flow	Date	Flow	Date	Flow	Date	Flow	Date	Flow	Date	Flow	Date	Flow	Date	Flow	Date	Flow	Date	Flow	Date	Flow
	(L/s)		(L/s)		(L/s)		(L/s)		(L/s)		(L/s)		(L/s)		(L/s)		(L/s)		(L/s)		(L/s)		(L/s)		(L/s)
5-Dec-97	78	2-Jan-98	96	4-Jan-99	65	4-Jan-00	0	2-Jan-01	96	2-Jan-02	159	2-Jan-03	93	2-Jan-04	140	4-Jan-05	138	3-Jan-06	110	2-Jan-07	153	2-Jan-08	102	2-Jan-09	127
8-Dec-97	78	5-Jan-98	96	7-Jan-99	94	6-Jan-00	170	4-Jan-01	91	4-Jan-02	156	3-Jan-03	92	5-Jan-04	140	5-Jan-05	136	4-Jan-06	110	3-Jan-07	155	3-Jan-08	102	5-Jan-09	127
11-Dec-97	78	6-Jan-98	96	11-Jan-99	92	10-Jan-00	166	8-Jan-01	94	8-Jan-02	120	6-Jan-03	92	6-Jan-04	88	6-Jan-05	138	5-Jan-06	110	4-Jan-07	94	4-Jan-08	100	6-Jan-09	129
15-Dec-97	78	8-Jan-98	96	14-Jan-99	90	13-Jan-00	63	11-Jan-01	70	11-Jan-02	112	7-Jan-03	93	7-Jan-04	88	7-Jan-05	138	6-Jan-06	110	5-Jan-07	94	7-Jan-08	102	7-Jan-09	131
18-Dec-97	105	12-Jan-98	96	18-Jan-99	80	17-Jan-00	63	15-Jan-01	74	15-Jan-02	110	8-Jan-03	94	8-Jan-04	88	10-Jan-05	136	9-Jan-06	108	8-Jan-07	94	8-Jan-08	102	8-Jan-09	131
22-Dec-97	105	13-Jan-98	96	21-Jan-99	137	20-Jan-00	63	19-Jan-01	75	18-Jan-02	110	9-Jan-03	94	9-Jan-04	88	11-Jan-05	136	10-Jan-06	108	9-Jan-07	94	9-Jan-08	103	9-Jan-09	131
27-Dec-97	96	15-Jan-98	96	25-Jan-99	137	24-Jan-00	63	22-Jan-01	70	22-Jan-02	108	10-Jan-03	94	12-Jan-04	88	12-Jan-05	136	11-Jan-06	108	10-Jan-07	91	10-Jan-08	103	12-Jan-09	129
29-Dec-97	98	19-Jan-98	84	28-Jan-99	137	27-Jan-00	60	25-Jan-01	61	25-Jan-02	108	13-Jan-03	94	13-Jan-04	88	13-Jan-05	134	12-Jan-06	108	11-Jan-07	91	11-Jan-08	102	13-Jan-09	125
		22-Jan-98	86	1-Feb-99	140	31-Jan-00	56	29-Jan-01	79	29-Jan-02	109	14-Jan-03	90	14-Jan-04	88	14-Jan-05	134	13-Jan-06	108	12-Jan-07	91	14-Jan-08	103	14-Jan-09	125
		26-Jan-98	86	4-Feb-99	137	3-Feb-00	53	1-Feb-01	62	1-Feb-02	84	15-Jan-03	88	15-Jan-04	90	17-Jan-05	131	16-Jan-06	108	15-Jan-07	91	15-Jan-08	105	15-Jan-09	131
		27-Jan-98	87	8-Feb-99	135	7-Feb-00	56	5-Feb-01	64	5-Feb-02	65	16-Jan-03	90	16-Jan-04	90	18-Jan-05	131	17-Jan-06	108	16-Jan-07	94	16-Jan-08	105	16-Jan-09	129
		29-Jan-98	87	11-Feb-99	73	10-Feb-00	56	8-Feb-01	75	8-Feb-02	65	17-Jan-03	94	19-Jan-04	86	19-Jan-05	131	18-Jan-06	105	17-Jan-07	91	17-Jan-08	105	19-Jan-09	129
		2-Feb-98	87	15-Feb-99	73	14-Feb-00	55	12-Feb-01	67	12-Feb-02	65	20-Jan-03	92	20-Jan-04	88	20-Jan-05	131	19-Jan-06	107	18-Jan-07	91	18-Jan-08	105	20-Jan-09	150
		5-Feb-98	87	18-Feb-99	100	17-Feb-00	54	15-Feb-01	56	15-Feb-02	66	21-Jan-03	88	21-Jan-04	88	21-Jan-05	132	20-Jan-06	105	19-Jan-07	94	21-Jan-08	102	21-Jan-09	159
		9-Feb-98	62	22-Feb-99	105	21-Feb-00	52	19-Feb-01	72	19-Feb-02	67	22-Jan-03	88	22-Jan-04	90	24-Jan-05	128	23-Jan-06	105	22-Jan-07	91	22-Jan-08	105	22-Jan-09	161
		12-Feb-98	38	25-Feb-99	108	24-Feb-00	61	22-Feb-01	62	22-Feb-02	82	23-Jan-03	88	23-Jan-04	88	25-Jan-05	128	24-Jan-06	105	23-Jan-07	94	23-Jan-08	105	23-Jan-09	157
		16-Feb-98	29	1-Mar-99	110	28-Feb-00	54	26-Feb-01	50	26-Feb-02	85	24-Jan-03	82	26-Jan-04	88	26-Jan-05	131	25-Jan-06	105	24-Jan-07	91	24-Jan-08	105	26-Jan-09	155
		19-Feb-98	25	4-Mar-99	110	2-Mar-00	51	1-Mar-01	70	1-Mar-02	84	27-Jan-03	88	27-Jan-04	84	27-Jan-05	128	26-Jan-06	105	25-Jan-07	91	25-Jan-08	105	27-Jan-09	155
		23-Feb-98	25	8-Mar-99	110	6-Mar-00	51	5-Mar-01	74	5-Mar-02	86	28-Jan-03	88	28-Jan-04	86	28-Jan-05	126	27-Jan-06	107	26-Jan-07	91	28-Jan-08	105	28-Jan-09	153
		26-Feb-98	25	11-Mar-99	110	9-Mar-00	48	8-Mar-01	99	8-Mar-02	119	29-Jan-03	87	29-Jan-04	84	31-Jan-05	128	30-Jan-06	105	29-Jan-07	89	29-Jan-08	135	29-Jan-09	155
		2-Mar-98	25	15-Mar-99	105	13-Mar-00	46	12-Mar-01	100	13-Mar-02	180	30-Jan-03	88	30-Jan-04	84	1-Feb-05	128	31-Jan-06	105	30-Jan-07	94	30-Jan-08	135	30-Jan-09	155
		5-Mar-98	25	18-Mar-99	105	16-Mar-00	111	15-Mar-01	106	15-Mar-02	185	31-Jan-03	90	2-Feb-04	86	2-Feb-05	126	1-Feb-06	105	31-Jan-07	91	31-Jan-08	135	2-Feb-09	149
		9-Mar-98	25	22-Mar-99	110	20-Mar-00	120	19-Mar-01	111	19-Mar-02	185	3-Feb-03	88	3-Feb-04	86	3-Feb-05	126	2-Feb-06	105	1-Feb-07	91	1-Feb-08	137	3-Feb-09	148
		12-Mar-98	25	25-Mar-99	110	23-Mar-00	111	22-Mar-01	99	22-Mar-02	180	4-Feb-03	90	4-Feb-04	85	4-Feb-05	128	3-Feb-06	105	2-Feb-07	91	4-Feb-08	139	4-Feb-09	142
		16-Mar-98	25	29-Mar-99	110	27-Mar-00	0	26-Mar-01	90	26-Mar-02	179	5-Feb-03	90	5-Feb-04	85	7-Feb-05	128	6-Feb-06	105	5-Feb-07	86	5-Feb-08	139	5-Feb-09	95
		19-Mar-98	25	1-Apr-99	112	31-Mar-00	120	29-Mar-01	113	28-Mar-02	175	6-Feb-03	88	6-Feb-04	85	8-Feb-05	124	7-Feb-06	105	6-Feb-07	86	6-Feb-08	139	6-Feb-09	99
		23-Mar-98	25	5-Apr-99	115	3-Apr-00	220	2-Apr-01	114	2-Apr-02	164	7-Feb-03	86	9-Feb-04	85	9-Feb-05	124	8-Feb-06	105	7-Feb-07	86	7-Feb-08	139	9-Feb-09	102
		24-Mar-98	20	8-Apr-99	117	6-Apr-00	110	5-Apr-01	116	5-Apr-02	94	10-Feb-03	88	10-Feb-04	85	10-Feb-05	123	9-Feb-06	105	8-Feb-07	91	8-Feb-08	139	10-Feb-09	104
		25-Mar-98	20	12-Apr-99	115	10-Apr-00	106	9-Apr-01	114	9-Apr-02	95	11-Feb-03	90	11-Feb-04	86	11-Feb-05	125	10-Feb-06	105	9-Feb-07	89	11-Feb-08	139	11-Feb-09	102
		26-Mar-98	20	15-Apr-99	117	13-Apr-00	0	12-Apr-01	114	12-Apr-02	97	12-Feb-03	87	12-Feb-04	86	14-Feb-05	121	13-Feb-06	105	12-Feb-07	86	12-Feb-08	132	12-Feb-09	102
		27-Mar-98	0	19-Apr-99	117	17-Apr-00	0	17-Apr-01	118	16-Apr-02	150	13-Feb-03	89	13-Feb-04	86	15-Feb-05	123	14-Feb-06	103	13-Feb-07	89	13-Feb-08	136	13-Feb-09	102
		28-Mar-98	23	22-Apr-99	120	20-Apr-00	0	20-Apr-01	161	19-Apr-02	203	14-Feb-03	87	16-Feb-04	85	16-Feb-05	65	15-Feb-06	103	14-Feb-07	86	14-Feb-08	137	17-Feb-09	102
		29-Mar-98	25	26-Apr-99	117	24-Apr-00	26	23-Apr-01	166	23-Apr-02	150	17-Feb-03	88	17-Feb-04	85	17-Feb-05	70	16-Feb-06	103	15-Feb-07	86	15-Feb-08	137	18-Feb-09	102
		30-Mar-98	25	29-Apr-99	98	27-Apr-00	0	26-Apr-01	80	26-Apr-02	105	18-Feb-03	85	18-Feb-04	85	18-Feb-05	72	17-Feb-06	103	16-Feb-07	89	19-Feb-08	137	19-Feb-09	102
		31-Mar-98	25	3-May-99	59	1-May-00	6	1-May-01	50	30-Apr-02	105	19-Feb-03	88	19-Feb-04	85	21-Feb-05	72	20-Feb-06	103	19-Feb-07	91	20-Feb-08	135	20-Feb-09	99
		2-Apr-98	61	6-May-99	49	4-May-00	6	4-May-01	60	3-May-02	103	20-Feb-03	88	20-Feb-04	85	22-Feb-05	72	21-Feb-06	103	20-Feb-07	91	21-Feb-08	137	23-Feb-09	97
		3-Apr-98	155	10-May-99	51	8-May-00	106	8-May-01	60	7-May-02	104	21-Feb-03	88	23-Feb-04	85	23-Feb-05	72	22-Feb-06	103	21-Feb-07	94	22-Feb-08	134	24-Feb-09	98
		6-Apr-98	102	13-May-99	82	11-May-00	106	11-May-01	60	10-May-02	104	24-Feb-03	88	24-Feb-04	85	24-Feb-05	70	23-Feb-06	103	22-Feb-07	94	25-Feb-08	134	25-Feb-09	99
		9-Apr-98	95	17-May-99	83	15-May-00	99	15-May-01	65	14-May-02	107	25-Feb-03	86	25-Feb-04	86	25-Feb-05	70	24-Feb-06	103	23-Feb-07	96	26-Feb-08	134	26-Feb-09	100
		13-Apr-98	77	20-May-99	102	18-May-00	216	18-May-01	75	17-May-02	106	26-Feb-03	88	26-Feb-04	85	28-Feb-05	72	27-Feb-06	103	26-Feb-07	94	27-Feb-08	134	27-Feb-09	100
		16-Apr-98	64	24-May-99	102	23-May-00	215	22-May-01	68	21-May-02	104	27-Feb-03	88	27-Feb-04	85	1-Mar-05	72	28-Feb-06	103	27-Feb-07	94	28-Feb-08	132	2-Mar-09	102
		20-Apr-98	89	27-May-99	125	26-May-00	208	25-May-01	99	24-May-02	105	28-Feb-03	88	1-Mar-04	85	2-Mar-05	72	1-Mar-06	103	28-Feb-07	94	29-Feb-08	132	3-Mar-09	100
		23-Apr-98	89	31-May-99	200	29-May-00	200	29-May-01	220	28-May-02	104	3-Mar-03	88	2-Mar-04	85	3-Mar-05	72	2-Mar-06	103	1-Mar-07	94	3-Mar-08	132	4-Mar-09	99
		27-Apr-98	63	3-Jun-99	223	1-Jun-00	25	1-Jun-01	232	31-May-02	104	4-Mar-03	85	3-Mar-04	85	4-Mar-05	89	3-Mar-06	100	2-Mar-07	93	4-Mar-08	132	5-Mar-09	99
		30-Apr-98	34	7-Jun-99	221	5-Jun-00	0	5-Jun-01	202	4-Jun-02	70	5-Mar-03	86	4-Mar-04	85	7-Mar-05	90	6-Mar-06	98	5-Mar-07	91	5-Mar-08	132	6-Mar-09	99
		4-May-98	34	10-Jun-99	211	8-Jun-00	0	8-Jun-01	197	7-Jun-02	72	6-Mar-03	86	5-Mar-04	85	8-Mar-05	90	7-Mar-06	98	6-Mar-07	94	6-Mar-08	132	9-Mar-09	97
		7-May-98	24	14-Jun-99	206	12-Jun-00	25	12-Jun-01	194	11-Jun-02	75	7-Mar-03	86	8-Mar-04	85	9-Mar-05	90	8-Mar-06	98	7-Mar-07	93	7-Mar-08	132	10-Mar-09	99
		11-May-98	70	17-Jun-99	122	15-Jun-00	0	15-Jun-01	113	14-Jun-02	75	10-Mar-03	86	9-Mar-04	85	10-Mar-05	90	9-Mar-06	98	8-Mar-07	93	10-Mar-08	129	11-Mar-09	99
		14-May-98	106.5	21-Jun-99	120	20-Jun-00	25	19-Jun-01	102	18-Jun-02	77	11-Mar-03	86	10-Mar-04	130	11-Mar-05	90	10-Mar-06	98	9-Mar-07	93	11-Mar-08	130	12-Mar-09	100
		19-May-98	80	24-Jun-99	250	22-Jun-00	0	22-Jun-01	96	21-Jun-02	76	12-Mar-03	86	11-Mar-04	128	14-Mar-05	90	13-Mar-06	98	12-Mar-07	93	12-Mar-08	129	13-Mar-09	100
		22-May-98	63.2	28-Jun-99	231	26-Jun-00	0	26-Jun-01	80	25-Jun-02	85	13-Mar-03	88	12-Mar-04	128	15-Mar-05	90	14-Mar-06	98	13-Mar-07	94	13-Mar-08	129	16-Mar-09	100
		25-May-98	39	2-Jul-99	44	29-Jun-00	27	29-Jun-01	85	28-Jun-02	109	14-Mar-03	86	15-Mar-04	125	16-Mar-05	90	15-Mar-06	98	14-Mar-07	94	14-Mar-08	130	17-Mar-09	100
		28-May-98	38.4	5-Jul-99	42	5-Jul-00	0	3-Jul-01	80	2-Jul-02	110	17-Mar-03	88	16-Mar-04	126	17-Mar-05	88	16-Mar-06	98	15-Mar-07	94	17-Mar-08	129	18-Mar-09	97
		1-Jun-98	39	8-Jul-99	46	7-Jul-00	0	6-Jul-01	80	5-Jul-02	108	18-Mar-03	88	17-Mar-04	126	18-Mar-05	89	17-Mar-06	98	16-Mar-07	94	18-Mar-08	127	19-Mar-09	99
		4-Jun-98	64	12-Jul-99	73	11-Jul-00	0	10-Jul-01	57	9-Jul-02	107	19-Mar-03	88	18-Mar-04	125	21-Mar-05	90	20-Mar-06	98	19-Mar-07	91	19-Mar-08	127	20-Mar-09	99
		8-Jun-98	57	15-Jul-99	73	14-Jul-00	0	13-Jul-01	58	12-Jul-02	108	20-Mar-03	88	19-Mar-04	125	22-Mar-05	89	21-Mar-06	98	20-Mar-07	91	20-Mar-08	125	23-Mar-09	97
		11-Jun-98	63	19-Jul-99	71	18-Jul-00	0	17-Jul-01	92	16-Jul-02	107	21-Mar-03	88	22-Mar-04	125	23-Mar-05	90	22-Mar-06	96	21-Mar-07	94	24-Mar-08	123	24-Mar-09	97
		15-Jun-98	80	22-Jul-99	73	21-Jul-00	0	20-Jul-01	154	19-Jul-02	107	24-Mar-03	88	23-Mar-04	126	24-Mar-05	88	23-Mar-06	96	22-Mar-07	94	25-Mar-08	125	25-Mar-09	97
		18-Jun-98	79	26-Jul-99	75	25-Jul-00	0	24-Jul-01	48	23-Jul-02	60	25-Mar-03	90	24-Mar-04	126	28-Mar-05	90	24-Mar-06	98	23-Mar-07	94	26-Mar-08	125	26-Mar-09	96
		22-Jun-98	79	29-Jul-99	75	28-Jul-00	0	27-Jul-01	48	26-Jul-02	62	26-Mar-03	90	25-Mar-04	126	29-Mar-05	90	27-Mar-06	98	26-Mar-07	94	27-Mar-08	125	27-Mar-09	96
		25-Jun-98	89	2-Aug-99	0	31-Jul-00	0	31-Jul-01	50	30-Jul-02	60	27-Mar-03	92	26-Mar-04	175	30-Mar-05	90	28-Mar-06	98	27-Mar-07	94	28-Mar-08	125	30-Mar-09	98
		29-Jun-98	89	6-Aug-99	0	1-Aug-00	23	3-Aug-01	50	2-Aug-02	67	28-Mar-03	90	29-Mar-04	175	31-Mar-05	90	29-Mar-06	96	28-Mar-07	94	31-Mar-08	122	31-Mar-09	98
		2-Jul-98	89	9-Aug-99	0	3-Aug-00	48	7-Aug-01	52	6-Aug-02	65	31-Mar-03	156	30-Mar-04	175	1-Apr-05	90	30-Mar-06	98	29-Mar-07	94	1-Apr-08	125	1-Apr-09	98
		6-Jul-98	89	12-Aug-99	0	8-Aug-00	50	10-Aug-01	54	9-Aug-02	67	1-Apr-03	163	31-Mar-04	175	4-Apr-05	90	31-Mar-06	98	30-Mar-07	94	2-Apr-08	125	2-Apr-09	97
		9-Jul-98	50.3	16-Aug-99	0	10-Aug-00	58	14-Aug-01	54	13-Aug-02	65	2-Apr-03	163	1-Apr-04	175	5-Apr-05	90	3-Apr-06	98	2-Apr-07	94	3-Apr-08	125	3-Apr-09	99
		13-Jul-98	50.3	19-Aug-99	110	14-Aug-00	57	17-Aug-01	54	16-Aug-02	64	3-Apr-03	161	2-Apr-04	175	6-Apr-05	90	4-Apr-06	98	3-Apr-07	94	4-Apr-08	125	6-Apr-09	100
		16-Jul-98	50.3	23-Aug-99	26	17-Aug-00	50	21-Aug-01	54	20-Aug-02	65	4-Apr-03	162	5-Apr-04	170	7-Apr-05	90	5-Apr-06	100	4-Apr-07	93	7-Apr-08	122	7-Apr-09	100
		20-Jul-98	50.3	26-Aug-99	29	21-Aug-00	48	24-Aug-01	54	23-Aug-02	52	7-Apr-03	161	6-Apr-04	168	8-Apr-05	90	6-Apr-06	100	5-Apr-07	94	8-Apr-08	122	8-Apr-09	100
		23-Jul-98	50.3	30-Aug-99	34	24-Aug-00	50	28-Aug-01	57	27-Aug-02	50	8-Apr-03	158	7-Apr-04	126	11-Apr-05	90	7-Apr-06	100	6-Apr-07	93	9-Apr-08	127	9-Apr-09	100
		27-Jul-98	45	2-Sep-99	34	28-Aug-00	50	31-Aug-01	55	30-Aug-02	50	9-Apr-03	158	8-Apr-04	126	12-Apr-05	90	10-Apr-06	100	9-Apr-07	91	10-Apr-08	125	13-Apr-09	97
		30-Jul-98	45	7-Sep-99	32	31-Aug-00	45	4-Sep-01	55	3-Sep-02	52	10-Apr-03	158	12-Apr-04	124	13-Apr-05	91	11-Apr-06	100	10-Apr-07	91	11-Apr-08	127	14-Apr-09	100
		4-Aug-98	25	9-Sep-99	34	5-Sep-00	47	7-Sep-01	55	6-Sep-02	52	11-Apr-03	158	13-Apr-04	100	14-Apr-05	91	12-Apr-06	100	11-Apr-07	91	14-Apr-08	127	15-Apr-09	100
		6-Aug-98	25	13-Sep-99	34	7-Sep-00	50	11-Sep-01	58	10-Sep-02	50	14-Apr-03	158	14-Apr-04	98	15-Apr-05	91	13-Apr-06	102	12-Apr-07	91	15-Apr-08	129	16-Apr-09	100
		10-Aug-98	30	16-Sep-99	34	11-Sep-00	50	14-Sep-01	70	13-Sep-02	49	15-Apr-03	156	15-Apr-04	99	18-Apr-05	90	17-Apr-06	102	13-Apr-07	96	16-Apr-08	129	17-Apr-09	100
		13-Aug-98	25	20-Sep-99	34	14-Sep-00	50	18-Sep-01	73	17-Sep-02	49	16-Apr-03	154	16-Apr-04	98	19-Apr-05	92	18-Apr-06	103	16-Apr-07	96	17-Apr-08	129	20-Apr-09	100
		17-Aug-98	25	23-Sep-99	34	18-Sep-00	50	21-Sep-01	100	20-Sep-02	50	17-Apr-03	151	19-Apr-04	98	20-Apr-05	89	19-Apr-06	103	17-Apr-07	96	18-Apr-08	132	21-Apr-09	102
		20-Aug-98	42	27-Sep-99	36	21-Sep-00	50	26-Sep-01	136	24-Sep-02	49	21-Apr-03	102	20-Apr-04	98	21-Apr-05	90	20-Apr-06	103	18-Apr-07	94	21-Apr-08	132	22-Apr-09	102
		24-Aug-98	97	30-Sep-99	73	25-Sep-00	50	28-Sep-01	176	27-Sep-02	49	22-Apr-03	104	21-Apr-04	103	22-Apr-05	90	21-Apr-06	103	19-Apr-07	96	22-Apr-08	132	23-Apr-09	105
		27-Aug-98	101	4-Oct-99	80	28-Sep-00	50	2-Oct-01	139	1-Oct-02	50	23-Apr-03	102	22-Apr-04	100	25-Apr-05	90	24-Apr-06	101	20-Apr-07	94	23-Apr-08	132	24-Apr-09	105
		31-Aug-98	42	7-Oct-99	80	2-Oct-00	47	5-Oct-01	140	4-Oct-02	62	24-Apr-03	105	23-Apr-04	100	26-Apr-05	90	25-Apr-06	100	23-Apr-07	96	24-Apr-08	132	27-Apr-09	105
		3-Sep-98	60	12-Oct-99	80	5-Oct-00	50	9-Oct-01	140	8-Oct-02	143	25-Apr-03	102	26-Apr-04	100	27-Apr-05	94	26-Apr-06	100	24-Apr-07	96	25-Apr-08	132	28-Apr-09	107
		8-Sep-98	78	14-Oct-99	80	10-Oct-00	50	12-Oct-01	138	11-Oct-02	142	28-Apr-03	104	27-Apr-04	100	28-Apr-05	94	27-Apr-06	100	25-Apr-07	96	28-Apr-08	132	29-Apr-09	107
		10-Sep-98	60	18-Oct-99	105	12-Oct-00	50	16-Oct-01	215	15-Oct-02	144	29-Apr-03	100	28-Apr-04	100	29-Apr-05	94	28-Apr-06	100	26-Apr-07	92	29-Apr-08	132	30-Apr-09	105
		14-Sep-98	63	21-Oct-99	127	16-Oct-00	47	19-Oct-01	200	18-Oct-02	142	30-Apr-03	100	29-Apr-04	75	2-May-05	92	1-May-06	100	27-Apr-07	92	30-Apr-08	132	1-May-09	105
		17-Sep-98	65	25-Oct-99	150	19-Oct-00	47	23-Oct-01	185	22-Oct-02	140	1-May-03	100	30-Apr-04	74	3-May-05	122	2-May-06	100	30-Apr-07	92	1-May-08	132	4-May-09	105
		21-Sep-98	61	28-Oct-99	147	23-Oct-00	47	26-Oct-01	250	25-Oct-02	138	2-May-03	100	3-May-04	75	4-May-05	118	3-May-06	97	1-May-07	93	2-May-08	132	5-May-09	107
		24-Sep-98	61	1-Nov-99	142	26-Oct-00	47	30-Oct-01	250	29-Oct-02	131	5-May-03	100	4-May-04	76	5-May-05	118	4-May-06	97	2-May-07	92	5-May-08	132	6-May-09	105
		28-Sep-98	115	4-Nov-99	146	30-Oct-00	47	2-Nov-01	250	1-Nov-02	56	6-May-03	100	5-May-04	75	6-May-05	116	5-May-06	95	3-May-07	92	6-May-08	132	7-May-09	105
		1-Oct-98	116	8-Nov-99	140	2-Nov-00	70	6-Nov-01	240	5-Nov-02	56	7-May-03	102	6-May-04	75	9-May-05	114	8-May-06	100	4-May-07	90	7-May-08	132	8-May-09	105

Table A1.2: Flow Data for Cell 18 Inflow to the Effluent Treatment Plant (Q-05)

1997		1998		1999		2000		2001		2002		2003		2004		2005		2006		2007		2008		2009	
Date	Flow	Date	Flow	Date	Flow	Date	Flow	Date	Flow	Date	Flow	Date	Flow	Date	Flow	Date	Flow	Date	Flow	Date	Flow	Date	Flow	Date	Flow
	(L/s)		(L/s)		(L/s)		(L/s)		(L/s)		(L/s)		(L/s)		(L/s)		(L/s)		(L/s)		(L/s)		(L/s)		(L/s)
		5-Oct-98	62	11-Nov-99	203	6-Nov-00	64	9-Nov-01	235	8-Nov-02	58	8-May-03	100	7-May-04	75	10-May-05	114	9-May-06	95	7-May-07	88	8-May-08	132	11-May-09	105
		8-Oct-98	124	15-Nov-99	190	10-Nov-00	94	13-Nov-01	203	12-Nov-02	57	9-May-03	100	10-May-04	75	11-May-05	117	10-May-06	97	8-May-07	46	9-May-08	132	12-May-09	102
		13-Oct-98	115	18-Nov-99	181	13-Nov-00	100	16-Nov-01	150	15-Nov-02	57	12-May-03	100	11-May-04	75	12-May-05	117	11-May-06	95	9-May-07	44	12-May-08	132	13-May-09	102
		15-Oct-98	70	22-Nov-99	170	16-Nov-00	112	20-Nov-01	150	19-Nov-02	58	13-May-03	100	12-May-04	75	13-May-05	115	12-May-06	97	10-May-07	44	13-May-08	129	14-May-09	100
		19-Oct-98	85	25-Nov-99	167	20-Nov-00	106	23-Nov-01	150	22-Nov-02	58	14-May-03	100	13-May-04	75	16-May-05	110	15-May-06	95	11-May-07	44	14-May-08	132	15-May-09	105
		22-Oct-98	85	29-Nov-99	167	23-Nov-00	59	27-Nov-01	150	26-Nov-02	57	15-May-03	100	14-May-04	75	17-May-05	75	16-May-06	100	14-May-07	47	15-May-08	129	19-May-09	102
		26-Oct-98	88	2-Dec-99	152	27-Nov-00	55	30-Nov-01	152	29-Nov-02	58	16-May-03	100	17-May-04	75	18-May-05	72	17-May-06	100	15-May-07	44	16-May-08	132	20-May-09	102
		29-Oct-98	90	6-Dec-99	159	30-Nov-00	55	4-Dec-01	135	3-Dec-02	58	20-May-03	100	18-May-04	104	19-May-05	72	18-May-06	100	16-May-07	47	20-May-08	129	21-May-09	102
		2-Nov-98	88	9-Dec-99	147	4-Dec-00	55	7-Dec-01	136	6-Dec-02	58	21-May-03	100	19-May-04	104	20-May-05	74	19-May-06	100	17-May-07	44	21-May-08	127	22-May-09	105
		5-Nov-98	80	13-Dec-99	142	7-Dec-00	53	11-Dec-01	140	10-Dec-02	60	22-May-03	100	20-May-04	107	24-May-05	75	23-May-06	100	18-May-07	44	22-May-08	129	25-May-09	105
		9-Nov-98	80	16-Dec-99	142	11-Dec-00	56	14-Dec-01	137	13-Dec-02	63	23-May-03	100	21-May-04	104	25-May-05	75	24-May-06	100	22-May-07	44	23-May-08	129	26-May-09	100
		12-Nov-98	105	20-Dec-99	0	12-Dec-00	56	18-Dec-01	135	17-Dec-02	61	26-May-03	100	25-May-04	107	26-May-05	72	25-May-06	102	23-May-07	46	26-May-08	129	27-May-09	102
		16-Nov-98	112	22-Dec-99	41	14-Dec-00	62	21-Dec-01	165	20-Dec-02	61	27-May-03	100	26-May-04	126	27-May-05	75	26-May-06	100	24-May-07	47	27-May-08	129	28-May-09	102
		19-Nov-98	112	23-Dec-99	58	18-Dec-00	59	25-Dec-01	167	24-Dec-02	92	28-May-03	100	27-May-04	127	30-May-05	76	29-May-06	102	25-May-07	46	28-May-08	127	29-May-09	105
		23-Nov-98	110	29-Dec-99	62	21-Dec-00	92	28-Dec-01	164	27-Dec-02	94	29-May-03	98	28-May-04	127	31-May-05	89	30-May-06	100	28-May-07	47	29-May-08	127	1-Jun-09	102
		26-Nov-98	112	30-Dec-99	62	27-Dec-00	0			30-Dec-02	94	30-May-03	98	31-May-04	125	1-Jun-05	86	31-May-06	102	29-May-07	46	30-May-08	127	2-Jun-09	102
		30-Nov-98	114			28-Dec-00	98			31-Dec-02	92	2-Jun-03	100	1-Jun-04	126	2-Jun-05	86	1-Jun-06	100	30-May-07	46	2-Jun-08	125	3-Jun-09	102
		3-Dec-98	160									3-Jun-03	100	2-Jun-04	124	3-Jun-05	86	2-Jun-06	100	31-May-07	44	3-Jun-08	70	4-Jun-09	102
		7-Dec-98	160									4-Jun-03	100	3-Jun-04	126	6-Jun-05	86	5-Jun-06	100	1-Jun-07	46	4-Jun-08	71	5-Jun-09	102
		10-Dec-98	104									5-Jun-03	100	4-Jun-04	123	7-Jun-05	89	6-Jun-06	100	4-Jun-07	46	5-Jun-08	71	8-Jun-09	100
		14-Dec-98	111									6-Jun-03	100	7-Jun-04	126	8-Jun-05	87	7-Jun-06	100	5-Jun-07	42	6-Jun-08	70	9-Jun-09	102
		17-Dec-98	110									9-Jun-03	100	8-Jun-04	126	9-Jun-05	87	8-Jun-06	100	6-Jun-07	42	9-Jun-08	71	10-Jun-09	100
		21-Dec-98	104									10-Jun-03	100	9-Jun-04	126	10-Jun-05	89	9-Jun-06	99	7-Jun-07	42	10-Jun-08	72	11-Jun-09	100
		24-Dec-98	107									11-Jun-03	172	10-Jun-04	126	13-Jun-05	86	12-Jun-06	100	8-Jun-07	42	11-Jun-08	72	12-Jun-09	100
		29-Dec-98	107									12-Jun-03	200	11-Jun-04	125	14-Jun-05	87	13-Jun-06	100	11-Jun-07	42	12-Jun-08	72	15-Jun-09	100
		31-Dec-98	67									13-Jun-03	200	14-Jun-04	124	15-Jun-05	89	14-Jun-06	100	12-Jun-07	47	13-Jun-08	72	16-Jun-09	100
												16-Jun-03	200	15-Jun-04	126	16-Jun-05	89	15-Jun-06	100	13-Jun-07	44	16-Jun-08	71	17-Jun-09	100
												17-Jun-03	192	16-Jun-04	124	17-Jun-05	87	16-Jun-06	96	14-Jun-07	44	17-Jun-08	85	18-Jun-09	100
												18-Jun-03	150	17-Jun-04	124	20-Jun-05	89	19-Jun-06	97	15-Jun-07	44	18-Jun-08	86	19-Jun-09	100
												19-Jun-03	150	18-Jun-04	126	21-Jun-05	89	20-Jun-06	95	18-Jun-07	44	19-Jun-08	86	22-Jun-09	100
												20-Jun-03	152	21-Jun-04	126	22-Jun-05	89	21-Jun-06	95	19-Jun-07	44	20-Jun-08	86	23-Jun-09	100
												23-Jun-03	122	22-Jun-04	124	23-Jun-05	89	22-Jun-06	95	20-Jun-07	44	23-Jun-08	86	24-Jun-09	50
												24-Jun-03	125	23-Jun-04	126	24-Jun-05	89	23-Jun-06	69	21-Jun-07	47	24-Jun-08	86	25-Jun-09	52
												25-Jun-03	125	24-Jun-04	122	27-Jun-05	89	26-Jun-06	69	22-Jun-07	47	25-Jun-08	88	26-Jun-09	51
												26-Jun-03	125	25-Jun-04	124	28-Jun-05	89	27-Jun-06	70	25-Jun-07	47	26-Jun-08	88	29-Jun-09	52
												27-Jun-03	125	28-Jun-04	122	29-Jun-05	89	28-Jun-06	70	26-Jun-07	47	27-Jun-08	88	30-Jun-09	52
												1-Jul-03	112	29-Jun-04	78	30-Jun-05	89	29-Jun-06	69	27-Jun-07	47	1-Jul-08	88	2-Jul-09	52
												2-Jul-03	112	30-Jun-04	78	4-Jul-05	89	30-Jun-06	69	28-Jun-07	47	2-Jul-08	88	3-Jul-09	52
												3-Jul-03	111	1-Jul-04	78	5-Jul-05	85	4-Jul-06	69	29-Jun-07	42	3-Jul-08	88	6-Jul-09	53
												4-Jul-03	115	5-Jul-04	78	6-Jul-05	85	5-Jul-06	69	3-Jul-07	42	4-Jul-08	88	7-Jul-09	54
												7-Jul-03	112	6-Jul-04	80	7-Jul-05	84	6-Jul-06	69	4-Jul-07	42	7-Jul-08	88	8-Jul-09	54
												8-Jul-03	112	7-Jul-04	80	8-Jul-05	84	7-Jul-06	70	5-Jul-07	42	8-Jul-08	88	9-Jul-09	54
												9-Jul-03	115	8-Jul-04	80	11-Jul-05	84	10-Jul-06	69	6-Jul-07	44	9-Jul-08	88	10-Jul-09	54
												10-Jul-03	111	9-Jul-04	80	12-Jul-05	50	11-Jul-06	69	9-Jul-07	44	10-Jul-08	88	13-Jul-09	54
												11-Jul-03	115	12-Jul-04	80	13-Jul-05	50	12-Jul-06	120	10-Jul-07	44	11-Jul-08	88	14-Jul-09	54
												14-Jul-03	116	13-Jul-04	85	14-Jul-05	36	13-Jul-06	120	11-Jul-07	42	14-Jul-08	88	15-Jul-09	54
												15-Jul-03	116	14-Jul-04	99	15-Jul-05	36	14-Jul-06	120	12-Jul-07	44	15-Jul-08	86	16-Jul-09	53
												16-Jul-03	116	15-Jul-04	96	18-Jul-05	36	17-Jul-06	120	13-Jul-07	44	16-Jul-08	86	17-Jul-09	54
												17-Jul-03	116	16-Jul-04	97	19-Jul-05	36	18-Jul-06	115	16-Jul-07	44	17-Jul-08	86	20-Jul-09	54
												18-Jul-03	115	19-Jul-04	101	20-Jul-05	36	19-Jul-06	115	17-Jul-07	44	18-Jul-08	86	21-Jul-09	56
												21-Jul-03	118	20-Jul-04	99	21-Jul-05	36	20-Jul-06	115	18-Jul-07	44	21-Jul-08	86	22-Jul-09	56
												22-Jul-03	118	21-Jul-04	100	22-Jul-05	36	21-Jul-06	115	19-Jul-07	44	22-Jul-08	86	23-Jul-09	56
												23-Jul-03	122	22-Jul-04	98	25-Jul-05	39	24-Jul-06	110	20-Jul-07	44	23-Jul-08	86	24-Jul-09	56
												24-Jul-03	120	23-Jul-04	99	26-Jul-05	38	25-Jul-06	110	23-Jul-07	44	24-Jul-08	86	27-Jul-09	56
												25-Jul-03	122	26-Jul-04	99	27-Jul-05	38	26-Jul-06	108	24-Jul-07	44	25-Jul-08	88	28-Jul-09	56
												28-Jul-03	167	27-Jul-04	97	28-Jul-05	38	27-Jul-06	110	25-Jul-07	44	28-Jul-08	86	29-Jul-09	54
												29-Jul-03	175	28-Jul-04	99	29-Jul-05	37	28-Jul-06	30	26-Jul-07	44	29-Jul-08	88	30-Jul-09	54
												30-Jul-03	177	29-Jul-04	99	2-Aug-05	36	31-Jul-06	28	27-Jul-07	43	30-Jul-08	86	31-Jul-09	56
												31-Jul-03	179	30-Jul-04	99	3-Aug-05	31	1-Aug-06	27	30-Jul-07	44	31-Jul-08	86	4-Aug-09	56
												1-Aug-03	179	3-Aug-04	99	4-Aug-05	31	3-Aug-06	124	31-Jul-07	44	1-Aug-08	86	5-Aug-09	56
												5-Aug-03	184	4-Aug-04	97	5-Aug-05	31	4-Aug-06	125	1-Aug-07	44	5-Aug-08	86	6-Aug-09	54
												6-Aug-03	180	5-Aug-04	97	8-Aug-05	31	8-Aug-06	120	2-Aug-07	44	6-Aug-08	72	7-Aug-09	54
												7-Aug-03	183	6-Aug-04	97	9-Aug-05	31	9-Aug-06	150	3-Aug-07	44	7-Aug-08	90	10-Aug-09	56
												8-Aug-03	130	9-Aug-04	95	10-Aug-05	31	10-Aug-06	150	7-Aug-07	44	8-Aug-08	92	11-Aug-09	56
												11-Aug-03	130	10-Aug-04	65	11-Aug-05	31	11-Aug-06	143	8-Aug-07	44	11-Aug-08	95	12-Aug-09	75
												12-Aug-03	130	11-Aug-04	63	12-Aug-05	31	14-Aug-06	134	9-Aug-07	46	12-Aug-08	95	13-Aug-09	76
												13-Aug-03	130	12-Aug-04	62	15-Aug-05	33	15-Aug-06	132	10-Aug-07	46	13-Aug-08	97	14-Aug-09	76
												14-Aug-03	132	13-Aug-04	62	16-Aug-05	33	16-Aug-06	147	13-Aug-07	44	14-Aug-08	95	17-Aug-09	75
												15-Aug-03	150	16-Aug-04	62	17-Aug-05	31	17-Aug-06	144	14-Aug-07	44	15-Aug-08	95	18-Aug-09	75
												18-Aug-03	150	17-Aug-04	62	18-Aug-05	33	18-Aug-06	142	15-Aug-07	46	18-Aug-08	95	19-Aug-09	75
												19-Aug-03	90	18-Aug-04	64	19-Aug-05	33	21-Aug-06	130	16-Aug-07	46	19-Aug-08	95	20-Aug-09	75
												20-Aug-03	88	19-Aug-04	64	22-Aug-05	38	22-Aug-06	150	17-Aug-07	44	20-Aug-08	92	21-Aug-09	74
												21-Aug-03	90	20-Aug-04	64	23-Aug-05	38	23-Aug-06	147	20-Aug-07	44	21-Aug-08	95	24-Aug-09	75
												22-Aug-03	89	23-Aug-04	64	24-Aug-05	38	24-Aug-06	140	21-Aug-07	44	22-Aug-08	95	25-Aug-09	75
												25-Aug-03	78	24-Aug-04	65	25-Aug-05	38	25-Aug-06	51	22-Aug-07	44	25-Aug-08	92	26-Aug-09	75
												26-Aug-03	78	25-Aug-04	66	26-Aug-05	38	28-Aug-06	50	23-Aug-07	44	26-Aug-08	90	27-Aug-09	73
												27-Aug-03	80	26-Aug-04	67	29-Aug-05	38	29-Aug-06	35	24-Aug-07	46	27-Aug-08	95	28-Aug-09	73
												28-Aug-03	80	27-Aug-04	67	30-Aug-05	38	30-Aug-06	31	27-Aug-07	46	28-Aug-08	92	31-Aug-09	73
												29-Aug-03	83	30-Aug-04	62	31-Aug-05	40	31-Aug-06	31	28-Aug-07	46	29-Aug-08	92	1-Sep-09	75
												2-Sep-03	80	31-Aug-04	62	1-Sep-05	40	1-Sep-06	45	29-Aug-07	44	2-Sep-08	92	2-Sep-09	75
												3-Sep-03	80	1-Sep-04	64	2-Sep-05	40	5-Sep-06	45	30-Aug-07	42	3-Sep-08	95	3-Sep-09	90
												4-Sep-03	98	2-Sep-04	64	6-Sep-05	40	6-Sep-06	54	31-Aug-07	42	4-Sep-08	90	4-Sep-09	90
												5-Sep-03	100	3-Sep-04	64	7-Sep-05	45	7-Sep-06	54	4-Sep-07	47	5-Sep-08	92	8-Sep-09	90
												8-Sep-03	102	7-Sep-04	65	8-Sep-05	45	8-Sep-06	60	5-Sep-07	47	8-Sep-08	92	9-Sep-09	92
												9-Sep-03	102	8-Sep-04	65	9-Sep-05	45	11-Sep-06	60	6-Sep-07	47	9-Sep-08	89	10-Sep-09	92
												10-Sep-03	102	9-Sep-04	65	12-Sep-05	48	12-Sep-06	58	7-Sep-07	47	10-Sep-08	90	11-Sep-09	92
												11-Sep-03	75	10-Sep-04	66	13-Sep-05	45	13-Sep-06	61	10-Sep-07	42	11-Sep-08	90	14-Sep-09	90
												12-Sep-03	75	13-Sep-04	65	14-Sep-05	45	14-Sep-06	58	11-Sep-07	47	12-Sep-08	90	15-Sep-09	92

Table A1.2: Flow Data for Cell 18 Inflow to the Effluent Treatment Plant (Q-05)

1997		1998		1999		2000		2001		2002		2003		2004		2005		2006		2007		2008		2009	
Date	Flow	Date	Flow	Date	Flow	Date	Flow	Date	Flow	Date	Flow	Date	Flow	Date	Flow	Date	Flow	Date	Flow	Date	Flow	Date	Flow	Date	Flow
	(L/s)		(L/s)		(L/s)		(L/s)		(L/s)		(L/s)		(L/s)		(L/s)		(L/s)		(L/s)		(L/s)		(L/s)		(L/s)
												15-Sep-03	72	14-Sep-04	65	15-Sep-05	45	15-Sep-06	58	12-Sep-07	47	15-Sep-08	97	16-Sep-09	90
												16-Sep-03	76	15-Sep-04	64	16-Sep-05	45	18-Sep-06	40	13-Sep-07	47	16-Sep-08	97	17-Sep-09	92
												17-Sep-03	77	16-Sep-04	64	19-Sep-05	45	19-Sep-06	40	14-Sep-07	47	17-Sep-08	94	18-Sep-09	90
												18-Sep-03	76	17-Sep-04	62	20-Sep-05	45	20-Sep-06	60	17-Sep-07	47	18-Sep-08	92	21-Sep-09	87
												19-Sep-03	75	20-Sep-04	0	21-Sep-05	45	21-Sep-06	60	18-Sep-07	47	19-Sep-08	94	22-Sep-09	89
												22-Sep-03	76	21-Sep-04	62	22-Sep-05	45	22-Sep-06	20	19-Sep-07	45	22-Sep-08	92	23-Sep-09	91
												23-Sep-03	115	22-Sep-04	62	23-Sep-05	43	25-Sep-06	65	20-Sep-07	45	23-Sep-08	67	24-Sep-09	89
												24-Sep-03	116	23-Sep-04	65	26-Sep-05	43	26-Sep-06	26	21-Sep-07	45	24-Sep-08	69	25-Sep-09	88
												25-Sep-03	115	24-Sep-04	65	27-Sep-05	45	27-Sep-06	29	24-Sep-07	45	25-Sep-08	65	28-Sep-09	89
												26-Sep-03	119	27-Sep-04	65	28-Sep-05	45	28-Sep-06	32	25-Sep-07	47	26-Sep-08	67	29-Sep-09	90
												29-Sep-03	115	28-Sep-04	65	29-Sep-05	62	29-Sep-06	31	26-Sep-07	47	29-Sep-08	65	30-Sep-09	85
												30-Sep-03	112	29-Sep-04	65	30-Sep-05	60	2-Oct-06	32	27-Sep-07	47	30-Sep-08	65	1-Oct-09	70
												1-Oct-03	112	30-Sep-04	65	3-Oct-05	62	3-Oct-06	32	28-Sep-07	47	1-Oct-08	55	2-Oct-09	70
												2-Oct-03	110	1-Oct-04	65	4-Oct-05	64	4-Oct-06	32	1-Oct-07	42	2-Oct-08	55	5-Oct-09	73
												3-Oct-03	150	4-Oct-04	65	5-Oct-05	64	5-Oct-06	32	2-Oct-07	42	3-Oct-08	53	6-Oct-09	70
												6-Oct-03	147	5-Oct-04	65	6-Oct-05	64	6-Oct-06	32	3-Oct-07	42	6-Oct-08	53	7-Oct-09	74
												7-Oct-03	145	6-Oct-04	65	7-Oct-05	65	10-Oct-06	36	4-Oct-07	42	7-Oct-08	53	8-Oct-09	73
												8-Oct-03	143	7-Oct-04	65	11-Oct-05	62	11-Oct-06	37	5-Oct-07	42	8-Oct-08	55	9-Oct-09	70
												9-Oct-03	144	8-Oct-04	65	12-Oct-05	66	12-Oct-06	35	9-Oct-07	45	9-Oct-08	55	14-Oct-09	74
												10-Oct-03	144	12-Oct-04	65	13-Oct-05	64	13-Oct-06	38	10-Oct-07	46	10-Oct-08	55	15-Oct-09	73
												14-Oct-03	140	13-Oct-04	65	14-Oct-05	64	16-Oct-06	37	11-Oct-07	46	14-Oct-08	54	16-Oct-09	75
												15-Oct-03	98	14-Oct-04	65	17-Oct-05	64	17-Oct-06	37	12-Oct-07	46	15-Oct-08	55	19-Oct-09	75
												16-Oct-03	98	15-Oct-04	65	18-Oct-05	64	18-Oct-06	40	15-Oct-07	45	16-Oct-08	55	20-Oct-09	75
												17-Oct-03	98	18-Oct-04	67	19-Oct-05	62	19-Oct-06	40	16-Oct-07	45	17-Oct-08	55	21-Oct-09	75
												20-Oct-03	98	19-Oct-04	65	20-Oct-05	64	20-Oct-06	40	17-Oct-07	47	20-Oct-08	55	22-Oct-09	75
												21-Oct-03	98	20-Oct-04	65	21-Oct-05	62	23-Oct-06	40	18-Oct-07	44	21-Oct-08	55	23-Oct-09	73
												22-Oct-03	97	21-Oct-04	65	24-Oct-05	64	24-Oct-06	42	22-Oct-07	47	22-Oct-08	55	26-Oct-09	75
												23-Oct-03	97	22-Oct-04	68	25-Oct-05	64	25-Oct-06	42	23-Oct-07	66	23-Oct-08	58	27-Oct-09	75
												24-Oct-03	100	25-Oct-04	65	26-Oct-05	64	26-Oct-06	42	24-Oct-07	106	24-Oct-08	55	28-Oct-09	75
												27-Oct-03	100	26-Oct-04	65	27-Oct-05	64	27-Oct-06	42	25-Oct-07	106	27-Oct-08	55	29-Oct-09	75
												28-Oct-03	101	27-Oct-04	65	28-Oct-05	72	30-Oct-06	42	26-Oct-07	110	28-Oct-08	55	30-Oct-09	75
												29-Oct-03	101	28-Oct-04	65	31-Oct-05	72	31-Oct-06	42	29-Oct-07	112	29-Oct-08	58	2-Nov-09	77
												30-Oct-03	100	29-Oct-04	65	1-Nov-05	72	1-Nov-06	42	30-Oct-07	113	30-Oct-08	58	3-Nov-09	77
												31-Oct-03	100	1-Nov-04	65	2-Nov-05	72	2-Nov-06	42	31-Oct-07	108	31-Oct-08	55	4-Nov-09	77
												3-Nov-03	100	2-Nov-04	67	3-Nov-05	72	3-Nov-06	44	1-Nov-07	108	3-Nov-08	55	5-Nov-09	80
												4-Nov-03	101	3-Nov-04	67	4-Nov-05	72	6-Nov-06	44	2-Nov-07	108	4-Nov-08	58	6-Nov-09	100
												5-Nov-03	98	4-Nov-04	67	7-Nov-05	74	7-Nov-06	47	5-Nov-07	105	5-Nov-08	55	9-Nov-09	130
												6-Nov-03	101	5-Nov-04	67	8-Nov-05	74	8-Nov-06	44	6-Nov-07	0	6-Nov-08	58	10-Nov-09	130
												7-Nov-03	101	8-Nov-04	67	9-Nov-05	72	9-Nov-06	44	7-Nov-07	106	7-Nov-08	58	11-Nov-09	130
												10-Nov-03	101	9-Nov-04	85	10-Nov-05	74	10-Nov-06	44	8-Nov-07	108	10-Nov-08	55	12-Nov-09	130
												11-Nov-03	101	10-Nov-04	87	11-Nov-05	74	13-Nov-06	44	9-Nov-07	108	11-Nov-08	55	13-Nov-09	135
												12-Nov-03	101	11-Nov-04	87	14-Nov-05	74	14-Nov-06	44	12-Nov-07	105	12-Nov-08	55	16-Nov-09	141
												13-Nov-03	101	12-Nov-04	85	15-Nov-05	96	15-Nov-06	44	14-Nov-07	0	13-Nov-08	55	17-Nov-09	141
												14-Nov-03	101	15-Nov-04	85	16-Nov-05	96	16-Nov-06	44	15-Nov-07	0	14-Nov-08	55	18-Nov-09	143
												17-Nov-03	103	16-Nov-04	87	17-Nov-05	96	17-Nov-06	43	16-Nov-07	106	17-Nov-08	58	19-Nov-09	141
												18-Nov-03	145	17-Nov-04	87	18-Nov-05	96	20-Nov-06	42	19-Nov-07	0	18-Nov-08	58	20-Nov-09	141
												19-Nov-03	200	18-Nov-04	87	21-Nov-05	96	21-Nov-06	42	20-Nov-07	104	19-Nov-08	55	23-Nov-09	140
												20-Nov-03	198	19-Nov-04	87	22-Nov-05	95	22-Nov-06	42	21-Nov-07	104	20-Nov-08	58	24-Nov-09	136
												21-Nov-03	197	22-Nov-04	87	23-Nov-05	96	23-Nov-06	44	22-Nov-07	104	21-Nov-08	55	25-Nov-09	136
												24-Nov-03	200	23-Nov-04	87	24-Nov-05	115	24-Nov-06	42	23-Nov-07	104	24-Nov-08	65	26-Nov-09	139
												25-Nov-03	200	24-Nov-04	87	25-Nov-05	115	27-Nov-06	42	26-Nov-07	104	25-Nov-08	64	27-Nov-09	139
												26-Nov-03	199	25-Nov-04	87	28-Nov-05	115	28-Nov-06	45	27-Nov-07	104	26-Nov-08	63	30-Nov-09	139
												27-Nov-03	198	26-Nov-04	87	29-Nov-05	117	29-Nov-06	65	28-Nov-07	104	27-Nov-08	63	1-Dec-09	139
												28-Nov-03	200	29-Nov-04	120	30-Nov-05	115	30-Nov-06	65	29-Nov-07	102	28-Nov-08	63	2-Dec-09	136
												1-Dec-03	196	30-Nov-04	120	1-Dec-05	115	1-Dec-06	65	30-Nov-07	100	1-Dec-08	63	3-Dec-09	136
												2-Dec-03	194	1-Dec-04	120	2-Dec-05	115	4-Dec-06	64	3-Dec-07	102	2-Dec-08	63	4-Dec-09	136
												3-Dec-03	194	2-Dec-04	120	5-Dec-05	115	5-Dec-06	64	4-Dec-07	104	3-Dec-08	63	7-Dec-09	136
												4-Dec-03	198	3-Dec-04	120	6-Dec-05	114	6-Dec-06	62	5-Dec-07	104	4-Dec-08	63	8-Dec-09	136
												5-Dec-03	194	6-Dec-04	140	7-Dec-05	114	7-Dec-06	64	6-Dec-07	101	5-Dec-08	65	9-Dec-09	136
												8-Dec-03	190	7-Dec-04	140	8-Dec-05	114	8-Dec-06	64	7-Dec-07	101	8-Dec-08	65	10-Dec-09	136
												9-Dec-03	190	8-Dec-04	140	9-Dec-05	114	11-Dec-06	64	10-Dec-07	96	9-Dec-08	65	11-Dec-09	134
												10-Dec-03	100	9-Dec-04	142	12-Dec-05	114	12-Dec-06	64	11-Dec-07	104	10-Dec-08	67	14-Dec-09	131
												11-Dec-03	100	10-Dec-04	141	13-Dec-05	114	13-Dec-06	79	12-Dec-07	99	11-Dec-08	66	15-Dec-09	131
												12-Dec-03	101	13-Dec-04	141	14-Dec-05	114	14-Dec-06	96	13-Dec-07	101	12-Dec-08	65	16-Dec-09	129
												15-Dec-03	101	14-Dec-04	141	15-Dec-05	110	15-Dec-06	160	14-Dec-07	101	15-Dec-08	65	17-Dec-09	129
												16-Dec-03	100	15-Dec-04	141	16-Dec-05	112	18-Dec-06	164	17-Dec-07	99	16-Dec-08	65	18-Dec-09	131
												17-Dec-03	100	16-Dec-04	141	19-Dec-05	112	19-Dec-06	164	18-Dec-07	99	17-Dec-08	85	21-Dec-09	129
												18-Dec-03	103	17-Dec-04	141	20-Dec-05	110	20-Dec-06	165	19-Dec-07	102	18-Dec-08	90	22-Dec-09	129
												19-Dec-03	148	20-Dec-04	141	21-Dec-05	110	21-Dec-06	164	20-Dec-07	100	19-Dec-08	85	23-Dec-09	85
												22-Dec-03	148	21-Dec-04	145	22-Dec-05	112	22-Dec-06	164	21-Dec-07	100	22-Dec-08	85	24-Dec-09	85
												23-Dec-03	147	22-Dec-04	155	23-Dec-05	110	27-Dec-06	158	24-Dec-07	104	23-Dec-08	90	29-Dec-09	87
												24-Dec-03	146	23-Dec-04	155	28-Dec-05	110	28-Dec-06	158	27-Dec-07	104	24-Dec-08	87	30-Dec-09	88
												29-Dec-03	148	24-Dec-04	155	29-Dec-05	110	29-Dec-06	158	28-Dec-07	104	29-Dec-08	130	31-Dec-09	88
												30-Dec-03	145	27-Dec-04	155	30-Dec-05	114			31-Dec-07	102	30-Dec-08	130		
												31-Dec-03	140	28-Dec-04	140							31-Dec-08	130		
														29-Dec-04	140										
														30-Dec-04	140										
														31-Dec-04	140										

Table A1.3: Surface Water Quality in Cell 14 at the Quirke TMA

Date	pH (pH units)	Sulphate (mg/L)	Radium (Bq/L)
Jun-92	3.4		
Sep-92	3.7		
Oct-92	3.3	374	
Nov-92	4.3	161	
Dec-92	7.4	45	
Jan-93	6.9	60	
Feb-93	7.2	68	
Mar-93	6.5	94	
Apr-93	5.2	45	
May-93	6.7	64	
Jun-93	7.1	57	
Jul-93	7.2	64	
Aug-93	7.2	76	
Sep-93	7.2	75	
Oct-93	7.0	73	
Nov-93	6.8	64	
Dec-93	6.8	16	
Jan-94	6.5	13	
Feb-94	6.8	56	
Mar-94	6.8	33	
Apr-94	6.7	41	
May-94	6.7	33	
Jun-94	7.1	36	
Jul-94	7.9	40	
Aug-94	6.9	44	
Sep-94	7.0	47	
Oct-94	7.0	51	
Nov-94	6.9	33	
Dec-94	7.0	41	
Jan-95	6.8	48	
Feb-95	6.7	53	
Mar-95	6.6	44	
Apr-95	6.8	9	
May-95	6.6	18	
Jun-95	6.5	14	
Jul-95	7.0	19	
Aug-95	7.4	29	
Sep-95	6.7	30	
Oct-95	6.6	32	
Nov-95	6.3	35	
Dec-95	7.0	38	
Jan-96	6.0	21	
Feb-96	5.9	10	
Mar-96	6.1	31	
Apr-96	6.5	31	
May-96	5.0	<5	
Jun-96	7.1	19	
Jul-96	7.1	19	
Aug-96	7.3	25	
Sep-96	7.4	25	
Oct-96	6.9	40	

Table A1.3: Surface Water Quality in Cell 14 at the Quirke TMA

Date	pH (pH units)	Sulphate (mg/L)	Radium (Bq/L)
Nov-96	6.7	35	
Dec-96	7.6	38	
Jan-97	6.4	19	
Feb-97	6.4	23	
Mar-97	7.0	35	
Apr-97	6.8	56	
May-97	6.8	26	
Jun-97	7.0	25.5	
Jul-97	7.3	<5	
Aug-97	7.0	38	
Sep-97	7.7	33	
Oct-97	7.0	42	
Nov-97	7.5	49	
Dec-97	7.8	51	
Jan-98	7.1	56	
Feb-98	7.0	51	0.509
Mar-98	7.0	44	
Apr-98	6.4	<5	
May-98	7.1	22.4	
Jun-98	7.5	21	
Jul-98	7.5	26.4	
Aug-98	6.9	31.8	
Sep-98	7.8	37	
Oct-98	7.6	42.2	
Nov-98	7.7	45.5	
Dec-98	7.6	43.6	
Jan-99	7.5	42.5	
Feb-99	7.3	29.9	
Mar-99	7.4	39.4	
Apr-99	6.6	7.6	
May-99	7.6	23.5	
Jun-99	7.7	28	
Jul-99	7.8	30	
Aug-99	8.2	30.1	
Sep-99	8.2	33	
Oct-99	7.7	35.6	
Nov-99	7.7	38.5	1.340
Dec-99	7.8	38.3	
Jan-00	7.8	63.8	
Feb-00	7.5	53.6	1.560
Mar-00	7.0	22.4	
Apr-00	6.2	4.8	
May-00	7.7	25.7	0.620
Jun-00	8.6	27.8	0.690
Jul-00	7.7	29.2	
Aug-00	7.7	25.1	1.560
Sep-00	8.0	33.9	
Oct-00	7.8	34.7	
Nov-00	7.8	43.1	2.190
Dec-00	7.7	53	
Jan-01	7.1	67.2	

Table A1.3: Surface Water Quality in Cell 14 at the Quirke TMA

Date	pH (pH units)	Sulphate (mg/L)	Radium (Bq/L)
Mar-01	7.0	56.3	
Apr-01	7.0	18.2	
May-01	7.7	21.4	0.820
Jun-01	7.6	22.4	
Jul-01	7.7	25.2	
Aug-01	8.0	30	1.900
Sep-01	8.1	28.9	
Oct-01	8.1	28.1	
Nov-01	7.5	27.3	1.600
Dec-01	7.6	30.1	
Jan-02	7.5	34.3	
Feb-02	7.3	34.8	1.300
Mar-02	7.5	35.6	
Apr-02	7.1	29.7	
May-02	7.7	22.5	0.770
Jun-02	7.8	23.1	
Jul-02	8.2	20.4	
Aug-02	7.5	26.7	2.300
Sep-02	7.8	23	
Oct-02	7.6	24.4	
Nov-02	7.6	25.7	2.070
Dec-02	7.6	30.3	
Apr-03	6.4		0.410
Apr-04	5.9		0.310
Oct-04	6.8		0.690
Apr-05	6.5		0.190
Aug-05	7.1	18.3	0.450
Sep-05	7.0	19.3	0.420
Oct-05	7.4	22	0.310
Nov-05	6.8	20	0.380
Dec-05	7.2	21.9	0.380
May-06	7.0	15	0.220
Jun-06	6.8	21	0.320
Jul-06	7.1	12	0.360
Aug-06	7.8	13	0.340
Oct-06	7.1	13	0.490
Nov-06	6.5	13	0.310
Mar-07	6.2	16	0.380
May-07	6.8	10	0.290
Aug-07	7.0	12	0.320
Nov-07	6.2	16	0.410
Feb-08	6.6	8.6	0.190
May-08	6.9	9.7	0.250
Aug-08	7.1	18	0.360
Nov-08	6.7	15	0.550
May-09	6.5	11	0.350
Nov-09	6.8	15	0.690

Table A1.4: Surface Water Quality in Cell 15 at the Quirke TMA

Date	Sulphate (mg/L)	Radium (Bq/L)
	mg/L	Bq/L
1-Oct-95		0.28
1-May-98		0.70
1-Jun-98	517	
1-Apr-03		0.08
1-Oct-03		0.32
1-Apr-04		0.01
1-Oct-04		0.36
1-Apr-05		0.05
1-Aug-05	515	0.40
1-Oct-05	730	0.33
10-May-06	470	0.34
9-Aug-06	490	0.22
8-Nov-06	580	0.20
14-Mar-07	310	0.64
10-May-07	430	0.32
8-Aug-07	640	0.20
14-Nov-07	740	0.35
13-Feb-08	9	0.25
15-May-08	380	0.32
13-Aug-08	480	0.20
12-Nov-08	690	0.26
21-May-09	440	0.40
12-Nov-09	560	0.36

Table A1.5: Surface Water Quality in Cell 16S at the Quirke TMA

Date	Sulphate (mg/L)	Radium (Bq/L)
Jan-90		7.136
Feb-90		5.786
Mar-90		9.961
Apr-90		11.428
May-90		6.103
Jun-90		6.336
Jul-90		11.707
Aug-90		13.749
Sep-90		11.431
Oct-90		4.566
Nov-90		4.229
Dec-90		3.195
Feb-91		5.074
Apr-91		1.133
May-91		1.893
Jun-91		1.173
Jul-91		1.067
Aug-91		0.784
Sep-91		0.154
Oct-91		0.214
Nov-91		0.636
Dec-91		0.749
Jan-92		0.261
Feb-92		0.188
Apr-92		0.33
May-92		0.222
Jun-92		<0.037
Jan-93		0.115
Feb-93		0.185
Mar-93		0.2
Apr-93		0.148
May-93		0.178
Jul-93		0.16
Sep-93		0.104
Oct-93		0.124
Nov-93		0.073
Dec-93		0.106
Jan-94		0.106
Feb-94		0.245
Mar-94		0.204
Apr-94		0.063
May-94		0.144
Jun-94		0.186
Jul-94		0.185
Aug-94		0.139
Sep-94		0.124
Oct-95		0.533
Mar-98		0.14
Apr-03		0.17
Oct-03		0.66
Apr-04		0.15

Table A1.5: Surface Water Quality in Cell 16S at the Quirke TMA

Date	Sulphate (mg/L)	Radium (Bq/L)
Oct-04		0.47
Apr-05		0.044
Aug-05	1245	0.74
Oct-05	1697	0.61
May-06	1000	0.63
Aug-06	1100	0.71
Nov-06	1100	0.6
Mar-07	1100	0.73
May-07	960	0.65
Aug-07	1200	0.61
Nov-07	1200	0.78
Feb-08	1100	0.81
May-08	990	0.57
Aug-08	910	0.59
Nov-08	1000	0.63
May-09	940	0.61
Nov-09	1000	0.48

Table A1.6: Surface Water Quality in Cell 17 at the Quirke TMA

Date	Sulphate (mg/L)	Radium (Bq/L)
1-Oct-95		0.524
1-Mar-98		0.13
1-Apr-03		0.41
1-Oct-03		1.24
1-Apr-04		0.35
1-Oct-04		1.13
1-Apr-05		0.15
1-Aug-05	1422	1.28
1-Oct-05	1768	1.5
10-May-06	1100	1.2
9-Aug-06	1200	1.2
8-Nov-06	1200	1.3
14-Mar-07	1200	0.93
10-May-07	980	1.1
8-Aug-07	1400	1.4
14-Nov-07	1200	1.05
13-Feb-08	1100	0.7
15-May-08	930	0.94
13-Aug-08	980	0.53
12-Nov-08	880	1.2
21-May-09	980	1.4
12-Nov-09	1100	0.69

Table A1.7: Surface Water Quality in Cell 18 (Q-05) at the Quirke TMA

Date	Sulphate (mg/L)	Radium (Bq/L)
Jan-87	1836	3.333
Feb-87	1868	2.372
Mar-87		1.046
Apr-87	1464	2.392
May-87	1590	1.923
Jun-87		2.382
Jul-87	1805	3.994
Aug-87		4.819
Sep-87		4.393
Oct-87	1579.5	4.862
Nov-87	1768	3.187
Dec-87		4.975
Jan-88	1642	9.084
Feb-88	1839	6.439
Mar-88		7.687
Apr-88	1381	5.047
May-88		5.138
Jun-88	1738	5.383
Jul-88	1792	4.021
Aug-88		3.169
Sep-88	1636.5	3.484
Oct-88	1624	2.593
Nov-88		1.969
Dec-88	1419	1.161
Jan-89	1560	2.025
Feb-89	1688	4.722
Mar-89	1728	4.473
Apr-89	1320	1.141
May-89	858	0.927
Jun-89	1665	1.307
Jul-89	1837	1.293
Aug-89	1950	1.007
Sep-89	1989	2.284
Oct-89	1825	2.825
Nov-89	1804	1.731
Dec-89	1838	1.476
Jan-90	1683	1.896
Feb-90	1694	1.886
Mar-90	1817	2.846
Apr-90	1617	3.686
May-90	1517	1.309
Jun-90	1878	2.147
Jul-90	1913	2.337
Aug-90	2471.7	3.384
Sep-90	2311	3.577
Oct-90	1996.3	2.114
Nov-90	1053.4	1.907
Dec-90	964.4	2.676
Jan-91	745	3.162
Feb-91	899	3.454
Mar-91	802	2.963

Table A1.7: Surface Water Quality in Cell 18 (Q-05) at the Quirke TMA

Date	Sulphate (mg/L)	Radium (Bq/L)
Apr-91	626	1.943
May-91	865	1.066
Jun-91	574	0.756
Jul-91	1874	1.003
Aug-91	1988	0.329
Sep-91	2042	0.177
Oct-91	1814	0.093
Nov-91	1699	0.155
Dec-91	1731	0.143
Jan-92	1962	0.198
Feb-92	2332	0.145
Mar-92	2419.3	0.176
Apr-92	2419.8	0.184
May-92	1447	0.129
Jun-92	1583	0.092
Jul-92		0.326
Aug-92	2162	0.172
Sep-92	2195	0.179
Oct-92	2023	0.151
Nov-92	1920	0.138
Dec-92	1755	0.145
Jan-93	1841	0.105
Feb-93	2002	0.118
Mar-93	2114	0.130
Apr-93	2032	0.108
May-93	1051	0.152
Jun-93	1522	0.091
Jul-93	1693	0.085
Aug-93		0.080
Sep-93		0.137
Oct-93	1843	0.103
Nov-93	1872	0.087
Dec-93	1859	0.101
Jan-94	2171	0.162
Feb-94	1846	0.180
Mar-94	1848	0.197
Apr-94	1799	0.202
May-94	1343	0.165
Jun-94	1685	0.143
Jul-94	1727	0.139
Aug-94	1826	0.212
Sep-94	1862	0.164
Oct-94		0.211
Nov-94	1828	0.197
Apr-95	1907	0.114
May-95	893	0.096
Jun-95	1298	0.334
Jul-95	1778	0.764
Oct-95	1832	0.413
Nov-95	1644	0.429
Dec-95	1620	0.416

Table A1.7: Surface Water Quality in Cell 18 (Q-05) at the Quirke TMA

Date	Sulphate (mg/L)	Radium (Bq/L)
Jan-96	1620	0.438
Feb-96	1506	0.345
Mar-96	1394	0.414
Apr-96	1437	0.353
May-96	554	0.258
Jun-96	1297	0.227
Jul-96		0.341
Aug-96	634	0.317
Sep-96	334	0.323
Oct-96	1208	0.351
Nov-96	1358	0.389
Dec-96	1404	0.380
Jan-97	772	2.242
Feb-97	1417	0.383
Mar-97	1269	0.324
Apr-97	869	0.275
May-97	776	0.383
Jun-97	1030	0.490
Jul-97	305	0.517
Aug-97	1318	0.605
Sep-97	683	0.526
Oct-97	952	0.412
Nov-97	1336	0.373
Dec-97	1367	0.450
Jan-98	1414	0.375
Feb-98	1491	0.475
Mar-98	1487.5	0.450
Apr-98	1443	0.444
May-98	572	0.433
Jun-98	1081	0.366
Jul-98	1227	0.263
Aug-98	1309	0.250
Sep-98	1494	0.222
Oct-98	1128	0.250
Nov-98	1265	0.226
Dec-98	1358	0.200
Jan-99	1409	0.265
Feb-99	1491	0.385
Mar-99	1479	0.359
Apr-99	1467	0.377
May-99	963	0.248
Jun-99	1139	0.278
Jul-99	1307	0.432
Aug-99	1409	0.455
Sep-99	1470	0.445
Oct-99	1490	0.415
Nov-99	1441	0.441
Dec-99	1402	0.565
Jan-00	1625	0.560
Feb-00	1568	0.591
Mar-00	1535	0.593

Table A1.7: Surface Water Quality in Cell 18 (Q-05) at the Quirke TMA

Date	Sulphate (mg/L)	Radium (Bq/L)
Apr-00	1058	0.515
May-00	1045	0.454
Jun-00	1132	0.495
Jul-00	1201	0.540
Aug-00	1454	0.500
Sep-00	1471	0.580
Oct-00	1337	0.580
Nov-00	1391	0.635
Dec-00	1500	0.622
Jan-01	1600	0.636
Feb-01	1541	0.680
Mar-01	1542	0.705
Apr-01	1541	0.685
May-01	726	0.368
Jun-01	841	0.378
Jul-01	1182	0.538
Aug-01	1312	0.615
Sep-01	1360	0.728
Oct-01	1300	0.762
Nov-01	1182	0.857
Dec-01	1649	0.742
Jan-02	1278	0.640
Feb-02	1252	0.738
Mar-02	1505	0.798
Apr-02	1241	0.708
May-02	883	0.768
Jun-02	1032	0.885
Jul-02	1081	1.260
Aug-02	1190	1.465
Sep-02	1430	1.478
Oct-02	1341	1.298
Nov-02	1322	1.265
Dec-02	1345	1.238
Jan-03		1.100
Feb-03	1444	1.200
Mar-03		1.100
Apr-03		0.720
May-03	805	0.790
Jun-03		0.720
Jul-03		1.120
Aug-03	1167	1.100
Sep-03		0.980
Oct-03		0.850
Nov-03	1329	1.040
Dec-03		0.900
Jan-04		0.820
Feb-04	1123	0.850
Mar-04		0.890
Apr-04		0.650
May-04	678	0.530
Jun-04		0.760

Table A1.7: Surface Water Quality in Cell 18 (Q-05) at the Quirke TMA

Date	Sulphate (mg/L)	Radium (Bq/L)
Jul-04		0.800
Aug-04	1128	1.050
Sep-04		0.850
Oct-04		1.070
Nov-04	1273	0.960
Dec-04		0.880
Jan-05		0.840
Feb-05	1235	0.710
Mar-05		0.910
Apr-05		0.860
May-05	794	0.610
Jun-05		0.780
Jul-05		0.980
Aug-05	1283	0.910
Sep-05		0.920
Oct-05		1.170
Nov-05	1360	1.210
Dec-05		1.310
Jan-06		1.000
Feb-06	1200	0.960
Mar-06		0.870
Apr-06		0.920
May-06	610	0.620
Jun-06		0.920
Jul-06		1.000
Aug-06	1100	0.700
Sep-06		1.400
Oct-06		1.500
Nov-06	1100	1.100
Dec-06		1.200
Jan-07		1.100
Feb-07	1100	0.940
Mar-07		1.000
Apr-07		0.810
May-07	830	0.730
Jun-07		0.910
Jul-07		1.100
Aug-07	1200	1.200
Sep-07		1.200
Oct-07		1.100
Nov-07	1200	0.940
Dec-07		0.640
Jan-08		1.000
Feb-08	1300	0.790
Mar-08		0.860
Apr-08		0.790
May-08	740	0.740
Jun-08		0.740
Jul-08		0.880
Aug-08	960	0.850
Sep-08		0.780

Table A1.7: Surface Water Quality in Cell 18 (Q-05) at the Quirke TMA

Date	Sulphate (mg/L)	Radium (Bq/L)
Oct-08		0.930
Nov-08	1100	0.910
Dec-08		1.010
Jan-09		0.940
Feb-09	1100	0.780
Mar-09		0.990
Apr-09		0.790
May-09	530	0.500
Jun-09		0.830
Jul-09		0.950
Aug-09	980	1.260
Sep-09		0.850
Oct-09		1.000
Nov-09	960	0.550
Dec-09		0.940

Table A1.8: Routine Monitoring Data in Piezometers at DK14-5

DK14-5A (366.2 masl)		DK14-5B (369.2 masl)		DK14-5C (370.5 masl)		DK14-5D (372.0 masl)	
Date	Radium (Bq/L)	Date	Radium (Bq/L)	Date	Radium (Bq/L)	Date	Radium (Bq/L)
13-Oct-92	1.5	13-Oct-92	0.9	13-Oct-92	1.5	13-Oct-92	1.0
22-Jun-93	1.2	22-Jun-93	1.0	22-Jun-93	1.5	22-Jun-93	0.5
16-Aug-93	1.9	16-Aug-93	1.0	16-Aug-93	1.7	16-Aug-93	0.9
5-Oct-93	1.8	4-Oct-93	1.3	4-Oct-93	1.1	4-Oct-93	1.3
20-Oct-94	0.9	20-Oct-94	0.7	20-Oct-94	0.7	20-Oct-94	0.2
3-Oct-95	2.6	3-Oct-95	3.1	3-Oct-95	1.7	3-Oct-95	1.3
10-Oct-96	2.5	8-Oct-96	2.1	8-Oct-96	2.0	8-Oct-96	1.4
25-Oct-97	2.7	25-Oct-97	2.3	25-Oct-97	2.2	25-Oct-97	1.5
11-Jun-98	1.9	11-Jun-98	2.0	11-Jun-98	2.0	11-Jun-98	0.8
22-Jun-99	2.6	23-Jun-99	1.8	23-Jun-99	1.5	23-Jun-99	0.6
27-Jun-00	1.8	27-Jun-00	2.2	27-Jun-00	1.5	27-Jun-00	0.7
29-Jun-01	2.8	29-Jun-01	1.9	29-Jun-01	2.0	29-Jun-01	0.9
31-May-02	3.3	22-Jul-02	1.7	22-Jul-02	1.5	22-Jul-02	0.8
				6-Aug-10	1.3		

Table A1.9: Routine Monitoring Data in Piezometers at DK15-2

DK15-2A (360.7 masl)		DK15-2B (363.6 masl)		DK15-2C (365.4 masl)		DK15-2D (366.8 masl)	
Date	Radium (Bq/L)	Date	Radium (Bq/L)	Date	Radium (Bq/L)	Date	Radium (Bq/L)
28-Jul-98	3.3	28-Jul-98	5.8	28-Jul-98	5.2	28-Jul-98	1.2
28-Sep-99	5.2	28-Sep-99	5.9	28-Sep-99	9.4	28-Sep-99	1.5
4-Jul-01	5.5	4-Jul-01	5.9	4-Jul-01	6.9	4-Jul-01	1.3
31-Oct-02	2.7	31-Oct-02	5.0	31-Oct-02	5.2	31-Oct-02	1.2
5-Sep-03	4.2	5-Sep-03	5.1	5-Sep-03	6.2	5-Sep-03	1.4
6-Aug-10	3.5	6-Aug-10	4.4	6-Aug-10	2.7	6-Aug-10	0.8

Table A1.10: Routine Monitoring Data in Piezometers at DK15-4

DK15-4A (360.8 masl)		DK15-4B (363.8 masl)		DK15-4C (365.3 masl)		DK15-4D (366.8 masl)	
Date	Radium (Bq/L)	Date	Radium (Bq/L)	Date	Radium (Bq/L)	Date	Radium (Bq/L)
21-Oct-96	2.9	21-Oct-96	1.1	21-Oct-96	0.8	21-Oct-96	0.8
31-Oct-97	5.4	31-Oct-97	1.9	31-Oct-97	1.1	31-Oct-97	0.9
28-Jul-98	3.4	28-Jul-98	1.4	28-Jul-98	1.3	28-Jul-98	0.9
29-Sep-99	3.9	29-Sep-99	1.6	29-Sep-99	1.7	29-Sep-99	1.7
1-Aug-00	3.5	1-Aug-00	1.4	6-Jul-01	1.5	6-Jul-01	1.6
31-Oct-02	3.8	31-Oct-02	1.3	31-Oct-02	1.3	31-Oct-02	1.1
5-Sep-03	5.6	5-Sep-03	1.5	5-Sep-03	1.5	5-Sep-03	1.4
9-Aug-10	3.7	9-Aug-10	0.2	9-Aug-10	1.0	9-Aug-10	0.2

Table A1.11: Routine Monitoring Data in Piezometers at DK16-2

DK16-2A (356.8 masl)		DK16-2B (359.9 masl)		DK16-2C (361.4 masl)		DK16-2D (362.9 masl)	
Date	Radium (Bq/L)	Date	Radium (Bq/L)	Date	Radium (Bq/L)	Date	Radium (Bq/L)
8-Oct-96	9.0	8-Oct-96	10.8	8-Oct-96	5.4	8-Oct-96	4.4
23-Oct-97	8.9	23-Oct-97	14.4	23-Oct-97	9.7	23-Oct-97	9.9
22-Jul-98	12.2	22-Jul-98	11.7	22-Jul-98	4.3	22-Jul-98	5.7
16-Sep-99	9.9	16-Sep-99	9.1	16-Sep-99	6.3	16-Sep-99	6.3
3-Aug-00	10.8	3-Aug-00	7.8	3-Aug-00	7.1	3-Aug-00	6.8
6-Jul-01	9.3	6-Jul-01	8.2	6-Jul-01	5.9	6-Jul-01	6.7
25-Jun-02	9.3	25-Jun-02	9.1	25-Jun-02	6.3	25-Jun-02	6.5
10-Aug-10	6.8	10-Aug-10	6.5	10-Aug-10	4.6	10-Aug-10	3.2

Table A1.12: Routine Monitoring Data in Piezometers at DK17-2

DK17-2A (353.8 masl)		DK17-2B (356.9 masl)		DK17-2C (358.4 masl)		DK17-2D (359.9 masl)	
Date	Radium (Bq/L)	Date	Radium (Bq/L)	Date	Radium (Bq/L)	Date	Radium (Bq/L)
26-Sep-96	2.6	26-Sep-96	6.6	26-Sep-96	5.1	26-Sep-96	3.9
20-Oct-97	1.3	20-Oct-97	5.3	20-Oct-97	4.3	20-Oct-97	3.6
14-Jul-98	1.2	14-Jul-98	4.9	14-Jul-98	4.9	14-Jul-98	4.2
14-Sep-99	1.0	14-Sep-99	5.4	14-Sep-99	5.8	14-Sep-99	4.6
19-Jul-00	3.3	19-Jul-00	3.8	19-Jul-00	3.6	19-Jul-00	2.9
9-Jul-01	1.3	9-Jul-01	4.9	9-Jul-01	5.0	9-Jul-01	4.7
31-May-02	2.4	31-May-02	4.9	31-May-02	4.7	31-May-02	5.0
9-Aug-10	2.2	9-Aug-10	4.9	9-Aug-10	3.4	9-Aug-10	5.3

APPENDIX 2

Detailed Data Quality Assessment

Table A2.1: Detailed Data Quality Assessment for Constituents in Solids

Analysis	Units	Method Detection Limit	RPD Data Quality Objective	Sample ID CORE 09-PSB-2 (5-10)	Duplicate ID CORE 09-EC-1 (0-5)	RPD (%) or AD	Sample ID CORE 09-SR-4 (10-15)	Duplicate ID CORE 09-EC-1 (5-10)	RPD (%) or AD	Sample ID CORE 09-QC14-2 (0-2.5)	Replicate ID CORE 09-EC-2 (0-2.5)	RPD (%) or AD	Sample ID CORE 09-QC14-2 (2.5-5)	Replicate ID CORE 09-EC-2 (2.5-5)	RPD (%) or AD	Sample ID CORE 09-QC14-2 (5-7.5)	Replicate ID CORE 09-EC-2 (5-7.5)	RPD (%) or AD
Conventional Parameters																		
Sulphur (S)	%	0.005	≤ 40%	1.57	1.17	29	1.00	0.762	27	0.633	0.628	1	0.885	1.03	15	0.871	1.18	30
Carbonate (CO_3)	%	0.005	≤ 40%	0.097	0.058	**50**	0.419	0.280	40	<0.005	<0.005	BD	<0.005	<0.005	BD	<0.005	<0.005	BD
Total Organic Carbon (TOC)	%	0.01	≤ 40%	9.78	10.5	7	16.8	16.7	1	0.519	0.617	17	0.289	0.206	34	0.121	0.090	29
Total Carbon (C)	%	0.005	≤ 40%	9.80	10.5	7	16.9	16.8	1	0.519	0.616	17	0.289	0.207	33	0.121	0.089	30
Sulphide	%	0.01	≤ 40%	0.36	0.47	27	0.65	0.70	7	0.52	0.53	2	0.77	1.04	30	0.84	1.07	24
Sulphate (SO_4)	%	0.1	≤ 40%	0.6	0.3	**0.3**	0.2	0.1	0.1	0.1	0.1	0	0.1	0.1	0	0.1	0.1	0
Metals																		
Radium-226 (Ra-226)	Bq/g	0.01	≤ 40%	4.5	4.1	9	2.1	1.6	27	4.3	7.0	**48**	6.5	8.3	24	9.3	20.0	**73**
Silver (Ag)	mg/kg	0.7	≤ 40%	<0.7	<0.7	BD	<0.7	<0.7	BD	0.8	1.5	**1**	1.0	1.2	0.2	1.1	1.1	0
Aluminum (Al)	mg/kg	1	≤ 40%	3600	3800	5	5600	5800	4	830	1500	**58**	690	1200	**54**	850	890	5
Arsenic (As)	mg/kg	1	≤ 40%	14	14	0	26	26	0	17	22	26	19	24	23	21	24	13
Barium (Ba)	mg/kg	0.05	≤ 40%	160	94	**52**	440	450	2	150	280	**60**	220	370	**51**	330	310	6
Beryllium (Be)	mg/kg	0.1	≤ 40%	0.34	0.35	0.01	0.12	0.13	0.01	0.28	0.51	**0.23**	0.28	0.41	0.1	0.34	0.34	0
Bismuth (Bi)	mg/kg	0.5	≤ 40%	11	12	9	<0.5	<0.5	BD	7.5	11	38	9.2	8.6	7	8.5	7.8	9
Calcium (Ca)	mg/kg	1	≤ 40%	7600	4600	**49**	7300	7400	1	190	230	19	130	110	17	79	63	23
Cadmium (Cd)	mg/kg	0.05	≤ 40%	4.5	4.0	12	1.8	1.8	0	0.18	0.25	33	0.22	0.27	20	0.22	0.29	27
Cerium (Ce)	mg/kg	0.006	≤ 40%	220	240	9	840	800	5	300	340	13	290	300	3	280	240	15
Cobalt (Co)	mg/kg	0.3	≤ 40%	15	15	0	16	17	6	15	16	6	18	21	15	17	22	26
Chromium (Cr)	mg/kg	0.5	≤ 40%	6.5	7.8	18	17	17	0	4.7	8.2	**54**	4.9	6.5	28	5.7	5.8	2
Cesium (Cs)	mg/kg	0.01	≤ 40%	0.97	1.1	13	0.87	0.90	3	0.18	0.32	**56**	0.22	0.20	10	0.31	0.19	**48**
Copper (Cu)	mg/kg	0.1	≤ 40%	14	15	7	56	56	0	43	50	15	46	54	16	42	54	25
Iron (Fe)	mg/kg	0.5	≤ 40%	240000	240000	0	12000	16000	29	10000	13000	26	12000	17000	34	13000	19000	38
Gallium (Ga)	mg/kg	0.03	≤ 40%	2.4	2.7	12	6.6	6.5	2	2.1	2.8	29	2.1	2.4	13	2.0	1.9	5
Germanium (Ge)	mg/kg	0.3	≤ 40%	7.2	7.2	0	3.8	4.0	5	1.2	1.4	0.2	1.2	1.4	0.2	1.2	1.2	0
Hafnium (Hf)	mg/kg	0.1	≤ 40%	0.1	0.1	0	0.6	0.9	40	0.3	0.5	**0.2**	0.6	0.7	15	1.0	0.7	35
Indium (In)	mg/kg	0.01	≤ 40%	<0.01	<0.01	BD	<0.01	0.01	BD	<0.01	0.02	BD	<0.01	0.01	BD	0.01	0.01	0
Potassium (K)	mg/kg	1	≤ 40%	190	210	10	270	270	0	210	330	44	230	300	26	250	230	8
Lanthanum (La)	mg/kg	0.001	≤ 40%	110	130	17	430	420	2	170	190	11	170	170	0	160	140	13
Lithium (Li)	mg/kg	0.1	≤ 40%	0.9	0.9	0	1.1	1.3	17	0.2	0.8	**120**	0.1	0.5	**0.4**	0.4	0.2	**0.2**
Lutetium (Lu)	mg/kg	0.001	≤ 40%	0.98	1.1	12	5.3	5.3	0	0.081	0.14	**53**	0.048	0.060	22	0.031	0.038	20
Magnesium (Mg)	mg/kg	1	≤ 40%	360	240	40	1400	1500	7	88	110	22	46	38	19	25	18	33
Manganese (Mn)	mg/kg	0.05	≤ 40%	89	84	6	180	180	0	13	18	32	8.6	7.6	12	4.7	4.6	2
Molybdenum (Mo)	mg/kg	0.5	≤ 40%	10	10	0	3.6	3.9	8	5.3	6.4	19	5.2	6.1	16	7.9	5.5	36
Sodium (Na)	mg/kg	1	≤ 40%	35	40	13	59	55	7	8	11	32	7	8	13	6	5	1
Niobium (Nb)	mg/kg	0.7	≤ 40%	2.8	2.7	4	0.8	<0.7	BD	7.0	9.7	32	8.2	7.8	5	8.4	7.5	11
Nickel (Ni)	mg/kg	1	≤ 40%	17	19	11	43	43	0	8	9	12	8	10	22	8	11	32
Lead (Pb)	mg/kg	0.7	≤ 40%	270	280	4	640	640	0	180	240	29	260	270	4	270	310	14
Phosphorous (P)	mg/kg	5	≤ 40%	740	810	9	340	360	6	260	400	**42**	300	360	18	360	330	9
Rubidium (Rb)	mg/kg	0.004	≤ 40%	2.1	2.5	17	4.0	4.0	0	1.9	2.6	31	1.9	2.0	5	1.8	1.4	25
Antimony (Sb)	mg/kg	1	≤ 40%	<1	<1	BD	<1	<1	BD	<1	1	BD	<1	<1	BD	<1	<1	BD
Scandium (Sc)	mg/kg	0.2	≤ 40%	1.3	1.6	21	2.7	3.0	11	0.5	0.9	**57**	0.4	0.8	**67**	0.5	0.6	0.1
Selenium (Se)	mg/kg	1	≤ 40%	<1	<2	BD	<1	<2	BD	<2	<2	BD	<2	<2	BD	<2	<2	BD
Tin (Sn)	mg/kg	6	≤ 40%	<6	<6	BD	<6	<6	BD	<6	<6	BD	<6	<6	BD	<6	<6	BD
Strontium (Sr)	mg/kg	0.01	≤ 40%	7.6	7.9	4	14	14	0	3.6	5.1	34	4.1	5.4	27	4.8	4.6	4
Sulphur (S)	mg/kg	1	≤ 40%	--	15000	--	11000	11000	0	6500	6700	3	8700	11000	23	8600	12000	33
Tantalum (Ta)	mg/kg	0.01	≤ 40%	0.05	0.05	0	0.15	0.23	**42**	0.04	0.07	**55**	0.05	0.12	**82**	0.12	0.28	**80**
Terbium (Tb)	mg/kg	0.01	≤ 40%	3.9	4.3	10	35	33	6	0.97	1.4	36	0.83	0.90	8	0.68	0.67	1
Tellurium (Te)	mg/kg	0.1	≤ 40%	0.1	0.1	0	<0.1	<0.1	BD	0.1	0.2	0.1	0.2	0.2	0	0.2	0.2	0
Thorium (Th)	mg/kg	0.01	≤ 40%	110	120	9	85	89	5	310	560	**57**	310	470	41	360	380	5
Titanium (Ti)	mg/kg	0.2	≤ 40%	82	91	10	210	220	5	210	330	**44**	250	260	4	260	240	8
Thallium (Tl)	mg/kg	3	≤ 40%	<3	<3	BD	<3	<3	BD	<3	<3	BD	<3	<3	BD	<3	<3	BD
Uranium (U)	mg/kg	3	≤ 40%	210	230	9	110	150	31	17	23	30	17	18	6	13	15	2
Vanadium (V)	mg/kg	0.1	≤ 40%	25	26	4	16	17	6	2.7	4.0	39	2.7	2.7	0	2.7	2.4	12
Tungsten (W)	mg/kg	1	≤ 40%	2	79	**190**	<1	5	BD	3	5	**2**	4	5	1	5	6	18
Yttrium (Y)	mg/kg	0.1	≤ 40%	78	84	7	740	750	1	9.1	12	27	6.8	6.7	1	5.5	5.2	6
Ytterbium (Yb)	mg/kg	0.1	≤ 40%	7.4	8.7	16	45	46	2	0.74	1.2	**47**	0.46	0.57	21	0.33	0.40	0.07
Zinc (Zn)	mg/kg	0.1	≤ 40%	64	65	2	55	58	5	8.8	8.9	1	6.9	8.0	15	4.7	5.8	21
Zirconium (Zr)	mg/kg	5	≤ 40%	6	6	0	6	<5	BD	20	30	40	26	27	4	28	26	7

Notes:

RPD - relative percent difference; is calculated for analytes with concentrations greater than or equal to five times the detection limit and should be less than or equal to 40%

AD - absolute difference; for samples having concentrations less than five times the detection limit, the difference between the sample and duplicate, or difference between the sample or duplicate and the detection limit if either the sample or duplicate analyte concentration is below detection limit; should not be greater then the detection limit

BD - Sample and/or replicate had analyte concentrations below detection limit

Boldface type and shaded indicates that Data Quality Objective was not achieved

Table A2.2: Detailed Data Quality Assessment for Constituents in Waters

Analysis	Units	Method Detection Limit	RPD Data Quality Objective	Sample ID	Duplicate ID	RPD (%) or AD	Sample ID	Duplicate ID	Dupicate ID	RPD (%) or AD	Sample ID	Replicate ID	RPD (%) or AD	Sample ID	Replicate ID	RPD (%) or AD	Sample ID	Replicate ID	RPD (%) or AD	Sample ID	Replicate ID	RPD (%) or AD	Sample ID	Replicate ID	RPD (%) or AD
				SW09-SR-4B	PW09-EC-1 (0-5)		PW09-QC14-3 (0-5)	PW09-QC14-4 (0-5)	PW09-EC-1 (5-10)		SW09-QC14-2T	SW09-EC-2T		SW09-QC14-2B	SW09-EC-2B		PW09-QC14-2 (0-2.5)	PW09-EC-2 (0-2.5)		PW09-QC14-2 (2.5-5)	PW09-EC-2 (2.5-5)		PW09-QC14-2 (5-7.5)	PW09-EC-2 (5-7.5)	
Conventional Parameters																									
Acidity (as $CaCO_3$)	mg/L	2	≤ 20%	<2.0	--	--	6	19	--	--	56	67	18	15	16	6	21	17	**21**	15	16	6	16	--	--
Dissolved Inorganic Carbon (DIC)	mg/L	0.2	≤ 20%	1.4	--	--	2.0	<1.0	--	BD	<1.0	<1.0	BD	<1.0	<1.0	BD	<1.0	4.2	BD	<1.0	1.1	BD	<1.0	--	BD
Dissolved Organic Carbon (DOC)	mg/L	0.2	≤ 20%	2.0	--	--	3.5	9.3	--	--	14.4	11.4	**23**	19.4	11.7	**50**	28	19	**38**	18.3	14.3	**25**	17.9	--	--
Sulphate (SO_4)	mg/L	0.2	≤ 20%	25	--	--	5.6	512	--	--	72	85	17	32	36	12	32	27	17	12	18	**40**	12	--	--
Hardness (as $CaCO_3$)	mg/L	0.5	≤ 20%	33.4	33.9	1	18	NC	17.8	1	16.9	17	1	16.6	16.8	1	26.2	21.7	19	16.9	16	5	17.9	16.4	9
Metals																									
Radium-226 (Ra-226)	Bq/L	0.01	≤ 20%	0.30	0.30	0	NC	4.1	4.7	14	0.82	0.78	5	0.91	0.85	7	3.6	2.9	**22**	2.8	3.3	16	5.9	5.4	9
Aluminum (Al)	mg/L	0.01	≤ 20%	<0.01	<0.01	BD	<0.01	NC	<0.01	BD	<0.01	0.03	BD	<0.01	<0.01	BD	<0.01	<0.01	BD	0.03	<0.01	BD	<0.01	<0.01	BD
Arsenic (As)	mg/L	0.0002	≤ 20%	0.0007	0.0006	0.0001	0.0026	NC	0.0024	8	0.0006	0.0007	0.0001	0.0011	0.0007	**0.0004**	0.0064	0.0058	10	0.0084	0.0046	**58**	0.0066	0.0065	2
Barium (Ba)	mg/L	0.00001	≤ 20%	0.222	0.221	0	0.333	NC	0.335	1	0.104	0.108	4	0.108	0.114	5	0.309	0.285	8	0.308	0.337	9	0.519	0.487	6
Beryllium (Be)	mg/L	0.00002	≤ 20%	<0.00002	<0.00002	BD	0.00013	NC	<0.00002	BD	<0.00002	0.00003	BD	<0.00002	0.00002	BD	<0.00002	<0.00002	BD	<0.00002	<0.00002	BD	<0.00002	<0.00002	BD
Boron (B)	mg/L	0.0002	≤ 20%	0.0089	0.0082	8	0.0026	NC	0.0028	0.0002	0.0045	0.0076	**51**	0.0056	0.0072	**25**	0.0054	0.0039	**32**	0.0047	0.0034	**32**	0.0051	0.0039	**27**
Bismuth (Bi)	mg/L	0.00001	≤ 20%	0.00001	<0.00001	BD	0.00012	NC	<0.00001	BD	<0.00001	0.00002	BD	<0.00001	0.00002	BD	0.00003	0.00003	0	0.00024	0.00006	**120**	0.00006	0.00003	**0.00003**
Calcium (Ca)	mg/L	0.03	≤ 20%	11.2	11.4	2	6.12	NC	6.06	1	5.69	5.69	0	5.55	5.63	1	8.79	7.28	19	5.68	5.35	6	6.06	5.54	9
Cadmium (Cd)	mg/L	0.000003	≤ 20%	0.000028	0.000012	0.000016	0.000112	NC	<0.000003	BD	0.000023	0.000046	**67**	0.000023	0.000056	**84**	0.000055	0.000031	**56**	<0.000003	0.000012	BD	0.000005	0.000009	**0.000004**
Cobalt (Co)	mg/L	0.000002	≤ 20%	0.00031	0.000321	3	0.00189	NC	0.00192	2	0.00549	0.00655	18	0.00169	0.00196	15	0.00521	0.00289	**57**	0.000917	0.0012	**27**	0.000766	0.00183	**82**
Chromium (Cr)	mg/L	0.0005	≤ 20%	<0.0005	<0.0005	BD	<0.0005	NC	<0.0005	BD	<0.0005	<0.0005	BD	<0.0005	<0.0005	BD	<0.0005	<0.0005	BD	<0.0005	<0.0005	BD	<0.0005	<0.0005	BD
Copper (Cu)	mg/L	0.0005	≤ 20%	0.0011	0.001	0.0001	<0.0005	NC	<0.0005	BD	0.0038	0.0037	3	0.0023	0.0029	**23**	0.0043	0.0018	**0.0025**	0.0025	0.0018	**0.0007**	0.0015	0.0011	**31**
Iron (Fe)	mg/L	0.01	≤ 20%	0.08	0.07	13	7.18	NC	6.63	8	0.04	0.07	**55**	0.01	0.04	**0.03**	0.03	0.44	**174**	0.52	3.3	**146**	2.46	5.71	**80**
Potassium (K)	mg/L	0.01	≤ 20%	0.80	0.80	0	0.37	NC	0.58	**44**	0.32	0.31	3	0.26	0.32	**21**	0.34	0.3	13	0.4	0.34	16	0.62	0.48	**25**
Lithium (Li)	mg/L	0.002	≤ 20%	<0.002	<0.002	BD	<0.002	NC	<0.002	BD	<0.002	<0.002	BD	<0.002	<0.002	BD	<0.002	<0.002	BD	<0.002	<0.002	BD	<0.002	<0.002	BD
Magnesium (Mg)	mg/L	0.003	≤ 20%	1.29	1.31	2	0.67	NC	0.655	2	0.663	0.67	1	0.657	0.663	1	1.02	0.864	17	0.664	0.634	5	0.675	0.632	7
Manganese (Mn)	mg/L	0.00001	≤ 20%	0.119	0.12	1	0.143	NC	0.142	1	0.0288	0.0315	9	0.0353	0.0319	10	0.282	0.217	**26**	0.133	0.134	1	0.133	0.132	1
Molybdenum (Mo)	mg/L	0.00001	≤ 20%	0.00032	0.00029	10	0.00045	NC	0.00051	13	<0.00001	0.00018	BD	0.00002	0.00008	**120**	0.00029	0.00015	**64**	0.00133	0.00116	14	0.00107	0.00149	**33**
Sodium (Na)	mg/L	0.01	≤ 20%	2.79	2.75	1	1.3	NC	1.24	5	1.82	1.59	13	1.83	1.58	15	2.35	2.2	7	1.98	1.87	6	1.79	1.5	18
Nickel (Ni)	mg/L	0.0001	≤ 20%	0.0006	0.0008	**29**	0.001	NC	0.001	0	0.0025	0.0022	13	0.0024	0.0022	9	0.0044	0.0024	**59**	0.0012	0.0013	8	0.0012	0.0017	**34**
Lead (Pb)	mg/L	0.00002	≤ 20%	0.00043	0.00023	**61**	0.00029	NC	0.00016	**58**	0.00717	0.00699	3	0.00597	0.00391	**42**	0.0242	0.00216	**167**	0.00596	0.0009	**148**	0.00098	0.00049	**67**
Phosphorous (P)	mg/L	0.01	≤ 20%	<0.01	<0.01	BD	<0.01	NC	<0.01	BD	0.01	<0.01	BD	<0.01	<0.01	BD	<0.01	0.07	BD	0.01	0.01	0	0.01	<0.01	BD
Antimony (Sb)	mg/L	0.0002	≤ 20%	0.0002	<0.0002	BD	<0.0002	NC	<0.0002	BD	0.0077	0.0086	11	0.0007	0.0016	**78**	0.0002	0.0003	0.0001	0.0006	<0.0002	BD	0.0004	<0.0002	BD
Selenium (Se)	mg/L	0.001	≤ 20%	<0.001	<0.001	BD	<0.001	NC	<0.001	BD	<0.001	<0.001	BD	<0.001	<0.001	BD	<0.001	<0.001	BD	<0.001	<0.001	BD	<0.001	<0.001	BD
Sulphur (S)	mg/L	0.01	≤ 20%	8.58	7.26	17	1.67	NC	1.58	6	4.69	4.64	1	4.74	4.63	2	8.28	6.26	**28**	3.87	3.35	14	3.61	4.21	15
Silicon (Si)	mg/L	0.01	≤ 20%	0.73	0.72	1	5.18	NC	5.07	2	0.58	0.59	2	0.59	0.6	2	1.23	1.42	14	1.71	1.86	8	2.15	2.71	**23**
Tin (Sn)	mg/L	0.00001	≤ 20%	0.00016	<0.00001	BD	<0.00001	NC	0.00002	BD	<0.00001	<0.00001	BD	<0.00001	<0.00001	BD	0.00004	0.00017	**124**	<0.00001	<0.00001	BD	<0.00001	0.00001	BD
Strontium (Sr)	mg/L	0.0001	≤ 20%	0.0268	0.0269	0	0.017	NC	0.0168	1	0.0121	0.0122	1	0.012	0.0122	2	0.0205	0.0168	20	0.0154	0.0149	3	0.0204	0.0187	9
Titanium (Ti)	mg/L	0.0001	≤ 20%	0.0001	<0.0001	BD	0.0003	NC	0.0003	0	0.0003	0.0004	0.0001	<0.0001	0.0001	BD	0.0003	0.0007	**80**	0.0062	0.0004	**0.0058**	0.0005	0.0002	**0.0003**
Thallium (Tl)	mg/L	0.0002	≤ 20%	<0.0002	<0.0002	BD	<0.0002	NC	<0.0002	BD	<0.0002	<0.0002	BD	<0.0002	<0.0002	BD	<0.0002	<0.0002	BD	<0.0002	<0.0002	BD	<0.0002	<0.0002	BD
Uranium (U)	mg/L	0.000001	≤ 20%	0.00122	0.000835	**37**	0.000744	NC	0.000671	10	0.000535	0.000654	20	0.000338	0.00079	**80**	0.000946	0.000173	**138**	0.000524	0.000115	**128**	0.000143	0.000105	**31**
Vanadium (V)	mg/L	0.00003	≤ 20%	0.00008	0.00007	0.00001	0.00019	NC	0.00005	**0.00014**	0.00006	0.00007	0.00001	0.00005	0.00007	0.00002	0.00007	0.00008	0.00001	0.00013	0.00007	**0.00006**	0.00006	0.00004	0.00002
Zinc (Zn)	mg/L	0.001	≤ 20%	0.004	0.003	0.001	0.002	NC	0.001	0.001	0.002	0.004	0.002	0.005	0.005	0	0.005	0.005	0	0.003	0.004	0.001	0.002	0.003	0.001

Notes:

RPD - relative percent difference; is calculated for analytes with concentrations greater than or equal to five times the detection limit and should be less than or equal to 40%

AD - absolute difference; for samples having concentrations less than five times the detection limit, the difference between the sample and duplicate, or difference between the sample or duplicate and the detection limit if either the sample or duplicate analyte concentration is below detection limit; should not be greater then the detection limit

BD - Sample and/or replicate had analyte concentrations below detection limit

"--" Indicates parameter was not analysed

"NC" Indicates that parameter in the sample was not compared to the duplicate/replicate sample in the data quality assessment

Boldface type and shaded indicates that Data Quality Objective was not achieved

Table A2.3: Detailed Data Quality Assessment for Constituents in the Blank Sample

Analysis	Units	Detection Limit	Data Quality Objective	Blank
Convential Parameters				
Acidity (as $CaCO_3$)	mg/L	2	4	**7**
Total Inorganic Carbon (DIC)	mg/L	1.0	2.0	<1.0
Total Organic Carbon (DOC)	mg/L	1.0	2.0	**2.4**
Sulphate (SO_4)	mg/L	2	4	<2
Hardness (as $CaCO_3$)	mg/L	0.5	1.0	<0.5
Metals				
Radium-226 (Ra-226)	Bq/L	0.01	0.02	<0.01
Aluminum (Al)	mg/L	0.01	0.02	<0.01
Arsenic (As)	mg/L	0.0002	0.0004	<0.0002
Barium (Ba)	mg/L	0.00001	0.00002	**0.00216**
Beryllium (Be)	mg/L	0.00002	0.00004	<0.00002
Boron (B)	mg/L	0.0002	0.0004	<0.0002
Bismuth (Bi)	mg/L	0.00001	0.00002	<0.00001
Calcium (Ca)	mg/L	0.03	0.06	0.03
Cadmium (Cd)	mg/L	0.000003	0.000006	<0.000003
Cobalt (Co)	mg/L	0.000002	0.000004	0.000003
Chromium (Cr)	mg/L	0.0005	0.0010	<0.0005
Copper (Cu)	mg/L	0.0005	0.0010	**0.0053**
Iron (Fe)	mg/L	0.01	0.02	<0.01
Potassium (K)	mg/L	0.01	0.02	<0.01
Lithium (Li)	mg/L	0.002	0.004	<0.002
Magnesium (Mg)	mg/L	0.003	0.006	<0.003
Manganese (Mn)	mg/L	0.00001	0.00002	**0.00034**
Molybdenum (Mo)	mg/L	0.00001	0.00002	<0.00001
Sodium (Na)	mg/L	0.01	0.02	**0.15**
Nickel (Ni)	mg/L	0.0001	0.0002	**0.0003**
Lead (Pb)	mg/L	0.00002	0.00004	<0.00002
Phosphorous (P)	mg/L	0.01	0.02	<0.01
Antimony (Sb)	mg/L	0.0002	0.0004	<0.0002
Selenium (Se)	mg/L	0.001	0.002	<0.001
Sulphur (S)	mg/L	0.01	0.02	**0.05**
Silicon (Si)	mg/L	0.01	0.02	<0.01
Tin (Sn)	mg/L	0.00001	0.00002	<0.00001
Strontium (Sr)	mg/L	0.0001	0.0002	0.0001
Titanium (Ti)	mg/L	0.0001	0.0002	<0.0001
Thallium (Tl)	mg/L	0.0002	0.0004	<0.0002
Uranium (U)	mg/L	0.000001	0.000002	<0.000001
Vanadium (V)	mg/L	0.00003	0.00006	<0.00003
Zinc (Zn)	mg/L	0.001	0.002	<0.001

Notes:

Boldface type and shaded indicates that Data Quality Objective was not achieved

EcoMetrix INCORPORATED

APPENDIX 3

Certificates of Analysis for the 2009 Field Data

ANALYSIS REPORT

Becquerel Laboratories Inc.
6790 Kitimat Rd., Unit 4
Mississauga, Ontario
Canada, L5N 5L9

Phone: (905) 826-3080
FAX: (905) 826-4151

Batch: T09-01487.0

Date: 13-Nov-2009

Lakefield Research Ltd.

185 Concession St., Postal Bag 4300
Lakefield, ON, K0L 2H0

attn: Brian Graham

Phone: (705) 652-2038
FAX: (705) 652-1918

Client Ref.
Oct 10063.R09
P.O: 17820

20 solid samples Sampled: 28-Sep-2009 Received: 21-Oct-2009

Results of Analysis

Sample	Test	Result	Units	Date	Method
CORE 09-EC-1 (0-5)	Ra-226	4.1	Bq/g	11-Nov-2009	ALPHA
CORE 09-EC-1 (5-10)	Ra-226	1.6	Bq/g	11-Nov-2009	ALPHA
CORE 09-EC-2 (0-2.5)	Ra-226	7.0	Bq/g	11-Nov-2009	ALPHA
CORE 09-EC-2 (2.5-5)	Ra-226	8.3	Bq/g	11-Nov-2009	ALPHA
CORE 09-EC-2 (5-7.5)	Ra-226	9.7	Bq/g	11-Nov-2009	ALPHA
CORE 09-QC14-1 (0-5)	Ra-226	19	Bq/g	11-Nov-2009	ALPHA
CORE 09-QC14-1 (5-10)	Ra-226	13	Bq/g	11-Nov-2009	ALPHA
CORE 09-QC14-1 (10-15)	Ra-226	9.7	Bq/g	11-Nov-2009	ALPHA
CORE 09-QC14-2 (0-2.5)	Ra-226	4.3	Bq/g	12-Nov-2009	ALPHA
CORE 09-QC14-2 (2.5-5)	Ra-226	6.5	Bq/g	12-Nov-2009	ALPHA
CORE 09-QC14-2 (5-7.5)	Ra-226	9.3	Bq/g	12-Nov-2009	ALPHA
CORE 09-QC14-2 (7.5-10)	Ra-226	9.0	Bq/g	12-Nov-2009	ALPHA
CORE 09-QC14-3 (0-5)	Ra-226	16	Bq/g	12-Nov-2009	ALPHA
CORE 09-QC14-3 (5-10)	Ra-226	22	Bq/g	12-Nov-2009	ALPHA
CORE 09-QC14-3 (10-15)	Ra-226	24	Bq/g	12-Nov-2009	ALPHA
CORE 09-QC14-3 (15-20)	Ra-226	23	Bq/g	12-Nov-2009	ALPHA
CORE 09-QC14-4 (0-5)	Ra-226	16	Bq/g	12-Nov-2009	ALPHA
CORE 09-QC14-4 (5-10)	Ra-226	17	Bq/g	12-Nov-2009	ALPHA
CORE 09-QC14-4 (10-15)	Ra-226	22	Bq/g	12-Nov-2009	ALPHA
CORE 09-QC14-4 (15-20)	Ra-226	19	Bq/g	12-Nov-2009	ALPHA

Becquerel LABORATORIES

ANALYSIS REPORT

Becquerel Laboratories Inc.
6790 Kitimat Rd., Unit 4
Mississauga, Ontario
Canada, L5N 5L9

Phone: (905) 826-3080
FAX: (905) 826-4151

Batch: T09-01487.0

Date: 13-Nov-2009

Methods: ALPHA BQ-RAD-ALPHA alpha-particle spectrometry

Units: Bq/g Becquerels per gram

These results relate only to the samples analysed and only to the items tested.

13-Nov-2009 approved by:

Donald D. Burgess PhD
Senior Scientist, Division Supervisor

SGS Lakefield Research Limited
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Ecometrix
Attn : Erin Clyde

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Tuesday, October 27, 2009

Date Rec. : 01 October 2009
LR. Ref. : **CA10063-OCT09**
Project : 09-1663

Copy to : #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: CORE 09-EC-1 (0-5)	6: CORE 09-EC-1 (5-10)	7: CORE 09-EC-2 (0-2.5)	8: CORE 09-EC-2 (2.5-5)	9: CORE 09-EC-2 (5-7.5)	10: CORE 09-QC14-1 (0-5)
Sample Date & Time			28-Sep-09	28-Sep-09	28-Sep-09	28-Sep-09	28-Sep-09	28-Sep-09
Ba as BaSO4 Calc. * [µg/g]	---	---	160	770	480	630	530	940
SO4 as BaSO4 Calc. ** [µg/g]	---	---	7280	2430	2430	2430	2430	14600
Total Sulphur [%]	09-Oct-09	10:07	1.17	0.762	0.628	1.03	1.18	1.21
Carbonate (CO3) [%]	08-Oct-09	10:46	0.058	0.280	< 0.005	< 0.005	< 0.005	< 0.005
Total Organic Carbon [%]	09-Oct-09	10:07	10.5	16.7	0.617	0.206	0.090	0.490
Total Carbon [%]	09-Oct-09	10:07	10.5	16.8	0.616	0.207	0.089	0.489
Sulphide [%]	08-Oct-09	11:47	0.47	0.70	0.53	1.04	1.07	0.96
Sulphate [%]	13-Oct-09	16:45	0.3	0.1	0.1	0.1	0.1	0.6
Silver [µg/g]	14-Oct-09	13:32	< 0.7	< 0.7	1.5	1.2	1.1	3.0
Aluminum [µg/g]	14-Oct-09	13:32	3800	5800	1500	1200	890	6700
Arsenic [µg/g]	14-Oct-09	13:32	14	26	22	24	24	37
Barium [µg/g]	14-Oct-09	13:32	94	450	280	370	310	550
Beryllium [µg/g]	14-Oct-09	13:32	0.35	0.13	0.51	0.41	0.34	1.5
Bismuth [µg/g]	14-Oct-09	13:32	12	< 0.5	11	8.6	7.8	15
Calcium [µg/g]	14-Oct-09	13:32	4600	7400	230	110	63	2400
Cadmium [µg/g]	14-Oct-09	13:32	4.0	1.8	0.25	0.27	0.29	0.45
Cerium [µg/g]	14-Oct-09	13:32	240	800	340	300	240	600
Cobalt [µg/g]	14-Oct-09	13:32	15	17	16	21	22	25
Chromium [µg/g]	14-Oct-09	13:32	7.8	17	8.2	6.5	5.8	16
Cesium [µg/g]	14-Oct-09	13:32	1.1	0.90	0.32	0.20	0.19	1.1
Copper [µg/g]	14-Oct-09	13:32	15	56	50	54	54	120
Iron [µg/g]	14-Oct-09	13:32	240000	16000	13000	17000	19000	22000
Gallium [µg/g]	14-Oct-09	13:32	2.7	6.5	2.8	2.4	1.9	5.3
Germanium [µg/g]	14-Oct-09	13:32	7.2	4.0	1.4	1.4	1.2	2.6
Hafnium [µg/g]	14-Oct-09	13:32	0.1	0.9	0.5	0.7	0.7	1.5
Indium [µg/g]	14-Oct-09	13:32	< 0.01	0.01	0.02	0.01	0.01	0.03
Potassium [µg/g]	14-Oct-09	13:32	210	270	330	300	230	570
Lanthanum [µg/g]	14-Oct-09	13:32	130	420	190	170	140	310
Lithium [µg/g]	14-Oct-09	13:32	0.9	1.3	0.8	0.5	0.2	4.7

OnLine LIMS

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LR Report : CA10063-OCT09

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: CORE 09-EC-1 (0-5)	6: CORE 09-EC-1 (5-10)	7: CORE 09-EC-2 (0-2.5)	8: CORE 09-EC-2 (2.5-5)	9: CORE 09-EC-2 (5-7.5)	10: CORE 09-QC14-1 (0-5)
Lutetium [µg/g]	14-Oct-09	13:32	1.1	5.3	0.14	0.060	0.038	1.1
Magnesium [µg/g]	14-Oct-09	13:32	240	1500	110	38	18	97
Manganese [µg/g]	14-Oct-09	13:32	84	180	18	7.6	4.6	14
Molybdenum [µg/g]	14-Oct-09	13:32	10	3.9	6.4	6.1	5.5	10
Sodium [µg/g]	14-Oct-09	13:32	40	55	11	8	5	15
Niobuim [µg/g]	14-Oct-09	13:32	2.7	< 0.7	9.7	7.8	7.5	13
Nickel [µg/g]	14-Oct-09	13:32	19	43	9	10	11	20
Lead [µg/g]	14-Oct-09	13:32	280	640	240	270	310	650
Phosphorus [µg/g]	14-Oct-09	13:32	810	360	400	360	330	820
Rubidium [µg/g]	14-Oct-09	13:32	2.5	4.0	2.6	2.0	1.4	4.1
Antimony [µg/g]	14-Oct-09	13:32	< 1	< 1	1	< 1	< 1	2
Scandium [µg/g]	14-Oct-09	13:32	1.6	3.0	0.9	0.8	0.6	2.8
Selenium [µg/g]	14-Oct-09	13:32	< 2	< 2	< 2	< 2	< 2	< 2
Tin [µg/g]	14-Oct-09	13:32	< 6	< 6	< 6	< 6	< 6	< 6
Strontium [µg/g]	14-Oct-09	13:32	7.9	14	5.1	5.4	4.6	11
Sulphur [µg/g]	14-Oct-09	13:32	15000	11000	6700	11000	12000	12000
Tantalum [µg/g]	14-Oct-09	13:32	0.05	0.23	0.07	0.12	0.28	0.30
Terbium [µg/g]	14-Oct-09	13:32	4.3	33	1.4	0.90	0.67	5.6
Tellerium [µg/g]	14-Oct-09	13:32	0.1	< 0.1	0.2	0.2	0.2	0.3
Thorium [µg/g]	14-Oct-09	13:32	120	89	560	470	380	1600
Titanium [µg/g]	14-Oct-09	13:32	91	220	330	260	240	610
Thallium [µg/g]	14-Oct-09	13:32	< 3	< 3	< 3	< 3	< 3	< 3
Uranium [µg/g]	14-Oct-09	13:32	230	150	23	18	15	83
Vanadium [µg/g]	14-Oct-09	13:32	26	17	4.0	2.7	2.4	7.2
Tungsten [µg/g]	14-Oct-09	13:32	79	5	5	5	6	8
Yttrium [µg/g]	14-Oct-09	13:32	84	750	12	6.7	5.2	87
Ytterbium [µg/g]	14-Oct-09	13:31	8.7	46	1.2	0.57	0.40	9.2
Zinc [µg/g]	14-Oct-09	13:32	65	58	8.9	8.0	5.8	23
Zirconium [µg/g]	14-Oct-09	13:32	6	< 5	30	27	26	58

Ra226 subcontracted to Becquerel Labs.
* BaSO4 Calculation based on Ba values and assumes all Ba is in BaSO4 form.
** BaSO4 Calculation based on SO4 values and assumes all SO4 is in BaSO4 form.

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OnLine LIMS

SGS

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Tuesday, October 27, 2009

Date Rec. : 01 October 2009
LR. Ref. : **CA10063-OCT09**
Project : 09-1663

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CERTIFICATE OF ANALYSIS

Final Report

Analysis	11: CORE 09-QC14-1 (5-10)	12: CORE 09-QC14-1 (10-15)	13: CORE 09-QC14-2 (0-2.5)	14: CORE 09-QC14-2 (2.5-5)	15: CORE 09-QC14-2 (5-7.5)	16: CORE 09-QC14-2 (7.5-10)	17: CORE 09-QC14-3 (0-5)
Sample Date & Time	28-Sep-09	28-Sep-09	28-Sep-09	28-Sep-09	28-Sep-09	28-Sep-09	28-Sep-09
Ba as BaSO4 Calc. * [µg/g]	580	480	260	370	560	540	920
SO4 as BaSO4 Calc. ** [µg/g]	53400	29100	2430	2430	2430	2430	<2430
Total Sulphur [%]	2.33	2.21	0.633	0.885	0.871	1.29	1.35
Carbonate (CO3) [%]	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.005
Total Organic Carbon [%]	0.114	0.065	0.519	0.289	0.121	0.086	0.617
Total Carbon [%]	0.115	0.064	0.519	0.289	0.121	0.086	0.618
Sulphide [%]	1.56	1.80	0.52	0.77	0.84	1.26	1.37
Sulphate [%]	2.2	1.2	0.1	0.1	0.1	0.1	< 0.1
Silver [µg/g]	1.7	1.3	0.8	1.0	1.1	1.3	3.4
Aluminum [µg/g]	3800	2600	830	690	850	1400	7700
Arsenic [µg/g]	33	26	17	19	21	23	36
Barium [µg/g]	340	280	150	220	330	320	540
Beryllium [µg/g]	0.81	0.61	0.28	0.28	0.34	0.51	1.7
Bismuth [µg/g]	10	8.1	7.5	9.2	8.5	7.6	15
Calcium [µg/g]	8900	4900	190	130	79	59	350
Cadmium [µg/g]	0.42	0.43	0.18	0.22	0.22	0.31	0.55
Cerium [µg/g]	610	430	300	290	280	250	770
Cobalt [µg/g]	35	36	15	18	17	24	38
Chromium [µg/g]	8.2	6.2	4.7	4.9	5.7	6.6	18
Cesium [µg/g]	0.49	0.32	0.18	0.22	0.31	0.20	0.55
Copper [µg/g]	100	88	43	46	42	51	140
Iron [µg/g]	21000	21000	10000	12000	13000	18000	22000
Gallium [µg/g]	4.3	3.0	2.1	2.1	2.0	1.9	6.2
Germanium [µg/g]	2.6	2.1	1.2	1.2	1.2	1.2	3.1
Hafnium [µg/g]	1.2	0.9	0.3	0.6	1.0	0.7	1.5
Indium [µg/g]	0.02	0.02	< 0.01	< 0.01	0.01	0.01	0.04
Potassium [µg/g]	440	290	210	230	250	250	600
Lanthanum [µg/g]	310	220	170	170	160	140	390
Lithium [µg/g]	1.8	1.0	0.2	0.1	0.4	0.7	5.7

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LR Report : **CA10063-OCT09**

Analysis	**11: CORE 09-QC14-1 (5-10)**	**12: CORE 09-QC14-1 (10-15)**	**13: CORE 09-QC14-2 (0-2.5)**	**14: CORE 09-QC14-2 (2.5-5)**	**15: CORE 09-QC14-2 (5-7.5)**	**16: CORE 09-QC14-2 (7.5-10)**	**17: CORE 09-QC14-3 (0-5)**
Lutetium [µg/g]	1.4	1.1	0.081	0.048	0.031	0.036	1.9
Magnesium [µg/g]	76	65	88	46	25	23	120
Manganese [µg/g]	5.3	5.4	13	8.6	4.7	3.9	20
Molybdenum [µg/g]	7.8	7.3	5.3	5.2	7.9	4.8	8.0
Sodium [µg/g]	12	7	8	7	6	6	16
Niobuim [µg/g]	7.2	4.9	7.0	8.2	8.4	7.7	15
Nickel [µg/g]	25	24	8	8	8	12	32
Lead [µg/g]	490	390	180	260	270	230	650
Phosphorus [µg/g]	490	320	260	300	360	350	830
Rubidium [µg/g]	3.2	2.1	1.9	1.9	1.8	1.6	4.3
Antimony [µg/g]	< 1	< 1	< 1	< 1	< 1	< 1	2
Scandium [µg/g]	1.5	1.0	0.5	0.4	0.5	0.8	3.0
Selenium [µg/g]	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Tin [µg/g]	< 6	< 6	< 6	< 6	< 6	< 6	< 6
Strontium [µg/g]	12	8.5	3.6	4.1	4.8	4.6	7.5
Sulphur [µg/g]	22000	20000	6500	8700	8600	12000	13000
Tantalum [µg/g]	0.15	0.09	0.04	0.05	0.12	0.35	0.45
Terbium [µg/g]	7.5	5.5	0.97	0.83	0.68	0.64	9.5
Tellerium [µg/g]	0.2	0.2	0.1	0.2	0.2	0.2	0.3
Thorium [µg/g]	880	630	310	310	360	580	1800
Titanium [µg/g]	370	240	210	250	260	240	630
Thallium [µg/g]	< 3	< 3	< 3	< 3	< 3	< 3	< 3
Uranium [µg/g]	71	47	17	17	13	15	120
Vanadium [µg/g]	3.7	2.8	2.7	2.7	2.7	2.6	8.0
Tungsten [µg/g]	7	7	3	4	5	6	8
Yttrium [µg/g]	160	100	9.1	6.8	5.5	5.1	180
Ytterbium [µg/g]	12	9.1	0.74	0.46	0.33	0.36	16
Zinc [µg/g]	28	24	8.8	6.9	4.7	5.4	42
Zirconium [µg/g]	38	27	20	26	28	25	57

Ra226 subcontracted to Becquerel Labs.
* BaSO4 Calculation based on Ba values and assumes all Ba is in BaSO4 form.
** BaSO4 Calculation based on SO4 values and assumes all SO4 is in BaSO4 form.

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Tuesday, October 27, 2009

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CERTIFICATE OF ANALYSIS

Final Report

Analysis	18: CORE 09-QC14-3 (5-10)	19: CORE 09-QC14-3 (10-15)	20: CORE 09-QC14-3 (15-20)	21: CORE 09-QC14-4 (0-5)	22: CORE 09-QC14-4 (5-10)	23: CORE 09-QC14-4 (10-15)	24: CORE 09-QC14-4 (15-20)
Sample Date & Time	28-Sep-09	28-Sep-09	28-Sep-09	28-Sep-09	28-Sep-09	28-Sep-09	28-Sep-09
Ba as BaSO4 Calc. * [µg/g]	1090	1120	1070	970	950	990	800
SO4 as BaSO4 Calc. ** [µg/g]	4850	7280	7280	4850	46100	87400	75200
Total Sulphur [%]	1.48	1.39	1.60	1.48	2.00	2.36	2.58
Carbonate (CO3) [%]	< 0.005	< 0.005	< 0.005	0.022	0.100	0.123	0.034
Total Organic Carbon [%]	0.136	0.112	0.097	0.683	0.188	0.178	0.109
Total Carbon [%]	0.136	0.113	0.096	0.688	0.208	0.202	0.116
Sulphide [%]	1.43	1.32	1.48	1.40	1.37	1.08	1.44
Sulphate [%]	0.2	0.3	0.3	0.2	1.9	3.6	3.1
Silver [µg/g]	3.2	3.9	3.7	3.0	2.9	4.0	2.9
Aluminum [µg/g]	7700	11000	9000	6500	6200	10000	7500
Arsenic [µg/g]	45	49	46	40	38	40	38
Barium [µg/g]	640	660	630	570	560	580	470
Beryllium [µg/g]	1.6	2.1	1.9	1.4	1.4	2.0	1.5
Bismuth [µg/g]	15	16	15	15	14	17	14
Calcium [µg/g]	710	940	1300	1400	9900	19000	16000
Cadmium [µg/g]	0.61	0.66	0.58	0.64	0.56	0.64	0.55
Cerium [µg/g]	1100	1200	1000	900	830	1100	890
Cobalt [µg/g]	45	41	38	39	35	38	38
Chromium [µg/g]	17	24	21	16	15	21	16
Cesium [µg/g]	0.77	0.88	0.76	0.54	0.70	0.87	0.81
Copper [µg/g]	140	160	160	130	120	160	130
Iron [µg/g]	24000	25000	24000	23000	22000	24000	23000
Gallium [µg/g]	7.5	8.6	7.5	6.4	6.1	8.0	6.3
Germanium [µg/g]	4.2	4.4	4.1	3.5	3.3	4.0	3.5
Hafnium [µg/g]	2.2	2.4	2.2	1.5	1.8	2.5	2.2
Indium [µg/g]	0.04	0.05	0.06	0.04	0.03	0.05	0.04
Potassium [µg/g]	630	730	690	600	600	760	650
Lanthanum [µg/g]	560	600	520	460	420	540	450
Lithium [µg/g]	5.2	7.7	7.0	4.9	5.7	10	6.2

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Analysis	**18: CORE 09-QC14-3 (5-10)**	**19: CORE 09-QC14-3 (10-15)**	**20: CORE 09-QC14-3 (15-20)**	**21: CORE 09-QC14-4 (0-5)**	**22: CORE 09-QC14-4 (5-10)**	**23: CORE 09-QC14-4 (10-15)**	**24: CORE 09-QC14-4 (15-20)**
Lutetium [µg/g]	3.1	3.3	2.8	2.3	2.0	3.5	2.6
Magnesium [µg/g]	300	220	120	770	520	1300	400
Manganese [µg/g]	35	31	18	79	53	130	57
Molybdenum [µg/g]	5.8	8.1	8.9	9.0	9.4	8.0	6.6
Sodium [µg/g]	15	18	15	18	16	21	18
Niobuim [µg/g]	9.5	9.0	8.9	13	11	12	10
Nickel [µg/g]	38	39	34	31	28	37	31
Lead [µg/g]	690	720	680	630	550	800	640
Phosphorus [µg/g]	840	930	860	760	740	950	710
Rubidium [µg/g]	4.8	5.8	5.4	4.3	4.3	5.4	5.0
Antimony [µg/g]	< 1	1	1	1	1	1	< 1
Scandium [µg/g]	3.1	4.2	3.6	2.7	2.5	3.8	2.9
Selenium [µg/g]	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Tin [µg/g]	< 6	< 6	< 6	< 6	< 6	< 6	< 6
Strontium [µg/g]	11	14	15	9.2	16	21	18
Sulphur [µg/g]	14000	14000	15000	14000	19000	22000	25000
Tantalum [µg/g]	0.27	0.27	0.28	0.48	0.57	0.55	0.48
Terbium [µg/g]	17	18	14	12	10	18	13
Tellerium [µg/g]	0.3	0.4	0.4	0.3	0.3	0.4	0.3
Thorium [µg/g]	1900	2400	2200	1600	1600	2400	1800
Titanium [µg/g]	660	680	640	590	550	740	570
Thallium [µg/g]	< 3	< 3	< 3	< 3	< 3	< 3	< 3
Uranium [µg/g]	100	110	110	100	100	140	110
Vanadium [µg/g]	7.7	9.3	8.3	7.4	6.4	9.8	6.7
Tungsten [µg/g]	8	9	8	8	8	8	8
Yttrium [µg/g]	370	350	290	240	220	360	260
Ytterbium [µg/g]	26	28	24	19	17	30	22
Zinc [µg/g]	58	59	51	46	42	59	46
Zirconium [µg/g]	64	68	64	56	54	70	58

Ra226 subcontracted to Becquerel Labs.
* BaSO4 Calculation based on Ba values and assumes all Ba is in BaSO4 form.
** BaSO4 Calculation based on SO4 values and assumes all SO4 is in BaSO4 form.

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OnLine LIMS

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CERTIFICATE OF ANALYSIS
Final Report (QC Report)

Analysis	25: MDL	26: QC - Blank	27: QC - STD % Recovery	28: QC - DUP % Recovery
Ba as BaSO4 Calc. * [µg/g]	---	---	---	---
SO4 as BaSO4 Calc. ** [µg/g]	---	---	---	---
Total Sulphur [%]	0.005	< 0.005	100%	98%
Carbonate (CO3) [%]	0.005	< 0.005	101%	100%
Total Organic Carbon [%]	0.01	---	---	---
Total Carbon [%]	0.005	< 0.005	100%	95%
Sulphide [%]	0.01	< 0.01	103%	100%
Sulphate [%]	0.1	< 0.1	98%	107%
Silver [µg/g]	0.7	< 0.7	98%	93%
Aluminum [µg/g]	1	< 1	99%	114%
Arsenic [µg/g]	1	< 1	98%	96%
Barium [µg/g]	0.05	< 0.05	100%	110%
Beryllium [µg/g]	0.1	< 0.1	100%	111%
Bismuth [µg/g]	0.5	< 0.5	98%	100%
Calcium [µg/g]	1	< 1	99%	103%
Cadmium [µg/g]	0.05	< 0.05	98%	100%
Cerium [µg/g]	0.006	< 0.006	107%	99%
Cobalt [µg/g]	0.3	< 0.3	96%	965
Chromium [µg/g]	0.5	< 0.5	99%	106%
Cesium [µg/g]	0.01	< 0.01	100%	99%
Copper [µg/g]	0.1	< 0.1	101%	110%
Iron [µg/g]	0.5	< 0.5	98%	91%
Gallium [µg/g]	0.03	< 0.03	100%	101%
Germanium [µg/g]	0.3	< 0.3	100%	95%
Hafnium [µg/g]	0.1	< 0.1	100%	120%
Indium [µg/g]	0.01	< 0.01	100%	109%
Potassium [µg/g]	1	< 1	100%	110%
Lanthanum [µg/g]	0.001	< 0.001	101%	99%
Lithium [µg/g]	0.1	< 0.1	99%	100%
Lutetium [µg/g]	0.001	< 0.001	96%	99%
Magnesium [µg/g]	1	< 1	100%	105%
Manganese [µg/g]	0.05	< 0.05	98%	108%
Molybdenum [µg/g]	0.5	< 0.5	101%	74%

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Project : 09-1663

LR Report : **CA10063-OCT09**

Analysis	25: MDL	26: QC - Blank	27: QC - STD % Recovery	28: QC - DUP % Recovery
Sodium [µg/g]	1	< 1	102%	104%
Niobuim [µg/g]	0.7	< 0.7	100%	99%
Nickel [µg/g]	1	< 1	99%	103%
Lead [µg/g]	0.7	< 0.7	98%	110%
Phosphorus [µg/g]	5	< 5	98%	106%
Rubidium [µg/g]	0.004	< 0.004	100%	100%
Antimony [µg/g]	1	< 1	102%	100%
Scandium [µg/g]	0.2	< 0.2	100%	103%
Selenium [µg/g]	1	< 2	97%	100%
Tin [µg/g]	6	< 6	103%	94%
Strontium [µg/g]	0.01	< 0.01	100%	96%
Sulphur [µg/g]	1	< 1	---	90%
Tantalum [µg/g]	0.01	< 0.01	100%	101%
Terbium [µg/g]	0.001	< 0.001	94%	100%
Tellerium [µg/g]	0.1	< 0.1	100%	107%
Thorium [µg/g]	0.01	< 0.01	100%	99%
Titanium [µg/g]	0.2	< 0.2	104%	99%
Thallium [µg/g]	3	< 3	97%	100%
Uranium [µg/g]	0.002	< 0.002	---	97%
Vanadium [µg/g]	0.1	< 0.1	100%	109%
Tungsten [µg/g]	1	< 1	99%	100%
Yttrium [µg/g]	0.1	< 0.1	100%	110%
Ytterbium [µg/g]	0.001	---	100%	100%
Zinc [µg/g]	0.1	< 0.1	98%	103%
Zirconium [µg/g]	5	< 5	102%	105%

Ra226 subcontracted to Becquerel Labs.
* BaSO4 Calculation based on Ba values and assumes all Ba is in BaSO4 form.
** BaSO4 Calculation based on SO4 values and assumes all SO4 is in BaSO4 form.

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ANALYSIS REPORT

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Batch: T09-01384.0

Date: 04-Nov-2009

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Client Ref.Oct 10066
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23 water samples   Received: 06-Oct-2009

Results of Analysis

Sample	Test	Result	Units	Date	Method
SW09-QC14-1T	Ra-226	0.77	Bq/l	27-Oct-2009	ALPHA
SW09-QC14-1B	Ra-226	1.0	Bq/l	27-Oct-2009	ALPHA
SW09-QC14-2T	Ra-226	0.82	Bq/l	27-Oct-2009	ALPHA
SW09-QC14-2B	Ra-226	0.91	Bq/l	27-Oct-2009	ALPHA
SW09-QC14-3T	Ra-226	0.71	Bq/l	27-Oct-2009	ALPHA
SW09-QC14-3B	Ra-226	0.95	Bq/l	31-Oct-2009	ALPHA
SW09-QC14-4T	Ra-226	0.79	Bq/l	31-Oct-2009	ALPHA
SW09-QC14-4B	Ra-226	0.95	Bq/l	31-Oct-2009	ALPHA
PW09-QC14-1 (0-5)	Ra-226	1.8	Bq/l	31-Oct-2009	ALPHA
PW09-QC14-1 (5-10)	Ra-226	1.4	Bq/l	01-Nov-2009	ALPHA
PW09-QC14-1 (10-15)	Ra-226	0.97	Bq/l	01-Nov-2009	ALPHA
PW09-QC14-2 (0-2.5)	Ra-226	3.6	Bq/l	01-Nov-2009	ALPHA
PW09-QC14-2 (2.5-5)	Ra-226	2.8	Bq/l	01-Nov-2009	ALPHA
PW09-QC14-2 (5-7.5)	Ra-226	5.9	Bq/l	01-Nov-2009	ALPHA
PW09-QC14-2 (7.5-10)	Ra-226	6.9	Bq/l	01-Nov-2009	ALPHA
PW09-QC14-3 (0-5)	Ra-226	4.1	Bq/l	01-Nov-2009	ALPHA
PW09-QC14-3 (5-10)	Ra-226	3.4	Bq/l	01-Nov-2009	ALPHA
PW09-QC14-3 (10-15)	Ra-226	2.6	Bq/l	01-Nov-2009	ALPHA
PW09-QC14-3 (15-20)	Ra-226	2.5	Bq/l	01-Nov-2009	ALPHA
PW09-QC14-4 (0-5)	Ra-226	4.8	Bq/l	01-Nov-2009	ALPHA
PW09-QC14-4 (5-10)	Ra-226	1.6	Bq/l	01-Nov-2009	ALPHA
PW09-QC14-4 (10-15)	Ra-226	2.2	Bq/l	01-Nov-2009	ALPHA
PW09-QC14-4 (15-20)	Ra-226	0.42	Bq/l	01-Nov-2009	ALPHA

Becquerel LABORATORIES

ANALYSIS REPORT

Becquerel Laboratories Inc.
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Mississauga, Ontario
Canada, L5N 5L9

Phone: (905) 826-3080
FAX: (905) 826-4151

Batch: T09-01384.0

Date: 04-Nov-2009

Methods: ALPHA BQ-RAD-ALPHA alpha-particle spectrometry MDL 0.01 Bq/l

Units: Bq/l Becquerels per litre

These results relate only to the samples analysed and only to the items tested.
These results have not been corrected for blanks

04-Nov-2009 approved by: [signature]
Donald D. Burgess PhD
Senior Scientist, Division Supervisor

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Phone: 905-794-2325, Fax:905-794-2338

October 14, 2009

Date Rec. : 01 October 2009
LR Report : **CA10066-OCT09**
Project : 09-1663

CERTIFICATE OF ANALYSIS
Final Report

Analysis	**1: Analysis Start Date**	**2: Analysis Start Time**	**3: Analysis Approval Date**	**4: Analysis Approval Time**	**13: PW09-QC14-1 (0-5)**	**14: PW09-QC14-1 (5-10)**	**15: PW09-QC14-1 (10-15)**	**16: PW09-QC14-2 (0-2.5)**	**17: PW09-QC14-2 (2.5-5)**
Sample Date & Time					27-Sep-09	27-Sep-09	29-Sep-09	28-Sep-09	28-Sep-09
Sulphate [mg/L]	02-Oct-09	19:39	06-Oct-09	14:20	---	---	1500	32	12
Tot. Suspended Solids [mg/L]	05-Oct-09	10:24	06-Oct-09	12:15	---	---	---	---	---
Dissolved Organic Carbon [mg/L]	02-Oct-09	10:00	06-Oct-09	13:53	---	---	4.7	28.0	18.3
Dissolved Inorganic Carbon [mg/L]	05-Oct-09	14:35	07-Oct-09	12:41	---	---	1.0	< 1.0	< 1.0
Total Organic Carbon [mg/L]	02-Oct-09	10:00	05-Oct-09	13:40	---	---	---	---	---
Acidity [mg/L as CaCO3]	02-Oct-09	15:00	08-Oct-09	09:53	---	---	49	21	15
Hardness [mg/L as CaCO3]	05-Oct-09	09:00	05-Oct-09	13:21	731	1294	1335	26.2	16.9
Aluminum [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	< 0.01	< 0.01	< 0.01	< 0.01	0.03
Arsenic [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.0082	0.0102	0.0064	0.0064	0.0084
Barium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.0577	0.0283	0.0212	0.309	0.308
Beryllium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002
Boron [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.0048	0.0107	0.0138	0.0054	0.0047
Bismuth [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	< 0.00001	< 0.00001	0.00008	0.00003	0.00024
Calcium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:21	290	516	532	8.79	5.68
Cadmium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.000012	0.000050	0.000118	0.000055	< 0.000003
Cobalt [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.0154	0.0367	0.0438	0.00521	0.000917
Chromium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Copper [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	< 0.0005	0.0008	0.0012	0.0043	0.0025
Iron [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	63.9	40.0	24.3	0.03	0.52
Potassium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	1.21	1.34	1.49	0.34	0.40
Lithium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	0.002	0.002	< 0.002	< 0.002	< 0.002
Magnesium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	1.63	1.48	1.37	1.02	0.664

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LR Report : **CA10066-OCT09**

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	13: PW09-QC14-1 (0-5)	14: PW09-QC14-1 (5-10)	15: PW09-QC14-1 (10-15)	16: PW09-QC14-2 (0-2.5)	17: PW09-QC14-2 (2.5-5)
Manganese [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.771	0.503	0.346	0.282	0.133
Molybdenum [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.00589	0.0119	0.00918	0.00029	0.00133
Sodium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	1.77	2.04	2.08	2.35	1.98
Nickel [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.0050	0.0172	0.0173	0.0044	0.0012
Phosphorus [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	< 0.01	< 0.01	< 0.01	< 0.01	0.01
Lead [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.00069	0.00078	0.00202	0.0242	0.00596
Sulphur [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	242	396	399	8.28	3.87
Antimony [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	< 0.0002	< 0.0002	< 0.0002	0.0002	0.0006
Selenium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Silica [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	8.09	10.3	10.3	1.23	1.71
Tin [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	< 0.00001	0.00004	0.00008	0.00004	< 0.00001
Strontium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	0.149	0.260	0.266	0.0205	0.0154
Titanium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.0006	0.0007	0.0007	0.0003	0.0062
Thallium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Uranium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.0136	0.0589	0.0445	0.000946	0.000524
Vanadium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.00010	0.00011	0.00013	0.00007	0.00013
Zinc [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.011	0.039	0.041	0.005	0.003

Groundwater samples are field filtered
Ra226 subcontracted to Becquerel Labs.

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Project Specialist
Environmental Services, Analytical

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October 14, 2009

Date Rec. : 01 October 2009
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Project : 09-1663

CERTIFICATE OF ANALYSIS
Final Report

Analysis	**18: PW09-QC14-2 (5-7.5)**	**19: PW09-QC14-2 (7.5-10)**	**20: PW09-QC14-3 (0-5)**	**21: PW09-QC14-3 (5-10)**	**22: PW09-QC14-3 (10-15)**	**23: PW09-QC14-3 (15-20)**	**24: PW09-QC14-4 (0-5)**	**25: PW09-QC14-4 (5-10)**	**26: PW09-QC14-4 (10-15)**	**27: PW09-QC14-4 (15-20)**
Sample Date & Time	28-Sep-09	28-Sep-09	29-Sep-09	29-Sep-09	29-Sep-09	29-Sep-09	29-Sep-09	29-Sep-09	29-Sep-09	29-Sep-09
Sulphate [mg/L]	12	---	5.6	6.8	18	240	560	1400	1400	1400
Tot. Suspended Solids [mg/L]	---	---	---	---	---	---	---	---	---	---
Dissolved Organic Carbon [mg/L]	17.9	---	3.5	3.2	2.8	3.8	9.3	6.6	7.3	4.0
Dissolved Inorganic Carbon [mg/L]	< 1.0	---	2.0	3.0	4.7	3.1	< 1.0	4.7	3.1	5.9
Total Organic Carbon [mg/L]	---	---	---	---	---	---	---	---	---	---
Acidity [mg/L as CaCO3]	16	---	6	< 4	< 4	< 4	19	< 4	---	---
Hardness [mg/L as CaCO3]	17.9	19.1	18.0	24.5	42.8	250	512	1362	1335	1310
Aluminum [mg/L]	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.04	< 0.01
Arsenic [mg/L]	0.0066	0.0066	0.0026	0.0025	0.0040	0.0042	0.0050	0.0054	0.0026	0.0027
Barium [mg/L]	0.519	0.499	0.333	0.233	0.131	0.0762	0.231	0.0657	0.0328	0.0197
Beryllium [mg/L]	< 0.00002	< 0.00002	0.00013	0.00005	0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002
Boron [mg/L]	0.0051	0.0044	0.0026	0.0070	0.0121	0.0162	0.0220	0.0944	0.0802	0.0387
Bismuth [mg/L]	0.00006	< 0.00001	0.00012	0.00004	0.00001	0.00001	0.00005	0.00002	0.00001	0.00003
Calcium [mg/L]	6.06	6.44	6.12	8.51	15.5	97.4	195	536	527	519
Cadmium [mg/L]	0.000005	0.000006	0.000112	0.000043	0.000034	0.000086	0.000029	0.000016	0.000017	0.000015
Cobalt [mg/L]	0.000766	0.000876	0.00189	0.00766	0.00912	0.0123	0.00473	0.00237	0.00186	0.00185
Chromium [mg/L]	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Copper [mg/L]	0.0015	0.0007	< 0.0005	< 0.0005	< 0.0005	< 0.0005	0.0009	0.0007	0.0006	0.0008
Iron [mg/L]	2.46	6.07	7.18	6.88	5.66	7.35	23.5	1.62	0.41	0.26
Potassium [mg/L]	0.62	0.53	0.37	0.50	0.60	0.90	0.65	1.06	0.94	0.92
Lithium [mg/L]	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.002	0.002	< 0.002	< 0.002
Magnesium [mg/L]	0.675	0.734	0.670	0.801	0.980	1.78	6.05	5.49	4.43	3.52

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Analysis	**18: PW09-QC14-2 (5-7.5)**	**19: PW09-QC14-2 (7.5-10)**	**20: PW09-QC14-3 (0-5)**	**21: PW09-QC14-3 (5-10)**	**22: PW09-QC14-3 (10-15)**	**23: PW09-QC14-3 (15-20)**	**24: PW09-QC14-4 (0-5)**	**25: PW09-QC14-4 (5-10)**	**26: PW09-QC14-4 (10-15)**	**27: PW09-QC14-4 (15-20)**
Manganese [mg/L]	0.133	0.146	0.143	0.161	0.191	0.249	1.27	0.400	0.352	0.251
Molybdenum [mg/L]	0.00107	0.00241	0.00045	0.00042	0.00155	0.00615	0.00339	0.0289	0.0291	0.0149
Sodium [mg/L]	1.79	1.51	1.30	1.20	1.36	1.63	2.05	2.00	1.94	1.80
Nickel [mg/L]	0.0012	0.0011	0.0010	0.0019	0.0020	0.0039	0.0025	0.0020	0.0018	0.0019
Phosphorus [mg/L]	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.02	< 0.01	0.02	< 0.01
Lead [mg/L]	0.00098	0.00018	0.00029	0.00023	0.00027	0.00042	0.00043	0.00047	0.00044	0.00059
Sulphur [mg/L]	3.61	4.46	1.67	2.21	5.91	69.9	155	391	387	385
Antimony [mg/L]	0.0004	0.0005	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	0.0003	0.0003	< 0.0002
Selenium [mg/L]	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.002	< 0.001	< 0.001	< 0.001	0.002
Silica [mg/L]	2.15	3.04	5.18	7.70	8.81	8.23	4.59	3.66	2.45	3.95
Tin [mg/L]	< 0.00001	< 0.00001	< 0.00001	< 0.00001	0.00005	0.00011	0.00004	0.00006	0.00010	0.00022
Strontium [mg/L]	0.0204	0.0211	0.0170	0.0318	0.0499	0.146	0.137	0.277	0.263	0.268
Titanium [mg/L]	0.0005	0.0002	0.0003	0.0005	0.0005	0.0005	0.0004	0.0004	0.0003	0.0003
Thallium [mg/L]	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Uranium [mg/L]	0.000143	0.000072	0.000744	0.000806	0.000839	0.00957	0.0421	0.275	0.242	0.233
Vanadium [mg/L]	0.00006	0.00006	0.00019	0.00012	0.00014	0.00016	0.00013	0.00022	0.00021	0.00023
Zinc [mg/L]	0.002	0.003	0.002	0.005	0.008	0.015	0.006	0.003	0.003	0.003

Groundwater samples are field filtered
Ra226 subcontracted to Becquerel Labs.

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Project Specialist
Environmental Services, Analytical

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Sample Date & Time	26-Sep-09	26-Sep-09	27-Sep-09	27-Sep-09	27-Sep-09	27-Sep-09	27-Sep-09	27-Sep-09
Sulphate [mg/L]	55	32	72	32	54	35	57	25
Tot. Suspended Solids [mg/L]	---	---	---	43	---	---	---	6
Dissolved Organic Carbon [mg/L]	13.3	18.5	14.4	19.4	15.1	16.0	13.4	14.2
Dissolved Inorganic Carbon [mg/L]	2.4	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Total Organic Carbon [mg/L]	---	---	---	5.3	---	---	---	5.2
Acidity [mg/L as CaCO3]	31	20	56	15	29	15	31	20
Hardness [mg/L as CaCO3]	17.1	18.3	16.9	16.6	16.7	16.9	16.8	16.9
Aluminum [mg/L]	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic [mg/L]	0.0006	0.0008	0.0006	0.0011	0.0007	0.0009	0.0006	0.0012
Barium [mg/L]	0.109	0.116	0.104	0.108	0.105	0.105	0.0989	0.109
Beryllium [mg/L]	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002
Boron [mg/L]	0.0044	0.0045	0.0045	0.0056	0.0045	0.0047	0.0043	0.0053
Bismuth [mg/L]	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001
Calcium [mg/L]	5.72	6.24	5.69	5.55	5.59	5.69	5.63	5.67
Cadmium [mg/L]	0.000023	0.000029	0.000023	0.000023	0.000021	0.000035	0.000017	0.000052
Cobalt [mg/L]	0.00304	0.00143	0.00549	0.00169	0.00246	0.00165	0.00297	0.00144
Chromium [mg/L]	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Copper [mg/L]	0.0051	0.0045	0.0038	0.0023	0.0040	0.0034	0.0030	0.0025
Iron [mg/L]	0.02	0.36	0.04	0.01	0.02	0.07	0.02	0.01
Potassium [mg/L]	0.32	0.30	0.32	0.26	0.31	0.29	0.30	0.27
Lithium [mg/L]	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Magnesium [mg/L]	0.679	0.667	0.663	0.657	0.660	0.658	0.664	0.667

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Manganese [mg/L]	0.0328	0.0379	0.0288	0.0353	0.0292	0.0337	0.0272	0.0348
Molybdenum [mg/L]	0.00001	0.00002	< 0.00001	0.00002	< 0.00001	< 0.00001	< 0.00001	0.00003
Sodium [mg/L]	1.84	1.87	1.82	1.83	1.81	1.78	1.88	1.73
Nickel [mg/L]	0.0027	0.0025	0.0025	0.0024	0.0024	0.0024	0.0023	0.0026
Phosphorus [mg/L]	0.01	< 0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Lead [mg/L]	0.00375	0.00604	0.00717	0.00597	0.00374	0.00642	0.00386	0.00361
Sulphur [mg/L]	4.72	5.21	4.69	4.74	4.64	4.78	4.74	4.76
Antimony [mg/L]	0.0034	0.0007	0.0077	0.0007	0.0021	0.0009	0.0027	0.0005
Selenium [mg/L]	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Silica [mg/L]	0.59	0.63	0.58	0.59	0.58	0.64	0.58	0.63
Tin [mg/L]	0.00002	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001
Strontium [mg/L]	0.0122	0.0125	0.0121	0.0120	0.0119	0.0122	0.0120	0.0122
Titanium [mg/L]	< 0.0001	< 0.0001	0.0003	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Thallium [mg/L]	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Uranium [mg/L]	0.00107	0.000679	0.000535	0.000338	0.000489	0.000749	0.000386	0.000459
Vanadium [mg/L]	0.00004	0.00004	0.00006	0.00005	0.00005	0.00004	0.00004	0.00004
Zinc [mg/L]	0.003	0.004	0.002	0.005	0.002	0.004	0.003	0.005

Ra226 subcontracted to Becquerel Labs.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

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SGS

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Env ICP-MS Metals

Project : 09-1663

October 7, 2010

Ecometrix
Attn : Erin Clyde

6800 Campobello Road, Mississauga
Canada, L5N 2L8
Phone: 905-794-2325, Fax:905-794-2338

Date Rec. : 01 October 2009
LR Report: **CA10066-OCT09**

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CERTIFICATE OF ANALYSIS
Final Report (QC Report)

Analysis	28: MDL	29: QC - Blank	30: QC - STD % Recovery	31: QC - DUP % Recovery
Sulphate [mg/L]	0.2	< 0.2	100%	110%
Tot. Suspended Solids [mg/L]	2	< 2	96%	83%
Dissolved Organic Carbon [mg/L]	0.2	< 0.2	105%	98%
Dissolved Inorganic Carbon [mg/L]	0.2	0.7	107%	100%
Total Organic Carbon [mg/L]	0.2	< 0.2	105%	98%
Acidity [mg/L as CaCO3]	4	< 4	98%	102%
Hardness [mg/L as CaCO3]	0.5	---	---	---
Aluminum [mg/L]	0.01	< 0.01	98%	---
Arsenic [mg/L]	0.0002	< 0.0002	106%	---
Barium [mg/L]	0.00001	< 0.00001	122%	---
Beryllium [mg/L]	0.00002	< 0.00002	104%	---
Boron [mg/L]	0.0002	< 0.0002	96%	---
Bismuth [mg/L]	0.00001	< 0.00001	109%	---
Calcium [mg/L]	0.03	< 0.03	101%	---
Cadmium [mg/L]	0.000003	0.000003	99%	---
Cobalt [mg/L]	0.000002	< 0.000002	102%	---
Chromium [mg/L]	0.0005	< 0.0005	102%	---
Copper [mg/L]	0.0005	< 0.0005	102%	---
Iron [mg/L]	0.01	< 0.01	102%	---
Potassium [mg/L]	0.01	< 0.01	98%	---
Lithium [mg/L]	0.002	< 0.002	98%	---
Magnesium [mg/L]	0.003	< 0.003	98%	---
Manganese [mg/L]	0.00001	< 0.00001	107%	---
Molybdenum [mg/L]	0.00001	< 0.00001	99%	---
Sodium [mg/L]	0.01	< 0.01	94%	---
Nickel [mg/L]	0.0001	< 0.0001	100%	---
Phosphorus [mg/L]	0.01	< 0.01	100%	---
Lead [mg/L]	0.00002	< 0.00002	106%	---

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Env ICP-MS Metals

Project : 09-1663

LR Report : **CA10066-OCT09**

Analysis	28: MDL	29: QC - Blank	30: QC - STD % Recovery	31: QC - DUP % Recovery
Sulphur [mg/L]	0.01	< 0.01	98%	---
Antimony [mg/L]	0.0002	< 0.0002	101%	---
Selenium [mg/L]	0.001	< 0.001	102%	---
Silica [mg/L]	0.01	< 0.01	104%	---
Tin [mg/L]	0.00001	< 0.00001	96%	---
Strontium [mg/L]	0.0001	< 0.0001	100%	---
Titanium [mg/L]	0.0001	< 0.0001	96%	---
Thallium [mg/L]	0.0002	< 0.0002	107%	---
Uranium [mg/L]	0.000001	0.000001	1065	---
Vanadium [mg/L]	0.00003	< 0.00003	107%	---
Zinc [mg/L]	0.001	< 0.001	104%	---

Ra226 subcontracted to Becquerel Labs.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

ANALYSIS REPORT

Becquerel Laboratories Inc.
6790 Kitimat Rd., Unit 4
Mississauga, Ontario
Canada, L5N 5L9

Phone: (905) 826-3080
FAX: (905) 826-4151

Batch: T09-01485.0

Date: 12-Nov-2009

Lakefield Research Ltd.

185 Concession St., Postal Bag 4300
Lakefield, ON, K0L 2H0

attn: Brian Graham

Phone: (705) 652-2038
FAX: (705) 652-1918

Client Ref.
Sep 10524.R09
P.O: 17820

9 rock samples   Sampled: 22-Sep-2009   Received: 21-Oct-2009

Results of Analysis

Sample	Test	Result	Units	Date	Method
CORE 09-PSB-1 0-2.5	Ra-226	12	Bq/g	07-Nov-2009	ALPHA
CORE 09-PSB-1 2.5-5	Ra-226	4.9	Bq/g	07-Nov-2009	ALPHA
CORE 09-PSB-1 5-7.5	Ra-226	1.6	Bq/g	07-Nov-2009	ALPHA
CORE 09-PSB-1 7.5-10	Ra-226	2.8	Bq/g	07-Nov-2009	ALPHA
CORE 09-PSB-1 10-15	Ra-226	2.2	Bq/g	08-Nov-2009	ALPHA
CORE 09-PSB-2 0-5	Ra-226	16	Bq/g	08-Nov-2009	ALPHA
CORE 09-PSB-2 5-10	Ra-226	4.5	Bq/g	08-Nov-2009	ALPHA
CORE 09-PSB-2 10-15	Ra-226	5.6	Bq/g	08-Nov-2009	ALPHA
CORE 09-PSB-2 15-20	Ra-226	14	Bq/g	08-Nov-2009	ALPHA

Methods: ALPHA BQ-RAD-ALPHA alpha-particle spectrometry

Units: Bq/g Becquerels per gram

These results relate only to the samples analysed and only to the items tested.

12-Nov-2009 approved by: ______________________
Donald D. Burgess PhD
Senior Scientist, Division Supervisor

NOV 24 2009

SGS Lakefield Research Limited
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Ecometrix
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L5N 2L8, Canada

Phone: 905-794-2325
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Tuesday, October 27, 2009

Date Rec. : 30 September 2009
LR. Ref. : **CA10524-SEP09**
Project : 09-1663

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CERTIFICATE OF ANALYSIS

Final Report

Analysis	**3: Analysis Approval Date**	**4: Analysis Approval Time**	**5: CORE 09-PSB-1 0-2.5**	**6: CORE 09-PSB-1 2.5-5**	**7: CORE 09-PSB-1 5-7.5**	**8: CORE 09-PSB-1 7.5-10**
Sample Date & Time			22-Sep-09	22-Sep-09	22-Sep-09	22-Sep-09
BaSO4 Calc. using Ba* [µg/g]	---	---	2210	870	680	610
BaSO4 Calc. using SO4** [µg/g]	---	---	14600	238000	330000	381000
Total Sulphur [%]	06-Oct-09	14:44	0.698	3.33	4.55	5.14
Carbonate (CO3) [%]	06-Oct-09	14:42	9.43	11.7	6.45	10.7
Total Organic Carbon [%]	06-Oct-09	14:42	2.25	0.940	0.380	0.260
Total Carbon [%]	06-Oct-09	14:45	4.14	3.27	1.67	2.41
Sulphide [%]	07-Oct-09	16:00	0.43	0.18	0.11	< 0.01
Sulphate [%]	23-Oct-09	10:29	0.6	9.8	14	16
Silver [µg/g]	14-Oct-09	14:09	< 0.7	< 0.7	< 0.7	< 0.7
Aluminum [µg/g]	14-Oct-09	14:09	15000	11000	13000	8400
Arsenic [µg/g]	14-Oct-09	14:09	37	24	27	18
Barium [µg/g]	14-Oct-09	14:09	1300	510	400	360
Beryllium [µg/g]	14-Oct-09	14:09	1.1	0.88	1.2	0.82
Bismuth [µg/g]	14-Oct-09	14:09	13	8.9	6.6	5.4
Calcium [µg/g]	14-Oct-09	14:09	67000	140000	140000	180000
Cadmium [µg/g]	14-Oct-09	14:09	3.8	2.5	2.5	2.0
Cerium [µg/g]	13-Oct-09	15:45	690	510	690	440
Cobalt [µg/g]	14-Oct-09	14:09	98	79	100	69
Chromium [µg/g]	14-Oct-09	14:09	16	13	15	10
Cesium [µg/g]	13-Oct-09	15:45	19	0.55	0.24	0.19
Copper [µg/g]	14-Oct-09	14:09	55	33	43	26
Iron [µg/g]	14-Oct-09	14:09	190000	140000	140000	110000
Gallium [µg/g]	13-Oct-09	15:45	7.3	4.5	4.3	2.8
Germanium [µg/g]	13-Oct-09	15:45	6.5	4.9	5.5	4.0
Hafnium [µg/g]	13-Oct-09	15:45	0.5	0.5	0.4	0.3
Indium [µg/g]	13-Oct-09	15:45	0.01	< 0.01	0.01	< 0.01
Potassium [µg/g]	14-Oct-09	14:09	310	220	130	150
Lanthanum [µg/g]	13-Oct-09	15:45	380	280	380	240
Lithium [µg/g]	14-Oct-09	14:09	9.9	7.3	3.6	4.5

SGS Lakefield Research Limited
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LR Report : CA10524-SEP09

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: CORE 09-PSB-1 0-2.5	6: CORE 09-PSB-1 2.5-5	7: CORE 09-PSB-1 5-7.5	8: CORE 09-PSB-1 7.5-10
Lutetium [µg/g]	13-Oct-09	15:45	3.0	2.6	3.3	2.2
Magnesium [µg/g]	14-Oct-09	14:09	9900	13000	9900	9000
Manganese [µg/g]	14-Oct-09	14:09	1600	750	770	660
Molybdenum [µg/g]	14-Oct-09	14:09	34	11	1.5	0.6
Sodium [µg/g]	14-Oct-09	14:09	62	48	29	40
Niobuim [µg/g]	13-Oct-09	15:45	3.3	2.3	1.7	1.3
Nickel [µg/g]	14-Oct-09	14:09	90	63	64	44
Lead [µg/g]	14-Oct-09	14:09	280	150	96	78
Phosphorus [µg/g]	14-Oct-09	14:09	280	150	110	120
Rubidium [µg/g]	13-Oct-09	15:44	2.5	1.4	0.63	0.58
Antimony [µg/g]	14-Oct-09	14:08	< 1	< 1	< 1	< 1
Scandium [µg/g]	13-Oct-09	15:44	2.1	1.4	1.4	1.0
Selenium [µg/g]	14-Oct-09	14:08	< 1	< 1	< 1	< 1
Tin [µg/g]	14-Oct-09	14:08	< 6	< 6	< 6	< 6
Strontium [µg/g]	14-Oct-09	14:08	30	30	23	35
Tantalum [µg/g]	13-Oct-09	15:44	0.10	0.09	0.07	0.06
Terbium [µg/g]	13-Oct-09	15:44	12	9.8	12	8.2
Tellerium [µg/g]	13-Oct-09	15:44	0.2	0.1	0.1	< 0.1
Thorium [µg/g]	13-Oct-09	15:44	350	300	420	290
Titanium [µg/g]	14-Oct-09	14:08	230	150	100	73
Thallium [µg/g]	14-Oct-09	14:08	< 3	< 3	< 3	< 3
Uranium [µg/g]	13-Oct-09	15:44	370	160	110	75
Vanadium [µg/g]	14-Oct-09	14:08	15	9.2	8.0	5.8
Tungsten [µg/g]	14-Oct-09	14:05	5	2	< 1	< 1
Yttrium [µg/g]	14-Oct-09	14:05	270	220	280	200
Ytterbium [µg/g]	13-Oct-09	15:44	23	20	25	17
Zinc [µg/g]	14-Oct-09	14:05	210	130	110	87
Zirconium [µg/g]	15-Oct-09	10:44	14	10	8	6

Ra226 subcontracted to Becquerel Labs.
* BaSO4 Calculation based on Ba values and assumes all Ba is in BaSO4 form.
** BaSO4 Calculation based on SO4 values and assumes all SO4 is in BaSO4 form.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

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Tuesday, October 27, 2009

Date Rec. : 30 September 2009
LR. Ref. : **CA10524-SEP09**
Project : 09-1663

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CERTIFICATE OF ANALYSIS

Final Report

Analysis	**9: CORE 09-PSB-1 10-15**	**10: CORE 09-PSB-2 0-5**	**11: CORE 09-PSB-2 5-10**	**12: CORE 09-PSB-2 10-15**	**13: CORE 09-PSB-2 15-20**
Sample Date & Time	22-Sep-09	23-Sep-09	23-Sep-09	23-Sep-09	23-Sep-09
BaSO4 Calc. using Ba* [µg/g]	540	580	270	310	320
BaSO4 Calc. using SO4** [µg/g]	418000	19400	14600	12100	14600
Total Sulphur [%]	5.96	1.31	1.57	2.00	2.23
Carbonate (CO3) [%]	9.65	0.170	0.097	0.052	0.071
Total Organic Carbon [%]	0.130	6.97	9.78	15.2	9.61
Total Carbon [%]	2.06	7.00	9.80	15.2	9.63
Sulphide [%]	< 0.01	0.18	0.36	0.88	1.82
Sulphate [%]	17	0.8	0.6	0.5	0.6
Silver [µg/g]	< 0.7	1.0	< 0.7	< 0.7	1.0
Aluminum [µg/g]	6800	8400	3600	3000	3300
Arsenic [µg/g]	15	30	14	12	19
Barium [µg/g]	320	340	160	180	190
Beryllium [µg/g]	0.66	0.75	0.34	0.37	0.66
Bismuth [µg/g]	4.5	13	11	14	21
Calcium [µg/g]	190000	9600	7600	9400	7600
Cadmium [µg/g]	1.6	5.7	4.5	0.86	0.96
Cerium [µg/g]	360	250	220	230	290
Cobalt [µg/g]	61	20	15	25	46
Chromium [µg/g]	8.6	15	6.5	13	17
Cesium [µg/g]	0.34	0.47	0.97	1.1	0.74
Copper [µg/g]	22	110	14	29	64
Iron [µg/g]	87000	290000	240000	45000	30000
Gallium [µg/g]	2.3	11	2.4	2.1	2.7
Germanium [µg/g]	3.5	8.1	7.2	2.1	1.9
Hafnium [µg/g]	0.3	0.2	0.1	0.1	0.3
Indium [µg/g]	< 0.01	0.02	< 0.01	< 0.01	0.01
Potassium [µg/g]	170	230	190	470	610
Lanthanum [µg/g]	200	130	110	110	140
Lithium [µg/g]	4.5	0.9	0.9	< 0.1	1.1

OnLine LIMS

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LR Report : CA10524-SEP09

Analysis	9: CORE 09-PSB-1 10-15	10: CORE 09-PSB-2 0-5	11: CORE 09-PSB-2 5-10	12: CORE 09-PSB-2 10-15	13: CORE 09-PSB-2 15-20
Lutetium [µg/g]	1.8	1.2	0.98	0.79	0.81
Magnesium [µg/g]	9900	540	360	510	410
Manganese [µg/g]	610	430	89	75	51
Molybdenum [µg/g]	< 0.5	128	10	4.3	3.9
Sodium [µg/g]	47	28	35	80	74
Niobuim [µg/g]	1.0	2.7	2.8	7.8	12
Nickel [µg/g]	39	22	17	22	30
Lead [µg/g]	80	270	270	190	410
Phosphorus [µg/g]	75	590	740	480	510
Rubidium [µg/g]	0.61	2.1	2.1	4.3	4.8
Antimony [µg/g]	< 1	< 1	< 1	< 1	< 1
Scandium [µg/g]	0.8	2.2	1.3	2.3	2.2
Selenium [µg/g]	< 1	< 1	< 1	< 1	< 1
Tin [µg/g]	< 6	< 6	< 6	< 6	< 6
Strontium [µg/g]	27	9.0	7.6	12	10
Tantalum [µg/g]	0.05	0.09	0.05	0.08	0.09
Terbium [µg/g]	6.8	5.1	3.9	3.0	3.5
Tellerium [µg/g]	< 0.1	0.1	0.1	0.1	0.3
Thorium [µg/g]	220	560	110	250	550
Titanium [µg/g]	60	81	82	140	240
Thallium [µg/g]	< 3	< 3	< 3	< 3	< 3
Uranium [µg/g]	68	480	210	84	94
Vanadium [µg/g]	4.6	11	25	9.4	11
Tungsten [µg/g]	< 1	14	2	< 1	1
Yttrium [µg/g]	170	97	78	51	61
Ytterbium [µg/g]	14	9.3	7.4	6.3	6.7
Zinc [µg/g]	83	170	64	27	76
Zirconium [µg/g]	5	8	6	8	18

Ra226 subcontracted to Becquerel Labs.
* BaSO4 Calculation based on Ba values and assumes all Ba is in BaSO4 form.
** BaSO4 Calculation based on SO4 values and assumes all SO4 is in BaSO4 form.

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Project Specialist
Environmental Services, Analytical

OnLine LIMS

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Project : 09-1663

October 7, 2010

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Date Rec. : 30 September 2009
LR Report: **CA10524-SEP09**

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CERTIFICATE OF ANALYSIS

Final Report (QC Report)

Analysis	14: MDL	15: QC - Blank	16: QC - STD % Recovery	17: QC - DUP % Recovery
BaSO4 Calc. using Ba* [µg/g]	---	---	---	---
BaSO4 Calc. using SO4** [µg/g]	---	---	---	---
Total Sulphur [%]	0.005	< 0.005	102%	100%
Carbonate (CO3) [%]	0.005	< 0.005	100%	140%
Total Organic Carbon [%]	0.01	< 0.01	---	100%
Total Carbon [%]	0.005	< 0.005	100%	100%
Sulphide [%]	0.01	< 0.01	90%	106%
Sulphate [%]	0.1	< 0.1	100%	107%
Silver [µg/g]	0.7	< 0.7	93%	100%
Aluminum [µg/g]	1	< 1	97%	100%
Arsenic [µg/g]	1	< 1	99%	94%
Barium [µg/g]	0.05	< 0.05	96%	100%
Beryllium [µg/g]	0.1	< 0.1	98%	102%
Bismuth [µg/g]	0.5	< 0.5	98%	104%
Calcium [µg/g]	1	< 1	98%	100%
Cadmium [µg/g]	0.05	< 0.05	97%	99%
Cerium [µg/g]	0.006	< 0.006	94%	110%
Cobalt [µg/g]	0.3	< 0.3	97%	100%
Chromium [µg/g]	0.5	< 0.5	98%	103%
Cesium [µg/g]	0.01	< 0.01	100%	107%
Copper [µg/g]	0.1	< 0.1	98%	100%
Iron [µg/g]	0.5	< 0.5	98%	100%
Gallium [µg/g]	0.03	< 0.03	100%	99%
Germanium [µg/g]	0.3	< 0.3	103%	105%
Hafnium [µg/g]	0.1	< 0.1	96%	150%
Indium [µg/g]	0.01	< 0.01	---	100%
Potassium [µg/g]	1	< 1	100%	100%
Lanthanum [µg/g]	0.001	0.001	94%	110%
Lithium [µg/g]	0.1	< 0.1	97%	107%
Lutetium [µg/g]	0.001	0.001	95%	102%

OnLine LIMS

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Project : 09-1663

LR Report : **CA10524-SEP09**

Analysis	14: MDL	15: QC - Blank	16: QC - STD % Recovery	17: QC - DUP % Recovery
Magnesium [µg/g]	1	< 1	96%	---
Manganese [µg/g]	0.05	< 0.05	98%	100%
Molybdenum [µg/g]	0.5	< 0.5	100%	154%
Sodium [µg/g]	1	< 1	97%	104%
Niobuim [µg/g]	0.7	< 0.7	99%	118%
Nickel [µg/g]	1	< 1	97%	101%
Lead [µg/g]	0.7	< 0.7	98%	100%
Phosphorus [µg/g]	5	< 5	98%	100%
Rubidium [µg/g]	0.004	< 0.004	---	105
Antimony [µg/g]	1	< 1	98	100%
Scandium [µg/g]	0.2	< 0.2	100%	99%
Selenium [µg/g]	1	< 1	99%	100%
Tin [µg/g]	6	< 6	100%	123%
Strontium [µg/g]	0.01	< 0.01	97%	103%
Tantalum [µg/g]	0.01	< 0.01	97%	108%
Terbium [µg/g]	0.01	< 0.001	96%	93%
Tellerium [µg/g]	0.1	< 0.1	99%	101%
Thorium [µg/g]	0.01	< 0.01	114%	100%
Titanium [µg/g]	0.2	< 0.2	98%	100%
Thallium [µg/g]	3	< 3	99%	76%
Uranium [µg/g]	3	< 3	---	100%
Vanadium [µg/g]	0.1	< 0.1	99%	102%
Tungsten [µg/g]	1	< 1	97%	93%
Yttrium [µg/g]	0.1	< 0.1	96%	100%
Ytterbium [µg/g]	0.1	< 0.1	98%	105%
Zinc [µg/g]	0.1	< 0.1	97%	100%
Zirconium [µg/g]	5	< 5	100%	107%

Ra226 subcontracted to Becquerel Labs.
* BaSO4 Calculation based on Ba values and assumes all Ba is in BaSO4 form.
** BaSO4 Calculation based on SO4 values and assumes all SO4 is in BaSO4 form.

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Environmental Services, Analytical

OnLine LIMS

ANALYSIS REPORT

Becquerel LABORATORIES

Becquerel Laboratories Inc.
6790 Kitimat Rd., Unit 4
Mississauga, Ontario
Canada, L5N 5L9

Phone: (905) 826-3080
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Batch: T09-01387.0

Date: 09-Nov-2009

Lakefield Research Ltd.

