Serpent River Watershed Cycle 4 (2010 to 2014) State of the Environment Report

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EXECUTIVE SUMMARY

Uranium mining was undertaken in the Elliot Lake area of north-eastern Ontario for 1997and 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 programs; 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 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 SRWMP, TOMP, and SAMP data from January 2010 to December 2014 (five years).

The licensees continue to make improvements in TMA infrastructure, treatment, and monitoring systems which allows for continuous improvement in TMA performance and demonstration of improving conditions within the licensed areas and downstream.

In-Basin Quality

Since decommissioning, conditions in the TMA basins have improved and basin water quality is generally at or near levels predicted in the Environmental Impact Statements (EIS). Water quality has continued to improve in recent years (2003 to 2014) based on decreasing concentrations of radium-226, sulphate, and uranium, as well as increasing pH levels, at most TMAs. The only exception was observed at Denison TMA-1 where radium-226 and barium concentrations have been increasing and pH has been decreasing in surface water. The radium-226 and barium trend appears to be associated with a step change in 2008 and is thought to be caused by decreasing sulphate concentrations in the TMA. This results in the dissolution of barium or calcium sulphate compounds to which radium-226 is associated, and subsequent release of radium-226 and barium from the tailings. It is expected that radium-226 concentrations in porewater will stabilize over time once the dissolution of sulphate compounds re-equilibrates with aqueous sulphate concentrations. Decreasing pH in the TMA-1 basin is believed to be associated with the depletion of lime that was added to the basin in 1998. While pH has decreased, the change in pH over the past 12 years has been very small and pH within the TMA remains neutral, achieving the Provincial Water Quality Objectives (PWQO) prior to treatment at Station D-1.

Generally, trends in porewater concentrations reflected those observed in surface water within the basins, but trends in groundwater were more variable. With few exceptions, porewater and groundwater trends indicated improving water quality and relative to Cycle 3, continue to be indicative of improved porewater and groundwater quality. Where increasing metals or decreasing pH trends were observed, these were associated with deeper sampling stratums and represent the flushing of historical porewater from the TMAs.

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 effluent concentrations have been increasing over time, although concentrations in the basin have been decreasing. The increase in radium-226 in the effluent may be, in part, associated with decreasing sulphate concentrations in the TMA basin. As sulphate decreases, more barium chloride is required to precipitate radium-226 with barium sulphate and remove it from the effluent. Thus, the increase in radium-226 and barium is associated with decreased treatment efficiencies attributed to lower sulphate concentrations in the TMA.

At Denison and Quirke TMA's, effluent pH showed a decreasing trend, but this appeared to be associated with a decrease in pH relative to previous pH levels which were higher due to in-basin liming activities. In all cases, effluent pH remains circum neutral.

Trend analysis for 2003-2014 data indicated barium concentrations have been increasing at the primary discharge locations (D2, D-3, Q-28, and CL-06) of the flooded basins, but this was largely due to greater barium chloride use either in response to increased flows or due to lower sulphate concentrations influencing treatment efficiencies. 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. Effluent has also been consistently non-lethal to *Daphnia magna* and rainbow trout with no mortality reported in semi-annual acute toxicity tests. Similarly, reproduction of *Ceriodaphnia* *dubia* was 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 and downstream of the Nordic Coffer Pond. Seepage concentrations have been improving over time at all seepage monitoring locations. 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 reports (Minnow 2011), the radium-226 load within the Serpent River downstream of the Denison TMA discharge (D-5) continues to be higher than the loading from the Denison TMA or the upstream watershed (D-4), and is likely associated with the historical deposits of treatment solids downstream of the Denison TMA (EcoMetrix 2011a). Diffusion modelling indicated that radium-226 release from the sediment should decrease with time (EcoMetrix 2011a). However, radium-226 concentrations in surface water immediately downstream at station D-5 remain well less than the SRWMP benchmark (*i.e.*, PWQO).

Watershed Conditions

The improvements within the TMAs were reflected in the downstream watershed. With few exceptions, annual mean water concentrations (2010 to 2014) were less than SRWMP benchmarks for most substances. All samples of barium, pH, radium-226, sulphate and uranium were less than (or greater than for pH) the water quality benchmarks. Manganese, which is only monitored at station D-6 (downstream of seepage from Denison TMA) only exceeded the benchmark in 10% (2 samples) of the samples collected over the 5 year period. Iron periodically, exceeded the benchmark at stations D-6, DS-18 and M-01, although most samples (≥ 80%) achieved the benchmark. Furthermore, concentrations of radium-226, sulphate, and uranium continue to decrease in surface water over time, with the exception of the outlet of McCabe Lake (SR-06), where radium-226 and barium have been increasing due to reduced treatment efficiencies at the Stanleigh TMA. However, both radium-226 and barium remain well below the water quality benchmarks at this location and achieve the concentrations predicted concentrations in the Environmental Impact Statement.

Sediment deposition rates within Quirke, McCabe, and Nordic lakes downstream of the TMAs were investigated as part of a two year study (2011 and 2012) to determine the expected sediment recovery rates for the watershed. The study found that deposition rates in the three lakes ranged from 0.3 mm/year to 0.74 mm/yr, which translates into the deposition of 1 cm of sediment every 33 to 13 years. Therefore, even at the lake with the highest deposition rates (Nordic Lake), it would take more than ten years to accumulate 1 cm of sediment. This means that the frequency of monitoring in the SRWMP (*i.e.*, five years) was too rapid to expect a detectable measurable improvement in benthic invertebrate community health and sediment quality. Based on the results of the sediment deposition study, the frequency of sediment and benthic invertebrate sampling was reduced to every 10 years. The next sediment and benthic invertebrate community monitoring will be conducted in 2019, and the findings of the assessment will be included in the next SOE report (2020).

Public Dose

To date estimates of public dose have been based on the use of very conservative values to demonstrate that public dose in the vicinity of Elliot Lake does not exceed the upper dose limit. Measurements of radon and gamma collected during mine operations result in dose estimates which are less than 5% of the public dose limit. Dietary exposure pathway analysis conducted in 2009 indicated that the total dose to generic human and a Serpent River Frist Nation (SRFN) member residing on area lakes and consuming fish, moose and waterfowl from near field lakes were also well below the public dose limit.

The licensee's (RAL and DMI) will develop an interim monitoring program to support representative public dose estimates for an Elliot Lake resident based on readily available information on public access and exposure under current closed conditions. The interim program will be developed and implemented in 2016 with updated representative public dose estimates reported in the annual SRWMP reports for 2016- 2020. An updated detailed design for public dose determination will be included in the Cycle 5 study design with results incorporated into the next SOE report (2020).

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. Public dose estimates using conservative measures indicated that the upper bounds of public dose are below the public dose limits. A monitoring program will be designed and implemented which will result in a more realistic estimate of public dose being incorporated into future SOE reports.

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1 INTRODUCTION

1.1 Site and Program History

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 (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 receiving environment monitoring programs with one comprehensive, harmonized watershed monitoring program. A

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

Site [d]	Operating Period	Decommissioning Period	TMA Tailings (million tonnes)	Area (ha)	Cover Type
Panel	Feb 1958 - June 1961; 1979 - Aug 1990	1992-1994	16.0	130.5	flooded
Denison (deposited in TMA-1 and TMA-2)	May 1957 - Apr 1992	1992-1998	59.7; 3	240	flooded
Lacnor	Sep 1957 - Jul 1960	1998-1999	2.7	27	vegetated
Milliken	Apr 1958 - June 1964	circa 1974	0.08 [a]	23.1	flooded
Nordic/Buckles [b]	Jan 1957 - Jul 1968	1997-1999	12.0	117.3	vegetated
Pronto	Aug 1958 - 1970	1999 2001	4.4 [c]	47	vegetated
Quirke	Sep 1956 - Feb 1961; Aug 1968 - 1992	1989-1997	46.0	192	flooded
Spanish-American	May 1958 - Feb. 1959	1994-1995	0.45	12	flooded
Stanleigh	Mar 1958 - June 1960; 1983 - June 1996	1996-2002	20.5	411	flooded
Stanrock and Canmet	1958 - late 1964 and Oct 1957 - Mar 1960	1992-1998	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, Canmet 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.

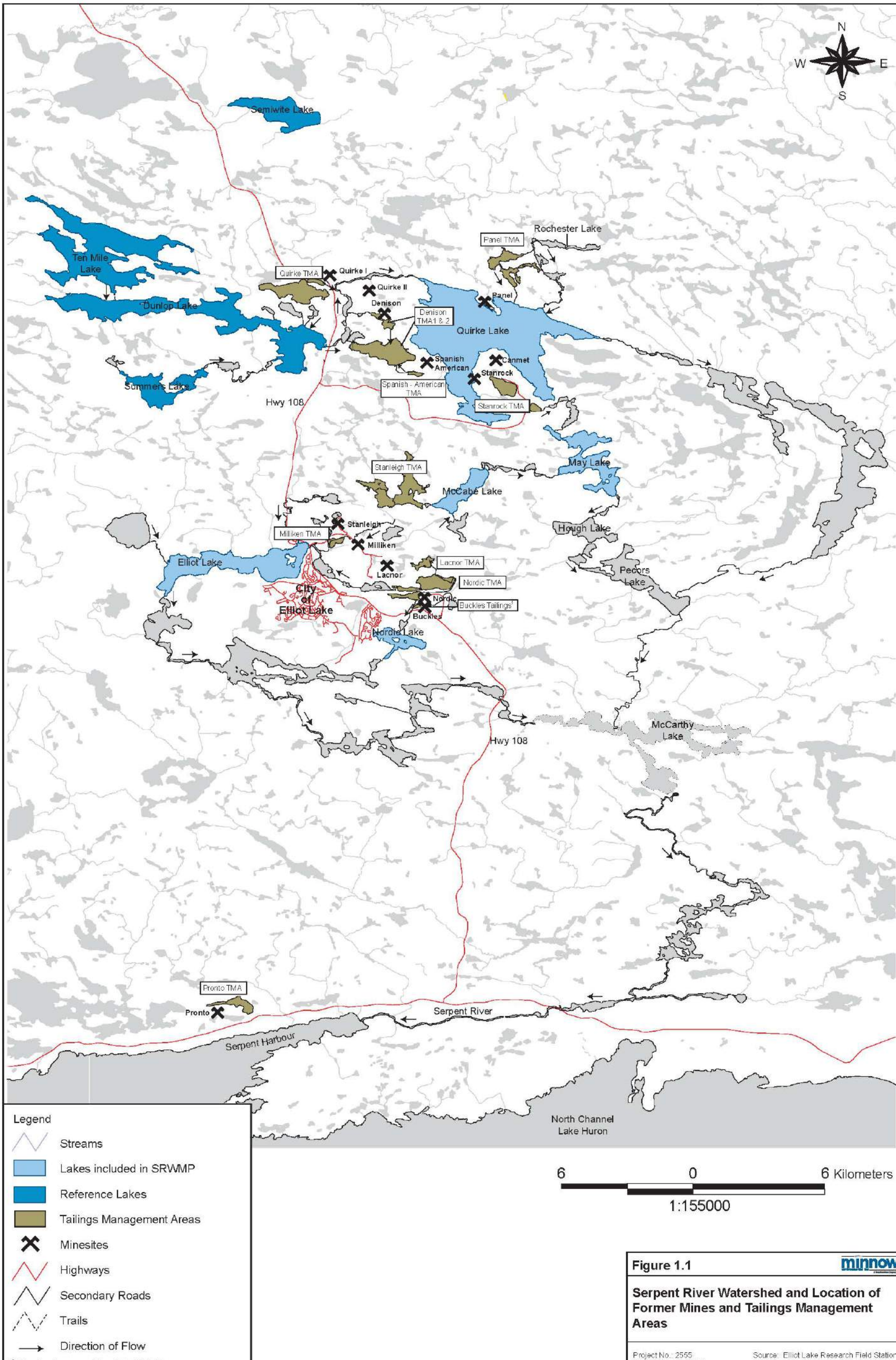


Figure 1.1

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

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 or control 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 and Climate Change (MOECC), Ontario Ministry of Natural Resources and Forestry (MNRF), Ontario Ministry of Labour (MOL) and the Ontario Ministry of Northern Development and Mines (MNDM). 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 presents 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. In 2009, the Cycle 3 sediment and biological monitoring study was implemented based on the approved study design. The results of this study were presented together with the findings of the SAMP and TOMP program in the Cycle 3 SOE Report (2005 to 2009; Minnow 2011). In 2014, the Cycle 4 SRW monitoring programs study design was reviewed and approved by the CNSC and JRG (Minnow 2014). In recognition of demonstrated low sediment deposition rates which determine the rate of change in sediment and benthos that can be monitored in the watershed, the frequency of sediment and biological monitoring was decreased to once every 10 years with the next study scheduled for 2019.

Therefore, this Cycle 4 SOE report presents the finding of the SRWMP (water quality only), SAMP and TOMP monitoring programs at the closed Denison Mines Inc. (DMI) and Rio Algom Limited (RAL) mines in Elliot Lake (2010 to 2014) based on the approved Cycle 4 Study Design.

1.2 Project Objectives and Approach

The objective of this Cycle 4 SRW State of the Environment Report is to integrate recent monitoring data (2010 to 2014) 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[1]. 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;

[1] While this report focuses on data collected from January 01 2010 to December 31, 2014, historical and longer term data has been considered in the assessment of temporal trends and for comparison to EIS predictions.

- Assess water quality conditions within the watershed relative to TMA sources and consider concentrations relative to background, water quality guidelines for the protection of aquatic life and EIS predictions and consider future implications through trend analysis; and
- Provide an assessment of public dose implications associated with mine source area relative to established public dose limits.

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).

1.3 Report Organization

This report is organized as follows. Section 2 presents the methodology used in the collection of samples and assessment of data. Section 3 presents the performance for each TMA (TOMP) and Section 4 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. The contributions to public dose and the estimated levels relative to established dose limits are summarized in Section 6. Conclusions and recommendations are presented in Section 7. References cited throughout the report are provided in Section 8. Supporting information for the methods is provided in Appendix A. A complete data quality assessment for the TOMP, SAMP, and SRWMP (2010 to 2014) is presented in Appendix B. Raw data and supporting information for the TOMP, SAMP, and SRWMP are presented in Appendices C to E respectively.

2 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 (2010 to 2014) 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 Water Chemistry and Toxicity

Surface water samples were collected under all three program (SRWMP, SAMP and TOMP), while groundwater and porewater samples were collected only in the TOMP (Table 2.1). In addition, effluent samples were collected for toxicity testing as part of the SAMP.

Water samples are collected under the SRWMP, SAMP and TOMP, with 15, 24, and 127 stations monitored, respectively (Table 2.1). Under these programs four types of water samples were collected:

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

Specific monitoring variables for each station were dependent on the program objectives and station type. Station locations, monitoring frequency and variables as approved in the Cycle 4 Study Design and reported here for each program (Tables 2.2, 2.3, and 2.4)[2].

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) that address all aspects of sample collection and management for the TOMP, SAMP, and SRWMP from sample

[2] As indicated in the Cycle 4 study and on Tables 2.3 and 2.4, SR-16 and SR-17 were added to both the SAMP and SRWMP to serve as reference stations representative of wetland/stream habitat. Within the SRWMP, SR-16 and SR-17 serve as reference stations for DS-18, M-01, SC-01 which have similar habitat characteristics to these stations. Within the SAMP it is expected that these stations will serve as future reference stations.

Table 2.1: Cycle 4 types of data collected and number of monitoring stations for each sampling program.

Data Collected	Sampling Program		
	TOMP	SAMP	SRWMP
Water Quality			
Surface Water	37	24	15
Groundwater	61		
Porewater	29		
Water Flow	25	18	
Water Elevation	12		
Water Toxicity			
Acute Toxicity		8	
Sublethal Toxicity		8	

Table 2.2: Cycle 4 approved substances and frequencies of TOMP data collected.

TMA	TOMP Stations	Station Type/Purpose	Elevation	Flow	pH	Conductivity	Sulphate	Radium-226	Lime or NaOH Consumption	Barium Chloride Consumption	TSS	Acidity	Iron	SAMP Metals[b]
			Parameters and Frequencies[a]											
Denison	D-1[f]	Basin performance (primary), ETP operations	W	D	M		Q	M	M	M		Q		Q
	D-22[f]	ETP operations			W		Q	M		M		Q		Q
	D-3[f]	Effluent		W[c]	W		M	W			W			M[c]
	D-2[f]	Effluent		W[c]	W		M	W			W			M[c]
	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	
S.A.[d]	ECA-128	Basin performance (primary)	M[e]	Q	Q		Q	Q				Q		Q
Quirke	Q-05[f]	Basin performance (primary), ETP operations	W	D	M		Q	M	M	M		Q		Q
	Q-03[f]	ETP operations			W									
	Q-04P[f]	ETP operations			D									
	Q-28[f]	Effluent		W[c]	W		M	W			W			M[c]
	Q-29	Perimeter monitoring	W	W[e]										
	Cell 14, 15, 16S, 17	Basin performance (secondary)	M[f]		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	
Panel	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,g], P-36[f,g]	Effluent		W	W		M	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	
Stanrock	DS-2[f]	Basin performance (primary), ETP operations		D	M		Q	M	M	M		Q		Q
	DS-3[f]	ETP operations			D									
	DS-4[f]	Effluent		W[c]	W		M	W			W			M[c]
	DS-1[f]	Additional pH control, radium monitoring		W	W			Q						
	DS-6[f]	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	
Stanleigh	CL-04[f]	Basin performance (primary), ETP operations	W	D	M		Q	M	M	M		Q		Q
	CL-05[f]	ETP Operations			D									
	CL-06[f]	Effluent		W[c]	W		M	W			W			M[c]
	SGW-3, SGW-5	Groundwater			A		A					A	A	
Lacnor/Nordic	L-03	Basin performance (primary)	M[e]	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[f]	S		S	S				S		S
	ECA-132	Basin performance (secondary)	M[e]	M[e]	M[e]		S	S				S		S
	NWPH	Basin performance (secondary)		M[e]	S		S	S				S		S
	ECA-131, N-20	Basin performance (secondary)			Q		Q	Q				Q		Q
	CPW	Basin performance (secondary)	M[e]	M[e]	M[e]		S	S				S		S
	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		A					A	A	
Pronto	PR-02[f]	Basin performance (primary), ETP operations	W	D	M		Q	M	M	M		Q		Q
	PR-03[f]	ETP operations			D									
	PR-04[f]	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] Monitoring requirement of SAMP.
[d] Spanish-American.
[e] During the snow-free period (April - November).
[f] Sampled when treatment plant is operating.
[g] P-14 will revert to P-36 upon ETP shut down.

Table 2.3: Cycle 4 approved SAMP stations, parameters and frequencies.

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

[a] D =daily, W = weekly, M = monthly, Q = quarterly, S = semi-annually (twice per year).

[b] SAMP metals - barium, cobalt, iron, manganese, uranium.

[c] Toxicity includes: acute (*Daphnia magna* and rainbow trout) and sublethal (*Ceriodaphnia dubia*) testing following Environment Canada (2000a,b and 2007) methods.

[d] This station is also TOMP effluent station and requirements have been 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 is based on influent flow to the ETP at P-13.

Table 2.4: Cycle 4 approved SRWMP water quality sample locations and frequencies (2015 to 2019).

Station	Location / Description	Reference vs Mine-exposed	Type	Frequency	Parameters[b]
D-4	Dunlop Lake Outlet (Q-14)	reference	lake	S	barium, pH, iron, manganese, radium-226, sulphate and uranium
SR-19	Inlet to Elliot Lake			Q	
SR-18	Outlet of Jim Christ Lake			S	
SR-16	Fox Creek at Highway 108		wetland/stream	Q	barium, pH, iron, manganese, radium-226, sulphate and uranium
SR-17	Unnamed Creek Drain Lake 3 @ Hwy 108			Q	
D-6[a]	Cinder Lake Outlet	mine-exposed	lake	Q	barium, iron, pH, radium-226, sulphate and uranium
DS-18	Halfmoon Lake Outlet		stream	Q	
M-01	Sherriff Creek @ Highway 108		stream	Q	
SC-01	Westner Lake Outlet		stream	A	
D-5	Serpent R between Denison & Quirke TMAs		lake	Q	barium, pH, radium-226, sulphate and uranium
Q-09	Serpent R Below Quirke TMA Effluent		lake	Q	
Q-20	Evans Lake Outlet to Dunlop Lake		lake	A	
SR-01	Quirke Lake Outlet		lake	A	
SR-06	McCabe Lake Outlet		lake	S	
SR-08	Nordic Lake Outlet		lake	Q	
Total Number of Locations and Samples/Year			15	45	

M=Monthly, S=Semi-Annually, A=Annually

[a] Manganese is also monitored at station D-6.

[b] Hardness monitored at reference and mine-exposed stations where sulphate concentrations are greater than 100 mg/L and at station D-6.

collection to laboratory submissions, data entry, validation and response. The SOPs ensure that the data produced are consistent with the objectives of these programs, regulatory requirements, and industry standards (Table 2.5). The detailed SOPs are provided in their entirety in Appendix A.

DES maintains contracts for various chemical analyses with SGS Laboratory, the Elliot Lake Field Research Station and Aquatox Testing and Consulting Inc.

Water samples collected for chemical analyses were shipped to SGS Lakefield Research Limited (Lakefield, Ontario), for chemical analysis based on established methods. Prior to 2011, radium-226 was analyzed by Becquerel Laboratories (Mississauga, Ontario), and from 2011-2014 radium-226 was analyzed by the Elliot Lake Research Field Station (ELRFS; Laurentian University, Sudbury, Ontario). All three laboratories are accredited by the Canadian Association for Laboratory Accreditation (CALA).

Water samples collected for toxicity testing were submitted to Aquatox Testing and Consulting Inc. (Aquatox; Guelph, Ontario), for acute (*Daphnia magna* and rainbow trout) and sub lethal (*Ceriodaphnia dubia*) testing following Environment Canada (2000 a, b and 2007) methods.

2.2 Data Entry and Extraction

Water data generated through the various monitoring programs were entered into an electronic database (emLine). ELRFS enters laboratory results into the program emLine, and SGS Laboratories enters data into their laboratory information management system (LIMS). DES imports the data from the laboratories' respective data management system into emLine. This minimizes data entry errors. Data entered or imported with any values outside the established data quality assessment limits were flagged. Prior to being accepted (*i.e.,* posted) in the database, any flagged data were reviewed and validated through a QA process (see procedures PR8.7.3-01, PR8.7.3-02 and PR8.7.2-02 in 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 DES. 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" and "Special Project" data).

Table 2.5: List of Operating Procedures associated with the implementation of the SAMF and the TOMP.

Procedure Name	Operating Procedure Number[a]
Control Limit Maintenance	PR8.7.2.02
Data Entry	PR8.7.3.01
Data Validation	PR8.7.3.02
Elevation Determination Procedure	PR8.6.4.03
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

[a] Operating Procedures provided in Appendix A.

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 (SAMP, TOMP and 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 2.6 and 2.7) 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.

Toxicity test QA/QC involved adherence to requirements defined in internal standard laboratory protocols (Aquatox) and in toxicity methods (Environment Canada 2000a, b and 2007). 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.

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.

Table 2.6: 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%
Flow	L/s	varies w/ method	-	0.1[a]	-	-	30%
Laboratory Water Chemistry							
Barium	mg/L	0.005	0.01	10%	20%	20%	20%
Hardness	mg/L	0.5	1.0	10%	-	-	
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%

[a] Minimum Detectable Difference as identified in instrument manual rather than measurement of analytical precision using replicate samples.
[b] CRM (Certified Reference Material).

Table 2.7: 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									
Conductivity	mS/cm	0.01	0.1	-	-	-	-	-	-
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%
DOC	mg/L	0.5	-	1	1	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%

TSS - Total Dissolved Solids
DOC - Dissolved Organic Carbon

2.4 Data Evaluation

Numerous types of data were compiled, summarized 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;
- Operational data related to TMA management, including water levels and regent use;
- Effluent toxicity data; and
- Flow data from TMA discharges, seepages and within the downstream receiving environment, which were used to compute loadings.

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 TMA specific appendices.

Groundwater quality has been monitored on an annual 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 10 times the appropriate receiving environment criteria were sometimes presented as the relevant basis for comparison of discharge water quality.

Water quality data are compared to benchmarks established for the SRWMP. SRWMP benchmarks are 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). To date, the benchmarks have been based on Ontario Provincial Water Quality Objectives for the protection of aquatic life (PWQO; OMOEE 1994) or the upper limit of background concentrations, whichever is higher. In recent years, Environment Canada has revised water quality guidelines based on current toxicity literature for some substances (CCME 2013). The rationale and supporting documents for many of the PWQO are now dated (*i.e.*, based on literature from the 1970's and 1980's) and do not provide the best basis for assessing potential effects to aquatic biota. Therefore, the most recent federal or Ontario guideline was used in the determination of benchmarks. In instances where neither jurisdiction (federal or Ontario) has developed a guideline (*i.e.*, barium, manganese and sulphate) the British Columbia Ministry of the Environment (BCMOE 2006, 2015) water quality guideline was applied (Table 2.8). 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 2.8). Based on habitat conditions at the sampling locations, SRWMP stations were classified as lake (D-6, D5, Q-09, Q-20, SR-01, SR-06 and SR-08) or stream/wetland (DS-18, M-01, SC-01) habitat (Table 2.4). Background values were derived for both lake reference habitats (D-4, SR-19 and SR-18) and stream/wetland (SR-16 and S-17) and the upper limit of background (or lower for pH) was applied to each station based on their habitat classification. It is expected that in the future SR-16 and SR-17 will be used as reference stations for comparison to SAMP water quality based on habitat conditions at the SAMP stations.

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.

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

Table 2.8: Water quality benchmarks for the Cycle 4 Serpent River Watershed Monitoring Program.

Parameter	Units	Upper Limit of Background (2003-2014)		Water Quality Guideline[c]	
		Lakes[a]	Wetlands[b]		
Barium	mg/L	0.057	0.021	1.0	British Columbia
Iron	mg/L	0.48	1.68	0.30	Ontario
Manganese[d]	mg/L	0.095	0.068	0.8	British Columbia
pH[e]	pH units	6.6	5.2	6.5	Ontario
Radium-226	Bq/L	0.008	0.006	1.0	Ontario
Sulphate[f]	mg/L	6.4	4.3	128 - 429	British Columbia
Uranium	mg/L	<0.0005	<0.0005	0.015	Federal

Benchmark applied to lake stations: D-5, D-6, Q-09, Q-20, SR-01, SR-06, SR-08.

Benchmark applied to wetland stations: M-01, DS-18, SC-01.

Benchmark applied to lake and wetland stations.

[a] Upper limit of background concentrations (95th percentile) based on data collected from lake reference stations (D-4, SR-18, SR-19), 2003 - 2014 (Appendix Table E.1).

[b] Upper limit of background concentrations (95th percentile) based on data collected from wetland reference stations (SR-16-SR-17), 2003 - 2014 (Appendix Table E.2).

[c] The most recent Ontario, British Columbia, or federal water quality guideline for the protection of aquatic life was used.

[d] Manganese guideline is hardness dependent and the value calculated for the SRWMP is based on the average hardness at station D-6, which is the only mine-exposed station where manganese is monitored (Appendix Table E.33).

[e] The lower limit of pH is used as the benchmark to identify potential mine-related reductions in pH in the receiving environment.

[f] Sulphate guideline is hardness dependent and the value calculated for the SRWMP is based on the average 2010 - 2014 at each station monitored (Appendix Table E.33).

(Environment Canada 2000b) and *Daphnia magna* (Environment Canada 2000a), while 1-week 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 2014 based on pH, sulphate, and iron levels. While acidity was also measured in porewater and groundwater during this time period, changes in analytical methods in 2006 precluded the use of prior data and as such only data from 2007 to 2014 were used for trend analysis. Surface water and seepage quality trends during the period 2003-2014 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 2003 to 2014 based on concentrations of pH, radium-226, sulphate, uranium, barium, iron, and manganese. While SRWMP data is available since 2000, trend analysis was only conducted on data collected between 2003 and 2014 to make the assessment period consistent with the SAMP and TOMP.

Prior to trend analysis, concentrations reported as less than the method detection limit (MDL) were replaced with concentrations equal to 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 as equal to 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 2.2, 2.3 and 2.4). 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. In some cases, data for two months were grouped (if different months were sampled within a “season” in different years. The more frequently sampled month was used as the label in this case) and/or data were averaged (if multiple values existed for each month within a given year). Therefore, there were as few as one or as many as 12 months 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:

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

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

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

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 trend analysis (seasonal and common) 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. All significant trends were plotted and presented in appendices.

2.4.4 Loadings Estimates

Annual loadings (2010 to 2014) of monitored substances were calculated 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. For all discharge types, concentrations reported as less than the detection limit were divided by two to reduce a concentration bias on total loadings.

Loadings from TMA discharge locations were based on monitoring results (flow and concentration) for each year (2010 to 2014). Weekly flow and concentration data measured during discharge periods at the main TMA discharge locations (2010-2014) 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 mean flows from site monitoring data if available or design flows reported in the EIS documents (Table 2.9). These flow rates were multiplied by mean annual concentrations (2010 to 2014) 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, historical WSC data, or calculated using GIS based tools (OMNRF 2015) for each of the downstream locations (Table 2.10). Mean annual flow was determined for each year (2010 to 2014) at each location and pro-rated flow estimates were multiplied by mean annual concentrations to roughly estimate annual loads at SRW monitoring stations.

Table 2.9: Non-point source discharge design and measured flow values.

TMA	SAMP Station	Description	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	1.1	<1	2.1	0.3	20	2010-01-27	2014-10-23	Table 6.2.4 -Quirke & Panel EIS[b]
	P-03	Pond C discharge	Rochester Creek	10.7	7.9	0	35	9.0	20	2010-01-27	2014-10-23	Table 6.2.4 -Quirke & Panel EIS[b]
	P-11	Site drainage	Panel Creek P-26	NA	21	<1	108	27.8	20	2010-01-27	2014-10-23	
Quirke	ECA-398	Site drainage	Serpent River Upstream of Q-09	[d]	1.3	0	8.8	2.2	20	2010-01-11	2014-11-17	
	Q-22	Site drainage	Serpent River Upstream of Q-09	[d]	6.5	<1	36	8.8	20	2010-01-11	2014-11-17	
	Q-23	Swamp Downstream of Dam K	Dunlop Lake	[d]	42	0	168	50.5	20	2010-01-21	2014-11-17	
	Q-27	Seepage from Dam J	Evans Lake	0.1	no flow data							Table 6.2.2 -Quirke & Panel EIS[b]
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	NA	17	<1	231	52.0	20	2010-01-13	2014-11-24	
Denison	D-3	Lower Williams Lake Discharge	Serpent River Upstream of D-5	0.3	9.2	0	279	20.7	1254	2010-01-04	2014-12-31	Table 6.2.2 -Denison & Stanrock EIS[c]
	D-9	Seepage at Dam 17	Quirke Lake	3.4	40	0	709	52.0	1254	2010-01-04	2014-12-31	Table 6.2.2 -Denison & Stanrock EIS[c]
	D-16	Seepage at Dam 9	Quirke Lake	0.3	1.3	0.3	5.0	1.0	20	2010-01-12	2014-10-21	Table 6.2.2 -Denison & Stanrock EIS[c]
Stanrock	DS-16	Drainage from Dam G and J	Quirke Lake	0.7	0.4	0	8.4	1.2	261	2010-01-05	2014-12-16	Table 6.2.2 -(Dams B, C, D)Denison & Stanrock EIS[c]

Shade denotes the flow values used for loading calculations presented within the SOE for seepage locations.

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

[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 2.10: Watershed areas and prorated flow estimates[a] for stations within the Serpent River Watershed, 2010 to 2014.

Station	Description	Watershed Area (Km^2)	Mean Flow (L/s)[a]						Drainage Area Source
			2010	2011	2012	2013	2014	Mean Annual Flow	
SR-16	Fox Creek at Hwy 108	5.6	46	66	60	133	124	86	OMNRF LIO 2015
SR-17	Unnamed Creek d/s of Lake 3 at Hwy 108	14.5	119	170	154	346	320	222	OMNRF LIO 2015
SR-18	Outlet of Jim Christ Lake	28.8	237	337	307	686	636	441	OMNRF LIO 2015
SR-19	Inlet of Elliot Lake	38.4	316	450	409	915	848	588	OMNRF LIO 2015
SR-01	Quirke Lake Outlet	319	2,627	3,738	3,397	7,603	7,044	4,882	WSC (02CD003)
M-01	Elliot Lake Inlet	18.56	153	217	198	442	410	284	Senes 2007[b]
P-05	Swamp Outlet north of Dam E	2.0	16	23	21	48	44	31	OMNRF LIO 2015
Q-20	Evans Lake Outlet	1.08	9	13	12	26	24	17	S. Kam e-mail June 14th 2007
DS-18	Halfmoon Lake Outlet	11.6	96	136	124	276	256	178	Table 6.3.3 Denison & Stanrock EIS
SR-05	Canyon Lake Outlet	7.57	62	89	81	180	167	116	Topo map 41 J10
SR-06	McCabe Lake Outlet	32.8	270	384	349	782	724	502	Senes 2007[b]
SR-08	Nordic Lake Outlet	32.3	266	378	344	770	713	494	Senes 2007[b]
D-6	Outlet of Cinder Lake	4.13	34	48	44	98	91	63	Topo map 41 J10
D-4	Outlet of Dunlop Lake	109	898	1,277	1,161	2,598	2,407	1,668	WSC (02CD002)
MPE	Outlet of Sherriff Creek Park	13.5	111	158	143	321	297	206	Golder 2004
Q-09	Quirke Lake Inlet	157	1,293	1,839	1,672	3,742	3,467	2,403	WSC (02CD006)
-	Serpent River @ Hwy 17	1350	11,655	18,200	11,949	28,883	25,579[c]	17,672	WSC (02CD001)
D-5	Serpent River downstream of Denison	118	972	1,383	1,257	2,812	2,606	1,806	Table 6.3.3 Denison & Stanrock EIS
SC-01	Westner Lake Outlet	2.37	20	28	25	56	52	36	Golder 2004

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.

[c] WSC station 02CD001 records do not include any data from May 3 to July 30, 2014.

3 TMA PERFORMANCE

Within the Serpent River Watershed there are eleven TMA's, although two of these discharge to other TMAs; Spanish-American, which discharges to the Denison TMA complex and Lacnor, which discharges to the Nordic TMA complex. Each TMA has either a vegetative cover or a water cover[3], which is intended to inhibit oxidation and acidification of tailings and reduce gamma and radon exposure. In water-covered TMAs (flooded) excess water flows from the TMA to an effluent treatment plant prior to discharge with the exception of the Milliken and Buckles TMAs which discharge directly to the receiving environment. 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.

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, located 16 km north of the City of Elliot Lake, 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

[3] Denison, Spanish-American, Quirke, and Stanleigh are flooded TMAs where tailings are covered with water. Stanrock, Nordic, Lacnor and Pronto are TMAs with vegetated covers over tailings. Milliken has both a water and vegetative cover.

Notes

- OBM © Queens Printer for Ontario, 2008.
- Mine structures and property limits were derived from Denison Mines records.
- Mapping export parameters = NAD83 WGS_1984_UTM Zone_17N (Central Meridian = 81°W).
- Contour interval = 10 metres.

Figure 3.1

minnow environmental inc.

Denison Site SAMP and TOMP Monitoring Stations

Project No.: 2555
Date: February 2016

File Source: Denison 9.3.2 Sample Location 2015.01

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). 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 station 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 the Stollery Lake Settling Pond, which then discharges into the Serpent River at station D-2 (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. Continual improvements have been made at the site since 1992, and are outlined in Table 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 3.2; Figure 3.1). Data from the Denison TOMP stations are summarized in the following sections and presented in Appendix C (Appendix Tables C.1.2- C.1.10).

3.1.2 Water Management

Water cover at the Denison TMA is used to inhibit oxidation and acidification of tailing and reduce gamma and radon exposure. Water levels within the Denison TMA have been consistently above the minimum operating level from 2010 to 2014 (Figure 3.2).

3.1.3 Basin Surface Water Quality

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

Since decommissioning, monitoring at station D-1 has shown that concentrations of radium-226, sulphate, and uranium have decreased and pH has remained neutral with levels becoming more stable over time (Figure 3.3). Concentrations of sulphate and pH are near the 50-year post-decommissioning predictions (*i.e.* 2040) (Figure 3.3).

More recently (2003-2014), radium-226 and barium have increased and pH has decreased in Denison TMA-1 (Table 3.3). The radium-226 and barium trend appears to be associated with a step change in 2008 (Appendix Figure C.1.1) and is thought to be caused by decreasing sulphate concentrations in the TMA, resulting in the dissolution of barium or calcium sulphate compounds with which radium-226 is associated, whereby radium-226 and barium are released from the tailings. It is expected that radium-226 concentrations in porewater will stabilize over time once the dissolution of sulphate compounds re-equilibrates with aqueous sulphate concentrations.

Table 3.1: Denison TMA site improvement undertakings since closure.

Year	Action	Rationale for Action
1992 - 1995	Beached tailings on east side of TMA-1 were hydraulically dredged and placed into deeper water on west side of TMA-1.	Reduce surface area of tailings to maintain water cover and inhibit oxidation of tailings.
1993 - 1996	Tailings from TMA-2 hydraulically relocated to TMA-1 and to underground workings.	Reduce amount of tailings and size of TMA-2 basin.
1996	Dam 10 stability and reduction berms completed and stabilization of dams surrounding TMA-1 for closure completed.	Upgrade containment and flow control structures to current standards and improve interception of tailings porewater and reduce groundwater contamination.
1997	Tailings along rock shoreline washed into TMA-2 basin.	To reduce exposed tailings and inhibit oxidation of tailings.
2000	Layer of coarse sand and gravel and rockfill placed over area downstream of D-3 sampling location.	Remediation project to attenuate elevated radium levels due to a historic spill.
	Removal of two culverts, construction of a spillway and planting of trees.	Discourage public access .
	Commence dismantling of older treatment plant.	Part of remediation/closure activities.
2005	Additional rip rap placed at toe of Dam 17 and improvements made to seepage collection ditch below dam.	For further stabilization the dam.
2006	Replacement of old propane tanks used to heat ETP at Lower Williams Lake.	Safety.
2007	Height of TMA-1 main and emergency spillways raised by six inches and concrete wall poured on downstream side of existing spillway.	To more efficiently capture flow from the TMA, and ensure adequate water cover over the tailings within the TMA at all times.
2011	Demolition of deteriorating boathouse and storage shed located on shoreline of Quirke Lake and adjacent to Denison House.	Safety/security.
	Construction of filter berm at the TMA-1 Stollery Lake Outlet, upstream of the final discharge.	Eliminate seasonal spikes in radium at Stollery Settling Pond Outlet.
	A spillway was also built in the new filter berm.	Allows for safe overflow of the structure during high flow periods and maintains berm integrity.
2012	Replaced four sets of culverts throughout the Cinder Lake drainage area to the Serpent River.	The galvanized culverts had reached their life expectancy and were replaced with 900mm HDPE corrugated culverts.
	Replaced the sand core of the Stollery Berm with coarser material.	To improve the rate of filtration and to reduce the water level in Stollery Lake Settling Pond.
2013	Relocation of TMA-1 ETP. New plant incorporates the following: reagent addition pump instead of gravity lines, construction of spill containment for reagent tanks, installation of siphon lines to better control water released from TMA, installation of remote monitoring and plant automation equipment.	Improve treatment reliability and incorporate instrumentation to enable remote monitoring and operation.
2014	Construction of new effluent collection ditch at lower Williams Lake.	Divert effluent to the south side of Lower Williams Lake to increase retention time to improve effluent polishing.
	Installation of test beaver deceiver at Little Cinder Lake outlet.	Improve water level control without trapping.
	Commissioning of precipitation gauge near Denison House on the Denison site.	Allow accurate collection of precipitation data for Elliot Lake sites.

Table 3.2: Cycle 4 approved TOMP monitoring stations, substances, and frequencies[a] at Denison TMA.

TMA	TOMP Stations	Station Type/Purpose	Parameters and Frequencies[a]										
			Elevation	Flow	pH	Sulphate	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	M	Q	M	M	M		Q		Q
	D-22	ETP operations			W	Q	M		M		Q		Q
	D-3	Effluent		W[c]	W	M	W			W			M[c]
	D-2	Effluent		W[c]	W	M	W			W			M[c]
	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.

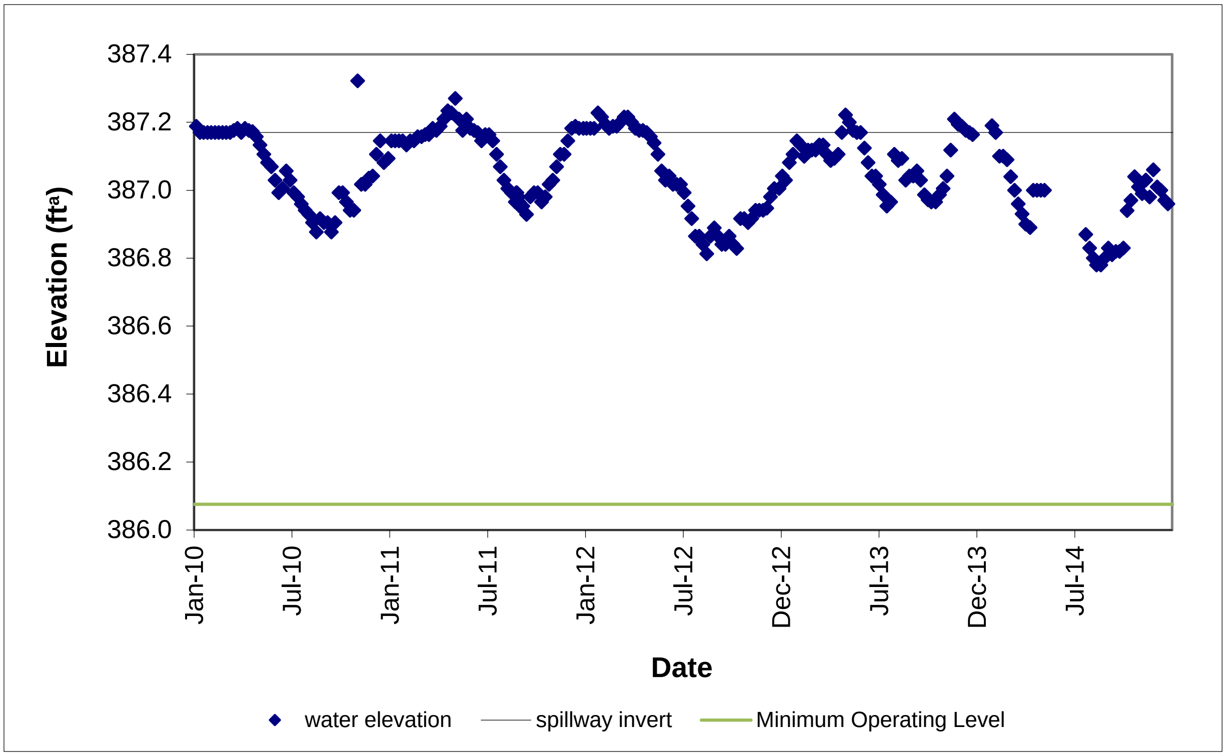


Figure 3.2: Water level at Denison TMA-1 relative to the spillway invert and minimum operating elevations, 2010-2014.

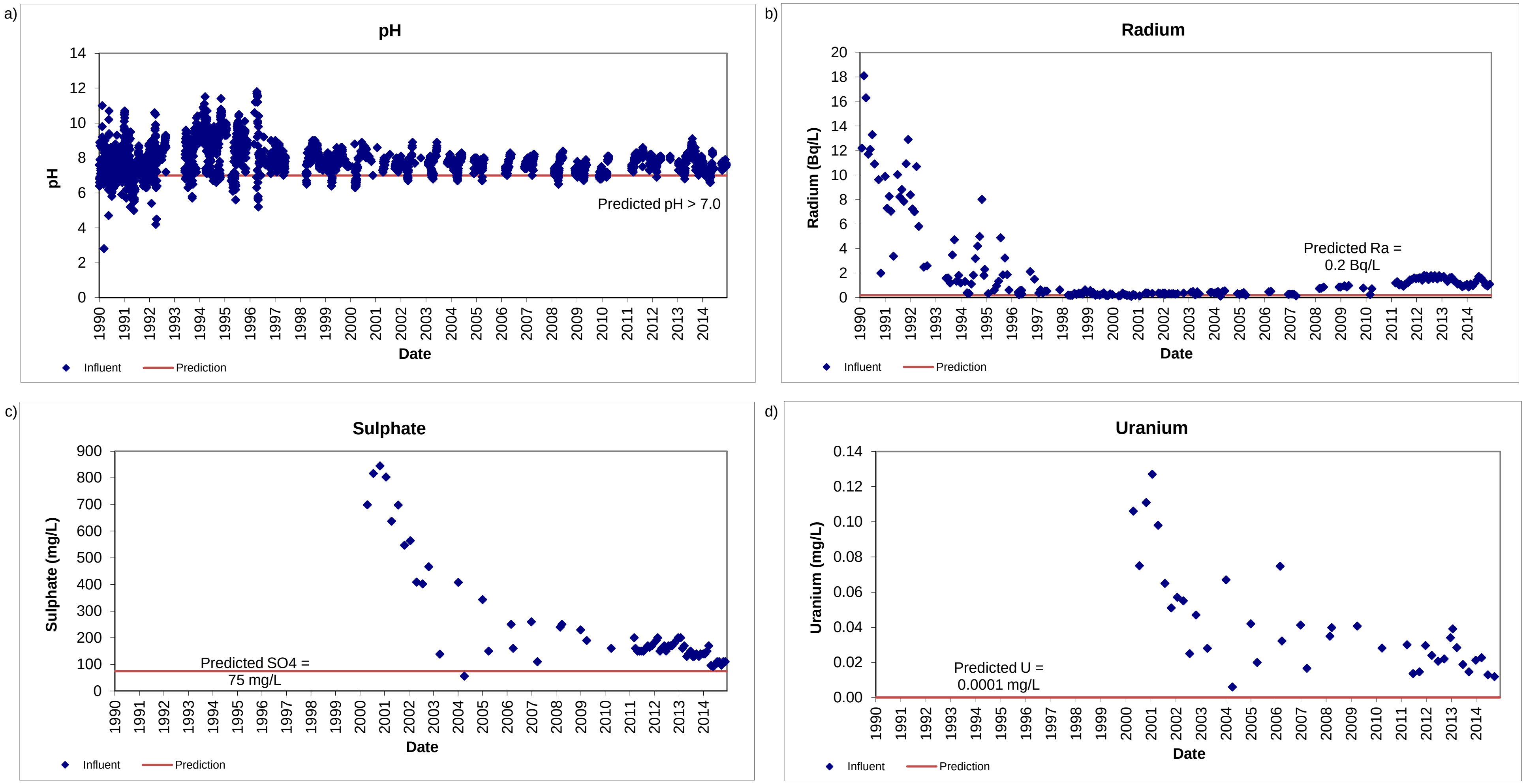


Figure 3.3: Water quality at the Denison TMA-1 ETP influent (D-1) relative to predictions for 50 years (2040) post-decomissioning.

Table 3.3: Summary of water quality trends[a] at TOMP monitoring stations, Denison TMA, 2003 to 2014.

Station ID	Type/Location	Number of Months Used in Common Trend[b]	Acidity	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium
D-1	TMA-1 Influent	1 to 8	ND	0.749	ND	**-0.205**	0.304	-0.270	0.702	*-0.334*	-0.262
D-25	Spillway between TMA-1 and TMA-2	1 to 10	ND	-[b]	-	**0.100**	-	0.198	*0.013*	**-0.667**	-
D-22	Influent to ETP at TMA-2	3 to 12	ND	0.343	-0.523	-0.033	0.059	0.080	-0.228	-0.197	-0.469

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

Italic text - mean monthly correlations significantly different, but common trend value provided.

Bold text - only one month was used in common trend analysis.

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.

"-" 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).

[a] Common (combined) trends based on rank correlation coefficients (rho) for monthly trends, shown in Appendix Table C.1.11 to C.1.13.

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

Decreasing pH in the TMA-1 basin is believed to be associated with the depletion of lime that was added to the basin in 1998. While pH has decreased, the change in pH over the past 12 years has been very small and pH within the TMA remains neutral, achieving the PWQO prior to treatment at Station D-1 (Figure 3.3; Appendix Figure C.1.1). In 2013, Denison Mines installed a new treatment plant at the Denison TMA to ensure effluent remains of good quality and compliant with effluent limits. Within TMA-2, radium-226 and uranium concentrations have been decreasing over time (Table 3.3).

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- D9), 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 (1991-2014), with iron and sulphate concentrations decreasing and pH levels increasing to neutral levels at the 66 m horizon in well BH91-D1 and both horizons (21 m and 48m) in well BH91-D3 (Table 3.4, Appendix Figures C.1.5 and C.1.6). Although sulphate concentrations have increased at the 45 m horizon in well BH91-D1, ground water at the 66m horizon sulphate has been decreasing together with iron and acidity and increasing pH (Table 3.4). Down-gradient of Dam 10 at the west end of TMA-1, pH in groundwater has been decreasing (Table 3.4) consistent with pH in surface water within the basin (Station D-1, Table 3.3; Appendix Figure C.1.4), although pH remains near neutral in both surface water and groundwater. Sulphate in groundwater downstream of all four dams has generally been decreasing, consistent with surface water concentrations over this period (Table 3.4, Figure 3.3).

Down-gradient of Dam 1 in TMA-2 (BH91-D9A), iron and acidity concentrations have demonstrated a trend of increasing concentrations (Table 3.4; Appendix Figure C.1.3). However, pH levels which were found to be decreasing in 2009 (Minnow 2011) appear to have stabilized at near neutral concentrations (Table C.1.9).

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 barium chloride (for treatment of radium-226) and caustic soda (to raise pH if significant rainwater or snowmelt occurs), although caustic soda has not been used since 2011 (Figure 3.4). Barium chloride consumption (kg/yr) has increased over the 2010 to 2014 period (Figure 3.4), which is likely associated with decreasing sulphate resulting in increasing radim-226 in TMA-1 influent during this period. The ETP also operated for more days each year

Table 3.4: Summary of water quality trends[a,b] in TOMP groundwater in Denison TMA, 1991[c] to 2014.

Location	Station	Depth (m)	Dates	Acidity[a]	Iron	pH	Sulphate
Downgradient of Dam 1 (TMA-2)	BH91-D9A	22	1991-2014	0.976	0.855	-0.199	-0.784
Downgradient of Dam 10 (TMA-1)	BH91-DG4B	10.9	1996-2014	ND	0.061	-0.777	-0.821
Downgradient of Dam 17 (TMA-1)	BH91-D1B	45	1991-2014	ND	-0.418	0.383	0.694
	BH91-D1A	66	1991-2014	-0.986	-0.86	0.91	-0.746
Downgradient of Dam 17 (TMA-1)	BH91-D3B	21	1991-2014	-1.00	-0.717	0.944	-0.855
	BH91-D3A	48	1991-2014	-0.976	-0.663	0.824	-0.81

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

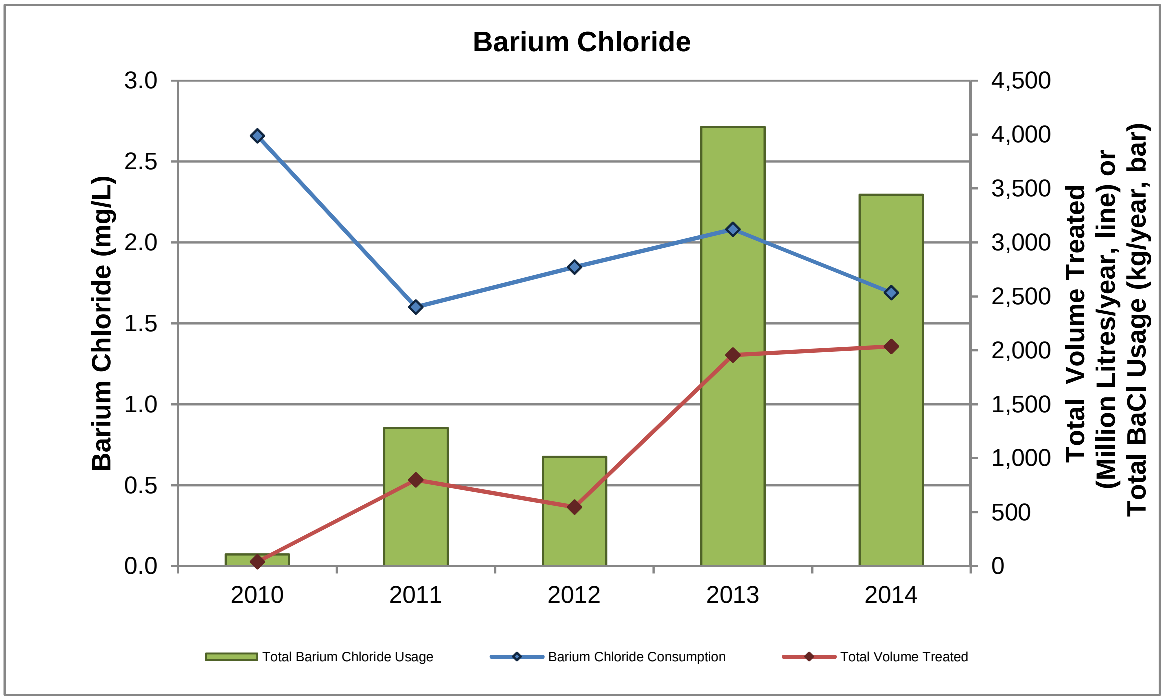
Decreasing (blue): D9A Sulphate; DG4B pH, Sulphate; D1A Acidity, Iron, Sulphate; D3B Acidity, Iron, Sulphate; D3A Acidity, Iron, Sulphate. Increasing (green): D9A Acidity, Iron; D1B Sulphate; D1A pH; D3B pH; D3A pH.

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.

[a] Due to a change in analytical technique for acidity in 2006, trends were assessed from 2007-2014.

[b] Common (combined) trends based on rank correlation coefficients (rho) for monthly trends, shown in Appendix Table C.1.14.

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



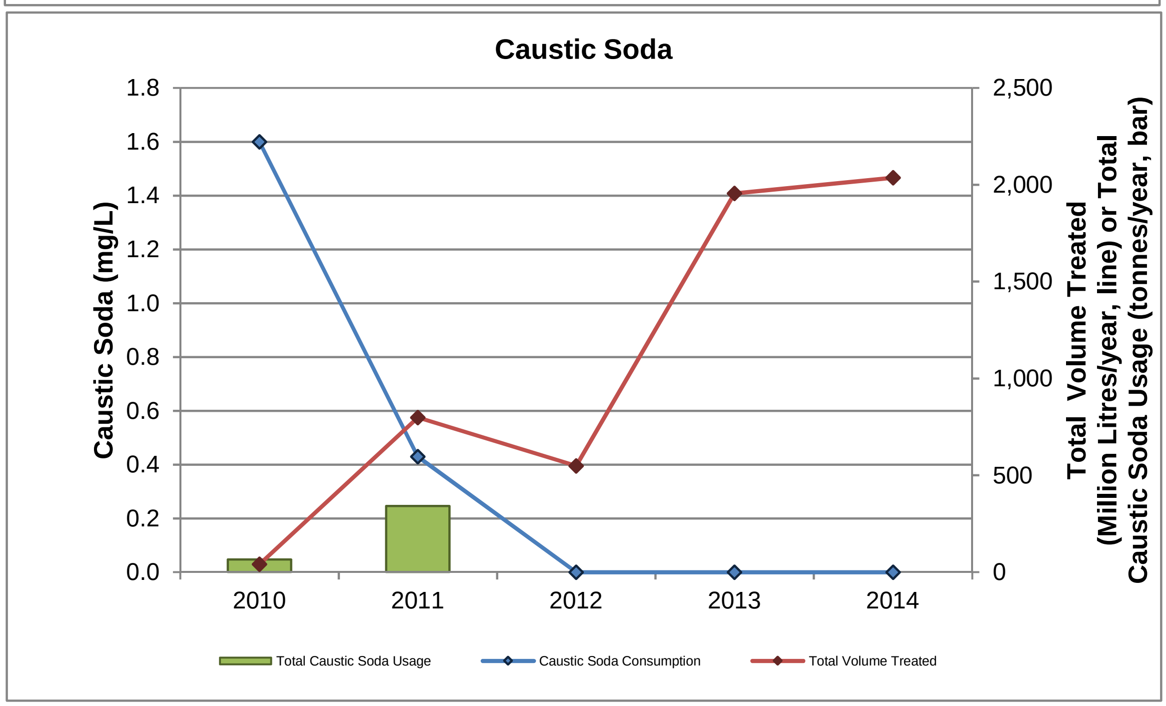


Figure 3.4: Comparison of total reagent consumed versus total volume treated at Denison TMA-1 from 2010-2014.

over the same period, reflected in the total volume of effluent treated due to a change in operating practice and several above average precipitation years.

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 (Figure 3.5), likely associated with a stable vegetative cover, reductions in radium-226 concentrations in TMA-2 influent and seepage flow rates that are more consistent than surficial runoff which is influenced by precipitation.

Treated effluent quality is monitored at the outlet of the settling ponds downstream of each ETP (TMA-1 is monitored at D-2 and TMA-2 is monitored at D-3). Over the past five years, effluent pH has consistently achieved discharge criteria at both discharges (Figures 3.6 and 3.7). Radium-226 concentrations in grab samples were greater than the monthly mean discharge criterion on a number of occasions between 2010 and 2012 at station D-2, although the values were well below the individual grab sample criterion of 1.11 Bq/L (Figure 3.6). Radium-226 concentrations at station D-3 have been consistently below the monthly average discharge criterion (Figure 3.7). TSS concentrations have been well below the monthly average discharge criterion at both stations over the past five years (Figure 3.6 and 3.7).

Effluent has also been consistently non-lethal to *Daphnia magna* and rainbow trout, with no mortality reported in semi-annual acute toxicity tests (Table 3.5). Similarly, reproduction of *Ceriodaphnia dubia* was not affected by exposure to 100% effluent over the past five years, with the exception of June 2014 (Table 3.4). However, the IC25 (effluent concentration causing 25% inhibition relative to control organisms) was 89%, whereas the Denison effluent concentration in the Serpent River is much lower (*i.e.*, <10%), therefore, effects to these invertebrates would not be expected downstream of the discharge.

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, radium-226 and uranium concentrations have continued to decrease in TMA-2. In TMA-1, pH has been decreasing but remains neutral and radium-226 has been increasing in surface water of the TMA. The increasing radium-226 at TMA-1 appears to be attributed to a step change in 2008, possibly related to decreases in sulphate over time. The pH levels with the basin remain neutral and frequently achieved the PWQO at D-1 prior to treatment and are much more stable than values observed immediately following closure. Groundwater down-gradient of the east end of TMA-1 reflects improving conditions since decommissioning, based on decreasing iron and sulphate concentrations and increasing pH to near-neutral. However, groundwater acidity and

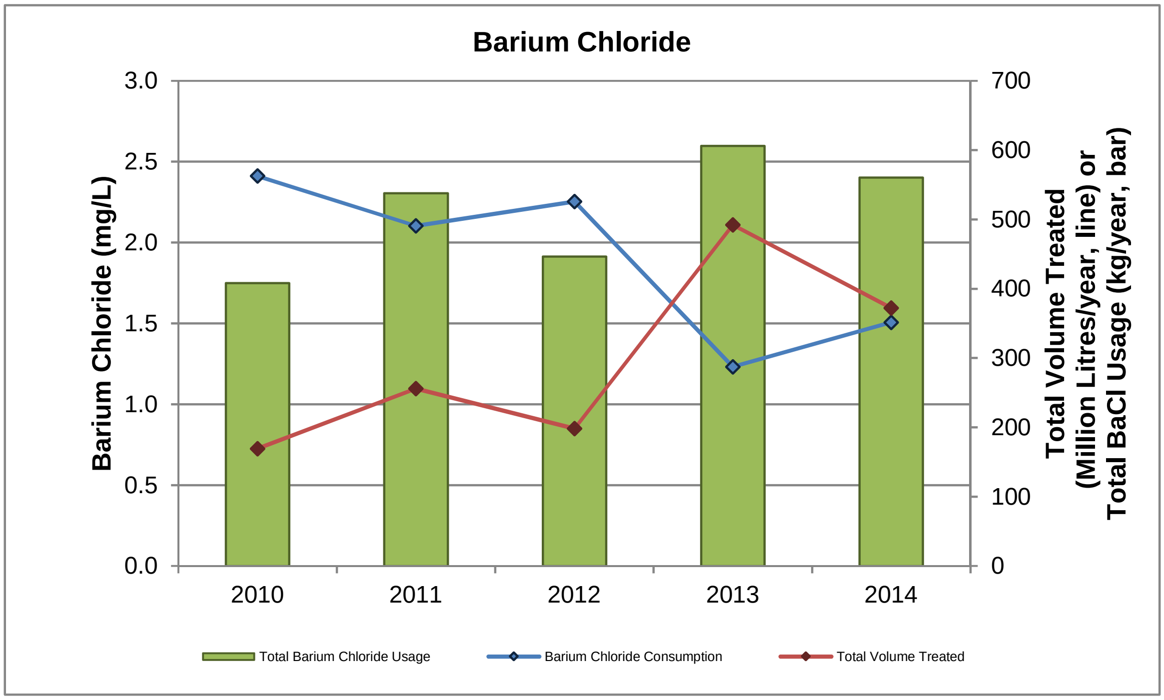


Figure 3.5: Comparison of total reagent consumed versus total volume treated at Denison TMA-2 from 2010-2014.

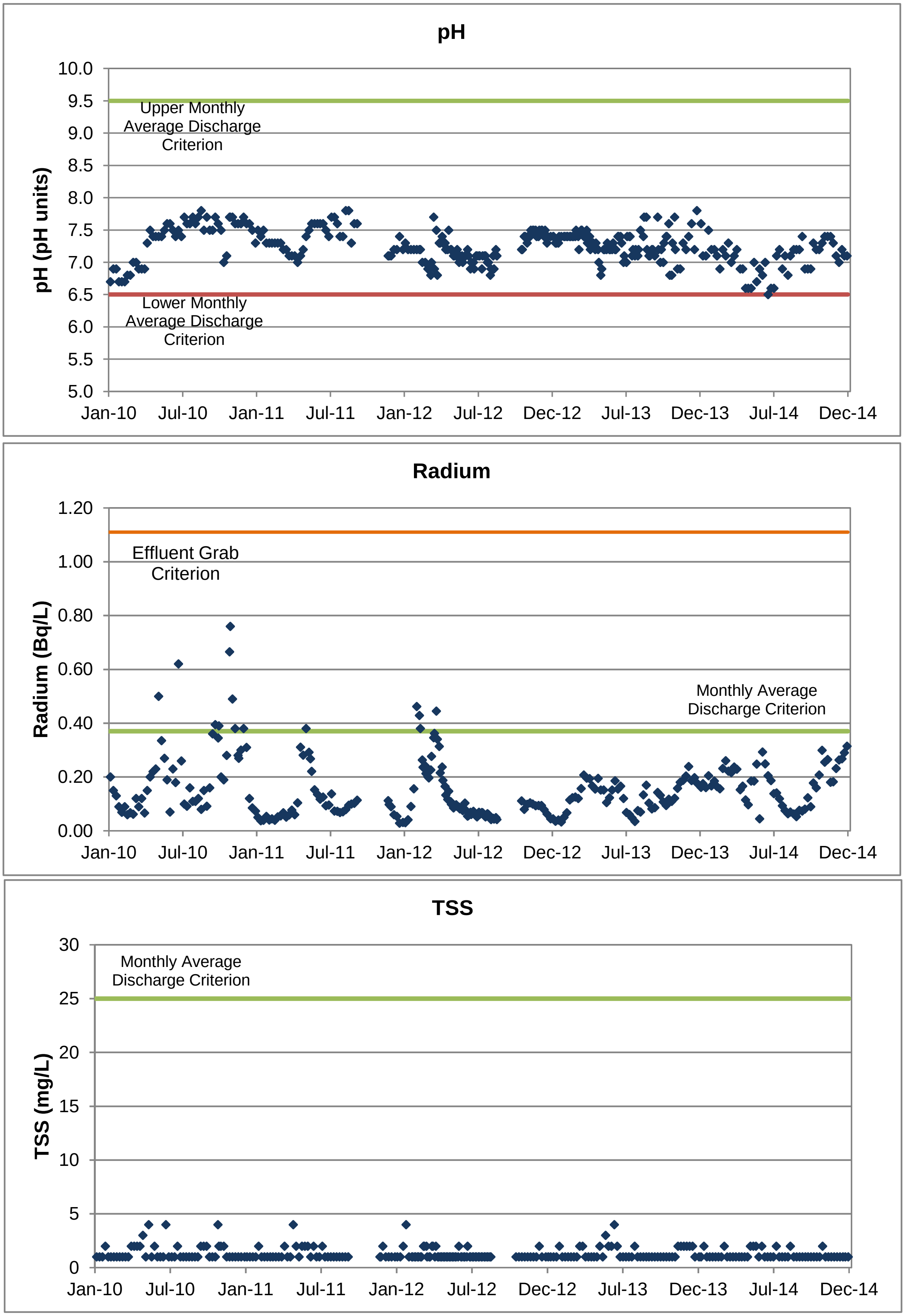


Figure 3.6: Effluent concentrations versus monthly average discharge criteria at Denison TMA station D-2.

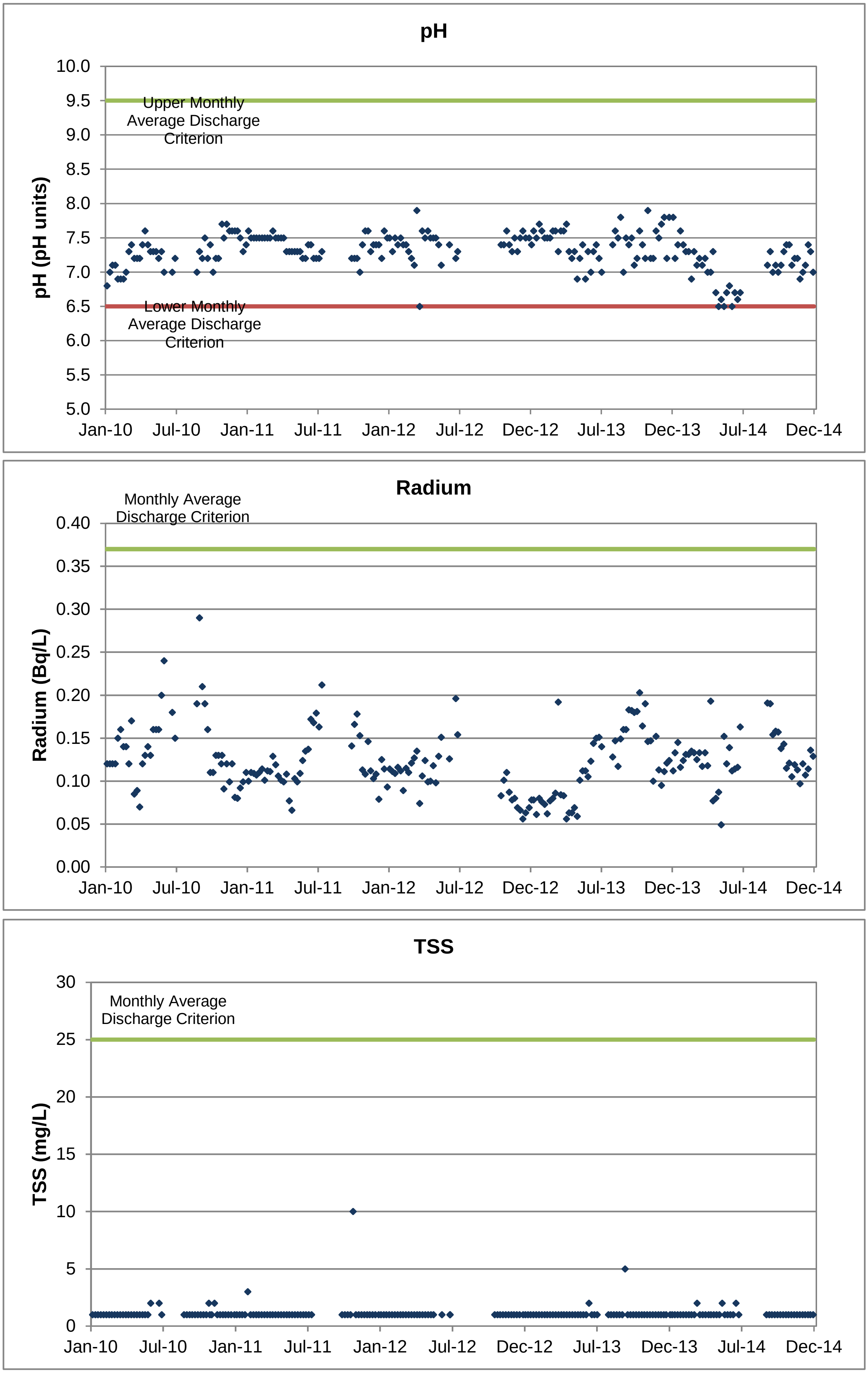


Figure 3.7: Effluent concentrations versus monthly average discharge criteria at Denison TMA station D-3.

Table 3.5: Toxicity test results for samples collected at Denison TMA station D-2, 2010 - 2014.

Sample Date (month-year)	Acute Toxicity (% mortality)		Reproduction (IC25[d] as % effluent)
	Daphnia magna [a]	**rainbow trout** [b]	***Ceriodaphnia dubia*** [c]
May-10	0	0	>100
October-10	0	0	>100
May-11	0	0	>100
December-11	0	0	>100
May-12	0	0	>100
November-12	0	0	>100
May-13	0	0	>100
October-13	0	0	>100
June-14	0	0	89
October-14	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.

iron concentrations have been increasing down-gradient of TMA-2. Groundwater pH has been or is approaching near-neutral at most stations. Reagent use has increased in recent years reflecting increased radium-226 in ETP influent associated with decreasing sulphate concentrations. Regardless, effluent quality has consistently achieved discharge criteria over the past five years and all acute toxicity tests on *Daphnia magna* and rainbow trout were non-toxic with only slight inhibition (89% effluent) of reproduction observed in sublethal tests with the invertebrate *Ceriodaphnia dubia*.

3.2 Spanish-American TMA

3.2.1 Basin History and Modifications

The Spanish-American mine and mill, located 10 km northeast of the City of Elliot Lake, operated from 1958 to 1959. During that time the mine deposited approximately 0.45 million tonnes of tailings into the Spanish-American TMA. Since 1994, continual improvements have been made to the site to improve water quality and to manage tailings (Table 3.6). Notable events include moving approximately 90,000 m^3 of exposed tailings beaches at the eastern end of Spanish-American TMA 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, and construction of two engineered berms (North and South berms) installed at the western outlet to flood the basin and confine the 10.92 ha Spanish-American TMA (Table 3.6).

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-128 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 3.7). 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 TMA prior to its discharge to Denison TMA-1 (ECA-128). Effluent from the TMA is treated at the Denison TMA-1 ETP 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 with no exposed tailings observed, and water levels were below the crest elevation of constructed berms (Figure 3.9).

Over the past twelve years (2003-2014), water quality within the basin has improved with decreasing concentrations of sulphate and uranium (Table 3.8). Past trends have suggested that radium-226 is increasing (Minnow 2011), however when data from the previous five years are

Table 3.6: Spanish-American TMA site improvement undertakings since closure.

Year	Action	Rationale for Action
1994	The tailings were regraded and two low berms, North and South Berms, were constructed. Exposed beach tailings were relocated to areas with water cover.	To provide improved water cover over tailings to inhibit oxidation, with a minimum depth of 1.5 m.
1994 - 1996 (summers)	Basin lime slurry addition during and after flooding.	Achieve target surface water pH of 7.0.
2008	North and South Berm survey.	Confirm as-built conditions align with design.
2014	Spillway survey.	Confirm spillway invert is at design elevation; establish reference benchmark for on-going monitoring and beaver debris management.

Table 3.7: 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	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).

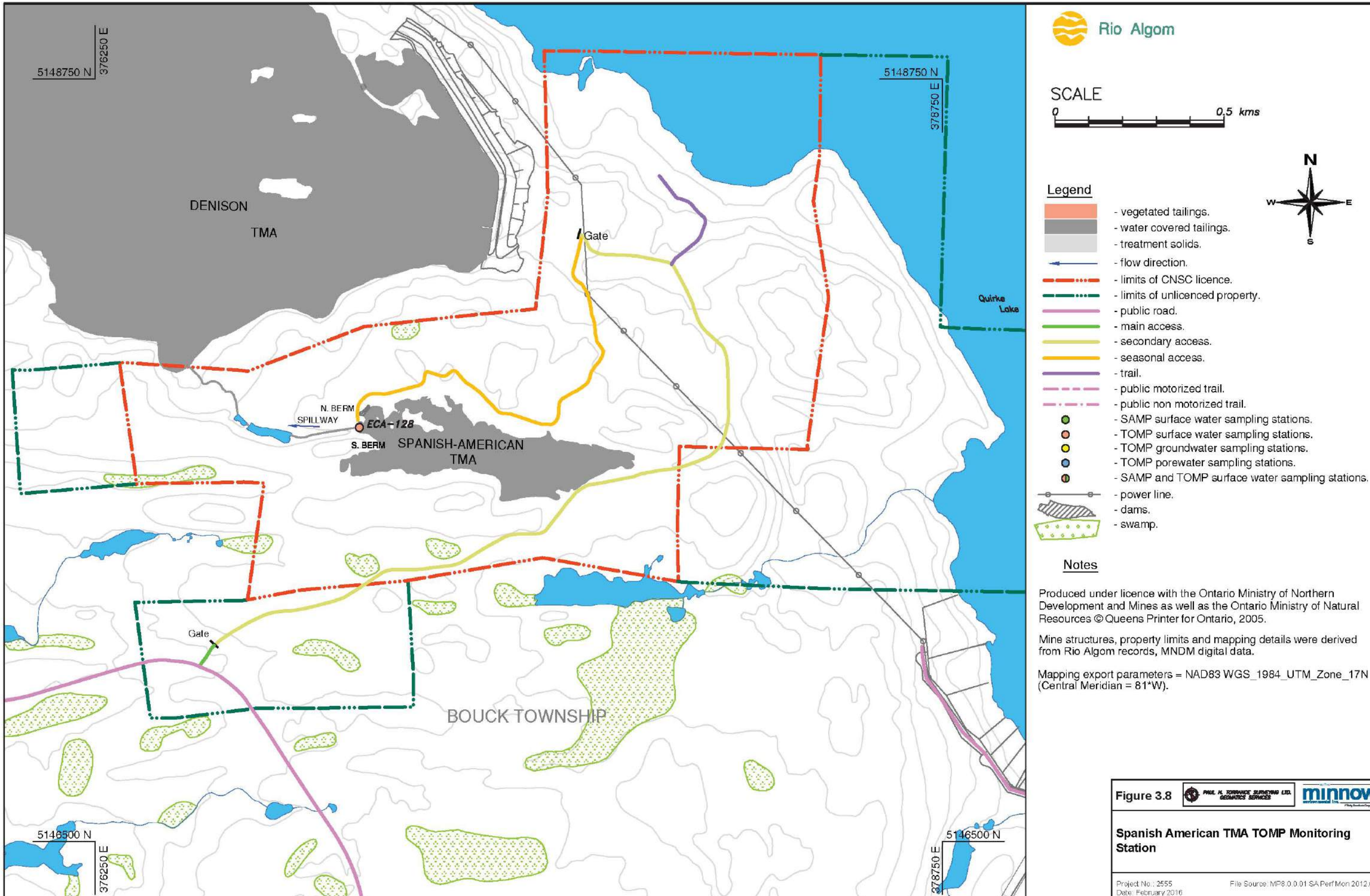


Figure 3.8

Spanish American TMA TOMP Monitoring Station

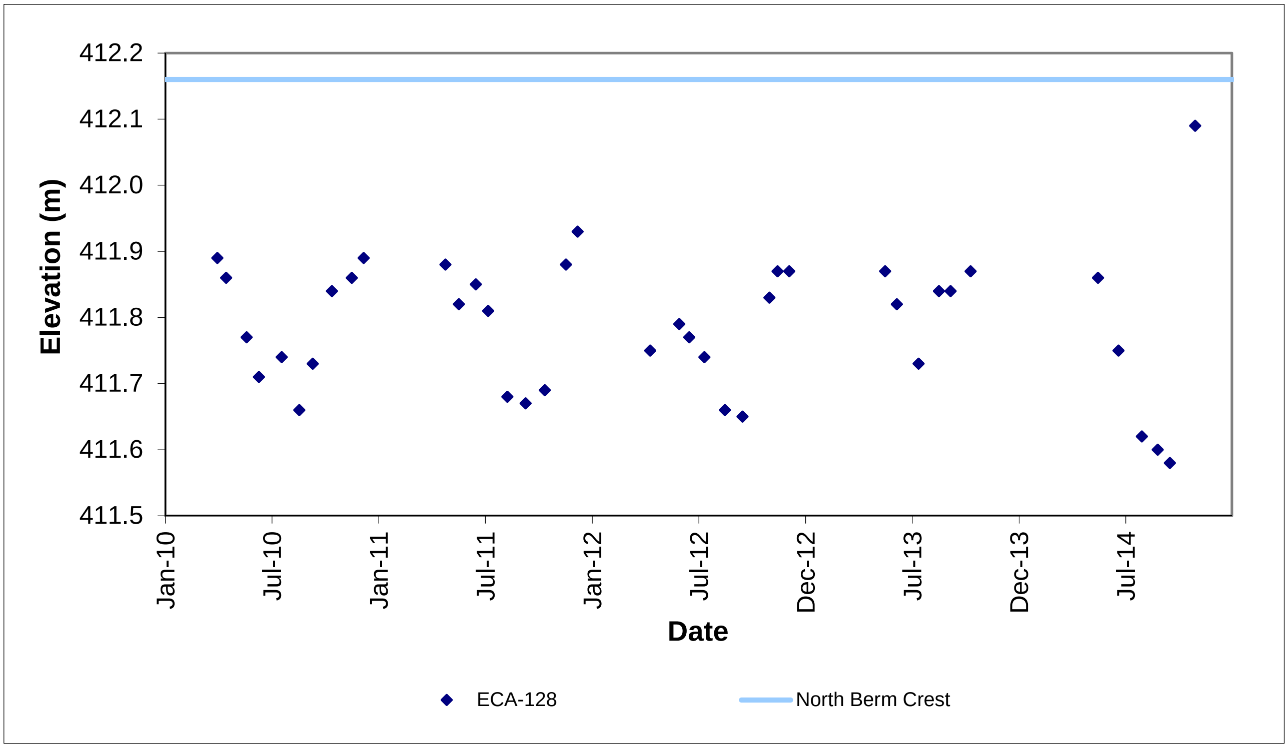


Figure 3.9: Water level at the Spanish-American TMA relative to the North Berm Crest Elevation, 2010-2014.

Table 3.8: Summary of water quality trends[a] at TOMP monitoring stations, Spanish-American TMA, 2003 to 2014.

Station ID	Type/Location	Number of Months Used in Common Trend	Acidity	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium
ECA-128	Sp. Am. TMA Effluent	4	-	0.375	ND	-0.356	-0.173	0.039	0.162	-0.638	-0.496

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

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

"-" 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).

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.

[a] Common (combined) trends based on rank correlation coefficients (rho) for monthly trends, shown in Appendix Table C.2.2.

included, no significant correlation is observed although concentrations appear to be decreasing over the past five years (Appendix Figure C.2.1). Barium concentrations were found to be increasing within the basin (Table 3.8). The increase in barium may be due to the dissolution of barium sulphate in the TMA as sulphate concentrations decrease. While barium is not added to the TMA, naturally occurring barium bound as barium sulphate may be involved in this process. The concentrations of barium remain extremely low (*i.e.*, < 0.040 mg/L, Appendix Figure C.2.2).

3.3 Quirke TMA

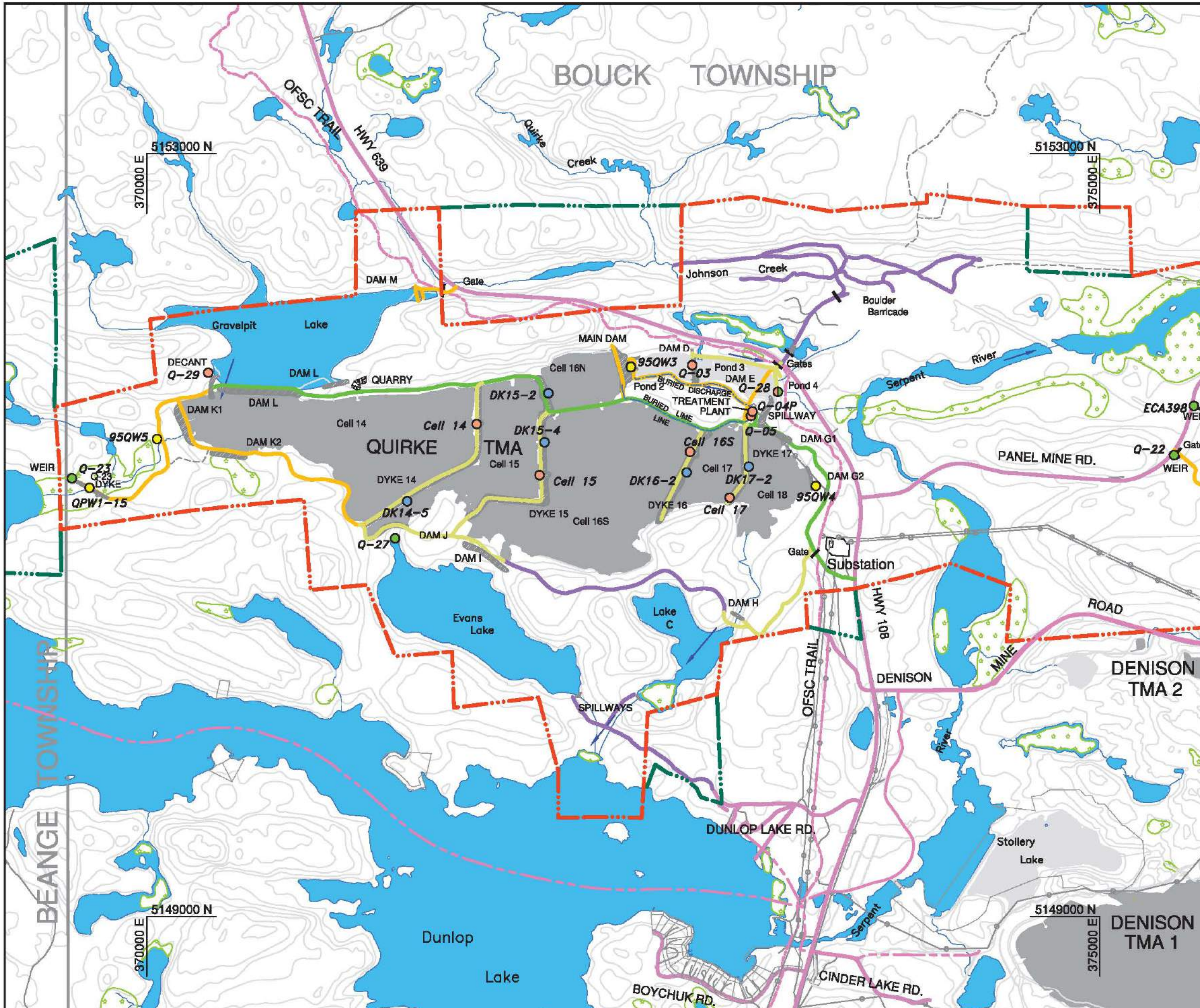
3.3.1 Basin History and Modifications

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 is a flooded tailings basin with a surface area of 183.5 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 3.10). 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 transferred from Gravel Pit Lake to Cell 14 to replenish and maintain the water cover in Cell 14. Following closure in 1990, site improvements have been made on a continuous basis to improve TMA performance and quality of effluent discharged into the receiving environment, including seepage and spillway control measures, treatment measures and performance monitoring methods (Table 3.9).

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 3.10) Data from the TOMP stations are summarized in the following sections and presented in Appendix C (Appendix Tables C.3.2 – C.3.17).

3.3.2 Water Management

Since the five cells of the Quirke TMA are terraced, water elevations are lower in each progressive cell (Figure 3.11). 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. Water is taken seasonally from Gravel Pit Lake to maintain average water elevations within Cell 14 (2010 – 2014) near the spillway overflow pipe level (invert elevation of 377.77 masl), during the water taking season (spring and fall). Water elevations in Cell 15 (invert elevation of 373.74 masl) have generally followed seasonal trends observed in Cell 14, with levels usually occurring below the spillway invert. Cells 16 and 17 have remained at or above spillway invert elevation for the reporting period



Rio Algom

SCALE

0 0,5 1,0 1,5 kms

N W E S

Legend

- vegetated tailings.
- water covered tailings.
- treatment sludge.
- flow direction.
- limits of licenced area.
- limits of unlicenced property.
- public road.
- main access.
- secondary access.
- seasonal access.
- trail.
- public motorized trail.
- public non motorized trail.
- SAMP surface water sampling stations.
- TOMP surface water sampling stations.
- TOMP groundwater sampling stations.
- TOMP porewater sampling stations.
- SAMP and TOMP surface water sampling stations.
- power line.
- dams.
- swamp.

Notes

- Produced by Tulloch Geomatics Inc. under licence with the Ontario Ministry of Northern Development and Mines as well as the Ontario Ministry of Natural Resources © Queens Printer for Ontario, 2005.
- Mine structures, property limits and mapping details were derived from Rio Algom records, MNDM digital data.
- Mapping export parameters = NAD83 WGS_1984_UTM_Zone_17N (Central Meridian = 81°W).

Figure 3.10 PAUL H. TORRANCE SURVEYING LTD. GEOMATICS SERVICES minnow environmental inc.

Quirke Site SAMP and TOMP Monitoring Stations

Project No.: 2555
Date: February 2016

File Source: Quirke OCM Performance Monitoring 2015.01

Table 3.9: Quirke TMA site improvement undertakings since closure.

Year	Action	Rationale for Action
1989 - 1990	Main Dam constructed with low permeability core; Dam L and Dam M raised.	Reduce seepage loss from TMA in preparation for flooding and raise Gravel Pit Lake elevation above Cell 14 to control flow direction towards the TMA.
1991-1992	Dyke 14 raised to form Cell 14.	Submerge tailings with minimum 0.6 m water cover.
1994-1996	Dykes 15, 16, 17 constructed.	Submerge tailings with minimum 0.6 m water cover.
1995 - 2015	Seasonal in-situ lime addition.	Accelerate neutralization of historic acidity.
1997	Dyke 14 and 15 upstream till blanket application.	Reduce seepage flow between cells.
1999	Overflow spillway constructed in bedrock immediately west of treatment plant.	Upgrade facility flood conveyance capacity.
2000	Dyke 14, 15, 16, 17 emergency overflow spillways constructed. Dams G1 and G2 raised.	Increase retention capacity and flood conveyance to improve containment during failure of upstream dykes.
2003	Dyke 14 till blanket extended along length of dyke and sand diffusion barrier applied to 68% of Cell 14.	Reduce seepage from Cell 14 as well as radium releases to overlying surface waters.
2007	Treatment plant inlet culvert replacement.	Improve longevity of treatment plant inlet sump culvert.
2008	Dykes 16, 17 and 23 design grade restored with addition of upstream erosion protection. Gravel Pit Lake back-up flow control valves added at Q-29.	Restore design conditions and improve erosion protection. Provide redundancy Cell 14 (Q-29) flow control.
2009	Replaced Q-22 and ECA-398 flow monitoring weirs with stainless steel V-notch weirs.	Improve flow measurement accuracy.
2013	Dam K1 and K2 design grade restored with addition of settlement plate at S abutment Dam K1. Dam D raised and drop box structures replaced with concrete spillway.	Restore design condition and improve settlement monitoring (Dams K1 and K2) Increase settling pond retention time and sludge storage capacity (Dam D).
	Remote Monitoring Network communications and centralized supervisory control and data acquisition system standardized and replaced.	Align remote monitoring approach across sites and improve reliability.
2014	Installation of snow fence along northern section of Dam D and placement of cobble erosion protection material along face of Dam D.	Minimize drifting along the toe access and stabilize the upstream slope.

Table 3.10: Cycle 4 approved TOMP monitoring stations, substances, and frequencies[a] at Quirke TMA.

		Parameters and Frequencies[a]										
TOMP Stations	Station Type/Purpose	Elevation	Flow	pH	Sulphate	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	M	W			W			M[c]
Q-29	Perimeter monitoring	W	W									
Cell 14, 15, 16S, 17	Basin performance (secondary)	M[d]		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).

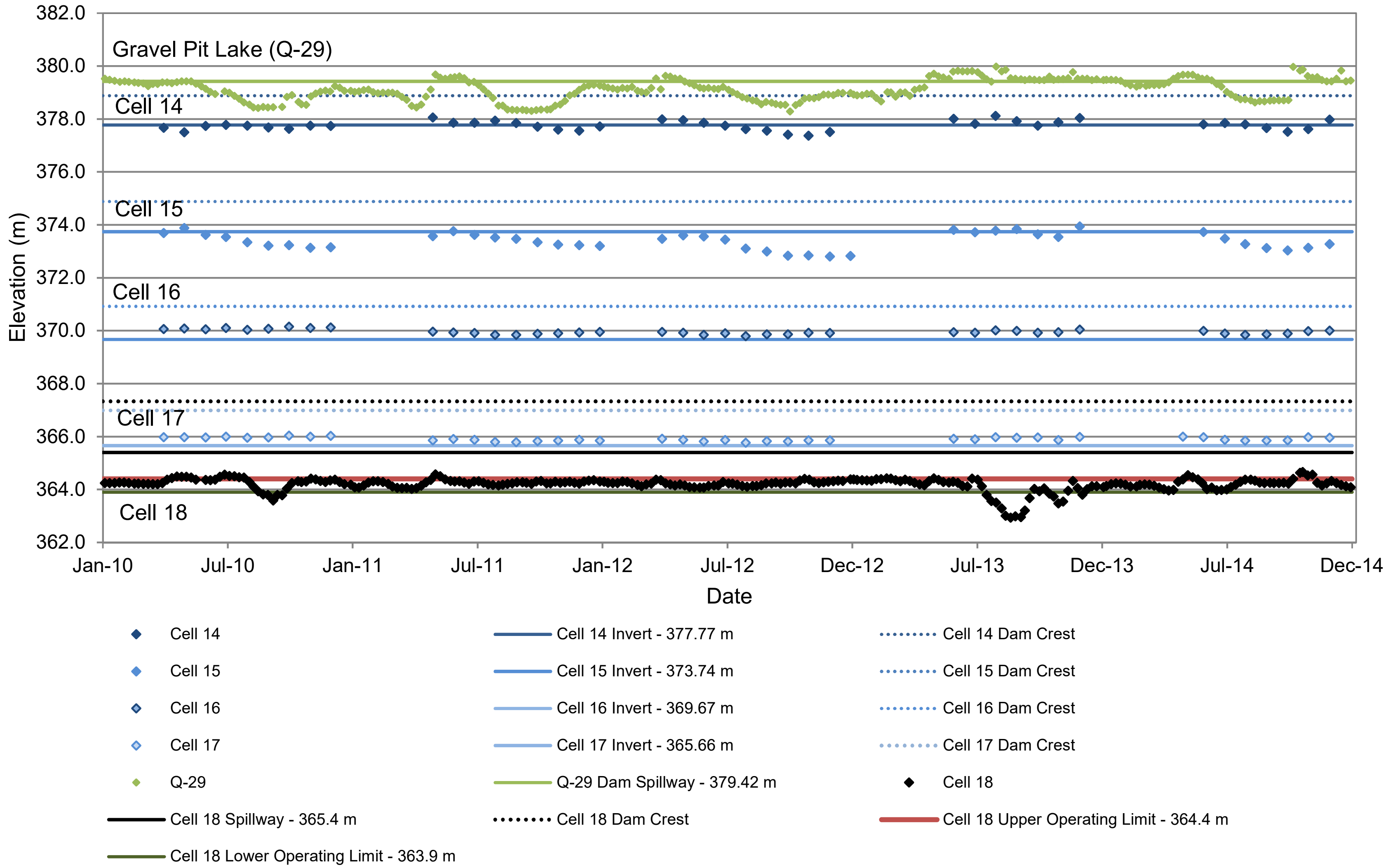


Figure 3.11: Water levels in cells of Quirke TMA, 2010-2014.

(Figure 3.11). Water elevations in Cell 18 were generally within the upper and lower operating limit for the TMA, with the exception of lower levels in the late summer and fall of 2013 to accommodate planned treatment shut-downs during Dam D repairs (Figure 3.11).

3.3.3 Basin Surface Water Quality

Basin surface water quality is monitored at five stations: the spillway of each cell (Cells 14, 15, 16S and 17) and at the ETP influent from Cell 18 (Q-05; Table 3.10, Figure 3.10). Since decommissioning (1990 to 1996), treatment plant influent concentrations of sulphate and uranium have decreased, and pH has increased to near neutral levels with some fluctuations in pH levels occurring (Figure 3.12). Concentrations of radium-226 increased slightly between 1992 and 2002, but following the application of the sand diffusion barrier to Cell 14 in 2003 concentrations have been stable or decreasing (Figure 3.12). Concentrations of radium-226, sulphate, and uranium are approaching the 50 year post decommissioning predictions (*i.e.* 2040) (Figure 3.12).

More recently (2003-2014), surface water has continued to improve with significant reductions in radium-226 and sulphate and increased pH in Cells 16 and 17, and corresponding significant reductions in acidity, barium, cobalt, manganese, radium-226, sulphate and uranium and increased pH at Q-05 (Table 3.11; Appendix Figures C.3.1 to C.3.4). These improvements are attributed to on-going lime additions within Cells 16 and 17 (Table 3.9). While radium-226 and barium have been decreasing at the ETP influent (Q-05 – Cell 18; Table 3.11), it is expected that as sulphate continues to decrease it will result in the dissolution of barium sulphate and the release of associated radium-226 (EcoMetrix 2011b). In Cell 14, pH showed a significantly reducing trend (Table 3.11), although pH has increased since 2011 (Appendix Figure C.3.1). The decline in pH was related to the covering of lime applied prior to flooding in 1994 with a till/sand diffusion barrier installed in 2003. As a decline in pH was observed at Cell 14 in 2011, lime slurry was added at Q-29 to increase the alkalinity and subsequently pH within the cell.

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 3.12, Figure 3.10). Porewater at the Quirke TMA represents surface water infiltrating the tailings and flushing of historic porewater and so it is not surprising that porewater demonstrated similar trends to basin surface water. Sulphate, iron, and acidity concentrations decreased over time (1990 to 2014), while pH increased at almost all locations and depths (Table 3.12; Appendix Figures C.3.5 to 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, Figure 3.13). In deeper (11-15m) porewater samples, pH is approaching the predicted level (Figure 3.13).

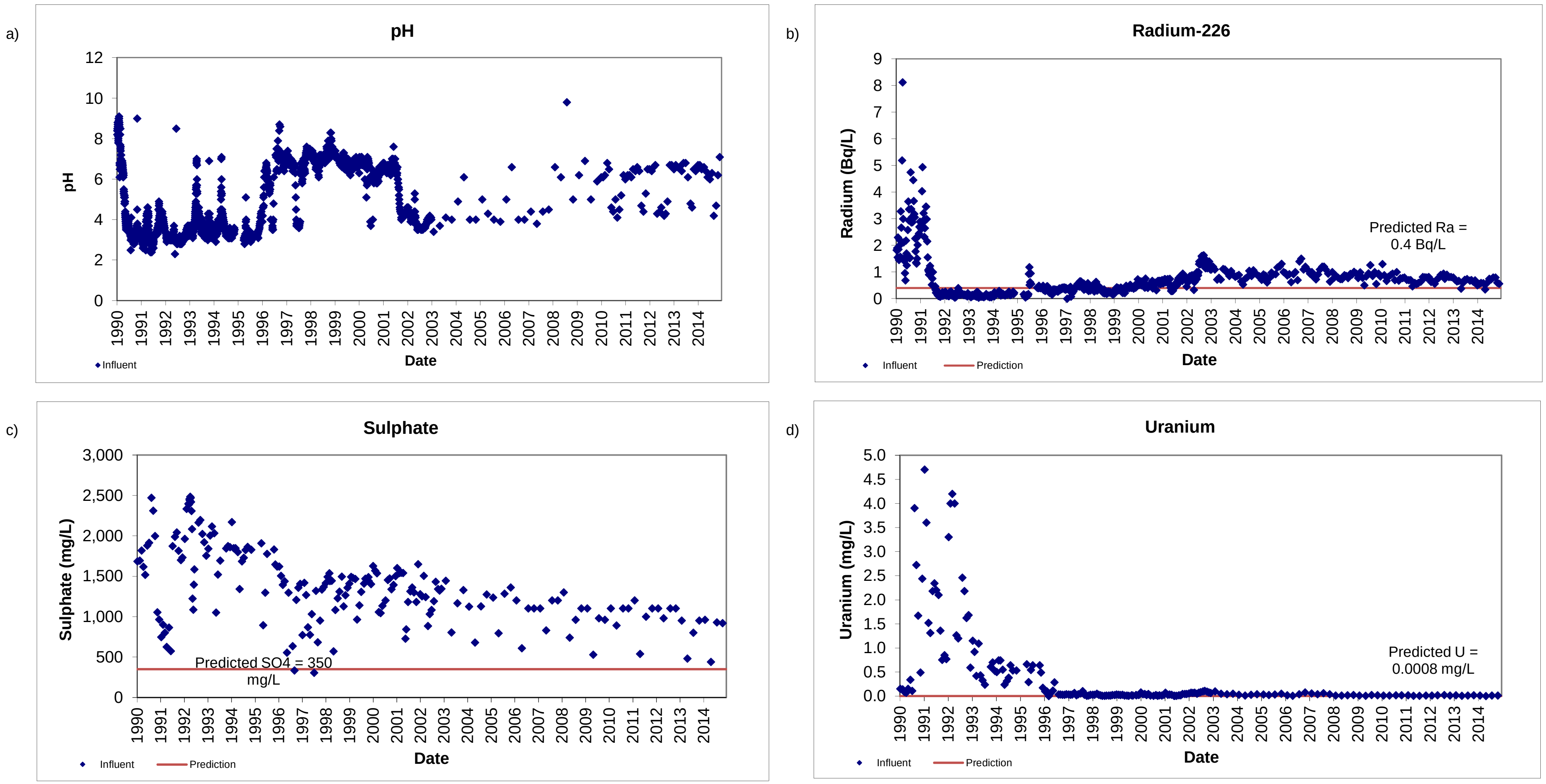


Figure 3.12: Water quality at the Quirke TMA ETP influent (Q-05) relative to predictions for 50 years (2040) post-decomissioning.

Table 3.11: Summary of water quality trends[a] for TOMP monitoring stations, Quirke TMA, 2003 to 2014.

Station ID	Type/Location	Number of Months Used in Common Trend[b]	Acidity	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium
Cell 14	Cell 14 at Spillway	2 to 5	-0.182	-	-	0.432	-	-0.379	0.194	0.177	-
Cell 15	Cell 15 at Spillway	2 to 5	ND	-	-	-0.304	-	0.149	0.041	-0.264	-0.199
Cell 16S	Cell 16S at Spillway	2 to 5	ND	-	-	-0.250	-	0.456	-0.533	-0.608	-
Cell 17	Cell 17 at Spillway	2 to 4	ND	-	-	0.250	-	0.632	-0.676	-0.452	-
Q-05	Treatment Plant Influent	4 to 12	-0.819	-0.593	-0.841	*-0.142*	-0.765	0.567	-0.621	-0.680	-0.762

decreasing trend, significant at p<0.05

increasing trend, significant at p<0.05

[a] Common (combined) trends based on rank correlation coefficients (rho) for monthly trends, shown in Appendix Table C.3.18 to C.3.22.

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

"-" 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).

Italic text - mean monthly correlations significantly different, but common trend value provided.

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 3.12: Summary of water quality trends[a,b] in TOMP porewater and groundwater in Quirke TMA, 1990[c] to 2014.

Type	Location	Station	Depth (m)	Dates	Acidity[a]	Iron	pH	Sulphate
Porewater	Cell 15 below Dyke 15	DK14-5C	5.91	1991-2014	ND	-0.539	0.711	-0.617
	Cell 16 below Dyke 15	DK15-2D	4.13	1995-2014	-0.600	-0.878	0.529	-0.872
		DK15-2C	5.5	1995-2014	-0.900	-0.993	0.33	-0.927
		DK15-2B	7.25	1995-2014	-0.900	-0.981	0.493	-0.939
		DK15-2A	10.24	1995-2014	-0.900	-0.979	0.708	-0.925
	Cell 16S below Dyke 15	DK15-4D	4.01	1995-2014	-0.500	-0.974	0.868	-0.88
		DK15-4C	5.61	1995-2014	-0.100	-0.919	0.712	-0.924
		DK15-4B	7.08	1995-2014	0.100	-0.957	0.541	-0.904
		DK15-4A	10.3	1995-2014	-0.600	-0.995	0.62	-0.922
	Cell 17 below Dyke 16	DK16-2D	4.01	1995-2014	-0.667	-0.853	0.835	-0.554
		DK16-2C	5.6	1995-2014	-0.667	-0.945	0.749	-0.527
		DK16-2B	7.1	1995-2014	ND	-0.926	0.732	-0.329
		DK16-2A	10.21	1995-2014	0.564	-0.381	0.042	-0.449
	Cell 17 below Dyke 17	DK17-2D	3.91	1995-2014	ND	-0.745	0.722	-0.382
		DK17-2C	5.57	1995-2014	ND	-0.376	0.111	-0.801
		DK17-2B	7	1995-2014	-1.00	-0.479	0.355	-0.692
		DK17-2A	12.17	1995-2014	-	0.282	0.883	0.129
Groundwater	Downgradient of Main Dam	95QW-3D	4.6	1995-2014	-0.800	-0.184	0.895	-0.797
		95QW-3C	9	1995-2014	-0.900	-0.719	0.914	-0.925
		95QW-3A	20.7	1995-2014	-0.900	-0.8	0.364	-0.893
	Downgradient of Dam G2 at east end of TMA	95QW-4	10	1995-2014	ND	-0.303	-0.636	0.110
	Downgradient of Dam K1	95QW-5D	4.3	1995-2014	ND	-0.532	-0.087	-0.245
		95QW-5A	9.75	1995-2014	-0.872	0.072	0.129	-0.074
	Downgradient of Dam K1, upgradient of Dyke 23	QPW1-1	2.1	1991-2014	ND	0.337	-0.405	-0.219
		QPW1-4	11.4	1990-2014	ND	0.691	-0.444	0.067
		QPW1-8	23.9	1990-2014	ND	0.626	-0.397	0.822

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

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.
"-" 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).

[a] Due to a change in analytical technique for acidity in 2006, trends were assessed from 2007-2014.

[b] Common (combined) trends based on rank correlation coefficients (rho) for monthly trends, shown in Appendix Table C.3.23 to C.3.24.

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

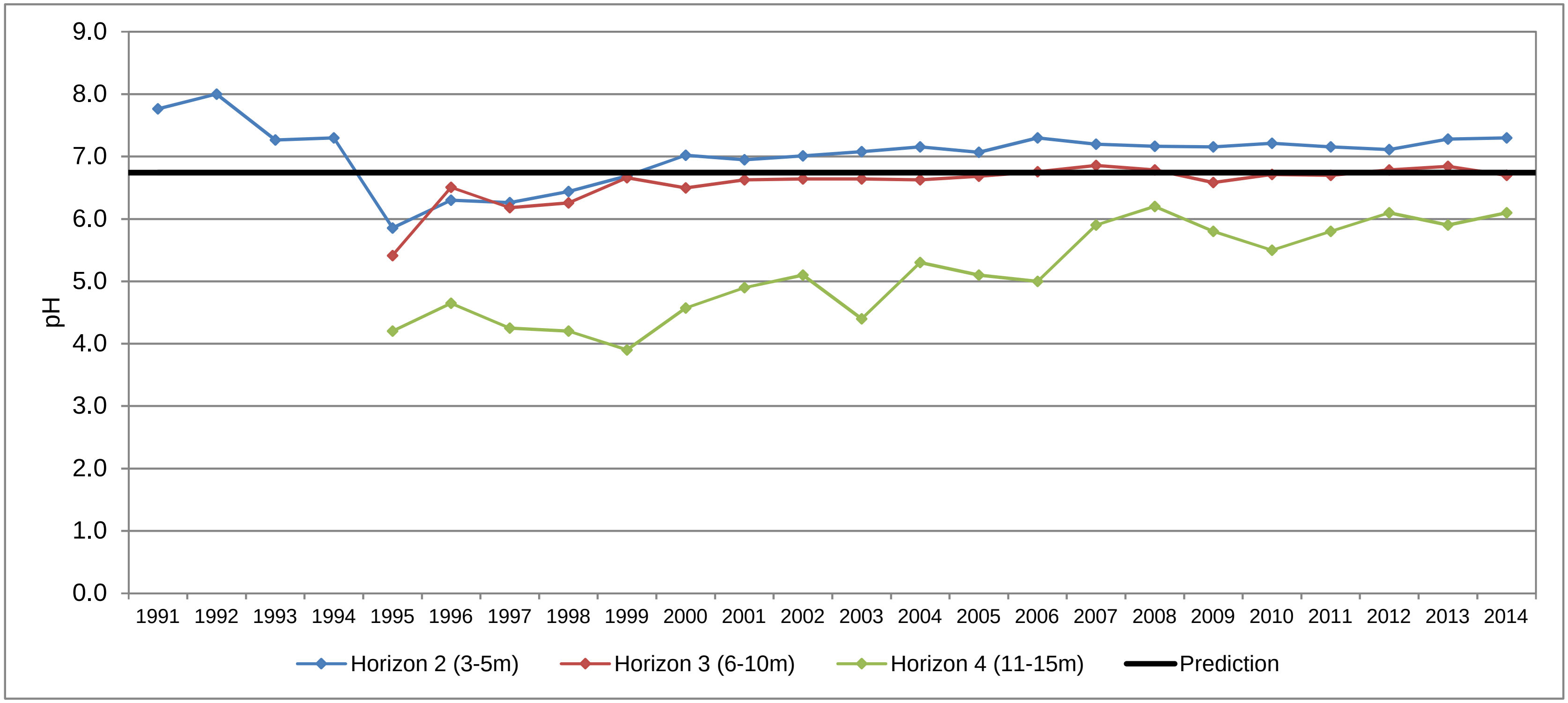


Figure 3.13: Comparison of mean porewater pH at various depths to EIS (2040) prediction, Quirke TMA, 1993-2014.

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, DK17-2B

Horizon 4 - DK17-2A

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 (95QW4), 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 3.10).

At the north end of the TMA, down-gradient of the Main Dam (95QW3), a significant increase in pH and decrease in acidity, iron, and sulphate indicated improved ground water quality over time (Table 3.12). Down-gradient of Dam G-2 at the east end of the TMA (95QW4), pH levels have significantly decreased over time, although pH was historically near 8.0, and remains near neutral (Table 3.12; Appendix Figure C.3.11). Down-gradient of Dam K1 (QPW1), iron and sulphate have been increasing in deeper wells with concentrations at 8 m possibly stabilizing since 2005 (Table 3.12, Appendix Figure C.3.13). Iron concentrations increased in 2005 at QPW1-4, but have steadily decreased since (Appendix Figure C.3.13). In these wells (QPW1), pH is decreasing, which differs from the previous SOE (Minnow 2011), and may be associated with historical liming in Cell 14, which had buffered the groundwater down-gradient of Cell 14, now being depleted. Overall, these trends likely reflect the slow flushing of contaminants in the west end of the basin since flooding in 1990.

3.3.6 Treatment Performance

The Quirke TMA ETP is located at the spillway from Cell 18 (Figure 3.10). Treatment includes both lime and barium chloride to reduce acidity and radium-226, respectively. Annual barium chloride consumption has remained relatively stable during the reporting period, while the lime consumption rate has declined from 0.018 to 0.012 mg/L (Figure 3.14). Total usage of barium chloride fluctuated yearly, while total usage of lime was consistent as a result of increasing volumes of effluent treated (Figure 3.14). 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 with decreases in seasonal variability of pH, radium-226 and TSS observed following the raising of Dam D in late 2013 (Figure 3.15).

Effluent has also been consistently non-lethal to *Daphnia magna* and rainbow trout with no mortality reported in semi-annual acute toxicity tests (Table 3.13). Similarly, reproduction of *Ceriodaphnia dubia* was not affected by exposure to 100% effluent in all but one of the tests conducted over the past five years (Table 3.13). However, the IC25 (effluent concentration causing 25% inhibition relative to control organisms) for this sample was 87%, whereas the Quirke effluent concentration in the Serpent River is much lower (*i.e.*, <5%, Calder 2015), therefore, effects to these invertebrates would not be expected downstream of the discharge.

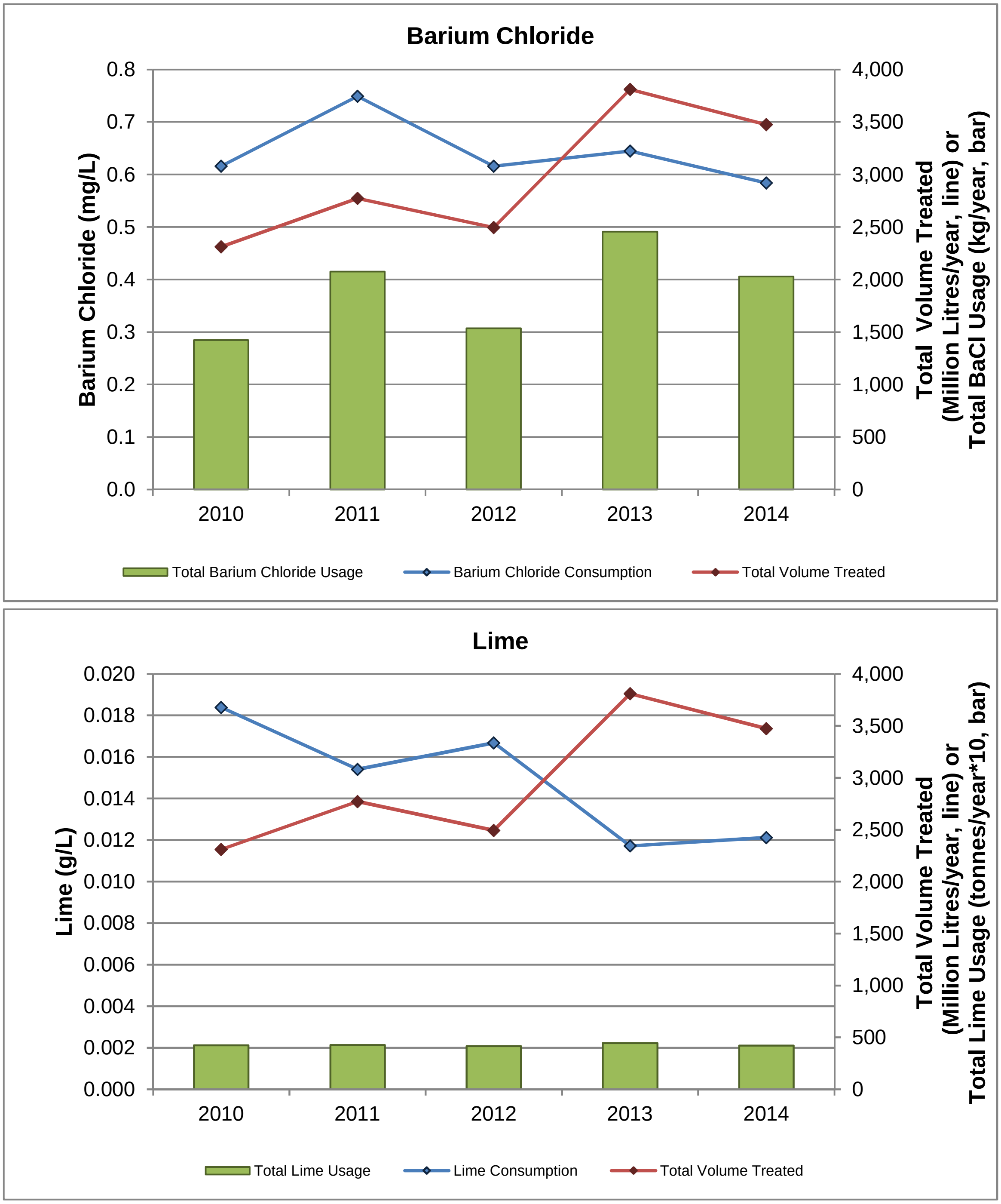
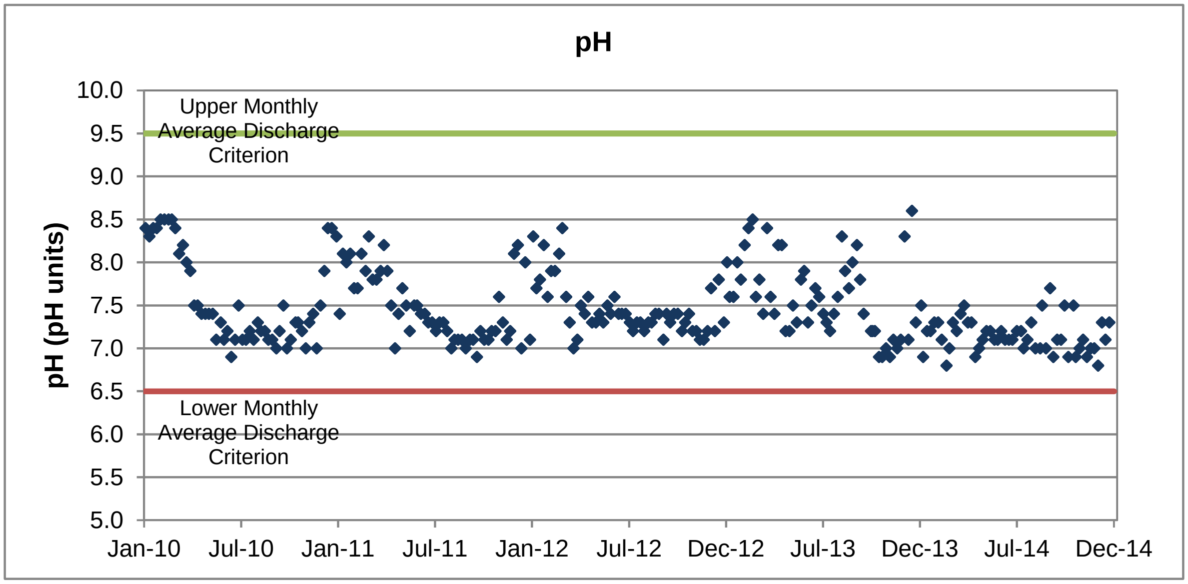
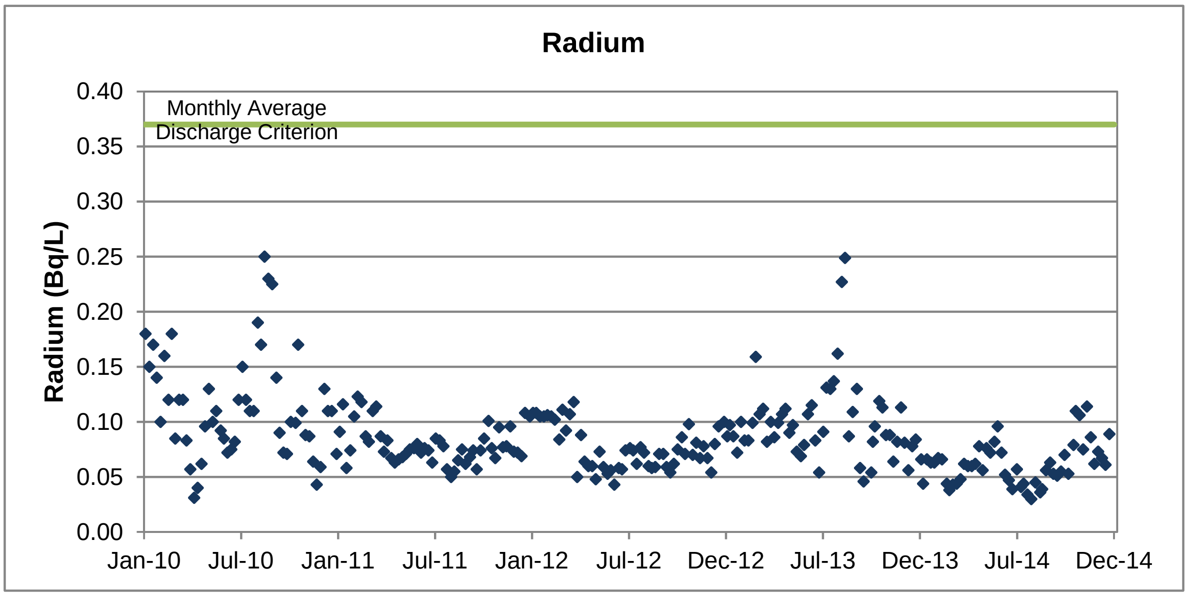


Figure 3.14: Comparison of total reagent consumed versus total volume treated at Quirke TMA from 2010-2014. (lime usage multiplied by 10)





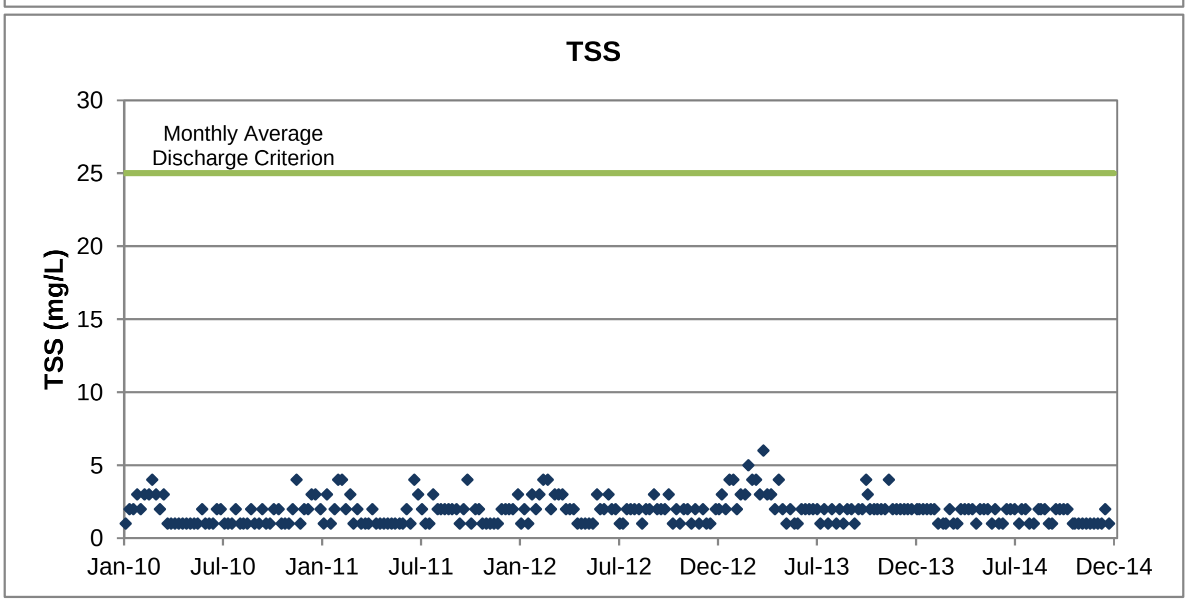


Figure 3.15: Effluent concentrations versus monthly average discharge criteria at Quirke TMA station Q-28.

Table 3.13: Toxicity test results for samples collected at Quirke TMA station Q-28, 2010 - 2014.

Sample Date (month-year)	Acute Toxicity (% mortality)		Reproduction (IC25[d] as % effluent)
	Daphnia magna [a]	rainbow trout [b]	*Ceriodaphnia dubia* [c]
May-10	0	0	>100
November-10	0	0	>100
May-11	0	0	>100
November-11	0	0	>100
May-12	0	0	87
November-12	0	0	>100
May-13	0	0	>100
November-13	0	0	>100
May-14	7	0	>100
November-14	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.

3.3.7 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 acute toxicity tests on *Daphnia magna* and rainbow trout were non-toxic, with only slight inhibition of reproduction exhibited in one test using *Ceriodaphnia dubia*. Overall, the Quirke TMA is performing well and conditions are improving over time.

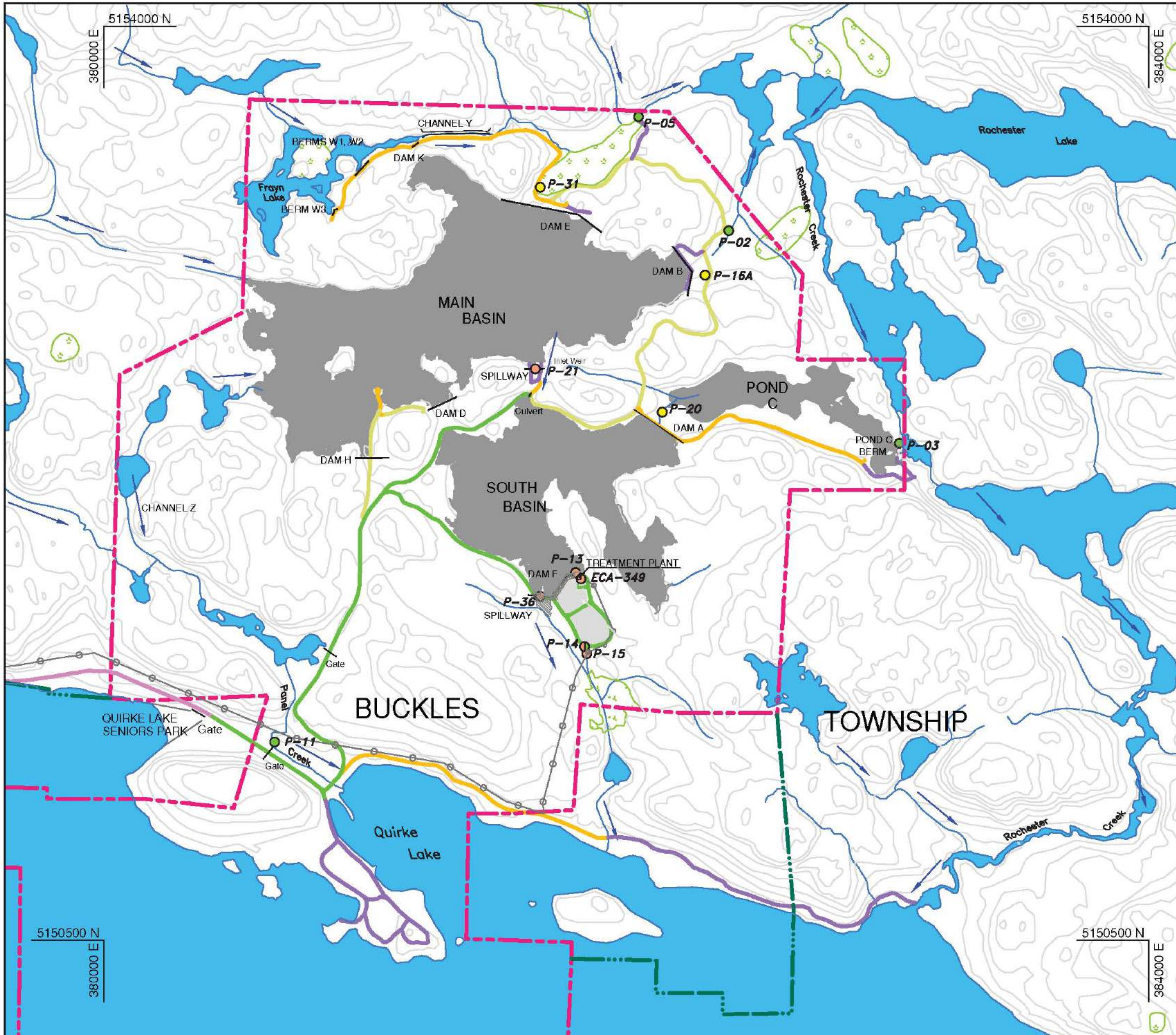
3.4 Panel TMA

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 Limited 1995).

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 3.16). The Main Basin drains into the South Basin via a spillway. 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 3.16). The overflow from the South Basin enters the ETP where it is treated with a mixture of lime slurry and barium chloride to maintain pH and remove radium-226, respectively. Improvements have been made since decommissioning (Table 3.14), and have included work to maintain water levels and flow through dam and treatment plant upgrades.

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 3.15). Data from the Panel TOMP stations are summarized in the following sections and presented in Appendix C (Appendix Tables C.4.2-C.4.8).



Rio Algom

SCALE

0 0.5 1.0 kms

N E S W

Legend

- vegetated tailings.
- water covered tailings.
- treatment solids.
- flow direction.
- limits of CNSC licence.
- limits of unlicenced property.
- public road.
- main access.
- secondary access.
- seasonal access.
- trail.
- public motorized trail.
- public non motorized trail.
- SAMP surface water sampling stations.
- TOMP surface water sampling stations.
- TOMP groundwater sampling stations.
- TOMP porewater sampling stations.
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- Mapping export parameters = NAD83 WGS_1984_ UTM_Zone_17N (Central Meridian = 81°W).
- Rev. 2013.02 May 2013.

Figure 3.16 PAUL H. TORRANCE SURVEYING LTD. GEOMATICS SERVICES minnow environmental inc.

Panel Site SAMP and TOMP Monitoring Stations

Project No.: 2555
Date: February 2016

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Table 3.14: Panel TMA site improvement undertakings since closure.

Year	Action	Rationale for Action
1992	Dam H constructed, Dam D decant sealed and Main Basin spillway cut from bedrock.	Submerge Main Basin tailings with minimum 1.5 m water cover and upgrade flood conveyance capacity to inhibit oxidation of tailings.
1994-1999	Main and South Basin seasonal in-situ lime slurry addition.	Increase pH and reduce metals in surface waters.
1999	Dam F overflow spillway in the South Basin and Pond C Berm constructed.	Upgrade South Basin flood conveyance capacity and submerge historic Pond C tailings with minimum 1.5 m water cover to inhibit oxidation of tailings.
2000 - 2002	Dams B, C and E frost protection added to crest.	Improve long-term stability of low permeability till core of the dams.
2003	Dams B and E upstream rockfill addition.	Strengthen erosion protection of dams.
2008	Pond C Berm raised with overflow spillway constructed in bedrock.	Increase storage and flood conveyance capacity of Pond C.
	Dam F upstream rockfill addition.	Strengthen erosion protection of dam.
2010	Lime storage tank replaced and secondary containment constructed.	Improve lime tank access, response to reagent tank failure or spills, and provide spill containment.
	Treatment plant sodium hydroxide addition system installed.	Provide gravity feed treatment capacity during power outage.
2013	Remote Monitoring Network communications and centralized supervisory control and data acquisition system standardized and replaced.	Align remote monitoring approach across sites and improve reliability.
2014	Incorporation of a pump into the barium chloride addition system.	Reduce line-clearing maintenance during routine operations.

Table 3.15: Cycle 4 approved TOMP monitoring stations, substances, and frequencies[a] at Panel TMA.

TOMP Stations	Station Type/Purpose	Elevation	Flow	pH	Conductivity	Sulphate	Radium-226	Lime or NaOH Consumption	Barium Chloride Consumption	TSS	Acidity	Iron	SAMP Metals[b]
		Parameters and Frequencies[a]											
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		M	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 has generally remained 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 393.4 m (Figure 3.17). In the South Basin, an operating practice is used to maintain a relatively 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 (*i.e.*, period when ETP is least efficient). At the time the last State of the Environment Report (Minnow 2011) was prepared, Rio Algom established winter and summer minimum 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 380.00 m with a restart target of 380.34 (0.34 m fluctuation). Water levels in both basins were typically within the established operating levels (Figure 3.17), however, water levels in the South Basin were drawn down below the minimum in the winter of 2014. Based on heavy snowfall during the winter of 2014, a significant increase in flow and water level during the spring melt and rains was expected and therefore, to provide sufficient freeboard for the anticipated melt event, the water level was lowered to below the winter minimum operating level for a short period before the freshet occurred (Figure 3.17).

3.4.3 Basin Surface Water Quality

Surface water quality is monitored at three stations: the spillway of the Main Basin (P-21), the South Basin ETP influent (P-13) and the ETP settling pond underflow drainage (P-15; Table 3.15; Figure 3.16). Since decommissioning, radium-226, sulphate and uranium concentrations have decreased and pH has increased to neutral at ETP-influent station P-13 (Figure 3.18), such that concentrations are at or approaching the 50 year post decommissioning predictions (*i.e.,* 2040).

More recently (2003-2014) surface water has continued to improve with significant reductions in the concentrations of acidity, cobalt, radium-226, and sulphate and increased pH at the ETP influent (P-13; Table 3.16; Appendix Figure C.4.1). At the main basin overflow, sulphate concentrations have significantly decreased, while iron and pH have increased (Table 3.16, Appendix Figure C.4.2). At the ETP influent, pH meets the discharge criterion (6.5 to 9.5) and radium-226 concentrations are approaching the criterion (median of 0.399 Bq/L versus the criteria of 0.37 Bq/L; Appendix Table C.4.3). At the outlet of the Main Basin, both pH and radium-226 achieve discharge criteria prior to treatment (Appendix Table C.4.5).

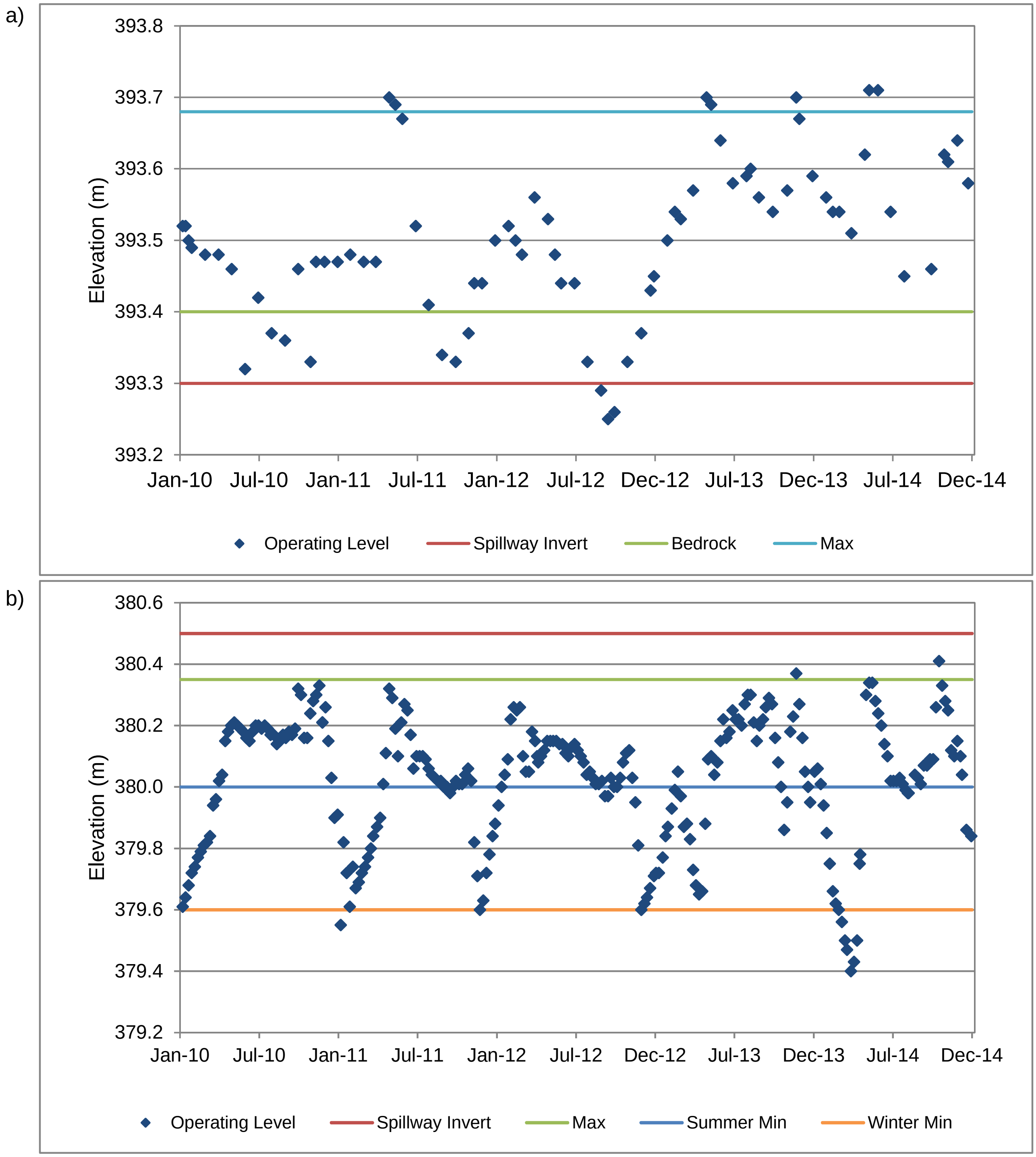


Figure 3.17: Water level at Panel main basin (a) and south basin (b) relative to minimum operating elevation, 2010-2014.

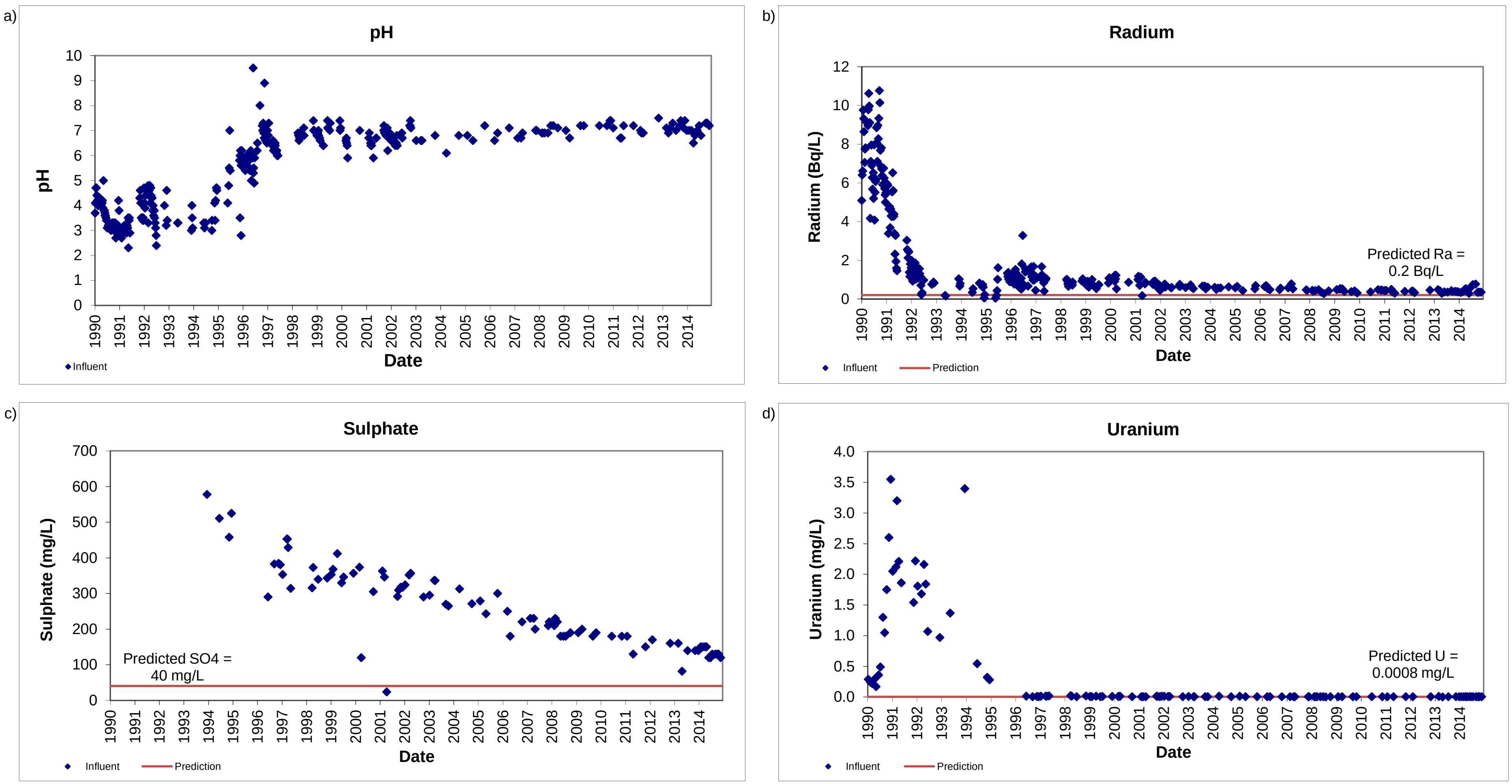


Figure 3.18: Water quality at the Panel TMA ETP influent (P-13) relative to predictions for 50 year (2040) post-decomissioning.

Table 3.16: Summary of water quality trends[a] for TOMP monitoring stations, Panel TMA, 2003 to 2014.

Station ID	Type/Location	Number of Months Used in Common Trend[b]	Acidity	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium
P-21	Main Basin Outflow	2 to 3	ND	-	-	0.766	-	0.566	0.104	-0.940	-
P-13	ETP Influent	3 to 8	-0.723	0.059	-0.463	*0.324*	-0.144	0.599	-0.766	-0.924	0.107

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

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

[a] Common (combined) trends based on rank correlation coefficients (rho) for monthly trends, shown in Appendix Table C.4.9 to C.4.10.

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

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.

"-" 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).

Italic text - mean monthly correlations significantly different, but common trend value provided.

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 3.16). 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 (1990-2014, Table 3.17), although conditions have been stable or possibly improving since 2003 (Appendix Figure C.4.4). These trends are representative of acidic waters from early decommissioning being flushed through the groundwater. However, seepage quality down-gradient of Dam B (P-02) has been improving over time (See Section 4.1.2). No significant trends were found at the other groundwater station down-gradient of the Main Basin (P-31). In the South Basin down-gradient of Dam A (P-20 – towards Pond C), sulphate in groundwater has decreased over time (Table 3.17, Appendix Figure C.4.3) consistent with the trend observed in South Basin surface water (Table 3.16).

3.4.5 Treatment Performance

Influent from the South Basin is treated at the ETP and associated settling ponds prior to discharge to the receiving environment at station P-14 (Figure 3.16). The TMA ETP uses both lime and barium chloride to reduce acidity and radium-226 levels, respectively. Both barium chloride and lime consumption (mg/L treated) have been relatively stable over the reporting period, although the total usage of both barium chloride and lime increased in 2013 and 2014 due to an increase in the volume of effluent treated (Figure 3.19).

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 3.20; 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 at station P-14 (Table 3.18). Similarly, reproduction of *Ceriodaphnia dubia* was not affected by exposure to 100% effluent in any tests conducted over the past five years at the same station (Table 3.18).

3.4.6 Summary

Water levels at the Panel TMA have been maintained within operating levels, with the exception of increased draw down in the South Basin in the winter of 2014 to accommodate large amounts of snow fall and the resultant increase in water levels during freshet. 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 (1990-2014), although conditions have been stable or possibly improving since 2003 and down-gradient

Table 3.17: Summary of water quality trends[a,b] in TOMP groundwater in Panel TMA, 1990[c] to 2014.

Location	Station	Depth (m)	Dates	Acidity[a]	Iron	pH	Sulphate
Downgradient of Dam A (South Basin)	P-20	13.9	1990-2014	ND	-0.183	-0.309	-0.887
Downgradient of Dam B (Main Basin)	P-16A	24.8	1990-2014	ND	-0.325	-0.42	0.442
Below Dam E (Main Basin)	P-31	9.97	1996-2014	ND	0.458	0.062	0.081

decreasing trend, significant at $p<0.05$

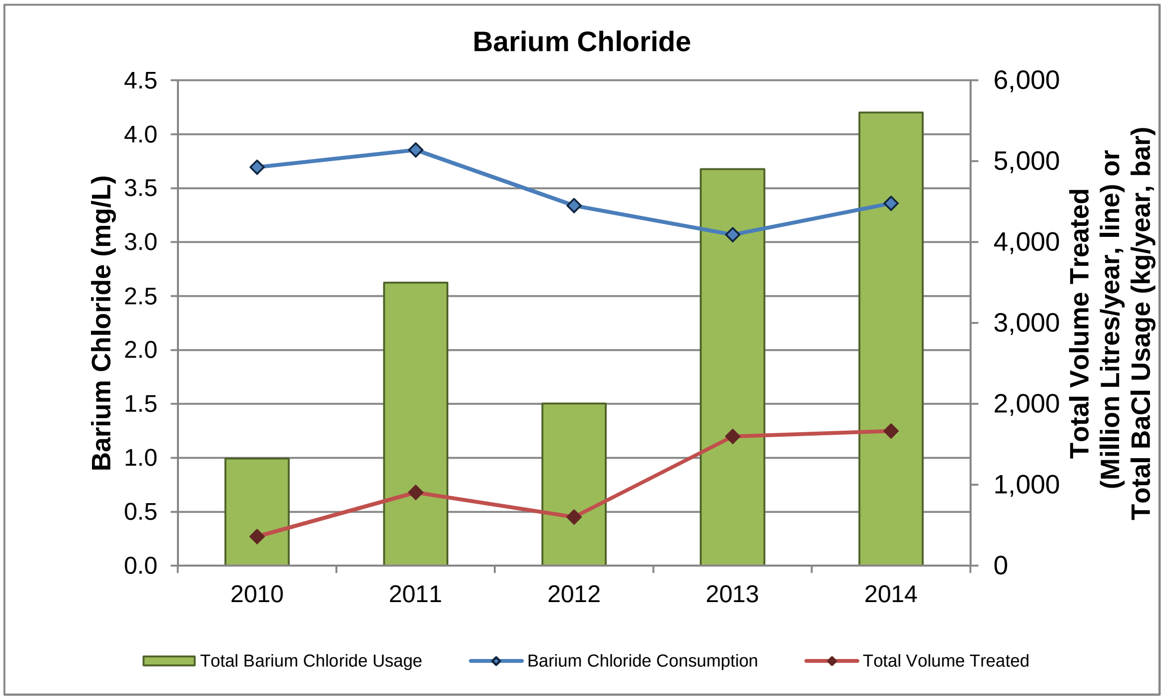
increasing trend, significant at $p<0.05$

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.

[a] Due to a change in analytical technique for acidity in 2006, trends were assessed from 2007-2014.

[b] Common (combined) trends based on rank correlation coefficients (rho) for monthly trends, shown in Appendix Table C.4.11.

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



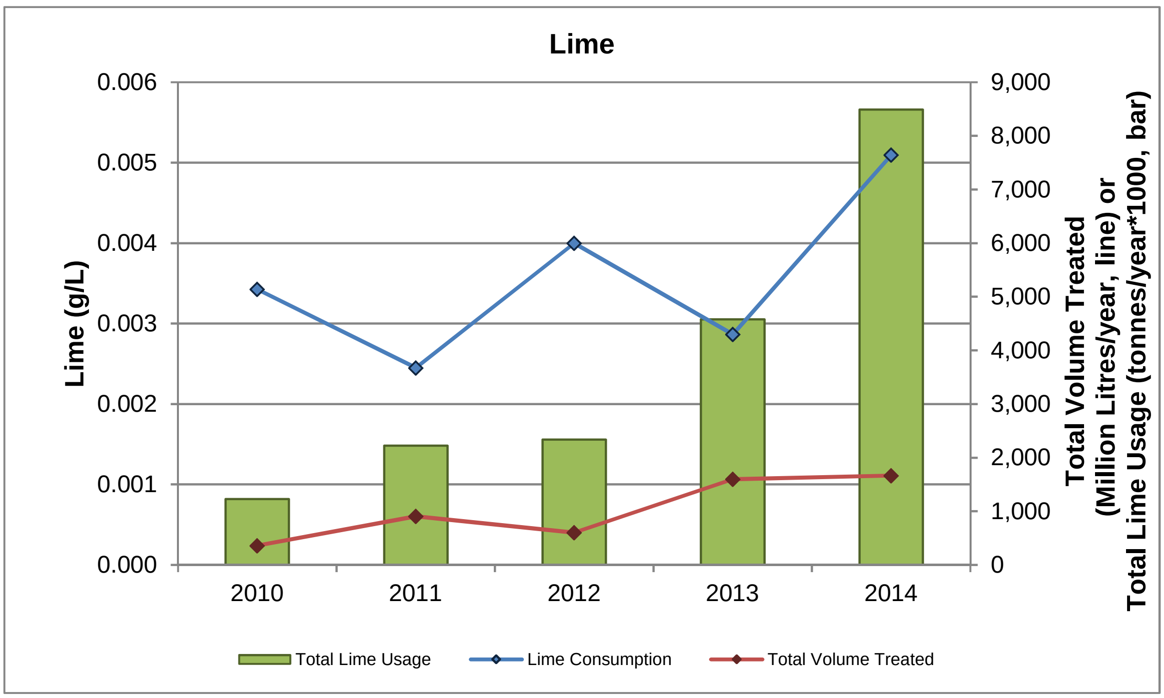


Figure 3.19: Comparison of total reagent consumed versus total volume treated at Panel TMA from 2010-2014. (lime usage multiplied by 1000)

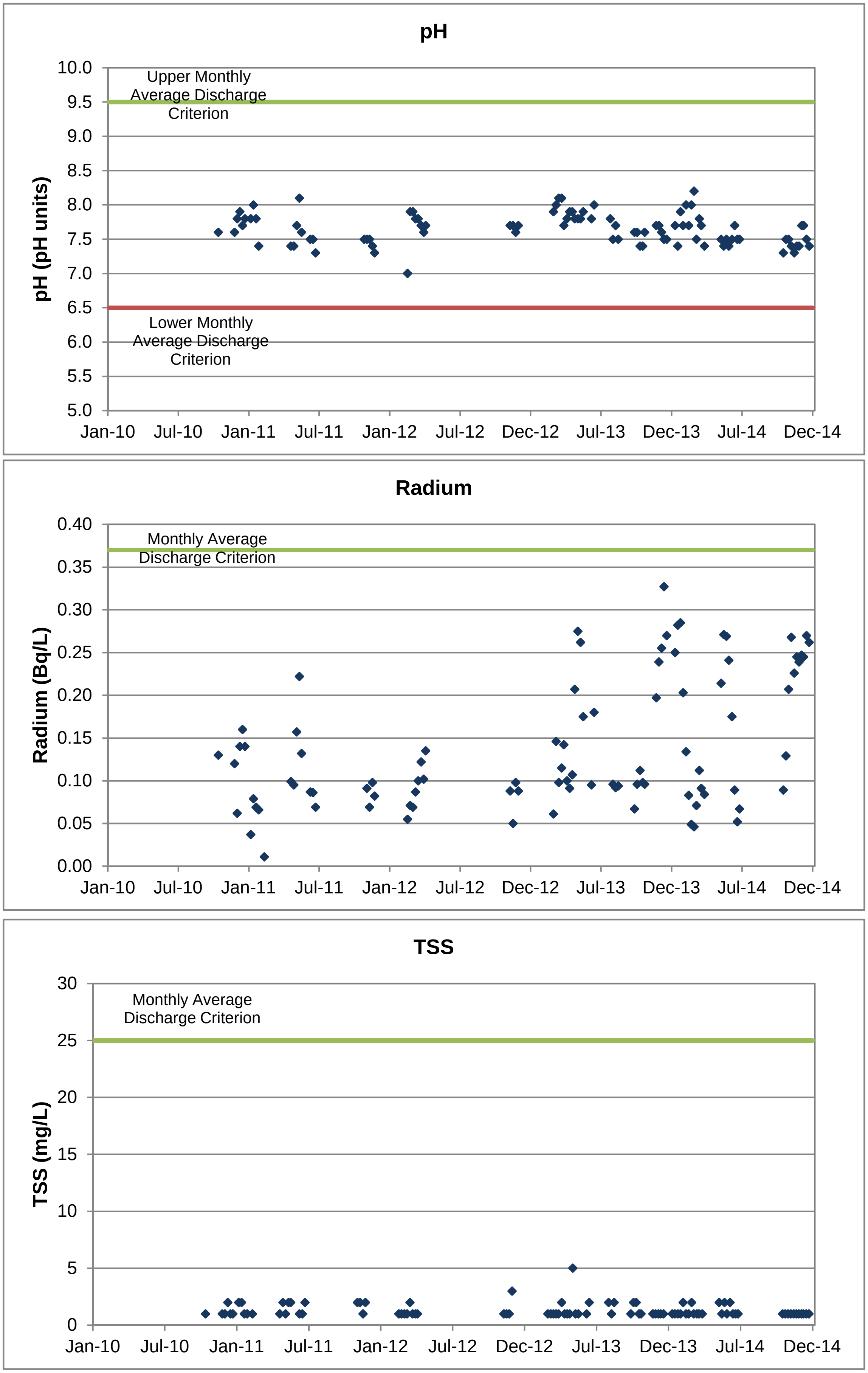


Figure 3.20: Effluent concentrations versus monthly average discharge criteria at Panel TMA station P-14.

Table 3.18: Toxicity test results for samples collected at Panel TMA station P-14, 2010 - 2014.

Sample Date (month-year)	Acute Toxicity (% mortality)		Reproduction (IC25[d] as % effluent)
	Daphnia magna [a]	rainbow trout [b]	*Ceriodaphnia dubia* [c]
October-10	0	0	- [e]
November-10	-	-	>100
May-11	0	0	>100
November-11	0	0	>100
March-12	0	0	- [e]
April-12	-	-	>100
November-12	0	0	>100
April-13	0	0	>100
October-13	0	0	>100
May-14	0	0	>100
November-14	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.

[e] Test re-analyzed due to mortality in control sample.

seepage at P-02 has been improving over time. 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 acute toxicity tests on *Daphnia magna*, rainbow trout, 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

The Stanrock Mine, located 21 km northeast of the City of Elliot Lake, began operations in early 1958 with mining occurring until 1970, and then again from 1978 to 1983. Tailings were discharged into the natural basin of a small lake located immediately south of the mine which became the Stanrock TMA (Figure 3.21). Approximately 5.7 million tonnes of tailings were produced and stored within the 52-hectare Stanrock TMA over the course of mine operations. A vegetative cover was chosen as the preferred option for decommissioning the Stanrock TMA. 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. Seepage from the Dam G is collected in a settling pond upstream of Dam M and pumped back to the Dam G Collection Pond. Water from Dam G Collection Pond is 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 3.21). Treated effluent is discharged into the Moose Lake settling pond which flows into Orient Lake polishing pond 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). Numerous site improvements have been made since tailings were vegetated in 1999 to control flows and water levels, contain historic tailings spills and to treat seepage and site water (Table 3.19).

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 3.20). Data from the Stanrock TOMP stations are summarized in the following sections and presented in Appendix C (Appendix Tables C.5.2-C.5.8).

3.5.2 Basin Surface Water Quality

Stanrock is a vegetative covered 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

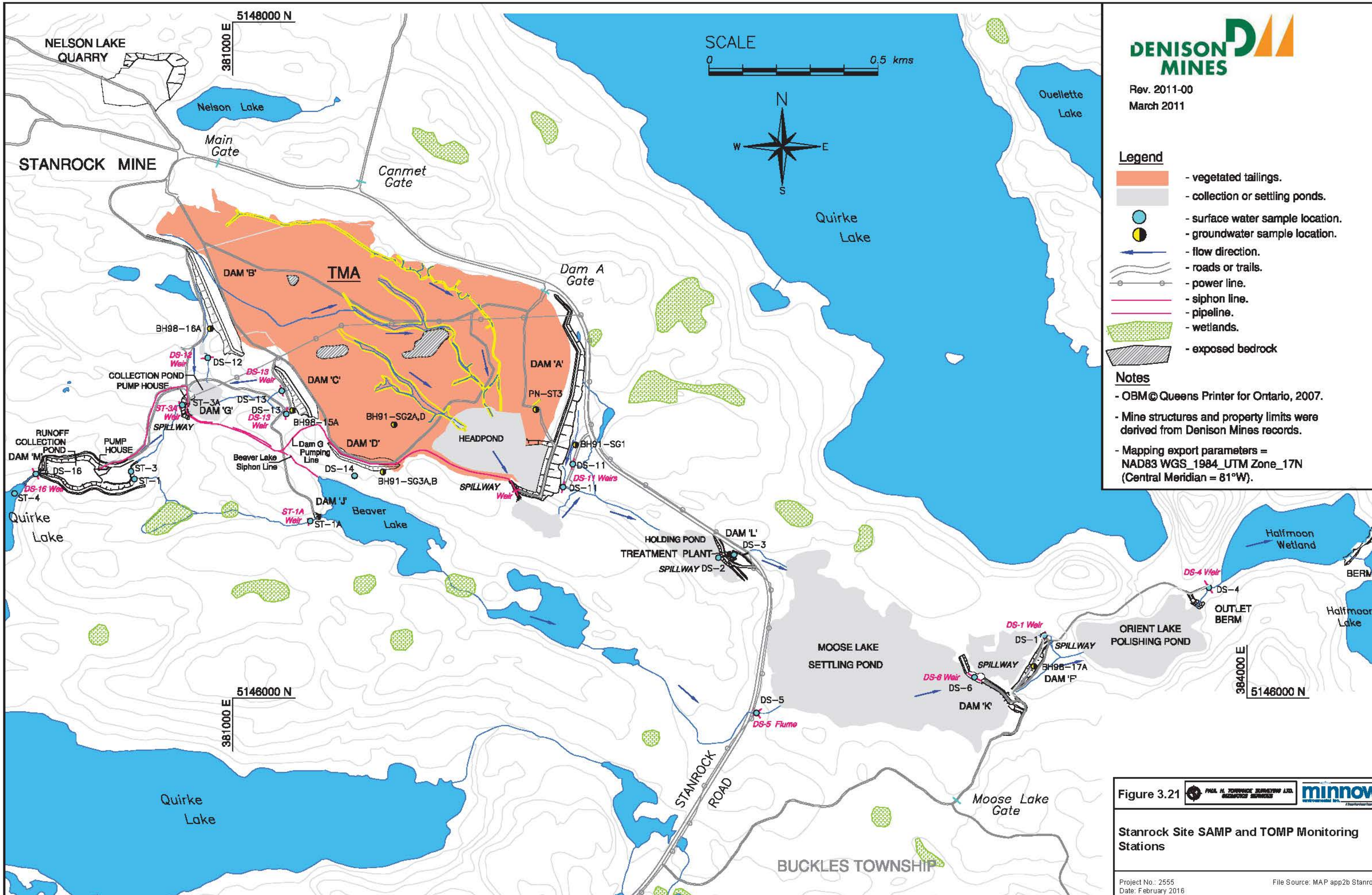


Figure 3.21 Stanrock Site SAMP and TOMP Monitoring Stations

Table 3.19: Stanrock TMA site improvement undertakings since closure.

Year	Action	Rationale for Action
2000	Spreading of bio-solids over TMA.	To stimulate further plant growth.
	Tailings removed from Quirke Lake and placed in Stanrock TMA.	To remove tailings from surface water and ensure proper containment and management of tailings.
	Revegetation work done inside and outside of TMA.	To promote TMA stability and achieve site reclamation commitments.
	Alarm system installation at ETP.	Safety/security.
2001	Biosolids spread over shatter spillway followed by seeding. Revegetation work also included addition of thin layer of soil on tailings and fertilizing and reseeding.	Establish sustainable vegetative cover over fine tailings, reduce acid generation, attenuate gamma exposure.
2004	A four-inch siphon line was installed to direct Beaver Lake water to Dam G Pond which is then pumped directly to ETP.	Reduce amount of Beaver Lake water entering Moose Lake without treatment.
	Installation of bypass at discharge to Beaver Lake and six-inch pipeline extension to Dam A spillway (appropriate valves also installed).	Direct seepage water to effluent treatment plant to reduce loads to the Serpent River Watershed.
2005	Revegetation of small areas of barren tailings within TMA.	Reduce tailings/air oxidation and subsequent acid production. Also minimize water and wind erosion and radiological exposures.
	Construction of a temporary treatment facility below Dam G, including installation of a sodium hydroxide treatment system and sludge collection system.	Increase pH of seepage that was entering Quirke Lake to comply with the Inspector's Direction issued by Environment Canada on September 16, 2005.
	Water siphoned from Beaver Lake to Dam G collection pond.	Reduce untreated seepage overflow to Moose Lake.
2006	Installation of an automated electric valve system as primary means of dispensing lime for treatment at ETP.	Efficiency and better pH control.
	Construction of new rock lined ditch.	To drain the ponded water away from Dam B to the existing drainage system at Stanrock TMA.
2008	Removal of spilled tailings in upper and lower wetland areas.	To ensure proper containment and management of tailings.
	Construction of collection pond and pumping station at downstream end of lower wetland area to collect surface runoff and seepage water prior to discharge to Quirke Lake.	Dam G Seepage Collection improvements in order to comply with the Inspector's Direction issued by Environment Canada on September 16, 2005.
2009	Excavation and relocation of tailings from historical spill, from the upper and lower wetland areas at Dam M.	To ensure proper containment and management of tailings.
	Excavation of organic/peat material.	For additional storage capacity within holding pond.
	Construction of Dam M, spillway and pumphouse, and associated pipeline to discharge to Dam G holding pond.	Dam G Seepage Collection improvements in order to comply with the Inspector's Direction issued by Environment Canada on September 16, 2005.
	Construction of freshwater diversion ditches to north and south of new holding pond to capture surface runoff and direct it beyond Dam M and through DS-16 to Quirke Lake.	Enhances access and storm water routing, and minimizes amount of sand and gravel washing into collection pond.
	Removal of the old temporary treatment facility from area.	Dam G Seepage Collection improvements in order to comply with the Inspector's Direction issued by Environment Canada on September 16, 2005.
	Upgrading of the existing Dam G pumping system and associated pipeline to accommodate additional water received from Dam M holding pond	

Table 3.19: Stanrock TMA site improvement undertakings since closure.

Year	Action	Rationale for Action
2010	Disposal areas on site were limed, seeded and fertilized.	To restore and/or establish sustainable vegetative cover.
	Applied rip rap material to perimeter of holding pond and a till blanket was constructed on upstream side of Dam M (50mx10mx1m). Additional material was excavated from area as well.	For erosion control, stabilization and increased storage capacity of pond.
	Overflow spillway of Dam M raised from 351.55m to 352.8m. Crest was also raised and minor reconstruction of north ditch.	To increase holding capacity of pond and to accommodate larger volumes of water in the north ditch.
	Improvements made to existing access road to Orient Lake outlet and construction of a new temporary road along south side of the wetland was completed.	Preparation for the Halfmoon Berm construction project.
2011	Replacing beaver dams at the outlet of the Halfmoon Wetland area with engineered berms.	To stabilize containment of treatment solids and tailings and maintain water levels.
	Fertilizing and seeding at Dam M in areas affected by construction.	Restore site conditions after Dam G Seepage Collection project.
2013	Siphons set up at Canmet site to lower pond level at a controlled rate.	Pond level was high due to beaver activity. Lowering pond level provides enhanced stability and function.
	Upgrade to siphon line from Beaver Lake to Dam G.	Allow for prolonged operation and to reduce maintenance.
	SCADA upgrade: installation of new PLC, communications system, pump controls, and electric effluent valve control at ETP, and installation of PLCs, communications system, pump controls and level sensors at Dam G and M pump stations.	Incorporate instrumentation to better enable remote monitoring and operation capabilities.
2014	Trees cut between Dam G and Dam M.	Improve communication by providing clear line of vision between the two sites.

Table 3.20: Cycle 4 approved TOMP monitoring stations, substances, and frequencies[a] at Stanrock TMA.

		Parameters and Frequencies[a]											
TOMP Stations	**Station Type/Purpose**	**Elevation**	**Flow**	**pH**	**Conductivity**	**Sulphate**	**Radium-226**	**Lime or NaOH Consumption**	**Barium Chloride Consumption**	**TSS**	**Acidity**	**Iron**	**SAMP Metals[b]**
DS-2	Basin performance (primary), ETP operations		D	M		Q	M	M	M		Q		Q
DS-3	ETP operations			D									
DS-4	Effluent		W[c]	W		M	W			W			M[c]
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.

the Stanrock ETP (DS-2). In addition, water quality is monitored within downstream settling ponds (DS-6), polishing ponds (DS-1), and final effluent (DS-4; Figure 3.21).

Since 2003, TMA water quality at the ETP influent has generally remained stable, except for a significant reduction in sulphate and a significant increase in barium (Table 3.21; Appendix Figure C.5.1). The previous SOE (Minnow 2011) showed a significant decrease in radium-226 over the monitoring period (2003-2009), however since the current cycle has been added (2010-2014), no significant trend was identified, suggesting that radium-226 concentrations have stabilized. Influent radium-226 is now below the discharge criterion (0.37 Bq/L), but sulphate remains elevated and acidity continues to require treatment (Appendix Table C.5.3).

3.5.3 Porewater

Porewater is monitored annually at two locations in the Stanrock TMA: up-gradient of Dam A (PN-STP3-P) and up-gradient of Dam D (BH91-SG2) for acidity, pH, iron, and sulphate. Up-gradient of Dam D, tailings porewater showed a significant increase in pH over time (Table 3.22; Appendix Figure C.5.2). Up-gradient of Dam A (PN-STP3-P) porewater chemistry improved at the shallow well (5.94 m – PN-STP-P3) with decreasing acidity and iron and increasing pH (Table 3.22, Appendix Figure C.5.4). pH also increased significantly in the shallowest porewater well (2.64 m – PN-ST3-P5; Table 3.22; Appendix Figure C.5.4), but decreased significantly over the same time at the deepest sampling depth (20.91 m PN-ST3-P8; Table 3.22, Appendix Figure C.5.6), consistent with results observed in 2010. Iron increased significantly at three of the four sampling depths, but decreased at 5.94 m (Table 3.22; Appendix Figure C.5.4). The increase in pH in shallower wells and the decrease in deeper wells likely reflects 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 3.22).

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 3.21). Down-gradient of Dam A groundwater is assessed at a depth of 5.49m. Here, pH levels have significantly increased and sulphate and acidity concentrations have significantly decreased over time (Table 3.22; Appendix Figure C.5.7) showing improvements in groundwater quality. In the previous cycle, a significant increasing trend in iron concentrations was observed, however when data from the current cycle is included, this trend is no longer significant indicating that iron levels are stabilizing. Down-gradient of Dams B, C, and D, iron concentrations significantly decreased, as did sulphate downstream of Dam C (Table 3.22;

Table 3.21: Summary of water quality trends[a] for TOMP monitoring stations, Stanrock TMA, 2003 to 2014.

Station ID	Type/Location	Number of Months Used in Common Trend[b]	Acidity	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium
DS-2	Treatment Plant Influent	5 to 12	-0.309	0.435	-0.067	-0.600	-0.037	-0.034	-0.002	-0.576	-0.271

(blue) decreasing trend, significant at p<0.05
(green) increasing trend, significant at p<0.05

[a] Common (combined) trends based on rank correlation coefficients (rho) for monthly trends, shown in Appendix Table C.5.9.

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

Table 3.22: Summary of water quality trends[a,b] in TOMP porewater and groundwater in Stanrock TMA, 1991[c] to 2014.

Type	Location	Station	Depth (m)	Dates	Acidity[a]	Iron	pH	Sulphate
Porewater	Upgradient of Dam D	BH91-SG2A	33.31	1991-2014	-0.491	0.079	0.606	-0.359
	Upgradient of Dam A	PN-ST3-P5	2.64	1999-2014	0.487	0.679	0.908	0.900
		PN-ST3-P3	5.94	1991-2014	-0.905	-0.599	0.727	-0.359
		PN-ST3-P6	11.58	1991-2014	0.929	0.653	0.316	-0.300
		PN-ST3-P8	20.91	1991-2014	0.929	0.968	-0.761	0.671
Groundwater	Downgradient of Dam A	BH91-SG1A	5.49	1991-2014	-0.850	0.391	0.84	-0.873
	Downgradient of Dam B	BH98-16A	5.49	1999-2014	0.024	-0.668	0.247	-0.342
	Downgradient of Dam C	BH98-15A	7.86	1999-2014	-1.00	-0.771	0.609	-0.982
	Downgradient of Dam D	BH91-SG3B	5.85	1999-2014	-	-0.291	-0.325	-
		BH91-SG3A	8.78	1999-2014	0.500	-0.923	-0.356	-

decreasing trend, significant at p<0.05

increasing trend, significant at p<0.05

"-" 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).

[a] Due to a change in analytical technique for acidity in 2006, trends were assessed from 2007-2014.

[b] Common (combined) trends based on rank correlation coefficients (rho) for monthly trends, shown in Appendix Table C.5.10 to C.5.11.

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

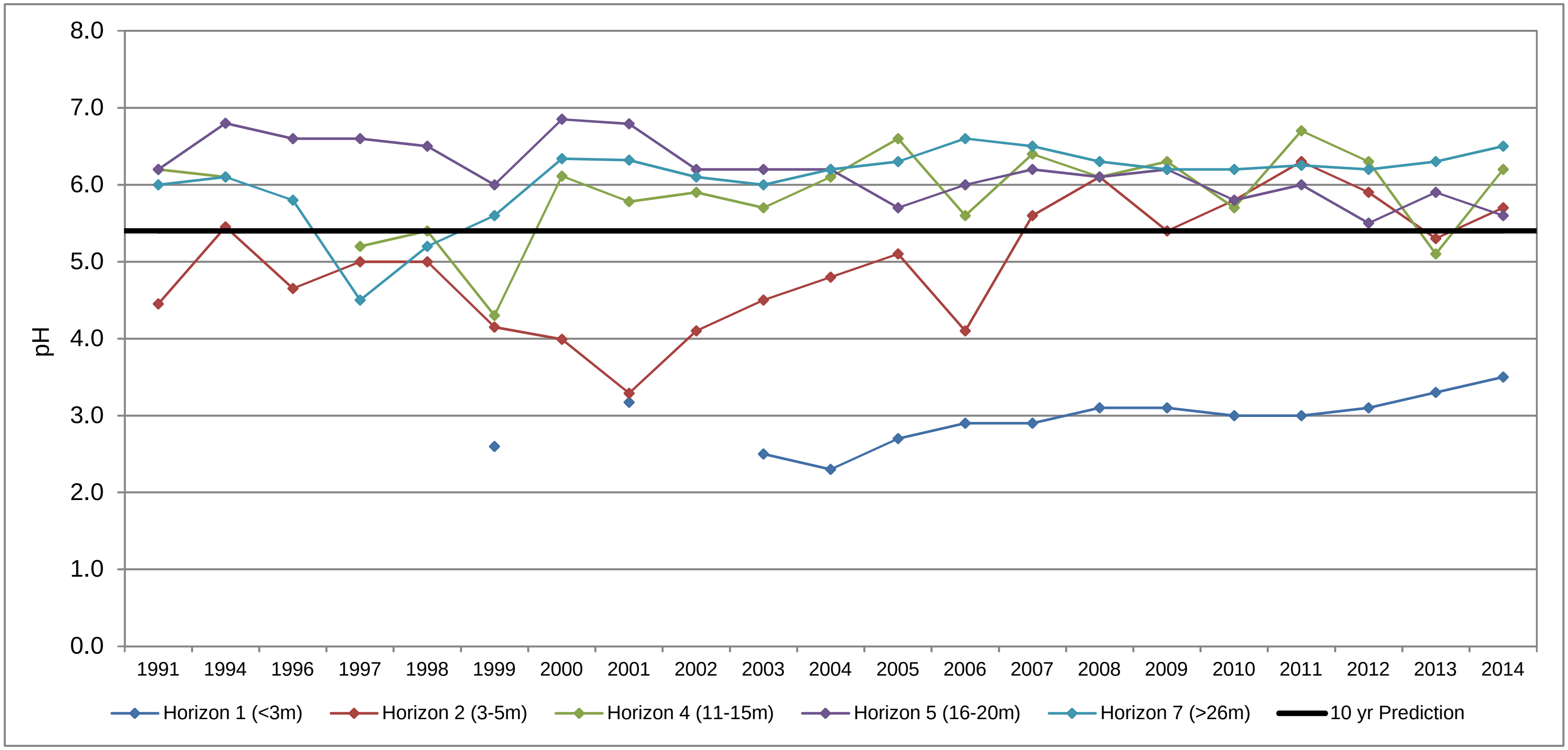


Figure 3.22: Comparison of mean porewater pH at various depths to EIS (2010) prediction, Stanrock TMA, 1991-2014.

Horizon 1 - PN-STP3-P5
Horizon 2 - PN-STP3-P3
Horizon 4 - PN-STP3-P6
Horizon 5 - PN-ST3-P8
Horizon 7 - BH91-SG2A

Appendix Figures C.5.8, C.5.9, and C.5.10). Down-gradient of Dam C, pH increased significantly over time, though measurements have been relatively stable since 2005 (Appendix Figure C.5.9).

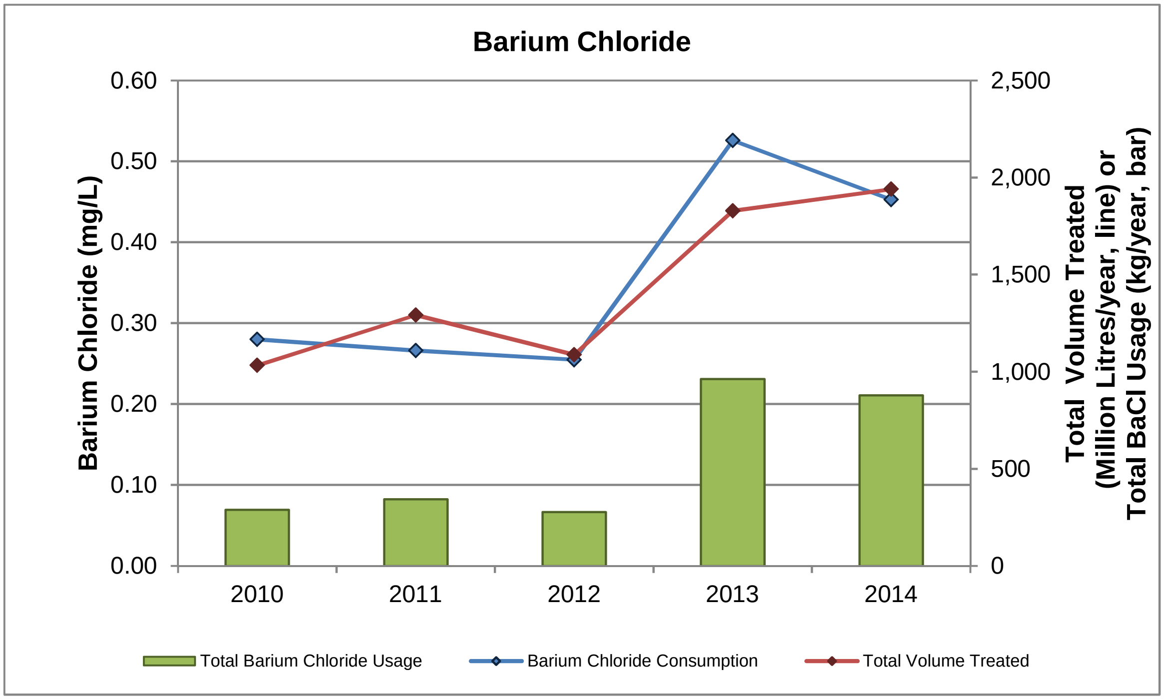
3.5.5 Treatment Performance

Water collected from the Stanrock TMA is treated at the Stanrock ETP, where it flows through a settling and polishing pond prior to discharge into Halfmoon Lake (Figure 3.21). Treatment includes both lime and barium chloride to reduce acidity and radium-226, respectively. Barium chloride consumption rates were consistent between 2010 and 2012, but increased in 2013 and 2014, corresponding to an increase in treated effluent volumes (Figure 3.23). Lime consumption rates declined over the reporting period, however total lime usage was similar over the same period, possibly reflecting the increase in the volume treated (Figure 3.23).

Following treatment, effluent quality is monitored at the outlet of the Orient Lake polishing pond (DS-4). Over the past five years, effluent quality has consistently achieved discharge criteria (Figure 3.24; 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 3.23). Similarly, reproduction of *Ceriodaphnia dubia* was not affected by exposure to 100% effluent for most test results, though effects were observed in May 2010 and June 2014 (Table 3.23), in which reproduction was affected at effluent concentrations of 3% and 54%, respectively.

3.5.6 Summary

Since 2003, water quality at the Stanrock 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. Groundwater down-gradient of Dams B, C, and D showed a significant decrease in iron since decommissioning. Barium chloride consumption in the ETP has increased in the past two years, corresponding to increased treatment volumes. Total 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. Similarly, reproduction of *Ceriodaphnia dubia* was not affected by exposure to 100% effluent in most tests, except for two samples collected in 2010 and 2014.



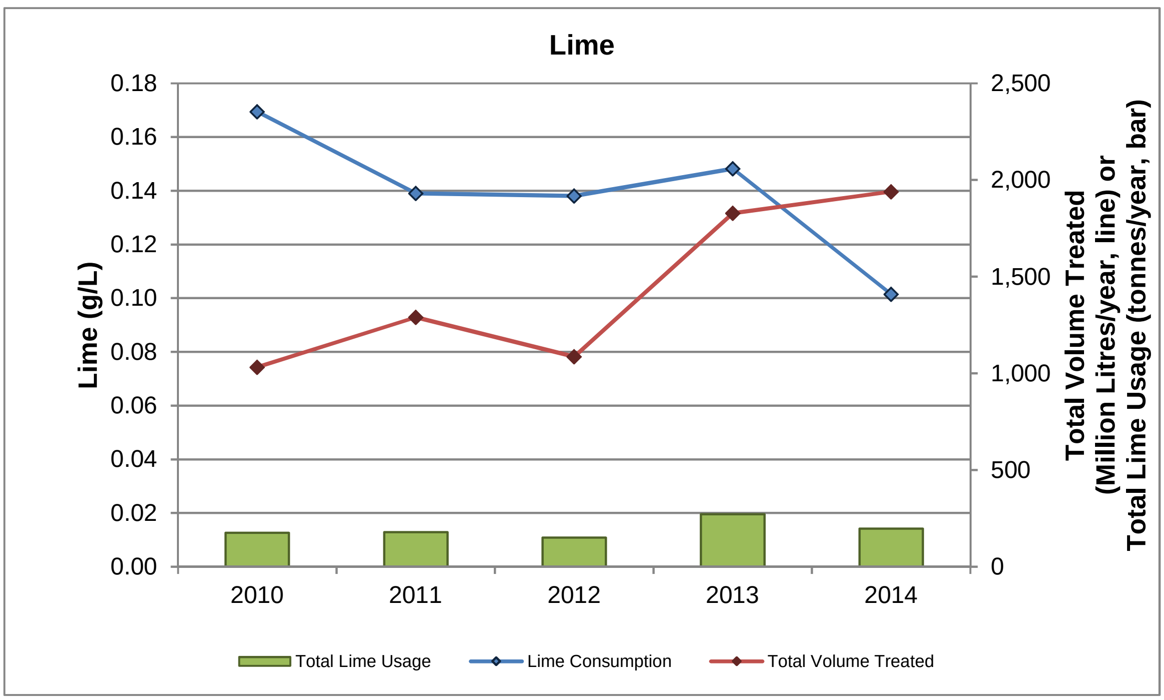
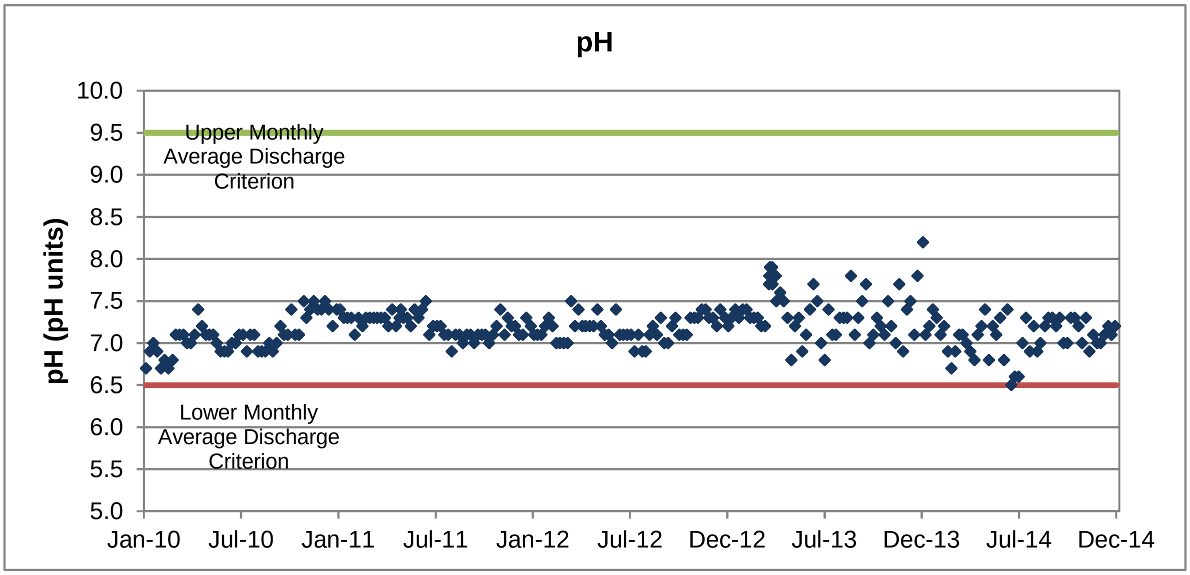
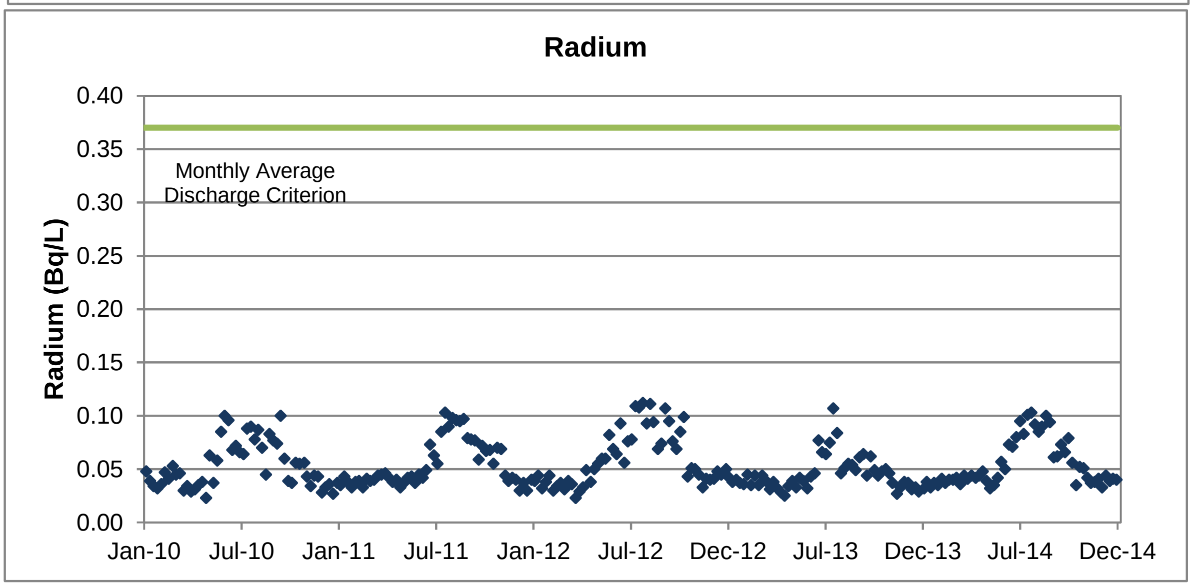


Figure 3.23: Comparison of total reagent consumed versus total volume treated at Stanrock TMA from 2010-2014.





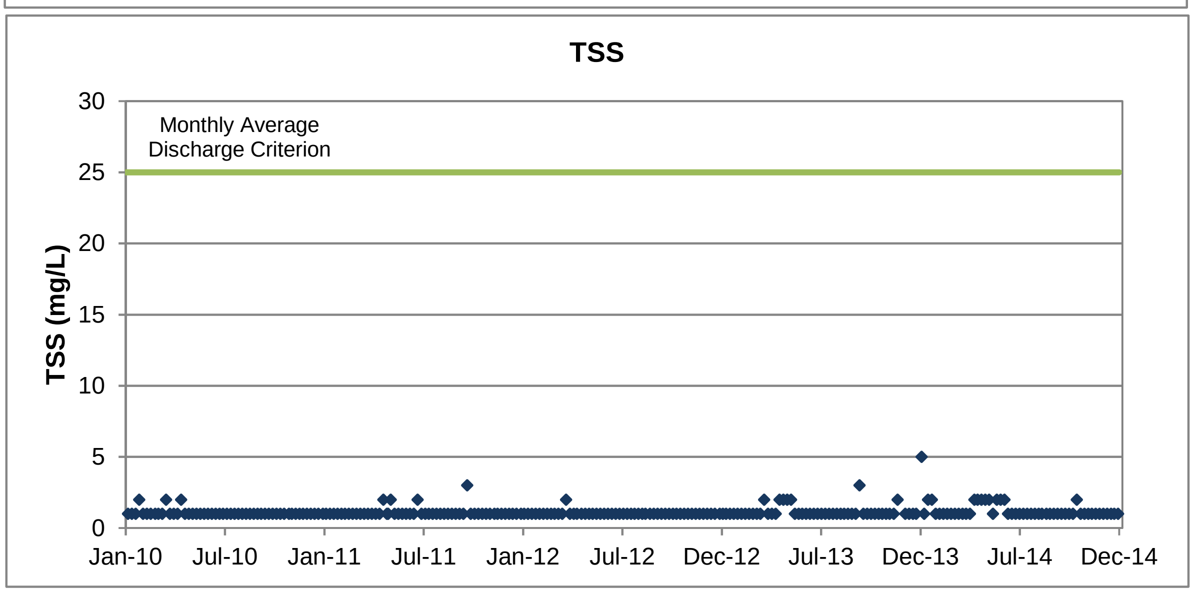


Figure 3.24: Effluent concentrations versus monthly average discharge criteria at Stanrock TMA station DS-4.

Table 3.23: Toxicity test results for samples collected at Stanrock TMA station DS-4, 2010 - 2014.

Sample Date (month-year)	Acute Toxicity (% mortality)		Reproduction (IC25[d] as % effluent)
	Daphnia magna [a]	rainbow trout [b]	*Ceriodaphnia dubia* [c]
May-10	0	0	3
October-10	0	0	>100
May-11	0	0	>100
October-11	0	0	- [e]
December-11	-	-	>100
May-12	0	0	>100
October-12	0	0	>100
May-13	0	0	>100
October-13	0	0	>100
June-14	3	0	54
October-14	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.

[e] Test re-analyzed due to mortality in control sample.

3.6 Stanleigh TMA

3.6.1 Basin History and Modifications

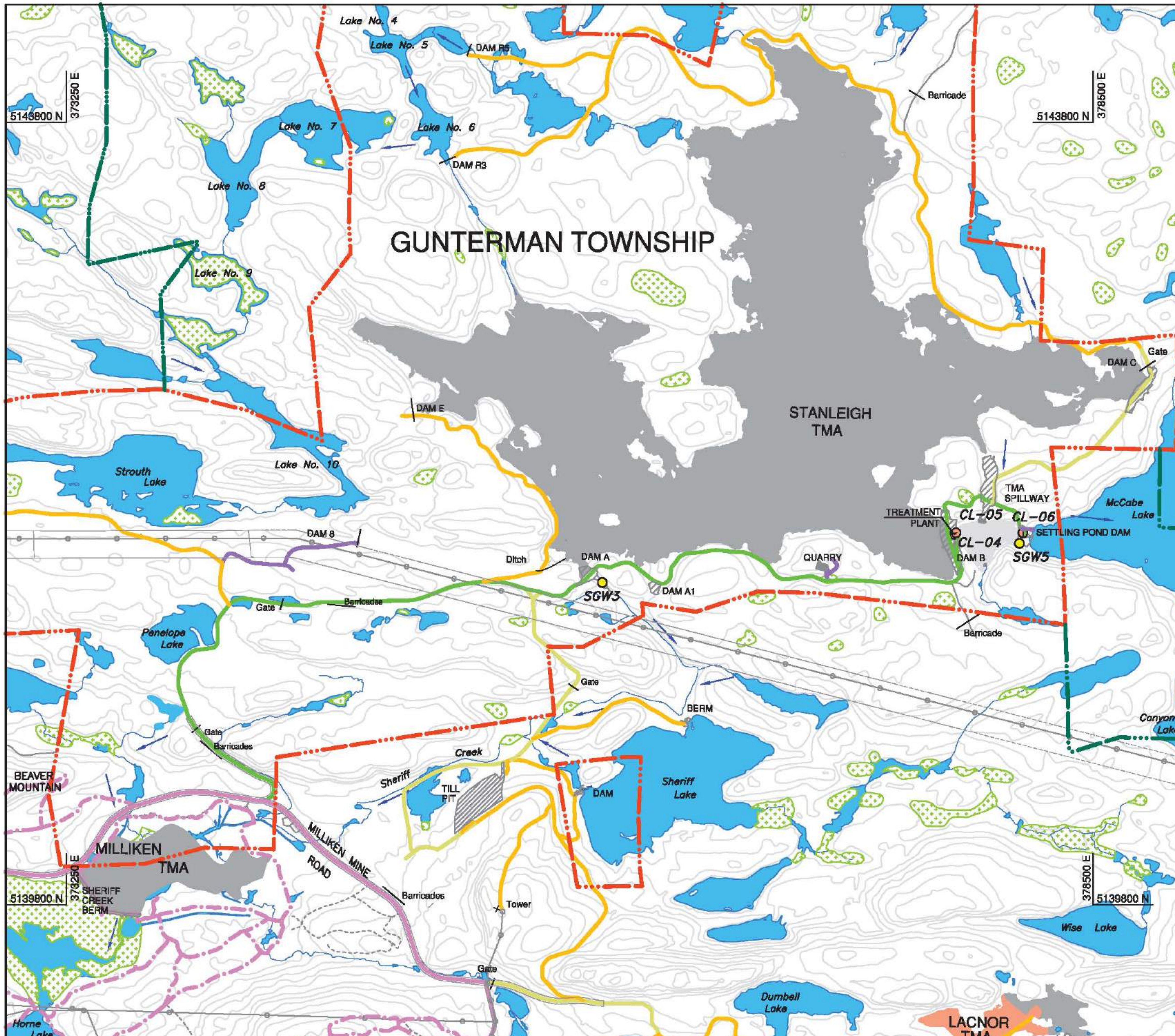
The Stanleigh TMA is located 5 km northeast of the City of Elliot Lake and contains 20 million tonnes of tailings from both the Milliken and Stanleigh mines and mills (Figure 3.25). During the initial operating period, 5.7 million tonnes were deposited in the west arm of the basin from the Milliken mill (1958 to 1964) and 1.7 million tonnes from the Stanleigh mill (1957 to 1960). In the mid-1960's, 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. Site improvements since decommissioning are detailed in Table 3.24 and below.

As part of the Stanleigh mill reactivation in the early 1980's, 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 and divert freshwater away from the TMA. Five low-permeability engineered structures were constructed at bedrock lows around the basin to form the 370-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. 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 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 3.25). Data from the Stanleigh TOMP stations are summarized in the following sections and presented in Appendix C (Appendix Tables C.6.2- C.6.5).



Rio Algom

SCALE

0 0.5 1.0 1.5 kms

N
W E
S

Legend

- vegetated tailings.
- water covered tailings.
- treatment solids.
- flow direction.
- limits of CNSC licence.
- limits of unlicenced property.
- public road.
- main access.
- secondary access.
- seasonal access.
- trail.
- public motorized trail.
- public non motorized trail.
- SAMP surface water sampling stations.
- TOMP surface water sampling stations.
- TOMP groundwater sampling stations.
- TOMP porewater sampling stations.
- SAMP and TOMP surface water sampling stations.
- power line.
- dams.
- swamp.

Notes

- Produced by Tulloch Geomatics Inc. under licence with the Ontario Ministry of Northern Development and Mines as well as the Ontario Ministry of Natural Resources © Queens Printer for Ontario, 2005.
- Mine structures, property limits and mapping details were derived from Rio Algom records, MNDM digital data.
- Mapping export parameters = NAD83 WGS_1984_ UTM_Zone_17N (Central Meridian = 81°W).
- Rev. 2015.01 November 2015.

Figure 3.25 PAUL N. TORRANCE SURVEYING LTD. GEOMATICS SERVICES minnow environmental inc.

Stanleigh Site SAMP and TOMP Monitoring Stations

Project No.: 2555
Date: February 2016

File Source: Stanleigh OCM Performance Monitoring 2015.01

Table 3.24: Stanleigh TMA site improvement undertakings since closure.

Year	Action	Rationale for Action
1998	Dams A1 and C newly constructed, Dam B replaced, and Dam A raised.	Submerge tailings with minimum 1.5 m water cover to inhibit oxidation and upgrade flood retention capacity.
1998 - 2001	Seasonal addition of in-situ lime slurry.	Increase pH and reduce metals in surface waters.
2007	Replaced existing sand filtration treatment plant with smaller gravity flow structure (new ETP) and constructed Settling Pond Dam for new settling pond. Raised TMA spillway by two feet to final elevation of 1207 feet.	Enable long-term, off-grid, robust treatment.
2008	Installed log boom upstream of Settling Pond Dam Spillway.	Prevent debris from entering spillway.
	Replaced culvert at southwest corner of TMA on Dam E access road with drive-through ditch.	Improve drainage and clearing of beaver debris and prevent ponding of water against Dam 8.
2012	Replaced flow monitoring weir at SR-05.	Achieve more accurate flow measurements.
2013	Remote Monitoring Network communications and centralized supervisory control and data acquisition system standardized and replaced.	Align remote monitoring approach across sites and improve reliability.

Table 3.25: Cycle 4 approved TOMP monitoring stations, substances, and frequencies[a] at Stanleigh TMA.

		Parameters and Frequencies[a]										
TOMP Stations	**Station Type/Purpose**	**Elevation**	**Flow**	**pH**	**Sulphate**	**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	M	W			W			M[c]
SGW-3, SGW-5[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.

3.6.2 Water Management

Water levels within the flooded basin were consistently between the minimum and maximum operating levels from 2010 to 2014 (Figure 3.26).

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 the final effluent (CL-06; Figure 3.25). Concentrations of radium-226, sulphate, and uranium have decreased and pH has increased to near neutral since basin flooding at ETP influent station CL-04 (Figure 3.27). Concentrations of sulphate and uranium are achieving 2012 predictions and radium-226 concentrations are near predicted values (Rio Algom 1995; Figure 3.27).

Surface water trends (2003-2014) indicate improvement based on significant reductions in barium, cobalt, manganese, radium-226, sulphate, and uranium in ETP influent (CL-04; Table 3.26; Appendix Figure C.6.1). The previous SOE report (Minnow 2011) showed increasing radium-226 concentrations within the TMA since 2004 which was assumed to be associated with a decrease in sulphate concentrations within the basin. With the addition of data from the current cycle (2010 to 2014), radium-226 concentrations were found to be decreasing despite lowering sulphate concentrations. This may be associated with the 2008 operating change to raise the lower operating elevation, thus decreasing fluctuations in basin water elevations, or it may be due to a general depletion of barium sulphate minerals, relative to other sulphate minerals. Influent pH achieves discharge criteria, however, basin water still requires treatment to achieve the discharge criterion for radium-226 (Appendix Table C.6.1).

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-5; Figure 3.25). Groundwater quality down gradient of Dam A (towards Sheriff Creek) has improved over the 1999 to 2014 period, with significant decreases in acidity, iron and sulphate concentrations and increases in pH (Table 3.27; Appendix Figure C.6.2). The groundwater monitoring station downstream of Dam B had insufficient data to perform trend analysis, as sampling at this station commenced in 2010. However, a review of the concentration data for this well indicates that measured groundwater quality is very good with pH and metal concentrations achieving surface water criteria and acidity below detection (Appendix Table C.6.5).

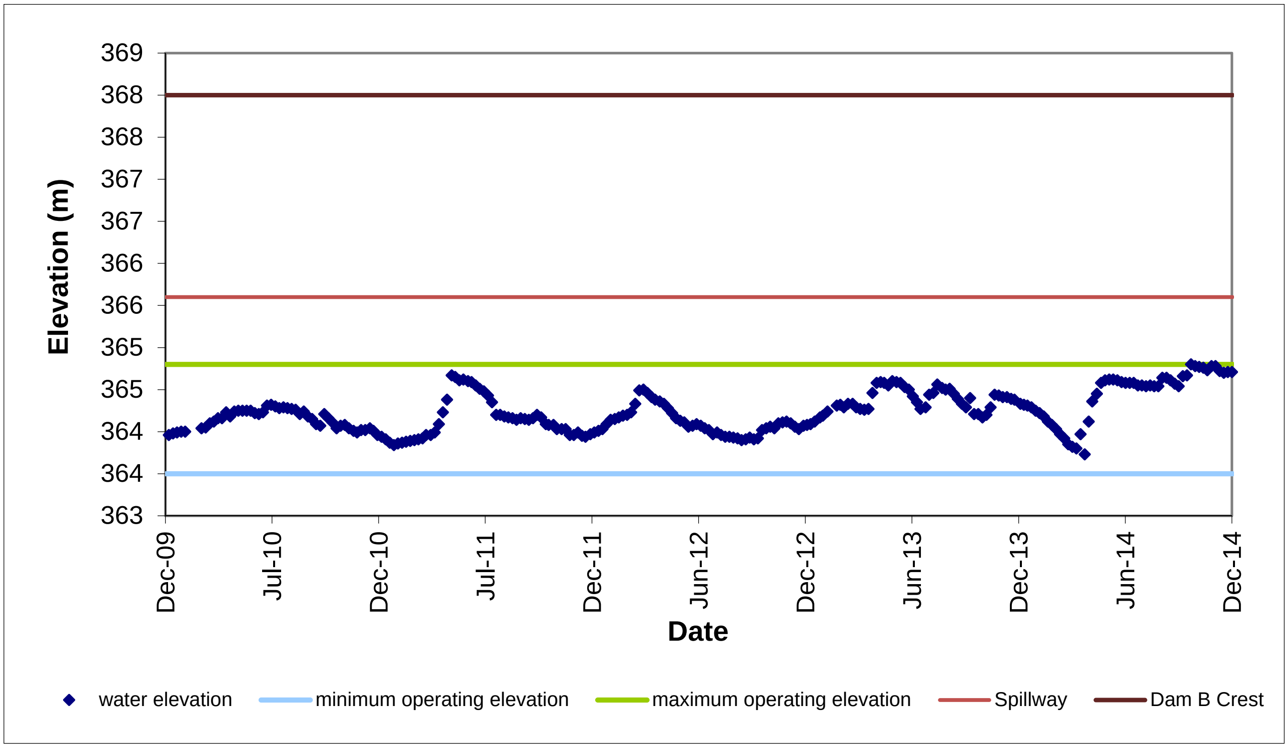


Figure 3.26: Water level at the Stanleigh TMA relative to minimum operating elevations.

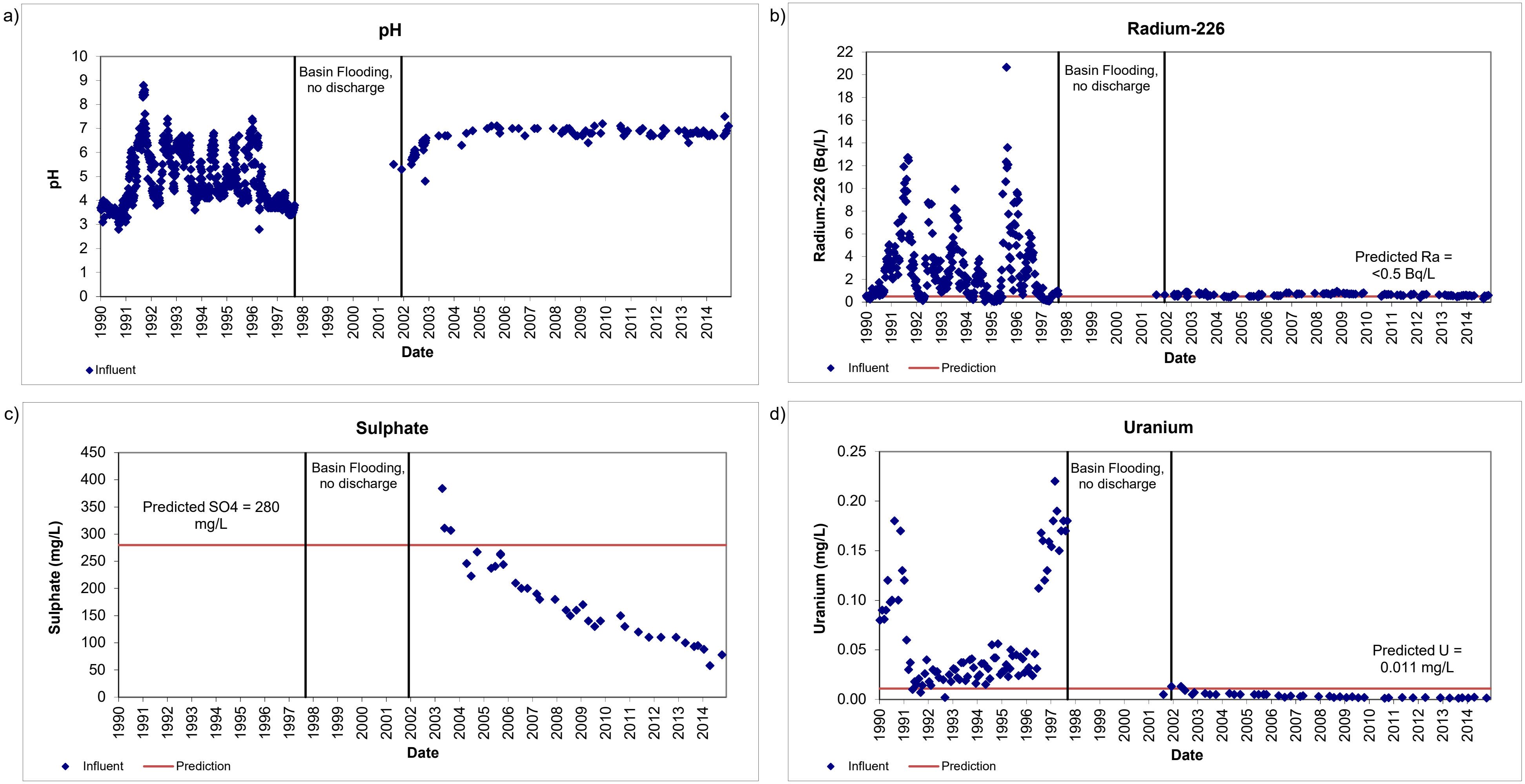


Figure 3.27: Water quality at the Stanleigh TMA ETP influent (CL-04) relative to predictions for 10 years (2012) post-decomissioning.

Table 3.26: Summary of water quality trends[a] for TOMP monitoring stations, Stanleigh TMA, 2003 to 2014.

Station ID	Type/Location	Number of Months Used in Common Trend[b]	Acidity	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium
CL-04	Treatment Plant Influent	2 to 10	0.183	-0.857	-0.626	-	-0.857	0.016	-0.286	-1.000	-0.815

decreasing trend, significant at $p<0.05$
increasing trend, significant at $p<0.05$

"-" 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).

[a] Common (combined) trends based on rank correlation coefficients (rho) for monthly trends, shown in Appendix Table C.6.6.

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

Table 3.27: Summary of water quality trends[a,b] in TOMP groundwater in Stanleigh TMA, 1999 to 2014.

Location	Station	Depth (m)	Dates	Acidity[a]	Iron	pH	Sulphate
Downgradient Dam A	SGW-3	6.04	1999-2014	-1.00	-0.979	0.976	-0.946
Downgradient Dam B	SGW-5	12.09	2010-2014	-	-	-	-

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

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

"-" 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).

[a] Due to a change in analytical technique for acidity in 2006, trends were assessed from 2007-2014.

[b] Common (combined) trends based on rank correlation coefficients (rho) for monthly trends, shown in Appendix Table C.6.7.

3.6.5 Treatment Performance

Treatment of basin surface water at the ETP includes both lime and barium chloride additions to reduce acidity and radium-226, respectively. Treatment volume and total reagent use fluctuated between years, but were higher in 2013 and 2014 (Figure 3.28). Barium chloride consumption rates have increased in recent years, associated with reduced treatment efficiencies at lower radium-226 and sulphate concentrations. However, consumption rates remain within the design range based on the Panel ETP which has similar influent. Lime consumption rates have remained stable despite increased volumes treated (Figure 3.28).

Following treatment, effluent quality is monitored at the settling pond outlet (CL-06), and over the past five years effluent quality has achieved discharge criteria (Figure 3.29; Appendix Table C.6.1). While one individual radium-226 concentration exceeded the monthly average discharge criterion in the fall of 2013, the value was well below the grab sample criterion of 1.11 Bq/L (Appendix Table D.6.1) and the monthly average remained below the compliance criterion of 0.37 Bq/L. Since 2010, effluent has been consistently non-lethal to *Daphnia magna* and rainbow trout, with no mortality reported in semi-annual acute toxicity tests (Table 3.28). Reproduction of *Ceriodaphnia dubia* was not affected by exposure to 100% effluent in any of the tests conducted over the past five years (Table 3.28).

3.6.6 Summary

Water levels within the flooded basin were consistently above the minimum operating level from 2010 to 2014. 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 twelve years (2003-2014) surface water has continued to improve with significant reductions in barium, cobalt, manganese, radium-226, sulphate, and uranium in the ETP influent. Groundwater conditions have been improving down-gradient of Dam A since TMA decommissioning. Since 2010, 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 (Figure 3.30). 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 a 17 hectare area 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

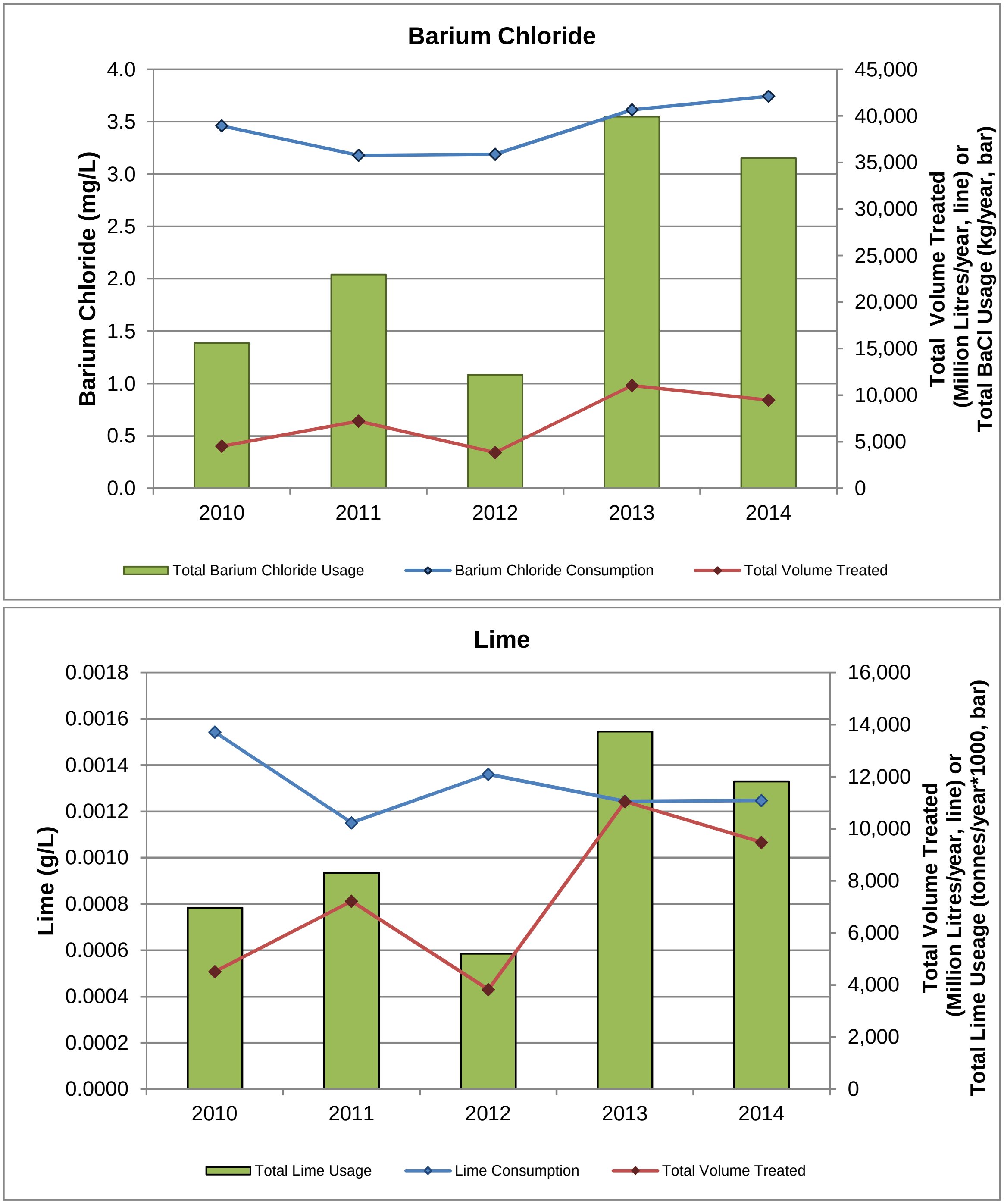


Figure 3.28: Comparison of total reagent consumed versus total volume treated at Stanleigh TMA from 2010-2014. (lime usage multiplied by 1000)

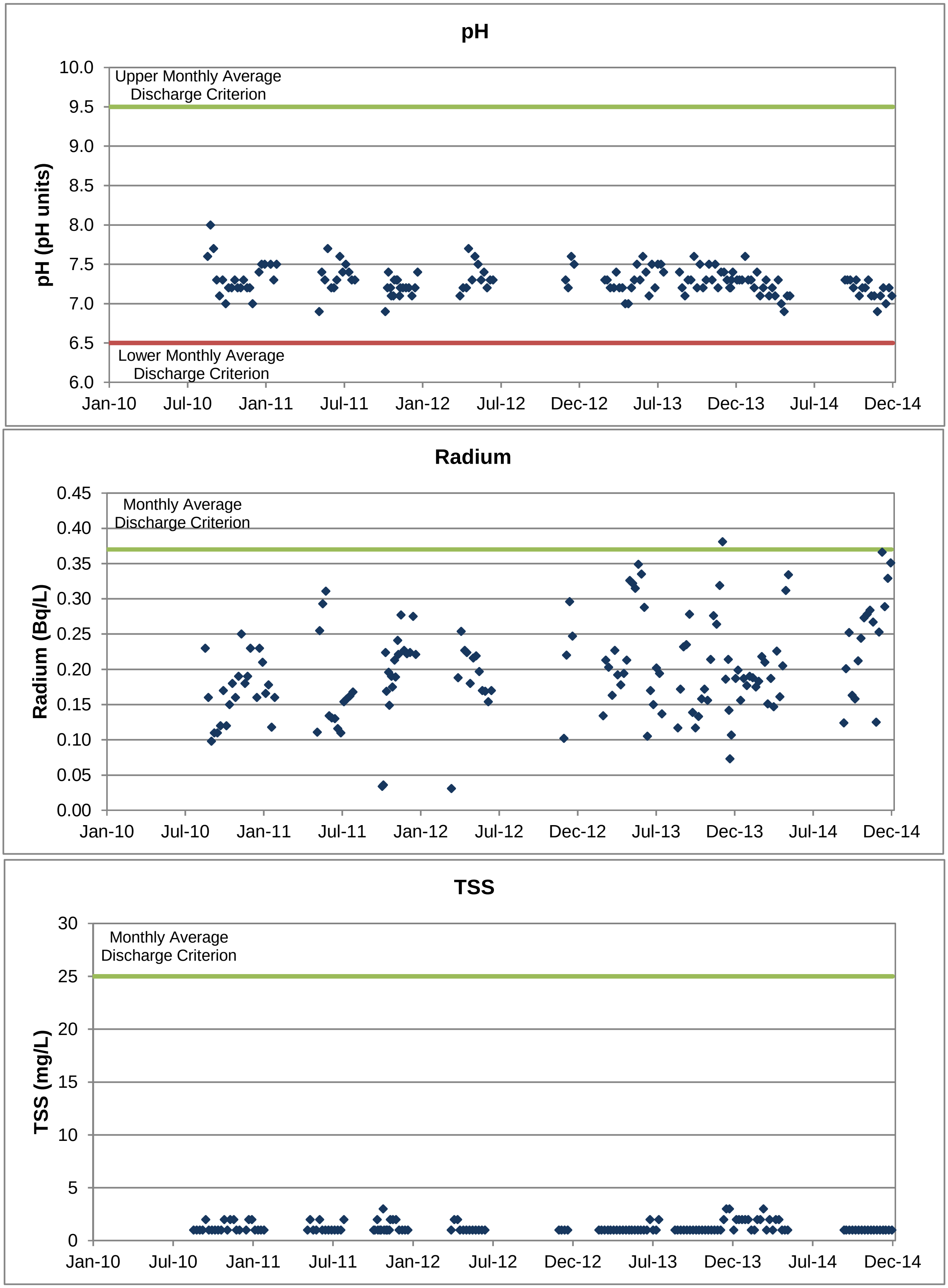


Figure 3.29: Effluent concentrations versus monthly average discharge criteria at Stanleigh TMA effluent station CL-06.

Table 3.28: Toxicity test results for samples collected at Stanleigh TMA station CL-06, 2010 - 2014.

Sample Date (month-year)	Acute Toxicity (% mortality)		Reproduction ($IC25^d$ as % effluent)
	Daphnia magna [a]	rainbow trout [b]	*Ceriodaphnia dubia* [c]
November-10	0	0	>100
June-11	0	0	- [e]
November-11	0	0	>100
May-12	0	0	>100
December-12	0	0	>100
May-13	0	0	>100
November-13	0	0	>100
May-14	0	0	>100
November-14	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.

[e] Outlier removed due to laboratory error.

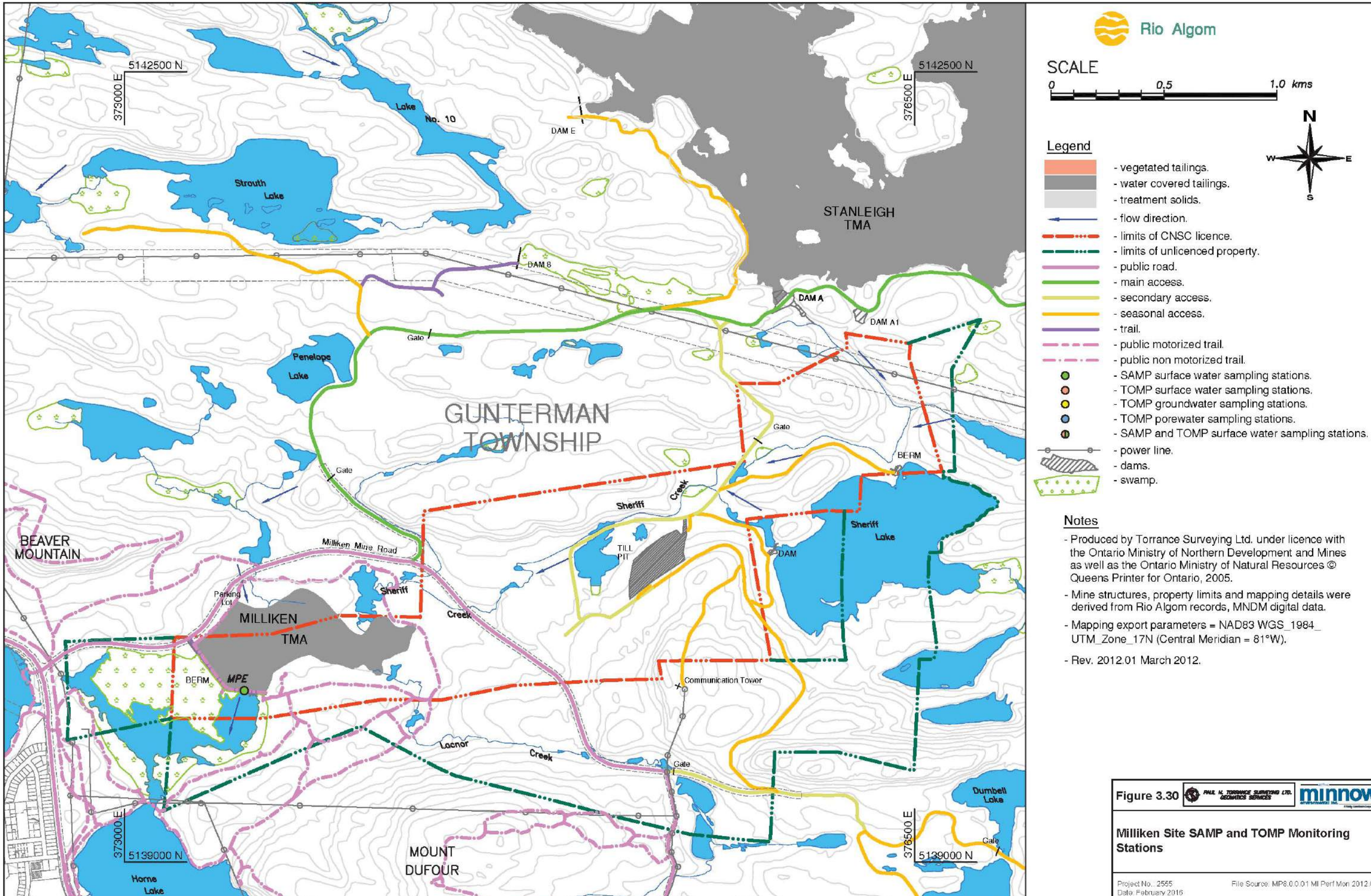


Figure 3.30 Milliken Site SAMP and TOMP Monitoring Stations

of the tailings to form playing fields and flooding the remaining tailings to form a wetland. Improvements to the Sheriff Creek Berm have been made several times during the past twenty years (Table 3.29). 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. 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 3.30). 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 3.30).

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. Water quality at MPE generally meets receiving water criteria (see Section 4.3 for a discussion of discharge quality).

Since 2010, 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 3.30). Similarly, reproduction of *Ceriodaphnia dubia* were not affected by exposure to 100% effluent, with the exception of one sample in May 2012 (Table 3.30).

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 3.31). The Lacnor TMA covers an area of 27 ha and has a watershed of 100 ha.

Table 3.29: Milliken TMA site improvement undertakings since closure.

Year	Action	Rationale for Action
1996	Sheriff Creek Berm riprap addition.	Prevent erosion of the berm attributed to water periodically overtopping the berm.
2005	Sheriff Creek Berm raised by 0.5 m, regraded with application of additional riprap.	Improve storm retention capacity and long-term stability.
2007	Sheriff Creek Berm foundation investigated and stability assessed.	Confirm stability meets current standards.
2010	Sheriff Lake Berm and Sheriff Lake Dam south abutment elevation restored to 1.6 m above Sheriff Lake Dam invert.	Conform with flood routing design.
2014	Sheriff Creek Berm spillway surveyed and beaver deceiver installed.	Confirm spillway invert is at design elevation; establish reference benchmark for on-going monitoring and reduce beaver debris management.

Table 3.30: Toxicity test results from samples collected at Milliken TMA station MPE, 2010 - 2014.

Sample Date (month-year)	Acute Toxicity (% mortality)		Reproduction (IC25[d] as % effluent)
	Daphnia magna [a]	rainbow trout [b]	*Ceriodaphnia dubia* [c]
May-10	0	0	>100
November-10	0	0	>100
May-11	0	0	>100
November-11	0	0	>100
May-12	0	0	3
November-12	0	0	>100
May-13	0	0	>100
November-13	0	0	>100
May-14	0	0	>100
November-14	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.

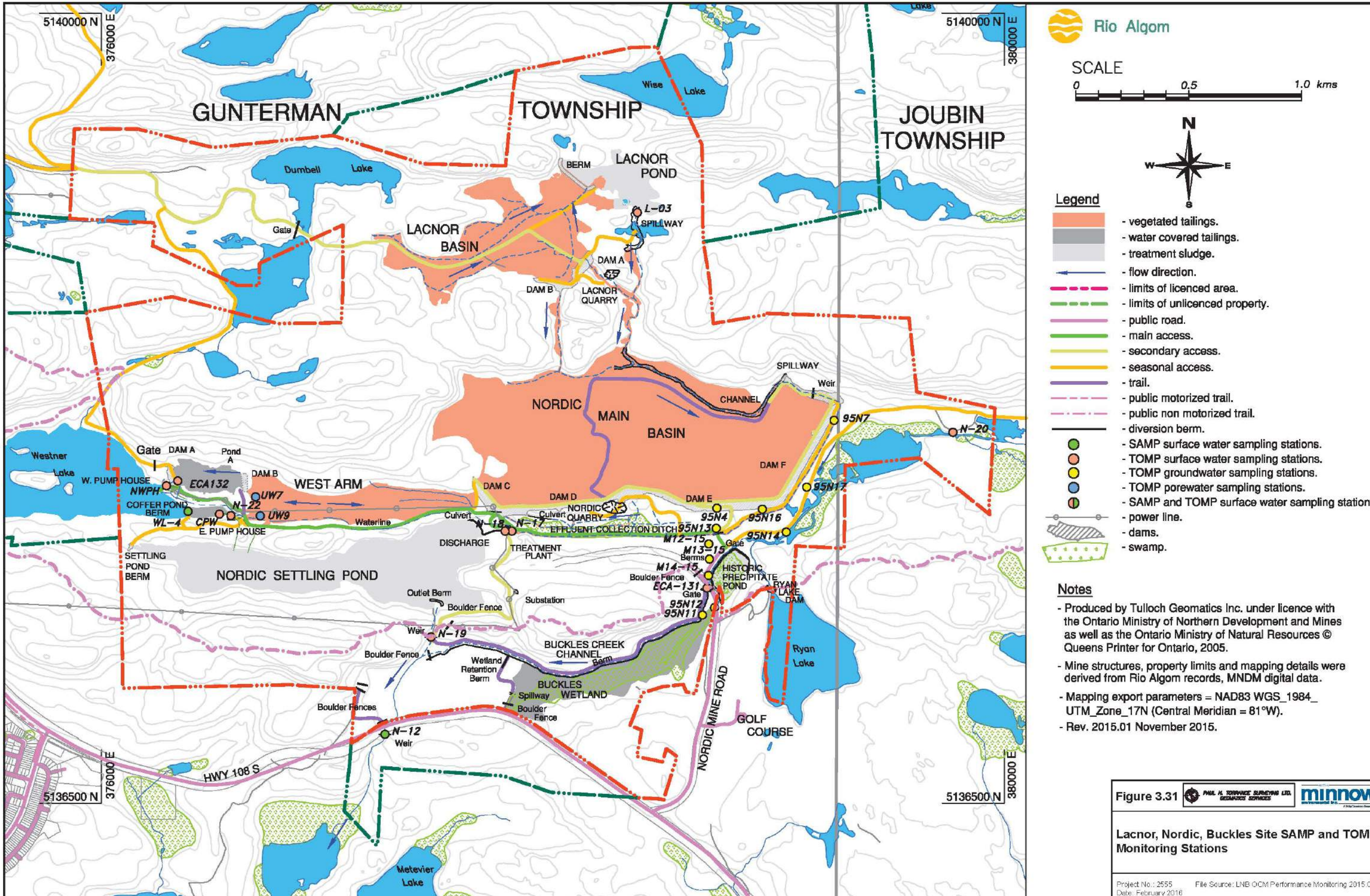


Figure 3.31

Lacnor, Nordic, Buckles Site SAMP and TOMP Monitoring Stations

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 (Table 3.31). 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 (Table 3.31), 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 3.31). Station L-03 monitors releases from the Lacnor TMA to the Nordic TMA (Table 3.32).

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 3.31).

The Nordic TMA was re-vegetated in the late 1970's (Rio Algom 2000). In 1998 and 1999, layers of rock 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 3.31). 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. 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 3.31). Site improvements have been made since 1999, which have primarily focused on stability of structures, management of flow and seepage interception (Table 3.33).

Within the Lacnor and Nordic TMAs, surface water, porewater and groundwater are monitored under the TOMP and the locations, substances and frequency monitored are specific to the

Table 3.31: Lacnor TMA site improvement undertakings since closure.

Year	Action	Rationale for Action
1970s	Original revegetation of tailings.	Establish vegetation.
1998-1999	Dams A and B slopes regraded to 2H:1V with incorporation of rockfill and toe berm. Lacnor Pond spillway capacity increased and concrete spillway installed.	Upgrade containment and flow control structures to current standards.
1998-1999	Rockfill and till soil cover applied to east end of TMA and then seeded.	Establish sustainable vegetative cover over poorly drained fine tailings.
2007	Northeast corner of TMA maintenance, including application of additional rockfill and till soil cover and deepening of drainage channel.	Establish sustainable vegetative cover over poorly drained fine tailings.

Table 3.32: Cycle 4 approved TOMP monitoring stations, substances, and frequencies[a] at Lacnor/Nordic TMA.

		Parameters and Frequencies[a]									
TOMP Stations	Station Type/Purpose	Elevation	Flow	pH	Sulphate	Radium-226	Lime or NaOH Consumption	TSS	Acidity	Iron	SAMP Metals[b]
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[e]	S	S	S			S		S
ECA-132	Basin performance (secondary)	M[d]	M[d]	M[d]	S	S			S		S
NWPH	Basin performance (secondary)		M[d]	S	S	S			S		S
ECA-131, N-20	Basin performance (secondary)			Q	Q	Q			Q		Q
CPW	Basin performance (secondary)	M[d]	M[d]	M[d]	S	S			S		S
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	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] 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.

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

[e] Sampled when treatment plant is operating.

Table 3.33: Nordic-Buckles TMA site improvement undertakings since closure.

Year	Action	Rationale for Action
1989	East and West Seepage Collection Berm construction.	Intercept West Arm seepage to Westner Lake and redirect to the Settling Pond.
1994	Effluent collection ditch lowered.	Improve interception of tailings porewater and reduce groundwater contamination.
1995 - 1994	West Arm application of rockfill and till cover followed by seeding.	Establish sustainable vegetative cover over poorly drained fine tailings.
1997	Settling Pond spillway excavated from bedrock and lowered.	Enable lowering of Effluent Collection Ditch to improve interception of tailings porewater and reduce groundwater contamination.
1998	North perimeter ditch deepened and levelled; Dam F spillway upgraded and flow control weir installed. Effluent Collection Ditch lowered along south perimeter of facility. Dam B breached, Dam A raised with slopes regraded to 2H:1V with incorporation of rockfill and addition of emergency spillway.	Upgrade containment and flow control structures to current standards. Improve interception of tailings porewater and reduce groundwater contamination.
1999	Dams C, D, E, F and Settling Pond Berm slopes regraded 2H:1V with incorporation of rockfill and addition of toe berm where applicable.	Upgrade containment and flow control structures to current standards.
	Treatment plant replaced.	Improve treatment reliability and incorporate instrumentation to enable remote monitoring and operation.
2002	24" culvert placed in the ground near collection ditch.	Act as a well for installation of submersible water pump.
2004	Coffer berm constructed downstream of East Collection Pond.	Facilitate removal of a small tailings spill.
	Engineered dam constructed at outlet of Westner Lake.	Replace the beaver dam that had been washed out to maintain lake water levels.
2005	Buckles Creek Diversion Channel berm grade restored and erosion protection added along 1.4 km section. Historic Precipitate Pond Berm grade restored and erosion protection added.	Stabilize water table in Buckles Wetland and Historic Precipitate Pond to reduce loadings to Buckles Creek.
	100 m^3 of tailings and lake bed sediments removed from east end of Westner Lake to west end of Nordic Settling Pond.	Remove exposed tailings from lake bottom discovered after beaver dam breach in fall of 2003.
	Nordic Settling Pond dredged - sludge off eastern shore of Settling Pond in immediate vicinity of treatment plant relocated to west end of Settling Pond.	Prevent sludge build-up near ETP and improve settling capacity.
2006	Buckles Creek stream bed raised at Nordic Mine Road.	Raise water elevation in Buckles Creek and increase hydraulic gradient towards Effluent Collection Ditch.
2007	N-19 weir replaced using sulphate resistant concrete.	Improve longevity of control structure.
2008	Minor earthworks completed in vicinity of pumphouses.	Enhance access and storm water routing, and minimize amount of sand and gravel washing into collection ponds.

Table 3.33: Nordic-Buckles TMA site improvement undertakings since closure.

Year	Action	Rationale for Action
2009	East and West Seepage Collection Pond, Coffer Pond and Pond A pumping and piping to Settling Pond upgraded.	Improve West Arm flood conveyance to manage a 1 in 100 year return, and 15-day rain-on-snow design hydrological event.
	Widening of crest of Buckles Creek Wetland retention berm and placement of additional rip rap protection on upstream face.	Improved stability.
	Installation of a gate at the Buckles Diversion Channel access trail.	Improve access to the N-19 final discharge point during periods of snow cover.
2012	Ryan Lake Outlet Structure replaced with an engineered structure. Precipitate Pond Berm design elevation restored with incorporation of rockfill. Restore design elevation and applied rip rap to Buckles Creek Emergency Spillway and Buckles Creek Control Spillway.	Improve flood conveyance and stability of Buckles Creek Diversion.
2013	Remote Monitoring Network communications and centralized supervisory control and data acquisition system standardized and replaced.	Align remote monitoring approach across sites and improve reliability.
2014	Treatment plant pH control sampling system modified.	Improve remote control of plant lime addition.
	Buckles Wetland spillway surveyed.	Confirm spillway invert is at design elevation; establish reference benchmark for on-going monitoring.

station type (Table 3.32). Data from the Lacnor and Nordic TOMP stations are summarized in the following sections and presented in Appendix C (Appendix Tables C.7.2- C.7.24).

3.8.2 Water Management

Water levels at the Lacnor pond were above the spillway invert over most of the 2010 to 2014 period, with only two measurements below the invert level (Figure 3.32). Water levels in the coffer pond have generally been below the maximum operating level, and above the normal operating levels (Figure 3.32). Pumping occurs from the coffer pond when water levels are above the normal operating level (334.5 masl).

3.8.3 Basin Surface Water Quality

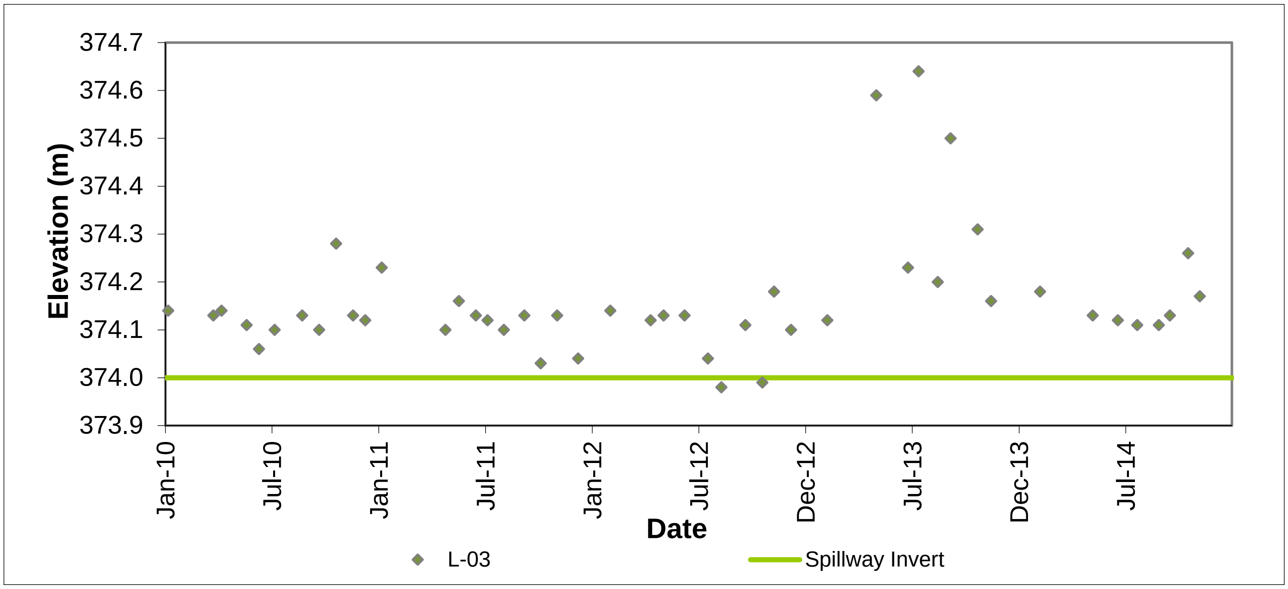
Surface water quality at the Lacnor/Nordic TMA is monitored at a number of stations to assess conditions associated with the various tailings deposits (Figure 3.31). Since 2003, sulphate and iron concentrations at L-03 (Lacnor outlet) have decreased significantly (Table 3.34; Appendix Figure C.7.1). 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 pH associated with the East Seepage Collection Pond (N-22) significantly increased between 2003 and 2014 (Table 3.34), though measurements remain acidic (pH 3; Appendix Figure C.7.4). At Nordic Pond A (ECA-132), pH has significantly decreased over the same period, however pH remains near neutral (Table 3.34, Appendix Figure C.7.6).

Decreasing concentrations of acidity, cobalt, radium-226, and sulphate and increasing pH upstream of the Buckles Creek wetland (ECA-131; Table 3.34, Appendix Figure C.7.5) 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. No trends were found at Buckles Creek upstream of the Nordic Plume (N-20, Table 3.34). At the Coffer Pond West station (CPW), radium-226 and sulphate have significantly decreased (Table 3.34, Appendix Figure C.7.7). Since 2003, water quality in the TMA influent (N-17) has significantly improved with decreasing concentrations of acidity, manganese, and uranium (Table 3.34; Appendix Figure C.7.2). Similarly, ETP effluent (N-19) has also improved over the past twelve years with significant decreases in manganese, radium-226, sulphate, and pH, though barium concentrations have increased over the same period (Table 3.34, Appendix Figure C.7.3).

3.8.4 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 (UW7 and UW9; Figure 3.31). Since 1993, iron has



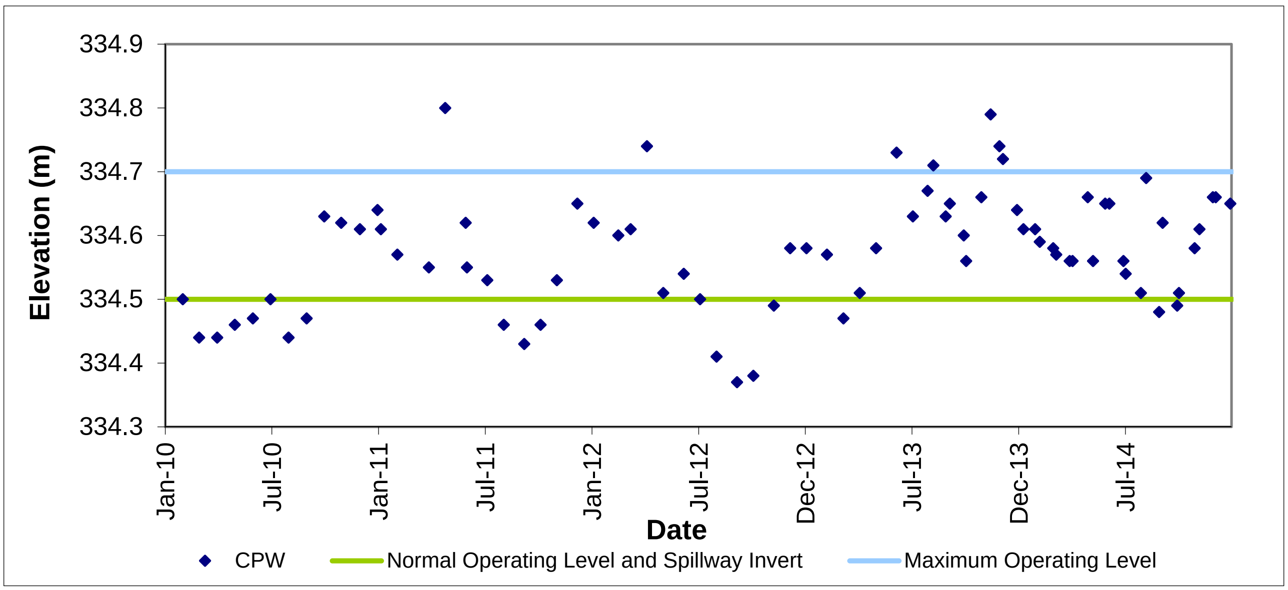


Figure 3.32: Water levels at the Lacnor-Nordic TMA relative to minimum operating elevations, 2010-2014.

Table 3.34: Summary of water quality trends[a] for TOMP monitoring stations, Lacnor/Nordic TMA, 2003 to 2014.

Station ID	Type/Location	Number of Months Used in Common Trend[b]	Acidity	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium
L-03	Lacnor Tailings Discharge	1 to 3	**-0.900**	**-0.667**	**-0.600**	-0.585	**-0.900**	0.017	-0.342	-0.770	-0.316
ECA-132	Nordic Pond A upstream of Westner seepage	1 to 12	ND	**-0.154**	**0.667**	**0.800**	**0.500**	-0.358	0.178	**-0.900**	**-0.616**
N-22	West Arm Pump Discharge (East Seepage Collection Pond)	1 to 2	-0.282	**-0.894**	**-0.500**	**-0.500**	**-0.600**	0.627	-0.313	**-0.500**	**-0.300**
N-20	Buckles Creek Upstream of Nordic Plume	3 to 8	ND	-0.085	0.052	-0.339	-0.400	0.146	-0.044	-0.370	-0.707
ECA-131	Buckles Creek at Mine Road	3 to 6	-0.681	-0.539	-0.577	-0.267	-0.267	0.376	-0.628	-0.544	ND
NWPH	North West Pump House	2 to 12	ND	-0.225	0.056	-0.665	-0.092	0.108	-0.131	-0.369	0.007
CPW	Coffer Pond West	1 to 12	**-0.707**	-0.154	0.150	0.100	0.150	-0.078	-0.811	-0.734	-0.493
N-17	Treatment Plant Influent	4 to 12	-0.383	0.245	-0.338	0.000	-0.365	0.169	-0.125	-0.164	-0.438
N-19	Final Treated Effluent	12	-	0.240	-0.075	*-0.218*	-0.182	-0.296	-0.303	-0.503	-0.153

decreasing trend, significant at $p<0.05$
increasing trend, significant at $p<0.05$

"-" 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).

Italic text - mean monthly correlations significantly different, but common trend value provided.

Bold text - only one month was used in common trend analysis.

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.

[a] Common (combined) trends based on rank correlation coefficients (rho) for monthly trends, shown in Appendix Table C.7.25 to C.7.33.

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

been significantly decreasing at both porewater locations (Table 3.35). Iron concentrations at UW7-4 (shallowest depth) have decreased from about 2,000 mg/L in 1993 to about 84 mg/L in 2014 (Appendix Figure C.7.9). Sulphate was found to be significantly decreasing at UW7-4 (5 m), but was significantly increasing at UW9-3 (4 m) (Table 3.35; Appendix Figure C.7.8 and C.7.9). Porewater pH at the north end of the West Arm (UW7) has significantly increased in the deepest well to near neutral and reflects a step change improvement following the upgrading of Dam A in 2000 (Table 3.35; Appendix Figure C.7.9).