185 Concession St., Postal Bag 4300
Lakefield, ON, K0L 2H0

attn: Brian Graham

Phone: (705) 652-2038
FAX: (705) 652-1918

Client Ref.Sep 10523
P.O: 17820

9 water samples

Received: 06-Oct-2009

Page 1 of 1

Results of Analysis

Sample	Test		Result	Units	Date	Method
PW09-PSB-1 0-2.5	Ra-226		0.76	Bq/l	06-Nov-2009	ALPHA
PW09-PSB-1 2.5-5	Ra-226		0.12	Bq/l	06-Nov-2009	ALPHA
PW09-PSB-1 5-7.5	Ra-226		0.02	Bq/l	06-Nov-2009	ALPHA
PW09-PSB-1 7.5-10	Ra-226	<	0.01	Bq/l	06-Nov-2009	ALPHA
PW09-PSB-1 10-15	Ra-226	<	0.01	Bq/l	06-Nov-2009	ALPHA
PW09-PSB-2 0-5	Ra-226		3.2	Bq/l	06-Nov-2009	ALPHA
PW09-PSB-2 5-10	Ra-226		1.8	Bq/l	06-Nov-2009	ALPHA
PW09-PSB-2 10-15	Ra-226		1.1	Bq/l	06-Nov-2009	ALPHA
PW09-PSB-2 15-20	Ra-226		1.4	Bq/l	06-Nov-2009	ALPHA

Methods: ALPHA BQ-RAD-ALPHA alpha-particle spectrometry

Units: Bq/l Becquerels per litre

These results relate only to the samples analysed and only to the items tested.

09-Nov-2009 approved by: [signature]
Donald D. Burgess PhD
Senior Scientist, Division Supervisor

SGS Lakefield Research Limited
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
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Ecometrix
Attn : Erin Clyde

6800 Campobello Road, Mississauga
Canada, L5N 2L8
Phone: 905-794-2325, Fax:905-794-2338

October 14, 2009

Date Rec. : 30 September 2009
LR Report : **CA10523-SEP09**
Project : 09-1663

CERTIFICATE OF ANALYSIS
Final Report

Analysis	**1: Analysis Start Date**	**2: Analysis Start Time**	**3: Analysis Approval Date**	**4: Analysis Approval Time**	**5: PW09-PSB-1 0-2.5**	**6: PW09-PSB-1 2.5-5**	**7: PW09-PSB-1 5-7.5**
Sample Date & Time					22-Sep-09	22-Sep-09	22-Sep-09
Temperature Upon Receipt [°C]	---	---	---	---	4.0	4.0	4.0
Sulphate [mg/L]	02-Oct-09	15:00	06-Oct-09	14:01	410	1100	1300
Dissolved Organic Carbon [mg/L]	02-Oct-09	10:00	06-Oct-09	13:52	10.7	9.9	12.2
Dissolved Inorganic Carbon [mg/L]	05-Oct-09	14:35	08-Oct-09	12:46	1.7	< 1.0	< 1.0
Alkalinity [mg/L as CaCO3]	02-Oct-09	15:19	05-Oct-09	15:11	24	24	33
Acidity [mg/L as CaCO3]	02-Oct-09	15:19	05-Oct-09	15:11	---	---	---
Hardness [mg/L as CaCO3]	02-Oct-09	09:00	08-Oct-09	16:00	504	934	1270
Aluminum [mg/L]	02-Oct-09	09:00	02-Oct-09	12:08	0.03	0.12	0.04
Arsenic [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.0018	0.0047	0.0059
Barium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.0167	0.00872	0.00558
Beryllium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	< 0.00002	< 0.00002	< 0.00002
Boron [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.0287	0.0284	0.0078
Bismuth [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	< 0.00001	0.00001	< 0.00001
Calcium [mg/L]	02-Oct-09	09:00	08-Oct-09	16:00	193	373	506
Cadmium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.000014	0.000017	0.000007
Cobalt [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.000458	0.000560	0.000695
Chromium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	< 0.0005	0.0006	0.0009
Copper [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.0014	0.0012	0.0014
Iron [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	< 0.01	< 0.01	0.01
Potassium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	10.3	17.3	23.3
Lithium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	< 0.002	< 0.002	0.003
Magnesium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	5.17	0.966	0.296

OnLine LIMS

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LR Report : **CA10523-SEP09**

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	5: PW09-PSB-1 0-2.5	6: PW09-PSB-1 2.5-5	7: PW09-PSB-1 5-7.5
Manganese [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.0679	0.00194	0.00031
Molybdenum [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.00679	0.0118	0.00655
Sodium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	6.60	10.0	13.0
Nickel [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.0043	0.0093	0.0126
Phosphorus [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	< 0.01	< 0.01	< 0.01
Lead [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.00025	0.00017	0.00008
Sulphur [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	179	331	449
Antimony [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	< 0.0002	< 0.0002	< 0.0002
Selenium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	< 0.001	< 0.001	< 0.001
Silica [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	0.44	0.22	0.13
Tin [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.00018	0.00026	0.00043
Strontium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	0.115	0.156	0.170
Titanium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.0002	0.0002	0.0003
Thallium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	< 0.0002	< 0.0002	< 0.0002
Uranium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.0636	0.00363	0.000341
Vanadium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.00005	0.00006	0.00019
Zinc [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.002	< 0.001	< 0.001

Samples are field filtered
Ra226 subcontracted to Becquerel Labs.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

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Phone: 905-794-2325, Fax:905-794-2338

October 14, 2009

Date Rec. : 30 September 2009
LR Report : **CA10523-SEP09**
Project : 09-1663

CERTIFICATE OF ANALYSIS
Final Report

Analysis	**8: PW09-PSB-1 7.5-10**	**9: PW09-PSB-1 10-15**	**10: PW09-PSB-2 0-5**	**11: PW09-PSB-2 5-10**	**12: PW09-PSB-2 10-15**	**13: PW09-PSB-2 15-20**
Sample Date & Time	22-Sep-09	22-Sep-09	23-Sep-09	23-Sep-09	23-Sep-09	23-Sep-09
Temperature Upon Receipt [°C]	4.0	4.0	4.0	4.0	4.0	4.0
Sulphate [mg/L]	1600	1800	190	250	---	---
Dissolved Organic Carbon [mg/L]	14.6	12.0	5.5	21.8	---	---
Dissolved Inorganic Carbon [mg/L]	< 1.0	< 1.0	8.6	14.6	---	---
Alkalinity [mg/L as CaCO3]	45	36	---	---	---	---
Acidity [mg/L as CaCO3]	---	---	< 2	< 2	---	---
Hardness [mg/L as CaCO3]	1970	1810	217	312	415	875
Aluminum [mg/L]	0.01	0.04	< 0.01	< 0.01	< 0.01	0.01
Arsenic [mg/L]	0.0069	0.0059	0.0012	0.0015	0.0028	0.0064
Barium [mg/L]	0.00624	0.00582	0.0443	0.0344	0.0266	0.0380
Beryllium [mg/L]	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002
Boron [mg/L]	0.0023	0.0077	0.0232	0.0422	0.0889	0.118
Bismuth [mg/L]	0.00001	< 0.00001	< 0.00001	< 0.00001	0.00001	< 0.00001
Calcium [mg/L]	787	723	76.4	106	138	297
Cadmium [mg/L]	0.000006	0.000013	0.000011	< 0.000003	0.000012	0.000010
Cobalt [mg/L]	0.000763	0.000834	0.00271	0.000540	0.000530	0.00114
Chromium [mg/L]	< 0.0005	0.0011	< 0.0005	< 0.0005	0.0010	0.0009
Copper [mg/L]	0.0021	0.0022	0.0008	0.0012	0.0022	0.0023
Iron [mg/L]	< 0.01	0.02	8.19	12.1	6.95	16.1
Potassium [mg/L]	29.7	35.8	7.51	11.8	17.4	29.2
Lithium [mg/L]	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.007
Magnesium [mg/L]	0.213	0.713	6.39	11.8	17.0	32.7

OnLine LIMS

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LR Report : **CA10523-SEP09**

Analysis	8: PW09-PSB-1 7.5-10	9: PW09-PSB-1 10-15	10: PW09-PSB-2 0-5	11: PW09-PSB-2 5-10	12: PW09-PSB-2 10-15	13: PW09-PSB-2 15-20
Manganese [mg/L]	0.00012	0.00100	1.85	0.753	0.790	1.67
Molybdenum [mg/L]	0.00633	0.00445	0.00113	0.00071	0.00437	0.00563
Sodium [mg/L]	15.9	17.5	5.62	10.2	16.1	24.2
Nickel [mg/L]	0.0151	0.0132	0.0026	0.0028	0.0035	0.0046
Phosphorus [mg/L]	0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.01
Lead [mg/L]	0.00016	0.00018	0.00012	0.00022	0.00025	0.00023
Sulphur [mg/L]	503	560	63.7	87.8	123	311
Antimony [mg/L]	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	0.0004
Selenium [mg/L]	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Silica [mg/L]	0.22	0.43	4.34	7.44	11.3	12.0
Tin [mg/L]	0.00055	0.00046	0.00017	0.00031	0.00017	0.00009
Strontium [mg/L]	0.193	0.216	0.0915	0.131	0.177	0.347
Titanium [mg/L]	0.0002	0.0004	0.0003	0.0006	0.0012	0.0012
Thallium [mg/L]	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Uranium [mg/L]	0.000330	0.000201	0.00706	0.0241	0.0330	0.0214
Vanadium [mg/L]	0.00011	0.00029	< 0.00003	0.00008	0.00041	0.00060
Zinc [mg/L]	< 0.001	< 0.001	0.002	0.002	0.002	0.003

Samples are field filtered
Ra226 subcontracted to Becquerel Labs.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

Copy to : #1

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Project : 09-1663

October 7, 2010

Ecometrix
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Date Rec. : 30 September 2009
LR Report: **CA10523-SEP09**

Copy: #1

CERTIFICATE OF ANALYSIS
Final Report - (QC Report)

Analysis	14: MDL	15: QC - Blank	16: QC - STD % Recovery	17: QC - DUP % Recovery
Sulphate [mg/L]	0.2	< 0.2	98%	102%
Dissolved Organic Carbon [mg/L]	0.2	< 0.2	105%	98%
Dissolved Inorganic Carbon [mg/L]	0.2	0.2	97%	110%
Alkalinity [mg/L as CaCO3]	2	< 2	101%	98%
Acidity [mg/L as CaCO3]	2	3	98%	102%
Hardness [mg/L as CaCO3]	0.5	---	---	---
Aluminum [mg/L]	0.01	< 0.01	95%	100%
Arsenic [mg/L]	0.0002	< 0.0002	106%	111%
Barium [mg/L]	0.00001	< 0.00001	105%	100%
Beryllium [mg/L]	0.00002	< 0.00002	103%	94%
Boron [mg/L]	0.0002	< 0.0002	99%	97%
Bismuth [mg/L]	0.00001	0.00001	105%	82%
Calcium [mg/L]	0.03	---	98%	100%
Cadmium [mg/L]	0.000003	< 0.000003	102%	107%
Cobalt [mg/L]	0.000002	< 0.000002	105%	99%
Chromium [mg/L]	0.0005	< 0.0005	103%	170%
Copper [mg/L]	0.0005	< 0.0005	106%	85%
Iron [mg/L]	0.01	---	97%	122%
Potassium [mg/L]	0.01	< 0.01	98%	99%
Lithium [mg/L]	0.002	< 0.002	94%	120%
Magnesium [mg/L]	0.003	---	95%	100%
Manganese [mg/L]	0.00001	< 0.00001	104%	99%
Molybdenum [mg/L]	0.00001	< 0.00001	95%	155%
Sodium [mg/L]	0.01	---	94.8	99.3
Nickel [mg/L]	0.0001	< 0.0001	105%	87%
Phosphorus [mg/L]	0.01	< 0.01	95%	100%
Lead [mg/L]	0.00002	< 0.00002	102%	30%
Sulphur [mg/L]	0.01	---	100%	101%
Antimony [mg/L]	0.0002	< 0.0002	94%	124%
Selenium [mg/L]	0.001	< 0.001	108%	100%

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Project : 09-1663

LR Report : **CA10523-SEP09**

Analysis	14: MDL	15: QC - Blank	16: QC - STD % Recovery	17: QC - DUP % Recovery
Silica [mg/L]	0.01	< 0.01	103%	101%
Tin [mg/L]	0.00001	< 0.00001	96%	140%
Strontium [mg/L]	0.0001	---	98%	100%
Titanium [mg/L]	0.0001	< 0.0001	95%	130%
Thallium [mg/L]	0.0002	< 0.0002	105%	106%
Uranium [mg/L]	0.000001	< 0.000001	102%	94%
Vanadium [mg/L]	0.00003	< 0.00003	106%	150%
Zinc [mg/L]	0.001	< 0.001	106%	90%

Samples are field filtered
Ra226 subcontracted to Becquerel Labs.
Revised to include Ra226 results from Becquerel.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

Becquerel LABORATORIES

ANALYSIS REPORT

Becquerel Laboratories Inc.
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Phone: (905) 826-3080
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Batch: T09-01381.0

Date: 20-Oct-2009

Lakefield Research Ltd.

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attn: Brian Graham

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FAX: (705) 652-1918

Client Ref.Sept 10522
P.O: 17820

4 water samples Sampled: 22-Sep-2009 Received: 06-Oct-2009

Results of Analysis

Sample	Test	Result	Units	Date	Method
SW09-PSB-1T	Ra-226	0.34	Bq/l	17-Oct-2009	ALPHA
SW09-PSB-1B	Ra-226	0.65	Bq/l	17-Oct-2009	ALPHA
SW09-PSB-2T	Ra-226	0.31	Bq/l	17-Oct-2009	ALPHA
SW09-PSB-2B	Ra-226	0.39	Bq/l	17-Oct-2009	ALPHA

Methods: ALPHA BQ-RAD-ALPHA alpha-particle spectrometry

Units: Bq/l Becquerels per litre

These results relate only to the samples analysed and only to the items tested.

20-Oct-2009 approved by: [signature]
Donald D. Burgess PhD
Senior Scientist, Division Supervisor

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October 14, 2009

Date Rec. : 30 September 2009
LR Report : **CA10522-SEP09**
Project : 09-1663

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	5: SW09-PSB-1T	6: SW09-PSB-1B	7: SW09-PSB-2T	8: SW09-PSB-2B
Sample Date & Time					22-Sep-09	22-Sep-09	23-Sep-09	23-Sep-09
Temperature Upon Receipt [°C]	---	---	---	---	4.0	4.0	4.0	4.0
Sulphate [mg/L]	02-Oct-09	15:00	06-Oct-09	14:19	180	410	180	180
Total Organic Carbon [mg/L]	02-Oct-09	10:00	05-Oct-09	13:41	2.1	4.6	2.2	4.0
Total Inorganic Carbon [mg/L]	05-Oct-09	14:35	08-Oct-09	12:45	3.5	< 1.0	2.9	< 1.0
Alkalinity [mg/L as CaCO3]	02-Oct-09	15:19	05-Oct-09	15:10	12	---	---	---
Acidity [mg/L as CaCO3]	02-Oct-09	15:19	05-Oct-09	15:10	---	20	< 2	15
Hardness [mg/L as CaCO3]	02-Oct-09	09:00	02-Oct-09	12:08	173	209	179	179
Aluminum [mg/L]	02-Oct-09	09:00	02-Oct-09	12:08	< 0.01	0.53	< 0.01	< 0.01
Arsenic [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.0005	0.0014	0.0004	0.0005
Barium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.0134	0.0196	0.0137	0.0160
Beryllium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.00007	0.00009	0.00002	< 0.00002
Boron [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.0249	0.0314	0.0252	0.0243
Bismuth [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.00007	0.00003	< 0.00001	0.00001
Calcium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:08	62.2	74.4	64.5	64.1
Cadmium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.000079	0.000082	0.000005	0.000015
Cobalt [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.000281	0.0186	0.000319	0.00120
Chromium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Copper [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.0025	0.0019	0.0015	0.0009
Iron [mg/L]	02-Oct-09	09:00	02-Oct-09	12:08	0.03	1.61	< 0.01	0.02
Potassium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:08	6.11	6.53	6.18	6.14
Lithium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:08	< 0.002	< 0.002	< 0.002	< 0.002

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LR Report : **CA10522-SEP09**

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	5: SW09-PSB-1T	6: SW09-PSB-1B	7: SW09-PSB-2T	8: SW09-PSB-2B
Magnesium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:08	4.30	5.53	4.45	4.47
Manganese [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.00475	0.203	0.00313	0.0273
Molybdenum [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.00017	0.00043	0.00008	0.00025
Sodium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:08	3.99	4.35	4.04	4.14
Nickel [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.0017	0.0101	0.0015	0.0025
Phosphorus [mg/L]	02-Oct-09	09:00	02-Oct-09	12:08	< 0.01	< 0.01	< 0.01	< 0.01
Lead [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.00057	0.00647	0.00013	0.00088
Sulphur [mg/L]	02-Oct-09	09:00	02-Oct-09	12:08	57.9	67.4	60.2	60.5
Antimony [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	< 0.0002	0.0084	0.0003	0.0015
Selenium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	< 0.001	< 0.001	< 0.001	< 0.001
Silica [mg/L]	02-Oct-09	09:00	02-Oct-09	12:08	0.99	1.14	1.01	1.12
Tin [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.00011	0.00035	0.00017	0.00020
Strontium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:08	0.0715	0.0765	0.0736	0.0742
Titanium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.0003	0.0002	0.0002	0.0002
Thallium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Uranium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.00245	0.0557	0.00273	0.00317
Vanadium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.00008	0.00004	< 0.00003	0.00007
Zinc [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.009	0.024	< 0.001	0.002

Ra226 subcontracted to Becquerel Labs.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

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SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Env ICP-MS Metals

Project : 09-1663

October 7, 2010

Ecometrix
Attn : Erin Clyde

6800 Campobello Road, Mississauga
Canada, L5N 2L8
Phone: 905-794-2325, Fax:905-794-2338

Date Rec. : 30 September 2009
LR Report: **CA10522-SEP09**

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CERTIFICATE OF ANALYSIS

Final Report

Analysis	9: MDL	10: QC - Blank	11: QC - STD % Recovery	12: QC - DUP % Recovery
Sulphate [mg/L]	0.2	< 0.2	98%	102%
Total Organic Carbon [mg/L]	0.2	< 0.2	105%	98%
Total Inorganic Carbon [mg/L]	0.2	< 0.2	110%	100%
Alkalinity [mg/L as CaCO3]	2	< 2	101%	98%
Acidity [mg/L as CaCO3]	2	2	98%	102%
Hardness [mg/L as CaCO3]	0.5	---	---	---
Aluminum [mg/L]	0.01	< 0.01	95%	100%
Arsenic [mg/L]	0.0002	< 0.0002	106%	111%
Barium [mg/L]	0.00001	< 0.00001	105%	100%
Beryllium [mg/L]	0.00002	< 0.00002	103%	94%
Boron [mg/L]	0.0002	< 0.0002	99%	97%
Bismuth [mg/L]	0.00001	0.00001	105%	82%
Calcium [mg/L]	0.03	---	97%	100%
Cadmium [mg/L]	0.000003	< 0.000003	102%	107%
Cobalt [mg/L]	0.000002	< 0.000002	105%	99%
Chromium [mg/L]	0.00005	< 0.0005	103%	170%
Copper [mg/L]	0.0005	< 0.0005	106%	85%
Iron [mg/L]	0.01	---	96.8	122
Potassium [mg/L]	0.01	< 0.01	98%	99.1
Lithium [mg/L]	0.002	< 0.002	94.2	120
Magnesium [mg/L]	0.003	---	94.8	100
Manganese [mg/L]	0.00001	< 0.00001	104%	99%
Molybdenum [mg/L]	0.00001	< 0.00001	95%	155%
Sodium [mg/L]	0.01	---	94.8	99.3
Nickel [mg/L]	0.0001	< 0.0001	105%	87%
Phosphorus [mg/L]	0.01	< 0.01	95%	100%
Lead [mg/L]	0.00002	< 0.00002	102%	30%
Sulphur [mg/L]	0.01	---	100%	101

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SGS Canada Inc.
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Env ICP-MS Metals

Project : 09-1663

LR Report : **CA10522-SEP09**

Analysis	9: MDL	10: QC - Blank	11: QC - STD % Recovery	12: QC - DUP % Recovery
Antimony [mg/L]	0.0002	< 0.0002	94%	124%
Selenium [mg/L]	0.001	< 0.001	108%	100%
Silica [mg/L]	0.01	< 0.01	103%	101%
Tin [mg/L]	0.00001	< 0.00001	96%	140%
Strontium [mg/L]	0.0001	---	98%	99.7
Titanium [mg/L]	0.0001	< 0.0001	95%	130%
Thallium [mg/L]	0.0002	< 0.0002	105%	106%
Uranium [mg/L]	0.000001	< 0.000001	102%	94%
Vanadium [mg/L]	0.00003	< 0.00003	106%	150%
Zinc [mg/L]	0.001	< 0.001	106%	90%

Ra226 subcontracted to Becquerel Labs.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

Becquerel LABORATORIES

ANALYSIS REPORT

Becquerel Laboratories Inc.
6790 Kitimat Rd., Unit 4
Mississauga, Ontario
Canada, L5N 5L9

Phone: (905) 826-3080
FAX: (905) 826-4151

Batch: T09-01486.0

Date: 30-Nov-2009

Lakefield Research Ltd.

185 Concession St., Postal Bag 4300
Lakefield, ON, K0L 2H0

Phone: (705) 652-2038
FAX: (705) 652-1918

attn: Brian Graham

Client Ref.
Oct 10521.R09
P.O: 17820

14 solid samples Sampled: 26-Sep-2009 Received: 21-Oct-2009 Page 1 of 1

Results of Analysis

Sample	Test	Result	Units	Date	Method
CORE 09-SR-1 (0-5)	Ra-226	0.16	Bq/g	23-Nov-2009	ALPHA
CORE 09-SR-1 (5-10)	Ra-226	0.08	Bq/g	23-Nov-2009	ALPHA
CORE 09-SR-1 (10-15)	Ra-226	0.02	Bq/g	23-Nov-2009	ALPHA
CORE 09-SR-1 (15-20)	Ra-226	0.04	Bq/g	29-Nov-2009	ALPHA
CORE 09-SR-2 (0-5)	Ra-226	14	Bq/g	29-Nov-2009	ALPHA
CORE 09-SR-2 (5-10)	Ra-226	4.6	Bq/g	29-Nov-2009	ALPHA
CORE 09-SR-2 (10-15)	Ra-226	0.06	Bq/g	29-Nov-2009	ALPHA
CORE 09-SR-3 (0-5)	Ra-226	8.2	Bq/g	29-Nov-2009	ALPHA
CORE 09-SR-3 (5-10)	Ra-226	9.7	Bq/g	29-Nov-2009	ALPHA
CORE 09-SR-3 (10-15)	Ra-226	16	Bq/g	29-Nov-2009	ALPHA
CORE 09-SR-3 (15-20)	Ra-226	20	Bq/g	29-Nov-2009	ALPHA
CORE 09-SR-4 (0-5)	Ra-226	2.6	Bq/g	29-Nov-2009	ALPHA
CORE 09-SR-4 (5-10)	Ra-226	2.7	Bq/g	29-Nov-2009	ALPHA
CORE 09-SR-4 (10-15)	Ra-226	2.1	Bq/g	29-Nov-2009	ALPHA

Methods: ALPHA BQ-RAD-ALPHA alpha-particle spectrometry

Units: Bq/g Becquerels per gram

These results relate only to the samples analysed and only to the items tested.

30-Nov-2009 approved by: Donald D. Burgess PhD
Senior Scientist, Division Supervisor

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Phone: 905-794-2325, Fax:905-794-2338

Tuesday, October 27, 2009

Date Rec. : 30 September 2009
LR. Ref. : **CA10521-SEP09**
Project : 09-1663

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CERTIFICATE OF ANALYSIS

Final Report

Analysis	**3: Analysis Approval Date**	**4: Analysis Approval Time**	**5: CORE 09-SR-1 (0-5)**	**6: CORE 09-SR-1 (5-10)**	**7: CORE 09-SR-1 (10-15)**	**8: CORE 09-SR-1 (15-20)**	**9: CORE 09-SR-2 (0-5)**	**10: CORE 09-SR-2 (5-10)**
Sample Date & Time			26-Sep-09	26-Sep-09	26-Sep-09	26-Sep-09	26-Sep-09	26-Sep-09
BaSO4 Calc. using Ba* [µg/g]	---	---	130	110	100	80	10900	4420
BaSO4 Calc. using SO4** [µg/g]	---	---	2430	<2430	2430	2430	12100	4860
Total Sulphur [%]	06-Oct-09	14:45	0.130	0.130	0.184	0.224	0.235	0.114
Carbonate (CO3) [%]	06-Oct-09	14:42	0.105	0.048	0.048	0.033	0.040	0.011
Total Organic Carbon [%]	06-Oct-09	14:45	5.34	4.23	5.87	5.94	2.05	0.820
Total Carbon [%]	06-Oct-09	14:45	5.36	4.24	5.88	5.95	2.05	0.825
Sulphide [%]	07-Oct-09	15:59	< 0.01	< 0.01	0.04	0.05	< 0.01	< 0.01
Sulphate [%]	23-Oct-09	14:22	0.1	< 0.1	0.1	0.1	0.5	0.2
Silver [µg/g]	14-Oct-09	14:05	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7
Aluminum [µg/g]	14-Oct-09	14:05	7600	6700	5300	4100	4400	2600
Arsenic [µg/g]	14-Oct-09	14:05	5	5	4	3	10	4
Barium [µg/g]	14-Oct-09	14:05	75	65	61	47	6400	2600
Beryllium [µg/g]	14-Oct-09	14:05	0.47	0.37	0.32	0.24	0.21	0.12
Bismuth [µg/g]	14-Oct-09	14:05	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Calcium [µg/g]	14-Oct-09	14:05	1900	1600	1500	1500	1100	720
Cadmium [µg/g]	14-Oct-09	14:05	1.2	0.96	1.2	1.1	0.42	0.18
Cerium [µg/g]	13-Oct-09	15:44	48	41	34	20	62	30
Cobalt [µg/g]	14-Oct-09	14:05	8.5	7.8	6.1	3.7	20	8.2
Chromium [µg/g]	14-Oct-09	14:05	19	18	15	12	9.8	6.8
Cesium [µg/g]	13-Oct-09	15:44	0.63	0.45	0.36	0.30	0.56	0.38
Copper [µg/g]	14-Oct-09	14:05	34	31	23	14	20	8.3
Iron [µg/g]	14-Oct-09	14:05	12000	9800	8100	6800	15000	7300
Gallium [µg/g]	13-Oct-09	15:44	2.9	2.6	2.0	1.6	2.8	1.4
Germanium [µg/g]	13-Oct-09	15:44	0.6	0.5	0.5	0.4	0.8	0.4
Hafnium [µg/g]	13-Oct-09	15:44	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Indium [µg/g]	13-Oct-09	15:44	0.05	0.02	0.01	< 0.01	< 0.01	< 0.01
Potassium [µg/g]	14-Oct-09	14:05	270	250	210	180	270	170
Lanthanum [µg/g]	13-Oct-09	15:44	25	21	18	12	33	16
Lithium [µg/g]	14-Oct-09	14:05	2.7	2.4	1.6	1.1	1.4	0.3

OnLine LIMS

SGS

SGS Lakefield Research Limited
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Lakefield - Ontario - KOL 2HO
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LR Report : CA10521-SEP09

Analysis	**3: Analysis Approval Date**	**4: Analysis Approval Time**	**5: CORE 09-SR-1 (0-5)**	**6: CORE 09-SR-1 (5-10)**	**7: CORE 09-SR-1 (10-15)**	**8: CORE 09-SR-1 (15-20)**	**9: CORE 09-SR-2 (0-5)**	**10: CORE 09-SR-2 (5-10)**
Lutetium [µg/g]	13-Oct-09	15:44	0.10	0.081	0.063	0.054	0.49	0.21
Magnesium [µg/g]	14-Oct-09	14:04	2100	1900	1500	1200	840	590
Manganese [µg/g]	14-Oct-09	14:04	250	180	200	230	1600	160
Molybdenum [µg/g]	14-Oct-09	14:04	< 0.5	< 0.5	< 0.5	< 0.5	2.8	1.3
Sodium [µg/g]	14-Oct-09	14:04	52	45	38	32	36	23
Niobuim [µg/g]	13-Oct-09	15:44	0.8	0.8	0.7	< 0.7	< 0.7	< 0.7
Nickel [µg/g]	14-Oct-09	14:04	15	13	11	7	19	8
Lead [µg/g]	14-Oct-09	14:04	61	44	32	19	100	38
Phosphorus [µg/g]	14-Oct-09	14:04	450	350	260	210	270	130
Rubidium [µg/g]	13-Oct-09	15:44	3.6	3.2	2.6	2.3	2.5	1.5
Antimony [µg/g]	14-Oct-09	14:04	< 1	< 1	< 1	< 1	< 1	< 1
Scandium [µg/g]	13-Oct-09	15:44	1.7	1.5	1.1	0.9	1.1	0.6
Selenium [µg/g]	14-Oct-09	14:04	< 1	< 1	< 1	< 1	< 1	< 1
Tin [µg/g]	14-Oct-09	14:04	< 6	< 6	< 6	< 6	< 6	< 6
Strontium [µg/g]	14-Oct-09	14:04	7.6	6.3	6.2	6.5	72	27
Sulphur [µg/g]	14-Oct-09	14:04	1100	1400	2000	2500	2400	1200
Tantalum [µg/g]	13-Oct-09	15:44	0.03	0.03	0.04	0.04	0.01	< 0.01
Terbium [µg/g]	13-Oct-09	15:44	0.47	0.33	0.22	0.16	2.0	0.87
Tellerium [µg/g]	13-Oct-09	15:44	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Thorium [µg/g]	13-Oct-09	15:44	9.5	7.7	7.0	3.4	33	12
Titanium [µg/g]	14-Oct-09	14:04	340	350	300	270	190	160
Thallium [µg/g]	14-Oct-09	14:04	< 3	< 3	< 3	< 3	< 3	< 3
Uranium [µg/g]	13-Oct-09	15:43	7.9	5.6	3.1	1.7	84	29
Vanadium [µg/g]	14-Oct-09	14:04	24	21	17	13	12	7.9
Tungsten [µg/g]	14-Oct-09	14:04	< 1	< 1	< 1	< 1	2	< 1
Yttrium [µg/g]	14-Oct-09	14:04	10	7.8	5.9	4.5	43	18
Ytterbium [µg/g]	13-Oct-09	15:43	0.76	0.59	0.46	0.37	4.0	1.6
Zinc [µg/g]	14-Oct-09	14:04	100	83	73	49	74	34
Zirconium [µg/g]	14-Oct-09	14:04	< 5	< 5	< 5	< 5	< 5	< 5

Ra226 subcontracted to Becquerel Labs.
* BaSO4 Calculation based on Ba values and assumes all Ba is in BaSO4 form.
** BaSO4 Calculation based on SO4 values and assumes all SO4 is in BaSO4 form.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

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Tuesday, October 27, 2009

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Project : 09-1663

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CERTIFICATE OF ANALYSIS

Final Report

Analysis	**11: CORE 09-SR-2 (10-15)**	**12: CORE 09-SR-3 (0-5)**	**13: CORE 09-SR-3 (5-10)**	**14: CORE 09-SR-3 (10-15)**	**15: CORE 09-SR-3 (15-20)**	**16: CORE 09-SR-4 (0-5)**	**17: CORE 09-SR-4 (5-10)**	**18: CORE 09-SR-4 (10-15)**
Sample Date & Time	26-Sep-09	27-Sep-09	27-Sep-09	27-Sep-09	27-Sep-09	27-Sep-09	27-Sep-09	27-Sep-09
BaSO4 Calc. using Ba* [µg/g]	340	3910	5100	6120	6970	1310	990	750
BaSO4 Calc. using SO4** [µg/g]	<2430	4860	9720	19400	24300	4860	4860	4860
Total Sulphur [%]	0.015	0.607	0.917	1.15	1.12	1.03	1.06	1.00
Carbonate (CO3) [%]	< 0.005	0.090	0.097	0.088	0.229	0.159	0.181	0.419
Total Organic Carbon [%]	0.330	13.9	14.6	13.3	10.7	16.8	17.6	16.8
Total Carbon [%]	0.326	13.9	14.6	13.3	10.7	16.8	17.6	16.9
Sulphide [%]	< 0.01	< 0.01	< 0.01	0.10	0.07	0.39	0.65	0.65
Sulphate [%]	< 0.1	0.2	0.4	0.8	1.0	0.2	0.2	0.2
Silver [µg/g]	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7
Aluminum [µg/g]	2000	8500	8300	9600	13000	7100	6000	5600
Arsenic [µg/g]	1	21	23	28	29	22	24	26
Barium [µg/g]	200	2300	3000	3600	4100	770	580	440
Beryllium [µg/g]	0.12	0.57	0.47	0.42	0.66	0.27	0.18	0.12
Bismuth [µg/g]	< 0.5	0.8	< 0.5	< 0.5	0.6	< 0.5	< 0.5	< 0.5
Calcium [µg/g]	420	3800	4600	4300	5100	6200	6700	7300
Cadmium [µg/g]	0.09	1.9	1.6	1.5	1.3	1.7	1.7	1.8
Cerium [µg/g]	15	170	200	240	310	590	680	840
Cobalt [µg/g]	2.6	59	60	64	48	28	21	16
Chromium [µg/g]	5.3	18	16	18	26	20	18	17
Cesium [µg/g]	0.21	0.70	0.81	1.1	1.6	0.86	0.82	0.87
Copper [µg/g]	2.3	57	64	84	98	61	58	56
Iron [µg/g]	5200	39000	34000	35000	50000	21000	16000	12000
Gallium [µg/g]	0.66	5.3	6.0	7.9	9.5	6.9	6.4	6.6
Germanium [µg/g]	0.3	1.7	1.8	2.0	2.6	3.1	3.3	3.8
Hafnium [µg/g]	< 0.1	0.2	0.2	0.3	0.3	0.5	0.6	0.6
Indium [µg/g]	< 0.01	< 0.01	< 0.01	< 0.01	0.02	0.01	< 0.01	< 0.01
Potassium [µg/g]	130	370	290	320	430	350	280	270
Lanthanum [µg/g]	8.9	87	110	120	140	300	360	430
Lithium [µg/g]	< 0.1	2.1	3.0	6.4	10	1.5	1.2	1.1

OnLine LIMS

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LR Report : **CA10521-SEP09**

Analysis	11: CORE 09-SR-2 (10-15)	12: CORE 09-SR-3 (0-5)	13: CORE 09-SR-3 (5-10)	14: CORE 09-SR-3 (10-15)	15: CORE 09-SR-3 (15-20)	16: CORE 09-SR-4 (0-5)	17: CORE 09-SR-4 (5-10)	18: CORE 09-SR-4 (10-15)
Lutetium [µg/g]	0.055	1.3	1.6	2.0	2.9	4.1	4.5	5.3
Magnesium [µg/g]	420	1300	1200	1300	1500	1400	1400	1400
Manganese [µg/g]	75	4200	2900	1100	480	550	280	180
Molybdenum [µg/g]	< 0.5	9.0	11	18	18	5.8	4.7	3.6
Sodium [µg/g]	18	53	43	43	54	64	58	59
Niobuim [µg/g]	< 0.7	0.9	1.0	1.1	1.4	1.0	0.9	0.8
Nickel [µg/g]	3	38	40	54	52	37	39	43
Lead [µg/g]	5.2	230	220	240	520	540	550	640
Phosphorus [µg/g]	68	650	580	650	660	470	380	340
Rubidium [µg/g]	1.00	3.8	3.3	3.9	5.1	4.1	3.8	4.0
Antimony [µg/g]	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Scandium [µg/g]	0.5	2.4	2.2	2.3	2.8	2.7	2.7	2.7
Selenium [µg/g]	< 1	1	1	< 1	< 1	< 1	< 1	< 1
Tin [µg/g]	< 6	< 6	< 6	< 6	< 6	< 6	< 6	< 6
Strontium [µg/g]	3.3	21	37	63	77	15	14	14
Sulphur [µg/g]	170	5500	7300	7900	7000	10000	11000	11000
Tantalum [µg/g]	< 0.01	0.04	0.07	0.07	0.09	0.11	0.13	0.15
Terbium [µg/g]	0.21	5.9	7.6	9.1	14	25	28	35
Tellerium [µg/g]	< 0.1	< 0.1	< 0.1	< 0.1	0.1	< 0.1	< 0.1	< 0.1
Thorium [µg/g]	3.4	85	120	160	490	180	120	85
Titanium [µg/g]	140	210	200	230	280	210	210	210
Thallium [µg/g]	< 3	5	< 3	< 3	< 3	< 3	< 3	< 3
Uranium [µg/g]	3.8	270	360	500	270	220	160	110
Vanadium [µg/g]	6.3	20	17	18	21	17	16	16
Tungsten [µg/g]	< 1	6	6	8	8	3	2	< 1
Yttrium [µg/g]	6.1	120	160	200	260	500	600	740
Ytterbium [µg/g]	0.41	11	14	16	24	34	38	45
Zinc [µg/g]	18	210	170	160	150	98	72	55
Zirconium [µg/g]	< 5	< 5	< 5	< 5	6	< 5	5	6

Ra226 subcontracted to Becquerel Labs.
* BaSO4 Calculation based on Ba values and assumes all Ba is in BaSO4 form.
** BaSO4 Calculation based on SO4 values and assumes all SO4 is in BaSO4 form.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Project : 09-1663

October 7, 2010

Ecometrix
Attn : Erin Clyde

6800 Campobello Road, Mississauga
Canada, L5N 2L8
Phone: 905-794-2325, Fax:905-794-2338

Date Rec. : 30 September 2009
LR Report: **CA10521-SEP09**

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CERTIFICATE OF ANALYSIS

Final Report (QC Report)

Analysis	19: MDL QC - Blank QC - STD % Recovery	20: QC - Blank	21: QC - STD % Recovery	22: QC - DUP % Recovery
BaSO4 Calc. using Ba* [µg/g]	---	---	---	---
BaSO4 Calc. using SO4** [µg/g]	---	---	---	---
Total Sulphur [%]	0.005	< 0.005	102%	---
Carbonate (CO3) [%]	0.005	< 0.005	100%	140%
Total Organic Carbon [%]	0.01	< 0.01	---	100%
Total Carbon [%]	0.005	< 0.005	100%	---
Sulphide [%]	0.01	< 0.01	90%	---
Sulphate [%]	0.1	< 0.1	100%	107%
Silver [µg/g]	0.7	< 0.7	93%	100%
Aluminum [µg/g]	1	< 1	97%	100%
Arsenic [µg/g]	1	< 1	99%	94%
Barium [µg/g]	0.05	< 0.05	96%	100%
Beryllium [µg/g]	0.1	< 0.1	98%	102%
Bismuth [µg/g]	0.5	< 0.5	98%	104%
Calcium [µg/g]	1	< 1	98%	100%
Cadmium [µg/g]	0.05	< 0.05	97%	99%
Cerium [µg/g]	0.006	< 0.006	94%	100%
Cobalt [µg/g]	0.3	< 0.3	97%	103%
Chromium [µg/g]	0.5	< 0.5	98%	103%
Cesium [µg/g]	0.01	< 0.01	---	107%
Copper [µg/g]	0.1	< 0.1	98%	102%
Iron [µg/g]	0.5	< 0.5	98%	100%
Gallium [µg/g]	0.03	< 0.03	---	99%
Germanium [µg/g]	0.3	< 0.3	103%	105%
Hafnium [µg/g]	0.1	< 0.1	96%	150%
Indium [µg/g]	0.01	< 0.01	100%	100%
Potassium [µg/g]	1	< 1	100%	100%

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LR Report : **CA10521-SEP09**

Analysis	19: MDL QC - Blank QC - STD % Recovery	20: QC - Blank	21: QC - STD % Recovery	22: QC - DUP % Recovery
Lanthanum [µg/g]	0.001	0.001	94%	110%
Lithium [µg/g]	0.1	< 0.1	97%	107%
Lutetium [µg/g]	0.001	0.001	95%	102%
Magnesium [µg/g]	1	< 1	87%	100%
Manganese [µg/g]	0.05	< 0.05	97%	100%
Molybdenum [µg/g]	0.5	< 0.5	100%	154%
Sodium [µg/g]	1	< 1	97%	104%
Niobuim [µg/g]	0.7	< 0.7	99%	118%
Nickel [µg/g]	1	< 1	97%	101%
Lead [µg/g]	0.7	< 0.7	98%	100%
Phosphorus [µg/g]	5	< 5	98%	100%
Rubidium [µg/g]	0.004	< 0.004	---	105%
Antimony [µg/g]	1	< 1	98%	100%
Scandium [µg/g]	0.2	< 0.2	100%	99%
Selenium [µg/g]	1	< 1	99%	100%
Tin [µg/g]	6	< 6	100%	1235
Strontium [µg/g]	0.01	< 0.01	97%	103%
Sulphur [µg/g]	1	< 1	100%	100%
Tantalum [µg/g]	0.01	< 0.01	97%	108%
Terbium [µg/g]	0.001	< 0.001	96%	93%
Tellerium [µg/g]	0.1	< 0.1	99%	101%
Thorium [µg/g]	0.01	< 0.01	114%	100%
Titanium [µg/g]	0.2	< 0.2	98%	104%
Thallium [µg/g]	3	< 3	99%	76%
Uranium [µg/g]	0.002	0.006	100%	100%
Vanadium [µg/g]	0.1	< 0.1	99%	102%
Tungsten [µg/g]	1	< 1	97%	93%
Yttrium [µg/g]	0.1	< 0.1	96%	100%
Ytterbium [µg/g]	0.001	0.002	98%	105%
Zinc [µg/g]	0.1	< 0.1	97%	103%
Zirconium [µg/g]	5	< 5	100%	107%

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** BaSO4 Calculation based on SO4 values and assumes all SO4 is in BaSO4 form.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

Becquerel LABORATORIES

ANALYSIS REPORT

Becquerel Laboratories Inc.
6790 Kitimat Rd., Unit 4
Mississauga, Ontario
Canada, L5N 5L9

Phone: (905) 826-3080
FAX: (905) 826-4151

Batch: T09-01386.0

Date: 12-Nov-2009

Lakefield Research Ltd.

185 Concession St., Postal Bag 4300
Lakefield, ON, K0L 2H0

attn: Brian Graham

Phone: (705) 652-2038
FAX: (705) 652-1918

Client Ref.Sep 10526
P.O: 17820

14 water samples

Received: 06-Oct-2009

Results of Analysis

Sample	Test		Result	Units	Date	Method
PW09-SR-1 (0-5)	Ra-226		0.02	Bq/l	08-Nov-2009	ALPHA
PW09-SR-1 (5-10)	Ra-226	<	0.02	Bq/l	08-Nov-2009	ALPHA
PW09-SR-1 (10-15)	Ra-226	<	0.01	Bq/l	08-Nov-2009	ALPHA
PW09-SR-1 (15-20)	Ra-226	<	0.01	Bq/l	08-Nov-2009	ALPHA
PW09-SR-2 (0-5)	Ra-226		2.4	Bq/l	08-Nov-2009	ALPHA
PW09-SR-2 (5-10)	Ra-226		2.3	Bq/l	08-Nov-2009	ALPHA
PW09-SR-2 (10-15)	Ra-226		0.87	Bq/l	08-Nov-2009	ALPHA
PW09-SR-3 (0-5)	Ra-226		5.1	Bq/l	08-Nov-2009	ALPHA
PW09-SR-3 (5-10)	Ra-226		6.0	Bq/l	08-Nov-2009	ALPHA
PW09-SR-3 (10-15)	Ra-226		5.4	Bq/l	08-Nov-2009	ALPHA
PW09-SR-3 (15-20)	Ra-226		4.5	Bq/l	08-Nov-2009	ALPHA
PW09-SR-4 (0-5)	Ra-226		0.87	Bq/l	08-Nov-2009	ALPHA
PW09-SR-4 (5-10)	Ra-226		1.2	Bq/l	08-Nov-2009	ALPHA
PW09-SR-4 (10-15)	Ra-226		1.4	Bq/l	08-Nov-2009	ALPHA

Methods: ALPHA BQ-RAD-ALPHA alpha-particle spectrometry

Units: Bq/l Becquerels per litre

These results relate only to the samples analysed and only to the items tested.

12-Nov-2009 approved by:
Donald D. Burgess PhD
Senior Scientist, Division Supervisor

SGS Lakefield Research Limited
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
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October 14, 2009

Date Rec. : 30 September 2009
LR Report : **CA10526-SEP09**
Project : 09-1663

CERTIFICATE OF ANALYSIS
Final Report

Analysis	**1: Analysis Start Date**	**2: Analysis Start Time**	**3: Analysis Approval Date**	**4: Analysis Approval Time**	**5: PW09-SR-1 (0-5)**	**6: PW09-SR-1 (5-10)**	**7: PW09-SR-1 (10-15)**	**8: PW09-SR-1 (15-20)**	**9: PW09-SR-2 (0-5)**
Sample Date & Time					26-Sep-09	26-Sep-09	26-Sep-09	26-Sep-09	26-Sep-09
Temperature Upon Receipt [°C]	---	---	---	---	4.0	4.0	4.0	4.0	4.0
Sulphate [mg/L]	02-Oct-09	15:00	07-Oct-09	09:19	2.6	< 2	< 2	< 2	16
Dissolved Organic Carbon [mg/L]	02-Oct-09	10:00	07-Oct-09	09:23	14.5	19.6	20.0	22.9	10.5
Dissolved Inorganic Carbon [mg/L]	05-Oct-09	14:35	08-Oct-09	12:47	< 1.0	< 1.0	3.1	2.7	2.4
Alkalinity [mg/L as CaCO3]	02-Oct-09	15:19	05-Oct-09	15:10	9	24	8	2	25
Acidity [mg/L as CaCO3]	02-Oct-09	15:19	05-Oct-09	15:10	6	< 2	3	6	< 2
Hardness [mg/L as CaCO3]	05-Oct-09	09:00	05-Oct-09	13:18	11.1	9.5	5.3	5.3	28.8
Aluminum [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	< 0.01	0.02	0.02	0.03	0.02
Arsenic [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.0014	0.0034	0.0054	0.0050	0.0015
Barium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.0271	0.0274	0.0313	0.0172	2.16
Beryllium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002
Boron [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.0052	0.0036	0.0057	0.0089	0.0046
Bismuth [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001
Calcium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	3.54	3.00	1.68	1.71	9.60
Cadmium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.000017	0.000016	0.000025	0.000056	0.000003
Cobalt [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.000762	0.000476	0.000120	0.000079	0.00216
Chromium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Copper [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.0025	0.0037	0.0023	0.0051	0.0021
Iron [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	0.29	0.81	0.06	0.08	0.01
Potassium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	0.24	0.26	0.34	0.38	0.79
Lithium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Magnesium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	0.538	0.492	0.277	0.255	1.16

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LR Report : **CA10526-SEP09**

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	5: PW09-SR-1 (0-5)	6: PW09-SR-1 (5-10)	7: PW09-SR-1 (10-15)	8: PW09-SR-1 (15-20)	9: PW09-SR-2 (0-5)
Manganese [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.365	0.305	0.245	0.325	3.91
Molybdenum [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.00069	0.00037	0.00024	0.00031	0.00064
Sodium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	1.85	1.83	1.64	2.17	2.57
Nickel [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.0007	0.0009	0.0006	0.0009	0.0011
Phosphorus [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Lead [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.00087	0.00213	0.00036	0.00124	0.00037
Sulphur [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	1.05	0.78	0.46	0.74	4.67
Antimony [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Selenium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Silica [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	1.52	1.96	2.35	2.84	1.63
Tin [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.00007	0.00022	< 0.00001	< 0.00001	< 0.00001
Strontium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	0.0121	0.0104	0.0064	0.0068	0.0668
Titanium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.0007	0.0011	0.0007	0.0012	0.0001
Thallium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Uranium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.000186	0.000137	0.000380	0.000250	0.00266
Vanadium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.00016	0.00026	0.00014	0.00029	0.00008
Zinc [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.002	0.002	0.002	0.003	0.002

Samples are field filtered
Ra226 subcontracted to Becquerel Labs.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

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CERTIFICATE OF ANALYSIS
Final Report

Analysis	10: PW09-SR-2 (5-10)	11: PW09-SR-2 (10-15)	12: PW09-SR-3 (0-5)	13: PW09-SR-3 (5-10)	14: PW09-SR-3 (10-15)	15: PW09-SR-3 (15-20)	16: PW09-SR-4 (0-5)	17: PW09-SR-4 (5-10)	18: PW09-SR-4 (10-15)
Sample Date & Time	26-Sep-09	26-Sep-09	27-Sep-09	27-Sep-09	27-Sep-09	27-Sep-09	27-Sep-09	27-Sep-09	27-Sep-09
Temperature Upon Receipt [°C]	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Sulphate [mg/L]	14	---	7.9	4.0	< 2	< 2	19	8.1	4.9
Dissolved Organic Carbon [mg/L]	26.5	---	9.9	18.8	13.2	---	---	---	---
Dissolved Inorganic Carbon [mg/L]	5.0	---	14.0	26.5	32.7	---	---	---	---
Alkalinity [mg/L as CaCO3]	5	---	69	99	135	177	33	---	87
Acidity [mg/L as CaCO3]	6	---	---	---	---	---	---	< 2	---
Hardness [mg/L as CaCO3]	25.6	31.5	42.6	67.1	87.2	130	45.2	63.4	78.8
Aluminum [mg/L]	0.07	0.07	< 0.01	< 0.01	< 0.01	0.02	< 0.01	0.01	0.02
Arsenic [mg/L]	0.0030	0.0027	0.0012	0.0014	0.0039	0.0027	0.0012	0.0022	0.0051
Barium [mg/L]	2.38	1.50	1.91	3.11	3.75	3.24	0.561	0.621	0.602
Beryllium [mg/L]	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002
Boron [mg/L]	0.0068	0.0090	0.0095	0.0146	0.0356	0.0758	0.0192	0.0424	0.0817
Bismuth [mg/L]	0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001
Calcium [mg/L]	8.74	10.5	14.7	23.8	31.6	47.6	15.7	22.3	27.8
Cadmium [mg/L]	0.000010	0.000010	0.000004	0.000005	0.000008	0.000007	0.000008	0.000007	0.000015
Cobalt [mg/L]	0.000948	0.000863	0.00704	0.00374	0.00264	0.00253	0.000880	0.000284	0.000291
Chromium [mg/L]	< 0.0005	0.0007	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Copper [mg/L]	0.0046	0.0049	0.0010	0.0010	0.0015	0.0014	0.0015	0.0016	0.0019
Iron [mg/L]	0.08	0.27	3.54	4.19	6.18	0.51	1.05	0.26	0.02
Potassium [mg/L]	0.95	2.11	1.03	1.86	3.28	6.21	0.96	1.57	2.77
Lithium [mg/L]	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.004	< 0.002	< 0.002	< 0.002
Magnesium [mg/L]	0.926	1.26	1.45	1.84	1.99	2.84	1.46	1.88	2.28

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LR Report : **CA10526-SEP09**

Analysis	**10: PW09-SR-2 (5-10)**	**11: PW09-SR-2 (10-15)**	**12: PW09-SR-3 (0-5)**	**13: PW09-SR-3 (5-10)**	**14: PW09-SR-3 (10-15)**	**15: PW09-SR-3 (15-20)**	**16: PW09-SR-4 (0-5)**	**17: PW09-SR-4 (5-10)**	**18: PW09-SR-4 (10-15)**
Manganese [mg/L]	1.82	1.34	10.8	8.04	5.58	2.89	1.24	0.613	0.341
Molybdenum [mg/L]	0.00150	0.00282	0.00065	0.00035	0.00369	0.00475	0.00056	0.00238	0.00909
Sodium [mg/L]	2.81	2.81	2.35	2.95	3.63	5.23	3.15	3.27	3.93
Nickel [mg/L]	0.0013	0.0012	0.0016	0.0018	0.0018	0.0019	0.0014	0.0009	0.0009
Phosphorus [mg/L]	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.01	< 0.01
Lead [mg/L]	0.00198	0.00084	0.00018	0.00008	0.00023	0.00004	0.00054	0.00091	0.00192
Sulphur [mg/L]	4.45	5.89	2.65	1.74	0.88	1.07	5.53	2.88	2.10
Antimony [mg/L]	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Selenium [mg/L]	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Silica [mg/L]	2.68	4.19	3.02	5.36	6.12	6.22	3.01	6.24	9.87
Tin [mg/L]	0.00004	< 0.00001	0.00003	< 0.00001	0.00007	< 0.00001	0.00002	< 0.00001	< 0.00001
Strontium [mg/L]	0.0685	0.0607	0.0508	0.0866	0.117	0.151	0.0328	0.0425	0.0515
Titanium [mg/L]	0.0012	0.0024	0.0002	0.0003	0.0004	0.0004	0.0002	0.0006	0.0008
Thallium [mg/L]	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Uranium [mg/L]	0.00258	0.000877	0.0113	0.00514	0.0400	0.0379	0.00413	0.00669	0.0110
Vanadium [mg/L]	0.00022	0.00082	0.00017	0.00033	0.00038	0.00071	0.00014	0.00032	0.00095
Zinc [mg/L]	0.004	0.005	0.002	0.004	0.003	0.003	0.003	0.002	0.002

Samples are field filtered
Ra226 subcontracted to Becquerel Labs.

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Project Specialist
Environmental Services, Analytical

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SGS

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Analysis	19: MDL	20: QC - Blank	21: QC - STD % Recovery	22: QC - DUP % Recovery
Temperature Upon Receipt [°C]	---	---	---	---
Sulphate [mg/L]	0.2	< 0.2	105%	100%
Dissolved Organic Carbon [mg/L]	0.2	< 0.2	105%	98%
Dissolved Inorganic Carbon [mg/L]	0.2	0.2	97%	100%
Alkalinity [mg/L as CaCO3]	2	< 2	101%	98%
Acidity [mg/L as CaCO3]	2	3	98%	102%
Hardness [mg/L as CaCO3]	0.5	< 0.5	---	---
Aluminum [mg/L]	0.01	< 0.01	98%	---
Arsenic [mg/L]	0.0002	< 0.0002	106%	---
Barium [mg/L]	0.00001	< 0.00001	122%	---
Beryllium [mg/L]	0.00002	< 0.00002	104%	---
Boron [mg/L]	0.0002	< 0.0002	96%	---
Bismuth [mg/L]	0.00001	< 0.00001	109%	---
Calcium [mg/L]	0.03	< 0.03	101%	---
Cadmium [mg/L]	0.000003	0.000003	99%	---
Cobalt [mg/L]	0.000002	< 0.000002	102%	---
Chromium [mg/L]	0.0005	< 0.0005	102%	---
Copper [mg/L]	0.0005	< 0.0005	102%	---
Iron [mg/L]	0.01	< 0.01	102%	---
Potassium [mg/L]	0.01	< 0.01	98%	---
Lithium [mg/L]	0.002	< 0.002	98%	---
Magnesium [mg/L]	0.003	< 0.003	99%	---
Manganese [mg/L]	0.00001	< 0.00001	107%	---
Molybdenum [mg/L]	0.00001	< 0.00001	99%	---
Sodium [mg/L]	0.01	< 0.01	94%	---
Nickel [mg/L]	0.0001	< 0.0001	100%	---
Phosphorus [mg/L]	0.01	< 0.01	100%	---
Lead [mg/L]	0.00002	< 0.00002	106%	---
Sulphur [mg/L]	0.01	< 0.01	100%	---
Antimony [mg/L]	0.0002	< 0.0002	101%	---

OnLine LIMS

SGS Canada Inc.
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Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Project : 09-1663

LR Report : **CA10526-SEP09**

Analysis	19: MDL	20: QC - Blank	21: QC - STD % Recovery	22: QC - DUP % Recovery
Selenium [mg/L]	0.001	< 0.001	102%	---
Silica [mg/L]	0.01	< 0.01	104%	---
Tin [mg/L]	0.00001	< 0.00001	96%	---
Strontium [mg/L]	0.0001	< 0.0001	100%	---
Titanium [mg/L]	0.0001	< 0.0001	96%	---
Thallium [mg/L]	0.0002	< 0.0002	107%	---
Uranium [mg/L]	0.000001	0.000001	106%	---
Vanadium [mg/L]	0.00003	< 0.00003	107%	---
Zinc [mg/L]	0.001	< 0.001	104%	---

Samples are field filtered
Ra226 subcontracted to Becquerel Labs.
Revised to include Ra226 results from Becquerel.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

ANALYSIS REPORT

Becquerel Laboratories Inc.
6790 Kitimat Rd., Unit 4
Mississauga, Ontario
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Phone: (905) 826-3080
FAX: (905) 826-4151

Batch: T09-01385.0

Date: 09-Nov-2009

Lakefield Research Ltd.

185 Concession St., Postal Bag 4300
Lakefield, ON, K0L 2H0

attn: Brian Graham

Phone: (705) 652-2038
FAX: (705) 652-1918

Client Ref.Sep 10525
P.O: 17820

9 water samples

Received: 06-Oct-2009

Results of Analysis

Sample	Test	Result	Units	Date	Method
SW09-SR-1T	Ra-226	< 0.01	Bq/l	06-Nov-2009	ALPHA
SW09-SR-1B	Ra-226	< 0.01	Bq/l	06-Nov-2009	ALPHA
SW09-SR-2T	Ra-226	0.11	Bq/l	06-Nov-2009	ALPHA
SW09-SR-2B	Ra-226	0.28	Bq/l	06-Nov-2009	ALPHA
SW09-SR-3T	Ra-226	0.15	Bq/l	06-Nov-2009	ALPHA
SW09-SR-3B	Ra-226	0.80	Bq/l	06-Nov-2009	ALPHA
SW09-SR-4T	Ra-226	0.19	Bq/l	06-Nov-2009	ALPHA
SW09-SR-4B	Ra-226	0.30	Bq/l	06-Nov-2009	ALPHA
Blank 1	Ra-226	< 0.01	Bq/l	06-Nov-2009	ALPHA

Methods: ALPHA BQ-RAD-ALPHA alpha-particle spectrometry

Units: Bq/l Becquerels per litre

These results relate only to the samples analysed and only to the items tested.

09-Nov-2009 approved by: *[signature]*
Donald D. Burgess PhD
Senior Scientist, Division Supervisor

SGS Lakefield Research Limited
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Ecometrix
Attn : Erin Clyde

6800 Campobello Road, Mississauga
Canada, L5N 2L8
Phone: 905-794-2325, Fax:905-794-2338

October 14, 2009

Date Rec. : 30 September 2009
LR Report : **CA10525-SEP09**
Project : 09-1663

CERTIFICATE OF ANALYSIS
Final Report

Analysis	**1: Analysis Start Date**	**2: Analysis Start Time**	**3: Analysis Approval Date**	**4: Analysis Approval Time**	**5: SW09-SR-1T**	**6: SW09-SR-1B**	**7: SW09-SR-2T**
Sample Date & Time					24-Sep-09	25-Sep-09	24-Sep-09
Temperature Upon Receipt [°C]	---	---	---	---	4.0	4.0	4.0
Sulphate [mg/L]	02-Oct-09	15:00	05-Oct-09	16:12	8.5	5.6	31
Total Organic Carbon [mg/L]	02-Oct-09	10:00	05-Oct-09	13:41	2.7	5.4	2.3
Total Inorganic Carbon [mg/L]	05-Oct-09	14:35	08-Oct-09	12:46	< 1.0	< 1.0	< 1.0
Alkalinity [mg/L as CaCO3]	02-Oct-09	15:19	05-Oct-09	15:13	---	---	---
Acidity [mg/L as CaCO3]	02-Oct-09	15:19	05-Oct-09	15:13	11	9	9
Hardness [mg/L as CaCO3]	02-Oct-09	09:00	02-Oct-09	12:09	10.4	10.2	34.8
Aluminum [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	0.02	0.02	< 0.01
Arsenic [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.0004	0.0003	0.0005
Barium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.0144	0.0155	0.120
Beryllium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	< 0.00002	< 0.00002	< 0.00002
Boron [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.0059	0.0050	0.0084
Bismuth [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	< 0.00001	< 0.00001	< 0.00001
Calcium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	3.26	3.21	11.8
Cadmium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.000013	0.000061	< 0.000003
Cobalt [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.00298	0.00250	0.00184
Chromium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	< 0.0005	< 0.0005	< 0.0005
Copper [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.0015	0.0016	0.0007
Iron [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	0.03	0.03	0.02
Potassium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	0.25	0.24	0.78
Lithium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	< 0.002	< 0.002	< 0.002
Magnesium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	0.542	0.524	1.31

SGS Lakefield Research Limited
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LR Report : **CA10525-SEP09**

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	5: SW09-SR-1T	6: SW09-SR-1B	7: SW09-SR-2T
Manganese [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.0313	0.0284	0.0545
Molybdenum [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.00007	0.00008	0.00022
Sodium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	1.83	1.89	2.06
Nickel [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.0004	0.0004	0.0005
Phosphorus [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	< 0.01	< 0.01	< 0.01
Lead [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.00031	0.00056	0.00031
Sulphur [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	1.66	1.67	9.17
Antimony [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.0045	0.0037	0.0028
Selenium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	< 0.001	< 0.001	< 0.001
Silica [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	0.63	0.63	0.63
Tin [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.00006	0.00019	0.00019
Strontium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	0.0117	0.0115	0.0270
Titanium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.0002	0.0002	0.0001
Thallium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	< 0.0002	< 0.0002	< 0.0002
Uranium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.000257	0.000138	0.00154
Vanadium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.00005	0.00012	0.00004
Zinc [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.003	0.003	< 0.001

Ra226 subcontracted to Becquerel Labs.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

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OnLine LIMS

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Ecometrix
Attn : Erin Clyde

6800 Campobello Road, Mississauga
Canada, L5N 2L8
Phone: 905-794-2325, Fax:905-794-2338

October 14, 2009

Date Rec. : 30 September 2009
LR Report : **CA10525-SEP09**
Project : 09-1663

CERTIFICATE OF ANALYSIS

Final Report

Analysis	**8: SW09-SR-2B**	**9: SW09-SR-3T**	**10: SW09-SR-3B**	**11: SW09-SR-4T**	**12: SW09-SR-4B**	**13: Blank 1**
Sample Date & Time	25-Sep-09	25-Sep-09	25-Sep-09	25-Sep-09	25-Sep-09	27-Sep-09
Temperature Upon Receipt [°C]	4.0	4.0	4.0	4.0	4.0	4.0
Sulphate [mg/L]	45	30	26	25	25	< 2
Total Organic Carbon [mg/L]	2.2	4.6	2.2	4.6	2.0	2.4
Total Inorganic Carbon [mg/L]	< 1.0	< 1.0	< 1.0	< 1.0	1.4	< 1.0
Alkalinity [mg/L as CaCO3]	---	---	7	---	---	---
Acidity [mg/L as CaCO3]	7	8	---	---	< 2	7
Hardness [mg/L as CaCO3]	36.5	33.7	32.7	33.0	33.4	< 0.5
Aluminum [mg/L]	0.04	< 0.01	< 0.01	0.01	< 0.01	< 0.01
Arsenic [mg/L]	0.0007	0.0004	0.0008	0.0004	0.0007	< 0.0002
Barium [mg/L]	0.294	0.147	0.334	0.191	0.222	0.00216
Beryllium [mg/L]	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002
Boron [mg/L]	0.0093	0.0079	0.0090	0.0081	0.0089	< 0.0002
Bismuth [mg/L]	< 0.00001	< 0.00001	< 0.00001	< 0.00001	0.00001	< 0.00001
Calcium [mg/L]	12.4	11.4	11.1	11.1	11.2	0.03
Cadmium [mg/L]	0.000045	0.000006	0.000011	0.000009	0.000028	< 0.000003
Cobalt [mg/L]	0.00270	0.00148	0.00178	0.000944	0.000310	0.000003
Chromium [mg/L]	0.0012	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Copper [mg/L]	0.0015	0.0012	0.0017	0.0009	0.0011	0.0053
Iron [mg/L]	0.02	0.02	0.40	0.02	0.08	< 0.01
Potassium [mg/L]	0.86	0.75	0.74	0.72	0.80	< 0.01
Lithium [mg/L]	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Magnesium [mg/L]	1.36	1.28	1.24	1.28	1.29	< 0.003

OnLine LIMS

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LR Report : **CA10525-SEP09**

Analysis	8: SW09-SR-2B	9: SW09-SR-3T	10: SW09-SR-3B	11: SW09-SR-4T	12: SW09-SR-4B	13: Blank 1
Manganese [mg/L]	0.253	0.0424	0.752	0.0251	0.119	0.00034
Molybdenum [mg/L]	0.00013	0.00026	0.00036	0.00029	0.00032	< 0.00001
Sodium [mg/L]	2.13	2.16	2.17	2.65	2.79	0.15
Nickel [mg/L]	0.0016	0.0006	0.0010	0.0005	0.0006	0.0003
Phosphorus [mg/L]	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Lead [mg/L]	0.00151	0.00029	0.00031	0.00027	0.00043	< 0.00002
Sulphur [mg/L]	9.22	8.86	8.73	8.40	8.58	0.05
Antimony [mg/L]	0.0041	0.0021	0.0006	0.0013	0.0002	< 0.0002
Selenium [mg/L]	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Silica [mg/L]	0.62	0.62	0.77	0.65	0.73	< 0.01
Tin [mg/L]	0.00029	0.00052	0.00009	0.00007	0.00016	< 0.00001
Strontium [mg/L]	0.0302	0.0267	0.0275	0.0266	0.0268	0.0001
Titanium [mg/L]	0.0001	0.0001	0.0002	0.0002	0.0001	< 0.0001
Thallium [mg/L]	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Uranium [mg/L]	0.00345	0.00131	0.00137	0.00146	0.00122	< 0.000001
Vanadium [mg/L]	0.00003	0.00007	0.00005	0.00005	0.00008	< 0.00003
Zinc [mg/L]	0.009	0.002	0.002	< 0.001	0.004	< 0.001

Ra226 subcontracted to Becquerel Labs.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

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SGS Canada Inc.
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Project : 09-1663

October 7, 2010

Ecometrix
Attn : Erin Clyde

6800 Campobello Road, Mississauga
Canada, L5N 2L8
Phone: 905-794-2325, Fax:905-794-2338

Date Rec. : 30 September 2009
LR Report: **CA10525-SEP09**

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CERTIFICATE OF ANALYSIS
Final Report - (QC Report)

Analysis	14: MDL	15: QC - Blank	16: QC - STD % Recovery	17: QC - DUP % Recovery
Sulphate [mg/L]	0.2	< 0.2	105%	100%
Total Organic Carbon [mg/L]	0.2	< 0.2	105%	98%
Total Inorganic Carbon [mg/L]	0.2	0.2	97%	100%
Alkalinity [mg/L as CaCO3]	2	< 2	101%	98%
Acidity [mg/L as CaCO3]	2	3	98%	102%
Hardness [mg/L as CaCO3]	0.5	---	---	---
Aluminum [mg/L]	0.01	< 0.01	95%	100%
Arsenic [mg/L]	0.0002	< 0.0002	106%	111%
Barium [mg/L]	0.00001	< 0.00001	105%	100%
Beryllium [mg/L]	0.00002	< 0.00002	103%	94%
Boron [mg/L]	0.0002	< 0.0002	99%	97%
Bismuth [mg/L]	0.00001	0.00001	105%	82%
Calcium [mg/L]	0.03	---	98%	100%
Cadmium [mg/L]	0.000003	< 0.000003	102%	107%
Cobalt [mg/L]	0.000002	< 0.000002	105%	99%
Chromium [mg/L]	0.0005	< 0.0005	103%	170%
Copper [mg/L]	0.0005	< 0.0005	106%	85%
Iron [mg/L]	0.01	---	96.8	122
Potassium [mg/L]	0.01	< 0.01	98%	99.1
Lithium [mg/L]	0.002	< 0.002	94.2	120
Magnesium [mg/L]	0.003	---	95%	100%
Manganese [mg/L]	0.00001	< 0.00001	104%	99%
Molybdenum [mg/L]	0.00001	< 0.00001	95%	155%
Sodium [mg/L]	0.01	---	95%	99%
Nickel [mg/L]	0.0001	< 0.0001	105%	87%
Phosphorus [mg/L]	0.01	< 0.01	95%	100%
Lead [mg/L]	0.00002	< 0.00002	102%	30%
Sulphur [mg/L]	0.01	---	100%	101%
Antimony [mg/L]	0.0002	< 0.0002	94%	124%
Selenium [mg/L]	0.001	< 0.001	108%	100%

SGS Canada Inc.
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Phone: 705-652-2000 FAX: 705-652-6365

Project : 09-1663

LR Report : **CA10525-SEP09**

Analysis	14: MDL	15: QC - Blank	16: QC - STD % Recovery	17: QC - DUP % Recovery
Silica [mg/L]	0.01	< 0.01	103%	101%
Tin [mg/L]	0.00001	< 0.00001	96%	140%
Strontium [mg/L]	0.0001	---	98%	100%
Titanium [mg/L]	0.0001	< 0.0001	95%	130%
Thallium [mg/L]	0.0002	< 0.0002	105%	106%
Uranium [mg/L]	0.000001	< 0.000001	102%	94%
Vanadium [mg/L]	0.00003	< 0.00003	106%	150%
Zinc [mg/L]	0.001	< 0.001	106%	90%

Ra226 subcontracted to Becquerel Labs.
Revised to include Ra226 results from Becquerel

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

ANALYSIS REPORT

Becquerel Laboratories Inc.
6790 Kitimat Rd., Unit 4
Mississauga, Ontario
Canada, L5N 5L9

Phone: (905) 826-3080
FAX: (905) 826-4151

Batch: T09-01383.0

Date: 20-Oct-2009

Lakefield Research Ltd.

185 Concession St., Postal Bag 4300
Lakefield, ON, K0L 2H0

attn: Brian Graham

Phone: (705) 652-2038
FAX: (705) 652-1918

Client Ref.Oct 10069
P.O: 17820

5 water samples   Sampled: 29-Sep-2009   Received: 06-Oct-2009   Page 1 of 1

Results of Analysis

Sample	Test	Result	Units	Date	Method
PW09 EC2 0-2.5	Ra-226	2.9	Bq/l	18-Oct-2009	ALPHA
PW09 EC2 2.5-5	Ra-226	3.3	Bq/l	18-Oct-2009	ALPHA
PW09 EC2 5-7.5	Ra-226	5.4	Bq/l	18-Oct-2009	ALPHA
PW09 EC1 0-5	Ra-226	0.30	Bq/l	18-Oct-2009	ALPHA
PW09 EC1 5-10	Ra-226	4.7	Bq/l	18-Oct-2009	ALPHA

Methods: ALPHA BQ-RAD-ALPHA alpha-particle spectrometry

Units: Bq/l Becquerels per litre

These results relate only to the samples analysed and only to the items tested.

20-Oct-2009 approved by:
Donald D. Burgess PhD
Senior Scientist, Division Supervisor

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October 14, 2009

Date Rec. : 01 October 2009
LR Report : **CA10069-OCT09**
Project : 09-1663

CERTIFICATE OF ANALYSIS

Final Report

Analysis	**1: Analysis Start Date**	**2: Analysis Start Time**	**3: Analysis Approval Date**	**4: Analysis Approval Time**	**5: PW09 EC2 0-2.5**	**6: PW09 EC2 2.5-5**	**7: PW09 EC2 5-7.5**	**8: PW09 EC1 0-5**	**9: PW09 EC1 5-10**
Sample Date & Time					29-Sep-09	29-Sep-09	29-Sep-09	29-Sep-09	29-Sep-09
Temperature Upon Receipt [°C]	---	---	---	---	9.0	9.0	9.0	9.0	9.0
Sulphate [mg/L]	02-Oct-09	19:39	06-Oct-09	12:35	27	18	---	---	---
Dissolved Organic Carbon [mg/L]	05-Oct-09	09:40	06-Oct-09	13:53	19.0	14.3	---	---	---
Dissolved Inorganic Carbon [mg/L]	06-Oct-09	08:15	07-Oct-09	12:40	4.2	1.1	---	---	---
Acidity [mg/L as CaCO3]	02-Oct-09	15:00	06-Oct-09	11:07	17	16	---	---	---
Hardness [mg/L as CaCO3]	05-Oct-09	09:00	05-Oct-09	13:17	21.7	16.0	16.4	33.9	17.8
Aluminum [mg/L]	05-Oct-09	09:00	05-Oct-09	13:17	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.0058	0.0046	0.0065	0.0006	0.0024
Barium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.285	0.337	0.487	0.221	0.335
Beryllium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002
Boron [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.0039	0.0034	0.0039	0.0082	0.0028
Bismuth [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.00003	0.00006	0.00003	< 0.00001	< 0.00001
Calcium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:17	7.28	5.35	5.54	11.4	6.06
Cadmium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.000031	0.000012	0.000009	0.000012	< 0.000003
Cobalt [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.00289	0.00120	0.00183	0.000321	0.00192
Chromium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Copper [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.0018	0.0018	0.0011	0.0010	< 0.0005
Iron [mg/L]	05-Oct-09	09:00	05-Oct-09	13:17	0.44	3.30	5.71	0.07	6.63
Potassium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:17	0.30	0.34	0.48	0.80	0.58
Lithium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:17	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Magnesium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:17	0.864	0.634	0.632	1.31	0.655

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SGS Lakefield Research Limited
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Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

LR Report : CA10069-OCT09

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	5: PW09 EC2 0-2.5	6: PW09 EC2 2.5-5	7: PW09 EC2 5-7.5	8: PW09 EC1 0-5	9: PW09 EC1 5-10
Manganese [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.217	0.134	0.132	0.120	0.142
Molybdenum [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.00015	0.00116	0.00149	0.00029	0.00051
Sodium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:17	2.20	1.87	1.50	2.75	1.24
Nickel [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.0024	0.0013	0.0017	0.0008	0.0010
Phosphorus [mg/L]	05-Oct-09	09:00	05-Oct-09	13:17	0.07	0.01	< 0.01	< 0.01	< 0.01
Lead [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.00216	0.00090	0.00049	0.00023	0.00016
Sulphur [mg/L]	05-Oct-09	09:00	05-Oct-09	13:17	6.26	3.35	4.21	7.26	1.58
Antimony [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.0003	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Selenium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Silica [mg/L]	05-Oct-09	09:00	05-Oct-09	13:17	1.42	1.86	2.71	0.72	5.07
Tin [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.00017	< 0.00001	0.00001	< 0.00001	0.00002
Strontium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:17	0.0168	0.0149	0.0187	0.0269	0.0168
Titanium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.0007	0.0004	0.0002	< 0.0001	0.0003
Thallium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Uranium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.000173	0.000115	0.000105	0.000835	0.000671
Vanadium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.00008	0.00007	0.00004	0.00007	0.00005
Zinc [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.005	0.004	0.003	0.003	0.001

Samples are field filtered
Ra226 subcontracted to Becquerel Labs.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

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LR Report : **CA10069-OCT09**

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Env ICP-MS Metals

Project : 09-1663

October 7, 2010

Ecometrix
Attn : Erin Clyde

6800 Campobello Road, Mississauga
Canada, L5N 2L8
Phone: 905-794-2325, Fax:905-794-2338

Date Rec. : 01 October 2009
LR Report: **CA10069-OCT09**

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CERTIFICATE OF ANALYSIS
Final Report

Analysis	10: MDL	11: QC - Blank	12: QC - STD % Recovery	13: QC - DUP % Recovery
Sulphate [mg/L]	0.2	< 0.2	100%	110%
Dissolved Organic Carbon [mg/L]	0.2	< 0.2	91%	100%
Dissolved Inorganic Carbon [mg/L]	0.2	0.7	107%	100%
Acidity [mg/L as CaCO3]	2	3	98%	102%
Hardness [mg/L as CaCO3]	0.5	< 0.5	---	---
Aluminum [mg/L]	0.01	< 0.01	98%	---
Arsenic [mg/L]	0.0002	< 0.0002	106%	---
Barium [mg/L]	0.00001	< 0.00001	122%	---
Beryllium [mg/L]	0.00002	< 0.00002	104%	---
Boron [mg/L]	0.0002	< 0.0002	96%	---
Bismuth [mg/L]	0.00001	< 0.00001	109%	---
Calcium [mg/L]	0.03	< 0.03	101%	---
Cadmium [mg/L]	0.000003	0.000003	99%	---
Cobalt [mg/L]	0.000002	< 0.000002	102%	---
Chromium [mg/L]	0.0005	< 0.0005	102%	---
Copper [mg/L]	0.0005	< 0.0005	102%	---
Iron [mg/L]	0.01	< 0.01	102%	---
Potassium [mg/L]	0.01	< 0.01	98%	---
Lithium [mg/L]	0.002	< 0.002	98%	---
Magnesium [mg/L]	0.003	< 0.003	98%	---
Manganese [mg/L]	0.00001	< 0.00001	107%	---
Molybdenum [mg/L]	0.00001	< 0.00001	99%	---
Sodium [mg/L]	0.01	< 0.01	94%	---
Nickel [mg/L]	0.0001	< 0.0001	100%	---
Phosphorus [mg/L]	0.01	< 0.01	100%	---
Lead [mg/L]	0.00002	< 0.00002	106%	---
Sulphur [mg/L]	0.01	< 0.01	98%	---
Antimony [mg/L]	0.0002	< 0.0002	101%	---

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SGS Canada Inc.
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Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Env ICP-MS Metals

Project : 09-1663

LR Report : **CA10069-OCT09**

Analysis	10: MDL	11: QC - Blank	12: QC - STD % Recovery	13: QC - DUP % Recovery
Selenium [mg/L]	0.001	< 0.001	102%	---
Silica [mg/L]	0.01	< 0.01	104%	---
Tin [mg/L]	0.00001	< 0.00001	96%	---
Strontium [mg/L]	0.0001	< 0.0001	100%	---
Titanium [mg/L]	0.0001	< 0.0001	96%	---
Thallium [mg/L]	0.0002	< 0.0002	107%	---
Uranium [mg/L]	0.000001	0.000001	107%	---
Vanadium [mg/L]	0.00003	< 0.00003	107%	---
Zinc [mg/L]	0.001	< 0.001	104%	---

Samples are field filtered
Ra226 subcontracted to Becquerel Labs.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

ANALYSIS REPORT

Becquerel Laboratories Inc.
6790 Kitimat Rd., Unit 4
Mississauga, Ontario
Canada, L5N 5L9

Phone: (905) 826-3080
FAX: (905) 826-4151

Batch: T09-01382.0

Date: 20-Oct-2009

Lakefield Research Ltd.

185 Concession St., Postal Bag 4300
Lakefield, ON, K0L 2H0

attn: Brian Graham

Phone: (705) 652-2038
FAX: (705) 652-1918

Client Ref.Oct 10064
P.O: 17820

6 water samples   Sampled: 28-Sep-2009   Received: 06-Oct-2009   Page 1 of 1

Results of Analysis

Sample	Test	Result	Units	Date	Method
SW09 QC15-1	Ra-226	0.42	Bq/l	17-Oct-2009	ALPHA
SW09 QC15-2	Ra-226	0.45	Bq/l	18-Oct-2009	ALPHA
SW09 QC15-3	Ra-226	0.46	Bq/l	18-Oct-2009	ALPHA
SW09 QC15-4	Ra-226	0.45	Bq/l	18-Oct-2009	ALPHA
SW09 EC-2T	Ra-226	0.78	Bq/l	18-Oct-2009	ALPHA
SW09 EC-2B	Ra-226	0.85	Bq/l	18-Oct-2009	ALPHA

Methods: ALPHA BQ-RAD-ALPHA alpha-particle spectrometry

Units: Bq/l Becquerels per litre

These results relate only to the samples analysed and only to the items tested.

20-Oct-2009 approved by: [signature]
Donald D. Burgess PhD
Senior Scientist, Division Supervisor

SGS Lakefield Research Limited
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Ecometrix
Attn : Erin Clyde

6800 Campobello Road, Mississauga
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Phone: 905-794-2325, Fax:905-794-2338

October 14, 2009

Date Rec. : 01 October 2009
LR Report : **CA10064-OCT09**
Project : 09-1663

CERTIFICATE OF ANALYSIS
Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	5: SW09 QC15-1	6: SW09 QC15-2	7: SW09 QC15-3	8: SW09 QC15-4	9: SW09 EC-2T	10: SW09 EC-2B
Sample Date & Time					28-Sep-09	28-Sep-09	28-Sep-09	28-Sep-09	28-Sep-09	28-Sep-09
Temperature Upon Receipt [°C]	---	---	---	---	9.0	9.0	9.0	9.0	9.0	9.0
Sulphate [mg/L]	02-Oct-09	19:39	06-Oct-09	14:22	570	570	570	600	85	36
Acidity [mg/L as CaCO3]	02-Oct-09	15:00	05-Oct-09	15:14	22	27	44	50	67	16
Total Organic Carbon [mg/L]	05-Oct-09	09:40	06-Oct-09	13:53	---	---	---	---	11.4	11.7
Total Inorganic Carbon [mg/L]	05-Oct-09	14:35	08-Oct-09	12:46	---	---	---	---	< 1.0	< 1.0
Hardness [mg/L as CaCO3]	05-Oct-09	09:00	05-Oct-09	13:19	529	535	532	549	17.0	16.8
Aluminum [mg/L]	05-Oct-09	09:00	05-Oct-09	13:19	< 0.01	< 0.01	< 0.01	0.02	0.03	< 0.01
Arsenic [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.0010	0.0009	0.0009	0.0011	0.0007	0.0007
Barium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.0334	0.0301	0.0300	0.0296	0.108	0.114
Beryllium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.00006	< 0.00002	0.00002	< 0.00002	0.00003	0.00002
Boron [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.113	0.113	0.115	0.116	0.0076	0.0072
Bismuth [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.00004	0.00002	0.00001	< 0.00001	0.00002	0.00002
Calcium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:19	202	205	204	210	5.69	5.63
Cadmium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.000074	0.000051	0.000039	0.000031	0.000046	0.000056
Cobalt [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.00558	0.00464	0.0106	0.0122	0.00655	0.00196
Chromium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Copper [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.0017	0.0014	0.0013	0.0016	0.0037	0.0029
Iron [mg/L]	05-Oct-09	09:00	05-Oct-09	13:19	0.10	0.06	0.16	0.18	0.07	0.04
Potassium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:19	10.8	11.0	10.9	11.9	0.31	0.32
Lithium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:19	0.008	0.008	0.008	0.009	< 0.002	< 0.002
Magnesium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:19	5.69	5.79	5.77	6.19	0.670	0.663

SGS Lakefield Research Limited
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LR Report : **CA10064-OCT09**

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	5: SW09 QC15-1	6: SW09 QC15-2	7: SW09 QC15-3	8: SW09 QC15-4	9: SW09 EC-2T	10: SW09 EC-2B
Manganese [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.207	0.214	0.214	0.310	0.0315	0.0319
Molybdenum [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.00319	0.00409	0.00368	0.00533	0.00018	0.00008
Sodium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:19	2.38	2.42	2.37	2.59	1.59	1.58
Nickel [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.0067	0.0067	0.0067	0.0068	0.0022	0.0022
Phosphorus [mg/L]	05-Oct-09	09:00	05-Oct-09	13:19	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Lead [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.00151	0.00098	0.00194	0.00548	0.00699	0.00391
Sulphur [mg/L]	05-Oct-09	09:00	05-Oct-09	13:19	157	160	160	166	4.64	4.63
Antimony [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.0017	0.0010	0.0093	0.0106	0.0086	0.0016
Selenium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Silica [mg/L]	05-Oct-09	09:00	05-Oct-09	13:19	5.46	5.55	5.54	5.55	0.59	0.60
Tin [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.00002	0.00012	0.00002	0.00025	< 0.00001	< 0.00001
Strontium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:19	0.159	0.161	0.160	0.166	0.0122	0.0122
Titanium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.0005	0.0004	0.0005	0.0004	0.0004	0.0001
Thallium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Uranium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.0143	0.0116	0.0144	0.0219	0.000654	0.00079
Vanadium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.00009	0.00004	0.00004	< 0.00003	0.00007	0.00007
Zinc [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.005	0.004	0.004	0.004	0.004	0.005

Ra226 subcontracted to Becquerel Labs.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

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Env ICP-MS Metals

Project : 09-1663

October 7, 2010

Ecometrix
Attn : Erin Clyde

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Phone: 905-794-2325, Fax:905-794-2338

Date Rec. : 01 October 2009
LR Report: **CA10064-OCT09**

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CERTIFICATE OF ANALYSIS
Final Report (QC Report)

Analysis	11: MDL	12: QC - Blank	13: QC - STD % Recovery	14: QC - DUP % Recovery
Sulphate [mg/L]	0.2	< 0.2	98%	102%
Acidity [mg/L as CaCO3]	2	3	98%	102%
Total Organic Carbon [mg/L]	1	< 1	91%	100%
Total Inorganic Carbon [mg/L]	0.2	0.2	97%	100%
Hardness [mg/L as CaCO3]	0.5	< 0.5	---	---
Aluminum [mg/L]	0.01	< 0.01	99%	---
Arsenic [mg/L]	0.0002	< 0.0002	106%	---
Barium [mg/L]	0.00001	< 0.00001	122%	---
Beryllium [mg/L]	0.00002	< 0.00002	104%	---
Boron [mg/L]	0.0002	< 0.0002	96%	---
Bismuth [mg/L]	0.00001	< 0.00001	109%	---
Calcium [mg/L]	0.03	< 0.03	101%	---
Cadmium [mg/L]	0.000003	0.000003	99%	---
Cobalt [mg/L]	0.000002	< 0.000002	102%	---
Chromium [mg/L]	0.0005	< 0.0005	102%	---
Copper [mg/L]	0.0005	< 0.0005	102%	---
Iron [mg/L]	0.01	< 0.01	102%	---
Potassium [mg/L]	0.01	< 0.01	98%	---
Lithium [mg/L]	0.002	< 0.002	98%	---
Magnesium [mg/L]	0.003	< 0.003	99%	---
Manganese [mg/L]	0.00001	< 0.00001	107%	---
Molybdenum [mg/L]	0.00001	< 0.00001	99%	---
Sodium [mg/L]	0.01	< 0.01	93%	---
Nickel [mg/L]	0.0001	< 0.0001	100%	---
Phosphorus [mg/L]	0.01	< 0.01	100%	---
Lead [mg/L]	0.00002	< 0.00002	106%	---
Sulphur [mg/L]	0.01	< 0.01	98%	---
Antimony [mg/L]	0.0002	< 0.0002	101%	---
Selenium [mg/L]	0.001	< 0.001	102%	---
Silica [mg/L]	0.01	< 0.01	104%	---
Tin [mg/L]	0.00001	< 0.00001	96%	---
Strontium [mg/L]	0.0001	< 0.0001	100%	---
Titanium [mg/L]	0.0001	< 0.0001	96%	---
Thallium [mg/L]	0.0002	< 0.0002	107%	---

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Env ICP-MS Metals

Project : 09-1663

LR Report : **CA10064-OCT09**

Analysis	11: MDL	12: QC - Blank	13: QC - STD % Recovery	14: QC - DUP % Recovery
Uranium [mg/L]	0.000001	0.000001	1065	---
Vanadium [mg/L]	0.00003	< 0.00003	107%	---
Zinc [mg/L]	0.001	< 0.001	104%	---

Ra226 subcontracted to Becquerel Labs.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

Radium-226 Release Controls in the Panel TMA

EcoMetrix Incorporated

CYCLE III SPECIAL STUDIES – RADIUM-226 RELEASE CONTROLS IN THE PANEL TMA

Report prepared for:

RIO ALGOM LIMITED
Elliot Lake, ON

Report prepared by:

ECOMETRIX INCORPORATED
6800 Campobello Road
Mississauga, Ontario
L5N 2L8

Ref. 09-1662:2
February 2011

CYCLE III SPECIAL STUDIES – RADIUM-226 RELEASE CONTROLS IN THE PANEL TMA

Erin Clyde, M.Sc.
Project Manager

Ronald V. Nicholson, Ph.D.
Project Principal

EXECUTIVE SUMMARY

The Panel Site (the Site) is a decommissioned uranium mine property located approximately 19 km northeast of the City of Elliot Lake and immediately north of Quirke Lake. The Site is owned and managed by Rio Algom Limited (RAL).

EcoMetrix Incorporated (EcoMetrix) was retained by RAL to complete a directed study that focused on the release of Ra-226 from the submerged tailings and treatment solids to the basin waters at the Panel Tailings Management Area (TMA).

The objectives of this investigation were to evaluate Ra-226 activities in solids, porewater and basin waters to develop an understanding of the controls on Ra-226 releases to the basin waters and to provide estimates for Ra-226 activities that may be observed in the basin waters in the future.

As part of the Environmental Impact Statement (EIS) for the Panel Mine, predictive modeling using the Uranium Tailings Assessment Program (UTAP.3) was performed to predict future Ra-226 activities and sulphate concentrations in porewater and basin water in the Panel TMA. The predicted Ra-226 activities were explained by the following conceptual model. Radium-226 activities in the Panel are related to sulphate concentrations because the source of Ra-226 is the dissolution of Ra-226 bearing sulphate precipitates, such as gypsum ($CaSO_4 \cdot 2H_2O$) and barite ($BaSO_4$). The EIS stated that in the first 100 years, the major source of Ra-226 in the porewater and basin water will be controlled by the dissolution of gypsum that contains co-precipitated Ra-226 ($Ca,RaSO_4 \bullet 2H_2O$). Once gypsum is depleted from the solids after approximately 100 years, the Ra-226 activities in solution will be controlled by the dissolution of barite that contains co-precipitated Ra-226 ($Ba,RaSO_4$). Therefore, solubility theory suggests that the Ra-226 activities will be depressed if sulphate concentrations remain high, for example near gypsum saturation, and could increase when sulphate concentrations decline.

Two stations were sampled in the Panel South Basin in September 2009 to obtain representative samples to quantify activities/concentrations of Ra-226 and other constituents that can potentially play a role in Ra-226 mobility in the basin waters. Where appropriate, data from the South Basin, Main Basin and Pond C collected during a 2006 field campaign were included in this report to provide a more thorough description of Ra-226 activities and mobility in the Panel TMA.

The investigation focused on Ra-226 in solids, porewater and basin waters at the Panel TMA. This approach was taken because it was understood that any release of Ra-226 to the basin waters would be initiated in the solid phase and that the release from solids would be reflected by the concentrations in the porewaters before eventual release to the overlying water.

Two mechanisms that could potentially control Ra-226 and barium activities/concentrations in the porewater, sorption and solubility controls were considered in this study. The first mechanism, sorption, can be represented by a Kd model and assumes that Ra-226 is distributed between solids and water so that the activities in the water are linearly correlated to the activities in the solids. The second mechanism, solubility, assumes that barium, for example, is distributed between the solids and water on the basis of thermodynamic solubility. The solubility model infers that the concentration of a constituent in the water is independent of the content in the solids, but will depend on the concentration of the companion ion in the water phase. These two models may not be mutually exclusive, and therefore, both mechanisms may influence Ra-226 and barium activities/concentrations in porewater.

Plots for Ra-226 and barium activities/concentrations in solids and porewater showed that the sorption equilibrium (or Kd) model does not dominate the solids-porewater interactions at the Panel TMA.

Strong correlations between Ra-226 and barium in the tailings, treatment solids and porewater samples supported a similar mechanism for the formation of Ra-226 and barium solids and suggested that similar mechanisms control the Ra-226 activities and barium concentrations in porewater.

Inverse correlations between barium and sulphate and between Ra-226 and sulphate in porewaters indicated that the solubility of a solid phase controls the barium concentrations and Ra-226 activities in porewater. The theoretical solubility of barium and sulphate in equilibrium with $BaSO_4$ solids provided further evidence that barium concentrations, and therefore Ra-226 activities, in porewater are controlled by sulphate concentrations.

The inverse relationship between Ra-226 and calcium indicated that Ra-226 activities in porewater are not directly controlled by gypsum dissolution as the conceptual model in the EIS suggests. Instead, the inverse correlation between Ra-226 and calcium results from indirect controls by gypsum related to the linkage between high calcium and sulphate in the presence of gypsum. The sulphate concentration controls Ra-226 activities in the porewater; therefore the presence of gypsum in the tailings solids indirectly controls the Ra-226 activities. This does not contradict the conceptual model in the EIS but provides a refinement for interpretation of the model.

Solubility theory suggests that barium and Ra-226 concentrations/activities will increase as sulphate concentrations decrease. Results from Pond C (PW06) with sulphate concentrations in porewater near 50 mg/L, exhibited Ra-226 activities in porewaters in the range of 4.1 to 5.5 Bq/L. These results are consistent with results from the study in Cell 14 at Quirke that showed when sulphate concentrations in porewater were in the range of 6 to 30 mg/L, the Ra-226 activities in porewater were between 3 and 7 Bq/L, with Ra-226 in the top portions of the tailings solids not exceeding 5 Bq/L.

Together, these results indicate that the maximum Ra-226 activity of 5.5 Bq/L measured in the porewater at the Panel TMA provides a reasonable upper-bound for Ra-226 activities that could be expected in the submerged solids porewater.

Concentration gradients between Ra-226 activities in porewater and basin water imply upward diffusion and mass transport of Ra-226 from porewater to the overlying water. At the Panel TMA, there are no external inputs of Ra-226; therefore diffusive transport is the primary mechanism for Ra-226 release to the basin water.

A total Ra-226 load of 560 MBq/a was calculated from diffusive flux calculations and agreed well with the Ra-226 load of 547 MBq/a estimated from routine monitoring data. Radium-226 activities in the outflow from the Panel TMA resulting from diffusive flux were estimated to be in the range of 0.25 to 0.96 Bq/L. These values agree well with the average Ra-226 activity of 0.5 Bq/L from routine monitoring at the South Basin outflow (P-13) for the 2006 through 2009 time period. The diffusive flux calculations provided strong evidence that the radium activities in the overlying basin water are controlled by diffusive flux of Ra-226 from the porewater in the submerged tailings.

Predicted Ra-226 activities that could occur in the basin water as a result of diffusive flux with the observed upper limit of Ra-226 activity of 5.5 Bq/L in porewater were in the range of 0.65 and 1.79 Bq/L. These calculations provide an indication of the potential range of Ra-226 activities in basin water that could be observed if porewater activities approach the maximum activities in porewater associated with the lowest sulphate concentrations of about 50 mg/L at the Panel TMA.

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1.0 INTRODUCTION

The Panel Site (the Site) is a decommissioned uranium mine property located approximately 19 km northeast of the City of Elliot Lake and immediately north of Quirke Lake (**Figure 1.1**). The Site is owned and managed by Rio Algom Limited (RAL).

EcoMetrix Incorporated (EcoMetrix) was retained by RAL to complete a directed study that focused on the release of Ra-226 from the submerged tailings and treatment solids to the basin waters at the Panel Tailings Management Area (TMA).

Routine monitoring at the Panel Mine Site is conducted as part of three directed programs. The Serpent River Watershed Monitoring Program (SRWMP) is a comprehensive watershed monitoring program that was implemented to replace the various, mine-specific environmental monitoring programs at each mine site. The Source Area Monitoring Program (SAMP) was developed to monitor the nature and quantity of constituents that discharge from the TMAs to the Serpent River Watershed. The TMA Operational Monitoring Program (TOMP) was designed to evaluate the performances of the TMAs.

EcoMetrix completed performance evaluations of the SAMP and TOMP results to 2008 (EcoMetrix, 2008). As part of the review, and where appropriate, special studies were recommended to complement the monitoring programs as well as to refine the understanding of the long-term performances of the tailings facilities. While Ra-226 activities in the Panel basins remain within Ra-226 release model sensitivity analysis ranges (0.4 Bq/L to 1.4 Bq/L) and within current treatment plant capacity ranges, activities reported in the State of Environment Report (Minnow, 2008) were above peak activities as predicted in Environmental Impact Statements (Rio Algom, 1995). Therefore, it was recommended that a special study be conducted at the Panel TMA to reduce the uncertainty related to the release of Ra-226 to the basin waters.

1.1 Objectives and Scope of Work

The objectives of this study were to investigate Ra-226 activities in solids, porewater and basin waters to develop an understanding of the controls on Ra-226 releases to the basin waters and to provide estimates for Ra-226 activities that may be observed in the basin waters.

The scope of work for this investigation included the following:

- review of routine monitoring data from the Panel TMA;
- review and compilation of data collected from a previous field study conducted by DES in 2006;

- collection of core samples and analysis of solids, porewaters and surface waters from two locations within the Panel South Basin;

- data assessment of constituents that can potentially play a role in Ra-226 mobility;

- assessment of Ra-226 and other constituent activities and concentrations in the solids, porewater and basin water to understand controls for Ra-226 release to the basin waters; and

- assessment of ranges of Ra-226 activities that could develop in basin waters associated with a range of Ra-226 activities in porewater.

2.0 BACKGROUND

The following section provides background information on the Panel TMA, a discussion of the theoretical controls on Ra-226 release to overlying waters, a summary of relevant trends observed for the routine monitoring results at the Panel TMA and a summary of results from the 2006 field study.

2.1 Panel TMA Configuration

The Panel mine and mill operated from 1958 to 1961, and again from 1979 to 1990, following rehabilitation and upgrading. The milling process consisted of a hot dilute sulphuric acid leach followed by removal of the uranium via precipitation of ammonium diuranate (yellow cake). Prior to discharge to the TMAs, the acidic slurry (i.e., tailings) generated during the milling process were neutralized with lime. A total of 16 million tonnes of tailings and waste rock were deposited in two natural basins, creating the Panel Main Basin and the Panel South Basin. Collectively, these areas are referred to as the Panel TMA (**Figure 2.1**).

Starting in 1974 and until construction of the new plant in 1978, lime and barium chloride were mixed in a small treatment plant adjacent to the mill and pumped to the basins via a two-inch line during the frost-free season. Treatment solids settled in what is now the South Basin and treated effluent was discharged to Rochester Creek via Dam A (**Figure 2.1**). In 1978, the Panel TMA was upgraded to the current TMA configuration. The water from the Main Basin was directed to flow to the South Basin. The effluent treatment plant (ETP) was re-located to the southern end of Panel South Basin (Dam F) and settling ponds were constructed to receive the treated water and allow treatment solids to settle prior to discharge into Quirke Lake.

The Main Basin contains tailings produced in the milling operation. The South Basin contains a small quantity of tailings disposed in the late 1950s, together with treatment solids from the original ETP. Pond C contains small volumes of fine tailings and treatment solids that were deposited prior to construction of the new ETP.

After closure of the mine in 1990, the Panel TMA was flooded. From 1992 to 1999, in-situ lime additions were initiated to neutralize the acidic pond water (Minnow, 2008). The overflow from the South Basin enters the Panel ETP where it is treated with lime and $BaCl_2$ to neutralize acidity and remove Ra-226.

Between 1998 and 1999 the Panel TMA was extended to include Pond C (**Figure 2.1**). This involved the construction of an engineered earth-fill dam at the outlet of Pond C to Rochester Creek. The dam was constructed to control water levels and submerge the fine tailings and treatment solids in Pond C. Currently, Pond C receives seepage from the South Basin through Dam A and run-off from its 65-ha drainage area (Minnow, 2008).

2.2 Conceptual Model for Ra-226 Release

As part of the Environmental Impact Statement (EIS) for the Panel Mine, predictive model simulations using the Uranium Tailings Assessment Program (UTAP.3) were performed to predict future Ra-226 activities and sulphate concentrations in the porewater and basin water in the Panel TMA. The model predicted Ra-226 activities of 0.5 and 1.1 Bq/L in the porewater after approximately 50 and 100 years post-flooding, respectively. The predicted Ra-226 activities in the basin water were 0.2 and 0.4 Bq/L after 50 and 100 years, respectively. Model sensitivity analysis predicted a range in Ra-226 activities between 0.4 and 1.4 Bq/L in the basin water at the Panel TMA. The model predicted sulphate concentrations that remained at 1,600 in the porewater for the first 100 years. Sulphate concentrations in the basin waters were predicted to peak at 100 mg/L in the first 10 years after closure and to steadily decrease to approximately 40 mg/L at 100 years. By 200 years, sulphate concentrations were predicted to decline to 250 and 15 mg/L in the porewaters and basin waters, respectively (Rio Algom, 1995).

The Ra-226 activities predicted in porewater and basin water were explained by the following conceptual model. Ra-226 activities in the Panel TMA are related to sulphate concentrations because the source of Ra-226 is the dissolution of Ra-226 bearing sulphate precipitates, such as gypsum ($CaSO_4 \cdot 2H_2O$) and barite ($BaSO_4$). In the first 100 years, the major source of Ra-226 in the porewater and basin water were expected to be controlled by the dissolution of gypsum that contains co-precipitated Ra-226 ($Ca,RaSO_4 \cdot 2H_2O$). Once gypsum is depleted from the solids after approximately 100 years, the Ra-226 activities in solution were expected to be controlled by the dissolution of barite that contains co-precipitated Ra-226 ($Ba,RaSO_4$) (SENES,1992). Therefore, solubility theory suggests that the Ra-226 activities will be depressed if sulphate concentrations remain high, for example near gypsum saturation, and could increase when sulphate concentrations decline.

2.3 Routine Monitoring Data

This section discusses the routine monitoring of the basin water at the Panel TMA. The locations of the routine monitoring stations are illustrated in **Figure 2.1**. The complete data sets are provided in **Appendix 1**.

2.3.1 Basin Water

Radium-226 activities together with barium and sulphate concentrations are presented as time-trend plots in **Figure 2.2** for stations P-21, P-13 and P-03 that represent the water quality in the outflows from Panel Main Basin, Panel South Basin and Pond C, respectively.

Historically, the Ra-226 activities in the outflow from the Main Basin, P-21, were as high as 21 Bq/L (data not shown on graph), however, these elevated values likely resulted from the flushing of Ra-226 from the porewater during flooding in 1990. Since 1998, Ra-226 activities have remained relatively constant and below 0.5 Bq/L. Barium concentrations in the Main Basin have remained constant ranging from 0.01 to 0.02 mg/L. In the past, sulphate concentrations were as high as 1,200 mg/L. However, since 2006, sulphate concentrations have generally been in the range of 230 to 400 mg/L and exhibit a decreasing trend with time.

Historically, the Ra-226 activities in the outflow from the South Basin, P-13, were as high as 11 Bq/L (data not shown on graph), however, these elevated values likely resulted from the flushing of Ra-226 from the porewater during flooding in 1990. Between 2001 and 2007, Ra-226 activities remained below 1 Bq/L with an overall decreasing trend with time. Since 2007, Ra-226 activities have remained fairly constant at values close to 0.5 Bq/L. Barium concentrations in the South Basin have generally ranged from 0.01 to 0.04 mg/L. In the past, sulphate concentrations were as high as 600 mg/L. However, since 2006, sulphate concentrations have remained close to 200 mg/L and show a decreasing trend with time.

Between 1990 and 2002, Ra-226 activities in the outflow from Pond C, P-03, were variable ranging from 0.05 to 3.7 Bq/L. Since 2002, the Ra-226 activities have remained fairly constant, ranging from 0.2 to 0.9 Bq/L. The decrease in Ra-226 activities in 2002 likely resulted from the flooding of Pond C in 1999. Barium concentrations in Pond C were variable between 1997 and 2006 ranging from less than the detection limit of 0.005 mg/L to 0.05 mg/L. Since 2006, barium concentrations have remained fairly constant ranging from 0.02 to 0.04 mg/L. Prior to flooding Pond C in 1999, sulphate concentrations were variable and ranged from 10 to 421 mg/L. Since 2001, sulphate concentrations have remained low and in the range of 4 to 23 mg/L in the out flow from Pond C.

2.4 Summary of Results from the 2006 Field Study

The results from the 2006 field study at the Panel TMA were incorporated into the discussion of the current investigation and therefore are summarized in this section. Solids and water samples were collected by Denison Environmental Services in October 2006. Samples were submitted to SGS Lakefield for chemical analysis that included a suite of constituents that are known or suspected to play a role in Ra-226 mobility. Summaries of selected results in solids, porewaters and basin waters are provided in **Tables 2.1 to 2.3**. The locations of the sample stations at the Panel TMA from the 2006 field campaign are presented in **Figure 2.3**. The complete data sets are provided in **Appendix 2**.

The activities/concentrations for Ra-226, barium, calcium and sulphate in solids are presented in **Table 2.1**. Solids samples were collected using coring and ponar sampling devices. The bracketed numbers in the sample ID for core samples represent the depth interval that the sample was collected in centimetres. Radium-226 activities in the solids were variable and ranged from 0.61 Bq/g to 19 Bq/g. Barium concentrations generally ranged from 39 to 190 mg/kg, with the exception of two samples, PSB-06-2 (0-4) and PSB-06-3 (12.5-15), that had concentrations of 600 and 390 mg/kg. The concentrations of calcium were variable and ranged from 1,300 to 160,000 mg/kg. Sulphate concentrations generally ranged from less than the detection limit of 0.4% to 12%.

Porewater was extracted from ponar solids samples. The results for Ra-226, barium, calcium and sulphate activities/concentrations in the solids porewater are provided in **Table 2.2**. Radium-226 activities in porewater were in the range of 0.9 to 5.5 Bq/L. Barium and calcium concentrations were in the ranges of 0.04 to 0.21 mg/L and 53 to 519 mg/L, respectively. Sulphate concentrations ranged from 54 to 1,500 mg/L.

The results for Ra-226, barium, calcium and sulphate activities/concentrations measured in the basin waters are presented in **Table 2.3**. Radium-226 activities ranged from 0.14 to 0.82 Bq/L. Barium and calcium concentrations were in the ranges of 0.01 to 0.05 mg/L and 15 to 159 mg/L, respectively. Sulphate concentrations ranged from 6 to 440 mg/L.

3.0 2009 SAMPLE COLLECTION AND PROCESSING

Two stations were sampled in the Panel South Basin to obtain representative samples to quantify the activities/concentrations of Ra-226 and other constituents that theoretically could play a role in Ra-226 mobility in the basin waters. The sample stations were located in areas similar to those sampled by DES in 2006 to provide better resolution of Ra-226 activities in solids and porewater. A site map illustrating the sampling locations is provided in **Figure 2.3**.

3.1 Solids Samples

Solids samples were collected using a 2-inch K-B coring device at station PSB-1 and a 4-inch K-B coring device at PSB-2. A total of 12 and 4 cores were collected at PSB-1 and PSB-2, respectively, to achieve sufficient sample volumes of porewater after extraction from the solids.

The cores were sectioned at 2.5 to 5 cm intervals to depths of 15 or 20 cm. The corresponding intervals from the core sets at each sampling station were composited and placed into dedicated Ziploc bags and stored at 4°C until the porewater samples were extracted.

After the porewater was extracted (described in **Section 3.2.2**) the solids samples were placed into dedicated Ziploc bags and stored at 4°C until analysis. Solids samples were submitted to SGS Lakefield for chemical analysis that included Ra-226, metals, major ions, as well as, sulphur and carbon.

3.2 Porewater Samples

Porewater samples were extracted from the core samples in a field-based laboratory facility within 24 hours of collection. Each composite of 2.5 to 5 cm core intervals was transferred into 750 mL centrifuge bottles. The samples were centrifuged at approximately 3,500 rpm for 45 to 50 minutes. After centrifugation, the porewater was decanted and filtered through a 0.45 µm nylon filter. The pH of the filtered porewater samples was measured and recorded. The samples were then transferred into sample bottles supplied by SGS Lakefield and samples to be analysed for metals and Ra-226 were preserved with nitric acid. All samples were stored at 4°C until analysis.

Porewater samples were sent to SGS Lakefield for chemical analysis of Ra-226, metals, major ions, sulphate and acidity or alkalinity. The Ra-226 analyses were completed by Becquerel Laboratories (Becquerel) under subcontract to SGS Lakefield.

3.3 Basin Water Samples

Basin water samples were collected from the top of the water column and at the solids-water interface at the two stations. Basin water was collected as grab samples from the top of the water column. The solids-water interface samples were collected and composited by siphoning the water above the solids in the core tubes.

All water samples were field filtered through a 0.45 µm disposable nylon filter and the pH values were measured and recorded. Water samples were then transferred into sample bottles supplied by SGS Lakefield and samples to be analysed for metals and Ra-226 were preserved with nitric acid. All samples were stored at 4°C until analysis.

Basin water samples were sent to SGS Lakefield for chemical analysis of Ra-226, metals, major ions, sulphate and acidity or alkalinity. The Ra-226 analyses were completed by Becquerel Laboratories (Becquerel) under subcontract to SGS Lakefield.

3.4 Field Observations

At the time of sample collection observations suggested that solids from sampling station PSB-1 were consistent with treatment solids, while solids from sampling station PSB-2 were more consistent with tailings. The texture of the solids at PSB-1 was fine and the solids were black, white, orange, red and grey in colour, while the texture of the solids at PSB-2 was coarser (silt to sand) and the solids were brown, black and grey in colour. Photographs of one core collected from each station are provided in **Figure 3.1** for illustrative purposes.

After the porewater extraction step, the pH of the porewater was measured and recorded (**Table 3.1**). The pH values in the solids porewater at PSB-1 were in the range of 7.5 to 10.7 and were consistent with expected pH values for lime treatment solids. The pH values in the solids porewater at PSB-2 were lower than those at PSB-1 and were in the range of 6.8 to 7.1. The pH measurements provide support the visual observations that two types of solids, treatment solids and tailings solids were collected in the Panel South Basin.

The presence of treatment solids in the South Basin is consistent with the original TMA configuration. Between 1974 and 1978, treatment solids settled in what is now the South Basin and overlying water discharged to Rochester Creek via Dam A. Sampling station PSB-1 was located upstream of Dam A and along what would have been the flow path for the treated effluent from the original ETP.

The presence of tailings solids at PSB-2 is consistent with the disposal of tailings to the South Basin in the late 1950's. Sampling station PSB-2 was located upstream of the original ETP, therefore little to no influences from settled treatment solids are expected at this location.

4.0 QUALITY ASSURANCE/QUALITY CONTROL

The field campaign that was conducted by EcoMetrix personnel in September 2009 included the collection of samples from three different decommissioned mine sites (Panel, Quirke and Denison) in the Elliot Lake area. The field campaign was carried out to help gain a further understanding of the knowledge gaps identified in the Cycle III SAMP and TOMP performance evaluation.

A detailed quality assessment (DQA) was completed by EcoMetrix to evaluate the quality of the data collected during Cycle III Special Studies Field Campaign. Similar sampling methods and procedures were used at each mine site therefore the data quality assessment incorporated all of the QA/QC data collected during the field sampling campaign. This section provides a summary of the QA/QC for selected constituents that are discussed in this report. Data quality results for the selected constituents are summarized in **Tables 4.1 to 4.3**. Data quality results for all of the constituents analysed and for duplicates and replicates from all studies are provided **Appendix 3**.

The precision of the duplicate and replicate samples were evaluated by calculating the relative percent difference (RPD) as follows:

$$RPD = \frac{2|C_1 - C_2|}{C_1 + C_2} \times 100\%$$

where: C_1 = sample concentration; and

C_2 = replicate (or duplicate) concentration.

The Data Quality Objectives (DQO) for solids samples were less than or equal to a RPD value of 40%. The DQO for water samples were less than or equal to a RPD value of 20%.

For duplicate/replicate samples having concentrations less than five times the detection limit, the DQO was the absolute difference (AD) between the sample and duplicate/replicate that should not have been greater than the detection limit value.

Blind duplicates and replicates of solids and water samples, as well as laboratory blank sample (de-ionized water), were submitted to SGS Lakefield. Duplicate samples were labeled as EC-1 and replicate samples were labeled as EC-2. The duplicate samples are split samples of solids, porewater or basin water collected from a selected core section or sampling station. The solids replicate samples are replicate core sets from sampling station QC14-2 and were sectioned in accordance with study protocols. Replicate water samples were collected from porewater generated from replicate core sections or from replicate basin water sampling. The calculated RPD or AD values for selected constituents are presented in **Tables 4.1 to 4.2**.

4.1 Solids Sample Data Quality Assessment

The DQA for selected constituents in field duplicates from Cores 09-PSB-2 and 09-SR-4 are summarized in **Table 4.1a**. On average, the DQO of 40% was achieved for all selected constituents (Ra-226, barium, calcium, sulphate), with the exception of three exceedances observed in the Core09-PSB-2 duplicate. Calcium and barium had RPD values less than 55% and sulphate had an AD value of 0.3. As these individual values were only marginally above the data quality objectives, there are no impacts on the interpretation of the results.

The DQA for selected constituents in replicate core section intervals of Core09-QC14-2 (0-2.5), (2.5-5) and (5-7.5) are summarized in **Table 4.1b**. On average, the DQO of 40% was achieved for all selected constituents, except for Ra-226 where the average RPD was 48%. For Ra-226 the DQO of 40% was exceeded twice with RPD values of 73% and 48%. For barium the DQO was exceeded twice with RPD values of 51% and 60%. As these individual values were only marginally above the data quality objectives, there are no impacts on the interpretation of the results.

4.2 Water Samples Data Quality Assessment

Two duplicate and 5 replicate water samples were collected and analysed. The duplicate and replicate RPD values were compared to a DQO of ≤20%. The DQA for selected constituents in the water samples are presented in **Tables 4.2a** and **b**.

As shown on **Table 4.2a**, the DQO of 20% in duplicate water samples was achieved for Ra-226, barium and calcium. Duplicate water samples are sample splits of basin water or porewater extracted from sectioned cores. The Ra-266 duplicate sample identification is PW09-EC-1 (5-10) and corresponds to sample PW09-QC14-4 (0-5). The barium and calcium duplicate sample identification PW09-EC-1 (5-10) and corresponds to sample PW09-QC14-3 (0-5). Sulphate duplicates were not analysed because of insufficient sample volume.

As shown on **Table 4.2b**, the DQO of 20% in replicate water samples was achieved on average for Ra-226, barium and calcium, with one DQO exceedance for Ra-226 with an RPD value of 22% in a replicate porewater sample. The average RPD of 21% for sulphate is marginally above the DQO. One DQO exceedance for sulphate had an RPD 40% in a replicate porewater sample.

4.3 Blank Sample Data Quality Assessment

One blank sample was subjected to the porewater extraction process that included centrifugation followed by filtration to determine potential for cross-contamination between samples. The results for selected constituents in the blank are provided **Table 4.3**. The Ra-226 activities and sulphate concentrations were below detection limits of 0.01 Bq/L and 2 mg/L, respectively. The calcium concentration in the blank sample was 0.03 mg/L and met the DQO of 0.06 mg/L. The dissolved barium concentration in the blank was 0.00216 mg/L and exceeded the DQO of 0.00002 mg/L. Barium concentrations measured in most of the water samples for the DQA (**Table 4.3**) are at least two orders of magnitude greater than the barium concentration measured in the blank. Therefore, the barium concentration that may be attributed to cross-contamination was negligible.

4.4 Laboratory Quality Assurance and Quality Control

Laboratory Quality Assurance/Quality Control (QA/QC) included analysis of laboratory blanks and laboratory duplicate sample analyses. The Certificates of Analysis, including internal laboratory QA/QC results, are provided in **Appendix 4** and indicate that the data have acceptable accuracy and precision.

5.0 FIELD AND LABORATORY SAMPLING RESULTS

Selected results from the September 2009 field sampling program are presented in **Figures 5.1 to 5.2** and are summarized in **Tables 5.1 to 5.2**. Concentrations of selected constituents in solids are presented in **Figure 5.1** as depth profiles. **Figure 5.2** presents the activities/concentrations in the basin water samples from each station as well as in the porewater samples with depths that correspond to the depths of the core sample intervals. The depths of the basin water samples plotted above the solids-water interface are not to scale. The actual depths for these samples below surface are provided in **Table 5.2**. The analytical data for all of the constituents analysed in all of the samples from the 2009 field program are provided as Certificates of Analysis in **Appendix 4**.

5.1 Solids Samples

The results for selected constituents from the solids analyses are presented in **Table 5.1** and are presented as depth profiles in **Figure 5.1**.

Radium-226 activities in the solids generally ranged from 2.0 to 6 Bq/g with peak concentrations in the range of 12 to 16 Bq/g in the upper sections of both cores (Core09-PSB-1 (0-2.5) and Core09-PSB-2 (0-5)) and the bottom section Core09-PSB-2 (15-20). Barium concentrations in the solids were higher in Core09-PSB-1 ranging from 320 to 1300 mg/kg compared to the range in concentrations of 190 to 340 mg/kg at Core09-PSB-2. Maximum barium concentrations were measured in the topmost portions of the solids at both locations (Core09-PSB-1 (0-2.5) and Core09-PSB-2 (0-5)).

Higher calcium and sulphate concentrations were also measured in Core09-PSB-1 compared to Core-09-PSB-2. Results from Core09-PSB-1 showed a consistent trend of increasing calcium and sulphate concentrations with depth. Calcium and sulphate concentrations increased with depth from 67,000 to 190,000 mg/kg and from 0.6 to 17%, respectively. In contrast, calcium and sulphate concentrations in Core09-PSB-2 were an order of magnitude lower and remained constant at depth. Calcium and sulphate concentrations at PSB-2 were in the ranges of 7,600 to 9,600 mg/kg and 0.5 to 0.8%, respectively.

Higher calcium and sulphate concentrations in the solids at Core09-PSB-1 compared to those from Core09-PSB-2 are consistent with the field observations that solids from Core09-PSB-1 are treatment solids that were deposited at the time the original ETP was operational.

5.2 Porewater and Basin Water Samples

The results for selected constituents in porewater and basin water samples are presented in **Table 5.2** and are presented as depth profiles in **Figure 5.2**.

The lowest Ra-226 activities were measured at PSB-1 with values ranging from less than the detection limit of 0.01 Bq/L to 0.76 Bq/L. Higher Ra-226 activities in porewater were measured at PSB-2, with a maximum value of 3.2 Bq/L measured in the top 5 cm and values ranging from 1.1 to 1.4 Bq/L at depths between 5 and 20 cm. The low Ra-226 activities measured at PSB-1 are likely a reflection of the treatment solids that were deposited at the time that the original ETP was operational.

Barium concentrations exhibited similar trends to those for Ra-226. The lowest barium concentrations that ranged 0.01 to 0.02 mg/L were measured at PSB-1. Higher barium activities in porewater were measured at PSB-2, with values ranging from 0.03 to 0.04 mg/L.

Calcium and sulphate concentrations exhibited inverse trends to those for Ra-226 and barium. The samples from PSB-1 exhibited the highest calcium and sulphate concentrations that were in the ranges of 193 to 723 mg/L and 410 to 1,800 mg/L, respectively. Lower calcium and sulphate concentrations in the ranges of 76 to 297 mg/L and 190 to 933 mg/L were measured at PSB-2, with the minimum value measured in the top-most interval.

Radium-226 activities and barium concentrations in the basin water were generally similar between sample stations and were in the ranges of 0.31 to 0.65 Bq/L and 0.01 to 0.02 mg/L, respectively, with slightly higher values measured at the solids-water interfaces. Similar trends in the basin water were observed for calcium and sulphate concentrations that were in the ranges of 62 to 74 mg/L and 180 to 410 mg/L, with similar values measured between stations and higher values measured at the solids-water interface.

Depth profiles for Ra-226, barium, calcium and sulphate in porewater and basin water are presented in **Figure 5.2**.

The depth profiles for Ra-226 activities and barium concentrations exhibited trends of highest activities/concentrations measured in the porewater in the topmost samples. Lower Ra-226 activities and barium concentrations were measured at depth in the porewater.

Depth profiles for calcium and sulphate in porewater exhibited similar trends with the lowest concentrations measured in the topmost samples and the highest concentrations measured at depth. The trends for calcium and sulphate are the inverse of those observed for Ra-226 and barium.

Radium-226 and barium activities/concentrations in porewater from the topmost samples were consistently higher than those in the basin waters. Calcium and sulphate concentrations in porewater from the topmost solids samples remained fairly constant with those measured in the overlying water. One exception was the depth profile for sulphate at PSB-1 that exhibited higher sulphate values in porewater from the topmost tailings sample and lower values in the overlying basin water.

6.0 DISCUSSION

This phase of the Cycle III Special Studies was completed to fill knowledge gaps and bound uncertainties related to the control of Ra-226 activities in basin waters. The investigation focused on Ra-226 activities in solids, porewater and basin waters in the Panel TMA. This approach was taken because it was understood that any release of Ra-226 to the basin waters would be initiated in the solid phase and that the release from solids would be reflected by activities/concentrations in the porewaters before eventual release to the overlying water. Where appropriate, data from the South Basin, Main Basin and Pond C collected during the 2006 field campaign were included in this report to provide a more thorough description of Ra-226 activities and mobility at the Panel TMA.

6.1 Solids and Porewater Interactions

Radium-226 activities in the solids and porewater samples ranged from 0.61 to 19 Bq/g (**Tables 2.1** and **5.1**) and from less than the detection limit of 0.01 Bq/L to 5.5 Bq/L (**Tables 2.2** and **5.1**), respectively. This range provides a strong basis to interpret relationships between the solids contents and concentrations in the porewaters.

Two mechanisms that can potentially control Ra-226 and barium activities/concentrations in the porewater include sorption and solubility. These two mechanisms may not be mutually exclusive.

The first mechanism, sorption, is commonly been used to quantify solids-water interactions and can be represented by a distribution coefficient (or Kd with units of L/kg). The Kd can be defined as the activities/concentrations in the solids phase (Bq/kg or mg/kg) divided by the respective activities/concentrations in porewater (Bq/L or mg/L). The Kd model assumes that Ra-226, for example, is distributed between solid and water on the basis of equilibrium sorption reactions. This infers that, for any Kd value, higher activities/concentrations in the solid phase will be reflected by higher activities/concentrations in the porewater.

The second mechanism, solubility, can control concentrations or activities in the porewater and can be quantified by thermodynamic equilibrium reactions. Solubility equilibrium controls assume that barium, for example, is distributed between the solids and water on the basis of solubility theory. This approach infers that activities/concentrations in the porewater are controlled by the dissolution of a solid phase, for example $BaSO_4$, to maintain equilibrium for constituents in the porewater and is consistent with the EIS conceptual model. The solubility model infers that the activity/concentration of a constituent in the water is independent of the content in the solids, but will depend on the concentration of another constituent in the water phase that is also present in the solid phase.

The sorption, or Kd, model and the solubility model may not be mutually exclusive in some environments, therefore, it is important to consider both approaches when understanding Ra-226 release in submerged tailings.

6.1.1 Evidence of Sorption Equilibrium Controls

Plots of Ra-226 and barium activities/concentrations in solids versus their respective Ra-226 activities/concentrations in porewater are shown in **Figure 6.1**. The data in **Figure 6.1** includes solids and porewater activities/concentrations measured in 2006 and 2009.

The water-solids partitioning plot for Ra-226 (**Figure 6.1a**) showed a weak correlation (R^2=0.21) and indicated that higher Ra-226 activities in the solids did not correlate strongly with higher Ra-226 activities in porewater.

The water-solids partitioning plot for barium is provided in **Figure 6.1b**. The regression line exhibited a negative slope indicating that higher concentrations of barium in the solids did not correlate with higher concentrations in the porewater.

The water-solids partitioning plots for Ra-226 and barium showed that activities/concentrations in porewater were not consistent with equilibrium sorption controls. Although the Kd model does not appear to control the solids-porewater system in the Panel TMA, sorption equilibrium controls on Ra-226 and barium activities/concentrations may exist for other geologic materials, as shown in the investigation on Serpent River sediments (EcoMetrix, 2011a). Therefore, the Kd relationships should not be completely dismissed from the interpretation of Ra-226 controls.

6.1.2 Evidence of Solubility Equilibrium Controls

6.1.2.1 Correlations in Solids

Selected relationships between constituents, for example Ra-226 and barium, in the solids are presented in **Figure 6.2**. The data in **Figure 6.2** include solids activities/concentrations measured in 2006 and 2009 samples.

When all of the data from the 2006 and 2009 samples for one constituent in solids versus another constituent in solids were plotted, weak or no correlations were evident as shown in **Figure 6.2a, b, c, d, e, f**. The relationship between calcium and sulphate was an exception. The plot for calcium and sulphate in **Figure 6.2b** exhibited a strong correlation (R^2=0.84) and reflects that the source of these constituents in the tailings solids is the moderately soluble mineral gypsum ($CaSO_4 \cdot 2H_2O$).

Visual inspection of the core samples identified two very different types of solids in the South Basin. Historic operations suggest that the material in the northwest area of the South Basin (Core09-PSB-1) represent treatment solids that were formed when acidic waters were treated with lime and barium chloride and discharged in the basin. The samples from the west central area of the basin (Core09-PSB-2) are considered to be tailings deposited there during the operation of the mill. When the data from solids composed of tailings were plotted separately from those that represent treatment solids, correlations between constituents became evident as shown in **Figure 6.2g, h** and **i**. The tailings are represented by the samples collected in 2006 and those from Core09-PSB-2. The treatment solids are represented by the samples from Core09-PSB-1 and two samples from the 2006 data that contained barium concentrations greater than 300 mg/kg. These two samples were considered to represent treatment solids because they exhibited anomalously high barium concentrations with low Ra-226 activities that were consistent with the PSB-1 values for solids.

Radium-226 and barium in the tailings and treatment solids exhibited correlations with R^2 values of 0.51 and 0.83, respectively (**Figure 6.2g**). These correlations are expected because, chemically, Ra-226 behaves similarly to barium. The relationship between Ra-226 and barium for the treatment solids is consistent with treatment of Ra-226 in the original ETP by the addition of lime for pH control and $BaCl_2$ to form $BaSO_4$ solids that settled out in Panel South Basin. Because Ra-226 behaves similarly to barium, correlations between barium and other constituents were similar to those for Ra-226 and the same constituents.

Correlations between calcium and sulphate with R^2 values of 0.68 and 0.87 for the tailings and treatment solids, respectively, likely reflect the presence of gypsum ($CaSO_4 \cdot 2H_2O$) in both types of solids (**Figure 6.2h**). Gypsum precipitated in the tailings in the mill when lime was added to neutralize the effluent prior to release to the basin. Gypsum also formed when lime was added to the acidic effluent in the ETP.

No correlation between barium and sulphate was observed in the tailings solids (**Figure 6.2i**). The poor correlation between barium and sulphate exists because most of the sulphate is in the form of gypsum resulting in only trace quantities of $BaSO_4$ in the tailings solids, compared to the percentage quantities of gypsum that are present. Any correlation between barium and sulphate that theoretically exists because of the presence $BaSO_4$ solids is lost in the strong correlation between calcium and sulphate due to the dominance of gypsum in the solids.

An inverse correlation for barium and sulphate (R^2=0.65) was observed in the treatment solids (**Figure 6.2i**) suggesting that when more sulphate solids formed, less barium precipitated. This relationship was not expected. Instead, it was expected that when more sulphate precipitated, more barium would also precipitate in the form of $BaSO_4$. However, the inverse relationship likely reflects treatment at the original ETP, whereby, higher acidity and sulphate concentrations required more lime ($Ca(OH)_2$) to neutralize the acidity. As a result, more gypsum was formed.

The higher concentrations of calcium that were added during periods of pH adjustment would have resulted in a competition between the two cations, Ca^{2+} and Ba^{2+}, for the formation of sulphate solids and therefore an inverse correlation between calcium and barium in the precipitated solids would be anticipated. Because calcium is strongly correlated with sulphate, the inverse correlation between barium and calcium (**Figure 6.2k**) translates to an inverse correlation between barium and sulphate (**Figure 6.2i**). As the acidity in the Panel TMA decreased, $BaCl_2$ treatment for Ra-226 removal became more important and less lime would have been added during treatment. The decrease in acidity and lime use would have resulted in larger barium to calcium ratios resulting in relatively greater proportions of precipitated $BaSO_4$ in the treatment solids.

6.1.2.2 Correlations in Porewater

Selected relationships between concentrations of constituents in porewater are presented in **Figure 6.3**. **Figure 6.3** includes porewater activities/concentrations measured in 2006 and 2009 samples.

When all of the data from the 2006 and 2009 field programs are plotted, the correlation between Ra-226 and barium in the porewater had an R^2=0.76 (**Figure 6.3a**). Similar correlations were observed when the data for tailings and treatment solids cores were plotted separately (**Figure 6.3f**). The correlations indicate that Ra-226 in the porewater behaves similarly to barium in porewater. This is supported by similar correlations observed for both barium and Ra-226 with other measured constituents (**Figure 6.3**).

The plots of barium and sulphate in porewater show inverse correlations that are consistent with a solubility control by a solid phase for barium in the porewater. The red and green solid curves in **Figure 6.3b** represent the theoretical solubility of barium and sulphate in equilibrium with $BaSO_4$ solids and show excellent fits to the data. These curves represent equilibrium conditions mathematically as: $K_{sp}=[Ba^{2+}][SO_4^{2-}]$ in which the K_{sp} is the solubility product that is a constant. The solubility relationship was solved using MINTEQ (Gustafsson, 2010) for solutions containing high and low calcium concentrations corresponding to the range of values observed in porewater samples. The concentrations of barium and sulphate are inversely correlated so that as the concentration of one constituent increases, the concentration of the other decreases. The agreement between the measured data and the theoretical solubility curve provides strong evidence for solubility controls on barium in porewater.

When data from the tailings and treatment solids are considered separately, it appears that the treatment solids exhibit a very close agreement with the theoretical solubility as shown in **Figure 6.3g**. The tailings values exhibit good agreement with the theoretical solubility of $BaSO_4$ but with more scatter.

The correlation plots for Ra-226 and sulphate (**Figure 6.3c**) show inverse trends that are similar to the correlation plot for barium and sulphate (**Figure 6.3b**). This further supports the claim that solubility of a solid sulphate phase controls the concentrations of barium, as well as Ra-226, in the porewater. The molar ratio of barium to Ra-226 is approximately $2x10^7$ indicating that only trace concentrations of Ra-226 exist compared to barium in the porewater. By inference, the Ra-226 contents in the sulphate solids should be 7 orders of magnitude lower than those of barium. Because Ra-226 is a trace constituent compared to barium, it is incorporated into a solid phase only by ionic substitution and therefore does not practically affect the solubility of the $BaSO_4$ solid phase.

The correlation plots of Ra-226 and calcium (**Figure 6.3e**) show inverse trends that are similar to the correlation plots for Ra-226 and sulphate (**Figure 6.3c**). The negative correlations between Ra-226 and calcium result from indirect controls by gypsum. When gypsum is present, calcium and sulphate concentrations are high. The inverse correlations between Ra-226 and calcium are therefore related to the linkage between high calcium and high sulphate in the presence of gypsum, and it is the high sulphate that controls Ra-226 to lower concentrations. The conceptual model in the EIS suggested the source of Ra-226 activities in porewater is gypsum dissolution when gypsum solubility controls the concentrations of sulphate and calcium. These results do not contradict the conceptual model in the EIS but provides a refinement of the interpretation of the model.

6.2 Controls on Ra-226 Activities in Porewater

Similar relationships between Ra-226 and barium were observed for both the water-solids partitioning, or Kd, plots and the solubility correlation plots. These relationships provide support that solubility equilibrium controls are acting to control Ra-226 activities and barium concentrations in porewater.

Inverse correlations between barium and sulphate provided strong support for solubility controls on Ra-226 in porewater and indicated that the solubility of a sulphate bearing solid phase controls barium concentrations in porewater. The theoretical solubility curves for barium and sulphate in equilibrium with $BaSO_4$ provided strong evidence that the dissolution of $BaSO_4$ controls barium concentrations in porewater.

Because Ra-226 and barium behave similarly and Ra-226 is also inversely correlated with sulphate, the results indicated that the solubility of the same sulphate phase that controls barium concentrations also controls Ra-226 activities in porewater. Collectively, these results suggest that sulphate concentrations in porewater control the solubility of $(Ba,Ra)SO_4$ solids and therefore control the barium and Ra-226 concentrations/activities in the porewaters associated with $(Ba,Ra)SO_4$ solids.

If Ra-226 activities in porewater are controlled by solubility equilibrium, solubility theory suggests that barium and Ra-226 concentrations/activities will increase as sulphate concentrations decrease. Results from Pond C (PW06) showed the lowest sulphate concentrations in porewater were near 50 mg/L, corresponding to concentrations in the overlying water of about 10 mg/L. The Ra-226 activities in porewaters associated with the lowest sulphate concentrations were in the range of 4.1 to 5.5 Bq/L, corresponding to activities in the overlying water of about 0.5 Bq/L. These results are consistent with results from the study in Cell 14 at Quirke that showed when sulphate concentrations in porewater were in the range of 6 to 30 mg/L, the Ra-226 activities in porewater were between 3 and 7 Bq/L, with Ra-226 in the top portions of the tailings solids not exceeding 5 Bq/L (EcoMetrix, 2011b). The results from Quirke also showed that Ra-226 activities associated with low sulphate concentrations defined upper-bounds for Ra-226 activities in porewater.

Together, these results indicate that the maximum Ra-226 activity of 5.5 Bq/L measured in the porewater at the Panel TMA provides a reasonable upper-bound for Ra-226 activities that could be expected in the submerged solids porewater for existing conditions.

6.3 Porewater and Basin Water Interactions

The Ra-226 activities in porewater provide insight into the potential for release to the basin water. At the Panel TMA, there are no external inputs of Ra-226 and therefore there is one primary mechanism that can release Ra-226 into the basin water. This mechanism is the release of soluble constituents from porewater to the basin waters by diffusion. Because diffusion is controlled by concentration gradients, the activities in the basin waters will always be less than those in the porewaters even when there is little or no flow through the basin.

The release of Ra-226 from porewater in the submerged solids to the basin water by diffusion is supported by the data that show Ra-226 activities in the porewater were greater than those in the overlying basin waters as shown in **Figure 6.4**. Porewater activities in the top portions of the solids were in the range of 0.76 to 5.5 Bq/L and the activities measured in the basin waters immediately above the solids-water interface ranged from 0.17 to 0.82 Bq/L. Radium-226 activities at the top of the water column ranged from 0.14 to 0.41 Bq/L. These results indicate that concentration gradients had developed and imply upward diffusion and mass transport of Ra-226 from the porewater to the overlying basin water.

The concentrations of barium, calcium and sulphate in porewaters and basin waters are also provided in **Figure 6.4**. The concentrations of these constituents showed similar trends to those observed for Ra-226, whereby higher concentrations were measured in the porewater compared to those in the basin waters. These results provide further evidence that the release of constituents in the Panel TMA is controlled by diffusion from the porewater to the water column.

6.4 Water Balance and Ra-226 Loads for the Panel TMA

A water balance was completed to estimate Ra-226 loads from the monitoring data. The observed Ra-226 loads in the South Basin outflow were calculated for comparison with Ra-226 loads estimated from the diffusive flux from the porewater (**Section 6.6**) to verify whether the observed Ra-226 loads could be explained by the dissolution of $(Ba,Ra)SO_4$ solids and subsequent diffusion from porewater to the basin water.

Annual flow rates were estimated to develop a mass balance for Ra-226 loads in the Panel TMA. The loads were calculated from average flows and Ra-226 activities measured from routine monitoring data for the period of 2006 through 2009. The Ra-226 activities measured from routine monitoring for the 2006 through 2009 time period are summarized in **Table 6.1**. The flow rates and estimated loads are presented in **Table 6.2**.

6.4.1 Water Balance

As part of the routine monitoring, outflow from the South Basin is measured at the ETP and was assumed to represent the total flow through the Panel TMA. The annual flow rate for the Panel TMA is dependent on net natural input (NNI) that represents precipitation and runoff minus evaporation. Flow from the South Basin was assumed to be representative of the NNI for the entire TMA. Therefore, the flow rates for the Main and South Basins were calculated as the fraction of the total flow based on the percentage of the watershed each basin represents. Average annual flow rates of approximately 660,000 and 1,100,000 for the Main and South Basins, respectively, were estimated using measured flow data from the South Basin outflow (P-13) for the 2006 through 2009 time period. The average flow rates for the Main and South Basins are presented in **Table 6.2**.

6.4.2 Ra-226 Loads

Radium-226 loads from the Main and South Basins were calculated using the estimated flow rates together with average Ra-226 activities from monitoring data at the outflow (**Table 6.2**). Radium-226 loads for each area were calculated as follows:

$$L = Q \bullet C_{BW} \qquad \text{Eq.1}$$

Where: L = Load (Bq/a);

Q = Flow (m^3/a); and

C_{BW} = Ra-226 activity in the basin water (Bq/L).

The cumulative Ra-226 loads for each basin are presented in **Table 6.2** together with their respective incremental loads. The incremental loads of Ra-226 represent the differences between the Ra-226 exiting and/or entering each basin.

The average Ra-226 load from the Main Basin was approximately 85 MBq/a. The total and incremental Ra-226 loads exiting the South Basin were 547and 462 MBq/a, respectively. The incremental loads indicate that the majority of the Ra-226 load from the Panel TMA originates in the South Basin. The Ra-226 loads from the Main and South Basins represent approximately 16% and 84% of the total load, respectively.

The average Ra-226 activities measured in the South Basin outflow are about 4 times higher than those measured in the Main Basin. Therefore, the higher load from the South Basin is consistent with higher Ra-226 activities in the basin water.

6.5 Ra-226 Flux and Loads from the Submerged Solids

The loads from the South Basin related to the diffusive flux of Ra-226 from the porewater were calculated to verify whether the loads calculated for the South Basin in **Section 6.4.2** could be explained diffusion to the basin water. The results from the calculations are presented in **Table 6.3**.

Radium-226 loads based on the diffusive flux were calculated as follows:

$$L = F \bullet A \qquad \text{Eq.2}$$

Where: L = Load (Bq/a);

F = Mass Flux ($Bq/m^2 \bullet a$);

A = Surface area over which the diffusion is taking place (m^2).

The mass flux was calculated as follows:

$$F = -D_e \bullet \frac{\partial C}{\partial z} \qquad \text{Eq.3}$$

Where: F = Mass Flux ($Bq/m^2 \bullet a$);

D_e = effective diffusion coefficient in the solids porewater (m^2/a);

C = Ra-226 activity in porewater or in the water column (Bq/L); and

z = interface thickness (m).

Typical values for diffusion coefficients (D) in aqueous solutions in a porous medium, neglecting porosity, were obtained from the literature (Spitz and Moreno, 1996). An average value of 8.43×10^{-10} m^2/s (2.66×10^{-2} m^2/a) was considered reasonable for this investigation. In porous media, such as tailings, the effective diffusion coefficient is smaller than that in pure aqueous solution because ions follow a longer path of diffusion through the pore spaces and do not migrate through the solid particles. Therefore, an effective diffusion coefficient, D_e, should be used for tailings and can be represented by:

$$D_e = D \bullet \eta$$

Where: η = porosity

The physical properties of the tailings were considered to be similar to those in Quirke Cell 14, therefore a porosity 0.45 for the tailings of was used (SENES, 2003). With a porosity of 0.45, the value of D_e becomes 3.79×10^{-10} m^2/s (1.20×10^{-2} m^2/a).

The change in Ra-226 activity across the interface, or concentration gradient, was estimated from the 2006 and 2009 sampling data and represents the concentration in porewater from the top 2.5 or 5 cm of the tailings, minus the concentration in water immediately above the solids. Interface thickness values equal to the depths at which the uppermost tailings samples were collected were considered for the calculation of gradients. These depths were 0.025 m for PSB-1 and 0.05 m for all other stations. Sensitivity on the interface thickness was tested using conservative values of 0.01 and 0.02 m. The interface thickness of 0.01 m was considered to represent a conservative upper value for gradients.

The incremental load for Ra-226 for the South Basin ranged from 949 to 191 MBq/a for interface thicknesses between 0.01 and 0.05 metres (**Table 6.3**). Total loads from the South Basin ranged from 1,034 to 276 MBq/a for the assumed range of interface thicknesses. Total loads for the South Basin were calculated from the observed load from the Main Basin in **Table 6.2** plus the calculated load for the South Basin in **Table 6.3**.

Radium-226 activities in the basin water were estimated using the total loads from the South Basin. The estimated Ra-226 activities were in the range of 0.25 and 0.94 Bq/L for the assumed interface thicknesses (**Table 6.3**). When an interface thickness of 0.02 m was used to calculate the diffusive flux, the Ra-226 activity calculated was 0.51 Bq/L. This value agrees well with the average Ra-226 activity of 0.5 Bq/L from routine monitoring at the South Basin outflow (P-13) for the 2006 through 2009 time period (**Table 6.1**). These results indicate that the Ra-226 activities measured in the outflow from the Panel TMA are consistent with Ra-226 loads resulting from a diffusive flux in the tailings and treatment solids porewaters to the basin water.

6.5.1 Estimated Ranges in Ra-226 Activities

The diffusive flux calculations provided strong evidence that upward diffusion of Ra-226 is the primary mechanism for Ra-226 release to the basin water. Sensitivity on flow through the Panel TMA was also tested to provide an estimate for the ranges in Ra-226 activities that may be anticipated in the basin waters as a result of natural variations in flow rates in the basins. The residence time in the South Basin is about 1 year. It is expected that it will require approximately three basin volumes of flow for the Ra-226 activities in the basin water to be substantially shifted from current values either by changes in the water balance in the basin or loading of Ra-226 from the porewater in the submerged tailings. Three basin volumes represent a total time of about three years with a residence time of one year.

Therefore, an averaging period of three years in the South Basin can be considered for variations in flow to the basin. Flow from the Panel TMA is measured at the outflow from the South Basin. The monthly flow data are presented in **Figure 6.5** as a time-trend plot for the period of 1991 (after flooding) through 2009. **Figure 6.5** also shows the 3-year moving average for the flow data that was used to determine representative minimum and maximum flow rates for the Panel TMA for that period. The observed high and low values for the 3-year moving average were 50 and 18 L/s, corresponding to annual flow rates of 1.58 and 0.57 Mm^3/a, respectively. The Ra-226 activities in the basin water were predicted for the high and low flow conditions.

The loads and activities were calculated using an interface thickness of 0.02 m. The estimated Ra-226 activities for the 3-year average high and low flows in the South Basin were 0.35 and 0.96 Bq/L, respectively (**Table 6.4**). These values were similar to the range of annual average values from the routine monitoring data presented in **Table 6.1**.

These results provide further support that Ra-226 activities measured in the outflow from the Panel TMA are consistent with Ra-226 loads resulting from diffusive flux in the porewater to the basin water with variations that are consistent with natural variations in the flow within the basins.

Similar calculations were performed for an estimated upper-bound Ra-226 activity of 5.5 Bq/L in the porewater of the submerged solids. With an activity of 5.5 Bq/L in porewater, the expected Ra-226 activities resulting from diffusive flux could be in the range of 0.65 to 1.79 Bq/L as shown in **Table 6.5**. These calculations provide an indication of Ra-226 activities that could be observed if porewater activities in the top few centimetres of the tailings approach the maximum values that were observed at the Panel TMA.

7.0 SUMMARY OF CONCLUSIONS

The objectives of this investigation were to investigate Ra-226 activities in solids, porewater and basin waters to develop an understanding of the controls on Ra-226 releases to the basin waters and to provide upper-bounds for Ra-226 activities that may be observed in the basin waters.

Two stations were sampled in the Panel South Basin in September 2009 to obtain representative samples of Ra-226 and other constituents that theoretically can potentially play a role in Ra-226 mobility in the basin waters. Where appropriate, data from the South Basin, Main Basin and Pond C collected during a 2006 field campaign were included in this report to provide a more thorough description of Ra-226 activities and mobility in the Panel TMA.

Plots for Ra-226 and barium activities/concentrations in solids and porewater showed that the sorption equilibrium (or Kd) model does not appear to control the solids-porewater interactions at the Panel TMA.

Strong correlations between Ra-226 and barium in the tailings, treatment solids and porewater samples supported a similar mechanism for the formation of Ra-226 and barium solids and suggested that similar mechanisms control the Ra-226 activities and barium concentrations in porewater.

Inverse correlations between barium and sulphate and between Ra-226 and sulphate in porewaters indicated that the solubility of a solid phase controls the barium concentrations and Ra-226 activities in porewater. The theoretical solubility of barium and sulphate in equilibrium with $BaSO_4$ solids provided further evidence that barium concentrations, and therefore Ra-226 activities, in porewater are controlled by sulphate concentrations.

The inverse relationship between Ra-226 and calcium indicated that Ra-226 activities in porewater are not directly controlled by gypsum dissolution as the conceptual model in the EIS suggests. Instead, the inverse correlation between Ra-226 and calcium results from indirect controls by gypsum related to the linkage between high calcium and sulphate in the presence of gypsum. The sulphate concentration controls Ra-226 activities in the porewater; therefore the presence of gypsum in the tailings solids indirectly controls the Ra-226 activities. This does not contradict the conceptual model in the EIS but provides a refinement for interpretation of the model.

Solubility theory suggests that barium and Ra-226 concentrations/activities will increase as sulphate concentrations decrease. Results from Pond C (PW06) sulphate concentrations in porewater near 50 mg/L, with Ra-226 activities in porewaters in the range of 4.1 to 5.5 Bq/L. These results are consistent with results from the study in Cell 14 at Quirke that showed when sulphate concentrations in porewater were in the range of 6 to 30 mg/L, the

Ra-226 activities in porewater were between 3 and 7 Bq/L, with Ra-226 in the top portions of the tailings solids not exceeding 5 Bq/L (EcoMetrix, 2011b).

Together, these results indicate that the maximum Ra-226 activity of 5.5 Bq/L measured in the porewater at the Panel TMA provides a reasonable upper-bound for Ra-226 activities that could be expected in the submerged solids porewater under existing conditions.

Concentration gradients between Ra-226 activities in porewater and basin water imply upward diffusion and mass transport of Ra-226 from porewater to the overlying water. At the Panel TMA, there are no external inputs of Ra-226; therefore diffusive transport is the primary mechanism for Ra-226 release to the basin water.

The Ra-226 loads and activities estimated from the diffusive flux calculations agreed well with the observed Ra-226 loads and activities from routine monitoring data. These results provided strong evidence that releases of Ra-226 from the porewater to the overlying basin water are controlled by diffusive flux.

Predicted Ra-226 activities in the basin water associated with a Ra-226 activity of 5.5 Bq/L in porewater were in the range of 0.65 and 1.79 Bq/L. These calculations provide an indication of Ra-226 activities in basin water that could be observed if porewater activities approach the maximum activities in porewater that were associated with the lowest sulphate concentrations of about 50 mg/L at the Panel TMA.

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TABLES

Table 2.1: Summary of Selected Constituents in Solids from the Panel TMA Sampled in 2006

Sample ID	Depth Interval (cm)	Radium-226 (Bq/g)	Barium (mg/kg)	Calcium (mg/kg)	Sulphate (%)
Core Sample Results					
Main Basin					
PMB-06-1	0-5	4.9	80	31,000	0.8
	12.5-17.5	3.8	39	8,400	2.1
PMB-06-2	0-5	3.4	100	59,000	8.1
	15-20	12	170	42,000	9.9
South Basin					
PSB-06-1	0-4	1.2	61	2,000	1.2
	17.5-20	7.6	150	10,000	3.0
PSB-06-2	0-4	1.2	600	2,000	1.0
	10-12.5	7.8	130	28,000	7.3
PSB-06-3	0-4	1.7	87	37,000	3.4
	12.5-15	0.61	390	160,000	12
Pond C					
PW-06-1	0-5	1.0	98	4,700	0.7
	10-15	7.8	160	2,800	0.5
PW-06-2	0-10	1.2	77	5,600	0.6
	15-20	4.6	48	4,100	1.1
PW-06-3	0-10	1.9	110	1,800	0.4
	15-20	9.6	130	280	<0.4
Ponar Sample Results					
Main Basin					
PMB-06-1	--	2.6	56	24,000	3.1
PMB-06-2	--	11	128	29,000	5.4
South Basin					
PSB-06-3	--	19	142	1,300	1.2
Pond C					
PW-06-1	--	3.7	43	3,500	2.3
PW-06-3	--	12	189	3,600	4.3

Notes:
"--" Depths not recorded for Ponar Samples

Table 2.2: Summary of Selected Constituents in Porewater from the Panel TMA Sampled in 2006

Sample ID	Radium-226 (Bq/L)	Barium (mg/L)	Calcium (mg/L)	Sulphate (mg/L)
Main Basin				
PMB-06-1	0.88	0.065	241	*564*
PMB-06-2	2.6	0.042	519	*1,503*
South Basin				
PSB-06-3	2.0	0.038	191	*897*
Pond C				
PW-06-1	4.1	0.092	56.4	*53.7*
PW-06-3	5.5	0.211	53.4	*75.3*

Notes:
Porewater extracted from ponar solids samples
Italicized sulphate concentrations indicate values estimated from total sulphur concentrations from ICP-MS scan.

Table 2.3: Summary of Selected Constituents in Basin Water from the Panel TMA Sampled in 2006

Sample ID	Radium-226	Barium	Calcium	Sulphate
	(Bq/L)	(mg/L)	(mg/L)	(mg/L)
Main Basin				
PMB-06-1SW	NS	NS	NS	NS
PMB-06-1SI	0.17	0.014	112	310
PMB-06-2SW	0.14	0.013	117	310
PMB-06-2SI	0.69	0.021	159	440
South Basin				
PSB-06-1SW	NS	NS	NS	NS
PSB-06-1SI	0.50	0.019	82.6	230
PSB-06-2SW	0.62	0.018	84.2	220
PSB-06-2SI	0.50	0.018	83.1	230
PSB-06-3SW	NS	NS	NS	NS
PSB-06-3SI	0.56	0.018	83.8	220
Pond C				
PW-06-1SW	0.41	0.026	17.7	5.8
PW-06-1SI	0.46	0.028	14.5	6.0
PW-06-2SW	NS	NS	NS	NS
PW-06-2SI	0.42	0.032	18.1	6.9
PW-06-3SW	NS	NS	NS	NS
PW-06-3SI	0.82	0.048	25.5	27

NS = not sampled because lack of water depth
SW = top of water column
SI = bottom of water column at solids-water interface

Table 3.1: Porewater pH Values Sampled by EcoMetrix in September 2009

Sample ID	Depth	pH
	(cm)	(pH units)
PW09-PSB-1	(0-2.5)	7.5
PW09-PSB-1	(2.5-5.0)	9.5
PW09-PSB-1	(5.0-7.5)	10.5
PW09-PSB-1	(7.5-10)	10.7
PW09-PSB-1	(10-15)	10.5
PW09-PSB-2	(0-5)	6.7
PW09-PSB-2	(5-10)	6.8
PW09-PSB-2	(10-15)	7.1
PW09-PSB-2	(15-20)	6.7

Notes:

PW - Porewater - Depth refers to "below solids-water interface"

Table 4.1a: Data Quality Assessment Summary for Selected Constituents in Solids - Duplicate Samples

		Parameter			
		Radium-226	Barium	Calcium	Sulphate
		(Bq/g)	(mg/kg)	(mg/kg)	(%)
Method Detection Limit		0.01	0.05	1	0.1
RPD Data Quality Objective		≤ 40%	≤ 40%	≤ 40%	≤ 40%
Sample ID	Core09-PSB-2 (5-10)	4.5	160	7,600	0.6
Replicate ID	CORE 09-EC-1 (0-5)	4.1	94	4,600	0.3
RPD (%) or AD		9	**52**	**49**	**0.3**
Sample ID	Core09-SR-4 (10-15)	2.1	440	7,300	0.2
Replicate ID	CORE 09-EC-1 (5-10)	1.6	450	7,400	0.1
RPD (%) or AD		27	2	1	0.1
Average RPD or AD		***18***	***27***	***25***	***0.2***
Count		*3*	*3*	*3*	*3*

Notes:

RPD - relative percent difference; is calculated for analytes with concentrations greater than or equal to five times the detection limit and should be less than or equal to 40%

AD - absolute difference; for samples having concentrations less than five times the detection limit, the difference between the sample and duplicate, or difference between the sample or duplicate and the detection limit if either the sample or duplicate analyte concentration is below detection limit; should not be greater then the detection limit

BD - Sample and/or replicate had analyte concentrations below detection limit

"--" Indicates parameter was not measured

Boldface type and shaded indicates that Data Quality Objective was not achieved

Table 4.1b: Data Quality Assessment Summary for Selected Constituents in Solids - Replicate Samples

		Parameter			
		Radium-226	Barium	Calcium	Sulphate
		(Bq/g)	(mg/kg)	(mg/kg)	(%)
Method Detection Limit		0.01	0.05	1	0.1
RPD Data Quality Objective		≤ 40%	≤ 40%	≤ 40%	≤ 40%
Sample ID	CORE 09-QC14-2 (0-2.5)	4.3	150	190	0.1
Replicate ID	CORE 09-EC-2 (0-2.5)	7.0	280	230	0.1
RPD (%) or AD		**48**	**60**	19	0
Sample ID	CORE 09-QC14-2 (2.5-5)	6.5	220	130	0.1
Replicate ID	CORE 09-EC-2 (2.5-5)	8.3	370	110	0.1
RPD (%) or AD		24	**51**	17	0
Sample ID	CORE 09-QC14-2 (5-7.5)	9.3	330	79	0.1
Replicate ID	CORE 09-EC-2 (5-7.5)	20.0	310	63	0.1
RPD (%) or AD		**73**	6	23	0
Average RPD or AD		***48***	***39***	***19***	***0***
Count		*3*	*3*	*3*	*3*

Notes:

RPD - relative percent difference; is calculated for analytes with concentrations greater than or equal to five times the detection limit and should be less than or equal to 40%

AD - absolute difference; for samples having concentrations less than five times the detection limit, the difference between the sample and duplicate, or difference between the sample or duplicate and the detection limit if either the sample or duplicate analyte concentration is below detection limit; should not be greater then the detection limit

BD - Sample and/or replicate had analyte concentrations below detection limit

"--" Indicates parameter was not measured

Boldface type and shaded indicates that Data Quality Objective was not achieved

Table 4.2a: Data Quality Assessment Summary for Selected Constituents in Water - Duplicate Samples

		Parameter			
		Radium-226	**Barium**	**Calcium**	**Sulphate**
		(Bq/L)	(mg/L)	(mg/L)	(mg/L)
Method Detection Limit		0.01	0.00001	0.03	0.2
RPD Data Quality Objective		≤ 20%	≤ 20%	≤ 20%	≤ 20%
Sample ID	SW09-SR-4B	0.30	0.222	11.2	25
Duplicate ID	PW09-EC-1 (0-5)	0.30	0.221	11.4	--
RPD (%) or AD		0	0	2	--
Sample ID	PW09-QC14-3 (0-5)	--	0.333	6.12	54
Duplicate ID	PW09-QC14-4 (0-5)	4.1	--	--	560
Duplicate ID	PW09-EC-1 (5-10)	4.7	0.335	6.06	--
RPD (%) or AD		14	1	1	--
Average RPD or AD		***7***	***1***	***1***	**--**
Count		*2*	*2*	*2*	--

Notes:

RPD - relative percent difference; is calculated for analytes with concentrations greater than or equal to five times the detection limit and should be less than or equal to 20%

AD - absolute difference; for samples having concentrations less than five times the detection limit, the difference between the sample and duplicate, or difference between the sample or duplicate and the detection limit if either the sample or duplicate analyte concentration is below detection limit; should not be greater then the detection limit

BD - Sample and/or replicate had analyte concentrations below detection limit

"--" Indicates parameter was not analysed because of insufficient sample volume

Boldface type and shaded indicates that Data Quality Objective was not achieved

Table 4.2b: Data Quality Assessment Summary for Selected Constituents in Water - Replicate Samples

		Parameter			
		Radium-226	**Barium**	**Calcium**	**Sulphate**
		(Bq/L)	(mg/L)	(mg/L)	(mg/L)
Method Detection Limit		0.01	0.00001	0.03	0.2
RPD Data Quality Objective		≤ 20%	≤ 20%	≤ 20%	≤ 20%
Sample ID	SW09-QC14-2T	0.82	0.104	5.69	72
Replicate ID	SW09-EC-2T	0.78	0.108	5.69	85
RPD (%) or AD		5	4	0	17
Sample ID	SW09-QC14-2B	0.91	0.108	5.55	32
Replicate ID	SW09-EC-2B	0.85	0.114	5.63	36
RPD (%) or AD		7	5	1	12
Sample ID	PW09-QC14-2 (0-2.5)	3.6	0.309	8.79	32
Replicate ID	PW09-EC-2 (0-2.5)	2.9	0.285	7.28	27
RPD (%) or AD		**22**	8	19	17
Sample ID	PW09-QC14-2 (2.5-5)	2.8	0.308	5.68	12
Replicate ID	PW09-EC-2 (2.5-5)	3.3	0.337	5.35	18
RPD (%) or AD		16	9	6	**40**
Sample ID	PW09-QC14-2 (5-7.5)	5.9	0.519	6.06	12
Replicate ID	PW09-EC-2 (5-7.5)	5.4	0.487	5.54	--
RPD (%) or AD		9	6	9	--
Average RPD or AD		***12***	***7***	***7***	***21***
Count		*5*	*5*	*5*	*4*

Notes:

RPD - relative percent difference; is calculated for analytes with concentrations greater than or equal to five times the detection limit and should be less than or equal to 20%

AD - absolute difference; for samples having concentrations less than five times the detection limit, the difference between the sample and duplicate, or difference between the sample or duplicate and the detection limit if either the sample or duplicate analyte concentration is below detection limit; should not be greater then the detection limit

BD - Sample and/or replicate had analyte concentrations below detection limit

"--" Indicates parameter was not analysed because of insufficient sample volume

Boldface type and shaded indicates that Data Quality Objective was not achieved

Table 4.3: Data Quality Assessment Summary for Selected Constituents in Blank Sample

Analysis	Units	Detection Limit	Data Quality Objective	Blank 1
Radium-226	Bq/L	0.01	0.02	<0.01
Barium	mg/L	0.00001	0.00002	**0.00216**
Calcium	mg/L	0.03	0.06	0.03
Sulphate	mg/L	2	4	<2

Notes:
Boldface type and shaded indicates that Data Quality Objective was not achieved

Table 5.1: Summary of Selected Constituents in Solids from Panel South Basin Sampled in September 2009

Sample ID	Depth Interval	Radium-226	Barium	Calcium	Sulphate
	(cm)	(Bq/g)	(mg/kg)	(mg/kg)	(%)
CORE 09-PSB-1	(0-2.5)	12	1,300	67,000	0.6
CORE 09-PSB-1	(2.5-5)	4.9	510	140,000	9.8
CORE 09-PSB-1	(5-7.5)	1.6	400	140,000	14
CORE 09-PSB-1	(7.5-10)	2.8	360	180,000	16
CORE 09-PSB-1	(10-15)	2.2	320	190,000	17
CORE 09-PSB-2	(0-5)	16	340	9,600	0.8
CORE 09-PSB-2	(5-10)	4.5	160	7,600	0.6
CORE 09-PSB-2	(10-15)	5.6	180	9,400	0.5
CORE 09-PSB-2	(15-20)	14	190	7,600	0.6

Table 5.2: Selected Constituents in Basin Water and Porewater in Panel South Basin Sampled in September 2009

Sample ID	Depth Interval	Radium-226	Barium	Calcium	Sulphate
	(cm)	(Bq/L)	(mg/L)	(mg/L)	(mg/L)
SW09-PSB-1T	0	0.34	0.013	62.2	180
SW09-PSB-1B	800	0.65	0.020	74.4	410
PW09-PSB-1	(0-2.5)	0.76	0.017	193	410
PW09-PSB-1	(2.5-5)	0.01	0.009	373	1,100
PW09-PSB-1	(5-7.5)	0.02	0.006	506	1,300
PW09-PSB-1	(7.5-10)	<0.01	0.006	787	1,600
PW09-PSB-1	(10-15)	<0.01	0.006	723	1,800
SW09-PSB-2T	0	0.31	0.014	64.5	180
SW09-PSB-2B	400	0.39	0.016	64.1	180
PW09-PSB-2	(0-5)	3.20	0.044	76.4	190
PW09-PSB-2	(5-10)	1.18	0.034	106	250
PW09-PSB-2	(10-15)	1.10	0.027	138	*369*
PW09-PSB-2	(15-20)	1.40	0.038	297	*933*

Notes:
SW - Basin Water - Depth refers to "below surface"
PW - Porewater - Depth refers to "below solids-water interface"
Italicized sulphate concentrations indicate values estimated from total sulphur concentrations from ICP-MS scan

Table 6.1: Average Ra-226 Activities (Bq/L) in the Main Basin and South Basin Outflows from Routine Monitoring

Year	Panel Main Basin (P-21)		Panel South Basin (P-13)	
	Average	**Count**	**Average**	**Count**
2006	0.12	2	0.57	6
2007	0.13	12	0.57	13
2008	0.13	3	0.41	11
2009	0.12	2	0.44	8
Average for 2006 through 2009	**0.13**	**19**	**0.50**	**38**

Note:
All Ra-226 activities are reported in Bq/L

Table 6.2: Average Annual Flow Rates and Radium-226 Loads at the Panel TMA

	Radium-226 Activities in Basin Waters[a]	Average Annual Flow Rate (m^3/a)[a,b,c]	Ra-226 Load (MBq/a)	Incremental Ra 226 Load (MBq/a)
Panel Main Basin				
[c]Average	0.13	656,582	85	85
Count	20	--	--	--
Panel South Basin				
[c]Average	0.50	1,094,303	547	462
Count	38	--	--	--

Notes:

[a] From routine monitoring data

[b] Panel Main Basin flow represents 60% of the total flow through the Panel TMA (CCL, 1992)

[c] Average for 2006 to 2009 period

Table 6.3: Ra-226 Fluxes, Loads and Activities in the Panel TMA for different Interface Thicknesses

Calculation	Units	Sample ID	Interface Thickness (m)		
			0.01	0.02	0.05
Panel South Basin					
Activity	(Bq/L)	PSB-09-1	Basin Water[a]		0.65
			Porewater		0.76
		PMB-09-1	Basin Water[a]		0.39
			Porewater		3.2
Activity Gradient	(Bq/L•m)	PSB-09-1[b]	11	6	4
		PSB-09-2	281	141	56
		Average [c]	***254***	***127***	***51***
Flux	(MBq/m^2•a)	PSB-09-1[b]	1.32E-04	6.58E-05	5.27E-05
		PSB-09-2	3.36E-03	1.68E-03	6.73E-04
		Average	***3.04E-03***	***1.52E-03***	***6.11E-04***
Diffusive Load to the South Basin	(MBq/a)	***Average***	***949***	***474***	***191***
Total Load to Basin Water[d]	(MBq/a)	***Average***	***1,034***	***560***	***276***
Calculated Activities in Basin Water	(Bq/L)	***Average***	***0.94***	***0.51***	***0.25***

Notes:
[a] Basin water activities taken from samples at solids-water interface
[b] Top most sample from 0 to 2.5 cm interval giving an interface thickness of of 0.025 m
[c] Weighted Average assuming the treatment solids from PSB-09-1 represent 10% of the solids in the South Basin
[d] Total Load to Basin Water equals the calculated load from the South Basin plus the measured load from the Main Baisin presented in Table 6.2
Average flow values from Table 6.2 were used to calculate Ra-226 activities in basin water
Solids surface area assumed to be 80% of the basin water surface area reported by CCL (1992)

Table 6.4: Predicted Range of Ra-226 Activities in Basin Water Based on Average Porewater Activities and a Range of Flow Rates

Calculation	Units	Flow (m^3/a)[a]	
		1,577,880	568,037
Panel South Basin			
Activity	(Bq/L)	Basin Water[b]	0.50
		Porewater[c]	3.0
Activity Gradient	(Bq/L•m)	123	123
Flux	(MBq/m^2•a)	1.47E-03	1.47E-03
Load from South Basin	(MBq/a)	***459***	***459***
Total Load to Basin Water[d]	(MBq/a)	***545***	***545***
Calculated Activities in Basin Water	(Bq/L)	***0.35***	***0.96***

Notes:

[a] Flow values represent high and low 3-year moving averages from Figure 6.5

[b] Average Ra-226 Activity in South Basin Water from Routine Monitoring Data for the 2006 through 2009 time period (Table 6.1)

[c] Weighted Average assuming the treatment solids from PSB-09-1 represent 10% of the solids in the South Basin

[d] Total Load to Basin Water equals the calculated load from the South Basin plus the measured load from the Main Baisin presented in Table 6.2

Interface thickness equals 0.02 m

Solids surface area assumed to be 80% of the basin water surface area reported by CCL (1992)

Table 6.5: Predicted Range of Ra-226 Activities in Basin Water Based on a Porewater Activity of 5.5 Bq/L

Calculation	**Units**	**Flow (m^3/a)[a]**	
		1,577,880	568,037
Panel South Basin			
Activity	(Bq/L)	Basin Water[b,c]	0.50
		Porewater	5.5
Activity Gradient	(Bq/L•m)	250	250
Flux	(MBq/m^2•a)	2.99E-03	2.99E-03
Load from South Basin	(MBq/a)	***934***	***934***
Total Load to Basin Water[d]	(MBq/a)	***1,019***	***1,019***
Calculated Activities in Basin Water	(Bq/L)	***0.65***	***1.79***

Notes:
[a] Flow values represent high and low 3-year moving averages from Figure 6.5
[b] Average Ra-226 Activity in South Basin Water from Routine Monitoring Data for the 2006 through 2009 time period (Table 6.1)
[c] Weighted Average assuming the treatment solids from PSB-09-1 represent 10% of the solids in the South Basin
[d] Total Load to Basin Water equals the calculated load from the South Basin plus the measured load from the Main Baisin presented in Table 6.2
Interface Thickness equals 0.02 m
Solids surface area assumed to be 80% of the basin water surface area reported by CCL (1992)

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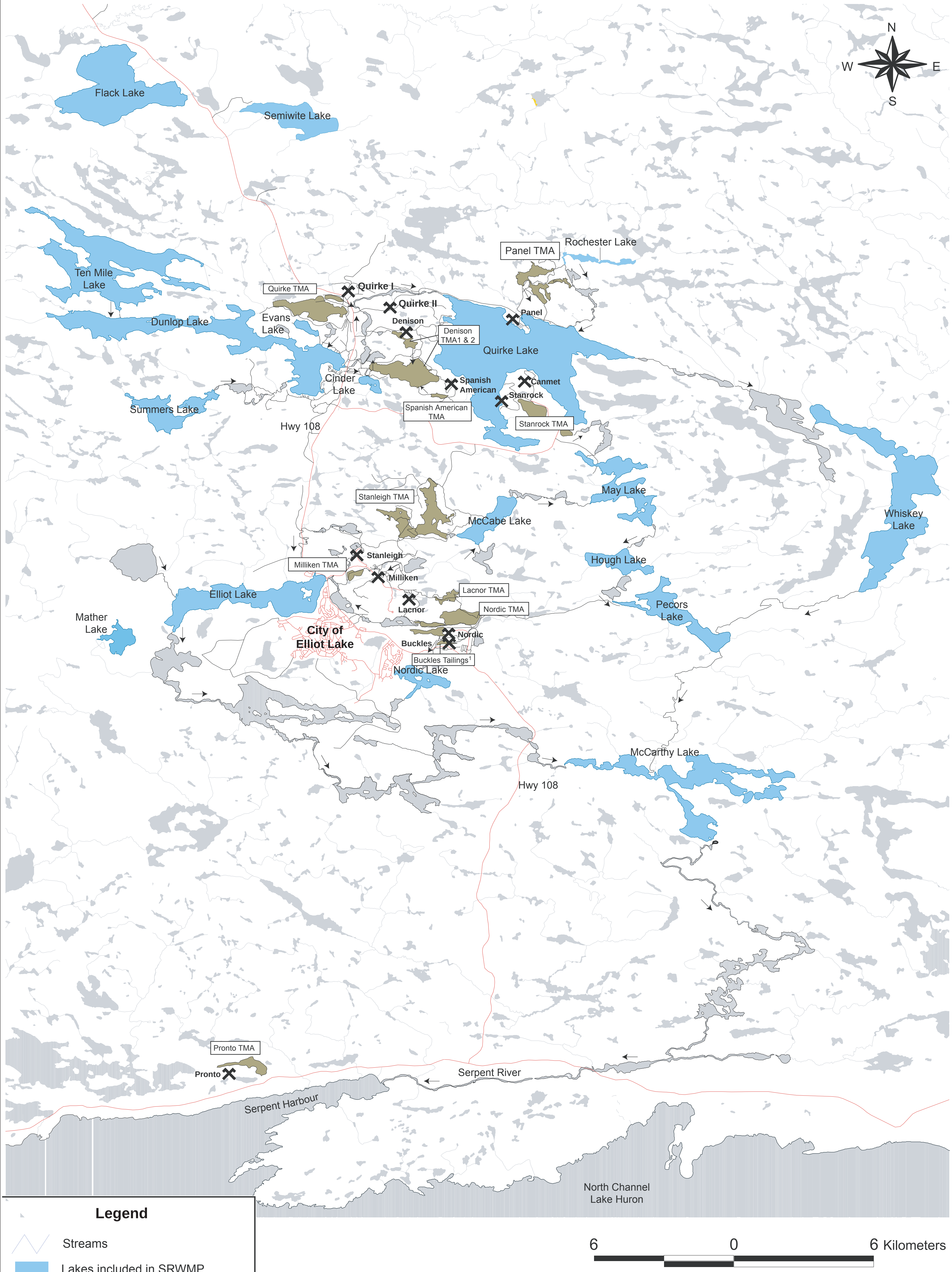
FIGURES



Legend

- Streams
- Lakes included in SRWMP
- Tailings Management Areas
- Minesites
- Highways
- Secondary Roads
- Trails
- Direction of Flow

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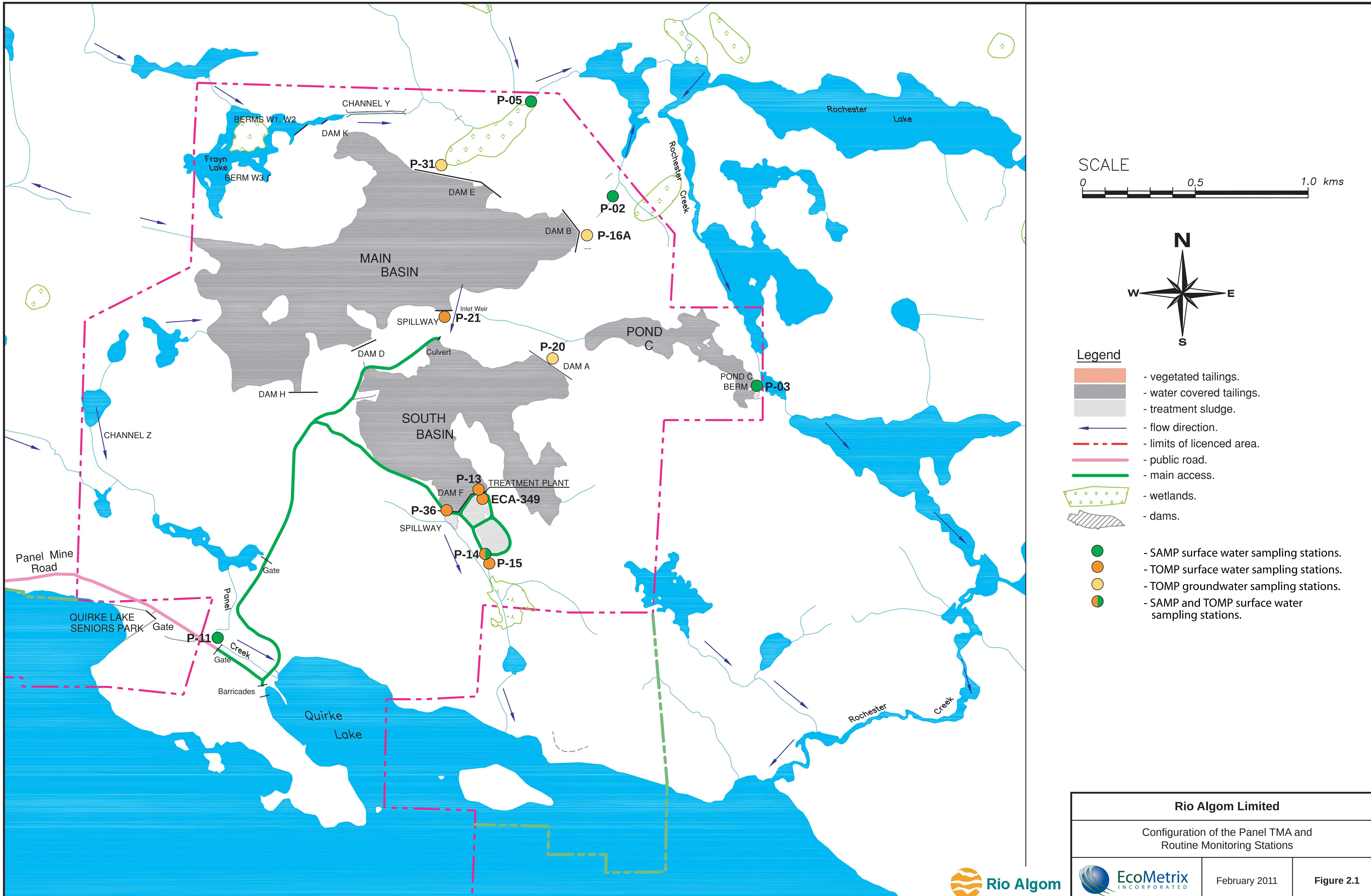
General Site Location of the Panel Mine and Tailings Management Area		
EcoMetrix INCORPORATED	February 2011	**Figure 1.1**



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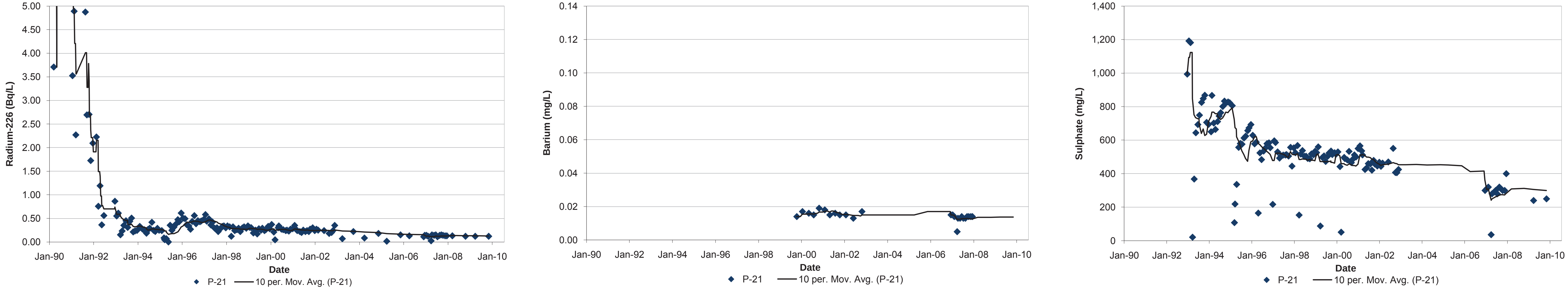
Configuration of the Panel TMA and Routine Monitoring Stations

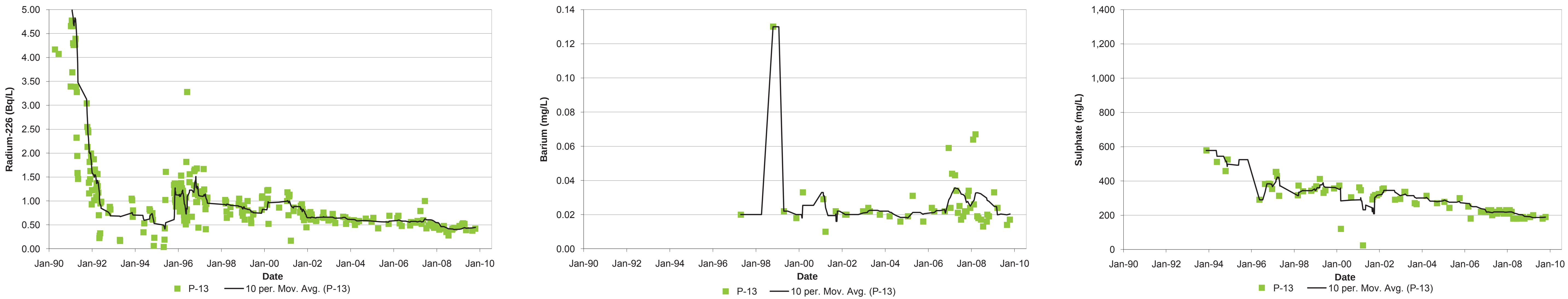
February 2011

Figure 2.1

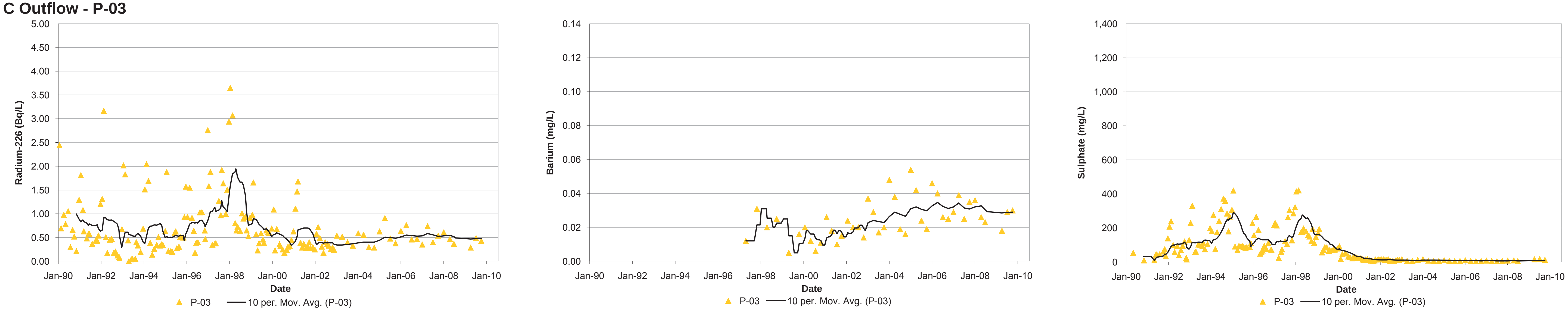
Main Basin Outflow - P-21



South Basin Outflow - P-13



Pond C Outflow - P-03



Note: Some data prior to 1992 are not shown

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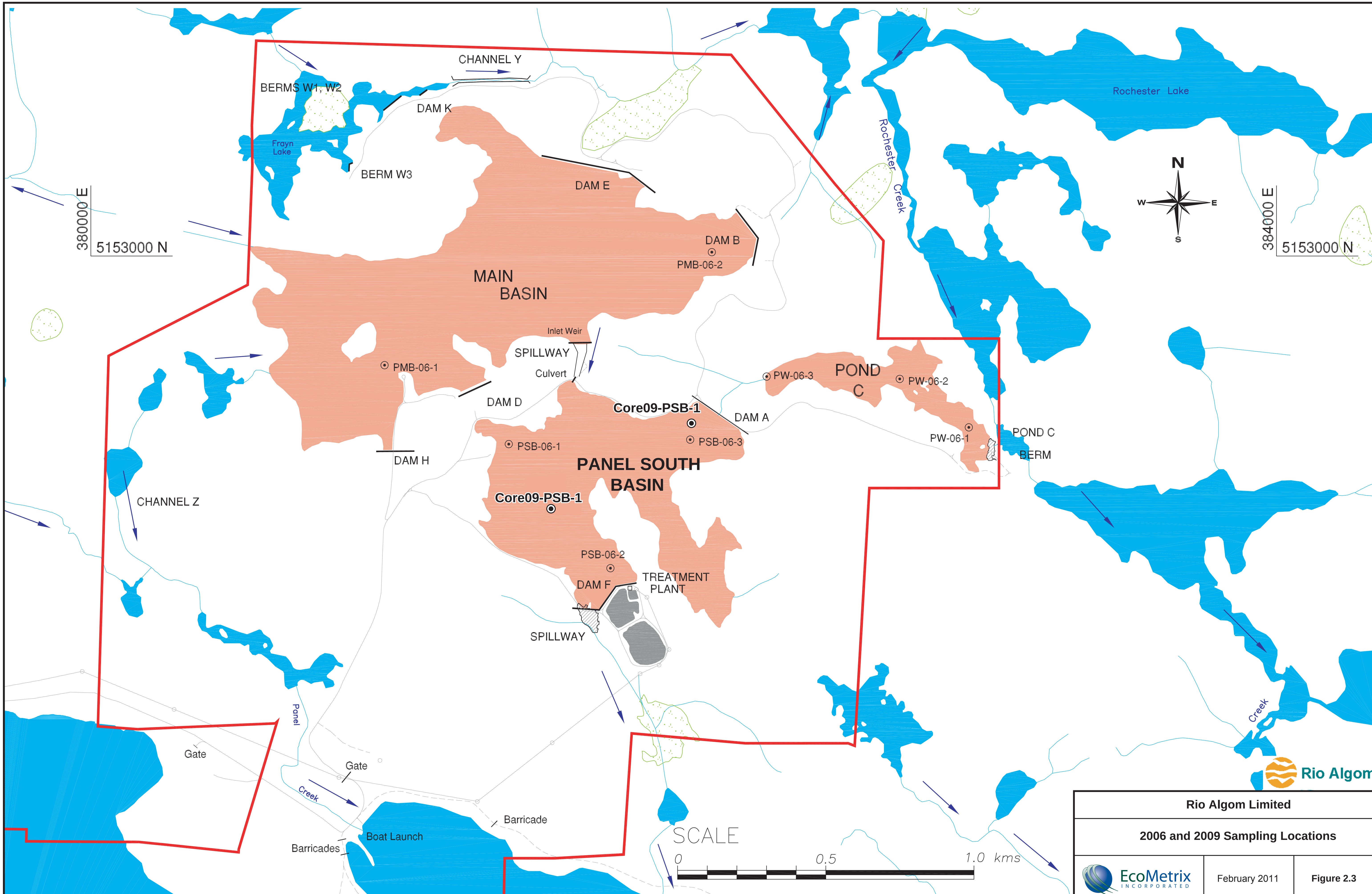
Routine Monitoring Data for Selected Constituents from the Panel TMA		
EcoMetrix INCORPORATED	February 2011	Figure 2.2



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2006 and 2009 Sampling Locations

EcoMetrix INCORPORATED	February 2011	**Figure 2.3**

Core09-PSB -1

Core09-PSB -2

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Photographs of Samples Core09-PSB-1 and Core09-PSB-2

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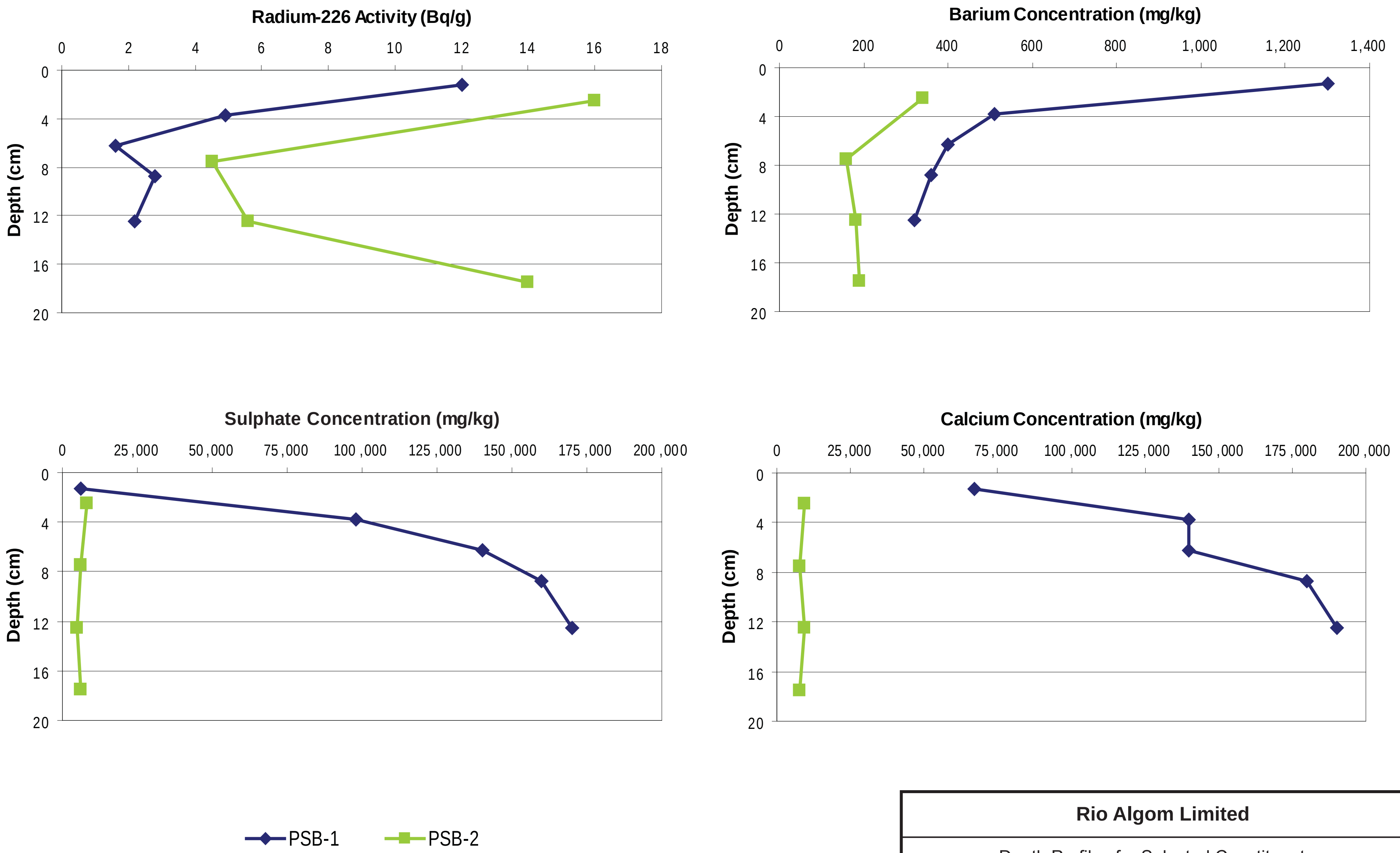
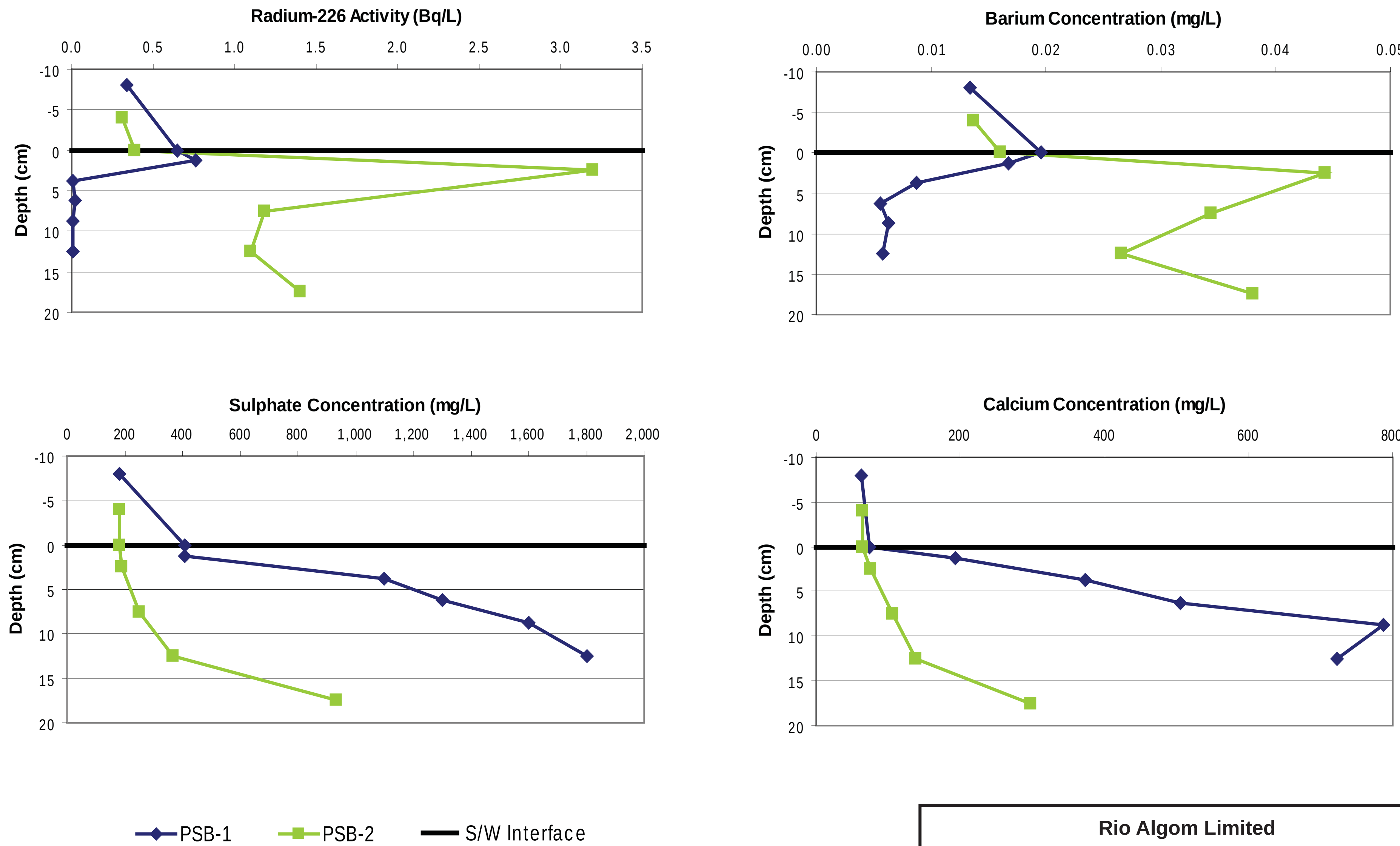
February 2011

Figure 3.1



Rio Algom

Rio Algom Limited		
Depth Profiles for Selected Constituents in Solids from the South Basin		
EcoMetrix INCORPORATED	February 2011	**Figure 5.1**



Note: Data points abpve the solids-water interface represent top and bottom water samples.
See Table 5.2 for actual depth values.