3.8.5 Groundwater Quality

Groundwater quality is monitored annually at several locations down-gradient of the Nordic TMA (Figure 3.31) to assess the effectiveness of measures to remediate the plume migrating south from the Main Tailings Basin. Generally, groundwater quality has been improving over time with decreasing concentrations of acidity, iron and sulphate and increasing pH at most locations where trends were observed (Table 3.35). Groundwater iron concentrations have been significantly decreasing at nearly all stations in the vicinity of the Nordic TMA, with the exception of two stations towards the southeast corner of the TMA (95N-17 and 95N-14, Table 3.35, Appendix Figures C.7.10 to C.7.20). 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 3.35; Appendix Figures C.7.13 to C.7.15). Similar improvements in sulphate concentrations have been noted as well, which are likely associated with lower oxidation of tailings (Table 3.35; Appendix Figures C.7.13 to C.7.15).

Remedial measures were undertaken down-gradient of the Nordic Main TMA and ECD to reduce Nordic groundwater seepage to Buckles Creek. In 1994, the ECD was 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 3.35; Appendix Figures C.7.10 to C.7.12 and C.7.16 to C.7.20). At well 95N-12, however, pH decreased significantly (Table 3.35; Appendix Figure C.7.16), though measurements remain near neutral. 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 2011c).

3.8.6 Treatment Performance

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-226 is co-precipitated with the iron

Table 3.35: Summary of water quality trends[a,b] in TOMP porewater and groundwater in Lacnor/Nordic TMA, 1993[c] to 2014.

Type	Location	Station	Depth (m)	Dates	Acidity[a]	Iron	pH	Sulphate
Porewater	Nordic west arm, porewater north	UW7-4	5.14	1993-2014	-0.929	-0.941	0.396	-0.789
		UW7-2	8.23	1993-2014	ND	0.044	-0.091	0.496
		UW7-6	16	1996-2014	ND	-0.409	0.64	0.197
	Nordic west arm, porewater south	UW9-3	4.27	1993-2014	0.214	0.356	-0.438	0.67
		UW9-2	6.4	1993-2014	-0.491	-0.644	0.266	-0.292
		UW9-1	8.53	1993-2014	-0.548	-0.829	0.343	-0.471
Groundwater	Downgradient of ECD at northeast corner Nordic main	95N-7B	3.69	1995-2014	0.548	-0.484	-0.462	0.421
		95N-7A	7.72	1995-2014	-0.554	-0.694	-0.33	-0.243
	Downgradient of ECD at east perimeter Nordic main	95N-17C	3.49	1995-2014	ND	0.28	-0.03	0.155
		95N-17B	8.09	1995-2014	ND	0.595	-0.104	-0.545
		95N-17A	12.68	1995-2014	ND	0.546	0.143	-0.534
	Downgradient of ECD at southeast corner Nordic main	95N-14C	3.49	1995-2014	ND	0.372	-0.083	-0.303
		95N-14B	7.6	1995-2014	ND	0.553	-0.287	-0.282
		95N-14A	11.39	1995-2014	ND	-0.27	0.417	-0.372
	Upgradient of ECD at head Nordic plume	95N-13E	2.82	1995-2014	-0.214	-0.879	0.782	-0.555
		95N-13C	9.61	1995-2014	-0.096	-0.919	0.515	-0.78
		95N-13A	15.36	1995-2014	-0.762	-0.935	0.421	-0.531
	Upgradient of ECD at southeast corner Nordic main	95N-16E	3.86	1995-2014	-0.524	-0.936	0.724	-0.86
		95N-16C	11.03	1995-2014	-0.310	-0.858	0.723	-0.826
		95N-16A	18.21	1995-2014	-0.810	-0.94	0.665	-0.664
	Upgradient of ECD at south perimeter Nordic main	95N-4B	5.31	1995-2014	-0.738	-0.904	-0.461	-0.809
		95N-4A	9.91	1995-2014	-0.786	-0.627	0.585	-0.073
	Downgradient of ECD, south of M-14; adjacent to ECA-131	95N-12B	3.67	1995-2014	ND	-0.296	-0.59	-0.816
		95N-12A	6.87	1995-2014	ND	0.006	-0.528	-0.342
	Downgradient of ECD, south of 95N-12	95N-11	4.34	1995-2014	-0.755	-0.84	-0.255	0.671
	Downgradient of ECD south of 95N-13	M-12-9	2.5	1994-2014	-0.756	-0.23	0.904	-0.823
		M-12-6	5.49	1993-2014	-0.491	-0.791	0.877	-0.888
		M-12-3	6.54	1993-2014	-0.429	-0.605	0.743	-0.588
		M-12-1	13.41	1993-2014	-0.455	-0.096	0.842	0.193
	Downgradient of ECD south of M-12	M-13-9	2.04	1993-2014	-0.761	-0.467	0.389	-0.924
		M-13-6	5.46	1993-2014	0.600	-0.915	0.781	-0.964
		M-13-3	6.43	1993-2014	-0.611	-0.67	0.852	-0.855
		M-13-1	11.46	1994-2014	-1.00	-0.437	0.598	-0.909
	Downgradient of ECD south of M-13; west of historic precipitate pond	M-14-9	1.8	1998-2014	ND	0.014	0.638	-0.874
		M-14-6	3.84	1998-2014	-0.875	-0.837	0.402	-0.842
		M-14-1	8.75	1998-2014	-0.893	-0.907	0.484	-0.648
		M-14-3	12.83	1998-2014	-0.786	-0.066	0.413	-0.534

decreasing trend, significant at $p<0.05$

increasing trend, significant at $p<0.05$

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.

[a] Due to a change in analytical technique for acidity in 2006, trends were assessed from 2007-2014.

[b] Common (combined) trends based on rank correlation coefficients (rho) for monthly trends, shown in Appendix Table C.7.34 to C.7.35.

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

hydroxides formed by lime addition and treatment plant influent (N-17) has met radium-226 discharge criteria. Total annual lime consumption has remained relatively stable over past five years, with some fluctuation in consumption rates (Figure 3.33).

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, with the exception of one pH measurement in 2012 (Figure 3.34; Appendix Table C.7.1). Effluent has also been consistently non-lethal to *Daphnia magna* and rainbow trout, with only one low-mortality event reported for rainbow trout in semi-annual acute toxicity tests (Table 3.36). Similarly, reproduction of *Ceriodaphnia dubia* was not affected by exposure to 100% effluent in all but one test conducted over the past five years (Table 3.36).

3.8.7 Summary

Surface water quality has improved in all areas of the Lacnor/Nordic TMA with decreasing concentrations observed for acidity, cobalt, manganese, radium-226 and sulphate and pH generally approaching near-neutral at various sites. The improvements are the result of remedial measures implemented at the TMA and presumed lower oxidation rates within the tailings. Porewater associated with the Nordic West Arm has generally been stable or improved, as indicated by decreasing iron and sulphate concentrations and increasing pH levels, although sulphate is increasing at UW9. 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 tailings. In the past five, years treated effluent consistently achieved discharge criteria and nearly all acute toxicity tests on *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. The vegetated 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 3.35).

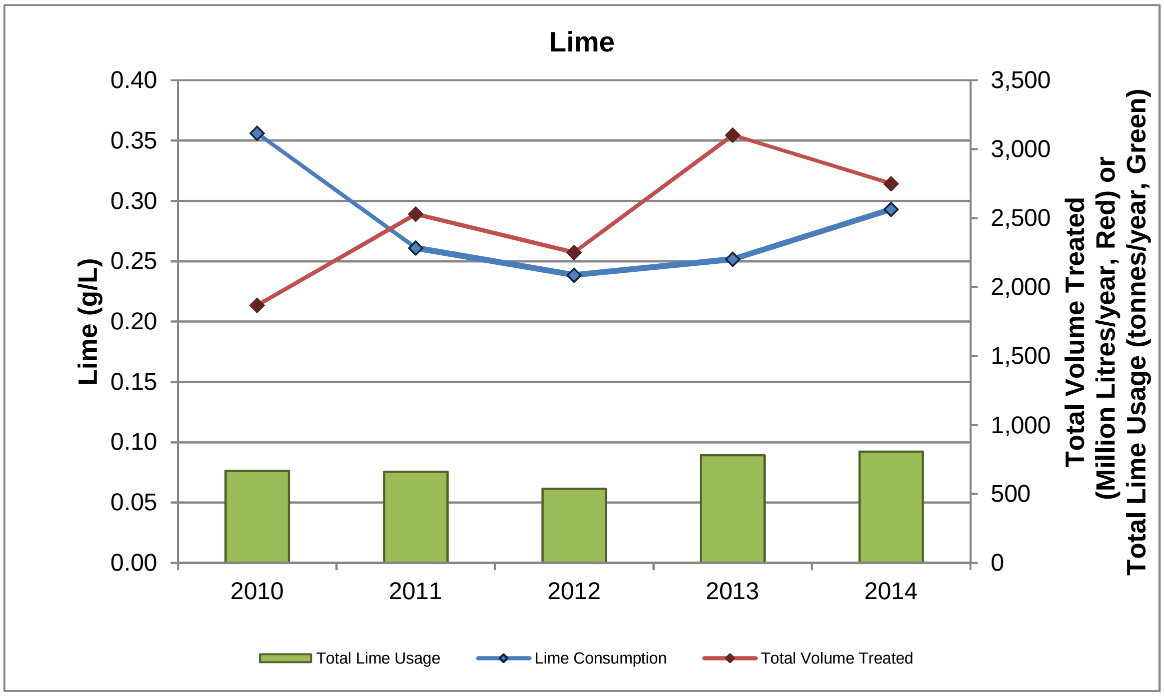


Figure 3.33: Comparison of total reagent consumed versus total volume treated at Nordic TMA from 2010-2014.

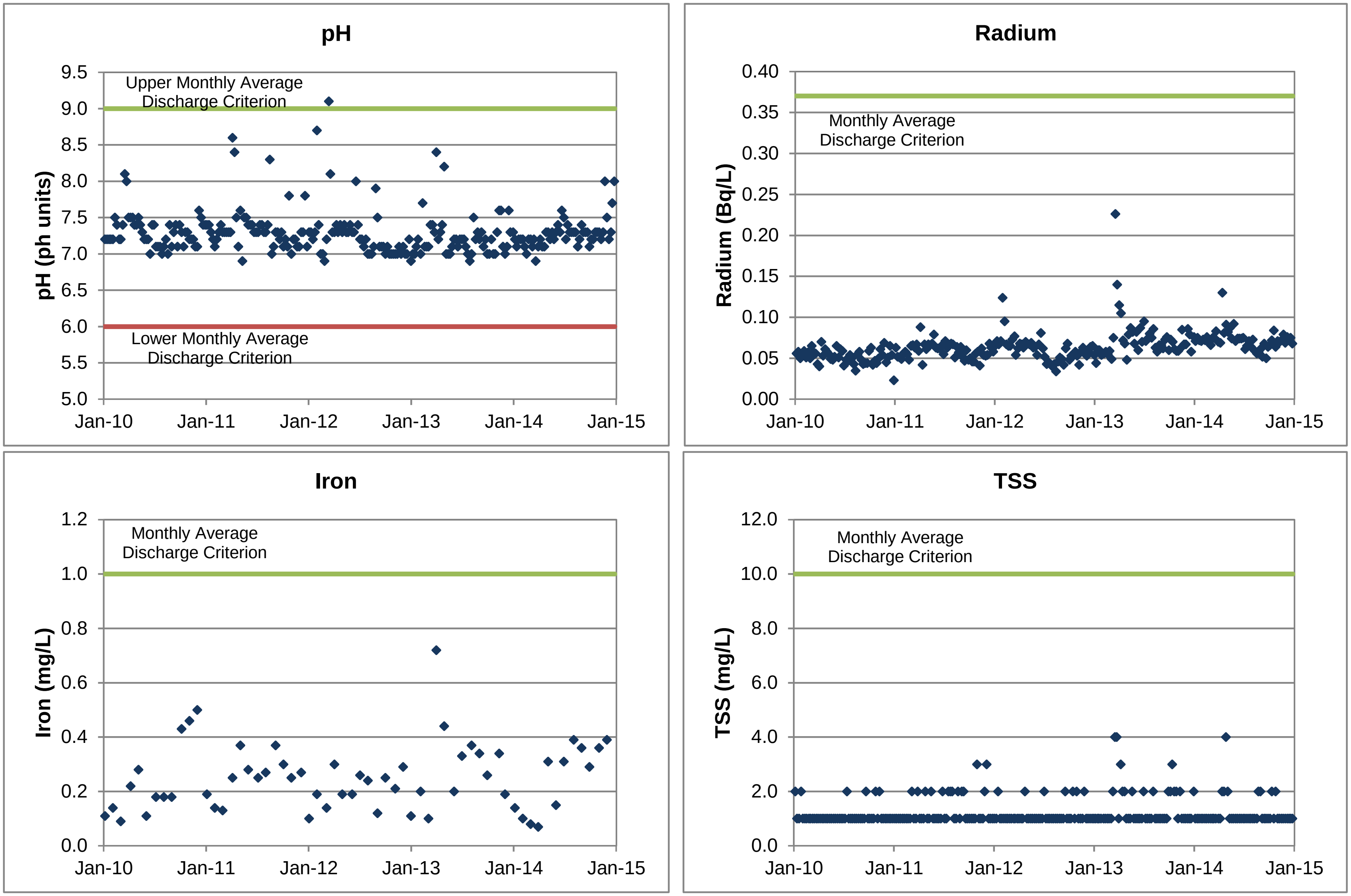


Figure 3.34: Effluent concentrations versus monthly average discharge criteria at Nordic TMA station N-19.

Table 3.36: Toxicity test results from samples collected at Lacnor/Nordic TMA station N-12, 2010 - 2014.

Sample Date (month-year)	Acute Toxicity (% mortality)		Reproduction (IC25[d] as % effluent)
	Daphnia magna [a]	rainbow trout [b]	*Ceriodaphnia dubia* [c]
May-10	0	0	>100
November-10	0	0	>100
June-11	0	0	- [e]
October-11	0	0	>100
May-12	0	0	39
November-12	0	10	>100
May-13	0	0	>100
November-13	0	0	>100
June-14	0	0	>100
November-14	0	0	>100

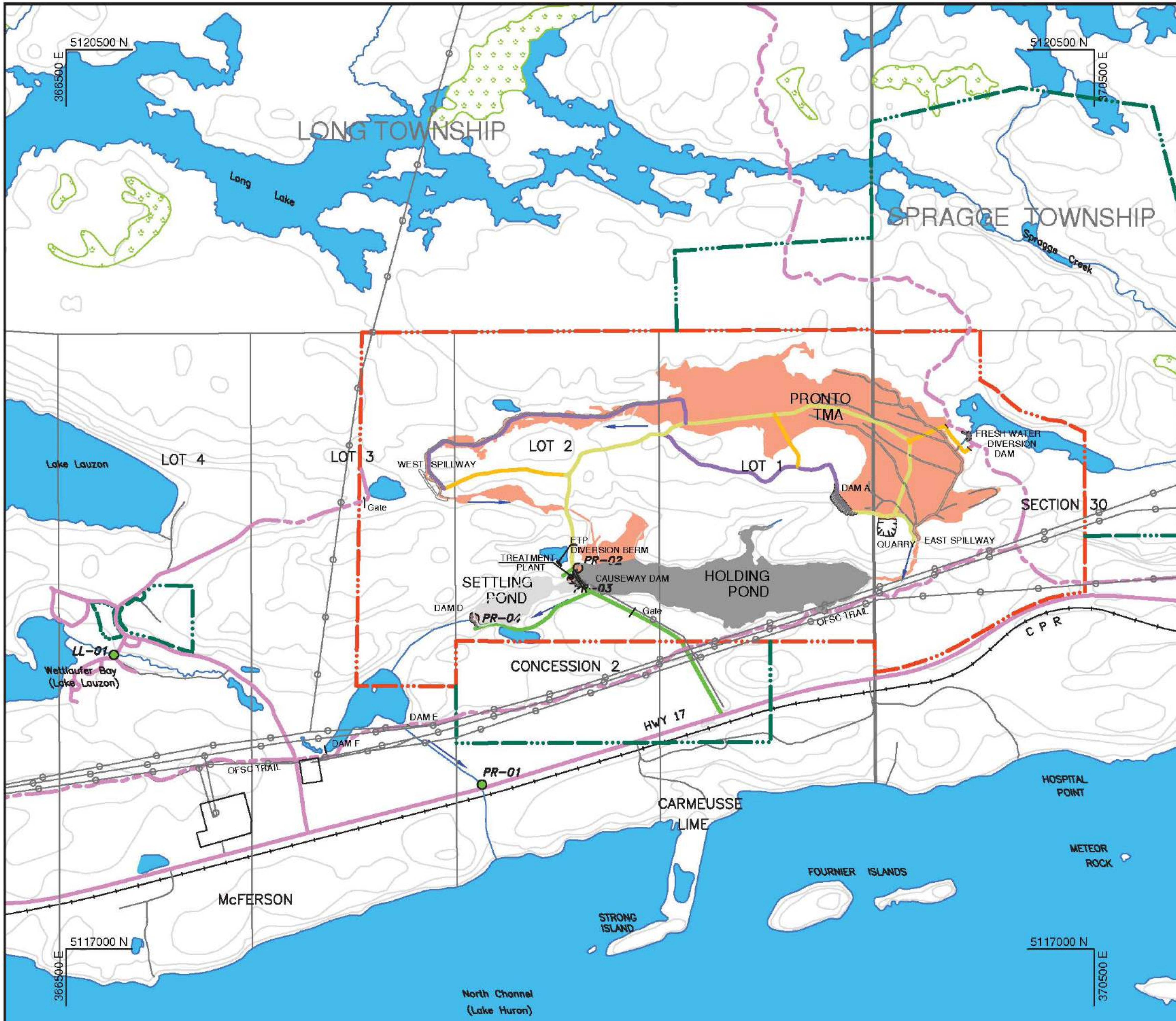
[a] *Daphnia magna* 48-hr LC50 test (Environment Canada 2000a).

[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.

[e] Outlier removed due to laboratory error.



Rio Algom

SCALE

0 0.5 1.0 kms

N W E S

Legend

- vegetated tailings.
- water covered tailings.
- treatment solids.
- flow direction.
- limits of CNSC licence.
- limits of unlicenced property.
- public road.
- main access.
- secondary access.
- seasonal access.
- trail.
- public motorized trail.
- public non motorized trail.
- SAMP surface water sampling stations.
- TOMP surface water sampling stations.
- TOMP groundwater sampling stations.
- TOMP porewater sampling stations.
- SAMP and TOMP surface water sampling stations.
- power line.
- dams.
- swamp.

Notes

- Produced by Tulloch Geomatics Inc. under licence with the Ontario Ministry of Northern Development and Mines as well as the Ontario Ministry of Natural Resources © Queens Printer for Ontario, 2005.
- Mine structures, property limits and mapping details were derived from Rio Algom records, MNDM digital data.
- Mapping export parameters = NAD83 WGS_1984_ UTM_Zone_17N (Central Meridian = 81°W).
- Rev. 2013.02 May 2013.

Figure 3.35 PAUL H. TORRANCE SURVEYING LTD. GEOMATICS SERVICES minnow

Pronto Site SAMP and TOMP Monitoring Stations

Project No.: 2555
Date: February 2016
File Source: MP8.0.0.01 PR Perf Mon 2013.02

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. Modifications were made to the TMA from 1999 to 2001 (Table 3.37), which have been effective in maintaining a 100% vegetative cover. Other site improvements have been made since 2001 to manage on-site flow, stability, vegetative cover, and effluent treatment (Table 3.37).

Within the TMA, surface water is monitored under the TOMP and the locations, substances and frequency monitored are specific to the station type (Table 3.38) Data from the Pronto 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 3.36).

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 3.35). Over the past twenty years, concentrations of radium-226 and pH levels have remained relatively stable at station PR-02, while some reduction in sulphate was observed in the past ten years, and, more recently, some reduction in uranium (Figure 3.37). Over the 2003 to 2014 period, there have been significant reductions in surface water at PR-02 for acidity and uranium concentrations and a significant increase in pH levels, although pH levels remain low (pH 3; Table 3.39; Appendix Figure C.8.1). Concentrations of barium, sulphate, and uranium have been decreasing in treated effluent, while iron concentrations have been increasing and pH has been decreasing (Table 3.39, Appendix Figure C.8.2).

3.9.4 Treatment Performance

Treatment at the ETP has included both lime and barium chloride to reduce acidity and radium-226, respectively. However, since 2009, barium has not been used in the treatment process because co-precipitation with lime was sufficient to reduce radium-226 levels to less than the discharge criterion. The lime consumption rate has decreased over the 5 year period, while total usage has remained stable and total volume treated has increased (Figure 3.38).

Table 3.37: Pronto TMA site improvement undertakings since closure.

Year	Action	Rationale for Action
1997	Dam D raised and a stop-log structure installed.	Increase Settling Pond retention time and provide contingency to stop discharge during upset conditions.
	New treatment facility constructed.	Improve treatment reliability and incorporate instrumentation to enable remote monitoring and operation.
1998 - 1999	Dam A slope regraded to 2H:1V with incorporation of rockfill and toe berm. Causeway Dam upgraded. Dam F raised to elevation 193.0 m and toe berm added. West and East spillways upgraded. Freshwater Diversion Dam constructed. Dredging of settling pond with sludge being deposited via slurry line to central area of collection basin.	Upgrade containment and flow control structures to current standards. Improve Settling Pond capacity.
1999-2001	East arm vegetation improvement consisting of 6 tonnes/ha of limestone and 500 kg/ha of fertilizer applied to bare areas, with 30 cm depth of biosolids (paper mill sludge).	Establish sustainable vegetative cover over poorly drained fine tailings.
2007	Dam F raised to crest elevation of 193.7 m, and inclined seepage barrier installed upstream. Restore Dam E Spillway elevation to 191.3.	Reduce seepage observed in August 2006 and increase storage capacity of downstream pond to improve containment during failure of upstream Causeway Dam, in conformance with Canadian Dam Safety hazard potential classification methodology.
2009	Saddle berm constructed north of the Fresh Water Diversion Berm.	Close off topographic low located north of Freshwater Diversion Berm identified in 2008 Dam Safety Inspection.
	Lime reject pile toe covered with coarse rockfill and soil cover.	Establish sustainable vegetative cover over poorly drained fine lime rejects.
2012	Excavation of shallow swale along toe of lime reject pile.	To collect and drain seepage water across berm toe and bring it over to the treatment plant head-pond for treatment.
	Modification to logic programming for lime pump operation.	Ensure ETP shuts down as required, on command and in response to pH alarm.
2013	Remote Monitoring Network communications and centralized supervisory control and data acquisition system standardized and replaced.	Align remote monitoring approach across sites and improve reliability.
2014	Dam E spillway survey.	Confirm spillway invert is at design elevation; establish reference benchmark for on-going monitoring and beaver debris management.

Table 3.38: Cycle 4 approved TOMP monitoring stations, substances, and frequencies[a] at Pronto TMA.

TOMP Stations	Station Type/Purpose	Parameters and Frequencies[a]: Elevation	Flow	pH	Sulphate	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.

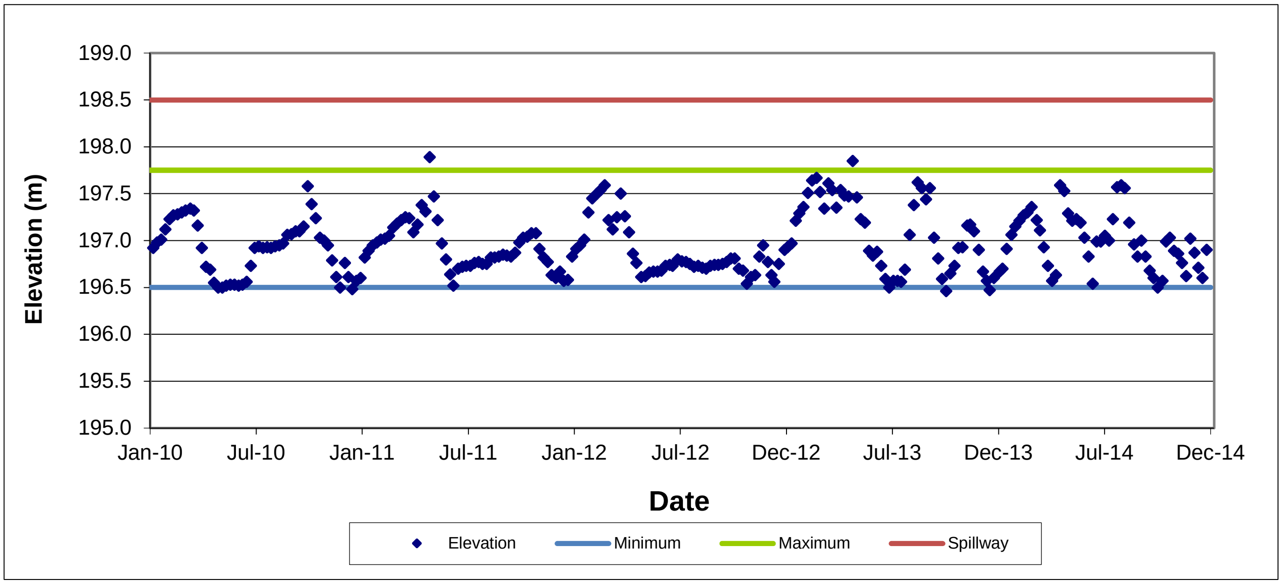


Figure 3.36: Water level at PR-02 relative to minimum operating elevation, 2010-2014.

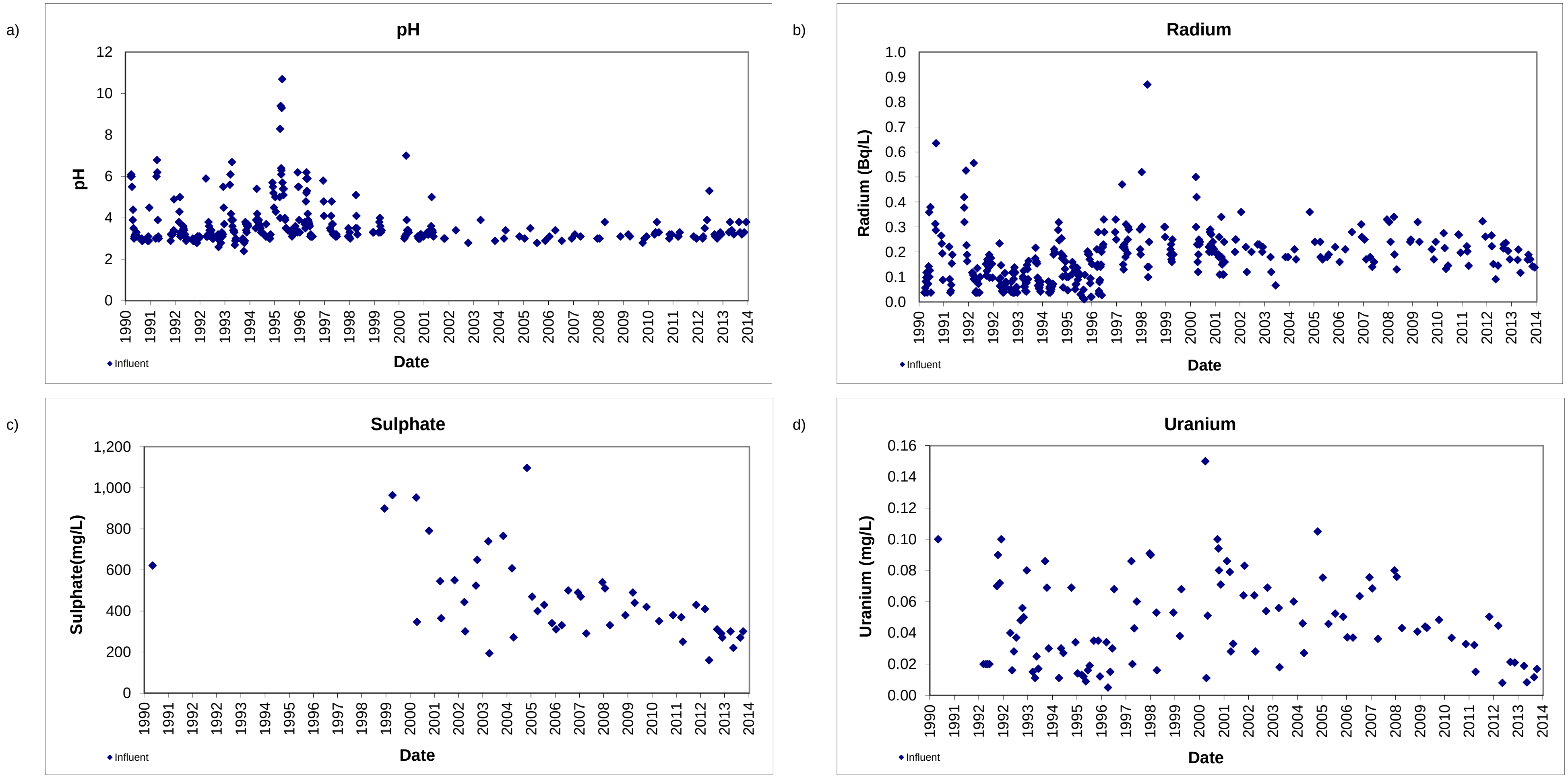


Figure 3.37: Water quality at the influent (PR-02) of the Pronto TMA treatment plant.

Table 3.39: Summary of water quality trends[a] for TOMP monitoring stations, Pronto TMA, 2003 to 2014.

Station ID	Type/Location	Number of Months Used in Common Trend[b]	Acidity	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium
PR-02	Treatment Plant Influent	1 to 8	-0.643	0.196	-0.365	-	**0.571**	0.487	-0.175	-0.414	-0.568
PR-04	Final Treated Effluent	3 to 8	-	-0.727	0.001	0.700	-0.045	-0.528	0.073	-0.631	-0.583

(blue) decreasing trend, significant at p<0.05
(green) increasing trend, significant at p<0.05
"-" 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).
Bold text - only one month was used in common trend analysis.
[a] Common (combined) trends based on rank correlation coefficients (rho) for monthly trends, shown in Appendix Table C.8.5 to C.8.6.
[b] Months used varied for substances based on suitability of data for trend analysis.

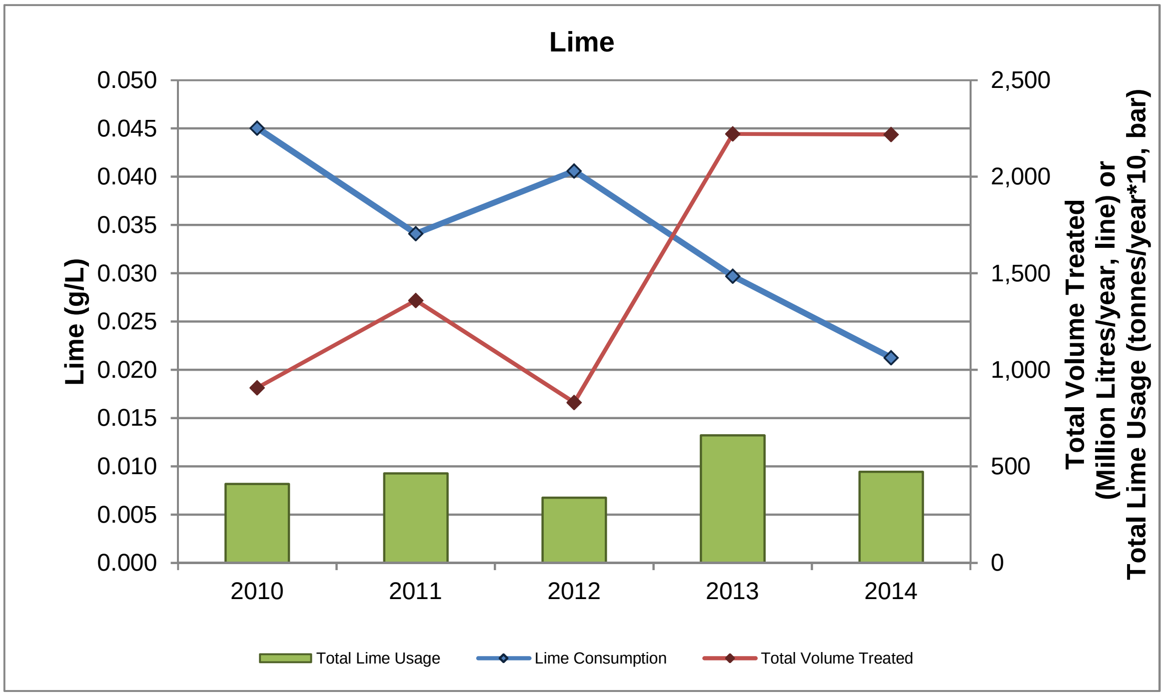


Figure 3.38: Comparison of total reagent consumed versus total volume treated at Pronto TMA from 2010-2014. (lime usage multiplied by 10)

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 3.39; Appendix Table C.8.1). Effluent has been consistently non-lethal to *Daphnia magna* and rainbow trout, with no mortality reported in semi-annual acute toxicity tests (Table 3.40). Similarly, reproduction of *Ceriodaphnia dubia* was not affected by exposure to 100% effluent in any tests conducted over the past five years (Table 3.40).

3.9.5 Summary

Water levels within the Holding Pond have been maintained above the minimum operating levels. Surface water quality has had decreasing acidity and uranium concentrations and increasing pH levels. In the past five years, treated effluent consistently achieved discharge criteria and all acute toxicity tests on *Daphnia magna*, rainbow trout, and *Ceriodaphnia dubia* were non-toxic.

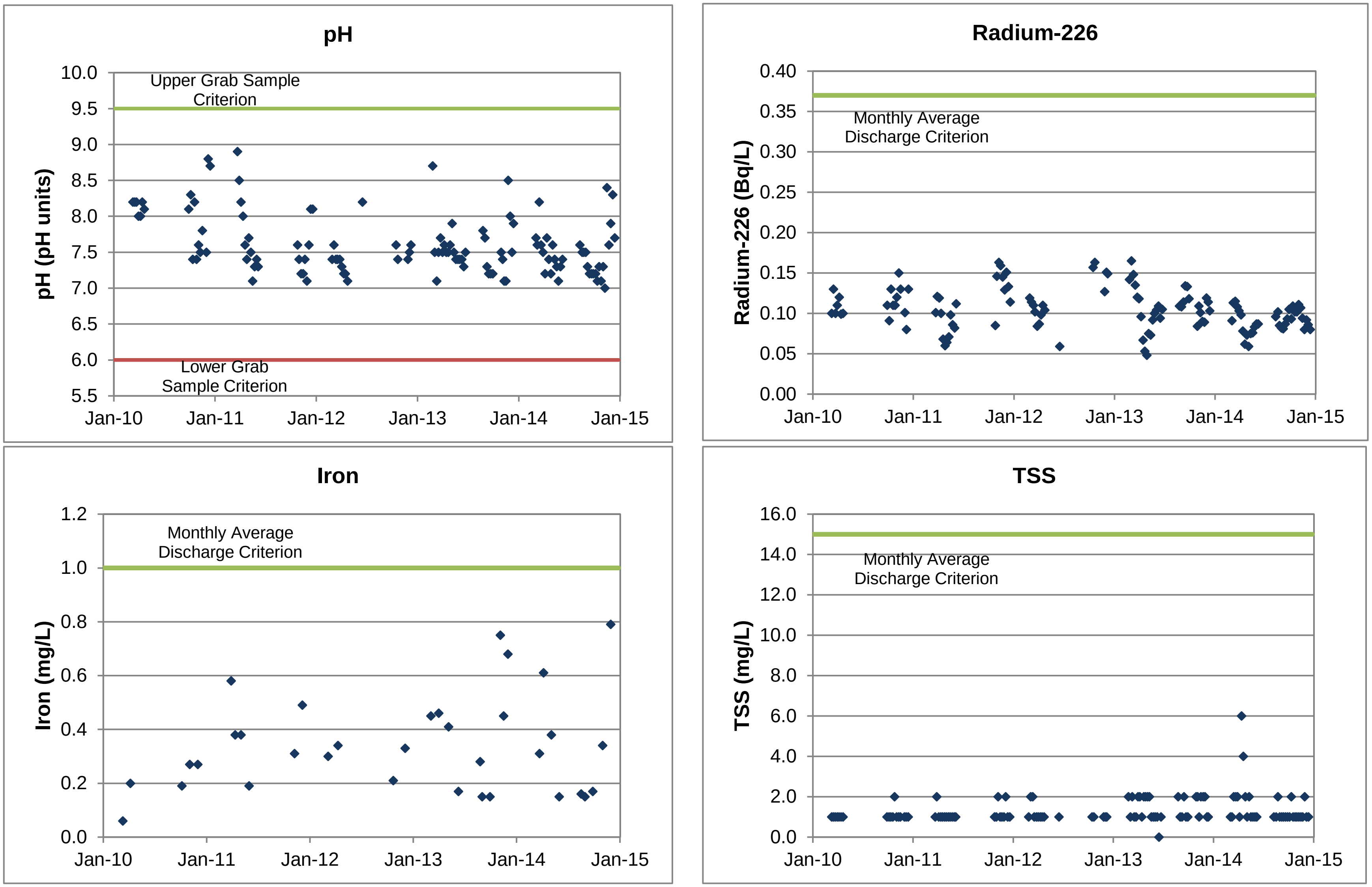


Figure 3.39: Effluent concentrations versus monthly average discharge criteria at Pronto TMA station PR-04.

Table 3.40: Toxicity test results from samples collected at Pronto TMA station PR-01, 2010 - 2014.

Sample Date (month-year)	Acute Toxicity (% mortality)		Reproduction (IC25[d] as % effluent)
	Daphnia magna [a]	rainbow trout [b]	*Ceriodaphnia dubia* [c]
March-10	0	0	>100
November-10	0	0	>100
April-11	0	0	>100
November-11	0	0	>100
April-12	0	0	>100
October-12	0	0	>100
May-13	0	0	>100
October-13	0	0	>100
May-14	0	0	>100
October-14	0	0	- [e]

[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.

[e] Outlier removed due to laboratory error.

4 SOURCES TO THE WATERSHED

Mine releases to the 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 10 times 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 2014) 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 from 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).

Discharge Quality and Loads

With few exceptions, mean mine discharge concentrations (2010-2014) of barium, cobalt, iron, manganese, radium-226, sulphate, and uranium achieved SRW benchmarks or were less than 10 times benchmarks in mine sources (Figure 4.2). Concentrations of barium tended to be highest in the primary discharges while concentrations of metals (cobalt, iron, manganese, and uranium) and sulphate were highest and pH lowest in secondary discharges (seepages) (Figure 4.2). The seepages with the highest concentrations (or lowest for pH) were ECA 398 (cobalt, uranium, and pH), D-9 (cobalt, iron, manganese, and sulphate), D-16 (iron, manganese, and sulphate) and Q-23 (pH) (Figure 4.2). While these concentrations were high, the associated loadings contributed to the watershed were low compared to primary discharges and background (upstream) loads (Figure 4.2).

[4] The Serpent River Watershed benchmarks are based on the upper limit of background or applicable guidelines, whichever is higher. See Section 2.4.1 for details.

Table 4.1: Cycle 4 approved SAMP stations, parameters and frequencies.

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

[a] W = weekly, M = monthly, Q = quarterly, S = semi-annually (twice per year).
[b] SAMP metals - barium, cobalt, iron, manganese, uranium.
[c] Toxicity includes: acute (*Daphnia magna* and rainbow trout) and sublethal (*Ceriodaphnia dubia*) testing following Environment Canada (2000a,b and 2007) methods.
[d] This station is also TOMP effluent station and requirements have been 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 is based on influent flow to the ETP at P-13.

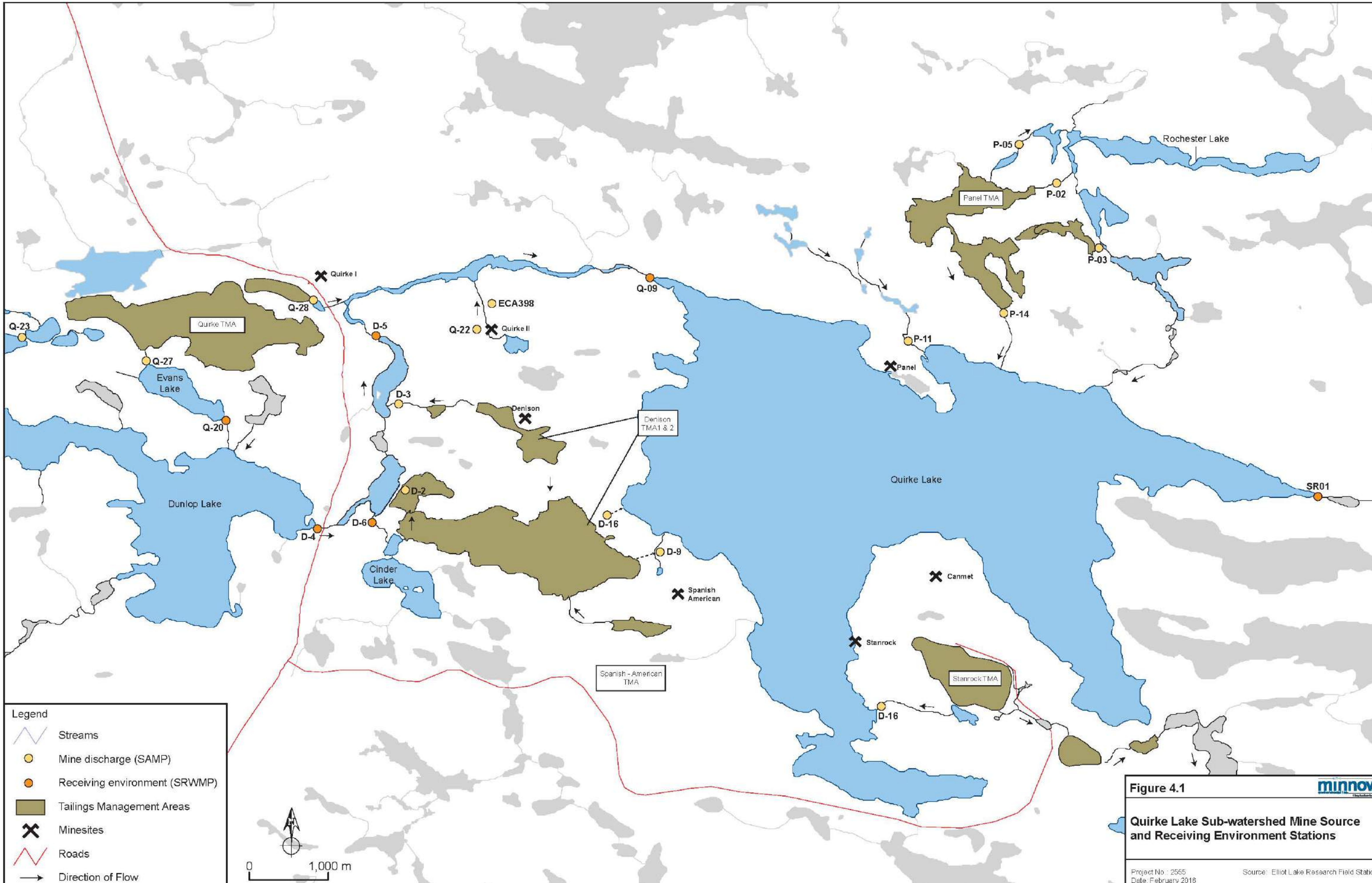


Figure 4.1

Quirke Lake Sub-watershed Mine Source and Receiving Environment Stations

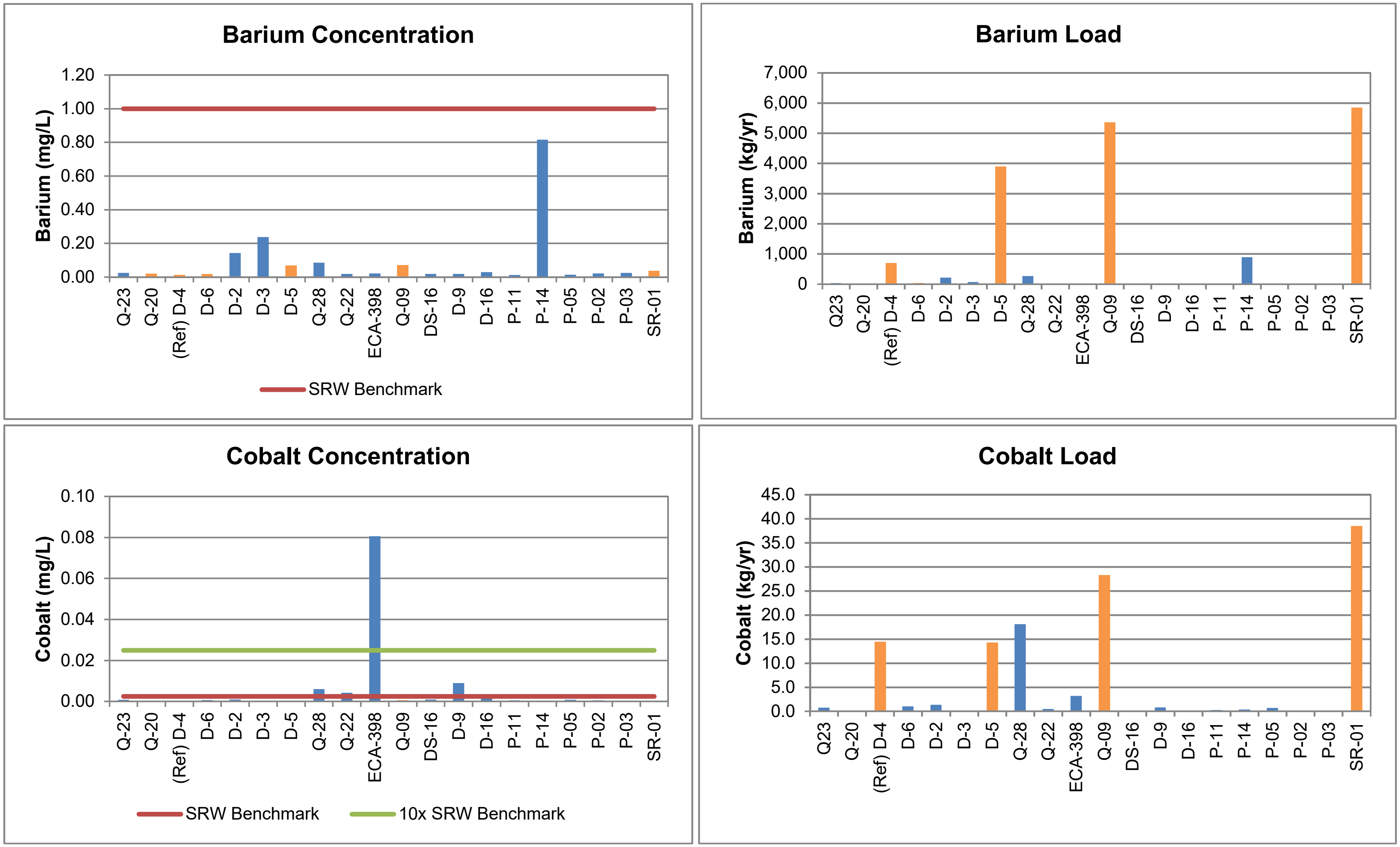


Figure 4.2: Mean concentrations and loads at monitoring stations upstream of Quirke Lake outlet, 2010-2014. Blue bars represent SAMP stations, orange bars represent SWRMP stations. * indicates no data collected at that station. SRW benchmark (Table 2.8) is a receiving environment standard based on background or approved guidelines.

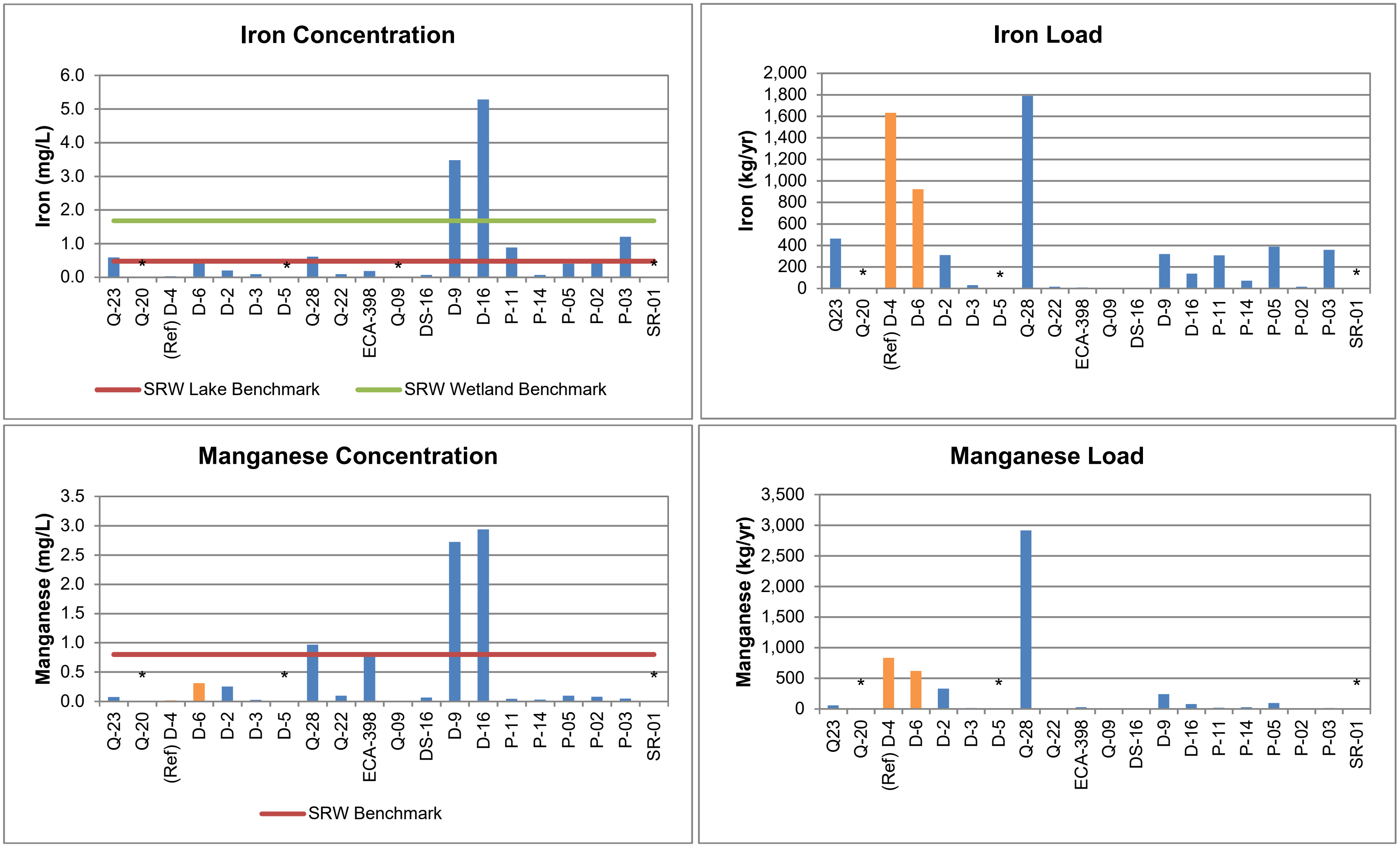


Figure 4.2: Mean concentrations and loads at monitoring stations upstream of Quirke Lake outlet, 2010-2014. Blue bars represent SAMP stations, orange bars represent SWRMP stations. * indicates no data collected at that station. SRW benchmark (Table 2.8) is a receiving environment standard based on background or approved guidelines.

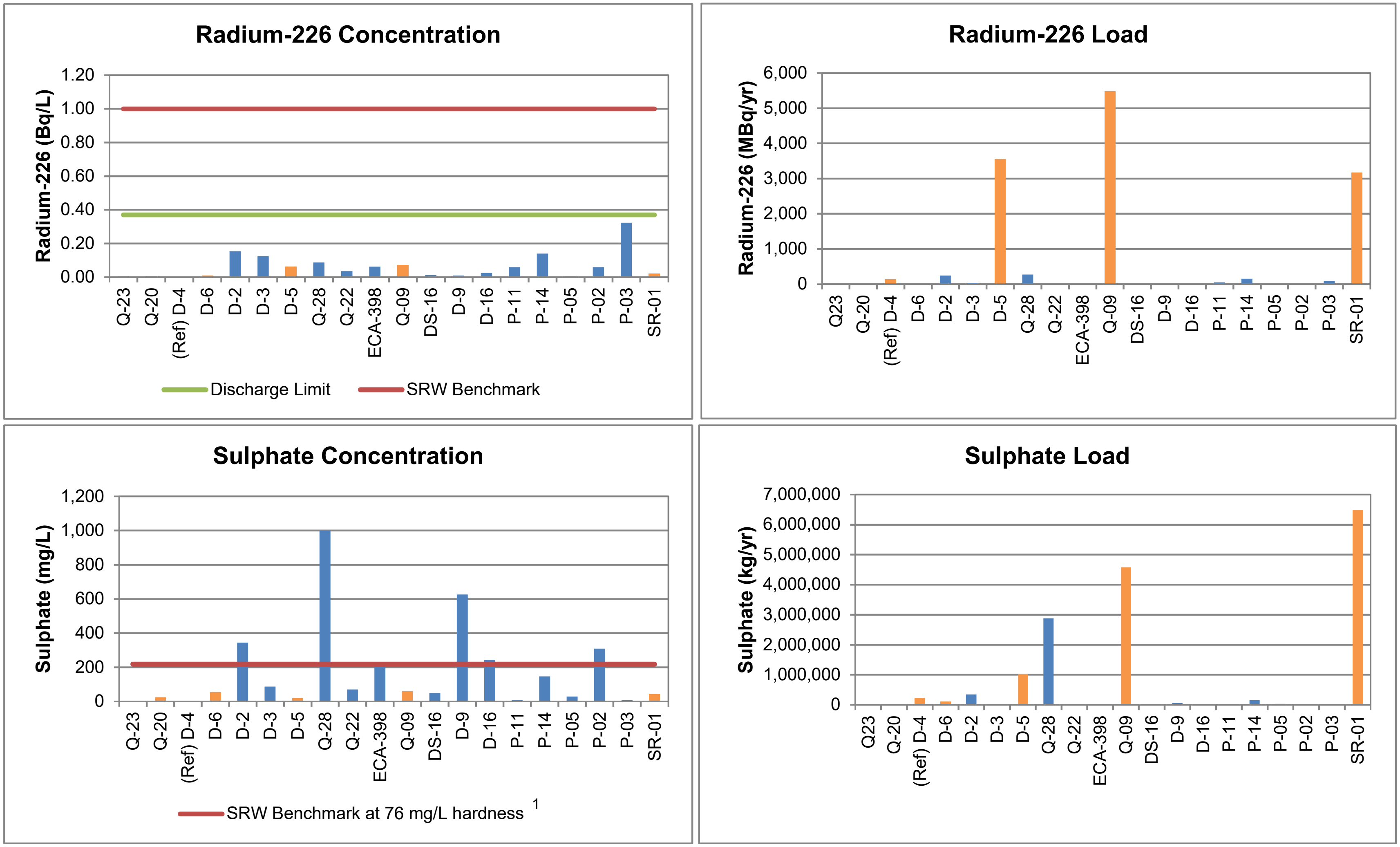
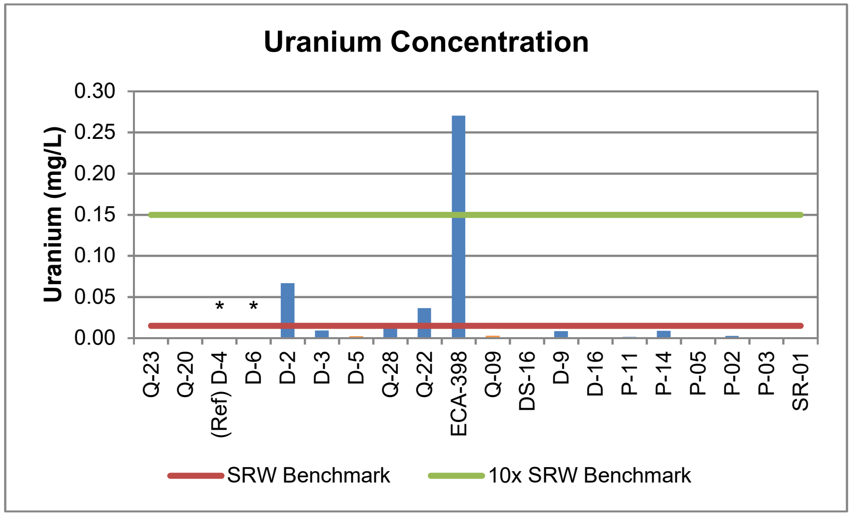
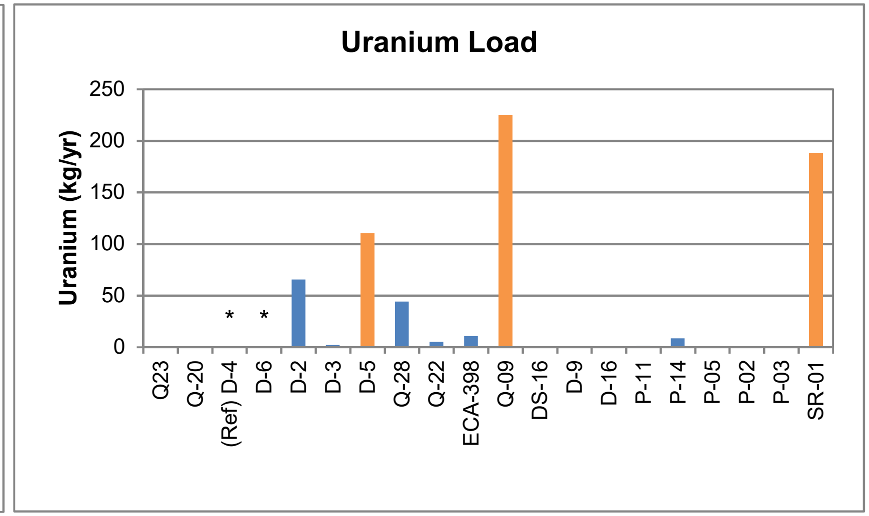


Figure 4.2: Mean concentrations and loads at monitoring stations upstream of Quirke Lake outlet, 2010-2014. Blue bars represent SAMP stations, orange bars represent SWRMP stations. * indicates no data collected at that station. SRW benchmark (Table 2.8) is a receiving environment standard based on background or approved guidelines.

[1] The hardness of 76 mg/L represents the average of all TMA exposed stations. Hardness specific sulphate guidelines are provided for each station in Appendix Table E.33.





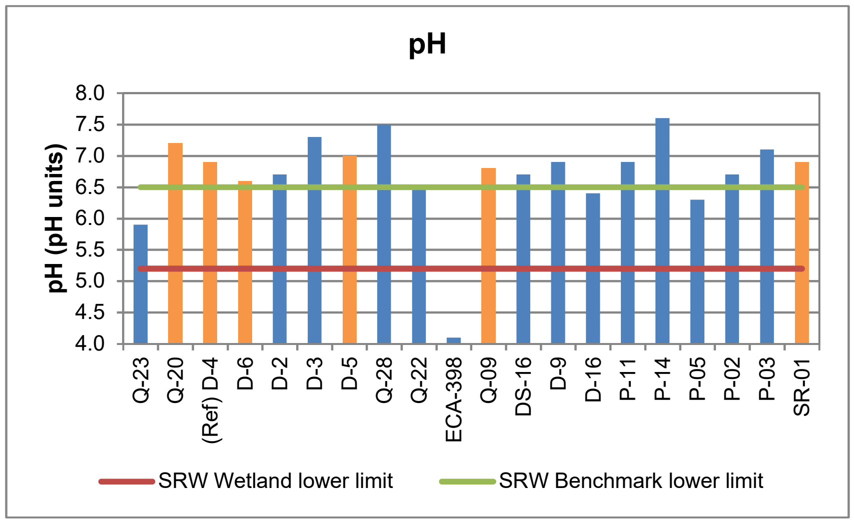


Figure 4.2: Mean concentrations and loads at monitoring stations upstream of Quirke Lake outlet, 2010-2014. Blue bars represent SAMP stations, orange bars represent SWRMP stations. * indicates no data collected at that station. SRW benchmark (Table 2.8) is a receiving environment standard based on background or approved guidelines.

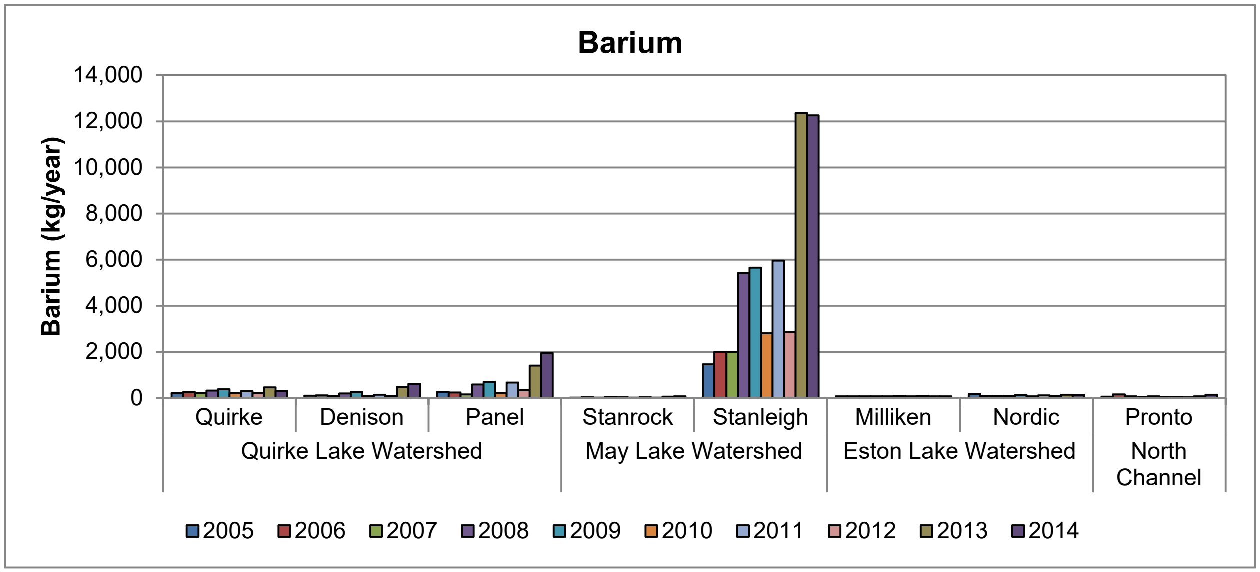
In terms of the relative loadings among TMAs within the Quirke Lake sub-watershed, the Quirke TMA tended to have the highest loading of most metals (cobalt, iron, manganese, and uranium) and sulphate (Figure 4.2). Barium loads were slightly higher from the Panel TMA than the others, while radium-226 loads were similar among TMAs (Figure 4.2). Barium loads have been increasing over time at the Panel TMA (Figure 4.3), while loads at Quirke and Denison have remained stable. Cobalt and manganese loadings from the Quirke TMA have been consistently higher than other discharges to Quirke Lake, but have been decreasing over time (Figure 4.3). Sulphate loadings have been stable at Quirke, Denison, and Panel TMAs over the last 10 years, but have been consistently higher at the Quirke TMA (Figure 4.3). Uranium loads have been decreasing at Quirke TMA over time, while uranium loads have been increasing at Denison TMA over the same period (Figure 4.3). The Denison TMA-1 discharge (D-2) contributed the highest proportion of the loading from the site for most substances, although station D-9 contributed large portions of cobalt, manganese, and iron loads (Appendix Figure D.1.1). However, over the past five years, the proportion of cobalt, iron, and manganese loading from station D-9 has decreased (Appendix Figure D.1.1). Within the Quirke TMA, 60 to 95% of annual loads for all analytes were associated with the primary discharge (Q-28, Appendix Figure D.2.1). At Panel, over 80% of the barium and uranium loads were from the primary discharge (P-14), whereas other discharges contributed large portions of the loads for other analytes, including P-05 (cobalt, iron, manganese, sulphate) and P-03 (iron and radium-226) (Appendix Figure D.3.1).

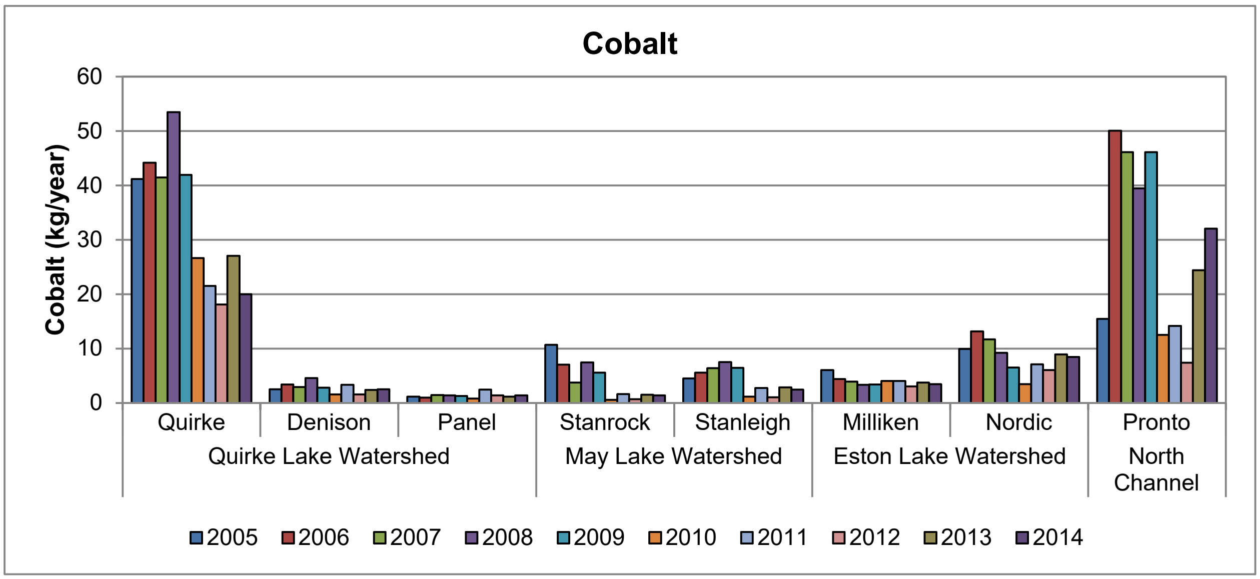
As noted in the previous SOE report (Minnow 2011), the radium-226 load within the Serpent River downstream of the Denison TMA discharge (D-5) was substantially greater than the loading from the Denison TMA (Figure 4.2) or upstream watershed (D-4) suggesting a radium-226 source within the river. This was attributed to settling and accumulation of historical treatment solids, and subsequent release of radium-226 from the sediment to the water column (EcoMetrix 2011a). 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 at SR-01 (Figure 4.2).

4.1.1 Source Trends

Cobalt, manganese, sulphate, radium-226 and uranium concentrations have decreased or been stable over the past twelve years in all discharges to Quirke Lake, with the exception of one Denison discharge station (D-3), where there was a small, albeit significant, increasing trend in manganese (Table 4.2), however this trend may be due to outlier measurements in 2011 and 2014 (Appendix Figure D.1.3). Barium concentrations increased over time at each of the primary discharge locations (D2, D-3, P-14 and Q-28; Table 4.2), largely due to greater barium chloride use to maintain treatment efficiencies at lower influent sulphate concentrations.





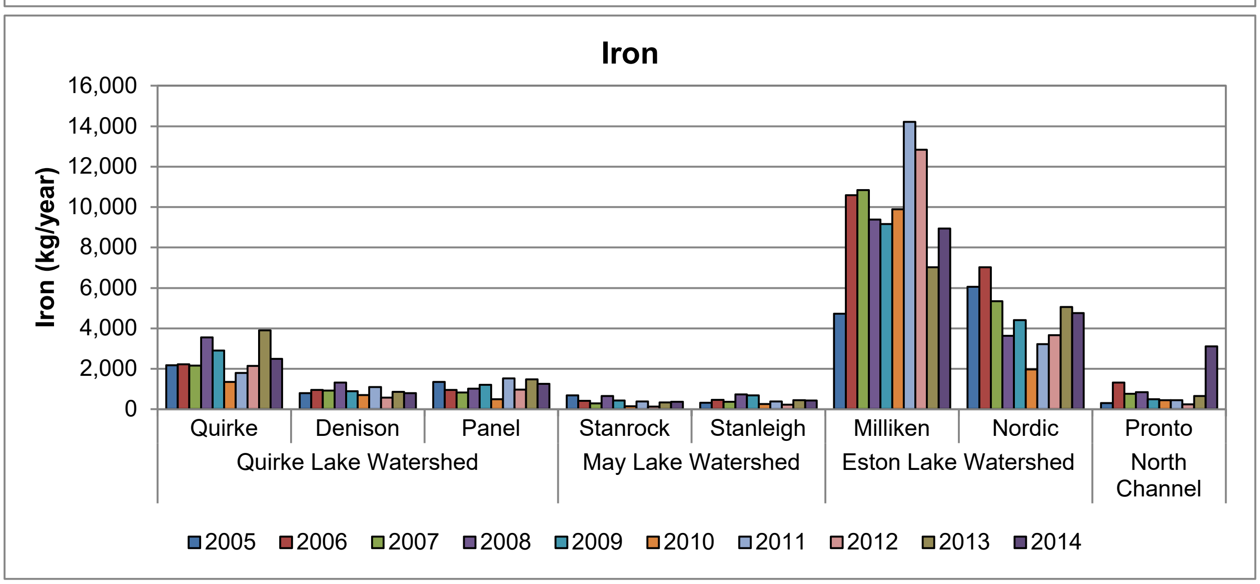


Figure 4.3: Annual loadings by TMA in Serpent River sub-watersheds (2005-2014).

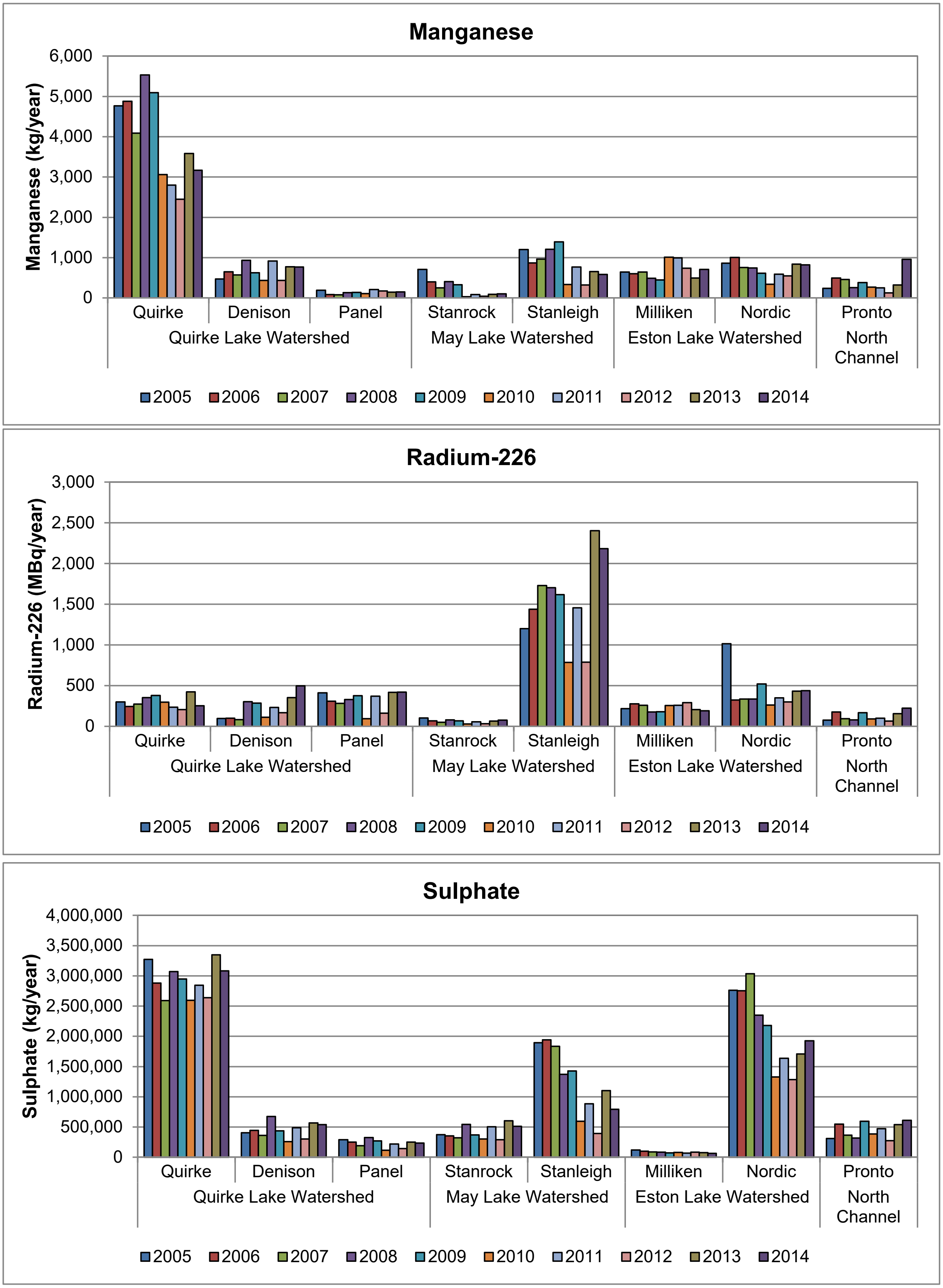


Figure 4.3: Annual loadings by TMA in Serpent River sub-watersheds (2005-2014).

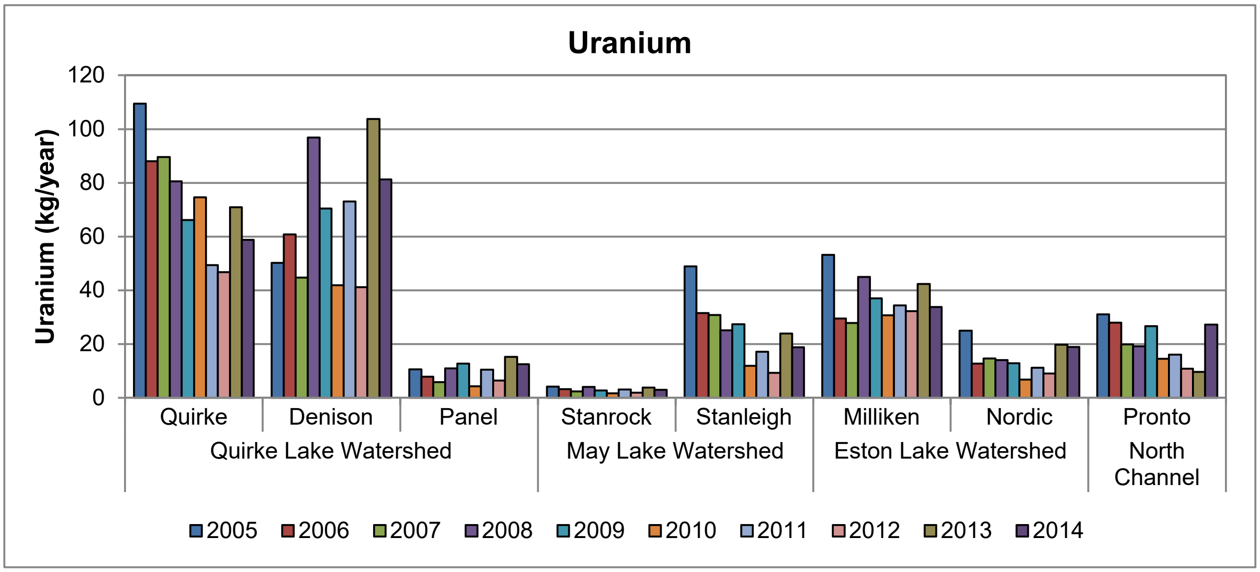


Figure 4.3: Annual loadings by TMA in Serpent River sub-watersheds (2005-2014).

Table 4.2: Summary of water quality trends[a] for SAMP water quality monitoring stations in Denison, Quirke, Panel, and Stanrock, 2003 to 2014.

TMA	Station ID	Type	Number of Months Used in Common Trend[b]	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	TSS[c]	Uranium
Denison	D-2	Primary	12	0.465	-0.501	0.222	-0.493	-0.203	*0.088*	-0.760	-0.147	-0.403
	D-3	Primary	12	0.517	ND	0.176	0.219	-0.189	0.080	-0.166	ND	-0.364
	D-9	Seepage	4	0.422	-0.897	-0.745	-0.404	0.629	-0.276	-0.158	-	*-0.087*
	D-16	Seepage	4	-0.220	-0.588	0.313	*-0.135*	0.720	-0.549	-0.297	-	ND
Quirke	ECA-398	Seepage	6	0.723	-0.822	-0.258	-0.734	0.404	-0.098	-0.908	-	-0.937
	Q-22	Drainage	4	-0.014	-0.707	-0.361	-0.537	0.481	-0.290	-0.283	-	-0.732
	Q-23	Drainage	4	-0.203	0.122	0.310	-0.295	0.128	ND	-0.726	-	ND
	Q-27	Seepage	4	0.248	*0.038*	-0.389	-0.097	-0.114	*-0.162*	0.228	-	-0.834
	Q-28	Primary	12	0.202	-0.731	*0.360*	-0.724	-0.457	*-0.215*	-0.652	-0.011	-0.734
Panel	P-02	Seepage	4	-0.274	-0.423	-0.009	-0.230	0.635	-0.119	-0.944	-	-0.373
	P-03	Drainage	4	-0.473	ND	-0.341	-0.241	0.031	-0.573	-0.574	-	ND
	P-05	Drainage	4	-0.246	0.139	-0.010	-0.001	-0.005	-0.248	-0.166	-	ND
	P-11	Drainage	4	0.112	*0.257*	0.443	0.105	0.307	-0.092	-0.549	-	ND
	P-14	Primary	9	0.865	*-0.206*	-0.709	-0.365	0.094	-0.160	-0.974	-0.516	-0.210
Stanrock	DS-16	Drainage	5 to 6	-0.002	-0.781	-0.504	-0.600	*0.347*	-0.526	-0.531	-	ND

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

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

Italic text - mean monthly correlations significantly different, but common trend value provided.

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.

"-" denotes that this station did not have a TSS TOMP requirement.

[a] Common (combined) trends based on rank correlation coefficients (rho) for monthly trends, ahoen in Appendix Table D.1.7-D.1.10, D.2.8-D.2.12, D.3.8-D.3.12, D.4.6.

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

[c] TSS is a TOMP requirement.

Iron concentrations increased in the primary discharges at both the Denison (D-2 and D-3) and Quirke (Q-28) TMAs from 2003 to 2014 (Table 4.2). Denison 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 Figure D.1.2 and D.1.3). For both TMAs, iron did not increase within the main basins (D-1 and Q-05; Sections 3.1 and 3.2). Despite the increasing trends, mean iron concentrations in effluent remained low (≤ background; Figure 4.2).

Discharge pH increased or remained stable at all discharge locations except for Quirke and Denison primary discharge locations (Q-28, D-2 and D-3; Table 4.2). With the exception of Quirke station ECA-298, pH at all discharges is near-neutral, or approaching neutral levels (Appendix Figures D.1.2 to D.1.5, D.2.2 to D.2.6, D.3.2 to D.3.6), and pH achieves the discharge criteria and PWQO (Figure 4.2).

At Stanrock station DS-16, trends have indicated improving water quality (decreasing metal concentrations, Table 4.2), likely associated with the 2009 removal of tailings from a historical tailings spill upstream of DS-16 and the construction of the Dam M Seepage Collection Pond and pumping system to collect and pump seepage towards the Stanrock ETP via Dam G Seepage Collection Pond (Appendix Figure D.4.3, Table 3.19).

4.2 May Lake Sub-watershed Sources

Within the May Lake sub-watershed there are two TMA's: Stanrock, with a primary discharge to Halfmoon Lake, and Stanleigh, with a primary discharge to McCabe Lake (Figure 4.4), with both lakes draining to May Lake. There are no seepages from these TMAs that drain directly to the May Lake sub-watershed. As part of the SRWMP, water quality is monitored at the outlet of McCabe Lake (SR-06) and at the outlet of Halfmoon Lake DS-18, Figure 4.4).

4.2.1 Discharge Quality and Loads

Concentrations from the source discharges are generally very good (less than the SRW benchmarks), with exception of barium at the Stanleigh discharge (CL-06) and sulphate at the Stanrock TMA discharge (DS-4; Figure 4.5). Barium concentrations in the Stanleigh TMA effluent (mean of 1.06 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 discharge (<400 mg/L) are less than the SRWMP benchmark (BCMOE guideline; Appendix Table D.4.1). Generally, concentrations in the immediate downstream receiving environment are less than the SRW benchmarks, with the exception of iron in Halfmoon Lake (Figure 4.5).

Loadings of most substances monitored are higher from the Stanleigh TMA than from the Stanrock TMA (Figure 4.5). Annual loadings of barium and radium-226 from the Stanleigh TMA

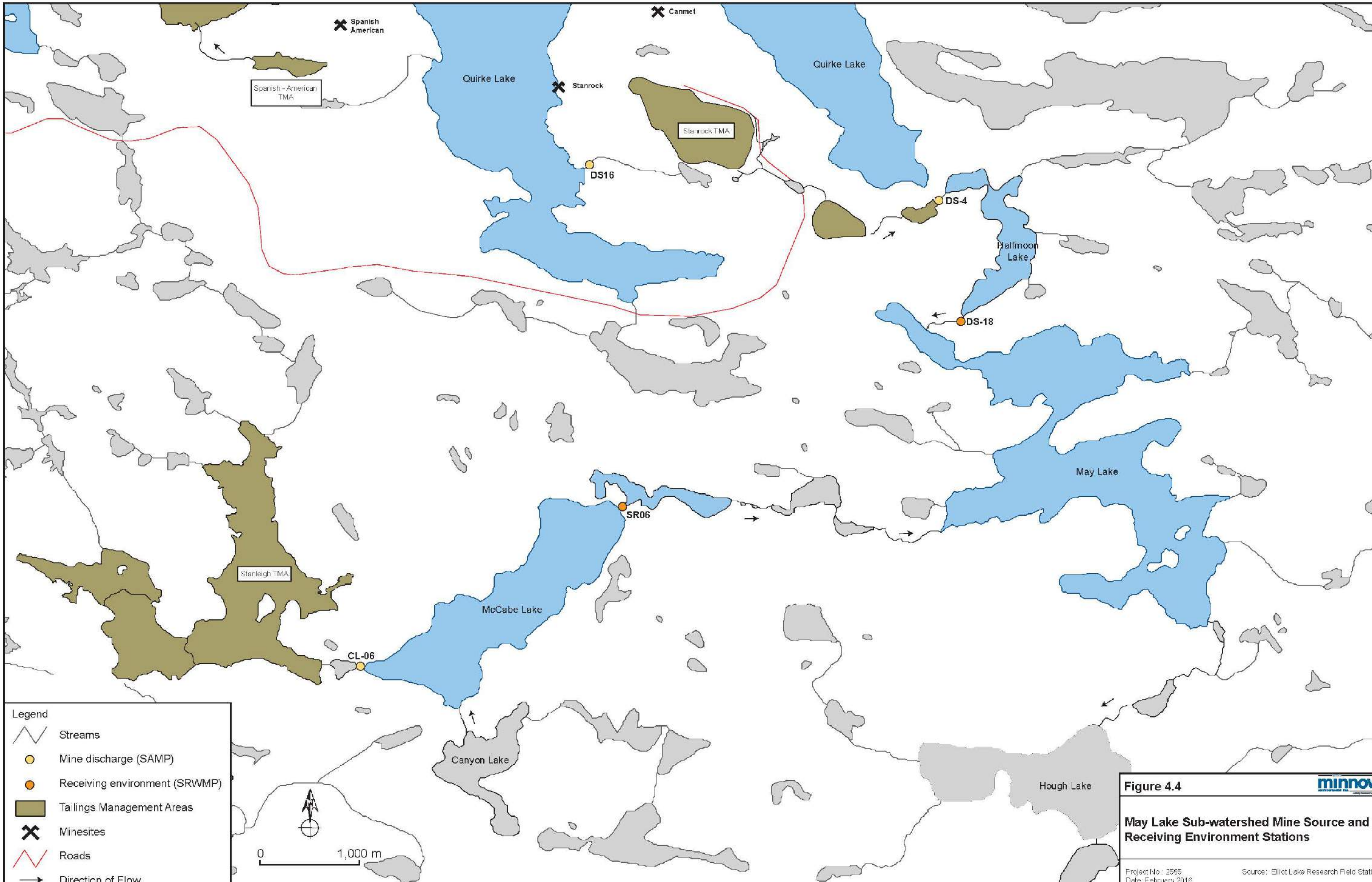


Figure 4.4

May Lake Sub-watershed Mine Source and Receiving Environment Stations

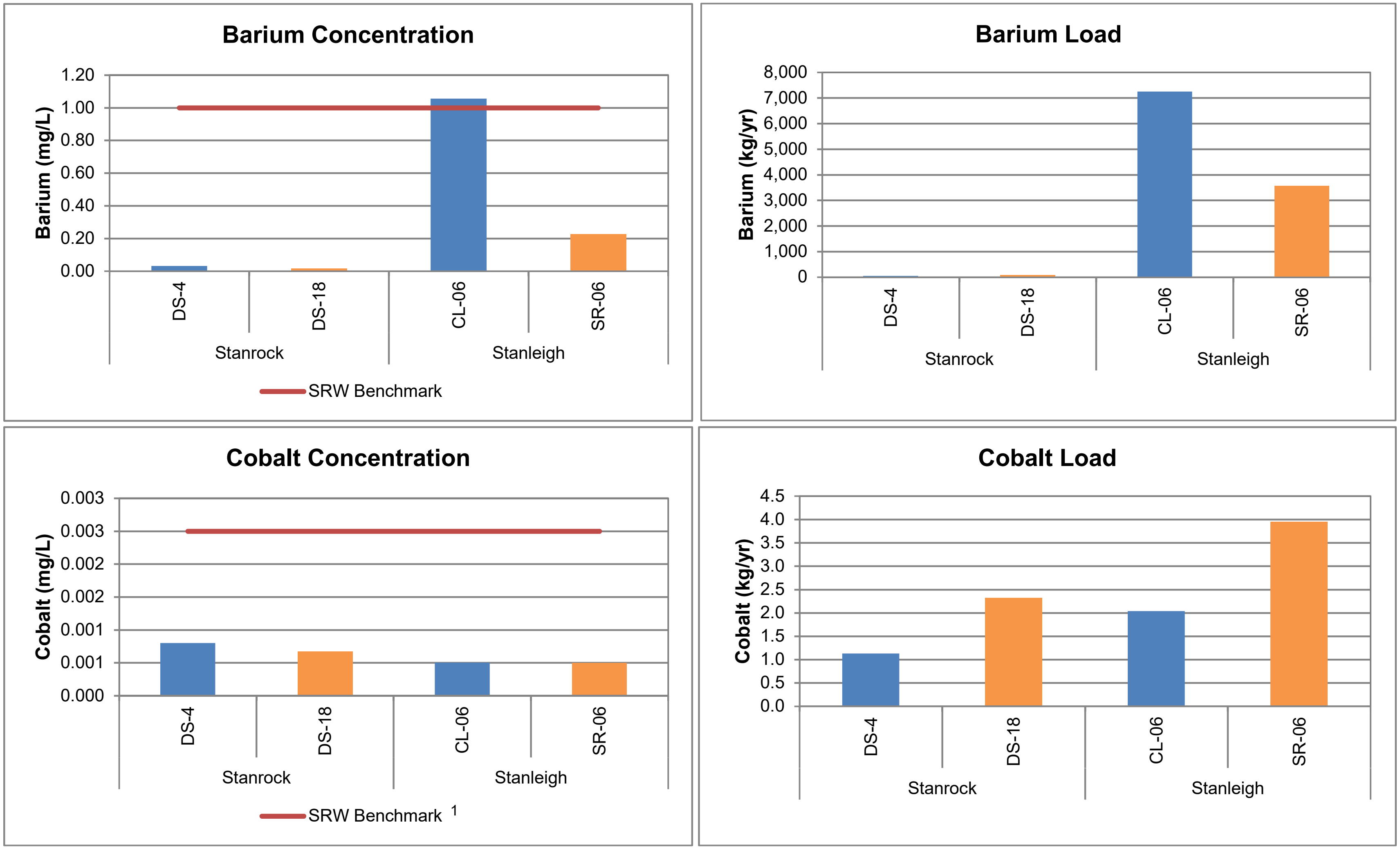


Figure 4.5: Mean concentrations and loads at monitoring stations downstream of Stanrock and Stanleigh TMAs, 2010-2014. Blue bars represent SAMP stations, orange bars represent SWRMP stations. * indicates no data collected at that station. SRW benchmark (Table 2.8) is a receiving environment standard based on background or approved guidelines.

[1] Cobalt is no longer included as a SRWMP substance but it continues to be monitored to allow for SAMP Cobalt data to be considered in light of receiving environment concentrations and loads the SRW benchmark referenced is the Federal Water Quality guideline of 0.0025 mg/L (Environment Canada, 2013).

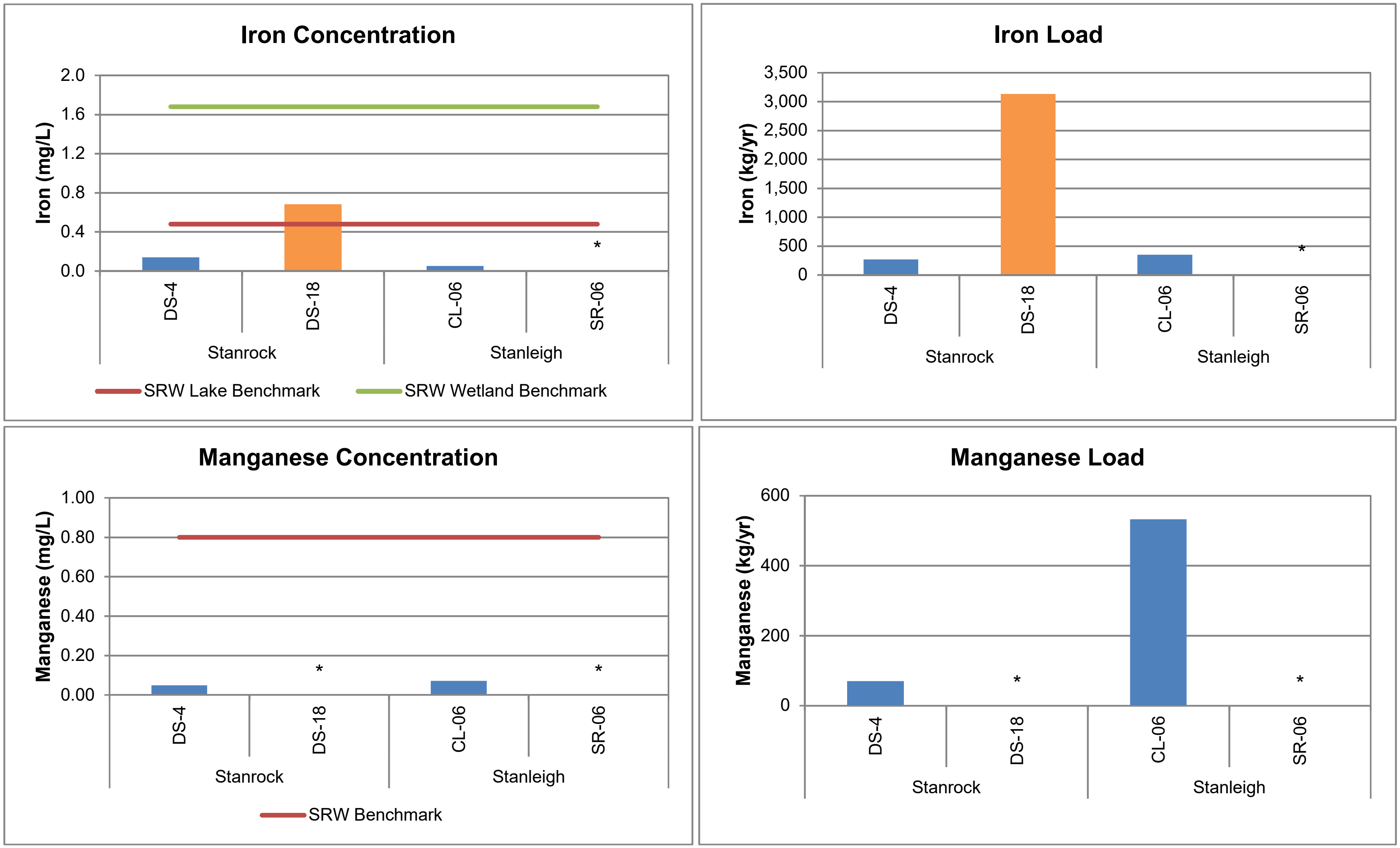


Figure 4.5: Mean concentrations and loads at monitoring stations downstream of Stanrock and Stanleigh TMAs, 2010-2014. Blue bars represent SAMP stations, orange bars represent SWRMP stations. * indicates no data collected at that station. SRW benchmark (Table 2.8) is a receiving environment standard based on background or approved guidelines.

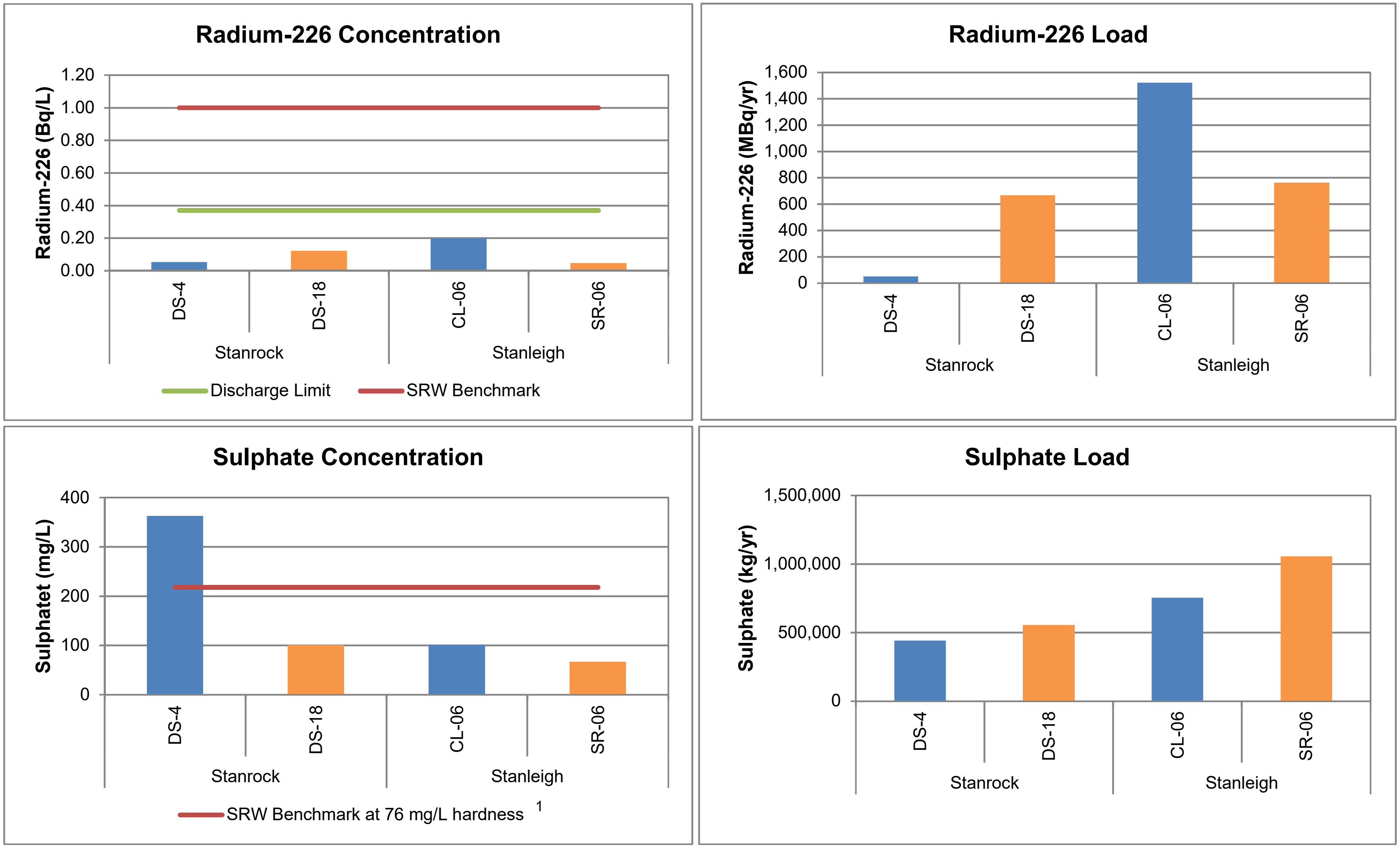


Figure 4.5: Mean concentrations and loads at monitoring stations downstream of Stanrock and Stanleigh TMAs, 2010-2014. Blue bars represent SAMP stations, orange bars represent SWRMP stations. * indicates no data collected at that station. SRW benchmark (Table 2.8) is a receiving environment standard based on background or approved guidelines.

[1] The hardness of 76 mg/L represents the average of all TMA exposed stations. Hardness specific sulphate guidelines are provided for each station in Appendix Table E.33.

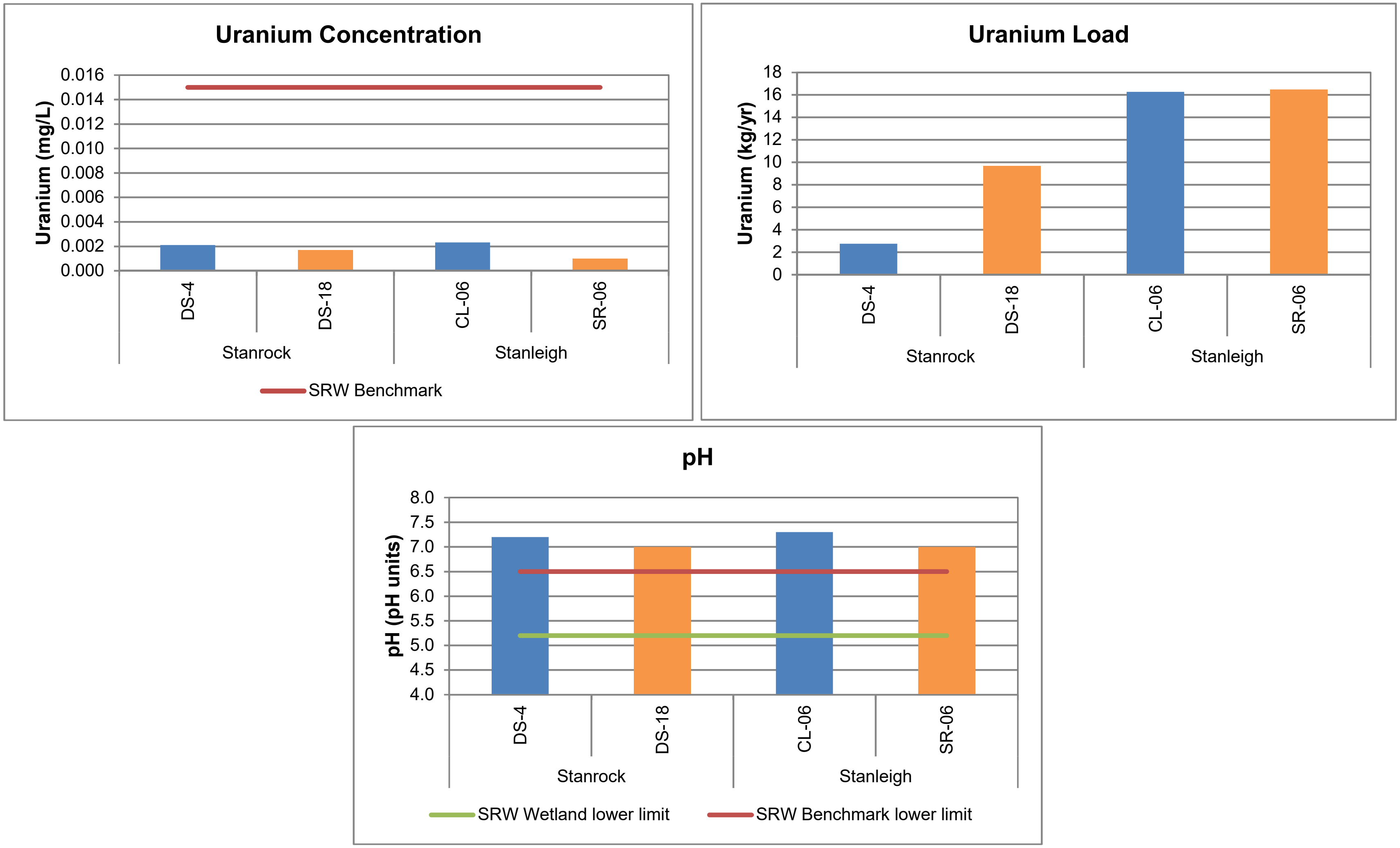


Figure 4.5: Mean concentrations and loads at monitoring stations downstream of Stanrock and Stanleigh TMAs, 2010-2014. Blue bars represent SAMP stations, orange bars represent SWRMP stations. * indicates no data collected at that station. SRW benchmark (Table 2.8) is a receiving environment standard based on background or approved guidelines.

have been increasing over time, while loads of cobalt, iron, manganese, sulphate, and uranium have remained consistent or decreased over time (Figure 4.3). Increased barium and radium-226 loads are attributed to decreasing sulphate concentrations within the TMA, requiring increased barium chloride usage in treatment to precipitate radium-226 prior to discharge (as discussed in Section 3.6).

4.2.2 Trends

Effluent concentrations of sulphate and manganese at the Stanleigh TMA have been decreasing over time (2003 to 2014) and uranium concentrations were so low in the 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, Appendix Figure D.5.1). While TMA concentrations of radium-226 have been decreasing over time (Table 3.26), effluent concentrations have been increasing over the same period (Table 4.3, Appendix Figure D.5.1). The increase in radium-226 in effluent may be, in part associated with decreasing sulphate concentrations in the TMA basin. As sulphate decreases more barium chloride is required to precipitate radium-226 with barium sulphate and remove it from the effluent. Thus, the increase in radium-226 and barium is associated with decreased treatment efficiencies attributed to lower sulphate concentrations in the TMA. Rio Algom is currently investigating factors influencing treatment efficiencies. Radium-226 concentrations remain below the discharge criterion (0.37 Bq/L) and well below the PWQO (1.0 Bq/L).

Concentrations of manganese, radium-226, sulphate, and uranium in effluent from the Stanrock TMA (DS-4) have been decreasing over time (Table 4.3). Cobalt concentrations significantly increased over the 2003 to 2014 period, however, concentrations appear to be decreasing since 2009 (Table 4.3, Appendix Figure D.4.2).

4.3 Esten Lake Sub-Watershed Sources

Within the Esten Lake sub-watershed, there are two TMAs: Milliken, with primary discharges into Elliot Lake via Sherriff Creek, and Nordic, with primary discharges into Nordic Lake via Buckles Creek (Figure 4.6). There are no seepages that drain directly to receiving 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, Figure 4.6).

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 4.7). Only iron concentrations were greater than the SRW benchmark in both TMA effluents. Concentrations at the outlet of Westner

Table 4.3: Summary of water quality trends[a] for SAMP monitoring stations in Stanleigh and Stanrock, 2003 to 2014.

TMA	Station ID	Type	Number of Months Used in Common Trend[b]	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	TSS[c]	Uranium
Stanleigh	CL-06	Primary	9 to 10	0.917	*-0.279*	-0.216	-0.723	-0.144	0.627	-0.922	ND	ND
Stanrock	DS-4	Primary	12	0.119	*0.194*	0.125	*-0.249*	-0.168	-0.602	-0.493	ND	-0.841

decreasing trend, significant at p<0.05

increasing trend, significant at p<0.05

Italic - text means monthly correlations significantly different, but common trend value provided.

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.

[a] Common (combined) trends based on rank correlation coefficients (rho) for monthly trends, ahoen in Appendix Table D.4.5, D.5.4.

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

[c] TSS is a TOMP requirement.

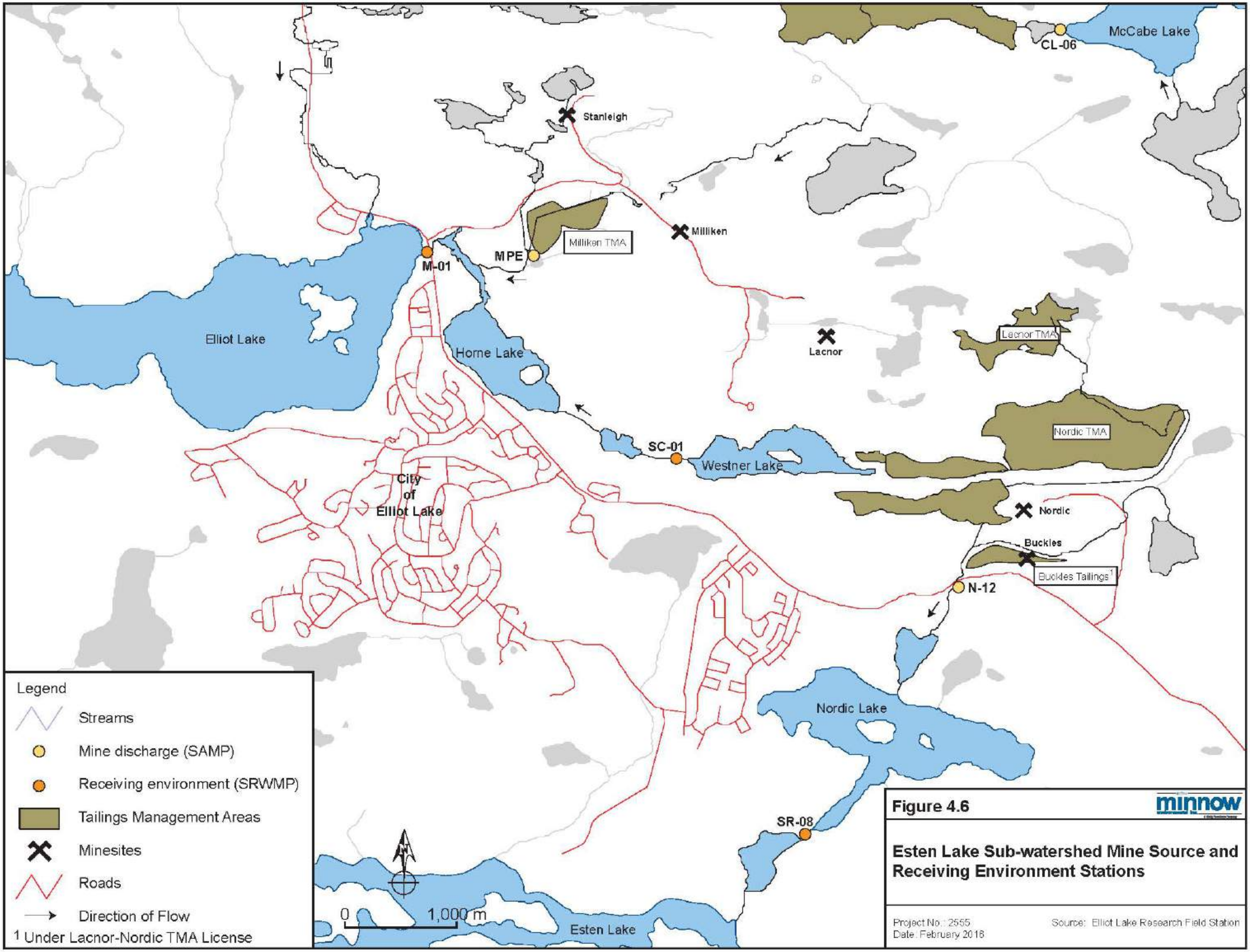


Figure 4.6

Esten Lake Sub-watershed Mine Source and Receiving Environment Stations

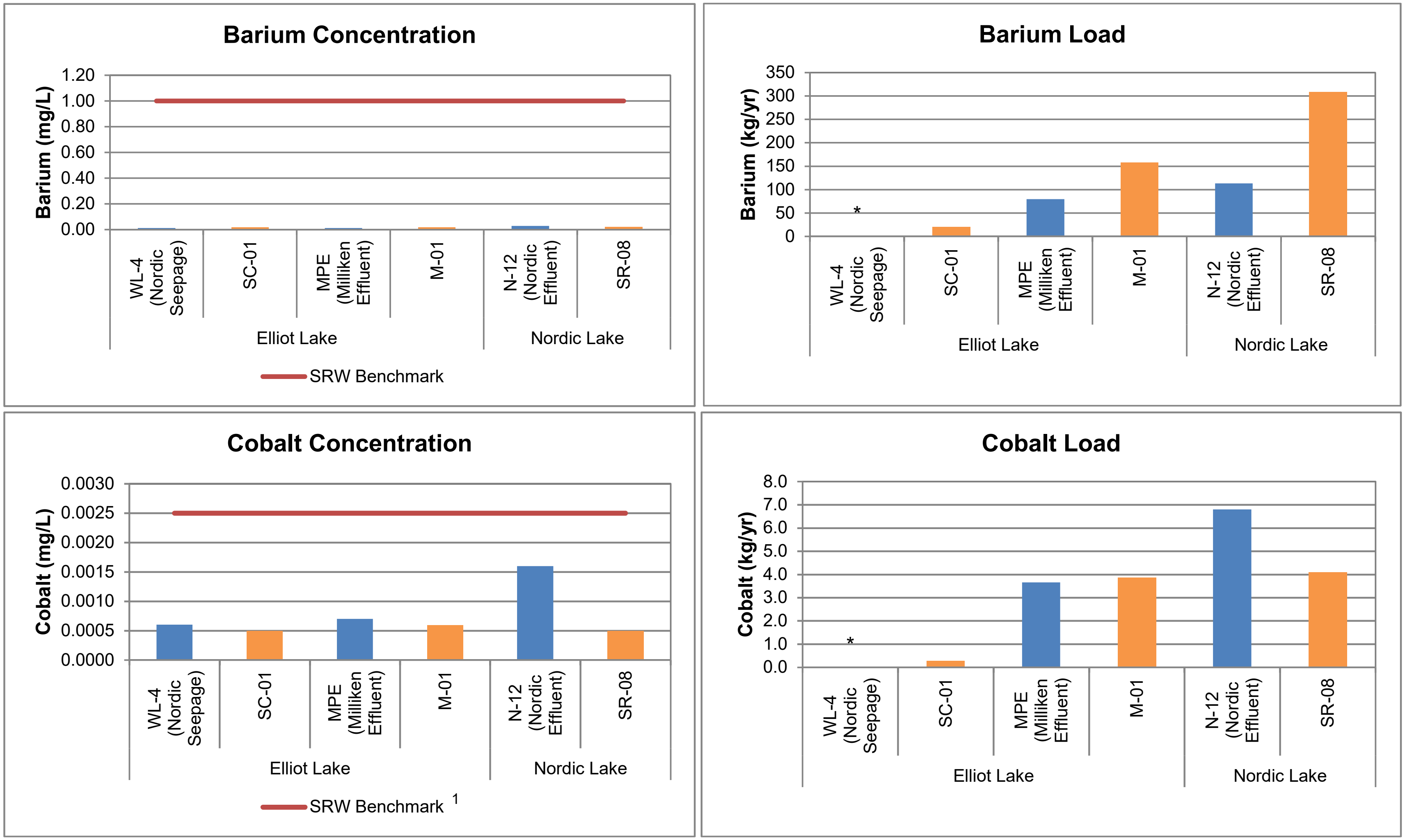


Figure 4.7: Mean concentrations and loads at monitoring stations downstream of Milliken and Nordic TMAs, 2010-2014. Blue bars represent SAMP stations, orange bars represent SWRMP stations. * indicates no data collected at that station or no flow data available. SRW benchmark (Table 2.8) is a receiving environment standard based on background or approved guidelines.

[1] Cobalt is no longer included as an SRWMP substance but it continues to be monitored to allow for SAMP Cobalt data to be considered in light of receiving environment concentrations and loads. The SRW benchmark referenced is the Federal Water Quality guideline of 0.0025 mg/L (Environment Canada, 2013).

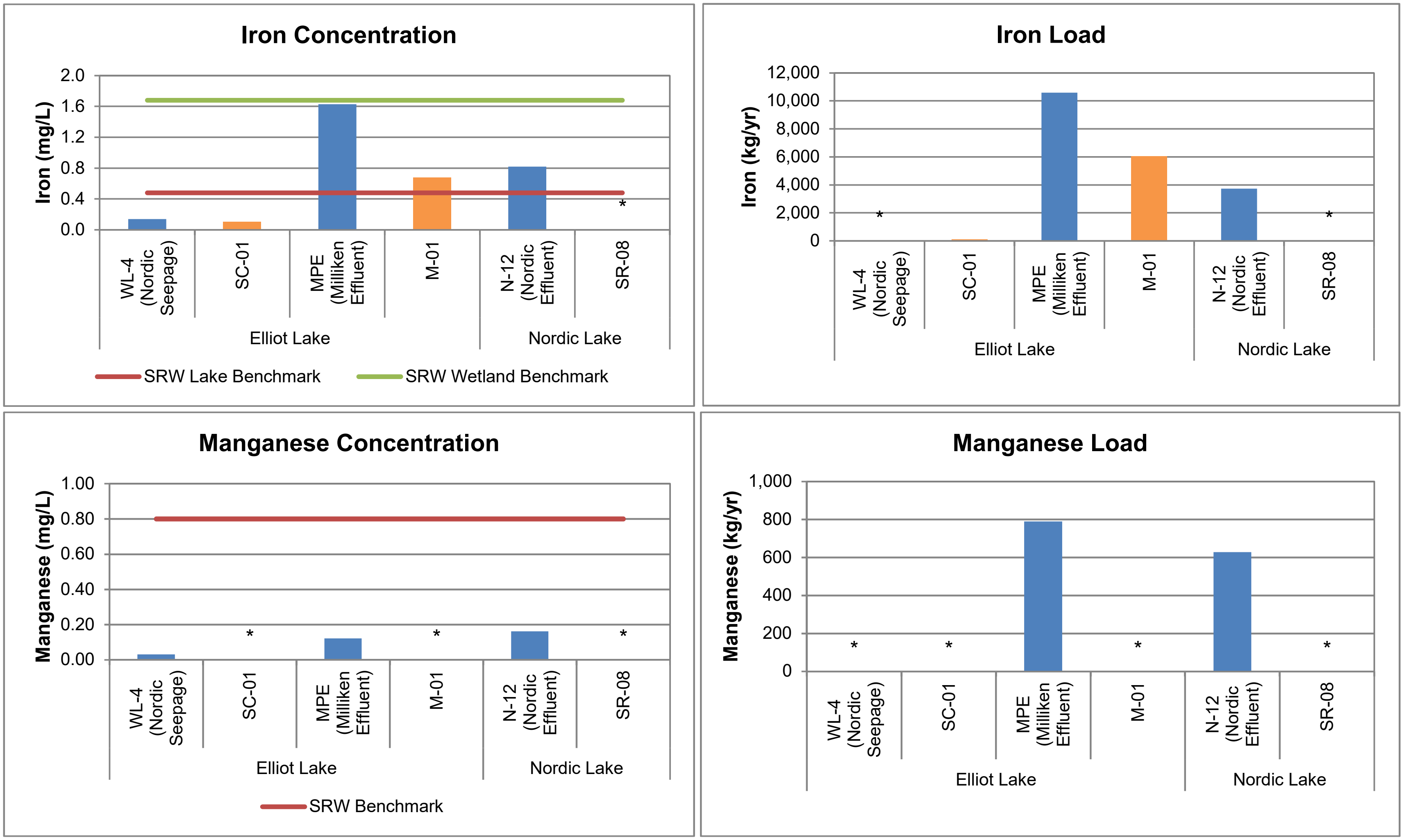


Figure 4.7: Mean concentrations and loads at monitoring stations downstream of Milliken and Nordic TMAs, 2010-2014. Blue bars represent SAMP stations, orange bars represent SWRMP stations. * indicates no data collected at that station or no flow data available. SRW benchmark (Table 2.8) is a receiving environment standard based on background or approved guidelines.

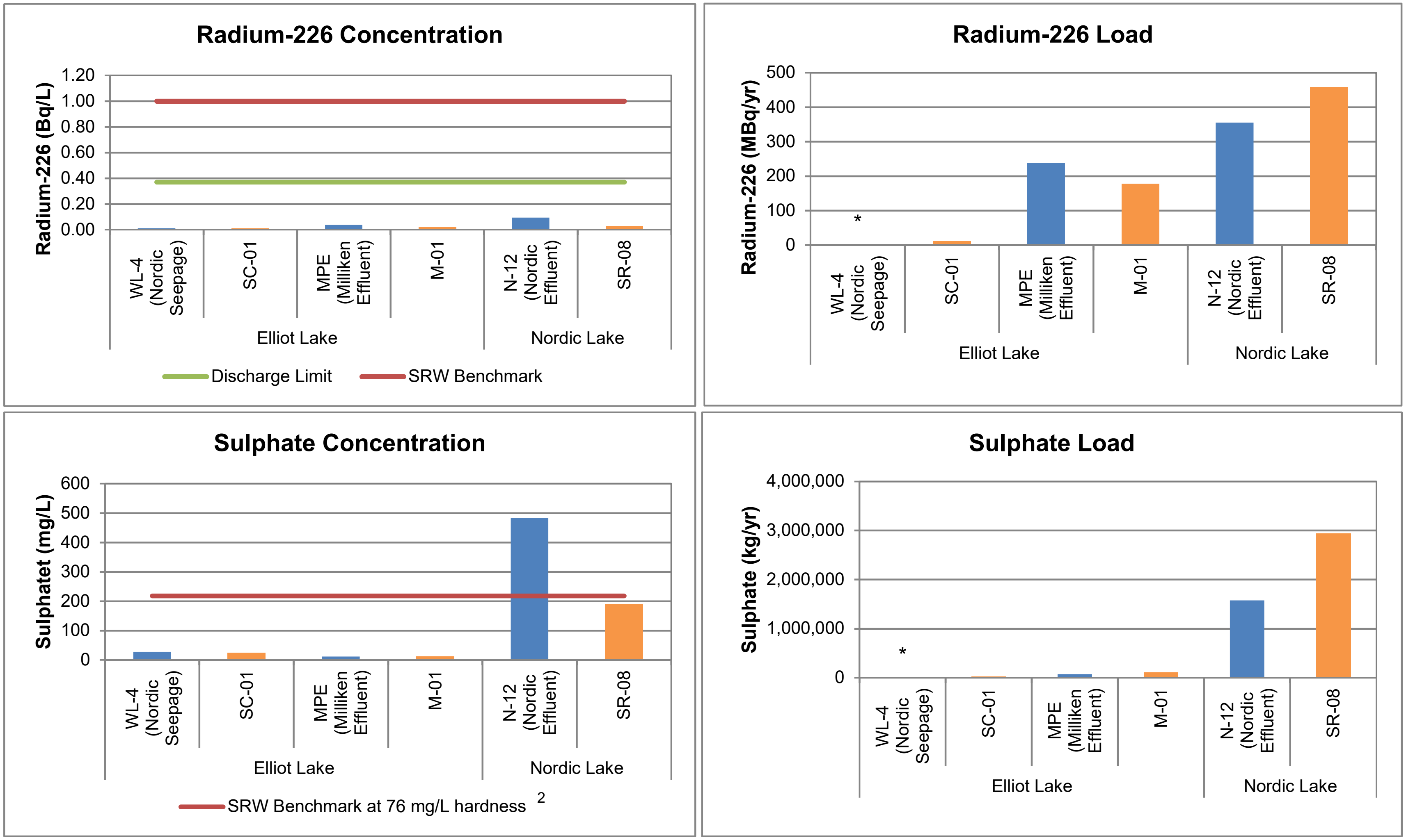


Figure 4.7: Mean concentrations and loads at monitoring stations downstream of Milliken and Nordic TMAs, 2010-2014. Blue bars represent SAMP stations, orange bars represent SWRMP stations. * indicates no data collected at that station or no flow data available. SRW benchmark (Table 2.8) is a receiving environment standard based on background or approved guidelines.

[2] The hardness of 76 mg/L represents the average of all TMA exposed stations. Hardness specific sulphate guidelines are provided for each station in Appendix Table E.33.

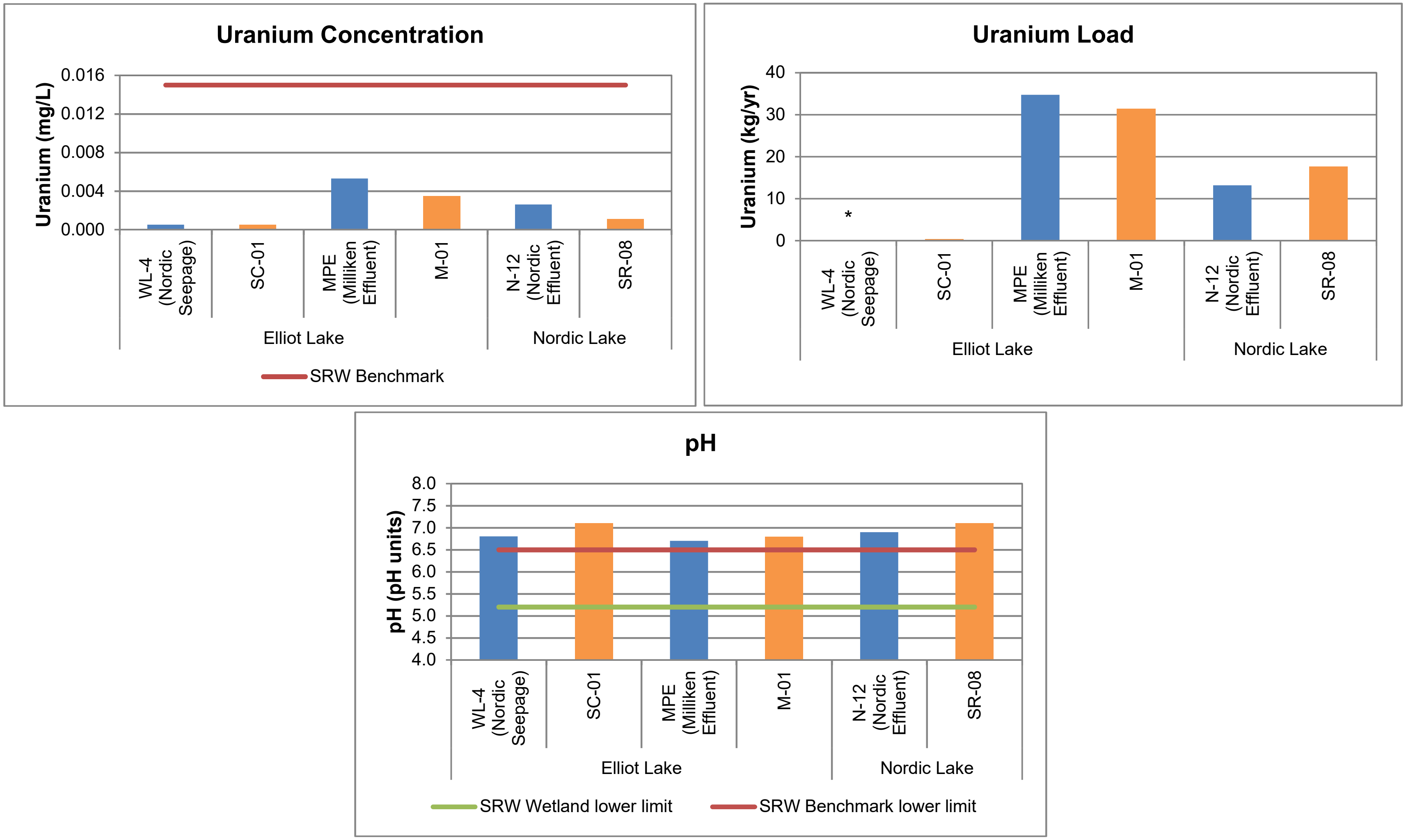


Figure 4.7: Mean concentrations and loads at monitoring stations downstream of Milliken and Nordic TMAs, 2010-2014. Blue bars represent SAMP stations, orange bars represent SWRMP stations. * indicates no data collected at that station or no flow data available. SRW benchmark (Table 2.8) is a receiving environment standard based on background or approved guidelines.

Lake (SC-01) were below SRW benchmarks[5], while concentrations downstream of Milliken (M-01) were well below the wetland benchmark and slightly above the lake benchmark (Figure 4.7). Given the vegetated habitat at M-01, the wetland benchmark is most applicable. Sulphate was elevated in the Nordic TMA effluent but substantially reduced to less than the SRW benchmark in the downstream receiving environment (Figure 4.7)

With the exception of iron, manganese, and uranium, Nordic TMA loads for all measured substances were higher than from the Milliken TMA (Figure 4.7). Loadings from the Milliken TMA are likely over-estimated because flow at this location is prorated based on drainage area (*i.e.*, measured concentrations are not synoptic with actual flows), and the highest concentrations occur under no flow conditions (due to re-mobilization of metals under anoxic conditions). Thus, when these concentrations are averaged and then multiplied by the prorated flow, a load is calculated when no flow/load may be occurring.

Loadings associated with the Milliken TMA have remained consistent over the past 10 years, with iron loads having the greatest variability (Figure 4.3). Loadings of other substances tended to show a similar pattern over time, which likely reflects changes in flow between years, although sulphate loads at Nordic TMA appear to be decreasing over time.

4.3.2 Trends

Significant trends were indicative of improving water quality in mine discharges at both TMAs (Table 4.4). At the Milliken primary discharge location, concentrations of radium-226 and sulphate were decreasing while concentrations of barium, cobalt, iron, manganese and uranium, as well as pH, remained stable (Table 4.4, Appendix Figure D.6.1). At the Nordic primary discharge location, concentrations of barium, cobalt, iron, radium-226, sulphate and uranium were decreasing and pH was increasing to near-neutral conditions (Table 4.4, Appendix Figure D.7.1).

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 4.8). Final effluent, monitored in the Discharge Channel at PR-01, reports directly to the North 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

[5] Iron is not monitored at SR-08 as concentrations here have been demonstrated to be consistently below the SRW benchmark.

Table 4.4: Summary of water quality trends[a] for SAMP monitoring stations in Nordic and Milliken, 2003 to 2014.

TMA	Station ID	Type	Number of Months Used in Common Trend[b]	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium
Nordic	N-12	Primary	12	-0.263	-0.246	-0.181	*-0.098*	0.523	-0.404	-0.264	-0.458
Milliken	MPE	Primary	12	-0.035	*0.054*	0.073	-0.064	-0.132	-0.389	-0.677	0.105

(blue) decreasing trend, significant at p<0.05
(green) increasing trend, significant at p<0.05
Italic text - mean monthly correlations significantly different, but common trend value provided.

[a] Common (combined) trends based on rank correlation coefficients (rho) for monthly trends, ahoen in Appendix Table D.6.3, D.7.5.
[b] Months used varied for substances based on suitability of data for trend analysis.

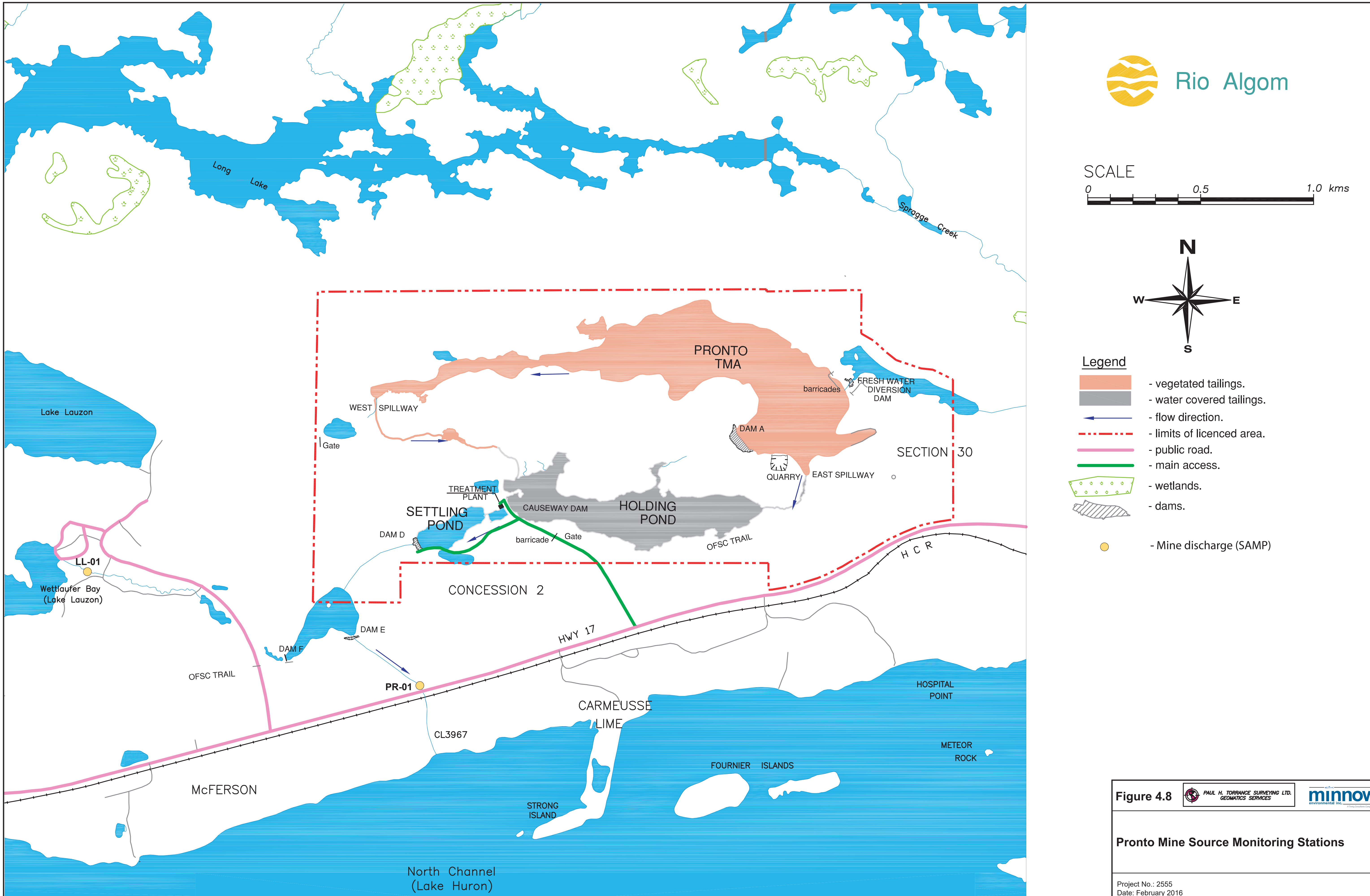


Figure 4.8

PAUL H. TORRANCE SURVEYING LTD. GEOMATICS SERVICES

minnow environmental inc.

Pronto Mine Source Monitoring Stations

Project No.: 2555
Date: February 2016

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, concentrations of other substances monitored at the primary discharge (PR-01) are below the SRW benchmarks (Figure 4.9). Mean cobalt concentrations at PR-01 are about five times the SRW benchmark (PWQO). Drainage to Lake Lauzon achieves receiving environment criteria for all substances, with the exception of iron (Figure 4.9).

Loads from the primary discharge (PR-01) are substantially greater (about 8 to 10 times) than those to Lake Lauzon, with the exception of iron, which is similar between stations (Figure 4.9). Over the past ten years, loadings from most parameters have been consistent, with the exception of fluctuations for cobalt (Figure 4.3).

Concentrations of barium and cobalt have been decreasing at station PR-01 (Table 4.5). Reductions in barium concentrations were associated with the ETP no longer using barium chloride for treatment as influent concentrations of radium-226 were sufficiently low (below discharge criteria, Appendix Table C.8.2) that both pH and radium-226 could be treated with lime. Since 2003, there has been a very small increase in the concentration of radium-226 (Table 4.5, Appendix Figure D.8.2), although levels remain well below the discharge criterion (0.37 Bq/L) and PWQO (1.0 Bq/L). Concentrations of barium, radium-226, sulphate, and uranium have been decreasing at station LL-01 since 2007 (Table 4.5; Appendix Figure D.8.3), and are associated with repairs to Dam F that same year. Iron concentrations have been increasing at station LL-01 (Table 4.5).

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 2010 to 2014. 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 generally consistent with trends observed within the TMAs.

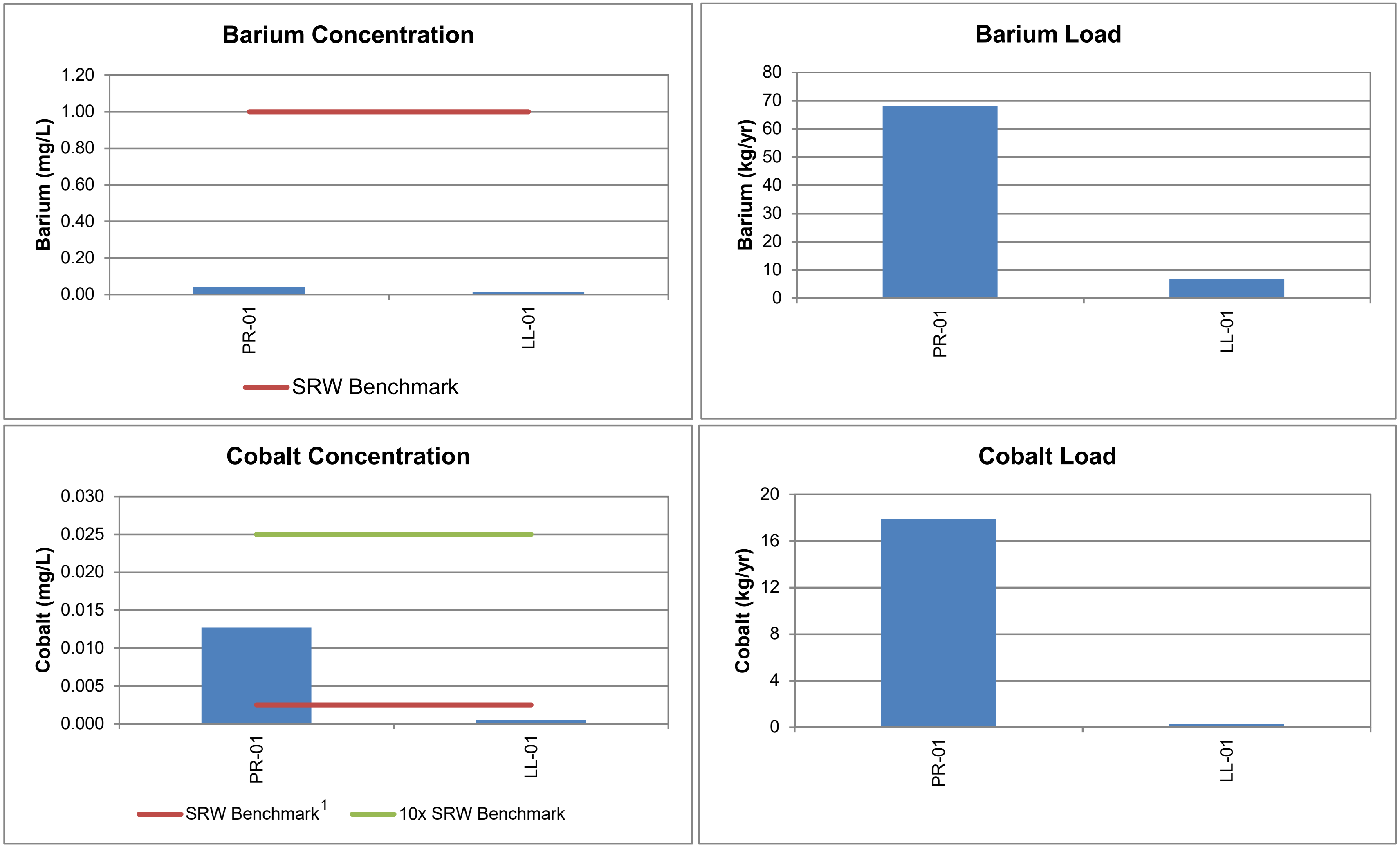


Figure 4.9: Mean concentrations and loads at monitoring stations downstream of Pronto TMA, 2010-2014. SRW benchmark (Table 2.8) is a receiving environment standard based on background or approved guidelines.

[1] Cobalt is no longer included as a SRWMP substance but it continues to be monitored to allow for SAMP Cobalt data to be considered in light of receiving environment concentrations and loads the SRW benchmark referenced is the Federal Water Quality guideline of 0.0025 mg/L (Environment Canada, 2013).

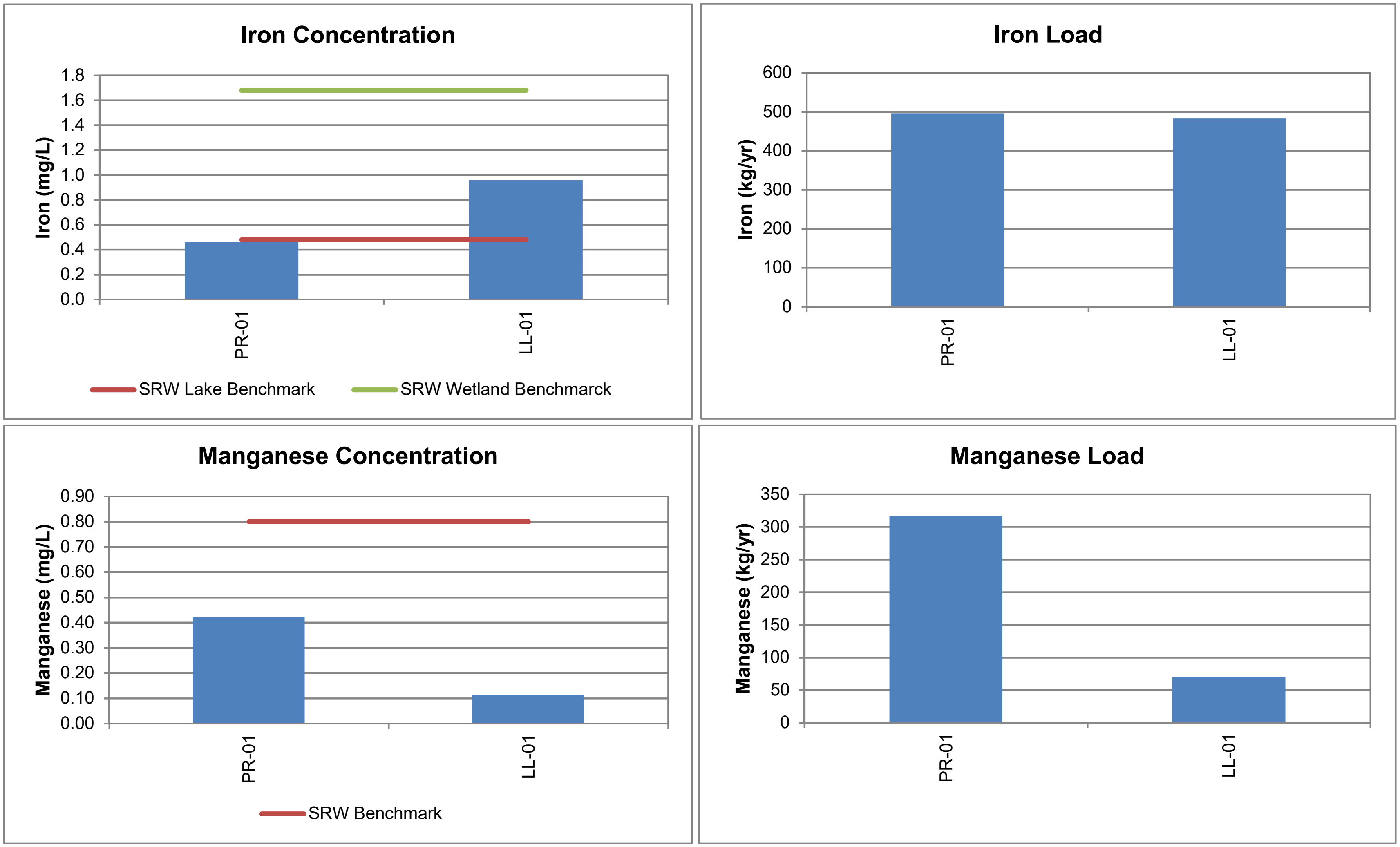


Figure 4.9: Mean concentrations and loads at monitoring stations downstream of Pronto TMA, 2010-2014. SRW benchmark (Table 2.8) is a receiving environment standard based on background or approved guidelines.

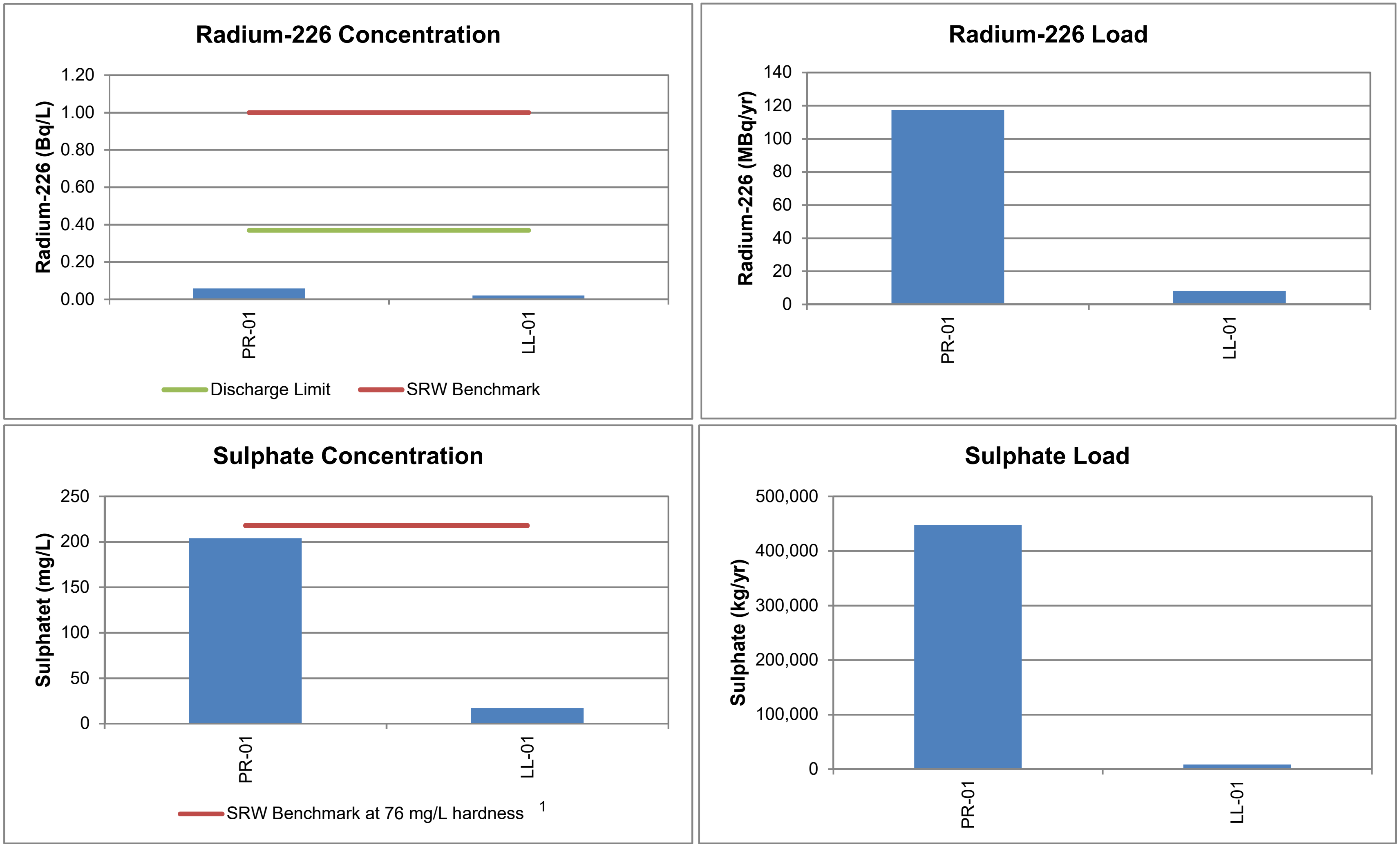


Figure 4.9: Mean concentrations and loads at monitoring stations downstream of Pronto TMA, 2010-2014. SRW benchmark (Table 2.8) is a receiving environment standard based on background or approved guidelines.

[1] The hardness of 76 mg/L represents the average of all TMA exposed stations. Hardness specific sulphate guidelines are provided for each station in Appendix Table E.33.

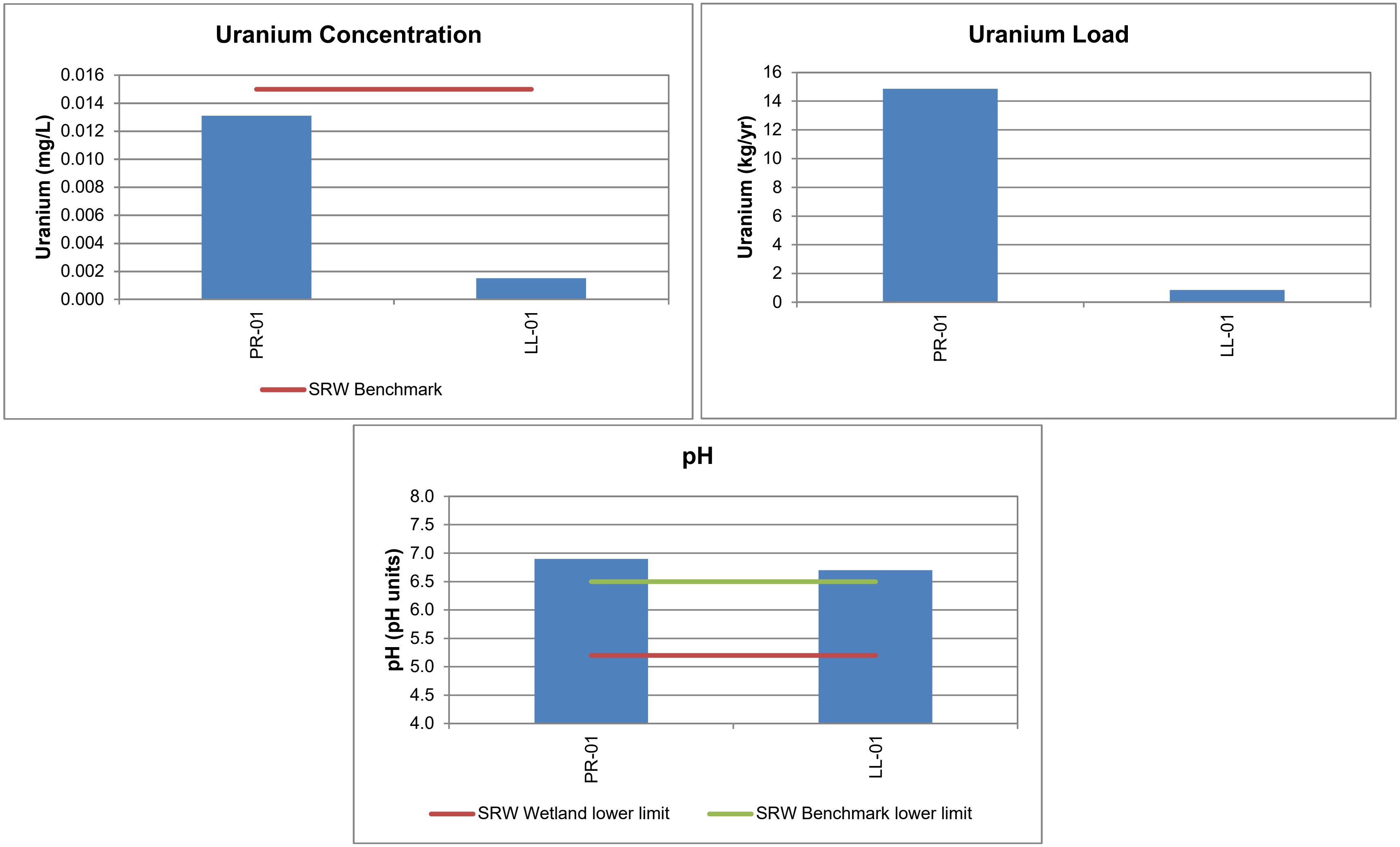


Figure 4.9: Mean concentrations and loads at monitoring stations downstream of Pronto TMA, 2010-2014. SRW benchmark (Table 2.8) is a receiving environment standard based on background or approved guidelines.

Table 4.5: Summary of water quality trends[a] for SAMP water quality monitoring stations in Pronto, 2003 to 2014.

TMA	Station ID	Type	Number of Months Used in Common Trend[b]	Barium	Cobalt	Iron	Manganese	pH	Radium-226	Sulphate	Uranium
Pronto	LL-01	Drainage	4	-0.764	ND	0.331	0.002	-0.144	-0.825	-0.757	-0.876
	PR-01	Primary	12	-0.428	-0.211	-0.042	-0.042	-0.134	0.218	-0.005	-0.134

(blue) decreasing trend, significant at p<0.05

(green) increasing trend, significant at p<0.05

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.

[a] Common (combined) trends based on rank correlation coefficients (rho) for monthly trends, ahoen in Appendix Table D.8.5-D.8.6.

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

5 SERPENT RIVER WATERSHED

5.1 Program Overview

The SRWMP was designed to assess the recovery of the receiving environment following the implementation of the decommissioning plans. The SRWMP was designed to evolve over time in response to conditions within the watershed such that as conditions improved, the scope of the program would retract based on acceptability criteria established at the onset of the program. The program was originally established to be conducted every five years based on a study design approved by the CNSC and the JRG (Beak 1999a). Each subsequent study design considered the findings of the previous cycle and proposed changes to the design based on observed conditions.

Initially, the program included water, sediment, and benthic invertebrate sampling in 20 lakes and 28 stream reaches with fish health assessments conducted in seven lakes. Sampling areas included both mine exposed and reference areas. The results of the first cycle (1999) SRWMP indicated no differences in fish health between mine exposed and reference lakes, although reduced abundance was observed in McCabe Lake. The lack of effects observed in the fish communities lead to the removal of fish health monitoring within the SRWMP in Cycle 2, but fish abundance in McCabe Lake continued until the end of Cycle 2 (2004). Results of Cycle 1 indicated that any mine related effects were confined to the deeper lakes, and thus monitoring in the shallower lakes was discontinued in Cycle 2. A lack of mine related effects on benthos within the connecting streams in Cycle 2 resulted in the removal of stream benthic sampling in Cycle 3. Thus, the Cycle 3 (2009) SRWMP focused on water, sediment, and benthic invertebrate sampling in deep lakes downstream of mine discharge locations and in selected reference areas.

Since 1999 water quality has improved dramatically resulting in a reduction in the substances monitored, focusing only on those elevated in mine effluent. The current program assessed concentrations of up to seven substances at 15 stations (5 reference and 10 mine exposed) on a quarterly, semi-annual or annual basis depending on the hydraulic residence time of the lake (Figure 5.1; Table 5.1). Water concentrations continue to improve, with most concentration less than water quality benchmarks. While water quality has improved dramatically over the past 10 to 15 years, sediment concentrations have shown little change during this time and are generally elevated downstream of the mines (Figure 5.2; Minnow 2011). However, sediment toxicity testing in 2009 showed no difference in growth or survival of the benthic invertebrate *Chironomus dilutes* between reference and mine-exposed lakes (Figure 5.3; Minnow 2011).

The benthic invertebrate communities downstream of the TMAs have shown some improvement since the implementation of the SRWMP in 1999 (*i.e.*, there are fewer reference vs. mine-exposed

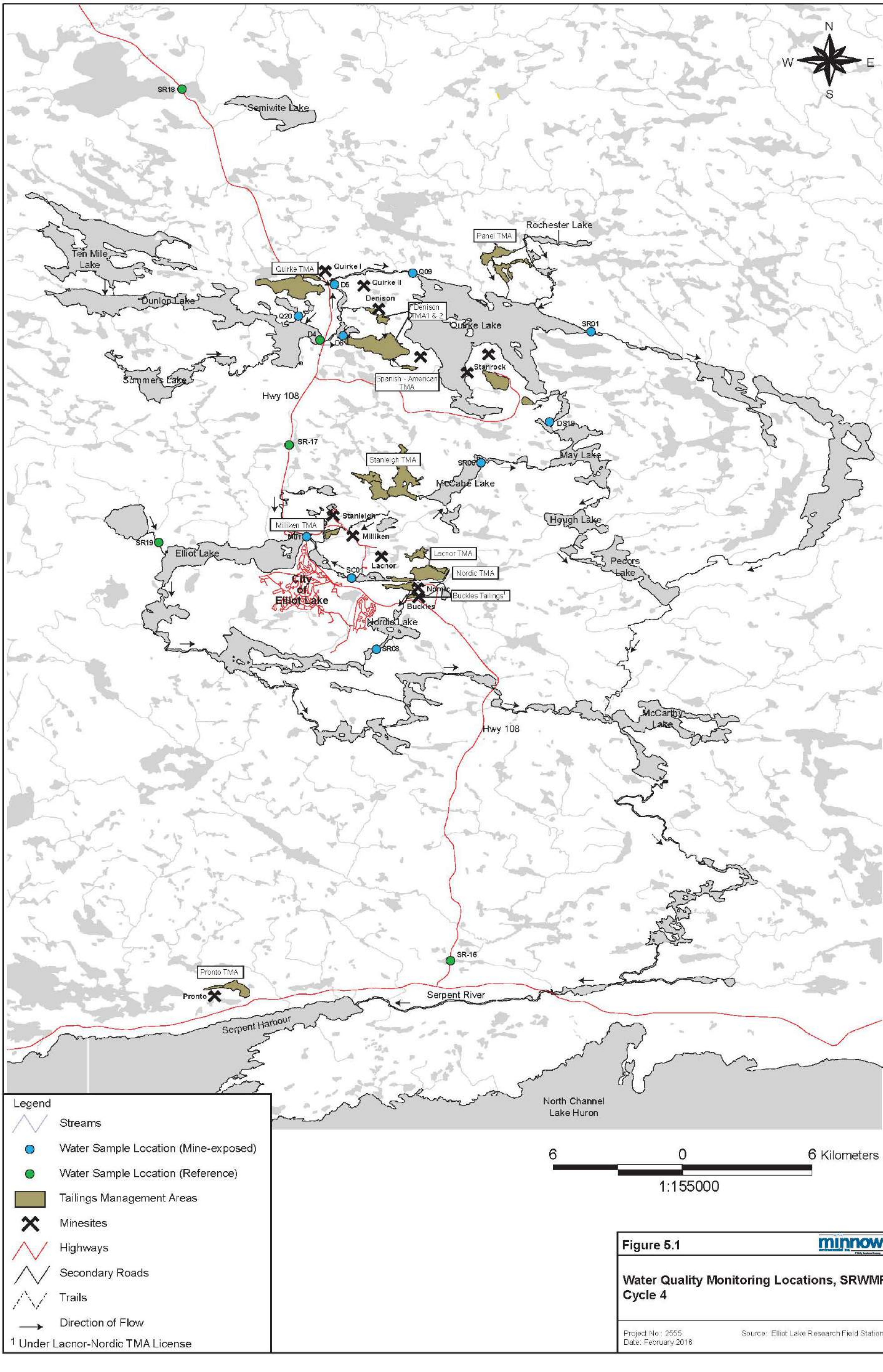


Figure 5.1

Water Quality Monitoring Locations, SRWMP Cycle 4

Table 5.1: Cycle 4 approved SRWMP water quality sample locations and frequencies[a].

Station	Location / Description	Reference vs Mine-exposed	Type	Frequency	Parameters[c]
D-4	Dunlop Lake Outlet (Q-14)	Reference	lake	S	barium, pH, iron, manganese, radium-226, sulphate and uranium
SR-19	Inlet to Elliot Lake			Q	
SR-18	Outlet of Jim Christ Lake			S	
SR-16	Fox Creek at Highway 108		wetland/stream	Q	barium, pH, iron, manganese, radium-226, sulphate and uranium
SR-17	Unnamed Creek Drain Lake 3 @ Hwy 108			Q	
D-6[b]	Cinder Lake Outlet	Mine-exposed	lake	Q	barium, iron, pH, radium-226, sulphate and uranium
DS-18	Halfmoon Lake Outlet		stream	Q	
M-01	Sherriff Creek @ Highway 108		stream	Q	
SC-01	Westner Lake Outlet		stream	A	
D-5	Serpent R between Denison & Quirke TMAs		lake	Q	barium, pH, radium-226, sulphate and uranium
Q-09	Serpent R Below Quirke TMA Effluent		lake	Q	
Q-20	Evans Lake Outlet to Dunlop Lake		lake	A	
SR-01	Quirke Lake Outlet		lake	A	
SR-06	McCabe Lake Outlet		lake	S	
SR-08	Nordic Lake Outlet		lake	Q	
Total Number of Locations and Samples/Year			15	45	

M=Monthly, S=Semi-Annually, A=Annually

[a] Water quality monitoring conducted from January 1, 2010 to December 31, 2014. The parameters, frequencies, and stations reflect the Cycle 4 approved study design.

[b] Manganese is also monitored at station D-6.

[c] Hardness monitored at reference and mine-exposed stations where sulphate concentrations are greater than 100 mg/L and at station D-6.

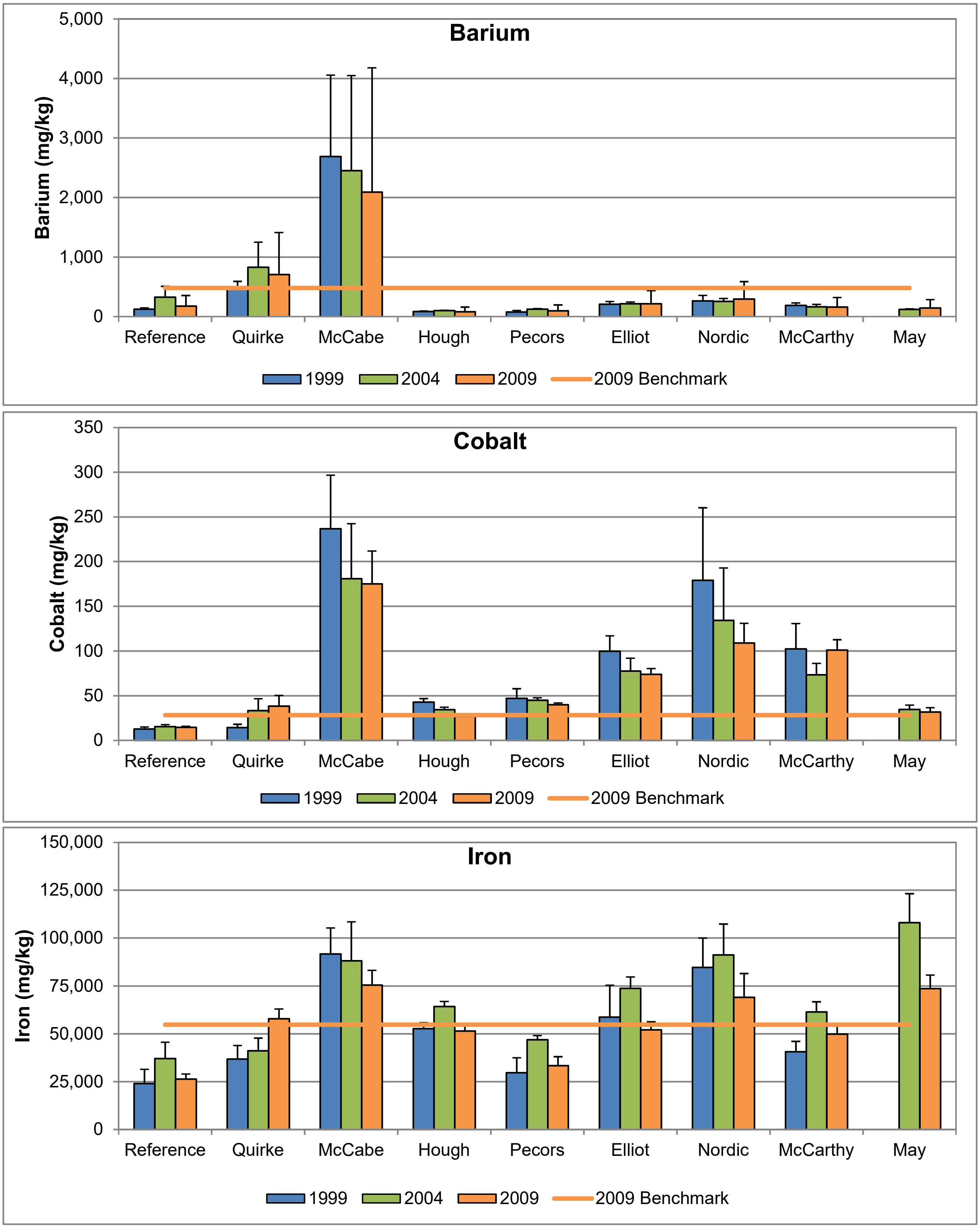
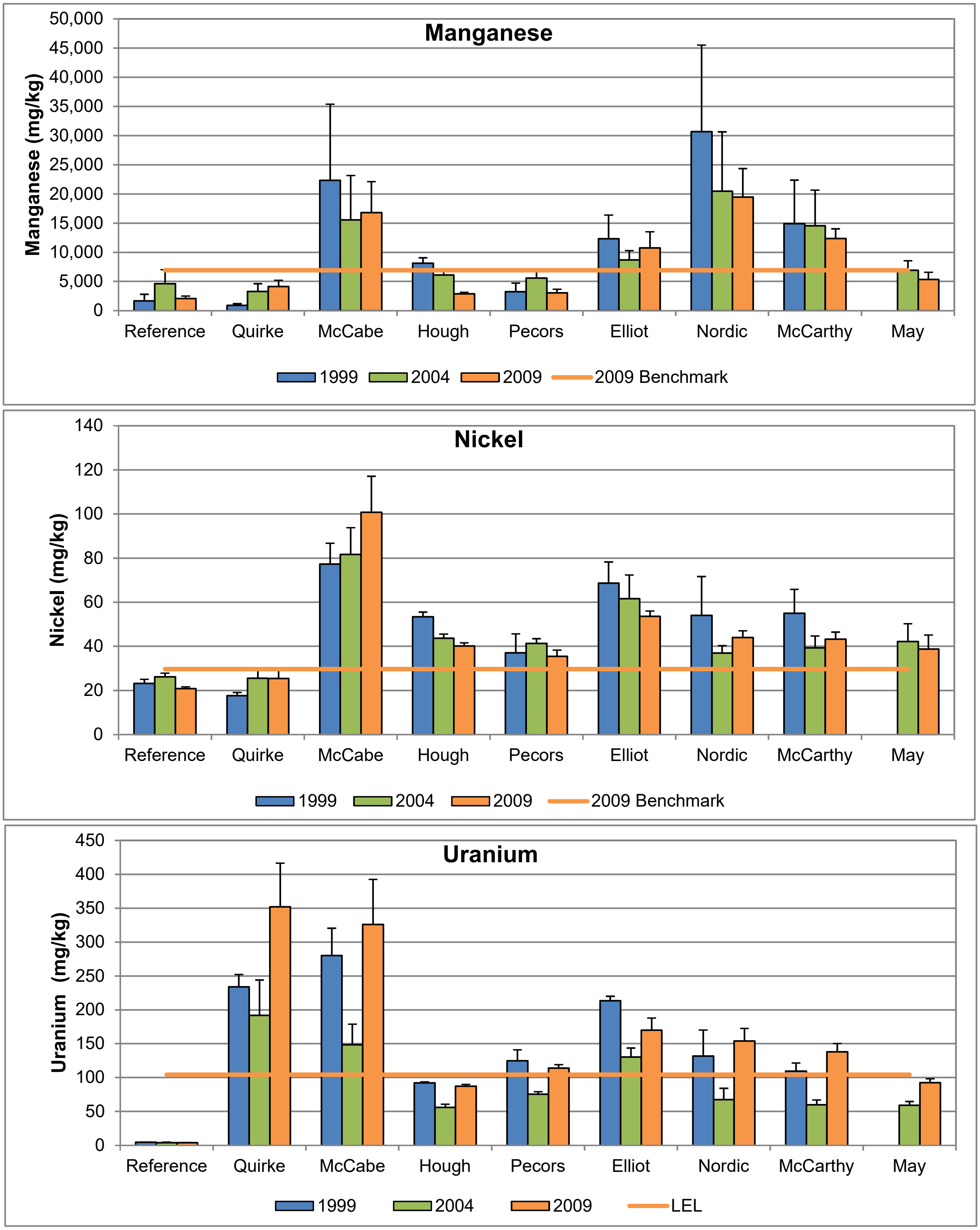


Figure 5.2: Mean lake sediment concentrations (± SE) for 1999 (cycle 1, n=3), 2004 (cycle 2, n=3), and 2009 (cycle 3, n=5).



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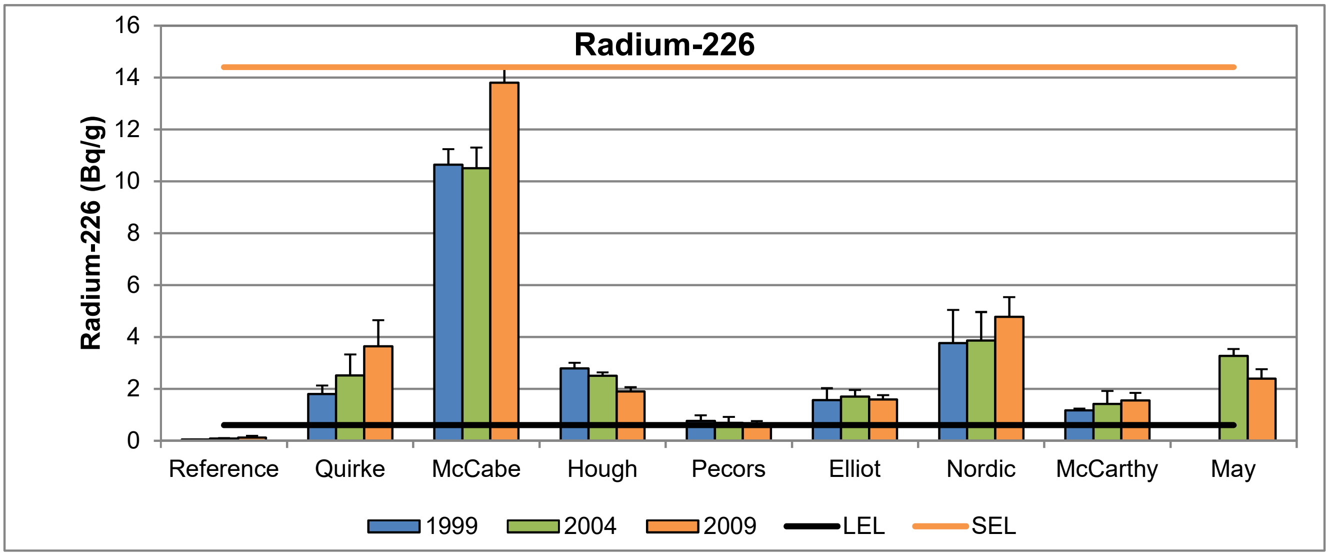


Figure 5.2: Mean lake sediment concentrations (± SE) for 1999 (cycle 1, n=3), 2004 (cycle 2, n=3), and 2009 (cycle 3, n=5).

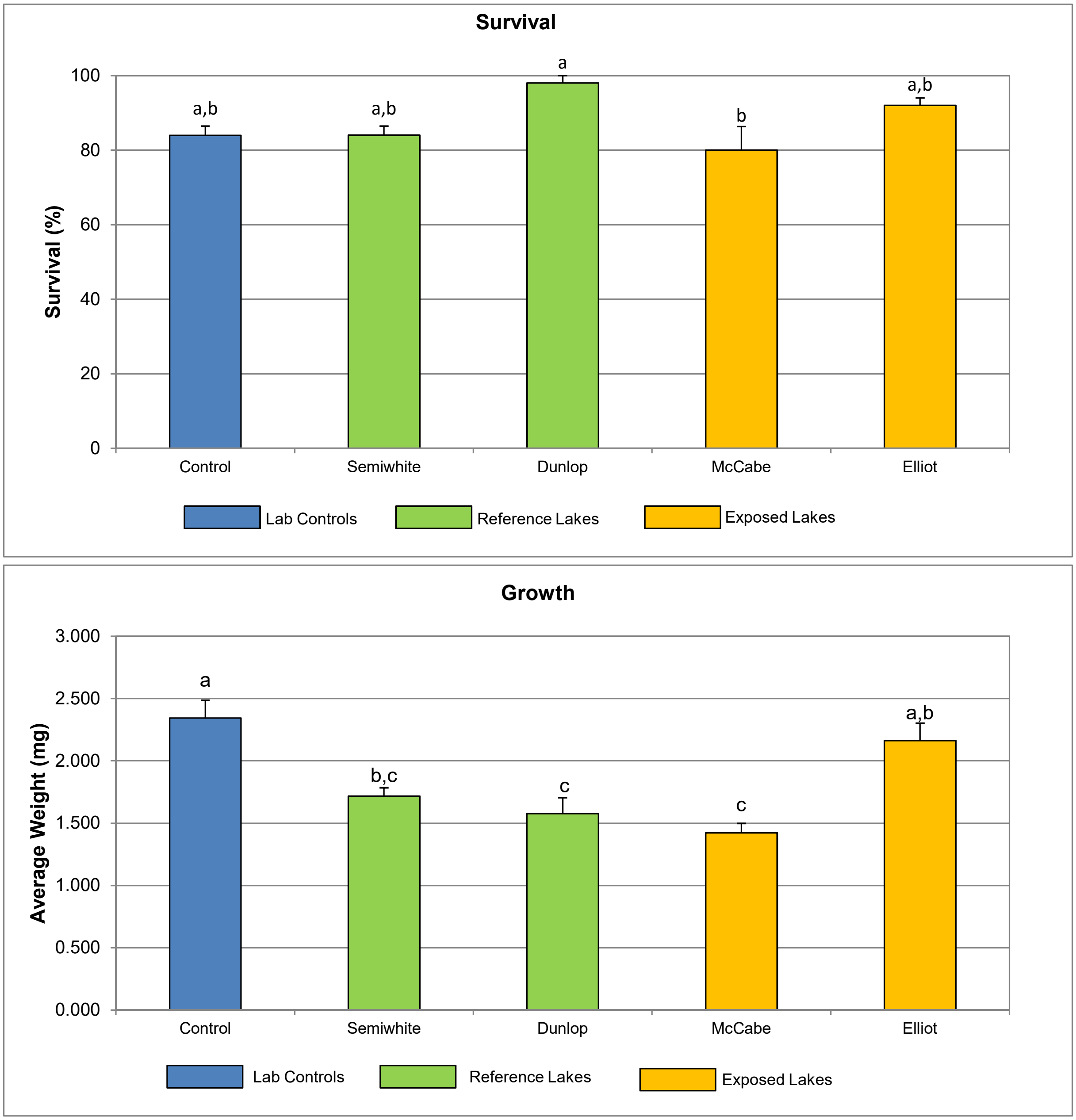


Figure 5.3: Survival and growth (+ SE) of *Chironomus dilutus* exposed to sediment samples, SRWMP 2009. Lakes with similar letters above bars were not significantly different (p<0.05).

differences), evident in increased densities and number of taxa in exposed lakes during each subsequent cycle (Table 5.2). However, the extent of improvement has not been as dramatic as that observed for water quality (Minnow 2011).

It was suspected that the slower improvement in sediment quality relative to surface water may be associated with slower than anticipated sediment deposition rates (assumed to be 2 mm/yr based on previous study conducted during operations). A key premise of the SRWMP design was that monitoring should occur at a frequency commensurate with the ability of the receiving environment to demonstrate change. Therefore, sediment deposition rates were confirmed through a two year study that included three near-field receiving lakes that have been the most influenced by historical mining activities (McCabe Lake, Quirke Lake, and Nordic Lake). Sediment deposition rates were determined using two approaches: sediment traps to assess the current sedimentation rate and fresh sediment quality, and sediment core profiling to investigate historical sediment quality and to determine how deposition rates changed over time relative to periods of historical mining activity within each lake.

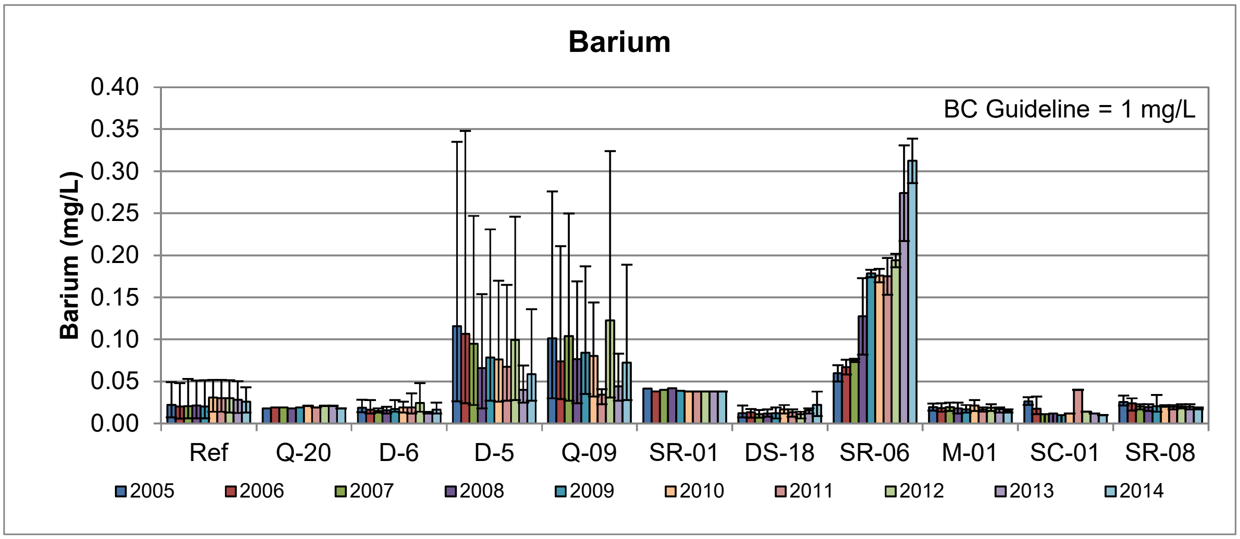
The study found that deposition rates in the three lakes ranged from 0.3 mm/year to 0.74 mm/yr, which translates into the deposition of 1 cm of sediment every 33 to 13 years. Therefore, even at the lake with the highest deposition rates (Nordic Lake), it would take more than ten years to accumulate 1 cm of sediment. This means that the frequency of monitoring in the SRWMP (*i.e.*, five years) is too rapid to expect to detect measurable improvement in benthic invertebrate community health and sediment quality. Based on the results of the sediment deposition study the frequency of sediment and benthic invertebrate was reduced to every 10 years. Thus the next sediment and benthic invertebrate community monitoring will be conducted in 2019. Therefore, this cycle of the SRWMP did not include sediment and benthic sampling, but routine water quality monitoring was conducted and data collected from January 2010 to December 2014 forms the basis for the SRWMP assessment within this SOE.

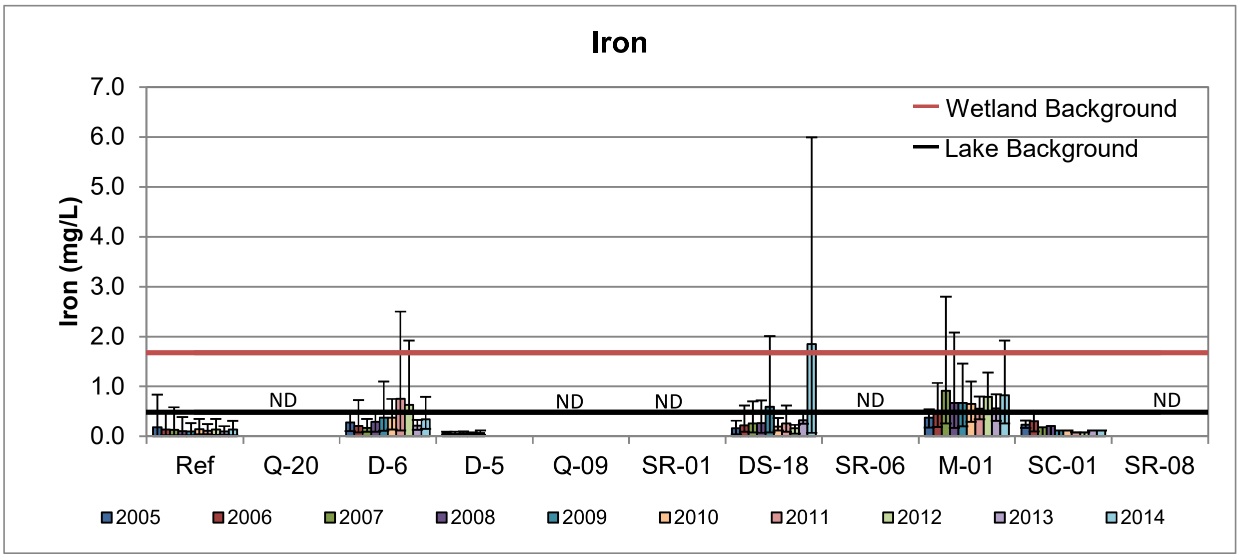
5.2 Water Quality

With few exceptions, annual mean water concentrations (2010 to 2014) were less than SRWMP benchmarks for most substances (Figure 5.4). All samples of barium, pH, radium-226, sulphate and uranium were less than (or greater than for pH) the water quality benchmarks (Table 5.3). Manganese, which is only monitored at station D-6 (downstream of seepage from Denison TMA, only exceeded the benchmark in 10% (2 samples) of the samples collected over the 5 year period (Table 5.3). Iron periodically, exceeded the benchmark at stations D-6, DS-18 and M-01, although most samples ($\geq$ 80%) achieved the benchmark (Table 5.3) and mean concentrations were well less than the benchmark (Figure 5.4), except for DS-18, and that appears to be due to three samples collected in the winter of 2014 (Appendix Table E.10). These elevated iron

Table 5.2. Benthic community metric means and significant patterns of increase (↑) or decrease (↓) among mine-exposed lakes relative to the reference mean (p<0.1).

Metric	Area	1999		2004		2009	
Density	Reference	4,523	↓	5,833	↓	6,826	↓
	Exposed	2,987		3,152		4,163	
Number of Taxa	Reference	10.8	↓	12.5	-	12.3	-
	Exposed	7.0		10.8		11.0	
CA Axis 1	Reference	-0.21	↑	-0.18	↑	-0.22	-
	Exposed	0.34		0.17		0.10	
CA Axis 2	Reference	0.23	-	0.36	↓	0.36	↓
	Exposed	0.10		0.08		-0.25	
CA Axis 3	Reference	0.36	↓	0.25	-	-0.22	-
	Exposed	0.15		0.12		-0.12	
Total Metrics for Which Exposure Lakes Differed from Reference		**4**		**3**		**2**	





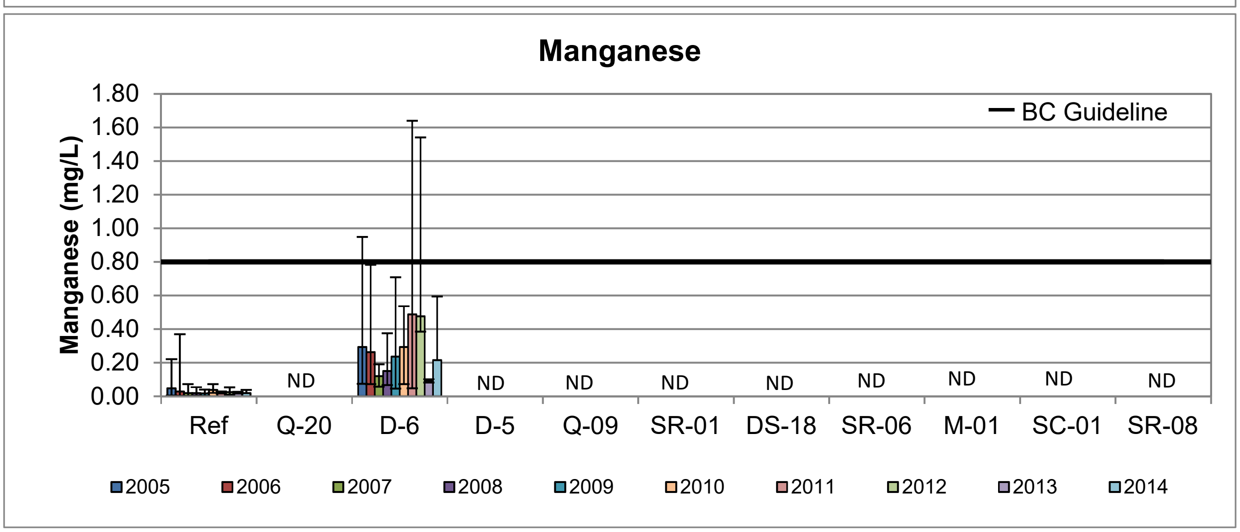


Figure 5.4: Mean, minimum and maximum water concentrations over time at mine exposed stations relative to pooled reference stations and water quality benchmarks. ND denotes no data available for that station as substance is no longer monitored.

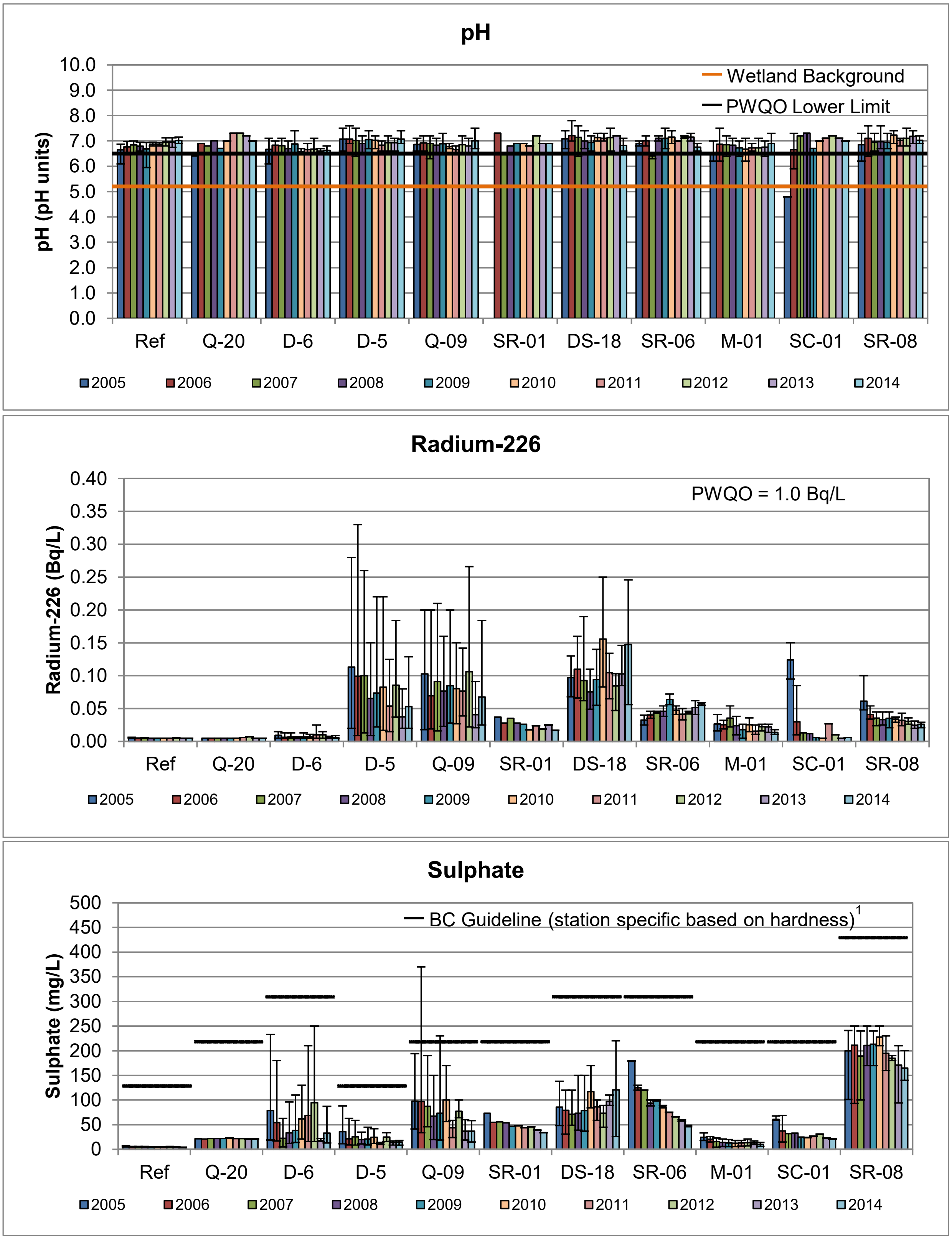


Figure 5.4: Mean, minimum and maximum water concentrations over time at mine exposed stations relative to pooled reference stations and water quality benchmarks. ND denotes no data available for that station as substance is no longer monitored.

[1] Station specific guideline based on hardness presented in Appendix Table E.33.

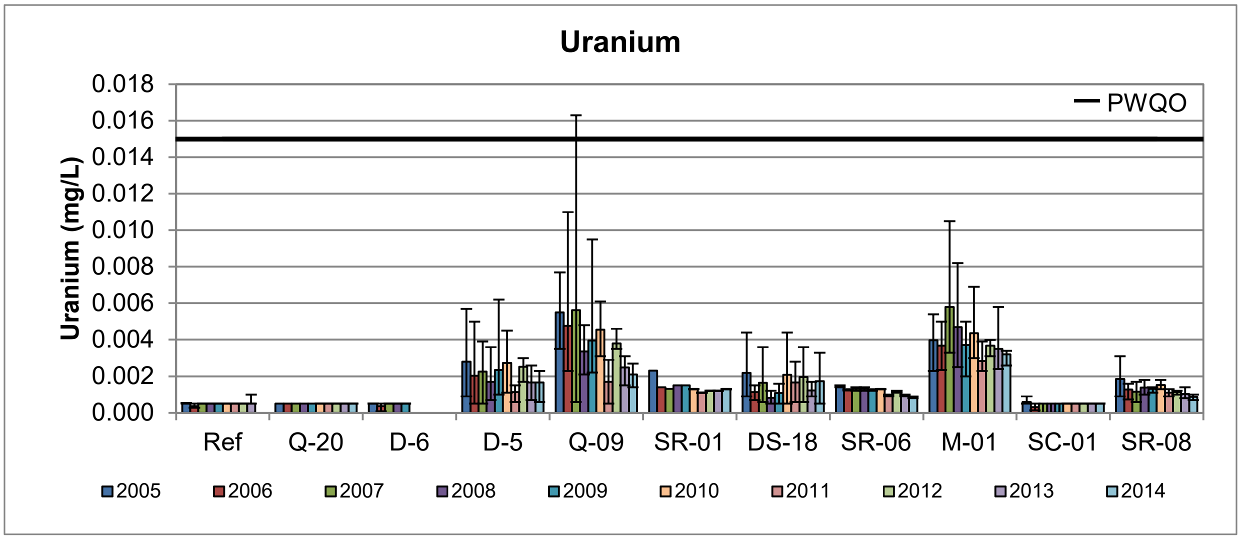


Figure 5.4: Mean, minimum and maximum water concentrations over time at mine exposed stations relative to pooled reference stations and water quality benchmarks. ND denotes no data available for that station as substance is no longer monitored.

Table 5.3: Percent of samples exceeding selected benchmarks (shaded values) at SRWMP stations, 2010-2014.

Station	# of Samples	Barium	Iron	Manganese[c]	pH	Radium-226	Sulphate[b]	Uranium
		mg/L	mg/L	mg/L	pH units	Bq/L	mg/L	mg/L
Upper limit of Background	**Lakes**	**0.057**	**0.48**	**0.095**	**6.6**	**0.008**	**6.4**	**<0.0005**
	Wetlands	**0.021**	**1.68**	**0.068**	**5.2**	**0.006**	**4.3**	**<0.0005**
Guideline		**1.0**	**0.30**	**0.80**	**6.5**	**1.0**	**128 - 429**	**0.015**
D-5	20	0%	na	na	0%	0%	0%	0%
D-6[d]	20	0%	20%	10%	0%	0%	0%	na
DS-18	22	0%	14%	na	0%	0%	0%	0%
M-01	20	0%	5%	na	0%	0%	0%	0%
Q-09	20 to 21	0%	na	na	0%	0%	0%	0%
Q-20	5	0%	na	na	0%	0%	0%	0%
SC-01	5	0%	0%	na	0%	0%	0%	0%
SR-01	5	0%	na	na	0%	0%	0%	0%
SR-06	10	0%	na	na	0%	0%	0%	0%
SR-08	20	0%	na	na	0%	0%	0%	0%

Benchmark applied to lake stations: D-5, D-6, Q-09, Q-20, SR-01, SR-06, SR-08. (blue)

Benchmark applied to wetland stations: M-01, DS-18, SC-01. (green)

Benchmark applied to lake and wetland stations. (grey)

[a] SRWMP benchmarks. See Table 2.9 for selection details.

[b] Benchmark dependent on site specific water hardness (mg/L): Very Soft (0-30): 128; Soft to moderately soft (31-75): 218; Moderately soft/hard to hard (76-180): 309; Very hard (181-250): 429; >250 determined based on site water. See Appendix Table E.33 for site hardness values used.

[c] Benckmark - BCMOE guideline is hardness dependent. Average hardness at station D-6 was used as the basis for the guideline selection see Appendix Table E.33.

[d] Two samples of manganese exceeded the benchmark based on the average hardness. Had the sample specific hardness been applied, only 1 sample (5%) would have exceeded the benchmark (Appendix Table E.9).

na - Parameter not sampled at respective station.

concentrations are likely the result of particulate matter within the sample during low flow as iron concentrations are expressed as total concentrations which can be extremely influenced by particulate matter (Horowitz 1985).

Generally, concentrations of radium-226, sulphate and uranium have been decreasing or remaining stable over time (Table 5.4). The only exception is downstream of the Stanleigh TMA at the outlet of McCabe Lake (SR-06), where barium and radium-226 concentrations have been increasing. However, the concentrations of barium and radium-226 remain well below the water quality benchmark (3 and 173 times lower, respectively) at SR-06 (Appendix Table E.16 and Figure E.9). The increase in the concentration is related to a decrease in treatment efficiencies associated with improved water quality within the TMA basin. Radium-226 and barium concentrations have been decreasing within the TMA (Table 3.26). The pH levels at most stations demonstrate stable conditions with no trends observed except for downstream of the Stanrock TMA (DS-18), where pH was found to be decreasing (Table 5.4; Appendix Figure E.4). However, the change in pH over the past twelve years was very small and pH remains neutral (Appendix Figure E.4).

Water quality downstream of the TMAs is meeting EIS predictions. Recent concentrations of sulphate and radium-226 downstream of the TMAs were close to or better than the 1999 cumulative predications or, in the case of Stanleigh, the 2012 predicted values for radium-226 and uranium (Table 5.5). 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.

5.3 Summary

Overall, water quality continues to improve in the Serpent River Watershed, with metal concentrations in surface water decreasing over time and pH stable at near-neutral levels. All samples of barium, pH, radium-226, sulphate, and uranium collected over the past five years (2010 to 2014) were less than the water quality benchmarks. Only manganese (D-6) and iron (D-6, DS-18 and M-01) occasionally (≦ 20%) had concentrations above the water quality benchmark. Generally, concentrations of manganese, radium-226, sulphate, and uranium have been decreasing over time, except at the outlet of McCabe Lake (SR-06) where barium and radium-226 concentrations have been increasing, although concentrations remain well below the water quality benchmark.

Table 5.4: Summary of water quality trends[a] for Serpent River monitoring stations, 2003 to 2014.

Station ID	Number of Months Used in Common Trend[b]	Barium	Iron	Manganese	pH	Radium-226	Sulphate	Uranium
Reference Stations								
D-4	4	-0.275	*0.042*	-0.031	-0.062	ND	-0.313	ND
SR-16	4	0.045	-0.125	-0.175	-0.004	ND	0.039	-
SR-17	4	0.389	-0.043	0.367	-0.081	ND	0.039	-
SR-18	2 to 4	-0.177	0.516	0.124	0.137	ND	-0.815	ND
SR-19	4 to 12	-0.139	0.033	-0.297	0.195	ND	-0.652	ND
Exposed Stations								
D-5	12	-0.182	*-0.093*	-	0.040	-0.322	-0.351	-0.113
D-6	12	-0.206	0.222	-0.129	0.044	-0.179	-0.308	ND
DS-18	12	0.102	0.200	-	-0.347	-0.326	-0.067	-0.104
M-01	12	-0.219	-0.224	-	0.208	-0.619	-0.509	-0.175
Q-09	12	-0.166	-	-	0.058	-0.193	*-0.287*	-0.335
Q-20	1	**-0.154**	-	-	**0.353**	**0.034**	**-0.802**	ND
SC-01	1	**-0.235**	-	-	**0.287**	**-0.689**	**-0.904**	ND
SR-01	1	**-0.554**	-	-	**0.131**	**-0.820**	**-0.950**	**-0.598**
SR-06	2	0.977	-	-	0.217	0.479	-0.974	-0.875
SR-08	12	-0.407	-	-	0.057	-0.716	-0.234	-0.571

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

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

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.

"-" 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, or not measured at site).

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

Bold text - only one month was used in common trend analysis.

[a] Common (combined) trends based on rank correlation coefficients (rho) for monthly trends, shown in Appendix Table E.18 to E.32.

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

Table 5.5: Concentration predictions at SRWMP stations compared to 2014[a] values.

TMA	Predicted vs Measured	Year	Sulphate (mg/L)	Radium-226 (Bq/L)	Uranium[b] (mg/L)
SR-01	Cumulative Prediction [c]	1999	173	0.067	-
	Current	2014	34	0.017	0.0013
	Cumulative Prediction [c]	2099	23	0.042	-
DS-18	Cumulative Prediction [c]	1999	215	0.170	-
	Current	2013	97	0.103	0.0012
	Cumulative Prediction [c]	2099	53	0.051	-
SR-06	2012[d] Prediction	2012	32	0.1	0.0029
	Current	2014	48	0.057	0.0009
	Cumulative Prediction [c]	2099	11	0.026	-

[a] Mean 2014 values used, except for DS-18 where 2013 mean was used as several values in 2014 were suspect.

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

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

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

6 PUBLIC DOSE

Public dose estimates for the Elliot Lake facilities have been undertaken to provide conservative estimates of public dose associated with potential radiation exposure. The upper limit of potential radiation exposure was calculated for radon, gamma, and dietary uptake exposure pathways. The total dose from these sources was compared to the Health Canada Guidelines for protection of public health as well as the Canadian Nuclear Safety Commission regulatory limits on public dose (Table 6.1). The public dose summarized in Table 6.1 and presented in the following sections represents upper bounds of incremental public dose arising from the decommissioned Elliot Lake uranium mines.

6.1 Radon

Extensive radon monitoring and modeling conducted during mine operations in the vicinity of the Elliot Lake tailings demonstrated that radon levels drop to near background levels within a few hundred metres of all tailings basins (Golder *et al.*, 1986; Senes 1986).

Post remediation radon monitoring shows the highest average concentration of radon, expressed as the radon progeny equivalent, is 0.009 Working Level (WL, CNSC 2002). Based on a casual access exposure period of 200 hours/year, the resulting incremental public dose is estimated to be 0.04 mSv (0.009 WL x 200 hrs x 1 Working Level Month (WLM)/170 hrs x 4 mSv/ WLM) or less than 5% of the public dose limit.

The critical receptor for radon emanation was determined to be the Nordic Lake receptor as the lack of a flooded or saturated cover at the Lacnor/Nordic tailings management area results in the highest radon release rates. The incremental dose from radon to a receptor living on the shore of Nordic Lake was determined to be 0.016 mSv/y (CNSC 2002) or 1 % of the public dose limit.

Maintenance of water and/or vegetative covers at the remediated sites and tailings management areas ensures that radon progeny concentrations remain at or below closure concentrations.

6.2 Gamma

Public dose estimates based on gamma radiation field surveys of licensed facilities and access time estimates of 200 hours/year project an annual average public dose for all properties of 0.016 mSv/yr (CNSC 2002) or 1.6% of the public dose limit of 1 mSv/year (Table 6.2).

Table 6.1: Upper bound of public dose from Elliot Lake facilities.

Source	Exposure Pathway	Reference	Annual Dose (mSv/y)
Radon	200 hours of casual tailings management area access at maximum exposure rate of 0.009 WL	CNSC 2002	0.04
Gamma	200 hours of casual tailings management area access at maximum gamma field	CNSC 2002	0.06
Dietary	1.5 liter water/day; 2.92 kg fish/year; 1 kg waterfowl/year; 1 kg moose/y from May Lake	Minnow 2011	0.103
Total Dose from all sources			0.203
Public Dose Limit			1
Health Canada Guideline			0.3

Table 6.2: Gamma Dose from casual access to mine properties, CNSC 2002[f].

Property	Dose From Casual Access to Mine Properties	
	μSv/y	% of Public Limit
Denison	5	0.5%
Quirke	13	1.30%
Panel	13	1.30%
Spanish-American	8[b,c]	0.80%
Stanrock	17	1.70%
Stanleigh	12	1.20%
Milliken	11b	1.10%
Lacnor/Nordic/Buckles	60[b,d]	6.00%
Pronto	7[b]	0.70%
Average	16	1.62%

[a] From Quirke and Panel Environmental Impact Statement (Rio Algom 1995) unless specified.
[b] Calculated and/or updated based on surveys completed from 1996 to 1998, using the same assumptions made in the Quirke and Panel EIS (Rio Algom Limited 1995).
[c] A one metre water cover reduces the gamma dose from the tailings to insignificant levels at the Spanish-American TMA. The incremental dose is entirely due to the time spent at the mine site.
[d] Actual dose from Lacnor TMA is conservative, as no allowance has been made for the cover placed after the 1997 gamma survey.
[e] Allowable public limit 1 mSv/yr (1000 mSv/y)
[f] CNSC 2002, Table 8.4.1

The dose attributed to casual access for each mine properties is summarized in Table 6.2. Gamma radiation remediation programs have been completed at former mine, mill and town sites associated with the TMAs (AECBa,b,c)[6]. The CNSC approved remediation criteria included:

- Clean-up of all surface areas with surface gamma radiation levels > 150 μR/hour; and
- Surface grid criterion for gamma radiation of < 100 μR/hour over a 10,000 m^2 area.

6.3 Pathway Analysis

Incremental dose estimates were updated in 2009 for ecological and human receptors based on site specific monitoring data collected at six watershed lakes (Quirke, Elliot, Nordic, McCabe and May lakes; EcoMetrix 2011d). Human receptors included generic human and a Serpent River Frist Nation (SRFN) member residing on area lakes and consuming fish, moose and waterfowl from the designated near field lakes. Consumption rates for SRFN members were based on a survey conducted by SRFN of consumption usage within the watershed. Total dose estimates range from 0.022 mSv/y at McCarthy Lake to 0.103 mSv/y at May Lake (Table 6.3). These upper bound limits were developed as part of the 2011 State of the Environment Report (Ecometrix 2011d in Minnow 2011) with supplemental data on polonium-210 used to update dose to Quirke Lake receptor in 2012 (Minnow 2012). These upper bound exposures are well the below public dose limit of 1 mSv/y, and these values will next be updated as part of the next State of the Environment report to be completed in 2020 (i.e., 2015 to 2019 study period).

6.4 Casual Access Dose Verification

The CNSC has requested annual reporting of public dose. Whereas all previous public dose estimations in SOE reports have focused on demonstrating upper bounds of public dose, using rather conservative assumptions for hypothetical human residents on downstream lakes, the intention moving forward is for annual SRWMP Reports to include realistic doses for a representative person residing in the town of Elliot Lake. This is the only lake in the watershed with a resident community. The “representative person” (ICRP 2007) is equivalent to and replaces the “average member of the critical group” (ICRP 1986) as the basis for determining compliance with public dose limits and guidelines.

Site-specific surveys will be undertaken in Elliot Lake to characterize the habits of residents relevant to important exposure pathways monitoring programs as part of periodic environmental effects. Based on previous dose estimations as described above, the important exposure pathways are casual access to mine properties (radon and direct gamma exposure) and ingestion

[6] The Decommissioning Audit reference for Stanleigh is currently outstanding but will be provided to reviewers when it becomes available.

Table 6.3. Incremental dose to hypothetical resident of downstream lakes.

Consumption Items		Incremental Dose Water (mSv/y)	Fish (mSv/y)	Moose (mSv/y)	Mallard[2] (mSv/y)	Total (mSv/y)
Ingestion Rate	Generic Human	1.5	2.92	1	1	-
	SRFN[3]	1.5	12.7	12.1	0.37	-
	Units	(L/d)	(kg/y)	(kg/y)	(kg/y)	-
Generic Human Dose by Lake	Quirke[1] Lake	0.03820	0.04252	0.00307	0.01068	0.09447
	Elliot Lake	0.01780	0.00628	0.00028	0.00000	0.02436
	Nordic Lake	0.01880	0.00649	0.00011	0.00000	0.02540
	McCabe Lake	0.02390	0.00695	0.00346	0.03388	0.06819
	May Lake	0.05740	0.01002	0.00285	0.03268	0.10295
	McCarthy Lake	0.01460	0.00609	0.00052	0.00149	0.02270
SRFN Dose in Watershed	SRFN Current[4]	0.01110	0.02002	0.01515	0.00269	0.04896
	SRFN Future[4]	0.01200	0.02026	0.01375	0.00067	0.04668

[1] Quirke Lake data from Minnow, 2012; all other data from Minnow, 2011.

[2] Incremental dose set at 0 for Elliot and Nordic Lakes where total dose is below background dose.

[3] SRFN - Serpent River First Nation Member.

[4] The current consumption was based on a survey conducted in 2010 of SRFN members and the future consumption was estimated by the SRFN Land and Resource Committee.

of drinking water and sport fish from Elliot Lake (collectively 99% of ingestion dose, Table 6.3). An updated detailed design for public dose determination will be included in the Cycle 5 study design report (2019).

An interim public dose determination for a representative member of the Elliot Lake public based on readily available data and seasonal site-specific radon and gamma surveys will be developed in early 2016, and data collection will be initiated shortly thereafter. Public dose estimates to be included in the 2016 to 2020 annual SRWMP Reports will be based on updated public dose estimates generated through the 2016 interim program.

6.5 Summary

To date estimates of public dose have been based on the use of very conservative values to demonstrate that public dose in the vicinity of Elliot Lake does not exceed the upper dose limit. Measurements of radon and gamma collected during mine operations, result in dose estimates which are less than 5% of the public dose limit. Dietary exposure pathway analysis conducted in 2009 indicated that the total dose to generic human and a Serpent River Frist Nation (SRFN) member residing on area lakes and consuming fish, moose and waterfowl from near field lakes were also well below the public dose limit.

The licensee's (RAL and DMI) will develop a detailed design for public dose determination as part of the Cycle 5 study design report to be provided in 2019. An interim public dose determination for a representative member of the Elliot Lake public based on readily available data and seasonal monitoring will be included in the 2016-2020 annual SRWMP Reports.

7 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 SRWMP and TOMP and SAMP data from January 2010 to December 2014 (five years).

The licensees continue to make improvements in TMA infrastructure, treatment, and monitoring systems which allows for continuous improvement in TMA performance and demonstrates improving conditions within the licensed areas and downstream.

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 2014) based on decreasing concentrations of radium-226, sulphate, and uranium, as well as increasing pH levels, at most TMAs. The only exception was observed at Denison TMA-1 where radium-226 and barium concentrations have been increasing and pH has been decreasing in surface water. The radium-226 and barium trend appears to be associated with a step change in 2008 and is thought to be caused by decreasing sulphate concentrations in the TMA. This results in the dissolution of barium or calcium sulphate compounds to which radium-226 is associated, and subsequent release of radium-226 and barium from the tailings. It is expected that radium-226 concentrations in porewater will stabilize over time once the dissolution of sulphate compounds re-equilibrates with aqueous sulphate concentrations. Decreasing pH in the TMA-1 basin is believed to be associated with the depletion of lime that was added to the basin in 1998. While pH has decreased, the change in pH over the past 12 years has been very small and pH within the TMA remains neutral, achieving the PWQO prior to treatment at Station D-1.

Generally, trends in porewater concentrations reflected those observed in surface water within the basins, but trends in groundwater were more variable. With few exceptions, porewater and groundwater trends indicated improving water quality and relative to Cycle 3, continue to be indicative of improved porewater and groundwater quality. Where increasing metals or decreasing pH trends were observed these were associated with deeper sampling stratums and represent the flushing of historical porewaters from the TMAs.

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 effluent concentrations have been increasing over time, although concentrations in the basin have been decreasing. The increase in radium-226 in effluent may be, in part, associated with decreasing sulphate concentrations in the TMA basin. As sulphate decreases, more barium chloride is required to precipitate radium-226 with barium sulphate and remove it from the effluent. Thus, the increase in radium-226 and barium is associated with decreased treatment efficiencies attributed to lower sulphate concentrations in the TMA.

At Denison and Quirke, effluent pH showed a decreasing trend, but this appeared to be associated with a decrease in pH relative to previous pH levels which were higher due to in-basin liming activities. 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 (D2, D-3, Q-28, and CL-06) of the flooded basins. This was largely due to greater barium chloride use either in response to increased flows or due to lower sulphate concentrations influencing treatment efficiencies. 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. Effluent has also been consistently non-lethal to *Daphnia magna* and rainbow trout with no mortality reported in semi-annual acute toxicity tests. Similarly, reproduction of *Ceriodaphnia dubia* was 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. Seepage concentrations have been improving over time at all seepage monitoring locations. 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 2011), the radium-226 load within the Serpent River downstream of the Denison TMA discharge (D-5) continues to be higher than the loading from the Denison TMA or the upstream watershed (D-4), and is likely associated with the historical deposits of treatment solids downstream of the Denison TMA (EcoMetrix 2011a). Diffusion modelling indicated that radium-226 release from the sediment should decrease with time (EcoMetrix 2011a).

Watershed Conditions

The improvements within the TMAs were reflected in the downstream watershed. With few exceptions, annual mean water concentrations (2010 to 2014) were less than SRWMP benchmarks for most substances. All samples of barium, pH, radium-226, sulphate and uranium were less than (or greater than for pH) the water quality benchmarks. Manganese, which is only monitored at station D-6 (downstream of seepage from Denison TMA, only exceeded the benchmark in 10% (2 samples) of the samples collected over the 5 year period. Iron periodically, exceeded the benchmark at stations D-6, DS-18 and M-01, although most samples ($\geq$ 80%) achieved the benchmark. Furthermore, concentrations of radium-226, sulphate, and uranium continue to decrease in surface water over time, with the exception of the outlet of McCabe Lake (SR-06) where radium-226 and barium have been increasing due to reduced treatment efficiencies at the Stanleigh TMA. However, both radium-226 and barium remain well below the water quality benchmarks and predicted concentrations at this location.

Sediment deposition rates within Quirke, McCabe, and Nordic lakes downstream of the TMAs were investigated as part of a two year study (2011 and 2012) to determine the expected sediment recovery rates for the watershed. The study found that deposition rates in the three lakes ranged from 0.3 mm/year to 0.74 mm/yr, which translates into the deposition of 1 cm of sediment every 33 to 18 years. Therefore, even at the lake with the highest deposition rates (Nordic Lake), it would take more than ten years to accumulate 1 cm of sediment. This means that the frequency of monitoring in the SRWMP (*i.e.*, five years) was too rapid to expect a detectable measurable improvement in benthic invertebrate community health and sediment quality. Based on the results of the sediment deposition study, the frequency of sediment and benthic invertebrate sampling was reduced to every 10 years. The next sediment and benthic invertebrate community monitoring will be conducted in 2019, and the findings of the assessment will be included in the next SOE report.

Public Dose

To date estimates of public dose have been based on the use of very conservative values to demonstrate that public dose in the vicinity of Elliot Lake does not exceed the upper dose limit. Measurements of radon and gamma collected during mine operations result in dose estimates which are less than 5% of the public dose limit. Dietary exposure pathway analysis conducted in 2009 indicated that the total dose to generic human and a Serpent River Frist Nation (SRFN) member residing on area lakes and consuming fish, moose and waterfowl from near field lakes were also well below the public dose limit.

The licensee's (RAL and DMI) will develop a detailed design for public dose determination as part of the Cycle 5 study design report to be prepared in 2019. An interim public dose determination for a representative member of the Elliot Lake public based on readily available data and seasonal monitoring will be included in the 2016-2020 annual SRWMP Reports.

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. Public dose estimate using conservative measures indicated that the upper bounds of public dose are well less than the public dose limits. A monitoring program will be designed and implemented which will result in a more realistic estimate of public dose being incorporated into future SOE reports.

7.2 Recommendations

The TOMP, SAMP, and SRWMP are functioning well and are able to capture changes in TMA performance, mine discharges, and the receiving environment. However, a few recommendations for changes to the SRWMP are recommended in light of the current study findings:

- The monitoring of May Lake water quality (SR-15) as well as sediment and benthic surveys (to be completed next in 2019) should be reinstated into the SRWMP in response to increasing radium-226 and barium at the outlet of McCabe Lake (SR-06). May Lake was removed from the SRWMP as part of the Cycle 3 Study design (Minnow 2009b). At that time RAL and DMI made a commitment to resume monitoring should concentrations in the upstream receiving environment increase in the future.
- Cobalt, iron and manganese are either no longer monitored within the SRWMP or only monitored at selected stations as is the case for iron and manganese. These substances were removed from the program as their concentrations were consistently below the SRWMP benchmarks. However, they continue to be monitored in the SAMP and TOMP. Part of the assessment conducted within the SOE Report is to determine the loadings of these substances from mine sources relative to loadings observed within the downstream receiving environments. In order to continue to undertake a comparative assessment of loadings, cobalt, iron and manganese should continue to be monitored within the SRWMP.

Data collected prior to the next study design should be considered and presented to support any further program changes deemed appropriate.

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APPENDIX A
METHODS

Water Quality Assessment and Response Plan

Operating Procedure: PR8.0.0.01 | Revision: 2011.01 |

Replaces: 2007.01

Approved: February 18, 2011 | Valid Until: February 18, 2016

Asset Owner	Reclamation Manager
Document Reviewer	Environmental Coordinator
Document Owner	Compliance Coordinator
Document Control	Document Clerk
Key Contacts	Environmental Manager

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

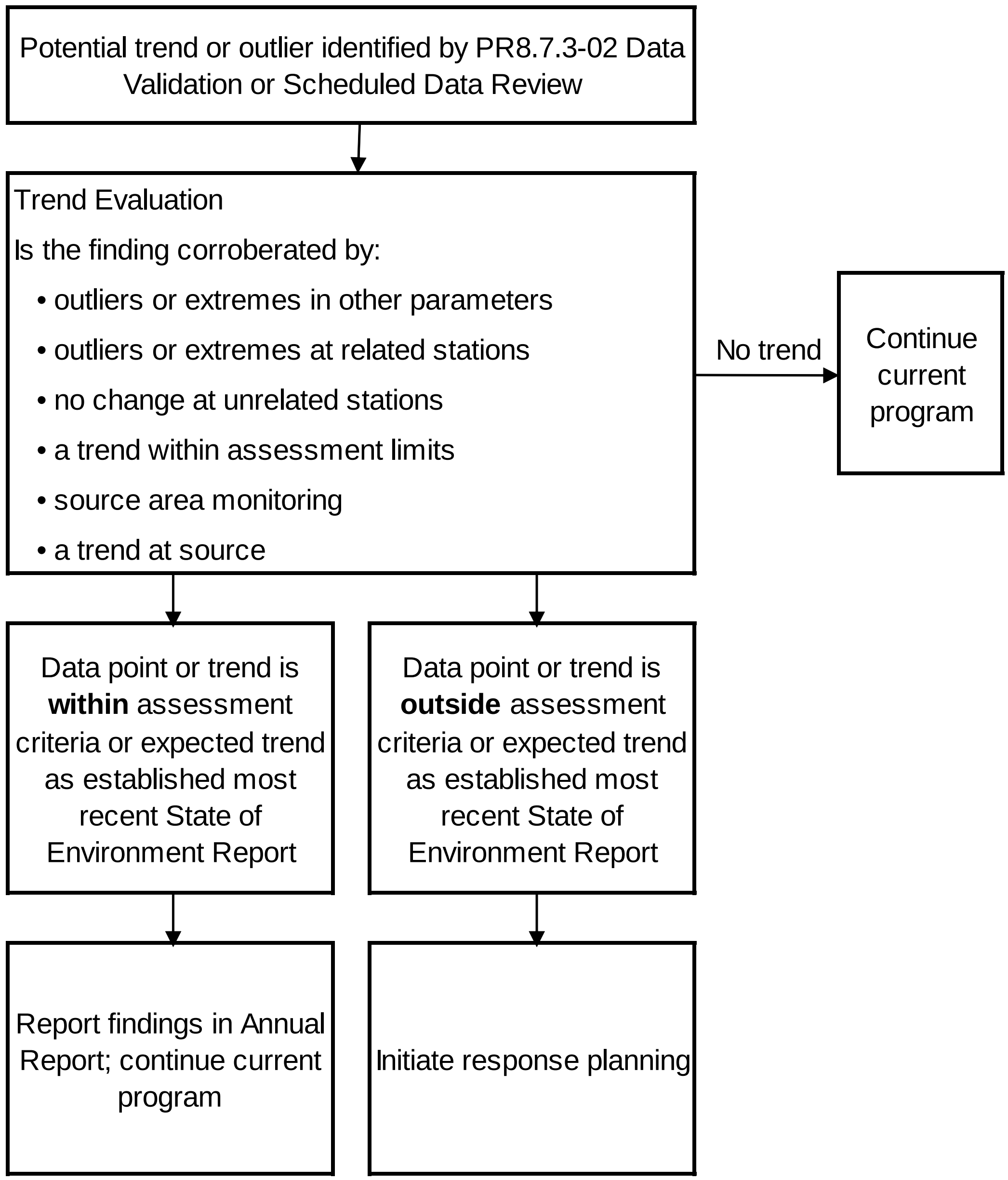
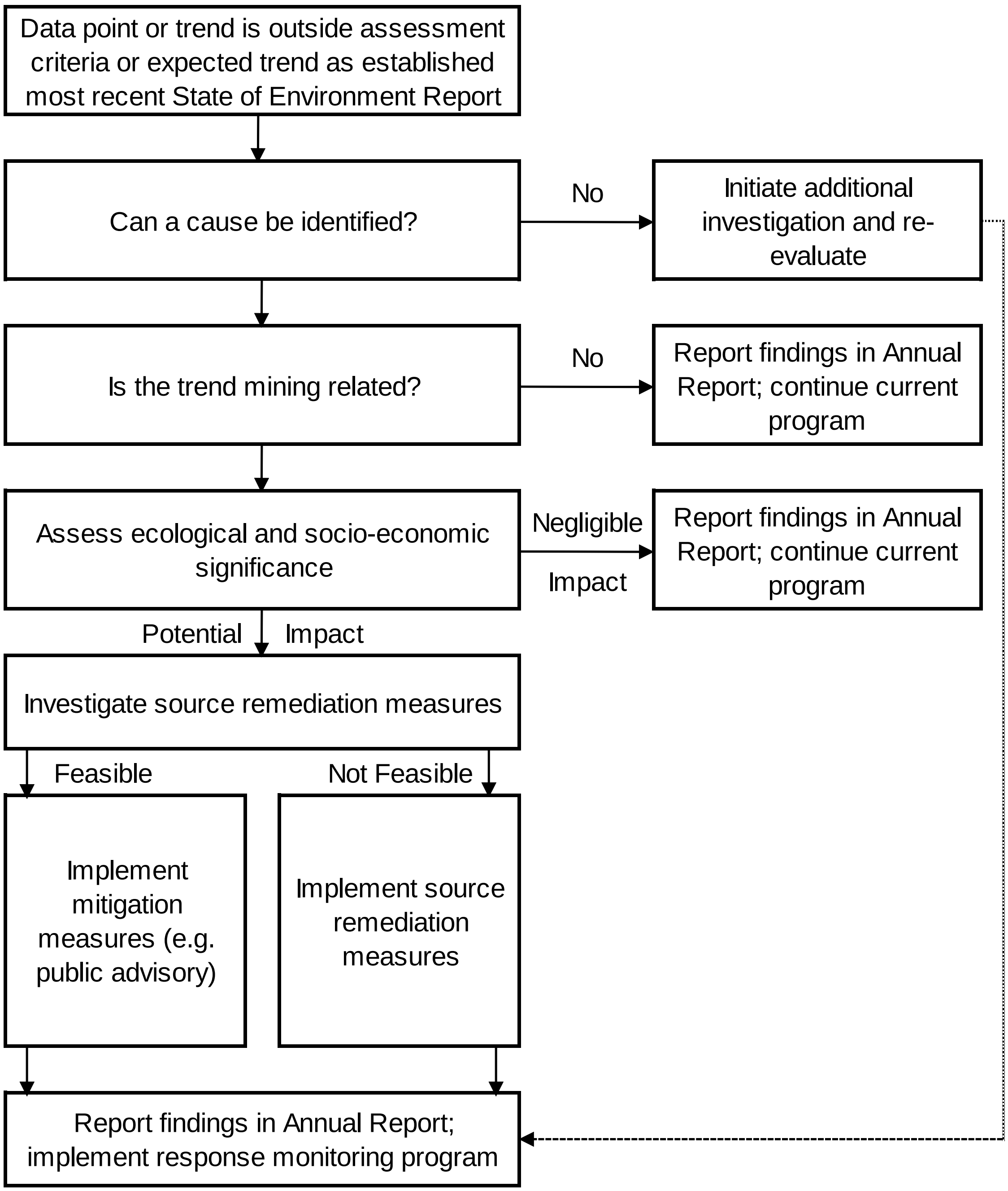


Figure 4.2. Environmental Response Plan Process



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	
	Replaces: 2007.01	
Approved: February 25, 2011		Valid Until: February 25, 2016
Asset Owner		Reclamation Manager
Document Reviewer		Environmental Coordinator
Document Owner		Compliance Coordinator
Document Control		Document Clerk
Key Contacts		Environmental Manager

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 |

Replaces: 2007.01

Approved: February 16, 2011 | Valid Until: February 16, 2016

Asset Owner	Reclamation Manager
Document Reviewer	Environmental Coordinator
Document Owner	Compliance Coordinator
Document Control	Document Clerk
Key Contacts	Environmental Manager

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 Compliance 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
Document Reviewer		Environmental Coordinator
Document Owner		Environmental Technician
Document Control		Document Clerk
Key Contacts		Environmental Manager

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

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 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

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.

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.

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

Location Selection

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.

Scheduling

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.

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;

The Compliance Coordinator is responsible for ensuring any changes to sampling programs are incorporated into the schedule as per PR8.7.2.01: Scheduling.

Sampling and Sample Delivery

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.

The sampler shall record any unusual sample conditions or observations in the waterproof field notebook at the time of sampling.

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.

Data Validation and Review

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

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
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

Replaces: 2007.01

Approved: February 25, 2011	Valid Until: February 25, 2016
Asset Owner	Reclamation Manager
Document Reviewer	Environmental Coordinator
Document Owner	Environmental Technician
Document Control	Document Clerk
Key Contacts	Environmental Manager

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

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 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

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.

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.

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

Equipment

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.

Scheduling

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.

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*.

The Compliance Coordinator is responsible for ensuring any changes to sampling programs are incorporated into the schedule as per PR8.7.2.01: Scheduling.

Sampling and Sample Delivery

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)

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.

The sampler shall record any unusual sample conditions or observations in the waterproof field notebook at the time of sampling.

The sampler, prior to shipment of the sample, shall verify that the container is properly labelled.

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

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, 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

Rio Algom

DENISON MINES

Groundwater Sampling

Replaces: 2007-01

Approved: February 25, 2011	Valid Until: February 25, 2016
Asset Owner	Reclamation Manager
Document Reviewer	Environmental Coordinator
Document Owner	Environmental Technician
Document Control	Document Clerk
Key Contacts	Environmental Manager

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

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 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

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.

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.

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

Equipment

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.

Scheduling

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.

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;

The Compliance Coordinator is responsible for ensuring any changes to sampling programs are incorporated into the schedule as per PR8.7.2.01: Scheduling.

Sampling

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;
- ALL 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 ≈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).

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.

Data Validation and Review

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

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, 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

PH Determination

PR8.6.3.01	Page 1 of 6
Revision: 2014.01	Replaces: 2011.01
Approved: October 1, 2014	Valid until: October 1, 2019
Document Owner	Environmental Technician
Functional Role (e.g. Permit Approver)	Environmental Manager
Key Contact	Operations Superintendent
	Environmental Coordinator

1 PURPOSE

The purpose of this procedure is to:

- Establish a field and Effluent Treatment Plant (ETP) pH determination standard operating procedure that is consistent with regulatory requirements and standard industry protocols.

2 APPLICATION

This procedure applies to field and ETP pH determinations 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 RESPONSIBILITIES

3.1 Rio Algom Reclamation Manager

The Rio Algom Reclamation Manager has overall responsibility for the on-going operating, care and maintenance of the Rio Algom Limited (RAL) Elliot Lake Facilities. Responsibilities specific to this procedure include:

- Providing the Care and Maintenance Contractor with documentation that would affect change to this procedure;
- Performing audits and inspections to verify that this procedure is being followed, as required.

3.2 Environmental Manager

The Environmental Manager has overall responsibility for ensuring that the Performance Monitoring Plan is implemented including field and ETP pH determinations. Responsibilities specific to this procedure include:

- Confirming care and maintenance personnel conducting all pH 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
- Final authorization of review and revisions of this procedure.

3.3 Environmental Coordinator

The Environmental Coordinator is responsible for overseeing implementation of the Field and ETP pH Determination Procedure. Responsibilities specific to this procedure include:

- Assigning responsibility for completion of 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 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.

3.4 Compliance Coordinator

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

- Scheduling field and ETP pH determinations in the environmental database in accordance with PR8.7.2.01: Scheduling.

3.5 Environmental Technician

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

- Conducting pH determination in accordance with PR8.6.3.01 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 PROCEDURE

4.1 Equipment Calibration and Preparation

4.1.1 The following equipment is required for field pH determination:

- pH meter and carrying case;
- Manufacturer’s instruction manual;

- Calibration log;
- pH buffer solutions (at least two) in small sample containers;
- Distilled water;
- Batteries.

4.1.2 The following equipment is required for ETP pH determination:

- pH bench meter (located in all ETPs)
- Manufacturer's instruction manual;
- RF7.3.0.01(xx) Workday Inspection Record;
- Magnetic bean
- Digital hotplate stirrer
- pH buffer solutions (at least two) in small sample containers;
- Distilled water.

4.2 Calibration

4.2.1 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.

4.2.2 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. Buffer solutions of 4, 7 and 10 are generally used for calibration depending on expected pH range;
- Calibration of the meter should be verified on a daily basis.
- 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.

4.2.3 The Field Technician or other adequately trained personnel shall record the calibration record for field pH on RF 8.6.3.01 Field Instrument Calibration Records. ETP pH measurements should be recorded on RF7.3.0.01 (XX) Workday Inspection Record (XX) ETP.

4.3 Field and ETP Instructions

4.3.1 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.

4.3.2 The Field Technician or other adequately trained personnel shall obtain ETP pH measurements in accordance with the meter-specific operation manual in addition to following these general guidelines:

- Rinse probe with distilled water after calibration, place sample on digital hotplate stirrer and immerse probe in sample. Let meter reading stabilize
- Record measurement on the workday inspection record along with any unusual sample conditions or observations.
- If taking multiple pH measurements, rinse probe with distilled water after every sample to avoid contamination.
- When the meter is not in use, the probe should be stored according to manufacturer specifications.

4.4 Scheduling

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.

4.4.1 The Compliance Coordinator is responsible for scheduling 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 (MDLs) 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.

4.5 Data Validation and Review

4.5.1 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

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
RF7.3.0.01 (XX)	Workday Inspection Record (XX) ETP
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
2013.01	Sept.19, 2013	Incorporated ETP pH determination into procedure.

Field Conductivity Determination

Operating Procedure: PR8.6.3.03	Revision: 2011.01	Page 1 of 6
	Replaces: 2007.01	
Approved: February 25, 2011		Valid Until: February 25, 2016
Asset Owner		Reclamation Manager
Document Reviewer		Environmental Coordinator
Document Owner		Environmental Technician
Document Control		Document Clerk
Key Contacts		Environmental Manager

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

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
RF8.6.3.01	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

Replaces: 2007.01

Approved: February 18, 2011 Valid Until: February 18, 2016

Asset Owner	Reclamation Manager
Document Reviewer	Environmental Coordinator
Document Owner	Environmental Technician
Document Control	Document Clerk
Key Contacts	Environmental Manager

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

Rio Algom

Water Elevation Determination Procedure

PR8.6.4.03	Page 1 of 11
Revision: 2015.01	Replaces: 2014.02
Approved: February 26, 2015	Valid Until: February 26, 2018
Document Maintainer:	Environmental Technician
Document Approver:	Environmental Manager
Key Contacts:	Environmental Coordinator

1 PURPOSE

The purpose of this procedure is to:

- Establish an Elevation Determination Program for Tailings Management Areas (TMAs) that is consistent with regulatory requirements and design criteria.
- Describe responsibilities and requirements to ensure that the Elevation Determination program is conducted in accordance with license requirements and PL7.2.0.01 Water Management Plan.

2 APPLICATION

This procedure applies to water elevation determination at all Rio Algom Limited 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 elevation monitoring requirements are documented in RG8.6.4.03 *Elevation Determination Registry*. Elevation determination at the Elliot Lake sites includes:

- Staff gauges;
- Stillwells;
- Weir plates; and
- Leveloggers

3 RESPONSIBILITIES

3.1 Site Manager

The Site Manager (SM) has overall responsibility for the ongoing operating, care and maintenance of the Elliot Lake Facilities including the water elevation program. Specific responsibilities include:

- Monthly review of key operating elevations as documented in the monthly care and maintenance report;

- Annual review of water elevations, graphs, action items and outliers;
- Informing Environmental Manager of changes to operating elevations resulting from periodic technical review and maintenance activities; and
- Follow-up response to outliers and action items to ensure that all items have been addressed in an appropriate and timely manner, and tailings management area basins and associated water conveyance channels are operated within target operating elevations.

3.2 Environmental Manager

The Environmental Manager (EM) has overall responsibility for execution of the care and maintenance contract including the water elevation program. Specific responsibilities include:

- Verifying resources and training are in place to implement the water elevation monitoring program in conformance with Rio Algom Limited General Program, Plan and procedural requirements;
- Initiating response to outliers including notification of SM;
- Verifying implementation of changes to operating elevations and supporting documentation as directed by SM; and
- Reviewing water elevation monitoring records to identify periodic/non-routine maintenance requirements for inclusion in annual maintenance plan.

3.3 Environmental Coordinator

The Environmental coordinator (EC) is responsible for overseeing the Water Elevation Program by:

- Reviewing documents, records and conducting field observations to verify that the Water Elevation program is conducted in accordance with PR8.6.4.03;
- Reviewing training records and conducting field observations to verify that Field Inspectors are adequately trained;
- Informing Field Inspectors of updates or changes to the Water Elevation program and confirming required operating limit updates in RG8.7.2.02 Control Limits and Environmental Data Management System (EDMS);
- Reviewing data and directing operational adjustments to maintain water elevations within target elevations;
- Reviewing action items, assigning responsibilities, issuing work orders (if applicable) and identifying requirements for scheduled maintenance including inspections after ice break-up/melt in the spring and survey of impacted staff gauges;
- Informing the EM of changes in water elevation requiring immediate attention or any item that poses a real or potential threat to health, safety and the environment.

3.4 Compliance Coordinator (CC):

The Compliance Coordinator is responsible for:

- Scheduling Water Elevation determination and control limit requirements in the EDMS;
- Data management and validation of water elevation data; and

- Initiating response to outliers and scheduling retesting and follow-up as required.

3.5 Field Inspector (FI):

The Field Inspector is responsible for:

- Conducting the Water Elevation Program in accordance with PR8.6.4.03;
- Participating in and completing the training requirements;
- Obtaining Water Elevation measurements and recording pertinent information and observations;
- Inspecting the elevation measurement structures (weirs, stillwells, staff gauges) for damage, leakage, etc. while performing measurements.
- Recording elevation station maintenance and calibration activities in EDMS station record;
- Entering all information electronically onto the appropriate forms and maintaining Reports;
- Entering data into the EDMS and ensuring data is validated and reviewed;
- Notifying EC immediately of any outlier data points & conducting repeat measurements as scheduled;
- Entering all action items into the *Action Item Database (AIDB)*, and reporting action items to the EC;
- Ensuring updates and revisions to the Elevation Determination Procedure are incorporated in the program in accordance with PR11.1.0.01 *Operating Document Review and Revision;*
- Informing the EC of needed updates or changes to the Water Elevation Program; and
- Informing the EC of any changes in water elevations requiring immediate attention or any item that poses a real or potential threat to health, safety and the environment.

3.6 Document Clerk

The Document Clerk (DC) is responsible for:

- Updating headers, footers and logos;
- Formatting and archiving documents and forms in current directories;
- Ensuring training records are maintained; and
- Producing an Annual Archive CD.

4 PROCEDURES

4.1 Training

Field Inspectors designated to monitor Water Elevations shall first thoroughly review this procedure and undergo training with an experienced Field Inspector that includes the following elements:

- Familiarization with TMAs, access routes, communication locations and associated facilities;
- Site-specific requirements as per RG8.6.4.03 *Elevation Determination Registry*, site-specific TMA Operating Manuals (MN7.0.0.01(xx) and site-specific water balance data files DF8.0.0.01(xx).
- Familiarization with the Environmental Data Management System (EDMS) data entry methodology as it pertains to elevation determination.

- Familiarization with operation and download of leveloggers and barologgers, and operation of the Leveloader (portable downloader) and Solinst Levelogger software.

4.2 Equipment and Preparation

The following equipment is required to determine water elevation measurements at Stillwells, Spillways, Weirs, ETPs, and other control structures:

- Tape measure (metric);
- Waterproof field notebook or daily ETP operation sheets.

Additional equipment required for downloading of information from leveloggers includes:

- Laptop computer with Solinst Levelogger Software or Leveloader with Optical Connector Cable.

4.3 Location, Frequency & Scheduling

Elevation determinations will be scheduled in the EDMS as required for each of SRWMP, SAMP and TOMP, as per the Cycle 4 Design documents and Canadian Nuclear Safety Commission program approval dated June 14, 2014.

The Compliance Coordinator is responsible for scheduling elevation determinations such that:

- Requirements are incorporated into the EDMS Schedule in accordance with PR8.7.2.01: *Scheduling*.
- The parameter code for elevation is indicative of the specific parameter used to obtain the elevation value as per RG8.6.4.03 *Water Elevation Determination Registry*.

Elevation monitoring locations and frequencies are identified on RG8.7.2.01 *Performance Monitoring Schedule*. Location-specific monitoring method (e.g. staff gauge, stillwell), and reference elevations are identified in RG8.6.4.03 *Elevation Determination Registry*.

4.4 Field Measurements

The Field Inspector shall obtain water elevations in the appropriate manner as indicated in RG8.6.4.03 *Elevation Determination Registry* and record the measurement in the designated waterproof field notebook or on the appropriate Workday or Weekly Shut-Down Inspection Record (RF7.3.0.01 and RF7.3.0.02 series report forms).

RAL Elevations are determined according to the following procedures:

4.4.1 Manual Measurement at Stillwells, Spillways, ETPs, etc.:

1. Remove any channel obstructions that may have artificially raised water elevations and allow sufficient time for elevation to reach equilibrium (dependent on size of pondage immediately upstream) before taking measurements.

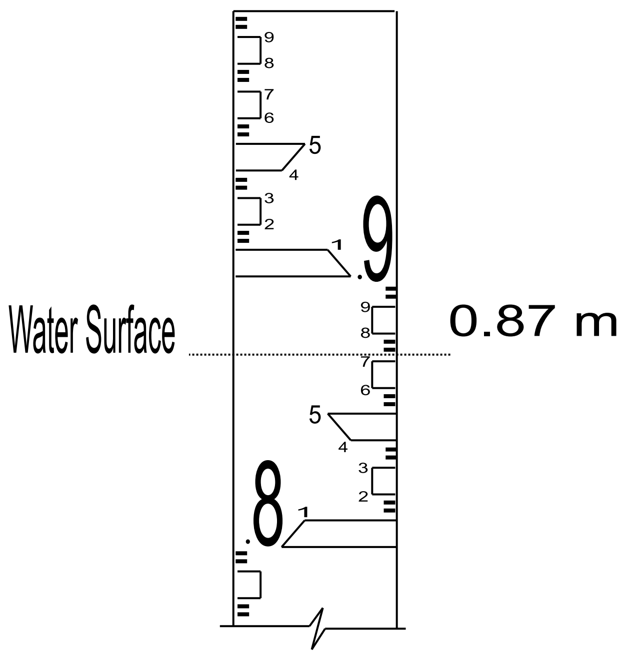
2. Measure the depth from the benchmark (refer to RG8.6.4.03 *Elevation Determination Registry*) elevation down to the water surface by slowly extending the tape measure until the end of tape

is just contacting the surface of the water. It may be necessary to move the tape up and down several times in order to confidently identify the interface depth.

3. Record this depth in metres (to two decimal places) in your field book or field sheet.
4. Calculate the water elevation: Benchmark Elevation – Depth To Water = Water Elevation (refer to field sheets or RG8.6.4.03 *Elevation Determination Registry* to find benchmark elevation values).
5. Confirm that the calculated number is consistent with previous measurement and site conditions (e.g. recent rain).
6. Record elevation in field book or appropriate cell of field sheet.

4.4.3 Staff Gauge Reading at Stillwells, Spillways, etc.:

1. Examine the staff gauge to determine the water level. In still water this will be easy to determine keeping in mind that the pointy end of the horizontal cm bars correspond to the large numbers (see figure). In moving water it may be necessary to approximate the water level to correct for waves or water being pushed up the gauge by the current. Readings are recorded to two decimal places.
2. Read the staff gauge as illustrated (to two decimal places).



3. Record this depth in metres in your field notebook or field sheet.
4. Calculate the water elevation: Benchmark Elevation + Depth = Water Elevation (refer to field sheets or RG8.6.4.03 *Elevation Determination Registry* to find benchmark elevation values).
5. Confirm that the calculated number is consistent with previous measurement and site conditions (e.g. recent rain).
6. Record elevation in field book or appropriate cell of field sheet.

4.4.4 Instantaneous Levelogger Readings at Stillwells, Spillways, etc.:

Leveloggers are configured to collect data at relatively high frequency, and are periodically downloaded to avoid overwriting data. However, when the required elevation monitoring frequency at a station equipped with a levelogger is higher than the logger download frequency, instantaneous readings using the Leveloader are performed in order to ensure that the required monitoring is completed as scheduled (this prevents required monitoring from being missed if a logger, which is assumed to be logging data, malfunctions or is damaged). Instantaneous logger readings are performed as follows, with detailed instructions for operation of the Leveloader presented in the user manual in Appendix A of this document.

1. Remove any channel obstructions that may have artificially raised water elevations and allow sufficient time for elevation to reach equilibrium (dependent on size of pondage immediately upstream) before taking measurements.
2. Connect the direct read cable from levelogger to be read to the Leveloader and follow instructions to view real-time measurements as shown in the user manual in Appendix A of this procedure. Record the water level and temperature readings from the levelogger in field notebook or on field sheet.
3. After recording the instantaneous readings from the levelogger, connect to the nearest barologger with the Leveloader and view the real-time measurements as shown in the user manual in Appendix A of this procedure. Record the pressure reading from the barologger in field notebook or on field sheet.
4. After returning to the office, enter the three recorded values into the Elevation Calculator for the station and record the calculated instantaneous elevation in field notebook or on field sheet, and enter value into the EDMS.

4.4.5 Levelogger Download at Stillwells, Spillways, etc.:

Leveloggers are configured to collect data at relatively high frequency and need to be downloaded periodically (dependant on logging frequency) to avoid overwriting data. Users should download data using the Leveloader according to the user manual presented in Appendix A of this document.