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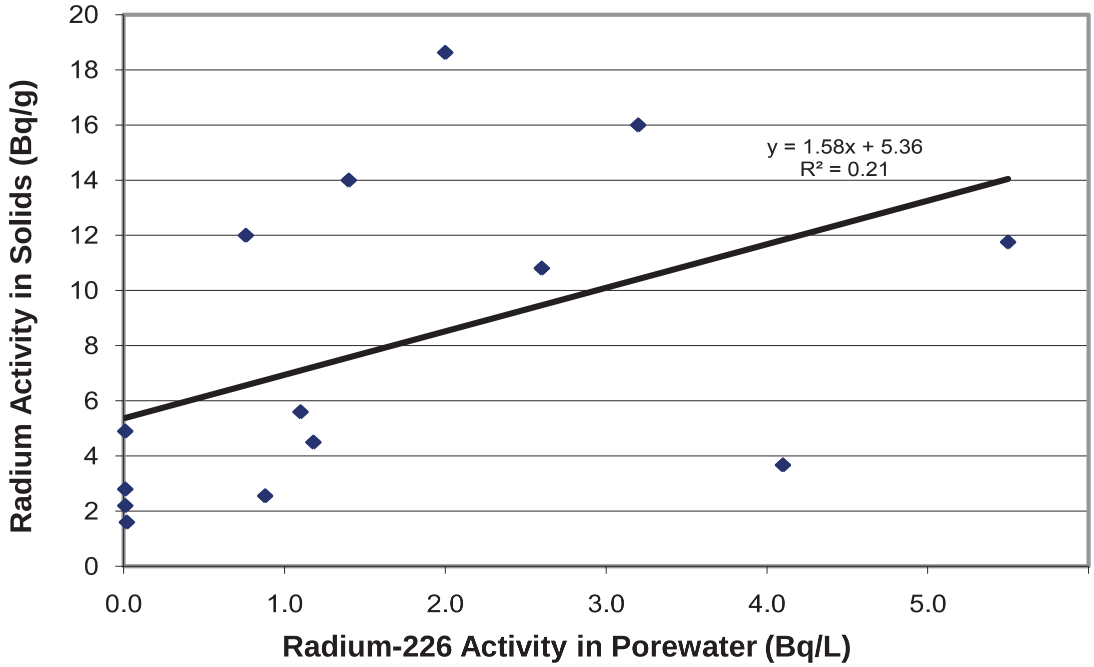
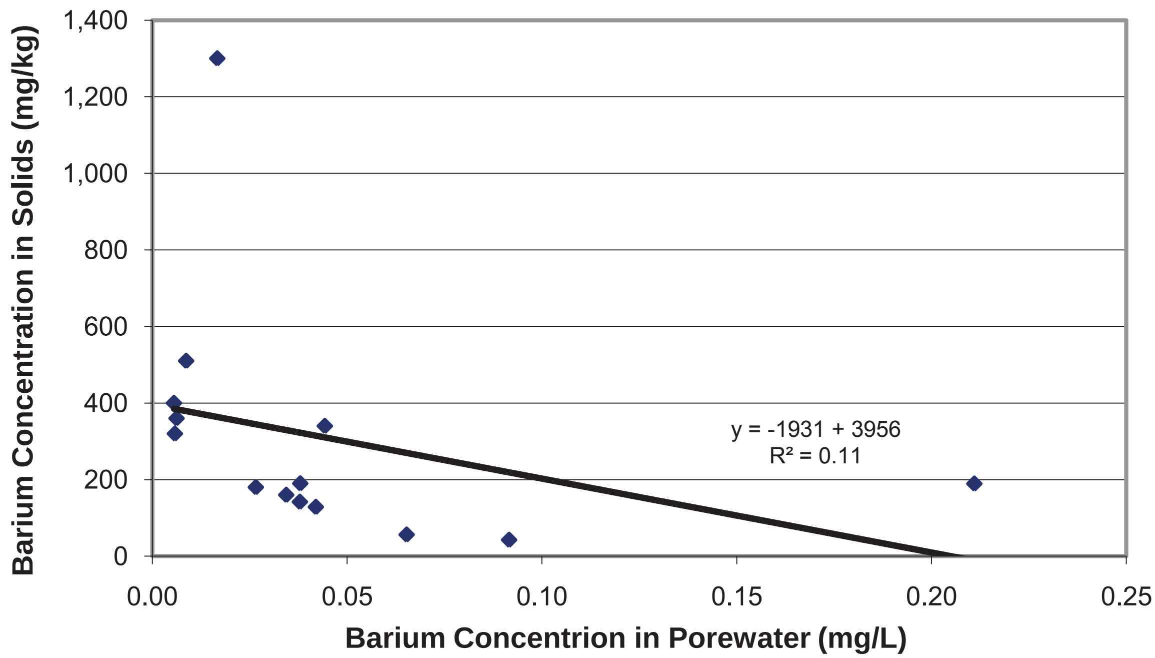
Depth Profiles for Selected Constituents in Porewater and Basin Water from the South Basin		
EcoMetrix INCORPORATED	February 2011	**Figure 5.2**

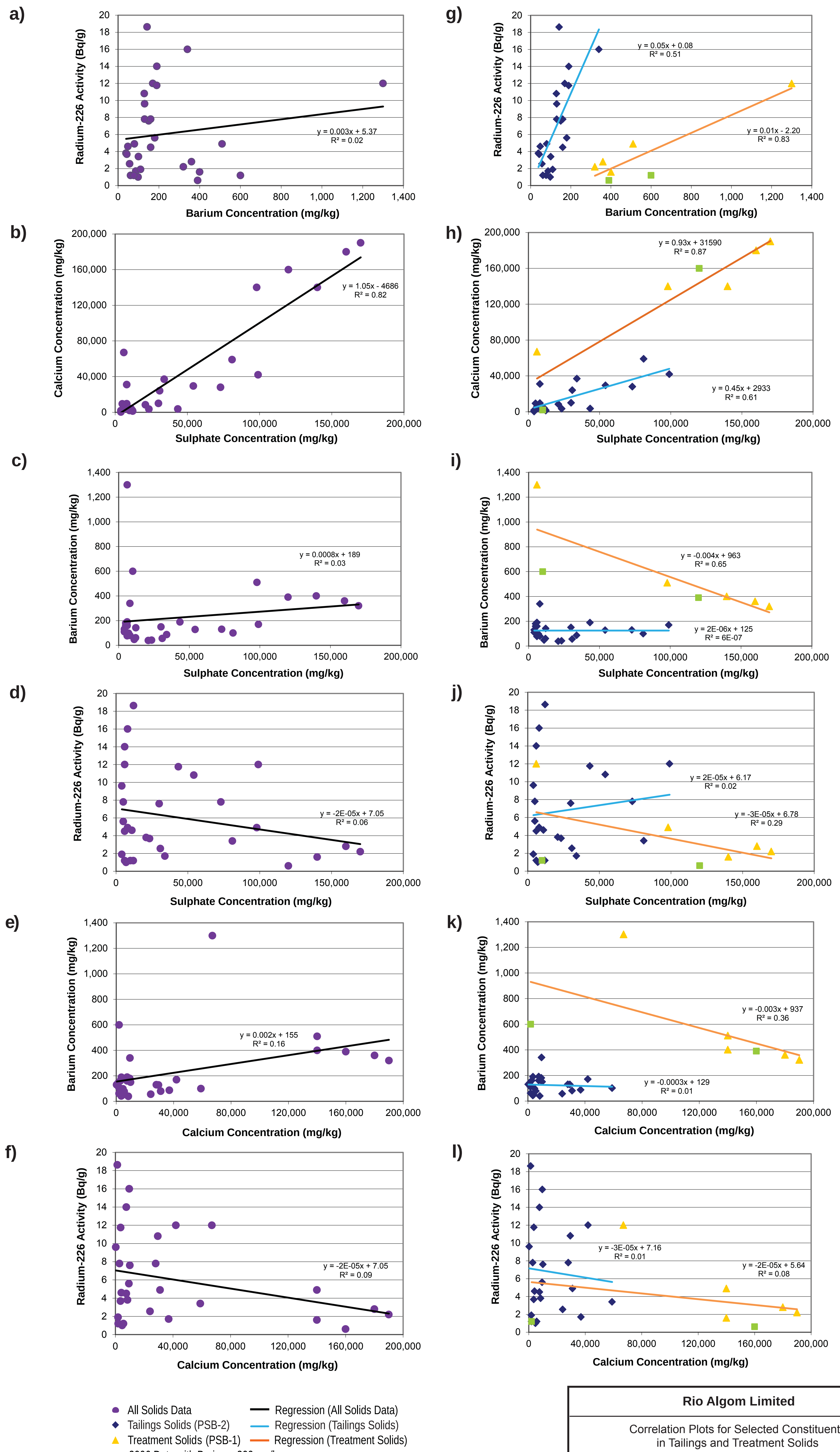
Radium-266



Barium



Rio Algom Limited			
Water-Solids Partitioning Plots for Radium-226 and Barium			
Rio Algom	EcoMetrix INCORPORATED	February 2011	**Figure 6.1**



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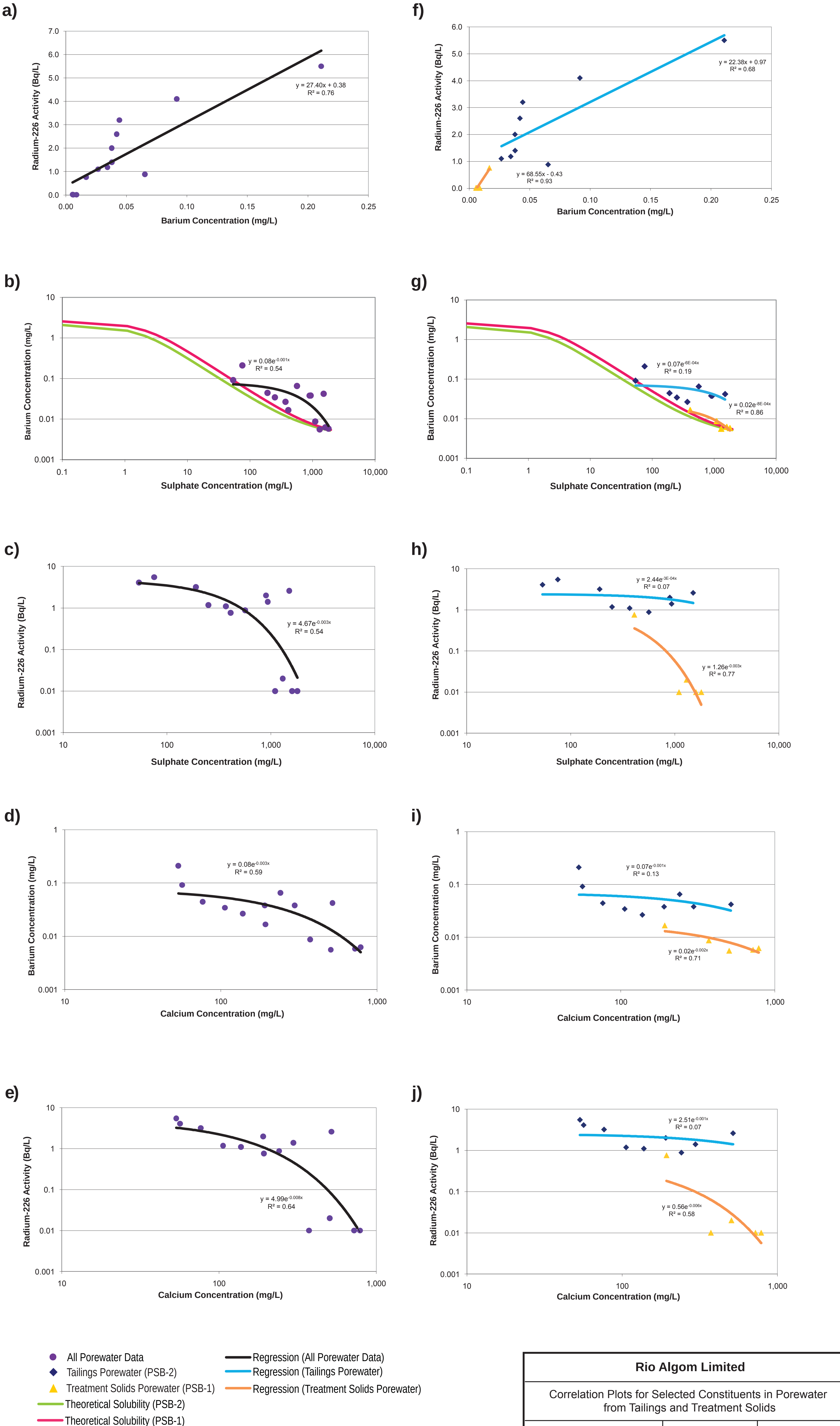
Correlation Plots for Selected Constituents in Tailings and Treatment Solids

Rio Algom | EcoMetrix Incorporated | February 2011 | Figure 6.2



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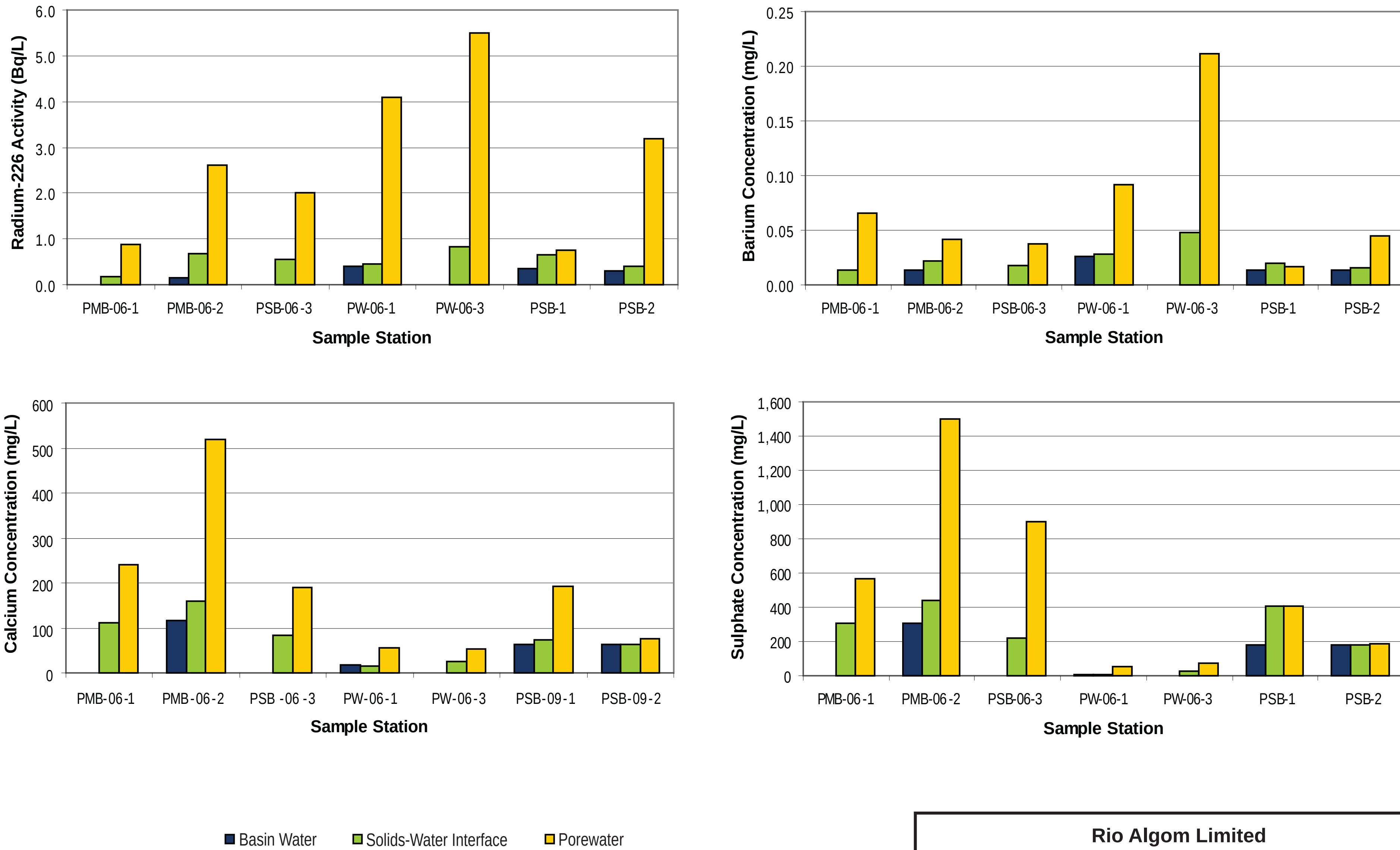
Correlation Plots for Selected Constituents in Porewater from Tailings and Treatment Solids

EcoMetrix INCORPORATED

EcoMetrix INCORPORATED	February 2011	**Figure 6.3**

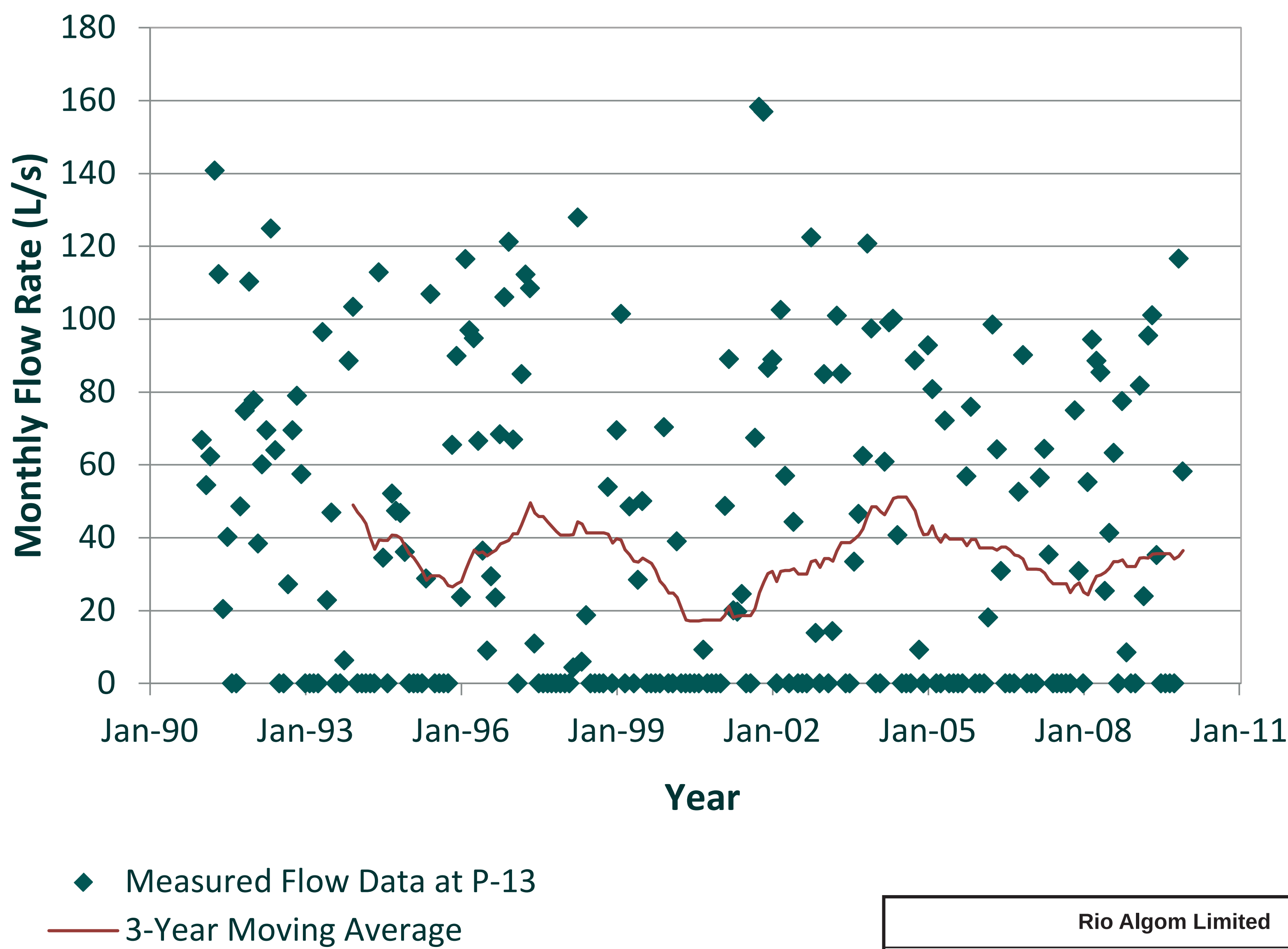


Rio Algom

Rio Algom Limited

Activities and Concentrations for Selected Constituents in Porewater and Basin Water

EcoMetrix Incorporated	February 2011	**Figure 6.4**



Rio Algom Limited		
Monthly Flow Data at the South Basin Outflow (P-13) from Routine Monitoring		
EcoMetrix Incorporated	February 2011	Figure 6.5

Rio Algom

EcoMetrix INCORPORATED

APPENDIX 1

Compilation of Routine Monitoring Data at the Panel TMA

Table A1.1: Routine Monitoring Data in the Main Basin (P-21) at the Panel TMA

Date	pH (pH units)	Acidity (mg/L as $CaCO_3$)	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)
8-Jan-90	6.4	33		14.882	
15-Jan-90	6.6	32			
22-Jan-90	6.7	14			
29-Jan-90	6.8	16			
5-Feb-90	6.7	30			
13-Feb-90	4.0	48		14.670	
19-Feb-90	5.0	84			
27-Feb-90	5.9	60			
7-Mar-90	7.0	38		14.641	
12-Mar-90	6.9	32		9.462	
19-Mar-90	6.2	18			
27-Mar-90	4.6	33			
2-Apr-90	5.9	182			
9-Apr-90	4.8	82		3.706	
16-Apr-90	4.8	21			
23-Apr-90	4.8	18			
30-Apr-90	4.0	58			
14-May-90	3.7	130			
22-May-90	3.7	110			
28-May-90	4.1	250			
29-May-90	3.6	89		8.182	
4-Jun-90	3.6	134			
11-Jun-90	3.4	126		6.301	
19-Jun-90	3.5	405			
25-Jun-90	3.3	144			
3-Jul-90	3.2	364			
9-Jul-90	3.1	172		5.649	
16-Jul-90	3.2	178			
23-Jul-90	3.1	167			
30-Jul-90	3.2	264			
7-Aug-90	3.1	270			
13-Aug-90	3.1	224		8.589	
20-Aug-90	3.1	224			
28-Aug-90	3.3	796			
4-Sep-90	3.0	650			
10-Sep-90	3.1	500		21.507	
17-Sep-90	3.0	484			
25-Sep-90	3.4	540			
1-Oct-90	3.6	300			
9-Oct-90	3.7	298		8.517	
16-Oct-90	3.6	252			
22-Oct-90	3.8	275			
29-Oct-90	3.7	198			
5-Nov-90	3.4	225			
14-Nov-90	3.5	250		8.204	
19-Nov-90	3.7	181			
26-Nov-90	4.2	150			
3-Dec-90	4.1	163			
10-Dec-90	3.9	185		6.477	
17-Dec-90	3.8	180			
24-Dec-90	3.2	270			
8-Jan-91	3.3	220		6.370	
15-Jan-91	3.5	230			
23-Jan-91	3.2	240			
29-Jan-91	3.2	270			
5-Feb-91	3.1	230			
12-Feb-91	3.0	232		3.523	
18-Feb-91	3.6	180			
25-Feb-91	3.5	215			
4-Mar-91	3.5	210			
11-Mar-91	3.5	240		4.888	
18-Mar-91	3.5	165			
25-Mar-91	3.4	260			
1-Apr-91	3.0	275			
8-Apr-91	3.8	60		2.268	
15-Apr-91	4.1	35			
12-Sep-91	4.0	40		4.871	
16-Sep-91	4.0	31			
23-Sep-91	3.5	90			
30-Sep-91	3.8	50			
7-Oct-91	3.8	97		2.692	
15-Oct-91	3.4	130			
21-Oct-91	3.8	98			
28-Oct-91	3.6	90			
4-Nov-91	3.5	154			
12-Nov-91	3.7	57		2.702	
18-Nov-91	3.5	140			
25-Nov-91	3.6	140			
2-Dec-91	3.6	168			
9-Dec-91	3.6	140		1.724	

Table A1.1: Routine Monitoring Data in the Main Basin (P-21) at the Panel TMA

Date	pH	Acidity	Sulphate	Radium-226	Barium
	(pH units)	(mg/L as $CaCO_3$)	(mg/L)	(Bq/L)	(mg/L)
16-Dec-91	3.6	142			
23-Dec-91	3.5	336			
30-Dec-91	3.5	180			
6-Jan-92	3.5	240			
13-Jan-92	3.5	170		2.092	
20-Jan-92	3.4	180			
27-Jan-92	3.4	150			
26-Feb-92	3.4	210			
3-Mar-92	3.4	170			
12-Mar-92	3.4	200		2.224	
16-Mar-92	3.4	215			
23-Mar-92	3.3	215			
30-Mar-92	3.3	150			
7-Apr-92	3.4	140			
13-Apr-92	3.2	220		0.756	
21-Apr-92	3.5	170			
27-Apr-92	3.7	100			
4-May-92	3.5	110			
11-May-92	3.3	160		1.190	
19-May-92	3.2	145			
25-May-92	3.3	72			
2-Jun-92	3.0	175			
8-Jun-92	3.0	195		0.362	
15-Jun-92	3.1	230			
22-Jun-92	3.1	266			
13-Jul-92	3.0	210		0.559	
4-Jan-93	3.0	380			
11-Jan-93	3.1	350	994	0.862	
9-Feb-93	3.0	340	1192	0.550	
22-Feb-93	3.0	402			
8-Mar-93	3.0	420	1182	0.610	
7-Apr-93	4.2	30			
12-Apr-93	4.4	20	21	0.152	
10-May-93	3.2	160	368	0.232	
7-Jun-93	3.2	310	644	0.351	
12-Jul-93	3.0	260	693	0.449	
4-Aug-93	3.0	260			
9-Aug-93	2.9	255	749	0.308	
13-Sep-93	3.3	325	825	0.437	
12-Oct-93	2.8	310	848	0.505	
8-Nov-93	2.7	315	868	0.212	
9-Dec-93	3.0	325	706	0.234	
11-Jan-94	2.9	275	694	0.245	
24-Feb-94	3.1	315	650	0.329	
10-Mar-94	2.9	300	867	0.312	
11-Apr-94	3.1	255	702	0.271	
9-May-94	3.4	180	664	0.259	
13-Jun-94	6.4	5		0.202	
15-Jun-94	6.7	6	711	0.185	
11-Jul-94	6.6	6	744	0.266	
8-Aug-94	5.8	6	764	0.291	
12-Sep-94	6.0	8	801	0.417	
11-Oct-94	8.3	<1	833	0.245	
7-Nov-94	8.3	<1	822	0.222	
12-Dec-94	6.6	6	828	0.288	
9-Jan-95	6.9	7	823	0.247	
22-Feb-95	6.9	6	806	0.240	
31-Mar-95	4.7	28	108	0.085	
10-Apr-95	5.5	17	219	0.048	
5-May-95	6.7	4			
8-May-95	6.9	2	336	0.069	
12-Jun-95	6.7	5	557	<0.037	
10-Jul-95	6.5	5	580	0.354	
8-Aug-95	6.6	4	576	0.247	
11-Sep-95	6.2	6	613	0.315	
10-Oct-95	6.7	4	624	0.374	
14-Nov-95	6.6	4	657	0.472	
6-Dec-95	6.4	5	673	0.428	
8-Jan-96	6.8	3	693	0.612	
8-Feb-96	6.7	4	629	0.503	
11-Mar-96	6.9	5	578	0.493	
9-Apr-96	6.4	8	588	0.366	
13-May-96	6.2	5	165	0.338	
10-Jun-96	7.0	4	524	0.269	
8-Jul-96	6.7	2	484	0.435	
12-Aug-96	6.7	5	535	0.558	
9-Sep-96	6.8	2	552	0.386	
9-Oct-96	6.8	1	579	0.450	
12-Nov-96	6.8	3	584	0.428	
4-Dec-96	6.3	3	555	0.444	

Table A1.1: Routine Monitoring Data in the Main Basin (P-21) at the Panel TMA

Date	pH	Acidity	Sulphate	Radium-226	Barium
	(pH units)	(mg/L as $CaCO_3$)	(mg/L)	(Bq/L)	(mg/L)
16-Jan-97	6.6	3	217	0.480	
11-Feb-97	6.8	4	596	0.580	
4-Mar-97	6.6	3	586	0.440	
9-Apr-97	6.9	3	530	0.490	
12-May-97	6.9	2	493	0.360	
9-Jun-97	6.7	12	507	0.420	
14-Jul-97	7.0	3	511	0.290	
20-Aug-97	6.9	3	511	0.300	
9-Sep-97	7.0	2	514	0.220	
14-Oct-97	6.7	4	505	0.280	
18-Nov-97	7.3	3	557	0.330	
12-Dec-97	7.2	3	445	0.340	
12-Jan-98	7.0	5	554	0.299	
9-Feb-98	7.1	4	525	0.340	
17-Mar-98	6.6	3	568	0.320	
13-Apr-98	6.5	4	153	0.120	
11-May-98	7.2	2	517	0.320	
9-Jun-98	7.0	2	538	0.240	
14-Jul-98	7.5	3	504	0.260	
11-Aug-98	7.0	5	504	0.290	
8-Sep-98	7.3	5	491	0.220	
13-Oct-98	7.1	3	489	0.297	
10-Nov-98	6.9	5	518	0.320	
16-Dec-98	7.2	3	513	0.290	
12-Jan-99	7.1	5	534	0.340	
7-Feb-99	7.1	3	526	0.310	
7-Mar-99	7.0	3	560	0.302	
12-Apr-99	5.6	5	88	0.190	
17-May-99	7.4	3	497	0.250	
14-Jun-99	7.3	2	506	0.170	
12-Jul-99	6.6	3	473	0.280	
17-Aug-99	7.3	2	504	0.250	
7-Sep-99	6.8	2	523	0.290	
12-Oct-99	6.5	3	535	0.240	
13-Oct-99	6.9				
3-Nov-99	6.8	3	514	0.260	0.014
13-Dec-99	7.1	4	525	0.330	
5-Jan-00	6.1	4	516	0.280	
7-Feb-00	7.0	3	530	0.370	0.017
14-Mar-00	6.5	4	442	0.210	
3-Apr-00	5.9	3	51	0.045	
25-May-00	7.0	5	497	0.300	0.016
5-Jun-00	7.0	3	490	0.340	
18-Jul-00	7.1	3	482	0.270	
16-Aug-00	7.2	3	533	0.260	0.015
25-Sep-00	7.0	3	466	0.240	
16-Oct-00	7.0	4	485	0.250	
16-Nov-00	6.7	5	512	0.230	0.019
14-Dec-00	6.6	6	500	0.270	
18-Jan-01	7.0	4	550	0.280	
20-Feb-01	6.9	3	566	0.350	0.018
21-Mar-01	6.9	3	536	0.260	
4-Apr-01	6.8	3	512	0.240	
17-May-01	6.7	3	425	0.220	0.015
14-Jun-01	7.2	2	434	0.200	
12-Jul-01	7.2	2	460	0.250	
16-Aug-01	6.9	3	458	0.220	0.016
12-Sep-01	6.2	5	421	0.240	
12-Oct-01	7.0	3	479	0.220	
2-Nov-01	7.1	2	457	0.270	0.015
14-Dec-01	7.0	2	446	0.300	
17-Jan-02	7.0	2	468	0.240	
14-Feb-02	6.9	2	444	0.270	0.015
14-Mar-02	6.9	2	463	0.250	
20-Jun-02	7.3	1	470	0.240	0.013
12-Sep-02	7.2	4	551	0.180	
21-Oct-02	7.0	2	407	0.200	
14-Nov-02	7.0	3	406	0.240	0.017
12-Dec-02	7.1	2	425	0.350	
17-Apr-03	6.1	5		0.069	
16-Oct-03	7.0	5		0.220	
15-Apr-04	6.6	7		0.083	
2-Dec-04	7.5	4		0.180	
18-Apr-05	6.0	5		0.015	
1-Dec-05	7.4	3		0.150	
25-Apr-06	7.0	<1		0.130	
18-Dec-06	7.0	<1		0.110	
4-Jan-07	7.1	<1	300	0.140	0.015
1-Feb-07	7.2	<1	310	0.140	0.015
1-Mar-07	7.2	<1	320	0.120	0.014

Table A1.1: Routine Monitoring Data in the Main Basin (P-21) at the Panel TMA

Date	pH	Acidity	Sulphate	Radium-226	Barium
	(pH units)	(mg/L as $CaCO_3$)	(mg/L)	(Bq/L)	(mg/L)
19-Apr-07	6.1	1	36	0.024	<0.005
3-May-07	7.2	<1	280	0.150	0.013
7-Jun-07	6.9	<1	290	0.140	0.013
5-Jul-07	7.6	<1	300	0.150	0.014
2-Aug-07	7.7	<1	280	0.110	0.013
6-Sep-07	7.6	<1	320	0.140	0.013
4-Oct-07	7.0	<1	310	0.150	0.014
1-Nov-07	7.0	<1	300	0.140	0.014
6-Dec-07	7.2	<1	300	0.130	0.014
3-Jan-08	6.9	<1	400	0.130	0.014
3-Apr-08	6.9	<1		0.130	
6-Nov-08	6.9	<1		0.120	
15-Apr-09	6.9	<1	240	0.120	
23-Nov-09	6.8	<1	250	0.120	

Table A1.2: Routine Monitoring Data in the South Basin (P-13) at the Panel TMA

Date	pH	Acidity	Sulphate	Radium-226	Barium
	(pH units)	(mg/L as $CaCO_3$)	(mg/L)	(Bq/L)	(mg/L)
2-Jan-90	3.7	102		5.090	
8-Jan-90	4.1	75		6.412	
15-Jan-90	4.7	35		6.616	
22-Jan-90	4.7	37		9.768	
29-Jan-90	4.4	36		9.321	
5-Feb-90	4.2	56		8.642	
13-Feb-90	4.0	47		7.050	
19-Feb-90	4.1	45		7.747	
26-Feb-90	4.0	50		7.812	
12-Mar-90	4.3	55		9.157	
19-Mar-90	4.2	41		9.094	
2-Apr-90	4.0	51		8.954	
9-Apr-90	4.2	102		9.774	
10-Apr-90	4.1	94		9.904	
16-Apr-90	4.1	137		10.622	
23-Apr-90	4.2	142		9.970	
30-Apr-90	3.9	101		9.115	
7-May-90	5.0	110		4.165	
14-May-90	3.8	72		7.110	
22-May-90	3.8	108		7.949	
28-May-90	3.7	95		6.898	
29-May-90	3.6	94			
4-Jun-90	3.6	27		6.270	
11-Jun-90	3.5	149		5.679	
19-Jun-90	3.4	142		6.521	
25-Jun-90	3.4	125		5.200	
3-Jul-90	3.1	184		7.962	
9-Jul-90	3.1	158		4.071	
16-Jul-90	3.2	162		5.507	
23-Jul-90	3.2	158		6.066	
30-Jul-90	3.2	224		6.186	
7-Aug-90	3.1	260		8.855	
13-Aug-90	3.1	232		8.059	
20-Aug-90	3.1	244		7.104	
28-Aug-90	3.0	364		8.974	
4-Sep-90	3.2	272		8.276	
10-Sep-90	3.3	252		9.339	
17-Sep-90	3.1	256		10.771	
25-Sep-90	3.3	210		10.145	
1-Oct-90	3.1	246		7.682	
9-Oct-90	3.3	260		6.866	
16-Oct-90	3.1	215		7.813	
22-Oct-90	3.2	268		6.717	
29-Oct-90	3.3	193		6.383	
5-Nov-90	2.7	210		5.913	
14-Nov-90	2.9	264		6.758	
19-Nov-90	2.9	232		6.755	
26-Nov-90	3.1	190		6.252	
3-Dec-90	3.1	191		5.704	
10-Dec-90	3.2	190		5.383	
17-Dec-90	4.2	250		5.002	
24-Dec-90	3.8	230		5.477	
8-Jan-91	2.9	250		5.960	
15-Jan-91	2.9	195		5.508	
23-Jan-91	2.8	250		5.875	
29-Jan-91	2.7	290		3.390	
5-Feb-91	2.9	230		4.652	
18-Feb-91	3.1	195		4.770	
25-Feb-91	3.1	230		3.691	
4-Mar-91	3.0	195		4.654	
11-Mar-91	3.2	245		4.300	
18-Mar-91	3.1	180		4.259	
25-Mar-91	3.0	240		5.538	
1-Apr-91	3.0	242		6.524	
8-Apr-91	3.1	245		5.594	
15-Apr-91	2.9	230		4.269	
22-Apr-91	3.2	198		4.391	
29-Apr-91	3.1	218		3.386	
6-May-91	3.5	196		2.321	
13-May-91	2.3	180		3.276	
21-May-91	3.4	102		1.941	
27-May-91	3.5	153		1.588	
3-Jun-91	2.9	175		1.458	
28-Oct-91	4.3	200		3.041	
4-Nov-91	4.6	234		2.549	
12-Nov-91	4.1	161		2.129	
18-Nov-91	3.5	172		2.476	
25-Nov-91	3.5	176		2.435	
2-Dec-91	3.5	180		1.383	
9-Dec-91	3.4	160		1.157	

Table A1.2: Routine Monitoring Data in the South Basin (P-13) at the Panel TMA

Date	pH (pH units)	Acidity (mg/L as $CaCO_3$)	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)
16-Dec-91	3.5	140		1.814	
23-Dec-91	3.4	330		1.452	
30-Dec-91	4.7	150		1.622	
6-Jan-92	4.1	212		1.993	
13-Jan-92	3.9	190		1.893	
20-Jan-92	4.4	160		0.929	
27-Jan-92	4.6	146		1.225	
26-Feb-92	4.8	160		1.870	
3-Mar-92	3.3	167		1.013	
10-Mar-92	4.4	140		1.650	
16-Mar-92	4.6	215		1.656	
23-Mar-92	4.8	150		1.576	
30-Mar-92	4.1	135		1.241	
6-Apr-92	4.7	180		1.082	
13-Apr-92	4.4	199		1.370	
21-Apr-92	4.3	220		1.296	
27-Apr-92	4.3	230		1.563	
4-May-92	3.8	202		1.314	
11-May-92	4.0	170		1.172	
19-May-92	3.6	100		0.705	
29-May-92	3.8	107		0.224	
2-Jun-92	3.5	140		0.273	
10-Jun-92	3.3	165		0.324	
16-Jun-92	3.1	130		0.948	
26-Jun-92	2.8	165		0.983	
29-Jun-92	2.4	190		0.980	
28-Oct-92	4.0	140		0.752	
23-Nov-92	3.2	155		0.878	
30-Nov-92	4.6	215		0.825	
7-Dec-92	3.4	190			
10-May-93	3.3	180		0.187	
17-May-93	3.3	125		0.162	
29-Nov-93	3.0	120		1.049	
6-Dec-93	4.0	105		1.013	
13-Dec-93	3.5	190	578	0.671	
20-Dec-93	3.1	183		0.801	
3-Jun-94	3.3	93			
14-Jun-94	3.1	100	511	0.344	
28-Jun-94	3.3	115		0.532	
27-Sep-94	3.0	105		0.826	
4-Oct-94	3.4	100		0.798	
9-Nov-94	4.1	63	458	0.629	
15-Nov-94	3.4	80		0.749	
22-Nov-94	4.2	65		0.608	
6-Dec-94	4.7	42		0.058	
9-Dec-94	4.7	48			
13-Dec-94	4.6	43	525	0.230	
24-May-95	4.1	45		<0.037	
6-Jun-95	4.8	18		0.190	
13-Jun-95	5.5	9		0.430	
20-Jun-95	7.0	7		1.020	
27-Jun-95	5.4	10		1.610	
14-Nov-95	5.8	7		1.331	
20-Nov-95				1.164	
21-Nov-95	3.5	16			
22-Nov-95	6.0	7			
23-Nov-95				1.277	
27-Nov-95	6.2	6		1.364	
30-Nov-95				1.022	
4-Dec-95				1.229	
5-Dec-95	2.8	70		1.161	
6-Dec-95	5.6	7			
7-Dec-95				1.166	
11-Dec-95	6.0	4		0.985	
14-Dec-95				1.081	
18-Dec-95	6.2	6		0.885	
6-Feb-96	5.4	10		1.207	
8-Feb-96				1.262	
13-Feb-96	5.8	5		1.262	
15-Feb-96				1.186	
20-Feb-96				1.064	
22-Feb-96				0.777	
26-Feb-96				1.363	
27-Feb-96	6.0	7		0.942	
4-Mar-96	5.6	8		1.132	
7-Mar-96				0.815	
11-Mar-96				1.529	
12-Mar-96	6.0	15		1.372	
14-Mar-96				1.290	
18-Mar-96	5.8	5		1.172	

Table A1.2: Routine Monitoring Data in the South Basin (P-13) at the Panel TMA

Date	pH	Acidity	Sulphate	Radium-226	Barium
	(pH units)	(mg/L as $CaCO_3$)	(mg/L)	(Bq/L)	(mg/L)
28-Mar-96	5.9	8		1.267	
1-Apr-96				1.177	
2-Apr-96	5.8	16		1.170	
4-Apr-96				1.058	
8-Apr-96	6.0	7		1.202	
9-Apr-96				1.052	
11-Apr-96				1.023	
15-Apr-96	5.4	20		1.213	
18-Apr-96				1.173	
22-Apr-96	5.9	12		1.051	
25-Apr-96				0.966	
29-Apr-96				0.887	
30-Apr-96	6.2	5		0.765	
2-May-96				0.706	
7-May-96	5.0	15		0.589	
17-May-96				0.833	
21-May-96	5.9	7		0.725	
27-May-96	6.0	6		0.719	
29-May-96				0.665	
3-Jun-96				0.513	
4-Jun-96	9.5	<1		1.075	
6-Jun-96	5.3	6		0.664	
11-Jun-96	5.5	6	290	1.817	
13-Jun-96				0.824	
17-Jun-96				0.658	
18-Jun-96	4.9	4		0.676	
20-Jun-96				0.812	
24-Jun-96				0.592	
25-Jun-96	5.9	5		3.276	
2-Aug-96	6.2	5		1.392	
6-Aug-96	6.5	5		1.556	
13-Sep-96	8.0	2	383	0.669	
15-Oct-96	7.2	3		1.329	
22-Oct-96	7.0	4		1.624	
29-Oct-96	7.3	3		1.655	
5-Nov-96	6.9	2		1.146	
14-Nov-96	6.7	4	384	1.159	
19-Nov-96	8.9	2		1.304	
26-Nov-96	7.1	3		0.975	
3-Dec-96	6.6	4		1.677	
10-Dec-96	6.8	3	381	0.977	
17-Dec-96	6.6	3		1.194	
24-Dec-96	6.5	3		1.117	
31-Dec-96	7.0	3		0.447	
7-Jan-97	6.8	2		1.130	
14-Jan-97	6.8	2	353	1.140	
21-Jan-97	7.3	7		1.100	
18-Mar-97	6.4	5	453	1.200	
25-Mar-97	6.6	8	453	1.100	
1-Apr-97	6.2	17		1.670	
8-Apr-97	6.4	10	429	1.240	
14-Apr-97	6.3	7		1.075	
22-Apr-97	6.5	9		0.970	
29-Apr-97	6.4	8		0.830	
6-May-97	6.2	7		0.410	
13-May-97	6.1	6	314	0.940	0.02
13-May-97					
20-May-97	6.2	6		1.030	
27-May-97	6.0	5		1.001	
3-Jun-97	6.0	2		1.070	
31-Mar-98	6.9	5	316	1.020	
7-Apr-98	6.8	3		0.950	
13-Apr-98	6.6	9	373	0.990	
20-Apr-98	6.7	4		0.780	
27-Apr-98	6.9	3		0.650	
25-Jun-98	7.1	3		0.720	
29-Jun-98	6.8	1	340	0.870	
12-Nov-98	7.4	2	343	0.930	0.13
16-Nov-98	7.0	4		0.910	
23-Nov-98	7.0	2		1.050	
4-Jan-99	6.8	2		0.910	
11-Jan-99	6.8	4	353	0.760	
17-Jan-99	6.9	4		0.840	
25-Jan-99	7.0	4		0.690	
31-Jan-99	6.8	4		0.896	
7-Feb-99	6.7	4	368	0.910	
15-Feb-99	6.7	3		0.860	
22-Feb-99	6.6	4		0.610	
8-Apr-99	6.4	4		0.800	
12-Apr-99	6.4	6	412	1.000	

Table A1.2: Routine Monitoring Data in the South Basin (P-13) at the Panel TMA

Date	pH	Acidity	Sulphate	Radium-226	Barium
	(pH units)	(mg/L as $CaCO_3$)	(mg/L)	(Bq/L)	(mg/L)
13-May-99					0.022
8-Jun-99	7.4	2		0.615	
14-Jun-99	7.1	2	330	0.540	
14-Jul-99	7.0	3	346	0.720	
19-Jul-99	7.3	2		0.740	
8-Dec-99	7.4	2	357	0.820	0.018
13-Dec-99	7.0	13		1.070	
20-Dec-99	7.1	4		1.095	
23-Dec-99	6.3				
7-Mar-00	6.6	4	374	0.920	
14-Mar-00	6.7	5		1.220	
19-Mar-00	6.5	4		1.050	
28-Mar-00	6.4	4		1.230	0.033
3-Apr-00	5.9	5	120	0.520	
28-Sep-00	7.0	6	305	0.860	
12-Feb-01	6.7	4	363	1.000	
19-Feb-01	6.9	4		1.180	
9-Mar-01	6.5	6		0.700	
12-Mar-01	6.4	6	346	1.100	0.029
19-Mar-01	6.5	6		1.100	
26-Mar-01	6.4	7		1.130	
18-Apr-01	5.9	4	24	0.170	0.010
29-May-01	6.7	3		0.790	
5-Jun-01	6.7	3		0.860	
20-Sep-01	7.0	2		0.770	
24-Sep-01	7.2	2	292	0.760	
1-Oct-01	6.9	3		0.900	
9-Oct-01	6.9	1	309	0.890	0.022
15-Oct-01	6.9	2		0.840	
22-Oct-01	6.8	3		0.930	
29-Oct-01	6.9	3		0.830	
5-Nov-01	6.8	5		0.670	
12-Nov-01	7.1	7	318	0.770	
19-Nov-01	6.2	4		0.660	
26-Nov-01	6.8	5		0.600	
6-Dec-01	6.7	3		0.660	
10-Dec-01	6.8	3	317	0.700	
17-Dec-01	6.9	4		0.740	
3-Jan-02	6.7	5		0.450	
7-Jan-02	6.6	4		0.650	
14-Jan-02	6.7	2	324	0.650	
21-Jan-02	6.6	3		0.640	
11-Mar-02	6.4	4		0.770	
18-Mar-02	6.5	4	352	0.610	0.020
25-Mar-02	6.5	4		0.700	
1-Apr-02	6.8	6		0.720	
8-Apr-02	6.4	3	357	0.660	0.020
17-Jun-02	6.9	3		0.580	
24-Jun-02	6.7	2		0.600	
8-Oct-02	7.2	3		0.660	
18-Oct-02	7.2	2	290	0.670	
21-Oct-02	7.4	2		0.760	
28-Oct-02	7.1	2		0.650	
14-Jan-03	6.6	5	295	0.590	0.022
27-Mar-03	6.6	7	337	0.730	0.022
10-Apr-03	6.6	7	336	0.610	0.024
8-May-03				0.540	0.022
4-Sep-03					
18-Sep-03	7.1	4	270	0.670	
23-Oct-03	6.8	3	265	0.660	0.020
6-Nov-03				0.520	
4-Dec-03				0.610	
18-Mar-04				0.600	
8-Apr-04	6.1	8	313	0.500	0.019
6-May-04				0.560	
10-Jun-04				0.580	
30-Jul-04					
7-Oct-04	6.8	2	271	0.630	0.016
13-Jan-05				0.570	
10-Feb-05	6.8	3	279	0.650	0.019
5-May-05	6.6	3	243	0.430	0.031
8-Sep-05					
27-Oct-05	7.2	2	300	0.520	0.016
10-Nov-05				0.690	
23-Mar-06	6.6	<1	250	0.640	0.024
13-Apr-06				0.690	
4-May-06	6.9	<1	180	0.530	0.022
8-Jun-06				0.480	
10-Aug-06					
26-Oct-06	7.1	<1	220	0.490	0.022

Table A1.2: Routine Monitoring Data in the South Basin (P-13) at the Panel TMA

Date	pH	Acidity	Sulphate	Radium-226	Barium
	(pH units)	(mg/L as $CaCO_3$)	(mg/L)	(Bq/L)	(mg/L)
9-Nov-06				0.560	
4-Jan-07	6.7	<1	220	0.550	0.059
1-Feb-07	6.7	<1	220	0.550	0.024
1-Mar-07	6.7	<1	230	0.580	0.044
19-Apr-07	6.7	<1	230	0.790	0.043
10-May-07	6.9	<1	200	0.520	0.034
7-Jun-07	7.0	<1	220	0.600	0.021
5-Jul-07	6.9	<1	220	1.000	0.025
2-Aug-07	6.4	<1	210	0.430	0.017
6-Sep-07	7.4	<1	230	0.490	0.019
4-Oct-07	7.1	<1	220	0.540	0.022
1-Nov-07	7.2	<1	220	0.500	0.022
22-Nov-07	7.0	<1	210	0.470	0.031
6-Dec-07	7.0	<1	220	0.440	0.034
3-Jan-08	6.9	<1	230	0.500	0.024
21-Feb-08	6.9	<1	210	0.440	0.064
6-Mar-08	6.9	<1	230	0.400	0.026
3-Apr-08	6.9	<1	220	0.430	0.067
1-May-08	6.9	<1	180	0.420	0.019
22-May-08	6.9	<1	180	0.480	0.018
3-Jul-08	7.2	<1	180	0.350	0.017
7-Aug-08	7.2	<1	180	0.280	0.013
9-Oct-08	7.2	<1	190	0.400	0.016
16-Oct-08	7.1	<1	190	0.420	0.02
13-Nov-08	7.2	<1	180	0.440	0.019
12-Feb-09	7.0	<1	190	0.480	0.033
26-Mar-09				0.510	
8-Apr-09	6.7	<1	200	0.530	0.024
7-May-09				0.520	
4-Jun-09				0.390	
16-Sep-09	7.2	<1	180	0.380	0.014
5-Nov-09	7.2	<1	190	0.420	0.017

Table A1.3: Routine Monitoring Data in Pond C (P-03) at the Panel TMA

Date	pH	Acidity	Sulphate	Radium-226	Barium
	(pH units)	(mg/L as $CaCO_3$)	(mg/L)	(Bq/L)	(mg/L)
13-Jan-90	6.8	37		2.324	
15-Feb-90	7.2	49		2.443	
14-Mar-90	6.6	22		0.695	
30-Apr-90	6.2	5		0.978	
29-May-90	7	5	54	0.785	
13-Jul-90	7.4	4		1.053	
20-Aug-90	7.3	5		0.297	
26-Sep-90	7.2	3		0.660	
24-Oct-90	7.5	3		0.522	
30-Nov-90	6.3	16	10	0.214	
15-Jan-91	7	30		1.295	
14-Feb-91	7.1	21		1.813	
22-Mar-91	6.6	40		1.080	
5-Apr-91	6.7	35		0.631	
27-May-91	7.3	10	10	0.483	
24-Jun-91	7.1	12	44	0.575	
8-Jul-91	6.6	10	45	0.582	
27-Aug-91	7.7	2	45	0.367	
30-Oct-91	7	5	62	0.450	
22-Nov-91	6.3	13	75	0.431	
11-Dec-91	6.4	25	34	0.543	
15-Jan-92	6.4	45	139	1.205	
13-Feb-92	6.8	59	208	1.313	
11-Mar-92	6.8	68	239	3.167	
15-Apr-92	5.7	19	100	0.508	
11-May-92	6.9	5	58	0.176	
24-Jun-92	6.9	4	94	0.457	
24-Jul-92	8.6	<1	40	0.475	
27-Aug-92	7.6	3	70	0.172	
25-Sep-92	7.1	3	95	0.207	
30-Oct-92	7.3	3	121	0.124	
27-Nov-92	6	21	25	0.094	
4-Dec-92	5.8	16	15	0.066	
15-Jan-93	6.8	15	130	0.675	
10-Feb-93	6.8	42	229	2.019	
11-Mar-93	6.7	120	331	1.830	
30-Apr-93	6.7	4	60	0.440	
12-May-93	6.8	7	61	<0.037	
23-Jun-93	8.9	<1	103	0.043	
15-Jul-93	9.5	<1	99	0.046	
31-Aug-93	8.4	<1	94	0.053	
16-Sep-93	7	8	113	0.402	
14-Oct-93	7	7	75	0.334	
29-Nov-93	6.2	14	105	0.194	
11-Jan-94	7.2	60	199	0.688	
9-Feb-94	6.7	61	181	1.513	
10-Mar-94	6.8	75	276	2.045	
12-Apr-94	6.7	15	76	1.691	
12-May-94	7.3	7	175	0.388	
15-Jun-94	7.1	5	241	0.140	
20-Jul-94	7.5	3	311	0.263	
31-Aug-94	7.1	8	373	0.346	
29-Sep-94	7.3	4	360	0.510	
31-Oct-94	7.3	3	285	0.333	
25-Nov-94	7.1	2	180	0.361	
15-Dec-94	6.4	40	267	0.341	
23-Jan-95	7	12	307	0.634	
16-Feb-95	6.9	147	420	1.878	
17-Mar-95	6.4	10	91	0.214	
28-Apr-95	6.5	8	70	0.219	
24-May-95	6.3	6	95	0.200	
28-Jun-95	7.4	6	92	0.589	
21-Jul-95	7	3	93	0.630	
10-Aug-95	7.3	3	90	0.278	
14-Sep-95	6.6	3	84	0.309	
5-Oct-95	6.7	4	87	0.515	
28-Nov-95	6.1	8	88	0.500	
15-Dec-95	6.5	25	111	0.928	
10-Jan-96	6.4	45	228	1.573	
6-Feb-96	6.2	15	158	0.935	
15-Mar-96	6.6	16	266	1.551	
23-Apr-96	6.2	36	189	0.915	
23-May-96	6.8	4	49	0.644	
14-Jun-96	7	4	59	0.182	
5-Jul-96	7.5	3	68	0.392	
2-Aug-96	8.5	2	95	0.401	
5-Sep-96	7.4	2	77	1.031	
10-Oct-96	7.6	2	111	1.036	
27-Nov-96	6.5	7	73	0.649	

Table A1.3: Routine Monitoring Data in Pond C (P-03) at the Panel TMA

Date	pH (pH units)	Acidity (mg/L as $CaCO_3$)	Sulphate (mg/L)	Radium-226 (Bq/L)	Barium (mg/L)
5-Dec-96	6.1	14	70	0.467	
17-Jan-97	7.3	42	217	2.760	
4-Feb-97	6.7	5	230	1.580	
4-Mar-97	6.3	6	215	1.880	
7-Apr-97	6.2	13	24	0.350	
16-May-97					0.012
22-May-97	7.2	2	59	0.380	
3-Jun-97	7.2	3	74	0.380	
25-Jul-97	9.1	<1	123	1.270	
28-Aug-97	8	1	106	0.970	
13-Sep-97	7.1	5	263	1.920	
8-Oct-97	7.4	4	304	1.640	
21-Nov-97	7.1	1	127	1.000	0.031
16-Dec-97	7	18	286	1.510	
14-Jan-98	6.9	35	322	2.940	
5-Feb-98	7	27	415	3.650	
17-Mar-98	6.7	68	421	3.070	
29-Apr-98	6.9	4	176	0.802	
11-May-98					0.020
21-May-98	7.4	3	175	0.650	
9-Jun-98	6.8	3	197	0.730	
23-Jul-98	8.2	1	180	0.640	
24-Aug-98	7.9	3	157	1.010	
18-Sep-98	8.2	2	150	0.900	
22-Oct-98	7.5	3	123	0.930	0.025
12-Nov-98	6.5	8	195	0.650	
11-Dec-98	6.5	8	113	0.530	
8-Jan-99	6.4	12	148	0.920	
16-Feb-99	6.4	3	170	0.980	
5-Mar-99	6.6	15	194	1.660	
22-Apr-99	6.4	4	56	0.570	
18-May-99	6.7	3	72	0.230	<0.005
10-Jun-99	6.5	3	87	0.380	
14-Jul-99	8.3	0	86	0.590	
16-Aug-99	7.4	2	66	0.460	
2-Sep-99	7.7	2	70	0.390	
13-Oct-99	7.6	2	69	0.650	
10-Nov-99	7.8	3	73	0.610	0.016
2-Dec-99	7.4	3	73	0.600	
12-Jan-00	6.9	15	80	0.690	
16-Feb-00	6.9	11	92	1.090	0.020
9-Mar-00	6.1	15	18	0.230	
7-Apr-00	6.4	10	46	0.680	
24-May-00	7.3	4	52	0.360	0.012
8-Jun-00	7.3	8	50	0.320	
18-Jul-00	7	11	32	0.250	
16-Aug-00	7.5	3	28	0.180	0.006
25-Sep-00	7.7	3	21	0.240	
16-Oct-00	7.9	3	23	0.310	
16-Nov-00	7.8	4	27	0.320	0.011
14-Dec-00	7.4	7	26	0.450	
18-Jan-01	7.2	12	23	0.630	
20-Feb-01	7.1	14	23	1.110	0.026
21-Mar-01	7	32	16	1.470	
4-Apr-01	6.8	27	10	1.680	
17-May-01	7.1	7	16	0.390	0.018
14-Jun-01	7.5	2	17	0.290	
12-Jul-01	7.7	4	12	0.370	
16-Aug-01	7.6	3	8	0.280	0.010
12-Sep-01	7.5	3	7	0.320	
12-Oct-01	7.3	3	9	0.400	
2-Nov-01	7.2	3	15	0.280	0.015
14-Dec-01	7	5	17	0.300	
17-Jan-02	6.7	10	16	0.250	
14-Feb-02	6.7	9	15	0.580	0.024
14-Mar-02	6.5	12	15	0.720	
11-Apr-02	6.3	26	13	0.490	
16-May-02	7.4	3	14	0.310	0.020
13-Jun-02	7.7	1	15	0.180	
11-Jul-02	7.5	4	7	0.400	
15-Aug-02	7.3	4	4	0.370	0.020
12-Sep-02	7.3	5	5	0.330	
17-Oct-02	7.5	4	11	0.260	
14-Nov-02	7.4	2	11	0.290	0.014
12-Dec-02	7.3	6	13	0.240	
27-Jan-03	6.8		16	0.540	0.037
28-Apr-03	6.8		7	0.520	0.029
28-Jul-03	7.4		7	0.400	0.017
27-Oct-03	7.4		12	0.330	0.020

Table A1.3: Routine Monitoring Data in Pond C (P-03) at the Panel TMA

Date	pH	Acidity	Sulphate	Radium-226	Barium
	(pH units)	(mg/L as $CaCO_3$)	(mg/L)	(Bq/L)	(mg/L)
26-Jan-04	6.7		17	0.590	0.048
26-Apr-04	6.7		8	0.560	0.038
26-Jul-04	7.6		7	0.300	0.019
25-Oct-04	7.2		7	0.290	0.016
24-Jan-05	6.3		10	0.630	0.054
25-Apr-05	6.6		7	0.910	0.042
25-Jul-05	7.2		5	0.480	0.024
24-Oct-05	7.1		6	0.380	0.019
23-Jan-06	6.6		10	0.640	0.046
25-Apr-06	6.9		7	0.760	0.040
25-Jul-06	7.3		5	0.460	0.026
24-Oct-06	7.3		6	0.470	0.025
22-Jan-07	6.5		8	0.354	0.029
23-Apr-07	6.9		6	0.740	0.039
23-Jul-07	7		5	0.400	0.025
22-Oct-07	6.6		6	0.540	0.035
24-Jan-08	6.4		9	0.610	0.036
8-May-08	6.8		10	0.470	0.026
15-Jul-08	7.5		6	0.369	0.023
15-Aug-08	7.3				
27-Apr-09	6.2		16	0.290	0.018
27-Jul-09	6.9		18	0.490	0.029
26-Oct-09	6.8		13	0.430	0.030

Table A1.4: Flow Data for the Panel TMA at the South Basin Outflow (P-13)

Month	FLOW (L/s)
Jan-87	115.6
Feb-87	119.3
Mar-87	122.5
Apr-87	140.8
May-87	134.6
Jun-87	114.0
Jul-87	101.1
Aug-87	82.0
Sep-87	24.6
Oct-87	79.1
Nov-87	115.5
Dec-87	127.6
Jan-88	121.9
Feb-88	117.0
Mar-88	119.9
Apr-88	170.1
May-88	155.2
Jun-88	146.7
Jul-88	103.2
Aug-88	103.8
Sep-88	96.4
Oct-88	115.5
Nov-88	170.5
Dec-88	190.8
Jan-89	176.9
Feb-89	159.2
Mar-89	151.7
Apr-89	169.6
May-89	172.4
Jun-89	158.5
Jul-89	128.1
Aug-89	69.2
Sep-89	83.6
Oct-89	75.5
Nov-89	114.4
Dec-89	119.2
Jan-90	115.2
Feb-90	125.1
Mar-90	144.4
Apr-90	137.5
May-90	120.2
Jun-90	116.6
Jul-90	143.6
Aug-90	115.2
Sep-90	101.6
Oct-90	58.9
Nov-90	59.9
Dec-90	64.4
Jan-91	66.8
Feb-91	54.4
Mar-91	62.3
Apr-91	140.8
May-91	112.4
Jun-91	20.3
Jul-91	40.2
Aug-91	0.0
Sep-91	0.0
Oct-91	48.6
Nov-91	74.8
Dec-91	110.2
Jan-92	77.8
Feb-92	38.3
Mar-92	60.1
Apr-92	69.5
May-92	124.8
Jun-92	64.0
Jul-92	0.0
Aug-92	0.0
Sep-92	27.2
Oct-92	69.5
Nov-92	78.9
Dec-92	57.4
Jan-93	0.0
Feb-93	0.0
Mar-93	0.0
Apr-93	0.0
May-93	96.5
Jun-93	22.8
Jul-93	46.8

Table A1.4: Flow Data for the Panel TMA at the South Basin Outflow (P-13)

Month	FLOW (L/s)
Aug-93	0.0
Sep-93	0.0
Oct-93	6.3
Nov-93	88.5
Dec-93	103.4
Jan-94	0.0
Feb-94	0.0
Mar-94	0.0
Apr-94	0.0
May-94	0.0
Jun-94	112.9
Jul-94	34.5
Aug-94	0.0
Sep-94	52.0
Oct-94	47.4
Nov-94	46.7
Dec-94	36.0
Jan-95	0.0
Feb-95	0.0
Mar-95	0.0
Apr-95	0.0
May-95	28.8
Jun-95	106.8
Jul-95	0.0
Aug-95	0.0
Sep-95	0.0
Oct-95	0.0
Nov-95	65.5
Dec-95	89.9
Jan-96	23.7
Feb-96	116.5
Mar-96	96.9
Apr-96	94.8
May-96	66.6
Jun-96	36.4
Jul-96	9.0
Aug-96	29.4
Sep-96	23.5
Oct-96	68.3
Nov-96	106.0
Dec-96	121.2
Jan-97	66.9
Feb-97	0.0
Mar-97	84.8
Apr-97	112.2
May-97	108.4
Jun-97	10.9
Jul-97	0.0
Aug-97	0.0
Sep-97	0.0
Oct-97	0.0
Nov-97	0.0
Dec-97	0.0
Jan-98	0.0
Feb-98	0.0
Mar-98	4.3
Apr-98	127.8
May-98	6.0
Jun-98	18.7
Jul-98	0.0
Aug-98	0.0
Sep-98	0.0
Oct-98	0.0
Nov-98	53.9
Dec-98	0.0
Jan-99	69.5
Feb-99	101.4
Mar-99	0.0
Apr-99	48.6
May-99	0.0
Jun-99	28.4
Jul-99	50.0
Aug-99	0.0
Sep-99	0.0
Oct-99	0.0
Nov-99	0.0
Dec-99	70.3
Jan-00	0.0
Feb-00	0.0

Table A1.4: Flow Data for the Panel TMA at the South Basin Outflow (P-13)

Month	FLOW (L/s)
Mar-00	38.9
Apr-00	0.0
May-00	0.0
Jun-00	0.0
Jul-00	0.0
Aug-00	0.0
Sep-00	9.2
Oct-00	0.0
Nov-00	0.0
Dec-00	0.0
Jan-01	0.0
Feb-01	48.7
Mar-01	89.0
Apr-01	20.0
May-01	19.7
Jun-01	24.5
Jul-01	0.0
Aug-01	0.0
Sep-01	67.3
Oct-01	158.2
Nov-01	156.9
Dec-01	86.6
Jan-02	88.9
Feb-02	0.0
Mar-02	102.5
Apr-02	56.9
May-02	0.0
Jun-02	44.3
Jul-02	0.0
Aug-02	0.0
Sep-02	0.0
Oct-02	122.4
Nov-02	13.8
Dec-02	0.0
Jan-03	84.8
Feb-03	0.0
Mar-03	14.3
Apr-03	100.9
May-03	85.0
Jun-03	0.0
Jul-03	0.0
Aug-03	33.4
Sep-03	46.5
Oct-03	62.4
Nov-03	120.7
Dec-03	97.4
Jan-04	0.0
Feb-04	0.0
Mar-04	60.9
Apr-04	99.1
May-04	100.0
Jun-04	40.6
Jul-04	0.0
Aug-04	0.0
Sep-04	0.0
Oct-04	88.7
Nov-04	9.2
Dec-04	0.0
Jan-05	92.8
Feb-05	80.8
Mar-05	0.0
Apr-05	0.0
May-05	72.1
Jun-05	0.0
Jul-05	0.0
Aug-05	0.0
Sep-05	0.0
Oct-05	56.8
Nov-05	75.9
Dec-05	0.0
Jan-06	0.0
Feb-06	0.0
Mar-06	18.0
Apr-06	98.5
May-06	64.2
Jun-06	30.9
Jul-06	0.0
Aug-06	0.0
Sep-06	0.0

Table A1.4: Flow Data for the Panel TMA at the South Basin Outflow (P-13)

Month	FLOW (L/s)
Oct-06	52.6
Nov-06	90.1
Dec-06	0.0
Jan-07	0.0
Feb-07	0.0
Mar-07	56.5
Apr-07	64.4
May-07	35.4
Jun-07	0.0
Jul-07	0.0
Aug-07	0.0
Sep-07	0.0
Oct-07	0.0
Nov-07	74.9
Dec-07	30.8
Jan-08	0.0
Feb-08	55.2
Mar-08	94.3
Apr-08	88.6
May-08	85.3
Jun-08	25.4
Jul-08	41.3
Aug-08	63.3
Sep-08	0.0
Oct-08	77.5
Nov-08	8.5
Dec-08	0.0
Jan-09	0.0
Feb-09	81.7
Mar-09	23.9
Apr-09	95.5
May-09	101.0
Jun-09	35.2
Jul-09	0.0
Aug-09	0.0
Sep-09	0.0
Oct-09	0.0
Nov-09	116.6
Dec-09	58.1
Jan-10	0.0

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APPENDIX 2

Compilation of Data from the 2006 Field Sampling Program

Table A2.1: Solids Data from the 2006 Field Sampling Program - Core Samples

	Sample ID	PMB-06-1 0-5	PMB-06-1 12.5-17.5	PMB-06-2 0-5	PMB-06-2 15-20	PSB-06-1 0-4	PSB-06-1 17.5-20	PSB-06-2 0-4	PSB-06-2 10-12.5	PSB-06-3 0-4
	Sample Date	10-Oct-06	10-Oct-06	10-Oct-06	10-Oct-06	04-Oct-06	04-Oct-06	05-Oct-06	05-Oct-06	05-Oct-06
Analysis	**Units**									
$BaSO_4$ [a]	mg/kg	140	67	170	290	100	250	1020	220	150
$BaSO_4$ [b]	mg/kg	73	1090	<50.0	< 50	510	< 50	870	1090	< 50
Ra-226	Bq/g	4.9	3.8	3.4	12	1.2	7.6	1.2	7.8	1.7
Acid Volatile Sulphide	mg/L	< 1	< 0.2	< 0.2	< 0.2	< 0.1	< 0.2	< 0.1	< 0.2	< 0.1
COD	mg/kg	3480	1150	1330	2510	10900	1170	508	908	1040
Sulphur	%	0.782	1.58	2.55	5.18	0.940	2.02	1.10	4.74	1.99
Carbonate	%	2.92	<0.005	3.35	0.009	0.030	<0.005	0.048	0.031	4.72
Total Organic Carbon	%	0.865	0.035	2.05	0.190	4.09	1.31	4.54	1.49	6.70
Total Carbon	%	1.45	0.035	2.72	0.191	4.10	1.31	4.55	1.49	7.65
Sulphide Sulphur	%	0.37	0.73	0.43	1.43	0.38	0.78	0.27	1.83	0.25
Sulphate	%	0.8	2.1	8.1	9.9	1.2	3.0	1.0	7.3	3.4
Silver	mg/kg	< 2	< 2	2.7	4.2	< 2	< 2	< 2	3.6	< 2
Aluminum	mg/kg	1100	160	15000	2800	8600	9800	14000	12000	35000
Barium	mg/kg	80	39	100	170	61	150	600	130	87
Calcium	mg/kg	31000	8400	59000	42000	2000	10000	2000	28000	37000
Cobalt	mg/kg	16	10	230	30	10	26	26	130	330
Iron	mg/kg	11000	7500	240000	40000	380000	160000	470000	46000	240000
Potassium	mg/kg	320	140	1200	1100	370	950	210	950	440
Magnesium	mg/kg	1800	23	3100	120	510	1900	340	95	27000
Manganese	mg/kg	530	3.4	3600	27	230	120	210	14	6500
Sodium	mg/kg	35	8	500	55	38	34	28	45	110
Lead	mg/kg	290	200	480	680	330	420	230	1100	530
Selenium	mg/kg	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Uranium	mg/kg	29	3.6	1500	99	170	160	340	130	1200

Notes:
[a] Calculated from barium concentration
[b] Calculated from sulphur concentration

Table A2.1: Solids Data from the 2006 Field Sampling Program - Core Samples

	Sample ID	PSB-06-3 12.5-15	PW-06-1 0-5	PW-06-1 10-15	PW-06-2 0-10	PW-06-2 15-20	PW-06-3 0-10	PW-06-3 15-20
	Sample Date	05-Oct-06	23-Oct-06	23-Oct-06	24-Oct-06	24-Oct-06	24-Oct-06	24-Oct-06
Analysis	**Units**							
$BaSO_4$[a]	mg/kg	660	170	270	130	82	190	220
$BaSO_4$[b]	mg/kg	360	950	220	1460	440	800	73
Ra-226	Bq/g	0.61	1.0	7.8	1.2	4.6	1.9	9.6
Acid Volatile Sulphide	mg/L	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.2
COD	mg/kg	2110	13600	6560	16800	9650	8680	7910
Sulphur	%	4.36	5.13	2.99	3.39	3.08	0.945	2.25
Carbonate	%	11.0	0.058	0.023	0.014	0.018	0.015	0.007
Total Organic Carbon	%	1.27	9.37	6.66	8.15	0.753	3.62	0.280
Total Carbon	%	3.48	9.38	6.67	8.15	0.757	3.62	0.282
Sulphide Sulphur	%	0.10	1.81	2.26	2.34	2.83	0.27	1.68
Sulphate	%	12	0.7	0.5	0.6	1.1	0.4	< 0.4
Silver	mg/kg	< 2	< 2	4.5	< 2	< 2	< 2	< 2
Aluminum	mg/kg	12000	2200	2500	1800	1500	670	620
Barium	mg/kg	390	98	160	77	48	110	130
Calcium	mg/kg	160000	4700	2800	5600	4100	1800	280
Cobalt	mg/kg	90	36	65	34	34	6.7	27
Iron	mg/kg	220000	270000	110000	150000	110000	88000	47000
Potassium	mg/kg	240	430	690	360	250	290	230
Magnesium	mg/kg	17000	320	91	160	37	85	18
Manganese	mg/kg	850	82	24	49	11	17	7.3
Sodium	mg/kg	62	26	16	41	10	18	8
Lead	mg/kg	120	200	1500	170	320	560	570
Selenium	mg/kg	< 1	< 1	< 1	< 1	< 1	2	2
Uranium	mg/kg	120	50	220	47	46	9.4	24

Notes:
[a] Calculated from barium concentration
[b] Calculated from sulphur concentration

Table A2.2: Solids Data from the 2006 Field Sampling Program - Ponar Samples

Analysis	Units	Sample ID				
		PMB-1	PMB-2	PSB-3	PW-1	PW-3
Radium-226 Analysis (Ra-226)	Bq/g	2.6	10.8	18.6	3.7	11.8
Aluminum (Al)	mg/kg	1,696	14,529	15,346	4,002	5,510
Antimony (Sb)	mg/kg	1.4	1.2	1.1	1.1	1.7
Arsenic (As)	mg/kg	9.1	20.0	47.6	25.3	36.1
Barium (Ba)	mg/kg	56.2	128.5	141.9	42.5	189.4
Beryllium (Be)	mg/kg	0.2	1.3	0.8	0.4	0.2
Bismuth (Bi)	mg/kg	3.4	26.3	17.2	33.9	23.4
Boron (B)	mg/kg	4.6	15.3	3.3	6.1	6.2
Cadmium (Cd)	mg/kg	0.1	8.6	3.4	7.9	0.4
Calcium (Ca)	mg/kg	24,046	29,430	1,304	3,509	3,637
Chromium (Cr)	mg/kg	2.0	12.3	23.0	20.6	11.8
Cobalt (Co)	mg/kg	12.8	444.1	13.9	18.9	17.2
Copper (Cu)	mg/kg	30.8	65.7	97.1	103.1	88.3
Iron (Fe)	mg/kg	11,289	398,275	244,874	563,766	105,947
Lead (Pb)	mg/kg	84.6	315.8	388.1	210.2	803.8
Lithium (Li)	mg/kg	2.2	2.4	2.3	2.5	2.7
Magnesium (Mg)	mg/kg	70,945	144,359	140,537	186,219	308,055
Manganese (Mn)	mg/kg	112	2,357	128	74	23
Molybdenum (Mo)	mg/kg	2.1	2.4	180.4	1.4	8.6
Nickel (Ni)	mg/kg	14.4	361.2	21.6	25.8	32.2
Phosphorus (P)	mg/kg	102.1	423.4	425.7	489.4	893.4
Potassium (K)	mg/kg	125.2	490.2	705.1	333.8	529.0
Selenium (Se)	mg/kg	3.0	6.9	3.6	3.8	6.5
Silicon (Si)	mg/kg	756.7	5,246.0	3,149.2	3,781.4	1,060.0
Silver (Ag)	mg/kg	3.1	3.2	3.4	3.1	3.5
Sodium (Na)	mg/kg	178,114	430,499	354,096	500,160	786,660
Strontium (Sr)	mg/kg	9.8	16.8	5.4	4.5	8.8
Sulfur (S)	mg/kg	10,122	15,969	3,479	6,273	13,978
Thallium (Tl)	mg/kg	3.1	3.4	3.1	3.1	3.5
Tin (Sn)	mg/kg	6.5	9.6	9.3	7.3	20.8
Titanium (Ti)	mg/kg	33.3	241.9	223.4	318.5	233.5
Uranium (U)	mg/kg	13	1,977	232	33	19
Vanadium (V)	mg/kg	1.4	10.7	17.3	29.5	15.7
Zinc (Zn)	mg/kg	16	1,477	98	95	38
Sulphate	mg/kg	30,837	54,147	12,177	23,348	43,394

Table A2.3: Porewater Data from the 2006 Field Sampling Program

Sample ID	PMB-1	PMB-2	PSB-3	PW-1	PW-3
Units	(Bq/L or mg/L)	(Bq/L or mg/L)	(Bq/L or mg/L)	(Bq/L or mg/L)	(Bq/L or mg/L)
Analysis					
Radium-226	0.88	2.6	2	4.1	5.5
Aluminum	0.126	0.0055	0.0048	0.0090	0.0067
Antimony	0.00138	0.00003	0.00008	0.00003	0.00010
Arsenic	0.0079	0.0019	0.0206	0.0019	0.0042
Barium	0.0653	0.0420	0.0379	0.0916	0.211
Beryllium	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Bismuth	0.00003	<0.00001	<0.00001	0.00003	0.00007
Boron	0.053	0.177	0.076	0.027	0.022
Cadmium	0.000116	0.000010	0.000034	0.000009	0.000019
Calcium	241	519	191	56.4	53.4
Chromium	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Cobalt	0.0167	0.130	0.0178	0.000740	0.00399
Copper	0.0167	0.0021	0.0008	0.0011	0.0051
Iron	<0.01	12.4	185	6.20	2.00
Lead	0.00141	0.00022	0.00024	0.00075	0.00250
Lithium	<0.002	<0.002	0.003	<0.002	<0.002
Magnesium	5.90	38.6	15.1	2.93	4.96
Manganese	0.0318	7.13	5.73	0.163	0.0764
Molybdenum	0.0127	0.00045	0.00042	0.00015	0.00063
Nickel	0.698	0.115	0.0105	0.0024	0.0049
Phosphorous	0.03	0.06	0.08	0.07	0.14
Potassium	22.6	20.0	13.7	33.6	7.03
Selenium	0.005	0.004	0.002	<0.001	<0.001
Silicon	1.74	2.44	7.15	5.13	2.53
Silver	0.00006	<0.00001	<0.00001	<0.00001	<0.00001
Sodium	10.9	31.0	7.34	6.28	3.58
Strontium	0.341	0.388	0.217	0.0559	0.0827
Sulphur	188	501	299	17.9	25.1
Thallium	0.000032	<0.000002	<0.000002	<0.000002	0.000005
Tin	0.00005	<0.00001	<0.00001	<0.00001	<0.00001
Titanium	0.0004	0.0007	0.0003	0.0006	0.0010
Uranium	0.00514	0.887	0.0111	0.00414	0.00475
Vanadium	0.00079	0.00005	<0.00003	0.00013	0.00022
Zinc	<0.01	<0.01	0.02	<0.01	<0.01
Sulphate	564	1503	897	54	75

Table A2.4: Basin Water Data from the 2006 Field Sampling Program

	Sample ID	PMB-06-1 SI	PMB-06-2 SW	PMB-06-2 SI	PSB-06-1 SI	PSB-06-2 SW	PSB-06-2 SI	PSB-06-3 SI	PW-06-1 SW	PW-06-1 SI
	Sample Date	10-Oct-06	10-Oct-06	10-Oct-06	04-Oct-06	05-Oct-06	05-Oct-06	05-Oct-06	23-Oct-06	23-Oct-06
Analysis	**Units**									
Alkalinity	mg/L as $CaCO_3$	12	12	46	11	11	11	11	41	44
SO4	mg/L	310	310	440	230	220	230	220	5.8	6.0
H2S	mg/L	< 0.02	---	< 0.02	< 0.02	---	< 0.02	< 0.02	---	< 0.02
Ag	mg/L	0.0036	0.0034	< 0.0001	< 0.00003	< 0.00003	< 0.00003	< 0.00003	0.0126	0.0037
Al	mg/L	< 0.00003	< 0.00003	< 0.00003	< 0.01	0.02	0.02	0.01	< 0.00003	0.00005
Ba	mg/L	0.0136	0.0131	0.0214	0.0189	0.0176	0.0176	0.0176	0.0262	0.0279
Ca	mg/L	112	117	159	82.6	84.2	83.1	83.8	17.7	14.5
Co	mg/L	0.000087	0.000134	0.00973	0.000079	0.000018	0.001869	0.003382	0.00009	0.00008
Fe	mg/L	< 0.01	0.04	0.53	0.05	0.13	0.02	0.02	0.32	0.16
K	mg/L	10.2	10.3	13.4	7.58	7.34	7.49	7.56	0.39	0.43
Mg	mg/L	7.29	7.56	12.7	5.78	5.57	5.60	5.65	0.928	0.883
Na	mg/L	0.00116	0.0126	1.97	5.33	5.13	5.23	5.26	0.0043	0.0036
Mn	mg/L	7.89	8.04	10.3	0.00618	0.0171	0.00736	0.00561	0.71	0.67
Pb	mg/L	< 0.00002	< 0.00002	< 0.00002	< 0.00002	0.00038	< 0.00002	< 0.00002	0.00003	< 0.00002
S	mg/L	< 0.003	< 0.003	< 0.003	70.9	71.9	71.0	71.0	< 0.003	< 0.003
Se	mg/L	95.1	98.2	134	< 0.003	< 0.003	< 0.003	< 0.003	2.21	2.26
U	mg/L	0.00715	0.00767	0.0576	0.00259	0.00290	0.00268	0.00255	0.0001	0.0002

Notes:
SW - Basin Water sample - collected from top of water column
SI - Solids-Water Interface sample

APPENDIX 3

Detailed Data Quality Assessment

Table A3.1: Detailed Data Quality Assessment for Constituents in Solids

Analysis	Units	Method Detection Limit	RPD Data Quality Objective	Sample ID	Duplicate ID	RPD (%) or AD	Sample ID	Duplicate ID	RPD (%) or AD	Sample ID	Replicate ID	RPD (%) or AD	Sample ID	Replicate ID	RPD (%) or AD	Sample ID	Replicate ID	RPD (%) or AD
				CORE 09-PSB-2 (5-10)	CORE 09-EC-1 (0-5)		CORE 09-SR-4 (10-15)	CORE 09-EC-1 (5-10)		CORE 09-QC14-2 (0-2.5)	CORE 09-EC-2 (0-2.5)		CORE 09-QC14-2 (2.5-5)	CORE 09-EC-2 (2.5-5)		CORE 09-QC14-2 (5-7.5)	CORE 09-EC-2 (5-7.5)	
Conventional Parameters																		
Sulphur (S)	%	0.005	≤ 40%	1.57	1.17	29	1.00	0.762	27	0.633	0.628	1	0.885	1.03	15	0.871	1.18	30
Carbonate (CO_3)	%	0.005	≤ 40%	0.097	0.058	**50**	0.419	0.280	40	<0.005	<0.005	BD	<0.005	<0.005	BD	<0.005	<0.005	BD
Total Organic Carbon (TOC)	%	0.01	≤ 40%	9.78	10.5	7	16.8	16.7	1	0.519	0.617	17	0.289	0.206	34	0.121	0.090	29
Total Carbon (C)	%	0.005	≤ 40%	9.80	10.5	7	16.9	16.8	1	0.519	0.616	17	0.289	0.207	33	0.121	0.089	30
Sulphide	%	0.01	≤ 40%	0.36	0.47	27	0.65	0.70	7	0.52	0.53	2	0.77	1.04	30	0.84	1.07	24
Sulphate (SO_4)	%	0.1	≤ 40%	0.6	0.3	**0.3**	0.2	0.1	0.1	0.1	0.1	0	0.1	0.1	0	0.1	0.1	0
Metals																		
Radium-226 (Ra-226)	Bq/g	0.01	≤ 40%	4.5	4.1	9	2.1	1.6	27	4.3	7.0	**48**	6.5	8.3	24	9.3	20.0	**73**
Silver (Ag)	mg/kg	0.7	≤ 40%	<0.7	<0.7	BD	<0.7	<0.7	BD	0.8	1.5	**1**	1.0	1.2	0.2	1.1	1.1	0
Aluminum (Al)	mg/kg	1	≤ 40%	3600	3800	5	5600	5800	4	830	1500	**58**	690	1200	**54**	850	890	5
Arsenic (As)	mg/kg	1	≤ 40%	14	14	0	26	26	0	17	22	26	19	24	23	21	24	13
Barium (Ba)	mg/kg	0.05	≤ 40%	160	94	**52**	440	450	2	150	280	**60**	220	370	**51**	330	310	6
Beryllium (Be)	mg/kg	0.1	≤ 40%	0.34	0.35	0.01	0.12	0.13	0.01	0.28	0.51	**0.23**	0.28	0.41	0.1	0.34	0.34	0
Bismuth (Bi)	mg/kg	0.5	≤ 40%	11	12	9	<0.5	<0.5	BD	7.5	11	38	9.2	8.6	7	8.5	7.8	9
Calcium (Ca)	mg/kg	1	≤ 40%	7600	4600	**49**	7300	7400	1	190	230	19	130	110	17	79	63	23
Cadmium (Cd)	mg/kg	0.05	≤ 40%	4.5	4.0	12	1.8	1.8	0	0.18	0.25	33	0.22	0.27	20	0.22	0.29	27
Cerium (Ce)	mg/kg	0.006	≤ 40%	220	240	9	840	800	5	300	340	13	290	300	3	280	240	15
Cobalt (Co)	mg/kg	0.3	≤ 40%	15	15	0	16	17	6	15	16	6	18	21	15	17	22	26
Chromium (Cr)	mg/kg	0.5	≤ 40%	6.5	7.8	18	17	17	0	4.7	8.2	**54**	4.9	6.5	28	5.7	5.8	2
Cesium (Cs)	mg/kg	0.01	≤ 40%	0.97	1.1	13	0.87	0.90	3	0.18	0.32	**56**	0.22	0.20	10	0.31	0.19	**48**
Copper (Cu)	mg/kg	0.1	≤ 40%	14	15	7	56	56	0	43	50	15	46	54	16	42	54	25
Iron (Fe)	mg/kg	0.5	≤ 40%	240000	240000	0	12000	16000	29	10000	13000	26	12000	17000	34	13000	19000	38
Gallium (Ga)	mg/kg	0.03	≤ 40%	2.4	2.7	12	6.6	6.5	2	2.1	2.8	29	2.1	2.4	13	2.0	1.9	5
Germanium (Ge)	mg/kg	0.3	≤ 40%	7.2	7.2	0	3.8	4.0	5	1.2	1.4	0.2	1.2	1.4	0.2	1.2	1.2	0
Hafnium (Hf)	mg/kg	0.1	≤ 40%	0.1	0.1	0	0.6	0.9	40	0.3	0.5	**0.2**	0.6	0.7	15	1.0	0.7	35
Indium (In)	mg/kg	0.01	≤ 40%	<0.01	<0.01	BD	<0.01	0.01	BD	<0.01	0.02	BD	<0.01	0.01	BD	0.01	0.01	0
Potassium (K)	mg/kg	1	≤ 40%	190	210	10	270	270	0	210	330	44	230	300	26	250	230	8
Lanthanum (La)	mg/kg	0.001	≤ 40%	110	130	17	430	420	2	170	190	11	170	170	0	160	140	13
Lithium (Li)	mg/kg	0.1	≤ 40%	0.9	0.9	0	1.1	1.3	17	0.2	0.8	**120**	0.1	0.5	**0.4**	0.4	0.2	**0.2**
Lutetium (Lu)	mg/kg	0.001	≤ 40%	0.98	1.1	12	5.3	5.3	0	0.081	0.14	**53**	0.048	0.060	22	0.031	0.038	20
Magnesium (Mg)	mg/kg	1	≤ 40%	360	240	40	1400	1500	7	88	110	22	46	38	19	25	18	33
Manganese (Mn)	mg/kg	0.05	≤ 40%	89	84	6	180	180	0	13	18	32	8.6	7.6	12	4.7	4.6	2
Molybdenum (Mo)	mg/kg	0.5	≤ 40%	10	10	0	3.6	3.9	8	5.3	6.4	19	5.2	6.1	16	7.9	5.5	36
Sodium (Na)	mg/kg	1	≤ 40%	35	40	13	59	55	7	8	11	32	7	8	13	6	5	1
Niobium (Nb)	mg/kg	0.7	≤ 40%	2.8	2.7	4	0.8	<0.7	BD	7.0	9.7	32	8.2	7.8	5	8.4	7.5	11
Nickel (Ni)	mg/kg	1	≤ 40%	17	19	11	43	43	0	8	9	12	8	10	22	8	11	32
Lead (Pb)	mg/kg	0.7	≤ 40%	270	280	4	640	640	0	180	240	29	260	270	4	270	310	14
Phosphorous (P)	mg/kg	5	≤ 40%	740	810	9	340	360	6	260	400	**42**	300	360	18	360	330	9
Rubidium (Rb)	mg/kg	0.004	≤ 40%	2.1	2.5	17	4.0	4.0	0	1.9	2.6	31	1.9	2.0	5	1.8	1.4	25
Antimony (Sb)	mg/kg	1	≤ 40%	<1	<1	BD	<1	<1	BD	<1	1	BD	<1	<1	BD	<1	<1	BD
Scandium (Sc)	mg/kg	0.2	≤ 40%	1.3	1.6	21	2.7	3.0	11	0.5	0.9	**57**	0.4	0.8	**67**	0.5	0.6	0.1
Selenium (Se)	mg/kg	1	≤ 40%	<1	<2	BD	<1	<2	BD	<2	<2	BD	<2	<2	BD	<2	<2	BD
Tin (Sn)	mg/kg	6	≤ 40%	<6	<6	BD	<6	<6	BD	<6	<6	BD	<6	<6	BD	<6	<6	BD
Strontium (Sr)	mg/kg	0.01	≤ 40%	7.6	7.9	4	14	14	0	3.6	5.1	34	4.1	5.4	27	4.8	4.6	4
Sulphur (S)	mg/kg	1	≤ 40%	--	15000	--	11000	11000	0	6500	6700	3	8700	11000	23	8600	12000	33
Tantalum (Ta)	mg/kg	0.01	≤ 40%	0.05	0.05	0	0.15	0.23	**42**	0.04	0.07	**55**	0.05	0.12	**82**	0.12	0.28	**80**
Terbium (Tb)	mg/kg	0.01	≤ 40%	3.9	4.3	10	35	33	6	0.97	1.4	36	0.83	0.90	8	0.68	0.67	1
Tellurium (Te)	mg/kg	0.1	≤ 40%	0.1	0.1	0	<0.1	<0.1	BD	0.1	0.2	0.1	0.2	0.2	0	0.2	0.2	0
Thorium (Th)	mg/kg	0.01	≤ 40%	110	120	9	85	89	5	310	560	**57**	310	470	41	360	380	5
Titanium (Ti)	mg/kg	0.2	≤ 40%	82	91	10	210	220	5	210	330	**44**	250	260	4	260	240	8
Thallium (Tl)	mg/kg	3	≤ 40%	<3	<3	BD	<3	<3	BD	<3	<3	BD	<3	<3	BD	<3	<3	BD
Uranium (U)	mg/kg	3	≤ 40%	210	230	9	110	150	31	17	23	30	17	18	6	13	15	2
Vanadium (V)	mg/kg	0.1	≤ 40%	25	26	4	16	17	6	2.7	4.0	39	2.7	2.7	0	2.7	2.4	12
Tungsten (W)	mg/kg	1	≤ 40%	2	79	**190**	<1	5	BD	3	5	**2**	4	5	1	5	6	18
Yttrium (Y)	mg/kg	0.1	≤ 40%	78	84	7	740	750	1	9.1	12	27	6.8	6.7	1	5.5	5.2	6
Ytterbium (Yb)	mg/kg	0.1	≤ 40%	7.4	8.7	16	45	46	2	0.74	1.2	**47**	0.46	0.57	21	0.33	0.40	0.07
Zinc (Zn)	mg/kg	0.1	≤ 40%	64	65	2	55	58	5	8.8	8.9	1	6.9	8.0	15	4.7	5.8	21
Zirconium (Zr)	mg/kg	5	≤ 40%	6	6	0	6	<5	BD	20	30	40	26	27	4	28	26	7

Notes:
RPD - relative percent difference; is calculated for analytes with concentrations greater than or equal to five times the detection limit and should be less than or equal to 40%
AD - absolute difference; for samples having concentrations less than five times the detection limit, the difference between the sample and duplicate, or difference between the sample or duplicate and the detection limit if either the sample or duplicate analyte concentration is below detection limit; should not be greater then the detection limit
BD - Sample and/or replicate had analyte concentrations below detection limit
Boldface type and shaded indicates that Data Quality Objective was not achieved

Table A3.2: Detailed Data Quality Assessment for Constituents in Waters

Analysis	Units	Method Detection Limit	RPD Data Quality Objective	Sample ID SW09-SR-4B	Duplicate ID PW09-EC-1 (0-5)	RPD (%) or AD	Sample ID PW09-QC14-3 (0-5)	Duplicate ID PW09-QC14-4 (0-5)	Dupicate ID PW09-EC-1 (5-10)	RPD (%) or AD	Sample ID SW09-QC14-2T	Replicate ID SW09-EC-2T	RPD (%) or AD	Sample ID SW09-QC14-2B	Replicate ID SW09-EC-2B	RPD (%) or AD	Sample ID PW09-QC14-2 (0-2.5)	Replicate ID PW09-EC-2 (0-2.5)	RPD (%) or AD	Sample ID PW09-QC14-2 (2.5-5)	Replicate ID PW09 EC2 2.5-5	RPD (%) or AD	Sample ID PW09-QC14-2 (5-7.5)	Replicate ID PW09 EC2 5-7.5	RPD (%) or AD
Conventional Parameters																									
Acidity (as $CaCO_3$)	mg/L	2	≤ 20%	<2.0	--	--	6	19	--	--	56	67	18	15	16	6	21	17	**21**	15	16	6	16	--	--
Dissolved Inorganic Carbon (DIC)	mg/L	0.2	≤ 20%	1.4	--	--	2.0	<1.0	--	BD	<1.0	<1.0	BD	<1.0	<1.0	BD	<1.0	4.2	BD	<1.0	1.1	BD	<1.0	--	BD
Dissolved Organic Carbon (DOC)	mg/L	0.2	≤ 20%	2.0	--	--	3.5	9.3	--	--	14.4	11.4	**23**	19.4	11.7	**50**	28	19	**38**	18.3	14.3	**25**	17.9	--	--
Sulphate (SO_4)	mg/L	0.2	≤ 20%	25	--	--	5.6	512	--	--	72	85	17	32	36	12	32	27	17	12	18	**40**	12	--	--
Hardness (as $CaCO_3$)	mg/L	0.5	≤ 20%	33.4	33.9	1	18	NC	17.8	1	16.9	17	1	16.6	16.8	1	26.2	21.7	19	16.9	16	5	17.9	16.4	9
Metals																									
Radium-226 (Ra-226)	Bq/L	0.01	≤ 20%	0.30	0.30	0	NC	4.1	4.7	14	0.82	0.78	5	0.91	0.85	7	3.6	2.9	**22**	2.8	3.3	16	5.9	5.4	9
Aluminum (Al)	mg/L	0.01	≤ 20%	<0.01	<0.01	BD	<0.01	NC	<0.01	BD	<0.01	0.03	BD	<0.01	<0.01	BD	<0.01	<0.01	BD	0.03	<0.01	BD	<0.01	<0.01	BD
Arsenic (As)	mg/L	0.0002	≤ 20%	0.0007	0.0006	0.0001	0.0026	NC	0.0024	8	0.0006	0.0007	0.0001	0.0011	0.0007	**0.0004**	0.0064	0.0058	10	0.0084	0.0046	**58**	0.0066	0.0065	2
Barium (Ba)	mg/L	0.00001	≤ 20%	0.222	0.221	0	0.333	NC	0.335	1	0.104	0.108	4	0.108	0.114	5	0.309	0.285	8	0.308	0.337	9	0.519	0.487	6
Beryllium (Be)	mg/L	0.00002	≤ 20%	<0.00002	<0.00002	BD	0.00013	NC	<0.00002	BD	<0.00002	0.00003	BD	<0.00002	0.00002	BD	<0.00002	<0.00002	BD	<0.00002	<0.00002	BD	<0.00002	<0.00002	BD
Boron (B)	mg/L	0.0002	≤ 20%	0.0089	0.0082	8	0.0026	NC	0.0028	0.0002	0.0045	0.0076	**51**	0.0056	0.0072	**25**	0.0054	0.0039	**32**	0.0047	0.0034	**32**	0.0051	0.0039	**27**
Bismuth (Bi)	mg/L	0.00001	≤ 20%	0.00001	<0.00001	BD	0.00012	NC	<0.00001	BD	<0.00001	0.00002	BD	<0.00001	0.00002	BD	0.00003	0.00003	0	0.00024	0.00006	**120**	0.00006	0.00003	**0.00003**
Calcium (Ca)	mg/L	0.03	≤ 20%	11.2	11.4	2	6.12	NC	6.06	1	5.69	5.69	0	5.55	5.63	1	8.79	7.28	19	5.68	5.35	6	6.06	5.54	9
Cadmium (Cd)	mg/L	0.000003	≤ 20%	0.000028	0.000012	0.000016	0.000112	NC	<0.000003	BD	0.000023	0.000046	**67**	0.000023	0.000056	**84**	0.000055	0.000031	**56**	<0.000003	0.000012	BD	0.000005	0.000009	**0.000004**
Cobalt (Co)	mg/L	0.000002	≤ 20%	0.00031	0.000321	3	0.00189	NC	0.00192	2	0.00549	0.00655	18	0.00169	0.00196	15	0.00521	0.00289	**57**	0.000917	0.0012	**27**	0.000766	0.00183	**82**
Chromium (Cr)	mg/L	0.0005	≤ 20%	<0.0005	<0.0005	BD	<0.0005	NC	<0.0005	BD	<0.0005	<0.0005	BD	<0.0005	<0.0005	BD	<0.0005	<0.0005	BD	<0.0005	<0.0005	BD	<0.0005	<0.0005	BD
Copper (Cu)	mg/L	0.0005	≤ 20%	0.0011	0.001	0.0001	<0.0005	NC	<0.0005	BD	0.0038	0.0037	3	0.0023	0.0029	**23**	0.0043	0.0018	**0.0025**	0.0025	0.0018	**0.0007**	0.0015	0.0011	**31**
Iron (Fe)	mg/L	0.01	≤ 20%	0.08	0.07	13	7.18	NC	6.63	8	0.04	0.07	**55**	0.01	0.04	**0.03**	0.03	0.44	**174**	0.52	3.3	**146**	2.46	5.71	**80**
Potassium (K)	mg/L	0.01	≤ 20%	0.80	0.80	0	0.37	NC	0.58	**44**	0.32	0.31	3	0.26	0.32	**21**	0.34	0.3	13	0.4	0.34	16	0.62	0.48	**25**
Lithium (Li)	mg/L	0.002	≤ 20%	<0.002	<0.002	BD	<0.002	NC	<0.002	BD	<0.002	<0.002	BD	<0.002	<0.002	BD	<0.002	<0.002	BD	<0.002	<0.002	BD	<0.002	<0.002	BD
Magnesium (Mg)	mg/L	0.003	≤ 20%	1.29	1.31	2	0.67	NC	0.655	2	0.663	0.67	1	0.657	0.663	1	1.02	0.864	17	0.664	0.634	5	0.675	0.632	7
Manganese (Mn)	mg/L	0.00001	≤ 20%	0.119	0.12	1	0.143	NC	0.142	1	0.0288	0.0315	9	0.0353	0.0319	10	0.282	0.217	**26**	0.133	0.134	1	0.133	0.132	1
Molybdenum (Mo)	mg/L	0.00001	≤ 20%	0.00032	0.00029	10	0.00045	NC	0.00051	13	<0.00001	0.00018	BD	0.00002	0.00008	**120**	0.00029	0.00015	**64**	0.00133	0.00116	14	0.00107	0.00149	**33**
Sodium (Na)	mg/L	0.01	≤ 20%	2.79	2.75	1	1.3	NC	1.24	5	1.82	1.59	13	1.83	1.58	15	2.35	2.2	7	1.98	1.87	6	1.79	1.5	18
Nickel (Ni)	mg/L	0.0001	≤ 20%	0.0006	0.0008	**29**	0.001	NC	0.001	0	0.0025	0.0022	13	0.0024	0.0022	9	0.0044	0.0024	**59**	0.0012	0.0013	8	0.0012	0.0017	**34**
Lead (Pb)	mg/L	0.00002	≤ 20%	0.00043	0.00023	**61**	0.00029	NC	0.00016	**58**	0.00717	0.00699	3	0.00597	0.00391	**42**	0.0242	0.00216	**167**	0.00596	0.0009	**148**	0.00098	0.00049	**67**
Phosphorous (P)	mg/L	0.01	≤ 20%	<0.01	<0.01	BD	<0.01	NC	<0.01	BD	0.01	<0.01	BD	<0.01	<0.01	BD	<0.01	0.07	BD	0.01	0.01	0	0.01	<0.01	BD
Antimony (Sb)	mg/L	0.0002	≤ 20%	0.0002	<0.0002	BD	<0.0002	NC	<0.0002	BD	0.0077	0.0086	11	0.0007	0.0016	**78**	0.0002	0.0003	0.0001	0.0006	<0.0002	BD	0.0004	<0.0002	BD
Selenium (Se)	mg/L	0.001	≤ 20%	<0.001	<0.001	BD	<0.001	NC	<0.001	BD	<0.001	<0.001	BD	<0.001	<0.001	BD	<0.001	<0.001	BD	<0.001	<0.001	BD	<0.001	<0.001	BD
Sulphur (S)	mg/L	0.01	≤ 20%	8.58	7.26	17	1.67	NC	1.58	6	4.69	4.64	1	4.74	4.63	2	8.28	6.26	**28**	3.87	3.35	14	3.61	4.21	15
Silicon (Si)	mg/L	0.01	≤ 20%	0.73	0.72	1	5.18	NC	5.07	2	0.58	0.59	2	0.59	0.6	2	1.23	1.42	14	1.71	1.86	8	2.15	2.71	**23**
Tin (Sn)	mg/L	0.00001	≤ 20%	0.00016	<0.00001	BD	<0.00001	NC	0.00002	BD	<0.00001	<0.00001	BD	<0.00001	<0.00001	BD	0.00004	0.00017	**124**	<0.00001	<0.00001	BD	<0.00001	0.00001	BD
Strontium (Sr)	mg/L	0.0001	≤ 20%	0.0268	0.0269	0	0.017	NC	0.0168	1	0.0121	0.0122	1	0.012	0.0122	2	0.0205	0.0168	20	0.0154	0.0149	3	0.0204	0.0187	9
Titanium (Ti)	mg/L	0.0001	≤ 20%	0.0001	<0.0001	BD	0.0003	NC	0.0003	0	0.0003	0.0004	0.0001	<0.0001	0.0001	BD	0.0003	0.0007	**80**	0.0062	0.0004	**0.0058**	0.0005	0.0002	**0.0003**
Thallium (Tl)	mg/L	0.0002	≤ 20%	<0.0002	<0.0002	BD	<0.0002	NC	<0.0002	BD	<0.0002	<0.0002	BD	<0.0002	<0.0002	BD	<0.0002	<0.0002	BD	<0.0002	<0.0002	BD	<0.0002	<0.0002	BD
Uranium (U)	mg/L	0.000001	≤ 20%	0.00122	0.000835	**37**	0.000744	NC	0.000671	10	0.000535	0.000654	20	0.000338	0.00079	**80**	0.000946	0.000173	**138**	0.000524	0.000115	**128**	0.000143	0.000105	**31**
Vanadium (V)	mg/L	0.00003	≤ 20%	0.00008	0.00007	0.00001	0.00019	NC	0.00005	**0.00014**	0.00006	0.00007	0.00001	0.00005	0.00007	0.00002	0.00007	0.00008	0.00001	0.00013	0.00007	**0.00006**	0.00006	0.00004	0.00002
Zinc (Zn)	mg/L	0.001	≤ 20%	0.004	0.003	0.001	0.002	NC	0.001	0.001	0.002	0.004	0.002	0.005	0.005	0	0.005	0.005	0	0.003	0.004	0.001	0.002	0.003	0.001

Notes:

RPD - relative percent difference; is calculated for analytes with concentrations greater than or equal to five times the detection limit and should be less than or equal to 40%

AD - absolute difference; for samples having concentrations less than five times the detection limit, the difference between the sample and duplicate, or difference between the sample or duplicate and the detection limit if either the sample or duplicate analyte concentration is below detection limit; should not be greater then the detection limit

BD - Sample and/or replicate had analyte concentrations below detection limit

"--" Indicates parameter was not analysed

"NC" Indicates that parameter in the sample was not compared to the duplicate/replicate sample in the data quality assessment

Boldface type and shaded indicates that Data Quality Objective was not achieved

Table A3.3: Detailed Data Quality Assessment for Constituents in the Blank Sample

Analysis	Units	Detection Limit	Data Quality Objective	Blank
Convential Parameters				
Acidity (as $CaCO_3$)	mg/L	2	4	**7**
Total Inorganic Carbon (DIC)	mg/L	1.0	2.0	<1.0
Total Organic Carbon (DOC)	mg/L	1.0	2.0	**2.4**
Sulphate (SO_4)	mg/L	2	4	<2
Hardness (as $CaCO_3$)	mg/L	0.5	1.0	<0.5
Metals				
Radium-226 (Ra-226)	Bq/L	0.01	0.02	<0.01
Aluminum (Al)	mg/L	0.01	0.02	<0.01
Arsenic (As)	mg/L	0.0002	0.0004	<0.0002
Barium (Ba)	mg/L	0.00001	0.00002	**0.00216**
Beryllium (Be)	mg/L	0.00002	0.00004	<0.00002
Boron (B)	mg/L	0.0002	0.0004	<0.0002
Bismuth (Bi)	mg/L	0.00001	0.00002	<0.00001
Calcium (Ca)	mg/L	0.03	0.06	0.03
Cadmium (Cd)	mg/L	0.000003	0.000006	<0.000003
Cobalt (Co)	mg/L	0.000002	0.000004	0.000003
Chromium (Cr)	mg/L	0.0005	0.0010	<0.0005
Copper (Cu)	mg/L	0.0005	0.0010	**0.0053**
Iron (Fe)	mg/L	0.01	0.02	<0.01
Potassium (K)	mg/L	0.01	0.02	<0.01
Lithium (Li)	mg/L	0.002	0.004	<0.002
Magnesium (Mg)	mg/L	0.003	0.006	<0.003
Manganese (Mn)	mg/L	0.00001	0.00002	**0.00034**
Molybdenum (Mo)	mg/L	0.00001	0.00002	<0.00001
Sodium (Na)	mg/L	0.01	0.02	**0.15**
Nickel (Ni)	mg/L	0.0001	0.0002	**0.0003**
Lead (Pb)	mg/L	0.00002	0.00004	<0.00002
Phosphorous (P)	mg/L	0.01	0.02	<0.01
Antimony (Sb)	mg/L	0.0002	0.0004	<0.0002
Selenium (Se)	mg/L	0.001	0.002	<0.001
Sulphur (S)	mg/L	0.01	0.02	**0.05**
Silicon (Si)	mg/L	0.01	0.02	<0.01
Tin (Sn)	mg/L	0.00001	0.00002	<0.00001
Strontium (Sr)	mg/L	0.0001	0.0002	0.0001
Titanium (Ti)	mg/L	0.0001	0.0002	<0.0001
Thallium (Tl)	mg/L	0.0002	0.0004	<0.0002
Uranium (U)	mg/L	0.000001	0.000002	<0.000001
Vanadium (V)	mg/L	0.00003	0.00006	<0.00003
Zinc (Zn)	mg/L	0.001	0.002	<0.001

Notes:
Boldface type and shaded indicates that Data Quality Objective was not achieved

Table A3.4: Data Quality Analysis of Basin Water pH and Acidity Values Sampled in September 2009

Sample ID	Depth Below Surface	pH	Acidity
	(m)	(pH units)	(mg/L as $CaCO_3$)
Average Value at P-21		**7.1**	**<1.0**
Average Value at P-13		**7.0**	**<1.0**
SW09-PSB-1T[a]	0	7.1	--
SW09-PSB-1B	8	6.2	20
SW09-PSB-2T	0	6.9	<2
SW09-PSB-2B	4	4.2	15

Notes:
Average pH and acidity values were calcuated from the routine monitoring data from 2006 through 2009
T - indicates sample from the top of water column
B - indicates sample from the sediment-water interface
[a] SW09-PSB-1T was not analysed for acidity because pH value was greater than 7.0
Basin Water pH data collected in 2009 was rejected because of anomalous pH and acidity values

APPENDIX 4

Certificates of Analysis for the 2009 Field Data

ANALYSIS REPORT

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Batch: T09-01485.0

Date: 12-Nov-2009

Lakefield Research Ltd.

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attn: Brian Graham

Phone: (705) 652-2038
FAX: (705) 652-1918

Client Ref.
Sep 10524.R09
P.O: 17820

9 rock samples Sampled: 22-Sep-2009 Received: 21-Oct-2009 Page 1 of 1

Results of Analysis

Sample	Test	Result	Units	Date	Method
CORE 09-PSB-1 0-2.5	Ra-226	12	Bq/g	07-Nov-2009	ALPHA
CORE 09-PSB-1 2.5-5	Ra-226	4.9	Bq/g	07-Nov-2009	ALPHA
CORE 09-PSB-1 5-7.5	Ra-226	1.6	Bq/g	07-Nov-2009	ALPHA
CORE 09-PSB-1 7.5-10	Ra-226	2.8	Bq/g	07-Nov-2009	ALPHA
CORE 09-PSB-1 10-15	Ra-226	2.2	Bq/g	08-Nov-2009	ALPHA
CORE 09-PSB-2 0-5	Ra-226	16	Bq/g	08-Nov-2009	ALPHA
CORE 09-PSB-2 5-10	Ra-226	4.5	Bq/g	08-Nov-2009	ALPHA
CORE 09-PSB-2 10-15	Ra-226	5.6	Bq/g	08-Nov-2009	ALPHA
CORE 09-PSB-2 15-20	Ra-226	14	Bq/g	08-Nov-2009	ALPHA

Methods: ALPHA BQ-RAD-ALPHA alpha-particle spectrometry

Units: Bq/g Becquerels per gram

These results relate only to the samples analysed and only to the items tested.

12-Nov-2009 approved by: S. Seg
for Donald D. Burgess PhD
Senior Scientist, Division Supervisor

NOV 24 2009

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Tuesday, October 27, 2009

Date Rec. : 30 September 2009
LR. Ref. : **CA10524-SEP09**
Project : 09-1663

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CERTIFICATE OF ANALYSIS

Final Report

Analysis	**3: Analysis Approval Date**	**4: Analysis Approval Time**	**5: CORE 09-PSB-1 0-2.5**	**6: CORE 09-PSB-1 2.5-5**	**7: CORE 09-PSB-1 5-7.5**	**8: CORE 09-PSB-1 7.5-10**
Sample Date & Time			22-Sep-09	22-Sep-09	22-Sep-09	22-Sep-09
BaSO4 Calc. using Ba* [µg/g]	---	---	2210	870	680	610
BaSO4 Calc. using SO4** [µg/g]	---	---	14600	238000	330000	381000
Total Sulphur [%]	06-Oct-09	14:44	0.698	3.33	4.55	5.14
Carbonate (CO3) [%]	06-Oct-09	14:42	9.43	11.7	6.45	10.7
Total Organic Carbon [%]	06-Oct-09	14:42	2.25	0.940	0.380	0.260
Total Carbon [%]	06-Oct-09	14:45	4.14	3.27	1.67	2.41
Sulphide [%]	07-Oct-09	16:00	0.43	0.18	0.11	< 0.01
Sulphate [%]	23-Oct-09	10:29	0.6	9.8	14	16
Silver [µg/g]	14-Oct-09	14:09	< 0.7	< 0.7	< 0.7	< 0.7
Aluminum [µg/g]	14-Oct-09	14:09	15000	11000	13000	8400
Arsenic [µg/g]	14-Oct-09	14:09	37	24	27	18
Barium [µg/g]	14-Oct-09	14:09	1300	510	400	360
Beryllium [µg/g]	14-Oct-09	14:09	1.1	0.88	1.2	0.82
Bismuth [µg/g]	14-Oct-09	14:09	13	8.9	6.6	5.4
Calcium [µg/g]	14-Oct-09	14:09	67000	140000	140000	180000
Cadmium [µg/g]	14-Oct-09	14:09	3.8	2.5	2.5	2.0
Cerium [µg/g]	13-Oct-09	15:45	690	510	690	440
Cobalt [µg/g]	14-Oct-09	14:09	98	79	100	69
Chromium [µg/g]	14-Oct-09	14:09	16	13	15	10
Cesium [µg/g]	13-Oct-09	15:45	19	0.55	0.24	0.19
Copper [µg/g]	14-Oct-09	14:09	55	33	43	26
Iron [µg/g]	14-Oct-09	14:09	190000	140000	140000	110000
Gallium [µg/g]	13-Oct-09	15:45	7.3	4.5	4.3	2.8
Germanium [µg/g]	13-Oct-09	15:45	6.5	4.9	5.5	4.0
Hafnium [µg/g]	13-Oct-09	15:45	0.5	0.5	0.4	0.3
Indium [µg/g]	13-Oct-09	15:45	0.01	< 0.01	0.01	< 0.01
Potassium [µg/g]	14-Oct-09	14:09	310	220	130	150
Lanthanum [µg/g]	13-Oct-09	15:45	380	280	380	240
Lithium [µg/g]	14-Oct-09	14:09	9.9	7.3	3.6	4.5

OnLine LIMS

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LR Report : CA10524-SEP09

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: CORE 09-PSB-1 0-2.5	6: CORE 09-PSB-1 2.5-5	7: CORE 09-PSB-1 5-7.5	8: CORE 09-PSB-1 7.5-10
Lutetium [μg/g]	13-Oct-09	15:45	3.0	2.6	3.3	2.2
Magnesium [μg/g]	14-Oct-09	14:09	9900	13000	9900	9000
Manganese [μg/g]	14-Oct-09	14:09	1600	750	770	660
Molybdenum [μg/g]	14-Oct-09	14:09	34	11	1.5	0.6
Sodium [μg/g]	14-Oct-09	14:09	62	48	29	40
Niobuim [μg/g]	13-Oct-09	15:45	3.3	2.3	1.7	1.3
Nickel [μg/g]	14-Oct-09	14:09	90	63	64	44
Lead [μg/g]	14-Oct-09	14:09	280	150	96	78
Phosphorus [μg/g]	14-Oct-09	14:09	280	150	110	120
Rubidium [μg/g]	13-Oct-09	15:44	2.5	1.4	0.63	0.58
Antimony [μg/g]	14-Oct-09	14:08	< 1	< 1	< 1	< 1
Scandium [μg/g]	13-Oct-09	15:44	2.1	1.4	1.4	1.0
Selenium [μg/g]	14-Oct-09	14:08	< 1	< 1	< 1	< 1
Tin [μg/g]	14-Oct-09	14:08	< 6	< 6	< 6	< 6
Strontium [μg/g]	14-Oct-09	14:08	30	30	23	35
Tantalum [μg/g]	13-Oct-09	15:44	0.10	0.09	0.07	0.06
Terbium [μg/g]	13-Oct-09	15:44	12	9.8	12	8.2
Tellerium [μg/g]	13-Oct-09	15:44	0.2	0.1	0.1	< 0.1
Thorium [μg/g]	13-Oct-09	15:44	350	300	420	290
Titanium [μg/g]	14-Oct-09	14:08	230	150	100	73
Thallium [μg/g]	14-Oct-09	14:08	< 3	< 3	< 3	< 3
Uranium [μg/g]	13-Oct-09	15:44	370	160	110	75
Vanadium [μg/g]	14-Oct-09	14:08	15	9.2	8.0	5.8
Tungsten [μg/g]	14-Oct-09	14:05	5	2	< 1	< 1
Yttrium [μg/g]	14-Oct-09	14:05	270	220	280	200
Ytterbium [μg/g]	13-Oct-09	15:44	23	20	25	17
Zinc [μg/g]	14-Oct-09	14:05	210	130	110	87
Zirconium [μg/g]	15-Oct-09	10:44	14	10	8	6

Ra226 subcontracted to Becquerel Labs.
* BaSO4 Calculation based on Ba values and assumes all Ba is in BaSO4 form.
** BaSO4 Calculation based on SO4 values and assumes all SO4 is in BaSO4 form.

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Tuesday, October 27, 2009

Date Rec. : 30 September 2009
LR. Ref. : **CA10524-SEP09**
Project : 09-1663

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CERTIFICATE OF ANALYSIS

Final Report

Analysis	**9: CORE 09-PSB-1 10-15**	**10: CORE 09-PSB-2 0-5**	**11: CORE 09-PSB-2 5-10**	**12: CORE 09-PSB-2 10-15**	**13: CORE 09-PSB-2 15-20**
Sample Date & Time	22-Sep-09	23-Sep-09	23-Sep-09	23-Sep-09	23-Sep-09
BaSO4 Calc. using Ba* [µg/g]	540	580	270	310	320
BaSO4 Calc. using SO4** [µg/g]	418000	19400	14600	12100	14600
Total Sulphur [%]	5.96	1.31	1.57	2.00	2.23
Carbonate (CO3) [%]	9.65	0.170	0.097	0.052	0.071
Total Organic Carbon [%]	0.130	6.97	9.78	15.2	9.61
Total Carbon [%]	2.06	7.00	9.80	15.2	9.63
Sulphide [%]	< 0.01	0.18	0.36	0.88	1.82
Sulphate [%]	17	0.8	0.6	0.5	0.6
Silver [µg/g]	< 0.7	1.0	< 0.7	< 0.7	1.0
Aluminum [µg/g]	6800	8400	3600	3000	3300
Arsenic [µg/g]	15	30	14	12	19
Barium [µg/g]	320	340	160	180	190
Beryllium [µg/g]	0.66	0.75	0.34	0.37	0.66
Bismuth [µg/g]	4.5	13	11	14	21
Calcium [µg/g]	190000	9600	7600	9400	7600
Cadmium [µg/g]	1.6	5.7	4.5	0.86	0.96
Cerium [µg/g]	360	250	220	230	290
Cobalt [µg/g]	61	20	15	25	46
Chromium [µg/g]	8.6	15	6.5	13	17
Cesium [µg/g]	0.34	0.47	0.97	1.1	0.74
Copper [µg/g]	22	110	14	29	64
Iron [µg/g]	87000	290000	240000	45000	30000
Gallium [µg/g]	2.3	11	2.4	2.1	2.7
Germanium [µg/g]	3.5	8.1	7.2	2.1	1.9
Hafnium [µg/g]	0.3	0.2	0.1	0.1	0.3
Indium [µg/g]	< 0.01	0.02	< 0.01	< 0.01	0.01
Potassium [µg/g]	170	230	190	470	610
Lanthanum [µg/g]	200	130	110	110	140
Lithium [µg/g]	4.5	0.9	0.9	< 0.1	1.1

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LR Report : CA10524-SEP09

Analysis	9: CORE 09-PSB-1 10-15	10: CORE 09-PSB-2 0-5	11: CORE 09-PSB-2 5-10	12: CORE 09-PSB-2 10-15	13: CORE 09-PSB-2 15-20
Lutetium [µg/g]	1.8	1.2	0.98	0.79	0.81
Magnesium [µg/g]	9900	540	360	510	410
Manganese [µg/g]	610	430	89	75	51
Molybdenum [µg/g]	< 0.5	128	10	4.3	3.9
Sodium [µg/g]	47	28	35	80	74
Niobuim [µg/g]	1.0	2.7	2.8	7.8	12
Nickel [µg/g]	39	22	17	22	30
Lead [µg/g]	80	270	270	190	410
Phosphorus [µg/g]	75	590	740	480	510
Rubidium [µg/g]	0.61	2.1	2.1	4.3	4.8
Antimony [µg/g]	< 1	< 1	< 1	< 1	< 1
Scandium [µg/g]	0.8	2.2	1.3	2.3	2.2
Selenium [µg/g]	< 1	< 1	< 1	< 1	< 1
Tin [µg/g]	< 6	< 6	< 6	< 6	< 6
Strontium [µg/g]	27	9.0	7.6	12	10
Tantalum [µg/g]	0.05	0.09	0.05	0.08	0.09
Terbium [µg/g]	6.8	5.1	3.9	3.0	3.5
Tellerium [µg/g]	< 0.1	0.1	0.1	0.1	0.3
Thorium [µg/g]	220	560	110	250	550
Titanium [µg/g]	60	81	82	140	240
Thallium [µg/g]	< 3	< 3	< 3	< 3	< 3
Uranium [µg/g]	68	480	210	84	94
Vanadium [µg/g]	4.6	11	25	9.4	11
Tungsten [µg/g]	< 1	14	2	< 1	1
Yttrium [µg/g]	170	97	78	51	61
Ytterbium [µg/g]	14	9.3	7.4	6.3	6.7
Zinc [µg/g]	83	170	64	27	76
Zirconium [µg/g]	5	8	6	8	18

Ra226 subcontracted to Becquerel Labs.
* BaSO4 Calculation based on Ba values and assumes all Ba is in BaSO4 form.
** BaSO4 Calculation based on SO4 values and assumes all SO4 is in BaSO4 form.

Chris Sullivan, B.Sc., C.Chem
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Project : 09-1663

October 7, 2010

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Date Rec. : 30 September 2009
LR Report: **CA10524-SEP09**

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CERTIFICATE OF ANALYSIS
Final Report (QC Report)

Analysis	14: MDL	15: QC - Blank	16: QC - STD % Recovery	17: QC - DUP % Recovery
BaSO4 Calc. using Ba* [µg/g]	---	---	---	---
BaSO4 Calc. using SO4** [µg/g]	---	---	---	---
Total Sulphur [%]	0.005	< 0.005	102%	100%
Carbonate (CO3) [%]	0.005	< 0.005	100%	140%
Total Organic Carbon [%]	0.01	< 0.01	---	100%
Total Carbon [%]	0.005	< 0.005	100%	100%
Sulphide [%]	0.01	< 0.01	90%	106%
Sulphate [%]	0.1	< 0.1	100%	107%
Silver [µg/g]	0.7	< 0.7	93%	100%
Aluminum [µg/g]	1	< 1	97%	100%
Arsenic [µg/g]	1	< 1	99%	94%
Barium [µg/g]	0.05	< 0.05	96%	100%
Beryllium [µg/g]	0.1	< 0.1	98%	102%
Bismuth [µg/g]	0.5	< 0.5	98%	104%
Calcium [µg/g]	1	< 1	98%	100%
Cadmium [µg/g]	0.05	< 0.05	97%	99%
Cerium [µg/g]	0.006	< 0.006	94%	110%
Cobalt [µg/g]	0.3	< 0.3	97%	100%
Chromium [µg/g]	0.5	< 0.5	98%	103%
Cesium [µg/g]	0.01	< 0.01	100%	107%
Copper [µg/g]	0.1	< 0.1	98%	100%
Iron [µg/g]	0.5	< 0.5	98%	100%
Gallium [µg/g]	0.03	< 0.03	100%	99%
Germanium [µg/g]	0.3	< 0.3	103%	105%
Hafnium [µg/g]	0.1	< 0.1	96%	150%
Indium [µg/g]	0.01	< 0.01	---	100%
Potassium [µg/g]	1	< 1	100%	100%
Lanthanum [µg/g]	0.001	0.001	94%	110%
Lithium [µg/g]	0.1	< 0.1	97%	107%
Lutetium [µg/g]	0.001	0.001	95%	102%

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Project : 09-1663

LR Report : **CA10524-SEP09**

Analysis	14: MDL	15: QC - Blank	16: QC - STD % Recovery	17: QC - DUP % Recovery
Magnesium [µg/g]	1	< 1	96%	---
Manganese [µg/g]	0.05	< 0.05	98%	100%
Molybdenum [µg/g]	0.5	< 0.5	100%	154%
Sodium [µg/g]	1	< 1	97%	104%
Niobuim [µg/g]	0.7	< 0.7	99%	118%
Nickel [µg/g]	1	< 1	97%	101%
Lead [µg/g]	0.7	< 0.7	98%	100%
Phosphorus [µg/g]	5	< 5	98%	100%
Rubidium [µg/g]	0.004	< 0.004	---	105
Antimony [µg/g]	1	< 1	98	100%
Scandium [µg/g]	0.2	< 0.2	100%	99%
Selenium [µg/g]	1	< 1	99%	100%
Tin [µg/g]	6	< 6	100%	123%
Strontium [µg/g]	0.01	< 0.01	97%	103%
Tantalum [µg/g]	0.01	< 0.01	97%	108%
Terbium [µg/g]	0.01	< 0.001	96%	93%
Tellerium [µg/g]	0.1	< 0.1	99%	101%
Thorium [µg/g]	0.01	< 0.01	114%	100%
Titanium [µg/g]	0.2	< 0.2	98%	100%
Thallium [µg/g]	3	< 3	99%	76%
Uranium [µg/g]	3	< 3	---	100%
Vanadium [µg/g]	0.1	< 0.1	99%	102%
Tungsten [µg/g]	1	< 1	97%	93%
Yttrium [µg/g]	0.1	< 0.1	96%	100%
Ytterbium [µg/g]	0.1	< 0.1	98%	105%
Zinc [µg/g]	0.1	< 0.1	97%	100%
Zirconium [µg/g]	5	< 5	100%	107%

Ra226 subcontracted to Becquerel Labs.
* BaSO4 Calculation based on Ba values and assumes all Ba is in BaSO4 form.
** BaSO4 Calculation based on SO4 values and assumes all SO4 is in BaSO4 form.

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Project Specialist
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OnLine LIMS

ANALYSIS REPORT

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9 water samples

Received: 06-Oct-2009

Page 1 of 1

Results of Analysis

Sample	Test		Result	Units	Date	Method
PW09-PSB-1 0-2.5	Ra-226		0.76	Bq/l	06-Nov-2009	ALPHA
PW09-PSB-1 2.5-5	Ra-226		0.12	Bq/l	06-Nov-2009	ALPHA
PW09-PSB-1 5-7.5	Ra-226		0.02	Bq/l	06-Nov-2009	ALPHA
PW09-PSB-1 7.5-10	Ra-226	<	0.01	Bq/l	06-Nov-2009	ALPHA
PW09-PSB-1 10-15	Ra-226	<	0.01	Bq/l	06-Nov-2009	ALPHA
PW09-PSB-2 0-5	Ra-226		3.2	Bq/l	06-Nov-2009	ALPHA
PW09-PSB-2 5-10	Ra-226		1.8	Bq/l	06-Nov-2009	ALPHA
PW09-PSB-2 10-15	Ra-226		1.1	Bq/l	06-Nov-2009	ALPHA
PW09-PSB-2 15-20	Ra-226		1.4	Bq/l	06-Nov-2009	ALPHA

Methods: ALPHA BQ-RAD-ALPHA alpha-particle spectrometry

Units: Bq/l Becquerels per litre

These results relate only to the samples analysed and only to the items tested.

09-Nov-2009 approved by:

Donald D. Burgess PhD
Senior Scientist, Division Supervisor

SGS Lakefield Research Limited
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Ecometrix
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Phone: 905-794-2325, Fax:905-794-2338

October 14, 2009

Date Rec. : 30 September 2009
LR Report : **CA10523-SEP09**
Project : 09-1663

CERTIFICATE OF ANALYSIS
Final Report

Analysis	**1: Analysis Start Date**	**2: Analysis Start Time**	**3: Analysis Approval Date**	**4: Analysis Approval Time**	**5: PW09-PSB-1 0-2.5**	**6: PW09-PSB-1 2.5-5**	**7: PW09-PSB-1 5-7.5**
Sample Date & Time					22-Sep-09	22-Sep-09	22-Sep-09
Temperature Upon Receipt [°C]	---	---	---	---	4.0	4.0	4.0
Sulphate [mg/L]	02-Oct-09	15:00	06-Oct-09	14:01	410	1100	1300
Dissolved Organic Carbon [mg/L]	02-Oct-09	10:00	06-Oct-09	13:52	10.7	9.9	12.2
Dissolved Inorganic Carbon [mg/L]	05-Oct-09	14:35	08-Oct-09	12:46	1.7	< 1.0	< 1.0
Alkalinity [mg/L as CaCO3]	02-Oct-09	15:19	05-Oct-09	15:11	24	24	33
Acidity [mg/L as CaCO3]	02-Oct-09	15:19	05-Oct-09	15:11	---	---	---
Hardness [mg/L as CaCO3]	02-Oct-09	09:00	08-Oct-09	16:00	504	934	1270
Aluminum [mg/L]	02-Oct-09	09:00	02-Oct-09	12:08	0.03	0.12	0.04
Arsenic [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.0018	0.0047	0.0059
Barium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.0167	0.00872	0.00558
Beryllium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	< 0.00002	< 0.00002	< 0.00002
Boron [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.0287	0.0284	0.0078
Bismuth [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	< 0.00001	0.00001	< 0.00001
Calcium [mg/L]	02-Oct-09	09:00	08-Oct-09	16:00	193	373	506
Cadmium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.000014	0.000017	0.000007
Cobalt [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.000458	0.000560	0.000695
Chromium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	< 0.0005	0.0006	0.0009
Copper [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.0014	0.0012	0.0014
Iron [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	< 0.01	< 0.01	0.01
Potassium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	10.3	17.3	23.3
Lithium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	< 0.002	< 0.002	0.003
Magnesium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	5.17	0.966	0.296

OnLine LIMS

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LR Report : **CA10523-SEP09**

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	5: PW09-PSB-1 0-2.5	6: PW09-PSB-1 2.5-5	7: PW09-PSB-1 5-7.5
Manganese [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.0679	0.00194	0.00031
Molybdenum [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.00679	0.0118	0.00655
Sodium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	6.60	10.0	13.0
Nickel [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.0043	0.0093	0.0126
Phosphorus [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	< 0.01	< 0.01	< 0.01
Lead [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.00025	0.00017	0.00008
Sulphur [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	179	331	449
Antimony [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	< 0.0002	< 0.0002	< 0.0002
Selenium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	< 0.001	< 0.001	< 0.001
Silica [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	0.44	0.22	0.13
Tin [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.00018	0.00026	0.00043
Strontium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	0.115	0.156	0.170
Titanium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.0002	0.0002	0.0003
Thallium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	< 0.0002	< 0.0002	< 0.0002
Uranium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.0636	0.00363	0.000341
Vanadium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.00005	0.00006	0.00019
Zinc [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.002	< 0.001	< 0.001

Samples are field filtered
Ra226 subcontracted to Becquerel Labs.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

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October 14, 2009

Date Rec. : 30 September 2009
LR Report : **CA10523-SEP09**
Project : 09-1663

CERTIFICATE OF ANALYSIS
Final Report

Analysis	**8: PW09-PSB-1 7.5-10**	**9: PW09-PSB-1 10-15**	**10: PW09-PSB-2 0-5**	**11: PW09-PSB-2 5-10**	**12: PW09-PSB-2 10-15**	**13: PW09-PSB-2 15-20**
Sample Date & Time	22-Sep-09	22-Sep-09	23-Sep-09	23-Sep-09	23-Sep-09	23-Sep-09
Temperature Upon Receipt [°C]	4.0	4.0	4.0	4.0	4.0	4.0
Sulphate [mg/L]	1600	1800	190	250	---	---
Dissolved Organic Carbon [mg/L]	14.6	12.0	5.5	21.8	---	---
Dissolved Inorganic Carbon [mg/L]	< 1.0	< 1.0	8.6	14.6	---	---
Alkalinity [mg/L as CaCO3]	45	36	---	---	---	---
Acidity [mg/L as CaCO3]	---	---	< 2	< 2	---	---
Hardness [mg/L as CaCO3]	1970	1810	217	312	415	875
Aluminum [mg/L]	0.01	0.04	< 0.01	< 0.01	< 0.01	0.01
Arsenic [mg/L]	0.0069	0.0059	0.0012	0.0015	0.0028	0.0064
Barium [mg/L]	0.00624	0.00582	0.0443	0.0344	0.0266	0.0380
Beryllium [mg/L]	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002
Boron [mg/L]	0.0023	0.0077	0.0232	0.0422	0.0889	0.118
Bismuth [mg/L]	0.00001	< 0.00001	< 0.00001	< 0.00001	0.00001	< 0.00001
Calcium [mg/L]	787	723	76.4	106	138	297
Cadmium [mg/L]	0.000006	0.000013	0.000011	< 0.000003	0.000012	0.000010
Cobalt [mg/L]	0.000763	0.000834	0.00271	0.000540	0.000530	0.00114
Chromium [mg/L]	< 0.0005	0.0011	< 0.0005	< 0.0005	0.0010	0.0009
Copper [mg/L]	0.0021	0.0022	0.0008	0.0012	0.0022	0.0023
Iron [mg/L]	< 0.01	0.02	8.19	12.1	6.95	16.1
Potassium [mg/L]	29.7	35.8	7.51	11.8	17.4	29.2
Lithium [mg/L]	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.007
Magnesium [mg/L]	0.213	0.713	6.39	11.8	17.0	32.7

OnLine LIMS

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Analysis	8: PW09-PSB-1 7.5-10	9: PW09-PSB-1 10-15	10: PW09-PSB-2 0-5	11: PW09-PSB-2 5-10	12: PW09-PSB-2 10-15	13: PW09-PSB-2 15-20
Manganese [mg/L]	0.00012	0.00100	1.85	0.753	0.790	1.67
Molybdenum [mg/L]	0.00633	0.00445	0.00113	0.00071	0.00437	0.00563
Sodium [mg/L]	15.9	17.5	5.62	10.2	16.1	24.2
Nickel [mg/L]	0.0151	0.0132	0.0026	0.0028	0.0035	0.0046
Phosphorus [mg/L]	0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.01
Lead [mg/L]	0.00016	0.00018	0.00012	0.00022	0.00025	0.00023
Sulphur [mg/L]	503	560	63.7	87.8	123	311
Antimony [mg/L]	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	0.0004
Selenium [mg/L]	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Silica [mg/L]	0.22	0.43	4.34	7.44	11.3	12.0
Tin [mg/L]	0.00055	0.00046	0.00017	0.00031	0.00017	0.00009
Strontium [mg/L]	0.193	0.216	0.0915	0.131	0.177	0.347
Titanium [mg/L]	0.0002	0.0004	0.0003	0.0006	0.0012	0.0012
Thallium [mg/L]	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Uranium [mg/L]	0.000330	0.000201	0.00706	0.0241	0.0330	0.0214
Vanadium [mg/L]	0.00011	0.00029	< 0.00003	0.00008	0.00041	0.00060
Zinc [mg/L]	< 0.001	< 0.001	0.002	0.002	0.002	0.003

Samples are field filtered
Ra226 subcontracted to Becquerel Labs.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

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Project : 09-1663

October 7, 2010

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Date Rec. : 30 September 2009
LR Report: **CA10523-SEP09**

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CERTIFICATE OF ANALYSIS
Final Report - (QC Report)

Analysis	14: MDL	15: QC - Blank	16: QC - STD % Recovery	17: QC - DUP % Recovery
Sulphate [mg/L]	0.2	< 0.2	98%	102%
Dissolved Organic Carbon [mg/L]	0.2	< 0.2	105%	98%
Dissolved Inorganic Carbon [mg/L]	0.2	0.2	97%	110%
Alkalinity [mg/L as CaCO3]	2	< 2	101%	98%
Acidity [mg/L as CaCO3]	2	3	98%	102%
Hardness [mg/L as CaCO3]	0.5	---	---	---
Aluminum [mg/L]	0.01	< 0.01	95%	100%
Arsenic [mg/L]	0.0002	< 0.0002	106%	111%
Barium [mg/L]	0.00001	< 0.00001	105%	100%
Beryllium [mg/L]	0.00002	< 0.00002	103%	94%
Boron [mg/L]	0.0002	< 0.0002	99%	97%
Bismuth [mg/L]	0.00001	0.00001	105%	82%
Calcium [mg/L]	0.03	---	98%	100%
Cadmium [mg/L]	0.000003	< 0.000003	102%	107%
Cobalt [mg/L]	0.000002	< 0.000002	105%	99%
Chromium [mg/L]	0.0005	< 0.0005	103%	170%
Copper [mg/L]	0.0005	< 0.0005	106%	85%
Iron [mg/L]	0.01	---	97%	122%
Potassium [mg/L]	0.01	< 0.01	98%	99%
Lithium [mg/L]	0.002	< 0.002	94%	120%
Magnesium [mg/L]	0.003	---	95%	100%
Manganese [mg/L]	0.00001	< 0.00001	104%	99%
Molybdenum [mg/L]	0.00001	< 0.00001	95%	155%
Sodium [mg/L]	0.01	---	94.8	99.3
Nickel [mg/L]	0.0001	< 0.0001	105%	87%
Phosphorus [mg/L]	0.01	< 0.01	95%	100%
Lead [mg/L]	0.00002	< 0.00002	102%	30%
Sulphur [mg/L]	0.01	---	100%	101%
Antimony [mg/L]	0.0002	< 0.0002	94%	124%
Selenium [mg/L]	0.001	< 0.001	108%	100%

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Project : 09-1663

LR Report : **CA10523-SEP09**

Analysis	14: MDL	15: QC - Blank	16: QC - STD % Recovery	17: QC - DUP % Recovery
Silica [mg/L]	0.01	< 0.01	103%	101%
Tin [mg/L]	0.00001	< 0.00001	96%	140%
Strontium [mg/L]	0.0001	---	98%	100%
Titanium [mg/L]	0.0001	< 0.0001	95%	130%
Thallium [mg/L]	0.0002	< 0.0002	105%	106%
Uranium [mg/L]	0.000001	< 0.000001	102%	94%
Vanadium [mg/L]	0.00003	< 0.00003	106%	150%
Zinc [mg/L]	0.001	< 0.001	106%	90%

Samples are field filtered
Ra226 subcontracted to Becquerel Labs.
Revised to include Ra226 results from Becquerel.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

Becquerel LABORATORIES

ANALYSIS REPORT

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Mississauga, Ontario
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FAX: (905) 826-4151

Batch: T09-01381.0

Date: 20-Oct-2009

Lakefield Research Ltd.

185 Concession St., Postal Bag 4300
Lakefield, ON, K0L 2H0

attn: Brian Graham

Phone: (705) 652-2038
FAX: (705) 652-1918

Client Ref.Sept 10522
P.O: 17820

4 water samples   Sampled: 22-Sep-2009   Received: 06-Oct-2009

Results of Analysis

Sample	Test	Result	Units	Date	Method
SW09-PSB-1T	Ra-226	0.34	Bq/l	17-Oct-2009	ALPHA
SW09-PSB-1B	Ra-226	0.65	Bq/l	17-Oct-2009	ALPHA
SW09-PSB-2T	Ra-226	0.31	Bq/l	17-Oct-2009	ALPHA
SW09-PSB-2B	Ra-226	0.39	Bq/l	17-Oct-2009	ALPHA

Methods: ALPHA BQ-RAD-ALPHA alpha-particle spectrometry

Units: Bq/l Becquerels per litre

These results relate only to the samples analysed and only to the items tested.

20-Oct-2009 approved by: [signature]
Donald D. Burgess PhD
Senior Scientist, Division Supervisor

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October 14, 2009

Date Rec. : 30 September 2009
LR Report : **CA10522-SEP09**
Project : 09-1663

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	5: SW09-PSB-1T	6: SW09-PSB-1B	7: SW09-PSB-2T	8: SW09-PSB-2B
Sample Date & Time					22-Sep-09	22-Sep-09	23-Sep-09	23-Sep-09
Temperature Upon Receipt [°C]	---	---	---	---	4.0	4.0	4.0	4.0
Sulphate [mg/L]	02-Oct-09	15:00	06-Oct-09	14:19	180	410	180	180
Total Organic Carbon [mg/L]	02-Oct-09	10:00	05-Oct-09	13:41	2.1	4.6	2.2	4.0
Total Inorganic Carbon [mg/L]	05-Oct-09	14:35	08-Oct-09	12:45	3.5	< 1.0	2.9	< 1.0
Alkalinity [mg/L as CaCO3]	02-Oct-09	15:19	05-Oct-09	15:10	12	---	---	---
Acidity [mg/L as CaCO3]	02-Oct-09	15:19	05-Oct-09	15:10	---	20	< 2	15
Hardness [mg/L as CaCO3]	02-Oct-09	09:00	02-Oct-09	12:08	173	209	179	179
Aluminum [mg/L]	02-Oct-09	09:00	02-Oct-09	12:08	< 0.01	0.53	< 0.01	< 0.01
Arsenic [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.0005	0.0014	0.0004	0.0005
Barium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.0134	0.0196	0.0137	0.0160
Beryllium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.00007	0.00009	0.00002	< 0.00002
Boron [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.0249	0.0314	0.0252	0.0243
Bismuth [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.00007	0.00003	< 0.00001	0.00001
Calcium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:08	62.2	74.4	64.5	64.1
Cadmium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.000079	0.000082	0.000005	0.000015
Cobalt [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.000281	0.0186	0.000319	0.00120
Chromium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Copper [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.0025	0.0019	0.0015	0.0009
Iron [mg/L]	02-Oct-09	09:00	02-Oct-09	12:08	0.03	1.61	< 0.01	0.02
Potassium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:08	6.11	6.53	6.18	6.14
Lithium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:08	< 0.002	< 0.002	< 0.002	< 0.002

OnLine LIMS

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LR Report : **CA10522-SEP09**

Analysis	**1: Analysis Start Date**	**2: Analysis Start Time**	**3: Analysis Approval Date**	**4: Analysis Approval Time**	**5: SW09-PSB-1T**	**6: SW09-PSB-1B**	**7: SW09-PSB-2T**	**8: SW09-PSB-2B**
Magnesium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:08	4.30	5.53	4.45	4.47
Manganese [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.00475	0.203	0.00313	0.0273
Molybdenum [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.00017	0.00043	0.00008	0.00025
Sodium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:08	3.99	4.35	4.04	4.14
Nickel [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.0017	0.0101	0.0015	0.0025
Phosphorus [mg/L]	02-Oct-09	09:00	02-Oct-09	12:08	< 0.01	< 0.01	< 0.01	< 0.01
Lead [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.00057	0.00647	0.00013	0.00088
Sulphur [mg/L]	02-Oct-09	09:00	02-Oct-09	12:08	57.9	67.4	60.2	60.5
Antimony [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	< 0.0002	0.0084	0.0003	0.0015
Selenium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	< 0.001	< 0.001	< 0.001	< 0.001
Silica [mg/L]	02-Oct-09	09:00	02-Oct-09	12:08	0.99	1.14	1.01	1.12
Tin [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.00011	0.00035	0.00017	0.00020
Strontium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:08	0.0715	0.0765	0.0736	0.0742
Titanium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.0003	0.0002	0.0002	0.0002
Thallium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Uranium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.00245	0.0557	0.00273	0.00317
Vanadium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.00008	0.00004	< 0.00003	0.00007
Zinc [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.009	0.024	< 0.001	0.002

Ra226 subcontracted to Becquerel Labs.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

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SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
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Env ICP-MS Metals

Project : 09-1663

October 7, 2010

Ecometrix
Attn : Erin Clyde

6800 Campobello Road, Mississauga
Canada, L5N 2L8
Phone: 905-794-2325, Fax:905-794-2338

Date Rec. : 30 September 2009
LR Report: **CA10522-SEP09**

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CERTIFICATE OF ANALYSIS
Final Report

Analysis	9: MDL	10: QC - Blank	11: QC - STD % Recovery	12: QC - DUP % Recovery
Sulphate [mg/L]	0.2	< 0.2	98%	102%
Total Organic Carbon [mg/L]	0.2	< 0.2	105%	98%
Total Inorganic Carbon [mg/L]	0.2	< 0.2	110%	100%
Alkalinity [mg/L as CaCO3]	2	< 2	101%	98%
Acidity [mg/L as CaCO3]	2	2	98%	102%
Hardness [mg/L as CaCO3]	0.5	---	---	---
Aluminum [mg/L]	0.01	< 0.01	95%	100%
Arsenic [mg/L]	0.0002	< 0.0002	106%	111%
Barium [mg/L]	0.00001	< 0.00001	105%	100%
Beryllium [mg/L]	0.00002	< 0.00002	103%	94%
Boron [mg/L]	0.0002	< 0.0002	99%	97%
Bismuth [mg/L]	0.00001	0.00001	105%	82%
Calcium [mg/L]	0.03	---	97%	100%
Cadmium [mg/L]	0.000003	< 0.000003	102%	107%
Cobalt [mg/L]	0.000002	< 0.000002	105%	99%
Chromium [mg/L]	0.00005	< 0.0005	103%	170%
Copper [mg/L]	0.0005	< 0.0005	106%	85%
Iron [mg/L]	0.01	---	96.8	122
Potassium [mg/L]	0.01	< 0.01	98%	99.1
Lithium [mg/L]	0.002	< 0.002	94.2	120
Magnesium [mg/L]	0.003	---	94.8	100
Manganese [mg/L]	0.00001	< 0.00001	104%	99%
Molybdenum [mg/L]	0.00001	< 0.00001	95%	155%
Sodium [mg/L]	0.01	---	94.8	99.3
Nickel [mg/L]	0.0001	< 0.0001	105%	87%
Phosphorus [mg/L]	0.01	< 0.01	95%	100%
Lead [mg/L]	0.00002	< 0.00002	102%	30%
Sulphur [mg/L]	0.01	---	100%	101

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Env ICP-MS Metals

Project : 09-1663

LR Report : **CA10522-SEP09**

Analysis	**9: MDL**	**10: QC - Blank**	**11: QC - STD % Recovery**	**12: QC - DUP % Recovery**
Antimony [mg/L]	0.0002	< 0.0002	94%	124%
Selenium [mg/L]	0.001	< 0.001	108%	100%
Silica [mg/L]	0.01	< 0.01	103%	101%
Tin [mg/L]	0.00001	< 0.00001	96%	140%
Strontium [mg/L]	0.0001	---	98%	99.7
Titanium [mg/L]	0.0001	< 0.0001	95%	130%
Thallium [mg/L]	0.0002	< 0.0002	105%	106%
Uranium [mg/L]	0.000001	< 0.000001	102%	94%
Vanadium [mg/L]	0.00003	< 0.00003	106%	150%
Zinc [mg/L]	0.001	< 0.001	106%	90%

Ra226 subcontracted to Becquerel Labs.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

Becquerel LABORATORIES

ANALYSIS REPORT

Becquerel Laboratories Inc.
6790 Kitimat Rd., Unit 4
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Canada, L5N 5L9

Phone: (905) 826-3080
FAX: (905) 826-4151

Batch: T09-01486.0

Date: 30-Nov-2009

Lakefield Research Ltd.

185 Concession St., Postal Bag 4300
Lakefield, ON, K0L 2H0

Phone: (705) 652-2038
FAX: (705) 652-1918

Client Ref.
Oct 10521.R09
P.O: 17820

attn: Brian Graham

14 solid samples Sampled: 26-Sep-2009 Received: 21-Oct-2009 Page 1 of 1

Results of Analysis

Sample	Test	Result	Units	Date	Method
CORE 09-SR-1 (0-5)	Ra-226	0.16	Bq/g	23-Nov-2009	ALPHA
CORE 09-SR-1 (5-10)	Ra-226	0.08	Bq/g	23-Nov-2009	ALPHA
CORE 09-SR-1 (10-15)	Ra-226	0.02	Bq/g	23-Nov-2009	ALPHA
CORE 09-SR-1 (15-20)	Ra-226	0.04	Bq/g	29-Nov-2009	ALPHA
CORE 09-SR-2 (0-5)	Ra-226	14	Bq/g	29-Nov-2009	ALPHA
CORE 09-SR-2 (5-10)	Ra-226	4.6	Bq/g	29-Nov-2009	ALPHA
CORE 09-SR-2 (10-15)	Ra-226	0.06	Bq/g	29-Nov-2009	ALPHA
CORE 09-SR-3 (0-5)	Ra-226	8.2	Bq/g	29-Nov-2009	ALPHA
CORE 09-SR-3 (5-10)	Ra-226	9.7	Bq/g	29-Nov-2009	ALPHA
CORE 09-SR-3 (10-15)	Ra-226	16	Bq/g	29-Nov-2009	ALPHA
CORE 09-SR-3 (15-20)	Ra-226	20	Bq/g	29-Nov-2009	ALPHA
CORE 09-SR-4 (0-5)	Ra-226	2.6	Bq/g	29-Nov-2009	ALPHA
CORE 09-SR-4 (5-10)	Ra-226	2.7	Bq/g	29-Nov-2009	ALPHA
CORE 09-SR-4 (10-15)	Ra-226	2.1	Bq/g	29-Nov-2009	ALPHA

Methods: ALPHA BQ-RAD-ALPHA alpha-particle spectrometry

Units: Bq/g Becquerels per gram

These results relate only to the samples analysed and only to the items tested.

30-Nov-2009 approved by: Donald D. Burgess PhD
Senior Scientist, Division Supervisor

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Phone: 905-794-2325, Fax:905-794-2338

Tuesday, October 27, 2009

Date Rec. : 30 September 2009
LR. Ref. : **CA10521-SEP09**
Project : 09-1663

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CERTIFICATE OF ANALYSIS

Final Report

Analysis	**3: Analysis Approval Date**	**4: Analysis Approval Time**	**5: CORE 09-SR-1 (0-5)**	**6: CORE 09-SR-1 (5-10)**	**7: CORE 09-SR-1 (10-15)**	**8: CORE 09-SR-1 (15-20)**	**9: CORE 09-SR-2 (0-5)**	**10: CORE 09-SR-2 (5-10)**
Sample Date & Time			26-Sep-09	26-Sep-09	26-Sep-09	26-Sep-09	26-Sep-09	26-Sep-09
BaSO4 Calc. using Ba* [µg/g]	---	---	130	110	100	80	10900	4420
BaSO4 Calc. using SO4** [µg/g]	---	---	2430	<2430	2430	2430	12100	4860
Total Sulphur [%]	06-Oct-09	14:45	0.130	0.130	0.184	0.224	0.235	0.114
Carbonate (CO3) [%]	06-Oct-09	14:42	0.105	0.048	0.048	0.033	0.040	0.011
Total Organic Carbon [%]	06-Oct-09	14:45	5.34	4.23	5.87	5.94	2.05	0.820
Total Carbon [%]	06-Oct-09	14:45	5.36	4.24	5.88	5.95	2.05	0.825
Sulphide [%]	07-Oct-09	15:59	< 0.01	< 0.01	0.04	0.05	< 0.01	< 0.01
Sulphate [%]	23-Oct-09	14:22	0.1	< 0.1	0.1	0.1	0.5	0.2
Silver [µg/g]	14-Oct-09	14:05	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7
Aluminum [µg/g]	14-Oct-09	14:05	7600	6700	5300	4100	4400	2600
Arsenic [µg/g]	14-Oct-09	14:05	5	5	4	3	10	4
Barium [µg/g]	14-Oct-09	14:05	75	65	61	47	6400	2600
Beryllium [µg/g]	14-Oct-09	14:05	0.47	0.37	0.32	0.24	0.21	0.12
Bismuth [µg/g]	14-Oct-09	14:05	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Calcium [µg/g]	14-Oct-09	14:05	1900	1600	1500	1500	1100	720
Cadmium [µg/g]	14-Oct-09	14:05	1.2	0.96	1.2	1.1	0.42	0.18
Cerium [µg/g]	13-Oct-09	15:44	48	41	34	20	62	30
Cobalt [µg/g]	14-Oct-09	14:05	8.5	7.8	6.1	3.7	20	8.2
Chromium [µg/g]	14-Oct-09	14:05	19	18	15	12	9.8	6.8
Cesium [µg/g]	13-Oct-09	15:44	0.63	0.45	0.36	0.30	0.56	0.38
Copper [µg/g]	14-Oct-09	14:05	34	31	23	14	20	8.3
Iron [µg/g]	14-Oct-09	14:05	12000	9800	8100	6800	15000	7300
Gallium [µg/g]	13-Oct-09	15:44	2.9	2.6	2.0	1.6	2.8	1.4
Germanium [µg/g]	13-Oct-09	15:44	0.6	0.5	0.5	0.4	0.8	0.4
Hafnium [µg/g]	13-Oct-09	15:44	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Indium [µg/g]	13-Oct-09	15:44	0.05	0.02	0.01	< 0.01	< 0.01	< 0.01
Potassium [µg/g]	14-Oct-09	14:05	270	250	210	180	270	170
Lanthanum [µg/g]	13-Oct-09	15:44	25	21	18	12	33	16
Lithium [µg/g]	14-Oct-09	14:05	2.7	2.4	1.6	1.1	1.4	0.3

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LR Report : **CA10521-SEP09**

Analysis	**3: Analysis Approval Date**	**4: Analysis Approval Time**	**5: CORE 09-SR-1 (0-5)**	**6: CORE 09-SR-1 (5-10)**	**7: CORE 09-SR-1 (10-15)**	**8: CORE 09-SR-1 (15-20)**	**9: CORE 09-SR-2 (0-5)**	**10: CORE 09-SR-2 (5-10)**
Lutetium [µg/g]	13-Oct-09	15:44	0.10	0.081	0.063	0.054	0.49	0.21
Magnesium [µg/g]	14-Oct-09	14:04	2100	1900	1500	1200	840	590
Manganese [µg/g]	14-Oct-09	14:04	250	180	200	230	1600	160
Molybdenum [µg/g]	14-Oct-09	14:04	< 0.5	< 0.5	< 0.5	< 0.5	2.8	1.3
Sodium [µg/g]	14-Oct-09	14:04	52	45	38	32	36	23
Niobuim [µg/g]	13-Oct-09	15:44	0.8	0.8	0.7	< 0.7	< 0.7	< 0.7
Nickel [µg/g]	14-Oct-09	14:04	15	13	11	7	19	8
Lead [µg/g]	14-Oct-09	14:04	61	44	32	19	100	38
Phosphorus [µg/g]	14-Oct-09	14:04	450	350	260	210	270	130
Rubidium [µg/g]	13-Oct-09	15:44	3.6	3.2	2.6	2.3	2.5	1.5
Antimony [µg/g]	14-Oct-09	14:04	< 1	< 1	< 1	< 1	< 1	< 1
Scandium [µg/g]	13-Oct-09	15:44	1.7	1.5	1.1	0.9	1.1	0.6
Selenium [µg/g]	14-Oct-09	14:04	< 1	< 1	< 1	< 1	< 1	< 1
Tin [µg/g]	14-Oct-09	14:04	< 6	< 6	< 6	< 6	< 6	< 6
Strontium [µg/g]	14-Oct-09	14:04	7.6	6.3	6.2	6.5	72	27
Sulphur [µg/g]	14-Oct-09	14:04	1100	1400	2000	2500	2400	1200
Tantalum [µg/g]	13-Oct-09	15:44	0.03	0.03	0.04	0.04	0.01	< 0.01
Terbium [µg/g]	13-Oct-09	15:44	0.47	0.33	0.22	0.16	2.0	0.87
Tellerium [µg/g]	13-Oct-09	15:44	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Thorium [µg/g]	13-Oct-09	15:44	9.5	7.7	7.0	3.4	33	12
Titanium [µg/g]	14-Oct-09	14:04	340	350	300	270	190	160
Thallium [µg/g]	14-Oct-09	14:04	< 3	< 3	< 3	< 3	< 3	< 3
Uranium [µg/g]	13-Oct-09	15:43	7.9	5.6	3.1	1.7	84	29
Vanadium [µg/g]	14-Oct-09	14:04	24	21	17	13	12	7.9
Tungsten [µg/g]	14-Oct-09	14:04	< 1	< 1	< 1	< 1	2	< 1
Yttrium [µg/g]	14-Oct-09	14:04	10	7.8	5.9	4.5	43	18
Ytterbium [µg/g]	13-Oct-09	15:43	0.76	0.59	0.46	0.37	4.0	1.6
Zinc [µg/g]	14-Oct-09	14:04	100	83	73	49	74	34
Zirconium [µg/g]	14-Oct-09	14:04	< 5	< 5	< 5	< 5	< 5	< 5

Ra226 subcontracted to Becquerel Labs.
* BaSO4 Calculation based on Ba values and assumes all Ba is in BaSO4 form.
** BaSO4 Calculation based on SO4 values and assumes all SO4 is in BaSO4 form.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

SGS

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Tuesday, October 27, 2009

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CERTIFICATE OF ANALYSIS

Final Report

Analysis	**11: CORE 09-SR-2 (10-15)**	**12: CORE 09-SR-3 (0-5)**	**13: CORE 09-SR-3 (5-10)**	**14: CORE 09-SR-3 (10-15)**	**15: CORE 09-SR-3 (15-20)**	**16: CORE 09-SR-4 (0-5)**	**17: CORE 09-SR-4 (5-10)**	**18: CORE 09-SR-4 (10-15)**
Sample Date & Time	26-Sep-09	27-Sep-09	27-Sep-09	27-Sep-09	27-Sep-09	27-Sep-09	27-Sep-09	27-Sep-09
BaSO4 Calc. using Ba* [µg/g]	340	3910	5100	6120	6970	1310	990	750
BaSO4 Calc. using SO4** [µg/g]	<2430	4860	9720	19400	24300	4860	4860	4860
Total Sulphur [%]	0.015	0.607	0.917	1.15	1.12	1.03	1.06	1.00
Carbonate (CO3) [%]	< 0.005	0.090	0.097	0.088	0.229	0.159	0.181	0.419
Total Organic Carbon [%]	0.330	13.9	14.6	13.3	10.7	16.8	17.6	16.8
Total Carbon [%]	0.326	13.9	14.6	13.3	10.7	16.8	17.6	16.9
Sulphide [%]	< 0.01	< 0.01	< 0.01	0.10	0.07	0.39	0.65	0.65
Sulphate [%]	< 0.1	0.2	0.4	0.8	1.0	0.2	0.2	0.2
Silver [µg/g]	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7
Aluminum [µg/g]	2000	8500	8300	9600	13000	7100	6000	5600
Arsenic [µg/g]	1	21	23	28	29	22	24	26
Barium [µg/g]	200	2300	3000	3600	4100	770	580	440
Beryllium [µg/g]	0.12	0.57	0.47	0.42	0.66	0.27	0.18	0.12
Bismuth [µg/g]	< 0.5	0.8	< 0.5	< 0.5	0.6	< 0.5	< 0.5	< 0.5
Calcium [µg/g]	420	3800	4600	4300	5100	6200	6700	7300
Cadmium [µg/g]	0.09	1.9	1.6	1.5	1.3	1.7	1.7	1.8
Cerium [µg/g]	15	170	200	240	310	590	680	840
Cobalt [µg/g]	2.6	59	60	64	48	28	21	16
Chromium [µg/g]	5.3	18	16	18	26	20	18	17
Cesium [µg/g]	0.21	0.70	0.81	1.1	1.6	0.86	0.82	0.87
Copper [µg/g]	2.3	57	64	84	98	61	58	56
Iron [µg/g]	5200	39000	34000	35000	50000	21000	16000	12000
Gallium [µg/g]	0.66	5.3	6.0	7.9	9.5	6.9	6.4	6.6
Germanium [µg/g]	0.3	1.7	1.8	2.0	2.6	3.1	3.3	3.8
Hafnium [µg/g]	< 0.1	0.2	0.2	0.3	0.3	0.5	0.6	0.6
Indium [µg/g]	< 0.01	< 0.01	< 0.01	< 0.01	0.02	0.01	< 0.01	< 0.01
Potassium [µg/g]	130	370	290	320	430	350	280	270
Lanthanum [µg/g]	8.9	87	110	120	140	300	360	430
Lithium [µg/g]	< 0.1	2.1	3.0	6.4	10	1.5	1.2	1.1

OnLine LIMS

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LR Report : CA10521-SEP09

Analysis	11: CORE 09-SR-2 (10-15)	12: CORE 09-SR-3 (0-5)	13: CORE 09-SR-3 (5-10)	14: CORE 09-SR-3 (10-15)	15: CORE 09-SR-3 (15-20)	16: CORE 09-SR-4 (0-5)	17: CORE 09-SR-4 (5-10)	18: CORE 09-SR-4 (10-15)
Lutetium [µg/g]	0.055	1.3	1.6	2.0	2.9	4.1	4.5	5.3
Magnesium [µg/g]	420	1300	1200	1300	1500	1400	1400	1400
Manganese [µg/g]	75	4200	2900	1100	480	550	280	180
Molybdenum [µg/g]	< 0.5	9.0	11	18	18	5.8	4.7	3.6
Sodium [µg/g]	18	53	43	43	54	64	58	59
Niobuim [µg/g]	< 0.7	0.9	1.0	1.1	1.4	1.0	0.9	0.8
Nickel [µg/g]	3	38	40	54	52	37	39	43
Lead [µg/g]	5.2	230	220	240	520	540	550	640
Phosphorus [µg/g]	68	650	580	650	660	470	380	340
Rubidium [µg/g]	1.00	3.8	3.3	3.9	5.1	4.1	3.8	4.0
Antimony [µg/g]	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Scandium [µg/g]	0.5	2.4	2.2	2.3	2.8	2.7	2.7	2.7
Selenium [µg/g]	< 1	1	1	< 1	< 1	< 1	< 1	< 1
Tin [µg/g]	< 6	< 6	< 6	< 6	< 6	< 6	< 6	< 6
Strontium [µg/g]	3.3	21	37	63	77	15	14	14
Sulphur [µg/g]	170	5500	7300	7900	7000	10000	11000	11000
Tantalum [µg/g]	< 0.01	0.04	0.07	0.07	0.09	0.11	0.13	0.15
Terbium [µg/g]	0.21	5.9	7.6	9.1	14	25	28	35
Tellerium [µg/g]	< 0.1	< 0.1	< 0.1	< 0.1	0.1	< 0.1	< 0.1	< 0.1
Thorium [µg/g]	3.4	85	120	160	490	180	120	85
Titanium [µg/g]	140	210	200	230	280	210	210	210
Thallium [µg/g]	< 3	5	< 3	< 3	< 3	< 3	< 3	< 3
Uranium [µg/g]	3.8	270	360	500	270	220	160	110
Vanadium [µg/g]	6.3	20	17	18	21	17	16	16
Tungsten [µg/g]	< 1	6	6	8	8	3	2	< 1
Yttrium [µg/g]	6.1	120	160	200	260	500	600	740
Ytterbium [µg/g]	0.41	11	14	16	24	34	38	45
Zinc [µg/g]	18	210	170	160	150	98	72	55
Zirconium [µg/g]	< 5	< 5	< 5	< 5	6	< 5	5	6

Ra226 subcontracted to Becquerel Labs.
* BaSO4 Calculation based on Ba values and assumes all Ba is in BaSO4 form.
** BaSO4 Calculation based on SO4 values and assumes all SO4 is in BaSO4 form.

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Environmental Services, Analytical

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Project : 09-1663

October 7, 2010

Ecometrix
Attn : Erin Clyde

6800 Campobello Road, Mississauga
Canada, L5N 2L8
Phone: 905-794-2325, Fax:905-794-2338

Date Rec. : 30 September 2009
LR Report: **CA10521-SEP09**

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CERTIFICATE OF ANALYSIS
Final Report (QC Report)

Analysis	**19: MDL QC - Blank QC - STD % Recovery**	**20: QC - Blank**	**21: QC - STD % Recovery**	**22: QC - DUP % Recovery**
BaSO4 Calc. using Ba* [µg/g]	---	---	---	---
BaSO4 Calc. using SO4** [µg/g]	---	---	---	---
Total Sulphur [%]	0.005	< 0.005	102%	---
Carbonate (CO3) [%]	0.005	< 0.005	100%	140%
Total Organic Carbon [%]	0.01	< 0.01	---	100%
Total Carbon [%]	0.005	< 0.005	100%	---
Sulphide [%]	0.01	< 0.01	90%	---
Sulphate [%]	0.1	< 0.1	100%	107%
Silver [µg/g]	0.7	< 0.7	93%	100%
Aluminum [µg/g]	1	< 1	97%	100%
Arsenic [µg/g]	1	< 1	99%	94%
Barium [µg/g]	0.05	< 0.05	96%	100%
Beryllium [µg/g]	0.1	< 0.1	98%	102%
Bismuth [µg/g]	0.5	< 0.5	98%	104%
Calcium [µg/g]	1	< 1	98%	100%
Cadmium [µg/g]	0.05	< 0.05	97%	99%
Cerium [µg/g]	0.006	< 0.006	94%	100%
Cobalt [µg/g]	0.3	< 0.3	97%	103%
Chromium [µg/g]	0.5	< 0.5	98%	103%
Cesium [µg/g]	0.01	< 0.01	---	107%
Copper [µg/g]	0.1	< 0.1	98%	102%
Iron [µg/g]	0.5	< 0.5	98%	100%
Gallium [µg/g]	0.03	< 0.03	---	99%
Germanium [µg/g]	0.3	< 0.3	103%	105%
Hafnium [µg/g]	0.1	< 0.1	96%	150%
Indium [µg/g]	0.01	< 0.01	100%	100%
Potassium [µg/g]	1	< 1	100%	100%

OnLine LIMS

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

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Analysis	19: MDL QC - Blank QC - STD % Recovery	20: QC - Blank	21: QC - STD % Recovery	22: QC - DUP % Recovery
Lanthanum [µg/g]	0.001	0.001	94%	110%
Lithium [µg/g]	0.1	< 0.1	97%	107%
Lutetium [µg/g]	0.001	0.001	95%	102%
Magnesium [µg/g]	1	< 1	87%	100%
Manganese [µg/g]	0.05	< 0.05	97%	100%
Molybdenum [µg/g]	0.5	< 0.5	100%	154%
Sodium [µg/g]	1	< 1	97%	104%
Niobuim [µg/g]	0.7	< 0.7	99%	118%
Nickel [µg/g]	1	< 1	97%	101%
Lead [µg/g]	0.7	< 0.7	98%	100%
Phosphorus [µg/g]	5	< 5	98%	100%
Rubidium [µg/g]	0.004	< 0.004	---	105%
Antimony [µg/g]	1	< 1	98%	100%
Scandium [µg/g]	0.2	< 0.2	100%	99%
Selenium [µg/g]	1	< 1	99%	100%
Tin [µg/g]	6	< 6	100%	1235
Strontium [µg/g]	0.01	< 0.01	97%	103%
Sulphur [µg/g]	1	< 1	100%	100%
Tantalum [µg/g]	0.01	< 0.01	97%	108%
Terbium [µg/g]	0.001	< 0.001	96%	93%
Tellerium [µg/g]	0.1	< 0.1	99%	101%
Thorium [µg/g]	0.01	< 0.01	114%	100%
Titanium [µg/g]	0.2	< 0.2	98%	104%
Thallium [µg/g]	3	< 3	99%	76%
Uranium [µg/g]	0.002	0.006	100%	100%
Vanadium [µg/g]	0.1	< 0.1	99%	102%
Tungsten [µg/g]	1	< 1	97%	93%
Yttrium [µg/g]	0.1	< 0.1	96%	100%
Ytterbium [µg/g]	0.001	0.002	98%	105%
Zinc [µg/g]	0.1	< 0.1	97%	103%
Zirconium [µg/g]	5	< 5	100%	107%

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Ra226 subcontracted to Becquerel Labs.
* BaSO4 Calculation based on Ba values and assumes all Ba is in BaSO4 form.
** BaSO4 Calculation based on SO4 values and assumes all SO4 is in BaSO4 form.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

ANALYSIS REPORT

Becquerel Laboratories Inc.
6790 Kitimat Rd., Unit 4
Mississauga, Ontario
Canada, L5N 5L9

Phone: (905) 826-3080
FAX: (905) 826-4151

Batch: T09-01386.0

Date: 12-Nov-2009

Lakefield Research Ltd.

185 Concession St., Postal Bag 4300
Lakefield, ON, K0L 2H0

attn: Brian Graham

Phone: (705) 652-2038
FAX: (705) 652-1918

Client Ref.Sep 10526
P.O: 17820

14 water samples

Received: 06-Oct-2009

Results of Analysis

Sample	Test		Result	Units	Date	Method
PW09-SR-1 (0-5)	Ra-226		0.02	Bq/l	08-Nov-2009	ALPHA
PW09-SR-1 (5-10)	Ra-226	<	0.02	Bq/l	08-Nov-2009	ALPHA
PW09-SR-1 (10-15)	Ra-226	<	0.01	Bq/l	08-Nov-2009	ALPHA
PW09-SR-1 (15-20)	Ra-226	<	0.01	Bq/l	08-Nov-2009	ALPHA
PW09-SR-2 (0-5)	Ra-226		2.4	Bq/l	08-Nov-2009	ALPHA
PW09-SR-2 (5-10)	Ra-226		2.3	Bq/l	08-Nov-2009	ALPHA
PW09-SR-2 (10-15)	Ra-226		0.87	Bq/l	08-Nov-2009	ALPHA
PW09-SR-3 (0-5)	Ra-226		5.1	Bq/l	08-Nov-2009	ALPHA
PW09-SR-3 (5-10)	Ra-226		6.0	Bq/l	08-Nov-2009	ALPHA
PW09-SR-3 (10-15)	Ra-226		5.4	Bq/l	08-Nov-2009	ALPHA
PW09-SR-3 (15-20)	Ra-226		4.5	Bq/l	08-Nov-2009	ALPHA
PW09-SR-4 (0-5)	Ra-226		0.87	Bq/l	08-Nov-2009	ALPHA
PW09-SR-4 (5-10)	Ra-226		1.2	Bq/l	08-Nov-2009	ALPHA
PW09-SR-4 (10-15)	Ra-226		1.4	Bq/l	08-Nov-2009	ALPHA

Methods: ALPHA BQ-RAD-ALPHA alpha-particle spectrometry

Units: Bq/l Becquerels per litre

These results relate only to the samples analysed and only to the items tested.

12-Nov-2009 approved by: [signature]
Donald D. Burgess PhD
Senior Scientist, Division Supervisor

SGS Lakefield Research Limited
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October 14, 2009

Date Rec. : 30 September 2009
LR Report : **CA10526-SEP09**
Project : 09-1663

CERTIFICATE OF ANALYSIS
Final Report

Analysis	**1: Analysis Start Date**	**2: Analysis Start Time**	**3: Analysis Approval Date**	**4: Analysis Approval Time**	**5: PW09-SR-1 (0-5)**	**6: PW09-SR-1 (5-10)**	**7: PW09-SR-1 (10-15)**	**8: PW09-SR-1 (15-20)**	**9: PW09-SR-2 (0-5)**
Sample Date & Time					26-Sep-09	26-Sep-09	26-Sep-09	26-Sep-09	26-Sep-09
Temperature Upon Receipt [°C]	---	---	---	---	4.0	4.0	4.0	4.0	4.0
Sulphate [mg/L]	02-Oct-09	15:00	07-Oct-09	09:19	2.6	< 2	< 2	< 2	16
Dissolved Organic Carbon [mg/L]	02-Oct-09	10:00	07-Oct-09	09:23	14.5	19.6	20.0	22.9	10.5
Dissolved Inorganic Carbon [mg/L]	05-Oct-09	14:35	08-Oct-09	12:47	< 1.0	< 1.0	3.1	2.7	2.4
Alkalinity [mg/L as CaCO3]	02-Oct-09	15:19	05-Oct-09	15:10	9	24	8	2	25
Acidity [mg/L as CaCO3]	02-Oct-09	15:19	05-Oct-09	15:10	6	< 2	3	6	< 2
Hardness [mg/L as CaCO3]	05-Oct-09	09:00	05-Oct-09	13:18	11.1	9.5	5.3	5.3	28.8
Aluminum [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	< 0.01	0.02	0.02	0.03	0.02
Arsenic [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.0014	0.0034	0.0054	0.0050	0.0015
Barium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.0271	0.0274	0.0313	0.0172	2.16
Beryllium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002
Boron [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.0052	0.0036	0.0057	0.0089	0.0046
Bismuth [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001
Calcium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	3.54	3.00	1.68	1.71	9.60
Cadmium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.000017	0.000016	0.000025	0.000056	0.000003
Cobalt [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.000762	0.000476	0.000120	0.000079	0.00216
Chromium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Copper [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.0025	0.0037	0.0023	0.0051	0.0021
Iron [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	0.29	0.81	0.06	0.08	0.01
Potassium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	0.24	0.26	0.34	0.38	0.79
Lithium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Magnesium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	0.538	0.492	0.277	0.255	1.16

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LR Report : **CA10526-SEP09**

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	5: PW09-SR-1 (0-5)	6: PW09-SR-1 (5-10)	7: PW09-SR-1 (10-15)	8: PW09-SR-1 (15-20)	9: PW09-SR-2 (0-5)
Manganese [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.365	0.305	0.245	0.325	3.91
Molybdenum [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.00069	0.00037	0.00024	0.00031	0.00064
Sodium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	1.85	1.83	1.64	2.17	2.57
Nickel [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.0007	0.0009	0.0006	0.0009	0.0011
Phosphorus [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Lead [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.00087	0.00213	0.00036	0.00124	0.00037
Sulphur [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	1.05	0.78	0.46	0.74	4.67
Antimony [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Selenium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Silica [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	1.52	1.96	2.35	2.84	1.63
Tin [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.00007	0.00022	< 0.00001	< 0.00001	< 0.00001
Strontium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	0.0121	0.0104	0.0064	0.0068	0.0668
Titanium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.0007	0.0011	0.0007	0.0012	0.0001
Thallium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Uranium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.000186	0.000137	0.000380	0.000250	0.00266
Vanadium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.00016	0.00026	0.00014	0.00029	0.00008
Zinc [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.002	0.002	0.002	0.003	0.002

Samples are field filtered
Ra226 subcontracted to Becquerel Labs.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

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Analysis	**10: PW09-SR-2 (5-10)**	**11: PW09-SR-2 (10-15)**	**12: PW09-SR-3 (0-5)**	**13: PW09-SR-3 (5-10)**	**14: PW09-SR-3 (10-15)**	**15: PW09-SR-3 (15-20)**	**16: PW09-SR-4 (0-5)**	**17: PW09-SR-4 (5-10)**	**18: PW09-SR-4 (10-15)**
Sample Date & Time	26-Sep-09	26-Sep-09	27-Sep-09	27-Sep-09	27-Sep-09	27-Sep-09	27-Sep-09	27-Sep-09	27-Sep-09
Temperature Upon Receipt [°C]	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Sulphate [mg/L]	14	---	7.9	4.0	< 2	< 2	19	8.1	4.9
Dissolved Organic Carbon [mg/L]	26.5	---	9.9	18.8	13.2	---	---	---	---
Dissolved Inorganic Carbon [mg/L]	5.0	---	14.0	26.5	32.7	---	---	---	---
Alkalinity [mg/L as CaCO3]	5	---	69	99	135	177	33	---	87
Acidity [mg/L as CaCO3]	6	---	---	---	---	---	---	< 2	---
Hardness [mg/L as CaCO3]	25.6	31.5	42.6	67.1	87.2	130	45.2	63.4	78.8
Aluminum [mg/L]	0.07	0.07	< 0.01	< 0.01	< 0.01	0.02	< 0.01	0.01	0.02
Arsenic [mg/L]	0.0030	0.0027	0.0012	0.0014	0.0039	0.0027	0.0012	0.0022	0.0051
Barium [mg/L]	2.38	1.50	1.91	3.11	3.75	3.24	0.561	0.621	0.602
Beryllium [mg/L]	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002
Boron [mg/L]	0.0068	0.0090	0.0095	0.0146	0.0356	0.0758	0.0192	0.0424	0.0817
Bismuth [mg/L]	0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001
Calcium [mg/L]	8.74	10.5	14.7	23.8	31.6	47.6	15.7	22.3	27.8
Cadmium [mg/L]	0.000010	0.000010	0.000004	0.000005	0.000008	0.000007	0.000008	0.000007	0.000015
Cobalt [mg/L]	0.000948	0.000863	0.00704	0.00374	0.00264	0.00253	0.000880	0.000284	0.000291
Chromium [mg/L]	< 0.0005	0.0007	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Copper [mg/L]	0.0046	0.0049	0.0010	0.0010	0.0015	0.0014	0.0015	0.0016	0.0019
Iron [mg/L]	0.08	0.27	3.54	4.19	6.18	0.51	1.05	0.26	0.02
Potassium [mg/L]	0.95	2.11	1.03	1.86	3.28	6.21	0.96	1.57	2.77
Lithium [mg/L]	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.004	< 0.002	< 0.002	< 0.002
Magnesium [mg/L]	0.926	1.26	1.45	1.84	1.99	2.84	1.46	1.88	2.28

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Analysis	10: PW09-SR-2 (5-10)	11: PW09-SR-2 (10-15)	12: PW09-SR-3 (0-5)	13: PW09-SR-3 (5-10)	14: PW09-SR-3 (10-15)	15: PW09-SR-3 (15-20)	16: PW09-SR-4 (0-5)	17: PW09-SR-4 (5-10)	18: PW09-SR-4 (10-15)
Manganese [mg/L]	1.82	1.34	10.8	8.04	5.58	2.89	1.24	0.613	0.341
Molybdenum [mg/L]	0.00150	0.00282	0.00065	0.00035	0.00369	0.00475	0.00056	0.00238	0.00909
Sodium [mg/L]	2.81	2.81	2.35	2.95	3.63	5.23	3.15	3.27	3.93
Nickel [mg/L]	0.0013	0.0012	0.0016	0.0018	0.0018	0.0019	0.0014	0.0009	0.0009
Phosphorus [mg/L]	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.01	< 0.01
Lead [mg/L]	0.00198	0.00084	0.00018	0.00008	0.00023	0.00004	0.00054	0.00091	0.00192
Sulphur [mg/L]	4.45	5.89	2.65	1.74	0.88	1.07	5.53	2.88	2.10
Antimony [mg/L]	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Selenium [mg/L]	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Silica [mg/L]	2.68	4.19	3.02	5.36	6.12	6.22	3.01	6.24	9.87
Tin [mg/L]	0.00004	< 0.00001	0.00003	< 0.00001	0.00007	< 0.00001	0.00002	< 0.00001	< 0.00001
Strontium [mg/L]	0.0685	0.0607	0.0508	0.0866	0.117	0.151	0.0328	0.0425	0.0515
Titanium [mg/L]	0.0012	0.0024	0.0002	0.0003	0.0004	0.0004	0.0002	0.0006	0.0008
Thallium [mg/L]	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Uranium [mg/L]	0.00258	0.000877	0.0113	0.00514	0.0400	0.0379	0.00413	0.00669	0.0110
Vanadium [mg/L]	0.00022	0.00082	0.00017	0.00033	0.00038	0.00071	0.00014	0.00032	0.00095
Zinc [mg/L]	0.004	0.005	0.002	0.004	0.003	0.003	0.003	0.002	0.002

Samples are field filtered
Ra226 subcontracted to Becquerel Labs.

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Project Specialist
Environmental Services, Analytical

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Analysis	**19: MDL**	**20: QC - Blank**	**21: QC - STD % Recovery**	**22: QC - DUP % Recovery**
Temperature Upon Receipt [°C]	---	---	---	---
Sulphate [mg/L]	0.2	< 0.2	105%	100%
Dissolved Organic Carbon [mg/L]	0.2	< 0.2	105%	98%
Dissolved Inorganic Carbon [mg/L]	0.2	0.2	97%	100%
Alkalinity [mg/L as CaCO3]	2	< 2	101%	98%
Acidity [mg/L as CaCO3]	2	3	98%	102%
Hardness [mg/L as CaCO3]	0.5	< 0.5	---	---
Aluminum [mg/L]	0.01	< 0.01	98%	---
Arsenic [mg/L]	0.0002	< 0.0002	106%	---
Barium [mg/L]	0.00001	< 0.00001	122%	---
Beryllium [mg/L]	0.00002	< 0.00002	104%	---
Boron [mg/L]	0.0002	< 0.0002	96%	---
Bismuth [mg/L]	0.00001	< 0.00001	109%	---
Calcium [mg/L]	0.03	< 0.03	101%	---
Cadmium [mg/L]	0.000003	0.000003	99%	---
Cobalt [mg/L]	0.000002	< 0.000002	102%	---
Chromium [mg/L]	0.0005	< 0.0005	102%	---
Copper [mg/L]	0.0005	< 0.0005	102%	---
Iron [mg/L]	0.01	< 0.01	102%	---
Potassium [mg/L]	0.01	< 0.01	98%	---
Lithium [mg/L]	0.002	< 0.002	98%	---
Magnesium [mg/L]	0.003	< 0.003	99%	---
Manganese [mg/L]	0.00001	< 0.00001	107%	---
Molybdenum [mg/L]	0.00001	< 0.00001	99%	---
Sodium [mg/L]	0.01	< 0.01	94%	---
Nickel [mg/L]	0.0001	< 0.0001	100%	---
Phosphorus [mg/L]	0.01	< 0.01	100%	---
Lead [mg/L]	0.00002	< 0.00002	106%	---
Sulphur [mg/L]	0.01	< 0.01	100%	---
Antimony [mg/L]	0.0002	< 0.0002	101%	---

OnLine LIMS

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Project : 09-1663

LR Report : **CA10526-SEP09**

Analysis	19: MDL	20: QC - Blank	21: QC - STD % Recovery	22: QC - DUP % Recovery
Selenium [mg/L]	0.001	< 0.001	102%	---
Silica [mg/L]	0.01	< 0.01	104%	---
Tin [mg/L]	0.00001	< 0.00001	96%	---
Strontium [mg/L]	0.0001	< 0.0001	100%	---
Titanium [mg/L]	0.0001	< 0.0001	96%	---
Thallium [mg/L]	0.0002	< 0.0002	107%	---
Uranium [mg/L]	0.000001	0.000001	106%	---
Vanadium [mg/L]	0.00003	< 0.00003	107%	---
Zinc [mg/L]	0.001	< 0.001	104%	---

Samples are field filtered
Ra226 subcontracted to Becquerel Labs.
Revised to include Ra226 results from Becquerel.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

ANALYSIS REPORT

Becquerel Laboratories Inc.
6790 Kitimat Rd., Unit 4
Mississauga, Ontario
Canada, L5N 5L9

Phone: (905) 826-3080
FAX: (905) 826-4151

Batch: T09-01385.0

Date: 09-Nov-2009

Lakefield Research Ltd.

185 Concession St., Postal Bag 4300
Lakefield, ON, K0L 2H0

attn: Brian Graham

Phone: (705) 652-2038
FAX: (705) 652-1918

Client Ref.Sep 10525
P.O: 17820

9 water samples

Received: 06-Oct-2009

Results of Analysis

Sample	Test	Result	Units	Date	Method
SW09-SR-1T	Ra-226	< 0.01	Bq/l	06-Nov-2009	ALPHA
SW09-SR-1B	Ra-226	< 0.01	Bq/l	06-Nov-2009	ALPHA
SW09-SR-2T	Ra-226	0.11	Bq/l	06-Nov-2009	ALPHA
SW09-SR-2B	Ra-226	0.28	Bq/l	06-Nov-2009	ALPHA
SW09-SR-3T	Ra-226	0.15	Bq/l	06-Nov-2009	ALPHA
SW09-SR-3B	Ra-226	0.80	Bq/l	06-Nov-2009	ALPHA
SW09-SR-4T	Ra-226	0.19	Bq/l	06-Nov-2009	ALPHA
SW09-SR-4B	Ra-226	0.30	Bq/l	06-Nov-2009	ALPHA
Blank 1	Ra-226	< 0.01	Bq/l	06-Nov-2009	ALPHA

Methods: ALPHA BQ-RAD-ALPHA alpha-particle spectrometry

Units: Bq/l Becquerels per litre

These results relate only to the samples analysed and only to the items tested.

09-Nov-2009 approved by: *[signature]*
Donald D. Burgess PhD
Senior Scientist, Division Supervisor

SGS Lakefield Research Limited
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Ecometrix
Attn : Erin Clyde

6800 Campobello Road, Mississauga
Canada, L5N 2L8
Phone: 905-794-2325, Fax:905-794-2338

October 14, 2009

Date Rec. : 30 September 2009
LR Report : **CA10525-SEP09**
Project : 09-1663

CERTIFICATE OF ANALYSIS
Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	5: SW09-SR-1T	6: SW09-SR-1B	7: SW09-SR-2T
Sample Date & Time					24-Sep-09	25-Sep-09	24-Sep-09
Temperature Upon Receipt [°C]	---	---	---	---	4.0	4.0	4.0
Sulphate [mg/L]	02-Oct-09	15:00	05-Oct-09	16:12	8.5	5.6	31
Total Organic Carbon [mg/L]	02-Oct-09	10:00	05-Oct-09	13:41	2.7	5.4	2.3
Total Inorganic Carbon [mg/L]	05-Oct-09	14:35	08-Oct-09	12:46	< 1.0	< 1.0	< 1.0
Alkalinity [mg/L as CaCO3]	02-Oct-09	15:19	05-Oct-09	15:13	---	---	---
Acidity [mg/L as CaCO3]	02-Oct-09	15:19	05-Oct-09	15:13	11	9	9
Hardness [mg/L as CaCO3]	02-Oct-09	09:00	02-Oct-09	12:09	10.4	10.2	34.8
Aluminum [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	0.02	0.02	< 0.01
Arsenic [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.0004	0.0003	0.0005
Barium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.0144	0.0155	0.120
Beryllium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	< 0.00002	< 0.00002	< 0.00002
Boron [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.0059	0.0050	0.0084
Bismuth [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	< 0.00001	< 0.00001	< 0.00001
Calcium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	3.26	3.21	11.8
Cadmium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.000013	0.000061	< 0.000003
Cobalt [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.00298	0.00250	0.00184
Chromium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	< 0.0005	< 0.0005	< 0.0005
Copper [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.0015	0.0016	0.0007
Iron [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	0.03	0.03	0.02
Potassium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	0.25	0.24	0.78
Lithium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	< 0.002	< 0.002	< 0.002
Magnesium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	0.542	0.524	1.31

OnLine LIMS

SGS Lakefield Research Limited
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

LR Report : **CA10525-SEP09**

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	5: SW09-SR-1T	6: SW09-SR-1B	7: SW09-SR-2T
Manganese [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.0313	0.0284	0.0545
Molybdenum [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.00007	0.00008	0.00022
Sodium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	1.83	1.89	2.06
Nickel [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.0004	0.0004	0.0005
Phosphorus [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	< 0.01	< 0.01	< 0.01
Lead [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.00031	0.00056	0.00031
Sulphur [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	1.66	1.67	9.17
Antimony [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.0045	0.0037	0.0028
Selenium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	< 0.001	< 0.001	< 0.001
Silica [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	0.63	0.63	0.63
Tin [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.00006	0.00019	0.00019
Strontium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	0.0117	0.0115	0.0270
Titanium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.0002	0.0002	0.0001
Thallium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	< 0.0002	< 0.0002	< 0.0002
Uranium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.000257	0.000138	0.00154
Vanadium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.00005	0.00012	0.00004
Zinc [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.003	0.003	< 0.001

Ra226 subcontracted to Becquerel Labs.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

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OnLine LIMS

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Ecometrix
Attn : Erin Clyde

6800 Campobello Road, Mississauga
Canada, L5N 2L8
Phone: 905-794-2325, Fax:905-794-2338

October 14, 2009

Date Rec. : 30 September 2009
LR Report : **CA10525-SEP09**
Project : 09-1663

CERTIFICATE OF ANALYSIS
Final Report

Analysis	8: SW09-SR-2B	9: SW09-SR-3T	10: SW09-SR-3B	11: SW09-SR-4T	12: SW09-SR-4B	13: Blank 1
Sample Date & Time	25-Sep-09	25-Sep-09	25-Sep-09	25-Sep-09	25-Sep-09	27-Sep-09
Temperature Upon Receipt [°C]	4.0	4.0	4.0	4.0	4.0	4.0
Sulphate [mg/L]	45	30	26	25	25	< 2
Total Organic Carbon [mg/L]	2.2	4.6	2.2	4.6	2.0	2.4
Total Inorganic Carbon [mg/L]	< 1.0	< 1.0	< 1.0	< 1.0	1.4	< 1.0
Alkalinity [mg/L as CaCO3]	---	---	7	---	---	---
Acidity [mg/L as CaCO3]	7	8	---	---	< 2	7
Hardness [mg/L as CaCO3]	36.5	33.7	32.7	33.0	33.4	< 0.5
Aluminum [mg/L]	0.04	< 0.01	< 0.01	0.01	< 0.01	< 0.01
Arsenic [mg/L]	0.0007	0.0004	0.0008	0.0004	0.0007	< 0.0002
Barium [mg/L]	0.294	0.147	0.334	0.191	0.222	0.00216
Beryllium [mg/L]	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002
Boron [mg/L]	0.0093	0.0079	0.0090	0.0081	0.0089	< 0.0002
Bismuth [mg/L]	< 0.00001	< 0.00001	< 0.00001	< 0.00001	0.00001	< 0.00001
Calcium [mg/L]	12.4	11.4	11.1	11.1	11.2	0.03
Cadmium [mg/L]	0.000045	0.000006	0.000011	0.000009	0.000028	< 0.000003
Cobalt [mg/L]	0.00270	0.00148	0.00178	0.000944	0.000310	0.000003
Chromium [mg/L]	0.0012	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Copper [mg/L]	0.0015	0.0012	0.0017	0.0009	0.0011	0.0053
Iron [mg/L]	0.02	0.02	0.40	0.02	0.08	< 0.01
Potassium [mg/L]	0.86	0.75	0.74	0.72	0.80	< 0.01
Lithium [mg/L]	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Magnesium [mg/L]	1.36	1.28	1.24	1.28	1.29	< 0.003

OnLine LIMS

SGS Lakefield Research Limited
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Lakefield - Ontario - KOL 2HO
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LR Report : **CA10525-SEP09**

Analysis	8: SW09-SR-2B	9: SW09-SR-3T	10: SW09-SR-3B	11: SW09-SR-4T	12: SW09-SR-4B	13: Blank 1
Manganese [mg/L]	0.253	0.0424	0.752	0.0251	0.119	0.00034
Molybdenum [mg/L]	0.00013	0.00026	0.00036	0.00029	0.00032	< 0.00001
Sodium [mg/L]	2.13	2.16	2.17	2.65	2.79	0.15
Nickel [mg/L]	0.0016	0.0006	0.0010	0.0005	0.0006	0.0003
Phosphorus [mg/L]	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Lead [mg/L]	0.00151	0.00029	0.00031	0.00027	0.00043	< 0.00002
Sulphur [mg/L]	9.22	8.86	8.73	8.40	8.58	0.05
Antimony [mg/L]	0.0041	0.0021	0.0006	0.0013	0.0002	< 0.0002
Selenium [mg/L]	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Silica [mg/L]	0.62	0.62	0.77	0.65	0.73	< 0.01
Tin [mg/L]	0.00029	0.00052	0.00009	0.00007	0.00016	< 0.00001
Strontium [mg/L]	0.0302	0.0267	0.0275	0.0266	0.0268	0.0001
Titanium [mg/L]	0.0001	0.0001	0.0002	0.0002	0.0001	< 0.0001
Thallium [mg/L]	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Uranium [mg/L]	0.00345	0.00131	0.00137	0.00146	0.00122	< 0.000001
Vanadium [mg/L]	0.00003	0.00007	0.00005	0.00005	0.00008	< 0.00003
Zinc [mg/L]	0.009	0.002	0.002	< 0.001	0.004	< 0.001

Ra226 subcontracted to Becquerel Labs.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

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OnLine LIMS

SGS

SGS Canada Inc.
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Project : 09-1663

October 7, 2010

Ecometrix
Attn : Erin Clyde

6800 Campobello Road, Mississauga
Canada, L5N 2L8
Phone: 905-794-2325, Fax:905-794-2338

Date Rec. : 30 September 2009
LR Report: **CA10525-SEP09**

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CERTIFICATE OF ANALYSIS
Final Report - (QC Report)

Analysis	14: MDL	15: QC - Blank	16: QC - STD % Recovery	17: QC - DUP % Recovery
Sulphate [mg/L]	0.2	< 0.2	105%	100%
Total Organic Carbon [mg/L]	0.2	< 0.2	105%	98%
Total Inorganic Carbon [mg/L]	0.2	0.2	97%	100%
Alkalinity [mg/L as CaCO3]	2	< 2	101%	98%
Acidity [mg/L as CaCO3]	2	3	98%	102%
Hardness [mg/L as CaCO3]	0.5	---	---	---
Aluminum [mg/L]	0.01	< 0.01	95%	100%
Arsenic [mg/L]	0.0002	< 0.0002	106%	111%
Barium [mg/L]	0.00001	< 0.00001	105%	100%
Beryllium [mg/L]	0.00002	< 0.00002	103%	94%
Boron [mg/L]	0.0002	< 0.0002	99%	97%
Bismuth [mg/L]	0.00001	0.00001	105%	82%
Calcium [mg/L]	0.03	---	98%	100%
Cadmium [mg/L]	0.000003	< 0.000003	102%	107%
Cobalt [mg/L]	0.000002	< 0.000002	105%	99%
Chromium [mg/L]	0.0005	< 0.0005	103%	170%
Copper [mg/L]	0.0005	< 0.0005	106%	85%
Iron [mg/L]	0.01	---	96.8	122
Potassium [mg/L]	0.01	< 0.01	98%	99.1
Lithium [mg/L]	0.002	< 0.002	94.2	120
Magnesium [mg/L]	0.003	---	95%	100%
Manganese [mg/L]	0.00001	< 0.00001	104%	99%
Molybdenum [mg/L]	0.00001	< 0.00001	95%	155%
Sodium [mg/L]	0.01	---	95%	99%
Nickel [mg/L]	0.0001	< 0.0001	105%	87%
Phosphorus [mg/L]	0.01	< 0.01	95%	100%
Lead [mg/L]	0.00002	< 0.00002	102%	30%
Sulphur [mg/L]	0.01	---	100%	101%
Antimony [mg/L]	0.0002	< 0.0002	94%	124%
Selenium [mg/L]	0.001	< 0.001	108%	100%

OnLine LIMS

SGS

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Project : 09-1663

LR Report : **CA10525-SEP09**

Analysis	14: MDL	15: QC - Blank	16: QC - STD % Recovery	17: QC - DUP % Recovery
Silica [mg/L]	0.01	< 0.01	103%	101%
Tin [mg/L]	0.00001	< 0.00001	96%	140%
Strontium [mg/L]	0.0001	---	98%	100%
Titanium [mg/L]	0.0001	< 0.0001	95%	130%
Thallium [mg/L]	0.0002	< 0.0002	105%	106%
Uranium [mg/L]	0.000001	< 0.000001	102%	94%
Vanadium [mg/L]	0.00003	< 0.00003	106%	150%
Zinc [mg/L]	0.001	< 0.001	106%	90%

Ra226 subcontracted to Becquerel Labs.
Revised to include Ra226 results from Becquerel

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

ANALYSIS REPORT

Becquerel Laboratories Inc.
6790 Kitimat Rd., Unit 4
Mississauga, Ontario
Canada, L5N 5L9

Phone: (905) 826-3080
FAX: (905) 826-4151

Batch: T09-01487.0

Date: 13-Nov-2009

Lakefield Research Ltd.

185 Concession St., Postal Bag 4300
Lakefield, ON, K0L 2H0

attn: Brian Graham

Phone: (705) 652-2038
FAX: (705) 652-1918

Client Ref.
Oct 10063.R09
P.O: 17820

20 solid samples Sampled: 28-Sep-2009 Received: 21-Oct-2009

Results of Analysis

Sample	Test	Result	Units	Date	Method
CORE 09-EC-1 (0-5)	Ra-226	4.1	Bq/g	11-Nov-2009	ALPHA
CORE 09-EC-1 (5-10)	Ra-226	1.6	Bq/g	11-Nov-2009	ALPHA
CORE 09-EC-2 (0-2.5)	Ra-226	7.0	Bq/g	11-Nov-2009	ALPHA
CORE 09-EC-2 (2.5-5)	Ra-226	8.3	Bq/g	11-Nov-2009	ALPHA
CORE 09-EC-2 (5-7.5)	Ra-226	9.7	Bq/g	11-Nov-2009	ALPHA
CORE 09-QC14-1 (0-5)	Ra-226	19	Bq/g	11-Nov-2009	ALPHA
CORE 09-QC14-1 (5-10)	Ra-226	13	Bq/g	11-Nov-2009	ALPHA
CORE 09-QC14-1 (10-15)	Ra-226	9.7	Bq/g	11-Nov-2009	ALPHA
CORE 09-QC14-2 (0-2.5)	Ra-226	4.3	Bq/g	12-Nov-2009	ALPHA
CORE 09-QC14-2 (2.5-5)	Ra-226	6.5	Bq/g	12-Nov-2009	ALPHA
CORE 09-QC14-2 (5-7.5)	Ra-226	9.3	Bq/g	12-Nov-2009	ALPHA
CORE 09-QC14-2 (7.5-10)	Ra-226	9.0	Bq/g	12-Nov-2009	ALPHA
CORE 09-QC14-3 (0-5)	Ra-226	16	Bq/g	12-Nov-2009	ALPHA
CORE 09-QC14-3 (5-10)	Ra-226	22	Bq/g	12-Nov-2009	ALPHA
CORE 09-QC14-3 (10-15)	Ra-226	24	Bq/g	12-Nov-2009	ALPHA
CORE 09-QC14-3 (15-20)	Ra-226	23	Bq/g	12-Nov-2009	ALPHA
CORE 09-QC14-4 (0-5)	Ra-226	16	Bq/g	12-Nov-2009	ALPHA
CORE 09-QC14-4 (5-10)	Ra-226	17	Bq/g	12-Nov-2009	ALPHA
CORE 09-QC14-4 (10-15)	Ra-226	22	Bq/g	12-Nov-2009	ALPHA
CORE 09-QC14-4 (15-20)	Ra-226	19	Bq/g	12-Nov-2009	ALPHA

ANALYSIS REPORT

Becquerel Laboratories Inc.
6790 Kitimat Rd., Unit 4
Mississauga, Ontario
Canada, L5N 5L9

Phone: (905) 826-3080
FAX: (905) 826-4151

Batch: T09-01487.0

Date: 13-Nov-2009

Methods: ALPHA BQ-RAD-ALPHA alpha-particle spectrometry

Units: Bq/g Becquerels per gram

These results relate only to the samples analysed and only to the items tested.

13-Nov-2009 approved by:

Donald D. Burgess PhD
Senior Scientist, Division Supervisor

SGS Lakefield Research Limited
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Tuesday, October 27, 2009

Date Rec. : 01 October 2009
LR. Ref. : **CA10063-OCT09**
Project : 09-1663

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CERTIFICATE OF ANALYSIS

Final Report

Analysis	**3: Analysis Approval Date**	**4: Analysis Approval Time**	**5: CORE 09-EC-1 (0-5)**	**6: CORE 09-EC-1 (5-10)**	**7: CORE 09-EC-2 (0-2.5)**	**8: CORE 09-EC-2 (2.5-5)**	**9: CORE 09-EC-2 (5-7.5)**	**10: CORE 09-QC14-1 (0-5)**
Sample Date & Time			28-Sep-09	28-Sep-09	28-Sep-09	28-Sep-09	28-Sep-09	28-Sep-09
Ba as BaSO4 Calc. * [µg/g]	---	---	160	770	480	630	530	940
SO4 as BaSO4 Calc. ** [µg/g]	---	---	7280	2430	2430	2430	2430	14600
Total Sulphur [%]	09-Oct-09	10:07	1.17	0.762	0.628	1.03	1.18	1.21
Carbonate (CO3) [%]	08-Oct-09	10:46	0.058	0.280	< 0.005	< 0.005	< 0.005	< 0.005
Total Organic Carbon [%]	09-Oct-09	10:07	10.5	16.7	0.617	0.206	0.090	0.490
Total Carbon [%]	09-Oct-09	10:07	10.5	16.8	0.616	0.207	0.089	0.489
Sulphide [%]	08-Oct-09	11:47	0.47	0.70	0.53	1.04	1.07	0.96
Sulphate [%]	13-Oct-09	16:45	0.3	0.1	0.1	0.1	0.1	0.6
Silver [µg/g]	14-Oct-09	13:32	< 0.7	< 0.7	1.5	1.2	1.1	3.0
Aluminum [µg/g]	14-Oct-09	13:32	3800	5800	1500	1200	890	6700
Arsenic [µg/g]	14-Oct-09	13:32	14	26	22	24	24	37
Barium [µg/g]	14-Oct-09	13:32	94	450	280	370	310	550
Beryllium [µg/g]	14-Oct-09	13:32	0.35	0.13	0.51	0.41	0.34	1.5
Bismuth [µg/g]	14-Oct-09	13:32	12	< 0.5	11	8.6	7.8	15
Calcium [µg/g]	14-Oct-09	13:32	4600	7400	230	110	63	2400
Cadmium [µg/g]	14-Oct-09	13:32	4.0	1.8	0.25	0.27	0.29	0.45
Cerium [µg/g]	14-Oct-09	13:32	240	800	340	300	240	600
Cobalt [µg/g]	14-Oct-09	13:32	15	17	16	21	22	25
Chromium [µg/g]	14-Oct-09	13:32	7.8	17	8.2	6.5	5.8	16
Cesium [µg/g]	14-Oct-09	13:32	1.1	0.90	0.32	0.20	0.19	1.1
Copper [µg/g]	14-Oct-09	13:32	15	56	50	54	54	120
Iron [µg/g]	14-Oct-09	13:32	240000	16000	13000	17000	19000	22000
Gallium [µg/g]	14-Oct-09	13:32	2.7	6.5	2.8	2.4	1.9	5.3
Germanium [µg/g]	14-Oct-09	13:32	7.2	4.0	1.4	1.4	1.2	2.6
Hafnium [µg/g]	14-Oct-09	13:32	0.1	0.9	0.5	0.7	0.7	1.5
Indium [µg/g]	14-Oct-09	13:32	< 0.01	0.01	0.02	0.01	0.01	0.03
Potassium [µg/g]	14-Oct-09	13:32	210	270	330	300	230	570
Lanthanum [µg/g]	14-Oct-09	13:32	130	420	190	170	140	310
Lithium [µg/g]	14-Oct-09	13:32	0.9	1.3	0.8	0.5	0.2	4.7

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LR Report : CA10063-OCT09

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: CORE 09-EC-1 (0-5)	6: CORE 09-EC-1 (5-10)	7: CORE 09-EC-2 (0-2.5)	8: CORE 09-EC-2 (2.5-5)	9: CORE 09-EC-2 (5-7.5)	10: CORE 09-QC14-1 (0-5)
Lutetium [µg/g]	14-Oct-09	13:32	1.1	5.3	0.14	0.060	0.038	1.1
Magnesium [µg/g]	14-Oct-09	13:32	240	1500	110	38	18	97
Manganese [µg/g]	14-Oct-09	13:32	84	180	18	7.6	4.6	14
Molybdenum [µg/g]	14-Oct-09	13:32	10	3.9	6.4	6.1	5.5	10
Sodium [µg/g]	14-Oct-09	13:32	40	55	11	8	5	15
Niobuim [µg/g]	14-Oct-09	13:32	2.7	< 0.7	9.7	7.8	7.5	13
Nickel [µg/g]	14-Oct-09	13:32	19	43	9	10	11	20
Lead [µg/g]	14-Oct-09	13:32	280	640	240	270	310	650
Phosphorus [µg/g]	14-Oct-09	13:32	810	360	400	360	330	820
Rubidium [µg/g]	14-Oct-09	13:32	2.5	4.0	2.6	2.0	1.4	4.1
Antimony [µg/g]	14-Oct-09	13:32	< 1	< 1	1	< 1	< 1	2
Scandium [µg/g]	14-Oct-09	13:32	1.6	3.0	0.9	0.8	0.6	2.8
Selenium [µg/g]	14-Oct-09	13:32	< 2	< 2	< 2	< 2	< 2	< 2
Tin [µg/g]	14-Oct-09	13:32	< 6	< 6	< 6	< 6	< 6	< 6
Strontium [µg/g]	14-Oct-09	13:32	7.9	14	5.1	5.4	4.6	11
Sulphur [µg/g]	14-Oct-09	13:32	15000	11000	6700	11000	12000	12000
Tantalum [µg/g]	14-Oct-09	13:32	0.05	0.23	0.07	0.12	0.28	0.30
Terbium [µg/g]	14-Oct-09	13:32	4.3	33	1.4	0.90	0.67	5.6
Tellerium [µg/g]	14-Oct-09	13:32	0.1	< 0.1	0.2	0.2	0.2	0.3
Thorium [µg/g]	14-Oct-09	13:32	120	89	560	470	380	1600
Titanium [µg/g]	14-Oct-09	13:32	91	220	330	260	240	610
Thallium [µg/g]	14-Oct-09	13:32	< 3	< 3	< 3	< 3	< 3	< 3
Uranium [µg/g]	14-Oct-09	13:32	230	150	23	18	15	83
Vanadium [µg/g]	14-Oct-09	13:32	26	17	4.0	2.7	2.4	7.2
Tungsten [µg/g]	14-Oct-09	13:32	79	5	5	5	6	8
Yttrium [µg/g]	14-Oct-09	13:32	84	750	12	6.7	5.2	87
Ytterbium [µg/g]	14-Oct-09	13:31	8.7	46	1.2	0.57	0.40	9.2
Zinc [µg/g]	14-Oct-09	13:32	65	58	8.9	8.0	5.8	23
Zirconium [µg/g]	14-Oct-09	13:32	6	< 5	30	27	26	58

Ra226 subcontracted to Becquerel Labs.
* BaSO4 Calculation based on Ba values and assumes all Ba is in BaSO4 form.
** BaSO4 Calculation based on SO4 values and assumes all SO4 is in BaSO4 form.

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Tuesday, October 27, 2009

Date Rec. : 01 October 2009
LR. Ref. : **CA10063-OCT09**
Project : 09-1663

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CERTIFICATE OF ANALYSIS

Final Report

Analysis	**11: CORE 09-QC14-1 (5-10)**	**12: CORE 09-QC14-1 (10-15)**	**13: CORE 09-QC14-2 (0-2.5)**	**14: CORE 09-QC14-2 (2.5-5)**	**15: CORE 09-QC14-2 (5-7.5)**	**16: CORE 09-QC14-2 (7.5-10)**	**17: CORE 09-QC14-3 (0-5)**
Sample Date & Time	28-Sep-09	28-Sep-09	28-Sep-09	28-Sep-09	28-Sep-09	28-Sep-09	28-Sep-09
Ba as BaSO4 Calc. * [µg/g]	580	480	260	370	560	540	920
SO4 as BaSO4 Calc. ** [µg/g]	53400	29100	2430	2430	2430	2430	<2430
Total Sulphur [%]	2.33	2.21	0.633	0.885	0.871	1.29	1.35
Carbonate (CO3) [%]	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.005
Total Organic Carbon [%]	0.114	0.065	0.519	0.289	0.121	0.086	0.617
Total Carbon [%]	0.115	0.064	0.519	0.289	0.121	0.086	0.618
Sulphide [%]	1.56	1.80	0.52	0.77	0.84	1.26	1.37
Sulphate [%]	2.2	1.2	0.1	0.1	0.1	0.1	< 0.1
Silver [µg/g]	1.7	1.3	0.8	1.0	1.1	1.3	3.4
Aluminum [µg/g]	3800	2600	830	690	850	1400	7700
Arsenic [µg/g]	33	26	17	19	21	23	36
Barium [µg/g]	340	280	150	220	330	320	540
Beryllium [µg/g]	0.81	0.61	0.28	0.28	0.34	0.51	1.7
Bismuth [µg/g]	10	8.1	7.5	9.2	8.5	7.6	15
Calcium [µg/g]	8900	4900	190	130	79	59	350
Cadmium [µg/g]	0.42	0.43	0.18	0.22	0.22	0.31	0.55
Cerium [µg/g]	610	430	300	290	280	250	770
Cobalt [µg/g]	35	36	15	18	17	24	38
Chromium [µg/g]	8.2	6.2	4.7	4.9	5.7	6.6	18
Cesium [µg/g]	0.49	0.32	0.18	0.22	0.31	0.20	0.55
Copper [µg/g]	100	88	43	46	42	51	140
Iron [µg/g]	21000	21000	10000	12000	13000	18000	22000
Gallium [µg/g]	4.3	3.0	2.1	2.1	2.0	1.9	6.2
Germanium [µg/g]	2.6	2.1	1.2	1.2	1.2	1.2	3.1
Hafnium [µg/g]	1.2	0.9	0.3	0.6	1.0	0.7	1.5
Indium [µg/g]	0.02	0.02	< 0.01	< 0.01	0.01	0.01	0.04
Potassium [µg/g]	440	290	210	230	250	250	600
Lanthanum [µg/g]	310	220	170	170	160	140	390
Lithium [µg/g]	1.8	1.0	0.2	0.1	0.4	0.7	5.7

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Analysis	**11: CORE 09-QC14-1 (5-10)**	**12: CORE 09-QC14-1 (10-15)**	**13: CORE 09-QC14-2 (0-2.5)**	**14: CORE 09-QC14-2 (2.5-5)**	**15: CORE 09-QC14-2 (5-7.5)**	**16: CORE 09-QC14-2 (7.5-10)**	**17: CORE 09-QC14-3 (0-5)**
Lutetium [µg/g]	1.4	1.1	0.081	0.048	0.031	0.036	1.9
Magnesium [µg/g]	76	65	88	46	25	23	120
Manganese [µg/g]	5.3	5.4	13	8.6	4.7	3.9	20
Molybdenum [µg/g]	7.8	7.3	5.3	5.2	7.9	4.8	8.0
Sodium [µg/g]	12	7	8	7	6	6	16
Niobuim [µg/g]	7.2	4.9	7.0	8.2	8.4	7.7	15
Nickel [µg/g]	25	24	8	8	8	12	32
Lead [µg/g]	490	390	180	260	270	230	650
Phosphorus [µg/g]	490	320	260	300	360	350	830
Rubidium [µg/g]	3.2	2.1	1.9	1.9	1.8	1.6	4.3
Antimony [µg/g]	< 1	< 1	< 1	< 1	< 1	< 1	2
Scandium [µg/g]	1.5	1.0	0.5	0.4	0.5	0.8	3.0
Selenium [µg/g]	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Tin [µg/g]	< 6	< 6	< 6	< 6	< 6	< 6	< 6
Strontium [µg/g]	12	8.5	3.6	4.1	4.8	4.6	7.5
Sulphur [µg/g]	22000	20000	6500	8700	8600	12000	13000
Tantalum [µg/g]	0.15	0.09	0.04	0.05	0.12	0.35	0.45
Terbium [µg/g]	7.5	5.5	0.97	0.83	0.68	0.64	9.5
Tellerium [µg/g]	0.2	0.2	0.1	0.2	0.2	0.2	0.3
Thorium [µg/g]	880	630	310	310	360	580	1800
Titanium [µg/g]	370	240	210	250	260	240	630
Thallium [µg/g]	< 3	< 3	< 3	< 3	< 3	< 3	< 3
Uranium [µg/g]	71	47	17	17	13	15	120
Vanadium [µg/g]	3.7	2.8	2.7	2.7	2.7	2.6	8.0
Tungsten [µg/g]	7	7	3	4	5	6	8
Yttrium [µg/g]	160	100	9.1	6.8	5.5	5.1	180
Ytterbium [µg/g]	12	9.1	0.74	0.46	0.33	0.36	16
Zinc [µg/g]	28	24	8.8	6.9	4.7	5.4	42
Zirconium [µg/g]	38	27	20	26	28	25	57

Ra226 subcontracted to Becquerel Labs.
* BaSO4 Calculation based on Ba values and assumes all Ba is in BaSO4 form.
** BaSO4 Calculation based on SO4 values and assumes all SO4 is in BaSO4 form.

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CERTIFICATE OF ANALYSIS

Final Report

Analysis	**18: CORE 09-QC14-3 (5-10)**	**19: CORE 09-QC14-3 (10-15)**	**20: CORE 09-QC14-3 (15-20)**	**21: CORE 09-QC14-4 (0-5)**	**22: CORE 09-QC14-4 (5-10)**	**23: CORE 09-QC14-4 (10-15)**	**24: CORE 09-QC14-4 (15-20)**
Sample Date & Time	28-Sep-09	28-Sep-09	28-Sep-09	28-Sep-09	28-Sep-09	28-Sep-09	28-Sep-09
Ba as BaSO4 Calc. * [µg/g]	1090	1120	1070	970	950	990	800
SO4 as BaSO4 Calc. ** [µg/g]	4850	7280	7280	4850	46100	87400	75200
Total Sulphur [%]	1.48	1.39	1.60	1.48	2.00	2.36	2.58
Carbonate (CO3) [%]	< 0.005	< 0.005	< 0.005	0.022	0.100	0.123	0.034
Total Organic Carbon [%]	0.136	0.112	0.097	0.683	0.188	0.178	0.109
Total Carbon [%]	0.136	0.113	0.096	0.688	0.208	0.202	0.116
Sulphide [%]	1.43	1.32	1.48	1.40	1.37	1.08	1.44
Sulphate [%]	0.2	0.3	0.3	0.2	1.9	3.6	3.1
Silver [µg/g]	3.2	3.9	3.7	3.0	2.9	4.0	2.9
Aluminum [µg/g]	7700	11000	9000	6500	6200	10000	7500
Arsenic [µg/g]	45	49	46	40	38	40	38
Barium [µg/g]	640	660	630	570	560	580	470
Beryllium [µg/g]	1.6	2.1	1.9	1.4	1.4	2.0	1.5
Bismuth [µg/g]	15	16	15	15	14	17	14
Calcium [µg/g]	710	940	1300	1400	9900	19000	16000
Cadmium [µg/g]	0.61	0.66	0.58	0.64	0.56	0.64	0.55
Cerium [µg/g]	1100	1200	1000	900	830	1100	890
Cobalt [µg/g]	45	41	38	39	35	38	38
Chromium [µg/g]	17	24	21	16	15	21	16
Cesium [µg/g]	0.77	0.88	0.76	0.54	0.70	0.87	0.81
Copper [µg/g]	140	160	160	130	120	160	130
Iron [µg/g]	24000	25000	24000	23000	22000	24000	23000
Gallium [µg/g]	7.5	8.6	7.5	6.4	6.1	8.0	6.3
Germanium [µg/g]	4.2	4.4	4.1	3.5	3.3	4.0	3.5
Hafnium [µg/g]	2.2	2.4	2.2	1.5	1.8	2.5	2.2
Indium [µg/g]	0.04	0.05	0.06	0.04	0.03	0.05	0.04
Potassium [µg/g]	630	730	690	600	600	760	650
Lanthanum [µg/g]	560	600	520	460	420	540	450
Lithium [µg/g]	5.2	7.7	7.0	4.9	5.7	10	6.2

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Analysis	**18: CORE 09-QC14-3 (5-10)**	**19: CORE 09-QC14-3 (10-15)**	**20: CORE 09-QC14-3 (15-20)**	**21: CORE 09-QC14-4 (0-5)**	**22: CORE 09-QC14-4 (5-10)**	**23: CORE 09-QC14-4 (10-15)**	**24: CORE 09-QC14-4 (15-20)**
Lutetium [µg/g]	3.1	3.3	2.8	2.3	2.0	3.5	2.6
Magnesium [µg/g]	300	220	120	770	520	1300	400
Manganese [µg/g]	35	31	18	79	53	130	57
Molybdenum [µg/g]	5.8	8.1	8.9	9.0	9.4	8.0	6.6
Sodium [µg/g]	15	18	15	18	16	21	18
Niobuim [µg/g]	9.5	9.0	8.9	13	11	12	10
Nickel [µg/g]	38	39	34	31	28	37	31
Lead [µg/g]	690	720	680	630	550	800	640
Phosphorus [µg/g]	840	930	860	760	740	950	710
Rubidium [µg/g]	4.8	5.8	5.4	4.3	4.3	5.4	5.0
Antimony [µg/g]	< 1	1	1	1	1	1	< 1
Scandium [µg/g]	3.1	4.2	3.6	2.7	2.5	3.8	2.9
Selenium [µg/g]	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Tin [µg/g]	< 6	< 6	< 6	< 6	< 6	< 6	< 6
Strontium [µg/g]	11	14	15	9.2	16	21	18
Sulphur [µg/g]	14000	14000	15000	14000	19000	22000	25000
Tantalum [µg/g]	0.27	0.27	0.28	0.48	0.57	0.55	0.48
Terbium [µg/g]	17	18	14	12	10	18	13
Tellerium [µg/g]	0.3	0.4	0.4	0.3	0.3	0.4	0.3
Thorium [µg/g]	1900	2400	2200	1600	1600	2400	1800
Titanium [µg/g]	660	680	640	590	550	740	570
Thallium [µg/g]	< 3	< 3	< 3	< 3	< 3	< 3	< 3
Uranium [µg/g]	100	110	110	100	100	140	110
Vanadium [µg/g]	7.7	9.3	8.3	7.4	6.4	9.8	6.7
Tungsten [µg/g]	8	9	8	8	8	8	8
Yttrium [µg/g]	370	350	290	240	220	360	260
Ytterbium [µg/g]	26	28	24	19	17	30	22
Zinc [µg/g]	58	59	51	46	42	59	46
Zirconium [µg/g]	64	68	64	56	54	70	58

Ra226 subcontracted to Becquerel Labs.
* BaSO4 Calculation based on Ba values and assumes all Ba is in BaSO4 form.
** BaSO4 Calculation based on SO4 values and assumes all SO4 is in BaSO4 form.

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Final Report (QC Report)

Analysis	25: MDL	26: QC - Blank	27: QC - STD % Recovery	28: QC - DUP % Recovery
Ba as BaSO4 Calc. * [µg/g]	---	---	---	---
SO4 as BaSO4 Calc. ** [µg/g]	---	---	---	---
Total Sulphur [%]	0.005	< 0.005	100%	98%
Carbonate (CO3) [%]	0.005	< 0.005	101%	100%
Total Organic Carbon [%]	0.01	---	---	---
Total Carbon [%]	0.005	< 0.005	100%	95%
Sulphide [%]	0.01	< 0.01	103%	100%
Sulphate [%]	0.1	< 0.1	98%	107%
Silver [µg/g]	0.7	< 0.7	98%	93%
Aluminum [µg/g]	1	< 1	99%	114%
Arsenic [µg/g]	1	< 1	98%	96%
Barium [µg/g]	0.05	< 0.05	100%	110%
Beryllium [µg/g]	0.1	< 0.1	100%	111%
Bismuth [µg/g]	0.5	< 0.5	98%	100%
Calcium [µg/g]	1	< 1	99%	103%
Cadmium [µg/g]	0.05	< 0.05	98%	100%
Cerium [µg/g]	0.006	< 0.006	107%	99%
Cobalt [µg/g]	0.3	< 0.3	96%	965
Chromium [µg/g]	0.5	< 0.5	99%	106%
Cesium [µg/g]	0.01	< 0.01	100%	99%
Copper [µg/g]	0.1	< 0.1	101%	110%
Iron [µg/g]	0.5	< 0.5	98%	91%
Gallium [µg/g]	0.03	< 0.03	100%	101%
Germanium [µg/g]	0.3	< 0.3	100%	95%
Hafnium [µg/g]	0.1	< 0.1	100%	120%
Indium [µg/g]	0.01	< 0.01	100%	109%
Potassium [µg/g]	1	< 1	100%	110%
Lanthanum [µg/g]	0.001	< 0.001	101%	99%
Lithium [µg/g]	0.1	< 0.1	99%	100%
Lutetium [µg/g]	0.001	< 0.001	96%	99%
Magnesium [µg/g]	1	< 1	100%	105%
Manganese [µg/g]	0.05	< 0.05	98%	108%
Molybdenum [µg/g]	0.5	< 0.5	101%	74%

OnLine LIMS

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Project : 09-1663

LR Report : **CA10063-OCT09**

Analysis	25: MDL	26: QC - Blank	27: QC - STD % Recovery	28: QC - DUP % Recovery
Sodium [µg/g]	1	< 1	102%	104%
Niobuim [µg/g]	0.7	< 0.7	100%	99%
Nickel [µg/g]	1	< 1	99%	103%
Lead [µg/g]	0.7	< 0.7	98%	110%
Phosphorus [µg/g]	5	< 5	98%	106%
Rubidium [µg/g]	0.004	< 0.004	100%	100%
Antimony [µg/g]	1	< 1	102%	100%
Scandium [µg/g]	0.2	< 0.2	100%	103%
Selenium [µg/g]	1	< 2	97%	100%
Tin [µg/g]	6	< 6	103%	94%
Strontium [µg/g]	0.01	< 0.01	100%	96%
Sulphur [µg/g]	1	< 1	---	90%
Tantalum [µg/g]	0.01	< 0.01	100%	101%
Terbium [µg/g]	0.001	< 0.001	94%	100%
Tellerium [µg/g]	0.1	< 0.1	100%	107%
Thorium [µg/g]	0.01	< 0.01	100%	99%
Titanium [µg/g]	0.2	< 0.2	104%	99%
Thallium [µg/g]	3	< 3	97%	100%
Uranium [µg/g]	0.002	< 0.002	---	97%
Vanadium [µg/g]	0.1	< 0.1	100%	109%
Tungsten [µg/g]	1	< 1	99%	100%
Yttrium [µg/g]	0.1	< 0.1	100%	110%
Ytterbium [µg/g]	0.001	---	100%	100%
Zinc [µg/g]	0.1	< 0.1	98%	103%
Zirconium [µg/g]	5	< 5	102%	105%

Ra226 subcontracted to Becquerel Labs.
* BaSO4 Calculation based on Ba values and assumes all Ba is in BaSO4 form.
** BaSO4 Calculation based on SO4 values and assumes all SO4 is in BaSO4 form.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

Becquerel LABORATORIES

ANALYSIS REPORT

Becquerel Laboratories Inc.
6790 Kitimat Rd., Unit 4
Mississauga, Ontario
Canada, L5N 5L9

Phone: (905) 826-3080
FAX: (905) 826-4151

Batch: T09-01384.0

Date: 04-Nov-2009

Lakefield Research Ltd.

185 Concession St., Postal Bag 4300
Lakefield, ON, K0L 2H0

attn: Brian Graham

Phone: (705) 652-2038
FAX: (705) 652-1918

Client Ref.Oct 10066
P.O: 17820

23 water samples   Received: 06-Oct-2009

Results of Analysis

Sample	Test	Result	Units	Date	Method
SW09-QC14-1T	Ra-226	0.77	Bq/l	27-Oct-2009	ALPHA
SW09-QC14-1B	Ra-226	1.0	Bq/l	27-Oct-2009	ALPHA
SW09-QC14-2T	Ra-226	0.82	Bq/l	27-Oct-2009	ALPHA
SW09-QC14-2B	Ra-226	0.91	Bq/l	27-Oct-2009	ALPHA
SW09-QC14-3T	Ra-226	0.71	Bq/l	27-Oct-2009	ALPHA
SW09-QC14-3B	Ra-226	0.95	Bq/l	31-Oct-2009	ALPHA
SW09-QC14-4T	Ra-226	0.79	Bq/l	31-Oct-2009	ALPHA
SW09-QC14-4B	Ra-226	0.95	Bq/l	31-Oct-2009	ALPHA
PW09-QC14-1 (0-5)	Ra-226	1.8	Bq/l	31-Oct-2009	ALPHA
PW09-QC14-1 (5-10)	Ra-226	1.4	Bq/l	01-Nov-2009	ALPHA
PW09-QC14-1 (10-15)	Ra-226	0.97	Bq/l	01-Nov-2009	ALPHA
PW09-QC14-2 (0-2.5)	Ra-226	3.6	Bq/l	01-Nov-2009	ALPHA
PW09-QC14-2 (2.5-5)	Ra-226	2.8	Bq/l	01-Nov-2009	ALPHA
PW09-QC14-2 (5-7.5)	Ra-226	5.9	Bq/l	01-Nov-2009	ALPHA
PW09-QC14-2 (7.5-10)	Ra-226	6.9	Bq/l	01-Nov-2009	ALPHA
PW09-QC14-3 (0-5)	Ra-226	4.1	Bq/l	01-Nov-2009	ALPHA
PW09-QC14-3 (5-10)	Ra-226	3.4	Bq/l	01-Nov-2009	ALPHA
PW09-QC14-3 (10-15)	Ra-226	2.6	Bq/l	01-Nov-2009	ALPHA
PW09-QC14-3 (15-20)	Ra-226	2.5	Bq/l	01-Nov-2009	ALPHA
PW09-QC14-4 (0-5)	Ra-226	4.8	Bq/l	01-Nov-2009	ALPHA
PW09-QC14-4 (5-10)	Ra-226	1.6	Bq/l	01-Nov-2009	ALPHA
PW09-QC14-4 (10-15)	Ra-226	2.2	Bq/l	01-Nov-2009	ALPHA
PW09-QC14-4 (15-20)	Ra-226	0.42	Bq/l	01-Nov-2009	ALPHA

ANALYSIS REPORT

Becquerel Laboratories Inc.
6790 Kitimat Rd., Unit 4
Mississauga, Ontario
Canada, L5N 5L9

Phone: (905) 826-3080
FAX: (905) 826-4151

Batch: T09-01384.0

Date: 04-Nov-2009

Methods: ALPHA BQ-RAD-ALPHA alpha-particle spectrometry MDL 0.01 Bq/l

Units: Bq/l Becquerels per litre

These results relate only to the samples analysed and only to the items tested.
These results have not been corrected for blanks

04-Nov-2009 approved by: ______________________
Donald D. Burgess PhD
Senior Scientist, Division Supervisor

SGS Lakefield Research Limited
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Phone: 905-794-2325, Fax:905-794-2338

October 14, 2009

Date Rec. : 01 October 2009
LR Report : **CA10066-OCT09**
Project : 09-1663

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	13: PW09-QC14-1 (0-5)	14: PW09-QC14-1 (5-10)	15: PW09-QC14-1 (10-15)	16: PW09-QC14-2 (0-2.5)	17: PW09-QC14-2 (2.5-5)
Sample Date & Time					27-Sep-09	27-Sep-09	29-Sep-09	28-Sep-09	28-Sep-09
Sulphate [mg/L]	02-Oct-09	19:39	06-Oct-09	14:20	---	---	1500	32	12
Tot. Suspended Solids [mg/L]	05-Oct-09	10:24	06-Oct-09	12:15	---	---	---	---	---
Dissolved Organic Carbon [mg/L]	02-Oct-09	10:00	06-Oct-09	13:53	---	---	4.7	28.0	18.3
Dissolved Inorganic Carbon [mg/L]	05-Oct-09	14:35	07-Oct-09	12:41	---	---	1.0	< 1.0	< 1.0
Total Organic Carbon [mg/L]	02-Oct-09	10:00	05-Oct-09	13:40	---	---	---	---	---
Acidity [mg/L as CaCO3]	02-Oct-09	15:00	08-Oct-09	09:53	---	---	49	21	15
Hardness [mg/L as CaCO3]	05-Oct-09	09:00	05-Oct-09	13:21	731	1294	1335	26.2	16.9
Aluminum [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	< 0.01	< 0.01	< 0.01	< 0.01	0.03
Arsenic [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.0082	0.0102	0.0064	0.0064	0.0084
Barium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.0577	0.0283	0.0212	0.309	0.308
Beryllium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002
Boron [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.0048	0.0107	0.0138	0.0054	0.0047
Bismuth [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	< 0.00001	< 0.00001	0.00008	0.00003	0.00024
Calcium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:21	290	516	532	8.79	5.68
Cadmium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.000012	0.000050	0.000118	0.000055	< 0.000003
Cobalt [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.0154	0.0367	0.0438	0.00521	0.000917
Chromium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Copper [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	< 0.0005	0.0008	0.0012	0.0043	0.0025
Iron [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	63.9	40.0	24.3	0.03	0.52
Potassium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	1.21	1.34	1.49	0.34	0.40
Lithium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	0.002	0.002	< 0.002	< 0.002	< 0.002
Magnesium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	1.63	1.48	1.37	1.02	0.664

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LR Report : **CA10066-OCT09**

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	13: PW09-QC14-1 (0-5)	14: PW09-QC14-1 (5-10)	15: PW09-QC14-1 (10-15)	16: PW09-QC14-2 (0-2.5)	17: PW09-QC14-2 (2.5-5)
Manganese [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.771	0.503	0.346	0.282	0.133
Molybdenum [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.00589	0.0119	0.00918	0.00029	0.00133
Sodium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	1.77	2.04	2.08	2.35	1.98
Nickel [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.0050	0.0172	0.0173	0.0044	0.0012
Phosphorus [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	< 0.01	< 0.01	< 0.01	< 0.01	0.01
Lead [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.00069	0.00078	0.00202	0.0242	0.00596
Sulphur [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	242	396	399	8.28	3.87
Antimony [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	< 0.0002	< 0.0002	< 0.0002	0.0002	0.0006
Selenium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Silica [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	8.09	10.3	10.3	1.23	1.71
Tin [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	< 0.00001	0.00004	0.00008	0.00004	< 0.00001
Strontium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	0.149	0.260	0.266	0.0205	0.0154
Titanium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.0006	0.0007	0.0007	0.0003	0.0062
Thallium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Uranium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.0136	0.0589	0.0445	0.000946	0.000524
Vanadium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.00010	0.00011	0.00013	0.00007	0.00013
Zinc [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.011	0.039	0.041	0.005	0.003

Groundwater samples are field filtered
Ra226 subcontracted to Becquerel Labs.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

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October 14, 2009

Date Rec. : 01 October 2009
LR Report : **CA10066-OCT09**
Project : 09-1663

CERTIFICATE OF ANALYSIS
Final Report

Analysis	18: PW09-QC14-2 (5-7.5)	19: PW09-QC14-2 (7.5-10)	20: PW09-QC14-3 (0-5)	21: PW09-QC14-3 (5-10)	22: PW09-QC14-3 (10-15)	23: PW09-QC14-3 (15-20)	24: PW09-QC14-4 (0-5)	25: PW09-QC14-4 (5-10)	26: PW09-QC14-4 (10-15)	27: PW09-QC14-4 (15-20)
Sample Date & Time	28-Sep-09	28-Sep-09	29-Sep-09	29-Sep-09	29-Sep-09	29-Sep-09	29-Sep-09	29-Sep-09	29-Sep-09	29-Sep-09
Sulphate [mg/L]	12	---	5.6	6.8	18	240	560	1400	1400	1400
Tot. Suspended Solids [mg/L]	---	---	---	---	---	---	---	---	---	---
Dissolved Organic Carbon [mg/L]	17.9	---	3.5	3.2	2.8	3.8	9.3	6.6	7.3	4.0
Dissolved Inorganic Carbon [mg/L]	< 1.0	---	2.0	3.0	4.7	3.1	< 1.0	4.7	3.1	5.9
Total Organic Carbon [mg/L]	---	---	---	---	---	---	---	---	---	---
Acidity [mg/L as CaCO3]	16	---	6	< 4	< 4	< 4	19	< 4	---	---
Hardness [mg/L as CaCO3]	17.9	19.1	18.0	24.5	42.8	250	512	1362	1335	1310
Aluminum [mg/L]	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.04	< 0.01
Arsenic [mg/L]	0.0066	0.0066	0.0026	0.0025	0.0040	0.0042	0.0050	0.0054	0.0026	0.0027
Barium [mg/L]	0.519	0.499	0.333	0.233	0.131	0.0762	0.231	0.0657	0.0328	0.0197
Beryllium [mg/L]	< 0.00002	< 0.00002	0.00013	0.00005	0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002
Boron [mg/L]	0.0051	0.0044	0.0026	0.0070	0.0121	0.0162	0.0220	0.0944	0.0802	0.0387
Bismuth [mg/L]	0.00006	< 0.00001	0.00012	0.00004	0.00001	0.00001	0.00005	0.00002	0.00001	0.00003
Calcium [mg/L]	6.06	6.44	6.12	8.51	15.5	97.4	195	536	527	519
Cadmium [mg/L]	0.000005	0.000006	0.000112	0.000043	0.000034	0.000086	0.000029	0.000016	0.000017	0.000015
Cobalt [mg/L]	0.000766	0.000876	0.00189	0.00766	0.00912	0.0123	0.00473	0.00237	0.00186	0.00185
Chromium [mg/L]	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Copper [mg/L]	0.0015	0.0007	< 0.0005	< 0.0005	< 0.0005	< 0.0005	0.0009	0.0007	0.0006	0.0008
Iron [mg/L]	2.46	6.07	7.18	6.88	5.66	7.35	23.5	1.62	0.41	0.26
Potassium [mg/L]	0.62	0.53	0.37	0.50	0.60	0.90	0.65	1.06	0.94	0.92
Lithium [mg/L]	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.002	0.002	< 0.002	< 0.002
Magnesium [mg/L]	0.675	0.734	0.670	0.801	0.980	1.78	6.05	5.49	4.43	3.52

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LR Report : CA10066-OCT09

Analysis	18: PW09-QC14-2 (5-7.5)	19: PW09-QC14-2 (7.5-10)	20: PW09-QC14-3 (0-5)	21: PW09-QC14-3 (5-10)	22: PW09-QC14-3 (10-15)	23: PW09-QC14-3 (15-20)	24: PW09-QC14-4 (0-5)	25: PW09-QC14-4 (5-10)	26: PW09-QC14-4 (10-15)	27: PW09-QC14-4 (15-20)
Manganese [mg/L]	0.133	0.146	0.143	0.161	0.191	0.249	1.27	0.400	0.352	0.251
Molybdenum [mg/L]	0.00107	0.00241	0.00045	0.00042	0.00155	0.00615	0.00339	0.0289	0.0291	0.0149
Sodium [mg/L]	1.79	1.51	1.30	1.20	1.36	1.63	2.05	2.00	1.94	1.80
Nickel [mg/L]	0.0012	0.0011	0.0010	0.0019	0.0020	0.0039	0.0025	0.0020	0.0018	0.0019
Phosphorus [mg/L]	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.02	< 0.01	0.02	< 0.01
Lead [mg/L]	0.00098	0.00018	0.00029	0.00023	0.00027	0.00042	0.00043	0.00047	0.00044	0.00059
Sulphur [mg/L]	3.61	4.46	1.67	2.21	5.91	69.9	155	391	387	385
Antimony [mg/L]	0.0004	0.0005	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	0.0003	0.0003	< 0.0002
Selenium [mg/L]	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.002	< 0.001	< 0.001	< 0.001	0.002
Silica [mg/L]	2.15	3.04	5.18	7.70	8.81	8.23	4.59	3.66	2.45	3.95
Tin [mg/L]	< 0.00001	< 0.00001	< 0.00001	< 0.00001	0.00005	0.00011	0.00004	0.00006	0.00010	0.00022
Strontium [mg/L]	0.0204	0.0211	0.0170	0.0318	0.0499	0.146	0.137	0.277	0.263	0.268
Titanium [mg/L]	0.0005	0.0002	0.0003	0.0005	0.0005	0.0005	0.0004	0.0004	0.0003	0.0003
Thallium [mg/L]	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Uranium [mg/L]	0.000143	0.000072	0.000744	0.000806	0.000839	0.00957	0.0421	0.275	0.242	0.233
Vanadium [mg/L]	0.00006	0.00006	0.00019	0.00012	0.00014	0.00016	0.00013	0.00022	0.00021	0.00023
Zinc [mg/L]	0.002	0.003	0.002	0.005	0.008	0.015	0.006	0.003	0.003	0.003

Groundwater samples are field filtered
Ra226 subcontracted to Becquerel Labs.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

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October 14, 2009

Date Rec. : 01 October 2009
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Project : 09-1663

CERTIFICATE OF ANALYSIS
Final Report

Analysis	**5: SW09-QC14-1T**	**6: SW09-QC14-1B**	**7: SW09-QC14-2T**	**8: SW09-QC14-2B**	**9: SW09-QC14-3T**	**10: SW09-QC14-3B**	**11: SW09-QC14-4T**	**12: SW09-QC14-4B**
Sample Date & Time	26-Sep-09	26-Sep-09	27-Sep-09	27-Sep-09	27-Sep-09	27-Sep-09	27-Sep-09	27-Sep-09
Sulphate [mg/L]	55	32	72	32	54	35	57	25
Tot. Suspended Solids [mg/L]	---	---	---	43	---	---	---	6
Dissolved Organic Carbon [mg/L]	13.3	18.5	14.4	19.4	15.1	16.0	13.4	14.2
Dissolved Inorganic Carbon [mg/L]	2.4	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Total Organic Carbon [mg/L]	---	---	---	5.3	---	---	---	5.2
Acidity [mg/L as CaCO3]	31	20	56	15	29	15	31	20
Hardness [mg/L as CaCO3]	17.1	18.3	16.9	16.6	16.7	16.9	16.8	16.9
Aluminum [mg/L]	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic [mg/L]	0.0006	0.0008	0.0006	0.0011	0.0007	0.0009	0.0006	0.0012
Barium [mg/L]	0.109	0.116	0.104	0.108	0.105	0.105	0.0989	0.109
Beryllium [mg/L]	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002
Boron [mg/L]	0.0044	0.0045	0.0045	0.0056	0.0045	0.0047	0.0043	0.0053
Bismuth [mg/L]	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001
Calcium [mg/L]	5.72	6.24	5.69	5.55	5.59	5.69	5.63	5.67
Cadmium [mg/L]	0.000023	0.000029	0.000023	0.000023	0.000021	0.000035	0.000017	0.000052
Cobalt [mg/L]	0.00304	0.00143	0.00549	0.00169	0.00246	0.00165	0.00297	0.00144
Chromium [mg/L]	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Copper [mg/L]	0.0051	0.0045	0.0038	0.0023	0.0040	0.0034	0.0030	0.0025
Iron [mg/L]	0.02	0.36	0.04	0.01	0.02	0.07	0.02	0.01
Potassium [mg/L]	0.32	0.30	0.32	0.26	0.31	0.29	0.30	0.27
Lithium [mg/L]	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Magnesium [mg/L]	0.679	0.667	0.663	0.657	0.660	0.658	0.664	0.667

OnLine LIMS

SGS Lakefield Research Limited
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

LR Report : **CA10066-OCT09**

Analysis	**5: SW09-QC14-1T**	**6: SW09-QC14-1B**	**7: SW09-QC14-2T**	**8: SW09-QC14-2B**	**9: SW09-QC14-3T**	**10: SW09-QC14-3B**	**11: SW09-QC14-4T**	**12: SW09-QC14-4B**
Manganese [mg/L]	0.0328	0.0379	0.0288	0.0353	0.0292	0.0337	0.0272	0.0348
Molybdenum [mg/L]	0.00001	0.00002	< 0.00001	0.00002	< 0.00001	< 0.00001	< 0.00001	0.00003
Sodium [mg/L]	1.84	1.87	1.82	1.83	1.81	1.78	1.88	1.73
Nickel [mg/L]	0.0027	0.0025	0.0025	0.0024	0.0024	0.0024	0.0023	0.0026
Phosphorus [mg/L]	0.01	< 0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Lead [mg/L]	0.00375	0.00604	0.00717	0.00597	0.00374	0.00642	0.00386	0.00361
Sulphur [mg/L]	4.72	5.21	4.69	4.74	4.64	4.78	4.74	4.76
Antimony [mg/L]	0.0034	0.0007	0.0077	0.0007	0.0021	0.0009	0.0027	0.0005
Selenium [mg/L]	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Silica [mg/L]	0.59	0.63	0.58	0.59	0.58	0.64	0.58	0.63
Tin [mg/L]	0.00002	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001
Strontium [mg/L]	0.0122	0.0125	0.0121	0.0120	0.0119	0.0122	0.0120	0.0122
Titanium [mg/L]	< 0.0001	< 0.0001	0.0003	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Thallium [mg/L]	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Uranium [mg/L]	0.00107	0.000679	0.000535	0.000338	0.000489	0.000749	0.000386	0.000459
Vanadium [mg/L]	0.00004	0.00004	0.00006	0.00005	0.00005	0.00004	0.00004	0.00004
Zinc [mg/L]	0.003	0.004	0.002	0.005	0.002	0.004	0.003	0.005

Ra226 subcontracted to Becquerel Labs.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

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OnLine LIMS

SGS

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Env ICP-MS Metals

Project : 09-1663

October 7, 2010

Ecometrix
Attn : Erin Clyde

6800 Campobello Road, Mississauga
Canada, L5N 2L8
Phone: 905-794-2325, Fax:905-794-2338

Date Rec. : 01 October 2009
LR Report: **CA10066-OCT09**

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report (QC Report)

Analysis	28: MDL	29: QC - Blank	30: QC - STD % Recovery	31: QC - DUP % Recovery
Sulphate [mg/L]	0.2	< 0.2	100%	110%
Tot. Suspended Solids [mg/L]	2	< 2	96%	83%
Dissolved Organic Carbon [mg/L]	0.2	< 0.2	105%	98%
Dissolved Inorganic Carbon [mg/L]	0.2	0.7	107%	100%
Total Organic Carbon [mg/L]	0.2	< 0.2	105%	98%
Acidity [mg/L as CaCO3]	4	< 4	98%	102%
Hardness [mg/L as CaCO3]	0.5	---	---	---
Aluminum [mg/L]	0.01	< 0.01	98%	---
Arsenic [mg/L]	0.0002	< 0.0002	106%	---
Barium [mg/L]	0.00001	< 0.00001	122%	---
Beryllium [mg/L]	0.00002	< 0.00002	104%	---
Boron [mg/L]	0.0002	< 0.0002	96%	---
Bismuth [mg/L]	0.00001	< 0.00001	109%	---
Calcium [mg/L]	0.03	< 0.03	101%	---
Cadmium [mg/L]	0.000003	0.000003	99%	---
Cobalt [mg/L]	0.000002	< 0.000002	102%	---
Chromium [mg/L]	0.0005	< 0.0005	102%	---
Copper [mg/L]	0.0005	< 0.0005	102%	---
Iron [mg/L]	0.01	< 0.01	102%	---
Potassium [mg/L]	0.01	< 0.01	98%	---
Lithium [mg/L]	0.002	< 0.002	98%	---
Magnesium [mg/L]	0.003	< 0.003	98%	---
Manganese [mg/L]	0.00001	< 0.00001	107%	---
Molybdenum [mg/L]	0.00001	< 0.00001	99%	---
Sodium [mg/L]	0.01	< 0.01	94%	---
Nickel [mg/L]	0.0001	< 0.0001	100%	---
Phosphorus [mg/L]	0.01	< 0.01	100%	---
Lead [mg/L]	0.00002	< 0.00002	106%	---

OnLine LIMS

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
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Phone: 705-652-2000 FAX: 705-652-6365

Env ICP-MS Metals

Project : 09-1663

LR Report : **CA10066-OCT09**

Analysis	28: MDL	29: QC - Blank	30: QC - STD % Recovery	31: QC - DUP % Recovery
Sulphur [mg/L]	0.01	< 0.01	98%	---
Antimony [mg/L]	0.0002	< 0.0002	101%	---
Selenium [mg/L]	0.001	< 0.001	102%	---
Silica [mg/L]	0.01	< 0.01	104%	---
Tin [mg/L]	0.00001	< 0.00001	96%	---
Strontium [mg/L]	0.0001	< 0.0001	100%	---
Titanium [mg/L]	0.0001	< 0.0001	96%	---
Thallium [mg/L]	0.0002	< 0.0002	107%	---
Uranium [mg/L]	0.000001	0.000001	1065	---
Vanadium [mg/L]	0.00003	< 0.00003	107%	---
Zinc [mg/L]	0.001	< 0.001	104%	---

Ra226 subcontracted to Becquerel Labs.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

ANALYSIS REPORT

Becquerel Laboratories Inc.
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Phone: (905) 826-3080
FAX: (905) 826-4151

Batch: T09-01383.0

Date: 20-Oct-2009

Lakefield Research Ltd.

185 Concession St., Postal Bag 4300
Lakefield, ON, K0L 2H0

attn: Brian Graham

Phone: (705) 652-2038
FAX: (705) 652-1918

Client Ref.Oct 10069
P.O: 17820

5 water samples   Sampled: 29-Sep-2009   Received: 06-Oct-2009   Page 1 of 1

Results of Analysis

Sample	Test	Result	Units	Date	Method
PW09 EC2 0-2.5	Ra-226	2.9	Bq/l	18-Oct-2009	ALPHA
PW09 EC2 2.5-5	Ra-226	3.3	Bq/l	18-Oct-2009	ALPHA
PW09 EC2 5-7.5	Ra-226	5.4	Bq/l	18-Oct-2009	ALPHA
PW09 EC1 0-5	Ra-226	0.30	Bq/l	18-Oct-2009	ALPHA
PW09 EC1 5-10	Ra-226	4.7	Bq/l	18-Oct-2009	ALPHA

Methods: ALPHA BQ-RAD-ALPHA alpha-particle spectrometry

Units: Bq/l Becquerels per litre

These results relate only to the samples analysed and only to the items tested.

20-Oct-2009 approved by:
Donald D. Burgess PhD
Senior Scientist, Division Supervisor

SGS Lakefield Research Limited
P.O. Box 4300 - 185 Concession St.
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Ecometrix
Attn : Erin Clyde

6800 Campobello Road, Mississauga
Canada, L5N 2L8
Phone: 905-794-2325, Fax:905-794-2338

October 14, 2009

Date Rec. : 01 October 2009
LR Report : **CA10069-OCT09**
Project : 09-1663

CERTIFICATE OF ANALYSIS
Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	5: PW09 EC2 0-2.5	6: PW09 EC2 2.5-5	7: PW09 EC2 5-7.5	8: PW09 EC1 0-5	9: PW09 EC1 5-10
Sample Date & Time					29-Sep-09	29-Sep-09	29-Sep-09	29-Sep-09	29-Sep-09
Temperature Upon Receipt [°C]	---	---	---	---	9.0	9.0	9.0	9.0	9.0
Sulphate [mg/L]	02-Oct-09	19:39	06-Oct-09	12:35	27	18	---	---	---
Dissolved Organic Carbon [mg/L]	05-Oct-09	09:40	06-Oct-09	13:53	19.0	14.3	---	---	---
Dissolved Inorganic Carbon [mg/L]	06-Oct-09	08:15	07-Oct-09	12:40	4.2	1.1	---	---	---
Acidity [mg/L as CaCO3]	02-Oct-09	15:00	06-Oct-09	11:07	17	16	---	---	---
Hardness [mg/L as CaCO3]	05-Oct-09	09:00	05-Oct-09	13:17	21.7	16.0	16.4	33.9	17.8
Aluminum [mg/L]	05-Oct-09	09:00	05-Oct-09	13:17	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.0058	0.0046	0.0065	0.0006	0.0024
Barium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.285	0.337	0.487	0.221	0.335
Beryllium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002
Boron [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.0039	0.0034	0.0039	0.0082	0.0028
Bismuth [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.00003	0.00006	0.00003	< 0.00001	< 0.00001
Calcium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:17	7.28	5.35	5.54	11.4	6.06
Cadmium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.000031	0.000012	0.000009	0.000012	< 0.000003
Cobalt [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.00289	0.00120	0.00183	0.000321	0.00192
Chromium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Copper [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.0018	0.0018	0.0011	0.0010	< 0.0005
Iron [mg/L]	05-Oct-09	09:00	05-Oct-09	13:17	0.44	3.30	5.71	0.07	6.63
Potassium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:17	0.30	0.34	0.48	0.80	0.58
Lithium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:17	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Magnesium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:17	0.864	0.634	0.632	1.31	0.655

SGS Lakefield Research Limited
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Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

LR Report : CA10069-OCT09

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	5: PW09 EC2 0-2.5	6: PW09 EC2 2.5-5	7: PW09 EC2 5-7.5	8: PW09 EC1 0-5	9: PW09 EC1 5-10
Manganese [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.217	0.134	0.132	0.120	0.142
Molybdenum [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.00015	0.00116	0.00149	0.00029	0.00051
Sodium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:17	2.20	1.87	1.50	2.75	1.24
Nickel [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.0024	0.0013	0.0017	0.0008	0.0010
Phosphorus [mg/L]	05-Oct-09	09:00	05-Oct-09	13:17	0.07	0.01	< 0.01	< 0.01	< 0.01
Lead [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.00216	0.00090	0.00049	0.00023	0.00016
Sulphur [mg/L]	05-Oct-09	09:00	05-Oct-09	13:17	6.26	3.35	4.21	7.26	1.58
Antimony [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.0003	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Selenium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Silica [mg/L]	05-Oct-09	09:00	05-Oct-09	13:17	1.42	1.86	2.71	0.72	5.07
Tin [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.00017	< 0.00001	0.00001	< 0.00001	0.00002
Strontium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:17	0.0168	0.0149	0.0187	0.0269	0.0168
Titanium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.0007	0.0004	0.0002	< 0.0001	0.0003
Thallium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Uranium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.000173	0.000115	0.000105	0.000835	0.000671
Vanadium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.00008	0.00007	0.00004	0.00007	0.00005
Zinc [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.005	0.004	0.003	0.003	0.001

Samples are field filtered
Ra226 subcontracted to Becquerel Labs.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

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Lakefield - Ontario - KOL 2HO
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LR Report : **CA10069-OCT09**

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OnLine LIMS

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Phone: 705-652-2000 FAX: 705-652-6365

Env ICP-MS Metals

Project : 09-1663

October 7, 2010

Ecometrix
Attn : Erin Clyde

6800 Campobello Road, Mississauga
Canada, L5N 2L8
Phone: 905-794-2325, Fax:905-794-2338

Date Rec. : 01 October 2009
LR Report: **CA10069-OCT09**

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CERTIFICATE OF ANALYSIS
Final Report

Analysis	10: MDL	11: QC - Blank	12: QC - STD % Recovery	13: QC - DUP % Recovery
Sulphate [mg/L]	0.2	< 0.2	100%	110%
Dissolved Organic Carbon [mg/L]	0.2	< 0.2	91%	100%
Dissolved Inorganic Carbon [mg/L]	0.2	0.7	107%	100%
Acidity [mg/L as CaCO3]	2	3	98%	102%
Hardness [mg/L as CaCO3]	0.5	< 0.5	---	---
Aluminum [mg/L]	0.01	< 0.01	98%	---
Arsenic [mg/L]	0.0002	< 0.0002	106%	---
Barium [mg/L]	0.00001	< 0.00001	122%	---
Beryllium [mg/L]	0.00002	< 0.00002	104%	---
Boron [mg/L]	0.0002	< 0.0002	96%	---
Bismuth [mg/L]	0.00001	< 0.00001	109%	---
Calcium [mg/L]	0.03	< 0.03	101%	---
Cadmium [mg/L]	0.000003	0.000003	99%	---
Cobalt [mg/L]	0.000002	< 0.000002	102%	---
Chromium [mg/L]	0.0005	< 0.0005	102%	---
Copper [mg/L]	0.0005	< 0.0005	102%	---
Iron [mg/L]	0.01	< 0.01	102%	---
Potassium [mg/L]	0.01	< 0.01	98%	---
Lithium [mg/L]	0.002	< 0.002	98%	---
Magnesium [mg/L]	0.003	< 0.003	98%	---
Manganese [mg/L]	0.00001	< 0.00001	107%	---
Molybdenum [mg/L]	0.00001	< 0.00001	99%	---
Sodium [mg/L]	0.01	< 0.01	94%	---
Nickel [mg/L]	0.0001	< 0.0001	100%	---
Phosphorus [mg/L]	0.01	< 0.01	100%	---
Lead [mg/L]	0.00002	< 0.00002	106%	---
Sulphur [mg/L]	0.01	< 0.01	98%	---
Antimony [mg/L]	0.0002	< 0.0002	101%	---

OnLine LIMS

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Env ICP-MS Metals

Project : 09-1663

LR Report : **CA10069-OCT09**

Analysis	10: MDL	11: QC - Blank	12: QC - STD % Recovery	13: QC - DUP % Recovery
Selenium [mg/L]	0.001	< 0.001	102%	---
Silica [mg/L]	0.01	< 0.01	104%	---
Tin [mg/L]	0.00001	< 0.00001	96%	---
Strontium [mg/L]	0.0001	< 0.0001	100%	---
Titanium [mg/L]	0.0001	< 0.0001	96%	---
Thallium [mg/L]	0.0002	< 0.0002	107%	---
Uranium [mg/L]	0.000001	0.000001	107%	---
Vanadium [mg/L]	0.00003	< 0.00003	107%	---
Zinc [mg/L]	0.001	< 0.001	104%	---

Samples are field filtered
Ra226 subcontracted to Becquerel Labs.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

ANALYSIS REPORT

Becquerel Laboratories Inc.
6790 Kitimat Rd., Unit 4
Mississauga, Ontario
Canada, L5N 5L9

Phone: (905) 826-3080
FAX: (905) 826-4151

Batch: T09-01382.0

Date: 20-Oct-2009

Lakefield Research Ltd.

185 Concession St., Postal Bag 4300
Lakefield, ON, K0L 2H0

attn: Brian Graham

Phone: (705) 652-2038
FAX: (705) 652-1918

Client Ref.Oct 10064
P.O: 17820

6 water samples   Sampled: 28-Sep-2009   Received: 06-Oct-2009

Results of Analysis

Sample	Test	Result	Units	Date	Method
SW09 QC15-1	Ra-226	0.42	Bq/l	17-Oct-2009	ALPHA
SW09 QC15-2	Ra-226	0.45	Bq/l	18-Oct-2009	ALPHA
SW09 QC15-3	Ra-226	0.46	Bq/l	18-Oct-2009	ALPHA
SW09 QC15-4	Ra-226	0.45	Bq/l	18-Oct-2009	ALPHA
SW09 EC-2T	Ra-226	0.78	Bq/l	18-Oct-2009	ALPHA
SW09 EC-2B	Ra-226	0.85	Bq/l	18-Oct-2009	ALPHA

Methods: ALPHA BQ-RAD-ALPHA alpha-particle spectrometry

Units: Bq/l Becquerels per litre

These results relate only to the samples analysed and only to the items tested.

20-Oct-2009 approved by: [signature]
Donald D. Burgess PhD
Senior Scientist, Division Supervisor

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Ecometrix
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Canada, L5N 2L8
Phone: 905-794-2325, Fax:905-794-2338

October 14, 2009

Date Rec. : 01 October 2009
LR Report : **CA10064-OCT09**
Project : 09-1663

CERTIFICATE OF ANALYSIS
Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	5: SW09 QC15-1	6: SW09 QC15-2	7: SW09 QC15-3	8: SW09 QC15-4	9: SW09 EC-2T	10: SW09 EC-2B
Sample Date & Time					28-Sep-09	28-Sep-09	28-Sep-09	28-Sep-09	28-Sep-09	28-Sep-09
Temperature Upon Receipt [°C]	---	---	---	---	9.0	9.0	9.0	9.0	9.0	9.0
Sulphate [mg/L]	02-Oct-09	19:39	06-Oct-09	14:22	570	570	570	600	85	36
Acidity [mg/L as CaCO3]	02-Oct-09	15:00	05-Oct-09	15:14	22	27	44	50	67	16
Total Organic Carbon [mg/L]	05-Oct-09	09:40	06-Oct-09	13:53	---	---	---	---	11.4	11.7
Total Inorganic Carbon [mg/L]	05-Oct-09	14:35	08-Oct-09	12:46	---	---	---	---	< 1.0	< 1.0
Hardness [mg/L as CaCO3]	05-Oct-09	09:00	05-Oct-09	13:19	529	535	532	549	17.0	16.8
Aluminum [mg/L]	05-Oct-09	09:00	05-Oct-09	13:19	< 0.01	< 0.01	< 0.01	0.02	0.03	< 0.01
Arsenic [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.0010	0.0009	0.0009	0.0011	0.0007	0.0007
Barium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.0334	0.0301	0.0300	0.0296	0.108	0.114
Beryllium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.00006	< 0.00002	0.00002	< 0.00002	0.00003	0.00002
Boron [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.113	0.113	0.115	0.116	0.0076	0.0072
Bismuth [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.00004	0.00002	0.00001	< 0.00001	0.00002	0.00002
Calcium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:19	202	205	204	210	5.69	5.63
Cadmium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.000074	0.000051	0.000039	0.000031	0.000046	0.000056
Cobalt [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.00558	0.00464	0.0106	0.0122	0.00655	0.00196
Chromium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Copper [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.0017	0.0014	0.0013	0.0016	0.0037	0.0029
Iron [mg/L]	05-Oct-09	09:00	05-Oct-09	13:19	0.10	0.06	0.16	0.18	0.07	0.04
Potassium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:19	10.8	11.0	10.9	11.9	0.31	0.32
Lithium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:19	0.008	0.008	0.008	0.009	< 0.002	< 0.002
Magnesium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:19	5.69	5.79	5.77	6.19	0.670	0.663

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LR Report : **CA10064-OCT09**

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	5: SW09 QC15-1	6: SW09 QC15-2	7: SW09 QC15-3	8: SW09 QC15-4	9: SW09 EC-2T	10: SW09 EC-2B
Manganese [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.207	0.214	0.214	0.310	0.0315	0.0319
Molybdenum [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.00319	0.00409	0.00368	0.00533	0.00018	0.00008
Sodium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:19	2.38	2.42	2.37	2.59	1.59	1.58
Nickel [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.0067	0.0067	0.0067	0.0068	0.0022	0.0022
Phosphorus [mg/L]	05-Oct-09	09:00	05-Oct-09	13:19	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Lead [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.00151	0.00098	0.00194	0.00548	0.00699	0.00391
Sulphur [mg/L]	05-Oct-09	09:00	05-Oct-09	13:19	157	160	160	166	4.64	4.63
Antimony [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.0017	0.0010	0.0093	0.0106	0.0086	0.0016
Selenium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Silica [mg/L]	05-Oct-09	09:00	05-Oct-09	13:19	5.46	5.55	5.54	5.55	0.59	0.60
Tin [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.00002	0.00012	0.00002	0.00025	< 0.00001	< 0.00001
Strontium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:19	0.159	0.161	0.160	0.166	0.0122	0.0122
Titanium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.0005	0.0004	0.0005	0.0004	0.0004	0.0001
Thallium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Uranium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.0143	0.0116	0.0144	0.0219	0.000654	0.00079
Vanadium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.00009	0.00004	0.00004	< 0.00003	0.00007	0.00007
Zinc [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.005	0.004	0.004	0.004	0.004	0.005

Ra226 subcontracted to Becquerel Labs.

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OnLine LIMS

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Env ICP-MS Metals

Project : 09-1663

October 7, 2010

Ecometrix
Attn : Erin Clyde

6800 Campobello Road, Mississauga
Canada, L5N 2L8
Phone: 905-794-2325, Fax:905-794-2338

Date Rec. : 01 October 2009
LR Report: **CA10064-OCT09**

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report (QC Report)

Analysis	11: MDL	12: QC - Blank	13: QC - STD % Recovery	14: QC - DUP % Recovery
Sulphate [mg/L]	0.2	< 0.2	98%	102%
Acidity [mg/L as CaCO3]	2	3	98%	102%
Total Organic Carbon [mg/L]	1	< 1	91%	100%
Total Inorganic Carbon [mg/L]	0.2	0.2	97%	100%
Hardness [mg/L as CaCO3]	0.5	< 0.5	---	---
Aluminum [mg/L]	0.01	< 0.01	99%	---
Arsenic [mg/L]	0.0002	< 0.0002	106%	---
Barium [mg/L]	0.00001	< 0.00001	122%	---
Beryllium [mg/L]	0.00002	< 0.00002	104%	---
Boron [mg/L]	0.0002	< 0.0002	96%	---
Bismuth [mg/L]	0.00001	< 0.00001	109%	---
Calcium [mg/L]	0.03	< 0.03	101%	---
Cadmium [mg/L]	0.000003	0.000003	99%	---
Cobalt [mg/L]	0.000002	< 0.000002	102%	---
Chromium [mg/L]	0.0005	< 0.0005	102%	---
Copper [mg/L]	0.0005	< 0.0005	102%	---
Iron [mg/L]	0.01	< 0.01	102%	---
Potassium [mg/L]	0.01	< 0.01	98%	---
Lithium [mg/L]	0.002	< 0.002	98%	---
Magnesium [mg/L]	0.003	< 0.003	99%	---
Manganese [mg/L]	0.00001	< 0.00001	107%	---
Molybdenum [mg/L]	0.00001	< 0.00001	99%	---
Sodium [mg/L]	0.01	< 0.01	93%	---
Nickel [mg/L]	0.0001	< 0.0001	100%	---
Phosphorus [mg/L]	0.01	< 0.01	100%	---
Lead [mg/L]	0.00002	< 0.00002	106%	---
Sulphur [mg/L]	0.01	< 0.01	98%	---
Antimony [mg/L]	0.0002	< 0.0002	101%	---
Selenium [mg/L]	0.001	< 0.001	102%	---
Silica [mg/L]	0.01	< 0.01	104%	---
Tin [mg/L]	0.00001	< 0.00001	96%	---
Strontium [mg/L]	0.0001	< 0.0001	100%	---
Titanium [mg/L]	0.0001	< 0.0001	96%	---
Thallium [mg/L]	0.0002	< 0.0002	107%	---

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Env ICP-MS Metals

Project : 09-1663

LR Report : **CA10064-OCT09**

Analysis	11: MDL	12: QC - Blank	13: QC - STD % Recovery	14: QC - DUP % Recovery
Uranium [mg/L]	0.000001	0.000001	1065	---
Vanadium [mg/L]	0.00003	< 0.00003	107%	---
Zinc [mg/L]	0.001	< 0.001	104%	---

Ra226 subcontracted to Becquerel Labs.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
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Radium-226 in Serpent River Sediments

EcoMetrix Incorporated

CYCLE III SPECIAL STUDIES – RADIUM-226 IN SERPENT RIVER SEDIMENTS

Report prepared for:

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09-1663
February 2011

CYCLE III SPECIAL STUDIES – RADIUM-226 IN SERPENT RIVER SEDIMENTS

Erin Clyde, M.Sc.
Project Manager

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Project Principal

EXECUTIVE SUMMARY

The Denison Site (the Site) is a decommissioned uranium mine property located approximately 12 km north of the City of Elliot Lake and immediately west of Quirke Lake and east of the Serpent River. The Site is owned by Denison Mines Inc. (DMI) and care and maintenance for the Site is provided by Denison Environmental Services (DES), a division of DMI.

EcoMetrix Incorporated (EcoMetrix) was retained by DMI to complete a directed study that focused on the hypothesis that historic accumulation of Ra-226 in the Serpent River sediments and the subsequent release of Ra-226 from the sediment to the surface water have resulted in majority of the observed load at D-5 that were reported in the 2008 State of the Environment report.

The main objective of this study was to evaluate Ra-226 activities in sediments, porewater and surface water from the Serpent River to develop and understanding of the source of the Ra-226 load differences between monitoring stations D-4 and D-5. The second objective was to evaluate future load trends in the Serpent River.

Load differences in the Serpent River between D-4 and D-5 cannot be explained by or attributed to the Ra-226 activities and loads that have discharged from the Denison TMA since 1990. It was hypothesized that the source of the Ra-226 loads in the Serpent River are related to high Ra-226 activities in the sediments that would have accumulated as a result of historic loads from the TMAs. The treated waters that currently discharge from the Denison TMAs have low Ra-226 activities. High concentrations in the sediment have initiated recovery of the sediment via release of Ra-226 into the water column.

Four stations were sampled along the main flow path of the Serpent River in the quiescent bays to quantify the changes in Ra-226 activities in the sediments between D-4 and D-5. Chemical characterization of the sediments showed that Ra-226 activities were elevated in downstream samples compared to those located upstream of the Denison Mine Site. These results indicated that in the past Ra-226 had accumulated in the sediments.

Chemical characterization of the sediment porewater and the overlying surface water showed that Ra-226 activities in the porewater were higher than those measured in the surface water. These results indicate that a concentration gradient has developed and imply that upward diffusion from the porewater to the surface water is occurring.

The high Ra-226 activities in the sediments and porewater, together with low Ra-226 activities in the discharge from the Denison TMAs, have likely initiated recovery of the sediment and release of Ra-226 to the surface water as a result of desorption from the solids into sediment porewater and diffusive transport from porewater to the water column.

A sediment model that includes diffusive processes as the primary mechanism for sediment recovery was applied to the field data to estimate Ra-226 loads from sediment to surface water and to evaluate the recovery of the sediments. The purpose of the modeling exercise was to verify whether the loads calculated at D-5 in the 2008 State of the Environment report could be the result of Ra-226 recovery via diffusive processes from the sediments. The model was not used to definitively predict Ra-226 activities or loads in the future, but rather was used as a tool to test the reasonableness of the observed loads and to illustrate potential future trends for Ra-226 loads.

The sediment model predicted a cumulative load of 3,420 MBq/a in 2009 that was expected to decrease with time. Accounting for the decrease in loads with time, the results from the model agreed well with the average load at D-5 of 5,300 MBq/a for the 2003 through 2006 time period calculated in the 2008 State of the Environment report. This result indicates that the Ra-226 load at D-5 can be explained by the recovery of historically accumulated Ra-226 in the sediments and its diffusive transport of Ra-226 from the porewater to the surface water.

The sediment model was used to illustrate potential future trends for Ra-226 loads for the 2009 through 2012 time period. The model indicated that over time the recovery of Ra-226 from the sediment will result in decreased loads at D-5.

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1.0 INTRODUCTION

The Denison Site (the Site) is a decommissioned uranium mine property located approximately 12 km north of Elliot Lake and immediately west of Quirke Lake and east of the Serpent River (**Figure 1.1**). The Site is owned by Denison Mines Inc. (DMI) and care and maintenance for the Site is provided by Denison Environmental Services (DES), a division of DMI.

EcoMetrix Incorporated (EcoMetrix) was retained by DMI to complete a directed study that focused on the hypothesis that historic accumulation of Ra-226 in the Serpent River sediments and the subsequent release of Ra-226 from the sediment to the surface water have resulted in the majority of the observed load at D-5 that were reported in the State of the Environment (SOE) report (Minnow, 2008).

Routine monitoring at the Denison Mine Site is conducted as three directed studies. The Serpent River Watershed Monitoring Program (SRWMP) is a comprehensive watershed monitoring program that was implemented to replace the various, mine-specific environmental monitoring programs at each mine site. The Source Area Monitoring Program (SAMP) was developed to monitor the nature and quantity of constituents that discharge from the Tailings Management Areas (TMAs) to the Serpent River Watershed. The TMA Operational Monitoring Program (TOMP) was designed to evaluate the performance of the TMAs.

EcoMetrix completed a performance evaluation of the SAMP and TOMP results to 2006 (EcoMetrix, 2008). As part of the review, and where appropriate, special studies were recommended to complement the monitoring programs as well as to refine our understanding of the long-term performances of the tailings facilities. Specifically, it was recommended that a special study be conducted in the Serpent River to verify the hypothesis that the historic accumulation of Ra-226 in the sediment and its subsequent release could be responsible for the observed increase in loads at D-5 downstream of the Denison Site.

1.1 Objectives and Scope of Work

The main objective of this study was to evaluate Ra-226 activities in sediments, porewater and surface water from the Serpent River to develop an understanding of the source of Ra-226 load differences between monitoring stations D-4 and D-5. The second objective was to evaluate future load trends in the Serpent River.

The scope of work for the Serpent River Study included the following:

- collection and analysis of sediment cores, porewater and surface water from four locations between monitoring stations D-4 and D-5;

- data assessment to determine potential reasons for the loading differences between D-4 and D-5; and
- modeling of the key constituents to investigate trends of future loadings and recovery.

2.0 BACKGROUND

The Denison Mine and Mill operated from 1957 to 1992, producing about 63 million tonnes of tailings. Approximately 60 million tonnes of tailings were deposited in TMA-1, formerly Bear Cub Lake and Long Lake, and 3 million tonnes of tailings deposited in TMA-2, formerly Upper Williams Lake (**Figure 2.1**). Following closure, decommissioning of the Denison TMAs included flooding the tailings (Minnow, 2008).

Overlying water from TMA-2 flows into TMA-1 via a constructed spillway. Effluent from TMA-1 is treated at the Denison Effluent Treatment Plant (ETP). Treatment at the Denison ETP consists of barium chloride addition for removal of Ra-226 and sodium hydroxide addition for pH adjustment. Treated water is released into the Stollery Settling Pond where treatment solids settle out prior to discharge into the Serpent River (**Figure 2.1**). The outflow from the Stollery Settling Pond is continuously monitored by DES at station D-2.

Seepage from TMA-2 is treated at the Lower Williams Lake Treatment Plant. Treatment includes the addition of barium chloride for removal of Ra-226 (Minnow, 2008). Effluent from the treatment plant is directed to the Lower Williams Settling Pond, where treatment solids settle out. The overflow from the pond discharges into the Serpent River as shown in **Figure 2.1** (Minnow, 2008). The outflow from the Lower Williams Settling Pond is monitored by DES at Station D-3.

Two monitoring stations, D-4 and D-5 are located in the Serpent River upstream and downstream of the Denison TMAs, respectively (**Figure 2.1**). These stations are sampled as part of the SRWMP in order to monitor the influences on the receiving environment from the discharge waters from the Denison TMA.

The monitoring data, to date, have demonstrated excellent performance and recovery of the Denison TMA. However, it was noted that loadings of Ra-226 in excess of the Ra-226 loads exiting the Denison TMAs have been observed in the Serpent River, adjacent to the Denison facilities (Minnow, 2008). The calculated Ra-226 loadings were estimated in 2008 to be approximately 300 MBq/a upstream of Denison at D-4 and approximately 5,300 MBq/a downstream from the TMAs at D-5 (**Figure 2.2**). It was hypothesized that Ra-226 present in the sediments as a result of historic loadings, prior to effective water treatment facilities, may be responsible for the observed loadings difference between stations. If historic loadings of Ra-226 were high, substantial accumulation of Ra-226 in the sediments might have occurred as a result of Ra-226 adsorption to, and deposition of, sediment materials. The treated waters that currently discharge from the Denison TMAs have low Ra-226 activities (**Figure 2.3**) and account for a Ra-226 load of approximately 200 MBq/a (**Figure 2.2**). The decrease in Ra-226 activities in the present discharge, with high concentrations in the sediment due to historic accumulation, could have initiated recovery of the sediment via release of Ra-226 into the water column. This behaviour is typical for sediment-water interactions. As recovery of the sediment occurs, the Ra-226 activity in the water will increase above the values entering the river from upstream. In this case, the Ra-

226 activities increased from values of less than 0.02 Bq/L at station D-4 to values close to 0.15 Bq/L at station D-5 (**Figure 2.3**) to account for a loadings difference of about 5,000 MBq/a between stations.

A compilation of the routine monitoring data for Ra-226 activities at sampling stations D-2, D-3, D-4, D-5 and D-6 is provided in **Appendix 1**.

3.0 SAMPLE COLLECTION AND PROCESSING

Sampling was conducted along the main flow path of the Serpent River near quiescent bays between stations D-4 and D-5 (**Figure 2.1**). Four stations were established to obtain representative samples to quantify the changes in Ra-226 activities in the sediments between D-4 and D-5. The first station (SR-1) was located upstream of the Stollery Settling Pond outflow confluence with the Serpent River. The second (SR-2) and third (SR-3) stations represented locations downstream of D-2, the discharge area from the Stollery Settling Pond. The fourth station (SR-4) was located downstream of the outflow from the Williams Settling Pond (D-3) and close to station D-5. A map illustrating the sampling locations is provided in **Figure 2.1**. A photographic log of the sampling stations and core samples collected at SR-3 and SR-4 are provided in **Appendix 2**.

3.1 Sediment Samples

Sediment samples were collected using a 4-inch diameter K-B coring device. At each location a total of four cores were collected to achieve sufficient sample volume for porewater extraction from the sediments.

The cores were sectioned at 5 cm intervals to depths of 15 or 20 cm. The corresponding intervals from the core sets at each sampling station were composited and placed into dedicated Ziploc bags and stored at 4°C until the porewater samples were extracted. Sub-samples of the sediments, pre-porewater extraction, were collected and transported to the EcoMetrix Laboratory for moisture content testing.

After the porewater was extracted (described in **Section 3.2**) the sediment samples were placed into dedicated Ziploc bags and stored at 4°C until analysed. Sediment samples were sent to SGS Lakefield Laboratories for chemical analysis that included Ra-226, metals, major ions, sulphate, sulphur and carbon. The Ra-226 analyses were completed by Becquerel Laboratories under subcontract to SGS Lakefield.

3.2 Porewater Samples

Porewater samples were extracted from the core samples in a field-based laboratory facility within 24 hours of collection. Each 5 cm interval from the composited core sets collected at each sampling station was transferred into 750 mL centrifuge bottles. The samples were centrifuged at approximately 3,500 rpm for 45 to 50 minutes. After centrifugation, the porewater was decanted and filtered through a 0.45μm nylon filter. The pH values of the filtered porewater samples were measured and recorded. The samples were then transferred into sample bottles supplied by SGS Lakefield and samples to be analysed for metals and Ra-226 were preserved with nitric acid. All samples were stored at 4°C until analysis.

Porewater samples were sent to SGS Lakefield Laboratories for chemical analysis that included Ra-226, metals, major ions, sulphate, dissolved organic carbon (DOC), and acidity or alkalinity. One sample, PW09-SR-2 (10-15), had insufficient volume and therefore was only submitted for Ra-226, metals and major ions analysis. The Ra-226 analyses were completed by Becquerel Laboratories under subcontract to SGS Lakefield.

3.3 Surface Water Samples

Surface water samples were collected at each of the four stations from the top of the water column and at the sediment/water interface. Surface water samples were collected as grab samples from the top of the water column. The sediment/water interface samples were collected and composited by siphoning the water above the sediments in the core tubes.

All water samples were field filtered through a 0.45μm disposable nylon filter and the pH values were measured and recorded. Water samples were then transferred into sample bottles supplied by SGS Lakefield and samples to be analysed for metals and Ra-226 were preserved with nitric acid. All samples were stored at 4°C until analysis.

Surface water samples were sent to SGS Lakefield Laboratories for chemical analysis, which included Ra-226, metals, major ions, sulphate, DOC and alkalinity. The Ra-226 analyses were completed by Becquerel Laboratories under subcontract to SGS Lakefield.

4.0 QUALITY ASSURANCE/QUALITY CONTROL

The field campaign that was conducted by EcoMetrix personnel in September 2009 included the collection of samples from three different decommissioned mine sites (Panel, Quirke and Denison) in the Elliot Lake area. The field campaign was carried out to help gain a further understanding of the knowledge gaps identified in the Cycle III SAMP and TOMP performance evaluation.

A detailed data quality assessment (DQA) was completed by EcoMetrix to evaluate the quality of the data collected during Cycle III Special Studies Field Campaign. Similar sampling methods and procedures were used at each mine site therefore the data quality assessment incorporated all of the QA/QC data collected during the field sampling campaign. This section provides a summary of the QA/QC for selected constituents that are discussed in this report. Data quality results for the selected constituents are summarized in **Tables 4.1 to 4.3**. Data quality results for all of the constituents analysed and for duplicates and replicates from all studies are provided **Appendix 3**.

The precision of the duplicate and replicate samples were evaluated by calculating the relative percent difference (RPD) as follows:

$$RPD = \frac{2|C_1 - C_2|}{C_1 + C_2} \times 100\%$$

where: C_1 = sample concentration; and

C_2 = replicate (or duplicate) concentration.

The Data Quality Objectives (DQO) for solids samples were less than or equal to a RPD value of 40%. The DQO for water samples were less than or equal to a RPD value of 20%.

For duplicate/replicate samples having concentrations less than five times the detection limit, the DQO was the absolute difference (AD) between the sample and duplicate/replicate that should not have been greater than the detection limit value.

Blind duplicates and replicates of solids and water samples, as well as laboratory blank sample (de-ionized water), were submitted to SGS Lakefield. Duplicate samples were labeled as EC-1 and replicate samples were labeled as EC-2. The duplicate samples are split samples of solids, porewater or basin water collected from a selected core section or sampling station. The solids replicate samples are replicate core sets from sampling station QC14-2 and were sectioned in accordance with study protocols. Replicate water samples were collected from porewater generated from replicate core sections or from replicate basin water sampling. The calculated RPD or AD values for selected constituents are presented in **Tables 4.1** to **4.2**.

4.1 Solids Sample Data Quality Assessment

The DQA for selected constituents in field duplicates from Cores 09-PSB-2 and 09-SR-4 are summarized in **Table 4.1a**. On average, the DQO of 40% was achieved for all selected constituents (Ra-226, barium, sulphate), with the exception of two exceedances observed in the Core09-PSB-2 duplicate. Barium that had RPD value of 52% and sulphate had an AD value of 0.3. As these individual values were only marginally above the data quality objectives, there are no impacts on the interpretation of the results.

The DQA for selected constituents in replicate core section intervals of Core09-QC14-2 (0-2.5), (2.5-5) and (5-7.5) are summarized in **Table 4.1b**. On average, the DQO of 40% was achieved for all selected constituents, except for Ra-226 where the average RPD was 48%. For Ra-226 the DQO of 40% was exceeded twice with RPD values of 73% and 48%. For barium the DQO was exceeded twice with RPD values of 51% and 60%. As these individual values were only marginally above the data quality objectives, there are no impacts on the interpretation of the results.

4.2 Water Sample Data Quality Assessment

Two duplicate and 5 replicate water samples were collected and analysed. The duplicate and replicate RPD values were compared to a DQO of ≤20%. The DQA for selected constituents in the water samples are presented in **Tables 4.2 a and b**.

As shown on **Table 4.2a**, the DQO of 20% in duplicate water samples was achieved for Ra-226 and barium. Duplicate water samples are sample splits of basin water or porewater extracted from sectioned cores. The Ra-266 duplicate sample identification is PW09-EC-1 (5-10) and corresponds to sample PW09-QC14-4 (0-5). The barium duplicate sample identification PW09-EC-1 (5-10) and corresponds to sample PW09-QC14-3 (0-5). Sulphate duplicates were not analysed because of insufficient sample volume.

As shown on **Table 4.2b**, the DQO of 20% in replicate water samples was achieved on average for Ra-226 and barium, with one DQO exceedance for Ra-226 with an RPD value of 22% in a replicate porewater sample. The average RPD of 21% for sulphate is marginally above the DQO. One DQO exceedance for sulphate had an RPD 40% in a replicate porewater sample.

4.3 Blank Sample Data Quality Assessment

One blank sample was subjected to the porewater extraction process that included centrifugation followed by filtration to determine potential for cross-contamination between samples. The results for selected constituents in the blank are provided **Table 4.3**. The Ra-226 activities and sulphate concentrations were below detection limits of 0.01 Bq/L and 2 mg/L, respectively. The dissolved barium concentration in the blank was 0.00216 mg/L and exceeded the DQO of 0.00002 mg/L. Barium concentrations measured in most of the water samples for the DQA (**Table 4.3**) are at least two orders of magnitude greater than the barium concentration measured in the blank. Therefore, the barium concentration that may be attributed to cross-contamination was negligible.

4.4 Anomalous pH Values in Surface Water Samples

The pH values measured in the surface water samples collected in the Serpent River by EcoMetrix in September 2009 are summarized in **Table 4.4**. Upon review of the pH data, DES personnel were concerned that the results were anomalous compared to all other pH measurements at D-4 and D-5 recorded in the past as part the routine monitoring. The results show that the pH is anomalously low with an average of 5.4 compared to the routine monitoring data at D-4 and D-5 that exhibited average pH values of 6.8 and 6.9 from 2003 through 2006. In response to the anomalous pH values, DES personnel measured pH at the top and bottom of the water column at each station in the Serpent River that were sampled by EcoMetrix. The pH values measured were by DES in June 2010 and are also summarized in **Table 4.4**. The results provided further indication that the pH values measured by EcoMetrix personnel (average pH 5.4) in September 2009 were anomalously low compared to an average of 6.8 measured by DES in June 2010 at the same sample stations.

Upon further investigation, the source of the anomalous pH values was found. The surface water samples were collected in sample bottles that were previously acidified with nitric acid in preparation for storage of samples for metals analysis. The bottles were rinsed three times in the field before collection of the samples for pH. However this rinsing was insufficient to remove all traces of acid. The pH values do not affect the interpretation of Ra-226 mobility in this investigation and therefore measured pH values were not used or discussed in this report.

4.5 Laboratory Quality Assurance and Quality Control

Laboratory Quality Assurance/Quality Control (QA/QC) included analysis of laboratory blanks and laboratory duplicate sample analyses. The Certificates of Analysis, including internal laboratory QA/QC results, are provided in **Appendix 4** and indicate that the data have acceptable accuracy and precision.

5.0 FIELD SAMPLE RESULTS

Selected results from the September 2009 field sampling program are presented in **Figures 5.1** and **5.2** and are summarized in **Tables 5.1** and **5.2**. Activities/concentrations of selected constituents in the sediments are provided in **Figure 5.1** as depth profiles. **Figure 5.2** presents the activities/concentrations in the surface water from each sampling station, as well as the porewater samples with depths that correspond to the depth of the core sample intervals. The surface water samples plotted above the sediment-water interface are not to scale. The actual depths below surface for these samples are provided in **Table 5.2**. The analytical data for all of the constituents analysed are provided as Certificates of Analysis in **Appendix 4**.

5.1 Sediment Samples

The results for selected constituents in the sediments are presented in **Table 5.1**. Results show that elevated Ra-226 activities are present in the sediments of the Serpent River. Depth profiles for Ra-226, barium and sulphate are presented in **Figure 5.1** and show similar trends.

Sample SR-1 was collected upstream of the Denison Mine Site at a location that was expected to have little to no influence from historical TMA operations. This station exhibited low Ra-226 activities that were in the range of 0.02 to 0.16 Bq/g and remained generally constant throughout the depth profile. The same trend was observed for barium and sulphate, with values in the ranges of 47 to 75 mg/kg and less than the detection limit of 0.1% to 0.1%, respectively.

Sample Station SR-2 was located downstream of D-2 and Dyke 8 at a location that may have been influenced by historical TMA operations. Dyke 8 separates the Stollery Settling Pond from the Serpent River. The highest Ra-226 activity of 14 Bq/g was measured in the shallowest sample (0 to 5 cm), with activities decreasing to 0.06 Bq/g at depth. Similar trends were observed for barium and sulphate, concentrations decreasing at depth from 6,400 to 200 mg/kg and 0.5 to <0.1%, respectively.

Sample SR-3 was collected further downstream from D-2 at a location upstream of D-3. The Ra-226 activities in the sediments at this Station increased from 8.2 to 20 Bq/g over the depth profile. Similar increases in concentrations were observed for barium and sulphate with concentrations increasing with depth from 2,300 to 4,100 mg/kg and 0.2 to 1.0%, respectively.

Sample Station SR-4 was located downstream from D-3, immediately upstream from D-5. Radium-226 activities at SR-4 were generally low and marginally higher in the top sediments compared to the lower sediments. Radium -226 activities in the 0 to 5 and 5 to 10 cm layers were 2.6 and 2.7 Bq/g, respectively. The Ra-226 activity in the 10 to15 cm section was 2.1 Bq/g. Barium concentrations exhibited a decreasing trend with depth from 770 to 440 mg/kg. Sulphate concentrations were constant at 0.2% over the depth profile.

In summary, the spatial trends for Ra-226, barium and sulphate showed higher acitivities/concentrations in sediments at SR-3 and SR-2, with lower values measured at SR-1 and SR-4. Radium-226 and barium activites/concentrations at SR-2 showed dramatically different trends compared to those for the same constituents at SR-3. Ra-226, barium and sulphate activities/concentrations at SR-2 decreased with depth, while the same constituents at SR-3 increased with depth.

5.2 Porewater and Surface Water Samples

The results for selected constituents in porewater and surface water are summarized in **Table 5.2** and are presented as depth profiles in **Figure 5.2**. Results show that Ra-226 activities in the porewater and surface water were higher at the sampling stations that exhibited higher concentrations in the sediments. The trends observed for Ra-226 in **Figure 5.2** are also observed for barium, while inverse trends were observed for sulphate concentrations in the sediment porewater.

The Ra-226 and barium concentrations in the porewater and surface water at SR-1 were low and generally constant over the depth profile. Radium-226 activities and barium concentrations ranged from less than 0.01 to 0.02 Bq/L and from 0.01 to 0.03 mg/L, respectively. The highest sulphate concentration of 8.5 mg/L was measured at the top of water column, with the concentration decreasing to 5.6 mg/L at the sediment water interface. Sulphate concentrations in the porewater were 2.6 in the topmost sample and decreased to less the detection limit of 2 mg/L at depth.

The trend for Ra-226 activities at Stations SR-2 and SR-3 exhibited the lowest activities in the surface waters, with higher Ra-226 activities in the porewaters. Radium-226 activities at the top of the water column were 0.11 and 0.15 Bq/L at SR-2 and SR-3, respectively. Radium-226 activities at the sediment-water interface were 0.28 and 0.80 Bq/L at SR-2 and SR-3, respectively. Porewater samples collected at SR-2 and SR-3 exhibited peak activities in the top 10 cm, with Ra-226 activities decreasing with depth. The highest Ra-226 activities in the porewaters were 2.4 and 6.0 Bq/L that were measured from samples SR-2 (0-5) and SR-3 (5-10), respectively. Radium-226 activities in the porewaters decreased with depth to values of 0.87 and 4.5 Bq/L at SR-2 and SR-3, respectively.

Barium concentrations exhibited similar trends to those noted for Ra-226 at Stations SR-2 and SR-3, with lower concentrations measured in the surface waters compared to those measured in the porewaters. Barium concentrations in the surface waters ranged from 0.12 to 0.29 mg/L and from 0.15 to 0.33 mg/L at SR-2 and SR-3, respectively. Peak barium concentrations in the porewaters were measured in the middle of the depth profiles at SR-2 and SR-3, with values decreasing above and below. The highest barium concentration was measured in the top 10 cm at SR-2, with a maximum concentration of 2.4 mg/L. The highest barium concentration at SR-3 was 3.75 mg/L from the 10 to 15 cm depth interval.

The depth-trends for sulphate concentrations at SR-2 and SR-3 were generally inverse to those observed for Ra-226 and barium. The highest concentrations of sulphate were observed in the surface waters, with lower sulphate concentrations measured in the porewaters. The highest sulphate concentration at SR-2 was from the sediment-water interface with a value of 45 mg/L. The highest concentration at SR-3 was from the top of the water column with a value of 30 mg/L. Porewater concentrations decreased with depth from 16 to 14 mg/L at SR-2 and from 7.9 to less than 2 mg/L at SR-3.

The Ra-226 and barium concentrations in the porewater and surface waters at SR-4 were lower than those observed at SR-2 and SR-3, but exhibited similar trends, with the lowest values measured in the surface water and higher values measured in the porewater. Radium-226 activities and barium concentrations in the surface water ranged from 0.19 to 0.30 Bq/L and 0.19 to 0.22 mg/L, respectively. Higher Ra-226 that ranged from 0.87 to 1.4 Bq/L were measured in the porewater, with values increasing slightly with depth. Barium concentrations in porewater were generally constant with depth and ranged from 0.56 mg/L to 0.62 mg/L. Sulphate trends were inverse to those observed for Ra-226 and barium, with a maximum concentration of 25 mg/L measured in the surface water and a minimum concentration of 4.9 mg/L measured at depth in the sediment porewater.

In summary, the depth profile trends showed the highest Ra-226 and barium activities/concentrations in the porewater, with the lower values measured in the surface waters, while the depth profiles for sulphate showed inverse trends to those for barium and Ra-226. The spatial trends for Ra-226 and barium showed the highest acitivities/concentrations in porewater at SR-3 and SR-2, with lower values at SR-1 and SR-4. These spatial trends are consistent with the spatial trends observed for Ra-226 and barium for sediment samples.

6.0 SEDIMENT MODELING OF RADIUM-226 RELEASE FROM THE SERPENT RIVER

6.1 Introduction

Recovery of metals from sediments involves the processes of metals partitioning from the solid phase to the dissolved phase, and subsequent diffusion through the porewater to the surface water. Diffusive processes and mass transport are well understood and can be modeled mathematically. A sediment model that includes diffusive processes as the primary mechanism for sediment recovery was applied to the field data to estimate Ra-226 loads from sediment to surface water and to evaluate the recovery of the sediments. The purpose of the modeling exercise was to verify whether the loadings calculated at D-5 by Minnow (2008) could be the result of Ra-226 recovery via diffusive processes from the sediments of the Serpent River. The model was not used to definitively predict Ra-226 activities or loads in the future, but rather was used as a tool to test the reasonableness of the observed loads and to illustrate potential future trends for Ra-226 loads.

6.1.1 Conceptual Model

The conceptual model for sediment-solute interaction in lakes is well known and is shown schematically in **Figure 6.1**. Although the water bodies being investigated are in the Serpent River, the slow flow and the deposition and accumulation of sediment in these wider reaches of the river behave as lakes.

Metals in the water column partition in equilibrium with suspended particulates, via sorption reactions. In this manner, the concentration in the water column controls the concentration of metals in the particulate matter. Sorption of constituents onto suspended particulates occurs and sedimentation results in the accumulation of metals in the sediment profile over time.

Chemical partitioning also occurs between the deposited sediments and the porewater in the sediment. The dissolved metals in porewater can exchange with the water column above the sediment. This exchange is controlled by the diffusion coefficient of the sediment-porewater system and the concentration gradient or difference between the porewater and the water column above the sediment. The metals can then be redistributed in the profile as a result of diffusion over time. Accumulation of constituents occurs when concentrations in the water column are greater than in the sediment porewater.

Sediment recovery occurs when concentrations in the water column decline, as a result of decreased loadings from upstream sources, for example. The higher concentrations in the porewater than in the water column results in a reversal of chemical gradients, and diffusive releases of constituents from the porewater to the water column. As constituents are released to the water column, concentrations in the porewater are replenished by the release of constituents from the sediments via de-sorption reactions, and the sediment recovery over time. As sediments recover, concentrations in the porewater slowly decrease, resulting in smaller concentration gradients between porewater and overlying water. Over time, the loads the porewater to overlying water decrease. Overall, these reactions result in a contribution of loadings from the sediment to the water column during recovery.

The conceptual model is presented mathematically in **Appendix 5**.

6.2 Model Parameterization

The key variables in the sediment accumulation model are:

- sediment accumulation rate (mm/a) – this variable is usually in the range of 1 to 5 mm/a, but can be constrained by the concentrations of total suspended solids in the water column;
- sediment-water partition coefficient or K_d (L/kg) – this variable describes a reversible sorption of a constituents onto the solids or particles that accumulate on the bottom of the river;
- effective diffusion coefficient (m^2/s) – this variable has a relatively narrow range and describes the diffusion of a dissolved constituent in the sediment porewater;
- total suspended solids or TSS (mg/L) – the total concentration of organic and inorganic substances suspended in a volume. The particle size is operationally defined to be greater than 0.2 µm ;
- activity in the water column (Bq/L) – obtained from the field data collected in 2009 (**Table 5.2**); and
- activity in the sediment (Bq/g) – obtained the field data collected in 2009 and represent historical concentrations that are present in deeper core sections (**Table 5.1**).

The physical properties of the material including moisture content and bulk density can be estimated for sediment and were based on laboratory data. Values for partitioning coefficients were also estimated using field and laboratory data from the current study.

Typical values for diffusion coefficients (D) in aqueous solutions in a porous medium neglecting porosity were obtained from the literature (Spitz and Moreno, 1996) and an average value of 8.43×10^{-10} m^2/s for silty clay were considered reasonable for this investigation. In porous media, such as sediment, the effective diffusion coefficient is smaller than that in aqueous solution because ions follow a longer path of diffusion through the pore spaces and do not migrate through the solid particles. Therefore, the effective diffusion coefficient, D_e, should be used for sediment and can be represented by:

$$D_e = D \bullet \eta$$

Where: D_e = effective diffusion coefficient in the sediment porewater (m^2/s);

D = diffusion coefficient in an aqueous solution (m^2/s)

η = porosity

Porosity values in sands typically range from 0.26 to 0.53 (Spitz and Moreno, 1996). Porosity values in organic rich sediments may be expected to be as high as 0.9. A porosity of 0.5 was considered a reasonable average value for the Serpent River sediments that consisted of mixtures of organic matter and sandy materials. The value for D_e was then calculated to be 4.22×10^{-10} m^2/s.

The model was constrained with the following limits:

- initial water concentrations – were assumed to be equal to the data (**Table 5.2**) from the top of the water column measured at the upstream sampling stations (SR-2 equals 0.01 Bq/L, SR-3 equals 0.11 Bq/L; SR-4 equals 0.15 Bq/L);
- inflow water concentrations – were assumed to be equal to the data (**Table 5.2**) from the top the of the water column measured at the upstream sampling stations (SR-2 equals 0.01 Bq/L; SR-3 equals 0.11 Bq/L; SR-4 equals 0.15 Bq/L);
- concentrations in sediment – were assumed to be equal to the measured data from the core sections (**Table 5.1**);
- effective diffusion coefficient – this variable calculated using values in the literature and a value of 4.22×10^{-10} m^2/s was considered to be reasonable;
- volume of water in the reaches of the Serpent River – the values for each station were estimated from Google Earth satellite images and were approximately 210,000 m^3 at SR-2, 104,000 m^3 at SR-3 and 104,000 m^3 at SR-4; and
- flow in the Serpent River – was estimated from Archived Hydrometric Data for the Serpent River Above Quirke Lake (Environment Canada, 2010). The flow values at SR-2 and SR-3 were 1,642 L/s and represent approximately 69% of the average flow (2,380 L/s) measured in 2009. The flow value at SR-4 was 1,785 L/s and represents approximately 75% of the average flow (2,380 L/s) measured in 2009.

The model is sensitive to two other critical variables that include the sediment deposition rate and the water-solid partitioning coefficient (K_d). The deposition rate is commonly on the order of 1 to 5 mm/a. In this case, it was assumed that the deposition rate was 2 mm/a a typical value in small lakes. The value of K_d was estimated from a plot of the Ra-226 activities in sediment versus those in porewater. **Figure 6.2** illustrates the linear correlation between the Ra-226 activities in the sediment solids versus those in the porewater in

Serpent River samples collected in this investigation. The slope of the line is equal to the K_d with a value of 2,600 L/kg. The dashed lines in **Figure 6.2** show the lower and upper 95% confidence intervals for the slope of the regression line and indicate a range in K_d values of 1,369 to 3,627 L/kg.

6.3 Load Calculations

Radium-226 loads were calculated using the results from the sediment diffusion model. The loads were calculated in terms of the diffusive flux for a unit area at sample stations SR-2, SR-3 and SR-4 and were calculated as follows:

$$L = F \bullet A$$

Where: L = Load (MBq/a);

F = Mass Flux (MBq/m^2•a);

A = Surface area over which the diffusion is taking place (m^2).

The mass flux was calculated as follows:

$$F = -D_e \bullet \frac{\partial C}{\partial z}$$

Where: F = Mass Flux (MBq/m^2•a);

D_e = effective diffusion coefficient in sediment porewater (m^2/a);

C = concentration (Bq/L); and

z = interface thickness (m).

6.4 Model Calibration

Model calibration involves the adjustment of model parameters within acceptable ranges until the model predictions match measured data. For this case, the measured data were obtained from routine monitoring of Ra-226 activities in water at station D-5. The monitoring data together with Archived Hydrometric Data for the Serpent River (Environment Canada, 2010) were used to calculate annual Ra-226 load values at D-5. These data are plotted in **Figure 6.3** for the years 2002 to 2009 and are shown as solid symbols. These data points represent annual loads that were calculated using the average annual concentrations measured at D-5 times the estimated annual flow rate ($75x10^6$ m^3/a) for the Serpent River at D-5.

The solid curves in **Figure 6.3** represent the estimated cumulative loads from SR-2, SR-3 and SR-4 for 2009 to 2012 at K_d values of 1,300, 1,700 and 2,600L/kg. The K_d value of 2,600 L/kg represents the best-fit slope of the regression line in **Figure 6.2**, while a K_d of 1,300 represents a value close to the lower 95% confidence interval of the slope of 1,369 L/kg. A K_d value of 1,700 L/kg was chosen to test the sensitivity of the model to K_d values between 1,300 L/kg and 2,600 L/kg.

The condition that provides the best visual fit for the annual loads was a K_d value of 1,300 L/kg. This value was consistent with the lower 95% confidence interval. A K_d value for Ra-226 of about 1,500 L/kg was reported by EcoMetrix (2009) for lake bottom sediments. Therefore, a K_d value of 1,300 L/kg was considered acceptable and used for subsequent the model simulations.

6.5 Model Results

The cumulative Ra-226 load from the sediment to the surface water at D-5 was approximately 3,420 MBq/a in 2009 as presented in **Figure 6.3** for a Kd of 1,300 L/kg. This result agrees well with the calculated annual load of 3,884 MBq/a for 2009 shown on the same plot. The model predicts that the observed annual load at D-5 will continue to decrease over time.

The model was also used to estimate individual loads of Ra-226 released from the sediments in the areas surrounding stations SR-2, SR-3 and SR-4 and the results are presented as time-trend plots in **Figure 6.4**. The results showed that from 2009 to 2012 the loads at stations SR-2, SR-3 and SR-4 should decrease with time. The downward trend was also observed for the calculated loads from 2002 through 2009 in **Figure 6.3**. The results also show that the majority of the cumulative Ra-226 load is from SR-2, while the Ra-226 loads at SR-4 represent much smaller contributions to the cumulative load.

The decreasing trend in Ra-226 loads can be explained by the spatial trends observed in the sediments. **Figure 6.5** illustrates the predicted changes in Ra-226 activities in sediment solids profiles with time. The symbols represent the concentrations measured in the sediment in 2009 and the solids curves represent the estimated concentrations in 2012. The predictions indicate that the Ra-226 activities in the top portions of the sediment will decline with time as sediments recover and release Ra-226 to the water column in the Serpent River.

Figures 6.4 and **6.5** illustrate a more rapid release of Ra-226 at SR-2 than SR-3, even though highest Ra-226 activities were measured at SR-3. This occurs because diffusion is controlled by concentration gradients that can be defined as the change in concentration over distance. Therefore, concentration gradients are inversely proportional to distance. Because the highest Ra-226 activity in the porewater at SR-3 was measured at depth, the concentration gradient would be small; this relationship results in a slower release of Ra-226 to the surface water. The highest Ra-226 activities at SR-2 were measured in the porewater from the topmost sediments and near the sediment-water interface. This condition results in a large concentration gradient and is responsible for the more rapid release of Ra-226 to the surface water at SR-2 than at SR-3.

7.0 DISCUSSION

Results from the chemical characterization of sediments from the Serpent River showed that Ra-226 had accumulated in the sediments in the vicinities of sampling stations SR-2, SR-3 and SR-4 (**Figure 5.1**). Porewater samples generally exhibited trends of higher Ra-226 activities in the 5 to 10 cm sections that decreased with depth (**Figure 5.2**). Together, the results for solids and porewater are consistent with the historic accumulation of Ra-226 in the sediment that likely resulted from elevated Ra-226 activities discharging from the Denison TMA in the past before the water was treated to remove Ra-226.

Radium-226 activities measured upstream of the Denison TMAs at SR-1 were at or below the detection limit of 0.01 Bq/L. These values are consistent with the routine monitoring data that show Ra-226 in the range of 0.01 to 0.02 Bq/L at D-4 that is also located upstream of the Denison TMAs (**Figure 2.3**). **Figure 2.3** also shows moving averages of Ra-226 activities at monitoring stations D-2, D-3 and D-6 that represent outflows from the Stollery and the Williams Settling Ponds, and potential seepage from TMA-1, respectively. The Ra-226 activities at these stations have remained between approximately 0.01 and 0.20 Bq/L since 1993. Because flows from the TMAs are small compared to flow in the Serpent River, Ra-226 activities were expected to decrease in the Serpent River downstream from D-2 and D-3. However, this was not supported by the data from the field study or by the data from the routine monitoring data at D-5. The data from the 2009 field study showed average Ra-226 activities of 0.20, 0.15 and 0.25 Bq/L in the Serpent River downstream of TMAs at SR-2, SR-3 and SR-4. Routine monitoring data at D-5 show average Ra-226 activities have remained between 0.10 and 0.20 Bq/L since 1992.

Average Ra-226 loads exiting the Denison TMAs at D-2, D-3 and D-6 calculated by Minnow (2008) for the 2003 to 2006 time period had values of 175, 31 and 11 MBq/a, while an average Ra-226 load of 5,300 MBq/a was calculated at D-5 (**Figure 2.2**). These average loads from D-2 and D-3 represent only small contributions of Ra-226 to the Serpent River and cannot explain the 5,300 MBq/a calculated at D-5, downstream from the TMAs. The load calculations from Minnow (2008), together with the Ra-226 activities measured in the 2009 field study between D-4 and D-5, indicate that there is a source load of Ra-226 in the Serpent River that has not been accounted for previously.

It was hypothesized that the recovery of Ra-226 in the sediment and its diffusion to the surface water has likely resulted in the observed Ra-226 loads at D-5. The low Ra-226 activities in the present discharge, together with high activities in the sediment from historic accumulation, have likely initiated recovery of the sediment via release of Ra-226 into the water column. This behaviour is typical for sediment-water interactions.

The Ra-226 activities shown in **Figure 5.2** exhibited trends with higher activities in the porewater compared to those measured in the surface water at stations SR-2, SR-3 and SR-4. These results indicate that a concentration gradient has developed and diffusion of Ra-226 from the porewater to the surface water was occurring at the time of sampling.

A sediment model was used to test the theory that the observed loads at D-5 are the result of Ra-226 recovery from sediments in the Serpent River. The model estimated a cumulative load of 3,420 MBq/a in 2009 that was based on a well-supported Ra-226 Kd value in the sediment. These results indicate that the Ra-226 load at D-5 can be explained by the recovery of historically accumulated Ra-226 in the sediments controlled by diffusive transport of Ra-226 from the porewater to the surface water. The model results also indicated that over time the recovery of Ra-226 from the sediment will result in decreasing loads at D-5 into the future.

8.0 SUMMARY OF CONCLUSIONS

The objectives of this study were to evaluate Ra-226 in the solids, porewater and overlying surface water from the Serpent River to determine the source of the load differences between monitoring stations D-4 and D-5 and to evaluate future loading trends in the Serpent River.

The key conclusions from this investigation are as follows:

- Load differences in the Serpent River between D-4 and D-5 cannot be explained by or attributed to the Ra-226 activities and loads that have discharged from the Denison TMA since 1990.
- It was hypothesized that the source of the Ra-226 loads in the Serpent River are related to low Ra-226 activities in the treated waters that discharge from the Denison TMAs, together with high Ra-226 activities in the sediment from historic accumulation that have initiated recovery of the sediment via release of Ra-226 into the water column.
- The results from the chemical characterization of the sediment and porewater were consistent with historic accumulation of Ra-226 in the sediment that likely resulted from elevated Ra-226 activities discharging from the Denison TMA in the past before the water was treated to remove Ra-226.
- The elevated Ra-226 activities in the sediments surrounding stations SR-2 and SR-3 represent the majority of the source load for Ra-226 in the Serpent River.
- The high activities in the sediment from historic accumulation, together with low Ra-226 activities in the present discharge from the Denison TMAs, have likely initiated recovery of the sediment via release of Ra-226 to the water column.
- Chemical characterization of sediment porewater and surface water in the Serpent River showed higher Ra-226 activities in the porewater compared to surface water indicating that concentration gradients have developed.
- Concentration gradients between Ra-226 activities in porewater and surface water imply upward diffusion and mass transport of Ra-226 from the porewater to the overlying water.
- The sediment model predictions verified that the calculated loads at D-5 can be explained by the recovery of historically accumulated Ra-226 in the sediments and its diffusion to the water column.
- The model predictions also showed that the Ra-226 loads at D-5 will continue to decrease as the sediments in the Serpent River recover over time.

9.0 REFERENCES

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TABLES

Table 4.1a: Data Quality Assessment Summary for Selected Constituents in Solids - Duplicate Samples

		Parameter		
		Radium-226	**Barium**	**Sulphate**
		(Bq/g)	(mg/kg)	(%)
Method Detection Limit		0.01	0.05	0.1
RPD Data Quality Objective		≤ 40%	≤ 40%	≤ 40%
Sample ID	Core09-PSB-2 (5-10)	4.5	160	0.6
Replicate ID	CORE 09-EC-1 (0-5)	4.1	94	0.3
RPD (%) or AD		9	**52**	**0.3**
Sample ID	Core09-SR-4 (10-15)	2.1	440	0.2
Replicate ID	CORE 09-EC-1 (5-10)	1.6	450	0.1
RPD (%) or AD		27	2	0.1
Average RPD or AD		***18***	***27***	***0.2***
Count		*3*	*3*	*3*

Notes:

RPD - relative percent difference; is calculated for analytes with concentrations greater than or equal to five times the detection limit and should be less than or equal to 40%

AD - absolute difference; for samples having concentrations less than five times the detection limit, the difference between the sample and duplicate, or difference between the sample or duplicate and the detection limit if either the sample or duplicate analyte concentration is below detection limit; should not be greater then the detection limit

BD - Sample and/or replicate had analyte concentrations below detection limit

Boldface type and shaded indicates that Data Quality Objective was not achieved

Table 4.1b: Data Quality Assessment Summary for Selected Constituents in Solids - Replicate Samples

		Parameter		
		Radium-226	**Barium**	**Sulphate**
		(Bq/g)	(mg/kg)	(%)
Method Detection Limit		0.01	0.05	0.1
RPD Data Quality Objective		≤ 40%	≤ 40%	≤ 40%
Sample ID	CORE 09-QC14-2 (0-2.5)	4.3	150	0.1
Replicate ID	CORE 09-EC-2 (0-2.5)	7.0	280	0.1
RPD (%) or AD		**48**	**60**	0
Sample ID	CORE 09-QC14-2 (2.5-5)	6.5	220	0.1
Replicate ID	CORE 09-EC-2 (2.5-5)	8.3	370	0.1
RPD (%) or AD		24	**51**	0
Sample ID	CORE 09-QC14-2 (5-7.5)	9.3	330	0.1
Replicate ID	CORE 09-EC-2 (5-7.5)	20.0	310	0.1
RPD (%) or AD		**73**	6	0
Average RPD or AD		***48***	***39***	***0***
Count		*3*	*3*	*3*

Notes:

RPD - relative percent difference; is calculated for analytes with concentrations greater than or equal to five times the detection limit and should be less than or equal to 40%

AD - absolute difference; for samples having concentrations less than five times the detection limit, the difference between the sample and duplicate, or difference between the sample or duplicate and the detection limit if either the sample or duplicate analyte concentration is below detection limit; should not be greater then the detection limit

BD - Sample and/or replicate had analyte concentrations below detection limit

Boldface type and shaded indicates that Data Quality Objective was not achieved

Table 4.2a: Data Quality Assessment Summary for Selected Constituents in Water - Duplicate Samples

		Parameter		
		Radium-226	**Barium**	**Sulphate**
		(Bq/L)	(mg/L)	(mg/L)
Method Detection Limit		0.01	0.00001	0.2
RPD Data Quality Objective		≤ 20%	≤ 20%	≤ 20%
Sample ID	SW09-SR-4B	0.30	0.222	25
Duplicate ID	PW09-EC-1 (0-5)	0.30	0.221	--
RPD (%) or AD		0	0	--
Sample ID	PW09-QC14-3 (0-5)	--	0.333	54
Duplicate ID	PW09-QC14-4 (0-5)	4.1	--	560
Duplicate ID	PW09-EC-1 (5-10)	4.7	0.335	--
RPD (%) or AD		14	1	--
Average RPD or AD		***7***	***1***	***--***
Count		*2*	*2*	--

Notes:
RPD - relative percent difference; is calculated for analytes with concentrations greater than or equal to five times the detection limit and should be less than or equal to 20%
AD - absolute difference; for samples having concentrations less than five times the detection limit, the difference between the sample and duplicate, or difference between the sample or duplicate and the detection limit if either the sample or duplicate analyte concentration is below detection limit; should not be greater then the detection limit
BD - Sample and/or replicate had analyte concentrations below detection limit
Boldface type and shaded indicates that Data Quality Objective was not achieved

Table 4.2b: Data Quality Assessment Summary for Selected Constituents in Water - Replicate Samples

		Parameter		
		Radium-226	**Barium**	**Sulphate**
		(Bq/L)	(mg/L)	(mg/L)
Method Detection Limit		0.01	0.00001	0.2
RPD Data Quality Objective		≤ 20%	≤ 20%	≤ 20%
Sample ID	SW09-QC14-2T	0.82	0.104	72
Replicate ID	SW09-EC-2T	0.78	0.108	85
RPD (%) or AD		5	4	17
Sample ID	SW09-QC14-2B	0.91	0.108	32
Replicate ID	SW09-EC-2B	0.85	0.114	36
RPD (%) or AD		7	5	12
Sample ID	PW09-QC14-2 (0-2.5)	3.6	0.309	32
Replicate ID	PW09-EC-2 (0-2.5)	2.9	0.285	27
RPD (%) or AD		**22**	8	17
Sample ID	PW09-QC14-2 (2.5-5)	2.8	0.308	12
Replicate ID	PW09-EC-2 (2.5-5)	3.3	0.337	18
RPD (%) or AD		16	9	**40**
Sample ID	PW09-QC14-2 (5-7.5)	5.9	0.519	12
Replicate ID	PW09-EC-2 (5-7.5)	5.4	0.487	--
RPD (%) or AD		9	6	--
Average RPD or AD		***12***	***7***	***21***
Count		*5*	*5*	*4*

Notes:
RPD - relative percent difference; is calculated for analytes with concentrations greater than or equal to five times the detection limit and should be less than or equal to 20%
AD - absolute difference; for samples having concentrations less than five times the detection limit, the difference between the sample and duplicate, or difference between the sample or duplicate and the detection limit if either the sample or duplicate analyte concentration is below detection limit; should not be greater then the detection limit
BD - Sample and/or replicate had analyte concentrations below detection limit
Boldface type and shaded indicates that Data Quality Objective was not achieved

Table 4.3: Data Quality Assessment Summary for Selected Constituents in Blank Sample

Analysis	Units	Detection Limit	Data Quality Objective	Blank 1
Radium-226	Bq/L	0.01	0.02	<0.01
Barium	mg/L	0.00001	0.00002	**0.00216**
Sulphate	mg/L	2	4	<2

Notes:

Boldface type and shaded indicates that Data Quality Objective was not achieved

Table 4.4: Surface Water pH Values Measured in the Serpent River by EcoMetrix in September 2009 and by DES in June 2010

Sample ID	Depth Below Surface	GPS Coordinates		pH Measured by EcoMetrix in September 2009	pH Measured by DES in June 2010
	(m)	Northing	Easting	(pH units)	(pH units)
SW09-SR-1T	0	5149088	373857	3.9	6.5
SW09-SR-1B	1.4			5.2	--
SW09-SR-2T	0	5149667	374281	4.2	6.8
SW09-SR-2B	1.1			3.5	6.8
SW09-SR-3T	0	5150279	374301	5.6	6.8
SW09-SR-3B	1.3			7.3	6.9
SW09-SR-4T	0	5151193	374131	6.5	7.1
SW09-SR-4B	0.6			6.7	6.9
Average pH Value				**5.4**	**6.8**
Average pH Values Measured in the SRWMP				**D-4**	**6.8**
				D-5	**6.9**

Notes:

"--" pH could not be measured because water level was too low

Average pH Values Measured in the SRWMP were calculated from routine monitoring data from 2003 through 2006 in Minnow (2008)

Table 5.1: Summary of Selected Constituents in Serpent River Sediments Sampled in 2009

Sample ID	Radium-226	Barium	Sulphate
	(Bq/g)	(mg/kg)	(%)
CORE 09-SR-1 (0-5)	0.16	75	0.1
CORE 09-SR-1 (5-10)	0.08	65	<0.1
CORE 09-SR-1 (10-15)	0.02	61	0.1
CORE 09-SR-1 (15-20)	0.04	47	0.1
CORE 09-SR-2 (0-5)	14	6,400	0.5
CORE 09-SR-2 (5-10)	4.6	2,600	0.2
CORE 09-SR-2 (10-15)	0.06	200	<0.1
CORE 09-SR-3 (0-5)	8.2	2,300	0.2
CORE 09-SR-3 (5-10)	9.7	3,000	0.4
CORE 09-SR-3 (10-15)	16	3,600	0.8
CORE 09-SR-3 (15-20)	20	4,100	1.0
CORE 09-SR-4 (0-5)	2.6	770	0.2
CORE 09-SR-4 (5-10)	2.7	580	0.2
CORE 09-SR-4 (10-15)	2.1	440	0.2

Table 5.2: Summary of Selected Constituents in Serpent River Surface Water Sampled in 2009

Sample ID	Depth (cm)	Radium-226 (Bq/L)	Barium (mg/L)	Sulphate (mg/L)
SW09-SR-1T	0	<0.01	0.01	8.5
SW09-SR-1B	140	<0.01	0.02	5.6
PW09-SR-1 (0-5)	0-5	0.02	0.03	2.6
PW09-SR-1 (5-10)	5-10	<0.02	0.03	<2
PW09-SR-1 (10-15)	10-15	<0.01	0.03	<2
PW09-SR-1 (15-20)	15-20	<0.01	0.02	<2
SW09-SR-2T	0	0.11	0.12	31
SW09-SR-2B	110	0.28	0.294	45
PW09-SR-2 (0-5)	0-5	2.4	2.16	16
PW09-SR-2 (5-10)	5-10	2.3	2.38	14
PW09-SR-2 (10-15)	10-15	0.87	1.5	--
SW09-SR-3T	0	0.15	0.147	30
SW09-SR-3B	130	0.80	0.334	26
PW09-SR-3 (0-5)	0-5	5.1	1.91	7.9
PW09-SR-3 (5-10)	5-10	6.0	3.11	4
PW09-SR-3 (10-15)	10-15	5.4	3.75	<2
PW09-SR-3 (15-20)	15-20	4.5	3.24	<2
SW09-SR-4T	0	0.19	0.191	25
SW09-SR-4B	60	0.30	0.222	25
PW09-SR-4 (0-5)	0-5	0.87	0.561	19
PW09-SR-4 (5-10)	5-10	1.2	0.621	8.1
PW09-SR-4 (10-15)	10-15	1.4	0.602	4.9

Notes:
SW - Surface Water - Depth refers to "below surface"
PW - Porewater - Depth refers to "below sediment-water interface"
T - top of water column
B - bottom of water column

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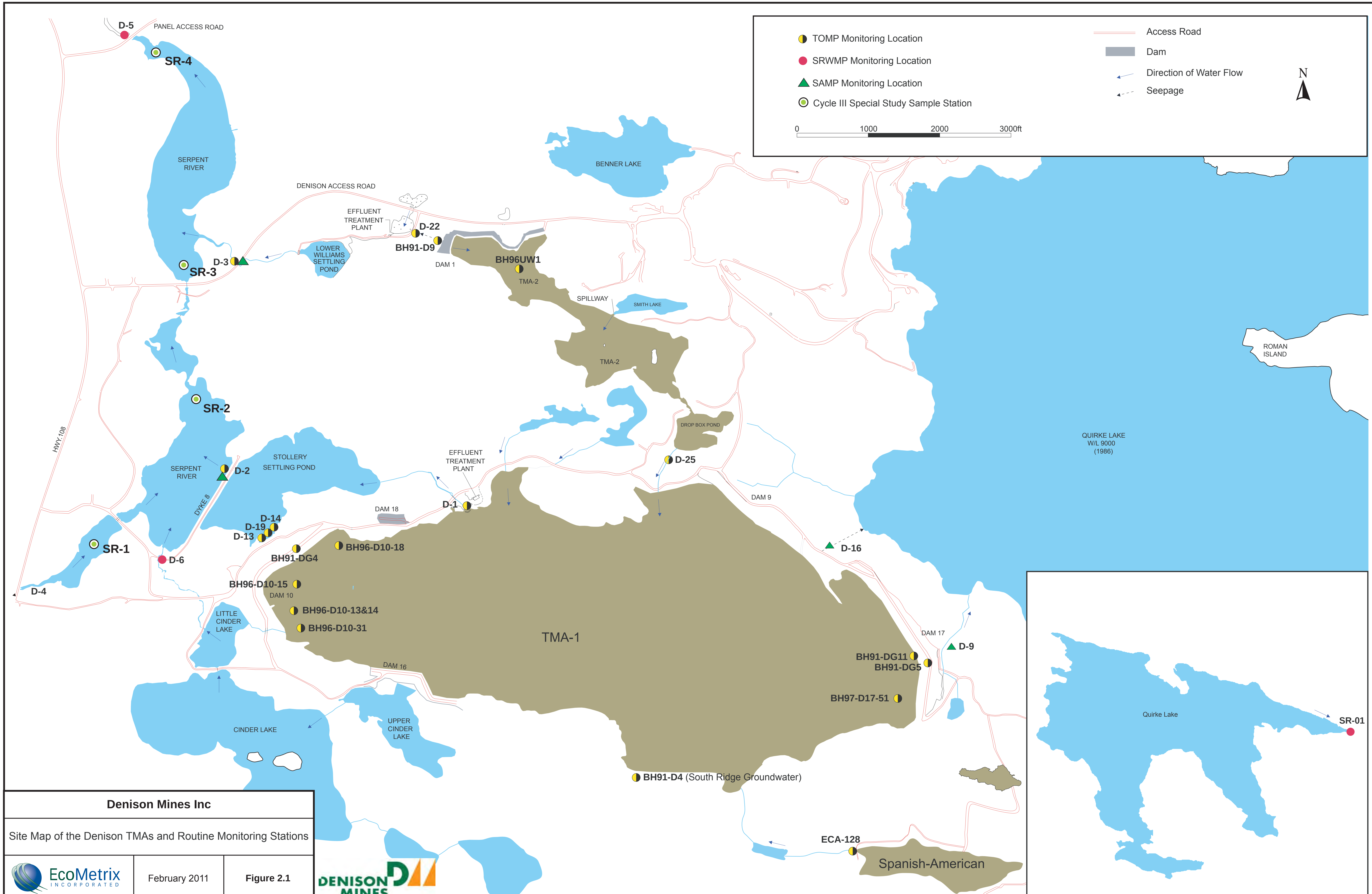
FIGURES

Denison Mines Inc.