1. Remove any channel obstructions that may have artificially raised water elevations and allow sufficient time for elevation to reach equilibrium (dependent on size of pondage immediately upstream) before taking measurements.
2. Connect direct read cable from levelogger to be downloaded to Leveloader and follow download instructions as shown in the user manual in Appendix A of this procedure.
3. After downloading all leveloggers, the barologger must also be downloaded according to the instructions as shown in the user manual in Appendix A of this procedure.
4. After returning to the office, the Leveloader data must be transferred to a computer with Levelogger software (free download from Solinst) using a data transfer cable per the instructions shown in the user manual in Appendix A of this procedure.
5. The data should be pressure compensated (refer to user help with levelogger software on PC) and exported as .csv file. Raw download files and .csv export files should be saved under RAL→ Working Documents → Dataloggers.

6. Data from the pressure compensated .csv file for the desired time period must be transferred into the Import Template file for the station and the instructions in the file followed to generate an import file to import daily average data from the logger into the EDMS.

4.5 Data Entry & Calculations

The Field Inspector is responsible for the following data entry activities:

- Entering data into EDMS as per PR8.7.3.01 *Data Entry Procedure*. Water elevations are to be reported to two significant digits and are reported as recorded and calculated (converted to MASL) on the field sheets.
- Entering any action items (e.g. maintenance requirements, instrument repairs) into the Action Item Database (AIDB).
- Transferring data from the pressure compensated .csv file into the Import Template file for the station (RAL → Working Documents → Dataloggers) and following instructions in the template to generate an import file to enter the daily average data from the logger into the EDMS.

4.6 Data Validation and Review

Data validation and review of elevation determinations shall be conducted in accordance with PR8.7.3.02 *Data Validation Procedure.*

The FI is responsible for entering data from the inspection form or workbook into the EDMS under the corresponding sample locations and parameters.

Data entered into the EDMS will be validated in the "Review Measurements" module by the Compliance Coordinator or designate as follows:

- Running the Control Limit script monthly.
- The script will flag all data that is +/- 3 standard deviations outside a 12 value mean;
- Flagged data is validated and reviewed monthly in accordance with PR8.7.3.02 *Data Validation Procedure*.

4.7 Recording & Reporting

The FI is responsible for filing completed Workday or Weekly Shut-Down inspections sheets on the designated flip charts in the care and maintenance office.

The Environmental Manager is responsible for ensuring that all flagged water elevation data as well as month-end water elevations for controlled basins are reported to the Site Manager via the monthly care and maintenance report. The operating elevation performance and strategy for the coming month will be reviewed with the Site Manager at the monthly meeting.

The Environmental Manager is responsible for ensuring that the AIDB is reviewed monthly and action items are completed and documented in a timely and effective manner. Reports identifying active and completed action items are included in the monthly care and maintenance report.

The Site Manager is responsible for compiling water elevation data and reviewing Operating Elevations as included in DF8.0.0.01(xx) *Site Water Balance* Files on an annual basis and communicating results of the review and any modifications to the Environmental Manager.

4.8 Levelogger Elevation Verification

All elevations calculated from levelogger readings are based on the absolute elevation of the levelogger, which is determined upon initial configuration of the levelogger and should be verified periodically (at least annually) to ensure calculated elevations are accurate. Verification of the levelogger elevation can be performed as follows:

1. Determine the elevation of the surface of the water in which the levelogger is immersed by an alternate method (e.g. calibrated staff gauge; manual measurement of water level from a solid, stationary point of known elevation). Record the date and time of the measurement.
2. Download the levelogger/barologger, and compensate the data. Copy and paste the data into the Import Template file and locate the levelogger elevation most closely corresponding to the date and time of the manual measurement.
3. Compare the elevations reported by the levelogger and the manual measurement. If the measurements are within ±0.03 m of one another, the levelogger elevation can be considered confirmed. If the measurements are not within ±0.03 m of one another, collect 2 additional manual measurements and compare to the corresponding logger measurements.
4. Average the differences between the three sets of manual and logger measurements, and adjust the levelogger elevation (used in RG8.6.4.03 *Elevation Determination*, the Elevation Calculator file for the station, and the Import Template file for the station) by this amount.
5. Revised levelogger elevations will apply to all instantaneous readings and downloads following implementation of the revision.

6 RELEVANT REFERENCES

Table 6.1 Companion Document Listing

Doc #	**Rev #**	**Title**
		Rio Algom Limited Action Item Database
	Mar 2002	Operating Care and Maintenance Program
	June 2005	Operating Care and Maintenance Plan
	Mar 2002	Milliken Operating, Care and Maintenance Plan
	Dec 2009	Nordic, Lacnor, Buckles Operating, Care and Maintenance Plan
	Sept 2002	Panel Operating, Care and Maintenance Plan
	Mar 2002	Pronto Operating, Care and Maintenance Plan
	Sept 2002	Quirke Operating, Care and Maintenance Plan
	Mar 2002	Spanish-American Operating, Care and Maintenance Plan
	Apr 2007	Stanleigh Operating, Care and Maintenance Plan
RG1.0.0.02	2015.01	Operating Document Registry
PL7.2.0.01	2014.01	Water Management Plan
RG8.6.4.03		Elevation Determination Registry
MN7.0.0.01(NT)		Nordic TMA Operating Manual
MN7.0.0.01(PA)		Panel TMA Operating Manual
MN7.0.0.01(PR)		Pronto TMA Operating Manual
MN7.0.0.01(QU)		Quirke TMA Operating Manual
MN7.0.0.01(ST)		Stanleigh TMA Operating Manual
RF7.3.0.01		Workday Inspection Forms
RF7.3.0.02		Weekly Shut-down Inspection Forms
DF8.0.0.01 NO		Nordic Water Balance
DF8.0.0.01 PA		Panel Water Balance
DF8.0.0.01 PR		Pronto Water Balance
DF8.0.0.01 QU		Quirke Water Balance
DF8.0.0.01 ST		Stanleigh Water Balance
PR8.7.2.01		Scheduling
RG8.7.2.01		Performance Monitoring Schedule
PR8.7.3.01		Data Entry Procedure
PR8.7.3.02	2011.01	Data Validation Procedure

PR11.1.0.01	2005.01	Operating Document Review and Revision

7 REVISION HISTORY

Table 7.1 Revision History

Revision	Date	Purpose of Revision
2014.01	June 4, 2014	Thorough procedure revision to present in a clear and concise format.
2014.02	Nov 13, 2014	Minor spelling, grammar and formatting revisions.
2015.01	Feb 26, 2015	Addition of further information regarding levelogger readings, downloads and elevation verification.

Control Limit Maintenance

Replaces: 2007.01

Approved: February 25, 2011 | Valid Until: February 25, 2016

Asset Owner	Reclamation Manager
Document Reviewer	Environmental Coordinator
Document Owner	Compliance Coordinator
Document Control	Document Clerk
Key Contacts	Environmental Manager

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-specfic 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-specfic 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

Procedure: PR8.7.3.01	Page 1 of 9
Revision: 2014.01	Replaces: 2011.01
Created: June 5, 2014	Valid until: June 5, 2019
Document Approver	Environmental Manager
Document Maintainer	Environmental Technician
Document Endorser	Environmental Coordinator
Document Resource	Compliance Coordinator

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 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 Technicians 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 PROCEDURE

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 request for lab analysis to ensure consistency and accuracy of the data:

- On the home page select "Request for Lab Analysis".
- Under lab, use drop down list to select the lab in which sample will be sent to.
- Select appropriate date for when sample was collected.
- Lab status should also be "pending".

- Event type should be water sample.
- Sample status should be “completed”.
- Hit refresh.
- Select each sample to be shipped by clicking on the blank box to the left of each sample.
- Fill in the appropriate information in the blank spaces provided.
- At the left select “Mark as Shipped”.
- Hit save.
- Select “Save Shipped Samples as File”. This will generate file to be emailed to lab for later importing. Save in desired location by selecting download followed by save.
- EmLine will automatically generate a name for the file.
- To include a paper Chain of Custody to go with shipments, select “Print Lab Request for Shipped Samples”.
- At the top left select the import icon and select PDF for a file format. Once open, save in a desired location and print to include with the sample shipment.

4.2.6 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; this location is where you saved the import files to;
- 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

Monthly C&M Reporting program, plan and procedures are to be reviewed in accordance with requirements and responsibilities identified in PR11.1.0.01 Operating Review & Revision.

6.3 Audit

The RAL RM is responsible for ensuring that Monthly C&M Reporting is audited in accordance with Program Audit Procedures.

7 RECORDS

Table 7.1 Companion Document Listing

Document Number	Revision Date	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	2014.06	Operating Document Registry
RG8.5.2.01	2012.01	Water Quality Monitoring Data Quality Objectives
PR8.7.2.01	2007.01	Scheduling
RG8.7.2-01	2014.01	Performance Monitoring Registry
RG8.7.2.02	2014.01	Control Limit Registry
PR8.7.3.02	2011.01	Data Validation Procedure
PR11.1.0.01	2002.01	Operating Document Review and Revision Procedures

8 REVISION RECORD

Table 8.1 Revision History

Revision	Date	Section	Pages	Purpose of Revision
2007-01	Aug 15, 2007	All	All	Update roles and responsibilities as well as procedure references and remove references to Envista.
2011-01	Feb 18, 2011	All	All	Redistributed the roles and responsibilities previously assigned to the HSEC Coordinator (previously section 3.4) and the Environmental Manager to the Environmental Coordinator.
2012.01	Aug 2, 2012	4.2.5	5	Added new section for “Request for Lab Analysis” procedure.
	Aug 2, 2012	All	All	Updated formatting according to PR11.0.0.01, rev. 2012.01, Procedure Template Guide.
	Aug 2, 2012	8	8	Revised revision summary table
2014.01	June 5, 2014	All	All	Revised formatting, headers, footers

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
Document Reviewer		Environmental Coordinator
Document Owner		Compliance Coordinator
Document Control		Document Clerk
Key Contacts		Environmental Manager

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

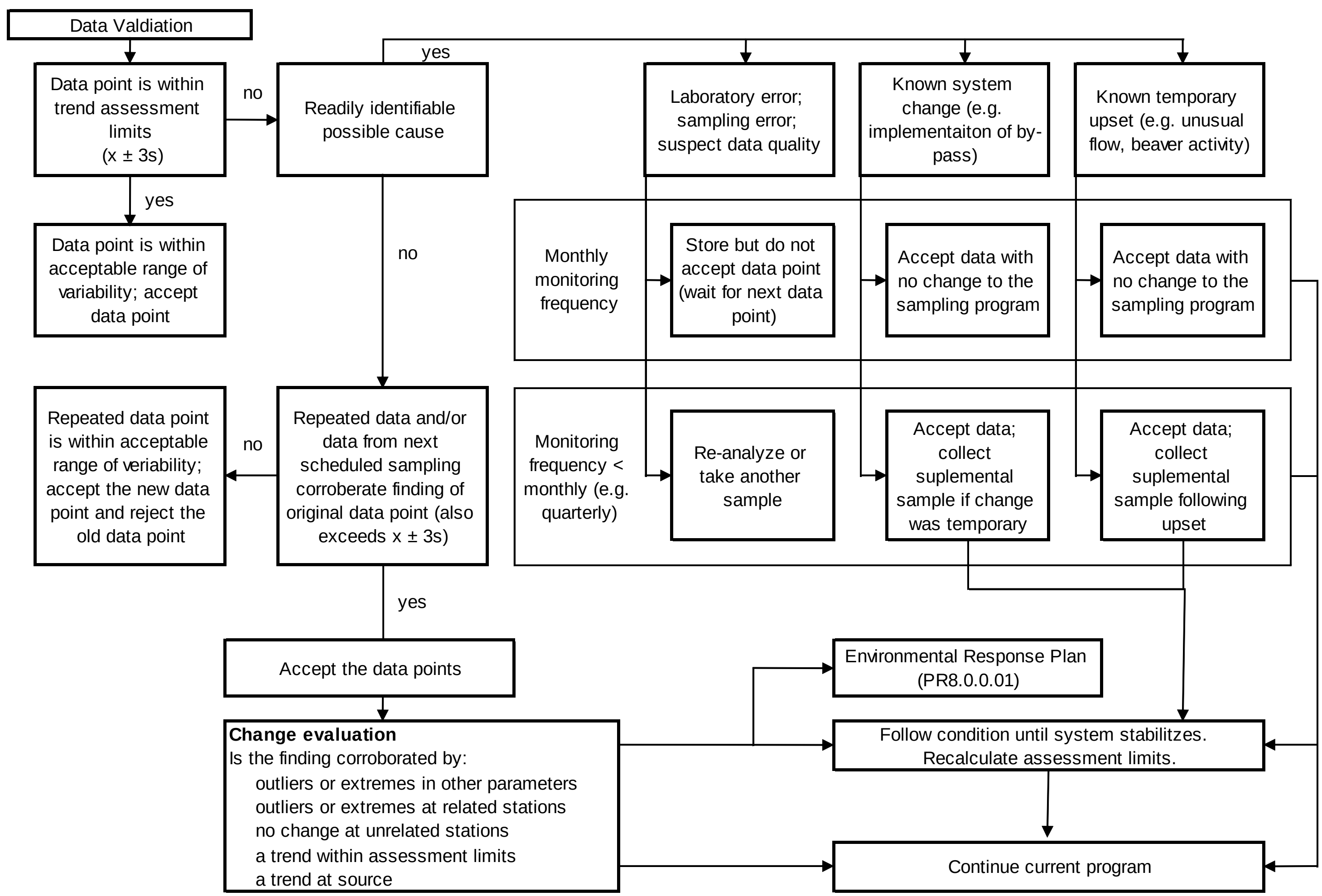
6.1 Procedure Review

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

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 2003 to 2009 had already been downloaded for use in the Cycle 3 SOE (Minnow 2011) and so retrieval of data was limited to data collected since the last SOE (i.e., January 2010 to December 2014)

Reagent Use & Treated Effluent Volume:

ETP Operating Summaries, running from January 1 2010 to December 31 2014, were pulled using the report form set up in emLine for the completion of the Annual Reports. Total flow data from these reports were not be used in the calculation of loadings as they are based on average monthly flows and not actual daily flows reported.

File: DF7.3.0.02(NO) Reagent 2014.02Updated
DF7.3.0.02(PA) Reagent 2014.02Updated
DF7.3.0.02(PR) Reagent 2014.02Updated
DF7.3.0.02(QU) Reagent 2014.02Updated
DF7.3.0.02(ST) Reagent 2014.02Updated
DenStanrock reagent 2010-2014

Surface Water:

SAMP results were pulled from emLine using Cycle 4 locations and parameters, running from January 1 2010 to December 31 2014, using the SAMP purpose. In addition, TSS, was also 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: SAMP Water Quality Data 2010-2014
Corrected PR-01 Water Quality data 2010-2014

TOMP results were pulled from emLine using Cycle 4 locations and parameters, running from January 1 2010 to December 31 2014. 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.

File: TOMP Water Quality Data 2010-2014

Groundwater:

Groundwater results were pulled from emLine using the Cycle 4 locations and parameters, running from January 1 2010 to December 31 2014. Any “<” symbols were segregated to a separate cell adjacent to the corresponding value to provide a workable spreadsheet. Each site and depth were assigned a separate worksheet, and were provided within the TOMP water quality file.

File: TOMP Water Quality Data 2010-2014

SRWMP Data:

Water quality results for the SRWMP were pulled using the Cycle3 locations and parameters, running from January 1 2010 to December 31 2014, 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: SRWMP Water Quality Data 2010-2014

Toxicity for SAMP Stations:

Toxicity results were pulled from emLine, running from January 1 2010 to December 31 2014, using the SAMP purpose. Each sample location was assigned to a separate worksheet.

File: DEN Stan Toxicity 2010-2014
Rio Toxicity 2010-2014

Water Elevations for TMA’s:

For flooded basins water elevation data was pulled from emLine, running from January 1 2010 to December 31 2014. Each sample location was assigned to a separate worksheet and provided within the TOMP water quality file.

File: TOMP Water Quality Data 2010-2014
Span Amer – ECA 128 flow elev

APPENDIX B

DATA QUALITY AND 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 2010 and December 2014. 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; Minnow 2014). Data quality for data collected during Cycle 4 of the TOMP, SAMP and SRWMP (2010 to 2014) 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 water sampling for SRWMP, SAMP and TOMP and represented a minimum of 10 percent of the total samples submitted for analysis.

Programs involving a large number 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 these programs.

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 PR8.7.3-02a)

The water samples were analyzed by SGS Laboratories (Lakefield, Ontario) from 2010 to 2014, with the exception of radium-226. In 2010, radium-226 was analyzed by Becquerel Laboratories (Mississauga, Ontario), and from 2011-2014 radium-226 was analyzed by the Elliot Lake Research Field Station (ELRFS; Laurentian University, Sudbury, Ontario) All laboratories are accredited by the Canadian Association of Environmental and Analytical Laboratories (CAEAL). ELRFS enters laboratory results into the program emLine, and SGS Laboratories enters 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 (2010-2014 annual reports can be found at the end of this appendix). Water samples were analyzed by SGS Laboratories from 2010 to 2014, with the exception of radium-226. In 2010, radium-226 was analyzed by Becquerel Laboratories, while in 2011 to 2014 it was measured by ELRFS. 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.

B2.0 WATER SAMPLES

B2.1 Method Detection Limits

The requested method detection limits (MDLs) were achieved for SRWMP, SAMP and TOMP for all parameters assessed during the 2010 to 2014 period with no exceptions (Tables B.3 and B.4). Therefore, 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. There was one case where a detected concentration was >2 times the MDL in TOMP station Q-05 (e.g., DOC; Table B.9), and no cases in SRWMP (Table B.5), SAMP (Table B.6 and B.7) or the remaining TOMP stations (Table B.8 and B.10). A number of samples from TOMP porewater/groundwater stations exceeded the field blank critera (Table B.11 and B.12). However concentrations were sufficiently low when compared to the concentrations detected in the actual samples that they are not expected to interfere with the interpretation of results.

Laboratory Blanks

Laboratory blank data were summarized as part of the annual quality control reports 2010 to 2014; however, data were not provided for individual laboratory blank samples (Table B.13). As a result, assessment and interpretation is limited to summarized data.

There were no mean laboratory blank concentrations that exceeded the lab criteria or the program criteria. 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

More than 200 duplicate water samples were collected in the field from 2010 to 2014 from SRWMP, SAMP, TOMP, and they generally showed good agreement in analyte concentrations (Tables B.14 to B.19). These RPDs are calculated using Minnow's approach (absolute difference between samples divided by the average of the samples, multiplied by 100). Most parameters with DQO exceedances could be considered isolated cases due to the low number of exceedances over the five-year sampling period: barium (2), cobalt (3), iron (3), DOC (6), and sulphate (1; exceedances summarized in Table B.20). There were more DQO exceedances observed for radium-226 (13) and TSS (29; Table B.20). Despite RPD exceedances ranging from 28.6% to 100% for TSS, in all cases the high RPD was a result of concentrations being close to the detection limit. Conversely, no exceedances for radium-226 can be explained by concentrations nearing the detection limit (20.3% to 37.0% RPD range). The majority of the exceedances for radium-226 mainly occurred in SAMP (20.5% to 32.9% RPD range) and TOMP (20.3% to 23.3% RPD range) stations at concentrations orders of magnitude higher than the MDL. Despite this, most exceedances were between 20% and 30% for radium-226, with only two RPDs >30%, and results were improved over the previous SOE (Minnow 2011). It may also be possible that some of the "field variability" for radium-226 may be caused by analytical difficulties, however radium-226 met all criteria in laboratory duplicates and CRM samples. Overall, since most DQO exceedances 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, however concentrations were well less than the guideline.

Laboratory Duplicate Samples

Overall, there is close agreement between original and duplicate water analysis in the laboratory for all parameters (Table B.21). Out of 6,868 laboratory duplicate analyses, only 82 (1.2%) exceeded the program DQO of 10%. In contrast to the previous SOE (Minnow 2011), no radium-226 duplicate analyses exceeded the DQO. All of the exceedances were recorded in 2013 and 2014, with no exceedances for any parameters in 2010 to 2012. Of those exceedances in 2013 and 2014, all are explained by detectable concentrations nearing the MDL, and are removed when a 10X limit of quantification (LOQ) is applied.

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.22). As with the lab duplicates, all the exceedances occurred in 2013 and 2014, and aside from barium can be explained by concentrations approaching the method detection limit. Barium recovery could be considered poor in 2013 and 2014, with 94.0% and 100% of samples showing <70% recovery (lab DQO), respectively. That number would be expected to increase when using the program criteria (80 – 120% recovery). In all years, barium was the only parameter to have recoveries <70% (on average). The laboratory suggested these poor recoveries were a result of concentrations of barium being spiked into the blank near the detection limit, making a number of the spikes appear to fail, as all barium spikes passed under the laboratory detection limit. 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 (7,965 analyses; Table B.23).

B3.0 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 was some variability in radium-226 that affected field precision results, however the concentrations at which they were measured were well below the guideline, and were generally isolated events. There may be opportunities to examine and discuss the results with the laboratory to identify opportunities to reduce variability and meet the program DQO for this parameter. Despite this, laboratory precision results and recovery of CRM were all within the criteria. However, the laboratory QA reports, in general, report summarized QA data, which makes data interpretation more challenging. For barium, the actual MDL is much lower than the target MDL and the spike concentration is also lower than the target MDL leading to greater variability in the reported barium concentrations and greater RPDs than are actually present. Thus, reporting of this parameter is possibly underestimated, at present.

Overall, the majority of data quality analysis (with the exception of barium laboratory concerns and to a lesser extent radium-226 in field duplicate samples, as mentioned above) was considered adequate to serve the project objectives.

Appendix Table B.1: Data quality objectives for the SRWMP.

Measurements	Units	Detecion 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%
Flow	L/s	varies w/ method	-	0.1[a]	-	-	30%
Laboratory Water Chemistry							
Barium	mg/L	0.005	0.01	10%	20%	20%	20%
Hardness	mg/L	0.5	1.0	10%	-	-	
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%

[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									
Conductivity	mS/cm	0.01	0.1	-	-	-	-	-	-
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%
DOC	mg/L	0.5	-	1	1	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%

TSS - Total Dissolved Solids

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
Hardness	mg/L	0	0
Dissolved Oxygen	mg/L	0	0
Laboratory			
Barium	mg/L	0.005	0.005
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
Uranium	mg/L	0.0005	0.0005

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			
Hardness	mg/L	0	0
pH	pH units	0.1	0.1
Laboratory			
Acidity	mg/L	2	1
Barium	mg/L	0.005	0.005
Cobalt	mg/L	0.0005	0.0005
DOC	mg/L	0.5	0.5
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
TSS	mg/L	1	1
Uranium	mg/L	0.0005	0.0005

MDL does not meet DQO

TSS - Total Dissolved Solids

Appendix Table B.5: Field blanks for SRWMP 2010-2014.

Date	Units	Field Blank Criterion	D-6									
			May-10	Nov-10	May-11	Nov-11	May-12	Nov-12	May-13	Nov-13	May-14	Nov-14
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
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
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	-					5.70	5.70	5.30	7.00	5.50	5.20
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
Sulphate	mg/L	0.2	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
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

Date	Units	Field Blank Criterion	M-01									
			May-10	Nov-10	May-11	Nov-11	May-12	Nov-12	May-13	Nov-13	May-14	Nov-14
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
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
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										
pH	pH units	-					5.70	5.80	5.50	5.70	5.70	5.40
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
Sulphate	mg/L	0.2	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
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

Field blank criterion not met

Actual MDL does not meet target MDL

Appendix Table B.6: Field blanks in SAMP (Station Q-28) water samples from 2010-2014.

Date	Units	Field Blank Criterion	Q-28												
			Feb-10	May-10	Aug-10	Nov-10	Feb-11	May-11	Aug-11	Nov-11	Feb-12	May-12	Jun-12	Aug-12	Sep-12
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
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
DOC	mg/L	1.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.9	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Hardness	mg/L	1.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.9	< 0.5	0.55	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
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
Manganese	mg/L	0.004	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.004	0.003	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
pH	-	-	5.5	5.5	5.5	4.9	5.7	5.1	5.4	5.6	5.5	5.8	5.8	5.8	5.9
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
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	< 0.1	< 0.1
TSS	mg/L	2									< 1	< 1	< 1	< 1	< 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

Date	Units	Field Blank Criterion	Q-28												
			Nov-12	Feb-13	May-13	Jun-13	Aug-13	Oct-13	Nov-13	Feb-14	May-14	Jun-14	Aug-14	Sep-14	Nov-14
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
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
DOC	mg/L	1.0	< 0.5	0.9	< 0.5	< 0.5	0.6	0.5	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Hardness	mg/L	1.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.81	0.45	< 0.5	< 0.5	< 0.5	< 0.5	0.98	< 0.5
Iron	mg/L	0.04	< 0.02	< 0.02	0.03	< 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	0.003	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
pH	-	-	5.8	5.49	4.9	5.3	5.3	5.3	5.3	5.36	4.84	4.52	5.02	5.21	5.32
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
Sulphate	mg/L	0.2	< 0.1	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
TSS	mg/L	2	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 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

Field blank criterion not met

Actual MDL does not meet target MDL

TSS - Total Dissolved Solids

Appendix Table B.7: Field blanks for SAMP (Station D-2) water samples from 2010-2014.

Date	Units	Field Blank Criterion	D-2											
			Jan-10	Feb-10	Mar-10	Apr-10	May-10	Jun-10	Jul-10	Aug-10	Sep-10	Oct-10	Nov-10	Dec-10
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
Cobalt	mg/L	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
DOC	mg/L	1.0			< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	3.8	< 0.5	< 0.5	< 0.5	< 0.5
Hardness	mg/L	1.0			< 0.5	< 0.5	1	< 0.5	1.1	< 0.5	< 0.05	0.93	< 0.5	0.5
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
Manganese	mg/L	0.004	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	0.006	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
pH	-	-	5.6	5.6	5.5	5.4	5.2	5.4	5.4	5	5.1	5.3	5.4	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	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
TSS	mg/L	2	< 1	< 1	< 1	< 1	2	< 1	< 1	< 1	< 1	< 1	1	< 1
Uranium	mg/L	0.001		< 0.0005	< 0.0005	< 0.0005	< 0.0005	0.0009	0.0006	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005

Date	Units	Field Blank Criterion	D-2											
			Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11
Barium	mg/L	0.01	< 0.005	< 0.005	0.011	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005				< 0.005
Cobalt	mg/L	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001				< 0.001
DOC	mg/L	1.0	< 0.5	< 0.5	< 0.5	< 0.5	0.6	1	< 0.5	0.6				< 0.5
Hardness	mg/L	1.0	< 0.5	< 0.5	0.61	< 0.5	< 0.5	< 0.5	0.16	0.69				< 0.5
Iron	mg/L	0.04	< 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
pH	-	-	5.5	5.5	5.6	5.7	5.7	5.7	5.7	5.5				5.5
Radium-226	Bq/L	0.01	< 0.005	< 0.005	0.014	< 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
TSS	mg/L	2	< 1	< 1	< 1	< 1	< 1	< 1	1	< 1				< 1
Uranium	mg/L	0.001	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005				< 0.0005

Date	Units	Field Blank Criterion	D-2											
			Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12
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
Cobalt	mg/L	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001		< 0.001	< 0.001	< 0.001
DOC	mg/L	1.0	< 0.5	< 0.5		< 0.5	< 0.5	< 0.5	0.5	< 0.5		< 0.5	< 0.5	< 0.5
Hardness	mg/L	1.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5		< 0.5	0.78	< 0.5
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	-	-	5.4	5.6	5.5	5.8	5.8	5.9	5.9	5.8			5.7	5.8
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	0.6	< 0.1
TSS	mg/L	2	1	< 1	< 1	< 1	< 1	< 1	< 1	< 1		< 1	< 1	< 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

Field blank criterion not met

Actual MDL does not meet target MDL

TSS - Total Dissolved Solids

Appendix Table B.7: Field blanks for SAMP (Station D-2) water samples from 2010-2014.

Date	Units	Field Blank Criterion	D-2											
			Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13
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
Cobalt	mg/L	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
DOC	mg/L	1.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.5	0.6	< 0.5	< 0.5	< 0.5
Hardness	mg/L	1.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Iron	mg/L	0.04	< 0.02	0.03	< 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	0.003	< 0.002	< 0.002	< 0.002	< 0.002	0.006	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
pH	-	-	5.8	5.6	5.6	5.5	5.9	5.8	5.7	5.2	5.6	5.8	5.9	5.8
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	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 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	< 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-2											
			Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-14	Jul-14	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14
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
Cobalt	mg/L	0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
DOC	mg/L	1.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Hardness	mg/L	1.0												
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
Manganese	mg/L	0.004	0.003	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
pH	-	-	5.7	5.7	5.8	5.2	5.4	5.7	5.5	5.6	5.7	5.2	5.12	5.8
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	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 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	< 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

TSS - Total Dissolved Solids

Appendix Table B.8: Field blanks for TOMP (Station N-19) water samples from 2010-2014.

Date	Units	Field Blank Criterion	N-19											
			Jan-10	Feb-10	Mar-10	Apr-10	May-10	Jun-10	Jul-10	Aug-10	Sep-10	Oct-10	Nov-10	Dec-10
Acidity	mg/L	2												
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
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
DOC	mg/L	1.0												
Hardness	mg/L	1.0												
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
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
pH	-	-	5.5	5.5	5.5	5.5	5.5	5.5	5.1	5.5	5.4	5.3	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	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 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	< 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	N-19											
			Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11
Acidity	mg/L	2												
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
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
DOC	mg/L	1.0	< 0.5	< 0.5										
Hardness	mg/L	1.0	< 0.5	< 0.5										
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
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
pH	-	-	5	5.2	5.5	5.4	6	5.6	5.5	5.6	5.5	5.7	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	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 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	< 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	N-19											
			Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12
Acidity	mg/L	2												
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
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
DOC	mg/L	1.0												
Hardness	mg/L	1.0												
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
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
pH	-	-	5.4	5.5	5.6	5.7	5.8	5.8	5.8	5.6	6.1	6.0	5.8	5.6
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	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 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	< 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

TSS - Total Dissolved Solids

Appendix Table B.8: Field blanks for TOMP (Station N-19) water samples from 2010-2014.

Date	Units	Field Blank Criterion	N-19											
			Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13
Acidity	mg/L	2												
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
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
DOC	mg/L	1.0												
Hardness	mg/L	1.0												
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
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
pH	-	-	5.8	4.96	5.2	5.3	5.3	5.1	5.3	5.3	5	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	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 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	< 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	N-19											
			Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-14	Jul-14	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14
Acidity	mg/L	2												
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
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
DOC	mg/L	1.0												
Hardness	mg/L	1.0												
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
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
pH	-	-	5.2	5	5.57	5.5	6.06	5.84	5.84	6.32	5.28	4.87	5.53	4.8
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	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 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	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005

(light shading)	Field blank criterion not met
(dark shading)	Actual MDL does not meet target MDL

TSS - Total Dissolved Solids

Appendix Table B.9: Field blanks for TOMP (Station Q-05) water samples from 2010-2014.

Date	Units	Field Blank Criterion	Q-05											
			Feb-11	May-11	Aug-11	Nov-11	Feb-12	May-12	Aug-12	Nov-12	Feb-13	May-13	Jun-13	Aug-13
Acidity	mg/L	2	2	9	1	2	< 1	1	3	3	3	1	1	< 1
Barium	mg/L	0.01												
Cobalt	mg/L	0.001												
DOC	mg/L	1.0	< 0.5	1.1	< 0.5	< 0.5								
Hardness	mg/L	1.0	< 0.5	< 0.5	< 0.5	< 0.5								
Iron	mg/L	0.04												
Manganese	mg/L	0.004												
pH	-	-	5.7	3.7	5.4	5.6	5.5	5.8	5.8	5.8	5.49	4.9	5.3	5.3
Radium-226	Bq/L	0.01												
Sulphate	mg/L	0.2												
TSS	mg/L	2												
Uranium	mg/L	0.001												

Date	Units	Field Blank Criterion	Q-05					
			Sep-13	Nov-13	Feb-14	May-14	Aug-14	Nov-14
Acidity	mg/L	2	1	2		1	1	1
Barium	mg/L	0.01						
Cobalt	mg/L	0.001						
DOC	mg/L	1.0						
Hardness	mg/L	1.0						
Iron	mg/L	0.04						
Manganese	mg/L	0.004						
pH	-	-	5.4	5.3	5.4	4.84	5.1	5.32
Radium-226	Bq/L	0.01						
Sulphate	mg/L	0.2						
TSS	mg/L	2						
Uranium	mg/L	0.001						

Field blank criterion not met

Actual MDL does not meet target MDL

TSS - Total Dissolved Solids

Appendix Table B.10: Field blanks for TOMP (Station DS-2) water samples from 2010-2014.

Date	Units	Field Blank Criterion	DS-2						
			Apr-13	Jul-13	Oct-11	Jan-14	Apr-14	Jul-14	Oct-14
Acidity	mg/L	2							
Barium	mg/L	0.01							
Cobalt	mg/L	0.001							
DOC	mg/L	1.0							
Hardness	mg/L	1.0							
Iron	mg/L	0.04							
Manganese	mg/L	0.004							
pH	-	-	5.5	5.5	5.8	5.6	5.2	5.5	5.2
Radium-226	Bq/L	0.01							
Sulphate	mg/L	0.2							
TSS	mg/L	2							
Uranium	mg/L	0.001							

(light grey)	Field blank criterion not met
(dark grey)	Actual MDL does not meet target MDL

TSS - Total Dissolved Solids

Appendix Table B.11: Field blanks in Rio Algom TOMP groundwater (GW) from 2010-2014.

Date	Units	Field Blank Criterion	UW9-1					95N4A					95QW5A						P-31				
			Jul-10	Aug-11	Jul-12	Jul-13	Jul-14	Jul-10	Aug-11	Aug-12	Jul-13	Aug-14	Aug-10	Jul-11	Jul-12	Jul-12	Aug-13	Jul-14	Jul-10	Jul-11	Jun-12	Jul-13	Jul-14
Acidity	mg/L as CaCO3	4	3	<1	3	13	1	2	2	3	2	<1	5	1	2	2	<1		2	<1	<1	<1	1
Iron	mg/L	0.04	1.57	<0.02	<0.02	<0.02	0.12	0.07	<0.02	0.02	0.11	<0.02	0.05	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
pH	pH units	-	4.86	5.07	5.33	5.6	5.02	6.38	5.4	5.91	5.2	5.33	4.92	5.23	5.6	5.6	5.6	5.43	5.91	4.79	6.15	5.3	5.2
Sulphate	mg/L	0.2	<0.1	<0.1	<0.1	<0.1	0.7	<0.1	0.2	<0.1	0.3	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1

Date	Units	Field Blank Criterion	DK162B						SGW-3					M12-1					95QW4					
			Aug-10	Jul-11	Jul-12	Jul-12	Aug-13	Jul-14	Jul-10	Aug-11	Jul-12	Jul-13	Jun-14	Jul-10	Aug-11	Aug-12	Jul-13	Aug-14	Aug-10	Jul-11	Jul-12	Jul-12	Aug-13	Jul-14
Acidity	mg/L as CaCO3	4	2	<1	<1	<1	<1	1	5	3	<1	1	3	2	3	<1	<1	1	2	<1	<1	<1	1	
Iron	mg/L	0.04	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	2.49	<0.02	<0.02	0.06	<0.02	<0.02	<0.02	0.05	0.02	0.06	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
pH	pH units	-	7.43	4.45	5.46	5.46	5.48	4.8	5.4	5.03	5.67	5.6	5.48	5.66	5.2	5.72	5.7	5.51	7.33	5.44	5.6	5.6	5.48	5
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	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2

Field blank criterion not met

Actual MDL does not meet target MDL

Appendix Table B.12: Field blanks in Denison TOMP groundwater (GW) from 2010-2014.

Date	Units	Field Blank Criterion	98-15A					BH91-DG4B				
			Jul-10	Aug-11	Aug-12	Aug-13	Aug-14	Jul-10	Sep-11	Aug-12	Aug-13	Aug-14
Acidity	mg/L as CaCO3	4		2	4	2	9	<1	<1	3	2	<1
Iron	mg/L	0.04	0.9	<0.02	0.03	<0.02	0.05	0.02	<0.02	0.04	<0.02	<0.02
pH	pH units	-	2.12	4.29	5.67	5.46	5.51	4.6	5.4	5.53	5.51	5.07
Sulphate	mg/L	0.2	1.9	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	0.2	<0.1	<0.1

(light grey)	Field blank criterion not met
(dark grey)	Actual MDL does not meet target MDL

Appendix Table B.13: Summary of laboratory blank results, 2010 to 2014.

Year	Description	Acidity	Barium	Cobalt	DOC	Iron	Hardness	Manganese	Radium-226	Sulphate	TSS	Uranium	Total
		mg/L	mg/L	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	2.00	0.04		0.004	0.01	0.2	2	0.001	
	Lab Criteria	4	0.01	0.001	2.00	0.04		0.004	0.01	0.2	2	0.001	
2010	Mean	1.73	0.0024	0.00024	0.124	0.0096	-	0.00095	<0.005	0.0502	0.524	0.00024	**-**
	# above criteria	0	0	0	0	0	-	0	0	0	0	0	**0**
	% above criteria	0	0	0	0	0	-	0	0	0	0	0	**0.0**
	# samples	79	163	163	308	203	-	168	75	190	278	163	**1790**
2011	Mean	2.05	0.00	0.00	0.24	0.01	0.21	0.01	0.00	0.13	0.44	0.00	**-**
	# above criteria	0	0	0	0	0	0	0	0	0	0	0	**0**
	% above criteria	0	0	0	0	0	0	0	0	0	0	0	**0.0**
	# samples	95	169	163	347	203	139	157	93	208	283	136	**1993**
2012	Mean	1.53	0.00	0.00	0.14	0.01	0.20	0.00	0.00	0.05	0.60	0.00	**-**
	# above criteria	0	0	0	0	0	0	0	0	0	0	0	**0**
	% above criteria	0	0	0	0	0	0	0	0	0	0	0	**0.0**
	# samples	95	158	152	324	189	133	148	95	194	58	154	**1700**
2013	Mean	1.63	0.00	0.00	0.02	0.01	0.03	0.00	0.00	0.05	0.50	0.00	**-**
	# above criteria	0	0	0	0	0	0	0	0	0	0	0	**0**
	% above criteria	0	0	0	0	0	0	0	0	0	0	0	**0.0**
	# samples	85	170	163	178	203	132	160	95	195	371	162	**1914**
2014	Mean	1.54	0.00	0.00	0.12	0.01	0.23	0.00	0.00	0.05	0.39	0.00	**-**
	# above criteria	0	0	0	0	0	0	0	0	0	0	0	**0**
	% above criteria	0	0	0	0	0	0	0	0	0	0	0	**0.0**
	# samples	103	187	193	75	217	167	180	99	210	368	182	**1981**
Total	**# above criteria**	**0**	**0**	**0**	**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**	**0.0**	**0.0**	**0.0**
	# samples	**457**	**847**	**834**	**1232**	**1015**	**571**	**813**	**457**	**997**	**1358**	**797**	**9378**

Samples above lab and program criteria

TSS - Total Dissolved Solids

Appendix Table B.14: Field duplicates for SRWMP from 2010 to 2014.

Date	Units	Field Precision Criteria (%)	D-6																	
			May-10			Nov-10			May-11			Nov-11			May-12			Nov-12		
			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%	0.013	0.013	0.0%	0.013	0.013	0.0%	0.012	0.012	0.0%	0.016	0.016	0.0%	0.020	0.020	0.0%
Cobalt	mg/L	20	0.001	0.001	0.0%	<0.0005	<0.0005	0.0%	<0.0005	<0.0005	0.0%	<0.0005	<0.0005	0.0%	<0.0005	<0.0005	0.0%	<0.0005	<0.0005	0.0%
Iron	mg/L	20	0.420	0.430	2.4%	0.140	0.140	0.0%	0.130	0.130	0.0%	0.110	0.120	8.7%	0.250	0.240	4.1%	0.190	0.180	5.4%
Manganese	mg/L	20	0.440	0.456	3.6%	0.076	0.072	5.4%	0.092	0.090	2.2%	0.048	0.048	0.0%	0.170	0.171	0.6%	0.092	0.091	1.1%
pH	-	20	6.600	6.600	0.0%	6.700	6.700	0.0%	6.500	6.500	0.0%	6.900	6.900	0.0%	6.500	6.500	0.0%	7.000	7.100	1.4%
Radium-226	Bq/L	20	0.010	0.011	9.5%	<0.005	0.005	0.0%	<0.005	<0.005	0.0%	<0.005	<0.005	0.0%	0.009	0.009	0.0%	0.009	0.011	20.0%
Sulphate	mg/L	20	74.000	73.000	1.4%	21.000	21.000	0.0%	15.000	16.000	6.5%	24.000	24.000	0.0%	46.000	46.000	0.0%	67.000	67.000	0.0%
Uranium	mg/L	20	<0.0005	<0.0005	0.0%	<0.0005	<0.0005	0.0%	<0.0005	<0.0005	0.0%	<0.0005	<0.0005	0.0%	<0.0005	<0.0005	0.0%	<0.0005	<0.0005	0.0%

Date	Units	Field Precision Criteria (%)	D-6											
			May-13			Nov-13			May-14			Nov-14		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20	0.012	0.012	0.0%	0.013	0.013	0.0%	0.012	0.013	8.0%	0.012	0.012	0.0%
Cobalt	mg/L	20	0.001	0.001	0.0%	0.001	0.001	0.0%	0.001	0.001	0.0%	0.001	0.001	0.0%
Iron	mg/L	20	0.320	0.330	3.1%	0.140	0.140	0.0%	0.170	0.160	6.1%	0.140	0.150	6.9%
Manganese	mg/L	20	0.098	0.097	1.0%	0.084	0.082	2.4%	0.086	0.087	1.2%	0.057	0.057	0.0%
pH	-	20	6.500	6.500	0.0%	6.600	6.600	0.0%	6.500	6.500	0.0%	6.800	6.800	0.0%
Radium-226	Bq/L	20	<0.005	0.006	18.2%	<0.005	<0.005	0.0%	<0.005	<0.005	0.0%	<0.005	<0.005	0.0%
Sulphate	mg/L	20	16.000	16.000	0.0%	18.000	16.000	11.8%	13.000	13.000	0.0%	17.000	17.000	0.0%
Uranium	mg/L	20	<0.0005	<0.0005	0.0%	<0.0005	<0.0005	0.0%	<0.0005	<0.0005	0.0%	<0.0005	<0.0005	0.0%

Field blank criterion not met

Actual MDL does not meet target MDL

Appendix Table B.14: Field duplicates for SRWMP from 2010 to 2014.

Date	Units	Field Precision Criteria (%)	M-01																	
			May-10			Nov-10			May-11			Nov-11			May-12			Nov-12		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20	0.018	0.018	0.0%	0.015	0.015	0.0%	0.016	0.016	0.0%	0.015	0.016	6.5%	0.019	0.019	0.0%	0.015	0.015	0.0%
Cobalt	mg/L	20	0.001	0.001	0.0%	<0.0005	<0.0005	0.0%	<0.0005	<0.0005	0.0%	<0.0005	<0.0005	0.0%	0.001	0.001	0.0%	<0.0005	<0.0005	0.0%
Iron	mg/L	20	0.480	0.530	9.9%	0.290	0.290	0.0%	0.360	0.360	0.0%	0.310	0.340	9.2%	0.950	0.980	3.1%	0.360	0.350	2.8%
Manganese	mg/L	20																		
pH	-	20	6.700	6.700	0.0%	7.100	7.100	0.0%	6.900	6.900	0.0%	6.600	6.600	0.0%	6.800	6.800	0.0%	6.500	6.500	0.0%
Radium-226	Bq/L	20	0.031	0.028	10.2%	0.013	0.015	14.3%	0.016	0.014	13.3%	0.014	0.013	7.4%	0.025	0.025	0.0%	0.019	0.023	19.0%
Sulphate	mg/L	20	14.000	14.000	0.0%	12.000	12.000	0.0%	13.000	13.000	0.0%	15.000	14.000	6.9%	12.000	12.000	0.0%	21.000	21.000	0.0%
Uranium	mg/L	20	0.004	0.004	2.8%	0.003	0.003	3.3%	0.002	0.002	0.0%	0.002	0.002	0.0%	0.005	0.004	14.0%	0.004	0.003	17.6%

Date	Units	Field Precision Criteria (%)	M-01											
			May-13			Nov-13			May-14			Nov-14		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20	0.017	0.018	5.7%	0.013	0.013	0.0%	0.017	0.014	19.4%	0.015	0.017	12.5%
Cobalt	mg/L	20	<0.0005	<0.0005	0.0%	<0.0005	<0.0005	0.0%	<0.0005	<0.0005	0.0%	<0.0005	<0.0005	0.0%
Iron	mg/L	20	0.480	0.470	2.1%	0.320	0.310	3.2%	0.270	0.260	3.8%	0.370	0.380	2.7%
Manganese	mg/L	20												
pH	-	20	6.900	6.900	0.0%	7.000	7.000	0.0%	7.300	7.300	0.0%	7.200	7.200	0.0%
Radium-226	Bq/L	20	0.027	0.026	3.8%	0.016	0.014	13.3%	0.013	0.014	7.4%	0.016	0.011	37.0%
Sulphate	mg/L	20	13.000	14.000	7.4%	10.000	10.000	0.0%	9.100	10.000	9.4%	11.000	11.000	0.0%
Uranium	mg/L	20	0.003	0.003	7.1%	0.003	0.003	7.1%	0.003	0.003	3.9%	0.004	0.003	18.7%

Field blank criterion not met

Actual MDL does not meet target MDL

Appendix Table B.15: Field duplicates for SAMP (Station Q-28) from 2010 to 2014.

Date	Units	Field Precision Criteria (%)	Q-28																				
			May-10			Aug-10			Nov-10			Feb-11			May-11			Aug-11			Nov-11		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Acidity	mg/L																						
Barium	mg/L	20	0.072	0.07	2.8%	0.09	0.092	2.2%	0.119	0.118	0.8%	0.08	0.084	4.9%	0.151	0.15	0.7%	0.07	0.068	2.9%	0.091	0.093	2.2%
Cobalt	mg/L	20	0.0049	0.0047	4.2%	0.0028	0.0028	0.0%	0.0089	0.009	1.1%	0.0107	0.0113	5.5%	0.0061	0.006	1.7%	0.0022	0.0022	0.0%	0.0071	0.007	1.4%
DOC	mg/L		0.8	1	22.2%	<0.5	<0.5	0.0%	<0.5	<0.5	0.0%	1.1	1.1	0.0%	1.4	1.3	7.4%	1.8	1.7	5.7%	0.8	0.5	46.2%
Hardness	mg/L		963	935	3.0%	1120	1111	0.8%	1100	1110	0.9%	1220	1250	2.4%	598	607	1.5%	1090	1080	0.9%	1030	1050	1.9%
Iron	mg/L	20	0.22	0.21	4.7%	0.22	0.22	0.0%	0.43	0.42	2.4%	0.928	0.941	1.1%	0.307	0.296	3.3%	0.242	0.235	0.0%	0.47	0.47	0.0%
Manganese	mg/L	20	0.846	0.837	1.1%	0.727	0.748	2.8%	1.6	1.63	1.9%	1.41	1.46	3.5%	0.734	0.713	2.9%	0.336	0.334	0.6%	1.26	1.28	1.6%
pH	-	20	7.4	7.4	0.0%	7.2	7.2	0.0%	7.3	7.3	0.0%	8.1	8.1	0.0%	7.5	7.5	0.0%	7.1	7.1	0.0%	7.1	7.1	0.0%
Radium-266	Bq/L	20	0.1	0.11	9.5%	0.25	0.25	0.0%	0.087	0.097	10.9%	0.118	0.111	6.1%	0.071	0.081	13.2%	0.055	0.052	5.6%	0.078	0.075	3.9%
Sulphate	mg/L	20	900	870	3.4%	1100	1100	0.0%	1100	1100	0.0%	1200	1200	0.0%	580	600	3.4%	1100	1100	0.0%	1100	1100	0.0%
TSS	mg/L																						
Uranium	mg/L	20	0.018	0.0173	4.0%	0.0145	0.0146	0.7%	0.0223	0.0224	0.4%	0.0184	0.019	3.2%	0.0092	0.009	2.2%	0.0145	0.0144	0.7%	0.0101	0.0104	2.9%

Date	Units	Field Precision Criteria (%)	Q-28																	
			Feb-12			May-12			Jun-12			Aug-12			Sep-12			Nov-12		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Acidity	mg/L																			
Barium	mg/L	20	0.091	0.09	1.1%	0.093	0.09	3.3%	0.072	0.075	4.1%	0.056	0.058	3.5%	0.064	0.061	4.8%	0.066	0.066	0.0%
Cobalt	mg/L	20	0.0086	0.0086	0.0%	0.004	0.0038	5.1%	0.003	0.0031	3.3%	0.0024	0.0024	0.0%	0.0017	0.0016	6.1%	0.0069	0.007	1.4%
DOC	mg/L		1.4	1.5	6.9%	1.3	1.3	0.0%	1.5	1.7	12.5%	<0.5	<0.5	0.0%	1.3	1.3	0.0%	0.5	<0.5	0.0%
Hardness	mg/L		1260	1270	0.8%	960	926	3.6%	1020	1060	3.8%	1090	1090	0.0%	1290	1260	2.4%	1130	1130	0.0%
Iron	mg/L	20	1.08	1.08	0.0%	0.27	0.25	7.7%	0.53	0.53	0.0%	0.55	0.54	1.8%	0.62	0.64	3.2%	0.51	0.5	2.0%
Manganese	mg/L	20	1.26	1.25	0.8%	0.7	0.659	6.0%	0.472	0.482	2.1%	0.322	0.32	0.6%	0.313	0.303	3.2%	1.04	1.05	1.0%
pH	-	20	7.9	7.9	0.0%	7.4	7.4	0.0%	7.4	7.4	0.0%	7.4	7.4	0.0%	7.4	7.4	0.0%	7.1	7.1	0.0%
Radium-266	Bq/L	20	0.102	0.103	1.0%	0.073	0.067	8.6%	0.058	0.06	3.4%	0.059	0.063	6.6%	0.059	0.059	0.0%	0.067	0.056	17.9%
Sulphate	mg/L	20	1100	1200	8.7%	900	970	7.5%	1100	1100	0.0%	1100	1100	0.0%	1091	1089	0.2%	1100	1000	9.5%
TSS	mg/L		4	4	0.0%	<1	<1	0.0%	3	2	40.0%	2	2	0.0%	2	2	0.0%	1	1	0.0%
Uranium	mg/L	20	0.0152	0.0153	0.7%	0.0131	0.0124	5.5%	0.0184	0.0189	2.7%	0.0189	0.0188	0.5%	0.0229	0.0236	3.0%	0.0161	0.0167	3.7%

Field blank criterion not met

Actual MDL does not meet target MDL

TSS - Total Dissolved Solids

Appendix Table B.15: Field duplicates for SAMP (Station Q-28) from 2010 to 2014.

Date	Units	Field Precision Criteria (%)	Q-28																	
			Feb-13			May-13			Jun-13			Aug-13			Oct-13			Nov-13		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Acidity	mg/L																			
Barium	mg/L	20	0.085	0.087	2.3%	0.173	0.168	2.9%	0.133	0.133	0.0%	0.185	0.183	1.1%	0.047	0.046	2.2%	0.043	0.046	6.7%
Cobalt	mg/L	20	0.009	0.0087	3.4%	0.0043	0.0042	2.4%	0.0041	0.0041	0.0%	0.0032	0.0032	0.0%	0.0064	0.0064	0.0%	0.0051	0.0053	3.8%
DOC	mg/L		2	1.8	10.5%	1.4	1.4	0.0%	1.4	1.4	0.0%	2.4	2.4	0.0%	1.7	1.6	6.1%	1.6	1.5	6.5%
Hardness	mg/L		1160	1194	2.9%	526	534	1.5%	691	724	4.7%	854	854	0.0%	989	996	0.7%	910	930	2.2%
Iron	mg/L	20	1.04	1.07	2.8%	0.37	0.38	2.7%	0.32	0.31	3.2%	0.34	0.35	2.9%	0.85	0.86	1.2%	1.11	1.18	6.1%
Manganese	mg/L	20	1.28	1.29	0.8%	0.646	0.62	4.1%	0.7	0.687	1.9%	0.755	0.76	0.7%	1.01	1.01	0.0%	0.76	0.774	1.8%
pH	-	20	8.36	8.48	1.2%	7.3	7.3	0.0%	7.5	7.5	0.0%	7.9	7.9	0.0%	6.9	6.9	0.0%	7.1	7.1	0.0%
Radium-266	Bq/L	20	0.083	0.102	20.5%	0.073	0.083	12.8%	0.115	0.114	0.9%	0.249	0.25	0.4%	0.119	0.103	14.4%	0.064	0.06	6.5%
Sulphate	mg/L	20	1200	1100	8.7%	500	510	2.0%	810	730	10.4%	750	790	5.2%	970	1000	3.0%	860	870	1.2%
TSS	mg/L		3	<1	100.0%	2	1	66.7%	2	2	0.0%	2	1	66.7%	2	2	0.0%	2	2	0.0%
Uranium	mg/L	20	0.0185	0.0185	0.0%	0.0127	0.0124	2.4%	0.0072	0.0072	0.0%	0.0073	0.007	4.2%	0.0227	0.0226	0.4%	0.0178	0.0183	2.8%

Date	Units	Field Precision Criteria (%)	Q-28																	
			Feb-14			May-14			Jun-14			Aug-14			Sep-14			Nov-14		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Acidity	mg/L																			
Barium	mg/L	20	0.082	0.084	2.4%	0.15	0.146	2.7%	0.06	0.061	1.7%	0.029	0.027	7.1%	0.034	0.032	6.1%	0.102	0.102	0.0%
Cobalt	mg/L	20	0.0062	0.0064	3.2%	0.0044	0.0043	2.3%	0.0034	0.0035	2.9%	0.0021	0.002	4.9%	0.0028	0.0028	0.0%	0.005	0.0048	4.1%
DOC	mg/L		1.5	1.4	6.9%	1.6	1.6	0.0%	1.6	1.5	6.5%	2	2.1	4.9%	1.2	1.2	0.0%	1	0.9	10.5%
Hardness	mg/L		1050	1050	0.0%	554	525	5.4%	647	665	2.7%	944	897	5.1%	928	900	3.1%	891	890	0.1%
Iron	mg/L	20	0.44	0.44	0.0%	0.41	0.39	5.0%	0.44	0.46	4.4%	0.62	0.59	5.0%	0.64	0.68	6.1%	0.4	0.39	2.5%
Manganese	mg/L	20	1.12	1.14	1.8%	0.776	0.749	3.5%	0.751	0.772	2.8%	0.399	0.388	2.8%	0.427	0.405	5.3%	1.22	1.18	3.3%
pH	-	20	7.14	7.12	0.0%	7.2	7.2	0.0%	7.06	7.06	0.0%	7.05	7.05	0.0%	6.9	6.9	0.0%	6.87	6.87	0.0%
Radium-266	Bq/L	20	0.066	0.079	17.9%	0.072	0.068	5.7%	0.052	0.056	7.4%	0.036	0.047	26.5%	0.053	0.047	12.0%	0.114	0.111	2.7%
Sulphate	mg/L	20	980	960	2.1%	520	520	0.0%	660	620	6.3%	890	890	0.0%	970	920	5.3%	940	910	3.2%
TSS	mg/L		2	3	40.0%	2	2	0.0%	1	1	0.0%	1	2	66.7%	1	2	66.7%	1	1	0.0%
Uranium	mg/L	20	0.0123	0.0123	0.0%	0.0084	0.0083	1.2%	0.0067	0.007	4.4%	0.0161	0.0155	3.8%	0.0116	0.0113	2.6%	0.0101	0.0107	5.8%

Field blank criterion not met

Actual MDL does not meet target MDL

TSS - Total Dissolved Solids

Appendix Table B.16: Field duplicates for SAMP/TOMP (Station D-2) from 2010 to 2014.

Date	Units	Field Precision Criteria (%)	D-2																	
			Jan-10			Feb-10			Mar-10			41/1/2010			May-10			Jun-10		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20				0.08	0.079	1.3%	0.087	0.085	2.3%	0.133	0.143	7.2%	0.389	0.352	10.0%	0.102	0.094	8.2%
Cobalt	mg/L	20				0.0024	0.0018	28.6%	0.0019	0.002	5.1%	0.0019	0.0019	0.0%	0.0013	0.0012	8.0%	0.0014	0.0014	0.0%
DOC	mg/L								2.7	2.6	3.8%	2.2	2.2	0.0%	3.3	2.9	12.9%	3.2	3.6	11.8%
Hardness	mg/L								497	498	0.2%	466	474	1.7%	479	491	2.5%	545	514	5.9%
Iron	mg/L	20				0.25	0.24	4.1%	0.2	0.2	0.0%	0.33	0.34	3.0%	0.32	0.33	3.1%	0.13	0.12	8.0%
Manganese	mg/L	20				0.442	0.439	0.7%	0.621	0.631	1.6%	0.446	0.448	0.4%	0.297	0.28	5.9%	0.421	0.413	1.9%
pH	-	20	6.9	6.9	0.0%	6.7	6.7	0.0%	7	7	0.0%	7.5	7.5	0.0%	7.4	7.4	0.0%	7.5	7.5	0.0%
Radium-226	Bq/L	20	0.15	0.14	6.9%	0.09	0.085	5.7%	0.12	0.13	8.0%	0.2	0.2	0.0%	0.335	0.32	4.6%	0.23	0.165	32.9%
Sulphate	mg/L	20				470	470	0.0%	450	460	2.2%	410	410	0.0%	440	440	0.0%	470	470	0.0%
TSS	mg/L		1	2	66.7%	<1	1	0.0%	1	1	0.0%	2	2	0.0%	4	3	28.6%	1	<1	0.0%
Uranium	mg/L	20				0.094	0.0947	0.7%	0.0872	0.0866	0.7%	0.074	0.0732	1.1%	0.0883	0.0886	0.3%	0.0912	0.0861	5.8%

Date	Units	Field Precision Criteria (%)	D-2																	
			Jul-10			Aug-10			Sep-10			Oct-10			Nov-10			Dec-10		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20	0.051	0.058	12.8%	0.081	0.078	3.8%	0.199	0.224	11.8%	0.138	0.131	5.2%	0.228	0.225	1.3%	0.091	0.092	1.1%
Cobalt	mg/L	20	0.001	0.001	0.0%	0.0007	0.0007	0.0%	0.0014	0.0015	6.9%	0.0013	0.0012	8.0%	0.0017	0.0017	0.0%	0.0022	0.0021	4.7%
DOC	mg/L		3.3	3.5	5.9%	2.3	2.5	8.3%	2.6	2.7	3.8%	3	3.1	3.3%	2.8	2.8	0.0%	2.4	2.6	8.0%
Hardness	mg/L		515	488	5.4%	509	514	1.0%	536	542	1.1%	529	515	2.7%	549	547	0.4%	422	405	4.1%
Iron	mg/L	20	0.091	0.09	0.0%	0.05	0.06	18.2%	0.16	0.17	6.1%	0.13	0.12	8.0%	0.22	0.22	0.0%	0.15	0.14	6.9%
Manganese	mg/L	20	0.345	0.298	14.6%	0.121	0.124	2.4%	0.369	0.373	1.1%	0.249	0.231	7.5%	0.3	0.294	2.0%	0.278	0.266	4.4%
pH	-	20	7.6	7.6	0.0%	7.7	7.7	0.0%	7.5	7.5	0.0%	7	7	0.0%	7.6	7.6	0.0%	7.6	7.6	0.0%
Radium-226	Bq/L	20	0.092	0.083	10.3%	0.12	0.13	8.0%	0.36	0.37	2.7%	0.19	0.21	10.0%	0.38	0.37	2.7%	0.12	0.13	8.0%
Sulphate	mg/L	20	480	480	0.0%	500	470	6.2%	510	510	0.0%	490	490	0.0%	490	490	0.0%	480	480	0.0%
TSS	mg/L		1	2	66.7%	1	1	0.0%	2	2	0.0%	1	<1	0.0%	2	2	0.0%	<1	<1	0.0%
Uranium	mg/L	20	0.0958	0.0938	2.1%	0.103	0.103	0.0%	0.115	0.114	0.9%	0.109	0.108	0.9%	0.123	0.123	0.0%	0.115	0.111	3.5%

Field blank criterion not met

Actual MDL does not meet target MDL

TSS - Total Dissolved Solids

Appendix Table B.16: Field duplicates for SAMP/TOMP (Station D-2) from 2010 to 2014.

Date	Units	Field Precision Criteria (%)	D-2																	
			Jan-11			Feb-11			Mar-11			Apr-11			May-11			Jun-11		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20	0.052	0.047	10.1%	0.054	0.045	18.2%	0.054	0.053	1.9%	0.077	0.081	5.1%	0.244	0.238	2.5%	0.168	0.137	20.3%
Cobalt	mg/L	20	0.0015	0.0015	0.0%	0.0016	0.0016	0.0%	0.0026	0.0023	12.2%	0.0022	0.0022	0.0%	0.0012	0.0011	8.7%	0.0013	0.0012	8.0%
DOC	mg/L		2.7	2.8	3.6%	3.3	3.1	6.2%	3.7	3	20.9%	1.6	2.1	27.0%	2.7	2.6	3.8%	3.5	3.7	5.6%
Hardness	mg/L		499	485	2.8%	611	587	4.0%	613	586	4.5%	498	485	2.6%	307	305	0.7%	426	432	1.4%
Iron	mg/L	20	0.2	0.19	5.1%	0.355	0.33	8.7%	0.351	0.306	12.1%	0.38	0.37	2.7%	0.25	0.25	0.0%	0.15	0.14	6.9%
Manganese	mg/L	20	0.305	0.295	3.3%	0.341	0.335	1.8%	0.413	0.388	6.2%	0.458	0.459	0.2%	0.197	0.194	1.5%	0.268	0.267	0.4%
pH	-	20	7.4	7.4	0.0%	7.3	7.3	0.0%	7.2	7.2	0.0%	7	7	0.0%	7.5	7.5	0.0%	7.6	7.6	0.0%
Radium-226	Bq/L	20	0.038	0.032	17.1%	0.045	0.051	12.5%	0.067	0.062	7.8%	0.104	0.086	18.9%	0.292	0.299	2.4%	0.126	0.137	8.4%
Sulphate	mg/L	20	500	490	2.0%	520	520	0.0%	520	520	0.0%	450	440	2.2%	250	250	0.0%	320	330	3.1%
TSS	mg/L		1	1	0.0%	1	1	0.0%	1	1	0.0%	1	1	0.0%	1	1	0.0%	2	2	0.0%
Uranium	mg/L	20	0.114	0.11	3.6%	0.107	0.106	0.9%	0.104	0.104	0.0%	0.0842	0.0823	2.3%	0.0391	0.0394	0.8%	0.0585	0.0586	0.2%

Date	Units	Field Precision Criteria (%)	D-2								
			Jul-11			Aug-11			Dec-11		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20	0.081	0.087	7.1%	0.087	0.078	10.9%	0.053	0.051	3.8%
Cobalt	mg/L	20	0.0007	0.0007	0.0%	0.0007	0.0007	0.0%	0.0008	0.0008	0.0%
DOC	mg/L		2.6	2.6	0.0%	3.2	2.8	13.3%	2.7	3	10.5%
Hardness	mg/L		424	425	0.2%	458	470	2.6%	475	468	1.5%
Iron	mg/L	20	0.07	0.07	0.0%	0.07	0.06	15.4%	0.07	0.08	13.3%
Manganese	mg/L	20	0.185	0.174	6.1%	0.115	0.113	1.8%	0.227	0.222	2.2%
pH	-	20	7.7	7.7	0.0%	7.8	7.8	0.0%	7.2	7.2	0.0%
Radium-226	Bq/L	20	0.074	0.056	27.7%	0.079	0.083	4.9%	0.054	0.054	0.0%
Sulphate	mg/L	20	360	360	0.0%	380	370	2.7%	420	420	0.0%
TSS	mg/L		1	2	66.7%	1	1	0.0%	1	1	0.0%
Uranium	mg/L	20	0.0611	0.0614	0.5%	0.0749	0.0735	1.9%	0.101	0.101	0.0%

Field blank criterion not met
Actual MDL does not meet target MDL
TSS - Total Dissolved Solids

Appendix Table B.16: Field duplicates for SAMP/TOMP (Station D-2) from 2010 to 2014.

Date	Units	Field Precision Criteria (%)	D-2																	
			Jan-12			Feb-12			Mar-12			Apr-12			May-12			Jun-12		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20	0.046	0.045	2.2%	0.103	0.099	4.0%	0.096	0.101	5.1%	0.1	0.094	6.2%	0.074	0.066	11.4%	0.051	0.051	0.0%
Cobalt	mg/L	20	0.0012	0.0012	0.0%	0.001	0.0009	10.5%	0.0016	0.0017	6.1%	0.0008	0.0008	0.0%	<0.0005	<0.0005	0.0%	<0.0005	<0.0005	0.0%
DOC	mg/L		3.1	3.7	17.6%	4.7	4.4	6.6%	3	2.8	6.9%	x	3		3.3	2.9	12.9%	3.4	3.8	11.1%
Hardness	mg/L		426	437	2.5%	409	396	3.2%	405	415	2.4%	374	381	1.9%	419	421	0.5%	432	414	4.3%
Iron	mg/L	20	0.15	0.13	14.3%	0.3	0.29	3.4%	0.81	0.84	3.6%	0.28	0.29	3.5%	0.08	0.07	13.3%	<0.02	<0.02	0.0%
Manganese	mg/L	20	0.3	0.3	0.0%	0.258	0.245	5.2%	0.381	0.395	3.6%	0.227	0.229	0.9%	0.064	0.054	16.9%	0.05	0.045	10.5%
pH	-	20	7.2	7.2	0.0%	7	7	0.0%	6.8	6.8	0.0%	7.3	7.3	0.0%	7.1	7.1	0.0%	6.9	6.9	0.0%
Radium-226	Bq/L	20	0.041	0.033	21.6%	0.263	0.269	2.3%	0.226	0.264	15.5%	0.165	0.149	10.2%	0.097	0.095	2.1%	0.069	0.077	11.0%
Sulphate	mg/L	20	420	410	2.4%	320	320	0.0%	350	350	0.0%	310	310	0.0%	350	370	5.6%	370	370	0.0%
TSS	mg/L		1	1	0.0%	1	1	0.0%	2	2	0.0%	1	2	66.7%	1	1	0.0%	<1	<1	0.0%
Uranium	mg/L	20	0.0813	0.0829	1.9%	0.0613	0.0587	4.3%	0.054	0.0546	1.1%	0.0518	0.0527	1.7%	0.0519	0.053	2.1%	0.0489	0.047	4.0%

Date	Units	Field Precision Criteria (%)	D-2														
			Jul-12			Aug-12			Oct-12			Nov-12			Dec-12		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20	0.044	0.045	2.2%	0.036	0.037	2.7%	0.084	0.086	2.4%	0.081	0.072	11.8%	0.065	0.063	3.1%
Cobalt	mg/L	20	<0.0005	<0.0005	0.0%	<0.0005	<0.0005	0.0%	0.0006	0.0007	15.4%	0.0007	0.0008	13.3%	0.0009	0.0009	0.0%
DOC	mg/L		3.6	3	18.2%	2.7	2.9	7.1%	4.8	3	46.2%	3.4	3.1	9.2%	3.2	3.9	19.7%
Hardness	mg/L		421	431	2.3%	454	461	1.5%	460	457	0.7%	478	481	0.6%	511	478	6.7%
Iron	mg/L	20	<0.02	<0.02	0.0%	<0.02	<0.02	0.0%	0.1	0.11	9.5%	0.15	0.15	0.0%	0.21	0.19	10.0%
Manganese	mg/L	20	0.089	0.096	7.6%	0.029	0.028	3.5%	0.245	0.278	12.6%	0.246	0.249	1.2%	0.297	0.296	0.3%
pH	-	20	6.9	6.9	0.0%	7.2	7.2	0.0%	x	x		7.5	7.5	0.0%	7.4	7.4	0.0%
Radium-226	Bq/L	20	0.068	0.068	0.0%	0.049	0.042	15.4%	0.08	0.114	35.1%	0.1	0.101	1.0%	0.079	0.073	7.9%
Sulphate	mg/L	20	380	390	2.6%	410	410	0.0%	420	430	2.4%	430	430	0.0%	430	440	2.3%
TSS	mg/L		1	1	0.0%	<1	<1	0.0%	1	<1	0.0%	1	<1	0.0%	2	2	0.0%
Uranium	mg/L	20	0.0501	0.0493	1.6%	0.0628	0.0632	0.6%	0.0965	0.102	5.5%	0.103	0.106	2.9%	0.0922	0.0932	1.1%

Field blank criterion not met

Actual MDL does not meet target MDL

TSS - Total Dissolved Solids

Appendix Table B.16: Field duplicates for SAMP/TOMP (Station D-2) from 2010 to 2014.

Date	Units	Field Precision Criteria (%)	D-2																	
			Jan-13			Feb-13			Mar-13			41/1/2013			May-13			Jun-13		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20	0.038	0.039	2.6%	0.144	0.162	11.8%	0.223	0.221	0.9%	0.255	0.262	2.7%	0.293	0.246	17.4%	0.172	0.193	11.5%
Cobalt	mg/L	20	0.0008	0.0009	11.8%	0.001	0.0011	9.5%	0.0006	0.0006	0.0%	0.0009	0.0009	0.0%	0.0011	0.0011	0.0%	0.0007	0.0008	13.3%
DOC	mg/L		4.4	4.1	7.1%	3.8	4.3	12.3%	3.5	3.6	2.8%	4.7	4.7	0.0%	2.9	2.9	0.0%	4.6	4.6	0.0%
Hardness	mg/L		476	511	7.1%	405	379	6.6%	337	339	0.6%	295	306	3.7%	281	275	2.2%	308	274	11.7%
Iron	mg/L	20	0.16	0.18	11.8%	0.32	0.34	6.1%	0.22	0.21	4.7%	0.31	0.32	3.2%	0.4	0.38	5.1%	0.15	0.13	14.3%
Manganese	mg/L	20	0.311	0.324	4.1%	0.343	0.365	6.2%	0.176	0.176	0.0%	0.184	0.181	1.6%	0.313	0.319	1.9%	0.263	0.282	7.0%
pH	-	20	7.3	7.3	0.0%	7.4	7.4	0.0%	7.5	7.5	0.0%	7.3	7.3	0.0%	7.2	7.2	0.0%	7.4	7.4	0.0%
Radium-226	Bq/L	20	0.036	0.033	8.7%	0.115	0.129	11.5%	0.157	0.185	16.4%	0.167	0.177	5.8%	0.105	0.127	19.0%	0.155	0.164	5.6%
Sulphate	mg/L	20	430	440	2.3%	360	350	2.8%	250	250	0.0%	230	230	0.0%	220	220	0.0%	240	240	0.0%
TSS	mg/L		1	<1	0.0%	1	<1	0.0%	<1	<1	0.0%	1	1	0.0%	1	1	0.0%	4	6	40.0%
Uranium	mg/L	20	0.0906	0.0893	1.4%	0.0757	0.0736	2.8%	0.0491	0.0481	2.1%	0.0423	0.0412	2.6%	0.0412	0.042	1.9%	0.0387	0.0409	5.5%

Date	Units	Field Precision Criteria (%)	D-2																	
			Jul-13			Aug-13			Sep-13			Oct-13			Nov-13			Dec-13		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20	0.095	0.093	2.1%	0.175	0.156	11.5%	0.14	0.118	17.1%	0.132	0.13	1.5%	0.139	0.148	6.3%	0.223	0.221	0.9%
Cobalt	mg/L	20	<0.0005	<0.0005	0.0%	0.0007	0.0006	15.4%	<0.0005	<0.0005	0.0%	0.0006	<0.0005	18.2%	0.0013	0.0013	0.0%	0.0012	0.0012	0.0%
DOC	mg/L		3.7	3.6	2.7%	4.4	4.4	0.0%	4.3	4.2	2.4%	4.7	4.6	2.2%	4.6	4.8	4.3%	4.7	4.8	2.1%
Hardness	mg/L		301	300	0.3%	306	304	0.7%	326	326	0.0%	318	312	1.9%	356	350	1.7%	273	273	0.0%
Iron	mg/L	20	0.05	0.05	0.0%	0.12	0.11	8.7%	0.11	0.11	0.0%	0.13	0.12	8.0%	0.21	0.21	0.0%	0.18	0.18	0.0%
Manganese	mg/L	20	0.043	0.038	12.3%	0.188	0.186	1.1%	0.112	0.099	12.3%	0.221	0.184	18.3%	0.411	0.391	5.0%	0.328	0.326	0.6%
pH	-	20	7.4	7.4	0.0%	7.4	7.4	0.0%	7.2	7.2	0.0%	7.4	7.4	0.0%	6.9	6.9	0.0%	7.6	7.6	0.0%
Radium-226	Bq/L	20	0.061	0.057	6.8%	0.134	0.103	26.2%	0.082	0.079	3.7%	0.094	0.079	17.3%	0.181	0.14	25.5%	0.187	0.192	2.6%
Sulphate	mg/L	20	260	260	0.0%	250	270	7.7%	260	260	0.0%	280	280	0.0%	130	300	79.1%	230	230	0.0%
TSS	mg/L		1	1	0.0%	<1	1	0.0%	<1	1	0.0%	1	1	0.0%	2	1	66.7%	2	1	66.7%
Uranium	mg/L	20	0.0365	0.0364	0.3%	0.0474	0.046	3.0%	0.0439	0.0421	4.2%	0.0476	0.0465	2.3%	0.0692	0.0664	4.1%	0.0442	0.044	0.5%

Field blank criterion not met

Actual MDL does not meet target MDL

TSS - Total Dissolved Solids

Appendix Table B.16: Field duplicates for SAMP/TOMP (Station D-2) from 2010 to 2014.

Date	Units	Field Precision Criteria (%)	D-2																	
			Jan-14			Feb-14			Mar-14			Apr-14			May-14			Jun-14		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20	0.23	0.235	2.2%	0.199	0.194	2.5%	0.249	0.231	7.5%	0.182	0.18	1.1%	0.228	0.247	8.0%	0.256	0.258	0.8%
Cobalt	mg/L	20	0.0008	0.0008	0.0%	0.0009	0.0008	11.8%	0.0007	0.0007	0.0%	0.0006	0.0006	0.0%	0.0011	0.0011	0.0%	0.0005	0.0005	0.0%
DOC	mg/L		5.1	4.7	8.2%	5	4.9	2.0%	4.8	4.9	2.1%	4.9	4.9	0.0%	3.9	4.1	5.0%	3.8	3.9	2.6%
Hardness	mg/L		247	261	5.5%	273	266	2.6%	261	249	4.7%	251	252	0.4%	202	208	2.9%	199	208	4.4%
Iron	mg/L	20	0.3	0.32	6.5%	0.3	0.29	3.4%	0.25	0.24	4.1%	0.18	0.19	5.4%	0.33	0.33	0.0%	0.08	0.08	0.0%
Manganese	mg/L	20	0.223	0.218	2.3%	0.227	0.216	5.0%	0.198	0.188	5.2%	0.163	0.161	1.2%	0.305	0.297	2.7%	0.2	0.198	1.0%
pH	-	20	7.1	7.1	0.0%	7.1	7.1	0.0%	7.3	7.3	0.0%	6.9	6.9	0.0%	7	7	0.0%	7	7	0.0%
Radium-226	Bq/L	20	0.161	0.18	11.1%	0.164	0.176	7.1%	0.222	0.211	5.1%	0.153	0.155	1.3%	0.185	0.191	3.2%	0.249	0.236	5.4%
Sulphate	mg/L	20	220	220	0.0%	220	210	4.7%	200	200	0.0%	200	200	0.0%	190	190	0.0%	150	150	0.0%
TSS	mg/L		2	2	0.0%	1	<1	0.0%	1	1	0.0%	1	1	0.0%	2	2	0.0%	<1	<1	0.0%
Uranium	mg/L	20	0.035	0.035	0.0%	0.0349	0.0336	3.8%	0.0328	0.0311	5.3%	0.0298	0.0298	0.0%	0.0269	0.0269	0.0%	0.0248	0.0246	0.8%

Date	Units	Field Precision Criteria (%)	D-2																	
			Jul-14			Aug-14			Sep-14			Oct-14			Nov-14			Dec-14		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Barium	mg/L	20	0.195	0.189	3.1%	0.095	0.093	2.1%	0.101	0.084	18.4%	0.146	0.137	6.4%	0.256	0.236	8.1%	0.331	0.354	6.7%
Cobalt	mg/L	20	0.0006	0.0006	0.0%	<0.0005	<0.0005	0.0%	<0.0005	<0.0005	0.0%	0.0012	0.0011	8.7%	0.0016	0.0016	0.0%	0.0006	0.0006	0.0%
DOC	mg/L		3.4	3.5	2.9%	3.1	3.1	0.0%	3.2	3.3	3.1%	3.5	3.6	2.8%	4	4	0.0%	4.9	4.8	2.1%
Hardness	mg/L		247	251	1.6%	281	287	2.1%	313	304	2.9%	315	313	0.6%	289	279	3.5%	230	232	0.9%
Iron	mg/L	20	0.11	0.11	0.0%	0.05	0.04	22.2%	0.09	0.09	0.0%	0.12	0.1	18.2%	0.16	0.15	6.5%	0.22	0.21	4.7%
Manganese	mg/L	20	0.204	0.197	3.5%	0.088	0.084	4.7%	0.11	0.102	7.5%	0.29	0.263	9.8%	0.305	0.304	0.3%	0.192	0.191	0.5%
pH	-	20	7.1	7.1	0.0%	7.1	7.1	0.0%	7.4	7.4	0.0%	7.2	7.2	0.0%	7.4	7.5	1.3%	7	7	0.0%
Radium-226	Bq/L	20	0.141	0.131	7.4%	0.07	0.063	10.5%	0.074	0.076	2.7%	0.16	0.156	2.5%	0.265	0.291	9.4%	0.263	0.305	14.8%
Sulphate	mg/L	20	190	200	5.1%	240	240	0.0%	270	270	0.0%	270	270	0.0%	240	240	0.0%	190	190	0.0%
TSS	mg/L		2	2	0.0%	2	<1	66.7%	<1	2	66.7%	1	2	66.7%	<1	1	0.0%	1	1	0.0%
Uranium	mg/L	20	0.0328	0.0337	2.7%	0.0373	0.0378	1.3%	0.0479	0.0477	0.4%	0.0568	0.0558	1.8%	0.0467	0.0457	2.2%	0.0341	0.0338	0.9%

Field blank criterion not met

Actual MDL does not meet target MDL

TSS - Total Dissolved Solids

Appendix Table B.17: Field duplicates for RioAlgom TOMP station N-19 from 2010 to 2014.

Date	Units	Field Precision Criteria (%)	N-19																	
			Jan-10			Feb-10			Mar-10			Apr-10			May-10			Jun-10		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Acidity	mg/L	20																		
Barium	mg/L	20	0.012	0.012	0.0%	0.013	0.013	0.0%	0.013	0.013	0.0%	0.012	0.012	0.0%	0.012	0.012	0.0%	0.013	0.013	0.0%
Cobalt	mg/L	20	0.0023	0.0024	4.3%	0.002	0.0019	5.1%	0.0018	0.0019	5.4%	0.0017	0.0016	6.1%	0.0013	0.0012	8.0%	0.001	0.0011	9.5%
DOC	mg/L	20																		
Hardness	mg/L	20																		
Iron	mg/L	20	0.11	0.11	0.0%	0.14	0.11	24.0%	0.09	0.09	0.0%	0.22	0.22	0.0%	0.28	0.23	19.6%	0.11	0.11	0.0%
Manganese	mg/L	20	0.151	0.159	5.2%	0.161	0.158	1.9%	0.141	0.14	0.7%	0.137	0.135	1.5%	0.142	0.141	0.7%	0.127	0.131	3.1%
pH	-	20	7.2	7.2	0.0%	7.2	7.2	0.0%	7.2	7.2	0.0%	7.5	7.5	0.0%	7.5	7.5	0.0%	7.2	7.2	0.0%
Radium-226	Bq/L	20	0.056	0.063	11.8%	0.059	0.058	1.7%	0.065	0.065	0.0%	0.07	0.06	15.4%	0.055	0.059	7.0%	0.065	0.063	3.1%
Sulphate	mg/L	20	860	870	1.2%	900	900	0.0%	920	890	3.3%	750	800	6.5%	820	820	0.0%	860	880	2.3%
TSS	mg/L	20	2	<1	66.7%	1	1	0.0%	1	1	0.0%	1	1	0.0%	<1	1	0.0%	1	<1	0.0%
Uranium	mg/L	20	0.003	0.0032	6.5%	0.0041	0.0039	5.0%	0.0034	0.0035	2.9%	0.0032	0.0031	3.2%	0.0033	0.0033	0.0%	0.0027	0.0029	7.1%

Date	Units	Field Precision Criteria (%)	N-19																	
			Jul-10			Aug-10			Sep-10			Oct-10			Nov-10			Dec-10		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Acidity	mg/L	20																		
Barium	mg/L	20	0.012	0.012	0.0%	0.012	0.012	0.0%	0.012	0.012	0.0%	0.014	0.013	7.4%	0.012	0.012	0.0%	0.011	0.011	0.0%
Cobalt	mg/L	20	0.001	0.0009	10.5%	0.0016	0.0013	20.7%	0.001	0.001	0.0%	0.0026	0.0022	16.7%	0.002	0.0022	9.5%	0.0023	0.0024	4.3%
DOC	mg/L	20																		
Hardness	mg/L	20																		
Iron	mg/L	20	0.18	0.19	5.4%	0.18	0.18	0.0%	0.18	0.18	0.0%	0.43	0.39	9.8%	0.46	0.45	2.2%	0.5	0.46	8.3%
Manganese	mg/L	20	0.1	0.105	4.9%	0.161	0.15	7.1%	0.12	0.117	2.5%	0.098	0.096	2.1%	0.13	0.132	1.5%	0.133	0.133	0.0%
pH	-	20	7.1	7.1	0.0%	7.1	7.1	0.0%	7.1	7.1	0.0%	7.3	7.3	0.0%	7.2	7.2	0.0%	7.1	7.1	0.0%
Radium-226	Bq/L	20	0.048	0.049	2.1%	0.043	0.048	11.0%	0.048	0.045	6.5%	0.063	0.056	11.8%	0.05	0.059	16.5%	0.045	0.053	16.3%
Sulphate	mg/L	20	960	940	2.1%	920	890	3.3%	970	970	0.0%	880	890	1.1%	850	850	0.0%	810	810	0.0%
TSS	mg/L	20	1	1	0.0%	1	<1	0.0%	1	1	0.0%	1	2	66.7%	1	1	0.0%	1	2	66.7%
Uranium	mg/L	20	0.0024	0.0023	4.3%	0.0028	0.0028	0.0%	0.0025	0.0025	0.0%	0.0036	0.0035	2.8%	0.0042	0.0041	2.4%	0.0034	0.0034	0.0%

Field blank criterion not met

Actual MDL does not meet target MDL

TSS - Total Dissolved Solids

Appendix Table B.17: Field duplicates for RioAlgom TOMP station N-19 from 2010 to 2014.

Date	Units	Field Precision Criteria (%)	N-19																	
			Jan-11			Feb-11			Mar-11			Apr-11			May-11			Jun-11		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Acidity	mg/L	20																		
Barium	mg/L	20	0.012	0.012	0.0%	0.013	0.012	8.0%	0.012	0.012	0.0%	0.012	0.012	0.0%	0.01	0.01	0.0%	0.012	0.012	0.0%
Cobalt	mg/L	20	0.002	0.002	0.0%	0.0025	0.0022	12.8%	0.002	0.0019	5.1%	0.0017	0.0017	0.0%	0.0025	0.0024	4.1%	0.0024	0.0025	4.1%
DOC	mg/L	20																		
Hardness	mg/L	20																		
Iron	mg/L	20	0.19	0.2	5.1%	0.136	0.133	7.4%	0.132	0.128	0.0%	0.251	0.256	3.9%	0.37	0.32	14.5%	0.28	0.3	6.9%
Manganese	mg/L	20	0.159	0.156	1.9%	0.158	0.155	1.9%	0.143	0.143	0.0%	0.11	0.109	0.9%	0.097	0.097	0.0%	0.122	0.13	6.3%
pH	-	20	7.4	7.4	0.0%	7.1	7.1	0.0%	7.3	7.3	0.0%	8.6	8.6	0.0%	7.6	7.6	0.0%	7.4	7.4	0.0%
Radium-226	Bq/L	20	0.063	0.067	6.2%	0.056	0.058	3.5%	0.065	0.062	4.7%	0.088	0.085	3.5%	0.067	0.067	0.0%	0.063	0.078	21.3%
Sulphate	mg/L	20	880	880	0.0%	850	840	1.2%	900	990	9.5%	860	870	1.2%	520	500	3.9%	660	690	4.4%
TSS	mg/L	20	1	1	0.0%	<1	1	0.0%	1	<1	0.0%	1	1	0.0%	1	2	66.7%	1	1	0.0%
Uranium	mg/L	20	0.0035	0.0036	2.8%	0.0038	0.0037	2.7%	0.0035	0.0034	2.9%	0.0046	0.0046	0.0%	0.0054	0.0053	1.9%	0.0034	0.0035	2.9%

Date	Units	Field Precision Criteria (%)	N-19																	
			Jul-11			Aug-11			Sep-11			Oct-11			Nov-11			Dec-11		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Acidity	mg/L	20																		
Barium	mg/L	20	0.016	0.013	20.7%	0.015	0.015	0.0%	0.016	0.015	6.5%	0.013	0.013	0.0%	0.013	0.013	0.0%	0.013	0.013	0.0%
Cobalt	mg/L	20	0.0019	0.0019	0.0%	0.002	0.0017	16.2%	0.0013	0.0012	8.0%	0.0019	0.0019	0.0%	0.0029	0.0026	10.9%	0.0028	0.0027	3.6%
DOC	mg/L	20																		
Hardness	mg/L	20																		
Iron	mg/L	20	0.25	0.25	0.0%	0.27	0.29	7.1%	0.37	0.33	11.4%	0.3	0.3	0.0%	0.25	0.26	3.9%	0.27	0.28	3.6%
Manganese	mg/L	20	0.124	0.123	0.8%	0.137	0.13	5.2%	0.1	0.101	1.0%	0.138	0.142	2.9%	0.177	0.175	1.1%	0.172	0.173	0.6%
pH	-	20	7.3	7.3	0.0%	7.3	7.3	0.0%	7.3	7.3	0.0%	7.1	7.1	0.0%	7	7	0.0%	7.3	7.3	0.0%
Radium-226	Bq/L	20	0.071	0.073	2.8%	0.067	0.053	23.3%	0.052	0.058	10.9%	0.05	0.048	4.1%	0.058	0.056	3.5%	0.054	0.061	12.2%
Sulphate	mg/L	20	770	770	0.0%	870	870	0.0%	870	890	2.3%	920	920	0.0%	950	940	1.1%	940	930	1.1%
TSS	mg/L	20	1	1	0.0%	2	1	66.7%	2	2	0.0%	1	2	66.7%	3	1	100.0%	3	1	100.0%
Uranium	mg/L	20	0.0027	0.0027	0.0%	0.0033	0.0031	6.3%	0.0029	0.003	3.4%	0.0025	0.0025	0.0%	0.0029	0.0028	3.5%	0.004	0.004	0.0%

Field blank criterion not met

Actual MDL does not meet target MDL

TSS - Total Dissolved Solids

Appendix Table B.17: Field duplicates for RioAlgom TOMP station N-19 from 2010 to 2014.

Date	Units	Field Precision Criteria (%)	N-19																	
			Jan-12			Feb-12			Mar-12			Apr-12			May-12			Jun-12		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Acidity	mg/L	20																		
Barium	mg/L	20	0.0133	0.0132	0.0%	0.014	0.014	0.0%	0.013	0.013	0.0%	0.013	0.013	0.0%	0.013	0.013	0.0%	0.018	0.015	18.2%
Cobalt	mg/L	20	0.0029	0.0028	3.5%	0.0017	0.0018	5.7%	0.0028	0.0027	3.6%	0.003	0.003	0.0%	0.004	0.0034	16.2%	0.0031	0.0031	0.0%
DOC	mg/L	20																		
Hardness	mg/L	20																		
Iron	mg/L	20	0.1	0.11	9.5%	0.19	0.19	0.0%	0.14	0.13	7.4%	0.3	0.3	0.0%	0.19	0.16	17.1%	0.19	0.19	0.0%
Manganese	mg/L	20	0.188	0.184	2.2%	0.153	0.147	4.0%	0.204	0.199	2.5%	0.169	0.168	0.6%	0.193	0.19	1.6%	0.203	0.2	1.5%
pH	-	20	7.3	7.3	0.0%	8.7	8.7	0.0%	7.2	7.2	0.0%	7.3	7.3	0.0%	7.3	7.3	0.0%	7.3	7.3	0.0%
Radium-226	Bq/L	20	0.065	0.053	20.3%	0.124	0.125	0.8%	0.073	0.068	7.1%	0.068	0.072	5.7%	0.068	0.072	5.7%	0.054	0.066	20.0%
Sulphate	mg/L	20	910	907	0.3%	810	870	7.1%	910	930	2.2%	770	760	1.3%	750	820	8.9%	910	940	3.2%
TSS	mg/L	20	<1	<1	0.0%	<1	<1	0.0%	<1	<1	0.0%	<1	1	0.0%	<1	<1	0.0%	1	1	0.0%
Uranium	mg/L	20	0.0039	0.0038	2.6%	0.0077	0.0076	1.3%	0.0035	0.0034	2.9%	0.0042	0.0042	0.0%	0.0041	0.004	2.5%	0.0031	0.0031	0.0%

Date	Units	Field Precision Criteria (%)	N-19																	
			Jul-12			Aug-12			Sep-12			Oct-12			Nov-12			Dec-12		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Acidity	mg/L	20																		
Barium	mg/L	20	0.015	0.015	0.0%	0.015	0.015	0.0%	0.016	0.015	6.5%	0.015	0.015	0.0%	0.016	0.016	0.0%	0.014	0.014	0.0%
Cobalt	mg/L	20	0.0025	0.0025	0.0%	0.0027	0.0022	20.4%	0.0015	0.0015	0.0%	0.0023	0.0022	4.4%	0.0042	0.0042	0.0%	0.0046	0.0045	2.2%
DOC	mg/L	20																		
Hardness	mg/L	20																		
Iron	mg/L	20	0.26	0.27	3.8%	0.24	0.28	15.4%	0.12	0.12	0.0%	0.25	0.25	0.0%	0.21	0.23	9.1%	0.29	0.3	3.4%
Manganese	mg/L	20	0.254	0.257	1.2%	0.277	0.278	0.4%	0.22	0.213	3.2%	0.24	0.239	0.4%	0.298	0.298	0.0%	0.313	0.313	0.0%
pH	-	20	7.2	7.2	0.0%	7	7	0.0%	7.46	7.46	0.0%	7	7	0.0%	7	7	0.0%	7.1	7.1	0.0%
Radium-226	Bq/L	20	0.052	0.054	3.8%	0.04	0.047	16.1%	0.049	0.052	5.9%	0.048	0.039	20.7%	0.042	0.048	13.3%	0.053	0.051	3.8%
Sulphate	mg/L	20	990	980	1.0%	1000	1000	0.0%	1000	1000	0.0%	1000	1000	0.0%	1000	1000	0.0%	1100	1100	0.0%
TSS	mg/L	20	2	2	0.0%	1	<1	0.0%	1	1	0.0%	1	1	0.0%	1	1	0.0%	1	1	0.0%
Uranium	mg/L	20	0.0028	0.0028	0.0%	0.002	0.0019	5.1%	0.0017	0.0017	0.0%	0.0016	0.0016	0.0%	0.0018	0.0018	0.0%	0.0022	0.0022	0.0%

(light grey)	Field blank criterion not met
(dark grey)	Actual MDL does not meet target MDL

TSS - Total Dissolved Solids

Appendix Table B.17: Field duplicates for RioAlgom TOMP station N-19 from 2010 to 2014.

Date	Units	Field Precision Criteria (%)	N-19																	
			Jan-13			Feb-13			Mar-13			Apr-13			May-13			Jun-13		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Acidity	mg/L	20																		
Barium	mg/L	20	0.014	0.014	0.0%	0.015	0.015	0.0%	0.015	0.015	0.0%	0.011	0.01	9.5%	0.007	0.007	0.0%	0.014	0.014	0.0%
Cobalt	mg/L	20	0.0046	0.0047	2.2%	0.0057	0.0052	9.2%	0.0045	0.0046	2.2%	0.0025	0.0024	4.1%	0.0012	0.0012	0.0%	0.0031	0.0031	0.0%
DOC	mg/L	20																		
Hardness	mg/L	20																		
Iron	mg/L	20	0.11	0.12	8.7%	0.2	0.16	22.2%	0.1	0.1	0.0%	0.72	0.71	1.4%	0.44	0.44	0.0%	0.2	0.19	5.1%
Manganese	mg/L	20	0.301	0.305	1.3%	0.365	0.357	2.2%	0.375	0.372	0.8%	0.185	0.174	6.1%	0.041	0.041	0.0%	0.245	0.249	1.6%
pH	-	20	6.9	6.9	0.0%	7.01	6.99	0.0%	7.1	7.1	0.0%	8.4	8.4	0.0%	8.2	8.2	0.0%	7.2	7.2	0.0%
Radium-226	Bq/L	20	0.054	0.055	1.8%	0.056	0.058	3.5%	0.049	0.045	8.5%	0.115	0.119	3.4%	0.048	0.046	4.3%	0.082	0.077	6.3%
Sulphate	mg/L	20	1000	1000	0.0%	1100	1100	0.0%	980	910	7.4%	620	590	5.0%	180	200	10.5%	85	84	1.2%
TSS	mg/L	20	<1	1	0.0%	<1	<1	0.0%	<1	<1	0.0%	1	2	66.7%	1	1	0.0%	1	<1	0.0%
Uranium	mg/L	20	0.0021	0.0021	0.0%	0.0025	0.0023	8.3%	0.0021	0.0021	0.0%	0.0093	0.0088	5.5%	0.0087	0.0086	1.2%	0.0035	0.0035	0.0%

Date	Units	Field Precision Criteria (%)	N-19																	
			Jul-13			Aug-13			Sep-13			Oct-13			Nov-13			Dec-13		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Acidity	mg/L	20																		
Barium	mg/L	20	0.014	0.014	0.0%				0.014	0.013	7.4%	0.014	0.014	0.0%	0.012	0.012	0.0%	0.014	0.013	7.4%
Cobalt	mg/L	20	0.0025	0.0025	0.0%				0.0019	0.0017	11.1%	0.0018	0.0017	5.7%	0.002	0.0019	5.1%	0.0022	0.0021	4.7%
DOC	mg/L	20																		
Hardness	mg/L	20																		
Iron	mg/L	20	0.33	0.31	6.3%				0.34	0.32	6.1%	0.26	0.26	0.0%	0.34	0.37	8.5%	0.19	0.18	5.4%
Manganese	mg/L	20	0.23	0.236	2.6%				0.163	0.16	1.9%	0.153	0.151	1.3%	0.135	0.131	3.0%	0.161	0.16	0.6%
pH	-	20	7.2	7.2	0.0%				7.2	7.2	0.0%	7	7	0.0%	7.6	7.6	0.0%	7	7	0.0%
Radium-226	Bq/L	20	0.095	0.091	4.3%				0.066	0.068	3.0%	0.06	0.062	3.3%	0.062	0.064	3.2%	0.067	0.075	11.3%
Sulphate	mg/L	20	760	790	3.9%				810	820	1.2%	775	750	3.3%	730	700	4.2%	750	710	5.5%
TSS	mg/L	20	2	2	0.0%				<1	1	0.0%	2	1	66.7%	2	1	66.7%	1	<1	0.0%
Uranium	mg/L	20	0.0027	0.0027	0.0%				0.0025	0.0025	0.0%	0.0024	0.0023	4.3%	0.007	0.0066	5.9%	0.0067	0.0068	1.5%

Field blank criterion not met

Actual MDL does not meet target MDL

TSS - Total Dissolved Solids

Appendix Table B.17: Field duplicates for RioAlgom TOMP station N-19 from 2010 to 2014.

Date	Units	Field Precision Criteria (%)	N-19																	
			Jan-14			Feb-14			Mar-14			Apr-14			May-14			Jun-14		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Acidity	mg/L	20																		
Barium	mg/L	20	0.013	0.014	7.4%	0.013	0.013	0.0%	0.014	0.014	0.0%	0.014	0.013	7.4%	0.011	0.011	0.0%	0.011	0.011	0.0%
Cobalt	mg/L	20	0.0024	0.0024	0.0%	0.0036	0.0032	11.8%	0.0031	0.0031	0.0%	0.003	0.003	0.0%	0.003	0.0029	3.4%	0.0017	0.0017	0.0%
DOC	mg/L	20																		
Hardness	mg/L	20																		
Iron	mg/L	20	0.14	0.14	0.0%	0.1	0.11	9.5%	0.08	0.08	0.0%	0.07	0.08	13.3%	0.31	0.32	3.2%	0.15	0.16	6.5%
Manganese	mg/L	20	0.166	0.164	1.2%	0.198	0.193	2.6%	0.204	0.203	0.5%	0.202	0.202	0.0%	0.161	0.161	0.0%	0.142	0.142	0.0%
pH	-	20	7.2	7.2	0.0%	7.2	7.2	0.0%	7.19	7.19	0.0%	7.1	7.1	0.0%	7.28	7.28	0.0%	7.25	7.25	0.0%
Radium-226	Bq/L	20	0.071	0.077	8.1%	0.073	0.074	1.4%	0.066	0.078	16.7%	0.07	0.077	9.5%	0.082	0.078	5.0%	0.071	0.078	9.4%
Sulphate	mg/L	20	780	750	3.9%	800	820	2.5%	840	820	2.4%	860	880	2.3%	520	530	1.9%	600	600	0.0%
TSS	mg/L	20	1	<1	0.0%	1	<1	0.0%	<1	<1	0.0%	1	<1	0.0%	2	2	0.0%	1	1	0.0%
Uranium	mg/L	20	0.0053	0.0052	1.9%	0.0055	0.0054	1.8%	0.0056	0.0054	3.6%	0.0051	0.0051	0.0%	0.0047	0.0049	4.2%	0.0041	0.0041	0.0%

Date	Units	Field Precision Criteria (%)	N-19																	
			Jul-14			Aug-14			Sep-14			Oct-14			Nov-14			Dec-14		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Acidity	mg/L	20																		
Barium	mg/L	20	0.013	0.013	0.0%	0.013	0.013	0.0%	0.011	0.011	0.0%	0.011	0.011	0.0%	0.01	0.01	0.0%	0.011	0.01	9.5%
Cobalt	mg/L	20	0.0019	0.002	5.1%	0.0023	0.0021	9.1%	0.0024	0.0024	0.0%	0.0027	0.0026	3.8%	0.0021	0.0021	0.0%	0.0019	0.0019	0.0%
DOC	mg/L	20																		
Hardness	mg/L	20																		
Iron	mg/L	20	0.31	0.3	3.3%	0.39	0.39	0.0%	0.36	0.36	0.0%	0.29	0.29	0.0%	0.36	0.35	2.8%	0.39	0.42	7.4%
Manganese	mg/L	20	0.136	0.141	3.6%	0.177	0.165	7.0%	0.147	0.148	0.7%	0.155	0.156	0.6%	0.166	0.16	3.7%	0.129	0.128	0.8%
pH	-	20	7.51	7.51	0.0%	7.3	7.25	0.0%	7.36	7.36	0.0%	7.13	7.23	1.4%	7.26	7.26	0.0%	7.5	7.5	0.0%
Radium-226	Bq/L	20	0.075	0.085	12.5%	0.073	0.065	11.6%	0.061	0.066	7.9%	0.064	0.052	20.7%	0.071	0.08	11.9%	0.069	0.073	5.6%
Sulphate	mg/L	20	690	670	2.9%	710	700	1.4%	720	710	1.4%	800	840	4.9%	740	740	0.0%	614	560	9.2%
TSS	mg/L	20	<1	1	0.0%	1	1	0.0%	2	2	0.0%	1	1	0.0%	1	<1	0.0%	<1	1	0.0%
Uranium	mg/L	20	0.004	0.004	0.0%	0.0037	0.0034	8.5%	0.0036	0.0035	2.8%	0.0036	0.0037	2.7%	0.0055	0.0055	0.0%	0.0098	0.0086	13.0%

Field blank criterion not met

Actual MDL does not meet target MDL

TSS - Total Dissolved Solids

Appendix Table B.18: Field duplicates for TOMP (Station Q-05) from 2010 to 2014.

Date	Units	Field Precision Criteria (%)	Q-05																	
			Feb-11			May-11			Aug-11			Nov-11			Feb-12			May-12		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Acidity	mg/L		<1	<1	0.0%	<1	<1	0.0%	6	5	18.2%	12	13	8.0%	2	2	0.0%	9	8	11.8%
Barium	mg/L	20																		
Cobalt	mg/L	20																		
DOC	mg/L		0.9	0.9	0.0%	1.7	1.7	0.0%	1.3	1.6	20.7%	0.7	1	35.3%						
Hardness	mg/L		1210	1110	8.6%	555	536	3.5%	1030	944	8.7%	1100	1050	4.7%						
Iron	mg/L	20																		
Manganese	mg/L	20																		
pH	-	20	6.2	6.2	0.0%	6.5	6.5	0.0%	6.4	6.4	0.0%	5.3	5.3	0.0%	6.4	6.4	0.0%	4.3	4.3	0.0%
Radium-226	Bq/L	20																		
Sulphate	mg/L	20																		
TSS	mg/L																			
Uranium	mg/L	20																		

Date	Units	Field Precision Criteria (%)	Q-05																	
			Aug-12			Nov-12			Feb-13			May-13			Aug-13			Nov-13		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Acidity	mg/L		10	10	0.0%	9	10	10.5%				<1	<1	0.0%	6	6	0.0%	13	13	0.0%
Barium	mg/L	20																		
Cobalt	mg/L	20																		
DOC	mg/L																			
Hardness	mg/L																			
Iron	mg/L	20																		
Manganese	mg/L	20																		
pH	-	20	4.2	4.2	0.0%	6.7	6.7	0.0%	6.7	6.78	1.5%	6.4	6.4	0.0%	6.1	6.1	0.0%	6.5	6.5	0.0%
Radium-226	Bq/L	20																		
Sulphate	mg/L	20																		
TSS	mg/L																			
Uranium	mg/L	20																		

Date	Units	Field Precision Criteria (%)	Q-05											
			Feb-14			May-14			Aug-14			Nov-14		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Acidity	mg/L					<1	<1	0.0%	6	6	0.0%	5	5	0.0%
Barium	mg/L	20												
Cobalt	mg/L	20												
DOC	mg/L													
Hardness	mg/L													
Iron	mg/L	20												
Manganese	mg/L	20												
pH	-	20	6.7	6.7	0.0%	6.39	6.39	0.0%	6.32	6.32	0.0%	6.16	6.16	0.0%
Radium-226	Bq/L	20												
Sulphate	mg/L	20												
TSS	mg/L													
Uranium	mg/L	20												

Field blank criterion not met

Actual MDL does not meet target MDL

TSS - Total Dissolved Solids

Appendix Table B.19: Field duplicates for Denison groundwater from 2010 to 2014.

Date	Units	Field Precision Criteria (%)	98-15A														
			Jul-10			Aug-11			Aug-12			Aug-13			Aug-14		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Acidity	mg/L	20	1790	1780	0.6%	1680		-	1450	1430	1.4%	1300	1390	6.7%	1240	1290	4.0%
Iron	mg/L	20	1010	1010	0.0%	1100	1080	1.8%	957	979	2.3%	935	916	2.1%	786	807	2.6%
pHf	-	20	5.49	5.48	0.2%	6	6	0.0%	6.19	6.22	0.5%	6.09	6.15	1.0%	5.94	5.91	0.5%
Sulphate	mg/L	20	3500	3600	2.8%	3100	3100	0.0%	3100	3100	0.0%	2900	2900	0.0%	2700	2400	11.8%

Date	Units	Field Precision Criteria (%)	BH91 DG4B											
			Jul-10			Aug-11			Aug-12			Aug-13		
			original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)	original	duplicate	RPD (%)
Acidity	mg/L	20	<1	<1	0.0%	<1	<1	0	<1	<1	0.0%	<1	<1	0.0%
Iron	mg/L	20	10.3	9.34	9.8%	14.8	13.6	8.5%	1.92	1.82	5.3%	3.02	2.75	9.4%
pHf	-	20	6.11	6.1	0.2%	6.3	6.4	1.6%	6.57	6.56	0.2%	6.18	6.2	0.3%
Sulphate	mg/L	20	830	930	11.4%	930	930	0.0%	700	770	9.5%	520	520	0.0%

(light grey)	Field blank criterion not met
(dark grey)	Actual MDL does not meet target MDL

Appendix Table B.20: Summary of field duplicate results that exceeded the DQO.

Program	Station	Parameter	Date	Units	MDL	RPD (%)	Original Conc.	Duplicate Conc.
SRWMP	M-01	Radium-226	Nov-14	mg/L	0.005	37.0	0.016	0.011
SAMP	Q-28	DOC	May-10	mg/L	0.5	22.2	0.8	1
			Nov-11	mg/L	0.5	46.2	0.8	0.5
		Radium-226	Feb-13	mg/L	0.005	20.5	0.083	0.102
			Aug-14	mg/L	0.005	26.5	0.036	0.047
	D-2	TSS	Jun-12	mg/L	1	40	3	2
			Feb-13	mg/L	1	100	3	1
			May-13	mg/L	1	66.7	2	1
			Aug-13	mg/L	1	66.7	2	1
			Feb-14	mg/L	1	40	2	3
			Aug-14	mg/L	1	66.7	1	2
			Sep-14	mg/L	1	66.7	1	2
		Barium	Jun-11	mg/L	0.005	20.3	0.168	0.137
		Cobalt	Feb-10	mg/L	0.0005	28.6	0.0024	0.0018
		DOC	Mar-11	mg/L	0.5	20.9	3.7	3
			Apr-11	mg/L	0.5	27	1.6	2.1
			Oct-12	mg/L	0.5	46.2	4.8	3
		Iron	Aug-14	mg/L	0.02	22.2	0.05	0.04
		Radium-226	Jun-10	mg/L	0.005	32.9	0.23	0.165
			Jul-11	mg/L	0.005	27.7	0.074	0.056
			Jan-12	mg/L	0.005	21.6	0.041	0.033
			Oct-12	mg/L	0.005	35.1	0.08	0.114
			Aug-13	mg/L	0.005	26.2	0.134	0.103
			Nov-13	mg/L	0.005	25.5	0.181	0.14
		Sulphate	Nov-13	mg/L	0.1	79.1	130	300
		TSS	Jan-10	mg/L	1	66.7	1	2
			May-10	mg/L	1	28.6	4	3
			Jun-10	mg/L	1	66.7	1	2
			Jul-11	mg/L	1	66.7	1	2
			Apr-12	mg/L	1	66.7	1	2
			Jun-13	mg/L	1	40	4	6
			Nov-13	mg/L	1	66.7	1	2
			Dec-13	mg/L	1	66.7	1	2
			Aug-14	mg/L	1	66.7	1	2
			Sep-14	mg/L	1	66.7	1	2
			Oct-14	mg/L	1	66.7	1	2
TOMP	N-19	Barium	Jul-11	mg/L	0.005	20.7	0.016	0.013
		Cobalt	Aug-10	mg/L	0.0005	20.7	0.0016	0.0013
			Aug-12	mg/L	0.0005	20.4	0.0027	0.0022
		Iron	Feb-10	mg/L	0.02	24	0.14	0.11
			Feb-13	mg/L	0.02	22.2	0.2	0.16
		Radium-226	Jun-11	mg/L	0.005	21.3	0.063	0.078
			Aug-11	mg/L	0.005	23.3	0.067	0.053
			Jan-12	mg/L	0.005	20.3	0.065	0.053
			Oct-12	mg/L	0.005	20.7	0.048	0.039
			Oct-14	mg/L	0.005	20.7	0.064	0.052
		TSS	Jan-10	mg/L	1	66.7	2	1
			Oct-10	mg/L	1	66.7	1	2
			Dec-10	mg/L	1	66.7	1	2
			May-11	mg/L	1	66.7	1	2
			Aug-11	mg/L	1	66.7	2	1
			Oct-11	mg/L	1	66.7	2	1
			Nov-11	mg/L	1	100	3	1
			Dec-11	mg/L	1	100	3	1
			Apr-13	mg/L	1	66.7	1	2
			Oct-13	mg/L	1	66.7	1	2
			Nov-13	mg/L	1	66.7	2	1
	Q-05	DOC	Nov-11	mg/L	0.5	35.3	0.7	1

(shaded) Exceedence of DQO (20%) not explained by concentrations near MDL

TSS - Total Dissolved Solids

Appendix Table B.21: Summary of laboratory duplicate results, 2010 to 2014.

Year	Description	Acidity	Barium	Cobalt	DOC	Iron	Hardness	Manganese	Radium-226	Sulphate	TSS	Uranium	Total
		mg/L	mg/L	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%	10%	10%	
	Lab Criteria	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	
2010	Mean	8.85	8.95	8.33	9.36	10.41	-	8.76	0.60	0.50	9.53	0.34	**-**
	# above criteria	0	0	0	0	0	0	0	0	0	0	0	**0**
	% above criteria	0	0	0	0	0	0	0	0	0	0	0	**0.0**
	# samples	43	115	114	180	139	-	118	75	148	246	145	**1323**
2011	Mean	0.55	0.73	-0.12	0.63	1.14	0.98	0.81	4.40	0.64	2.25	0.56	**-**
	# above criteria	0	0	0	0	0	0	0	0	0	0	0	**0**
	% above criteria	0	0	0	0	0	0	0	0	0	0	0	**0.0**
	# samples	88	154	133	230	148	113	136	93	156	193	110	**1554**
2012	Mean	0.31	0.07	-0.04	-0.45	-0.87	0.20	0.35	5.46	0.58	1.80	0.01	**-**
	# above criteria	0	0	0	0	0	0	0	0	0	0	0	**0**
	% above criteria	0	0	0	0	0	0	0	0	0	0	0	**0.0**
	# samples	66	112	105	204	135	101	104	95	135	36	106	**1199**
2013	Mean	0.20	1.30	0.60	2.50	0.50	0.90	0.60	4.10	2.10	0.00	0.60	**-**
	# above criteria	0	1	0	14	12	1	0	0	0	0	0	**28**
	% above criteria	0	1	0	16	7	1	0	0	0	0	0	**2.6**
	# samples	68	133	125	85	162	108	123	95	59	0	126	**1084**
2014	Mean	0.00	0.70	1.60	-0.40	1.80	0.40	2.00	4.65	0.80	0.80	2.00	**-**
	# above criteria	38	0	1	7	0	0	0	0	1	0	7	**54**
	% above criteria	48	0	1	13	0	0	0	0	1	0	4	**3.2**
	# samples	79	176	181	53	201	146	168	99	107	326	172	**1708**
Total	**# above criteria**	**38**	**1**	**1**	**21**	**12**	**1**	**0**	**0**	**1**	**0**	**7**	**82**
	% above criteria	**11.0**	**0.1**	**0.2**	**2.8**	**1.5**	**0.2**	**0.0**	**0.0**	**0.2**	**0.0**	**1.1**	**1.2**
	# samples	**344**	**690**	**658**	**752**	**785**	**468**	**649**	**457**	**605**	**801**	**659**	**6868**

[shaded] Samples above lab and program criteria

TSS - Total Dissolved Solids

Appendix Table B.22: Summary of laboratory matrix spike blank quality control results, 2010 to 2014.

Year	Description	Acidity	Barium	Cobalt	DOC	Iron	Hardness	Manganese	Radium-226	Sulphate	Uranium	Total
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L as CaCO3	mg/L	Bq/L	mg/L	mg/L	
	Program Criteria	80 - 120%	80 - 120%	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%	80 - 120%	70 - 130%	70 - 130%	
2010	Mean	107.1	64.2	100.6	99.5	104.9		100.6	92.4	100.1	100.5	**-**
	# above criteria	0	0	0	0	0	0	0	0	0	0	**0**
	% above criteria	0	0	0	0	0	0	0	0	0	0	**0**
	# samples	33	160	159	325	195		156	75	190	160	**1453**
2011	Mean	104.0	59.3	101.8	98.8	107.5	103.0	104.5	98.8	100.18	99.8	**-**
	# above criteria	0	0	0	0	0	0	0	0	0	0	**0**
	% above criteria	0	0	0	0	0	0	0	0	0	0	**0.0**
	# samples	81	201	172	356	193	144	137	93	176	144	**1697**
2012	Mean	106.7	52.2	98.0	100.4	102.9	101.8	105.05	102.8	99.86	98.2	**-**
	# above criteria	0	0	0	0	0	0	0	0	0	0	**0**
	% above criteria	0	0	0	0	0	0	0	0	0	0	**0.0**
	# samples	64	156	148	316	182	81	144	95	191	152	**1529**
2013	Mean	102.5	52.0	96.9	99.9	101.3	101.9	101.4	100.0	99.5	96.8	**-**
	# above criteria	0	190	0	0	0	0	9	0	0	0	**199**
	% above criteria	0	94	0	0	0	0	5	0	0	0	**12.69943**
	# samples	86	203	195	293	168	224	165	95	75	63	**1567**
2014	Mean	105.6	50.1	94.0	100.4	97.9	103.1	103.8	102.4	100.4	96.1	**-**
	# above criteria	1	171	2	0	3	0	25	0	0	0	**202**
	% above criteria	1	100	1	0	2	0	15	0	0	0	**14.55331**
	# samples	98	171	182	110	158	97	162	99	171	140	**1388**
Total	**# above criteria**	**1**	**361**	**2**	**0**	**3**	**0**	**34**	**0**	**0**	**0**	**401**
	% above criteria	**0**	**40.5**	**0**	**0**	**0.3**	**0.0**	**4**	**0**	**0**	**0**	**5.3**
	# samples	**362**	**891**	**856**	**1400**	**896**	**546**	**764**	**457**	**803**	**659**	**7634**

Mean spike recovery does not meet program DQO.

Samples outside lab criteria, but not necessarily outside program criteria.

TSS - Total Dissolved Solids

Appendix Table B.23: Summary of laboratory certified reference material (CRM) quality control results, 2010 to 2014.

Year	Description	Acidity	Barium	Cobalt	DOC	Iron	Hardness	Manganese	Radium-226	Sulphate	Uranium	Total
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	Bq/L	mg/L	mg/L	
	Program Criteria	80 - 120%	80 - 120%	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%	80 - 120%	80 - 120%	
2010	Mean	100.4	102.0	101.0	100.4	99.5		103.0	95.8[a,b]	101.6	103.0	**-**
	# above criteria	0	0	0	0	0	0	0	0	0	0	**0**
	% above criteria	0	0	0	0	0	0	0	0	0	0	**0**
	# samples	79	171	170	354	207		168	75	174	170	**1568**
2011	Mean	79.6	100.0	1750.0	908.0	82.9	83.5	100.0	100.0	100.6	100.0	**-**
	# above criteria	0	0	0	0	0	0	0	0	0	0	**0**
	% above criteria	0	0	0	0	0	0	0	0	0	0	**0.0**
	# samples	97	198	208	391	231	160	184	93	171	162	**1895**
2012	Mean	96.2	100.0	100.0	99.5	100.0	99.9	100.0	102.3	99.4	100.0	**-**
	# above criteria	0	0	0	0	0	0	0	0	0	0	**0**
	% above criteria	0	0	0	0	0	0	0	0	0	0	**0.0**
	# samples	69	150	144	281	173	123	139	95	173	147	**1494**
2013	Mean	97.2	100.0	100.0	100.5	99.7	99.2	100.0	100.0	99.8	100.0	**-**
	# above criteria	0	0	0	0	0	0	0	0	0	0	**0**
	% above criteria	0	0	0	0	0	0	0	0	0	0	**0**
	# samples	79	164	150	155	198	132	155	95	146	158	**1432**
2014	Mean	99.0	100.0	100.0	98.1	100.2	98.4	100.0	102.3	100.8	98430.0	**-**
	# above criteria	0	0	0	0	0	0	0	0	0	0	**0**
	% above criteria	0	0	0	0	0	0	0	0	0	0	**0**
	# samples	87	179	184	54	203	152	164	99	122	332	**1576**
Total	**# above criteria**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	% above criteria	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.0**
	# samples	**411**	**862**	**856**	**1235**	**1012**	**567**	**810**	**457**	**786**	**969**	**7965**

Samples above lab criteria, but not necessarily above program criteria

TSS - Total Dissolved Solids

APPENDIX C
TOMP RAW DATA AND SUPPORTING INFORMATION

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 2010 to 2014.

Date m/d/yr	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
3/17/2010						7.0	0.26		
4/13/2010	< 1	0.031	< 0.0005	0.04	0.015	8.1	0.73	160	0.0281
3/23/2011						7.5	1.204	200	
4/12/2011	< 1	0.054	< 0.0005	0.12	0.052	7.7	1.306	160	0.0300
5/10/2011						8.1	1.033	150	
6/14/2011						7.9	1.057	150	
7/12/2011	< 1	0.046	< 0.0005	0.06	0.067		0.934	150	0.0136
8/9/2011							1.091	150	
9/13/2011							1.191	160	
10/11/2011	< 1	0.063	0.0005	0.12	0.049		1.441	170	0.0146
11/8/2011							1.469	164	
12/13/2011						7.9	1.605	170	
1/10/2012	< 1	0.066	< 0.0005	0.06	0.015	8.0	1.559	180	0.0296
2/14/2012						7.9	1.588	190	
3/6/2012						7.6	1.632	200	
4/10/2012	< 1	0.06	< 0.0005	0.18	0.033	8.0	1.434	150	0.0240
5/8/2012						8.0	1.821	160	
6/12/2012							1.773	170	
7/10/2012	< 1	0.064	0.0005	0.09	0.191		1.477	150	0.0207
8/14/2012							1.797	170	
9/11/2012							1.571	170	
10/9/2012	< 1	0.076	0.0007	0.24	0.123		1.802	170	0.0220
11/13/2012							1.53	180	
12/11/2012							1.794	190	
1/8/2013	< 1	0.077	< 0.0005	0.09	0.05		1.649	200	0.0340
2/12/2013	< 1	0.109	0.0007	0.08	0.125	7.6	1.733	200	0.0391
3/12/2013						7.5	1.54	160	
4/9/2013	< 1	0.062	0.0007	0.12	0.051	7.3	1.333	170	0.0285
5/14/2013						7.9	1.624	130	
6/11/2013						8.2	1.663	140	
7/9/2013	< 1	0.055	< 0.0005	0.06	0.053		1.39	150	0.0188
8/13/2013						8.6	1.292	130	
9/3/2013							1.122	130	
10/7/2013	< 1	0.051	< 0.0005	0.07	0.036	7.3	1.087	140	0.0146
11/12/2013							0.887	130	
12/10/2013						7.5	0.967	140	
1/14/2014	< 1	0.049	< 0.0005	0.05	0.034	7.4	1.066	140	0.0213
2/11/2014						7.2	0.865	140	
3/11/2014						7.1	1.124	150	
4/9/2014	< 1	0.044	< 0.0005	0.03	0.047	7.0	0.964	170	0.0227
5/13/2014						7.2	1.202	96	
6/10/2014						8.2	1.442	92	
7/8/2014	< 1	0.127	< 0.0005	0.09	0.101	7.4	1.745	97	0.0129
8/11/2014							1.601	110	
9/9/2014							1.363	110	
10/14/2014	< 1	0.052	< 0.0005	0.08	0.014		1.033	97	0.0119
11/11/2014						7.7	0.953	110	
12/9/2014						7.7	1.088	110	
Number	17	17	17	17	17	1254	48	47	17
Minimum	< 1	0.031	< 0.0005	0.03	0.014	6.6	0.26	92	0.0119
Maximum	< 1	0.127	0.0007	0.24	0.191	9.1	1.821	200	0.0391
Mean	< 1	0.064	< 0.0005	0.09	0.062	7.7	1.330	151	0.0227
Median	< 1	0.060	0.0005	0.08	0.050	7.7	1.377	150	0.0220
10th Percentile	1	0.045	0.0005	0.05	0.015	7.1	0.947	110	0.0133
95th Percentile	1	0.113	0.0007	0.19	0.138	8.2	1.796	200	0.0350

[a] pH measures shown only for dates when other substances were measured but summary statistics reflect all measured values.

Appendix Table C.1.3: Water quality at station D-22 from 2010 to 2014.

Date m/d/yr	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
1/12/2010	< 2	0.029	< 0.0005	0.09	0.166	6.6	0.160	190	0.0007
3/9/2010						6.5	0.210		
4/13/2010	< 1	0.016	< 0.0005	0.15	0.024	7.0	0.100	68	0.0008
5/11/2010						6.7	0.600		
6/8/2010						6.7	1.600		
9/14/2010						6.8	1.900		
10/12/2010	< 1	0.035	< 0.0005	3.03	0.145	6.9	0.510	170	0.0012
11/9/2010						6.9	0.180		
12/14/2010						6.7	0.510		
1/11/2011	< 1	0.036	0.0019	4.06	0.583	6.5	0.596	150	0.0030
2/8/2011						6.6	0.804		
3/8/2011						6.5	0.698		
4/12/2011	< 1	0.018	0.0012	0.16	0.437	6.8	0.057	25	0.0008
5/10/2011						6.6	0.161		
6/14/2011						6.9	0.442		
7/12/2011	< 1	0.047	0.0005	6.61	0.348	6.9	1.140	130	0.0033
8/9/2011						6.9	1.089		
9/13/2011						6.8	2.511		
10/11/2011	< 1	0.062	0.0005	5.99	0.249	6.8	1.206	270	0.0015
11/8/2011						7.2	0.104		
12/13/2011						6.7	0.239		
1/10/2012	< 1	0.035	0.0013	3.17	0.527	6.7	0.501	190	0.002
2/14/2012						6.9	0.314		
3/6/2012						7.0	0.461		
4/10/2012	< 1	0.028	< 0.0005	0.45	0.043	6.9	0.192	100	0.0007
5/8/2012						6.8	0.401		
6/12/2012						6.8	1.738		
7/10/2012	< 1	0.082	0.0007	10.50	0.090	6.8	1.903	120	0.0083
9/11/2012						6.9	1.393		
9/18/2012				3.62		7.0			0.0045
10/9/2012	< 1	0.074	< 0.0005	3.36	0.141	6.9	0.885	330	0.0016
11/13/2012						7.0	0.087		
12/11/2012						6.8	0.191		
1/8/2013	< 1	0.032	< 0.0005	0.57	0.086	6.8	0.179	160	< 0.0005
2/12/2013						6.6	0.030		
3/12/2013						6.5	0.119		
4/9/2013	< 1	0.027	< 0.0005	0.14	0.055	7.1	0.042	46	< 0.0005
5/14/2013						6.8	0.100		
6/11/2013						7.0	0.276		
7/9/2013	< 1	0.059	0.0006	13.00	1.540	6.8	1.623	110	0.0037
8/13/2013						7.2	0.211		
9/3/2013						7.1	0.327		
10/7/2013	< 1	0.018	< 0.0005	0.32	0.094	7.2	0.072	64	< 0.0005
11/12/2013						7.1	0.067		
12/10/2013						7.4	0.092		
1/14/2014	< 1	0.03	0.0009	0.62	0.362	7.1	0.147	97	0.0007
2/12/2014						6.5	0.140		
3/11/2014						6.7	0.191		
4/9/2014	< 1	0.026	0.0016	0.97	0.623	6.8	0.092	74	0.0009
5/13/2014						6.5	0.038		
6/10/2014						6.5	0.543		
7/8/2014	< 1	0.065	0.0010	13.60	1.470	6.9	1.141	100	0.0045
8/26/2014						6.8	2.216		
9/9/2014						6.7	0.990		
9/16/2014						6.6	0.363		
9/23/2014	< 1	0.043		2.23	0.157	6.7	0.313	160	0.0005
10/14/2014	< 1	0.018	0.0006	0.39	0.083	6.9	0.067	50	0.0005
11/11/2014						6.9	0.046		
12/9/2014						6.6	0.141		
Number	16	16	5	17	16	261	47	16	17
Minimum	< 1	0.016	0.0005	0.09	0.024	6.3	0.030	25	0.0005
Maximum	< 2	0.082	0.0005	13.60	1.540	7.7	2.511	330	0.0083
Mean	< 1	0.039	< 0.0005	3.48	0.361	6.8	0.559	130.2	< 0.0019
Median	< 1	0.034	0.0005	2.23	0.162	6.8	0.295	115	0.0009
10th Percentile	1	0.018	0.0005	0.15	0.054	6.5	0.067	49.6	0.0005
95th Percentile	1.05	0.074	0.0005	13.00	1.474	7.1	1.900	273	0.0045

[a] pH measures shown only for dates when other substances were measured but summary statistics reflect all measured values.

Appendix Table C.1.4: Water quality at station D-25 from 2010 to 2014.

Date m/d/yr		Acidity mg/L	Fe mg/L	pH[a]	Ra Bq/L	Sulphate mg/L
4/13/2010	<	1	0.39	7.5	0.53	190
10/12/2010	<	1	0.11	7.3	0.28	210
4/12/2011	<	1	0.20	7.5	0.287	160
10/11/2011	<	1	1.40	6.9	0.449	210
4/10/2012	<	1	0.24	7.6	0.366	170
10/16/2012	<	1	1.85	7.1	0.263	220
4/8/2013	<	1	0.23	7.7	0.319	150
10/7/2013	<	1	0.29	7.0	0.258	150
5/13/2014	<	1	0.62	7.0	0.403	94
10/14/2014	<	1	0.26	7.2	0.211	110
Number		10	10	60	10	10
Minimum		1	0.11	6.8	0.211	94
Maximum	<	1	1.85	7.7	0.530	220
Mean	<	1	0.56	7.4	0.337	166
Median		1	0.28	7.4	0.303	165
10th Percentile	<	1	0.19	7.0	0.253	108
95th Percentile		1	1.65	7.5	0.494	216

[a] pH measures shown only for dates when other substances were measured but summary statistics reflect all measured values.

Table C.1.5: Water quality at groundwater station BH91-D1A from 2010 to 2014.

Date m/d/y	Acidity mg/L	Fe mg/L	pH	Ra Bq/L	Sulphate mg/L
9/7/2011		43.20	7.8		940
9/12/2012	5	39.40	7.6		900
8/28/2013	< 1	37.90	7.3		830
8/25/2014	< 1	38.80	7.2	0.017	870
Number	3	4	4	1	4
Minimum	1	37.90	7.2	0.017	830
Maximum	5	43.20	7.8	0.017	940
Mean	< 2	39.83	7.5	0.0	885
Median	1	39.10	7.5	0.017	885
10th Percentile	1	38.17	7.2	0.017	842
95th Percentile	5	42.63	7.8	0.017	934

Table C.1.6: Water quality at groundwater station BH91-D1B from 2010 to 2014.

Date m/d/y	Acidity mg/L	Fe mg/L	pH	Ra Bq/L	Sulphate mg/L
7/9/2010	< 1	< 0.02	7.1		620
9/7/2011	< 1	0.03	8.3		680
9/12/2012	< 1	< 0.02	8.3		660
8/28/2013	< 1	0.05	8.1		580
8/25/2014	< 1	< 0.02	8.1	0.018	570
Number	5	5	5	1	5
Minimum	1	0.02	7.1	0.018	570
Maximum	1	0.05	8.3	0.018	680
Mean	< 1	0.03	8.0	0.018	622
Median	1	0.02	8.1	0.018	620
10th Percentile	1	0.02	7.5	0.018	574
95th Percentile	1	0.05	8.3	0.018	676

Table C.1.7: Water quality at groundwater station BH91-D3A from 2010 to 2014.

Date m/d/y	Acidity mg/L	Fe mg/L	pH	Ra Bq/L	Sulphate mg/L
7/12/2010	585	419	6.3		2200
9/7/2011	469	349	7.1		2000
9/12/2012	400	317	7.0		1930
8/29/2013	312	301	7.0		1800
8/25/2014	266	258	7.1	0.078	1800
Number	5	5	5	1	5
Minimum	266	258	6.3	0.078	1800
Maximum	469	349	7.1	0.078	2000
Mean	406.4	328.8	6.9	0.078	1946
Median	400	317	7.0	0.078	1930
10th Percentile	284.4	275.2	6.6	0.078	1800
95th Percentile	561.8	405	7.1	0.078	2160

Table C.1.8: Water quality at groundwater station BH91-D3B from 2010 to 2014.

Date m/d/y	Acidity mg/L	Fe mg/L	pH	Ra Bq/L	Sulphate mg/L
7/8/2010	526	389	6.1		2100
9/7/2011	524	378	6.9		2000
9/12/2012	439	353	7.0		1850
8/29/2013	469	344	7.1		1800
8/25/2014	405	279	6.8	0.097	1800
Number	5	5	5	1	5
Minimum	405	279	6.1	0.097	1800
Maximum	524	378	7.1	0.097	2000
Mean	472.6	348.6	6.8	0.097	1910
Median	469	353	6.9	0.097	1850
10th Percentile	418.6	305	6.4	0.097	1800
95th Percentile	525.6	386.8	7.1	0.097	2080

Table C.1.9: Water quality at groundwater station BH91-D9A from 2010 to 2014.

Date m/d/y	Acidity mg/L	Fe mg/L	pH	Ra Bq/L	Sulphate mg/L
7/12/2010	254	275	6.1		1900
9/8/2011	249	278	6.4		1800
9/13/2012	256	266	6.9		1900
8/28/2013	258	295	7.1		1700
8/19/2014	262	221	7.3	0.501	1700
Number	5	5	5	1	5
Minimum	249	221	6.1	0.501	1700
Maximum	262	295	7.3	0.501	1900
Mean	256	267	6.8	0.501	1800
Median	256	275	6.9	0.501	1800
10th Percentile	251	239	6.2	0.501	1700
95th Percentile	261	292	7.3	0.501	1900

Table C.1.10: Water quality at groundwater station BH91-DG4B from 2010 to 2014.

Date m/d/y	Acidity mg/L	Fe mg/L	pH	Ra Bq/L	Sulphate mg/L
7/8/2010	< 1	10.30	6.1		830
9/2/2011	< 1	14.80	6.3		930
8/20/2012	< 1	1.92	6.6		700
8/28/2013	< 1	3.02	6.2		520
8/21/2014	< 1	2.27	6.6	0.991	580
Number	5	5	5	1	5
Minimum	1	1.92	6.1	0.991	520
Maximum	1	14.80	6.6	0.991	930
Mean	1	6.46	6.4	0.991	712
Median	1	3.02	6.3	0.991	700
10th Percentile	1	2.06	6.1	0.991	544
95th Percentile	1	13.90	6.6	0.991	910

Appendix Table C.1.11: Summary of seasonal trends for station D-1 from 2003-2014.

Month	Spearman's rho	Acidity	Ba	Co	Fe	Mn	pH	Ra	Sulphate	U
January	Correlation Coefficient	-	0.700	0.866		0.800	-0.310	0.786	-0.964	-0.900
	Sig. (2-tailed)	-	0.188	0.058		0.104	0.456	0.036	0.000	0.037
	N	5	5	5		5	8	7	7	5
February	Correlation Coefficient						-0.2	0.536		
	Sig. (2-tailed)						0.606	0.215		
	N						9	7		
March	Correlation Coefficient						-0.266	0.629	-0.986	
	Sig. (2-tailed)						0.404	0.028	0.000	
	N						12	12	6	
April	Correlation Coefficient	-	0.786	0.063	-0.205	-0.071	0.091	0.86	0.572	0.164
	Sig. (2-tailed)	-	0.021	0.881	0.741	0.867	0.779	0.000	0.052	0.651
	N	8	8	8	5	8	12	12	12	10
May	Correlation Coefficient						-0.536	0.905		
	Sig. (2-tailed)						0.089	0.002		
	N						11	8		
June	Correlation Coefficient						-0.571	0.771		
	Sig. (2-tailed)						0.139	0.072		
	N						8	6		
November	Correlation Coefficient							0.2		
	Sig. (2-tailed)							0.747		
	N							5		
December	Correlation Coefficient						-0.143	0.783		
	Sig. (2-tailed)						0.736	0.013		
	N						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).

[grey box] Significant trend where p<0.05.

Appendix Table C.1.12 Summary of seasonal trends for station D-22 from 2003-2014.

Month	Spearman's rho	Acidity	Ba	Co	Fe	Mn	pH	Ra	Sulphate	U
January	Correlation Coefficient	-0.707	0.738	-0.354	0.100	0.333	0.229	-0.455	-0.218	-0.498
	Sig. (2-tailed)	0.182	0.037	0.559	0.873	0.42	0.473	0.138	0.495	0.099
	N	5	8	5	5	8	12	12	12	12
February	Correlation Coefficient						0.458	-0.355		
	Sig. (2-tailed)						0.135	0.284		
	N						12	11		
March	Correlation Coefficient						0.27	-0.14		
	Sig. (2-tailed)						0.397	0.665		
	N						12	12		
April	Correlation Coefficient	-	0.659	-0.655	0.4	0.119	-0.277	-0.396	0.07	-0.358
	Sig. (2-tailed)	-	0.076	0.158	0.505	0.779	0.384	0.202	0.829	0.254
	N	5	8	6	5	8	12	12	12	12
May	Correlation Coefficient						-0.502	-0.175		
	Sig. (2-tailed)						0.096	0.587		
	N						12	12		
June	Correlation Coefficient						-0.057	0.203		
	Sig. (2-tailed)						0.861	0.527		
	N						12	12		
July	Correlation Coefficient		0.319			0.543	0.046	0.533	-0.477	-0.126
	Sig. (2-tailed)		0.538			0.266	0.888	0.139	0.194	0.748
	N		6			6	12	9	9	9
August	Correlation Coefficient						0.413	0.143		
	Sig. (2-tailed)						0.235	0.736		
	N						10	8		
September	Correlation Coefficient						0.351	-0.624		
	Sig. (2-tailed)						0.263	0.040		
	N						12	11		
October	Correlation Coefficient	-	-0.347	-0.541	-0.6	-0.683	0.312	-0.252	-0.203	-0.842
	Sig. (2-tailed)	-	0.399	0.268	0.285	0.062	0.323	0.429	0.527	0.001
	N	5	8	6	5	8	12	12	12	12
November	Correlation Coefficient						-0.211	-0.707		
	Sig. (2-tailed)						0.511	0.010		
	N						12	12		
December	Correlation Coefficient						-0.042	-0.347		
	Sig. (2-tailed)						0.896	0.269		
	N						12	12		

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).

Significant trend where $p<0.05$.

Appendix Table C.1.13: Summary of seasonal trends for station D-25 from 2003-2014.

Month	Spearman's rho	Acidity	Fe	pH	Ra	Sulphate
January	Correlation Coefficient			-0.110		
	Sig. (2-tailed)			0.795		
	N			8		
February	Correlation Coefficient			0.111		
	Sig. (2-tailed)			0.793		
	N			8		
March	Correlation Coefficient			-0.136		
	Sig. (2-tailed)			0.727		
	N			9		
April	Correlation Coefficient	0.866		0.833	0.556	
	Sig. (2-tailed)	0.012		0.001	0.076	
	N	7		11	11	
May	Correlation Coefficient			0.179		
	Sig. (2-tailed)			0.672		
	N			8		
June	Correlation Coefficient			-0.449		
	Sig. (2-tailed)			0.265		
	N			8		
July	Correlation Coefficient			0.872		
	Sig. (2-tailed)			0.054		
	N			5		
August	Correlation Coefficient					
	Sig. (2-tailed)					
	N					
September	Correlation Coefficient					
	Sig. (2-tailed)					
	N					
October	Correlation Coefficient	0.845	0.1	-0.077	-0.504	-0.667
	Sig. (2-tailed)	0.008	0.873	0.811	0.094	0.219
	N	8	5	12	12	5
November	Correlation Coefficient			0.449		
	Sig. (2-tailed)			0.265		
	N			8		
December	Correlation Coefficient			0.442		
	Sig. (2-tailed)			0.273		
	N			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).

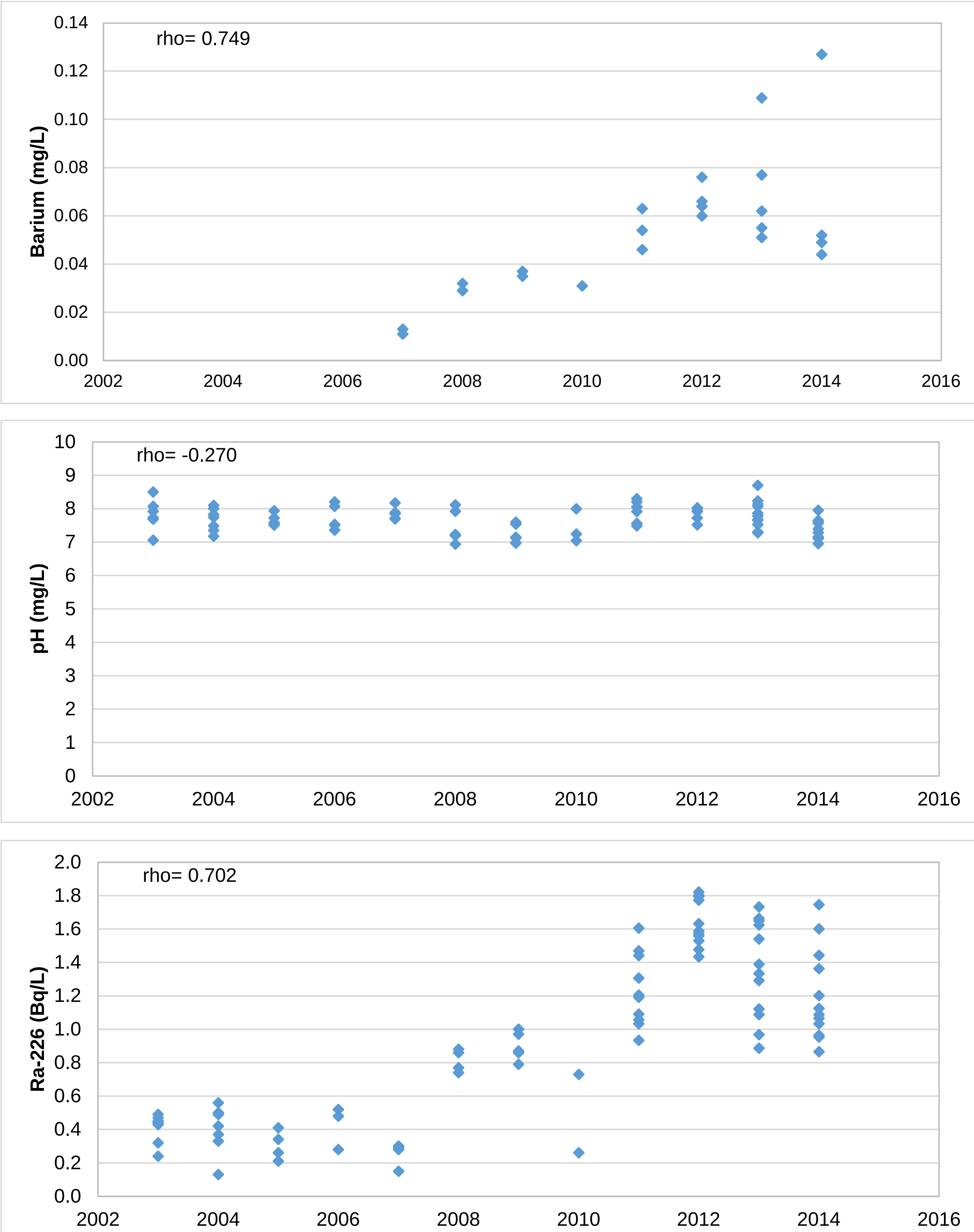
[grey shading] Significant trend where p<0.05.

Appendix Table C.1.14: Summary of annual trends for Denison groundwater stations from 1991 to 2014.

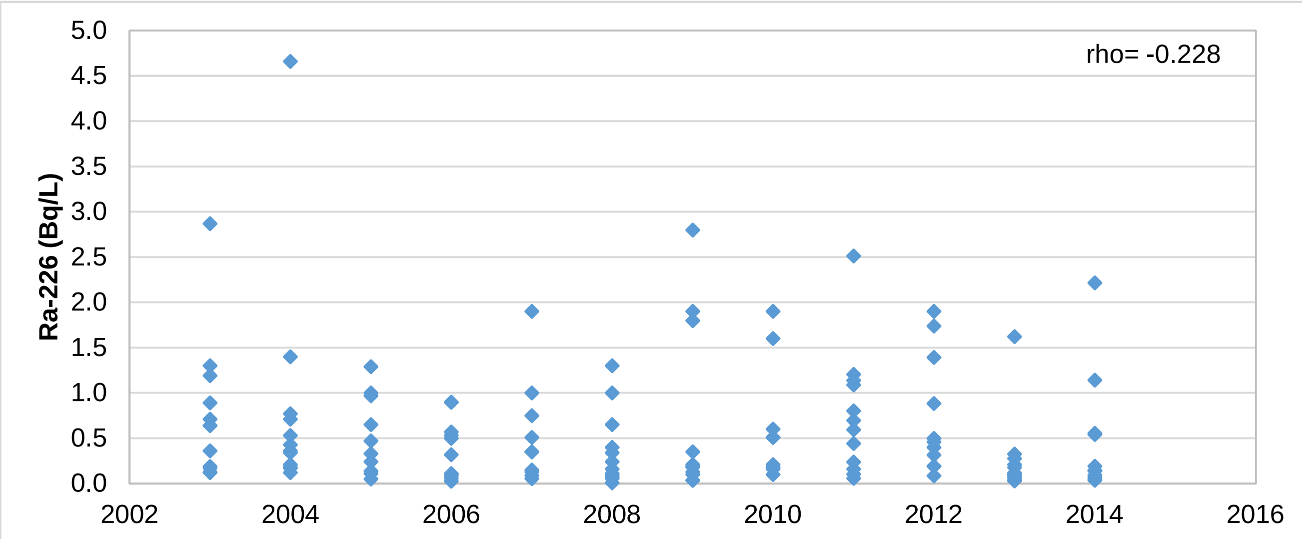
Station	Spearman rho	Acidity	Iron	pH	Sulphate
BH91-DG4B	Correlation Coefficient	-	0.061	-0.777	-0.821
	Sig. (2-tailed)	-	0.803	0.000	0.023
	N	8	19	18	7
BH91-D9A	Correlation Coefficient	0.976	0.855	-0.199	-0.784
	Sig. (2-tailed)	0.000	0.000	0.386	0.021
	N	8	21	21	8
BH91-D1A	Correlation Coefficient	-0.986	-0.86	0.91	-0.746
	Sig. (2-tailed)	0.000	0.000	0.000	0.001
	N	6	20	20	15
BH91-D1B	Correlation Coefficient	-	-0.418	0.383	0.694
	Sig. (2-tailed)	-	0.075	0.096	0.003
	N	8	19	20	16
BH91-D3A	Correlation Coefficient	-1.00	-0.663	0.824	-0.81
	Sig. (2-tailed)	0.000	0.001	0.000	0.000
	N	8	21	21	16
BH91-D3B	Correlation Coefficient	-0.976	-0.717	0.944	-0.855
	Sig. (2-tailed)	0.000	0.000	0.000	0.000
	N	8	21	20	15

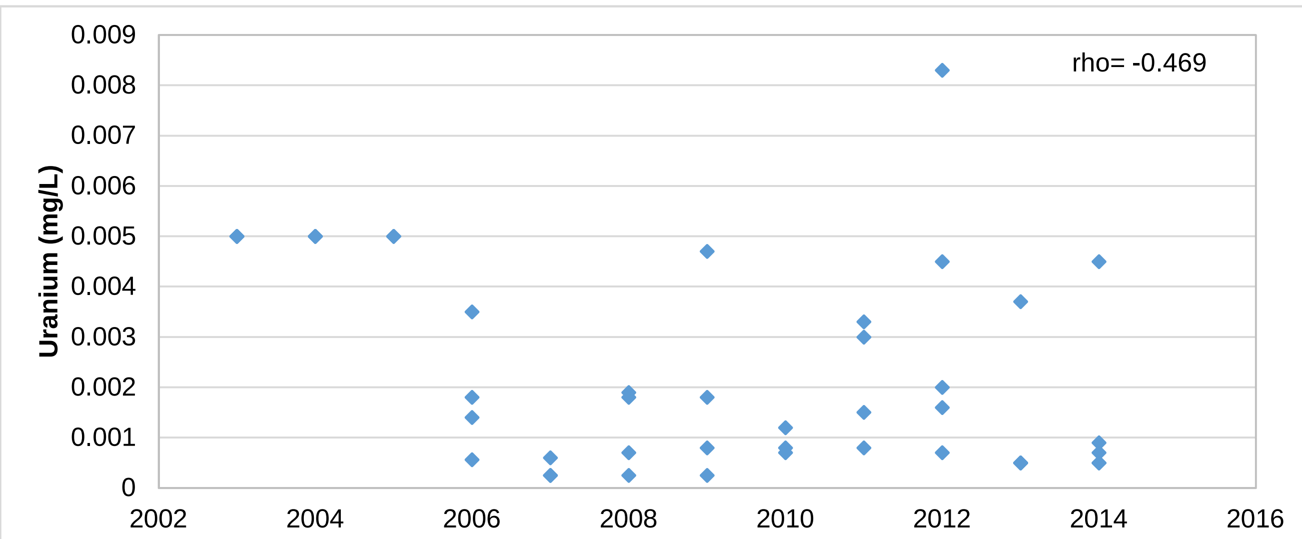
Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

[shaded box] Significant trend where p<0.05.

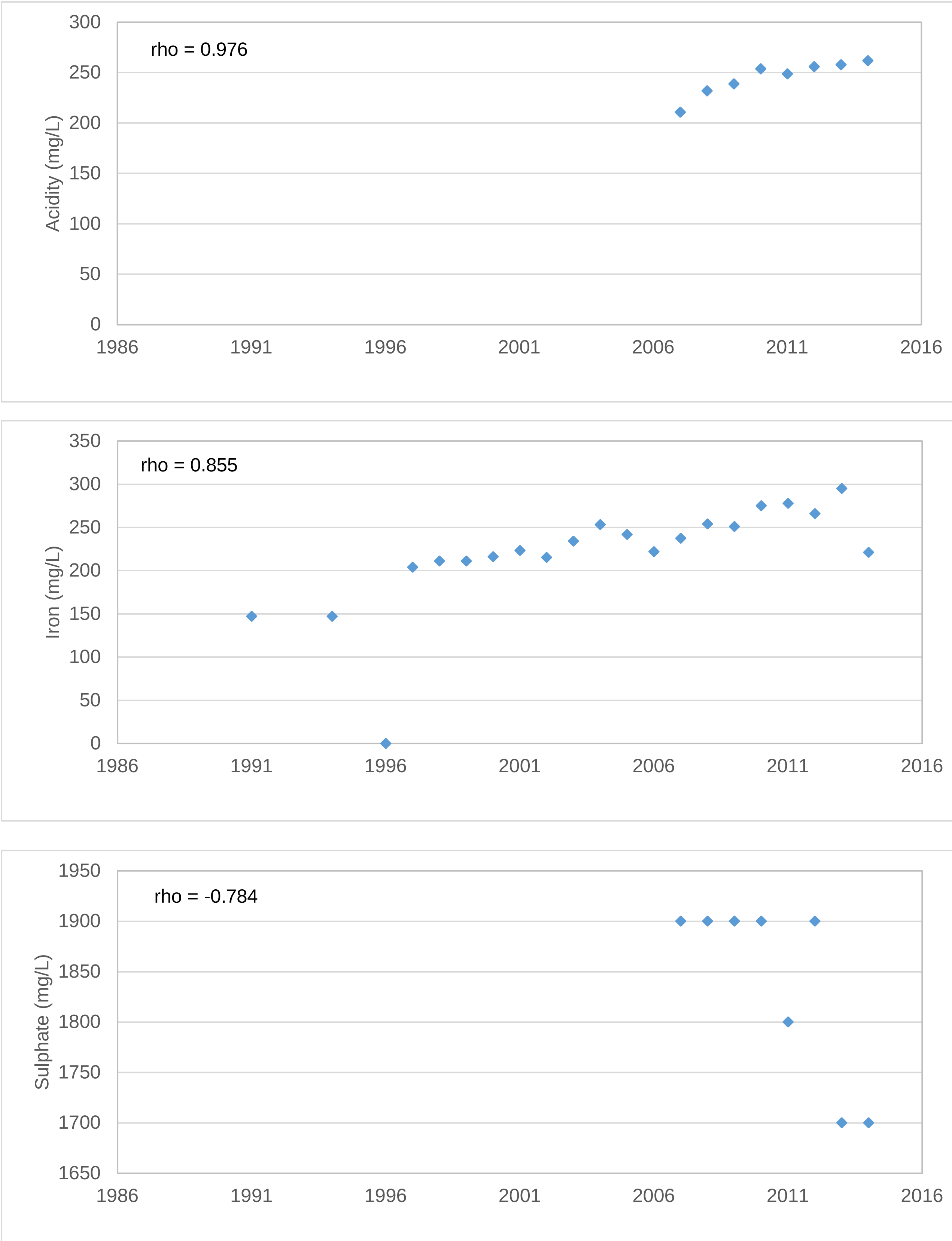


Appendix Figure C.1.1: Significant common (average) trends observed for barium, pH and radium-226 over all seasons at Station D-1, 2003 to 2014.

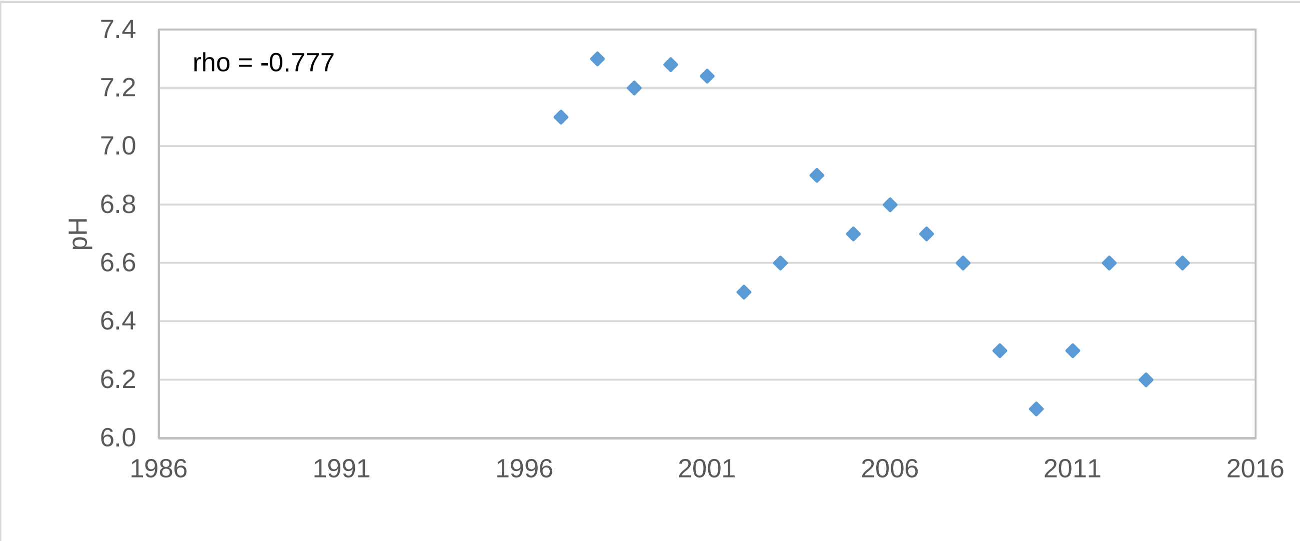


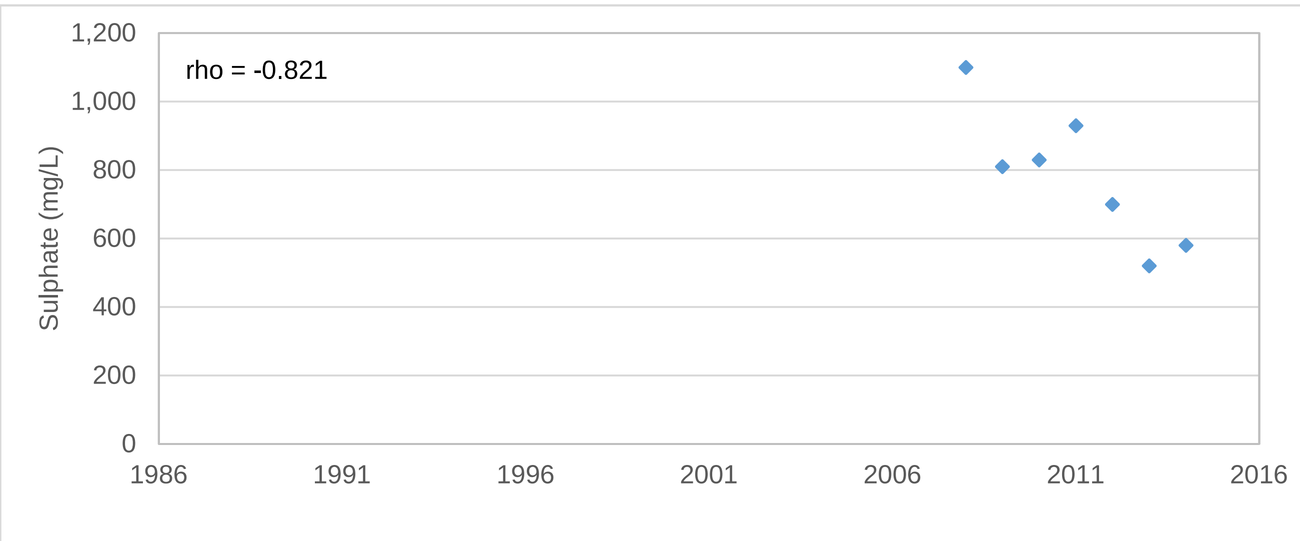


Appendix Figure C.1.2: Significant common (average) trends observed for radium-226 and uranium over all seasons at Station D-22, 2003 to 2014.

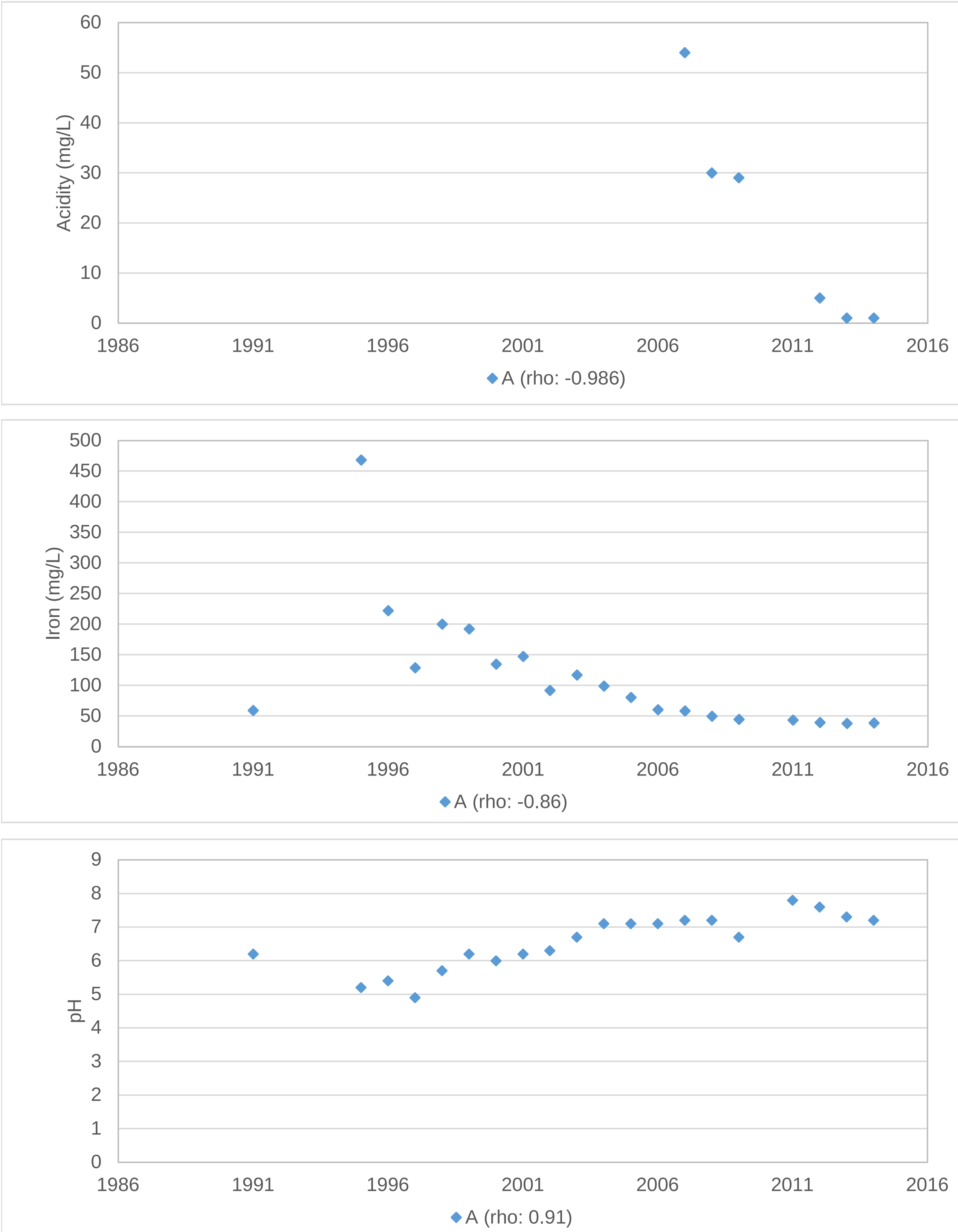


Appendix Figure C.1.3: Significant trends observed for acidity, iron and sulphate at station BH91-D9A, 1991 to 2014.

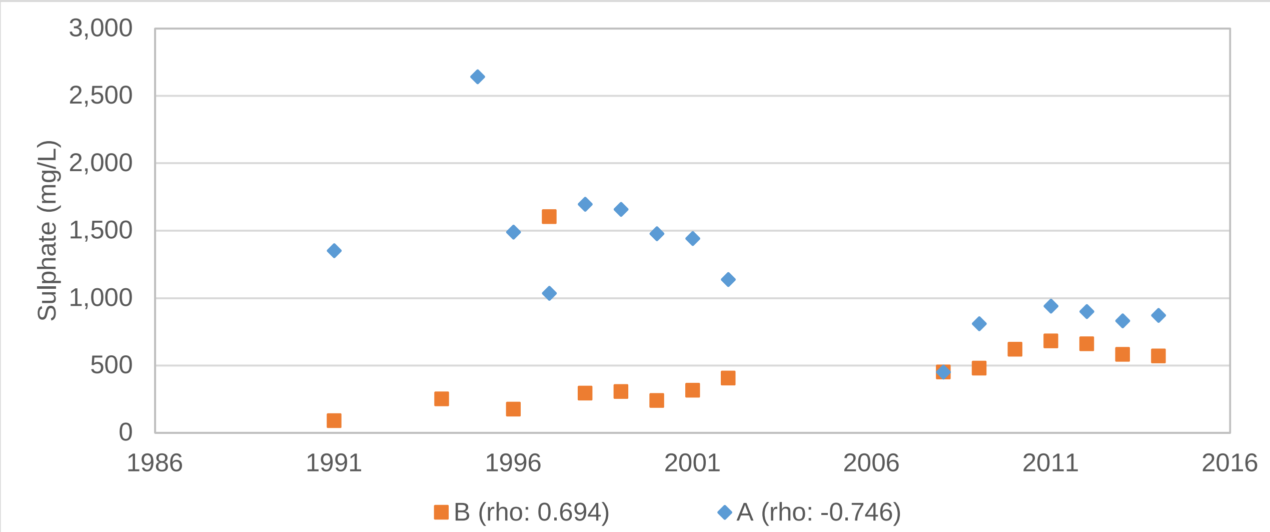




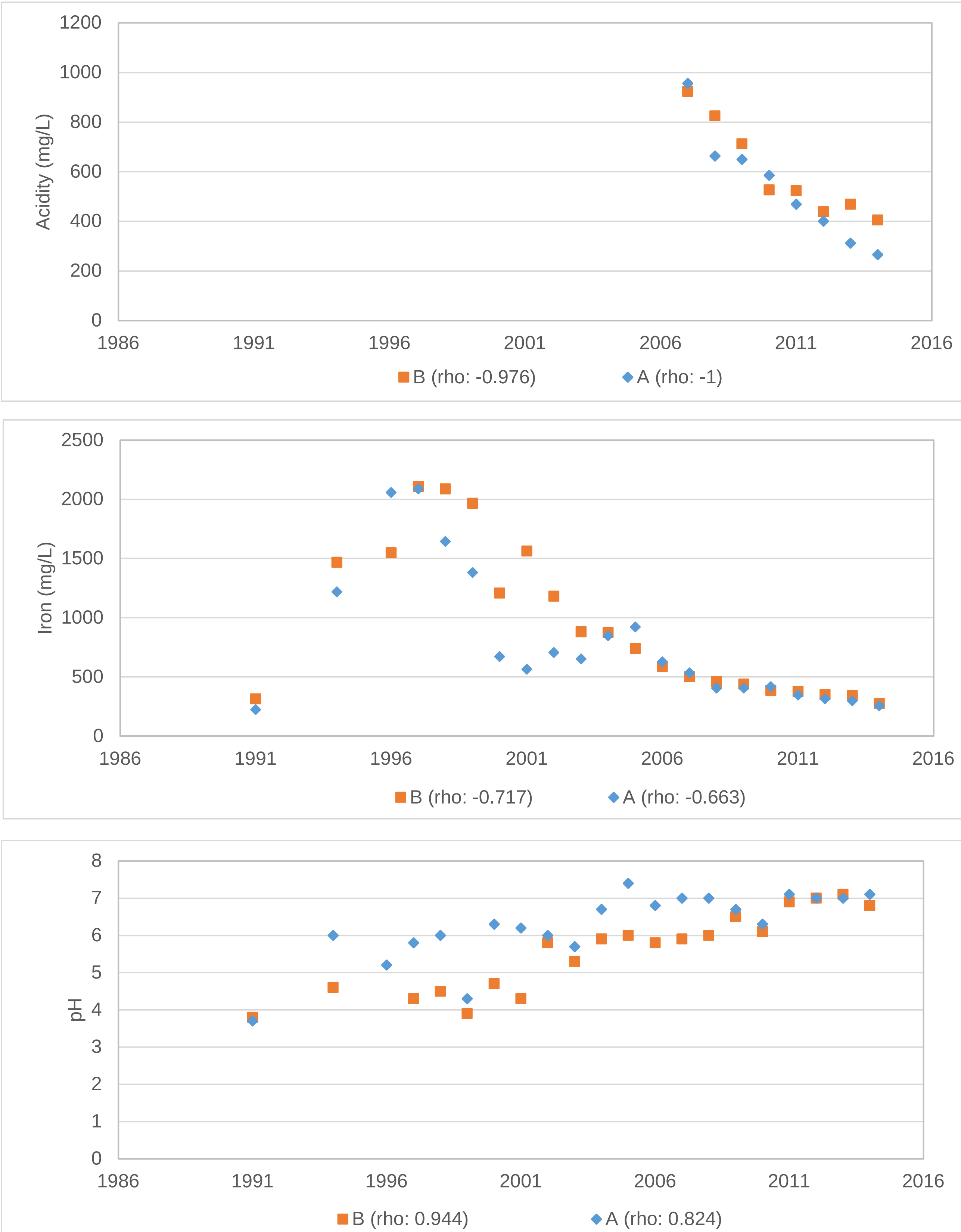
Appendix Figure C.1.4: Significant trends observed for pH and sulphate at station BH91-DG4B, 1996 to 2014.



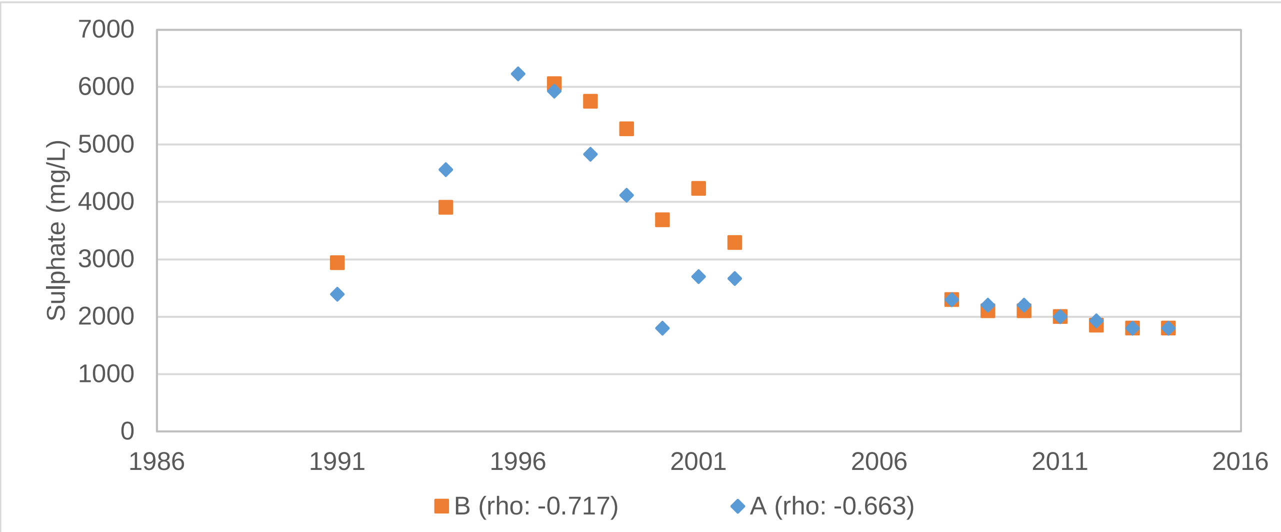
Appendix Figure C.1.5: Significant trends observed for acidity, iron, pH and sulphate at stations BH91-D1A,B, 1991 to 2014.



Appendix Figure C.1.5: Significant trends observed for acidity, iron, pH and sulphate at stations BH91-D1A,B, 1991 to 2014.



Appendix Figure C.1.6: Significant trends observed for acidity, iron, pH and sulphate at station BH91-D3A,B, 1991 to 2014.



Appendix Figure C.1.6: Significant trends observed for acidity, iron, pH and sulphate at station BH91-D3A,B, 1991 to 2014.

APPENDIX C.2
Spanish American TMA

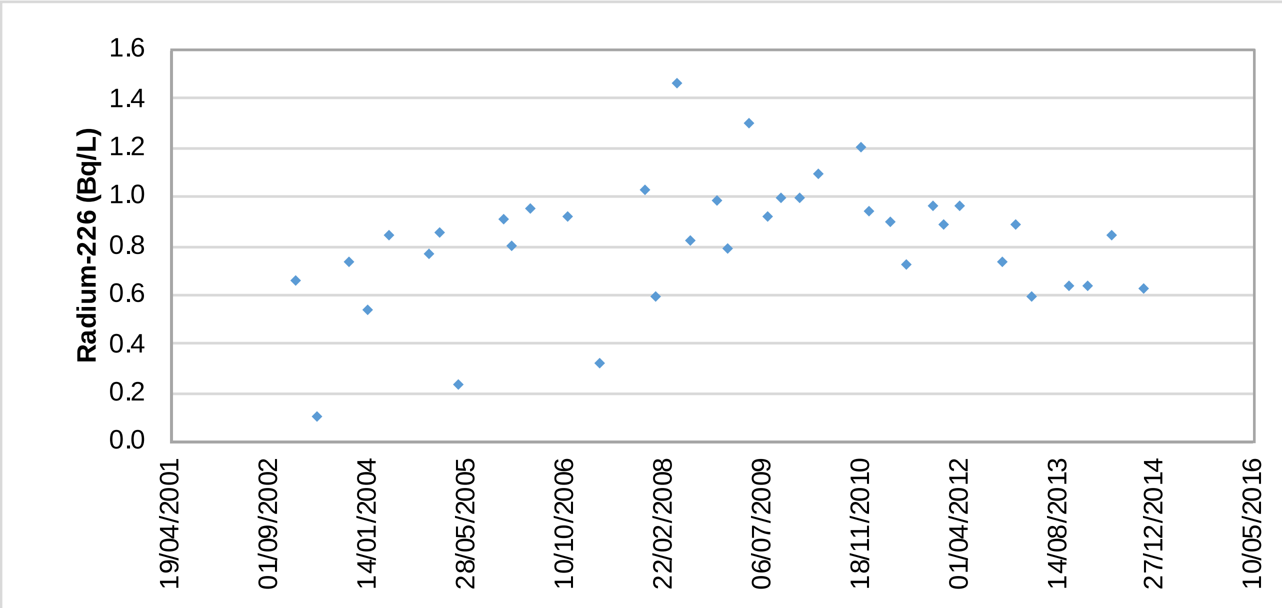
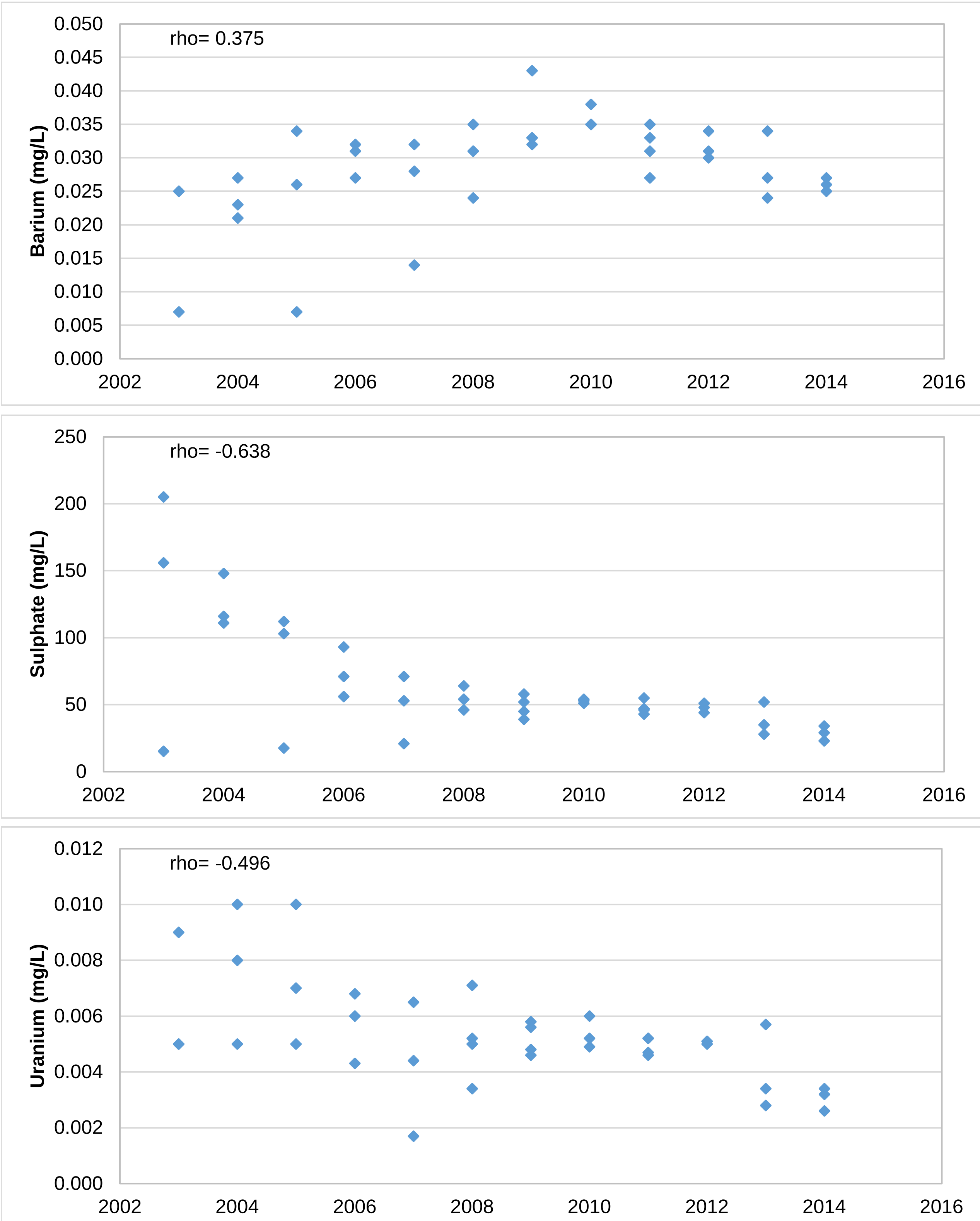


Figure C.2.1: Radium-226 concentrations at Spanish American TMA (ECA-128) from 2003 to 2014.



Appendix Figure C.2.2: Significant common (average) trends observed for barium, sulphat and uranium over all seasons at Station ECA-128, 2003 to 2014.

Appendix Table C.2.1: Water quality at station ECA-128 from 2010 to 2014.

Date m/d/yr	Acidity mg/L	Ba mg/L	Co mg/L	Fe mg/L	Mn mg/L	pH	Ra Bq/L	Sulphate mg/L	TSS mg/L	U mg/L
1/13/2010	< 1	0.035	< 0.0005	0.04	0.006	7.1	1	54		0.0060
4/15/2010	< 1	0.038	< 0.0005	0.08	0.044	7.5	1.1	51		0.0049
11/16/2010	< 1	0.035	< 0.0005	0.03	0.006	7.8	1.2	53		0.0052
1/6/2011	< 1	0.035	< 0.0005	< 0.02	0.004	7.4	0.94	55	2	0.0052
4/25/2011	< 1	0.031	< 0.0005	0.07	0.019	7.3	0.901	46	1	0.0046
7/7/2011	< 1	0.027	< 0.0005	0.06	0.015	8.5	0.728	43	1	0.0047
11/17/2011	< 1	0.033	< 0.0005	0.04	0.006	7.5	0.969	47	< 1	0.0052
1/16/2012	< 1	0.034	< 0.0005	< 0.02	0.003	7.5	0.891	51	< 1	0.0050
4/9/2012	< 1	0.031	0.0005	0.16	0.062	7.7	0.965	44	1	0.0051
11/13/2012	< 1	0.03	< 0.0005	0.03	0.005	7.7	0.741	48	1	0.0051
1/9/2013	< 1	0.034	< 0.0005	< 0.02	0.002	7.6	0.883	52	< 1	0.0057
4/11/2013	< 1	0.024	0.0007	0.18	0.059	7.1	0.598	28	< 1	0.0028
10/9/2013	< 1	0.027	< 0.0005	0.04	0.012	7.4	0.635	35	< 1	0.0034
1/15/2014	< 1	0.026	< 0.0005	0.04	0.005	7.6	0.637	34	< 1	0.0034
5/15/2014	< 1	0.027	< 0.0005	0.19	0.08	7.1	0.847	23	1	0.0026
10/28/2014	< 1	0.025	< 0.0005	0.05	0.009	7.5	0.627	29	1	0.0032
Number	16	16	16	16	16	16	16	16	13	16
Minimum	< 1	0.024	0.0005	< 0.02	0.002	7.1	0.598	23	1	0.0026
Maximum	< 1	0.038	0.0007	0.19	0.080	8.5	1.200	55	2	0.0060
Mean	< 1	0.031	< 0.0005	0.07	0.021	7.5	0.854	43.3	< 1.1	0.0045
Median	< 1	0.031	0.0005	0.04	0.008	7.5	0.887	46.5	1	0.0050
10th Percentile	< 1	0.0255	0.0005	0.02	0.0035	7.1	0.631	28.5	1	0.0030
95th Percentile	1	0.0358	0.00055	0.183	0.0665	7.975	1.125	54.25	1.4	0.0058

Appendix Table C.2.2: Summary of seasonal trends for station ECA-128 from 2003-2014.

Month	Spearman's rho	Acidity	Ba	Co	Fe	Mn	pH	Ra	Sulphate	TSS	U
January	Correlation Coefficient	-	0.599	0.552	-0.349	-0.579	0.384	0.445	-0.818		-0.684
	Sig. (2-tailed)	-	0.040	0.063	0.266	0.049	0.217	0.147	0.001		0.014
	N	5	12	12	12	12	12	12	12		12
April	Correlation Coefficient		0.634	0.217	0.049	0.055	0.146	0.491	0.067		-0.322
	Sig. (2-tailed)		0.049	0.546	0.894	0.881	0.687	0.15	0.855		0.364
	N		10	10	10	10	10	10	10		10
October	Correlation Coefficient		-0.103	0.866	-0.447	0.1	-0.6	-0.6	-1		-0.9
	Sig. (2-tailed)		0.87	0.058	0.45	0.873	0.285	0.285	0.000		0.037
	N		5	5	5	5	5	5	5		5
November	Correlation Coefficient		0.143	0.866	-0.789	-0.126	-0.036	0	-0.964		-0.126
	Sig. (2-tailed)		0.76	0.012	0.035	0.788	0.939	1	0.000		0.788
	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).

Significant trend where p<0.05.

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 2010 to 2014.

Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH
1/4/2010	8.7	1/4/2011	7.4	1/9/2012	8.5	1/7/2013	8.5	1/6/2014	9.0
1/11/2010	8.4	1/10/2011	8.7	1/16/2012	8.7	1/14/2013	8.0	1/13/2014	9.1
1/18/2010	8.5	1/17/2011	8.8	1/23/2012	8.7	1/21/2013	9.2	1/20/2014	9.1
1/25/2010	8.6	1/24/2011	8.6	1/30/2012	8.0	1/28/2013	8.7	1/27/2014	9.1
2/1/2010	8.7	1/31/2011	8.2	2/6/2012	8.1	2/4/2013	8.6	2/3/2014	9.0
2/8/2010	8.7	2/7/2011	8.1	2/13/2012	8.6	2/11/2013	8.8	2/10/2014	8.7
2/16/2010	8.7	2/14/2011	8.4	2/21/2012	8.6	2/19/2013	8.8	2/19/2014	9.2
2/22/2010	8.6	2/22/2011	8.4	2/27/2012	8.8	2/25/2013	8.1	2/24/2014	9.3
3/1/2010	8.5	2/28/2011	8.5	3/5/2012	8.3	3/4/2013	8.4	3/3/2014	9.4
3/8/2010	8.6	3/7/2011	7.8	3/12/2012	7.7	3/11/2013	8.5	3/10/2014	9.4
3/15/2010	8.5	3/14/2011	8.1	3/19/2012	8.0	3/18/2013	8.2	3/17/2014	9.2
3/22/2010	8.6	3/21/2011	8.7	3/27/2012	8.3	3/25/2013	8.3	3/24/2014	9.1
3/29/2010	8.5	3/28/2011	8.7	4/2/2012	8.6	4/1/2013	7.6	3/31/2014	8.8
4/5/2010	8.0	4/4/2011	8.4	4/9/2012	8.6	4/8/2013	8.7	4/7/2014	9.1
4/12/2010	8.0	4/11/2011	8.4	4/16/2012	8.7	4/15/2013	8.8	4/14/2014	8.2
4/19/2010	8.4	4/18/2011	7.6	4/23/2012	8.6	4/22/2013	8.6	4/21/2014	9.0
4/26/2010	8.4	4/25/2011	8.2	4/30/2012	8.7	4/29/2013	8.1	4/28/2014	9.0
5/3/2010	8.6	5/2/2011	7.2	5/7/2012	8.7	5/6/2013	8.8	5/5/2014	8.4
5/10/2010	8.6	5/9/2011	8.7	5/14/2012	8.4	5/13/2013	8.4	5/12/2014	7.7
5/17/2010	8.7	5/16/2011	8.5	5/22/2012	8.6	5/21/2013	8.6	5/20/2014	8.4
5/25/2010	8.3	5/24/2011	8.8	5/28/2012	8.3	5/27/2013	8.4	5/26/2014	8.5
5/31/2010	8.4	5/30/2011	8.5	6/4/2012	8.4	6/3/2013	8.5	6/2/2014	8.6
6/7/2010	8.5	6/6/2011	8.4	6/12/2012	8.5	6/10/2013	8.6	6/9/2014	8.6
6/14/2010	8.3	6/13/2011	8.4	6/18/2012	8.6	6/17/2013	9.1	6/16/2014	8.8
6/21/2010	8.4	6/20/2011	8.5	6/25/2012	8.5	6/24/2013	7.4	6/23/2014	9.0
6/28/2010	8.5	6/27/2011	8.5	7/3/2012	8.3	7/2/2013	8.6	7/1/2014	9.0
7/5/2010	8.3	7/4/2011	8.4	7/9/2012	8.5	7/8/2013	8.5	7/7/2014	8.7
7/12/2010	8.5	7/11/2011	8.4	7/16/2012	8.5	7/15/2013	8.5	7/14/2014	8.5
7/19/2010	8.6	7/18/2011	8.4	7/23/2012	8.5	7/22/2013	8.8	7/21/2014	8.1
7/26/2010	8.5	7/25/2011	8.5	7/30/2012	8.5	7/29/2013	8.8	7/28/2014	8.3
8/3/2010	8.6	8/2/2011	8.4	8/7/2012	8.4	8/6/2013	9.2	8/5/2014	8.5
8/9/2010	8.5	8/8/2011	8.5	8/13/2012	8.5	8/12/2013	8.7	8/11/2014	8.6
8/16/2010	8.4	8/15/2011	8.6	8/20/2012	8.5	8/19/2013	9.3	8/18/2014	8.8
8/23/2010	8.4	8/22/2011	8.4	8/27/2012	8.6	8/26/2013	8.9	8/25/2014	8.9
8/30/2010	8.4	8/29/2011	8.3	9/4/2012	8.5	9/3/2013	9.2	9/2/2014	8.8
9/7/2010	8.6	9/6/2011	8.6	9/10/2012	8.5	9/9/2013	-	9/8/2014	8.6
9/13/2010	8.4	9/12/2011	8.7	9/17/2012	8.5	9/16/2013	-	9/15/2014	8.7
9/20/2010	8.5	9/19/2011	8.6	9/24/2012	8.4	9/23/2013	-	9/22/2014	8.7
9/27/2010	7.6	9/26/2011	8.7	10/1/2012	8.5	9/30/2013	7.5	9/30/2014	8.8
10/4/2010	8.6	10/3/2011	8.6	10/9/2012	8.2	10/7/2013	8.7	10/6/2014	8.6
10/13/2010	8.2	10/17/2011	8.2	10/15/2012	8.5	10/15/2013	9.1	10/16/2014	8.3
10/18/2010	8.6	10/24/2011	8.7	10/22/2012	8.7	10/21/2013	9.1	10/20/2014	8.3
10/25/2010	8.7	10/31/2011	8.8	10/29/2012	8.4	10/28/2013	9.2	10/27/2014	8.5
11/1/2010	8.0	11/7/2011	8.2	11/5/2012	8.5	11/4/2013	9.4	11/3/2014	8.7
11/8/2010	8.5	11/14/2011	8.6	11/12/2012	8.2	11/11/2013	9.8	11/10/2014	7.5
11/15/2010	8.2	11/21/2011	8.5	11/19/2012	8.9	11/18/2013	9.1	11/17/2014	8.4
11/22/2010	8.2	11/28/2011	9.0	11/26/2012	8.3	11/25/2013	8.7	11/24/2014	8.8
11/29/2010	9.2	12/5/2011	8.8	12/3/2012	8.7	12/2/2013	9.2	12/1/2014	8.8
12/6/2010	8.5	12/12/2011	8.6	12/10/2012	8.6	12/9/2013	9.8	12/8/2014	9.1
12/13/2010	8.7	12/19/2011	8.7	12/17/2012	8.7	12/16/2013	9.4	12/15/2014	8.9
12/20/2010	8.7	12/28/2011	8.5	12/28/2012	8.5	12/23/2013	9.1	12/22/2014	9.1
12/29/2010	8.8	1/3/2012	8.8	1/2/2013	8.6	1/2/2014	9.1	12/29/2014	9.0
count	**257.0**	**min**	**7.2**	**max**	**9.8**	**mean**	**8.6**	**median**	**8.6**

Appendix Table C.3.3: Water quality at station Q-04P from 2010 to 2014.

Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH
1/4/2010	9.3	3/18/2010	9.7	6/2/2010	10.2	8/17/2010	9.3	11/1/2010	9.6	1/17/2011	9.5
1/5/2010	9.2	3/19/2010	9.7	6/3/2010	10.3	8/18/2010	9.4	11/2/2010	9.6	1/18/2011	9.2
1/6/2010	9.2	3/22/2010	9.7	6/4/2010	10.3	8/19/2010	9.4	11/3/2010	9.6	1/19/2011	9.3
1/7/2010	9.2	3/23/2010	9.8	6/7/2010	10.3	8/20/2010	9.5	11/4/2010	9.9	1/20/2011	9.4
1/8/2010	9.1	3/24/2010	9.8	6/8/2010	10.5	8/23/2010	9.3	11/5/2010	9.6	1/21/2011	9.3
1/11/2010	9.3	3/25/2010	10.1	6/9/2010	10.6	8/24/2010	9.2	11/8/2010	9.6	1/24/2011	9.3
1/12/2010	9.3	3/26/2010	10.4	6/10/2010	10.6	8/25/2010	9.5	11/9/2010	9.7	1/25/2011	9.2
1/13/2010	9.3	3/29/2010	10.4	6/11/2010	10.6	8/26/2010	9.5	11/10/2010	9.6	1/26/2011	9.3
1/14/2010	9.3	3/30/2010	10.4	6/14/2010	10.4	8/27/2010	9.5	11/11/2010	9.5	1/27/2011	9.3
1/15/2010	9.3	3/31/2010	10.4	6/15/2010	10.4	8/30/2010	9.6	11/12/2010	9.4	1/28/2011	9.1
1/18/2010	9.3	4/1/2010	10.4	6/16/2010	10.4	8/31/2010	9.6	11/15/2010	9.4	1/31/2011	9.2
1/19/2010	9.2	4/5/2010	10.4	6/17/2010	10.5	9/1/2010	9.5	11/16/2010	9.6	2/1/2011	9.3
1/20/2010	9.3	4/6/2010	10.5	6/18/2010	10.4	9/2/2010	9.6	11/17/2010	9.5	2/2/2011	9.2
1/21/2010	9.2	4/7/2010	10.4	6/21/2010	10.5	9/3/2010	9.6	11/18/2010	9.4	2/3/2011	9.3
1/22/2010	9.4	4/8/2010	10.7	6/22/2010	10.4	9/7/2010	9.6	11/19/2010	9.4	2/4/2011	9.1
1/25/2010	9.3	4/9/2010	10.7	6/23/2010	10.4	9/8/2010	10.8	11/22/2010	9.7	2/7/2011	9.2
1/26/2010	9.3	4/12/2010	10.3	6/24/2010	9.9	9/9/2010	10.7	11/23/2010	9.8	2/8/2011	9.1
1/27/2010	9.3	4/13/2010	10.5	6/25/2010	10.3	9/10/2010	10.6	11/24/2010	9.8	2/9/2011	9.2
1/28/2010	9.3	4/14/2010	10.4	6/28/2010	9.9	9/13/2010	10.6	11/25/2010	9.8	2/10/2011	9.2
1/29/2010	9.3	4/15/2010	10.3	6/29/2010	9.9	9/14/2010	10.6	11/26/2010	9.8	2/11/2011	9.2
2/1/2010	9.4	4/16/2010	9.8	6/30/2010	9.8	9/15/2010	10.8	11/29/2010	9.8	2/14/2011	9.1
2/2/2010	9.4	4/19/2010	9.8	7/1/2010	9.9	9/16/2010	10.7	11/30/2010	9.3	2/15/2011	9.1
2/3/2010	9.3	4/20/2010	9.7	7/5/2010	9.7	9/17/2010	10.7	12/1/2010	9.3	2/16/2011	9
2/4/2010	9.3	4/21/2010	9.9	7/6/2010	10.3	9/20/2010	10.7	12/2/2010	9.3	2/17/2011	9
2/5/2010	9.3	4/22/2010	9.9	7/7/2010	10.3	9/21/2010	10.7	12/3/2010	9.1	2/18/2011	9
2/8/2010	9.3	4/23/2010	9.9	7/8/2010	10.3	9/22/2010	10.6	12/6/2010	9.3	2/22/2011	9
2/9/2010	9.3	4/26/2010	9.9	7/9/2010	10.1	9/23/2010	10.6	12/7/2010	9.2	2/23/2011	9
2/10/2010	9.3	4/27/2010	9.9	7/12/2010	10.3	9/24/2010	10.6	12/8/2010	9.4	2/24/2011	9.1
2/11/2010	9.3	4/28/2010	9.9	7/13/2010	10.3	9/27/2010	10.6	12/9/2010	9.3	2/25/2011	9.1
2/12/2010	9.3	4/29/2010	9.9	7/14/2010	10.2	9/28/2010	10.7	12/10/2010	9.1	2/28/2011	9
2/16/2010	9.3	4/30/2010	9.9	7/15/2010	10.1	9/29/2010	10.8	12/13/2010	9.4	3/1/2011	9.2
2/17/2010	9.3	5/3/2010	9.9	7/16/2010	10.3	9/30/2010	10.7	12/14/2010	9.1	3/2/2011	9.2
2/18/2010	9.2	5/4/2010	9.9	7/19/2010	10.4	10/1/2010	10.8	12/15/2010	9.2	3/3/2011	9.2
2/19/2010	9.2	5/5/2010	9.9	7/20/2010	10.2	10/4/2010	10.6	12/16/2010	9.0	3/4/2011	8.9
2/22/2010	9.2	5/6/2010	10.0	7/21/2010	10.3	10/5/2010	10.0	12/17/2010	9.2	3/7/2011	9.1
2/23/2010	9.3	5/7/2010	10.0	7/22/2010	10.2	10/6/2010	10.2	12/20/2010	9.2	3/8/2011	9.2
2/24/2010	9.3	5/10/2010	9.9	7/23/2010	10.4	10/7/2010	9.9	12/21/2010	9.2	3/9/2011	9.1
2/25/2010	9.3	5/11/2010	9.9	7/26/2010	10.1	10/8/2010	9.9	12/22/2010	9.4	3/10/2011	9.1
2/26/2010	9.3	5/12/2010	9.9	7/27/2010	9.4	10/12/2010	10.0	12/23/2010	9.2	3/11/2011	9
3/1/2010	9.3	5/13/2010	9.8	7/28/2010	9.7	10/13/2010	9.9	12/24/2010	9.5	3/14/2011	9
3/2/2010	9.3	5/14/2010	9.9	7/29/2010	9.8	10/14/2010	10.0	12/29/2010	9.3	3/15/2011	9.1
3/3/2010	9.2	5/17/2010	9.7	7/30/2010	9.6	10/15/2010	9.8	12/30/2010	9.1	3/16/2011	9.3
3/4/2010	9.2	5/18/2010	10.1	8/3/2010	9.6	10/18/2010	9.8	12/31/2010	9.2	3/17/2011	9.1
3/5/2010	9.1	5/19/2010	10.0	8/4/2010	9.2	10/19/2010	9.7	1/4/2011	9.1	3/18/2011	9.1
3/8/2010	9.1	5/20/2010	10.0	8/5/2010	9.4	10/20/2010	9.6	1/5/2011	9.2	3/21/2011	9.3
3/9/2010	9.2	5/21/2010	10.2	8/6/2010	9.3	10/21/2010	9.6	1/6/2011	9.1	3/22/2011	9.2
3/10/2010	9.1	5/25/2010	10.2	8/9/2010	9.4	10/22/2010	10.5	1/7/2011	9.3	3/23/2011	9.2
3/11/2010	9.1	5/26/2010	10.3	8/10/2010	9.4	10/25/2010	10.6	1/10/2011	9.3	3/24/2011	9.2
3/12/2010	9.1	5/27/2010	10.2	8/11/2010	9.4	10/26/2010	10.2	1/11/2011	9.8	3/25/2011	9.2
3/15/2010	9.1	5/28/2010	10.2	8/12/2010	9.3	10/27/2010	10.2	1/12/2011	9.8	3/28/2011	9.3
3/16/2010	9.9	5/31/2010	10.0	8/13/2010	9.3	10/28/2010	9.7	1/13/2011	9.8	3/29/2011	9.3
3/17/2010	9.7	6/1/2010	10.2	8/16/2010	9.4	10/29/2010	9.5	1/14/2011	9.8	3/30/2011	9.4

Appendix Table C.3.3: Water quality at station Q-04P from 2010 to 2014.

Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH
3/31/2011	9.2	6/20/2011	9.7	9/8/2011	10.4	11/25/2011	9.7	2/15/2012	9.2	5/4/2012	10
4/1/2011	9.2	6/21/2011	10.1	9/9/2011	10.3	11/28/2011	9.9	2/16/2012	9.2	5/7/2012	9.8
4/4/2011	9.3	6/22/2011	10.1	9/12/2011	10.4	11/29/2011	9.7	2/17/2012	9.2	5/8/2012	9.9
4/5/2011	9.2	6/23/2011	10.1	9/13/2011	10.7	11/30/2011	9.7	2/21/2012	9.2	5/9/2012	10
4/6/2011	9.3	6/24/2011	9.9	9/14/2011	10.5	12/1/2011	9.7	2/22/2012	9.1	5/10/2012	10.1
4/7/2011	9.3	6/27/2011	9.9	9/15/2011	10.4	12/2/2011	9.6	2/23/2012	9.2	5/11/2012	10.2
4/8/2011	9.4	6/28/2011	9.7	9/16/2011	9.9	12/5/2011	9.6	2/24/2012	9.2	5/14/2012	10.1
4/11/2011	9.2	6/29/2011	9.7	9/19/2011	10.4	12/6/2011	9.3	2/27/2012	9.3	5/15/2012	10
4/12/2011	9.2	6/30/2011	9.7	9/20/2011	10.4	12/7/2011	9.4	2/28/2012	9.4	5/16/2012	10.2
4/13/2011	9.3	7/4/2011	9.6	9/21/2011	10.4	12/8/2011	9.4	2/29/2012	9.2	5/17/2012	10.3
4/14/2011	9.5	7/5/2011	9.6	9/22/2011	10.4	12/9/2011	9.4	3/1/2012	9.2	5/18/2012	10.5
4/15/2011	9.5	7/6/2011	9.7	9/23/2011	10.4	12/12/2011	9.3	3/2/2012	9.2	5/22/2012	10.5
4/18/2011	9.5	7/7/2011	9.7	9/26/2011	10.5	12/13/2011	9.3	3/5/2012	9.2	5/23/2012	10.3
4/19/2011	9.7	7/8/2011	9.7	9/27/2011	10.5	12/14/2011	9.5	3/6/2012	9.0	5/24/2012	10.3
4/20/2011	9.4	7/11/2011	9.6	9/28/2011	10.0	12/15/2011	9.5	3/7/2012	9.1	5/25/2012	10.3
4/21/2011	9.4	7/12/2011	9.8	9/29/2011	10.0	12/16/2011	9.5	3/8/2012	9.1	5/28/2012	10.3
4/25/2011	9.1	7/13/2011	9.6	9/30/2011	9.8	12/19/2011	9.6	3/9/2012	9.1	5/29/2012	10.4
4/26/2011	9.0	7/14/2011	9.8	10/3/2011	10.0	12/20/2011	9.5	3/12/2012	9.2	5/30/2012	10.4
4/27/2011	9.1	7/15/2011	9.8	10/4/2011	10.0	12/21/2011	9.4	3/13/2012	9.3	5/31/2012	10.4
4/28/2011	9.0	7/18/2011	10.0	10/5/2011	9.9	12/22/2011	9.4	3/14/2012	9.2	6/1/2012	10.4
4/29/2011	8.9	7/19/2011	10.0	10/6/2011	9.8	12/23/2011	9.4	3/15/2012	9.5	6/4/2012	10.4
5/2/2011	9.0	7/20/2011	10.0	10/7/2011	9.8	12/28/2011	9.4	3/16/2012	9.6	6/5/2012	10.5
5/3/2011	9.0	7/21/2011	9.9	10/11/2011	9.8	12/29/2011	9.4	3/19/2012	9.4	6/6/2012	10.4
5/4/2011	9.1	7/22/2011	10.1	10/12/2011	9.8	12/30/2011	9.4	3/20/2012	9.4	6/7/2012	10.5
5/5/2011	9.3	7/25/2011	10.2	10/13/2011	10.0	1/3/2012	9.4	3/21/2012	9.4	6/8/2012	10.5
5/6/2011	9.3	7/26/2011	10.2	10/14/2011	9.9	1/4/2012	9.2	3/22/2012	9.1	6/11/2012	10.5
5/9/2011	9.2	7/27/2011	10.2	10/17/2011	9.8	1/5/2012	9.3	3/23/2012	8.9	6/12/2012	10.6
5/10/2011	9.3	7/28/2011	10.2	10/18/2011	9.9	1/6/2012	9.2	3/26/2012	9.3	6/13/2012	10.4
5/11/2011	9.4	7/29/2011	10.4	10/19/2011	9.9	1/9/2012	9.3	3/27/2012	9.5	6/14/2012	10.5
5/12/2011	9.4	8/2/2011	10.4	10/20/2011	9.9	1/10/2012	9.3	3/28/2012	9.6	6/15/2012	10.4
5/13/2011	9.3	8/3/2011	10.6	10/21/2011	10.0	1/11/2012	9.4	3/29/2012	9.5	6/18/2012	10.4
5/16/2011	9.3	8/4/2011	10.6	10/24/2011	9.9	1/12/2012	9.4	3/30/2012	9.8	6/19/2012	10.4
5/17/2011	9.3	8/5/2011	10.4	10/25/2011	9.7	1/13/2012	9.3	4/2/2012	9.6	6/20/2012	10.5
5/18/2011	9.4	8/8/2011	10.7	10/26/2011	9.7	1/16/2012	9.3	4/3/2012	9.7	6/21/2012	10.4
5/19/2011	9.3	8/9/2011	10.7	10/27/2011	9.6	1/17/2012	9.3	4/4/2012	9.7	6/22/2012	10.2
5/20/2011	9.4	8/10/2011	10.7	10/28/2011	9.7	1/18/2012	9.3	4/5/2012	9.8	6/25/2012	10.2
5/24/2011	9.5	8/11/2011	10.8	10/31/2011	9.7	1/19/2012	9.3	4/9/2012	9.8	6/26/2012	9.7
5/25/2011	9.5	8/12/2011	10.7	11/1/2011	9.6	1/20/2012	9.3	4/10/2012	9.8	6/27/2012	9.7
5/26/2011	9.4	8/15/2011	10.8	11/2/2011	9.7	1/23/2012	9.3	4/11/2012	9.7	6/28/2012	9.7
5/27/2011	9.5	8/16/2011	10.7	11/3/2011	9.7	1/24/2012	9.3	4/12/2012	9.8	6/29/2012	9.7
5/30/2011	9.5	8/17/2011	10.4	11/4/2011	9.6	1/25/2012	9.3	4/13/2012	9.8	7/3/2012	9.8
5/31/2011	9.4	8/18/2011	10.4	11/7/2011	9.6	1/26/2012	9.3	4/16/2012	9.8	7/4/2012	9.7
6/1/2011	9.8	8/19/2011	10.4	11/8/2011	9.4	1/27/2012	9.3	4/17/2012	10.0	7/5/2012	10.2
6/2/2011	9.8	8/22/2011	10.4	11/9/2011	9.7	1/30/2012	9.2	4/18/2012	10.0	7/6/2012	10.2
6/3/2011	10.2	8/23/2011	10.3	11/10/2011	9.6	1/31/2012	9.2	4/19/2012	10.0	7/9/2012	10.2
6/6/2011	9.4	8/24/2011	10.3	11/11/2011	9.8	2/1/2012	9.1	4/20/2012	10.0	7/10/2012	10.2
6/7/2011	9.5	8/25/2011	10.5	11/14/2011	9.7	2/2/2012	9.3	4/23/2012	10.0	7/11/2012	10.1
6/8/2011	9.4	8/26/2011	10.6	11/15/2011	9.9	2/3/2012	9.2	4/24/2012	9.9	7/12/2012	10.2
6/9/2011	9.5	8/29/2011	10.6	11/16/2011	9.9	2/6/2012	9.2	4/25/2012	10.0	7/13/2012	10.2
6/10/2011	9.5	8/30/2011	10.5	11/17/2011	9.8	2/7/2012	9.1	4/26/2012	9.8	7/16/2012	10.3
6/13/2011	9.4	8/31/2011	10.2	11/18/2011	9.9	2/8/2012	9.2	4/27/2012	9.8	7/17/2012	10.3
6/14/2011	9.7	9/1/2011	9.9	11/21/2011	9.8	2/9/2012	9.2	4/30/2012	9.9	7/18/2012	10.3
6/15/2011	9.6	9/2/2011	10.2	11/22/2011	9.8	2/10/2012	9.3	5/1/2012	9.9	7/19/2012	10.2
6/16/2011	9.7	9/6/2011	10.2	11/23/2011	9.9	2/13/2012	9.3	5/2/2012	9.9	7/20/2012	10.2
6/17/2011	9.7	9/7/2011	10.3	11/24/2011	9.6	2/14/2012	9.1	5/3/2012	10.1	7/23/2012	10.2

Appendix Table C.3.3: Water quality at station Q-04P from 2010 to 2014.

Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH
7/24/2012	10.2	10/12/2012	10.3	1/2/2013	9.3	3/21/2013	9.2	6/10/2013	9.5	8/28/2013	10
7/25/2012	10.3	10/15/2012	10.4	1/3/2013	9.3	3/22/2013	9.1	6/11/2013	10.1	8/29/2013	10
7/26/2012	10.3	10/16/2012	10.2	1/4/2013	9.3	3/25/2013	9.1	6/12/2013	10.1	8/30/2013	9.9
7/27/2012	10.3	10/17/2012	10.2	1/7/2013	9.2	3/26/2013	9.0	6/13/2013	10.2	9/3/2013	9.9
7/30/2012	10.4	10/18/2012	10.1	1/8/2013	9.2	3/27/2013	9.2	6/14/2013	10.2	9/4/2013	9.9
7/31/2012	10.4	10/19/2012	10.1	1/9/2013	9.3	3/28/2013	9.2	6/17/2013	10.2	9/5/2013	9.9
8/1/2012	10.4	10/22/2012	10.2	1/10/2013	9.5	4/1/2013	9.2	6/18/2013		9/6/2013	9.8
8/2/2012	10.4	10/23/2012	9.9	1/11/2013	9.3	4/2/2013	9.3	6/19/2013		9/9/2013	
8/3/2012	10.4	10/24/2012	9.5	1/14/2013	9.4	4/3/2013	9.3	6/20/2013		9/10/2013	
8/7/2012	10.5	10/25/2012	9.5	1/15/2013	9.3	4/4/2013	9.2	6/21/2013		9/11/2013	
8/8/2012	10.5	10/26/2012	9.5	1/16/2013	9.6	4/5/2013	9.3	6/24/2013	10.5	9/12/2013	
8/9/2012	10.5	10/29/2012	9.7	1/17/2013	9.4	4/8/2013	9.3	6/25/2013	10.5	9/13/2013	
8/10/2012	10.5	10/30/2012	9.5	1/18/2013	9.3	4/9/2013	9.3	6/26/2013	10.5	9/16/2013	
8/13/2012	10.6	10/31/2012	9.7	1/21/2013	9.6	4/10/2013	9.3	6/27/2013	10.1	9/17/2013	
8/14/2012	10.6	11/1/2012	9.6	1/22/2013	9.2	4/11/2013	9.2	6/28/2013	9.8	9/18/2013	
8/15/2012	10.6	11/2/2012	9.7	1/23/2013	9.2	4/12/2013	9.2	7/2/2013	9.7	9/19/2013	10.8
8/16/2012	10.6	11/5/2012	9.7	1/24/2013	9.2	4/15/2013	9.3	7/3/2013	9.3	9/20/2013	10.7
8/17/2012	10.6	11/6/2012	9.7	1/25/2013	9.2	4/16/2013	9.3	7/4/2013	9.2	9/23/2013	10.7
8/20/2012	10.6	11/7/2012	9.7	1/28/2013	9.3	4/17/2013	9.2	7/5/2013	9.3	9/24/2013	10.6
8/21/2012	10.6	11/8/2012	9.7	1/29/2013	9.3	4/18/2013	9.3	7/8/2013	9.3	9/25/2013	10
8/22/2012	10.6	11/9/2012	9.6	1/30/2013	9.3	4/19/2013	9.1	7/9/2013	9.3	9/26/2013	10
8/23/2012	10.6	11/12/2012	9.8	1/31/2013	9.3	4/22/2013	9.3	7/10/2013	9.3	9/27/2013	9.6
8/24/2012	10.6	11/13/2012	9.8	2/1/2013	9.4	4/23/2013	9.3	7/11/2013	9.2	9/30/2013	9.3
8/27/2012	10.6	11/14/2012	10.1	2/4/2013	9.4	4/24/2013	9.3	7/12/2013	9.2	10/1/2013	9.2
8/28/2012	10.6	11/15/2012	10.0	2/5/2013	9.4	4/25/2013	9.3	7/15/2013	9.3	10/2/2013	10.5
8/29/2012	10.6	11/16/2012	9.9	2/6/2013	9.1	4/26/2013	9.3	7/16/2013	9.5	10/3/2013	10.6
8/30/2012	10.5	11/19/2012	10.0	2/7/2013	9.3	4/29/2013	9.1	7/17/2013	9.5	10/4/2013	10.5
8/31/2012	10.6	11/20/2012	9.9	2/8/2013	9.3	4/30/2013	9.1	7/18/2013	9.4	10/7/2013	10.5
9/4/2012	10.4	11/21/2012	9.7	2/11/2013	9.2	5/1/2013	9.1	7/19/2013	9.6	10/8/2013	10.5
9/5/2012	10.5	11/22/2012	9.7	2/12/2013	9.2	5/2/2013	9.2	7/22/2013	9.5	10/9/2013	9.9
9/6/2012	10.5	11/23/2012	9.7	2/13/2013	9.3	5/3/2013	9.4	7/23/2013	9.8	10/10/2013	9.8
9/7/2012	10.5	11/26/2012	9.7	2/14/2013	9.2	5/6/2013	9.3	7/24/2013	9.7	10/11/2013	9.8
9/10/2012	10.6	11/27/2012	9.7	2/15/2013	9.2	5/7/2013	9.3	7/25/2013	9.9	10/15/2013	9.6
9/11/2012	10.6	11/28/2012	9.5	2/19/2013	9.2	5/8/2013	9.4	7/26/2013	9.9	10/16/2013	9.6
9/12/2012	10.2	11/29/2012	9.4	2/20/2013	9.0	5/9/2013	9.7	7/29/2013	10.0	10/17/2013	9.6
9/13/2012	10.2	11/30/2012	9.4	2/21/2013	9.1	5/10/2013	9.7	7/30/2013	10.0	10/18/2013	9.6
9/14/2012	10.3	12/3/2012	9.3	2/22/2013	9.0	5/13/2013	9.5	7/31/2013	9.8	10/21/2013	9.7
9/17/2012	10.3	12/4/2012	9.0	2/25/2013	9.0	5/14/2013	9.6	8/1/2013	9.7	10/22/2013	9.8
9/18/2012	10.2	12/5/2012	9.1	2/26/2013	9.1	5/15/2013	9.7	8/2/2013	9.8	10/23/2013	9.7
9/19/2012	10.3	12/6/2012	9.2	2/27/2013	9.2	5/16/2013	9.8	8/6/2013	9.7	10/24/2013	9.8
9/20/2012	10.3	12/7/2012	9.5	2/28/2013	9.1	5/17/2013	9.7	8/7/2013	9.1	10/25/2013	9.8
9/21/2012	10.3	12/10/2012	9.5	3/1/2013	9.1	5/21/2013	9.7	8/8/2013	9.2	10/28/2013	9.9
9/24/2012	10.3	12/11/2012	9.4	3/4/2013	9.2	5/22/2013	9.6	8/9/2013	9.2	10/29/2013	9.9
9/25/2012	10.3	12/12/2012	9.4	3/5/2013	9.1	5/23/2013	9.6	8/12/2013	9.3	10/30/2013	9.9
9/26/2012	10.4	12/13/2012	9.3	3/6/2013	9.1	5/24/2013	9.4	8/13/2013	9.2	10/31/2013	9.9
9/27/2012	10.2	12/14/2012	9.4	3/7/2013	8.9	5/27/2013	9.5	8/14/2013	9.5	11/1/2013	10.8
9/28/2012	10.1	12/17/2012	9.5	3/8/2013	9.2	5/28/2013	9.6	8/15/2013	10.4	11/4/2013	10.9
10/1/2012	10.2	12/18/2012	9.4	3/11/2013	9.3	5/29/2013	9.5	8/16/2013	10.4	11/5/2013	11.4
10/2/2012	10.2	12/19/2012	9.2	3/12/2013	9.2	5/30/2013	9.5	8/19/2013	10.4	11/6/2013	11.4
10/3/2012	10.1	12/20/2012	9.2	3/13/2013	9.2	5/31/2013	9.4	8/20/2013	10.0	11/7/2013	11.4
10/4/2012	10.0	12/21/2012	9.3	3/14/2013	9.3	6/3/2013	9.5	8/21/2013	10.0	11/8/2013	11.4
10/5/2012	9.9	12/24/2012	9.3	3/15/2013	9.4	6/4/2013	9.4	8/22/2013	10.0	11/11/2013	10.9
10/9/2012	10.1	12/27/2012	9.3	3/18/2013	9.1	6/5/2013	9.5	8/23/2013	10.0	11/12/2013	10.1
10/10/2012	10.3	12/28/2012	9.3	3/19/2013	9.2	6/6/2013	9.5	8/26/2013	10.0	11/13/2013	10.2
10/11/2012	10.3	12/31/2012	9.4	3/20/2013	9.2	6/7/2013	9.5	8/27/2013	10.0	11/14/2013	10.2

Appendix Table C.3.3: Water quality at station Q-04P from 2010 to 2014.

Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH
11/15/2013	10.3	2/5/2014	9.2	4/25/2014	9.4	7/15/2014	11.1	10/2/2014	9.9	12/19/2014	9.4
11/18/2013	10.2	2/6/2014	9.2	4/28/2014	9.3	7/16/2014	11.1	10/3/2014	9.9	12/22/2014	9.3
11/19/2013	8.8	2/7/2014	9.2	4/29/2014	9.3	7/17/2014	11.3	10/6/2014	9.7	12/23/2014	9.3
11/20/2013	8.7	2/10/2014	9.2	4/30/2014	9.3	7/18/2014	11.1	10/7/2014	9.9	12/24/2014	9.3
11/21/2013	8.7	2/11/2014	9.2	5/1/2014	9.1	7/21/2014	11.1	10/8/2014	9.7	12/29/2014	9.3
11/22/2013	8.8	2/12/2014	9.2	5/2/2014	9.1	7/22/2014	11.1	10/9/2014	9.8	12/30/2014	9.3
11/25/2013	8.7	2/13/2014	9.2	5/5/2014	9.0	7/23/2014	11.2	10/10/2014	9.8	12/31/2014	9.3
11/26/2013	9.2	2/14/2014	9.6	5/6/2014	9.0	7/24/2014	11.2	10/14/2014	9.7	**count**	**1242**
11/27/2013	9.5	2/18/2014	9.9	5/7/2014	8.9	7/25/2014	11.2	10/15/2014	9.7	**min**	**8.7**
11/28/2013	9.5	2/19/2014	9.8	5/8/2014	8.9	7/28/2014	11.2	10/16/2014	9.8	**max**	**11.4**
11/29/2013	9.6	2/20/2014	10.1	5/9/2014	9.0	7/29/2014	11.3	10/17/2014	9.1	**mean**	**9.71**
12/2/2013	9.4	2/21/2014	9.9	5/12/2014	8.9	7/30/2014	10.4	10/20/2014	9.7	**median**	**9.6**
12/3/2013	10.2	2/24/2014	9.8	5/13/2014	8.9	7/31/2014	10.4	10/21/2014	9.2		
12/4/2013	10.2	2/25/2014	9.9	5/14/2014	8.9	8/1/2014	10.5	10/22/2014	9.2		
12/5/2013	10.1	2/26/2014	9.8	5/15/2014	8.9	8/5/2014	10.4	10/23/2014	9.3		
12/6/2013	10.2	2/27/2014	9.6	5/16/2014	9.0	8/6/2014	10.4	10/24/2014	9.4		
12/9/2013	10.3	2/28/2014	9.6	5/20/2014	9.2	8/7/2014	10.4	10/27/2014	9.3		
12/10/2013	10.2	3/3/2014	9.4	5/21/2014	9.2	8/8/2014	10.4	10/28/2014	9.7		
12/11/2013	10.2	3/4/2014	9.4	5/22/2014	9.2	8/11/2014	10.1	10/29/2014	9.6		
12/12/2013	9.7	3/5/2014	9.3	5/23/2014	9.3	8/12/2014	10.0	10/30/2014	9.7		
12/13/2013	9.4	3/6/2014	9.4	5/26/2014	9.3	8/13/2014	10.1	10/31/2014	9.6		
12/16/2013	9.3	3/7/2014	9.5	5/27/2014	9.3	8/14/2014	10.1	11/3/2014	8.9		
12/17/2013	9.0	3/10/2014	9.4	5/28/2014	9.3	8/15/2014	10.1	11/4/2014	8.9		
12/18/2013	9.0	3/11/2014	9.3	5/29/2014	9.3	8/18/2014	10.2	11/5/2014	8.9		
12/19/2013	8.9	3/12/2014	9.3	5/30/2014	9.4	8/19/2014	10.1	11/6/2014	8.8		
12/20/2013	9.1	3/13/2014	9.3	6/2/2014	9.4	8/20/2014	10.2	11/7/2014	8.7		
12/23/2013	9.3	3/14/2014	9.4	6/3/2014	9.4	8/21/2014	10.2	11/10/2014	8.9		
12/24/2013	9.2	3/17/2014	9.4	6/4/2014	9.4	8/22/2014	10.1	11/11/2014	9.1		
12/27/2013	9.2	3/18/2014	9.2	6/5/2014	9.4	8/25/2014	10.1	11/12/2014	9.1		
12/30/2013	9.2	3/19/2014	9.1	6/6/2014	9.6	8/26/2014	10.0	11/13/2014	9.1		
12/31/2013	9.3	3/20/2014	9.2	6/9/2014	9.6	8/27/2014	10.0	11/14/2014	9.3		
1/2/2014	9.3	3/21/2014	9.2	6/10/2014	9.8	8/28/2014	10.0	11/17/2014	9.3		
1/3/2014	9.2	3/24/2014	9.2	6/11/2014	9.9	8/29/2014	10.1	11/18/2014	9.3		
1/6/2014	9.5	3/25/2014	9.2	6/12/2014	10.3	9/2/2014	9.9	11/19/2014	9.4		
1/7/2014	9.5	3/26/2014	9.2	6/13/2014	10.3	9/3/2014	10.0	11/20/2014	9.4		
1/8/2014	9.5	3/27/2014	9.2	6/16/2014	10.4	9/4/2014	10.1	11/21/2014	9.4		
1/9/2014	9.3	3/28/2014	9.2	6/17/2014	10.4	9/5/2014	10.0	11/24/2014	9.2		
1/10/2014	9.2	3/31/2014	9.3	6/18/2014	10.4	9/8/2014	10.0	11/25/2014	9.2		
1/13/2014	9.1	4/1/2014	9.2	6/19/2014	10.5	9/9/2014	10.0	11/26/2014	9.2		
1/14/2014	9.2	4/2/2014	9.2	6/20/2014	10.5	9/10/2014	10.0	11/27/2014	9.3		
1/15/2014	9.2	4/3/2014	9.2	6/23/2014	10.5	9/11/2014	9.7	11/28/2014	9.4		
1/16/2014	9.2	4/4/2014	9.2	6/24/2014	10.5	9/12/2014	9.8	12/1/2014	9.3		
1/17/2014	9.2	4/7/2014	9.2	6/25/2014	10.5	9/15/2014	9.9	12/2/2014	9.3		
1/20/2014	9.3	4/8/2014	9.2	6/26/2014	10.7	9/16/2014	9.9	12/3/2014	9.3		
1/21/2014	9.3	4/9/2014	9.2	6/27/2014	10.7	9/17/2014	9.9	12/4/2014	9.4		
1/22/2014	9.3	4/10/2014	9.2	7/1/2014	10.8	9/18/2014	9.9	12/5/2014	9.5		
1/23/2014	9.2	4/11/2014	9.2	7/2/2014	10.8	9/19/2014	9.9	12/8/2014	9.3		
1/24/2014	9.2	4/14/2014	9.3	7/3/2014	10.8	9/22/2014	9.9	12/9/2014	9.3		
1/27/2014	9.2	4/15/2014	9.4	7/4/2014	10.9	9/23/2014	9.9	12/10/2014	9.3		
1/28/2014	9.2	4/16/2014	9.4	7/7/2014	11.0	9/24/2014	9.9	12/11/2014	9.3		
1/29/2014	9.2	4/17/2014	9.4	7/8/2014	11.1	9/25/2014	9.9	12/12/2014	9.3		
1/30/2014	9.2	4/21/2014	9.4	7/9/2014	11.1	9/26/2014	9.9	12/15/2014	9.3		
1/31/2014	9.2	4/22/2014	9.3	7/10/2014	11.2	9/29/2014	9.9	12/16/2014	9.3		
2/3/2014	9.2	4/23/2014	9.3	7/11/2014	11.1	9/30/2014	9.9	12/17/2014	9.3		
2/4/2014	9.2	4/24/2014	9.3	7/14/2014	11.1	10/1/2014	9.9	12/18/2014	9.3		

Appendix Table C.3.4: Water quality at station Q-05 from 2010 to 2014.

Date m/d/yr	Acidity mg/L	Ba mg/L	Co mg/L	Fe mg/L	Mn mg/L	pH	Ra Bq/L	Sulphate mg/L	U mg/L
1/11/2010						6.1	0.830		
2/8/2010	< 1	0.016	0.0162		2.00	6.1	1.300	1100	0.0132
3/8/2010						6.2	0.880		
4/12/2010						6.8	0.670		
5/10/2010	9	0.013	0.0169	2.23	1.93	6.5	0.820	890	0.0124
6/14/2010						4.6	0.890		
7/12/2010						4.4	0.940		
8/16/2010	7	0.015	0.0136	0.93	2.05	5.0	0.700	1100	0.0184
9/13/2010						4.1	1.000		
10/13/2010						4.5	0.680		
11/8/2010	9	0.015	0.0111	0.96	1.79	5.2	0.770	1100	0.0199
12/13/2010						6.2	0.780		
1/10/2011						6.0	0.791		
2/14/2011	< 1	0.013	0.0099	2.44	1.42	6.2	0.708	1200	0.0161
3/14/2011						6.2	0.701		
4/11/2011						6.1	0.699		
5/9/2011	< 1	0.01	0.0075	2.28	0.77	6.5	0.467	540	0.0055
6/13/2011						6.4	0.588		
7/11/2011						6.6	0.551		
8/8/2011	6	0.014	0.0053	0.83	1.11	6.4	0.594	1000	0.0043
9/12/2011						4.7	0.640		
10/11/2011						4.4	0.819		
11/14/2011	12	0.014	0.0096	2.92	1.48	5.3	0.803	1100	0.0142
12/12/2011						6.5	0.792		
1/9/2012						6.5	0.811		
2/13/2012	2	0.013	0.0084	2.92	1.22	6.4	0.632	1100	0.0128
3/12/2012						6.6	0.643		
4/9/2012						6.7	0.561		
5/7/2012	9	0.011	0.0104	1.45	1.20	4.3	0.711	980	0.0166
6/12/2012						4.4	0.783		
7/9/2012						4.6	0.894		
8/20/2012	10	0.015	0.0109	0.79	1.58	4.2	0.937	1100	0.0224
9/10/2012						4.3	0.742		
10/9/2012						4.9	0.901		
11/12/2012	9	0.013	0.0077	1.70	1.16	6.7	0.814	1100	0.011
12/10/2012						6.7	0.812		
1/14/2013						6.5	0.794		
2/11/2013	4	0.013	0.008	2.73	1.24	6.7	0.707	950	0.0158
3/11/2013						6.6	0.652		
4/8/2013						6.6	0.667		
5/13/2013	< 1	0.009	0.0046	2.35	0.69	6.4	0.377	480	0.006
6/10/2013						6.8	0.588		
7/8/2013						6.8	0.710		
8/12/2013	6	0.014	0.007	2.59	1.22	6.1	0.741	800	0.0116
9/23/2013						4.8	0.683		
10/15/2013						4.6	0.696		
11/11/2013	13	0.015	0.0085	7.09	1.44	6.5	0.640	950	0.0161
12/9/2013						6.4	0.684		
1/13/2014						6.7	0.505		
2/10/2014	< 1	0.013	0.0071	1.80	1.10	6.7	0.551	960	0.0096
3/10/2014						6.5	0.588		

Appendix Table C.3.4: Water quality at station Q-05 from 2010 to 2014.

Date m/d/yr	Acidity mg/L	Ba mg/L	Co mg/L	Fe mg/L	Mn mg/L	pH	Ra Bq/L	Sulphate mg/L	U mg/L
4/14/2014						6.6	0.585		
5/12/2014	< 1	0.01	0.0041	1.31	0.58	6.4	0.345	440	0.0037
6/9/2014						6.1	0.588		
7/14/2014						6.0	0.747		
8/11/2014	6	0.016	0.0087	0.55	1.55	6.3	0.731	930	0.012
9/8/2014						4.2	0.797		
10/16/2014						4.7	0.798		
11/10/2014	5	0.013	0.0064	1.86	1.32	6.2	0.597	920	0.0114
12/8/2014						7.1	0.564		
Number	20	20	20	19	20	60	60	20	20
Minimum	1.0	0.009	0.0041	0.55	0.58	4.1	0.345	440	0.004
Maximum	13.0	0.016	0.0169	7.09	2.05	7.1	1.300	1200	0.0
Mean	5.7	0.013	0.0091	2.09	1.34	5.9	0.716	937	0.013
Median	6.0	0.013	0.0085	1.86	1.28	6.2	0.708	970	0.013
10th Percentile	1.0	0.010	0.0052	0.82	0.76	4.4	0.560	534	0.005
95th Percentile	12.1	0.016	0.0162	3.34	2.00	6.8	0.937	1105	0.020

Appendix Table C.3.5: Water quality at station Cell 14 from 2010 to 2014.

Date m/d/yr	Acidity mg/L	Ba mg/L	Co mg/L	Fe mg/L	Mn mg/L	pH	Ra Bq/L	Sulphate mg/L	TSS mg/L
5/12/2010	1			0.17		6.8	0.44	13	
11/10/2010	< 1			0.12		6.1	1.6	22	
5/9/2011	3	0.078		0.16		6.3	0.599	13	
11/14/2011	6	0.234		0.13		4.5	2.712	26	
12/12/2011	5	0.316		0.15		5.0	3.472	36	
2/13/2012	4	0.257		0.15	0.182	4.7	3.215	33	1
3/12/2012	< 1	0.081		0.37	0.122	7.0	0.704	14	1
4/9/2012	2	0.098		0.2	0.054	6.8	0.974	16	2
5/7/2012	2	0.104		0.21	0.056	7.0	1.079	17	1
6/12/2012	6	0.137		0.13	0.067	5.1	1.69	21	2
7/9/2012	5	0.15		0.1	0.084	5.3	1.791	22	8
8/20/2012	6	0.151		0.08	0.055	6.1	1.573	25	2
9/10/2012	4	0.157		0.04	0.062	5.2	1.656	27	< 1
10/9/2012	2	0.161		0.11	0.068	5.4	1.714	29	2
11/12/2012	7	0.144		0.18	0.077	5.8	1.426	32	6
2/11/2013	4	0.195		0.22	0.156	5.6	1.559	42	< 1
3/11/2013	2	0.123		0.19	0.157	5.8	0.999	32	< 1
4/8/2013	< 1	0.04		0.4	0.135	6.4	0.163	10	< 1
5/13/2013	1	0.056		0.16	0.066	6.5	0.403	14	< 1
6/10/2013	< 1	0.05		0.08	0.021	7.0	0.341	16	1
7/8/2013	< 1	0.055		0.06	0.006	7.1	0.406	17	< 1
8/12/2013	< 1	0.053		0.04	0.006	7.0	0.427	15	1
9/23/2013	< 1	0.069		< 0.02	0.005	7.3	0.4	18	1
10/15/2013	< 1	0.073		0.04	0.01	6.4	0.437	20	2
11/11/2013	1	0.059		0.24	0.048	7.4	0.372	17	1
1/28/2014						6.5			
2/10/2014	< 1	0.079	0.0006	0.49	0.033	6.5	0.363	18	< 1
2/28/2014						6.2			
3/10/2014	< 1	0.071	< 0.0005	0.15	0.023	6.2	0.419	20	1
3/28/2014						6.0			
4/28/2014						5.1			
5/12/2014	< 1	0.045	0.001	0.12	0.042	6.3	0.304	13	1
5/28/2014						6.4			
6/9/2014	< 1	0.053	< 0.0005	0.03	0.014	5.7	0.424	15	< 1
6/28/2014						7.7			
7/14/2014	< 1	0.061	< 0.0005	0.06	0.014	6.8	0.368	16	2
7/28/2014						6.6			
8/11/2014	1	0.066	0.0005	0.04	0.014	6.8	0.499	18	2
8/28/2014						7.0			
9/8/2014	< 1	0.07	< 0.0005	0.04	0.012	6.3	0.433	19	< 1
9/28/2014						7.0			
10/16/2014	2	0.07	0.0008	0.03	0.015	6.4	0.449	19	2
10/28/2014						6.9			
11/13/2014	2	0.063	0.0009	0.12	0.03	6.3	0.421	17	2
11/28/2014						7.2			
Number	34	32	9	34	29	45	34	34	29
Minimum	< 1.0	0.04	< 0.0005	0.02	0.01	4.5	0.16	10.0	1.0
Maximum	7.0	0.32	0.0010	0.49	0.18	7.7	3.47	42.0	8.0
Mean	2.4	0.11	0.0006	0.14	0.06	6.3	1.00	20.6	1.7
Median	1.0	0.08	0.0005	0.13	0.05	6.4	0.47	18.0	1.0
10th Percentile	1.0	0.05	0.0005	0.04	0.01	5.1	0.36	13.3	1.0
95th Percentile	6.0	0.24	0.0010	0.38	0.16	7.3	2.89	34.1	4.4

Appendix Table C.3.6: Water quality at station Cell 15 from 2010 to 2014.

Date m/d/yr	Acidity mg/L	Ba mg/L	Co mg/L	Fe mg/L	Mn mg/L	pH	Ra Bq/L	Sulphate mg/L	TSS mg/L
5/12/2010	< 1			0.83		6.4	0.39	500	
11/10/2010	< 1			0.82		6.5	0.4	720	
5/9/2011	< 1	0.039		0.73		6.8	0.391	400	
11/14/2011	< 1	0.03		0.64		6.4	0.232	560	
12/12/2011	2	0.034		0.68		6.1	0.337	680	
2/13/2012	< 1	0.032		0.41	0.17	6.6	0.342	670	2
3/12/2012	< 1	0.161		0.21	0.176	6.7	1.926	290	2
4/9/2012	< 1	0.033		0.69	0.337	6.8	0.427	500	3
5/7/2012	< 1	0.037		0.41	0.268	6.9	0.433	530	< 1
6/12/2012	< 1	0.038		0.27	0.14	6.9	0.353	520	2
7/9/2012	< 1	0.029		0.24	0.111	6.9	0.365	550	1
8/20/2012	< 1	0.024		0.52	0.063	7.0	0.336	600	3
9/10/2012	< 1	0.024		0.24	0.053	7.5	0.296	626	1
10/9/2012	< 1	0.024		0.51	0.115	7.2	0.336	630	2
11/12/2012	< 1	0.023		0.87	0.174	7.1	0.38	730	3
2/11/2013	< 1	0.03		1.21	0.349	6.8	0.391	840	5
3/11/2013	< 1	0.029		0.88	0.309	6.9	0.34	770	3
4/8/2013	< 1	0.029		0.58	0.314	6.8	0.302	700	2
5/13/2013	< 1	0.025		0.81	0.461	6.7	0.323	400	2
6/10/2013	< 1	0.027		0.36	0.361	7.1	0.305	470	2
7/8/2013	< 1	0.025		0.18	0.232	6.8	0.335	450	1
8/12/2013	< 1	0.024		0.3	0.085	7.0	0.308	410	2
9/23/2013	< 1	0.025		0.33	0.046	7.1	0.271	440	1
10/15/2013	< 1	0.026		0.5	0.064	7.0	0.277	500	2
11/11/2013	< 1	0.026		0.45	0.086	7.2	0.269	450	2
1/28/2014						6.7			
2/10/2014	< 1	0.053	0.0044	1.31	0.119	6.8	0.583	350	2
2/28/2014						6.3			
3/28/2014						6.4			
4/28/2014						5.6			
5/12/2014	< 1	0.025	0.0064	0.64	0.361	6.3	0.303	380	2
5/28/2014						6.7			
6/28/2014						7.1			
7/28/2014						7.5			
8/11/2014	< 1	0.022	0.0007	0.22	0.039	6.8	0.281	500	1
8/28/2014						7.0			
9/28/2014						7.0			
10/28/2014						6.9			
11/13/2014	< 1	0.02	0.0028	0.68	0.082	7.0	0.261	600	2
Number	29	27	4	29	24	39	29	29	24
Minimum	< 1.0	0.02	0.0007	0.18	0.039	5.6	0.23	290	< 1.0
Maximum	2.0	0.16	0.0064	1.31	0.461	7.5	1.93	840	5.0
Mean	< 1.0	0.03	0.0036	0.57	0.188	6.8	0.40	544	2.0
Median	1.0	0.03	0.0036	0.52	0.155	6.8	0.34	520	2.0
10th Percentile	1.0	0.02	0.0013	0.24	0.056	6.4	0.27	396	1.0
95th Percentile	1.0	0.05	0.0061	1.08	0.361	7.2	0.52	754	3.0

Appendix Table C.3.7: Water quality at station Cell 16S from 2010 to 2014.

Date m/d/yr		Acidity mg/L	Ba mg/L	Co mg/L	Fe mg/L	Mn mg/L	pH	Ra Bq/L	Sulphate mg/L	TSS mg/L
5/12/2010	<	1			0.96		7.0	1.1	1100	
11/10/2010	<	1			1.67		7.6	0.24	1100	
5/9/2011	<	1	0.01		1.62		6.9	0.374	950	
11/14/2011	<	1	0.01		1.91		6.5	0.237	1100	
2/13/2012	<	1	0.011		2.76		6.6	0.35	1100	5
3/12/2012		2	0.011		2.92		6.7	0.46	1100	3
4/9/2012		2	0.01		2.99		6.6	0.381	1000	4
5/7/2012		5	0.01		1.77		6.0	0.373	1100	2
6/12/2012		5	0.013		0.51		6.4	0.482	1100	1
7/9/2012		8	0.011		0.59		7.8	0.427	1100	2
8/20/2012	<	1	0.011		1.07		7.7	0.321	1100	3
9/10/2012	<	1	0.012		1.67		7.7	0.275	1049	4
10/9/2012	<	1	0.01		1		7.3	0.255	1000	2
11/12/2012	<	1	0.01		1.41		7.1	0.239	1100	3
2/11/2013	<	1	0.013		2.29		6.7	0.375	1300	4
3/11/2013	<	1	0.011		2.12		6.7	0.348	1100	4
4/8/2013	<	1	0.012		4.88		6.5	0.552	1000	2
5/13/2013	<	1	0.01		2.2		6.6	0.338	920	2
6/10/2013		2	0.01		1.17		6.7	0.368	1000	2
7/8/2013		4	0.011		0.53		8.4	0.377	990	2
8/12/2013	<	1	0.01		0.47		7.0	0.323	810	1
9/23/2013		1	0.012		1.46		6.4	0.278	900	3
10/15/2013		3	0.012		1.44		6.5	0.293	960	4
11/11/2013	<	1	0.011		1.89		7.2	0.288	930	6
2/10/2014	<	1	0.013	0.0058	1.39	0.993	6.9	0.337	960	4
4/14/2014	<	1					6.1			
4/28/2014							6.3			
5/12/2014	<	1	0.011	0.0083	2.33	1.26	6.3	0.328	860	3
5/28/2014							6.6			
6/9/2014	<	1					5.7			
6/28/2014							7.5			
7/14/2014	<	1					6.8			
7/28/2014							6.9			
8/11/2014	<	1	0.011	0.0074	0.51	1.4	7.3	0.329	920	2
8/28/2014							7.1			
9/8/2014	<	1					8.2			
9/28/2014							7.4			
10/16/2014	<	1					8.4			
10/28/2014							7.5			
11/13/2014	<	1	0.009	0.0052	1.29	0.563	7.0	0.214	940	3
11/28/2014							7.2			
Number		33	26	4	28	4	41	28	28	24
Minimum	<	1.0	0.009	0.0052	0.47	0.56	5.7	0.21	810	1.0
Maximum		8.0	0.013	0.0083	4.88	1.40	8.4	1.10	1300	6.0
Mean		1.7	0.011	0.0067	1.67	1.05	7.0	0.37	1021	3.0
Median		1.0	0.011	0.0066	1.54	1.13	6.9	0.34	1000	3.0
10th Percentile		1.0	0.010	0.0054	0.52	0.69	6.3	0.24	914	2.0
95th Percentile		5.0	0.013	0.0082	2.97	1.38	8.2	0.53	1100	4.9

Appendix Table C.3.8: Water quality at station Cell 17 from 2010 to 2014.

Date m/d/yr	Acidity mg/L	Ba mg/L	Co mg/L	Fe mg/L	Mn mg/L	pH	Ra Bq/L	Sulphate mg/L	TSS mg/L
5/12/2010	< 1			1.01		7.0	1.2	1100	
11/10/2010	< 1			1.37		6.5	0.74	1100	
5/9/2011	8	0.01		4.64		6.3	0.766	1000	
11/14/2011	5	0.012		1.74		6.3	0.754	1100	
2/13/2012	< 1	0.012		2.31		6.5	0.729	1200	3
3/12/2012	2	0.011		2.12		6.5	0.725	1100	2
4/9/2012	12	0.009		5.64		6.5	0.919	1000	2
5/7/2012	9	0.011		1.34		4.7	1.035	1200	2
6/12/2012	< 1	0.013		0.89		7.0	0.728	1200	3
7/9/2012	5	0.011		1.63		7.5	0.664	1200	4
8/20/2012	7	0.012		1.11		6.9	0.729	1200	4
9/10/2012	< 1	0.012		1.15		7.3	0.661	1151	4
10/9/2012	< 1	0.011		0.85		7.3	0.702	1100	3
11/12/2012	< 1	0.011		1.46		7.0	0.883	1100	2
2/11/2013	< 1	0.011		1.47		6.7	0.549	1200	2
3/11/2013	< 1	0.011		1.89		6.6	0.581	1100	4
4/8/2013	< 1	0.013		3.1		6.6	0.877	1000	2
5/13/2013	14	0.01		7.73		6.4	1.061	920	3
6/10/2013	< 1	0.01		0.73		6.8	0.888	1000	2
7/8/2013	< 1	0.011		1.03		6.7	0.812	1300	3
8/12/2013	3	0.011		0.83		6.5	0.81	890	2
9/23/2013	3	0.013		1.71		6.4	0.624	1000	4
10/15/2013	< 1	0.012		1.3		6.9	0.67	1000	3
11/11/2013	< 1	0.011		1.41		7.0	0.604	950	3
2/10/2014	< 1	0.012	0.0071	1.17	1.03	6.7	0.547	980	2
4/14/2014	< 1					6.2			
4/28/2014						6.6			
5/12/2014	14	0.01	0.012	8.63	1.3	6.4	0.858	870	5
5/28/2014						6.6			
6/9/2014	6					5.4			
6/28/2014						7.0			
7/14/2014	< 1					6.7			
7/28/2014						6.8			
8/11/2014	6	0.013	0.0089	1.29	1.42	6.6	0.921	1000	2
8/28/2014						7.0			
9/8/2014	< 1					6.2			
9/28/2014						8.4			
10/16/2014	< 1					7.4			
10/28/2014						7.0			
11/13/2014	< 1	0.01	0.0076	1.36	0.671	7.0	0.596	980	2
11/28/2014						6.9			
Number	33	26	4	28	4	41	28	28	24
Minimum	< 1.0	0.009	0.0071	0.73	0.67	4.7	0.55	870	2.0
Maximum	14.0	0.013	0.0120	8.63	1.42	8.4	1.20	1300	5.0
Mean	3.5	0.011	0.0089	2.18	1.11	6.7	0.77	1069	2.8
Median	1.0	0.011	0.0083	1.39	1.17	6.7	0.73	1100	3.0
10th Percentile	1.0	0.010	0.0073	0.88	0.78	6.3	0.59	941	2.0
95th Percentile	12.8	0.013	0.0115	7.00	1.40	7.4	1.05	1200	4.0

Appendix Table C.3.9: Water quality at porewater station DK-14-5C from 2010 to 2014.

Date m/d/y	Acidity mg/L	Fe mg/L	pH	Ra Bq/L	Sulphate mg/L
8/6/2010	< 1	< 0.02	7.8	1.3	1700
7/6/2011	< 1	0.1	8.1		1700
7/5/2012	< 1	0.15	8.1		1500
8/13/2013	< 1	< 0.02	8.3		1500
7/10/2014	< 1	< 0.02	8.3	1.4	1600
Number	5	5	5	2	5
Minimum	< 1	< 0.02	7.8	1.3	1500
Maximum	< 1	0.15	8.3	1.4	1700
Mean	< 1	0.06	8.1	1.4	1600
Median	< 1	0.02	8.1	1.4	1600
10th Percentile	1	0.02	7.9	1.3	1500
95th Percentile	1	0.14	8.3	1.4	1700

Appendix Table C.3.10: Water quality at porewater stations DK-15-2 A, B, C, D from 2010 to 2014.

Station	Date m/d/y	Acidity mg/L	Fe mg/L	pH	Ra Bq/L	Sulphate mg/L
DK15-2A	8/6/2010	756	473	6.2	3.5	2100
	7/18/2011	783	533	6.2		2300
	7/4/2012	650	423	6.0		1900
	8/14/2013	548	344	5.9		1800
	7/11/2014	291	175	6.2	4.361	1600
	Number	5	5	5	2	5
	Minimum	291	175	5.9	3.5	1600
	Maximum	783	533	6.2	4.4	2300
	Mean	606	390	6.1	3.9	1940
	Median	650	423	6.2	3.9	1900
	10th Percentile	394	243	5.9	3.6	1680
	95th Percentile	778	521	6.2	4.3	2260
DK15-2B	8/6/2010	736	454	6.0	4.4	2100
	7/18/2011	806	545	6.0		2300
	7/4/2012	700	446	5.9		1800
	8/14/2013	579	399	5.9		1900
	7/11/2014	326	166	5.9	4.39	1800
	Number	5	5	5	2	5
	Minimum	326	166	5.9	4.4	1800
	Maximum	806	545	6.0	4.4	2300
	Mean	629	402	5.9	4.4	1980
	Median	700	446	5.9	4.4	1900
	10th Percentile	427	259	5.9	4.4	1800
	95th Percentile	792	527	6.0	4.4	2260
DK15-2C	8/6/2010	762	437	6.0	2.7	2100
	7/18/2011	749	465	5.5		2200
	7/4/2012	526	405	5.8		1700
	8/14/2013	599	388	5.3		1900
	7/11/2014	295	160	5.9	3.31	1600
	Number	5	5	5	2	5
	Minimum	295	160	5.3	2.7	1600
	Maximum	762	465	6.0	3.3	2200
	Mean	586	371	5.7	3.0	1900
	Median	599	405	5.8	3.0	1900
	10th Percentile	387	251	5.4	2.8	1640
	95th Percentile	759	459	6.0	3.3	2180
DK15-2D	8/6/2010	666	430	6.3	0.75	2000
	7/18/2011	660	454	6.2		2100
	7/4/2012	540	451	6.3		1800
	8/14/2013	555	379	6.5		1900
	7/11/2014	567	372	6.3	0.823	1900
	Number	5	5	5	2	5
	Minimum	540	372	6.2	0.8	1800
	Maximum	666	454	6.5	0.8	2100
	Mean	598	417	6.3	0.8	1940
	Median	567	430	6.3	0.8	1900
	10th Percentile	546	375	6.2	0.8	1840
	95th Percentile	665	453	6.5	0.8	2080

Appendix Table C.3.11: Water quality at porewater stations DK-15-4 A, B, C, D from 2010 to 2014.

Station	Date m/d/y	Acidity mg/L	Fe mg/L	pH	Ra Bq/L	Sulphate mg/L
DK15-4A	8/9/2010	264	189	6.6	3.7	1700
	7/20/2011	237	170	6.4		1700
	7/9/2012	178	165	6.5		1700
	8/15/2013	202	152	6.5		1800
	7/14/2014	212	141	6.5	3.134	1600
	Number	5	5	5	2	5
	Minimum	178	141	6.4	3.1	1600
	Maximum	264	189	6.6	3.7	1800
	Mean	219	163	6.5	3.4	1700
	Median	212	165	6.5	3.4	1700
	10th Percentile	188	145	6.4	3.2	1640
	95th Percentile	259	185	6.6	3.7	1780
DK15-4B	8/9/2010	373	257	6.4	0.23	1900
	7/20/2011	370	257	6.3		1300
	7/9/2012	308	246	6.4		1800
	8/15/2013	354	246	6.4		1900
	7/14/2014	392	281	6.3	1.223	1800
	Number	5	5	5	2	5
	Minimum	308	246	6.3	0.2	1300
	Maximum	392	281	6.4	1.2	1900
	Mean	359	257	6.4	0.7	1740
	Median	370	257	6.4	0.7	1800
	10th Percentile	326	246	6.3	0.3	1500
	95th Percentile	388	276	6.4	1.2	1900
DK15-4C	8/9/2010	426	277	6.3	0.96	2000
	7/20/2011	450	298	6.3		2000
	7/9/2012	305	280	6.4		1900
	8/15/2013	420	266	6.4		1900
	7/14/2014	447	301	6.3	1.08	1900
	Number	5	5	5	2	5
	Minimum	305	266	6.3	1.0	1900
	Maximum	450	301	6.4	1.1	2000
	Mean	410	284	6.3	1.0	1940
	Median	426	280	6.3	1.0	1900
	10th Percentile	351	270	6.3	1.0	1900
	95th Percentile	449	300	6.4	1.1	2000
DK15-4D	8/9/2010	462	306	6.2	0.23	2000
	7/20/2011	475	299	6.5		2000
	7/9/2012	342	290	6.4		1900
	8/15/2013	420	278	6.3		1900
	7/14/2014	430	302	6.3	1	2000
	Number	5	5	5	2	5
	Minimum	342	278	6.2	0.2	1900
	Maximum	475	306	6.5	1.0	2000
	Mean	426	295	6.3	0.6	1960
	Median	430	299	6.3	0.6	2000
	10th Percentile	373	283	6.2	0.3	1900
	95th Percentile	472	305	6.5	1.0	2000

Appendix Table C.3.12: Water quality at porewater stations DK-16-2 A, B, C, D from 2010 to 2014.

Station	Date m/d/y	Acidity mg/L	Fe mg/L	pH	Ra Bq/L	Sulphate mg/L
DK16-2A	8/10/2010	23	50.1	6.9	6.8	1500
	7/19/2011	12	46	6.6		1500
	7/11/2012	17	45.7	7.2		1400
	8/13/2013	8	42.4	7.3		1300
	7/10/2014	3	41.3	6.9	6.8	1700
	Number	5	5	5	2	5
	Minimum	3	41	6.6	6.8	1300
	Maximum	23	50	7.3	6.8	1700
	Mean	13	45	7.0	6.8	1480
	Median	12	46	6.9	6.8	1500
	10th Percentile	5	42	6.7	6.8	1340
	95th Percentile	22	49	7.3	6.8	1660
DK16-2B	8/10/2010	< 1	< 0.02	8.4	6.5	1500
	7/19/2011	< 1	0.04	8.9		1500
	7/11/2012	< 1	0.03	8.8		1600
	8/13/2013	< 1	< 0.02	8.7		1300
	7/10/2014	< 1	< 0.02	8.4	7.7	1600
	Number	5	5	5	2	5
	Minimum	1	0	8.4	6.5	1300
	Maximum	1	0	8.9	7.7	1600
	Mean	1	0	8.6	7.1	1500
	Median	1	0	8.7	7.1	1500
	10th Percentile	1	0	8.4	6.6	1380
	95th Percentile	1	0	8.9	7.7	1600
DK16-2C	8/10/2010	2	4.07	6.8	4.6	1600
	7/19/2011	9	3.94	6.6		1500
	7/11/2012	7	4.07	6.5		1600
	8/13/2013	< 1	3.77	7		1400
	7/10/2014	< 1	3.96	6.9	5.1	1400
	Number	5	5	5	2	5
	Minimum	1	4	6.5	4.6	1400
	Maximum	9	4	7.0	5.1	1600
	Mean	4	4	6.8	4.8	1500
	Median	2	4	6.8	4.8	1500
	10th Percentile	1	4	6.5	4.6	1400
	95th Percentile	9	4	7.0	5.1	1600
DK16-2D	8/10/2010	27	10.4	5.7	3.2	1600
	7/19/2011	21	11.2	5.7		1500
	7/11/2012	23	8.93	5.2		1700
	8/13/2013	20	8.45	5.7		1400
	7/10/2014	21	10.4	6	3.8	1500
	Number	5	5	5	2	5
	Minimum	20	8	5.2	3.2	1400
	Maximum	27	11	6.0	3.8	1700
	Mean	22	10	5.7	3.5	1540
	Median	21	10	5.7	3.5	1500
	10th Percentile	20	9	5.4	3.3	1440
	95th Percentile	26	11	5.9	3.8	1680

Appendix Table C.3.13: Water quality at porewater stations DK-17-2 A, B, C, D from 2010 to 2014.

Station	Date m/d/y	Acidity mg/L	Fe mg/L	pH	Ra Bq/L	Sulphate mg/L
DK17-2A	8/9/2010	1990	1103	5.5	2.2	3800
	7/13/2011		1040	5.8		3600
	7/5/2012	2200	984	6.1		3200
	8/13/2013	1100	819	5.9		2800
	7/10/2014	1330	750	6.1	1.7	3000
	Number	4	5	5	2	5
	Minimum	1100	750	5.5	1.7	2800
	Maximum	2200	1103	6.1	2.2	3800
	Mean	1655	939	5.9	2.0	3280
	Median	1660	984	5.9	2.0	3200
	10th Percentile	1169	778	5.6	1.8	2880
	95th Percentile	2169	1090	6.1	2.2	3760
DK17-2B	8/9/2010	310	207	6.5	4.9	1900
	7/6/2011	195	167	6.5		1800
	7/5/2012	84	63.4	6.7		1500
	8/12/2013	52	58.4	7.2		1400
	7/10/2014	21	35	6.7	4.2	1500
	Number	5	5	5	2	5
	Minimum	21	35	6.5	4.2	1400
	Maximum	310	207	7.2	4.9	1900
	Mean	132	106	6.7	4.6	1620
	Median	84	63	6.7	4.6	1500
	10th Percentile	33	44	6.5	4.3	1440
	95th Percentile	287	199	7.1	4.9	1880
DK17-2C	8/9/2010	< 1	0.32	9.6	3.4	1400
	7/13/2011	< 1	< 0.02	9.4		1500
	7/5/2012	< 1	0.05	9.3		1400
	8/13/2013	< 1	0.03	9.7		1200
	7/10/2014	< 1	< 0.02	9.5	3.8	1400
	Number	5	5	5	2	5
	Minimum	1	0	9.3	3.4	1200
	Maximum	1	0	9.7	3.8	1500
	Mean	1	0	9.5	3.6	1380
	Median	1	0	9.5	3.6	1400
	10th Percentile	1	0	9.3	3.4	1280
	95th Percentile	1	0	9.7	3.8	1480
DK17-2D	8/9/2010	< 1	0.1	10.2	5.3	1500
	7/13/2011	< 1	0.06	10.1		1600
	7/5/2012	< 1	0.11	10		1400
	8/12/2013	< 1	0.08	10.3		1300
	7/10/2014	< 1	0.06	10.2	4.4	1400
	Number	5	5	5	2	5
	Minimum	1	0	10.0	4.4	1300
	Maximum	1	0	10.3	5.3	1600
	Mean	1	0	10.2	4.9	1440
	Median	1	0	10.2	4.9	1400
	10th Percentile	1	0	10.0	4.5	1340
	95th Percentile	1	0	10.3	5.3	1580

Appendix Table C.3.14: Water quality at groundwater stations QPW-1-1,4,8 from 2010 to 2014.

Station	Date m/d/y		Acidity mg/L	Fe mg/L	pH		Ra Bq/L	Sulphate mg/L
QPW-1-1	8/4/2010	<	1	13.6	6.5			0.2
	7/4/2011	<	1	12	6.2			2.6
	6/28/2012	<	1	12.2	6.6			2.4
	8/7/2013		1	8.99	6.7			3.6
	7/7/2014	<	1	10.1	6.4		0.012	1.2
	Number		5	5	5		1	5
	Minimum	<	1	9.0	6.20		0.012	0.2
	Maximum		1	13.6	6.70		0.012	3.6
	Mean		1	11.4	6.48		0.012	2.0
	Median		1	12.0	6.50		0.012	2.4
	10th Percentile		1	9.4	6.28		0.012	0.6
	95th Percentile		1	13.3	6.68		0.012	3.4
QPW-1-4	8/4/2010	<	1	3.16	6.9			61
	7/4/2011	<	1	3.21	6.3			51
	6/28/2012	<	1	3.45	6.5			51
	8/7/2013	<	1	2.25	6.6			55
	7/7/2014	<	1	1.75	6.6		0.007	72
	Number		5	5	5		1	5
	Minimum	<	1	1.8	6.30		0.007	51
	Maximum	<	1	3.5	6.90		0.007	72
	Mean	<	1	2.8	6.58		0.007	58
	Median		1	3.2	6.60		0.007	55
	10th Percentile		1	2.0	6.38		0.007	51
	95th Percentile		1	3.4	6.84		0.007	70
QPW-1-8	8/4/2010	<	1	15.5	7			260
	7/4/2011	<	1	17.9	6.5			280
	6/28/2012	<	1	17.7	6.9			260
	8/7/2013		1	16	7.2			260
	7/7/2014	<	1	19.2	7	<	0.005	300
	Number		5	5	5		1	5
	Minimum	<	1	15.5	6.50		0.005	260
	Maximum		1	19.2	7.20		0.005	300
	Mean		1	17.3	6.92		0.005	272
	Median		1	17.7	7.00		0.005	260
	10th Percentile		1	15.7	6.66		0.005	260
	95th Percentile		1	18.9	7.16		0.005	296

Appendix Table C.3.15: Water quality at groundwater stations 95-QW-3 A, C, D from 2010 to 2014.

Station	Date m/d/y	Acidity mg/L	Fe mg/L	pH	Ra Bq/L	Sulphate mg/L
95QW-3A	8/5/2010	254	192	6.4		1600
	7/6/2011	231	187	6.5		1500
	6/28/2012	243	169	6.3		1500
	8/6/2013	190	139	6.8		1400
	7/3/2014	182	129	6.3	0.036	1300
	Number	5	5	5	1	5
	Minimum	182	129	6.3	0.036	1300
	Maximum	254	192	6.8	0.036	1600
	Mean	220	163	6.5	0.036	1460
	Median	231	169	6.4	0.036	1500
	10th Percentile	185	133	6.3	0.036	1340
	95th Percentile	252	191	6.7	0.036	1580
95QW-3C	8/5/2010	266	189	6.3		1600
	7/6/2011	246	196	6.3		1500
	6/28/2012	257	177	6.2		1400
	8/6/2013	202	145	6.4		1300
	8/14/2013	219	160	6.3		1300
	7/3/2014	194	134	6.2	0.008	1300
	Number	5	5	5	1	5
	Minimum	194	134	6.2	0.008	1300
	Maximum	257	196	6.4	0.008	1500
	Mean	224	162	6.3	0.008	1360
	Median	219	160	6.3	0.008	1300
	10th Percentile	197	138	6.2	0.008	1300
	95th Percentile	255	192	6.4	0.008	1480
95QW-3D	8/5/2010	228	136	5.5		1500
	7/6/2011	231	132	4.9		1500
	6/28/2012	211	106	5.2		1400
	8/6/2013	82	34.5	5.1		940
	8/29/2013	106	51.3	5.2		1100
	7/3/2014	198	129	6.4	< 0.005	1300
	Number	5	5	5	1	5
	Minimum	82	35	4.9	0.005	940
	Maximum	231	132	6.4	0.005	1500
	Mean	166	91	5.4	0.005	1248
	Median	198	106	5.2	0.005	1300
	10th Percentile	92	41	5.0	0.005	1004
	95th Percentile	227	131	6.2	0.005	1480

Appendix Table C.3.16: Water quality at groundwater stations 95-QW-4 from 2010 to 2014.

Date m/d/y	Acidity mg/L	Fe mg/L	pH	Ra Bq/L	Sulphate mg/L
8/6/2010	< 1	< 0.02	6.9		950
7/7/2011	< 1	< 0.02	7.6		970
7/9/2012	< 1	< 0.02	7.4		920
8/8/2013	< 1	< 0.02	7.2		750
7/9/2014	< 1	< 0.02	6.9	0.006	870
Number	5	5	5	1	5
Minimum	< 1	0.02	6.9	0.006	750
Maximum	< 1	0.02	7.6	0.006	970
Mean	< 1	0.02	7.2	0.006	892
Median	< 1	0.02	7.2	0.006	920
10th Percentile	1	0.02	6.9	0.006	798
95th Percentile	1	0.02	7.6	0.006	966

Appendix Table C.3.17: Water quality at groundwater stations 95-QW-5A, D from 2010 to 2014.

Station	Date m/d/y	Acidity mg/L	Fe mg/L	pH	Ra Bq/L	Sulphate mg/L
95QW-5A	8/4/2010	27	14.6	6		770
	7/7/2011	14	17.2	5.9		670
	7/12/2012	15	17.1	5.8		800
	8/8/2013	< 1	12.4	5.9		460
	7/9/2014	< 1	7.66	5.7	0.008	380
	Number	5	5	5	1	5
	Minimum	< 1	7.66	5.7	0.008	380
	Maximum	27	17.20	6.0	0.008	800
	Mean	12	13.79	5.9	0.008	616
	Median	14	14.60	5.9	0.008	670
	10th Percentile	1	9.56	5.7	0.008	412
	95th Percentile	25	17.18	6.0	0.008	794
95QW-5D	8/4/2010	< 1	0.07	6.1		8.1
	7/7/2011	< 1	0.03	6.1		8.0
	7/12/2012	< 1	0.03	6.3		9.0
	8/8/2013	< 1	< 0.02	6.3		7.7
	7/9/2014	< 1	< 0.02	6.1	0.007	7.0
	Number	5	5	5	1	5.0
	Minimum	< 1	0.02	6.1	0.007	7.0
	Maximum	< 1	0.07	6.3	0.007	9.0
	Mean	< 1	0.03	6.2	0.007	8.0
	Median	1	0.03	6.1	0.007	8.0
	10th Percentile	1	0.02	6.1	0.007	7.3
	95th Percentile	1	0.06	6.3	0.007	8.8

Appendix Table C.3.18: Summary of seasonal trends for station Q-05 from 2003-2014.

Month	Spearman's rho	Acidity	Ba	Co	Fe	Mn	pH	Ra	Sulphate	U
January	Correlation Coefficient						0.872	-0.737		
	Sig. (2-tailed)						0.054	0.006		
	N						5	12		
February	Correlation Coefficient	-0.829	-0.679	-0.888	-0.383	-0.895	0.872	-0.692	-0.745	-0.748
	Sig. (2-tailed)	0.001	0.015	0.000	0.308	0.000	0.000	0.013	0.005	0.005
	N	12	12	12	9	12	12	12	12	12
March	Correlation Coefficient						0.632	-0.811		
	Sig. (2-tailed)						0.252	0.001		
	N						5	12		
April	Correlation Coefficient						-0.359	-0.564		
	Sig. (2-tailed)						0.553	0.056		
	N						5	12		
May	Correlation Coefficient	-0.776	-0.65	-0.776	-0.767	-0.648	0.391	-0.49	-0.357	-0.664
	Sig. (2-tailed)	0.003	0.022	0.003	0.016	0.023	0.209	0.106	0.255	0.018
	N	12	12	12	9	12	12	12	12	12
June	Correlation Coefficient						0.3	-0.352		
	Sig. (2-tailed)						0.624	0.262		
	N						5	12		
July	Correlation Coefficient						0.5	-0.671		
	Sig. (2-tailed)						0.391	0.017		
	N						5	12		
August	Correlation Coefficient	-0.843	-0.107	-0.79	-0.017	-0.664	0.688	-0.427	-0.761	-0.769
	Sig. (2-tailed)	0.001	0.74	0.002	0.966	0.018	0.013	0.166	0.004	0.003
	N	12	12	12	9	12	12	12	12	12
September	Correlation Coefficient						0.3	-0.613		
	Sig. (2-tailed)						0.624	0.034		
	N						5	12		
October	Correlation Coefficient						0.6	-0.65		
	Sig. (2-tailed)						0.285	0.022		
	N						5	12		
November	Correlation Coefficient	-0.828	-0.936	-0.909	0.6	-0.853	0.916	-0.811	-0.856	-0.867
	Sig. (2-tailed)	0.001	0.000	0.000	0.088	0.000	0.000	0.001	0.000	0.000
	N	12	12	12	9	12	12	12	12	12
December	Correlation Coefficient						0.7	-0.629		
	Sig. (2-tailed)						0.188	0.028		
	N						5	12		

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).

[grey box] Significant trend where $p<0.05$.

Appendix Table C.3.19: Summary of seasonal trends for station Cell 14 from 2003-2014.

Month	Spearman's rho	Acidity	Ba	Co	Fe	Mn	pH	Ra	Sulphate	TSS
April	Correlation Coefficient	-0.7					-0.203	-0.4		
	Sig. (2-tailed)	0.188					0.700	0.505		
	N	5					6	5		
May	Correlation Coefficient	0.297			0.432		-0.532	0.633	0.356	
	Sig. (2-tailed)	0.438			0.333		0.141	0.067	0.347	
	N	9			7		9	9	9	
August	Correlation Coefficient	-0.447					-0.6	0.3	-0.1	
	Sig. (2-tailed)	0.450					0.285	0.624	0.873	
	N	5					5	5	5	
October	Correlation Coefficient	-0.339					-0.6	-0.143	-0.2	
	Sig. (2-tailed)	0.510					0.208	0.787	0.747	
	N	6					6	6	5	
November	Correlation Coefficient	0.006			0.432		-0.055	0.358	0.445	
	Sig. (2-tailed)	0.986			0.333		0.881	0.310	0.197	
	N	10			7		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).

Significant trend where p<0.05.

Appendix Table C.3.20: Summary of seasonal trends for station Cell 15 from 2003-2014.

Month	Spearman's rho	Acidity	Ba	Co	Fe	Mn	pH	Ra	Sulphate	TSS
April	Correlation Coefficient						0.872	0.6		
	Sig. (2-tailed)						0.054	0.285		
	N						5	5		
May	Correlation Coefficient	-			0.036		-0.211	0.008	-0.235	-0.199
	Sig. (2-tailed)	-			0.939		0.586	0.983	0.542	0.607
	N	8			7		9	9	9	9
August	Correlation Coefficient						-0.158	-0.4	-0.3	
	Sig. (2-tailed)						0.800	0.505	0.624	
	N						5	5	5	
October	Correlation Coefficient						-0.29	-0.3		
	Sig. (2-tailed)						0.577	0.624		
	N						6	5		
November	Correlation Coefficient	-0.577			-0.643		0.563	0.233	-0.268	-0.267
	Sig. (2-tailed)	0.134			0.119		0.114	0.546	0.486	0.562
	N	8			7		9	9	9	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).

Significant trend where $p<0.05$.

Appendix Table C.3.21: Summary of seasonal trends for station Cell 16S from 2003-2014.

Month	Spearman's rho	Acidity	Ba	Co	Fe	Mn	pH	Ra	Sulphate	TSS
April	Correlation Coefficient						0.771	0.6		
	Sig. (2-tailed)						0.072	0.285		
	N						6	5		
May	Correlation Coefficient	-0.812			-0.286		0.583	-0.8	-0.452	
	Sig. (2-tailed)	0.014			0.535		0.099	0.010	0.222	
	N	8			7		9	9	9	
August	Correlation Coefficient						0.2	-0.6	-0.872	
	Sig. (2-tailed)						0.747	0.285	0.054	
	N						5	5	5	
October	Correlation Coefficient						0.551	-0.8		
	Sig. (2-tailed)						0.257	0.104		
	N						6	5		
November	Correlation Coefficient	-0.577			-0.214		0.184	-0.833	-0.577	
	Sig. (2-tailed)	0.134			0.645		0.635	0.005	0.104	
	N	8			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).

[grey box] Significant trend where p<0.05.

Appendix Table C.3.22: Summary of seasonal trends for station Cell 17 from 2003-2014.

Month	Spearman's rho	Acidity	Ba	Co	Fe	Mn	pH	Ra	Sulphate	TSS
April	Correlation Coefficient						0.829	0.5		
	Sig. (2-tailed)						0.042	0.391		
	N						6	5		
May	Correlation Coefficient	-0.323			0.9		0.695	-0.519	-0.336	
	Sig. (2-tailed)	0.435			0.037		0.038	0.152	0.376	
	N	8			5		9	9	9	
October	Correlation Coefficient						0.771	-0.7		
	Sig. (2-tailed)						0.072	0.188		
	N						6	5		
November	Correlation Coefficient	-0.546			-0.4		0.305	-0.817	-0.568	
	Sig. (2-tailed)	0.162			0.505		0.425	0.007	0.110	
	N	8			5		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).

[grey box] Significant trend where p<0.05.

Appendix Table C.3.23: Summary of seasonal trends for Quirke porewater stations from 1991 to 2014.

Station	Spearman rho	Acidity	Iron	pH	Sulphate
DK14-5C	Correlation Coefficient	-	-0.539	0.711	-0.617
	Sig. (2-tailed)	-	0.010	0.000	0.005
	N	5	22	24	19
DK15-2A	Correlation Coefficient	-0.900	-0.979	0.708	-0.925
	Sig. (2-tailed)	0.037	0.000	0.000	0.000
	N	5	19	20	15
DK15-2B	Correlation Coefficient	-0.900	-0.981	0.493	-0.939
	Sig. (2-tailed)	0.037	0.000	0.027	0.000
	N	5	19	20	15
DK15-2C	Correlation Coefficient	-0.900	-0.993	0.330	-0.927
	Sig. (2-tailed)	0.037	0.000	0.156	0.000
	N	5	19	20	15
DK15-2D	Correlation Coefficient	-0.600	-0.878	0.529	-0.872
	Sig. (2-tailed)	0.285	0.000	0.020	0.000
	N	5	18	19	15
DK15-4A	Correlation Coefficient	-0.600	-0.995	0.620	-0.922
	Sig. (2-tailed)	0.285	0.000	0.004	0.000
	N	5	19	20	15
DK15-4B	Correlation Coefficient	0.100	-0.957	0.541	-0.904
	Sig. (2-tailed)	0.873	0.000	0.014	0.000
	N	5	19	20	15
DK15-4C	Correlation Coefficient	-0.100	-0.919	0.712	-0.924
	Sig. (2-tailed)	0.873	0.000	0.000	0.000
	N	5	19	20	15
DK15-4D	Correlation Coefficient	-0.500	-0.974	0.868	-0.880
	Sig. (2-tailed)	0.391	0.000	0.000	0.000
	N	5	19	20	15
DK16-2A	Correlation Coefficient	-0.900	-0.381	0.042	-0.449
	Sig. (2-tailed)	0.037	0.108	0.862	0.093
	N	5	19	20	15
DK16-2B	Correlation Coefficient	-	-0.926	0.732	-0.329
	Sig. (2-tailed)	-	0.000	0.000	0.231
	N	5	19	20	15
DK16-2C	Correlation Coefficient	-0.667	-0.945	0.749	-0.527
	Sig. (2-tailed)	0.219	0.000	0.000	0.043
	N	5	19	20	15
DK16-2D	Correlation Coefficient	-0.667	-0.853	0.835	-0.554
	Sig. (2-tailed)	0.219	0.000	0.000	0.032
	N	5	19	20	15
DK17-2A	Correlation Coefficient	-	0.282	0.883	0.129
	Sig. (2-tailed)	-	0.241	0.000	0.648
	N	4	19	20	15
DK17-2B	Correlation Coefficient	-1.000	-0.479	0.355	-0.692
	Sig. (2-tailed)	0.000	0.038	0.124	0.004
	N	5	19	20	15
DK17-2C	Correlation Coefficient	-	-0.376	0.111	-0.801
	Sig. (2-tailed)	-	0.113	0.641	0.000
	N	5	19	20	15
DK17-2D	Correlation Coefficient	-	-0.745	0.722	-0.382
	Sig. (2-tailed)	-	0.000	0.000	0.160
	N	5	19	20	15

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).

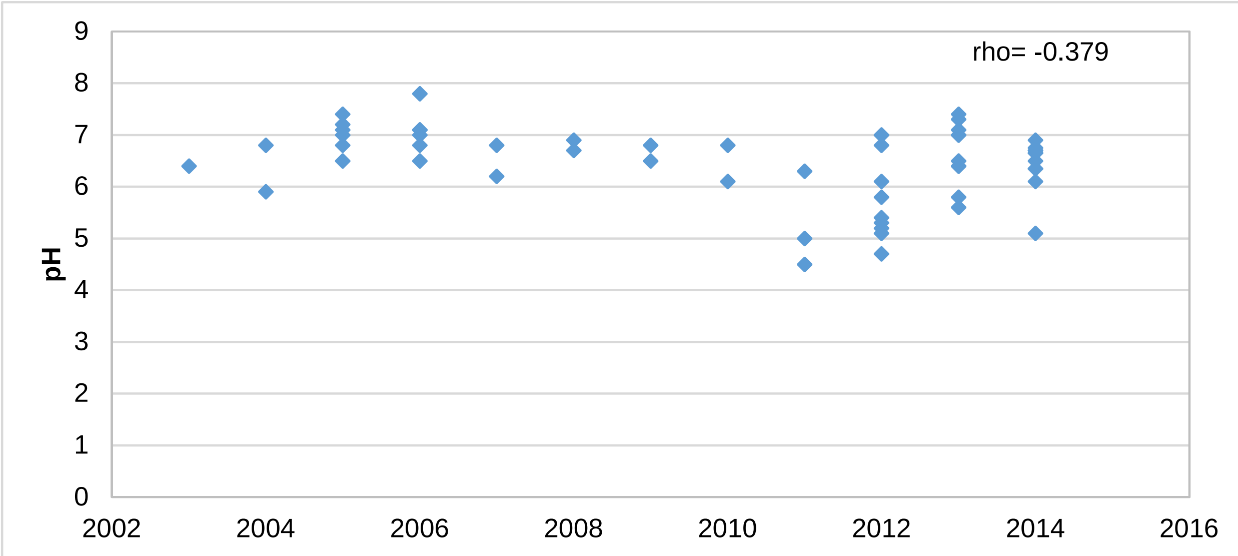
Significant trend where p<0.05.

Appendix Table C.3.24: Summary of seasonal trends for Quirke groundwater stations from 1990 to 2014.

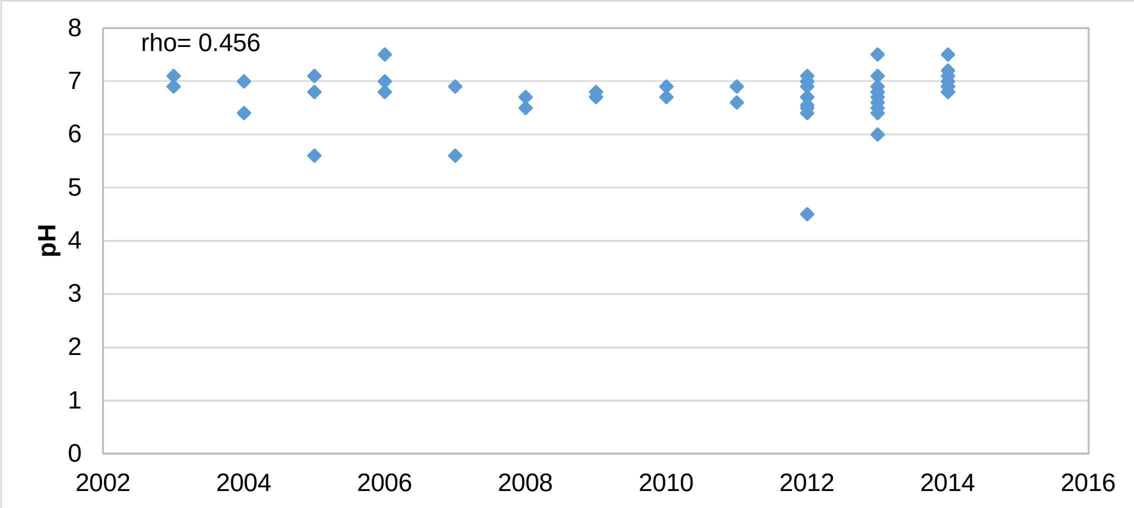
Station	Spearman rho	Acidity	Iron	pH	Sulphate
95QW-3A	Correlation Coefficient	-0.900	-0.800	0.364	-0.893
	Sig. (2-tailed)	0.037	0.000	0.115	0.000
	N	5	19	20	16
95QW-3C	Correlation Coefficient	-0.900	-0.719	0.914	-0.925
	Sig. (2-tailed)	0.037	0.001	0.000	0.000
	N	5	19	20	16
95QW-3D	Correlation Coefficient	-0.800	-0.184	0.895	-0.797
	Sig. (2-tailed)	0.104	0.450	0.000	0.000
	N	5	19	20	16
95QW-4	Correlation Coefficient	-	-0.303	-0.636	0.110
	Sig. (2-tailed)	-	0.207	0.003	0.663
	N	5	19	20	18
95QW-5A	Correlation Coefficient	-0.872	0.072	0.129	-0.074
	Sig. (2-tailed)	0.054	0.770	0.588	0.769
	N	5	19	20	18
95QW-5D	Correlation Coefficient	-	-0.532	-0.087	-0.245
	Sig. (2-tailed)	-	0.019	0.714	0.328
	N	5	19	20	18
QPW1-1	Correlation Coefficient	-	0.337	-0.405	-0.219
	Sig. (2-tailed)	-	0.125	0.061	0.354
	N	5	22	22	20
QPW1-4	Correlation Coefficient	-	0.691	-0.444	0.067
	Sig. (2-tailed)	-	0.000	0.026	0.762
	N	5	25	25	23
QPW1-8	Correlation Coefficient	-	0.626	-0.397	0.822
	Sig. (2-tailed)	-	0.001	0.050	0.000
	N	5	25	25	23

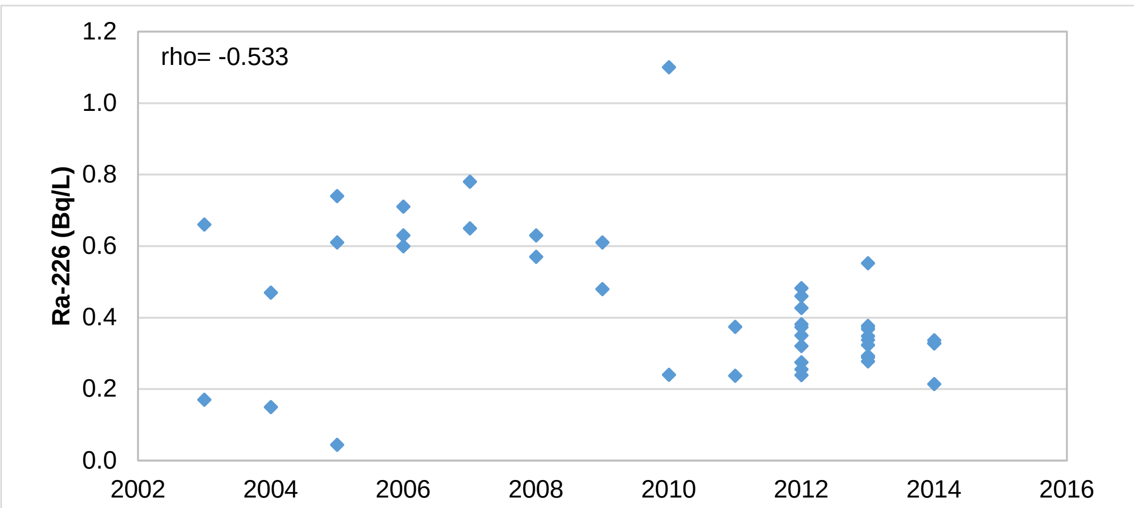
Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

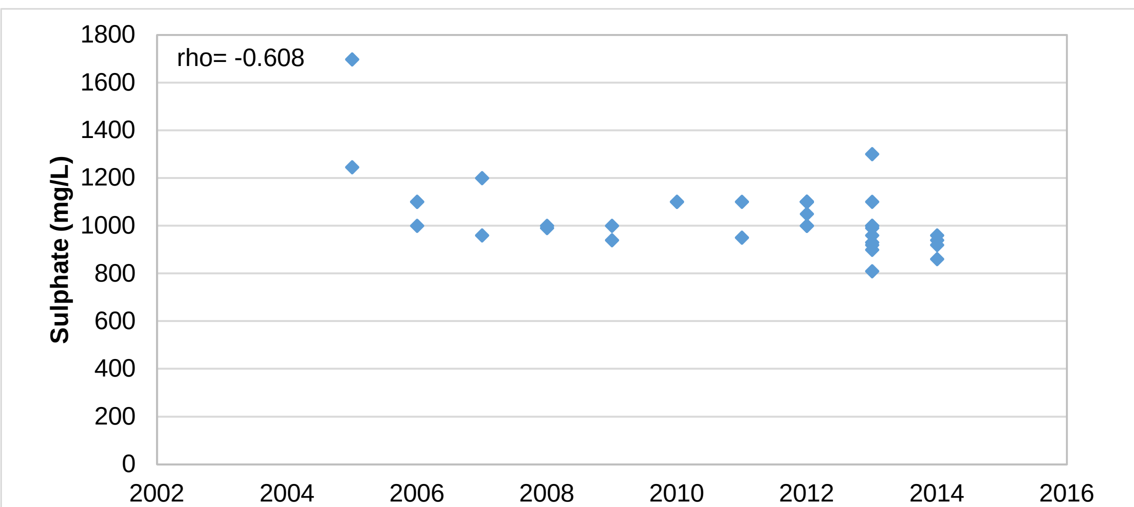
[shaded box] Significant trend where $p<0.05$.



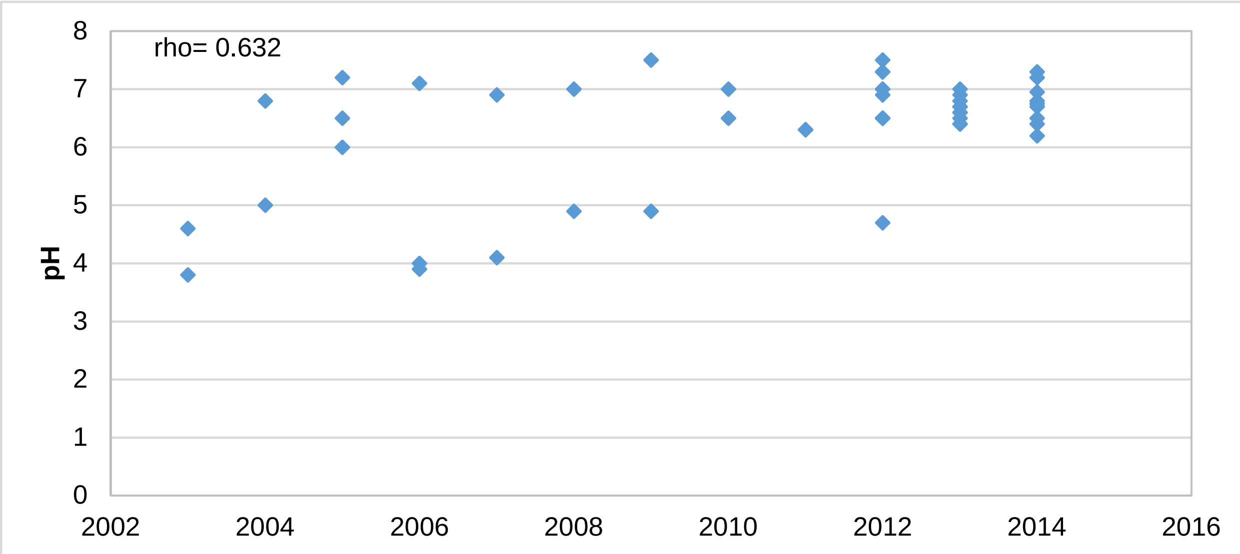
Appendix Figure C.3.1: Significant common (average) trends observed for pH over all seasons at Station Cell 14, 2003 to 2014.

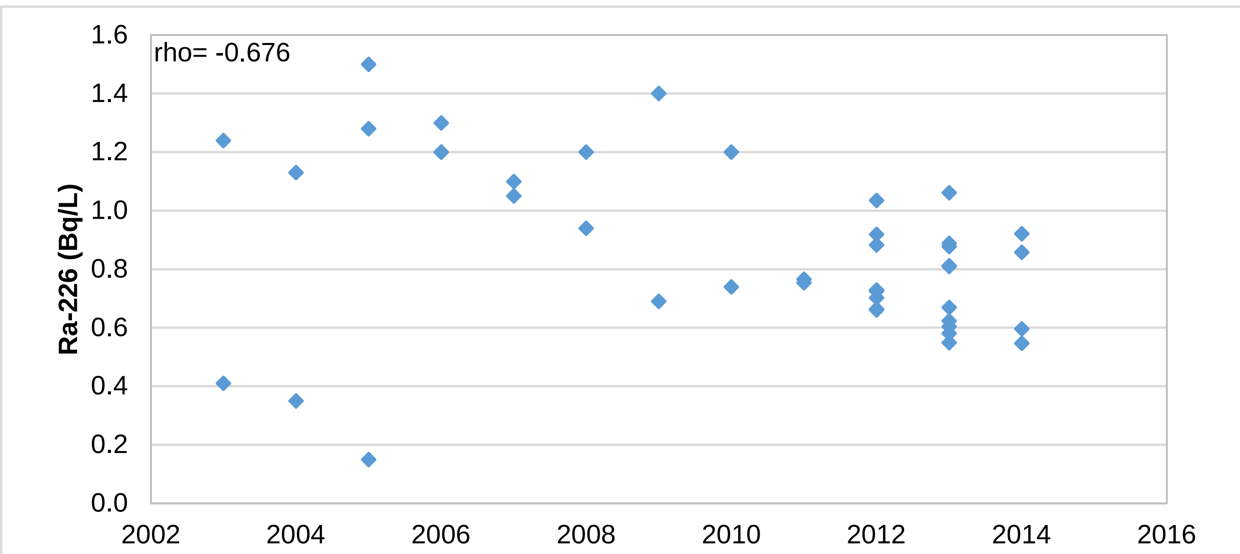




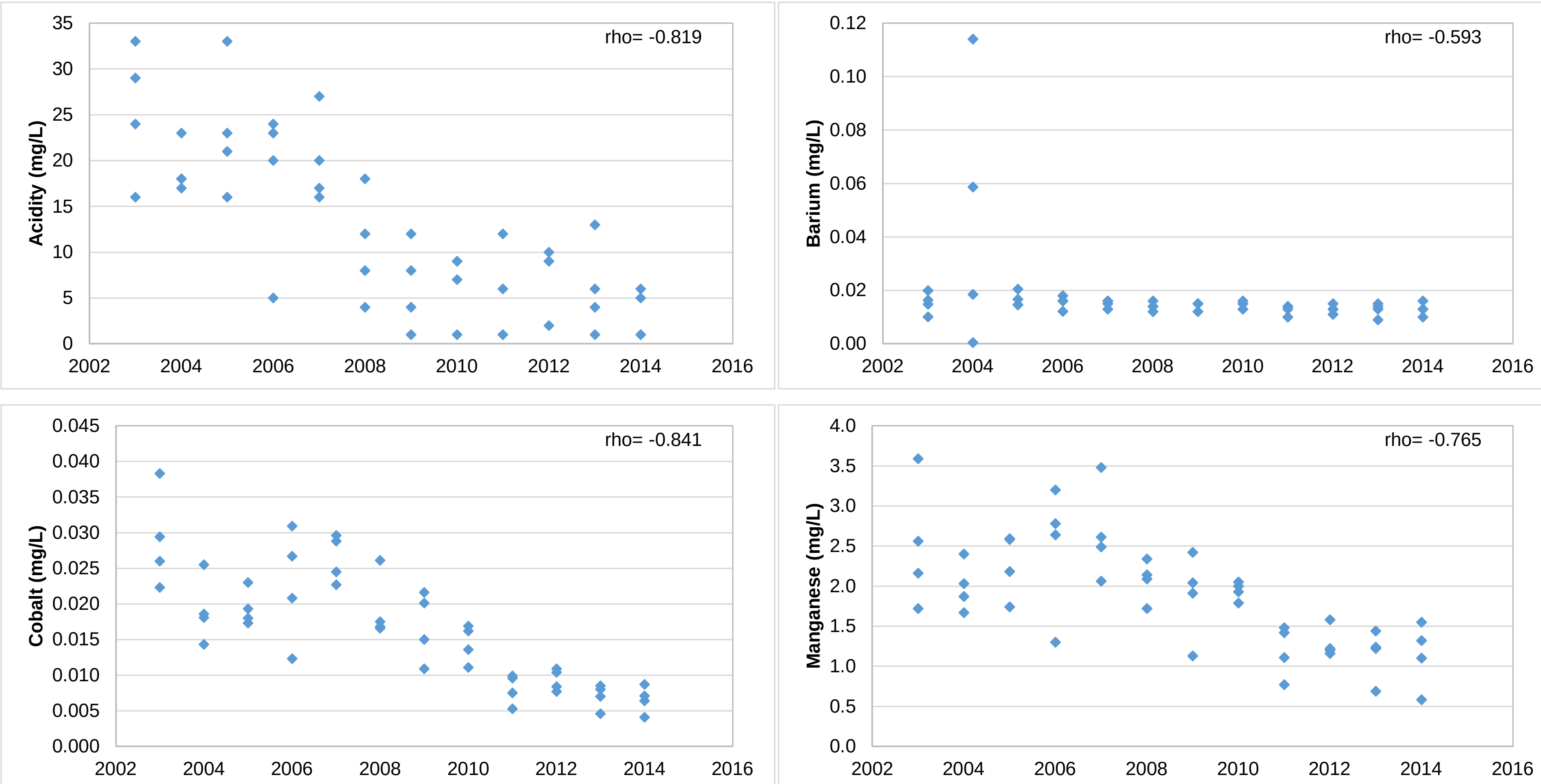


Appendix Figure C.3.2: Significant common (average) trends observed for pH, radium-226 and sulphate, over all seasons at Station Cell 16S, 2003 to 2014.

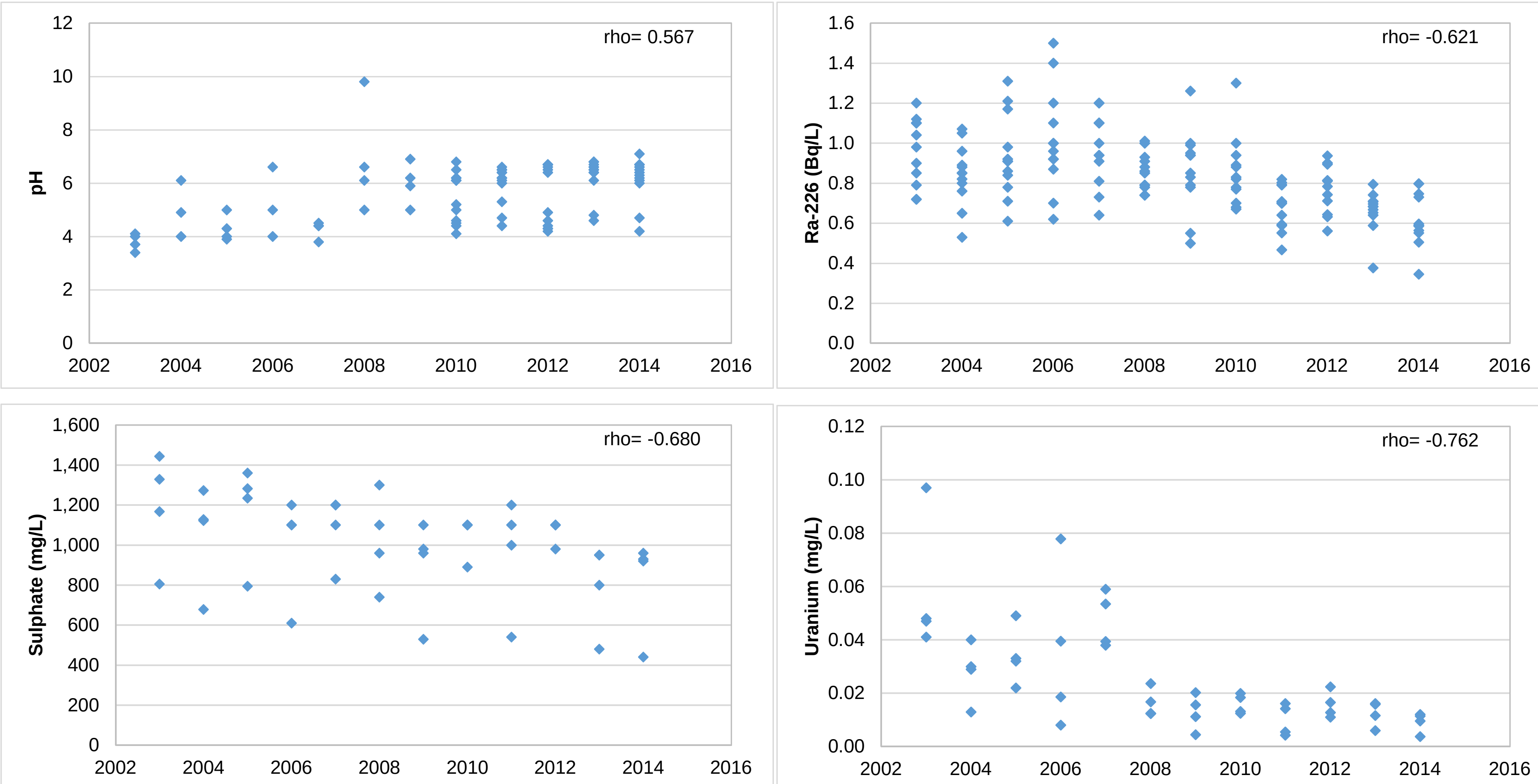




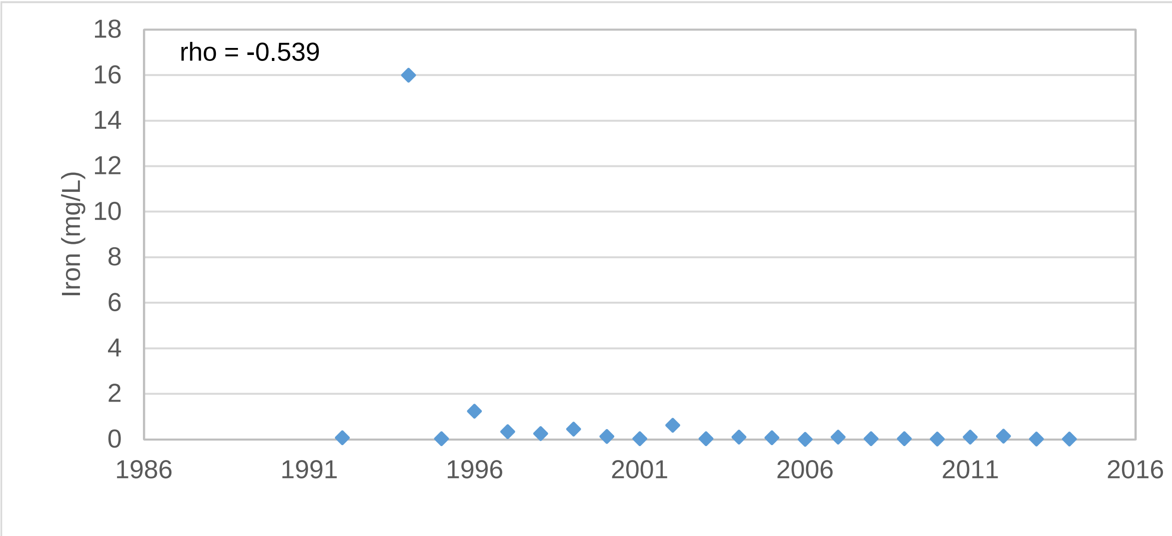
Appendix Figure C.3.3: Significant common (average) trends observed for pH and radium-226 over all seasons at Station Cell 17, 2003 to 2014.

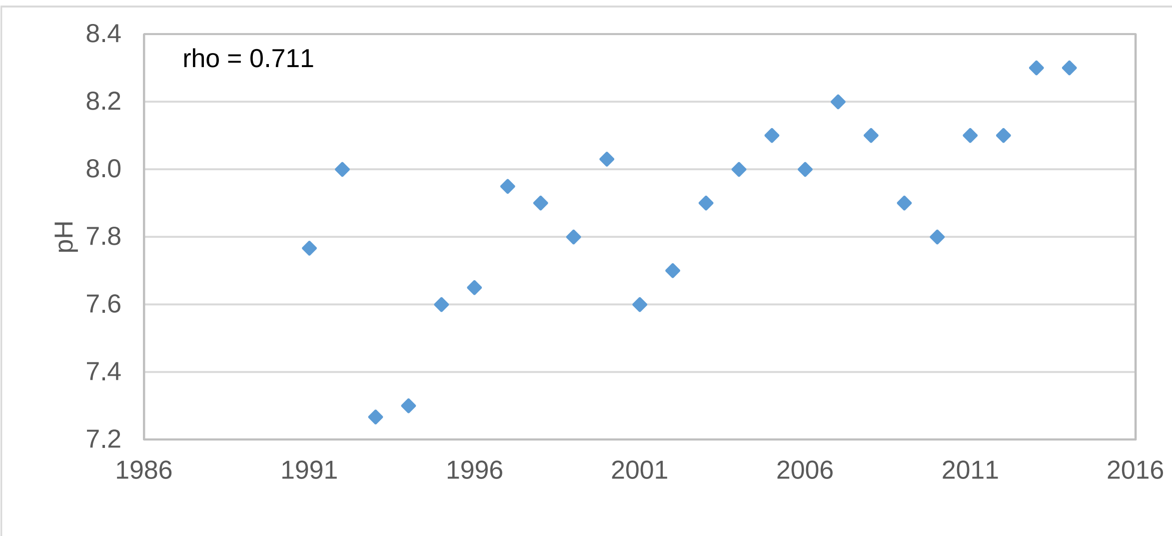


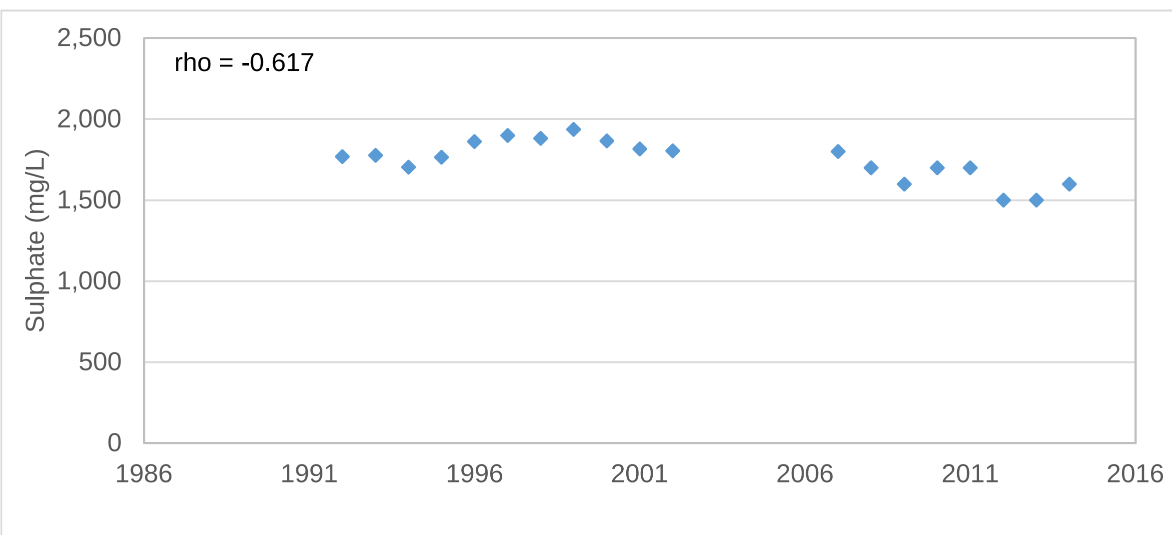
Appendix Figure C.3.4: Significant common (average) trends observed for acidity, barium, cobalt, manganese, pH, radium-226, sulphate and uranium, over all seasons at Station Q-05, 2003 to 2014.



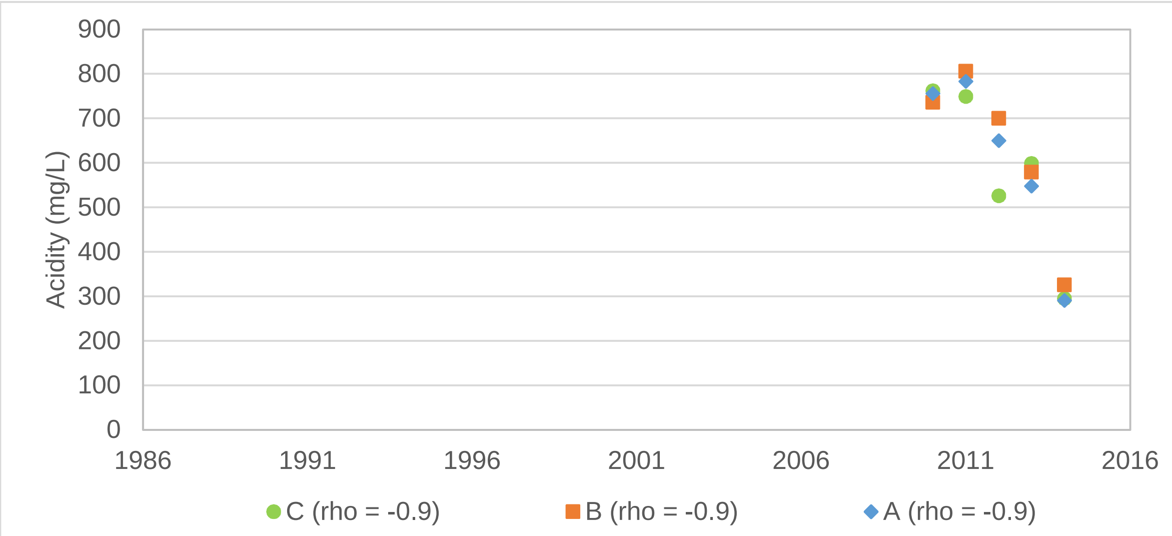
Appendix Figure C.3.4: Significant common (average) trends observed for acidity, barium, cobalt, manganese, pH, radium-226, sulphate and uranium, over all seasons at Station Q-05, 2003 to 2014.

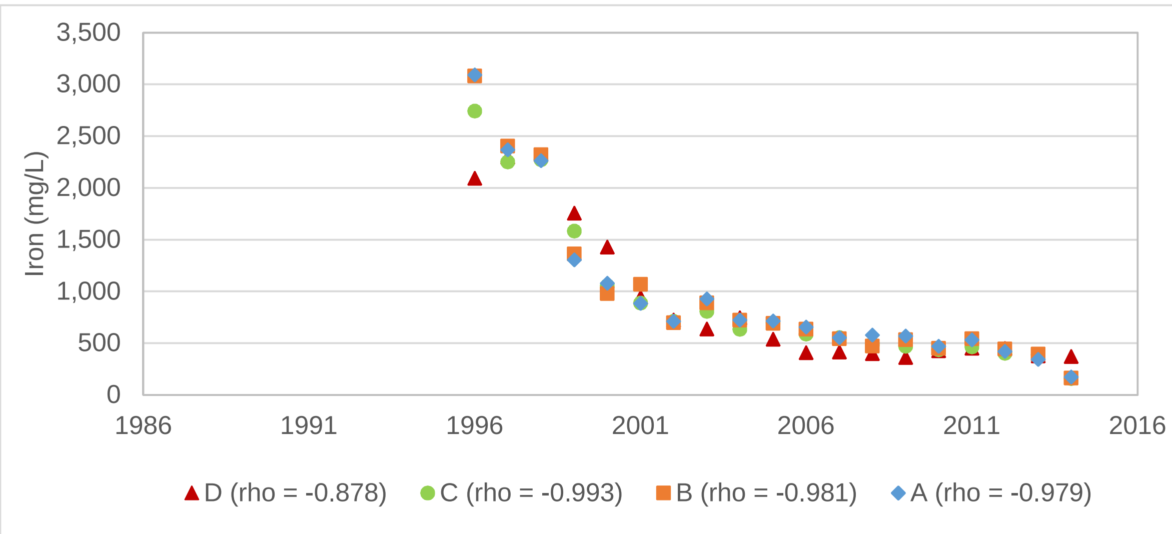


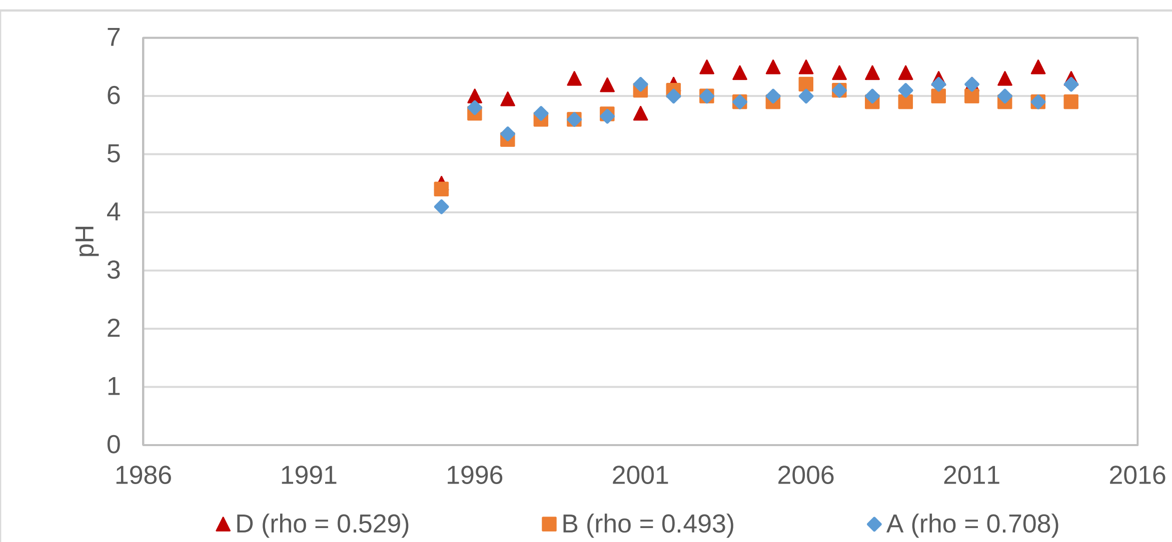




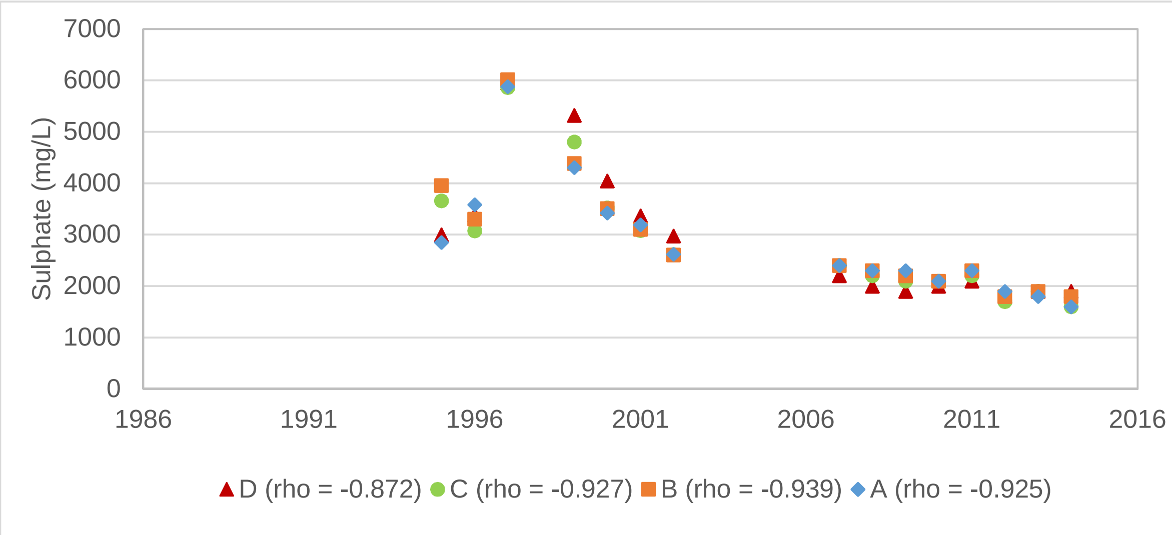
Appendix Figure C.3.5: Significant trends observed for iron, pH and sulphate at station DK14-5C, 1991 to 2014.



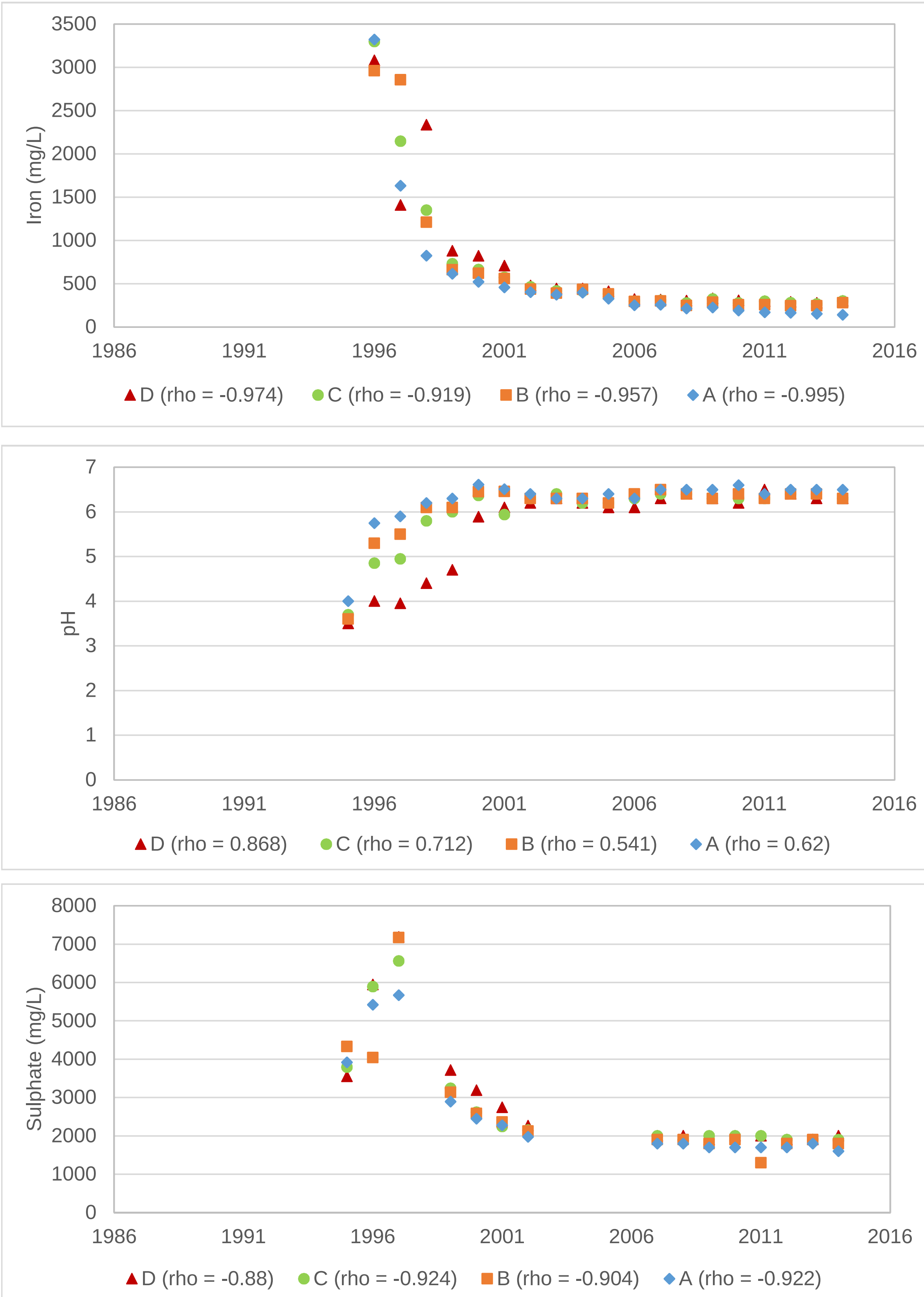




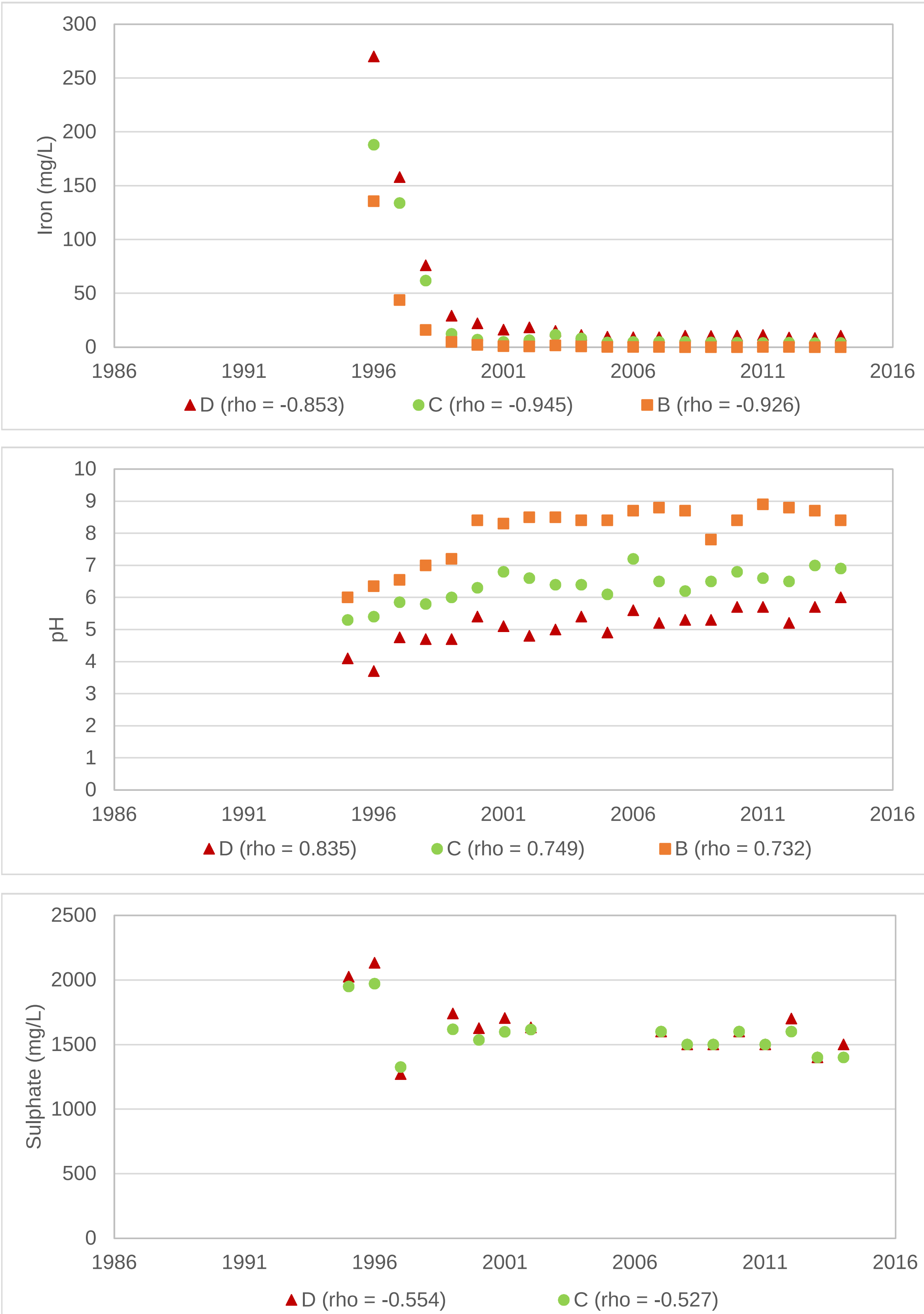
Appendix Figure C.3.6: Significant trends observed for acidity, iron, pH and sulphate at station DK15-2A,B,C,D, 1995 to 2014.



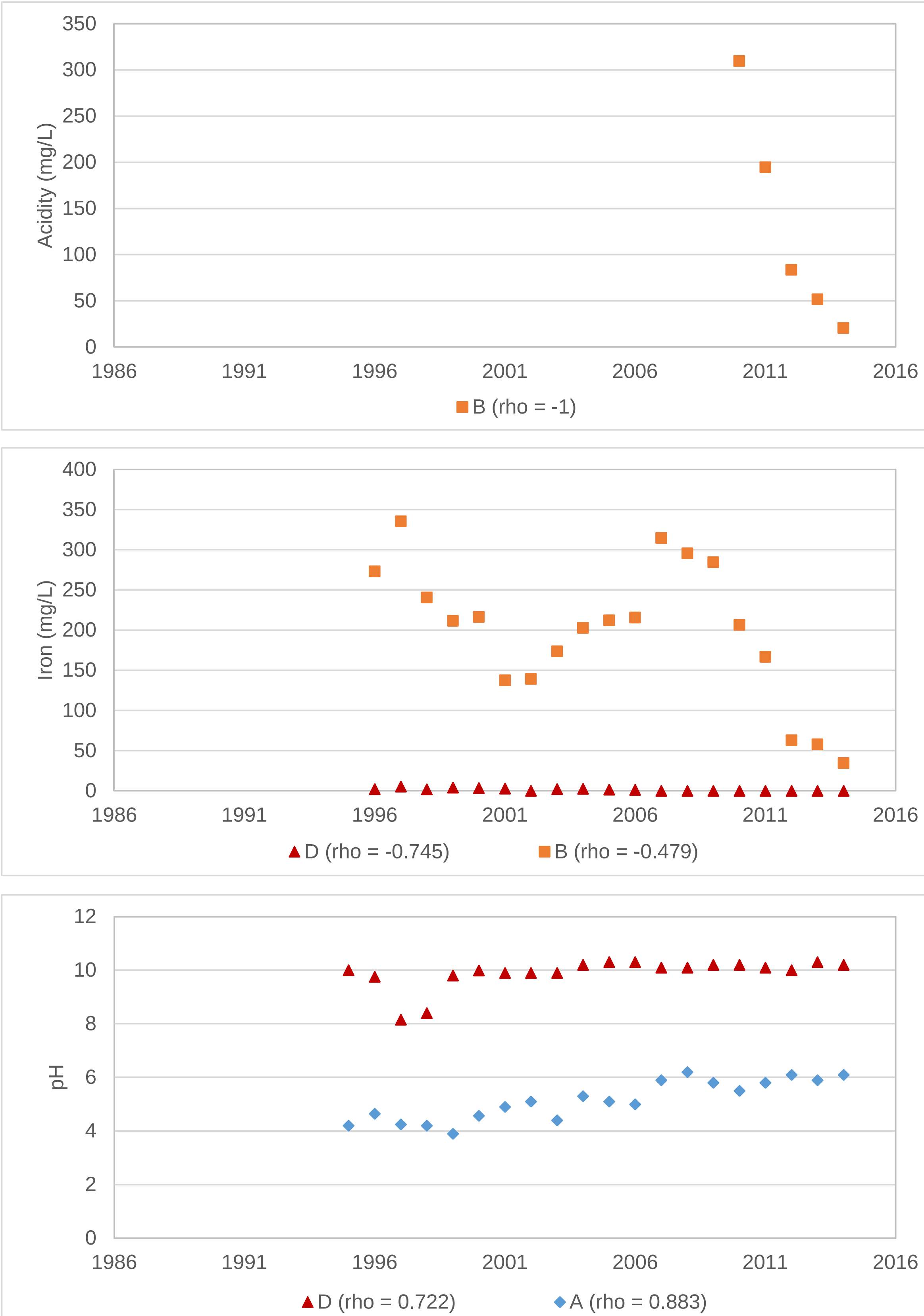
Appendix Figure C.3.6: Significant trends observed for acidity, iron, pH and sulphate at station DK15-2A,B,C,D, 1995 to 2014.



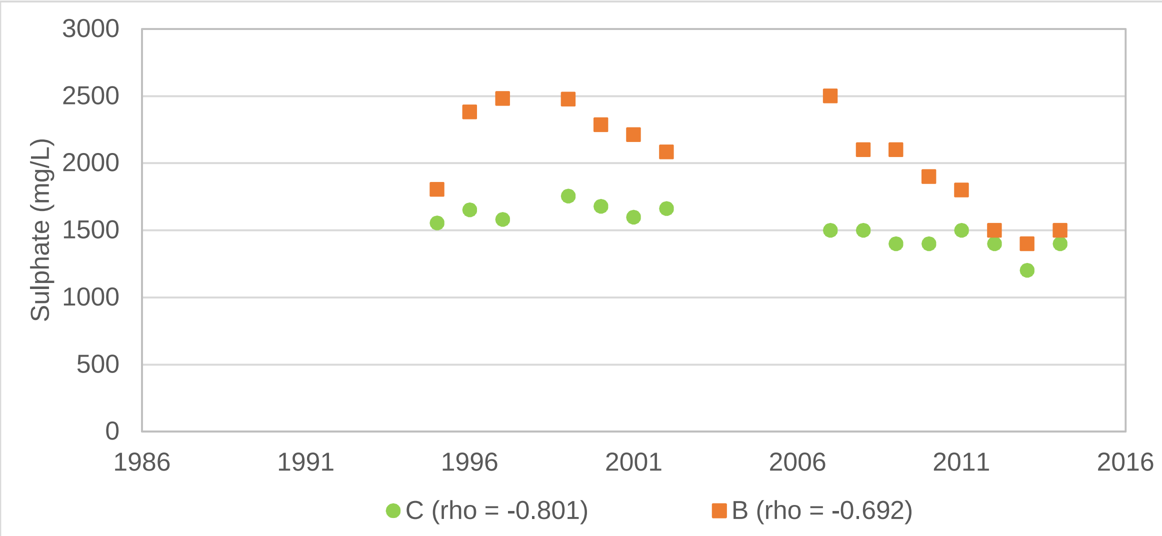
Appendix Figure C.3.7: Significant trends observed for iron, pH and sulphate at station DK15-4A,B,C,D, 1995 to 2014.



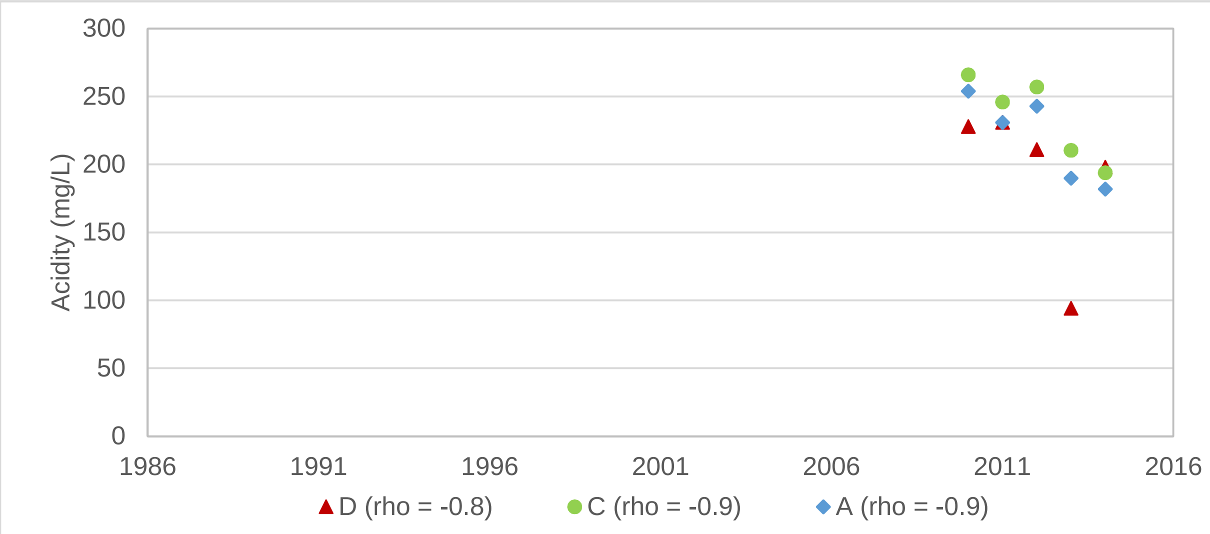
Appendix Figure C.3.8: Significant trends observed for iron, pH and sulphate at station DK16-2A,B,C,D, 1995 to 2014.

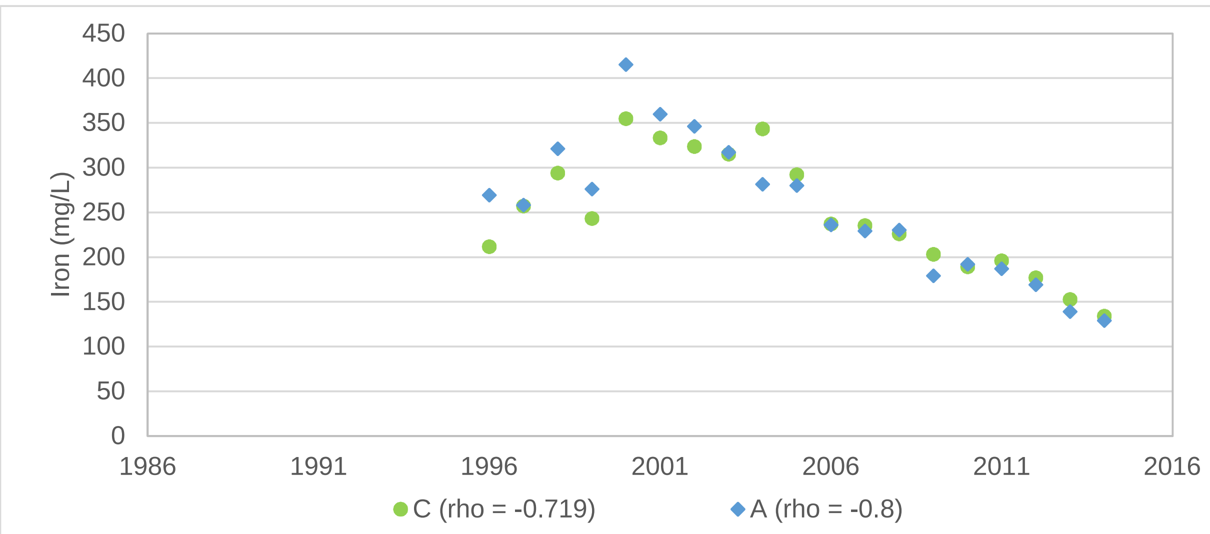


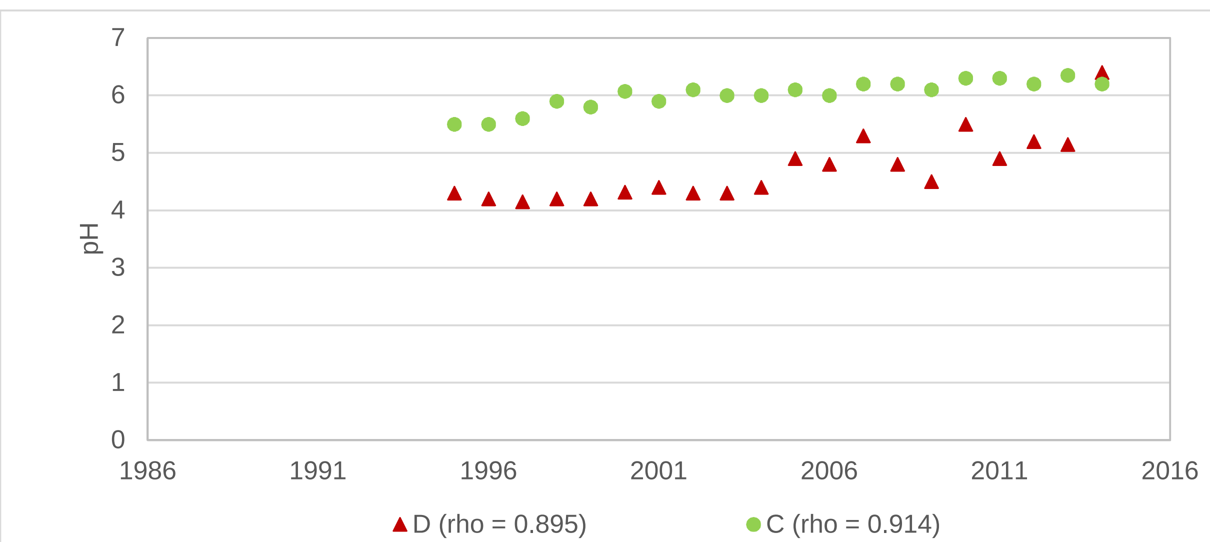
Appendix Figure C.3.9: Significant trends observed for acidity, iron, pH and sulphate at station DK17-2A,B,C,D, 1995 to 2014.



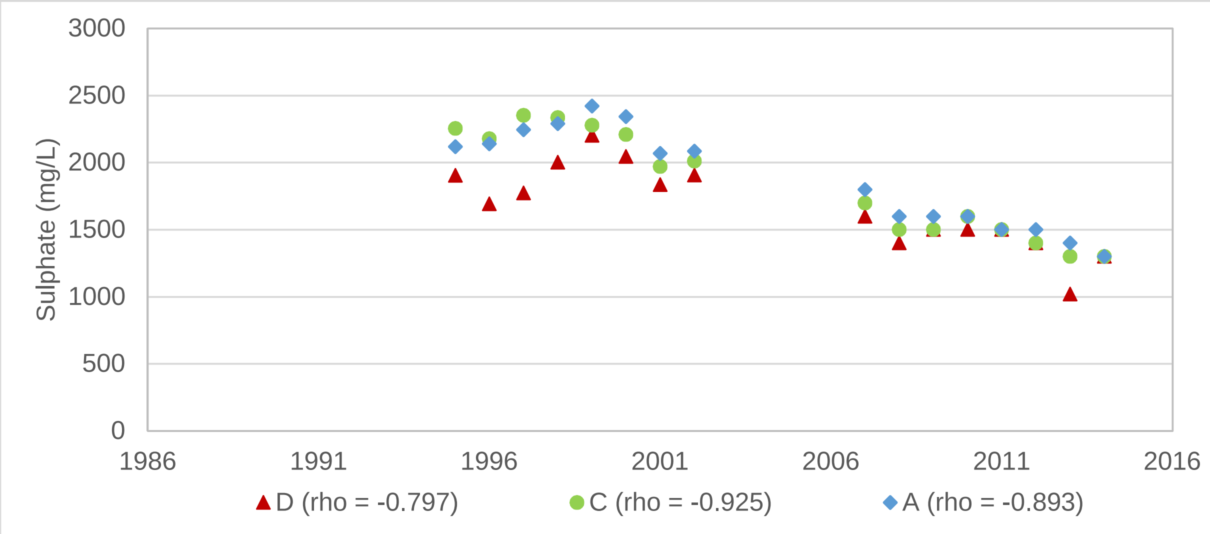
Appendix Figure C.3.9: Significant trends observed for acidity, iron, pH and sulphate at station DK17-2A,B,C,D, 1995 to 2014.



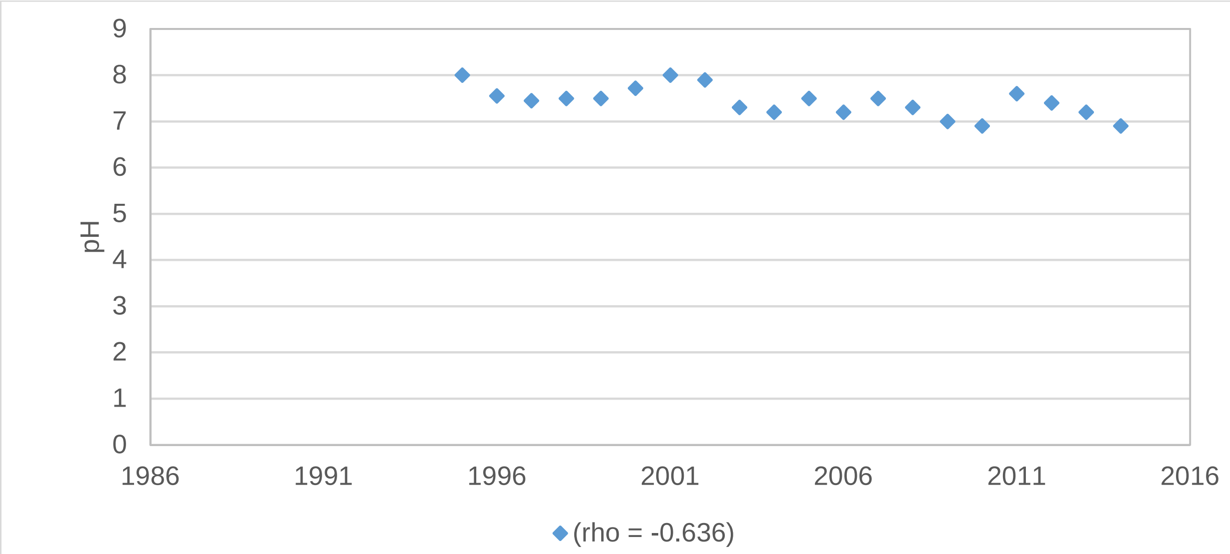




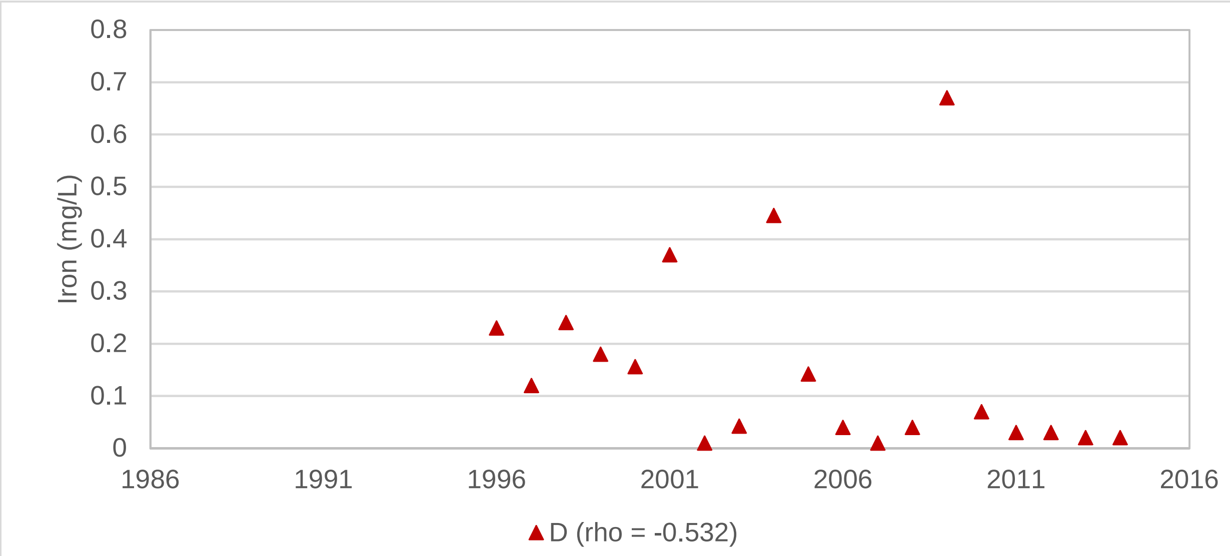
Appendix Figure C.3.10: Significant trends observed for acidity, iron, pH and sulphate at station 95QW3A,C,D, 1995 to 2014.



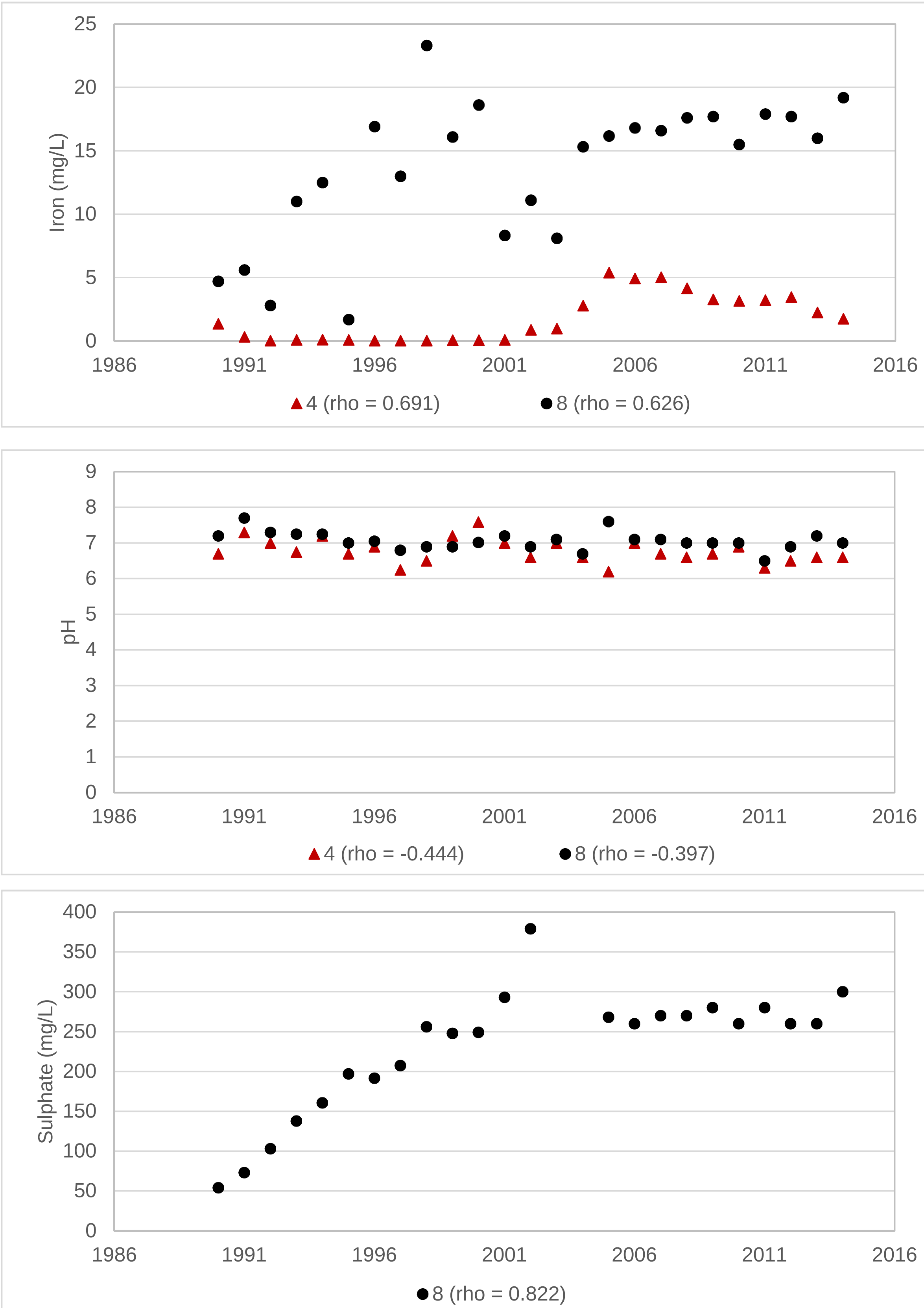
Appendix Figure C.3.10: Significant trends observed for iron, pH and sulphate at station 95QW-3A,C,D, 1995 to 2014.



Appendix Figure C.3.11: Significant trends observed for pH at station 95QW-4, 1995 to 2014.



Appendix Figure C.3.12: Significant trends observed for iron at station 95QW-5D, 1995 to 2014.



Appendix Figure C.3.13: Significant trends observed for iron, pH and sulphate at station QPW1-1,4,8, 1990 to 2014.

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 2010 to 2014

Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH
9/29/2010	8.3	4/19/2011	8.3	11/17/2011	8.2	11/14/2012	8.2	4/19/2013	8.0
9/30/2010	8.3	4/20/2011	8.2	11/18/2011	8.3	11/15/2012	8.2	4/22/2013	8.0
10/1/2010	8.5	4/21/2011	8.4	11/21/2011	8.3	11/16/2012	8.3	4/23/2013	8.2
10/8/2010	8.3	4/25/2011	8.3	11/22/2011	8.2	11/19/2012	8.2	4/24/2013	8.1
10/12/2010	8.6	4/26/2011	8.3	11/23/2011	8.2	11/20/2012	8.2	4/25/2013	8.1
10/13/2010	9.1	4/27/2011	8.3	2/14/2012	8.3	11/21/2012	8.2	4/26/2013	8.1
10/14/2010	8.8	4/28/2011	8.1	2/15/2012	8.3	11/22/2012	8.2	4/29/2013	7.9
11/18/2010	8.2	4/29/2011	8.4	2/16/2012	8.2	11/23/2012	8.2	4/30/2013	7.9
11/19/2010	8.3	5/2/2011	8.1	2/17/2012	8.2	11/26/2012	8.2	5/1/2013	7.9
11/22/2010	8.4	5/3/2011	8.2	2/21/2012	8.2	11/27/2012	8.3	5/2/2013	8.2
11/23/2010	8.5	5/4/2011	8.3	2/22/2012	8.1	11/28/2012	8.1	5/3/2013	8.2
11/24/2010	8.5	5/5/2011	8.1	2/23/2012	8.2	11/29/2012	8.1	5/6/2013	8.0
11/25/2010	8.5	5/6/2011	8.3	2/24/2012	8.2	11/30/2012	8.2	5/7/2013	8.0
11/26/2010	8.4	5/9/2011	8.3	2/27/2012	8.3	2/22/2013	8.2	5/8/2013	8.2
11/30/2010	8.4	5/10/2011	8.3	2/28/2012	8.3	2/25/2013	8.4	5/9/2013	8.2
12/1/2010	8.3	5/11/2011	8.1	2/29/2012	8.0	2/26/2013	8.2	5/10/2013	8.0
12/2/2010	8.4	5/12/2011	8.0	3/1/2012	8.2	2/27/2013	8.3	5/13/2013	7.9
12/3/2010	8.4	5/13/2011	8.4	3/2/2012	8.2	2/28/2013	8.2	5/14/2013	8.2
12/6/2010	8.2	5/16/2011	8.2	3/5/2012	7.9	3/1/2013	8.3	5/15/2013	8.1
12/7/2010	8.6	5/17/2011	8.3	3/6/2012	8.1	3/4/2013	8.3	5/16/2013	8.0
12/8/2010	8.4	5/18/2011	8.1	3/7/2012	7.9	3/5/2013	8.3	5/17/2013	8.0
12/9/2010	8.2	6/6/2011	8.1	3/8/2012	8.2	3/6/2013	8.2	5/21/2013	7.9
12/10/2010	8.2	6/7/2011	8.1	3/9/2012	8.0	3/7/2013	8.2	6/4/2013	8.2
12/13/2010	7.8	6/8/2011	8.3	3/12/2012	8.0	3/8/2013	8.3	6/5/2013	8.2
12/14/2010	8.2	6/9/2011	8.1	3/13/2012	8.0	3/11/2013	8.2	6/6/2013	8.1
12/15/2010	8.0	6/10/2011	8.1	3/14/2012	7.8	3/12/2013	8.2	6/7/2013	8.0
12/16/2010	8.5	6/13/2011	8.3	3/15/2012	8.4	3/13/2013	8.1	6/10/2013	8.0
12/17/2010	8.1	6/14/2011	8.2	3/16/2012	7.8	3/14/2013	8.2	6/11/2013	8.2
12/20/2010	8.4	6/15/2011	8.2	3/19/2012	7.9	3/15/2013	8.2	6/12/2013	8.1
12/21/2010	8.2	6/16/2011	8.1	3/20/2012	7.8	3/18/2013	8.2	6/13/2013	8.2
12/22/2010	8.2	6/17/2011	8.2	3/21/2012	8.1	3/19/2013	8.1	6/14/2013	8.0
12/23/2010	8.0	6/20/2011	8.2	3/22/2012	8.1	3/20/2013	8.1	7/25/2013	8.0
12/24/2010	8.1	6/21/2011	8.1	3/23/2012	8.0	3/21/2013	8.1	7/26/2013	8.0
1/4/2011	8.4	6/22/2011	8.1	3/26/2012	7.7	3/22/2013	8.2	7/29/2013	8.3
1/5/2011	8.2	6/23/2011	7.9	3/27/2012	8.2	3/25/2013	8.1	7/30/2013	8.3
1/6/2011	8.5	10/25/2011	8.2	3/28/2012	7.9	3/26/2013	8.1	7/31/2013	8.3
1/7/2011	8.2	10/26/2011	8.1	3/29/2012	8.0	3/27/2013	8.0	8/1/2013	8.3
1/10/2011	8.3	10/27/2011	8.2	3/30/2012	8.2	3/28/2013	8.1	8/2/2013	8.5
1/11/2011	8.5	10/28/2011	8.3	4/2/2012	8.1	4/1/2013	8.1	8/6/2013	8.3
1/12/2011	8.1	10/31/2011	8.3	4/3/2012	8.2	4/2/2013	8.0	8/7/2013	8.3
1/13/2011	8.0	11/1/2011	8.3	4/4/2012	8.1	4/3/2013	8.2	8/8/2013	8.2
1/14/2011	8.4	11/2/2011	8.3	4/5/2012	8.2	4/4/2013	8.1	8/9/2013	8.5
1/17/2011	8.1	11/3/2011	8.3	5/31/2012	8.3	4/5/2013	8.0	8/12/2013	8.5
1/18/2011	8.1	11/4/2011	8.1	6/1/2012	8.5	4/8/2013	8.0	8/13/2013	8.5
1/19/2011	8.1	11/7/2011	8.2	11/2/2012	8.4	4/9/2013	8.2	8/14/2013	8.3
1/20/2011	8.0	11/8/2011	8.2	11/5/2012	8.4	4/10/2013	8.0	8/15/2013	8.3
1/21/2011	8.1	11/9/2011	8.2	11/6/2012	8.4	4/11/2013	8.2	8/16/2013	8.1
1/24/2011	8.1	11/10/2011	8.0	11/7/2012	8.4	4/12/2013	8.2	8/19/2013	8.3
1/25/2011	8.1	11/11/2011	8.2	11/8/2012	8.4	4/15/2013	8.0	9/24/2013	8.1
1/26/2011	8.2	11/14/2011	8.1	11/9/2012	8.4	4/16/2013	8.0	9/25/2013	8.2
1/27/2011	8.0	11/15/2011	8.2	11/12/2012	8.2	4/17/2013	8.1	9/26/2013	8.4
4/18/2011	8.4	11/16/2011	8.2	11/13/2012	8.2	4/18/2013	8.0	9/27/2013	8.2

Appendix Table C.4.2: Water quality at station ECA-349 from 2010 to 2014

Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH
9/30/2013	8.2	1/15/2014	8.3	5/1/2014	8.0	10/27/2014	8.1		
10/1/2013	8.3	1/16/2014	8.2	5/2/2014	8.0	10/28/2014	8.0		
10/2/2013	8.4	1/17/2014	8.2	5/5/2014	8.1	10/29/2014	8.1		
10/3/2013	8.3	1/20/2014	8.3	5/6/2014	8.1	10/30/2014	8.1		
10/4/2013	8.4	1/21/2014	8.2	5/7/2014	8.0	10/31/2014	8.1		
10/7/2013	8.5	1/22/2014	8.2	5/8/2014	8.1	11/3/2014	8.0		
10/8/2013	8.4	1/23/2014	8.2	5/9/2014	8.2	11/4/2014	8.0		
10/9/2013	8.3	1/24/2014	8.2	5/12/2014	8.1	11/5/2014	8.0		
10/10/2013	8.3	1/27/2014	8.3	5/13/2014	8.2	11/6/2014	7.9		
10/11/2013	8.4	1/28/2014	8.3	5/14/2014	8.1	11/7/2014	8.0		
10/15/2013	8.4	1/29/2014	8.4	5/15/2014	8.2	11/10/2014	8.0		
10/16/2013	8.4	1/30/2014	8.2	5/16/2014	8.0	11/11/2014	8.0		
10/17/2013	8.5	1/31/2014	8.2	5/20/2014	8.2	11/12/2014	7.9		
10/18/2013	8.5	2/3/2014	8.2	5/21/2014	8.2	11/13/2014	8.0		
10/21/2013	8.5	2/4/2014	8.4	5/22/2014	8.1	11/14/2014	8.0		
10/22/2013	8.5	2/5/2014	8.4	5/23/2014	8.1	11/17/2014	8.2		
11/13/2013	8.4	2/6/2014	8.3	5/26/2014	8.3	11/18/2014	8.1		
11/14/2013	8.6	2/7/2014	8.0	5/27/2014	8.3	11/19/2014	8.1		
11/15/2013	8.6	2/10/2014	8.4	5/28/2014	8.3	11/20/2014	8.1		
11/18/2013	8.3	2/11/2014	8.2	5/29/2014	8.3	11/21/2014	8.3		
11/19/2013	8.2	2/12/2014	8.1	5/30/2014	8.3	11/24/2014	8.2		
11/20/2013	8.2	2/13/2014	8.4	6/2/2014	8.3	11/25/2014	8.4		
11/21/2013	8.3	2/14/2014	8.5	6/4/2014	8.4	11/26/2014	8.4		
11/22/2013	8.4	2/18/2014	8.7	6/5/2014	8.1	11/27/2014	8.4		
11/25/2013	8.3	2/19/2014	8.6	6/6/2014	8.1	11/28/2014	8.2		
11/26/2013	8.4	2/20/2014	8.7	6/9/2014	8.2	12/1/2014	8.4		
11/27/2013	8.3	2/21/2014	8.7	6/10/2014	8.1	12/2/2014	8.4		
11/28/2013	8.3	2/24/2014	8.4	6/11/2014	8.2	12/3/2014	8.3		
11/29/2013	8.3	2/25/2014	8.5	6/12/2014	8.3	12/4/2014	8.1		
12/2/2013	8.3	2/26/2014	8.5	6/13/2014	8.3	12/5/2014	8.1		
12/3/2013	8.2	2/27/2014	8.5	6/16/2014	8.1	12/8/2014	8.1		
12/4/2013	8.3	2/28/2014	8.1	6/17/2014	8.4	12/9/2014	8.2		
12/5/2013	8.2	3/3/2014	8.0	6/18/2014	8.5	12/10/2014	8.0		
12/6/2013	8.3	3/4/2014	8.0	6/19/2014	8.5	12/11/2014	7.9		
12/9/2013	8.2	3/5/2014	8.0	6/20/2014	8.5	12/12/2014	8.0		
12/10/2013	8.2	3/6/2014	8.0	6/23/2014	8.3	12/15/2014	8.1		
12/11/2013	8.2	3/7/2014	8.0	6/24/2014	8.6	12/16/2014	8.0		
12/12/2013	8.3	3/10/2014	8.0	6/25/2014	8.5	12/17/2014	8.1		
12/13/2013	8.2	3/11/2014	8.0	6/26/2014	8.5	12/18/2014	8.0		
12/16/2013	8.2	3/12/2014	8.1	6/27/2014	8.5	12/19/2014	8.0		
12/17/2013	8.2	3/13/2014	8.1	10/8/2014	8.3	12/22/2014	8.0		
12/18/2013	8.3	3/14/2014	8.0	10/9/2014	8.3	12/23/2014	8.0		
12/19/2013	8.3	3/17/2014	7.9	10/10/2014	8.3	**count**	**458**		
12/20/2013	8.3	3/18/2014	8.0	10/14/2014	8.3	**min**	**7.7**		
12/23/2013	8.3	3/19/2014	8.1	10/15/2014	8.1	**max**	**9.1**		
1/6/2014	8.6	3/20/2014	8.1	10/16/2014	7.9	**mean**	**8.2**		
1/7/2014	8.6	3/21/2014	8.0	10/17/2014	7.8	**median**	**8.2**		
1/8/2014	8.6	3/24/2014	8.1	10/20/2014	7.8				
1/9/2014	8.6	3/25/2014	8.1	10/21/2014	7.8				
1/10/2014	8.6	3/26/2014	8.0	10/22/2014	8.0				
1/13/2014	8.6	3/27/2014	8.1	10/23/2014	8.0				
1/14/2014	8.4	4/30/2014	7.9	10/24/2014	8.0				

Appendix Table C.4.3: Water quality at station P-13 from 2010 to 2014.

Date m/d/yr	Acidity mg/L	Ba mg/L	Co mg/L	Fe mg/L	Mn mg/L	pH	Ra Bq/L	Sulphate mg/L	TSS mg/L	U mg/L
24-06-10	< 1	0.018	< 0.0005	0.05	0.028	7.2	0.37	180		0.0041
14-10-10						7.2	0.48			
11-11-10										
25-11-10	< 1	0.02	< 0.0005	0.09	0.013	7.4	0.46	180		0.0059
09-12-10						7.4	0.46			
13-01-11						7.1	0.427			
10-02-11	< 1	0.03	< 0.0005	0.03	0.034		0.449	180		0.0059
10-03-11			< 0.0005							
28-04-11						6.7	0.498			
12-05-11	< 1	0.02	0.001	0.17	0.058	6.7	0.365	130		0.0043
16-06-11						7.2	0.297			
10-11-11	< 1	0.021	< 0.0005	0.1	0.015	7.2	0.387	150		0.0048
23-02-12	< 1	0.025	< 0.0005	0.16	0.035	7.0	0.401	170		0.0063
08-03-12						6.9	0.412			
03-04-12						6.9	0.328			
15-11-12	< 1	0.024	< 0.0005	0.1	0.011	7.5	0.459	160		0.0066
14-03-13	< 1	0.031	< 0.0005	0.1	0.032	7.1	0.481	160		0.0077
11-04-13						6.9	0.425			
09-05-13	< 1	0.015	< 0.0005	0.11	0.021	7.1	0.287	82		0.0008
13-06-13						7.3	0.372			
01-08-13	< 1	0.021	< 0.0005	1.86	0.039	7.0	0.354	140		0.0043
26-09-13						7.2	0.43			
10-10-13						7.4	0.399			
21-11-13	< 1	0.022	< 0.0005	0.23	0.018	7.1	0.387	140		0.0058
11-12-13						7.4	0.384			
09-01-14	< 1	0.024	< 0.0005	0.21	0.025	7.0	0.366	140	1	0.0064
13-02-14	< 1	0.024	< 0.0005	0.15	0.026	7.0	0.344	150	1	0.0066
18-03-14	< 1	0.023	< 0.0005	0.3	0.041	7.0	0.388	150	< 1	0.0066
16-04-14	< 1	0.025	< 0.0005	0.82	0.065	6.5	0.525	150	2	0.0056
08-05-14	< 1	0.024	0.0006	0.23	0.166	6.8	0.527	150	< 1	0.0062
12-06-14	< 1	0.017	< 0.0005	0.52	0.062	7.0	0.291	120	< 1	0.0048
10-07-14	< 1	0.025	< 0.0005	0.73	0.187	7.2	0.607	120	2	0.004
05-08-14	< 1	0.026	< 0.0005	0.84	0.441	6.8	0.742	130	2	0.0036
18-09-14	< 1	0.028	0.0007	0.57	0.587		0.768	130	2	0.0037
16-10-14	< 1	0.021	< 0.0005	0.25	0.022	7.3	0.339	130	< 1	0.0052
06-11-14	< 1	0.019	< 0.0005	0.12	0.013	7.3	0.352	130		0.0049
08-12-14	< 1	0.021	< 0.0005	0.32	0.016	7.2	0.358	120	< 1	0.0058
count	23	23	24	23	23	33	35	23	11	23
min	< 1	0.015	< 0.0005	0.03	0.011	6.5	0.287	82	< 1	0.001
max	1	0.031	0.0010	1.86	0.587	7.5	0.768	180	2	0.008
mean	1	0.023	0.0005	0.35	0.085	7.1	0.426	143	1.4	0.005
median	1	0.023	0.0005	0.21	0.032	7.1	0.399	140	1	0.006
10th Percentile	1	0.018	0.0005	0.09	0.013	6.8	0.332	120	1	0.004
95th Percentile	1	0.030	0.0007	0.84	0.416	7.4	0.648	180	2	0.007

[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 C4.4: Water quality at station P-15 from 2010 to 2014.

Date m/d/yr	Conductivity µmho/cm	Date m/d/yr	Conductivity µmho/cm
1/15/2010	422.7	7/12/2012	484.0
2/12/2010	465.0	8/9/2012	514.0
3/16/2010	409.8	9/13/2012	536.0
4/26/2010	415.5	10/11/2012	572.0
5/19/2010	433.4	11/15/2012	422.0
6/11/2010	506.0	12/12/2012	467.0
7/26/2010	551.0	1/10/2013	519.0
8/18/2010	583.0	2/14/2013	483.0
9/22/2010	583.0	3/14/2013	336.0
10/25/2010	524.0	4/11/2013	355.0
11/10/2010	531.0	5/15/2013	352.3
12/17/2010	474.0	6/13/2013	374.8
1/13/2011	498.0	7/11/2013	421.4
2/10/2011	498.0	8/8/2013	313.0
3/10/2011	494.0	9/19/2013	373.9
4/14/2011	430.0	10/18/2013	352.8
5/12/2011	340.0	11/26/2013	319.9
6/9/2011	393.0	12/11/2013	348.4
7/14/2011	455.0	1/13/2014	321.8
8/11/2011	471.0	2/13/2014	271.7
9/8/2011	492.0	3/24/2014	373.8
10/14/2011	518.0	4/16/2014	271.1
11/10/2011	484.0	5/21/2014	267.7
12/8/2011	402.0	6/18/2014	340.9
1/12/2012	478.0	7/10/2014	368.3
2/9/2012	646.0	8/6/2014	375.1
3/8/2012	420.0	9/18/2014	378.6
4/12/2012	418.0	10/17/2014	251.8
5/10/2012	544.0	11/6/2014	283.7
6/14/2012	455.0	12/8/2014	290.1
count	**60**	**mean**	**428**
min	**252**	**median**	**422**
max	**646**		

Appendix Table C.4.5: Water quality at station P-21 from 2010 to 2014.

Date m/d/yr	Acidity mg/L	Ba mg/L	Co mg/L	Fe mg/L	Mn mg/L	pH	Ra Bq/L	Sulphate mg/L	TSS mg/L	U mg/L
5/12/2010	< 1			0.03		7.3	0.085	230		
11/10/2010	< 1			0.02		7.3	0.100	230		
5/12/2011	< 1	0.019		0.03		7.0	0.090	180		
11/10/2011	< 1	0.015		0.11		7.0	0.112	210		
2/13/2012	< 1	0.014		< 0.02		7.1	0.118	230		
5/14/2012	< 1	0.014		0.04		7.6	0.121	220		
2/14/2013	< 1	0.016		< 0.02		7.4	0.143	220		
5/9/2013	< 1	0.016		0.05		7.3	0.086	140		
8/8/2013	< 1	0.012		0.05		7.6	0.088	190		
11/21/2013	< 1	0.022		0.07		7.3	0.125	190		
2/13/2014	< 1	0.02	< 0.0005	< 0.02	0.019	7.1	0.109	200	< 1	0.0142
5/8/2014	< 1	0.012	< 0.0005	0.06	0.066	7.5	0.117	140	1	0.0108
11/6/2014	< 1	0.012	< 0.0005	0.06	0.037	7.4	0.100	180	< 1	0.0125
count	13	11	3	13	3	13	13	13	3	3
min	< 1	0.012	< 0.0005	< 0.02	0.019	7	0.085	140	< 1	0.0108
max	< 1	0.022	< 0.0005	0.11	0.066	7.6	0.143	230	1	0.0142
mean	< 1	0.016	< 0.0005	0.04	0.041	7.3	0.107	197	1	0.0125
median	1	0.015	0.0005	0.04	0.037	7.3	0.109	200	1	0.0125
10th Percentile	1	0.012	0.0005	0.02	0.023	7.02	0.086	148	1	0.0111
95th Percentile	1	0.021	0.0005	0.09	0.063	7.6	0.132	230	1	0.0140

Appendix Table C.4.6: Water quality at groundwater station P-16A from 2010 to 2014.

Date m/d/yr	Acidity mg/L	Fe mg/L	pH	Ra Bq/L	Sulphate mg/L
7/12/2010	< 1	0.63	6.5		1200
7/20/2011	< 1	0.05	7.2		1100
6/26/2012	< 1	0.15	7.3		1100
7/23/2013	< 1	0.06	7.0		930
7/2/2014	< 1	0.04	7.2	0.041	990
count	5	5	5	1	5
min	< 1	0.04	6.5	0.041	930
max	< 1	0.63	7.3	0.041	1200
mean	< 1	0.19	7.0	0.041	1064
median	1	0.06	7.2	0.041	1100
10th Percentile	1	0.04	6.7	0.041	954
95th Percentile	1	0.53	7.3	0.041	1180

Appendix Table C.4.7: Water quality at groundwater station P-20 from 2010 to 2014.

Date m/d/yr	Acidity mg/L	Fe mg/L	pH	Ra Bq/L	Sulphate mg/L
7/13/2010	< 1	3.61	6.6		480
7/22/2011	< 1	4.25	7.2		500
6/26/2012	< 1	2.04	7.3		440
7/23/2013	< 1	3.78	6.8		500
7/2/2014	< 1	1.51	7.2	0.424	400
count	5	5	5	1	5
min	< 1	1.51	6.6	0.424	400
max	< 1	4.25	7.3	0.424	500
mean	< 1	3.04	7.0	0.424	464
median	1	3.61	7.2	0.424	480
10th Percentile	1	1.72	6.7	0.424	416
95th Percentile	1	4.16	7.3	0.424	500

Appendix Table C.4.8: Water quality at groundwater station P-31 from 2010 to 2014.

Date m/d/yr	Acidity mg/L	Fe mg/L	pH	Ra Bq/L	Sulphate mg/L
7/12/2010	< 1	0.11	6.3		1000
7/22/2011	< 1	0.15	6.8		1100
6/26/2012	< 1	0.13	6.8		1100
7/23/2013	< 1	0.23	6.9		1000
7/2/2014	< 1	0.16	7.3	0.008	1000
count	5	5	5	1	5
min	< 1	0.11	6.3	0.008	1000
max	< 1	0.23	7.3	0.008	1100
mean	< 1	0.16	6.8	0.008	1040
median	1	0.15	6.8	0.008	1000
10th Percentile	1	0.12	6.5	0.008	1000
95th Percentile	1	0.22	7.2	0.008	1100

Appendix Table C.4.9: Summary of seasonal trends for station P-13 from 2003-2014.

Month	Spearman's rho	Acidity	Ba	Co	Fe	Mn	pH	Ra	Sulphate	TSS	U
February	Correlation Coefficient	-0.655	-0.143	-0.828		-0.714	0.894	-0.829	-1		0.086
	Sig. (2-tailed)	0.158	0.787	0.042		0.111	0.041	0.042	0.000		0.872
	N	6	6	6		6	5	6	6		6
March	Correlation Coefficient	-0.655	0.257	-0.88		-0.771	0.946	-0.867	-0.986		0.638
	Sig. (2-tailed)	0.158	0.623	0.021		0.072	0.001	0.002	0.000		0.173
	N	6	6	6		6	7	9	6		6
April	Correlation Coefficient	-0.778	0.486	-0.37		0.714	0.345	-0.564	-1		-0.543
	Sig. (2-tailed)	0.069	0.329	0.47		0.111	0.363	0.09	0.000		0.266
	N	6	6	6		6	9	10	6		6
May	Correlation Coefficient	-0.612	-0.464	-0.786	-0.7	0	0.259	-0.578	-0.829		-0.071
	Sig. (2-tailed)	0.144	0.294	0.036	0.188	1	0.574	0.08	0.021		0.879
	N	7	7	7	5	7	7	10	7		7
June	Correlation Coefficient							-0.893			
	Sig. (2-tailed)							0.007			
	N							7			
October	Correlation Coefficient	-0.926	0.429	0.741	0.8	0.314	0.861	-0.976	-0.771		-0.03
	Sig. (2-tailed)	0.008	0.397	0.092	0.104	0.544	0.006	0.000	0.072		0.954
	N	6	6	6	5	6	8	8	6		6
November	Correlation Coefficient	-	-0.143	-0.612	0.872	-0.396	0.36	-0.894	-0.964		0.536
	Sig. (2-tailed)	-	0.76	0.144	0.054	0.379	0.427	0.000	0.000		0.215
	N	7	7	7	5	7	7	10	7		7
December	Correlation Coefficient							-0.543			
	Sig. (2-tailed)							0.266			
	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).

[shaded] Significant trend where p<0.05.

Appendix Table C.4.10: Summary of seasonal trends for station P-21 from 2003-2014.

Month	Spearman's rho	Acidity	Ba	Co	Fe	Mn	pH	Ra	Sulphate	TSS	U
April	Correlation Coefficient	-0.837					0.491	0.432			
	Sig. (2-tailed)	0.019					0.263	0.333			
	N	7					7	7			
May	Correlation Coefficient	-			0.975		0.462	0.5	-0.872		
	Sig. (2-tailed)	-			0.005		0.434	0.391	0.054		
	N	5			5		5	5	5		
November	Correlation Coefficient	-			0.58		0.727	-0.546	-1		
	Sig. (2-tailed)	-			0.228		0.064	0.205	0.000		
	N	7			6		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).

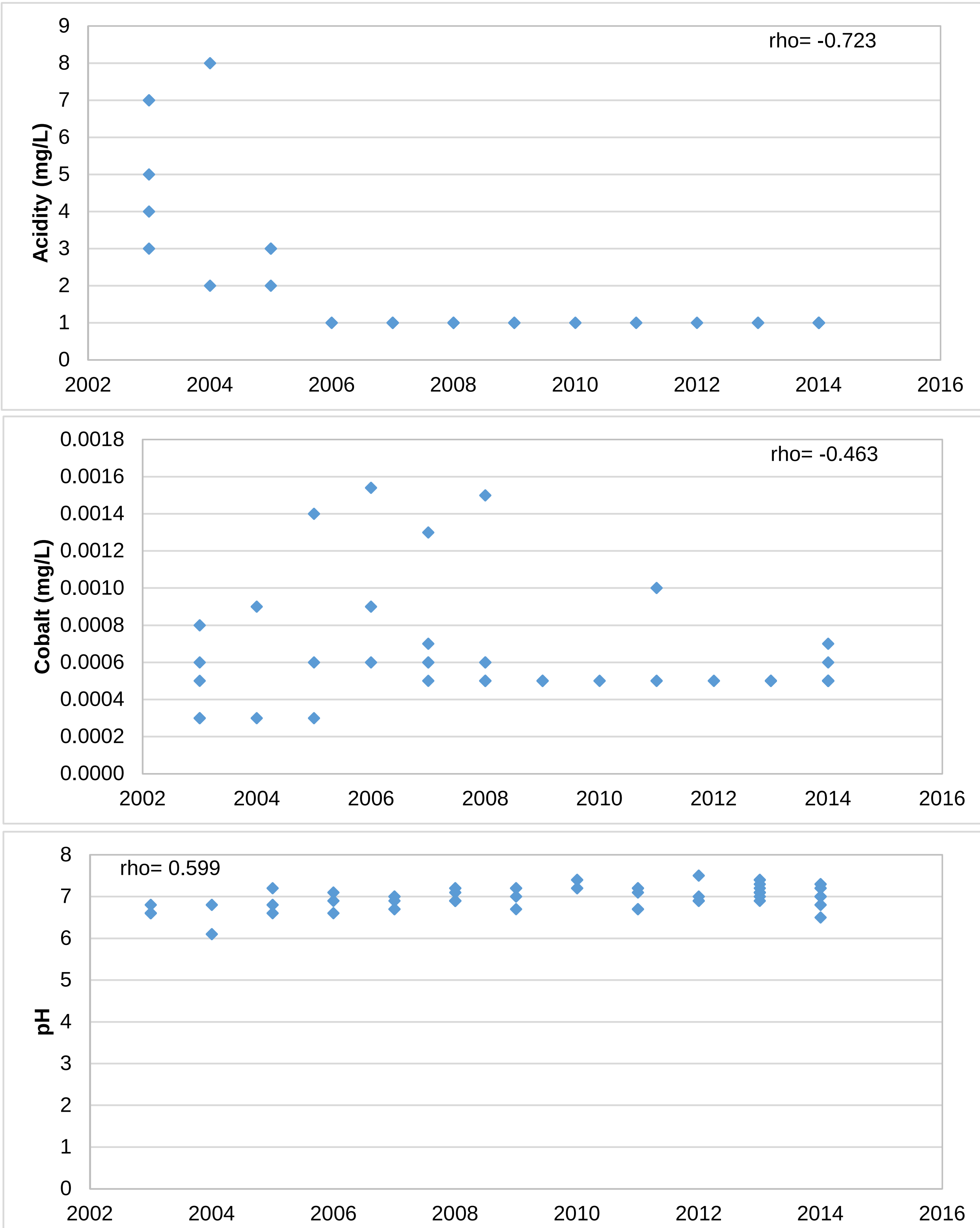
(shaded) Significant trend where p<0.05.

Appendix Table C.4.11: Summary of seasonal trends for Panel groundwater stations, 2003 - 2014.

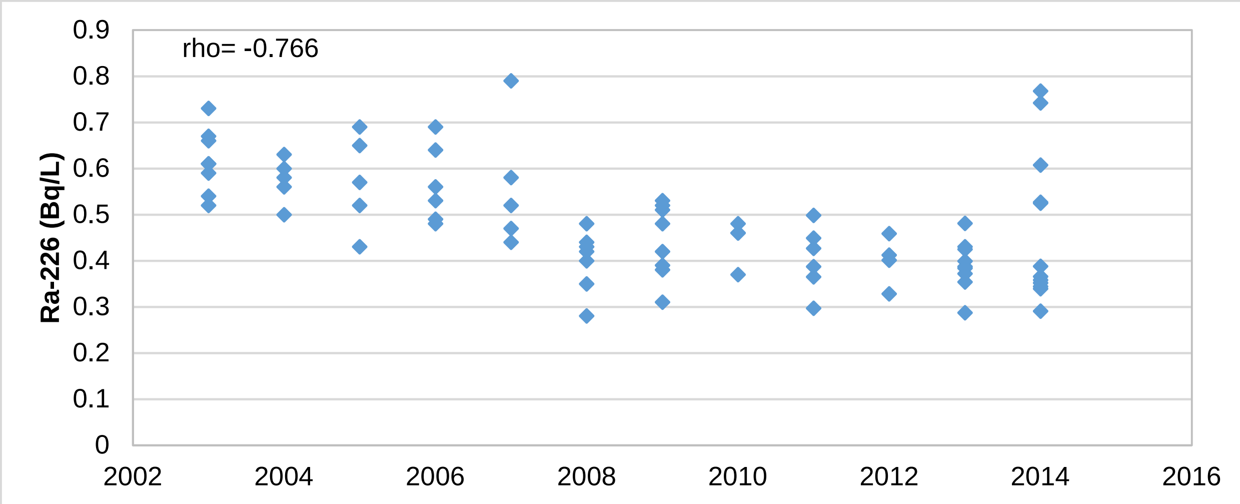
Station	Spearman rho	Acidity	Iron	pH	Sulphate
P-16A	Correlation Coefficient	-	-0.325	-0.420	0.442
	Sig. (2-tailed)	-	0.112	0.036	0.035
	N	5	25	25	23
P-20	Correlation Coefficient	-	-0.183	-0.309	-0.887
	Sig. (2-tailed)	-	0.381	0.133	0.000
	N	5	25	25	21
P-31	Correlation Coefficient	-	0.458	0.062	0.081
	Sig. (2-tailed)	-	0.086	0.828	0.792
	N	5	15	15	13

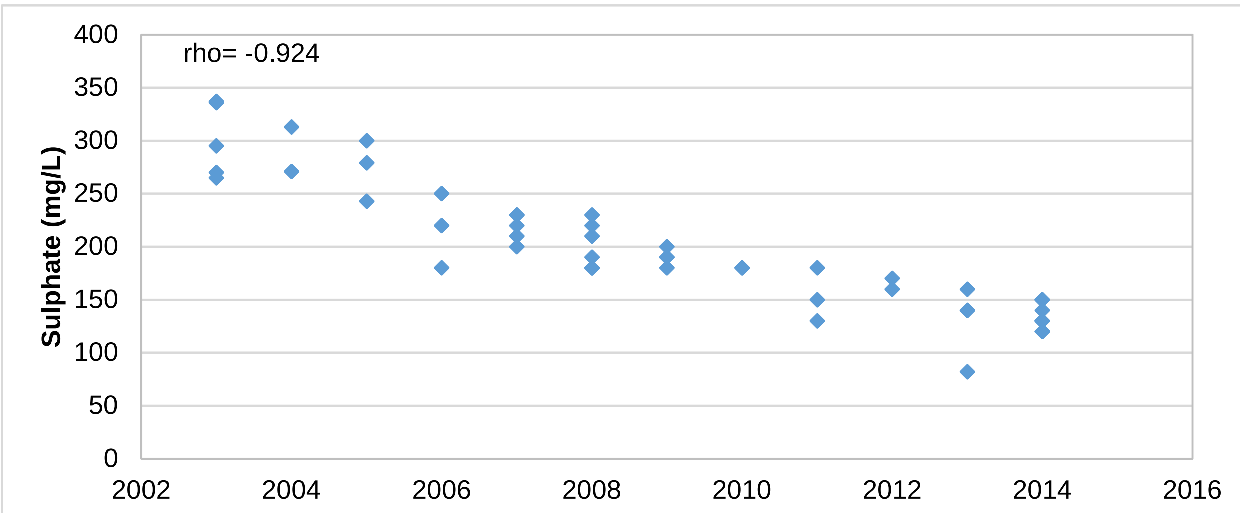
Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

Significant trend where $p<0.05$. (shaded cells)

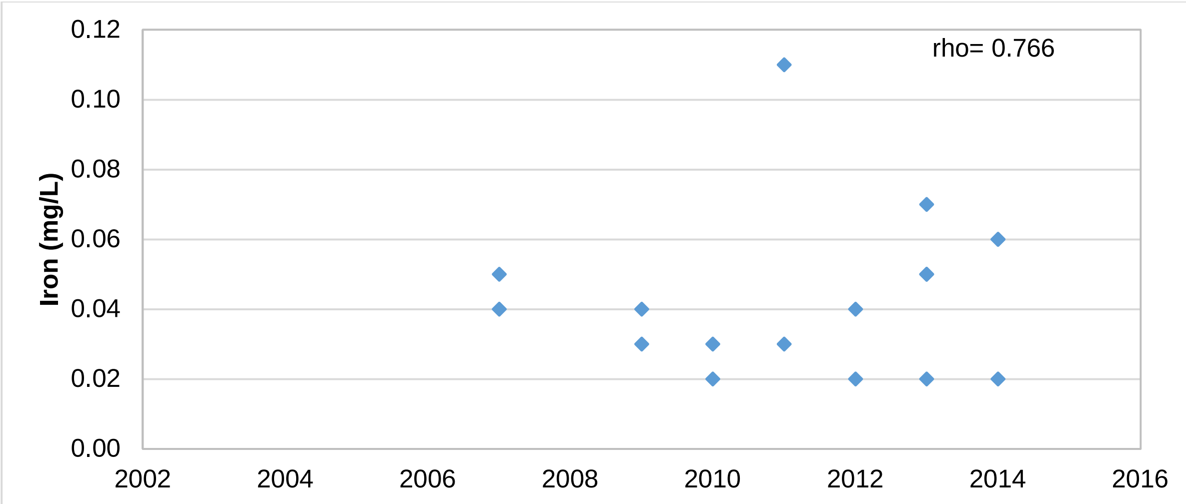


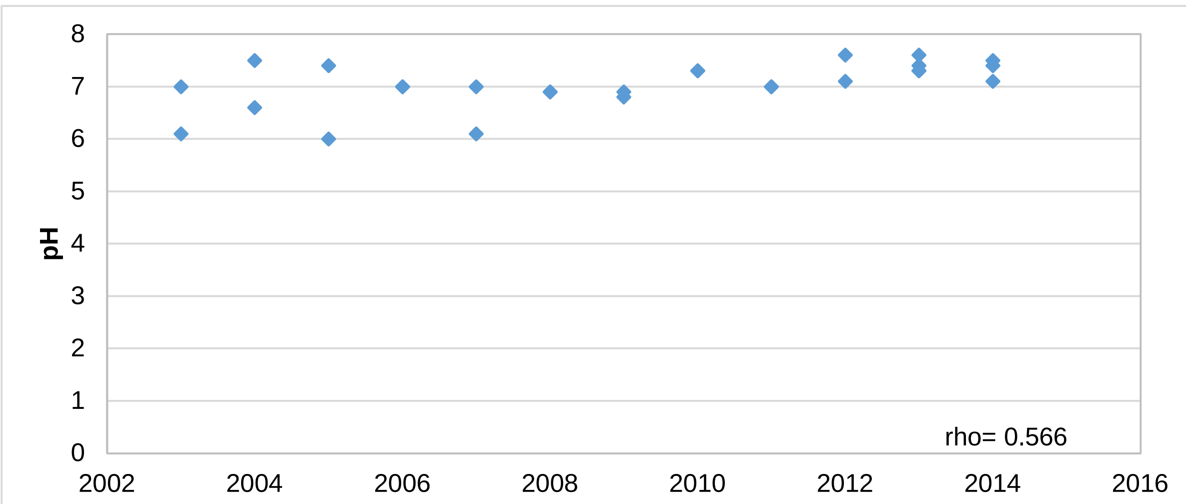
Appendix Figure C.4.1: Significant common (average) trends observed for acidity, cobalt, pH, radium-226 and sulphate, over all seasons at Station P-13, 2003 to 2014.

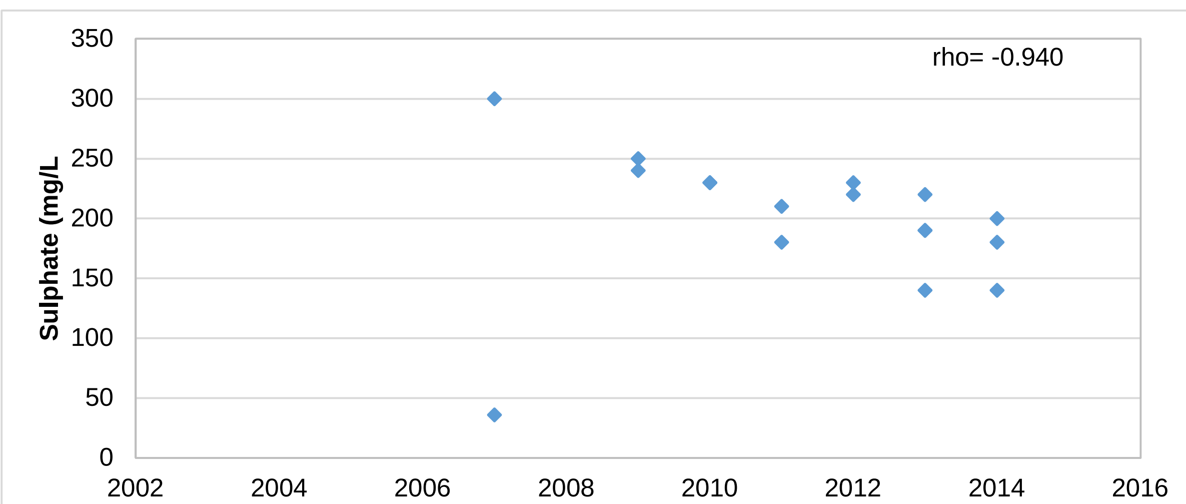




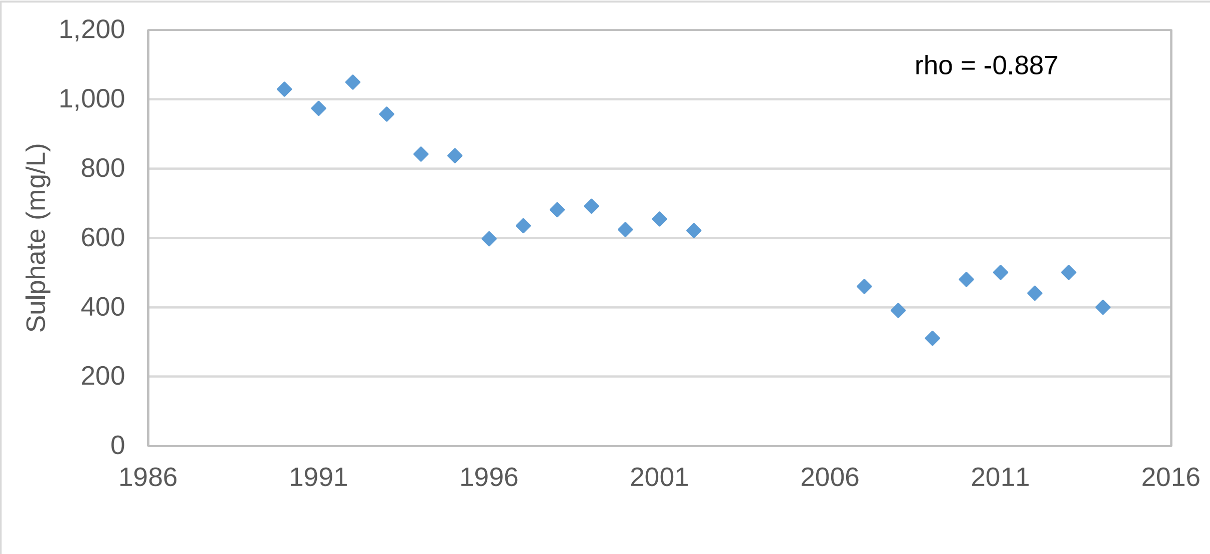
Appendix Figure C.4.1: Significant common (average) trends observed for acidity, cobalt, pH, radium-226 and sulphate, over all seasons at Station P-13, 2003 to 2014.



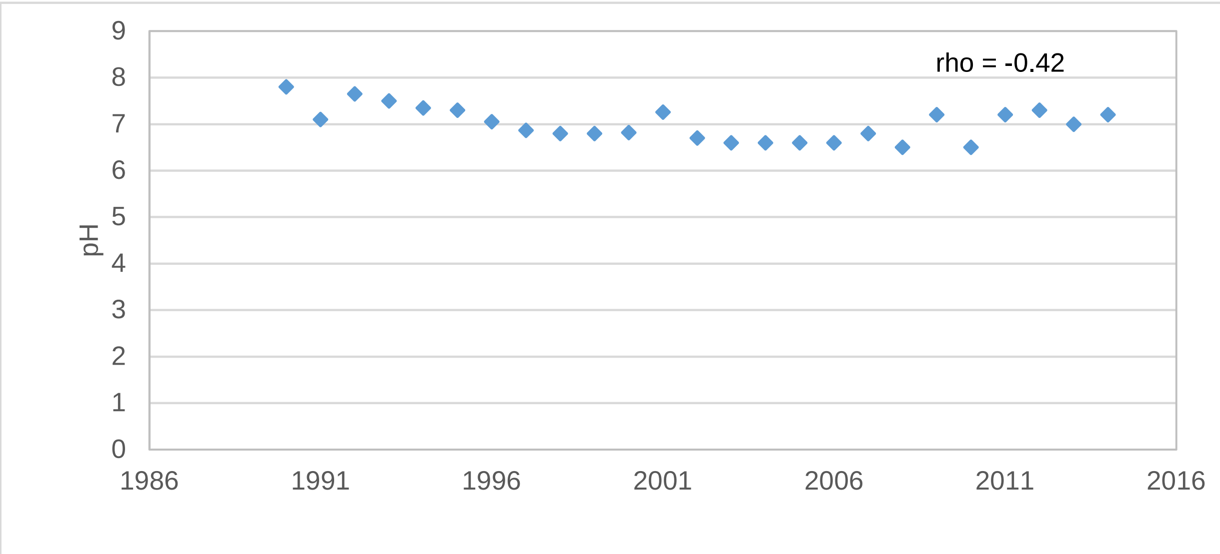


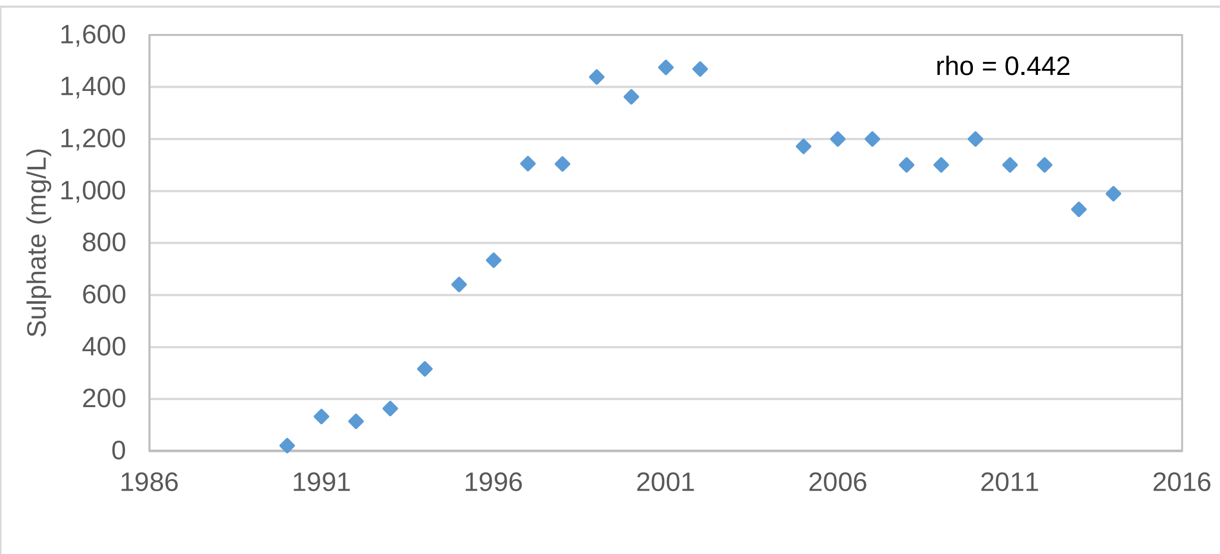


Appendix Figure C.4.2: Significant common (average) trends observed for iron, pH and sulphate, over all seasons at Station P-21, 2003 to 2014.



Appendix Figure C.4.3: Significant trends observed for sulphate at station P-20, 1990 to 2014.





Appendix Figure C.4.4: Significant trends observed for pH and sulphate at station P-16A, 1990 to 2014.

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 from 2010 to 2014.

Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH
1/4/2010	7.0	4/7/2010	7.4	9/28/2010	7.6	2/3/2011	7.1	5/31/2011	7.6
1/5/2010	6.7	4/8/2010	7.4	9/29/2010	7.8	2/4/2011	7.3	6/7/2011	7.7
1/6/2010	7.2	4/9/2010	7.6	9/30/2010	7.6	2/7/2011	7.1	6/14/2011	7.9
1/7/2010	7.0	4/12/2010	7.8	10/1/2010	7.5	2/8/2011	7.3	6/17/2011	7.9
1/11/2010	6.8	4/13/2010	7.8	10/4/2010	7.4	2/10/2011	7.1	6/21/2011	8.0
1/12/2010	6.8	4/14/2010	7.8	10/5/2010	7.5	2/15/2011	7.0	6/28/2011	7.8
1/13/2010	6.8	4/15/2010	7.8	10/12/2010	7.4	2/17/2011	6.9	7/5/2011	8.0
1/14/2010	6.8	4/19/2010	7.5	10/14/2010	7.3	2/22/2011	7.2	7/12/2011	8.2
1/19/2010	6.9	4/20/2010	7.5	10/15/2010	7.3	2/24/2011	7.1	7/14/2011	7.9
1/21/2010	6.8	4/26/2010	7.4	10/19/2010	7.4	2/28/2011	7.0	7/15/2011	8.0
1/25/2010	6.8	4/27/2010	7.4	10/22/2010	7.4	3/1/2011	7.1	7/19/2011	8.0
1/26/2010	6.8	5/3/2010	7.3	10/26/2010	7.4	3/8/2011	7.0	7/25/2011	8.0
1/28/2010	6.7	5/4/2010	7.4	10/27/2010	7.5	3/10/2011	6.9	7/26/2011	7.9
1/29/2010	6.8	5/11/2010	7.1	10/28/2010	7.6	3/14/2011	7.1	7/27/2011	7.9
2/1/2010	6.7	5/18/2010	7.5	10/29/2010	7.7	3/15/2011	7.2	7/29/2011	8.0
2/2/2010	6.7	5/25/2010	7.6	11/1/2010	7.7	3/16/2011	7.2	8/2/2011	7.9
2/3/2010	6.8	5/27/2010	7.4	11/2/2010	7.7	3/21/2011	7.2	8/9/2011	7.9
2/4/2010	6.9	5/28/2010	7.4	11/3/2010	7.6	3/22/2011	7.2	8/16/2011	8.0
2/5/2010	6.8	6/1/2010	7.5	11/4/2010	7.6	3/23/2011	7.4	8/23/2011	7.5
2/8/2010	6.6	6/8/2010	7.5	11/5/2010	7.6	3/24/2011	7.5	8/30/2011	7.7
2/9/2010	6.7	6/14/2010	7.6	11/9/2010	7.5	3/29/2011	7.3	9/6/2011	7.8
2/16/2010	6.7	6/15/2010	7.8	11/11/2010	7.5	4/4/2011	7.3	9/13/2011	7.7
2/19/2010	6.7	6/16/2010	7.6	11/16/2010	7.4	4/5/2011	7.4	9/20/2011	7.5
2/22/2010	6.7	6/17/2010	7.6	11/19/2010	7.3	4/6/2011	7.4	9/27/2011	7.5
2/24/2010	6.7	6/18/2010	7.5	11/22/2010	7.4	4/7/2011	7.9	10/4/2011	7.2
2/25/2010	6.7	6/21/2010	7.6	11/23/2010	7.3	4/8/2011	8.6	10/11/2011	7.4
3/1/2010	7.1	6/22/2010	7.6	11/24/2010	7.4	4/11/2011	8.7	10/18/2011	7.4
3/2/2010	7.1	6/23/2010	7.5	11/25/2010	7.7	4/12/2011	8.0	10/21/2011	7.4
3/3/2010	7.0	6/24/2010	7.5	11/26/2010	7.4	4/13/2011	8.1	10/25/2011	7.2
3/4/2010	7.0	6/25/2010	7.4	11/29/2010	7.4	4/14/2011	8.1	11/1/2011	7.3
3/5/2010	7.0	6/28/2010	7.5	11/30/2010	7.4	4/15/2011	7.7	11/2/2011	7.0
3/8/2010	7.0	6/29/2010	7.6	12/1/2010	7.4	4/18/2011	7.9	11/3/2011	7.1
3/9/2010	7.0	7/6/2010	7.7	12/2/2010	7.4	4/19/2011	8.1	11/4/2011	7.2
3/10/2010	7.1	7/13/2010	7.7	12/3/2010	7.6	4/20/2011	8.1	11/7/2011	7.2
3/11/2010	7.0	7/14/2010	7.5	12/7/2010	7.4	4/21/2011	8.4	11/8/2011	7.3
3/12/2010	7.0	7/20/2010	7.6	12/14/2010	7.4	4/25/2011	8.7	11/9/2011	7.3
3/15/2010	7.1	7/27/2010	7.7	12/20/2010	7.2	4/26/2011	8.6	11/10/2011	7.4
3/16/2010	7.3	7/28/2010	7.6	12/21/2010	7.3	4/27/2011	8.3	11/11/2011	7.3
3/17/2010	8.1	7/29/2010	7.6	12/29/2010	7.1	4/28/2011	8.1	11/14/2011	7.5
3/18/2010	7.7	7/30/2010	7.6	1/4/2011	7.3	4/29/2011	7.5	11/15/2011	7.3
3/19/2010	7.4	8/3/2010	7.5	1/6/2011	7.2	5/2/2011	7.8	11/16/2011	7.3
3/22/2010	7.7	8/10/2010	7.7	1/11/2011	7.2	5/3/2011	8.0	11/17/2011	7.3
3/23/2010	7.7	8/17/2010	7.6	1/14/2011	7.3	5/4/2011	7.8	11/18/2011	7.3
3/24/2010	7.2	8/24/2010	7.5	1/18/2011	7.3	5/5/2011	7.9	11/22/2011	7.2
3/25/2010	7.2	8/31/2010	7.6	1/21/2011	7.3	5/6/2011	7.8	11/28/2011	7.1
3/26/2010	7.0	9/3/2010	7.4	1/25/2011	7.3	5/10/2011	7.7	11/29/2011	7.1
3/29/2010	7.0	9/7/2010	7.4	1/27/2011	7.2	5/12/2011	7.5	11/30/2011	7.1
3/30/2010	6.9	9/14/2010	7.6	1/28/2011	7.4	5/17/2011	7.5	12/1/2011	7.2
3/31/2010	6.9	9/21/2010	7.6	1/31/2011	7.4	5/24/2011	7.6	12/2/2011	7.0
4/5/2010	7.0	9/24/2010	7.4	2/1/2011	7.3	5/26/2011	7.5	12/5/2011	7.2
4/6/2010	7.0	9/27/2010	7.5	2/2/2011	7.2	5/27/2011	7.6	12/6/2011	7.1

Appendix Table C.5.2: Water quality at station DS-1 from 2010 to 2014.

Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH
12/7/2011	7.3	3/23/2012	7.4	9/28/2012	7.6	3/5/2013	7.3	6/5/2013	8.0
12/8/2011	7.1	3/26/2012	8.4	10/1/2012	7.5	3/7/2013	7.2	6/11/2013	7.8
12/9/2011	7.1	3/27/2012	8.5	10/2/2012	7.6	3/12/2013	7.1	6/18/2013	7.3
12/12/2011	7.1	3/28/2012	8.1	10/4/2012	7.5	3/13/2013	7.1	6/25/2013	7.4
12/13/2011	7.2	3/29/2012	7.8	10/9/2012	7.5	3/14/2013	7.7	6/26/2013	7.4
12/14/2011	7.2	3/30/2012	7.8	10/16/2012	7.4	3/15/2013	8.1	6/28/2013	7.4
12/15/2011	7.2	4/2/2012	7.8	10/19/2012	7.4	3/18/2013	9.5	7/2/2013	7.5
12/16/2011	7.2	4/3/2012	7.7	10/23/2012	7.4	3/19/2013	9.7	7/9/2013	7.5
12/19/2011	7.2	4/4/2012	7.6	10/30/2012	7.4	3/20/2013	9.7	7/11/2013	7.7
12/20/2011	7.1	4/5/2012	7.6	11/1/2012	7.3	3/21/2013	9.8	7/23/2013	7.3
12/21/2011	7.1	4/9/2012	7.5	11/2/2012	7.0	3/22/2013	9.8	7/24/2013	7.4
12/22/2011	7.2	4/10/2012	7.5	11/5/2012	7.1	3/25/2013	9.5	7/25/2013	7.4
12/28/2011	7.2	4/11/2012	7.5	11/6/2012	7.0	3/26/2013	9.2	7/26/2013	7.5
1/3/2012	7.0	4/12/2012	7.5	11/7/2012	7.2	3/27/2013	9.3	7/29/2013	7.5
1/5/2012	6.8	4/17/2012	7.5	11/8/2012	7.4	3/28/2013	9.3	7/30/2013	7.5
1/9/2012	7.0	4/24/2012	7.5	11/9/2012	7.3	4/1/2013	8.6	7/31/2013	7.6
1/10/2012	7.2	4/27/2012	7.5	11/12/2012	7.2	4/2/2013	8.4	8/1/2013	7.7
1/13/2012	7.0	5/1/2012	7.6	11/13/2012	7.5	4/3/2013	8.4	8/2/2013	7.4
1/16/2012	6.9	5/2/2012	7.3	11/14/2012	7.2	4/4/2013	8.4	8/6/2013	7.6
1/17/2012	6.9	5/8/2012	7.6	11/15/2012	7.3	4/5/2013	8.5	8/7/2013	7.5
1/19/2012	6.9	5/10/2012	7.5	11/20/2012	7.6	4/8/2013	9.0	8/8/2013	8.4
1/20/2012	6.9	5/15/2012	7.5	11/27/2012	7.3	4/9/2013	9.0	8/9/2013	7.9
1/24/2012	7.1	5/22/2012	7.6	11/29/2012	6.9	4/10/2013	9.1	8/12/2013	7.9
1/25/2012	6.9	5/24/2012	7.8	11/30/2012	7.1	4/11/2013	8.5	8/13/2013	7.8
1/26/2012	6.8	5/25/2012	7.7	12/3/2012	7.3	4/15/2013	8.9	8/15/2013	8.2
1/27/2012	7.0	5/29/2012	7.7	12/4/2012	7.4	4/16/2013	8.8	8/19/2013	7.5
1/30/2012	6.9	6/5/2012	8.1	12/5/2012	7.0	4/17/2013	8.5	8/20/2013	8.3
1/31/2012	7.2	6/8/2012	7.8	12/11/2012	7.3	4/18/2013	8.8	8/21/2013	7.5
2/1/2012	6.7	6/12/2012	7.9	12/13/2012	6.9	4/19/2013	8.1	8/22/2013	7.4
2/2/2012	6.9	6/19/2012	7.8	12/14/2012	7.4	4/22/2013	8.9	8/27/2013	7.4
2/7/2012	7.1	6/21/2012	7.9	12/18/2012	7.3	4/23/2013	8.8	8/29/2013	7.4
2/10/2012	6.8	6/26/2012	7.8	12/27/2012	7.2	4/24/2013	9.1	9/3/2013	7.3
2/14/2012	6.9	7/3/2012	7.9	1/2/2013	7.3	4/25/2013	7.0	9/5/2013	7.6
2/15/2012	6.8	7/6/2012	7.9	1/3/2013	7.3	4/26/2013	6.7	9/6/2013	7.6
2/17/2012	6.9	7/10/2012	8.1	1/7/2013	7.1	4/29/2013	7.5	9/9/2013	7.5
2/21/2012	7.1	7/17/2012	8.0	1/8/2013	7.2	4/30/2013	7.1	9/10/2013	7.7
2/22/2012	6.9	7/24/2012	7.8	1/9/2013	7.3	5/1/2013	7.2	9/11/2013	6.6
2/24/2012	6.7	7/31/2012	7.8	1/10/2013	7.3	5/2/2013	7.4	9/12/2013	8.0
2/28/2012	7.0	8/7/2012	7.9	1/14/2013	7.2	5/3/2013	7.7	9/13/2013	7.6
3/1/2012	6.7	8/10/2012	7.8	1/15/2013	7.2	5/6/2013	7.7	9/16/2013	7.4
3/2/2012	6.7	8/13/2012	7.7	1/16/2013	7.4	5/7/2013	7.6	9/17/2013	7.9
3/6/2012	6.9	8/21/2012	7.6	1/17/2013	7.2	5/8/2013	7.5	9/24/2013	7.1
3/8/2012	6.9	8/22/2012	7.5	1/22/2013	7.4	5/10/2013	7.5	9/27/2013	7.8
3/9/2012	6.4	8/28/2012	7.5	1/29/2013	7.3	5/14/2013	7.5	9/30/2013	7.0
3/12/2012	7.3	9/4/2012	7.6	2/5/2013	7.6	5/16/2013	7.4	10/1/2013	7.0
3/13/2012	7.9	9/10/2012	8.1	2/6/2013	7.1	5/17/2013	7.7	10/2/2013	7.2
3/14/2012	6.7	9/11/2012	7.9	2/12/2013	7.3	5/21/2013	7.2	10/3/2013	7.2
3/15/2012	7.5	9/18/2012	7.6	2/13/2013	7.2	5/23/2013	7.7	10/8/2013	7.3
3/16/2012	8.0	9/21/2012	7.5	2/14/2013	7.4	5/24/2013	7.7	10/10/2013	7.6
3/19/2012	7.3	9/24/2012	7.6	2/19/2013	7.4	5/27/2013	7.3	10/15/2013	7.2
3/20/2012	7.5	9/25/2012	7.6	2/22/2013	7.6	5/28/2013	7.5	10/17/2013	6.9
3/21/2012	7.2	9/26/2012	7.5	2/26/2013	7.3	5/29/2013	7.2	10/21/2013	7.3
3/22/2012	6.4	9/27/2012	7.5	2/28/2013	7.2	6/4/2013	7.7	10/22/2013	7.0

Appendix Table C.5.2: Water quality at station DS-1 from 2010 to 2014.

Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	Ra Bq/L
10/29/2013	7.7	3/7/2014	7.1	7/18/2014	7.4	11/7/2014	7.3	1/12/2010	0.024
10/30/2013	7.3	3/10/2014	7.4	7/22/2014	7.8	11/10/2014	7.2	4/13/2010	0.029
10/31/2013	7.3	3/11/2014	7.4	7/24/2014	7.8	11/11/2014	7.5	7/13/2010	0.02
11/1/2013	6.1	3/12/2014	7.4	7/25/2014	7.7	11/12/2014	7.5	10/12/2010	0.023
11/4/2013	7.0	3/17/2014	7.6	7/28/2014	7.6	11/18/2014	7.4	1/11/2011	0.024
11/5/2013	7.2	3/18/2014	7.4	7/29/2014	7.6	11/24/2014	7.1	4/12/2011	0.029
11/6/2013	7.0	3/20/2014	7.1	7/31/2014	7.6	11/25/2014	7.3	7/12/2011	0.024
11/7/2013	7.3	3/24/2014	7.2	8/5/2014	7.4	11/26/2014	7.0	10/11/2011	0.032
11/8/2013	8.0	3/25/2014	7.3	8/7/2014	7.5	11/27/2014	7.3	1/10/2012	0.03
11/11/2013	7.6	3/26/2014	7.1	8/11/2014	7.5	11/28/2014	7.2	4/9/2012	0.03
11/12/2013	6.9	3/27/2014	7.0	8/14/2014	7.5	12/2/2014	7.2	7/10/2012	0.02
11/13/2013	7.4	3/31/2014	7.1	8/15/2014	7.5	12/3/2014	7.2	10/9/2012	0.019
11/14/2013	6.7	4/1/2014	7.2	8/18/2014	7.5	12/4/2014	7.1	1/8/2013	0.026
11/15/2013	7.1	4/2/2014	7.0	8/19/2014	7.6	12/5/2014	7.1	4/9/2013	0.014
11/18/2013	7.3	4/3/2014	7.6	8/21/2014	7.5	12/8/2014	7.0	7/9/2013	0.026
11/19/2013	7.4	4/4/2014	8.1	8/25/2014	7.7	12/9/2014	7.1	10/8/2013	0.024
11/20/2013	6.9	4/7/2014	7.7	8/26/2014	7.7	12/11/2014	7.0	1/14/2014	0.031
11/21/2013	7.3	4/9/2014	8.1	8/27/2014	7.7	12/12/2014	7.0	4/9/2014	0.036
11/22/2013	7.3	4/10/2014	7.3	8/29/2014	7.7	12/15/2014	7.0	7/8/2014	0.023
11/25/2013	7.0	4/11/2014	7.3	9/2/2014	7.5	12/16/2014	7.0	10/14/2014	0.017
11/26/2013	7.0	4/14/2014	8.3	9/3/2014	7.6	12/22/2014	7.2	**count**	**20**
11/27/2013	7.5	4/15/2014	8.4	9/4/2014	7.6	12/23/2014	7.0	**min**	**0.014**
11/28/2013	7.0	4/16/2014	8.4	9/5/2014	7.5	12/29/2014	7.2	**max**	**0.036**
11/29/2013	8.0	4/17/2014	9.0	9/8/2014	7.5	**count**	**702**	**mean**	**0.025**
12/2/2013	7.7	4/21/2014	8.9	9/9/2014	7.6	**min**	**6.1**	**median**	**0.024**
12/3/2013	7.3	4/22/2014	8.9	9/10/2014	7.5	**max**	**9.8**		
12/4/2013	7.5	4/23/2014	8.6	9/11/2014	7.4	**mean**	**7.5**		
12/5/2013	8.0	4/24/2014	8.3	9/15/2014	7.3	**median**	**7.4**		
12/6/2013	8.4	4/28/2014	8.5	9/16/2014	7.4				
12/9/2013	7.8	4/29/2014	8.9	9/18/2014	7.4				
12/10/2013	7.5	4/30/2014	8.5	9/22/2014	7.5				
12/11/2013	7.8	5/1/2014	8.9	9/23/2014	7.5				
12/13/2013	8.0	5/2/2014	8.9	9/25/2014	7.5				
12/16/2013	7.7	5/5/2014	9.0	9/26/2014	7.2				
12/17/2013	7.6	5/6/2014	8.7	9/30/2014	7.1				
12/18/2013	8.0	5/7/2014	8.8	10/3/2014	7.5				
12/19/2013	8.1	5/9/2014	8.9	10/6/2014	7.8				
12/20/2013	8.0	5/12/2014	8.3	10/7/2014	7.7				
12/23/2013	7.9	5/13/2014	8.4	10/9/2014	7.5				
1/2/2014	8.3	5/20/2014	8.0	10/10/2014	7.5				
1/3/2014	8.1	5/27/2014	7.8	10/14/2014	7.5				
1/6/2014	7.9	6/3/2014	7.1	10/15/2014	7.3				
1/7/2014	7.5	6/5/2014	7.8	10/16/2014	7.6				
1/14/2014	7.3	6/10/2014	7.0	10/17/2014	7.4				
1/20/2014	7.4	6/17/2014	6.8	10/20/2014	7.5				
1/21/2014	7.5	6/24/2014	6.8	10/21/2014	7.6				
1/28/2014	7.7	6/26/2014	7.2	10/23/2014	7.3				
2/4/2014	7.9	7/1/2014	6.8	10/28/2014	7.4				
2/11/2014	7.3	7/3/2014	6.9	10/31/2014	7.3				
2/18/2014	7.0	7/4/2014	7.6	11/3/2014	7.3				
2/25/2014	7.3	7/7/2014	7.6	11/4/2014	7.4				
2/26/2014	7.2	7/8/2014	7.5	11/5/2014	7.5				
3/4/2014	7.3	7/15/2014	7.7	11/6/2014	7.4				

Appendix Table C.5.3: Water quality at station DS-2 from 2010 to 2014.

Date m/d/yr	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
1/12/2010	419	0.023	0.171	93	3.98	2.7	0.23	970	0.0579
2/9/2010						2.7	0.15		
3/9/2010						3.0	0.13		
4/13/2010	490	0.011	0.126	72.3	2.09	2.9	0.15	660	0.0369
7/13/2010	440	0.009	0.19	54.4	4.41	2.5	0.14	1100	0.0499
9/28/2010						2.9	0.17		
10/12/2010	272	0.014	0.139	43	2.85	2.9	0.15	710	0.0588
11/9/2010						2.9	0.18		
1/13/2011	250	0.015	0.119	69	2.62	2.8	0.174	770	0.0431
3/10/2011						3.0	0.124		
4/12/2011	37	0.01	0.0188	9.52	0.292	3.7	0.068	91	0.0058
5/10/2011						3.0	0.245		
6/14/2011						2.8	0.213		
7/12/2011	233	0.015	0.122	29.9	2.5	2.6	0.276	700	0.0306
11/8/2011	316	0.013	0.141	59.4	2.31	2.7	0.141	750	0.0493
12/13/2011						3.1	0.075		
1/10/2012	226	0.02	0.116	55.6	2.57		0.155	640	0.0467
2/14/2012						3.2	0.115		
3/6/2012						3.1	0.131		
4/9/2012	236	0.016	0.117	61.4	1.45	2.9	0.117	550	0.0458
5/9/2012						2.9	0.135		
10/11/2012	347	0.008	0.11	58.6	3.75	2.7	0.097	850	0.0285
11/13/2012						2.9	0.094		
12/11/2012						3.1	0.165		
1/8/2013	378	0.017	0.171	79.7	2.98	2.9	0.146	900	0.0633
2/12/2013						3.0	0.12		
3/12/2013						3.9	0.049		
4/9/2013	29	0.012	0.008	4.06	0.169	3.7	0.029	49	0.0032
5/14/2013						2.9	0.126		
6/13/2013						2.8	0.156		
7/23/2013	281	0.016	0.111	33	2.27	2.7	0.309	730	0.037
8/13/2013						2.9	0.254		
9/3/2013						2.7	0.247		
10/8/2013	246	0.015	0.11	38.1	2.01	2.9	0.183	660	0.0358
11/12/2013						2.9	0.156		
12/11/2013						3.1	0.125		
1/13/2014	187	0.034	0.0763	48.3	1.75	3.0	0.138	520	0.0246
2/12/2014						3.0	0.158		
3/20/2014						2.9	0.181		
4/9/2014	75	0.032	0.0313	19.2	0.842	3.8	0.069	220	0.0095
5/13/2014						3.1	0.169		
6/11/2014						2.6	0.177		
7/8/2014	190	0.027	0.062	24	1.69	2.7	0.355	490	0.0171
9/9/2014						2.8	0.302		
10/14/2014	172	0.018	0.0658	29.9	1.42	2.6	0.195	460	0.0241
11/11/2014						3.0	0.21		
12/10/2014						3.0	0.113		
count	19	19	19	19	19	660	47	19	19
min	29	0.008	0.008	4.1	0.169	2.5	0.029	49	0.003
max	490	0.034	0.190	93.0	4.410	5.4	0.355	1100	0.063
mean	254	0.017	0.106	46.4	2.208	3.0	0.162	622	0.035
median	246	0.015	0.116	48.3	2.270	2.9	0.150	660	0.037
10th Percentile	67	0.010	0.029	17.3	0.732	2.6	0.086	194	0.009
95th Percentile	445	0.032	0.173	81.0	4.023	3.4	0.294	983	0.059

[a] pH measures shown only for dates when other substances were measured but summary statistics reflect all measured values.

Appendix Table C.5.4: Water quality at station DS-3 from 2010 to 2014.

Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH
1/7/2010	10.7	6/24/2010	10.9	12/9/2010	10.9	5/3/2011	10.5	11/10/2011	10.8
1/8/2010	10.9	6/25/2010	10.9	12/10/2010	10.9	5/4/2011	10.5	11/11/2011	10.8
1/12/2010	11.0	6/28/2010	10.7	12/16/2010	10.9	5/5/2011	10.6	11/15/2011	10.8
1/13/2010	11.0	6/29/2010	11.0	12/17/2010	10.8	5/6/2011	10.6	11/16/2011	10.8
1/15/2010	11.0	6/30/2010	11.0	12/23/2010	10.8	5/9/2011	10.6	11/17/2011	10.7
1/20/2010	11.0	7/13/2010	10.8	12/24/2010	10.9	5/10/2011	10.5	11/18/2011	10.7
1/22/2010	11.0	7/14/2010	10.8	1/5/2011	10.9	5/11/2011	10.6	11/24/2011	10.8
1/25/2010	10.7	8/20/2010	10.8	1/6/2011	10.9	5/12/2011	10.6	11/25/2011	10.8
1/26/2010	10.7	8/23/2010	10.7	1/13/2011	10.9	5/13/2011	10.6	11/28/2011	10.9
1/28/2010	10.9	8/24/2010	10.9	1/14/2011	10.9	5/17/2011	10.6	11/30/2011	11.2
1/29/2010	10.8	8/25/2010	10.9	1/20/2011	10.9	5/18/2011	10.8	12/1/2011	10.7
2/3/2010	11.1	8/30/2010	10.8	1/21/2011	10.9	5/19/2011	10.7	12/5/2011	10.9
2/4/2010	11.7	8/31/2010	10.8	1/26/2011	10.9	5/20/2011	10.7	12/6/2011	10.7
2/9/2010	11.3	9/8/2010	10.8	1/27/2011	10.9	5/24/2011	11.0	12/7/2011	10.8
2/12/2010	11.4	9/9/2010	10.8	2/10/2011	10.9	5/25/2011	10.8	12/8/2011	10.7
2/18/2010	11.2	9/10/2010	10.8	2/11/2011	10.9	5/26/2011	10.8	12/13/2011	10.8
2/19/2010	11.0	9/20/2010	10.8	2/17/2011	10.9	5/27/2011	10.8	12/14/2011	10.7
2/23/2010	11.0	9/21/2010	10.9	2/18/2011	10.9	5/30/2011	10.9	12/15/2011	10.8
2/24/2010	11.2	9/22/2010	10.8	2/25/2011	10.9	5/31/2011	10.5	12/16/2011	10.8
2/25/2010	11.0	9/23/2010	10.6	3/10/2011	10.9	6/7/2011	10.8	12/19/2011	10.8
2/26/2010	11.3	9/24/2010	10.8	3/11/2011	10.9	6/8/2011	10.4	12/20/2011	10.7
3/3/2010	11.0	9/27/2010	11.1	3/17/2011	11.0	6/9/2011	10.7	12/21/2011	10.8
3/4/2010	11.0	9/28/2010	10.9	3/18/2011	10.8	6/10/2011	10.7	12/22/2011	10.8
3/5/2010	11.1	9/29/2010	11.0	3/21/2011	11.0	6/13/2011	10.9	1/6/2012	10.8
3/8/2010	10.9	9/30/2010	10.5	3/22/2011	11.1	6/14/2011	10.4	1/12/2012	10.8
3/9/2010	11.0	10/1/2010	10.9	3/23/2011	11.0	6/15/2011	10.7	1/13/2012	10.9
3/10/2010	11.0	10/12/2010	10.9	3/24/2011	11.1	6/22/2011	10.6	1/17/2012	10.8
3/11/2010	10.4	10/13/2010	10.8	3/28/2011	11.0	6/23/2011	10.7	1/18/2012	10.8
3/12/2010	10.7	10/25/2010	10.8	3/29/2011	10.9	6/24/2011	10.6	1/23/2012	10.8
3/15/2010	10.8	10/26/2010	11.0	3/30/2011	10.9	6/29/2011	10.7	1/24/2012	10.9
3/16/2010	10.7	10/27/2010	11.1	3/31/2011	10.9	6/30/2011	10.7	1/25/2012	10.9
3/17/2010	10.7	10/28/2010	11.0	4/1/2011	10.9	7/12/2011	10.7	1/26/2012	10.8
3/19/2010	11.0	10/29/2010	11.1	4/4/2011	10.8	7/13/2011	10.7	1/27/2012	10.8
3/26/2010	10.9	11/1/2010	10.8	4/5/2011	10.8	7/14/2011	10.8	1/30/2012	10.8
4/1/2010	11.2	11/2/2010	10.8	4/6/2011	10.8	7/22/2011	10.8	1/31/2012	10.9
4/5/2010	10.9	11/4/2010	10.7	4/7/2011	10.9	8/31/2011	10.8	2/1/2012	10.5
4/6/2010	10.9	11/5/2010	11.3	4/8/2011	10.8	9/27/2011	10.9	2/3/2012	11.7
4/7/2010	10.9	11/9/2010	11.1	4/11/2011	10.9	10/6/2011	10.8	2/9/2012	10.8
4/8/2010	10.9	11/10/2010	11.1	4/12/2011	10.8	10/7/2011	10.8	2/10/2012	10.8
4/9/2010	10.6	11/11/2010	11.8	4/13/2011	10.8	10/18/2011	10.8	2/17/2012	10.9
4/12/2010	10.7	11/12/2010	11.1	4/14/2011	10.9	10/19/2011	10.8	2/22/2012	10.8
4/13/2010	10.9	11/15/2010	11.0	4/15/2011	11.1	10/20/2011	10.8	2/24/2012	10.6
4/14/2010	10.9	11/16/2010	11.1	4/18/2011	10.6	10/21/2011	10.9	2/28/2012	10.7
4/16/2010	10.9	11/17/2010	11.0	4/19/2011	10.6	10/26/2011	10.8	2/29/2012	10.8
4/22/2010	10.8	11/22/2010	10.9	4/20/2011	10.5	10/27/2011	10.8	3/1/2012	10.9
4/23/2010	10.8	11/25/2010	10.8	4/21/2011	10.6	11/1/2011	10.8	3/2/2012	10.9
5/6/2010	11.0	11/26/2010	10.9	4/25/2011	10.6	11/2/2011	10.8	3/6/2012	10.8
5/7/2010	10.9	11/29/2010	11.0	4/26/2011	10.6	11/3/2011	10.8	3/7/2012	10.8
5/21/2010	10.8	11/30/2010	10.9	4/27/2011	10.6	11/4/2011	10.8	3/8/2012	10.9
5/26/2010	10.8	12/1/2010	10.9	4/28/2011	10.8	11/7/2011	10.8	3/9/2012	10.8
6/4/2010	10.8	12/2/2010	11.1	4/29/2011	10.4	11/8/2011	10.8	3/12/2012	10.7
6/23/2010	10.7	12/3/2010	10.9	5/2/2011	10.7	11/9/2011	10.8	3/13/2012	10.8

Appendix Table C.5.4: Water quality at station DS-3 from 2010 to 2014.

Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH
3/14/2012	10.8	10/17/2012	11.1	2/13/2013	10.9	5/13/2013	10.5	10/7/2013	10.8
3/15/2012	10.7	10/18/2012	11.0	2/14/2013	10.8	5/14/2013	11.0	10/8/2013	11.0
3/16/2012	11.5	10/19/2012	11.0	2/15/2013	10.8	5/15/2013	10.8	10/9/2013	11.0
3/17/2012	11.5	10/29/2012	10.9	2/20/2013	10.8	5/16/2013	10.7	10/10/2013	11.1
3/18/2012	10.5	10/30/2012	10.9	2/21/2013	10.8	5/17/2013	10.9	10/11/2013	11.1
3/19/2012	10.5	10/31/2012	10.8	2/27/2013	10.8	5/21/2013	10.8	10/17/2013	10.8
3/20/2012	11.0	11/1/2012	10.8	2/28/2013	10.8	5/22/2013	11.0	10/18/2013	11.0
3/21/2012	11.1	11/2/2012	10.8	3/1/2013	10.8	5/23/2013	10.8	10/21/2013	10.8
3/22/2012	11.1	11/5/2012	10.8	3/6/2013	10.8	5/24/2013	10.8	10/22/2013	11.1
3/23/2012	11.2	11/6/2012	10.8	3/7/2013	10.9	5/27/2013	11.3	10/23/2013	10.8
3/26/2012	10.8	11/9/2012	10.9	3/8/2013	10.8	5/28/2013	11.1	10/25/2013	10.8
3/27/2012	10.8	11/12/2012	10.9	3/11/2013	10.8	5/29/2013	11.2	10/29/2013	10.9
3/29/2012	11.1	11/13/2012	11.0	3/12/2013	11.0	6/3/2013	11.3	10/30/2013	11.3
3/30/2012	10.6	11/14/2012	11.0	3/13/2013	10.8	6/4/2013	11.2	10/31/2013	11.0
4/3/2012	11.1	11/15/2012	10.8	3/14/2013	10.6	6/5/2013	11.0	11/1/2013	10.6
4/4/2012	10.8	11/16/2012	11.0	3/15/2013	10.8	6/6/2013	10.8	11/4/2013	10.9
4/5/2012	11.0	11/19/2012	10.9	3/18/2013	12.0	6/7/2013	10.8	11/5/2013	10.7
4/9/2012	11.2	11/20/2012	11.1	3/20/2013	11.0	6/13/2013	10.8	11/6/2013	10.7
4/10/2012	11.2	11/21/2012	11.0	3/21/2013	10.3	6/14/2013	10.8	11/7/2013	10.8
4/11/2012	11.2	11/22/2012	11.1	3/22/2013	10.5	6/24/2013	10.5	11/8/2013	10.9
4/12/2012	10.9	11/29/2012	10.8	3/26/2013	10.3	6/25/2013	10.2	11/11/2013	11.0
4/13/2012	10.9	11/30/2012	10.8	3/27/2013	10.3	6/26/2013	9.7	11/12/2013	11.0
4/16/2012	11.2	12/3/2012	10.8	3/28/2013	10.6	6/27/2013	11.1	11/13/2013	10.9
4/17/2012	11.3	12/4/2012	10.8	4/1/2013	10.5	7/22/2013	9.5	11/15/2013	10.7
4/18/2012	11.0	12/6/2012	10.9	4/2/2013	10.7	7/23/2013	11.4	11/18/2013	10.8
4/20/2012	10.9	12/7/2012	10.9	4/3/2013	10.6	7/24/2013	11.3	11/19/2013	10.6
4/24/2012	10.9	12/12/2012	10.9	4/4/2013	10.6	7/26/2013	11.0	11/20/2013	10.7
4/25/2012	10.9	12/14/2012	10.8	4/5/2013	10.7	7/29/2013	10.5	11/21/2013	10.7
4/26/2012	10.9	12/18/2012	11.2	4/8/2013	10.5	7/30/2013	10.5	11/22/2013	11.0
5/1/2012	10.8	12/19/2012	11.2	4/9/2013	10.6	7/31/2013	10.3	11/27/2013	11.1
5/2/2012	10.8	12/26/2012	10.8	4/10/2013	10.6	8/1/2013	10.6	11/28/2013	10.8
5/3/2012	10.9	12/27/2012	10.9	4/11/2013	10.7	8/2/2013	8.5	12/2/2013	11.1
5/4/2012	10.8	1/7/2013	10.9	4/12/2013	10.7	8/7/2013	10.7	12/4/2013	11.1
5/9/2012	11.0	1/8/2013	10.7	4/15/2013	10.7	8/8/2013	11.4	12/5/2013	11.2
5/10/2012	10.8	1/10/2013	10.8	4/16/2013	10.5	8/9/2013	10.4	12/6/2013	11.1
5/24/2012	10.8	1/14/2013	10.9	4/17/2013	10.5	8/13/2013	10.8	12/9/2013	11.1
5/25/2012	10.8	1/15/2013	10.8	4/18/2013	11.0	8/14/2013	11.0	12/11/2013	10.9
6/4/2012	10.9	1/16/2013	10.7	4/19/2013	10.8	8/15/2013	11.8	12/12/2013	10.7
6/5/2012	10.6	1/17/2013	10.6	4/22/2013	10.7	8/19/2013	10.8	12/13/2013	10.7
6/15/2012	11.7	1/21/2013	10.8	4/23/2013	10.8	8/20/2013	10.6	12/17/2013	10.9
6/20/2012	10.8	1/22/2013	10.9	4/24/2013	10.8	8/21/2013	10.8	12/18/2013	10.9
6/21/2012	10.6	1/25/2013	10.8	4/25/2013	10.5	8/28/2013	10.7	12/20/2013	10.8
6/25/2012	10.8	1/28/2013	10.8	4/26/2013	10.6	8/29/2013	11.0	12/23/2013	10.9
6/26/2012	10.7	1/29/2013	10.8	4/29/2013	11.1	8/30/2013	10.7	12/24/2013	10.8
8/30/2012	10.8	1/30/2013	10.8	4/30/2013	10.6	9/3/2013	10.7	1/2/2014	10.8
9/18/2012	10.9	1/31/2013	10.8	5/1/2013	10.9	9/6/2013	10.7	1/7/2014	10.7
9/26/2012	10.8	2/1/2013	10.8	5/2/2013	10.8	9/10/2013	10.9	1/8/2014	10.7
9/27/2012	10.8	2/4/2013	10.8	5/3/2013	11.0	9/11/2013	11.0	1/9/2014	10.7
10/11/2012	10.9	2/5/2013	10.9	5/6/2013	10.9	9/12/2013	10.8	1/13/2014	11.0
10/12/2012	10.8	2/6/2013	10.8	5/7/2013	10.8	9/13/2013	10.8	1/14/2014	10.9
10/15/2012	10.7	2/7/2013	10.8	5/8/2013	10.7	9/19/2013	10.8	1/15/2014	10.7
10/16/2012	11.1	2/12/2013	10.8	5/10/2013	11.0	9/20/2013	10.7	1/16/2014	10.9

Appendix Table C.5.4: Water quality at station DS-3 from 2010 to 2014.

Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH
1/17/2014	10.8	5/13/2014	11.0	10/21/2014	10.8				
1/20/2014	10.9	5/14/2014	10.9	10/22/2014	10.8				
1/21/2014	10.9	5/15/2014	10.7	10/23/2014	10.9				
1/24/2014	10.8	5/16/2014	10.9	10/24/2014	10.8				
1/27/2014	10.8	5/20/2014	10.8	10/28/2014	10.8				
1/29/2014	10.8	5/21/2014	10.7	10/29/2014	10.6				
1/30/2014	10.8	5/22/2014	10.7	10/30/2014	10.7				
1/31/2014	10.7	5/23/2014	10.8	10/31/2014	10.6				
2/6/2014	10.9	5/26/2014	10.7	11/4/2014	10.8				
2/7/2014	10.9	5/27/2014	10.7	11/5/2014	10.7				
2/12/2014	10.9	5/28/2014	10.8	11/6/2014	10.8				
2/13/2014	10.9	5/30/2014	10.8	11/7/2014	10.8				
2/20/2014	10.9	6/2/2014	10.8	11/10/2014	10.8				
2/21/2014	10.9	6/3/2014	10.7	11/11/2014	10.8				
2/25/2014	10.8	6/4/2014	10.7	11/12/2014	10.8				
2/26/2014	10.8	6/5/2014	10.8	11/13/2014	10.8				
2/28/2014	10.8	6/6/2014	10.8	11/15/2014	10.8				
3/6/2014	10.9	6/11/2014	10.8	11/16/2014	10.8				
3/7/2014	10.9	6/12/2014	10.6	11/18/2014	10.9				
3/12/2014	10.7	6/13/2014	10.7	11/19/2014	10.9				
3/13/2014	10.7	6/26/2014	10.8	11/21/2014	10.8				
3/20/2014	10.8	6/27/2014	10.8	11/24/2014	10.7				
3/21/2014	11.0	7/3/2014	10.8	11/25/2014	10.7				
3/26/2014	10.8	7/4/2014	10.8	11/26/2014	10.8				
3/27/2014	10.7	7/8/2014	10.8	11/27/2014	10.8				
4/2/2014	10.6	7/9/2014	10.8	11/28/2014	10.9				
4/3/2014	10.5	7/29/2014	10.8	12/2/2014	10.8				
4/4/2014	10.2	7/30/2014	10.8	12/3/2014	10.8				
4/8/2014	10.3	7/31/2014	10.9	12/4/2014	10.8				
4/9/2014	10.1	8/1/2014	10.9	12/5/2014	10.8				
4/10/2014	10.1	8/5/2014	10.8	12/10/2014	10.8				
4/11/2014	10.0	9/2/2014	10.8	12/11/2014	11.0				
4/14/2014	10.4	9/3/2014	10.8	12/12/2014	10.9				
4/15/2014	10.0	9/5/2014	10.8	12/15/2014	10.9				
4/16/2014	10.5	9/9/2014	10.8	12/16/2014	10.9				
4/17/2014	10.9	9/10/2014	10.8	12/17/2014	10.9				
4/21/2014	10.7	9/11/2014	11.0	12/18/2014	10.8				
4/22/2014	10.8	9/12/2014	10.9	12/19/2014	10.8				
4/23/2014	10.6	9/17/2014	10.8	12/22/2014	10.9				
4/24/2014	10.8	9/18/2014	11.1	12/23/2014	10.7				
4/25/2014	10.8	10/2/2014	10.9	12/24/2014	11.1				
4/28/2014	10.8	10/3/2014	10.9	12/29/2014	10.9				
4/29/2014	10.6	10/6/2014	10.9	12/30/2014	10.8				
4/30/2014	11.0	10/7/2014	10.8	12/31/2014	11.0				
5/1/2014	10.9	10/8/2014	10.8	**count**	**668.0**				
5/2/2014	11.0	10/9/2014	11.0	**min**	**8.5**				
5/5/2014	11.0	10/10/2014	10.9	**max**	**12.0**				
5/6/2014	11.0	10/14/2014	10.8	**mean**	**10.8**				
5/7/2014	11.0	10/15/2014	10.8	**median**	**10.8**				
5/8/2014	11.0	10/16/2014	10.8						
5/9/2014	10.9	10/17/2014	10.7						
5/12/2014	11.0	10/20/2014	10.6						

Appendix Table C.5.5: Water quality at station DS-5 from 2010 to 2014.

Date m/d/yr	Acidity mg/L	Ba mg/L	Co mg/L	Cond µmho/cm	Fe mg/L	Mn mg/L	pH[a]	Ra Bq/L	Sulphate mg/L	U mg/L
1/12/2010	32	0.026	0.0126	172.8	4.28	0.212	3.4	0.043	110	0.0061
4/13/2010	36	0.014	0.005	136.3	1.87	0.084	3.6	0.03	39	0.0034
10/12/2010	36	0.03	0.0112	244.9	7.22	0.178	3.6	0.019	96	0.005
1/11/2011	40	0.025	0.0128	217.7	4.84	0.163	3.4	0.055	93	0.0083
4/12/2011	23	0.012	0.0041	108.1	4.16	0.084	3.7	0.032	42	0.0033
11/8/2011	44	0.023	0.0099	189.0	2.21	0.126	3.4	0.056	74	0.0061
1/10/2012	26	0.029	0.0127	188.7	1.77	0.192	3.8	0.059	100	0.0066
4/9/2012	25	0.019	0.0081	178.0	2.21	0.121	3.6	0.038	62	0.0045
10/16/2012				171.0			3.7			
1/8/2013				168.1			3.9			
4/9/2013				114.3			3.9			
10/9/2013				244.8			3.3			
1/14/2014				156.1			3.5			
4/9/2014				69.2			4.0			
10/20/2014				134.7			3.7			
count	8	8	8	15	8	8	121	8	8	8
min	23	0.012	0.0041	69	1.8	0.084	3.3	0.019	39	0.0033
max	44	0.030	0.0128	245	7.2	0.212	5.5	0.059	110	0.0083
mean	33	0.022	0.0096	166	3.6	0.145	3.6	0.042	77	0.0054
median	34	0.024	0.0106	171	3.2	0.145	3.5	0.041	84	0.0056
10th Percentile	24	0.013	0.0047	111	1.8	0.084	3.4	0.027	41	0.0034
95th Percentile	43	0.030	0.0128	245	6.4	0.205	3.7	0.058	107	0.0077

[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 from 2010 to 2014.

Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH
1/4/2010	7.0	4/12/2010	8.8	3/16/2011	8.4	11/18/2011	7.7	3/12/2012	7.1
1/5/2010	6.8	4/13/2010	8.9	3/21/2011	8.3	11/22/2011	7.5	3/13/2012	7.9
1/6/2010	7.4	4/15/2010	8.8	3/22/2011	8.3	11/28/2011	7.5	3/14/2012	6.8
1/7/2010	7.2	4/19/2010	8.4	3/23/2011	8.4	11/29/2011	7.6	3/15/2012	7.5
1/11/2010	7.2	4/20/2010	8.4	3/24/2011	8.2	11/30/2011	7.5	3/16/2012	9.9
1/12/2010	7.2	6/29/2010	8.6	3/29/2011	8.3	12/1/2011	7.5	3/19/2012	6.5
1/13/2010	7.3	9/24/2010	7.6	4/4/2011	8.2	12/2/2011	7.4	3/20/2012	7.2
1/14/2010	7.2	9/27/2010	7.9	4/5/2011	7.6	12/5/2011	7.4	3/21/2012	7.2
1/19/2010	7.3	9/28/2010	7.9	4/6/2011	7.5	12/6/2011	7.3	3/22/2012	6.5
1/21/2010	7.3	9/29/2010	8.4	4/7/2011	9.0	12/7/2011	7.3	3/23/2012	7.9
1/25/2010	7.3	9/30/2010	8.3	4/8/2011	9.6	12/8/2011	7.3	3/26/2012	9.4
1/26/2010	7.2	10/1/2010	8.2	4/11/2011	7.6	12/9/2011	7.3	3/27/2012	9.4
1/28/2010	7.4	10/26/2010	7.7	4/12/2011	7.3	12/12/2011	7.3	3/28/2012	9.3
1/29/2010	7.3	10/27/2010	7.8	4/13/2011	7.9	12/13/2011	7.3	3/29/2012	9.2
2/1/2010	7.3	10/28/2010	8.3	4/14/2011	7.5	12/14/2011	7.4	3/30/2012	9.1
2/2/2010	7.3	10/29/2010	8.3	4/15/2011	7.5	12/15/2011	7.4	4/2/2012	9.1
2/3/2010	7.1	11/1/2010	8.4	4/18/2011	7.5	12/16/2011	7.4	4/3/2012	9.0
2/4/2010	7.3	11/2/2010	8.2	4/19/2011	7.7	12/19/2011	7.4	4/4/2012	8.9
2/5/2010	7.4	11/3/2010	8.2	4/20/2011	8.8	12/20/2011	7.4	4/5/2012	8.9
2/8/2010	7.2	11/4/2010	8.2	4/21/2011	8.8	12/21/2011	7.4	4/9/2012	8.5
2/9/2010	7.2	11/5/2010	8.1	4/25/2011	8.7	12/22/2011	7.3	4/10/2012	8.4
2/16/2010	7.2	11/9/2010	7.9	4/26/2011	9.1	12/28/2011	7.3	4/11/2012	8.5
2/19/2010	7.2	11/11/2010	8.0	4/27/2011	9.2	1/3/2012	7.5	4/12/2012	8.4
2/22/2010	7.1	11/16/2010	7.9	4/28/2011	7.9	1/5/2012	7.5	4/17/2012	8.4
2/24/2010	7.1	11/19/2010	7.9	4/29/2011	7.6	1/9/2012	7.3	4/24/2012	7.9
2/25/2010	7.2	11/22/2010	7.7	5/2/2011	8.6	1/10/2012	7.3	4/27/2012	7.8
3/1/2010	7.6	11/23/2010	7.7	5/3/2011	8.6	1/13/2012	7.3	5/1/2012	7.7
3/2/2010	7.2	11/24/2010	7.7	5/4/2011	8.5	1/16/2012	7.2	5/2/2012	7.4
3/3/2010	7.1	11/25/2010	7.6	5/5/2011	8.4	1/17/2012	7.3	5/8/2012	7.9
3/4/2010	7.6	11/26/2010	7.7	5/6/2011	8.5	1/20/2012	7.1	5/10/2012	7.8
3/5/2010	7.3	11/29/2010	7.7	5/10/2011	8.4	1/24/2012	7.2	6/5/2012	8.0
3/8/2010	7.5	11/30/2010	7.7	5/12/2011	8.2	1/25/2012	7.1	6/8/2012	7.9
3/9/2010	7.4	12/1/2010	7.6	5/24/2011	7.8	1/26/2012	6.8	6/21/2012	8.1
3/10/2010	7.4	12/2/2010	7.7	5/26/2011	7.9	1/27/2012	7.1	6/26/2012	8.3
3/11/2010	7.4	12/3/2010	7.7	5/27/2011	8.0	1/30/2012	6.9	10/19/2012	8.0
3/12/2010	7.5	12/7/2010	7.5	5/31/2011	8.0	1/31/2012	6.9	10/23/2012	8.1
3/15/2010	7.1	12/20/2010	7.7	6/7/2011	8.0	2/1/2012	6.9	10/30/2012	7.5
3/16/2010	7.2	12/21/2010	7.7	6/14/2011	8.1	2/2/2012	6.9	11/1/2012	7.4
3/17/2010	7.6	12/29/2010	7.8	6/17/2011	8.1	2/7/2012	6.9	11/2/2012	7.4
3/18/2010	7.2	1/4/2011	7.8	11/1/2011	7.5	2/10/2012	6.9	11/5/2012	7.4
3/19/2010	6.9	1/6/2011	7.7	11/2/2011	7.5	2/14/2012	7.0	11/6/2012	7.4
3/22/2010	7.0	1/11/2011	7.7	11/3/2011	7.5	2/15/2012	6.9	11/7/2012	7.5
3/23/2010	7.0	1/14/2011	7.8	11/4/2011	7.6	2/17/2012	6.9	11/8/2012	7.7
3/24/2010	6.5	1/18/2011	7.9	11/7/2011	7.9	2/21/2012	7.1	11/9/2012	7.5
3/25/2010	7.5	1/21/2011	8.0	11/8/2011	7.9	2/22/2012	7.0	11/12/2012	7.7
3/29/2010	6.9	1/25/2011	7.9	11/9/2011	7.7	2/24/2012	6.7	11/13/2012	7.8
3/30/2010	6.8	1/27/2011	7.8	11/10/2011	7.6	2/28/2012	7.0	11/14/2012	7.6
4/5/2010	8.8	1/28/2011	7.8	11/11/2011	7.7	3/1/2012	6.8	11/15/2012	7.6
4/6/2010	9.0	1/31/2011	7.7	11/14/2011	7.7	3/2/2012	6.8	11/20/2012	7.8
4/7/2010	8.9	2/1/2011	7.7	11/15/2011	7.6	3/6/2012	6.9	11/27/2012	7.6
4/8/2010	9.0	3/14/2011	8.4	11/16/2011	7.7	3/8/2012	6.9	11/29/2012	7.5
4/9/2010	9.0	3/15/2011	8.2	11/17/2011	7.2	3/9/2012	6.6	11/30/2012	7.7

Appendix Table C.5.6: Water quality at station DS-6 from 2010 to 2014.

Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH
12/3/2012	7.5	4/19/2013	7.0	9/10/2013	8.2	1/20/2014	7.9	9/15/2014	8.0
12/4/2012	7.6	4/22/2013	7.1	9/11/2013	8.2	1/21/2014	8.0	9/16/2014	7.9
12/5/2012	7.6	4/23/2013	7.1	9/12/2013	8.3	1/28/2014	8.6	9/18/2014	8.0
12/11/2012	7.6	4/24/2013	8.0	9/13/2013	8.5	2/4/2014	7.8	9/22/2014	7.6
12/13/2012	7.5	4/25/2013	6.7	9/16/2013	8.1	2/25/2014	8.1	9/23/2014	7.7
12/14/2012	7.6	4/26/2013	6.7	9/17/2013	8.2	2/26/2014	9.1	9/30/2014	7.6
12/17/2012	7.4	4/29/2013	6.7	10/8/2013	7.5	3/7/2014	8.9	10/3/2014	7.8
12/18/2012	7.6	4/30/2013	6.5	10/10/2013	7.7	3/10/2014	8.5	10/6/2014	8.3
12/19/2012	7.8	5/1/2013	8.6	10/17/2013	7.4	3/11/2014	8.7	10/7/2014	8.3
12/20/2012	7.6	5/2/2013	8.8	10/21/2013	7.6	3/12/2014	8.7	10/9/2014	8.4
1/8/2013	7.5	5/3/2013	9.1	10/22/2013	7.6	3/24/2014	8.0	10/10/2014	8.3
1/9/2013	7.6	5/6/2013	8.8	10/29/2013	7.5	3/25/2014	8.3	10/14/2014	8.1
1/10/2013	7.6	5/7/2013	8.7	10/30/2013	7.4	3/26/2014	8.0	10/15/2014	7.7
1/14/2013	7.4	5/8/2013	8.5	10/31/2013	7.4	3/27/2014	8.9	10/16/2014	8.1
1/15/2013	7.4	5/14/2013	8.3	11/1/2013	6.9	3/31/2014	8.7	10/17/2014	7.8
1/16/2013	7.6	5/16/2013	8.1	11/4/2013	7.3	4/1/2014	8.5	10/20/2014	8.2
1/17/2013	7.6	5/17/2013	8.0	11/5/2013	7.2	4/2/2014	8.8	10/21/2014	8.6
1/22/2013	7.6	5/21/2013	7.8	11/6/2013	7.0	4/3/2014	9.0	10/23/2014	8.4
1/29/2013	7.6	5/23/2013	8.0	11/7/2013	7.3	4/4/2014	8.8	10/28/2014	7.9
2/5/2013	7.6	5/24/2013	7.8	11/8/2013	7.9	4/7/2014	8.6	10/31/2014	7.9
2/6/2013	7.4	5/27/2013	8.0	11/11/2013	7.3	4/9/2014	9.2	11/3/2014	7.8
2/12/2013	7.4	5/28/2013	8.2	11/12/2013	7.1	4/10/2014	9.1	11/4/2014	7.5
2/13/2013	7.5	5/29/2013	8.3	11/13/2013	7.6	4/11/2014	8.8	11/5/2014	7.8
2/14/2013	7.5	6/4/2013	8.9	11/14/2013	7.3	4/14/2014	8.3	11/6/2014	7.9
2/19/2013	7.4	6/5/2013	9.0	11/15/2013	7.1	4/15/2014	6.9	11/7/2014	7.7
2/22/2013	7.6	6/11/2013	8.7	11/18/2013	7.3	4/16/2014	8.0	11/10/2014	7.5
2/26/2013	7.4	6/18/2013	8.6	11/19/2013	7.4	4/17/2014	7.9	11/11/2014	7.6
2/28/2013	7.5	6/25/2013	9.0	11/20/2013	6.9	4/21/2014	8.6	11/12/2014	7.8
3/5/2013	7.4	6/26/2013	8.9	11/21/2013	7.3	4/22/2014	8.7	11/18/2014	7.7
3/7/2013	7.3	6/28/2013	8.8	11/22/2013	7.5	4/23/2014	7.6	11/24/2014	7.5
3/12/2013	7.4	7/2/2013	8.8	11/25/2013	8.0	4/24/2014	7.2	11/25/2014	7.4
3/13/2013	7.4	7/9/2013	8.6	11/26/2013	7.9	4/28/2014	8.8	11/26/2014	7.3
3/14/2013	8.6	7/11/2013	8.6	11/27/2013	7.9	4/29/2014	9.7	11/27/2014	7.4
3/15/2013	9.6	7/23/2013	8.5	11/28/2013	7.8	4/30/2014	9.6	11/28/2014	7.3
3/18/2013	9.1	7/24/2013	8.6	11/29/2013	8.1	5/1/2014	8.4	12/2/2014	7.5
3/19/2013	8.9	7/25/2013	8.6	12/2/2013	7.9	5/2/2014	8.3	12/3/2014	7.2
3/20/2013	7.9	7/29/2013	8.3	12/3/2013	7.8	5/5/2014	9.3	12/4/2014	7.1
3/21/2013	9.6	7/30/2013	8.5	12/4/2013	7.7	5/6/2014	9.2	12/5/2014	7.2
3/22/2013	9.0	7/31/2013	8.6	12/5/2013	8.0	5/7/2014	9.2	12/8/2014	7.1
3/25/2013	7.6	8/1/2013	8.6	12/6/2013	8.0	5/9/2014	9.4	12/9/2014	7.2
3/26/2013	7.5	8/2/2013	8.8	12/9/2013	8.5	5/12/2014	9.1	12/11/2014	7.2
3/27/2013	9.4	8/7/2013	8.6	12/10/2013	8.6	5/13/2014	9.0	12/12/2014	7.1
3/28/2013	8.9	8/8/2013	8.7	12/11/2013	8.7	5/20/2014	8.7	12/15/2014	7.0
4/1/2013	8.7	8/9/2013	8.9	12/13/2013	8.5	5/22/2014	8.6	12/16/2014	7.3
4/2/2013	8.7	8/12/2013	8.9	12/16/2013	8.0	5/27/2014	8.1	12/22/2014	7.1
4/3/2013	8.4	8/13/2013	8.8	12/17/2013	8.4	6/3/2014	7.8	12/23/2014	7.1
4/4/2013	8.4	8/15/2013	9.2	12/18/2013	8.5	6/5/2014	8.0	12/29/2014	7.2
4/5/2013	7.6	8/20/2013	8.6	12/19/2013	8.7	6/10/2014	7.6	**count**	527
4/8/2013	8.4	8/21/2013	8.7	12/20/2013	8.6	7/4/2014	8.2	**min**	6.5
4/9/2013	8.8	8/22/2013	8.9	12/23/2013	8.2	7/18/2014	8.4	**max**	9.9
4/10/2013	8.8	8/27/2013	8.6	1/2/2014	8.8	9/2/2014	7.9	**mean**	7.9
4/15/2013	8.8	8/29/2013	8.4	1/3/2014	8.7	9/3/2014	8.0	**median**	7.8
4/16/2013	8.6	9/3/2013	8.3	1/6/2014	8.6	9/4/2014	7.9		
4/17/2013	7.7	9/5/2013	8.3	1/7/2014	8.6	9/5/2014	7.8		
4/18/2013	8.1	9/9/2013	8.3	1/14/2014	8.2	9/11/2014	8.0		

Appendix Table C.5.7: Water quality at Stanrock porewater stations from 2010 to 2014.

Station	Date m/d/y	Acidity mg/L	pH	Sulphate mg/L	Fe mg/L	Ra Bq/L
PN-ST3-P3	7/7/2010	1070	5.8	2600	596	
	9/1/2011	1110	6.3	2300	606	
	8/21/2012	864	5.9	2200	406	
	8/21/2013	980	5.3	2500	543	
	8/14/2014	954	5.7	2300	427	2.308
	count	5	5	5	5	1
	min	864	5	2200	406	2.308
	max	1110	6	2600	606	2.308
	mean	995.6	6	2380	515.6	2.308
	median	980	6	2300	543	2.308
	10th Percentile	900	5	2240	414.4	2.308
	95th Percentile	1102	6	2580	604	2.308
PN-ST3-P5	7/7/2010	1310	3	2700	643	
	9/1/2011	1520	3	2600	742	
	8/21/2012	1400	3.1	2800	642	
	8/21/2013	1640	3.3	3000	853	
	8/14/2014	1950	3.5	3200	1120	1.575
	count	5	5	5	5	1
	min	1310	3	2600	642	1.575
	max	1950	4	3200	1120	1.575
	mean	1564	3	2860	800	1.575
	median	1520	3	2800	742	1.575
	10th Percentile	1346	3	2640	642.4	1.575
	95th Percentile	1888	3	3160	1066.6	1.575
PN-ST3-P6	7/7/2010	2710	5.7	4600	1600	
	9/1/2011		6.7	4400	1810	
	8/21/2012	3070	6.3	4500	1570	
	8/21/2013	3460	5.1	4900	2140	
	8/14/2014	3540	6.2	4300	1640	1.751
	count	4	5	5	5	1
	min	2710	5	4300	1570	1.751
	max	3540	7	4900	2140	1.751
	mean	3195	6	4540	1752	1.751
	median	3265	6	4500	1640	1.751
	10th Percentile	2818	5	4340	1582	1.751
	95th Percentile	3528	7	4840	2074	1.751
PN-ST3-P8	7/7/2010	6240	5.8	8700	3880	
	9/1/2011	8640	6	12000	5310	
	8/21/2012	7810	5.5	11000	5000	
	8/21/2013	9770	5.9	12000	6130	
	8/14/2014	9560	5.6	12000	5540	0.756
	count	5	5	5	5	1
	min	6240	6	8700	3880	0.756
	max	9770	6	12000	6130	0.756
	mean	8404	6	11140	5172	0.756
	median	8640	6	12000	5310	0.756
	10th Percentile	6868	6	9620	4328	0.756
	95th Percentile	9728	6	12000	6012	0.756
BH91-SG2A	7/6/2010	2180	6.2	5000	1370	
	8/29/2011	1250	6.4	3200	640	
	9/2/2011	1250	6.1	3200	640	
	8/21/2012	2190	6.2	4800	1340	
	8/22/2013	2290	6.3	4800	1670	
	8/13/2014	2290	6.5	4600	1400	0.069
	count	6	6	6	6	1
	min	1250	6	3200.0	640	0.069
	max	2290	7	5000.0	1670	0.069
	mean	1908	6	4266.7	1176.667	0
	median	2185	6	4700.0	1355	0.069
	10th Percentile	1250	6	3200.0	640	0.069
	95th Percentile	2290	6	4950.0	1602.5	0.069

Appendix Table C.5.8: Water quality at Stanrock groundwater stations from 2010 to 2014.

Station	Date m/d/y	Acidity mg/L	Fe mg/L	pH	Ra Bq/L	Sulphate mg/L
BH98-15A	7/7/2010	1790	1010	5.5		3500
	8/31/2011	1680	1100	6.0		3100
	8/21/2012	1450	957	6.2		3100
	8/22/2013	1300	935	6.1		2900
	8/14/2014	1240	786	5.9	0.416	2700
	count	5	5	5	1	5
	min	1240	786	5.5	0.416	2700
	max	1790	1100	6.2	0.416	3500
	mean	1492	958	5.9	0.416	3060
	median	1450	957	6.0	0.416	3100
	10th Percentile	1264	846	5.7	0.416	2780
	95th Percentile	1768	1082	6.2	0.416	3420
BH98-16A	7/7/2010	3270	2130	5.6		5600
	8/31/2011	2370	1590	5.7		4100
	8/21/2012	2180	1350	5.8		4100
	8/21/2013	3980	2840	5.9		6200
	8/14/2014	2050	1430	5.9	0.111	3900
	count	5	5	5	1	5
	min	2050	1350	5.6	0.111	3900
	max	3980	2840	5.9	0.111	6200
	mean	2770	1868	5.8	0.111	4780
	median	2370	1590	5.8	0.111	4100
	10th Percentile	2102	1382	5.6	0.111	3980
	95th Percentile	3838	2698	5.9	0.111	6080
BH91-SG1A	7/6/2010	4150	2230	4.1		6100
	9/1/2011	4400	2200	3.9		5100
	8/21/2012	4110	1840	4.2		5700
	8/21/2013	4150	2320	4.3		5700
	8/14/2014	3400	1810	4.5	0.211	4800
	count	5	5	5	1	5
	min	3400	1810	3.9	0.211	4800
	max	4400	2320	4.5	0.211	6100
	mean	4042	2080	4.2	0.211	5480
	median	4150	2200	4.2	0.211	5700
	10th Percentile	3684	1822	4.0	0.211	4920
	95th Percentile	4350	2302	4.5	0.211	6020
SG-3A	7/7/2010	2330	1020	3.7		3900
	8/31/2011	2160	1170	4.0		3300
SG-3B	8/31/2011	1360	566	3.3		2800

Appendix Table C.5.9: Summary of seasonal trends for station DS-2 from 2003-2014.

Month	Spearman's rho	Acidity	Ba	Co	Fe	Mn	pH	Ra	Sulphate	U
January	Correlation Coefficient	-0.7	0.3	-0.564	-0.7	-0.7	0.164	-0.31	-0.7	-0.3
	Sig. (2-tailed)	0.188	0.624	0.322	0.188	0.188	0.631	0.456	0.188	0.624
	N	5	5	5	5	5	11	8	5	5
February	Correlation Coefficient						0.127	0.829		
	Sig. (2-tailed)						0.695	0.042		
	N						12	6		
March	Correlation Coefficient	0.371	0.829	0.6		0.543	-0.042	0.032	-0.257	0.086
	Sig. (2-tailed)	0.468	0.042	0.208		0.266	0.897	0.926	0.623	0.872
	N	6	6	6		6	12	11	6	6
April	Correlation Coefficient	-0.5	0.8	-0.5	-0.5	-0.5	0.119	-0.406	-0.5	-0.3
	Sig. (2-tailed)	0.391	0.104	0.391	0.391	0.391	0.712	0.191	0.391	0.624
	N	5	5	5	5	5	12	12	5	5
May	Correlation Coefficient						0.58	-0.405		
	Sig. (2-tailed)						0.048	0.32		
	N						12	8		
June	Correlation Coefficient	-0.9	-0.1	-0.5		-0.4	-0.249	-0.117	-0.6	-0.5
	Sig. (2-tailed)	0.037	0.873	0.391		0.505	0.436	0.765	0.285	0.391
	N	5	5	5		5	12	9	5	5
July	Correlation Coefficient						-0.42	0.771		
	Sig. (2-tailed)						0.198	0.072		
	N						11	6		
August	Correlation Coefficient						-0.334			
	Sig. (2-tailed)						0.289			
	N						12			
September	Correlation Coefficient						-0.257	0.657		
	Sig. (2-tailed)						0.446	0.156		
	N						11	6		
October	Correlation Coefficient						0.127	0.048		
	Sig. (2-tailed)						0.694	0.911		
	N						12	8		
November	Correlation Coefficient						-0.028	-0.091		
	Sig. (2-tailed)						0.931	0.79		
	N						12	11		
December	Correlation Coefficient	0.058	0.314	0.486		0.714	-0.21	-0.465	-0.829	-0.371
	Sig. (2-tailed)	0.913	0.544	0.329		0.111	0.513	0.15	0.042	0.468
	N	6	6	6		6	12	11	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).

[shaded cell] Significant trend where p<0.05.

Appendix Table C.5.10: Summary of trends for Stanrock porewater stations from 1991 to 2014.

Station	Spearman rho	Acidity	Iron	pH	Sulphate
PN-ST3-P3	Correlation Coefficient	-0.905	-0.599	0.727	-0.359
	Sig. (2-tailed)	0.002	0.004	0.000	0.553
	N	8	21	21	5
PN-ST3-P5	Correlation Coefficient	0.487	-0.440	0.835	0.900
	Sig. (2-tailed)	0.268	0.115	0.000	0.037
	N	7	14	14	5
PN-ST3-P6	Correlation Coefficient	0.929	0.653	0.316	-0.300
	Sig. (2-tailed)	0.003	0.001	0.175	0.624
	N	7	21	20	5
PN-ST3-P8	Correlation Coefficient	0.929	0.968	-0.761	0.671
	Sig. (2-tailed)	0.001	0.000	0.000	0.215
	N	8	21	21	5
BH91-SG2-A	Correlation Coefficient	-0.491	0.079	0.606	-0.359
	Sig. (2-tailed)	0.217	0.735	0.004	0.553
	N	8	21	21	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).

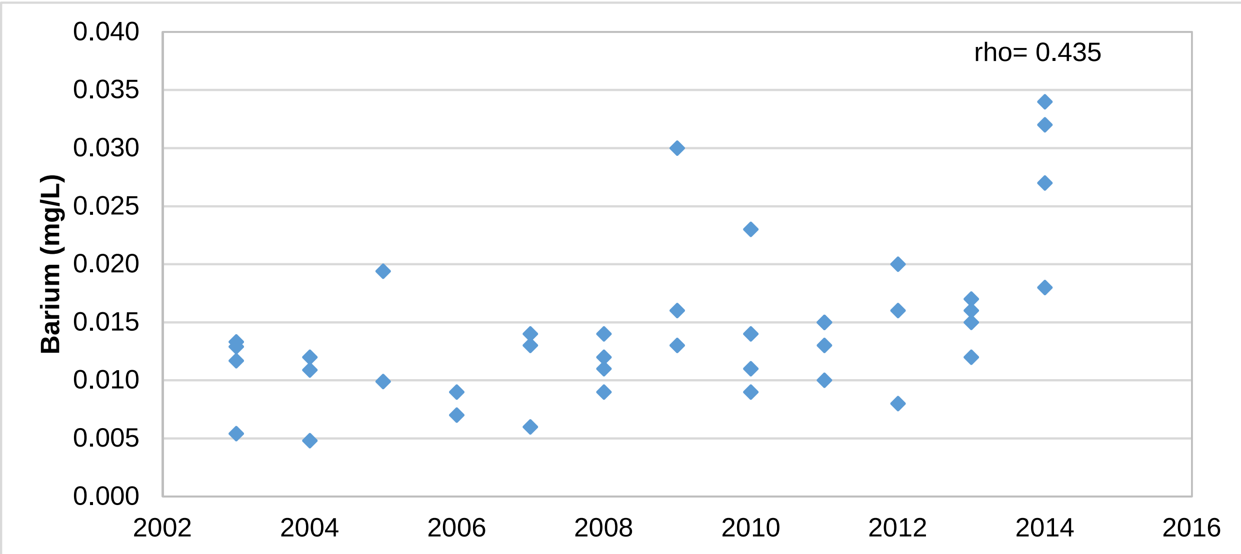
[shaded box] Significant trend where $p<0.05$.

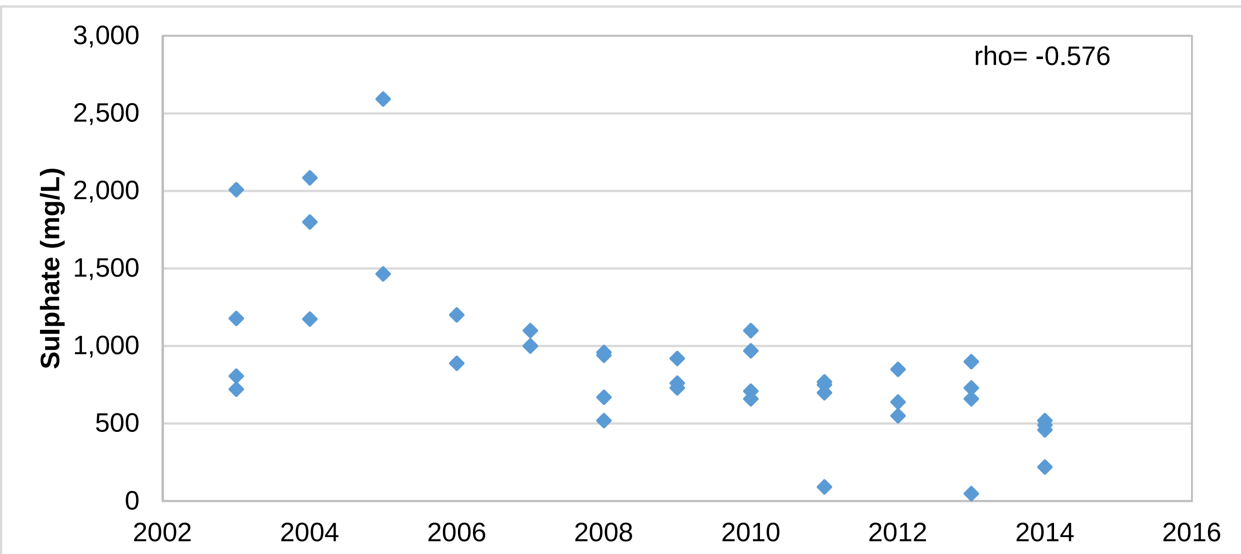
Appendix Table C.5.11: Summary of trends for Stanrock groundwater stations from 1991 to 2014.

Station	Spearman rho	Acidity	pH	Iron	Sulphate
BH91-SG1A	Correlation Coefficient	-0.850	0.391	0.840	-0.873
	Sig. (2-tailed)	0.007	0.098	0.000	0.010
	N	8	19	19	7
BH91-SG3A	Correlation Coefficient	0.500	-0.923	-0.356	0.400
	Sig. (2-tailed)	0.391	0.000	0.257	0.600
	N	5	12	12	4
BH91-SG3B	Correlation Coefficient	-0.400	-0.291	-0.325	-0.500
	Sig. (2-tailed)	0.600	0.385	0.330	0.667
	N	4	11	11	3
BH98-15A	Correlation Coefficient	-1.000	-0.771	0.609	-0.982
	Sig. (2-tailed)	0.000	0.000	0.012	0.000
	N	8	16	16	7
BH98-16A	Correlation Coefficient	0.024	-0.668	0.247	-0.342
	Sig. (2-tailed)	0.955	0.005	0.375	0.452
	N	8	16	15	7

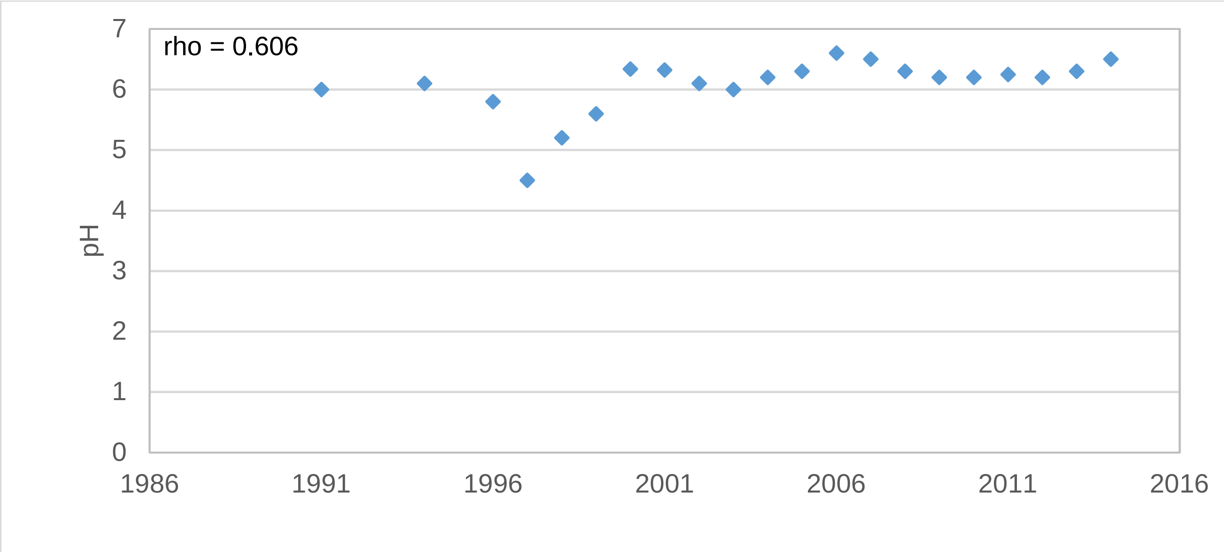
Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

[shaded box] Significant trend where p<0.05.

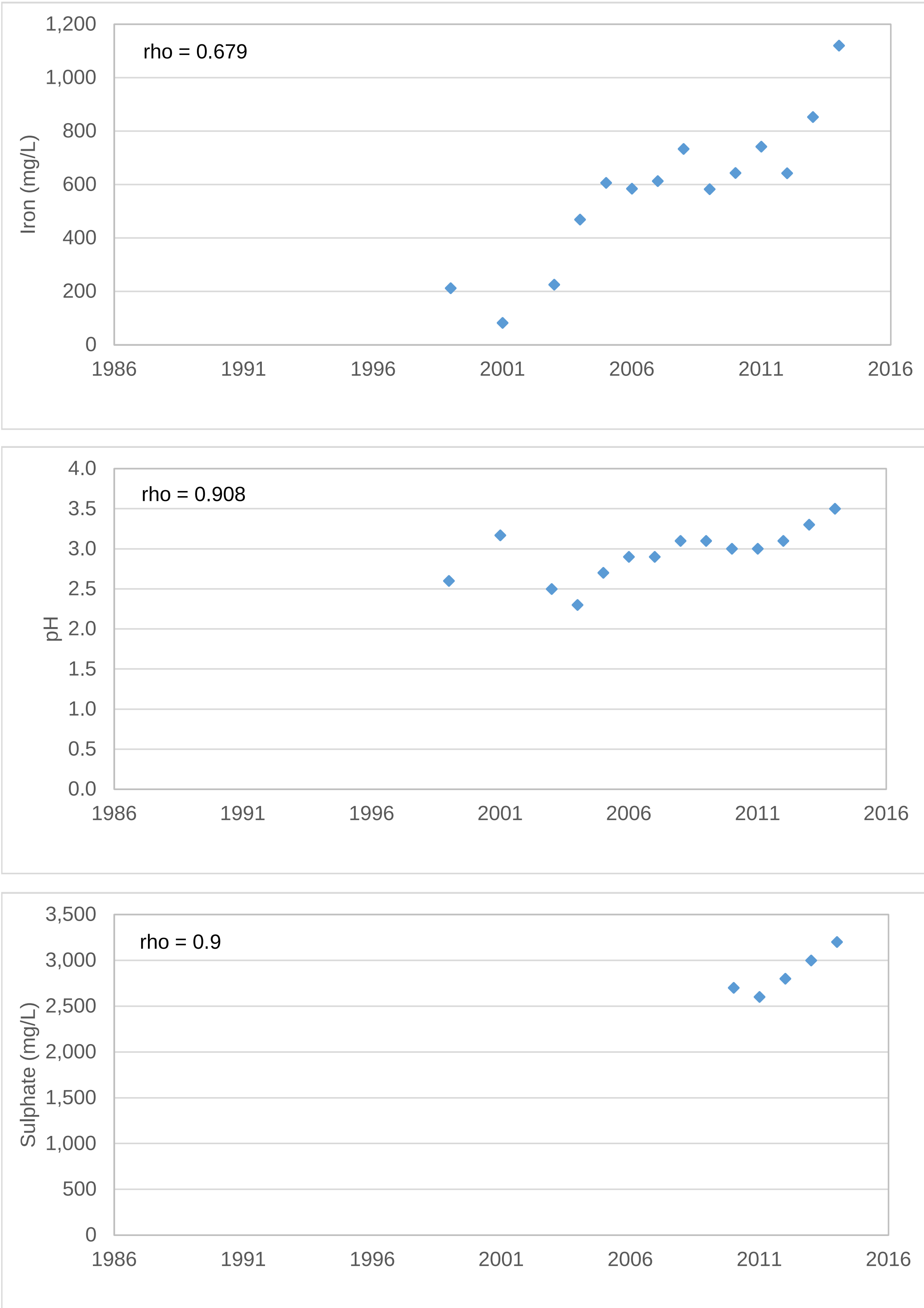




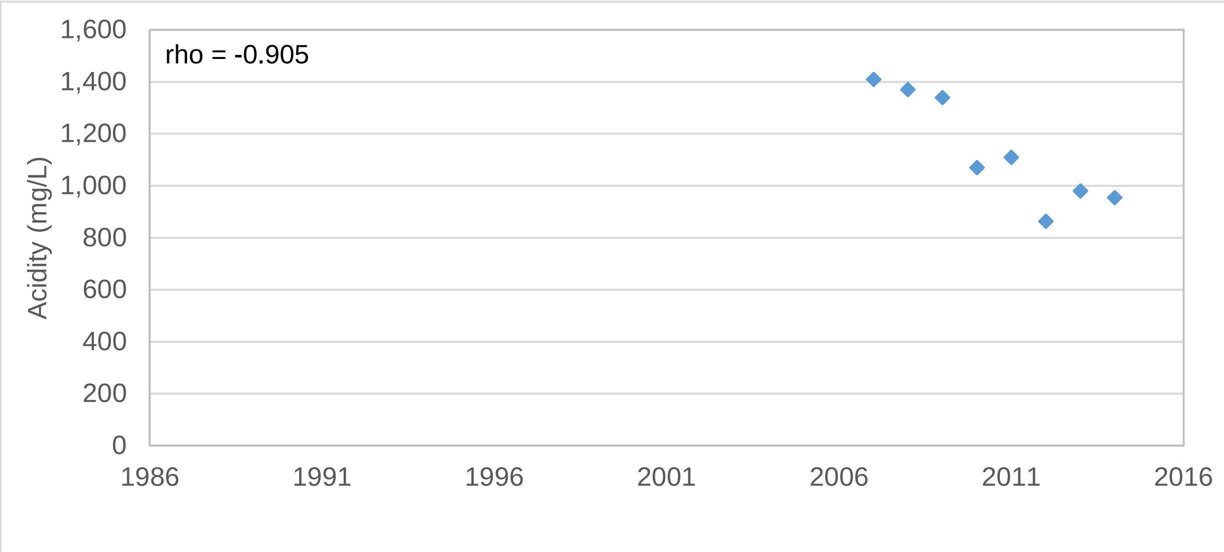
Appendix Figure C.5.1: Significant common (average) trends observed for barium and sulphate, over all seasons at Station DS-2, 2003 to 2014.

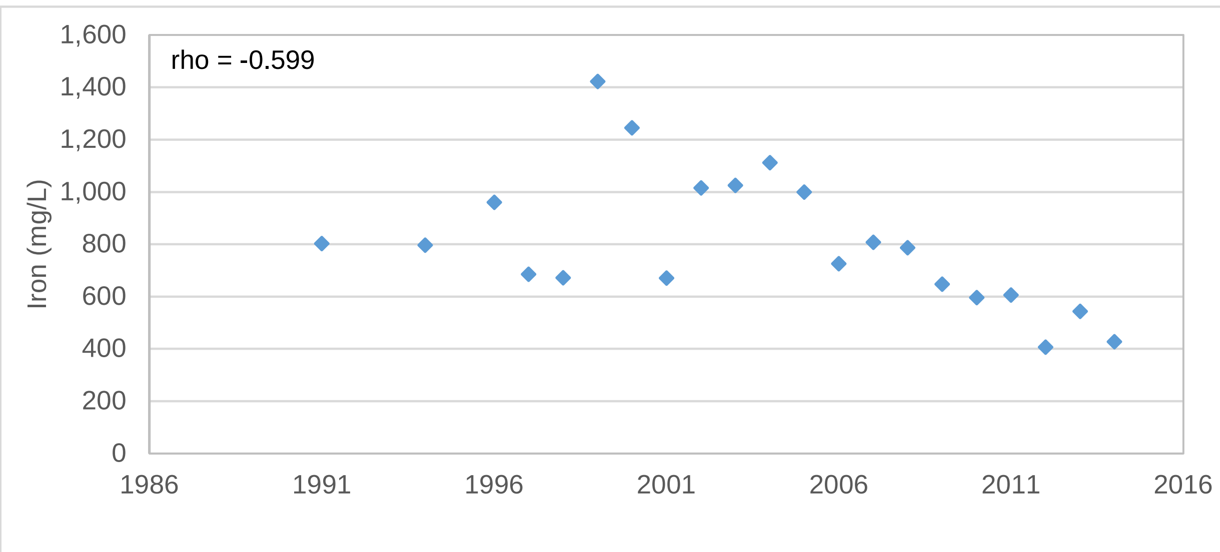


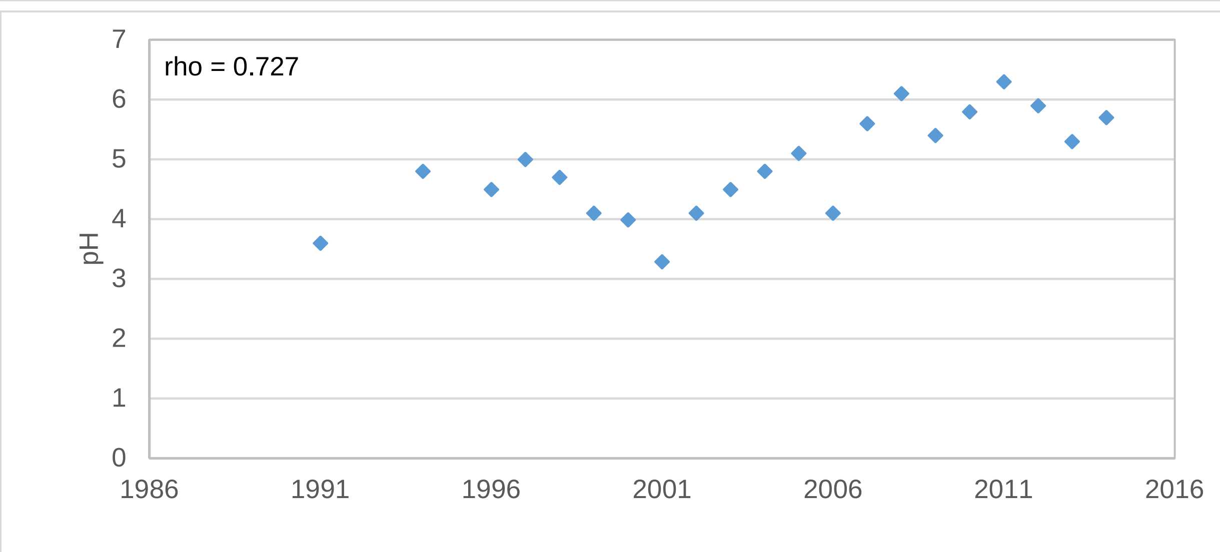
Appendix Figure C.5.2: Significant trends observed for pH at station BH91-SG2A, 1991 to 2014.



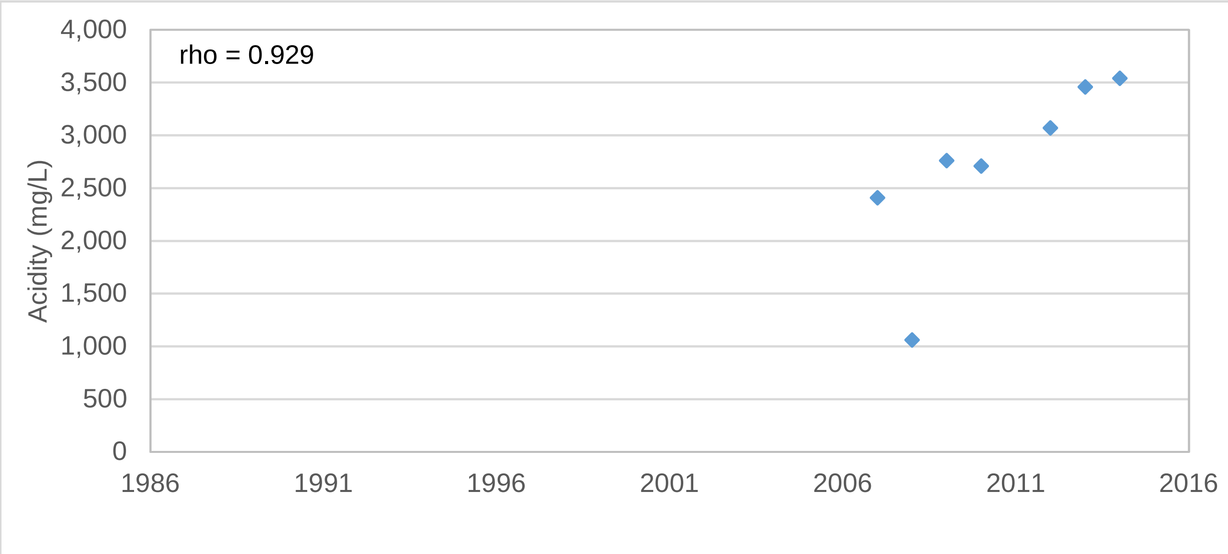
Appendix Figure C.5.3: Significant trends observed for iron, pH and sulphate at station PN-ST3-P5, 1999 to 2014.

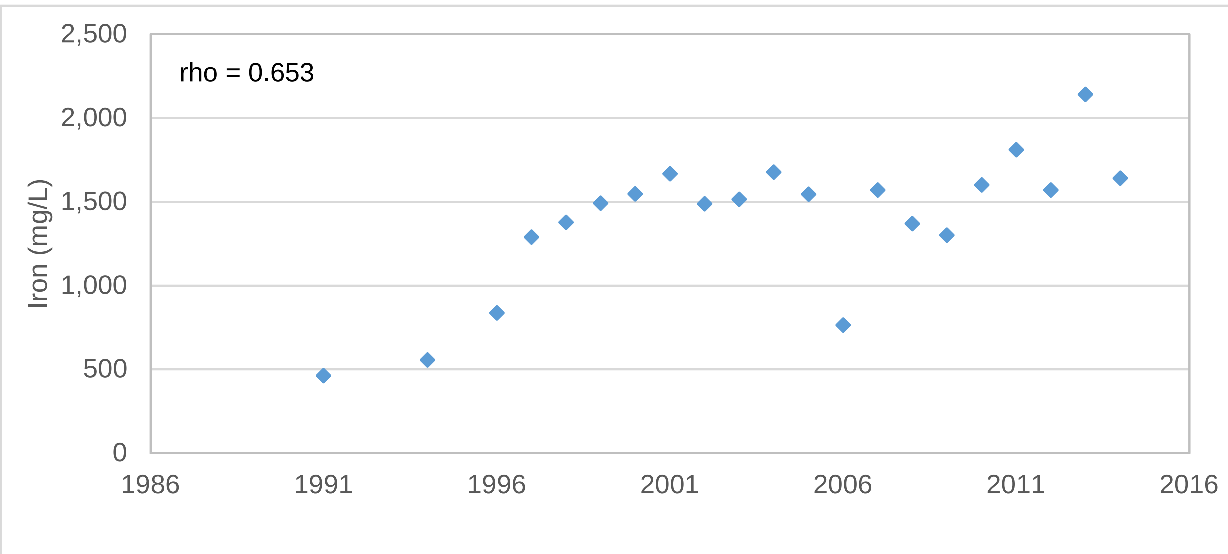




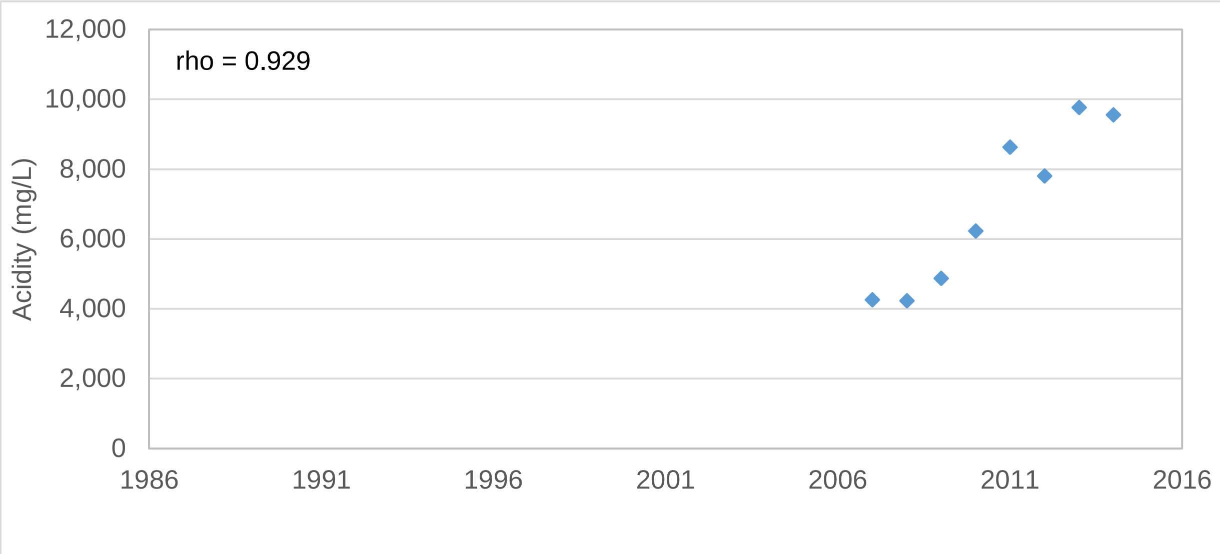


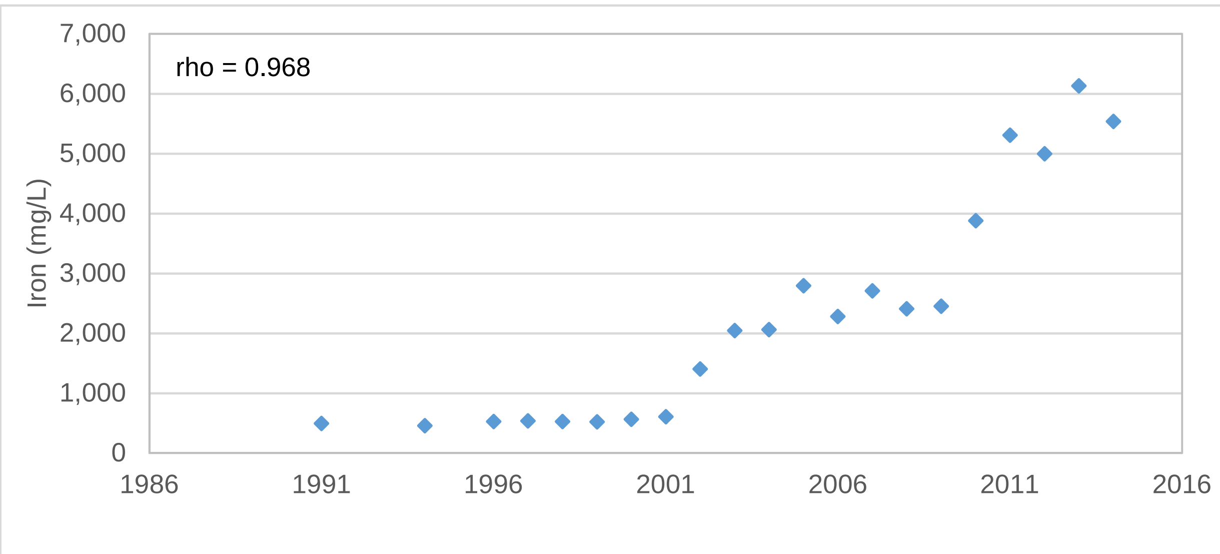
Appendix Figure C.5.4: Significant trends observed for acidity, iron and pH at station PN-ST3-P3, 1991 to 2014.