General Site Location of the Denison Mine and Tailings Management Area

February 2011

Figure 1.1

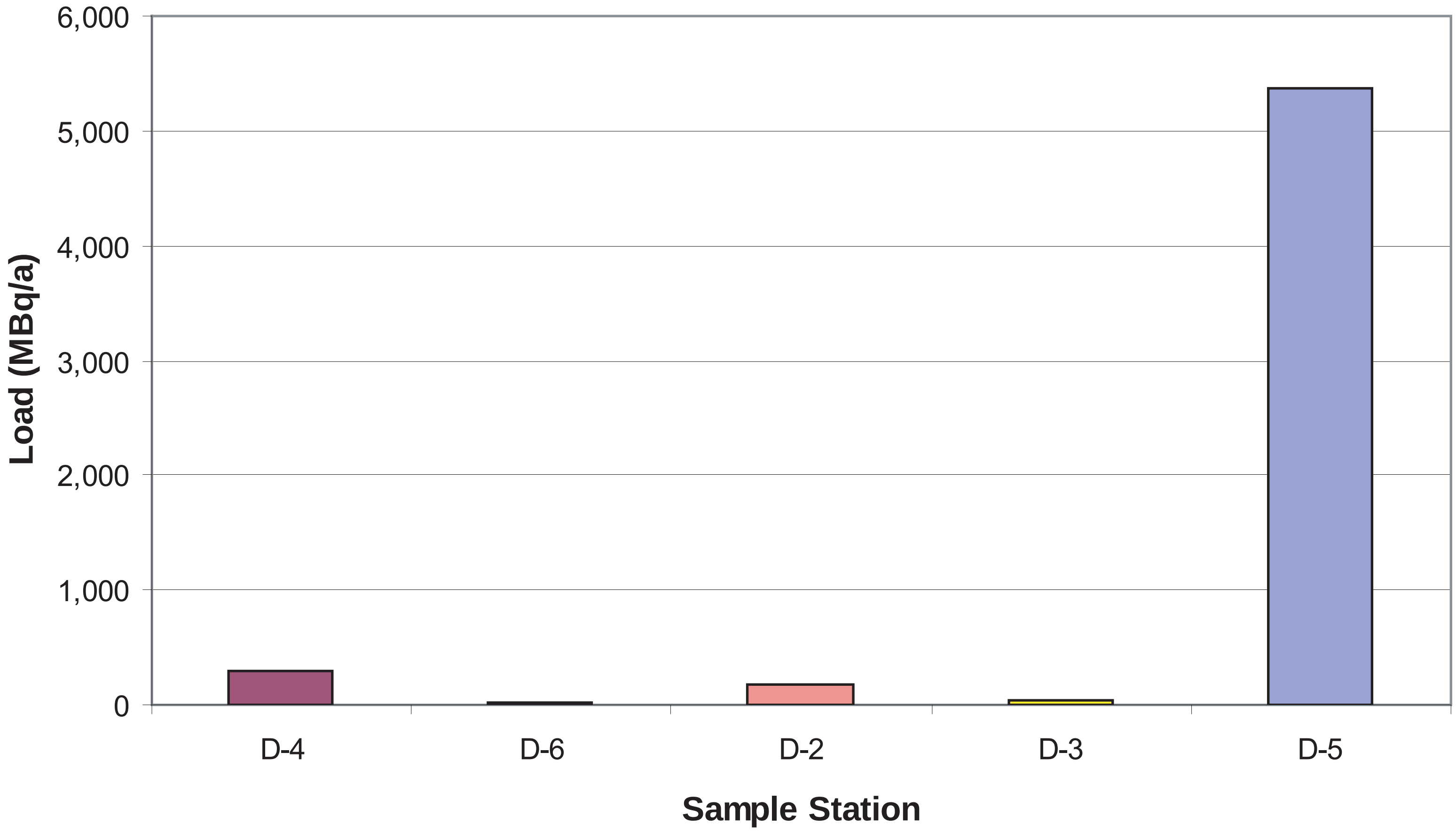


Denison Mines Inc

Site Map of the Denison TMAs and Routine Monitoring Stations

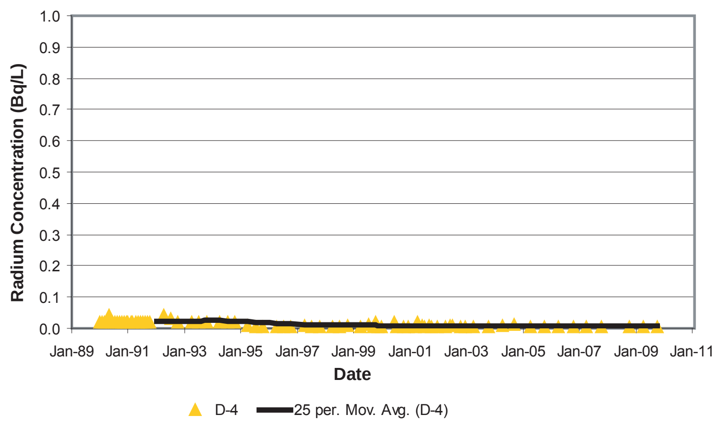
February 2011

Figure 2.1

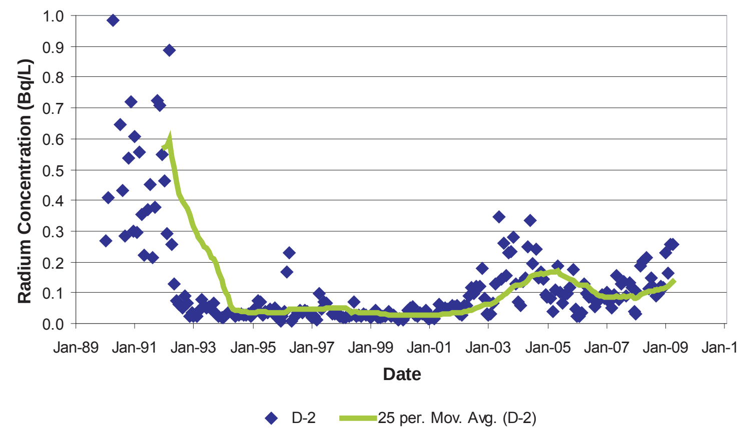


Denison Mines Inc.		
Mean Radium-226 Loadings from Denison Mine and Relative Contributions to Receiving Waters 2003-2006 (Minnow, 2008)		
EcoMetrix Incorporated	February 2011	**Figure 2.2**

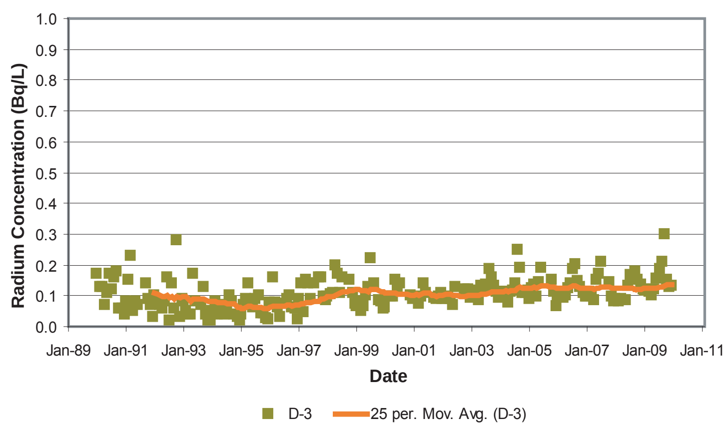
D-4



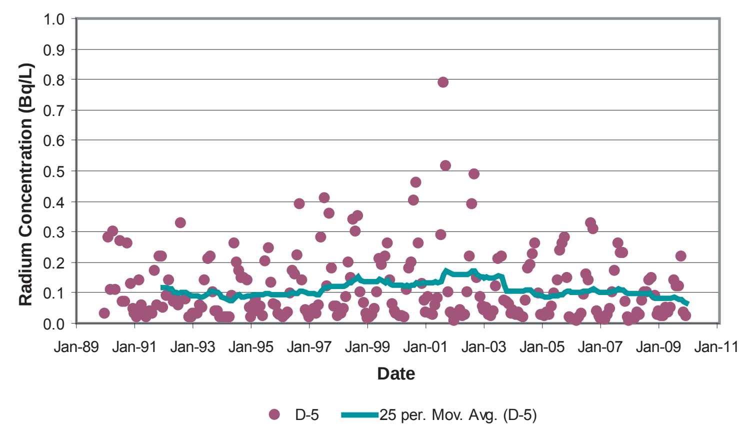
D-2



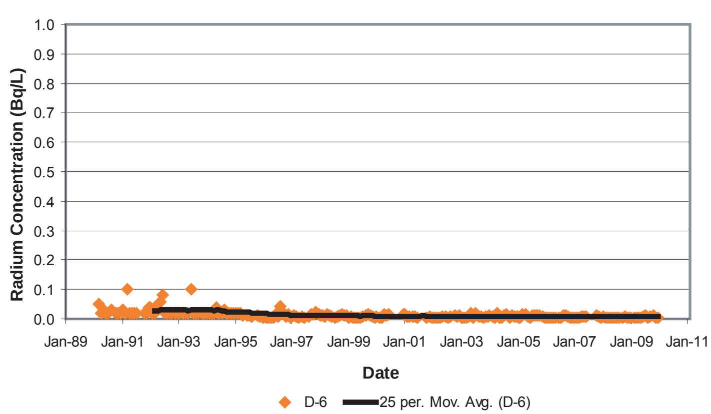
D-3



D-5



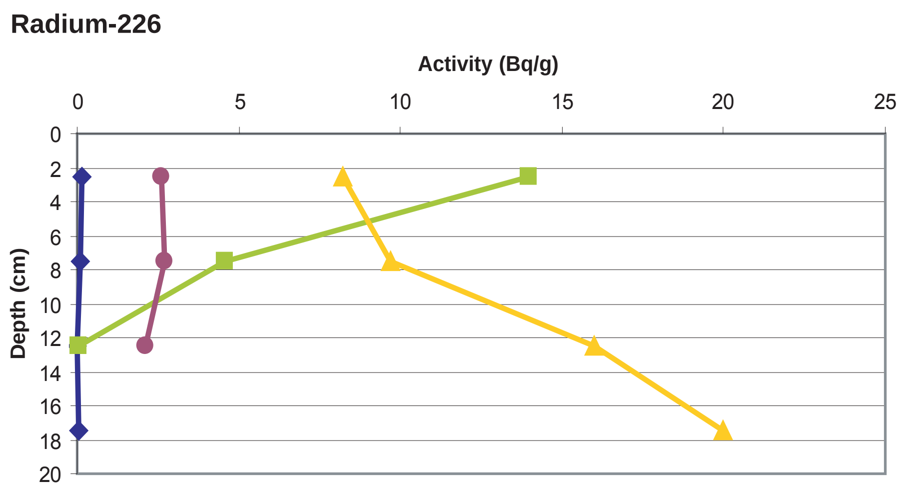
D-6

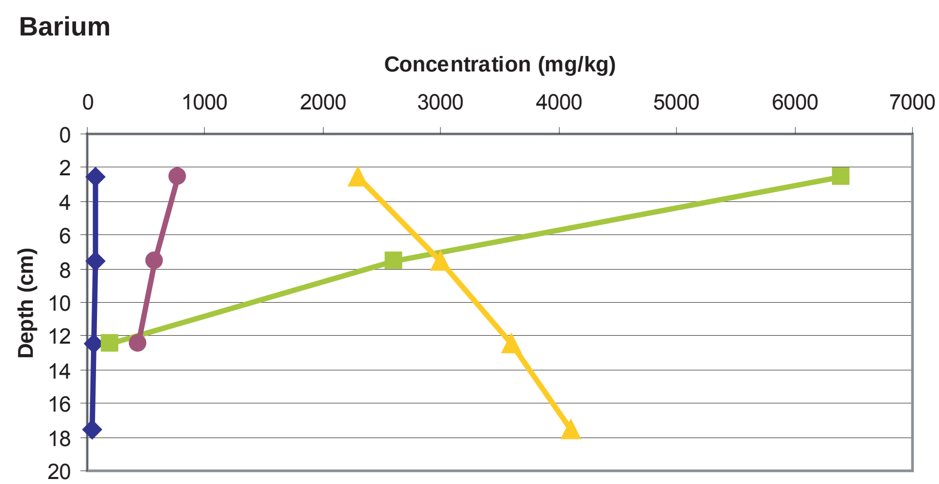


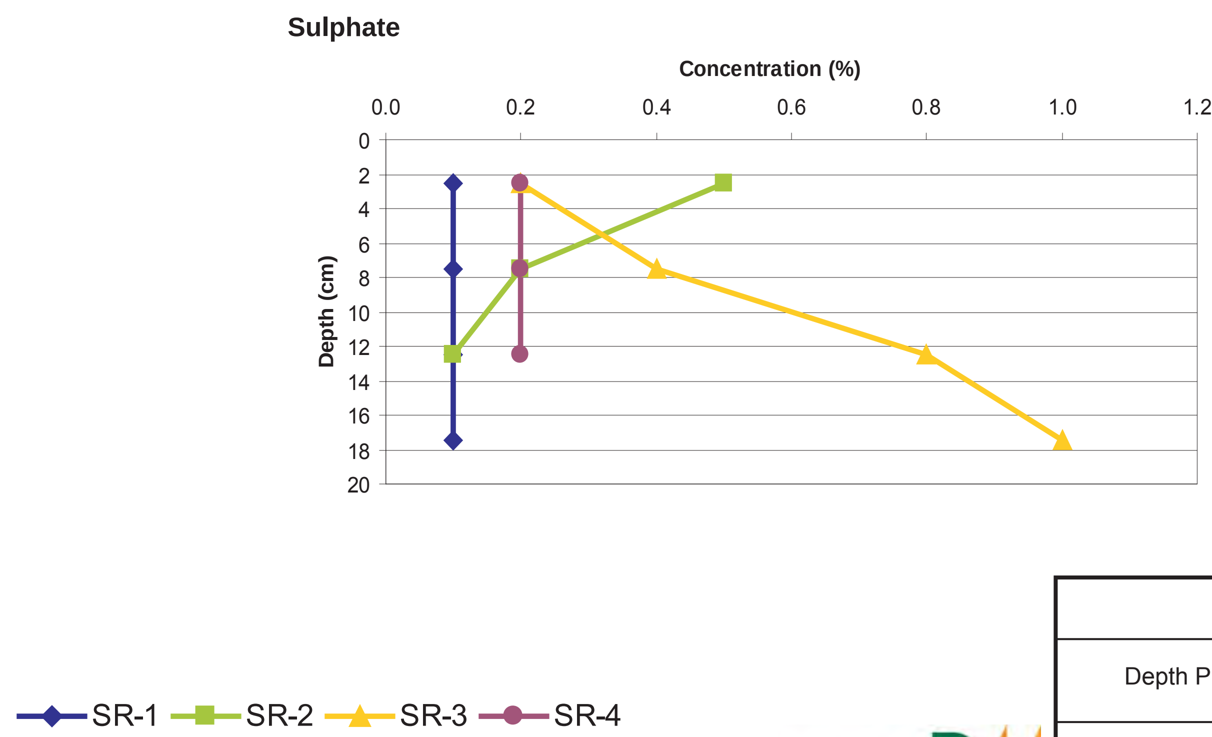
Notes: Some data prior to 1990 not shown for D-2

DENISON MINES

Denison Mines Inc.		
Routine Monitoring Data for Radium-226 from Selected Stations for the Denison TMAs		
EcoMetrix INCORPORATED	February 2011	**Figure 2.3**

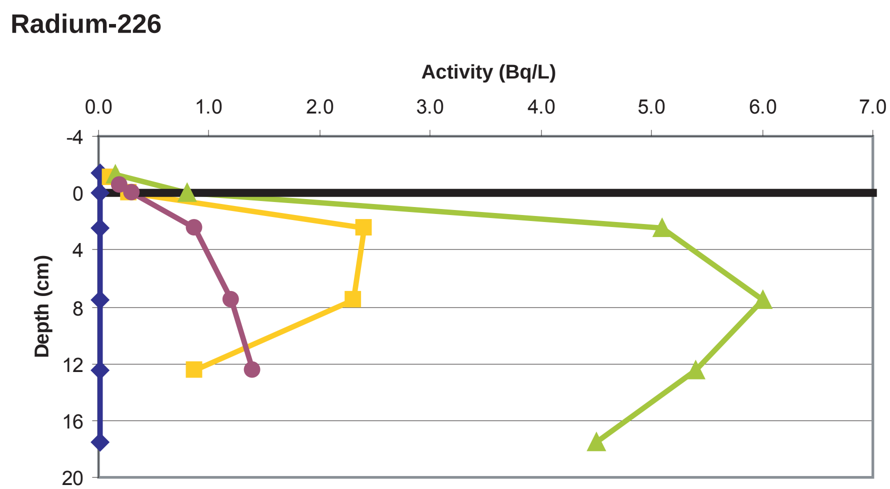


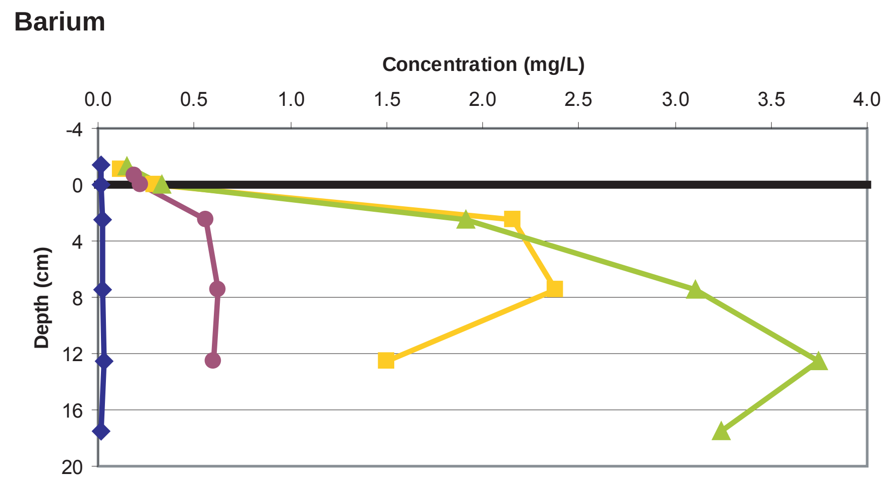


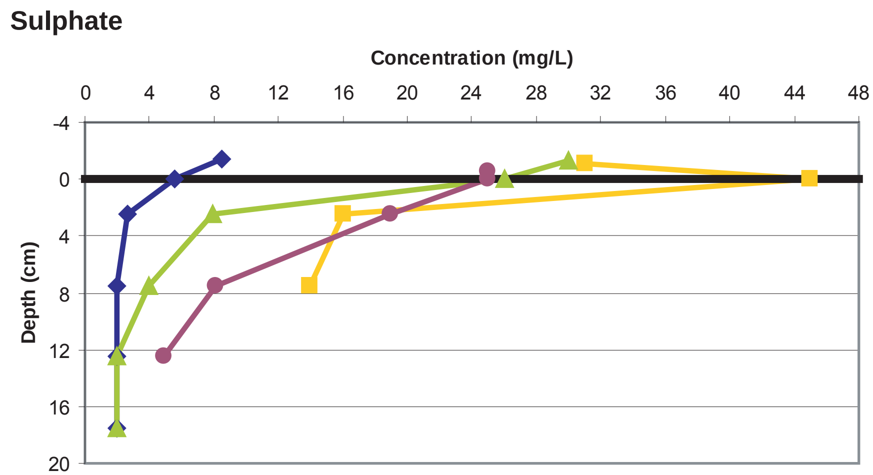


DENISON MINES

Denison Mines Inc.		
Depth Profiles for Selected Constituents in Sediment		
EcoMetrix INCORPORATED	February 2011	**Figure 5.1**





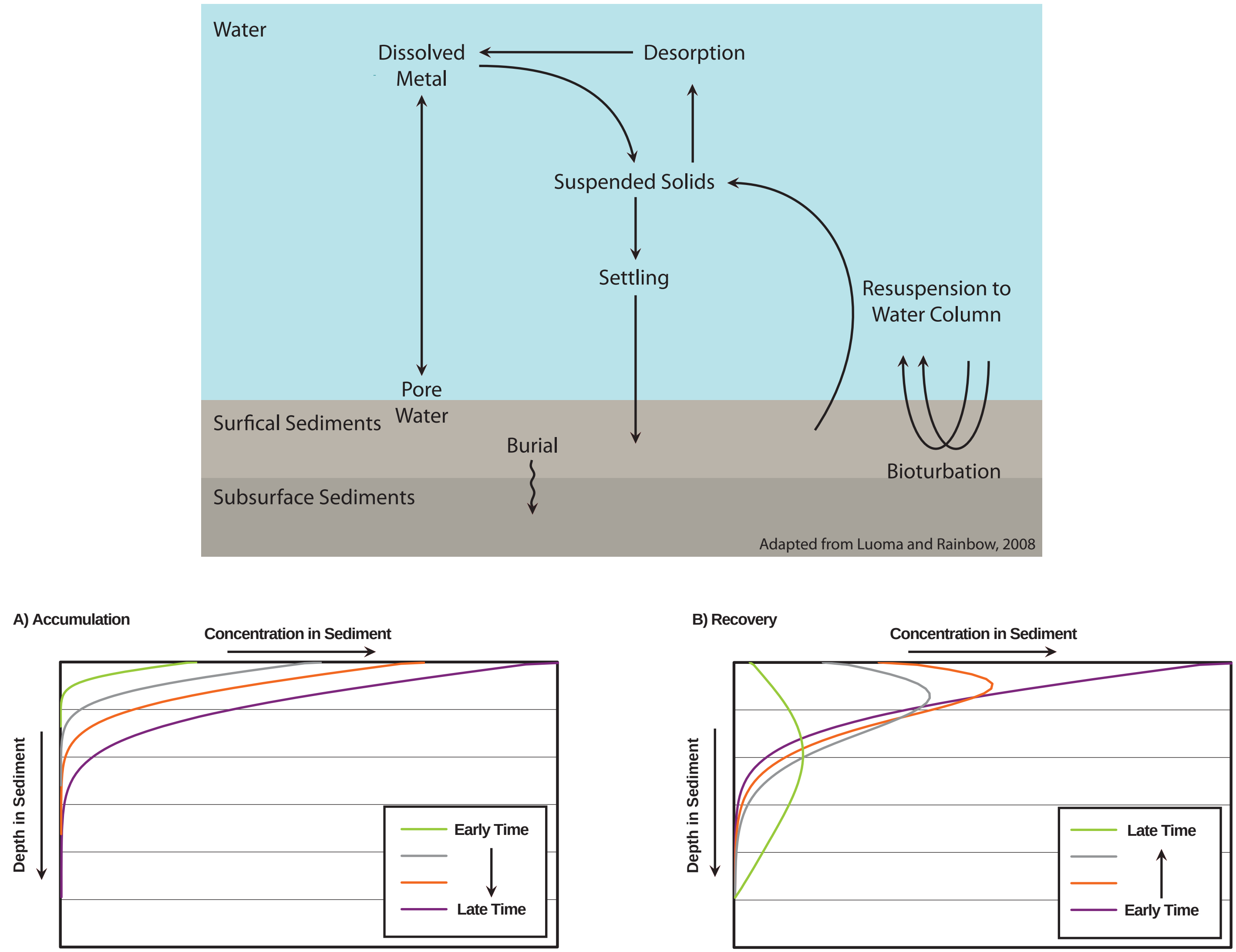


SR-1 SR-2 SR-3 SR-4 S/W Interface

Notes: Sulphate not analysed for the 10 to 15 cm section from SR-2 due to lack of sample volume
Data points above the surface water interface represent Top and Bottom water samples.
See Table 5.2 for actual depth values.

DENISON MINES

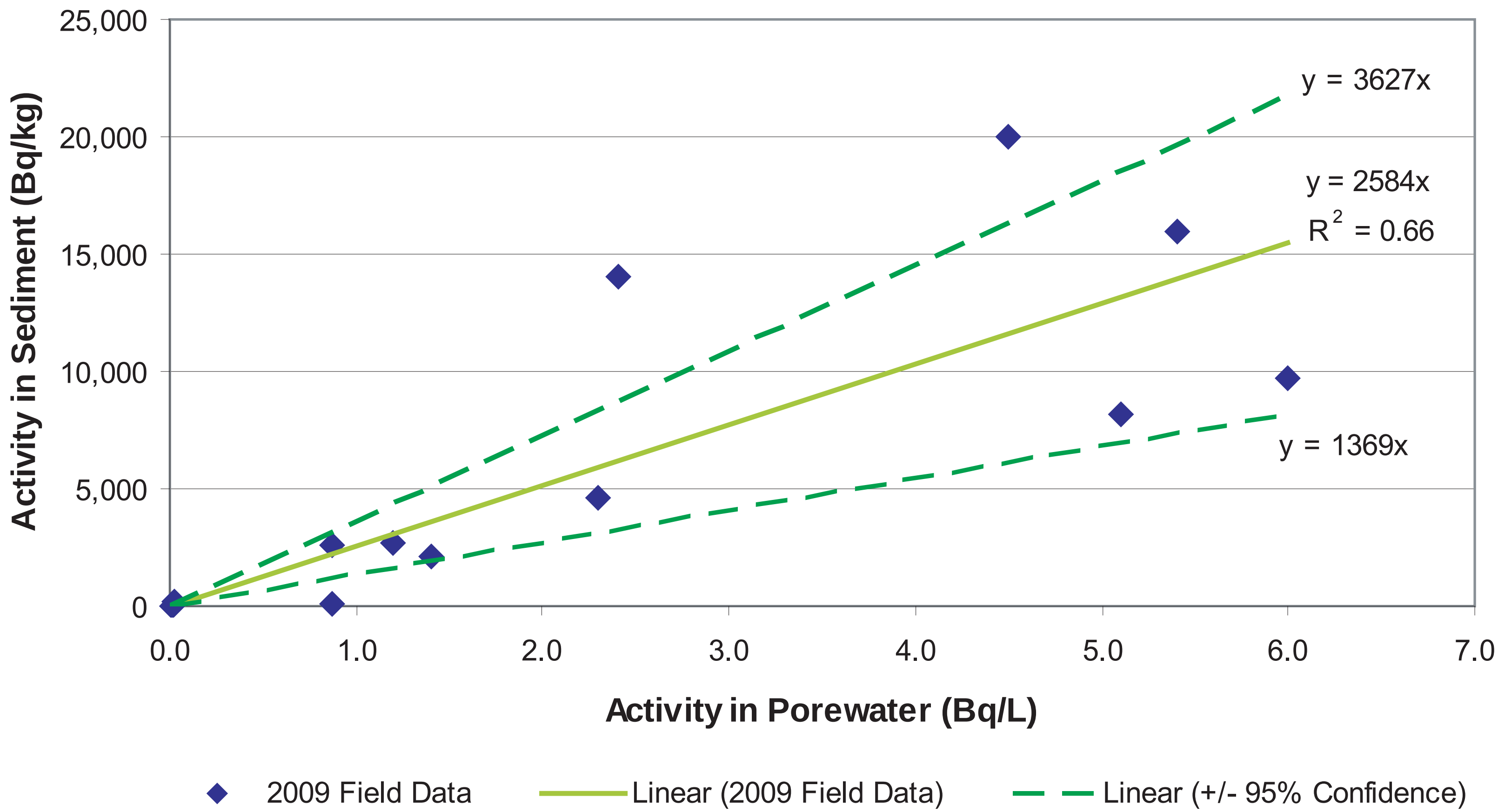
Denison Mines Inc.		
Depth Profiles for Selected Constituents in Surface Water and Porewater		
EcoMetrix INCORPORATED	February 2011	**Figure 5.2**



Denison Mines Inc.

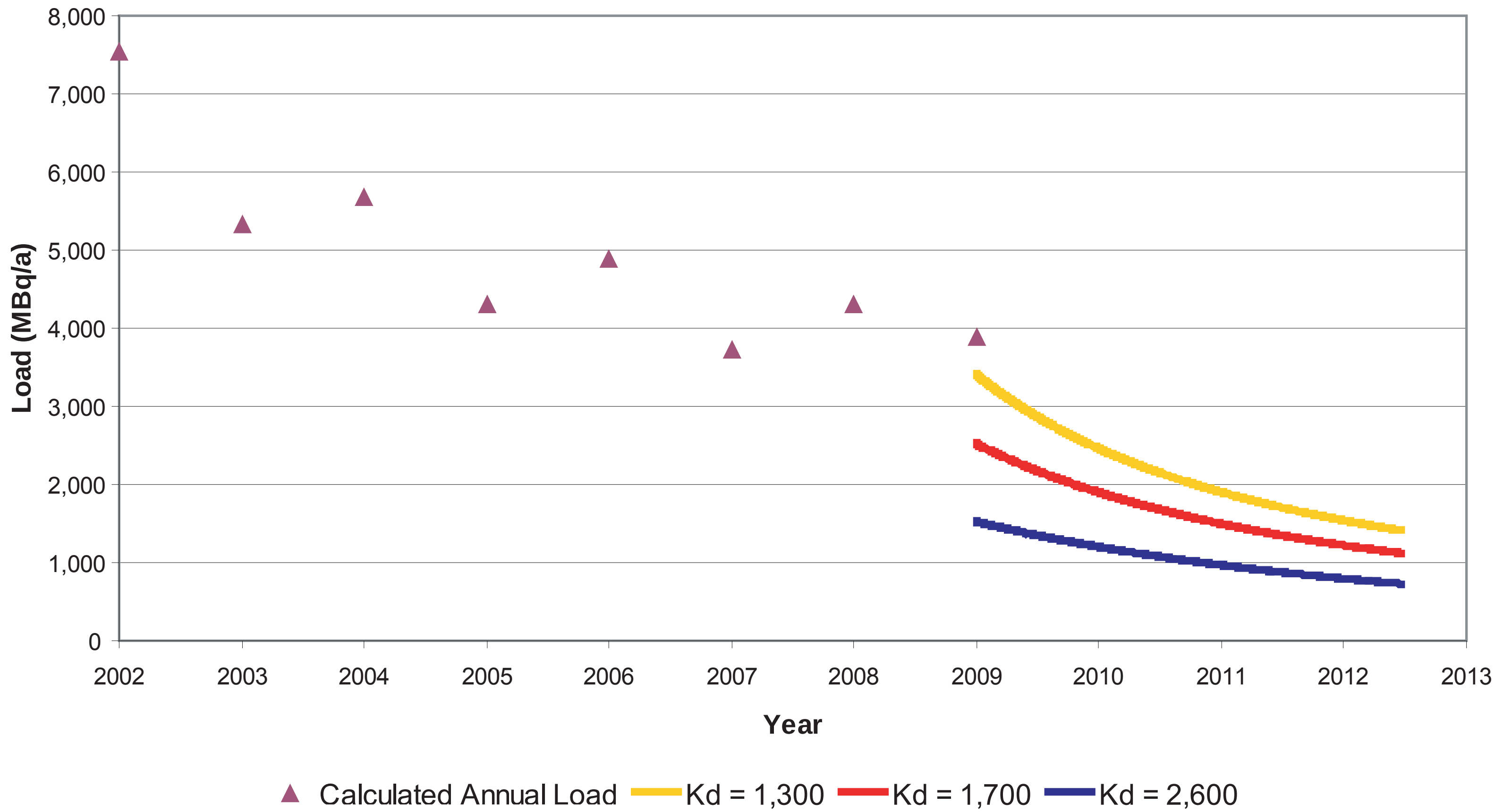
Conceptual Model for Accumulation and Recovery for Ra-226 in Sediments

EcoMetrix INCORPORATED	February 2011	**Figure 6.1**



DENISON MINES

Denison Mines Inc.		
Kd Plot for Radium-226 in Serpent River Sediment Samples		
EcoMetrix INCORPORATED	February 2011	**Figure 6.2**



DENISON MINES

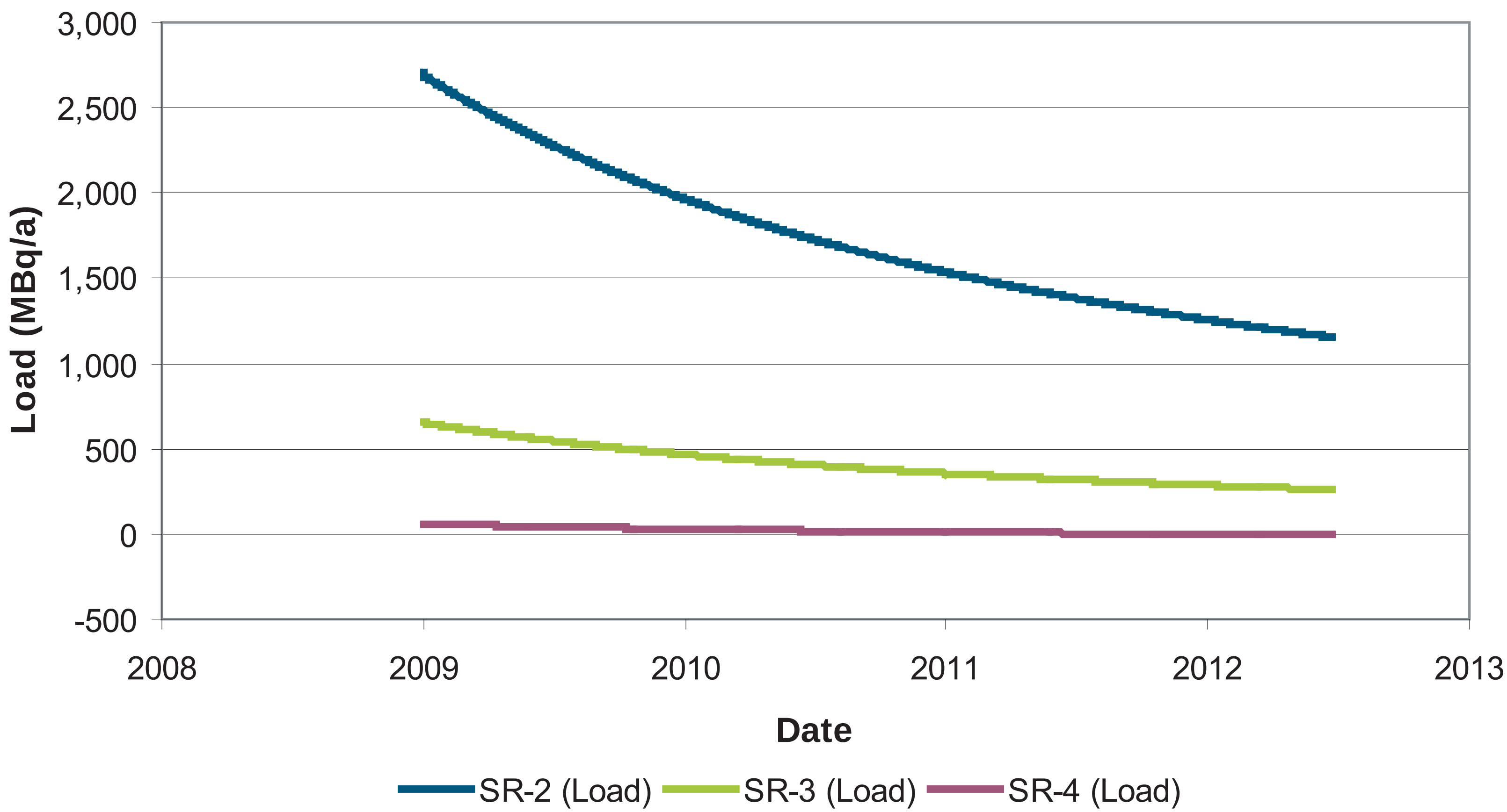
Denison Mines Inc.

Calculated Annual Loads and Modeled Cumulative Loads at D-5 in the Serpent River

EcoMetrix INCORPORATED

February 2011

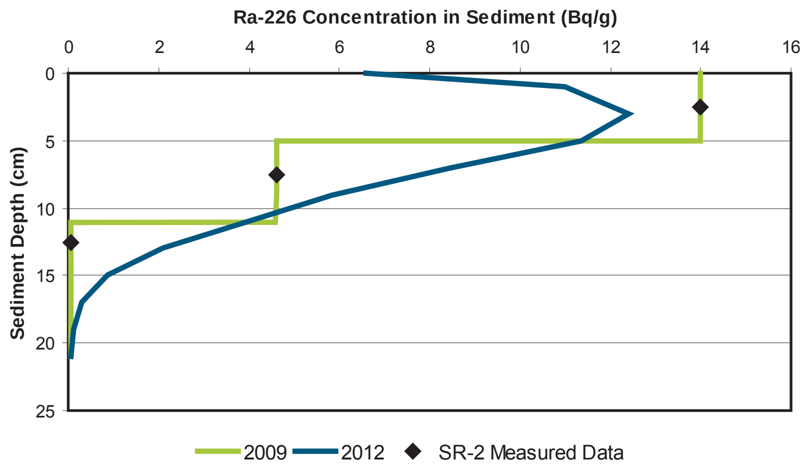
Figure 6.3



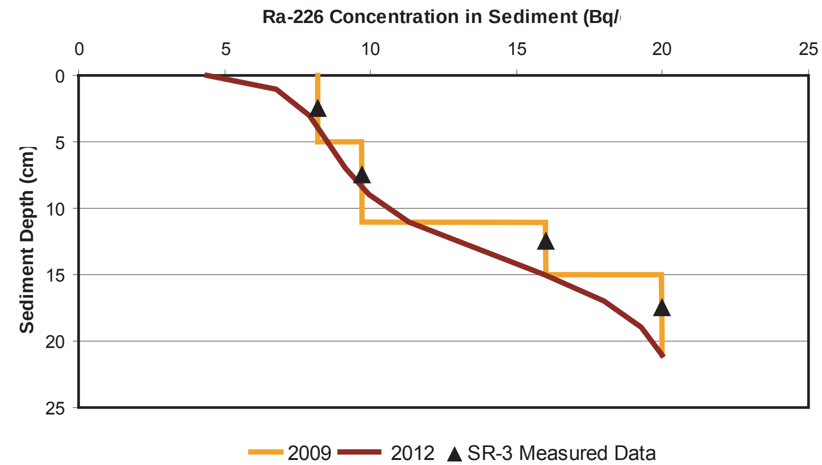
Denison Mines Inc.		
Predicted Loads at SR-2, SR-3 and SR-4		
EcoMetrix INCORPORATED	February 2011	**Figure 6.4**

DENISON MINES

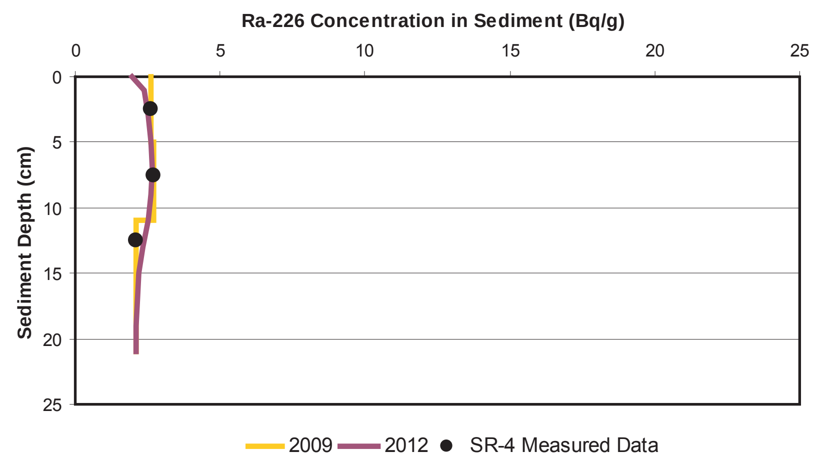
SR-2



SR-3



SR-4



Note: Measured data from 2009 field study (Table 5.1).

Denison Mines Inc.		
Depth Profiles for Ra-226 Recovery		
EcoMetrix INCORPORATED	February 2011	**Figure 6.5**

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APPENDIX 1

Compilation of Routine Monitoring Data for Radium-226 at the Denison TMA

Table A1.1: Routine Monitoring Data for Radium-226 Activities at the Denison TMA

D2		D3		D4		D5		D6	
Sample Date	Radium-226 Activity (Bq/L)	Sample Date	Radium-226 Activity (Bq/L)	Sample Date	Radium-226 Activity (Bq/L)	Sample Date	Radium-226 Activity (Bq/L)	Sample Date	Radium-226 Activity (Bq/L)
Jan-90	0.268	Jan-90	0.17	Jan-90	<0.02	Jan-90	0.03	Mar-90	0.05
Feb-90	0.407	Feb-90	0.13	Feb-90	<0.02	Feb-90	0.28	Apr-90	<0.02
Mar-90	1.58	Mar-90	0.13	Mar-90	<0.02	Mar-90	0.11	May-90	0.03
Apr-90	0.985	Apr-90	0.07	Apr-90	0.02	Apr-90	0.3	Jun-90	<0.02
May-90	1.26	May-90	0.11	May-90	0.04	May-90	0.11	Jul-90	0.02
Jun-90	1.013	Jun-90	0.17	Jun-90	<0.02	Jun-90		Aug-90	0.03
Jul-90	0.646	Jul-90	0.12	Jul-90	<0.02	Jul-90	0.27	Sep-90	
Aug-90	0.433	Aug-90	0.16	Aug-90	<0.02	Aug-90	0.07	Oct-90	<0.02
Sep-90	0.285	Sep-90	0.18	Sep-90	<0.02	Sep-90	0.07	Nov-90	<0.02
Oct-90	0.536	Oct-90	0.06	Oct-90	<0.02	Oct-90	0.26	Dec-90	0.02
Nov-90	0.72	Nov-90	0.06	Nov-90	<0.02	Nov-90	0.13	Jan-91	0.03
Dec-90	0.3	Dec-90	0.04	Dec-90	<0.02	Dec-90	0.045	Feb-91	<0.02
Jan-91	0.608	Jan-91	0.08	Jan-91	<0.02	Jan-91	0.03	Mar-91	0.1
Feb-91	0.297	Feb-91	0.15	Feb-91	0.02	Feb-91	0.02	Apr-91	<0.02
Mar-91	0.558	Mar-91	0.23	Mar-91	0.02	Mar-91	0.14	May-91	<0.02
Apr-91	0.356	Apr-91	0.05	Apr-91	<0.02	Apr-91	0.06	Jun-91	0.02
May-91	0.22	May-91	0.08	May-91	0.02	May-91	0.04	Jul-91	0.02
Jun-91	0.37	Jun-91	0.07	Jun-91	<0.02	Jun-91	<0.02	Aug-91	
Jul-91	0.452	Jul-91		Jul-91	<0.02	Jul-91	0.04	Sep-91	
Aug-91	0.215	Aug-91		Aug-91	<0.02	Aug-91	0.03	Oct-91	<0.02
Sep-91	0.378	Sep-91	0.14	Sep-91	<0.02	Sep-91	0.17	Nov-91	<0.02
Oct-91	0.724	Oct-91	0.09	Oct-91	0.02	Oct-91	0.06	Dec-91	0.04
Nov-91	0.71	Nov-91	0.07	Nov-91		Nov-91	0.22	Jan-92	0.04
Dec-91	0.55	Dec-91	0.03	Dec-91		Dec-91	0.22	Feb-92	0.02
Jan-92	0.462	Jan-92	0.1	Jan-92		Jan-92	0.05	Mar-92	<0.02
Feb-92	0.292	Feb-92	0.08	Feb-92		Feb-92	0.09	Apr-92	0.05
Mar-92	0.886	Mar-92	0.07	Mar-92		Mar-92	0.14	May-92	0.06
Apr-92	0.258	Apr-92	0.06	Apr-92	0.04	Apr-92	0.09	Jun-92	0.08
May-92	0.13	May-92	0.08	May-92		May-92	0.07	Jul-92	<0.02
Jun-92	0.074	Jun-92	0.16	Jun-92		Jun-92	0.08	Aug-92	0.02
Jul-92	0.062	Jul-92	<0.02	Jul-92	0.03	Jul-92	0.06	Sep-92	<0.02
Aug-92	0.052	Aug-92	0.14	Aug-92		Aug-92	0.33	Oct-92	<0.02
Sep-92	0.088	Sep-92	0.06	Sep-92		Sep-92		Nov-92	<0.02
Oct-92	0.068	Oct-92	0.28	Oct-92	<0.02	Oct-92	0.08	Dec-92	<0.02
Nov-92	0.025	Nov-92	0.03	Nov-92		Nov-92	0.02	Jan-93	<0.02
Dec-92	0.034	Dec-92	0.09	Dec-92		Dec-92	0.02	Mar-93	0.02
Jan-93	0.023	Jan-93	0.08	Jan-93		Jan-93	0.03	Apr-93	0.02
Feb-93	0.023	Feb-93	0.05	Feb-93		Feb-93	0.03	May-93	0.02
Mar-93	0.04	Mar-93	0.04	Mar-93		Mar-93	0.03	Jun-93	0.1
Apr-93	0.077	Apr-93	0.04	Apr-93	<0.02	Apr-93	0.06	Jul-93	<0.02
May-93	0.06	May-93	0.17	May-93		May-93	0.05	Aug-93	0.02
Jun-93	0.052	Jun-93	0.08	Jun-93		Jun-93	0.14	Sep-93	<0.02
Jul-93	0.055	Jul-93		Jul-93	<0.02	Jul-93	0.21	Nov-93	0.02
Aug-93	0.046	Aug-93	0.07	Aug-93		Aug-93	0.22	Dec-93	<0.02
Sep-93	0.065	Sep-93	0.13	Sep-93		Sep-93	0.1	Jan-94	<0.02
Oct-93	0.033	Oct-93	0.04	Oct-93	0.02	Oct-93	0.04	Feb-94	<0.02
Nov-93	0.024	Nov-93	0.02	Apr-94	<0.02	Nov-93	0.04	Mar-94	<0.02
Dec-93	0.02	Dec-93	0.02	Jul-94	<0.02	Dec-93	<0.02	Apr-94	<0.02
Jan-94	0.02	Jan-94	0.05	Sep-94		Jan-94	<0.02	May-94	0.04
Feb-94	0.028	Feb-94	0.08	Oct-94	<0.02	Feb-94	<0.02	Jun-94	<0.02
Mar-94	0.034	Mar-94	0.04	Apr-95	0.007	Mar-94	<0.02	Jul-94	<0.02
Apr-94	0.04	Apr-94	0.07	Jul-95	<0.005	Apr-94	<0.02	Aug-94	0.03
May-94	0.03	May-94	0.05	Oct-95	<0.005	May-94	0.09	Sep-94	<0.02
Jun-94	0.025	Jun-94	0.04	Jan-96		Jun-94	0.26	Oct-94	<0.02
Jul-94	0.028	Jul-94	0.05	Apr-96	<0.005	Jul-94	0.2	Nov-94	<0.02
Aug-94	0.03	Aug-94	0.1	Jul-96	<0.005	Aug-94	0.17	Dec-94	0.02
Sep-94	0.028	Sep-94	0.08	Oct-96	<0.005	Sep-94	0.15	Jan-95	<0.02
Oct-94	0.028	Oct-94	0.04	Apr-97	0.006	Oct-94	0.15	Feb-95	<0.02
Nov-94	0.032	Nov-94	0.03	Jul-97	<0.005	Nov-94	0.14	Mar-95	<0.02
Dec-94	0.023	Dec-94	0.02	Oct-97	<0.005	Dec-94	0.05	Apr-95	0.01
Jan-95	0.026	Jan-95	0.04	Apr-98	<0.005	Jan-95	0.02	May-95	
Feb-95	0.05	Feb-95	0.07	Jul-98	<0.005	Feb-95	0.06	Jun-95	0.01
Mar-95	0.073	Mar-95	0.09	Oct-98	0.006	Mar-95	0.08	Jul-95	0.011
Apr-95	0.07	Apr-95	0.14	Apr-99	<0.005	Apr-95	0.041	Aug-95	0.009
May-95	0.027	May-95	0.078	Jul-99	0.013	May-95	0.054	Oct-95	0.013
Jun-95	0.04	Jun-95	0.063	Sep-99	<0.005	Jun-95	0.024	Nov-95	0.007
Jul-95	0.035	Jul-95	0.091	Oct-99	0.017	Jul-95	0.203	Jan-96	<0.005
Aug-95	0.048	Aug-95	0.101	Nov-99	<0.005	Aug-95	0.245	Feb-96	<0.005
Sep-95	0.035	Sep-95	0.042	Jan-00	<0.005	Sep-95	0.133	Mar-96	<0.005
Oct-95	0.05	Oct-95	0.044	Jun-00	0.018	Oct-95	0.063	Apr-96	<0.005
Nov-95	0.014	Nov-95	0.026	Jul-00	<0.005	Nov-95	0.06	May-96	<0.005
Dec-95	0.009	Dec-95	0.025	Oct-00	<0.005	Dec-95	0.032	Jun-96	0.016
Jan-96	0.024	Jan-96	0.076	Dec-00	<0.005	Jan-96	0.029	Jul-96	0.006
Feb-96	0.039	Feb-96	0.16	Mar-01	<0.005	Feb-96	0.019	Aug-96	0.041
Mar-96	0.166	Mar-96	0.077	Apr-01	0.017	Mar-96	0.026	Sep-96	0.023
Apr-96	0.23	Apr-96	0.064	Jun-01	0.007	Apr-96	0.034	Oct-96	0.007
May-96	0.008	May-96	0.031	Jul-01	<0.005	May-96	0.098	Nov-96	0.014
Jun-96	0.022	Jun-96		Sep-01	0.008	Jun-96	0.17	Dec-96	<0.005
Jul-96	0.034	Jul-96	0.072	Oct-01	<0.005	Jul-96	0.161	Jan-97	0.006
Aug-96	0.042	Aug-96	0.091	Dec-01	<0.005	Aug-96	0.221	Feb-97	0.011
Sep-96	0.035	Sep-96	0.1	Apr-02	<0.005	Sep-96	0.39	Mar-97	0.009
Oct-96	0.041	Oct-96	0.061	Jun-02	0.007	Oct-96	0.14	Apr-97	<0.005

Table A1.1: Routine Monitoring Data for Radium-226 Activities at the Denison TMA

D2		D3		D4		D5		D6	
Sample Date	Radium-226 Activity (Bq/L)	Sample Date	Radium-226 Activity (Bq/L)	Sample Date	Radium-226 Activity (Bq/L)	Sample Date	Radium-226 Activity (Bq/L)	Sample Date	Radium-226 Activity (Bq/L)
Nov-96	0.04	*Nov-96*	0.06	*Jul-02*	0.007	*Nov-96*	0.043	*May-97*	0.008
Dec-96	0.032	*Dec-96*	0.022	*Oct-02*	<0.005	*Dec-96*	0.03	*Jun-97*	<0.005
Jan-97	0.02	*Jan-97*	0.091	*Dec-02*	<0.005	*Jan-97*	0.02	*Jul-97*	
Feb-97	0.022	*Feb-97*	0.14	*Apr-03*	<0.005	*Feb-97*	0.034	*Aug-97*	0.008
Mar-97	0.013	*Mar-97*	0.047	*Oct-03*	<0.005	*Mar-97*	0.045	*Sep-97*	0.015
Apr-97	0.097	*Apr-97*	0.15	*Apr-04*	0.009	*Apr-97*	0.032	*Oct-97*	0.014
May-97	0.047	*May-97*	0.14	*Sep-04*	0.01	*May-97*	0.057	*Nov-97*	0.025
Jun-97	0.07	*Jun-97*	0.09	*Apr-05*	<0.005	*Jun-97*	0.28	*Dec-97*	0.014
Jul-97	0.066	*Jul-97*	0.14	*Oct-05*	<0.005	*Jul-97*	0.41	*Jan-98*	0.011
Aug-97		*Aug-97*		*Apr-06*	<0.005	*Aug-97*	0.12	*Feb-98*	0.01
Sep-97	0.033	*Sep-97*	0.16	*Oct-06*	<0.005	*Sep-97*	0.36	*Mar-98*	0.006
Oct-97	0.032	*Oct-97*	0.16	*Apr-07*	<0.005	*Oct-97*	0.18	*Apr-98*	0.016
Nov-97	0.033	*Nov-97*	0.097	*Oct-07*	<0.005	*Nov-97*	0.054	*May-98*	0.011
Dec-97	0.022	*Dec-97*	0.087	*Apr-08*		*Dec-97*	0.055	*Jun-98*	0.006
Jan-98	0.025	*Jan-98*	0.099	*Oct-08*	<0.005	*Jan-98*	0.023	*Jul-98*	<0.005
Feb-98	0.021	*Feb-98*	0.105	*Apr-09*	<0.005	*Feb-98*	0.03	*Aug-98*	0.008
Mar-98	0.021	*Mar-98*	0.11	*Oct-09*	<0.005	*Mar-98*	0.047	*Sep-98*	0.011
Apr-98	0.023	*Apr-98*	0.2			*Apr-98*	0.086	*Oct-98*	0.015
May-98	0.029	*May-98*	0.17			*May-98*	0.201	*Nov-98*	0.01
Jun-98	0.071	*Jun-98*	0.11			*Jun-98*	0.15	*Dec-98*	0.01
Jul-98	0.023	*Jul-98*	0.16			*Jul-98*	0.34	*Jan-99*	<0.005
Aug-98	0.026	*Aug-98*				*Aug-98*	0.3	*Feb-99*	0.006
Sep-98	0.024	*Sep-98*				*Sep-98*	0.35	*Mar-99*	0.005
Oct-98	0.03	*Oct-98*	0.15			*Oct-98*	0.101	*Apr-99*	<0.005
Nov-98	0.027	*Nov-98*	0.11			*Nov-98*	0.068	*May-99*	<0.005
Dec-98	0.023	*Dec-98*	0.075			*Dec-98*	0.033	*Jun-99*	<0.005
Jan-99	0.02	*Jan-99*	0.068			*Jan-99*	0.014	*Jul-99*	0.008
Feb-99	0.028	*Feb-99*	0.082			*Feb-99*	0.021	*Aug-99*	0.01
Mar-99	0.043	*Mar-99*	0.051			*Mar-99*	0.028	*Sep-99*	0.017
Apr-99	0.021	*Apr-99*	0.067			*Apr-99*	0.048	*Oct-99*	0.012
May-99	0.021	*May-99*	0.1			*May-99*	0.1	*Nov-99*	0.008
Jun-99	0.022	*Jun-99*	0.13			*Jun-99*	0.21	*Dec-99*	<0.005
Jul-99	0.022	*Jul-99*	0.22			*Jul-99*	0.19	*Jan-00*	0.007
Aug-99	0.039	*Aug-99*	0.14			*Aug-99*	0.22	*Feb-00*	0.005
Sep-99	0.025	*Sep-99*				*Sep-99*	0.26	*Mar-00*	<0.005
Oct-99	0.029	*Oct-99*	0.085			*Oct-99*	0.14	*Apr-00*	0.014
Nov-99	0.021	*Nov-99*	0.082			*Nov-99*	0.063	*May-00*	0.013
Dec-99	0.012	*Dec-99*	0.06			*Dec-99*	0.041	*Jun-00*	0.015
Jan-00	0.017	*Jan-00*	0.061			*Jan-00*	0.03	*Jul-00*	
Feb-00	0.012	*Feb-00*	0.097			*Feb-00*	0.024	*Aug-00*	
Mar-00	0.025	*Mar-00*	0.098			*Mar-00*	0.022	*Sep-00*	
Apr-00	0.043	*Apr-00*	0.096			*Apr-00*	0.019	*Oct-00*	
May-00	0.049	*May-00*	0.15			*May-00*	0.11	*Nov-00*	
Jun-00	0.054	*Jun-00*	0.13			*Jun-00*	0.18	*Dec-00*	0.015
Jul-00	0.028	*Jul-00*	0.14			*Jul-00*	0.2	*Jan-01*	0.015
Aug-00	0.022	*Aug-00*				*Aug-00*	0.401	*Feb-01*	0.006
Sep-00	0.034	*Sep-00*				*Sep-00*	0.461	*Mar-01*	0.009
Oct-00	0.031	*Oct-00*				*Oct-00*	0.261	*Apr-01*	0.007
Nov-00	0.041	*Nov-00*	0.103			*Nov-00*	0.13	*May-01*	0.007
Dec-00	0.015	*Dec-00*	0.089			*Dec-00*	0.074	*Jun-01*	<0.005
Jan-01	0.017	*Jan-01*	0.092			*Jan-01*	0.035	*Jul-01*	
Feb-01	0.02	*Feb-01*	0.094			*Feb-01*	0.084	*Aug-01*	
Mar-01	0.016	*Mar-01*	0.073			*Mar-01*	0.032	*Sep-01*	
Apr-01	0.03	*Apr-01*	0.099			*Apr-01*	0.028	*Oct-01*	<0.005
May-01	0.062	*May-01*	0.14			*May-01*	0.06	*Nov-01*	0.008
Jun-01	0.045	*Jun-01*	0.11			*Jun-01*	0.081	*Dec-01*	<0.005
Jul-01	0.052	*Jul-01*				*Jul-01*	0.29	*Jan-02*	<0.005
Aug-01	0.045	*Aug-01*				*Aug-01*	0.79	*Feb-02*	<0.005
Sep-01	0.052	*Sep-01*	0.093			*Sep-01*	0.515	*Mar-02*	<0.005
Oct-01	0.058	*Oct-01*	0.09			*Oct-01*	0.1	*Apr-02*	<0.005
Nov-01	0.053	*Nov-01*	0.098			*Nov-01*	0.035	*May-02*	0.007
Dec-01	0.059	*Dec-01*	0.11			*Dec-01*	0.029	*Jun-02*	0.007
Jan-02	0.031	*Jan-02*	0.09			*Jan-02*	0.009	*Jul-02*	<0.005
Feb-02	0.026	*Feb-02*	0.088			*Feb-02*	0.032	*Aug-02*	0.008
Mar-02	0.06	*Mar-02*	0.096			*Mar-02*	0.042	*Sep-02*	
Apr-02	0.058	*Apr-02*	0.09			*Apr-02*	0.024	*Oct-02*	0.011
May-02	0.09	*May-02*	0.071			*May-02*	0.026	*Nov-02*	0.006
Jun-02	0.115	*Jun-02*	0.13			*Jun-02*	0.1	*Dec-02*	0.011
Jul-02	0.098	*Jul-02*				*Jul-02*	0.22	*Jan-03*	<0.005
Aug-02	0.119	*Aug-02*				*Aug-02*	0.39	*Feb-03*	<0.005
Sep-02	0.122	*Sep-02*				*Sep-02*	0.49	*Mar-03*	<0.005
Oct-02	0.178	*Oct-02*	0.122			*Oct-02*	0.15	*Apr-03*	0.006
Nov-02	0.082	*Nov-02*	0.12			*Nov-02*	0.084	*May-03*	0.021
Dec-02	0.03	*Dec-02*	0.095			*Dec-02*	0.056	*Jun-03*	<0.005
Jan-03	0.027	*Jan-03*	0.109			*Jan-03*	0.042	*Jul-03*	0.019
Feb-03	0.033	*Feb-03*	0.105			*Feb-03*	0.052	*Aug-03*	0.007
Mar-03	0.068	*Mar-03*	0.116			*Mar-03*	0.027	*Sep-03*	0.009
Apr-03	0.127	*Apr-03*	0.086			*Apr-03*	0.025	*Oct-03*	0.005
May-03	0.345	*May-03*	0.131			*May-03*	0.039	*Nov-03*	0.008
Jun-03	0.145	*Jun-03*	0.118			*Jun-03*	0.12	*Dec-03*	0.009
Jul-03	0.262	*Jul-03*	0.137			*Jul-03*	0.21	*Jan-04*	0.011
Aug-03	0.155	*Aug-03*	0.185			*Aug-03*	0.22	*Feb-04*	0.009

Table A1.1: Routine Monitoring Data for Radium-226 Activities at the Denison TMA

D2		D3		D4		D5		D6	
Sample Date	Radium-226 Activity (Bq/L)	Sample Date	Radium-226 Activity (Bq/L)	Sample Date	Radium-226 Activity (Bq/L)	Sample Date	Radium-226 Activity (Bq/L)	Sample Date	Radium-226 Activity (Bq/L)
Sep-03	0.228	*Sep-03*	0.16			*Sep-03*	0.076	*Mar-04*	<0.005
Oct-03	0.232	*Oct-03*	0.134			*Oct-03*	0.072	*Apr-04*	0.021
Nov-03	0.282	*Nov-03*	0.114			*Nov-03*	0.063	*May-04*	0.005
Dec-03	0.127	*Dec-03*	0.092			*Dec-03*	0.032	*Jun-04*	<0.005
Jan-04	0.071	*Jan-04*	0.106			*Jan-04*	0.044	*Jul-04*	0.01
Feb-04	0.059	*Feb-04*	0.111			*Feb-04*	0.028	*Aug-04*	0.014
Mar-04	0.137	*Mar-04*	0.111			*Mar-04*	0.037	*Sep-04*	<0.005
Apr-04	0.146	*Apr-04*	0.077			*Apr-04*	0.024	*Oct-04*	0.01
May-04	0.25	*May-04*	0.111			*May-04*	0.021	*Nov-04*	0.007
Jun-04	0.334	*Jun-04*	0.116			*Jun-04*	0.074	*Dec-04*	0.008
Jul-04	0.193	*Jul-04*	0.142			*Jul-04*	0.18	*Jan-05*	0.008
Aug-04	0.242	*Aug-04*	0.25			*Aug-04*	0.19	*Feb-05*	<0.005
Sep-04	0.148	*Sep-04*	0.19			*Sep-04*	0.225	*Mar-05*	0.015
Oct-04	0.168	*Oct-04*	0.109			*Oct-04*	0.26	*Apr-05*	0.015
Nov-04	0.144	*Nov-04*	0.11			*Nov-04*	0.098	*May-05*	0.006
Dec-04	0.092	*Dec-04*	0.116			*Dec-04*	0.028	*Jun-05*	<0.005
Jan-05	0.087	*Jan-05*	0.091			*Jan-05*	0.029	*Jul-05*	0.011
Feb-05	0.08	*Feb-05*	0.124			*Feb-05*	0.023	*Aug-05*	0.011
Mar-05	0.039	*Mar-05*	0.136			*Mar-05*	0.035	*Sep-05*	0.011
Apr-05	0.109	*Apr-05*	0.098			*Apr-05*	0.029	*Oct-05*	0.012
May-05	0.186	*May-05*	0.144			*May-05*	0.055	*Nov-05*	0.007
Jun-05	0.1	*Jun-05*	0.19			*Jun-05*	0.099	*Dec-05*	<0.005
Jul-05	0.067	*Jul-05*				*Jul-05*	0.14	*Jan-06*	<0.005
Aug-05	0.095	*Aug-05*				*Aug-05*	0.24	*Feb-06*	<0.005
Sep-05	0.096	*Sep-05*				*Sep-05*	0.26	*Mar-06*	<0.005
Oct-05	0.115	*Oct-05*	0.15			*Oct-05*	0.28	*Apr-06*	0.005
Nov-05	0.176	*Nov-05*	0.112			*Nov-05*	0.15	*May-06*	0.005
Dec-05	0.046	*Dec-05*	0.068			*Dec-05*	0.02	*Jun-06*	0.005
Jan-06	0.022	*Jan-06*	0.099			*Jan-06*	0.017	*Jul-06*	<0.005
Feb-06	0.025	*Feb-06*	0.101			*Feb-06*	0.012	*Aug-06*	0.011
Mar-06	0.034	*Mar-06*	0.094			*Mar-06*	0.009	*Sep-06*	0.013
Apr-06	0.128	*Apr-06*	0.102			*Apr-06*	0.018	*Oct-06*	0.008
May-06	0.097	*May-06*	0.126			*May-06*	0.03	*Nov-06*	<0.005
Jun-06	0.086	*Jun-06*	0.14			*Jun-06*	0.095	*Dec-06*	<0.005
Jul-06	0.082	*Jul-06*	0.185			*Jul-06*	0.16	*Jan-07*	<0.005
Aug-06	0.053	*Aug-06*	0.203			*Aug-06*	0.14	*Feb-07*	0.005
Sep-06	0.072	*Sep-06*	0.149			*Sep-06*	0.33	*Mar-07*	<0.005
Oct-06	0.079	*Oct-06*	0.13			*Oct-06*	0.31	*Apr-07*	0.007
Nov-06	0.092	*Nov-06*	0.11			*Nov-06*	0.041	*May-07*	0.007
Dec-06	0.082	*Dec-06*	0.097			*Dec-06*	0.024	*Jun-07*	0.007
Jan-07	0.103	*Jan-07*	0.099			*Jan-07*	0.015	*Jul-07*	
Feb-07	0.071	*Feb-07*	0.112			*Feb-07*	0.019	*Aug-07*	
Mar-07	0.049	*Mar-07*	0.099			*Mar-07*	0.013	*Sep-07*	
Apr-07	0.092	*Apr-07*	0.086			*Apr-07*	0.027	*Oct-07*	0.013
May-07	0.156	*May-07*	0.15			*May-07*	0.048	*Nov-07*	0.007
Jun-07	0.079	*Jun-07*	0.173			*Jun-07*	0.1	*Dec-07*	<0.005
Jul-07	0.128	*Jul-07*	0.21			*Jul-07*	0.17	*Jan-08*	0.007
Aug-07	0.136	*Aug-07*				*Aug-07*	0.26	*Feb-08*	<0.005
Sep-07	0.088	*Sep-07*				*Sep-07*	0.23	*Mar-08*	<0.005
Oct-07	0.134	*Oct-07*	0.143			*Oct-07*	0.23	*Apr-08*	<0.005
Nov-07	0.118	*Nov-07*	0.096			*Nov-07*	0.071	*May-08*	<0.005
Dec-07	0.038	*Dec-07*	0.083			*Dec-07*	0.02	*Jun-08*	<0.005
Jan-08	0.031	*Jan-08*	0.088			*Jan-08*	0.009	*Jul-08*	<0.005
Feb-08	0.097	*Feb-08*	0.082			*Feb-08*	0.015	*Aug-08*	0.005
Mar-08	0.185	*Mar-08*	0.089			*Mar-08*	0.015	*Sep-08*	<0.005
Apr-08	0.202	*Apr-08*	0.085			*Apr-08*	0.035	*Oct-08*	0.007
May-08	0.215	*May-08*	0.087			*May-08*	0.027	*Nov-08*	<0.005
Jun-08	0.112	*Jun-08*	0.131			*Jun-08*	0.074	*Dec-08*	<0.005
Jul-08	0.146	*Jul-08*	0.168			*Jul-08*	0.1	*Jan-09*	<0.005
Aug-08	0.117	*Aug-08*	0.16			*Aug-08*	0.1	*Feb-09*	0.005
Sep-08	0.089	*Sep-08*	0.18			*Sep-08*	0.14	*Mar-09*	<0.005
Oct-08	0.099	*Oct-08*	0.153			*Oct-08*	0.15	*Apr-09*	<0.005
Nov-08	0.12	*Nov-08*	0.135			*Nov-08*	0.089	*May-09*	<0.005
Dec-08	0.117	*Dec-08*	0.122			*Dec-08*	0.029	*Jun-09*	0.007
Jan-09	0.23	*Jan-09*	0.117			*Jan-09*	0.038	*Jul-09*	0.013
Feb-09	0.165	*Feb-09*	0.115			*Feb-09*	0.022	*Aug-09*	<0.005
Mar-09	0.258	*Mar-09*	0.113			*Mar-09*	0.023	*Sep-09*	0.009
Apr-09	0.258	*Apr-09*	0.101			*Apr-09*	0.052	*Oct-09*	0.012
		May-09	0.12			*May-09*	0.037	*Nov-09*	<0.005
		Jun-09	0.154			*Jun-09*	0.051	*Dec-09*	<0.005
		Jul-09	0.188			*Jul-09*	0.14		
		Aug-09	0.21			*Aug-09*	0.12		
		Sep-09	0.3			*Sep-09*	0.12		
		Oct-09	0.153			*Oct-09*	0.22		
		Nov-09	0.128			*Nov-09*	0.035		
		Dec-09	0.132			*Dec-09*	0.025		

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APPENDIX 2

Photographic Log of Field Sampling in 2009

Core Sample: Core09-SR-3

Core Sample: Core09-SR-4

Denison Mines Inc		
Photographs from the Serpent River Field Sampling Program		
EcoMetrix INCORPORATED	February 2011	**Figure A2.1**

Serpent River Sampling Location SR-1

Denison Mines Inc		
Photographs from the Serpent River Field Sampling Program		
EcoMetrix INCORPORATED	February 2011	**Figure A2.2**

Serpent River Sampling Location SR-2

Denison Mines Inc

Photographs from the Serpent River Field Sampling Program

EcoMetrix INCORPORATED | February 2011 | **Figure A2.3**

Serpent River Sampling Location SR-3

Denison Mines Inc		
Photographs from the Serpent River Field Sampling Program		
EcoMetrix INCORPORATED	February 2011	**Figure A2.4**

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APPENDIX 3

Detailed Data Quality Assessment

Table A3.1: Detailed Data Quality Assessment for Constituents in Solids

Analysis	Units	Method Detection Limit	RPD Data Quality Objective	Sample ID CORE 09-PSB-2 (5-10)	Duplicate ID CORE 09-EC-1 (0-5)	RPD (%) or AD	Sample ID CORE 09-SR-4 (10-15)	Duplicate ID CORE 09-EC-1 (5-10)	RPD (%) or AD	Sample ID CORE 09-QC14-2 (0-2.5)	Replicate ID CORE 09-EC-2 (0-2.5)	RPD (%) or AD	Sample ID CORE 09-QC14-2 (2.5-5)	Replicate ID CORE 09-EC-2 (2.5-5)	RPD (%) or AD	Sample ID CORE 09-QC14-2 (5-7.5)	Replicate ID CORE 09-EC-2 (5-7.5)	RPD (%) or AD
Conventional Parameters																		
Sulphur (S)	%	0.005	≤ 40%	1.57	1.17	29	1.00	0.762	27	0.633	0.628	1	0.885	1.03	15	0.871	1.18	30
Carbonate (CO_3)	%	0.005	≤ 40%	0.097	0.058	**50**	0.419	0.280	40	<0.005	<0.005	BD	<0.005	<0.005	BD	<0.005	<0.005	BD
Total Organic Carbon (TOC)	%	0.01	≤ 40%	9.78	10.5	7	16.8	16.7	1	0.519	0.617	17	0.289	0.206	34	0.121	0.090	29
Total Carbon (C)	%	0.005	≤ 40%	9.80	10.5	7	16.9	16.8	1	0.519	0.616	17	0.289	0.207	33	0.121	0.089	30
Sulphide	%	0.01	≤ 40%	0.36	0.47	27	0.65	0.70	7	0.52	0.53	2	0.77	1.04	30	0.84	1.07	24
Sulphate (SO_4)	%	0.1	≤ 40%	0.6	0.3	**0.3**	0.2	0.1	0.1	0.1	0.1	0	0.1	0.1	0	0.1	0.1	0
Metals																		
Radium-226 (Ra-226)	Bq/g	0.01	≤ 40%	4.5	4.1	9	2.1	1.6	27	4.3	7.0	**48**	6.5	8.3	24	9.3	20.0	**73**
Silver (Ag)	mg/kg	0.7	≤ 40%	<0.7	<0.7	BD	<0.7	<0.7	BD	0.8	1.5	**1**	1.0	1.2	0.2	1.1	1.1	0
Aluminum (Al)	mg/kg	1	≤ 40%	3600	3800	5	5600	5800	4	830	1500	**58**	690	1200	**54**	850	890	5
Arsenic (As)	mg/kg	1	≤ 40%	14	14	0	26	26	0	17	22	26	19	24	23	21	24	13
Barium (Ba)	mg/kg	0.05	≤ 40%	160	94	**52**	440	450	2	150	280	**60**	220	370	**51**	330	310	6
Beryllium (Be)	mg/kg	0.1	≤ 40%	0.34	0.35	0.01	0.12	0.13	0.01	0.28	0.51	**0.23**	0.28	0.41	0.1	0.34	0.34	0
Bismuth (Bi)	mg/kg	0.5	≤ 40%	11	12	9	<0.5	<0.5	BD	7.5	11	38	9.2	8.6	7	8.5	7.8	9
Calcium (Ca)	mg/kg	1	≤ 40%	7600	4600	**49**	7300	7400	1	190	230	19	130	110	17	79	63	23
Cadmium (Cd)	mg/kg	0.05	≤ 40%	4.5	4.0	12	1.8	1.8	0	0.18	0.25	33	0.22	0.27	20	0.22	0.29	27
Cerium (Ce)	mg/kg	0.006	≤ 40%	220	240	9	840	800	5	300	340	13	290	300	3	280	240	15
Cobalt (Co)	mg/kg	0.3	≤ 40%	15	15	0	16	17	6	15	16	6	18	21	15	17	22	26
Chromium (Cr)	mg/kg	0.5	≤ 40%	6.5	7.8	18	17	17	0	4.7	8.2	**54**	4.9	6.5	28	5.7	5.8	2
Cesium (Cs)	mg/kg	0.01	≤ 40%	0.97	1.1	13	0.87	0.90	3	0.18	0.32	**56**	0.22	0.20	10	0.31	0.19	**48**
Copper (Cu)	mg/kg	0.1	≤ 40%	14	15	7	56	56	0	43	50	15	46	54	16	42	54	25
Iron (Fe)	mg/kg	0.5	≤ 40%	240000	240000	0	12000	16000	29	10000	13000	26	12000	17000	34	13000	19000	38
Gallium (Ga)	mg/kg	0.03	≤ 40%	2.4	2.7	12	6.6	6.5	2	2.1	2.8	29	2.1	2.4	13	2.0	1.9	5
Germanium (Ge)	mg/kg	0.3	≤ 40%	7.2	7.2	0	3.8	4.0	5	1.2	1.4	0.2	1.2	1.4	0.2	1.2	1.2	0
Hafnium (Hf)	mg/kg	0.1	≤ 40%	0.1	0.1	0	0.6	0.9	40	0.3	0.5	**0.2**	0.6	0.7	15	1.0	0.7	35
Indium (In)	mg/kg	0.01	≤ 40%	<0.01	<0.01	BD	<0.01	0.01	BD	<0.01	0.02	BD	<0.01	0.01	BD	0.01	0.01	0
Potassium (K)	mg/kg	1	≤ 40%	190	210	10	270	270	0	210	330	44	230	300	26	250	230	8
Lanthanum (La)	mg/kg	0.001	≤ 40%	110	130	17	430	420	2	170	190	11	170	170	0	160	140	13
Lithium (Li)	mg/kg	0.1	≤ 40%	0.9	0.9	0	1.1	1.3	17	0.2	0.8	**120**	0.1	0.5	**0.4**	0.4	0.2	**0.2**
Lutetium (Lu)	mg/kg	0.001	≤ 40%	0.98	1.1	12	5.3	5.3	0	0.081	0.14	**53**	0.048	0.060	22	0.031	0.038	20
Magnesium (Mg)	mg/kg	1	≤ 40%	360	240	40	1400	1500	7	88	110	22	46	38	19	25	18	33
Manganese (Mn)	mg/kg	0.05	≤ 40%	89	84	6	180	180	0	13	18	32	8.6	7.6	12	4.7	4.6	2
Molybdenum (Mo)	mg/kg	0.5	≤ 40%	10	10	0	3.6	3.9	8	5.3	6.4	19	5.2	6.1	16	7.9	5.5	36
Sodium (Na)	mg/kg	1	≤ 40%	35	40	13	59	55	7	8	11	32	7	8	13	6	5	1
Niobium (Nb)	mg/kg	0.7	≤ 40%	2.8	2.7	4	0.8	<0.7	BD	7.0	9.7	32	8.2	7.8	5	8.4	7.5	11
Nickel (Ni)	mg/kg	1	≤ 40%	17	19	11	43	43	0	8	9	12	8	10	22	8	11	32
Lead (Pb)	mg/kg	0.7	≤ 40%	270	280	4	640	640	0	180	240	29	260	270	4	270	310	14
Phosphorous (P)	mg/kg	5	≤ 40%	740	810	9	340	360	6	260	400	**42**	300	360	18	360	330	9
Rubidium (Rb)	mg/kg	0.004	≤ 40%	2.1	2.5	17	4.0	4.0	0	1.9	2.6	31	1.9	2.0	5	1.8	1.4	25
Antimony (Sb)	mg/kg	1	≤ 40%	<1	<1	BD	<1	<1	BD	<1	1	BD	<1	<1	BD	<1	<1	BD
Scandium (Sc)	mg/kg	0.2	≤ 40%	1.3	1.6	21	2.7	3.0	11	0.5	0.9	**57**	0.4	0.8	**67**	0.5	0.6	0.1
Selenium (Se)	mg/kg	1	≤ 40%	<1	<2	BD	<1	<2	BD	<2	<2	BD	<2	<2	BD	<2	<2	BD
Tin (Sn)	mg/kg	6	≤ 40%	<6	<6	BD	<6	<6	BD	<6	<6	BD	<6	<6	BD	<6	<6	BD
Strontium (Sr)	mg/kg	0.01	≤ 40%	7.6	7.9	4	14	14	0	3.6	5.1	34	4.1	5.4	27	4.8	4.6	4
Sulphur (S)	mg/kg	1	≤ 40%	--	15000	--	11000	11000	0	6500	6700	3	8700	11000	23	8600	12000	33
Tantalum (Ta)	mg/kg	0.01	≤ 40%	0.05	0.05	0	0.15	0.23	**42**	0.04	0.07	**55**	0.05	0.12	**82**	0.12	0.28	**80**
Terbium (Tb)	mg/kg	0.01	≤ 40%	3.9	4.3	10	35	33	6	0.97	1.4	36	0.83	0.90	8	0.68	0.67	1
Tellurium (Te)	mg/kg	0.1	≤ 40%	0.1	0.1	0	<0.1	<0.1	BD	0.1	0.2	0.1	0.2	0.2	0	0.2	0.2	0
Thorium (Th)	mg/kg	0.01	≤ 40%	110	120	9	85	89	5	310	560	**57**	310	470	41	360	380	5
Titanium (Ti)	mg/kg	0.2	≤ 40%	82	91	10	210	220	5	210	330	**44**	250	260	4	260	240	8
Thallium (Tl)	mg/kg	3	≤ 40%	<3	<3	BD	<3	<3	BD	<3	<3	BD	<3	<3	BD	<3	<3	BD
Uranium (U)	mg/kg	3	≤ 40%	210	230	9	110	150	31	17	23	30	17	18	6	13	15	2
Vanadium (V)	mg/kg	0.1	≤ 40%	25	26	4	16	17	6	2.7	4.0	39	2.7	2.7	0	2.7	2.4	12
Tungsten (W)	mg/kg	1	≤ 40%	2	79	**190**	<1	5	BD	3	5	**2**	4	5	1	5	6	18
Yttrium (Y)	mg/kg	0.1	≤ 40%	78	84	7	740	750	1	9.1	12	27	6.8	6.7	1	5.5	5.2	6
Ytterbium (Yb)	mg/kg	0.1	≤ 40%	7.4	8.7	16	45	46	2	0.74	1.2	**47**	0.46	0.57	21	0.33	0.40	0.07
Zinc (Zn)	mg/kg	0.1	≤ 40%	64	65	2	55	58	5	8.8	8.9	1	6.9	8.0	15	4.7	5.8	21
Zirconium (Zr)	mg/kg	5	≤ 40%	6	6	0	6	<5	BD	20	30	40	26	27	4	28	26	7

Notes:
RPD - relative percent difference; is calculated for analytes with concentrations greater than or equal to five times the detection limit and should be less than or equal to 40%
AD - absolute difference; for samples having concentrations less than five times the detection limit, the difference between the sample and duplicate, or difference between the sample or duplicate and the detection limit if either the sample or duplicate analyte concentration is below detection limit; should not be greater then the detection limit
BD - Sample and/or replicate had analyte concentrations below detection limit
Boldface type and shaded indicates that Data Quality Objective was not achieved

Table A3.2: Detailed Data Quality Assessment for Constituents in Waters

Analysis	Units	Method Detection Limit	RPD Data Quality Objective	Sample ID	Duplicate ID	RPD (%) or AD	Sample ID	Duplicate ID	Dupicate ID	RPD (%) or AD	Sample ID	Replicate ID	RPD (%) or AD	Sample ID	Replicate ID	RPD (%) or AD	Sample ID	Replicate ID	RPD (%) or AD	Sample ID	Replicate ID	RPD (%) or AD	Sample ID	Replicate ID	RPD (%) or AD
				SW09-SR-4B	PW09-EC-1 (0-5)		PW09-QC14-3 (0-5)	PW09-QC14-4 (0-5)	PW09-EC-1 (5-10)		SW09-QC14-2T	SW09-EC-2T		SW09-QC14-2B	SW09-EC-2B		PW09-QC14-2 (0-2.5)	PW09-EC-2 (0-2.5)		PW09-QC14-2 (2.5-5)	PW09-EC-2 (2.5-5)		PW09-QC14-2 (5-7.5)	PW09-EC-2 (5-7.5)	
Conventional Parameters																									
Acidity (as $CaCO_3$)	mg/L	2	≤ 20%	<2.0	--	--	6	19	--	--	56	67	18	15	16	6	21	17	**21**	15	16	6	16	--	--
Dissolved Inorganic Carbon (DIC)	mg/L	0.2	≤ 20%	1.4	--	--	2.0	<1.0	--	BD	<1.0	<1.0	BD	<1.0	<1.0	BD	<1.0	4.2	BD	<1.0	1.1	BD	<1.0	--	BD
Dissolved Organic Carbon (DOC)	mg/L	0.2	≤ 20%	2.0	--	--	3.5	9.3	--	--	14.4	11.4	**23**	19.4	11.7	**50**	28	19	**38**	18.3	14.3	**25**	17.9	--	--
Sulphate (SO_4)	mg/L	0.2	≤ 20%	25	--	--	5.6	512	--	--	72	85	17	32	36	12	32	27	17	12	18	**40**	12	--	--
Hardness (as $CaCO_3$)	mg/L	0.5	≤ 20%	33.4	33.9	1	18	NC	17.8	1	16.9	17	1	16.6	16.8	1	26.2	21.7	19	16.9	16	5	17.9	16.4	9
Metals																									
Radium-226 (Ra-226)	Bq/L	0.01	≤ 20%	0.30	0.30	0	NC	4.1	4.7	14	0.82	0.78	5	0.91	0.85	7	3.6	2.9	**22**	2.8	3.3	16	5.9	5.4	9
Aluminum (Al)	mg/L	0.01	≤ 20%	<0.01	<0.01	BD	<0.01	NC	<0.01	BD	<0.01	0.03	BD	<0.01	<0.01	BD	<0.01	<0.01	BD	0.03	<0.01	BD	<0.01	<0.01	BD
Arsenic (As)	mg/L	0.0002	≤ 20%	0.0007	0.0006	0.0001	0.0026	NC	0.0024	8	0.0006	0.0007	0.0001	0.0011	0.0007	**0.0004**	0.0064	0.0058	10	0.0084	0.0046	**58**	0.0066	0.0065	2
Barium (Ba)	mg/L	0.00001	≤ 20%	0.222	0.221	0	0.333	NC	0.335	1	0.104	0.108	4	0.108	0.114	5	0.309	0.285	8	0.308	0.337	9	0.519	0.487	6
Beryllium (Be)	mg/L	0.00002	≤ 20%	<0.00002	<0.00002	BD	0.00013	NC	<0.00002	BD	<0.00002	0.00003	BD	<0.00002	0.00002	BD	<0.00002	<0.00002	BD	<0.00002	<0.00002	BD	<0.00002	<0.00002	BD
Boron (B)	mg/L	0.0002	≤ 20%	0.0089	0.0082	8	0.0026	NC	0.0028	0.0002	0.0045	0.0076	**51**	0.0056	0.0072	**25**	0.0054	0.0039	**32**	0.0047	0.0034	**32**	0.0051	0.0039	**27**
Bismuth (Bi)	mg/L	0.00001	≤ 20%	0.00001	<0.00001	BD	0.00012	NC	<0.00001	BD	<0.00001	0.00002	BD	<0.00001	0.00002	BD	0.00003	0.00003	0	0.00024	0.00006	**120**	0.00006	0.00003	**0.00003**
Calcium (Ca)	mg/L	0.03	≤ 20%	11.2	11.4	2	6.12	NC	6.06	1	5.69	5.69	0	5.55	5.63	1	8.79	7.28	19	5.68	5.35	6	6.06	5.54	9
Cadmium (Cd)	mg/L	0.000003	≤ 20%	0.000028	0.000012	0.000016	0.000112	NC	<0.000003	BD	0.000023	0.000046	**67**	0.000023	0.000056	**84**	0.000055	0.000031	**56**	<0.000003	0.000012	BD	0.000005	0.000009	**0.000004**
Cobalt (Co)	mg/L	0.000002	≤ 20%	0.00031	0.000321	3	0.00189	NC	0.00192	2	0.00549	0.00655	18	0.00169	0.00196	15	0.00521	0.00289	**57**	0.000917	0.0012	**27**	0.000766	0.00183	**82**
Chromium (Cr)	mg/L	0.0005	≤ 20%	<0.0005	<0.0005	BD	<0.0005	NC	<0.0005	BD	<0.0005	<0.0005	BD	<0.0005	<0.0005	BD	<0.0005	<0.0005	BD	<0.0005	<0.0005	BD	<0.0005	<0.0005	BD
Copper (Cu)	mg/L	0.0005	≤ 20%	0.0011	0.001	0.0001	<0.0005	NC	<0.0005	BD	0.0038	0.0037	3	0.0023	0.0029	**23**	0.0043	0.0018	**0.0025**	0.0025	0.0018	**0.0007**	0.0015	0.0011	**31**
Iron (Fe)	mg/L	0.01	≤ 20%	0.08	0.07	13	7.18	NC	6.63	8	0.04	0.07	**55**	0.01	0.04	**0.03**	0.03	0.44	**174**	0.52	3.3	**146**	2.46	5.71	**80**
Potassium (K)	mg/L	0.01	≤ 20%	0.80	0.80	0	0.37	NC	0.58	**44**	0.32	0.31	3	0.26	0.32	**21**	0.34	0.3	13	0.4	0.34	16	0.62	0.48	**25**
Lithium (Li)	mg/L	0.002	≤ 20%	<0.002	<0.002	BD	<0.002	NC	<0.002	BD	<0.002	<0.002	BD	<0.002	<0.002	BD	<0.002	<0.002	BD	<0.002	<0.002	BD	<0.002	<0.002	BD
Magnesium (Mg)	mg/L	0.003	≤ 20%	1.29	1.31	2	0.67	NC	0.655	2	0.663	0.67	1	0.657	0.663	1	1.02	0.864	17	0.664	0.634	5	0.675	0.632	7
Manganese (Mn)	mg/L	0.00001	≤ 20%	0.119	0.12	1	0.143	NC	0.142	1	0.0288	0.0315	9	0.0353	0.0319	10	0.282	0.217	**26**	0.133	0.134	1	0.133	0.132	1
Molybdenum (Mo)	mg/L	0.00001	≤ 20%	0.00032	0.00029	10	0.00045	NC	0.00051	13	<0.00001	0.00018	BD	0.00002	0.00008	**120**	0.00029	0.00015	**64**	0.00133	0.00116	14	0.00107	0.00149	**33**
Sodium (Na)	mg/L	0.01	≤ 20%	2.79	2.75	1	1.3	NC	1.24	5	1.82	1.59	13	1.83	1.58	15	2.35	2.2	7	1.98	1.87	6	1.79	1.5	18
Nickel (Ni)	mg/L	0.0001	≤ 20%	0.0006	0.0008	**29**	0.001	NC	0.001	0	0.0025	0.0022	13	0.0024	0.0022	9	0.0044	0.0024	**59**	0.0012	0.0013	8	0.0012	0.0017	**34**
Lead (Pb)	mg/L	0.00002	≤ 20%	0.00043	0.00023	**61**	0.00029	NC	0.00016	**58**	0.00717	0.00699	3	0.00597	0.00391	**42**	0.0242	0.00216	**167**	0.00596	0.0009	**148**	0.00098	0.00049	**67**
Phosphorous (P)	mg/L	0.01	≤ 20%	<0.01	<0.01	BD	<0.01	NC	<0.01	BD	0.01	<0.01	BD	<0.01	<0.01	BD	<0.01	0.07	BD	0.01	0.01	0	0.01	<0.01	BD
Antimony (Sb)	mg/L	0.0002	≤ 20%	0.0002	<0.0002	BD	<0.0002	NC	<0.0002	BD	0.0077	0.0086	11	0.0007	0.0016	**78**	0.0002	0.0003	0.0001	0.0006	<0.0002	BD	0.0004	<0.0002	BD
Selenium (Se)	mg/L	0.001	≤ 20%	<0.001	<0.001	BD	<0.001	NC	<0.001	BD	<0.001	<0.001	BD	<0.001	<0.001	BD	<0.001	<0.001	BD	<0.001	<0.001	BD	<0.001	<0.001	BD
Sulphur (S)	mg/L	0.01	≤ 20%	8.58	7.26	17	1.67	NC	1.58	6	4.69	4.64	1	4.74	4.63	2	8.28	6.26	**28**	3.87	3.35	14	3.61	4.21	15
Silicon (Si)	mg/L	0.01	≤ 20%	0.73	0.72	1	5.18	NC	5.07	2	0.58	0.59	2	0.59	0.6	2	1.23	1.42	14	1.71	1.86	8	2.15	2.71	**23**
Tin (Sn)	mg/L	0.00001	≤ 20%	0.00016	<0.00001	BD	<0.00001	NC	0.00002	BD	<0.00001	<0.00001	BD	<0.00001	<0.00001	BD	0.00004	0.00017	**124**	<0.00001	<0.00001	BD	<0.00001	0.00001	BD
Strontium (Sr)	mg/L	0.0001	≤ 20%	0.0268	0.0269	0	0.017	NC	0.0168	1	0.0121	0.0122	1	0.012	0.0122	2	0.0205	0.0168	20	0.0154	0.0149	3	0.0204	0.0187	9
Titanium (Ti)	mg/L	0.0001	≤ 20%	0.0001	<0.0001	BD	0.0003	NC	0.0003	0	0.0003	0.0004	0.0001	<0.0001	0.0001	BD	0.0003	0.0007	**80**	0.0062	0.0004	**0.0058**	0.0005	0.0002	**0.0003**
Thallium (Tl)	mg/L	0.0002	≤ 20%	<0.0002	<0.0002	BD	<0.0002	NC	<0.0002	BD	<0.0002	<0.0002	BD	<0.0002	<0.0002	BD	<0.0002	<0.0002	BD	<0.0002	<0.0002	BD	<0.0002	<0.0002	BD
Uranium (U)	mg/L	0.000001	≤ 20%	0.00122	0.000835	**37**	0.000744	NC	0.000671	10	0.000535	0.000654	20	0.000338	0.00079	**80**	0.000946	0.000173	**138**	0.000524	0.000115	**128**	0.000143	0.000105	**31**
Vanadium (V)	mg/L	0.00003	≤ 20%	0.00008	0.00007	0.00001	0.00019	NC	0.00005	**0.00014**	0.00006	0.00007	0.00001	0.00005	0.00007	0.00002	0.00007	0.00008	0.00001	0.00013	0.00007	**0.00006**	0.00006	0.00004	0.00002
Zinc (Zn)	mg/L	0.001	≤ 20%	0.004	0.003	0.001	0.002	NC	0.001	0.001	0.002	0.004	0.002	0.005	0.005	0	0.005	0.005	0	0.003	0.004	0.001	0.002	0.003	0.001

Notes:

RPD - relative percent difference; is calculated for analytes with concentrations greater than or equal to five times the detection limit and should be less than or equal to 40%

AD - absolute difference; for samples having concentrations less than five times the detection limit, the difference between the sample and duplicate, or difference between the sample or duplicate and the detection limit if either the sample or duplicate analyte concentration is below detection limit; should not be greater then the detection limit

BD - Sample and/or replicate had analyte concentrations below detection limit

"--" Indicates parameter was not analysed

"NC" Indicates that parameter in the sample was not compared to the duplicate/replicate sample in the data quality assessment

Boldface type and shaded indicates that Data Quality Objective was not achieved

Table A3.3: Detailed Data Quality Assessment for Constituents in the Blank Sample

Analysis	Units	Detection Limit	Data Quality Objective	Blank
Convential Parameters				
Acidity (as $CaCO_3$)	mg/L	2	4	**7**
Total Inorganic Carbon (DIC)	mg/L	1.0	2.0	<1.0
Total Organic Carbon (DOC)	mg/L	1.0	2.0	**2.4**
Sulphate (SO_4)	mg/L	2	4	<2
Hardness (as $CaCO_3$)	mg/L	0.5	1.0	<0.5
Metals				
Radium-226 (Ra-226)	Bq/L	0.01	0.02	<0.01
Aluminum (Al)	mg/L	0.01	0.02	<0.01
Arsenic (As)	mg/L	0.0002	0.0004	<0.0002
Barium (Ba)	mg/L	0.00001	0.00002	**0.00216**
Beryllium (Be)	mg/L	0.00002	0.00004	<0.00002
Boron (B)	mg/L	0.0002	0.0004	<0.0002
Bismuth (Bi)	mg/L	0.00001	0.00002	<0.00001
Calcium (Ca)	mg/L	0.03	0.06	0.03
Cadmium (Cd)	mg/L	0.000003	0.000006	<0.000003
Cobalt (Co)	mg/L	0.000002	0.000004	0.000003
Chromium (Cr)	mg/L	0.0005	0.0010	<0.0005
Copper (Cu)	mg/L	0.0005	0.0010	**0.0053**
Iron (Fe)	mg/L	0.01	0.02	<0.01
Potassium (K)	mg/L	0.01	0.02	<0.01
Lithium (Li)	mg/L	0.002	0.004	<0.002
Magnesium (Mg)	mg/L	0.003	0.006	<0.003
Manganese (Mn)	mg/L	0.00001	0.00002	**0.00034**
Molybdenum (Mo)	mg/L	0.00001	0.00002	<0.00001
Sodium (Na)	mg/L	0.01	0.02	**0.15**
Nickel (Ni)	mg/L	0.0001	0.0002	**0.0003**
Lead (Pb)	mg/L	0.00002	0.00004	<0.00002
Phosphorous (P)	mg/L	0.01	0.02	<0.01
Antimony (Sb)	mg/L	0.0002	0.0004	<0.0002
Selenium (Se)	mg/L	0.001	0.002	<0.001
Sulphur (S)	mg/L	0.01	0.02	**0.05**
Silicon (Si)	mg/L	0.01	0.02	<0.01
Tin (Sn)	mg/L	0.00001	0.00002	<0.00001
Strontium (Sr)	mg/L	0.0001	0.0002	0.0001
Titanium (Ti)	mg/L	0.0001	0.0002	<0.0001
Thallium (Tl)	mg/L	0.0002	0.0004	<0.0002
Uranium (U)	mg/L	0.000001	0.000002	<0.000001
Vanadium (V)	mg/L	0.00003	0.00006	<0.00003
Zinc (Zn)	mg/L	0.001	0.002	<0.001

Notes:

Boldface type and shaded indicates that Data Quality Objective was not achieved

EcoMetrix INCORPORATED

APPENDIX 4

Certificates of Analysis for the 2009 Field Data

ANALYSIS REPORT

Becquerel LABORATORIES

Becquerel Laboratories Inc.
6790 Kitimat Rd., Unit 4
Mississauga, Ontario
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Phone: (905) 826-3080
FAX: (905) 826-4151

Batch: T09-01486.0

Date: 30-Nov-2009

Lakefield Research Ltd.

185 Concession St., Postal Bag 4300
Lakefield, ON, K0L 2H0

attn: Brian Graham

Phone: (705) 652-2038
FAX: (705) 652-1918

Client Ref.
Oct 10521.R09
P.O: 17820

14 solid samples Sampled: 26-Sep-2009 Received: 21-Oct-2009

Results of Analysis

Sample	Test	Result	Units	Date	Method
CORE 09-SR-1 (0-5)	Ra-226	0.16	Bq/g	23-Nov-2009	ALPHA
CORE 09-SR-1 (5-10)	Ra-226	0.08	Bq/g	23-Nov-2009	ALPHA
CORE 09-SR-1 (10-15)	Ra-226	0.02	Bq/g	23-Nov-2009	ALPHA
CORE 09-SR-1 (15-20)	Ra-226	0.04	Bq/g	29-Nov-2009	ALPHA
CORE 09-SR-2 (0-5)	Ra-226	14	Bq/g	29-Nov-2009	ALPHA
CORE 09-SR-2 (5-10)	Ra-226	4.6	Bq/g	29-Nov-2009	ALPHA
CORE 09-SR-2 (10-15)	Ra-226	0.06	Bq/g	29-Nov-2009	ALPHA
CORE 09-SR-3 (0-5)	Ra-226	8.2	Bq/g	29-Nov-2009	ALPHA
CORE 09-SR-3 (5-10)	Ra-226	9.7	Bq/g	29-Nov-2009	ALPHA
CORE 09-SR-3 (10-15)	Ra-226	16	Bq/g	29-Nov-2009	ALPHA
CORE 09-SR-3 (15-20)	Ra-226	20	Bq/g	29-Nov-2009	ALPHA
CORE 09-SR-4 (0-5)	Ra-226	2.6	Bq/g	29-Nov-2009	ALPHA
CORE 09-SR-4 (5-10)	Ra-226	2.7	Bq/g	29-Nov-2009	ALPHA
CORE 09-SR-4 (10-15)	Ra-226	2.1	Bq/g	29-Nov-2009	ALPHA

Methods: ALPHA BQ-RAD-ALPHA alpha-particle spectrometry

Units: Bq/g Becquerels per gram

These results relate only to the samples analysed and only to the items tested.

30-Nov-2009 approved by: [signature]
Donald D. Burgess PhD
Senior Scientist, Division Supervisor

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Ecometrix
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Phone: 905-794-2325, Fax:905-794-2338

Tuesday, October 27, 2009

Date Rec. : 30 September 2009
LR. Ref. : **CA10521-SEP09**
Project : 09-1663

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CERTIFICATE OF ANALYSIS

Final Report

Analysis	**3: Analysis Approval Date**	**4: Analysis Approval Time**	**5: CORE 09-SR-1 (0-5)**	**6: CORE 09-SR-1 (5-10)**	**7: CORE 09-SR-1 (10-15)**	**8: CORE 09-SR-1 (15-20)**	**9: CORE 09-SR-2 (0-5)**	**10: CORE 09-SR-2 (5-10)**
Sample Date & Time			26-Sep-09	26-Sep-09	26-Sep-09	26-Sep-09	26-Sep-09	26-Sep-09
BaSO4 Calc. using Ba* [µg/g]	---	---	130	110	100	80	10900	4420
BaSO4 Calc. using SO4** [µg/g]	---	---	2430	<2430	2430	2430	12100	4860
Total Sulphur [%]	06-Oct-09	14:45	0.130	0.130	0.184	0.224	0.235	0.114
Carbonate (CO3) [%]	06-Oct-09	14:42	0.105	0.048	0.048	0.033	0.040	0.011
Total Organic Carbon [%]	06-Oct-09	14:45	5.34	4.23	5.87	5.94	2.05	0.820
Total Carbon [%]	06-Oct-09	14:45	5.36	4.24	5.88	5.95	2.05	0.825
Sulphide [%]	07-Oct-09	15:59	< 0.01	< 0.01	0.04	0.05	< 0.01	< 0.01
Sulphate [%]	23-Oct-09	14:22	0.1	< 0.1	0.1	0.1	0.5	0.2
Silver [µg/g]	14-Oct-09	14:05	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7
Aluminum [µg/g]	14-Oct-09	14:05	7600	6700	5300	4100	4400	2600
Arsenic [µg/g]	14-Oct-09	14:05	5	5	4	3	10	4
Barium [µg/g]	14-Oct-09	14:05	75	65	61	47	6400	2600
Beryllium [µg/g]	14-Oct-09	14:05	0.47	0.37	0.32	0.24	0.21	0.12
Bismuth [µg/g]	14-Oct-09	14:05	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Calcium [µg/g]	14-Oct-09	14:05	1900	1600	1500	1500	1100	720
Cadmium [µg/g]	14-Oct-09	14:05	1.2	0.96	1.2	1.1	0.42	0.18
Cerium [µg/g]	13-Oct-09	15:44	48	41	34	20	62	30
Cobalt [µg/g]	14-Oct-09	14:05	8.5	7.8	6.1	3.7	20	8.2
Chromium [µg/g]	14-Oct-09	14:05	19	18	15	12	9.8	6.8
Cesium [µg/g]	13-Oct-09	15:44	0.63	0.45	0.36	0.30	0.56	0.38
Copper [µg/g]	14-Oct-09	14:05	34	31	23	14	20	8.3
Iron [µg/g]	14-Oct-09	14:05	12000	9800	8100	6800	15000	7300
Gallium [µg/g]	13-Oct-09	15:44	2.9	2.6	2.0	1.6	2.8	1.4
Germanium [µg/g]	13-Oct-09	15:44	0.6	0.5	0.5	0.4	0.8	0.4
Hafnium [µg/g]	13-Oct-09	15:44	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Indium [µg/g]	13-Oct-09	15:44	0.05	0.02	0.01	< 0.01	< 0.01	< 0.01
Potassium [µg/g]	14-Oct-09	14:05	270	250	210	180	270	170
Lanthanum [µg/g]	13-Oct-09	15:44	25	21	18	12	33	16
Lithium [µg/g]	14-Oct-09	14:05	2.7	2.4	1.6	1.1	1.4	0.3

OnLine LIMS

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LR Report : CA10521-SEP09

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: CORE 09-SR-1 (0-5)	6: CORE 09-SR-1 (5-10)	7: CORE 09-SR-1 (10-15)	8: CORE 09-SR-1 (15-20)	9: CORE 09-SR-2 (0-5)	10: CORE 09-SR-2 (5-10)
Lutetium [µg/g]	13-Oct-09	15:44	0.10	0.081	0.063	0.054	0.49	0.21
Magnesium [µg/g]	14-Oct-09	14:04	2100	1900	1500	1200	840	590
Manganese [µg/g]	14-Oct-09	14:04	250	180	200	230	1600	160
Molybdenum [µg/g]	14-Oct-09	14:04	< 0.5	< 0.5	< 0.5	< 0.5	2.8	1.3
Sodium [µg/g]	14-Oct-09	14:04	52	45	38	32	36	23
Niobuim [µg/g]	13-Oct-09	15:44	0.8	0.8	0.7	< 0.7	< 0.7	< 0.7
Nickel [µg/g]	14-Oct-09	14:04	15	13	11	7	19	8
Lead [µg/g]	14-Oct-09	14:04	61	44	32	19	100	38
Phosphorus [µg/g]	14-Oct-09	14:04	450	350	260	210	270	130
Rubidium [µg/g]	13-Oct-09	15:44	3.6	3.2	2.6	2.3	2.5	1.5
Antimony [µg/g]	14-Oct-09	14:04	< 1	< 1	< 1	< 1	< 1	< 1
Scandium [µg/g]	13-Oct-09	15:44	1.7	1.5	1.1	0.9	1.1	0.6
Selenium [µg/g]	14-Oct-09	14:04	< 1	< 1	< 1	< 1	< 1	< 1
Tin [µg/g]	14-Oct-09	14:04	< 6	< 6	< 6	< 6	< 6	< 6
Strontium [µg/g]	14-Oct-09	14:04	7.6	6.3	6.2	6.5	72	27
Sulphur [µg/g]	14-Oct-09	14:04	1100	1400	2000	2500	2400	1200
Tantalum [µg/g]	13-Oct-09	15:44	0.03	0.03	0.04	0.04	0.01	< 0.01
Terbium [µg/g]	13-Oct-09	15:44	0.47	0.33	0.22	0.16	2.0	0.87
Tellerium [µg/g]	13-Oct-09	15:44	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Thorium [µg/g]	13-Oct-09	15:44	9.5	7.7	7.0	3.4	33	12
Titanium [µg/g]	14-Oct-09	14:04	340	350	300	270	190	160
Thallium [µg/g]	14-Oct-09	14:04	< 3	< 3	< 3	< 3	< 3	< 3
Uranium [µg/g]	13-Oct-09	15:43	7.9	5.6	3.1	1.7	84	29
Vanadium [µg/g]	14-Oct-09	14:04	24	21	17	13	12	7.9
Tungsten [µg/g]	14-Oct-09	14:04	< 1	< 1	< 1	< 1	2	< 1
Yttrium [µg/g]	14-Oct-09	14:04	10	7.8	5.9	4.5	43	18
Ytterbium [µg/g]	13-Oct-09	15:43	0.76	0.59	0.46	0.37	4.0	1.6
Zinc [µg/g]	14-Oct-09	14:04	100	83	73	49	74	34
Zirconium [µg/g]	14-Oct-09	14:04	< 5	< 5	< 5	< 5	< 5	< 5

Ra226 subcontracted to Becquerel Labs.
* BaSO4 Calculation based on Ba values and assumes all Ba is in BaSO4 form.
** BaSO4 Calculation based on SO4 values and assumes all SO4 is in BaSO4 form.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

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Tuesday, October 27, 2009

Date Rec. : 30 September 2009
LR. Ref. : **CA10521-SEP09**
Project : 09-1663

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CERTIFICATE OF ANALYSIS

Final Report

Analysis	**11: CORE 09-SR-2 (10-15)**	**12: CORE 09-SR-3 (0-5)**	**13: CORE 09-SR-3 (5-10)**	**14: CORE 09-SR-3 (10-15)**	**15: CORE 09-SR-3 (15-20)**	**16: CORE 09-SR-4 (0-5)**	**17: CORE 09-SR-4 (5-10)**	**18: CORE 09-SR-4 (10-15)**
Sample Date & Time	26-Sep-09	27-Sep-09	27-Sep-09	27-Sep-09	27-Sep-09	27-Sep-09	27-Sep-09	27-Sep-09
BaSO4 Calc. using Ba* [µg/g]	340	3910	5100	6120	6970	1310	990	750
BaSO4 Calc. using SO4** [µg/g]	<2430	4860	9720	19400	24300	4860	4860	4860
Total Sulphur [%]	0.015	0.607	0.917	1.15	1.12	1.03	1.06	1.00
Carbonate (CO3) [%]	< 0.005	0.090	0.097	0.088	0.229	0.159	0.181	0.419
Total Organic Carbon [%]	0.330	13.9	14.6	13.3	10.7	16.8	17.6	16.8
Total Carbon [%]	0.326	13.9	14.6	13.3	10.7	16.8	17.6	16.9
Sulphide [%]	< 0.01	< 0.01	< 0.01	0.10	0.07	0.39	0.65	0.65
Sulphate [%]	< 0.1	0.2	0.4	0.8	1.0	0.2	0.2	0.2
Silver [µg/g]	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7
Aluminum [µg/g]	2000	8500	8300	9600	13000	7100	6000	5600
Arsenic [µg/g]	1	21	23	28	29	22	24	26
Barium [µg/g]	200	2300	3000	3600	4100	770	580	440
Beryllium [µg/g]	0.12	0.57	0.47	0.42	0.66	0.27	0.18	0.12
Bismuth [µg/g]	< 0.5	0.8	< 0.5	< 0.5	0.6	< 0.5	< 0.5	< 0.5
Calcium [µg/g]	420	3800	4600	4300	5100	6200	6700	7300
Cadmium [µg/g]	0.09	1.9	1.6	1.5	1.3	1.7	1.7	1.8
Cerium [µg/g]	15	170	200	240	310	590	680	840
Cobalt [µg/g]	2.6	59	60	64	48	28	21	16
Chromium [µg/g]	5.3	18	16	18	26	20	18	17
Cesium [µg/g]	0.21	0.70	0.81	1.1	1.6	0.86	0.82	0.87
Copper [µg/g]	2.3	57	64	84	98	61	58	56
Iron [µg/g]	5200	39000	34000	35000	50000	21000	16000	12000
Gallium [µg/g]	0.66	5.3	6.0	7.9	9.5	6.9	6.4	6.6
Germanium [µg/g]	0.3	1.7	1.8	2.0	2.6	3.1	3.3	3.8
Hafnium [µg/g]	< 0.1	0.2	0.2	0.3	0.3	0.5	0.6	0.6
Indium [µg/g]	< 0.01	< 0.01	< 0.01	< 0.01	0.02	0.01	< 0.01	< 0.01
Potassium [µg/g]	130	370	290	320	430	350	280	270
Lanthanum [µg/g]	8.9	87	110	120	140	300	360	430
Lithium [µg/g]	< 0.1	2.1	3.0	6.4	10	1.5	1.2	1.1

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LR Report : CA10521-SEP09

Analysis	11: CORE 09-SR-2 (10-15)	12: CORE 09-SR-3 (0-5)	13: CORE 09-SR-3 (5-10)	14: CORE 09-SR-3 (10-15)	15: CORE 09-SR-3 (15-20)	16: CORE 09-SR-4 (0-5)	17: CORE 09-SR-4 (5-10)	18: CORE 09-SR-4 (10-15)
Lutetium [µg/g]	0.055	1.3	1.6	2.0	2.9	4.1	4.5	5.3
Magnesium [µg/g]	420	1300	1200	1300	1500	1400	1400	1400
Manganese [µg/g]	75	4200	2900	1100	480	550	280	180
Molybdenum [µg/g]	< 0.5	9.0	11	18	18	5.8	4.7	3.6
Sodium [µg/g]	18	53	43	43	54	64	58	59
Niobuim [µg/g]	< 0.7	0.9	1.0	1.1	1.4	1.0	0.9	0.8
Nickel [µg/g]	3	38	40	54	52	37	39	43
Lead [µg/g]	5.2	230	220	240	520	540	550	640
Phosphorus [µg/g]	68	650	580	650	660	470	380	340
Rubidium [µg/g]	1.00	3.8	3.3	3.9	5.1	4.1	3.8	4.0
Antimony [µg/g]	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Scandium [µg/g]	0.5	2.4	2.2	2.3	2.8	2.7	2.7	2.7
Selenium [µg/g]	< 1	1	1	< 1	< 1	< 1	< 1	< 1
Tin [µg/g]	< 6	< 6	< 6	< 6	< 6	< 6	< 6	< 6
Strontium [µg/g]	3.3	21	37	63	77	15	14	14
Sulphur [µg/g]	170	5500	7300	7900	7000	10000	11000	11000
Tantalum [µg/g]	< 0.01	0.04	0.07	0.07	0.09	0.11	0.13	0.15
Terbium [µg/g]	0.21	5.9	7.6	9.1	14	25	28	35
Tellerium [µg/g]	< 0.1	< 0.1	< 0.1	< 0.1	0.1	< 0.1	< 0.1	< 0.1
Thorium [µg/g]	3.4	85	120	160	490	180	120	85
Titanium [µg/g]	140	210	200	230	280	210	210	210
Thallium [µg/g]	< 3	5	< 3	< 3	< 3	< 3	< 3	< 3
Uranium [µg/g]	3.8	270	360	500	270	220	160	110
Vanadium [µg/g]	6.3	20	17	18	21	17	16	16
Tungsten [µg/g]	< 1	6	6	8	8	3	2	< 1
Yttrium [µg/g]	6.1	120	160	200	260	500	600	740
Ytterbium [µg/g]	0.41	11	14	16	24	34	38	45
Zinc [µg/g]	18	210	170	160	150	98	72	55
Zirconium [µg/g]	< 5	< 5	< 5	< 5	6	< 5	5	6

Ra226 subcontracted to Becquerel Labs.
* BaSO4 Calculation based on Ba values and assumes all Ba is in BaSO4 form.
** BaSO4 Calculation based on SO4 values and assumes all SO4 is in BaSO4 form.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

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Project : 09-1663

October 7, 2010

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Date Rec. : 30 September 2009
LR Report: **CA10521-SEP09**

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CERTIFICATE OF ANALYSIS

Final Report (QC Report)

Analysis	19: MDL QC - Blank QC - STD % Recovery	20: QC - Blank	21: QC - STD % Recovery	22: QC - DUP % Recovery
BaSO4 Calc. using Ba* [µg/g]	---	---	---	---
BaSO4 Calc. using SO4** [µg/g]	---	---	---	---
Total Sulphur [%]	0.005	< 0.005	102%	---
Carbonate (CO3) [%]	0.005	< 0.005	100%	140%
Total Organic Carbon [%]	0.01	< 0.01	---	100%
Total Carbon [%]	0.005	< 0.005	100%	---
Sulphide [%]	0.01	< 0.01	90%	---
Sulphate [%]	0.1	< 0.1	100%	107%
Silver [µg/g]	0.7	< 0.7	93%	100%
Aluminum [µg/g]	1	< 1	97%	100%
Arsenic [µg/g]	1	< 1	99%	94%
Barium [µg/g]	0.05	< 0.05	96%	100%
Beryllium [µg/g]	0.1	< 0.1	98%	102%
Bismuth [µg/g]	0.5	< 0.5	98%	104%
Calcium [µg/g]	1	< 1	98%	100%
Cadmium [µg/g]	0.05	< 0.05	97%	99%
Cerium [µg/g]	0.006	< 0.006	94%	100%
Cobalt [µg/g]	0.3	< 0.3	97%	103%
Chromium [µg/g]	0.5	< 0.5	98%	103%
Cesium [µg/g]	0.01	< 0.01	---	107%
Copper [µg/g]	0.1	< 0.1	98%	102%
Iron [µg/g]	0.5	< 0.5	98%	100%
Gallium [µg/g]	0.03	< 0.03	---	99%
Germanium [µg/g]	0.3	< 0.3	103%	105%
Hafnium [µg/g]	0.1	< 0.1	96%	150%
Indium [µg/g]	0.01	< 0.01	100%	100%
Potassium [µg/g]	1	< 1	100%	100%

OnLine LIMS

SGS Canada Inc.
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Lakefield - Ontario - KOL 2HO
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Project : 09-1663

LR Report : **CA10521-SEP09**

Analysis	19: MDL QC - Blank QC - STD % Recovery	20: QC - Blank	21: QC - STD % Recovery	22: QC - DUP % Recovery
Lanthanum [µg/g]	0.001	0.001	94%	110%
Lithium [µg/g]	0.1	< 0.1	97%	107%
Lutetium [µg/g]	0.001	0.001	95%	102%
Magnesium [µg/g]	1	< 1	87%	100%
Manganese [µg/g]	0.05	< 0.05	97%	100%
Molybdenum [µg/g]	0.5	< 0.5	100%	154%
Sodium [µg/g]	1	< 1	97%	104%
Niobuim [µg/g]	0.7	< 0.7	99%	118%
Nickel [µg/g]	1	< 1	97%	101%
Lead [µg/g]	0.7	< 0.7	98%	100%
Phosphorus [µg/g]	5	< 5	98%	100%
Rubidium [µg/g]	0.004	< 0.004	---	105%
Antimony [µg/g]	1	< 1	98%	100%
Scandium [µg/g]	0.2	< 0.2	100%	99%
Selenium [µg/g]	1	< 1	99%	100%
Tin [µg/g]	6	< 6	100%	1235
Strontium [µg/g]	0.01	< 0.01	97%	103%
Sulphur [µg/g]	1	< 1	100%	100%
Tantalum [µg/g]	0.01	< 0.01	97%	108%
Terbium [µg/g]	0.001	< 0.001	96%	93%
Tellerium [µg/g]	0.1	< 0.1	99%	101%
Thorium [µg/g]	0.01	< 0.01	114%	100%
Titanium [µg/g]	0.2	< 0.2	98%	104%
Thallium [µg/g]	3	< 3	99%	76%
Uranium [µg/g]	0.002	0.006	100%	100%
Vanadium [µg/g]	0.1	< 0.1	99%	102%
Tungsten [µg/g]	1	< 1	97%	93%
Yttrium [µg/g]	0.1	< 0.1	96%	100%
Ytterbium [µg/g]	0.001	0.002	98%	105%
Zinc [µg/g]	0.1	< 0.1	97%	103%
Zirconium [µg/g]	5	< 5	100%	107%

OnLine LIMS

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Project : 09-1663

LR Report : **CA10521-SEP09**

Ra226 subcontracted to Becquerel Labs.
* BaSO4 Calculation based on Ba values and assumes all Ba is in BaSO4 form.
** BaSO4 Calculation based on SO4 values and assumes all SO4 is in BaSO4 form.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

ANALYSIS REPORT

Becquerel Laboratories Inc.
6790 Kitimat Rd., Unit 4
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Phone: (905) 826-3080
FAX: (905) 826-4151

Batch: T09-01386.0

Date: 12-Nov-2009

Lakefield Research Ltd.

185 Concession St., Postal Bag 4300
Lakefield, ON, K0L 2H0

attn: Brian Graham

Phone: (705) 652-2038
FAX: (705) 652-1918

Client Ref.Sep 10526
P.O: 17820

14 water samples   Received: 06-Oct-2009   Page 1 of 1

Results of Analysis

Sample	Test		Result	Units	Date	Method
PW09-SR-1 (0-5)	Ra-226		0.02	Bq/l	08-Nov-2009	ALPHA
PW09-SR-1 (5-10)	Ra-226	<	0.02	Bq/l	08-Nov-2009	ALPHA
PW09-SR-1 (10-15)	Ra-226	<	0.01	Bq/l	08-Nov-2009	ALPHA
PW09-SR-1 (15-20)	Ra-226	<	0.01	Bq/l	08-Nov-2009	ALPHA
PW09-SR-2 (0-5)	Ra-226		2.4	Bq/l	08-Nov-2009	ALPHA
PW09-SR-2 (5-10)	Ra-226		2.3	Bq/l	08-Nov-2009	ALPHA
PW09-SR-2 (10-15)	Ra-226		0.87	Bq/l	08-Nov-2009	ALPHA
PW09-SR-3 (0-5)	Ra-226		5.1	Bq/l	08-Nov-2009	ALPHA
PW09-SR-3 (5-10)	Ra-226		6.0	Bq/l	08-Nov-2009	ALPHA
PW09-SR-3 (10-15)	Ra-226		5.4	Bq/l	08-Nov-2009	ALPHA
PW09-SR-3 (15-20)	Ra-226		4.5	Bq/l	08-Nov-2009	ALPHA
PW09-SR-4 (0-5)	Ra-226		0.87	Bq/l	08-Nov-2009	ALPHA
PW09-SR-4 (5-10)	Ra-226		1.2	Bq/l	08-Nov-2009	ALPHA
PW09-SR-4 (10-15)	Ra-226		1.4	Bq/l	08-Nov-2009	ALPHA

Methods: ALPHA BQ-RAD-ALPHA alpha-particle spectrometry

Units: Bq/l Becquerels per litre

These results relate only to the samples analysed and only to the items tested.

12-Nov-2009 approved by:
Donald D. Burgess PhD
Senior Scientist, Division Supervisor

SGS Lakefield Research Limited
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Ecometrix
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Phone: 905-794-2325
Fax:905-794-2338

October 14, 2009

Date Rec. : 30 September 2009
LR Report : **CA10526-SEP09**
Project : 09-1663

CERTIFICATE OF ANALYSIS

Final Report

Analysis	**1: Analysis Start Date**	**2: Analysis Start Time**	**3: Analysis Approval Date**	**4: Analysis Approval Time**	**5: PW09-SR-1 (0-5)**	**6: PW09-SR-1 (5-10)**	**7: PW09-SR-1 (10-15)**	**8: PW09-SR-1 (15-20)**	**9: PW09-SR-2 (0-5)**
Sample Date & Time					26-Sep-09	26-Sep-09	26-Sep-09	26-Sep-09	26-Sep-09
Temperature Upon Receipt [°C]	---	---	---	---	4.0	4.0	4.0	4.0	4.0
Sulphate [mg/L]	02-Oct-09	15:00	07-Oct-09	09:19	2.6	< 2	< 2	< 2	16
Dissolved Organic Carbon [mg/L]	02-Oct-09	10:00	07-Oct-09	09:23	14.5	19.6	20.0	22.9	10.5
Dissolved Inorganic Carbon [mg/L]	05-Oct-09	14:35	08-Oct-09	12:47	< 1.0	< 1.0	3.1	2.7	2.4
Alkalinity [mg/L as CaCO3]	02-Oct-09	15:19	05-Oct-09	15:10	9	24	8	2	25
Acidity [mg/L as CaCO3]	02-Oct-09	15:19	05-Oct-09	15:10	6	< 2	3	6	< 2
Hardness [mg/L as CaCO3]	05-Oct-09	09:00	05-Oct-09	13:18	11.1	9.5	5.3	5.3	28.8
Aluminum [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	< 0.01	0.02	0.02	0.03	0.02
Arsenic [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.0014	0.0034	0.0054	0.0050	0.0015
Barium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.0271	0.0274	0.0313	0.0172	2.16
Beryllium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002
Boron [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.0052	0.0036	0.0057	0.0089	0.0046
Bismuth [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001
Calcium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	3.54	3.00	1.68	1.71	9.60
Cadmium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.000017	0.000016	0.000025	0.000056	0.000003
Cobalt [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.000762	0.000476	0.000120	0.000079	0.00216
Chromium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Copper [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.0025	0.0037	0.0023	0.0051	0.0021
Iron [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	0.29	0.81	0.06	0.08	0.01
Potassium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	0.24	0.26	0.34	0.38	0.79
Lithium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Magnesium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	0.538	0.492	0.277	0.255	1.16

OnLine LIMS

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LR Report : **CA10526-SEP09**

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	5: PW09-SR-1 (0-5)	6: PW09-SR-1 (5-10)	7: PW09-SR-1 (10-15)	8: PW09-SR-1 (15-20)	9: PW09-SR-2 (0-5)
Manganese [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.365	0.305	0.245	0.325	3.91
Molybdenum [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.00069	0.00037	0.00024	0.00031	0.00064
Sodium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	1.85	1.83	1.64	2.17	2.57
Nickel [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.0007	0.0009	0.0006	0.0009	0.0011
Phosphorus [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Lead [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.00087	0.00213	0.00036	0.00124	0.00037
Sulphur [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	1.05	0.78	0.46	0.74	4.67
Antimony [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Selenium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Silica [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	1.52	1.96	2.35	2.84	1.63
Tin [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.00007	0.00022	< 0.00001	< 0.00001	< 0.00001
Strontium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	0.0121	0.0104	0.0064	0.0068	0.0668
Titanium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.0007	0.0011	0.0007	0.0012	0.0001
Thallium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Uranium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.000186	0.000137	0.000380	0.000250	0.00266
Vanadium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.00016	0.00026	0.00014	0.00029	0.00008
Zinc [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.002	0.002	0.002	0.003	0.002

Samples are field filtered
Ra226 subcontracted to Becquerel Labs.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

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October 14, 2009

Date Rec. : 30 September 2009
LR Report : **CA10526-SEP09**
Project : 09-1663

CERTIFICATE OF ANALYSIS
Final Report

Analysis	**10: PW09-SR-2 (5-10)**	**11: PW09-SR-2 (10-15)**	**12: PW09-SR-3 (0-5)**	**13: PW09-SR-3 (5-10)**	**14: PW09-SR-3 (10-15)**	**15: PW09-SR-3 (15-20)**	**16: PW09-SR-4 (0-5)**	**17: PW09-SR-4 (5-10)**	**18: PW09-SR-4 (10-15)**
Sample Date & Time	26-Sep-09	26-Sep-09	27-Sep-09	27-Sep-09	27-Sep-09	27-Sep-09	27-Sep-09	27-Sep-09	27-Sep-09
Temperature Upon Receipt [°C]	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Sulphate [mg/L]	14	---	7.9	4.0	< 2	< 2	19	8.1	4.9
Dissolved Organic Carbon [mg/L]	26.5	---	9.9	18.8	13.2	---	---	---	---
Dissolved Inorganic Carbon [mg/L]	5.0	---	14.0	26.5	32.7	---	---	---	---
Alkalinity [mg/L as CaCO3]	5	---	69	99	135	177	33	---	87
Acidity [mg/L as CaCO3]	6	---	---	---	---	---	---	< 2	---
Hardness [mg/L as CaCO3]	25.6	31.5	42.6	67.1	87.2	130	45.2	63.4	78.8
Aluminum [mg/L]	0.07	0.07	< 0.01	< 0.01	< 0.01	0.02	< 0.01	0.01	0.02
Arsenic [mg/L]	0.0030	0.0027	0.0012	0.0014	0.0039	0.0027	0.0012	0.0022	0.0051
Barium [mg/L]	2.38	1.50	1.91	3.11	3.75	3.24	0.561	0.621	0.602
Beryllium [mg/L]	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002
Boron [mg/L]	0.0068	0.0090	0.0095	0.0146	0.0356	0.0758	0.0192	0.0424	0.0817
Bismuth [mg/L]	0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001
Calcium [mg/L]	8.74	10.5	14.7	23.8	31.6	47.6	15.7	22.3	27.8
Cadmium [mg/L]	0.000010	0.000010	0.000004	0.000005	0.000008	0.000007	0.000008	0.000007	0.000015
Cobalt [mg/L]	0.000948	0.000863	0.00704	0.00374	0.00264	0.00253	0.000880	0.000284	0.000291
Chromium [mg/L]	< 0.0005	0.0007	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Copper [mg/L]	0.0046	0.0049	0.0010	0.0010	0.0015	0.0014	0.0015	0.0016	0.0019
Iron [mg/L]	0.08	0.27	3.54	4.19	6.18	0.51	1.05	0.26	0.02
Potassium [mg/L]	0.95	2.11	1.03	1.86	3.28	6.21	0.96	1.57	2.77
Lithium [mg/L]	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.004	< 0.002	< 0.002	< 0.002
Magnesium [mg/L]	0.926	1.26	1.45	1.84	1.99	2.84	1.46	1.88	2.28

OnLine LIMS

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LR Report : CA10526-SEP09

Analysis	10: PW09-SR-2 (5-10)	11: PW09-SR-2 (10-15)	12: PW09-SR-3 (0-5)	13: PW09-SR-3 (5-10)	14: PW09-SR-3 (10-15)	15: PW09-SR-3 (15-20)	16: PW09-SR-4 (0-5)	17: PW09-SR-4 (5-10)	18: PW09-SR-4 (10-15)
Manganese [mg/L]	1.82	1.34	10.8	8.04	5.58	2.89	1.24	0.613	0.341
Molybdenum [mg/L]	0.00150	0.00282	0.00065	0.00035	0.00369	0.00475	0.00056	0.00238	0.00909
Sodium [mg/L]	2.81	2.81	2.35	2.95	3.63	5.23	3.15	3.27	3.93
Nickel [mg/L]	0.0013	0.0012	0.0016	0.0018	0.0018	0.0019	0.0014	0.0009	0.0009
Phosphorus [mg/L]	0.02	0.02	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.01	< 0.01
Lead [mg/L]	0.00198	0.00084	0.00018	0.00008	0.00023	0.00004	0.00054	0.00091	0.00192
Sulphur [mg/L]	4.45	5.89	2.65	1.74	0.88	1.07	5.53	2.88	2.10
Antimony [mg/L]	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Selenium [mg/L]	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Silica [mg/L]	2.68	4.19	3.02	5.36	6.12	6.22	3.01	6.24	9.87
Tin [mg/L]	0.00004	< 0.00001	0.00003	< 0.00001	0.00007	< 0.00001	0.00002	< 0.00001	< 0.00001
Strontium [mg/L]	0.0685	0.0607	0.0508	0.0866	0.117	0.151	0.0328	0.0425	0.0515
Titanium [mg/L]	0.0012	0.0024	0.0002	0.0003	0.0004	0.0004	0.0002	0.0006	0.0008
Thallium [mg/L]	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Uranium [mg/L]	0.00258	0.000877	0.0113	0.00514	0.0400	0.0379	0.00413	0.00669	0.0110
Vanadium [mg/L]	0.00022	0.00082	0.00017	0.00033	0.00038	0.00071	0.00014	0.00032	0.00095
Zinc [mg/L]	0.004	0.005	0.002	0.004	0.003	0.003	0.003	0.002	0.002

Samples are field filtered
Ra226 subcontracted to Becquerel Labs.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

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SGS

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Project : 09-1663

October 7, 2010

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Phone: 905-794-2325
Fax:905-794-2338

Date Rec. : 30 September 2009
LR Report: **CA10526-SEP09**

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CERTIFICATE OF ANALYSIS
Final Report - (QC Report)

Analysis	19: MDL	20: QC - Blank	21: QC - STD % Recovery	22: QC - DUP % Recovery
Temperature Upon Receipt [°C]	---	---	---	---
Sulphate [mg/L]	0.2	< 0.2	105%	100%
Dissolved Organic Carbon [mg/L]	0.2	< 0.2	105%	98%
Dissolved Inorganic Carbon [mg/L]	0.2	0.2	97%	100%
Alkalinity [mg/L as CaCO3]	2	< 2	101%	98%
Acidity [mg/L as CaCO3]	2	3	98%	102%
Hardness [mg/L as CaCO3]	0.5	< 0.5	---	---
Aluminum [mg/L]	0.01	< 0.01	98%	---
Arsenic [mg/L]	0.0002	< 0.0002	106%	---
Barium [mg/L]	0.00001	< 0.00001	122%	---
Beryllium [mg/L]	0.00002	< 0.00002	104%	---
Boron [mg/L]	0.0002	< 0.0002	96%	---
Bismuth [mg/L]	0.00001	< 0.00001	109%	---
Calcium [mg/L]	0.03	< 0.03	101%	---
Cadmium [mg/L]	0.000003	0.000003	99%	---
Cobalt [mg/L]	0.000002	< 0.000002	102%	---
Chromium [mg/L]	0.0005	< 0.0005	102%	---
Copper [mg/L]	0.0005	< 0.0005	102%	---
Iron [mg/L]	0.01	< 0.01	102%	---
Potassium [mg/L]	0.01	< 0.01	98%	---
Lithium [mg/L]	0.002	< 0.002	98%	---
Magnesium [mg/L]	0.003	< 0.003	99%	---
Manganese [mg/L]	0.00001	< 0.00001	107%	---
Molybdenum [mg/L]	0.00001	< 0.00001	99%	---
Sodium [mg/L]	0.01	< 0.01	94%	---
Nickel [mg/L]	0.0001	< 0.0001	100%	---
Phosphorus [mg/L]	0.01	< 0.01	100%	---
Lead [mg/L]	0.00002	< 0.00002	106%	---
Sulphur [mg/L]	0.01	< 0.01	100%	---
Antimony [mg/L]	0.0002	< 0.0002	101%	---

SGS Canada Inc.
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Project : 09-1663

LR Report : **CA10526-SEP09**

Analysis	19: MDL	20: QC - Blank	21: QC - STD % Recovery	22: QC - DUP % Recovery
Selenium [mg/L]	0.001	< 0.001	102%	---
Silica [mg/L]	0.01	< 0.01	104%	---
Tin [mg/L]	0.00001	< 0.00001	96%	---
Strontium [mg/L]	0.0001	< 0.0001	100%	---
Titanium [mg/L]	0.0001	< 0.0001	96%	---
Thallium [mg/L]	0.0002	< 0.0002	107%	---
Uranium [mg/L]	0.000001	0.000001	106%	---
Vanadium [mg/L]	0.00003	< 0.00003	107%	---
Zinc [mg/L]	0.001	< 0.001	104%	---

Samples are field filtered
Ra226 subcontracted to Becquerel Labs.
Revised to include Ra226 results from Becquerel.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

ANALYSIS REPORT

Becquerel Laboratories Inc.
6790 Kitimat Rd., Unit 4
Mississauga, Ontario
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Phone: (905) 826-3080
FAX: (905) 826-4151

Batch: T09-01385.0

Date: 09-Nov-2009

Lakefield Research Ltd.

185 Concession St., Postal Bag 4300
Lakefield, ON, K0L 2H0

attn: Brian Graham

Phone: (705) 652-2038
FAX: (705) 652-1918

Client Ref.Sep 10525
P.O: 17820

9 water samples

Received: 06-Oct-2009

Results of Analysis

Sample	Test	Result	Units	Date	Method
SW09-SR-1T	Ra-226	< 0.01	Bq/l	06-Nov-2009	ALPHA
SW09-SR-1B	Ra-226	< 0.01	Bq/l	06-Nov-2009	ALPHA
SW09-SR-2T	Ra-226	0.11	Bq/l	06-Nov-2009	ALPHA
SW09-SR-2B	Ra-226	0.28	Bq/l	06-Nov-2009	ALPHA
SW09-SR-3T	Ra-226	0.15	Bq/l	06-Nov-2009	ALPHA
SW09-SR-3B	Ra-226	0.80	Bq/l	06-Nov-2009	ALPHA
SW09-SR-4T	Ra-226	0.19	Bq/l	06-Nov-2009	ALPHA
SW09-SR-4B	Ra-226	0.30	Bq/l	06-Nov-2009	ALPHA
Blank 1	Ra-226	< 0.01	Bq/l	06-Nov-2009	ALPHA

Methods: ALPHA BQ-RAD-ALPHA alpha-particle spectrometry

Units: Bq/l Becquerels per litre

These results relate only to the samples analysed and only to the items tested.

09-Nov-2009 approved by: Donald D. Burgess

Donald D. Burgess PhD
Senior Scientist, Division Supervisor

SGS Lakefield Research Limited
P.O. Box 4300 - 185 Concession St.
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Ecometrix
Attn : Erin Clyde

6800 Campobello Road, Mississauga
Canada, L5N 2L8
Phone: 905-794-2325, Fax:905-794-2338

October 14, 2009

Date Rec. : 30 September 2009
LR Report : **CA10525-SEP09**
Project : 09-1663

CERTIFICATE OF ANALYSIS
Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	5: SW09-SR-1T	6: SW09-SR-1B	7: SW09-SR-2T
Sample Date & Time					24-Sep-09	25-Sep-09	24-Sep-09
Temperature Upon Receipt [°C]	---	---	---	---	4.0	4.0	4.0
Sulphate [mg/L]	02-Oct-09	15:00	05-Oct-09	16:12	8.5	5.6	31
Total Organic Carbon [mg/L]	02-Oct-09	10:00	05-Oct-09	13:41	2.7	5.4	2.3
Total Inorganic Carbon [mg/L]	05-Oct-09	14:35	08-Oct-09	12:46	< 1.0	< 1.0	< 1.0
Alkalinity [mg/L as CaCO3]	02-Oct-09	15:19	05-Oct-09	15:13	---	---	---
Acidity [mg/L as CaCO3]	02-Oct-09	15:19	05-Oct-09	15:13	11	9	9
Hardness [mg/L as CaCO3]	02-Oct-09	09:00	02-Oct-09	12:09	10.4	10.2	34.8
Aluminum [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	0.02	0.02	< 0.01
Arsenic [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.0004	0.0003	0.0005
Barium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.0144	0.0155	0.120
Beryllium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	< 0.00002	< 0.00002	< 0.00002
Boron [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.0059	0.0050	0.0084
Bismuth [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	< 0.00001	< 0.00001	< 0.00001
Calcium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	3.26	3.21	11.8
Cadmium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.000013	0.000061	< 0.000003
Cobalt [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.00298	0.00250	0.00184
Chromium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	< 0.0005	< 0.0005	< 0.0005
Copper [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.0015	0.0016	0.0007
Iron [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	0.03	0.03	0.02
Potassium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	0.25	0.24	0.78
Lithium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	< 0.002	< 0.002	< 0.002
Magnesium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	0.542	0.524	1.31

OnLine LIMS

SGS Lakefield Research Limited
P.O. Box 4300 - 185 Concession St.
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LR Report : **CA10525-SEP09**

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	5: SW09-SR-1T	6: SW09-SR-1B	7: SW09-SR-2T
Manganese [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.0313	0.0284	0.0545
Molybdenum [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.00007	0.00008	0.00022
Sodium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	1.83	1.89	2.06
Nickel [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.0004	0.0004	0.0005
Phosphorus [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	< 0.01	< 0.01	< 0.01
Lead [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.00031	0.00056	0.00031
Sulphur [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	1.66	1.67	9.17
Antimony [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.0045	0.0037	0.0028
Selenium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	< 0.001	< 0.001	< 0.001
Silica [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	0.63	0.63	0.63
Tin [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.00006	0.00019	0.00019
Strontium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	0.0117	0.0115	0.0270
Titanium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.0002	0.0002	0.0001
Thallium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	< 0.0002	< 0.0002	< 0.0002
Uranium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.000257	0.000138	0.00154
Vanadium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.00005	0.00012	0.00004
Zinc [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.003	0.003	< 0.001

Ra226 subcontracted to Becquerel Labs.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

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OnLine LIMS

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Ecometrix
Attn : Erin Clyde

6800 Campobello Road, Mississauga
Canada, L5N 2L8
Phone: 905-794-2325, Fax:905-794-2338

October 14, 2009

Date Rec. : 30 September 2009
LR Report : **CA10525-SEP09**
Project : 09-1663

CERTIFICATE OF ANALYSIS

Final Report

Analysis	**8: SW09-SR-2B**	**9: SW09-SR-3T**	**10: SW09-SR-3B**	**11: SW09-SR-4T**	**12: SW09-SR-4B**	**13: Blank 1**
Sample Date & Time	25-Sep-09	25-Sep-09	25-Sep-09	25-Sep-09	25-Sep-09	27-Sep-09
Temperature Upon Receipt [°C]	4.0	4.0	4.0	4.0	4.0	4.0
Sulphate [mg/L]	45	30	26	25	25	< 2
Total Organic Carbon [mg/L]	2.2	4.6	2.2	4.6	2.0	2.4
Total Inorganic Carbon [mg/L]	< 1.0	< 1.0	< 1.0	< 1.0	1.4	< 1.0
Alkalinity [mg/L as CaCO3]	---	---	7	---	---	---
Acidity [mg/L as CaCO3]	7	8	---	---	< 2	7
Hardness [mg/L as CaCO3]	36.5	33.7	32.7	33.0	33.4	< 0.5
Aluminum [mg/L]	0.04	< 0.01	< 0.01	0.01	< 0.01	< 0.01
Arsenic [mg/L]	0.0007	0.0004	0.0008	0.0004	0.0007	< 0.0002
Barium [mg/L]	0.294	0.147	0.334	0.191	0.222	0.00216
Beryllium [mg/L]	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002
Boron [mg/L]	0.0093	0.0079	0.0090	0.0081	0.0089	< 0.0002
Bismuth [mg/L]	< 0.00001	< 0.00001	< 0.00001	< 0.00001	0.00001	< 0.00001
Calcium [mg/L]	12.4	11.4	11.1	11.1	11.2	0.03
Cadmium [mg/L]	0.000045	0.000006	0.000011	0.000009	0.000028	< 0.000003
Cobalt [mg/L]	0.00270	0.00148	0.00178	0.000944	0.000310	0.000003
Chromium [mg/L]	0.0012	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Copper [mg/L]	0.0015	0.0012	0.0017	0.0009	0.0011	0.0053
Iron [mg/L]	0.02	0.02	0.40	0.02	0.08	< 0.01
Potassium [mg/L]	0.86	0.75	0.74	0.72	0.80	< 0.01
Lithium [mg/L]	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Magnesium [mg/L]	1.36	1.28	1.24	1.28	1.29	< 0.003

OnLine LIMS

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LR Report : **CA10525-SEP09**

Analysis	**8: SW09-SR-2B**	**9: SW09-SR-3T**	**10: SW09-SR-3B**	**11: SW09-SR-4T**	**12: SW09-SR-4B**	**13: Blank 1**
Manganese [mg/L]	0.253	0.0424	0.752	0.0251	0.119	0.00034
Molybdenum [mg/L]	0.00013	0.00026	0.00036	0.00029	0.00032	< 0.00001
Sodium [mg/L]	2.13	2.16	2.17	2.65	2.79	0.15
Nickel [mg/L]	0.0016	0.0006	0.0010	0.0005	0.0006	0.0003
Phosphorus [mg/L]	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Lead [mg/L]	0.00151	0.00029	0.00031	0.00027	0.00043	< 0.00002
Sulphur [mg/L]	9.22	8.86	8.73	8.40	8.58	0.05
Antimony [mg/L]	0.0041	0.0021	0.0006	0.0013	0.0002	< 0.0002
Selenium [mg/L]	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Silica [mg/L]	0.62	0.62	0.77	0.65	0.73	< 0.01
Tin [mg/L]	0.00029	0.00052	0.00009	0.00007	0.00016	< 0.00001
Strontium [mg/L]	0.0302	0.0267	0.0275	0.0266	0.0268	0.0001
Titanium [mg/L]	0.0001	0.0001	0.0002	0.0002	0.0001	< 0.0001
Thallium [mg/L]	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Uranium [mg/L]	0.00345	0.00131	0.00137	0.00146	0.00122	< 0.000001
Vanadium [mg/L]	0.00003	0.00007	0.00005	0.00005	0.00008	< 0.00003
Zinc [mg/L]	0.009	0.002	0.002	< 0.001	0.004	< 0.001

Ra226 subcontracted to Becquerel Labs.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

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OnLine LIMS

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Project : 09-1663

October 7, 2010

Ecometrix
Attn : Erin Clyde

6800 Campobello Road, Mississauga
Canada, L5N 2L8
Phone: 905-794-2325, Fax:905-794-2338

Date Rec. : 30 September 2009
LR Report: **CA10525-SEP09**

Copy: #1

CERTIFICATE OF ANALYSIS
Final Report - (QC Report)

Analysis	14: MDL	15: QC - Blank	16: QC - STD % Recovery	17: QC - DUP % Recovery
Sulphate [mg/L]	0.2	< 0.2	105%	100%
Total Organic Carbon [mg/L]	0.2	< 0.2	105%	98%
Total Inorganic Carbon [mg/L]	0.2	0.2	97%	100%
Alkalinity [mg/L as CaCO3]	2	< 2	101%	98%
Acidity [mg/L as CaCO3]	2	3	98%	102%
Hardness [mg/L as CaCO3]	0.5	---	---	---
Aluminum [mg/L]	0.01	< 0.01	95%	100%
Arsenic [mg/L]	0.0002	< 0.0002	106%	111%
Barium [mg/L]	0.00001	< 0.00001	105%	100%
Beryllium [mg/L]	0.00002	< 0.00002	103%	94%
Boron [mg/L]	0.0002	< 0.0002	99%	97%
Bismuth [mg/L]	0.00001	0.00001	105%	82%
Calcium [mg/L]	0.03	---	98%	100%
Cadmium [mg/L]	0.000003	< 0.000003	102%	107%
Cobalt [mg/L]	0.000002	< 0.000002	105%	99%
Chromium [mg/L]	0.0005	< 0.0005	103%	170%
Copper [mg/L]	0.0005	< 0.0005	106%	85%
Iron [mg/L]	0.01	---	96.8	122
Potassium [mg/L]	0.01	< 0.01	98%	99.1
Lithium [mg/L]	0.002	< 0.002	94.2	120
Magnesium [mg/L]	0.003	---	95%	100%
Manganese [mg/L]	0.00001	< 0.00001	104%	99%
Molybdenum [mg/L]	0.00001	< 0.00001	95%	155%
Sodium [mg/L]	0.01	---	95%	99%
Nickel [mg/L]	0.0001	< 0.0001	105%	87%
Phosphorus [mg/L]	0.01	< 0.01	95%	100%
Lead [mg/L]	0.00002	< 0.00002	102%	30%
Sulphur [mg/L]	0.01	---	100%	101%
Antimony [mg/L]	0.0002	< 0.0002	94%	124%
Selenium [mg/L]	0.001	< 0.001	108%	100%

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Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Project : 09-1663

LR Report : **CA10525-SEP09**

Analysis	14: MDL	15: QC - Blank	16: QC - STD % Recovery	17: QC - DUP % Recovery
Silica [mg/L]	0.01	< 0.01	103%	101%
Tin [mg/L]	0.00001	< 0.00001	96%	140%
Strontium [mg/L]	0.0001	---	98%	100%
Titanium [mg/L]	0.0001	< 0.0001	95%	130%
Thallium [mg/L]	0.0002	< 0.0002	105%	106%
Uranium [mg/L]	0.000001	< 0.000001	102%	94%
Vanadium [mg/L]	0.00003	< 0.00003	106%	150%
Zinc [mg/L]	0.001	< 0.001	106%	90%

Ra226 subcontracted to Becquerel Labs.
Revised to include Ra226 results from Becquerel

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

Becquerel LABORATORIES

ANALYSIS REPORT

Becquerel Laboratories Inc.
6790 Kitimat Rd., Unit 4
Mississauga, Ontario
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Phone: (905) 826-3080
FAX: (905) 826-4151

Batch: T09-01383.0

Date: 20-Oct-2009

Lakefield Research Ltd.

185 Concession St., Postal Bag 4300
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Phone: (705) 652-2038
FAX: (705) 652-1918

Client Ref.Oct 10069
P.O: 17820

5 water samples Sampled: 29-Sep-2009 Received: 06-Oct-2009 Page 1 of 1

Results of Analysis

Sample	Test	Result	Units	Date	Method
PW09 EC2 0-2.5	Ra-226	2.9	Bq/l	18-Oct-2009	ALPHA
PW09 EC2 2.5-5	Ra-226	3.3	Bq/l	18-Oct-2009	ALPHA
PW09 EC2 5-7.5	Ra-226	5.4	Bq/l	18-Oct-2009	ALPHA
PW09 EC1 0-5	Ra-226	0.30	Bq/l	18-Oct-2009	ALPHA
PW09 EC1 5-10	Ra-226	4.7	Bq/l	18-Oct-2009	ALPHA

Methods: ALPHA BQ-RAD-ALPHA alpha-particle spectrometry

Units: Bq/l Becquerels per litre

These results relate only to the samples analysed and only to the items tested.

20-Oct-2009 approved by:
Donald D. Burgess PhD
Senior Scientist, Division Supervisor

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October 14, 2009

Date Rec. : 01 October 2009
LR Report : **CA10069-OCT09**
Project : 09-1663

CERTIFICATE OF ANALYSIS
Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	5: PW09 EC2 0-2.5	6: PW09 EC2 2.5-5	7: PW09 EC2 5-7.5	8: PW09 EC1 0-5	9: PW09 EC1 5-10
Sample Date & Time					29-Sep-09	29-Sep-09	29-Sep-09	29-Sep-09	29-Sep-09
Temperature Upon Receipt [°C]	---	---	---	---	9.0	9.0	9.0	9.0	9.0
Sulphate [mg/L]	02-Oct-09	19:39	06-Oct-09	12:35	27	18	---	---	---
Dissolved Organic Carbon [mg/L]	05-Oct-09	09:40	06-Oct-09	13:53	19.0	14.3	---	---	---
Dissolved Inorganic Carbon [mg/L]	06-Oct-09	08:15	07-Oct-09	12:40	4.2	1.1	---	---	---
Acidity [mg/L as CaCO3]	02-Oct-09	15:00	06-Oct-09	11:07	17	16	---	---	---
Hardness [mg/L as CaCO3]	05-Oct-09	09:00	05-Oct-09	13:17	21.7	16.0	16.4	33.9	17.8
Aluminum [mg/L]	05-Oct-09	09:00	05-Oct-09	13:17	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.0058	0.0046	0.0065	0.0006	0.0024
Barium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.285	0.337	0.487	0.221	0.335
Beryllium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002
Boron [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.0039	0.0034	0.0039	0.0082	0.0028
Bismuth [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.00003	0.00006	0.00003	< 0.00001	< 0.00001
Calcium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:17	7.28	5.35	5.54	11.4	6.06
Cadmium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.000031	0.000012	0.000009	0.000012	< 0.000003
Cobalt [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.00289	0.00120	0.00183	0.000321	0.00192
Chromium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Copper [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.0018	0.0018	0.0011	0.0010	< 0.0005
Iron [mg/L]	05-Oct-09	09:00	05-Oct-09	13:17	0.44	3.30	5.71	0.07	6.63
Potassium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:17	0.30	0.34	0.48	0.80	0.58
Lithium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:17	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Magnesium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:17	0.864	0.634	0.632	1.31	0.655

OnLine LIMS

SGS Lakefield Research Limited
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

LR Report : **CA10069-OCT09**

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	5: PW09 EC2 0-2.5	6: PW09 EC2 2.5-5	7: PW09 EC2 5-7.5	8: PW09 EC1 0-5	9: PW09 EC1 5-10
Manganese [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.217	0.134	0.132	0.120	0.142
Molybdenum [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.00015	0.00116	0.00149	0.00029	0.00051
Sodium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:17	2.20	1.87	1.50	2.75	1.24
Nickel [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.0024	0.0013	0.0017	0.0008	0.0010
Phosphorus [mg/L]	05-Oct-09	09:00	05-Oct-09	13:17	0.07	0.01	< 0.01	< 0.01	< 0.01
Lead [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.00216	0.00090	0.00049	0.00023	0.00016
Sulphur [mg/L]	05-Oct-09	09:00	05-Oct-09	13:17	6.26	3.35	4.21	7.26	1.58
Antimony [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.0003	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Selenium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Silica [mg/L]	05-Oct-09	09:00	05-Oct-09	13:17	1.42	1.86	2.71	0.72	5.07
Tin [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.00017	< 0.00001	0.00001	< 0.00001	0.00002
Strontium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:17	0.0168	0.0149	0.0187	0.0269	0.0168
Titanium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.0007	0.0004	0.0002	< 0.0001	0.0003
Thallium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Uranium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.000173	0.000115	0.000105	0.000835	0.000671
Vanadium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.00008	0.00007	0.00004	0.00007	0.00005
Zinc [mg/L]	02-Oct-09	14:45	05-Oct-09	13:17	0.005	0.004	0.003	0.003	0.001

Samples are field filtered
Ra226 subcontracted to Becquerel Labs.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

SGS Lakefield Research Limited
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

LR Report : **CA10069-OCT09**

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OnLine LIMS

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Env ICP-MS Metals

Project : 09-1663

October 7, 2010

Ecometrix
Attn : Erin Clyde

6800 Campobello Road, Mississauga
Canada, L5N 2L8
Phone: 905-794-2325, Fax:905-794-2338

Date Rec. : 01 October 2009
LR Report: **CA10069-OCT09**

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	10: MDL	11: QC - Blank	12: QC - STD % Recovery	13: QC - DUP % Recovery
Sulphate [mg/L]	0.2	< 0.2	100%	110%
Dissolved Organic Carbon [mg/L]	0.2	< 0.2	91%	100%
Dissolved Inorganic Carbon [mg/L]	0.2	0.7	107%	100%
Acidity [mg/L as CaCO3]	2	3	98%	102%
Hardness [mg/L as CaCO3]	0.5	< 0.5	---	---
Aluminum [mg/L]	0.01	< 0.01	98%	---
Arsenic [mg/L]	0.0002	< 0.0002	106%	---
Barium [mg/L]	0.00001	< 0.00001	122%	---
Beryllium [mg/L]	0.00002	< 0.00002	104%	---
Boron [mg/L]	0.0002	< 0.0002	96%	---
Bismuth [mg/L]	0.00001	< 0.00001	109%	---
Calcium [mg/L]	0.03	< 0.03	101%	---
Cadmium [mg/L]	0.000003	0.000003	99%	---
Cobalt [mg/L]	0.000002	< 0.000002	102%	---
Chromium [mg/L]	0.0005	< 0.0005	102%	---
Copper [mg/L]	0.0005	< 0.0005	102%	---
Iron [mg/L]	0.01	< 0.01	102%	---
Potassium [mg/L]	0.01	< 0.01	98%	---
Lithium [mg/L]	0.002	< 0.002	98%	---
Magnesium [mg/L]	0.003	< 0.003	98%	---
Manganese [mg/L]	0.00001	< 0.00001	107%	---
Molybdenum [mg/L]	0.00001	< 0.00001	99%	---
Sodium [mg/L]	0.01	< 0.01	94%	---
Nickel [mg/L]	0.0001	< 0.0001	100%	---
Phosphorus [mg/L]	0.01	< 0.01	100%	---
Lead [mg/L]	0.00002	< 0.00002	106%	---
Sulphur [mg/L]	0.01	< 0.01	98%	---
Antimony [mg/L]	0.0002	< 0.0002	101%	---

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Env ICP-MS Metals

Project : 09-1663

LR Report : **CA10069-OCT09**

Analysis	10: MDL	11: QC - Blank	12: QC - STD % Recovery	13: QC - DUP % Recovery
Selenium [mg/L]	0.001	< 0.001	102%	---
Silica [mg/L]	0.01	< 0.01	104%	---
Tin [mg/L]	0.00001	< 0.00001	96%	---
Strontium [mg/L]	0.0001	< 0.0001	100%	---
Titanium [mg/L]	0.0001	< 0.0001	96%	---
Thallium [mg/L]	0.0002	< 0.0002	107%	---
Uranium [mg/L]	0.000001	0.000001	107%	---
Vanadium [mg/L]	0.00003	< 0.00003	107%	---
Zinc [mg/L]	0.001	< 0.001	104%	---

Samples are field filtered
Ra226 subcontracted to Becquerel Labs.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

ANALYSIS REPORT

Becquerel Laboratories Inc.
6790 Kitimat Rd., Unit 4
Mississauga, Ontario
Canada, L5N 5L9

Phone: (905) 826-3080
FAX: (905) 826-4151

Batch: T09-01382.0

Date: 20-Oct-2009

Lakefield Research Ltd.

185 Concession St., Postal Bag 4300
Lakefield, ON, K0L 2H0

attn: Brian Graham

Phone: (705) 652-2038
FAX: (705) 652-1918

Client Ref.Oct 10064
P.O: 17820

6 water samples Sampled: 28-Sep-2009 Received: 06-Oct-2009 Page 1 of 1

Results of Analysis

Sample	Test	Result	Units	Date	Method
SW09 QC15-1	Ra-226	0.42	Bq/l	17-Oct-2009	ALPHA
SW09 QC15-2	Ra-226	0.45	Bq/l	18-Oct-2009	ALPHA
SW09 QC15-3	Ra-226	0.46	Bq/l	18-Oct-2009	ALPHA
SW09 QC15-4	Ra-226	0.45	Bq/l	18-Oct-2009	ALPHA
SW09 EC-2T	Ra-226	0.78	Bq/l	18-Oct-2009	ALPHA
SW09 EC-2B	Ra-226	0.85	Bq/l	18-Oct-2009	ALPHA

Methods: ALPHA BQ-RAD-ALPHA alpha-particle spectrometry

Units: Bq/l Becquerels per litre

These results relate only to the samples analysed and only to the items tested.

20-Oct-2009 approved by: [signature]
Donald D. Burgess PhD
Senior Scientist, Division Supervisor

SGS

SGS Lakefield Research Limited
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Ecometrix
Attn : Erin Clyde

6800 Campobello Road, Mississauga
Canada, L5N 2L8
Phone: 905-794-2325, Fax:905-794-2338

October 14, 2009

Date Rec. : 01 October 2009
LR Report : **CA10064-OCT09**
Project : 09-1663

CERTIFICATE OF ANALYSIS
Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	5: SW09 QC15-1	6: SW09 QC15-2	7: SW09 QC15-3	8: SW09 QC15-4	9: SW09 EC-2T	10: SW09 EC-2B
Sample Date & Time					28-Sep-09	28-Sep-09	28-Sep-09	28-Sep-09	28-Sep-09	28-Sep-09
Temperature Upon Receipt [°C]	---	---	---	---	9.0	9.0	9.0	9.0	9.0	9.0
Sulphate [mg/L]	02-Oct-09	19:39	06-Oct-09	14:22	570	570	570	600	85	36
Acidity [mg/L as CaCO3]	02-Oct-09	15:00	05-Oct-09	15:14	22	27	44	50	67	16
Total Organic Carbon [mg/L]	05-Oct-09	09:40	06-Oct-09	13:53	---	---	---	---	11.4	11.7
Total Inorganic Carbon [mg/L]	05-Oct-09	14:35	08-Oct-09	12:46	---	---	---	---	< 1.0	< 1.0
Hardness [mg/L as CaCO3]	05-Oct-09	09:00	05-Oct-09	13:19	529	535	532	549	17.0	16.8
Aluminum [mg/L]	05-Oct-09	09:00	05-Oct-09	13:19	< 0.01	< 0.01	< 0.01	0.02	0.03	< 0.01
Arsenic [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.0010	0.0009	0.0009	0.0011	0.0007	0.0007
Barium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.0334	0.0301	0.0300	0.0296	0.108	0.114
Beryllium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.00006	< 0.00002	0.00002	< 0.00002	0.00003	0.00002
Boron [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.113	0.113	0.115	0.116	0.0076	0.0072
Bismuth [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.00004	0.00002	0.00001	< 0.00001	0.00002	0.00002
Calcium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:19	202	205	204	210	5.69	5.63
Cadmium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.000074	0.000051	0.000039	0.000031	0.000046	0.000056
Cobalt [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.00558	0.00464	0.0106	0.0122	0.00655	0.00196
Chromium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Copper [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.0017	0.0014	0.0013	0.0016	0.0037	0.0029
Iron [mg/L]	05-Oct-09	09:00	05-Oct-09	13:19	0.10	0.06	0.16	0.18	0.07	0.04
Potassium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:19	10.8	11.0	10.9	11.9	0.31	0.32
Lithium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:19	0.008	0.008	0.008	0.009	< 0.002	< 0.002
Magnesium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:19	5.69	5.79	5.77	6.19	0.670	0.663

OnLine LIMS

SGS Lakefield Research Limited
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Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

LR Report : CA10064-OCT09

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	5: SW09 QC15-1	6: SW09 QC15-2	7: SW09 QC15-3	8: SW09 QC15-4	9: SW09 EC-2T	10: SW09 EC-2B
Manganese [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.207	0.214	0.214	0.310	0.0315	0.0319
Molybdenum [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.00319	0.00409	0.00368	0.00533	0.00018	0.00008
Sodium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:19	2.38	2.42	2.37	2.59	1.59	1.58
Nickel [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.0067	0.0067	0.0067	0.0068	0.0022	0.0022
Phosphorus [mg/L]	05-Oct-09	09:00	05-Oct-09	13:19	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Lead [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.00151	0.00098	0.00194	0.00548	0.00699	0.00391
Sulphur [mg/L]	05-Oct-09	09:00	05-Oct-09	13:19	157	160	160	166	4.64	4.63
Antimony [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.0017	0.0010	0.0093	0.0106	0.0086	0.0016
Selenium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Silica [mg/L]	05-Oct-09	09:00	05-Oct-09	13:19	5.46	5.55	5.54	5.55	0.59	0.60
Tin [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.00002	0.00012	0.00002	0.00025	< 0.00001	< 0.00001
Strontium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:19	0.159	0.161	0.160	0.166	0.0122	0.0122
Titanium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.0005	0.0004	0.0005	0.0004	0.0004	0.0001
Thallium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Uranium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.0143	0.0116	0.0144	0.0219	0.000654	0.00079
Vanadium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.00009	0.00004	0.00004	< 0.00003	0.00007	0.00007
Zinc [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.005	0.004	0.004	0.004	0.004	0.005

Ra226 subcontracted to Becquerel Labs.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

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SGS Canada Inc.
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Phone: 705-652-2000 FAX: 705-652-6365

Env ICP-MS Metals

Project : 09-1663

October 7, 2010

Ecometrix
Attn : Erin Clyde

6800 Campobello Road, Mississauga
Canada, L5N 2L8
Phone: 905-794-2325, Fax:905-794-2338

Date Rec. : 01 October 2009
LR Report: **CA10064-OCT09**

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CERTIFICATE OF ANALYSIS

Final Report (QC Report)

Analysis	11: MDL	12: QC - Blank	13: QC - STD % Recovery	14: QC - DUP % Recovery
Sulphate [mg/L]	0.2	< 0.2	98%	102%
Acidity [mg/L as CaCO3]	2	3	98%	102%
Total Organic Carbon [mg/L]	1	< 1	91%	100%
Total Inorganic Carbon [mg/L]	0.2	0.2	97%	100%
Hardness [mg/L as CaCO3]	0.5	< 0.5	---	---
Aluminum [mg/L]	0.01	< 0.01	99%	---
Arsenic [mg/L]	0.0002	< 0.0002	106%	---
Barium [mg/L]	0.00001	< 0.00001	122%	---
Beryllium [mg/L]	0.00002	< 0.00002	104%	---
Boron [mg/L]	0.0002	< 0.0002	96%	---
Bismuth [mg/L]	0.00001	< 0.00001	109%	---
Calcium [mg/L]	0.03	< 0.03	101%	---
Cadmium [mg/L]	0.000003	0.000003	99%	---
Cobalt [mg/L]	0.000002	< 0.000002	102%	---
Chromium [mg/L]	0.0005	< 0.0005	102%	---
Copper [mg/L]	0.0005	< 0.0005	102%	---
Iron [mg/L]	0.01	< 0.01	102%	---
Potassium [mg/L]	0.01	< 0.01	98%	---
Lithium [mg/L]	0.002	< 0.002	98%	---
Magnesium [mg/L]	0.003	< 0.003	99%	---
Manganese [mg/L]	0.00001	< 0.00001	107%	---
Molybdenum [mg/L]	0.00001	< 0.00001	99%	---
Sodium [mg/L]	0.01	< 0.01	93%	---
Nickel [mg/L]	0.0001	< 0.0001	100%	---
Phosphorus [mg/L]	0.01	< 0.01	100%	---
Lead [mg/L]	0.00002	< 0.00002	106%	---
Sulphur [mg/L]	0.01	< 0.01	98%	---
Antimony [mg/L]	0.0002	< 0.0002	101%	---
Selenium [mg/L]	0.001	< 0.001	102%	---
Silica [mg/L]	0.01	< 0.01	104%	---
Tin [mg/L]	0.00001	< 0.00001	96%	---
Strontium [mg/L]	0.0001	< 0.0001	100%	---
Titanium [mg/L]	0.0001	< 0.0001	96%	---
Thallium [mg/L]	0.0002	< 0.0002	107%	---

OnLine LIMS

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Analysis	11: MDL	12: QC - Blank	13: QC - STD % Recovery	14: QC - DUP % Recovery
Uranium [mg/L]	0.000001	0.000001	1065	---
Vanadium [mg/L]	0.00003	< 0.00003	107%	---
Zinc [mg/L]	0.001	< 0.001	104%	---

Ra226 subcontracted to Becquerel Labs.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

ANALYSIS REPORT

Becquerel LABORATORIES

Becquerel Laboratories Inc.
6790 Kitimat Rd., Unit 4
Mississauga, Ontario
Canada, L5N 5L9
Phone: (905) 826-3080
FAX: (905) 826-4151

Batch: T09-01485.0

Date: 12-Nov-2009

Lakefield Research Ltd.

185 Concession St., Postal Bag 4300
Lakefield, ON, K0L 2H0

Phone: (705) 652-2038
FAX: (705) 652-1918

attn: Brian Graham

Client Ref.
Sep 10524.R09
P.O: 17820

9 rock samples Sampled: 22-Sep-2009 Received: 21-Oct-2009 Page 1 of 1

Results of Analysis

Sample	Test	Result	Units	Date	Method
CORE 09-PSB-1 0-2.5	Ra-226	12	Bq/g	07-Nov-2009	ALPHA
CORE 09-PSB-1 2.5-5	Ra-226	4.9	Bq/g	07-Nov-2009	ALPHA
CORE 09-PSB-1 5-7.5	Ra-226	1.6	Bq/g	07-Nov-2009	ALPHA
CORE 09-PSB-1 7.5-10	Ra-226	2.8	Bq/g	07-Nov-2009	ALPHA
CORE 09-PSB-1 10-15	Ra-226	2.2	Bq/g	08-Nov-2009	ALPHA
CORE 09-PSB-2 0-5	Ra-226	16	Bq/g	08-Nov-2009	ALPHA
CORE 09-PSB-2 5-10	Ra-226	4.5	Bq/g	08-Nov-2009	ALPHA
CORE 09-PSB-2 10-15	Ra-226	5.6	Bq/g	08-Nov-2009	ALPHA
CORE 09-PSB-2 15-20	Ra-226	14	Bq/g	08-Nov-2009	ALPHA

Methods: ALPHA BQ-RAD-ALPHA alpha-particle spectrometry

Units: Bq/g Becquerels per gram

These results relate only to the samples analysed and only to the items tested.

12-Nov-2009 approved by: S. Seg

Donald D. Burgess PhD
Senior Scientist, Division Supervisor

NOV 24 2009

SGS Lakefield Research Limited
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Ecometrix
Attn : Erin Clyde

6800 Campobello Road
Mississauga, Ontario
L5N 2L8, Canada

Phone: 905-794-2325
Fax:905-794-2338

Tuesday, October 27, 2009

Date Rec. : 30 September 2009
LR. Ref. : **CA10524-SEP09**
Project : 09-1663

Copy to : #1

CERTIFICATE OF ANALYSIS

Final Report

Analysis	**3: Analysis Approval Date**	**4: Analysis Approval Time**	**5: CORE 09-PSB-1 0-2.5**	**6: CORE 09-PSB-1 2.5-5**	**7: CORE 09-PSB-1 5-7.5**	**8: CORE 09-PSB-1 7.5-10**
Sample Date & Time			22-Sep-09	22-Sep-09	22-Sep-09	22-Sep-09
BaSO4 Calc. using Ba* [µg/g]	---	---	2210	870	680	610
BaSO4 Calc. using SO4** [µg/g]	---	---	14600	238000	330000	381000
Total Sulphur [%]	06-Oct-09	14:44	0.698	3.33	4.55	5.14
Carbonate (CO3) [%]	06-Oct-09	14:42	9.43	11.7	6.45	10.7
Total Organic Carbon [%]	06-Oct-09	14:42	2.25	0.940	0.380	0.260
Total Carbon [%]	06-Oct-09	14:45	4.14	3.27	1.67	2.41
Sulphide [%]	07-Oct-09	16:00	0.43	0.18	0.11	< 0.01
Sulphate [%]	23-Oct-09	10:29	0.6	9.8	14	16
Silver [µg/g]	14-Oct-09	14:09	< 0.7	< 0.7	< 0.7	< 0.7
Aluminum [µg/g]	14-Oct-09	14:09	15000	11000	13000	8400
Arsenic [µg/g]	14-Oct-09	14:09	37	24	27	18
Barium [µg/g]	14-Oct-09	14:09	1300	510	400	360
Beryllium [µg/g]	14-Oct-09	14:09	1.1	0.88	1.2	0.82
Bismuth [µg/g]	14-Oct-09	14:09	13	8.9	6.6	5.4
Calcium [µg/g]	14-Oct-09	14:09	67000	140000	140000	180000
Cadmium [µg/g]	14-Oct-09	14:09	3.8	2.5	2.5	2.0
Cerium [µg/g]	13-Oct-09	15:45	690	510	690	440
Cobalt [µg/g]	14-Oct-09	14:09	98	79	100	69
Chromium [µg/g]	14-Oct-09	14:09	16	13	15	10
Cesium [µg/g]	13-Oct-09	15:45	19	0.55	0.24	0.19
Copper [µg/g]	14-Oct-09	14:09	55	33	43	26
Iron [µg/g]	14-Oct-09	14:09	190000	140000	140000	110000
Gallium [µg/g]	13-Oct-09	15:45	7.3	4.5	4.3	2.8
Germanium [µg/g]	13-Oct-09	15:45	6.5	4.9	5.5	4.0
Hafnium [µg/g]	13-Oct-09	15:45	0.5	0.5	0.4	0.3
Indium [µg/g]	13-Oct-09	15:45	0.01	< 0.01	0.01	< 0.01
Potassium [µg/g]	14-Oct-09	14:09	310	220	130	150
Lanthanum [µg/g]	13-Oct-09	15:45	380	280	380	240
Lithium [µg/g]	14-Oct-09	14:09	9.9	7.3	3.6	4.5

OnLine LIMS

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LR Report : CA10524-SEP09

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: CORE 09-PSB-1 0-2.5	6: CORE 09-PSB-1 2.5-5	7: CORE 09-PSB-1 5-7.5	8: CORE 09-PSB-1 7.5-10
Lutetium [µg/g]	13-Oct-09	15:45	3.0	2.6	3.3	2.2
Magnesium [µg/g]	14-Oct-09	14:09	9900	13000	9900	9000
Manganese [µg/g]	14-Oct-09	14:09	1600	750	770	660
Molybdenum [µg/g]	14-Oct-09	14:09	34	11	1.5	0.6
Sodium [µg/g]	14-Oct-09	14:09	62	48	29	40
Niobuim [µg/g]	13-Oct-09	15:45	3.3	2.3	1.7	1.3
Nickel [µg/g]	14-Oct-09	14:09	90	63	64	44
Lead [µg/g]	14-Oct-09	14:09	280	150	96	78
Phosphorus [µg/g]	14-Oct-09	14:09	280	150	110	120
Rubidium [µg/g]	13-Oct-09	15:44	2.5	1.4	0.63	0.58
Antimony [µg/g]	14-Oct-09	14:08	< 1	< 1	< 1	< 1
Scandium [µg/g]	13-Oct-09	15:44	2.1	1.4	1.4	1.0
Selenium [µg/g]	14-Oct-09	14:08	< 1	< 1	< 1	< 1
Tin [µg/g]	14-Oct-09	14:08	< 6	< 6	< 6	< 6
Strontium [µg/g]	14-Oct-09	14:08	30	30	23	35
Tantalum [µg/g]	13-Oct-09	15:44	0.10	0.09	0.07	0.06
Terbium [µg/g]	13-Oct-09	15:44	12	9.8	12	8.2
Tellerium [µg/g]	13-Oct-09	15:44	0.2	0.1	0.1	< 0.1
Thorium [µg/g]	13-Oct-09	15:44	350	300	420	290
Titanium [µg/g]	14-Oct-09	14:08	230	150	100	73
Thallium [µg/g]	14-Oct-09	14:08	< 3	< 3	< 3	< 3
Uranium [µg/g]	13-Oct-09	15:44	370	160	110	75
Vanadium [µg/g]	14-Oct-09	14:08	15	9.2	8.0	5.8
Tungsten [µg/g]	14-Oct-09	14:05	5	2	< 1	< 1
Yttrium [µg/g]	14-Oct-09	14:05	270	220	280	200
Ytterbium [µg/g]	13-Oct-09	15:44	23	20	25	17
Zinc [µg/g]	14-Oct-09	14:05	210	130	110	87
Zirconium [µg/g]	15-Oct-09	10:44	14	10	8	6

Ra226 subcontracted to Becquerel Labs.
* BaSO4 Calculation based on Ba values and assumes all Ba is in BaSO4 form.
** BaSO4 Calculation based on SO4 values and assumes all SO4 is in BaSO4 form.

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Tuesday, October 27, 2009

Date Rec. : 30 September 2009
LR. Ref. : **CA10524-SEP09**
Project : 09-1663

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CERTIFICATE OF ANALYSIS

Final Report

Analysis	9: CORE 09-PSB-1 10-15	10: CORE 09-PSB-2 0-5	11: CORE 09-PSB-2 5-10	12: CORE 09-PSB-2 10-15	13: CORE 09-PSB-2 15-20
Sample Date & Time	22-Sep-09	23-Sep-09	23-Sep-09	23-Sep-09	23-Sep-09
BaSO4 Calc. using Ba* [µg/g]	540	580	270	310	320
BaSO4 Calc. using SO4** [µg/g]	418000	19400	14600	12100	14600
Total Sulphur [%]	5.96	1.31	1.57	2.00	2.23
Carbonate (CO3) [%]	9.65	0.170	0.097	0.052	0.071
Total Organic Carbon [%]	0.130	6.97	9.78	15.2	9.61
Total Carbon [%]	2.06	7.00	9.80	15.2	9.63
Sulphide [%]	< 0.01	0.18	0.36	0.88	1.82
Sulphate [%]	17	0.8	0.6	0.5	0.6
Silver [µg/g]	< 0.7	1.0	< 0.7	< 0.7	1.0
Aluminum [µg/g]	6800	8400	3600	3000	3300
Arsenic [µg/g]	15	30	14	12	19
Barium [µg/g]	320	340	160	180	190
Beryllium [µg/g]	0.66	0.75	0.34	0.37	0.66
Bismuth [µg/g]	4.5	13	11	14	21
Calcium [µg/g]	190000	9600	7600	9400	7600
Cadmium [µg/g]	1.6	5.7	4.5	0.86	0.96
Cerium [µg/g]	360	250	220	230	290
Cobalt [µg/g]	61	20	15	25	46
Chromium [µg/g]	8.6	15	6.5	13	17
Cesium [µg/g]	0.34	0.47	0.97	1.1	0.74
Copper [µg/g]	22	110	14	29	64
Iron [µg/g]	87000	290000	240000	45000	30000
Gallium [µg/g]	2.3	11	2.4	2.1	2.7
Germanium [µg/g]	3.5	8.1	7.2	2.1	1.9
Hafnium [µg/g]	0.3	0.2	0.1	0.1	0.3
Indium [µg/g]	< 0.01	0.02	< 0.01	< 0.01	0.01
Potassium [µg/g]	170	230	190	470	610
Lanthanum [µg/g]	200	130	110	110	140
Lithium [µg/g]	4.5	0.9	0.9	< 0.1	1.1

OnLine LIMS

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LR Report : CA10524-SEP09

Analysis	9: CORE 09-PSB-1 10-15	10: CORE 09-PSB-2 0-5	11: CORE 09-PSB-2 5-10	12: CORE 09-PSB-2 10-15	13: CORE 09-PSB-2 15-20
Lutetium [µg/g]	1.8	1.2	0.98	0.79	0.81
Magnesium [µg/g]	9900	540	360	510	410
Manganese [µg/g]	610	430	89	75	51
Molybdenum [µg/g]	< 0.5	128	10	4.3	3.9
Sodium [µg/g]	47	28	35	80	74
Niobuim [µg/g]	1.0	2.7	2.8	7.8	12
Nickel [µg/g]	39	22	17	22	30
Lead [µg/g]	80	270	270	190	410
Phosphorus [µg/g]	75	590	740	480	510
Rubidium [µg/g]	0.61	2.1	2.1	4.3	4.8
Antimony [µg/g]	< 1	< 1	< 1	< 1	< 1
Scandium [µg/g]	0.8	2.2	1.3	2.3	2.2
Selenium [µg/g]	< 1	< 1	< 1	< 1	< 1
Tin [µg/g]	< 6	< 6	< 6	< 6	< 6
Strontium [µg/g]	27	9.0	7.6	12	10
Tantalum [µg/g]	0.05	0.09	0.05	0.08	0.09
Terbium [µg/g]	6.8	5.1	3.9	3.0	3.5
Tellerium [µg/g]	< 0.1	0.1	0.1	0.1	0.3
Thorium [µg/g]	220	560	110	250	550
Titanium [µg/g]	60	81	82	140	240
Thallium [µg/g]	< 3	< 3	< 3	< 3	< 3
Uranium [µg/g]	68	480	210	84	94
Vanadium [µg/g]	4.6	11	25	9.4	11
Tungsten [µg/g]	< 1	14	2	< 1	1
Yttrium [µg/g]	170	97	78	51	61
Ytterbium [µg/g]	14	9.3	7.4	6.3	6.7
Zinc [µg/g]	83	170	64	27	76
Zirconium [µg/g]	5	8	6	8	18

Ra226 subcontracted to Becquerel Labs.
* BaSO4 Calculation based on Ba values and assumes all Ba is in BaSO4 form.
** BaSO4 Calculation based on SO4 values and assumes all SO4 is in BaSO4 form.

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Project : 09-1663

October 7, 2010

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Date Rec. : 30 September 2009
LR Report: **CA10524-SEP09**

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CERTIFICATE OF ANALYSIS
Final Report (QC Report)

Analysis	14: MDL	15: QC - Blank	16: QC - STD % Recovery	17: QC - DUP % Recovery
BaSO4 Calc. using Ba* [µg/g]	---	---	---	---
BaSO4 Calc. using SO4** [µg/g]	---	---	---	---
Total Sulphur [%]	0.005	< 0.005	102%	100%
Carbonate (CO3) [%]	0.005	< 0.005	100%	140%
Total Organic Carbon [%]	0.01	< 0.01	---	100%
Total Carbon [%]	0.005	< 0.005	100%	100%
Sulphide [%]	0.01	< 0.01	90%	106%
Sulphate [%]	0.1	< 0.1	100%	107%
Silver [µg/g]	0.7	< 0.7	93%	100%
Aluminum [µg/g]	1	< 1	97%	100%
Arsenic [µg/g]	1	< 1	99%	94%
Barium [µg/g]	0.05	< 0.05	96%	100%
Beryllium [µg/g]	0.1	< 0.1	98%	102%
Bismuth [µg/g]	0.5	< 0.5	98%	104%
Calcium [µg/g]	1	< 1	98%	100%
Cadmium [µg/g]	0.05	< 0.05	97%	99%
Cerium [µg/g]	0.006	< 0.006	94%	110%
Cobalt [µg/g]	0.3	< 0.3	97%	100%
Chromium [µg/g]	0.5	< 0.5	98%	103%
Cesium [µg/g]	0.01	< 0.01	100%	107%
Copper [µg/g]	0.1	< 0.1	98%	100%
Iron [µg/g]	0.5	< 0.5	98%	100%
Gallium [µg/g]	0.03	< 0.03	100%	99%
Germanium [µg/g]	0.3	< 0.3	103%	105%
Hafnium [µg/g]	0.1	< 0.1	96%	150%
Indium [µg/g]	0.01	< 0.01	---	100%
Potassium [µg/g]	1	< 1	100%	100%
Lanthanum [µg/g]	0.001	0.001	94%	110%
Lithium [µg/g]	0.1	< 0.1	97%	107%
Lutetium [µg/g]	0.001	0.001	95%	102%

OnLine LIMS

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Project : 09-1663

LR Report : **CA10524-SEP09**

Analysis	14: MDL	15: QC - Blank	16: QC - STD % Recovery	17: QC - DUP % Recovery
Magnesium [µg/g]	1	< 1	96%	---
Manganese [µg/g]	0.05	< 0.05	98%	100%
Molybdenum [µg/g]	0.5	< 0.5	100%	154%
Sodium [µg/g]	1	< 1	97%	104%
Niobuim [µg/g]	0.7	< 0.7	99%	118%
Nickel [µg/g]	1	< 1	97%	101%
Lead [µg/g]	0.7	< 0.7	98%	100%
Phosphorus [µg/g]	5	< 5	98%	100%
Rubidium [µg/g]	0.004	< 0.004	---	105
Antimony [µg/g]	1	< 1	98	100%
Scandium [µg/g]	0.2	< 0.2	100%	99%
Selenium [µg/g]	1	< 1	99%	100%
Tin [µg/g]	6	< 6	100%	123%
Strontium [µg/g]	0.01	< 0.01	97%	103%
Tantalum [µg/g]	0.01	< 0.01	97%	108%
Terbium [µg/g]	0.01	< 0.001	96%	93%
Tellerium [µg/g]	0.1	< 0.1	99%	101%
Thorium [µg/g]	0.01	< 0.01	114%	100%
Titanium [µg/g]	0.2	< 0.2	98%	100%
Thallium [µg/g]	3	< 3	99%	76%
Uranium [µg/g]	3	< 3	---	100%
Vanadium [µg/g]	0.1	< 0.1	99%	102%
Tungsten [µg/g]	1	< 1	97%	93%
Yttrium [µg/g]	0.1	< 0.1	96%	100%
Ytterbium [µg/g]	0.1	< 0.1	98%	105%
Zinc [µg/g]	0.1	< 0.1	97%	100%
Zirconium [µg/g]	5	< 5	100%	107%

Ra226 subcontracted to Becquerel Labs.
* BaSO4 Calculation based on Ba values and assumes all Ba is in BaSO4 form.
** BaSO4 Calculation based on SO4 values and assumes all SO4 is in BaSO4 form.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

Becquerel LABORATORIES

ANALYSIS REPORT

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Batch: T09-01387.0

Date: 09-Nov-2009

Lakefield Research Ltd.

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Phone: (705) 652-2038
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Client Ref.Sep 10523
P.O: 17820

9 water samples

Received: 06-Oct-2009

Page 1 of 1

Results of Analysis

Sample	Test		Result	Units	Date	Method
PW09-PSB-1 0-2.5	Ra-226		0.76	Bq/l	06-Nov-2009	ALPHA
PW09-PSB-1 2.5-5	Ra-226		0.12	Bq/l	06-Nov-2009	ALPHA
PW09-PSB-1 5-7.5	Ra-226		0.02	Bq/l	06-Nov-2009	ALPHA
PW09-PSB-1 7.5-10	Ra-226	<	0.01	Bq/l	06-Nov-2009	ALPHA
PW09-PSB-1 10-15	Ra-226	<	0.01	Bq/l	06-Nov-2009	ALPHA
PW09-PSB-2 0-5	Ra-226		3.2	Bq/l	06-Nov-2009	ALPHA
PW09-PSB-2 5-10	Ra-226		1.8	Bq/l	06-Nov-2009	ALPHA
PW09-PSB-2 10-15	Ra-226		1.1	Bq/l	06-Nov-2009	ALPHA
PW09-PSB-2 15-20	Ra-226		1.4	Bq/l	06-Nov-2009	ALPHA

Methods: ALPHA BQ-RAD-ALPHA alpha-particle spectrometry

Units: Bq/l Becquerels per litre

These results relate only to the samples analysed and only to the items tested.

09-Nov-2009 approved by: [signature]
Donald D. Burgess PhD
Senior Scientist, Division Supervisor

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October 14, 2009

Date Rec. : 30 September 2009
LR Report : **CA10523-SEP09**
Project : 09-1663

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	5: PW09-PSB-1 0-2.5	6: PW09-PSB-1 2.5-5	7: PW09-PSB-1 5-7.5
Sample Date & Time					22-Sep-09	22-Sep-09	22-Sep-09
Temperature Upon Receipt [°C]	---	---	---	---	4.0	4.0	4.0
Sulphate [mg/L]	02-Oct-09	15:00	06-Oct-09	14:01	410	1100	1300
Dissolved Organic Carbon [mg/L]	02-Oct-09	10:00	06-Oct-09	13:52	10.7	9.9	12.2
Dissolved Inorganic Carbon [mg/L]	05-Oct-09	14:35	08-Oct-09	12:46	1.7	< 1.0	< 1.0
Alkalinity [mg/L as CaCO3]	02-Oct-09	15:19	05-Oct-09	15:11	24	24	33
Acidity [mg/L as CaCO3]	02-Oct-09	15:19	05-Oct-09	15:11	---	---	---
Hardness [mg/L as CaCO3]	02-Oct-09	09:00	08-Oct-09	16:00	504	934	1270
Aluminum [mg/L]	02-Oct-09	09:00	02-Oct-09	12:08	0.03	0.12	0.04
Arsenic [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.0018	0.0047	0.0059
Barium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.0167	0.00872	0.00558
Beryllium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	< 0.00002	< 0.00002	< 0.00002
Boron [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.0287	0.0284	0.0078
Bismuth [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	< 0.00001	0.00001	< 0.00001
Calcium [mg/L]	02-Oct-09	09:00	08-Oct-09	16:00	193	373	506
Cadmium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.000014	0.000017	0.000007
Cobalt [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.000458	0.000560	0.000695
Chromium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	< 0.0005	0.0006	0.0009
Copper [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.0014	0.0012	0.0014
Iron [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	< 0.01	< 0.01	0.01
Potassium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	10.3	17.3	23.3
Lithium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	< 0.002	< 0.002	0.003
Magnesium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	5.17	0.966	0.296

OnLine LIMS

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LR Report : CA10523-SEP09

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	5: PW09-PSB-1 0-2.5	6: PW09-PSB-1 2.5-5	7: PW09-PSB-1 5-7.5
Manganese [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.0679	0.00194	0.00031
Molybdenum [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.00679	0.0118	0.00655
Sodium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	6.60	10.0	13.0
Nickel [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.0043	0.0093	0.0126
Phosphorus [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	< 0.01	< 0.01	< 0.01
Lead [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.00025	0.00017	0.00008
Sulphur [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	179	331	449
Antimony [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	< 0.0002	< 0.0002	< 0.0002
Selenium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	< 0.001	< 0.001	< 0.001
Silica [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	0.44	0.22	0.13
Tin [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.00018	0.00026	0.00043
Strontium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:09	0.115	0.156	0.170
Titanium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.0002	0.0002	0.0003
Thallium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	< 0.0002	< 0.0002	< 0.0002
Uranium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.0636	0.00363	0.000341
Vanadium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.00005	0.00006	0.00019
Zinc [mg/L]	01-Oct-09	16:00	02-Oct-09	12:09	0.002	< 0.001	< 0.001

Samples are field filtered
Ra226 subcontracted to Becquerel Labs.