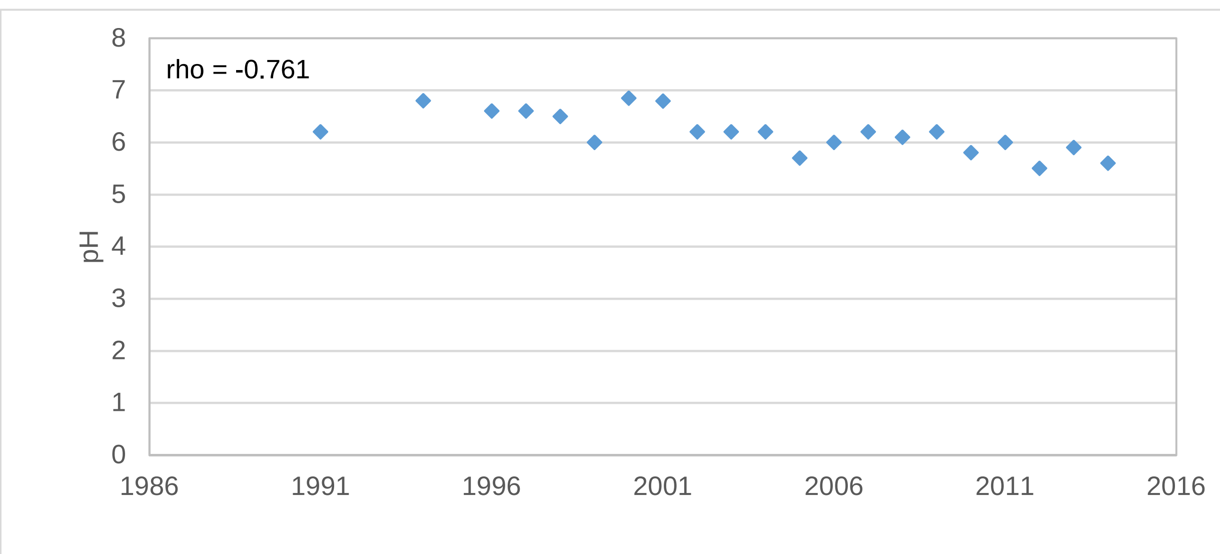




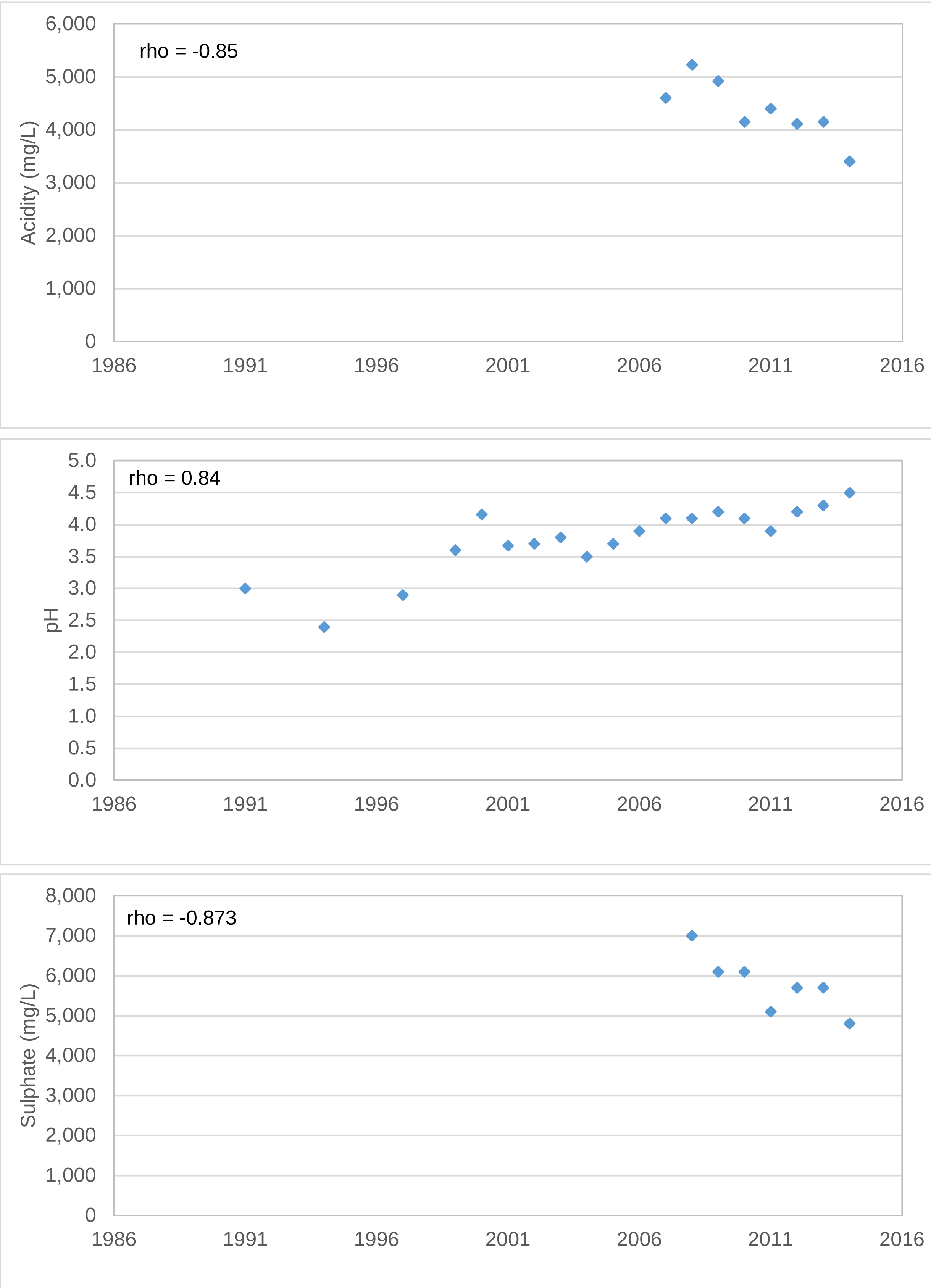
Appendix Figure C.5.5: Significant trends observed for acidity and iron at station PN-ST3-P6, 1991 to 2014.



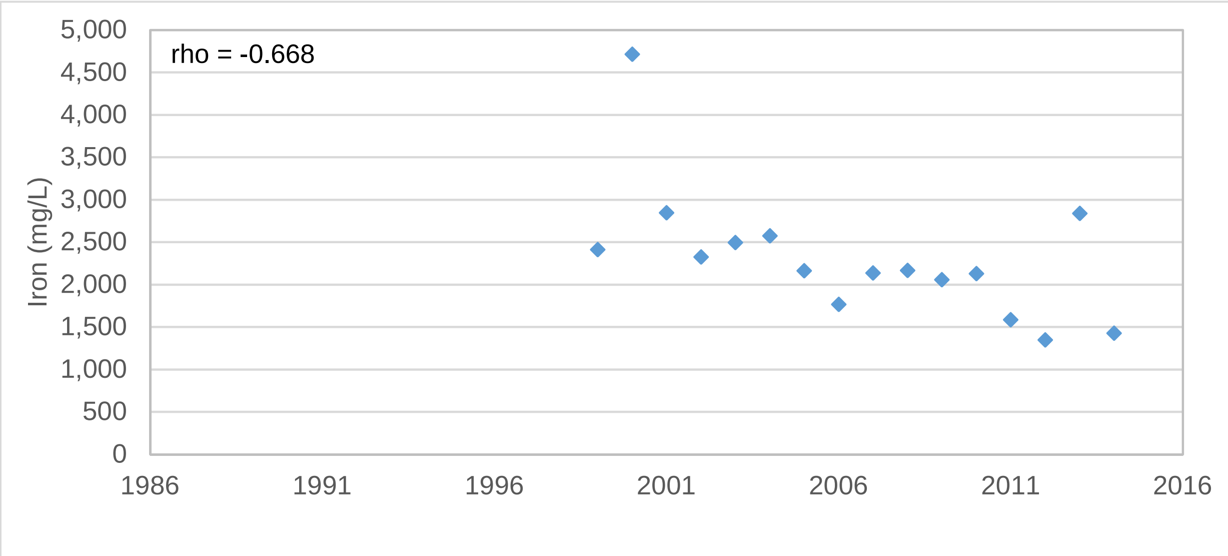




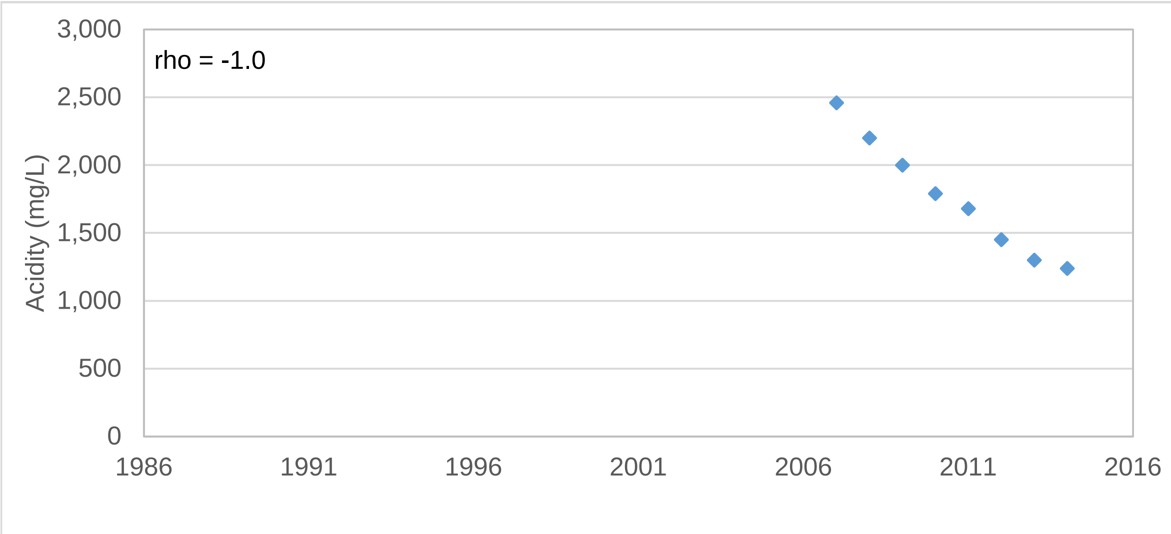
Appendix Figure C.5.6: Significant trends observed for acidity, iron and pH at station PN-ST3-P8, 1991 to 2014.

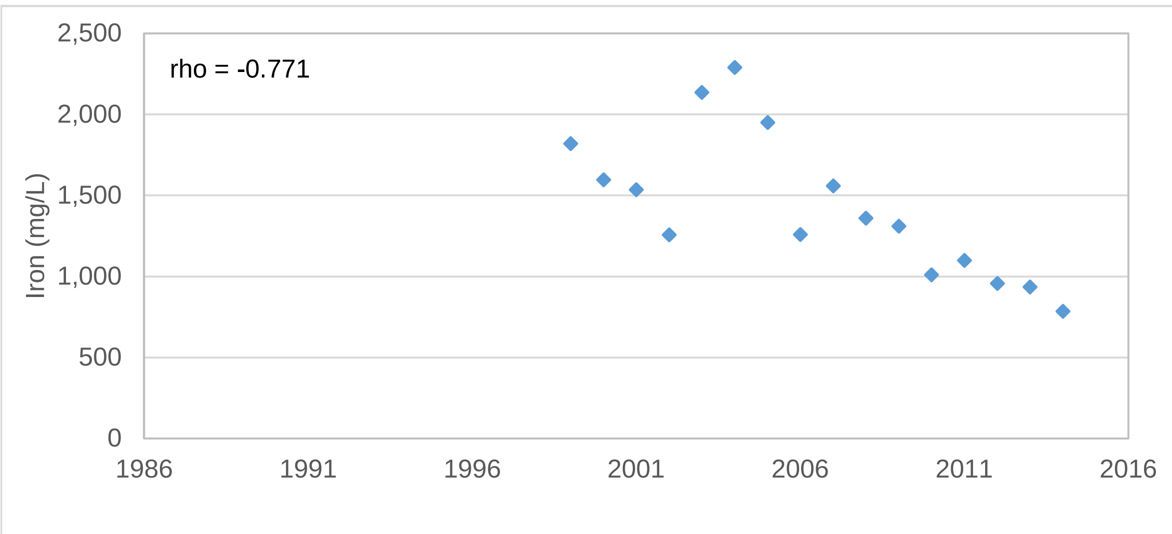


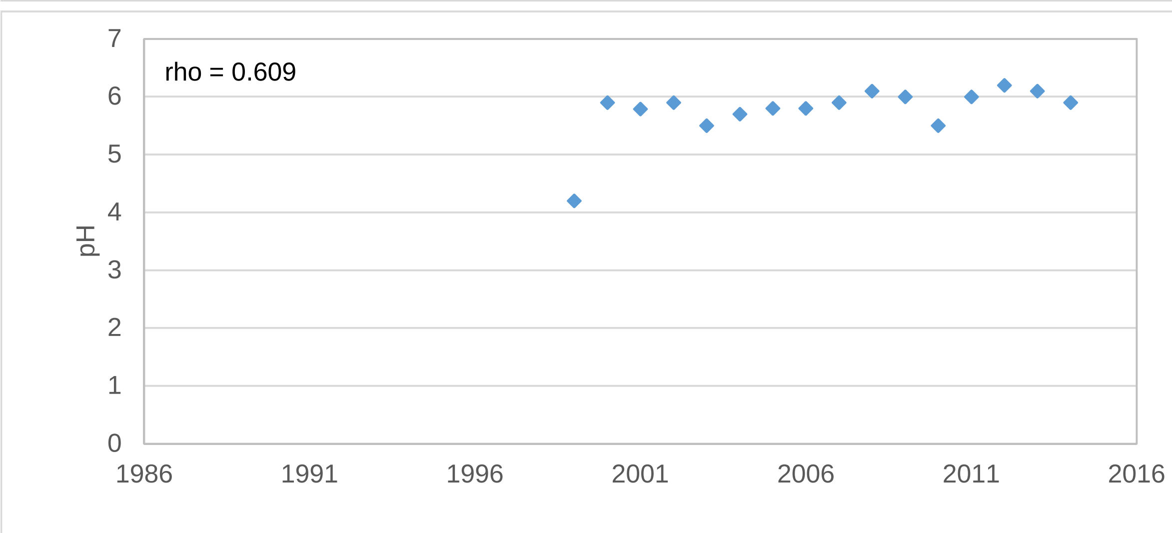
Appendix Figure C.5.7: Significant trends observed for acidity, pH and sulphate at station BH91-SG1A, 1991 to 2014.



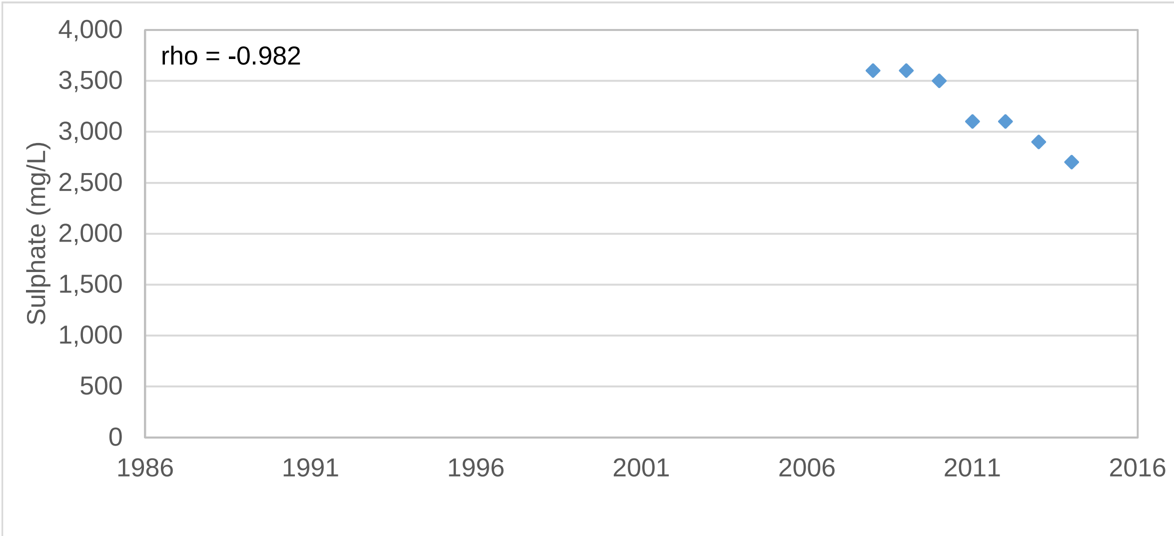
Appendix Figure C.5.8: Significant trends observed for iron at station BH98-16A, 1999 to 2014.



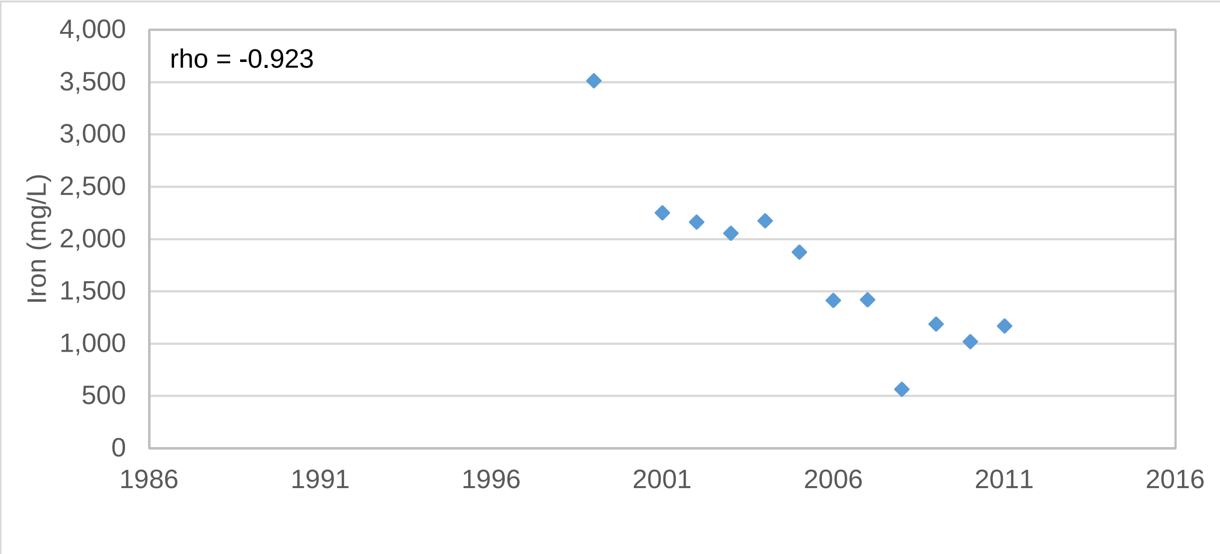




Appendix Figure C.5.9: Significant trends observed for acidity, iron, pH and sulphate at station BH98-15A, 1999 to 2014.



Appendix Figure C.5.9: Significant trends observed for acidity, iron, pH and sulphate at station BH98-15A, 1999 to 2014.



Appendix Figure C.5.10: Significant trends observed for iron at station BH91-SG3A, 1999 to 2014.

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 from 2010 to 2014.

Date m/d/yr	Acidity mg/L	Ba mg/L	Co mg/L	Fe mg/L	Mn mg/L	pH	Ra Bq/L	Sulphate mg/L	TSS mg/L	U mg/L
8/18/2010						7.1	0.51			
9/1/2010	< 1	0.028	< 0.0005	0.04	0.024	7.0	0.6	150		0.0012
10/6/2010						6.7	0.71			
11/3/2010	< 1	0.032	0.0006	0.06	0.092	6.8	0.67	130		0.0018
12/1/2010						6.9	0.69			
1/5/2011							0.656		< 1	
4/6/2011							0.612			
5/25/2011	< 1	0.028	< 0.0005	0.07	0.108	6.9	0.639	120	< 1	0.0019
6/2/2011						6.9	0.582		< 1	
7/6/2011						7.0	0.576		1	
10/18/2011						6.7	0.628		1	
10/25/2011		0.034		0.05		6.7	0.691		< 1	
11/1/2011	< 1	0.031	< 0.0005	0.05	0.077	6.8	0.637	110	< 1	0.0016
12/7/2011						6.7	0.704		< 1	
3/12/2012							0.391			
4/4/2012						6.7	0.647		1	
5/2/2012	< 1	0.027	0.0007	0.07	0.092	7.0	0.645	110	1	0.0019
6/6/2012						6.9	0.683		< 1	
12/12/2012	< 1	0.032	0.0005	0.05	0.064	6.9	0.636	110	< 1	0.0018
3/6/2013						6.9	0.639			
4/3/2013						6.7	0.567			
5/1/2013	< 1	0.029	< 0.0005	0.1	0.078	6.4	0.571	100		0.0015
5/28/2013						6.8	0.583			
6/4/2013		0.03				6.8	0.595			
7/2/2013						6.8	0.549			
8/27/2013						6.9	0.472			
9/10/2013	< 1	0.03	< 0.0005	0.05	0.016	6.8	0.511	93		0.0011
10/1/2013						6.8	0.499			
11/5/2013	< 1	0.029	< 0.0005	0.06	0.057	6.8	0.571	95		0.0016
12/3/2013						6.9	0.597			
1/8/2014						6.8	0.61			
2/4/2014	< 1	0.029	< 0.0005	0.03	0.069	6.7	0.556	88		0.0014
3/4/2014						6.7	0.601			
4/1/2014						6.8	0.535			
5/5/2014	< 1	0.021	0.0015	0.28	0.182	6.7	0.576	58		0.0023
9/23/2014						6.7	0.281			
10/7/2014						7.5	0.559			
10/21/2014						6.8				
11/4/2014	< 1	0.027	0.0005	0.07	0.074	6.9	0.522	78		0.0014
12/2/2014						7.1	0.605			
count	12	14	12	13	12	37	39	12	12	12
min	< 1	0.021	0.0005	0.03	0.016	6.4	0.281	58	< 1	0.0011
max	1	0.034	0.0015	0.28	0.182	7.5	0.710	150	1	0.0023
mean	< 1	0.029	< 0.0006	0.08	0.078	6.8	0.587	104	< 1	0.0016
median	1	0.029	0.0005	0.06	0.076	6.8	0.597	105	1	0.0016
10th Percentile	1	0.027	0.0005	0.04	0.027	6.7	0.508	79	1	0.0012
95th Percentile	1	0.033	0.0011	0.17	0.141	7.1	0.692	139	1	0.0021

Appendix Table C.6.3: Water quality at station CL-05 from 2010 to 2014.

Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH
8/12/2010	9.3	10/27/2010	8.9	1/19/2011	9.1	7/7/2011	8.7	11/29/2011	9.0
8/13/2010	9.2	10/28/2010	9.0	1/20/2011	9.3	7/8/2011	8.4	11/30/2011	8.9
8/16/2010	9.4	10/29/2010	9.2	1/21/2011	8.9	7/11/2011	8.8	12/1/2011	8.9
8/17/2010	9.1	11/1/2010	8.9	1/24/2011	9.1	7/12/2011	9.0	12/2/2011	9.2
8/18/2010	9.2	11/2/2010	9.0	1/25/2011	9.1	7/13/2011	8.8	12/5/2011	8.9
8/19/2010	9.2	11/3/2010	8.9	1/26/2011	9.1	7/14/2011	8.8	12/6/2011	9.1
8/20/2010	9.2	11/4/2010	9.0	5/2/2011	8.9	7/15/2011	8.9	12/7/2011	9.1
8/23/2010	9.1	11/5/2010	9.1	5/3/2011	9.0	7/18/2011	8.8	12/8/2011	9.4
8/24/2010	9.1	11/8/2010	9.2	5/4/2011	9.2	7/19/2011	9.0	12/9/2011	8.9
8/25/2010	9.5	11/9/2010	9.1	5/5/2011	9.1	7/20/2011	8.7	12/12/2011	9.2
8/26/2010	9.1	11/10/2010	9.2	5/6/2011	9.1	7/21/2011	9.0	12/13/2011	9.0
8/27/2010	9.0	11/11/2010	9.0	5/9/2011	9.1	7/22/2011	8.9	12/14/2011	9.0
8/30/2010	9.1	11/12/2010	9.2	5/10/2011	9.1	7/25/2011	8.8	12/15/2011	9.1
8/31/2010	9.2	11/15/2010	9.0	5/11/2011	9.1	7/26/2011	9.0	12/16/2011	9.0
9/1/2010	9.2	11/16/2010	9.2	5/12/2011	9.1	7/27/2011	8.7	12/19/2011	9.1
9/2/2010	9.1	11/17/2010	9.1	5/13/2011	9.2	10/6/2011	8.9	12/20/2011	9.1
9/3/2010	8.9	11/18/2010	9.2	5/16/2011	9.2	10/7/2011	8.7	1/12/2012	9.1
9/7/2010	9.1	11/19/2010	9.2	5/17/2011	9.0	10/11/2011	9.0	1/13/2012	9.2
9/8/2010	8.9	11/22/2010	9.2	5/18/2011	9.2	10/12/2011	8.9	3/22/2012	8.9
9/9/2010	9.0	11/23/2010	9.1	5/19/2011	9.0	10/13/2011	8.9	3/23/2012	9.1
9/10/2010	9.0	11/24/2010	9.3	5/20/2011	9.2	10/14/2011	8.8	3/26/2012	9.0
9/13/2010	9.1	11/25/2010	9.4	5/24/2011	9.0	10/17/2011	8.9	3/27/2012	9.1
9/14/2010	9.0	11/26/2010	9.2	5/25/2011	9.0	10/18/2011	8.9	3/28/2012	8.9
9/15/2010	9.1	11/29/2010	9.1	5/26/2011	8.9	10/19/2011	8.8	3/29/2012	8.9
9/16/2010	8.7	11/30/2010	9.1	5/27/2011	8.9	10/20/2011	8.9	3/30/2012	8.9
9/17/2010	8.8	12/1/2010	9.1	5/30/2011	9.0	10/21/2011	8.9	4/2/2012	8.8
9/20/2010	9.0	12/2/2010	9.3	5/31/2011	8.9	10/24/2011	8.9	4/3/2012	9.0
9/21/2010	8.8	12/3/2010	9.4	6/1/2011	8.9	10/25/2011	8.8	4/4/2012	8.8
9/22/2010	8.9	12/6/2010	9.2	6/2/2011	8.9	10/26/2011	8.9	4/5/2012	8.8
9/23/2010	9.2	12/7/2010	9.0	6/3/2011	9.0	10/27/2011	8.9	4/9/2012	9.0
9/24/2010	9.1	12/15/2010	8.9	6/6/2011	8.9	10/28/2011	8.8	4/10/2012	9.0
9/27/2010	8.8	12/16/2010	9.1	6/7/2011	8.9	10/31/2011	8.8	4/11/2012	9.1
9/28/2010	9.2	12/17/2010	9.1	6/8/2011	8.8	11/1/2011	9.0	4/12/2012	8.9
9/29/2010	9.1	12/20/2010	8.9	6/9/2011	8.9	11/2/2011	8.9	4/13/2012	8.8
9/30/2010	9.2	12/21/2010	9.2	6/10/2011	8.8	11/3/2011	8.9	4/16/2012	8.9
10/1/2010	9.2	12/22/2010	9.3	6/13/2011	8.9	11/4/2011	8.9	4/17/2012	9.0
10/4/2010	9.0	12/23/2010	9.2	6/14/2011	8.9	11/7/2011	9.0	4/18/2012	9.0
10/5/2010	9.0	12/24/2010	9.0	6/15/2011	9.0	11/8/2011	8.8	4/19/2012	9.0
10/6/2010	9.0	12/29/2010	9.1	6/16/2011	8.9	11/9/2011	8.9	4/20/2012	9.1
10/7/2010	8.9	12/30/2010	8.9	6/17/2011	8.8	11/10/2011	8.7	4/23/2012	8.9
10/8/2010	9.1	12/31/2010	9.2	6/20/2011	9.0	11/11/2011	9.0	4/24/2012	9.0
10/12/2010	9.1	1/4/2011	8.9	6/21/2011	8.9	11/14/2011	9.0	4/25/2012	9.1
10/13/2010	8.9	1/5/2011	9.4	6/22/2011	9.0	11/15/2011	8.7	4/26/2012	9.1
10/14/2010	8.9	1/6/2011	9.1	6/23/2011	9.0	11/16/2011	8.9	4/27/2012	9.1
10/15/2010	8.9	1/7/2011	8.9	6/24/2011	8.9	11/17/2011	8.9	4/30/2012	9.1
10/18/2010	9.0	1/10/2011	9.1	6/27/2011	9.1	11/18/2011	8.9	5/1/2012	9.1
10/19/2010	9.1	1/11/2011	9.1	6/28/2011	8.9	11/21/2011	8.9	5/2/2012	9.0
10/20/2010	9.0	1/12/2011	9.0	6/29/2011	8.8	11/22/2011	8.8	5/3/2012	9.2
10/21/2010	9.0	1/13/2011	8.9	6/30/2011	8.8	11/23/2011	8.8	5/4/2012	9.2
10/22/2010	8.8	1/14/2011	9.0	7/4/2011	8.8	11/24/2011	8.8	5/7/2012	8.9
10/25/2010	8.9	1/17/2011	8.8	7/5/2011	8.6	11/25/2011	8.9	5/8/2012	8.9
10/26/2010	8.9	1/18/2011	8.9	7/6/2011	8.6	11/28/2011	8.9	5/9/2012	8.9

Appendix Table C.6.3: Water quality at station CL-05 from 2010 to 2014.

Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH
5/10/2012	8.7	3/8/2013	9.0	5/23/2013	8.9	9/10/2013	8.8	11/22/2013	8.7
5/11/2012	8.9	3/11/2013	8.9	5/24/2013	9.0	9/11/2013	9.0	11/25/2013	8.8
5/14/2012	8.7	3/12/2013	8.8	5/27/2013	8.9	9/12/2013	8.9	11/26/2013	8.9
5/15/2012	8.7	3/13/2013	9.0	5/28/2013	9.1	9/13/2013	8.9	11/27/2013	9.0
5/16/2012	8.7	3/14/2013	8.8	5/29/2013	9.0	9/16/2013	8.8	11/28/2013	8.8
5/17/2012	8.8	3/15/2013	9.0	5/30/2013	9.0	9/17/2013	8.7	11/29/2013	8.8
5/18/2012	8.8	3/18/2013	8.9	5/31/2013	9.0	9/18/2013	8.9	12/2/2013	9.0
5/22/2012	8.9	3/19/2013	9.0	6/3/2013	9.1	9/19/2013	8.9	12/3/2013	9.0
5/23/2012	8.9	3/20/2013	8.9	6/4/2013	9.0	9/20/2013	8.8	12/4/2013	9.0
5/24/2012	8.9	3/21/2013	8.8	6/5/2013	9.1	9/23/2013	8.8	12/5/2013	9.0
5/25/2012	8.9	3/22/2013	8.9	6/6/2013	9.0	9/24/2013	8.9	12/6/2013	9.0
5/28/2012	8.7	3/25/2013	8.8	6/7/2013	8.9	9/25/2013	8.8	12/9/2013	9.0
5/29/2012	8.9	3/26/2013	9.0	6/10/2013	9.0	9/26/2013	8.8	12/10/2013	9.1
5/30/2012	8.9	3/27/2013	8.9	6/11/2013	8.9	9/27/2013	8.8	12/11/2013	9.0
5/31/2012	8.8	3/28/2013	8.7	6/12/2013	9.0	9/30/2013	8.8	12/12/2013	9.2
6/1/2012	8.8	4/1/2013	8.9	6/13/2013	8.8	10/1/2013	8.8	12/13/2013	9.1
6/4/2012	8.9	4/2/2013	8.8	6/14/2013	9.1	10/2/2013	8.9	12/16/2013	8.9
6/5/2012	8.7	4/3/2013	8.9	6/17/2013	9.0	10/3/2013	8.8	12/17/2013	9.4
6/6/2012	8.8	4/4/2013	8.8	6/18/2013	9.0	10/4/2013	8.8	12/18/2013	9.1
6/7/2012	9.0	4/5/2013	8.9	6/19/2013	8.8	10/7/2013	8.8	12/19/2013	8.9
6/8/2012	8.7	4/8/2013	8.9	6/20/2013	8.8	10/8/2013	8.9	12/20/2013	9.3
6/11/2012	8.7	4/9/2013	8.9	6/21/2013	8.9	10/9/2013	8.7	12/23/2013	9.0
6/12/2012	8.7	4/10/2013	8.9	6/24/2013	8.9	10/10/2013	8.9	12/24/2013	8.9
6/13/2012	8.8	4/11/2013	8.7	6/25/2013	8.9	10/11/2013	8.9	12/27/2013	9.0
6/14/2012	8.7	4/12/2013	9.0	6/26/2013	8.9	10/15/2013	8.9	12/30/2013	9.1
6/15/2012	8.8	4/15/2013	8.9	6/27/2013	8.8	10/16/2013	8.8	12/31/2013	9.0
11/27/2012	8.9	4/16/2013	8.8	6/28/2013	8.9	10/17/2013	9.0	1/2/2014	8.9
11/28/2012	9.0	4/17/2013	8.9	7/2/2013	8.9	10/18/2013	8.9	1/3/2014	8.7
11/29/2012	9.0	4/18/2013	8.8	7/3/2013	8.7	10/21/2013	8.9	1/6/2014	9.0
11/30/2012	8.9	4/19/2013	8.9	7/4/2013	8.8	10/22/2013	8.8	1/7/2014	9.0
12/3/2012	9.0	4/22/2013	9.0	7/5/2013	8.8	10/23/2013	8.9	1/8/2014	8.7
12/4/2012	9.0	4/23/2013	8.8	7/8/2013	8.8	10/24/2013	8.8	1/9/2014	8.7
12/5/2012	8.9	4/24/2013	8.8	7/9/2013	8.6	10/25/2013	8.9	1/10/2014	8.9
12/6/2012	8.8	4/25/2013	8.8	7/10/2013	8.8	10/28/2013	8.8	1/13/2014	8.8
12/7/2012	9.0	4/26/2013	8.8	7/11/2013	8.8	10/29/2013	8.9	1/14/2014	8.7
12/10/2012	9.0	4/29/2013	8.8	7/12/2013	8.8	10/30/2013	8.8	1/15/2014	8.9
12/11/2012	8.9	4/30/2013	8.7	7/15/2013	8.9	10/31/2013	8.9	1/16/2014	8.8
12/12/2012	9.0	5/1/2013	8.9	8/19/2013	8.8	11/1/2013	8.9	1/17/2014	8.7
12/13/2012	8.7	5/2/2013	8.8	8/20/2013	8.9	11/4/2013	8.7	1/20/2014	9.0
12/14/2012	9.0	5/3/2013	9.0	8/21/2013	8.8	11/5/2013	8.8	1/21/2014	9.0
12/17/2012	9.1	5/6/2013	8.8	8/22/2013	8.7	11/6/2013	8.8	1/22/2014	8.8
12/18/2012	8.9	5/7/2013	8.9	8/23/2013	8.8	11/7/2013	9.0	1/23/2014	8.9
12/19/2012	9.0	5/8/2013	8.7	8/26/2013	8.7	11/8/2013	8.8	1/24/2014	8.9
12/20/2012	8.9	5/9/2013	9.0	8/27/2013	8.7	11/11/2013	8.8	1/27/2014	8.9
2/26/2013	9.0	5/10/2013	8.9	8/28/2013	8.7	11/12/2013	8.8	1/28/2014	8.9
2/27/2013	9.0	5/13/2013	9.1	8/29/2013	8.7	11/13/2013	8.8	1/29/2014	8.9
2/28/2013	9.0	5/14/2013	9.1	8/30/2013	8.7	11/14/2013	8.8	1/30/2014	8.9
3/1/2013	9.0	5/15/2013	8.9	9/3/2013	8.7	11/15/2013	8.8	1/31/2014	8.9
3/4/2013	8.9	5/16/2013	9.0	9/4/2013	8.8	11/18/2013	8.8	2/3/2014	8.9
3/5/2013	9.1	5/17/2013	9.0	9/5/2013	8.9	11/19/2013	8.7	2/4/2014	8.9
3/6/2013	9.1	5/21/2013	9.1	9/6/2013	8.8	11/20/2013	8.8	2/5/2014	8.8
3/7/2013	9.0	5/22/2013	9.0	9/9/2013	8.8	11/21/2013	8.7	2/6/2014	8.8

Appendix Table C.6.3: Water quality at station CL-05 from 2010 to 2014.

Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH
2/7/2014	8.7	4/24/2014	8.8	11/5/2014	8.7				
2/10/2014	8.8	4/25/2014	8.8	11/6/2014	8.4				
2/11/2014	8.9	4/28/2014	8.8	11/7/2014	8.5				
2/12/2014	8.9	4/29/2014	8.7	11/10/2014	8.6				
2/13/2014	8.7	4/30/2014	8.7	11/11/2014	8.6				
2/14/2014	8.8	5/1/2014	8.8	11/12/2014	8.7				
2/18/2014	8.7	5/2/2014	8.7	11/13/2014	8.7				
2/19/2014	9.0	5/5/2014	8.8	11/14/2014	8.7				
2/20/2014	8.7	5/6/2014	8.8	11/17/2014	8.7				
2/21/2014	8.7	5/7/2014	9.0	11/18/2014	8.7				
2/24/2014	8.6	5/8/2014	8.8	11/19/2014	8.7				
2/25/2014	8.5	5/9/2014	8.8	11/20/2014	8.7				
2/26/2014	8.4	9/9/2014	9.0	11/21/2014	8.5				
2/27/2014	8.6	9/10/2014	8.8	11/24/2014	8.5				
2/28/2014	8.8	9/11/2014	8.8	11/25/2014	8.5				
3/3/2014	8.7	9/12/2014	8.7	11/26/2014	8.8				
3/4/2014	8.7	9/15/2014	8.8	11/27/2014	8.7				
3/5/2014	8.8	9/16/2014	8.6	11/28/2014	8.9				
3/6/2014	8.5	9/17/2014	8.8	12/1/2014	8.7				
3/7/2014	8.5	9/18/2014	8.8	12/2/2014	8.7				
3/10/2014	8.9	9/19/2014	9.0	12/3/2014	8.8				
3/11/2014	8.7	9/22/2014	8.9	12/4/2014	8.6				
3/12/2014	8.6	9/23/2014	8.9	12/5/2014	8.9				
3/13/2014	8.7	9/24/2014	8.9	12/8/2014	8.8				
3/14/2014	8.8	9/25/2014	9.2	12/9/2014	8.8				
3/17/2014	8.6	9/26/2014	9.1	12/10/2014	8.8				
3/18/2014	8.6	9/29/2014	8.9	12/11/2014	8.5				
3/19/2014	8.7	9/30/2014	9.1	12/12/2014	8.8				
3/20/2014	8.7	10/1/2014	9.3	12/15/2014	9.0				
3/21/2014	8.6	10/2/2014	9.1	12/16/2014	9.0				
3/24/2014	8.7	10/3/2014	9.0	12/17/2014	9.0				
3/25/2014	9.1	10/6/2014	9.1	12/18/2014	9.2				
3/26/2014	8.9	10/7/2014	8.8	12/19/2014	9.2				
3/27/2014	8.8	10/8/2014	8.8	12/22/2014	8.9				
3/28/2014	9.0	10/9/2014	8.7	12/23/2014	8.8				
3/31/2014	9.0	10/10/2014	9.0	12/24/2014	9.0				
4/1/2014	9.0	10/14/2014	8.7	12/29/2014	9.0				
4/2/2014	8.9	10/15/2014	8.7	12/30/2014	8.9				
4/3/2014	9.0	10/16/2014	8.8	12/31/2014	9.1				
4/4/2014	9.0	10/17/2014	8.7	**count**	**663**				
4/7/2014	8.9	10/20/2014	8.7	**min**	**6.9**				
4/8/2014	9.0	10/21/2014	8.7	**max**	**9.5**				
4/9/2014	9.0	10/22/2014	8.7	**mean**	**8.9**				
4/10/2014	8.9	10/23/2014	8.7	**median**	**8.9**				
4/11/2014	9.0	10/24/2014	8.7						
4/14/2014	8.9	10/27/2014	8.7						
4/15/2014	8.9	10/28/2014	8.7						
4/16/2014	9.0	10/29/2014	8.7						
4/17/2014	8.9	10/30/2014	8.6						
4/21/2014	8.9	10/31/2014	8.6						
4/22/2014	8.7	11/3/2014	8.6						
4/23/2014	8.8	11/4/2014	6.9						

Appendix Table C.6.4: Water quality at groundwater station SGW3 from 2010 to 2014.

Date m/d/yr	Acidity mg/L	Fe mg/L	pH	Ra Bq/L	Sulphate mg/L
7/13/2010	1100	584	5		2200
8/3/2011	938	533	5.7		2000
7/12/2012	875	543	5.4		2100
7/3/2013	805	472	5.4		1800
6/25/2014	801	455	5.9	< 0.005	1800
count	5	5	5	1	5
min	801	455	5	< 0.005	1800
max	1100	584	5.9	< 0.005	2200
mean	904	517	5.48	0.005	1980
median	875	533	5.4	0.005	2000
10th Percentile	803	462	5.16	0.005	1800
95th Percentile	1068	576	5.86	0.005	2180

Appendix Table C.6.5: Water quality at groundwater station SGW5 from 2010 to 2014.

Date m/d/yr	Acidity mg/L	Fe mg/L	pH	Ra Bq/L	Sulphate mg/L
8/3/2011	< 1	< 0.02	6.9		89
9/24/2012	< 1	0.11	7.4		84
7/3/2013	< 1	0.24	7.1		88
6/25/2014	< 1	< 0.02	6.8	< 0.005	69
count	4	4	4	1	4
min	< 1	< 0.02	6.8	< 0.005	69
max	< 1	0.24	7.4	< 0.005	89
mean	< 1	0.10	7.1	< 0.005	83
median	1	0.07	7.0	0.005	86
10th Percentile	1	0.02	6.8	0.005	74
95th Percentile	1	0.22	7.4	0.005	89

Appendix Table C.6.6: Summary of seasonal trends for station CL-04 from 2003-2014.

Month	Spearman's rho	Acidity	Ba	Co	Fe	Mn	pH	Ra	Sulphate	TSS	U
March	Correlation Coefficient							-0.6			
	Sig. (2-tailed)							0.285			
	N							5			
April	Correlation Coefficient						0.235	-0.45			
	Sig. (2-tailed)						0.653	0.224			
	N						6	9			
May	Correlation Coefficient	0.183	-0.738	-0.446		-0.762	-0.603	0.009	-1		-0.707
	Sig. (2-tailed)	0.665	0.037	0.268		0.028	0.085	0.979	0.000		0.050
	N	8	8	8		8	9	11	8		8
June	Correlation Coefficient						0.309	0.164			
	Sig. (2-tailed)						0.552	0.651			
	N						6	10			
July	Correlation Coefficient						-0.216	0.214			
	Sig. (2-tailed)						0.681	0.61			
	N						6	8			
August	Correlation Coefficient						-0.105	-0.321			
	Sig. (2-tailed)						0.866	0.482			
	N						5	7			
September	Correlation Coefficient						-0.103	-0.286			
	Sig. (2-tailed)						0.87	0.535			
	N						5	7			
October	Correlation Coefficient						0.356	-0.393			
	Sig. (2-tailed)						0.434	0.383			
	N						7	7			
November	Correlation Coefficient	0.183	-0.976	-0.805		-0.952	0.217	-0.738	-1		-0.922
	Sig. (2-tailed)	0.665	0.000	0.016		0.000	0.606	0.037	0.000		0.001
	N	8	8	8		8	8	8	8		8
December	Correlation Coefficient						0.111	-0.628			
	Sig. (2-tailed)						0.812	0.07			
	N						7	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).

Significant trend where $p<0.05$.

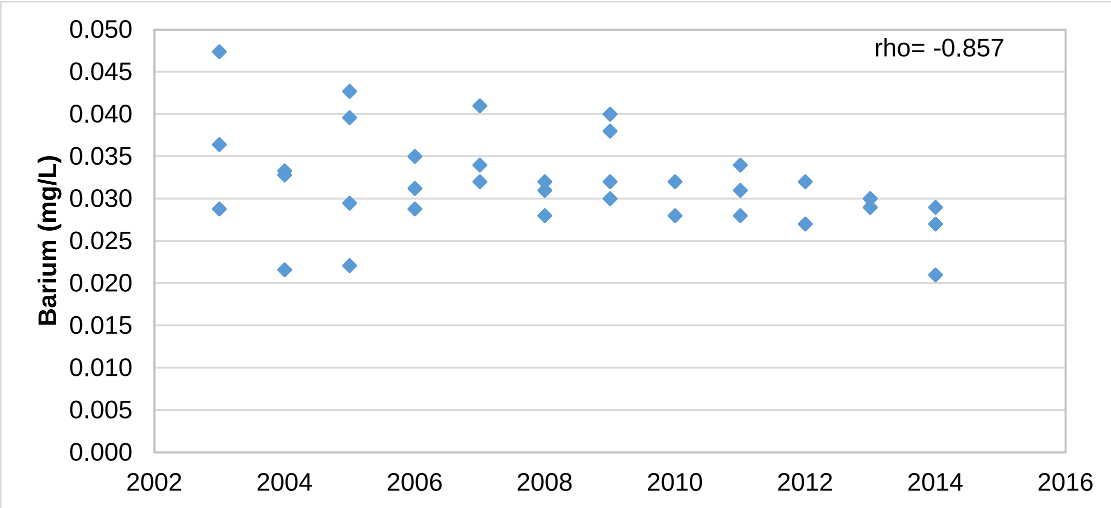
Appendix Table C.6.7: Summary of trends for Stanleigh groundwater stations from 1999 to 2014.

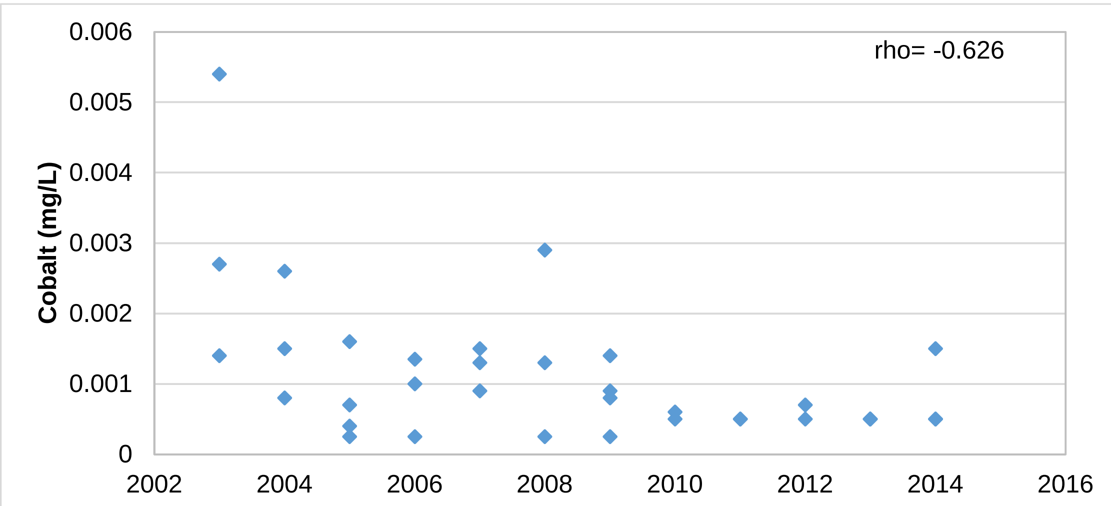
Station	Spearman rho	Acidity	Iron	pH	Sulphate
SGW-3	Correlation Coefficient	-1.00	-0.979	0.976	-0.946
	Sig. (2-tailed)	0.000	0.000	0.000	0.000
	N	8	16	16	14
SGW-5	Correlation Coefficient	-	-	-	-
	Sig. (2-tailed)	-	-	-	-
	N	-	-	-	-

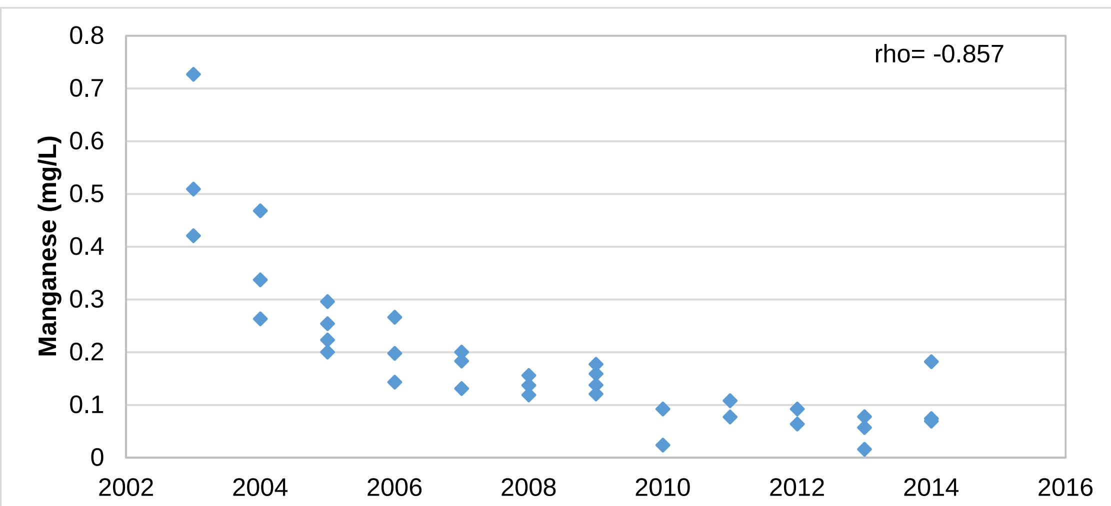
Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

"-" denotes less than 5 years of data so analysis was not conducted.

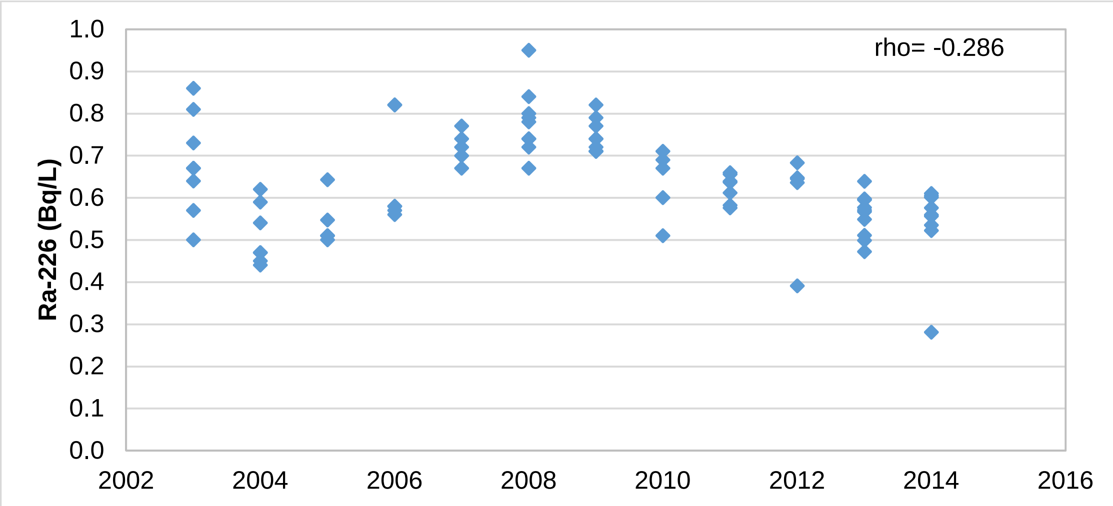
[shaded box] Significant trend where p<0.05.

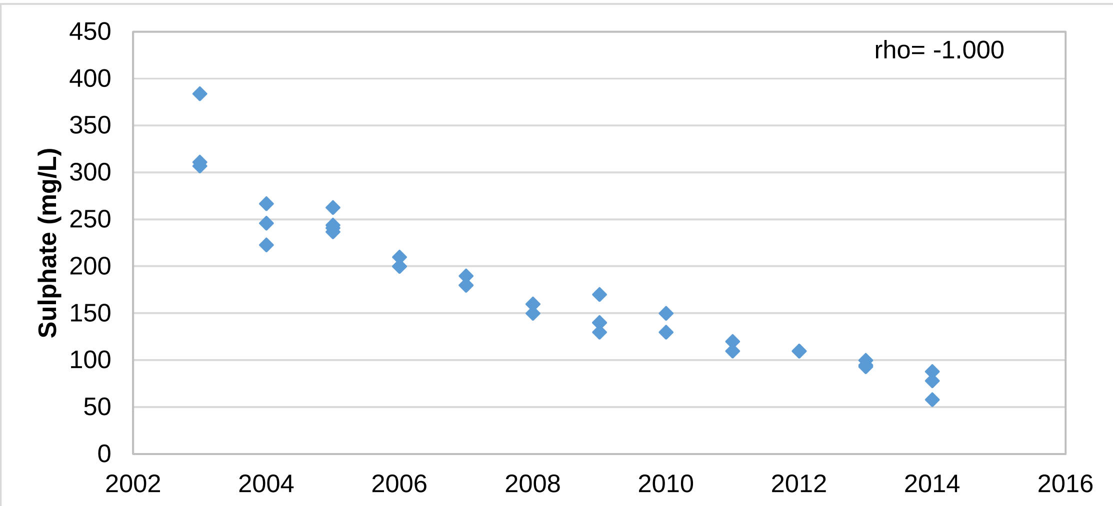


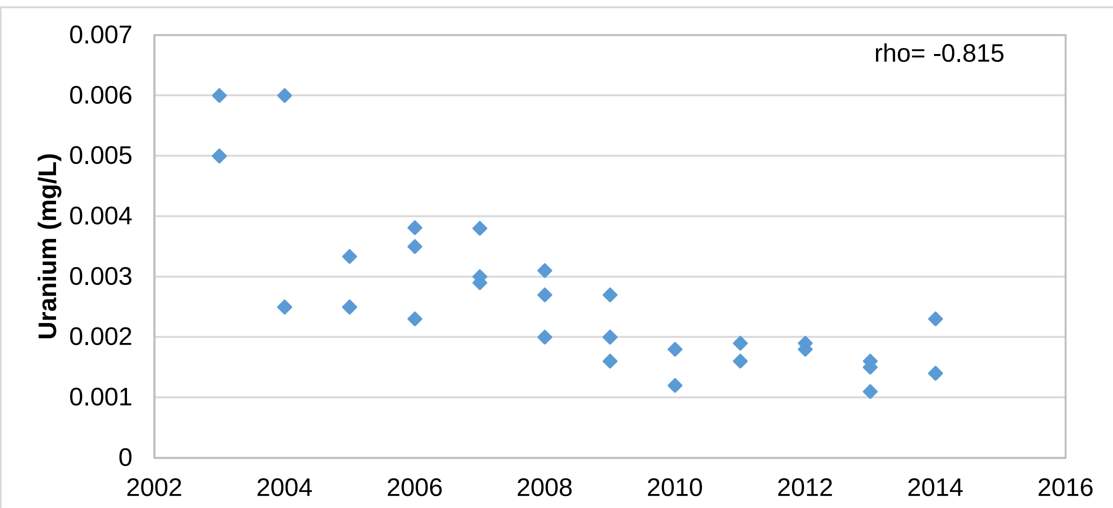




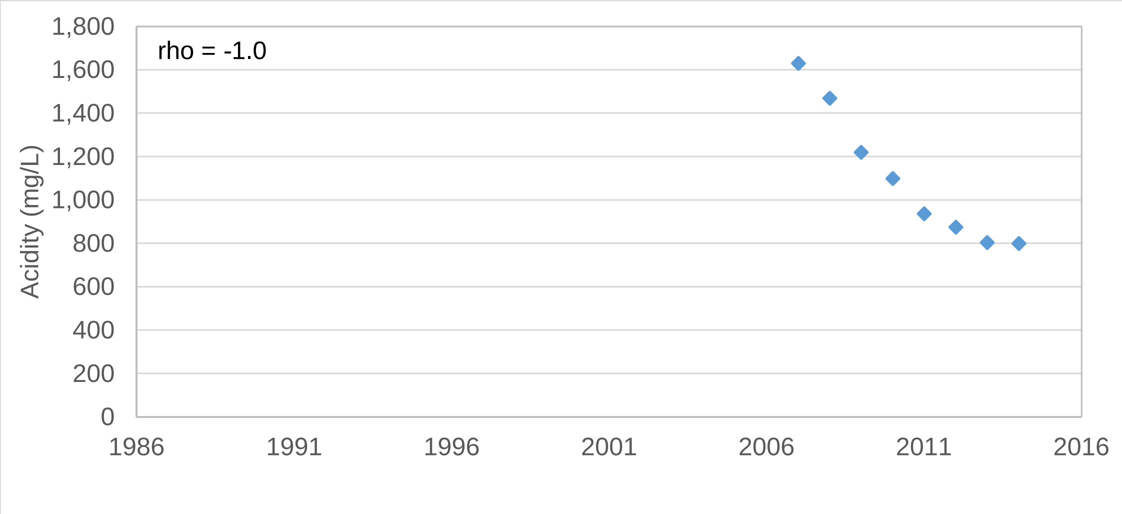
Appendix Figure C.6.1: Significant common (average) trends observed for barium, cobalt, manganese, radium-226, sulphate and uranium, over all seasons at Station CL-04, 2003 to 2014.

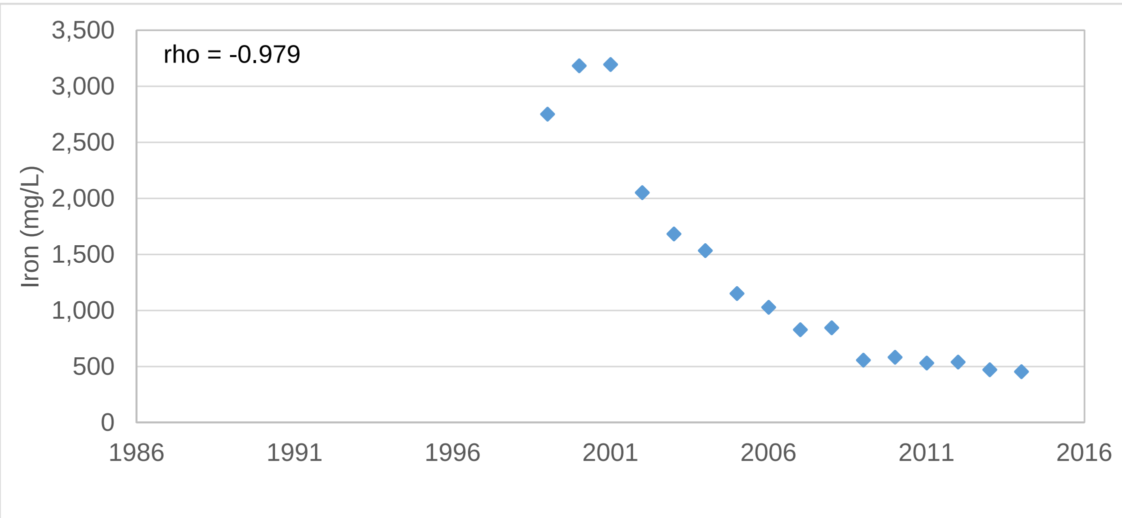


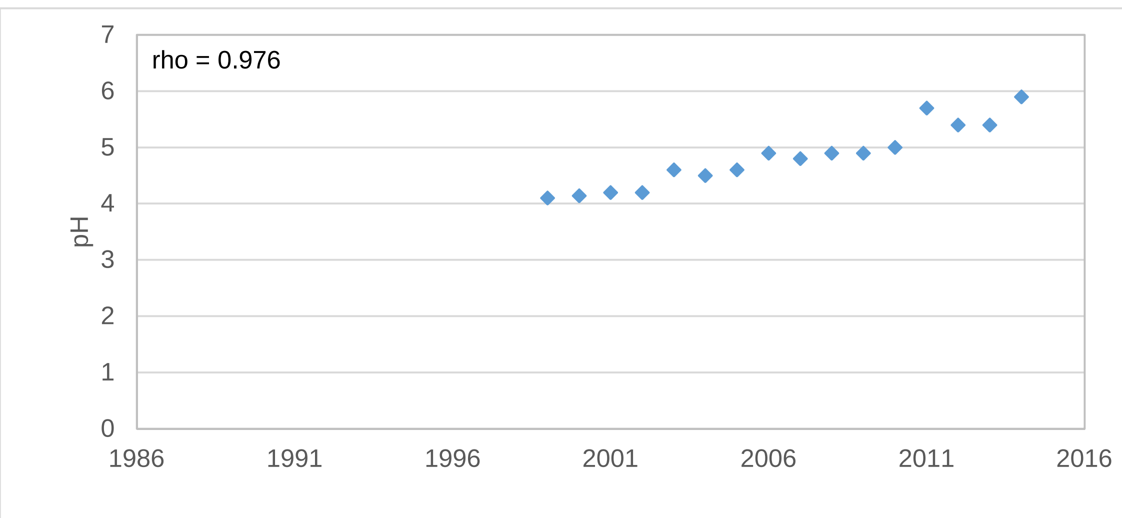




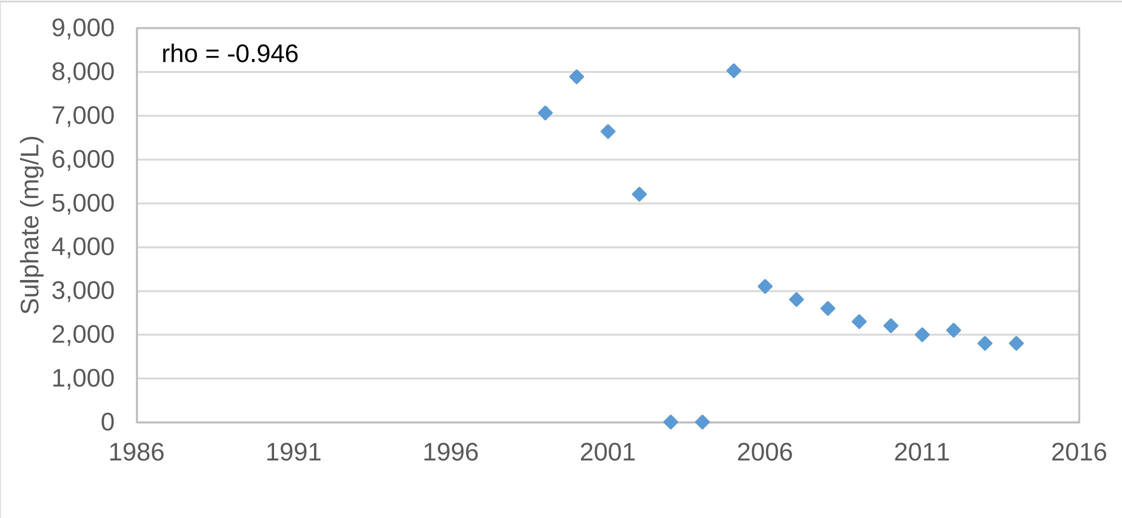
Appendix Figure C.6.1: Significant common (average) trends observed for barium, cobalt, manganese, radium-226, sulphate and uranium, over all seasons at Station CL-04, 2003 to 2014.







Appendix Figure C.6.2: Significant trends observed for acidity, iron, pH and sulphate at station SGW-3, 1999 to 2014.



Appendix Figure C.6.2: Significant trends observed for acidity, iron, pH and sulphate at station SGW-3, 1999 to 2014.

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 2010 to 2014.

Date m/d/yr	Acidity mg/L	Ba mg/L	Co mg/L	Fe mg/L	Mn mg/L	pH	Ra Bq/L	Sulphate mg/L	TSS mg/L	U mg/L
1/7/2010	< 1	0.01	< 0.0005	1.23	0.113	6.3	< 0.005	8.1		< 0.0005
2/3/2010	< 1	0.013	0.0006	1.55	0.165	6.3	0.013	9.5		< 0.0005
5/3/2010	< 1	0.022	0.0011	3.24	0.372	6.4	0.029	19		< 0.0005
11/1/2010	< 1	0.007	< 0.0005	0.44	0.023	6.7	< 0.005	3.4		< 0.0005
2/2/2011	< 1	0.01	< 0.0005	0.44	0.123	6.4	< 0.005	4.4	< 1	< 0.0005
5/4/2011	< 1	0.01	< 0.0005	0.29	0.072	6.6	0.006	4.5	1	< 0.0005
11/2/2011	3	0.02	0.0021	9.08	0.235	6.1	0.012	40	3	0.0063
2/1/2012	< 1	0.01	< 0.0005	0.7	0.118	6.8	< 0.005	5.6	< 1	< 0.0005
5/2/2012	< 1	0.014	0.0007	3.58	0.154	6.7	0.014	21	9	0.001
11/7/2012	< 1	0.035	< 0.0005	1.9	0.326	6.6	0.009	8.6	1	0.0022
2/6/2013	< 1	0.008	< 0.0005	0.53	0.13	6.6	< 0.005	4.8	< 1	< 0.0005
5/1/2013	< 1	0.01	0.0005	0.17	0.069	6.8	0.01	3.5	< 1	< 0.0005
8/14/2013	< 1	0.014	0.0007	2.52	0.122	6.7	0.009	9.1	4	0.0016
11/13/2013	< 1	0.008	< 0.0005	0.29	0.042	6.9	< 0.005	3.9	1	< 0.0005
2/5/2014	< 1	0.008	< 0.0005	0.62	0.154	6.6	< 0.005	7	1	< 0.0005
5/6/2014	< 1	0.008	< 0.0005	0.31	0.067	6.5	0.006	4.2	< 1	< 0.0005
8/6/2014	< 1	0.032	0.0018	11.6	0.307	6.5	0.011	43	4	0.0044
11/5/2014	< 1	0.008	< 0.0005	0.88	0.052	6.9	< 0.005	5.6	< 1	0.0006
count	17	18	18	18	18	18	18	18	14	18
min	1	0.007	0.0005	0.17	0.023	6.1	0.005	3.4	1.0	0.0005
max	1	0.035	0.0021	11.60	0.372	6.9	0.029	43.0	9.0	0.0063
mean	1	0.014	0.0007	2.19	0.147	6.6	0.009	11.4	2.1	0.0012
median	1	0.010	0.0005	0.79	0.123	6.6	0.006	6.3	1.0	0.0005
10th Percentile	1	0.008	0.0005	0.29	0.049	6.3	0.005	3.8	1.0	0.0005
95th Percentile	1	0.032	0.0018	9.46	0.333	6.9	0.016	40.5	5.8	0.0047

Appendix Table C.7.3: Water quality at station ECA-132 from 2010 to 2014.

Date m/d/yr	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
5/5/2010	< 1	0.029	0.0013	0.41	0.076	8	0.61	160	0.0019
11/3/2010	< 1	0.026	0.0009	0.7	0.021	6.9	0.5	170	0.0028
6/8/2011	< 1	0.023	0.0018	0.42	0.063	7.1	0.548	110	0.0019
11/15/2011	< 1	< 0.005	0.0006	0.59	0.02	7.2	0.104	130	0.0024
5/28/2012	< 1	0.022	0.0006	0.38	0.036	7.5	0.517	120	0.0011
11/7/2012	< 1	0.024	0.0006	0.82	0.018	7.4	0.488	140	0.0036
5/28/2013	< 1	0.022	0.0035	0.39	0.137	6.4	0.613	89	0.0016
11/13/2013	< 1	0.026	0.003	1.62	0.153	7	0.607	120	0.0024
5/7/2014	< 1	0.021	0.0075	2.17	0.318	5.7	0.987	72	0.0016
11/5/2014	< 1	0.019	0.0031	1.12	0.088	8.3	0.544	100	0.0014
count	10	10	10	10	10	66	10	10	10
min	1	0.005	0.0006	0.38	0.018	5.5	0.104	72	0.0011
max	1	0.029	0.0075	2.17	0.318	8.8	0.987	170	0.0036
mean	1	0.022	0.0023	0.86	0.093	7.0	0.552	121	0.0021
median	1	0.023	0.0016	0.65	0.070	7.0	0.546	120	0.0019
10th Percentile	1	0.018	0.0006	0.39	0.020	6.3	0.450	87	0.0014
95th Percentile	1	0.028	0.0057	1.92	0.244	8.0	0.819	166	0.0032

[a] pH measures shown only for dates when other substances were measured but summary statistics reflect all measured values.

Appendix Table C.7.4: Water quality at station L-03 from 2010 to 2014.

Date m/d/yr	Acidity mg/L	Ba mg/L	Co mg/L	Fe mg/L	Mn mg/L	pH	Ra Bq/L	Sulphate mg/L	U mg/L
1/6/2010	156	0.016	0.0327	31.8	0.892	2.9	0.66	460	0.0421
4/7/2010	127	0.013	0.0262	27.5	0.672	3.0	0.45	381	0.0329
10/20/2010	157	0.018	0.0261	27.4	0.953	2.8	0.65	480	0.0282
1/6/2011	124	0.016	0.0225	31.0	0.761	3.1	0.47	380	0.0277
4/25/2011	62	0.01	0.0122	20.2	0.272	3.6	0.221	200	0.0178
11/2/2011	135	0.018	0.0221	25.9	0.988	2.9	0.686	450	0.0259
2/1/2012	96	0.019	0.0194	21.2	0.585	3.3	0.477	330	0.0344
5/2/2012	137	0.014	0.0251	30.4	0.637	3.1	0.419	390	0.0314
11/7/2012	140	0.007	0.0256	29.1	0.532	3.0	0.864	520	0.0326
2/6/2013	152	0.017	0.0293	26.9	1.06	3.0	0.729	660	0.0393
5/1/2013	24	0.007	0.0085	7.9	0.075	3.6	0.114	62	0.0115
8/14/2013	123	0.021	0.0295	18.0	0.683	2.9	0.802	360	0.0462
11/13/2013	120	0.017	0.0292	25.4	0.716	3.1	0.536	370	0.0428
2/5/2014	13	0.015	0.0284	20.6	0.66	2.9	0.46	330	0.0338
5/6/2014	29	0.009	0.0068	6.8	0.136	3.7	0.181	92	0.0068
9/15/2014	119	0.018	0.0204	17.8	0.71	3.0	0.632	350	0.022
11/5/2014	92	0.014	0.0159	19.5	0.529	3.1	0.446	290	0.0172
count	17	17	17	17	17	17	17	17	17
min	13	0.007	0.0068	6.8	0.075	2.8	0.114	62	0.0068
max	157	0.021	0.0327	31.8	1.060	3.7	0.864	660	0.0462
mean	106	0.015	0.0223	22.8	0.639	3.1	0.517	359	0.0290
median	123	0.016	0.0251	25.4	0.672	3.0	0.477	370	0.0314
10th Percentile	27	0.008	0.0107	13.8	0.218	2.9	0.205	157	0.0149
95th Percentile	156	0.019	0.0301	31.2	1.002	3.6	0.814	548	0.0435

Appendix Table C.7.5: Water quality at station N-17 from 2010 to 2014.

Date m/d/yr	Acidity mg/L	Ba mg/L	Co mg/L	Fe mg/L	Mn mg/L	pH	Ra Bq/L	Sulphate mg/L	U mg/L
1/6/2010						4.9	0.120		
2/3/2010	568	0.016	0.0906	254	1.5	4.8	0.084	1100	0.0532
3/3/2010						4.8	0.071		
4/7/2010						4.9	0.084		
5/5/2010	406	0.014	0.084	197	1.2	4.8	0.072	970	0.0384
6/2/2010						5.1	0.080		
7/7/2010						4.7	0.053		
8/4/2010	554	0.018	0.0899	309	1.61	4.4	0.080	1300	0.0365
9/1/2010						5.0	0.083		
10/6/2010						5.1	0.090		
11/3/2010	343	0.018	0.0685	199	1.19	3.3	0.210	840	0.0435
12/1/2010						3.1	0.150		
1/5/2011						3.8	0.151		
2/2/2011	712	0.02	0.104	333	1.68	5.2	0.103	1400	0.042
3/2/2011						5.6	0.080		
4/6/2011						3.5	0.235		
5/4/2011	238	0.015	0.0446	96.4	0.618	3.5	0.220	480	0.0366
6/1/2011						3.4	0.245		
7/6/2011						5.1	0.080		
8/3/2011	578	0.019	0.111	350	1.78	5.3	0.098	1400	0.047
9/7/2011						5.2	0.088		
10/5/2011						5.1	0.085		
11/2/2011	448	0.015	0.0846	250	1.25	4.8	0.109	1100	0.0374
12/7/2011						3.5	0.364		
1/4/2012						5.3	0.123		
2/1/2012	462	0.021	0.0947	227	1.35	3.7	0.219	1100	0.0556
3/7/2012						5.0	0.096		
4/4/2012						4.1	0.176		
5/2/2012	524	0.021	0.105	310	1.39	4.6	0.130	1500	0.0483
6/6/2012						4.9	0.120		
7/4/2012						5.1	0.074		
8/1/2012	736	0.025	0.105	417	1.94	5.4	0.086	1700	0.0557
9/5/2012						5.4	0.090		
10/3/2012						5.2	0.096		
11/7/2012	548	0.023	0.125	403	1.83	5.1	0.101	1600	0.0441
12/5/2012						3.5	0.251		
1/2/2013						5.3	0.096		
2/6/2013	624	0.019	0.121	339	1.73	4.1	0.145	1600	0.0503
3/6/2013						5.1	0.094		
4/3/2013						3.5	0.318		
5/1/2013	93	0.014	0.0276	44.9	0.32	3.5	0.245	230	0.0308
6/5/2013						3.5	0.235		
7/3/2013						5.0	0.092		
8/7/2013	244	0.018	0.0536	133	0.819	3.8	0.316	62	0.049
9/4/2013						4.6	0.121		
10/2/2013						4.8	0.092		
11/13/2013	277	0.017	0.0557	128	0.872	3.5	0.226	630	0.0523
12/4/2013						4.7	0.154		
1/8/2014						5.3	0.107		
2/5/2014	97	0.018	0.132	358	1.75	5.3	0.098	1400	0.0483
3/5/2014						5.2	0.087		

Appendix Table C.7.5: Water quality at station N-17 from 2010 to 2014.

Date m/d/yr	Acidity mg/L	Ba mg/L	Co mg/L	Fe mg/L	Mn mg/L	pH	Ra Bq/L	Sulphate mg/L	U mg/L
4/2/2014						5.2	0.093		
5/7/2014	240	0.015	0.0557	113	0.759	3.4	0.237	570	0.0343
6/4/2014						3.7	0.212		
7/2/2014						4.7	0.094		
8/6/2014	580	0.017	0.152	352	1.65	5.0	0.090	1300	0.0574
9/3/2014						3.4	0.250		
10/1/2014						4.6	0.126		
11/5/2014	221	0.015	0.0651	116	0.79	3.7	0.264	660	0.0448
12/3/2014						4.8	0.226		
count	20	20	20	20	20	60	60	20	20
min	93	0.014	0.028	45	0.32	3.1	0.053	62	0.031
max	736	0.025	0.152	417	1.94	5.6	0.364	1700	0.057
mean	425	0.018	0.088	246	1.30	4.5	0.144	1047	0.045
median	455	0.018	0.090	252	1.37	4.8	0.105	1100	0.046
10th Percentile	209	0.015	0.053	111	0.74	3.5	0.080	455	0.036
95th Percentile	713	0.023	0.133	404	1.84	5.3	0.267	1605	0.056

Appendix Table C.7.6: Water quality at station N-18 from 2010 to 2014.

Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH
1/4/2010	10.3	3/18/2010	8.8	6/2/2010	10.0	8/17/2010	7.8	11/1/2010	9.6
1/5/2010	9.9	3/19/2010	8.7	6/3/2010	10.4	8/18/2010	10.6	11/2/2010	10.1
1/6/2010	9.9	3/22/2010	9.0	6/4/2010	9.7	8/19/2010	9.8	11/3/2010	9.7
1/7/2010	10.3	3/23/2010	9.7	6/7/2010	10.0	8/20/2010	9.7	11/4/2010	10.0
1/8/2010	10.2	3/24/2010	8.8	6/8/2010	10.1	8/23/2010	8.3	11/5/2010	10.0
1/11/2010	10.3	3/25/2010	8.8	6/9/2010	9.6	8/24/2010	9.9	11/8/2010	10.1
1/12/2010	10.0	3/26/2010	9.2	6/10/2010	10.1	8/25/2010	9.9	11/9/2010	9.9
1/13/2010	10.0	3/29/2010	9.4	6/11/2010	10.3	8/26/2010	8.8	11/10/2010	9.7
1/14/2010	9.9	3/30/2010	10.2	6/14/2010	10.1	8/27/2010	10.3	11/11/2010	10.0
1/15/2010	9.9	3/31/2010	10.1	6/15/2010	10.4	8/30/2010	10.2	11/12/2010	10.0
1/18/2010	10.3	4/1/2010	10.1	6/16/2010	10.0	8/31/2010	10.1	11/15/2010	9.7
1/19/2010	10.2	4/5/2010	10.0	6/17/2010	10.0	9/1/2010	10.1	11/16/2010	9.9
1/20/2010	10.2	4/6/2010	10.0	6/18/2010	10.2	9/2/2010	10.2	11/17/2010	10.0
1/21/2010	10.1	4/7/2010	10.0	6/21/2010	10.0	9/3/2010	9.6	11/18/2010	10.1
1/22/2010	10.0	4/8/2010	10.1	6/22/2010	9.6	9/7/2010	10.3	11/19/2010	9.7
1/25/2010	10.3	4/9/2010	10.1	6/23/2010	10.0	9/8/2010	10.1	11/22/2010	9.9
1/26/2010	10.1	4/12/2010	10.0	6/24/2010	10.0	9/9/2010	10.2	11/23/2010	9.9
1/27/2010	10.1	4/13/2010	10.0	6/25/2010	10.1	9/10/2010	9.9	11/24/2010	10.0
1/28/2010	10.2	4/14/2010	10.0	6/28/2010	10.0	9/13/2010	10.2	11/25/2010	9.9
1/29/2010	10.3	4/15/2010	9.9	6/29/2010	10.1	9/14/2010	10.1	11/26/2010	9.8
2/1/2010	10.0	4/16/2010	9.9	6/30/2010	10.1	9/15/2010	10.1	11/29/2010	10.0
2/2/2010	9.9	4/19/2010	10.3	7/1/2010	10.0	9/16/2010	10.5	11/30/2010	10.3
2/3/2010	9.9	4/20/2010	10.0	7/5/2010	9.9	9/17/2010	9.9	12/1/2010	9.5
2/4/2010	9.9	4/21/2010	10.0	7/6/2010	9.9	9/20/2010	10.0	12/2/2010	9.6
2/5/2010	10.1	4/22/2010	10.5	7/7/2010	10.1	9/21/2010	10.0	12/3/2010	9.5
2/8/2010	10.3	4/23/2010	10.2	7/8/2010	10.2	9/22/2010	10.1	12/6/2010	9.9
2/9/2010	10.1	4/26/2010	9.8	7/9/2010	9.7	9/23/2010	10.2	12/7/2010	10.1
2/10/2010	10.1	4/27/2010	10.2	7/12/2010	10.2	9/24/2010	9.1	12/8/2010	10.1
2/11/2010	10.1	4/28/2010	10.0	7/13/2010	9.9	9/27/2010	9.5	12/9/2010	10.0
2/12/2010	10.1	4/29/2010	10.2	7/14/2010	10.1	9/28/2010	9.6	12/10/2010	9.7
2/16/2010	10.0	4/30/2010	10.0	7/15/2010	10.1	9/29/2010	9.9	12/13/2010	9.8
2/17/2010	9.9	5/3/2010	10.1	7/16/2010	9.9	9/30/2010	9.5	12/14/2010	10.6
2/18/2010	10.2	5/4/2010	10.1	7/19/2010	10.1	10/1/2010	9.6	12/15/2010	9.9
2/19/2010	10.2	5/5/2010	10.1	7/20/2010	9.9	10/4/2010	10.3	12/16/2010	10.2
2/22/2010	10.0	5/6/2010	10.1	7/21/2010	9.9	10/5/2010	9.6	12/17/2010	10.2
2/23/2010	10.0	5/7/2010	9.9	7/22/2010	9.9	10/6/2010	10.0	12/20/2010	10.3
2/24/2010	9.9	5/10/2010	10.3	7/23/2010	9.5	10/7/2010	10.0	12/21/2010	9.7
2/25/2010	9.9	5/11/2010	10.1	7/26/2010	10.1	10/8/2010	10.2	12/22/2010	10.0
2/26/2010	10.1	5/12/2010	10.1	7/27/2010	10.3	10/12/2010	10.1	12/23/2010	10.4
3/1/2010	10.2	5/13/2010	9.7	7/28/2010	10.1	10/13/2010	10.2	12/24/2010	9.9
3/2/2010	9.8	5/14/2010	10.1	7/29/2010	9.9	10/14/2010	10.1	12/29/2010	10.2
3/3/2010	9.8	5/17/2010	9.9	7/30/2010	10.1	10/15/2010	9.9	12/30/2010	10.2
3/4/2010	10.0	5/18/2010	10.2	8/3/2010	10.1	10/18/2010	10.1	12/31/2010	9.9
3/5/2010	10.0	5/19/2010	10.4	8/4/2010	9.5	10/19/2010	9.9	1/4/2011	10.1
3/8/2010	10.4	5/20/2010	10.4	8/5/2010	9.0	10/20/2010	10.0	1/5/2011	9.7
3/9/2010	9.9	5/21/2010	9.8	8/6/2010	10.1	10/21/2010	9.7	1/6/2011	10.4
3/10/2010	9.9	5/25/2010	10.0	8/9/2010	9.7	10/22/2010	10.2	1/7/2011	10.3
3/11/2010	10.0	5/26/2010	10.1	8/10/2010	10.1	10/25/2010	10.5	1/10/2011	9.9
3/12/2010	8.5	5/27/2010	10.0	8/11/2010	10.1	10/26/2010	9.9	1/11/2011	9.8
3/15/2010	8.5	5/28/2010	10.1	8/12/2010	9.7	10/27/2010	9.3	1/12/2011	10.2
3/16/2010	8.8	5/31/2010	10.2	8/13/2010	10.1	10/28/2010	9.3	1/13/2011	9.9
3/17/2010	8.5	6/1/2010	10.3	8/16/2010	10.2	10/29/2010	9.8	1/14/2011	9.8

Appendix Table C.7.6: Water quality at station N-18 from 2010 to 2014.

Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH
1/17/2011	10.2	4/5/2011	9.9	6/23/2011	9.9	9/13/2011	10.0	11/30/2011	10.2
1/18/2011	9.7	4/6/2011	10.2	6/24/2011	9.8	9/14/2011	10.0	12/1/2011	9.8
1/19/2011	10.0	4/7/2011	9.2	6/27/2011	10.2	9/15/2011	10.0	12/2/2011	9.9
1/20/2011	9.8	4/8/2011	9.5	6/28/2011	9.7	9/16/2011	10.1	12/5/2011	9.3
1/21/2011	10.2	4/11/2011	7.7	6/29/2011	9.6	9/19/2011	10.0	12/6/2011	9.5
1/24/2011	9.9	4/12/2011	7.9	6/30/2011	9.8	9/20/2011	9.7	12/7/2011	9.7
1/25/2011	9.9	4/13/2011	8.0	7/4/2011	9.9	9/21/2011	10.1	12/8/2011	9.6
1/26/2011	10.2	4/14/2011	8.2	7/5/2011	9.7	9/22/2011	10.0	12/9/2011	9.8
1/27/2011	9.8	4/15/2011	8.6	7/6/2011	9.6	9/23/2011	9.8	12/12/2011	9.9
1/28/2011	9.8	4/18/2011	8.5	7/7/2011	9.7	9/26/2011	10.1	12/13/2011	9.0
1/31/2011	9.9	4/19/2011	8.6	7/8/2011	9.9	9/27/2011	9.6	12/14/2011	9.6
2/1/2011	10.0	4/20/2011	8.8	7/11/2011	9.7	9/28/2011	9.8	12/15/2011	9.5
2/2/2011	10.3	4/21/2011	8.7	7/12/2011	9.8	9/29/2011	9.8	12/16/2011	10.1
2/3/2011	9.9	4/25/2011	8.9	7/13/2011	9.7	9/30/2011	10.2	12/19/2011	10.0
2/4/2011	10.2	4/26/2011	8.7	7/14/2011	9.8	10/3/2011	9.8	12/20/2011	9.5
2/7/2011	10.1	4/27/2011	8.7	7/15/2011	10.1	10/4/2011	10.0	12/21/2011	9.4
2/8/2011	9.9	4/28/2011	8.9	7/18/2011	9.8	10/5/2011	9.8	12/22/2011	9.6
2/9/2011	10.1	4/29/2011	9.0	7/19/2011	9.9	10/6/2011	9.8	12/23/2011	9.5
2/10/2011	9.8	5/2/2011	9.2	7/20/2011	9.8	10/7/2011	10.1	12/28/2011	9.5
2/11/2011	10.3	5/3/2011	9.0	7/21/2011	9.8	10/11/2011	9.9	12/29/2011	9.6
2/14/2011	10.1	5/4/2011	9.4	7/22/2011	10.0	10/12/2011	10.0	12/30/2011	9.9
2/15/2011	10.2	5/5/2011	9.2	7/25/2011	10.0	10/13/2011	10.0	1/3/2012	9.9
2/16/2011	10.3	5/6/2011	9.3	7/26/2011	9.9	10/14/2011	10.0	1/4/2012	9.5
2/17/2011	9.8	5/9/2011	10.1	7/27/2011	9.9	10/17/2011	9.6	1/5/2012	9.8
2/18/2011	10.1	5/10/2011	9.9	7/28/2011	9.7	10/18/2011	10.0	1/6/2012	9.6
2/22/2011	10.3	5/11/2011	10.1	7/29/2011	9.7	10/19/2011	10.1	1/9/2012	9.7
2/23/2011	9.8	5/12/2011	9.8	8/2/2011	9.9	10/20/2011	9.7	1/10/2012	9.9
2/24/2011	9.8	5/13/2011	10.1	8/3/2011	9.6	10/21/2011	9.6	1/11/2012	9.8
2/25/2011	10.0	5/16/2011	10.0	8/4/2011	9.9	10/24/2011	10.1	1/12/2012	9.8
2/28/2011	10.2	5/17/2011	10.0	8/5/2011	10.0	10/25/2011	9.9	1/13/2012	9.6
3/1/2011	10.2	5/18/2011	10.1	8/8/2011	10.1	10/26/2011	9.8	1/16/2012	9.7
3/2/2011	10.0	5/19/2011	9.8	8/9/2011	9.7	10/27/2011	10.1	1/17/2012	9.8
3/3/2011	10.3	5/20/2011	10.2	8/10/2011	9.7	10/28/2011	9.9	1/18/2012	9.8
3/4/2011	9.9	5/24/2011	9.5	8/11/2011	9.7	10/31/2011	9.9	1/19/2012	9.6
3/7/2011	10.2	5/25/2011	9.8	8/12/2011	9.8	11/1/2011	10.2	1/20/2012	10.0
3/8/2011	9.8	5/26/2011	9.9	8/15/2011	10.2	11/2/2011	9.9	1/23/2012	9.5
3/9/2011	10.3	5/27/2011	10.0	8/16/2011	9.4	11/3/2011	9.4	1/24/2012	9.6
3/10/2011	10.0	5/30/2011	9.8	8/17/2011	9.4	11/4/2011	9.5	1/25/2012	9.4
3/11/2011	10.2	5/31/2011	9.5	8/18/2011	9.6	11/7/2011	9.6	1/26/2012	9.4
3/14/2011	10.0	6/1/2011	9.9	8/19/2011	9.6	11/8/2011	10.1	1/27/2012	8.5
3/15/2011	9.8	6/2/2011	10.1	8/22/2011	9.9	11/9/2011	10.0	1/30/2012	8.5
3/16/2011	9.9	6/3/2011	10.1	8/23/2011	10.1	11/10/2011	9.1	1/31/2012	8.7
3/17/2011	10.2	6/6/2011	9.5	8/24/2011	9.7	11/11/2011	9.4	2/1/2012	8.5
3/18/2011	10.3	6/7/2011	9.8	8/25/2011	9.3	11/14/2011	10.2	2/2/2012	8.5
3/21/2011	10.2	6/8/2011	9.5	8/26/2011	9.8	11/15/2011	9.5	2/3/2012	8.5
3/22/2011	10.2	6/9/2011	10.2	8/29/2011	10.0	11/16/2011	9.9	2/6/2012	9.0
3/23/2011	9.9	6/10/2011	10.4	8/30/2011	10.2	11/17/2011	10.0	2/7/2012	9.0
3/24/2011	9.8	6/13/2011	10.0	8/31/2011	10.1	11/18/2011	9.7	2/8/2012	9.2
3/25/2011	10.2	6/14/2011	10.1	9/1/2011	10.0	11/21/2011	10.1	2/9/2012	9.3
3/28/2011	9.9	6/15/2011	9.6	9/2/2011	9.8	11/22/2011	9.8	2/10/2012	9.2
3/29/2011	10.3	6/16/2011	9.7	9/6/2011	10.0	11/23/2011	10.1	2/13/2012	9.8
3/30/2011	9.8	6/17/2011	9.8	9/7/2011	10.2	11/24/2011	10.1	2/14/2012	9.3
3/31/2011	9.8	6/20/2011	9.8	9/8/2011	10.1	11/25/2011	10.0	2/15/2012	9.4
4/1/2011	9.9	6/21/2011	9.6	9/9/2011	9.8	11/28/2011	9.5	2/16/2012	9.6
4/4/2011	10.3	6/22/2011	9.6	9/12/2011	9.9	11/29/2011	9.8	2/17/2012	9.5

Appendix Table C.7.6: Water quality at station N-18 from 2010 to 2014.

Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH
2/21/2012	9.5	5/9/2012	9.5	7/27/2012	9.1	10/17/2012	10.2	1/7/2013	10.0
2/22/2012	9.6	5/10/2012	9.3	7/30/2012	8.9	10/18/2012	9.7	1/8/2013	10.2
2/23/2012	9.8	5/11/2012	9.5	7/31/2012	8.7	10/19/2012	9.5	1/9/2013	9.9
2/24/2012	9.9	5/14/2012	9.8	8/1/2012	8.9	10/22/2012	9.9	1/10/2013	10.1
2/27/2012	10.1	5/15/2012	9.5	8/2/2012	8.8	10/23/2012	9.8	1/11/2013	10.0
2/28/2012	10.0	5/16/2012	9.6	8/3/2012	9.0	10/24/2012	9.8	1/14/2013	9.0
2/29/2012	10.3	5/17/2012	9.5	8/7/2012	9.3	10/25/2012	9.7	1/15/2013	9.3
3/1/2012	10.3	5/18/2012	9.5	8/8/2012	9.0	10/26/2012	9.7	1/16/2013	9.6
3/2/2012	10.4	5/22/2012	9.8	8/9/2012	9.5	10/29/2012	9.8	1/17/2013	9.5
3/5/2012	10.5	5/23/2012	9.6	8/10/2012	8.9	10/30/2012	9.9	1/18/2013	9.6
3/6/2012	10.3	5/24/2012	9.5	8/13/2012	9.3	10/31/2012	9.8	1/21/2013	9.3
3/7/2012	9.8	5/25/2012	9.6	8/14/2012	8.8	11/1/2012	9.8	1/22/2013	9.5
3/8/2012	9.6	5/28/2012	9.4	8/15/2012	9.2	11/2/2012	10.2	1/23/2013	9.0
3/9/2012	9.5	5/29/2012	9.3	8/16/2012	9.3	11/5/2012	9.9	1/24/2013	9.4
3/12/2012	10.1	5/30/2012	9.0	8/17/2012	9.0	11/6/2012	9.8	1/25/2013	9.3
3/13/2012	9.6	5/31/2012	9.2	8/20/2012	9.1	11/7/2012	10.0	1/28/2013	9.7
3/14/2012	8.4	6/1/2012	8.1	8/21/2012	8.7	11/8/2012	9.8	1/29/2013	9.7
3/15/2012	8.2	6/4/2012	9.5	8/22/2012	9.3	11/9/2012	10.0	1/30/2013	9.0
3/16/2012	8.4	6/5/2012	9.8	8/23/2012	8.9	11/12/2012	9.1	1/31/2013	9.2
3/19/2012	8.8	6/6/2012	9.4	8/24/2012	8.9	11/13/2012	8.8	2/1/2013	9.1
3/20/2012	8.1	6/7/2012	9.7	8/27/2012	9.3	11/14/2012	9.2	2/4/2013	9.2
3/21/2012	8.6	6/8/2012	9.5	8/28/2012	9.5	11/15/2012	9.2	2/5/2013	9.1
3/22/2012	8.6	6/11/2012	9.9	8/29/2012	9.1	11/16/2012	9.4	2/6/2013	9.0
3/23/2012	8.7	6/12/2012	9.7	8/30/2012	9.0	11/19/2012	9.6	2/7/2013	9.0
3/26/2012	9.0	6/13/2012	9.7	8/31/2012	9.0	11/20/2012	9.7	2/8/2013	9.2
3/27/2012	8.6	6/14/2012	9.3	9/4/2012	9.3	11/21/2012	9.6	2/11/2013	9.2
3/28/2012	9.2	6/15/2012	9.4	9/5/2012	9.3	11/22/2012	9.7	2/12/2013	9.1
3/29/2012	9.0	6/18/2012	9.8	9/6/2012	9.4	11/23/2012	9.7	2/13/2013	9.1
3/30/2012	9.2	6/19/2012	8.8	9/7/2012	9.3	11/26/2012	10.0	2/14/2013	9.0
4/2/2012	9.0	6/20/2012	8.5	9/10/2012	9.5	11/27/2012	10.0	2/15/2013	9.2
4/3/2012	9.0	6/21/2012	8.3	9/11/2012	9.1	11/28/2012	9.8	2/19/2013	9.2
4/4/2012	9.3	6/22/2012	9.2	9/12/2012	8.9	11/29/2012	9.8	2/20/2013	9.2
4/5/2012	9.3	6/25/2012	9.1	9/13/2012	8.8	11/30/2012	10.2	2/21/2013	9.4
4/9/2012	10.0	6/26/2012	8.7	9/14/2012	9.0	12/3/2012	9.8	2/22/2013	9.6
4/10/2012	9.6	6/27/2012	8.6	9/17/2012	9.6	12/4/2012	9.1	2/25/2013	9.7
4/11/2012	9.6	6/28/2012	8.6	9/18/2012	9.0	12/5/2012	9.2	2/26/2013	9.5
4/12/2012	9.4	6/29/2012	8.4	9/19/2012	9.1	12/6/2012	8.3	2/27/2013	9.8
4/13/2012	9.8	7/3/2012	8.9	9/20/2012	8.6	12/7/2012	8.5	2/28/2013	9.4
4/16/2012	9.7	7/4/2012	8.9	9/21/2012	9.0	12/10/2012	8.6	3/1/2013	9.1
4/17/2012	9.5	7/5/2012	8.6	9/24/2012	9.4	12/11/2012	8.9	3/4/2013	9.5
4/18/2012	9.5	7/6/2012	8.9	9/25/2012	9.3	12/12/2012	9.0	3/5/2013	10.0
4/19/2012	9.4	7/9/2012	8.9	9/26/2012	9.6	12/13/2012	9.6	3/6/2013	9.9
4/20/2012	9.6	7/10/2012	8.6	9/27/2012	9.3	12/14/2012	9.2	3/7/2013	9.4
4/23/2012	9.5	7/11/2012	8.3	9/28/2012	9.3	12/17/2012	9.6	3/8/2013	9.5
4/24/2012	9.3	7/12/2012	8.3	10/1/2012	9.3	12/18/2012	9.6	3/11/2013	9.0
4/25/2012	9.6	7/13/2012	8.7	10/2/2012	9.7	12/19/2012	10.0	3/12/2013	8.8
4/26/2012	9.4	7/16/2012	8.3	10/3/2012	9.4	12/20/2012	9.9	3/13/2013	8.7
4/27/2012	9.8	7/17/2012	8.4	10/4/2012	9.5	12/21/2012	9.4	3/14/2013	8.5
4/30/2012	9.4	7/18/2012	8.7	10/5/2012	9.5	12/24/2012	10.1	3/15/2013	8.5
5/1/2012	9.5	7/19/2012	8.8	10/9/2012	9.5	12/27/2012	10.1	3/18/2013	8.1
5/2/2012	9.5	7/20/2012	8.4	10/10/2012	9.1	12/28/2012	10.2	3/19/2013	8.1
5/3/2012	9.3	7/23/2012	8.7	10/11/2012	9.5	12/31/2012	10.0	3/20/2013	8.2
5/4/2012	9.6	7/24/2012	8.3	10/12/2012	9.4	1/2/2013	10.1	3/21/2013	8.5
5/7/2012	9.3	7/25/2012	9.0	10/15/2012	9.0	1/3/2013	10.1	3/22/2013	8.5
5/8/2012	9.4	7/26/2012	9.3	10/16/2012	9.4	1/4/2013	10.2	3/25/2013	8.8

Appendix Table C.7.6: Water quality at station N-18 from 2010 to 2014.

Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH
3/26/2013	8.6	6/13/2013	10.3	9/3/2013	10.1	11/20/2013	9.6	2/10/2014	10.8
3/27/2013	8.6	6/14/2013	10.2	9/4/2013	10.2	11/21/2013	9.3	2/11/2014	10.2
3/28/2013	9.2	6/17/2013	9.8	9/5/2013	9.9	11/22/2013	9.6	2/12/2014	10.2
4/1/2013	8.5	6/18/2013	10.1	9/6/2013	10.8	11/25/2013	9.4	2/13/2014	10.6
4/2/2013	8.4	6/19/2013	10.2	9/9/2013	10.2	11/26/2013	9.4	2/14/2014	10.6
4/3/2013	8.2	6/20/2013	10.4	9/10/2013	10.0	11/27/2013	9.8	2/18/2014	10.2
4/4/2013	8.1	6/21/2013	10.3	9/11/2013	10.2	11/28/2013	9.7	2/19/2014	10.1
4/5/2013	8.9	6/24/2013	10.1	9/12/2013	9.9	11/29/2013	10.1	2/20/2014	10.5
4/8/2013	8.5	6/25/2013	10.3	9/13/2013	10.0	12/2/2013	10.1	2/21/2014	10.0
4/9/2013	8.8	6/26/2013	10.1	9/16/2013	10.3	12/3/2013	9.8	2/24/2014	10.3
4/10/2013	9.0	6/27/2013	10.0	9/17/2013	10.4	12/4/2013	10.1	2/25/2014	10.4
4/11/2013	8.7	6/28/2013	10.0	9/18/2013	10.2	12/5/2013	10.3	2/26/2014	10.3
4/12/2013	9.0	7/2/2013	10.3	9/19/2013	10.4	12/6/2013	10.3	2/27/2014	9.9
4/15/2013	9.3	7/3/2013	9.9	9/20/2013	10.2	12/9/2013	10.3	2/28/2014	10.3
4/16/2013	9.2	7/4/2013	10.3	9/23/2013	10.2	12/10/2013	9.9	3/3/2014	9.9
4/17/2013	9.0	7/5/2013	9.9	9/24/2013	10.2	12/11/2013	10.2	3/4/2014	9.6
4/18/2013	9.1	7/8/2013	10.1	9/25/2013	10.2	12/12/2013	10.4	3/5/2014	10.2
4/19/2013	9.5	7/9/2013	10.0	9/26/2013	10.4	12/13/2013	10.4	3/6/2014	10.3
4/22/2013	9.5	7/10/2013	9.9	9/27/2013	10.4	12/16/2013	9.6	3/7/2014	10.2
4/23/2013	8.7	7/11/2013	9.9	9/30/2013	10.5	12/17/2013	9.7	3/10/2014	10.5
4/24/2013	9.0	7/12/2013	9.9	10/1/2013	10.2	12/18/2013	9.6	3/11/2014	10.4
4/25/2013	9.1	7/15/2013	10.2	10/2/2013	10.4	12/19/2013	9.8	3/12/2014	9.8
4/26/2013	9.1	7/16/2013	10.1	10/3/2013	10.1	12/20/2013	9.8	3/13/2014	10.1
4/29/2013	9.1	7/17/2013	9.8	10/4/2013	10.4	12/23/2013	9.3	3/14/2014	10.3
4/30/2013	9.1	7/18/2013	10.0	10/7/2013	10.3	12/24/2013	9.3	3/17/2014	10.2
5/1/2013	9.2	7/19/2013	10.3	10/8/2013	10.2	12/27/2013	9.9	3/18/2014	10.5
5/2/2013	9.3	7/22/2013	10.0	10/9/2013	10.5	12/30/2013	9.9	3/19/2014	10.5
5/3/2013	9.1	7/23/2013	10.2	10/10/2013	10.2	12/31/2013	9.8	3/20/2014	10.5
5/6/2013	9.9	7/24/2013	10.3	10/11/2013	10.2	1/2/2014	9.0	3/21/2014	10.2
5/7/2013	10.2	7/25/2013	10.3	10/15/2013	10.4	1/3/2014	8.9	3/24/2014	10.2
5/8/2013	10.5	7/26/2013	10.2	10/16/2013	10.1	1/6/2014	9.6	3/25/2014	10.5
5/9/2013	10.2	7/29/2013	9.9	10/17/2013	10.2	1/7/2014	9.6	3/26/2014	10.5
5/10/2013	10.1	7/30/2013	9.9	10/18/2013	10.0	1/8/2014	10.0	3/27/2014	10.4
5/13/2013	10.3	7/31/2013	10.5	10/21/2013	10.1	1/9/2014	9.8	3/28/2014	10.4
5/14/2013	10.3	8/1/2013	9.7	10/22/2013	9.9	1/10/2014	9.7	3/31/2014	10.6
5/15/2013	10.2	8/2/2013	10.2	10/23/2013	10.2	1/13/2014	9.7	4/1/2014	10.1
5/16/2013	10.1	8/6/2013	10.7	10/24/2013	10.0	1/14/2014	9.7	4/2/2014	10.2
5/17/2013	9.9	8/7/2013	9.6	10/25/2013	9.9	1/15/2014	9.5	4/3/2014	10.3
5/21/2013	10.0	8/8/2013	9.9	10/28/2013	10.3	1/16/2014	9.6	4/4/2014	10.2
5/22/2013	9.4	8/9/2013	10.2	10/29/2013	10.2	1/17/2014	9.7	4/7/2014	10.0
5/23/2013	9.7	8/12/2013	10.8	10/30/2013	10.1	1/20/2014	9.7	4/8/2014	9.3
5/24/2013	9.7	8/13/2013	11.2	10/31/2013	10.2	1/21/2014	9.8	4/9/2014	9.8
5/27/2013	9.8	8/14/2013	10.1	11/1/2013	9.7	1/22/2014	9.7	4/10/2014	8.6
5/28/2013	10.2	8/15/2013	10.2	11/4/2013	10.2	1/23/2014	10.2	4/11/2014	9.6
5/29/2013	9.6	8/16/2013	10.1	11/5/2013	10.1	1/24/2014	10.0	4/14/2014	8.4
5/30/2013	10.1	8/19/2013	10.3	11/6/2013	9.9	1/27/2014	9.9	4/15/2014	8.1
5/31/2013	10.1	8/20/2013	10.1	11/7/2013	9.5	1/28/2014	10.7	4/16/2014	8.5
6/3/2013	9.7	8/21/2013	9.9	11/8/2013	9.5	1/29/2014	10.3	4/17/2014	8.7
6/4/2013	10.0	8/22/2013	10.0	11/11/2013	9.8	1/30/2014	9.9	4/21/2014	8.4
6/5/2013	9.9	8/23/2013	10.2	11/12/2013	9.5	1/31/2014	9.9	4/22/2014	8.6
6/6/2013	10.2	8/26/2013	9.9	11/13/2013	9.5	2/3/2014	10.0	4/23/2014	9.0
6/7/2013	10.2	8/27/2013	10.1	11/14/2013	9.6	2/4/2014	9.9	4/24/2014	8.7
6/10/2013	10.1	8/28/2013	10.5	11/15/2013	9.8	2/5/2014	10.1	4/25/2014	8.8
6/11/2013	10.2	8/29/2013	9.9	11/18/2013	9.2	2/6/2014	9.4	4/28/2014	9.5
6/12/2013	9.9	8/30/2013	10.0	11/19/2013	9.5	2/7/2014	9.9	4/29/2014	8.6

Appendix Table C.7.6: Water quality at station N-18 from 2010 to 2014.

Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH
4/30/2014	8.0	7/18/2014	9.7	10/7/2014	10.2	12/24/2014	10.7		
5/1/2014	8.7	7/21/2014	9.6	10/8/2014	9.8	12/29/2014	9.1		
5/2/2014	9.0	7/22/2014	9.6	10/9/2014	10.5	12/30/2014	9.3		
5/5/2014	9.2	7/23/2014	9.6	10/10/2014	9.8	12/31/2014	9.6		
5/6/2014	9.5	7/24/2014	9.7	10/14/2014	10.0	**count**	**1254**		
5/7/2014	9.4	7/25/2014	10.0	10/15/2014	8.8	**min**	**7.7**		
5/8/2014	9.5	7/28/2014	10.2	10/16/2014	8.8	**max**	**11.2**		
5/9/2014	9.4	7/29/2014	10.2	10/17/2014	9.0	**mean**	**9.7**		
5/12/2014	9.5	7/30/2014	10.1	10/20/2014	9.8	**median**	**9.8**		
5/13/2014	9.4	7/31/2014	9.7	10/21/2014	9.9				
5/14/2014	9.4	8/1/2014	9.7	10/22/2014	9.9				
5/15/2014	9.3	8/5/2014	9.8	10/23/2014	10.0				
5/16/2014	9.3	8/6/2014	9.8	10/24/2014	9.8				
5/20/2014	9.5	8/7/2014	10.1	10/27/2014	10.2				
5/21/2014	9.6	8/8/2014	10.0	10/28/2014	10.1				
5/22/2014	9.8	8/11/2014	9.8	10/29/2014	10.0				
5/23/2014	10.0	8/12/2014	10.0	10/30/2014	10.0				
5/26/2014	9.9	8/13/2014	10.1	10/31/2014	10.2				
5/27/2014	9.9	8/14/2014	10.3	11/3/2014	10.1				
5/28/2014	9.9	8/15/2014	9.8	11/4/2014	10.1				
5/29/2014	9.7	8/18/2014	9.9	11/5/2014	10.1				
5/30/2014	9.8	8/19/2014	10.3	11/6/2014	10.0				
6/2/2014	9.7	8/20/2014	10.2	11/7/2014	10.0				
6/3/2014	9.8	8/21/2014	10.1	11/10/2014	10.4				
6/4/2014	9.9	8/22/2014	9.8	11/11/2014	9.9				
6/5/2014	9.8	8/25/2014	9.9	11/12/2014	9.8				
6/6/2014	9.8	8/26/2014	10.0	11/13/2014	9.9				
6/9/2014	9.6	8/27/2014	9.8	11/14/2014	10.0				
6/10/2014	10.1	8/28/2014	9.8	11/17/2014	10.4				
6/11/2014	9.8	8/29/2014	9.6	11/18/2014	10.0				
6/12/2014	9.9	9/2/2014	9.0	11/19/2014	10.1				
6/13/2014	10.0	9/3/2014	9.6	11/20/2014	10.0				
6/16/2014	9.8	9/4/2014	9.5	11/21/2014	9.9				
6/17/2014	10.0	9/5/2014	9.5	11/24/2014	9.8				
6/18/2014	9.9	9/8/2014	9.5	11/25/2014	9.5				
6/19/2014	10.0	9/9/2014	9.4	11/26/2014	9.9				
6/20/2014	10.1	9/10/2014	9.4	11/27/2014	9.6				
6/23/2014	9.9	9/11/2014	9.3	11/28/2014	8.6				
6/24/2014	9.9	9/12/2014	9.6	12/1/2014	9.0				
6/25/2014	9.7	9/15/2014	9.7	12/2/2014	9.6				
6/26/2014	9.5	9/16/2014	9.4	12/3/2014	10.1				
6/27/2014	9.6	9/17/2014	9.4	12/4/2014	10.5				
7/1/2014	9.7	9/18/2014	9.6	12/5/2014	10.1				
7/2/2014	9.5	9/19/2014	9.7	12/8/2014	10.3				
7/3/2014	9.6	9/22/2014	9.9	12/9/2014	10.7				
7/4/2014	9.6	9/23/2014	9.9	12/10/2014	10.4				
7/7/2014	9.5	9/24/2014	9.9	12/11/2014	10.6				
7/8/2014	9.6	9/25/2014	9.9	12/12/2014	10.6				
7/9/2014	9.6	9/26/2014	9.8	12/15/2014	10.7				
7/10/2014	9.8	9/29/2014	9.7	12/16/2014	11.0				
7/11/2014	9.5	9/30/2014	9.9	12/17/2014	10.1				
7/14/2014	9.8	10/1/2014	9.9	12/18/2014	10.5				
7/15/2014	9.6	10/2/2014	9.8	12/19/2014	10.5				
7/16/2014	9.5	10/3/2014	9.6	12/22/2014	10.7				
7/17/2014	10.3	10/6/2014	9.8	12/23/2014	10.6				

Appendix Table C.7.7: Water quality at station N-19 from 2010 to 2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Mn mg/L	pH	Ra Bq/L	Sulphate mg/L	TSS mg/L	U mg/L
1/6/2010	0.012	0.0023	0.11	0.151	7.2	0.056	860	2	0.0030
1/13/2010					7.2	0.058		< 1	
1/20/2010					7.2	0.050		< 1	
1/27/2010					7.2	0.054		< 2	
2/3/2010	0.013	0.002	0.14	0.161	7.2	0.059	900	1	0.0041
2/10/2010					7.5	0.051		1	
2/17/2010					7.4	0.057		< 1	
2/25/2010					7.2	0.050		< 1	
3/3/2010	0.013	0.0018	0.09	0.141	7.2	0.065	920	1	0.0034
3/10/2010					7.4	0.057		< 1	
3/17/2010					8.1	0.056		1	
3/24/2010					8.0	0.043		< 1	
3/31/2010					7.5	0.040		< 1	
4/7/2010	0.012	0.0017	0.22	0.137	7.5	0.070	750	1	0.0032
4/14/2010					7.5	0.053		1	
4/21/2010					7.4	0.061		1	
4/28/2010					7.4	0.058		1	
5/5/2010	0.012	0.0013	0.28	0.142	7.5	0.055	820	< 1	0.0033
5/12/2010					7.4	0.049		< 1	
5/19/2010					7.3	0.048		1	
5/26/2010					7.2	0.052		< 1	
6/2/2010	0.013	0.001	0.11	0.127	7.2	0.065	860	1	0.0027
6/9/2010					7.2	0.051		1	
6/16/2010					7.0	0.061		1	
6/23/2010					7.4	0.059		1	
6/29/2010					7.4	0.041		1	
7/7/2010	0.012	0.001	0.18	0.1	7.1	0.048	960	1	0.0024
7/14/2010					7.1	0.047		2	
7/21/2010					7.1	0.054		1	
7/28/2010					7.0	0.050		1	
8/4/2010	0.012	0.0016	0.18	0.161	7.1	0.043	920	1	0.0028
8/11/2010					7.2	0.035		1	
8/18/2010					7.0	0.055		< 1	
8/25/2010					7.4	0.058		1	
9/1/2010	0.012	0.001	0.18	0.12	7.1	0.048	970	1	0.0025
9/8/2010					7.3	0.043		1	
9/15/2010					7.4	0.044		1	
9/22/2010					7.1	0.044		2	
9/29/2010					7.4	0.059		1	
10/6/2010	0.014	0.0026	0.43	0.098	7.3	0.063	880	1	0.0036
10/13/2010					7.1	0.042		1	
10/20/2010					7.3	0.047		1	
10/27/2010					7.3	0.044		2	
11/3/2010	0.012	0.002	0.46	0.13	7.2	0.050	850	1	0.0042
11/10/2010					7.2	0.061		2	
11/17/2010					7.2	0.054		1	
11/24/2010					7.1	0.069		1	
12/1/2010	0.011	0.0023	0.5	0.133	7.1	0.045	810	1	0.0034
12/8/2010					7.6	0.051		1	
12/15/2010					7.5	0.065		< 1	
12/22/2010					7.4	0.054		< 1	

Appendix Table C.7.7: Water quality at station N-19 from 2010 to 2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Mn mg/L	pH	Ra Bq/L	Sulphate mg/L	TSS mg/L	U mg/L
12/29/2010					7.4	0.023		1	
1/5/2011	0.012	0.002	0.19	0.159	7.4	0.063	880	1	0.0035
1/12/2011					7.4	0.052		1	
1/19/2011					7.3	0.051		1	
1/26/2011					7.2	0.049		1	
2/2/2011	0.013	0.0025	0.14	0.158	7.1	0.056	850	< 1	0.0038
2/9/2011					7.2	0.058		< 1	
2/16/2011					7.3	0.055		< 1	
2/23/2011					7.4	0.048		1	
3/2/2011	0.012	0.002	0.13	0.143	7.3	0.065	900	1	0.0035
3/9/2011					7.3	0.066		2	
3/16/2011					7.3	0.063		< 1	
3/23/2011					7.3	0.067		1	
3/30/2011					7.3	0.059		2	
4/6/2011	0.012	0.0017	0.25	0.11	8.6	0.088	860	1	0.0046
4/13/2011					8.4	0.042		1	
4/20/2011					7.5	0.067		1	
4/27/2011					7.1	0.061		2	
5/4/2011	0.01	0.0025	0.37	0.097	7.6	0.067	520	1	0.0054
5/11/2011					6.9	0.066		1	
5/18/2011					7.5	0.068		2	
5/25/2011					7.5	0.079		1	
6/1/2011	0.012	0.0024	0.28	0.122	7.4	0.063	660	1	0.0034
6/8/2011					7.4	0.062		1	
6/15/2011					7.4	0.062		1	
6/22/2011					7.3	0.065		1	
6/29/2011					7.3	0.055		2	
7/6/2011	0.016	0.0019	0.25	0.124	7.3	0.071	770	1	0.0027
7/13/2011					7.4	0.063		1	
7/20/2011					7.4	0.066		2	
7/27/2011					7.3	0.068		2	
8/3/2011	0.015	0.002	0.27	0.137	7.3	0.067	870	2	0.0033
8/10/2011					7.4	0.051		1	
8/17/2011					8.3	0.064		1	
8/24/2011					7.0	0.057		2	
8/31/2011					7.1	0.064		1	
9/7/2011	0.016	0.0013	0.37	0.1	7.3	0.052	870	2	0.0029
9/14/2011					7.3	0.047		2	
9/21/2011					7.2	0.060		1	
9/28/2011					7.3	0.048		< 1	
10/5/2011	0.013	0.0019	0.3	0.138	7.1	0.050	920	1	0.0025
10/12/2011					7.2	0.046		1	
10/19/2011					7.1	0.046		1	
10/25/2011					7.8	0.056		< 1	
11/2/2011	0.013	0.0029	0.25	0.177	7.0	0.058	950	3	0.0029
11/9/2011					7.2	0.041		1	
11/16/2011					7.2	0.062		1	
11/23/2011					7.1	0.054		1	
11/30/2011					7.1	0.053		2	
12/7/2011	0.013	0.0028	0.27	0.172	7.3	0.054	940	3	0.0040
12/14/2011					7.3	0.068		1	

Appendix Table C.7.7: Water quality at station N-19 from 2010 to 2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Mn mg/L	pH	Ra Bq/L	Sulphate mg/L	TSS mg/L	U mg/L
12/21/2011					7.8	0.063		1	
12/28/2011					7.1	0.058		< 1	
1/4/2012	0.013	0.0029	0.1	0.188	7.3	0.065	910	< 1	0.0039
1/11/2012					7.3	0.071		< 1	
1/18/2012					7.2	0.067		2	
1/25/2012					7.3	0.071		< 1	
2/1/2012	0.014	0.0017	0.19	0.153	8.7	0.124	810	< 1	0.0077
2/8/2012					7.4	0.095		< 1	
2/15/2012					7.0	0.067		< 1	
2/22/2012					7.0	0.065		< 1	
2/29/2012					6.9	0.065		1	
3/7/2012	0.013	0.0028	0.14	0.204	7.2	0.073	910	< 1	0.0035
3/15/2012					9.1	0.077		1	
3/20/2012					8.1	0.054		< 1	
3/28/2012					7.3	0.062		1	
4/4/2012	0.013	0.003	0.3	0.169	7.3	0.068	770	< 1	0.0042
4/11/2012					7.4	0.067		1	
4/17/2012					7.3	0.063		1	
4/25/2012					7.4	0.070		2	
5/2/2012	0.013	0.004	0.19	0.193	7.3	0.068	750	< 1	0.0041
5/9/2012					7.4	0.067		1	
5/16/2012					7.3	0.069		1	
5/23/2012					7.3	0.063		< 1	
5/30/2012					7.4	0.064		< 1	
6/6/2012	0.018	0.0031	0.19	0.203	7.3	0.054	910	1	0.0031
6/13/2012					7.3	0.067		1	
6/20/2012					8.0	0.081		1	
6/27/2012					7.4	0.062		1	
7/4/2012	0.015	0.0025	0.26	0.254	7.2	0.052	990	2	0.0028
7/11/2012					7.2	0.043		1	
7/18/2012					7.1	0.045		1	
7/25/2012					7.2	0.043		1	
8/1/2012	0.015	0.0027	0.24	0.277	7.0	0.040	1000	1	0.0020
8/8/2012					7.0	0.043		< 1	
8/15/2012					7.0	0.034		1	
8/22/2012					7.1	0.046		< 1	
8/29/2012					7.9	0.051		1	
9/5/2012	0.016	0.0015	0.12	0.22	7.5	0.049	1000	1	0.0017
9/12/2012					7.1	0.042		1	
9/19/2012					7.1	0.062		2	
9/26/2012					7.1	0.068		1	
10/3/2012	0.015	0.0023	0.25	0.24	7.0	0.048	1000	1	0.0016
10/10/2012					7.1	0.053		< 1	
10/17/2012					7.0	0.053		2	
10/24/2012					7.0	0.058		1	
10/31/2012					7.0	0.053		2	
11/7/2012	0.016	0.0042	0.21	0.298	7.0	0.042	1000	1	0.0018
11/14/2012					7.0	0.058		1	
11/21/2012					7.1	0.063		1	
11/28/2012					7.0	0.058		2	
12/5/2012	0.014	0.0046	0.29	0.313	7.1	0.053	1100	1	0.0022

Appendix Table C.7.7: Water quality at station N-19 from 2010 to 2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Mn mg/L	pH	Ra Bq/L	Sulphate mg/L	TSS mg/L	U mg/L
12/12/2012					7.0	0.058		1	
12/19/2012					7.0	0.064		< 1	
12/27/2012					7.2	0.065		< 1	
1/2/2013	0.014	0.0046	0.11	0.301	6.9	0.054	1000	< 1	0.0021
1/9/2013					7.0	0.044		1	
1/16/2013					7.0	0.060		< 1	
1/21/2013					7.1	0.060		< 1	
1/28/2013					7.2	0.054		1	
2/6/2013	0.015	0.0057	0.2	0.365	7.0	0.056	1100	< 1	0.0025
2/13/2013					7.7	0.058		1	
2/20/2013					7.1	0.055		1	
2/27/2013					7.1	0.059		1	
3/6/2013	0.015	0.0045	0.1	0.375	7.1	0.049	980	< 1	0.0021
3/13/2013					7.4	0.075		2	
3/20/2013					7.4	0.226		4	
3/27/2013					7.3	0.140		4	
4/3/2013	0.011	0.0025	0.72	0.185	8.4	0.115	620	1	0.0093
4/10/2013					7.2	0.105		3	
4/17/2013					7.3	0.072		2	
4/24/2013					7.4	0.068		2	
5/1/2013	0.007	0.0012	0.44	0.041	8.2	0.048	180	1	0.0087
5/8/2013					7.0	0.079		1	
5/15/2013					7.0	0.087		1	
5/22/2013					7.0	0.082		2	
5/29/2013					7.1	0.068		1	
6/5/2013	0.014	0.0031	0.2	0.245	7.2	0.082	85	1	0.0035
6/12/2013					7.2	0.060		1	
6/19/2013					7.1	0.087		1	
6/26/2013					7.2	0.070		1	
7/3/2013	0.014	0.0025	0.33	0.23	7.2	0.095	760	2	0.0027
7/10/2013					7.2	0.071		1	
7/17/2013					7.1	0.074		1	
7/24/2013					7.0	0.080		1	
7/31/2013					6.9	0.075		1	
8/7/2013	0.013	0.0023	0.37	0.173	7.0	0.086	760	2	0.0029
8/14/2013					7.5	0.063		< 1	
8/21/2013					7.2	0.058		< 1	
8/28/2013					7.3	0.066		1	
9/4/2013	0.014	0.0019	0.34	0.163	7.2	0.066	810	< 1	0.0025
9/11/2013					7.3	0.062		1	
9/18/2013					7.1	0.073		1	
9/25/2013					7.2	0.076		1	
10/2/2013	0.014	0.0018	0.26	0.153	7.0	0.060	775	2	0.0024
10/9/2013					7.0	0.073		2	
10/16/2013					7.2	0.070		3	
10/23/2013					7.0	0.061		2	
10/30/2013					7.0	0.059		2	
11/6/2013					7.3	0.059		1	
11/13/2013	0.012	0.002	0.34	0.135	7.6	0.062	730	2	0.0070
11/20/2013					7.6	0.085		1	
11/27/2013					7.1	0.067		1	

Appendix Table C.7.7: Water quality at station N-19 from 2010 to 2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Mn mg/L	pH	Ra Bq/L	Sulphate mg/L	TSS mg/L		U mg/L
12/4/2013	0.014	0.0022	0.19	0.161	7.0	0.067	750	<	1	0.0067
12/11/2013					7.1	0.086			1	
12/18/2013					7.6	0.079			1	
12/23/2013					7.3	0.058			1	
1/2/2014					7.3	0.076		<	2	
1/8/2014	0.013	0.0024	0.14	0.166	7.2	0.071	780		1	0.0053
1/15/2014					7.1	0.075			1	
1/22/2014					7.2	0.072			1	
1/29/2014					7.2	0.071		<	1	
2/5/2014	0.013	0.0036	0.1	0.198	7.2	0.073	800		1	0.0055
2/12/2014					7.1	0.072			1	
2/19/2014					7.0	0.076			1	
2/26/2014					7.2	0.070		<	1	
3/5/2014	0.014	0.0031	0.08	0.204	7.2	0.066	840	<	1	0.0056
3/12/2014					7.1	0.075		<	1	
3/17/2014					7.2	0.075		<	1	
3/24/2014					6.9	0.083		<	1	
4/2/2014	0.014	0.003	0.07	0.202	7.1	0.070	860		1	0.0051
4/9/2014					7.2	0.069			1	
4/16/2014					7.1	0.130			2	
4/23/2014					7.1	0.081			2	
4/30/2014					7.3	0.091			4	
5/7/2014	0.011	0.003	0.31	0.161	7.3	0.082	520		2	0.0047
5/14/2014					7.2	0.087			1	
5/21/2014					7.3	0.074			1	
5/28/2014					7.2	0.092		<	1	
6/4/2014	0.011	0.0017	0.15	0.142	7.3	0.071	600		1	0.0041
6/11/2014					7.4	0.074			1	
6/18/2014					7.3	0.074			1	
6/25/2014					7.6	0.074			1	
7/2/2014	0.013	0.0019	0.31	0.136	7.5	0.075	690	<	1	0.0040
7/9/2014					7.2	0.061			1	
7/16/2014					7.4	0.065			1	
7/23/2014					7.3	0.071			1	
7/30/2014					7.3	0.064		<	1	
8/6/2014	0.013	0.0023	0.39	0.177	7.3	0.073	710		1	0.0037
8/13/2014					7.3	0.059			1	
8/21/2014					7.1	0.056			1	
8/27/2014					7.2	0.058			2	
9/3/2014	0.011	0.0024	0.36	0.147	7.4	0.061	720		2	0.0036
9/10/2014					7.3	0.052		<	1	
9/17/2014					7.3	0.068			1	
9/24/2014					7.3	0.050		<	1	
10/1/2014	0.011	0.0027	0.29	0.155	7.1	0.064	800		1	0.0036
10/8/2014					7.2	0.066			1	
10/15/2014					7.2	0.072			2	
10/22/2014					7.3	0.084			1	
10/29/2014					7.3	0.064			2	
11/5/2014	0.01	0.0021	0.36	0.166	7.3	0.071	740		1	0.0055
11/12/2014					7.2	0.070			1	
11/19/2014					7.3	0.072		<	1	

Appendix Table C.7.7: Water quality at station N-19 from 2010 to 2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Mn mg/L	pH	Ra Bq/L	Sulphate mg/L		TSS mg/L	U mg/L
11/26/2014					8.0	0.079			1	
12/3/2014	0.011	0.0019	0.39	0.129	7.5	0.069	614	<	1	0.0098
12/10/2014					7.2	0.076			1	
12/17/2014					7.3	0.073			1	
12/22/2014					7.7	0.075		<	1	
12/29/2014					8.0	0.068			1	
count	60	60	60	60	261	261	60		261	60
min	0.007	0.0010	0.07	0.041	6.9	0.023	85	<	1.0	0.0016
max	0.018	0.0057	0.72	0.375	9.1	0.226	1100		4.0	0.0098
mean	0.013	0.0024	0.25	0.174	7.3	0.064	814		1.2	0.0039
median	0.013	0.0023	0.25	0.161	7.2	0.063	850		1.0	0.0035
10th Percentile	0.011	0.0015	0.11	0.119	7.0	0.047	619		1.0	0.0022
95th Percentile	0.016	0.0045	0.44	0.302	7.9	0.087	1000		2.0	0.0078

Appendix Table C.7.8: Water quality at station N-20 from 2010 to 2014.

Date m/d/yr	Acidity mg/L	Ba mg/L	Co mg/L	Fe mg/L	Mn mg/L	pH	Sulphate mg/L	Ra Bq/L	TSS mg/L	U mg/L
2/3/2010	< 1	0.008	0.0005	0.61	0.249	6.1	4.2	< 0.005		< 0.0005
5/3/2010	< 1	0.008	0.0006	0.35	0.376	6.2	4.0	< 0.005		< 0.0005
11/1/2010	< 1	0.008	0.0005	0.33	0.083	6.6	3.4	< 0.005		< 0.0005
2/2/2011	< 1	0.008	0.0006	0.51	0.244	6.3	4.4	< 0.005	< 1	< 0.0005
5/4/2011	< 1	0.008	0.0006	0.21	0.076	6.5	3.5	0.005	1	< 0.0005
8/3/2011	< 1	0.009	0.0009	0.77	1.100	6.4	3.2	< 0.005	1	< 0.0005
11/2/2011	< 1	0.008	0.0007	0.34	0.225	6.2	3.8	0.006	1	< 0.0005
2/1/2012	< 1	0.009	0.0005	0.32	0.131	6.6	4.0	0.005	< 1	< 0.0005
5/2/2012	< 1	0.008	0.0008	0.39	0.303	6.6	5.1	0.008	< 1	< 0.0005
8/1/2012	< 1	0.006	0.0007	0.61	0.756	6.7	3.4	< 0.005	1	< 0.0005
11/7/2012	< 1	0.007	0.0009	0.48	0.871	6.8	3.9	< 0.005	1	< 0.0005
2/6/2013	< 1	0.010	0.0006	0.47	0.192	6.6	5.7	0.007	1	< 0.0005
5/1/2013	1	0.009	< 0.0005	0.15	0.043	6.5	2.9	< 0.005	1	< 0.0005
8/14/2013	< 1	0.009	0.0008	0.55	0.270	6.7	3.1	< 0.005	1	< 0.0005
11/13/2013	< 1	0.008	< 0.0005	0.31	0.086	6.9	3.5	0.007	< 1	< 0.0005
2/5/2014	< 1	0.007	0.0007	0.42	0.232	6.4	3.8	< 0.005	< 1	< 0.0005
5/6/2014	< 1	0.008	< 0.0005	0.23	0.069	6.5	3.6	< 0.005	< 1	< 0.0005
8/6/2014	< 1	0.007	0.0007	0.57	0.768	6.4	3.2	0.010	1	< 0.0005
11/5/2014	< 2	0.009	0.0006	0.45	0.137	6.3	3.4	< 0.005	< 1	< 0.0005
count	19	19	19	19	19	19	19	19	16	19
min	< 1	0.006	< 0.0005	0.15	0.043	6.1	2.9	< 0.005	< 1	0.0005
max	2	0.010	0.0009	0.77	1.100	6.9	5.7	0.010	1	0.0005
mean	1	0.008	0.0006	0.42	0.327	6.5	3.8	0.006	1	0.0005
median	1	0.008	0.0006	0.42	0.232	6.5	3.6	0.005	1	0.0005
10th Percentile	1	0.007	0.0005	0.23	0.075	6.2	3.2	0.005	1	0.0005
95th Percentile	1	0.009	0.0009	0.63	0.894	6.8	5.2	0.008	1	0.0005

Appendix Table C.7.9: Water quality at station N-22 from 2010 to 2014.

Date m/d/yr	Acidity mg/L	Ba mg/L	Co mg/L	Fe mg/L	Mn mg/L	pH	Ra Bq/L	Sulphate mg/L	U mg/L
5/5/2010	438	0.014	0.180	138.0	0.440	2.8	0.23	910	0.0329
11/3/2010	518	0.020	0.196	200.0	0.502	3.0	0.17	1100	0.0350
5/28/2011						2.9			
6/8/2011	435	0.014	0.167	147.0	0.415	3.1	0.386	840	0.0408
11/15/2011	683	0.020	0.237	237.0	0.506	3.1	0.556	1300	0.0417
5/2/2012	425	0.014	0.174	158.0	0.404	3.2	0.298	900	0.0517
11/7/2012	750	0.020	0.271	312.0	0.723	3.3	0.46	1500	0.0524
5/1/2013	149	0.014	0.085	36.6	0.250	3.0	0.133	410	0.0362
11/13/2013	278	0.011	0.111	68.6	0.364	3.0	0.161	560	0.0394
5/7/2014	19	0.008	0.020	8.2	0.234	5.4	0.02	300	0.0020
11/5/2014	260	0.010	0.126	76.4	0.331	3.3	0.241	720	0.0314
count	10	10	10	10	10	11	10	10	10
min	19	0.008	0.020	8.2	0.234	2.8	0.020	300	0.0020
max	750	0.020	0.271	312.0	0.723	5.4	0.556	1500	0.0524
mean	396	0.015	0.157	138.2	0.417	3.3	0.266	854	0.0364
median	430	0.014	0.171	142.5	0.410	3.1	0.236	870	0.0378
10th Percentile	136	0.010	0.078	33.8	0.248	2.9	0.122	399	0.0285
95th Percentile	720	0.020	0.256	278.3	0.625	4.4	0.513	1410	0.0521

Appendix Table C.7.10: Water quality at station NWPH from 2010 to 2014.

Date m/d/yr	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
5/5/2010	< 1	0.034	0.0025	5.81	0.26	7.1	0.360	290	0.0010
11/3/2010	< 1	0.035	0.0036	8.82	0.306	6.1	0.360	300	0.0013
6/8/2011	< 1	0.035	0.026	2.72	0.103	6.6	0.244	160	0.0110
11/15/2011	< 1	0.028	0.0023	8.82	0.265	6.4	0.449	250	0.0010
5/2/2012	< 1	0.026	0.0025	4.29	0.139	6.6	0.236	830	0.0010
11/7/2012	< 1	0.032	0.0028	11.7	0.367	6.7	0.443	300	0.0012
5/1/2013	< 1	0.019	0.0028	1.32	0.074	5.9	0.306	73	0.0017
11/13/2013	< 1	0.031	0.0031	3.31	0.156	6.8	0.535	130	0.0016
5/7/2014	< 1	0.024	0.0006	0.87	0.049	6.1	0.102	92	< 0.0005
11/5/2014	< 1	0.025	0.0012	4.32	0.157	6.8	0.305	160	0.0006
count	10	10	10	10	10	50	10	10	10
min	1	0.019	0.0006	0.9	0.049	5.9	0.102	73	0.0005
max	1	0.035	0.0260	11.7	0.367	7.1	0.535	830	0.0110
mean	1	0.029	0.0047	5.2	0.188	6.5	0.334	259	0.0021
median	1	0.030	0.0027	4.3	0.157	6.5	0.333	205	0.0011
10th Percentile	1	0.024	0.0011	1.3	0.072	6.1	0.223	90	0.0006
95th Percentile	1	0.035	0.0159	10.4	0.340	6.8	0.496	591	0.0068

[a] pH measures shown only for dates when other substances were measured but summary statistics reflect all measured values.

Appendix Table C.7.11: Water quality at station CP West from 2010 to 2014 .

Date	Acidity mg/L	Ba mg/L	Co mg/L	Fe mg/L	Mn mg/L	pH	Ra Bq/L	Sulphate mg/L	U mg/L
1/18/2010						6.6			
2/3/2010						7.2			
3/2/2010						7.1			
4/6/2010						6.8			
5/3/2010	< 1	0.007	0.0005	0.16	0.003	10.3	0.027	730	< 0.0005
6/7/2010						7			
7/5/2010						9.6			
8/4/2010						10.1			
9/7/2010						7			
10/6/2010						6.4			
11/2/2010	13	0.01	0.0175	6.19	0.268	5.8	0.029	820	0.0007
12/7/2010						11.6			
1/5/2011						11.8			
2/2/2011						11.5			
3/28/2011						11.3			
4/25/2011						5.9			
5/4/2011	1	0.011	0.0082	0.99	0.105	6.1	0.014	370	0.0006
6/1/2011						11.1			
7/6/2011						7.3			
8/3/2011						7			
9/7/2011						11.3			
10/5/2011						8.6			
11/2/2011	< 1	0.007	0.0063	1.3	0.118	6.8	0.019	810	0.0008
12/7/2011						9.1			
1/4/2012						8.7			
2/15/2012						8.7			
3/7/2012						8.3			
4/4/2012						6.8			
5/2/2012	< 1	0.008	0.0025	1.26	0.036	7.8	0.016	700	< 0.0005
6/6/2012						6.7			
7/4/2012						8.9			
8/1/2012						7.2			
9/5/2012						5.9			
10/3/2012						11			
11/7/2012	< 1	0.008	0.0078	2.49	0.124	6.7	0.013	960	0.0008
12/5/2012						11.1			
1/2/2013						11.1			
2/6/2013						7.6			
3/6/2013						10.2			
4/3/2013						7.7			
5/1/2013	< 1	< 0.005	0.0016	0.32	0.017	6.2	< 0.005	22	< 0.0005
6/5/2013						9.3			
7/3/2013						11.1			
8/7/2013						6.7			
9/4/2013						6.7			
10/2/2013						7			
11/13/2013	< 1	0.007	0.001	0.31	0.01	10.2	0.006	660	< 0.0005
12/4/2013						9.4			
1/8/2014						9.1			
2/5/2014						8.6			
3/5/2014						7.1			

Appendix Table C.7.11: Water quality at station CP West from 2010 to 2014 .

Date	Acidity mg/L	Ba mg/L	Co mg/L	Fe mg/L	Mn mg/L	pH	Ra Bq/L	Sulphate mg/L	U mg/L
4/2/2014						6.7			
5/7/2014	< 1	0.008	0.012	2.82	0.172	6.1	0.008	250	< 0.0005
6/4/2014						10.6			
7/2/2014						6.9			
8/6/2014						6.7			
9/3/2014						9.2			
10/1/2014						7.9			
11/5/2014	< 1	0.009	0.0115	1.9	0.216	9.1	0.013	660	< 0.0005
12/3/2014						8.2			
count	10	10	10	10	10	60	10	10	10
min	< 1	< 0.005	0.0005	0.16	0.003	5.8	< 0.005	22	< 0.0005
max	13	0.011	0.0175	6.19	0.268	11.8	0.029	960	0.0008
mean	2	0.008	0.0069	1.77	0.107	8.3	0.015	598.2	0.0006
median	< 1	0.0080	0.007	1.28	0.112	7.9	0.014	680	0.0005
10th Percentile	< 1	0.0068	0.001	0.30	0.009	6.4	0.006	227	0.0005
95th Percentile	8	0.0106	0.015	4.67	0.245	11.3	0.028	897	0.0008

Appendix Table C.7.12: Water quality at porewater stations UW7-2, 4 and 6 from 2010 to 2014.

Station	Date m/d/y		Acidity mg/L	Fe mg/L	pH	Ra Bq/L	Sulphate mg/L
UW7-2	7/22/2010	<	1	206	6.8		3600
	8/17/2011	<	1	191	6.8		3500
	7/26/2012	<	1	186	6.8		3700
	7/8/2013	<	1	185	6.9		3100
	7/15/2014	<	1	141	6.7	3.98	3900
	count		5	5	5	1	5
	min		1	141	6.7	3.98	3100
	max	<	1	206	6.9	3.98	3900
	mean	<	1	182	6.8	3.98	3560
	median		1	186	6.8	3.98	3600
	10th Percentile	<	1	159	6.7	3.98	3260
	95th Percentile		1	203	6.9	3.98	3860
UW7-4	7/22/2010		650	428	5.4		2300
	8/16/2011		603	399	5.8		2100
	7/26/2012		470	343	5.8		2400
	7/8/2013		286	174	5.9		1600
	7/15/2014		152	84.8	5.9	2.90	1600
	count		5	5	5	1	5
	min		152	85	5.4	2.90	1600
	max		650	428	5.9	2.90	2400
	mean		432.2	286	5.8	2.90	2000
	median		470	343	5.8	2.90	2100
	10th Percentile		205.6	120	5.6	2.90	1600
	95th Percentile		640.6	422	5.9	2.90	2380
UW7-6	7/22/2010	<	1	75.9	6.7		1900
	8/17/2011	<	1	55.6	6.9		1900
	7/26/2012	<	1	60.5	6.9		1800
	7/9/2013	<	1	87.4	6.8		1900
	7/15/2014	<	1	65.0	6.8	0.52	1800
	count		5	5	5	1	5
	min	<	1	56	6.7	0.52	1800
	max	<	1	87	6.9	0.52	1900
	mean	<	1	69	6.8	0.52	1860
	median		1	65	6.8	0.52	1900
	10th Percentile	<	1	58	6.7	0.52	1800
	95th Percentile		1	85	6.9	0.52	1900

Appendix Table C.7.13: Water quality at porewater stations UW9-1, 2 and 3 from 2010 to 2014.

Station	Date m/d/y	Acidity mg/L	Fe mg/L	pH	Ra Bq/L	Sulphate mg/L
UW9-1	7/22/2010	2320	973	4.2		3600
	8/17/2011	1930	742	4.3		3200
	7/25/2012	1380	749	4.2		3700
	7/8/2013	1710	710	4.2		3000
	7/15/2014	1790	672	4	4.58	3600
	count	5	5	5	1	5
	min	1380	672	4.0	4.58	3000
	max	2320	973	4.3	4.58	3700
	mean	1826	769	4.2	4.58	3420
	median	1790	742	4.2	4.58	3600
	10th Percentile	1512	687	4.1	4.58	3080
	95th Percentile	2242	928	4.3	4.58	3680
UW9-2	7/22/2010	1750	604	4		3100
	8/17/2011	1520	553	3.7		2900
	7/25/2012	1710	584	4.1		3000
	7/8/2013	1710	578	4		3100
	7/15/2014	1670	565	3.5	1.61	3000
	count	5	5	5	1	5
	min	1520	553	3.5	1.61	2900
	max	1750	604	4.1	1.61	3100
	mean	1672	577	3.9	1.61	3020
	median	1710	578	4.0	1.61	3000
	10th Percentile	1580	558	3.6	1.61	2940
	95th Percentile	1742	600	4.1	1.61	3100
UW9-3	7/22/2010	2190	786	2.6		3100
	8/17/2011	1980	698	2.1		3400
	7/25/2012	2430	797	2.1		3600
	7/8/2013	1510	494	2.4		2900
	7/15/2014	1280	392	2.4	0.56	2600
	count	5	5	5	1	5
	min	1280	392	2.1	0.56	2600
	max	2430	797	2.6	0.56	3600
	mean	1878	633	2.3	0.56	3120
	median	1980	698	2.4	0.56	3100
	10th Percentile	1372	433	2.1	0.56	2720
	95th Percentile	2382	795	2.6	0.56	3560

Appendix Table C.7.14: Water quality at groundwater stations M-12-1, 3, 6 and 9 from 2010 to 2014

Station	Date m/d/y		Acidity mg/L	Fe mg/L	pH	Ra Bq/L	Sulphate mg/L
M-12-1	7/26/2010		3820	2520	6.0		6500
	8/19/2011		3590	2220	6.1		6800
	8/13/2012		3580	2380	6.3		6400
	7/15/2013		3590	2310	6.2		5900
	7/31/2014		3890	2480	6.3	0.05	6300
	8/19/2014		3860	2120	6.2	0.04	6200
	count		6	6	6	2	6
	min		3580	2120	6.0	0.04	5900
	max		3890	2520	6.3	0.05	6800
	mean		3722	2338	6.2	0.04	6350
	median		3705	2345	6.2	0.04	6350
	10th Percentile		3585	2170	6.1	0.04	6050
	95th Percentile		3883	2510	6.3	0.04	6725
M-12-3	7/26/2010		3080	2110	5.8		4400
	8/19/2011		2490	1730	6.1		4200
	8/13/2012		2720	1840	6.1		4300
	7/15/2013		201	155	6.3		460
	8/19/2013		2	44.2	6.4		60
	7/31/2014		444	346	6.2	0.06	960
	count		6	6	6	1	6
	min		2	44	5.8	0.06	60
	max		3080	2110	6.4	0.06	4400
	mean		1490	1038	6.2	0.06	2397
	median		1467	1038	6.2	0.06	2580
	10th Percentile		101.5	100	6.0	0.06	260
	95th Percentile		2990	2043	6.4	0.06	4375
M-12-6	7/26/2010		63	54.7	6.0		310
	8/19/2011		33	50.9	6.3		250
	8/13/2012		69	73.5	6.3		320
	7/15/2013	<	1	16.1	6.8		48
	8/19/2013	<	1	17.5	6.4		48
	7/31/2014	<	1	22.3	6.3	0.01	58
	count		6	6	6	1	6
	min	<	1	16	6.0	0.01	48
	max	<	69	74	6.8	0.01	320
	mean	<	28	39	6.4	0.01	172
	median	<	17	37	6.3	0.01	154
	10th Percentile	<	1	17	6.2	0.01	48
	95th Percentile		67.5	69	6.7	0.01	318
M-12-9	7/26/2010		14	9.61	5.1		83
	8/19/2011		2	4.4	5.4		51
	8/13/2012	<	1	5.84	5.9		29
	7/15/2013	<	1	10.8	6.2		64
	7/31/2014	<	1	16.3	6.3	0.02	30
	count		5	5	5	1	5
	min	<	1	4	5.1	0.02	29
	max	<	14	16	6.3	0.02	83
	mean	<	3.8	9	5.8	0.02	51
	median	<	1	10	5.9	0.02	51
	10th Percentile	<	1	5	5.2	0.02	29
	95th Percentile		11.6	15	6.3	0.02	79

Appendix Table C.7.15: Water quality at groundwater stations M-13-1, 3, 6 and 9 from 2010 to 2014.

Station	Date m/d/y	Acidity mg/L	Fe mg/L	pH	Ra Bq/L	Sulphate mg/L
M-13-1	7/19/2010	2900	1610	5.9		4700
	8/18/2011	2490	1710	6.0		4100
	8/13/2012	1590	1080	6.3		2600
	7/24/2013	425	316	6.6		790
	8/19/2013	375	248	6.7		660
	7/30/2014	140	75.8	6.6	0.05	200
	count	6	6	6	1	6
	min	140	76	5.9	0.05	200
	max	2900	1710	6.7	0.05	4700
	mean	1320	840	6.4	0.05	2175
	median	1007.5	698	6.5	0.05	1695
	10th Percentile	257.5	162	6.0	0.05	430
	95th Percentile	2797.5	1685	6.7	0.05	4550
M-13-3	7/19/2010	608	378	6.3		1100
	8/11/2010	864	570	6.4		1700
	8/18/2011	98	90.9	6.3		230
	8/13/2012	130	112	6.5		330
	7/24/2013	< 1	26.9	6.7		15
	8/19/2013	< 1	22.7	6.6		12
	7/30/2014	< 1	29.7	6.6	0.03	19
	count	7	7	7	1	7
	min	< 1	23	6.3	0.03	12
	max	< 864	570	6.7	0.03	1700
	mean	< 243	176	6.5	0.03	487
	median	< 98	91	6.5	0.03	230
	10th Percentile	< 1	25	6.3	0.03	14
	95th Percentile	787.2	512	6.7	0.03	1520
M-13-6	7/19/2010	37	34.3	6.4		24
	8/13/2012	10	19.3	6.3		14
	count	2	2	2		2
	min	10	19	6.3		14
	max	37	34	6.4		24
	mean	24	27	6.4		19
	median	23.5	27	6.4		19
	10th Percentile	12.7	21	6.3		15
	95th Percentile	35.65	34	6.4		24
M-13-9	7/19/2010	34	16	5.2		18
	8/18/2011	< 1	3.26	5.7		10
	8/13/2012	< 1	0.92	6.3		3.6
	7/24/2013	< 1	5.31	6.4		4.1
	7/30/2014	< 1	7.58	6.3	0.01	2.9
	count	5	5	5	1	5
	min	< 1	1	5.2	0.01	3
	max	< 34	16	6.4	0.01	18
	mean	< 8	7	6.0	0.01	8
	median	< 1	5	6.3	0.01	4
	10th Percentile	< 1	2	5.4	0.01	3
	95th Percentile	27.4	14	6.4	0.01	16

Appendix Table C.7.16: Water quality at groundwater stations M-14-1, 3, 6 and 9 from 2010 to 201

Station	Date m/d/y		Acidity mg/L	Fe mg/L	pH	Ra Bq/L		Sulphate mg/L
M-14-1	7/20/2010		2660	1490	6.2			5300
	8/22/2011			1070	6.6			4200
	8/15/2012		1740	1130	6.5			1300
	7/15/2013		1120	740	6.5			2900
	7/30/2014		1950	1120	6.3	1.21		4400
	count		4	5	5	1		5
	min		1120	740	6.2	1.21		1300
	max	<	2660	1490	6.6	1.21		5300
	mean	<	1868	1110	6.4	1.21		3620
	median		1845	1120	6.5	1.21		4200
	10th Percentile	<	1306	872	6.2	1.21		1940
	95th Percentile		2553.5	1418	6.6	1.21		5120
M-14-3	8/22/2011			331	6.6			1600
	8/15/2012		312	272	6.9			4400
	7/15/2013		290	220	6.6			1300
	7/30/2014		184	156	6.7	0.56		1000
	count		4	5	5	2		5
	min		184	156	6.6	0.56		1000
	max		2553.5	1418	6.9	1.21		5120
	mean		835	479	6.7	0.89		2684
	median		301	272	6.6	0.89		1600
	10th Percentile		215.8	182	6.6	0.62		1120
	95th Percentile		2217.275	1201	6.9	1.18		4976
M-14-6	7/20/2010	<	1	17.6	6.6			20
	8/11/2010	<	1	19.4	6.6			24
	8/22/2011		4	23.3	7.0			7.2
	8/15/2012	<	1	12.5	7.1			3.6
	7/15/2013							
	8/19/2013	<	1	8.06	6.9			7.9
	7/30/2014	<	1	7.49	7.0	0.29		8.4
	count		6	6	6	1		6.0
	min	<	1	7	6.6	0.29		3.6
	max	<	4	23	7.1	0.29		24.0
	mean	<	2	15	6.9	0.29		11.9
	median	<	1	15	7.0	0.29		8.2
	10th Percentile	<	1	8	6.6	0.29		5.4
	95th Percentile		3.25	22	7.1	0.29		23.0
M-14-9	8/15/2012	<	1	4.97	6.5		<	0.1
	7/15/2013	<	1	21.85	6.4			3.9
	7/30/2014	<	1	14.7	6.3	0.06		0.8
	count		3	3	3	1		3.00
	min	<	1	5	6.3	0.06		0.10
	max	<	1	22	6.5	0.06		3.90
	mean	<	1	14	6.4	0.06		1.60
	median	<	1	15	6.4	0.06		0.80
	10th Percentile	<	1	7	6.3	0.06		0.24
	95th Percentile		1	21	6.5	0.06		3.59

Appendix Table C.7.17: Water quality at groundwater station 95N-4A and B from 2010 to 2014.

Station	Date m/d/y	Acidity mg/L	Fe mg/L	pH	Ra Bq/L	Sulphate mg/L
95N-4A	7/27/2010	2480	1560	5.9		4400
	8/19/2011	2180	1420	5.8		3900
	8/13/2012	2090	1380	6.4		4000
	7/22/2013	2210	1430	6.4		4200
	8/5/2014	2010	1320	5.8	0.195	4200
	count	5	5	5	1	5
	min	2010	1320	5.8	0.195	3900
	max	2480	1560	6.4	0.195	4400
	mean	2194	1422	6.1	0.195	4140
	median	2180	1420	5.9	0.195	4200
	10th Percentile	2042	1344	5.8	0.195	3940
	95th Percentile	2426	1534	6.4	0.195	4360
95N-4B	7/27/2010	2080	1150	5.2		3600
	8/19/2011	1840	1180	5.1		3400
	8/13/2012	1680	1050	4.9		3200
	7/22/2013	1830	955	4.9		3100
	8/5/2014	1930	1160	5	0.128	3400
	count	5	5	5	1	5
	min	1680	955	4.9	0.128	3100
	max	2080	1180	5.2	0.128	3600
	mean	1872	1099	5.0	0.128	3340
	median	1840	1150	5.0	0.128	3400
	10th Percentile	1740	993	4.9	0.128	3140
	95th Percentile	2050	1176	5.2	0.128	3560

Appendix Table C.7.18: Water quality at groundwater station 95N-7A and B from 2010 to 2014.

Station	Date m/d/y	Acidity mg/L		Fe mg/L	pH	Ra Bq/L	Sulphate mg/L
95N-7A	7/21/2010	13		0.19	4.1		39
	8/19/2011	10		0.04	4.8		29
	8/9/2012	6		0.03	4.7		38
	7/17/2013	6	<	0.02	4.9		29
	7/29/2014	8		0.08	4.9	0.062	36
	count	5		5.00	5	1	5
	min	6	<	0.02	4.1	0.062	29
	max	13		0.19	4.9	0.062	39
	mean	9		0.07	4.7	0.062	34
	median	8		0.04	4.8	0.062	36
	10th Percentile	6		0.02	4.3	0.062	29
	95th Percentile	12		0.17	4.9	0.062	39
95N-7B	7/21/2010	53		12.2	4.5		220
	8/19/2011	59		15.8	4.7		200
	8/9/2012	74		15.9	4.6		270
	7/17/2013	80		24	4.5		230
	7/29/2014	63		18.8	4.8	0.197	180
	count	5		5.0	5	1	5
	min	53		12.2	4.5	0.197	180
	max	80		24.0	4.8	0.197	270
	mean	66		17.3	4.6	0.197	220
	median	63		15.9	4.6	0.197	220
	10th Percentile	55		13.6	4.5	0.197	188
	95th Percentile	79		23.0	4.8	0.197	262

Appendix Table C.7.19 Water quality at station 95N-11 from 2010 to 2014.

Date m/d/y	Acidity mg/L	Fe mg/L	pH	Ra Bq/L	Sulphate mg/L
7/26/2010	20	0.37	5.0		320
8/18/2011	13	0.33	5.1		280
8/9/2012	23	0.76	4.9		460
7/17/2013	18	0.10	5.1		240
8/5/2014	13	0.14	5.1	0.031	410
count	5	5	5	1	5
min	13	0.10	4.9	0.031	240
max	23	0.76	5.1	0.031	460
mean	17	0.34	5.0	0.031	342
median	18	0.33	5.1	0.031	320
10th Percentile	13	0.12	4.9	0.031	256
95th Percentile	22	0.68	5.1	0.031	450

Appendix Table C.7.20: Water quality at groundwater stations 95N-12A and B from 2010 to 2014.

Station	Date m/d/y		Acidity mg/L	Fe mg/L	pH	Ra Bq/L	Sulphate mg/L
95N-12A	7/21/2010	<	1	8.05	6.4		18
	8/15/2011	<	1	7.19	6.6		17
	8/8/2012	<	1	6.39	6.8		14
	7/22/2013	<	1	6.03	6.8		18
	7/16/2014	<	1	6.03	6.6	0.03	19
	count		5	5	5	1	5
	min		1	6.03	6.4	0.03	14
	max	<	1	8.05	6.8	0.03	19
	mean	<	1	6.74	6.6	0.03	17
	median		1	6.39	6.6	0.03	18
	10th Percentile	<	1	6.03	6.5	0.03	15
	95th Percentile		1	7.88	6.8	0.03	19
95N-12B	7/21/2010	<	1	6.16	6.5		15
	8/15/2011	<	1	7.63	6.7		17
	8/8/2012	<	1	6.61	6.8		15
	7/22/2013	<	1	5.22	6.9		17
	7/16/2014	<	1	4.02	6.8	0.04	17
	count		5	5	5	1	5
	min		1	4.02	6.5	0.04	15
	max	<	1	7.63	6.9	0.04	17
	mean	<	1	5.93	6.7	0.04	16
	median		1	6.16	6.8	0.04	17
	10th Percentile	<	1	4.50	6.6	0.04	15
	95th Percentile		1	7.43	6.9	0.04	17

Appendix Table C.7.21: Water quality at groundwater station 95N-13A, C, and E from 2010 to 2014

Station	Date m/d/y	Acidity mg/L	Fe mg/L	pH	Ra Bq/L	Sulphate mg/L
95N-13A	2010.07.22	1450	851	6.2		3400
	2011.08.04	1290	852	6.6		3200
	2012.07.26	1380	817	6.4		3300
	2013.07.11	1130	751	6.5		3200
	2014.07.16	1300	780	6.1	0.036	3200
	count	5	5	5	1	5
	min	1130	751	6.1	0.036	3200
	max	1450	852	6.6	0.036	3400
	mean	1310	810	6.4	0.036	3260
	median	1300	817	6.4	0.036	3200
	10th Percentile	1194	763	6.1	0.036	3200
	95th Percentile	1436	852	6.6	0.036	3380
95N-13C	2010.07.22	1460	859	6.2		3300
	2011.08.15	1410	812	6.1		3300
	2012.07.26	1320	857	6.5		3700
	2013.07.11	1220	732	6.5		3300
	2014.07.16	1460	854	6	0.036	3500
	count	5	5	5	1	5
	min	1220	732	6.0	0.036	3300
	max	1460	859	6.5	0.036	3700
	mean	1374	823	6.3	0.036	3420
	median	1410	854	6.2	0.036	3300
	10th Percentile	1260	764	6.0	0.036	3300
	95th Percentile	1460	859	6.5	0.036	3660
95N-13E	2010.07.22	2030	1080	5.6		3500
	2011.08.04	1820	1060	6		3400
	2012.07.26	1770	969	5.5		3600
	2013.07.11	1340	786	5.9		2600
	2014.07.16	1780	866	5.5	0.071	3400
	count	5	5	5	1	5
	min	1340	786	5.5	0.071	2600
	max	2030	1080	6.0	0.071	3600
	mean	1748	952	5.7	0.071	3300
	median	1780	969	5.6	0.071	3400
	10th Percentile	1512	818	5.5	0.071	2920
	95th Percentile	1988	1076	6.0	0.071	3580

Appendix Table C.7.22: Water quality at groundwater station 95N-14A, B, and C from 2010 to 2014.

Station	Date m/d/y	Acidity mg/L	Fe mg/L	pH	Ra Bq/L	Sulphate mg/L
95N-14A	7/20/2010	< 1	6.5	6.4		5.2
	8/16/2011	< 1	9.55	7.2		3.7
	7/24/2012	< 1	7.66	7.1		4.5
	7/11/2013	< 1	6.89	7.4		6.9
	7/28/2014	< 1	4.39	7.3	0.007	7.8
	count	5	5	5	1	5
	min	< 1	4.39	6.4	0.007	3.7
	max	1	9.55	7.4	0.007	7.8
	mean	1	7.00	7.1	0.007	5.6
	median	1	6.89	7.2	0.007	5.2
	10th Percentile	1	5.23	6.7	0.007	4.0
	95th Percentile	1	9.17	7.4	0.007	7.6
95N-14B	7/20/2010	< 1	5.14	6.6		3.5
	8/16/2011	< 1	5.21	7.3		1.7
	7/24/2012	< 1	5.93	7.2		0.5
	7/11/2013	< 1	5.95	7.6		1.1
	7/28/2014	< 1	4.09	7.5	0.006	4.9
	count	5	5	5	1	5
	min	< 1	4.09	6.6	0.006	0.5
	max	1	5.95	7.6	0.006	4.9
	mean	1	5.26	7.2	0.006	2.3
	median	1	5.21	7.3	0.006	1.7
	10th Percentile	1	4.51	6.8	0.006	0.7
	95th Percentile	1	5.95	7.6	0.006	4.6
95N-14C	7/20/2010	< 1	5.27	6.7		0.1
	8/16/2011	< 1	4.61	7.3		< 0.1
	7/24/2012	< 1	4.42	7.2		0.3
	7/11/2013	< 1	4.28	7.6		0.3
	7/28/2014	< 1	2.09	7.6	< 0.005	4.8
	count	5	5	5	1	5
	min	< 1	2.09	6.7	0.005	< 0.1
	max	1	5.27	7.6	0.005	4.8
	mean	1	4.13	7.3	0.005	1.1
	median	1	4.42	7.3	0.005	0.3
	10th Percentile	1	2.97	6.9	0.005	0.1
	95th Percentile	1	5.14	7.6	0.005	3.9

Appendix Table C.7.23: Water quality at groundwater station 95N-16A, C, and E from 2010 to 2014

Station	Date m/d/y	Acidity mg/L	Fe mg/L	pH	Ra Bq/L	Sulphate mg/L
95N-16A	7/27/2010	489	299	6.4		2400
	8/18/2011	314	282	6.7		2200
	8/8/2012	219	291	6.5		2200
	7/9/2013	206	235	6.7		2200
	7/29/2014	217	230	6.6	0.039	2300
	count	5	5	5	1	5
	min	206	230	6.4	0.039	2200
	max	489	299	6.7	0.039	2400
	mean	289	267	6.6	0.039	2260
	median	219	282	6.6	0.039	2200
	10th Percentile	210	232	6.4	0.039	2200
	95th Percentile	454	297	6.7	0.039	2380
95N-16C	7/27/2010	393	295	6.3		2500
	8/18/2011	320	315	6.7		2300
	8/8/2012	312	252	6.5		2300
	7/9/2013	302	283	6.7		2200
	7/29/2014	332	291	6.5	0.025	2400
	count	5	5	5	1	5
	min	302	252	6.3	0.025	2200
	max	393	315	6.7	0.025	2500
	mean	332	287	6.5	0.025	2340
	median	320	291	6.5	0.025	2300
	10th Percentile	306	264	6.4	0.025	2240
	95th Percentile	381	311	6.7	0.025	2480
95N-16E	7/27/2010	1370	758	6		3100
	8/18/2011	1140	733	6.2		2800
	8/8/2012	1040	613	6.3		2600
	7/9/2013	1050	650	6.5		2700
	7/29/2014	1060	579	6.5	0.017	2800
	count	5	5	5	1	5
	min	1040	579	6.0	0.017	2600
	max	1370	758	6.5	0.017	3100
	mean	1132	667	6.3	0.017	2800
	median	1060	650	6.3	0.017	2800
	10th Percentile	1044	593	6.1	0.017	2640
	95th Percentile	1324	753	6.5	0.017	3040

Appendix Table C.7.24: Water quality at groundwater station 95N-17A, B, and C from 2010 to 2014.

Station	Date m/d/y	Acidity mg/L	Fe mg/L	pH	Ra Bq/L	Sulphate mg/L
95N-17A	7/19/2010	< 1	3.39	6.3		9.5
	8/18/2011	< 1	0.72	7		11
	7/24/2012	< 1	3.66	7.2		8.1
	7/9/2013	< 1	3.83	7.2		7.8
	7/31/2014	< 1	3.97	7.1	< 0.005	7.8
	count	5	5	5	1	5
	min	< 1	0.72	6.3	< 0.005	7.8
	max	< 1	3.97	7.2	0.005	11.0
	mean	< 1	3.11	7.0	0.005	8.8
	median	< 1	3.66	7.1	0.005	8.1
	10th Percentile	1	1.79	6.6	0.005	7.8
	95th Percentile	1	3.94	7.2	0.005	10.7
95N-17B	7/19/2010	< 1	6.41	6.3		0.1
	8/15/2011	< 1	7.43	6.8		< 0.1
	7/24/2012	< 1	7.16	7		0.9
	7/9/2013	< 1	5.93	7.2		6.9
	7/31/2014	< 1	6.75	7	< 0.005	1
	count	5	5	5	1	5
	min	< 1	5.93	6.3	< 0.005	0.1
	max	< 1	7.43	7.2	0.005	6.9
	mean	< 1	6.74	6.9	0.005	1.8
	median	< 1	6.75	7.0	0.005	0.9
	10th Percentile	1	6.12	6.5	0.005	0.1
	95th Percentile	1	7.38	7.2	0.005	5.7
95N-17C	7/19/2010	< 1	6.67	6.9		0.1
	8/18/2011	< 1	6.17	6.8		4.5
	7/24/2012	< 1	5.88	6.9		7.6
	7/9/2013	< 1	5.85	7.2		7.4
	7/28/2014	< 1	5.87	6.8	< 0.005	7
	count	5	5	5	1	5
	min	< 1	5.85	6.8	< 0.005	0.1
	max	< 1	6.67	7.2	0.005	7.6
	mean	< 1	6.09	6.9	0.005	5.3
	median	< 1	5.88	6.9	0.005	7.0
	10th Percentile	1	5.86	6.8	0.005	1.9
	95th Percentile	1	6.57	7.1	0.005	7.6

Appendix Table C.7.25: Summary of seasonal trends for station ECA-131 from 2003-2014.

Month	Spearman's rho	Acidity	Ba	Co	Fe	Mn	pH	Ra	Sulphate	TSS	U
January	Correlation Coefficient	-0.862					-0.407	-0.952			
	Sig. (2-tailed)	0.006					0.317	0.000			
	N	8					8	8			
February	Correlation Coefficient	-	-0.949	-0.707	-0.300	-0.100	0.638	-0.778	-0.486		-
	Sig. (2-tailed)	-	0.014	0.182	0.624	0.873	0.173	0.069	0.329		-
	N	6	5	5	5	5	6	6	6		5
April	Correlation Coefficient	-0.764					0.145	-0.595			
	Sig. (2-tailed)	0.046					0.756	0.159			
	N	7					7	7			
May	Correlation Coefficient	-0.757	-0.821	-0.671	-0.300	-0.900	0.786	-0.703	-0.821		0.000
	Sig. (2-tailed)	0.049	0.089	0.215	0.624	0.037	0.036	0.078	0.023		1.000
	N	7	5	5	5	5	7	7	7		5
July	Correlation Coefficient	-0.464					0.507	-0.657			
	Sig. (2-tailed)	0.354					0.305	0.156			
	N	6					6	6			
November	Correlation Coefficient	-0.436	0.154	-0.354	-0.200	0.200	0.663	-0.114	-0.321		-0.051
	Sig. (2-tailed)	0.280	0.805	0.559	0.747	0.747	0.073	0.788	0.482		0.935
	N	8	5	5	5	5	8	8	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).

[grey box] Significant trend where $p<0.05$.

Appendix Table C.7.26: Summary of seasonal trends for station ECA-132 from 2003-2014.

Month	Spearman's rho	Acidity	Ba	Co	Fe	Mn	pH	Ra	Sulphate	U
January	Correlation Coefficient						-0.100			
	Sig. (2-tailed)						0.873			
	N						5			
February	Correlation Coefficient						-0.500			
	Sig. (2-tailed)						0.391			
	N						5			
March	Correlation Coefficient						-0.500			
	Sig. (2-tailed)						0.391			
	N						5			
April	Correlation Coefficient						-0.060			
	Sig. (2-tailed)						0.888			
	N						8			
May	Correlation Coefficient	-					-0.218	-0.095		
	Sig. (2-tailed)	-					0.572	0.823		
	N	8					9	8		
June	Correlation Coefficient						-0.103			
	Sig. (2-tailed)						0.870			
	N						5			
July	Correlation Coefficient						-0.800			
	Sig. (2-tailed)						0.104			
	N						5			
August	Correlation Coefficient						-0.667			
	Sig. (2-tailed)						0.219			
	N						5			
September	Correlation Coefficient						-0.700			
	Sig. (2-tailed)						0.188			
	N						5			
October	Correlation Coefficient						-0.747			
	Sig. (2-tailed)						0.033			
	N						8			
November	Correlation Coefficient	-	-0.154	0.667	0.800	0.500	0.017	0.433	-0.900	-0.616
	Sig. (2-tailed)	-	0.805	0.219	0.104	0.391	0.966	0.244	0.037	0.269
	N	9	5	5	5	5	9	9	5	5
December	Correlation Coefficient						-0.100			
	Sig. (2-tailed)						0.873			
	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).

[shaded cell] Significant trend where p<0.05.

Appendix Table C.7.27: Summary of seasonal trends for station L-03 from 2003-2014.

Month	Spearman's rho	Acidity	Ba	Co	Fe	Mn	pH	Ra	Sulphate	U
January	Correlation Coefficient						-0.097	-0.429	-0.881	
	Sig. (2-tailed)						0.819	0.289	0.004	
	N						8	8	8	
April	Correlation Coefficient						-0.265	0.024	-0.479	
	Sig. (2-tailed)						0.526	0.954	0.230	
	N						8	8	8	
November	Correlation Coefficient	-0.900	-0.667	-0.600		-0.900	0.445	-0.643	-0.964	
	Sig. (2-tailed)	0.037	0.219	0.285		0.037	0.317	0.119	0.000	
	N	5	5	5		5	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).

[shaded box] Significant trend where p<0.05.

Appendix Table C.7.28: Summary of seasonal trends for station N-17 from 2003-2014.

Month	Spearman's rho	Acidity	Ba	Co	Fe	Mn	pH	Ra	Sulphate	U
January	Correlation Coefficient						0.073	-0.263		
	Sig. (2-tailed)						0.863	0.409		
	N						8	12		
February	Correlation Coefficient	-0.333	0.750	0.017	0.700	0.033	0.168	0.063	0.266	-0.517
	Sig. (2-tailed)	0.381	0.020	0.966	0.188	0.932	0.666	0.846	0.489	0.154
	N	9	9	9	5	9	9	12	9	9
March	Correlation Coefficient						0.400	-0.449		
	Sig. (2-tailed)						0.505	0.143		
	N						5	12		
April	Correlation Coefficient						0.359	-0.503		
	Sig. (2-tailed)						0.382	0.095		
	N						8	12		
May	Correlation Coefficient	-0.500	-0.120	-0.700	-0.300	-0.717	-0.234	-0.105	-0.510	-0.883
	Sig. (2-tailed)	0.170	0.759	0.036	0.624	0.030	0.544	0.746	0.160	0.002
	N	9	9	9	5	9	9	12	9	9
June	Correlation Coefficient						-0.300	0.347		
	Sig. (2-tailed)						0.624	0.269		
	N						5	12		
July	Correlation Coefficient						0.356	0.000		
	Sig. (2-tailed)						0.387	1.000		
	N						8	12		
August	Correlation Coefficient	-0.033	0.239	-0.200	0.200	-0.259	0.360	-0.021	0.050	-0.083
	Sig. (2-tailed)	0.932	0.535	0.606	0.747	0.500	0.342	0.948	0.897	0.831
	N	9	9	9	5	9	9	12	9	9
September	Correlation Coefficient						-0.600	-0.077		
	Sig. (2-tailed)						0.285	0.812		
	N						5	12		
October	Correlation Coefficient						0.337	-0.566		
	Sig. (2-tailed)						0.414	0.055		
	N						8	12		
November	Correlation Coefficient	-0.667	0.111	-0.467	-0.600	-0.517	0.100	-0.130	-0.460	-0.267
	Sig. (2-tailed)	0.050	0.776	0.205	0.285	0.154	0.797	0.688	0.213	0.488
	N	9	9	9	5	9	9	12	9	9
December	Correlation Coefficient						0.975	0.203		
	Sig. (2-tailed)						0.005	0.527		
	N						5	12		

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).

Significant trend where $p<0.05$.

Appendix Table C.7.29: Summary of seasonal trends for station N-19 from 2003-2014.

Month	Spearman's rho	Ba	Co	Fe	Mn	pH	Ra	Sulphate	TSS	U
January	Correlation Coefficient	-0.102	-0.217	-0.378	-0.336	-0.113	-0.671	-0.067	-0.063	-0.615
	Sig. (2-tailed)	0.753	0.499	0.403	0.286	0.727	0.017	0.865	0.845	0.033
	N	12	12	7	12	12	12	9	12	12
February	Correlation Coefficient	0.102	-0.189	-0.631	-0.357	-0.067	-0.417	-0.350	0.288	-0.329
	Sig. (2-tailed)	0.754	0.557	0.129	0.254	0.837	0.178	0.356	0.365	0.296
	N	12	12	7	12	12	12	9	12	12
March	Correlation Coefficient	0.335	-0.231	-0.714	-0.287	0.035	-0.357	-0.617	0.102	-0.592
	Sig. (2-tailed)	0.287	0.470	0.071	0.365	0.914	0.255	0.077	0.752	0.043
	N	12	12	7	12	12	12	9	12	12
April	Correlation Coefficient	0.401	-0.523	-0.643	0.077	-0.168	-0.273	0.437	0.007	-0.420
	Sig. (2-tailed)	0.197	0.081	0.119	0.812	0.601	0.391	0.240	0.982	0.175
	N	12	12	7	12	12	12	9	12	12
May	Correlation Coefficient	-0.376	-0.317	0.286	-0.615	-0.105	-0.427	-0.824	-0.158	0.253
	Sig. (2-tailed)	0.228	0.315	0.535	0.033	0.745	0.167	0.006	0.623	0.428
	N	12	12	7	12	12	12	9	12	12
June	Correlation Coefficient	0.356	-0.014	-0.536	-0.315	-0.601	-0.413	-0.750	0.337	-0.340
	Sig. (2-tailed)	0.256	0.965	0.215	0.319	0.039	0.183	0.020	0.285	0.280
	N	12	12	7	12	12	12	9	12	12
July	Correlation Coefficient	0.424	0.281	0.929	-0.042	-0.643	-0.154	-0.706	0.804	0.105
	Sig. (2-tailed)	0.169	0.376	0.003	0.897	0.024	0.633	0.034	0.002	0.744
	N	12	12	7	12	12	12	9	12	12
August	Correlation Coefficient	0.570	0.165	0.357	0.049	-0.515	-0.245	-0.577	0.572	0.070
	Sig. (2-tailed)	0.053	0.609	0.432	0.880	0.087	0.443	0.104	0.052	0.828
	N	12	12	7	12	12	12	9	12	12
September	Correlation Coefficient	0.399	0.214	0.357	-0.116	-0.530	0.084	-0.533	0.523	-0.036
	Sig. (2-tailed)	0.198	0.504	0.432	0.721	0.076	0.795	0.139	0.081	0.912
	N	12	12	7	12	12	12	9	12	12
October	Correlation Coefficient	0.579	0.189	-0.821	-0.077	-0.336	0.098	-0.714	0.352	-0.175
	Sig. (2-tailed)	0.048	0.557	0.023	0.812	0.286	0.762	0.047	0.262	0.587
	N	12	12	7	12	12	12	8	12	12
November	Correlation Coefficient	-0.035	-0.074	-0.643	-0.161	-0.211	-0.126	-0.782	-0.079	0.322
	Sig. (2-tailed)	0.913	0.820	0.119	0.618	0.511	0.697	0.013	0.807	0.307
	N	12	12	7	12	12	12	9	12	12
December	Correlation Coefficient	0.231	-0.179	-0.179	0.000	-0.301	-0.734	-0.571	0.218	-0.077
	Sig. (2-tailed)	0.470	0.578	0.702	1.000	0.342	0.007	0.139	0.496	0.812
	N	12	12	7	12	12	12	8	12	12

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).

[grey box] Significant trend where p<0.05.

Appendix Table C.7.30: Summary of seasonal trends for station N-20 from 2003-2014.

Month	Spearman's rho	Acidity	Ba	Co	Fe	Mn	pH	Ra	Sulphate	TSS	U
January	Correlation Coefficient	-0.852					-0.532	-0.775			
	Sig. (2-tailed)	0.015					0.219	0.041			
	N	7					7	7			
February	Correlation Coefficient	-	-0.147	0.738	-0.143	-0.600	0.152	0.257	-0.338		-
	Sig. (2-tailed)	-	0.781	0.155	0.787	0.285	0.774	0.623	0.512		-
	N	6	6	5	6	5	6	6	6		5
April	Correlation Coefficient	-0.941					-0.116	-0.093			
	Sig. (2-tailed)	0.005					0.827	0.862			
	N	6					6	6			
May	Correlation Coefficient	.	-0.338	-0.632	-0.371	-0.800	0.692	0.536	-0.507		-
	Sig. (2-tailed)	.	0.512	0.252	0.468	0.104	0.085	0.215	0.305		-
	N	7	6	5	6	5	7	7	6		5
July	Correlation Coefficient	-0.833					0.530	-0.794			
	Sig. (2-tailed)	0.039					0.280	0.059			
	N	6					6	6			
August	Correlation Coefficient	-	-0.205		-0.900		0.000	0.359	-0.224	-0.707	
	Sig. (2-tailed)	-	0.741		0.037		1.000	0.553	0.718	0.182	
	N	5	5		5		5	5	5	5	
October	Correlation Coefficient	-0.698					-0.058	-0.463			
	Sig. (2-tailed)	0.123					0.913	0.355			
	N	6					6	6			
November	Correlation Coefficient	0.612	0.338	0.051	0.000	0.200	0.468	0.613	-0.395		-
	Sig. (2-tailed)	0.144	0.512	0.935	1.000	0.747	0.289	0.144	0.439		-
	N	7	6	5	6	5	7	7	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).

[grey box] Significant trend where p<0.05.

Appendix Table C.7.31: Summary of seasonal trends for station N-22 from 2003-2014.

Month	Spearman's rho	Acidity	Ba	Co	Fe	Mn	pH	Ra	Sulphate	U
May	Correlation Coefficient	-0.405					0.621	-0.371		
	Sig. (2-tailed)	0.320					0.074	0.365		
	N	8					9	8		
November	Correlation Coefficient	-0.167	-0.894	-0.500	-0.500	-0.600	0.633	-0.259	-0.500	-0.300
	Sig. (2-tailed)	0.668	0.041	0.391	0.391	0.285	0.067	0.500	0.391	0.624
	N	9	5	5	5	5	9	9	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).

[shaded box] Significant trend where $p<0.05$.

Appendix Table C.7.32: Summary of seasonal trends for station NWPH from 2007-2014.

Month	Spearman's rho	Acidity	Ba	Co	Fe	Mn	pH	Ra	Sulphate	U
January	Correlation Coefficient						0.174			
	Sig. (2-tailed)						0.742			
	N						6			
February	Correlation Coefficient						0.056			
	Sig. (2-tailed)						0.905			
	N						7			
March	Correlation Coefficient						-0.145			
	Sig. (2-tailed)						0.784			
	N						6			
April	Correlation Coefficient						0.116			
	Sig. (2-tailed)						0.827			
	N						6			
May	Correlation Coefficient	-	-0.429	0.234		0.429	-0.53	0.036	-0.286	
	Sig. (2-tailed)	-	0.337	0.613		0.337	0.177	0.939	0.535	
	N	6	7	7		7	8	7	7	
June	Correlation Coefficient						0.273			
	Sig. (2-tailed)						0.6			
	N						6			
July	Correlation Coefficient						0.359			
	Sig. (2-tailed)						0.553			
	N						5			
August	Correlation Coefficient						0.522			
	Sig. (2-tailed)						0.288			
	N						6			
September	Correlation Coefficient						0.3			
	Sig. (2-tailed)						0.624			
	N						5			
October	Correlation Coefficient						0.738			
	Sig. (2-tailed)						0.155			
	N						5			
November	Correlation Coefficient	-	-0.036	-0.108	-0.406	-0.575	-0.122	-0.286	-0.446	0.257
	Sig. (2-tailed)	-	0.933	0.799	0.425	0.136	0.774	0.493	0.268	0.623
	N	7	8	8	6	8	8	8	8	6
December	Correlation Coefficient						-0.205			
	Sig. (2-tailed)						0.741			
	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).

Significant trend where $p<0.05$.

Appendix Table C.7.33: Summary of seasonal trends for station NWPH from 2003-2014.

Month	Spearman's rho	Acidity	Ba	Co	Fe	Mn	pH	Ra	Sulphate	U
January	Correlation Coefficient						0.3			
	Sig. (2-tailed)						0.624			
	N						5			
February	Correlation Coefficient						0.1			
	Sig. (2-tailed)						0.873			
	N						5			
March	Correlation Coefficient						-0.103			
	Sig. (2-tailed)						0.87			
	N						5			
April	Correlation Coefficient						0.103			
	Sig. (2-tailed)						0.870			
	N						5			
May	Correlation Coefficient	-	-0.103	0.6	0.7	0.6	-0.564	-0.8	-0.8	-0.354
	Sig. (2-tailed)	-	0.870	0.285	0.188	0.285	0.322	0.104	0.104	0.559
	N	5	5	5	5	5	5	5	5	5
June	Correlation Coefficient						0.2			
	Sig. (2-tailed)						0.747			
	N						5			
July	Correlation Coefficient						-0.3			
	Sig. (2-tailed)						0.624			
	N						5			
August	Correlation Coefficient						-0.872			
	Sig. (2-tailed)						0.054			
	N						5			
September	Correlation Coefficient						-0.1			
	Sig. (2-tailed)						0.873			
	N						5			
October	Correlation Coefficient						0.2			
	Sig. (2-tailed)						0.747			
	N						5			
November	Correlation Coefficient	-0.707	-0.205	-0.3	-0.5	-0.3	0.8	-0.821	-0.667	-0.632
	Sig. (2-tailed)	0.182	0.741	0.624	0.391	0.624	0.104	0.089	0.219	0.252
	N	5	5	5	5	5	5	5	5	5
December	Correlation Coefficient						-0.7			
	Sig. (2-tailed)						0.188			
	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).

Significant trend where $p<0.05$.

Appendix Table C.7.34: Summary of trends for Lacnor/Nordic porewater stations, from 1993 to 2014.

Station	Spearman rho	Acidity	Iron	pH	Sulphate
UW7-2	Correlation Coefficient	.	0.044	-0.091	0.496
	Sig. (2-tailed)	.	0.855	0.702	0.051
	N	8	20	20	16
UW7-4	Correlation Coefficient	-0.929	-0.941	0.396	-0.789
	Sig. (2-tailed)	0.001	0.000	0.084	0.000
	N	8	20	20	16
UW7-6	Correlation Coefficient	.	-0.409	0.640	0.197
	Sig. (2-tailed)	.	0.082	0.003	0.480
	N	7	19	19	15
UW9-1	Correlation Coefficient	-0.548	-0.829	0.343	-0.471
	Sig. (2-tailed)	0.160	0.000	0.139	0.066
	N	8	20	20	16
UW9-2	Correlation Coefficient	-0.491	-0.644	0.266	-0.292
	Sig. (2-tailed)	0.217	0.002	0.258	0.272
	N	8	20	20	16
UW9-3	Correlation Coefficient	0.214	0.356	-0.438	0.670
	Sig. (2-tailed)	0.610	0.124	0.053	0.005
	N	8	20	20	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).

[shaded cell] Significant trend where $p<0.05$.

Appendix Table C.7.35: Summary of trends for Lacnor/Nordic groundwater stations. from 1993 to 2014.

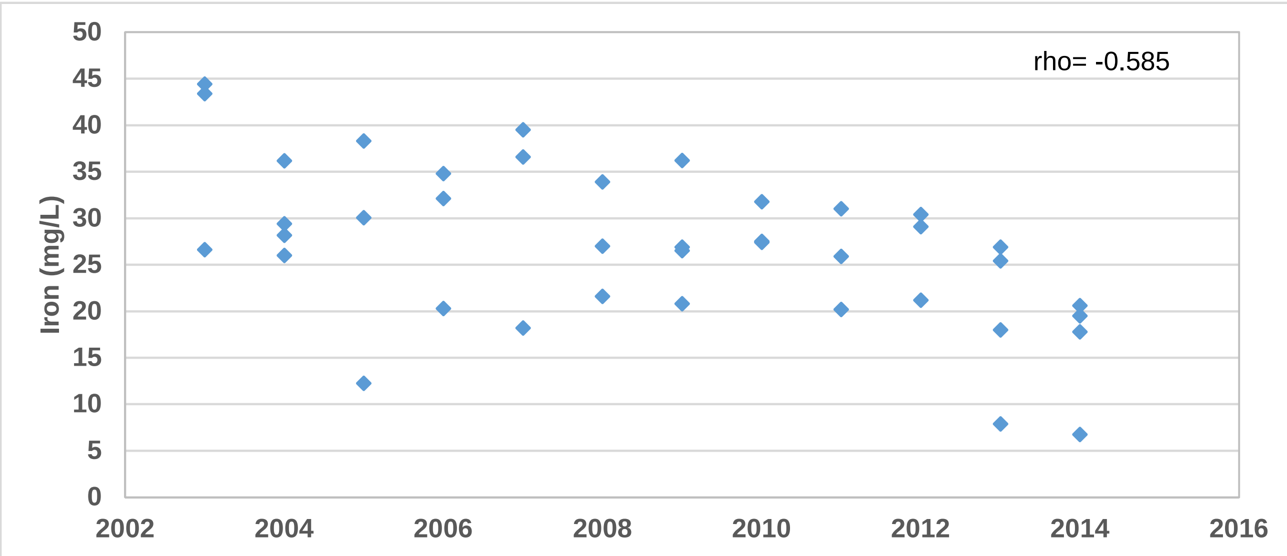
Station	Spearman rho	Acidity	Iron	pH	Sulphate
M-12-1	Correlation Coefficient	-0.455	-0.096	0.842	0.193
	Sig. (2-tailed)	0.257	0.686	0.000	0.528
	N	8	20	20	13
M-12-3	Correlation Coefficient	-0.429	-0.605	0.743	-0.588
	Sig. (2-tailed)	0.289	0.005	0.000	0.035
	N	8	20	20	13
M-12-6	Correlation Coefficient	-0.491	-0.791	0.877	-0.888
	Sig. (2-tailed)	0.217	0.000	0.000	0.000
	N	8	19	19	12
M-12-9	Correlation Coefficient	-0.756	-0.230	0.904	-0.823
	Sig. (2-tailed)	0.030	0.358	0.000	0.001
	N	8	18	18	12
M-13-1	Correlation Coefficient	-1.000	-0.437	0.598	-0.909
	Sig. (2-tailed)	0.000	0.070	0.009	0.000
	N	8	18	18	14
M-13-3	Correlation Coefficient	-0.611	-0.670	0.852	-0.855
	Sig. (2-tailed)	0.108	0.002	0.000	0.000
	N	8	19	19	14
M-13-6	Correlation Coefficient	0.600	-0.915	0.781	-0.964
	Sig. (2-tailed)	0.285	0.000	0.000	0.000
	N	5	16	16	11
M-13-9	Correlation Coefficient	-0.761	-0.467	0.389	-0.924
	Sig. (2-tailed)	0.028	0.050	0.110	0.000
	N	8	18	18	13
M-14-1	Correlation Coefficient	-0.786	-0.066	0.413	-0.534
	Sig. (2-tailed)	0.036	0.831	0.160	0.112
	N	7	13	13	10
M-14-3	Correlation Coefficient	-0.893	-0.907	0.484	-0.648
	Sig. (2-tailed)	0.007	0.000	0.094	0.043
	N	7	13	13	10
M-14-6	Correlation Coefficient	-0.875	-0.837	0.402	-0.842
	Sig. (2-tailed)	0.004	0.000	0.154	0.002
	N	8	14	14	10
M-14-9	Correlation Coefficient	.	0.014	0.638	-0.874
	Sig. (2-tailed)	.	0.968	0.035	0.005
	N	5	11	11	8
95N-4A	Correlation Coefficient	-0.786	-0.627	0.585	-0.073
	Sig. (2-tailed)	0.021	0.007	0.014	0.804
	N	8	17	17	14
95N-4B	Correlation Coefficient	-0.738	-0.904	-0.461	-0.809
	Sig. (2-tailed)	0.037	0.000	0.063	0.000
	N	8	17	17	14
95N-7A	Correlation Coefficient	-0.554	-0.694	-0.330	-0.243
	Sig. (2-tailed)	0.154	0.002	0.195	0.423
	N	8	17	17	13
95N-7B	Correlation Coefficient	0.548	-0.484	-0.462	0.421
	Sig. (2-tailed)	0.160	0.049	0.062	0.152
	N	8	17	17	13

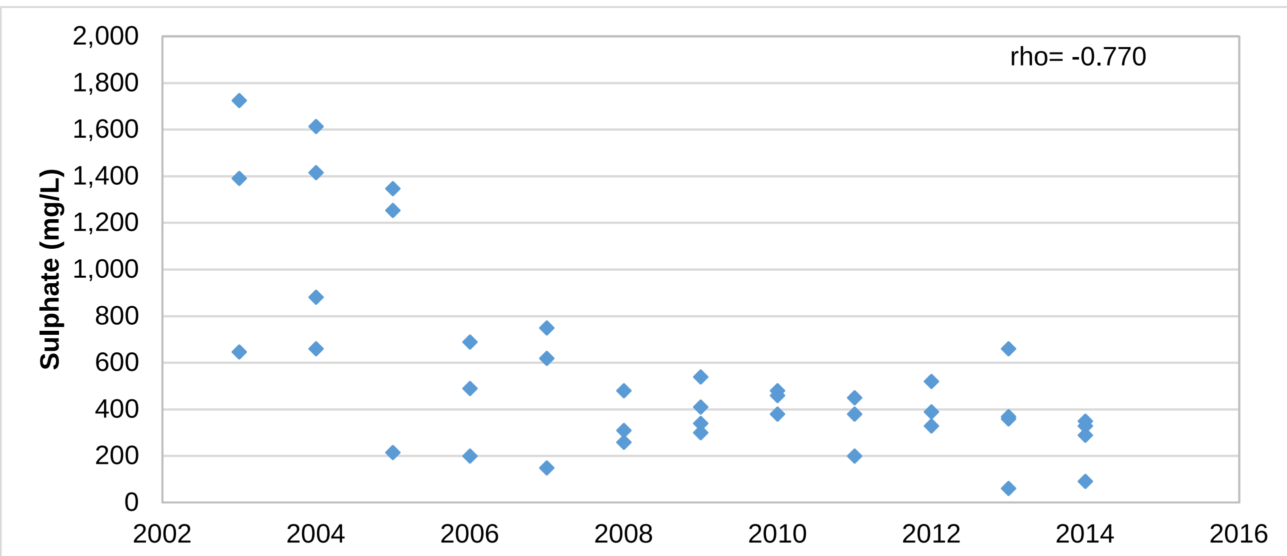
Appendix Table C.7.35: Summary of trends for Lacnor/Nordic groundwater stations. from 1993 to 2014.

Station	Spearman rho	Acidity	Iron	pH	Sulphate
95N-11	Correlation Coefficient	-0.755	-0.840	-0.255	0.671
	Sig. (2-tailed)	0.031	0.000	0.307	0.017
	N	8	17	18	12
95N-12A	Correlation Coefficient	.	0.006	-0.528	-0.342
	Sig. (2-tailed)	.	0.980	0.020	0.231
	N	8	19	19	14
95N-12B	Correlation Coefficient	.	-0.296	-0.590	-0.816
	Sig. (2-tailed)	.	0.233	0.010	0.001
	N	8	18	18	13
95N-13A	Correlation Coefficient	-0.762	-0.935	0.421	-0.531
	Sig. (2-tailed)	0.028	0.000	0.073	0.034
	N	8	19	19	16
95N-13C	Correlation Coefficient	-0.096	-0.919	0.515	-0.780
	Sig. (2-tailed)	0.820	0.000	0.024	0.000
	N	8	19	19	16
95N-13E	Correlation Coefficient	-0.214	-0.879	0.782	-0.555
	Sig. (2-tailed)	0.610	0.000	0.000	0.026
	N	8	19	19	16
95N-14A	Correlation Coefficient	.	-0.270	0.417	-0.372
	Sig. (2-tailed)	.	0.263	0.075	0.156
	N	8	19	19	16
95N-14B	Correlation Coefficient	.	0.553	-0.287	-0.282
	Sig. (2-tailed)	.	0.014	0.233	0.308
	N	8	19	19	15
95N-14C	Correlation Coefficient	.	0.372	-0.083	-0.303
	Sig. (2-tailed)	.	0.117	0.735	0.292
	N	8	19	19	14
95N-16A	Correlation Coefficient	-0.810	-0.940	0.665	-0.664
	Sig. (2-tailed)	0.015	0.000	0.004	0.007
	N	8	17	17	15
95N-16C	Correlation Coefficient	-0.310	-0.858	0.723	-0.826
	Sig. (2-tailed)	0.456	0.000	0.001	0.000
	N	8	17	17	15
95N-16E	Correlation Coefficient	-0.524	-0.936	0.724	-0.860
	Sig. (2-tailed)	0.183	0.000	0.001	0.000
	N	8	17	17	15
95N-17A	Correlation Coefficient	.	0.546	0.143	-0.534
	Sig. (2-tailed)	.	0.019	0.559	0.040
	N	8	18	19	15
95N-17B	Correlation Coefficient	.	0.595	-0.104	-0.545
	Sig. (2-tailed)	.	0.009	0.673	0.036
	N	8	18	19	15
95N-17C	Correlation Coefficient	.	0.280	-0.030	0.155
	Sig. (2-tailed)	.	0.261	0.902	0.581
	N	8	18	19	15

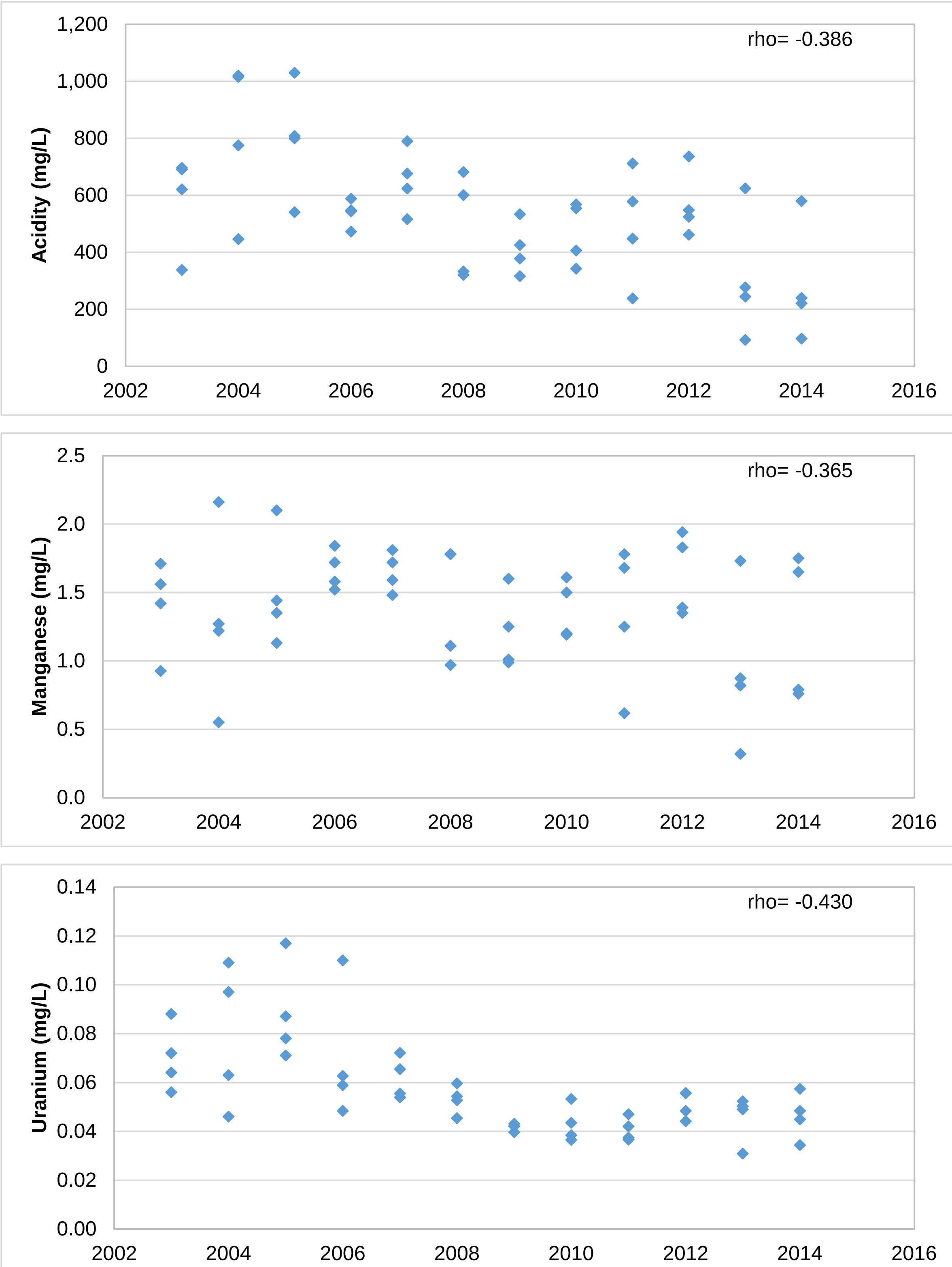
Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

[shaded box] Significant trend where p<0.05.

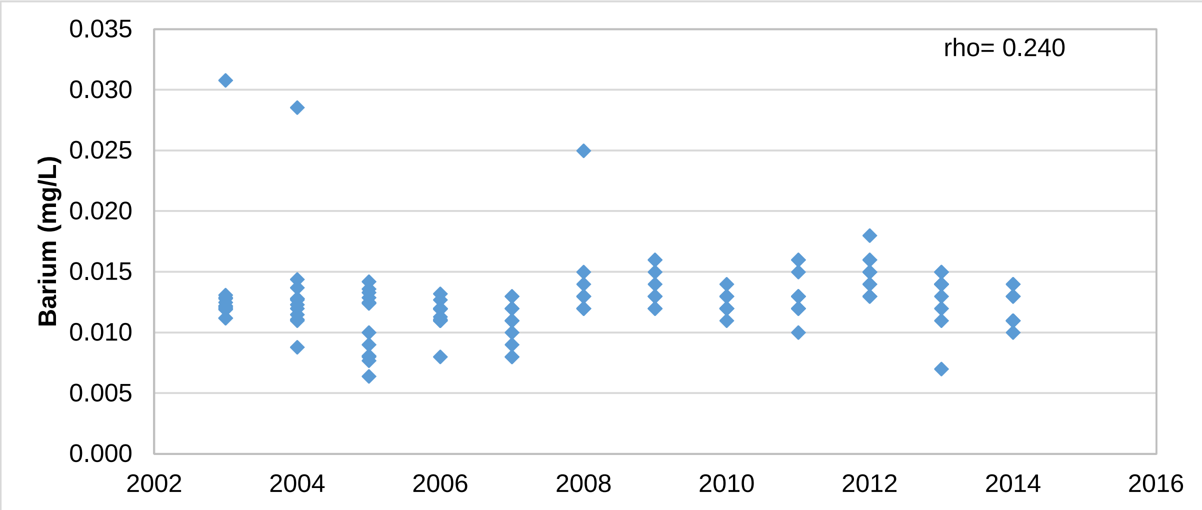


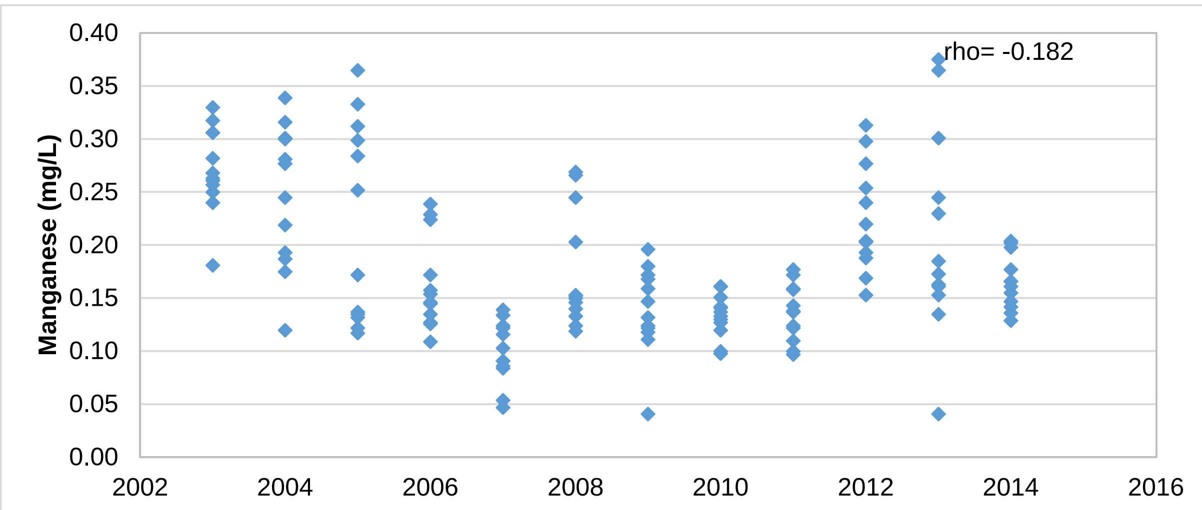


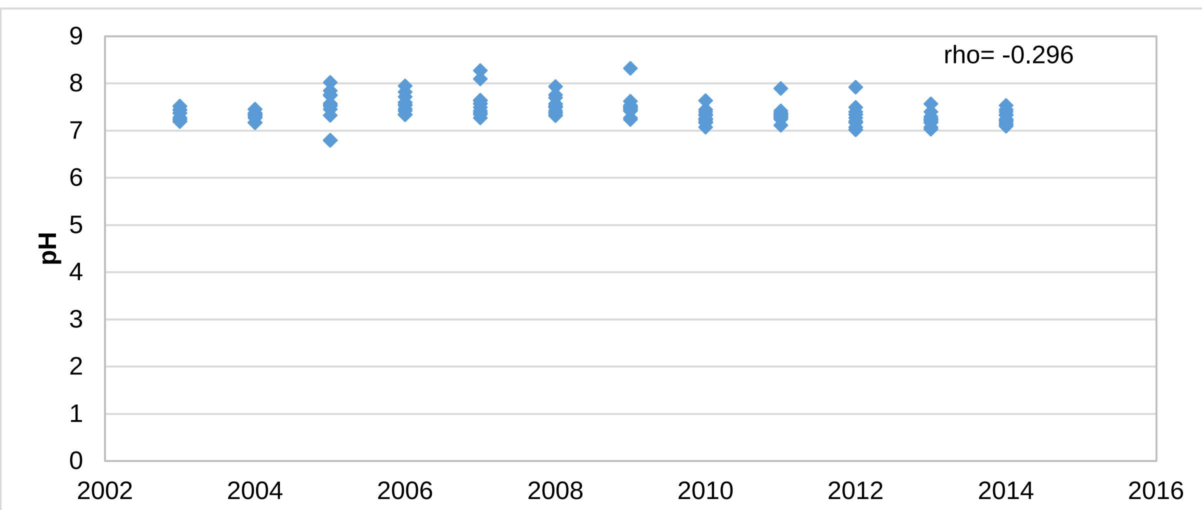
Appendix Figure C.7.1: Significant common (average) trends observed for iron and sulphate over all seasons at Station L-03, 2003 to 2014.



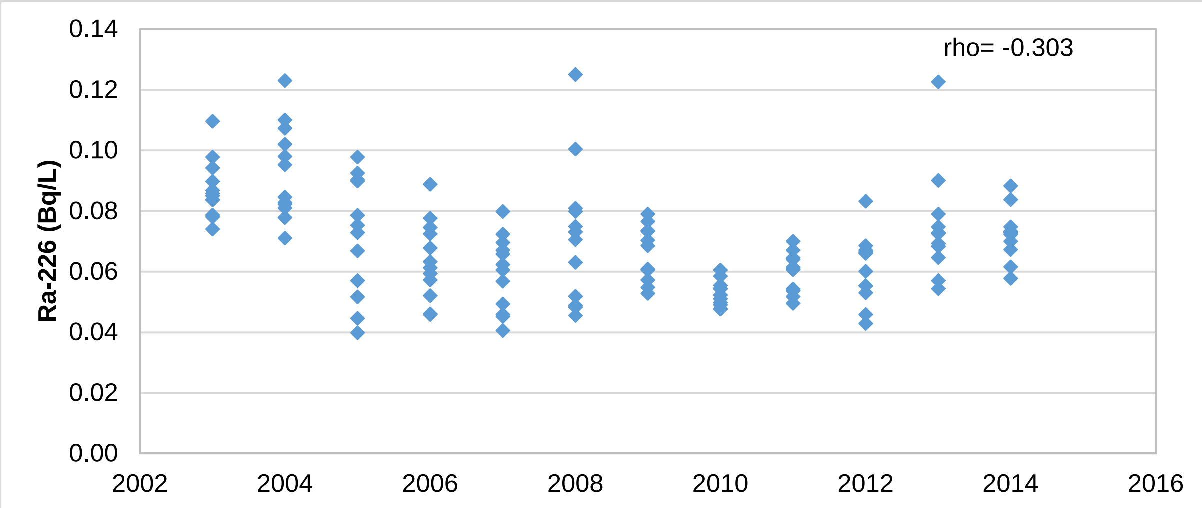
Appendix Figure C.7.2: Significant common (average) trends observed for acidity, manganese and uranium over all seasons at Station N-17, 2003 to 2014.

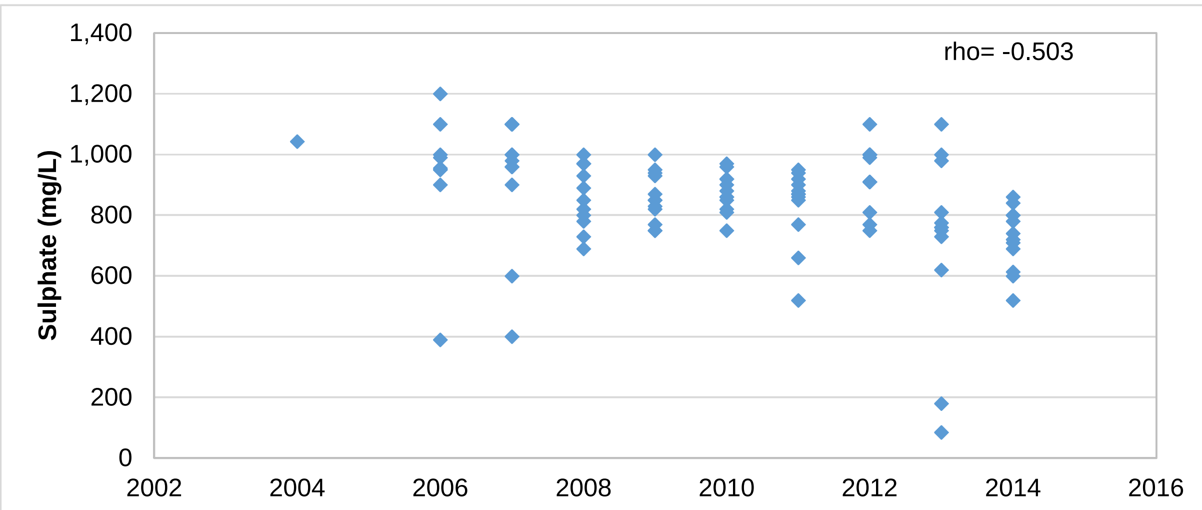




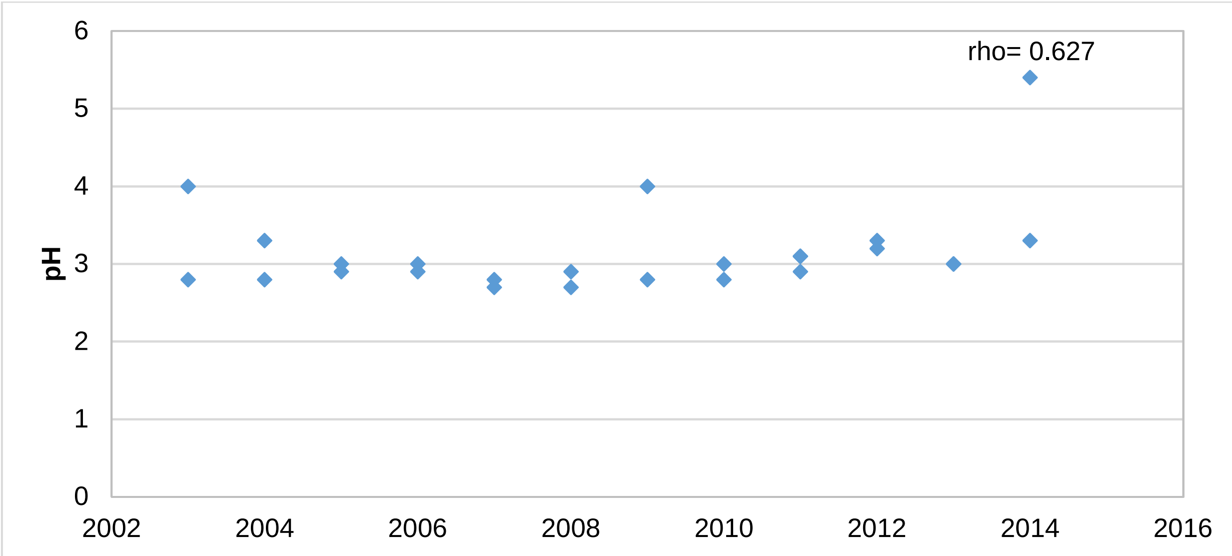


Appendix Figure C.7.3: Significant common (average) trends observed for barium, manganese, pH, radium-226 and sulphate, over all seasons at Station N-19, 2003 to 2014.

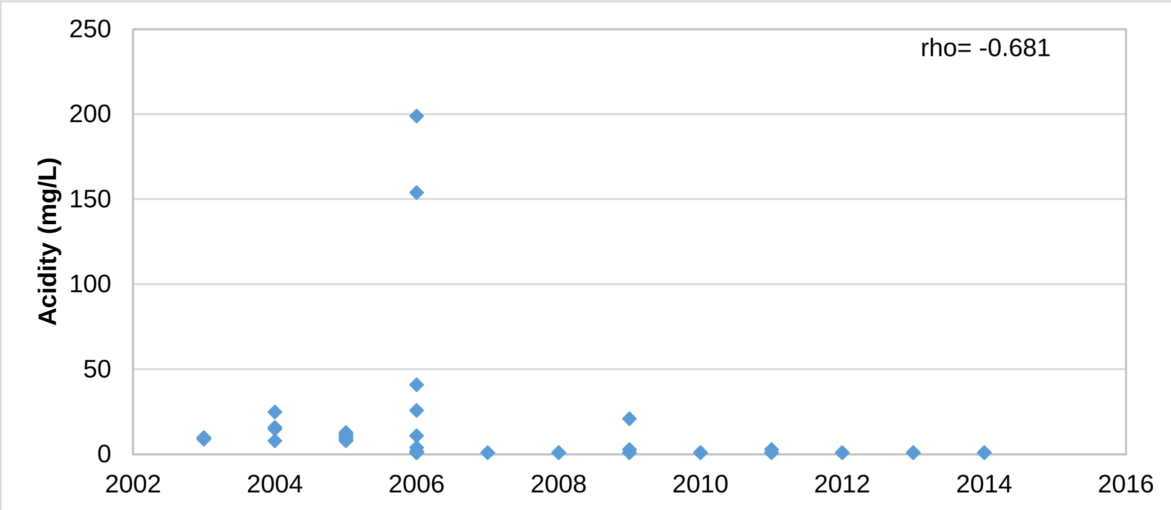


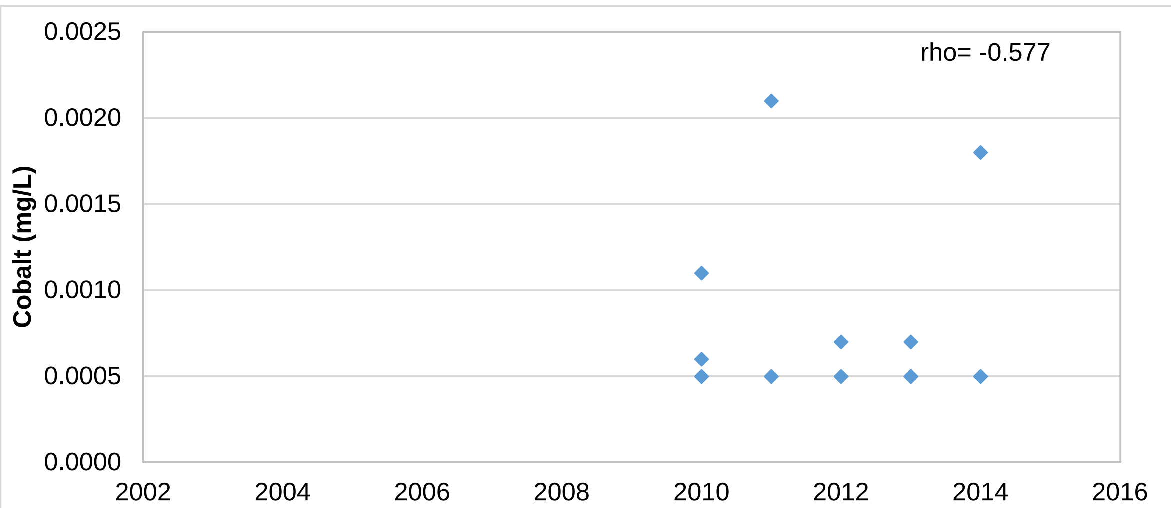


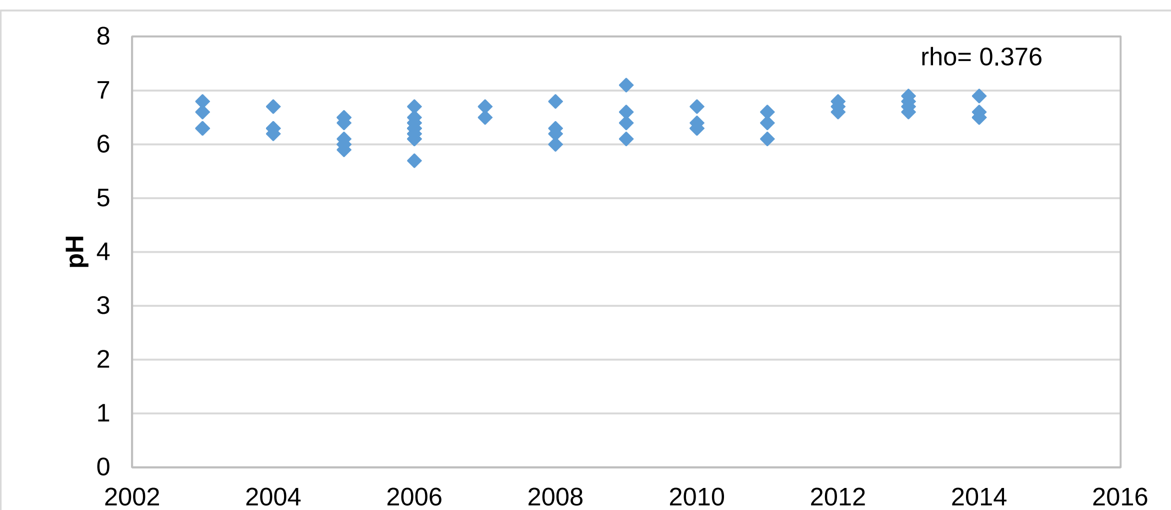
Appendix Figure C.7.3: Significant common (average) trends observed for barium, manganese, pH, radium-226 and sulphate, over all seasons at Station N-19, 2003 to 2014.



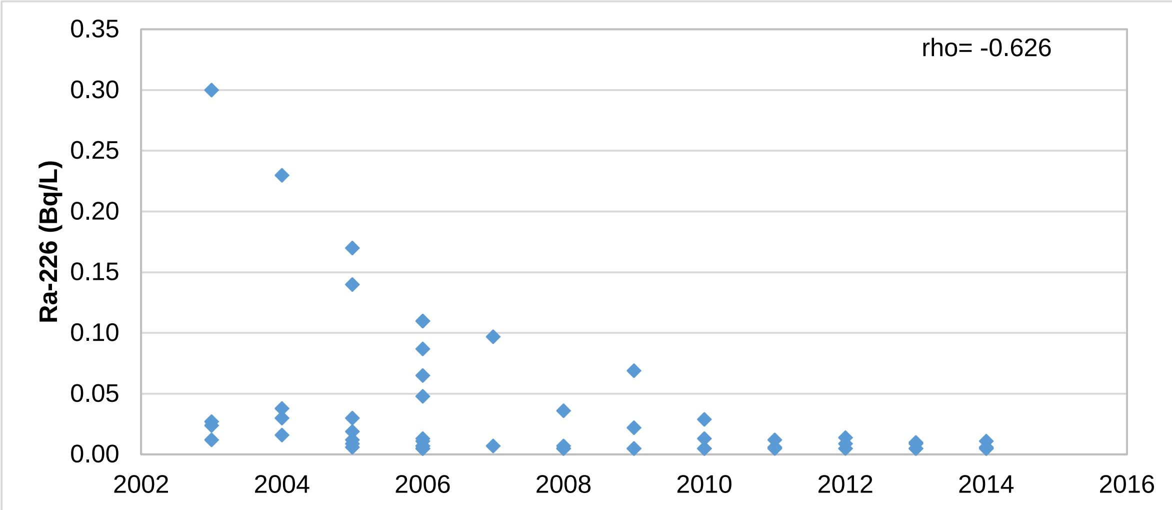
Appendix Figure C.7.4: Significant common (average) trends observed for pH over all seasons at Station N-22, 2003 to 2014.

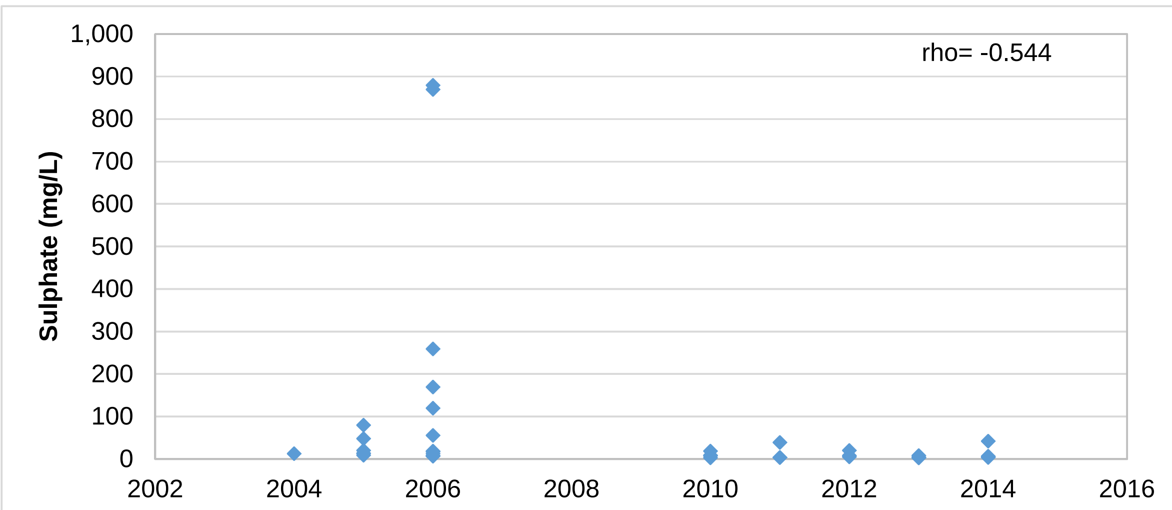




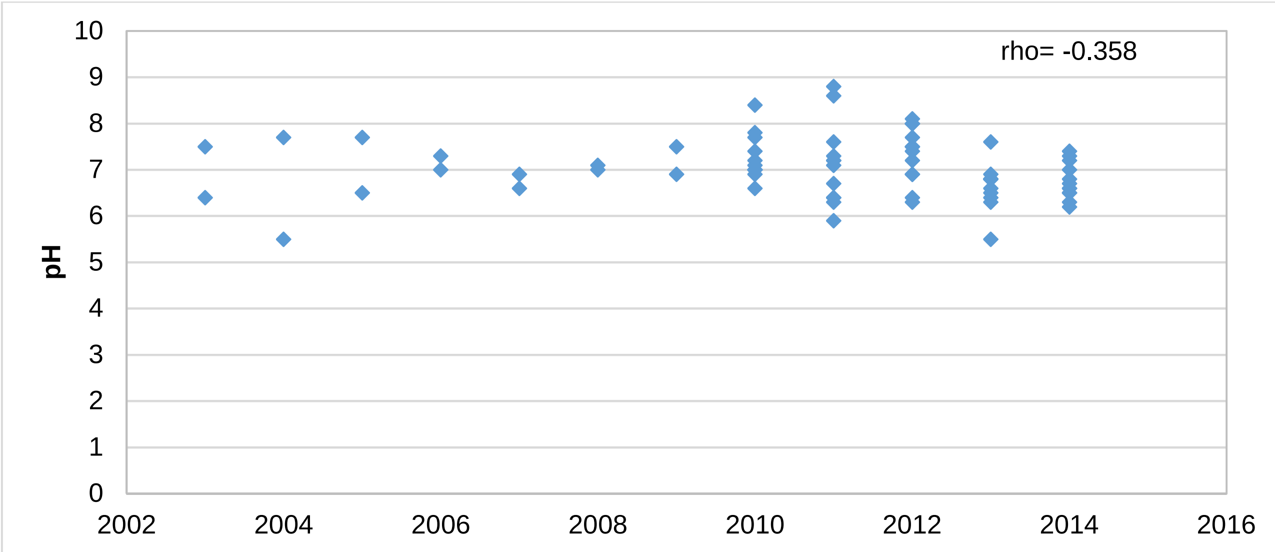


Appendix Figure C.7.5: Significant common (average) trends observed for acidity, cobalt, pH, radium-226 and sulphate, over all seasons at Station ECA-131, 2003 to 2014.

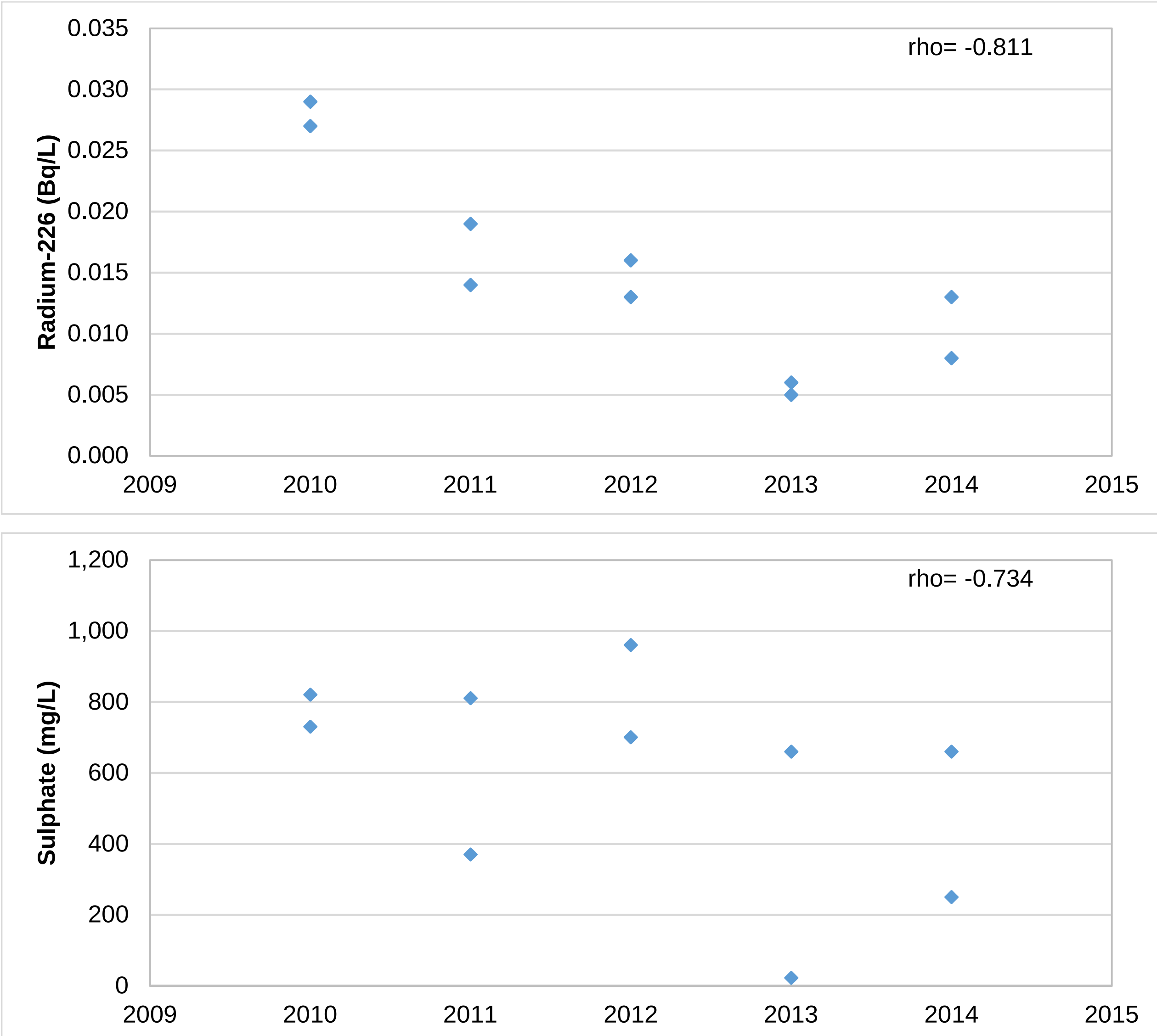




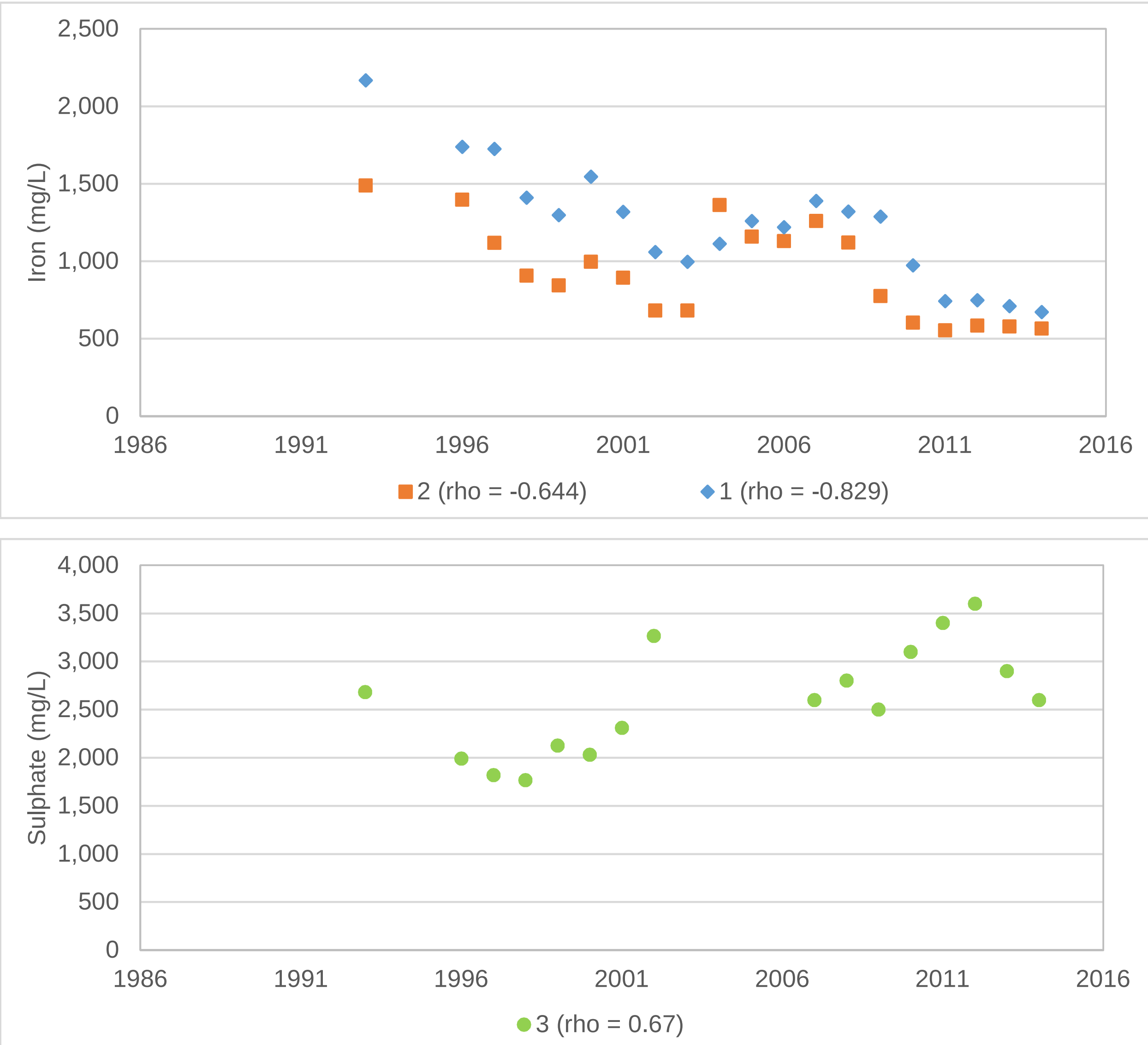
Appendix Figure C.7.5: Significant common (average) trends observed for acidity, cobalt, pH, radium-226 and sulphate, over all seasons at Station ECA-131, 2003 to 2014.



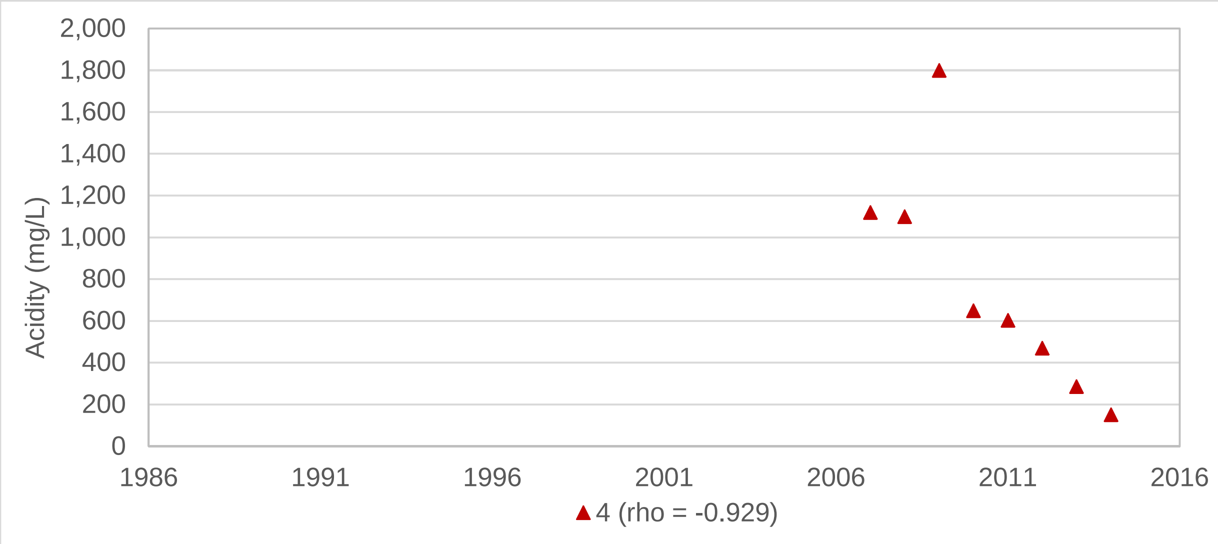
Appendix Figure C.7.6: Significant common (average) trends observed for pH over all seasons at Station ECA-132, 2003 to 2014.

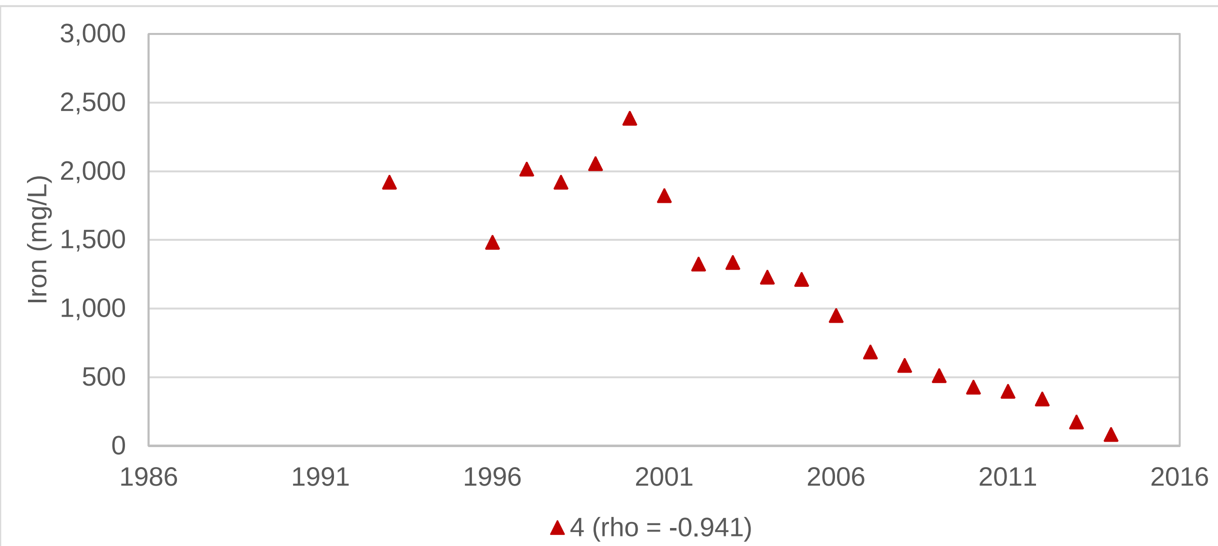


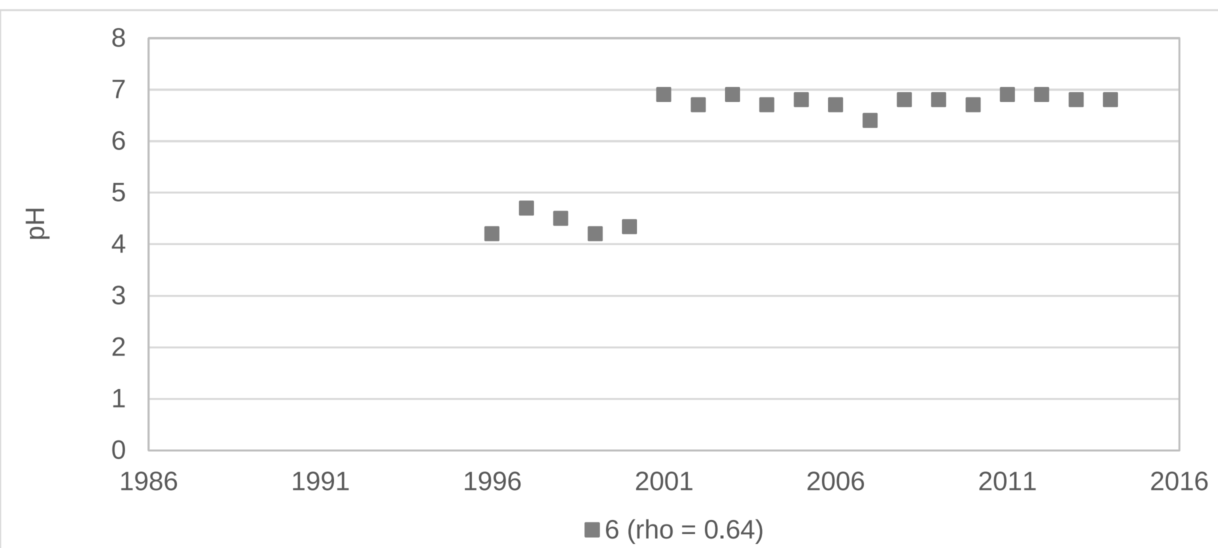
Appendix Figure C.7.7: Significant common (average) trends observed for pH over all seasons at Station CPW, 2003 to 2014.



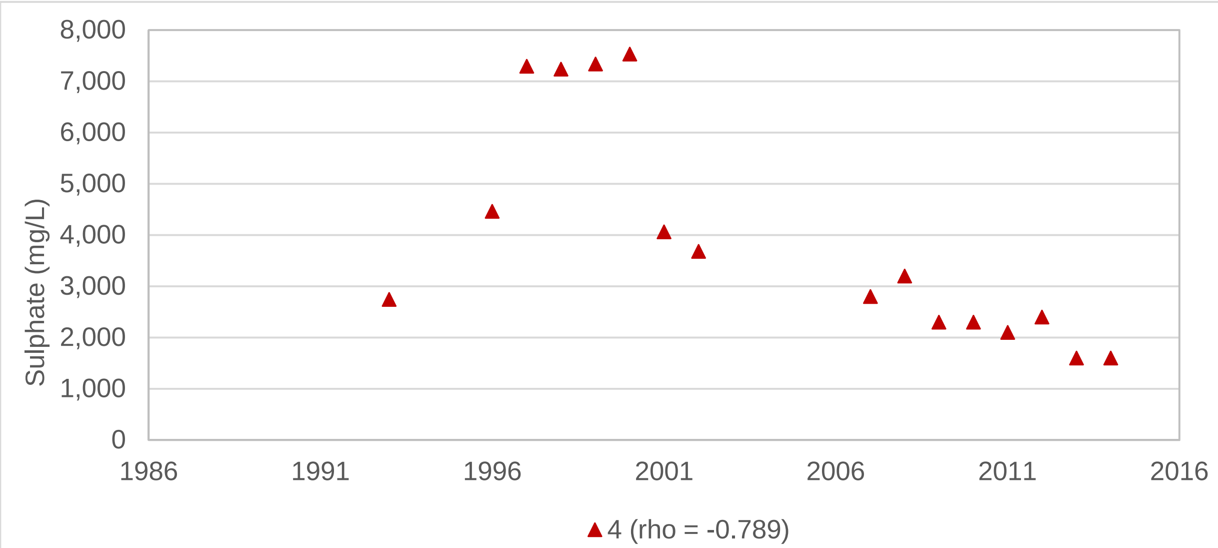
Appendix Figure C.7.8: Significant trends observed for iron and sulphate at station UW9-1,2
1993 to 2014.



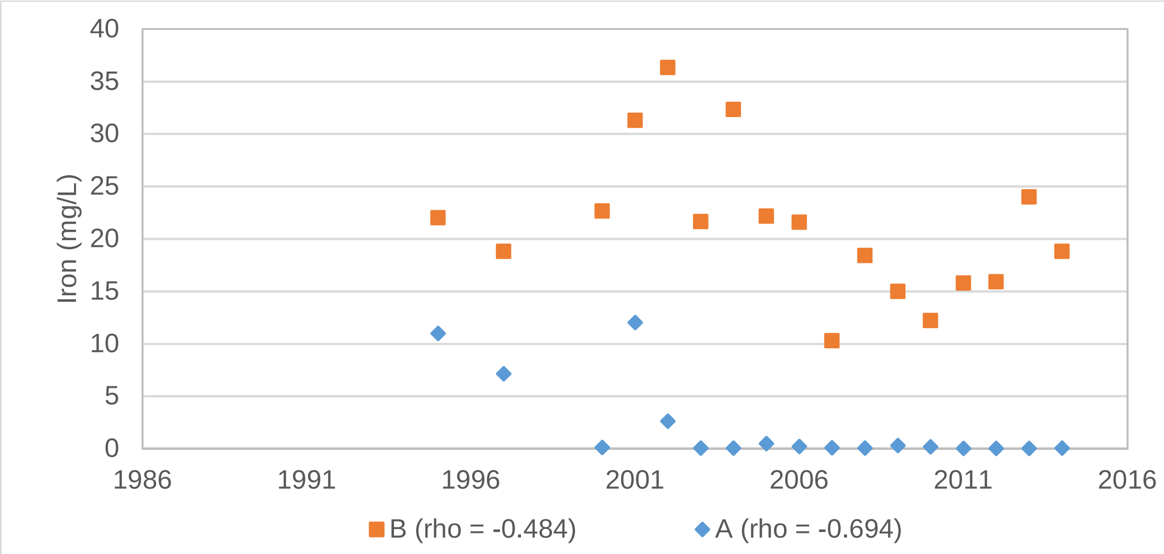




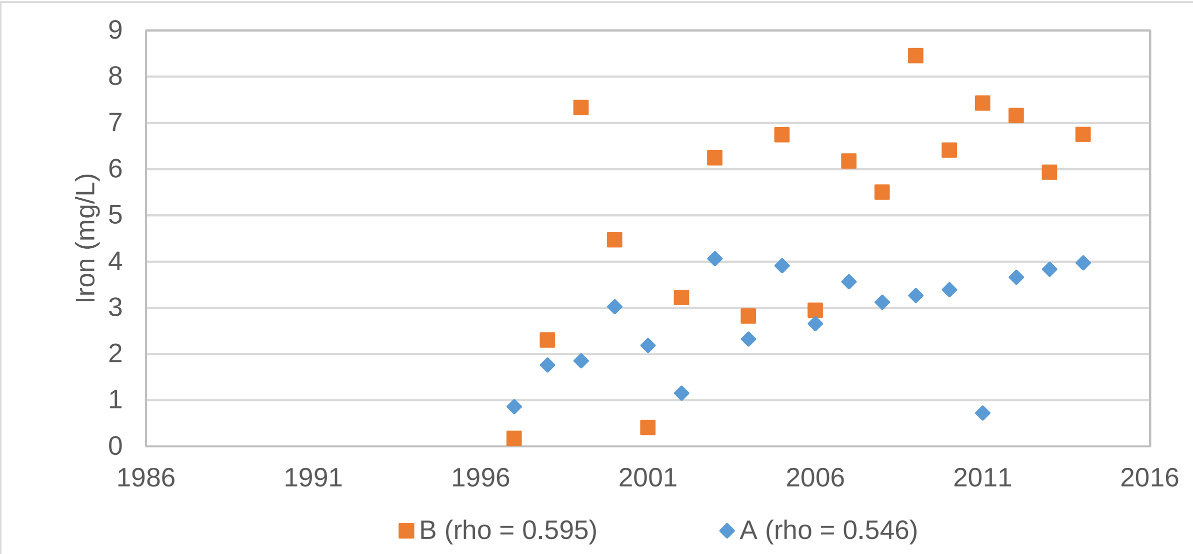
Appendix Figure C.7.9: Significant trends observed for acidity, iron, pH and sulphate at station UW7-2,4,6, 1993 to 2014.

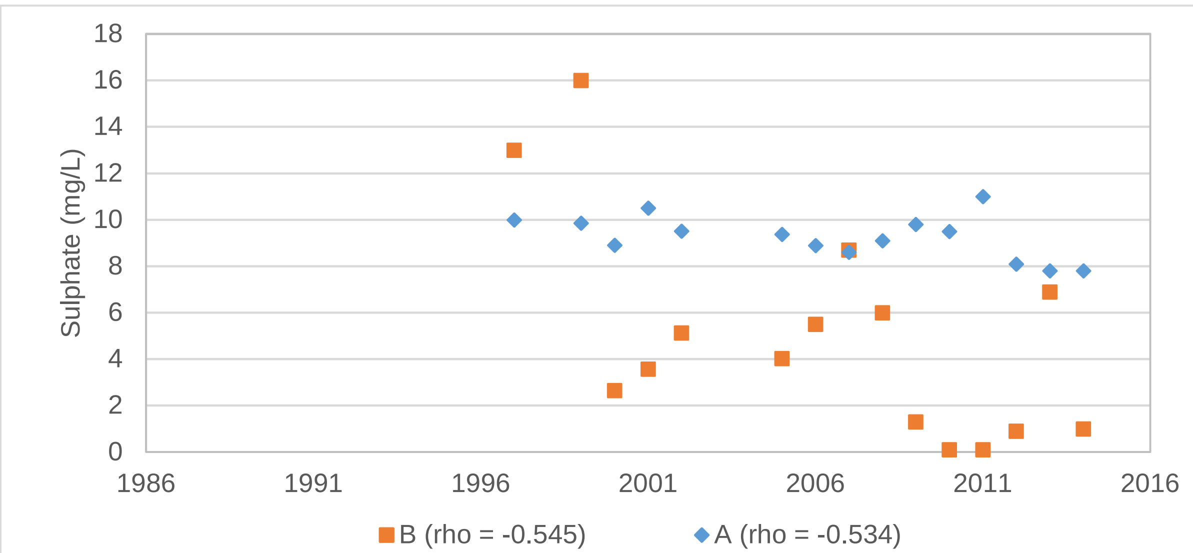


Appendix Figure C.7.9: Significant trends observed for acidity, iron, pH and sulphate at station UW7-2,4,6, 1993 to 2014.

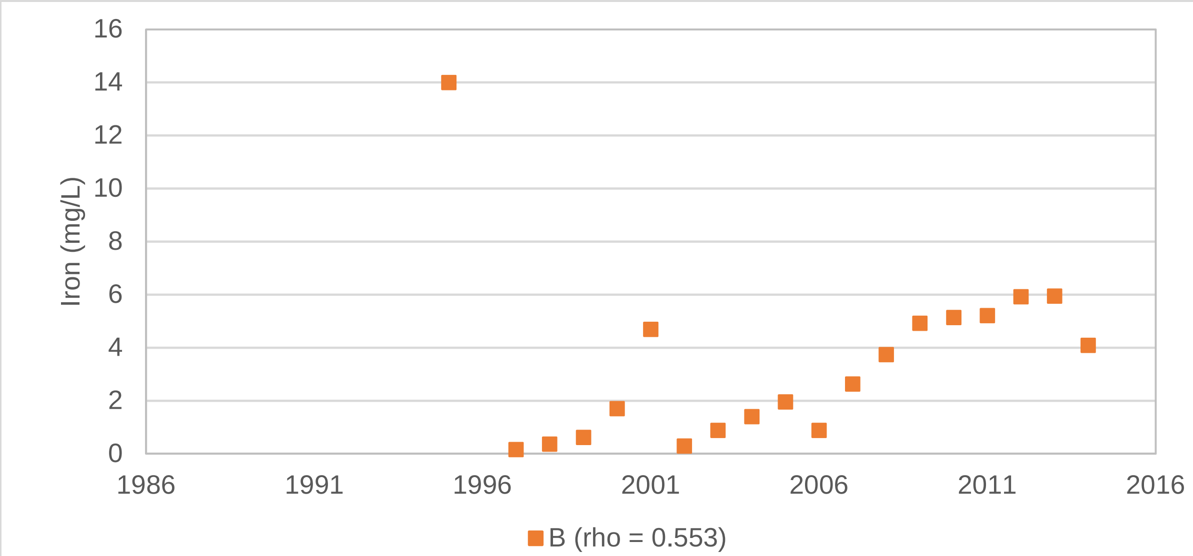


Appendix Figure C.7.10: Significant trends observed for iron at station 95N-7A,B, 1995 to 2014.

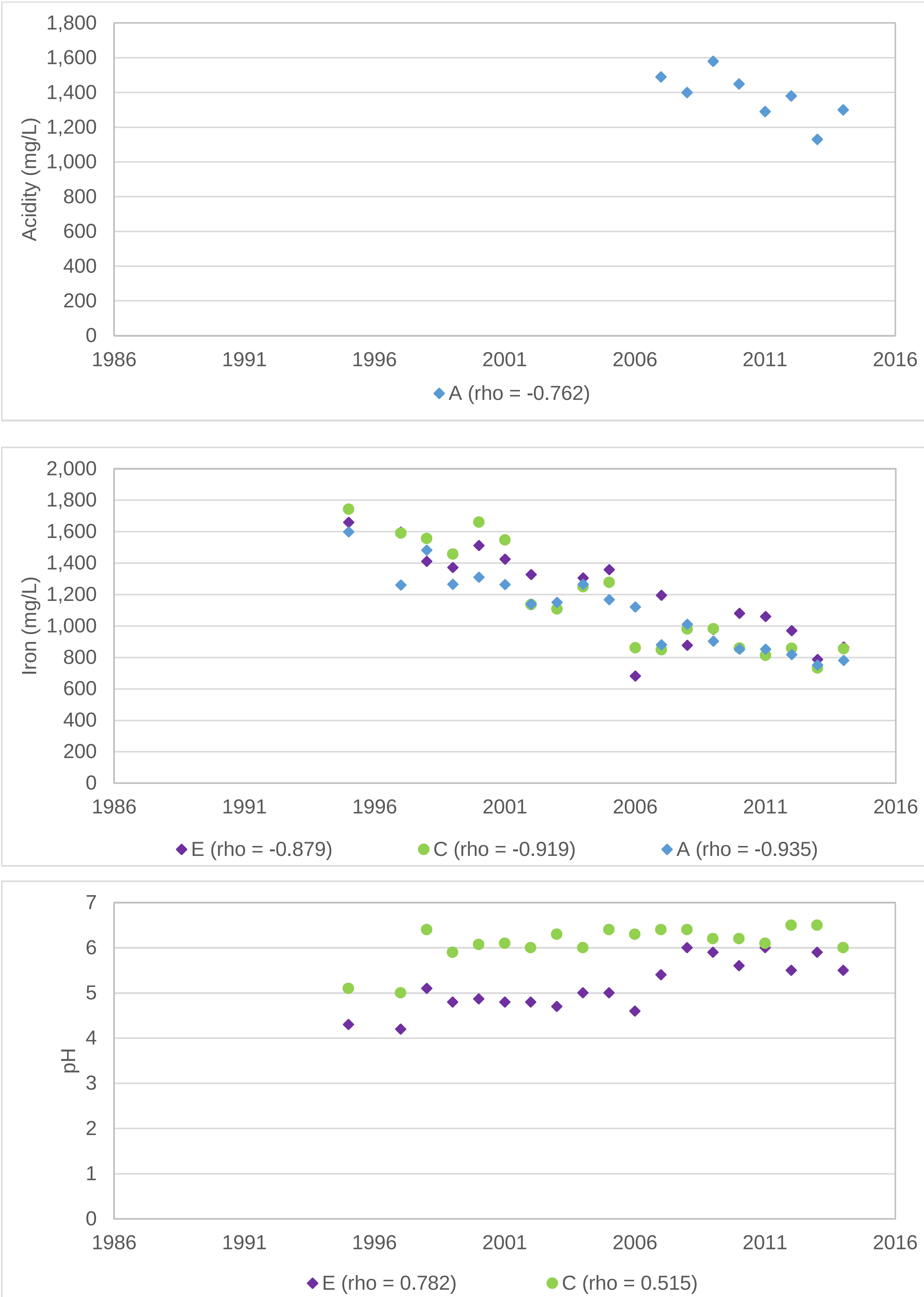




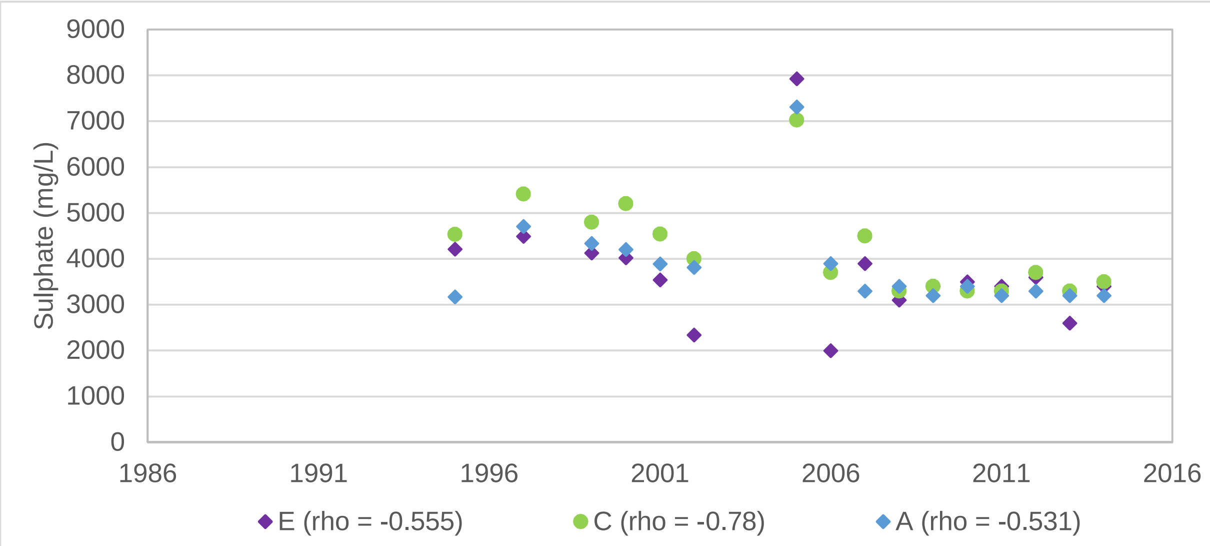
Appendix Figure C.7.11: Significant trends observed for iron and sulphate at station 95N-17A,B,C, 1995 to 2014.



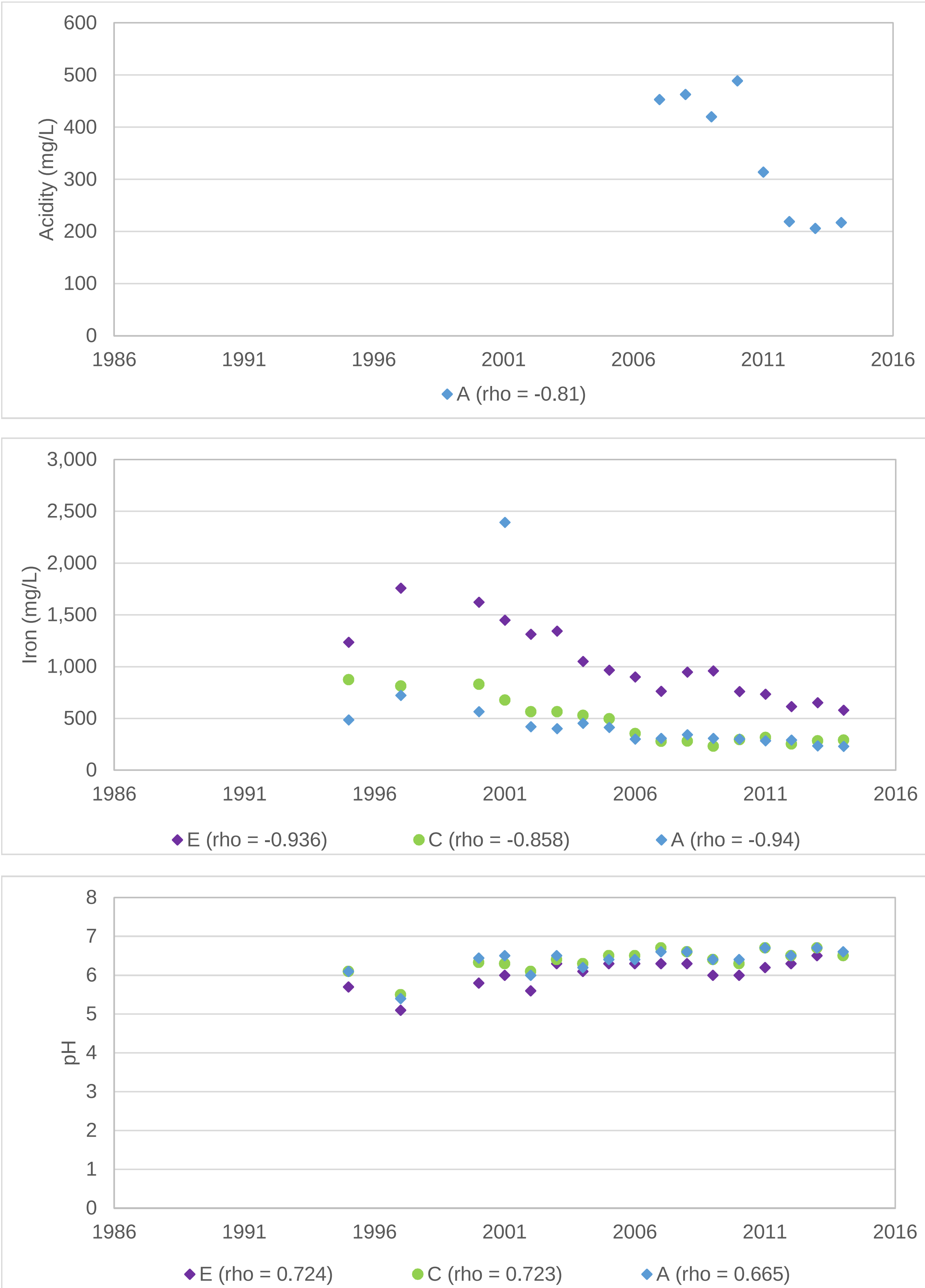
Appendix Figure C.7.12: Significant trends observed for iron at station 95N-14A,B,C, 1995 to 2014.



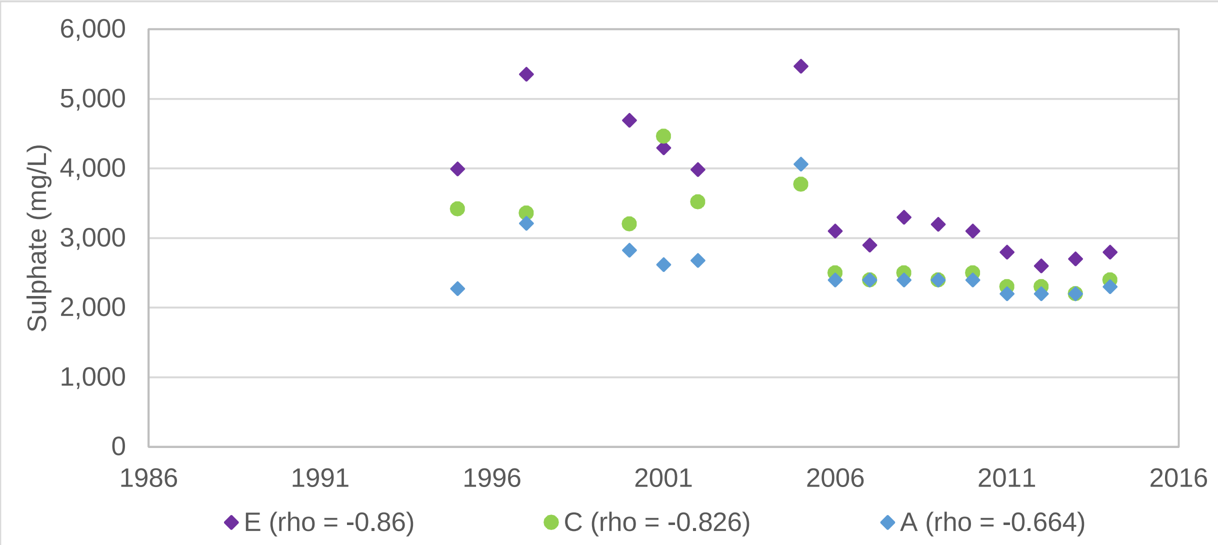
Appendix Figure C.7.13: Significant trends observed for acidity, iron, pH and sulphate at station 95N-13A,C,E, 1995 to 2014.



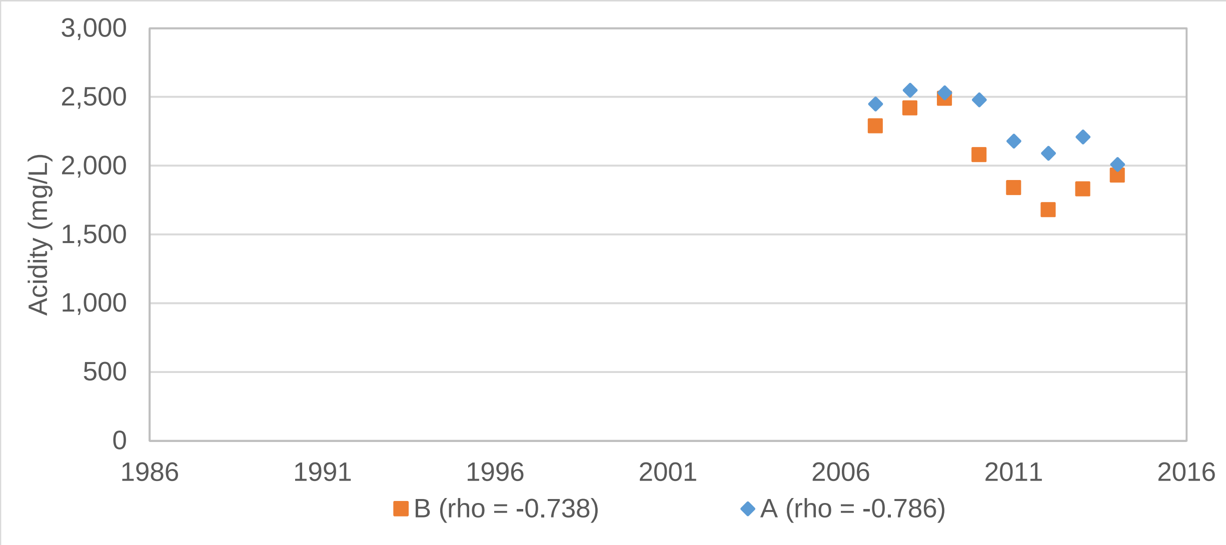
Appendix Figure C.7.13: Significant trends observed for acidity, iron, pH and sulphate at station 95N-13A,C,E, 1995 to 2014.

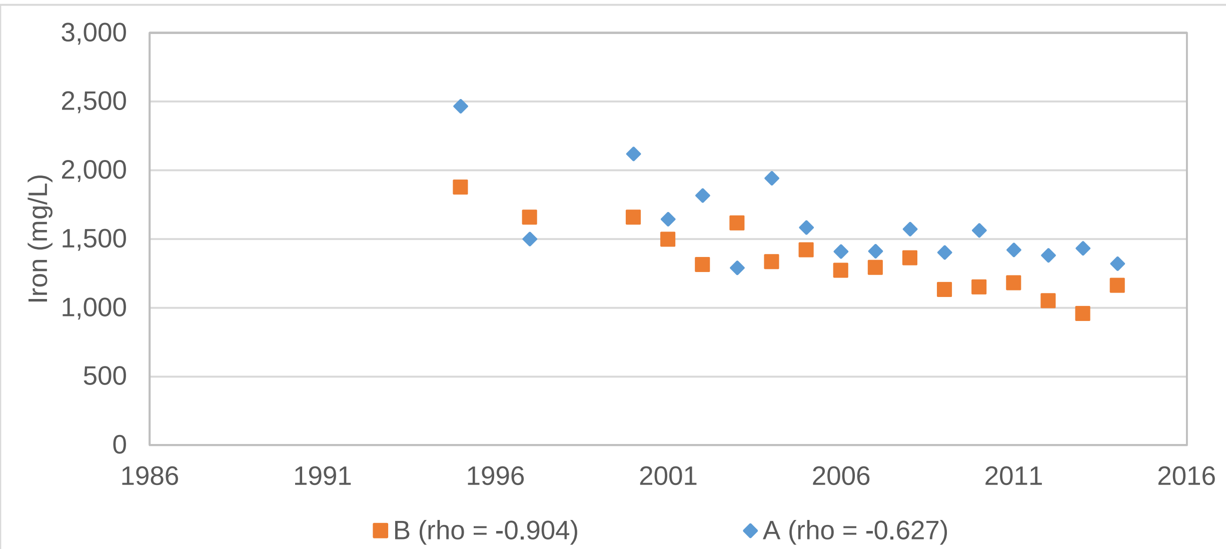


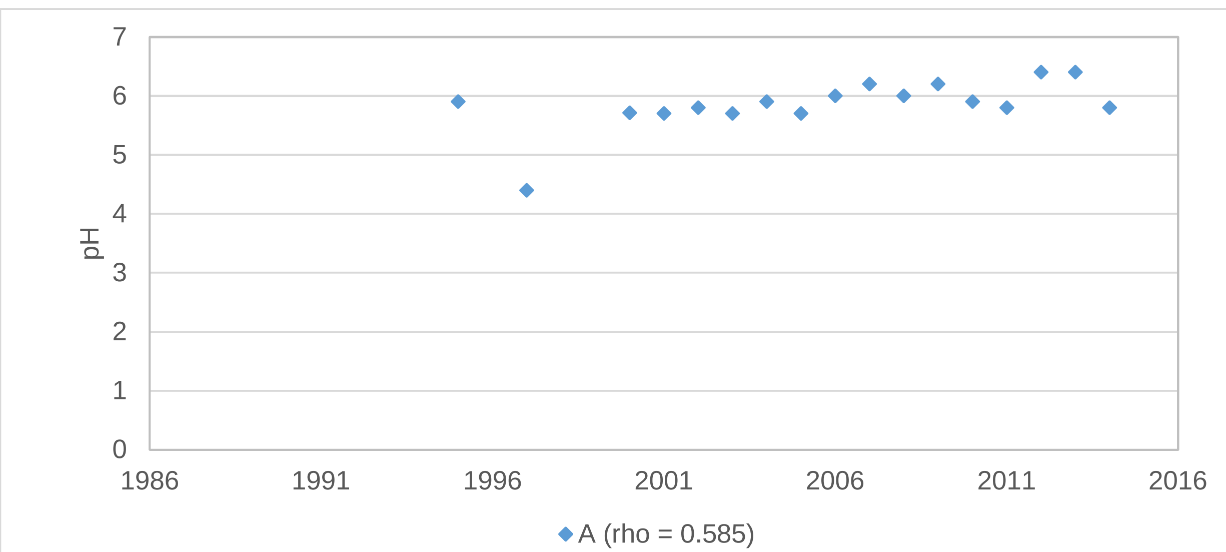
Appendix Figure C.7.14: Significant trends observed for acidity, iron, pH and sulphate at station 95N-16A,C,E, 1995 to 2014.



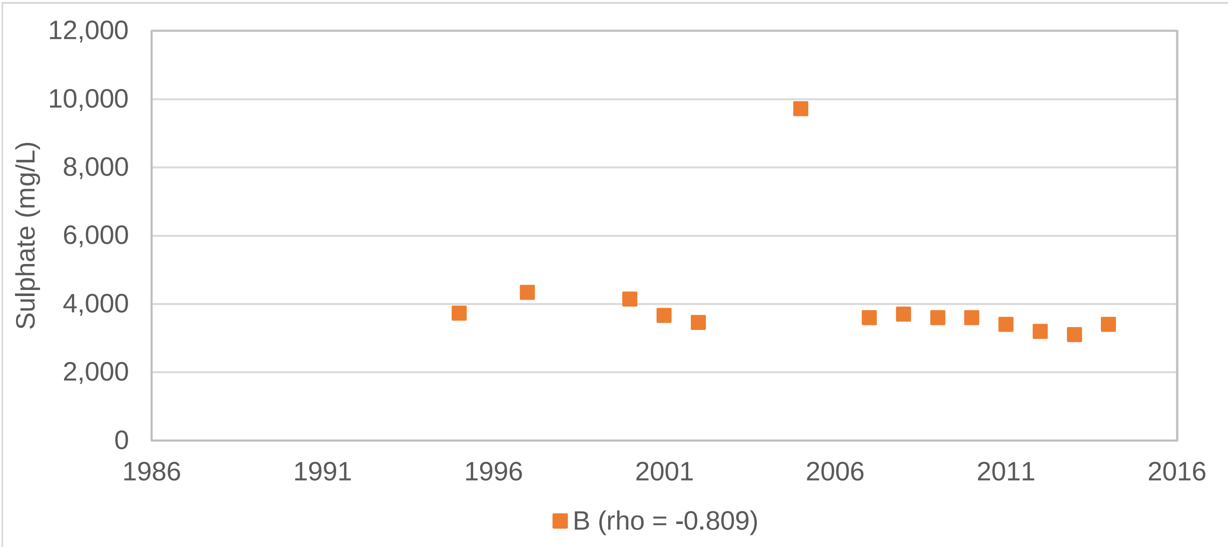
Appendix Figure C.7.14: Significant trends observed for acidity, iron, pH and sulphate at station 95N-16A,C,E, 1995 to 2014.



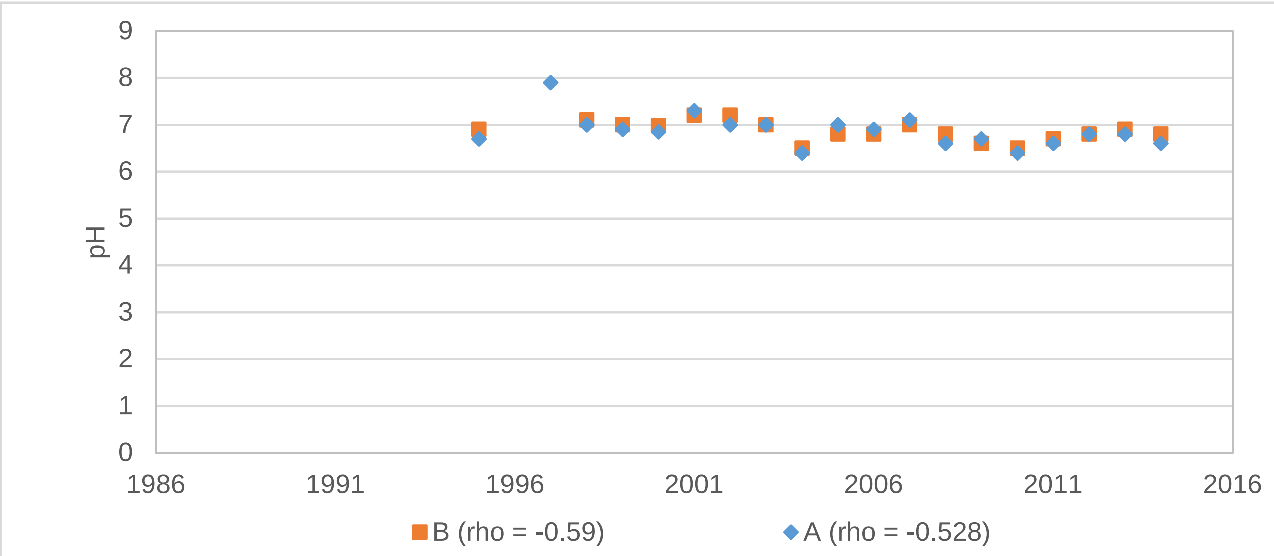


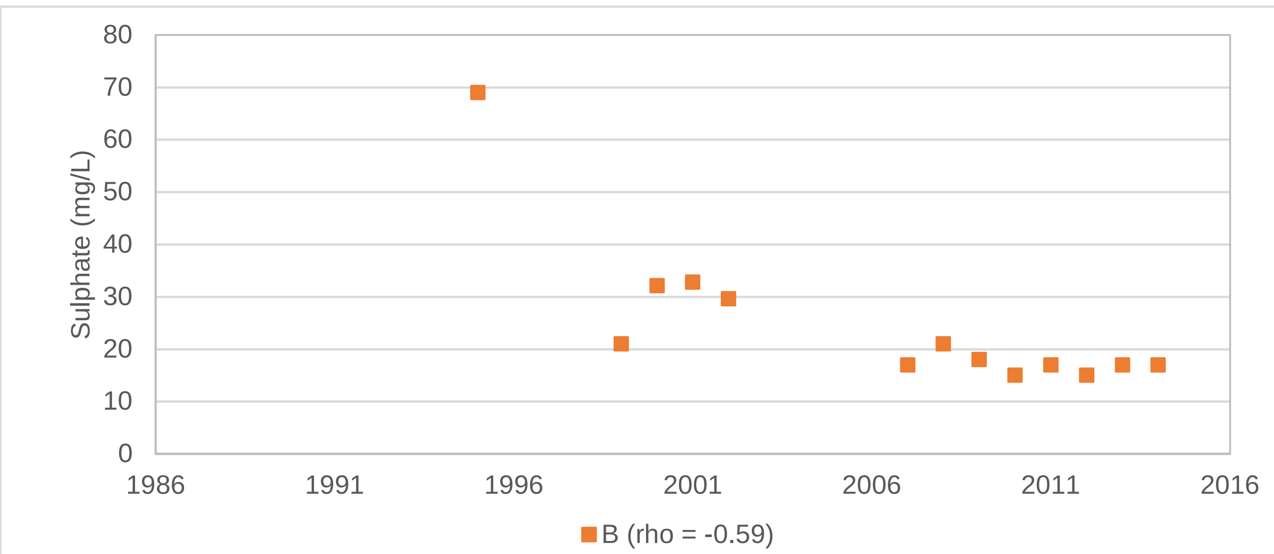


Appendix Figure C.7.15: Significant trends observed for acidity, iron, pH and sulphate at station 95N-4A,B, 1995 to 2014.

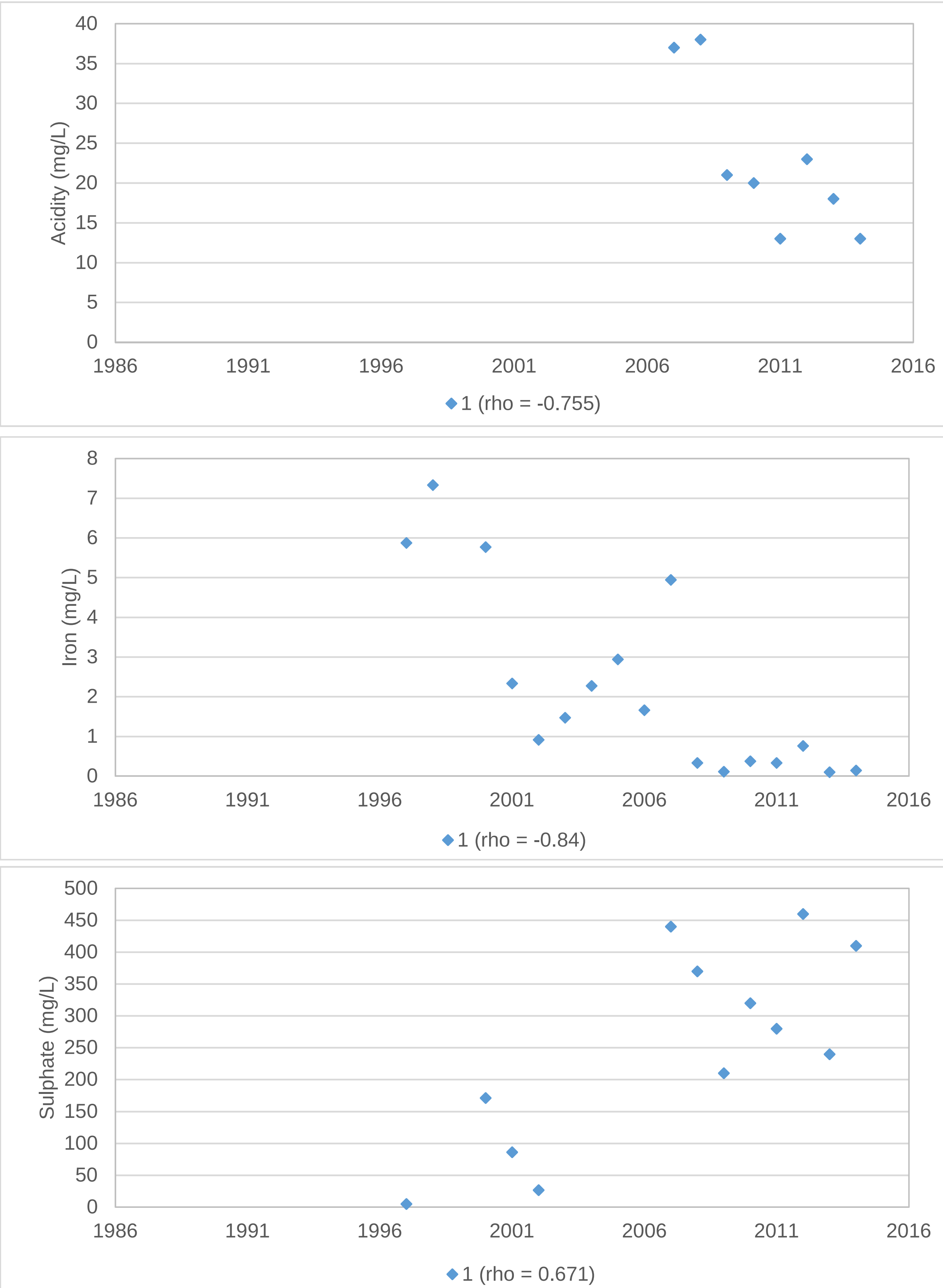


Appendix Figure C.7.15: Significant trends observed for acidity, iron, pH and sulphate at station 95N-4A,B, 1995 to 2014.

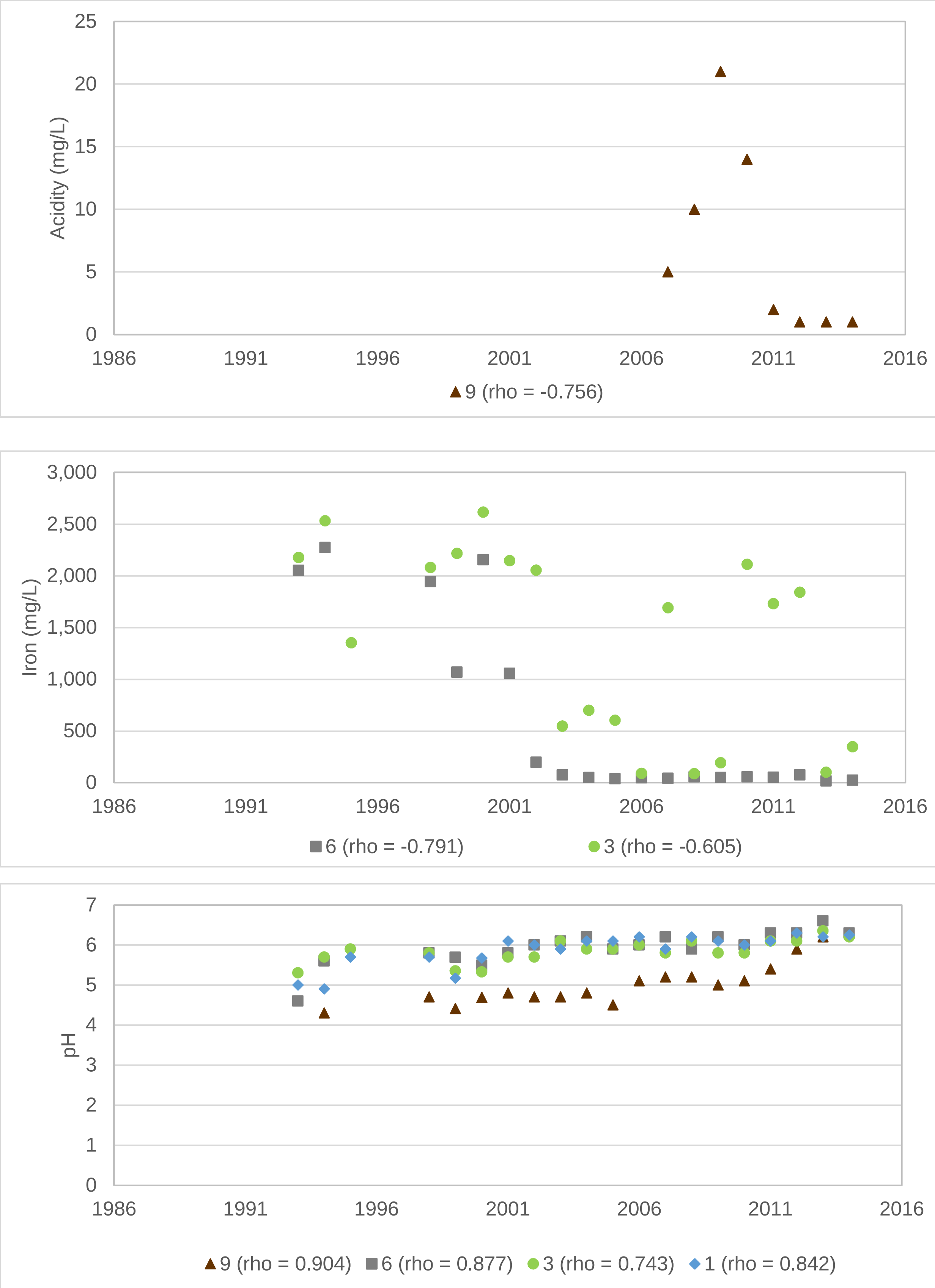




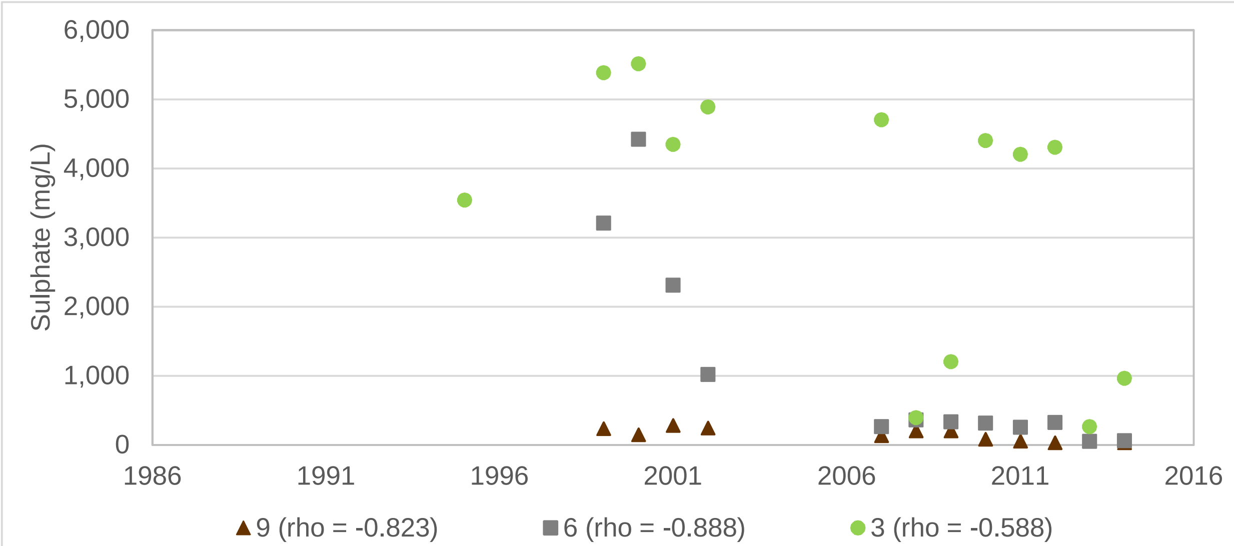
Appendix Figure C.7.16: Significant trends observed for pH and sulphate at station 95N-12A, 1995 to 2014.



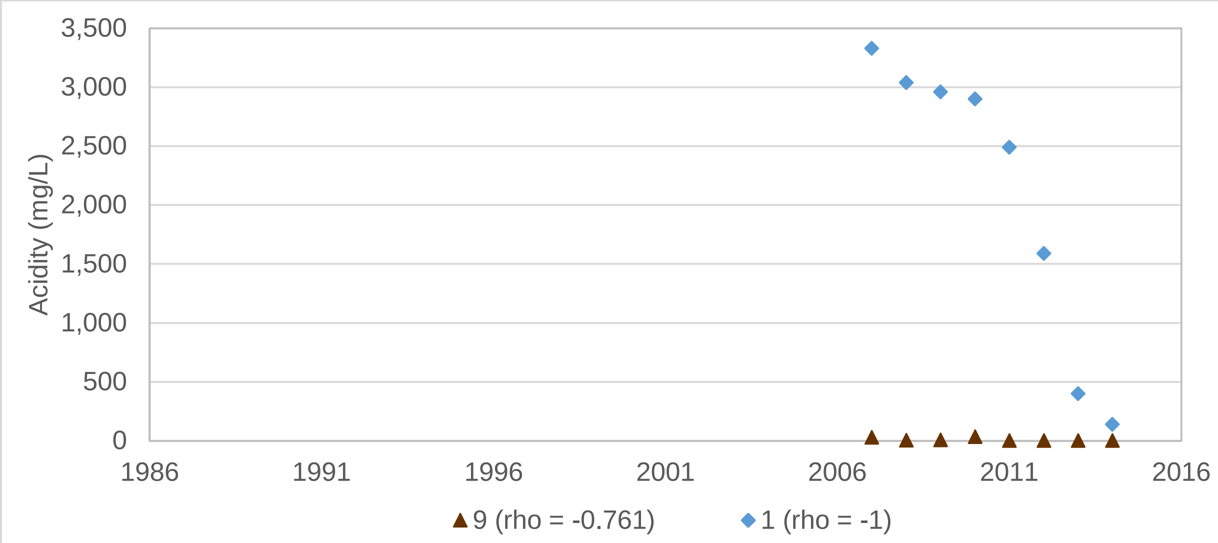
Appendix Figure C.7.17: Significant trends observed for acidity, iron, and sulphate at station 95N-11, 1995 to 2014.

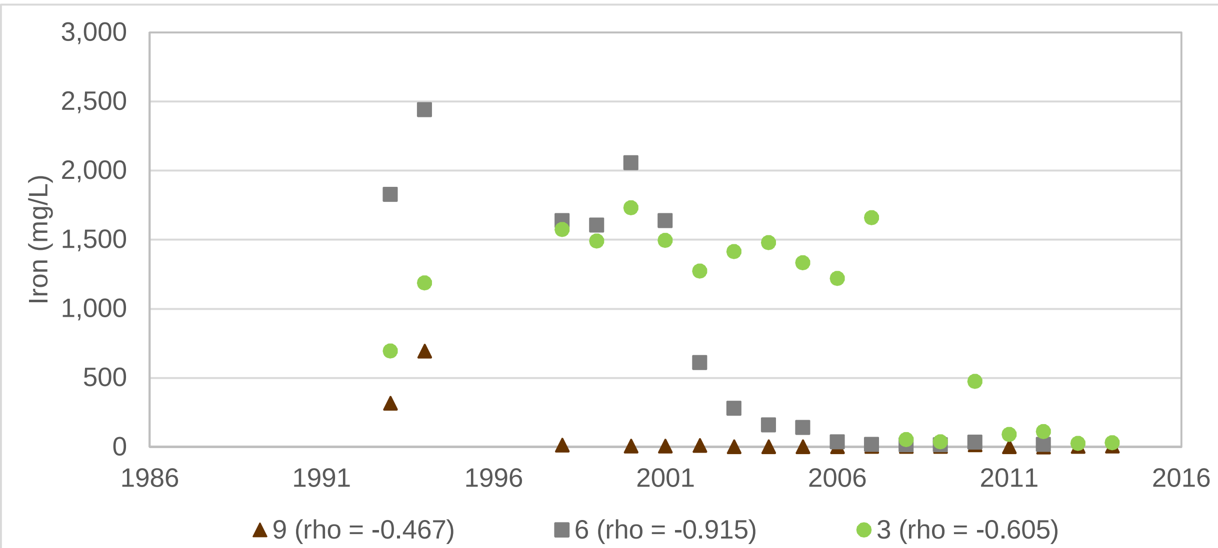


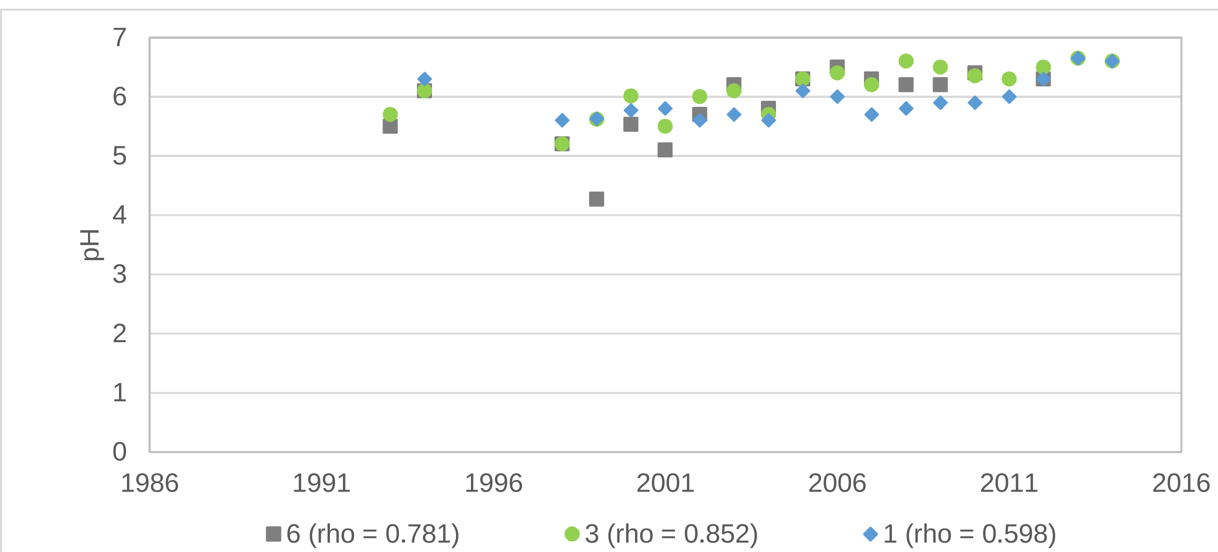
Appendix Figure C.7.18: Significant trends observed for acidity, iron, pH and sulphate at station M-12-1,3,6,9, 1993 to 2014.



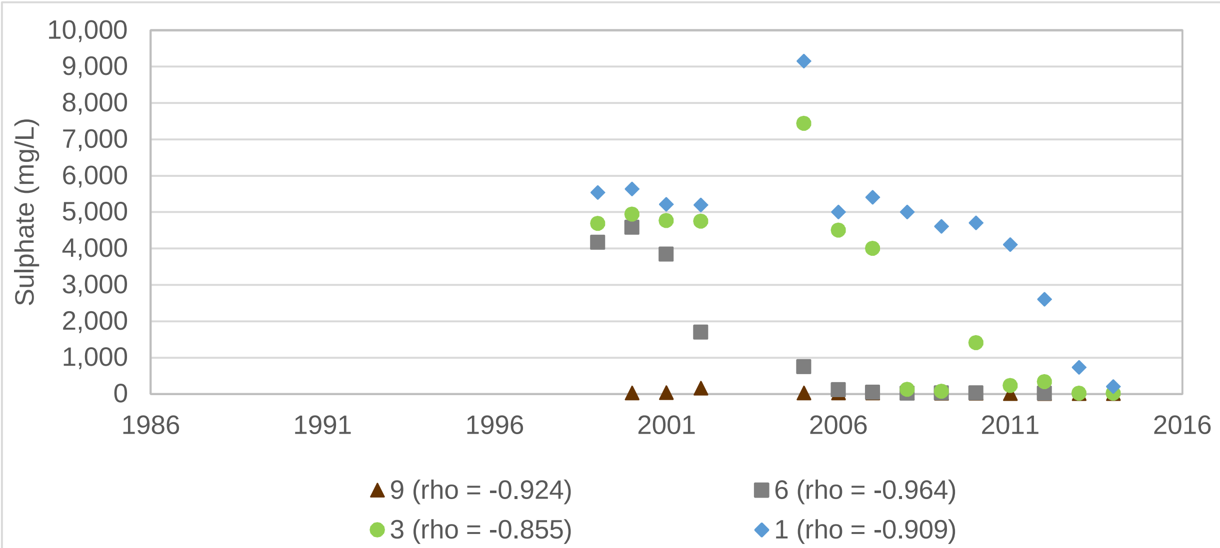
Appendix Figure C.7.18 Significant trends observed for acidity, iron, pH and sulphate at station M-12-1,3,6,9, 1993 to 2014.



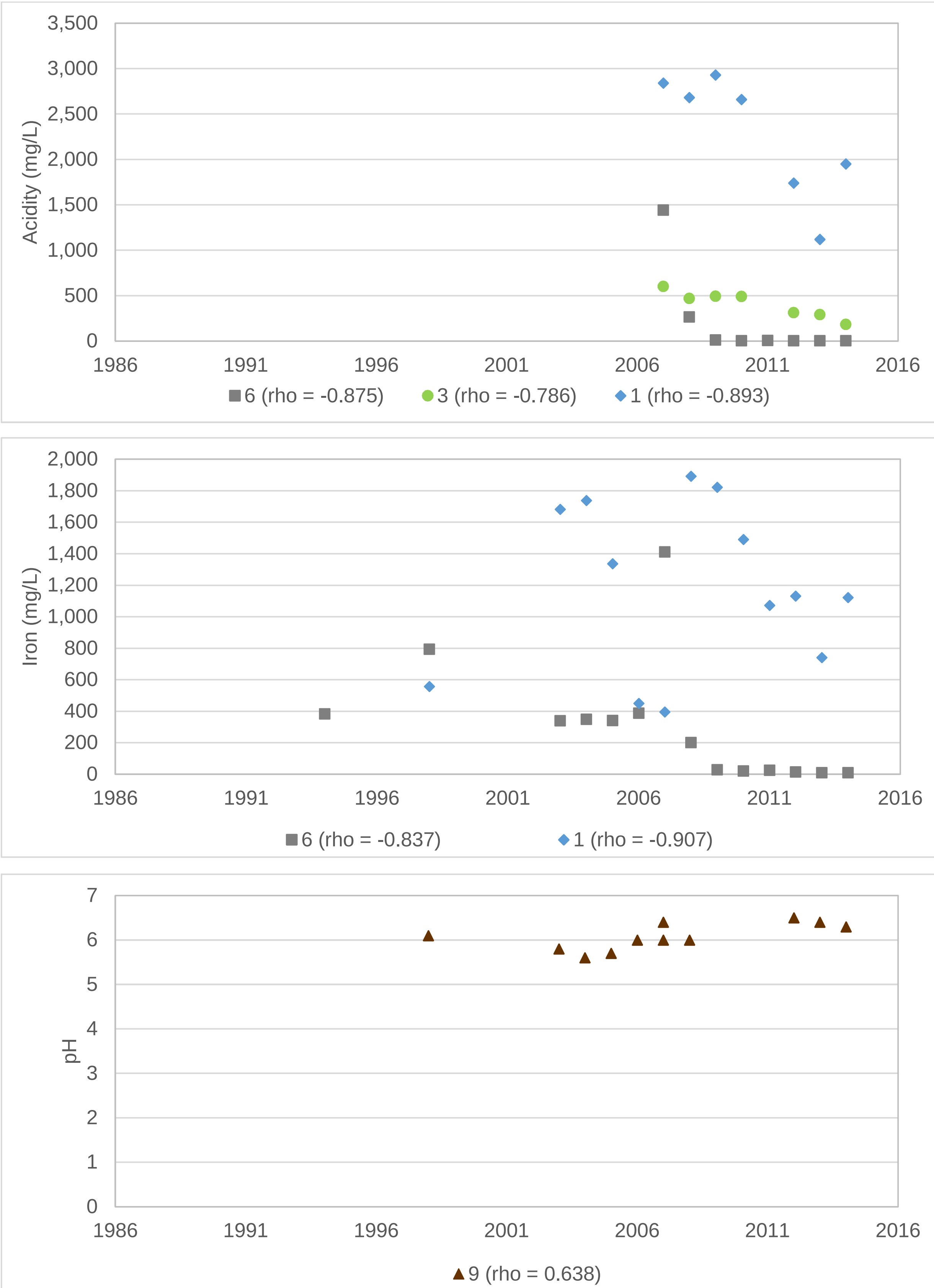




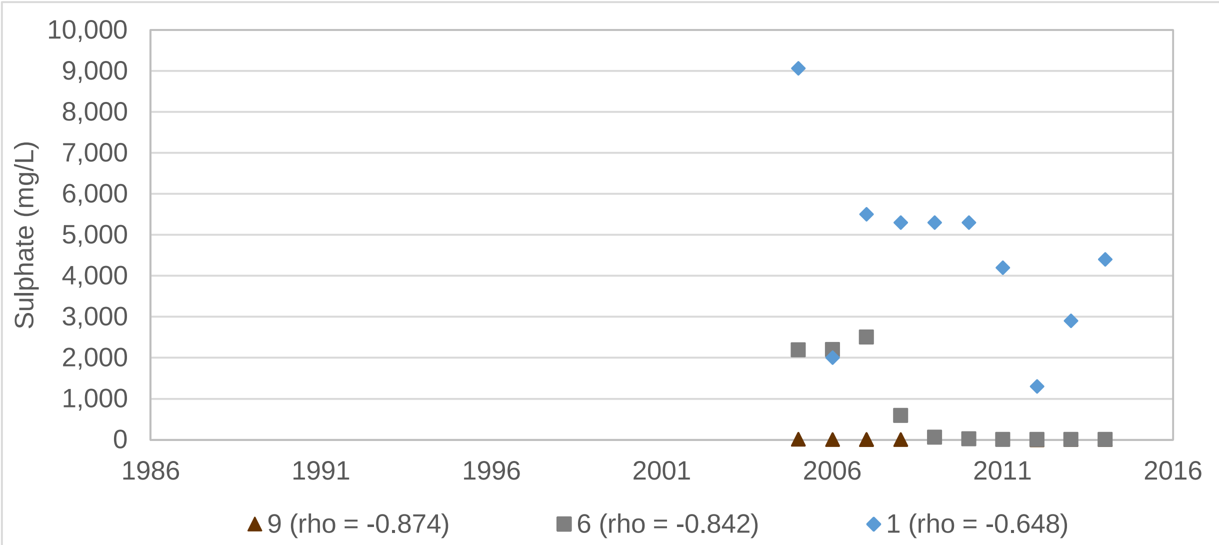
Appendix Figure C.7.19: Significant trends observed for acidity, iron, pH and sulphate at station M-13-1,3,6,9, 1993 to 2014.



Appendix Figure C.7.19: Significant trends observed for acidity, iron, pH and sulphate at station M-13-1,3,6,9, 1993 to 2014.



Appendix Figure C.7.20: Significant trends observed for acidity, iron, pH and sulphate M-14-1,3,6,9, 1998 to 2014.



Appendix Figure C.7.20: Significant trends observed for acidity, iron, pH and sulphate M-14-1,3,6,9, 1998 to 2014.

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 from 2010 to 2014.

Date m/d/yr	Acidity mg/L	Ba mg/L	Co mg/L	Fe mg/L	pH	Ra Bq/L	Sulphate mg/L	U mg/L
3/11/2010	82	0.038	0.171	24.4	3.2	0.32	490	0.044
4/7/2010	72	0.028	0.145	16.1	3.1	0.24	440	0.0433
10/6/2010	70	0.033	0.159	5.97	2.8	0.21	420	0.0483
11/3/2010					3.0	0.17		
12/2/2010					3.1	0.24		
3/30/2011					3.2	0.275		
4/13/2011	56	0.028	0.0979	14.5	3.3	0.216	350	0.0368
5/4/2011					3.8	0.132		
6/1/2011					3.3	0.146		
11/2/2011					3.0	0.27		
11/9/2011	67	0.026	0.107	9.56	3.2	0.268	380	0.0328
12/7/2011					3.2	0.197		
3/7/2012					3.1	0.223		
3/14/2012		0.028	0.0944	12.1	3.1	0.202	370	0.0322
4/4/2012	41	0.022	0.0644	9.63	3.3	0.145	250	0.0151
10/24/2012	63	0.03	0.132	11.3	3.1	0.323	430	0.0504
12/5/2012					3.0	0.261		
3/6/2013	83	0.031	0.235	16.3	3.0	0.266	410	0.0445
3/13/2013					3.1	0.223		
4/3/2013					3.5	0.152		
5/8/2013	18	0.023	0.0828	4.69	3.9	0.091	160	0.008
6/12/2013					5.3	0.146		
8/28/2013					3.2	0.215		
9/4/2013	44	0.032	0.123	5.71	3.1	0.23	310	0.0213
10/2/2013					3.0	0.236		
11/7/2013	43	0.028	0.1	6.92	3.2	0.204	290	0.021
11/19/2013					3.3		270	
12/4/2013					3.2	0.17		
3/26/2014	42	0.032	0.113	6.97	3.3	0.168	300	0.0188
4/9/2014					3.8	0.209		
5/7/2014	32	0.022	0.0519	7.47	3.4	0.117	220	0.0083
6/4/2014					3.2			
8/21/2014	6	0.032	0.0559	1.03	3.8	0.169	270	0.0116
9/3/2014					3.3	0.189		
10/1/2014	40	0.031	0.0719	2.54	3.2	0.17	300	0.0169
11/5/2014					3.3	0.143		
12/3/2014					3.8	0.138		
count	15	16	16	16	37	35	17	16
min	6	0.022	0.052	1	2.80	0.091	160	0.0080
max	83	0.038	0.235	24	5.30	0.323	490	0.0504
mean	51	0.029	0.113	10	3.32	0.202	333	0.0283
median	44	0.029	0.104	9	3.20	0.204	310	0.0268
10th Percentile	24	0.023	0.060	4	3.00	0.140	238	0.0100
95th Percentile	82	0.034	0.187	18	3.82	0.289	450	0.0488

Appendix Table C.8.3: Water quality at station PR-03 from 2010 to 2014.

Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH
3/9/2010	8.4	10/25/2010	9.1	4/15/2011	8.4	11/15/2011	8.3	3/27/2012	8.4
3/10/2010	8.0	10/26/2010	9.1	4/18/2011	8.3	11/16/2011	8.3	3/28/2012	8.3
3/11/2010	8.2	10/27/2010	8.9	4/19/2011	8.3	11/17/2011	8.5	3/29/2012	8.4
3/12/2010	8.2	10/28/2010	9.0	4/20/2011	8.4	11/18/2011	8.4	3/30/2012	8.4
3/15/2010	8.4	10/29/2010	9.1	4/21/2011	8.5	11/21/2011	8.4	4/2/2012	8.3
3/16/2010	8.4	11/1/2010	9.1	4/25/2011	8.3	11/22/2011	8.3	4/3/2012	8.4
3/17/2010	8.4	11/2/2010	9.0	4/26/2011	8.3	11/23/2011	8.4	4/4/2012	8.4
3/18/2010	8.4	11/3/2010	9.1	4/27/2011	8.5	11/24/2011	8.7	4/5/2012	8.4
3/19/2010	8.7	11/4/2010	9.2	4/28/2011	8.3	11/25/2011	8.5	4/9/2012	8.4
3/22/2010	8.4	11/5/2010	9.3	4/29/2011	8.3	11/28/2011	8.5	4/10/2012	8.4
3/23/2010	8.4	11/8/2010	8.9	5/2/2011	8.4	11/29/2011	8.7	4/11/2012	8.2
3/24/2010	8.4	11/9/2010	9.0	5/3/2011	8.3	11/30/2011	8.7	4/12/2012	8.3
3/25/2010	8.4	11/10/2010	9.1	5/4/2011	8.3	12/1/2011	8.6	4/13/2012	8.5
3/26/2010	8.4	11/11/2010	8.9	5/5/2011	8.3	12/2/2011	8.6	4/16/2012	8.0
3/29/2010	9.0	11/12/2010	9.0	5/6/2011	8.4	12/5/2011	8.6	4/17/2012	8.3
3/30/2010	8.4	11/15/2010	9.1	5/9/2011	8.4	12/6/2011	8.6	4/18/2012	8.0
3/31/2010	8.6	11/16/2010	9.0	5/10/2011	8.3	12/7/2011	8.6	4/19/2012	8.4
4/1/2010	8.6	11/17/2010	8.9	5/11/2011	8.4	12/8/2011	8.4	4/20/2012	8.6
4/5/2010	8.9	11/18/2010	9.1	5/12/2011	8.3	12/9/2011	8.4	4/23/2012	8.4
4/6/2010	9.0	11/19/2010	9.1	5/13/2011	8.3	12/12/2011	8.5	4/24/2012	8.6
4/7/2010	8.6	11/22/2010	9.2	5/16/2011	8.2	12/13/2011	8.3	4/25/2012	8.3
4/8/2010	8.6	12/1/2010	8.8	5/17/2011	8.2	12/14/2011	8.4	4/26/2012	8.4
4/9/2010	8.6	12/2/2010	8.9	5/18/2011	8.4	12/15/2011	8.2	4/27/2012	8.6
4/12/2010	9.0	12/3/2010	8.9	5/19/2011	8.7	12/16/2011	8.3	4/30/2012	8.5
4/13/2010	8.9	12/6/2010	9.1	5/20/2011	8.4	12/19/2011	8.1	5/1/2012	8.7
4/14/2010	9.0	12/7/2010	9.0	5/24/2011	8.5	12/20/2011	8.3	10/10/2012	8.4
4/15/2010	8.9	12/8/2010	8.9	5/25/2011	8.5	12/21/2011	8.1	10/11/2012	8.6
4/16/2010	8.9	12/9/2010	8.9	5/26/2011	8.6	12/22/2011	8.2	10/12/2012	8.6
4/19/2010	8.9	12/10/2010	8.3	5/27/2011	8.3	2/22/2012	8.5	10/15/2012	8.4
4/20/2010	8.9	12/13/2010	8.3	5/30/2011	8.5	2/23/2012	8.6	10/16/2012	8.4
4/21/2010	8.9	12/14/2010	8.3	5/31/2011	8.5	2/24/2012	8.3	10/17/2012	8.4
4/22/2010	9.0	12/15/2010	8.6	6/1/2011	8.6	2/27/2012	8.2	10/18/2012	8.5
9/24/2010	6.8	12/16/2010	8.6	6/2/2011	8.4	2/28/2012	8.2	10/19/2012	8.3
9/27/2010	8.5	3/21/2011	9.0	6/3/2011	8.2	2/29/2012	8.2	10/22/2012	8.4
9/28/2010	9.2	3/22/2011	9.1	6/6/2011	8.3	3/1/2012	8.1	10/23/2012	8.3
9/29/2010	8.3	3/23/2011	9.0	6/7/2011	8.5	3/2/2012	8.2	10/24/2012	8.4
9/30/2010	8.1	3/24/2011	8.9	10/24/2011	8.4	3/5/2012	8.1	10/25/2012	8.4
10/1/2010	8.5	3/25/2011	8.5	10/25/2011	8.4	3/6/2012	8.2	10/26/2012	8.6
10/4/2010	9.2	3/28/2011	8.7	10/26/2011	8.4	3/7/2012	8.3	10/29/2012	8.6
10/5/2010	8.6	3/29/2011	8.4	10/27/2011	8.4	3/8/2012	8.3	11/27/2012	8.4
10/6/2010	8.4	3/30/2011	8.2	10/28/2011	8.3	3/9/2012	8.2	11/28/2012	8.4
10/7/2010	8.2	3/31/2011	8.2	10/31/2011	8.3	3/12/2012	8.3	11/29/2012	8.4
10/8/2010	8.2	4/1/2011	8.2	11/1/2011	8.3	3/13/2012	8.4	11/30/2012	8.5
10/12/2010	8.4	4/4/2011	8.3	11/2/2011	8.4	3/14/2012	8.3	12/3/2012	8.5
10/13/2010	8.5	4/5/2011	8.2	11/3/2011	8.3	3/15/2012	8.3	12/4/2012	8.2
10/14/2010	8.5	4/6/2011	8.4	11/4/2011	8.3	3/16/2012	8.4	12/5/2012	8.4
10/15/2010	8.5	4/7/2011	8.3	11/7/2011	8.4	3/19/2012	8.5	12/6/2012	8.4
10/18/2010	8.6	4/8/2011	8.2	11/8/2011	8.4	3/20/2012	8.6	12/7/2012	8.4
10/19/2010	8.8	4/11/2011	8.3	11/9/2011	8.3	3/21/2012	8.5	12/10/2012	8.3
10/20/2010	9.1	4/12/2011	8.1	11/10/2011	8.4	3/22/2012	8.5	12/11/2012	8.4
10/21/2010	9.1	4/13/2011	8.3	11/11/2011	8.4	3/23/2012	8.4	2/21/2013	8.5
10/22/2010	9.4	4/14/2011	8.6	11/14/2011	8.3	3/26/2012	8.6	2/22/2013	8.5

Appendix Table C.8.3: Water quality at station PR-03 from 2010 to 2014.

Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH
2/25/2013	8.5	5/9/2013	8.5	9/13/2013	8.6	3/10/2014	8.5	5/23/2014	8.6
2/26/2013	8.5	5/10/2013	8.3	9/16/2013	8.6	3/11/2014	8.3	5/26/2014	8.5
2/27/2013	8.3	5/13/2013	8.4	9/17/2013	8.6	3/12/2014	8.3	5/27/2014	8.5
2/28/2013	8.1	5/14/2013	8.6	9/18/2013	8.6	3/13/2014	8.4	5/28/2014	8.6
3/1/2013	8.1	5/15/2013	8.5	9/19/2013	8.6	3/14/2014	8.6	5/29/2014	8.6
3/4/2013	8.2	5/16/2013	8.5	9/20/2013	8.7	3/17/2014	8.5	5/30/2014	8.6
3/5/2013	8.1	5/17/2013	8.6	9/23/2013	8.7	3/18/2014	8.5	6/2/2014	8.6
3/6/2013	7.9	5/21/2013	8.4	9/24/2013	8.5	3/19/2014	8.3	6/3/2014	8.6
3/7/2013	8.0	5/22/2013	8.5	9/25/2013	8.8	3/20/2014	8.2	6/4/2014	8.6
3/8/2013	8.0	5/23/2013	8.4	9/26/2013	8.6	3/21/2014	8.2	6/5/2014	8.6
3/11/2013	8.0	5/24/2013	8.7	9/27/2013	8.5	3/24/2014	8.2	6/6/2014	8.7
3/12/2013	8.0	5/27/2013	8.3	9/30/2013	8.8	3/25/2014	8.1	6/9/2014	8.8
3/13/2013	8.2	5/28/2013	8.6	10/1/2013	8.9	3/26/2014	8.3	6/10/2014	8.8
3/14/2013	8.2	5/29/2013	8.6	10/2/2013	8.8	3/27/2014	8.2	6/11/2014	8.8
3/15/2013	8.4	5/30/2013	8.4	10/30/2013	8.5	3/28/2014	8.1	6/12/2014	8.8
3/18/2013	8.1	5/31/2013	8.6	10/31/2013	8.6	3/31/2014	8.1	6/13/2014	8.8
3/19/2013	8.2	6/3/2013	8.5	11/1/2013	8.5	4/1/2014	8.1	8/8/2014	8.2
3/20/2013	8.2	6/4/2013	8.4	11/4/2013	8.5	4/2/2014	8.1	8/11/2014	
3/21/2013	8.1	6/5/2013	8.4	11/5/2013	8.4	4/3/2014	8.1	8/12/2014	8.3
3/22/2013	8.3	6/6/2013	8.5	11/6/2013	8.5	4/4/2014	8.1	8/13/2014	8.4
3/25/2013	8.0	6/7/2013	8.5	11/7/2013	8.6	4/7/2014	8.1	8/14/2014	8.6
3/26/2013	8.1	6/10/2013	8.5	11/8/2013	8.6	4/8/2014	8.1	8/15/2014	8.8
3/27/2013	8.1	6/11/2013	8.7	11/11/2013	8.6	4/9/2014	8.1	8/18/2014	8.8
3/28/2013	8.1	6/12/2013	8.5	11/12/2013	8.6	4/10/2014	8.1	8/19/2014	8.7
4/1/2013	8.1	6/13/2013	8.6	11/13/2013	8.7	4/11/2014	8.0	8/20/2014	8.8
4/2/2013	8.2	6/14/2013	8.7	11/14/2013	8.6	4/14/2014	8.3	8/21/2014	8.8
4/3/2013	8.1	6/17/2013	8.6	11/15/2013	8.9	4/15/2014	8.5	8/22/2014	8.7
4/4/2013	8.1	6/18/2013	8.7	11/18/2013	8.8	4/16/2014	8.5	8/25/2014	8.7
4/5/2013	8.2	6/19/2013	8.8	11/19/2013	8.9	4/17/2014	8.4	8/26/2014	8.7
4/8/2013	8.0	6/20/2013	8.8	11/20/2013	8.9	4/21/2014	8.5	8/27/2014	8.7
4/9/2013	8.1	6/21/2013	8.8	11/21/2013	8.9	4/22/2014	8.3	8/28/2014	8.7
4/10/2013	8.1	6/24/2013	8.8	11/22/2013	8.9	4/23/2014	8.3	8/29/2014	8.8
4/11/2013	8.5	6/25/2013	8.8	11/25/2013	8.9	4/24/2014	8.1	9/2/2014	8.8
4/12/2013	8.4	6/26/2013	8.6	11/26/2013	8.9	4/25/2014	8.3	9/3/2014	8.6
4/15/2013	8.5	6/27/2013	8.6	11/27/2013	8.9	4/28/2014	8.3	9/4/2014	8.6
4/16/2013	8.5	6/28/2013	8.6	11/28/2013	8.6	4/29/2014	8.3	9/5/2014	8.6
4/17/2013	8.5	8/21/2013	8.8	11/29/2013	8.6	4/30/2014	8.4	9/8/2014	8.6
4/18/2013	8.5	8/22/2013	8.7	12/2/2013	8.4	5/1/2014	8.5	9/9/2014	8.6
4/19/2013	8.3	8/23/2013	8.6	12/3/2013	8.5	5/2/2014	8.4	9/10/2014	8.6
4/22/2013	8.4	8/26/2013	8.8	12/4/2013	8.5	5/5/2014	9.0	9/11/2014	8.7
4/23/2013	8.5	8/27/2013	8.7	12/5/2013	8.6	5/6/2014	8.4	9/12/2014	8.8
4/24/2013	8.5	8/28/2013	8.6	12/6/2013	8.4	5/7/2014	8.5	9/15/2014	8.7
4/25/2013	8.5	8/29/2013	8.5	12/9/2013	8.5	5/8/2014	8.4	9/16/2014	8.6
4/26/2013	8.7	8/30/2013	8.5	12/10/2013	8.5	5/9/2014	8.4	9/17/2014	8.6
4/29/2013	8.5	9/3/2013	8.7	12/11/2013	8.4	5/12/2014	8.5	9/18/2014	8.7
4/30/2013	8.6	9/4/2013	8.5	12/12/2013	8.6	5/13/2014	8.4	9/19/2014	8.8
5/1/2013	8.5	9/5/2013	8.3	12/13/2013	8.6	5/14/2014	8.4	9/22/2014	8.9
5/2/2013	8.6	9/6/2013	8.5	12/16/2013	8.6	5/15/2014	8.4	9/23/2014	8.8
5/3/2013	8.5	9/9/2013	8.5	3/4/2014	8.6	5/16/2014	8.6	9/24/2014	8.9
5/6/2013	8.6	9/10/2013	8.5	3/5/2014	8.8	5/20/2014	8.5	9/25/2014	9.0
5/7/2013	8.5	9/11/2013	8.5	3/6/2014	8.6	5/21/2014	8.5	9/26/2014	8.9
5/8/2013	8.5	9/12/2013	8.5	3/7/2014	8.6	5/22/2014	8.6	9/29/2014	9.0

Appendix Table C.8.3: Water quality at station PR-03 from 2010 to 2014.

Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH	Date (m/d/y)	pH
9/30/2014	8.9	12/12/2014	8.8						
10/1/2014	9.0	12/15/2014	8.6						
10/2/2014	9.1	12/16/2014	8.6						
10/3/2014	9.2	12/17/2014	8.6						
10/6/2014	8.9	**count**	**575**						
10/7/2014	8.9	**min**	**6.8**						
10/8/2014	8.9	**max**	**9.4**						
10/9/2014	9.1	**mean**	**8.5**						
10/10/2014	9.0	**median**	**8.5**						
10/14/2014	8.8								
10/15/2014	8.7								
10/16/2014	8.8								
10/17/2014	8.7								
10/20/2014	8.7								
10/21/2014	8.7								
10/22/2014	8.8								
10/23/2014	8.8								
10/24/2014	8.9								
10/27/2014	8.8								
10/28/2014	9.0								
10/29/2014	9.1								
10/30/2014	8.9								
10/31/2014	9.0								
11/3/2014	8.9								
11/4/2014	8.9								
11/5/2014	8.9								
11/6/2014	8.9								
11/7/2014	8.9								
11/10/2014	9.0								
11/11/2014	8.9								
11/12/2014	9.1								
11/13/2014	9.2								
11/14/2014	8.9								
11/17/2014	8.9								
11/18/2014	8.8								
11/19/2014	8.7								
11/20/2014	8.9								
11/21/2014	8.9								
11/24/2014	8.7								
11/25/2014	8.7								
11/26/2014	8.9								
11/27/2014	8.9								
11/28/2014	8.7								
12/1/2014	8.8								
12/2/2014	8.7								
12/3/2014	8.6								
12/4/2014	8.6								
12/5/2014	8.6								
12/8/2014	8.6								
12/9/2014	8.7								
12/10/2014	8.8								
12/11/2014	8.5								

Appendix Table C.8.4: Water quality at station PR-04 from 2010 to 2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Mn mg/L	pH	Ra Bq/L	Sulphate mg/L	TSS mg/L	U mg/L
3/11/2010	0.03	0.0118	0.06	0.155	8.2	0.1	400	1	0.0175
3/17/2010					8.2	0.13		1	
3/24/2010					8.2	0.1		< 1	
3/31/2010					8.0	0.11		1	
4/7/2010	0.023	0.0119	0.2	0.185	8.0	0.12	400	1	0.0077
4/14/2010					8.2	0.099		1	
4/21/2010					8.1	0.1		1	
9/29/2010					8.1	0.11		1	
10/6/2010	0.023	0.0243	0.19	0.263	8.3	0.091	470	1	0.0097
10/13/2010					7.4	0.13		< 1	
10/20/2010					8.2	0.11		1	
10/27/2010					7.4	0.11		2	
11/3/2010	0.023	0.0215	0.27	0.329	7.6	0.12	420	1	0.0081
11/10/2010					7.5	0.15		< 1	
11/17/2010					7.8	0.13		1	
12/2/2010	0.021	0.023	0.27	0.308	7.5	0.101	400	1	0.0107
12/8/2010					8.8	0.08		1	
12/15/2010					8.7	0.13		< 1	
3/24/2011					8.9	0.101		1	
3/30/2011	0.023	0.0275	0.58	0.371	8.5	0.121	480	2	0.0228
4/6/2011					8.2	0.119		1	
4/13/2011	0.023	0.0219	0.38	0.295	8.0	0.1	340	< 1	0.0205
4/20/2011					7.6	0.068		1	
4/27/2011					7.4	0.06		1	
5/4/2011	0.015	0.0145	0.38	0.178	7.7	0.064	230	1	0.0073
5/11/2011					7.5	0.071		1	
5/18/2011					7.1	0.098		1	
5/25/2011					7.3	0.086		1	
6/1/2011	0.019	0.0131	0.19	0.195	7.4	0.082	290	1	0.0026
6/7/2011					7.3	0.112		1	
10/27/2011					7.6	0.085		1	
11/2/2011					7.4	0.146		1	
11/9/2011	0.022	0.0375	0.31	0.383	7.2	0.163	370	2	0.0069
11/16/2011					7.2	0.159		< 1	
11/23/2011					7.4	0.145		< 1	
11/30/2011					7.1	0.129		1	
12/7/2011	0.024	0.0288	0.49	0.311	7.6	0.151	340	2	0.0075
12/14/2011					8.1	0.133		1	
12/21/2011					8.1	0.114		1	
2/29/2012					7.4	0.119		1	
3/7/2012	0.023	0.0293	0.3	0.338	7.6	0.114	370	2	0.0122
3/14/2012					7.4	0.11		2	
3/20/2012					7.4	0.102		< 1	
3/28/2012					7.4	0.084		1	
4/4/2012					7.3	0.087		1	
4/11/2012	0.018	0.0184	0.34	0.215	7.2	0.098	280	< 1	0.0029
4/17/2012					7.2	0.11		1	
4/25/2012					7.1	0.104		1	
6/18/2012					8.2	0.059		1	
10/17/2012					7.6	0.157		1	
10/24/2012	0.025	0.0426	0.21	0.424	7.4	0.163	380	1	0.0108

Appendix Table C.8.4: Water quality at station PR-04 from 2010 to 2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Mn mg/L	pH	Ra Bq/L	Sulphate mg/L	TSS mg/L	U mg/L
11/29/2012					7.4	0.127		1	
12/5/2012	0.023	0.0562	0.33	0.406	7.5	0.151	430	1	0.0092
12/10/2012					7.6	0.149		1	
2/27/2013					8.7	0.142		2	
3/6/2013	0.025	0.0806	0.45	0.491	7.5	0.165	420	1	0.0149
3/13/2013					7.1	0.148		2	
3/20/2013					7.5	0.135		1	
3/27/2013					7.7	0.12		1	
4/3/2013	0.024	0.0835	0.46	0.33	7.5	0.118	270	2	0.0125
4/10/2013					7.6	0.096		2	
4/17/2013					7.5	0.067		1	
4/24/2013					7.5	0.053		2	
5/1/2013					7.6	0.048		2	
5/8/2013	0.02	0.0328	0.41	0.167	7.9	0.075	180	2	0.0062
5/15/2013					7.5	0.073		2	
5/22/2013					7.4	0.092		1	
5/29/2013					7.4	0.1		1	
6/5/2013					7.4	0.104		1	
6/12/2013	0.023	0.0341	0.17	0.223	7.4	0.109	270	1	0.0024
6/19/2013					7.3	0.094		<1	
6/26/2013					7.5	0.105		1	
8/28/2013	0.025	0.0217	0.28	0.181	7.8	0.109	260	2	0.0078
9/4/2013	0.026	0.0246	0.15	0.214	7.7	0.108	280	1	0.0052
9/11/2013					7.3	0.114		1	
9/18/2013					7.2	0.134		2	
9/25/2013					7.2	0.133		1	
10/2/2013	0.026	0.0254	0.15	0.235	7.2	0.118	320	1	0.0038
11/1/2013					7.5	0.084		2	
11/7/2013	0.023	0.0358	0.75	0.274	7.4	0.109	280	2	0.0068
11/12/2013					7.1	0.101		1	
11/19/2013			0.45		7.1	0.09	260	2	
11/27/2013					8.5	0.089		2	
12/4/2013	0.024	0.0315	0.68	0.274	8.0	0.119	280	2	0.0054
12/11/2013					7.5	0.114		1	
12/16/2013					7.9	0.103		< 1	
3/7/2014					7.7	0.091		1	
3/12/2014					7.6	0.113		1	
3/19/2014					8.2	0.115		2	
3/26/2014	0.026	0.0427	0.31	0.331	7.6	0.108	310	2	0.0101
4/2/2014					7.5	0.103		2	
4/9/2014	0.023	0.0265	0.61	0.282	7.2	0.098	300	1	0.0133
4/16/2014					7.7	0.078		6	
4/23/2014					7.4	0.062		4	
4/30/2014					7.2	0.073		2	
5/7/2014	0.019	0.0122	0.38	0.177	7.6	0.059	210	1	0.0042
5/14/2014					7.4	0.075		2	
5/21/2014					7.3	0.076		1	
5/28/2014					7.1	0.083		1	
6/4/2014	0.023	0.0147	0.15	0.17	7.3	0.087	220	1	0.0022
6/11/2014					7.4	0.087		1	
8/13/2014					7.6	0.096		1	

Appendix Table C.8.4: Water quality at station PR-04 from 2010 to 2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Mn mg/L	pH	Ra Bq/L	Sulphate mg/L	TSS mg/L		U mg/L
8/21/2014	0.025	0.0131	0.16	0.17	7.5	0.102	250		1	0.0039
8/27/2014					7.5	0.085			2	
9/3/2014	0.021	0.0069	0.15	0.113	7.5	0.082	270		1	0.0047
9/10/2014					7.3	0.081		<	1	
9/17/2014					7.2	0.087			1	
9/24/2014					7.2	0.093			1	
10/1/2014	0.023	0.0124	0.17	0.161	7.2	0.105	280	<	1	0.0035
10/9/2014					7.2	0.093			1	
10/15/2014					7.1	0.109			2	
10/22/2014					7.3	0.102			1	
10/29/2014					7.1	0.102			1	
11/5/2014	0.021	0.0149	0.34	0.212	7.3	0.111	230	<	1	0.0039
11/12/2014					7.0	0.107			1	
11/19/2014					8.4	0.094		<	1	
11/26/2014					7.6	0.08			1	
12/3/2014	0.024	0.0131	0.79	0.176	7.9	0.092	170		2	0.0076
12/10/2014					8.3	0.086		<	1	
12/17/2014					7.7	0.08			1	
count	33	33	34	33	120	120	34		119	33
min	0.015	0.0069	0.06	0.113	7.0	0.048	170	<	1.0	0.0022
max	0.030	0.0835	0.79	0.491	8.9	0.165	480		6.0	0.0228
mean	0.023	0.0275	0.34	0.259	7.6	0.104	314		1.3	0.0083
median	0.023	0.0243	0.31	0.235	7.5	0.102	285		1.0	0.0075
10th Percentile	0.019	0.0122	0.15	0.168	7.2	0.075	223		1.0	0.0030
95th Percentile	0.026	0.0660	0.70	0.413	8.4	0.151	444		2.0	0.0187

Appendix Table C.8.5: Summary of seasonal trends for station PR-02 from 2003 to 2014.

Month	Spearman's rho	Acidity	Ba	Co	Fe	Mn	pH	Ra	Sulphate	U
January	Correlation Coefficient							-0.100		
	Sig. (2-tailed)							0.873		
	N							5		
March	Correlation Coefficient	-0.486	0.500	-0.250			0.464	0.055	-0.750	-0.893
	Sig. (2-tailed)	0.329	0.253	0.589			0.354	0.881	0.052	0.007
	N	6	7	7			6	10	7	7
April	Correlation Coefficient	-0.552	0.255	-0.079		0.571	-0.103	0.425	0.286	0.139
	Sig. (2-tailed)	0.098	0.476	0.829		0.180	0.750	0.169	0.424	0.701
	N	10	10	10		7	12	12	10	10
May	Correlation Coefficient							-0.886		
	Sig. (2-tailed)							0.019		
	N							6		
June	Correlation Coefficient							-0.359		
	Sig. (2-tailed)							0.553		
	N							5		
October	Correlation Coefficient	-1.000	0.600	-0.700			0.618	-0.371	-0.800	-0.800
	Sig. (2-tailed)	0.000	0.285	0.188			0.191	0.468	0.104	0.104
	N	5	5	5			6	6	5	5
November	Correlation Coefficient	-0.600	-0.667	-0.600			0.927	-0.150	-0.667	-1.000
	Sig. (2-tailed)	0.285	0.219	0.285			0.003	0.700	0.219	0.000
	N	5	5	5			7	9	5	5
December	Correlation Coefficient						0.748	-0.345		
	Sig. (2-tailed)						0.053	0.328		
	N						7	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).

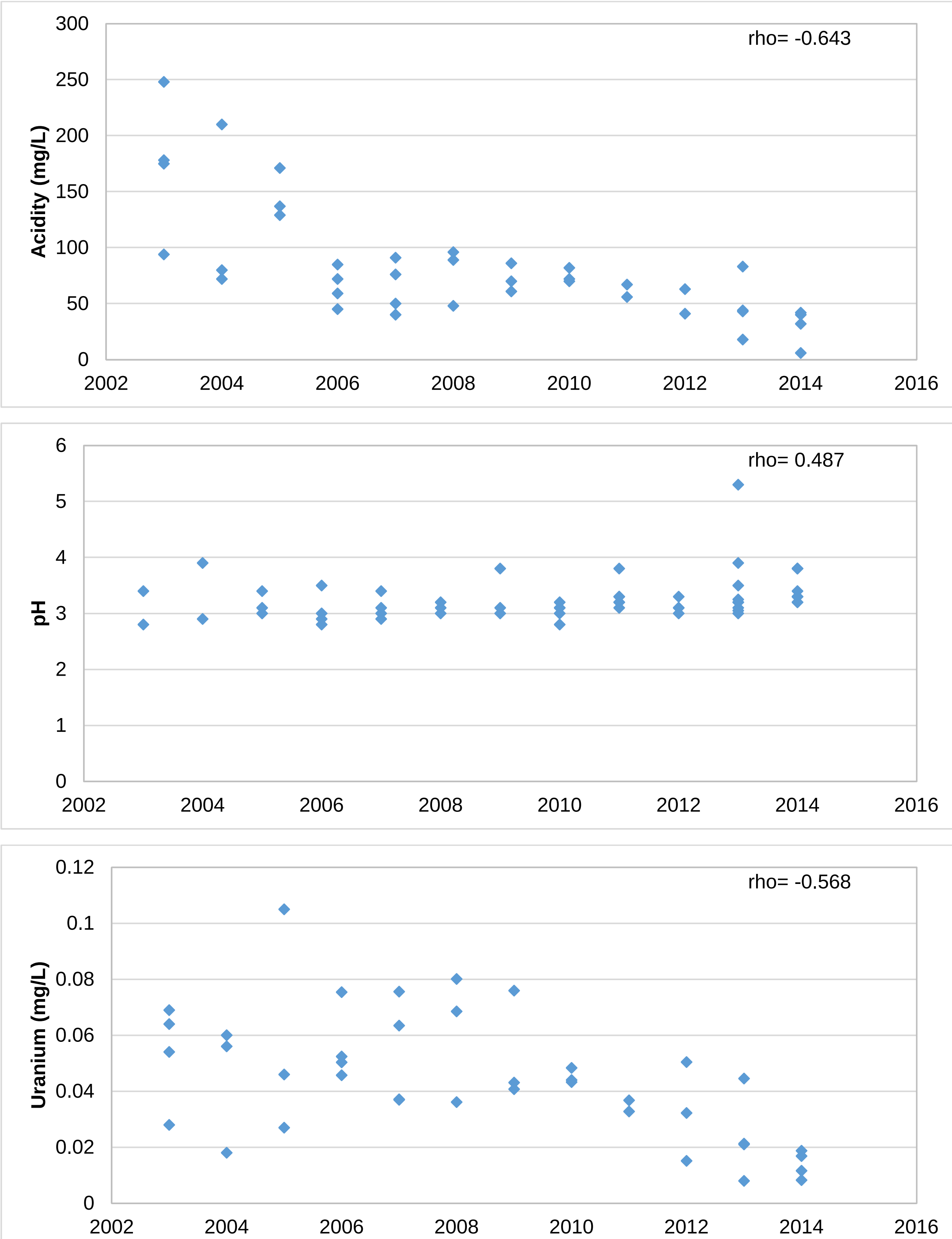
Significant trend where p<0.05.

Appendix Table C.8.6: Summary of seasonal trends for station PR-04 from 2003 to 2014.

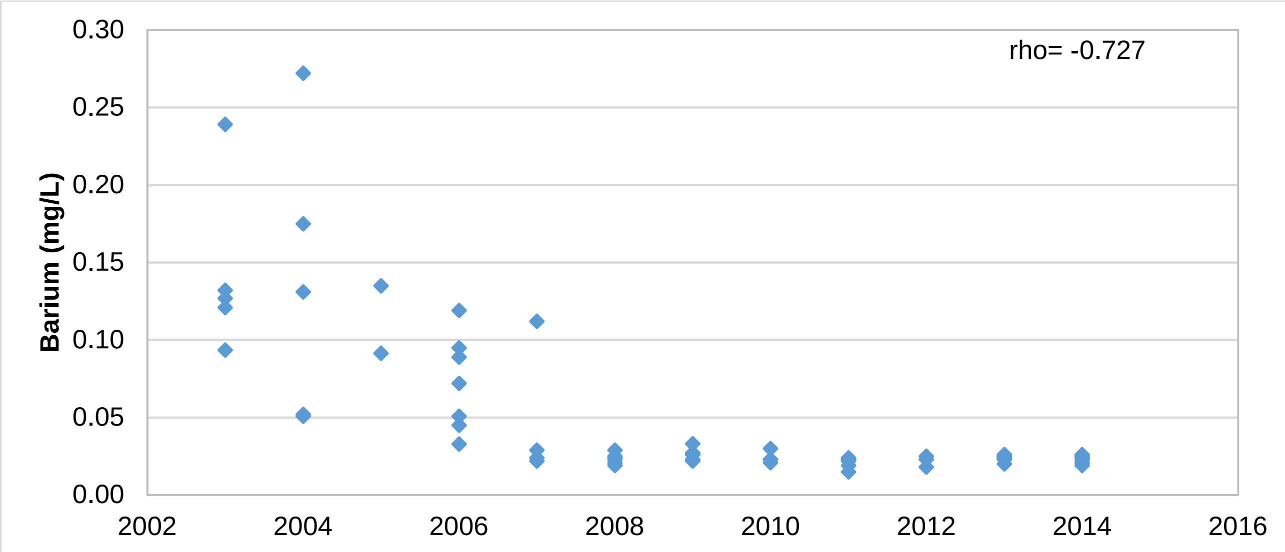
Month	Spearman's rho	Ba	Co	Fe	Mn	pH	Ra	Sulphate	TSS	U
January	Correlation Coefficient	-0.800	-0.300		-0.600	0.600	0.000		-0.800	-0.600
	Sig. (2-tailed)	0.104	0.624		0.285	0.285	1.000		0.104	0.285
	N	5	5		5	5	5		5	5
March	Correlation Coefficient	-0.731	-0.048	0.300	-0.071	-0.523	0.273	-0.143	0.093	-0.929
	Sig. (2-tailed)	0.040	0.911	0.624	0.867	0.121	0.446	0.787	0.798	0.001
	N	8	8	5	8	10	10	6	10	8
April	Correlation Coefficient	-0.829	0.056	0.900	0.501	-0.706	0.469	-0.153	0.131	-0.357
	Sig. (2-tailed)	0.001	0.862	0.037	0.097	0.010	0.124	0.694	0.686	0.255
	N	12	12	5	12	12	12	9	12	12
May	Correlation Coefficient	-0.857	0.107		-0.107	-0.643	-0.214	-0.943	0.741	0.216
	Sig. (2-tailed)	0.014	0.819		0.819	0.119	0.645	0.005	0.057	0.641
	N	7	7		7	7	7	6	7	7
June	Correlation Coefficient	-0.447	-0.200		0.000	-0.378	0.107		0.408	-1.000
	Sig. (2-tailed)	0.450	0.747		1.000	0.403	0.819		0.363	0.000
	N	5	5		5	7	7		7	5
October	Correlation Coefficient	-0.696	-0.143		-0.600	-0.964	-0.357	-1.000	0.556	-0.600
	Sig. (2-tailed)	0.125	0.787		0.208	0.000	0.432	0.000	0.195	0.208
	N	6	6		6	7	7	5	7	6
November	Correlation Coefficient	-0.937	0.321		0.214	-0.683	0.250	-0.900	0.254	-1.000
	Sig. (2-tailed)	0.002	0.482		0.645	0.042	0.516	0.037	0.509	0.000
	N	7	7		7	9	9	5	9	7
December	Correlation Coefficient	-0.497	0.079	0.900	-0.030	-0.612	-0.128	-0.810	0.326	-0.539
	Sig. (2-tailed)	0.144	0.829	0.037	0.934	0.060	0.725	0.015	0.358	0.108
	N	10	10	5	10	10	10	8	10	10

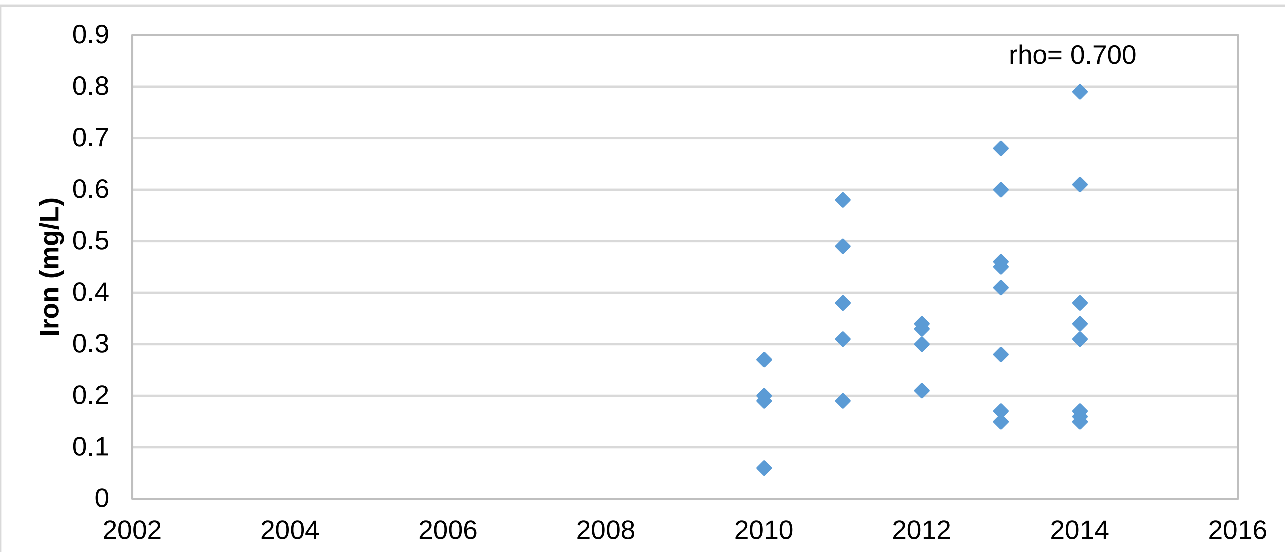
Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

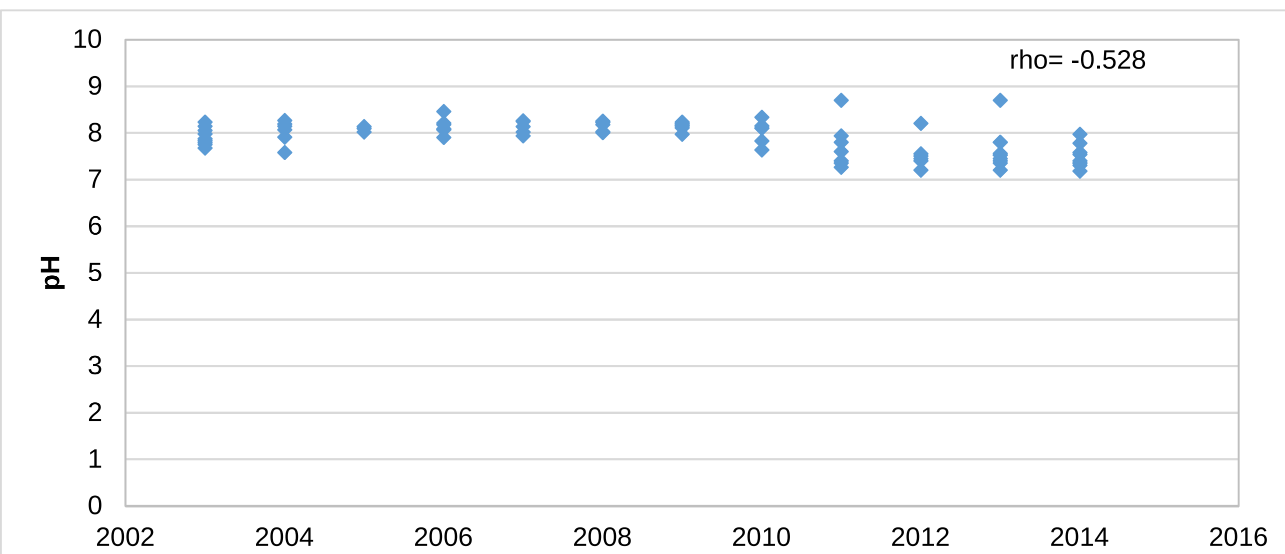
Significant trend where $p<0.05$.



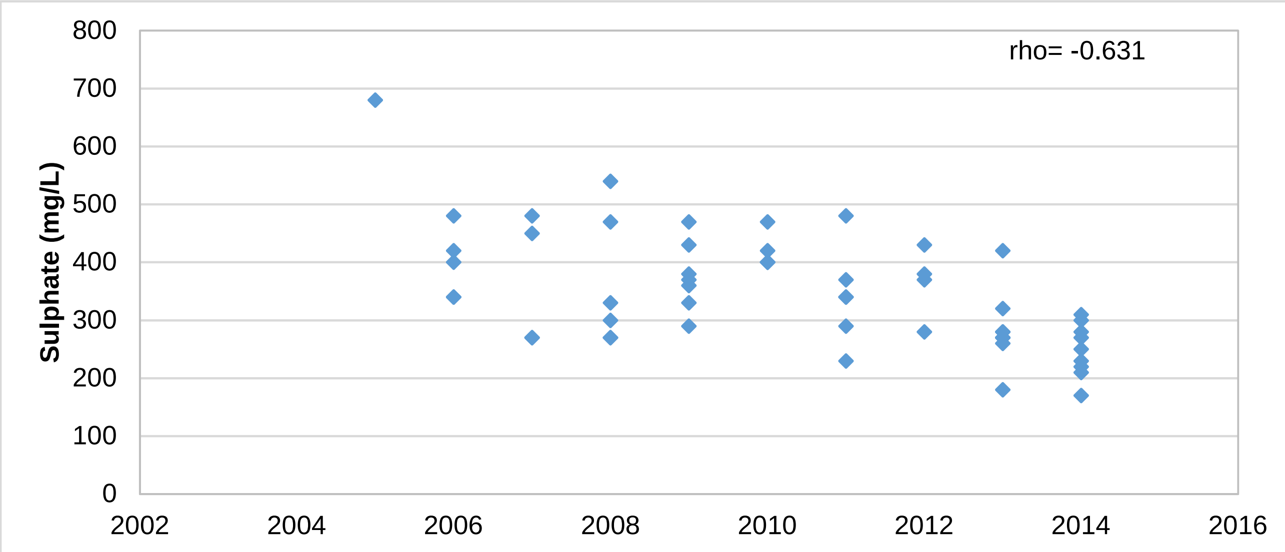
Appendix Figure C.8.1: Significant common (average) trends observed for acidity, pH and uranium, over all seasons at Station PR-02, 2003 to 2014.

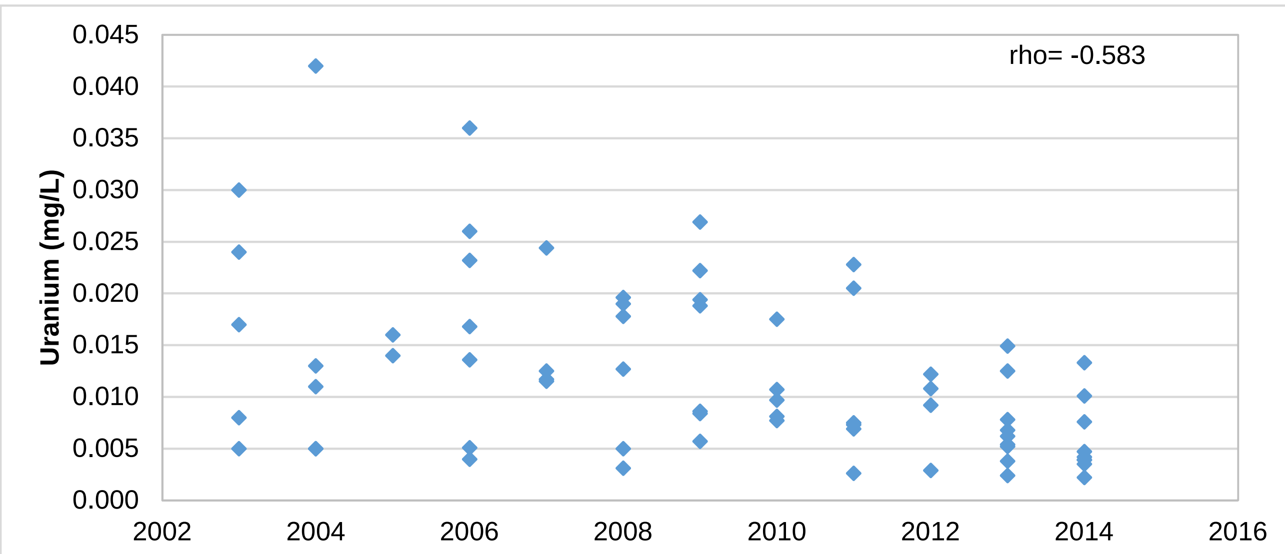






Appendix Figure C.8.2: Significant common (average) trends observed for barium, iron pH, sulphate and uranium, over all seasons at Station PR-04, 2003 to 2014.





Appendix Figure C.8.2: Significant common (average) trends observed for barium, iron pH, sulphate and uranium, over all seasons at Station PR-04, 2003 to 2014.

APPENDIX D
SAMP RAW DATA AND SUPPORTING INFORMATION

APPENDIX D.1
Denison and Spanish American TMA

Appendix Table D.1.1: Water quality at station D-2 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	TSS [a] mg/L	U mg/L
1/5/2010						6.7	0.200		1	
1/12/2010	0.125	0.0016	0.68	367	0.31	6.9	0.150	340	1	0.0622
1/19/2010						6.9	0.130		< 1	
1/26/2010						6.7	0.090		2	
2/2/2010						6.7	0.069		1	
2/9/2010	0.08	0.0024	0.25	499	0.442	6.7	0.090	470	< 1	0.0940
2/16/2010						6.8	0.060		< 1	
2/23/2010						6.8	0.067		1	
3/2/2010						7.0	0.062		1	
3/9/2010	0.087	0.0019	0.2	497	0.621	7.0	0.120	450	< 1	0.0872
3/16/2010						6.9	0.090		< 1	
3/23/2010						6.9	0.120		< 1	
3/30/2010						6.9	0.066		2	
4/6/2010						7.3	0.150		2	
4/13/2010	0.133	0.0019	0.33	466	0.446	7.5	0.200	410	2	0.0740
4/20/2010						7.4	0.220		2	
4/27/2010						7.4	0.230		3	
5/4/2010						7.4	0.500		< 1	
5/11/2010	0.389	0.0013	0.32	479	0.297	7.4	0.335	440	4	0.0883
5/18/2010						7.5	0.270		1	
5/25/2010						7.6	0.190		2	
6/1/2010						7.6	0.070		1	
6/8/2010	0.102	0.0014	0.13	545	0.421	7.5	0.230	470	1	0.0912
6/15/2010						7.4	0.180		< 1	
6/22/2010						7.5	0.620		4	
6/29/2010						7.4	0.260		1	
7/6/2010						7.7	0.100		1	
7/13/2010	0.051	0.001	0.09	515	0.345	7.6	0.092	480	1	0.0958
7/20/2010						7.6	0.160		2	
7/27/2010						7.7	0.110		< 1	
8/3/2010						7.6	0.110		1	
8/10/2010	0.081	0.0007	0.05	509	0.121	7.7	0.120	500	1	0.1030
8/17/2010						7.8	0.080		< 1	
8/24/2010						7.5	0.150		1	
8/31/2010						7.7	0.092		1	
9/7/2010						7.5	0.160		< 1	
9/14/2010	0.199	0.0014	0.16	536	0.369	7.5	0.360	510	2	0.1150
9/21/2010						7.7	0.395		2	
9/28/2010						7.6	0.345		2	
9/30/2010							0.390			
10/5/2010						7.5	0.200		1	
10/12/2010	0.138	0.0013	0.13	529	0.249	7.0	0.190	490	1	0.1090
10/19/2010						7.1	0.280		1	
10/26/2010						7.7	0.665		4	
10/28/2010						7.7	0.760		2	
11/2/2010						7.7	0.490		2	
11/9/2010	0.228	0.0017	0.22	549	0.3	7.6	0.380	490	2	0.1230
11/16/2010						7.6	0.280		1	
11/18/2010							0.270			
11/23/2010						7.6	0.300		1	
11/30/2010						7.7	0.380		1	

Appendix Table D.1.1: Water quality at station D-2 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	TSS [a] mg/L	U mg/L
12/7/2010						7.6	0.310		1	
12/14/2010	0.091	0.0022	0.15	422	0.278	7.6	0.120	480	< 1	0.1150
12/21/2010						7.5	0.085		1	
12/29/2010						7.3	0.074		1	
1/4/2011						7.5	0.050		1	
1/11/2011	0.052	0.0015	0.2	499	0.305	7.4	0.038	500	1	0.1140
1/18/2011						7.5	0.039		< 1	
1/25/2011						7.3	0.054		1	
2/1/2011						7.3	0.040		2	
2/8/2011	0.054	0.0016	0.35	611	0.341	7.3	0.045	520	1	0.1070
2/15/2011						7.3	0.039		1	
2/22/2011						7.3	0.052		1	
3/1/2011						7.3	0.056		< 1	
3/8/2011	0.054	0.0026	0.35	613	0.413	7.2	0.067	520	1	0.1040
3/15/2011						7.2	0.051		1	
3/22/2011						7.1	0.059		< 1	
3/29/2011						7.1	0.077		< 1	
4/5/2011						7.1	0.060		2	
4/12/2011	0.077	0.0022	0.38	498	0.458	7.0	0.104	450	1	0.0842
4/19/2011						7.1	0.311		1	
4/26/2011						7.2	0.281		4	
5/3/2011						7.4	0.380		2	
5/10/2011	0.244	0.0012	0.25	307	0.197	7.5	0.292	250	1	0.0391
5/14/2011							0.268			
5/17/2011						7.6	0.221		2	
5/24/2011						7.6	0.153		2	
5/31/2011						7.6	0.136		2	
6/7/2011						7.6	0.118		1	
6/14/2011	0.168	0.0013	0.15	426	0.268	7.6	0.126	320	2	0.0585
6/21/2011						7.5	0.093		1	
6/28/2011						7.4	0.096		< 1	
7/5/2011						7.7	0.137		2	
7/12/2011	0.081	0.0007	0.07	424	0.185	7.7	0.074	360	1	0.0611
7/19/2011						7.6	0.073		1	
7/26/2011						7.4	0.068		1	
8/2/2011						7.4	0.071		1	
8/9/2011	0.087	0.0007	0.07	458	0.115	7.8	0.079	380	1	0.0749
8/16/2011						7.8	0.095		1	
8/23/2011						7.3	0.100		1	
8/30/2011						7.6	0.102		< 1	
9/6/2011						7.6	0.114		1	
11/22/2011						7.1	0.112		1	
11/24/2011						7.1	0.098		1	
11/29/2011	0.055	0.0009	0.07	458	0.163	7.1	0.090	440	2	0.0776
12/6/2011						7.2	0.060		1	
12/13/2011	0.053	0.0008	0.07	475	0.227	7.2	0.054	420	1	0.1010
12/20/2011						7.4	0.029		1	
12/28/2011						7.2	0.031		1	
1/3/2012						7.3	0.030		1	
1/10/2012	0.046	0.0012	0.15	426	0.3	7.2	0.041	420	1	0.0813
1/17/2012						7.2	0.091		2	

Appendix Table D.1.1: Water quality at station D-2 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	TSS [a] mg/L	U mg/L
1/24/2012						7.2	0.156		4	
1/31/2012						7.2	0.462		< 1	
2/7/2012						7.2	0.429		1	
2/9/2012						7.2	0.380		1	
2/14/2012	0.103	0.001	0.3	409	0.258	7.0	0.263	320	1	0.0613
2/16/2012							0.236		1	
2/21/2012						7.0	0.242		< 1	
2/23/2012							0.213		1	
2/28/2012						6.9	0.201		1	
3/1/2012						6.9	0.197		< 1	
3/6/2012	0.096	0.0016	0.81	405	0.381	6.8	0.226	350	2	0.0540
3/8/2012						7.0	0.277		2	
3/13/2012						7.7	0.346		2	
3/15/2012						6.9	0.362		1	
3/20/2012						7.5	0.445		1	
3/22/2012						6.8	0.341		1	
3/27/2012						7.3	0.314		2	
3/29/2012						7.3	0.216		2	
4/3/2012						7.4	0.237		1	
4/5/2012						7.3	0.188		2	
4/10/2012	0.1	0.0008	0.28	374	0.227	7.3	0.165	310	1	0.0518
4/12/2012						7.2	0.133		1	
4/17/2012						7.2	0.117		1	
4/19/2012						7.5	0.147		1	
4/24/2012						7.2	0.109		1	
4/26/2012						7.2	0.099		1	
5/1/2012						7.1	0.085		< 1	
5/3/2012						7.1	0.092		< 1	
5/8/2012	0.074	< 0.0005	0.08	419	0.064	7.1	0.097	350	1	0.0519
5/10/2012						7.2	0.091		1	
5/15/2012						7.0	0.088		1	
5/17/2012						7.1	0.082		< 1	
5/22/2012						7.1	0.088		1	
5/24/2012						7.0	0.075		1	
5/29/2012						7.1	0.103		< 1	
5/31/2012						7.1	0.077		2	
6/5/2012						7.2	0.055		1	
6/7/2012						7.1	0.057		< 1	
6/12/2012	0.051	< 0.0005	< 0.02	432	0.05	6.9	0.069	370	< 1	0.0489
6/14/2012						7.0	0.061		< 1	
6/19/2012						7.0	0.073		1	
6/21/2012						6.9	0.065		2	
6/26/2012						7.1	0.056		< 1	
6/28/2012						7.1	0.052		< 1	
7/3/2012						7.1	0.069		1	
7/5/2012						7.1	0.061		< 1	
7/10/2012	0.044	< 0.0005	< 0.02	421	0.089	6.9	0.068	380	1	0.0501
7/12/2012						7.1	0.067		< 1	
7/17/2012						7.1	0.056		< 1	
7/19/2012						7.1	0.052		< 1	
7/24/2012						7.0	0.064		< 1	

Appendix Table D.1.1: Water quality at station D-2 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	TSS [a] mg/L	U mg/L
7/26/2012						7.0	0.061		< 1	
7/31/2012						6.8	0.049		< 1	
8/2/2012						6.9	0.042		< 1	
8/7/2012						7.1	0.047		< 1	
8/9/2012						6.9	0.044		< 1	
8/14/2012	0.036	< 0.0005	< 0.02	454	0.029	7.2	0.049	410	< 1	0.0628
8/16/2012						7.1	0.042		< 1	
10/16/2012						7.2	0.111		1	
10/18/2012						7.2				
10/23/2012	0.084	0.0006	0.1	460	0.245	7.4	0.080	420	1	0.0965
10/25/2012						7.4				
10/30/2012						7.3	0.099		1	
11/1/2012						7.4				
11/6/2012						7.4	0.104		1	
11/8/2012						7.5				
11/13/2012	0.081	0.0007	0.15	478	0.246	7.5	0.100	430	1	0.1030
11/15/2012						7.5				
11/20/2012						7.5	0.093		1	
11/22/2012						7.4				
11/27/2012						7.4	0.094		1	
11/29/2012						7.5				
12/4/2012						7.5	0.094		1	
12/6/2012						7.5				
12/11/2012	0.065	0.0009	0.21	511	0.297	7.4	0.079	430	2	0.0922
12/13/2012						7.5				
12/18/2012						7.3	0.063		1	
12/20/2012						7.4				
12/27/2012						7.4	0.045		1	
1/2/2013						7.4	0.045		1	
1/3/2013						7.4				
1/8/2013	0.038	0.0008	0.16	476	0.311	7.3	0.036	430	1	0.0906
1/10/2013						7.3				
1/15/2013						7.3	0.040		< 1	
1/17/2013						7.4				
1/22/2013						7.4	0.033		1	
1/29/2013						7.4	0.050		2	
1/31/2013						7.4				
2/5/2013						7.4	0.067		1	
2/7/2013						7.4				
2/12/2013	0.144	0.001	0.32	405	0.343	7.4	0.115	360	1	0.0757
2/14/2013						7.4				
2/19/2013						7.4	0.123		< 1	
2/21/2013						7.4				
2/26/2013						7.4	0.126		1	
2/28/2013						7.5				
3/5/2013						7.4	0.120		1	
3/7/2013						7.2				
3/12/2013	0.223	0.0006	0.22	337	0.176	7.5	0.157	250	< 1	0.0491
3/14/2013						7.5				
3/19/2013						7.4	0.208		2	
3/21/2013						7.4				

Appendix Table D.1.1: Water quality at station D-2 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	TSS [a] mg/L	U mg/L
3/26/2013						7.5	0.196		2	
3/28/2013						7.3				
4/2/2013						7.4	0.194		< 1	
4/4/2013						7.2				
4/9/2013	0.255	0.0009	0.31	295	0.184	7.3	0.167	230	1	0.0423
4/11/2013						7.3				
4/16/2013						7.2	0.155		1	
4/18/2013						7.3				
4/23/2013						7.2	0.195		1	
4/25/2013						7.0				
4/30/2013						6.8	0.152		< 1	
5/2/2013						6.9				
5/7/2013						7.2	0.152		2	
5/9/2013						7.2				
5/14/2013	0.293	0.0011	0.4	281	0.313	7.2	0.105	220	1	0.0412
5/16/2013						7.3				
5/21/2013						7.2	0.123		3	
5/23/2013						7.2				
5/28/2013						7.2	0.152		2	
5/30/2013						7.3				
6/4/2013						7.2	0.186		2	
6/6/2013						7.2				
6/11/2013	0.172	0.0007	0.15	308	0.263	7.4	0.155	240	4	0.0387
6/13/2013						7.4				
6/18/2013						7.4	0.166		2	
6/20/2013						7.3				
6/25/2013						7.0	0.120		1	
6/27/2013						7.1				
7/2/2013						7.0	0.068		1	
7/4/2013						7.4				
7/9/2013	0.095	< 0.0005	0.05	301	0.043	7.4	0.061	260	1	0.0365
7/11/2013						7.4				
7/16/2013						7.1	0.048		1	
7/18/2013						7.2				
7/23/2013						7.1	0.035		< 1	
7/25/2013						7.2				
7/30/2013						7.1	0.075		2	
8/1/2013						7.2				
8/6/2013						7.5	0.070		1	
8/13/2013	0.175	0.0007	0.12	306	0.188	7.4	0.134	250	< 1	0.0474
8/15/2013						7.7				
8/20/2013						7.7	0.170		1	
8/22/2013						7.2				
8/27/2013						7.1	0.103		1	
8/29/2013						7.1				
9/3/2013	0.14	< 0.0005	0.11	326	0.112	7.2	0.082	260	< 1	0.0439
9/5/2013						7.2				
9/10/2013						7.1	0.086		1	
9/17/2013						7.7	0.143		1	
9/19/2013						7.2				
9/24/2013						7.0	0.132		1	

Appendix Table D.1.1: Water quality at station D-2 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	TSS [a] mg/L	U mg/L
9/26/2013						7.2				
10/1/2013						7.0	0.108		< 1	
10/3/2013						7.3				
10/8/2013	0.132	0.0006	0.13	318	0.221	7.4	0.094	280	1	0.0476
10/10/2013						7.4				
10/15/2013						7.6	0.118		< 1	
10/17/2013						6.8				
10/22/2013						6.8	0.110		1	
10/24/2013						7.3				
10/29/2013						7.7	0.121		1	
10/31/2013						7.2				
11/5/2013						6.9	0.158		1	
11/12/2013	0.139	0.0013	0.21	356	0.411	6.9	0.181	130	2	0.0692
11/19/2013						7.3	0.188		2	
11/26/2013						7.2	0.204		2	
12/3/2013						7.4	0.239		2	
12/10/2013	0.223	0.0012	0.18	273	0.328	7.6	0.187	230	2	0.0442
12/17/2013						7.2	0.198		2	
12/23/2013						7.8	0.178		1	
1/2/2014						7.6	0.162		1	
1/7/2014						7.1	0.175		1	
1/14/2014	0.23	0.0008	0.3	247	0.223	7.1	0.161	220	2	0.0350
1/21/2014						7.5	0.205		1	
1/28/2014						7.2	0.167		1	
2/4/2014						7.2	0.185		1	
2/11/2014	0.199	0.0009	0.3	273	0.227	7.1	0.164	220	1	0.0349
2/18/2014						6.9	0.156		1	
2/25/2014						7.2	0.232		< 1	
3/4/2014						7.1	0.261		2	
3/11/2014	0.249	0.0007	0.25	261	0.198	7.3	0.222	200	1	0.0328
3/18/2014						7.0	0.217		1	
3/25/2014						7.1	0.237		1	
4/1/2014						7.2	0.229		1	
4/9/2014	0.182	0.0006	0.18	251	0.163	6.9	0.153	200	1	0.0298
4/15/2014						6.9	0.166		1	
4/22/2014						6.6	0.115		< 1	
4/29/2014						6.6	0.097		1	
5/6/2014						6.6	0.185		2	
5/13/2014	0.228	0.0011	0.33	202	0.305	7.0	0.185	190	2	0.0269
5/20/2014						6.7	0.248		2	
5/27/2014						6.9	0.045		< 1	
6/3/2014						6.8	0.293		2	
6/10/2014	0.256	0.0005	0.08	199	0.2	7.0	0.249	150	< 1	0.0248
6/17/2014						6.5	0.205		1	
6/24/2014						6.6	0.187		1	
7/1/2014						6.6	0.138		< 1	
7/8/2014	0.195	0.0006	0.11	247	0.204	7.1	0.141	190	2	0.0328
7/15/2014						7.2	0.119		1	
7/22/2014						6.9	0.093		< 1	
7/29/2014						7.1	0.075		1	
8/5/2014						6.8	0.064		< 1	

Appendix Table D.1.1: Water quality at station D-2 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	TSS [a] mg/L	U mg/L
8/11/2014	0.095	< 0.0005	0.05	281	0.088	7.1	0.070	240	2	0.0373
8/19/2014						7.2	0.063		1	
8/26/2014						7.2	0.053		1	
9/2/2014						7.2	0.076		1	
9/9/2014	0.101	< 0.0005	0.09	313	0.11	7.4	0.074	270	< 1	0.0479
9/16/2014						6.9	0.081		< 1	
9/23/2014						6.9	0.123		< 1	
9/30/2014						6.9	0.090		< 1	
10/7/2014						7.3	0.178		1	
10/14/2014	0.146	0.0012	0.12	315	0.29	7.2	0.160	270	1	0.0568
10/21/2014						7.2	0.208		1	
10/28/2014						7.3	0.299		2	
11/4/2014						7.4	0.255		1	
11/11/2014	0.256	0.0016	0.16	289	0.305	7.4	0.265	240	< 1	0.0467
11/18/2014						7.4	0.181		1	
11/25/2014						7.3	0.182		< 1	
12/2/2014						7.1	0.232		1	
12/9/2014	0.331	0.0006	0.22	230	0.192	7.0	0.263	190	1	0.0341
12/16/2014						7.2	0.268		1	
12/22/2014						7.1	0.290		1	
12/29/2014						7.1	0.315		1	
Number	57	57	57	57	57	322	276	57	274	57
Maximum	0.389	0.0026	0.81	613	0.621	7.8	0.760	520	4	0.1230
Minimum	0.036	< 0.0005	< 0.02	199	0.029	6.5	0.029	130	< 1	0.0248
Mean	0.142	0.0010	0.20	396	0.253	6.7	0.154	344	1	0.0666
St. Dev.	0.082	0.0005	0.15	107	0.120	0.3	0.111	112	1	0.0280
Median	0.103	0.0009	0.16	419	0.249	7.2	0.120	350	1	0.0611
10th Percentile	0.052	0.0005	0.06	257	0.102	6.9	0.052	200	1	0.0346
95th Percentile	0.263	0.0022	0.38	546	0.443	7.7	0.367	502	2	0.1142

[a] TOMP requirement

Appendix Table D.1.2: Water quality at station D-3 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	TSS[a] mg/L	U mg/L
1-5-2010						6.8	0.120		< 1	
1-12-2010	0.253	< 0.0005	0.04	125	0.005	7.0	0.120	80	< 1	0.0123
1-19-2010						7.1	0.120		< 1	
1-26-2010						7.1	0.120		< 1	
2-2-2010						6.9	0.150		< 1	
2-9-2010	0.253	< 0.0005	0.08	152	0.008	6.9	0.160	100	< 1	0.0253
2-16-2010						6.9	0.140		< 1	
2-23-2010						7.0	0.140		< 1	
3-2-2010						7.3	0.120		1	
3-9-2010	0.241	< 0.0005	0.06	185	0.023	7.4	0.170	120	< 1	0.0236
3-16-2010						7.2	0.085		< 1	
3-23-2010						7.2	0.089		< 1	
3-30-2010						7.2	0.070		< 1	
4-6-2010						7.4	0.120		< 1	
4-13-2010	0.217	< 0.0005	0.03	157	0.005	7.6	0.130	100	< 1	0.0118
4-20-2010						7.4	0.140		< 1	
4-27-2010						7.3	0.130		< 1	
5-4-2010						7.3	0.160		1	
5-11-2010	0.204	< 0.0005	0.08	138	0.016	7.3	0.160	88	< 1	0.0113
5-18-2010						7.2	0.160		1	
5-25-2010						7.3	0.200		< 1	
6-1-2010						7.0	0.240		2	
6-22-2010						7.0	0.180		2	
6-29-2010						7.2	0.150		< 1	
8-24-2010						7.0	0.190		< 1	
8-31-2010						7.3	0.290		< 1	
9-7-2010						7.2	0.210		< 1	
9-14-2010	0.227	< 0.0005	0.04	177	0.014	7.5	0.190	110	< 1	0.0122
9-21-2010						7.2	0.160		< 1	
9-28-2010						7.4	0.110		< 1	
10-5-2010						7.0	0.110		< 1	
10-12-2010	0.177	< 0.0005	0.06	151	0.007	7.2	0.130	98	< 1	0.0125
10-19-2010						7.2	0.130		< 1	
10-26-2010							0.120		2	
10-28-2010						7.7	0.130		1	
11-2-2010						7.5	0.091		< 1	
11-9-2010	0.199	< 0.0005	0.04	144	0.004	7.7	0.120	91	2	0.0124
11-16-2010						7.6	0.099		< 1	
11-23-2010						7.6	0.120		< 1	
11-30-2010						7.6	0.081		< 1	
12-7-2010						7.6	0.080		< 1	
12-14-2010	0.190	< 0.0005	0.04	109	0.003	7.5	0.092	87	< 1	0.0098
12-21-2010						7.3	0.099		< 1	
12-29-2010						7.4	0.110		1	
1-4-2011						7.6	0.100		< 1	
1-11-2011	0.201	< 0.0005	0.05	142	0.01	7.5	0.110	100	< 1	0.0126
1-18-2011						7.5	0.109		< 1	
1-25-2011						7.5	0.107		< 1	
2-1-2011						7.5	0.110		3	
2-8-2011	0.180	< 0.0005	0.04	188	0.003	7.5	0.114	110	< 1	0.0228
2-15-2011						7.5	0.101		< 1	

Appendix Table D.1.2: Water quality at station D-3 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	TSS[a] mg/L	U mg/L
2-22-2011						7.5	0.112		< 1	
3-1-2011						7.5	0.111		< 1	
3-8-2011	0.203	< 0.0005	0.04	223	0.014	7.6	0.129	130	< 1	0.0374
3-15-2011						7.5	0.119		< 1	
3-22-2011						7.5	0.106		< 1	
3-29-2011						7.5	0.101		< 1	
4-5-2011						7.5	0.099		< 1	
4-12-2011	0.258	0.0007	0.22	62	0.205	7.3	0.108	41	< 1	0.0016
4-19-2011						7.3	0.077		1	
4-26-2011						7.3	0.066		< 1	
5-3-2011						7.3	0.103		< 1	
5-10-2011	0.249	< 0.0005	0.03	85	0.004	7.3	0.099	54	< 1	0.0021
5-17-2011						7.3	0.109		< 1	
5-24-2011						7.2	0.124		1	
5-31-2011						7.2	0.135		< 1	
6-7-2011						7.4	0.137		< 1	
6-14-2011	0.228	< 0.0005	0.05	150	0.012	7.4	0.172	86	< 1	0.0047
6-21-2011						7.2	0.168		< 1	
6-28-2011						7.2	0.179		< 1	
7-5-2011						7.2	0.163		< 1	
7-12-2011	0.211	< 0.0005	0.26	131	0.056	7.3	0.212	73	1	0.0051
9-27-2011						7.2	0.141		< 1	
10-4-2011						7.2	0.166		< 1	
10-11-2011	0.198	< 0.0005	0.04	155	0.014	7.2	0.178	98	< 1	0.0076
10-18-2011						7.0	0.153		< 1	
10-25-2011						7.4	0.113		10	
11-1-2011						7.6	0.108		< 1	
11-8-2011	0.210	< 0.0005	0.05	158	< 0.002	7.6	0.146	99	1	0.0122
11-15-2011						7.3	0.112		< 1	
11-22-2011						7.4	0.103		< 1	
11-29-2011						7.4	0.108		1	
12-6-2011						7.4	0.079		< 1	
12-13-2011	0.239	< 0.0005	0.05	120	0.003	7.2	0.125	83	< 1	0.0068
12-20-2011						7.6	0.114		< 1	
12-28-2011						7.5	0.093		< 1	
1-3-2012						7.5	0.114		< 1	
1-10-2012	0.204	< 0.0005	0.02	133	0.003	7.3	0.111	91	< 1	0.0100
1-17-2012						7.5	0.109		1	
1-24-2012						7.4	0.116		< 1	
1-31-2012						7.5	0.112		< 1	
2-7-2012						7.4	0.089		< 1	
2-14-2012	0.204	< 0.0005	0.06	157	< 0.002	7.4	0.115	100	< 1	0.0067
2-21-2012						7.3	0.110		< 1	
2-28-2012						7.2	0.121		< 1	
3-6-2012	0.206	< 0.0005	0.03	176	0.002	7.1	0.127	120	1	0.0166
3-13-2012						7.9	0.135		1	
3-20-2012						6.5	0.074		< 1	
3-27-2012						7.6	0.106		< 1	
4-3-2012						7.5	0.124		< 1	
4-10-2012	0.212	< 0.0005	0.03	137	0.003	7.6	0.099	85	< 1	0.0072
4-17-2012						7.5	0.100		< 1	

Appendix Table D.1.2: Water quality at station D-3 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	TSS[a] mg/L	U mg/L
4-24-2012						7.5	0.118		< 1	
5-1-2012						7.5	0.098		< 1	
5-8-2012	0.214	< 0.0005	0.02	151	0.005	7.4	0.129	100	< 1	0.0095
5-15-2012						7.1	0.151		< 1	
6-5-2012						7.4	0.126		1	
6-21-2012	0.266	< 0.0005	0.04	177	0.009	7.2	0.196	97		0.0079
6-25-2012									< 1	
6-26-2012						7.3	0.154		< 1	
10-16-2012						7.4	0.083		< 1	
10-23-2012	0.131	< 0.0005	< 0.02	186	< 0.002	7.4	0.101	140	< 1	0.0125
10-30-2012						7.6	0.110		< 1	
11-6-2012						7.4	0.087		< 1	
11-13-2012	0.113	< 0.0005	0.03	187	< 0.002	7.3	0.078	140	< 1	0.0178
11-20-2012						7.5	0.080		< 1	
11-27-2012						7.3	0.069		< 1	
12-4-2012						7.5	0.066		< 1	
12-11-2012	0.093	< 0.0005	< 0.02	163	0.003	7.6	0.056	110	< 1	0.0127
12-18-2012						7.5	0.063		< 1	
12-27-2012						7.5	0.069		< 1	
1-2-2013						7.4	0.078		< 1	
1-8-2013	0.102	< 0.0005	< 0.02	178	< 0.002	7.6	0.078	130	< 1	0.0177
1-15-2013						7.5	0.061		< 1	
1-22-2013						7.7	0.080		< 1	
1-29-2013						7.6	0.076		< 1	
2-5-2013						7.5	0.073		< 1	
2-12-2013	0.107	< 0.0005	< 0.02	173	0.002	7.5	0.062	130	< 1	0.0124
2-19-2013						7.5	0.077		< 1	
2-26-2013						7.6	0.080		< 1	
3-5-2013						7.6	0.086		< 1	
3-12-2013	0.169	< 0.0005	0.15	152	0.037	7.3	0.192	100	< 1	0.0060
3-19-2013						7.6	0.084		< 1	
3-26-2013						7.6	0.083		< 1	
4-2-2013						7.7	0.056		< 1	
4-9-2013	0.198	< 0.0005	0.04	92	0.002	7.3	0.063	64	< 1	0.0019
4-16-2013						7.2	0.063		< 1	
4-23-2013						7.3	0.069		< 1	
4-30-2013						6.9	0.059		< 1	
5-7-2013						7.2	0.101		< 1	
5-14-2013	0.221	< 0.0005	0.03	129	0.005	7.4	0.112	83	< 1	0.0069
5-21-2013						6.9	0.112		1	
5-28-2013						7.3	0.105		< 1	
6-4-2013						7.0	0.123		< 1	
6-11-2013	0.177	< 0.0005	0.05	126	0.011	7.3	0.144	71	2	0.0046
6-18-2013						7.4	0.150		< 1	
6-25-2013						7.2	0.151		< 1	
7-2-2013						7.0	0.140		< 1	
7-30-2013						7.4	0.128		< 1	
8-6-2013						7.6	0.147		1	
8-13-2013	0.225	< 0.0005	0.09	95	0.012	7.5	0.117	41	< 1	0.0046
8-20-2013						7.8	0.149		< 1	
8-27-2013						7.0	0.160		1	

Appendix Table D.1.2: Water quality at station D-3 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	TSS[a] mg/L	U mg/L
9-3-2013	0.289	< 0.0005	0.18	108	0.024	7.5	0.160	47	< 1	0.0060
9-10-2013						7.4	0.183		5	
9-17-2013						7.5	0.182		1	
9-24-2013						7.1	0.180		< 1	
10-1-2013						7.2	0.181		< 1	
10-8-2013	0.482	< 0.0005	0.14	123	0.035	7.6	0.203	63	1	0.0098
10-15-2013						7.4	0.164		1	
10-22-2013						7.2	0.190		1	
10-29-2013						7.9	0.146		1	
11-5-2013						7.2	0.147		1	
11-12-2013	0.322	< 0.0005	0.13	82	0.018	7.2	0.100	49	< 1	0.0044
11-19-2013						7.6	0.152		1	
11-26-2013						7.5	0.113		< 1	
12-3-2013						7.7	0.095		< 1	
12-10-2013	0.373	< 0.0005	0.12	64	0.014	7.8	0.111	39	< 1	0.0026
12-17-2013						7.2	0.121		1	
12-23-2013						7.8	0.124		< 1	
1-2-2014						7.8	0.112		< 1	
1-7-2014						7.2	0.133		< 1	
1-14-2014	0.450	< 0.0005	0.15	94	0.038	7.4	0.145	57	< 1	0.0035
1-21-2014						7.6	0.116		< 1	
1-28-2014						7.4	0.124		< 1	
2-4-2014						7.3	0.131		< 1	
2-11-2014	0.334	< 0.0005	0.12	118	0.017	7.3	0.131	68	1	0.0053
2-18-2014						6.9	0.135		< 1	
2-25-2014						7.3	0.133		< 1	
3-4-2014						7.1	0.125		< 1	
3-11-2014	0.290	< 0.0005	0.2	144	0.019	7.2	0.133	96	2	0.0069
3-18-2014						7.1	0.117		< 1	
3-25-2014						7.2	0.133		< 1	
4-1-2014						7.0	0.118		< 1	
4-9-2014	0.327	< 0.0005	0.24	144	0.273	7.0	0.193	97	1	0.0047
4-15-2014						7.3	0.077		1	
4-22-2014						6.7	0.080		1	
4-29-2014						6.5	0.087		< 1	
5-6-2014						6.6	0.049		< 1	
5-13-2014	0.261	< 0.0005	0.2	51	0.046	6.5	0.152	43	2	0.0016
5-20-2014						6.7	0.120		< 1	
5-27-2014						6.8	0.139		< 1	
6-3-2014						6.5	0.112		< 1	
6-10-2014	0.195	< 0.0005	0.28	65	0.037	6.7	0.114	39	1	0.0011
6-17-2014						6.6	0.116		2	
6-24-2014						6.7	0.163		1	
9-2-2014						7.1	0.191		< 1	
9-9-2014	0.309	< 0.0005	0.12	128	0.026	7.3	0.190	87	< 1	0.0031
9-16-2014						7.0	0.154		< 1	
9-23-2014						7.1	0.158		< 1	
9-30-2014						7.0	0.157		< 1	
10-7-2014						7.1	0.138		1	
10-14-2014	0.246	< 0.0005	0.19	95	0.012	7.3	0.143	63	< 1	0.0055
10-21-2014						7.4	0.115		< 1	

Appendix Table D.1.2: Water quality at station D-3 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	TSS[a] mg/L	U mg/L
10-28-2014						7.4	0.121		< 1	
11-4-2014						7.1	0.105		< 1	
11-11-2014	0.361	< 0.0005	0.22	92	0.008	7.2	0.119	62	< 1	0.0042
11-18-2014						7.2	0.113		< 1	
11-25-2014						6.9	0.097		< 1	
12-2-2014						7.0	0.120		< 1	
12-9-2014	0.422	< 0.0005	0.23	84	0.011	7.1	0.107	56	< 1	0.0027
12-16-2014						7.4	0.114		1	
12-22-2014						7.3	0.136		< 1	
12-29-2014						7.0	0.129		1	
Number	49	49	49	49	49	212	213	49	213	49
Maximum	0.482	0.0007	0.28	223.0	0.273	7.9	0.290	140	10	0.0374
Minimum	0.093	< 0.0005	< 0.02	51.4	< 0.002	6.5	0.049	39	< 1	0.0011
Mean	0.238	0.0005	0.09	133.8	0.022	7.3	0.123	86	1	0.0093
St. Dev.	0.083	0.0000	0.07	38.8	0.047	0.3	0.037	28	1	0.0070
Median	0.217	0.0005	0.05	138.0	0.010	7.3	0.119	88	1	0.0072
10th Percentile	0.161	0.0005	0.02	83.5	0.002	7.0	0.078	46	1	0.0025
95th Percentile	0.402	0.0005	0.24	186.6	0.052	7.6	0.190	130	1.4	0.0233

[a] TOMP requirement

Appendix Table D.1.3: Water quality at station D-9 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	U mg/L
1/12/2010	0.020	0.0133	6.43	781	3.53	6.7	0.010	730	0.0093
4/13/2010	0.014	0.0072	3.13	512	1.83	7.1	0.005	390	0.0057
7/15/2010	0.022	0.0161	5.56	841	4.07	6.6	0.007	920	0.0074
10/12/2010	0.023	0.0136	5.48	757	3.60	6.6	0.008	780	0.0071
1/11/2011	0.019	0.0145	6.13	804	3.91	6.7	0.008	850	0.0131
4/12/2011	0.011	0.0031	1.45	262	1.12	7.1	0.005	190	0.0030
7/12/2011	0.020	0.0119	3.55	798	3.61	6.8	0.012	780	0.0068
10/12/2011	0.023	0.0128	4.98	923	3.63	6.5	0.011	860	0.0073
1/10/2012	0.019	0.0096	3.39	749	2.73	7.0	0.011	720	0.0100
4/10/2012	0.018	0.0074	2.56	715	2.20	7.1	0.015	620	0.0084
7/10/2012	0.021	0.0122	3.50	891	3.83	6.7	0.008	900	0.0089
10/9/2012	0.026	0.0134	2.16	872	4.23	6.7	0.018	750	0.0079
1/8/2013	0.018	0.0092	5.16	864	2.95	7.0	< 0.005	750	0.0121
4/8/2013	0.012	0.0048	2.25	449	1.61	7.3	0.007	320	0.0080
7/9/2013	0.021	0.0088	3.69	780	3.31	6.8	0.010	790	0.0096
10/7/2013	0.013	0.0029	1.55	337	1.09	7.0	< 0.005	280	0.0038
1/14/2014	0.019	0.0055	2.72	614	1.98	6.8	0.009	510	0.0103
5/13/2014	0.018	0.0027	0.94	371	0.93	6.8	0.009	300	0.0055
7/8/2014	0.024	0.0078	3.21	776	2.81	7.0	0.010	700	0.0131
10/21/2014	0.017	0.0038	1.82	437	1.41	6.9	0.008	360	0.0067
Number	20	20	20	20	20	20	20	20	20
Maximum	0.026	0.0161	6.43	923	4.23	7.3	0.018	920	0.0158
Minimum	0.011	0.0027	0.94	262	0.93	6.5	< 0.005	190	0.0030
Mean	0.019	0.0090	3.48	677	2.72	6.9	0.009	625	0.0082
St. Dev.	0.004	0.0040	1.64	206	1.10	0.2	0.003	235	0.0030
Median	0.019	0.0090	3.30	767	2.88	6.8	0.009	725	0.0080
10th Percentile	0.013	0.0031	1.54	368	1.12	6.6	0.005	298	0.0053
95th Percentile	0.024	0.0146	6.15	893	4.08	7.1	0.015	901	0.0131

Appendix Table D.1.4: Water quality at station D-16 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	U mg/L
1/12/2010	0.026	0.0008	0.41	309	0.77	6.0	0.016	290	< 0.0005
4/13/2010	0.027	0.0005	0.30	284	0.67	6.1	0.017	250	< 0.0005
7/15/2010	0.045	0.0056	28.50	371	5.82	6.3	0.064	360	0.0013
10/12/2010	0.022	0.0006	1.41	249	0.71	6.3	0.022	230	< 0.0005
1/11/2011	0.028	0.0023	0.70	320	1.17	6.0	0.016	310	< 0.0005
4/12/2011	0.021	0.0030	0.97	138	1.50	6.1	0.011	120	< 0.0005
7/12/2011	0.029	0.0029	11.10	297	4.79	6.4	0.031	260	< 0.0005
10/12/2011	0.033	0.0021	6.10	336	2.13	6.3	0.025	290	< 0.0005
1/10/2012	0.021	0.0006	0.21	290	0.53	6.3	0.007	300	< 0.0005
4/10/2012	0.020	< 0.0005	0.17	250	0.25	6.3	0.006	220	< 0.0005
7/10/2012	0.043	0.0059	15.50	379	6.71	6.4	0.044	350	0.0006
10/9/2012	0.036	0.0032	6.59	356	2.34	6.4	0.055	320	< 0.0005
1/8/2013	0.021	< 0.0005	0.27	344	0.35	6.4	< 0.005	320	< 0.0005
4/8/2013	0.018	0.0011	0.42	201	0.68	6.5	< 0.005	170	< 0.0005
7/9/2013	0.029	0.0045	14.30	260	11.20	6.7	0.031	220	0.0006
10/7/2013	0.031	0.0028	4.61	163	4.89	6.7	0.032	160	< 0.0005
1/14/2014	0.029	0.0018	0.83	259	1.76	6.9	0.016	230	< 0.0005
5/13/2014	0.019	0.0006	0.33	110	0.32	6.8	0.009	100	< 0.0005
7/8/2014	0.051	0.0091	12.30	286	11.60	6.8	0.049	230	0.0008
10/21/2014	0.021	0.0008	0.49	144	0.52	6.5	0.009	130	< 0.0005
Number	20	20	20	20	20	20	20	20	20
Maximum	0.051	0.0091	28.50	379	11.60	6.9	0.064	360	0.0013
Minimum	0.018	< 0.0005	0.17	110	0.25	6.0	< 0.005	100	< 0.0005
Mean	0.029	0.0024	5.28	267	2.94	6.4	0.024	243	0.0006
St. Dev.	0.009	0.0020	7.50	80	3.50	0.3	0.018	77	0.0002
Median	0.028	0.0020	0.90	285	1.34	6.4	0.017	240	0.0005
10th Percentile	0.020	0.0005	0.26	143	0.34	6.1	0.006	129	0.0005
95th Percentile	0.045	0.0061	16.15	371	11.22	6.8	0.055	351	0.0008

Appendix Table D.1.5a: Summary of annual plant operations and discharge at Denison TMA-1, 2010-2014.

ITEM	2010	2011	2012	2013	2014
PLANT OPERATIONS[a]					
Operating Days	21	122	127	245	223
Maximum Daily Plant Flow (L/s @ D-1)	62	659	189	199	186
Minimum Daily Plant Flow (L/s @ D-1)	0	0	0	29	0
Monthly Average Daily Plant Flow (L/s @ D-1)	23	76	50	92	106
Total Volume Treated (ML)	41	799	548	1,956	2,036
Barium Chloride Consumption					
Total (kg/year)	109	1,279	1,012	4,071	3,442
Monthly Average (mg/L)	2.7	1.6	1.8	2.1	1.7
Caustic Soda Consumption					
Total (kg/year)	66	343	0	0	0
Monthly Average (mg/L)	1.60	0.43	0	0	0
DAM 10 SEEPAGE					
Discharge Days	365	365	366	0	0
Max Daily Seepage Flow (L/s @ D-13,D-14,D-19)	18	20	19	0	0
Min Daily Seepage Flow (L/s @ D-13,D-14,D-19)	18	18	0	0	0
Monthly Seepage Flow (L/s @ D-13,D-14,D-19)	18	18	14	0	0
Total Volume (ML)	572	576	431	0	0
Site Total Including ETP Operations (ML)	613	1,375	979	0	0
EFFLUENT[b]					
Discharge Days	365	294	310	365	365
Maximum Daily Discharge Flow (L/s @ D-2)	75	709	169	217	200
Minimum Daily Discharge Flow (L/s @ D-2)	1	0	0	9	9
Monthly Average Daily Discharge Flow (L/s @ D-2)	14	40	23	67	69
Total Annual Volume Discharged (ML)	448	1,016	612	2,106	2,162

[a] Influent flows based on daily monitoring requirements as per TOMP

[b] 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, 2010-2014.

ITEM	2010	2011	2012	2013	2014
PLANT OPERATIONS[a]					
Operating Days	309	365	324	365	363
Maximum Daily Plant Flow (L/s @ D-3)	138	149	69	279	210
Minimum Daily Plant Flow (L/s @ D-3)	1	0	0	1	0
Monthly Average Daily Plant Flow (L/s @ D-3)	6.3	8	7	16	12
Total Volume Treated (ML)	169	256	198	492	372
Barium Chloride Consumption					
Total (kg/year)	408	538	446	606	560
Monthly Average (mg/L)	2.4	2.1	2.3	1.2	1.5
Caustic Soda Consumption					
Total (kg/year)	0	0	0	0	0
Monthly Average (mg/L)	0	0	0	0	0
EFFLUENT[b]					
Discharge Days	301	294	239	343	302
Maximum Daily Discharge Flow (L/s @ D-3)	138	149	69	279	210
Minimum Daily Discharge Flow (L/s @ D-3)	1	0	0	1	0
Monthly Average Daily Discharge Flow (L/s @ D-3)	6.3	10	8	16	14
Total Annual Volume Discharged (ML)	164	246	173	463	372

[a] Influent flows based on daily monitoring requirements as per TOMP

[b] Effluent flows based on weekly monitoring requirement as per SAMP

Appendix Table D.1.6: Mean annual discharge and seepage loadings from Denison TMA, 2010 - 2014.

Station		Drainage Type	Mean Annual Discharge (m^3)		Barium (kg/yr)	Cobalt (kg/yr)	Iron (kg/yr)	Manganese (kg/yr)	Radium (MBq/yr)	Sulphate (kg/yr)	Uranium (kg/yr)
Serpent River Drainage	D-4	Outlet of Dunlop Lake	52,602,048	Mean	700		1,631	831	132	231,989	
				S.D.	35		471	205	0	7,058	
	D-6	Outlet of Cinder Lake	1,986,768	Mean	37		924	624	13	109,925	
				S.D.	8		442	340	4	60,660	
	D-2	ETP Discharge	1,229,904	Mean	214	1.3	310	331	240	344,753	65
				S.D.	209	0.6	147	169	141	137,348	27
	D-3	Seepage from TMA 2	283,824	Mean	69	0.1	31	14.1	30	22,022	2.1
				S.D.	43	0.0	32	18.3	14.2	6,793	0.3
	D-5	Serpent River d/s of Denison	56,954,016	Mean	3,892				3,554	1,028,777	110
				S.D.	1,249				1,185	352,719	38
	Q-09	Quirke Lake Intlet	75,781,008	Mean	5,365				5,484	4,575,791	225
				S.D.	2626				1,804	2,102,412	87
Quirke Lake Drainage	D-9	Seepage from Dam 17	97,762	Mean	1.7	0.8	320	241	0.8	55,755	0.8
				S.D.	0.5	0.4	148	116	0.4	22,264	0.2
	D-16	Seepage from Dam 9	40,997	Mean	1.0	0.1	138	79	0.7	8,401	0.01
				S.D.	0.4	0.1	93	40	0.4	3,292	0.01
	SR-01	Outlet of Quirke Lake	153,958,752	Mean	5,850				3,171	6,496,877	188
				S.D.	0				561	873,615	13

MBq/yr = Million Bequerels per year

Appendix Table D.1.7: Summary of seasonal trends for station D-1 from 2003-2014.

Season	Spearman's rho	Ba	Co	Fe	Hardness	Mn	pH	Ra	SO4	U
January	Correlation Coefficient	0.469	-0.717	0.060	-0.300	-0.455	0.308	0.469	-0.643	-0.175
	Sig. (2-tailed)	0.124	0.009	0.854	0.624	0.138	0.331	0.124	0.024	0.587
	N	12	12	12	5	12	12	12	12	12
February	Correlation Coefficient	0.811	-0.65	0.245	-0.900	-0.748	-0.028	0.669	-0.783	-0.301
	Sig. (2-tailed)	0.001	0.022	0.442	0.037	0.005	0.931	0.017	0.003	0.342
	N	12	12	12	5	12	12	12	12	12
March	Correlation Coefficient	0.909	-0.507	0.448	-0.900	-0.643	-0.077	0.559	-0.753	-0.378
	Sig. (2-tailed)	0.000	0.092	0.145	0.037	0.024	0.812	0.059	0.005	0.226
	N	12	12	12	5	12	12	12	12	12
April	Correlation Coefficient	0.245	-0.259	0.126	-0.900	0.147	-0.035	0.531	0.305	0.487
	Sig. (2-tailed)	0.443	0.417	0.696	0.037	0.649	0.914	0.075	0.335	0.108
	N	12	12	12	5	12	12	12	12	12
May	Correlation Coefficient	0.483	-0.940	0.196	-0.9	-0.839	-0.573	-0.392	-0.937	-0.657
	Sig. (2-tailed)	0.112	0.000	0.541	0.037	0.001	0.051	0.208	0.000	0.020
	N	12	12	12	5	12	12	12	12	12
June	Correlation Coefficient	0.503	-0.635	0.140	-0.900	-0.58	-0.697	0.084	-0.860	-0.622
	Sig. (2-tailed)	0.095	0.026	0.664	0.037	0.048	0.012	0.795	0.000	0.031
	N	12	12	12	5	12	12	12	12	12
July	Correlation Coefficient	0.168	-0.520	0.114		-0.427	-0.385	-0.559	-0.879	-0.559
	Sig. (2-tailed)	0.602	0.083	0.724		0.167	0.217	0.059	0.000	0.059
	N	12	12	12		12	12	12	12	12
August	Correlation Coefficient	0.007	-0.451	-0.230		-0.524	-0.340	-0.517	-0.902	-0.476
	Sig. (2-tailed)	0.983	0.141	0.473		0.080	0.280	0.085	0.000	0.118
	N	12	12	12		12	12	12	12	12
September	Correlation Coefficient	0.491	-0.209	0.360		-0.309	-0.237	-0.100	-0.855	-0.539
	Sig. (2-tailed)	0.150	0.562	0.307		0.385	0.483	0.770	0.002	0.108
	N	10	10	10		10	11	11	10	10
October	Correlation Coefficient	0.688	-0.374	0.510		-0.355	-0.187	-0.082	-0.945	-0.756
	Sig. (2-tailed)	0.019	0.257	0.109		0.285	0.582	0.811	0.000	0.007
	N	11	11	11		11	11	11	11	11
November	Correlation Coefficient	0.300	-0.305	0.287	-0.900	-0.691	-0.214	0.035	-0.982	-0.733
	Sig. (2-tailed)	0.370	0.361	0.392	0.037	0.019	0.505	0.914	0.000	0.010
	N	11	11	11	5	11	12	12	11	11
December	Correlation Coefficient	0.517	-0.406	0.434	-0.600	-0.483	0.032	0.343	-0.916	-0.172
	Sig. (2-tailed)	0.085	0.191	0.158	0.285	0.112	0.923	0.276	0.000	0.593
	N	12	12	12	5	12	12	12	12	12

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).

[grey box] Significant trend where p<0.05.

Appendix Table D.1.8: Summary of seasonal trends for station D-3 from 2003-2014.

Month	Spearman's rho	Ba	Co	Fe	Hardness	Mn	pH	Ra	SO4	U
January	Correlation Coefficient	0.350	0.819	-0.039	-0.100	0.523	0.294	0.308	-0.224	-0.165
	Sig. (2-tailed)	0.264	0.001	0.905	0.873	0.081	0.354	0.331	0.484	0.609
	N	12	12	12	5	12	12	12	12	12
February	Correlation Coefficient	0.403	0.819	0.302	-0.300	-0.049	-0.060	0.049	-0.007	-0.490
	Sig. (2-tailed)	0.194	0.001	0.340	0.624	0.879	0.854	0.880	0.983	0.106
	N	12	12	12	5	12	12	12	12	12
March	Correlation Coefficient	0.644	0.819	0.186	-0.900	0.014	-0.182	0.077	-0.314	-0.413
	Sig. (2-tailed)	0.024	0.001	0.563	0.037	0.966	0.572	0.812	0.320	0.183
	N	12	12	12	5	12	12	12	12	12
April	Correlation Coefficient	0.294	0.563	-0.148	-0.100	0.063	-0.021	0.287	0.340	-0.109
	Sig. (2-tailed)	0.353	0.057	0.646	0.873	0.846	0.948	0.366	0.280	0.736
	N	12	12	12	5	12	12	12	12	12
May	Correlation Coefficient	0.594	0.782	0.214	-0.500	0.439	-0.720	-0.238	-0.280	-0.319
	Sig. (2-tailed)	0.042	0.003	0.504	0.391	0.154	0.008	0.456	0.379	0.313
	N	12	12	12	5	12	12	12	12	12
June	Correlation Coefficient	0.609	0.789	0.337		0.351	-0.817	0.186	-0.200	-0.647
	Sig. (2-tailed)	0.047	0.004	0.311		0.290	0.001	0.564	0.555	0.031
	N	11	11	11		11	12	12	11	11
July	Correlation Coefficient	0.371	0.464	0.600		0.600	-0.112	0.126	-0.143	-0.771
	Sig. (2-tailed)	0.468	0.354	0.208		0.208	0.811	0.788	0.787	0.072
	N	6	6	6		6	7	7	6	6
August	Correlation Coefficient	0.771	0.169	-0.429		-0.493	0.020	-0.250	-0.657	-0.486
	Sig. (2-tailed)	0.072	0.749	0.397		0.321	0.966	0.589	0.156	0.329
	N	6	6	6		6	7	7	6	6
September	Correlation Coefficient	0.943	0.169	-0.486		-0.371	-0.673	0.109	0.143	-0.257
	Sig. (2-tailed)	0.005	0.749	0.329		0.468	0.047	0.781	0.787	0.623
	N	6	6	6		6	9	9	6	6
October	Correlation Coefficient	0.427	0.753	0.462	-0.600	0.445	0.146	0.070	-0.232	-0.296
	Sig. (2-tailed)	0.167	0.005	0.130	0.285	0.147	0.651	0.829	0.469	0.351
	N	12	12	12	5	12	12	12	12	12
November	Correlation Coefficient	0.580	0.753	0.453	-0.500	0.214	-0.114	-0.098	-0.368	-0.347
	Sig. (2-tailed)	0.048	0.005	0.140	0.391	0.504	0.724	0.762	0.239	0.269
	N	12	12	12	5	12	12	12	12	12
December	Correlation Coefficient	0.399	0.753	0.389	-0.500	0.596	-0.021	0.266	-0.105	-0.217
	Sig. (2-tailed)	0.199	0.005	0.212	0.391	0.041	0.948	0.404	0.746	0.499
	N	12	12	12	5	12	12	12	12	12

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).

[shaded cell] Significant trend where p<0.05.

Appendix Table D.1.9: Summary of seasonal trends for station D-9 from 2003-2014.

Month	Spearman's rho	Ba	Co	Fe	Hardness	Mn	pH	Ra	SO4	U
January	Correlation Coefficient	0.197	-0.923	-0.769	-0.300	-0.532	0.474	-0.390	-0.098	-0.105
	Sig. (2-tailed)	0.539	0.000	0.003	0.624	0.075	0.119	0.210	0.762	0.746
	N	12	12	12	5	12	12	12	12	12
April	Correlation Coefficient	0.657	-0.785	-0.406	-0.200	0.238	0.643	0.568	0.361	0.368
	Sig. (2-tailed)	0.020	0.003	0.190	0.747	0.457	0.024	0.054	0.249	0.240
	N	12	12	12	5	12	12	12	12	12
July	Correlation Coefficient	0.608	-0.923	-0.930	-0.700	-0.832	0.910	-0.723	-0.371	0.161
	Sig. (2-tailed)	0.036	0.000	0.000	0.188	0.001	0.000	0.008	0.236	0.617
	N	12	12	12	5	12	12	12	12	12
October	Correlation Coefficient	0.225	-0.958	-0.874	-0.600	-0.490	0.489	-0.560	-0.524	-0.771
	Sig. (2-tailed)	0.483	0.000	0.000	0.285	0.106	0.106	0.058	0.080	0.003
	N	12	12	12	5	12	12	12	12	12

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).

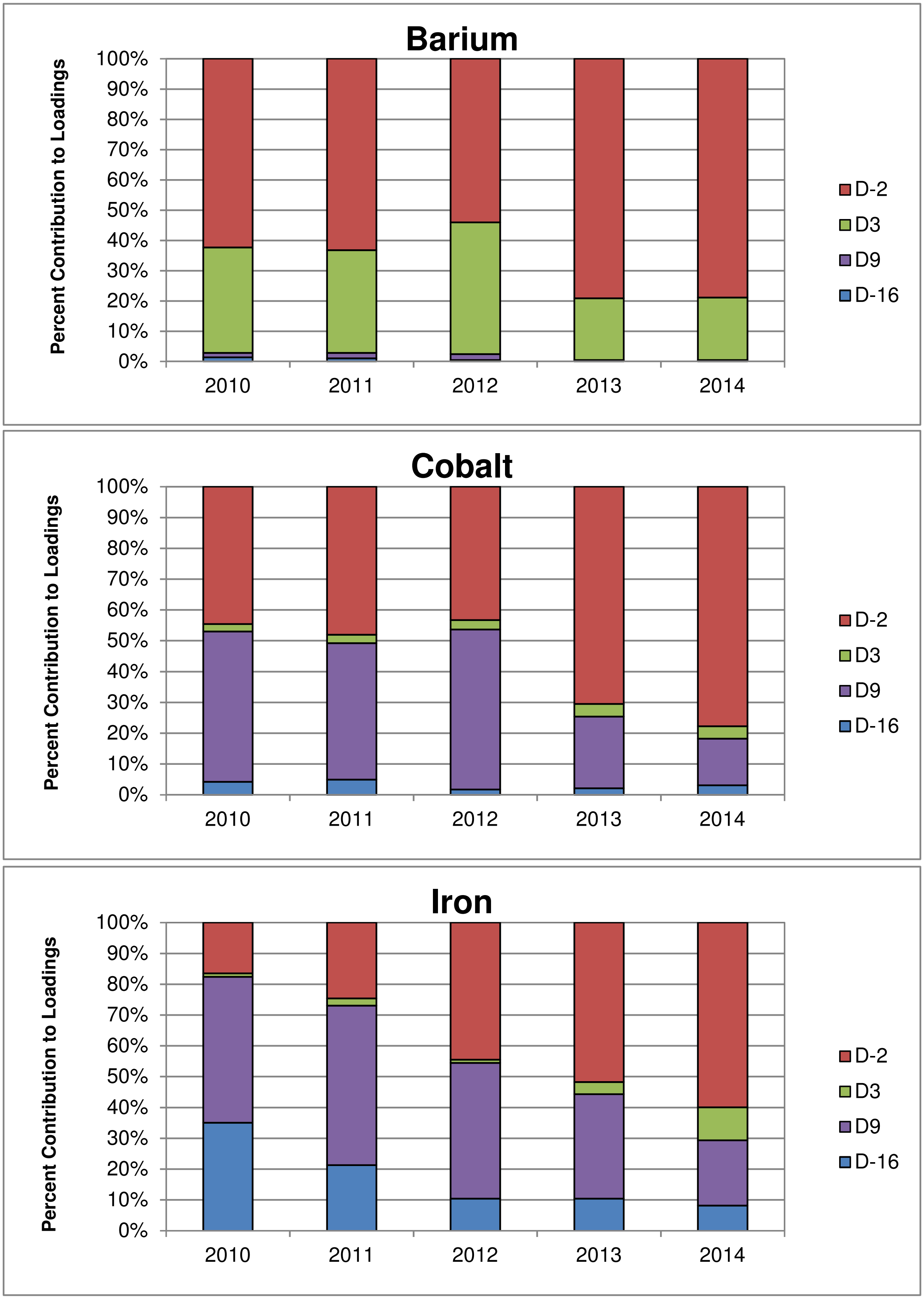
[shaded box] Significant trend where p<0.05.

Appendix Table D.1.10: Summary of seasonal trends for station D-16 from 2003-2014.

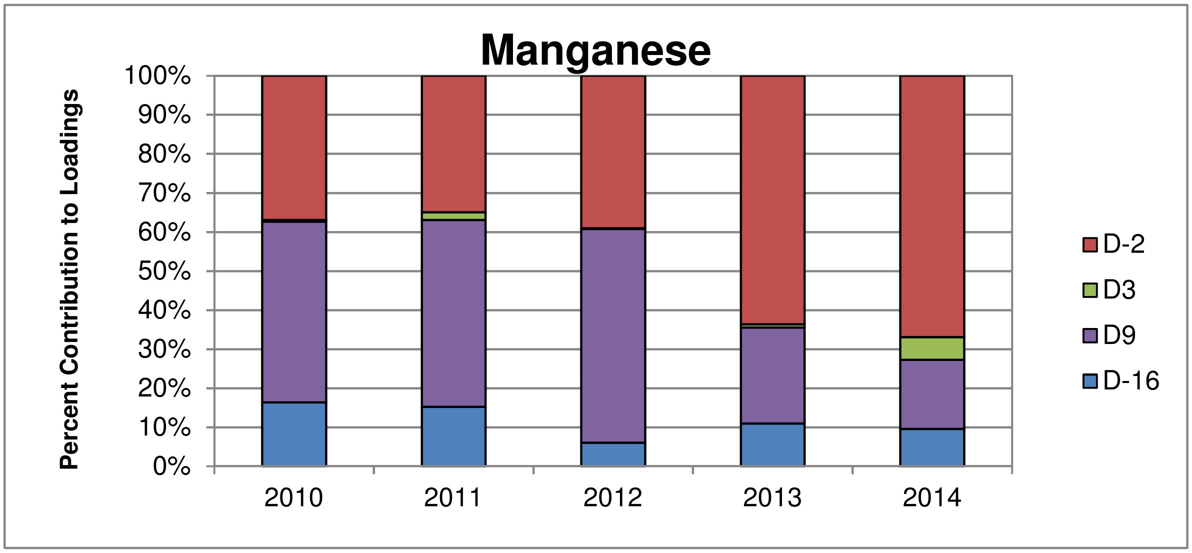
Month	Spearman's rho	Ba	Co	Fe	Hardness	Mn	pH	Ra	SO4	U
January	Correlation Coefficient	-0.299	-0.357	0.567	-0.300	-0.322	0.386	-0.574	-0.011	-0.529
	Sig. (2-tailed)	0.345	0.255	0.054	0.624	0.308	0.215	0.051	0.974	0.077
	N	12	12	12	5	12	12	12	12	12
April	Correlation Coefficient	-0.656	-0.862	0.685	-0.700	-0.706	0.904	-0.882	-0.228	-0.529
	Sig. (2-tailed)	0.020	0.000	0.014	0.188	0.010	0.000	0.000	0.476	0.077
	N	12	12	12	5	12	12	12	12	12
July	Correlation Coefficient	0.151	-0.642	0.084	-0.600	0.601	0.810	-0.340	-0.431	-0.586
	Sig. (2-tailed)	0.640	0.024	0.795	0.285	0.039	0.001	0.279	0.162	0.045
	N	12	12	12	5	12	12	12	12	12
October	Correlation Coefficient	-0.074	-0.490	-0.084	-0.600	-0.112	0.781	-0.399	-0.519	-0.794
	Sig. (2-tailed)	0.820	0.106	0.795	0.285	0.729	0.003	0.199	0.084	0.002
	N	12	12	12	5	12	12	12	12	12

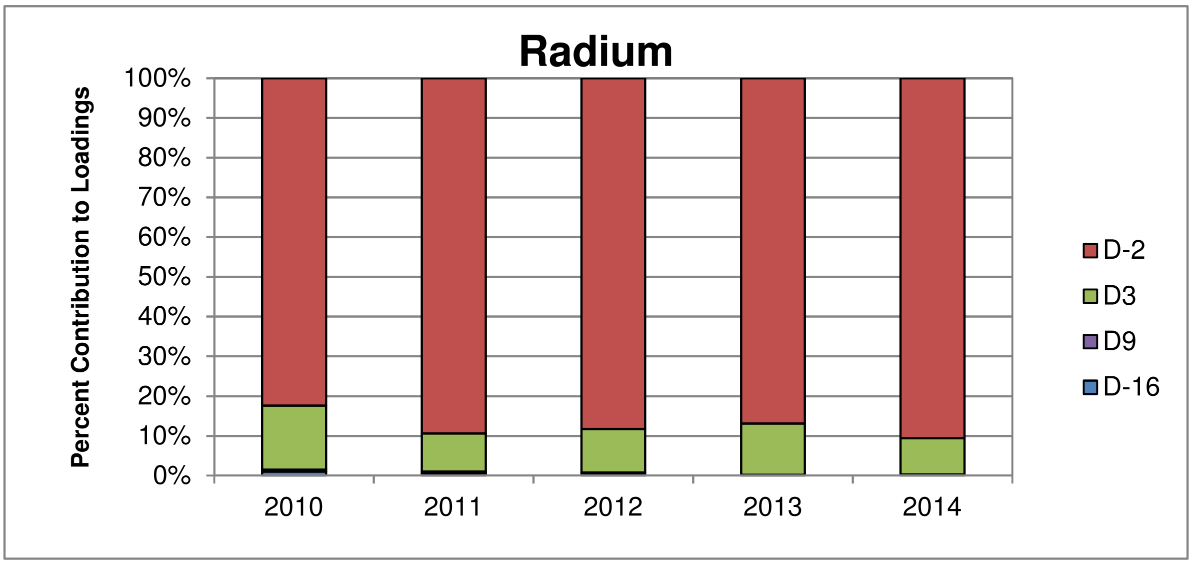
Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

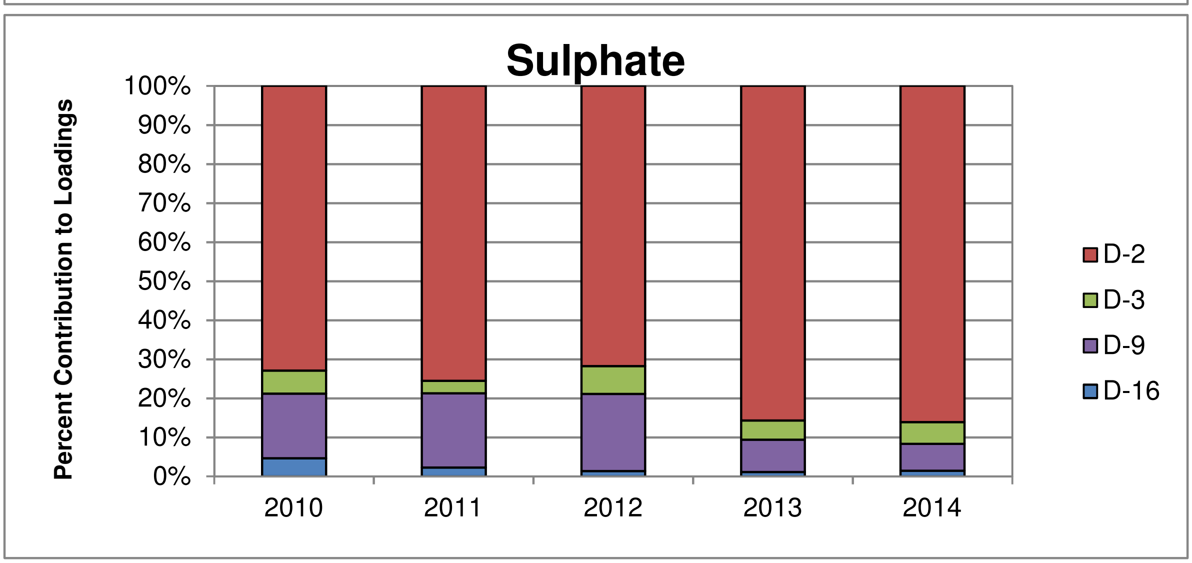
(shaded) Significant trend where $p<0.05$.



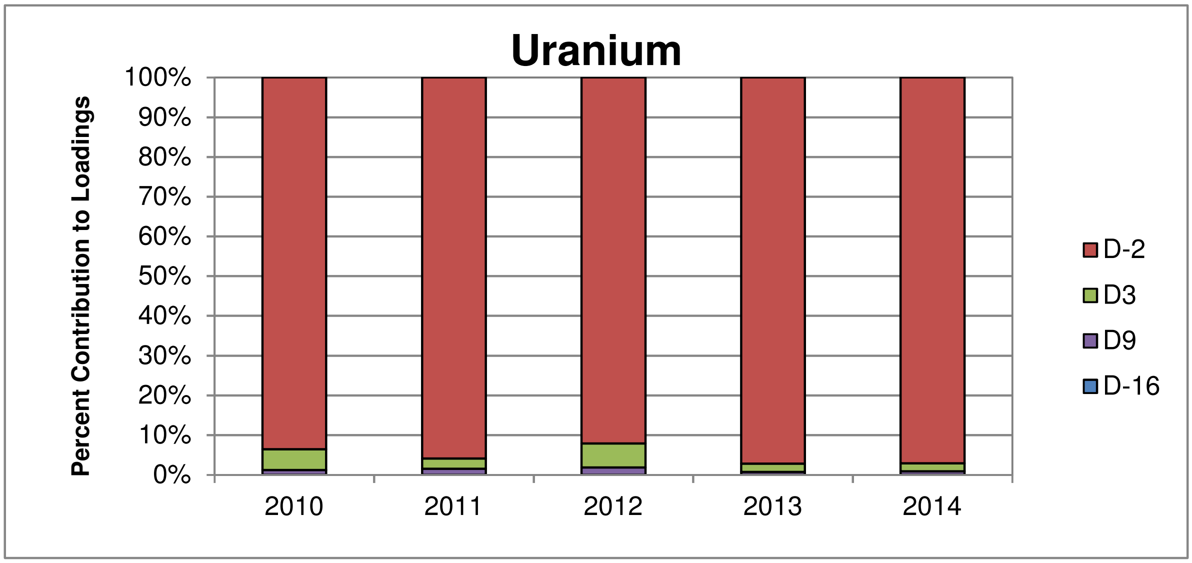
Appendix Figure D.1.1: Percent contribution to total Deinson loads from TMA discharge points.



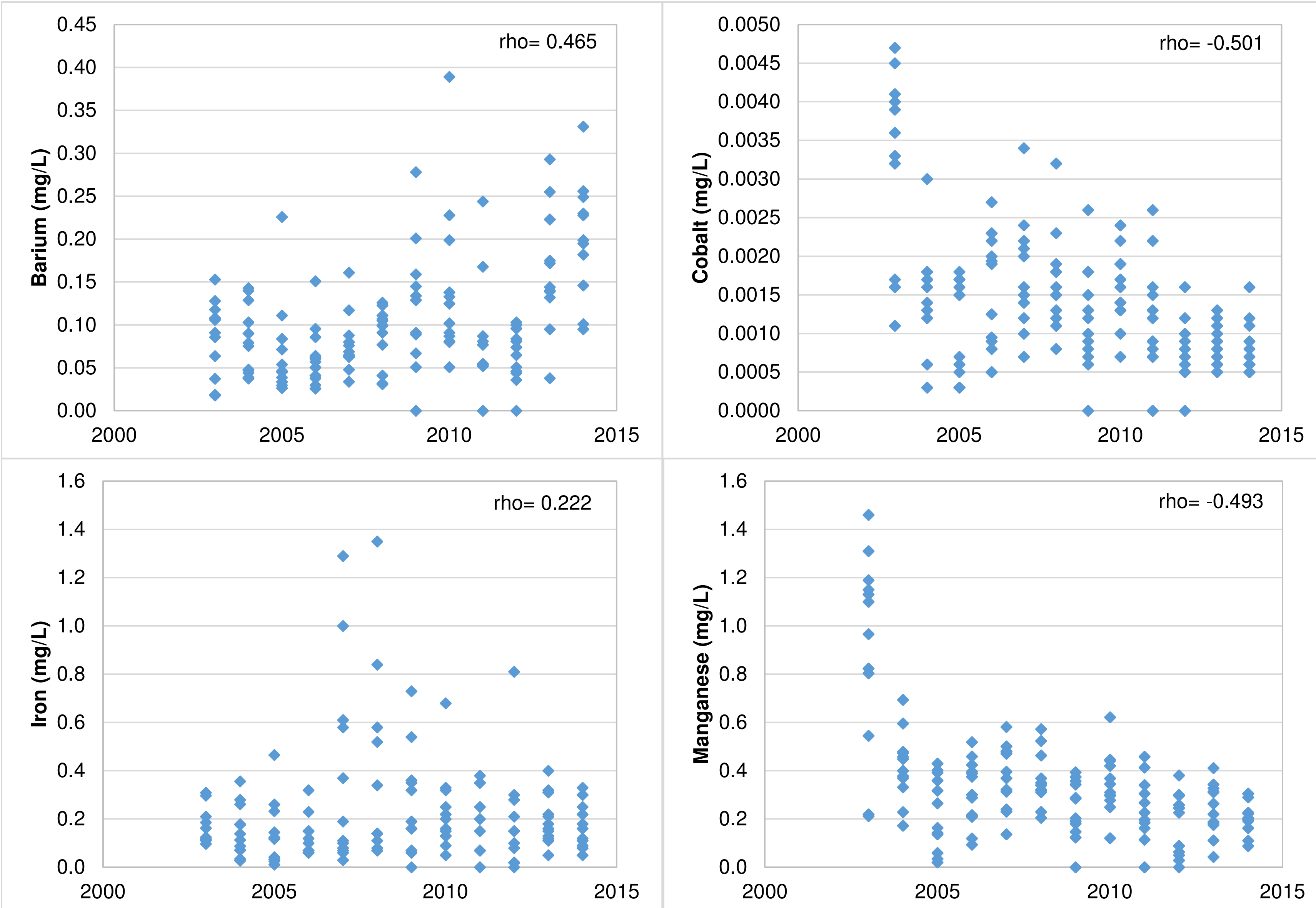




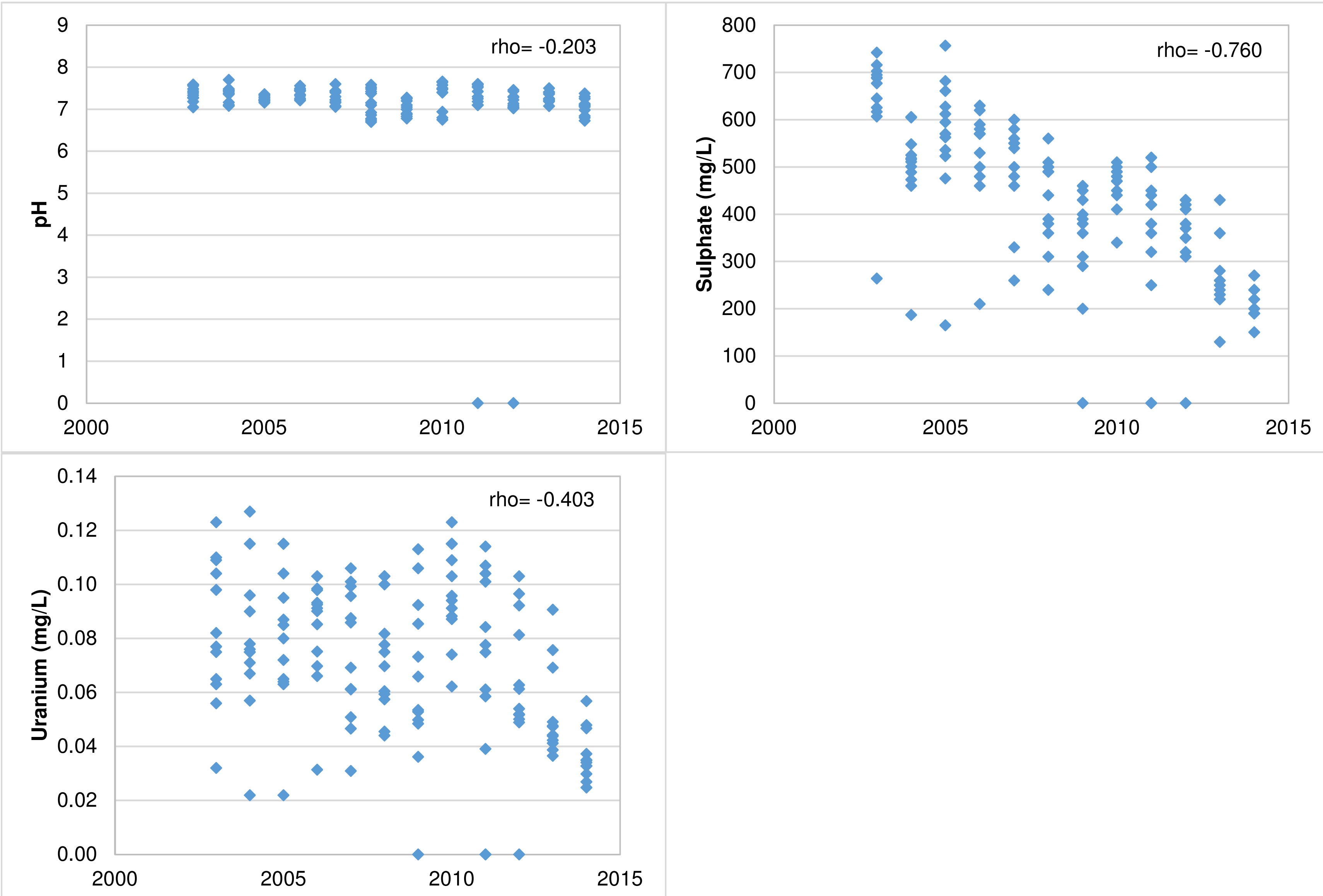
Appendix Figure D.1.1: Percent contribution to total Deinson loads from TMA discharge points.



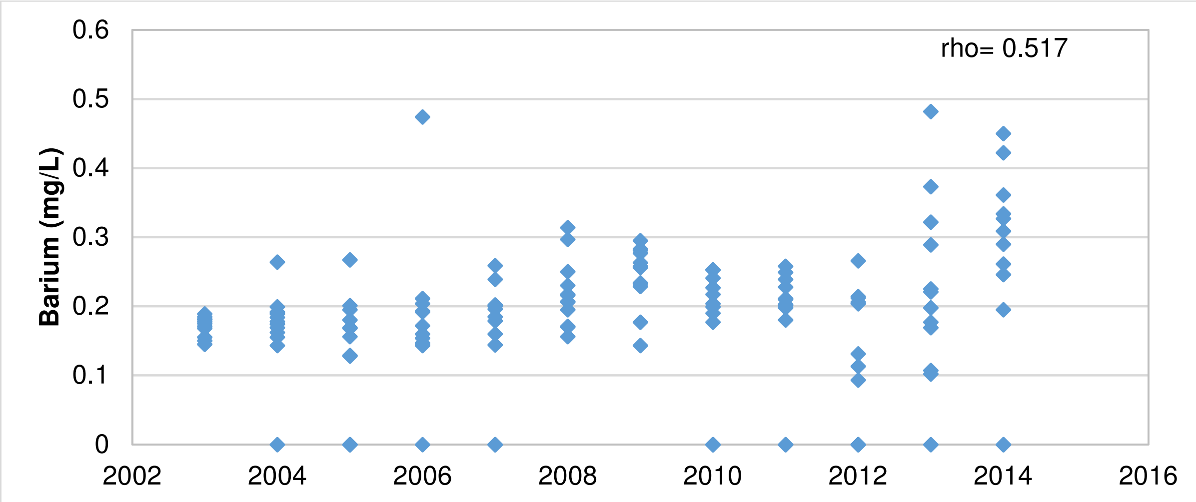
Appendix Figure D.1.1: Percent contribution to total Deinson loads from TMA discharge points.

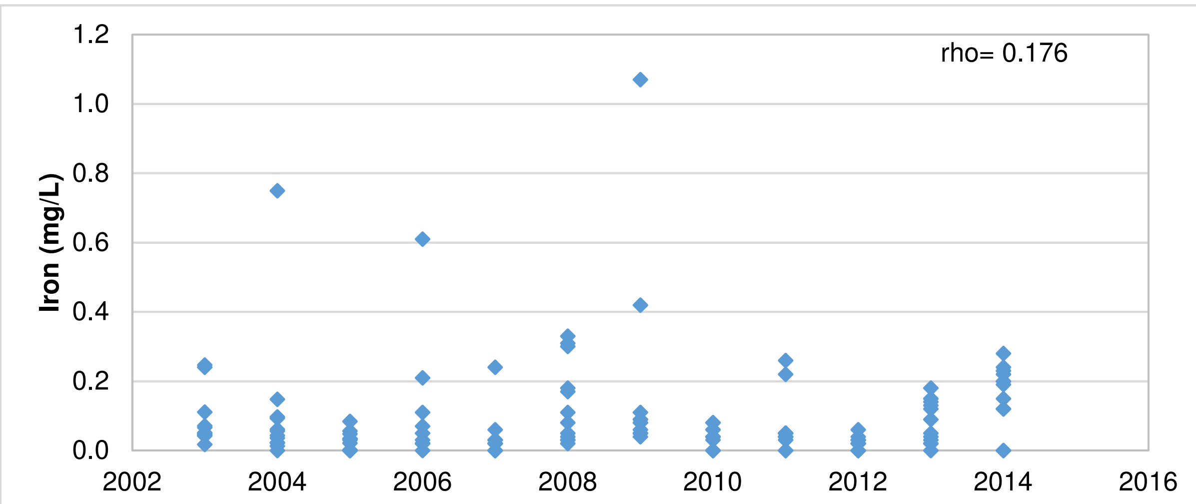


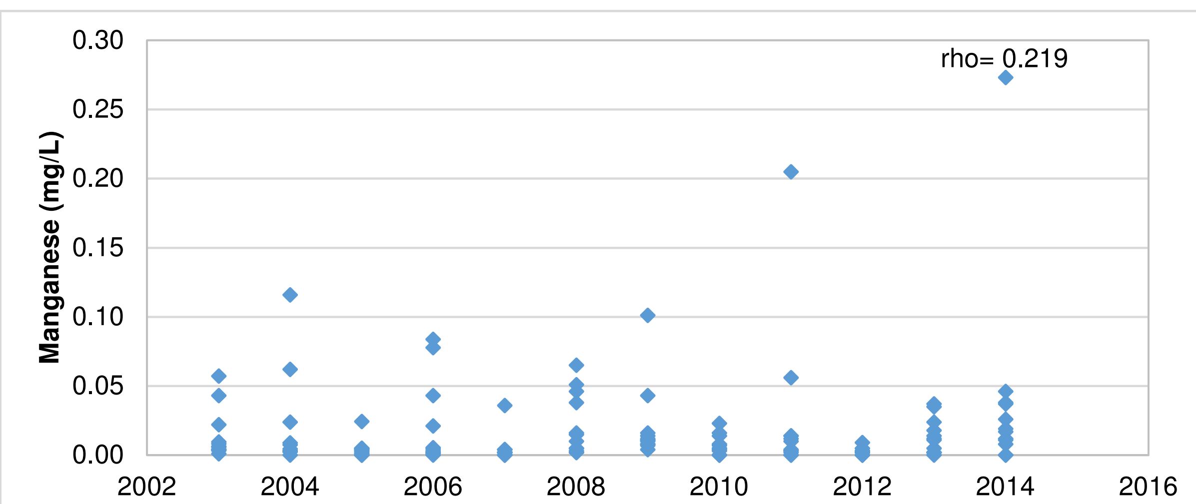
Appendix Figure D.1.2: Significant common (average) trends observed for barium, cobalt, iron, manganese, pH, sulphate and uranium over all seasons at Station D-2, 2003 to 2014.



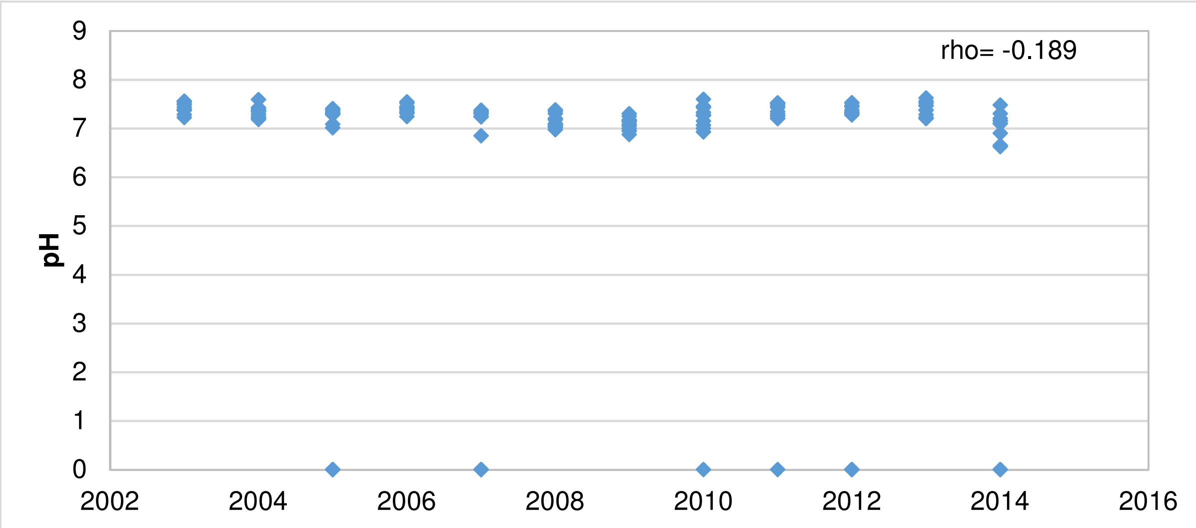
Appendix Figure D.1.2: Significant common (average) trends observed for barium, cobalt, iron, manganese, pH, sulphate and uranium over all seasons at Station D-2, 2003 to 2014.

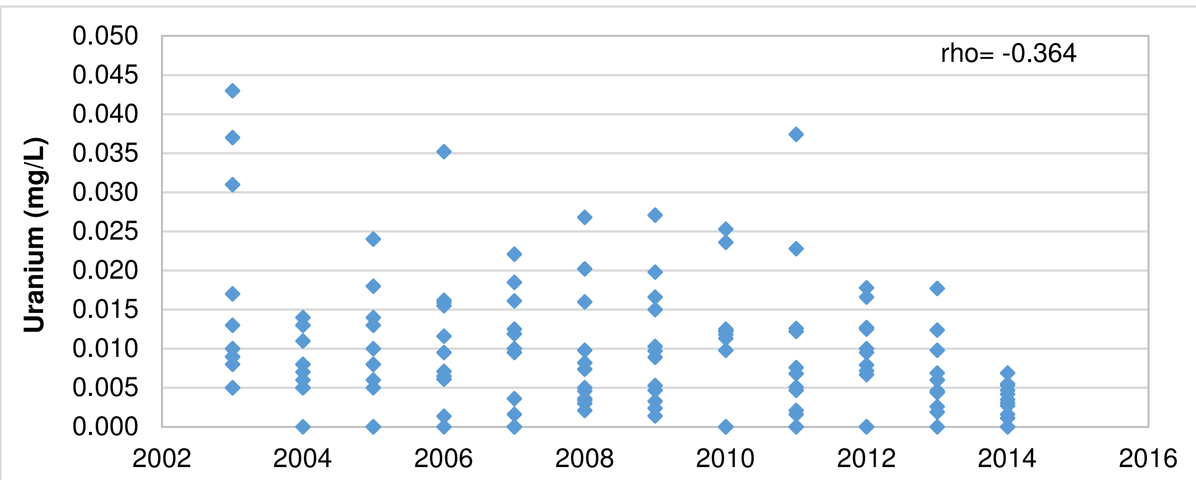




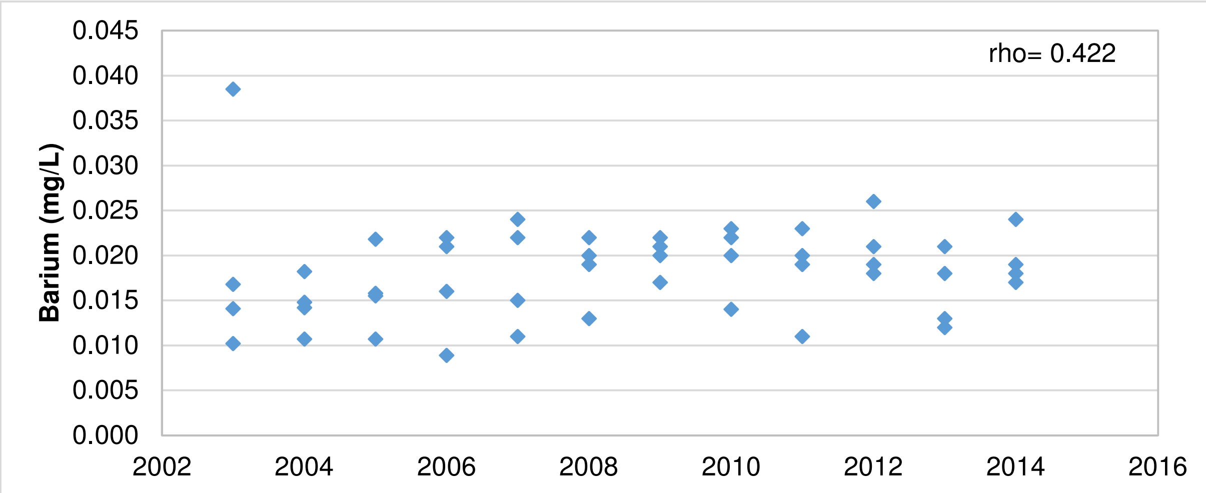


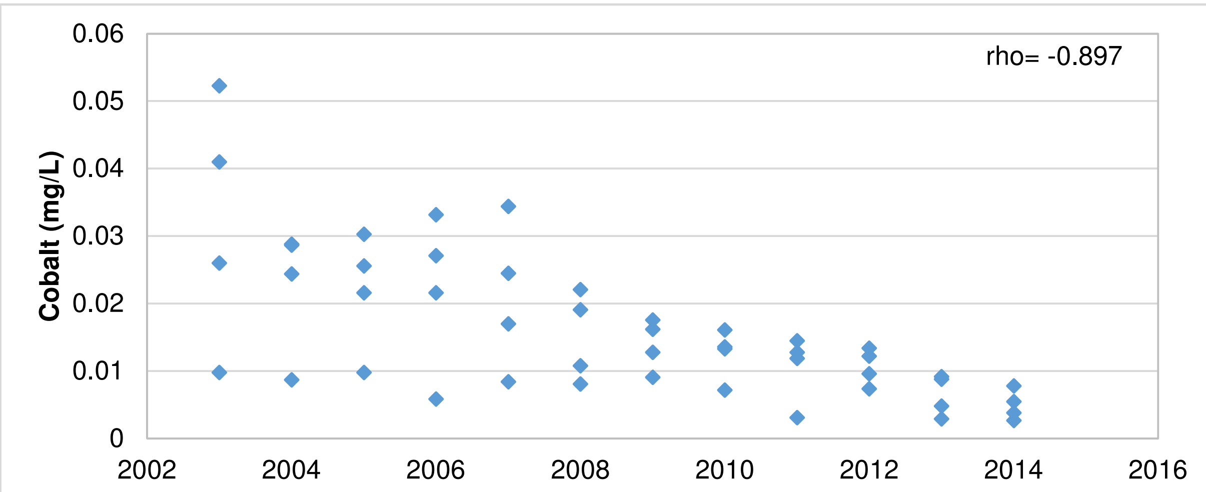
Appendix Figure D.1.3: Significant common (average) trends observed for barium, iron, manganese, pH and uranium over all seasons at Station D-3, 2003 to 2014.

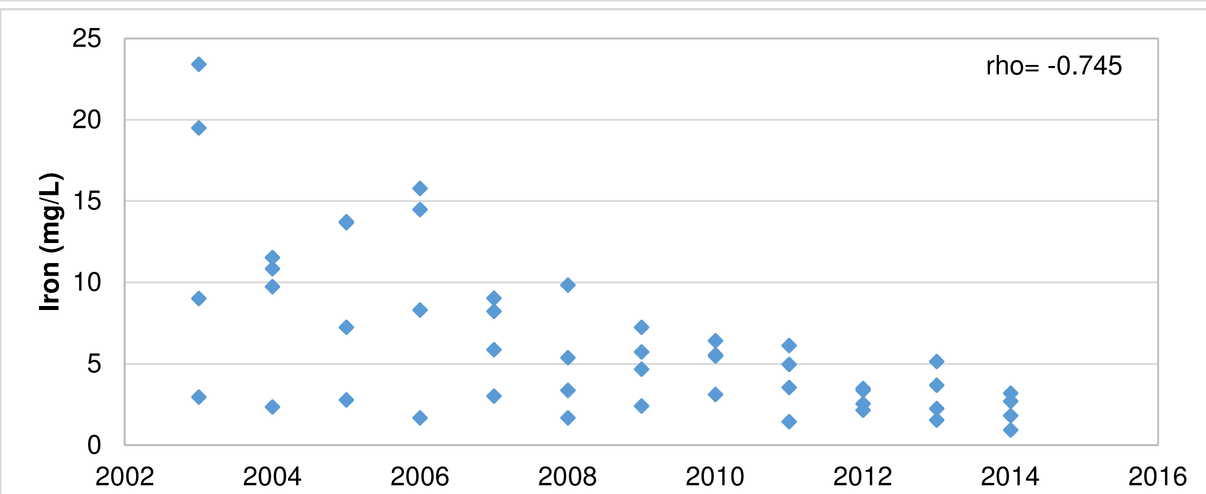




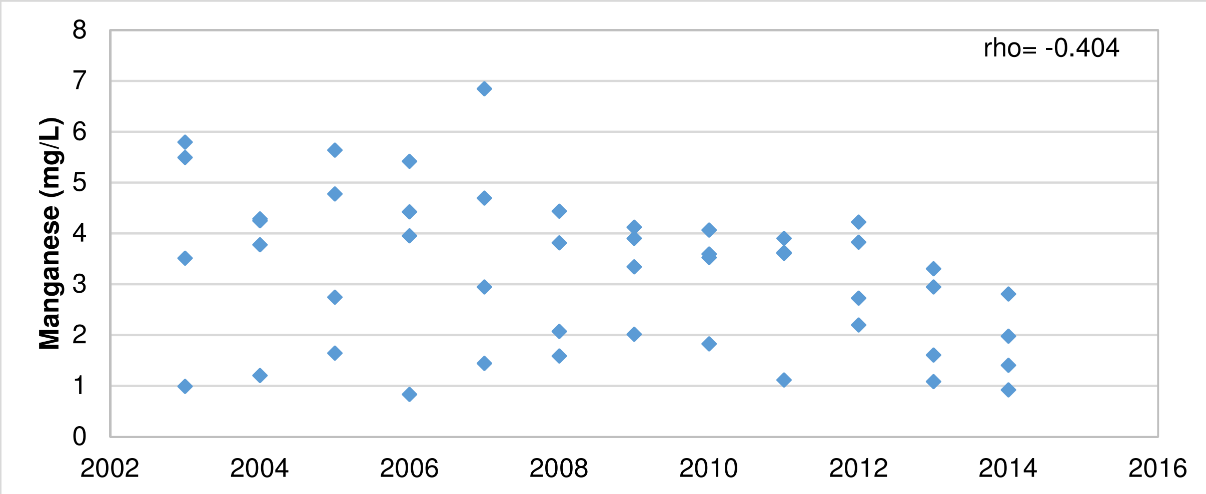
Appendix Figure D.1.3: Significant common (average) trends observed for barium, iron, manganese, pH and uranium over all seasons at Station D-3, 2003 to 2014.

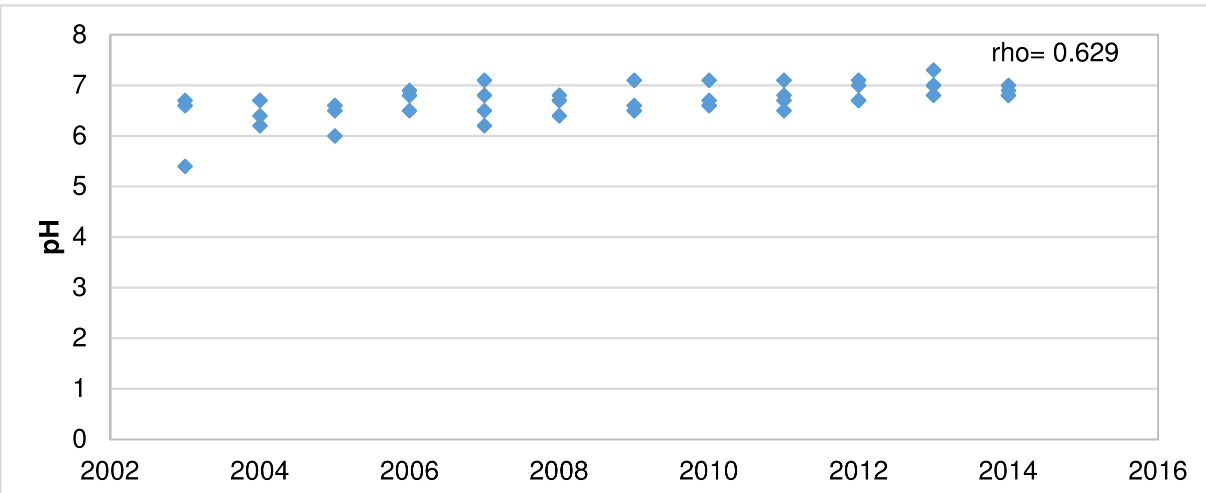




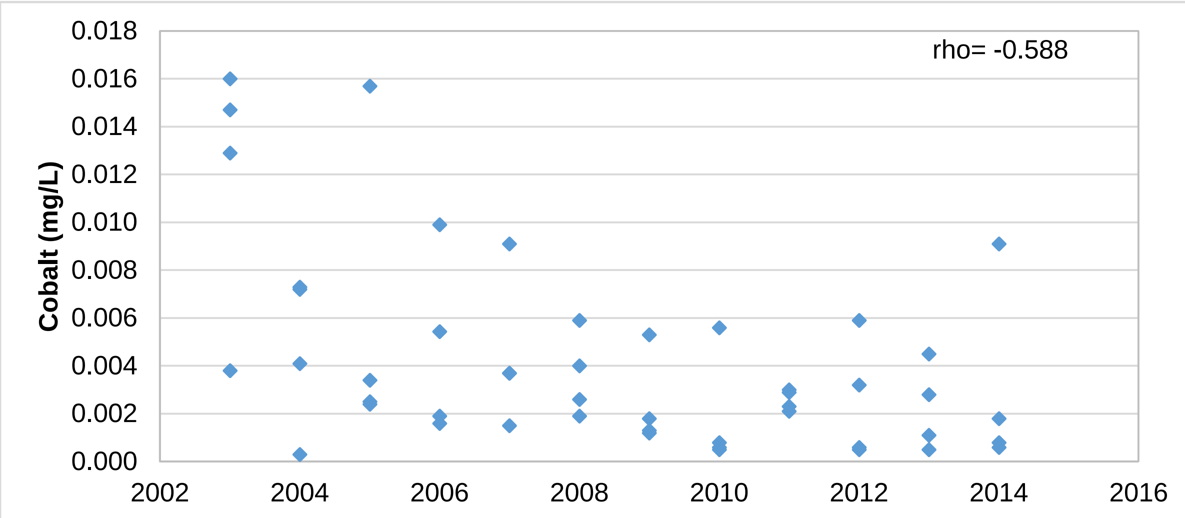


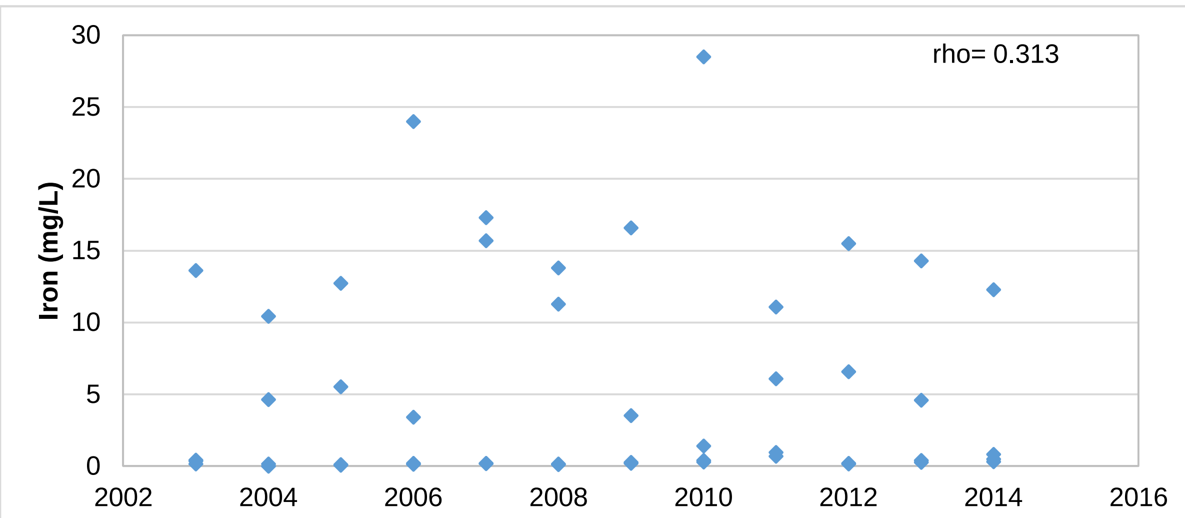
Appendix Figure D.1.4 Significant common (average) trends observed for barium, cobalt, iron, manganese and pH over all seasons at Station D-9, 2003 to 2014.

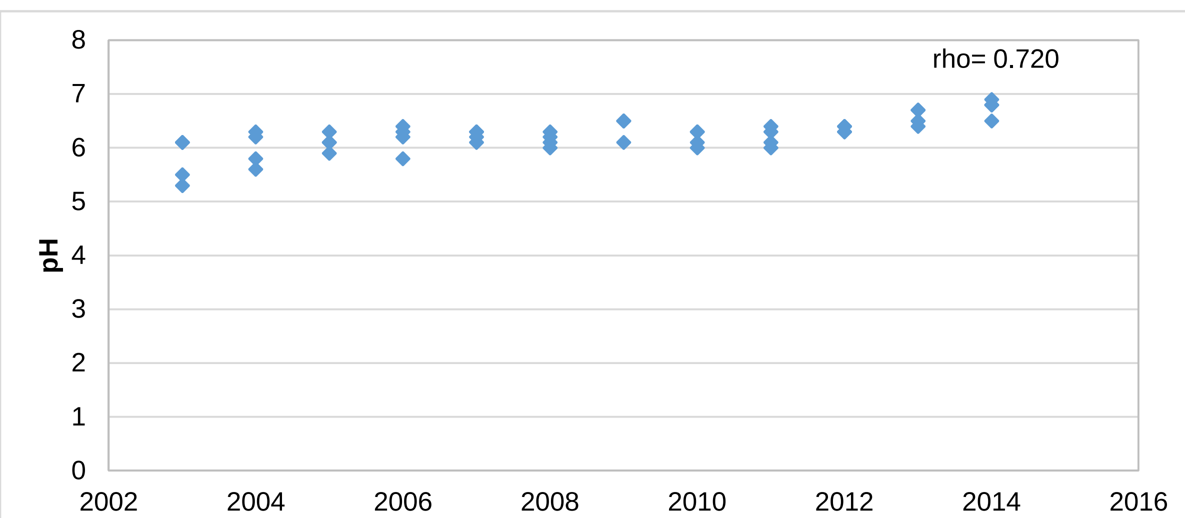




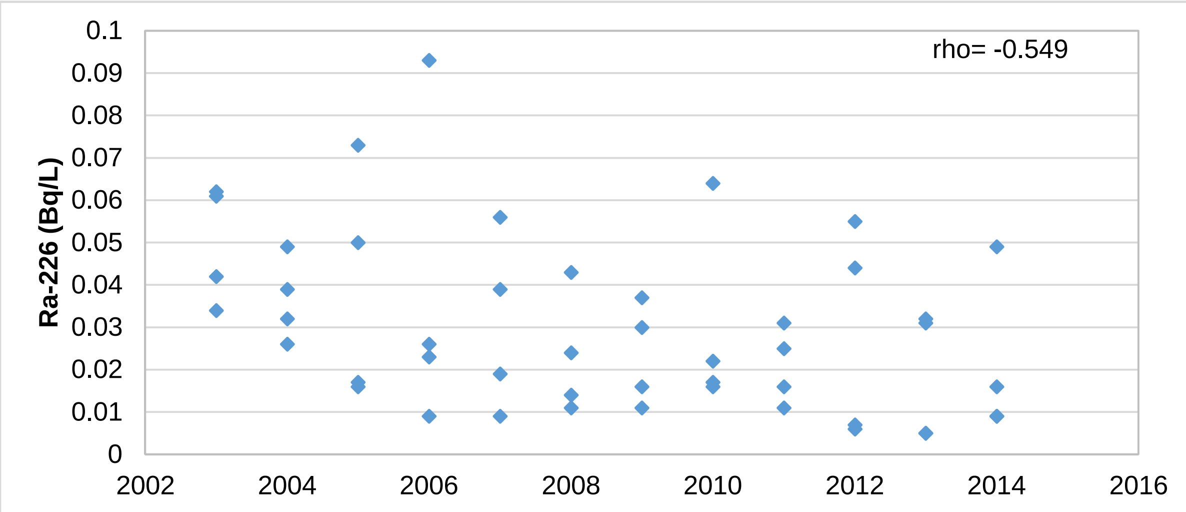
Appendix Figure D.1.4 Significant common (average) trends observed for barium, cobalt, iron, manganese and pH over all seasons at Station D-9, 2003 to 2014.

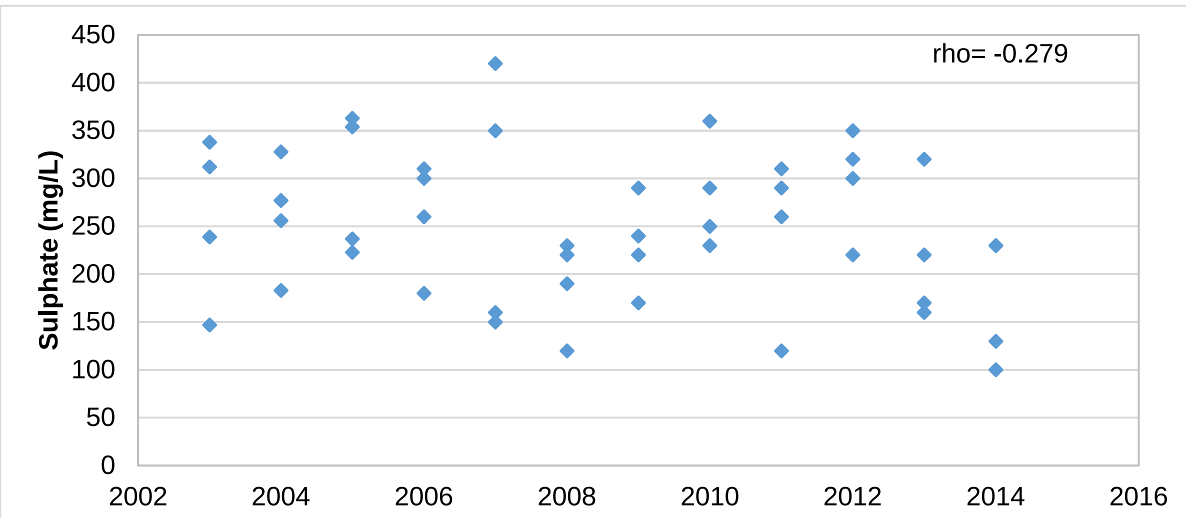




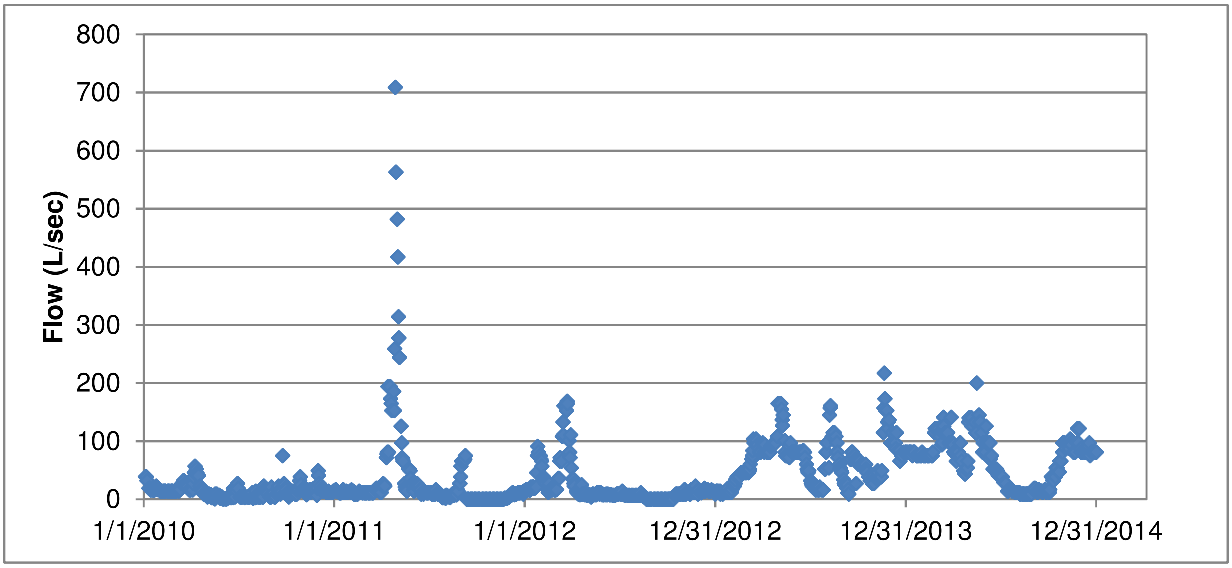


Appendix Figure D.1.5: Significant common (average) trends observed for cobalt, iron, pH, radium-226 and sulphate over all seasons at Station D-16, 2003 to 2014.

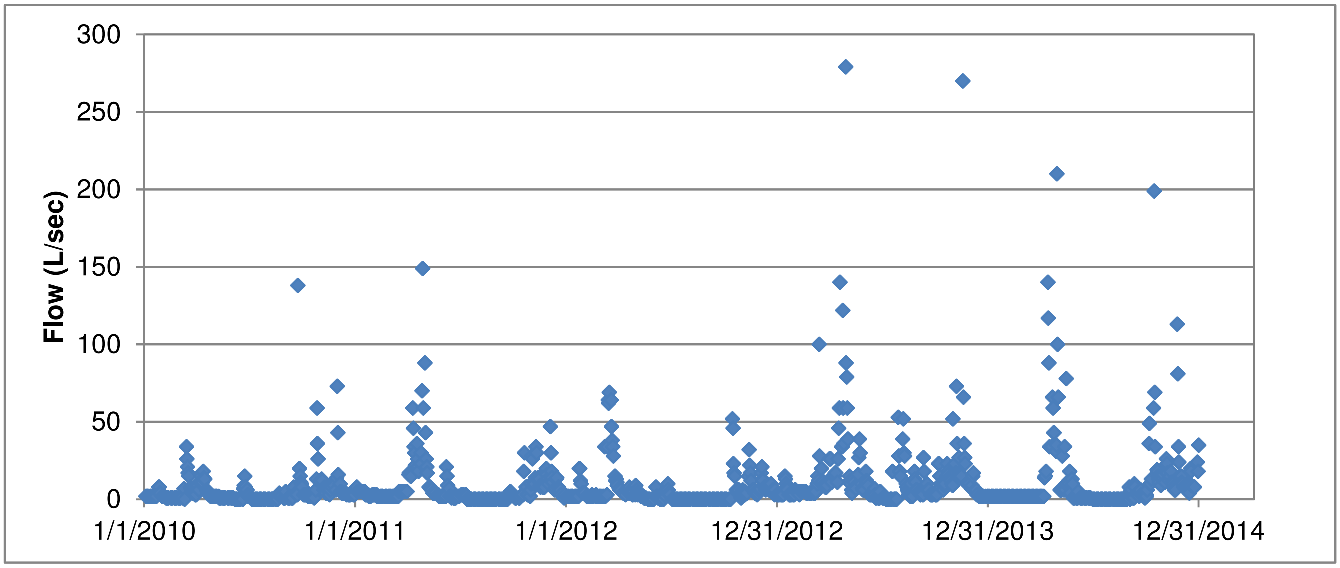




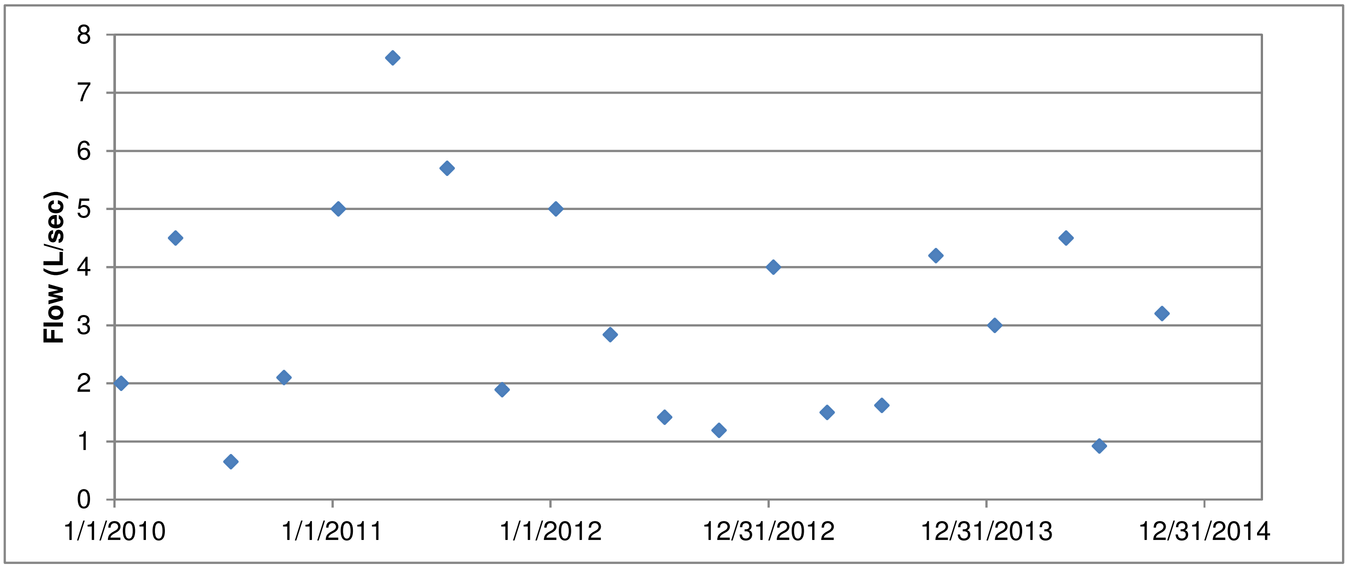
Appendix Figure D.1.5: Significant common (average) trends observed for cobalt, iron, pH, radium-226 and sulphate over all seasons at Station D-16, 2003 to 2014.



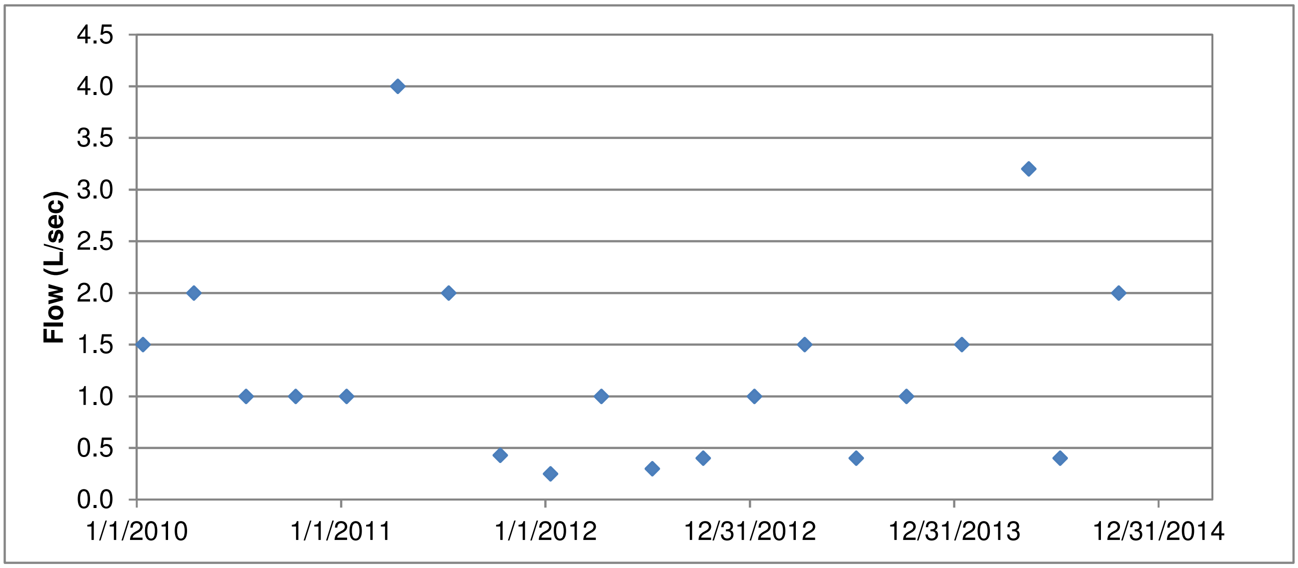
Appendix Figure D.1.6: Flows at station D-2 from 2010 to 2014.



Appendix Figure D.1.7: Flows at station D-3 from 2010 to 2014.



Appendix Figure D.1.8: Flows at station D-9 from 2010 to 2014.



Appendix Figure D.1.9: Flows at station D-16 from 2010 to 2014.

APPENDIX D.2
Quirke TMA

Appendix Table D.2.1: Water quality at station ECA-398 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	U mg/L
1/11/2010	0.017	0.0919	0.16	199	0.977	3.9	0.026	250	0.311
5/10/2010	0.018	0.0849	0.16	204	0.801	4.0	0.045	210	0.260
11/17/2010	0.022	0.0937	0.19	217	0.894	4.1	0.061	230	0.308
2/10/2011	0.017	0.0886	0.15	243	0.994	4.2	0.042	260	0.293
5/11/2011	0.022	0.0714	0.19	172	0.578	4.0	0.058	180	0.236
6/13/2011		0.0751	0.18	196	0.707	4.3	0.113	210	0.264
11/2/2011	0.024	0.0916	0.24	292	1.100	4.0	0.066	300	0.354
2/8/2012	0.016	0.079	0.15	225	0.772	4.3	0.095	240	0.225
5/14/2012	0.021	0.0742	0.14	209	0.701	4.2	0.051	220	0.274
11/21/2012	0.021	0.1000	0.19	275	0.944	4.2	0.065	290	0.314
2/11/2013	0.015	0.1000	0.14	231	0.934	4.4	0.039	260	0.302
5/13/2013	0.020	0.066	0.17	152	0.448	4.0	0.067	190	0.213
8/13/2013	0.030	0.0796	0.26	195	0.576	3.9	0.104	170	0.337
11/26/2013	0.025	0.0713	0.19	173	0.658	4.1	0.065	180	0.259
2/10/2014	0.019	0.0772	0.15	209	0.817	4.1	0.039	220	0.222
5/14/2014	0.020	0.0499	0.20	160	0.371	4.1	0.059	150	0.176
11/17/2014	0.023	0.0751	0.19	181	0.609	3.9	0.049	200	0.250
Number	16	17	17	17	17	17	17	17	17
Maximum	0.030	0.1000	0.26	292	1.100	4.4	0.113	300	0.354
Minimum	0.015	0.0499	0.14	152	0.371	3.9	0.026	150	0.176
Mean	0.021	0.0806	0.18	208	0.758	4.1	0.061	221	0.271
St. Dev.	0.004	0.0130	0.03	38	0.203	0.1	0.024	42	0.048
Median	0.021	0.0790	0.18	204	0.772	4.1	0.059	220	0.264
10th Percentile	0.017	0.0692	0.15	167	0.525	3.9	0.039	176	0.218
95th Percentile	0.026	0.1000	0.24	278	1.015	4.3	0.106	292	0.340

Appendix Table D.2.2: Water quality at station Q-22 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	U mg/L
1/11/2010	0.014	0.0042	0.06	48.7	0.073	6.4	0.012	45	0.0277
5/10/2010	0.018	0.0065	0.15	78.4	0.120	6.2	0.031	69	0.0334
8/9/2010	0.036	0.0258	0.18	242.0	0.612	4.8	0.056	260	0.2010
11/17/2010	0.014	0.0026	0.08	51.8	0.048	6.5	0.02	42	0.0288
2/10/2011	0.015	0.0039	0.06	71.4	0.084	6.5	0.025	54	0.0307
5/11/2011	0.014	0.0024	0.05	42.9	0.028	6.5	0.032	32	0.0231
8/17/2011	0.053	0.0075	0.22	208.0	0.274	6.0	0.110	210	0.0466
11/2/2011	0.015	0.0021	0.12	49.6	0.057	6.3	0.023	40	0.0274
2/8/2012	0.010	0.0017	0.04	42.4	0.029	6.9	0.062	30	0.0167
5/14/2012	0.034	0.0046	0.03	142.0	0.107	6.3	0.063	140	0.0341
11/21/2012	0.015	0.0025	0.07	52.7	0.042	6.6	0.032	49	0.0294
2/11/2013	0.012	0.0015	0.04	40.4	0.023	6.9	0.021	32	0.0182
5/13/2013	0.017	0.0027	0.06	49.9	0.030	6.6	0.032	46	0.0279
8/13/2013	0.019	0.0023	0.19	51.6	0.046	6.6	0.050	41	0.0362
11/26/2013	0.012	0.0031	0.10	40.3	0.040	7.1	0.014	33	0.0259
2/10/2014	0.012	0.0022	0.08	51.6	0.045	6.5	0.016	39	0.0192
5/14/2014	0.010	0.0011	0.06	26.7	0.011	6.5	0.014	19	0.0163
8/7/2014	0.033	0.0036	0.07	122.0	0.123	6.6	0.042	110	0.0319
11/17/2014	0.012	0.0017	0.11	37.2	0.026	6.9	0.014	31	0.0193
Number	19	19	19	19	19	19	19	19	19
Maximum	0.053	0.0258	0.22	242	0.612	7.1	0.110	260	0.2010
Minimum	0.010	0.0011	0.03	26.7	0.011	4.8	0.012	19	0.0163
Mean	0.019	0.0043	0.09	76.3	0.096	6.5	0.035	70	0.0365
St. Dev.	0.011	0.0055	0.05	59.9	0.139	0.5	0.024	66	0.0406
Median	0.015	0.0026	0.07	51.6	0.046	6.5	0.031	42	0.0279
10th Percentile	0.012	0.0017	0.04	39.7	0.025	6.2	0.014	30.8	0.0179
95th Percentile	0.038	0.0093	0.19	211.4	0.308	6.9	0.068	215	0.0620

Appendix Table D.2.3: Water quality at station Q-23 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	U mg/L
1/21/2010	0.027	0.0009	0.87	10.4	0.108	5.7	< 0.005	4.3	< 0.0005
4/15/2010	0.019	< 0.0005	0.18	7.2	0.023	5.8	< 0.005	4.2	< 0.0005
10/21/2010	0.027	< 0.0005	0.45	10.9	0.034	5.8	< 0.005	4.1	< 0.0005
1/19/2011	0.030	0.0009	0.59	11.4	0.089	5.8	< 0.005	5.2	< 0.0005
4/25/2011	0.017	0.0005	0.14	5.4	0.020	5.7	< 0.005	2.9	< 0.0005
7/19/2011	0.029	0.0015	1.03	10.7	0.182	5.7	< 0.005	2.2	< 0.0005
10/18/2011	0.023	< 0.0005	0.66	9.4	0.038	6.6	< 0.005	1.7	< 0.0005
2/23/2012	0.026	0.0008	0.71	10.6	0.072	5.9	< 0.005	4.6	< 0.0005
5/14/2012	0.025	0.0007	0.40	9.7	0.071	6.4	< 0.005	3.5	< 0.0005
8/21/2012	0.030	0.0012	1.23	12.4	0.132	6.0	< 0.005	1.4	< 0.0005
11/21/2012	0.028	0.0006	0.22	10.8	0.025	6.2	< 0.005	5.7	< 0.0005
2/11/2013	0.026	0.0008	0.65	10.9	0.081	6.0	< 0.005	4.8	< 0.0005
5/13/2013	0.022	0.0006	0.34	6.9	0.035	5.9	< 0.005	3.4	< 0.0005
8/12/2013	0.029	0.0009	0.59	8.8	0.079	5.4	< 0.005	2.1	< 0.0005
11/26/2013	0.023	0.0007	0.36	7.8	0.043	6.4	0.006	3.3	< 0.0005
2/10/2014	0.024	0.0013	0.98	9.5	0.110	5.8	< 0.005	2.9	0.0006
5/14/2014	0.018	< 0.0005	0.23	6.3	0.022	6.0	< 0.005	3.0	< 0.0005
8/12/2014	0.025	0.0020	1.28	9.1	0.210	5.6	< 0.005	1.4	< 0.0005
11/17/2014	0.021	0.0006	0.33	8.4	0.040	5.7	< 0.005	3.7	< 0.0005
Number	19	19	19	19	19	19	19	19	19
Maximum	0.030	0.0020	1.28	12.4	0.210	6.6	0.006	5.7	0.0006
Minimum	0.017	< 0.0005	0.14	5.4	0.020	5.4	< 0.005	1.4	< 0.0005
Mean	0.025	0.0008	0.59	9.3	0.074	5.9	< 0.005	3.4	< 0.0005
St. Dev.	0.004	0.0004	0.35	1.9	0.054	0.3	0.000	1.3	0.0000
Median	0.025	0.0007	0.59	9.5	0.071	5.8	< 0.005	3.4	< 0.0005
10th Percentile	0.019	< 0.0005	0.21	6.8	0.023	5.7	< 0.005	1.6	< 0.0005
95th Percentile	0.030	0.0016	1.24	11.5	0.185	6.4	0.005	5.3	0.0005

Appendix Table D.2.4: Water quality at station Q-27 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	U mg/L
4/15/2010	0.108	0.0320	19.2	274	2.91	5.8	0.013	300	0.0015
11/16/2010	0.104	0.0251	22.7	253	2.69	6.0	0.010	240	0.0012
4/25/2011	0.082	0.0315	13.4	296	2.79	5.7	0.011	310	0.0016
10/25/2011	0.143	0.0319	20.0	370	3.51	5.8	0.018	370	0.0015
11/21/2012	0.097	0.0190	20.8	283	2.25	6.0	0.010	270	0.0014
5/13/2013	0.073	0.0307	14.4	293	2.70	5.5	0.010	290	0.0019
8/12/2013	0.108	0.0258	19.8	270	2.34	5.7	0.021	260	0.0012
11/26/2013	0.088	0.0203	10.8	233	2.05	5.9	0.006	240	0.0016
5/14/2014	0.067	0.0187	10.4	286	1.89	5.8	0.007	270	0.0013
11/17/2014	0.086	0.0209	17.0	295	2.36	5.7	0.013	290	0.0012
Number	10	10	10	10	10	10	10	10	10
Maximum	0.143	0.0320	22.7	370	3.51	6.0	0.021	370	0.0019
Minimum	0.067	0.0187	10.4	233	1.89	5.5	0.006	240	0.0012
Mean	0.096	0.0256	16.9	285	2.55	5.8	0.012	284	0.0014
St. Dev.	0.022	0.0056	4.35	35.9	0.47	0.2	0.005	38	0.0002
Median	0.093	0.0255	18.1	285	2.53	5.8	0.011	280	0.0015
10th Percentile	0.072	0.0190	10.8	251	2.03	5.7	0.007	240	0.0012
95th Percentile	0.127	0.0320	21.8	337	3.24	6.0	0.020	343	0.0018

Appendix Table D.2.5: Water quality at station Q-28 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	TSS[a] mg/L	U mg/L
1/4/2010						8.4	0.180		1	
1/11/2010	0.083	0.0141	0.77	928	2.100	8.3	0.150	1100	2	0.0181
1/18/2010						8.4	0.170		2	
1/25/2010						8.4	0.140		3	
2/1/2010						8.5	0.100		2	
2/8/2010	0.084	0.0130	0.65	975	1.950	8.5	0.160	1200	3	0.0183
2/16/2010						8.5	0.120		3	
2/22/2010						8.5	0.180		4	
3/1/2010						8.4	0.085		3	
3/8/2010	0.082	0.0116	0.59	1103	1.960	8.1	0.120	1200	2	0.0176
3/15/2010						8.2	0.120		3	
3/22/2010						8.0	0.083		1	
3/29/2010						7.9	0.057		1	
4/5/2010						7.5	0.031		1	
4/12/2010	0.044	0.0086	0.29	888	1.230	7.5	0.040	910	1	0.0250
4/19/2010						7.4	0.062		< 1	
4/26/2010						7.4	0.096		1	
5/3/2010						7.4	0.130		1	
5/10/2010	0.072	0.0049	0.22	963	0.846	7.4	0.100	900	< 1	0.0180
5/17/2010						7.1	0.110		1	
5/25/2010						7.3	0.092		2	
5/31/2010						7.1	0.085		1	
6/7/2010						7.2	0.072		1	
6/14/2010	0.056	0.0027	0.21	1190	0.400	6.9	0.075	1000	1	0.0210
6/21/2010						7.1	0.082		2	
6/28/2010						7.5	0.120		2	
7/5/2010						7.1	0.150		1	
7/12/2010	0.060	0.0020	0.21	977	0.448	7.1	0.120	1100	1	0.0180
7/19/2010						7.2	0.110		< 1	
7/26/2010						7.1	0.110		2	
8/3/2010						7.3	0.190		1	
8/9/2010						7.2	0.170		< 1	
8/16/2010	0.090	0.0028	0.22	1120	0.727	7.2	0.250	1100	< 1	0.0145
8/23/2010						7.1	0.230		2	
8/30/2010						7.1	0.225		1	
9/7/2010						7.0	0.140		1	
9/13/2010	0.099	0.0028	0.40	1070	0.785	7.2	0.090	1200	2	0.0172
9/20/2010						7.5	0.072		1	
9/27/2010						7.0	0.071		1	
10/4/2010						7.1	0.100		< 2	
10/13/2010	0.082	0.0055	0.39	1101	0.929	7.3	0.099	1100	2	0.0268
10/18/2010						7.3	0.170		1	
10/25/2010						7.2	0.110		1	
11/1/2010						7.0	0.088		1	
11/8/2010	0.119	0.0089	0.43	1100	1.600	7.3	0.087	1100	2	0.0223
11/15/2010						7.4	0.064		4	
11/22/2010						7.0	0.043		1	
11/29/2010						7.5	0.059		2	
12/6/2010						7.9	0.130		2	
12/13/2010	0.104	0.0118	0.92	1120	1.450	8.4	0.110	1300	3	0.0165
12/20/2010						8.4	0.110		3	

Appendix Table D.2.5: Water quality at station Q-28 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	TSS[a] mg/L	U mg/L
12/29/2010						8.3	0.071		2	
1/4/2011						7.4	0.091		1	
1/10/2011	0.069	0.0113	0.67	1240	1.540	8.1	0.116	1200	3	0.0183
1/17/2011						8.0	0.058		1	
1/24/2011						8.1	0.074		2	
1/31/2011						7.7	0.105		4	
2/7/2011						7.7	0.123		4	
2/14/2011	0.080	0.0107	0.93	1220	1.410	8.1	0.118	1200	2	0.0184
2/22/2011						7.9	0.087		3	
2/28/2011						8.3	0.082		1	
3/7/2011						7.8	0.110		2	
3/14/2011	0.089	0.0105	1.03	1220	1.390	7.8	0.114	1200	1	0.0206
3/22/2011						7.9	0.087		1	
3/28/2011						8.2	0.073		1	
4/4/2011						7.9	0.083		2	
4/11/2011	0.050	0.0082	0.55	966	1.100	7.5	0.067	940	1	0.0173
4/18/2011						7.0	0.063		1	
4/25/2011						7.4	0.066		1	
5/2/2011						7.7	0.068		1	
5/9/2011	0.151	0.0061	0.31	598	0.734	7.5	0.071	580	1	0.0092
5/16/2011						7.2	0.075		1	
5/24/2011						7.5	0.076		1	
5/30/2011						7.5	0.080		< 1	
6/6/2011						7.4	0.072		2	
6/13/2011	0.115	0.0044	0.21	882	0.713	7.4	0.076	890	1	0.0103
6/20/2011						7.3	0.074		4	
6/27/2011						7.3	0.063		3	
7/4/2011						7.2	0.085		2	
7/11/2011	0.128	0.0032	0.22	1040	0.647	7.3	0.083	970	1	0.0127
7/18/2011						7.3	0.078		1	
7/25/2011						7.2	0.057		3	
8/2/2011						7.0	0.050		2	
8/8/2011	0.070	0.0022	0.24	1090	0.336	7.1	0.055	1100	2	0.0145
8/15/2011						7.1	0.065		2	
8/22/2011						7.1	0.075		2	
8/29/2011						7.0	0.062		2	
9/6/2011						7.1	0.068		2	
9/12/2011	0.099	0.0025	0.28	1130	0.351	7.1	0.074	1100	1	0.0140
9/19/2011						6.9	0.057		2	
9/26/2011						7.2	0.074		4	
10/3/2011						7.1	0.085		< 1	
10/11/2011	0.112	0.0032	0.26	1130	0.731	7.1	0.101	1100	2	0.0143
10/17/2011						7.2	0.076		2	
10/24/2011						7.2	0.067		1	
10/31/2011						7.6	0.095		1	
11/7/2011						7.3	0.077		1	
11/14/2011	0.091	0.0071	0.47	1030	1.260	7.1	0.078	1100	1	0.0101
11/21/2011						7.2	0.096		1	
11/28/2011						8.1	0.073		2	
12/5/2011						8.2	0.072		2	
12/12/2011	0.081	0.0094	0.78	1180	1.430	7.0	0.069	1200	2	0.0166
12/19/2011						8.0	0.108		2	
12/28/2011						7.1	0.105		3	
1/3/2012						8.3	0.108		1	
1/9/2012	0.087	0.0091	1.08	1140	1.370	7.7	0.108	1200	2	0.0162

Appendix Table D.2.5: Water quality at station Q-28 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	TSS[a] mg/L	U mg/L
1/16/2012						7.8	0.105		1	
1/23/2012						8.2	0.105		3	
1/30/2012						7.6	0.106		2	
2/6/2012						7.9	0.105		3	
2/13/2012	0.091	0.0086	1.08	1260	1.260	7.9	0.102	1100	4	0.0152
2/21/2012						8.1	0.084		4	
2/27/2012						8.4	0.111		2	
3/5/2012						7.6	0.092		3	
3/12/2012	0.095	0.0106	1.24	1200	1.490	7.3	0.107	1100	3	0.0156
3/19/2012						7.0	0.118		3	
3/26/2012						7.1	0.050		2	
4/2/2012						7.5	0.088		2	
4/9/2012	0.101	0.0067	0.30	747	0.822	7.4	0.064	710	< 2	0.0119
4/16/2012						7.6	0.060		1	
4/23/2012						7.3	0.060		1	
4/30/2012						7.3	0.048		< 1	
5/7/2012	0.093	0.0040	0.27	960	0.700	7.4	0.073	900	< 1	0.0131
5/14/2012						7.3	0.059		1	
5/22/2012						7.5	0.053		3	
5/28/2012						7.4	0.056		2	
6/4/2012						7.6	0.043		2	
6/12/2012	0.072	0.0030	0.53	1020	0.472	7.4	0.058	1100	3	0.0184
6/18/2012						7.4	0.057		2	
6/25/2012						7.4	0.074		2	
7/3/2012						7.3	0.076		1	
7/9/2012	0.076	0.0024	0.51	1130	0.422	7.2	0.074	1000	1	0.0157
7/16/2012						7.3	0.062		2	
7/23/2012						7.3	0.077		2	
7/30/2012						7.2	0.072		2	
8/7/2012						7.3	0.060		2	
8/13/2012						7.3	0.058		1	
8/20/2012	0.056	0.0024	0.55	1090	0.322	7.4	0.059	1100	2	0.0189
8/27/2012						7.4	0.071		2	
9/4/2012						7.1	0.071		3	
9/10/2012	0.064	0.0017	0.62	1290	0.313	7.4	0.059	1091	2	0.0229
9/17/2012						7.3	0.054		2	
9/24/2012						7.4	0.062		2	
10/1/2012						7.4	0.075		3	
10/9/2012	0.069	0.0042	0.61	1260	0.690	7.2	0.086	1100	1	0.0228
10/15/2012						7.3	0.071		2	
10/22/2012						7.4	0.098		1	
10/29/2012						7.2	0.070		2	
11/5/2012						7.2	0.081		2	
11/12/2012	0.066	0.0069	0.51	1130	1.040	7.1	0.067	1100	1	0.0161
11/19/2012						7.1	0.078		2	
11/26/2012						7.2	0.067		1	
12/3/2012						7.7	0.054		2	
12/10/2012	0.070	0.0093	1.02	1260	1.260	7.2	0.080	1100	1	0.0151
12/17/2012						7.8	0.096		1	
12/27/2012						7.3	0.100		2	
1/2/2013						8.0	0.087		2	
1/7/2013						7.6	0.097		3	
1/14/2013	0.074	0.0083	1.01	1080	1.300	7.6	0.087	1100	2	0.0146
1/21/2013						8.0	0.072		4	
1/28/2013						7.8	0.100		4	

Appendix Table D.2.5: Water quality at station Q-28 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	TSS[a] mg/L	U mg/L
2/4/2013						8.2	0.083		2	
2/11/2013	0.085	0.0090	1.04	1160	1.280	8.4	0.083	1200	3	0.0185
2/19/2013						8.5	0.099		3	
2/25/2013	0.126	0.0091	1.38	1138	1.310	7.6	0.159	1100	5	0.0157
3/4/2013	0.104	0.0092	1.32	1178	1.210	7.8	0.107	1100	4	0.0157
3/11/2013	0.135	0.0099	1.33	1107	1.260	7.4	0.112	1100	4	0.0171
3/18/2013						8.4	0.082		3	
3/25/2013						7.6	0.100		6	
4/1/2013						7.4	0.086		3	
4/8/2013	0.106	0.0075	0.97	1030	1.080	8.2	0.099	940	3	0.0168
4/15/2013						8.2	0.107		2	
4/22/2013						7.2	0.112		4	
4/29/2013						7.2	0.090		2	
5/6/2013						7.5	0.097		1	
5/13/2013	0.173	0.0043	0.37	526	0.646	7.3	0.073	500	2	0.0127
5/21/2013						7.8	0.069		1	
5/27/2013						7.9	0.079		1	
6/3/2013						7.3	0.107		2	
6/10/2013	0.133	0.0041	0.32	691	0.700	7.5	0.115	810	2	0.0072
6/17/2013						7.7	0.083		2	
6/24/2013						7.6	0.054		2	
7/2/2013						7.4	0.091		2	
7/8/2013	0.150	0.0032	0.33	854	0.624	7.3	0.131	840	1	0.0076
7/15/2013						7.2	0.130		2	
7/22/2013						7.4	0.137		1	
7/29/2013						7.6	0.162		2	
8/6/2013						8.3	0.227		1	
8/12/2013	0.185	0.0032	0.34	854	0.755	7.9	0.249	750	2	0.0073
8/19/2013						7.7	0.087		1	
8/26/2013						8.0	0.109		2	
9/3/2013						8.2	0.130		2	
9/9/2013						7.8	0.058		1	
9/16/2013						7.4	0.046		2	
9/30/2013	0.037	0.0046	0.79	913	0.846	7.2	0.054	990	2	0.0301
10/3/2013	0.043	0.0048	1.02		0.874	7.2	0.082	910	4	0.0259
10/7/2013						7.2	0.096		3	
10/15/2013	0.047	0.0064	0.85	989	1.010	6.9	0.119	970	2	0.0227
10/21/2013						6.9	0.113		2	
10/28/2013						7.0	0.088		2	
11/4/2013						6.9	0.088		2	
11/11/2013	0.043	0.0051	1.11	910	0.760	7.1	0.064	860	2	0.0178
11/18/2013						7.0	0.082		4	
11/25/2013						7.1	0.113		2	
12/2/2013						8.3	0.081		2	
12/9/2013	0.059	0.0044	0.57	940	0.951	7.1	0.056	940	2	0.0131
12/16/2013						8.6	0.078		2	
12/23/2013						7.3	0.084		2	
1/2/2014						7.5	0.066		2	
1/6/2014						6.9	0.044		2	
1/13/2014	0.071	0.0056	0.62	987	1.100	7.2	0.066	1000	2	0.0129
1/20/2014						7.2	0.063		2	
1/27/2014						7.3	0.063		2	
2/3/2014						7.3	0.067		2	
2/10/2014	0.082	0.0062	0.44	1050	1.120	7.1	0.066	980	2	0.0123
2/19/2014						6.8	0.044		1	

Appendix Table D.2.5: Water quality at station Q-28 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	TSS[a] mg/L	U mg/L
2/24/2014						7.0	0.038		1	
3/3/2014						7.3	0.043		1	
3/10/2014	0.043	0.0046	0.47	1030	0.963	7.2	0.044	1000	2	0.0156
3/17/2014						7.4	0.048		1	
3/24/2014						7.5	0.062		1	
3/31/2014						7.3	0.060		2	
4/7/2014						7.3	0.060		2	
4/14/2014	0.078	0.0062	0.45	917	0.993	6.9	0.062	870	2	0.0114
4/21/2014						7.0	0.078		2	
4/28/2014						7.1	0.056		1	
5/5/2014						7.2	0.076		2	
5/12/2014	0.150	0.0044	0.41	554	0.776	7.2	0.072	520	2	0.0084
5/20/2014						7.1	0.082		2	
5/26/2014						7.1	0.096		< 1	
6/2/2014						7.2	0.072		2	
6/9/2014	0.060	0.0034	0.44	647	0.751	7.1	0.052	660	1	0.0067
6/16/2014						7.1	0.047		1	
6/23/2014						7.1	0.039		2	
7/1/2014						7.2	0.057		2	
7/9/2014						7.2	0.041		2	
7/14/2014	0.034	0.0022	0.66	853	0.414	7.0	0.044	840	1	0.0110
7/21/2014						7.1	0.034		2	
7/28/2014						7.3	0.030		2	
8/5/2014						7.0	0.045		1	
8/14/2014	0.029	0.0021	0.62	944	0.399	7.0	0.036	890	1	0.0161
8/18/2014						7.5	0.039		2	
8/25/2014						7.0	0.056		2	
9/2/2014						7.7	0.063		2	
9/8/2014	0.034	0.0028	0.64	928	0.427	6.9	0.053	970	1	0.0116
9/15/2014						7.1	0.051		1	
9/22/2014						7.1	0.055		2	
9/29/2014						7.5	0.070		2	
10/6/2014						6.9	0.053		2	
10/16/2014	0.061	0.0042	0.65	887	0.612	7.5	0.079	860	2	0.0132
10/20/2014						6.9	0.110		1	
10/27/2014						7.0	0.106		1	
11/3/2014						7.1	0.075		1	
11/10/2014	0.102	0.0050	0.40	891	1.220	6.9	0.114	940	1	0.0101
11/17/2014						7.0	0.086		1	
11/24/2014						7.0	0.062		1	
12/1/2014						6.8	0.073		1	
12/8/2014	0.086	0.0048	0.61	949	1.100	7.3	0.067	930	1	0.0138
12/15/2014						7.1	0.061		1	
12/22/2014						7.3	0.089		2	
12/29/2014						7.2	0.075		< 1	
Number	63	63	63	62	63	261	261	63	261	63
Maximum	0.185	0.0141	1.38	1290	2.100	8.6	0.250	1300	6	0.0301
Minimum	0.029	0.0017	0.21	526	0.313	6.8	0.030	500	< 1	0.0067
Mean	0.085	0.0060	0.61	1012	0.964	7.5	0.086	999	2.0	0.0158
St. Dev.	0.034	0.0032	0.32	174	0.422	0.4	0.036	171	1.0	0.0049
Median	0.082	0.0050	0.55	1030	0.929	7.3	0.078	1000	2.0	0.0157
10th Percentile	0.043	0.0024	0.24	853	0.416	7.0	0.053	816	1.0	0.0101
95th Percentile	0.150	0.0116	1.23	1259	1.594	8.4	0.159	1200	4.0	0.0248

[a] TOMP requirement

Appendix Table D.2.6: Summary of annual plant operations and discharge at Quirke, 2010-2014.