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Phone: 905-794-2325, Fax:905-794-2338

October 14, 2009

Date Rec. : 30 September 2009
LR Report : **CA10523-SEP09**
Project : 09-1663

CERTIFICATE OF ANALYSIS
Final Report

Analysis	**8: PW09-PSB-1 7.5-10**	**9: PW09-PSB-1 10-15**	**10: PW09-PSB-2 0-5**	**11: PW09-PSB-2 5-10**	**12: PW09-PSB-2 10-15**	**13: PW09-PSB-2 15-20**
Sample Date & Time	22-Sep-09	22-Sep-09	23-Sep-09	23-Sep-09	23-Sep-09	23-Sep-09
Temperature Upon Receipt [°C]	4.0	4.0	4.0	4.0	4.0	4.0
Sulphate [mg/L]	1600	1800	190	250	---	---
Dissolved Organic Carbon [mg/L]	14.6	12.0	5.5	21.8	---	---
Dissolved Inorganic Carbon [mg/L]	< 1.0	< 1.0	8.6	14.6	---	---
Alkalinity [mg/L as CaCO3]	45	36	---	---	---	---
Acidity [mg/L as CaCO3]	---	---	< 2	< 2	---	---
Hardness [mg/L as CaCO3]	1970	1810	217	312	415	875
Aluminum [mg/L]	0.01	0.04	< 0.01	< 0.01	< 0.01	0.01
Arsenic [mg/L]	0.0069	0.0059	0.0012	0.0015	0.0028	0.0064
Barium [mg/L]	0.00624	0.00582	0.0443	0.0344	0.0266	0.0380
Beryllium [mg/L]	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002
Boron [mg/L]	0.0023	0.0077	0.0232	0.0422	0.0889	0.118
Bismuth [mg/L]	0.00001	< 0.00001	< 0.00001	< 0.00001	0.00001	< 0.00001
Calcium [mg/L]	787	723	76.4	106	138	297
Cadmium [mg/L]	0.000006	0.000013	0.000011	< 0.000003	0.000012	0.000010
Cobalt [mg/L]	0.000763	0.000834	0.00271	0.000540	0.000530	0.00114
Chromium [mg/L]	< 0.0005	0.0011	< 0.0005	< 0.0005	0.0010	0.0009
Copper [mg/L]	0.0021	0.0022	0.0008	0.0012	0.0022	0.0023
Iron [mg/L]	< 0.01	0.02	8.19	12.1	6.95	16.1
Potassium [mg/L]	29.7	35.8	7.51	11.8	17.4	29.2
Lithium [mg/L]	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.007
Magnesium [mg/L]	0.213	0.713	6.39	11.8	17.0	32.7

SGS Lakefield Research Limited
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

LR Report : **CA10523-SEP09**

Analysis	8: PW09-PSB-1 7.5-10	9: PW09-PSB-1 10-15	10: PW09-PSB-2 0-5	11: PW09-PSB-2 5-10	12: PW09-PSB-2 10-15	13: PW09-PSB-2 15-20
Manganese [mg/L]	0.00012	0.00100	1.85	0.753	0.790	1.67
Molybdenum [mg/L]	0.00633	0.00445	0.00113	0.00071	0.00437	0.00563
Sodium [mg/L]	15.9	17.5	5.62	10.2	16.1	24.2
Nickel [mg/L]	0.0151	0.0132	0.0026	0.0028	0.0035	0.0046
Phosphorus [mg/L]	0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.01
Lead [mg/L]	0.00016	0.00018	0.00012	0.00022	0.00025	0.00023
Sulphur [mg/L]	503	560	63.7	87.8	123	311
Antimony [mg/L]	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	0.0004
Selenium [mg/L]	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Silica [mg/L]	0.22	0.43	4.34	7.44	11.3	12.0
Tin [mg/L]	0.00055	0.00046	0.00017	0.00031	0.00017	0.00009
Strontium [mg/L]	0.193	0.216	0.0915	0.131	0.177	0.347
Titanium [mg/L]	0.0002	0.0004	0.0003	0.0006	0.0012	0.0012
Thallium [mg/L]	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Uranium [mg/L]	0.000330	0.000201	0.00706	0.0241	0.0330	0.0214
Vanadium [mg/L]	0.00011	0.00029	< 0.00003	0.00008	0.00041	0.00060
Zinc [mg/L]	< 0.001	< 0.001	0.002	0.002	0.002	0.003

Samples are field filtered
Ra226 subcontracted to Becquerel Labs.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

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SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
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Project : 09-1663

October 7, 2010

Ecometrix
Attn : Erin Clyde

6800 Campobello Road, Mississauga
Canada, L5N 2L8
Phone: 905-794-2325, Fax:905-794-2338

Date Rec. : 30 September 2009
LR Report: **CA10523-SEP09**

Copy: #1

CERTIFICATE OF ANALYSIS

Final Report - (QC Report)

Analysis	14: MDL	15: QC - Blank	16: QC - STD % Recovery	17: QC - DUP % Recovery
Sulphate [mg/L]	0.2	< 0.2	98%	102%
Dissolved Organic Carbon [mg/L]	0.2	< 0.2	105%	98%
Dissolved Inorganic Carbon [mg/L]	0.2	0.2	97%	110%
Alkalinity [mg/L as CaCO3]	2	< 2	101%	98%
Acidity [mg/L as CaCO3]	2	3	98%	102%
Hardness [mg/L as CaCO3]	0.5	---	---	---
Aluminum [mg/L]	0.01	< 0.01	95%	100%
Arsenic [mg/L]	0.0002	< 0.0002	106%	111%
Barium [mg/L]	0.00001	< 0.00001	105%	100%
Beryllium [mg/L]	0.00002	< 0.00002	103%	94%
Boron [mg/L]	0.0002	< 0.0002	99%	97%
Bismuth [mg/L]	0.00001	0.00001	105%	82%
Calcium [mg/L]	0.03	---	98%	100%
Cadmium [mg/L]	0.000003	< 0.000003	102%	107%
Cobalt [mg/L]	0.000002	< 0.000002	105%	99%
Chromium [mg/L]	0.0005	< 0.0005	103%	170%
Copper [mg/L]	0.0005	< 0.0005	106%	85%
Iron [mg/L]	0.01	---	97%	122%
Potassium [mg/L]	0.01	< 0.01	98%	99%
Lithium [mg/L]	0.002	< 0.002	94%	120%
Magnesium [mg/L]	0.003	---	95%	100%
Manganese [mg/L]	0.00001	< 0.00001	104%	99%
Molybdenum [mg/L]	0.00001	< 0.00001	95%	155%
Sodium [mg/L]	0.01	---	94.8	99.3
Nickel [mg/L]	0.0001	< 0.0001	105%	87%
Phosphorus [mg/L]	0.01	< 0.01	95%	100%
Lead [mg/L]	0.00002	< 0.00002	102%	30%
Sulphur [mg/L]	0.01	---	100%	101%
Antimony [mg/L]	0.0002	< 0.0002	94%	124%
Selenium [mg/L]	0.001	< 0.001	108%	100%

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Project : 09-1663
LR Report : **CA10523-SEP09**

Analysis	14: MDL	15: QC - Blank	16: QC - STD % Recovery	17: QC - DUP % Recovery
Silica [mg/L]	0.01	< 0.01	103%	101%
Tin [mg/L]	0.00001	< 0.00001	96%	140%
Strontium [mg/L]	0.0001	---	98%	100%
Titanium [mg/L]	0.0001	< 0.0001	95%	130%
Thallium [mg/L]	0.0002	< 0.0002	105%	106%
Uranium [mg/L]	0.000001	< 0.000001	102%	94%
Vanadium [mg/L]	0.00003	< 0.00003	106%	150%
Zinc [mg/L]	0.001	< 0.001	106%	90%

Samples are field filtered
Ra226 subcontracted to Becquerel Labs.
Revised to include Ra226 results from Becquerel.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

Becquerel LABORATORIES

ANALYSIS REPORT

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Phone: (905) 826-3080
FAX: (905) 826-4151

Batch: T09-01381.0

Date: 20-Oct-2009

Lakefield Research Ltd.

185 Concession St., Postal Bag 4300
Lakefield, ON, K0L 2H0

attn: Brian Graham

Phone: (705) 652-2038
FAX: (705) 652-1918

Client Ref.Sept 10522
P.O: 17820

4 water samples Sampled: 22-Sep-2009 Received: 06-Oct-2009 Page 1 of 1

Results of Analysis

Sample	Test	Result	Units	Date	Method
SW09-PSB-1T	Ra-226	0.34	Bq/l	17-Oct-2009	ALPHA
SW09-PSB-1B	Ra-226	0.65	Bq/l	17-Oct-2009	ALPHA
SW09-PSB-2T	Ra-226	0.31	Bq/l	17-Oct-2009	ALPHA
SW09-PSB-2B	Ra-226	0.39	Bq/l	17-Oct-2009	ALPHA

Methods: ALPHA BQ-RAD-ALPHA alpha-particle spectrometry

Units: Bq/l Becquerels per litre

These results relate only to the samples analysed and only to the items tested.

20-Oct-2009 approved by: [signature]
Donald D. Burgess PhD
Senior Scientist, Division Supervisor

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Ecometrix
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Phone: 905-794-2325, Fax:905-794-2338

October 14, 2009

Date Rec. : 30 September 2009
LR Report : **CA10522-SEP09**
Project : 09-1663

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	5: SW09-PSB-1T	6: SW09-PSB-1B	7: SW09-PSB-2T	8: SW09-PSB-2B
Sample Date & Time					22-Sep-09	22-Sep-09	23-Sep-09	23-Sep-09
Temperature Upon Receipt [°C]	---	---	---	---	4.0	4.0	4.0	4.0
Sulphate [mg/L]	02-Oct-09	15:00	06-Oct-09	14:19	180	410	180	180
Total Organic Carbon [mg/L]	02-Oct-09	10:00	05-Oct-09	13:41	2.1	4.6	2.2	4.0
Total Inorganic Carbon [mg/L]	05-Oct-09	14:35	08-Oct-09	12:45	3.5	< 1.0	2.9	< 1.0
Alkalinity [mg/L as CaCO3]	02-Oct-09	15:19	05-Oct-09	15:10	12	---	---	---
Acidity [mg/L as CaCO3]	02-Oct-09	15:19	05-Oct-09	15:10	---	20	< 2	15
Hardness [mg/L as CaCO3]	02-Oct-09	09:00	02-Oct-09	12:08	173	209	179	179
Aluminum [mg/L]	02-Oct-09	09:00	02-Oct-09	12:08	< 0.01	0.53	< 0.01	< 0.01
Arsenic [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.0005	0.0014	0.0004	0.0005
Barium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.0134	0.0196	0.0137	0.0160
Beryllium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.00007	0.00009	0.00002	< 0.00002
Boron [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.0249	0.0314	0.0252	0.0243
Bismuth [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.00007	0.00003	< 0.00001	0.00001
Calcium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:08	62.2	74.4	64.5	64.1
Cadmium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.000079	0.000082	0.000005	0.000015
Cobalt [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.000281	0.0186	0.000319	0.00120
Chromium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Copper [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.0025	0.0019	0.0015	0.0009
Iron [mg/L]	02-Oct-09	09:00	02-Oct-09	12:08	0.03	1.61	< 0.01	0.02
Potassium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:08	6.11	6.53	6.18	6.14
Lithium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:08	< 0.002	< 0.002	< 0.002	< 0.002

OnLine LIMS

SGS Lakefield Research Limited
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Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

LR Report : **CA10522-SEP09**

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	5: SW09-PSB-1T	6: SW09-PSB-1B	7: SW09-PSB-2T	8: SW09-PSB-2B
Magnesium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:08	4.30	5.53	4.45	4.47
Manganese [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.00475	0.203	0.00313	0.0273
Molybdenum [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.00017	0.00043	0.00008	0.00025
Sodium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:08	3.99	4.35	4.04	4.14
Nickel [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.0017	0.0101	0.0015	0.0025
Phosphorus [mg/L]	02-Oct-09	09:00	02-Oct-09	12:08	< 0.01	< 0.01	< 0.01	< 0.01
Lead [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.00057	0.00647	0.00013	0.00088
Sulphur [mg/L]	02-Oct-09	09:00	02-Oct-09	12:08	57.9	67.4	60.2	60.5
Antimony [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	< 0.0002	0.0084	0.0003	0.0015
Selenium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	< 0.001	< 0.001	< 0.001	< 0.001
Silica [mg/L]	02-Oct-09	09:00	02-Oct-09	12:08	0.99	1.14	1.01	1.12
Tin [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.00011	0.00035	0.00017	0.00020
Strontium [mg/L]	02-Oct-09	09:00	02-Oct-09	12:08	0.0715	0.0765	0.0736	0.0742
Titanium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.0003	0.0002	0.0002	0.0002
Thallium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Uranium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.00245	0.0557	0.00273	0.00317
Vanadium [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.00008	0.00004	< 0.00003	0.00007
Zinc [mg/L]	01-Oct-09	16:00	02-Oct-09	12:08	0.009	0.024	< 0.001	0.002

Ra226 subcontracted to Becquerel Labs.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

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SGS Canada Inc.
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Env ICP-MS Metals

Project : 09-1663

October 7, 2010

Ecometrix
Attn : Erin Clyde

6800 Campobello Road, Mississauga
Canada, L5N 2L8
Phone: 905-794-2325, Fax:905-794-2338

Date Rec. : 30 September 2009
LR Report: **CA10522-SEP09**

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CERTIFICATE OF ANALYSIS
Final Report

Analysis	9: MDL	10: QC - Blank	11: QC - STD % Recovery	12: QC - DUP % Recovery
Sulphate [mg/L]	0.2	< 0.2	98%	102%
Total Organic Carbon [mg/L]	0.2	< 0.2	105%	98%
Total Inorganic Carbon [mg/L]	0.2	< 0.2	110%	100%
Alkalinity [mg/L as CaCO3]	2	< 2	101%	98%
Acidity [mg/L as CaCO3]	2	2	98%	102%
Hardness [mg/L as CaCO3]	0.5	---	---	---
Aluminum [mg/L]	0.01	< 0.01	95%	100%
Arsenic [mg/L]	0.0002	< 0.0002	106%	111%
Barium [mg/L]	0.00001	< 0.00001	105%	100%
Beryllium [mg/L]	0.00002	< 0.00002	103%	94%
Boron [mg/L]	0.0002	< 0.0002	99%	97%
Bismuth [mg/L]	0.00001	0.00001	105%	82%
Calcium [mg/L]	0.03	---	97%	100%
Cadmium [mg/L]	0.000003	< 0.000003	102%	107%
Cobalt [mg/L]	0.000002	< 0.000002	105%	99%
Chromium [mg/L]	0.00005	< 0.0005	103%	170%
Copper [mg/L]	0.0005	< 0.0005	106%	85%
Iron [mg/L]	0.01	---	96.8	122
Potassium [mg/L]	0.01	< 0.01	98%	99.1
Lithium [mg/L]	0.002	< 0.002	94.2	120
Magnesium [mg/L]	0.003	---	94.8	100
Manganese [mg/L]	0.00001	< 0.00001	104%	99%
Molybdenum [mg/L]	0.00001	< 0.00001	95%	155%
Sodium [mg/L]	0.01	---	94.8	99.3
Nickel [mg/L]	0.0001	< 0.0001	105%	87%
Phosphorus [mg/L]	0.01	< 0.01	95%	100%
Lead [mg/L]	0.00002	< 0.00002	102%	30%
Sulphur [mg/L]	0.01	---	100%	101

OnLine LIMS

SGS Canada Inc.
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Env ICP-MS Metals

Project : 09-1663

LR Report : **CA10522-SEP09**

Analysis	9: MDL	10: QC - Blank	11: QC - STD % Recovery	12: QC - DUP % Recovery
Antimony [mg/L]	0.0002	< 0.0002	94%	124%
Selenium [mg/L]	0.001	< 0.001	108%	100%
Silica [mg/L]	0.01	< 0.01	103%	101%
Tin [mg/L]	0.00001	< 0.00001	96%	140%
Strontium [mg/L]	0.0001	---	98%	99.7
Titanium [mg/L]	0.0001	< 0.0001	95%	130%
Thallium [mg/L]	0.0002	< 0.0002	105%	106%
Uranium [mg/L]	0.000001	< 0.000001	102%	94%
Vanadium [mg/L]	0.00003	< 0.00003	106%	150%
Zinc [mg/L]	0.001	< 0.001	106%	90%

Ra226 subcontracted to Becquerel Labs.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

ANALYSIS REPORT

Becquerel LABORATORIES

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FAX: (905) 826-4151

Batch: T09-01487.0

Date: 13-Nov-2009

Lakefield Research Ltd.

185 Concession St., Postal Bag 4300
Lakefield, ON, K0L 2H0

attn: Brian Graham

Phone: (705) 652-2038
FAX: (705) 652-1918

Client Ref.
Oct 10063.R09
P.O: 17820

20 solid samples Sampled: 28-Sep-2009 Received: 21-Oct-2009

Results of Analysis

Sample	Test	Result	Units	Date	Method
CORE 09-EC-1 (0-5)	Ra-226	4.1	Bq/g	11-Nov-2009	ALPHA
CORE 09-EC-1 (5-10)	Ra-226	1.6	Bq/g	11-Nov-2009	ALPHA
CORE 09-EC-2 (0-2.5)	Ra-226	7.0	Bq/g	11-Nov-2009	ALPHA
CORE 09-EC-2 (2.5-5)	Ra-226	8.3	Bq/g	11-Nov-2009	ALPHA
CORE 09-EC-2 (5-7.5)	Ra-226	9.7	Bq/g	11-Nov-2009	ALPHA
CORE 09-QC14-1 (0-5)	Ra-226	19	Bq/g	11-Nov-2009	ALPHA
CORE 09-QC14-1 (5-10)	Ra-226	13	Bq/g	11-Nov-2009	ALPHA
CORE 09-QC14-1 (10-15)	Ra-226	9.7	Bq/g	11-Nov-2009	ALPHA
CORE 09-QC14-2 (0-2.5)	Ra-226	4.3	Bq/g	12-Nov-2009	ALPHA
CORE 09-QC14-2 (2.5-5)	Ra-226	6.5	Bq/g	12-Nov-2009	ALPHA
CORE 09-QC14-2 (5-7.5)	Ra-226	9.3	Bq/g	12-Nov-2009	ALPHA
CORE 09-QC14-2 (7.5-10)	Ra-226	9.0	Bq/g	12-Nov-2009	ALPHA
CORE 09-QC14-3 (0-5)	Ra-226	16	Bq/g	12-Nov-2009	ALPHA
CORE 09-QC14-3 (5-10)	Ra-226	22	Bq/g	12-Nov-2009	ALPHA
CORE 09-QC14-3 (10-15)	Ra-226	24	Bq/g	12-Nov-2009	ALPHA
CORE 09-QC14-3 (15-20)	Ra-226	23	Bq/g	12-Nov-2009	ALPHA
CORE 09-QC14-4 (0-5)	Ra-226	16	Bq/g	12-Nov-2009	ALPHA
CORE 09-QC14-4 (5-10)	Ra-226	17	Bq/g	12-Nov-2009	ALPHA
CORE 09-QC14-4 (10-15)	Ra-226	22	Bq/g	12-Nov-2009	ALPHA
CORE 09-QC14-4 (15-20)	Ra-226	19	Bq/g	12-Nov-2009	ALPHA

ANALYSIS REPORT

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Batch: T09-01487.0

Date: 13-Nov-2009

Methods: ALPHA BQ-RAD-ALPHA alpha-particle spectrometry

Units: Bq/g Becquerels per gram

These results relate only to the samples analysed and only to the items tested.

13-Nov-2009 approved by:
Donald D. Burgess PhD
Senior Scientist, Division Supervisor

SGS

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Ecometrix
Attn : Erin Clyde

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Tuesday, October 27, 2009

Date Rec. : 01 October 2009
LR. Ref. : **CA10063-OCT09**
Project : 09-1663

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CERTIFICATE OF ANALYSIS

Final Report

Analysis	**3: Analysis Approval Date**	**4: Analysis Approval Time**	**5: CORE 09-EC-1 (0-5)**	**6: CORE 09-EC-1 (5-10)**	**7: CORE 09-EC-2 (0-2.5)**	**8: CORE 09-EC-2 (2.5-5)**	**9: CORE 09-EC-2 (5-7.5)**	**10: CORE 09-QC14-1 (0-5)**
Sample Date & Time			28-Sep-09	28-Sep-09	28-Sep-09	28-Sep-09	28-Sep-09	28-Sep-09
Ba as BaSO4 Calc. * [µg/g]	---	---	160	770	480	630	530	940
SO4 as BaSO4 Calc. ** [µg/g]	---	---	7280	2430	2430	2430	2430	14600
Total Sulphur [%]	09-Oct-09	10:07	1.17	0.762	0.628	1.03	1.18	1.21
Carbonate (CO3) [%]	08-Oct-09	10:46	0.058	0.280	< 0.005	< 0.005	< 0.005	< 0.005
Total Organic Carbon [%]	09-Oct-09	10:07	10.5	16.7	0.617	0.206	0.090	0.490
Total Carbon [%]	09-Oct-09	10:07	10.5	16.8	0.616	0.207	0.089	0.489
Sulphide [%]	08-Oct-09	11:47	0.47	0.70	0.53	1.04	1.07	0.96
Sulphate [%]	13-Oct-09	16:45	0.3	0.1	0.1	0.1	0.1	0.6
Silver [µg/g]	14-Oct-09	13:32	< 0.7	< 0.7	1.5	1.2	1.1	3.0
Aluminum [µg/g]	14-Oct-09	13:32	3800	5800	1500	1200	890	6700
Arsenic [µg/g]	14-Oct-09	13:32	14	26	22	24	24	37
Barium [µg/g]	14-Oct-09	13:32	94	450	280	370	310	550
Beryllium [µg/g]	14-Oct-09	13:32	0.35	0.13	0.51	0.41	0.34	1.5
Bismuth [µg/g]	14-Oct-09	13:32	12	< 0.5	11	8.6	7.8	15
Calcium [µg/g]	14-Oct-09	13:32	4600	7400	230	110	63	2400
Cadmium [µg/g]	14-Oct-09	13:32	4.0	1.8	0.25	0.27	0.29	0.45
Cerium [µg/g]	14-Oct-09	13:32	240	800	340	300	240	600
Cobalt [µg/g]	14-Oct-09	13:32	15	17	16	21	22	25
Chromium [µg/g]	14-Oct-09	13:32	7.8	17	8.2	6.5	5.8	16
Cesium [µg/g]	14-Oct-09	13:32	1.1	0.90	0.32	0.20	0.19	1.1
Copper [µg/g]	14-Oct-09	13:32	15	56	50	54	54	120
Iron [µg/g]	14-Oct-09	13:32	240000	16000	13000	17000	19000	22000
Gallium [µg/g]	14-Oct-09	13:32	2.7	6.5	2.8	2.4	1.9	5.3
Germanium [µg/g]	14-Oct-09	13:32	7.2	4.0	1.4	1.4	1.2	2.6
Hafnium [µg/g]	14-Oct-09	13:32	0.1	0.9	0.5	0.7	0.7	1.5
Indium [µg/g]	14-Oct-09	13:32	< 0.01	0.01	0.02	0.01	0.01	0.03
Potassium [µg/g]	14-Oct-09	13:32	210	270	330	300	230	570
Lanthanum [µg/g]	14-Oct-09	13:32	130	420	190	170	140	310
Lithium [µg/g]	14-Oct-09	13:32	0.9	1.3	0.8	0.5	0.2	4.7

OnLine LIMS

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LR Report : CA10063-OCT09

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: CORE 09-EC-1 (0-5)	6: CORE 09-EC-1 (5-10)	7: CORE 09-EC-2 (0-2.5)	8: CORE 09-EC-2 (2.5-5)	9: CORE 09-EC-2 (5-7.5)	10: CORE 09-QC14-1 (0-5)
Lutetium [µg/g]	14-Oct-09	13:32	1.1	5.3	0.14	0.060	0.038	1.1
Magnesium [µg/g]	14-Oct-09	13:32	240	1500	110	38	18	97
Manganese [µg/g]	14-Oct-09	13:32	84	180	18	7.6	4.6	14
Molybdenum [µg/g]	14-Oct-09	13:32	10	3.9	6.4	6.1	5.5	10
Sodium [µg/g]	14-Oct-09	13:32	40	55	11	8	5	15
Niobuim [µg/g]	14-Oct-09	13:32	2.7	< 0.7	9.7	7.8	7.5	13
Nickel [µg/g]	14-Oct-09	13:32	19	43	9	10	11	20
Lead [µg/g]	14-Oct-09	13:32	280	640	240	270	310	650
Phosphorus [µg/g]	14-Oct-09	13:32	810	360	400	360	330	820
Rubidium [µg/g]	14-Oct-09	13:32	2.5	4.0	2.6	2.0	1.4	4.1
Antimony [µg/g]	14-Oct-09	13:32	< 1	< 1	1	< 1	< 1	2
Scandium [µg/g]	14-Oct-09	13:32	1.6	3.0	0.9	0.8	0.6	2.8
Selenium [µg/g]	14-Oct-09	13:32	< 2	< 2	< 2	< 2	< 2	< 2
Tin [µg/g]	14-Oct-09	13:32	< 6	< 6	< 6	< 6	< 6	< 6
Strontium [µg/g]	14-Oct-09	13:32	7.9	14	5.1	5.4	4.6	11
Sulphur [µg/g]	14-Oct-09	13:32	15000	11000	6700	11000	12000	12000
Tantalum [µg/g]	14-Oct-09	13:32	0.05	0.23	0.07	0.12	0.28	0.30
Terbium [µg/g]	14-Oct-09	13:32	4.3	33	1.4	0.90	0.67	5.6
Tellerium [µg/g]	14-Oct-09	13:32	0.1	< 0.1	0.2	0.2	0.2	0.3
Thorium [µg/g]	14-Oct-09	13:32	120	89	560	470	380	1600
Titanium [µg/g]	14-Oct-09	13:32	91	220	330	260	240	610
Thallium [µg/g]	14-Oct-09	13:32	< 3	< 3	< 3	< 3	< 3	< 3
Uranium [µg/g]	14-Oct-09	13:32	230	150	23	18	15	83
Vanadium [µg/g]	14-Oct-09	13:32	26	17	4.0	2.7	2.4	7.2
Tungsten [µg/g]	14-Oct-09	13:32	79	5	5	5	6	8
Yttrium [µg/g]	14-Oct-09	13:32	84	750	12	6.7	5.2	87
Ytterbium [µg/g]	14-Oct-09	13:31	8.7	46	1.2	0.57	0.40	9.2
Zinc [µg/g]	14-Oct-09	13:32	65	58	8.9	8.0	5.8	23
Zirconium [µg/g]	14-Oct-09	13:32	6	< 5	30	27	26	58

Ra226 subcontracted to Becquerel Labs.
* BaSO4 Calculation based on Ba values and assumes all Ba is in BaSO4 form.
** BaSO4 Calculation based on SO4 values and assumes all SO4 is in BaSO4 form.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

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CERTIFICATE OF ANALYSIS

Final Report

Analysis	**11: CORE 09-QC14-1 (5-10)**	**12: CORE 09-QC14-1 (10-15)**	**13: CORE 09-QC14-2 (0-2.5)**	**14: CORE 09-QC14-2 (2.5-5)**	**15: CORE 09-QC14-2 (5-7.5)**	**16: CORE 09-QC14-2 (7.5-10)**	**17: CORE 09-QC14-3 (0-5)**
Sample Date & Time	28-Sep-09	28-Sep-09	28-Sep-09	28-Sep-09	28-Sep-09	28-Sep-09	28-Sep-09
Ba as BaSO4 Calc. * [µg/g]	580	480	260	370	560	540	920
SO4 as BaSO4 Calc. ** [µg/g]	53400	29100	2430	2430	2430	2430	<2430
Total Sulphur [%]	2.33	2.21	0.633	0.885	0.871	1.29	1.35
Carbonate (CO3) [%]	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.005
Total Organic Carbon [%]	0.114	0.065	0.519	0.289	0.121	0.086	0.617
Total Carbon [%]	0.115	0.064	0.519	0.289	0.121	0.086	0.618
Sulphide [%]	1.56	1.80	0.52	0.77	0.84	1.26	1.37
Sulphate [%]	2.2	1.2	0.1	0.1	0.1	0.1	< 0.1
Silver [µg/g]	1.7	1.3	0.8	1.0	1.1	1.3	3.4
Aluminum [µg/g]	3800	2600	830	690	850	1400	7700
Arsenic [µg/g]	33	26	17	19	21	23	36
Barium [µg/g]	340	280	150	220	330	320	540
Beryllium [µg/g]	0.81	0.61	0.28	0.28	0.34	0.51	1.7
Bismuth [µg/g]	10	8.1	7.5	9.2	8.5	7.6	15
Calcium [µg/g]	8900	4900	190	130	79	59	350
Cadmium [µg/g]	0.42	0.43	0.18	0.22	0.22	0.31	0.55
Cerium [µg/g]	610	430	300	290	280	250	770
Cobalt [µg/g]	35	36	15	18	17	24	38
Chromium [µg/g]	8.2	6.2	4.7	4.9	5.7	6.6	18
Cesium [µg/g]	0.49	0.32	0.18	0.22	0.31	0.20	0.55
Copper [µg/g]	100	88	43	46	42	51	140
Iron [µg/g]	21000	21000	10000	12000	13000	18000	22000
Gallium [µg/g]	4.3	3.0	2.1	2.1	2.0	1.9	6.2
Germanium [µg/g]	2.6	2.1	1.2	1.2	1.2	1.2	3.1
Hafnium [µg/g]	1.2	0.9	0.3	0.6	1.0	0.7	1.5
Indium [µg/g]	0.02	0.02	< 0.01	< 0.01	0.01	0.01	0.04
Potassium [µg/g]	440	290	210	230	250	250	600
Lanthanum [µg/g]	310	220	170	170	160	140	390
Lithium [µg/g]	1.8	1.0	0.2	0.1	0.4	0.7	5.7

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Analysis	**11: CORE 09-QC14-1 (5-10)**	**12: CORE 09-QC14-1 (10-15)**	**13: CORE 09-QC14-2 (0-2.5)**	**14: CORE 09-QC14-2 (2.5-5)**	**15: CORE 09-QC14-2 (5-7.5)**	**16: CORE 09-QC14-2 (7.5-10)**	**17: CORE 09-QC14-3 (0-5)**
Lutetium [µg/g]	1.4	1.1	0.081	0.048	0.031	0.036	1.9
Magnesium [µg/g]	76	65	88	46	25	23	120
Manganese [µg/g]	5.3	5.4	13	8.6	4.7	3.9	20
Molybdenum [µg/g]	7.8	7.3	5.3	5.2	7.9	4.8	8.0
Sodium [µg/g]	12	7	8	7	6	6	16
Niobuim [µg/g]	7.2	4.9	7.0	8.2	8.4	7.7	15
Nickel [µg/g]	25	24	8	8	8	12	32
Lead [µg/g]	490	390	180	260	270	230	650
Phosphorus [µg/g]	490	320	260	300	360	350	830
Rubidium [µg/g]	3.2	2.1	1.9	1.9	1.8	1.6	4.3
Antimony [µg/g]	< 1	< 1	< 1	< 1	< 1	< 1	2
Scandium [µg/g]	1.5	1.0	0.5	0.4	0.5	0.8	3.0
Selenium [µg/g]	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Tin [µg/g]	< 6	< 6	< 6	< 6	< 6	< 6	< 6
Strontium [µg/g]	12	8.5	3.6	4.1	4.8	4.6	7.5
Sulphur [µg/g]	22000	20000	6500	8700	8600	12000	13000
Tantalum [µg/g]	0.15	0.09	0.04	0.05	0.12	0.35	0.45
Terbium [µg/g]	7.5	5.5	0.97	0.83	0.68	0.64	9.5
Tellerium [µg/g]	0.2	0.2	0.1	0.2	0.2	0.2	0.3
Thorium [µg/g]	880	630	310	310	360	580	1800
Titanium [µg/g]	370	240	210	250	260	240	630
Thallium [µg/g]	< 3	< 3	< 3	< 3	< 3	< 3	< 3
Uranium [µg/g]	71	47	17	17	13	15	120
Vanadium [µg/g]	3.7	2.8	2.7	2.7	2.7	2.6	8.0
Tungsten [µg/g]	7	7	3	4	5	6	8
Yttrium [µg/g]	160	100	9.1	6.8	5.5	5.1	180
Ytterbium [µg/g]	12	9.1	0.74	0.46	0.33	0.36	16
Zinc [µg/g]	28	24	8.8	6.9	4.7	5.4	42
Zirconium [µg/g]	38	27	20	26	28	25	57

Ra226 subcontracted to Becquerel Labs.
* BaSO4 Calculation based on Ba values and assumes all Ba is in BaSO4 form.
** BaSO4 Calculation based on SO4 values and assumes all SO4 is in BaSO4 form.

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CERTIFICATE OF ANALYSIS

Final Report

Analysis	18: CORE 09-QC14-3 (5-10)	19: CORE 09-QC14-3 (10-15)	20: CORE 09-QC14-3 (15-20)	21: CORE 09-QC14-4 (0-5)	22: CORE 09-QC14-4 (5-10)	23: CORE 09-QC14-4 (10-15)	24: CORE 09-QC14-4 (15-20)
Sample Date & Time	28-Sep-09	28-Sep-09	28-Sep-09	28-Sep-09	28-Sep-09	28-Sep-09	28-Sep-09
Ba as BaSO4 Calc. * [µg/g]	1090	1120	1070	970	950	990	800
SO4 as BaSO4 Calc. ** [µg/g]	4850	7280	7280	4850	46100	87400	75200
Total Sulphur [%]	1.48	1.39	1.60	1.48	2.00	2.36	2.58
Carbonate (CO3) [%]	< 0.005	< 0.005	< 0.005	0.022	0.100	0.123	0.034
Total Organic Carbon [%]	0.136	0.112	0.097	0.683	0.188	0.178	0.109
Total Carbon [%]	0.136	0.113	0.096	0.688	0.208	0.202	0.116
Sulphide [%]	1.43	1.32	1.48	1.40	1.37	1.08	1.44
Sulphate [%]	0.2	0.3	0.3	0.2	1.9	3.6	3.1
Silver [µg/g]	3.2	3.9	3.7	3.0	2.9	4.0	2.9
Aluminum [µg/g]	7700	11000	9000	6500	6200	10000	7500
Arsenic [µg/g]	45	49	46	40	38	40	38
Barium [µg/g]	640	660	630	570	560	580	470
Beryllium [µg/g]	1.6	2.1	1.9	1.4	1.4	2.0	1.5
Bismuth [µg/g]	15	16	15	15	14	17	14
Calcium [µg/g]	710	940	1300	1400	9900	19000	16000
Cadmium [µg/g]	0.61	0.66	0.58	0.64	0.56	0.64	0.55
Cerium [µg/g]	1100	1200	1000	900	830	1100	890
Cobalt [µg/g]	45	41	38	39	35	38	38
Chromium [µg/g]	17	24	21	16	15	21	16
Cesium [µg/g]	0.77	0.88	0.76	0.54	0.70	0.87	0.81
Copper [µg/g]	140	160	160	130	120	160	130
Iron [µg/g]	24000	25000	24000	23000	22000	24000	23000
Gallium [µg/g]	7.5	8.6	7.5	6.4	6.1	8.0	6.3
Germanium [µg/g]	4.2	4.4	4.1	3.5	3.3	4.0	3.5
Hafnium [µg/g]	2.2	2.4	2.2	1.5	1.8	2.5	2.2
Indium [µg/g]	0.04	0.05	0.06	0.04	0.03	0.05	0.04
Potassium [µg/g]	630	730	690	600	600	760	650
Lanthanum [µg/g]	560	600	520	460	420	540	450
Lithium [µg/g]	5.2	7.7	7.0	4.9	5.7	10	6.2

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Analysis	**18: CORE 09-QC14-3 (5-10)**	**19: CORE 09-QC14-3 (10-15)**	**20: CORE 09-QC14-3 (15-20)**	**21: CORE 09-QC14-4 (0-5)**	**22: CORE 09-QC14-4 (5-10)**	**23: CORE 09-QC14-4 (10-15)**	**24: CORE 09-QC14-4 (15-20)**
Lutetium [µg/g]	3.1	3.3	2.8	2.3	2.0	3.5	2.6
Magnesium [µg/g]	300	220	120	770	520	1300	400
Manganese [µg/g]	35	31	18	79	53	130	57
Molybdenum [µg/g]	5.8	8.1	8.9	9.0	9.4	8.0	6.6
Sodium [µg/g]	15	18	15	18	16	21	18
Niobuim [µg/g]	9.5	9.0	8.9	13	11	12	10
Nickel [µg/g]	38	39	34	31	28	37	31
Lead [µg/g]	690	720	680	630	550	800	640
Phosphorus [µg/g]	840	930	860	760	740	950	710
Rubidium [µg/g]	4.8	5.8	5.4	4.3	4.3	5.4	5.0
Antimony [µg/g]	< 1	1	1	1	1	1	< 1
Scandium [µg/g]	3.1	4.2	3.6	2.7	2.5	3.8	2.9
Selenium [µg/g]	< 2	< 2	< 2	< 2	< 2	< 2	< 2
Tin [µg/g]	< 6	< 6	< 6	< 6	< 6	< 6	< 6
Strontium [µg/g]	11	14	15	9.2	16	21	18
Sulphur [µg/g]	14000	14000	15000	14000	19000	22000	25000
Tantalum [µg/g]	0.27	0.27	0.28	0.48	0.57	0.55	0.48
Terbium [µg/g]	17	18	14	12	10	18	13
Tellerium [µg/g]	0.3	0.4	0.4	0.3	0.3	0.4	0.3
Thorium [µg/g]	1900	2400	2200	1600	1600	2400	1800
Titanium [µg/g]	660	680	640	590	550	740	570
Thallium [µg/g]	< 3	< 3	< 3	< 3	< 3	< 3	< 3
Uranium [µg/g]	100	110	110	100	100	140	110
Vanadium [µg/g]	7.7	9.3	8.3	7.4	6.4	9.8	6.7
Tungsten [µg/g]	8	9	8	8	8	8	8
Yttrium [µg/g]	370	350	290	240	220	360	260
Ytterbium [µg/g]	26	28	24	19	17	30	22
Zinc [µg/g]	58	59	51	46	42	59	46
Zirconium [µg/g]	64	68	64	56	54	70	58

Ra226 subcontracted to Becquerel Labs.
* BaSO4 Calculation based on Ba values and assumes all Ba is in BaSO4 form.
** BaSO4 Calculation based on SO4 values and assumes all SO4 is in BaSO4 form.

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CERTIFICATE OF ANALYSIS
Final Report (QC Report)

Analysis	25: MDL	26: QC - Blank	27: QC - STD % Recovery	28: QC - DUP % Recovery
Ba as BaSO4 Calc. * [µg/g]	---	---	---	---
SO4 as BaSO4 Calc. ** [µg/g]	---	---	---	---
Total Sulphur [%]	0.005	< 0.005	100%	98%
Carbonate (CO3) [%]	0.005	< 0.005	101%	100%
Total Organic Carbon [%]	0.01	---	---	---
Total Carbon [%]	0.005	< 0.005	100%	95%
Sulphide [%]	0.01	< 0.01	103%	100%
Sulphate [%]	0.1	< 0.1	98%	107%
Silver [µg/g]	0.7	< 0.7	98%	93%
Aluminum [µg/g]	1	< 1	99%	114%
Arsenic [µg/g]	1	< 1	98%	96%
Barium [µg/g]	0.05	< 0.05	100%	110%
Beryllium [µg/g]	0.1	< 0.1	100%	111%
Bismuth [µg/g]	0.5	< 0.5	98%	100%
Calcium [µg/g]	1	< 1	99%	103%
Cadmium [µg/g]	0.05	< 0.05	98%	100%
Cerium [µg/g]	0.006	< 0.006	107%	99%
Cobalt [µg/g]	0.3	< 0.3	96%	965
Chromium [µg/g]	0.5	< 0.5	99%	106%
Cesium [µg/g]	0.01	< 0.01	100%	99%
Copper [µg/g]	0.1	< 0.1	101%	110%
Iron [µg/g]	0.5	< 0.5	98%	91%
Gallium [µg/g]	0.03	< 0.03	100%	101%
Germanium [µg/g]	0.3	< 0.3	100%	95%
Hafnium [µg/g]	0.1	< 0.1	100%	120%
Indium [µg/g]	0.01	< 0.01	100%	109%
Potassium [µg/g]	1	< 1	100%	110%
Lanthanum [µg/g]	0.001	< 0.001	101%	99%
Lithium [µg/g]	0.1	< 0.1	99%	100%
Lutetium [µg/g]	0.001	< 0.001	96%	99%
Magnesium [µg/g]	1	< 1	100%	105%
Manganese [µg/g]	0.05	< 0.05	98%	108%
Molybdenum [µg/g]	0.5	< 0.5	101%	74%

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SGS Canada Inc.
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Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

Project : 09-1663

LR Report : **CA10063-OCT09**

Analysis	25: MDL	26: QC - Blank	27: QC - STD % Recovery	28: QC - DUP % Recovery
Sodium [µg/g]	1	< 1	102%	104%
Niobuim [µg/g]	0.7	< 0.7	100%	99%
Nickel [µg/g]	1	< 1	99%	103%
Lead [µg/g]	0.7	< 0.7	98%	110%
Phosphorus [µg/g]	5	< 5	98%	106%
Rubidium [µg/g]	0.004	< 0.004	100%	100%
Antimony [µg/g]	1	< 1	102%	100%
Scandium [µg/g]	0.2	< 0.2	100%	103%
Selenium [µg/g]	1	< 2	97%	100%
Tin [µg/g]	6	< 6	103%	94%
Strontium [µg/g]	0.01	< 0.01	100%	96%
Sulphur [µg/g]	1	< 1	---	90%
Tantalum [µg/g]	0.01	< 0.01	100%	101%
Terbium [µg/g]	0.001	< 0.001	94%	100%
Tellerium [µg/g]	0.1	< 0.1	100%	107%
Thorium [µg/g]	0.01	< 0.01	100%	99%
Titanium [µg/g]	0.2	< 0.2	104%	99%
Thallium [µg/g]	3	< 3	97%	100%
Uranium [µg/g]	0.002	< 0.002	---	97%
Vanadium [µg/g]	0.1	< 0.1	100%	109%
Tungsten [µg/g]	1	< 1	99%	100%
Yttrium [µg/g]	0.1	< 0.1	100%	110%
Ytterbium [µg/g]	0.001	---	100%	100%
Zinc [µg/g]	0.1	< 0.1	98%	103%
Zirconium [µg/g]	5	< 5	102%	105%

Ra226 subcontracted to Becquerel Labs.
* BaSO4 Calculation based on Ba values and assumes all Ba is in BaSO4 form.
** BaSO4 Calculation based on SO4 values and assumes all SO4 is in BaSO4 form.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

ANALYSIS REPORT

Becquerel Laboratories Inc.
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Mississauga, Ontario
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Phone: (905) 826-3080
FAX: (905) 826-4151

Batch: T09-01384.0

Date: 04-Nov-2009

Lakefield Research Ltd.

185 Concession St., Postal Bag 4300
Lakefield, ON, K0L 2H0

attn: Brian Graham

Phone: (705) 652-2038
FAX: (705) 652-1918

Client Ref.Oct 10066
P.O: 17820

23 water samples   Received: 06-Oct-2009

Results of Analysis

Sample	Test	Result	Units	Date	Method
SW09-QC14-1T	Ra-226	0.77	Bq/l	27-Oct-2009	ALPHA
SW09-QC14-1B	Ra-226	1.0	Bq/l	27-Oct-2009	ALPHA
SW09-QC14-2T	Ra-226	0.82	Bq/l	27-Oct-2009	ALPHA
SW09-QC14-2B	Ra-226	0.91	Bq/l	27-Oct-2009	ALPHA
SW09-QC14-3T	Ra-226	0.71	Bq/l	27-Oct-2009	ALPHA
SW09-QC14-3B	Ra-226	0.95	Bq/l	31-Oct-2009	ALPHA
SW09-QC14-4T	Ra-226	0.79	Bq/l	31-Oct-2009	ALPHA
SW09-QC14-4B	Ra-226	0.95	Bq/l	31-Oct-2009	ALPHA
PW09-QC14-1 (0-5)	Ra-226	1.8	Bq/l	31-Oct-2009	ALPHA
PW09-QC14-1 (5-10)	Ra-226	1.4	Bq/l	01-Nov-2009	ALPHA
PW09-QC14-1 (10-15)	Ra-226	0.97	Bq/l	01-Nov-2009	ALPHA
PW09-QC14-2 (0-2.5)	Ra-226	3.6	Bq/l	01-Nov-2009	ALPHA
PW09-QC14-2 (2.5-5)	Ra-226	2.8	Bq/l	01-Nov-2009	ALPHA
PW09-QC14-2 (5-7.5)	Ra-226	5.9	Bq/l	01-Nov-2009	ALPHA
PW09-QC14-2 (7.5-10)	Ra-226	6.9	Bq/l	01-Nov-2009	ALPHA
PW09-QC14-3 (0-5)	Ra-226	4.1	Bq/l	01-Nov-2009	ALPHA
PW09-QC14-3 (5-10)	Ra-226	3.4	Bq/l	01-Nov-2009	ALPHA
PW09-QC14-3 (10-15)	Ra-226	2.6	Bq/l	01-Nov-2009	ALPHA
PW09-QC14-3 (15-20)	Ra-226	2.5	Bq/l	01-Nov-2009	ALPHA
PW09-QC14-4 (0-5)	Ra-226	4.8	Bq/l	01-Nov-2009	ALPHA
PW09-QC14-4 (5-10)	Ra-226	1.6	Bq/l	01-Nov-2009	ALPHA
PW09-QC14-4 (10-15)	Ra-226	2.2	Bq/l	01-Nov-2009	ALPHA
PW09-QC14-4 (15-20)	Ra-226	0.42	Bq/l	01-Nov-2009	ALPHA

Becquerel LABORATORIES

ANALYSIS REPORT

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6790 Kitimat Rd., Unit 4
Mississauga, Ontario
Canada, L5N 5L9

Phone: (905) 826-3080
FAX: (905) 826-4151

Batch: T09-01384.0

Date: 04-Nov-2009

Methods: ALPHA BQ-RAD-ALPHA alpha-particle spectrometry MDL 0.01 Bq/l

Units: Bq/l Becquerels per litre

These results relate only to the samples analysed and only to the items tested.
These results have not been corrected for blanks

04-Nov-2009 approved by: _______________
Donald D. Burgess PhD
Senior Scientist, Division Supervisor

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October 14, 2009

Date Rec. : 01 October 2009
LR Report : **CA10066-OCT09**
Project : 09-1663

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	13: PW09-QC14-1 (0-5)	14: PW09-QC14-1 (5-10)	15: PW09-QC14-1 (10-15)	16: PW09-QC14-2 (0-2.5)	17: PW09-QC14-2 (2.5-5)
Sample Date & Time					27-Sep-09	27-Sep-09	29-Sep-09	28-Sep-09	28-Sep-09
Sulphate [mg/L]	02-Oct-09	19:39	06-Oct-09	14:20	---	---	1500	32	12
Tot. Suspended Solids [mg/L]	05-Oct-09	10:24	06-Oct-09	12:15	---	---	---	---	---
Dissolved Organic Carbon [mg/L]	02-Oct-09	10:00	06-Oct-09	13:53	---	---	4.7	28.0	18.3
Dissolved Inorganic Carbon [mg/L]	05-Oct-09	14:35	07-Oct-09	12:41	---	---	1.0	< 1.0	< 1.0
Total Organic Carbon [mg/L]	02-Oct-09	10:00	05-Oct-09	13:40	---	---	---	---	---
Acidity [mg/L as CaCO3]	02-Oct-09	15:00	08-Oct-09	09:53	---	---	49	21	15
Hardness [mg/L as CaCO3]	05-Oct-09	09:00	05-Oct-09	13:21	731	1294	1335	26.2	16.9
Aluminum [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	< 0.01	< 0.01	< 0.01	< 0.01	0.03
Arsenic [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.0082	0.0102	0.0064	0.0064	0.0084
Barium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.0577	0.0283	0.0212	0.309	0.308
Beryllium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002
Boron [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.0048	0.0107	0.0138	0.0054	0.0047
Bismuth [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	< 0.00001	< 0.00001	0.00008	0.00003	0.00024
Calcium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:21	290	516	532	8.79	5.68
Cadmium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.000012	0.000050	0.000118	0.000055	< 0.000003
Cobalt [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.0154	0.0367	0.0438	0.00521	0.000917
Chromium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Copper [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	< 0.0005	0.0008	0.0012	0.0043	0.0025
Iron [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	63.9	40.0	24.3	0.03	0.52
Potassium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	1.21	1.34	1.49	0.34	0.40
Lithium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	0.002	0.002	< 0.002	< 0.002	< 0.002
Magnesium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	1.63	1.48	1.37	1.02	0.664

OnLine LIMS

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LR Report : **CA10066-OCT09**

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	13: PW09-QC14-1 (0-5)	14: PW09-QC14-1 (5-10)	15: PW09-QC14-1 (10-15)	16: PW09-QC14-2 (0-2.5)	17: PW09-QC14-2 (2.5-5)
Manganese [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.771	0.503	0.346	0.282	0.133
Molybdenum [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.00589	0.0119	0.00918	0.00029	0.00133
Sodium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	1.77	2.04	2.08	2.35	1.98
Nickel [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.0050	0.0172	0.0173	0.0044	0.0012
Phosphorus [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	< 0.01	< 0.01	< 0.01	< 0.01	0.01
Lead [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.00069	0.00078	0.00202	0.0242	0.00596
Sulphur [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	242	396	399	8.28	3.87
Antimony [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	< 0.0002	< 0.0002	< 0.0002	0.0002	0.0006
Selenium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Silica [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	8.09	10.3	10.3	1.23	1.71
Tin [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	< 0.00001	0.00004	0.00008	0.00004	< 0.00001
Strontium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:18	0.149	0.260	0.266	0.0205	0.0154
Titanium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.0006	0.0007	0.0007	0.0003	0.0062
Thallium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Uranium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.0136	0.0589	0.0445	0.000946	0.000524
Vanadium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.00010	0.00011	0.00013	0.00007	0.00013
Zinc [mg/L]	02-Oct-09	14:45	05-Oct-09	13:18	0.011	0.039	0.041	0.005	0.003

Groundwater samples are field filtered
Ra226 subcontracted to Becquerel Labs.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

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October 14, 2009

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Project : 09-1663

CERTIFICATE OF ANALYSIS

Final Report

Analysis	**18: PW09-QC14-2 (5-7.5)**	**19: PW09-QC14-2 (7.5-10)**	**20: PW09-QC14-3 (0-5)**	**21: PW09-QC14-3 (5-10)**	**22: PW09-QC14-3 (10-15)**	**23: PW09-QC14-3 (15-20)**	**24: PW09-QC14-4 (0-5)**	**25: PW09-QC14-4 (5-10)**	**26: PW09-QC14-4 (10-15)**	**27: PW09-QC14-4 (15-20)**
Sample Date & Time	28-Sep-09	28-Sep-09	29-Sep-09	29-Sep-09	29-Sep-09	29-Sep-09	29-Sep-09	29-Sep-09	29-Sep-09	29-Sep-09
Sulphate [mg/L]	12	---	5.6	6.8	18	240	560	1400	1400	1400
Tot. Suspended Solids [mg/L]	---	---	---	---	---	---	---	---	---	---
Dissolved Organic Carbon [mg/L]	17.9	---	3.5	3.2	2.8	3.8	9.3	6.6	7.3	4.0
Dissolved Inorganic Carbon [mg/L]	< 1.0	---	2.0	3.0	4.7	3.1	< 1.0	4.7	3.1	5.9
Total Organic Carbon [mg/L]	---	---	---	---	---	---	---	---	---	---
Acidity [mg/L as CaCO3]	16	---	6	< 4	< 4	< 4	19	< 4	---	---
Hardness [mg/L as CaCO3]	17.9	19.1	18.0	24.5	42.8	250	512	1362	1335	1310
Aluminum [mg/L]	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.04	< 0.01
Arsenic [mg/L]	0.0066	0.0066	0.0026	0.0025	0.0040	0.0042	0.0050	0.0054	0.0026	0.0027
Barium [mg/L]	0.519	0.499	0.333	0.233	0.131	0.0762	0.231	0.0657	0.0328	0.0197
Beryllium [mg/L]	< 0.00002	< 0.00002	0.00013	0.00005	0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002
Boron [mg/L]	0.0051	0.0044	0.0026	0.0070	0.0121	0.0162	0.0220	0.0944	0.0802	0.0387
Bismuth [mg/L]	0.00006	< 0.00001	0.00012	0.00004	0.00001	0.00001	0.00005	0.00002	0.00001	0.00003
Calcium [mg/L]	6.06	6.44	6.12	8.51	15.5	97.4	195	536	527	519
Cadmium [mg/L]	0.000005	0.000006	0.000112	0.000043	0.000034	0.000086	0.000029	0.000016	0.000017	0.000015
Cobalt [mg/L]	0.000766	0.000876	0.00189	0.00766	0.00912	0.0123	0.00473	0.00237	0.00186	0.00185
Chromium [mg/L]	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Copper [mg/L]	0.0015	0.0007	< 0.0005	< 0.0005	< 0.0005	< 0.0005	0.0009	0.0007	0.0006	0.0008
Iron [mg/L]	2.46	6.07	7.18	6.88	5.66	7.35	23.5	1.62	0.41	0.26
Potassium [mg/L]	0.62	0.53	0.37	0.50	0.60	0.90	0.65	1.06	0.94	0.92
Lithium [mg/L]	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.002	0.002	< 0.002	< 0.002
Magnesium [mg/L]	0.675	0.734	0.670	0.801	0.980	1.78	6.05	5.49	4.43	3.52

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LR Report : **CA10066-OCT09**

Analysis	18: PW09-QC14-2 (5-7.5)	19: PW09-QC14-2 (7.5-10)	20: PW09-QC14-3 (0-5)	21: PW09-QC14-3 (5-10)	22: PW09-QC14-3 (10-15)	23: PW09-QC14-3 (15-20)	24: PW09-QC14-4 (0-5)	25: PW09-QC14-4 (5-10)	26: PW09-QC14-4 (10-15)	27: PW09-QC14-4 (15-20)
Manganese [mg/L]	0.133	0.146	0.143	0.161	0.191	0.249	1.27	0.400	0.352	0.251
Molybdenum [mg/L]	0.00107	0.00241	0.00045	0.00042	0.00155	0.00615	0.00339	0.0289	0.0291	0.0149
Sodium [mg/L]	1.79	1.51	1.30	1.20	1.36	1.63	2.05	2.00	1.94	1.80
Nickel [mg/L]	0.0012	0.0011	0.0010	0.0019	0.0020	0.0039	0.0025	0.0020	0.0018	0.0019
Phosphorus [mg/L]	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.02	< 0.01	0.02	< 0.01
Lead [mg/L]	0.00098	0.00018	0.00029	0.00023	0.00027	0.00042	0.00043	0.00047	0.00044	0.00059
Sulphur [mg/L]	3.61	4.46	1.67	2.21	5.91	69.9	155	391	387	385
Antimony [mg/L]	0.0004	0.0005	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	0.0003	0.0003	< 0.0002
Selenium [mg/L]	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.002	< 0.001	< 0.001	< 0.001	0.002
Silica [mg/L]	2.15	3.04	5.18	7.70	8.81	8.23	4.59	3.66	2.45	3.95
Tin [mg/L]	< 0.00001	< 0.00001	< 0.00001	< 0.00001	0.00005	0.00011	0.00004	0.00006	0.00010	0.00022
Strontium [mg/L]	0.0204	0.0211	0.0170	0.0318	0.0499	0.146	0.137	0.277	0.263	0.268
Titanium [mg/L]	0.0005	0.0002	0.0003	0.0005	0.0005	0.0005	0.0004	0.0004	0.0003	0.0003
Thallium [mg/L]	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Uranium [mg/L]	0.000143	0.000072	0.000744	0.000806	0.000839	0.00957	0.0421	0.275	0.242	0.233
Vanadium [mg/L]	0.00006	0.00006	0.00019	0.00012	0.00014	0.00016	0.00013	0.00022	0.00021	0.00023
Zinc [mg/L]	0.002	0.003	0.002	0.005	0.008	0.015	0.006	0.003	0.003	0.003

Groundwater samples are field filtered
Ra226 subcontracted to Becquerel Labs.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

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CERTIFICATE OF ANALYSIS
Final Report

Analysis	5: SW09-QC14-1T	6: SW09-QC14-1B	7: SW09-QC14-2T	8: SW09-QC14-2B	9: SW09-QC14-3T	10: SW09-QC14-3B	11: SW09-QC14-4T	12: SW09-QC14-4B
Sample Date & Time	26-Sep-09	26-Sep-09	27-Sep-09	27-Sep-09	27-Sep-09	27-Sep-09	27-Sep-09	27-Sep-09
Sulphate [mg/L]	55	32	72	32	54	35	57	25
Tot. Suspended Solids [mg/L]	---	---	---	43	---	---	---	6
Dissolved Organic Carbon [mg/L]	13.3	18.5	14.4	19.4	15.1	16.0	13.4	14.2
Dissolved Inorganic Carbon [mg/L]	2.4	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Total Organic Carbon [mg/L]	---	---	---	5.3	---	---	---	5.2
Acidity [mg/L as CaCO3]	31	20	56	15	29	15	31	20
Hardness [mg/L as CaCO3]	17.1	18.3	16.9	16.6	16.7	16.9	16.8	16.9
Aluminum [mg/L]	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Arsenic [mg/L]	0.0006	0.0008	0.0006	0.0011	0.0007	0.0009	0.0006	0.0012
Barium [mg/L]	0.109	0.116	0.104	0.108	0.105	0.105	0.0989	0.109
Beryllium [mg/L]	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002
Boron [mg/L]	0.0044	0.0045	0.0045	0.0056	0.0045	0.0047	0.0043	0.0053
Bismuth [mg/L]	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001
Calcium [mg/L]	5.72	6.24	5.69	5.55	5.59	5.69	5.63	5.67
Cadmium [mg/L]	0.000023	0.000029	0.000023	0.000023	0.000021	0.000035	0.000017	0.000052
Cobalt [mg/L]	0.00304	0.00143	0.00549	0.00169	0.00246	0.00165	0.00297	0.00144
Chromium [mg/L]	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Copper [mg/L]	0.0051	0.0045	0.0038	0.0023	0.0040	0.0034	0.0030	0.0025
Iron [mg/L]	0.02	0.36	0.04	0.01	0.02	0.07	0.02	0.01
Potassium [mg/L]	0.32	0.30	0.32	0.26	0.31	0.29	0.30	0.27
Lithium [mg/L]	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Magnesium [mg/L]	0.679	0.667	0.663	0.657	0.660	0.658	0.664	0.667

OnLine LIMS

SGS Lakefield Research Limited
P.O. Box 4300 - 185 Concession St.
Lakefield - Ontario - KOL 2HO
Phone: 705-652-2000 FAX: 705-652-6365

LR Report : **CA10066-OCT09**

Analysis	**5: SW09-QC14-1T**	**6: SW09-QC14-1B**	**7: SW09-QC14-2T**	**8: SW09-QC14-2B**	**9: SW09-QC14-3T**	**10: SW09-QC14-3B**	**11: SW09-QC14-4T**	**12: SW09-QC14-4B**
Manganese [mg/L]	0.0328	0.0379	0.0288	0.0353	0.0292	0.0337	0.0272	0.0348
Molybdenum [mg/L]	0.00001	0.00002	< 0.00001	0.00002	< 0.00001	< 0.00001	< 0.00001	0.00003
Sodium [mg/L]	1.84	1.87	1.82	1.83	1.81	1.78	1.88	1.73
Nickel [mg/L]	0.0027	0.0025	0.0025	0.0024	0.0024	0.0024	0.0023	0.0026
Phosphorus [mg/L]	0.01	< 0.01	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Lead [mg/L]	0.00375	0.00604	0.00717	0.00597	0.00374	0.00642	0.00386	0.00361
Sulphur [mg/L]	4.72	5.21	4.69	4.74	4.64	4.78	4.74	4.76
Antimony [mg/L]	0.0034	0.0007	0.0077	0.0007	0.0021	0.0009	0.0027	0.0005
Selenium [mg/L]	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Silica [mg/L]	0.59	0.63	0.58	0.59	0.58	0.64	0.58	0.63
Tin [mg/L]	0.00002	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001
Strontium [mg/L]	0.0122	0.0125	0.0121	0.0120	0.0119	0.0122	0.0120	0.0122
Titanium [mg/L]	< 0.0001	< 0.0001	0.0003	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
Thallium [mg/L]	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Uranium [mg/L]	0.00107	0.000679	0.000535	0.000338	0.000489	0.000749	0.000386	0.000459
Vanadium [mg/L]	0.00004	0.00004	0.00006	0.00005	0.00005	0.00004	0.00004	0.00004
Zinc [mg/L]	0.003	0.004	0.002	0.005	0.002	0.004	0.003	0.005

Ra226 subcontracted to Becquerel Labs.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

Copy to : #1

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Env ICP-MS Metals

Project : 09-1663

October 7, 2010

Ecometrix
Attn : Erin Clyde

6800 Campobello Road, Mississauga
Canada, L5N 2L8
Phone: 905-794-2325, Fax:905-794-2338

Date Rec. : 01 October 2009
LR Report: **CA10066-OCT09**

Copy: #1

CERTIFICATE OF ANALYSIS
Final Report (QC Report)

Analysis	28: MDL	29: QC - Blank	30: QC - STD % Recovery	31: QC - DUP % Recovery
Sulphate [mg/L]	0.2	< 0.2	100%	110%
Tot. Suspended Solids [mg/L]	2	< 2	96%	83%
Dissolved Organic Carbon [mg/L]	0.2	< 0.2	105%	98%
Dissolved Inorganic Carbon [mg/L]	0.2	0.7	107%	100%
Total Organic Carbon [mg/L]	0.2	< 0.2	105%	98%
Acidity [mg/L as CaCO3]	4	< 4	98%	102%
Hardness [mg/L as CaCO3]	0.5	---	---	---
Aluminum [mg/L]	0.01	< 0.01	98%	---
Arsenic [mg/L]	0.0002	< 0.0002	106%	---
Barium [mg/L]	0.00001	< 0.00001	122%	---
Beryllium [mg/L]	0.00002	< 0.00002	104%	---
Boron [mg/L]	0.0002	< 0.0002	96%	---
Bismuth [mg/L]	0.00001	< 0.00001	109%	---
Calcium [mg/L]	0.03	< 0.03	101%	---
Cadmium [mg/L]	0.000003	0.000003	99%	---
Cobalt [mg/L]	0.000002	< 0.000002	102%	---
Chromium [mg/L]	0.0005	< 0.0005	102%	---
Copper [mg/L]	0.0005	< 0.0005	102%	---
Iron [mg/L]	0.01	< 0.01	102%	---
Potassium [mg/L]	0.01	< 0.01	98%	---
Lithium [mg/L]	0.002	< 0.002	98%	---
Magnesium [mg/L]	0.003	< 0.003	98%	---
Manganese [mg/L]	0.00001	< 0.00001	107%	---
Molybdenum [mg/L]	0.00001	< 0.00001	99%	---
Sodium [mg/L]	0.01	< 0.01	94%	---
Nickel [mg/L]	0.0001	< 0.0001	100%	---
Phosphorus [mg/L]	0.01	< 0.01	100%	---
Lead [mg/L]	0.00002	< 0.00002	106%	---

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Env ICP-MS Metals

Project : 09-1663

LR Report : **CA10066-OCT09**

Analysis	28: MDL	29: QC - Blank	30: QC - STD % Recovery	31: QC - DUP % Recovery
Sulphur [mg/L]	0.01	< 0.01	98%	---
Antimony [mg/L]	0.0002	< 0.0002	101%	---
Selenium [mg/L]	0.001	< 0.001	102%	---
Silica [mg/L]	0.01	< 0.01	104%	---
Tin [mg/L]	0.00001	< 0.00001	96%	---
Strontium [mg/L]	0.0001	< 0.0001	100%	---
Titanium [mg/L]	0.0001	< 0.0001	96%	---
Thallium [mg/L]	0.0002	< 0.0002	107%	---
Uranium [mg/L]	0.000001	0.000001	1065	---
Vanadium [mg/L]	0.00003	< 0.00003	107%	---
Zinc [mg/L]	0.001	< 0.001	104%	---

Ra226 subcontracted to Becquerel Labs.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

EcoMetrix INCORPORATED

APPENDIX 5

Mathematical Description of the Sediment Model

Equation for the surface layer of sediment:

$$\frac{\partial C}{\partial t} = \frac{g_w \cdot f_w \cdot C_w}{z} - \frac{g \cdot C}{z} + \frac{k_{ws}}{z}\left[(1 - f_w) \cdot C_w - \frac{(1-f)}{\varepsilon}C\right] + \frac{k_{ss}}{z}\left[\frac{(1-f_a) \cdot C_a}{\varepsilon_a} - \frac{(1-f)}{\varepsilon}C\right]$$

Equation for the layers of sediment below the surface:

$$\frac{\partial C}{\partial t} = \frac{g_s \cdot C_s}{z} - \frac{g \cdot C}{z} + \frac{k_{ss}}{z}\left[\frac{(1-f_s) \cdot C_s}{\varepsilon_s} - \frac{(1-f)}{\varepsilon}C\right] + \frac{k_{ss}}{z}\left[\frac{(1-f_a) \cdot C_a}{\varepsilon_a} - \frac{(1-f)}{\varepsilon}C\right]$$

The fraction of contaminant that is particulate in sediment is given by:

$$f = \frac{K_d \cdot \frac{\rho}{\varepsilon}}{1 + K_d \cdot \frac{\rho}{\varepsilon}}; \quad f_s = \frac{K_{d_s} \cdot \frac{\rho_s}{\varepsilon_s}}{1 + K_{d_s} \cdot \frac{\rho_s}{\varepsilon_s}}; \quad f_a = \frac{K_{d_a} \cdot \frac{\rho_a}{\varepsilon_a}}{1 + K_{da} \cdot \frac{\rho_a}{\varepsilon_a}}$$

The fraction of contaminant that is particulate in water is given by:

$$f_w = \frac{K_{d-w} \cdot S}{1 + K_{d-w} \cdot S}$$

The settling and burial rates are given by:

$$g = \frac{g_w \cdot S}{\rho}; \quad g_s = \frac{g_w \cdot S}{\rho_s}$$

The diffusion transport coefficients are given by:

$$k_{ws} = \frac{D}{z_{\text{int}}}; \quad k_{ss} = \frac{D_a}{z_{\text{int}_A}}$$

where;

- C is the concentration in the sediment layer (mg/L);
- C_w is the concentration in the overlying water layer (mg/L);
- q_w settling rate of particles in water column (m/s);
- g burial rate in sediment layer (m/s);
- k_{ws} water to sediment diffusive transport coefficient (m/s);
- k_{ss} sediment to sediment diffusive transport coefficient (m/s);
- f fraction of contaminant that is particulate in sediment layer ( );
- f_w fraction of contaminant that is particulate in water layer ( );
- ε porosity of sediment ( );

ρ dry bulk density of sediment (kg/L);

z thickness of sediment layer (m);

z_{int} interface thickness (m);

K_d distribution coefficient in sediment layer (L/kg);

S suspended solids concentration in water (kg/L);

D diffusion coefficient for sediment layer (m^2/s);

Subscript ”*w*” denotes water and subscripts ”*s*” and ”*a*” denote upper and lower layers, respectively.

APPENDIX H

CELL 15 WATER BALANCE AND ACIDITY ASSESSMENT

CELL 15 WATER BALANCE

GOLDER ASSOCIATES

TECHNICAL MEMORANDUM

DATE	February 10, 2011	**PROJECT No.**	10-1118-0030 (5000)
TO	Debbie Berthelot, Reclamation Manager Rio Algom Limited		
CC	Art Coggan		
FROM	Peter Merry, Shiu Kam	**EMAIL**	pmerry@golder.com

QUIRKE TMA
CELL 15 WATER BALANCE

1.0 INTRODUCTION

Golder Associates (Golder) was retained by Rio Algom Limited (Rio Algom) to complete a water balance study for Cell 15 at Quirke Tailings Management Area (TMA). The water balance was based on available historical data in order to determine seepage losses from Cell 15.

This memorandum describes the development of the water balance and calculations to estimate seepage losses from Cell 15. It also includes a discussion on current seepage from Cell 14 as compared with historical estimates prior to applying the till cover over the majority of Cell 14 in 2003.

2.0 BACKGROUND

Quirke TMA is a terraced water-covered facility consisting of five cells separated by earth and rockfill dykes founded on tailings. Water from Gravel Pit Lake flows into Cell 14 and then cascades via spillways on the internal dykes from Cell 14 to Cell 18 where water is treated and is then discharged into a series of settling ponds. Final discharge from the TMA is to the Serpent River. Aside from minor external seepage that occurs at the perimeter dams, groundwater movements are easterly towards the lowest cell (Cell 18). The cell levels drop an average of 3.5 m from west to east. A minimum water cover depth of 0.6 m was selected to safeguard the exposure of the tailings during drought conditions. Internal seepage through and under the dykes can affect the water cover on the deposited tailings. Historically, the inflow from Gravel Pit Lake has been used to maintain a stable water cover on the tailings, especially in Cell 14.

The tailings cells and internal dykes were constructed during the period of 1992 to 1995. Cell 14 has been flooded since 1993. During the initial filling of Cell 14 up to 10 L/s was estimated to flow into the old landfill south of the east arm of Dam L. Field observations suggested that the water likely entered the overburden aquifer and emerged in Cell 16 through the granular main dyke and the original rockfill main dam that were founded on the overburden. Dyke 15 was completed in 1994 followed by Dykes 16 and 17 in 1995. During the early stage of filling Cell 15 in 1995 and 1996 substantial water loss from the cell was noted. Seepage occurred through the dykes as well as through the granular overburden that underlies the tailings. Dyke seepage is typically variable depending on the nature of the deposited tailings and the configuration of the original rockfill dyke foundation. Old cross dykes that have been buried are potentially major seepage pathways as well.

Several measures have been implemented to reduce the dyke seepage. During the construction of Dyke 15, a till cut-off trench was installed at each of the known old cross-dyke locations. This was followed by the installation of till berms upstream of these locations in 1997. The berms were intended to increase the seepage pathway to reduce the risk of piping through the till blanket that was placed during initial construction. About 100 m of Dyke 14 near the north abutment was also sealed with a till berm in 1997. Upon remediation it was still evident that Cell 14 and 15 were both experiencing a greater than expected water loss due to seepage.

In 2003, Rio Algom drained Cell 14 and placed a 0.3 m thick till blanket on the upstream face of Dyke 14 and applied a silty sand diffusion barrier (also some till) to the accessible areas of the Cell. Approximately 68% of the cell was covered. This work was intended to reduce seepage loss from the Cell and to minimize the upward release of radium from the porewater in the tailings into the water cover above. Rockfill was added on the till blanket along Dyke 14 for erosion protection. Cell 14 was re-flooded in early 2004.

No water deficit problems are evident for Cells 16, 17 and 18 which are constantly recharged by the upstream cells. Following the installation of the till blanket in Cell 14, Rio Algom reported a significant reduction in seepage from Cell 14.

Several studies have been carried out to assess the hydrologic condition of the flooded cells with respect to water cover fluctuation.

- Golder Associates Ltd., 1992. "Probabilistic Assessment of the Long-Term Performance of the Quirke Mine Waste Management Area". Report to Rio Algom Limited, July 1992.
- Golder Associates Ltd., 1994. "Interim Assessment of the Hydrogeological Performance of Cell No. 14, Quirke Mine Waste Management Area". Report to Rio Algom Limited, July 1994.
- Golder Associates Ltd., 1997. "Summary of Water Budget Analyses". Technical memorandum to Rio Algom Limited, January 1997.
- Cumming Cockburn Limited, 2000. "Weather Analysis - Quirke". Report to Rio Algom Limited, February 1999.
- Cumming Cockburn Limited, 2000. "Water Budget Analysis for Quirke WMA Additional Watersheds". Report to Rio Algom Limited, May 2000.
- Rio Algom Limited, 2001. "Quirke Tailings Management Area, Cell 14, Cell 15 and Gravel Pit Lake Watershed Augmentation and Johnston Creek Diversion". September 2001.
- Golder Associates Ltd., 2002. "Water Budget Review and Remediation Options Evaluation, Cells 14 and 15 Quirke WMA". Technical memorandum to Billiton BHP, January 2002.

3.0 WATER BALANCE MODEL

This section describes the water balance model which was used to predict seepage losses from Cell 14 and Cell 15. The analysis was performed for selected time periods with reliable data. The significant inflow components to the system are direct precipitation on the pond, surface runoff from surrounding areas within the watershed, and direct inflow from Gravel Pit Lake. The outflow components from the system are evaporation from the pond surface, seepage losses through the perimeter dams and their foundations (Dams K1, K2, and J), direct discharge to Cell 16 over the Dyke No. 15 spillway, and seepage loss through Dyke 15 and its foundation.

3.1 Water Balance Parameters

The water balance model was based on available climate data, monitoring records, and historical reports. Below is a summary of the information used in the model.

Precipitation and Evaporation Data

Precipitation data was provided by Rio Algom from 1970 to 2009. The water balance analysis was completed from 2005 to 2009, after the till blanket was placed in Cell 14 and the cell was flooded. The weather data for this period was obtained from Environment Canada through the Elliot Lake Station A. Additional information on the temperature and snowfall accumulations were available for this period. A summary of the precipitation data is provided on Sheet 2 in Appendix A.

Evaporation data was collected from the report entitled "Weather Analysis - Quirke" completed by Cummings Cockburn Limited (CCL) in 1999. The evaporation data was transposed from Amos, Quebec (AES, Environment Canada, 1998) and was compared with evaporation data from the Quirke TMA. The average yearly evaporation rate for the Quirke site was 692 mm/yr. Monthly evaporation data is found on Sheet 3 in Appendix A.

Runoff from Contributing Watersheds

Figure 1 illustrates the Quirke TMA and contributing watershed areas. The watershed areas were taken from CCL (1998) and compared with areas measured from recent AutoCAD drawings. A runoff coefficient of 60% was used for the natural ground runoff surrounding the tailings facility and 100% for the pond surface. Sheet 4 in Appendix A contains the areas of the contributing watersheds for Cell 14 and Cell 15.

Flow from the Gravel Pit Lake

Rio Algom provided flow information from Gravel Pit Lake from 1990 to 2009. For the period of interest, measurements were recorded 4 to 5 times a month throughout the year which provided a good indication of the volume of water entering Cell 14. Sheet 9 in Appendix A contains the average flow rates.

Seepage

Seepage through Dams K1 & K2 and Dam J were assumed to be 2.5 L/s (Golder, 1994) and 1 L/s (assumed), respectively. No other seepage into or out of the system was included in this analysis. Sheet 8 in Appendix A contains the summary of the seepage rates. No seepage was assumed from Gravel Pit Lake to Cell 14 through Dam L due to the low hydraulic gradient. It should be noted that a portion of the seepage from Cell 14 reports to Cell 16 directly through the granular overburden at depth (Golder 1994).

Flow through the Culverts

Based on information from Denison Environmental Services, water frequently flows through the culverts on Dyke 14 but has not been allowed to flow through the culverts from Cell 15 to Cell 16 since 2005. This is an operating practice that has been implemented since 2005 to reduce the volume of water put through the system. However based on the record of water levels, it appears that the Cell 15 pond level had been above the spillway invert for short durations and discharge might have occurred.

Calculating the volume of water discharging through the culverts is very sensitive to the duration of discharge and depth of flow through the culverts. It was therefore assumed the dyke did not overflow as reported by Denison Environmental Services, which could result in a slightly higher seepage estimate than actual.

Estimates for Cell 14 seepage are therefore difficult to determine based on the limited knowledge of discharge through the active spillway on Dyke 14. Time periods with water level below the spillway were used to estimate the seepage. Results are discussed in Section 3.2.2.

3.2 Water Balance Model Results

3.2.1 Combined Cell 14 and 15

The water balance was completed on the combined Cell 14 and Cell 15 system to determine the seepage rate from Cell 15. This approach was implemented to eliminate the uncertainty with actual discharge through the culverts on Dyke 14. However, as discussed previously, the calculated seepage may not be entirely through or beneath Dyke 15 as it may be travelling through the landfill from Cell 14 and bypassing Cell 15 or through the gravel overburden that underlies the tailings.

The analysis was completed on an annual basis for 4 years as broken down below:

- October 2005 to September 2006;
- October 2006 to September 2007;
- October 2007 to September 2008; and
- October 2008 to September 2009.

The water balance for the combined Cell 14 and Cell 15 system revealed that seepage rates from Cell 15 are in the range of 37 to 51 L/s. A sensitivity analyses on the evaporation rate (+/- 10%) and natural ground runoff coefficients (+/- 10%) were completed. The results of the water balance model and sensitivity analysis are provided in Table 1.

Table 1: Calculated Seepage Rates 2005 to 2009

Year	Calculated Seepage Rates (L/s)				
	Average Conditions	+10% Evaporation	-10% Evaporation	Runoff Coefficient = 50%	Runoff Coefficient = 70%
Oct 2005 to Sept 2006	44	42	46	43	45
Oct 2006 to Sept 2007	51	49	53	50	52
Oct 2007 to Sept 2008	37	35	39	36	38
Oct 2008 to Sept 2009	47	45	49	46	48

A change in evaporation of +/- 10% equates to a change in seepage of ± 2 L/s, respectively. A change in runoff coefficient by -/+ 10% typically equates to a change in seepage of ± 1L/s. This indicates that the seepage rate is not highly sensitive to the changes in evaporation and run-off coefficients.

3.2.2 Cell 14

A water balance was completed on Cell 14 during two summer periods, each 3 months in length, when zero discharge through the spillway on Dyke 14 was observed. The results are shown on Sheet 13 in Appendix A. The average seepage loss from Cell 14 was calculated at 46 L/s. This value is not considered accurate given the performance of the cells and knowledge that there is less seepage from Cell 14 than Cell 15 as evident by the volume of water that overflows Cell 14 to Cell 15 through the culverts on Dyke 14 but there is no overflow from Cell 15 to Cell 16. To more accurately estimate the seepage from Cell 14, a longer time period with accurate discharge flows is required.

Also included on Sheet 13 is a sensitivity analysis that is based on an annual water balance and assumes various discharge rates through the culverts on Dyke 14. The results indicate that assuming zero discharge through the culverts, the seepage rate is expected to vary between 35.5 and 44.4 L/s, which is less than the calculated values discussed above on the 3 month analysis and further defends the limits of a short analysis period. The minimum calculated seepage on the annual balance of 35.5 L/s could be inferred as the actual maximum seepage rate from Cell 14 assuming near zero discharge through the culverts on Dyke 14 during the modelled year. The difference between the 35.5 L/s and the other calculated seepage rates (41.9 L/s, 43.7 L/s, and 44.4 L/s) could be actual discharge rates through the culverts on Dyke 14. Similar to the discussions presented above, the calculated seepage from Cell 14 could occur as: seepage through Dyke 14, seepage through the tailings beneath Dyke 14, deep seepage through the granular overburden beneath the tailings, and seepage through the landfill to Cell 16.

3.3 Water Balance Model Limitations

The precision of the information collected was inadequate to complete the water balance on a monthly basis. The limitations of the model are provided in the following list:

- Water levels records for the cells were available only once a month and during some months not available at all. Fluctuations in the water level can result in significant differences in the calculations of storage volume. Estimating the seepage on a monthly basis is difficult because a small change in water level of +/- centimetres can result in significant differences in volumes and therefore calculated seepage rates.
- Flow through the culverts on the active spillway from Cell 14 to Cell 15 was not available. Detailed measurements would be required to increase confidence in the modelled results.

The water balance completed on an annual basis provides a good representation of the average seepage rate because the water level fluctuations over the course of the year typically can be ignored (i.e., no net change in cell storage).

3.4 Conclusions

Based on the analysis completed, the seepage rate from the combined Cell 14 and Cell 15 is approximately 45 L/s which is consistent with historical estimates. This loss is a combination of the following:

- From Cell 14 through the landfill to Cell 16;
- From Cell 14 through the gravel overburden beneath the tailings to Cell 16;
- Through Dyke 15; and
- Beneath Dyke 15.

Of the four likely seepage pathways, those from Cell 14 bypassing to Cell 16 are likely minor as a result of the till blanket placed on Cell 14 in 2003.

The total seepage from Cell 14 is estimated on the order of 35 l/sec.

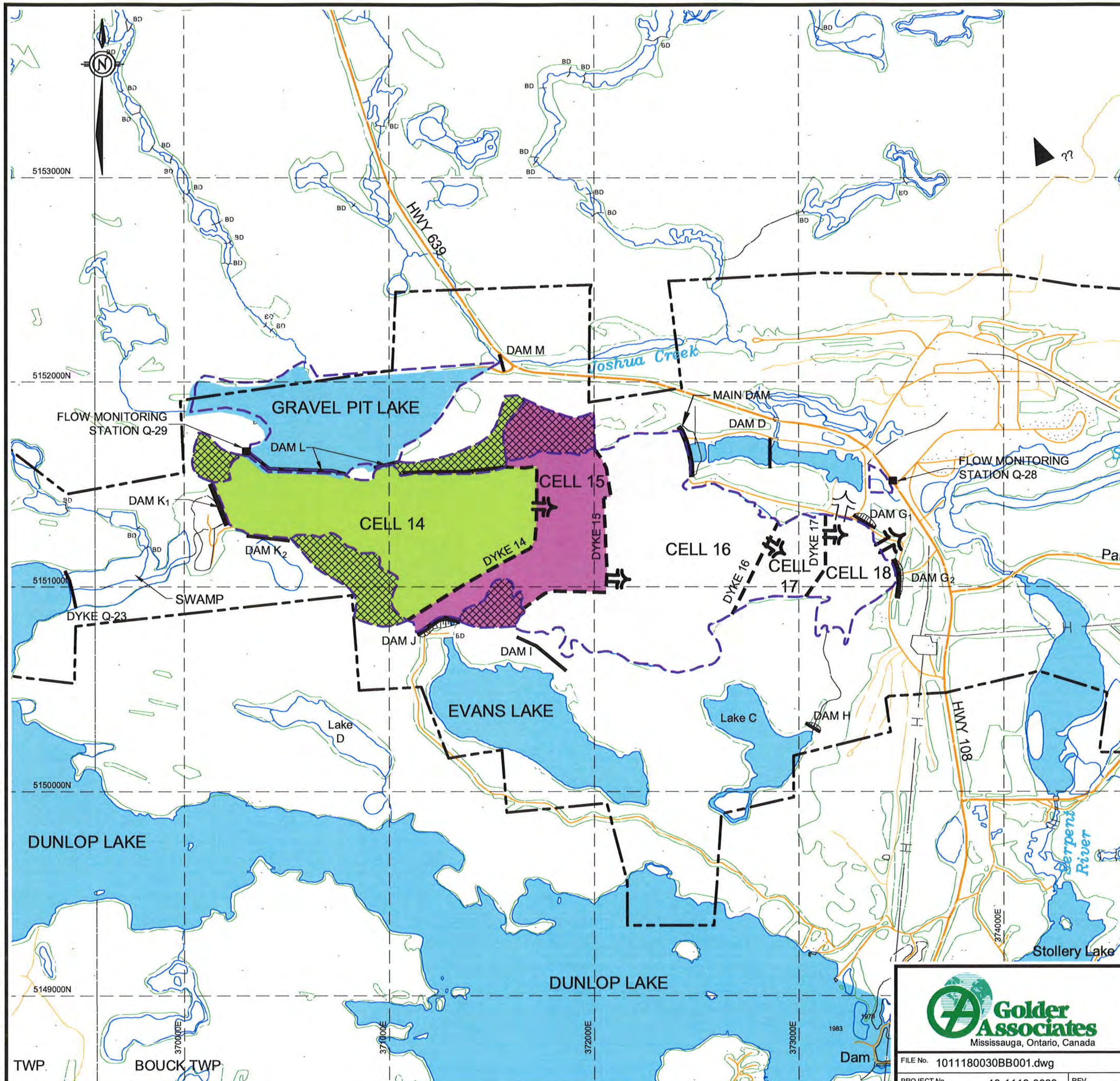
Peter Merry, P.Eng.
Geotechnical Engineer

Shiu Kam, P.Eng.
Principal

MT/WPM/SNK/dh
Attachments: Figure 1
Appendix A – Water Balance

\\mis1-s-filesrv1\data\active\2010\1118\10-1118-0030 rio algom\working files\5000 water balance quirke cell 15\final memo\10-1118-0030 (5000) quirke water balance memo final 10feb11.docx

Figures



LEGEND:

- SPILLWAY
- ROAD
- CREEK/DRAINAGE DITCH AND FLOW DIRECTION
- DAM
- INTERNAL DYKE
- TAILINGS MANAGEMENT AREA
- RIO ALGOM PROPERTY LIMITS
- NATURAL GROUND
- CELL 14 WATERSHED
- CELL 15 WATERSHED

NOTES:

1. ELEVATIONS ARE REFERENCED TO LOCAL DATUM.
2. DATUM IS UTM NAD27, ZONE 17.

REFERENCES:

1. ONTARIO BASE MAPS, SHEET No.s 2017360051400 AND 2017370051400 SCALE 1:20,000 METRIC, PROVIDED BY AGGMAP INC. ON OCTOBER 4, 2002.

400 0 400 800
SCALE 1:20,000 METRES

Golder Associates
Mississauga, Ontario, Canada

SCALE	AS SHOWN	TITLE	QUIRKE TAILINGS MANAGEMENT AREA AND CONTRIBUTING WATERSHEDS TO CELLS 14 AND 15
DATE	Jun. 7, 2010		
DESIGN	MT		
CAD	JS		
FILE No. 1011180030BB001.dwg		CHECK	WPM
PROJECT No. 10-1118-0030	REV. -	REVIEW	SK

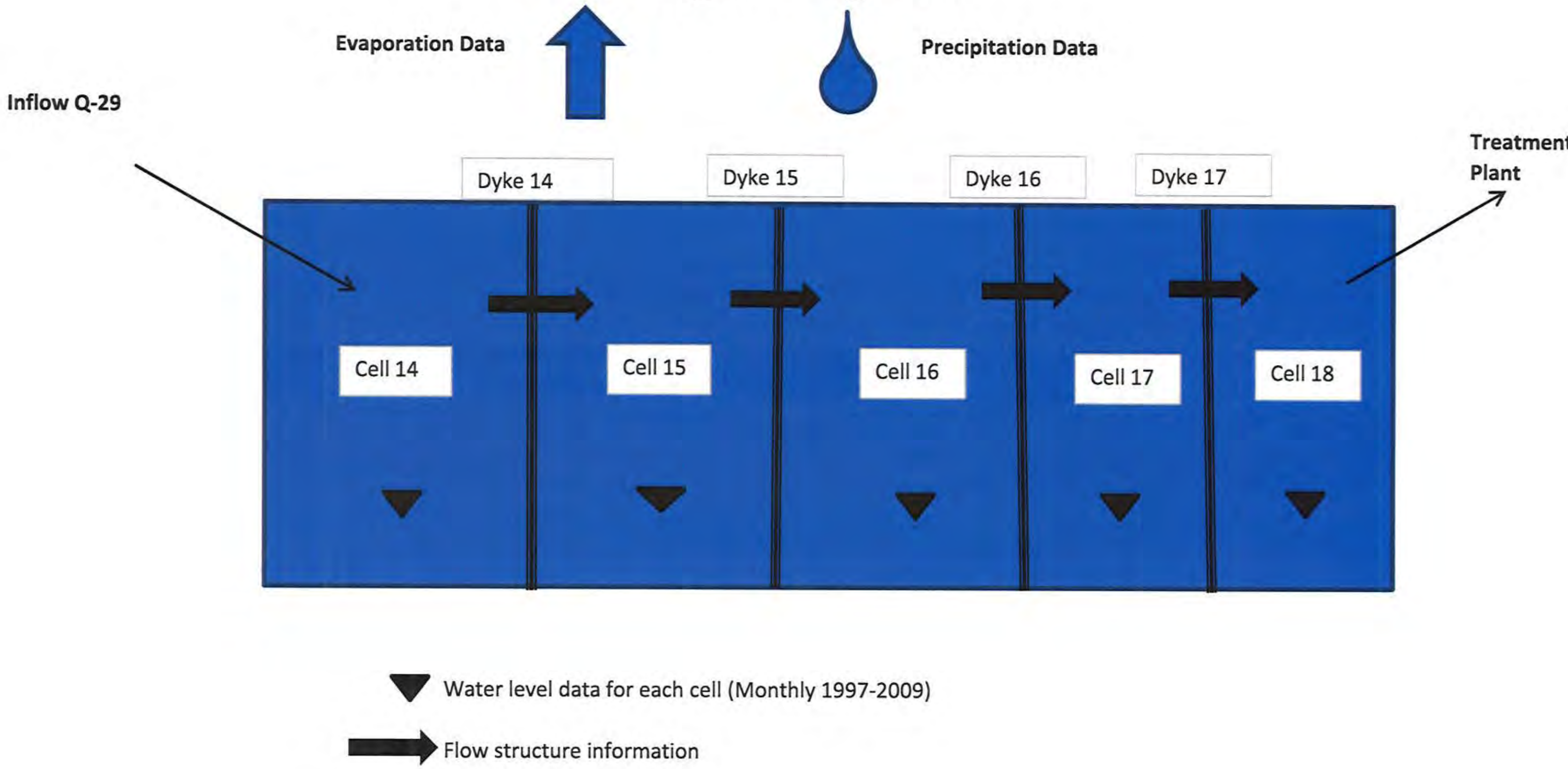
RIO ALGOM LIMITED
MILLIKAN PROPERTY

FIGURE 1

PLOT DATE: June 7, 2010
FILENAME: T:\Projects\2010\10-1118-0030 (RAL, Elliot Lake)\-BB-\1011180030BB001.dwg

APPENDIX A
Water Balance

Sheet 1
Flow Logic Diagram



	Spillway Invert (m)	Culvert Invert (m)
Dyke 14	378.51	377.77
Dyke 15	374.49	373.74
Dyke 16	370.25	369.67
Dyke 17	366.14	365.66
Dyke 18	365.30	

Reference:

1. Spillway and Culvert information provided by Rio Algom Limited on January 11, 2011. Filename "Quirke Water Balance.xls". The information is based on Surveys completed by Torrance between 2007 and 2008. The 2007 Torrance survey covered all dykes and 2008 Torrance survey covered Dykes 16 and 17 following maintenance work.

Sheet 2
Precipitation Data

Meteorological Station(s)	Elliot Lake Station A

Historical Precipitation			Factored Runoff		
			From natural ground	From ponds	Monthly runoff coefficient [1]
Month	Year	Precipitation per Month	60%	100%	
			Factored runoff used in the flow model	Factored runoff used in the flow model	Expressed as a % of accumulation
		(mm)	(mm)	(mm)	(%)
Oct	2005	69.4	41.6	69.4	100
Nov	2005	141.2	84.7	141.2	100
Dec	2005	42.9	25.7	42.9	0
Jan	2006	85.0	51.0	85.0	0
Feb	2006	60.7	36.4	60.7	0
Mar	2006	50.9	30.5	50.9	80
April	2006	65.8	39.5	65.8	100
May	2006	91.4	54.8	91.4	100
June	2006	59.8	35.9	59.8	100
July	2006	85.2	51.1	85.2	100
Aug	2006	110.0	66.0	110.0	100
Sept	2006	121.2	72.7	121.2	100
Oct	2006	111.2	66.7	111.2	100
Nov	2006	75.0	45.0	75.0	100
Dec	2006	124.1	74.5	124.1	0
Jan	2007	41.7	25.0	41.7	0
Feb	2007	21.0	12.6	21.0	0
Mar	2007	63.4	38.0	63.4	80
April	2007	71.0	42.6	71.0	100
May	2007	29.9	17.9	29.9	100
June	2007	66.2	39.7	66.2	100
July	2007	89.4	53.6	89.4	100
Aug	2007	58.0	34.8	58.0	100
Sept	2007	53.2	31.9	53.2	100
Oct	2007	149.6	89.8	149.6	100
Nov	2007	89.0	53.4	89.0	100
Dec	2007	100.2	60.1	100.2	0
Jan	2008	149.3	89.6	149.3	0
Feb	2008	79.2	47.5	79.2	0
Mar	2008	65.4	39.2	65.4	80
April	2008	122.2	73.3	122.2	100
May	2008	93.4	56.0	93.4	100
June	2008	90.4	54.2	90.4	100
July	2008	48.2	28.9	48.2	100
Aug	2008	65.0	39.0	65.0	100
Sept	2008	64.2	38.5	64.2	100
Oct	2008	56.2	33.7	56.2	100
Nov	2008	105.8	63.5	105.8	100
Dec	2008	186.4	111.8	186.4	0
Jan	2009	45.2	27.1	45.2	0
Feb	2009	78.1	46.9	78.1	0
Mar	2009	62.6	37.6	62.6	80
April	2009	92.9	55.7	92.9	100
May	2009	100.0	60.0	100.0	100
June	2009	79.4	47.6	79.4	100
July	2009	160.0	96.0	160.0	100
Aug	2009	114.0	68.4	114.0	100
Sept	2009	53.4	32.0	53.4	100
Oct	2009	182.6	109.6	182.6	100
Nov	2009	58.6	35.2	58.6	100
Dec	2009	100.5	60.3	100.5	0

Notes:
1 Runoff coefficient based on daily temperatures and accumulated snow values.

Sheet 3

Evaporation Data

Meteorological Station(s)	
	- From Amos, Quebec
	-
	-

Evaporation				
Month		Annual selected for flow modelling (mm/yr)		691.8
		Lake evaporation used in flow model		
	Pan Evaporation	Evaporation Multiplier	Monthly distribution	Factored Evaporation used in the model
	(mm)	1.00	(% of total)	(mm)
Oct	42.1	42.1	6.1	42.1
Nov	0.0	0.0	0.0	0.0
Dec	0.0	0.0	0.0	0.0
Jan	0.0	0.0	0.0	0.0
Feb	0.0	0.0	0.0	0.0
Mar	0.0	0.0	0.0	0.0
April	0.0	0.0	0.0	0.0
May	121.1	121.1	17.5	121.1
June	156.9	156.9	22.7	156.9
July	150.6	150.6	21.8	150.6
Aug	136.4	136.4	19.7	136.4
Sept	84.7	84.7	12.2	84.7
TOTAL	**691.8**	**691.8**	**100.0**	**691.8**

Notes:
1) Evaporation Data from "Weather Analysis-Quirke" (CCL, 1999)

Sheet 4
Watershed Areas

Area	Facility	Watershed Area (ha)	Watershed Area % of total	Watershed Area (ha)	Watershed Area (m^2)	Runoff source	Flow Number
1	Cell 14	86.0	26	22.0	220,000	Natural ground	R1
			74	64.0	640,000	Pond surface	R2
2	Cell 15	40.0	33	13.0	130,000	Natural ground	R3
			68	27.0	270,000	Pond surface	R4
3	Cell 16	102.0	26	27.0	270,000	Natural ground	R5
			74	75.0	750,000	Pond surface	R6
4	Cell 17	19.0	37	7.0	70,000	Natural ground	R7
			63	12.0	120,000	Pond surface	R8
5	Cell 18	45.0	69	31.0	310,000	Natural ground	R9
			31	14.0	140,000	Pond surface	R10
Total Area		**292.0**			**1,920,000**	**Pond surface**	
					1,000,000	**Natural ground**	

Notes:
Catchment areas taken from "Dam Breach Analysis for Quirke WMA System" (CCL, 1999)

Sheet 5

Flows Associated with Runoff from Precipitation

Subwatershed: Cell 14

		Factored Precipitation (mm)			Runoff #	Runoff Flow (m^3 / month) – Cell 14 Natural Ground				Runoff Flow (m^3 / month) – Cell 14 Pond Surface			
					Area (m^2)	220,000				640,000			
Month	Year	From natural ground	From ponds	Monthly runoff expressed as % of the total accumu-lation (If less than 100% it is because of freeze-up)	Month	Available runoff (area x factored runoff)	Total available runoff (available plus runoff not discharged the previous month)	R1 Actual monthly runoff (total available x % runoff)	Left over each month (total available -actual runoff)	Available runoff (area x factored runoff)	Total available runoff (available plus runoff not discharged the previous month)	R2 Actual monthly runoff (total available x % runoff)	Left over each month (total available -actual runoff)
Oct	2005	41.6	69.4	100	Oct	9,161	9,161	9,161	0	44,416	44,416	44,416	0
Nov	2005	84.7	141.2	100	Nov	18,640	18,640	18,640	0	90,374	90,374	90,374	0
Dec	2005	25.7	42.9	0	Dec	5,663	5,663	0	5,663	27,456	27,456	0	27,456
Jan	2006	51.0	85.0	0	Jan	11,220	16,883	0	16,883	54,400	81,856	0	81,856
Feb	2006	36.4	60.7	0	Feb	8,012	24,895	0	24,895	38,848	120,704	0	120,704
Mar	2006	30.5	50.9	80	March	6,719	31,614	25,291	6,323	32,576	153,280	122,624	30,656
April	2006	39.5	65.8	100	April	8,686	15,008	15,008	0	42,112	72,768	72,768	0
May	2006	54.8	91.4	100	May	12,065	12,065	12,065	0	58,496	58,496	58,496	0
June	2006	35.9	59.8	100	June	7,894	7,894	7,894	0	38,272	38,272	38,272	0
July	2006	51.1	85.2	100	July	11,246	11,246	11,246	0	54,528	54,528	54,528	0
Aug	2006	66.0	110.0	100	Aug	14,520	14,520	14,520	0	70,400	70,400	70,400	0
Sept	2006	72.7	121.2	100	Sept	15,998	15,998	15,998	0	77,568	77,568	77,568	0
Oct	2006	66.7	111.2	100	Oct	14,678	14,678	14,678	0	71,168	71,168	71,168	0
Nov	2006	45.0	75.0	100	Nov	9,900	9,900	9,900	0	48,000	48,000	48,000	0
Dec	2006	74.5	124.1	0	Dec	16,381	16,381	0	16,381	79,424	79,424	0	79,424
Jan	2007	25.0	41.7	0	Jan	5,504	21,886	0	21,886	26,688	106,112	0	106,112
Feb	2007	12.6	21.0	0	Feb	2,772	24,658	0	24,658	13,440	119,552	0	119,552
Mar	2007	38.0	63.4	80	March	8,369	33,026	26,421	6,605	40,576	160,128	128,102	32,026
April	2007	42.6	71.0	100	April	9,372	15,977	15,977	0	45,440	77,466	77,466	0
May	2007	17.9	29.9	100	May	3,947	3,947	3,947	0	19,136	19,136	19,136	0
June	2007	39.7	66.2	100	June	8,738	8,738	8,738	0	42,368	42,368	42,368	0
July	2007	53.6	89.4	100	July	11,801	11,801	11,801	0	57,216	57,216	57,216	0
Aug	2007	34.8	58.0	100	Aug	7,656	7,656	7,656	0	37,120	37,120	37,120	0
Sept	2007	31.9	53.2	100	Sept	7,022	7,022	7,022	0	34,048	34,048	34,048	0
Oct	2007	89.8	149.6	100	Oct	19,747	19,747	19,747	0	95,744	95,744	95,744	0
Nov	2007	53.4	89.0	100	Nov	11,748	11,748	11,748	0	56,960	56,960	56,960	0
Dec	2007	60.1	100.2	0	Dec	13,226	13,226	0	13,226	64,128	64,128	0	64,128
Jan	2008	89.6	149.3	0	Jan	19,708	32,934	0	32,934	95,552	159,680	0	159,680
Feb	2008	47.5	79.2	0	Feb	10,454	43,388	0	43,388	50,688	210,368	0	210,368
Mar	2008	39.2	65.4	80	March	8,633	52,021	41,617	10,404	41,856	252,224	201,779	50,445
April	2008	73.3	122.2	100	April	16,130	26,535	26,535	0	78,208	128,653	128,653	0
May	2008	56.0	93.4	100	May	12,329	12,329	12,329	0	59,776	59,776	59,776	0
June	2008	54.2	90.4	100	June	11,933	11,933	11,933	0	57,856	57,856	57,856	0
July	2008	28.9	48.2	100	July	6,362	6,362	6,362	0	30,848	30,848	30,848	0
Aug	2008	39.0	65.0	100	Aug	8,580	8,580	8,580	0	41,600	41,600	41,600	0
Sept	2008	38.5	64.2	100	Sept	8,474	8,474	8,474	0	41,088	41,088	41,088	0
Oct	2008	33.7	56.2	100	Oct	7,418	7,418	7,418	0	35,968	35,968	35,968	0
Nov	2008	63.5	105.8	100	Nov	13,966	13,966	13,966	0	67,712	67,712	67,712	0
Dec	2008	111.8	186.4	0	Dec	24,605	24,605	0	24,605	119,296	119,296	0	119,296
Jan	2009	27.1	45.2	0	Jan	5,966	30,571	0	30,571	28,928	148,224	0	148,224
Feb	2009	46.9	78.1	0	Feb	10,309	40,880	0	40,880	49,984	198,208	0	198,208
Mar	2009	37.6	62.6	80	March	8,263	49,144	39,315	9,829	40,064	238,272	190,618	47,654
April	2009	55.7	92.9	100	April	12,263	22,092	22,092	0	59,456	107,110	107,110	0
May	2009	60.0	100.0	100	May	13,200	13,200	13,200	0	64,000	64,000	64,000	0
June	2009	47.6	79.4	100	June	10,481	10,481	10,481	0	50,816	50,816	50,816	0
July	2009	96.0	160.0	100	July	21,120	21,120	21,120	0	102,400	102,400	102,400	0
Aug	2009	68.4	114.0	100	Aug	15,048	15,048	15,048	0	72,960	72,960	72,960	0
Sept	2009	32.0	53.4	100	Sept	7,049	7,049	7,049	0	34,176	34,176	34,176	0
Oct	2009	109.6	182.6	100	Oct	24,103	24,103	24,103	0	116,864	116,864	116,864	0
Nov	2009	35.2	58.6	100	Nov	7,735	7,735	7,735	0	37,504	37,504	37,504	0
Dec	2009	60.3	100.5	0	Dec	13,266	13,266	0	13,266	64,320	64,320	0	64,320

Sheet 6

Flows Associated with Runoff from Precipitation

Subwatershed: Cell 15

Month	Year	Factored Precipitation (mm) From natural ground	Factored Precipitation (mm) From ponds	Monthly runoff expressed as % of the total accumu-lation (If less than 100% it is because of freeze-up)
Oct	2005	41.6	69.4	100
Nov	2005	84.7	141.2	100
Dec	2005	25.7	42.9	0
Jan	2006	51.0	85.0	0
Feb	2006	36.4	60.7	0
Mar	2006	30.5	50.9	80
April	2006	39.5	65.8	100
May	2006	54.8	91.4	100
June	2006	35.9	59.8	100
July	2006	51.1	85.2	100
Aug	2006	66.0	110.0	100
Sept	2006	72.7	121.2	100
Oct	2006	66.7	111.2	100
Nov	2006	45.0	75.0	100
Dec	2006	74.5	124.1	0
Jan	2007	25.0	41.7	0
Feb	2007	12.6	21.0	0
Mar	2007	38.0	63.4	80
April	2007	42.6	71.0	100
May	2007	17.9	29.9	100
June	2007	39.7	66.2	100
July	2007	53.6	89.4	100
Aug	2007	34.8	58.0	100
Sept	2007	31.9	53.2	100
Oct	2007	89.8	149.6	100
Nov	2007	53.4	89.0	100
Dec	2007	60.1	100.2	0
Jan	2008	89.6	149.3	0
Feb	2008	47.5	79.2	0
Mar	2008	39.2	65.4	80
April	2008	73.3	122.2	100
May	2008	56.0	93.4	100
June	2008	54.2	90.4	100
July	2008	28.9	48.2	100
Aug	2008	39.0	65.0	100
Sept	2008	38.5	64.2	100
Oct	2008	33.7	56.2	100
Nov	2008	63.5	105.8	100
Dec	2008	111.8	186.4	0
Jan	2009	27.1	45.2	0
Feb	2009	46.9	78.1	0
Mar	2009	37.6	62.6	80
April	2009	55.7	92.9	100
May	2009	60.0	100.0	100
June	2009	47.6	79.4	100
July	2009	96.0	160.0	100
Aug	2009	68.4	114.0	100
Sept	2009	32.0	53.4	100
Oct	2009	109.6	182.6	100
Nov	2009	35.2	58.6	100
Dec	2009	60.3	100.5	0

	Runoff Flow (m^3 / month)							
Runoff	Cell 15 Natural Ground				Cell 15 Pond Surface			
Area (m^2)	130,000				270,000			
Month	Available runoff (area x factored runoff)	Total available runoff (available plus runoff not discharged the previous month)	R3 Actual monthly runoff (total available x % runoff)	Left over each month (total available -actual runoff)	Available runoff (area x factored runoff)	Total available runoff (available plus runoff not discharged the previous month)	R4 Actual monthly runoff (total available x % runoff)	Left over each month (total available -actual runoff)
Oct	5,413	5,413	5,413	0	18,738	18,738	18,738	0
Nov	11,014	11,014	11,014	0	38,127	38,127	38,127	0
Dec	3,346	3,346	0	3,346	11,583	11,583	0	11,583
Jan	6,630	9,976	0	9,976	22,950	34,533	0	34,533
Feb	4,735	14,711	0	14,711	16,389	50,922	0	50,922
March	3,970	18,681	14,945	3,736	13,743	64,665	51,732	12,933
April	5,132	8,869	8,869	0	17,766	30,699	30,699	0
May	7,129	7,129	7,129	0	24,678	24,678	24,678	0
June	4,664	4,664	4,664	0	16,146	16,146	16,146	0
July	6,646	6,646	6,646	0	23,004	23,004	23,004	0
Aug	8,580	8,580	8,580	0	29,700	29,700	29,700	0
Sept	9,454	9,454	9,454	0	32,724	32,724	32,724	0
Oct	8,674	8,674	8,674	0	30,024	30,024	30,024	0
Nov	5,850	5,850	5,850	0	20,250	20,250	20,250	0
Dec	9,680	9,680	0	9,680	33,507	33,507	0	33,507
Jan	3,253	12,932	0	12,932	11,259	44,766	0	44,766
Feb	1,638	14,570	0	14,570	5,670	50,436	0	50,436
March	4,945	19,516	15,612	3,903	17,118	67,554	54,043	13,511
April	5,538	9,441	9,441	0	19,170	32,681	32,681	0
May	2,332	2,332	2,332	0	8,073	8,073	8,073	0
June	5,164	5,164	5,164	0	17,874	17,874	17,874	0
July	6,973	6,973	6,973	0	24,138	24,138	24,138	0
Aug	4,524	4,524	4,524	0	15,660	15,660	15,660	0
Sept	4,150	4,150	4,150	0	14,364	14,364	14,364	0
Oct	11,669	11,669	11,669	0	40,392	40,392	40,392	0
Nov	6,942	6,942	6,942	0	24,030	24,030	24,030	0
Dec	7,816	7,816	0	7,816	27,054	27,054	0	27,054
Jan	11,645	19,461	0	19,461	40,311	67,365	0	67,365
Feb	6,178	25,639	0	25,639	21,384	88,749	0	88,749
March	5,101	30,740	24,592	6,148	17,658	106,407	85,126	21,281
April	9,532	15,680	15,680	0	32,994	54,275	54,275	0
May	7,285	7,285	7,285	0	25,218	25,218	25,218	0
June	7,051	7,051	7,051	0	24,408	24,408	24,408	0
July	3,760	3,760	3,760	0	13,014	13,014	13,014	0
Aug	5,070	5,070	5,070	0	17,550	17,550	17,550	0
Sept	5,008	5,008	5,008	0	17,334	17,334	17,334	0
Oct	4,384	4,384	4,384	0	15,174	15,174	15,174	0
Nov	8,252	8,252	8,252	0	28,566	28,566	28,566	0
Dec	14,539	14,539	0	14,539	50,328	50,328	0	50,328
Jan	3,526	18,065	0	18,065	12,204	62,532	0	62,532
Feb	6,092	24,157	0	24,157	21,087	83,619	0	83,619
March	4,883	29,039	23,232	5,808	16,902	100,521	80,417	20,104
April	7,246	13,054	13,054	0	25,083	45,187	45,187	0
May	7,800	7,800	7,800	0	27,000	27,000	27,000	0
June	6,193	6,193	6,193	0	21,438	21,438	21,438	0
July	12,480	12,480	12,480	0	43,200	43,200	43,200	0
Aug	8,892	8,892	8,892	0	30,780	30,780	30,780	0
Sept	4,165	4,165	4,165	0	14,418	14,418	14,418	0
Oct	14,243	14,243	14,243	0	49,302	49,302	49,302	0
Nov	4,571	4,571	4,571	0	15,822	15,822	15,822	0
Dec	7,839	7,839	0	7,839	27,135	27,135	0	27,135

Sheet 7
Evaporation Losses

Lake Evaporation (mm)
42.1
0.0
0.0
0.0
0.0
0.0
0.0
121.1
156.9
150.6
136.4
84.7
691.8

Evaporation Losses (m^3 / month)			
Location	**From Cell 14**	**From Cell 15**	**Total**
Flow #	**E1**	**E2**	
Area (m^2)	640,000	270,000	
Oct	26,944	11,367	38,311
Nov	0	0	0
Dec	0	0	0
Jan	0	0	0
Feb	0	0	0
Mar	0	0	0
April	0	0	0
May	77,504	32,697	110,201
June	100,416	42,363	142,779
July	96,384	40,662	137,046
Aug	87,296	36,828	124,124
Sept	54,208	22,869	77,077
TOTAL	**442,752**	**186,786**	**629,538**

Sheet 8

Seepage Flows

Location		Through Dam K1 and K2[1]	Through Dam J	Total
Seepage #		S1	S2	
Seepage estimate (m^3/day)		216	86	
Days/ month	Month	Seepage (m^3 / month)		
31	Oct	6,696	2,678	9,374
30	Nov	6,480	2,592	9,072
31	Dec	6,696	2,678	9,374
31	Jan	6,696	2,678	9,374
28	Feb	6,048	2,419	8,467
31	Mar	6,696	2,678	9,374
30	April	6,480	2,592	9,072
31	May	6,696	2,678	9,374
30	June	6,480	2,592	9,072
31	July	6,696	2,678	9,374
31	Aug	6,696	2,678	9,374
30	Sept	6,480	2,592	9,072
365	TOTAL	**78,840**	**31,536**	**110,376**

Notes: 1 Seepage through Dam based on "Interim Assessment of Hydrogeologic Performance of Cell No. 14" (Golder, 1994)

Sheet 9
Flows from Gravel Pit Lake

Volumetric Flows into Cell 14 from Gravel Pit Lake

Month	Days Per Month	Year	Average Flow Rate[1] (L/s)	Average Flow Volume (m³) F1
Oct	31	2005	23.42	62,728
Nov	30	2005	25.00	64,800
Dec	31	2005	25.00	66,960
Jan	31	2006	25.00	66,960
Feb	28	2006	25.00	60,480
Mar	31	2006	56.25	150,660
April	30	2006	87.50	226,800
May	31	2006	33.00	88,387
June	30	2006	77.50	200,880
July	31	2006	32.40	86,780
Aug	31	2006	23.50	62,942
Sept	30	2006	17.55	45,483
Oct	31	2006	52.00	139,277
Nov	30	2006	97.50	252,720
Dec	31	2006	31.25	83,700
Jan	31	2007	1.00	2,678
Feb	28	2007	0.00	0
Mar	31	2007	25.00	66,960
April	30	2007	70.00	181,440
May	31	2007	28.48	76,270
June	30	2007	33.00	85,536
July	31	2007	48.00	128,563
Aug	31	2007	42.50	113,832
Sept	30	2007	9.25	23,976
Oct	31	2007	0.00	0
Nov	30	2007	31.00	80,352
Dec	31	2007	7.50	20,088
Jan	31	2008	46.80	125,349
Feb	28	2008	46.80	113,219
Mar	31	2008	14.00	37,498
April	30	2008	19.20	49,766
May	31	2008	13.50	36,158
June	30	2008	17.50	45,360
July	31	2008	40.00	107,136
Aug	31	2008	40.00	107,136
Sept	30	2008	22.90	59,346
Oct	31	2008	32.75	87,718
Nov	30	2008	35.00	90,720
Dec	31	2008	28.00	74,995
Jan	31	2009	0.00	0
Feb	28	2009	0.00	0
Mar	31	2009	50.00	133,920
April	30	2009	25.00	64,800
May	31	2009	40.00	107,136
June	30	2009	45.00	116,640
July	31	2009	37.50	100,440
Aug	31	2009	35.00	93,744
Sept	30	2009	32.50	84,240
Oct	31	2009	30.00	80,339
Nov	30	2009	35.00	90,720
Dec	31	2009	33.75	90,396

Notes:
1. Data provided by Rio Algom. Filename: "Quirke Water Balance.xls"

Sheet 10

Historical Water Levels

Area of Cell 14	**640,000**	**m^2**
Area of Cell 15	**270,000**	**m^2**

Month	Year	Water Level Elevation in Cell 14[1]	Change in Water Storage in Cell 14	Water Level Elevation in Cell 15[1]	Change in Water Storage in Cell 15
		(m)	(m^3)	(m)	(m^3)
Oct	2005	377.63	0	373.23	0
Nov	2005	377.63	0	373.24	3,915
Dec	2005	377.60	-19,200	373.27	7,425
Jan	2006	377.60	0	373.30	8,100
Feb	2006	377.60	0	373.30	0
Mar	2006	378.10	320,000	373.30	0
April	2006	378.20	64,000	374.10	216,000
May	2006	378.18	-12,800	374.08	-5,400
June	2006	377.93	-160,000	373.97	-28,800
July	2006	377.93	0	373.87	-28,800
Aug	2006	377.80	-83,200	373.76	-28,800
Sept	2006	377.70	-64,000	373.60	-43,200
Oct	2006	377.58	-76,800	373.50	-27,000
Nov	2006	377.55	-19,200	373.43	-18,900
Dec	2006	377.60	32,000	373.40	-8,100
Jan	2007	377.60	0	374.06	178,200
Feb	2007	377.60	0	373.90	-43,200
Mar	2007	377.80	128,000	373.78	-32,400
April	2007	377.80	0	373.79	2,700
May	2007	377.80	0	373.82	8,100
June	2007	377.64	-102,400	373.60	-59,400
July	2007	377.60	-25,600	373.40	-54,000
Aug	2007	377.57	-19,200	373.24	-43,200
Sept	2007	377.47	-64,000	373.08	-43,200
Oct	2007	377.51	25,600	373.06	-5,400
Nov	2007	377.54	19,200	373.14	21,600
Dec	2007	377.50	-25,600	373.10	-10,800
Jan	2008	377.50	0	373.10	0
Feb	2008	377.50	0	373.10	0
Mar	2008	377.50	0	373.10	0
April	2008	377.60	64,000	374.10	270,000
May	2008	377.64	25,600	374.05	-13,500
June	2008	377.52	-76,800	373.91	-37,800
July	2008	377.46	-38,400	373.77	-37,800
Aug	2008	377.53	44,800	373.77	0
Sept	2008	377.48	-32,000	373.52	-67,500
Oct	2008	377.46	-12,800	373.40	-32,400
Nov	2008	377.46	0	373.41	2,700
Dec	2008	377.50	25,600	373.40	-2,700
Jan	2009	377.50	0	373.40	0
Feb	2009	377.50	0	373.40	0
Mar	2009	377.60	64,000	373.40	0
April	2009	377.60	0	374.00	162,000
May	2009	377.52	-51,200	373.96	-10,800
June	2009	377.52	0	373.90	-16,200
July	2009	377.48	-25,600	373.87	-8,100
Aug	2009	377.50	12,800	373.77	-27,000
Sept	2009	377.46	-25,600	373.56	-56,700
Oct	2009	377.54	51,200	373.51	-13,500
Nov	2009	377.50	-25,600	373.61	27,000
Dec	2009	377.50	0	373.66	13,500

Notes:
1) Historical water levels provided by Rio Algom in Excel format. Filename "Quirke Water Balance.xls". Some water levels were interpreted by Golder for missing or ambiguous data.

Sheet 11
Flow Summary
Subwatershed: Cell 14 and Cell 15

		Flows (m³/month)								
		R1	R2	-E1	R3	R4	-E2	-S1	-S2	+F1
Month	Year	Direct Precipitation onto Cell 14	Runoff into Cell 14	Evaporation on Pond Surface from Cell 14	Direct Precipitation onto Cell 15	Runoff into Cell 15	Evaporation on Pond Surface of Cell 15	Seepage under Dam K1 and K2	Seepage under Dam J	Flow from Gravel Pit
Oct	2005	44,416	9,161	26,944	18,738	5,413	11,367	6,696	2,678	62,728
Nov	2005	90,374	18,640	0	38,127	11,014	0	6,480	2,592	64,800
Dec	2005	0	0	0	0	0	0	6,696	2,678	66,960
Jan	2006	0	0	0	0	0	0	6,696	2,678	66,960
Feb	2006	0	0	0	0	0	0	6,048	2,419	60,480
Mar	2006	122,624	25,291	0	51,732	14,945	0	6,696	2,678	150,660
April	2006	72,768	15,008	0	30,699	8,869	0	6,480	2,592	226,800
May	2006	58,496	12,065	77,504	24,678	7,129	32,697	6,696	2,678	88,387
June	2006	38,272	7,894	100,416	16,146	4,664	42,363	6,480	2,592	200,880
July	2006	54,528	11,246	96,384	23,004	6,646	40,662	6,696	2,678	86,780
Aug	2006	70,400	14,520	87,296	29,700	8,580	36,828	6,696	2,678	62,942
Sept	2006	77,568	15,998	54,208	32,724	9,454	22,869	6,480	2,592	45,483
Oct	2006	71,168	14,678	26,944	30,024	8,674	11,367	6,696	2,678	139,277
Nov	2006	48,000	9,900	0	20,250	5,850	0	6,480	2,592	252,720
Dec	2006	0	0	0	0	0	0	6,696	2,678	83,700
Jan	2007	0	0	0	0	0	0	6,696	2,678	2,678
Feb	2007	0	0	0	0	0	0	6,048	2,419	0
Mar	2007	128,102	26,421	0	54,043	15,612	0	6,696	2,678	66,960
April	2007	77,466	15,977	0	32,681	9,441	0	6,480	2,592	181,440
May	2007	19,136	3,947	77,504	8,073	2,332	32,697	8,896	2,678	76,270
June	2007	42,368	8,738	100,416	17,874	5,164	42,363	6,480	2,592	85,536
July	2007	57,216	11,801	96,384	24,138	6,973	40,662	6,696	2,678	128,563
Aug	2007	37,120	7,656	87,296	15,660	4,524	36,828	6,696	2,678	113,832
Sept	2007	34,048	7,022	54,208	14,364	4,150	22,869	6,480	2,592	23,976
Oct	2007	95,744	19,747	26,944	40,392	11,669	11,367	6,696	2,678	0
Nov	2007	56,960	11,748	0	24,030	6,942	0	6,480	2,592	80,352
Dec	2007	0	0	0	0	0	0	6,696	2,678	20,088
Jan	2008	0	0	0	0	0	0	6,696	2,678	125,349
Feb	2008	0	0	0	0	0	0	6,048	2,419	113,219
Mar	2008	201,779	41,617	0	85,126	24,592	0	6,696	2,678	37,498
April	2008	128,653	26,535	0	54,275	15,680	0	6,480	2,592	49,766
May	2008	59,776	12,329	77,504	25,218	7,285	32,697	6,696	2,678	36,158
June	2008	57,856	11,933	100,416	24,408	7,051	42,363	6,480	2,592	45,360
July	2008	30,848	6,362	96,384	13,014	3,760	40,662	6,696	2,678	107,136
Aug	2008	41,600	8,580	87,296	17,550	5,070	36,828	6,696	2,678	107,136
Sept	2008	41,088	8,474	54,208	17,334	5,008	22,869	6,480	2,592	59,346
Oct	2008	35,968	7,418	26,944	15,174	4,384	11,367	6,696	2,678	87,718
Nov	2008	67,712	13,966	0	28,566	8,252	0	6,480	2,592	90,720
Dec	2008	0	0	0	0	0	0	6,696	2,678	74,995
Jan	2009	0	0	0	0	0	0	6,696	2,678	0
Feb	2009	0	0	0	0	0	0	6,048	2,419	0
Mar	2009	190,618	39,315	0	80,417	23,232	0	6,696	2,678	133,920
April	2009	107,110	22,092	0	45,187	13,054	0	6,480	2,592	64,800
May	2009	64,000	13,200	77,504	27,000	7,800	32,697	6,696	2,678	107,136
June	2009	50,816	10,481	100,416	21,438	6,193	42,363	6,480	2,592	116,640
July	2009	102,400	21,120	96,384	43,200	12,480	40,662	6,696	2,678	100,440
Aug	2009	72,960	15,048	87,296	30,780	8,892	36,828	6,696	2,678	93,744
Sept	2009	34,176	7,049	54,208	14,418	4,165	22,869	6,480	2,592	84,240
Oct	2009	116,864	24,103	26,944	49,302	14,243	11,367	6,696	2,678	80,339
Nov	2009	37,504	7,735	0	15,822	4,571	0	6,480	2,592	90,720
Dec	2009	0	0	0	0	0	0	6,696	2,678	90,396

Sheet 12
Calculated Seepage
Sub watershed: Combined Cell 14 and Cell 15

Year	Total Flow from Gravel Pit Lake	Total Precipitation	Total Evaporation	Seepage Through Dams J, K1, K2	Change in Pond Volume	Total Seepage	Average Seepage Rate	Sensitivity Analysis			
								+10% Evap	-10% Evap	Runoff Coefficient on Natural Ground = 50%	Runoff Coefficient on Natural Ground = 70%
	m^3	m^3	m^3	m^3	m^3	m^3	(L/s)	(L/s)	(L/s)	(L/s)	(L/s)
Oct 2005 to Sept 2006	1,183,861	1,101,531	629,538	110,376	145,240	**1,400,238**	**44.4**	42.4	46.4	43.3	45.5
Oct 2006 to Sept 2007	1,154,953	900,592	629,538	110,376	-287,600	**1,603,231**	**50.8**	48.8	52.8	49.7	52.0
Oct 2007 to Sept 2008	781,409	1,250,032	629,538	110,376	125,200	**1,166,327**	**37.0**	35.0	39.0	35.9	38.0
Oct 2008 to Sept 2009	954,353	1,270,080	629,538	110,376	-2,000	**1,486,519**	**47.1**	45.1	49.1	46.1	48.2

Sheet 13
Calculated Seepage

Sub watershed: Cell 14

Year	Total Flow from Gravel Pit Lake	Total Precipitation	Total Evaporation	Seepage Through Dams K1, K2	Change in Pond Volume	Overflow from Cell 14 to Cell 15	Total Seepage	Average Seepage Rate
	m³	m³	m³	m³	m³	m³	m³	(L/s)
Sep 2008 to Nov 2008	237,784	174,626	81,152	19,656	-44,800	0	**356,402**	**45.3**
Jul 2009 to Sep 2009	278,424	252,753	168,448	19,872	-38,400	0	**381,257**	**48.0**

Year	Total Flow from Gravel Pit Lake	Total Precipitation	Total Evaporation	Seepage Through Dams K1, K2	Change in Pond Volume	Assumed Overflow from Cell 14 to Cell 15	Total Seepage	Average Seepage Rate
	m³	m³	m³	m³	m³	m³	m³	(L/s)
Oct 2005 to Sept 2006	1,183,861	759,270	442,752	78,840	44,800	0	**1,376,739**	**43.7**
Oct 2006 to Sept 2007	1,154,953	620,765	442,752	78,840	-147,200	0	**1,401,326**	**44.4**
Oct 2007 to Sept 2008	781,409	861,629	442,752	78,840	6,400	0	**1,115,046**	**35.4**
Oct 2008 to Sept 2009	954,353	875,448	442,752	78,840	-12,800	0	**1,321,009**	**41.9**

Year	Total Flow from Gravel Pit Lake	Total Precipitation	Total Evaporation	Seepage Through Dams K1, K2	Change in Pond Volume	Assumed Overflow from Cell 14 to Cell 15 (25 l/s for 3 months)	Total Seepage	Average Seepage Rate
	m³	m³	m³	m³	m³	m³	m³	(L/s)
Oct 2005 to Sept 2006	1,183,861	759,270	442,752	78,840	44,800	197,100	**1,179,639**	**37.4**
Oct 2006 to Sept 2007	1,154,953	620,765	442,752	78,840	-147,200	197,100	**1,204,226**	**38.2**
Oct 2007 to Sept 2008	781,409	861,629	442,752	78,840	6,400	197,100	**917,946**	**29.1**
Oct 2008 to Sept 2009	954,353	875,448	442,752	78,840	-12,800	197,100	**1,123,909**	**35.6**

Year	Total Flow from Gravel Pit Lake	Total Precipitation	Total Evaporation	Seepage Through Dams K1, K2	Change in Pond Volume	Assumed Overflow from Cell 14 to Cell 15 (25 l/s for 6 months)	Total Seepage	Average Seepage Rate
	m³	m³	m³	m³	m³	m³	m³	(L/s)
Oct 2005 to Sept 2006	1,183,861	759,270	442,752	78,840	44,800	394,200	**982,539**	**31.2**
Oct 2006 to Sept 2007	1,154,953	620,765	442,752	78,840	-147,200	394,200	**1,007,126**	**31.9**
Oct 2007 to Sept 2008	781,409	861,629	442,752	78,840	6,400	394,200	**720,846**	**22.9**
Oct 2008 to Sept 2009	954,353	875,448	442,752	78,840	-12,800	394,200	**926,809**	**29.4**

ACIDITY RELEASE CONTROLS
AT QUIRKE CELL 15

ECOMETRIX INCORPORATED

ACIDITY RELEASE CONTROLS AT QUIRKE CELL 15

Report prepared for:

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Elliot Lake, ON

Report prepared by:

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ACIDITY RELEASE CONTROLS AT QUIRKE CELL 15

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EXECUTIVE SUMMARY

The Quirke Site (the Site) is a decommissioned uranium mine property located approximately 13 km north of the City of Elliot Lake and immediately north of Dunlop Lake. The Site is owned and managed by Rio Algom Limited (RAL). The Quirke tailings were divided into cells and flooded at decommissioning.

EcoMetrix Incorporated (EcoMetrix) was retained by RAL to complete a study that focused on acidity release from periodically exposed tailings in Cell 15 at the Quirke Tailings Management Area (TMA). The study was completed in response to the October 2007 inspection report from the Canadian Nuclear Safety Commission (CNSC) that recommended RAL review the water balance issue associated with the partial loss of water cover in Cell 15 during parts of the year. As part of the review, it was recommended that the potential acidity loads from the periodically exposed tailings in Cell 15 be addressed.

The objectives of the study were to estimate potential acidity loads from the periodically exposed tailings and to determine whether or not the loads contribute important amounts of acidity to the TMA.

Sampling was conducted at five stations in Cell 15 to obtain representative tailings and water samples to quantify concentrations of constituents associated with acid generation. Tailings samples were collected from areas that had been or could potentially be partially exposed from the loss of the water cover in Cell 15. The analyses on the tailing solids included ABA and metals to estimate the degree of sulphide oxidation and inventories of leachable metals. Shake flask tests were also completed on the tailings solids to estimate the concentrations of soluble acidity and other constituents.

The results from the field sampling program and laboratory testing indicated that some of the periodically exposed tailings exhibited trends that are consistent with on-going sulphide oxidation and thus acid generation in addition to the historical acidity and soluble oxidation products that had accumulated in the beached tailings prior to flooding.

Areas of periodically exposed tailings were estimated from bathymetric and elevation survey data. The results for the measured soluble acidities in the shallow tailings were used to calculate potential acidity loads and corresponding lime demands from the tailings to the water cover in Cell 15. The estimated acidity loads represented potential lime demands of approximately 1 to 5 tonnes of CaO per annum.

A water balance was completed to estimate the average annual flow rates from Cells 14 and 15. The flow data, together with on-going water quality monitoring data at the outflows of Cell 14 and Cell 15, were used to estimate actual acidity loads in terms of lime demand. The on-going monitoring data showed that the average acidity concentrations in the cells were approximately 1 to 2 mg/L as $CaCO_3$. At this concentration, the total lime demand for

Cell 14 was 0.88 tonnes of CaO per annum and the incremental lime demand for Cell 15 was 1.14 tonnes per year.

When compared to the total operating lime use at the Quirke ETP, the estimated lime demands represented about 1 to 3% of the minimum annual lime use of 145 tonnes of CaO per year (2001 to 2009). Therefore, the periodically exposed tailings in Cell 15 contribute little to no measureable acidity loads for the impoundment, overall. Collectively, these results showed that the acidity load from Cell 15 is almost negligible and has little to no influence on the lime use for pH control at the Quirke TMA.

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1.0 INTRODUCTION

The Quirke Site (the Site) is a decommissioned uranium mine property located approximately 13 km north of the City of Elliot Lake and immediately north of Dunlop Lake (**Figure 1.1**). The Site is owned and managed by Rio Algom Limited (RAL). The Quirke tailings were divided into cells and flooded at decommissioning.

EcoMetrix Incorporated (EcoMetrix) was retained by RAL to complete a study that focused on acidity release from periodically exposed tailings in Cell 15 at the Quirke Tailings Management Area (TMA). The study was completed in response to the October 2007 inspection report from the Canadian Nuclear Safety Commission (CNSC) that recommended RAL review the water balance issue associated with the partial loss of water cover during parts of the year in Cell 15. As part of the review it was recommended that the potential acidity loads from the periodically exposed tailings in Cell 15 be addressed.

1.1 Objectives and Scope of Work

The objectives of the study were to estimate potential acidity loads from the periodically exposed tailings and to determine whether or not the loads contribute important amounts of acidity to the TMA.

The scope of work for this investigation included the following:

- collection and characterization of tailings from Cell 15 in areas that have been periodically exposed to air as a result of declines in water elevations;
- leachability assessment of acidity and other oxidation products from the near surface tailings;
- assessment of potential sources of acidity, including acidity release from the periodically exposed tailings;
- estimation of acidity loads that reflect spatial and temporal changes in water cover;
- comparison of acidity loads to the operating capacity of the Quirke Treatment System; and
- evaluation of the requirement for the mitigation of acid release from Cell 15 tailings.

2.0 BACKGROUND

The following section provides general background information on the Quirke TMA, the generation and release of acidity from tailings, as well as a summary of relevant trends observed for acidity from routine monitoring at the Quirke TMA.

2.1 Quirke TMA Tailings and Configuration

The Quirke mine and mill operated from 1956 to 1961, and in 1968 the mine was re-opened and operated until closure in August 1990. The Quirke mill produced approximately 42 million tonnes of tailings that were placed in the TMA.

The milling process consisted of a hot dilute sulphuric acid leach followed by removal of the uranium via precipitation of ammonium diuranate (yellow cake). Prior to discharge to the TMA, the acidic wastes (i.e., tailings) generated during the milling process were neutralized with lime to pH values of 8.5 to 10.5. The ore contained pyrite as an accessory mineral. Therefore, the tailings were sulphide bearing with little or no neutralization potential and consequently potentially acid generating. During operation the tailings were exposed and unsaturated conditions developed at shallow depths within the tailings. The unsaturated zone allowed oxygen and precipitation to enter the tailings, initiating acid generation, resulting in acidic porewater in the unsaturated zone. Upon closure, the tailings were flooded by raising the original dams to mitigate acid generation. Cell 14 was flooded by raising Dyke 14 between 1991 and 1992 (**Figure 2.1**). Downstream of Cell 14, Cells 15 and 16 were flooded in 1994 by raising Dykes 15 and 16; and Cell 17 was flooded in 1995 by raising Dyke 17 (Golder, 1996).

The Quirke TMA consists of five terraced flooded cells (Cells 14 to 18) within a bedrock-rimmed basin, separated by engineered, low permeability dykes that were constructed on the existing tailings (**Figure 2.1**). The cell elevations drop an average of 3.5 m per cell resulting in an elevation change of 14 m between Cell 14 and Cell 18, the final downstream cell. **Figure 2.2** provides a schematic of the cross-sectional profile of the Quirke TMA and the flow conditions within the flooded basin. The changes in water elevations across the TMA induced subsurface flow (seepage) through the tailings below the internal dykes.

Previous water balance calculations showed that the water cover could be partially lost in Cell 14 during some periods of the year because of seepage losses from Cell 14. To maintain appropriate water cover, modifications were completed to reduce seepage losses from Cell 14 to Cell 15. In 1997, a till blanket was applied to selected sections on the upstream side of Dyke 14 that reduced the seepage rate to approximately 50 L/s (CCL, 2000). In 2003, the till blanket was extended at Dyke 14 and a diffusion barrier was applied to 68% of the cell, further reducing seepage losses to approximately 35 L/s (Golder, 2011).

As a result of lower seepage flows, the water cover in Cell 15 is partially lost during some periods of some years. In 1997, a till blanket was also applied to selected sections of the upstream side of Dyke 15 in an effort to reduce seepage losses to Cell 16. Despite the addition of the till cover, loss of water cover in Cell 15 during some parts of low precipitation years has occurred, resulting in periodic seasonal exposure of small areas of tailings and loss of saturation in the associated surface layers.

2.2 Acidity Generation

Acidity generation occurs when sulphide bearing minerals are exposed to water and oxygen. Exposed and unsaturated sulphide minerals undergo oxidation, resulting in the liberation of hydrogen ions, acidity and metals into the porewater. The highest rates of oxidation and the largest quantities of acidity and other oxidation products are generally produced closest to the tailings surface. It is well known that oxygen transport is generally rate-limiting in submerged sulphide tailings and that oxygen ingress into the tailings is controlled to a large degree by the moisture content and degree of saturation in exposed tailings (INAP, 2011). An oxidation zone in sulphide tailings can extend from a few centimeters to a few metres below surface depending on the moisture content of the tailings. Acidity generation typically occurs in the uppermost portion of tailings where oxygen and water can readily infiltrate or diffuse into the tailings. Below the zone of effective saturation, such as the water table or the top of the capillary fringe, acidity generation is generally negligible due to the slow transport of oxygen through water.

Acid generation in tailings over a long period of time typically results in the depletion of sulphide and associated metals in the shallow tailings, with less depletion at depth. Because the oxidation products produced via sulphide oxidation accumulate in the porewater within the tailings, trends that are observed in the tailings are also reflected in the porewater. When sulphide oxidation and acid generation occur, porewater typically exhibits acidic pH values and elevated sulphate and iron concentrations in the zones that also exhibit sulphide and metal depletion.

The Quirke tailings were exposed for many years during operation and prior to flooding. The tailings, therefore, generated acid and other oxidation products that resided in the tailings porewater and were likely transported slowly downward through the tailings with time until flooding occurred.

2.3 Conceptual Model for the Reclamation of Quirke Tailings

After closure, and as part of the reclamation plan, the tailings were divided into cells by dykes and sequentially flooded beginning with Cell 14. The design of the TMA resulted in a 14 m elevation change from Cell 14 at the west of the basin to Cell 18 at the east end of the basin. The changes in elevation between the cells induced subsurface flow (seepage) through the tailings from upstream cells to downstream cells. Seepage is generally concentrated near the dykes because the shortest travel paths for subsurface water flow represent the highest hydraulic gradients that control the flow. The flow conditions within the flooded tailings basin at Quirke are shown schematically in **Figure 2.2**.

Cell to cell seepage occurs through the tailings below the internal dykes and results in the flow of tailings porewater downward at the upstream cells and upward at the downstream cells. Although seepage beneath the dykes does not result in release to the receiving environment, historic oxidation products are released to the respective downstream cells. The reason for and the expected behaviour associated with these releases are shown schematically in **Figure 2.3**.

When the tailings were initially flooded, the oxidation zones containing elevated concentrations of iron, acidity and sulphate, together with low pH values were likely a few meters deep in the near-surface tailings (**Figure 2.3a**). When the tailings were flooded, some oxidation products present in the near-surface porewater would have been released by an "initial flush" that resulted from flooding of the cells. This flushing would have diminished with time as the original porewater in the seepage zones was replaced by the overlying waters. Once the tailings were flooded, oxidation of the sulphides in the tailings would have been controlled by diffusion of dissolved oxygen from the water column into the flooded tailings, a very slow process that generally has a negligible effect on the quality of the overlying water. In uni-level basins, such as the Panel and Stanleigh TMAs, this initial release of historic porewater acidity was treated by a two to three year period of in-situ lime addition during flooding within the basins. Basin waters at those TMAs have remained near neutral.

At the multi-level Quirke facility, soon after flooding, seepage flow below the dykes, initiated by the differences in water elevations between adjoining cells would have represented substantial flow of acidic porewater to the overlying waters in the downstream cells. Diffusion of dissolved oxidation products in the near-surface porewaters would have been driven by the elevated concentrations in the tailings but was likely a less significant contributor of acidity to the water covers in the cells. Diffusion is a slow transfer process; therefore flow would dominate the transfer of soluble constituents and have a greater effect on the resident soluble masses of oxidation products in the upper zone of the tailings soon after flooding. The flow rates in the tailings are likely on the order of one to five metres per year, therefore, it will require many years to move porewater from the shallow zone of the upstream tailings to the tailings-water interface in the downstream cell. Nevertheless, it is expected that, over time subsurface flushing and the releases of oxidation products will decrease. This will be reflected by decreased acidity concentrations in the basin water. In addition, diffusive transport of oxidation products from the tailings to the overlying water will also decrease with time as the concentration gradients decrease. Therefore, the acidity loadings to the water covers in the cells are expected to decline with time.

2.4 Acidity Release from Periodically Exposed Tailings

Some oxidation of the tailings will occur when the tailings are exposed and become unsaturated as a result of periodically declining water levels. The release of these oxidation products may contribute some acidity loads to the TMA. Oxidation products produced in the unsaturated tailings could potentially be released via two mechanisms. The first mechanism is referred to as porewater flushing that occurs during precipitation events. The downward movement, or infiltration, of water in the near surface zone effectively displaces porewater as seepage and runoff into the basin water. Oxidation products may also be released from the tailings porewater by a rinsing effect caused by water level fluctuations. Both mechanisms were considered in this assessment of acidity loadings to Cell 15 and the magnitude and implications of such loadings are presented and discussed in this report.

2.5 Routine Monitoring Data

This section discusses the routine monitoring of basin water and porewater in each cell at the Quirke TMA. Time-trend plots for selected constituents in porewater and basin water are presented in **Figures 2.4 and 2.5**. The complete data sets are provided in **Appendix 1**.

2.5.1 Porewater Quality

Acidity concentrations measured in the porewater up-gradient and down-gradient of each dyke are presented as time-trend plots in **Figure 2.4**. The up-gradient acidity concentrations are presented as closed symbols and down-gradient concentrations are presented as open symbols.

Acidity concentrations in the porewater in Cell 14 are represented by piezometer nest DK14-4 that is located along the upstream side of Dyke 14. Acidity concentrations in the shallow porewater have decreased from approximately 500 mg/L in 1994 to values less than the detection of 1 mg/L in 2009. No statistical trends have been observed in the porewater from the deeper piezometers that have screen elevations below the water elevation in Cell 16 (DK14-4A) (Minnow, 2011). The short-term increase in acidity concentrations in 2004 and 2005 were likely the result of the dewatering of Cell 14 for the placement of the diffusion barrier in 2003.

Down-gradient of Dyke 14, acidity concentrations in porewater in Cell 15 are represented by piezometer nest DK14-5. The data show that acidity concentrations in the shallow porewater have decreased from approximately 300 mg/L to less than the detection limit of 1 mg/L between 1994 and 2009. The low acidity concentrations at DK14-5 confirm the passage of the post-flooding acidity front.

Acidity concentrations in the porewater in Cell 15 upstream of Dyke 15 are represented by piezometer nest DK15-1. Acidity concentrations in the porewater have shown a consistent decreasing trend since 1995, after the cell was flooded. Between 2006 and 2009, average acidity concentrations at DK15-1 have decreased from 476 to 213 mg/L.

Down-gradient of Dyke 15, acidity concentrations in porewater in Cell 16 are represented by piezometer nest DK15-2. Acidity concentrations in the porewater have shown a consistent decreasing trend since 1996, with values of approximately 5,000 mg/L in 1996 that have decreased to values of about 1,000 mg/L in 2009. Between 2006 and 2009, average acidity values at DK15-2 have decreased from 2,175 to 897 mg/L.

Acidity concentrations in the porewater in Cell 16 upstream of Dyke 16 are represented by piezometer nest DK16-1. Acidity concentrations in the porewater have shown a consistent decreasing trend since 1996, after the cell was flooded. In 1996, acidity concentrations in the range of 104 to 870 mg/L were measured at DK16-1. These values have decreased to between 6 and 21 mg/L in 2009.

Down-gradient of Dyke 16, acidity concentrations in porewater in Cell 17 are represented by piezometer nest DK16-2. Acidity concentrations in the porewater have shown a consistent decreasing trend since 1996. Average acidity values at DK16-2 have decreased from 357 mg/L in 1996 to 13 mg/L in 2009.

Acidity concentrations in the porewater in Cell 17 upstream of Dyke 17 are represented by piezometer nest DK17-1. Down-gradient of Dyke 17, acidity concentrations in porewater in Cell 18 are represented by piezometer nest DK17-2. Porewater samples from DK17-1 and DK17-2 are collected below the water elevation of Cell 18. Acidity concentrations measured in piezometers with screen elevations between 358 and 361 masl (DK17-1B, C and DK17-2C, D) have acidity concentrations less the detection limit of 1 mg/L. These porewaters are reflective of residual process water in the tailings (Minnow, 2011). The deeper piezometers at DK17-2 (DK17-2A, B) exhibit acidic porewater with an average acidity value of 1,230 mg/L.

In general, porewater quality within the Quirke TMA has shown significant improvement over time. Porewater monitoring at the Quirke facility indicates that subsurface flushing and release of acidity is nearing completion in Cells 14 and 15, and is progressing in the downstream cells (**Figure 2.4**). Subsurface flushing of acidity from the porewater is reflected by decreasing trends of acidity and sulphate in the basin water (**Figure 2.5**).

2.5.2 Basin Surface Water Quality

Acidity and sulphate concentrations and pH values measured in the outflow from each cell are presented as time-trend plots in **Figure 2.5**.

Closure of the Quirke mill and flooding of the Quirke TMA (early 1990s) reduced acidity concentrations upstream of the treatment plant by orders of magnitude (**Figure 2.5**). . Flooding and in-situ liming of Cells 16 and 17 maintains near neutral pH values in all of the cells, except Cell 18 where the pH is maintained between 3.5 and 7.0 to assist in Ra-226 removal during the treatment process. However, neither Cell 14 nor Cell 15 have required in-situ lime addition to maintain neutral pH values in the basin waters since 2000.

Acidity concentrations in Cell 14 have remained less than 10 mg/L since 1993, with an average value of 1 mg/L between 2006 and 2009. Acidity concentrations in Cell 15 have remained less than 15 mg/L since 1996, with an average value of 2 mg/L between 2006 and 2009. The low acidity concentrations in Cells 14 and 15 are reflected by near neutral pH and low sulphate values in the basin waters (**Figure 2.5**).

Since 1996, acidity concentrations in Cells 16 and 17 have shown significant decreases and have remained less than 51 mg/L and acidity concentrations in Cell 18 have ranged from 1 to 99 mg/L. Average acidity concentrations in Cells 16, 17 and 18 were 11, 12 and 14 mg/L, respectively, between 2006 and 2009. The low acidity and near neutral pH values observed in **Figure 2.5** for Cells 16, 17 and 18 reflect in-situ lime additions to Cells 16 and 17.

Increasing sulphate concentrations from Cell 14 (less than 20 mg/L) to Cell 18 (greater than 1,500 mg/L) reflect continued flushing of historic oxidation products. **Figure 2.5** indicates a long-term decreasing trend in sulphate concentrations in Cell 18 that has been statistically confirmed in the 2006 through 2009 TOMP reporting period (Minnow, 2011).

3.0 FIELD SAMPLING AND LABORATORY TESTING

Sampling was conducted at five stations in Cell 15 to obtain representative samples to quantify concentrations of constituents associated with acid generation. Tailings samples were collected from areas that have been or could potentially be partially exposed from the loss of the water cover in Cell 15. The locations of the sampling stations are presented in **Figure 3.1**.

3.1 Field Sampling Methods

3.1.1 Core Sample Collection

Tailings were collected using a 4-inch K-B coring device at five stations in the west area of Cell 15 (**Figure 3.1**). Sampling stations represented areas where beached tailings existed or may potentially exist depending on the elevation of the water cover. The sampling stations were chosen to represent areas where acidity may have developed as a result of loss of saturation and oxidation of the tailings. Three sampling stations were located along the downstream toe of Dyke 14 (QC15-1, QC15-2 and QC15-3), were flooded at the time of sampling and are exposed to seepage form Cell 14. Sampling Stations QC15-4 and QC15-5 were located near a historic deposition beach at the southeast corner of Cell 15. Samples at QC15-5 were collected from the beached tailings, while the samples at QC15-4 were collected from an adjacent near-shore area (QC15-4).

The cores were sectioned at 10 cm intervals to depths of 30 to 50 cm. Each 10 cm section was placed into a dedicated Ziploc bag, stored at 4°C and transported to the EcoMetrix Laboratory for further testing.

3.1.2 Basin Water Sample Collection

Basin water samples were collected as grab samples from the top of the water column from four of the five sampling stations. Basin water sampling stations included QC15-1, QC15-2, QC15-3 and QC15-4. Basin water was not sampled at QC15-5 because this sampling station was located on beached tailings.

Basin water samples were field filtered through 0.45 µm nylon filters and the pH of the basin water samples was measured and recorded. Water samples were then transferred into sample bottles supplied by SGS Lakefield Laboratories (SGS Lakefield). Water samples to be analysed for metals and Ra-226 were preserved with nitric acid and all samples were stored at 4°C until analysis.

Basin water samples were sent to SGS Lakefield for chemical analyses that included acidity, Ra-226, metals and sulphate.

3.2 Laboratory Testing Methods

The tailings samples were homogenized and sub-sampled at the EcoMetrix Laboratory. Rinse pH was measured on one set of sub-samples. A second set of sub-samples were submitted to SGS Lakefield for Acid Base Accounting (ABA), Ra-226 and metals analyses.

The wet tailings from each sampling station were subjected to short-term leach (Shake Flask) tests using distilled water. The leach tests used a 3:1 water:solids ratio (approximately 300 mL of water to 100 g of material). The samples were constantly agitated for approximately 24 hours prior to extraction of leachate samples. After agitation, leachate samples were filtered (0.45 µm), and samples for Ra-226 and metals analyses were acidified (HNO_3), prior to submission for analyses to SGS Lakefield.

The liquid fractions from the leach tests were analysed for pH, acidity, Ra-226 and metals to evaluate the key indicators of acidity releases to basin water. The leach test methods were generally consistent with those described in the “Draft Guidelines for the Prediction of Metal Leaching and Acid Rock Drainage at Mine Sites in British Columbia” (Price, 1997).

4.0 QUALITY ASSURANCE/QUALITY CONTROL

A detailed data quality assessment (DQA) was completed by EcoMetrix to evaluate the quality of the data collected during the Cell 15 field campaign. This section provides a summary of the QA/QC for selected constituents that are discussed in this report. Data quality results for the selected constituents are summarized in **Tables 4.1 to 4.3**. Data quality results for all of the constituents analysed are provided in **Appendix 2**.

The precision for the duplicate and replicate samples were evaluated by calculating the relative percent difference (RPD) as follows:

$$RPD = \frac{2|C_1 - C_2|}{C_1 + C_2} \times 100\%$$

where: C_1 = sample concentration; and

C_2 = replicate (or duplicate) concentration.

The Data Quality Objectives (DQO) for solids samples and supernatant water from shake flask tests were less than or equal to a RPD value of 40%.

For duplicate/replicate samples having concentrations less than five times the detection limit, the DQO was the absolute difference (AD) between the sample and duplicate/replicate that should not have been greater than the detection limit value.

Blind duplicates and replicates of solids and water samples, as well as a laboratory blank sample (distilled water), were submitted to SGS Lakefield. Duplicate and replicate samples were labeled as QC15-6. The duplicate samples were solids sample splits from a selected core section. The replicate samples were supernatant water from replicate shake flask tests conducted on replicate core sections. The calculated RPD or AD values for selected constituents are presented in **Tables 4.1 and 4.2**.

4.1 Tailings Solids Data Quality Assessment

The DQA for selected constituents in tailings solids duplicates from Core09-QC15-4 (20-30) and Core09-QC15-2 (10-20) are summarized in **Table 4.1**. On average, the DQO of 40% was achieved for all selected constituents (neutralization potential, sulphide-sulphur, aluminum, iron and manganese), with the exception of sulphide-sulphur (Sulphide-S) that had an average RPD value of 71%. The DQO for sulphide-S was exceeded in one sample with an RPD value of 116%. As sulphide-S is a supporting constituent and is not used in the calculations for acidity loads, there are no impacts on the interpretation of the results.

4.2 Shake Flask Test Data Quality Assessment

The DQA for selected constituents in supernatant water from shake flask tests from replicates of core samples Core09-QC15-2 (10-20) and Core09-QC15-4 (10-20) are summarized in **Table 4.2**. On average, the DQO of 40% was achieved for all selected constituents (acidity, sulphate, aluminum, iron and manganese). The DQO was exceeded for acidity in one replicate sample with an RPD value of 104%. The DQO was exceeded for iron in one replicate sample with an RPD value of 76%. As these individual values were only marginally above the data quality objectives, there are no impacts on the interpretation of the results.

4.3 Blank Sample Data Quality Assessment

One blank sample was subjected to the shake flask test procedure that included the 24-hour leach and filtration to determine potential cross-contamination between samples. The results for selected constituents in the blank are provided in **Table 4.3**. Acidity, sulphate and manganese concentrations exceeded DQOs in the blank sample, with concentrations of 6, 0.6 and 0.00049 mg/L, respectively. Aluminum and iron concentrations were less than detection limits of 0.01 mg/L. The sulphate and manganese data were considered acceptable because the concentrations in the blank sample were at least 2 orders of magnitude less than the sulphate and manganese concentrations measured in the samples from Cell 15 (sulphate range = 32 to 1,500 mg/L; manganese range = 0.018 to 3.49 mg/L). The acidity data were considered acceptable because the blank sample was collected from water that was exposed to the atmosphere and carbon dioxide. Carbon dioxide dissolves in water to form carbonic acid that can be detected as low level acidity.

4.4 Anomalous pH and Acidity in Basin Water Samples

The chemical results from basin water samples are summarized in **Table 4.4**. The results show anomalously low pH values between 3.4 and 4.3 compared to monitoring data for Cell 15 outflow. The routine outflow samples have typically exhibited average pH values of about 7 since 2005. The acidity values were also anomalously high with an average of about 36 mg/L compared to an average of about 2 mg/L since 2005. In addition, the standard deviation for the four sulphate concentrations was only about 3% of the average value, suggesting that the water cover is well mixed, whereas the standard deviation for acidity values was on the order of 40%, indicating larger variability. Upon further investigation, the source of the anomalous pH and acidity values was found. The four basin water samples were collected in sample bottles that were previously acidified with nitric acid in preparation for storage of samples for metals analysis. The bottles were rinsed three times in the field before collection of the samples for pH and acidity. However this rinsing was insufficient to remove all traces of nitric acid. The pH and acidity values for the Cell 15 basin water samples collected by EcoMetrix in September 2009 were, therefore, ignored and were not used in this study.

4.5 Laboratory Quality Assurance and Quality Control

Laboratory QA/QC included analysis of laboratory blank and laboratory duplicate samples. The Certificates of Analysis, including internal laboratory QA/QC results are provided in **Appendix 3** and indicate that the data have acceptable accuracy and precision.

5.0 RESULTS

Selected results from the September 2009 field sampling program are presented in **Figures 5.1 and 5.2** and are summarized in **Tables 5.1 to 5.3**. Concentrations of selected constituents in tailings are provided in **Figure 5.1** as depth profiles. **Figure 5.2** presents depth profiles for selected soluble constituents from the leach tests. A summary of selected constituent concentrations in the basin water at each sampling station that had overlying water is provided in **Table 5.3**. A complete compilation of the data is provided as Certificates of Analysis in **Appendix 3**.

5.1 Acid Base Accounting and Metals Contents

Selected results from the ABA and metals analyses on the tailings are summarized in **Table 5.1** and presented as depth profiles in **Figure 5.1**.

Tailings samples collected along the north toe of Dyke 14 (QC15-1 and QC15-2) are characterized by depressed rinse pH (5.0 to 6.3) and low residual sulphide-S contents (0.11 to 0.82%). Iron and manganese concentrations at QC15-1 and QC15-2 in the surface samples were elevated with concentrations of 13,000 and 17,000 mg/kg and 12 and 11 mg/kg, respectively (**Figure 5.1**). The results for rinse pH, sulphide-S, iron and manganese are consistent with the surface precipitation of oxidation products in Cell 15 that originated from Cell 14 seepage.

A similar but less pronounced characterization occurs at the centre toe of Dyke 14 (QC15-3) where rinse pH values and sulphide-S were similar to those measured at QC15-1 and QC15-2. The pH values ranged from 4.2 to 4.9 and sulphide-S contents ranged from 1.8 to 4.5%. Iron concentrations at QC15-3 were higher compared to those measured at QC15-1 and QC15-2 and ranged from 29,000 to 46,000 mg/kg. However, the trends for iron concentrations with depth were consistent with the trends observed at QC15-1 and QC15-2. Surface concentrations of aluminum (1,300 mg/kg) and manganese (232 mg/kg) are notably highest at QC15-3 and may reflect construction sand and materials imported to this location during dyke construction.

Tailings collected from the exposed beach in the southeast corner of Cell 15 (QC15-5) are characterized by a uniformly depressed pH (3.0 to 3.2) and increasing sulphide-S and iron concentrations with depth. These results are consistent with surface oxidation of the beached tailings and the downward migration of oxidation products. The near shore saturated tailings (QC15-4) are also characterized by depressed rinse pH values (3.3 to 4.8) and elevated sulphide-S concentrations ranging from 1.4 to 9.6%. The lowest rinse pH value was measured in the 20 to 30 cm section and the highest sulphide-S concentration in the 10 to 20 cm interval.

The NP contents measured in the samples collected from Cell 15 were low and ranged from 3.0 to 4.5 kg $CaCO_3$/t. The results for carbonate from the ABA analysis (**Table 5.1**) indicate that generally no NP was attributable to carbonate bearing minerals. It is likely that most, if not all, of the measured NP in the Quirke tailings is considered to be unavailable NP and, therefore, the tailings contain little to no effective neutralizing potential. The lack of effective neutralizing potential in the tailings is consistent with the use of sulphuric acid during the milling process to recover uranium.

5.2 Leach Testing

Shake flask tests were completed to estimate soluble concentrations of selected constituents in the tailings porewater. The soluble concentrations are presented as depth profiles in **Figure 5.2** and the values are summarized in **Table 5.2**. The values were calculated to units of mg of soluble constituent per kg of tailings or mg/kg.

Leachate from tailings samples collected along the north toe of Dyke 14 (QC15-1 and QC15-2) had pH values in the range of 3.0 to 6.1 and released between 27 and 116 mg/kg of acidity. Soluble sulphate concentrations ranged from 319 to 6,787 mg/kg and were highest in the QC15-2 surface layers.

Leachate pH values (4.5 to 4.8) and acidity concentrations (42 to 72 mg/kg) from the solids collected at the center toe of Dyke 14 (QC15-3) were generally consistent at all depths compared to trends from other sampling stations. Soluble sulphate ranged from 2,885 to 5,308 mg/kg, with the highest values measured at depth. The maximum soluble manganese concentration of 17 mg/kg from the surface tailings was consistent with the elevated manganese content of 232 mg/kg measured in the solids.

Leachate pH values were lowest (2.7 to 3.1) and soluble acidity concentrations were highest (70 to 191 mg/kg) in the samples collected from the exposed tailings at station QC15-5. Leachate pH values were moderately high (3.2 to 4.2) and soluble acidity concentrations lower (43 to 115 mg/kg) from the saturated tailings at station QC15-4 compared to those measured from samples at QC15-5. Concentrations of soluble iron and aluminum from the exposed tailings at QC15-5 were generally an order of magnitude higher than the soluble concentrations from other sampling stations (iron range = <0.04 to 0.64 mg/kg; aluminum range = <0.04 to 1.08 mg/kg).

In general, the trends among constituents and locations are generally consistent with sulphide oxidation, whereby samples that exhibited low pH values in the leachate also exhibited higher concentrations of acidity, iron and aluminum.

5.3 Basin Surface Water Samples

A summary of selected constituent concentrations in the basin water at each sampling station that had overlying water is provided in **Table 5.3**. The concentrations of selected constituents in the basin water were constant between sampling stations. Sulphate concentrations ranged from 570 to 600 mg/L. The iron and aluminum concentrations ranged from 0.06 to 0.16 mg/L and less than 0.01 to 0.02 mg/L, respectively. Manganese concentrations in the samples collected from Cell 15 ranged between 0.21 and 0.31 mg/L. Acidity values were calculated using the average pH value from routine monitoring from 2006 through 2009 and basin water data for aluminum, iron and manganese measured from the 2009 field campaign. Calculated acidity values ranged from 0.6 to 1.2 mg/L as $CaCO_3$.

6.0 ACIDITY IN CELL 15

The following section discusses the available acidity in the periodically exposed and unsaturated tailings and their potential to generate acidity. Acidity loads calculated from the shake flask test and on-going monitoring data are also discussed in this section.

6.1 Available Acidity in Periodically Exposed Tailings

It is clear from the results that the sulphidic tailings in Cell 15 may be a potential source of acidity loads to the Quirke TMA if they become unsaturated and exposed to the atmosphere. The results from the ABA and short-term leach testing at some locations in Cell 15 exhibited trends that were consistent with on-going sulphide oxidation. Specifically, the samples collected at QC15-5 and QC15-4 showed acidic pH values throughout the depth profiles as well as evidence of historic sulphide and iron depletion in the shallow tailings (**Figure 5.1**). These trends were reflected by elevated concentrations of soluble oxidation products, such as acidity, iron and aluminum, measured in the short-term leach tests (**Figure 5.2**). The soluble acidity concentrations at these locations showed that between 50 and 190 mg of acidity (as $CaCO_3$) per kg of tailings are in soluble form and may be available to be released into the basin water.

The results from QC15-1 and QC15-2 showed neutral to slightly acidic pH values with comparatively low sulphide and iron contents over the depth profile (**Figure 5.1**). These results imply that historic generation and releases of acidity prior to basin filling may have depleted the sulphide and iron at these locations. Even with lower sulphide concentrations measured in the solids, the acidity produced during short-term leach tests from the solids collected at the toe of Dyke 14 resulted in acidity concentrations between 30 and 115 mg/kg.

The average soluble acidity from all of the short-term leach tests was approximately 80 mg of acidity per kg of tailings.

6.2 Bathymetric Study in Cell 15

The water elevations in Cell 15 have been measured regularly since 1997 and are presented in **Figure 6.1** and tabulated in **Appendix 1**. Monitoring data have shown that water levels in Cell 15 fluctuate between 374.4 and 372.6 masl. The lowest recorded elevation of 372.6 masl occurred in April 2001 (**Figure 6.1**) and was a 1 in 50 year return drought event (Pers. Comm., Golder Associates, 2011). Since 2002, the water elevations have remained above 373.0 masl.

A bathymetric study in Cell 15 was conducted by Torrance Surveying Ltd. Cell 15 was divided into three separate Areas (A, B and C) as presented in **Figure 6.2**. The bathymetry data were used to determine the areas of tailings that would be potentially exposed at three selected water elevations including 373.0, 372.5 and 372.0 masl. These elevations were selected to reflect conditions 0.5 m above and 0.5 m below the 1 in 50 year return drought event observed between 2000 and 2001.

Figures 6.3 to 6.5 illustrate the locations of potentially exposed tailings. **Table 6.1** tabulates the areas of exposed tailings at the three water elevations for Areas A, B and C. The results show that at water elevations between 373.0 and 372.0 masl, the exposed tailings generally exist in the areas along the toe of Dyke 14 and the southwest corner of Cell 15. The total areas of exposed tailings were estimated to be approximately 37,800, 52,600 and 74,000 m^2 at water elevations of 373.0, 372.5 and 372.0 masl, respectively. The exposed tailings areas estimated for each of these elevations were used to estimate the potential acidity loads from the tailings to Cell 15 and to estimate the lime demand that could be required to neutralize the acidity loads.

6.3 Acidity Load and Lime Demand

Soluble acidity loads were calculated using the data from the short-term leach tests to estimate the maximum acidity load that could potentially be released from the periodically exposed tailings on an annual basis. Not all of the soluble acidity in the tailings will be released to the basin water each year. Some porewater may be flushed from the tailings as the water level increases and re-floods tailings after a dry, exposed period, but not all pore water will be displaced. It was conservatively assumed that the pore water to a maximum depth of 55 cm of tailings could be flushed annually, corresponding to the porewater above 372.5 masl. The annual acidity loads in tonnes of $CaCO_3$ per year from the tailings to the basin water are presented in **Table 6.2**. Calculations of annual acidity loads at water elevations of 373.0 and 372.5 masl were completed using the cut volumes of 9,322 and 31,606 m^3 for exposed tailings (**Table 6.1**). The cut volumes were used because they provide representative depths of about 20 to 55 cm for tailings above the specified water elevations that may potentially oxidize when exposed. The cut volume of 62,775 m^3 at a water elevation of 372.0 masl represented an average depth of about 85 cm and would not be representative of practical depths for oxidation in these wet tailings. Therefore the acidity load calculations were completed using the total area of exposed tailings times an effective flushing depth of 55 cm.

A maximum value of 55 cm was considered to be conservative because although some areas of tailings may be exposed at the surface, tailings below the surface will remain relatively saturated near the surface. This is especially true for tailings at the base of Dyke 14 where upstream seepage will maintain a degree of saturation that is likely much less than 55 cm below the tailings surface even when tailings are exposed.

Three soluble acidity values were considered for the acidity load calculations to provide a conservative range of potential acidity loads. The maximum soluble acidity value measured from the short-term leach tests was 190 mg/kg. The average leachable amount of acidity from QC15-4 and QC15-5, the two sampling stations most likely to have periodically exposed tailings, was 115 mg/kg. The average soluble acidity measured from all of the samples was 80 mg/kg.

Calculated acidity loads to Cell 15 from the periodically exposed tailings were converted to a lime equivalent and compared to the results to the total lime used at the Quirke TMA. The total areas of exposed tailings estimated from the bathymetric study along with the calculated acidity loads were used to estimate the annual lime demands for varying water elevations in Cell 15. The estimated lime demands are also presented in **Table 6.2**.

At a water elevation of 373.0 masl, the maximum estimated lime demand would be 1.3 tonnes of CaO per year. A water elevation of 372.5 masl would correspond to a maximum lime demand of be 4.4 tonnes of CaO per annum. If extreme drought conditions were to exist and if the water elevation in Cell 15 decreased to 372.0 masl, the maximum annual lime demand would be approximately 5.6 tonnes CaO per annum. Considering a more representative acidity concentration of 80 mg/kg, the annual lime demand would be 2.4 tonnes of CaO.

These estimates show that potential lime demands for a range of water elevations fall in a relatively small range of approximately 1 to 6 tonnes of CaO per year.

6.4 Influence of Acidity Loads on Quirke Operating Limits

The total amount of lime used annually for direct lime addition to the cells and that used at the Quirke ETP since 1997 are presented in **Table 6.3**. The total annual lime use at Quirke prior to 2001, including in-basin lime addition and lime used in the treatment plant, was between 1,093 and 1,524 tonnes of CaO per year. In 2001, the lime supply changed resulting in improved lime distribution and lime use accounting. Since 2001, the annual lime use at Quirke has ranged from 145 to 217 tonnes of CaO per year. The potential acidity loads from the periodically exposed tailings represent approximately 1 to 4% of the minimum annual lime use.

6.5 Basin Water pH and Acidity in Cell 15

Monitoring at the outflow from Cell 15 to Cell 16 has been on-going since 1995. Time-trend plots of routine monitoring at the outflow from Cell 15 to Cell 16 for pH and acidity are presented in **Figure 2.5**. The trends shown in **Figure 2.5** reflect important processes as well as water management activities that have occurred since flooding.

It is clear that there is a potential for acidity generation from periodically exposed tailings in Cell 15. However, time-trend plots for pH and acidity measured at the outflow of Cell 15 presented in **Figure 2.5** indicate that acidity concentrations have exhibited a decreasing trend since 2003 and that the periodically exposed tailings appear to have little influence on the basin water quality exiting Cell 15.

During mining operations and prior to flooding of the tailings, sulphide oxidation and acidity generation resulted in the accumulation of oxidation products in the tailings porewater. In 1994, when the basin began filling, flushing of historic oxidation products from the shallow tailings occurred and seepage from upstream cells to downstream cells was initiated. The elevated acidity concentrations observed shortly after flooding (1995 to 2002) are consistent with the expected flushing and seepage of historic oxidation products from the tailings porewater. Because acidic pH values occurred between 1995 and 2000, lime was periodically applied directly to Cell 15 to neutralize the water cover. The elevated pH values observed at that time were the result of direct lime addition. Since 2000, in-situ lime addition has not been required because the pH at the outflow of Cell 15 has remained near neutral. The neutral pH conditions are also reflected by low acidity concentrations. Since 2002, the acidity concentrations in Cell 15 have remained between less than the detection limit of 1 mg/L and 5 mg/L (**Figure 2.5**), with an overall average of 2 mg/L.

The recent trends in pH and acidity imply that acidity loads from the periodically exposed tailings represent little to no contributions of acidity to the basin water in Cell 15. Acidity concentrations in the outflow from Cell 15 have been decreasing since 2003 to values at the detection limit of 1 mg/L, suggesting that there are no important on-going acidity contributions to the basin water in Cell 15.

6.6 Water Balance and Lime Demands for Cells 14 and 15

Annual flow rates were calculated in order to develop a mass balance for acidity loads from Cells 14 and 15. The estimated flow rates are based on measured flows into and out of the Quirke basin as well as the estimated natural inputs to each cell. The results are presented in **Table 6.4**.

The annual flow rate for Cell 14 is dependent on the input from Gravel Pit Lake (Q-29) and the net natural input (NNI) from precipitation and runoff minus evaporation. The annual flow rate for Cell 15 is maintained by the inflow from Cell 14 and the NNI. The NNI for the TMA was estimated from the average annual outflow from the Quirke TMA at Cell 18 (Q-05) less the average annual input from Gravel Pit Lake (Q-29). The values used for the average annual flows from Gravel Pit Lake (Q-29) and Cell 18 (Q-05) represent the average measured flow rates from 2006 through 2009. Only the flow rates since 2006 were considered for this investigation to remain consistent with the Serpent River Watershed State of the Environment reporting cycle.

The NNI for Cells 14 and 15 were calculated as the fraction of the total NNI based on the percentage of the watershed each cell represents. The total flow rates for Cell 14 and Cell 15 were calculated as the total input to the Cell plus the respective NNI. Calculated annual flow rates for Cells 14 and 15 were approximately 1,600,000 and 1,800,000 m^3/yr, respectively (**Table 6.4**).

Acidity loads in terms of lime demand (i.e. tonnes of CaO per year) were calculated using the average flow rates and acidity data from the outflows of Cells 14 and 15 for the 2006 through 2009 time period. During that time, the average acidity concentrations in Cells 14 and 15 were 1 and 2 mg/L, respectively.

The cumulative lime demand for Cell 14 and Cell 15 are presented in **Table 6.5** together with the incremental lime demand for Cell 15. The lime demand for Cell 14 was 0.88 tonnes of CaO per year. The total lime demand for Cell 15 was 2.02 t/a (as CaO), with an incremental lime demand of 1.14 t/a (as CaO) that represents the difference between the acidity load entering and that leaving Cell 15.

The total annual average lime demand for Cell 14 represents about 1% of the minimum operating lime consumption rate of 145 tonnes per year. The incremental lime demand from Cell 15 of 1.14 t/a (as CaO) also represents approximately 1% of the minimum lime consumption rate. These results indicate that the lime demands for Cells 14 and 15 represent only a small fraction of the total acidity treated by the Quirke Treatment System.

These calculations also indicate that the actual acidity loads from the periodically exposed tailings are consistent with the minimum estimate of 1 t/a (as CaO) and that the maximum estimate of 6 t/a (as CaO) has not been observed in Cell 15 since 2001.

7.0 CONCLUSIONS

The objectives of this investigation were to estimate potential acidity loads from the periodically exposed tailings in Quirke Cell 15 and to determine whether or not the loads contribute important amounts of acidity to the TMA.

The results from the field sampling program and laboratory testing indicated that some of the periodically exposed tailings exhibit trends that are consistent with on-going sulphide oxidation and thus acid generation.

Estimated potential acidity loads, in terms of lime demand (i.e. tonnes of CaO per year), calculated from the areas of exposed tailings were in the range of 1 to 6 tonnes of CaO per annum and represent approximately 1 to 4% of the minimum operating lime use of 145 tonnes of CaO per year (2005 to 2009). These potential acidity loads indicate that periodic exposure of Cell 15 tailings would contribute little to no measureable acidity to the TMA.

Flow data together with on-going water quality monitoring data at the outflows of Cell 14 and Cell 15 were used to estimate acidity loads and lime demands. The estimated incremental lime demand for Cell 15 was about 1 tonne of CaO per year. The lime demands for Cells 14 and 15 each represented about 1% of the minimum operating lime consumption rate of 145 tonnes of CaO per year. These results indicate that the acidity loads to the Quirke TMA originating from Cell 15 have been very small.

Collectively, these results showed that the acidity load from Cell 15 is almost negligible and has little to no influence on the lime use for pH control at the Quirke TMA.