ITEM	2010	2011	2012	2013	2014
PLANT OPERATIONS[a]					
Operating Days	365	365	366	348	365
Maximum Daily Plant Flow (L/s @ Q-05)	130	165	151	280	220
Minimum Daily Plant Flow (L/s @ Q-05)	30	40	38	48	30
Monthly Average Daily Plant Flow (L/s @ Q-05)	73	88	79	127	110
Total Volume Treated (ML @ Q-05)	2,310	2,772	2,494	3,809	3,474
Barium Chloride Consumption					
total kg/year	1,423	2,076	1,536	2,456	2,027
monthly average mg/litre	0.62	0.75	0.62	0.64	0.58
Lime Consumption					
total dry tonnes/year	42	43	42	45	42
monthly average g/litre	0.018	0.015	0.017	0.012	0.012
BASIN NEUTRALIZATION					
Lime Consumption					
Cell 16 S total dry tonnes/year	81	39	56	33	48
Cell 16 N total dry tonnes/year	48	30	48	36	69
Cell 17 total dry tonnes/year	5.8	4.3	10.7	6.7	11.8
Site total including ETP Operations (tonnes)	177	116	156	120	170
EFFLUENT[b]					
Discharge Days	365	365	366	360	365
Maximum Discharge Flow (L/s @ Q-28)	122	164	151	280	220
Minimum Discharge Flow (L/s @ Q-28)	30	43	40	1	30
Monthly Average Discharge Flow (L/s @ Q-28)	73	88	78	118	112
Total Volume Discharged (ML)	2,313	2,763	2,479	3,684	3,527

ML - Million Litres

[a] Influent flows based on daily monitoring requirements as per TOMP

[b] Effluent flows based on weekly monitoring requirement as per SAMP

Appendix Table D.2.7: Mean annual discharge and seepage loadings from Quirke TMA, 2010 - 2014.

Station	Drainage Type	Mean Annual Discharge (m^3)		Barium (kg/yr)	Cobalt (kg/yr)	Iron (kg/yr)	Manganese (kg/yr)	Radium (MBq/yr)	Sulphate (kg/yr)	Uranium (kg/yr)
Q-23	Seepage from Dam J	1,337,126	Mean	29	0.8	463	57	3.81	4,416	0.3
			S.D.	17.5	0.6	335	41	2.70	1,808	0.2
Q-27	Swamp Downstream of Dam K	3,154	Mean	0.3	0.1	55	8	0.04	898	0.0
			S.D.	0.0	0.0	10	1.3	0.01	99	0.0
D-4	Dunlop Lake Outlet	52,602,048	Mean	700		1,631	831	132	231,989	
			S.D.	35		471	205	0.0	7,058	
D-5	Serpent River d/s of Denison	56,954,016	Mean	3,892				3,554	1,028,777	110
			S.D.	1,249				1,185	352,719	38
Q-28	Controlled Discharge	2,964,384	Mean	268	18	1,790	2,912	271	2,880,929	44
			S.D.	86	2.2	668	382	82	313,488	5.0
ECA-398	Site Drainage	40,997	Mean	0.9	3.2	7.8	29	2.53	8,401	10.8
			S.D.	0.6	2.6	5.2	25.7	1.54	6,216	8.5
Q-22	Site Drainage	204,984	Mean	2.7	0.5	16	8	4.82	7,447	4.9
			S.D.	1.5	0.2	11.8	3.2	1.82	2,814	2.4
All Quirke Sources				**301**	**23**	**2,332**	**3,013**	**282**	**2,902,091**	**60**
Q-09	Serpent River u/s of Quirke Lake	75,781,008	Mean	5,365				5,484	4,575,791	225
			S.D.	2,626				1,804	2,102,412	87

MBq/yr = Million Bequerels per year

Appendix Table D.2.8: Summary of seasonal trends for station ECA-398 from 2003-2014.

Month	Spearman's rho	Ba	Co	Fe	Hardness	Mn	pH	Ra	SO4	U
January	Correlation Coefficient	0.737	-0.690	-0.084		-0.714	0.124	-0.599	-0.976	-0.929
	Sig. (2-tailed)	0.037	0.058	0.844		0.047	0.771	0.117	0.000	0.001
	N	8	8	8		8	8	8	8	8
February	Correlation Coefficient	0.748	-0.900	-0.898		-0.867	0.641	0.000	-0.954	-0.950
	Sig. (2-tailed)	0.020	0.001	0.001		0.002	0.063	1.000	0.000	0.000
	N	9	9	9		9	9	9	9	9
April	Correlation Coefficient	0.750	-0.643	0.214		-0.464	0.535	-0.214	-0.829	-0.847
	Sig. (2-tailed)	0.052	0.119	0.645		0.294	0.216	0.645	0.021	0.016
	N	7	7	7		7	7	7	7	7
May	Correlation Coefficient	0.547	-0.915	-0.245	-0.600	-0.782	0.725	0.128	-0.879	-0.964
	Sig. (2-tailed)	0.102	0.000	0.496	0.285	0.008	0.018	0.725	0.001	0.000
	N	10	10	10	5	10	10	10	10	10
June	Correlation Coefficient	0.905	-0.800	0.259		-0.661	0.129	0.167	-0.946	-0.950
	Sig. (2-tailed)	0.002	0.010	0.500		0.053	0.741	0.668	0.000	0.000
	N	8	9	9		9	9	9	9	9
November	Correlation Coefficient	0.681	-0.939	-0.696	-0.600	-0.867	0.260	-0.128	-0.863	-0.964
	Sig. (2-tailed)	0.030	0.000	0.025	0.285	0.001	0.469	0.724	0.001	0.000
	N	10	10	10	5	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).

[shaded box] Significant trend where p<0.05.

Appendix Table D.2.9: Summary of seasonal trends for station Q-22 from 2003-2014.

Month	Spearman's rho	Ba	Co	Fe	Hardness	Mn	pH	Ra	SO4	U
January	Correlation Coefficient	-0.131	-0.860	-0.436	-0.200	-0.669	0.188	-0.476	-0.483	-0.853
	Sig. (2-tailed)	0.685	0.000	0.157	0.747	0.017	0.558	0.118	0.112	0.000
	N	12	12	12	5	12	12	12	12	12
April	Correlation Coefficient	0.273	-0.501	-0.239	-0.500	-0.315	0.389	0.042	0.077	-0.573
	Sig. (2-tailed)	0.391	0.097	0.454	0.391	0.319	0.212	0.897	0.812	0.051
	N	12	12	12	5	12	12	12	12	12
July	Correlation Coefficient	0.419	-0.682	-0.064		-0.418	0.555	0.036	-0.036	-0.636
	Sig. (2-tailed)	0.199	0.021	0.852		0.201	0.076	0.915	0.915	0.035
	N	11	11	11		11	11	11	11	11
October	Correlation Coefficient	-0.596	-0.783	-0.690	-0.700	-0.741	0.796	-0.746	-0.678	-0.860
	Sig. (2-tailed)	0.041	0.003	0.013	0.188	0.006	0.002	0.005	0.015	0.000
	N	12	12	12	5	12	12	12	12	12

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).

Significant trend where p<0.05.

Appendix Table D.2.10: Summary of seasonal trends for station Q-23 from 2003-2014.

Month	Spearman's rho	Ba	Co	Fe	Hardness	Mn	pH	Ra	SO4	U
January	Correlation Coefficient	-0.469	0.566	0.720	-0.300	-0.018	-0.066	-0.753	-0.848	-0.529
	Sig. (2-tailed)	0.124	0.055	0.008	0.624	0.957	0.839	0.005	0.000	0.077
	N	12	12	12	5	12	12	12	12	12
April	Correlation Coefficient	-0.270	-0.158	0.650	-0.200	-0.322	0.541	-0.701	-0.881	-0.753
	Sig. (2-tailed)	0.396	0.623	0.022	0.747	0.308	0.070	0.011	0.000	0.005
	N	12	12	12	5	12	12	12	12	12
July	Correlation Coefficient	-0.104	-0.410	-0.055		-0.600	-0.087	.	-0.872	-0.696
	Sig. (2-tailed)	0.776	0.240	0.881		0.067	0.811	.	0.001	0.025
	N	10	10	10		10	10	10	10	10
October	Correlation Coefficient	0.039	0.438	-0.109	-0.800	-0.270	0.105	0.393	-0.315	-0.753
	Sig. (2-tailed)	0.905	0.154	0.737	0.104	0.397	0.745	0.206	0.319	0.005
	N	12	12	12	5	12	12	12	12	12

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).

[grey box] Significant trend where $p<0.05$.

Appendix Table D.2.11: Summary of seasonal trends for station Q-27 from 2003-2014.

Month	Spearman's rho	Ba	Co	Fe	Hardness	Mn	pH	Ra	SO4	U
January	Correlation Coefficient	0.371	0.714	-0.829		0.143	-0.714	0.000	0.771	-0.771
	Sig. (2-tailed)	0.468	0.111	0.042		0.787	0.111	1.000	0.072	0.072
	N	6	6	6		6	6	6	6	6
April	Correlation Coefficient	0.082	-0.800	-0.500		-0.591	0.553	-0.667	-0.509	-0.849
	Sig. (2-tailed)	0.811	0.003	0.117		0.056	0.078	0.025	0.110	0.001
	N	11	11	11		11	11	11	11	11
July	Correlation Coefficient	0.900	0.800	0.100		0.800	-0.667	1.000	0.872	-0.791
	Sig. (2-tailed)	0.037	0.104	0.873		0.104	0.219	.	0.054	0.111
	N	5	5	5		5	5	5	5	5
October	Correlation Coefficient	-0.070	-0.077	-0.280	0.000	-0.329	-0.011	-0.491	0.176	-0.888
	Sig. (2-tailed)	0.829	0.812	0.379	1.000	0.297	0.973	0.105	0.585	0.000
	N	12	12	12	5	12	12	12	12	12

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).

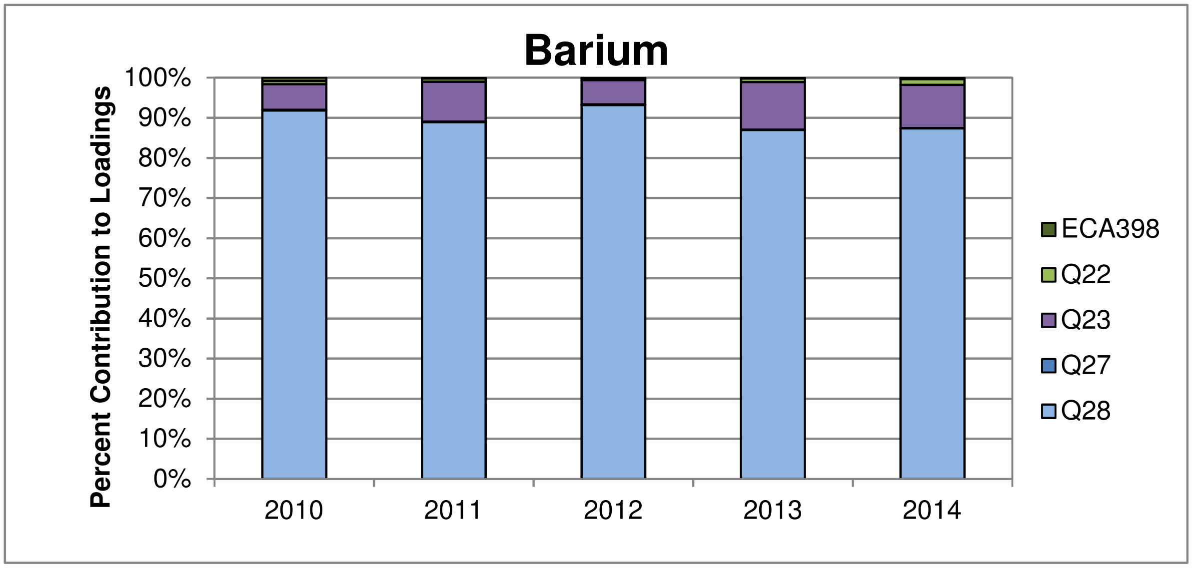
(shaded cell) Significant trend where p<0.05.

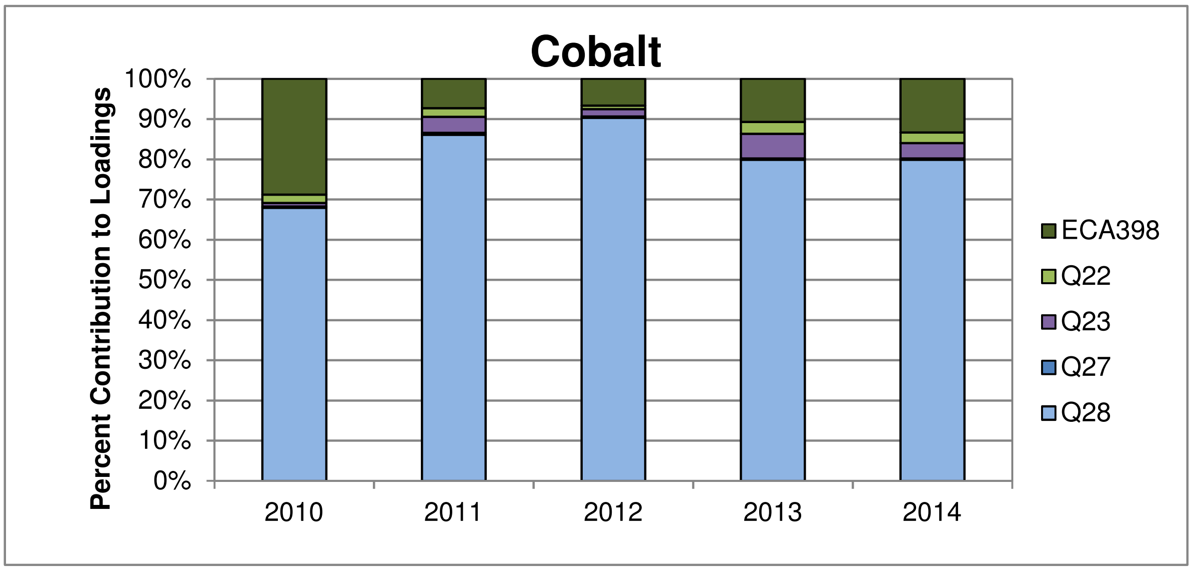
Appendix Table D.2.12: Summary of seasonal trends for station Q-28 from 2003-2014.

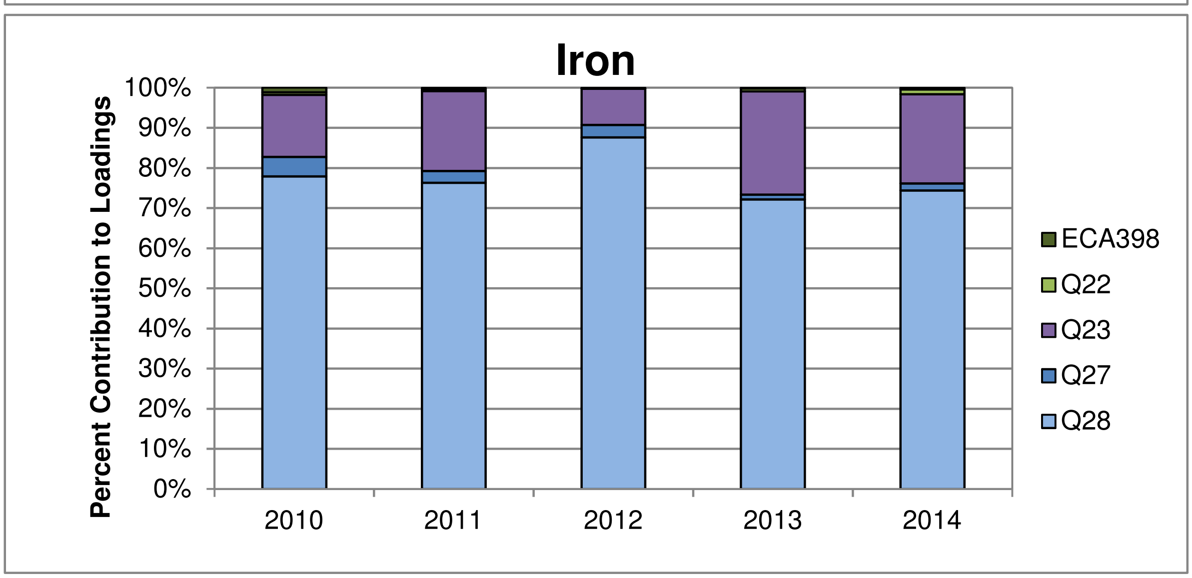
Month	Spearman's rho	Ba	Co	Fe	Hardness	Mn	pH	Ra	SO4	U
January	Correlation Coefficient	-0.196	-0.888	-0.112	0.000	-0.761	-0.288	-0.636	-0.619	-0.832
	Sig. (2-tailed)	0.542	0.000	0.729	1.000	0.004	0.364	0.026	0.032	0.001
	N	12	12	12	5	12	12	12	12	12
February	Correlation Coefficient	0.063	-0.867	0.056	0.100	-0.944	-0.182	-0.490	-0.511	-0.762
	Sig. (2-tailed)	0.846	0.000	0.863	0.873	0.000	0.572	0.106	0.090	0.004
	N	12	12	12	5	12	12	12	12	12
March	Correlation Coefficient	0.210	-0.839	0.175	-0.400	-0.923	-0.343	-0.497	-0.660	-0.740
	Sig. (2-tailed)	0.513	0.001	0.586	0.505	0.000	0.275	0.101	0.020	0.006
	N	12	12	12	5	12	12	12	12	12
April	Correlation Coefficient	0.231	-0.916	-0.469	0.300	-0.902	-0.316	-0.021	-0.754	-0.767
	Sig. (2-tailed)	0.471	0.000	0.124	0.624	0.000	0.316	0.948	0.005	0.004
	N	12	12	12	5	12	12	12	12	12
May	Correlation Coefficient	0.727	-0.916	0.694	-0.800	-0.909	-0.201	0.580	-0.413	-0.741
	Sig. (2-tailed)	0.007	0.000	0.012	0.104	0.000	0.531	0.048	0.182	0.006
	N	12	12	12	5	12	12	12	12	12
June	Correlation Coefficient	0.063	-0.641	0.452	-0.900	-0.403	-0.607	-0.392	-0.441	-0.671
	Sig. (2-tailed)	0.846	0.025	0.140	0.037	0.194	0.036	0.208	0.151	0.017
	N	12	12	12	5	12	12	12	12	12
July	Correlation Coefficient	0.305	-0.751	0.690	-0.600	-0.734	-0.735	-0.098	-0.823	-0.817
	Sig. (2-tailed)	0.336	0.005	0.013	0.285	0.007	0.007	0.762	0.001	0.001
	N	12	12	12	5	12	12	12	12	12
August	Correlation Coefficient	0.112	-0.753	0.564	-0.872	-0.671	-0.410	-0.035	-0.737	-0.753
	Sig. (2-tailed)	0.729	0.005	0.056	0.054	0.017	0.185	0.914	0.006	0.005
	N	12	12	12	5	12	12	12	12	12
September	Correlation Coefficient	0.098	-0.469	0.671	-0.500	-0.552	-0.527	-0.084	-0.902	-0.431
	Sig. (2-tailed)	0.761	0.124	0.017	0.391	0.063	0.078	0.795	0.000	0.162
	N	12	12	12	5	12	12	12	12	12
October	Correlation Coefficient	0.448	-0.140	0.806	-0.600	-0.336	-0.825	0.224	-0.829	-0.608
	Sig. (2-tailed)	0.145	0.664	0.002	0.285	0.286	0.001	0.484	0.001	0.036
	N	12	12	12	5	12	12	12	12	12
November	Correlation Coefficient	0.476	-0.722	0.762	-0.700	-0.722	-0.638	-0.168	-0.744	-0.879
	Sig. (2-tailed)	0.118	0.008	0.004	0.188	0.008	0.026	0.602	0.006	0.000
	N	12	12	12	5	12	12	12	12	12
December	Correlation Coefficient	-0.112	-0.867	0.028	-0.500	-0.827	-0.410	-0.958	-0.388	-0.811
	Sig. (2-tailed)	0.729	0.000	0.931	0.391	0.001	0.186	0.000	0.213	0.001
	N	12	12	12	5	12	12	12	12	12

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).

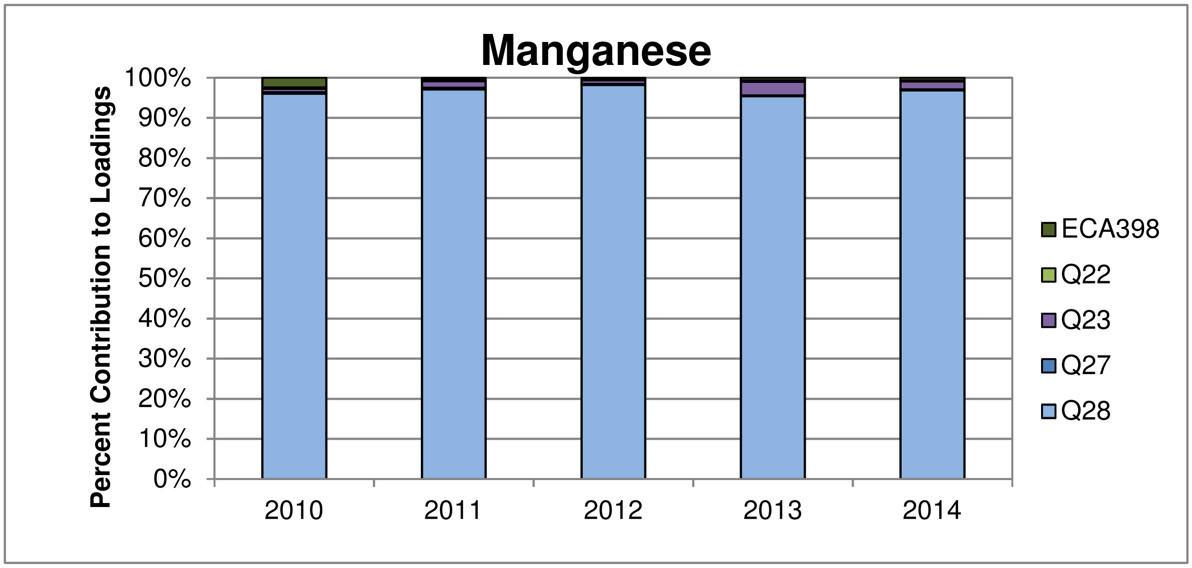
[shaded cell] Significant trend where p<0.05.

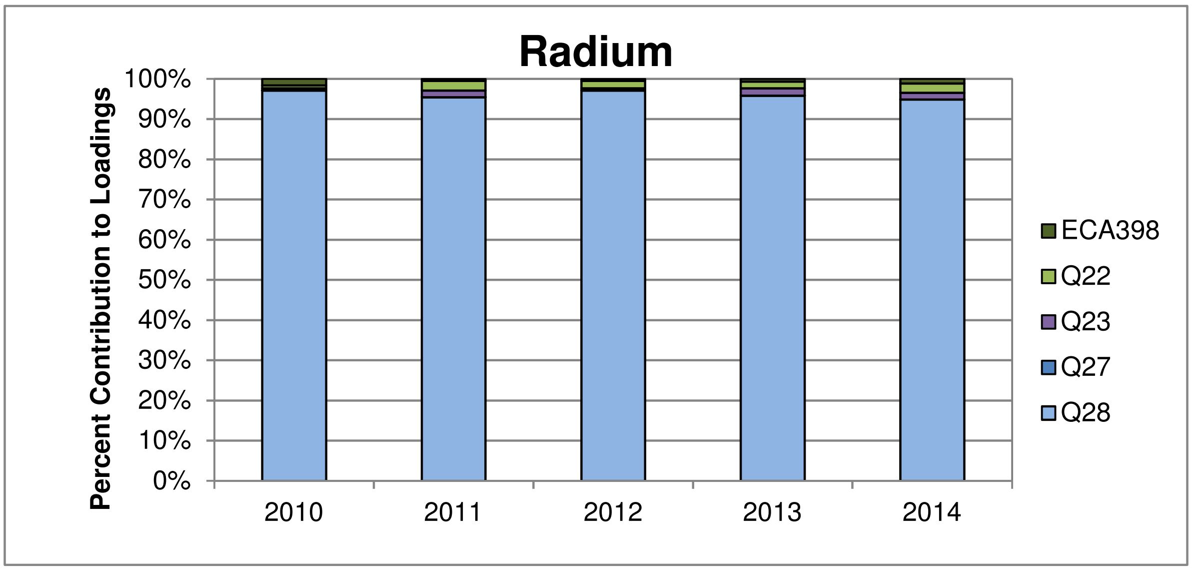


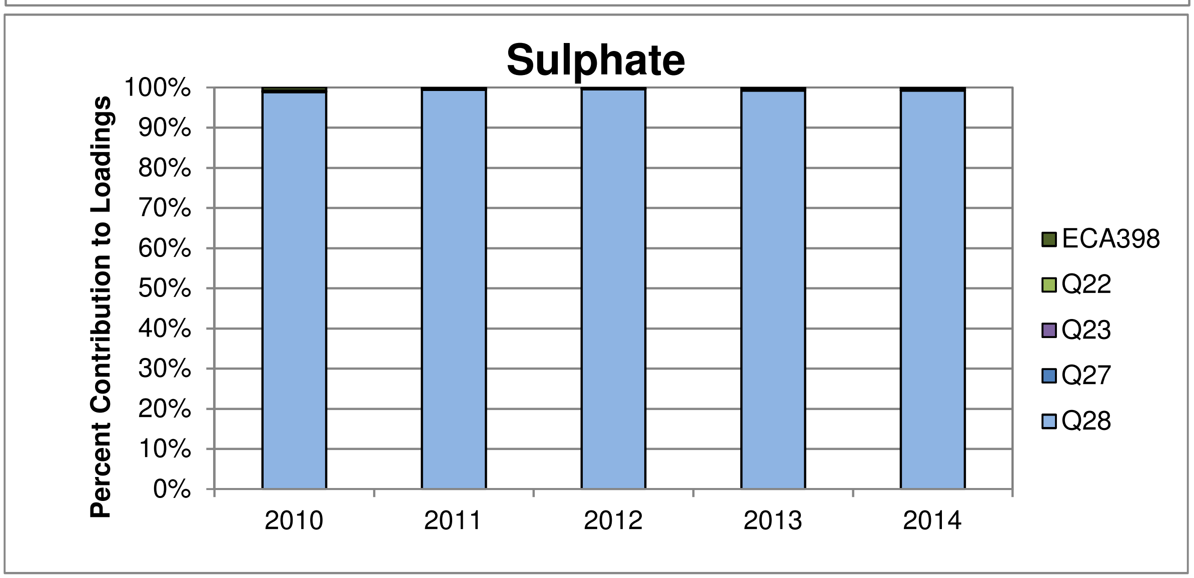




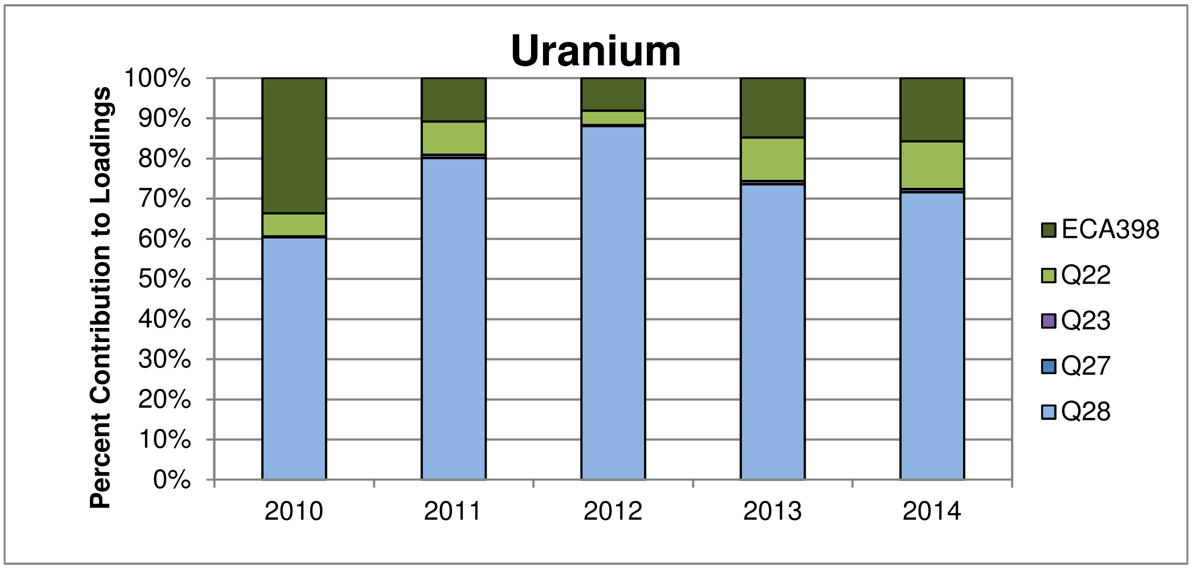
Appendix Figure D.2.1: Percent contribution to total Quirke loads from TMA discharge points.



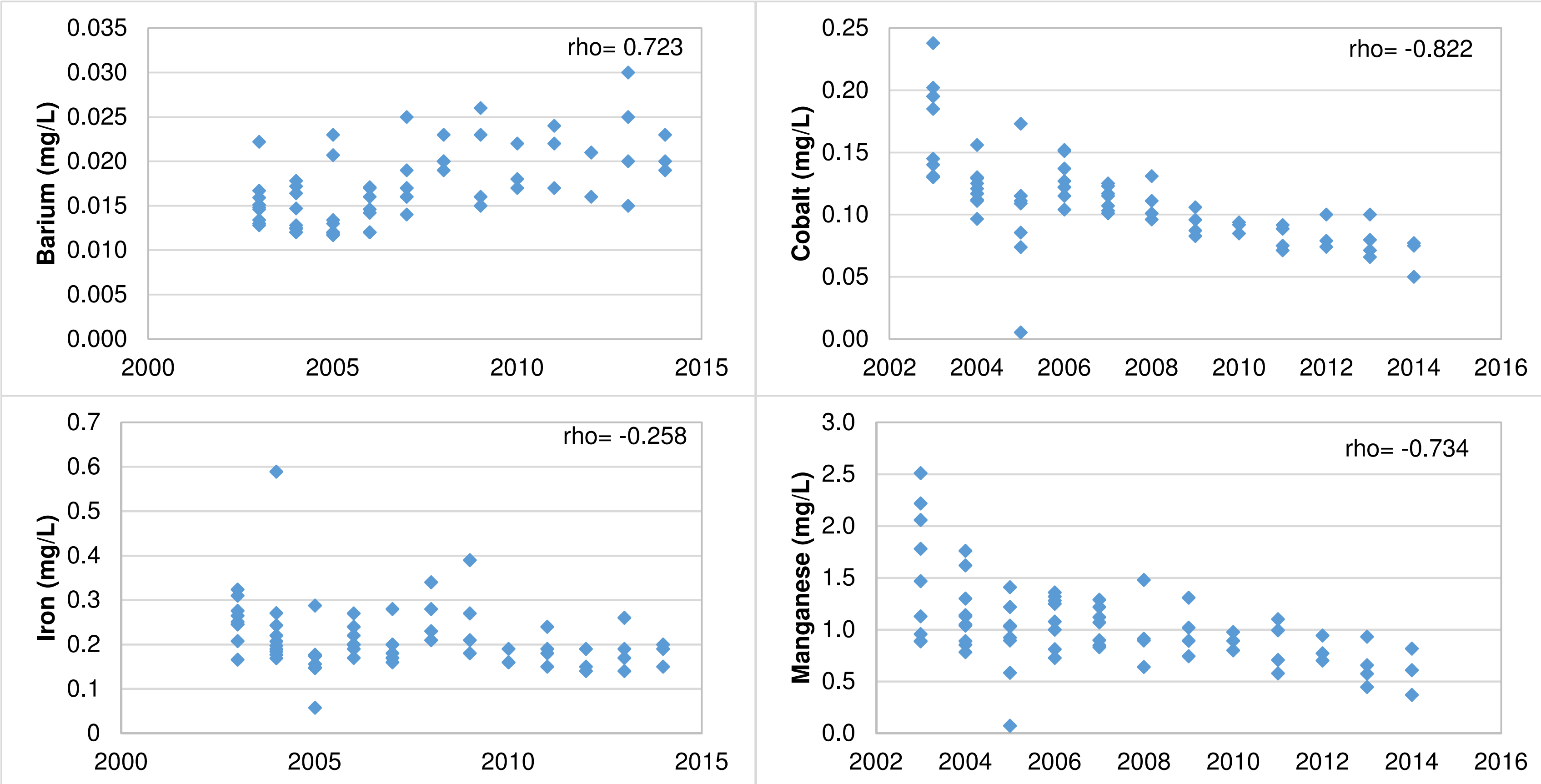




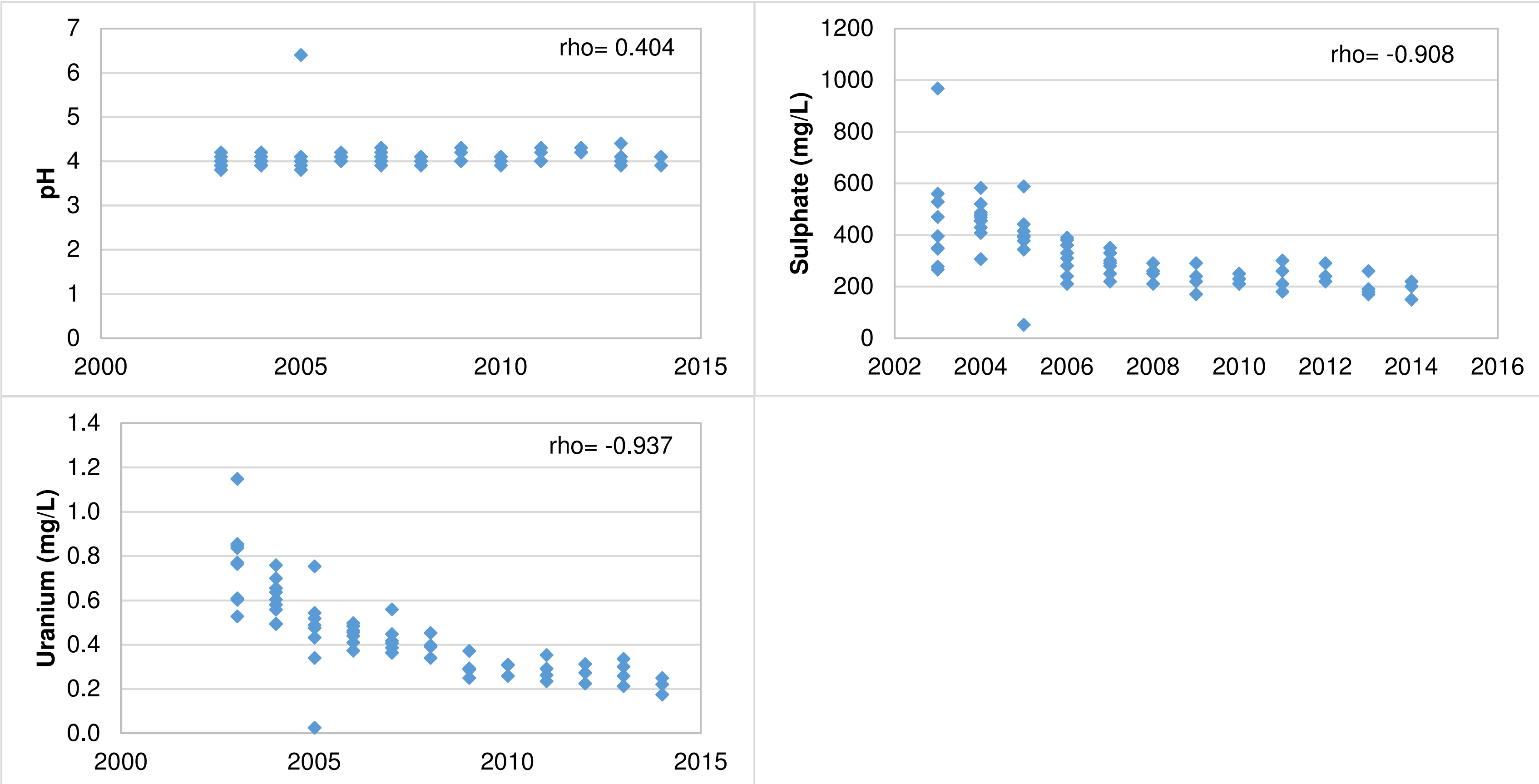
Appendix Figure D.2.1: Percent contribution to total Quirke loads from TMA discharge points.



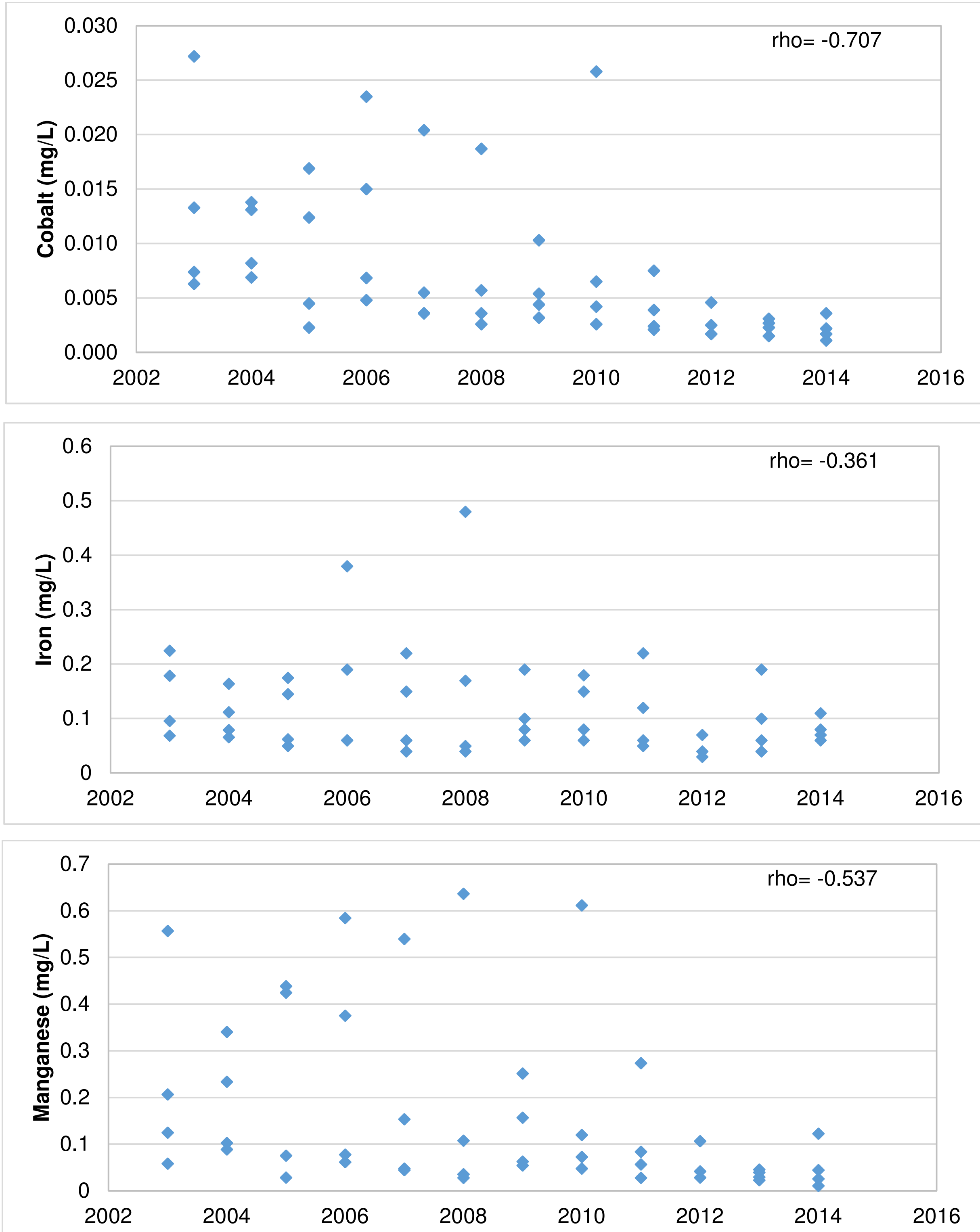
Appendix Figure D.2.1: Percent contribution to total Quirke loads from TMA discharge points.



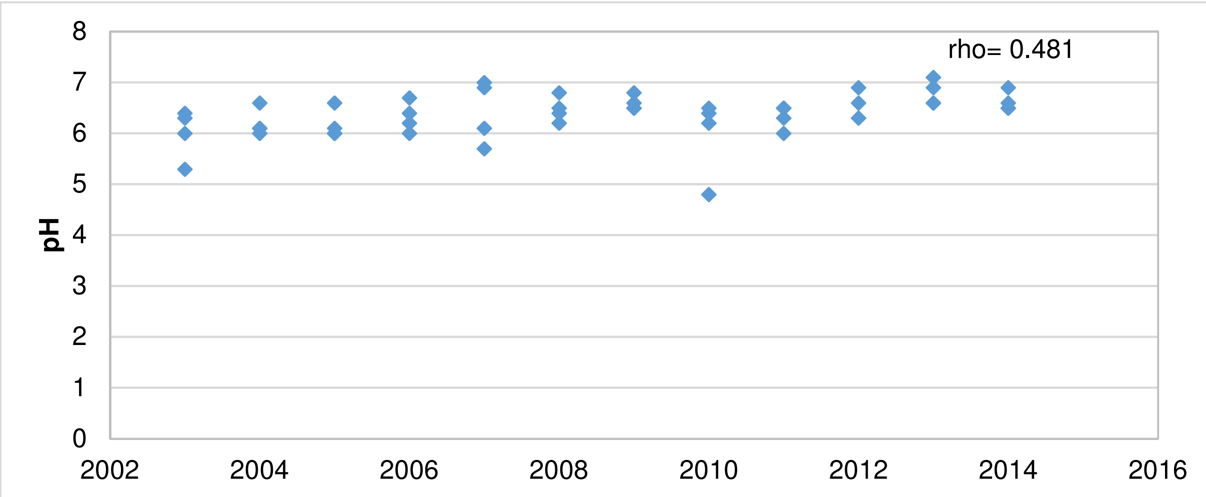
Appendix Figure D.2.2: Significant common (average) trends observed for barium, cobalt, iron, manganese, pH, sulphate and uranium over all seasons at Station ECA-398, 2003 to 2014.

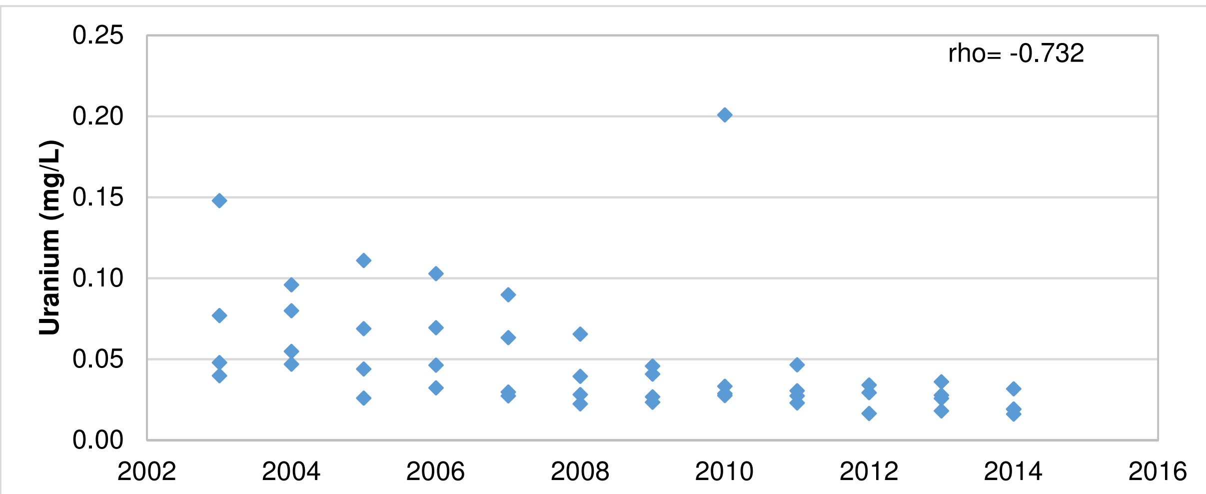


Appendix Figure D.2.2: Significant common (average) trends observed for barium, cobalt, iron, manganese, pH, sulphate and uranium over all seasons at Station ECA-398, 2003 to 2014.

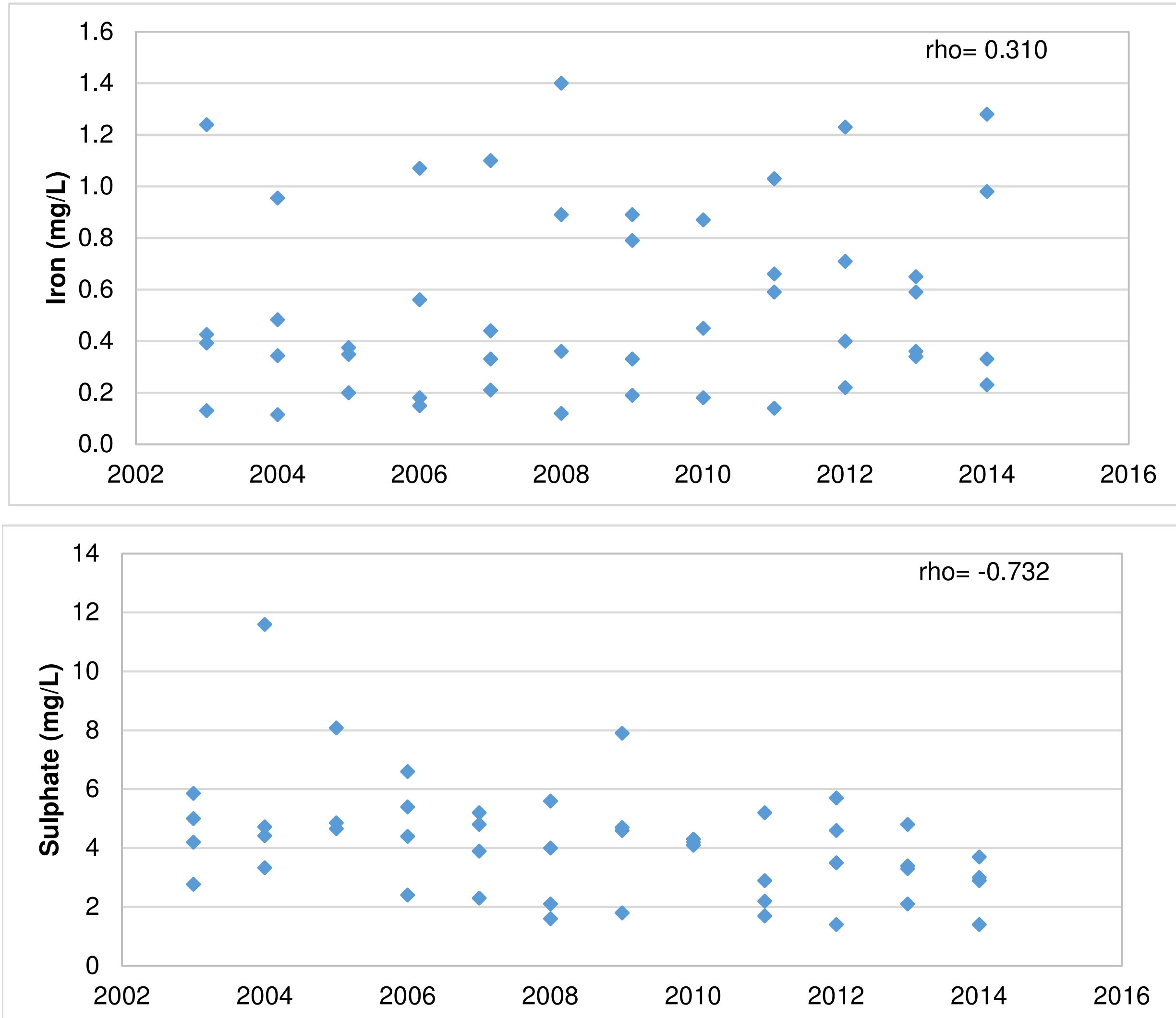


Appendix Figure D.2.3: Significant common (average) trends observed for cobalt iron, manganese, pH and uranium over all seasons at Station Q-22, 2003 to 2014.

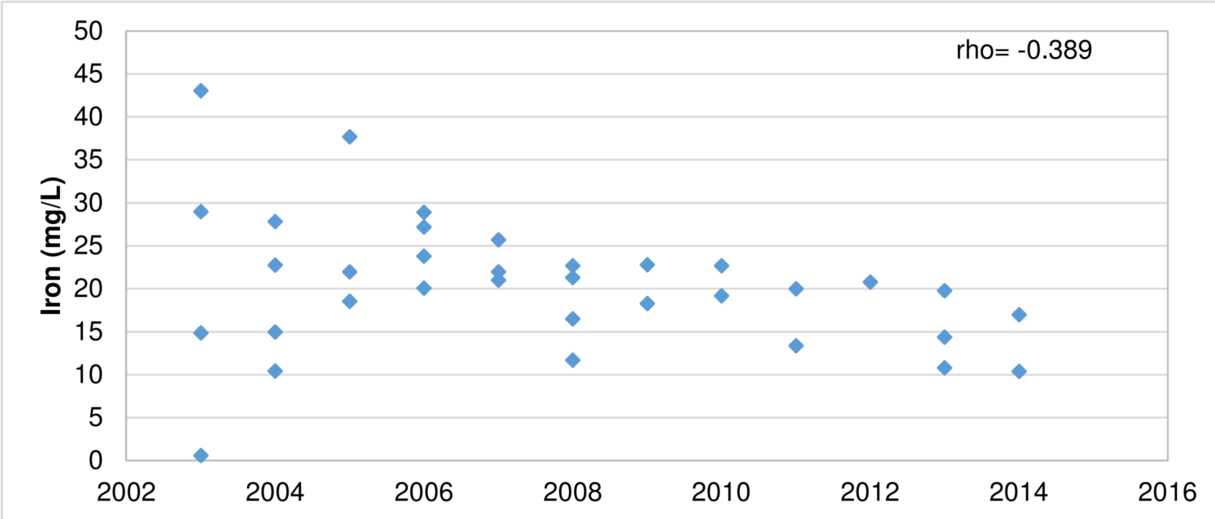


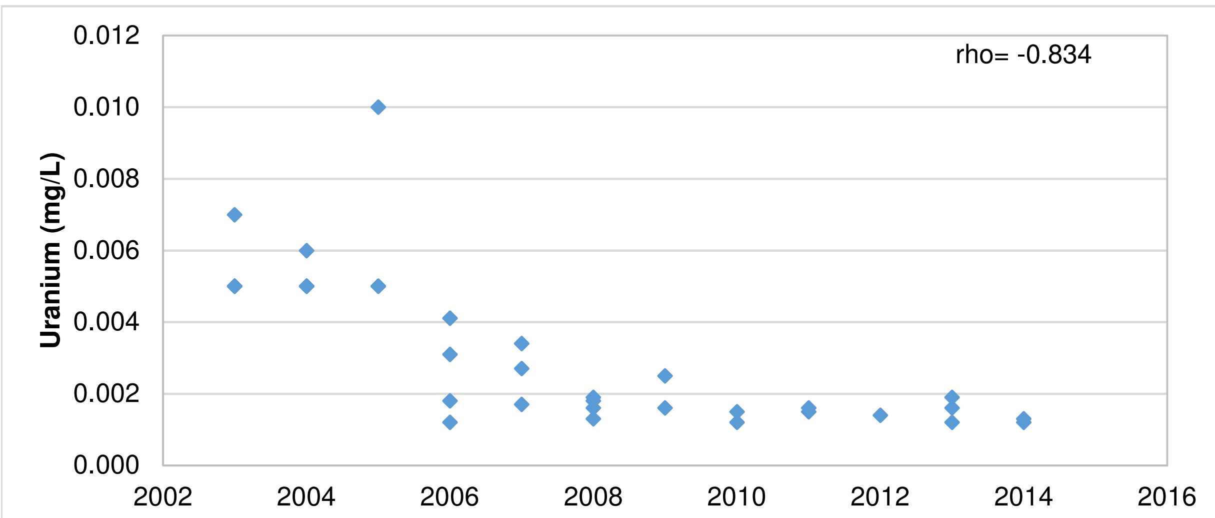


Appendix Figure D.2.3: Significant common (average) trends observed for cobalt iron, manganese, pH and uranium over all seasons at Station Q-22, 2003 to 2014.

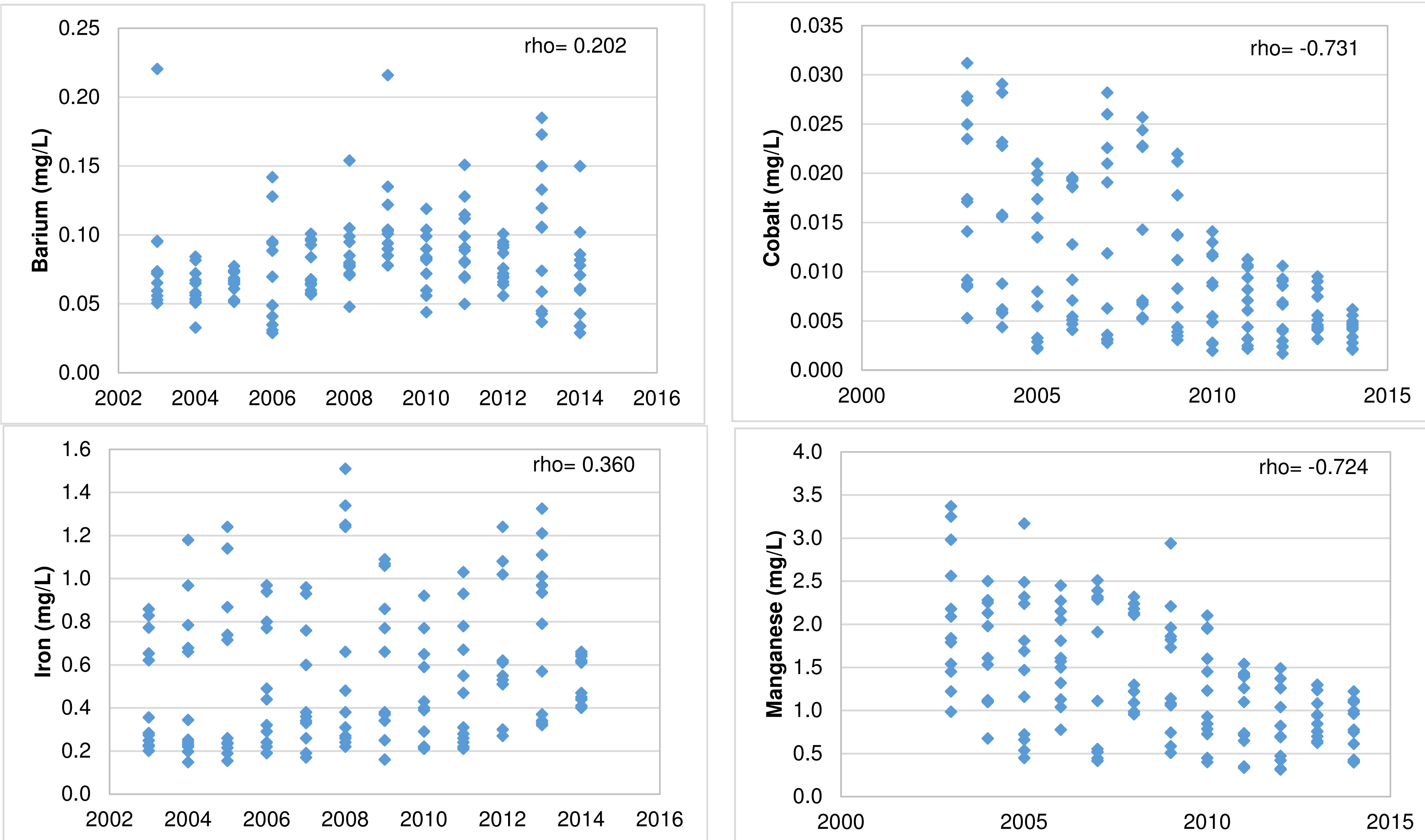


Appendix Figure D.2.4: Significant common (average) trends observed for iron and sulphate over all seasons at Station Q-23, 2003 to 2014.

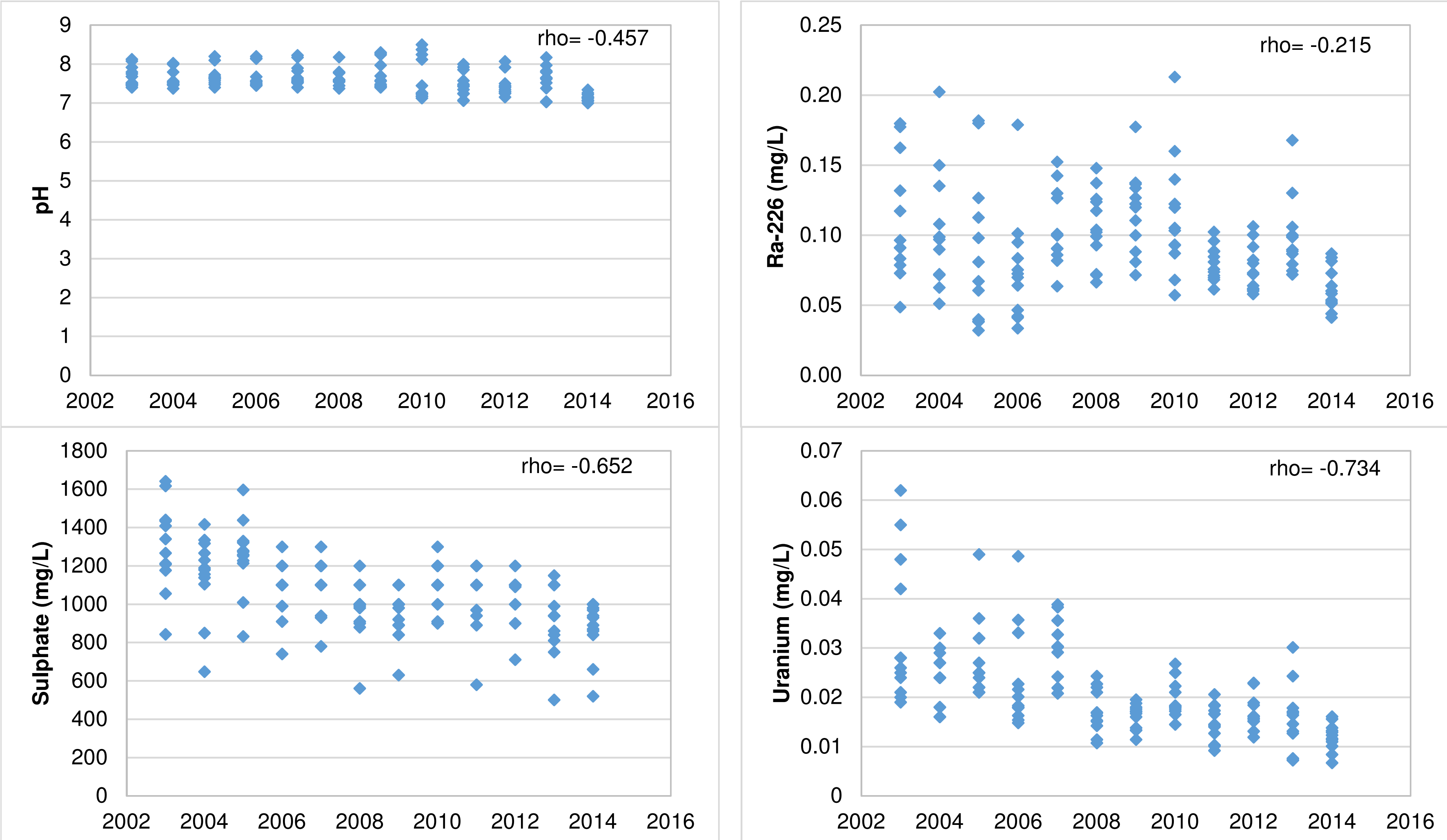




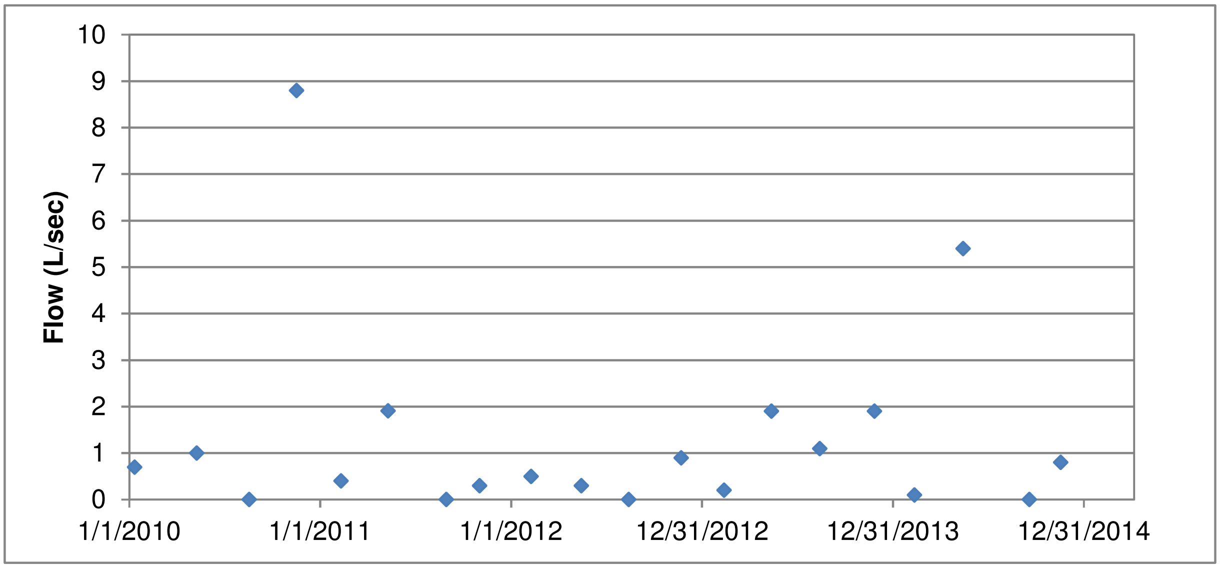
Appendix Figure D.2.5: Significant common (average) trends observed for iron and uranium over all seasons at Station Q-27, 2003 to 2014.



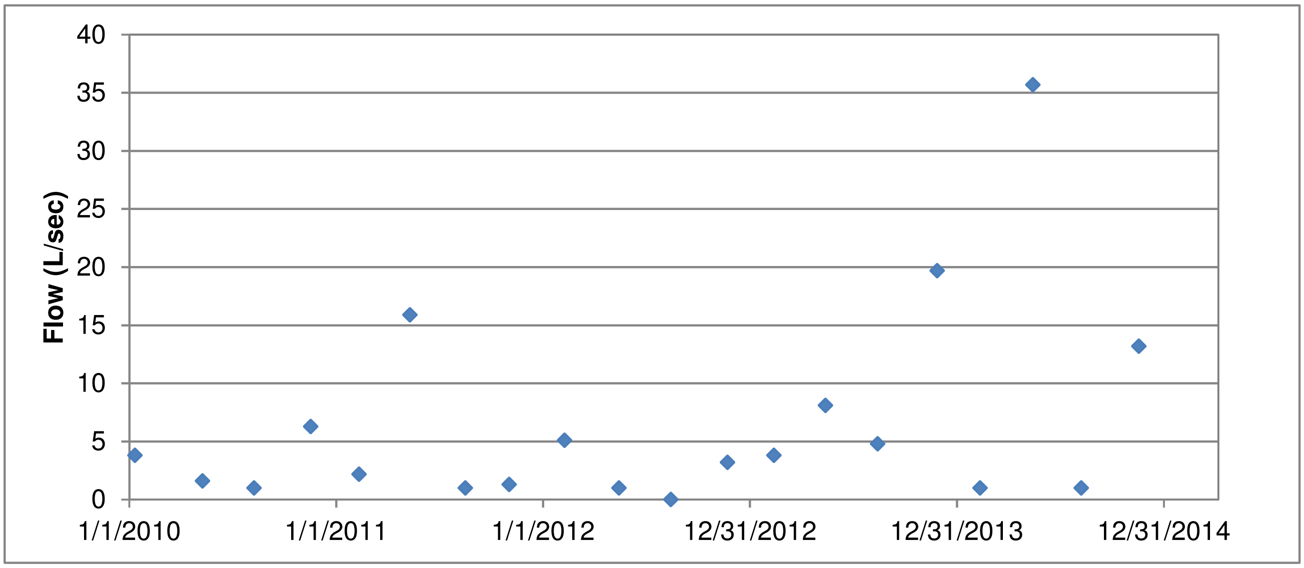
Appendix Figure D.2.6: Significant common (average) trends observed for barium, cobalt, iron, manganese, pH, radium-226, sulphate and uranium over all seasons at Station Q-28, 2003 to 2014.



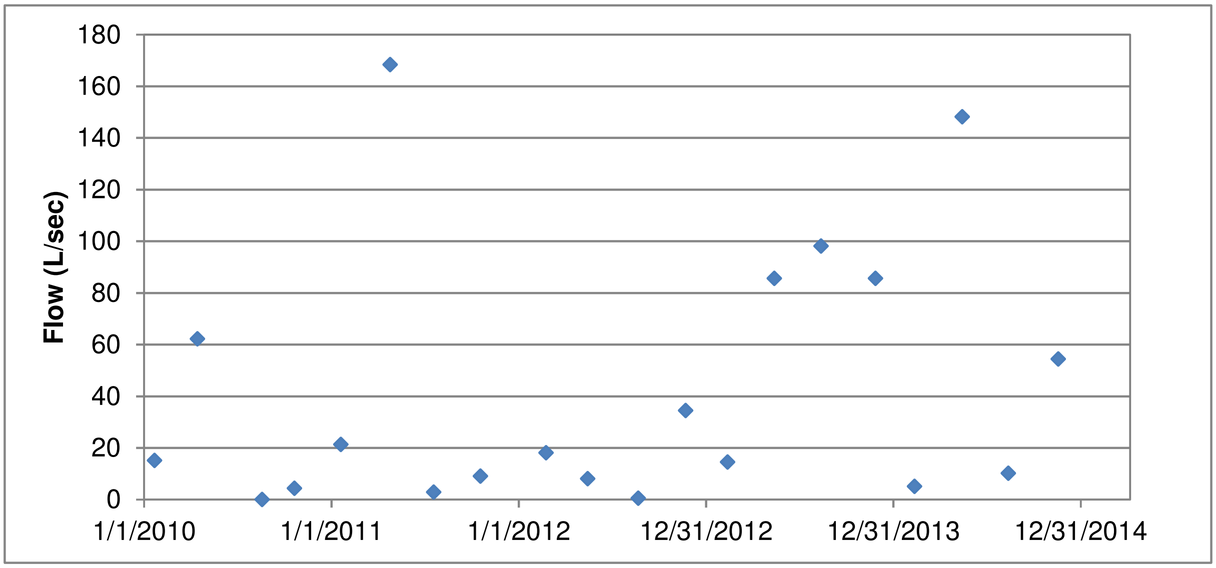
Appendix Figure D.2.6: Significant common (average) trends observed for barium, cobalt, iron, manganese, pH, radium-226, sulphate and uranium over all seasons at Station Q-28, 2003 to 2014.



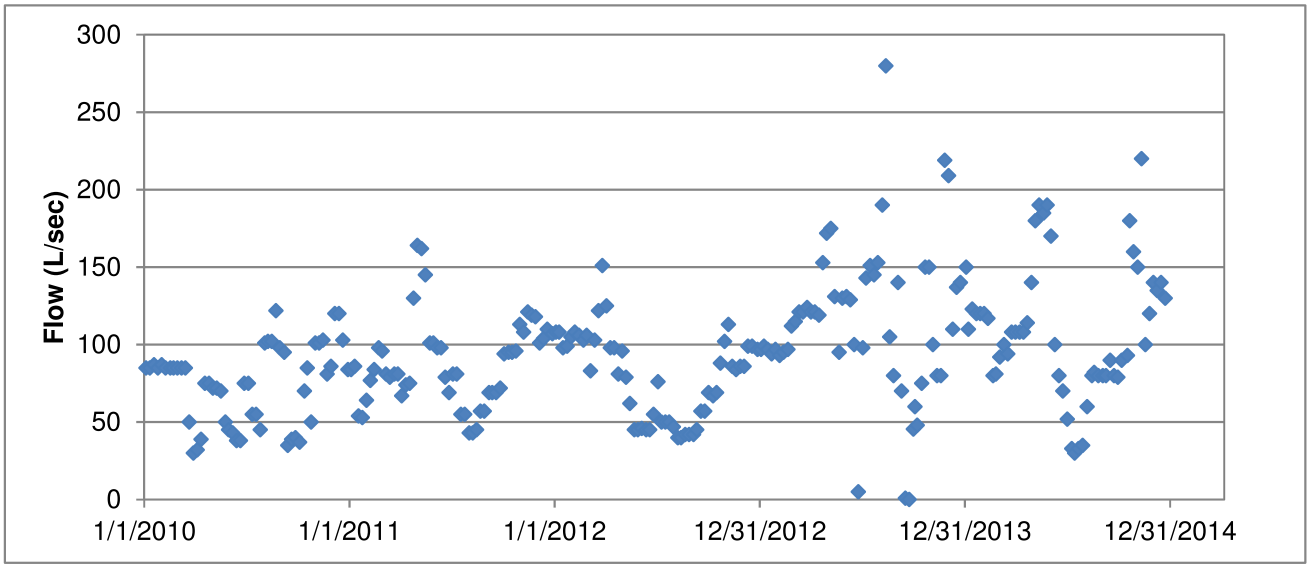
Appendix Figure D.2.7: Flows at station ECA-398 from 2010 to 2014.



Appendix Figure D.2.8: Flows at station Q-22 from 2010 to 2014.



Appendix Figure D.2.9: Flows at station Q-23 from 2010 to 2014.



Appendix Figure D.2.10: Flows at station Q-28 from 2010 to 2014.

APPENDIX D.3
Panel TMA

Appendix Table D.3.1: Water quality at station P-02 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	U mg/L
1/27/2010	0.021	0.0009	0.87	417	0.106	6.7	0.027	380	0.0042
4/26/2010	0.021	0.0007	0.42	413	0.087	6.9	0.036	400	0.0030
7/26/2010	0.021	< 0.0005	0.45	399	0.044	6.8	0.050	410	0.0022
10/25/2010	0.021	< 0.0005	0.14	402	0.025	6.6	0.061	360	0.0017
1/25/2011	0.020	0.0007	0.84	389	0.085	6.7	0.020	370	0.0042
5/5/2011	0.022	< 0.0005	< 0.02	243	< 0.002	6.4	0.066	210	< 0.0005
7/20/2011	0.028	0.0011	0.28	416	0.044	6.5	0.179	350	0.0007
10/24/2011	0.017	< 0.0005	0.12	345	0.011	6.7	0.070	300	0.0011
1/30/2012	0.020	< 0.0005	0.35	377	0.055	6.7	0.043	330	0.0028
4/23/2012	0.019	0.0005	0.60	355	0.088	6.9	0.029	310	0.0022
7/24/2012	0.027	< 0.0005	0.41	383	0.073	6.6	0.135	320	0.0010
10/23/2012	0.020	< 0.0005	0.24	327	0.072	6.7	0.032	300	0.0025
1/31/2013	0.020	0.0009	1.33	369	0.220	6.9	0.040	310	0.0038
4/15/2013	0.018	0.0007	0.53	321	0.150	6.9	0.043	270	0.0026
7/22/2013	0.023	< 0.0005	0.26	320	0.056	6.6	0.228	280	0.0016
10/28/2013	0.019	< 0.0005	0.58	307	0.109	6.5	0.052	270	0.0030
1/23/2014	0.025	0.0008	1.15	360	0.142	6.8	0.034	320	0.0049
4/10/2014	0.019	< 0.0005	0.13	282	0.079	6.6	0.007	240	0.0029
7/28/2014	0.024	0.0006	0.11	293	0.068	6.6	0.010	250	0.0026
10/23/2014	0.019	< 0.0005	0.28	229	0.053	6.5	0.027	190	0.0019
Number	20	20	20	20	20	20	20	20	20
Maximum	0.028	0.0011	1.33	417	0.22	6.9	0.228	410	0.0049
Minimum	0.017	< 0.0005	< 0.02	229	< 0.002	6.4	0.007	190	< 0.0005
Mean	0.021	0.0006	0.46	347.4	0.078	6.7	0.059	309	0.0025
St. Dev.	0.003	0.0002	0.36	56.1	0.051	0.2	0.057	60	0.0012
Median	0.021	0.0005	0.38	357.5	0.073	6.7	0.042	310	0.0026
10th Percentile	0.019	0.0005	0.12	278.1	0.024	6.5	0.019	237	0.0010
95th Percentile	0.027	0.0009	1.16	416.1	0.154	6.9	0.181	401	0.0042

Appendix Table D.3.2: Water quality at station P-03 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	U mg/L
1/27/2010	0.039	< 0.0005	0.4	64.6	0.024	6.6	0.580	14.0	< 0.0005
4/26/2010	0.030	< 0.0005	0.38	55.3	0.009	7.5	0.400	9.5	< 0.0005
10/25/2010	0.024	< 0.0005	0.18	45.3	< 0.002	7.2	0.290	6.5	< 0.0005
1/25/2011	0.035	< 0.0005	0.34	62.9	0.013	7.1	0.384	11.0	< 0.0005
5/5/2011	0.024	< 0.0005	1.98	41.3	0.027	7.0	0.384	5.5	< 0.0005
7/20/2011	0.020	< 0.0005	0.7	36.5	0.006	7.5	0.225	5.6	< 0.0005
10/24/2011	0.015	< 0.0005	0.22	32.8	0.003	7.1	0.157	5.6	< 0.0005
1/30/2012	0.030	< 0.0005	0.48	55.1	0.031	7.1	0.327	9.3	< 0.0005
4/23/2012	0.020	< 0.0005	1.07	43.0	0.005	7.6	0.280	7.0	< 0.0005
10/23/2012	0.014	< 0.0005	0.18	33.5	0.002	7.5	0.182	6.1	< 0.0005
1/31/2013	0.035	< 0.0005	0.56	70.2	0.122	7.2	0.473	8.5	< 0.0005
4/15/2013	0.025	0.0006	4.32	38.6	0.145	6.6	0.451	4.9	< 0.0005
7/22/2013	0.015	< 0.0005	0.72	33.4	0.005	7.1	0.204	5.0	< 0.0005
10/28/2013	0.016	< 0.0005	0.34	34.5	< 0.002	7.3	0.185	4.4	< 0.0005
1/23/2014	0.031	0.0005	1.36	49.8	0.196	7.4	0.225	5.2	< 0.0005
4/10/2014	0.034	0.0007	7.06	59.8	0.243	6.5	0.714	3.5	< 0.0005
7/28/2014	0.014	< 0.0005	1.2	31.7	0.013	7.0	0.174	4.0	< 0.0005
10/23/2014	0.014	< 0.0005	0.2	28.9	0.002	7.0	0.186	5.0	< 0.0005
Number	18	18	18	18	18	18	18	18	18
Maximum	0.039	0.0007	7.06	70.2	0.243	7.6	0.714	14	< 0.0005
Minimum	0.014	< 0.0005	0.18	28.9	< 0.002	6.5	0.157	3.5	< 0.0005
Mean	0.024	< 0.0005	1.20	45.4	0.047	7.1	0.323	6.7	< 0.0005
St. Dev.	0.009	0.0001	1.77	13.0	0.075	0.3	0.156	2.7	0
Median	0.024	< 0.0005	0.52	42.2	0.011	7.1	0.285	5.6	< 0.0005
10th Percentile	0.014	< 0.0005	0.19	32.5	0.002	6.6	0.180	4.3	< 0.0005
95th Percentile	0.036	0.0006	4.73	65.4	0.203	7.5	0.600	11.5	< 0.0005

Appendix Table D.3.3: Water quality at station P-05 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	U mg/L
1/27/2010	0.01	< 0.0005	0.30	34.0	0.054	5.9	< 0.005	28	< 0.0005
4/26/2010	0.011	< 0.0005	0.19	32.0	0.044	6.2	< 0.005	26	< 0.0005
7/26/2010	0.033	0.0009	0.56	85.6	0.189	6.6	< 0.005	65	< 0.0005
10/25/2010	0.017	0.001	0.33	57.6	0.106	6.3	< 0.005	47	< 0.0005
1/25/2011	0.012	0.0008	0.45	40.7	0.096	6.1	< 0.005	34	< 0.0005
5/5/2011	0.007	< 0.0005	0.17	12.9	0.031	5.9	< 0.005	9.6	< 0.0005
7/20/2011	0.028	0.0013	0.67	72.3	0.309	6.8	< 0.005	41	< 0.0005
10/24/2011	0.023	0.0017	0.35	55.5	0.116	5.9	0.006	48	< 0.0005
1/30/2012	0.007	< 0.0005	0.17	13.3	0.027	6.3	< 0.005	10	< 0.0005
4/23/2012	0.011	0.0006	0.23	36.6	0.054	6.3	< 0.005	31	< 0.0005
7/24/2012	0.012	0.0017	1.10	61.3	0.370	6.7	0.009	26	< 0.0005
10/23/2012	0.021	0.0015	0.54	66.1	0.142	6.4	0.015	54	< 0.0005
1/31/2013	0.007	< 0.0005	0.20	19.8	0.020	5.9	< 0.005	15	< 0.0005
4/15/2013	0.008	< 0.0005	0.21	20.8	0.020	6.0	< 0.005	16	< 0.0005
7/22/2013	0.014	0.0009	0.55	39.2	0.118	6.3	< 0.005	24	< 0.0005
10/28/2013	0.007	< 0.0005	0.22	17.4	0.015	6.5	0.007	12	< 0.0005
1/23/2014	0.015	0.001	0.65	32.2	0.081	6.8	< 0.005	25	< 0.0005
4/10/2014	0.009	0.0007	0.33	31.9	0.048	6.1	< 0.005	24	< 0.0005
7/28/2014	0.016	0.0005	0.53	50.1	0.082	6.9	0.006	27	< 0.0005
10/23/2014	0.007	< 0.0005	0.18	13.7	0.021	6.2	< 0.005	10	< 0.0005
Number	20	20	20	20	20	20	20	20	20
Maximum	0.033	0.0017	1.10	85.6	0.37	6.9	0.015	65	< 0.0005
Minimum	0.007	< 0.0005	0.17	12.9	0.015	5.9	< 0.005	10	< 0.0005
Mean	0.014	0.0008	0.40	39.6	0.097	6.3	0.006	29	< 0.0005
St. Dev.	0.007	0.0004	0.24	21.2	0.096	0.3	0.002	16	0
Median	0.012	0.0007	0.33	35.3	0.068	6.3	0.005	26	< 0.0005
10th Percentile	0.007	< 0.0005	0.18	13.7	0.020	5.9	< 0.005	10	< 0.0005
95th Percentile	0.028	0.0017	0.69	73.0	0.312	6.8	0.009	55	< 0.0005

Appendix Table D.3.4: Water quality at station P-11 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	U mg/L
1/27/2010	0.01	< 0.0005	0.51	14.8	0.04	6.8	0.033	8.3	0.0008
4/26/2010	0.011	< 0.0005	0.22	18.4	0.011	6.7	0.053	12	0.0008
7/26/2010	0.011	< 0.0005	0.98	20.7	0.032	6.7	0.034	8.4	0.0012
10/25/2010	0.011	< 0.0005	0.39	18.6	0.018	6.2	0.08	11	0.0012
1/24/2011	0.012	0.0005	0.76	17.7	0.064	6.8	0.06	8.6	0.001
5/5/2011	0.01	< 0.0005	0.17	11.7	0.014	6.4	0.089	7.3	0.0016
7/20/2011	0.012	< 0.0005	1.2	24.3	0.026	6.7	0.051	3.8	0.0012
10/24/2011	0.014	0.0008	0.49	16.3	0.026	6.5	0.107	12	0.0024
1/30/2012	0.012	< 0.0005	0.36	15.8	0.026	7.0	0.053	9.6	0.0013
4/23/2012	0.011	< 0.0005	0.3	15.0	0.02	6.9	0.089	11	0.0013
7/24/2012	0.011	< 0.0005	3.67	26.8	0.034	7.0	0.035	2.1	0.0017
10/23/2012	0.016	0.0006	0.63	22.4	0.034	7.1	0.091	17	0.0024
1/31/2013	0.015	0.0009	1.13	21.9	0.132	7.1	0.083	12	0.0014
4/15/2013	0.01	< 0.0005	0.35	13.9	0.023	7.0	0.029	7.3	0.0014
7/22/2013	0.012	0.0005	1.92	17.9	0.054	7.1	0.06	6.2	0.0016
10/28/2013	0.009	< 0.0005	0.67	13.6	0.024	7.3	0.038	5.2	0.0012
1/23/2014	0.029	0.0011	1.66	17.7	0.16	7.5	0.087	7.7	0.0015
4/10/2014	0.01	< 0.0005	0.55	9.7	0.044	6.6	0.03	4.5	0.0009
7/28/2014	0.013	< 0.0005	1.41	19.8	0.032	6.9	0.052	4.1	0.0013
10/23/2014	0.01	< 0.0005	0.32	11.4	0.013	7.0	0.032	6.6	0.0014
Number	20	20	20	20	20	20	20	20	20
Maximum	0.029	0.0011	3.67	26.8	0.16	7.5	0.107	17	0.0024
Minimum	0.009	< 0.0005	0.17	9.7	0.011	6.2	0.029	2.1	0.0008
Mean	0.012	0.0006	0.88	17.4	0.041	6.9	0.059	8.2	0.0014
St. Dev.	0.004	0.0002	0.82	4.4	0.038	0.3	0.025	3.6	0.0004
Median	0.011	0.0005	0.59	17.7	0.029	6.9	0.053	8.0	0.0013
10th Percentile	0.010	< 0.0005	0.29	11.7	0.014	6.5	0.032	4.1	0.0009
95th Percentile	0.017	0.0009	2.01	24.4	0.133	7.3	0.092	12.3	0.0024

Appendix Table D.3.5: Water quality at station P-14 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	TSS[a] mg/L	U mg/L
10/14/2010	0.53	< 0.0005	0.04	199	0.011	7.6	0.130	170	1	0.0182
11/25/2010	0.53	< 0.0005	0.04	200	0.010	7.6	0.120	170	1	0.0117
12/2/2010						7.8	0.062		1	
12/9/2010	0.56	< 0.0005	0.05	219	0.011	7.9	0.140	170	2	0.0080
12/16/2010						7.7	0.160		1	
12/22/2010						7.8	0.140		1	
1/6/2011						7.8	0.037		2	
1/13/2011	0.56	0.0012	0.14	217	0.034	8.0	0.079	180	2	0.0071
1/20/2011						7.8	0.069		1	
1/27/2011						7.4	0.066		1	
2/10/2011	0.27	< 0.0005	0.02	234	0.013		0.011	190	< 1	0.0072
4/20/2011						7.4	0.099		1	
4/28/2011	0.58	0.0008	0.09	188	0.045	7.4	0.095	160	< 2	0.0083
5/5/2011						7.7	0.157		1	
5/12/2011	1.17	0.0009	0.12	170	0.054	8.1	0.222	130	2	0.0054
5/18/2011						7.6	0.132		2	
6/9/2011						7.5	0.087		1	
6/16/2011	0.62	< 0.0005	0.04	175	0.041	7.5	0.086	150	< 1	0.0079
6/23/2011						7.3	0.069		2	
10/27/2011						7.5				
11/3/2011						7.5	0.091		2	
11/10/2011	0.46	< 0.0005	0.04	187	0.009	7.5	0.069	150	2	0.0063
11/17/2011						7.4	0.098		1	
11/23/2011						7.3	0.082		2	
2/16/2012						7.0	0.055		1	
2/23/2012	0.63	< 0.0005	0.10	219	0.027	7.9	0.071	170	1	0.0076
3/1/2012						7.9	0.069		< 1	
3/8/2012	0.62	< 0.0005	0.09	216	0.029	7.8	0.087	170	1	0.0068
3/15/2012						7.8	0.100		2	
3/22/2012						7.7	0.122		1	
3/29/2012						7.6	0.102		1	
4/3/2012	0.65	0.0005	0.15	170	0.041	7.7	0.135	140	1	0.0069
11/8/2012						7.7	0.088		1	
11/15/2012	0.48	< 0.0005	0.04	180	0.008	7.7	0.05	160	1	0.0132
11/22/2012						7.6	0.098		< 1	
11/29/2012						7.7	0.088		3	
2/28/2013						7.9	0.061		1	
3/7/2013						8.0	0.146		< 1	
3/14/2013	0.59	< 0.0005	0.06	201	0.024	8.1	0.098	150	< 1	0.0087
3/21/2013						8.1	0.115		1	
3/27/2013						7.7	0.142		1	
4/4/2013						7.8	0.100		2	
4/11/2013	0.75	< 0.0005	0.11	220	0.036	7.9	0.091	150	1	0.0090
4/18/2013						7.9	0.107		< 1	
4/24/2013						7.8	0.207		1	
5/2/2013						7.8	0.275		5	
5/9/2013	1.37	< 0.0005	0.14	142	0.044	7.8	0.262	120	< 1	0.0077
5/16/2013						7.9	0.175		1	
6/6/2013						7.8	0.095		1	
6/13/2013	0.74	< 0.0005	0.04	142	0.059	8.0	0.180	140	2	0.0088
7/25/2013						7.8				
8/1/2013	0.55	< 0.0005	0.03	163	0.011	7.5	0.096	140	2	0.0112

Appendix Table D.3.5: Water quality at station P-14 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	TSS[a] mg/L	U mg/L
8/8/2013						7.7	0.092		1	
8/15/2013						7.5	0.094		2	
9/26/2013	0.55	< 0.0005	< 0.02	167	0.012	7.6	0.067	150	1	0.0189
10/3/2013						7.6	0.096		2	
10/10/2013	0.57	< 0.0005	0.02	157	0.014	7.4	0.112	130	2	0.0077
10/17/2013						7.4	0.098		1	
10/22/2013						7.6	0.096		1	
11/21/2013	1.20	< 0.0005	0.06	158	0.015	7.7	0.197	130	1	0.0077
11/28/2013						7.7	0.239		1	
12/5/2013						7.6	0.255		1	
12/11/2013	1.61	< 0.0005	0.08	168	0.018	7.5	0.327	140	< 1	0.0067
12/18/2013						7.5	0.270		1	
1/9/2014	1.74	< 0.0005	0.07	176	0.019	7.7	0.250	140	< 1	0.0064
1/16/2014						7.4	0.282		1	
1/23/2014						7.9	0.285		< 1	
1/30/2014						7.7	0.203		1	
2/6/2014						8.0	0.134		2	
2/13/2014	0.94	< 0.0005	0.05	186	0.023	7.7	0.083	150	1	0.0069
2/20/2014						8.0	0.049		< 1	
2/27/2014						8.2	0.046		2	
3/5/2014						7.5	0.071		1	
3/13/2014						7.8	0.112		1	
3/18/2014	1.17	< 0.0005	0.04	215	0.036	7.7	0.091	150	1	0.0071
3/26/2014						7.4	0.084		1	
5/8/2014	1.30	0.0005	0.15	129	0.073	7.5	0.214	99	2	0.0061
5/15/2014						7.4	0.271		1	
5/22/2014						7.5	0.269		2	
5/28/2014						7.4	0.241		< 1	
6/5/2014						7.5	0.175		2	
6/12/2014	0.72	< 0.0005	0.04	141	0.048	7.7	0.089	120	1	0.0072
6/19/2014						7.5	0.052		1	
6/25/2014						7.5	0.067		< 1	
10/16/2014	0.58	< 0.0005	0.02	144	0.008	7.3	0.089	120	1	0.0129
10/23/2014						7.5	0.129		1	
10/30/2014						7.5	0.207		1	
11/6/2014	1.07	< 0.0005	0.05	148	0.011	7.4	0.268	120	< 1	0.0055
11/13/2014						7.3	0.226		1	
11/20/2014						7.4	0.245		1	
11/26/2014						7.4	0.239		< 1	
12/3/2014						7.7	0.247		< 1	
12/8/2014	1.38	< 0.0005	0.06	160	0.015	7.7	0.245	130	1	0.0064
12/15/2014						7.5	0.270		< 1	
12/22/2014						7.4	0.262		< 1	
Number	30	30	30	30	30	94	93	30	93	30
Maximum	1.74	0.0012	0.15	234	0.073	8.2	0.327	190	5	0.0189
Minimum	0.27	< 0.0005	< 0.02	129	0.008	7.0	0.011	99	< 1	0.0054
Mean	0.82	0.0005	0.07	180	0.027	7.6	0.139	146	1	0.0086
St. Dev.	0.38	0.0002	0.04	29	0.018	0.2	0.076	21	1	0.0033
Median	0.63	0.0005	0.05	176	0.021	7.7	0.102	150	1	0.0077
10th Percentile	0.52	< 0.0005	0.02	142	0.010	7.4	0.066	120	1	0.0063
95th Percentile	1.51	0.0009	0.15	220	0.057	8.0	0.270	176	2	0.0160

[a] TOMP requirement

Appendix Table D.3.6: Summary of annual plant operations and discharge at Panel, 2010-2014.

ITEM	2010	2011	2012	2013	2014
PLANT OPERATIONS[a]					
Operating Days	44	101	85	196	216
Maximum Daily Plant Flow (L/s @ P-13)	101	152	100	150	160
Minimum Daily Plant Flow (L/s @ P-13)	0	0	0	0	0
Monthly Average Daily Plant Flow (L/s @ P-13)	94	104	82	94	89
Total Volume Treated (ML)	359	908	600	1597	1666
Barium Chloride Consumption					
Total (kg/yr)	1327	3500	2005	4903	5600
Monthly Average (mg/L)	3.70	3.86	3.34	3.07	3.36
Lime Consumption					
Dry (tonne/yr)	1.23	2.22	2.34	4.58	8.49
Average (g/L)	0.003	0.002	0.004	0.003	0.005
EFFLUENT[b]					
Discharge Days	40	100	80	194	216
Maximum Daily Discharge Flow (L/s @ P-14)	99	150	100	147	150
Minimum Daily Discharge Flow (L/s @ P-14)	0	0	0	0	0
Monthly Average Daily Discharge Flow (L/s @ P-14)	93	100	84	95	87
Total Annual Volume Discharged (ML)	321	862	579	1584	1616

ML - Million Litres

[a] Influent flows based on daily monitoring requirements as per TOMP

[b] Effluent flows based on weekly monitoring requirement as per SAMP

Appendix Table D.3.7: Mean annual discharge and seepage loadings from Panel TMA, 2010 - 2014.

Station	Drainage Type	Mean Annual Discharge (m^3)		Barium (kg/yr)	Cobalt (kg/yr)	Iron (kg/yr)	Manganese (kg/yr)	Radium (MBq/yr)	Sulphate (kg/yr)	Uranium (kg/yr)
Q-09	Quirke Lake Inflet	75,781,008	Mean	5,365				5,484	4,575,791	225
			S.D.	2,626				1,804	2,102,412	87
P-14	Controlled Discharge	1,009,152	Mean	889	0.4	72	27	154	146,209	8.4
			S.D.	745	0.2	42	19	128	69,536	4.3
P-02	Seepage from Dam B	34,690	Mean	0.73	0.02	16	3	2.0	10,929	0.1
			S.D.	0.1	0.00	5	1	0.88	3,180	0.0
P-03	Pond C Discharge	249,134	Mean	5.9	0.1	359	13	84	1,563	0.1
			S.D.	2.63	0.0	256.4	13	42	558	0.0
P-05	Seepage from Dam E	977,616	Mean	13.44	0.7	388	95	3.9	27,979	0.2
			S.D.	3.71	0.3	79.9	46	1.81	9,546	0.0
P-11	Site Drainage	5,058,374	Mean	7.7	0.3	308	19	47	5,772	1.1
			S.D.	5.6	0.2	151	10	53	4,498	1.0
			All Panel Sources	**917**	**1.4**	**1,143**	**157**	**292**	**192,452**	**10**
SR-01	Outlet of Quirke Lake	153,958,752	Mean	5,850				3,171	6,496,877	188
			S.D.	0				561	873,615	13

MBq/yr = Million Bequerels per year

Appendix Table D.3.8: Summary of seasonal trends for station P-02 from 2003-2014.

Month	Spearman's rho	Ba	Co	Fe	Hardness	Mn	pH	Ra	SO4	U
January	Correlation Coefficient	-0.577	-0.277	0.420	-1.000	0.126	0.810	-0.301	-0.965	-0.351
	Sig. (2-tailed)	0.049	0.384	0.175	0.000	0.696	0.001	0.342	0.000	0.263
	N	12	12	12	5	12	12	12	12	12
April	Correlation Coefficient	-0.408	-0.415	-0.007	-0.400	-0.133	0.815	-0.410	-0.839	-0.395
	Sig. (2-tailed)	0.188	0.180	0.983	0.505	0.681	0.001	0.186	0.001	0.204
	N	12	12	12	5	12	12	12	12	12
July	Correlation Coefficient	0.292	-0.490	-0.168	-0.900	-0.508	0.531	0.140	-0.979	-0.442
	Sig. (2-tailed)	0.356	0.105	0.602	0.037	0.092	0.076	0.665	0.000	0.151
	N	12	12	12	5	12	12	12	12	12
October	Correlation Coefficient	-0.404	-0.508	-0.280	-1.000	-0.406	0.382	0.095	-0.991	-0.733
	Sig. (2-tailed)	0.193	0.092	0.379	0.000	0.191	0.220	0.770	0.000	0.007
	N	12	12	12	5	12	12	12	12	12

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).

Significant trend where p<0.05.

Appendix Table D.3.9: Summary of seasonal trends for station P-03 from 2003-2014.

Month	Spearman's rho	Ba	Co	Fe	Hardness	Mn	pH	Ra	SO4	U
January	Correlation Coefficient	-0.647	-0.259	-0.564	-0.400	-0.182	0.621	-0.645	-0.655	-0.775
	Sig. (2-tailed)	0.031	0.442	0.071	0.505	0.592	0.041	0.032	0.029	0.005
	N	11	11	11	5	11	11	11	11	11
April	Correlation Coefficient	-0.510	0.211	-0.273	0.100	-0.154	0.021	-0.503	-0.427	-0.753
	Sig. (2-tailed)	0.090	0.511	0.391	0.873	0.633	0.948	0.095	0.166	0.005
	N	12	12	12	5	12	12	12	12	12
July	Correlation Coefficient	-0.248	0.798	-0.345	-1.000	-0.055	-0.451	-0.541	-0.460	-0.798
	Sig. (2-tailed)	0.489	0.006	0.328	0.000	0.880	0.191	0.106	0.181	0.006
	N	10	10	10	3	10	10	10	10	10
October	Correlation Coefficient	-0.474	0.775	-0.187	-0.600	-0.566	-0.092	-0.606	-0.755	-0.775
	Sig. (2-tailed)	0.141	0.005	0.581	0.285	0.070	0.789	0.048	0.007	0.005
	N	11	11	11	5	11	11	11	11	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).

Significant trend where p<0.05.

Appendix Table D.3.10: Summary of seasonal trends for station P-05 from 2003-2014.

Month	Spearman's rho	Ba	Co	Fe	Hardness	Mn	pH	Ra	SO4	U
January	Correlation Coefficient	-0.724	-0.464	-0.636	-0.500	-0.636	-0.028	-0.650	-0.333	-0.753
	Sig. (2-tailed)	0.008	0.128	0.026	0.391	0.026	0.931	0.022	0.291	0.005
	N	12	12	12	5	12	12	12	12	12
April	Correlation Coefficient	-0.322	0.180	0.042	-0.100	0.105	-0.318	-0.324	0.235	-0.753
	Sig. (2-tailed)	0.307	0.576	0.896	0.873	0.746	0.314	0.304	0.463	0.005
	N	12	12	12	5	12	12	12	12	12
July	Correlation Coefficient	0.291	0.348	0.413	-0.900	0.455	0.423	-0.017	-0.336	-0.753
	Sig. (2-tailed)	0.359	0.268	0.183	0.037	0.138	0.171	0.959	0.286	0.005
	N	12	12	12	5	12	12	12	12	12
October	Correlation Coefficient	-0.228	0.490	0.140	-0.700	0.074	-0.098	0.000	-0.231	-0.753
	Sig. (2-tailed)	0.477	0.106	0.665	0.188	0.820	0.761	1.000	0.471	0.005
	N	12	12	12	5	12	12	12	12	12

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).

Significant trend where p<0.05.

Appendix Table D.3.11: Summary of seasonal trends for station P-11 from 2003-2014.

Month	Spearman's rho	Ba	Co	Fe	Hardness	Mn	pH	Ra	SO4	U
January	Correlation Coefficient	0.064	-0.073	0.231	0.667	0.144	0.575	0.266	-0.648	-0.251
	Sig. (2-tailed)	0.843	0.821	0.471	0.219	0.656	0.050	0.404	0.023	0.432
	N	12	12	12	5	12	12	12	12	12
April	Correlation Coefficient	0.086	0.753	0.462	-0.700	0.221	0.000	-0.095	-0.238	-0.469
	Sig. (2-tailed)	0.790	0.005	0.130	0.188	0.491	1.000	0.770	0.456	0.124
	N	12	12	12	5	12	12	12	12	12
July	Correlation Coefficient	0.417	0.671	0.733	-0.500	0.146	0.298	-0.200	-0.718	0.023
	Sig. (2-tailed)	0.202	0.024	0.010	0.391	0.669	0.374	0.555	0.013	0.947
	N	11	11	11	5	11	11	11	11	11
October	Correlation Coefficient	-0.106	-0.304	0.361	-0.700	-0.091	0.355	-0.343	-0.599	-0.669
	Sig. (2-tailed)	0.744	0.337	0.249	0.188	0.778	0.257	0.276	0.040	0.017
	N	12	12	12	5	12	12	12	12	12

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).

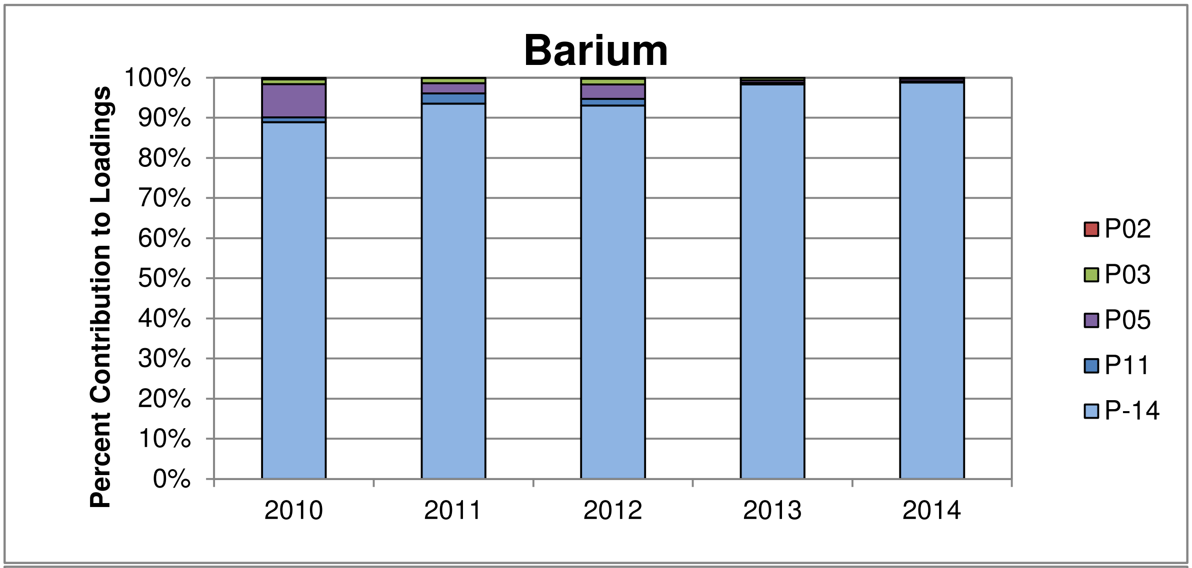
[shaded cell] Significant trend where p<0.05.

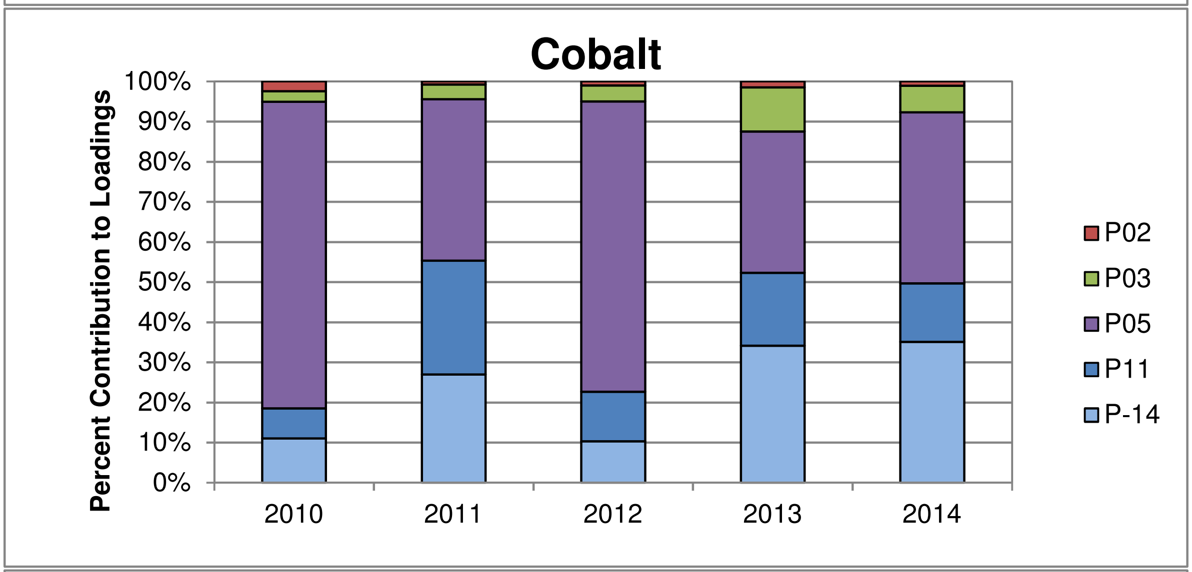
Appendix Table D.3.12: Summary of seasonal trends for station P-14 from 2003-2014.

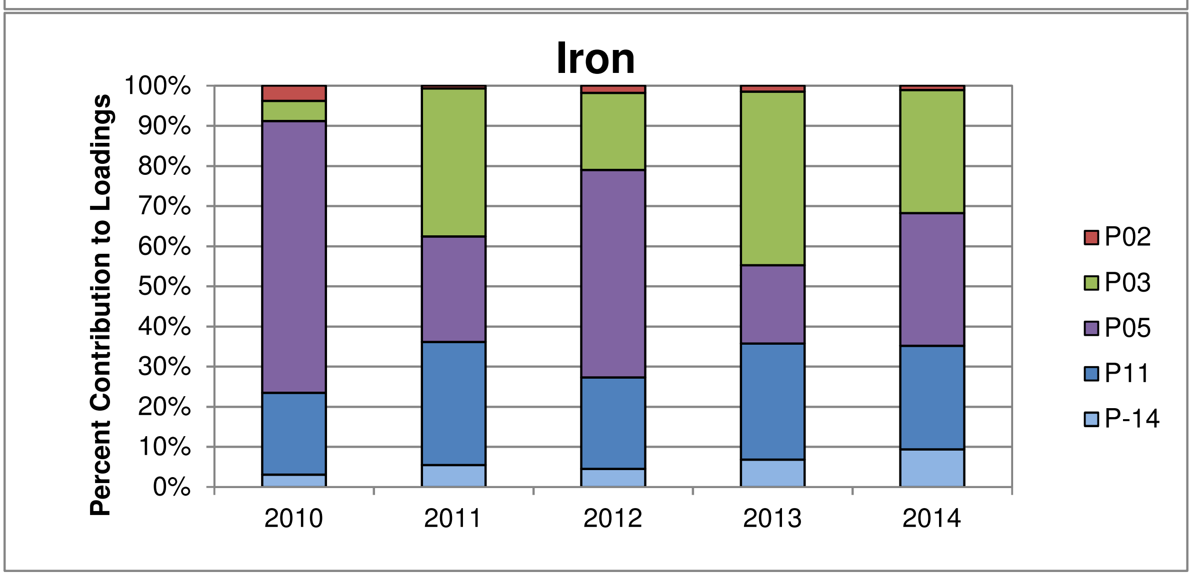
Month	Spearman's rho	Ba	Co	Fe	Hardness	Mn	pH	Ra	SO4	U
February	Correlation Coefficient	0.486	-0.778	-0.714		-0.771	0.714	0.095	-0.986	-0.086
	Sig. (2-tailed)	0.329	0.069	0.111		0.072	0.111	0.823	0.000	0.872
	N	6	6	6		6	6	8	6	6
March	Correlation Coefficient	0.964	.	-0.775		0.071	0.167	-0.286	-0.955	0.144
	Sig. (2-tailed)	0.000	.	0.041		0.879	0.668	0.493	0.001	0.758
	N	7	7	7		7	9	8	7	7
April	Correlation Coefficient	0.900	-0.287	-0.817		-0.417	0.271	-0.200	-0.967	-0.383
	Sig. (2-tailed)	0.001	0.454	0.007		0.265	0.480	0.606	0.000	0.308
	N	9	9	9		9	9	9	9	9
May	Correlation Coefficient	0.818	-0.648	-0.552		-0.273	0.018	0.224	-0.967	-0.685
	Sig. (2-tailed)	0.004	0.043	0.098		0.446	0.960	0.533	0.000	0.029
	N	10	10	10		10	10	10	10	10
June	Correlation Coefficient	0.943	-0.845	-0.880		-0.029	0.036	-0.321	-1.000	0.143
	Sig. (2-tailed)	0.005	0.034	0.021		0.957	0.939	0.482	0.000	0.787
	N	6	6	6		6	7	7	6	6
October	Correlation Coefficient	0.976	0.845	-0.651		0.000	-0.481	-0.571	-0.929	-0.096
	Sig. (2-tailed)	0.000	0.008	0.081		1.000	0.190	0.139	0.001	0.821
	N	8	8	8		8	9	8	8	8
November	Correlation Coefficient	0.903	-0.078	-0.571	-1.000	-0.669	-0.028	-0.176	-0.982	0.091
	Sig. (2-tailed)	0.000	0.831	0.085	0.000	0.035	0.935	0.627	0.000	0.803
	N	10	10	10	5	10	11	10	10	10
December	Correlation Coefficient	0.943	-0.655	-0.714		-0.829	-0.324	0.029	-1.000	-0.143
	Sig. (2-tailed)	0.005	0.158	0.111		0.042	0.531	0.957	0.000	0.787
	N	6	6	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).

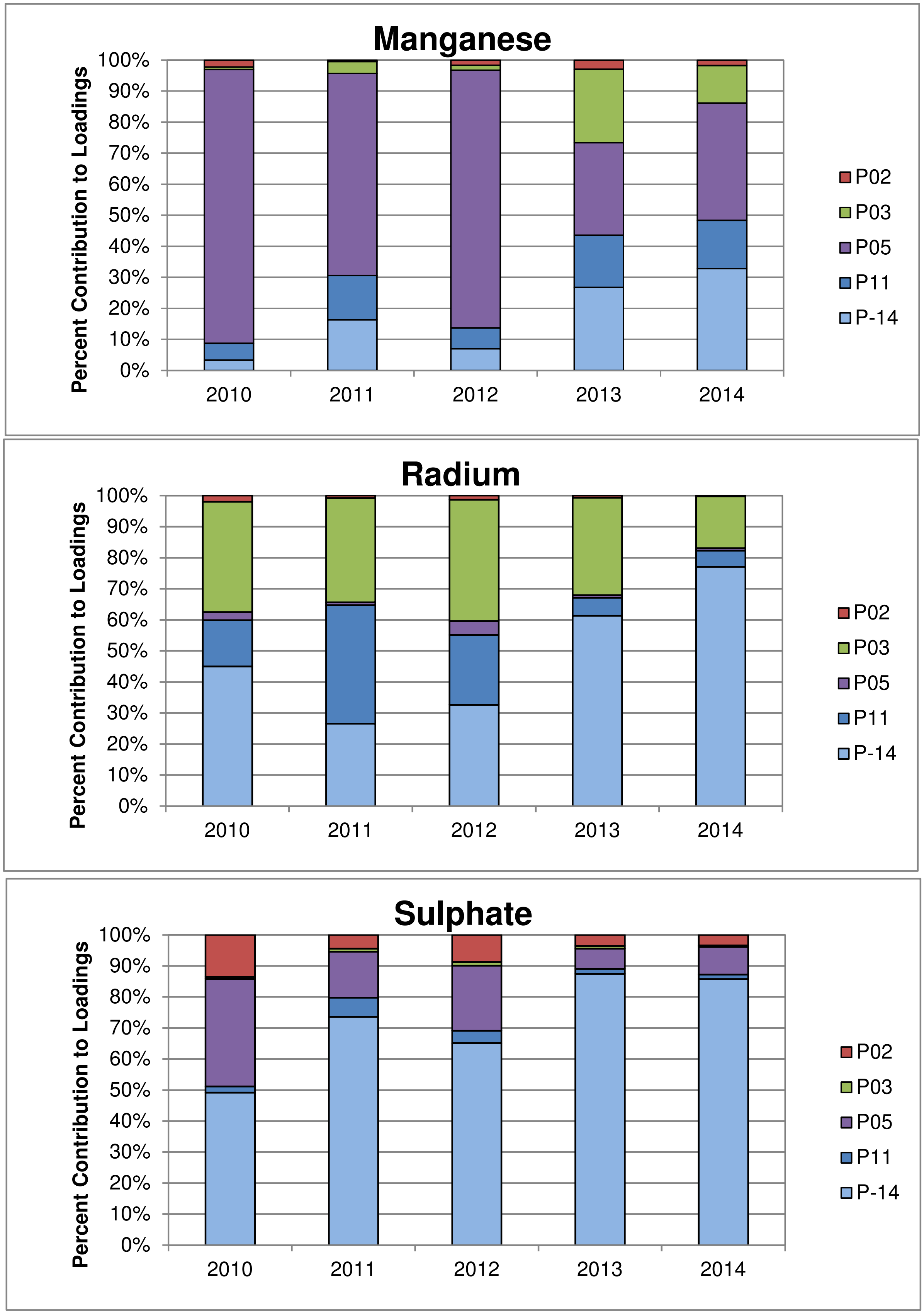
[shaded box] Significant trend where p<0.05.



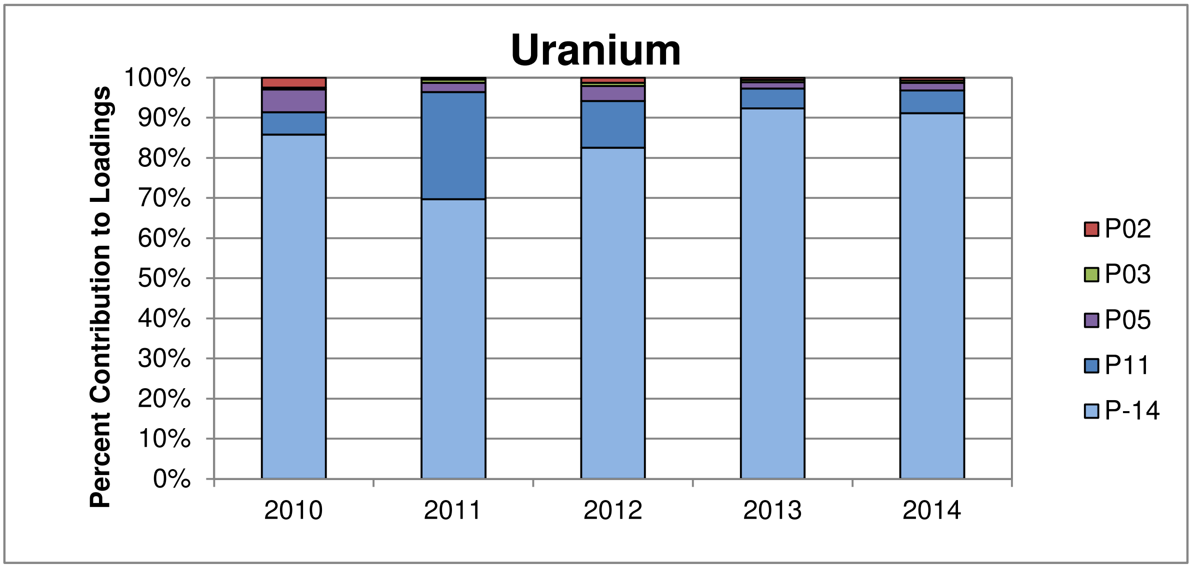




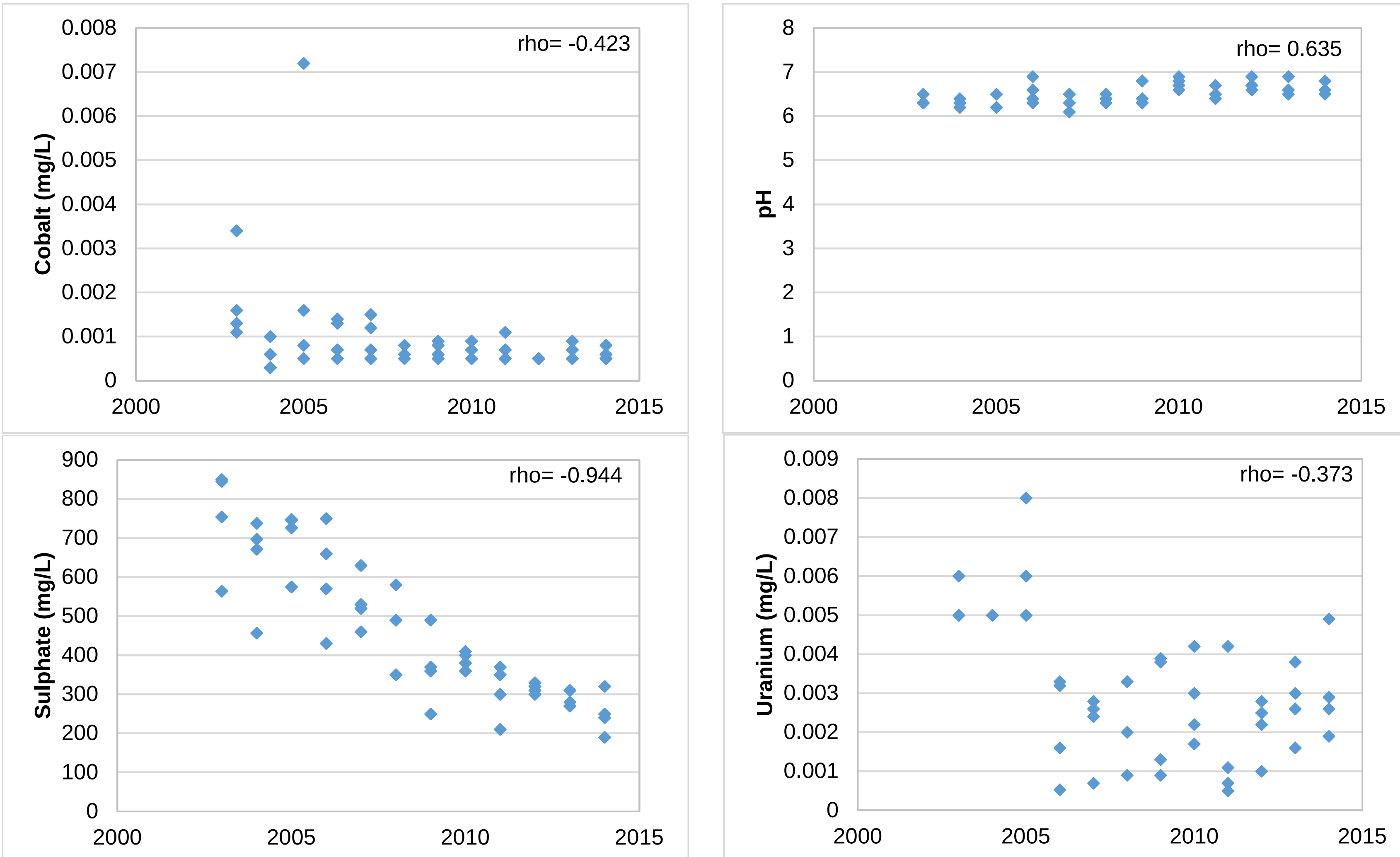
Appendix Figure D.3.1: Percent contribution to total Panel loads from TMA discharge points.



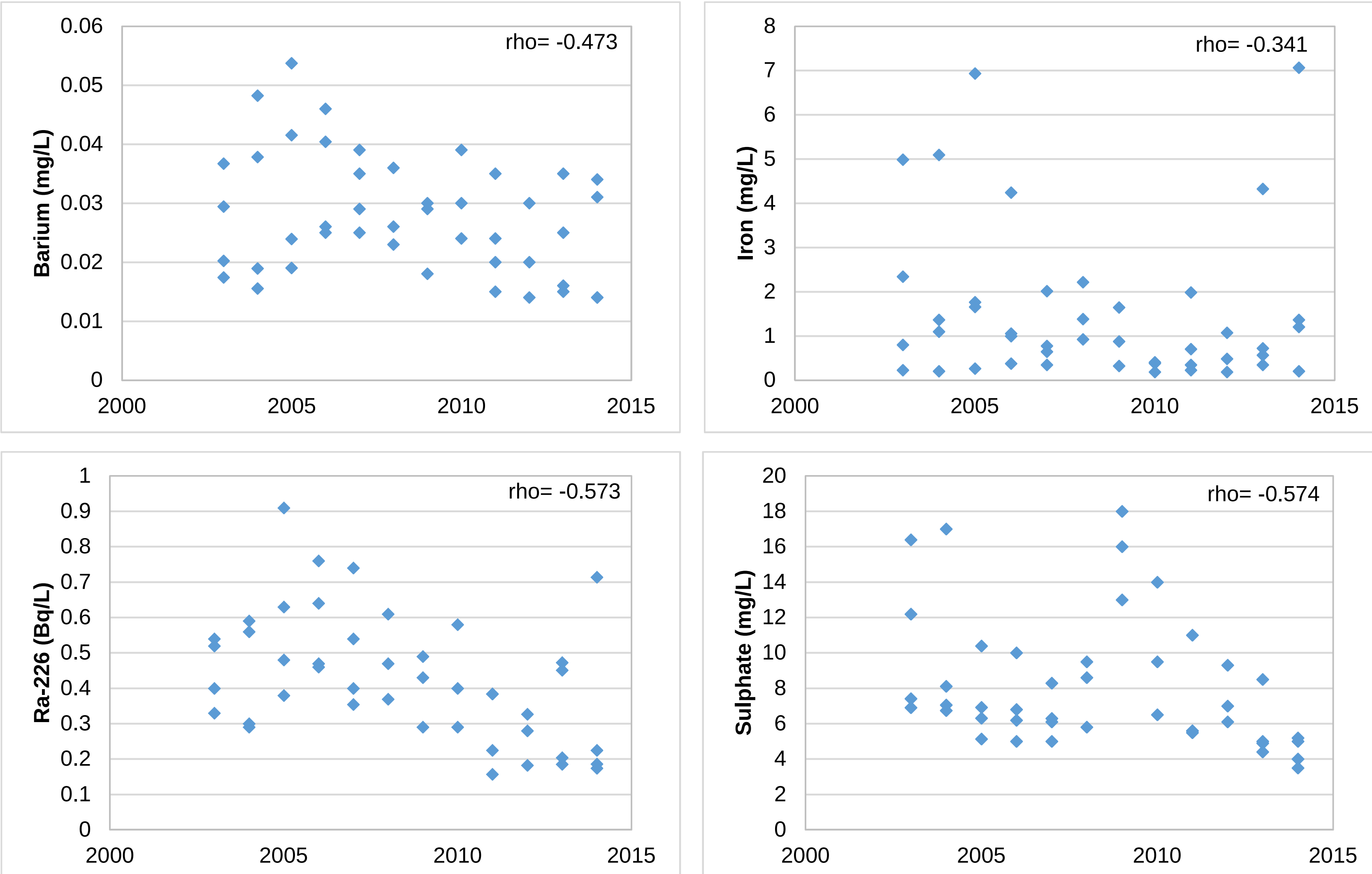
Appendix Figure D.3.1: Percent contribution to total Panel loads from TMA discharge points.



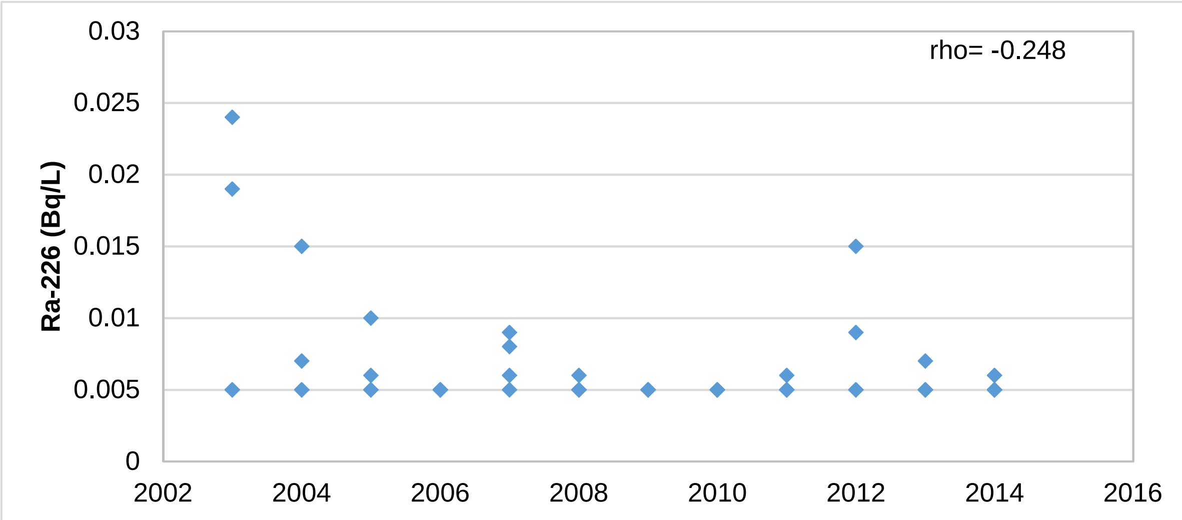
Appendix Figure D.3.1: Percent contribution to total Panel loads from TMA discharge points.



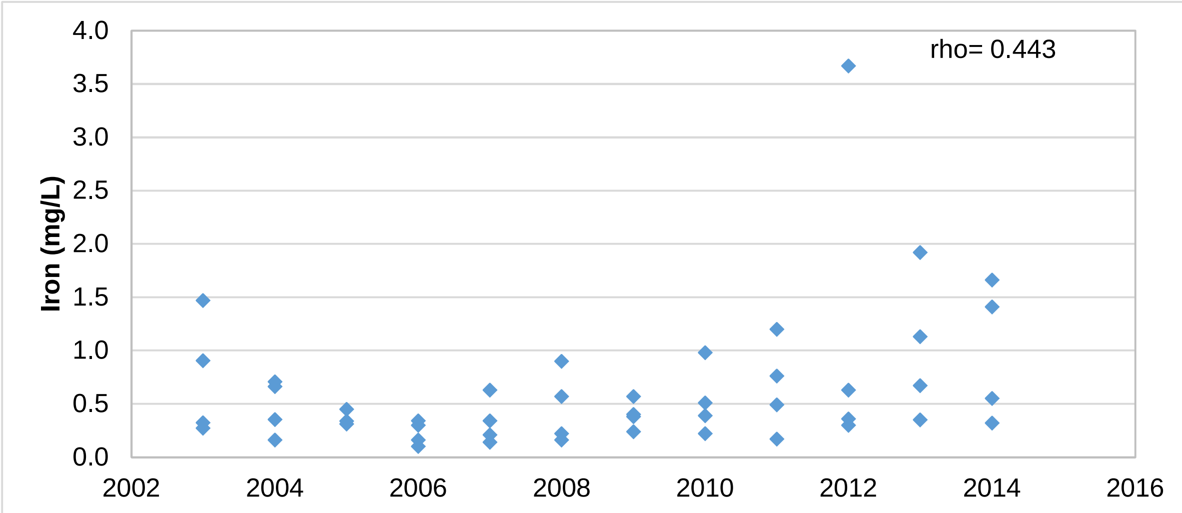
Appendix Figure D.3.2: Significant common (average) trends observed for cobalt, pH, sulphate and uranium over all seasons at Station P-02, 2003 to 2014.

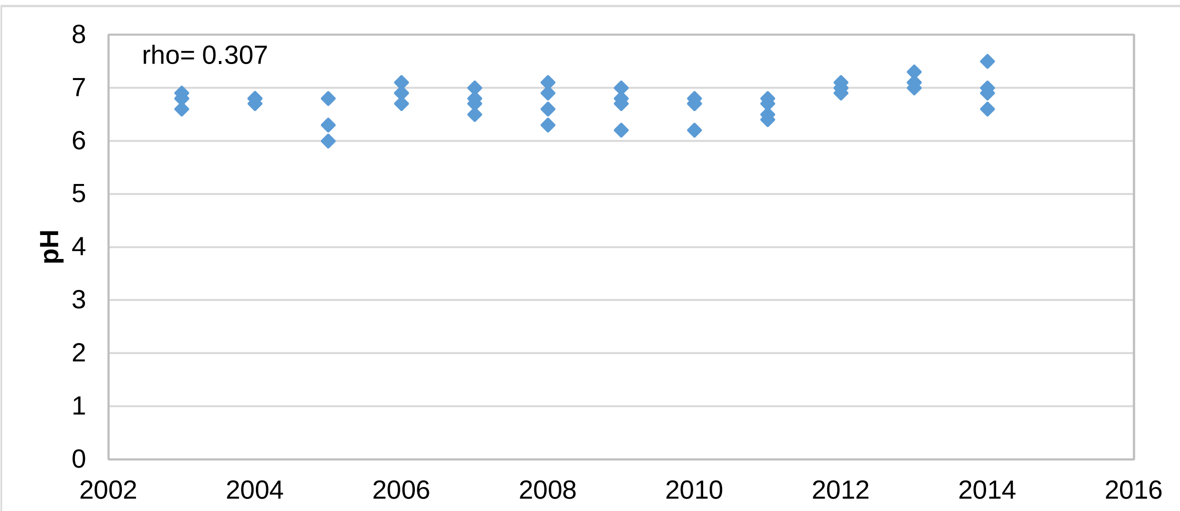


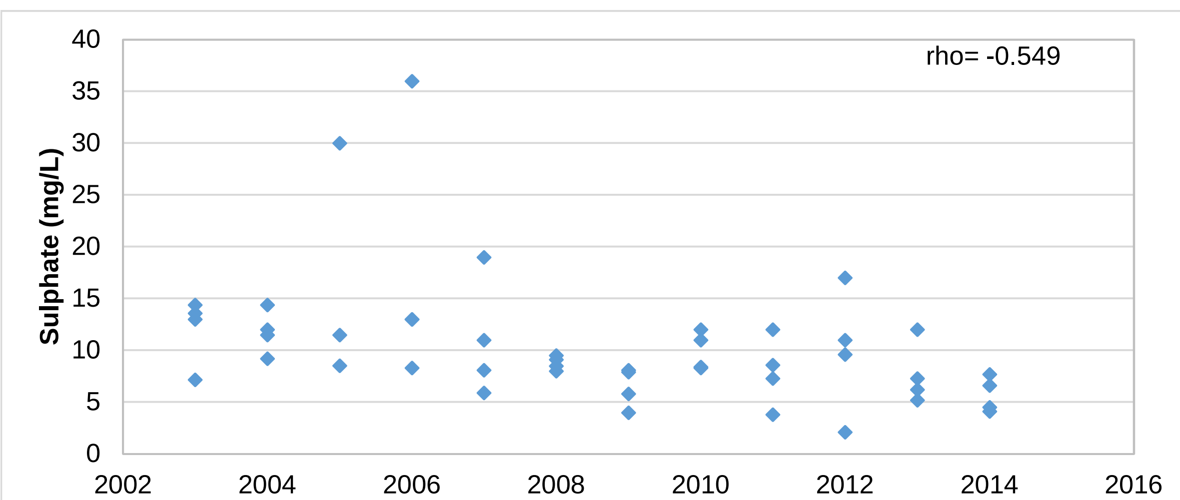
Appendix Figure D.3.3: Significant common (average) trends observed for barium, radium-226, iron and sulphate over all seasons at Station P-03, 2003 to 2014.



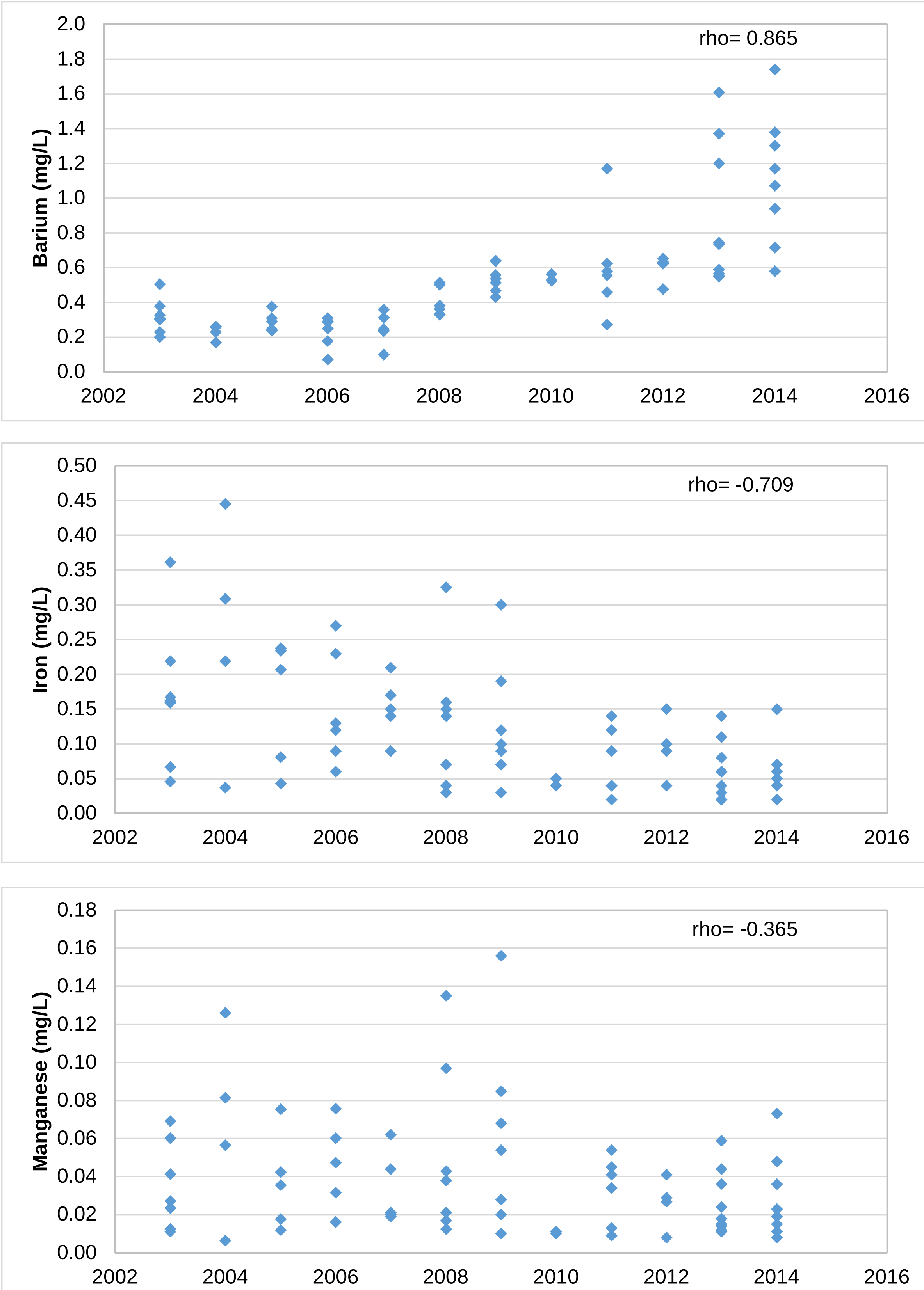
Appendix Figure D.3.4: Significant common (average) trends observed for radium-226 over all seasons at Station P-05, 2003 to 2014.



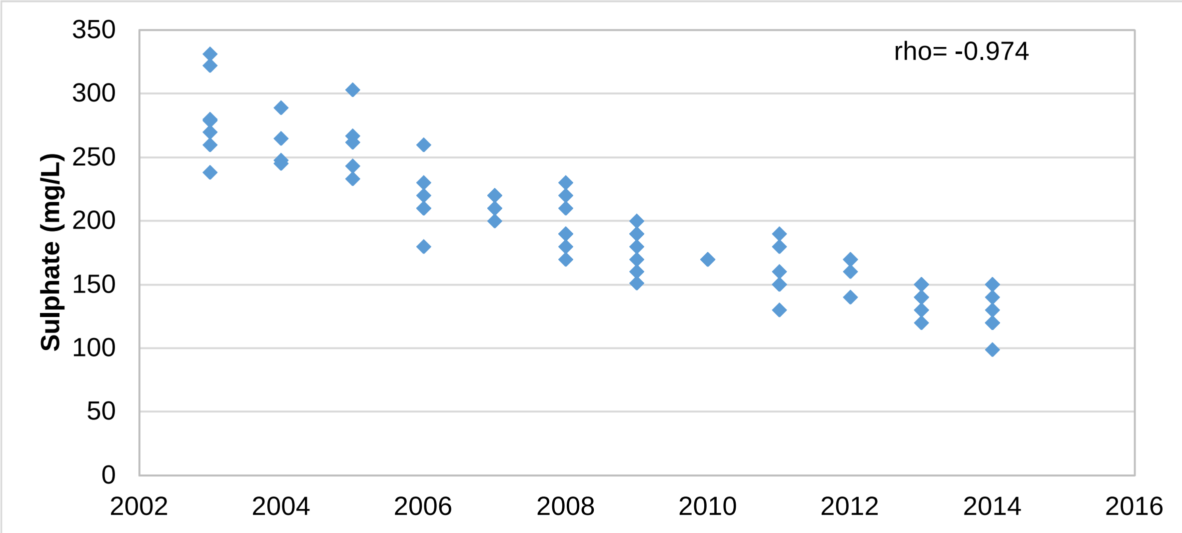


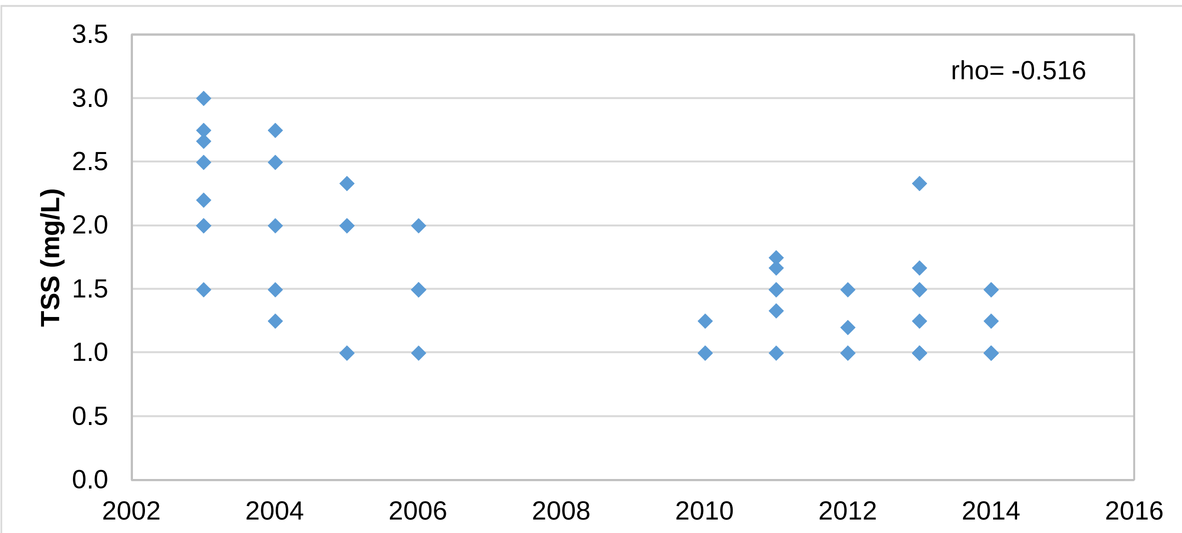


Appendix Figure D.3.5: Significant common (average) trends observed for iron, pH and sulphate over all seasons at Station P-11, 2003 to 2014.

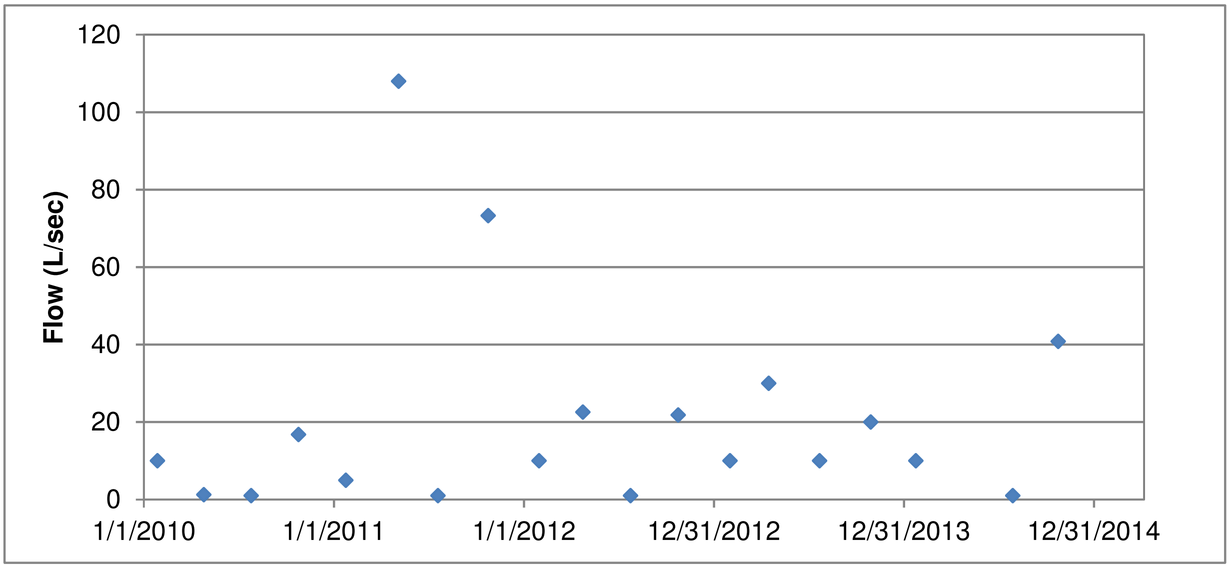


Appendix Figure D.3.6: Significant common (average) trends observed for barium, iron, manganese, sulphate and total suspended solids over all seasons at Station P-14, 2003 to 2014.

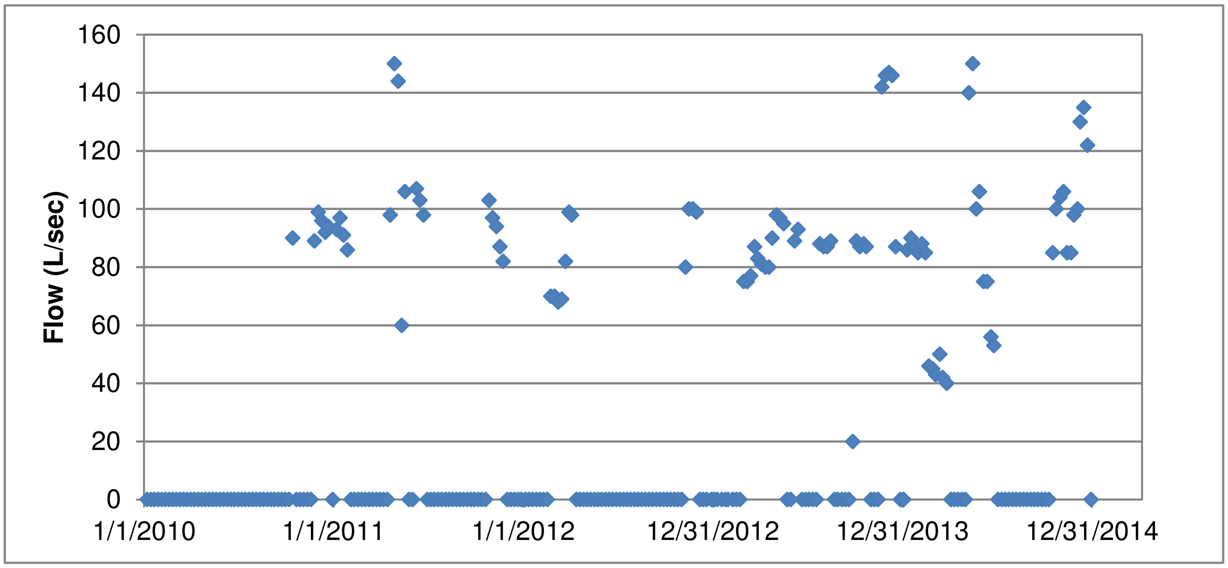




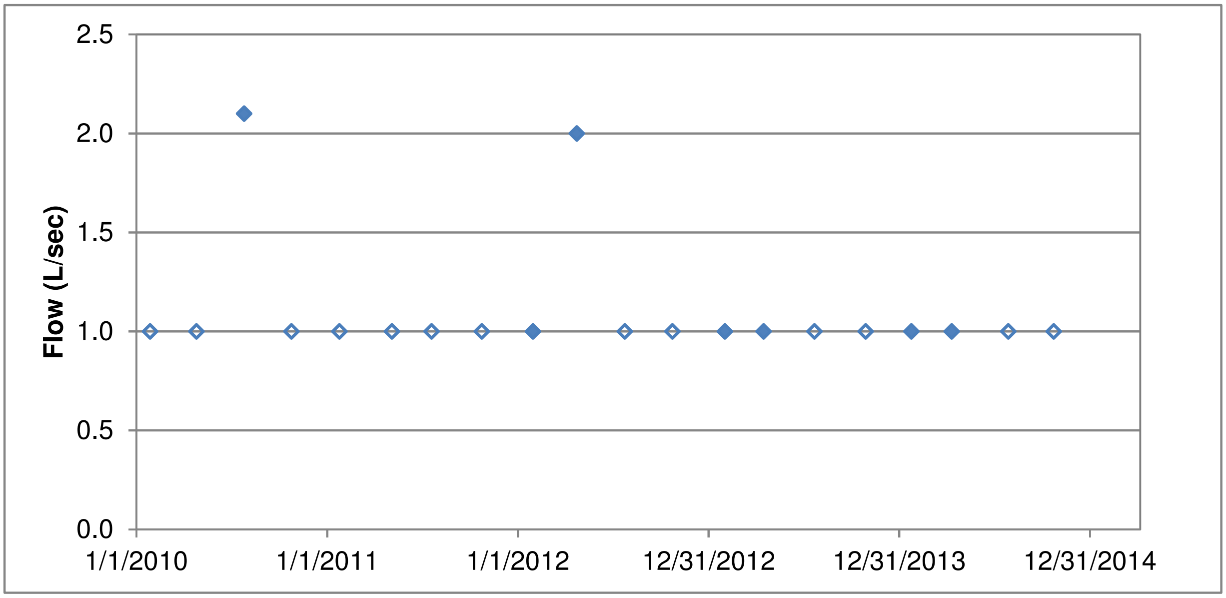
Appendix Figure D.3.6: Significant common (average) trends observed for barium, iron, manganese, sulphate and total suspended solids over all seasons at Station P-14, 2003 to 2014.



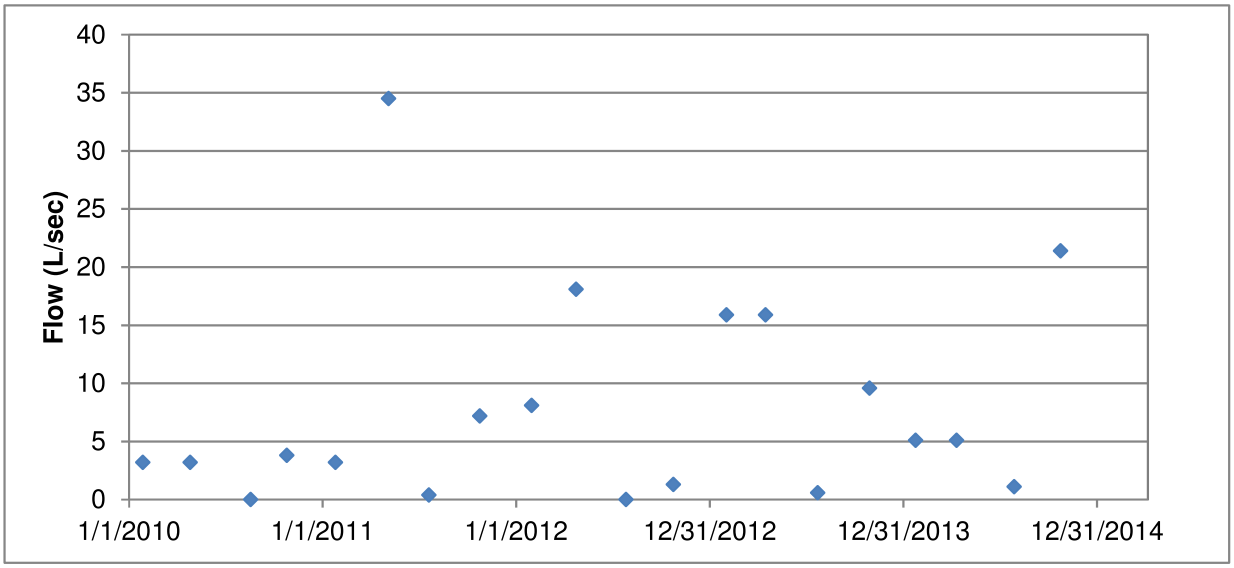
Appendix Figure D.3.7: Flows at station P-11 from 2010 to 2014.



Appendix Figure D.3.8: Flows at station P-14 from 2010 to 2014.



Appendix Figure D.3.9: Flows at station P-02 from 2010 to 2014. Hollow points represent flow of less than 1 L/sec.



Appendix Figure D.3.10: Flows at station P-03 from 2010 to 2014.

APPENDIX D.4
Stanrock TMA

Appendix Table D.4.1: Water quality at station DS-4 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	TSS[a] mg/L	U mg/L
1/5/2010						6.7	0.048		1	
1/12/2010	0.026	0.0012	0.17	421	0.054	6.9	0.039	400	1	0.0024
1/19/2010						7.0	0.034		< 1	
1/26/2010						6.9	0.032		2	
2/2/2010						6.7	0.036		1	
2/9/2010	0.027	0.0005	0.16	461	0.043	6.8	0.047	430	< 1	0.0021
2/16/2010						6.7	0.041		< 1	
2/24/2010						6.8	0.053		1	
3/2/2010						7.1	0.045		1	
3/9/2010	0.028	0.001	0.18	474	0.057	7.1	0.046	450	< 1	0.0022
3/16/2010						7.1	0.030		2	
3/23/2010						7.0	0.034		1	
3/30/2010						7.0	0.029		< 1	
4/6/2010						7.1	0.031		1	
4/13/2010	0.029	0.0014	0.25	393	0.063	7.4	0.035	350	< 2	0.0019
4/20/2010						7.2	0.038		1	
4/27/2010						7.1	0.023		< 1	
5/4/2010						7.1	0.063		< 1	
5/11/2010	0.030	< 0.0005	0.07	433	0.033	7.1	0.037	400	< 1	0.0018
5/18/2010						7.0	0.058		< 1	
5/25/2010						6.9	0.085		< 1	
6/1/2010						6.9	0.100		< 1	
6/8/2010	0.037	< 0.0005	0.04	450	0.078	6.9	0.096	420	1	0.0011
6/15/2010						7.0	0.068		< 1	
6/22/2010						7.0	0.072		< 1	
6/29/2010						7.1	0.066		< 1	
7/6/2010						7.1	0.064		< 1	
7/13/2010	0.029	0.0017	0.22	429	0.099	6.9	0.088	450	< 1	0.0015
7/20/2010						7.1	0.090		< 1	
7/27/2010						7.1	0.078		1	
8/3/2010						6.9	0.087		< 1	
8/10/2010	0.025	< 0.0005	0.06	437	0.054	6.9	0.070	430	< 1	0.0015
8/17/2010						6.9	0.045		< 1	
8/24/2010						7.0	0.083		< 1	
8/31/2010						6.9	0.077		1	
9/7/2010						7.0	0.074		< 1	
9/14/2010	0.025	< 0.0005	0.08	443	0.065	7.2	0.100	440	< 1	0.0021
9/21/2010						7.1	0.060		< 1	
9/28/2010						7.1	0.039		< 1	
10/5/2010						7.4	0.037		< 1	
10/12/2010	0.024	0.0007	0.38	466	0.04	7.1	0.056	440	< 1	0.0029
10/19/2010						7.1	0.055		1	
10/28/2010						7.5	0.056		< 1	
11/2/2010						7.3	0.043		< 1	
11/9/2010	0.023	0.0005	0.13	484	0.02	7.4	0.034	440	1	0.0029
11/16/2010						7.5	0.044		< 1	
11/23/2010						7.4	0.043		1	
11/30/2010						7.4	0.028		< 1	
12/7/2010						7.5	0.033		< 1	
12/14/2010	0.022	0.0012	0.10	363	0.025	7.4	0.036	440	< 1	0.0028
12/21/2010						7.2	0.027		< 1	

Appendix Table D.4.1: Water quality at station DS-4 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	TSS[a] mg/L	U mg/L
12/29/2010						7.4	0.037		< 1	
1/4/2011						7.4	0.035		< 1	
1/11/2011	0.022	< 0.0005	0.08	412	0.037	7.3	0.043	440	< 1	0.0031
1/18/2011						7.3	0.038		1	
1/25/2011						7.3	0.033		< 1	
2/1/2011						7.1	0.038		< 1	
2/8/2011	0.025	< 0.0005	0.10	498	0.043	7.3	0.039	500	1	0.0029
2/15/2011						7.2	0.033		< 1	
2/22/2011						7.3	0.041		1	
3/1/2011						7.3	0.039		< 1	
3/8/2011	0.024	0.0009	0.09	547	0.044	7.3	0.040	320	1	0.0031
3/15/2011						7.3	0.044		< 1	
3/22/2011						7.3	0.045		< 1	
3/29/2011						7.3	0.046		1	
4/5/2011						7.2	0.042		< 1	
4/12/2011	0.027	0.0013	0.34	423	0.076	7.4	0.038	350	1	0.0019
4/19/2011						7.2	0.040		2	
4/26/2011						7.3	0.033		1	
4/28/2011						7.4			1	
5/3/2011						7.3	0.037		2	
5/10/2011	0.033	0.0014	0.17	311	0.049	7.3	0.042	290	< 1	0.0015
5/17/2011						7.2	0.043		< 1	
5/24/2011						7.4	0.037		< 1	
5/31/2011						7.3	0.045		< 1	
6/7/2011						7.4	0.042		1	
6/14/2011	0.030	0.0006	0.05	437	0.018	7.5	0.049	350	1	0.0017
6/21/2011						7.1	0.073		< 2	
6/28/2011						7.2	0.063		< 1	
7/5/2011						7.2	0.055		< 1	
7/12/2011	0.030	0.0009	0.06	419	0.048	7.2	0.085	380	< 1	0.0014
7/19/2011						7.1	0.103		< 1	
7/26/2011						7.1	0.090		< 1	
8/2/2011						6.9	0.098		< 1	
8/9/2011	0.030	0.0005	0.06	451	0.088	7.1	0.096	390	1	0.0013
8/16/2011						7.1	0.095		< 1	
8/23/2011						7.0	0.097		1	
8/30/2011						7.1	0.079		1	
9/6/2011						7.1	0.078		1	
9/13/2011	0.025	0.002	0.08	438	0.072	7.0	0.077	410	< 1	0.0024
9/20/2011						7.1	0.059		3	
9/27/2011						7.1	0.072		< 1	
10/4/2011						7.1	0.067		< 1	
10/11/2011	0.023	0.0006	0.07	449	0.058	7.0	0.068	410	1	0.0030
10/18/2011						7.1	0.055		1	
10/25/2011						7.2	0.070		< 1	
11/1/2011						7.4	0.069		< 1	
11/9/2011	0.021	< 0.0005	0.24	402	0.018	7.1	0.044	390	1	0.0033
11/15/2011						7.3	0.039		1	
11/22/2011						7.2	0.042		1	
11/29/2011						7.2	0.040		1	
12/6/2011						7.1	0.030		1	

Appendix Table D.4.1: Water quality at station DS-4 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	TSS[a] mg/L	U mg/L
12/13/2011	0.024	0.0024	0.27	402	0.031	7.1	0.037	380	1	0.0026
12/20/2011						7.3	0.030		1	
12/28/2011						7.2	0.040		< 1	
1/3/2012						7.1	0.039		1	
1/10/2012	0.024	0.001	0.17	395	0.041	7.1	0.044	390	< 1	0.0024
1/17/2012						7.1	0.032		1	
1/24/2012						7.2	0.038		1	
1/31/2012						7.3	0.044		< 1	
2/7/2012						7.2	0.030		< 1	
2/14/2012	0.024	0.0009	0.17	423	0.063	7.0	0.034	360	< 1	0.0020
2/21/2012						7.0	0.037		< 1	
2/28/2012						7.0	0.031		< 1	
3/6/2012	0.027	0.0011	0.18	442	0.085	7.0	0.039	410	1	0.0025
3/13/2012						7.5	0.036		1	
3/20/2012						7.2	0.023		2	
3/27/2012						7.4	0.029		1	
4/3/2012						7.2	0.033		< 1	
4/9/2012	0.028	0.0013	0.10	299	0.05	7.2	0.049	260	1	0.0014
4/17/2012						7.2	0.038		< 1	
4/24/2012						7.2	0.050		1	
5/1/2012						7.4	0.055		< 1	
5/8/2012	0.028	< 0.0005	0.06	367	0.03	7.2	0.060	330	1	0.0018
5/15/2012						7.1	0.060		< 1	
5/22/2012						7.1	0.082		< 1	
5/29/2012						7.0	0.069		< 1	
6/5/2012						7.4	0.064		1	
6/12/2012	0.032	0.0007	0.03	377	0.043	7.1	0.093	350	< 1	0.0010
6/19/2012						7.1	0.056		1	
6/26/2012						7.1	0.076		< 1	
7/3/2012						7.1	0.078		< 1	
7/10/2012	0.028	0.001	0.03	387	0.059	6.9	0.109	350	< 1	0.0012
7/17/2012						7.1	0.108		< 1	
7/24/2012						6.9	0.112		< 1	
7/31/2012						6.9	0.093		1	
8/7/2012						7.1	0.111		< 1	
8/13/2012	0.023	< 0.0005	0.06	396	0.068	7.2	0.094	380	< 1	0.0019
8/21/2012						7.1	0.069		< 1	
8/28/2012						7.3	0.074		< 1	
9/4/2012						7.0	0.107		< 1	
9/11/2012	0.023	0.0014	0.07	399	0.083	7.0	0.095	330	< 1	0.0021
9/18/2012						7.2	0.076		1	
9/25/2012						7.3	0.069		< 1	
10/2/2012						7.1	0.085		< 1	
10/9/2012	0.020	< 0.0005	0.08	396	0.077	7.1	0.099	350	< 1	0.0029
10/16/2012						7.1	0.043		< 1	
10/23/2012						7.3	0.051		< 1	
10/30/2012						7.3	0.050		< 1	
11/6/2012						7.3	0.045		1	
11/13/2012	0.020	< 0.0005	0.22	420	0.017	7.4	0.033	380	< 1	0.0039
11/20/2012						7.4	0.041		1	
11/27/2012						7.3	0.040		1	

Appendix Table D.4.1: Water quality at station DS-4 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	TSS[a] mg/L	U mg/L
12/4/2012						7.3	0.041		1	
12/11/2012	0.022	< 0.0005	0.19	452	0.023	7.2	0.048	410	1	0.0032
12/18/2012						7.4	0.045		< 1	
12/27/2012						7.3	0.050		< 1	
1/2/2013						7.2	0.042		< 1	
1/8/2013	0.022	0.001	0.14	439	0.044	7.3	0.038	410	< 1	0.0032
1/15/2013						7.4	0.040		< 1	
1/22/2013						7.3	0.037		1	
1/29/2013						7.4	0.036		< 1	
2/5/2013						7.4	0.045		< 1	
2/12/2013	0.029	< 0.0005	0.12	443	0.05	7.3	0.035	450	< 1	0.0030
2/19/2013						7.3	0.044		1	
2/26/2013						7.3	0.035		< 1	
3/5/2013						7.2	0.044		< 1	
3/12/2013	0.023	0.0008	0.28	461	0.082	7.2	0.039	400	1	0.0027
3/19/2013						7.7	0.031		2	
3/20/2013						7.8				
3/21/2013						7.9				
3/25/2013						7.9				
3/26/2013						7.7	0.038		1	
3/27/2013						7.8				
3/28/2013						7.8				
4/1/2013						7.8				
4/2/2013						7.5	0.032		1	
4/9/2013	0.041	0.0011	0.25	422	0.079	7.6	0.028	370	< 1	0.0018
4/16/2013						7.5	0.025		2	
4/23/2013						7.3	0.034		2	
4/30/2013						6.8	0.039		2	
5/7/2013						7.2	0.033		2	
5/14/2013	0.054	0.0011	0.16	238	0.048	7.3	0.042	200	1	0.0012
5/21/2013						6.9	0.039		< 1	
5/28/2013						7.1	0.032		< 1	
6/4/2013						7.4	0.043		< 1	
6/11/2013	0.044	0.0003	0.09	329	0.024	7.7	0.046	320	1	0.0017
6/18/2013						7.5	0.077		< 1	
6/25/2013						7.0	0.066		< 1	
7/2/2013						6.8	0.064		< 1	
7/9/2013	0.035	< 0.0005	0.04	358	0.035	7.4	0.075	340	< 1	0.0012
7/16/2013						7.1	0.107		1	
7/23/2013						7.1	0.084		< 1	
7/30/2013						7.3	0.046		1	
8/6/2013						7.3	0.051		1	
8/13/2013	0.028	< 0.0005	0.07	408	0.017	7.3	0.055	380	< 1	0.0029
8/20/2013						7.8	0.054		1	
8/27/2013						7.1	0.049		< 1	
9/3/2013	0.027	< 0.0005	0.08	401	0.028	7.3	0.061	370	< 1	0.0028
9/10/2013						7.5	0.064		3	
9/17/2013						7.7	0.044		< 1	
9/24/2013						7.0	0.062		1	
10/1/2013						7.1	0.049		< 1	
10/8/2013	0.025	0.0016	0.11	380	0.039	7.3	0.044	360	1	0.0032

Appendix Table D.4.1: Water quality at station DS-4 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	TSS[a] mg/L	U mg/L
10/15/2013						7.2	0.048		1	
10/22/2013						7.1	0.050		1	
10/29/2013						7.5	0.046		1	
11/4/2013						7.2	0.037		1	
11/12/2013	0.027	0.0005	0.21	381	0.021	7.0	0.027	340	< 1	0.0024
11/19/2013						7.7	0.033		2	
11/26/2013						6.9	0.038			
12/3/2013						7.4	0.037		1	
12/10/2013	0.036	0.0012	0.24	347	0.039	7.5	0.031	330	1	0.0020
12/17/2013						7.1	0.033		1	
12/23/2013						7.8	0.029		1	
1/2/2014						8.2	0.032		5	
1/7/2014						7.1	0.038		< 1	
1/14/2014	0.040	0.001	0.23	374	0.044	7.2	0.033	350	2	0.0018
1/21/2014						7.4	0.037		2	
1/28/2014						7.3	0.035		1	
2/4/2014						7.1	0.041		< 1	
2/11/2014	0.040	0.0009	0.17	379	0.052	7.2	0.037	360	1	0.0019
2/18/2014						6.9	0.040		1	
2/25/2014						6.7	0.040		< 1	
3/4/2014						6.9	0.042		< 1	
3/11/2014	0.043	0.0008	0.17	383	0.069	7.1	0.036	350	1	0.0020
3/18/2014						7.1	0.044		< 1	
3/25/2014						7.0	0.041		1	
4/1/2014						6.9	0.044		1	
4/9/2014	0.040	0.001	0.29	372	0.097	6.8	0.042	360	2	0.0020
4/15/2014						7.1	0.044		2	
4/22/2014						7.2	0.048		2	
4/29/2014						7.4	0.039		2	
5/6/2014						6.8	0.032		2	
5/13/2014	0.062	0.0007	0.15	209	0.04	7.2	0.035	190	1	0.0010
5/20/2014						7.1	0.042		2	
5/27/2014						7.3	0.057		2	
6/3/2014						6.8	0.050		2	
6/10/2014	0.061	< 0.0005	0.05	287	0.023	7.4	0.073	240	< 1	0.0010
6/17/2014						6.5	0.071		< 1	
6/24/2014						6.6	0.080		1	
7/1/2014						6.6	0.095		< 1	
7/8/2014	0.049	0.0006	0.03	317	0.062	7.0	0.083	280	< 1	0.0010
7/15/2014						7.3	0.101		1	
7/22/2014						6.9	0.103		1	
7/29/2014						7.2	0.092		1	
8/5/2014						6.9	0.085		< 1	
8/11/2014	0.039	< 0.0005	0.08	339	0.081	7.0	0.090	310	< 1	0.0011
8/19/2014						7.2	0.100		< 1	
8/26/2014						7.3	0.094		1	
9/2/2014						7.3	0.061		1	
9/9/2014	0.033	< 0.0005	0.09	308	0.029	7.2	0.062	300	< 1	0.0023
9/16/2014						7.3	0.073		< 1	
9/23/2014						7.0	0.066		< 1	
9/30/2014						7.0	0.079		< 1	

Appendix Table D.4.1: Water quality at station DS-4 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	TSS[a] mg/L	U mg/L
10/7/2014						7.3	0.056		1	
10/14/2014	0.033	0.0006	0.15	272	0.026	7.3	0.035	260	2	0.0021
10/21/2014						7.2	0.052		1	
10/28/2014						7.0	0.051		< 1	
11/4/2014						7.3	0.042		< 1	
11/11/2014	0.049	0.0009	0.17	271	0.025	6.9	0.037	250	< 1	0.0017
11/18/2014						7.1	0.038		< 1	
11/25/2014						7.0	0.041		< 1	
12/2/2014						7.0	0.033		1	
12/9/2014	0.056	0.0007	0.26	282	0.038	7.1	0.044	260	1	0.0017
12/16/2014						7.2	0.039		1	
12/22/2014						7.1	0.041		< 1	
12/29/2014						7.2	0.040		< 1	
Number	60	60	60	60	60	268	261	60	262	60
Maximum	0.062	0.0024	0.38	547	0.099	8.2	0.112	500	5	0.0039
Minimum	0.020	< 0.0005	0.03	209	0.017	6.5	0.023	190	< 1	0.0010
Mean	0.031	0.0008	0.14	393	0.049	7.2	0.053	363	1	0.0021
St. Dev.	0.010	0.0004	0.08	66	0.022	0.2	0.022	65	0	0.0007
Median	0.028	0.0007	0.13	402	0.044	7.2	0.044	365	1	0.0020
10th Percentile	0.022	< 0.0005	0.05	298	0.023	6.9	0.033	260	1	0.0012
95th Percentile	0.054	0.0016	0.28	475	0.085	7.7	0.098	450	2	0.0032

Appendix Table D.4.2: Water quality at station DS-16 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	U mg/L
3/16/2010						6.3			
3/23/2010						6.0			
4/13/2010						6.4			
9/28/2010						6.2			
11/9/2010	0.023	0.0007	0.05	50.8	0.032	6.7	0.008	32	< 0.0005
11/16/2010						6.8			
11/30/2010						6.9			
12/7/2010						6.4			
12/14/2010						6.5			
1/4/2011						6.7			
4/5/2011						6.7			
4/12/2011						6.6			
4/19/2011						6.5			
4/26/2011						6.6			
5/3/2011						6.6			
5/10/2011	0.022	0.0029	0.12	68.1	0.148	6.7	0.017	56	< 0.0005
5/24/2011						6.8			
11/15/2011						6.6			
11/22/2011						6.7			
11/29/2011	0.019	0.0012	0.11	73.4	0.121	6.5	0.015	62	< 0.0005
12/6/2011						6.7			
12/13/2011						6.7			
12/20/2011						6.2			
1/24/2012						7.0			
3/13/2012						7.2			
3/20/2012						6.8			
3/27/2012						6.7			
4/3/2012						6.3			
11/13/2012	0.028	0.0005	0.02	105.0	0.034	6.9	0.011	90	< 0.0005
12/4/2012						6.9			
3/12/2013	0.017	0.0011	0.14	40.8	0.061	6.5	0.015	26	0.0005
3/19/2013						6.7			
3/26/2013						6.7			
4/2/2013						6.8			
4/11/2013						7.0			
4/16/2013						6.9			
4/23/2013						6.7			
4/30/2013						6.5			
5/7/2013						6.5			
11/12/2013	0.013	< 0.0005	0.02	42.2	0.012	6.7	< 0.005	32	< 0.0005
11/20/2013						6.8			
11/28/2013						6.8			
12/3/2013						6.9			
4/15/2014						6.6			
4/22/2014						6.6			
4/29/2014						6.5			
5/6/2014						6.6			
5/13/2014	0.016	< 0.0005	0.03	57.1	0.02	7.1	0.009	45	< 0.0005
5/20/2014						6.7			
5/27/2014						7.1			
6/3/2014						6.5			

Appendix Table D.4.2: Water quality at station DS-16 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	U mg/L
10/7/2014						6.5			
10/16/2014						6.5			
10/21/2014						7.0			
10/28/2014						6.9			
11/4/2014						6.7			
11/11/2014	0.015	0.0009	0.1	54.0	0.067	6.6	< 0.005	46	< 0.0005
11/18/2014						6.5			
11/25/2014						6.7			
12/2/2014						6.5			
12/9/2014						6.5			
12/16/2014						6.6			
Number	8	8	8	8	8	62	8	8	8
Maximum	0.028	0.0029	0.14	105.0	0.148	7.2	0.017	90	0.0005
Minimum	0.013	< 0.0005	0.02	40.8	0.012	6.0	< 0.005	26	< 0.0005
Mean	0.019	0.0010	0.07	61.4	0.062	6.7	0.011	49	< 0.0005
St. Dev.	0.005	0.0008	0.05	20.9	0.049	0.2	0.005	21	0.0000
Median	0.017	0.0009	0.10	57.1	0.061	6.7	0.011	46	< 0.0005
10th Percentile	0.014	0.0005	0.02	41.8	0.018	6.4	< 0.005	30	< 0.0005
95th Percentile	0.026	0.0023	0.13	93.9	0.139	7.0	0.016	80	0.0005

Appendix Table D.4.3: Summary of annual plant operations and discharge at Stanrock, 2010-2014.

ITEM	2010	2011	2012	2013	2014
PLANT OPERATIONS[a]					
Operating Days	123	143	121	200	185
Maximum Daily Plant Flow (L/s @ DS-2)	142	185	175	191	200
Minimum Daily Plant Flow (L/s @ DS-2)	46	53	0	45	16
Monthly Average Daily Plant Flow (L/s @ DS-2)	97	104	104	106	121
Total Volume Treated (ML)	1,032	1,291	1,087	1,828	1,940
Barium Chloride Consumption					
Total (kg/year)	289	343	277	961	878
Monthly Average (mg/L)	0.28	0.27	0.25	0.53	0.45
Lime Consumption					
Total Dry (tonne/year)	175	179	150	271	197
Monthly Average (g/L)	0.17	0.14	0.14	0.15	0.10
ORIENT CREEK					
Discharge Days	288	252	266	0	0
Max Daily Flow (L/s @ DS-5)	12	22	74	0	0
Min Daily Flow (L/s @ DS-5)	0	0	0	0	0
Monthly Average Daily Flow (L/s @ DS-5)	2.9	4.5	6.8	0	0
Total Volume (ML)	72	97	155	0	0
Site Total Including ETP Operations (ML)	1,104	1,388	1,242	0	0
NEUTRALIZATION					
Lime Consumption					
Beaver Lake Total Dry (tonnes/month)	0	0	0	0	0
Site Total Including ETP Operations	175	179	150	271	197
Caustic Soda Consumption					
Orient Creek Total (kg/month)	0	0	0	0	0
Sodium Carbonate Consumption					
Orient Creek Total (kg/month)	0	0	0	0	0
Moose Lake (DS-1 & DS-6) Total (kg/month)	0	0	0	0	0
EFFLUENT[b]					
Discharge Days	365	365	366	365	365
Maximum Daily Discharge Flow (L/s @ DS-4)	153	758	191	299	599
Minimum Daily Discharge Flow (L/s @ DS-04)	1	1	1	1	2
Monthly Average Daily Discharge Flow (L/s @ DS-04)	22	41	25	54	52
Total Annual Volume Discharged (ML)	697	1,278	797	1,712	1,639

[a] Influent flows based on daily monitoring requirements as per TOMP

[b] Effluent flows based on weekly monitoring requirement as per SAMP

Appendix Table D.4.4: Mean annual discharge and seepage loadings from Stanrock TMA, 2010 - 2014.

Station		Drainage Type	Mean Annual Discharge (m^3)		Barium (kg/yr)	Cobalt (kg/yr)	Iron (kg/yr)	Manganese (kg/yr)	Radium (MBq/yr)	Sulphate (kg/yr)	Uranium (kg/yr)
May Lake Drainage	DS-4	Controlled Discharge	1,261,440	Mean	41	1.1	267	70	50	440,411	2.7
				S.D.	24	0.5	124	29	20.0	139,631	0.9
	DS-18	Halfmoon Lake Outlet	5,613,408	Mean	88		3,131		666	554,702	9.7
				S.D.	24		4,043		173	112,359	1.8
Quirke Lake Drainage	Q-09	Inlet to Quirke Lake	75,781,008	Mean	5,365				5,484	4,575,791	225
				S.D.	2,626				1,804	2,102,412	87
	DS-16	Seepage from Dam G and J	12,614	Mean	0.20	0.0	1.1	0.8	0.1	494	0.004
				S.D.	0.15	0.0	0.9	0.5	0.1	419	0.003
	SR-01	Outlet of Quirke Lake	153,958,752	Mean	5,850				3,171	6,496,877	188
				S.D.	0				561	873,615	13

MBq/yr = Million Bequerels per year

Appendix Table D.4.5: Summary of seasonal trends for station DS-4 from 2003-2014.

Month	Spearman's rho	Ba	Co	Fe	Hardness	Mn	pH	Ra	SO4	U
January	Correlation Coefficient	-0.317	0.131	-0.189	-0.400	-0.592	0.084	-0.606	-0.439	-0.794
	Sig. (2-tailed)	0.315	0.686	0.556	0.505	0.043	0.795	0.037	0.153	0.002
	N	12	12	12	5	12	12	12	12	12
February	Correlation Coefficient	0.312	-0.266	-0.200	-0.800	-0.550	-0.168	-0.657	-0.218	-0.869
	Sig. (2-tailed)	0.324	0.403	0.533	0.104	0.064	0.601	0.020	0.497	0.000
	N	12	12	12	5	12	12	12	12	12
March	Correlation Coefficient	0.437	0.000	0.197	-0.800	-0.140	0.207	-0.790	-0.795	-0.820
	Sig. (2-tailed)	0.156	1.000	0.539	0.104	0.665	0.519	0.002	0.002	0.001
	N	12	12	12	5	12	12	12	12	12
April	Correlation Coefficient	-0.441	-0.723	-0.291	-0.300	-0.531	-0.140	-0.392	0.235	-0.737
	Sig. (2-tailed)	0.152	0.008	0.358	0.624	0.075	0.664	0.208	0.462	0.006
	N	12	12	12	5	12	12	12	12	12
May	Correlation Coefficient	-0.039	-0.403	0.205	-0.900	-0.914	-0.408	-0.217	-0.224	-0.894
	Sig. (2-tailed)	0.905	0.194	0.523	0.037	0.000	0.187	0.499	0.484	0.000
	N	12	12	12	5	12	12	12	12	12
June	Correlation Coefficient	0.364	0.064	0.225	-1.000	-0.252	-0.193	-0.515	-0.561	-0.799
	Sig. (2-tailed)	0.245	0.843	0.483	0.000	0.429	0.549	0.087	0.058	0.002
	N	12	12	12	5	12	12	12	12	12
July	Correlation Coefficient	0.168	0.771	0.133	-1.000	0.343	-0.486	-0.476	-0.501	-0.982
	Sig. (2-tailed)	0.601	0.003	0.681	0.000	0.276	0.109	0.118	0.097	0.000
	N	12	12	12	5	12	12	12	12	12
August	Correlation Coefficient	0.035	0.746	0.722	-0.800	0.266	-0.170	-0.671	-0.660	-0.784
	Sig. (2-tailed)	0.914	0.005	0.008	0.104	0.404	0.598	0.017	0.020	0.003
	N	12	12	12	5	12	12	12	12	12
September	Correlation Coefficient	-0.123	0.636	0.384	-0.900	-0.168	-0.187	-0.909	-0.709	-0.735
	Sig. (2-tailed)	0.704	0.026	0.218	0.037	0.602	0.561	0.000	0.010	0.006
	N	12	12	12	5	12	12	12	12	12
October	Correlation Coefficient	0.455	0.853	0.197	-1.000	0.378	-0.104	-0.811	-0.734	-0.926
	Sig. (2-tailed)	0.137	0.000	0.540	0.000	0.226	0.747	0.001	0.007	0.000
	N	12	12	12	5	12	12	12	12	12
November	Correlation Coefficient	0.298	0.535	0.242	-0.900	-0.308	-0.329	-0.755	-0.785	-0.840
	Sig. (2-tailed)	0.347	0.073	0.448	0.037	0.331	0.297	0.005	0.003	0.001
	N	12	12	12	5	12	12	12	12	12
December	Correlation Coefficient	0.274	-0.021	-0.126	-0.600	-0.524	-0.124	-0.428	-0.529	-0.916
	Sig. (2-tailed)	0.389	0.948	0.696	0.285	0.080	0.701	0.165	0.077	0.000
	N	12	12	12	5	12	12	12	12	12

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).

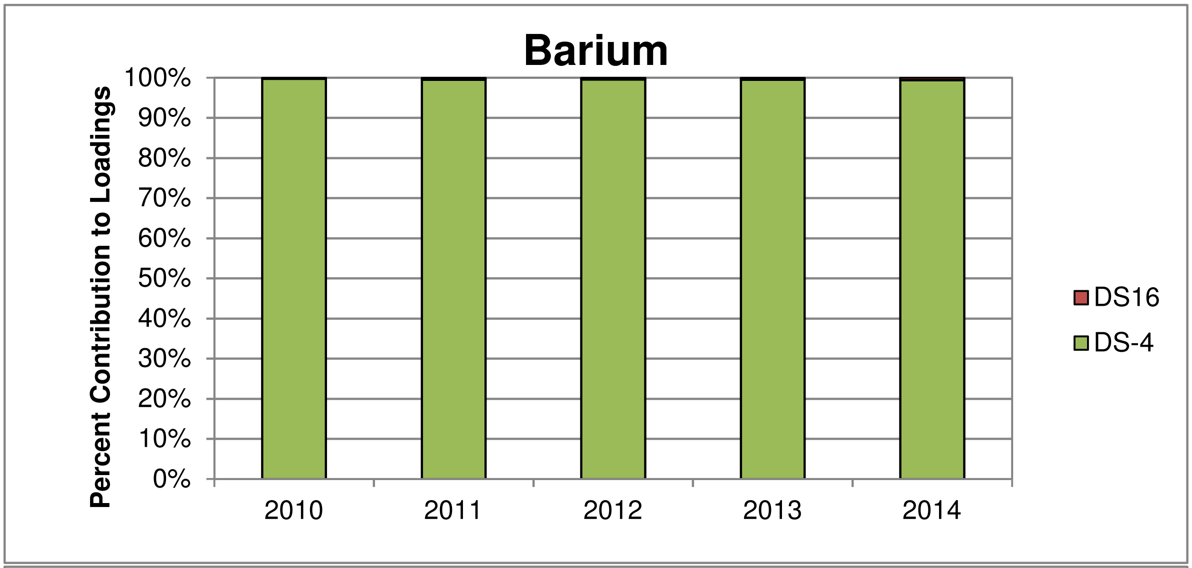
Significant trend where p<0.05.

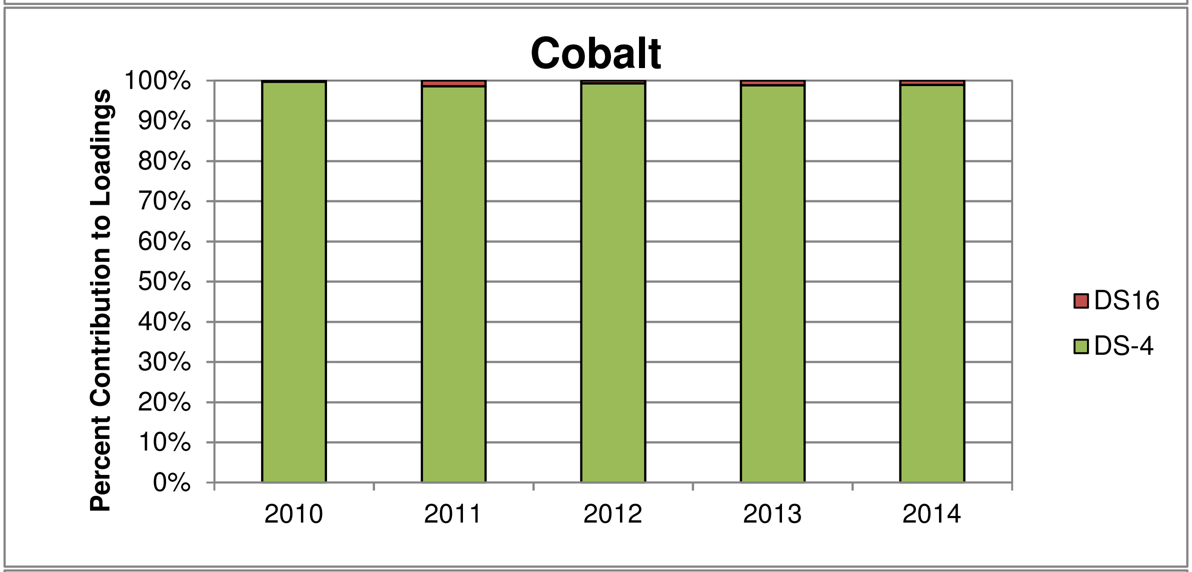
Appendix Table D.4.6: Summary of seasonal trends for station DS-16 from 2003-2014.

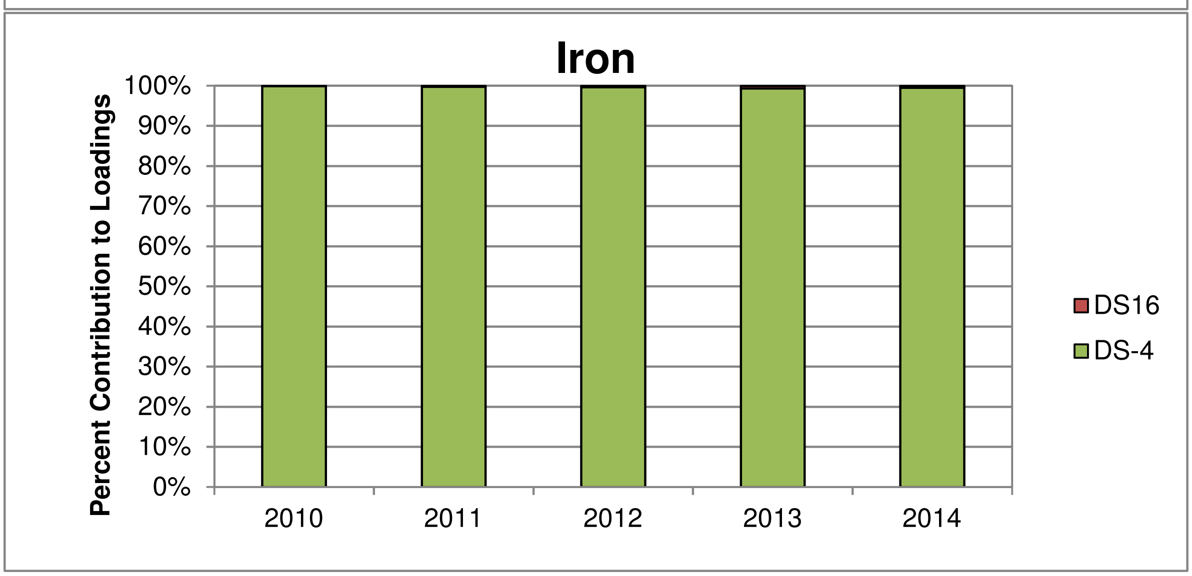
Month	Spearman's rho	Ba	Co	Fe	Hardness	Mn	pH	Ra	SO4	U
January	Correlation Coefficient	-0.500	-0.833	-0.786		-0.738	0.436	-0.810	-0.874	-0.714
	Sig. (2-tailed)	0.207	0.010	0.021		0.037	0.180	0.015	0.005	0.047
	N	8	8	8		8	11	8	8	8
April	Correlation Coefficient	0.500	-0.905	-0.479		-0.857	0.343	-0.778	-0.714	-0.801
	Sig. (2-tailed)	0.207	0.002	0.230		0.007	0.276	0.023	0.047	0.017
	N	8	8	8		8	12	8	8	8
July	Correlation Coefficient	-0.505	-0.714	-0.750		-0.571	0.893	-0.071	-0.667	-0.927
	Sig. (2-tailed)	0.248	0.071	0.052		0.180	0.007	0.867	0.071	0.001
	N	7	7	7		7	7	8	8	8
October	Correlation Coefficient	0.414	-0.893	0.036		-0.357	0.690	-0.180	0.071	-0.630
	Sig. (2-tailed)	0.355	0.007	0.939		0.432	0.058	0.699	0.879	0.129
	N	7	7	7		7	8	7	7	7
November	Correlation Coefficient	0.086	-0.522	-0.522	-0.100	-0.429	-0.679	-0.812	-0.406	-0.655
	Sig. (2-tailed)	0.872	0.288	0.288	0.873	0.397	0.094	0.050	0.425	0.158
	N	6	6	6	5	6	7	6	6	6
December	Correlation Coefficient						-0.436			
	Sig. (2-tailed)						0.328			
	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).

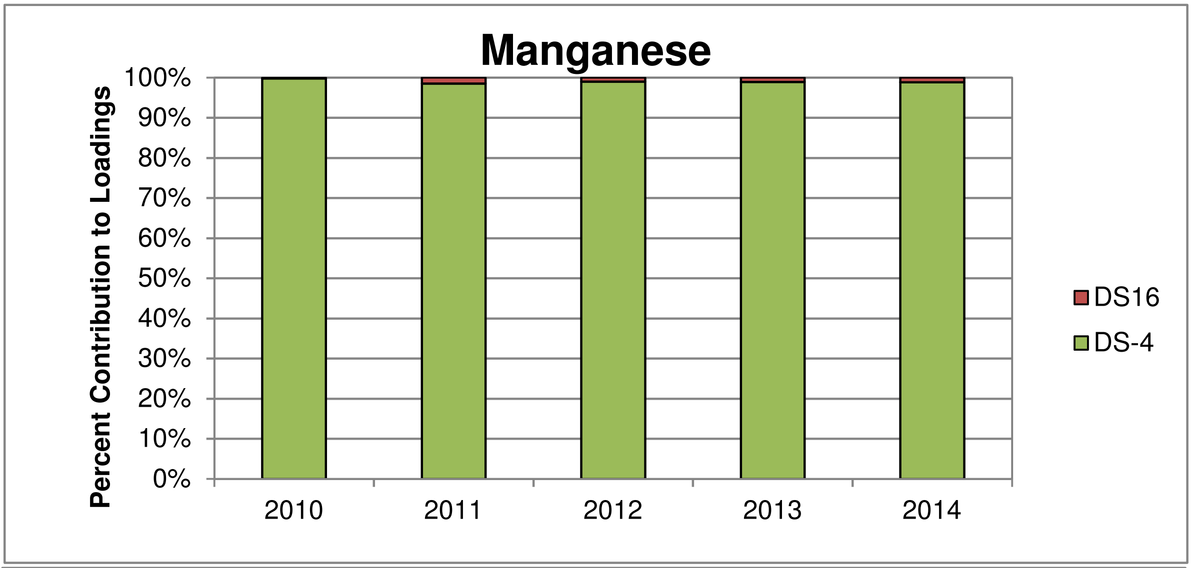
Significant trend where p<0.05.

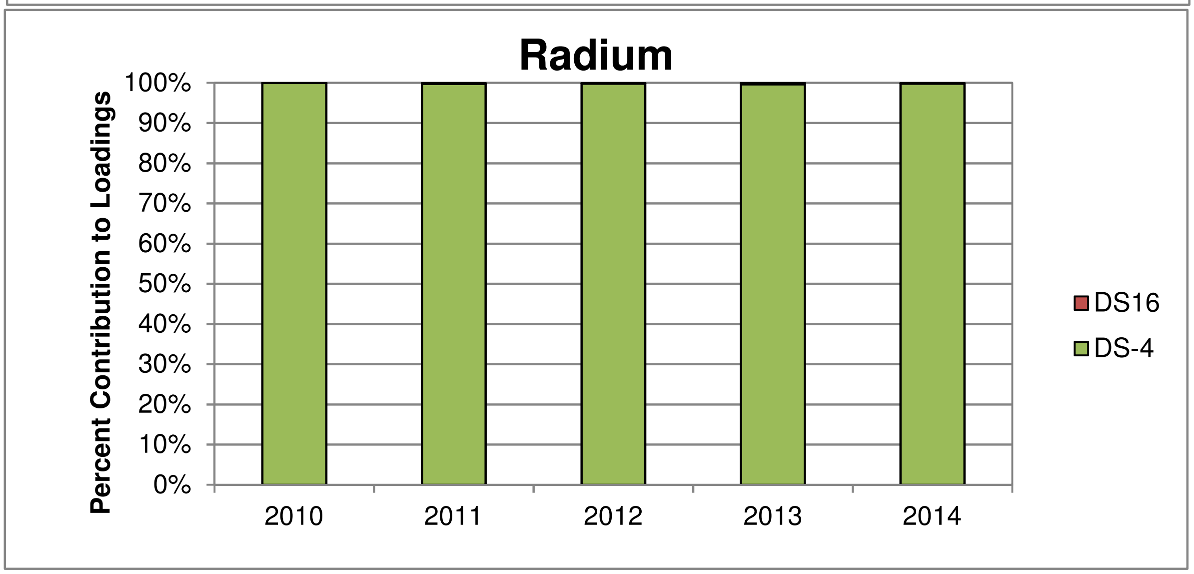


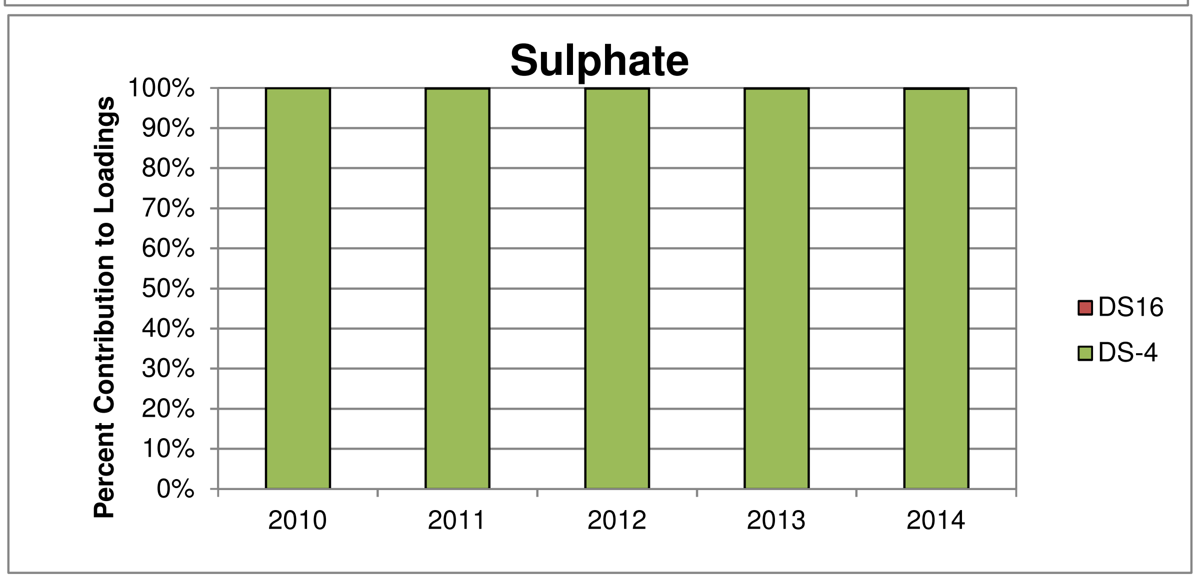




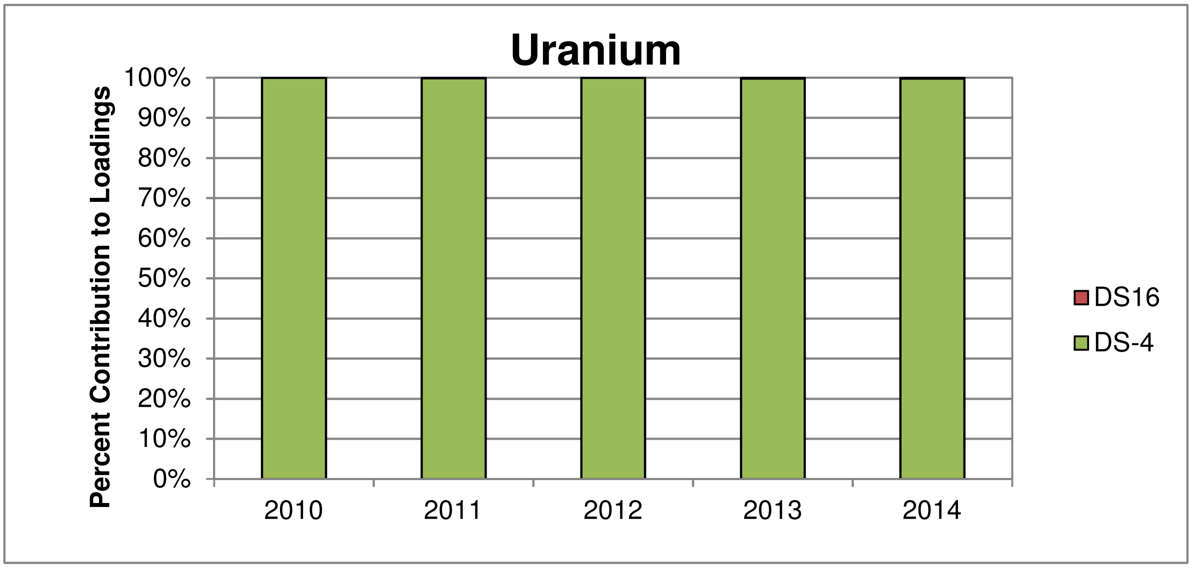
Appendix Figure D.4.1: Percent contribution to total Stanrock loads from TMA discharge points.



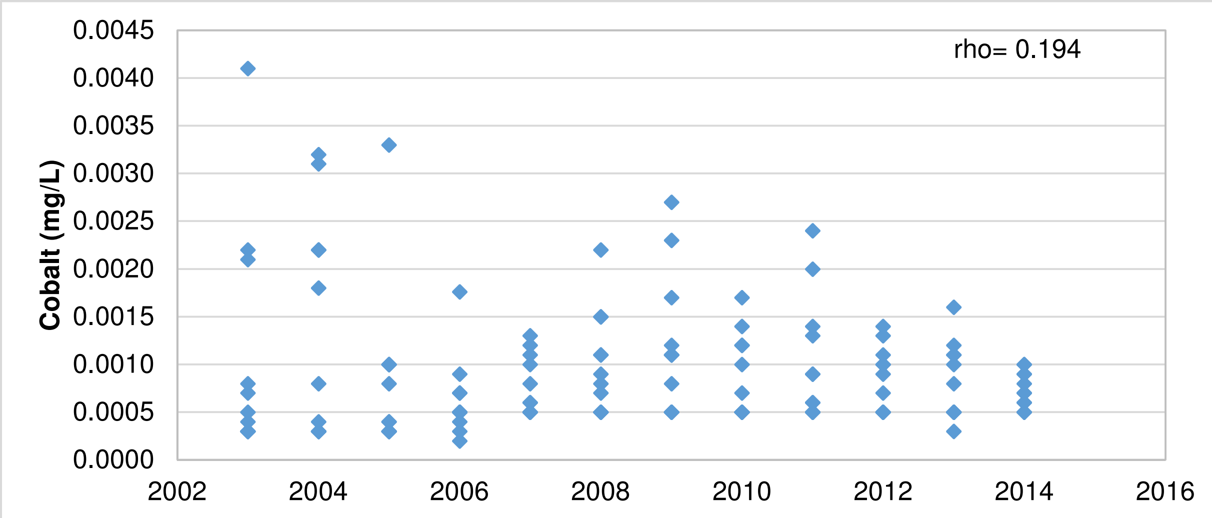


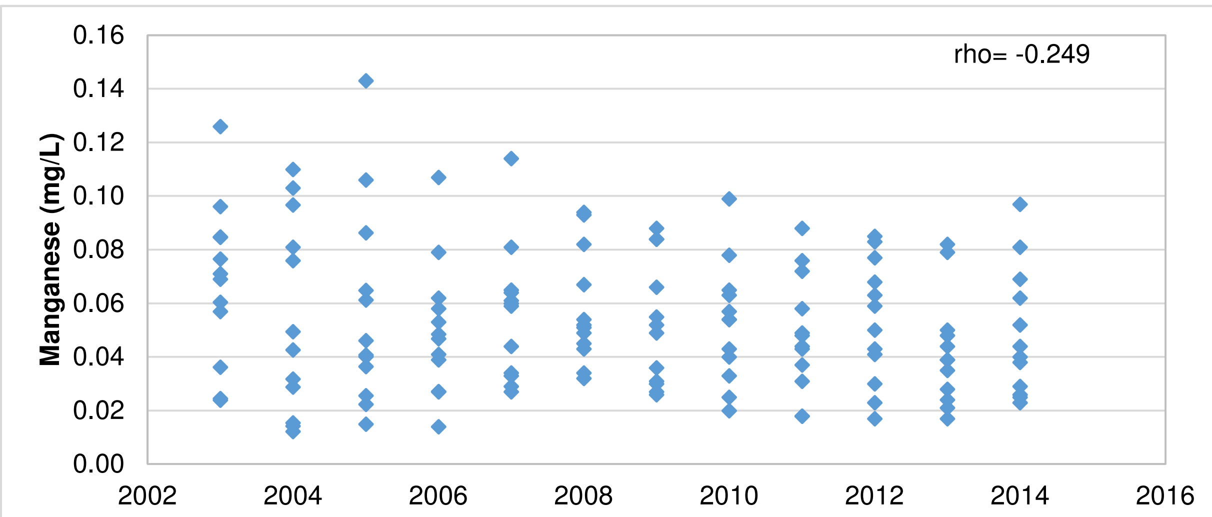


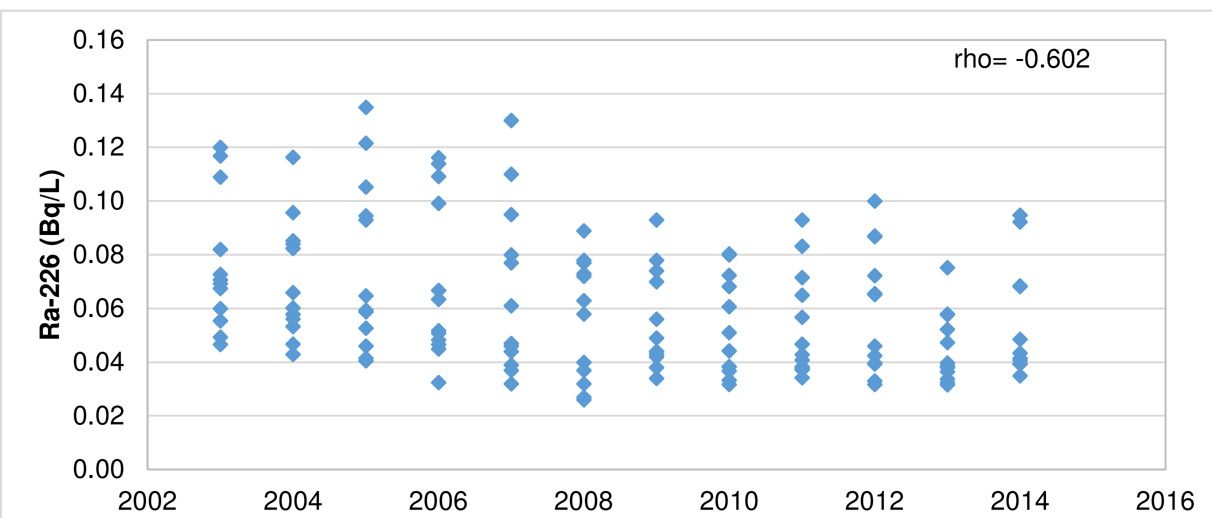
Appendix Figure D.4.1: Percent contribution to total Stanrock loads from TMA discharge points.



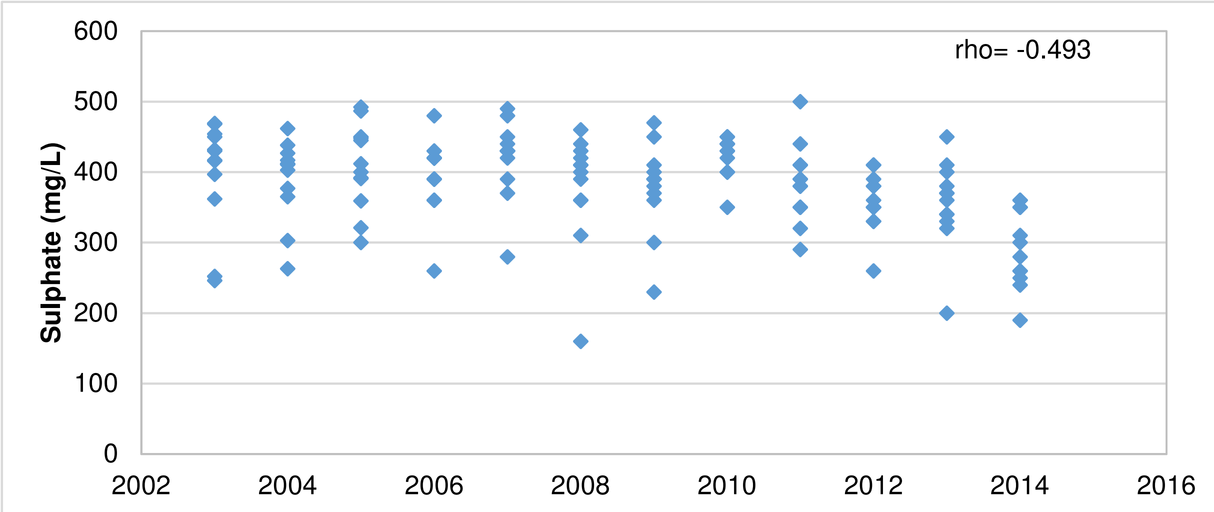
Appendix Figure D.4.1: Percent contribution to total Stanrock loads from TMA discharge points.

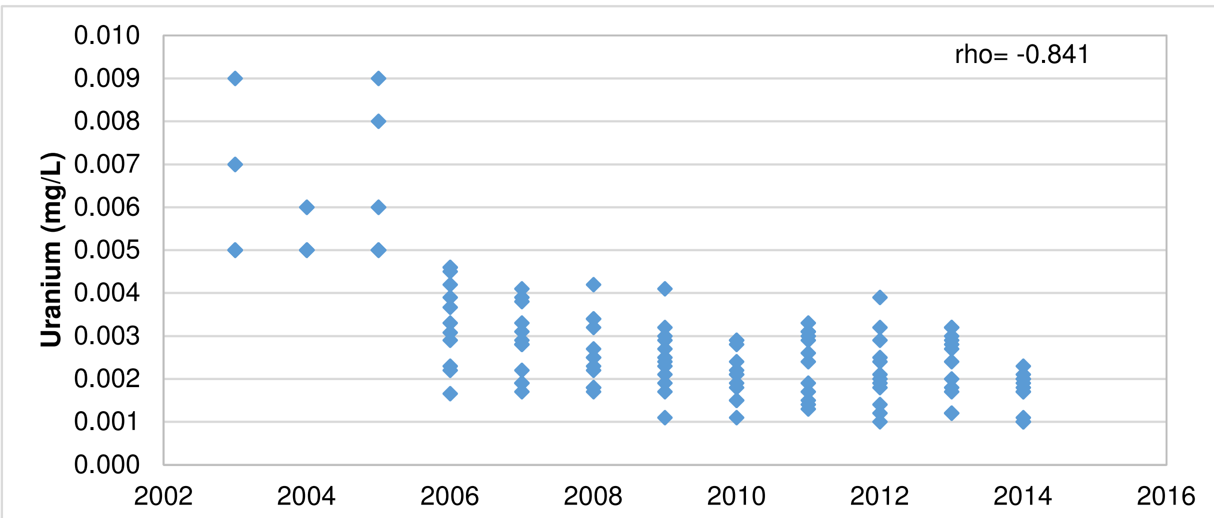




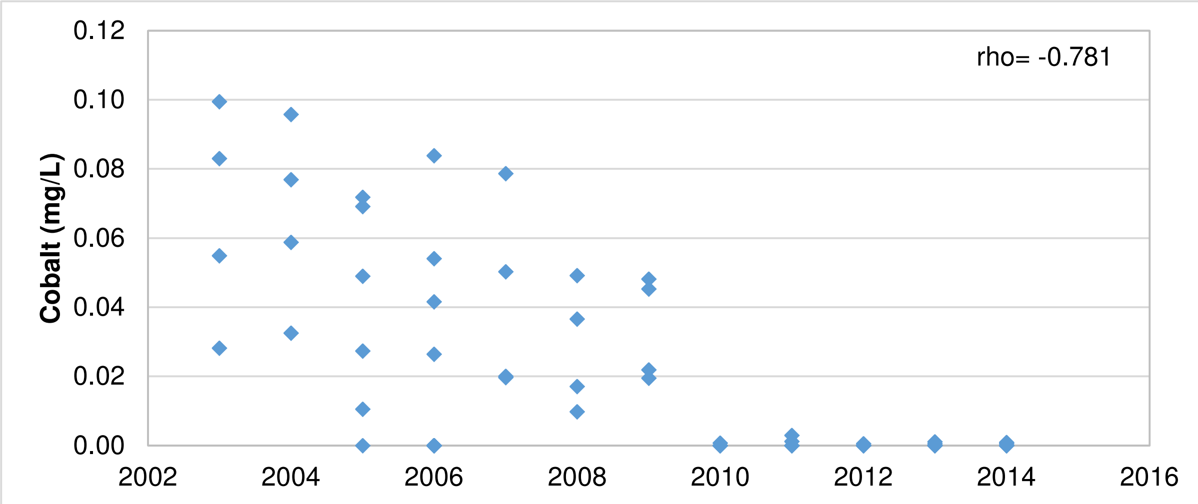


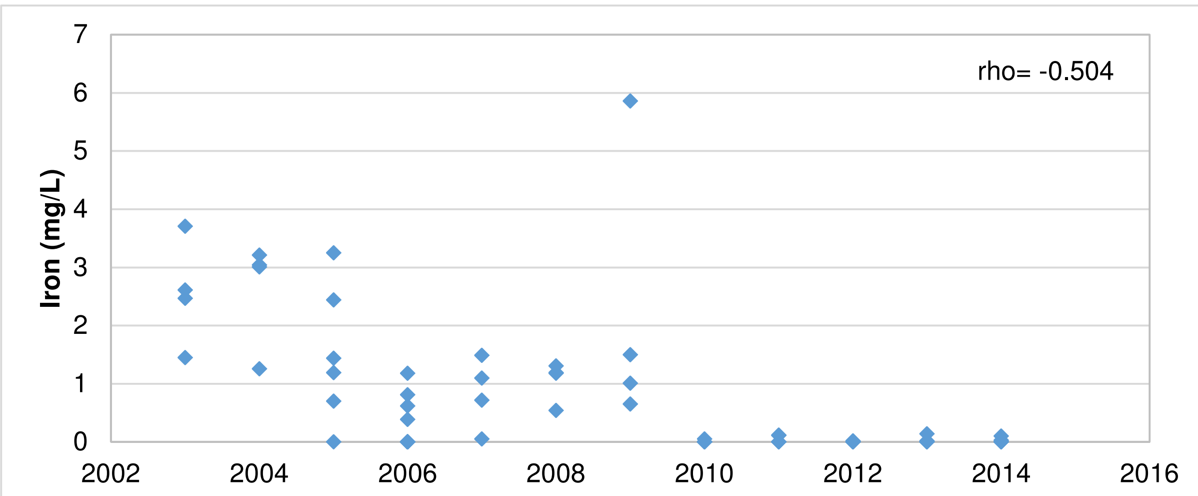
Appendix Figure D.4.2: Significant common (average) trends observed for cobalt, manganese, radium-226, sulphate and uranium over all seasons at Station DS-4, 2003 to 2014.

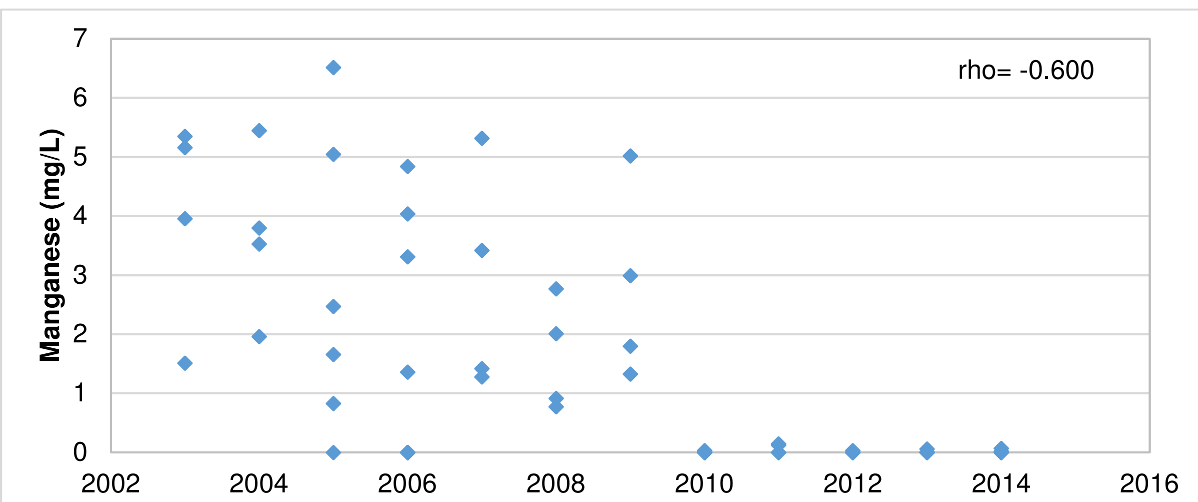




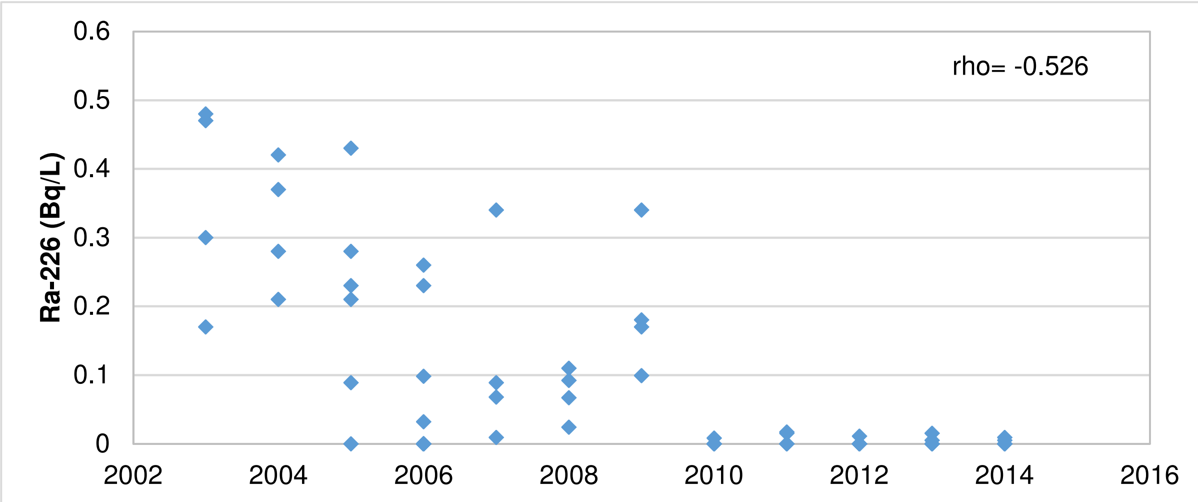
Appendix Figure D.4.2: Significant common (average) trends observed for cobalt, manganese, radium-226, sulphate and uranium over all seasons at Station DS-4, 2003 to 2014.

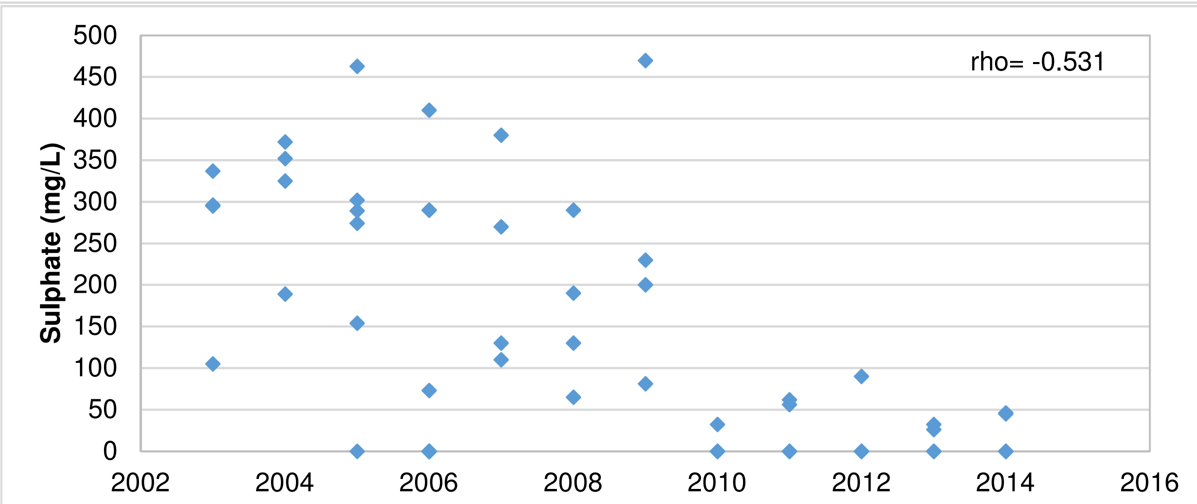




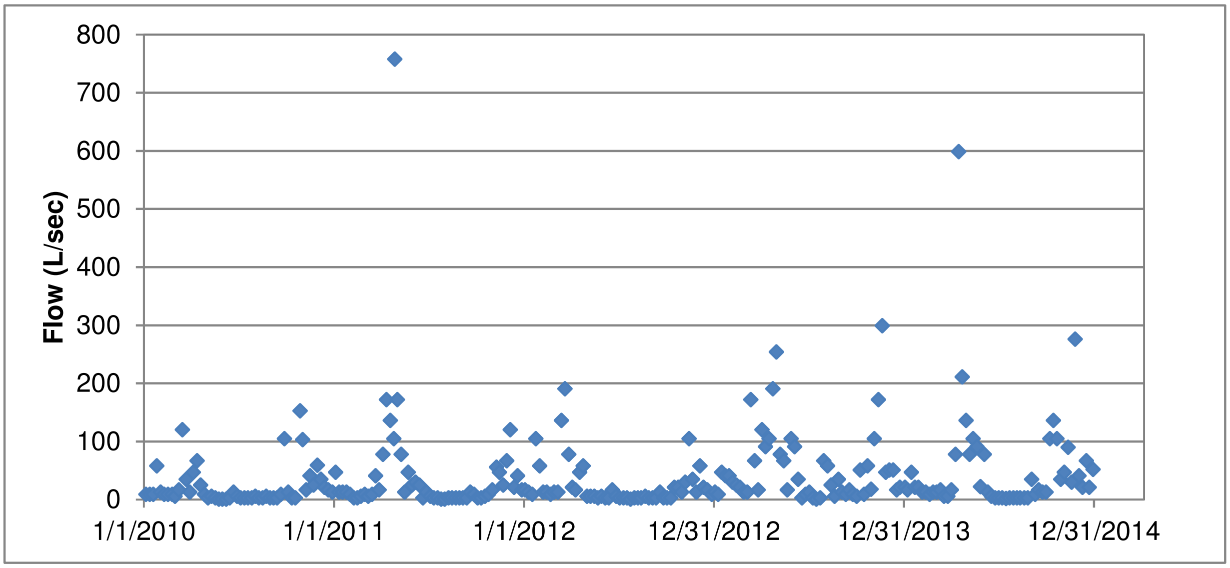


Appendix Figure D.4.3: Significant common (average) trends observed for cobalt, iron, manganese, radium-226 and sulphate over all seasons at Station DS-16, 2003 to 2014.

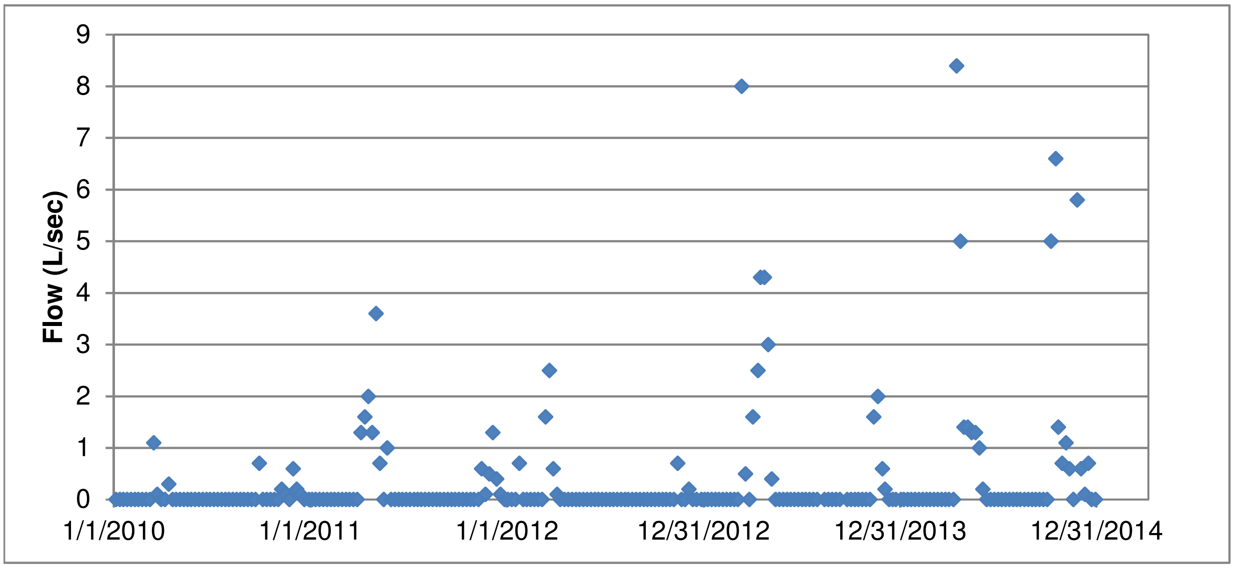




Appendix Figure D.4.3: Significant common (average) trends observed for cobalt, iron, manganese, radium-226 and sulphate over all seasons at Station DS-16, 2003 to 2014.



Appendix Figure D.4.4: Flows at station DS-4 from 2010 to 2014.



Appendix Figure D4.5: Flows at station DS-16 from 2010 to 2014.

APPENDIX D.5
Stanleigh TMA

Appendix Table D.5.1: Water quality at station CL-06 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	TSS [a] mg/L	U mg/L
8/18/2010	1.070	< 0.0005	0.03	157	0.039	7.6	0.230	140	1	0.0041
8/25/2010						8.0	0.160		1	
9/1/2010	0.680	< 0.0005	0.02	135	0.015	7.7	0.098	140	< 1	0.0027
9/8/2010						7.3	0.110		1	
9/15/2010						7.1	0.110		2	
9/22/2010						7.3	0.120		1	
9/29/2010						7.0	0.170		1	
10/6/2010	0.500	< 0.0005	0.08	147	0.142	7.2	0.120	130	< 1	0.0027
10/13/2010						7.2	0.150		1	
10/20/2010						7.3	0.180		1	
10/27/2010						7.2	0.160		2	
11/3/2010	0.520	< 0.0005	0.08	131	0.09	7.2	0.190	130	1	0.0023
11/10/2010						7.3	0.250		2	
11/18/2010						7.2	0.180		2	
11/24/2010						7.2	0.190		1	
12/1/2010	0.559	< 0.0005	0.06	138	0.076	7.0	0.230	120	1	0.0022
12/16/2010						7.4	0.160		< 1	
12/22/2010						7.5	0.230		2	
12/29/2010						7.5	0.210		2	
1/5/2011	0.603	< 0.0005	0.04	136	0.084		0.166	130	1	0.0022
1/12/2011						7.5	0.178		1	
1/19/2011						7.3	0.118		< 1	
1/26/2011						7.5	0.160		1	
5/5/2011						6.9	0.111		1	
5/11/2011						7.4	0.255		2	
5/18/2011						7.3	0.293		1	
5/25/2011	1.960	< 0.0005	0.05	132	0.103	7.7	0.311	110	< 1	0.0027
6/2/2011	0.919	0.0006	0.03	129	0.104	7.2	0.134	110	< 2	0.0025
6/8/2011						7.2	0.131		1	
6/15/2011						7.3	0.130		1	
6/22/2011						7.6	0.116		1	
6/29/2011						7.4	0.110		1	
7/6/2011	0.689	0.0006	0.04	133	0.112	7.5	0.154	110	1	0.0017
7/13/2011						7.4	0.158		1	
7/20/2011						7.3	0.162		1	
7/27/2011						7.3	0.168		2	
10/3/2011							0.034		< 1	
10/6/2011						6.9	0.036		< 1	
10/11/2011	0.988		0.03			7.2	0.224		2	
10/13/2011						7.4	0.169		1	
10/18/2011	0.631	< 0.0005	0.07	128	0.136	7.2	0.196	120	1	0.0022
10/20/2011	0.589		0.08			7.1	0.149		1	
10/25/2011	0.682		0.06			7.1	0.190		3	
10/27/2011	0.747		0.07			7.3	0.175		1	
11/1/2011	0.720	< 0.0005	0.06	131	0.084	7.3	0.213	100	1	0.0022
11/3/2011	0.623		0.06			7.3	0.189		< 1	
11/8/2011	0.638		0.07			7.1	0.241		< 1	
11/10/2011	0.777		0.07			7.2	0.221		2	
11/16/2011						7.2	0.277		2	
11/23/2011						7.2	0.227		2	
11/30/2011						7.2	0.222		1	
12/7/2011	0.729	< 0.0005	0.07	129	0.078	7.1	0.224	110	1	0.0025
12/14/2011						7.2	0.275		1	

Appendix Table D.5.1: Water quality at station CL-06 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	TSS [a] mg/L	U mg/L
12/20/2011						7.4	0.221		1	
3/12/2012							0.031			
3/28/2012						7.1	0.188		< 1	
4/4/2012						7.2	0.254		2	
4/12/2012	0.882	< 0.0005	0.08	125	0.100	7.2	0.227	100	2	0.0030
4/17/2012						7.7	0.224		1	
4/25/2012						7.3	0.180		1	
5/2/2012	0.662	0.0006	0.07	123	0.089	7.6	0.216	110	1	0.0021
5/9/2012						7.5	0.219		1	
5/16/2012						7.3	0.197		1	
5/23/2012						7.4	0.170		1	
5/30/2012						7.2	0.169		< 1	
6/6/2012	0.675	< 0.0005	0.02	128	0.07	7.3	0.154	100	< 1	0.0019
6/13/2012						7.3	0.170		< 1	
11/29/2012						7.3	0.102		1	
12/5/2012						7.2	0.220		1	
12/12/2012	0.754	< 0.0005	0.05	132	0.064	7.6	0.296	100	1	0.0029
12/19/2012						7.5	0.247		< 1	
2/28/2013						7.3	0.134		< 1	
3/6/2013	0.809	< 0.0005	0.02	137	0.064	7.3	0.213	100	1	0.0025
3/13/2013						7.2	0.203		1	
3/21/2013						7.2	0.163		1	
3/27/2013						7.4	0.227		< 1	
4/3/2013	0.566	< 0.0005	0.03	125	0.074	7.2	0.192	110	< 1	0.0020
4/10/2013						7.2	0.178		< 1	
4/17/2013						7.0	0.194		1	
4/24/2013						7.0	0.213		< 1	
5/1/2013	1.660	< 0.0005	0.08	114	0.072	7.2	0.326	94	< 1	0.0025
5/8/2013						7.3	0.322		< 1	
5/14/2013						7.5	0.315		1	
5/21/2013						7.3	0.349		1	
5/28/2013	2.330					7.6	0.335		1	
6/4/2013	2.460	< 0.0005	< 0.02	107	0.084	7.4	0.288	93	< 1	0.0024
6/11/2013	0.623					7.1	0.105		< 1	
6/18/2013						7.5	0.170		< 1	
6/25/2013						7.2	0.150		2	
7/2/2013	0.806	< 0.0005	0.03	103	0.081	7.5	0.202	96	< 1	0.0017
7/9/2013						7.5	0.194		< 1	
7/15/2013						7.4	0.137		2	
8/21/2013						7.4	0.117		< 1	
8/27/2013	1.490	< 0.0005	0.02	99.9	0.015	7.2	0.172	88	< 1	0.0022
9/3/2013						7.1	0.232		< 1	
9/10/2013	1.730	< 0.0005	0.05	105	0.019	7.3	0.235	88	1	0.0020
9/17/2013						7.3	0.278		< 1	
9/24/2013						7.6	0.139		1	
10/1/2013	0.721	< 0.0005	0.02	103	0.028	7.2	0.117	97	1	0.0015
10/8/2013						7.5	0.133		1	
10/15/2013						7.2	0.158		1	
10/22/2013						7.3	0.172		1	
10/29/2013						7.5	0.156		1	
11/5/2013	0.795	< 0.0005	0.06	102	0.051	7.3	0.214	93	1	0.0019
11/12/2013						7.5	0.276		1	
11/19/2013						7.2	0.264		1	

Appendix Table D.5.1: Water quality at station CL-06 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	TSS [a] mg/L	U mg/L
11/26/2013						7.4	0.319		< 1	
12/3/2013	1.930	< 0.0005	0.06	105	0.063	7.4	0.381	94	< 1	0.0024
12/10/2013	2.160					7.3	0.186		2	
12/16/2013	1.260					7.2	0.214		3	
12/18/2013						7.2	0.142			
12/20/2013						7.3	0.073			
12/23/2013	0.889					7.4	0.107		3	
1/2/2014	1.020					7.3	0.187		1	
1/8/2014	1.020	< 0.0005	0.04	106	0.062	7.3	0.199	86	2	0.0017
1/14/2014						7.3	0.156		2	
1/21/2014						7.6	0.187		2	
1/28/2014						7.3	0.177		2	
2/4/2014	0.634	< 0.0005	0.03	111	0.060	7.3	0.190	89	2	0.0015
2/11/2014						7.2	0.188		1	
2/18/2014						7.4	0.175		1	
2/25/2014						7.1	0.183		2	
3/4/2014	0.725	< 0.0005	0.02	104	0.061	7.2	0.218	93	2	0.0017
3/11/2014						7.3	0.210		3	
3/18/2014						7.1	0.151		1	
3/25/2014						7.2	0.187		2	
4/1/2014	0.786	< 0.0005	0.03	107	0.063	7.1	0.147	86	1	0.0015
4/8/2014						7.3	0.226		2	
4/15/2014						7.0	0.161		2	
4/22/2014						6.9	0.205		1	
4/29/2014						7.1	0.312		< 1	
5/5/2014	1.830	< 0.0005	0.15	86	0.098	7.1	0.334	66	< 1	0.0024
9/11/2014						7.3	0.124		< 1	
9/16/2014						7.3	0.201		< 1	
9/23/2014	1.870	< 0.0005	0.02	88	0.04	7.3	0.252	74	< 1	0.0027
9/30/2014						7.2	0.163		1	
10/7/2014	1.160	< 0.0005	0.04	88	0.082	7.3	0.158	73	1	0.0028
10/14/2014						7.1	0.212		1	
10/21/2014						7.2	0.244		1	
10/28/2014						7.2	0.273		< 1	
11/4/2014	1.890	< 0.0005	0.05	86	0.039	7.3	0.278	76	< 1	0.0017
11/11/2014						7.1	0.284		< 1	
11/18/2014						7.1	0.267		< 1	
11/25/2014						6.9	0.125		< 1	
12/2/2014	1.870	< 0.0005	0.04	87	0.043	7.1	0.253	79	< 1	0.0020
12/9/2014						7.2	0.366		< 1	
12/15/2014						7.0	0.289		< 1	
12/22/2014						7.2	0.329		< 1	
12/29/2014						7.1	0.351		< 1	
Number	48	35	42	35	35	146	149	35	146	35
Maximum	2.460	0.0006	0.15	157	0.142	8.0	0.381	140	3	0.0041
Minimum	0.500	< 0.0005	< 0.02	86	0.015	6.9	0.031	66	< 1	0.0015
Mean	1.055	< 0.0005	0.05	117	0.071	7.3	0.198	101	1	0.0023
St. Dev.	0.551	0.0000	0.03	19	0.031	0.2	0.067	19	0	0.0005
Median	0.791	< 0.0005	0.05	123	0.072	7.3	0.190	100	1	0.0022
10th Percentile	0.599	< 0.0005	0.02	88	0.032	7.1	0.118	77	1	0.0017
95th Percentile	2.090	0.0006	0.08	141	0.119	7.6	0.324	133	2	0.0029

[a] TOMP requirement

Appendix Table D.5.2: Summary of annual plant operations and discharge at Stanleigh , 2010-2014.