8.0 REFERENCES

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TABLES

Table 4.1: Data Quality Assessment Summary for Selected Constituents in Tailings Solids

Analysis	Units	Method Detection Limit	RPD Data Quality Objective	Sample ID Core09-QC15-4 (20-30)	Duplicate ID Core09-QC15-6 (0-10)	RPD (%) or AD	Sample ID Core09-QC15-2 (10-20)	Duplicate ID Core09-QC15-6 (10-20)	RPD (%) or AD	Average RPD or AD	Count
Acid Base Accounting											
Neutralization Potential	t $CaCO_3$/1000t	--	≤ 40%	3.0	4.0	29	3.3	3.5	6	17	2
Sulphide-Sulphur	%	0.1	≤ 40%	2.11	7.94	**116**	0.28	0.36	25	**71**	2
Metals											
Aluminum	mg/kg	1	≤ 40%	170	180	6	170	180	6	6	2
Iron	mg/kg	0.5	≤ 40%	54,000	66,000	20	4,200	4,400	5	12	2
Manganese	mg/kg	0.05	≤ 40%	0.48	0.56	15	0.31	0.43	32	24	2

Notes:

RPD - relative percent difference; is calculated for analytes with concentrations greater than or equal to five times the detection limit and should be less than or equal to 40%

AD - absolute difference; for samples having concentrations less than five times the detection limit, the difference between the sample and duplicate, or difference between the sample or duplicate and the detection limit if either the sample or duplicate analyte concentration is below detection limit; should not be greater then the detection limit

"--" Indicates method detection limit not applicable

Boldface type and shaded indicates that Data Quality Objective was not achieved

Table 4.2: Detailed Data Quality Assessment for Constituents in Supernatant Water from Shake Flask Tests

Analysis	Units	Method Detection Limit	RPD Data Quality Objective	Sample ID Core09-QC15-2 (10-20)	Replicate ID Core09-QC15-6 (10-20)	RPD (%) or AD	Sample ID Core09-QC15-4 (10-20)	Replicate ID Core09-QC15-6 (20-30)	RPD (%) or AD	Average RPD or AD	Count
Conventional Parameters											
Acidity (as $CaCO_3$)	mg/L	2	≤ 40%	13	41	**104**	30	27	11	34	2
Sulphate	mg/L	0.2	≤ 40%	1500	1200	22	48	48	0	11	2
Metals											
Aluminum	mg/L	0.01	≤ 40%	<0.01	0.05	BD	0.28	0.32	13	13	1
Iron	mg/L	0.01	≤ 40%	0.02	0.05	0.03	0.09	0.20	**76**	38	2
Manganese	mg/L	0.00001	≤ 40%	0.0311	0.0299	4	0.0274	0.0261	5	4	2

Notes:
RPD - relative percent difference; is calculated for analytes with concentrations greater than or equal to five times the detection limit and should be less than or equal to 40%
AD - absolute difference; for samples having concentrations less than five times the detection limit, the difference between the sample and duplicate, or difference between the sample or duplicate and the detection limit if either the sample or duplicate analyte concentration is below detection limit; should not be greater then the detection limit
Boldface type and shaded indicates that Data Quality Objective was not achieved

Table 4.3: Detailed Data Quality Assessment for Constituents in the Blank Sample

Analysis	Units	Detection Limit	Data Quality Objective	Blank
Convential Parameters				
Acidity (as $CaCO_3$)	mg/L	2	4	**6**
Sulphate (SO_4)	mg/L	0.1	0.2	**0.6**
Metals				
Aluminum (Al)	mg/L	0.01	0.02	<0.01
Iron (Fe)	mg/L	0.01	0.02	<0.01
Manganese (Mn)	mg/L	0.00001	0.00002	**0.00049**

Notes:
Boldface type and shaded indicates that Data Quality Objective was not achieved

Table 4.4: Basin Water pH and Acidity Values in Cell 15 Samples in September 2009

Sample ID	pH (pH units)	Acidity (mg/L as $CaCO_3$)
Average at Cell 15 Outflow	**6.8**	**2**
Count	13	13
SW09-QC15-1	3.9	22
SW09-QC15-2	4.3	27
SW09-QC15-3	3.7	44
SW09-QC15-4	3.4	50

Notes:
SW - Basin water
Average calculated from routine monitoring data from 2006 through 2009

Table 5.1: Summary of Selected ABA and Metals Results for Tailings Solids

Sample ID	Rinse pH	Neutralization Potential	Acid Potential	NP/AP	Sulphide-Sulphur	Carbonate (CO_3)	Iron	Aluminum	Manganese
	pH units	(kg $CaCO_3$/t)	(kg $CaCO_3$/t)	--	(%)	(%)	(mg/kg)	(mg/kg)	(mg/kg)
CORE 09-QC-15-1 (0-10)	5.90	4.5	10.9	0.41	0.35	<0.005	13,000	710	12
CORE 09-QC-15-1 (10-20)	6.15	3.4	7.12	0.48	0.23	<0.005	3,300	500	2.6
CORE 09-QC-15-1 (20-30)	5.93	4.0	9.59	0.42	0.31	<0.005	4,100	830	2.3
CORE 09-QC-15-1 (30-40)	5.46	3.1	9.69	0.32	0.31	<0.005	4,000	260	1.9
CORE 09-QC-15-2 (0-10)	6.31	3.9	3.32	1.17	0.11	<0.005	17,000	330	11
CORE 09-QC-15-2 (10-20)	6.06	3.5	8.84	0.40	0.28	<0.005	4,400	180	0.43
CORE 09-QC-15-2 (20-30)	5.83	3.3	15.3	0.22	0.49	<0.005	5,700	150	0.14
CORE 09-QC-15-2 (30-40)	5.00	3.3	25.7	0.13	0.82	<0.005	9,600	170	0.47
CORE 09-QC-15-3 (0-10)	4.54	3.2	56.5	0.06	1.81	0.014	46,000	1,300	232
CORE 09-QC-15-3 (10-20)	4.20	3.2	140	0.02	4.50	<0.005	36,000	180	4.1
CORE 09-QC-15-3 (20-30)	4.67	3.7	83.5	0.04	2.67	<0.005	32,000	140	0.53
CORE 09-QC-15-3 (30-40)	4.86	3.6	86.8	0.04	2.78	<0.005	29,000	150	0.47
CORE 09-QC-15-4 (0-10)	4.76	4.1	44.1	0.09	1.41	<0.005	36,000	200	4.5
CORE 09-QC-15-4 (10-20)	4.16	3.4	300	0.01	9.60	<0.005	63,000	160	0.60
CORE 09-QC-15-4 (20-30)	3.25	3.0	66.1	0.05	2.11	<0.005	54,000	170	0.48
CORE 09-QC-15-4 (30-40)	4.03	3.2	172	0.02	5.50	<0.005	94,000	190	0.73
CORE 09-QC-15-5 (0-10)	3.04	4.0	13.8	0.29	0.44	<0.005	6,400	150	1.9
CORE 09-QC-15-5 (10-20)	3.14	4.1	138	0.03	4.41	<0.005	59,000	140	0.50
CORE 09-QC-15-5 (20-30)	3.16	3.3	99.9	0.03	3.20	<0.005	60,000	150	0.69
CORE 09-QC-15-5 (30-40)	3.10	4.3	168	0.03	5.38	<0.005	110,000	170	1.1
CORE 09-QC-15-5 (40-50)	3.09	4.2	290	0.01	9.29	<0.005	110,000	170	1.1

Notes:
"--" denotes parameter does not have units

Table 5.2: Summary of Selected Soluble Constituent Concentrations

Sample ID	pH	Acidity	Sulphate	Iron	Aluminum	Manganese
	pH units	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Core09-QC15-1 (0-10)	5.20	42	421	0.37	0.05	0.92
Core09-QC15-1 (10-20)	2.95	116	319	0.09	0.56	0.16
Core09-QC15-1 (20-30)	6.06	67	544	<0.04	0.29	0.12
Core09-QC15-1 (30-40)	4.95	49	2,775	0.08	0.08	0.09
Core09-QC15-2 (0-10)	6.08	27	6,787	<0.05	<0.05	0.66
Core09-QC15-2 (10-20)	5.33	52	6,040	0.08	<0.04	0.13
Core09-QC15-2 (20-30)	4.84	60	372	0.08	0.20	0.11
Core09-QC15-2 (30-40)	3.51	76	1,042	0.12	0.52	0.18
Core09-QC15-3 (0-10)	4.78	44	2,885	<0.05	<0.05	17
Core09-QC15-3 (10-20)	4.81	72	3,765	0.04	<0.04	0.74
Core09-QC15-3 (20-30)	4.45	48	5,220	<0.04	<0.04	0.24
Core09-QC15-3 (30-40)	4.74	42	5,308	<0.04	0.04	0.16
Core09-QC15-4 (0-10)	4.23	43	295	0.09	0.09	0.83
Core09-QC15-4 (10-20)	3.17	115	185	0.35	1.08	0.11
Core09-QC15-4 (20-30)	3.19	102	173	0.64	0.68	0.09
Core09-QC15-4 (30-40)	3.17	45	134	0.48	0.22	0.07
Core09-QC15-5 (0-10)	2.71	151	219	3.54	7.01	0.58
Core09-QC15-5 (10-20)	2.96	139	127	25.0	3.50	0.28
Core09-QC15-5 (20-30)	3.14	170	158	43.3	3.62	0.39
Core09-QC15-5 (30-40)	2.94	70	136	37.5	2.68	0.34
Core09-QC15-5 (40-50)	2.93	191	153	42.6	2.09	0.35

Notes:
mg/kg - mg of soluble constituent per kg of tailings

Table 5.3: Summary of Selected Constituent Concentrations in Basin Water in Cell 15

Parameter	Units	SW09 QC15-1	SW09 QC15-2	SW09 QC15-3	SW09 QC15-4
Acidity (as $CaCO_3$)[a]	mg/L	0.7	0.6	0.9	1.2
Sulphate	mg/L	570	570	570	600
Iron	mg/L	0.10	0.06	0.16	0.18
Aluminum	mg/L	<0.01	<0.01	<0.01	0.02
Manganese	mg/L	0.207	0.214	0.214	0.310

Notes:
SW - Basin water
[a] Acidity calculated from the average routine monitoring pH value and iron, aluminum and manganese concentrations
Auminum concentrations that were reported as less than the detection were assumed to be equal to 0.01 mg/L.
Average routine monitoring pH value was calculated for the 2005 through 2009 time period.

Table 6.1: Estimated Areas and Cut Volumes of Potentially Exposed Tailings

Water Elevation (masl)	Area	Average Area (m^2)[a]	Total Area (m^2)	Cut Volume (m^3)	Total Cut Volume (m^3)
373.0	A	22,266	37,772	3,873	9,322
	B	350		37	
	C	15,156		5,412	
372.5	A	35,890	52,591	18,126	31,606
	B	1,524		479	
	C	15,178		13,001	
372.0	A	55,458	74,023	40,527	62,775
	B	3,387		1,659	
	C	15,178		20,589	

Notes:

Data Provided by Torrence Surveying

[a] Represent the average of area calculated using donut area and rectangle area methods

Table 6.2: Potential Annual Acidity Loads from Periodically Exposed Tailings

Concentration of Acidity	Annual Acidity Load	Annual Lime Demand
(mg/kg as $CaCO_3$)	(t-$CaCO_3$/a)	(t-CaO/a)
Water Elevation of 373.0 m[a]		
190	2.30	1.29
115	1.39	0.78
80	0.97	0.54
Water Elevation of 372.5 m[b]		
190	7.81	4.37
115	4.73	2.65
80	3.29	1.84
Water Elevation of 372.0 m[b]		
190	10.06	5.63
115	6.09	3.41
80	4.23	2.37

Notes:

[a] Calculated from Total Cut Volume (Table 6.1)

[b] Calculated from Total Area (Table 6.1) times assumed flushing depth of 0.5 m

Bulk density is equal to 1,300 kg/m^3 (Golder, 1991)

Areas and Cut Volumes provided by Torrence Surveying

Table 6.3: Total Annual Lime Use at the Quirke Effluent Treatment Plant

Year	Lime Use (tonnes - CaO)						
	Cell 15	Cell 16 S	Cell 16 N	Cell 17	Cell 18	Quirke ETP	Total
1997	115	728	0	129	45	76	1,093
1998	62	799	0	214	97	53	1,225
1999	58	1,198	0	206	0	63	1,524
2000	28	933	0	149	0	84	1,194
2001	0	118	0	32	0	67	217
2002	0	93	0	19	0	91	203
2003	0	135	0	25	0	56	216
2004	0	150	0	16	0	42	208
2005	0	107	0	7	0	36	151
2006	0	46	48	5	0	47	145
2007	0	85	47	6	0	46	184
2008	0	54	89	5	0	42	190
2009	0	54	62	4	0	37	157

Notes:
Lime supply changed in 2001 resulting in improved lime distribution and accounting
No in basin lime addition to Cell 15 required since 2000 because of near neutral basin water
Lime is not added to Cell 18 to maintain an influent pH of 5.0 to the Quirke Effluent Treatment Plant

Table 6.4: Water Balance Calculations for Cell 14 and Cell 15 Watersheds

Annual Flow (m^3/year)			Surface Area (ha)			Annual Flow (m^3/year)			
Q-29[a]	Q-05[b]	Natural TMA Flow Q-05 to Q-29	TMA Watershed	Cell 14 Watershed	Cell 15 Watershed	Cell 14 NNI[c]	Cell 14 Total Flow	Cell 15 NNI[c]	Cell 15 Total Flow
1,053,077	2,786,883	1,733,806	292	86	40	510,641	1,563,718	237,508	1,801,226

Notes:

[a] Q-29 represents average inflow from Gravel Pit Lake for the 2006 through 2009 time period

[b] Q-05 represents average outflow from Cell 18 for the 2006 through 2009 time period

[c] NNI = Net Natural Input (Precipitation + Runoff - Evaporation)

Surface Area values from CCL (1999)

Table 6.5: Acidity Loadings for Cell 14 and Cell 15 from Routine Basin Water Monitoring Data

Acidity Concentration Measure in Surface Water		Acidity Load (tonnes-CaO/a)	Incremental Acidity Load (tonnes-CaO/a)
Cell 14			
[a]Average	1	0.88	0.88
Count	15	--	--
Cell 15			
[a]Average	2	2.02	1.14
Count	13	--	--

Notes:
[a] Average for 2006 through 2009 period
Flow values from Table 6.4 used to calculate Loads

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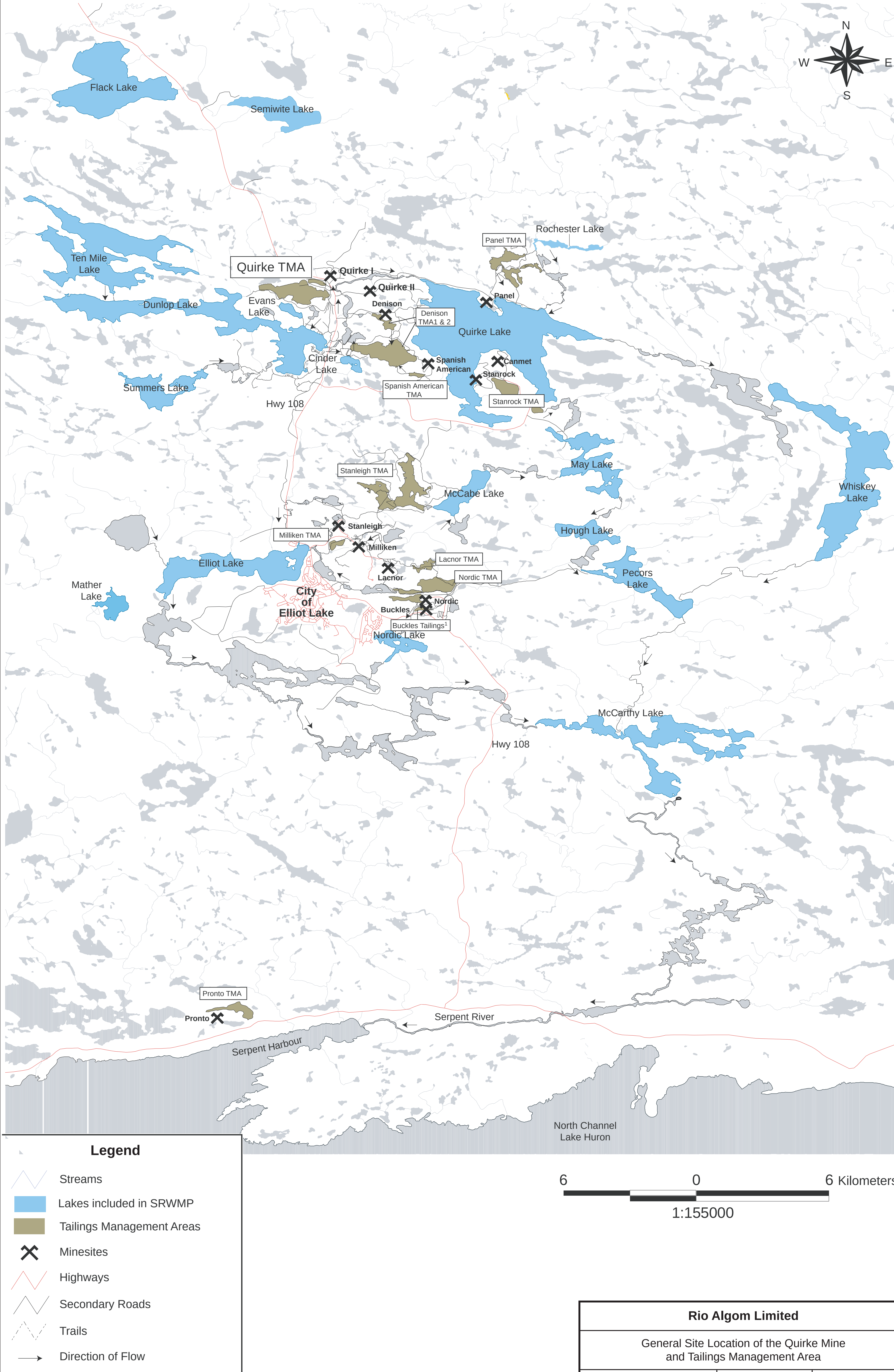
FIGURES



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General Site Location of the Quirke Mine and Tailings Management Area

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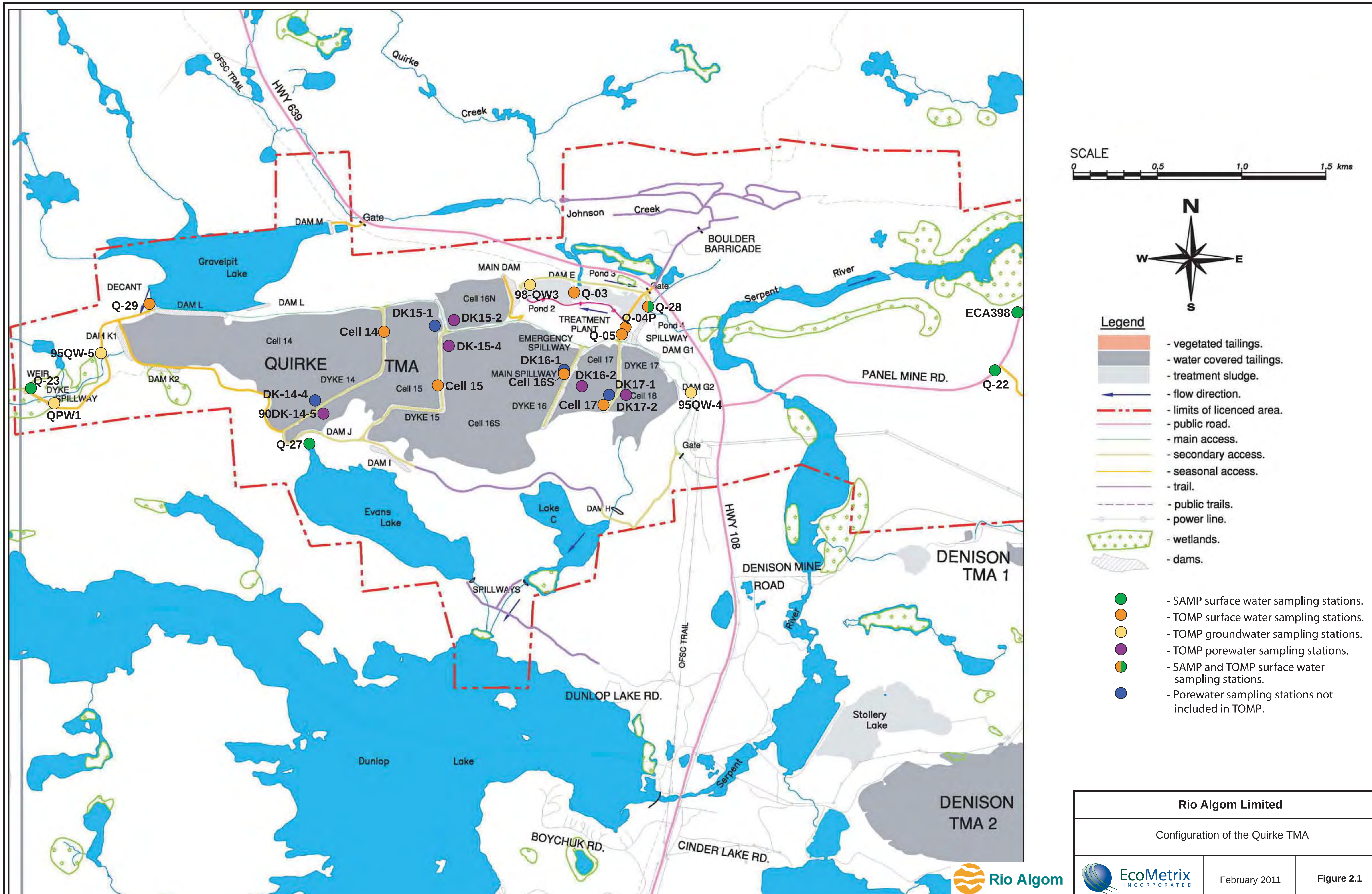
Figure 1.1



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Configuration of the Quirke TMA

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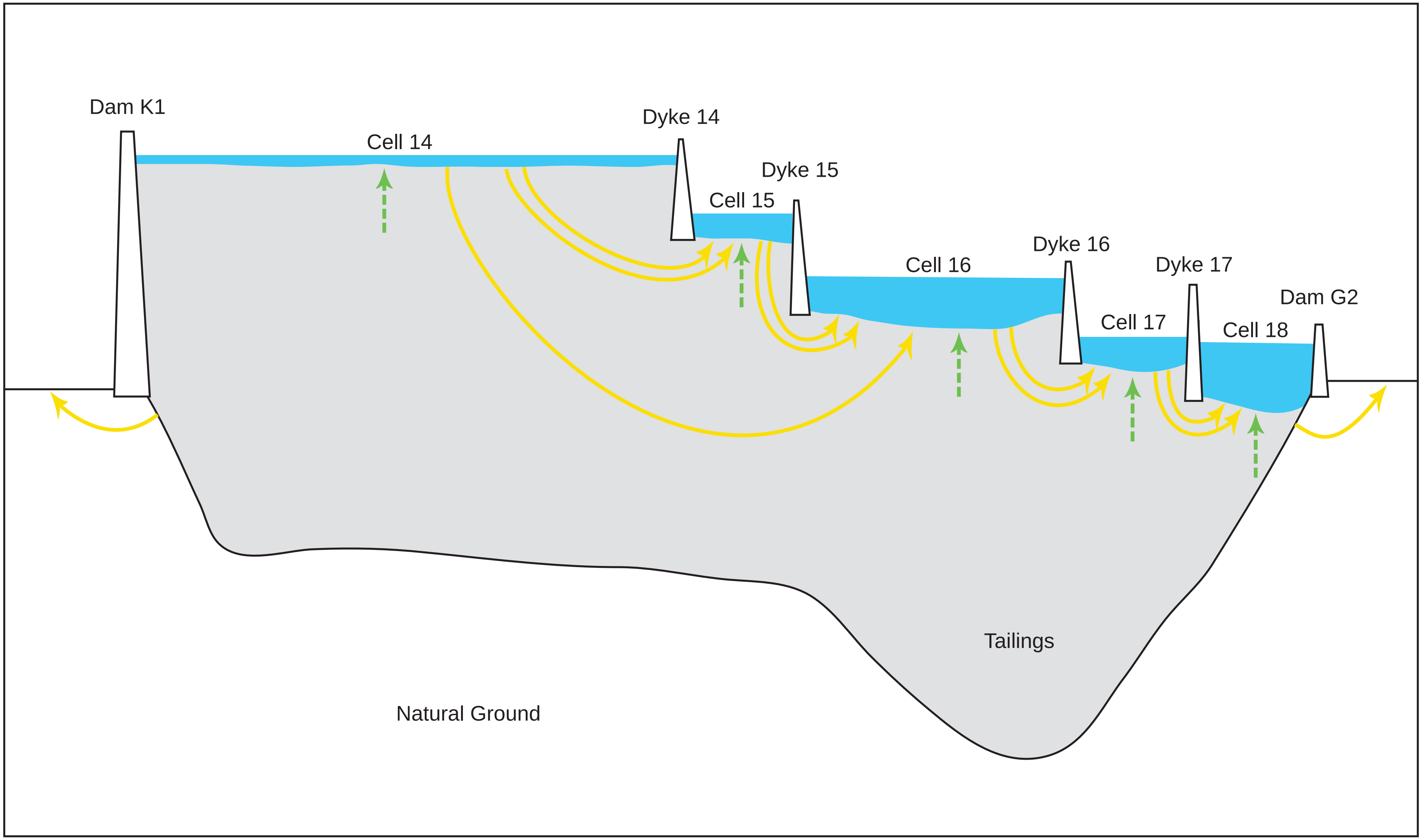
Figure 2.1



Tailings
Water
Seepage
Diffusion

Rio Algom

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Schematic Cross-section Flow Conditions in the Flooded Tailings at the Quirke TMA

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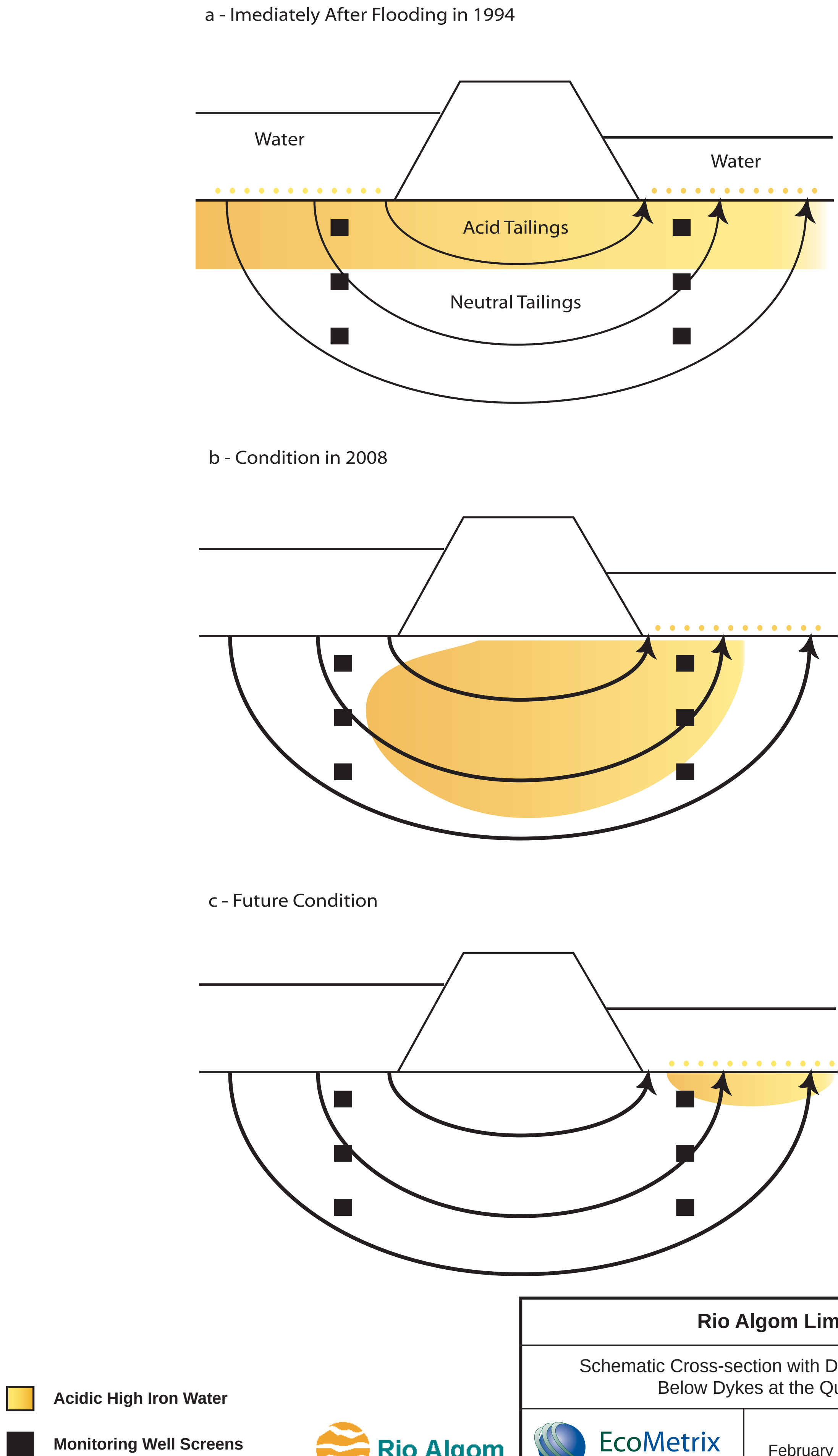
Figure 2.2



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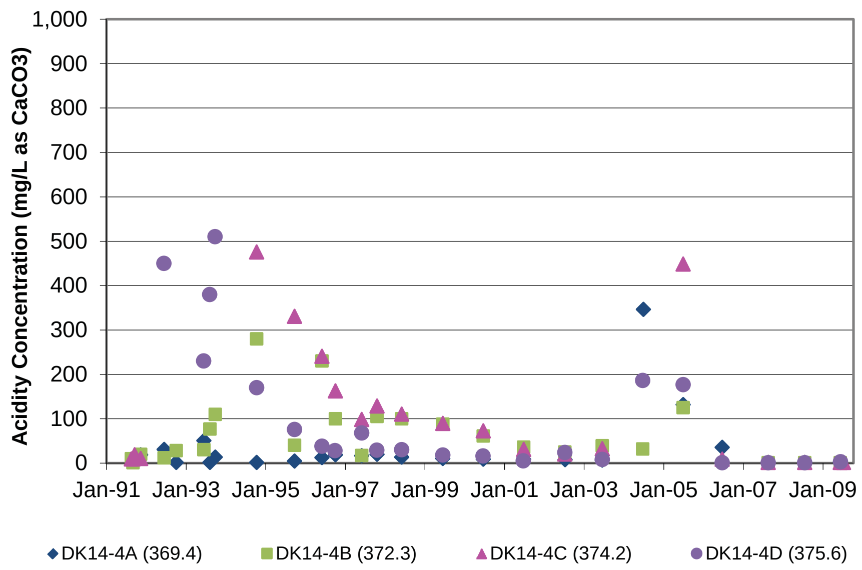
Schematic Cross-section with Detailed Acidity Flow Below Dykes at the Qurike TMA

Rio Algom | EcoMetrix Incorporated | February 2011 | **Figure 2.3**

PIEZOMETERS UP-GRADIENT OF DYKES

PIEZOMETERS DOWN-GRADIENT OF DYKES

DK14-4



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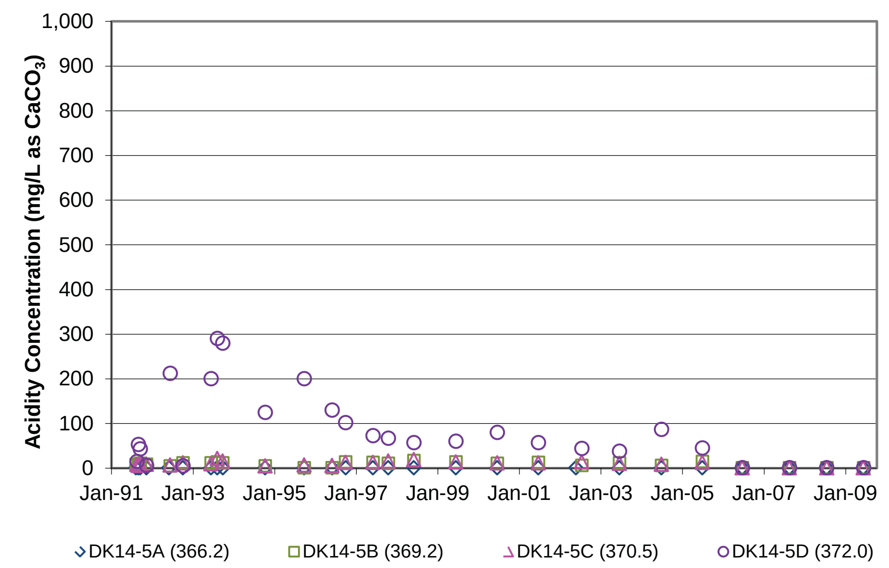

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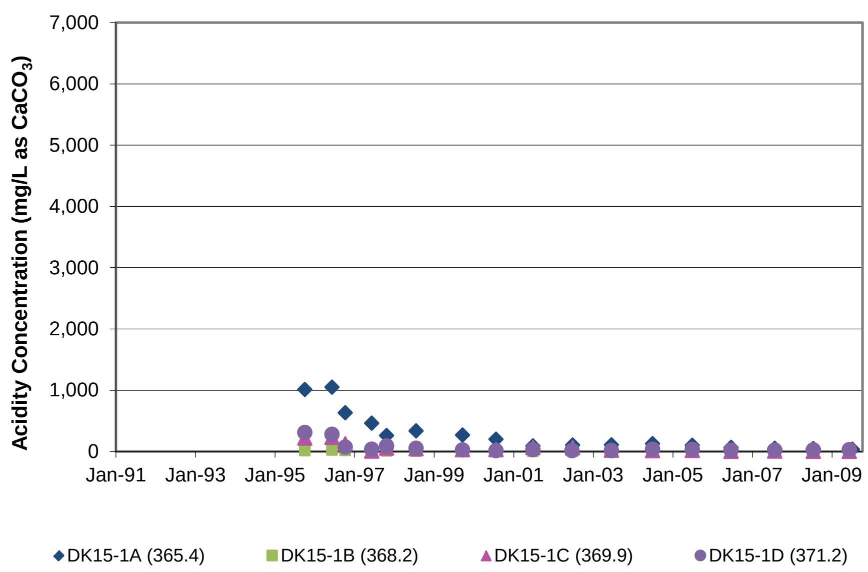

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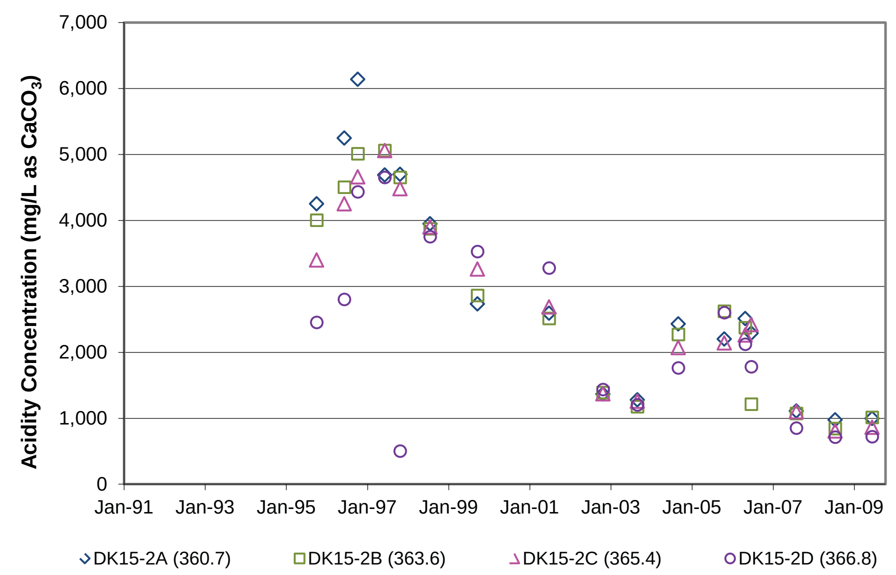

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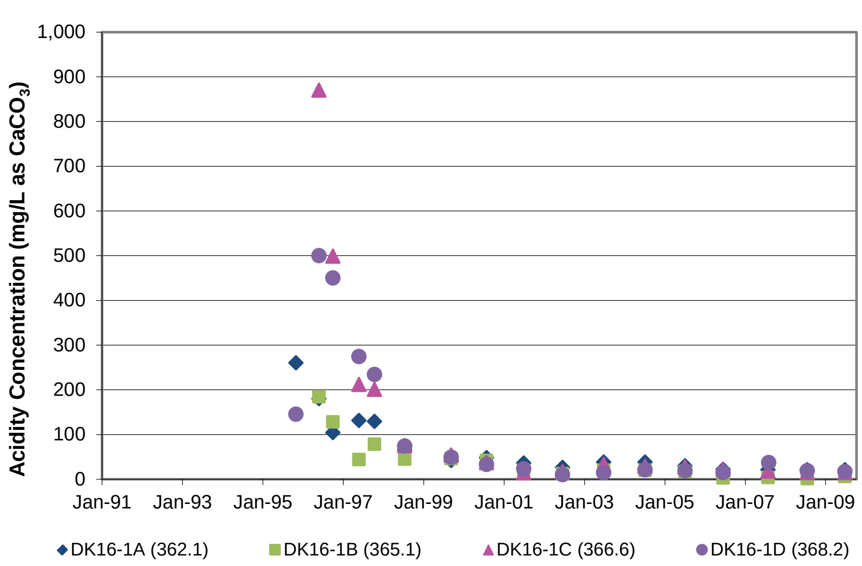

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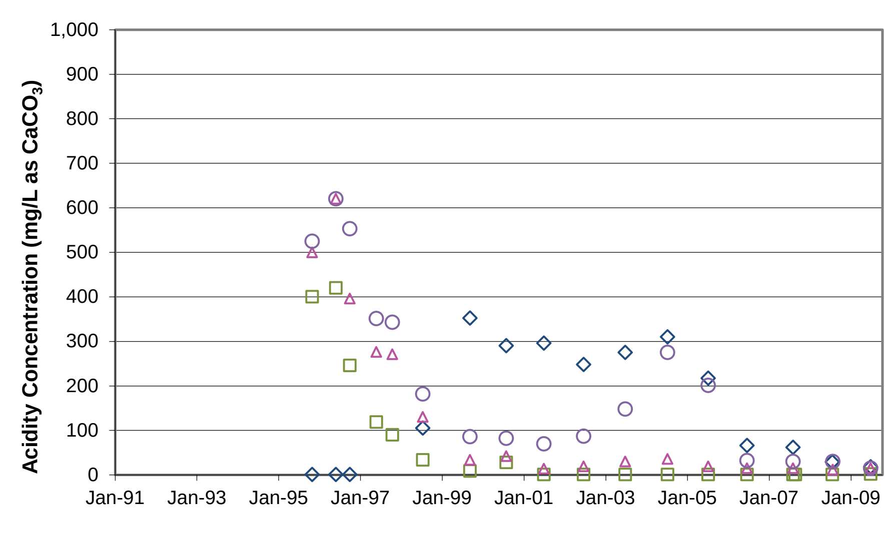

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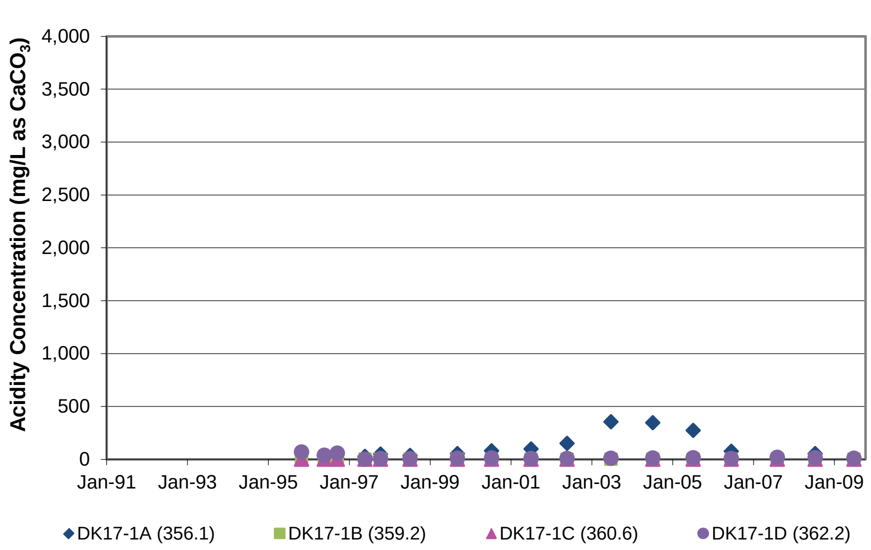
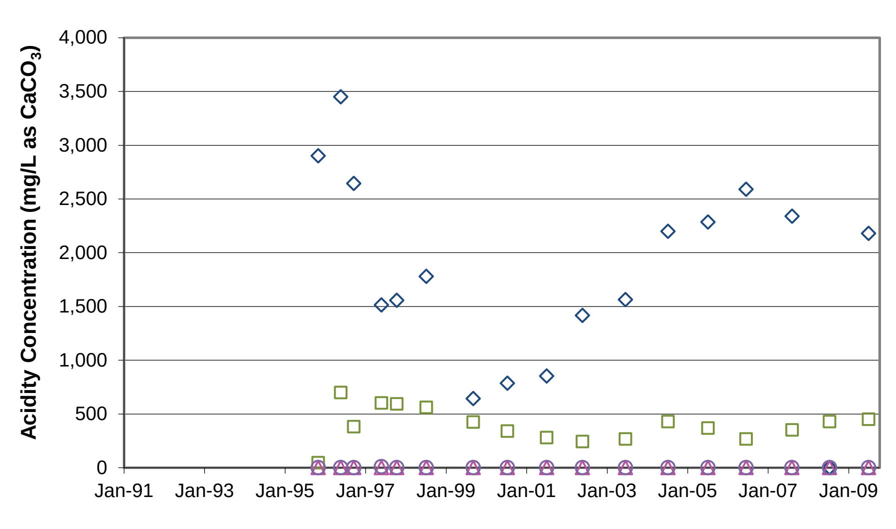


DK17-2

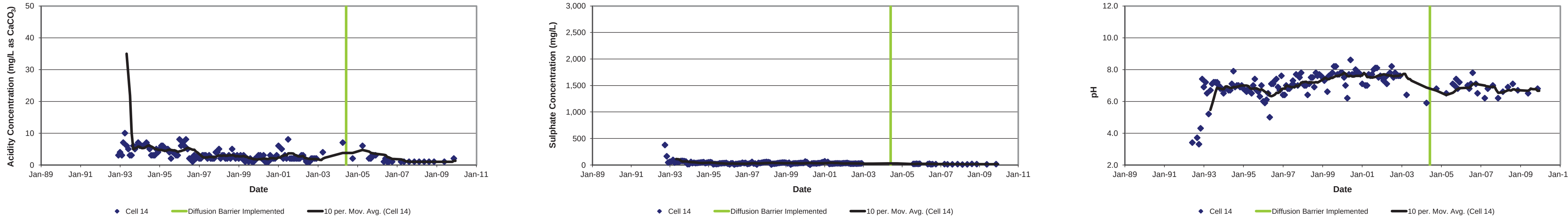


Notes: Some data for DK14-4 prior to 1994 are not shown
Some data for DK16-1 prior to 1996 are not shown

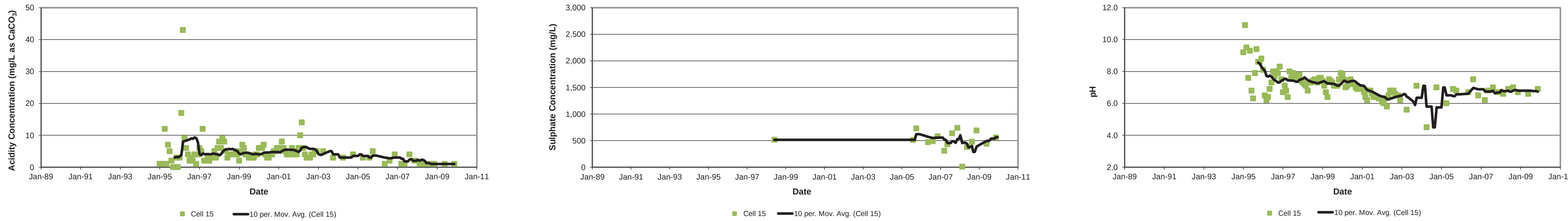
Rio Algom

Rio Algom Limited		
Time-Trend Plots of Acidity Concentrations in Porewater at the Quirke TMA		
EcoMetrix INCORPORATED	February 2011	**Figure 2.4**

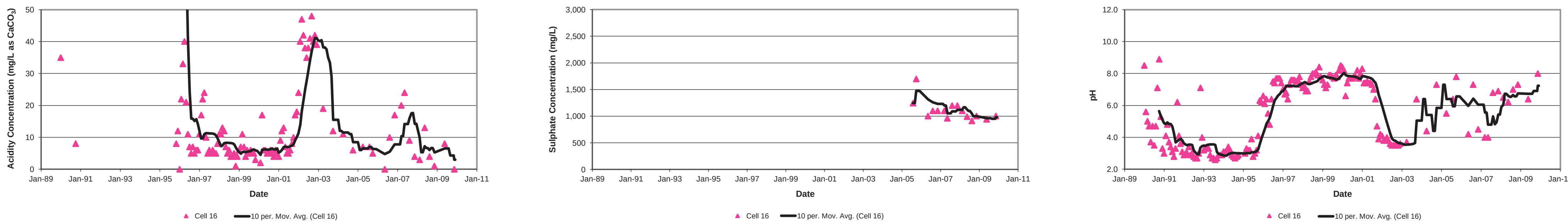
a) Cell 14 Outflow



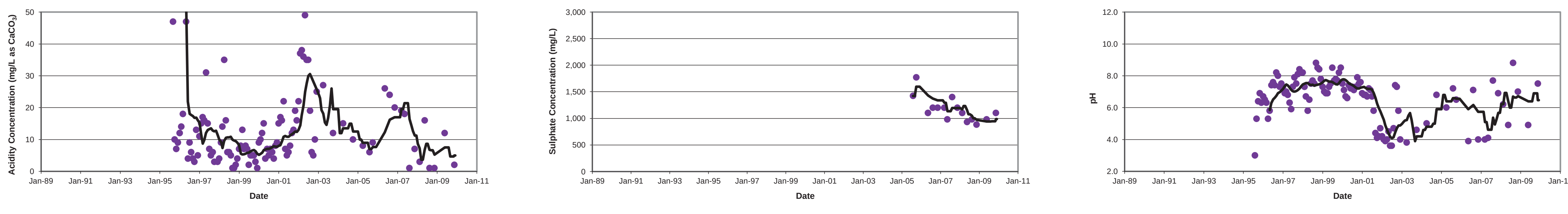
b) Cell 15 Outflow



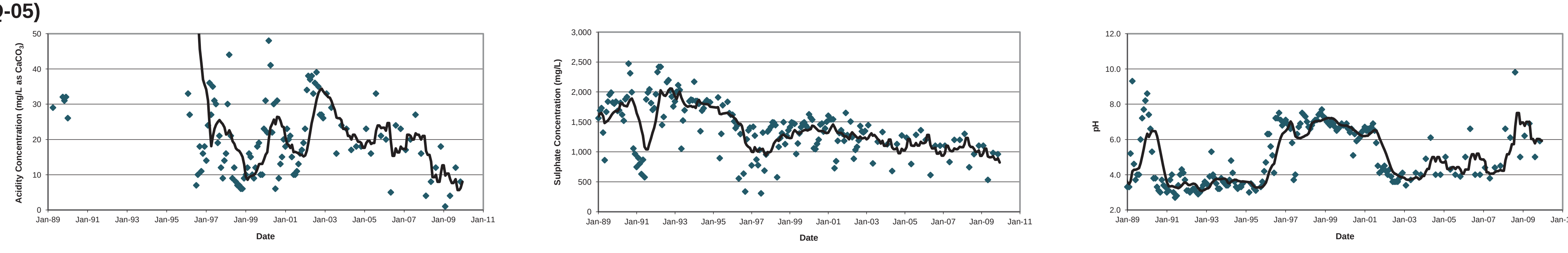
c) Cell 16 Outflow



d) Cell 17 Outflow



e) Cell 18 Outflow to ETP (Q-05)

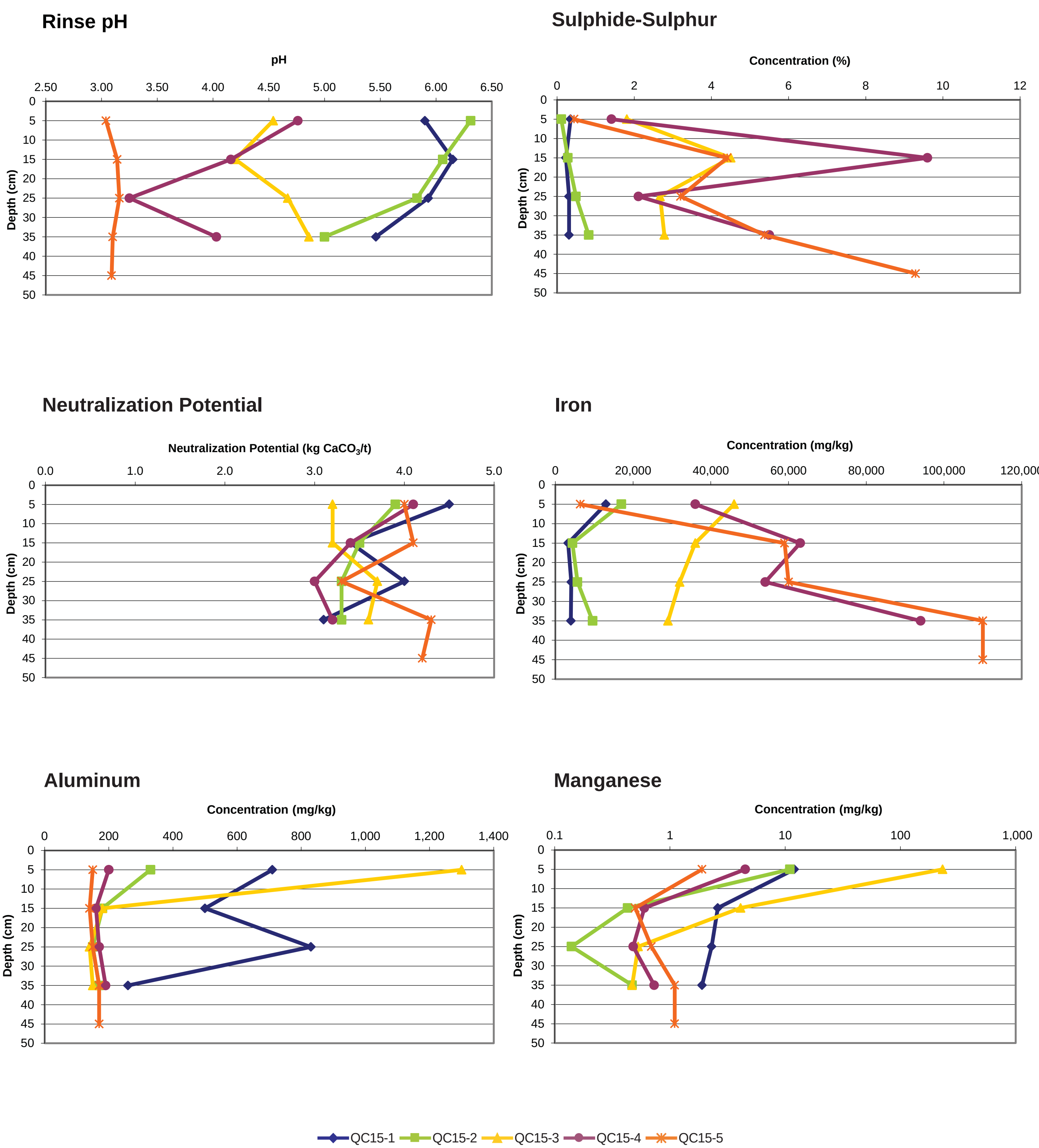


Note: Some data prior to 1996 are not shown

Rio Algom Limited		
Routine Monitoring Data for Selected Constituents from the Quirke TMA		
EcoMetrix Incorporated	February 2011	Figure 2.5

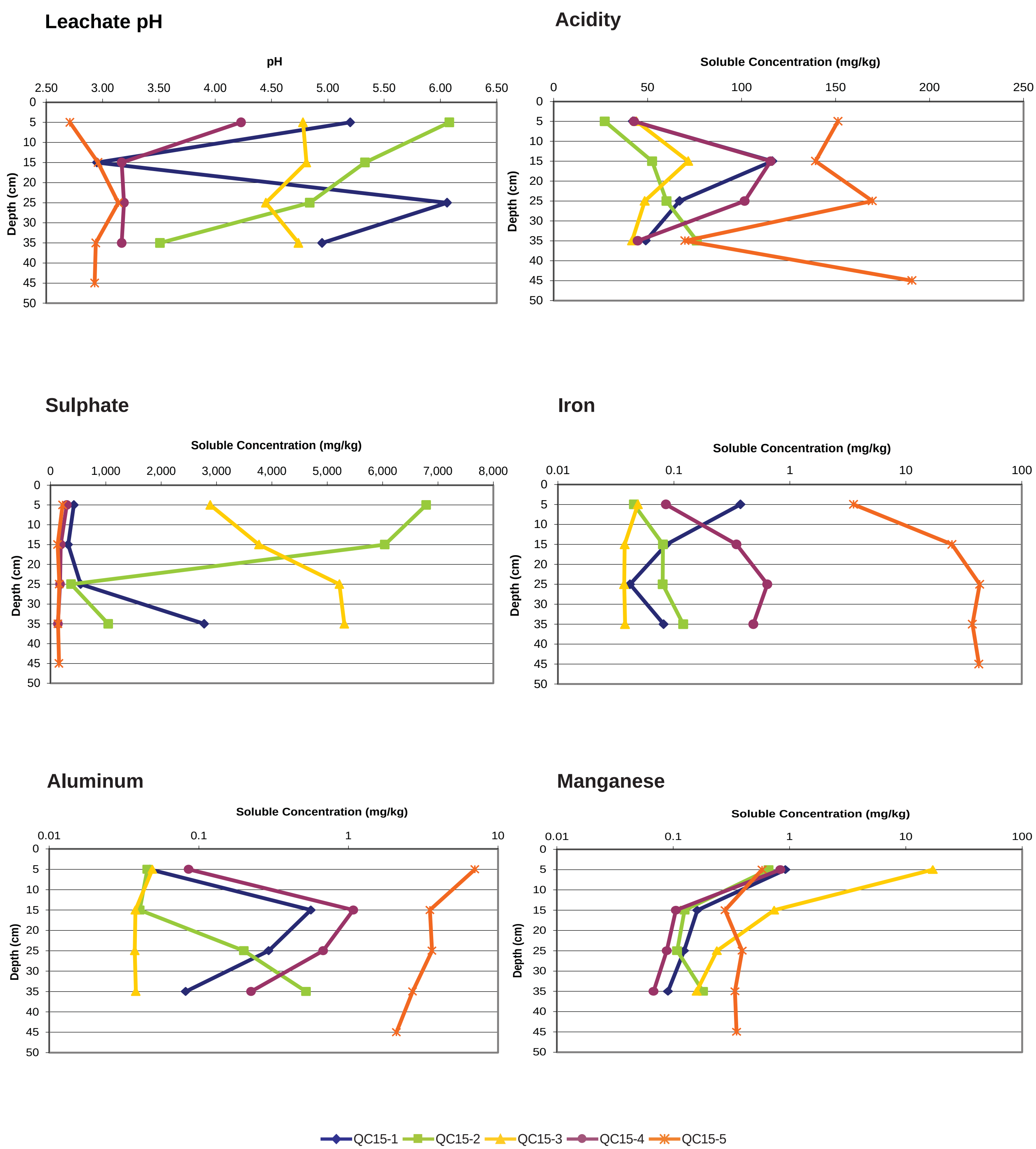
Rio Algom

Rio Algom Limited		
Quirke Cell 15 Sampling Stations		
EcoMetrix INCORPORATED	February 2011	**Figure 3.1**



Rio Algom

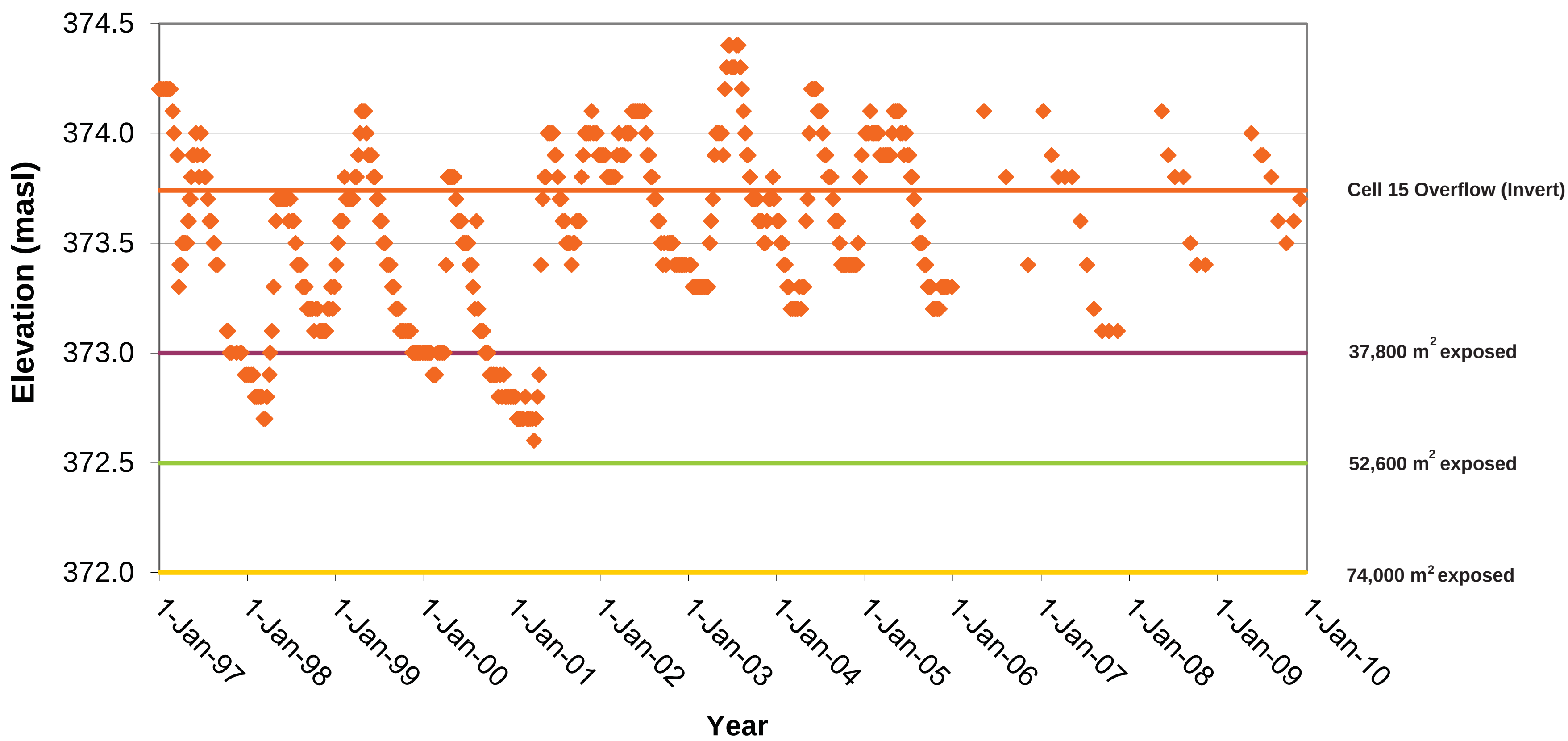
Rio Algom Limited		
Depth Profiles for Selected Constituents in Tailings Soilds		
EcoMetrix INCORPORATED	February 2011	**Figure 5.1**



Rio Algom Limited

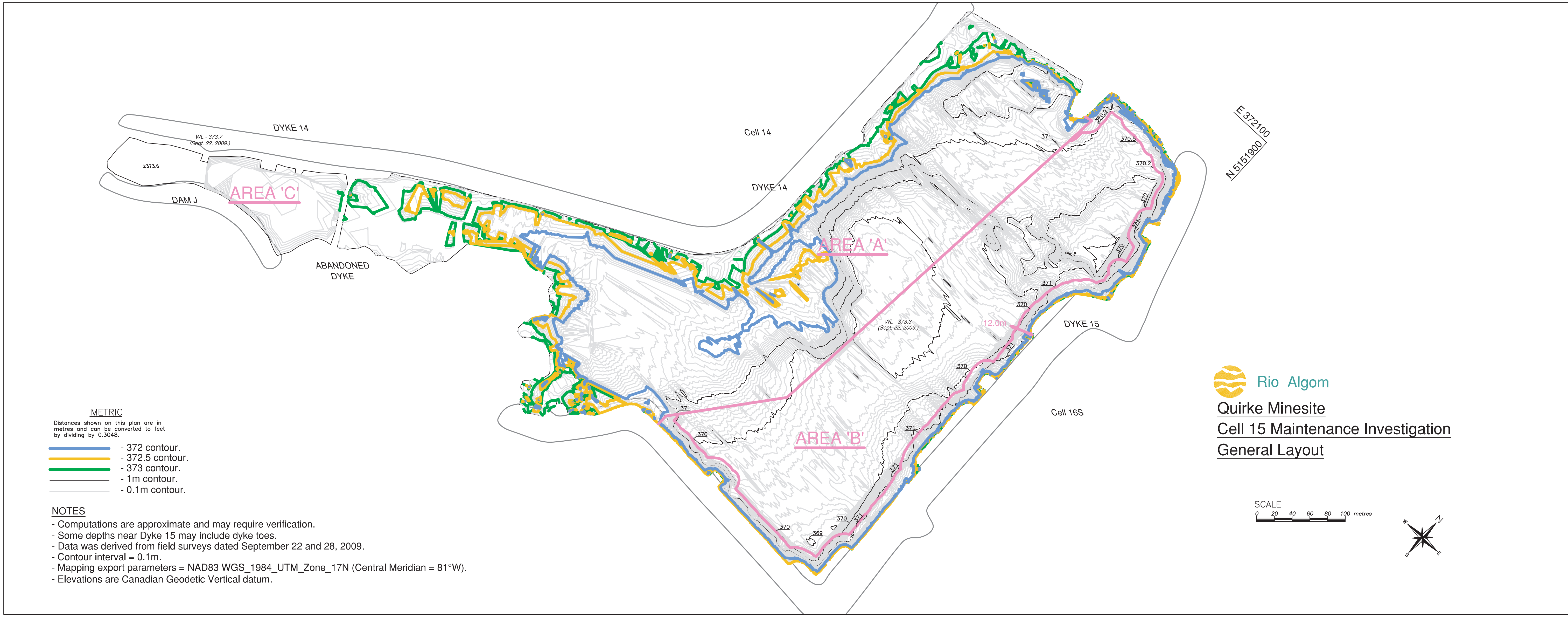
Depth Profiles for Selected Soluble Constituents

Rio Algom | EcoMetrix INCORPORATED | February 2011 | **Figure 5.2**



Rio Algom

Rio Algom Limited		
Time-Trend Plot for Water Elevations in Cell 15		
EcoMetrix INCORPORATED	February 2011	**Figure 6.1**



PAUL H. TORRANCE SURVEYING LTD.
GEOMATICS SERVICES
3A Elizabeth Walk, Elliot Lake, Ontario P5A 1Z2 (705) 848-9175 fax (705) 848-5464
torrance@inorth.on.ca

PLAN	DATE	REFERENCE
Ebenau	October 6, 2009	205-018

2005\205-018\quirke\2009\Cell 15\sound (2000)

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Areas A, B and C Surveyed in the Bathymetric Study

EcoMetrix INCORPORATED

February 2011

Figure 6.2

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torrance@inorth.on.ca

PLAN	DATE	REFERENCE
Ebenau	October 6, 2009	205-018

2005\205-018\quirke\2009\Cell 15\sound (373)

Rio Algom

Rio Algom Limited

Estimated Area of Exposed Tailings at Water Elevation 373.0 masl

EcoMetrix INCORPORATED

February 2011

Figure 6.3

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torrance@inorth.on.ca

PLAN	DATE	REFERENCE
Ebenau	October 6, 2009	205-018

2005\205-018\quirke\2009\Cell 15\sound (372.5)

Rio Algom

Rio Algom Limited

Estimated Area of Exposed Tailings at Water Elevation 372.5 masl

EcoMetrix INCORPORATED

February 2011

Figure 6.4

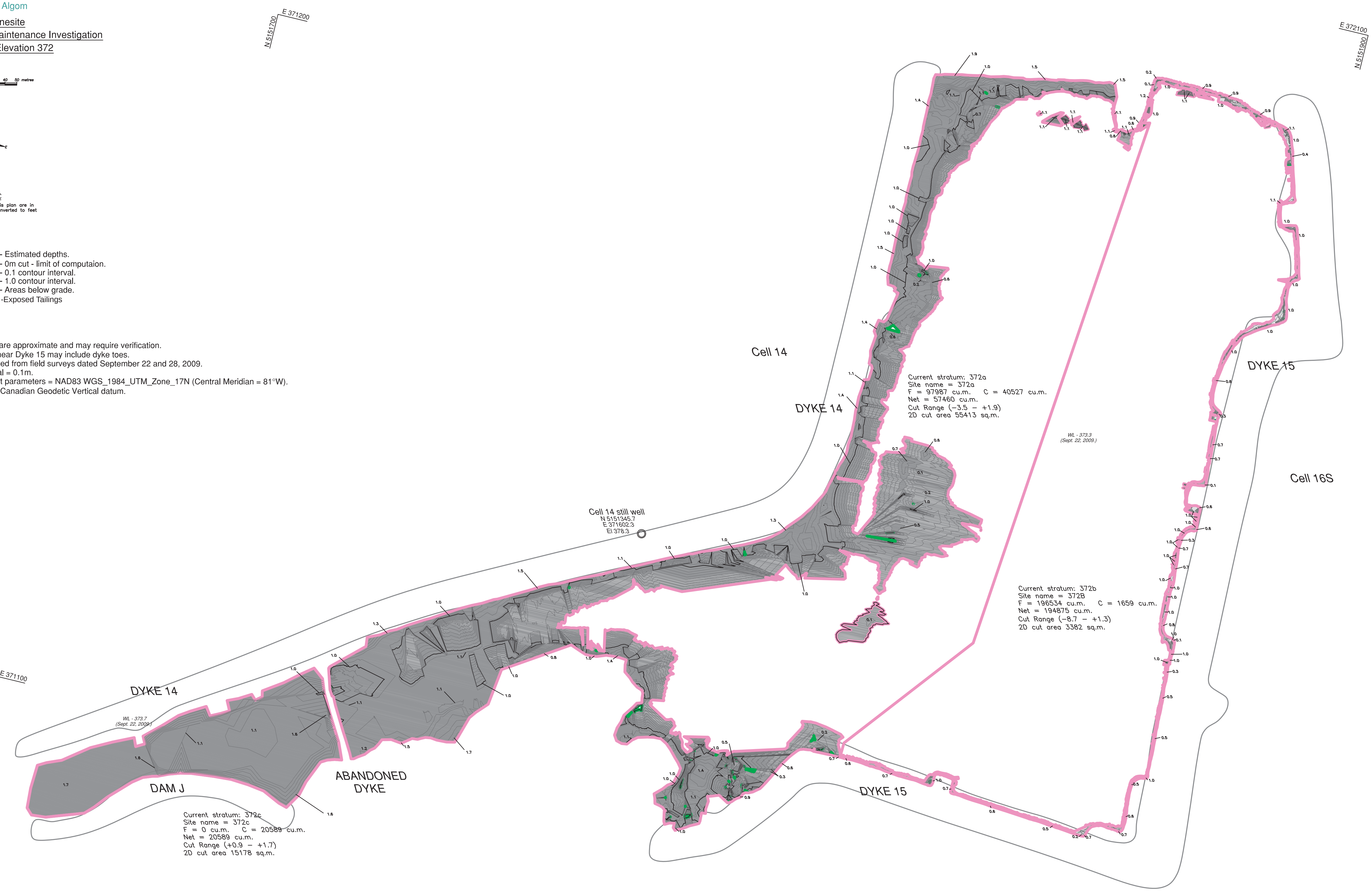
Rio Algom
Quirke Minesite
Cell 15 Maintenance Investigation
Contour Elevation 372

SCALE 0 10 20 30 40 50 metres

METRIC
Distances shown on this plan are in metres and can be converted to feet by dividing by 0.3048.

- 1.0 - Estimated depths.
- 0m cut - limit of computaion.
- 0.1 contour interval.
- 1.0 contour interval.
- Areas below grade.
- Exposed Tailings

NOTES
- Computations are approximate and may require verification.
- Some depths near Dyke 15 may include dyke toes.
- Data was derived from field surveys dated September 22 and 28, 2009.
- Contour interval = 0.1m.
- Mapping export parameters = NAD83 WGS_1984_UTM_Zone_17N (Central Meridian = 81°W).
- Elevations are Canadian Geodetic Vertical datum.



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torrance@inorth.on.ca

PLAN	DATE	REFERENCE
Ebenau	October 6, 2009	205-018

2005\205-018\quirke\2009\Cell 15\sound (372)

E 372100
N 5151100

Rio Algom

Rio Algom Limited

Estimated Area of Exposed Tailings at Water Elevation 372.0 masl

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February 2011

Figure 6.5

EcoMetrix
INCORPORATED

APPENDIX 1

Compilation of Routine Monitoring Data at the Quirke TMA

Table A1.1: Routine Monitoring Data for Basin Water in Cell 14

Date	pH (pH units)	Acidity (mg/L as $CaCO_3$)	Sulphate (mg/L)
1-Jun-92	3.4	75	
1-Sep-92	3.7	65	
1-Oct-92	3.3	120	374.0
1-Nov-92	4.3	57	161.0
1-Dec-92	7.4	3	45.0
1-Jan-93	6.9	4	60.0
1-Feb-93	7.2	3	68.0
1-Mar-93	6.5	7	94.0
1-Apr-93	5.2	10	45.0
1-May-93	6.7	6	64.0
1-Jun-93	7.1	5	57.0
1-Jul-93	7.2	3	64.0
1-Aug-93	7.2	3	76.0
1-Sep-93	7.2	6	75.0
1-Oct-93	7.0	5	73.0
1-Nov-93	6.8	6	64.0
1-Dec-93	6.8	7	16.0
1-Jan-94	6.5	6	13.0
1-Feb-94	6.8	6	56.0
1-Mar-94	6.8	6	33.0
1-Apr-94	6.7	6	41.0
1-May-94	6.7	7	33.0
1-Jun-94	7.1	6	36.0
1-Jul-94	7.9	5	40.0
1-Aug-94	6.9	3	44.0
1-Sep-94	7.0	3	47.0
1-Oct-94	7.0	3	51.0
1-Nov-94	6.9	5	33.0
1-Dec-94	7.0	4	41.0
1-Jan-95	6.8	5	48.0
1-Feb-95	6.7	6	53.0
1-Mar-95	6.6	6	44.0
1-Apr-95	6.8	5	9.0
1-May-95	6.6	5	18.0
1-Jun-95	6.5	5	14.0
1-Jul-95	7.0	4	19.0
1-Aug-95	7.4	2	29.0
1-Sep-95	6.7	4	30.0
1-Oct-95	6.6	4	32.0
1-Nov-95	6.3	3	35.0
1-Dec-95	7.0	3	38.0
1-Jan-96	6.0	8	21.0
1-Feb-96	5.9	6	10.0
1-Mar-96	6.1	7	31.0
1-Apr-96	6.5	6	31.0
1-May-96	5.0	8	5.0
1-Jun-96	7.1	5	19.0
1-Jul-96	7.1	2	19.0
1-Aug-96	7.3	2	25.0
1-Sep-96	7.4	1	25.0
1-Oct-96	6.9	3	40.0
1-Nov-96	6.7	2	35.0
1-Dec-96	7.6	3	38.0
1-Jan-97	6.4	2	19.0
1-Feb-97	6.4	2	23.0
1-Mar-97	7.0	3	35.0
1-Apr-97	6.8	3	56.0
1-May-97	6.8	3	26.0
1-Jun-97	7.0	2	25.5
1-Jul-97	7.3	3	5.0
1-Aug-97	7.0	2	38.0
1-Sep-97	7.7	2	33.0
1-Oct-97	7.0	2	42.0
1-Nov-97	7.5	4	49.0
1-Dec-97	7.8	4	51.0
1-Jan-98	7.1	5	56.0
1-Feb-98	7.0	2	51.0
1-Mar-98	7.0	3	44.0
1-Apr-98	6.4	3	5.0
1-May-98	7.1	2	22.4
1-Jun-98	7.5	2	21.0
1-Jul-98	7.5	3	26.4
1-Aug-98	6.9	2	31.8
1-Sep-98	7.8	5	37.0
1-Oct-98	7.6	3	42.2

Table A1.1: Routine Monitoring Data for Basin Water in Cell 14

Date	pH (pH units)	Acidity (mg/L as $CaCO_3$)	Sulphate (mg/L)
1-Nov-98	7.7	2	45.5
1-Dec-98	7.6	3	43.6
1-Jan-99	7.5	2	42.5
1-Feb-99	7.3	3	29.9
1-Mar-99	7.4	2	39.4
1-Apr-99	6.6	3	7.6
1-May-99	7.6	1	23.5
1-Jun-99	7.7	2	28.0
1-Jul-99	7.8	1	30.0
1-Aug-99	8.2	2	30.1
1-Sep-99	8.2	1	33.0
1-Oct-99	7.7	1	35.6
1-Nov-99	7.7	2	38.5
1-Dec-99	7.8	2	38.3
1-Jan-00	7.8	3	63.8
1-Feb-00	7.5	3	53.6
1-Mar-00	7.0	2	22.4
1-Apr-00	6.2	3	4.8
1-May-00	7.7	1	25.7
1-Jun-00	8.6	<1	27.8
1-Jul-00	7.7	1	29.2
1-Aug-00	7.7	3	25.1
1-Sep-00	8.0	2	33.9
1-Oct-00	7.8	2	34.7
1-Nov-00	7.8	2	43.1
1-Dec-00	7.7	3	53.0
1-Jan-01	7.1	6	67.2
1-Feb-01	0.0		
1-Mar-01	7.0	5	56.3
1-Apr-01	7.0	2	18.2
1-May-01	7.7	3	21.4
1-Jun-01	7.6	2	22.4
1-Jul-01	7.7	8	25.2
1-Aug-01	8.0	2	30.0
1-Sep-01	8.1	2	28.9
1-Oct-01	8.1	2	28.1
1-Nov-01	7.5	2	27.3
1-Dec-01	7.6	2	30.1
1-Jan-02	7.5	2	34.3
1-Feb-02	7.3	2	34.8
1-Mar-02	7.5	3	35.6
1-Apr-02	7.1	3	29.7
1-May-02	7.7	2	22.5
1-Jun-02	7.8	1	23.1
1-Jul-02	8.2	1	20.4
1-Aug-02	7.5	1	26.7
1-Sep-02	7.8	2	23.0
1-Oct-02	7.6	2	24.4
1-Nov-02	7.6	2	25.7
1-Dec-02	7.6	2	30.3
1-Jan-03			
1-Feb-03			
1-Mar-03			
1-Apr-03	6.4	4	
1-May-03			
1-Jun-03			
1-Jul-03			
1-Apr-04	5.9	7	
1-Oct-04	6.8	2	
1-Apr-05	6.5	6	
1-Aug-05	7.1	2	18.3
1-Sep-05	7.0	2	19.3
1-Oct-05	7.4	3	22.0
1-Nov-05	6.8	3	20.0
1-Dec-05	7.2	3	21.9
1-May-06	7.0	1	15.0
1-Jun-06	6.8	2	21.0
1-Jul-06	7.1	1	12.0
1-Aug-06	7.8	1	13.0
1-Oct-06	7.1	1	13.0
1-Nov-06	6.5		
14-Mar-07	6.2	1	16.0
11-Apr-07			
10-May-07	6.8	1	10.0
13-Jun-07			

Table A1.1: Routine Monitoring Data for Basin Water in Cell 14

Date	pH (pH units)	Acidity (mg/L as $CaCO_3$)	Sulphate (mg/L)
11-Jul-07			
8-Aug-07	7.0	1	12.0
12-Sep-07			
10-Oct-07			
14-Nov-07	6.2	1	16.0
13-Feb-08	6.6	1	8.6
15-May-08	6.9	1	9.7
11-Jun-08			
9-Jul-08			
13-Aug-08	7.1	1	18.0
10-Sep-08			
8-Oct-08			
12-Nov-08	6.7	<1.0	15
21-May-09	6.5	<1.0	11
30-Jun-09			
8-Jul-09			
12-Aug-09			
9-Sep-09			
14-Oct-09			
12-Nov-09	6.8	2	15.0
9-Dec-09			

Table A1.2: Routine Monitoring Data for Basin Water in Cell 15

Date	pH	Acidity	Sulphate
	(pH units)	(mg/L as $CaCO_3$)	(mg/L)
1-Jan-95	9.2	1	
1-Feb-95	10.9	1	
1-Mar-95	9.5	1	
1-Apr-95	7.6	12	
1-May-95	9.3	1	
1-Jun-95	6.8	7	
1-Jul-95	6.3	5	
1-Aug-95	7.9	2	
1-Sep-95	9.4	0	
1-Oct-95	8.6	0	
1-Nov-95	8.6	3	
1-Dec-95	8.8	0	
1-Jan-96	8.1	3	
1-Feb-96	6.5	17	
1-Mar-96	6.2	43	
1-Apr-96	6.4	9	
1-May-96	6.9	6	
1-Jun-96	7.3	4	
1-Jul-96	8.0	2	
1-Aug-96	7.7	3	
1-Sep-96	8.0	2	
1-Oct-96	7.9	4	
1-Nov-96	8.3	1	
1-Dec-96	7.5	4	
1-Jan-97	6.7	6	
1-Feb-97	7.1	5	
1-Mar-97	6.8	12	
1-Apr-97	6.4	2	
1-May-97	8.0	2	
1-Jun-97	7.6	3	
1-Jul-97	7.9	2	
1-Aug-97	7.7	3	
1-Sep-97	7.8	3	
1-Oct-97	7.6	5	
1-Nov-97	7.8	3	
1-Dec-97	7.4	6	
1-Jan-98	7.3	8	
1-Feb-98	7.2	6	
1-Mar-98	7.1	9	
1-Apr-98	6.8	8	
1-May-98	7.3	5	
1-Jun-98	7.3	3	517
1-Jul-98	7.4	4	
1-Aug-98	7.5	4	
1-Sep-98	7.4	4	
1-Oct-98	7.3	4	
1-Nov-98	7.6	5	
1-Dec-98	7.6	4	
1-Jan-99	7.4	2	
1-Feb-99	7.1	5	
1-Mar-99	6.7	7	
1-Apr-99	6.4	6	
1-May-99	7.5	4	
1-Jun-99	7.4	4	
1-Jul-99	7.3	3	
1-Aug-99	7.1	3	
1-Sep-99	7.1	3	
1-Oct-99	7.1	3	
1-Nov-99	7.5	4	
1-Dec-99	7.9	4	
1-Jan-00	7.8	6	
1-Feb-00	7.5	6	
1-Mar-00	7.0	6	
1-Apr-00	7.1	7	
1-May-00	7.4	4	
1-Jun-00	7.5	3	
1-Jul-00	7.2	3	
1-Aug-00	7.2	4	
1-Sep-00	7.0	4	
1-Oct-00	6.9	5	
1-Nov-00	7.0	5	
1-Dec-00	6.9	6	
1-Jan-01	7.0	6	
1-Feb-01	6.7	6	
1-Mar-01	6.4	8	
1-Apr-01	6.2	6	

Table A1.2: Routine Monitoring Data for Basin Water in Cell 15

Date	pH (pH units)	Acidity (mg/L as $CaCO_3$)	Sulphate (mg/L)
1-May-01	6.8	5	
1-Jun-01	6.8	4	
1-Jul-01	6.6	4	
1-Aug-01	6.4	4	
1-Sep-01	6.4	6	
1-Oct-01	6.4	5	
1-Nov-01	6.3	4	
1-Dec-01	6.3	4	
1-Jan-02	6.1	6	
1-Feb-02	6.0	10	
1-Mar-02	6.3	14	
1-Apr-02	5.8	6	
1-May-02	6.5	4	
1-Jun-02	6.8	3	
1-Jul-02	6.7	3	
1-Aug-02	6.8	3	
1-Sep-02	6.6	4	
1-Oct-02	6.5	4	
1-Nov-02	6.5	5	
1-Dec-02	6.2	5	
1-Jan-03			
1-Feb-03			
1-Mar-03			
1-Apr-03	5.6	5	
1-May-03			
1-Jun-03			
1-Jul-03			
1-Aug-03			
1-Sep-03			
1-Oct-03	7.1	3	
1-Nov-03			
1-Dec-03			
1-Jan-04			
1-Feb-04			
1-Mar-04			
1-Apr-04	4.5	3	
1-May-04			
1-Jun-04			
1-Jul-04			
1-Aug-04			
1-Sep-04			
1-Oct-04	7.0	4	
1-Nov-04			
1-Dec-04			
1-Jan-05			
1-Feb-05			
1-Mar-05			
1-Apr-05	6.0	3	
1-May-05			
1-Jun-05			
1-Jul-05			
1-Aug-05	6.9	3	515
1-Sep-05			
1-Oct-05	6.8	5	730
1-Nov-05			
1-Dec-05			
10-May-06	6.7	1	470
9-Aug-06	7.5	2	490
8-Nov-06	6.5	4	580
10-Jan-07			
14-Feb-07			
14-Mar-07	6.2	1	310
11-Apr-07			
10-May-07	6.8	1	430
13-Jun-07			
11-Jul-07			
8-Aug-07	7.0	4	640
12-Sep-07			
10-Oct-07			
14-Nov-07	6.7	2	740
12-Dec-07			
9-Jan-08			
13-Feb-08	6.6	1	9
12-Mar-08			
9-Apr-08			
15-May-08	6.9	1	380

Table A1.2: Routine Monitoring Data for Basin Water in Cell 15

Date	pH (pH units)	Acidity (mg/L as $CaCO_3$)	Sulphate (mg/L)
11-Jun-08			
9-Jul-08			
13-Aug-08	7.0	1	480
10-Sep-08			
8-Oct-08			
12-Nov-08	6.7	<1.0	690
21-May-09	6.6	<1.0	440
30-Jun-09			
8-Jul-09			
12-Aug-09			
9-Sep-09			
14-Oct-09			
12-Nov-09	6.9	<1.0	560
9-Dec-09			

Table A1.3: Routine Monitoring Data for Basin Water in Cell 16

Date	pH (pH units)	Acidity (mg/L as $CaCO_3$)	Sulphate (mg/L)
1-Jan-90	8.5	35	
1-Feb-90	5.6	154	
1-Mar-90	5.0	132	
1-Apr-90	4.7	214	
1-May-90	3.7	388	
1-Jun-90	4.7	242	
1-Jul-90	3.5	775	
1-Aug-90	4.7	359	
1-Sep-90	7.1	91	
1-Oct-90	8.9	8	
1-Nov-90	5.3	122	
1-Dec-90	3.3	247	
1-Jan-91	3.0	379	
1-Feb-91	4.1	393	
1-Mar-91	4.8	339	
1-Apr-91	3.7	559	
1-May-91	3.4	1115	
1-Jun-91	3.1	652	
1-Jul-91	2.8	788	
1-Aug-91	3.3	666	
1-Sep-91	6.2	159	
1-Oct-91	4.1	645	
1-Nov-91	3.6	946	
1-Dec-91	3.1	1700	
1-Jan-92	2.9	2175	
1-Feb-92	3.0	2075	
1-Mar-92	3.0	2197	
1-Apr-92	3.4	680	
1-May-92	2.9	1196	
1-Jun-92	3.0	1002	
1-Jul-92	2.8	788	
1-Aug-92	2.7	1249	
1-Sep-92	2.7	1008	
1-Oct-92	3.0	740	
1-Nov-92	7.1	125	
1-Dec-92	4.0	238	
1-Jan-93	3.2	813	
1-Feb-93	3.3	1428	
1-Mar-93	3.4	1584	
1-Apr-93	3.3	618	
1-May-93	2.9	1039	
1-Jun-93	2.7	1010	
1-Jul-93	2.7	1093	
1-Aug-93	2.6	1163	
1-Sep-93	2.7	1109	
1-Oct-93	2.9	772	
1-Nov-93	2.9	691	
1-Dec-93	2.9	744	
1-Jan-94	3.1	936	
1-Feb-94	3.1	858	
1-Mar-94	3.1	1009	
1-Apr-94	3.4	731	
1-May-94	3.2	602	
1-Jun-94	2.9	507	
1-Jul-94	2.8	742	
1-Aug-94	2.7	641	
1-Sep-94	2.8	662	
1-Oct-94	2.9	613	
1-Feb-95	3.0	700	
1-Mar-95	3.3	275	
1-Apr-95	3.2	295	
1-May-95	3.2	311	
1-Jun-95	3.9	259	
1-Jul-95	2.8	321	
1-Aug-95	3.0	257	
1-Sep-95	3.2	183	
1-Oct-95	4.1	89	
1-Nov-95	6.3	8	
1-Dec-95	6.2	12	
1-Jan-96	6.6	16	
1-Feb-96	6.1	22	
1-Mar-96	6.4	33	
1-Apr-96	5.5	40	
1-May-96	4.8	21	
1-Jun-96	6.4	11	
1-Jul-96	7.5	7	

Table A1.3: Routine Monitoring Data for Basin Water in Cell 16

Date	pH	Acidity	Sulphate
	(pH units)	(mg/L as $CaCO_3$)	(mg/L)
1-Aug-96	7.4	5	
1-Sep-96	7.7	7	
1-Oct-96	7.7	5	
1-Nov-96	7.7	6	
1-Dec-96	7.4	6	
1-Jan-97	7.0	11	
1-Feb-97	6.7	17	
1-Mar-97	6.8	22	
1-Apr-97	6.4	24	
1-May-97	7.3	10	
1-Jun-97	7.6	5	
1-Jul-97	7.6	6	
1-Aug-97	7.6	5	
1-Sep-97	7.5	6	
1-Oct-97	7.6	5	
1-Nov-97	7.8	5	
1-Dec-97	7.3	8	
1-Jan-98	7.1	11	
1-Feb-98	7.2	11	
1-Mar-98	6.9	13	
1-Apr-98	6.9	12	
1-May-98	7.5	7	
1-Jun-98	7.8	5	
1-Jul-98	8.0	6	
1-Aug-98	8.0	4	
1-Sep-98	8.1	4	
1-Oct-98	7.9	5	
1-Nov-98	8.4	1	
1-Dec-98	7.8	4	
1-Jan-99	7.6	6	
1-Feb-99	7.3	7	
1-Mar-99	7.1	11	
1-Apr-99	7.3	7	
1-May-99	7.9	4	
1-Jun-99	7.9	6	
1-Jul-99	7.8	5	
1-Aug-99	7.7	6	
1-Sep-99	7.9	5	
1-Oct-99	7.8	5	
1-Nov-99	8.2	3	
1-Dec-99	8.5	0	
1-Jan-00	8.4	0	
1-Feb-00	8.2	2	
1-Mar-00	6.6	17	
1-Apr-00	7.4	6	
1-May-00	7.7	6	
1-Jun-00	7.7	5	
1-Jul-00	7.7	5	
1-Aug-00	7.8	6	
1-Sep-00	7.8	5	
1-Oct-00	8.2	4	
1-Nov-00	7.7	6	
1-Dec-00	8.0	5	
1-Jan-01	8.3	4	
1-Feb-01	7.4	9	
1-Mar-01	7.4	12	
1-Apr-01	7.5	13	
1-May-01	7.4	7	
1-Jun-01	7.4	5	
1-Jul-01	7.3	5	
1-Aug-01	7.0	6	
1-Sep-01	6.4	8	
1-Oct-01	4.7	10	
1-Nov-01	3.9	17	
1-Dec-01	4.2	18	
1-Jan-02	4.1	24	
1-Feb-02	3.8	40	
1-Mar-02	3.8	47	
1-Apr-02	4.0	42	
1-May-02	3.8	38	
1-Jun-02	3.6	35	
1-Jul-02	3.5	38	
1-Aug-02	3.5	41	
1-Sep-02	3.5	48	
1-Oct-02	3.5	40	
1-Nov-02	3.5	42	

Table A1.3: Routine Monitoring Data for Basin Water in Cell 16

Date	pH	Acidity	Sulphate
	(pH units)	(mg/L as $CaCO_3$)	(mg/L)
1-Dec-02	3.6	39	
1-Jan-03			
1-Feb-03			
1-Mar-03			
1-Apr-03	3.7	19	
1-May-03			
1-Jun-03			
1-Jul-03			
1-Aug-03			
1-Sep-03			
1-Oct-03	6.4	12	
1-Nov-03			
1-Dec-03			
1-Jan-04			
1-Feb-04			
1-Mar-04			
1-Apr-04	4.4	11	
1-May-04			
1-Jun-04			
1-Jul-04			
1-Aug-04			
1-Sep-04			
1-Oct-04	7.3	6	
1-Nov-04			
1-Dec-04			
1-Jan-05			
1-Feb-05			
1-Mar-05			
1-Apr-05	5.5	7	
1-May-05			
1-Jun-05			
1-Jul-05			
1-Aug-05	6.4	7	1245
1-Sep-05			
1-Oct-05	7.8	5	1697
1-Nov-05			
1-Dec-05			
10-May-06	4.2	14	1000
9-Aug-06	7.3	10	1100
8-Nov-06	4.5	17	1100
10-Jan-07			
14-Feb-07			
14-Mar-07	4.0	20	1100
11-Apr-07			
10-May-07	4.0	24	960
13-Jun-07			
11-Jul-07			
8-Aug-07	6.8	9	1200
12-Sep-07			
10-Oct-07			
14-Nov-07	6.9	4	1200
12-Dec-07			
9-Jan-08			
13-Feb-08	6.5	3	1100
12-Mar-08			
9-Apr-08			
15-May-08	6.2	13	990
11-Jun-08			
9-Jul-08			
13-Aug-08	7.0	4	910
10-Sep-08			
8-Oct-08			
12-Nov-08	7.3	1	1000
21-May-09	6.4	8	940
30-Jun-09			
31-Jul-09			
28-Aug-09			
30-Sep-09			
31-Oct-09			
12-Nov-09	8.0	<1	1000
30-Nov-09			

Table A1.4: Routine Monitoring Data for Basin Water in Cell 17

Date	pH (pH units)	Acidity (mg/L as $CaCO_3$)	Sulphate (mg/L)
1-Aug-95	3	300	
1-Sep-95	5.3	47	
1-Oct-95	6.4	10	
1-Nov-95	6.9	7	
1-Dec-95	6.3	9	
1-Jan-96	6.7	12	
1-Feb-96	6.5	14	
1-Mar-96	6.3	18	
1-Apr-96	5.3	51	
1-May-96	5.8	47	
1-Jun-96	7.4	4	
1-Jul-96	7.6	9	
1-Aug-96	7.4	6	
1-Sep-96	8.2	4	
1-Oct-96	8	3	
1-Nov-96	7.3	13	
1-Dec-96	7.5	5	
1-Jan-97	7.3	11	
1-Feb-97	6.9	15	
1-Mar-97	7	17	
1-Apr-97	6.8	16	
1-May-97	6.3	31	
1-Jun-97	5.9	15	
1-Jul-97	7.3	7	
1-Aug-97	7.9	5	
1-Sep-97	7.5	6	
1-Oct-97	8.1	3	
1-Nov-97	8.4	0	
1-Dec-97	8.2	3	
1-Jan-98	8.2	4	
1-Feb-98	7.3	9	
1-Mar-98	6.7	14	
1-Apr-98	5.8	35	
1-May-98	6.5	16	
1-Jun-98	7.5	6	
1-Jul-98	7.7	6	
1-Aug-98	7.5	5	
1-Sep-98	8.8	1	
1-Oct-98	8.5	1	
1-Nov-98	8.4	2	
1-Dec-98	7.8	4	
1-Jan-99	7.3	7	
1-Feb-99	7	8	
1-Mar-99	6.9	13	
1-Apr-99	6.9	7	
1-May-99	7.3	8	
1-Jun-99	7.5	7	
1-Jul-99	8.5	2	
1-Aug-99	7.7	5	
1-Sep-99	7.8	5	
1-Oct-99	7.7	5	
1-Nov-99	8.2	3	
1-Dec-99	8.5	1	
1-Jan-00	7.5	9	
1-Feb-00	7.1	10	
1-Mar-00	6.7	12	
1-Apr-00	6.6	15	
1-May-00	7.4	4	
1-Jun-00	7.2	7	
1-Jul-00	7.3	5	
1-Aug-00	7.1	7	
1-Sep-00	7.3	6	
1-Oct-00	7.9	4	
1-Nov-00	7.5	8	
1-Dec-00	7.6	9	
1-Jan-01	6.9	15	
1-Feb-01	6.8	17	
1-Mar-01	6.8	16	
1-Apr-01	6.7	22	
1-May-01	7.2	7	
1-Jun-01	7.1	5	
1-Jul-01	6.7	6	
1-Aug-01	5.8	8	
1-Sep-01	4.4	12	
1-Oct-01	4.1	13	
1-Nov-01	4.2	19	

Table A1.4: Routine Monitoring Data for Basin Water in Cell 17

Date	pH (pH units)	Acidity (mg/L as $CaCO_3$)	Sulphate (mg/L)
1-Dec-01	4.7	16	
1-Jan-02	4.2	22	
1-Feb-02	4	37	
1-Mar-02	3.9	38	
1-Apr-02	4	36	
1-May-02	4.5	49	
1-Jun-02	3.6	35	
1-Jul-02	3.6	35	
1-Aug-02	4.7	19	
1-Sep-02	7.4	6	
1-Oct-02	7.3	5	
1-Nov-02	5.8	10	
1-Dec-02	4	25	
1-Jan-03			
1-Feb-03			
1-Mar-03			
1-Apr-03	3.8	27	
1-May-03			
1-Jun-03			
1-Jul-03			
1-Aug-03			
1-Sep-03			
1-Oct-03	4.6	12	
1-Nov-03			
1-Dec-03			
1-Jan-04			
1-Feb-04			
1-Mar-04			
1-Apr-04	5	15	
1-May-04			
1-Jun-04			
1-Jul-04			
1-Aug-04			
1-Sep-04			
1-Oct-04	6.8	10	
1-Nov-04			
1-Dec-04			
1-Jan-05			
1-Feb-05			
1-Mar-05			
1-Apr-05	6	8	
1-May-05			
1-Jun-05			
1-Jul-05			
1-Aug-05	7.2	6	1422
1-Sep-05			
1-Oct-05	6.5	9	1768
1-Nov-05			
1-Dec-05			
10-May-06	3.9	26	1100
9-Aug-06	7.1	24	1200
8-Nov-06	4	20	1200
10-Jan-07			
14-Feb-07			
14-Mar-07	4	19	1200
11-Apr-07			
10-May-07	4.1	18	980
13-Jun-07			
11-Jul-07			
8-Aug-07	7.7	<1	1400
12-Sep-07			
10-Oct-07			
14-Nov-07	6.9	7	1200
12-Dec-07			
9-Jan-08			
13-Feb-08	6.2	3	1100
12-Mar-08			
9-Apr-08			
15-May-08	4.9	16	930
11-Jun-08			
9-Jul-08			
13-Aug-08	8.8	<1	980
10-Sep-08			
8-Oct-08			
12-Nov-08	7	<1.0	880
21-May-09	4.9	12	980

Table A1.4: Routine Monitoring Data for Basin Water in Cell 17

Date	pH (pH units)	Acidity (mg/L as $CaCO_3$)	Sulphate (mg/L)
30-Jun-09			
31-Jul-09			
28-Aug-09			
30-Sep-09			
31-Oct-09			
12-Nov-09	7.5	2	1100
30-Nov-09			

Table A1.5: Routine Monitoring Data in Piezometers at DK14-4

DK14-4A (369.4 masl)		DK14-4B (372.3 masl)		DK14-4C (374.2 masl)		DK14-4D (375.6 masl)	
Date	Acidity (mg/L as $CaCO_3$)	Date	Acidity (mg/L as $CaCO_3$)	Date	Acidity (mg/L as $CaCO_3$)	Date	Acidity (mg/L as $CaCO_3$)
22/11/1991	18	29/08/1991	10	29/08/1991	9	22/06/1992	450
23/06/1992	30	12/09/1991	<1	12/09/1991	9	22/06/1993	230
13/10/1992	<1	27/09/1991	8	27/09/1991	18	16/08/1993	380
23/06/1993	50	22/11/1991	20	22/11/1991	10	04/10/1993	510
18/08/1993	<1	23/06/1992	12	23/06/1992	4500	20/10/1994	170
05/10/1993	13	13/10/1992	28	23/06/1993	3350	03/10/1995	76
20/10/1994	<1	23/06/1993	30	18/08/1993	4000	10/06/1996	38
03/10/1995	4	18/08/1993	77	05/10/1993	3450	08/10/1996	28
11/06/1996	12	05/10/1993	110	20/10/1994	475	09/06/1997	68
11/10/1996	18	20/10/1994	280	03/10/1995	330	25/10/1997	29
10/06/1997	16	03/10/1995	40	11/06/1996	240	11/06/1998	30
28/10/1997	19	11/06/1996	230	11/10/1996	162	23/06/1999	18
11/06/1998	13	11/10/1996	100	09/06/1997	98	27/06/2000	16
23/06/1999	10	10/06/1997	17	28/10/1997	128	29/06/2001	5
28/06/2000	8	28/10/1997	105	11/06/1998	110	17/07/2002	24
03/07/2001	8	11/06/1998	100	23/06/1999	89	25/06/2003	8
18/07/2002	7	23/06/1999	88	28/06/2000	72	30/06/2004	186
25/06/2003	6	28/06/2000	61	03/07/2001	30	05/07/2005	177
05/07/2004	346	03/07/2001	36	17/07/2002	20	28/06/2006	<1
05/07/2005	131	17/07/2002	25	25/06/2003	32	24/08/2007	<1
28/06/2006	35	25/06/2003	39	05/07/2004	1106	23/07/2008	<1
24/08/2007	<1	30/06/2004	32	05/07/2005	448	17/06/2009	3
24/07/2008	<1	05/07/2005	125	28/06/2006	8		
15/06/2009	<1	24/08/2007	<1	24/08/2007	<1		
		24/07/2008	<1	23/07/2008	<1		
		15/06/2009	<1	16/06/2009	<1		
				14/07/2009	<1		

Table A1.6: Routine Monitoring Data in Piezometers at DK14-5

DK14-5A (366.2 masl)		DK14-5B (369.2 masl)		DK14-5C (370.5 masl)		DK14-5D (372.0 masl)	
Date	Acidity (mg/L as $CaCO_3$)	Date	Acidity (mg/L as $CaCO_3$)	Date	Acidity (mg/L as $CaCO_3$)	Date	Acidity (mg/L as $CaCO_3$)
20/08/1991	<1	20/08/1991	8	29/08/1991	8	29/08/1991	15
11/09/1991	<1	11/09/1991	6	11/09/1991	6	11/09/1991	53
26/09/1991	<1	26/09/1991	11	26/09/1991	9	26/09/1991	43
22/11/1991	<1	22/11/1991	9	22/11/1991	9	22/11/1991	6
10/06/1992	<1	22/06/1992	5	22/06/1992	7	22/06/1992	212
13/10/1992	<1	13/10/1992	12	13/10/1992	12	13/10/1992	5
22/06/1993	<1	22/06/1993	12	22/06/1993	10	22/06/1993	200
16/08/1993	<1	16/08/1993	14	16/08/1993	22	16/08/1993	290
05/10/1993	<1	04/10/1993	12	04/10/1993	16	04/10/1993	280
20/10/1994	<1	20/10/1994	5	20/10/1994	5	20/10/1994	125
03/10/1995	<1	03/10/1995	1	03/10/1995	7	03/10/1995	200
11/06/1996	<1	10/06/1996	<1	10/06/1996	6	10/06/1996	130
10/10/1996	<1	08/10/1996	14	08/10/1996	13	08/10/1996	102
09/06/1997	<1	09/06/1997	13	09/06/1997	13	09/06/1997	73
25/10/1997	<1	25/10/1997	11	25/10/1997	16	25/10/1997	67
11/06/1998	<1	11/06/1998	17	11/06/1998	19	11/06/1998	57
22/06/1999	<1	23/06/1999	14	23/06/1999	14	23/06/1999	60
27/06/2000	<1	27/06/2000	11	27/06/2000	12	27/06/2000	80
29/06/2001	<1	29/06/2001	13	29/06/2001	12	29/06/2001	57
31/05/2002	<1	22/07/2002	6	22/07/2002	14	22/07/2002	44
24/06/2003	<1	24/06/2003	12	24/06/2003	11	24/06/2003	38
05/07/2004	<1	06/07/2004	6	06/07/2004	9	06/07/2004	87
05/07/2005	<1	05/07/2005	15	05/07/2005	13	05/07/2005	45
28/06/2006	<1	28/06/2006	<1	29/06/2006	<1	29/06/2006	<1
24/08/2007	<1	24/08/2007	<1	24/08/2007	<1	24/08/2007	<1
23/07/2008	<1	24/07/2008	<1	24/07/2008	<1	23/07/2008	<1
16/06/2009	<1	17/06/2009	<1	15/06/2009	<1	17/06/2009	<1

Table A1.7: Routine Monitoring Data in Piezometers at DK15-1

DK15-1A (365.4 masl)		DK15-1B (368.2 masl)		DK15-1C (369.9 masl)		DK15-1D (371.2 masl)	
Date	Acidity (mg/L as $CaCO_3$)	Date	Acidity (mg/L as $CaCO_3$)	Date	Acidity (mg/L as $CaCO_3$)	Date	Acidity (mg/L as $CaCO_3$)
12/10/1995	1010	12/10/1995	12	12/10/1995	220	12/10/1995	310
17/06/1996	1050	17/06/1996	25	17/06/1996	230	17/06/1996	280
17/10/1996	632	17/10/1996	18	17/10/1996	124	17/10/1996	70
16/06/1997	462	16/06/1997	8	16/06/1997	5	16/06/1997	37
31/10/1997	259	31/10/1997	9	31/10/1997	57	31/10/1997	88
28/07/1998	337	28/07/1998	7	28/07/1998	45	28/07/1998	50
28/09/1999	269	28/09/1999	4	28/09/1999	27	28/09/1999	25
31/07/2000	199	31/07/2000	8	31/07/2000	29	31/07/2000	12
04/07/2001	90	04/07/2001	3	04/07/2001	61	04/07/2001	28
04/07/2002	104	04/07/2002	4	04/07/2002	60	27/06/2002	13
26/06/2003	108	26/06/2003	4	26/06/2003	21	26/06/2003	14
07/07/2004	129	07/07/2004	3	07/07/2004	14	07/07/2004	36
05/07/2005	102	05/07/2005	6	05/07/2005	18	05/07/2005	34
26/06/2006	66	26/06/2006	<1	26/06/2006	<1	26/06/2006	22
02/08/2007	51	02/08/2007	<1	02/08/2007	4	02/08/2007	22
21/07/2008	47	21/07/2008	<1	21/07/2008	<1	21/07/2008	24
17/06/2009	<1	16/06/2009	<1	16/06/2009	<1	16/06/2009	29
13/07/2009	38						

Table A1.8: Routine Monitoring Data in Piezometers at DK15-2

DK15-2A (360.7 masl)		DK15-2B (363.6 masl)		DK15-2C (365.4 masl)		DK15-2D (366.8 masl)	
Date	Acidity (mg/L as $CaCO_3$)	Date	Acidity (mg/L as $CaCO_3$)	Date	Acidity (mg/L as $CaCO_3$)	Date	Acidity (mg/L as $CaCO_3$)
12/10/1995	4250	12/10/1995	4000	12/10/1995	3400	12/10/1995	2450
17/06/1996	5250	17/06/1996	4500	17/06/1996	4250	17/06/1996	2800
17/10/1996	6140	17/10/1996	5010	17/10/1996	4660	17/10/1996	4430
16/06/1997	4690	16/06/1997	5060	16/06/1997	5060	16/06/1997	4650
31/10/1997	4700	31/10/1997	4650	31/10/1997	4480	31/10/1997	500
28/07/1998	3950	28/07/1998	3870	28/07/1998	3900	28/07/1998	3750
28/09/1999	2732	28/09/1999	2860	28/09/1999	3262	28/09/1999	3525
04/07/2001	2593	04/07/2001	2512	04/07/2001	2687	04/07/2001	3275
31/10/2002	1366	31/10/2002	1389	31/10/2002	1371	31/10/2002	1432
05/09/2003	1280	05/09/2003	1172	05/09/2003	1256	05/09/2003	1202
08/09/2004	2430	08/09/2004	2270	08/09/2004	2070	08/09/2004	1760
26/10/2005	2200	26/10/2005	2620	26/10/2005	2140	26/10/2005	2600
04/05/2006	2510	04/05/2006	2370	04/05/2006	2260	04/05/2006	2120
26/06/2006	2290	26/06/2006	1210	26/06/2006	2420	26/06/2006	1780
07/08/2007	1110	07/08/2007	1070	07/08/2007	1100	07/08/2007	848
21/07/2008	976	21/07/2008	840	21/07/2008	805	21/07/2008	711
17/06/2009	996	17/06/2009	1010	17/06/2009	864	17/06/2009	719

Table A1.9: Routine Monitoring Data in Piezometers at DK16-1

DK16-1A (362.1 masl)		DK16-1B (365.1 masl)		DK16-1C (366.6 masl)		DK16-1D (368.2 masl)	
Date	Acidity (mg/L as $CaCO_3$)	Date	Acidity (mg/L as $CaCO_3$)	Date	Acidity (mg/L as $CaCO_3$)	Date	Acidity (mg/L as $CaCO_3$)
07/11/1995	260	07/11/1995	1400	07/11/1995	1100	07/11/1995	145
04/06/1996	180	04/06/1996	184	04/06/1996	870	04/06/1996	500
08/10/1996	104	08/10/1996	128	08/10/1996	499	08/10/1996	450
02/06/1997	131	02/06/1997	44	02/06/1997	212	02/06/1997	274
20/10/1997	129	20/10/1997	78	20/10/1997	201	20/10/1997	234
22/07/1998	65	22/07/1998	45	22/07/1998	75	22/07/1998	74
16/09/1999	42	16/09/1999	46	16/09/1999	54	16/09/1999	49
03/08/2000	48	03/08/2000	42	03/08/2000	37	03/08/2000	33
06/07/2001	36	06/07/2001	20	06/07/2001	14	06/07/2001	23
24/06/2002	26	24/06/2002	12	24/06/2002	17	24/06/2002	10
02/07/2003	38	02/07/2003	20	02/07/2003	33	02/07/2003	14
12/07/2004	38	12/07/2004	20	13/07/2004	29	13/07/2004	21
11/07/2005	30	11/07/2005	17	11/07/2005	27	11/07/2005	19
22/06/2006	22	22/06/2006	3	22/06/2006	22	22/06/2006	15
02/08/2007	21	02/08/2007	4	02/08/2007	18	08/08/2007	37
23/07/2008	21	24/07/2008	<1	24/07/2008	15	24/07/2008	19
01/07/2009	21	01/07/2009	6	01/07/2009	15	01/07/2009	17

Table A1.10: Routine Monitoring Data in Piezometers at DK16-2

DK16-2A (356.8 masl)		DK16-2B (359.9 masl)		DK16-2C (361.4 masl)		DK16-2D (362.9 masl)	
Date	Acidity (mg/L as $CaCO_3$)	Date	Acidity (mg/L as $CaCO_3$)	Date	Acidity (mg/L as $CaCO_3$)	Date	Acidity (mg/L as $CaCO_3$)
07/11/1995	<1	07/11/1995	400	07/11/1995	500	07/11/1995	525
04/06/1996	<1	04/06/1996	420	04/06/1996	620	04/06/1996	620
08/10/1996	<1	08/10/1996	246	08/10/1996	396	08/10/1996	553
02/06/1997		02/06/1997	119	02/06/1997	276	02/06/1997	351
23/10/1997		23/10/1997	90	23/10/1997	271	23/10/1997	343
22/07/1998	105	22/07/1998	34	22/07/1998	130	22/07/1998	182
16/09/1999	352	16/09/1999	9	16/09/1999	34	16/09/1999	86
03/08/2000	290	03/08/2000	28	03/08/2000	42	03/08/2000	82
06/07/2001	296	06/07/2001	<1	06/07/2001	14	06/07/2001	70
25/06/2002	248	25/06/2002	<1	25/06/2002	19	25/06/2002	87
02/07/2003	275	02/07/2003	<1	02/07/2003	30	02/07/2003	148
13/07/2004	310	13/07/2004	<1	13/07/2004	36	13/07/2004	275
11/07/2005	217	11/07/2005	<1	11/07/2005	19	11/07/2005	201
23/06/2006	66	23/06/2006	<1	23/06/2006	15	23/06/2006	32
08/08/2007	62	08/08/2007	<1	08/08/2007	15	08/08/2007	30
24/07/2008	29	28/08/2007	<1	28/07/2008	12	28/07/2008	30
01/07/2009	18	24/07/2008	<1	01/07/2009	15	01/07/2009	15
		01/07/2009	2				

Table A1.11: Routine Monitoring Data in Piezometers at DK17-1

DK17-1A (356.1 masl)		DK17-1B (359.2 masl)		DK17-1C (360.6 masl)		DK17-1D (362.2 masl)	
Date	Acidity (mg/L as $CaCO_3$)	Date	Acidity (mg/L as $CaCO_3$)	Date	Acidity (mg/L as $CaCO_3$)	Date	Acidity (mg/L as $CaCO_3$)
07/11/1995	<1	07/11/1995	<1	07/11/1995	<1	07/11/1995	70
31/05/1996	35	31/05/1996	<1	31/05/1996	<1	31/05/1996	38
26/09/1996	5	26/09/1996	<1	26/09/1996	<1	26/09/1996	58
02/06/1997	27	02/06/1997	<1	02/06/1997	<1	02/06/1997	<1
20/10/1997	49	20/10/1997	<1	20/10/1997	<1	20/10/1997	9
14/07/1998	36	14/07/1998	<1	14/07/1998	<1	14/07/1998	6
14/09/1999	55	14/09/1999	<1	14/09/1999	<1	14/09/1999	11
19/07/2000	81	19/07/2000	<1	19/07/2000	<1	19/07/2000	13
09/07/2001	98	09/07/2001	<1	09/07/2001	<1	09/07/2001	8
31/05/2002	150	31/05/2002	<1	31/05/2002	<1	31/05/2002	7
01/07/2003	356	01/07/2003	<1	01/07/2003		01/07/2003	10
13/07/2004	346	13/07/2004	<1	13/07/2004	<1	13/07/2004	12
12/07/2005	274	12/07/2005	<1	12/07/2005	<1	12/07/2005	14
21/06/2006	75	21/06/2006	<1	21/06/2006	<1	21/06/2006	8
10/08/2007	14	10/08/2007	<1	10/08/2007	<1	10/08/2007	20
17/07/2008	55	17/07/2008	<1	17/07/2008	<1	17/07/2008	15
02/07/2009	<1	02/07/2009	<1	02/07/2009	<1	02/07/2009	11

Table A1.12: Routine Monitoring Data in Piezometers at DK17-2

DK17-2A (353.8 masl)		DK17-2B (356.9 masl)		DK17-2C (358.4 masl)		DK17-2D (359.9 masl)	
Date	Acidity (mg/L as $CaCO_3$)	Date	Acidity (mg/L as $CaCO_3$)	Date	Acidity (mg/L as $CaCO_3$)	Date	Acidity (mg/L as $CaCO_3$)
07/11/1995	2900	07/11/1995	46	07/11/1995	<1	07/11/1995	<1
31/05/1996	3450	31/05/1996	700	31/05/1996	<1	31/05/1996	<1
26/09/1996	2643	26/09/1996	382	26/09/1996	<1	26/09/1996	<1
02/06/1997	1513	02/06/1997	603	02/06/1997	<1	02/06/1997	10
20/10/1997	1557	20/10/1997	593	20/10/1997	<1	20/10/1997	<1
14/07/1998	1780	14/07/1998	560	14/07/1998	<1	14/07/1998	<1
14/09/1999	644	14/09/1999	424	14/09/1999	<1	14/09/1999	<1
19/07/2000	785	19/07/2000	341	19/07/2000	<1	19/07/2000	<1
09/07/2001	853	09/07/2001	280	09/07/2001	<1	09/07/2001	<1
31/05/2002	1416	31/05/2002	243	31/05/2002	<1	31/05/2002	<1
25/06/2003	1563	25/06/2003	268	25/06/2003	<1	25/06/2003	<1
14/07/2004	2199	14/07/2004	429	14/07/2004	<1	14/07/2004	<1
12/07/2005	2284	12/07/2005	369	12/07/2005	<1	12/07/2005	<1
22/06/2006	2590	22/06/2006	267	22/06/2006	<1	22/06/2006	<1
13/08/2007	2340	13/08/2007	351	10/08/2007	<1	10/08/2007	<1
18/07/2008	<1	18/07/2008	429	18/07/2008	<1	18/07/2008	<1
06/07/2009	2180	06/07/2009	451	06/07/2009	<1	06/07/2009	<1

Table A1.13: Cell 15 Water Elevations

Date	Elevation (masl)	Invert (masl)	Spillway (masl)
2-Jan-97	374.2	373.7	373.9
7-Jan-97	374.2	373.7	373.9
14-Jan-97	374.2	373.7	373.9
21-Jan-97	374.2	373.7	373.9
28-Jan-97	374.2	373.7	373.9
4-Feb-97	374.2	373.7	373.9
12-Feb-97	374.2	373.7	373.9
18-Feb-97	374.2	373.7	373.9
26-Feb-97	374.1	373.7	373.9
4-Mar-97	374.0	373.7	373.9
18-Mar-97	373.9	373.7	373.9
24-Mar-97	373.3	373.7	373.9
27-Mar-97	373.4	373.7	373.9
31-Mar-97	373.4	373.7	373.9
3-Apr-97	373.4	373.7	373.9
7-Apr-97	373.5	373.7	373.9
10-Apr-97	373.5	373.7	373.9
14-Apr-97	373.5	373.7	373.9
17-Apr-97	373.5	373.7	373.9
21-Apr-97	373.5	373.7	373.9
28-Apr-97	373.5	373.7	373.9
2-May-97	373.6	373.7	373.9
5-May-97	373.6	373.7	373.9
8-May-97	373.7	373.7	373.9
12-May-97	373.7	373.7	373.9
15-May-97	373.8	373.7	373.9
20-May-97	373.9	373.7	373.9
26-May-97	373.9	373.7	373.9
3-Jun-97	374.0	373.7	373.9
10-Jun-97	373.9	373.7	373.9
17-Jun-97	373.8	373.7	373.9
24-Jun-97	374.0	373.7	373.9
2-Jul-97	373.9	373.7	373.9
9-Jul-97	373.8	373.7	373.9
14-Jul-97	373.8	373.7	373.9
22-Jul-97	373.7	373.7	373.9
29-Jul-97	373.6	373.7	373.9
5-Aug-97	373.6	373.7	373.9
15-Aug-97	373.5	373.7	373.9
19-Aug-97	373.5	373.7	373.9
26-Aug-97	373.4	373.7	373.9
2-Sep-97	373.4	373.7	373.9
9-Oct-97	373.1	373.7	373.9
14-Oct-97	373.1	373.7	373.9
21-Oct-97	373.0	373.7	373.9
28-Oct-97	373.0	373.7	373.9
19-Nov-97	373.0	373.7	373.9
5-Dec-97	373.0	373.7	373.9
9-Dec-97	373.0	373.7	373.9
23-Dec-97	372.9	373.7	373.9
30-Dec-97	372.9	373.7	373.9
6-Jan-98	372.9	373.7	373.9
13-Jan-98	372.9	373.7	373.9
20-Jan-98	372.9	373.7	373.9
27-Jan-98	372.9	373.7	373.9
3-Feb-98	372.8	373.7	373.9
10-Feb-98	372.8	373.7	373.9
17-Feb-98	372.8	373.7	373.9
25-Feb-98	372.8	373.7	373.9
3-Mar-98	372.8	373.7	373.9
10-Mar-98	372.7	373.7	373.9
17-Mar-98	372.7	373.7	373.9
24-Mar-98	372.8	373.7	373.9
3-Apr-98	372.9	373.7	373.9
7-Apr-98	373.0	373.7	373.9
14-Apr-98	373.1	373.7	373.9
21-Apr-98	373.3	373.7	373.9
1-May-98	373.6	373.7	373.9
5-May-98	373.7	373.7	373.9
12-May-98	373.7	373.7	373.9
19-May-98	373.7	373.7	373.9
26-May-98	373.7	373.7	373.9
2-Jun-98	373.7	373.7	373.9
9-Jun-98	373.7	373.7	373.9
16-Jun-98	373.7	373.7	373.9

Table A1.13: Cell 15 Water Elevations

Date	Elevation (masl)	Invert (masl)	Spillway (masl)
23-Jun-98	373.6	373.7	373.9
30-Jun-98	373.7	373.7	373.9
7-Jul-98	373.6	373.7	373.9
14-Jul-98	373.6	373.7	373.9
21-Jul-98	373.5	373.7	373.9
28-Jul-98	373.4	373.7	373.9
4-Aug-98	373.4	373.7	373.9
11-Aug-98	373.4	373.7	373.9
18-Aug-98	373.3	373.7	373.9
25-Aug-98	373.3	373.7	373.9
1-Sep-98	373.3	373.7	373.9
8-Sep-98	373.2	373.7	373.9
15-Sep-98	373.2	373.7	373.9
22-Sep-98	373.2	373.7	373.9
29-Sep-98	373.2	373.7	373.9
6-Oct-98	373.1	373.7	373.9
13-Oct-98	373.2	373.7	373.9
20-Oct-98	373.2	373.7	373.9
27-Oct-98	373.1	373.7	373.9
3-Nov-98	373.1	373.7	373.9
10-Nov-98	373.1	373.7	373.9
17-Nov-98	373.1	373.7	373.9
24-Nov-98	373.1	373.7	373.9
1-Dec-98	373.2	373.7	373.9
8-Dec-98	373.2	373.7	373.9
15-Dec-98	373.3	373.7	373.9
22-Dec-98	373.2	373.7	373.9
29-Dec-98	373.3	373.7	373.9
5-Jan-99	373.4	373.7	373.9
12-Jan-99	373.5	373.7	373.9
19-Jan-99	373.6	373.7	373.9
26-Jan-99	373.6	373.7	373.9
2-Feb-99	373.6	373.7	373.9
9-Feb-99	373.8	373.7	373.9
16-Feb-99	373.7	373.7	373.9
23-Feb-99	373.7	373.7	373.9
2-Mar-99	373.7	373.7	373.9
9-Mar-99	373.7	373.7	373.9
16-Mar-99	373.7	373.7	373.9
23-Mar-99	373.8	373.7	373.9
30-Mar-99	373.8	373.7	373.9
6-Apr-99	373.9	373.7	373.9
13-Apr-99	374.0	373.7	373.9
20-Apr-99	374.1	373.7	373.9
27-Apr-99	374.1	373.7	373.9
4-May-99	374.1	373.7	373.9
11-May-99	374.0	373.7	373.9
18-May-99	373.9	373.7	373.9
25-May-99	373.9	373.7	373.9
1-Jun-99	373.9	373.7	373.9
8-Jun-99	373.8	373.7	373.9
15-Jun-99	373.8	373.7	373.9
22-Jun-99	373.7	373.7	373.9
29-Jun-99	373.7	373.7	373.9
6-Jul-99	373.6	373.7	373.9
13-Jul-99	373.6	373.7	373.9
20-Jul-99	373.5	373.7	373.9
27-Jul-99	373.5	373.7	373.9
3-Aug-99	373.4	373.7	373.9
10-Aug-99	373.4	373.7	373.9
17-Aug-99	373.4	373.7	373.9
24-Aug-99	373.3	373.7	373.9
31-Aug-99	373.3	373.7	373.9
7-Sep-99	373.2	373.7	373.9
14-Sep-99	373.2	373.7	373.9
21-Sep-99	373.2	373.7	373.9
28-Sep-99	373.1	373.7	373.9
5-Oct-99	373.1	373.7	373.9
12-Oct-99	373.1	373.7	373.9
19-Oct-99	373.1	373.7	373.9
26-Oct-99	373.1	373.7	373.9
2-Nov-99	373.1	373.7	373.9
9-Nov-99	373.1	373.7	373.9
16-Nov-99	373.0	373.7	373.9
23-Nov-99	373.0	373.7	373.9

Table A1.13: Cell 15 Water Elevations

Date	Elevation (masl)	Invert (masl)	Spillway (masl)
30-Nov-99	373.0	373.7	373.9
7-Dec-99	373.0	373.7	373.9
14-Dec-99	373.0	373.7	373.9
21-Dec-99	373.0	373.7	373.9
29-Dec-99	373.0	373.7	373.9
4-Jan-00	373.0	373.7	373.9
11-Jan-00	373.0	373.7	373.9
18-Jan-00	373.0	373.7	373.9
25-Jan-00	373.0	373.7	373.9
1-Feb-00	373.0	373.7	373.9
8-Feb-00	372.9	373.7	373.9
15-Feb-00	372.9	373.7	373.9
22-Feb-00	372.9	373.7	373.9
29-Feb-00	373.0	373.7	373.9
7-Mar-00	373.0	373.7	373.9
14-Mar-00	373.0	373.7	373.9
21-Mar-00	373.0	373.7	373.9
28-Mar-00	373.0	373.7	373.9
4-Apr-00	373.4	373.7	373.9
11-Apr-00	373.8	373.7	373.9
18-Apr-00	373.8	373.7	373.9
25-Apr-00	373.8	373.7	373.9
2-May-00	373.8	373.7	373.9
9-May-00	373.8	373.7	373.9
16-May-00	373.7	373.7	373.9
23-May-00	373.6	373.7	373.9
30-May-00	373.6	373.7	373.9
6-Jun-00	373.6	373.7	373.9
13-Jun-00	373.5	373.7	373.9
20-Jun-00	373.5	373.7	373.9
27-Jun-00	373.5	373.7	373.9
4-Jul-00	373.5	373.7	373.9
11-Jul-00	373.4	373.7	373.9
19-Jul-00	373.4	373.7	373.9
25-Jul-00	373.3	373.7	373.9
1-Aug-00	373.2	373.7	373.9
8-Aug-00	373.6	373.7	373.9
15-Aug-00	373.2	373.7	373.9
22-Aug-00	373.1	373.7	373.9
29-Aug-00	373.1	373.7	373.9
5-Sep-00	373.1	373.7	373.9
12-Sep-00	373.0	373.7	373.9
19-Sep-00	373.0	373.7	373.9
26-Sep-00	373.0	373.7	373.9
3-Oct-00	372.9	373.7	373.9
10-Oct-00	372.9	373.7	373.9
17-Oct-00	372.9	373.7	373.9
18-Oct-00	372.9	373.7	373.9
24-Oct-00	372.9	373.7	373.9
31-Oct-00	372.9	373.7	373.9
7-Nov-00	372.8	373.7	373.9
14-Nov-00	372.9	373.7	373.9
21-Nov-00	372.8	373.7	373.9
28-Nov-00	372.9	373.7	373.9
5-Dec-00	372.8	373.7	373.9
12-Dec-00	372.8	373.7	373.9
19-Dec-00	372.8	373.7	373.9
27-Dec-00	372.8	373.7	373.9
2-Jan-01	372.8	373.7	373.9
9-Jan-01	372.8	373.7	373.9
16-Jan-01	372.8	373.7	373.9
23-Jan-01	372.7	373.7	373.9
30-Jan-01	372.7	373.7	373.9
6-Feb-01	372.7	373.7	373.9
13-Feb-01	372.7	373.7	373.9
20-Feb-01	372.7	373.7	373.9
27-Feb-01	372.8	373.7	373.9
6-Mar-01	372.7	373.7	373.9
13-Mar-01	372.7	373.7	373.9
20-Mar-01	372.7	373.7	373.9
28-Mar-01	372.7	373.7	373.9
3-Apr-01	372.6	373.7	373.9
10-Apr-01	372.7	373.7	373.9
17-Apr-01	372.8	373.7	373.9
24-Apr-01	372.9	373.7	373.9

Table A1.13: Cell 15 Water Elevations

Date	Elevation (masl)	Invert (masl)	Spillway (masl)
1-May-01	373.4	373.7	373.9
9-May-01	373.7	373.7	373.9
16-May-01	373.8	373.7	373.9
23-May-01	373.8	373.7	373.9
30-May-01	374.0	373.7	373.9
6-Jun-01	374.0	373.7	373.9
13-Jun-01	374.0	373.7	373.9
20-Jun-01	374.0	373.7	373.9
27-Jun-01	373.9	373.7	373.9
4-Jul-01	373.9	373.7	373.9
11-Jul-01	373.8	373.7	373.9
18-Jul-01	373.7	373.7	373.9
25-Jul-01	373.7	373.7	373.9
31-Jul-01	373.6	373.7	373.9
8-Aug-01	373.6	373.7	373.9
15-Aug-01	373.5	373.7	373.9
22-Aug-01	373.5	373.7	373.9
29-Aug-01	373.5	373.7	373.9
5-Sep-01	373.4	373.7	373.9
12-Sep-01	373.5	373.7	373.9
19-Sep-01	373.5	373.7	373.9
26-Sep-01	373.6	373.7	373.9
3-Oct-01	373.6	373.7	373.9
10-Oct-01	373.6	373.7	373.9
17-Oct-01	373.8	373.7	373.9
24-Oct-01	373.9	373.7	373.9
31-Oct-01	374.0	373.7	373.9
7-Nov-01	374.0	373.7	373.9
14-Nov-01	374.0	373.7	373.9
21-Nov-01	374.0	373.7	373.9
28-Nov-01	374.1	373.7	373.9
5-Dec-01	374.0	373.7	373.9
12-Dec-01	374.0	373.7	373.9
19-Dec-01	374.0	373.7	373.9
26-Dec-01	373.9	373.7	373.9
2-Jan-02	373.9	373.7	373.9
9-Jan-02	373.9	373.7	373.9
16-Jan-02	373.9	373.7	373.9
23-Jan-02	373.9	373.7	373.9
30-Jan-02	373.8	373.7	373.9
6-Feb-02	373.8	373.7	373.9
13-Feb-02	373.8	373.7	373.9
20-Feb-02	373.8	373.7	373.9
27-Feb-02	373.8	373.7	373.9
6-Mar-02	373.8	373.7	373.9
13-Mar-02	373.9	373.7	373.9
20-Mar-02	374.0	373.7	373.9
27-Mar-02	373.9	373.7	373.9
3-Apr-02	373.9	373.7	373.9
10-Apr-02	373.9	373.7	373.9
17-Apr-02	374.0	373.7	373.9
24-Apr-02	374.0	373.7	373.9
1-May-02	374.0	373.7	373.9
8-May-02	374.0	373.7	373.9
15-May-02	374.1	373.7	373.9
22-May-02	374.1	373.7	373.9
29-May-02	374.1	373.7	373.9
5-Jun-02	374.1	373.7	373.9
12-Jun-02	374.1	373.7	373.9
19-Jun-02	374.1	373.7	373.9
26-Jun-02	374.1	373.7	373.9
3-Jul-02	374.1	373.7	373.9
10-Jul-02	374.0	373.7	373.9
17-Jul-02	373.9	373.7	373.9
24-Jul-02	373.9	373.7	373.9
31-Jul-02	373.8	373.7	373.9
7-Aug-02	373.8	373.7	373.9
14-Aug-02	373.7	373.7	373.9
21-Aug-02	373.7	373.7	373.9
28-Aug-02	373.6	373.7	373.9
4-Sep-02	373.6	373.7	373.9
11-Sep-02	373.5	373.7	373.9
18-Sep-02	373.4	373.7	373.9
25-Sep-02	373.5	373.7	373.9
2-Oct-02	373.4	373.7	373.9

Table A1.13: Cell 15 Water Elevations

Date	Elevation (masl)	Invert (masl)	Spillway (masl)
9-Oct-02	373.5	373.7	373.9
16-Oct-02	373.5	373.7	373.9
23-Oct-02	373.5	373.7	373.9
30-Oct-02	373.5	373.7	373.9
6-Nov-02	373.4	373.7	373.9
13-Nov-02	373.4	373.7	373.9
20-Nov-02	373.4	373.7	373.9
27-Nov-02	373.4	373.7	373.9
4-Dec-02	373.4	373.7	373.9
11-Dec-02	373.4	373.7	373.9
18-Dec-02	373.4	373.7	373.9
25-Dec-02	373.4	373.7	373.9
6-Jan-03	373.4	373.7	373.9
13-Jan-03	373.4	373.7	373.9
20-Jan-03	373.3	373.7	373.9
27-Jan-03	373.3	373.7	373.9
3-Feb-03	373.3	373.7	373.9
10-Feb-03	373.3	373.7	373.9
17-Feb-03	373.3	373.7	373.9
24-Feb-03	373.3	373.7	373.9
3-Mar-03	373.3	373.7	373.9
10-Mar-03	373.3	373.7	373.9
17-Mar-03	373.3	373.7	373.9
24-Mar-03	373.3	373.7	373.9
31-Mar-03	373.5	373.7	373.9
7-Apr-03	373.6	373.7	373.9
14-Apr-03	373.7	373.7	373.9
21-Apr-03	373.9	373.7	373.9
28-Apr-03	374.0	373.7	373.9
5-May-03	374.0	373.7	373.9
12-May-03	374.0	373.7	373.9
20-May-03	374.0	373.7	373.9
26-May-03	373.9	373.7	373.9
2-Jun-03	374.2	373.7	373.9
9-Jun-03	374.3	373.7	373.9
16-Jun-03	374.4	373.7	373.9
23-Jun-03	374.4	373.7	373.9
1-Jul-03	374.3	373.7	373.9
7-Jul-03	374.3	373.7	373.9
14-Jul-03	374.3	373.7	373.9
21-Jul-03	374.4	373.7	373.9
28-Jul-03	374.4	373.7	373.9
5-Aug-03	374.3	373.7	373.9
11-Aug-03	374.2	373.7	373.9
18-Aug-03	374.1	373.7	373.9
25-Aug-03	374.0	373.7	373.9
2-Sep-03	373.9	373.7	373.9
8-Sep-03	373.9	373.7	373.9
15-Sep-03	373.8	373.7	373.9
22-Sep-03	373.7	373.7	373.9
29-Sep-03	373.7	373.7	373.9
6-Oct-03	373.7	373.7	373.9
14-Oct-03	373.7	373.7	373.9
20-Oct-03	373.6	373.7	373.9
27-Oct-03	373.6	373.7	373.9
3-Nov-03	373.6	373.7	373.9
10-Nov-03	373.5	373.7	373.9
17-Nov-03	373.5	373.7	373.9
24-Nov-03	373.6	373.7	373.9
1-Dec-03	373.7	373.7	373.9
8-Dec-03	373.7	373.7	373.9
17-Dec-03	373.8	373.7	373.9
22-Dec-03	373.7	373.7	373.9
5-Jan-04	373.6	373.7	373.9
12-Jan-04	373.6	373.7	373.9
19-Jan-04	373.5	373.7	373.9
26-Jan-04	373.5	373.7	373.9
2-Feb-04	373.4	373.7	373.9
9-Feb-04	373.4	373.7	373.9
16-Feb-04	373.3	373.7	373.9
23-Feb-04	373.3	373.7	373.9
1-Mar-04	373.2	373.7	373.9
8-Mar-04	373.2	373.7	373.9
15-Mar-04	373.2	373.7	373.9
22-Mar-04	373.2	373.7	373.9

Table A1.13: Cell 15 Water Elevations

Date	Elevation (masl)	Invert (masl)	Spillway (masl)
29-Mar-04	373.2	373.7	373.9
5-Apr-04	373.3	373.7	373.9
12-Apr-04	373.2	373.7	373.9
19-Apr-04	373.3	373.7	373.9
26-Apr-04	373.3	373.7	373.9
3-May-04	373.6	373.7	373.9
10-May-04	373.7	373.7	373.9
17-May-04	374.0	373.7	373.9
25-May-04	374.2	373.7	373.9
31-May-04	374.2	373.7	373.9
7-Jun-04	374.2	373.7	373.9
14-Jun-04	374.2	373.7	373.9
21-Jun-04	374.1	373.7	373.9
28-Jun-04	374.1	373.7	373.9
5-Jul-04	374.1	373.7	373.9
12-Jul-04	374.0	373.7	373.9
19-Jul-04	373.9	373.7	373.9
26-Jul-04	373.9	373.7	373.9
3-Aug-04	373.8	373.7	373.9
9-Aug-04	373.8	373.7	373.9
16-Aug-04	373.8	373.7	373.9
23-Aug-04	373.7	373.7	373.9
30-Aug-04	373.6	373.7	373.9
7-Sep-04	373.6	373.7	373.9
13-Sep-04	373.6	373.7	373.9
20-Sep-04	373.5	373.7	373.9
27-Sep-04	373.4	373.7	373.9
4-Oct-04	373.4	373.7	373.9
12-Oct-04	373.4	373.7	373.9
18-Oct-04	373.4	373.7	373.9
25-Oct-04	373.4	373.7	373.9
1-Nov-04	373.4	373.7	373.9
8-Nov-04	373.4	373.7	373.9
15-Nov-04	373.4	373.7	373.9
22-Nov-04	373.4	373.7	373.9
29-Nov-04	373.4	373.7	373.9
6-Dec-04	373.5	373.7	373.9
13-Dec-04	373.8	373.7	373.9
20-Dec-04	373.9	373.7	373.9
4-Jan-05	374.0	373.7	373.9
10-Jan-05	374.0	373.7	373.9
17-Jan-05	374.0	373.7	373.9
24-Jan-05	374.1	373.7	373.9
31-Jan-05	374.0	373.7	373.9
7-Feb-05	374.0	373.7	373.9
14-Feb-05	374.0	373.7	373.9
21-Feb-05	374.0	373.7	373.9
28-Feb-05	374.0	373.7	373.9
7-Mar-05	373.9	373.7	373.9
14-Mar-05	373.9	373.7	373.9
21-Mar-05	373.9	373.7	373.9
28-Mar-05	373.9	373.7	373.9
4-Apr-05	373.9	373.7	373.9
11-Apr-05	373.9	373.7	373.9
18-Apr-05	373.9	373.7	373.9
25-Apr-05	374.0	373.7	373.9
2-May-05	374.1	373.7	373.9
9-May-05	374.1	373.7	373.9
16-May-05	374.1	373.7	373.9
24-May-05	374.1	373.7	373.9
30-May-05	374.0	373.7	373.9
6-Jun-05	374.0	373.7	373.9
13-Jun-05	373.9	373.7	373.9
20-Jun-05	374.0	373.7	373.9
27-Jun-05	373.9	373.7	373.9
4-Jul-05	373.9	373.7	373.9
11-Jul-05	373.8	373.7	373.9
18-Jul-05	373.8	373.7	373.9
25-Jul-05	373.7	373.7	373.9
8-Aug-05	373.6	373.7	373.9
10-Aug-05	373.6	373.7	373.9
15-Aug-05	373.5	373.7	373.9
22-Aug-05	373.5	373.7	373.9
29-Aug-05	373.5	373.7	373.9
6-Sep-05	373.4	373.7	373.9

Table A1.13: Cell 15 Water Elevations

Date	Elevation (masl)	Invert (masl)	Spillway (masl)
12-Sep-05	373.4	373.7	373.9
19-Sep-05	373.3	373.7	373.9
26-Sep-05	373.3	373.7	373.9
3-Oct-05	373.3	373.7	373.9
11-Oct-05	373.2	373.7	373.9
12-Oct-05	373.2	373.7	373.9
17-Oct-05	373.2	373.7	373.9
24-Oct-05	373.2	373.7	373.9
31-Oct-05	373.2	373.7	373.9
7-Nov-05	373.2	373.7	373.9
14-Nov-05	373.3	373.7	373.9
21-Nov-05	373.3	373.7	373.9
28-Nov-05	373.3	373.7	373.9
5-Dec-05	373.3	373.7	373.9
12-Dec-05	373.3	373.7	373.9
19-Dec-05		373.7	
29-Dec-05	373.3	373.7	373.9
10-May-06	374.1	373.7	373.9
9-Aug-06	373.8	373.7	373.9
8-Nov-06	373.4	373.7	373.9
10-Jan-07	374.1	373.7	373.9
14-Feb-07	373.9	373.7	373.9
14-Mar-07	373.8	373.7	373.9
11-Apr-07	373.8	373.7	373.9
10-May-07	373.8	373.7	373.9
13-Jun-07	373.6	373.7	373.9
11-Jul-07	373.4	373.7	373.9
8-Aug-07	373.2	373.7	373.9
12-Sep-07	373.1	373.7	373.9
10-Oct-07	373.1	373.7	373.9
14-Nov-07	373.1	373.7	373.9
15-May-08	374.1	373.7	373.9
11-Jun-08	373.9	373.7	373.9
9-Jul-08	373.8	373.7	373.9
13-Aug-08	373.8	373.7	373.9
10-Sep-08	373.5	373.7	373.9
8-Oct-08	373.4	373.7	373.9
12-Nov-08	373.4	373.7	373.9
21-May-09	374.0	373.7	373.9
30-Jun-09	373.9	373.7	373.9
8-Jul-09	373.9	373.7	373.9
12-Aug-09	373.8	373.7	373.9
9-Sep-09	373.6	373.7	373.9
14-Oct-09	373.5	373.7	373.9
12-Nov-09	373.6	373.7	373.9
9-Dec-09	373.7	373.7	373.9

Table A1.14: Flow Data for Gravel Pit Lake Inflow to Cell 14 (Q-29)

2006		2007		2008		2009	
Date	Flow (L/s)	Date	Flow (L/s)	Date	Flow (L/s)	Date	Flow (L/s)
3-Jan-06	25	2-Jan-07	5	2-Jan-08	50	5-Jan-09	0
9-Jan-06	25	8-Jan-07	0	7-Jan-08	50	12-Jan-09	0
16-Jan-06	25	15-Jan-07	0	14-Jan-08	60	19-Jan-09	0
23-Jan-06	25	22-Jan-07	0	21-Jan-08	60	26-Jan-09	0
30-Jan-06	25	29-Jan-07	0	29-Jan-08	14	2-Feb-09	0
6-Feb-06	25	5-Feb-07	0	4-Feb-08	14	9-Feb-09	0
13-Feb-06	25	12-Feb-07	0	11-Feb-08	14	17-Feb-09	0
20-Feb-06	25	19-Feb-07	0	19-Feb-08	14	23-Feb-09	0
27-Feb-06	25	26-Feb-07	0	25-Feb-08	14	2-Mar-09	0
6-Mar-06	25	5-Mar-07	0	3-Mar-08	18	9-Mar-09	0
13-Mar-06	25	12-Mar-07	0	10-Mar-08	18	16-Mar-09	50
20-Mar-06	25	19-Mar-07	0	17-Mar-08	20	23-Mar-09	100
27-Mar-06	150	26-Mar-07	100	24-Mar-08	20	31-Mar-09	100
3-Apr-06	150	2-Apr-07	100	31-Mar-08	20	6-Apr-09	100
10-Apr-06	25	9-Apr-07	100	7-Apr-08	20	13-Apr-09	0
17-Apr-06	25	16-Apr-07	100	14-Apr-08	20	20-Apr-09	0
24-Apr-06	150	23-Apr-07	25	21-Apr-08	20	27-Apr-09	0
1-May-06	25	30-Apr-07	25	28-Apr-08	15	4-May-09	0
8-May-06	20	7-May-07	25	5-May-08	15	11-May-09	55
15-May-06	20	10-May-07	25	12-May-08	15	19-May-09	55
23-May-06	20	14-May-07	25	20-May-08	14	25-May-09	50
29-May-06	80	22-May-07	35	26-May-08	10	1-Jun-09	50
5-Jun-06	80	28-May-07	32	2-Jun-08	10	8-Jun-09	50
12-Jun-06	80	4-Jun-07	37	9-Jun-08	10	15-Jun-09	50
19-Jun-06	80	11-Jun-07	35	16-Jun-08	25	22-Jun-09	40
26-Jun-06	70	18-Jun-07	30	23-Jun-08	25	29-Jun-09	35
4-Jul-06	50	25-Jun-07	30	2-Jul-08	35	6-Jul-09	40
10-Jul-06	40	3-Jul-07	30	7-Jul-08	35	13-Jul-09	35
17-Jul-06	25	9-Jul-07	35	14-Jul-08	40	20-Jul-09	40
24-Jul-06	25	16-Jul-07	35	21-Jul-08	45	27-Jul-09	35
31-Jul-06	22	23-Jul-07	40	28-Jul-08	45	4-Aug-09	35
8-Aug-06	22	30-Jul-07	100	5-Aug-08	40	10-Aug-09	35
14-Aug-06	25	7-Aug-07	40	11-Aug-08	40	17-Aug-09	35
21-Aug-06	22	13-Aug-07	45	18-Aug-08	40	24-Aug-09	35
28-Aug-06	25	20-Aug-07	45	25-Aug-08	40	31-Aug-09	35
5-Sep-06	25	27-Aug-07	40	2-Sep-08	40	8-Sep-09	35
11-Sep-06	23	4-Sep-07	37	8-Sep-08	35	15-Sep-09	35
18-Sep-06	0	10-Sep-07	0	15-Sep-08	45	21-Sep-09	30
25-Sep-06	22	17-Sep-07	0	22-Sep-08	40	29-Sep-09	30
2-Oct-06	25	24-Sep-07	0	29-Sep-08	35	5-Oct-09	30
10-Oct-06	25	1-Oct-07	0	6-Oct-08	0	14-Oct-09	30
16-Oct-06	10	9-Oct-07	0	14-Oct-08	48	19-Oct-09	30
23-Oct-06	100	15-Oct-07	0	20-Oct-08	48	26-Oct-09	30
30-Oct-06	100	22-Oct-07	0	27-Oct-08	35	2-Nov-09	35
6-Nov-06	90	29-Oct-07	0	3-Nov-08	35	9-Nov-09	35
13-Nov-06	100	5-Nov-07	0	10-Nov-08	35	16-Nov-09	35
20-Nov-06	100	12-Nov-07	42	17-Nov-08	35	23-Nov-09	35
27-Nov-06	100	19-Nov-07	42	24-Nov-08	35	30-Nov-09	35
4-Dec-06	100	26-Nov-07	40	1-Dec-08	35	7-Dec-09	35
11-Dec-06	25	3-Dec-07	35	8-Dec-08	35	14-Dec-09	35
18-Dec-06	0	10-Dec-07	30	15-Dec-08	35	21-Dec-09	35
27-Dec-06	0	17-Dec-07	35	22-Dec-08	35	29-Dec-09	30
		24-Dec-07	50	29-Dec-08	0		

Table A1.15: Flow Data for Cell 18 Inflow to the Effluent Treatment Plant (Q-05)

2006		2007		2008		2009	
Date	Flow	Date	Flow	Date	Flow	Date	Flow
	(L/s)		(L/s)		(L/s)		(L/s)
3-Jan-06	110	2-Jan-07	153	2-Jan-08	102	2-Jan-09	127
4-Jan-06	110	3-Jan-07	155	3-Jan-08	102	5-Jan-09	127
5-Jan-06	110	4-Jan-07	94	4-Jan-08	100	6-Jan-09	129
6-Jan-06	110	5-Jan-07	94	7-Jan-08	102	7-Jan-09	131
9-Jan-06	108	8-Jan-07	94	8-Jan-08	102	8-Jan-09	131
10-Jan-06	108	9-Jan-07	94	9-Jan-08	103	9-Jan-09	131
11-Jan-06	108	10-Jan-07	91	10-Jan-08	103	12-Jan-09	129
12-Jan-06	108	11-Jan-07	91	11-Jan-08	102	13-Jan-09	125
13-Jan-06	108	12-Jan-07	91	14-Jan-08	103	14-Jan-09	125
16-Jan-06	108	15-Jan-07	91	15-Jan-08	105	15-Jan-09	131
17-Jan-06	108	16-Jan-07	94	16-Jan-08	105	16-Jan-09	129
18-Jan-06	105	17-Jan-07	91	17-Jan-08	105	19-Jan-09	129
19-Jan-06	107	18-Jan-07	91	18-Jan-08	105	20-Jan-09	150
20-Jan-06	105	19-Jan-07	94	21-Jan-08	102	21-Jan-09	159
23-Jan-06	105	22-Jan-07	91	22-Jan-08	105	22-Jan-09	161
24-Jan-06	105	23-Jan-07	94	23-Jan-08	105	23-Jan-09	157
25-Jan-06	105	24-Jan-07	91	24-Jan-08	105	26-Jan-09	155
26-Jan-06	105	25-Jan-07	91	25-Jan-08	105	27-Jan-09	155
27-Jan-06	107	26-Jan-07	91	28-Jan-08	105	28-Jan-09	153
30-Jan-06	105	29-Jan-07	89	29-Jan-08	135	29-Jan-09	155
31-Jan-06	105	30-Jan-07	94	30-Jan-08	135	30-Jan-09	155
1-Feb-06	105	31-Jan-07	91	31-Jan-08	135	2-Feb-09	149
2-Feb-06	105	1-Feb-07	91	1-Feb-08	137	3-Feb-09	148
3-Feb-06	105	2-Feb-07	91	4-Feb-08	139	4-Feb-09	142
6-Feb-06	105	5-Feb-07	86	5-Feb-08	139	5-Feb-09	95
7-Feb-06	105	6-Feb-07	86	6-Feb-08	139	6-Feb-09	99
8-Feb-06	105	7-Feb-07	86	7-Feb-08	139	9-Feb-09	102
9-Feb-06	105	8-Feb-07	91	8-Feb-08	139	10-Feb-09	104
10-Feb-06	105	9-Feb-07	89	11-Feb-08	139	11-Feb-09	102
13-Feb-06	105	12-Feb-07	86	12-Feb-08	132	12-Feb-09	102
14-Feb-06	103	13-Feb-07	89	13-Feb-08	136	13-Feb-09	102
15-Feb-06	103	14-Feb-07	86	14-Feb-08	137	17-Feb-09	102
16-Feb-06	103	15-Feb-07	86	15-Feb-08	137	18-Feb-09	102
17-Feb-06	103	16-Feb-07	89	19-Feb-08	137	19-Feb-09	102
20-Feb-06	103	19-Feb-07	91	20-Feb-08	135	20-Feb-09	99
21-Feb-06	103	20-Feb-07	91	21-Feb-08	137	23-Feb-09	97
22-Feb-06	103	21-Feb-07	94	22-Feb-08	134	24-Feb-09	98
23-Feb-06	103	22-Feb-07	94	25-Feb-08	134	25-Feb-09	99
24-Feb-06	103	23-Feb-07	96	26-Feb-08	134	26-Feb-09	100
27-Feb-06	103	26-Feb-07	94	27-Feb-08	134	27-Feb-09	100
28-Feb-06	103	27-Feb-07	94	28-Feb-08	132	2-Mar-09	102
1-Mar-06	103	28-Feb-07	94	29-Feb-08	132	3-Mar-09	100
2-Mar-06	103	1-Mar-07	94	3-Mar-08	132	4-Mar-09	99
3-Mar-06	100	2-Mar-07	93	4-Mar-08	132	5-Mar-09	99
6-Mar-06	98	5-Mar-07	91	5-Mar-08	132	6-Mar-09	99
7-Mar-06	98	6-Mar-07	94	6-Mar-08	132	9-Mar-09	97
8-Mar-06	98	7-Mar-07	93	7-Mar-08	132	10-Mar-09	99
9-Mar-06	98	8-Mar-07	93	10-Mar-08	129	11-Mar-09	99
10-Mar-06	98	9-Mar-07	93	11-Mar-08	130	12-Mar-09	100
13-Mar-06	98	12-Mar-07	93	12-Mar-08	129	13-Mar-09	100
14-Mar-06	98	13-Mar-07	94	13-Mar-08	129	16-Mar-09	100
15-Mar-06	98	14-Mar-07	94	14-Mar-08	130	17-Mar-09	100
16-Mar-06	98	15-Mar-07	94	17-Mar-08	129	18-Mar-09	97
17-Mar-06	98	16-Mar-07	94	18-Mar-08	127	19-Mar-09	99
20-Mar-06	98	19-Mar-07	91	19-Mar-08	127	20-Mar-09	99
21-Mar-06	98	20-Mar-07	91	20-Mar-08	125	23-Mar-09	97
22-Mar-06	96	21-Mar-07	94	24-Mar-08	123	24-Mar-09	97
23-Mar-06	96	22-Mar-07	94	25-Mar-08	125	25-Mar-09	97
24-Mar-06	98	23-Mar-07	94	26-Mar-08	125	26-Mar-09	96
27-Mar-06	98	26-Mar-07	94	27-Mar-08	125	27-Mar-09	96
28-Mar-06	98	27-Mar-07	94	28-Mar-08	125	30-Mar-09	98
29-Mar-06	96	28-Mar-07	94	31-Mar-08	122	31-Mar-09	98
30-Mar-06	98	29-Mar-07	94	1-Apr-08	125	1-Apr-09	98
31-Mar-06	98	30-Mar-07	94	2-Apr-08	125	2-Apr-09	97
3-Apr-06	98	2-Apr-07	94	3-Apr-08	125	3-Apr-09	99
4-Apr-06	98	3-Apr-07	94	4-Apr-08	125	6-Apr-09	100
5-Apr-06	100	4-Apr-07	93	7-Apr-08	122	7-Apr-09	100
6-Apr-06	100	5-Apr-07	94	8-Apr-08	122	8-Apr-09	100
7-Apr-06	100	6-Apr-07	93	9-Apr-08	127	9-Apr-09	100
10-Apr-06	100	9-Apr-07	91	10-Apr-08	125	13-Apr-09	97
11-Apr-06	100	10-Apr-07	91	11-Apr-08	127	14-Apr-09	100
12-Apr-06	100	11-Apr-07	91	14-Apr-08	127	15-Apr-09	100
13-Apr-06	102	12-Apr-07	91	15-Apr-08	129	16-Apr-09	100
17-Apr-06	102	13-Apr-07	96	16-Apr-08	129	17-Apr-09	100
18-Apr-06	103	16-Apr-07	96	17-Apr-08	129	20-Apr-09	100
19-Apr-06	103	17-Apr-07	96	18-Apr-08	132	21-Apr-09	102
20-Apr-06	103	18-Apr-07	94	21-Apr-08	132	22-Apr-09	102
21-Apr-06	103	19-Apr-07	96	22-Apr-08	132	23-Apr-09	105
24-Apr-06	101	20-Apr-07	94	23-Apr-08	132	24-Apr-09	105

Table A1.15: Flow Data for Cell 18 Inflow to the Effluent Treatment Plant (Q-05)

2006		2007		2008		2009	
Date	Flow	Date	Flow	Date	Flow	Date	Flow
	(L/s)		(L/s)		(L/s)		(L/s)
25-Apr-06	100	23-Apr-07	96	24-Apr-08	132	27-Apr-09	105
26-Apr-06	100	24-Apr-07	96	25-Apr-08	132	28-Apr-09	107
27-Apr-06	100	25-Apr-07	96	28-Apr-08	132	29-Apr-09	107
28-Apr-06	100	26-Apr-07	92	29-Apr-08	132	30-Apr-09	105
1-May-06	100	27-Apr-07	92	30-Apr-08	132	1-May-09	105
2-May-06	100	30-Apr-07	92	1-May-08	132	4-May-09	105
3-May-06	97	1-May-07	93	2-May-08	132	5-May-09	107
4-May-06	97	2-May-07	92	5-May-08	132	6-May-09	105
5-May-06	95	3-May-07	92	6-May-08	132	7-May-09	105
8-May-06	100	4-May-07	90	7-May-08	132	8-May-09	105
9-May-06	95	7-May-07	88	8-May-08	132	11-May-09	105
10-May-06	97	8-May-07	46	9-May-08	132	12-May-09	102
11-May-06	95	9-May-07	44	12-May-08	132	13-May-09	102
12-May-06	97	10-May-07	44	13-May-08	129	14-May-09	100
15-May-06	95	11-May-07	44	14-May-08	132	15-May-09	105
16-May-06	100	14-May-07	47	15-May-08	129	19-May-09	102
17-May-06	100	15-May-07	44	16-May-08	132	20-May-09	102
18-May-06	100	16-May-07	47	20-May-08	129	21-May-09	102
19-May-06	100	17-May-07	44	21-May-08	127	22-May-09	105
23-May-06	100	18-May-07	44	22-May-08	129	25-May-09	105
24-May-06	100	22-May-07	44	23-May-08	129	26-May-09	100
25-May-06	102	23-May-07	46	26-May-08	129	27-May-09	102
26-May-06	100	24-May-07	47	27-May-08	129	28-May-09	102
29-May-06	102	25-May-07	46	28-May-08	127	29-May-09	105
30-May-06	100	28-May-07	47	29-May-08	127	1-Jun-09	102
31-May-06	102	29-May-07	46	30-May-08	127	2-Jun-09	102
1-Jun-06	100	30-May-07	46	2-Jun-08	125	3-Jun-09	102
2-Jun-06	100	31-May-07	44	3-Jun-08	70	4-Jun-09	102
5-Jun-06	100	1-Jun-07	46	4-Jun-08	71	5-Jun-09	102
6-Jun-06	100	4-Jun-07	46	5-Jun-08	71	8-Jun-09	100
7-Jun-06	100	5-Jun-07	42	6-Jun-08	70	9-Jun-09	102
8-Jun-06	100	6-Jun-07	42	9-Jun-08	71	10-Jun-09	100
9-Jun-06	99	7-Jun-07	42	10-Jun-08	72	11-Jun-09	100
12-Jun-06	100	8-Jun-07	42	11-Jun-08	72	12-Jun-09	100
13-Jun-06	100	11-Jun-07	42	12-Jun-08	72	15-Jun-09	100
14-Jun-06	100	12-Jun-07	47	13-Jun-08	72	16-Jun-09	100
15-Jun-06	100	13-Jun-07	44	16-Jun-08	71	17-Jun-09	100
16-Jun-06	96	14-Jun-07	44	17-Jun-08	85	18-Jun-09	100
19-Jun-06	97	15-Jun-07	44	18-Jun-08	86	19-Jun-09	100
20-Jun-06	95	18-Jun-07	44	19-Jun-08	86	22-Jun-09	100
21-Jun-06	95	19-Jun-07	44	20-Jun-08	86	23-Jun-09	100
22-Jun-06	95	20-Jun-07	44	23-Jun-08	86	24-Jun-09	50
23-Jun-06	69	21-Jun-07	47	24-Jun-08	86	25-Jun-09	52
26-Jun-06	69	22-Jun-07	47	25-Jun-08	88	26-Jun-09	51
27-Jun-06	70	25-Jun-07	47	26-Jun-08	88	29-Jun-09	52
28-Jun-06	70	26-Jun-07	47	27-Jun-08	88	30-Jun-09	52
29-Jun-06	69	27-Jun-07	47	1-Jul-08	88	2-Jul-09	52
30-Jun-06	69	28-Jun-07	47	2-Jul-08	88	3-Jul-09	52
4-Jul-06	69	29-Jun-07	42	3-Jul-08	88	6-Jul-09	53
5-Jul-06	69	3-Jul-07	42	4-Jul-08	88	7-Jul-09	54
6-Jul-06	69	4-Jul-07	42	7-Jul-08	88	8-Jul-09	54
7-Jul-06	70	5-Jul-07	42	8-Jul-08	88	9-Jul-09	54
10-Jul-06	69	6-Jul-07	44	9-Jul-08	88	10-Jul-09	54
11-Jul-06	69	9-Jul-07	44	10-Jul-08	88	13-Jul-09	54
12-Jul-06	120	10-Jul-07	44	11-Jul-08	88	14-Jul-09	54
13-Jul-06	120	11-Jul-07	42	14-Jul-08	88	15-Jul-09	54
14-Jul-06	120	12-Jul-07	44	15-Jul-08	86	16-Jul-09	53
17-Jul-06	120	13-Jul-07	44	16-Jul-08	86	17-Jul-09	54
18-Jul-06	115	16-Jul-07	44	17-Jul-08	86	20-Jul-09	54
19-Jul-06	115	17-Jul-07	44	18-Jul-08	86	21-Jul-09	56
20-Jul-06	115	18-Jul-07	44	21-Jul-08	86	22-Jul-09	56
21-Jul-06	115	19-Jul-07	44	22-Jul-08	86	23-Jul-09	56
24-Jul-06	110	20-Jul-07	44	23-Jul-08	86	24-Jul-09	56
25-Jul-06	110	23-Jul-07	44	24-Jul-08	86	27-Jul-09	56
26-Jul-06	108	24-Jul-07	44	25-Jul-08	88	28-Jul-09	56
27-Jul-06	110	25-Jul-07	44	28-Jul-08	86	29-Jul-09	54
28-Jul-06	30	26-Jul-07	44	29-Jul-08	88	30-Jul-09	54
31-Jul-06	28	27-Jul-07	43	30-Jul-08	86	31-Jul-09	56
1-Aug-06	27	30-Jul-07	44	31-Jul-08	86	4-Aug-09	56
3-Aug-06	124	31-Jul-07	44	1-Aug-08	86	5-Aug-09	56
4-Aug-06	125	1-Aug-07	44	5-Aug-08	86	6-Aug-09	54
8-Aug-06	120	2-Aug-07	44	6-Aug-08	72	7-Aug-09	54
9-Aug-06	150	3-Aug-07	44	7-Aug-08	90	10-Aug-09	56
10-Aug-06	150	7-Aug-07	44	8-Aug-08	92	11-Aug-09	56
11-Aug-06	143	8-Aug-07	44	11-Aug-08	95	12-Aug-09	75
14-Aug-06	134	9-Aug-07	46	12-Aug-08	95	13-Aug-09	76
15-Aug-06	132	10-Aug-07	46	13-Aug-08	97	14-Aug-09	76
16-Aug-06	147	13-Aug-07	44	14-Aug-08	95	17-Aug-09	75
17-Aug-06	144	14-Aug-07	44	15-Aug-08	95	18-Aug-09	75

Table A1.15: Flow Data for Cell 18 Inflow to the Effluent Treatment Plant (Q-05)

2006		2007		2008		2009	
Date	Flow (L/s)	Date	Flow (L/s)	Date	Flow (L/s)	Date	Flow (L/s)
18-Aug-06	142	15-Aug-07	46	18-Aug-08	95	19-Aug-09	75
21-Aug-06	130	16-Aug-07	46	19-Aug-08	95	20-Aug-09	75
22-Aug-06	150	17-Aug-07	44	20-Aug-08	92	21-Aug-09	74
23-Aug-06	147	20-Aug-07	44	21-Aug-08	95	24-Aug-09	75
24-Aug-06	140	21-Aug-07	44	22-Aug-08	95	25-Aug-09	75
25-Aug-06	51	22-Aug-07	44	25-Aug-08	92	26-Aug-09	75
28-Aug-06	50	23-Aug-07	44	26-Aug-08	90	27-Aug-09	73
29-Aug-06	35	24-Aug-07	46	27-Aug-08	95	28-Aug-09	73
30-Aug-06	31	27-Aug-07	46	28-Aug-08	92	31-Aug-09	73
31-Aug-06	31	28-Aug-07	46	29-Aug-08	92	1-Sep-09	75
1-Sep-06	45	29-Aug-07	44	2-Sep-08	92	2-Sep-09	75
5-Sep-06	45	30-Aug-07	42	3-Sep-08	95	3-Sep-09	90
6-Sep-06	54	31-Aug-07	42	4-Sep-08	90	4-Sep-09	90
7-Sep-06	54	4-Sep-07	47	5-Sep-08	92	8-Sep-09	90
8-Sep-06	60	5-Sep-07	47	8-Sep-08	92	9-Sep-09	92
11-Sep-06	60	6-Sep-07	47	9-Sep-08	89	10-Sep-09	92
12-Sep-06	58	7-Sep-07	47	10-Sep-08	90	11-Sep-09	92
13-Sep-06	61	10-Sep-07	42	11-Sep-08	90	14-Sep-09	90
14-Sep-06	58	11-Sep-07	47	12-Sep-08	90	15-Sep-09	92
15-Sep-06	58	12-Sep-07	47	15-Sep-08	97	16-Sep-09	90
18-Sep-06	40	13-Sep-07	47	16-Sep-08	97	17-Sep-09	92
19-Sep-06	40	14-Sep-07	47	17-Sep-08	94	18-Sep-09	90
20-Sep-06	60	17-Sep-07	47	18-Sep-08	92	21-Sep-09	87
21-Sep-06	60	18-Sep-07	47	19-Sep-08	94	22-Sep-09	89
22-Sep-06	20	19-Sep-07	45	22-Sep-08	92	23-Sep-09	91
25-Sep-06	65	20-Sep-07	45	23-Sep-08	67	24-Sep-09	89
26-Sep-06	26	21-Sep-07	45	24-Sep-08	69	25-Sep-09	88
27-Sep-06	29	24-Sep-07	45	25-Sep-08	65	28-Sep-09	89
28-Sep-06	32	25-Sep-07	47	26-Sep-08	67	29-Sep-09	90
29-Sep-06	31	26-Sep-07	47	29-Sep-08	65	30-Sep-09	85
2-Oct-06	32	27-Sep-07	47	30-Sep-08	65	1-Oct-09	70
3-Oct-06	32	28-Sep-07	47	1-Oct-08	55	2-Oct-09	70
4-Oct-06	32	1-Oct-07	42	2-Oct-08	55	5-Oct-09	73
5-Oct-06	32	2-Oct-07	42	3-Oct-08	53	6-Oct-09	70
6-Oct-06	32	3-Oct-07	42	6-Oct-08	53	7-Oct-09	74
10-Oct-06	36	4-Oct-07	42	7-Oct-08	53	8-Oct-09	73
11-Oct-06	37	5-Oct-07	42	8-Oct-08	55	9-Oct-09	70
12-Oct-06	35	9-Oct-07	45	9-Oct-08	55	14-Oct-09	74
13-Oct-06	38	10-Oct-07	46	10-Oct-08	55	15-Oct-09	73
16-Oct-06	37	11-Oct-07	46	14-Oct-08	54	16-Oct-09	75
17-Oct-06	37	12-Oct-07	46	15-Oct-08	55	19-Oct-09	75
18-Oct-06	40	15-Oct-07	45	16-Oct-08	55	20-Oct-09	75
19-Oct-06	40	16-Oct-07	45	17-Oct-08	55	21-Oct-09	75
20-Oct-06	40	17-Oct-07	47	20-Oct-08	55	22-Oct-09	75
23-Oct-06	40	18-Oct-07	44	21-Oct-08	55	23-Oct-09	73
24-Oct-06	42	22-Oct-07	47	22-Oct-08	55	26-Oct-09	75
25-Oct-06	42	23-Oct-07	66	23-Oct-08	58	27-Oct-09	75
26-Oct-06	42	24-Oct-07	106	24-Oct-08	55	28-Oct-09	75
27-Oct-06	42	25-Oct-07	106	27-Oct-08	55	29-Oct-09	75
30-Oct-06	42	26-Oct-07	110	28-Oct-08	55	30-Oct-09	75
31-Oct-06	42	29-Oct-07	112	29-Oct-08	58	2-Nov-09	77
1-Nov-06	42	30-Oct-07	113	30-Oct-08	58	3-Nov-09	77
2-Nov-06	42	31-Oct-07	108	31-Oct-08	55	4-Nov-09	77
3-Nov-06	44	1-Nov-07	108	3-Nov-08	55	5-Nov-09	80
6-Nov-06	44	2-Nov-07	108	4-Nov-08	58	6-Nov-09	100
7-Nov-06	47	5-Nov-07	105	5-Nov-08	55	9-Nov-09	130
8-Nov-06	44	6-Nov-07	0	6-Nov-08	58	10-Nov-09	130
9-Nov-06	44	7-Nov-07	106	7-Nov-08	58	11-Nov-09	130
10-Nov-06	44	8-Nov-07	108	10-Nov-08	55	12-Nov-09	130
13-Nov-06	44	9-Nov-07	108	11-Nov-08	55	13-Nov-09	135
14-Nov-06	44	12-Nov-07	105	12-Nov-08	55	16-Nov-09	141
15-Nov-06	44	14-Nov-07	0	13-Nov-08	55	17-Nov-09	141
16-Nov-06	44	15-Nov-07	0	14-Nov-08	55	18-Nov-09	143
17-Nov-06	43	16-Nov-07	106	17-Nov-08	58	19-Nov-09	141
20-Nov-06	42	19-Nov-07	0	18-Nov-08	58	20-Nov-09	141
21-Nov-06	42	20-Nov-07	104	19-Nov-08	55	23-Nov-09	140
22-Nov-06	42	21-Nov-07	104	20-Nov-08	58	24-Nov-09	136
23-Nov-06	44	22-Nov-07	104	21-Nov-08	55	25-Nov-09	136
24-Nov-06	42	23-Nov-07	104	24-Nov-08	65	26-Nov-09	139
27-Nov-06	42	26-Nov-07	104	25-Nov-08	64	27-Nov-09	139
28-Nov-06	45	27-Nov-07	104	26-Nov-08	63	30-Nov-09	139
29-Nov-06	65	28-Nov-07	104	27-Nov-08	63	1-Dec-09	139
30-Nov-06	65	29-Nov-07	102	28-Nov-08	63	2-Dec-09	136
1-Dec-06	65	30-Nov-07	100	1-Dec-08	63	3-Dec-09	136
4-Dec-06	64	3-Dec-07	102	2-Dec-08	63	4-Dec-09	136
5-Dec-06	64	4-Dec-07	104	3-Dec-08	63	7-Dec-09	136
6-Dec-06	62	5-Dec-07	104	4-Dec-08	63	8-Dec-09	136

Table A1.15: Flow Data for Cell 18 Inflow to the Effluent Treatment Plant (Q-05)

2006		2007		2008		2009	
Date	Flow (L/s)	Date	Flow (L/s)	Date	Flow (L/s)	Date	Flow (L/s)
7-Dec-06	64	6-Dec-07	101	5-Dec-08	65	9-Dec-09	136
8-Dec-06	64	7-Dec-07	101	8-Dec-08	65	10-Dec-09	136
11-Dec-06	64	10-Dec-07	96	9-Dec-08	65	11-Dec-09	134
12-Dec-06	64	11-Dec-07	104	10-Dec-08	67	14-Dec-09	131
13-Dec-06	79	12-Dec-07	99	11-Dec-08	66	15-Dec-09	131
14-Dec-06	96	13-Dec-07	101	12-Dec-08	65	16-Dec-09	129
15-Dec-06	160	14-Dec-07	101	15-Dec-08	65	17-Dec-09	129
18-Dec-06	164	17-Dec-07	99	16-Dec-08	65	18-Dec-09	131
19-Dec-06	164	18-Dec-07	99	17-Dec-08	85	21-Dec-09	129
20-Dec-06	165	19-Dec-07	102	18-Dec-08	90	22-Dec-09	129
21-Dec-06	164	20-Dec-07	100	19-Dec-08	85	23-Dec-09	85
22-Dec-06	164	21-Dec-07	100	22-Dec-08	85	24-Dec-09	85
27-Dec-06	158	24-Dec-07	104	23-Dec-08	90	29-Dec-09	87
28-Dec-06	158	27-Dec-07	104	24-Dec-08	87	30-Dec-09	88
29-Dec-06	158	28-Dec-07	104	29-Dec-08	130	31-Dec-09	88
		31-Dec-07	102	30-Dec-08	130		
				31-Dec-08	130		

APPENDIX 2

Detailed Data Quality Assessment

Table A2.1: Data Quality Assessment Summary for Selected Constituents in Solids

Analysis	Units	Method Detection Limit	RPD Data Quality Objective	Sample ID Core09-QC15-4 (20-30)	Duplicate ID Core09-QC15-6 (0-10)	RPD (%) or AD	Sample ID Core09-QC15-2 (10-20)	Duplicate ID Core09-QC15-6 (10-20)	RPD (%) or AD
Conventional Parameters									
Sulphate (SO_4)	%	0.1	≤ 40%	0.1	0.1	0	0.3	0.3	0
Acid Base Accounting									
Neutralization Potential (NP)	t $CaCO_3$/1000t	--	≤ 40%	3.0	4.0	29	3.3	3.5	6
Acid Potential (AP)	t $CaCO_3$/1000t	3.1	≤ 40%	66.1	248	**116**	15.3	11.2	**4.1**
Sulphur (S)	%	0.1	≤ 40%	8.14	8.26	1	0.583	0.492	17
Sulphate-S	%	0.1	≤ 40%	6.02	0.32	**180**	0.30	0.13	0.2
Sulphide-S	%	0.1	≤ 40%	2.11	7.94	**116**	0.28	0.36	0.1
Carbon	%	0.005	≤ 40%	0.065	0.015	**0.050**	0.022	0.015	**0.007**
Carbonate (CO_3)	%	0.005	≤ 40%	<0.005	<0.005	BD	<0.005	<0.005	BD
Metals									
Radium-226 (Ra-226)	Bq/g	0.01	≤ 40%	5.8	7.2	22	7.2	6.3	13
Silver (Ag)	mg/kg	0.7	≤ 40%	0.8	1.0	0.2	<0.7	<0.7	BD
Aluminum (Al)	mg/kg	1	≤ 40%	170	180	6	170	180	6
Arsenic (As)	mg/kg	1	≤ 40%	34	40	16	13	14	7
Barium (Ba)	mg/kg	0.05	≤ 40%	74	76	3	280	300	7
Beryllium (Be)	mg/kg	0.1	≤ 40%	<0.1	<0.1	BD	<0.1	<0.1	BD
Bismuth (Bi)	mg/kg	0.5	≤ 40%	7.5	8.6	14	5.6	5.9	5
Calcium (Ca)	mg/kg	1	≤ 40%	88	73	19	1300	1200	8
Cadmium (Cd)	mg/kg	0.05	≤ 40%	0.88	1.1	22	0.08	0.09	0.01
Cerium (Ce)	mg/kg	0.006	≤ 40%	140	150	7	320	310	3
Cobalt (Co)	mg/kg	0.3	≤ 40%	98	130	28	7.3	7.1	3
Chromium (Cr)	mg/kg	0.5	≤ 40%	<0.5	<0.5	BD	<0.5	<0.5	BD
Cesium (Cs)	mg/kg	0.01	≤ 40%	0.24	0.35	37	0.27	0.27	0
Copper (Cu)	mg/kg	0.1	≤ 40%	78	53	38	43	39	10
Iron (Fe)	mg/kg	0.5	≤ 40%	54000	66000	20	4200	4400	5
Gallium (Ga)	mg/kg	0.03	≤ 40%	0.75	0.80	6	1.7	1.7	0
Germanium (Ge)	mg/kg	0.3	≤ 40%	2.6	3.1	18	1.2	1.3	8
Hafnium (Hf)	mg/kg	0.1	≤ 40%	0.5	0.6	18	0.5	0.5	0
Indium (In)	mg/kg	0.01	≤ 40%	<0.01	<0.01	BD	<0.01	<0.01	BD
Potassium (K)	mg/kg	1	≤ 40%	120	130	8	170	180	6
Lanthanum (La)	mg/kg	0.001	≤ 40%	78	88	12	180	180	0
Lithium (Li)	mg/kg	0.1	≤ 40%	<0.1	<0.1	BD	<0.1	<0.1	BD
Lutetium (Lu)	mg/kg	0.001	≤ 40%	0.015	0.018	18	0.040	0.043	7
Magnesium (Mg)	mg/kg	1	≤ 40%	7	8	13	7	7	0
Manganese (Mn)	mg/kg	0.05	≤ 40%	0.48	0.56	15	0.31	0.43	32
Molybdenum (Mo)	mg/kg	0.5	≤ 40%	4.2	3.1	30	2.4	4.5	**61**
Sulphur (S)	mg/kg	1	≤ 40%	71000	86000	19	5700	5400	5
Sodium (Na)	mg/kg	1	≤ 40%	3	3	0	6	6	0
Niobium (Nb)	mg/kg	0.7	≤ 40%	2.6	2.8	0.2	1.9	1.9	0.0
Nickel (Ni)	mg/kg	1	≤ 40%	42	54	25	3	3	0
Lead (Pb)	mg/kg	0.7	≤ 40%	290	310	7	250	250	0
Phosphorous (P)	mg/kg	5	≤ 40%	66	68	3	150	150	0
Rubidium (Rb)	mg/kg	0.004	≤ 40%	0.98	1.2	20	1.6	1.7	6
Antimony (Sb)	mg/kg	1	≤ 40%	<1	<1	BD	<1	<1	BD
Scandium (Sc)	mg/kg	0.2	≤ 40%	<0.2	<0.2	BD	<0.2	<0.2	BD
Selenium (Se)	mg/kg	1	≤ 40%	2	1	1	<1	<1	BD
Tin (Sn)	mg/kg	6	≤ 40%	<6	<6	BD	<6	<6	BD
Strontium (Sr)	mg/kg	0.01	≤ 40%	3.1	3.3	6	6.7	6.8	1
Tantalum (Ta)	mg/kg	0.01	≤ 40%	0.10	0.19	62	0.16	0.17	6
Terbium (Tb)	mg/kg	0.01	≤ 40%	0.37	0.40	8	0.96	0.97	1
Tellurium (Te)	mg/kg	0.1	≤ 40%	0.3	0.3	0	<0.1	<0.1	BD
Thorium (Th)	mg/kg	0.01	≤ 40%	23	27	16	42	42	0
Titanium (Ti)	mg/kg	0.2	≤ 40%	27	28	4	37	38	3
Thallium (Tl)	mg/kg	3	≤ 40%	<3	<3	BD	<3	<3	BD
Uranium (U)	mg/kg	3	≤ 40%	7.2	8.0	1	3.8	3.9	0
Vanadium (V)	mg/kg	0.1	≤ 40%	0.1	0.1	0.0	0.2	0.2	0.0
Tungsten (W)	mg/kg	1	≤ 40%	19	25	27	2	2	0
Yttrium (Y)	mg/kg	0.1	≤ 40%	2.9	3.2	10	6.7	6.9	3
Ytterbium (Yb)	mg/kg	0.1	≤ 40%	0.12	0.14	0.0	0.35	0.37	0.0
Zinc (Zn)	mg/kg	0.1	≤ 40%	4.4	5.1	15	6.0	7.8	26
Zirconium (Zr)	mg/kg	5	≤ 40%	9	9	0	8	8	0

Notes:

RPD - relative percent difference; is calculated for analytes with concentrations greater than or equal to five times the detection limit and should be less than or equal to 40%

AD - absolute difference; for samples having concentrations less than five times the detection limit, the difference between the sample and duplicate, or difference between the sample or duplicate and the detection limit if either the sample or duplicate analyte concentration is below detection limit; should not be greater then the detection limit

BD - Sample and/or replicate had analyte concentrations below detection limit

Boldface type and shaded indicates that Data Quality Objective was not achieved

Table A2.2: Detailed Data Quality Assessment for Constituents in Short-Term Leachate Waters

Analysis	Units	Method Detection Limit	RPD Data Quality Objective	Sample ID Core09-QC15-2 (10-20)	Replicate ID Core09-QC15-6 (10-20)	RPD (%) or AD	Sample ID Core09-QC15-4 (10-20)	Replicate ID Core09-QC15-6 (20-30)	RPD (%) or AD
Conventional Parameters									
Acidity (as $CaCO_3$)	mg/L	2	≤ 20%	13	41	**104**	30	27	11
Sulphate (SO_4)	mg/L	0.2	≤ 20%	1500	1200	**22**	48	48	0
Hardness (as $CaCO_3$)	mg/L	0.5	≤ 20%	1440	1196	19	38.1	39.1	3
Metals									
Radium-226 (Ra-226)	Bq/L	0.01	≤ 20%	1.4	1.3	7	3.7	3.3	11
Aluminum (Al)	mg/L	0.01	≤ 20%	<0.01	0.05	BD	0.28	0.32	13
Arsenic (As)	mg/L	0.0002	≤ 20%	0.0060	0.0074	**21**	0.0380	0.0370	3
Barium (Ba)	mg/L	0.00001	≤ 20%	0.0239	0.0286	18	0.0480	0.0427	12
Beryllium (Be)	mg/L	0.00002	≤ 20%	<0.00002	<0.00002	BD	0.00002	0.00003	0.00001
Boron (B)	mg/L	0.0002	≤ 20%	0.0149	0.0150	1	0.0086	0.0083	4
Bismuth (Bi)	mg/L	0.00001	≤ 20%	0.00012	0.00023	**63**	0.00095	0.00090	5
Calcium (Ca)	mg/L	0.03	≤ 20%	574	478	18	14.6	15.0	3
Cadmium (Cd)	mg/L	0.000003	≤ 20%	0.00127	0.00152	18	0.000619	0.000614	1
Cobalt (Co)	mg/L	0.000002	≤ 20%	0.0173	0.0181	5	0.0218	0.0208	5
Chromium (Cr)	mg/L	0.0005	≤ 20%	<0.0005	<0.0005	BD	<0.0005	<0.0005	BD
Copper (Cu)	mg/L	0.0005	≤ 20%	0.0056	0.0214	**117**	0.0121	0.0070	**53**
Iron (Fe)	mg/L	0.01	≤ 20%	0.02	0.05	0.03	0.09	0.20	**76**
Potassium (K)	mg/L	0.01	≤ 20%	2.91	2.87	1	1.64	1.72	5
Lithium (Li)	mg/L	0.002	≤ 20%	<0.002	0.002	BD	<0.002	<0.002	BD
Magnesium (Mg)	mg/L	0.003	≤ 20%	0.479	0.487	2	0.412	0.423	3
Manganese (Mn)	mg/L	0.00001	≤ 20%	0.0311	0.0299	4	0.0274	0.0261	5
Molybdenum (Mo)	mg/L	0.00001	≤ 20%	0.00104	0.00082	**24**	0.00192	0.00228	17
Sodium (Na)	mg/L	0.01	≤ 20%	0.76	0.67	13	0.46	0.49	6
Nickel (Ni)	mg/L	0.0001	≤ 20%	0.0392	0.0391	0	0.0093	0.0096	3
Lead (Pb)	mg/L	0.00002	≤ 20%	<0.01	<0.01	BD	<0.01	<0.01	BD
Phosphorous (P)	mg/L	0.01	≤ 20%	3.06	3.54	15	13.5	12.1	11
Antimony (Sb)	mg/L	0.0002	≤ 20%	0.0012	0.0014	15	0.0040	0.0038	5
Selenium (Se)	mg/L	0.001	≤ 20%	0.002	0.002	0	0.007	0.007	0
Sulphur (S)	mg/L	0.01	≤ 20%	5.88	5.56	6	3.06	3.31	8
Silicon (Si)	mg/L	0.01	≤ 20%	486	408	17	17.8	18.5	4
Tin (Sn)	mg/L	0.00001	≤ 20%	<0.00001	<0.00001	BD	0.00011	0.00011	0
Strontium (Sr)	mg/L	0.0001	≤ 20%	0.240	0.196	20	0.0040	0.0038	5
Titanium (Ti)	mg/L	0.0001	≤ 20%	0.0012	0.0010	18	0.0035	0.0038	8
Thallium (Tl)	mg/L	0.0002	≤ 20%	0.0017	0.0020	16	0.0006	0.0006	0
Uranium (U)	mg/L	0.000001	≤ 20%	0.00342	0.0139	**121**	0.122	0.139	13
Vanadium (V)	mg/L	0.00003	≤ 20%	<0.00003	0.00004	BD	<0.00003	<0.00003	BD
Zinc (Zn)	mg/L	0.001	≤ 20%	0.058	0.091	44	0.003	0.007	**0.004**

Notes:

RPD - relative percent difference; is calculated for analytes with concentrations greater than or equal to five times the detection limit and should be less than or equal to 40%

AD - absolute difference; for samples having concentrations less than five times the detection limit, the difference between the sample and duplicate, or difference between the sample or duplicate and the detection limit if either the sample or duplicate analyte concentration is below detection limit; should not be greater then the detection limit

BD - Sample and/or replicate had analyte concentrations below detection limit

Boldface type and shaded indicates that Data Quality Objective was not achieved

Table A2.3: Detailed Data Quality Assessment for Constituents in the Blank Sample

Analysis	Units	Detection Limit	Data Quality Objective	Blank
Convential Parameters				
Acidity (as $CaCO_3$)	mg/L	2	4	**6**
Sulphate (SO_4)	mg/L	0.1	0.2	**0.6**
Hardness (as $CaCO_3$)	mg/L	0.5	1.0	<0.5
Metals				
Radium-226 (Ra-226)	Bq/L	0.01	0.02	<0.01
Aluminum (Al)	mg/L	0.01	0.02	<0.01
Arsenic (As)	mg/L	0.0002	0.0004	**0.0007**
Barium (Ba)	mg/L	0.00001	0.00002	**0.00060**
Beryllium (Be)	mg/L	0.00002	0.00004	<0.00002
Boron (B)	mg/L	0.0002	0.0004	0.0004
Bismuth (Bi)	mg/L	0.00001	0.00002	**0.00003**
Calcium (Ca)	mg/L	0.03	0.06	0.05
Cadmium (Cd)	mg/L	0.000003	0.000006	**0.000011**
Cobalt (Co)	mg/L	0.000002	0.000004	**0.000260**
Chromium (Cr)	mg/L	0.0005	0.0010	<0.0005
Copper (Cu)	mg/L	0.0005	0.0010	**0.0068**
Iron (Fe)	mg/L	0.01	0.02	<0.01
Potassium (K)	mg/L	0.01	0.02	<0.01
Lithium (Li)	mg/L	0.002	0.004	<0.002
Magnesium (Mg)	mg/L	0.003	0.006	<0.003
Manganese (Mn)	mg/L	0.00001	0.00002	**0.00049**
Molybdenum (Mo)	mg/L	0.00001	0.00002	**0.00009**
Sodium (Na)	mg/L	0.01	0.02	0.02
Nickel (Ni)	mg/L	0.0001	0.0002	**0.0006**
Lead (Pb)	mg/L	0.00002	0.00004	**0.0968**
Phosphorous (P)	mg/L	0.01	0.02	<0.01
Antimony (Sb)	mg/L	0.0002	0.0004	<0.0002
Selenium (Se)	mg/L	0.001	0.002	<0.001
Sulphur (S)	mg/L	0.01	0.02	0.02
Silicon (Si)	mg/L	0.01	0.02	<0.01
Tin (Sn)	mg/L	0.00001	0.00002	<0.00001
Strontium (Sr)	mg/L	0.0001	0.0002	<0.0001
Titanium (Ti)	mg/L	0.0001	0.0002	0.0001
Thallium (Tl)	mg/L	0.0002	0.0004	<0.0002
Uranium (U)	mg/L	0.000001	0.000002	**0.000464**
Vanadium (V)	mg/L	0.00003	0.00006	<0.00003
Zinc (Zn)	mg/L	0.001	0.002	0.001

Notes:
Boldface type and shaded indicates that Data Quality Objective was not achieved

EcoMetrix INCORPORATED

APPENDIX 3

Certificates of Analysis for the 2009 Field and Laboratory Data

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Analysis	**1: Analysis Start Date**	**2: Analysis Start Time**	**3: Analysis Approval Date**	**4: Analysis Approval Time**	**5: CORE 09-QC-15-1 (0-10)**	**6: CORE 09-QC-15-1 (10-20)**	**7: CORE 09-QC-15-1 (20-30)**	**8: CORE 09-QC-15-1 (30-40)**	**9: CORE 09-QC-15-2 (0-10)**
Sample Date & Time					07-Oct-09	07-Oct-09	07-Oct-09	07-Oct-09	07-Oct-09
Paste pH [units]	22-Oct-09	09:00	25-Oct-09	14:15	5.53	5.15	5.05	4.66	5.88
Fizz Rate [---]	22-Oct-09	09:00	25-Oct-09	14:15	1	1	1	1	1
Sample [weight(g)]	22-Oct-09	09:00	25-Oct-09	14:15	1.96	1.96	2.03	1.96	2.02
HCl added [mL]	22-Oct-09	09:00	25-Oct-09	14:15	20.00	20.00	20.00	20.00	20.00
HCl [Normality]	22-Oct-09	09:00	25-Oct-09	14:15	0.10	0.10	0.10	0.10	0.10
NaOH [Normality]	22-Oct-09	09:00	25-Oct-09	14:15	0.10	0.10	0.10	0.10	0.10
NaOH to [pH=8.3 mL]	22-Oct-09	09:00	25-Oct-09	14:15	18.25	18.66	18.38	18.78	18.43
Final pH [units]	22-Oct-09	09:00	25-Oct-09	14:15	0.98	1.37	1.08	1.38	1.17
NP [t CaCO3/1000t]	22-Oct-09	09:00	25-Oct-09	14:15	4.5	3.4	4.0	3.1	3.9
AP [t CaCO3/1000 t]	25-Oct-09	14:15	25-Oct-09	14:15	10.9	7.12	9.59	9.69	3.32
Net NP [t CaCO3/1000 t]	25-Oct-09	14:15	25-Oct-09	14:15	-6.39	-3.72	-5.59	-6.59	0.58
NP/AP [ratio]	25-Oct-09	14:15	25-Oct-09	14:15	0.41	0.48	0.42	0.32	1.17
S [%]	21-Oct-09	10:46	21-Oct-09	11:11	0.375	0.385	0.352	0.473	0.461
SO4-S [%]	21-Oct-09	10:46	22-Oct-09	10:40	0.03	0.16	0.04	0.16	0.35
Sulphide-S [%]	21-Oct-09	10:46	22-Oct-09	10:40	0.35	0.23	0.31	0.31	0.11
C [%]	21-Oct-09	10:46	21-Oct-09	11:11	0.148	0.045	0.058	0.021	0.116
CO3 [%]	21-Oct-09	10:46	25-Oct-09	14:02	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005

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```
*NP (Neutralization Potential)
 = 50 x (N of HCL x Total HCL added - N NaOH x NaOH added)
   -------------------------------------------------------
                        Weight of Sample

*AP (Acid Potential) = % Sulphide Sulphur x 31.25
*Net NP (Net Neutralization Potential) = NP-AP
NP/AP Ratio = NP/AP
*Results expressed as tonnes CaCO3 equivalent/1000 tonnes of material
Samples with a % Sulphide value of <0.01 will be calculated using a 0.01 value.

Sulphur analysis performed following BC ARD Guidelines (Price 1997)
```

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Analysis	**10: CORE 09-QC-15-2 (10-20)**	**11: CORE 09-QC-15-2 (20-30)**	**12: CORE 09-QC-15-2 (30-40)**	**13: CORE 09-QC-15-3 (0-10)**	**14: CORE 09-QC-15-3 (10-20)**	**15: CORE 09-QC-15-3 (20-30)**	**16: CORE 09-QC-15-3 (30-40)**	**17: CORE 09-QC-15-4 (0-10)**	**18: CORE 09-QC-15-4 (10-20)**
Sample Date & Time	07-Oct-09	07-Oct-09	07-Oct-09	07-Oct-09	07-Oct-09	07-Oct-09	07-Oct-09	07-Oct-09	07-Oct-09
Paste pH [units]	5.11	5.09	4.10	5.20	4.16	4.77	4.52	4.72	3.72
Fizz Rate [---]	1	1	1	1	1	1	1	1	1
Sample [weight(g)]	2.00	2.04	2.03	1.97	1.96	2.04	2.03	2.00	1.97
HCl added [mL]	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
HCl [Normality]	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
NaOH [Normality]	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
NaOH to [pH=8.3 mL]	18.58	18.64	18.68	18.73	18.75	18.50	18.54	18.34	18.64
Final pH [units]	1.24	1.28	1.21	1.14	1.01	1.05	0.93	0.98	1.14
NP [t CaCO3/1000t]	3.5	3.3	3.3	3.2	3.2	3.7	3.6	4.1	3.4
AP [t CaCO3/1000 t]	8.84	15.3	25.7	56.5	140	83.5	86.8	44.1	300
Net NP [t CaCO3/1000 t]	-5.34	-11.99	-22.39	-53.31	-137.30	-79.84	-83.15	-39.96	-296.64
NP/AP [ratio]	0.40	0.22	0.13	0.06	0.02	0.04	0.04	0.09	0.01
S [%]	0.583	0.801	1.000	2.29	4.58	3.64	3.49	3.57	10.6
SO4-S [%]	0.30	0.31	0.18	0.48	0.08	0.96	0.72	2.16	1.04
Sulphide-S [%]	0.28	0.49	0.82	1.81	4.50	2.67	2.78	1.41	9.60
C [%]	0.022	0.017	0.022	0.356	0.026	0.015	0.026	0.190	0.061
CO3 [%]	< 0.005	< 0.005	< 0.005	0.014	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005

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Analysis	19: CORE 09-QC-15-4 (20-30)	20: CORE 09-QC-15-4 (30-40)	21: CORE 09-QC-15-5 (0-10)	22: CORE 09-QC-15-5 (10-20)	23: CORE 09-QC-15-5 (20-30)	24: CORE 09-QC-15-5 (30-40)	25: CORE 09-QC-15-5 (40-50)	26: CORE 09-QC-15-6 (0-10)	27: CORE 09-QC-15-6 (10-20)
Sample Date & Time	07-Oct-09	07-Oct-09	07-Oct-09	07-Oct-09	07-Oct-09	07-Oct-09	07-Oct-09	07-Oct-09	07-Oct-09
Paste pH [units]	3.30	3.32	3.00	3.02	2.97	2.81	2.81	3.27	4.70
Fizz Rate [---]	1	1	1	1	1	1	1	1	1
Sample [weight(g)]	1.99	2.00	2.02	1.96	2.01	2.00	2.01	1.99	2.01
HCl added [mL]	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
HCl [Normality]	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
NaOH [Normality]	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
NaOH to [pH=8.3 mL]	18.80	18.73	18.39	18.40	18.67	18.29	18.30	18.42	18.60
Final pH [units]	1.23	0.97	1.09	1.31	1.05	1.15	1.07	1.04	1.04
NP [t CaCO3/1000t]	3.0	3.2	4.0	4.1	3.3	4.3	4.2	4.0	3.5
AP [t CaCO3/1000 t]	66.1	172	13.8	138	99.9	168	290	248	11.2
Net NP [t CaCO3/1000 t]	-63.09	-168.82	-9.77	-133.75	-96.62	-163.98	-285.98	-244.10	-7.66
NP/AP [ratio]	0.05	0.02	0.29	0.03	0.03	0.03	0.01	0.02	0.31
S [%]	8.14	12.9	0.521	8.69	5.61	10.9	13.8	8.26	0.492
SO4-S [%]	6.02	7.40	0.08	4.28	2.42	5.54	4.50	0.32	0.13
Sulphide-S [%]	2.11	5.50	0.44	4.41	3.20	5.38	9.29	7.94	0.36
C [%]	0.065	0.066	0.123	0.055	0.016	0.055	0.051	0.015	0.015
CO3 [%]	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005

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Analysis	**3: Analysis Approval Date**	**4: Analysis Approval Time**	**5: CORE 09-QC-15-1 (0-10)**	**6: CORE 09-QC-15-1 (10-20)**	**7: CORE 09-QC-15-1 (20-30)**	**8: CORE 09-QC-15-1 (30-40)**	**9: CORE 09-QC-15-2 (0-10)**	**10: CORE 09-QC-15-2 (10-20)**	**11: CORE 09-QC-15-2 (20-30)**
Sample Date & Time			07-Oct-09	07-Oct-09	07-Oct-09	07-Oct-09	07-Oct-09	07-Oct-09	07-Oct-09
BaSO4 Calc. using Ba* [µg/g]	---	---	290	310	290	310	440	510	320
BaSO4 Calc. using SO4** [µg/g]	---	---	2430	2430	2430	4860	26700	7290	2430
Sulphate [%]	26-Oct-09	09:36	0.1	0.1	0.1	0.2	1.1	0.3	0.1
Silver [µg/g]	21-Oct-09	13:04	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7	< 0.7
Aluminum [µg/g]	21-Oct-09	13:04	710	500	830	260	330	180	150
Arsenic [µg/g]	21-Oct-09	13:04	11	10	11	10	13	14	13
Barium [µg/g]	21-Oct-09	13:04	170	180	170	180	260	300	190
Beryllium [µg/g]	21-Oct-09	13:04	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Bismuth [µg/g]	21-Oct-09	13:04	1.8	1.1	1.5	2.6	6.0	5.9	3.7
Calcium [µg/g]	21-Oct-09	13:04	250	130	210	730	4500	1200	210
Cadmium [µg/g]	21-Oct-09	13:04	0.31	0.09	0.13	< 0.05	0.29	0.09	0.10
Cerium [µg/g]	20-Oct-09	16:07	200	220	210	220	280	310	250
Cobalt [µg/g]	21-Oct-09	13:04	8.8	6.3	6.7	6.6	5.1	7.1	11
Chromium [µg/g]	21-Oct-09	13:04	1.0	< 0.5	0.6	0.9	0.8	< 0.5	< 0.5
Cesium [µg/g]	20-Oct-09	16:07	0.15	0.12	0.23	0.40	0.38	0.27	0.14
Copper [µg/g]	21-Oct-09	13:04	27	21	22	30	29	39	37
Iron [µg/g]	21-Oct-09	13:04	13000	3300	4100	4000	17000	4400	5700
Gallium [µg/g]	20-Oct-09	16:07	1.2	1.2	1.2	1.3	1.7	1.7	1.4
Germanium [µg/g]	20-Oct-09	16:07	1.2	1.0	0.9	1.0	1.6	1.3	1.1
Hafnium [µg/g]	20-Oct-09	16:07	0.3	0.3	0.3	0.4	0.6	0.5	0.4
Indium [µg/g]	20-Oct-09	16:07	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Potassium [µg/g]	21-Oct-09	13:04	77	68	80	130	260	180	130
Lanthanum [µg/g]	20-Oct-09	16:07	110	120	120	130	150	180	140
Lithium [µg/g]	21-Oct-09	13:04	< 0.1	< 0.1	< 0.1	< 0.1	0.1	0.1	< 0.1
Lutetium [µg/g]	20-Oct-09	16:07	0.17	0.15	0.084	0.019	0.36	0.043	0.023
Magnesium [µg/g]	21-Oct-09	13:04	42	17	23	49	37	7	6
Manganese [µg/g]	21-Oct-09	13:04	12	2.6	2.3	1.9	11	0.43	0.14
Molybdenum [µg/g]	21-Oct-09	13:04	7.0	5.4	5.2	4.1	9.0	4.5	5.0
Sulphur [µg/g]		11:12	3200	2100	3000	4600	5300	5400	6300
Sodium [µg/g]	21-Oct-09	13:04	4	3	4	9	14	6	3

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LR Report : **CA10157-OCT09**

Analysis	3: Analysis Approval Date	4: Analysis Approval Time	5: CORE 09-QC-15-1 (0-10)	6: CORE 09-QC-15-1 (10-20)	7: CORE 09-QC-15-1 (20-30)	8: CORE 09-QC-15-1 (30-40)	9: CORE 09-QC-15-2 (0-10)	10: CORE 09-QC-15-2 (10-20)	11: CORE 09-QC-15-2 (20-30)
Niobuim [µg/g]	20-Oct-09	16:07	1.3	1.1	1.0	1.2	2.2	1.9	1.4
Nickel [µg/g]	21-Oct-09	13:04	6	5	6	3	4	3	4
Lead [µg/g]	21-Oct-09	13:04	140	98	130	150	300	250	150
Phosphorus [µg/g]	21-Oct-09	13:04	100	100	100	110	130	150	120
Rubidium [µg/g]	20-Oct-09	16:07	0.83	0.81	0.92	1.3	2.5	1.7	1.2
Antimony [µg/g]	21-Oct-09	13:04	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Scandium [µg/g]	20-Oct-09	16:07	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	0.2	< 0.2
Selenium [µg/g]	21-Oct-09	13:04	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Tin [µg/g]	21-Oct-09	13:04	< 6	< 6	< 6	< 6	< 6	< 6	< 6
Strontium [µg/g]	21-Oct-09	13:04	3.8	3.7	3.8	4.5	7.7	6.8	4.8
Tantalum [µg/g]	20-Oct-09	16:07	0.04	0.05	0.04	0.06	0.04	0.17	0.11
Terbium [µg/g]	20-Oct-09	16:07	1.1	0.95	0.68	0.58	2.2	0.97	0.69
Tellerium [µg/g]	20-Oct-09	16:07	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Thorium [µg/g]	20-Oct-09	16:07	25	24	23	28	48	42	31
Titanium [µg/g]	21-Oct-09	13:04	28	24	29	57	66	38	24
Thallium [µg/g]	21-Oct-09	13:04	< 3	< 3	< 3	< 3	< 3	< 3	< 3
Uranium [µg/g]	20-Oct-09	16:07	29	5.8	5.5	2.0	29	3.9	4.0
Vanadium [µg/g]	21-Oct-09	13:04	0.9	0.6	0.9	0.8	0.5	0.2	0.2
Tungsten [µg/g]	21-Oct-09	13:04	4	1	2	1	6	2	2
Yttrium [µg/g]	21-Oct-09	13:04	13	7.7	4.8	3.7	32	6.9	4.7
Ytterbium [µg/g]	20-Oct-09	16:07	1.4	1.2	0.68	0.16	2.8	0.37	0.20
Zinc [µg/g]	21-Oct-09	13:04	22	11	23	4.7	16	7.8	5.0
Zirconium [µg/g]	21-Oct-09	15:00	6	< 5	5	8	13	8	6

Ra226 subcontracted to Becquerel Labs.
* BaSO4 Calculation based on Ba values and assumes all Ba is in BaSO4 form.
** BaSO4 Calculation based on SO4 values and assumes all SO4 is in BaSO4 form.

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Tuesday, October 27, 2009

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LR. Ref. : **CA10157-OCT09**

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CERTIFICATE OF ANALYSIS

Final Report

Analysis	**12: CORE 09-QC-15-2 (30-40)**	**13: CORE 09-QC-15-3 (0-10)**	**14: CORE 09-QC-15-3 (10-20)**	**15: CORE 09-QC-15-3 (20-30)**	**16: CORE 09-QC-15-3 (30-40)**	**17: CORE 09-QC-15-4 (0-10)**	**18: CORE 09-QC-15-4 (10-20)**	**19: CORE 09-QC-15-4 (20-30)**
Sample Date & Time	07-Oct-09	07-Oct-09	07-Oct-09	07-Oct-09	07-Oct-09	07-Oct-09	07-Oct-09	07-Oct-09
BaSO4 Calc. using Ba* [µg/g]	320	220	220	170	200	150	120	130
BaSO4 Calc. using SO4** [µg/g]	2430	7290	17000	17000	17000	2430	2430	2430
Sulphate [%]	0.1	0.3	0.7	0.7	0.7	0.1	0.1	0.1
Silver [µg/g]	< 0.7	< 0.7	1.2	< 0.7	< 0.7	< 0.7	0.9	0.8
Aluminum [µg/g]	170	1300	180	140	150	200	160	170
Arsenic [µg/g]	13	29	21	18	18	25	36	34
Barium [µg/g]	190	130	130	100	120	90	70	74
Beryllium [µg/g]	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Bismuth [µg/g]	6.3	8.1	11	6.2	6.1	4.9	9.3	7.5
Calcium [µg/g]	250	1600	4700	3100	3200	250	92	88
Cadmium [µg/g]	0.15	0.82	0.58	0.54	0.50	0.63	1.1	0.88
Cerium [µg/g]	250	190	200	170	170	190	130	140
Cobalt [µg/g]	16	44	66	60	54	58	120	98
Chromium [µg/g]	< 0.5	2.3	0.7	< 0.5	< 0.5	0.8	< 0.5	< 0.5
Cesium [µg/g]	0.25	0.33	0.22	0.15	2200	0.22	0.15	0.24
Copper [µg/g]	37	43	76	59	67	62	74	78
Iron [µg/g]	9600	46000	36000	32000	29000	36000	63000	54000
Gallium [µg/g]	1.4	1.2	1.1	0.93	0.94	1.1	0.72	0.75
Germanium [µg/g]	1.3	2.2	2.1	1.9	1.7	2.1	2.9	2.6
Hafnium [µg/g]	0.4	0.5	0.7	0.5	0.5	0.5	0.6	0.5
Indium [µg/g]	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Potassium [µg/g]	210	160	120	110	120	83	110	120
Lanthanum [µg/g]	140	100	120	95	97	110	75	78
Lithium [µg/g]	< 0.1	0.2	0.3	0.3	0.1	< 0.1	< 0.1	< 0.1
Lutetium [µg/g]	0.030	0.41	0.040	0.021	0.021	0.025	0.016	0.015
Magnesium [µg/g]	7	48	9	6	6	9	7	7
Manganese [µg/g]	0.47	232	4.1	0.53	0.47	4.5	0.60	0.48
Molybdenum [µg/g]	3.0	10	5.6	8.6	5.5	20	13	4.2
Sulphur [µg/g]	10000	20000	43000	38000	35000	34000	83000	71000
Sodium [µg/g]	5	5	4	3	3	3	3	3

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Analysis	**12: CORE 09-QC-15-2 (30-40)**	**13: CORE 09-QC-15-3 (0-10)**	**14: CORE 09-QC-15-3 (10-20)**	**15: CORE 09-QC-15-3 (20-30)**	**16: CORE 09-QC-15-3 (30-40)**	**17: CORE 09-QC-15-4 (0-10)**	**18: CORE 09-QC-15-4 (10-20)**	**19: CORE 09-QC-15-4 (20-30)**
Niobuim [µg/g]	1.8	2.8	4.1	2.8	2.7	3.5	2.7	2.6
Nickel [µg/g]	7	16	28	27	24	25	47	42
Lead [µg/g]	220	350	510	260	250	140	310	290
Phosphorus [µg/g]	130	120	95	77	82	160	63	66
Rubidium [µg/g]	1.8	1.3	1.3	0.96	0.92	0.64	0.76	0.98
Antimony [µg/g]	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Scandium [µg/g]	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Selenium [µg/g]	< 1	< 1	< 1	< 1	< 1	< 1	1	2
Tin [µg/g]	< 6	< 6	< 6	< 6	< 6	< 6	< 6	< 6
Strontium [µg/g]	5.5	4.3	6.0	4.9	5.2	3.3	2.9	3.1
Tantalum [µg/g]	0.10	0.08	0.18	0.14	0.12	0.24	0.08	0.10
Terbium [µg/g]	0.77	1.6	0.63	0.47	0.48	0.54	0.36	0.37
Tellerium [µg/g]	< 0.1	0.2	0.2	0.2	0.2	0.1	0.3	0.3
Thorium [µg/g]	36	69	44	34	34	37	24	23
Titanium [µg/g]	36	49	42	29	30	27	26	27
Thallium [µg/g]	< 3	< 3	< 3	< 3	< 3	< 3	< 3	< 3
Uranium [µg/g]	3.1	44	9.2	5.9	4.1	16	8.2	7.2
Vanadium [µg/g]	0.2	2.0	0.2	0.1	0.1	0.7	< 0.1	0.1
Tungsten [µg/g]	4	17	13	12	10	14	22	19
Yttrium [µg/g]	5.3	17	4.4	3.5	3.6	4.1	3.0	2.9
Ytterbium [µg/g]	0.27	3.4	0.33	0.17	0.17	0.20	0.12	0.12
Zinc [µg/g]	2.9	15	5.0	4.0	4.3	3.3	4.5	4.4
Zirconium [µg/g]	6	13	14	8	8	12	9	9

Ra226 subcontracted to Becquerel Labs.
* BaSO4 Calculation based on Ba values and assumes all Ba is in BaSO4 form.
** BaSO4 Calculation based on SO4 values and assumes all SO4 is in BaSO4 form.

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CERTIFICATE OF ANALYSIS

Final Report

Analysis	**20: CORE 09-QC-15-4 (30-40)**	**21: CORE 09-QC-15-5 (0-10)**	**22: CORE 09-QC-15-5 (10-20)**	**23: CORE 09-QC-15-5 (20-30)**	**24: CORE 09-QC-15-5 (30-40)**	**25: CORE 09-QC-15-5 (40-50)**	**26: CORE 09-QC-15-6 (0-10)**	**27: CORE 09-QC-15-6 (10-20)**
Sample Date & Time	07-Oct-09	07-Oct-09	07-Oct-09	07-Oct-09	07-Oct-09	07-Oct-09	07-Oct-09	07-Oct-09
BaSO4 Calc. using Ba* [µg/g]	120	220	140	130	110	120	130	480
BaSO4 Calc. using SO4** [µg/g]	2430	2430	2430	2430	2430	2430	2430	7290
Sulphate [%]	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.3
Silver [µg/g]	1.4	< 0.7	0.7	0.8	1.4	1.6	1.0	< 0.7
Aluminum [µg/g]	190	150	140	150	170	170	180	170
Arsenic [µg/g]	55	13	28	31	55	61	40	13
Barium [µg/g]	71	130	81	75	66	70	76	280
Beryllium [µg/g]	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Bismuth [µg/g]	12	2.9	5.5	6.1	11	12	8.6	5.6
Calcium [µg/g]	92	52	18	18	24	25	73	1300
Cadmium [µg/g]	1.6	0.09	0.93	0.95	1.9	1.8	1.1	0.08
Cerium [µg/g]	130	250	170	150	130	130	150	320
Cobalt [µg/g]	180	12	110	110	210	210	130	7.3
Chromium [µg/g]	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Cesium [µg/g]	0.29	0.14	0.13	0.13	0.53	0.15	0.35	0.27
Copper [µg/g]	86	16	67	64	82	82	53	43
Iron [µg/g]	94000	6400	59000	60000	110000	110000	66000	4200
Gallium [µg/g]	0.67	1.3	0.90	0.81	0.65	0.66	0.80	1.7
Germanium [µg/g]	4.1	1.1	2.8	3.0	4.7	4.6	3.1	1.2
Hafnium [µg/g]	0.6	0.3	0.4	0.5	0.6	0.5	0.6	0.5
Indium [µg/g]	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Potassium [µg/g]	140	100	98	110	120	130	130	170
Lanthanum [µg/g]	73	150	100	88	74	77	88	180
Lithium [µg/g]	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Lutetium [µg/g]	0.015	0.017	0.014	0.014	0.015	0.015	0.018	0.040
Magnesium [µg/g]	9	6	5	6	7	8	8	7
Manganese [µg/g]	0.73	1.9	0.50	0.69	1.1	1.1	0.56	0.31
Molybdenum [µg/g]	9.2	7.5	6.9	2.8	27	10	3.1	2.4
Sulphur [µg/g]	130000	5700	78000	80000	150000	150000	86000	5700
Sodium [µg/g]	3	3	2	2	3	3	3	6

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LR Report : **CA10157-OCT09**

Analysis	20: CORE 09-QC-15-4 (30-40)	21: CORE 09-QC-15-5 (0-10)	22: CORE 09-QC-15-5 (10-20)	23: CORE 09-QC-15-5 (20-30)	24: CORE 09-QC-15-5 (30-40)	25: CORE 09-QC-15-5 (40-50)	26: CORE 09-QC-15-6 (0-10)	27: CORE 09-QC-15-6 (10-20)
Niobuim [µg/g]	3.2	1.4	2.0	2.4	3.0	2.9	2.8	1.9
Nickel [µg/g]	74	4	45	45	90	89	54	3
Lead [µg/g]	340	170	310	310	330	380	310	250
Phosphorus [µg/g]	61	130	81	67	59	62	68	150
Rubidium [µg/g]	1.1	0.60	0.56	0.67	0.70	0.71	1.2	1.6
Antimony [µg/g]	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
Scandium [µg/g]	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Selenium [µg/g]	2	< 1	1	1	5	4	1	< 1
Tin [µg/g]	< 6	< 6	< 6	< 6	< 6	< 6	< 6	< 6
Strontium [µg/g]	3.4	3.3	3.2	3.2	3.2	3.5	3.3	6.7
Tantalum [µg/g]	0.11	0.07	0.07	0.08	0.10	0.09	0.19	0.16
Terbium [µg/g]	0.33	0.65	0.45	0.40	0.35	0.34	0.40	0.96
Tellerium [µg/g]	0.5	< 0.1	0.2	0.3	0.5	0.5	0.3	< 0.1
Thorium [µg/g]	24	31	29	25	26	26	27	42
Titanium [µg/g]	34	16	18	20	24	25	28	37
Thallium [µg/g]	< 3	< 3	< 3	< 3	< 3	< 3	< 3	< 3
Uranium [µg/g]	8.1	4.4	3.0	3.6	5.6	5.9	8.0	3.8
Vanadium [µg/g]	< 0.1	0.2	< 0.1	0.1	< 0.1	< 0.1	0.1	0.2
Tungsten [µg/g]	35	3	21	22	42	41	25	2
Yttrium [µg/g]	2.7	4.6	3.5	2.9	2.8	2.8	3.2	6.7
Ytterbium [µg/g]	0.12	0.14	0.11	0.11	0.12	0.12	0.14	0.35
Zinc [µg/g]	7.0	1.9	3.6	4.2	6.7	9.9	5.1	6.0
Zirconium [µg/g]	12	< 5	6	7	9	8	9	8

Ra226 subcontracted to Becquerel Labs.
* BaSO4 Calculation based on Ba values and assumes all Ba is in BaSO4 form.
** BaSO4 Calculation based on SO4 values and assumes all SO4 is in BaSO4 form.

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ANALYSIS REPORT

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Batch: T09-01484.0

Date: 30-Nov-2009

Lakefield Research Ltd.

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Client Ref.
Oct 10157.R09
P.O: 17820

23 rock samples Sampled: 07-Oct-2009 Received: 21-Oct-2009

Results of Analysis

Sample	Test	Result	Units	Date	Method
CORE 09-QC-15-1 (0-10)	Ra-226	3.5	Bq/g	22-Nov-2009	ALPHA
CORE 09-QC-15-1 (10-20)	Ra-226	3.7	Bq/g	22-Nov-2009	ALPHA
CORE 09-QC-15-1 (20-30)	Ra-226	4.1	Bq/g	22-Nov-2009	ALPHA
CORE 09-QC-15-1 (30-40)	Ra-226	4.9	Bq/g	22-Nov-2009	ALPHA
CORE 09-QC-15-2 (0-10)	Ra-226	9.0	Bq/g	22-Nov-2009	ALPHA
CORE 09-QC-15-2 (10-20)	Ra-226	7.2	Bq/g	22-Nov-2009	ALPHA
CORE 09-QC-15-2 (20-30)	Ra-226	6.1	Bq/g	22-Nov-2009	ALPHA
CORE 09-QC-15-2 (30-40)	Ra-226	6.8	Bq/g	22-Nov-2009	ALPHA
CORE 09-QC-15-3 (0-10)	Ra-226	4.5	Bq/g	29-Nov-2009	ALPHA
CORE 09-QC-15-3 (10-20)	Ra-226	6.1	Bq/g	22-Nov-2009	ALPHA
CORE 09-QC-15-3 (20-30)	Ra-226	5.7	Bq/g	22-Nov-2009	ALPHA
CORE 09-QC-15-3 (30-40)	Ra-226	5.2	Bq/g	29-Nov-2009	ALPHA
CORE 09-QC-15-4 (0-10)	Ra-226	3.8	Bq/g	29-Nov-2009	ALPHA
CORE 09-QC-15-4 (10-20)	Ra-226	6.3	Bq/g	23-Nov-2009	ALPHA
CORE 09-QC-15-4 (20-30)	Ra-226	5.8	Bq/g	23-Nov-2009	ALPHA
CORE 09-QC-15-4 (30-40)	Ra-226	6.5	Bq/g	23-Nov-2009	ALPHA
CORE 09-QC-15-5 (0-10)	Ra-226	4.3	Bq/g	23-Nov-2009	ALPHA
CORE 09-QC-15-5 (10-20)	Ra-226	5.2	Bq/g	23-Nov-2009	ALPHA
CORE 09-QC-15-5 (20-30)	Ra-226	5.1	Bq/g	23-Nov-2009	ALPHA
CORE 09-QC-15-5 (30-40)	Ra-226	6.5	Bq/g	23-Nov-2009	ALPHA
CORE 09-QC-15-5 (40-50)	Ra-226	4.8	Bq/g	23-Nov-2009	ALPHA
CORE 09-QC-15-6 (0-10)	Ra-226	7.2	Bq/g	23-Nov-2009	ALPHA
CORE 09-QC-15-6 (10-20)	Ra-226	6.3	Bq/g	23-Nov-2009	ALPHA

Becquerel LABORATORIES

ANALYSIS REPORT

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Phone: (905) 826-3080
FAX: (905) 826-4151

Batch: T09-01484.0

Date: 30-Nov-2009

Methods: ALPHA BQ-RAD-ALPHA alpha-particle spectrometry

Units: Bq/g Becquerels per gram

These results relate only to the samples analysed and only to the items tested.

30-Nov-2009 approved by: [signature]
Donald D. Burgess PhD
Senior Scientist, Division Supervisor

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CERTIFICATE OF ANALYSIS

Final Report

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Sample Date & Time					15-Oct-09	15-Oct-09	15-Oct-09	15-Oct-09	15-Oct-09	15-Oct-09	15-Oct-09	15-Oct-09
Temperature Upon Receipt [°C]	---	---	---	---	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Sulphate [mg/L]	26-Oct-09	13:29	02-Nov-09	12:16	90	74	130	680	1500	1500	93	260
Acidity [mg/L as CaCO3]	03-Nov-09	09:13	04-Nov-09	15:55	9	27	16	12	6	13	15	19
Hardness [mg/L as CaCO3]	23-Oct-09	07:54	26-Oct-09	11:13	98.5	77.4	137	680	1440	1440	104	276
Aluminum [mg/L]	23-Oct-09	07:54	26-Oct-09	11:12	0.01	0.13	0.07	0.02	< 0.01	< 0.01	0.05	0.13
Arsenic [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.0030	0.0168	0.0318	0.0038	0.0026	0.0060	0.0157	0.0061
Barium [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.0882	0.0769	0.0699	0.0292	0.0307	0.0239	0.0685	0.0385
Beryllium [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.00004	0.00015	0.00012	0.00003	< 0.00002	< 0.00002	< 0.00002	0.00005
Boron [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.0509	0.0302	0.0336	0.0104	0.0622	0.0149	0.0168	0.0226
Bismuth [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.00002	0.00002	0.00003	0.00009	0.00002	0.00012	0.00038	0.00014
Calcium [mg/L]	23-Oct-09	07:54	26-Oct-09	11:13	37.9	29.9	53.8	272	575	574	40.9	109
Cadmium [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.000121	0.00355	0.00459	0.000530	0.000168	0.00127	0.00201	0.000746
Cobalt [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.0345	0.275	0.372	0.00691	0.0443	0.0173	0.00823	0.0188
Chromium [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Copper [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.0005	0.0072	0.0026	0.0150	0.0015	0.0056	0.0194	0.124
Iron [mg/L]	23-Oct-09	07:54	26-Oct-09	11:13	0.08	0.02	< 0.01	0.02	< 0.01	0.02	0.02	0.03
Potassium [mg/L]	23-Oct-09	07:54	26-Oct-09	11:13	2.18	2.01	1.98	1.96	3.69	2.91	2.07	3.14
Lithium [mg/L]	23-Oct-09	07:54	26-Oct-09	11:13	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Magnesium [mg/L]	23-Oct-09	07:54	26-Oct-09	11:13	0.914	0.691	0.628	0.449	1.30	0.479	0.445	0.747
Manganese [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.197	0.0374	0.0296	0.0221	0.146	0.0311	0.0270	0.0450
Molybdenum [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.00027	0.00020	0.00032	0.00041	0.00025	0.00104	0.00057	0.00019
Sodium [mg/L]	23-Oct-09	07:54	26-Oct-09	11:13	0.29	0.47	0.45	0.52	0.83	0.76	0.57	0.54
Nickel [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.0635	0.500	0.662	0.0137	0.155	0.0392	0.0127	0.0236

OnLine LIMS

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LR Report : **CA11276-OCT09**

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Phosphorus [mg/L]	23-Oct-09	07:54	26-Oct-09	11:13	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Lead [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.0129	0.667	1.25	1.72	0.0398	3.06	1.01	2.08
Sulphur [mg/L]	23-Oct-09	07:54	26-Oct-09	11:13	33.3	27.9	47.7	234	486	486	35.4	97.1
Antimony [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	< 0.0002	0.0007	0.0009	0.0004	< 0.0002	0.0012	0.0014	0.0008
Selenium [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	< 0.001	< 0.001	< 0.001	0.002	0.002	0.002	< 0.001	0.002
Silica [mg/L]	23-Oct-09	07:54	26-Oct-09	11:13	6.96	5.14	5.94	3.77	12.2	5.88	6.36	5.12
Tin [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	0.00007	< 0.00001
Strontium [mg/L]	23-Oct-09	07:54	26-Oct-09	11:13	0.0446	0.0316	0.0404	0.118	0.258	0.240	0.0446	0.0758
Titanium [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.0005	0.0004	0.0004	0.0007	0.0008	0.0012	0.0050	0.0014
Thallium [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.0008	0.0019	0.0040	0.0004	0.0019	0.0017	0.0018	0.0019
Uranium [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.00523	0.00845	0.00751	0.00290	0.00779	0.00342	0.00268	0.0135
Vanadium [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	< 0.00003	< 0.00003	0.00005	< 0.00003	0.00004	< 0.00003	< 0.00003	< 0.00003
Zinc [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.008	0.507	0.725	0.021	0.013	0.058	0.027	0.075

Ra226 subcontracted to Becquerel Labs.

Dianne Griffin
Project Specialist

OnLine LIMS

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Sample Date & Time					15-Oct-09	15-Oct-09	15-Oct-09	15-Oct-09	15-Oct-09	15-Oct-09	15-Oct-09	15-Oct-09
Temperature Upon Receipt [°C]	---	---	---	---	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Sulphate [mg/L]	26-Oct-09	13:29	02-Nov-09	12:16	590	1000	1400	1400	69	48	46	36
Acidity [mg/L as CaCO3]	03-Nov-09	09:13	04-Nov-09	15:55	9	19	13	11	10	30	27	12
Hardness [mg/L as CaCO3]	23-Oct-09	07:54	26-Oct-09	11:13	580	1020	1380	1390	75.4	38.1	33.4	28.6
Aluminum [mg/L]	23-Oct-09	07:54	26-Oct-09	11:12	< 0.01	< 0.01	< 0.01	0.01	0.02	0.28	0.18	0.06
Arsenic [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.0012	0.0051	0.0048	0.0043	0.0009	0.0380	0.0646	0.157
Barium [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.0330	0.0303	0.0310	0.0481	0.112	0.0480	0.0592	0.0760
Beryllium [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	< 0.00002	< 0.00002	< 0.00002	< 0.00002	< 0.00002	0.00002	< 0.00002	< 0.00002
Boron [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.0317	0.0115	0.0104	0.0114	0.0234	0.0086	0.0073	0.0079
Bismuth [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	< 0.00001	0.00008	0.00010	0.00012	0.00004	0.00095	0.00079	0.00161
Calcium [mg/L]	23-Oct-09	07:54	26-Oct-09	11:13	229	409	552	556	29.0	14.6	12.8	10.9
Cadmium [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.00262	0.00239	0.00161	0.000444	0.000014	0.000619	0.000531	0.000305
Cobalt [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.0334	0.0413	0.0330	0.0159	0.0150	0.0218	0.0101	0.0042
Chromium [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Copper [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.0042	0.0023	0.0025	0.0019	0.0021	0.0121	0.0164	0.0025
Iron [mg/L]	23-Oct-09	07:54	26-Oct-09	11:13	< 0.01	0.01	< 0.01	< 0.01	0.02	0.09	0.17	0.13
Potassium [mg/L]	23-Oct-09	07:54	26-Oct-09	11:13	2.61	1.97	2.33	2.93	1.44	1.64	1.65	1.64
Lithium [mg/L]	23-Oct-09	07:54	26-Oct-09	11:13	< 0.002	0.004	0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Magnesium [mg/L]	23-Oct-09	07:54	26-Oct-09	11:13	1.89	0.395	0.364	0.368	0.724	0.412	0.365	0.318
Manganese [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	3.49	0.196	0.0637	0.0420	0.195	0.0274	0.0234	0.0182
Molybdenum [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.00003	0.00071	0.00144	0.00156	0.00038	0.00192	0.00246	0.00404
Sodium [mg/L]	23-Oct-09	07:54	26-Oct-09	11:13	0.62	0.58	0.63	0.63	0.55	0.46	0.43	0.43
Nickel [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.0528	0.0395	0.0426	0.0250	0.0088	0.0093	0.0060	0.0038

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Phosphorus [mg/L]	23-Oct-09	07:54	26-Oct-09	11:13	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.03
Lead [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.0535	2.27	2.60	2.56	0.0474	13.5	14.4	8.79
Sulphur [mg/L]	23-Oct-09	07:54	26-Oct-09	11:13	200	348	468	472	26.2	17.8	17.1	13.1
Antimony [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	< 0.0002	0.0015	0.0018	0.0019	0.0003	0.0040	0.0029	0.0026
Selenium [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.001	0.003	0.004	0.007	< 0.001	0.007	0.008	0.009
Silica [mg/L]	23-Oct-09	07:54	26-Oct-09	11:13	6.44	4.25	5.93	7.45	4.85	3.06	3.78	4.22
Tin [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	< 0.00001	< 0.00001	< 0.00001	0.00006	< 0.00001	0.00011	0.00014	0.00010
Strontium [mg/L]	23-Oct-09	07:54	26-Oct-09	11:13	0.0973	0.125	0.192	0.198	0.0317	0.0040	0.0068	0.0116
Titanium [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.0005	0.0007	0.0013	0.0018	0.0009	0.0035	0.0042	0.0065
Thallium [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.0006	0.0013	0.0004	< 0.0002	0.0005	0.0006	0.0004	0.0003
Uranium [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.0106	0.00784	0.00360	0.00158	0.000791	0.122	0.127	0.03115
Vanadium [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	< 0.00003	< 0.00003	< 0.00003	< 0.00003	< 0.00003	< 0.00003	< 0.00003	0.00011
Zinc [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.034	0.053	0.036	0.016	0.003	0.003	0.002	0.003

Ra226 subcontracted to Becquerel Labs.

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Project Specialist

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Sample Date & Time					15-Oct-09	15-Oct-09	15-Oct-09	15-Oct-09	15-Oct-09	15-Oct-09	15-Oct-09	15-Oct-09
Temperature Upon Receipt [°C]	---	---	---	---	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Sulphate [mg/L]	26-Oct-09	13:29	02-Nov-09	12:16	55	32	42	37	41	1200	48	0.6
Acidity [mg/L as CaCO3]	03-Nov-09	09:13	04-Nov-09	15:55	38	35	45	19	51	41	27	6
Hardness [mg/L as CaCO3]	23-Oct-09	07:54	26-Oct-09	11:13	22.9	4.2	3.9	3.4	3.2	1196	39.1	< 0.5
Aluminum [mg/L]	23-Oct-09	07:54	26-Oct-09	11:12	1.76	0.88	0.96	0.73	0.56	0.05	0.32	< 0.01
Arsenic [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.0084	0.0069	0.0129	0.0053	0.0027	0.0074	0.0370	0.0007
Barium [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.0596	0.0902	0.0906	0.117	0.100	0.0286	0.0427	0.00060
Beryllium [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.00009	0.00005	0.00006	0.00004	0.00005	0.00002	0.00003	< 0.00002
Boron [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.0063	0.0027	0.0032	0.0028	0.0026	0.0150	0.0083	0.0004
Bismuth [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.00018	0.00040	0.00068	0.00054	0.00042	0.00023	0.00090	0.00003
Calcium [mg/L]	23-Oct-09	07:54	26-Oct-09	11:13	8.46	1.35	1.17	1.00	0.94	478	15.0	0.05
Cadmium [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.000069	0.000018	0.000019	0.000011	0.000010	0.00152	0.000614	0.000011
Cobalt [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.0304	0.0176	0.0219	0.0197	0.0211	0.0181	0.0208	0.000260
Chromium [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Copper [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.109	0.130	0.0981	0.0625	0.0518	0.0214	0.0070	0.0068
Iron [mg/L]	23-Oct-09	07:54	26-Oct-09	11:13	0.89	6.28	11.5	10.2	11.4	0.05	0.20	< 0.01
Potassium [mg/L]	23-Oct-09	07:54	26-Oct-09	11:13	1.98	1.40	1.68	1.58	1.53	2.87	1.72	< 0.01
Lithium [mg/L]	23-Oct-09	07:54	26-Oct-09	11:13	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.002	< 0.002	< 0.002
Magnesium [mg/L]	23-Oct-09	07:54	26-Oct-09	11:13	0.444	0.194	0.246	0.214	0.206	0.487	0.423	< 0.003
Manganese [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.146	0.0702	0.104	0.0924	0.0938	0.0299	0.0261	0.00049
Molybdenum [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.00026	0.00015	0.00024	0.00020	0.00017	0.00082	0.00228	0.00009
Sodium [mg/L]	23-Oct-09	07:54	26-Oct-09	11:13	0.49	0.44	0.43	0.44	0.46	0.67	0.49	0.02
Nickel [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.0173	0.0085	0.0102	0.0091	0.0097	0.0391	0.0096	0.0006

OnLine LIMS

SGS Lakefield Research Limited
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LR Report : CA11276-OCT09

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	21: Core09-QC15-5 (0-10)	22: Core09-QC15-5 (10-20)	23: Core09-QC15-5 (20-30)	24: Core09-QC15-5 (30-40)	25: Core09-QC15-5 (40-50)	26: Core09-QC15-6 (10-20)	27: Core09-QC15-6 (20-30)	28: Core09-QC15-6 (30-40)
Phosphorus [mg/L]	23-Oct-09	07:54	26-Oct-09	11:13	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Lead [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	8.87	11.2	9.30	9.28	9.27	3.54	12.1	0.0968
Sulphur [mg/L]	23-Oct-09	07:54	26-Oct-09	11:13	20.5	12.4	15.9	14.8	15.2	408	18.5	0.02
Antimony [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.0007	0.0013	0.0014	0.0010	0.0008	0.0014	0.0038	< 0.0002
Selenium [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.001	0.005	0.006	0.006	0.007	0.002	0.007	< 0.001
Silica [mg/L]	23-Oct-09	07:54	26-Oct-09	11:13	3.74	3.45	4.53	4.36	4.27	5.56	3.31	< 0.01
Tin [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.00002	< 0.00001	< 0.00001	< 0.00001	0.00006	< 0.00001	0.00011	< 0.00001
Strontium [mg/L]	23-Oct-09	07:54	26-Oct-09	11:13	0.0144	0.0085	0.0110	0.0115	0.0107	0.196	0.0038	< 0.0001
Titanium [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.0013	0.0012	0.0016	0.0016	0.0014	0.0010	0.0038	0.0001
Thallium [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.0015	0.0006	0.0005	0.0004	0.0004	0.0020	0.0006	< 0.0002
Uranium [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.161	0.0311	0.0425	0.0213	0.0117	0.0139	0.139	0.000464
Vanadium [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	< 0.00003	< 0.00003	< 0.00003	< 0.00003	< 0.00003	0.00004	0.00003	< 0.00003
Zinc [mg/L]	22-Oct-09	14:59	25-Oct-09	14:20	0.012	0.013	0.006	0.005	0.004	0.091	0.007	0.001

Ra226 subcontracted to Becquerel Labs.

Dianne Griffin
Project Specialist

OnLine LIMS

ANALYSIS REPORT

Becquerel Laboratories Inc.
6790 Kitimat Rd., Unit 4
Mississauga, Ontario
Canada, L5N 5L9

Phone: (905) 826-3080
FAX: (905) 826-4151

Batch: T09-01511.0

Date: 23-Nov-2009

Lakefield Research Ltd.

185 Concession St., Postal Bag 4300
Lakefield, ON, K0L 2H0

attn: Brian Graham

Phone: (705) 652-2038
FAX: (705) 652-1918

Client Ref.Oct 11276
P.O: 44250

24 water samples Sampled: 15-Oct-2009 Received: 28-Oct-2009

Results of Analysis

Sample	Test	Result	Units	Date	Method
Core09-QC15-1 (0-10)	Ra-226	2.5	Bq/l	13-Nov-2009	ALPHA
Core09-QC15-1 (10-20)	Ra-226	3.4	Bq/l	13-Nov-2009	ALPHA
Core09-QC15-1 (20-30)	Ra-226	3.2	Bq/l	13-Nov-2009	ALPHA
Core09-QC15-1 (30-40)	Ra-226	1.4	Bq/l	13-Nov-2009	ALPHA
Core09-QC15-2 (0-10)	Ra-226	1.5	Bq/l	13-Nov-2009	ALPHA
Core09-QC15-2 (10-20)	Ra-226	1.4	Bq/l	13-Nov-2009	ALPHA
Core09-QC15-2 (20-30)	Ra-226	4.4	Bq/l	13-Nov-2009	ALPHA
Core09-QC15-2 (30-40)	Ra-226	2.5	Bq/l	13-Nov-2009	ALPHA
Core09-QC15-3 (0-10)	Ra-226	1.2	Bq/l	15-Nov-2009	ALPHA
Core09-QC15-3 (10-20)	Ra-226	1.4	Bq/l	15-Nov-2009	ALPHA
Core09-QC15-3 (20-30)	Ra-226	1.4	Bq/l	15-Nov-2009	ALPHA
Core09-QC15-3 (30-40)	Ra-226	2.1	Bq/l	15-Nov-2009	ALPHA
Core09-QC15-4 (0-10)	Ra-226	5.4	Bq/l	15-Nov-2009	ALPHA
Core09-QC15-4 (10-20)	Ra-226	3.7	Bq/l	15-Nov-2009	ALPHA
Core09-QC15-4 (20-30)	Ra-226	5.0	Bq/l	15-Nov-2009	ALPHA
Core09-QC15-4 (30-40)	Ra-226	4.5	Bq/l	15-Nov-2009	ALPHA
Core09-QC15-5 (0-10)	Ra-226	5.3	Bq/l	16-Nov-2009	ALPHA
Core09-QC15-5 (10-20)	Ra-226	7.0	Bq/l	16-Nov-2009	ALPHA
Core09-QC15-5 (20-30)	Ra-226	3.5	Bq/l	16-Nov-2009	ALPHA
Core09-QC15-5 (30-40)	Ra-226	4.5	Bq/l	16-Nov-2009	ALPHA
Core09-QC15-5 (40-50)	Ra-226	4.2	Bq/l	16-Nov-2009	ALPHA
Core09-QC15-6 (10-20)	Ra-226	1.3	Bq/l	16-Nov-2009	ALPHA
Core09-QC15-6 (20-30)	Ra-226	3.3	Bq/l	16-Nov-2009	ALPHA
Core09-QC15-6 (30-40)	Ra-226	< 0.01	Bq/l	16-Nov-2009	ALPHA

ANALYSIS REPORT

Becquerel Laboratories Inc.
6790 Kitimat Rd., Unit 4
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Phone: (905) 826-3080
FAX: (905) 826-4151

Batch: T09-01511.0

Date: 23-Nov-2009

Methods: ALPHA BQ-RAD-ALPHA alpha-particle spectrometry

Units: Bq/l Becquerels per litre

These results relate only to the samples analysed and only to the items tested.

23-Nov-2009 approved by: [signature]
Donald D. Burgess PhD
Senior Scientist, Division Supervisor

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Ecometrix
Attn : Erin Clyde

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Phone: 905-794-2325, Fax:905-794-2338

October 14, 2009

Date Rec. : 01 October 2009
LR Report : **CA10064-OCT09**
Project : 09-1663

CERTIFICATE OF ANALYSIS

Final Report

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	5: SW09 QC15-1	6: SW09 QC15-2	7: SW09 QC15-3	8: SW09 QC15-4	9: SW09 EC-2T	10: SW09 EC-2B
Sample Date & Time					28-Sep-09	28-Sep-09	28-Sep-09	28-Sep-09	28-Sep-09	28-Sep-09
Temperature Upon Receipt [°C]	---	---	---	---	9.0	9.0	9.0	9.0	9.0	9.0
Sulphate [mg/L]	02-Oct-09	19:39	06-Oct-09	14:22	570	570	570	600	85	36
Acidity [mg/L as CaCO3]	02-Oct-09	15:00	05-Oct-09	15:14	22	27	44	50	67	16
Total Organic Carbon [mg/L]	05-Oct-09	09:40	06-Oct-09	13:53	---	---	---	---	11.4	11.7
Total Inorganic Carbon [mg/L]	05-Oct-09	14:35	08-Oct-09	12:46	---	---	---	---	< 1.0	< 1.0
Hardness [mg/L as CaCO3]	05-Oct-09	09:00	05-Oct-09	13:19	529	535	532	549	17.0	16.8
Aluminum [mg/L]	05-Oct-09	09:00	05-Oct-09	13:19	< 0.01	< 0.01	< 0.01	0.02	0.03	< 0.01
Arsenic [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.0010	0.0009	0.0009	0.0011	0.0007	0.0007
Barium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.0334	0.0301	0.0300	0.0296	0.108	0.114
Beryllium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.00006	< 0.00002	0.00002	< 0.00002	0.00003	0.00002
Boron [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.113	0.113	0.115	0.116	0.0076	0.0072
Bismuth [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.00004	0.00002	0.00001	< 0.00001	0.00002	0.00002
Calcium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:19	202	205	204	210	5.69	5.63
Cadmium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.000074	0.000051	0.000039	0.000031	0.000046	0.000056
Cobalt [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.00558	0.00464	0.0106	0.0122	0.00655	0.00196
Chromium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Copper [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.0017	0.0014	0.0013	0.0016	0.0037	0.0029
Iron [mg/L]	05-Oct-09	09:00	05-Oct-09	13:19	0.10	0.06	0.16	0.18	0.07	0.04
Potassium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:19	10.8	11.0	10.9	11.9	0.31	0.32
Lithium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:19	0.008	0.008	0.008	0.009	< 0.002	< 0.002
Magnesium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:19	5.69	5.79	5.77	6.19	0.670	0.663

OnLine LIMS

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LR Report : **CA10064-OCT09**

Analysis	1: Analysis Start Date	2: Analysis Start Time	3: Analysis Approval Date	4: Analysis Approval Time	5: SW09 QC15-1	6: SW09 QC15-2	7: SW09 QC15-3	8: SW09 QC15-4	9: SW09 EC-2T	10: SW09 EC-2B
Manganese [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.207	0.214	0.214	0.310	0.0315	0.0319
Molybdenum [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.00319	0.00409	0.00368	0.00533	0.00018	0.00008
Sodium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:19	2.38	2.42	2.37	2.59	1.59	1.58
Nickel [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.0067	0.0067	0.0067	0.0068	0.0022	0.0022
Phosphorus [mg/L]	05-Oct-09	09:00	05-Oct-09	13:19	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Lead [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.00151	0.00098	0.00194	0.00548	0.00699	0.00391
Sulphur [mg/L]	05-Oct-09	09:00	05-Oct-09	13:19	157	160	160	166	4.64	4.63
Antimony [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.0017	0.0010	0.0093	0.0106	0.0086	0.0016
Selenium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Silica [mg/L]	05-Oct-09	09:00	05-Oct-09	13:19	5.46	5.55	5.54	5.55	0.59	0.60
Tin [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.00002	0.00012	0.00002	0.00025	< 0.00001	< 0.00001
Strontium [mg/L]	05-Oct-09	09:00	05-Oct-09	13:19	0.159	0.161	0.160	0.166	0.0122	0.0122
Titanium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.0005	0.0004	0.0005	0.0004	0.0004	0.0001
Thallium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Uranium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.0143	0.0116	0.0144	0.0219	0.000654	0.00079
Vanadium [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.00009	0.00004	0.00004	< 0.00003	0.00007	0.00007
Zinc [mg/L]	02-Oct-09	14:45	05-Oct-09	13:19	0.005	0.004	0.004	0.004	0.004	0.005

Ra226 subcontracted to Becquerel Labs.

Chris Sullivan, B.Sc., C.Chem
Project Specialist
Environmental Services, Analytical

OnLine LIMS

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ANALYSIS REPORT

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Batch: T09-01382.0

Date: 20-Oct-2009

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Phone: (705) 652-2038
FAX: (705) 652-1918

Client Ref.Oct 10064
P.O: 17820

6 water samples Sampled: 28-Sep-2009 Received: 06-Oct-2009 Page 1 of 1

Results of Analysis

Sample	Test	Result	Units	Date	Method
SW09 QC15-1	Ra-226	0.42	Bq/l	17-Oct-2009	ALPHA
SW09 QC15-2	Ra-226	0.45	Bq/l	18-Oct-2009	ALPHA
SW09 QC15-3	Ra-226	0.46	Bq/l	18-Oct-2009	ALPHA
SW09 QC15-4	Ra-226	0.45	Bq/l	18-Oct-2009	ALPHA
SW09 EC-2T	Ra-226	0.78	Bq/l	18-Oct-2009	ALPHA
SW09 EC-2B	Ra-226	0.85	Bq/l	18-Oct-2009	ALPHA

Methods: ALPHA BQ-RAD-ALPHA alpha-particle spectrometry

Units: Bq/l Becquerels per litre

These results relate only to the samples analysed and only to the items tested.

20-Oct-2009 approved by:

Donald D. Burgess PhD
Senior Scientist, Division Supervisor

EcoMetrix INCORPORATED

APPENDIX 4

Compilation of Laboratory Shake Flask Test Data

Table A4.1: Shake Flask Test Set-Up and Results

RESULTS	Units	Core09-QC15-1 (0-10)	Core09-QC15-1 (10-20)	Core09-QC15-1 (20-30)	Core09-QC15-1 (30-40)	Core09-QC15-2 (0-10)	Core09-QC15-2 (10-20)	Core09-QC15-2 (20-30)	Core09-QC15-2 (30-40)	Core09-QC15-3 (0-10)	Core09-QC15-3 (10-20)	Core09-QC15-3 (20-30)	Core09-QC15-3 (30-40)	Core09-QC15-4 (0-10)	Core09-QC15-4 (10-20)	Core09-QC15-4 (20-30)	Core09-QC15-4 (30-40)	Core09-QC15-5 (0-10)	Core09-QC15-5 (10-20)	Core09-QC15-5 (20-30)	Core09-QC15-5 (30-40)	Core09-QC15-5 (40-50)
MOISTURE CONTENT																						
Set A																						
Mass of Tray	g	1.34	1.33	1.34	1.31	1.32	1.33	1.32	1.32	1.33	1.35	1.31	1.32	1.31	1.32	1.31	1.32	1.34	1.31	1.32	1.31	1.32
Sample mass Start SA#1	g	35.00	36.49	28.50	21.18	38.20	26.89	20.92	23.40	31.40	26.12	26.91	27.36	26.6	24.94	23.96	27.04	32.11	50.59	23.62	27.91	25.01
Sample mass End	g	25.21	28.73	23.11	15.57	28.37	21.91	17.32	19.26	21.86	22.58	23.28	23.39	20.79	21.00	20.77	23.50	26.69	41.16	20.40	24.13	21.70
Moisture content		0.291	0.221	0.198	0.282	0.267	0.195	0.184	0.188	0.317	0.143	0.142	0.152	0.230	0.167	0.141	0.138	0.176	0.191	0.144	0.142	0.140
Set B																						
Mass of Tray	g	1.35	1.33	1.30	1.32	1.32	1.34	1.33	1.310	1.30	1.33	1.32	1.31	1.32	1.31	1.32	1.33	1.33	1.33	1.33	1.32	1.33
Sample mass Start SA#1	g	53.79	37.50	31.32	27.72	39.36	18.02	28.01	26.68	40.92	18.56	28.6	24.23	22.33	20.45	27.87	26.58	30.88	36.01	20.35	28.42	27.65
Sample mass End	g	39.19	29.51	24.57	23.94	29.34	14.86	23.03	21.90	29.21	16.05	24.91	20.79	17.45	17.36	24.03	23.14	25.32	29.66	17.54	24.65	23.96
Moisture content		0.278	0.221	0.225	0.143	0.263	0.189	0.187	0.188	0.296	0.146	0.135	0.150	0.232	0.161	0.145	0.136	0.188	0.183	0.148	0.139	0.140
Set C																						
Mass of Tray	g	1.33	1.31	1.33	1.31	1.33	1.33	1.33	1.31	1.31	1.33	1.31	1.31	1.33	1.31	1.32	1.32	1.32	1.33	1.32	1.32	1.32
Sample mass Start SA#1	g	40.03	27.67	23.06	24.45	42.01	27.69	27.82	25.02	46.41	22.58	27.35	30.70	31.37	29.11	30.07	26.47	31.27	36.65	30.1	27.05	31.34
Sample mass End	g	28.91	20.83	17.94	20.57	31.21	22.60	22.84	20.60	32.04	19.51	23.73	26.44	24.42	24.38	25.70	23.14	25.72	29.80	25.75	23.59	27.24
Moisture content		0.287	0.259	0.236	0.168	0.265	0.193	0.188	0.186	0.319	0.144	0.139	0.145	0.231	0.170	0.152	0.132	0.185	0.194	0.151	0.134	0.137
Moisture Content Average		**0.286**	**0.234**	**0.220**	**0.198**	**0.265**	**0.192**	**0.186**	**0.187**	**0.310**	**0.144**	**0.139**	**0.149**	**0.231**	**0.166**	**0.146**	**0.135**	**0.183**	**0.189**	**0.148**	**0.139**	**0.139**
SHAKE FLASK SET-UP																						
Mass of Bottle	g	38.67	38.59	38.64	38.98	38.62	38.22	38.59	38.83	38.81	39.01	38.82	38.87	39.21	38.69	39.02	38.76	38.88	39.08	38.84	38.73	38.65
Mass of Sample Added	g	131.2	130.41	131.27	130.04	130.74	130.79	130.59	130.32	130.74	130.00	130.38	130.14	131.14	131.62	130.79	130.19	130.57	131.86	130.87	132.25	130.04
Water Added	mL	401.34	400.23	400.04	400.11	400.07	400.10	401.04	400.07	400.24	400.08	400.59	400.38	400.79	400.48	401.40	401.48	400.60	400.50	400.93	400.55	400.58
Total Mass (measured)	g	571.20	569.22	569.95	569.14	569.42	569.11	570.22	569.23	569.78	569.08	569.79	569.39	571.15	570.79	571.21	570.44	570.04	571.43	570.64	571.52	569.26
Equiv Dry Mass	g	93.74	99.93	102.44	104.33	96.07	105.62	106.29	105.89	90.15	111.23	112.30	110.73	100.83	109.75	111.72	112.56	106.65	106.88	111.53	113.92	111.99
Mass Water in Sample	mL	37.46	30.48	28.83	25.71	34.67	25.17	24.30	24.43	40.59	18.77	18.08	19.41	30.31	21.87	19.07	17.63	23.92	24.98	19.34	18.33	18.05
Total Water	mL	438.80	430.71	428.87	425.82	434.74	425.27	425.34	424.50	440.83	418.85	418.67	419.79	431.10	422.35	420.47	419.11	424.52	425.48	420.27	418.88	418.63
ANALYSIS																						
pH	pH Units	5.20	2.95	6.06	4.95	6.08	5.33	4.84	3.51	4.78	4.81	4.45	4.74	4.23	3.17	3.19	3.17	2.71	2.96	3.14	2.94	2.93
Sulphate (SO4)	mg/L	90	74	130	680	1500	1500	93	260	590	1000	1400	1400	69	48	46	36	55	32	42	37	41
Acidity (as CaCO3)	mg/L	9	27	16	12	6	13	15	19	9	19	13	11	10	30	27	12	38	35	45	19	51
Hardness (as CaCO3)	mg/L	98.5	77.4	137	680	1440	1440	104	276	580	1020	1380	1390	75.4	38.1	33.4	28.6	22.9	4.2	3.9	3.4	3.2
Radium-226	Bq/L	2.5	3.4	3.2	1.4	1.5	1.4	4.4	2.5	1.2	1.4	1.4	2.1	5.4	3.7	5.0	4.5	5.3	7.0	3.5	4.5	4.2
Aluminum (Al)	mg/L	0.01	0.13	0.07	0.02	<0.01	<0.01	0.05	0.13	<0.01	<0.01	<0.01	0.01	0.02	0.28	0.18	0.06	1.76	0.88	0.96	0.73	0.56
Arsenic (As)	mg/L	0.0030	0.0168	0.0318	0.0038	0.0026	0.0060	0.0157	0.0061	0.0012	0.0051	0.0048	0.0043	0.0009	0.0380	0.0646	0.157	0.0084	0.0069	0.0129	0.0053	0.0027
Barium (Ba)	mg/L	0.0882	0.0769	0.0699	0.0292	0.0307	0.0239	0.0685	0.0385	0.0330	0.0303	0.0310	0.0481	0.112	0.0480	0.0592	0.0760	0.0596	0.0902	0.0906	0.117	0.100
Beryllium (Be)	mg/L	0.00004	0.00015	0.00012	0.00003	<0.00002	<0.00002	<0.00002	0.00005	<0.00002	<0.00002	<0.00002	<0.00002	<0.00002	0.00002	<0.00002	<0.00002	0.00009	0.00005	0.00006	0.00004	0.00005
Boron (B)	mg/L	0.0509	0.0302	0.0336	0.0104	0.0622	0.0149	0.0168	0.0226	0.0317	0.0115	0.0104	0.0114	0.0234	0.0086	0.0073	0.0079	0.0063	0.0027	0.0032	0.0028	0.0026
Bismuth (Bi)	mg/L	0.00002	0.00002	0.00003	0.00009	0.00002	0.00012	0.00038	0.00014	<0.00001	0.00008	0.00010	0.00012	0.00004	0.00095	0.00079	0.00161	0.00018	0.00040	0.00068	0.00054	0.00042
Calcium (Ca)	mg/L	37.9	29.9	53.8	272	575	574	40.9	109	229	409	552	556	29.0	14.6	12.8	10.9	8.46	1.35	1.17	1.00	0.94
Cadmium (Cd)	mg/L	0.000121	0.00355	0.00459	0.000530	0.000168	0.00127	0.00201	0.000746	0.00262	0.00239	0.00161	0.000444	0.000014	0.000619	0.000531	0.000305	0.000069	0.000018	0.000019	0.000011	0.000010
Cobalt (Co)	mg/L	0.0345	0.275	0.372	0.00691	0.0443	0.0173	0.00823	0.0188	0.0334	0.0413	0.0330	0.0159	0.0150	0.0218	0.0101	0.0042	0.0304	0.0176	0.0219	0.0197	0.0211
Chromium (Cr)	mg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Copper (Cu)	mg/L	0.0005	0.0072	0.0026	0.0150	0.0015	0.0056	0.0194	0.124	0.0042	0.0023	0.0025	0.0019	0.0021	0.0121	0.0164	0.0025	0.109	0.130	0.0981	0.0625	0.0518
Iron (Fe)	mg/L	0.08	0.02	<0.01	0.02	<0.01	0.02	0.02	0.03	<0.01	0.01	<0.01	<0.01	0.02	0.09	0.17	0.13	0.89	6.28	11.5	10.2	11.4
Potassium (K)	mg/L	2.18	2.01	1.98	1.96	3.69	2.91	2.07	3.14	2.61	1.97	2.33	2.93	1.44	1.64	1.65	1.64	1.98	1.40	1.68	1.58	1.53
Lithium (Li)	mg/L	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.004	0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Magnesium (Mg)	mg/L	0.914	0.691	0.628	0.449	1.30	0.479	0.445	0.747	1.89	0.395	0.364	0.368	0.724	0.412	0.365	0.318	0.444	0.194	0.246	0.214	0.206
Manganese (Mn)	mg/L	0.197	0.0374	0.0296	0.0221	0.146	0.0311	0.0270	0.0450	3.49	0.196	0.0637	0.0420	0.195	0.0274	0.0234	0.0182	0.146	0.0702	0.104	0.0924	0.0938
Molybdenum (Mo)	mg/L	0.00027	0.00020	0.00032	0.00041	0.00025	0.00104	0.00057	0.00019	0.00003	0.00071	0.00144	0.00156	0.00038	0.00192	0.00246	0.00404	0.00026	0.00015	0.00024	0.00020	0.00017
Sodium (Na)	mg/L	0.29	0.47	0.45	0.52	0.83	0.76	0.57	0.54	0.62	0.58	0.63	0.63	0.55	0.46	0.43	0.43	0.49	0.44	0.43	0.44	0.46
Nickel (Ni)	mg/L	0.0635	0.500	0.662	0.0137	0.155	0.0392	0.0127	0.0236	0.0528	0.0395	0.0426	0.0250	0.0088	0.0093	0.0060	0.0038	0.0173	0.0085	0.0102	0.0091	0.0097
Lead (Pb)	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.03	<0.01	<0.01	<0.01	<0.01	<0.01
Phosphorous (P)	mg/L	0.0129	0.667	1.25	1.72	0.0398	3.06	1.01	2.08	0.0535	2.27	2.60	2.56	0.0474	13.5	14.4	8.79	8.87	11.2	9.30	9.28	9.27
Antimony (Sb)	mg/L	33.3	27.9	47.7	234	486	486	35.4	97.1	200	348	468	472	26.2	17.8	17.1	13.1	20.5	12.4	15.9	14.8	15.2
Selenium (Se)	mg/L	<0.0002	0.0007	0.0009	0.0004	<0.0002	0.0012	0.0014	0.0008	<0.0002	0.0015	0.0018	0.0019	0.0003	0.0040	0.0029	0.0026	0.0007	0.0013	0.0014	0.0010	0.0008
Sulphur (S)	mg/L	<0.001	<0.001	<0.001	0.002	0.002	0.002	<0.001	0.002	0.001	0.003	0.004	0.007	<0.001	0.007	0.008	0.009	0.001	0.005	0.006	0.006	0.007
Silicon (Si)	mg/L	6.96	5.14	5.94	3.77	12.2	5.88	6.36	5.12	6.44	4.25	5.93	7.45	4.85	3.06	3.78	4.22	3.74	3.45	4.53	4.36	4.27
Tin (Sn)	mg/L	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	0.00007	<0.00001	<0.00001	<0.00001	<0.00001	0.00006	<0.00001	0.00011	0.00014	0.00010	0.00002	<0.00001	<0.00001	<0.00001	0.00006
Strontium (Sr)	mg/L	0.0446	0.0316	0.0404	0.118	0.258	0.240	0.0446	0.0758	0.0973	0.125	0.192	0.198	0.0317	0.0040	0.0068	0.0116	0.0144	0.0085	0.0110	0.0115	0.0107
Titanium (Ti)	mg/L	0.0005	0.0004	0.0004	0.0007	0.0008	0.0012	0.0050	0.0014	0.0005	0.0007	0.0013	0.0018	0.0009	0.0035	0.0042	0.0065	0.0013	0.0012	0.0016	0.0016	0.0014
Thallium (Tl)	mg/L	0.0008	0.0019	0.0040	0.0004	0.0019	0.0017	0.0018	0.0019	0.0006	0.0013	0.0004	<0.0002	0.0005	0.0006	0.0004	0.0003	0.0015	0.0006	0.0005	0.0004	0.0004
Uranium (U)	mg/L	0.00523	0.00845	0.00751	0.00290	0.00779	0.00342	0.00268	0.0135	0.0106	0.00784	0.00360	0.00158	0.000791	0.122	0.127	0.03115	0.161	0.0311	0.0425	0.0213	0.0117
Vanadium (V)	mg/L	<0.00003	<0.00003	0.00005	<0.00003	0.00004	<0.00003	<0.00003	<0.00003	<0.00003	<0.00003	<0.00003	<0.00003	<0.00003	<0.00003	<0.00003	0.00011	<0.00003	<0.00003	<0.00003	<0.00003	<0.00003
Zinc (Zn)	mg/L	0.008	0.507	0.725	0.021	0.013	0.058	0.027	0.075	0.034	0.053	0.036	0.016	0.003	0.003	0.002	0.003	0.012	0.013	0.006	0.005	0.004
SOLUBLE AMOUNT																						
Sulphate (SO4)	mg/kg	421	319	544	2775	6787	6040	372	1042	2885	3765	5220	5308	295	185	173	134	219	127	158	136	153
Acidity (as CaCO3)	mg/kg	42	116	67	49	27	52	60	76	44	72	48	42	43	115	102	45	151	139	170	70	191
Hardness (as CaCO3)	mg/kg	461.1	333.6	574	2775	6516	5798	416	1106	2836	3841	5145	5270	322.4	146.6	125.7	106.5	91.2	16.7	14.7	12.5	12.0
Radium-226	Bq/g	0.012	0.015	0.013	0.006	0.007	0.006	0.018	0.010	0.006	0.005	0.005	0.008	0.023	0.014	0.019	0.017	0.021	0.028	0.013	0.017	0.016
Aluminum (Al)	mg/kg	0.05	0.56	0.29	0.08	<0.05	<0.04	0.20	0.52	<0.05	<0.04	<0.04	0.04	0.09	1.08	0.68	0.22	7.01	3.50	3.62	2.68	2.09
Arsenic (As)	mg/kg	0.0140	0.0724	0.1331	0.0155	0.0118	0.0242	0.0628	0.0245	0.0059	0.0192	0.0179	0.0163	0.0038	0.1462	0.2431	0.585	0.0334	0.0275	0.0486	0.0195	0.0101
Barium (Ba)	mg/kg	0.4129	0.3314	0.2926	0.1192	0.1389	0.0962	0.2741	0.1543	0.1614	0.1141	0.1156	0.1824	0.479	0.1847	0.2228	0.2830	0.2372	0.3591	0.3414	0.430	0.374
Beryllium (Be)	mg/kg	0.00019	0.00065	0.00050	0.00012	<0.00009	<0.00008	<0.00008	0.00020	<0.00010	<0.00008	<0.00007	<0.00008	<0.00009	0.00008	<0.00008	<0.00007	0.00036	0.00020	0.00023	0.00015	0.00019
Boron (B)	mg/kg	0.2383	0.1302	0.1407	0.0424	0.2815	0.0600	0.0672	0.0906	0.1550	0.0433	0.0388	0.0432	0.1000	0.0331	0.0275	0.0294	0.0251	0.0107	0.0121	0.0103	0.0097
Bismuth (Bi)	mg/kg	0.00009	0.00009	0.00013	0.00037	0.00009	0.00048	0.00152	0.00056	<0.00005	0.00030	0.00037	0.00045	0.00017	0.00366	0.00297	0.00599	0.00072	0.00159	0.00256	0.00199	0.00157
Calcium (Ca)	mg/kg	177.4	128.9	225.2	1110	2602	2311	163.7	437	1120	1540	2058	2108	124.0	56.2	48.2	40.6	33.68	5.37	4.41	3.68	3.51
Cadmium (Cd)	mg/kg	0.000566	0.01530	0.01922	0.002163	0.000760	0.00511	0.00804	0.002991	0.01281	0.00900	0.00600	0.001683	0.000060	0.002382	0.001999	0.001136	0.000275	0.000072	0.000072	0.000040	0.000037
Cobalt (Co)	mg/kg	0.1615	1.185	1.557	0.02820	0.2005	0.0697	0.03294	0.0754	0.1633	0.1555	0.1230	0.0603	0.0641	0.0839	0.0380	0.0156	0.1210	0.0701	0.0825	0.0724	0.0789
Chromium (Cr)	mg/kg	<0.0023	<0.0022	<0.0021	<0.0020	<0.0023	<0.0020	<0.0020	<0.0020	<0.0024	<0.0019	<0.0019	<0.0019	<0.0021	<0.0019	<0.0019	<0.0019	<0.0020	<0.0020	<0.0019	<0.0018	<0.0019
Copper (Cu)	mg/kg	0.0023	0.0310	0.0109	0.0612	0.0068	0.0225	0.0776	0.497	0.0205	0.0087	0.0093	0.0072	0.0090	0.0466	0.0617	0.0093	0.434	0.518	0.3697	0.2298	0.1936
Iron (Fe)	mg/kg	0.37	0.09	<0.04	0.08	<0.05	0.08	0.08	0.12	<0.05	0.04	<0.04	<0.04	0.09	0.35	0.64	0.48	3.54	25.00	43.3	37.5	42.6
Potassium (K)	mg/kg	10.20	8.66	8.29	8.00	16.70	11.72	8.28	12.59	12.76	7.42	8.69	11.11	6.16	6.31	6.21	6.11	7.88	5.57	6.33	5.81	5.72
Lithium (Li)	mg/kg	<0.009	<0.009	<0.008	<0.008	<0.009	<0.008	<0.008	<0.008	<0.010	0.015	0.007	<0.008	<0.009	<0.008	<0.008	<0.007	<0.008	<0.008	<0.008	<0.007	<0.007
Magnesium (Mg)	mg/kg	4.279	2.978	2.629	1.833	5.88	1.929	1.781	2.995	9.24	1.487	1.357	1.395	3.095	1.585	1.374	1.184	1.767	0.772	0.927	0.787	0.770
Manganese (Mn)	mg/kg	0.922	0.1612	0.1239	0.0902	0.661	0.1252	0.1081	0.1804	17.07	0.738	0.2375	0.1592	0.834	0.1054	0.0881	0.0678	0.581	0.2795	0.392	0.3397	0.3506
Molybdenum (Mo)	mg/kg	0.00126	0.00086	0.00134	0.00167	0.00113	0.00419	0.00228	0.00076	0.00015	0.00267	0.00537	0.00591	0.00162	0.00739	0.00926	0.01504	0.00103	0.00060	0.00090	0.00074	0.00064
Sodium (Na)	mg/kg	1.36	2.03	1.88	2.12	3.76	3.06	2.28	2.16	3.03	2.18	2.35	2.39	2.35	1.77	1.62	1.60	1.95	1.75	1.62	1.62	1.72
Nickel (Ni)	mg/kg	0.2973	2.155	2.772	0.0559	0.701	0.1578	0.0508	0.0946	0.2582	0.1487	0.1588	0.0948	0.0376	0.0358	0.0226	0.0141	0.0689	0.0338	0.0384	0.0335	0.0363
Lead (Pb)	mg/kg	<0.05	<0.04	<0.04	<0.04	<0.05	<0.04	<0.04	<0.04	<0.05	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.11	<0.04	<0.04	<0.04	<0.04	<0.04
Phosphorous (P)	mg/kg	0.0604	2.875	5.23	7.02	0.1801	12.32	4.04	8.34	0.2616	8.55	9.69	9.71	0.2027	51.9	54.2	32.73	35.31	44.6	35.04	34.12	34.65
Antimony (Sb)	mg/kg	155.9	120.2	199.7	955	2199	1957	141.7	389.3	978	1310	1745	1789	112.0	68.5	64.4	48.8	81.6	49.4	59.9	54.4	56.8
Selenium (Se)	mg/kg	<0.0009	0.0030	0.0038	0.0016	<0.0009	0.0048	0.0056	0.0032	<0.0010	0.0056	0.0067	0.0072	0.0013	0.0154	0.0109	0.0097	0.0028	0.0052	0.0053	0.0037	0.0030
Sulphur (S)	mg/kg	<0.005	<0.004	<0.004	0.008	0.009	0.008	<0.004	0.008	0.005	0.011	0.015	0.027	<0.004	0.027	0.030	0.034	0.004	0.020	0.023	0.022	0.026
Silicon (Si)	mg/kg	32.58	22.15	24.87	15.39	55.2	23.68	25.45	20.52	31.49	16.00	22.11	28.24	20.74	11.78	14.23	15.71	14.89	13.73	17.07	16.03	15.96
Tin (Sn)	mg/kg	<0.00005	<0.00004	<0.00004	<0.00004	<0.00005	<0.00004	0.00028	<0.00004	<0.00005	<0.00004	<0.00004	0.00023	<0.00004	0.00042	0.00053	0.00037	0.00008	<0.00004	<0.00004	<0.00004	0.00022
Strontium (Sr)	mg/kg	0.2088	0.1362	0.1691	0.482	1.167	0.966	0.1785	0.3039	0.4758	0.471	0.716	0.751	0.1355	0.0154	0.0256	0.0432	0.0573	0.0338	0.0414	0.0423	0.0400
Titanium (Ti)	mg/kg	0.0023	0.0017	0.0017	0.0029	0.0036	0.0048	0.0200	0.0056	0.0024	0.0026	0.0048	0.0068	0.0038	0.0135	0.0158	0.0242	0.0052	0.0048	0.0060	0.0059	0.0052
Thallium (Tl)	mg/kg	0.0037	0.0082	0.0167	0.0016	0.0086	0.0068	0.0072	0.0076	0.0029	0.0049	0.0015	<0.0008	0.0021	0.0023	0.0015	0.0011	0.0060	0.0024	0.0019	0.0015	0.0015
Uranium (U)	mg/kg	0.02448	0.03642	0.03144	0.01184	0.03525	0.01377	0.01073	0.0541	0.0518	0.02952	0.01342	0.00599	0.003382	0.469	0.478	0.11599	0.641	0.1238	0.1601	0.0783	0.0437
Vanadium (V)	mg/kg	<0.00014	<0.00013	0.00021	<0.00012	0.00018	<0.00012	<0.00012	<0.00012	<0.00015	<0.00011	<0.00011	<0.00011	<0.00013	<0.00012	<0.00011	0.00041	<0.00012	<0.00012	<0.00011	<0.00011	<0.00011
Zinc (Zn)	mg/kg	0.037	2.185	3.035	0.086	0.059	0.234	0.108	0.301	0.166	0.200	0.134	0.061	0.013	0.012	0.008	0.011	0.048	0.052	0.023	0.018	0.015

APPENDIX J

Comments Provided by CNSC on Serpent River Watershed State of the Environment Report

1- Assess watershed conditions relative to TMA sources through water and sediment quality and benthic invertebrate community composition.

Water quality

Uranium levels still regularly exceed PWQO only at M-01 (Inlet Elliot Lake) and Q-09 (Inlet Quirke Lake). In general, Ra-226, sulphate and uranium levels are either stable or decreasing in the SRW. The pH remain stables with the exception of SR-06 (McCabe Lake) where pH has decreased. Cobalt regularly exceeded the threshold at SC-01 (Towards Elliot Lake), Q-20 (Dunlop Lake), Q-09 (Quirke Inlet) and M-01 (Elliot Lake inlet) and only decreased at Quirke and Elliot Lake inlets. The licensee has not compared the current uranium levels to the new CCME guidelines. With few exceptions, mean surface water concentrations of mine related substances are less than the SRWMP benchmark and where concentrations exceed the benchmark they do not exceed the new CCME guideline.

Table 5.1: Percent of samples exceeding selected benchmarks (shaded values) at SRWMP stations, 2005-2009.

Station	# of Samples	Barium	Cobalt	Iron	Manganese	pH	Radium	Sulphate[b]	Uranium
		mg/L	mg/L	mg/L	mg/L	pH units	Bq/L	mg/L	mg/L
Upper limit of Background		0.047	0.0007	0.47	0.098	6.3	0.006	6.3	0.0006
PWQO[a]		-	0.0009	0.30	-	6.5	1.0	100	0.005
D-5	60	48%	0%	0%	0%	0%	0%	0%	5%
D-6	57	0%	5%	14%	65%	2%	0%	12%	0%
DS-18	60	0%	0%	15%	0%	0%	0%	20%	0%
M-01	50	0%	22%	56%	na	4%	0%	0%	24%
Q-09	60	52%	15%	na	na	0%	0%	17%	25%
Q-20	5	0%	20%	na	na	0%	0%	0%	0%
SC-01	16	0%	69%	0%	na	18%	0%	0%	0%
SR-01	5	0%	0%	na	na	0%	0%	0%	0%
SR-06	10	100%	0%	na	na	0%	0%	60%	0%
SR-08	60	0%	0%	na	na	2%	0%	97%	0%

[a] Provincial Water Quality Objectives (OMOEE 1994)
[b] Sulphate criterion based on BCMOE
na - Parameter not sampled at respective station.

Table 5.2: Summary of water quality trends[a] for Serpent River monitoring stations, 2000 to 2009.

Station ID	Number of Seasons Used in Common Trend[b]	Barium	Cobalt[c]	Iron[d,e]	Manganese[d]	pH[e]	Radium-226[c]	Sulphate	Uranium[c,e]
Reference Stations									
D-4	2	0.165	ND	0.645	0.621	-0.069	ND	-0.593	ND
P-22	2	0.435	ND	-	-	-0.038	ND	-0.515	ND
SR-05	10	-0.012	ND	-	-	0.070	ND	-0.786	ND
SR-14	1	-0.215	ND	-	-	0.0243	ND	-0.608	ND
SR-18	2	-0.099	ND	-	-	0.289	ND	-0.721	ND
SR-19	12	-0.191	ND	-	-	0.087	ND	-0.579	ND
Exposed Stations									
D-5	12	-0.124	ND	*-0.134*	-0.367	-0.011	-0.405	-0.412	*-0.276*
D-6	12	-0.093	ND	0.244	-0.046	*0.010*	-0.290	-0.258	ND
DS-18	12	-0.121	ND	0.368	-0.321	-0.084	-0.668	-0.442	-0.254
M01	10	-0.229	-0.219	-0.004	-	0.414	-0.660	-0.619	0.162
Q09	12	0.038	-0.292	-	-	-0.095	-0.374	-0.244	-0.379
Q20	1	0.622	ND	-	-	0.582	-0.834	-0.264	ND
SC-01	1 or 2	-0.360	ND	0.446	-	0.655	-0.739	-0.053	ND
SR-01	1	0.422	ND	-	-	0.387	-0.887	-0.967	-0.845
SR-06	2	0.984	ND	-	-	-0.572	0.394	-0.935	-0.977
SR08	12	0.172	ND	-	-	-0.076	-0.416	-0.539	-0.740

(blue) decreasing trend, significant at $p<0.05$
(green) increasing trend, significant at $p<0.05$
[a] Based on rank correlation coefficients (rho) shown in table for common (combined) seasonal trends.
[b] Seasons used varied for substances based on suitability of data for trend analysis.
[c] ND denotes that this parameter was not included in the trend analysis for that particular station due to >50% non-detectable concentrations in the samples available for the analysis.
[d] "-" denotes that this parameter was not included in the trend analysis for that particular station due to the absence of data (e.g. there were <5 years worth of data for that parameter)
[e] Italic text mean monthly correlations were significantly different, but common trend value provided was not necessarily significant.

Sediment Quality

While surface water quality has dramatically improved since decommissioning and the inception of the SRWMP, sediment is changing slowly with few statistical differences found between 1999 and 2009. This is not surprising because the first centimeter of surface sediments was analysed which represents likely a decade or more of historical contaminant loading. In addition, samples taken at 15m deep may have important benthos activity that can contribute to homogenize the sedimentary profile. Therefore, a fine sedimentary core profile at the deepest part of the lakes where anoxic conditions would limit benthic activity, would provide better evidence of sediment recovery.

Sediment toxicity results (Fig.5.4 & 5.5) were not consistent with sediment chemistry showing reduced survival in lakes with some of the lowest sediment concentrations. Pecors, McCarthy and Nordic Lake had reduced survival and growth in test with *Hyalella azetca*. However, results of *Chironomus dilutus* test showed no difference between exposure and reference lakes measures for growth or survival.

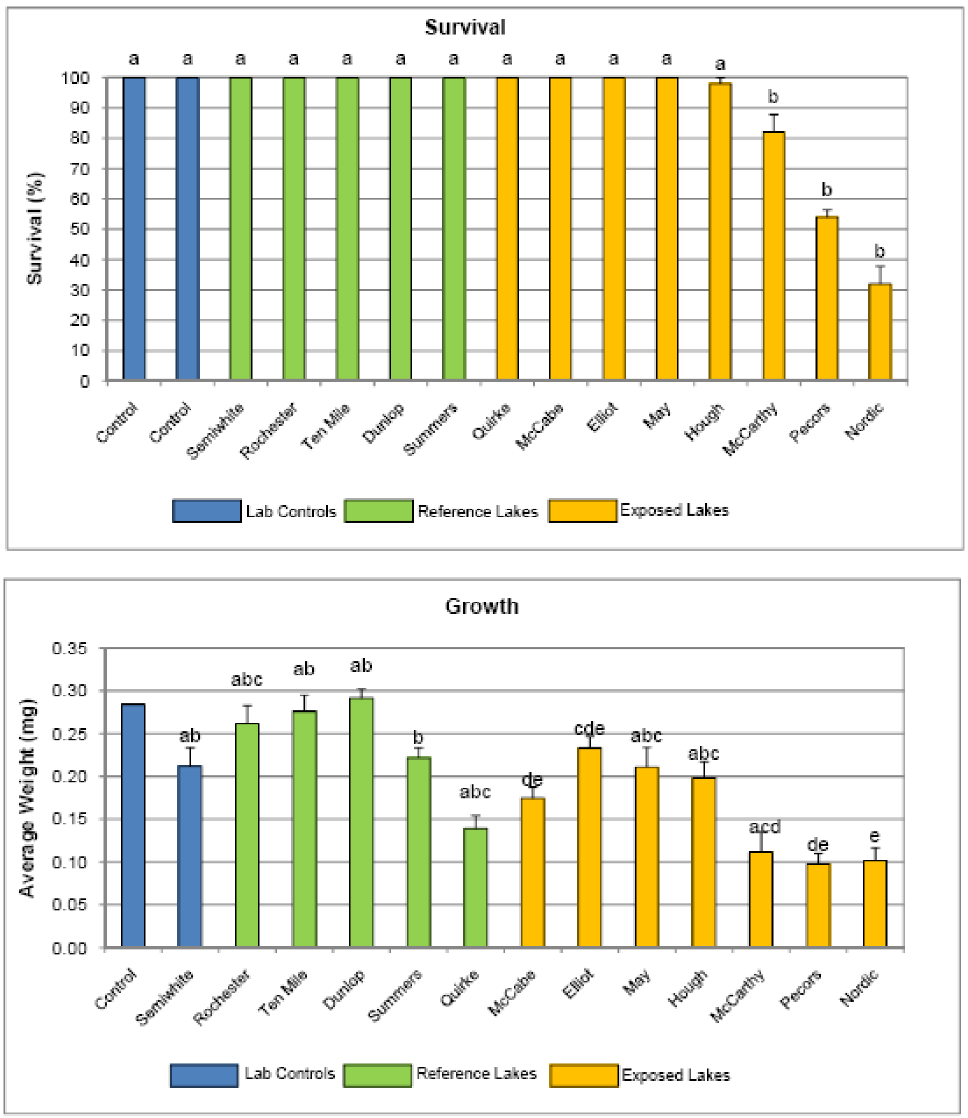


Figure 5.4: Survival and growth (+ SE) of *Hyalella azteca* exposed to sediment samples, SRWMP 2009. Lakes with similar letters above bars were not significantly different (p<0.05).

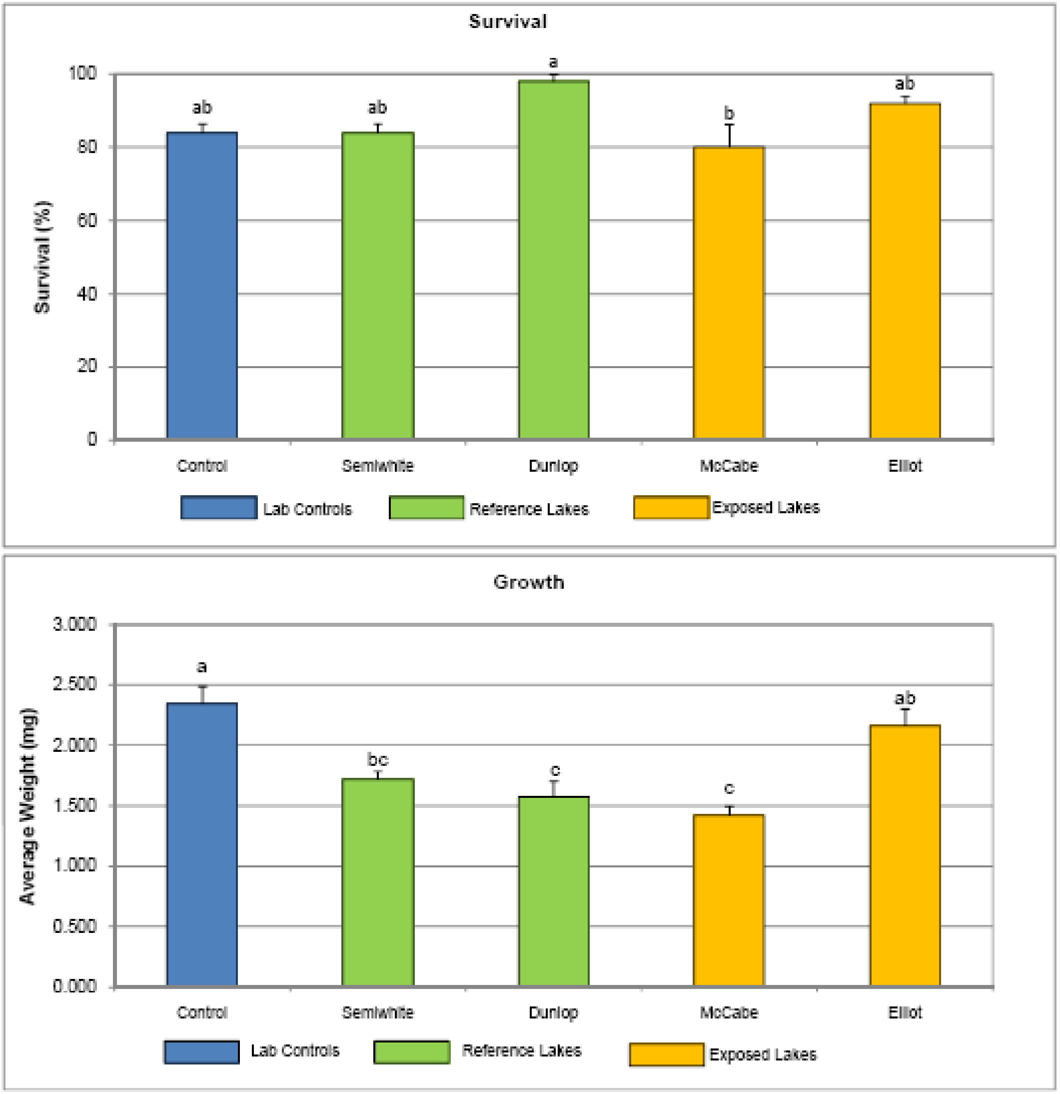


Figure 5.5: Survival and growth (+ SE) of *Chironomus dilutus* exposed to sediment samples, SRWMP 2009. Lakes with similar letters above bars were not significantly different ($p<0.05$).

Impacts to aquatic environment

Impacts on stream benthic communities (erosional habitats)

Erosional and depositional stream stations were discontinued in the Cycle 3 design based on water quality and habitat standardization (CNSC 2009). These stations were retired with the focus retained on lake depositional environments.

Impacts on benthic communities in depositional habitat

The communities in Quirke, McCabe, and May lakes showed more significant differences from the mean reference community than the other lakes (i.e., more metrics differed; Fig. 5.7).

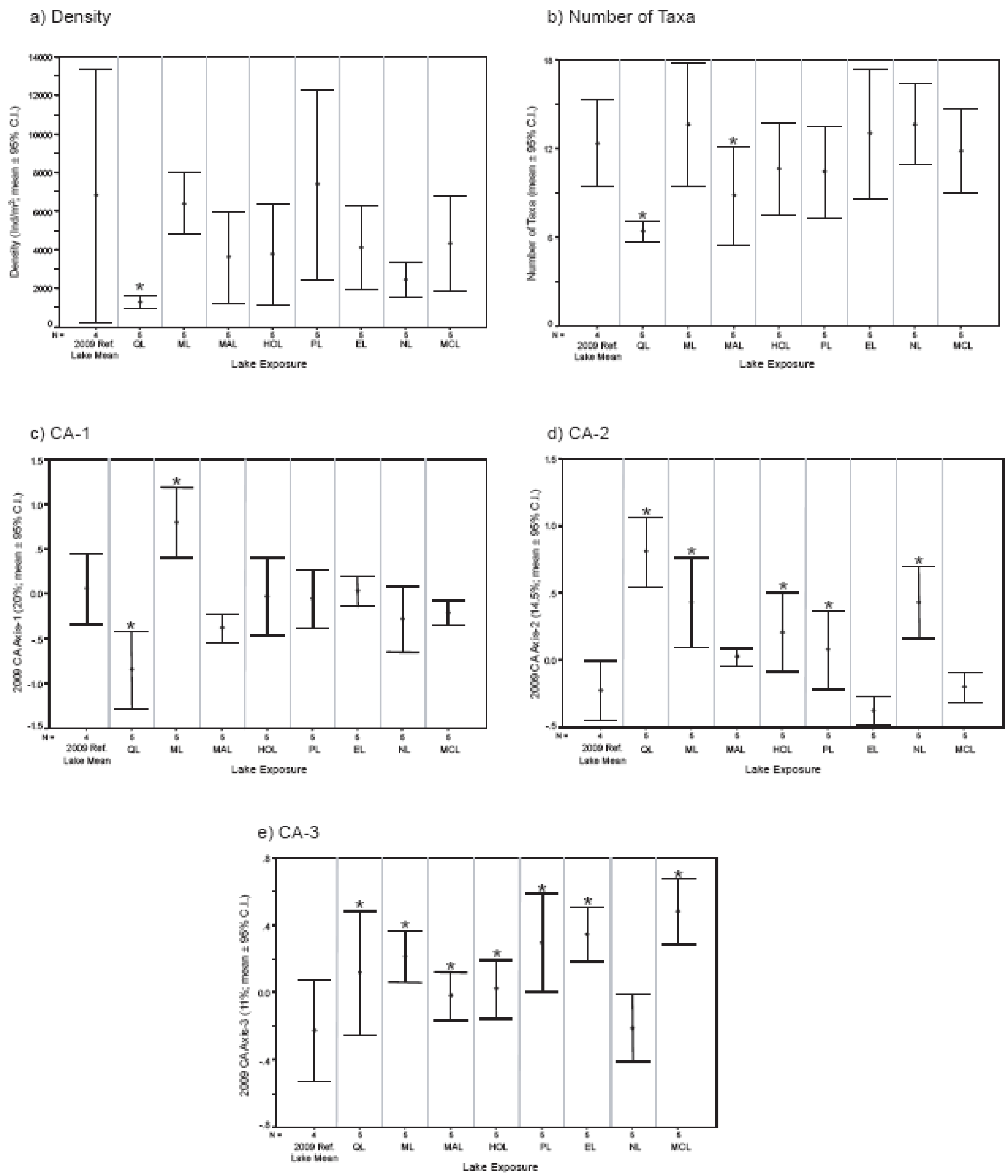


Figure 5.7: Benthic community characteristics in mine-exposed lakes of the Serpent River watershed relative to the pooled reference lakes. Asterisks (*) indicate exposure lakes that were statistically different from reference for each metric (p<0.1).

The pattern of deviations from reference mean values for the exposure lakes generally decreased through the three cycles of study, from 4 out of 5 metrics in 1999, to 3 out of 5 in 2004, and to only 2 out of 5 metrics in 2009. This supports a hypothesis of gradual recovery in the exposure lakes since 1999, though deviations from the reference means persist in both the density and community structure in the 2009 samples (Fig.5.8).

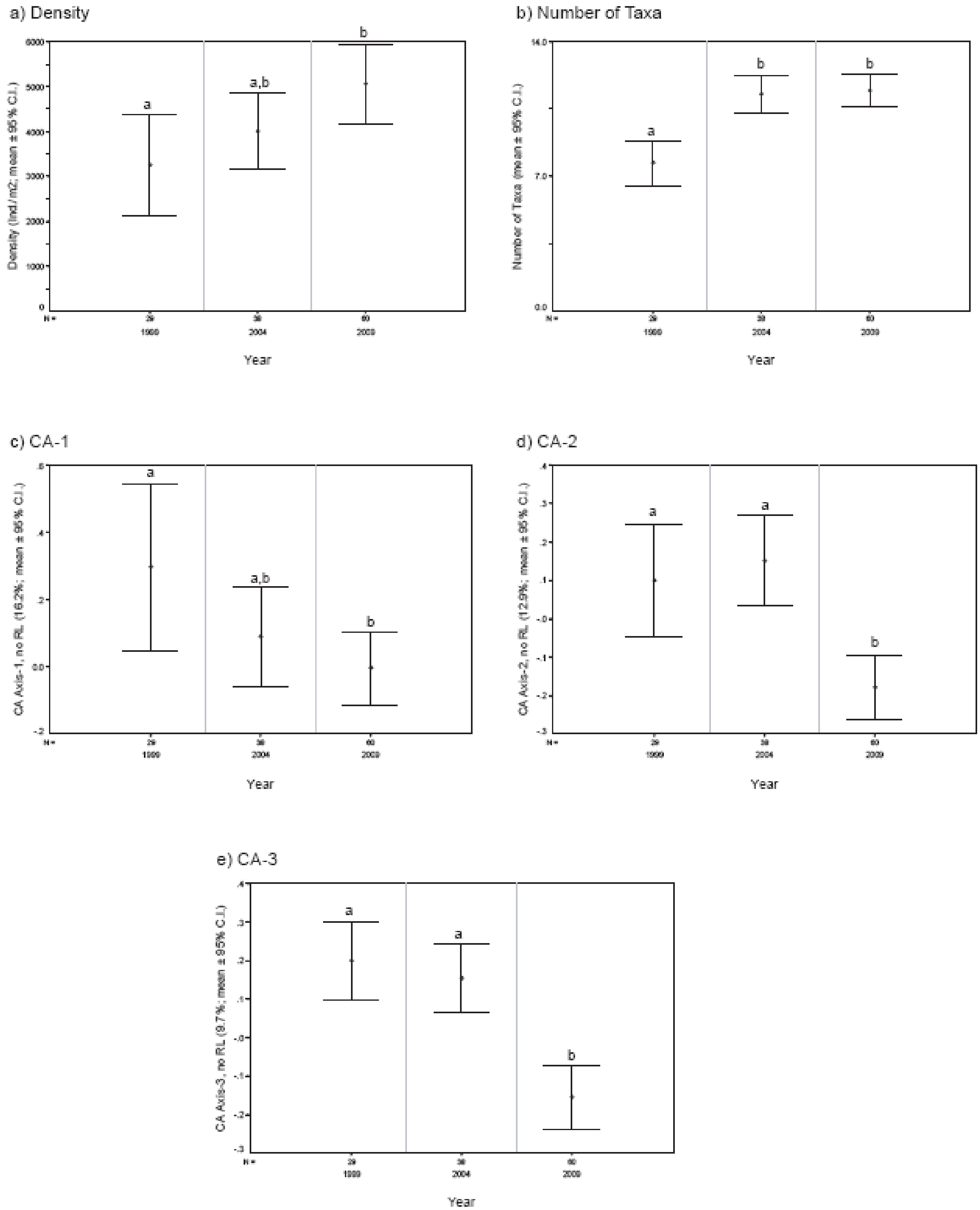


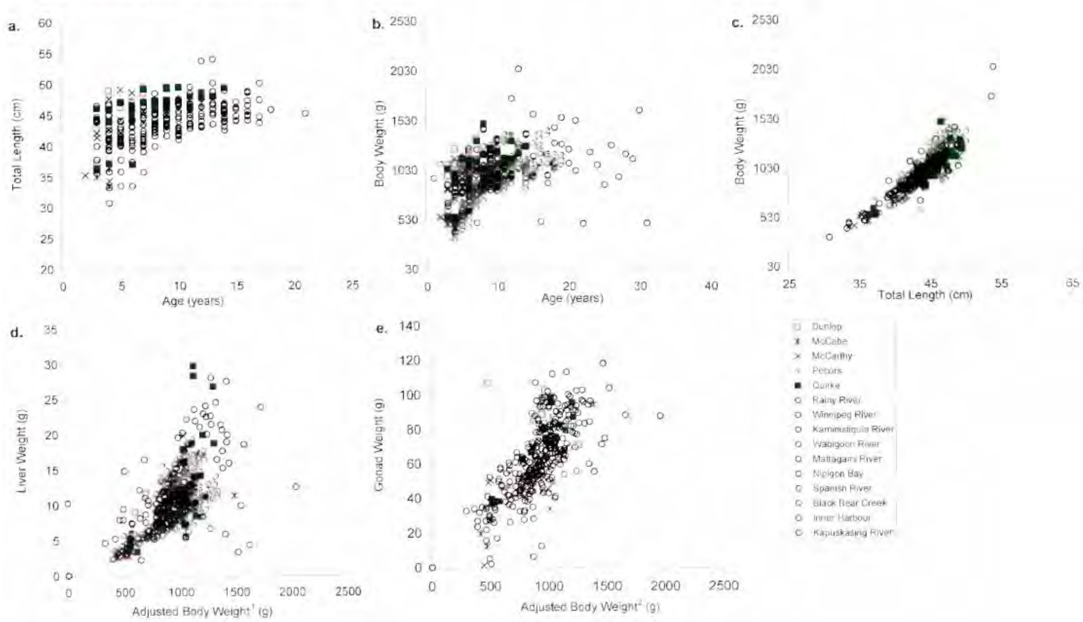
Figure 5.8: Benthic invertebrate community metrics for combined reference and exposure stations among years (1999, 2004, 2009). Years with similar letters were not significantly different ($p > 0.1$).

Impact to fish

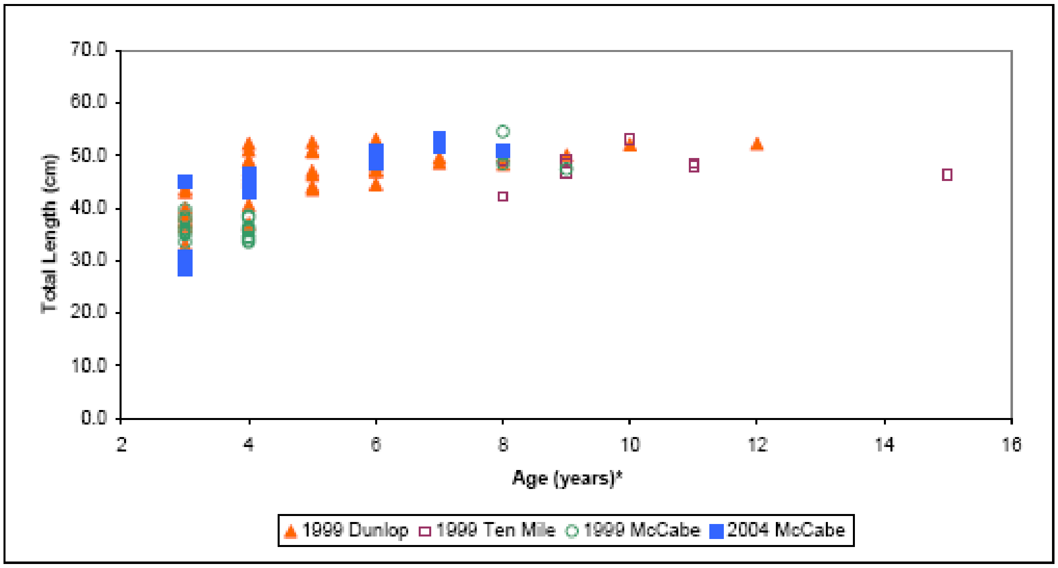
Fish Health

A detailed survey of white sucker populations was undertaken in two reference lakes (Ten Mile and Dunlop Lakes), three near-field lakes (Quirke, McCabe, and Nordic Lakes), and two far-field lakes (Pecors and McCarthy Lakes) in 1999 (Minnow and Beak 2001). Fish abundance was not adversely impacted in the five mine-exposed lakes compared to reference lakes. The exception to this was McCabe Lake, where there was some evidence of reduced abundance and diversity. Fish health was also assessed by measurement of characteristics associated with the growth, condition, and reproduction of white sucker. The fish residing in the lakes downstream of the mines showed similar health characteristics to those residing in the reference lakes. Further comparison was undertaken by obtaining data for more than 200 white sucker collected from un-impacted (reference) areas in nine other Northern Ontario watersheds using similar methods (Fig.7.6). The data for SRW white sucker were within the range of natural variation indicated by the white sucker from the other nine watersheds. The exception was potential reductions in some characteristics among McCabe Lake sucker relative to reference.

Figure 7.6: Male White Sucker, Dunlop Lake, McCabe Lake, McCarthy Lake, Pecors Lake, Quirke Lake and Regional Reference Data, SRW, 1999.



Based on the findings of Cycle 1 (Minnow and Beak 2001), the Cycle 2 SRWMP (Minnow 2006) focused on evaluation of the fish community and white sucker abundance and population health in McCabe Lake. The fish heath survey conducted in McCabe Lake in 2004 (Cycle 2) focused on abundance, growth, and condition of white sucker. Estimates of catch-per-unit-effort (CPUE) indicated a substantial increase in white sucker abundance between 1999 and 2004 from 1.1 to 2.85 white sucker per 1,000 ft hours respectively (Minnow 2006). The abundance measured in McCabe Lake in 2004 was similar to that measured in 1999 in Dunlop Lake (2.9/1,000 ft hrs) and greater than that measured in Ten Mile Lake (0.52/1,000 ft hrs) indicating that white sucker abundance is in the range of reference lakes. In 2004 white sucker were collected over a broader size range enabling comparison to the 1999 reference data (Figure 5.1). These data show that both growth and condition are within the range of reference fish.



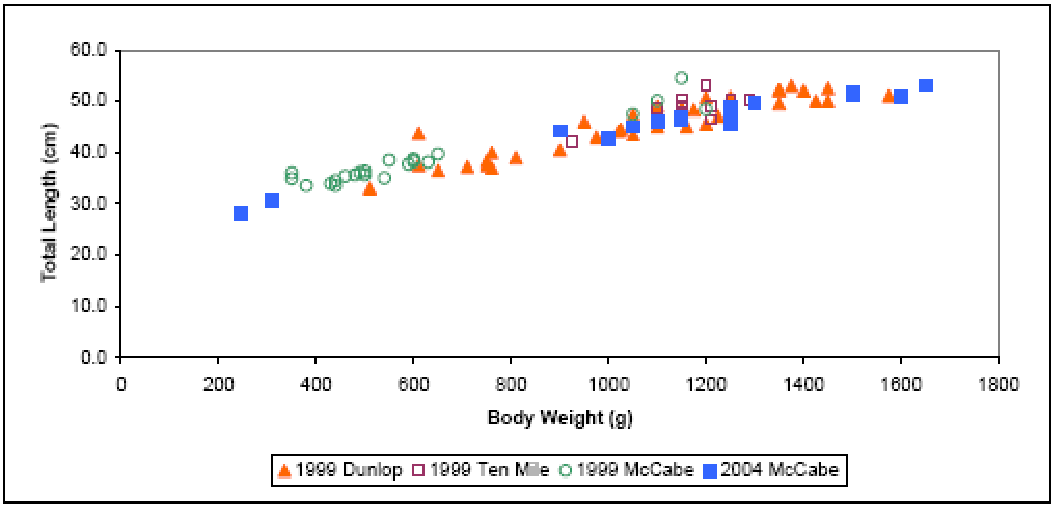


Figure 5.1: Growth and condition of white sucker caught in McCabe Lake and reference lakes in 1999 vs. 2004. Asterisk (*) indicates age inferred from length for some juveniles. All adults were aged. In order to reduce mortalities in juveniles, only some individuals from different length classes were aged. (0-7 cm assumed as YOY, 9-18 cm assumed as 1 year).

Given the improvement in abundance and the confirmation that growth and condition are within the range of background, no further sampling of the fish within McCabe Lake was proposed and accepted by CNSC.

Fish Tissue

Fish tissue samples collected in 1999 and 2004 indicated that fish have not accumulated mine related chemicals to concentrations of concern with respect to the health of human consumers (benchmarks). In fact, tissue concentrations were generally 10 to 1,000 times less than the benchmark (Tables 5.2). There is no reason to expect tissue concentrations to exceed benchmarks in the future if water and sediment concentrations remain less than 1999 levels. Thus, the fish tissue monitoring was eliminated from the SRWMP (CNSC 2009).

Table 5.2: Comparison of 1999 and 2004 mean concentrations of metals and radionuclides in fish muscle relative to human health benchmarks.

Lake	Year	Fish[a]	Component	Aluminum	Barium	Cobalt	Iron	Lead	Manganese	Radium-226	Selenium	Silver	Thorium	Uranium
			Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	Bq/kg	mg/kg	mg/kg	mg/kg	mg/kg
			Benchmark	6422.02	51.38	32.11	-	11.56	450	21.11	16.06	16.06	16.68	1.93
Dunlop (Reference)	1999	SMB	Mean	< 2	na	< 0.050	< 5	0.11	0.15	< 0.20	1.1	0.060	na	< 0.05
	2004	W, SMB, LT, WS	Mean	2.8	0.11	0.004	4	0.21	0.13	0.10	0.76	0.015	0.03	0.01
Elliot	1999	SMB	Mean	2.1	na	< 0.050	13	< 0.10	0.21	0.19	0.62	< 0.050	na	< 0.05
	2004	SMB, NP	Mean	1.5	0.06	0.007	5	0.16	0.15	0.20	0.46	0.008	0.03	0.01
McCarthy	1999	SMB	Mean	< 2.0	na	< 0.050	< 5	< 0.10	0.10	0.23	0.52	< 0.050	na	< 0.05
	2004	SMB, NP	Mean	3.9	0.04	0.008	3	0.12	0.49	0.32	0.42	0.014	0.03	0.01
Quirke	1999	SMB	Mean	2.3	na	< 0.050	9	< 0.10	0.22	0.22	1.9	< 0.050	na	0.05
	2004	SMB, LT	Mean	1.9	0.06	0.008	3	0.13	0.21	0.25	0.79	0.013	0.03	0.01

na - not analyzed

Value exceeds benchmark.

[a] LT - lake trout, NP - northern pike, SMB - smallmouth bass, W - walleye, WS - white sucker

Dose to Biota

The largest calculated doses to aquatic biota occurred at Quirke Lake, where the doses to fish, aquatic plants and benthos were 0.92, 2.61 and 0.256 mGy/d, respectively. For all aquatic biota, the largest component of dose was internal and the largest contributor to dose was generally Po-210 for both fish and benthic invertebrates. CNSC staff independently verified the Ecometrix dose calculations, obtaining a dose to pelagic fish of 43 µGy/h (i.e. 1.03mGy/d), a value similar to those obtained by Ecometrix.

Benthic community indices in Quirke Lake are different than reference indicating benthic invertebrate impairment persists (Fig.5.7), however, white sucker health indicators appear similar to reference lakes. Whether or not the benthic invertebrate community impairment can be ascribed to radiotoxicity or chemical toxicity remains to be proven. Hence, the licensee, in the spirit of transparency, in addition to indicating that dose rates are well below the UNSCEAR (1996) benchmark dose of 10 mGy/d (or 400 µGy/h) should acknowledge that the dose rates calculations are higher than the 0.24mGy/d used in the ERICA tool (Brown et al. 2008) for some aquatic biota and the more conservative CNSC dose rate criterion of 0.6 mGy/d. The more recently derived CNSC dose rate criteria (0.6 mGy/d for fish, 3 mGy/d for aquatic plants, and 6 mGy/d for benthic invertebrates) and the ERICA tool screening benchmark for the assessment of effects to aquatic biota should have been included in the ecological risk assessment and the SOE report and shall be included in future reports.

Dose to Humans

The calculated doses ranged from 0.036 to 0.301 mSv/a, all less than the public dose limit of 1 mSv/a, before background correction. Background dose from the same pathways was estimated at 0.013 mSv/a. Therefore, incremental doses ranged from 0.023 to 0.288 mSv/a. The smallest doses were at McCarthy, Elliot and Nordic lakes, whereas the largest dose was at Quirke Lake. The dose at Quirke Lake was dominated by consumption of mallard ducks, and was driven by the high concentration of Po-210 in aquatic macrophytes at Quirke Lake. However, macrophytes were collected in Quirke Lake from a former tailings deposition area near Panel Mine and thus likely over estimate typical macrophyte uptake within the lake. The estimated dose at Quirke Lake without the waterfowl component is 0.072 mSv/a (total) or 0.064 mSv/a (incremental).

The contributions of water, fish, moose and waterfowl to the SRFN dose are approximately 28%, 37%, 25% and 10%, respectively, with slight variations between actual use and future use scenarios.

Spatial extent of impacts

There are obvious trends which indicate that the environmental impacts are decreasing both in overall magnitude and spatial extent in the Serpent River watershed. Areas of concern can now be restricted to Quirke Lake, McCabe Lake and May Lake. In addition, loadings from the Pronto TMA continue to require further attention and monitoring.

Reversibility of impacts

With water quality improving, it is only a matter of time before sediment also show a clear indication of recovery. Statistically measurable sediment recovery will be delayed as a result of the low depositional rates one would expect in these environments and the influence of bioturbation. Benthic invertebrate impacts are mainly observed in Quirke Lake and McCabe and May lake which receive contaminants from Quirke and Denison TMAs and Stanleigh TMA, respectively. As long as released are actively controlled at the TMAs, environmental conditions should continue to improve in the Serpent River Watershed.

Conclusion

In general, water quality is improving and environmental impacts, such as decreased benthic community taxonomic richness and abundance have reduced in magnitude and spatial extent such that only waterbodies immediately downstream of Quirke, Denison, Panel and Stanleigh are measurably impacted. Lakes further afield are generally in good environmental health conditions. While sediment contaminant levels continue to appear somewhat elevated, sediment cores in zones of limited benthic activity may better define historical contaminant deposition from recent contaminant deposition.

2- Evaluate mine sources (TMA releases) in terms of concentrations and loads to the Serpent River Watershed (SRW) and utilize trend analysis to anticipate future conditions in source contributions to the watershed;

Quirke Lake:
In the spirit of continuous improvement the licensee should within the present management system:

- investigate options for limiting loadings from the Quirke and Denison TMAs;
- investigate opportunities to minimize seepage from the Quirke II mine, in particular with respect to cobalt; and
- investigate whether improved control of Ra-226 at the Denison TMAs can be achieved considering the recent increase in loadings documented in this report.

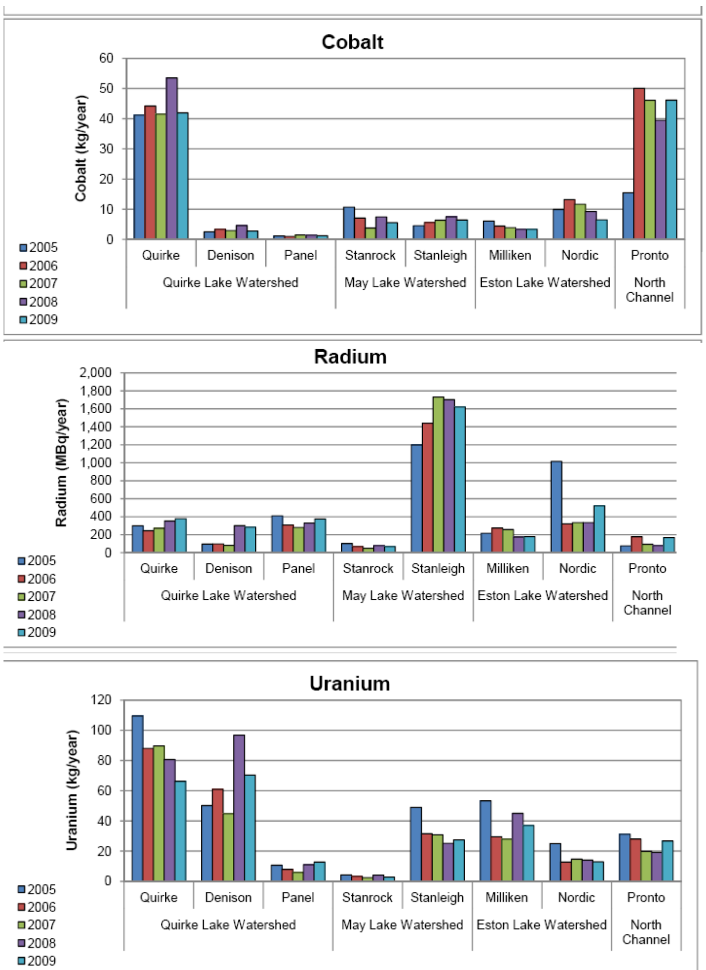


Figure 4.3: Annual TMA loadings by watershed (2005-2009).

Stanley TMAs:
In the spirit of continuous improvement the licensee should, within the present management system:

- review present practices for opportunities to optimise performance and demonstrate that releases are being kept as low as reasonably achievable, social and economics considered.

Pronto TMAs:

In the spirit of continuous improvement the licensee should within the present management system:

- review present practices for opportunities to optimise performance with specific attention paid to cobalt.

3- **Assess TMA performance relative to discharge criteria as well as performance objectives and predictions made in the Environmental Impact Statements (EIS);**

No comments

4- Changes in SRWMP

<u>Background</u>
At the onset of the SRWMP it was recognized that the program would need to be modified over time and the requirement for monitoring should be reduced as the zone of influence of the decommissioned mines recedes and conditions in the watershed improve. Consistent with this understanding the SRWMP was designed to evolve over time responding to previous study findings. Environmental acceptability criteria were developed and approved as the basis for assessing study findings and reducing/eliminating aspects of the program (Beak 1999). Given the long-term history of mine-related activities in the watershed, and existing knowledge of environmental conditions, a "weight-of-evidence approach" was approved by CNSC for defining environmental acceptability. Criteria denoting acceptable environmental quality include:

- Contaminant concentrations in environmental media are below objectives or guidelines (*e.g.,* Provincial Water Quality Objectives (PWQO) (MOEE 1994) or Canadian Water Quality Guidelines (CWQG), Provincial Sediment Quality Guidelines (PSQG) (MOE 1993)), or the Interim Sediment Quality Assessment Values (ISQAV) (Environment Canada 1995); The guidelines of Thompson et al. 2005 should also be considered.
- Contaminant concentrations above guidelines, but within the natural range of background variability (*i.e.,* as measured at reference stations);
- Acceptable doses and risks for human and ecological receptors based on site specific information and compared to risk guidelines and/or background levels; and
- Contaminant concentrations demonstrating stable and/or decreasing trends or, if increasing, doing so in accordance with EIS predictions.

At the time the program was developed (1999) it was expected that few areas of the watershed would reach guideline levels in the foreseeable future. Some near-field areas were expected to recover over a very long time frame while recovery of far-field areas was expected on a shorter time frame. Therefore, acceptability criteria were expected to be different for different areas of the watershed. The SRWMP design document (Beak 1999) stated that:

"Should monitoring demonstrate that an area is achieving relevant guidelines, then this should be defined as acceptable conditions, eliminating the need for further monitoring. In other areas, acceptability may be achieved when a stable or slowly decreasing trend is documented".

A rationale/decision path for modifying the program was established and approved as part of the Implementation Document for the SRWMP (Figure 1.2). This decision path presents the criteria for acceptability of evaluation endpoints and the ensuing change to the program based on the findings of the previous study. Based on the decision path and the acceptability criteria, stations (*i.e.*, whole lakes or creek/river areas) with concentrations of mine indicator parameters in water and sediment below guidelines (or at background if background exceeds the guideline) and with no ecologically significant effects on benthic and fish community parameters can be eliminated from the program. Similarly, if a particular parameter meets criteria for water, sediment, and tissue quality, and there are no detectable effects on benthic and fish communities at all areas, that parameter can be eliminated from the program. Ultimately, it is expected that the program should retract spatially with improvement and only expand in response to ecosystem impacts.

While the acceptability criteria and decision pathway for modifying the program were described in SRWMP Framework and Implementation documents (Beak 1999), the application of the acceptability criteria to specific program components (*i.e.*, water quality, sediment quality, benthos, fish, and dose and risk) has been described in more detail in this document in the context of the findings from the Cycle 2 study. Consistent with the guiding principals of the program design, a weight of evidence approach has been employed to rationalize changes to the program.

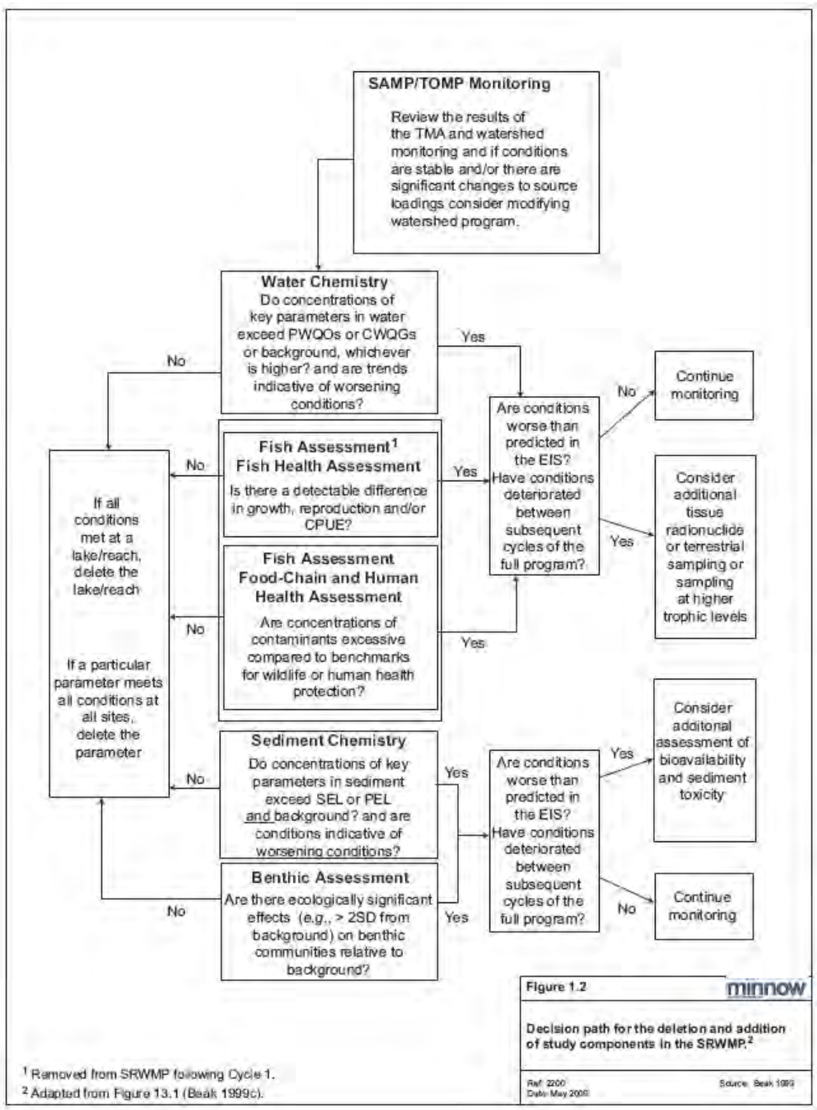


Figure 1.2

Decision path for the deletion and addition of study components in the SRWMP.[2]

Recommended change to the SRWMP

Based on this rationale, the licensee now recommends:

- Conditions are expected to continue to improve, but the rate of change in sediment and benthic invertebrates is slow, so consideration should be given to reducing the frequency of monitoring to once every 10 years.
- When the next SRWMP is implemented the list of exposure lakes to be included should be reduced to remove those lakes showing limited or no effects on benthic invertebrates (Elliot, Hough and McCarthy).

CNSC response

The following documents the CNSC staff position regarding the proposed changes to the monitoring program

Benthic Community:

- It is the position of CNSC staff that the sampling frequency should remain the same given that impacts are still noted at Quirke, McCabe and May lakes and that correspondence analysis still indicate differences with control areas at most sites.

Sediments:

- CNSC staff concur with the Licensee's statement that collecting surface sediment samples every 5 years may not demonstrate sediment recovery in the short term due to bioturbation and low depositional rates (e.g., possibly 2mm/yr)
- This difficulty was known when the protocols were developed; however, the primary objective at that time was to link sediment contamination with impacts to the benthic community. When the benthic community indices at historically exposed lakes become similar to the reference lakes, it is the position of CNSC staff that the sediment sampling program should be modified to include the collection of deep water cores to be sectioned at 0.5 cm to 1 cm horizons (to be discussed by the CNSC and the licensee). Should the cores indicate clear evidence of improved sediment quality since the decommissioning activities, CNSC staff will consider eliminating the sediment monitoring program.

Removal of Elliott, Hough and McCarthy lakes from the program:

- It is CNSC staff position that Elliot Lake should remain in the monitoring program as it is the only monitored receiving environment receiving drainage from Nordic and Milliken TMAs.
- It is CNSC staff position that Hough and McCarthy lakes may be removed from the program. This is based on the evidence which demonstrates that water quality is meeting the PWQO and that the benthic communities are similar compared to references.

CNSC recommended changes to the SRWMP

- It is CNSC staff position that the licensee should verify the high Po-210 numbers in forage fish. If these numbers are confirmed by the laboratory, resampling should be performed as they are well beyond the norms measured at other exposure sites and Po-210 is the dominant radionuclide responsible to the calculated dose above the ERICA screening benchmark in Quirke Lake.

- Should these elevated numbers be confirmed consideration will be given to modifications to the present monitoring program to follow-up on the role and importance of Po-210 in the environment at this site.

CNSC staff noted that Po-210 level in whole forage fish were well beyond the norms measured at other exposure sites. In light of these elevated results and the fact that Po-210 is the dominant radionuclide responsible to calculated doses, means that these results merited further confirmation and discussion. The forage fish results were not placed in context to any Po-210 levels in fish from the 1999, 2004 or 2009 (may not be available) nor unfortunately were any literature comparisons made.

In light of this finding CNSC staff completed a quick review of the available Po-210 data for Elliot Lake with some of the findings provided below to assist the licensee.

Table 3.4: Average Activity Concentrations of U-238 and Th-232 Decay Chain Radionuclides in Whole Forage Fish (fresh weight)

Lake	U Bq/kg	Th-230 Bq/kg	Ra-226 Bq/kg	Pb-210 Bq/kg	Po-210 Bq/kg	Th-232 Bq/kg	Ra-228 Bq/kg	Th-228 Bq/kg
Quirke	63.55	22.000	59.667	30.000	1006.67	< 5	*106.667*	*4.667*
Elliot	14.92	*4.333*	11.000	< 20	29.000	< 5	*116.667*	< 5
Nordic	4.51	< 5	10.333	< 20	396.667	< 5	< 100	< 5
McCabe	11.40	< 5	21.667	*36.667*	503.333	< 5	*223.333*	< 5
May	5.41	*5.000*	13.000	*23.333*	453.333	< 5	*143.333*	*5.667*
McCarthy	10.70	< 5	9.000	< 20	56.000	< 5	< 100	< 5

Note: values in italics contain some detects and some non-detects taken at face value

Despite the elevated levels in forage fish, Po-210 was not detected in water (Table 3.3). The licensee indicated that forage fish might have been exposed to Po-210 by interaction with historically contaminated sediments downstream of the Panel TMA.

Table 3.3: Measured Activity Concentrations of U-238 and Th-232 Decay Chain Radionuclides in Lake Water

Lake	U Bq/L	Th-230 Bq/L	Ra-226 Bq/L	Pb-210 Bq/L	Po-210 Bq/L	Th-232 Bq/L	Ra-228 Bq/L	Th-228 Bq/L
Quirke	0.0640	< 0.01	0.05	0.06	< 0.01	< 0.01	< 0.1	< 0.01
Elliot	0.0418	< 0.01	< 0.01	0.03	< 0.01	< 0.01	< 0.1	< 0.01
Nordic	0.0394	< 0.01	0.03	0.03	< 0.01	< 0.01	< 0.1	< 0.01
McCabe	0.0295	< 0.01	0.06	0.03	< 0.01	< 0.01	< 0.1	< 0.01
May	0.0369	< 0.01	0.05	< 0.02	< 0.01	< 0.01	< 0.1	< 0.01
McCarthy	0.0123	< 0.01	< 0.01	0.03	< 0.01	< 0.01	< 0.1	< 0.01

In addition, the Pb210 to Po-210 ratio in gut contents (Clulow et al. 1998) are different from sediments possibly indicating that food prey items are the main Po-210 source.

Pb210/Po210 ratios in Fish from different lakes in the Elliott Lake area (Clulow et al. 1998)

Fish	Bone	Muscle	Gut contents
Lake Trout			
Quirke	1.1	NA	0.76
McCabe	NA	NA	0.74
Whiskey	0.87	NA	1.35

Elliot	NA	NA	NA
JimChrist	NA	NA	NA
Whitefish			
McCabe	1.0	NA	NA
Whiskey	1.3	NA	0.27
Elliott	NA	NA	1.44
Semiwite	NA	NA	NA

NA Pb-210 were below detection limit of 50 Bq/Kg

Other than the study of Clulow et al. (1998), the licensee should provide the Po-210 levels in bone, gut and tissue of sport fish as well as indicate if there is cause for concern from Po-210 in fish tissue consumed by humans. Data from Clulow et al. (1998) indicated that the polonium although present in the gut, seems to preferably accumulate in bone like uranium and not much in fish tissue. Based on the results of dose estimates for forage fish, benthos effects, and contaminant loading estimates in Quirke Lake, fish health and fish tissue survey should be considered for Quirke Lake. The licensee has committed to provide a sampling protocol to CNSC in order to discuss a monitoring campaign that will measure levels of Po-210 in sport fish in 2011

Reference:

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APPENDIX K

Response to CNSC Comments Provided by Rio Algom Limited and Denison Mines Inc

Response to Comments Provided by the CNSC on the State of the Environment Report

1 Introduction

Rio Algom Limited (RAL) and Denison Mines Inc. (DMI) retained Minnow Environmental to prepare the Serpent River Watershed State of the Environment (SOE) Report. The objective of the SOE is to integrate information regarding tailings management areas (TMAs) performance with the conditions in the downstream Serpent River Watershed. This allows trends in mine sources to be used to anticipate future conditions within the watershed.

To achieve this objective a number of goals were identified:

- Evaluate mine sources (TMA releases) relative to current watershed conditions;
- Assess TMA performance relative to discharge criteria as well as performance objectives and predictions made in the Environmental Impact Statements (EIS);
- Compare dose and risk values anticipated under closure conditions to those based on measured values within the watershed and assess progress against closure objectives; and
- Identify anticipated near and long-term future conditions within the TMAs and watershed through trend analysis, review of anticipated changes within TMAs (EIS predictions) and assess the environmental risks of anticipated performance on the downstream receiving environment.

To meet the project objective and goals, a weight of evidence approach was used that incorporated existing performance, trend analysis, loadings assessment and downstream conditions relative to established criteria and expected conditions (EIS predictions).

RAL and DMI submitted the Regulatory Review Draft of the SOE to the Canadian Nuclear Safety Commission (CNSC) and members of the Elliot Lake Joint Review Group (JRG) on March 4, 2011. CNSC issued review comments on the draft report April 21, 2011. The licensees, RAL and DMI, presented their initial response to comments to members of the JRG at a review meeting held in Elliot Lake on May 12, 2011. It is planned that the CNSC Detailed Review of the Draft Serpent River Watershed SOE Report will be included in the final SOE report as Appendix J with this response to comments included as Appendix K.

The response to comments is organized in a parallel manner to the comments received from CNSC.

2 Assess Watershed Conditions

2.1 Water quality

The licensees are in agreement with the summary of water quality conditions presented in the CNSC comments but wish to acknowledge the following:

- While concentrations of uranium were found to exceed the PWQO at M-01 and Q-09, the Canadian Water Quality Guideline (CWQG) was recently updated (CCME 2011) based on the most recent toxiciology data. The new value is 15 ug/L (0.015 mg/L) which is higher than the PWQO. The CWQG is the value set by the Canadian Council of Ministers of the Environment (CCME) and used by Environment Canada for the protection of aquatic life. When the SRWMP data are compared to this guideline almost all samples collected between 2005 and 2009 were below the CWQG for uranium at all stations (Table 2.1). The only exception is one uranium sample at Q-09 in August 2007 and even this sample (0.0163 mg/L) was just marginally above the CCME guideline of 0.015 mg/L. Therefore, it should be concluded that uranium concentrations within the downstream receiving environment (SRW) are at levels which are protective of fish and aquatic life.

- Similar to uranium, cobalt was elevated above the PWQO in some samples at some locations. However, a new cobalt guideline has been developed federally under CEPA and Environment Canada is expected to adopt this guideline. The new cobalt guideline value is based on a "predicted no-effect-concentration" (PNEC) of 2.5 µg/L. When the receiving water data in the SRW are compared to this value, the concentrations at all locations except SC-01 are less than the new guideline (Table 2.1). It should be noted that the values at SC-01 which were above 2.5 µg/L were measured in 2005 and 2006 and are associated with the dam breech on Westner Lake. Since 2006, all values at all stations are less than the PNEC of 2.5 µg/L. Therefore, current cobalt concentrations are at acceptable levels in the watershed and protective of fish and aquatic life.
- The apparent trend in pH (decreasing over time) at the outlet of McCabe Lake needs to be considered in the context of natural variability and influent flows. The trend (Figure E.13 in the SOE report) is largely attributed to lower pH values which occurred during a period of low pH inflow from Canyon Lake (Figure 2.1). At no time did pH in McCabe Lake drop below background levels.

Figure 2.1. McCabe Lake, Canyon Creek and Stanleigh Discharge pH

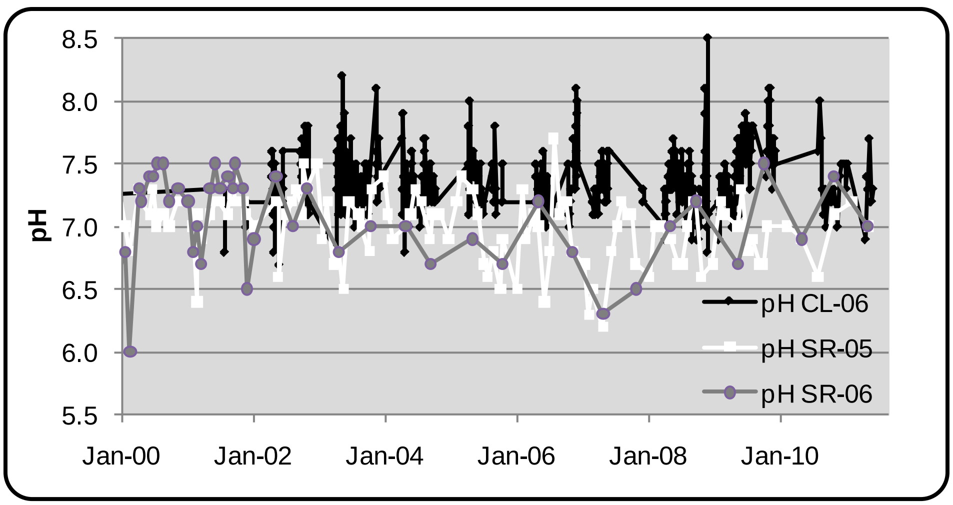


Table 2.1. Percent of samples exceeding selected benchmarks (shaded values) at SRWMP stations, 2005-2009.

Station	# of Samples	Barium	Cobalt[c]	Iron	Manganese	pH	Radium	Sulphate[b]	Uranium[d]
		mg/L	mg/L	mg/L	mg/L	pH units	Bq/L	mg/L	mg/L
Upper limit of Background		**0.047**	**0.0007**	**0.47**	**0.098**	**6.3**	**0.006**	**6.3**	**0.0006**
PWQO[a]		**-**	**0.0025**	**0.30**	**-**	**6.5**	**1.0**	**100**	**0.015**
D-5	60	48%	0%	0%	0%	0%	0%	0%	0%
D-6	57	0%	0%	14%	65%	2%	0%	12%	0%
DS-18	60	0%	0%	15%	0%	0%	0%	20%	0%
M-01	50	0%	0%	56%	na	4%	0%	0%	0%
Q-09	60	52%	0%	na	na	0%	0%	17%	2%
Q-20	5	0%	0%	na	na	0%	0%	0%	0%
SC-01	16	0%	44%	0%	na	18%	0%	0%	0%
SR-01	5	0%	0%	na	na	0%	0%	0%	0%
SR-06	10	100%	0%	na	na	0%	0%	60%	0%
SR-08	60	0%	0%	na	na	2%	0%	97%	0%

[a] Provincial Water Quality Objectives (OMOEE 1994)

[b] Sulphate criterion based on BCMOE

[c] CEPA value to be adopted by CCME

[d] CCME value from Canadian Environmental Quality Guidelines, Canadian Council of Ministers of the Environment (CCME), 2011

na - Parameter not sampled at respective station.

2.2 Sediment quality

The licensees agree with the CNSC's comments that sediment chemistry is changing slowly. There are a number of factors which could be influencing the slow rate of demonstrated change in sediment concentrations including:

- Sediment deposition rates may be slower than anticipated (2 mm/yr). Work by McKee *et. al.* (1987) found that pre-mining sedimentation rates in Quirke Lake ranged from 0.31 to 0.45 mm/yr. This could mean that surface sediments in the top 1 cm (sampling interval) are changing very slowly (10 to 30 years).
- Changes in the partitioning of metals may also contribute to observed improvements in the benthic invertebrate community while seeing no changes in bulk sediment chemistry. Over time, increased pH and improved general water quality will influence the flux of metals (to and from the sediments, respectively).
- Bioturbation at the sampling locations (15 m depth to sediment water interface) could further complicate the detection of improvement.

As discussed at the JRG meeting of May 12th, the continued value of sediment monitoring at the current frequency may be questionable given our ability to detect change. The licensees will investigate tools to evaluate deposition rates, including deep water cores, and incorporate the findings in the Cycle 4 SRWMP Study Design.

2.3 Impact to aquatic environment

The licensees agree with the assessment of conditions summarized by the CNSC.

2.4 Impact to fish

The licensees agree with the assessment of conditions summarized by the CNSC.

2.5 Dose to Biota

The licensees acknowledge that dose rates to biota in Quirke, McCabe, May and to a lesser extent Nordic Lakes exceed the ERICA tool benchmark of 0.24 mGy/d, but disagree that this is an appropriate benchmark for a quantitative risk assessment. With respect to proposed CNSC benchmarks (0.6 mGy/d fish, 3.0 mGy/d aquatic plants, 6.0 Gy/d aquatic biota), only forage fish in Quirke Lake exceeded the proposed CNSC benchmark at 0.92 mGy/d.

The United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) reviewed the 0.24 mGy/d benchmark used by the ERICA tool and concluded that the benchmark is inappropriate for quantitative assessment of ecological risk as the proposed benchmark is below any observed effect level (UNSCEAR, 2008). Similarly, the draft CSA N288.6 standard does not recommend that benchmark for use in quantitative ecological risk assessment (D. Hart, pers comm.).

The ERICA benchmark was derived as a conservative screening value for derivation of radionuclide screening concentrations (Tier 1 of the ERICA framework). While ERICA decided to also use the benchmark for Tier 2 quantitative assessment, we consider this to be inappropriate because it results in incorrect conclusions about risk.

The conservatism in derivation of the 0.24 mGy/day value arises firstly from using extrapolated EDR10 values from each study as species "effect": levels, and secondly from the application of a safety factor to the 5th percentile of those values. The lowest actually observed effect levels from those studies were never lower than 200 uGy/h (4.8 mGy/day). This agrees with the UNSCEAR (2008) finding of only minor effects in some studies at chronic dose rates less than 100 uGy/h (2.4 mGy/day). UNSCEAR concludes that maximum dose rates of 100 uGy/h (2.4

mGy/day) and 400 uGy/h (9.6 mGy/d) would be unlikely to have significant effects on terrestrial and aquatic populations, respectively. None of the doses determined for biota in the Serpent River Watershed exceeded these international benchmarks.

The dose benchmark of 0.6 mGy/day suggested for fish by Environment Canada/Health Canada (2003) is based on studies of silver carp in a Chernobyl cooling pond where likely confounding factors include higher parental exposures and chemical pollution. UNSCEAR (2008) reviewed the Chernobyl cooling pond studies and did not find convincing evidence of effects on fish populations due to chronic irradiation at this level.

2.6 Dose to Humans

The licensees agree with the assessment of human dose as summarized by the CNSC.

2.7 Spatial extent of impacts

The licensees agree with the assessment of conditions summarized by the CNSC that areas of concern can now be restricted to Quirke Lake, McCabe Lake and May Lake. With respect to the Pronto TMA, the licensees would like to note the following:

- Loadings from the Pronto TMA will continue to be monitored at PR-01 through the SAMP program. Concentrations at PR-01 are within an order of magnitude of SRW receiving environment criteria. Furthermore, Pronto TMA effluent is consistently non-toxic and the loadings are unlikely to result in measurable changes in Lake Huron concentrations outside of the immediate mixing area. Water quality monitoring downstream of PR-01 (in Pronto discharge channel and Lake Huron) is not included in the receiving environment monitoring program (SRWMP) due to confounding influences immediately downstream of the TMA discharge, including a rail line, Highway 17, and drainage from a lime calcining plant which enters Lake Huron adjacent to the Pronto discharge channel (Minnow, 2009).

2.8 Reversibility of impacts

The licensees agree with the assessment of conditions summarized by the CNSC that benthic invertebrate impacts are mainly observed in Quirke Lake, McCabe Lake and May Lake and that "*As long as releases are actively controlled at the TMAs, environmental conditions should continue to improve in the Serpent River Watershed*". However, it should be noted that the rate of improvement particularly with sediment may be slower than anticipated and future monitoring scope and frequency will need to reflect this.

3 Evaluate Mine Sources

3.1 Commitment to Continuous Improvement

CNSC has suggested that "*in the spirit of continuous improvement" the licensees should within the present management system"* investigate options for reducing releases from a number of the Elliot Lake facilities. An overview of the present management system and effectiveness of continuous improvement projects is presented below with response to specific locations provided in Sections 3.2 thru 3.4.

The Rio Algom Limited and Denison Mines Inc. Elliot Lake facilities have been decommissioned in full conformance with decommissioning plans that were subject to environmental assessments and regulatory approvals (RAL, 1995; DMI, 1995; SENES, 1997; CNSC, 2001). Individual and cumulative effects on health and safety of persons and the environment were predicted and determined to be permissible in Canada at the time of the regulatory decision (P-

290 CNSC, 2004) and performance indicators and targets based on sound science were developed for follow-up evaluation (P-223, CNSC, 2001).

Operating care and maintenance of the Rio Algom sites is conducted in conformance with Waste Facility Operating License WFOL-W5-3101.03.indf which incorporates Operating, Care and Maintenance Program and Plans that specify the elements of the management system that apply to the sites. Operating, care and maintenance of the Denison Mines Inc. sites is conducted in conformance with UMDL-MINEMILL-DENISON.01/indf and UMDL-MINEMILL-STANROCK.02/indf. With respect to control of source contributions to the watershed, both companies conform to the Water Quality Assessment and Response Plan (Minnow, 2011 App. A) which has been highly effective in focusing continuous improvement efforts in the watershed. Both companies have also implemented inspection and operational review programs that also contribute to focusing source reduction, but also focus efforts on risk reduction. Table 3.1 provides a brief summary of projects initiated through each of these programs and demonstrates the source and risk reduction effectiveness of these continuous improvement projects.

Table 3.1. Continuous Improvement Source and Risk Reductions

Project	Description	Source Reduction	Risk Reduction
Water Quality Program Response			
2004 Westner Lake Outlet Structure Replacement: RAL	2003 beaver dam failure dropped lake level by 3 m exposing historic sediments resulting in depressed pH and increased cobalt and iron. Outlet structure replaced and lake neutralized.	Water quality restored to pre dam failure quality within 18 months of response program trigger (RAL & DMI, 2007 Table 4.3) ; pH and cobalt remain within SRWMP water quality guidelines (Minnow, 2011 Table E.8).	Beaver dam replaced with engineered structure designed to safely convey Timmins Storm via spillway and overtop with no loss of containment during PMP (Golder, 2004)
2005 Buckles Creek Channel Maintenance: RAL	2005 restoration of Buckles Creek Diversion Channel and historic precipitate pond berm to improve isolation of Historic Precipitate Pond and Buckles Wetland from Buckles Creek.	Decreasing trends in barium, radium and uranium at station N-12 (Minnow, 2011 Table 4.4) with mean annual loadings of radium decreasing from 1180 MBq/y in 2003 - 2006 (Minnow, 2009 Table J.71) to 450 MBq/y in 2005-2009 (Minnow, 2011 Table D.7.3)	Buckles creek channel and associated retention and conveyance structures upgraded to safely convey Timmins Storm (Golder, 2005)
Inspection Program Response			
2007 Pronto Dam F: RAL	2007 maintenance of Pronto Dam F to reduce seepage and improve flood protection.	Decreasing trends in barium, manganese, radium, sulphate and uranium (Minnow, 2011 Table 4.5) with mean annual loadings of radium decreasing from 28 MBq/y in 2003 - 2006 (Minnow, 2009 Table K.11) to 15 MBq/y in 2005-2009 (Minnow, 2011 Table D.8.4).	Dam F upgraded by installation of upstream inclined core and 0.3 m raise to reduce seepage and protect structure during probable maximum failure or upstream dam failure (Golder, 2007)
2008 Panel Pond C: RAL	2008 maintenance Panel Pond C Berm to reduce seepage and improve flood protection.	Emerging radium decreasing trend (RAL, 2011) not confirmed in Table 4.2 of SOE (Minnow, 2011) due to SOE data set ending in 2009	French drain replaced with bedrock spillway; structure raised to convey Timmins Storm via spillway and overtop with no loss of containment during PMP (Golder, 2008)
Operational Reviews			
2003 pH set point adjustment: RAL	2003 increase pH set-point to improve removal of cobalt at Pronto and Quirke.	Pronto decreasing trend not detected as change implemented concurrent with commencement of TOMP in 2003; PR-01 mean annual loading decrease from 42 kg/y in 2003 - 2006 (Minnow, 2009 Table K.11) to 39 kg/y in 2005 - 2009 (Minnow, 2011 Table D.8.4) despite 60% increase in mean annual discharge in 2003 - 2006 compared to 2005 - 2009. Decreasing trend detected at Quirke with loadings decreasing from 42 kg/y to 38 kg/y at similar mean annual discharge rates (Minnow, 2009, Table E.73 and Minnow, 2011 Table D.2.7).	
2005 Panel lime addition RAL	2005 restoration of lime neutralization to improve radium removal following completion of testing of sodium hydroxide as alternative low-energy consumption neutralization alternative	Decreasing trend in radium (Minnow, 2011 Table 4.2) with mean annual radium loading decreasing from 255 MBq/y in 2003 - 2006 (Minnow, 2009 Table F22) to 126 MBq/y in 2005 - 2009 (Minnow, 2011 Table D.3.7).	Sodium hydroxide system maintained on stand-by to provide neutalization during power outage when lime pumping and agitation not powered.
2009 Beaver Lake siphon installation: DMI	2010 C of A acquired for operations of Beaver Lake siphon for improved water control at Stanrock treatment plant	Water quality improvements in Orient Creek.	Improvements in treatment efficiency and control on final discharge by directing Beaver Lake water to Stanrock Effluent Treatment Plant.
2010 Stanrock Dam M Coillection Pond and Pump Station: DMI	2010 completion of Dam M Collection Pond and Pump Station for directing contaminant seepages to Stanrock treatment plant.	Significant reduction of seepage (DS-16) into Quirke Lake.	Seepage collected and pumped to Stanrock Effluent Treatment Plant for treatment.
2010/11 Halfmoon Wetland Berm Construction: DMI	2010/11 construction of Halfmoon Wetland berms replaced beaver dams to provide long term dam stability and preservation of wetland downstream of Stanrock effluent disharge point.		Beaver Dams replaced with engineered berms.

3.2 Quirke Lake

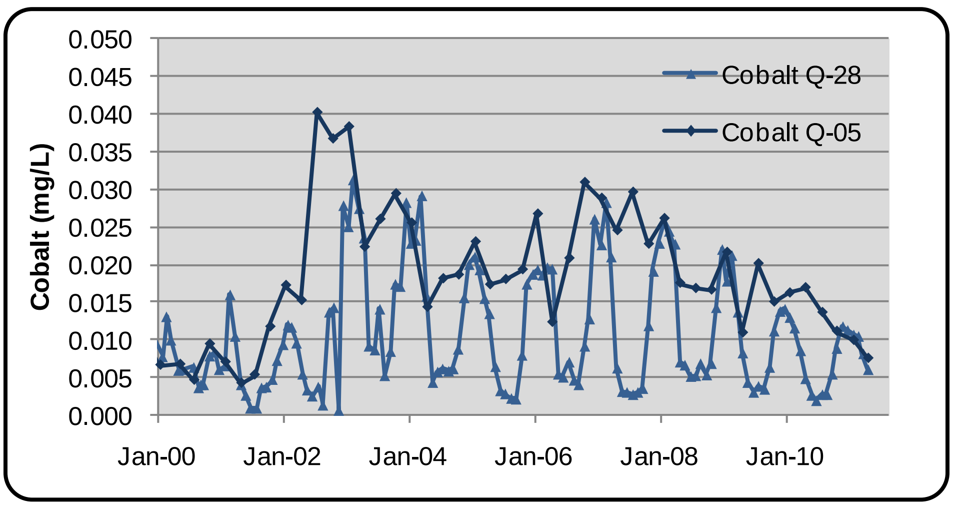
3.2.1 Quirke TMA

Discharge from the Quirke TMA continues to be consistently better than discharge criteria with decreasing trends of cobalt, manganese, sulphate and uranium (Minnow, 2011 Figure 3.12 and Table 4.2). Basin surface water generally achieves Environmental Impact Statement predictions with decreasing trends of influent sulphate and uranium (Minnow, 2011 Figure 3.11 and Table 3.8).

In 2001 RAL replaced the tanker-based *in-situ* lime addition system with a plant-based dilute lime batching and cell distribution system. Implementing the system reduced cell lime consumption by 75% with moderate increases in TMA and discharge cobalt concentrations that have since declined (Figure 3.1). RAL intends to continue to operate the *in-situ* lime addition system as long as it remains effective in neutralizing historic acidic porewaters and reducing cobalt concentrations in basin waters and discharges.

Iron, manganese, cobalt and to a lesser extent radium concentrations in discharge reflect a seasonal pattern with highest concentrations occurring during periods of ice cover. Opportunities to reduce concentrations during ice cover will be considered as part of the Dam D drop box maintenance incorporated in the current five year maintenance plan. In the interim, operational efforts to optimize storage in Cell 18 to reduce peak winter flows in response to mid-winter melt events will continue.

Figure 3.1. Quirke Cobalt Concentrations in Influent and Discharge



3.2.2 Denison TMA

The Denison TMA was decommissioned as flooded tailings following mine closure in 1992, with decommissioning completed in 1997. TMA-1 Final Effluent Discharge is monitored at Stollery Lake Outlet, (D-2) which drains into the Serpent River. DMI acknowledges CNSC comments regarding the consideration for continuous improvement measures to reduce radium releases. Although effluent discharge quality has remained compliant, DMI is currently investigating effluent quality improvement options as noted most recently in the 2010 Annual Report.

3.2.3 Quirke II Mine Site

The Quirke II mine site was decommissioned and rehabilitated in the 1992 – 1995 time period. A combination of excavation and covering was used to shape and grade the waste rock pile and ensure conformance with gamma remediation criteria (RAL, 1999). Sustainable vegetation in the form of grasses and trees has been established on the site (photo 3.1).

Drainage from the Quirke II mine site as monitored at ECA-398 has decreasing concentrations of cobalt, manganese, radium, sulphate and uranium and increasing pH (Minnow, 2011 Table 4.2). Annual mean loads of uranium have declined from 25 kg/y in 2003 – 2006 to (Minnow, 2009 Table E.73) to 16.3 kg/y in 2005 – 2009 (Minnow, 2011 Table D.2.7). During the same timeframes, cobalt annual mean loads have declined from 5.8 kg/y to 4.4 kg/y.

The ECA-398 channel flows through a series of wetlands (Photos 3.2 and 3.3) prior to discharging to a cranberry bog on the south shore of the Serpent River (photo 3.4). Water quality downstream at Q-09 occasionally exceeds provincial water quality objectives for uranium and cobalt, but is consistently better than CCME uranium guideline of 0.015 mg/L and proposed cobalt Canadian water quality guideline of 0.0025 mg/L. Water quality at Q-09 shows decreasing trends for cobalt, radium, uranium and sulphate (Minnow, 2011 Table 5.2).

Given the mature status of the site and minimal, if any, impact on receiving environment, RAL does not plan any incremental remedial measures at this site, but will continue to monitor improving conditions.

Photo 3.1. Quirke II Mine Site

Photo 3.3. Quirke II Dranage Wetland 3

Photo 3.2. Quirke II Drainage Wetland 1

Photo 3.4. Quirke II Drainage looking north to Serpent River from south shore Cranberry Bog

3.3 Stanleigh TMA

Discharge from the Stanleigh TMA continues to be consistently better than discharge criteria with decreasing trends of manganese, and sulphate (Minnow, 2011 Figure 3.28 and Table 4.3). Basin surface water generally achieves Environmental Impact Statement predictions with decreasing trends of influent iron, manganese, sulphate and uranium (Minnow, 2011 Figure 3.26 and Table 3.20). Concentrations of radium, uranium, iron, manganese, and cobalt in influent, discharge and receiving environment are all consistently better than water quality benchmarks (Figure 3.2).

RAL replaced the aging high energy sand filtration treatment plant with a small conventional treatment plant powered by a cross-flow turbine in the influent in 2007. The new plant utilizes retention and gravity in the downstream Settling Pond to remove treatment solids. Barium chloride consumption has increased to levels consistent with other conventional treatment plants operated in the region with moderate increases in radium concentration releases. Operational controls in the form of reduced flow rates during spring turnover and melt have reduced seasonal peak radium releases (Figure 3.3). Optimization of the treatment system will continue through on-going operational monitoring and reviews.

Figure 3.2. Stanleigh Basin Surface Water (CL-04), Discharge (CL-06) and Receiving Environment (SR-06) Water Quality Trends

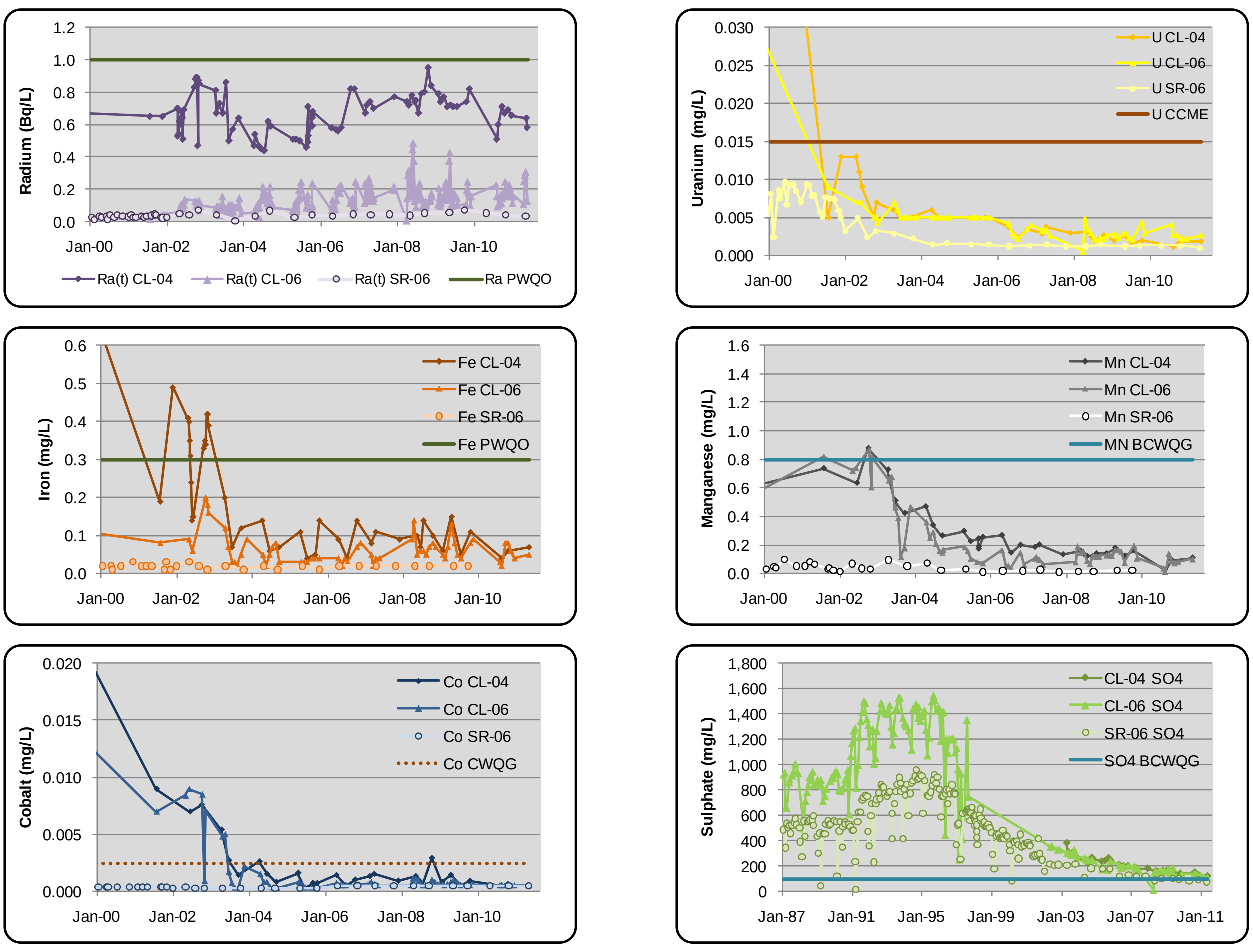
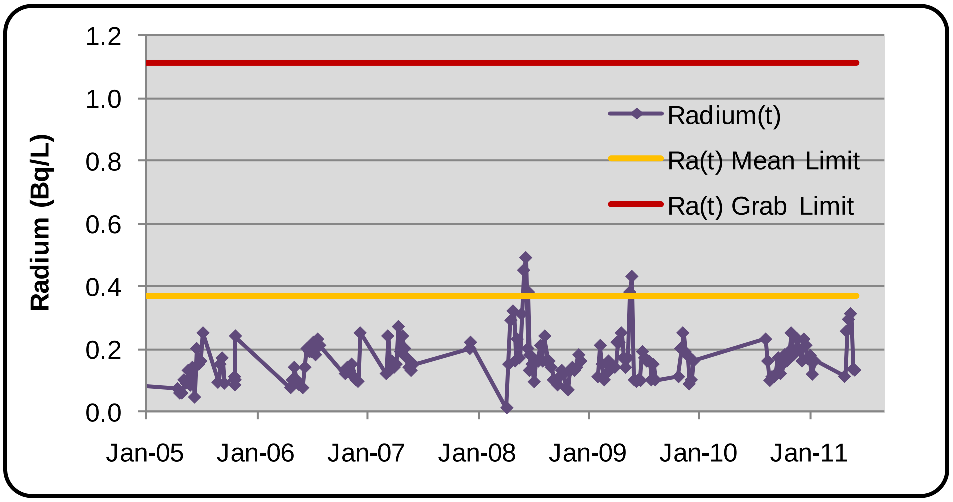


Figure 3.3. Stanleigh Discharge Radium Control 2005 - 2011



3.4 Pronto TMA

Discharge from the Pronto TMA continues to be consistently better than discharge criteria with decreasing trends of barium (Minnow, 2011 Figure 3.38 and Table 4.2).

Projects to improve the quality of discharge from the Pronto facility have included:

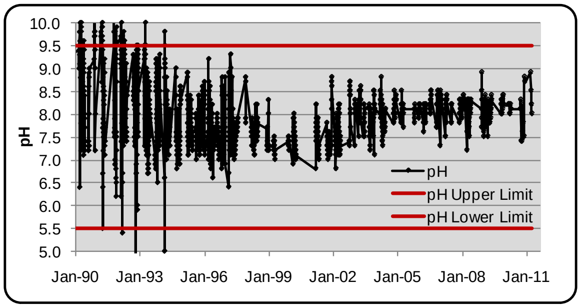
- 1997 replacement of the treatment facility including improvements in pH control and retention to provide better control of discharge pH and TSS (Figure 3.4a and 3.4b)
- 1998 rehabilitation of the lime reject pile immediately upstream of treatment plant to provide better control of discharge pH and TSS
- 199 dredging of the Settling Pond to improve retention time and settling of treatment solids
- 2003 pH set-point increase to improve removal of cobalt (see Table 3.1).

Temporary increases in influent cobalt concentrations during rehabilitation activities may be associated with the decrease of lime reject alkalinity in the Holding Pond (Figure 3.4c) and are returning to historic levels. In addition to pH set-point increase, the following operational adjustments have been implemented to reduce discharge cobalt concentration (Figure 3.4d)

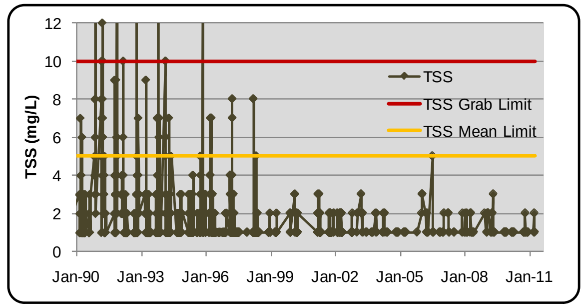
- Optimizing storage in the Holding Pond to reduce peak winter flows and increase retention under ice cover conditions.
- Reduced flow and increased lime addition during period of plant start-up to provide improved treatment of high acidity water that pools upstream of plant intake during periods of plant shut-down.

Optimization of the treatment system will continue through on-going operational monitoring and reviews.

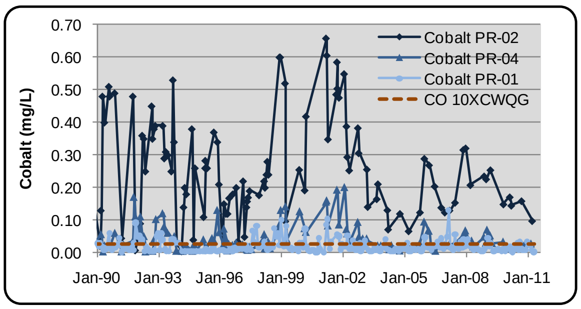
Figure 3.4. Pronto Influent (PR-02), Discharge (PR-04) and Downstream (PR-01) Water Quality Trends 1990 - 2011



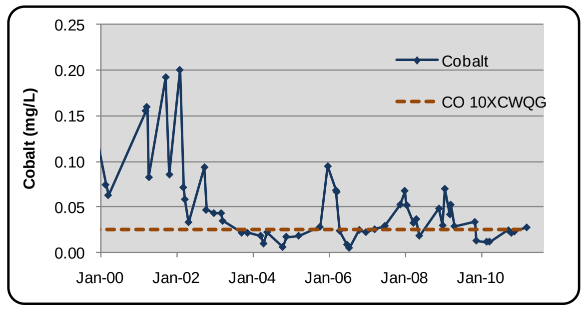
3.4a. PR-04 Discharge pH



3.4b. PR-04 Discharge Total Suspended Solids



3..4c. Pronto influent, discharge and downstream cobalt



3.4d. PR-04 Discharge cobalt

4 Assess TMA Performance

In response to comments section 3, the licensees have identified sections of the TMA Performance Review that are relevant to evaluation of continuous improvement and source reduction undertakings.

5 Changes in SRWMP

The licensees confirm that the following actions will be taken with respect to CNSC recommendations for changes to the SRWMP:

- The licensees agree that benthic invertebrate sampling at McCabe, Quirke and May Lakes will be included in the Cycle 4 Study Design.
- The licensees acknowledge the CNSC's comments with respect to the difficulty in demonstrating change (improvement) in sediment quality. The licensees will investigate tools to evaluate deposition rates, including deep water cores, and incorporate the findings in the Cycle 4 SRWMP Study Design
- The licensees agree with the CNSC's assessment to remove McCarthy and Hough Lake from the SRWMP.
- To address concerns with respect to polonium-210 in fish tissue, the licensees intend to conduct a supplementary study in the summer of 2011 in Quirke Lake. The program will include sampling the muscle tissue of 10 sport fish (likely lake trout and small mouth bass) and five composite samples of forage (small-bodied) fish from different areas

within the lake. Samples will be analyzed for the radionuclides found to contribute to dose (U, Ra226, Po210, Pb210, Th230 and Ra228). The results of the study will be provided in a technical memorandum to the CNSC. It should be noted that polonium concentrations measured in 2009 as part of the special investigation were not compared to previous years because prior monitoring programs have not included polonium but rather focused on radium-226 and metals.

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