ITEM	2010	2011	2012	2013	2014
PLANT OPERATIONS[a]					
Operating Days	133	189	112	275	242
Maximum Daily Plant Flow (L/s @ CL-04)	460	510	500	550	560
Minimum Daily Plant Flow (L/s @ CL-04)	0	0	0	0	0
Monthly Average Daily Plant Flow (L/s @ CL-04)	393	442	395	465	453
Total Volume Treated (ML)	4,512	7,223	3,827	11,047	9,471
Barium Chloride Consumption					
Total (kg/yr)	15,609	22,950	12,200	39,907	35,450
Monthly Average (mg/L)	3.46	3.18	3.19	3.61	3.74
Lime Consumption					
Dry (tonne/yr)	7.0	8.3	5.2	13.7	11.8
Average (g/L)	0.002	0.001	0.001	0.001	0.001
EFFLUENT[b]					
Discharge Days	132	190	110	274	242
Maximum Daily Discharge Flow (L/s @ CL-06)	460	510	500	540	550
Minimum Daily Discharge Flow (L/s @ CL-06)	0	0	0	0	0
Monthly Average Daily Discharge Flow (L/s @ CL-06)	391	442	395	464	452
Total Annual Volume Discharged (ML)	4,459	7,256	3,757	10,989	9,455

ML - Million Litres

[a] Influent flows based on daily monitoring requirements as per TOMP

[b] Effluent flows based on weekly monitoring requirement as per SAMP

Appendix Table D.5.3: Mean annual discharge loadings from Stanleigh TMA, 2010 - 2014.

Station	Drainage Type	Mean Annual Discharge (m^3)		Barium (kg/yr)	Cobalt (kg/yr)	Iron (kg/yr)	Manganese (kg/yr)	Radium (MBq/yr)	Sulphate (kg/yr)	Uranium (kg/yr)
CL-06	Controlled Discharge	8,830,080	Mean	7,251	2.0	346	532.4	1,523	753,127	16
			S.D.	4,794	0.9	105	199.2	758	271,598	5.8
SR-06	Outlet of McCabe Lake	15,831,072	Mean	3,582				765	1,055,847	16
			S.D.	998.4				97	237,091	2.9

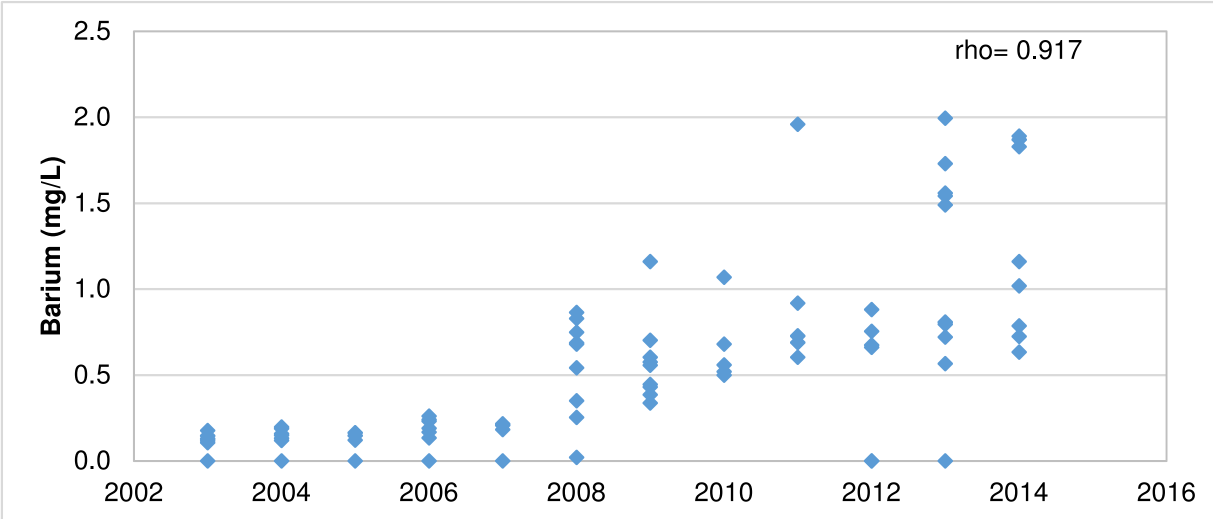
MBq/yr = Million Bequerels per year

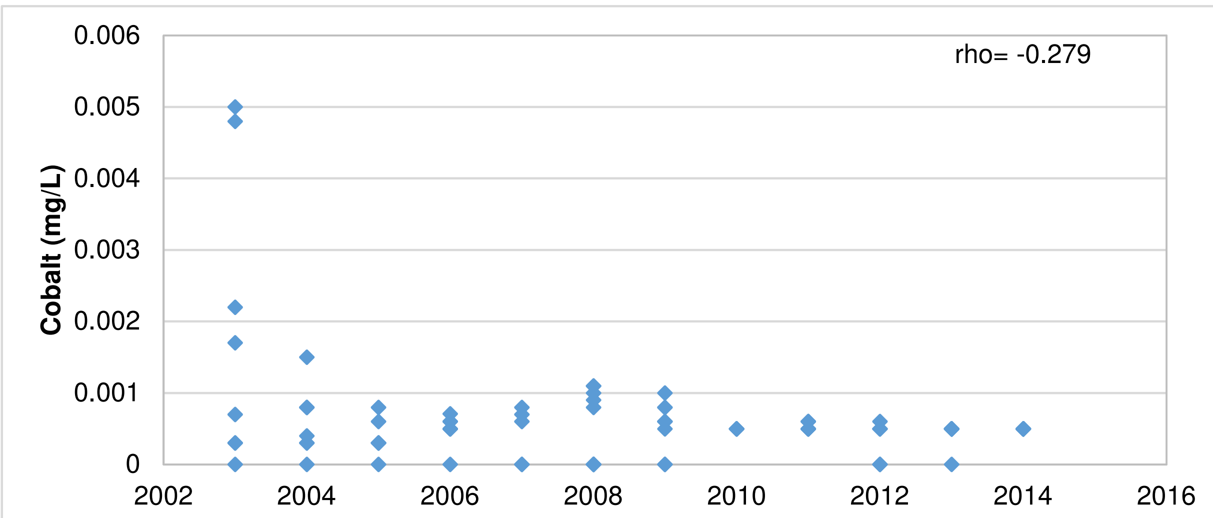
Appendix Table D.5.4: Summary of seasonal trends for station CL-06 from 2003-2014.

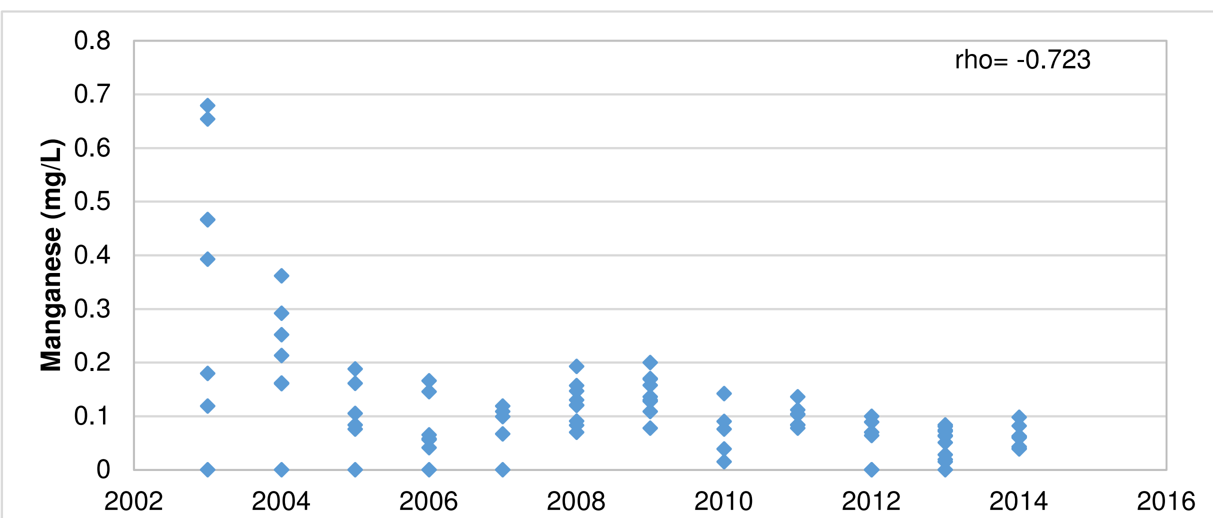
Month	Spearman's rho	Ba	Co	Fe	Hardness	Mn	pH	Ra	SO4	U
March	Correlation Coefficient	0.800	-0.775	-0.949		-0.800	-0.100	0.500	-1.000	-1.000
	Sig. (2-tailed)	0.200	0.225	0.051		0.200	0.873	0.391	0.000	0.000
	N	4	4	4		4	5	5	4	4
April	Correlation Coefficient	0.771	-0.894	-0.872		-0.714	-0.603	0.883	-0.371	-0.900
	Sig. (2-tailed)	0.072	0.041	0.054		0.111	0.086	0.002	0.468	0.037
	N	6	5	5		6	9	9	6	5
May	Correlation Coefficient	0.918	-0.839	0.433		-0.845	-0.355	0.900	-0.970	-0.943
	Sig. (2-tailed)	0.000	0.001	0.184		0.001	0.285	0.000	0.000	0.000
	N	11	11	11		11	11	11	11	11
June	Correlation Coefficient	0.867	-0.596	-0.080		-0.491	-0.251	0.721	-0.948	-0.924
	Sig. (2-tailed)	0.001	0.090	0.827		0.150	0.485	0.019	0.000	0.000
	N	10	9	10		10	10	10	10	10
July	Correlation Coefficient	0.881	-0.337	0.145		-0.524	0.595	0.143	-0.976	-0.945
	Sig. (2-tailed)	0.004	0.414	0.733		0.183	0.120	0.736	0.000	0.000
	N	8	8	8		8	8	8	8	8
August	Correlation Coefficient	0.964	-0.224	-0.306		-0.893	0.334	0.179	-0.964	-0.580
	Sig. (2-tailed)	0.000	0.718	0.504		0.007	0.465	0.702	0.000	0.172
	N	7	5	7		7	7	7	7	7
September	Correlation Coefficient	0.929	0.878	-0.364		-0.821	0.612	0.607	-1.000	-0.718
	Sig. (2-tailed)	0.003	0.021	0.423		0.023	0.144	0.148	0.000	0.069
	N	7	6	7		7	7	7	7	7
October	Correlation Coefficient	0.929	0.828	-0.214		-0.857	-0.426	0.893	-1.000	-0.595
	Sig. (2-tailed)	0.003	0.042	0.645		0.014	0.293	0.007	0.000	0.159
	N	7	6	7		7	8	7	7	7
November	Correlation Coefficient	1.000	-0.039	-0.146		-0.571	-0.479	0.567	-0.976	-0.850
	Sig. (2-tailed)	.	0.933	0.729		0.139	0.192	0.112	0.000	0.007
	N	8	7	8		8	9	9	8	8
December	Correlation Coefficient	0.983	-0.881	-0.824	-0.900	-0.817	-0.503	0.733	-1.000	-0.778
	Sig. (2-tailed)	0.000	0.002	0.006	0.037	0.007	0.138	0.016	0.000	0.014
	N	9	9	9	5	9	10	10	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).

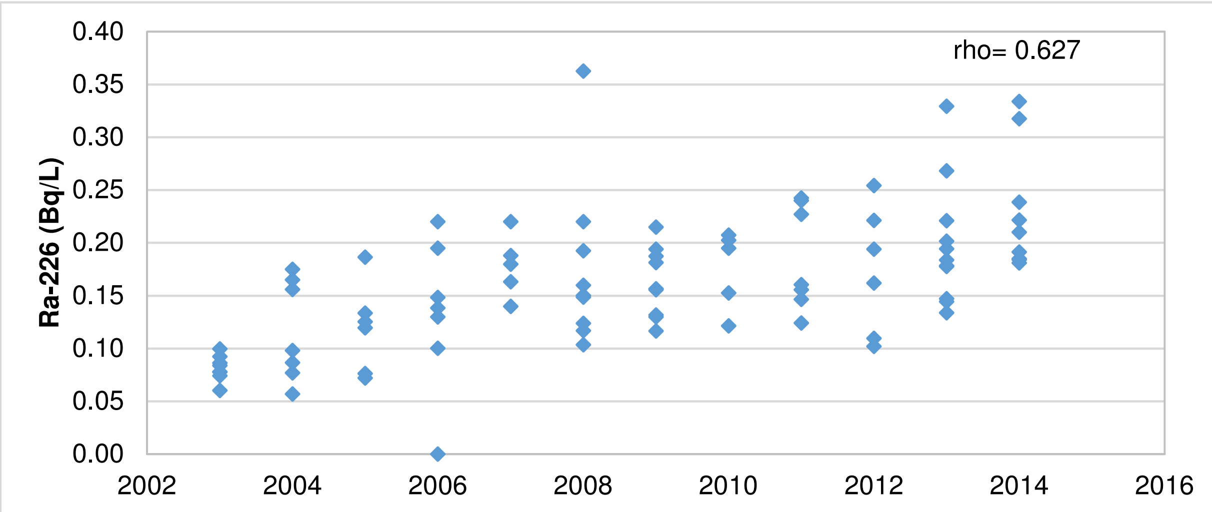
[grey box] Significant trend where p<0.05.

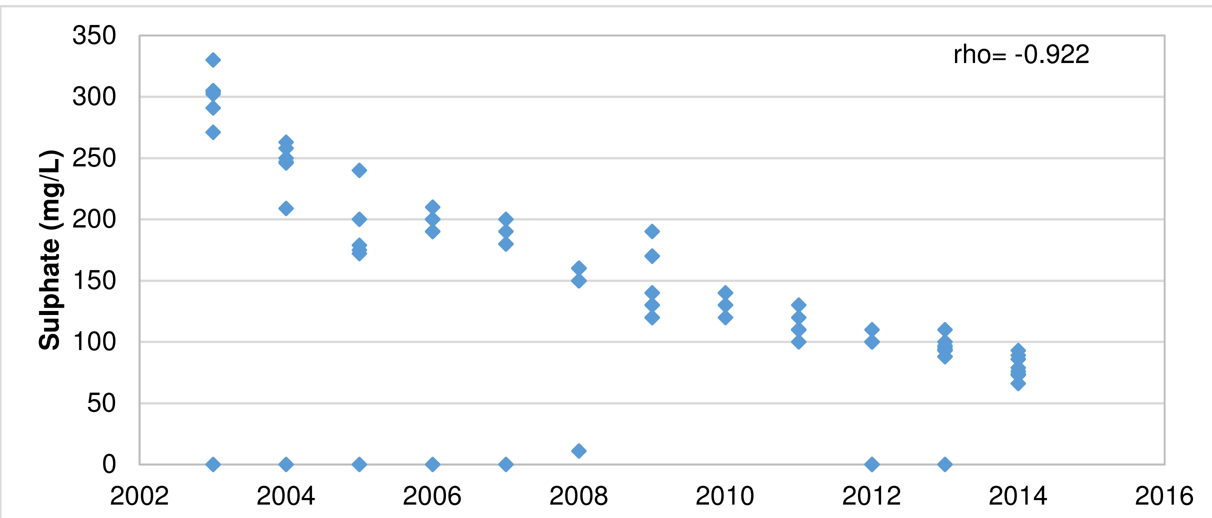




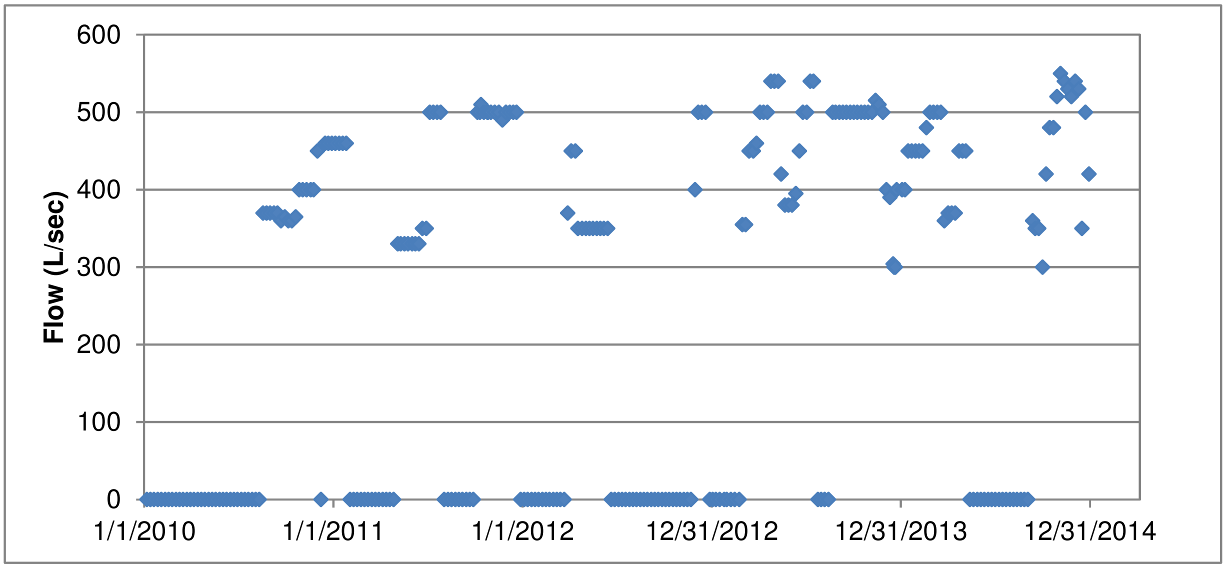


Appendix Figure D.5.1: Significant common (average) trends observed for barium cobalt, manganese, radium-226 and sulphate over all seasons at Station CL-06, 2003 to 2014.





Appendix Figure D.5.1: Significant common (average) trends observed for barium cobalt, manganese, radium-226 and sulphate over all seasons at Station CL-06, 2003 to 2014.



Appendix Figure D.5.2: Flows at station CL-06 from 2010 to 2014.

APPENDIX D.6
Milliken TMA

Appendix Table D.6.1: Water quality at station MPE from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	U mg/L
1/6/2010	0.012	0.0008	0.8	30	0.136	6.6	0.025	15.0	0.0118
2/17/2010	0.012	0.0009	0.91	30	0.105	6.1	0.046	17.0	0.0033
3/15/2010	0.011	0.0019	0.61	21.6	0.285	6.4	0.034	11.0	0.0047
4/21/2010	0.012	< 0.0005	0.49	26.1	0.043	6.7	0.036	13.0	0.0030
5/17/2010	0.012	< 0.0005	0.56	30.9	0.047	7.0	0.035	15.0	0.0026
5/25/2010	0.015	0.0007	0.88	35.7	0.205	6.8	0.057	14.0	0.0027
6/22/2010	0.012	< 0.0005	2.48	34.5	0.069	6.9	0.033	7.8	0.0021
7/19/2010	0.016	0.0008	3.96	38.8	0.364	6.3	0.075	7.6	0.0020
8/16/2010	0.02	0.0008	4.1	41.7	0.474	6.4	0.077	3.5	0.0015
9/20/2010	0.011	< 0.0005	2.27	33.7	0.086	6.5	0.027	7.1	0.0013
10/18/2010	0.013	< 0.0005	1.27	28.3	0.053	6.2	0.025	11.0	0.0024
11/15/2010	0.012	< 0.0005	0.7	31	0.043	7.1	0.014	22.0	0.0077
12/20/2010	0.012	0.0007	0.75	33.2	0.112	6.7	0.023	13.0	0.0165
1/17/2011	0.013	0.0009	1.25	33.6	0.151	6.6	0.030	15.0	0.0111
2/23/2011	0.013	0.0011	1.61	37.1	0.185	6.6	0.031	15.0	0.0111
3/21/2011	0.013	0.0012	1.26	34.2	0.18	6.5	0.030	15.0	0.0107
4/18/2011	0.008	0.0005	0.38	18.5	0.048	6.7	0.019	9.0	0.0064
5/16/2011	0.011	< 0.0005	0.63	25.4	0.028	7.1	0.026	11.0	0.0030
6/20/2011	0.014	0.0008	1.99	33.1	0.204	6.6	0.066	10.0	0.0036
7/18/2011	0.012	0.0005	3.09	36.9	0.196	6.5	0.045	7.3	0.0022
8/15/2011	0.018	0.0009	6.89	41.3	0.454	6.6	0.113	3.1	0.0019
9/20/2011	0.013	< 0.0005	5.23	41.6	0.14	6.7	0.042	3.4	0.0017
10/18/2011	0.013	< 0.0005	2.98	35.7	0.154	7.1	0.033	9.9	0.0012
11/21/2011	0.011	< 0.0005	0.48	27.9	0.033	6.8	0.022	15.0	0.0034
12/19/2011	0.011	0.0006	0.47	29.1	0.061	6.6	0.018	14.0	0.0073
1/16/2012	0.012	0.0007	0.83	31.3	0.127	6.5	0.030	14.0	0.0075
2/21/2012	0.011	0.0006	0.65	30.3	0.082	7.1	0.019	13.0	0.0071
3/21/2012	0.008	0.0006	0.26	17.2	0.037	6.5	0.015	8.2	0.0039
4/16/2012	0.013	< 0.0005	0.51	35.2	0.044	7.2	0.035	17.0	0.0123
5/23/2012	0.014	< 0.0005	0.86	36.1	0.054	6.8	0.043	13.0	0.0034
6/19/2012	0.01	< 0.0005	2.58	35.3	0.12	6.9	0.050	11.0	0.0026
7/16/2012	0.017	0.0007	5.27	41.9	0.324	6.6	0.091	8.4	0.0025
8/27/2012	0.013	< 0.0005	4.28	45.6	0.084	6.7	0.040	5.5	0.0015
9/17/2012	0.017	< 0.0005	5.47	54.8	0.246	6.8	0.095	6.2	0.0024
10/17/2012	0.014	< 0.0005	1.81	40.2	0.044	7.2	0.052	16.0	0.0018
11/19/2012	0.014	0.0006	0.52	38.8	0.055	6.5	0.037	24.0	0.0059
12/18/2012	0.013	0.0009	0.67	36.1	0.151	6.8	0.028	18.0	0.0087
1/21/2013	0.013	0.0009	0.56	32.2	0.079	6.8	0.031	19.0	0.0042
2/25/2013	0.011	0.0006	0.65	31.4	0.087	6.6	0.028	15.0	0.0127
3/20/2013	0.012	0.0006	0.3	30.4	0.046	6.9	0.021	13.0	0.0169
4/16/2013	0.01	0.0006	0.24	27.3	0.036	6.9	0.017	12.0	0.0122
5/22/2013	0.011	0.0013	0.77	26.5	0.055	6.9	0.049	13.0	0.0025
6/19/2013	0.012	< 0.0005	1.47	28.1	0.086	6.5	0.045	10.0	0.0039
7/15/2013	0.013	0.0007	3.91	31.5	0.206	6.9	0.080	7.7	0.0032
8/22/2013	0.01	< 0.0005	1.05	28.3	0.041	6.4	0.023	10.0	0.0031
9/18/2013	0.013	< 0.0005	2.04	28.9	0.086	6.4	0.035	7.8	0.0029
10/22/2013	0.011	< 0.0005	0.99	26.6	0.048	6.9	0.023	9.8	0.0027
11/11/2013	0.01	< 0.0005	0.37	25.3	0.025	7.5	0.009	9.2	0.0098
12/16/2013	0.011	0.0009	0.63	25.2	0.116	6.5	0.017	11.0	0.0043
1/20/2014	0.01	0.0011	1.03	26	0.146	6.9	0.024	13.0	0.0046
2/20/2014	0.012	0.0011	1.2	33.2	0.168	6.5	0.029	13.0	0.0089

Appendix Table D.6.1: Water quality at station MPE from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	U mg/L
3/17/2014	0.014	0.0012	1.31	34.2	0.188	6.0	0.029	14.0	0.0058
4/22/2014	0.009	< 0.0005	0.23	22.7	0.033	6.7	0.017	8.8	0.0084
5/20/2014	0.009	< 0.0005	0.28	20.5	0.023	6.6	0.016	8.8	0.0055
6/16/2014	0.014	< 0.0005	1.62	33.2	0.096	6.7	0.050	11.0	0.0025
7/23/2014	0.014	< 0.0005	4	40.4	0.141	6.6	0.048	8.9	0.0022
8/18/2014	0.013	< 0.0005	3.74	35.3	0.253	6.6	0.055	5.5	0.0020
9/16/2014	0.012	< 0.0005	1.7	24.9	0.089	6.5	0.026	8.0	0.0018
10/20/2014	0.009	< 0.0005	0.31	19.2	0.025	6.8	0.022	7.2	0.0061
11/19/2014	0.01	0.0006	0.51	26.1	0.077	6.8	0.018	11.0	0.0064
12/15/2014	0.011	0.0006	0.59	27.1	0.069	6.5	0.015	10.0	0.0082
Number	61	61	61	61	61	61	61	61	61
Maximum	0.02	0.0019	6.89	54.8	0.474	7.5	0.113	24.0	0.0169
Minimum	0.008	< 0.0005	0.23	17.2	0.023	6.0	0.009	3.1	0.0012
Mean	0.012	0.0007	1.63	31.8	0.122	6.7	0.037	11.4	0.0053
St. Dev.	0.002	0.0003	1.57	6.9	0.100	0.3	0.021	4.2	0.0039
Median	0.012	0.0006	0.91	31.4	0.086	6.7	0.030	11.0	0.0036
10th Percentile	0.010	< 0.0005	0.37	24.9	0.036	6.4	0.017	7.1	0.0018
95th Percentile	0.017	0.0012	5.23	41.7	0.324	7.1	0.080	18.0	0.0123

Appendix Table D.6.2: Mean annual discharge and seepage loadings from Milliken TMA, 2010 - 2014.

Station	Drainage Type	Mean Annual Discharge (m^3)		Barium (kg/yr)	Cobalt (kg/yr)	Iron (kg/yr)	Manganese (kg/yr)	Radium (MBq/yr)	Sulphate (kg/yr)	Uranium (kg/yr)
SC-01	Westner Lake Outlet	1,135,296	Mean	20		119		11	28,824	0.3
			S.D.	14		25		12	4,459	0.0
MPE	Discharge	6,496,416	Mean	80	3.7	10,581	789	239	74,018	35
			S.D.	5	0.4	2,920	216	41	7,488	4.5
M-01	Sheriff Creek Park Dam	8,956,224	Mean	158		6,060		178	111,609	31
			S.D.	22		1,126		44	11,791	5.1

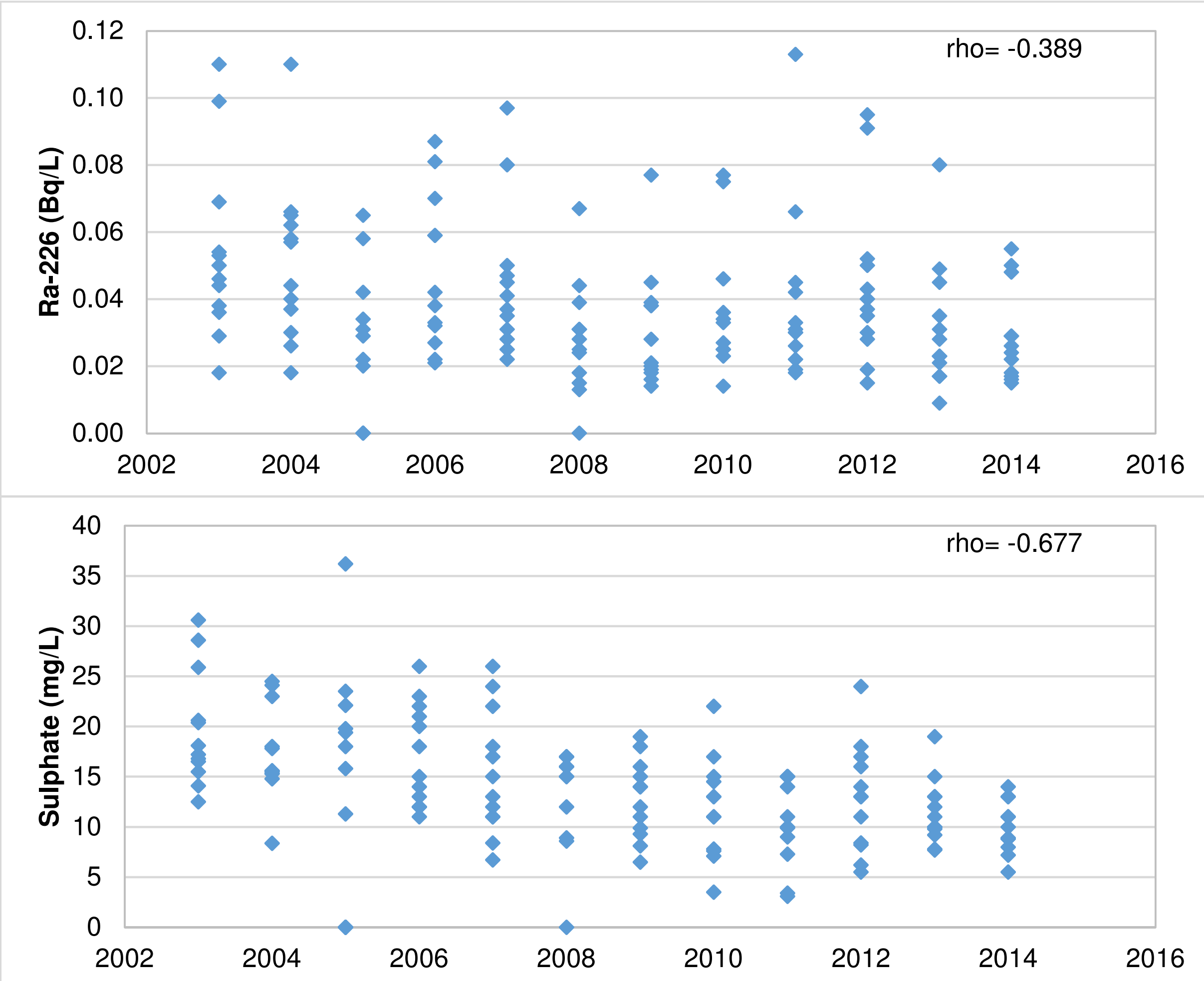
MBq/yr = Million Bequerels per year

Appendix Table D.6.3: Summary of seasonal trends for station MPE from 2003-2014.

Month	Spearman's rho	Ba	Co	Fe	Hardness	Mn	pH	Ra	SO4	U
January	Correlation Coefficient	-0.263	-0.291	-0.119	-0.300	-0.147	0.637	-0.404	-0.714	-0.536
	Sig. (2-tailed)	0.409	0.359	0.712	0.624	0.649	0.026	0.192	0.009	0.089
	N	12	12	12	5	12	12	12	12	11
February	Correlation Coefficient	-0.516	-0.528	-0.256	0.400	-0.343	0.105	-0.396	-0.952	-0.318
	Sig. (2-tailed)	0.086	0.078	0.422	0.505	0.276	0.744	0.202	0.000	0.340
	N	12	12	12	5	12	12	12	12	11
March	Correlation Coefficient	-0.439	-0.554	-0.287	0.359	-0.266	-0.284	-0.644	-0.851	-0.301
	Sig. (2-tailed)	0.153	0.062	0.366	0.553	0.404	0.371	0.024	0.000	0.341
	N	12	12	12	5	12	12	12	12	12
April	Correlation Coefficient	-0.120	-0.366	0.224	0.100	0.056	0.018	-0.443	-0.275	0.406
	Sig. (2-tailed)	0.711	0.241	0.484	0.873	0.863	0.957	0.149	0.388	0.244
	N	12	12	12	5	12	12	12	12	10
May	Correlation Coefficient	-0.226	0.818	0.399	-0.500	-0.042	-0.456	-0.410	-0.947	0.000
	Sig. (2-tailed)	0.480	0.001	0.199	0.391	0.897	0.136	0.186	0.000	1.000
	N	12	12	12	5	12	12	12	12	9
June	Correlation Coefficient	-0.196	-0.443	0.035	-0.300	-0.308	-0.316	-0.133	-0.770	-0.067
	Sig. (2-tailed)	0.541	0.149	0.914	0.624	0.331	0.317	0.680	0.003	0.865
	N	12	12	12	5	12	12	12	12	9
July	Correlation Coefficient	0.711	0.274	0.236	0.100	0.391	-0.075	0.027	-0.806	0.343
	Sig. (2-tailed)	0.014	0.415	0.484	0.873	0.235	0.816	0.936	0.003	0.366
	N	11	11	11	5	11	12	11	11	9
August	Correlation Coefficient	0.239	-0.256	-0.264	-0.600	-0.159	-0.039	-0.150	-0.592	0.574
	Sig. (2-tailed)	0.480	0.446	0.433	0.285	0.640	0.910	0.659	0.055	0.106
	N	11	11	11	5	11	11	11	11	9
September	Correlation Coefficient	0.351	0.804	0.067	-0.600	0.195	-0.383	-0.394	-0.624	0.418
	Sig. (2-tailed)	0.320	0.005	0.855	0.285	0.590	0.244	0.260	0.054	0.262
	N	10	10	10	5	10	11	10	10	9
October	Correlation Coefficient	-0.115	0.866	-0.173	-0.600	-0.509	-0.102	-0.573	-0.445	0.594
	Sig. (2-tailed)	0.736	0.001	0.612	0.285	0.110	0.766	0.066	0.170	0.092
	N	11	11	11	5	11	11	11	11	9
November	Correlation Coefficient	-0.221	0.539	0.427	-0.600	0.112	0.014	-0.634	-0.475	0.255
	Sig. (2-tailed)	0.489	0.070	0.167	0.285	0.729	0.965	0.027	0.119	0.450
	N	12	12	12	5	12	12	12	12	11
December	Correlation Coefficient	0.459	-0.113	0.564	-0.600	0.273	-0.706	-0.498	-0.663	0.063
	Sig. (2-tailed)	0.133	0.725	0.056	0.285	0.391	0.010	0.099	0.019	0.845
	N	12	12	12	5	12	12	12	12	12

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).

Significant trend where $p<0.05$.



Appendix Figure D.6.1: Significant common (average) trends observed for radium-226 and sulphate over all seasons at Station MPE, 2003 to 2014.

APPENDIX D.7
Lacnor/Nordic TMA

Appendix Table D.7.1: Water quality at station N-12 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	U mg/L
1/7/2010	0.027	0.0015	0.75	443	0.151	6.7	0.098	450	0.0020
2/3/2010	0.033	0.0016	0.92	505	0.187	6.7	0.110	510	0.0028
3/1/2010	0.035	0.0021	1.90	602	0.236	6.8	0.140	610	0.0031
4/5/2010	0.031	0.0014	0.48	541	0.143	7.0	0.096	510	0.0025
5/3/2010	0.027	0.0014	0.33	675	0.185	7.1	0.098	690	0.0030
6/7/2010	0.027	0.0009	0.26	855	0.127	7.2	0.071	780	0.0032
7/5/2010	0.025	0.0009	0.07	1630	0.132	7.0	0.083	810	0.0023
8/3/2010	0.043	0.0010	0.53	743	0.152	7.0	0.180	710	0.0025
9/7/2010	0.055	0.0008	0.52	714	0.127	7.0	0.170	720	0.0026
10/4/2010	0.024	0.0010	0.69	380	0.089	6.7	0.084	390	0.0019
11/1/2010	0.022	0.0011	0.64	380	0.069	6.9	0.067	330	0.0020
12/7/2010	0.017	0.0007	0.48	321	0.068	7.1	0.053	310	0.0021
1/5/2011	0.026	0.0011	0.77	336	0.148	6.9	0.078	330	0.0019
2/2/2011	0.028	0.0012	0.80	376	0.155	6.9	0.096	390	0.0020
3/9/2011	0.027	0.0027	1.04	460	0.143	6.8	0.081	450	0.0031
4/6/2011	0.031	0.0014	1.13	434	0.171	7.2	0.114	410	0.0027
5/4/2011	0.017	0.0012	0.47	219	0.083	6.9	0.047	200	0.0022
6/6/2011	0.029	0.0019	0.61	494	0.131	7.0	0.106	460	0.0026
7/6/2011	0.032	0.0015	0.42	651	0.159	6.9	0.105	580	0.0021
8/3/2011	0.025	0.0013	0.33	803	0.127	7.0	0.070	760	0.0024
9/7/2011	0.051	0.0023	1.06	632	0.245	6.8	0.176	570	0.0024
10/5/2011	0.036	0.0020	0.73	833	0.196	6.8	0.114	810	0.0026
11/2/2011	0.027	0.0022	1.17	690	0.206	6.6	0.080	650	0.0024
12/7/2011	0.018	0.0011	0.53	329	0.104	7.0	0.062	280	0.0015
1/4/2012	0.031	0.0014	1.25	335	0.165	6.5	0.075	320	0.0019
2/1/2012	0.029	0.0011	0.86	347	0.143	7.0	0.110	320	0.0033
3/14/2012	0.025	0.0015	1.03	260	0.110	6.7	0.081	230	0.0030
4/4/2012	0.022	0.0022	1.58	460	0.178	7.0	0.085	410	0.0031
5/2/2012	0.029	0.0027	0.73	661	0.198	7.1	0.137	630	0.0036
6/6/2012	0.047	0.0026	0.59	784	0.201	7.2	0.180	710	0.0032
7/4/2012	0.018	0.0009	0.88	222	0.192	6.8	0.039	220	0.0009
8/1/2012	0.022	0.0012	0.27	979	0.129	6.9	0.056	950	0.0019
9/5/2012	0.02	0.0011	0.26	1100	0.126	7.1	0.071	990	0.0016
10/3/2012	0.028	0.0019	0.49	916	0.206	7.0	0.088	870	0.0018
11/7/2012	0.042	0.0026	1.36	656	0.297	6.8	0.098	670	0.0012
12/5/2012	0.026	0.0033	1.35	560	0.247	6.6	0.072	550	0.0022
1/2/2013	0.025	0.0020	0.70	329	0.185	6.9	0.077	330	0.0012
2/6/2013	0.031	0.0025	0.80	422	0.211	6.6	0.088	430	0.0015
3/6/2013	0.035	0.0023	1.23	445	0.250	7.0	0.094	390	0.0015
4/3/2013	0.023	0.0014	0.87	290	0.152	7.2	0.084	250	0.0040
5/1/2013	0.018	0.0008	0.43	84.3	0.058	7.0	0.034	72	0.0033
6/5/2013	0.018	0.0017	0.99	338	0.180	7.2	0.061	330	0.0023
7/3/2013	0.031	0.0020	1.07	598	0.253	6.8	0.133	550	0.0025
8/14/2013	0.029	0.0021	1.54	522	0.195	7.1	0.116	480	0.0037
9/4/2013	0.035	0.0016	1.51	609	0.180	6.7	0.133	560	0.0034
10/2/2013	0.043	0.0021	1.27	700	0.234	7.1	0.139	680	0.0032
11/13/2013	0.019	0.0011	0.61	302	0.092	6.9	0.062	290	0.0027
12/4/2013	0.025	0.0013	1.00	330	0.145	7.2	0.066	290	0.0035
1/8/2014	0.045	0.0017	1.38	418	0.190	7.1	0.110	360	0.0033
2/5/2014	0.033	0.0020	1.37	459	0.193	6.9	0.102	430	0.0035
3/5/2014	0.028	0.0017	1.16	444	0.187	6.6	0.082	400	0.0030

Appendix Table D.7.1: Water quality at station N-12 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	U mg/L
4/2/2014	0.033	0.0019	1.20	468	0.186	6.8	0.089	420	0.0031
5/6/2014	0.016	0.0012	0.42	207	0.087	6.5	0.046	170	0.0020
6/4/2014	0.025	0.0013	0.64	379	0.155	6.6	0.104	340	0.0027
7/2/2014	0.031	0.0013	0.47	567	0.141	7.0	0.103	520	0.0033
8/6/2014	0.027	0.0015	0.41	729	0.176	7.1	0.080	620	0.0030
9/2/2014	0.032	0.0017	0.85	468	0.155	7.1	0.106	420	0.0031
10/1/2014	0.024	0.0020	0.75	611	0.171	7.0	0.086	570	0.0032
11/5/2014	0.014	0.0011	0.76	299	0.098	6.9	0.058	290	0.0028
12/3/2014	0.014	0.0009	0.61	212	0.112	6.7	0.041	210	0.0032
Number	60	60	60	60	60	60	60	60	60
Maximum	0.055	0.0033	1.9	1630	0.297	7.2	0.180	990	0.004
Minimum	0.014	0.0007	0.07	84	0.058	6.5	0.034	72	0.0009
Mean	0.028	0.0016	0.82	526	0.162	6.9	0.093	483	0.0026
St. Dev.	0.009	0.0006	0.39	254	0.051	0.2	0.034	203	0.0007
Median	0.027	0.0015	0.76	464	0.157	6.9	0.087	440	0.0026
10th Percentile	0.018	0.0009	0.40	287	0.092	6.6	0.056	248	0.0016
95th Percentile	0.045	0.0026	1.51	919	0.247	7.2	0.170	813	0.0035

Appendix Table D.7.2: Water quality at station WL-4 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	U mg/L
1/18/2010						7.0			
2/3/2010						7.0			
3/2/2010						6.6			
4/6/2010						6.7			
5/3/2010	0.011	0.0005	0.08		0.032	7.0	0.01	23	< 0.0005
6/7/2010						6.9			
7/5/2010						7.2			
8/4/2010						6.9			
9/7/2010						7.1			
10/6/2010						6.7			
11/2/2010	0.012	0.0006	0.19		0.021	7.0	0.008	33	< 0.0005
12/7/2010						7.2			
1/5/2011						6.9			
2/2/2011						6.5			
3/28/2011						6.7			
4/25/2011						6.2			
5/4/2011	0.013	0.0013	0.15		0.063	6.2	0.013	31	< 0.0005
6/1/2011						6.9			
7/6/2011						6.9			
8/3/2011						7.0			
9/7/2011						6.9			
10/5/2011						6.8			
11/2/2011	0.014	< 0.0005	0.1		0.017	6.8	0.011	28	< 0.0005
12/7/2011						6.8			
1/4/2012						6.7			
2/15/2012						6.4			
3/7/2012						6.2			
4/4/2012						7.0			
5/2/2012	0.013	0.0006	0.12		0.03	7.2		43	< 0.0005
6/6/2012						7.0			
7/4/2012						7.0			
8/1/2012						7.2			
9/5/2012						6.5			
10/3/2012						7.3			
11/7/2012	0.014	< 0.0005	0.16		0.018	7.2		33	< 0.0005
12/5/2012						7.3			
1/2/2013						7.4			
2/6/2013						8.2			
3/6/2013						6.7			
4/3/2013						6.4			
5/1/2013	0.007	0.0008	0.07		0.014	5.7	< 0.005	5.5	< 0.0005
6/5/2013						6.5			
7/3/2013						6.8			
8/7/2013						6.3			
9/4/2013						6.6			
10/2/2013						6.5			
11/13/2013	0.012	< 0.0005	0.15		0.019	6.6	0.007	34	< 0.0005
12/4/2013						6.4			
1/8/2014						6.6			
2/5/2014	0.017	0.0005	0.18	37.3	0.022	7.0	0.007	25	< 0.0005
3/5/2014						6.8			

Appendix Table D.7.2: Water quality at station WL-4 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	U mg/L
4/2/2014						7.0			
5/7/2014	0.012	0.0007	0.16	27.4	0.081	6.0	0.008	19	< 0.0005
6/4/2014						7.4			
7/2/2014						7.2			
8/6/2014	0.011	< 0.0005	0.13	33.1	0.021	6.5	0.012	22	< 0.0005
9/3/2014						7.0			
10/1/2014						7.1			
11/5/2014	0.012	< 0.0005	0.23	44.2	0.024	7.1	< 0.005	34	< 0.0005
12/3/2014						7.1			
Number	12	12	12	4	12	60	10	12	12
Maximum	0.017	0.0013	0.23	44.2	0.081	8.2	0.013	43	< 0.0005
Minimum	0.007	< 0.0005	0.07	27.4	0.014	5.7	< 0.005	5.5	< 0.0005
Mean	0.012	0.0006	0.14	35.5	0.030	6.8	0.009	27.5	< 0.0005
St. Dev.	0.002	0.0002	0.05	7.1	0.021	0.4	0.003	9.6	0
Median	0.012	0.0005	0.15	35.2	0.022	6.9	0.008	29.5	< 0.0005
10th Percentile	0.011	< 0.0005	0.08	29.1	0.017	6.4	< 0.005	19.3	< 0.0005
95th Percentile	0.015	0.0010	0.21	43.2	0.071	7.3	0.013	38.1	< 0.0005

Appendix Table D.7.3: Summary of annual plant operations and discharge at Nordic, 2010-2014.

ITEM	2010	2011	2012	2013	2014
PLANT OPERATIONS[a]					
Operating Days	365	365	366	365	365
Maximum Daily Plant Flow (L/s @ N-17)	1,200	827	332	1,094	1,100
Minimum Daily Plant Flow (L/s @ N-17)	19	18	33	29	22
Monthly Average Daily Plant Flow (L/s @ N-17)	59	80	71	98	87
Total Volume Treated (ML)	1,868	2,528	2,252	3,102	2,750
Lime Consumption					
Dry (tonne/yr)	668	660	537	781	806
Average (g/L)	0.36	0.26	0.24	0.25	0.29
EFFLUENT[b]					
Discharge Days	365	365	366	365	365
Maximum Daily Discharge Flow (L/s @ N-19)	1,200	827	332	1,094	1,100
Minimum Daily Discharge Flow (L/s @ N-19)	19	18	33	29	22
Monthly Average Daily Discharge Flow (L/s @ N-19)	59	80	71	98	87
Total Annual Volume Discharged (ML)	1,868	2,528	2,252	3,102	2,750
Annual Average Discharge Rate (L/s)					

ML - Million Litres

[a] Influent flows based on daily monitoring requirements as per TOMP

[b] Effluent flows based on weekly monitoring requirement as per SAMP

Appendix Table D.7.4: Mean annual loadings from Lacnor and Nordic TMAs, 2010 - 2014.

Station	Drainage Type	Mean Annual Discharge (m^3)		Barium (kg/yr)	Cobalt (kg/yr)	Iron (kg/yr)	Manganese (kg/yr)	Radium (MBq/yr)	Sulphate (kg/yr)	Uranium (kg/yr)
N-12	Combined Site Discharge	5,058,374	Mean	113	7	3,728	628	355	1,575,610	13
			S.D.	30	2	1,244	209	79	270,130	6
SR-08	Outlet of Nordic Lake	15,588,560	Mean	309				459	2,941,548	18
			S.D.	20				62	384,518	4

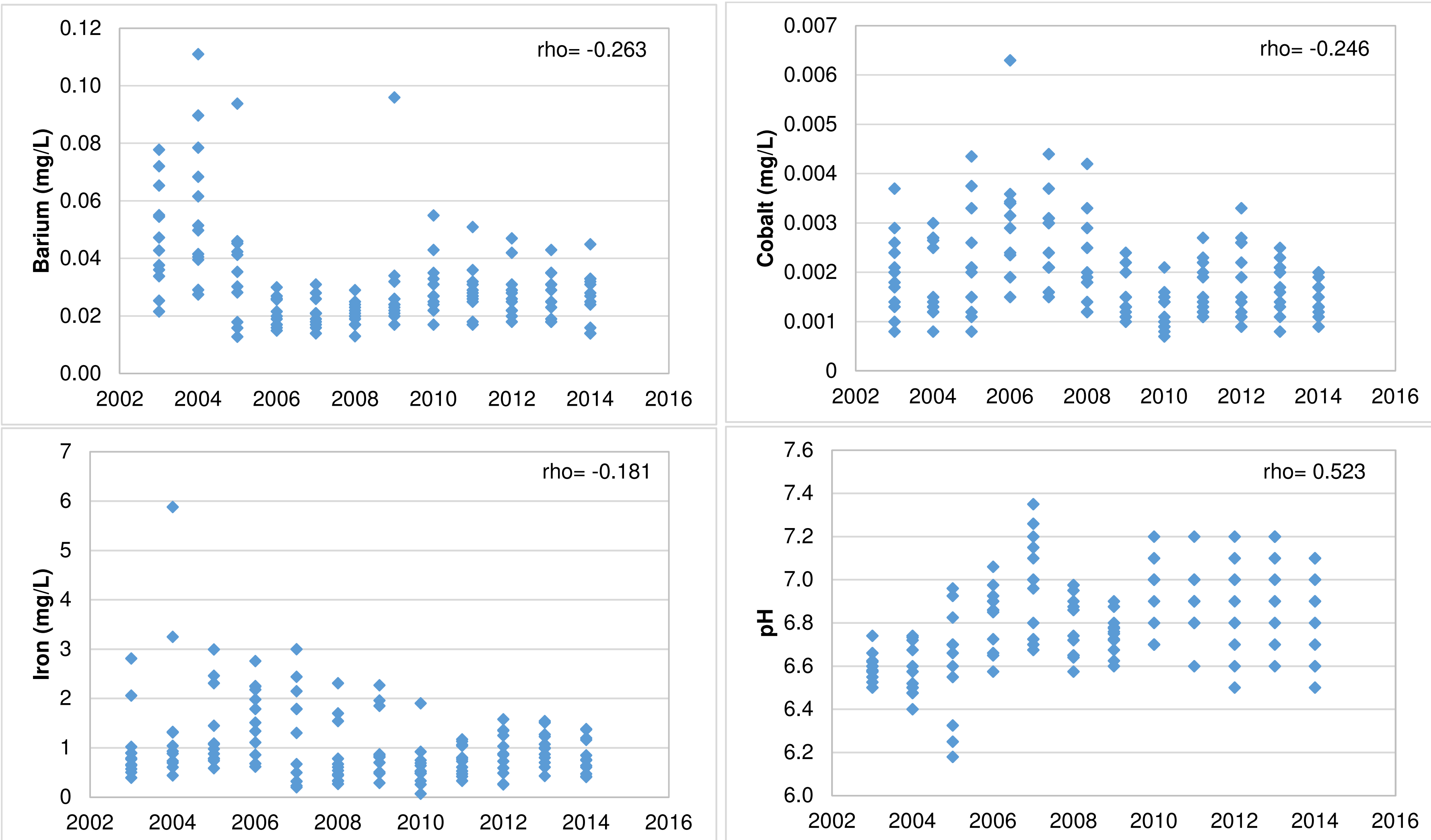
MBq/yr = Million Bequerels per year

Appendix Table D.7.5: Summary of seasonal trends for station N-12 from 2003-2014.

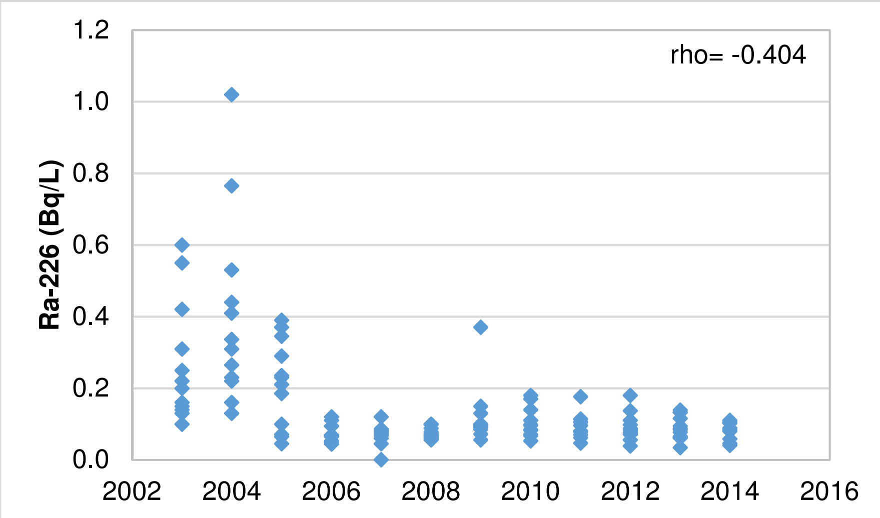
Month	Spearman's rho	Ba	Co	Fe	Hardness	Mn	pH	Ra	SO4	U
January	Correlation Coefficient	-0.140	-0.084	0.042	-0.400	-0.042	0.646	-0.217	-0.261	-0.724
	Sig. (2-tailed)	0.665	0.795	0.897	0.505	0.897	0.023	0.499	0.413	0.012
	N	12	12	12	5	12	12	12	12	11
February	Correlation Coefficient	-0.210	-0.389	-0.182	-0.100	-0.601	0.684	-0.343	-0.140	-0.370
	Sig. (2-tailed)	0.512	0.212	0.571	0.873	0.039	0.014	0.275	0.664	0.293
	N	12	12	12	5	12	12	12	12	10
March	Correlation Coefficient	-0.326	-0.375	-0.378	-0.700	-0.552	0.467	-0.414	-0.392	-0.431
	Sig. (2-tailed)	0.301	0.230	0.226	0.188	0.063	0.126	0.181	0.208	0.214
	N	12	12	12	5	12	12	12	12	10
April	Correlation Coefficient	0.270	-0.039	0.329	-0.300	0.909	0.688	-0.400	0.547	-0.371
	Sig. (2-tailed)	0.396	0.905	0.296	0.624	0.000	0.013	0.223	0.065	0.291
	N	12	12	12	5	12	12	11	12	10
May	Correlation Coefficient	-0.706	-0.144	-0.427	-0.800	-0.137	0.439	-0.720	-0.403	-0.236
	Sig. (2-tailed)	0.010	0.656	0.167	0.104	0.672	0.153	0.008	0.194	0.511
	N	12	12	12	5	12	12	12	12	10
June	Correlation Coefficient	-0.497	0.225	-0.508	-0.800	0.252	0.528	-0.531	-0.095	-0.650
	Sig. (2-tailed)	0.101	0.483	0.092	0.104	0.430	0.078	0.075	0.770	0.042
	N	12	12	12	5	12	12	12	12	10
July	Correlation Coefficient	-0.298	-0.538	-0.315	-0.700	-0.308	0.378	-0.573	-0.685	-0.733
	Sig. (2-tailed)	0.346	0.071	0.319	0.188	0.331	0.226	0.051	0.014	0.010
	N	12	12	12	5	12	12	12	12	11
August	Correlation Coefficient	-0.483	-0.558	-0.515	-0.500	-0.462	0.502	-0.601	-0.210	-0.525
	Sig. (2-tailed)	0.112	0.059	0.087	0.391	0.131	0.096	0.039	0.512	0.097
	N	12	12	12	5	12	12	12	12	11
September	Correlation Coefficient	-0.196	-0.259	-0.063	-0.700	-0.196	0.344	-0.126	-0.532	-0.553
	Sig. (2-tailed)	0.541	0.416	0.846	0.188	0.542	0.274	0.697	0.075	0.097
	N	12	12	12	5	12	12	12	12	10
October	Correlation Coefficient	-0.070	-0.060	-0.063	0.100	0.294	0.751	-0.214	-0.217	-0.477
	Sig. (2-tailed)	0.828	0.854	0.846	0.873	0.354	0.005	0.505	0.499	0.194
	N	12	12	12	5	12	12	12	12	9
November	Correlation Coefficient	-0.413	-0.375	-0.245	-0.700	-0.231	0.559	-0.364	-0.354	-0.176
	Sig. (2-tailed)	0.183	0.230	0.443	0.188	0.471	0.059	0.245	0.259	0.627
	N	12	12	12	5	12	12	12	12	10
December	Correlation Coefficient	-0.081	-0.351	0.154	-0.100	-0.102	0.290	-0.350	-0.420	-0.244
	Sig. (2-tailed)	0.803	0.263	0.633	0.873	0.753	0.361	0.264	0.175	0.469
	N	12	12	12	5	12	12	12	12	11

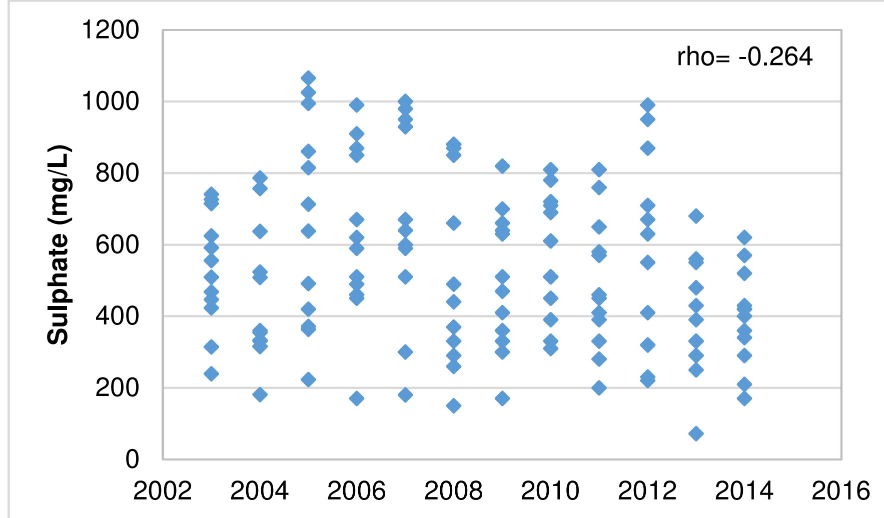
Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearman Rank Correlation Coefficient (Zar 1984).

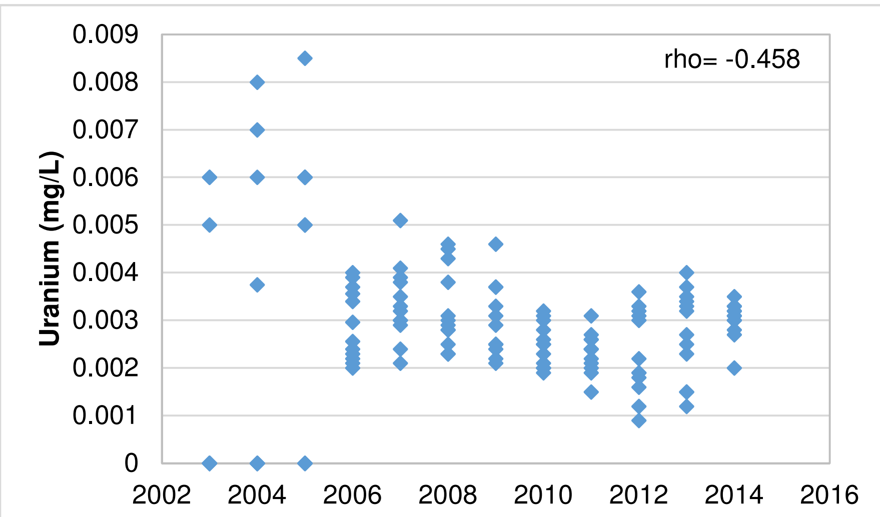
Significant trend where p<0.05.



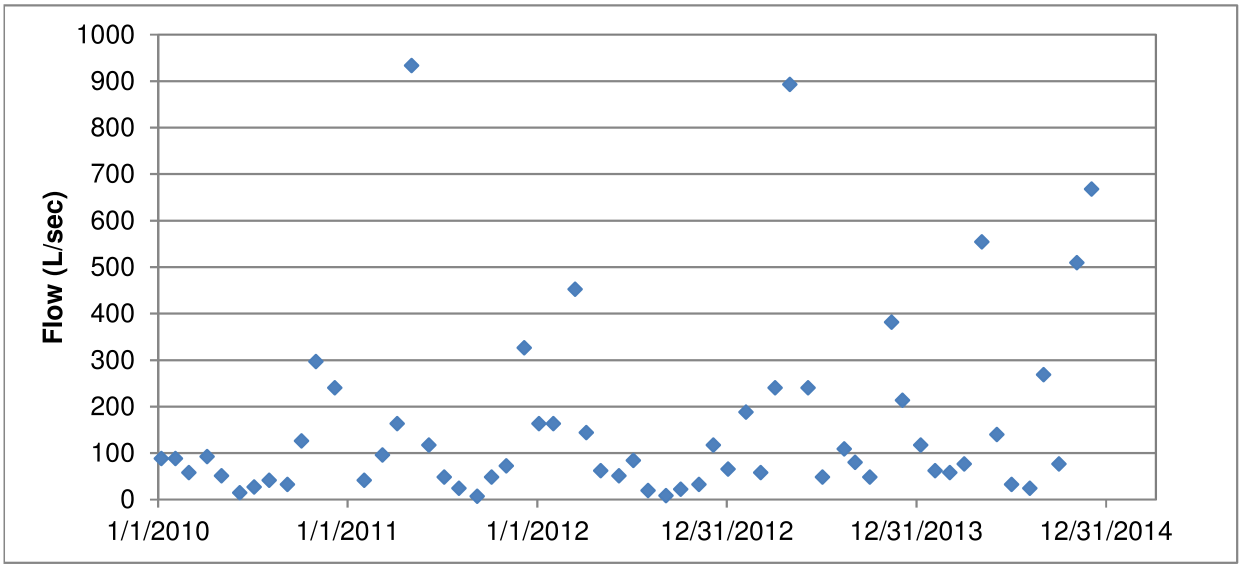
Appendix Figure D.7.1: Significant common (average) trends observed for barium, cobalt, iron, pH, radium-226, sulphate and uranium over all seasons at Station N-12, 2003 to 2014.







Appendix Figure D.7.1: Significant common (average) trends observed for barium, cobalt, iron, pH, radium-226, sulphate and uranium over all seasons at Station N-12, 2003 to 2014.



Appendix Figure D.7.2: Flows at station N-12 from 2010 to 2014.

APPENDIX D.8
Pronto TMA

Appendix Table D.8.1: Water quality at station PR-01 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	U mg/L
1/13/2010	0.038	0.0153	0.23	266	0.261	6.6	0.069	210	0.0097
2/10/2010	0.052	0.0165	0.15	344	0.365	6.5	0.065	340	0.0139
3/10/2010	0.040	0.0171	0.33	261	0.385	6.9	0.062	200	0.0196
3/31/2010	0.031	0.0035	0.08	370	0.043	6.9	0.070	360	0.0142
4/21/2010	0.030	0.0029	0.06	366	0.035	6.7	0.050	350	0.0054
5/12/2010	0.039	0.0070	0.21	168	0.110	7.1	0.021	100	0.0138
6/9/2010	0.072	0.0116	0.62	263	0.464	6.9	0.060	170	0.0402
7/21/2010	0.117	0.0282	4.28	252	4.440	6.9	0.150	80	0.0422
8/11/2010	0.081	0.0083	1.04	325	1.130	6.8	0.084	250	0.0268
9/8/2010	0.096	0.0315	0.92	199	0.720	6.7	0.140	120	0.0299
10/13/2010	0.046	0.0100	0.48	318	0.186	6.7	0.060	260	0.0132
11/10/2010	0.029	0.0068	0.1	404	0.112	7.0	0.080	370	0.0071
12/8/2010	0.029	0.0087	0.09	437	0.130	6.9	0.054	420	0.0085
1/12/2011	0.048	0.0332	0.67	367	0.494	6.8	0.082	300	0.0185
2/16/2011	0.043	0.0233	0.242	365	0.577	6.9	0.056	320	0.0335
3/9/2011	0.042	0.0222	0.204	376	0.597	6.9	0.069	320	0.0355
4/13/2011	0.021	0.0089	0.22	235	0.170	6.9	0.032	210	0.0101
5/11/2011	0.024	0.0025	0.08	247	0.030	6.8	0.044	220	0.0040
6/9/2011	0.028	0.0103	0.7	220	0.257	7.0	0.055	160	0.0082
7/7/2011	0.029	0.0090	0.72	200	0.717	6.9	0.036	66	0.0412
8/16/2011	0.046	0.0029	0.57	211	0.361	7.0	0.044	78	0.0285
10/12/2011	0.044	0.0061	0.45	159	0.682	6.9	0.023	27	0.0238
11/9/2011	0.043	0.0071	0.147	295	0.104	7.0	0.062	270	0.0125
12/14/2011	0.024	0.0107	0.12	310	0.132	6.7	0.068	290	0.0051
1/12/2012	0.044	0.0200	0.311	284	0.435	6.9	0.064	230	0.0081
2/8/2012	0.048	0.0237	0.405	208	0.428	6.7	0.016	130	0.0079
3/20/2012	0.019	0.0078	0.219	171	0.156	6.8	0.032	140	0.0054
4/11/2012	0.023	0.0033	0.068	274	0.043	7.1	0.050	250	0.0036
5/9/2012	0.028	0.0037	0.173	188	0.099	6.8	0.048	130	0.0052
6/13/2012	0.034	0.0057	0.553	149	0.456	7.2	0.025	10	0.0356
10/24/2012	0.059	0.0036	0.07	334	0.050	7.1	0.080	320	0.0228
11/14/2012	0.028	0.0020	0.19	196	0.031	6.9	0.027	140	0.0073
12/12/2012	0.035	0.0147	0.04	433	0.138	7.0	0.084	400	0.0037
1/14/2013	0.028	0.0062	0.23	212	0.138	6.9	0.031	180	0.0063
2/13/2013	0.030	0.0098	0.291	223	0.272	6.8	0.034	140	0.0089
3/7/2013	0.030	0.0290	0.07	435	0.349	7.0	0.070	410	0.0095
4/8/2013	0.020	0.0181	0.18	180	0.104	7.1	0.053	140	0.0060
5/8/2013	0.027	0.0047	0.12	183	0.044	6.7	0.049	160	0.0029
6/12/2013	0.034	0.0055	0.22	273	0.088	6.6	0.071	230	0.0025
7/10/2013	0.056	0.0515	0.86	250	3.540	7.1	0.060	190	0.0340
8/15/2013	0.033	0.0125	1.13	144	0.221	7.3	0.033	87	0.0095
9/4/2013	0.056	0.0083	0.72	258	0.147	6.7	0.082	220	0.0035
10/2/2013	0.055	0.0057	0.243	261	0.098	7.0	0.064	270	0.0022
11/14/2013	0.031	0.0067	0.15	239	0.076	7.1	0.062	220	0.0026
12/11/2013	0.029	0.0105	0.13	281	0.131	6.5	0.062	280	0.0027
1/15/2014	0.023	0.0093	0.49	162	0.199	7.0	0.039	94	0.0062
2/12/2014	0.052	0.0345	1.58	191	1.040	6.6	0.063	130	0.0153
3/5/2014	0.063	0.0719	2.37	213	2.100	6.6	0.080	120	0.0228
4/10/2014	0.026	0.0119	0.3	225	0.201	6.5	0.050	170	0.0105
5/7/2014	0.029	0.0026	0.18	175	0.034	7.0	0.042	150	0.0036
6/11/2014	0.043	0.0050	0.23	236	0.111	6.6	0.076	220	0.0022
7/23/2014	0.039	0.0096	0.89	104	0.375	6.6	0.033	13	0.0071
8/13/2014	0.054	0.0031	0.26	189	0.065	6.7	0.069	140	0.0069
9/10/2014	0.055	0.0041	0.23	245	0.131	6.6	0.075	220	0.0039
10/1/2014	0.042	0.0029	0.2	252	0.055	7.0	0.073	230	0.0022
11/12/2014	0.026	0.0048	0.16	206	0.066	6.9	0.052	190	0.0028
12/10/2014	0.024	0.0062	0.2	191	0.105	6.8	0.045	180	0.0052
Number	57	57	57	57	57	57	57	57	57
Maximum	0.117	0.0719	4.28	437	4.440	7.3	0.15	420	0.0422
Minimum	0.019	0.002	0.040	104	0.030	6.5	0.016	10	0.0022
Mean	0.041	0.0127	0.459	255	0.422	6.9	0.058	204	0.0131
St. Dev.	0.019	0.0127	0.660	79.2	0.773	0.2	0.024	100	0.0116
Median	0.035	0.0087	0.230	245	0.156	6.9	0.060	200	0.0082
10th Percentile	0.024	0.0030	0.080	170	0.044	6.6	0.032	84	0.0028
95th Percentile	0.074	0.0335	1.22	410	1.324	7.1	0.084	376	0.0365

Appendix Table D.8.2: Water quality at station LL-01 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hardness mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	U mg/L
1/13/2010	0.016	< 0.0005	1.24	77.6	0.166	6.6	0.014	25.0	0.0025
4/21/2010	0.013	< 0.0005	0.52	58.5	0.077	6.5	0.016	24.0	0.0015
7/21/2010	0.018	0.0005	2.07	60.5	0.292	6.5	0.036	7.6	0.0013
10/13/2010	0.014	< 0.0005	0.92	60.7	0.042	6.5	0.014	16.0	0.0013
1/12/2011	0.017	0.0005	1.26	78.4	0.201	6.6	0.021	28.0	0.0016
4/13/2011	0.012	< 0.0005	0.44	37.9	0.056	6.5	0.021	17.0	0.0014
7/7/2011	0.012	< 0.0005	1.68	57.4	0.134	6.6	0.026	8.5	0.0013
10/12/2011	0.012	< 0.0005	0.88	58.7	0.080	6.8	0.019	8.5	0.0010
2/8/2012	0.015	< 0.0005	1.51	75.6	0.112	6.7	0.061	23.0	0.0016
5/9/2012	0.012	0.0006	1.16	60.8	0.236	6.8	0.018	17.0	0.0015
8/8/2012	0.010	< 0.0005	1.18	57.3	0.135	6.7	0.017	8.1	0.0010
11/14/2012	0.015	< 0.0005	0.33	88.6	0.020	7.1	0.021	42.0	0.0024
2/13/2013	0.016	< 0.0005	0.79	75.5	0.086	7.0	0.013	27.0	0.0015
5/8/2013	0.013	0.0008	0.67	54.9	0.153	6.6	0.013	16.0	0.0013
8/15/2013	0.011	< 0.0005	0.73	48.2	0.068	6.8	0.014	8.5	0.0012
11/14/2013	0.011	< 0.0005	0.60	37.4	0.022	6.6	0.010	11.0	0.0014
2/12/2014	0.017	< 0.0005	0.59	77.4	0.104	6.7	0.014	26.0	0.0020
5/7/2014	0.011	< 0.0005	0.49	35.3	0.050	7.0	0.010	1.4	0.0014
8/13/2014	0.013	< 0.0005	1.21	61.5	0.074	6.8	0.021	12.0	0.0014
11/24/2014	0.013	0.0006	1.01	43.9	0.156	6.6	0.015	16.0	0.0017
Number	20	20	20	20	20	20	20	20	20
Maximum	0.018	0.0008	2.07	88.6	0.292	7.1	0.061	42.0	0.0025
Minimum	0.010	< 0.0005	0.33	35.3	0.020	6.5	0.010	1.4	0.0010
Mean	0.014	0.0005	0.96	60.3	0.113	6.7	0.020	17.1	0.0015
St. Dev.	0.002	0.0001	0.45	15.1	0.072	0.2	0.011	9.6	0.0004
Median	0.013	0.0005	0.90	59.6	0.095	6.7	0.017	16.0	0.0014
10th Percentile	0.011	< 0.0005	0.49	37.9	0.040	6.5	0.013	8.1	0.0012
95th Percentile	0.017	0.0006	1.70	78.9	0.239	7.0	0.037	28.7	0.0024

Appendix Table D.8.3: Summary of annual plant operations and discharge at Pronto, 2010-2014.

ITEM	2010	2011	2012	2013	2014
PLANT OPERATIONS[a]					
Operating Days	121	139	105	219	232
Maximum Daily Plant Flow (L/s @ PR-02)	115	196	124	196	180
Minimum Daily Plant Flow (L/s @ PR-02)	0	0	0	0	0
Monthly Average Daily Plant Flow (L/s @ PR-02)	87	113	92	117	111
Total Volume Treated (ML)	908	1,360	832	2,222	2,219
Lime Consumption					
Dry (tonne/yr)	41	46	34	66	47
Average (g/L)	0.05	0.03	0.04	0.030	0.021
EFFLUENT[b]					
Discharge Days	122	136	105	217	229
Maximum Daily Discharge Flow (L/s @ PR-04)	115	196	124	196	180
Minimum Daily Discharge Flow (L/s @ PR-04)	0	0	0	0	0
Monthly Average Daily Discharge Flow (L/s @ PR-04)	87	114	88	118	111
Total Annual Volume Discharged (ML)	914	1,336	799	2,206	2,198

ML - Million Litres

[a] Influent flows based on daily monitoring requirements as per TOMP

[b] Effluent flows based on weekly monitoring requirement as per SAMP

Appendix Table D.8.4: Mean annual discharge and seepage loadings from Pronto TMA, 2010 - 2014.

Station	Drainage Type	Mean Annual Discharge (m^3)		Barium (kg/yr)	Cobalt (kg/yr)	Iron (kg/yr)	Manganese (kg/yr)	Radium (MBq/yr)	Sulphate (kg/yr)	Uranium (kg/yr)
PR-01	Controlled Discharge	2,065,608	Mean	68	18	496	316	117	447,190	15
			S.D.	33	10	386	205	54	124,322	6
LL-01	Upstream Source to Lake Lauzon	510,883	Mean	6.7	0.3	482	69.8	8	8,128	0.9
			S.D.	11.2	0.5	841	128.0	12.4	12,562	1.5
			All Pronto Sources	**75**	**18**	**978**	**386**	**125**	**455,318**	**16**

MBq/yr = Million Bequerels per year

Appendix Table D.8.5: Summary of seasonal trends for station PR-01 from 2003-2014.

Month	Spearman's rho	Ba	Co	Fe	Hardness	Mn	pH	Ra	SO4	U
January	Correlation Coefficient	-0.536	-0.193	0.816	-0.700	0.049	0.144	0.011	-0.581	-0.350
	Sig. (2-tailed)	0.073	0.549	0.001	0.188	0.880	0.656	0.974	0.047	0.265
	N	12	12	12	5	12	12	12	12	12
February	Correlation Coefficient	-0.385	-0.266	0.701	-0.800	0.133	0.161	0.119	-0.350	-0.140
	Sig. (2-tailed)	0.216	0.404	0.011	0.104	0.681	0.617	0.713	0.264	0.665
	N	12	12	12	5	12	12	12	12	12
March	Correlation Coefficient	-0.371	0.042	0.748	-0.100	-0.081	-0.302	0.385	-0.028	-0.007
	Sig. (2-tailed)	0.235	0.897	0.005	0.873	0.803	0.340	0.217	0.931	0.983
	N	12	12	12	5	12	12	12	12	12
April	Correlation Coefficient	-0.754	0.126	0.650	-0.800	0.322	-0.183	0.331	0.186	-0.098
	Sig. (2-tailed)	0.005	0.697	0.022	0.104	0.308	0.570	0.293	0.564	0.762
	N	12	12	12	5	12	12	12	12	12
May	Correlation Coefficient	-0.530	-0.330	0.650	0.000	-0.119	-0.137	0.214	0.389	-0.524
	Sig. (2-tailed)	0.076	0.295	0.022	1.000	0.713	0.671	0.505	0.212	0.080
	N	12	12	12	5	12	12	12	12	12
June	Correlation Coefficient	-0.451	0.036	0.791	0.100	0.382	-0.281	0.597	0.073	-0.291
	Sig. (2-tailed)	0.164	0.915	0.004	0.873	0.247	0.376	0.053	0.832	0.385
	N	11	11	11	5	11	12	11	11	11
July	Correlation Coefficient	-0.079	0.321	0.697		0.648	0.070	-0.248	-0.268	0.571
	Sig. (2-tailed)	0.829	0.365	0.025		0.043	0.838	0.489	0.486	0.084
	N	10	10	10		10	11	10	9	10
August	Correlation Coefficient	-0.342	-0.582	0.609		-0.255	-0.197	0.200	0.045	0.418
	Sig. (2-tailed)	0.304	0.060	0.047		0.450	0.562	0.555	0.894	0.201
	N	11	11	11		11	11	11	11	11
September	Correlation Coefficient	-0.345	-0.430	0.729		-0.527	-0.767	0.535	0.304	-0.273
	Sig. (2-tailed)	0.328	0.214	0.017		0.117	0.010	0.111	0.393	0.446
	N	10	10	10		10	10	10	10	10
October	Correlation Coefficient	-0.070	-0.308	0.853	-0.200	-0.287	-0.104	0.312	0.147	-0.256
	Sig. (2-tailed)	0.829	0.331	0.000	0.747	0.366	0.747	0.324	0.649	0.422
	N	12	12	12	5	12	12	12	12	12
November	Correlation Coefficient	-0.637	-0.308	0.622	-0.700	-0.287	0.172	-0.025	0.119	-0.196
	Sig. (2-tailed)	0.026	0.331	0.031	0.188	0.366	0.593	0.940	0.712	0.542
	N	12	12	12	5	12	12	12	12	12
December	Correlation Coefficient	-0.587	-0.615	0.615	-0.900	-0.455	-0.238	0.189	-0.105	-0.389
	Sig. (2-tailed)	0.045	0.033	0.033	0.037	0.138	0.455	0.556	0.746	0.212
	N	12	12	12	5	12	12	12	12	12

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).

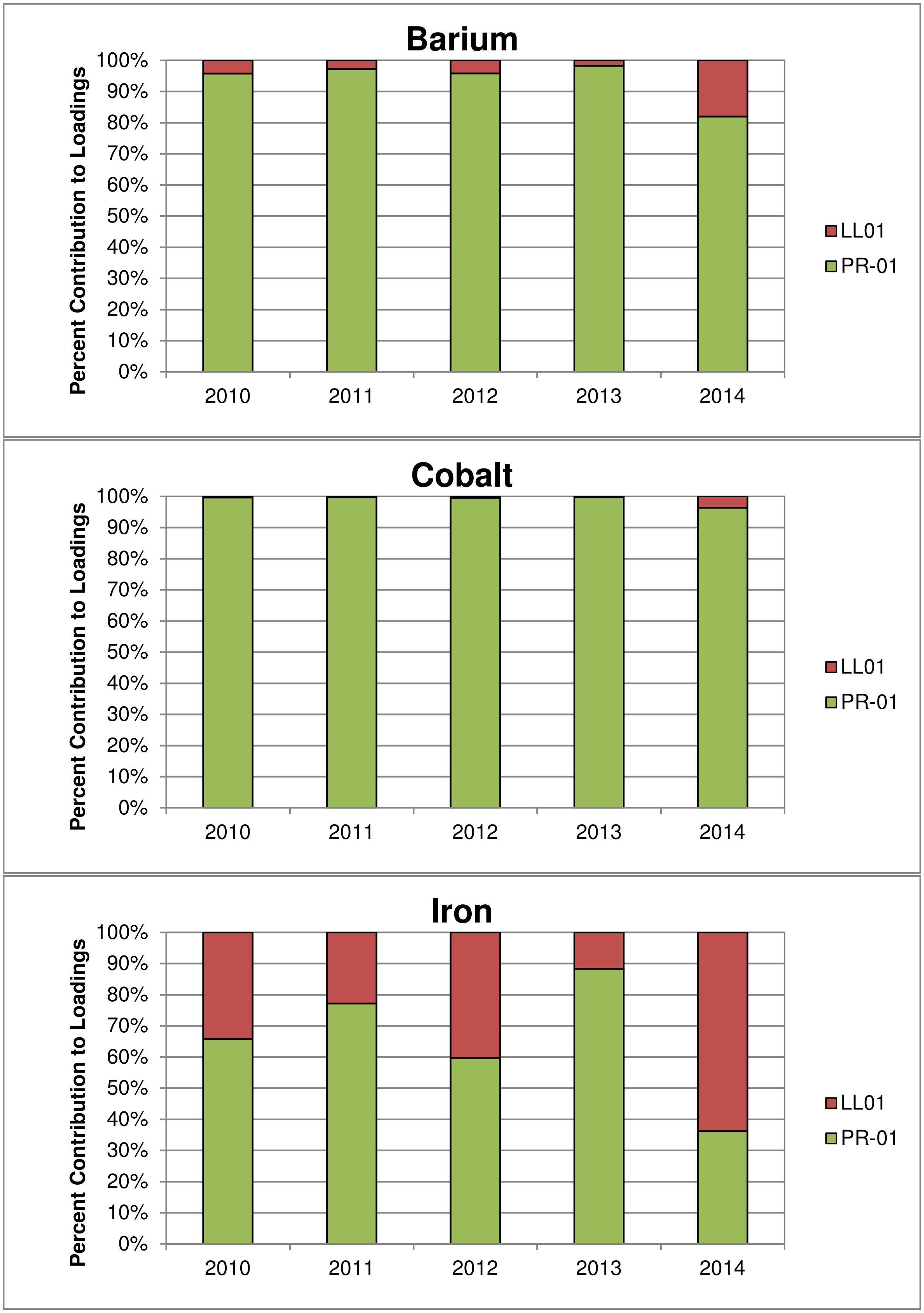
[shaded box] Significant trend where p<0.05.

Appendix Table D.8.6: Summary of seasonal trends for station LL-01 from 2003-2014.

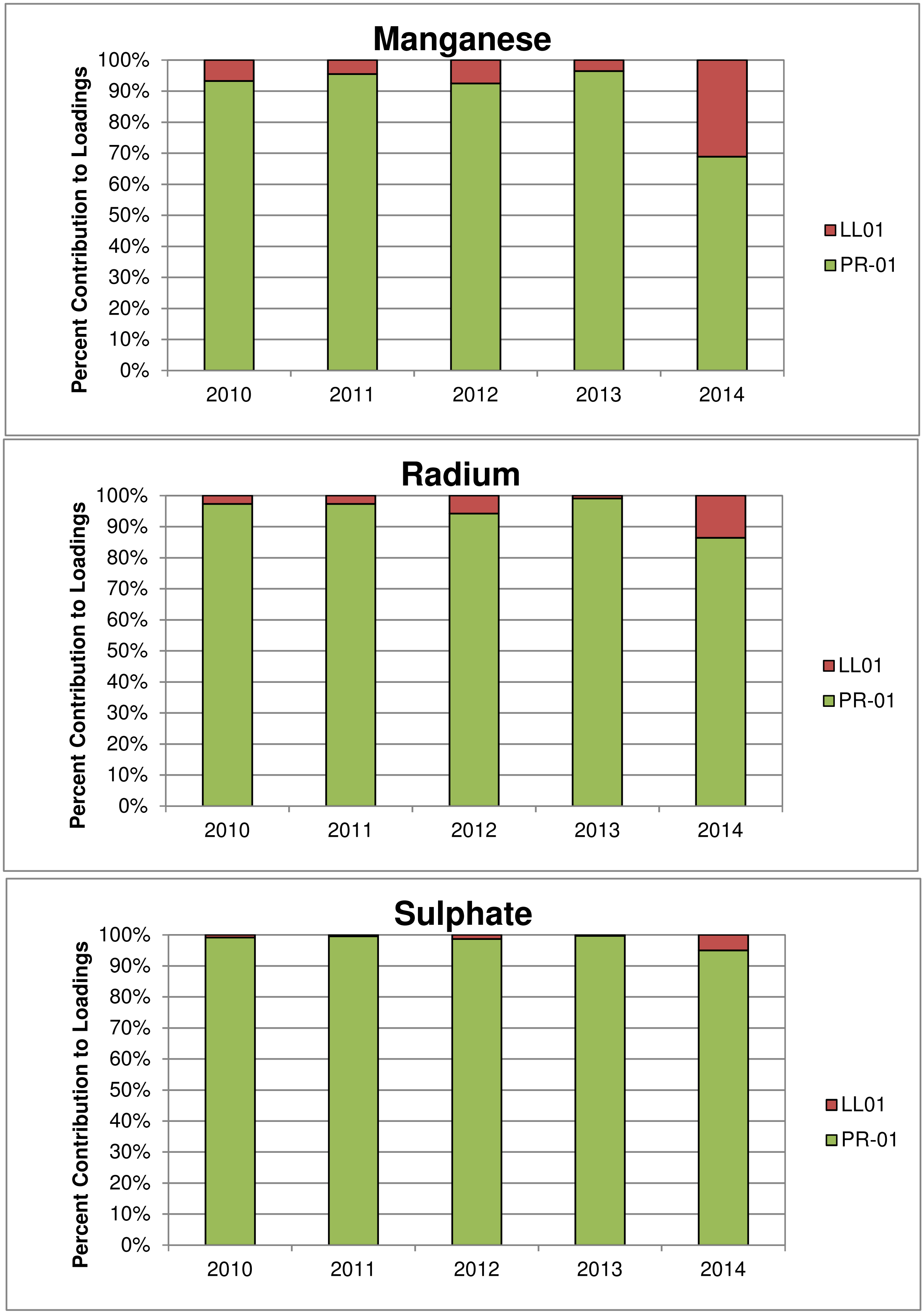
Month	Spearman's rho	Ba	Co	Fe	Hardness	Mn	pH	Ra	SO4	U
January	Correlation Coefficient	-0.723	0.470	0.525	-0.600	-0.035	-0.093	-0.883	-0.706	-0.870
	Sig. (2-tailed)	0.008	0.123	0.079	0.285	0.914	0.774	0.000	0.010	0.000
	N	12	12	12	5	12	12	12	12	12
April	Correlation Coefficient	-0.622	0.395	0.329	-0.500	0.084	0.260	-0.788	-0.725	-0.958
	Sig. (2-tailed)	0.031	0.204	0.296	0.391	0.795	0.415	0.002	0.008	0.000
	N	12	12	12	5	12	12	12	12	12
July	Correlation Coefficient	-0.830	-0.118	0.119	0.000	0.084	-0.333	-0.853	-0.743	-0.891
	Sig. (2-tailed)	0.001	0.714	0.713	1.000	0.795	0.290	0.000	0.006	0.000
	N	12	12	12	5	12	12	12	12	12
October	Correlation Coefficient	-0.879	0.813	0.350	-0.600	-0.126	-0.411	-0.776	-0.855	-0.783
	Sig. (2-tailed)	0.000	0.001	0.265	0.285	0.697	0.185	0.003	0.000	0.003
	N	12	12	12	5	12	12	12	12	12

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).

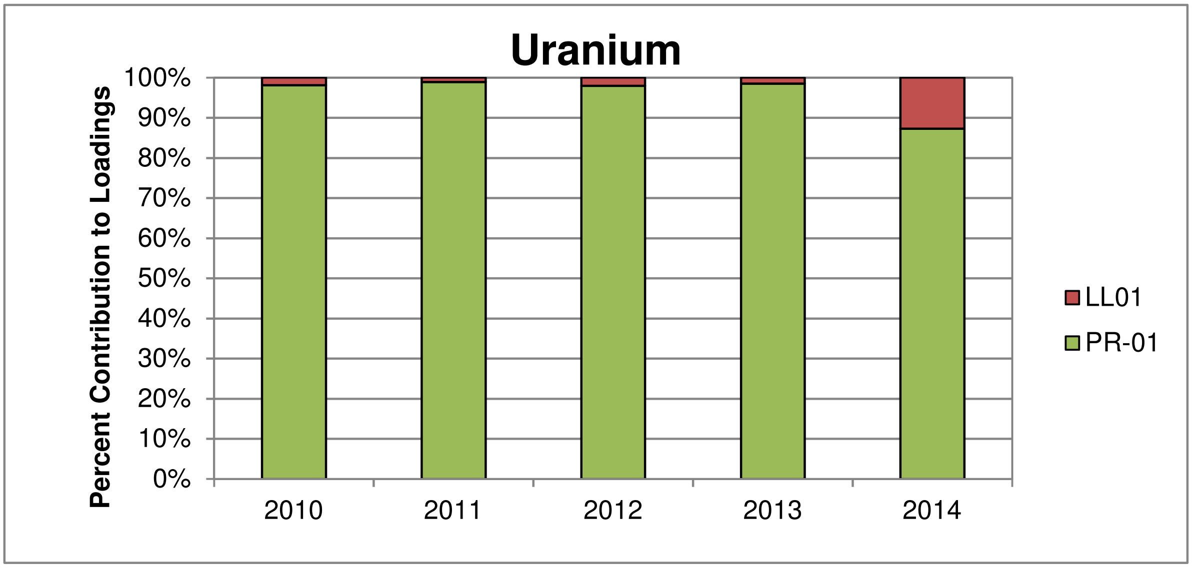
[shaded box] Significant trend where $p<0.05$.



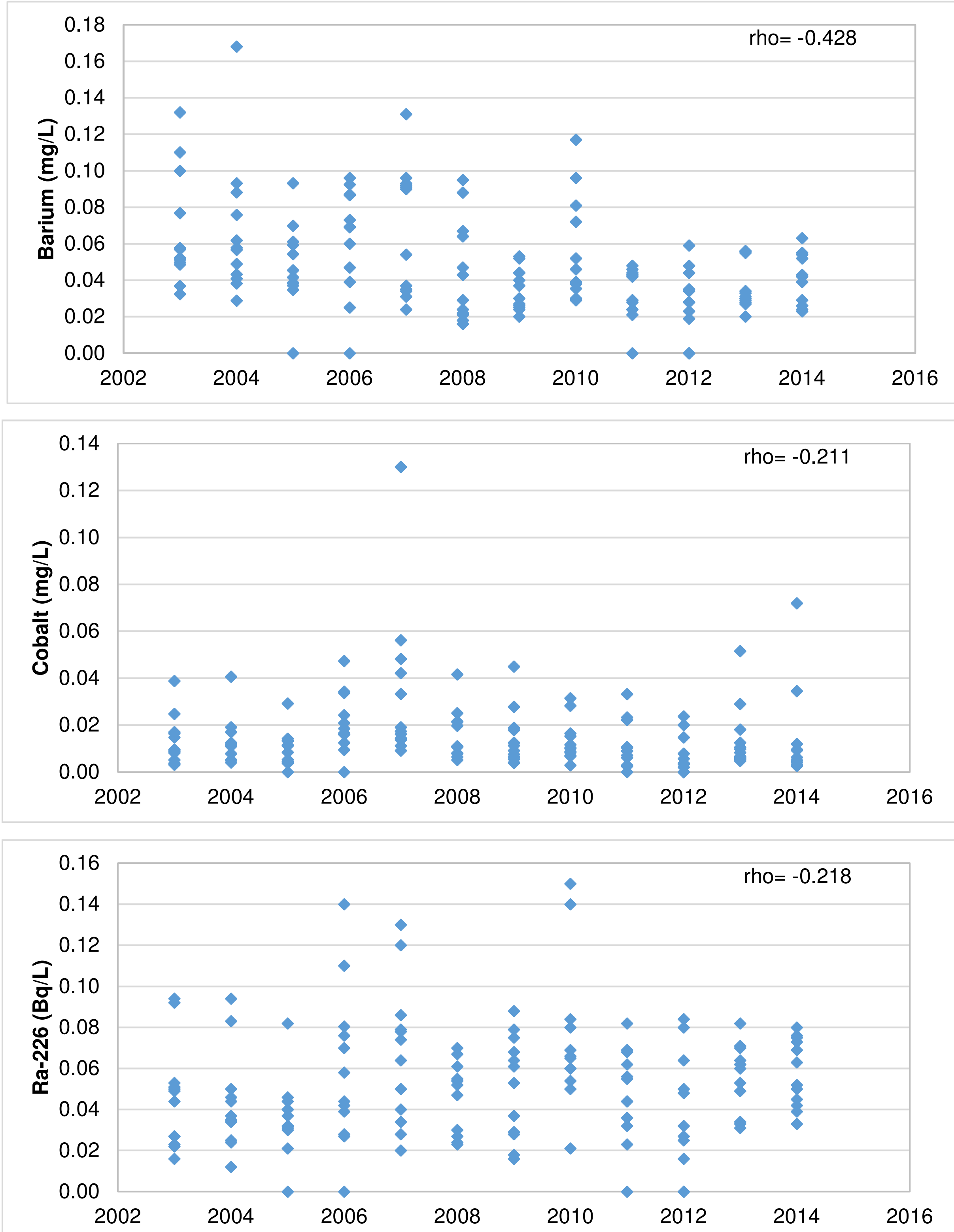
Appendix Figure D.8.1: Percent contribution to total Pronto loads from TMA discharge points.



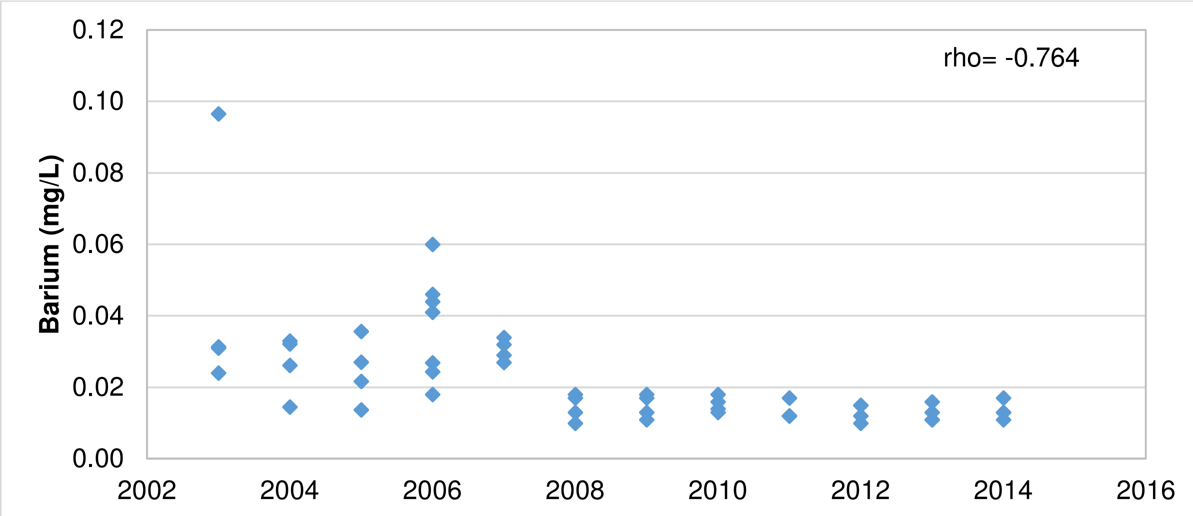
Appendix Figure D.8.1: Percent contribution to total Pronto loads from TMA discharge points.

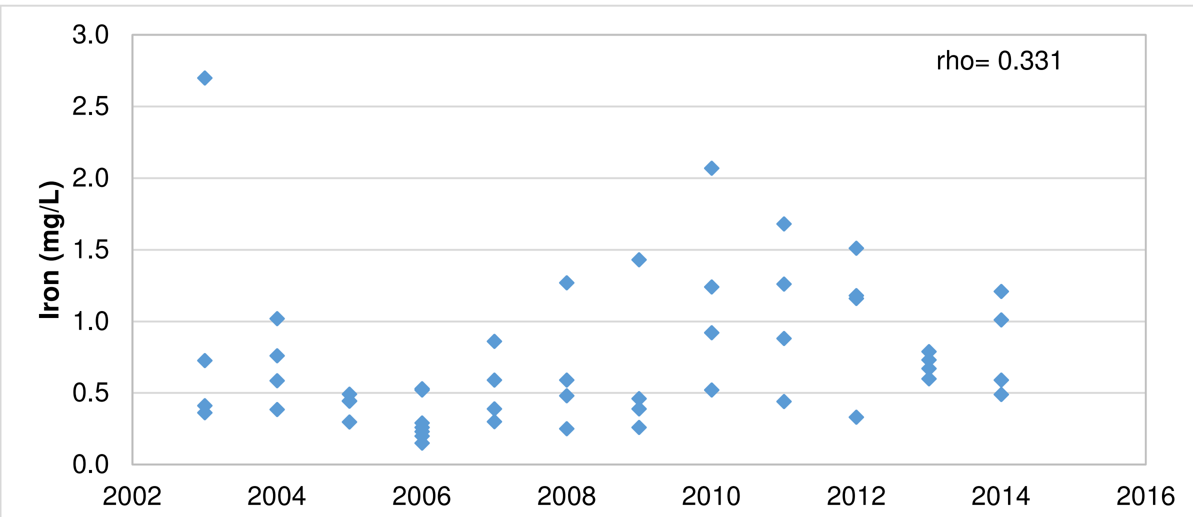


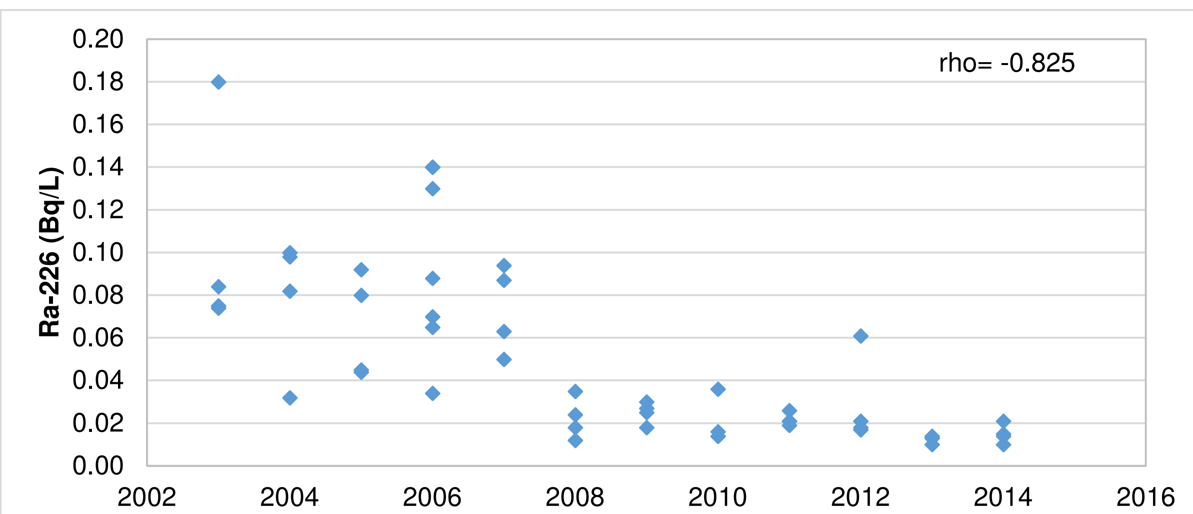
Appendix Figure D.8.1: Percent contribution to total Pronto loads from TMA discharge points.



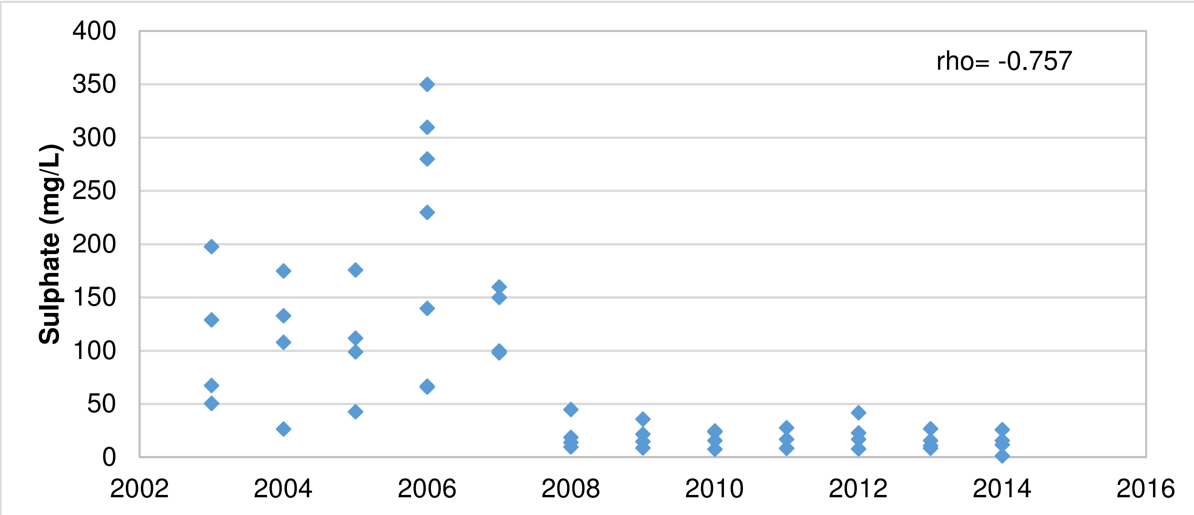
Appendix Figure D.8.2: Significant common (average) trends observed for barium, cobalt and radium-226 over all seasons at Station PR-01, 2003 to 2014.

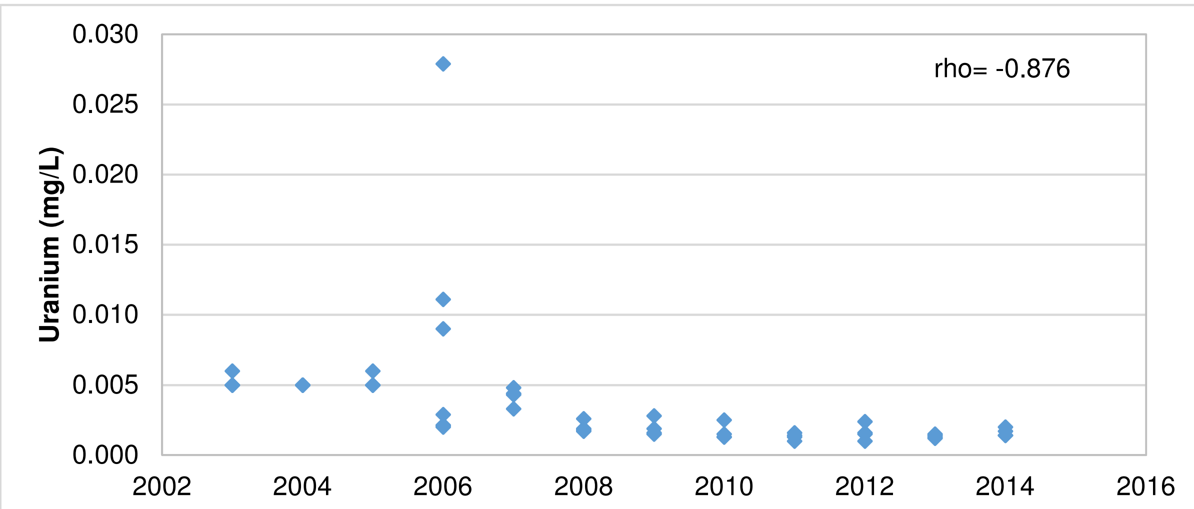




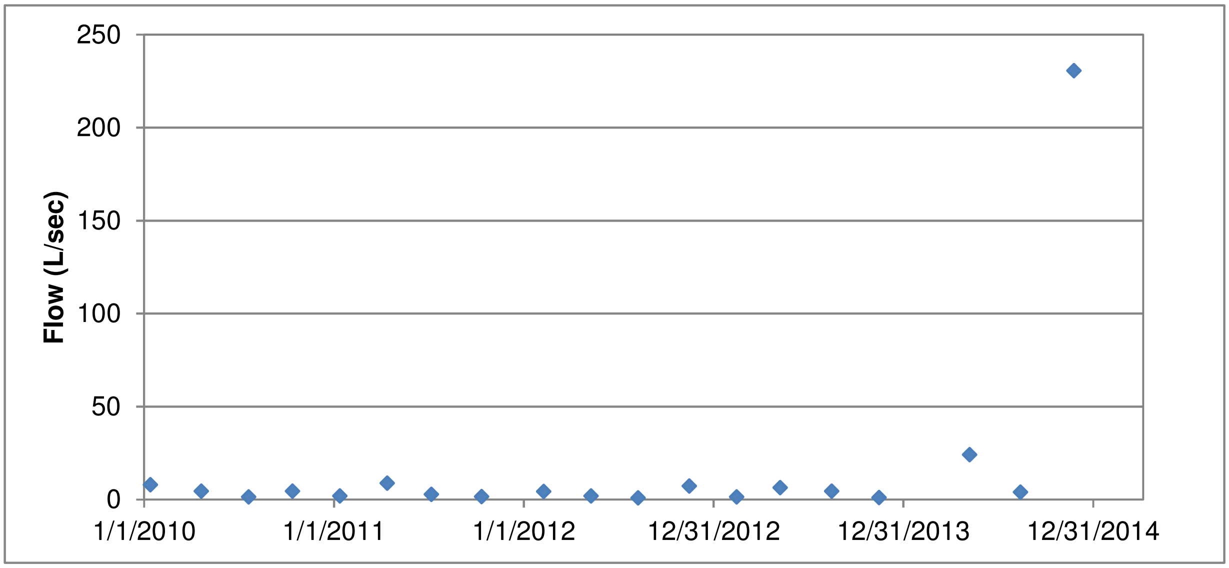


Appendix Figure D.8.3: Significant common (average) trends observed for barium, iron, radium-226, sulphate and uranium over all seasons at Station LL-01, 2003 to 2014.

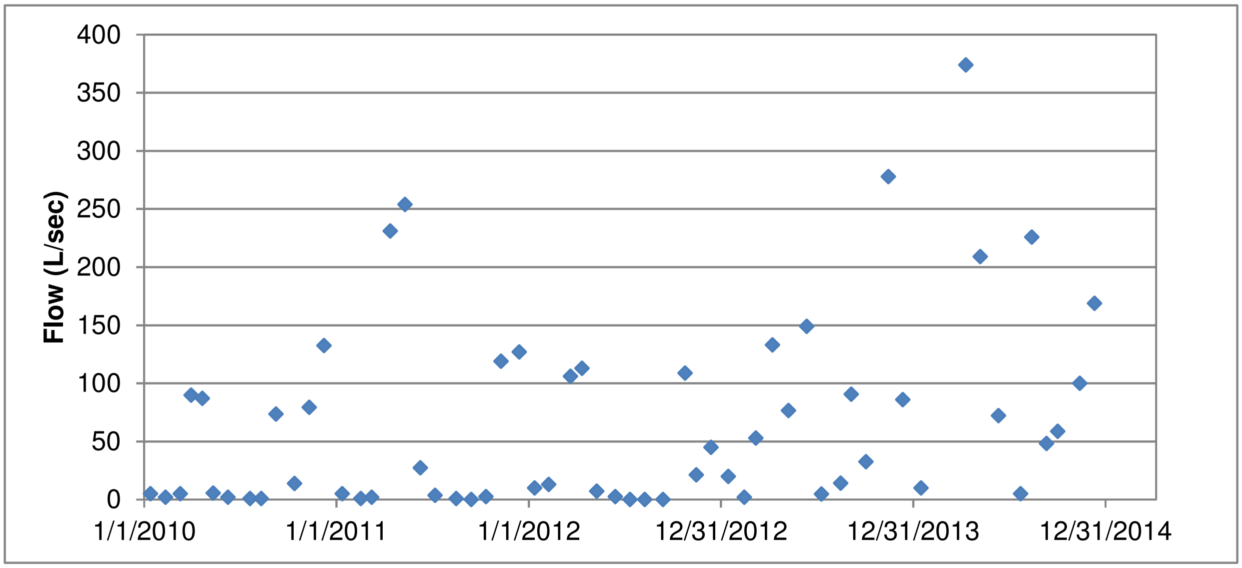




Appendix Figure D.8.3: Significant common (average) trends observed for barium, iron, radium-226, sulphate and uranium over all seasons at Station LL-01, 2003 to 2014.



Appendix Figure D.8.4: Flows at Station LL-01 from 2010 to 2014.



Appendix Figure D.8.5: Flows at station PR-01 from 2010 to 2014.

APPENDIX E
SEWMP RAW DATA AND SUPPORTING INFORMATION

Table E.1: Annual mean reference station lake water quality (D-4, SR-18, SR-19) and 95% confidence limits[a], 2003 - 2014[b].

Station	Year	Ba (mg/L)	Co (mg/L)	Fe (mg/L)	Mn (mg/L)	pH	Ra (Bq/L)	SO4 (mg/L)	U (mg/L)
D-4	2003	0.014	<0.0003	0.02	0.008	6.8	<0.005	5.4	<0.0005
	2004	0.013	<0.0003	0.02	0.008	7.0	0.010	5.8	<0.0005
	2005	0.014	<0.0003	0.02	0.009	6.6	<0.005	6.0	0.0006
	2006	0.014	<0.0005	0.05	0.017	7.0	<0.005	5.5	<0.0005
	2007	0.013	<0.0005	0.03	0.011	7.0	<0.005	5.2	<0.0005
	2008	0.0135	<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
	2010	0.014	<0.0005	0.04	0.020	7.0	<0.005	4.3	<0.0005
	2011	0.014	0.0005	0.04	0.018	6.8	<0.005	4.4	<0.0005
	2012	0.013	<0.0005	0.03	0.014	7.0	<0.005	4.5	<0.0005
	2013	0.0125	<0.0005	0.04	0.017	6.8	<0.005	4.3	<0.0005
	2014	0.013		<0.03	0.010	7.2	<0.005	4.6	
SR-18	2003	0.051	<0.0003	0.04	0.014	6.6	0.011	6.5	<0.0005
	2004	0.063	<0.0003	0.02	0.004	6.6	0.005	6.2	<0.0005
	2005	0.050	<0.0003	0.02	0.008	6.7	0.007	7.4	<0.0005
	2006	0.048	<0.0005	0.03	0.011	6.6	<0.005	5.8	<0.0005
	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
	2010	0.052	<0.0005	0.05	0.021	6.9	<0.005	5.7	<0.0005
	2011	0.052	<0.0005	0.06	0.018	6.9	<0.005	5.4	<0.0005
	2012	0.052	<0.0005	0.04	0.010	6.8	0.006	5.9	<0.0005
	2013	0.051	<0.0005	0.06	0.025	7.0	0.005	5.0	<0.0005
	2014	0.043		0.07	0.013	6.9	<0.005	4.3	
SR-19	2003	0.024	0.0004	0.29	0.050	6.8	0.010	5.2	0.0005
	2004	0.022	0.0003	0.34	0.040	6.9	0.008	5.3	0.0005
	2005	0.032	0.0008	0.84	0.221	6.7	0.005	5.2	0.0005
	2006	0.025	0.0006	0.48	0.083	6.8	<0.005	4.7	<0.0005
	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
	2010	0.027	<0.0005	0.35	0.073	6.8	<0.005	4.5	<0.0005
	2011	0.024	<0.0005	0.25	0.029	6.9	<0.005	4.4	<0.0005
	2012	0.026	0.0005	0.35	0.054	7.1	<0.005	4.4	<0.0005
	2013	0.022	<0.0005	0.21	0.028	7.1	<0.005	4.2	<0.0005
	2014	0.022		0.31	0.038	7.0	<0.005	3.7	
Benchmark Calculation (t-statistic = 1.6883, df= 36, 1-tailed, p=0.05; t-statistic = 1.6896, df= 35, 1-tailed, p=0.05)									
Mean of Means		0.030	0.0005	0.15	0.030	6.9	0.006	5.1	0.0005
Standard Deviation of Means		0.016	0.0001	0.19	0.039	0.2	0.0015	0.8	0.0000
95% Confidence Limit		**0.057**	**0.0007**	**0.48**	**0.095**	**6.6**	**0.008**	**6.4**	**0.0005**

[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).

[b] Samples collected up to November 2014.

Table E.2: Annual mean reference station wetland water quality and 95% confidence limits[a], 2003 - 2014[b].

Station	Year	Ba (mg/L)	Co (mg/L)	Fe (mg/L)	Mn (mg/L)	pH	Ra (Bq/L)	SO4 (mg/L)	U (mg/L)
SR-16	2003	0.008	0.0004	0.65	0.052	5.8	0.006	2.5	<0.0005
	2004	0.007	0.0004	0.52	0.050	5.1	0.006	1.7	<0.0005
	2005	0.005	0.0003	0.33	0.032	5.4	<0.005	2.3	<0.0005
	2006	0.006	0.0006	0.59	0.040	5.4	<0.005	2.1	<0.0005
	2007	0.007	<0.0005	0.45	0.045	5.5	<0.005	2.7	<0.0005
	2008	0.006	<0.0005	0.29	0.026	5.5	<0.005	2.4	<0.0005
	2009	0.006	<0.0005	0.32	0.027	5.8	<0.005	2.1	<0.0005
	2010	0.007	0.0008	1.58	0.055	5.4	<0.005	1.1	<0.0005
	2011	0.008	0.0007	0.83	0.049	5.6	<0.005	1.2	<0.0005
	2012	0.007	0.0005	0.59	0.034	5.8	0.006	1.7	<0.0005
	2013	0.007	0.0008	1.11	0.057	5.4	0.005	1.4	<0.0005
	2014	0.007		0.77	0.045	5.5	<0.005	1.1	
SR-17	2003	0.017	0.0006	0.38	0.049	5.2	0.006	5.4	<0.0005
	2004	0.017	0.0009	1.06	0.048	5.5	<0.005	3.5	<0.0005
	2005	0.017	0.0006	0.32	0.036	5.5	0.005	4.4	<0.0005
	2006	0.017	0.0008	1.33	0.042	5.7	<0.005	3.4	<0.0005
	2007	0.022	0.0008	1.00	0.044	5.5	0.006	3.6	<0.0005
	2008	0.015	0.0006	0.44	0.039	5.6	<0.005	3.4	<0.0005
	2009	0.011	0.0006	0.54	0.029	5.6	<0.005	2.8	<0.0005
	2010	0.014	0.0008	1.05	0.044	5.5	0.005	2.7	<0.0005
	2011	0.015	0.0012	1.24	0.079	5.6	<0.005	2.5	<0.0005
	2012	0.020	0.0011	2.14	0.064	5.7	0.005	2.4	<0.0005
	2013	0.018	0.0010	1.54	0.053	5.6	0.005	2.8	<0.0005
	2014	0.018		1.19	0.067	5.4	<0.005	2.8	
Benchmark Calculation (t-statistic = 1.7139, df = 23, 1-tailed, p=0.05; t-statistic = 1.7172, df = 23, 1-tailed, p=0.05)									
Mean of Means		0.012	0.0007	0.84	0.046	5.5	0.005	2.6	<0.0005
Standard Deviation of Means		0.006	0.0002	0.49	0.013	0.2	0.0004	1.0	0.0000
95% Confidence Limit		**0.021**	**0.0011**	**1.68**	**0.068**	**5.2**	**0.006**	**4.3**	**<0.0005**

[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).

[b] Samples collected up to November 2014.

Appendix Table E.3: Water quality at reference station D-4 from 2010-2014.

Date m/d/yr	Ba mg/L	Hardness mg/L	Co mg/L	Fe mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	U mg/L
04-05-10	0.014	9.6	< 0.0005	0.03	0.011	6.9	< 0.005	4.0	< 0.0005
08-11-10	0.014	10.3	< 0.0005	0.05	0.029	7.0	< 0.005	4.6	< 0.0005
11-05-11	0.015	9.8	0.0005	0.04	0.015	6.6	< 0.005	4.4	< 0.0005
14-11-11	0.013	10.0	< 0.0005	0.04	0.021	7.0	< 0.005	4.3	< 0.0005
07-05-12	0.013	10.7	< 0.0005	< 0.02	0.008	6.8	< 0.005	4.6	< 0.0005
01-11-12	0.013	10.6	< 0.0005	0.04	0.02	7.1	< 0.005	4.4	< 0.0005
02-05-13	0.012	10.3	< 0.0005	< 0.02	0.005	6.7	< 0.005	4.2	< 0.0005
14-11-13	0.013	10.5	< 0.0005	0.05	0.029	6.8	< 0.005	4.4	< 0.0005
05-05-14	0.013	10.1	< 0.0005	< 0.02	0.006	7.4	< 0.005	3.8	< 0.0005
06-11-14	0.013	9.8	< 0.0005	0.03	0.014	6.9	< 0.005	5.4	< 0.0005
Number	10	10	10	10	10	10	10	10	10
Maximum	0.015	10.7	0.0005	0.05	0.029	7.4	< 0.005	5.4	< 0.0005
Minimum	0.012	9.6	< 0.0005	< 0.02	0.005	6.6	< 0.005	3.8	< 0.0005
Mean	0.013	10.2	< 0.0005	0.03	0.016	6.9	< 0.005	4.4	< 0.0005
St. Dev.	0.001	0.37	0.0000	0.01	0.009	0.2	< 0.000	0.4	< 0.0000
Median	0.013	10.2	< 0.0005	0.04	0.015	6.9	< 0.005	4.4	< 0.0005
10th Percentile	0.013	9.8	< 0.0005	0.02	0.006	6.7	< 0.005	4.0	< 0.0005
95th Percentile	0.015	10.7	0.0005	0.05	0.029	7.3	< 0.005	5.0	< 0.0005

Appendix Table E.4: Water quality at reference station SR-18 from 2010-2014.

Date m/d/yr	Ba mg/L	Hardness mg/L	Co mg/L	Fe mg/L	Mn mg/L	pH	Ra mg/L	SO4 mg/L	U mg/L
03-05-10	0.049	11	< 0.0005	0.02	0.009	6.8	< 0.005	5.7	< 0.0005
17-11-10	0.055	15.9	< 0.0005	0.07	0.033	6.9	< 0.005	5.6	< 0.0005
18-05-11	0.048	12.2	< 0.0005	0.03	0.009	6.8	< 0.005	5.2	< 0.0005
16-11-11	0.056	12.6	< 0.0005	0.09	0.027	6.9	< 0.005	5.5	< 0.0005
07-05-12	0.047	12	< 0.0005	0.02	0.008	6.5	0.006	5.6	< 0.0005
22-11-12	0.056	13.1	< 0.0005	0.05	0.012	7.1	0.006	6.1	< 0.0005
09-05-13	0.050	10.5	< 0.0005	0.04	0.009	6.5	< 0.005	5.0	< 0.0005
26-11-13	0.051	11	< 0.0005	0.07	0.041	7.5	< 0.005	5.0	< 0.0005
05-05-14	0.043	10.1	< 0.0005	0.05	0.01	7.3	< 0.005	3.9	< 0.0005
26-11-14	0.043	10.9	< 0.0005	0.09	0.015	6.5	< 0.005	4.7	< 0.0005
Number	10	10	10	10	10	10	10	10	10
Maximum	0.056	15.9	< 0.0005	0.09	0.041	7.5	0.006	6.1	< 0.0005
Minimum	0.043	10.1	< 0.0005	0.02	0.008	6.5	< 0.005	3.9	< 0.0005
Mean	0.05	11.9	< 0.0005	0.05	0.017	6.9	0.005	5.2	< 0.0005
St. Dev.	0.005	1.69	0.0000	0.03	0.012	0.3	0.0004	0.6	0.0000
Median	0.050	11.5	< 0.0005	0.05	0.011	6.9	0.005	5.4	< 0.0005
10th Percentile	0.043	10.5	< 0.0005	0.02	0.009	6.5	0.005	4.6	< 0.0005
95th Percentile	0.056	14.6	< 0.0005	0.09	0.037	7.4	0.006	5.9	< 0.0005

Appendix Table E.5: Water quality at reference station SR-19 from 2010-2014.

Date m/d/yr	Ba mg/L	Hardness mg/L	Co mg/L	Fe mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	U mg/L
11-02-10	0.025	20.2	< 0.0005	0.33	0.022	6.7	< 0.005	5.3	< 0.0005
18-05-10	0.025	18.6	< 0.0005	0.24	0.060	6.9	< 0.005	4.3	< 0.0005
16-08-10	0.035	24.1	< 0.0005	0.64	0.185	6.5	< 0.005	4.3	< 0.0005
17-11-10	0.022	16.6	< 0.0005	0.18	0.025	7.1	< 0.005	4.2	< 0.0005
14-02-11	0.023	17.4	< 0.0005	0.28	0.020	7.0	< 0.005	4.7	< 0.0005
18-05-11	0.020	17.9	< 0.0005	0.12	0.023	6.8	< 0.005	4.5	< 0.0005
17-08-11	0.030	22	< 0.0005	0.38	0.046	6.9	< 0.005	4.2	< 0.0005
16-11-11	0.022	13.7	< 0.0005	0.20	0.025	7.0	< 0.005	4.3	< 0.0005
13-02-12	0.023	17.8	< 0.0005	0.13	0.041	6.8	< 0.005	4.4	< 0.0005
16-05-12	0.024	17.9	< 0.0005	0.17	0.037	7.4	< 0.005	4.4	< 0.0005
09-08-12	0.035	26.2	0.0005	0.89	0.104	7.1	< 0.005	4.2	< 0.0005
22-11-12	0.022	14.2	< 0.0005	0.20	0.033	7.2	< 0.005	4.6	< 0.0005
20-02-13	0.023	16.9	< 0.0005	0.21	0.021	7.1	< 0.005	4.7	< 0.0005
09-05-13	0.022	14.6	< 0.0005	0.14	0.023	7.0	< 0.005	4.2	< 0.0005
21-08-13	0.023	18.1	< 0.0005	0.27	0.038	7.2	< 0.005	4.0	< 0.0005
25-11-13	0.020	15.1	< 0.0005	0.20	0.028	7.2	< 0.005	3.8	< 0.0005
24-02-14	0.022	17.4	< 0.0005	0.38	0.018	7.1	< 0.005	3.9	< 0.0005
22-05-14	0.018	10.6	< 0.0005	0.12	0.025	7.2	< 0.005	3.5	< 0.0005
19-08-14	0.032	21.6	< 0.0005	0.51	0.083	7.1	< 0.005	4.0	< 0.0005
26-11-14	0.016	10.3	< 0.0005	0.23	0.025	6.6	< 0.005	3.2	< 0.0005
Number	20	20	20	20	20	20	20	20	20
Maximum	0.035	26.2	< 0.0005	0.89	0.185	7.4	< 0.005	5.3	< 0.0005
Minimum	0.016	10.3	< 0.0005	0.12	0.018	6.5	< 0.005	3.2	< 0.0005
Mean	0.024	17.56	< 0.0005	0.29	0.044	7.0	< 0.005	4.2	< 0.0005
St. Dev.	0.005	4.0	0.0000	0.19	0.04	0.2	0.000	0.5	0.0000
Median	0.023	17.6	< 0.0005	0.22	0.027	7.1	< 0.005	4.3	< 0.0005
10th Percentile	0.020	13.4	< 0.0005	0.13	0.021	6.7	< 0.005	3.8	< 0.0005
95th Percentile	0.035	24.2	< 0.0005	0.65	0.108	7.2	< 0.005	4.7	< 0.0005

Appendix Table E.6: Water quality at reference station SR-16 from 2010-2014.

Date m/d/yr	Ba mg/L	Hardness mg/L	Co mg/L	Fe mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	U mg/L
18-01-10	0.008	9.7	0.0006	1.32	0.053	5.0	< 0.005	1.6	< 0.0005
14-04-10	0.005	6.2	< 0.0005	0.24	0.018	5.7	< 0.005	1.6	< 0.0005
21-07-10	< 0.005	8.5	0.0008	2.02	0.057	5.3	< 0.005	0.6	< 0.0005
13-10-10	0.009	13.1	0.0012	2.73	0.092	5.4	< 0.005	0.7	< 0.0005
12-01-11	0.008	12.7	0.0008	1.03	0.054	5.6	< 0.005	1.6	< 0.0005
13-04-11	< 0.005	4.9	< 0.0005	0.33	0.039	5.4	< 0.005	1.7	< 0.0005
07-07-11	0.009	9.2	0.0008	1.92	0.055	5.4	< 0.005	0.7	< 0.0005
06-10-11	0.008		0.0005	< 0.02	0.047	6.1	< 0.005	0.7	< 0.0005
12-01-12	0.008	9.1	0.0005	0.85	0.051	5.9	< 0.005	2.0	< 0.0005
16-04-12	0.008	7.4	< 0.0005	0.15	0.012	5.7	< 0.005	3.0	< 0.0005
11-07-12	0.006	7	0.0006	0.79	0.042	5.7	< 0.005	0.8	< 0.0005
10-10-12	0.006	7.3	< 0.0005	0.56	0.03	5.8	0.010	1.0	< 0.0005
14-01-13	0.010	10.9	0.0011	1.50	0.101	5.0	< 0.005	2.1	< 0.0005
17-04-13	< 0.005	5.3	< 0.0005	0.28	0.021	5.3	< 0.005	2.3	< 0.0005
10-07-13	0.006	8.9	0.001	1.75	0.065	5.5	< 0.005	0.8	< 0.0005
09-10-13	0.008	8.3	< 0.0005	0.91	0.039	5.6	< 0.005	0.4	< 0.0005
12-02-14	0.009	9.1	0.0012	1.57	0.104	5.5	< 0.005	0.9	< 0.0005
14-05-14	< 0.005	4.6	< 0.0005	0.26	0.014	5.4	< 0.005	1.5	< 0.0005
13-08-14	0.005	6.7	0.0006	0.78	0.043	5.4	< 0.005	0.5	< 0.0005
24-11-14	0.008	7.2	< 0.0005	0.47	0.019	5.6	< 0.005	1.5	< 0.0005
Number	20	19	20	20	20	20	20	20	20
Maximum	0.010	13.1	0.0012	2.73	0.104	6.1	0.010	3.0	< 0.0005
Minimum	< 0.005	4.6	< 0.0005	< 0.02	0.012	5.0	< 0.005	0.4	< 0.0005
Mean	0.007	8.2	0.0007	0.97	0.048	5.5	0.005	1.3	< 0.0005
St. Dev.	0.002	2.4	0.0003	0.74	0.027	0.3	0.001	0.7	0.0000
Median	0.006	8.3	0.0006	0.78	0.039	5.5	0.005	1.0	< 0.0005
10th Percentile	0.005	5.2	0.0005	0.28	0.018	5.2	0.005	0.5	< 0.0005
95th Percentile	0.010	12.7	0.0012	1.68	0.103	5.7	0.008	2.2	< 0.0005

Appendix Table E.7: Water quality at reference station SR-17 from 2010-2014.

Date m/d/yr	Ba mg/L	Hardness mg/L	Co mg/L	Fe mg/L	Mn mg/L	pH	Ra Bq/L	SO4 mg/L	U mg/L
18-01-10	0.013	10.4	0.0008	1.10	0.052	5.3	< 0.005	3.4	< 0.0005
14-04-10	0.013	8.3	< 0.0005	0.29	0.018	5.7	< 0.005	3.7	< 0.0005
21-07-10	0.018	10.1	0.0011	1.70	0.069	5.4	< 0.005	1.4	< 0.0005
13-10-10	0.013	9.2	0.0006	1.11	0.035	5.4	0.005	2.4	< 0.0005
12-01-11	0.016	11.1	0.001	0.82	0.049	5.5	< 0.005	4.1	< 0.0005
13-04-11	0.010	6.6	0.001	0.28	0.115	5.6	< 0.005	3.4	< 0.0005
07-07-11	0.018	10.3	0.002	3.28	0.112	5.5	< 0.005	1.0	< 0.0005
06-10-11	0.017		0.0007	0.57	0.041	5.7	< 0.005	1.6	< 0.0005
12-01-12	0.015	9.4	0.0009	1.00	0.060	5.8	< 0.005	3.8	< 0.0005
16-04-12	0.017	10.0	< 0.0005	0.31	0.022	5.7	< 0.005	4.2	< 0.0005
11-07-12	0.028	15.9	0.0022	6.19	0.113	5.5	< 0.005	0.8	< 0.0005
21-08-12	0.024	14.1	0.0013	2.50	0.088	5.6	< 0.005	0.9	< 0.0005
10-10-12	0.017	11.3	0.0006	0.71	0.039	5.8	0.007	2.1	< 0.0005
14-01-13	0.019	12.0	0.0009	0.62	0.053	5.7	< 0.005	4.4	< 0.0005
17-04-13	0.019	9.9	< 0.0005	0.45	0.03	5.4	< 0.005	4.4	< 0.0005
10-07-13	0.019	11.9	0.002	4.09	0.094	5.7	< 0.005	1.1	< 0.0005
09-10-13	0.016	8.0	0.0006	0.99	0.033	5.4	< 0.005	1.4	< 0.0005
06-02-14	0.019	11.3	0.0013	1.14	0.083	5.6	< 0.005	2.4	< 0.0005
14-05-14	0.012	6.0	< 0.0005	0.24	0.017	5.4	< 0.005	3.2	< 0.0005
13-08-14	0.029	16.3	0.002	2.82	0.116	5.3	< 0.005	2.3	< 0.0005
24-11-14	0.012	7.1	0.0007	0.56	0.051	5.4	< 0.005	3.2	< 0.0005
Number	21	20	21	21	21	21	21	21	21
Maximum	0.029	16.3	0.0022	6.19	0.116	5.8	0.007	4.4	< 0.0005
Minimum	0.01	6.0	< 0.0005	0.24	0.017	5.3	< 0.005	0.8	< 0.0005
Mean	0.017	10.5	0.0010	1.47	0.061	5.5	0.005	2.6	< 0.0005
St. Dev.	0.005	2.7	0.0006	1.52	0.034	0.2	0.000	1.2	0.0000
Median	0.017	10.2	0.0009	0.99	0.052	5.5	0.005	2.4	< 0.0005
10th Percentile	0.012	7.1	0.0005	0.29	0.022	5.4	0.005	1.0	< 0.0005
95th Percentile	0.028	15.9	0.0020	4.09	0.115	5.8	0.005	4.4	< 0.0005

Appendix Table E.8: Water quality at station D-5 from 2010-2014.

Date m/d/yr	Ba mg/L	Hard mg/L	Co mg/L	pH	Ra Bq/L	SO4[a] mg/L	U mg/L
Benchmark	1.0	-		6.5	1.0	128	0.015
2/1/2010	0.026	20.7	< 0.0005	7.1	0.017	12	0.0011
5/4/2010	0.058	52.2	< 0.0005	7.1	0.065	42	0.0037
8/9/2010	0.170	38.5	< 0.0005	6.7	0.220	29	0.0045
11/8/2010	0.050	23.1	< 0.0005	7.2	0.028	15	0.0016
2/10/2011	0.027	19.3	< 0.0005	6.9	0.015	13	0.0010
5/11/2011	0.034	18.4	< 0.0005	6.6	0.025	11	0.0014
8/11/2011	0.165	24.4	< 0.0005	7.0	0.125	14	0.0015
11/14/2011	0.044	17.5	< 0.0005	6.8	0.050	10	0.0006
2/6/2012	0.028	36.7	< 0.0005	6.6	0.037	25	0.0030
5/7/2012	0.053	25.2	< 0.0005	6.9	0.046	16	0.0017
8/2/2012	0.246	40.2	< 0.0005	7.0	0.184	25	0.0026
11/1/2012	0.071	43.6	< 0.0005	7.2	0.075	34	0.0028
2/4/2013	0.025	20.5	< 0.0005	7.0	0.020	13	0.0014
5/2/2013	0.033	27.6	< 0.0005	6.6	0.024	17	0.0026
8/19/2013	0.069	26.8	< 0.0005	7.1	0.080	17	0.0019
11/14/2013	0.033	15.3	< 0.0005	7.0	0.025	9	0.0007
2/3/2014	0.029		< 0.0005	6.9	0.020	15	0.0016
5/5/2014	0.027		< 0.0005	7.4	0.020	9	0.0006
8/5/2014	0.136		< 0.0005	7.1	0.129	18	0.0021
11/6/2014	0.043		< 0.0005	6.9	0.043	18	0.0023
Number	20	16	20	20	20	20	20
Maximum	0.246	52.2	< 0.0005	7.4	0.22	42	0.0045
Minimum	0.025	15.3	< 0.0005	6.6	0.015	9	0.0006
Mean	0.068	28.1	< 0.0005	7.0	0.062	18	0.0019
St. Dev.	0.061	10.8	0.0000	0.2	0.059	8.8	0.001
Median	0.044	24.8	< 0.0005	7.000	0.040	15.50	0.0017
10th Percentile	0.027		< 0.0005	6.600	0.020	9.87	0.0007
95th Percentile	0.174	45.8	< 0.0005	7.210	0.186	34.40	0.0037

Shaded values exceed benchmark

[a] Benchmark dependent on water hardness. See Table 2.8 for details.

Appendix Table E.9: Water quality at station D-6 from 2010-2014.

Date m/d/yr	Ba mg/L	Hardness mg/L	Co mg/L	Fe mg/L	Mn[a] mg/L	pH	Ra Bq/L	SO4[a] mg/L	U mg/L
Benchmark	1.0	-		0.48	0.8	6.5	1.0	309	0.015
2/8/2010	0.016	28.1	< 0.0005	0.18	0.11	6.5	< 0.005	23	< 0.0005
5/10/2010	0.022	85.7	0.0007	0.43	0.456	6.6	0.011	73	< 0.0005
8/9/2010	0.026	144	0.0012	0.75	0.536	6.5	0.007	130	0.0009
11/8/2010	0.013	34.4	< 0.0005	0.14	0.072	6.7	0.005	21	< 0.0005
2/10/2011	0.015	35.5	< 0.0005	0.26	0.176	6.6	< 0.005	25	< 0.0005
5/11/2011	0.013	23	< 0.0005	0.13	0.09	6.5	< 0.005	16	< 0.0005
8/11/2011	0.036	254	0.0014	2.5	1.64	6.6	0.025	210	< 0.0005
11/15/2011	0.012	31.1	< 0.0005	0.12	0.048	6.9	< 0.005	24	< 0.0005
2/13/2012	0.014	24.7	< 0.0005	0.19	0.101	6.5	< 0.005	16	< 0.0005
5/7/2012	0.016	55	< 0.0005	0.24	0.171	6.5	0.009	46	< 0.0005
8/2/2012	0.048	311	0.0022	1.92	1.54	6.6	0.015	250	< 0.0005
11/1/2012	0.020	73.8	< 0.0005	0.18	0.091	7.1	0.011	67	< 0.0005
2/4/2013	0.014	24.5	< 0.0005	0.13	0.084	6.7	< 0.005	16	< 0.0005
5/2/2013	0.012	22.7	< 0.0005	0.33	0.097	6.5	0.006	16	< 0.0005
8/19/2013	0.013	30.5	< 0.0005	0.26	0.102	6.6	0.008	22	< 0.0005
11/14/2013	0.013	25.3	< 0.0005	0.14	0.082	6.6	< 0.005	16	< 0.0005
2/11/2014	0.016	24.2	< 0.0005	0.27	0.123	6.6	< 0.005	15	< 0.0005
5/12/2014	0.013	18.9	< 0.0005	0.16	0.087	6.5	< 0.005	13	< 0.0005
8/14/2014	0.025	102	0.0009	0.79	0.594	6.6	0.009	87	< 0.0005
11/6/2014	0.012	23.5	< 0.0005	0.15	0.057	6.8	< 0.005	17	< 0.0005
Number	20	20	20	20	20	20	20	20	20
Maximum	0.048	311.0	0.0022	2.5	1.64	7.1	0.025	250	0.0009
Minimum	0.012	18.9	< 0.0005	0.12	0.048	6.5	< 0.005	13	0.0005
Mean	0.018	68.6	0.0007	0.46	0.313	6.6	0.008	55.1	0.0005
St. Dev.	0.009	80.7	0.0004	0.63	0.466	0.2	0.005	67.6	0.0001
Median	0.015	30.8	0.0005	0.22	0.102	6.6	0.005	22.5	0.0005
10th Percentile	0.012		< 0.0005	0.13	0.071	6.5	0.005	15.9	0.0005
95th Percentile	0.037	256.9	0.0014	1.95	1.545	6.9	0.016	212	0.0005

Shaded values exceed benchmark

[a] Benchmark dependent on water hardness. See Table 2.8 for details.

Appendix Table E.10: Water quality at station DS-18 from 2010-2014.

Date m/d/yr	Ba mg/L	Fe mg/L	Hard mg/L	Co mg/L	pH	Ra Bq/L	SO4[a] mg/L	U mg/L
Benchmark	1.0	1.68	-		5.2	1.0	309	0.015
2/16/2010	0.015	0.37	98	< 0.0005	7.0	0.120	84	0.0005
5/18/2010	0.018	0.16	172	< 0.0005	7.0	0.170	130	0.0007
8/17/2010	0.012	0.12	129	< 0.0005	7.3	0.083	85	0.0044
11/9/2010	0.022	0.14	216	< 0.0005	7.2	0.250	170	0.0027
2/15/2011	0.014	0.62	123	0.0006	7.0	0.134	100	0.0014
5/17/2011	0.014	0.21	112	< 0.0005	7.0	0.085	87	0.0006
8/9/2011	0.008	0.09	92	< 0.0005	7.3	0.065	59	0.0028
11/16/2011	0.017	0.13	139	< 0.0005	7.1	0.134	100	0.0018
2/14/2012	0.012	0.19	116	< 0.0005	6.6	0.090	89	0.0006
5/9/2012	0.014	0.13	122	< 0.0005	7.1	0.103	89	0.0007
8/13/2012	0.006	0.11	79	< 0.0005	7.5	0.047	45	0.0029
11/13/2012	0.012	0.23	100	< 0.0005	7.3	0.098	71	0.0036
2/19/2013	0.018	0.49	136	< 0.0005	7.2	0.146	110	0.0013
5/14/2013	0.018	0.28	109	< 0.0005	7.2	0.095	91	0.0010
8/19/2013	0.012	0.25	115	< 0.0005	7.2	0.085	89	0.0017
11/21/2013	0.014	0.28	116	< 0.0005	7.2	0.085	100	0.0009
2/11/2014	0.021	5.99	163	0.0014	7.0	0.158	140	0.0033
3/4/2014	0.038	2.20	238	0.0011	6.8	0.246	220	0.0022
4/9/2014	0.031	2.18	237	0.0027	6.8	0.237	210	0.0032
5/14/2014	0.019	0.22	80	< 0.0005	6.6	0.078	61	0.0005
8/14/2014	0.009	0.07	54	< 0.0005	7.1	0.056	26	0.0006
11/25/2014	0.015	0.42	80	< 0.0005	6.6	0.111	67	0.0006
Number	22	22	22	22	22	22	22	22
Maximum	0.038	5.99	238	0.0027	7.5	0.25	220	0.0044
Minimum	0.006	0.07	53.5	< 0.0005	6.6	0.047	26	0.0005
Mean	0.016	0.68	128.4	0.0007	7.0	0.122	101	0.0017
St. Dev.	0.007		49.6	0.0005	0.2	0.059	48.2	0.0012
Median	0.018	0.28	115	0.0005	7.0	0.095	91	0.0010
10th Percentile	0.011	0.19	74.3	< 0.0005	6.6	0.074	54	0.0006
95th Percentile	0.035	4.47	237.6	0.0014	7.2	0.242	216	0.0033

Shaded values exceed benchmark

[a] Benchmark dependent on water hardness. See Table 2.8 for details.

Appendix Table E.11: Water quality at station M-01 from 2010-2014.

Date m/d/yr	Ba mg/L	Fe mg/L	Hard mg/L	Co mg/L	pH	Ra Bq/L	SO4[a] mg/L	U mg/L
Benchmark	1.0	1.68	-		5.2	1.0	218	0.015
2/17/2010	0.028	0.68	42.3	0.0009	6.2	0.022	18	0.0040
5/17/2010	0.018	0.53	40.8	0.0006	6.7	0.028	14	0.0035
8/16/2010	0.024	1.10	63.2	0.0013	6.7	0.036	6	0.0069
11/15/2010	0.015	0.29	37.6	< 0.0005	7.1	0.015	12	0.0030
2/23/2011	0.019	0.80	45.5	0.0006	6.7	0.025	18	0.0039
5/16/2011	0.016	0.36	37.3	< 0.0005	6.9	0.014	13	0.0024
8/15/2011	0.014	0.72	47.1	< 0.0005	6.7	0.011	7	0.0027
11/21/2011	0.016	0.34	37.9	< 0.0005	6.6	0.013	14	0.0023
2/21/2012	0.017	0.56	39.0	0.0005	7.1	0.016	15	0.0039
5/23/2012	0.019	0.98	38.4	0.0009	6.8	0.025	12	0.0040
8/27/2012	0.023	1.28	49.5	< 0.0005	6.5	0.026	7	0.0037
11/19/2012	0.015	0.35	41.5	< 0.0005	6.5	0.023	21	0.0031
2/25/2013	0.019	0.63	43.6	0.0006	6.7	0.025	17	0.0058
5/21/2013	0.018	0.47	34.8	< 0.0005	6.9	0.026	14	0.0029
8/22/2013	0.018	0.84	38.6	< 0.0005	6.4	0.024	11	0.0024
11/11/2013	0.013	0.31	29.1	< 0.0005	7.0	0.014	10	0.0029
2/20/2014	0.016	0.73		< 0.0005	6.5	0.018	14	0.0034
5/21/2014	0.014	0.26		< 0.0005	7.3	0.014	10	0.0026
8/18/2014	0.013	1.92		< 0.0005	6.6	0.012	6	0.0034
11/20/2014	0.017	0.38		< 0.0005	7.2	0.011	11	0.0034
Number	20	20	16	20	20	20	20	20
Maximum	0.028	1.92	63.2	0.0013	7.3	0.036	21	0.0069
Minimum	0.013	0.26	29.1	< 0.0005	6.2	0.011	6	0.0023
Mean	0.018	0.68	41.6	0.0006	6.8	0.020	12.5	0.0035
St. Dev.	0.004	0.41	7.6	0.0002	0.3	0.007	4.2	0.0011
Median	0.017	0.60	39.9	0.0005	6.7	0.020	12.5	0.0034
10th Percentile	0.014		36.1	< 0.0005	6.5	0.012	6.6	0.0024
95th Percentile	0.024	1.31	52.9	0.0009	7.2	0.028	18.2	0.0059

Shaded values exceed benchmark

[a] Benchmark dependent on water hardness. See Table 2.8 for details.

Appendix Table E.12: Water quality at station Q-09 from 2010-2014.

Date m/d/yr	Ba mg/L	Hard mg/L		Co mg/L	pH	Ra Bq/L	SO4[a] mg/L		U mg/L
Benchmark	1.0	-			6.5	1.0	218		0.015
2/1/2010	0.032	78.6		0.0007	6.7	0.027	65		0.0031
5/4/2010	0.094	120		0.0009	6.9	0.150	110		0.0058
8/9/2010	0.144	180		0.0009	6.7	0.100	170		0.0061
11/8/2010	0.052	65.2	<	0.0005	6.8	0.045	56		0.0032
2/10/2011	0.035	95.5		0.0007	6.7	0.027	76		0.0031
5/11/2011	0.039	33.4	<	0.0005	6.5	0.039	24		0.0022
6/13/2011		60.8	<	0.0005	6.7	0.080	49		0.0029
8/11/2011	0.023	15.9	<	0.0005	6.8	0.142	59	<	0.001
11/14/2011	0.041	51.7	<	0.0005	6.6	0.045	43		0.0012
2/6/2012	0.031	80.8		0.0006	6.5	0.022	69		0.0035
5/7/2012	0.065	72.7	<	0.0005	6.8	0.075	64		0.0035
8/2/2012	0.324	93.2	<	0.0005	6.9	0.266	77		0.0046
11/1/2012	0.070	107	<	0.0005	7.2	0.062	100		0.0036
2/4/2013	0.027	65.8	<	0.0005	6.8	0.021	60		0.0027
5/2/2013	0.033	26.2	<	0.0005	6.5	0.025	19		0.0026
8/19/2013	0.083	58.8	<	0.0005	7.1	0.091	48		0.0031
11/14/2013	0.033	29.6	<	0.0005	6.8	0.026	21		0.0015
2/3/2014	0.033	70.2	<	0.0005	6.7	0.029	58		0.0022
5/5/2014	0.028	22.7	<	0.0005	7.5	0.025	15		0.0014
8/5/2014	0.189	50.2	<	0.0005	6.9	0.184	36		0.0027
11/6/2014	0.040	46.3	<	0.0005	6.9	0.033	39		0.0021
Number	20	21		21	21	21	21		21
Maximum	0.324	180		0.0009	7.5	0.266	170		0.0061
Minimum	0.023	15.9	<	0.0005	6.5	0.021	15	<	0.001
Mean	0.071	67.8		0.0006	6.8	0.072	59.9		0.0029
St. Dev.	0.073	38		0.0001	0.2	0.065	35.3		0.0014
Median	0.040			0.0005	6.8	0.045	58		0.0029
10th Percentile	0.028	26.2	<	0.0005	6.5	0.025	21		0.0014
95th Percentile	0.196	120.0		0.0009	7.2	0.184	110		0.0058

Shaded values exceed benchmark

[a] Benchmark dependent on water hardness. See Table 2.8 for details.

Appendix Table E.13: Water quality at station Q-20 from 2010-2014.

Date m/d/yr	Ba mg/L	Hard mg/L	Co mg/L	pH	Ra Bq/L	SO4[a] mg/L	U mg/L
Benchmark	1.0	-		6.5	1.0	218	0.015
11/16/2010	0.021	38.3	< 0.0005	7.0	< 0.005	23	< 0.0005
11/17/2011	0.019	37.5	< 0.0005	7.3	0.006	22	< 0.0005
11/22/2012	0.021	40.2	< 0.0005	7.3	0.007	22	< 0.0005
11/25/2013	0.021	39.5	< 0.0005	7.2	< 0.005	21	< 0.0005
11/18/2014	0.018		< 0.0005	7.0	< 0.005	21	< 0.0005
Number	5	4	5	5	5	5	5
Maximum	0.021	40.2	0.0005	7.3	0.007	23	< 0.0005
Minimum	0.018	37.5	< 0.0005	7.0	< 0.005	21	< 0.0005
Mean	0.020	38.9	< 0.0005	7.2	0.006	21.8	< 0.0005
St. Dev.	0.001	1.2	0.0000	0.2	0.001	0.8	0
Median	0.021	38.9	< 0.0005	7.2	0.005	22.0	< 0.0005
10th Percentile	0.018	37.7	< 0.0005	7.0	0.005	21.0	< 0.0005
95th Percentile	0.021	40.1	< 0.0005	7.3	0.007	22.8	< 0.0005

Shaded values exceed benchmark

[a] Benchmark dependent on water hardness. See Table 2.8 for details.

Appendix Table E.14: Water quality at station SC-01 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Fe mg/L	Hard mg/L	pH	Ra Bq/L	SO4[a] mg/L	U mg/L
Benchmark	1.0		1.68	-	5.2	1.0	218	0.015
11/8/2010	0.012	< 0.0005	0.12	33.2	7.0	< 0.005	24	< 0.0005
11/16/2011	0.040	< 0.0005	0.08	36.5	7.1	0.027	27	< 0.0005
11/22/2012	0.014	< 0.0005	0.08	39.5	7.2	0.010	31	< 0.0005
11/25/2013	0.012	< 0.0005	0.12	33.8	7.1	< 0.005	23	< 0.0005
11/18/2014	0.010	< 0.0005	0.12		7.0	0.006	21	< 0.0005
Number	5	5	5	4	5	5	5	5
Maximum	0.040	0.0005	0.12	39.5	7.2	0.027	31	< 0.0005
Minimum	0.010	< 0.0005	0.08	33.2	7.0	< 0.005	21	< 0.0005
Mean	0.018	< 0.0005	0.10	35.8	7.1	0.011	25	< 0.0005
St. Dev.	0.013	0.0000	0.02	2.9	0.1	0.009	3.9	0
Median	0.012	< 0.0005	0.12	35.2	7.1	0.006	24.0	0.0005
10th Percentile	0.011	< 0.0005	0.08	33.4	7.0	0.005	21.8	0.0005
95th Percentile	0.035	< 0.0005	0.12	39.1	7.2	0.024	30.2	0.0005

Shaded values exceed benchmark

[a] Benchmark dependent on water hardness. See Table 2.8 for details.

Appendix Table E.15: Water quality at station SR-01 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Hard mg/L	pH	Ra Bq/L	SO4[a] mg/L	U mg/L
Benchmark	1.0		-	6.5	1.0	218	0.015
11/11/2010	0.038	< 0.0005	54.2	6.9	0.018	48	0.0013
11/3/2011	0.038	< 0.0005	53.6	6.8	0.024	44	0.0011
11/15/2012	0.038	< 0.0005	51.9	7.2	0.019	46	0.0012
11/20/2013	0.038	< 0.0005	46.3	6.9	0.025	39	0.0012
11/3/2014	0.038	< 0.0005		6.9	0.017	34	0.0013
Number	5	5	4	5	5	5	5
Maximum	0.038	0.0005	54.2	7.2	0.025	48	0.0013
Minimum	0.038	< 0.0005	46.3	6.8	0.017	34	0.0011
Mean	0.038	< 0.0005	51.5	6.9	0.021	42	0.0012
St. Dev.	0	0.0000	3.6	0.2	0.004	5.7	0.0001
Median	0.038	< 0.0005	52.8	6.9	0.019	44.0	0.0012
10th Percentile	0.038	< 0.0005	48.0	6.8	0.0174	36.0	0.00114
95th Percentile	0.038	< 0.0005	54.1	7.1	0.025	47.6	0.0013

Shaded values exceed benchmark

[a] Benchmark dependent on water hardness. See Table 2.8 for details.

Appendix Table E.16: Water quality at station SR-06 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Hard mg/L	pH	Ra Bq/L	SO4[a] mg/L	U mg/L
Benchmark	1.0		-	6.5	1.0	309	0.015
5/13/2010	0.168	< 0.0005	94.2	6.9	0.054	84	0.0013
11/11/2010	0.184	< 0.0005	101.0	7.4	0.041	89	0.0013
5/19/2011	0.153	< 0.0005	87.5	7.0	0.033	75	0.0010
11/3/2011	0.197	< 0.0005	89.7	7.0	0.050	75	0.0009
5/17/2012	0.202	< 0.0005	83.1	7.2	0.042	66	0.0012
11/15/2012	0.186	< 0.0005	81.6	7.1	0.046	66	0.0011
5/15/2013	0.217	< 0.0005	68.3	7.3	0.041	60	0.0009
11/20/2013	0.331	< 0.0005	71.3	7.0	0.062	57	0.0010
5/26/2014	0.286	< 0.0005		6.6	0.055	49	0.0008
11/3/2014	0.339	< 0.0005		6.9	0.059	46	0.0009
Number	10	10	8	10	10	10	10
Maximum	0.339	0.0005	101.0	7.4	0.062	89	0.0013
Minimum	0.153	< 0.0005	68.3	6.6	0.033	46	0.0008
Mean	0.226	< 0.0005	84.6	7.0	0.048	67	0.0010
St. Dev.	0.067	0.0000	11.0	0.2	0.009	14	0.0002
Median	0.200	< 0.0005	85.3	7.0	0.048	66	0.0010
10th Percentile	0.167	< 0.0005	70.4	6.9	0.040	49	0.0009
95th Percentile	0.335	< 0.0005	98.6	7.4	0.061	87	0.0013

Shaded values exceed benchmark

[a] Benchmark dependent on water hardness. See Table 2.8 for details.

Appendix Table E.17: Water quality at station SR-08 from 2010-2014.

Date m/d/yr	Ba mg/L	Co mg/L	Hard mg/L	pH	Ra Bq/L	SO4[a] mg/L	U mg/L
Benchmark	1.0		-	6.5	1.0	429	0.015
2/11/2010	0.022	< 0.0005	275	6.9	0.036	250	0.0013
5/17/2010	0.021	< 0.0005	258	7.4	0.034	210	0.0015
8/16/2010	0.020	< 0.0005	261	7.2	0.029	230	0.0018
11/17/2010	0.022	< 0.0005	264	7.4	0.037	220	0.0015
2/14/2011	0.021	< 0.0005	254	7.1	0.024	230	0.0012
5/18/2011	0.019	< 0.0005	183	7.1	0.035	160	0.0009
8/17/2011	0.017	< 0.0005	206	6.8	0.043	190	0.0010
11/16/2011	0.022	< 0.0005	239	7.1	0.026	200	0.0013
2/13/2012	0.023	< 0.0005	220	6.8	0.030	180	0.0011
5/16/2012	0.019	< 0.0005	217	7.5	0.026	180	0.0012
8/9/2012	0.018	0.0005	228	6.9	0.036	190	0.0010
11/22/2012	0.021	< 0.0005	227	7.2	0.030	190	0.0012
2/20/2013	0.021	< 0.0005	233	7.2	0.031	210	0.0014
5/9/2013	0.023	< 0.0005	98	6.9	0.023	94	0.0008
8/21/2013	0.017	< 0.0005	195	7.2	0.020	180	0.0009
11/25/2013	0.019	< 0.0005	215	7.4	0.024	200	0.0010
2/24/2014	0.019	< 0.0005	220	7.1	0.026	200	0.0010
5/22/2014	0.017	< 0.0005	119	6.9	0.021	140	0.0007
8/25/2014	0.018	< 0.0005	179	7.2	0.029	150	0.0009
11/18/2014	0.017	< 0.0005	187	6.9	0.029	170	0.0009
Number	20	20	20	20	20	20	20
Maximum	0.023	0.0005	275	7.5	0.043	250	0.0018
Minimum	0.017	< 0.0005	98.0	6.8	0.020	94	0.0007
Mean	0.020	< 0.0005	214	7.1	0.029	189	0.0011
St. Dev.	0.002	0.0000	45.4	0.2	0.006	35.3	0.0003
Median	0.020	< 0.0005	220	7.1	0.029	190	0.0011
10th Percentile	0.017	0.0005	173	6.9	0.023	149	0.0009
95th Percentile	0.023	0.0005	265	7.4	0.037	231	0.0015

Shaded values exceed benchmark

[a] Benchmark dependent on water hardness. See Table 2.8 for details.

Appendix Table E.18: Summary of seasonal trends for station D-4 from 2003-2014.

Season	Spearman's rho	Ba	Fe	Mn	pH	Ra	Sulphate	U
April	Correlation Coefficient	0.162	0.691	0.685	0.236	-0.393	-0.786	0.000
	Sig. (2-tailed)	0.728	0.086	0.090	0.610	0.441	0.036	1.000
	N	7	7	7	7	6	7	7
May	Correlation Coefficient	-0.718	-0.783	-0.800	0.300	.	-0.300	
	Sig. (2-tailed)	0.172	0.118	0.104	0.624	.	0.624	
	N	5	5	5	5	5	5	
October	Correlation Coefficient	0.029	0.577	0.348	-0.265	.	-0.406	-0.393
	Sig. (2-tailed)	0.957	0.231	0.499	0.612	.	0.425	0.441
	N	6	6	6	6	6	6	6
November	Correlation Coefficient	-0.707	-0.527	-0.564	-0.564	.	0.359	
	Sig. (2-tailed)	0.182	0.361	0.322	0.322	.	0.553	
	N	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).

Significant trend where p<0.05.

Appendix Table E.19: Summary of seasonal trends for station SR-18 from 2003-2014.

Season	Spearman's rho	Ba	Fe	Mn	pH	Ra	Sulphate	U
April	Correlation Coefficient	-0.523			0.523	-0.668	-0.750	0.000
	Sig. (2-tailed)	0.229			0.229	0.101	0.052	1.000
	N	7			7	7	7	7
May	Correlation Coefficient	-0.400	0.821	0.447	0.105	0.000	-0.900	
	Sig. (2-tailed)	0.505	0.089	0.450	0.866	1.000	0.037	
	N	5	5	5	5	5	5	
October	Correlation Coefficient	0.841			-0.088	-0.414	-0.912	.
	Sig. (2-tailed)	0.036			0.868	0.414	0.011	.
	N	6			6	6	6	6
November	Correlation Coefficient	-0.667	0.211	-0.200	-0.051	0.000	-0.700	
	Sig. (2-tailed)	0.219	0.734	0.747	0.935	1.000	0.188	
	N	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).

Significant trend where p<0.05.

Appendix Table E.20: Summary of seasonal trends for station SR-19 from 2003-2014.

Season	Spearman's rho	Ba	Fe	Mn	pH	Ra	Sulphate	U
January	Correlation Coefficient	-0.857			-0.218	-0.408	-0.937	0.000
	Sig. (2-tailed)	0.014			0.638	0.363	0.002	1.000
	N	7			7	7	7	7
February	Correlation Coefficient	-0.189	0.100	-0.500	0.245	-0.480	-0.887	0.000
	Sig. (2-tailed)	0.557	0.873	0.391	0.442	0.114	0.000	1.000
	N	12	5	5	12	12	12	7
March	Correlation Coefficient	-0.270			-0.546	-0.408	-0.821	0.000
	Sig. (2-tailed)	0.558			0.205	0.363	0.023	1.000
	N	7			7	7	7	7
April	Correlation Coefficient	0.306			0.873	-0.408	0.252	.
	Sig. (2-tailed)	0.504			0.010	0.363	0.585	.
	N	7			7	7	7	7
May	Correlation Coefficient	-0.095	-0.564	-0.410	0.064	.	-0.877	0.000
	Sig. (2-tailed)	0.770	0.322	0.493	0.844	.	0.000	1.000
	N	12	5	5	12	12	12	7
June	Correlation Coefficient	0.000			-0.703	-0.158	-0.679	-0.401
	Sig. (2-tailed)	1.000			0.078	0.735	0.094	0.373
	N	7			7	7	7	7
July	Correlation Coefficient	0.036			-0.054	-0.408	-0.414	0.000
	Sig. (2-tailed)	0.939			0.908	0.363	0.355	1.000
	N	7			7	7	7	7
August	Correlation Coefficient	-0.113	-0.300	-0.500	0.716	.	-0.721	.
	Sig. (2-tailed)	0.726	0.624	0.391	0.009	.	0.008	.
	N	12	5	5	12	12	12	7
September	Correlation Coefficient	-0.739			0.764	-0.408	-0.703	.
	Sig. (2-tailed)	0.058			0.046	0.363	0.078	.
	N	7			7	7	7	7
October	Correlation Coefficient	0.090			0.631	-0.867	-0.286	.
	Sig. (2-tailed)	0.848			0.129	0.012	0.535	.
	N	7			7	7	7	7
November	Correlation Coefficient	0.278	0.894	0.224	0.493	-0.480	-0.797	.
	Sig. (2-tailed)	0.381	0.041	0.718	0.103	0.114	0.002	.
	N	12	5	5	12	12	12	7
December	Correlation Coefficient	-0.270			-0.187	-0.802	-0.721	.
	Sig. (2-tailed)	0.558			0.688	0.030	0.068	.
	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).

Significant trend where p<0.05.

Appendix Table E.21: Summary of seasonal trends for station SR-16 from 2003-2014.

Season	Spearman's rho	Ba	Fe	Mn	pH	Ra	Sulphate
January	Correlation Coefficient	0.775	0.200	0.400	0.105	.	0.949
	Sig. (2-tailed)	0.225	0.800	0.600	0.895	.	0.051
	N	4	4	4	4	4	4
April	Correlation Coefficient	0.258	0.000	0.000	-0.632	.	0.800
	Sig. (2-tailed)	0.742	1.000	1.000	0.368	.	0.200
	N	4	4	4	4	4	4
July	Correlation Coefficient	0.316	-0.800	0.200	0.800	.	0.949
	Sig. (2-tailed)	0.684	0.200	0.800	0.200	.	0.051
	N	4	4	4	4	4	4
October	Correlation Coefficient	-0.632	-0.200	-0.800	0.200	0.258	-0.316
	Sig. (2-tailed)	0.368	0.800	0.200	0.800	0.742	0.684
	N	4	4	4	4	4	4

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).

Significant trend where p<0.05.

Appendix Table E.22: Summary of seasonal trends for station SR-17 from 2003-2014.

Season	Spearman's rho	Ba	Fe	Mn	pH	Ra	Sulphate
January	Correlation Coefficient	0.800	-0.800	0.600	0.800	.	0.800
	Sig. (2-tailed)	0.200	0.200	0.400	0.200	.	0.200
	N	4	4	4	4	4	4
April	Correlation Coefficient	0.800	0.800	0.400	-0.632	.	0.800
	Sig. (2-tailed)	0.200	0.200	0.600	0.368	.	0.200
	N	4	4	4	4	4	4
July	Correlation Coefficient	0.738	0.800	0.400	0.949	.	-0.400
	Sig. (2-tailed)	0.262	0.200	0.600	0.051	.	0.600
	N	4	4	4	4	4	4
October	Correlation Coefficient	0.316	-0.200	-0.400	0.105	0.258	-0.800
	Sig. (2-tailed)	0.684	0.800	0.600	0.895	0.742	0.200
	N	4	4	4	4	4	4

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).

Significant trend where p<0.05.

Appendix Table E.23: Summary of seasonal trends for station D-5 from 2003-2014.

Season	Spearman's rho	Ba	Hardness	Fe	pH	Ra	Sulphate	U
January	Correlation Coefficient	-0.450		0.072	-0.546	-0.607	0.250	0.429
	Sig. (2-tailed)	0.310		0.878	0.205	0.148	0.589	0.337
	N	7		7	7	7	7	7
February	Correlation Coefficient	0.060		0.487	-0.283	-0.239	-0.392	-0.028
	Sig. (2-tailed)	0.854		0.268	0.373	0.455	0.208	0.931
	N	12		7	12	12	12	12
March	Correlation Coefficient	-0.180		0.643	0.018	-0.536	-0.321	0.321
	Sig. (2-tailed)	0.699		0.119	0.969	0.215	0.482	0.482
	N	7		7	7	7	7	7
April	Correlation Coefficient	-0.179		0.679	0.505	0.679	0.000	0.143
	Sig. (2-tailed)	0.702		0.094	0.248	0.094	1.000	0.760
	N	7		7	7	7	7	7
May	Correlation Coefficient	-0.203		-0.145	-0.188	-0.294	-0.350	-0.028
	Sig. (2-tailed)	0.527		0.756	0.559	0.354	0.264	0.931
	N	12		7	12	12	12	12
June	Correlation Coefficient	-0.393		-0.857	0.808	-0.613	-0.559	-0.393
	Sig. (2-tailed)	0.383		0.014	0.028	0.144	0.192	0.383
	N	7		7	7	7	7	7
July	Correlation Coefficient	-0.179		-0.445	0.118	-0.757	-0.071	-0.306
	Sig. (2-tailed)	0.702		0.317	0.801	0.049	0.879	0.504
	N	7		7	7	7	7	7
August	Correlation Coefficient	-0.497		-0.721	0.087	-0.550	-0.406	-0.172
	Sig. (2-tailed)	0.101		0.068	0.788	0.064	0.191	0.593
	N	12		7	12	12	12	12
September	Correlation Coefficient	-0.393		-0.800	0.727	0.000	-0.536	-0.536
	Sig. (2-tailed)	0.383		0.031	0.064	1.000	0.215	0.215
	N	7		7	7	7	7	7
October	Correlation Coefficient	0.643		-0.342	-0.463	-0.071	-0.429	-0.071
	Sig. (2-tailed)	0.119		0.452	0.296	0.879	0.337	0.879
	N	7		7	7	7	7	7
November	Correlation Coefficient	-0.490		0.182	0.036	-0.517	-0.469	-0.071
	Sig. (2-tailed)	0.106		0.696	0.913	0.085	0.124	0.879
	N	12		7	12	12	12	7
December	Correlation Coefficient	0.214		0.126	-0.162	-0.252	-0.847	-0.679
	Sig. (2-tailed)	0.645		0.788	0.728	0.585	0.016	0.094
	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).

[shaded box] Significant trend where p<0.05.

Appendix Table E.24: Summary of seasonal trends for station D-6 from 2003-2014.

Season	Spearman's rho	Ba	Fe	Mn	pH	Ra	Sulphate	U
January	Correlation Coefficient	-0.764	-0.607	-0.429	-0.200	-0.296	-0.643	0.000
	Sig. (2-tailed)	0.046	0.148	0.337	0.667	0.520	0.119	1.000
	N	7	7	7	7	7	7	7
February	Correlation Coefficient	-0.198	0.375	-0.203	-0.065	-0.393	-0.456	0.000
	Sig. (2-tailed)	0.538	0.230	0.527	0.842	0.206	0.136	1.000
	N	12	12	12	12	12	12	7
March	Correlation Coefficient	-0.180	0.393	-0.214	0.099	-0.204	-0.679	0.000
	Sig. (2-tailed)	0.699	0.383	0.645	0.834	0.661	0.094	1.000
	N	7	7	7	7	7	7	7
April	Correlation Coefficient	-0.704	0.250	-0.198	0.487	-0.630	-0.234	0.000
	Sig. (2-tailed)	0.077	0.589	0.670	0.268	0.129	0.613	1.000
	N	7	7	7	7	7	7	7
May	Correlation Coefficient	-0.561	-0.232	-0.350	-0.814	-0.127	-0.364	0.000
	Sig. (2-tailed)	0.058	0.469	0.265	0.001	0.694	0.244	1.000
	N	12	12	12	12	12	12	7
June	Correlation Coefficient	-0.107	0.393	0.321	0.275	0.632	-0.536	0.000
	Sig. (2-tailed)	0.819	0.383	0.482	0.550	0.127	0.215	1.000
	N	7	7	7	7	7	7	7
July	Correlation Coefficient	-0.314	0.257	-0.143	0.551	-0.348	-0.543	-0.655
	Sig. (2-tailed)	0.544	0.623	0.787	0.257	0.499	0.266	0.158
	N	6	6	6	6	6	6	6
August	Correlation Coefficient	0.301	0.555	0.409	0.285	0.119	0.209	.
	Sig. (2-tailed)	0.369	0.077	0.212	0.395	0.727	0.537	.
	N	11	11	11	11	11	11	6
September	Correlation Coefficient	0.314	0.771	0.314	0.880	0.029	-0.086	.
	Sig. (2-tailed)	0.544	0.072	0.544	0.021	0.956	0.872	.
	N	6	6	6	6	6	6	6
October	Correlation Coefficient	0.595	0.631	0.071	0.741	0.396	0.107	.
	Sig. (2-tailed)	0.159	0.129	0.879	0.057	0.379	0.819	.
	N	7	7	7	7	7	7	7
November	Correlation Coefficient	-0.421	0.014	-0.406	-0.370	-0.456	-0.448	.
	Sig. (2-tailed)	0.173	0.965	0.190	0.236	0.136	0.144	.
	N	12	12	12	12	12	12	7
December	Correlation Coefficient	-0.342	0.000	-0.643	-0.808	-0.802	-0.054	-0.408
	Sig. (2-tailed)	0.452	1.000	0.119	0.028	0.030	0.908	0.363
	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).

Significant trend where p<0.05.

Appendix Table E.25: Summary of seasonal trends for station DS-18 from 2003-2014.

Season	Spearman's rho	Ba	Hardness	Fe	pH	Ra	Sulphate	U
January	Correlation Coefficient	0.126		0.250	-0.808	-0.162	0.536	0.270
	Sig. (2-tailed)	0.788		0.589	0.028	0.728	0.215	0.558
	N	7		7	7	7	7	7
February	Correlation Coefficient	0.444	0.900	0.406	0.108	0.444	0.561	0.341
	Sig. (2-tailed)	0.148	0.037	0.190	0.739	0.149	0.058	0.278
	N	12	5	12	12	12	12	12
March	Correlation Coefficient	0.143		0.619	-0.533	-0.310	0.286	0.036
	Sig. (2-tailed)	0.736		0.102	0.173	0.456	0.493	0.933
	N	8		8	8	8	8	8
April	Correlation Coefficient	-0.143		0.595	-0.516	-0.299	0.143	0.071
	Sig. (2-tailed)	0.736		0.120	0.191	0.471	0.736	0.867
	N	8		8	8	8	8	8
May	Correlation Coefficient	-0.018	-0.900	0.154	-0.551	-0.369	-0.273	-0.479
	Sig. (2-tailed)	0.957	0.037	0.632	0.063	0.238	0.391	0.115
	N	12	5	12	12	12	12	12
June	Correlation Coefficient	-0.107		0.107	0.020	-0.837	-0.464	-0.450
	Sig. (2-tailed)	0.819		0.819	0.967	0.019	0.294	0.310
	N	7		7	7	7	7	7
July	Correlation Coefficient	-0.143		-0.357	-0.808	-0.937	0.000	-0.107
	Sig. (2-tailed)	0.760		0.432	0.028	0.002	1.000	0.819
	N	7		7	7	7	7	7
August	Correlation Coefficient	0.145	-0.700	-0.182	-0.190	-0.608	0.088	0.06
	Sig. (2-tailed)	0.653	0.188	0.571	0.553	0.036	0.787	0.854
	N	12	5	12	12	12	12	12
September	Correlation Coefficient	0.225		-0.162	0.018	-0.811	-0.429	-0.252
	Sig. (2-tailed)	0.628		0.728	0.969	0.027	0.337	0.585
	N	7		7	7	7	7	7
October	Correlation Coefficient	-0.414		-0.018	-0.661	-0.679	-0.786	-0.500
	Sig. (2-tailed)	0.355		0.969	0.106	0.094	0.036	0.253
	N	7		7	7	7	7	7
November	Correlation Coefficient	0.499	-0.900	0.535	0.211	-0.091	-0.310	-0.138
	Sig. (2-tailed)	0.099	0.037	0.073	0.511	0.779	0.326	0.67
	N	12	5	12	12	12	12	12
December	Correlation Coefficient	0.252		0.342	-0.771	0.500	-0.321	-0.200
	Sig. (2-tailed)	0.585		0.452	0.042	0.253	0.482	0.667
	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).

[grey box] Significant trend where p<0.05.

Appendix Table E.26: Summary of seasonal trends for station M-01 from 2003-2014.

Season	Spearman's rho	Ba	Hardness	Fe	pH	Ra	Sulphate	U
January	Correlation Coefficient	-0.703		-0.679	0.182	-0.396	-0.571	-0.288
	Sig. (2-tailed)	0.078		0.094	0.696	0.379	0.180	0.531
	N	7		7	7	7	7	7
February	Correlation Coefficient	0.172		-0.329	0.393	-0.511	-0.877	-0.482
	Sig. (2-tailed)	0.593		0.297	0.206	0.089	0.000	0.113
	N	12		12	12	12	12	12
March	Correlation Coefficient	-0.126		-0.571	0.180	-0.847	-0.746	0.500
	Sig. (2-tailed)	0.788		0.180	0.699	0.016	0.054	0.253
	N	7		7	7	7	7	7
April	Correlation Coefficient	-0.054		-0.714	0.524	-0.631	0.036	0.143
	Sig. (2-tailed)	0.908		0.071	0.227	0.129	0.939	0.760
	N	7		7	7	7	7	7
May	Correlation Coefficient	0.105		0.319	0.350	-0.379	-0.804	0.169
	Sig. (2-tailed)	0.759		0.339	0.292	0.250	0.003	0.619
	N	11		11	11	11	11	11
July	Correlation Coefficient	-0.300		0.600	-0.100	-0.700	-0.800	0.600
	Sig. (2-tailed)	0.624		0.285	0.873	0.188	0.104	0.285
	N	5		5	5	5	5	5
August	Correlation Coefficient	-0.350		-0.300	-0.220	-0.762	0.393	-0.700
	Sig. (2-tailed)	0.356		0.433	0.569	0.017	0.295	0.036
	N	9		9	9	9	9	9
October	Correlation Coefficient	-0.030		0.200	0.370	-0.657	-0.429	0.029
	Sig. (2-tailed)	0.954		0.704	0.470	0.156	0.397	0.957
	N	6		6	6	6	6	6
November	Correlation Coefficient	-0.162		-0.196	0.316	-0.683	-0.571	-0.300
	Sig. (2-tailed)	0.615		0.542	0.316	0.014	0.053	0.343
	N	12		12	12	12	12	12
December	Correlation Coefficient	-0.250		0.071	-0.200	-0.214	-0.464	-0.786
	Sig. (2-tailed)	0.589		0.879	0.667	0.645	0.294	0.036
	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).

Significant trend where p<0.05.

Appendix Table E.27: Summary of seasonal trends for station SC-01 from 2003-2014.

Season	Spearman's rho	Ba	Hardness	Fe	pH	Ra	Sulphate	U
November	Correlation Coefficient	-0.235	-0.775		0.287	-0.689	-0.904	.
	Sig. (2-tailed)	0.543	0.014		0.454	0.040	0.001	.
	N	9	9		9	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).

[shaded box] Significant trend where $p<0.05$.

Appendix Table E.28: Summary of seasonal trends for station Q-09 from 2003-2014.

Season	Spearman's rho	Ba	Hardness	Fe	Mn	pH	Ra	Sulphate	U
January	Correlation Coefficient	-0.450				0.019	-0.464	-0.286	-0.179
	Sig. (2-tailed)	0.310				0.968	0.294	0.535	0.702
	N	7				7	7	7	7
February	Correlation Coefficient	-0.063	-0.600			-0.192	-0.214	-0.382	-0.617
	Sig. (2-tailed)	0.846	0.285			0.550	0.503	0.221	0.032
	N	12	5			12	12	12	12
March	Correlation Coefficient	-0.491				-0.184	-0.071	-0.750	-0.607
	Sig. (2-tailed)	0.263				0.694	0.879	0.052	0.148
	N	7				7	7	7	7
April	Correlation Coefficient	-0.571				0.468	0.607	-0.429	-0.107
	Sig. (2-tailed)	0.180				0.290	0.148	0.337	0.819
	N	7				7	7	7	7
May	Correlation Coefficient	-0.399	-0.900			-0.233	-0.501	-0.378	-0.559
	Sig. (2-tailed)	0.199	0.037			0.467	0.097	0.225	0.059
	N	12	5			12	12	12	12
June	Correlation Coefficient	-0.357				0.038	-0.771	0.048	-0.455
	Sig. (2-tailed)	0.432				0.929	0.025	0.911	0.257
	N	7				8	8	8	8
July	Correlation Coefficient	0.179				0.327	-0.306	-0.750	0.007
	Sig. (2-tailed)	0.702				0.474	0.504	0.052	0.983
	N	7				7	7	7	12
August	Correlation Coefficient	-0.280	-0.400			0.121	0.000	-0.734	-0.524
	Sig. (2-tailed)	0.379	0.505			0.707	1.000	0.007	0.080
	N	12	5			12	12	12	12
September	Correlation Coefficient	-0.071				0.741	0.500	-0.429	-0.342
	Sig. (2-tailed)	0.879				0.057	0.253	0.337	0.452
	N	7				7	7	7	7
October	Correlation Coefficient	0.607				-0.327	-0.036	0.643	0.714
	Sig. (2-tailed)	0.148				0.474	0.939	0.119	0.071
	N	7				7	7	7	7
November	Correlation Coefficient	-0.340	-0.600			0.068	-0.683	-0.564	-0.538
	Sig. (2-tailed)	0.279	0.285			0.835	0.014	0.056	0.071
	N	12	5			12	12	12	12
December	Correlation Coefficient	0.393				0.018	-0.107	0.857	-1.000
	Sig. (2-tailed)	0.383				0.969	0.819	0.014	1.000
	N	7				7	7	7	2

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).

Significant trend where p<0.05.

Appendix Table E.29: Summary of seasonal trends for station Q-20 from 2003-2014.

Season	Spearman's rho	Ba	Hardness	pH	Ra	Sulphate	U
November	Correlation Coefficient	-0.154		0.353	0.034	-0.802	.
	Sig. (2-tailed)	0.770		0.492	0.949	0.055	.
	N	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).

Significant trend where p<0.05.

Appendix Table E.30: Summary of seasonal trends for station SR-01 from 2003-2014.

Season	Spearman's rho	Ba	Hardness	pH	Ra	Sulphate	U
November	Correlation Coefficient	-0.554		0.131	-0.820	-0.950	-0.598
	Sig. (2-tailed)	0.121		0.737	0.007	0.000	0.089
	N	9		9	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).

[grey box] Significant trend where p<0.05.

Appendix Table E.31: Summary of seasonal trends for station SR-06 from 2003-2014.

Season	Spearman's rho	Ba	Hardness	pH	Ra	Sulphate	U
May	Correlation Coefficient	0.972		0.170	0.315	-0.949	-0.900
	Sig. (2-tailed)	0.000		0.598	0.319	0.000	0.000
	N	12		12	12	12	12
November	Correlation Coefficient	0.982		0.267	0.651	-1.000	-0.848
	Sig. (2-tailed)	0.000		0.428	0.030	0.000	0.001
	N	11		11	11	11	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).

[grey box] Significant trend where p<0.05.

Appendix Table E.32: Summary of seasonal trends for station SR-08 from 2003-2014.

Season	Spearman's rho	Ba	Hardness	pH	Ra	Sulphate	U
January	Correlation Coefficient	-0.685		0.109	-0.786	0.054	-0.436
	Sig. (2-tailed)	0.090		0.816	0.036	0.908	0.328
	N	7		7	7	7	7
February	Correlation Coefficient	-0.140	-0.821	0.473	-0.483	-0.210	-0.471
	Sig. (2-tailed)	0.664	0.089	0.121	0.111	0.512	0.122
	N	12	5	12	12	12	12
March	Correlation Coefficient	-0.185		-0.217	-0.786	-0.408	-0.165
	Sig. (2-tailed)	0.691		0.641	0.036	0.364	0.723
	N	7		7	7	7	7
April	Correlation Coefficient	-0.429		0.655	-0.643	0.643	0.234
	Sig. (2-tailed)	0.337		0.111	0.119	0.119	0.613
	N	7		7	7	7	7
May	Correlation Coefficient	-0.411	-0.800	-0.154	-0.870	-0.600	-0.683
	Sig. (2-tailed)	0.185	0.104	0.634	0.000	0.039	0.014
	N	12	5	12	12	12	12
June	Correlation Coefficient	-0.286		-0.631	-0.321	-0.198	-0.852
	Sig. (2-tailed)	0.535		0.129	0.482	0.670	0.015
	N	7		7	7	7	7
July	Correlation Coefficient	-0.179		0.131	-0.893	0.072	-0.546
	Sig. (2-tailed)	0.702		0.780	0.007	0.878	0.205
	N	7		7	7	7	7
August	Correlation Coefficient	-0.818	-0.900	0.457	-0.715	-0.608	-0.779
	Sig. (2-tailed)	0.001	0.037	0.135	0.009	0.036	0.003
	N	12	5	12	12	12	12
September	Correlation Coefficient	0.018		0.180	-0.714	-0.371	-0.714
	Sig. (2-tailed)	0.969		0.699	0.071	0.413	0.071
	N	7		7	7	7	7
October	Correlation Coefficient	-0.036		-0.134	-0.643	-0.342	-0.613
	Sig. (2-tailed)	0.939		0.775	0.119	0.452	0.144
	N	7		7	7	7	7
November	Correlation Coefficient	-0.612	-1.000	0.123	-0.888	-0.642	-0.863
	Sig. (2-tailed)	0.035	0.000	0.702	0.000	0.024	0.000
	N	12	5	12	12	12	12
December	Correlation Coefficient	-0.991		-0.546	-0.811	0.198	-0.786
	Sig. (2-tailed)	0.000		0.205	0.027	0.670	0.036
	N	7		7	7	7	7

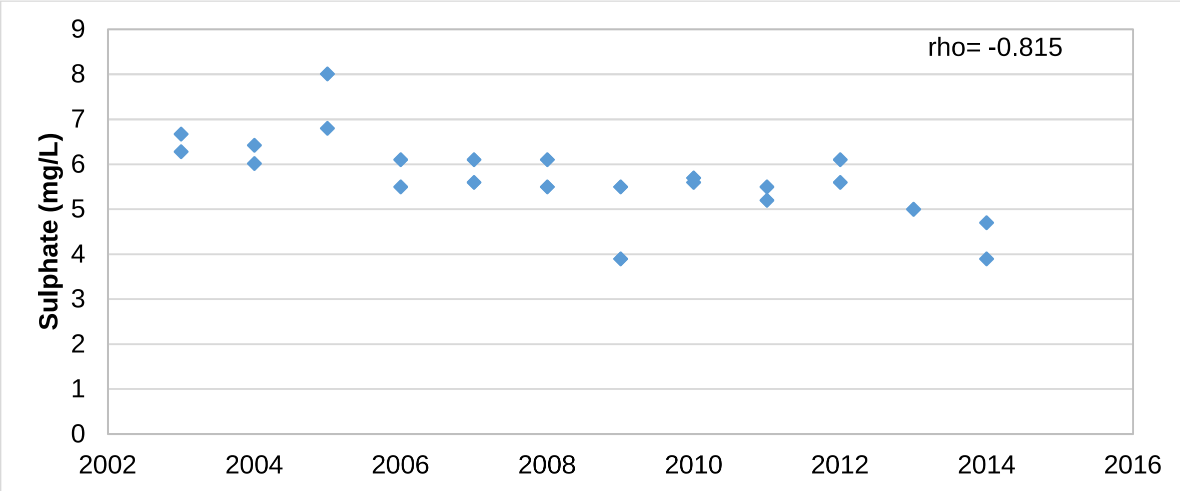
Note: p-values for n<10 where there is only one season used are based on Table of Critical Values of the Spearr
Correlation Coefficient (Zar 1984).

Significant trend where $p<0.05$.

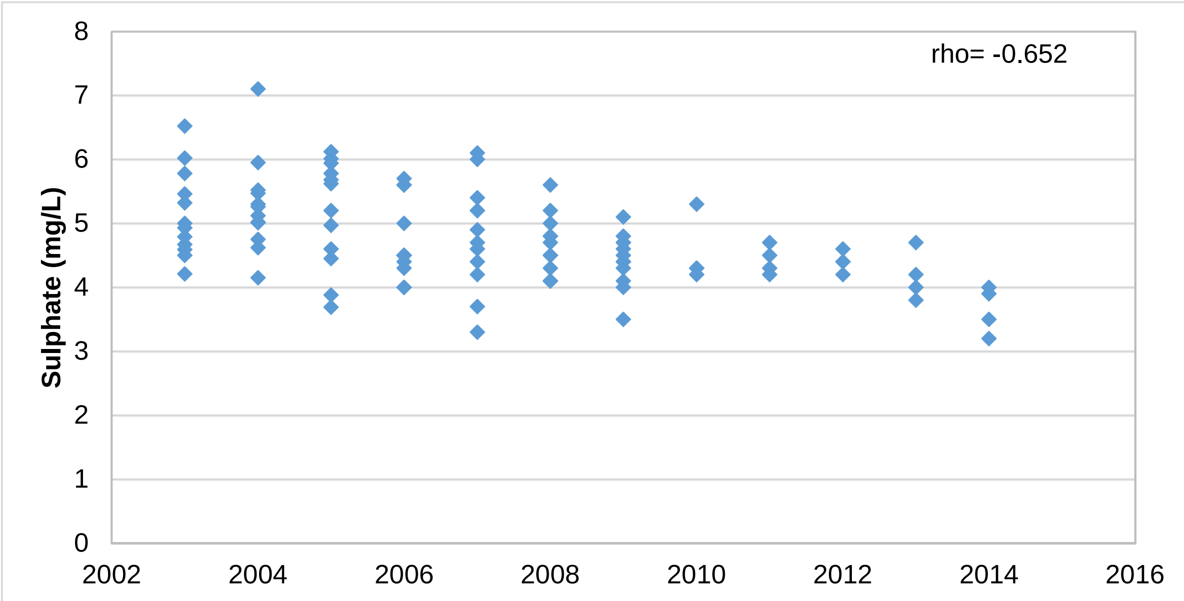
Table E.33: Mean hardness concentrations (mg/L) at SRWMP stations 2010 to 2014 and resulting BCMOE sulphate and manganese guidelines.

Station Type		Location	Mean Hardness (mg/L)	BCMOE Sulphate[a] Guideline	BCMOE Manganese[b] Guideline
Reference	Lake	D-4	10.2	128	0.7
		SR-18	11.9		
		SR-19	17.6		
	Wetland	SR-16	8.2		
		SR-17	10.5		
Mine-exposed		D-5	28.1	128	NA
		D-6	68.6	309	0.8
		DS-18	128.4	309	NA
		M-01	41.6	218	NA
		Q-09	67.8	218	NA
		Q-20	38.9	218	NA
		SC-01	35.8	218	NA
		SR-01	51.5	218	NA
		SR-06	84.6	309	NA
		SR-08	213.9	429	NA

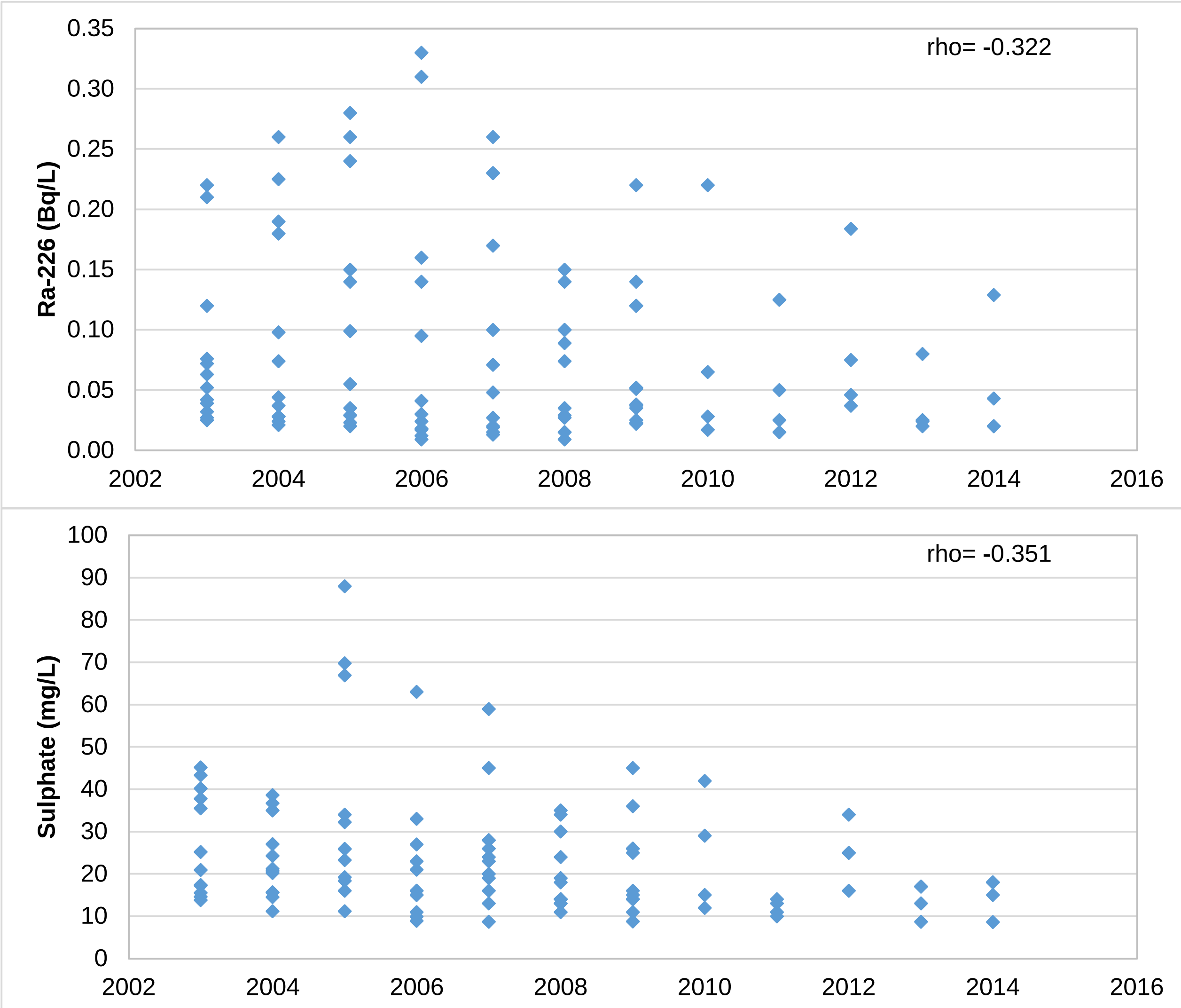
[a] BCMOE 2013.
[b] BCMOE 2006.
NA - not applicable.



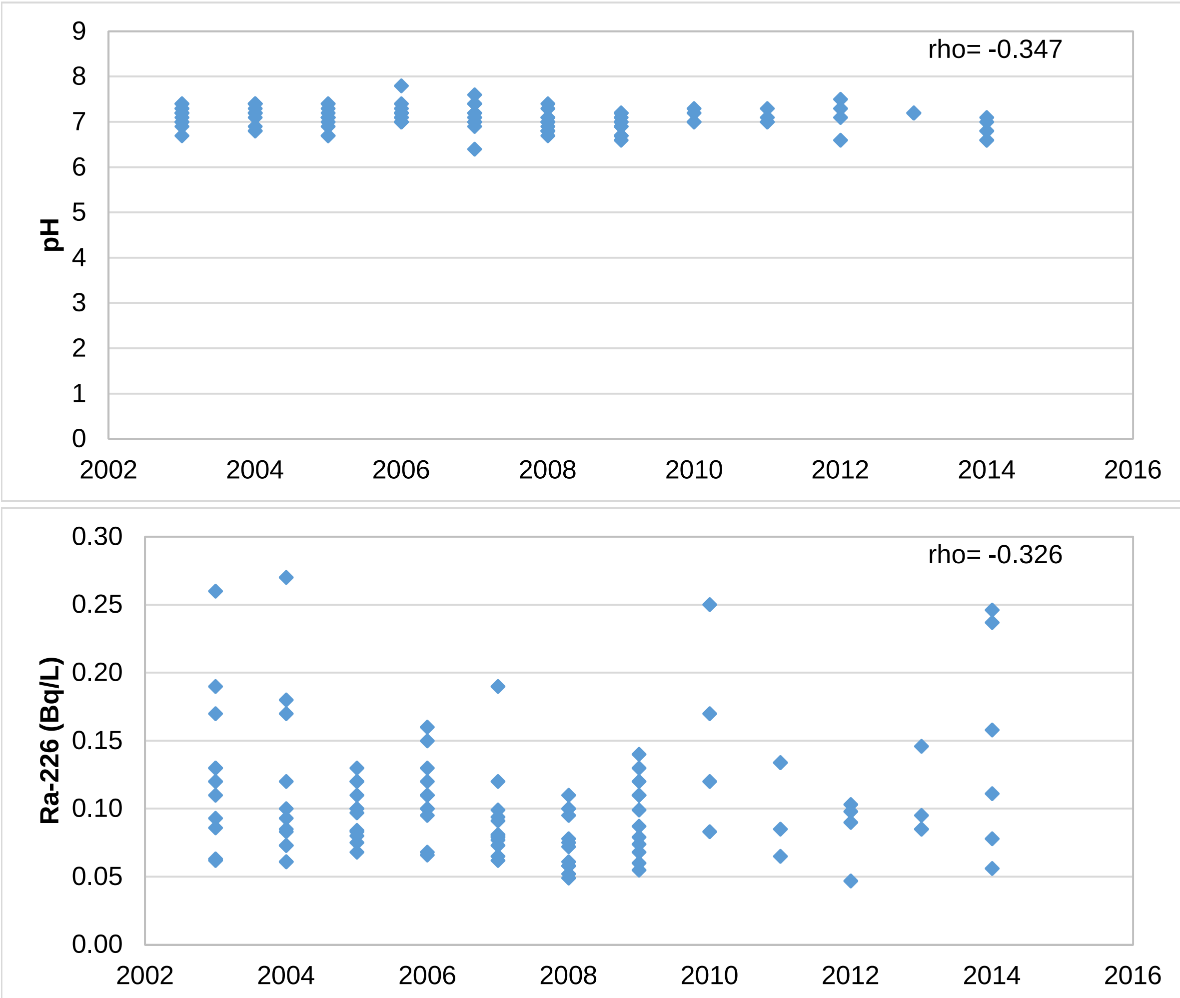
Appendix Figure E.1: Significant common (average) trends observed for sulphate over all seasons at Station SR-18, 2003 to 2014.



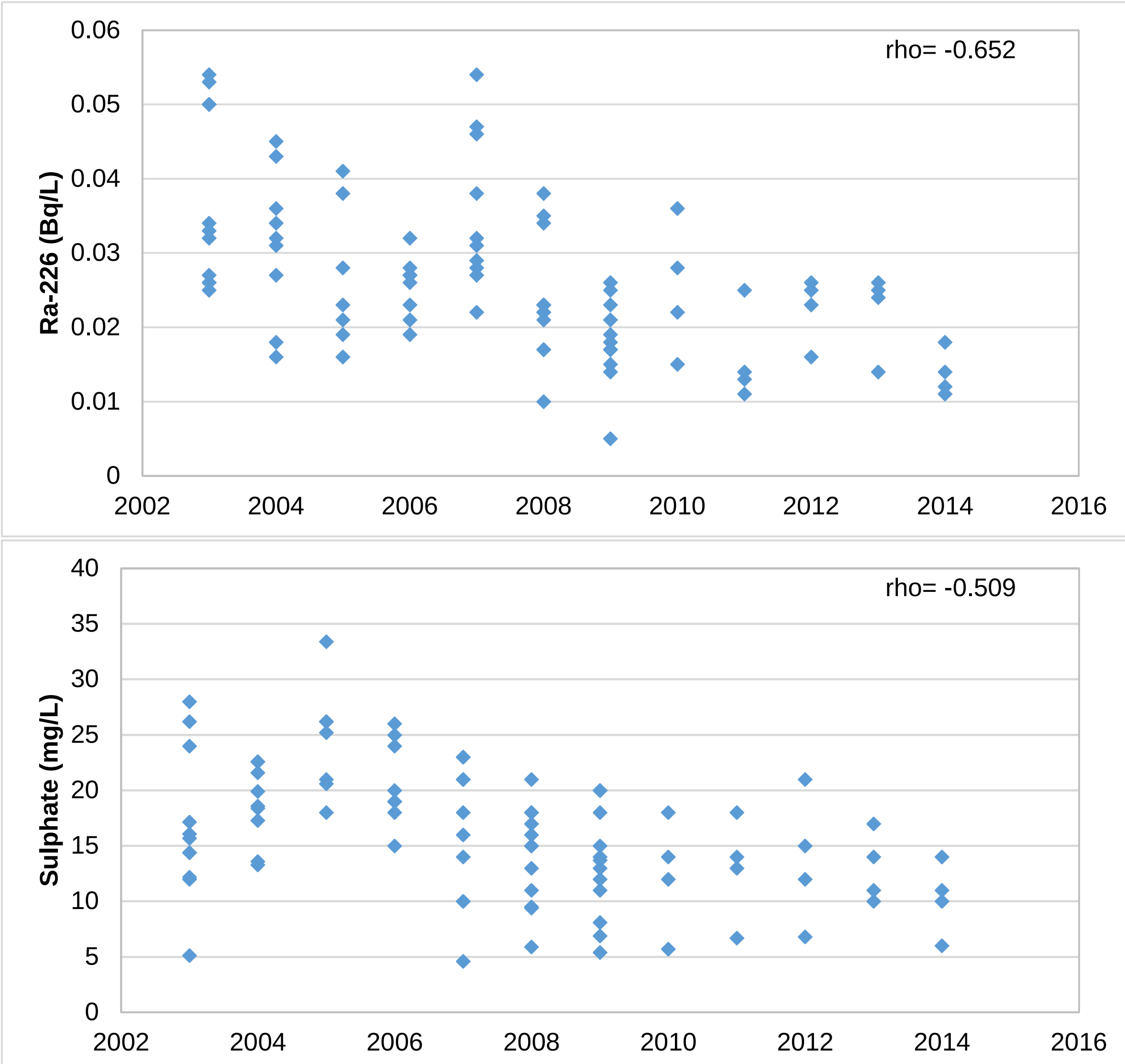
Appendix Figure E.2: Significant common (average) trends observed for sulphate over all seasons at Station SR-19, 2003 to 2014.



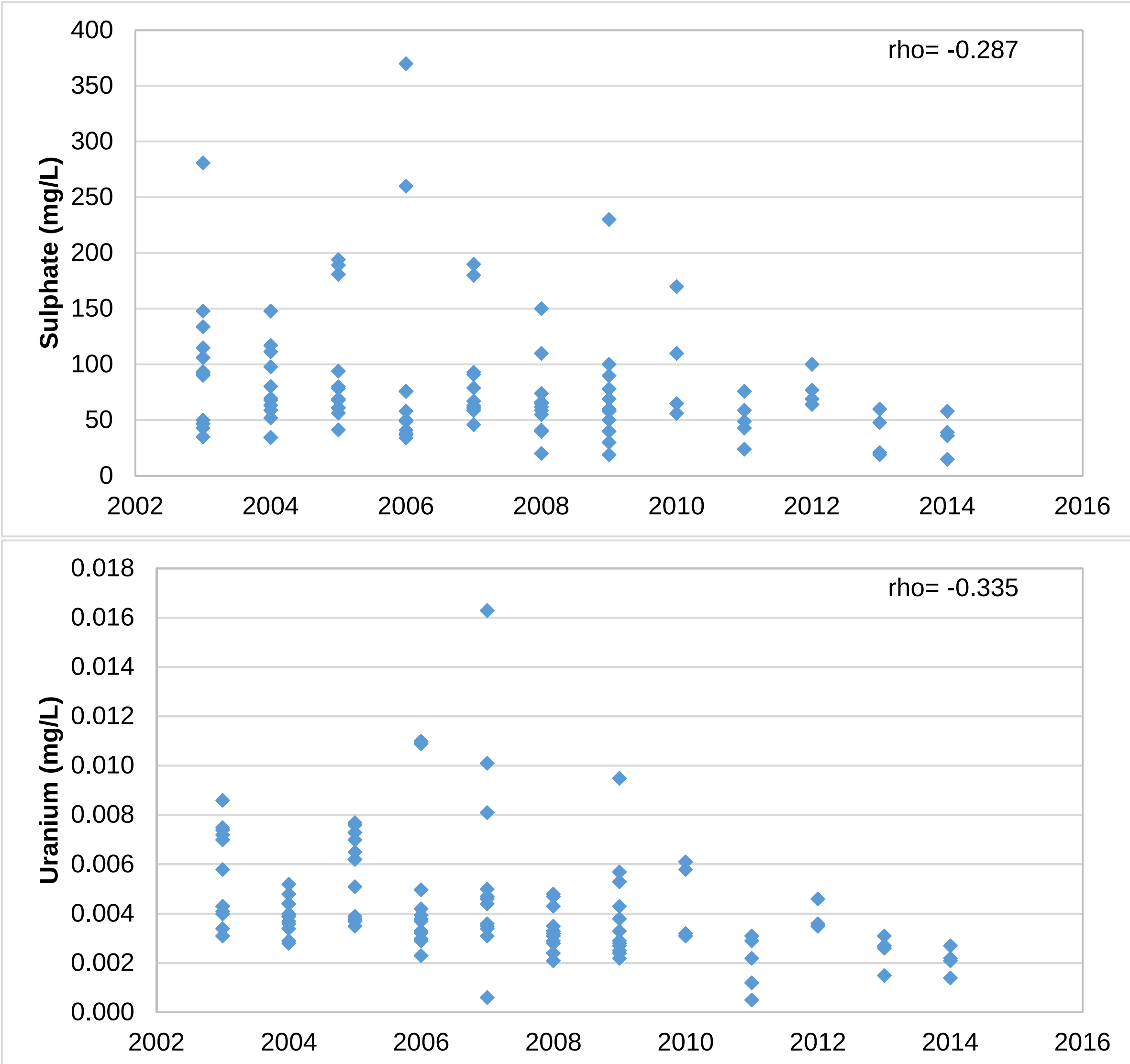
Appendix Figure E.3: Significant common (average) trends observed for radium-226 and sulphate over all seasons at Station D-5, 2003 to 2014.



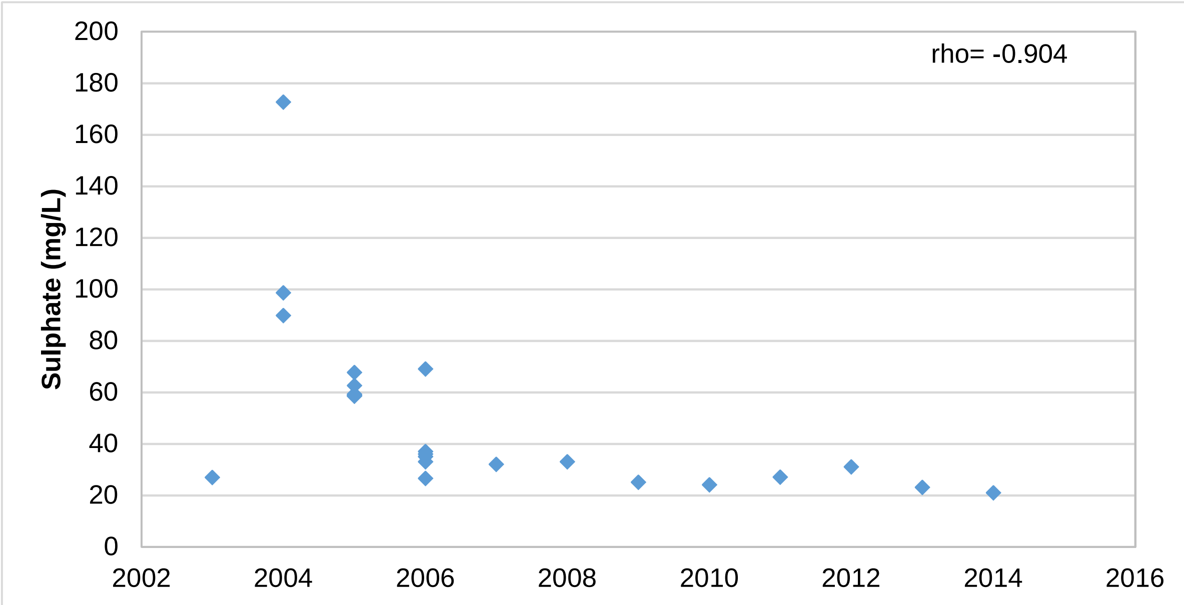
Appendix Figure E.4: Significant common (average) trends observed for pH and radium-226 over all seasons at Station DS-18, 2003 to 2014.



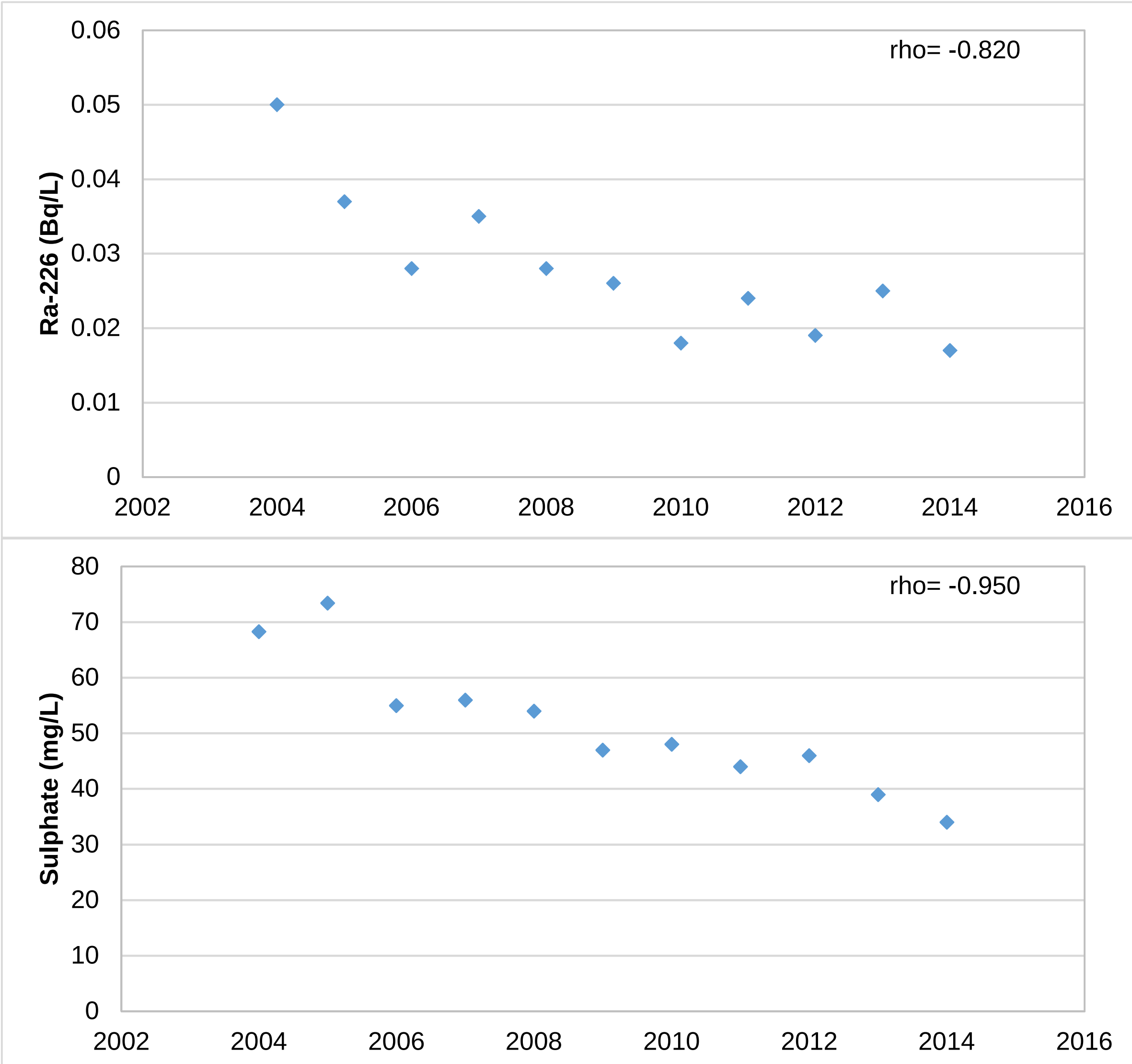
Appendix Figure E.5: Significant common (average) trends observed for radium-226 and sulphate over all seasons at Station M-01, 2003 to 2014.



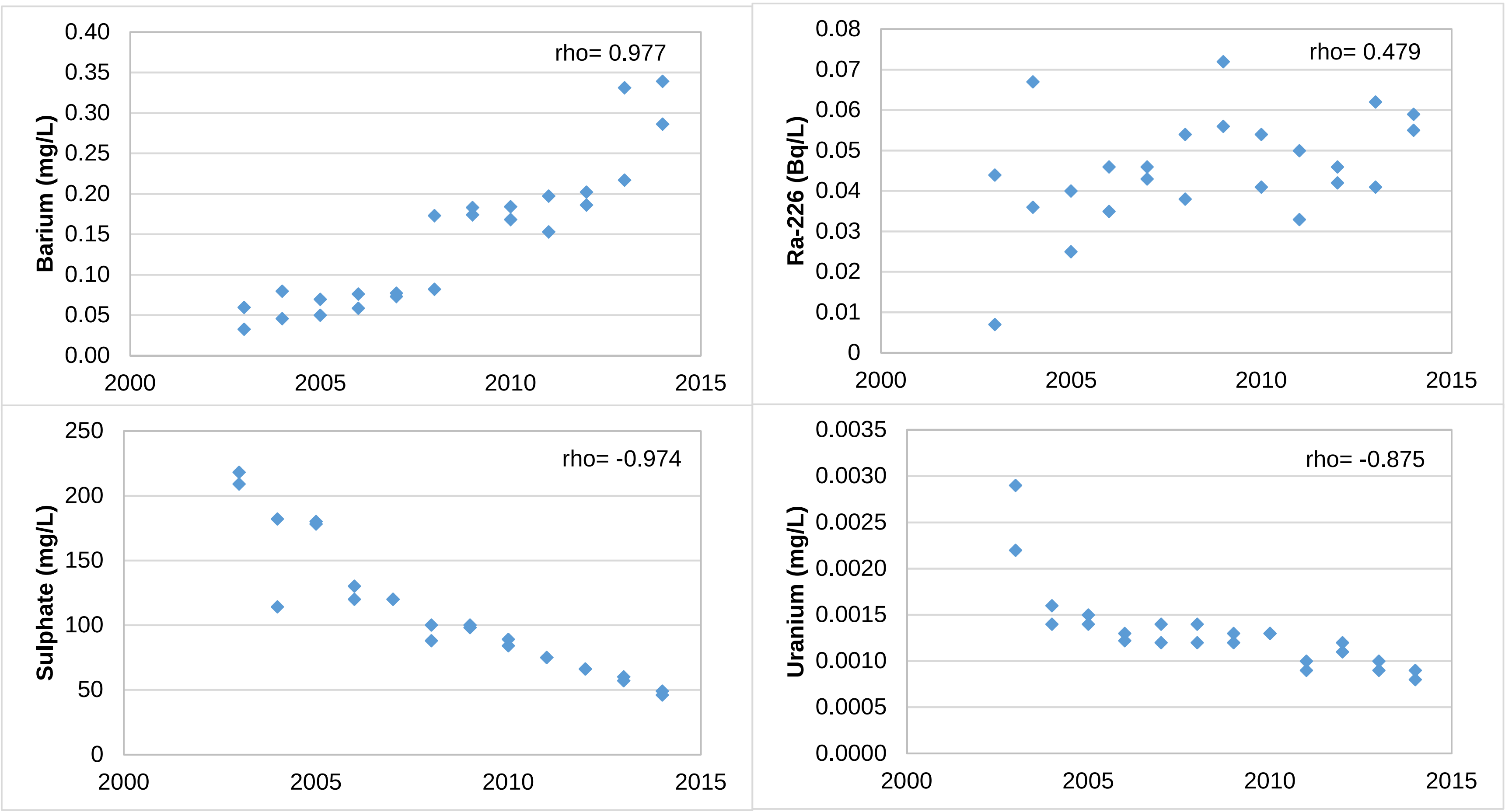
Appendix Figure E.6: Significant common (average) trends observed for sulphate and uranium over all seasons at Station Q-09, 2003 to 2014.



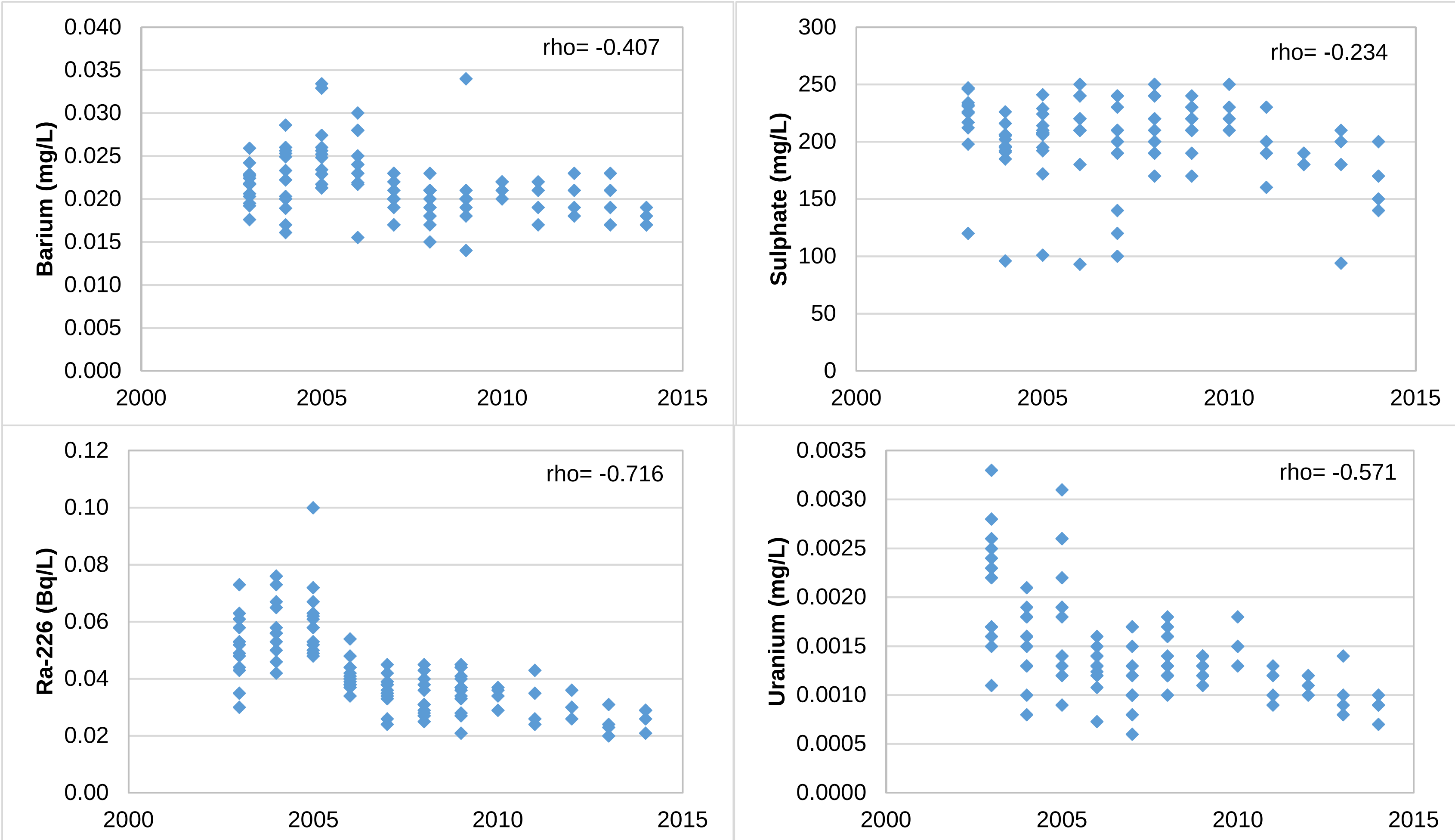
Appendix Figure E.7: Significant common (average) trends observed for sulphate over all seasons at Station SC-01, 2003 to 2014.



Appendix Figure E.8: Significant common (average) trends observed for radium-226 and sulphate over all seasons at Station SR-01, 2003 to 2014.



Appendix Figure E.9: Significant common (average) trends observed for barium, radium-226, sulphate and uranium over all seasons at Station SR-06, 2003 to 2014.



Appendix Figure E.10: Significant common (average) trends observed for barium, radium-226, sulphate and uranium over all seasons at Station SR-08, 2003 to 2014.

APPENDIX F
AGENCY COMMENT AND LICENSEE RESPONSES

Directorate of Nuclear Cycle
and Facilities Regulation

File No: 2.05
e-Doc 5363916

Telephone: (613) 995-6535
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October 16, 2017

Debbie Berthelot
Site Manager
Canadian Sites, BHP Billiton
PO Box 38,
Elliot Lake, ON, P5A 2J6

Subject: CNSC review of licensee responses to comments from CNSC staff on the Serpent River Watershed State of the Environment Report (2016)

Dear Ms. Berthelot,

CNSC staff have completed their review of the responses that Rio Algom Limited and Denison Mines Inc. provided concerning the Serpent River Watershed State of the Environment Report (SOE report 2016). CNSC staff have concluded that the SOE report 2016 has satisfied the objectives of the report and has met CNSC expectations for environmental protection; no further information for the SOE report 2016 is required. CNSC staff have provided several comments that should be addressed for the next SOE report in the attached table; all other responses were noted and considered acceptable.

If you have any questions, please contact me by phone 613-995-6535 or by email at karina.lange@canada.ca.

Yours sincerely,

K. L

Karina Lange
Senior Project Officer
Wastes and Decommissioning Division

cc: Karine Glenn (CNSC)

CNSC staff disposition of licensee responses for the Serpent River Watershed SOE Report 2016*

*CNSC staff have additional comments on responses 2, 4, 5, 7, 8, 9, 12; all other responses were noted and found to be acceptable.

#	CNSC Comment	Licensee Response	CNSC Response to Licensee
2	The information presented in the report identified increasing 226Ra, and exceedance of action level during the 5 year reporting period (on December 3, 2013 but also in 2008 and 2009 as documented in e-doc 4951484 (Recommencement of Pilot Testing of Ferric Sulfate Addition at Stanleigh Effluent Treatment plant)) at the Stanleigh TMA final point of control for discharge (CL-06). Also, increasing 226Ra was observed at Denison TMA-1. Increasing barium concentration trends were observed at the primary discharge locations (D-2, D-3, Q-28 and CL-06). The potential risk of this increasing of concentrations and loadings of Ra-226 and barium should be evaluated by licensees, even in all cases barium concentrations in discharges were below toxicity thresholds as explained in the report. Expectation to address comment: Licensee is expected to conduct a detailed investigation on those findings and ensure the effluent control and mitigation measures are effective; receiving environment, aquatic life and human health are protected.	To be clear, radium-226 is not increasing within the TMAs. Trend analysis showed decreasing or stable trends in all TMAs with the exception of Denison TMA-1 (TMA-2 was decreasing over time). The radium-226 and barium trend at Denison TMA-1 appears to be associated with a step change in 2008 (Appendix Figure C.1.1 in SOE) and is thought to be caused by decreasing sulphate concentrations in the TMA (now at 100 mg/L or lower), resulting in the dissolution of barium or calcium sulphate compounds with which radium-226 is associated, whereby radium-226 and barium are released from the tailings. It is expected that radium-226 concentrations in porewater will stabilize over time once the dissolution of sulphate compounds re-equilibrates with aqueous sulphate concentrations (see response to comment 8). Effluent concentrations of radium-226 were found to be stable or decreasing at all TMAs except for Stanleigh where periodically effluent treatment efficiency has been reduced likely due to a change in influent chemistry causing concentrations to exceed action levels (i.e. the issue is confined to Stanleigh TMA). This has resulted in increasing trends in radium-226 and barium in Stanleigh TMA effluent (CL-06; Table 4.3 in the SOE) and downstream at the outlet of McCabe Lake (SR-06; Table 5.4 in the SOE). Rio Algom has initiated a special investigation to determine the factors influencing radium concentrations in effluent at the Stanleigh Mine. It is important to note that radium-226 concentrations are decreasing in the Stanleigh basin (influent). It is expected that the	Partially acceptable. With respect to controlling Ra-226 at Stanleigh, CNSC will continue to monitor Rio Algom's review and improvements to water treatment to ensure effective removal of Ra-226. It is noted that Rio Algom is currently undergoing testing related to Ra-226 removal at Stanleigh (Fall 2017).

		periodic increase in effluent radium concentrations is due to some change in the speciation of influent chemistry which influences treatment efficiency. Initial phases of this investigation at Stanleigh suggest no influence of anoxia on radium release. The second phase of this investigation will focus on the potential role of iron and associated oxyhydroxides and/or organic carbon on the speciation of radium and the influence on treatment efficiency. This study will examine radium associated with colloids (possibly iron colloids) at specific times in the discharge season. While concentrations of radium-226 and barium are still below the water quality benchmarks in McCabe Lake, additional downstream monitoring (May Lake) has been added to the SRWMP consistent with the commitments made in the Study Design. The outlet of May Lake (SR-15) was removed from the program in 2009 as part of the Cycle 3 Study Design based on the water quality achieving benchmarks and the performance of the upstream mines. With the increasing trends at Stanleigh, the outlet of May Lake was added back into the program as of June 2016. As noted above, water quality downstream continues to achieve water quality benchmarks established for the SRWMP which are based on guidelines for the protection of fish and aquatic life or background whichever is higher.	
4	In table 1, the description of changes to the monitoring programs to remove shallow lakes from the sediment and benthic sampling program (Westner, Halfmoon and Horne lakes) and the reduction in benthic and sediment sampling to 1/10 years based on measured deposition rates need to be re-reviewed, and may need to be re-instated according to the original	With respect to the change in sediment and benthic sampling frequency, the SRWMP was designed to monitor at a frequency that the system could demonstrate change. Initially, sediment monitoring was based on operational deposition rates measured at 2 mm/yr. However, the lack of observed change in sediment concentrations over time caused the licensees to question the original assumptions of sediment deposition rates downstream of the mines. This issue was outlined in the	Response is acceptable. For the next SOE report, the licensee is expected to consider the trends for Ra-226 at Halfmoon Lake in evaluating whether further benthic sampling is required in Halfmoon Lake.

	monitoring program design. The prior removal of stations and sampling frequency reduction was based on limited monitoring data relative to the need for long-term performance monitoring. Expectation to address comment: Sediment and benthic community sampling in Halfmoon lake and within the Serpent River (downstream of the Denison and Quirke tailings management facilities, but upstream of Quirke) should be re-instated, especially in light of increased radium. Proposed changes to monitoring station locations, measured parameters, and sampling frequency should be based on a thorough review of available monitoring data and comparison with modeled predictions.	recommendations in the Cycle 3 SOE report (Minnow 2011). The CNSC staff acknowledged that the deposition rates may be lower than expected and indicated that if the licensees could determine the deposition rates, then the CNSC would be open to reducing the monitoring frequency. A two year study was completed and provided to the CNSC for review. The study was conducted in 2011 and 2012 to investigate sediment deposition rates. Three near-field receiving lakes that have been the most influenced by historical mining activities were selected for the study (McCabe Lake, Quirke Lake, and Nordic Lake). Sediment deposition rates were determined using two approaches: sediment traps to assess the current sedimentation rate and fresh sediment quality, and sediment core profiling to investigate historical sediment quality and to determine how deposition rates changed over time relative to periods of historical mining activity within each lake. (Response continued in licensee submission Ref [1]).	
5	The data presented in the 5 year SOE is limited and inconsistent, making it difficult to review the geochemistry, and verify statements about the improvements in the watershed. The data presented in the document are typically amalgamated in some way, having been subject to statistical analyses and presented as general trends that are referred to in the text and the trends presented in tables. Time series graphs of effluent concentrations are included for one or a few sites at each TMA (e.g., D-1, 2, and 3 but not D-22 or D-25 (for the Denison site)). The only data for D-22 or D-25 is significant common trends which do not display the same information as	The Cycle 4 SOE report integrates the findings of three monitoring programs at 11 TMAs over a five year time period so the data must be amalgamated for effective presentation. The time series graphs are of influent and are used to demonstrate influent concentrations relative to EIS predictions. For the substances with predicted concentrations (sulphate, pH, radium-226 and uranium) some data is available back to 1990 but others are only available from the inception of SAMP in 2003. Stations D-2 and D-3 are in both the TOMP and SAMP programs and so the trends for these stations are presented in the SAMP section (Table 4.2). The trends for groundwater are presented in Table 3.4. The remaining TOMP trends are presented in Table 3.3. The TOMP trends are generally assessed from the	The response is acceptable. Nonetheless, efforts should be made to make the presentation of data and its treatment as transparent as possible. For example, when trends are plotted a reference to where the raw data may be found should always be included.

	effluent concentrations. In the appendices, raw data is only provided for D-1, 22, and 25 but not for D-2, D-3. In Appendix Figure D.3.6 the graph for Ra is missing despite the apparent increase in Ra over time observed in Figure 3.20. This inconsistent presentation of data occurs in other sections throughout the report and many stations have different types of effluent concentration graphs, trend analysis graphs and raw data presented.	inception of the program 2003 to present (2014). Any significant trends are graphed over time and presented in Appendix C and the figure numbers are listed in the footnote on the bottom of the table showing the significant trends. Please note that Figure D.3.6 is for Panel station P-14 and there is no graph for radium-226 because there was no trend for radium-226 at this station (Table 4.2 in the SOE). (Response continued in licensee submission Ref [1]).	
7	Groundwater wells BH91-D3A (0.078 Bq/L) and BH91-D3B (0.097 Bq/L), which are downgradient of Denison TMA Dam 17, appear to have elevated a concentrations. Wells BH91-D9A (0.501 Bq/L) and BH91-DG4B (0.991 Bq/L) have even higher Ra concentrations that approach the PWQO guideline. Groundwater stations BH91-D1A and BH91-D1B had Ra concentrations of 0.017 and 0.018 Bq/L respectively. These levels are taken as background in the absence of actual reference data and are substantially lower than the levels reported in D3A, D3B, D9A and DG4B. Several groundwater wells at other TMA's also appear to have elevated Ra concentrations, which is based a single value for Ra. These include: Panel: P-16A, P-20, Stanrock: BH91-SG1A, BH98-16A, BH98-15A, BH91-SG3A,B Lancor/Nordic: M-14-1,3,6,95N-4A,B; 95N-7A,B; 95N-13A,C,E; 95N-16A,C,E. The highest of these is M-14-1 which had a Ra concentration of 1.21 Bq/L. This value is higher than the Ontario PWQO. The current groundwater monitoring program appears to lack many of the key characteristics necessary to	Hydrogeological studies have been completed for Quirke; Denison; Panel; Stanleigh, Stanrock; Lacnor; Nordic and Pronto TMAs and the geology and groundwater flow has been summarized in the following documents: • Geological and Hydrogeological Assessment; Supporting Documents, Volume 2 Decommissioning Study; Denison Mine Tailings Management Areas (Golders 1992a). • Geological and Hydrogeological Assessment; Supporting Documents, Volume 2 Decommissioning Study; Stanrock Mine Tailings Management Areas (Golders 1992b). • Hydrogeological Assessments of the Effects of Quirke/Panel Mine Flooding on Regional and Local Groundwater Flow Systems, Elliot Lake Ontario (Golders 1991a). • Hydrogeological Assessment, Panel Mine Waste Management Area, Elliot Lake Ontario (Golders 1991b). • Hydrogeological Modelling of the Stanleigh Waste Management Area, Post Closure Conditions (Golders,1996).	The response is acceptable. CNSC staff agree that the basic hydrogeologic conceptual models for the TMA's should be provided in the next SOE report. In addition to this a summary explaining the history of groundwater monitoring and the results of previous studies should be included in order to provide the context necessary for a reader to interpret the results.

	adequately protect groundwater including clear objectives, the establishment of a groundwater evaluation criterion, a process to address exceedances, a robust and consistent monitoring strategy, a conceptual model and a justification for which nuclear and hazardous substances are monitored (CSA N288.7-15). Furthermore, as each well reported a single sample with Ra data (2014) it is difficult to determine conclusively if groundwater contamination trends exist. No comparison to a pre-mining or regional reference is provided and additional analytes were omitted which makes general characterization of groundwater geochemistry and the identification of temporal trends impossible. The elevated Ra in groundwater and absence of trending data justify expanding the groundwater monitoring program as these new results are not adequately understood and could lead to increased risk in the future to uses of groundwater or in groundwater discharge points (CSA N288.7-15). Expectation to address comment: The licensee should account for the absence of Ra measurements from 2010 to 2013. Furthermore, an explanation of the elevated Ra concentrations in groundwater should be provided along with data on groundwater flow, including gradients and directions. All monitoring data for groundwater should be provided as well as time series graphs of SO4, U, Ba, Fe and Ra. Pre-mining baseline and reference site groundwater data should also be provided and compared to the levels observed in the SOE. The establishment of	• Contaminant Plume Evaluation, Nordic Tailings Management Area; Elliot Lake (Golder 1982). • Cycle III Special Studies – Nordic Groundwater Assessment (EcoMetrix 2011a). • Long-Term Management and Decommissioning Overview, Pronto Waste Management Area, Elliot Lake (Golder 1997). • Long-Term Management and Decommissioning Overview, Lacnor Waste Management Area, Elliot Lake (Golder 1998a). • Long-Term Management and Decommissioning Overview, Nordic Waste Management Area, Elliot Lake (Golder 1998b). These documents form the basis for the current groundwater monitoring program. The key finding of all of these assessments is that groundwater from the TMAs reports to local surface water bodies. These downstream water bodies are monitored and assessed as part of the SRWMP. In the case of Quirke and Panel TMAs, groundwater will first flow towards the underground workings and fill these voids before reporting to surface water. The Panel Mine underground workings are still in the process of being flooded. With respect to Nordic TMA, a recent assessment (EcoMetrix 2011) indicated that remediation work on the effluent collection ditch (ECD) conducted in 1997 has resulted in the ECD capturing all groundwater migrating from the TMA. Therefore, groundwater is either contained within the TMA or is reporting to surface water which is monitored as part of the SRWMP. The current groundwater monitoring program is conducted under the TMA Operational Monitoring Program (TOMP) as perimeter monitoring to	

	a groundwater monitoring program that is in alignment with CSA N288.7-15 should be considered.	assess the movement of TMA-influenced water downgradient of the TMAs. The substances monitored in groundwater (acidity, pH, iron and sulphate) represent conservative mine indicator parameters and are suitable for representing mine influence in groundwater downgradient of the TMAs. Similar to surface water, groundwater trends are assessed using non-parametric statistics. Summaries of trends by well and elevation are presented for each TMA in the TOMP section of the SOE. Time series graphs are provided for all significant trends in Appendix C. Radium-226 is not monitored in groundwater but was included in 2013 as a due diligence check and as such there is no further data available for this time period. A review of radium-226 concentrations in groundwater indicates that only one value (2% of the samples) was above the Ontario PWQO of 1.0 Bq/L and 3 values (6%) were above the Health Canada drinking water guideline of 0.5 Bq/L (see Figure 4).. (Response continued in licensee submission Ref [1]).	
8	Radium is being remobilized in several sites, in recent years (Denison, Stanleigh, Panel, and Nordic) and has been a problem at other sites in the early 2000s that required attention (Quirke). The cause of increasing Ra-226 (along with Ba) is assumed by the licensee to be the dissolution of sulfate minerals (suggested in the 2011 special study – SOE 2011 Appendix G – though radium desorption from iron oxyhydroxides could not be excluded as a contributing factor), caused by the overall decreasing sulfate concentrations in the tailings pond. Once pond sulfate concentrations were low enough, sulfate minerals that were sequestering Ra-226 began	The result of increasing Ra-226 within the TMA basins was predicted (modelled) and the results were included in the Environmental Impact Statements (1993, 1995). As outlined in the original, and subsequent documents, on the basis of the UTAP.3 model, it is expected that Ra-226 is initially released through the dissolution of $CaSO_4$ (gypsum) followed by the dissolution of barite ($BaSO_4$). Barite is sparingly soluble, while gypsum is more soluble, therefore gypsum will preferentially dissolve. Porewater concentrations of sulphate will prevent barite from dissolving until sulphate concentrations are low enough (i.e., gypsum is no longer the control for sulphate dissolution) at which point Ra-226 may rise a little, but will eventually stabilize	Response is acceptable. The licensee presented CNSC staff with results of Ra-226 research in 2016 and regarding Ra-226 water treatment optimization studies in 2016 and 2017. These studies are ongoing.

	to dissolve (thus Ra-226 is either released by dissolution or desorption). The hypothesis in the report for the longer term behaviour of Ra-226, is that porewater Ra-226 values will stabilize, once the hosting sulfate minerals re-equilibrate with aqueous sulfate concentrations. This hypothesis is not substantiated by field or laboratory data or geochemical modelling, and is based solely on the concentration of SO4 and solubility of (Ra, Ba) SO4. While at Quirke, radium was found to be associated with sulfate minerals (e.g. Martin et al., 2003), sequential extraction experiments (by CNSC) showed an association between radium and iron oxyhydroxides (rather than with sulfate minerals) from tailings collected at Denison TMA1 – suggesting that other mechanisms for Ra-226 mobilization / stabilization play a role in uranium tailings in the Elliot Lake region .	(as can be observed for P-03; when sulphate concentrations decreased to less than 100 mg/L; Figure 6). In 2012, the CNSC collected sediment samples for sequential extraction from the north shore (close to Dam 9) of the Denison TMA-1. The results of the sequential extraction analysis indicate that Ra-226 is more associated with iron oxyhydroxides than with barium sulphate (the alkaline earth sulphate extraction). It should be noted that the majority of barium and sulphur are present in the residual fraction suggesting that the alkaline earth sulphate extraction was not sufficient to digest barite.. (Response continued in licensee submission Ref [1]).	
9	Page 11 Site specific radium criteria: The Provincial Water Quality Objective (PWQO) of 1 Bq of Ra-226/L is based on drinking water requirements; these were derived from dose-response relationships as recommended by the International Commission on Radiological Protection (ICRP) in Publication 26. The radium criterion is very high when compared to benchmarks derived using current science for the protection of aquatic life. For example, the current screening approach used internationally is based on the European ERICA tool framework. It recommends an ecosystem protection level of 10µGy/hr as a default objective,	With respect to the Cycle 4 SOE report, the radium-226 surface water data for the Serpent River receiving environment was compared to the Provincial Water Quality Objective (PWQO) of 1.0 Bq/L as this was the benchmark in the Cycle 4 Study Design which was approved by the CNSC and JRG members (See Appendix E of the Cycle 4 SOE Study Design). The value of the benchmark has not and will not influence the ability of the monitoring program to capture changes occurring at the Elliot Lake sites. The method detection limit used in the SAMP, TOMP and SRWMP for radium-226 in water is 0.005 Bq/L (200 x less than the PWQO). This MDL allows for concentrations to be measured over time and trend analysis to be conducted	CNSC staff accepts that the licensee conduct a review of the radium-226 benchmark to be used in the SRWMP for evaluating water quality in the receiving environment. CNSC staff understands that this review will be conducted as part of the Cycle 5 Study Design to be submitted to the CNSC and JRG in late 2018 or early 2019. The results of this review should be used to derive their own site-specific water

	with appropriate calculations to determine corresponding limits for concentrations of radionuclides in water or sediments. ERICA also provides a set of default transfer parameters for representative aquatic organisms. Using default parameters, one can derive an Environmental Media Concentration Limit of ~ 0.001 Bq/L for Ra-226 in freshwater (ERICA tool help file listings, with insect larvae as the limiting reference organism; note this is for Ra-226 dose on its own, ignoring parent and daughter U-238/235 decay chain nuclides that would make any hypothetical screening concentration lower). The selection of site specific criteria should also be meaningful for the sampled location. For example, the Nuclear Waste Management Organization Interim Acceptance criteria for surface water in the context of a Deep Geological Repository is 0.0006 Bq for Ra-226/L. Considering that radium levels in unaffected areas of the Serpent River Watershed are less than 0.005 Bq/L, the Ontario Provincial Water Quality Objective used to assess the water quality downstream of the tailings facilities is too high to capture any change occurring at the Elliot Lake sites. Expectation to address comment: CNSC staff recommend that the licensee derive site-specific radium water quality objectives for the protection of aquatic life, to provide realistic limits/targets based on current science, and that can be applied to the management of radium releases	both within the basins (TMAs) and downstream. We do not support the use of the ERICA screening value (10 uGy/hr) as it is designed to screen areas for possible further assessment. Given the extensive monitoring data available and the history of the site, a screening assessment should not be the focus for a benchmark for the ongoing monitoring. The licensees will review the available information from the watershed and the scientific community to conduct a review of the radium-226 benchmark to be used in the SRWMP for evaluating water quality in the receiving environment. This review will be conducted as part of the Cycle 5 Study Design to be submitted to the CNSC and JRG in late 2018 or early 2019.	quality objective for radium.

	from TMAs in the Elliot Lake region (Comment 8).		
12	Section 6, page 50: It is indicated in the SOE that doses to human receptors will be updated as part of the next SOE report to be completed in 2020. CNSC staff expect that with the updated dose assessment, the complete methodology and all assumptions used will be provided. The CSA standard N-288.6-12 Environmental risk assessments at Class I nuclear facilities and uranium mines and mills should be followed. Expectation to address comment: In the next SOE, provide the complete methodology and all assumptions used to estimate doses to human receptors.	The Licensees will provide a complete methodology for the human dose estimates either before the next SOE Study Design or within the next SOE Study Design. An interim approach, and a preliminary design for a site-specific survey and monitoring program to support the public dose calculation, outlined by EcoMetrix (2016), will be refined as appropriate based on results of the program over the first several years.	Response is acceptable. CNSC staff notes that the licensee has committed to submit an updated dose estimate for human receptors at or before the next SOE report submission.